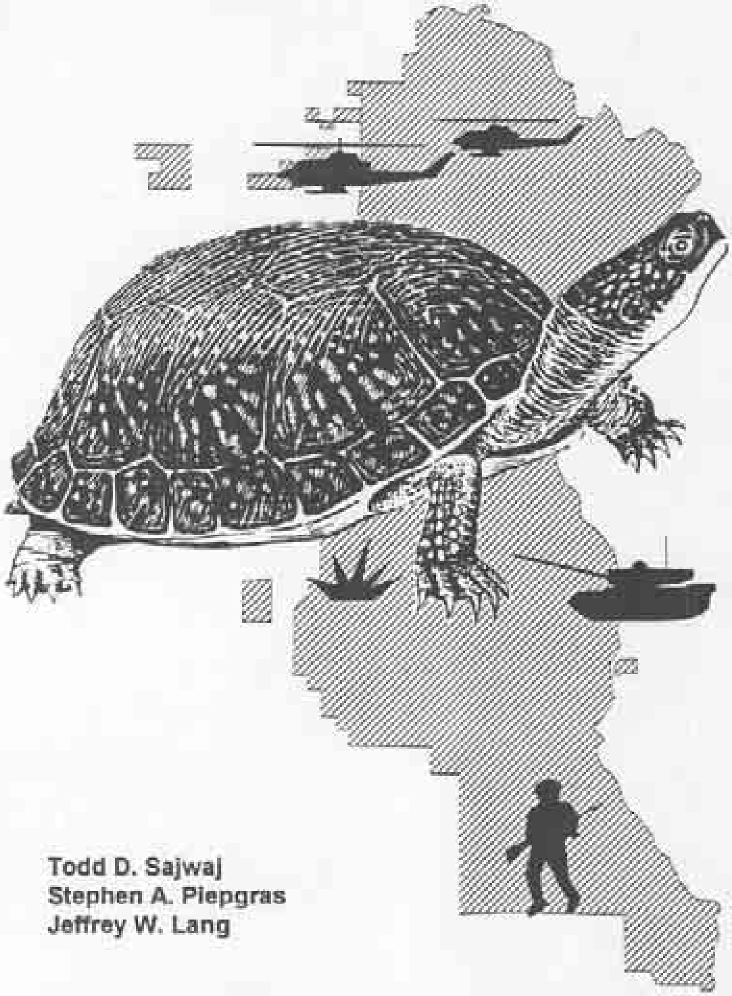
Please note that all specific location information has been removed from this document to protect the Blanding's turtle populations

Blanding's Turtle (*Emydoidea blandingii*) at Camp Ripley:

Critical habitats, population status and management guidelines



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Title: Blanding's Turtle *(Emydoidea blandingii)* at Camp Ripley: critical habitats, population status, management guidelines.

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Abstract: Recent studies in Minnesota indicate that Blanding's turtle is long-lived, reproduces over many seasons, and utilizes a mosaic of widely spaced wetlands and uplands. Effective conservation requires information about population status and detailed data on seasonal habitat use by all age/ sex classes. In this report, we provide an introduction and background on the study species, describe the study site and our study methods, present the results, and then discuss our findings in light of previous studies. Finally, we make recommendations on managing the habitats critical to the continued well being of the Blanding's turtles at Camp Ripley and surrounding areas, and on monitoring and managing the turtles, particularly in delineated areas where significant numbers of the population are known to nest, spend the summer months, and overwinter.

Table of Contents

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List of Table's .

List of Figures

1. INTRODUCTION/BACKGROUND

Blanding's turtle *(Emydoidea blandingii) is* a medium sized, semi aquatic turtle with a distinctive dome shaped carapace and a conspicuous yellow chin and threat. The species is distributed throughout the upper Midwest and New England where it characteristically inhabits shallow sloughs and marshes in woodlands and grasslands (Vogt 1981; Oldfield & Moriarty 1994). The life history and ecology of Blanding's turtle has been studied extensively, particularly in conjunction with conservation initiatives. Recent investigations included studies dealing with growth and maturation (Congdon & Van Loben Sels 191,1993; Rowe 1992), feeding ecology (Kofron & Schreiber 1985), activity and movements (Rove 1987; Rowe & Anderson 1990; Rowe & Moll 1991; Linck & Moriarty 1996), habitat selection (Pappas & Brecke 1992), nesting and hatchling ecology (Graham & Doyle 1979; Congdon et al. 1983; MacCulloch & Weller 11987; Linck et al. 1989; Butler & Graham 1995), and population ecology (Gibbons 1968; Ross 1989; Congdon et al.1993).

Several key features of the species' natural history are especially relevant to protection efforts. Blanding's turtle is long-lived, a trait which complicates efforts to obtain accurate life history data. Reproduction is delayed (a female reached sexual maturity at 14 to 20 years) and prolonged (a female may reproduce to 60 years of age). In stable populations, survivorship of juveniles and adults is high (Congdon et a1.1993). As a consequence, any significant source of mortality on these older age classes, particularly adults, will be detrimental, irregardless of efforts (e.g. nest protection, head starting) to augment hatchling survival (Congdon et al.1993). Similar conclusions about the importance of protecting adult turtles (vs. eggs and/or hatchlings) have been reached in other conservation scenarios (Brooks et al.1991,1993; Frazer 1992). Nevertheless, high levels of mortality associated with nesting and/or hatchlings may pose real threats to some populations (Congdon et al. 1983; Ross 1990; Linck & Moriarty 1996). In addition, Blanding's turtle exhibits temperature-dependent sex determination (Ewert & 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 essential, including potential sources of mortality as well as levels of recruitment.

In developing a management plan, understanding how Blanding's turtles utilize wetlands and uplands is central to protecting habitats critical to their well-being. Unlike most other freshwater turtles, females typically nest far afield, necessitating long distance, overland movements and similar excursions back to wetlands by neonates upon emergence (Congdon et al. 1983; Butler & Graham 195; Linck & Moriarty 1996). Furthermore, such movements are not necessarily restricted to nesting females and emerging hatchlings, but appear to be typical of adult males as well as juveniles throughout the year (Ross & Anderson 1990; Pappas & Brecke 1992; Linck & Moriarty 1996). Widely spaced, vernal pool, small wetlands, and permanent wetlands serve as important basking, feeding, breeding, and overwintering sites for this species in New England (Graham & Butler 1995) and in the Minnesota populations studied to date (Linck~ & Moriarty 1996). 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" (Coffin & Pfannmuller 1988), a status likely to continue (Baker 1996). The species has a substantial range within the state where it prefers open areas with shallow water and aquatic vegetation (Oldfield & 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 . turtle in the state have focused on populations in the metro area and surrounding communities, with the notable exception of the Weaver Dunes population on the Mississippi River floodplain. In all of these localities, turtle habitats have been extensively altered by human activity (Linck & Moriarty 1996). Blanding's turtle occurs at Camp Ripley, a large tract of riparian wetlands and uplands bordering the Mississippi River near Little Falls, and in adjacent areas in Morrison County (Mn DNR Element Occurrences 1995; Merrill 1995). Although, previous metro-based studies may be useful in formulating general conservation guidelines statewide, a management plan for Blanding's turtles at the Camp Ripley site should serve as the basis for the management of rural populations at numerous out-state localities.

2. PROJECT RATIONALE/ OBJECTIVES

Recent fieldwork has established that Blanding's turtles *(Emydoidea blandingii)* occur at Camp Ripley and surrounding areas. Although its occurrence is now well documented, little is known about the status of the population and/or the specific habitats necessary for its continued survival. On the bases of previous studies, females are known to venture far from water during nesting forays. Permanent wetlands are necessary for overwintering of all age classes; but temporary wetlands are essential for seasonal feeding and foraging activities. Thus, it is likely that these turtles utilize a variety of wetland and upland areas throughout the year. In addition, this species is late maturing, long lived, and has relatively low recruitment. Consequently, any appreciable mortality of adults /juveniles jeopardizes population survival, to a much greater extent than mortality of eggs/ hatchlings.

At Camp Ripley, various sites are utilized for military training. In order to ensure that these activities will have minimal impact on turtle populations, a management plan will be developed, based on detailed studies of the species' natural history at the facility. It is anticipated that an effective plan will entail (1) maintaining critical habitats, and (2) protecting turtle populations by enhancing survivorship of breeding adults as well as assuring hatchling recruitment

A. The objectives of the proposed study are:

(1) to determine the distribution and estimate the abundance of Blanding's turtles at Camp Ripley and the surrounding areas, as appropriate
    a. compile and evaluate previous records,
    b. determine present distribution,
    c. estimate current abundance,
    d. establish population trend (? stable, increasing, decreasing)

(2) to identify critical habitats for all age/ sex classes of the population; including hatchlings, juveniles, adult males, and adult females,

(3) to delineate the spatial and temporal patterns of usage throughout the annul cycle for each group, including spring emergence, nesting, summer and fall feeding periods, and overwintering, including winter movements; considering 2 & 3 above, habitat utilization is likely to be age and/ car sex-specific during each seasonal period, with possible overlaps,

(4) to formulate a management plan based on 1-3 above
    a. compile spatial information from the study seasonally, utilizing GPS and integrating these data into existing GIS, databases,
    b. develop and evaluate various management strategies on a provisional basis;, as the study progresses, e.g., nest protection, travel corridors, etc.
    c. produce a long-term management plan for the Blanding's turtle at Camp Ripley, based on relevant features of the species' biology, particularly those known to affect or judged likely to affect this population.

3. STUDY SITE

The Camp Ripley Training Site (CRTS) is located in Morrison County in central Minnesota, approximately 16 km north of Little Falls, MN (fig. 1). Camp Ripley is bounded on the north by the Crow Wing River and to the east by the Mississippi River, covering approximately 21,500 ha (53,000 acres). The private lands adjacent to Camp that were included in the survey encompassed part of the Haycreek Drainage which is approximately 360 ha (900 acres) in size.

The majority of the XXXXXX sections of Camp Ripley appear to hold significant areas of potential Blandings turtle habitat. The XXXXXX are also potential Blandings turtle travel corridors as evidenced by one documented sighting of a basking Blandings turtle on the Mississippi, near the XXXXXX area (Merrill, 1994).

Historically, Camp Ripley is classified as lying within the St. Croix glacial end moraine at the south end of the Pine Moraine ecological landscape region. It falls within the transitional zone of northern coniferous and deciduous forests in Minnesota The landscape is characterized by a steep knob and kettle topography with elevations ranging from 1122 -1535 ft above mean sea level. Development at Camp Ripley is negligible and consists mainly of secondary roads and trails. Intensive training and range firing exercises along with the ammunition impact zones and required range fans (buffer zones) prevent extensive land development. Forestry is the only predominant land management practice utilized on the site. Most of the wetlands across Camp Ripley are maintained and protected from military activities. This is in addition to certain wetlands already designated as protected Blandings turtle habitat. Many upland and lowland areas have also been designated as no-fly zones or off-limits to training personnel and vehicles in order to protect the habitats of various plant and animal, species such Bald Eagles.

The wetlands of Camp Ripley are extensive, consisting of many small lakes, potholes, beaver impoundments and semi-permanent shallow marshes. The southwestern section is an extensive wetland complex that is drained by Hay Creek and its tributaries. The northern and eastern parts of Camp Riley are also coveted in a large wetland complex that is drained by the Crow Wing and Mississippi Rivers respectively. The vegetative composition of these wetlands is diverse, ranging from shrub swamps and floating bog complexes to sedge meadows, and cattail marshes. Emergent vegetation is balanced with small open water areas (Brown, 1995).

The soils of Camp Ripley and surrounding areas were formed during the advances' of the late Wisconsin glacier and are well drained, steep slope soils. The majority of Camp Ripley is the Mahtomedi-Menahga Association, which is characterized by dark gray loamy sands with gravelly sand subsoils. A small part of the northwest corner is occupied by the Cushing-Mahtomedi Association consisting of a sandy loam topsoil and a clay loam subsoil. Lastly, the eastern edge of Camp, along the Mississippi River is occupied by the Hubbard- Duelm- Isan Association, characterized by black and dark brown loamy sands with sand subsoils. The soil types that offer favorable turtle nesting habitat are the Mahtomedi, Menahga and Hubbard sands that occupy most of the training site and adjacent lands (Brown, 1995).

The upland habitat is characterized by extensive forest regions, open fields, and cleared training ranges and impact areas. Forest stands are a combination of fragmented and contiguous tracts of mixed hardwoods and conifers. Open fields at Camp Ripley are propagated and maintained by clear cutting, burning and military training activities and consist mainly of short grasses, small shrubs and forbes along with small open pockets of sand and gopher mounds.

4. METHODS

4.1 Turtle surveys and capture

Trapping using aquatic nets: We used commercial nylon hoop traps (Memphis Net and Twin) baited with 0.25 kg of frozen smelt or sardines in oil and a handful of cracked corn. Bait was placed in a plastic cup with holes drilled into it to facilitate scent but not bait dispersal. Traps were placed into marshes with the entrance of the trap submerged; trap entrances were fitted with plastic swing doors to discourage turtles entering the trap from leaving. The top of the trap was left exposed to prevent and captured turtles from drowning

Marsh size determined the number of traps set, from two to twelve traps per wetland. Traps were shifted to new marshes every 1-3 weeks. Four basking traps were also used, proved to be ineffective: no Blandings turtles were captured in basking traps.

Trap distribution on the Camp Ripley Training Site (CRTS) for the 1996 and 1997 field seasons varied. In 1996, trapping effort was centered in the areas XXXXXX (see results, sec 5.1). Marshes XXXXX were surveyed intermittently during 1996. In 1997, trapping was focused in the XXXXXX4 region (see results, sec. 5-1). Trays were located in wetlands XXXXXX. Troop activities and training exercises hindered more extensive surveys XXXXXX. The distribution of trapping in wetlands at CRTS during the study is shown in Figure 2.

Initially, trapping effort in 1996 extended over a greater proportion of the season in 1996, relative to 1997. In 1996, 5834 trap nights (number of traps X days set) were recorded; in 1997, 3971 trap nights were logged. The combined total for the two years of the study was 9805 trap nights. Considering the total trapping effort, traps set south of XXXXXX accounted for 7419 trap nights or ~75% of all traps set, due primarily to the initial focus in the XXXXXX6 region in 1996. We did not set many traps during the months of June- July 1997 because of limited access due to extensive military activity during this period and because trapping success was low during this season, based on 1996 returns. Additional details on the trapping strategy and results are included in the project progress reports (included as Appendix D).

Trap success (pooled '96 and '97 data) depended on the season and area being trapped. Trapping accounted for 59 total captures, including 25 recaptures of previously marked turtles;

overall trap effort accounted for 0.006 Blanding's turtles per trap night. Based on our efforts at CRTS during two field seasons, trapping is most effective in the spring and late summer, with very low success during June arid July. Trapping in the method described appeared to produce a strong age/ sex class bias in captured turtles; we caught more male and juveniles than females in traps. In only one instance was a turtle captured by hand in the water, and this hand capture resulted when a female turtle was recovered from shallow water as she was investigating a standard minnow trap that was set to collect native fish species to use as bait in turtle traps.

Capturing turtles along roadways: This capture technique was most effective in locating turtles during the nesting period in June and early July; mostly gravid females were recovered (92% of all roadway captures). The few males/ juveniles found were collected incidental to other activities, such as following telemetered turtles, etc). Surveys were conducted from just prior to the start of nesting until a few days after the last gravid female was captured (June 7 - July 20, 1996 and June 6 - June 22, 1997).

Areas were surveyed by conducting vehicle searches in areas of known or potential nesting habitat in circular routes on timed intervals from 1700 - 2400 hours can a daily basis. In 1996, 2 - 3 trucks ran routes in each area every night during the periods of nesting. In 1997, 1- 2 trucks surveyed each selected area (3 areas). Any observed tracks or signs were investigated in an effort to locate the turtle that left the sign. Sites away from roads were periodically checked on foot to look for turtles.

In 1996, nesting surveys were focused in the XXXXXX region. primarily XXXXXX. The area from XXXXXX to XXXXXX constituted most of our effort looking for turtles in vehicles. In 1996, 4 single truck was used in the XXXXXX and another in the XXXXXX. Occasional trips were made to the XXXXXX. In 1997, nesting surveys were extended to the XXXXXX, as well as maintaining survey routes in the XXXXXX. Several additional trucks surveyed the XXXXXX region; most effort was focused in areas XXXXXX. Periodic road closures and a very large area to survey limited daily coverage in XXXXXX.

However, despite logistic difficulties, this survey method was extremely effective in locating gravid females. In 1996, nest surveys were conducted intensively from June 7 - June 26 and intermittently from June 27 - July 20. Fourteen turtles were captured in 340 hours of effort; this equaled 0.041 turtles/ hr. In 1997, surveys were conducted from June 7 - June 22. . These surveys accounted for 20 total captures in 336 hours of effort, equivalent to 0.059 turtles / hr.

Holding conditions When turtles were captured or being transported in the field, they were kept in burlap bags tied shut with rope. The bags were placed in a shaded spot of the vehicle to keep ambient temperatures low and the turtle was returned as soon as possible to a wetland or the lab. Turtles in the lab were kept in large plastic wading pools, out of direct sunlight, with approximately 8 cm of water and a heat lamp. They were offered food, mostly frozen smelt, while held in these conditions, and most turtles readily feed on a daily basis.

4.2 Marking procedure and data collection

All captured turtles were brought back to the lab for processing. We measured the midline length of the carapace and plastron to the nearest millimeter, using a large caliper; 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 where recorded. Female reproductive status was determined by palpating for the presence to shelled eggs. Age was determined by counting growth rings on the plastron. juveniles smaller than 210 mm were easily aged in this fashion, but we had difficulty reliably determining the number of growth annualae in individuals larger than 210 mm. Secondary sex characteristics that were noted included a concave plastron and large tail in males, and the absence of these features in females. Each turtle was assigned and individual identification code (Cagle 1939) that was filed into the marginal scutes of the carapace in a marking scheme shown in Figure 3. Gravid females were spray painted with brightly colored, distinct markings to facilitate re-identification in the field.

4.3 Telemetry and movement

Transmitter distribution: The transmitters (36), receivers (2) and antennas (4) used in this study were manufactured by Advanced Telemetry Systems; these included 34 for adult turtles (mean weight = 29.1 gm) and 2 for juveniles (mean weight = 11.9 gm). Frequencies used were on 150 and 151 with 16 channel receivers. Most of the transmitters used, in this study (30 out of 36) had an ambient temperature monitor built into the transmitter circuit; consequently, temperature was measured when the transmitter was monitored for location. Six transmitters used in 1997 included an additional activity function.

Transmitters were distributed to turtles on the basis on transmitter availability, sex, size of turtle and geographic location. Only a few transmitters were available that were small enough to fit juveniles, so not all of those captured were tracked. Initially, preference was given to gravid females and turtles found in locations that were poorly documented. When surplus transmitters were available, all turtles captured were fitted with transmitters.

Telemetry protocols: Transmitters were affixed to the turtles using a fast drying (5min) epoxy compound. Turtles were immobilized with duct tape to prevent movement. The epoxy was mixed and smeared onto the base of the transmitter. The transmitter was then applied to the carapace approximately midway down the turtle between the dorsal line and the marginal scutes, as shown in 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. Initially antennae were also glued down to the carapace but this was later discontinued as there seemed to be a tendency for these antennae to dislodge from the transmitter.

Telemetry procedures: Turtles were located 2 -10 times a week in the summer as activities allowed. Winter locations were conducted as time and weather allowed. Each turtle was located a minimum of two times over the winter period, Winter locations were found by walking to each turtle's overwintering site using the telemetry equipment. Summer activity locations were calculated using a three or four element yagi antenna and a radio telemetry receiver. Bearings to the animal were taken from three fixed positions around each marsh using a compass. Each telemetry stake was GPS'ed to obtain a UTM grid coordinate. This data was entered into Locate, a triangulation software program. This program outputted a UTM location and error polygon for each location. There was a lot of error in the locations from the software. Often turtles were plotted or land even though they were in the marsh (based on walking around the marsh. This method was used exclusively in 1996 and early 1997.

In mid May 1997, a new procedure for locations was used to decrease these telemetry software errors. Digital orthophoto quadrangles (digitally enhanced aerial photos or DOQ's) were used to make detailed drawings of the 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 taken 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.

Daily movements were calculated by subtracting the distances between a previous location and the recent location on a subsequent date. If the monitoring dates were more than 1 day apart, the total distance moved between locations was averaged by the number of intervening days to produce a value for daily movement.

4.4 GIS and GPS protocols

GPS: A Trimble Global Positioning Satellite unit was used to record locations of specific sites (i.e. overwintering sites, nests, telemetry points). This unit had post processing correctional capabilities to account for selective availability. Accuracy is from 0.5 - 2 meters. This data was then incorporated with a GIS database.

GIS database: The software that was incorporated for analysis was ArcView from Environmental Systems Research Institute (ESRI). The ArcInfo coverages used in this report came from the GIS lab at Camp Ripley. These coverages 16 provide the bases for the habitat and wetland classifications. The DOQ's came from Camp Riley as well as from the USGS.

4.5 Nesting, egg incubation, and hatchling methods

Nest site protocol: When a nest site was located during an evening of nesting surveys; it was immediately protected by staking a large wire screen over the nest to protect it from depredation. The next day the nest was carefully excavated using a trowel, plastic spoon and hand. The eggs were carefully placed into a protective plastic bucket in the same orientation that they were in the nest, to prevent dislodging the embryo. The nest characteristics were then measured. The eggs were immediately returned to the lab. Each egg was candled to determine viability, measured for length and width to the nearest millimeter, and weighed to the nearest 0.1 gram. The nest parameters recorded included depth to eggs, total nest depth and nest width.

Nest temperature monitoring: After the eggs were measured, they were returned to the exact site of excavation where they were replaced in the same position that they were found. At the same time a temperature logger was placed immediately along side the clutch at mid-nest depth. These temperature loggers were manufactured by Onset Computer Corporation. Typically they were set to record temperatures every 1.5 - 2 hours. In addition to nest placements, several loggers were buried in surrounding soils at similar depths to obtain on accurate representation of available temperatures.

Nest/ hatchling protection: Nests were protected in 1996; in 1997, eggs were returned to nests after processing in order to monitor predation. Nest protection consisted of staking a large wire cage over the nest and temperature logger until hatchlings were observed emerging. In 1996, nests that were considered to be in areas of high mortality (i.e. roads and tank trails) were kept in the lab for incubation. After a nest incubated in the field began to emerge, all hatchlings were brought back to the lab. These were measured, marked with toe clip and notches in the scutes, and released in a wetland close to the nest.

In 1996, there was no nest predation noted in protected nests. In 1997, many of the nests (>60%) that were left unprotected were subsequently predated during the incubation period.

4.6 Temperature, activity, and feeding studies methodology

Turtle temperature methods: In order to continuously measure internal body temperature in turtles over long periods of time, a small temperature logger (Tidbit; Onset Computer Corporation) was implanted into the body cavity of each turtle via surgical incision in the inguinal cavity. Each logger was set to record temperature at 24 - 72 minute intervals, with an accuracy of 0.2-0.4 C.

A temperature function in each transmitter allowed us to record transmitter temperatures (affixed to the turtle's carapace) periodically with a stopwatch used to time signal pulses that were temperature-dependent. The value measured was later converted into a temperature value, by using a conversion formula provided with the transmitter. Accuracy of these reading was determined to be ± 0.5 C.

Activity methods: Activity transmitters had a mercury switch that had a steady pulse when the turtle was inactive but when the turtle was active the pulse rate varied according to the degree of movement. Each transmitter was monitored intermittently in order to determine a level of activity of an individual turtle. Activity was classified as: no activity, moderately active and highly active. These transmitters were attached to representative sex/ age classes in one area.

Operative temperature models: Fiberglass models were built to represent juveniles, females, and males; nine replicates of each size (27 total) were constructed, using actual turtle shells to produce a realistic external shape for the carapace/ plastron in each size category. These models were painted dark brown to closely simulate the thermoregulatory properties of the actual turtles.

Temperature loggers were sealed and placed into the model. Each set of three models (s, m and 1) was then filled either with water or air and sealed with silicone. 2 sets of models (1 air filled set and 1 water filled set) were each placed in one of three locations in a wetland (XXXXXX) in the XXXXXX area. The models were positioned as such: completely out of the water to simulate a basking turtle, partially submerged in the water to simulate a floating turtle, or completely submerged in 0.3 -0.5 m of water to simulate an inactive, submerged turtle.

Environmental temperature monitoring: Temperature recorders were placed in different wetlands over the course of the two field seasons. These recorders were set to measure water surface temperatures, bottom water temperatures and mid-column water temperatures over the course of several weeks to months. Winter marsh temperatures were measured in a similar way, but with only air temperature and bottom temperatures recorded. This was done by drilling a hole in the ice and inserting a stick with the loggers attached. These were left in place throughout the winter. Air temperature records were obtained from the weather recording station at Camp Ripley. Marsh air temperatures were monitored with temperature loggers placed in individual wetlands.

Stomach flushing protocols: Stomach flushing was conducted on representative turtles. The turtle was immobilized onto a board with its head gently extended. The mouth was opened and a long soft flexible tube was gently inserted until the stomach was reached. A small flow of water was then turned on and the turtle was inverted. Any material and water that was excreted was poured through filter paper to be strained; the contents were then stored in ethanol and later analyzed.

Feeding trials: captive turtles were fed different type of prey items to determine a preference or dislike for each prey type. Specimens included snails, crayfish, tadpoles, aquatic invertebrates, frozen smelt and sardines.

5. RESULTS

5.1 Surveys/Capture/ Distribution

Turtle Survey: The Camp Ripley Training Site (CRTS) occupies an approximate rectangle of 207 km^2, with a east west width of 10 km bordered on the east by the Mississippi River and on the west by a county road, and a north-south length of 28.5 km bordered by the Crow Wing River on the north and by a county road on the south. The training site varied regionally in military usage, and consequently, in access to potential turtle survey sites. For the purposes of this study, the CRTS may be divided into three regions: XXXXXX.

The XXXXXX region includes all of XXXXXX, is closest (12 km.) to XXXXX, and covers 61 km^2. Because of short travel distances and light military usage that only infrequently necessitated road closures, our turtle surveys in this region were virtually unrestricted. The XXXXXX region includes the area XXXXXX, is an intermediate distance (26 km) from XXXXXX, and is approximately 80 km^2 in area extent. Military use of this area is extensive and often intense. It includes a large artillery impact area (XXXXXX) that is active from May through September. Because of persistent and widespread road closures associated with this impact area, our turtle surveys in the XXXXXX5 region were rare during the study period.

The XXXXXX region is 66 km^2, includes all of XXXXXX, and is most distant (37.5 km) from XXXXXX. Military use of this area includes light vehicular traffic and another large artillery impact area (XXXXXX) that is in moderate use from May through September. Because of long travel distances and frequent road closures throughout this region associated with the impact area, turtle surveys were largely confined to easily accessible major roads. In addition, turtle sightings in this region were rare prior to the 1997 field season, and initial efforts were concentrated on the XXXXXX6 region where frequent turtle sightings were well documented in recent years.

Turtle Captures: Our study encompassed two full field seasons (spring-summer-fall), and an intervening winter. During this period, 71 individual Blandings turtles were captured and marked at CRTS. In 1996, we marked 29 new turtles and recaptured 3 turtles marked in 1992 by Carol Dorff. In 1997, 39 new turtles were found and 16 turtles were recaptured. An inventory of the marked turtles is presented in Tables 1-3 (males, females, and juveniles, respectively); included here for each turtle are: the date captured, capture method, identification code, location, body measurements, and estimated minimum age.

Distribution: We found three areas within the CRTS where turtles appeared to be concentrated. Two of these are located in the XXXXXX6 region described previously: the XXXXXX area including XXXXXX and the XXXXXX2 area XXXXXX. The other concentration was located in the XXXXXX region, and is referred to as the XXXXXX area. No comparable turtle concentrations were located in the XXXXXX region, but this area was inaccessible to us during most of the study period, and was under-represented in surveys. The three areas where concentrations of turtles were observed are shown in Figures 4-5; the delineated boundaries include the summer, overwintering and nesting habitats used by the turtles at CRTS.

Some telemetered turtles spent long periods throughout the year in wetlands that are adjacent to, but outside of, the boundaries of Camp Ripley. At any time, as many as 30% of the turtles marked in the XXXXXX6 region of CRTS were living in habitats offbase. We found 15 of 52 turtles from the XXXXXX area and the XXXXXX area utilized wetlands outside the XXXXXX boundary of Camp Ripley, especially the wetlands of the XXXXXX. A similar tendency to move offbase is strongly suggested by the movements of two turtles XXXXXX; these individuals are presumed to have traveled along and/or across the XXXXXX of CRTS. The telemetered turtles were tracked on a daily basis XXXXXX, and then each one disappeared in a day or two. Despite numerous attempts to relocate these XXXXXX, neither turtle was recovered subsequently within the CRTS. We assume these turtles moved XXXXXX and away from Camp Ripley.

The marked turtles in each area of concentration showed no patterns of movement between areas. However, since the XXXXXX5 region was under-surveyed, and because the XXXXXX4 region was surveyed extensively only in 1997, it is difficult to judge the degree of movement among these areas onto determine if here were any actual or potential barriers to movement across the CRTS, particularly in a XXXXXX direction that would connect the XXXXXX are where turtles were concentrated. In the absence of any definitive evidence that such barriers exist, for the purposes of this report we are assuming that the population of turtles at CRTS is contiguous.

5.2 Population Structure/ Densities

Population structure: In the XXXXXX1 area, we captured 11 males, 18 females, and 4 juveniles (32 turtles total). In the XXXXXX2 area, we captured 6 males, 7 females and 6 juveniles (20 turtles total). In the XXXXXX3 area, we captured 6 males, 17 females, and 3 juveniles (26 turtles total). In all three areas, females outnumber males, by 1-3 times: and adults outnumber juveniles, by 1-7 times. The disproportionate ratio of males to females and adults to juveniles suggest that adult males and juveniles may be under-represented in our surveys. However, based solely on the demography of the captured turtles, in each area there appear to be various age classes/ sexes represented, and in each area the marked turtles probably represent viable, reproducing components of the CRTS turtle population. The yearly captures of age/ sex classes and the demography of new vs. recaptures for each area during the study at CRTS are shown in Table 4.

Density: During the study period, we observed seasonal and regional differences in turtle densities. Turtle densities were estimated by dividing the estimated number of turtles in an area by the total wetland area utilized by the turtles during overwintering and/or during the active season. Consequently, these areas represent the minimum amount of wetland habitat required by the turtles engaged in seasonal activities.

For XXXXXX2 area turtles, overlap between overwintering habitat and habitats utilized at other times of year was high. Consequently, turtle densities do not change appreciably on a seasonal basis. Densities for the estimated total population during overwintering were 1.45 vs. 1.41 turtles/ ha for other times of year. However, turtles of the XXXXXX1 area were observed to use twice the habitat, 102 ha, during the activity season relative to that utilized, during overwintering, 50.7 ha. Consequently, the estimated density for the XXXXXX1 area turtles is higher during overwintering, 0.95 vs 0.47 turtles/ ha for other times of year. Thus, depending on season, densities in the XXXXXX2 area are 50 - 300% higher than those for turtles in the XXXXXX1 area. A comparison of densities of the various age/ sex glasses in these two areas is shown in Table 5.

Because mark-recapture estimates of population size are unavailable for the XXXXXX4 region, we based a "guesstimate" of the size of the population on the estimated densities turtles in the XXXXXX region. A conservative estimate of available XXXXXX3 habitat, 321 ha, is based on the combined area of wetlands in the immediate vicinity of XXXXXX3 capture locations. Using the density estimates for the active season from the two XXXXXX areas, we estimate the lower and upper limits of the population to be 151- 453 turtles in the XXXXXX3 region. A comparison of densities of the various age/ sex classes in this area is shown in Table 2.

5.4 Habitats / Movements

Turtles Monitored: From May 1996 thru August 1997, 46 individual turtles (15 males, 24 females and 7 juveniles) were outfitted with radio transmitters for varying intervals. We tracked 23 turtles from XXXXXX1 area (7 males, 14 females and 2 juveniles), 17 turtles from the XXXXXX2 area (5 male, 7 females and 5 juvenile), and 6 turtles from the XXXXXX3 area (3 males, 3 females). For each turtle telemetered, the turtle identification, sex, transmitter frequency, start and end dates as well as the total number of days monitored is listed in Table 7.

Habitat

Summer Sites: During the active season (15Apri1-15 November), 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 0.04 to 362 ha. Although there was considerable diversity in wetland features, most turtles spent 80% of the total days during the active season in shrub swamps. This wetland type is characterized by water depths of 0.1-2 meters, and extensive aquatic vegetation, including bog mats. Water depths for most summer wetlands ranged between 1- 2 m., with some containing deeper regions (3-4 m. in depth). The wetlands that the turtles utilized typically contained abundant emergent vegetation, including cattails, sedges, and floating bog complexes, and intermittent open water. Sub-aquatic vegetation was common. Details for 23 wetlands utilized by the ten representative turtles, the characteristics of each, and their usage by telemetered turtles are included in Table 8.

In wetlands frequented by turtles, the potential prey consisted of aquatic invertebrates, amphibian larvae, snails, crayfish and various minnow species. Trapping records indicate that painted turtles *(Chrysemys picta)* were commonly present in wetlands occupied by Blanding's turtles (~89%; 25 of 28 wetlands sampled). In contrast, snapping turtles *(Chelydra serpentina)* were found less often (~32%; 9 of 28 wetlands sampled). An inventory describing all of the wetlands used by Blanding's turtles during this study is provided in Table 9.

Overwintering Sites: During the winter of 1996-97, we located 27 overwintering turtles in tie XXXXXX1 area and in the XXXXXX 2 area. The locations of these overwintering sites are shown in Figures 6-7. Regardless of age/ sex, turtles selected aquatic locations, often in wetlands that were frequented during the springy summer, and/or fall. These wetlands were almost exclusively shrub swamps (~96%; 26 of 27 sites). Sites were often located close to shore (<5 meters), with water depths ranging from 0.4 -1.7 m; maximum water depth available was frequently greater than 2 m. Substrate was a mixture of soft mud and decaying vegetative material. Whether overwintering turtles burrowed into the muddy bottom or sat on top of it was not determined. The overwintering site for each turtle and its features, including details of location, wetland type, water depth, and the duration of overwintering are shown in Table 10.

Nesting sites: Most observed nests (~90%; 28 of 31 sites) occurred in, on or near man-made disturbances such as roads, roadsides, training areas cleared of vegetation, disturbed fields, and old fields. The majority of nest sites had little

24 or no canopy cover and sparse vegetative composition. The locations of nests located during this study are shown in Figures 8-10. Descriptions of nest sites are included in the following section on nesting ecology.

Movements

The movements of the CRTS turtles have been analyzed within the context of seasonal activities throughout the year. Turtles were generally active from about 15 April through 15 November (comprising spring, summer, and fall), and inactive (overwintering) from mid November until mid-April the following year. This analysis focuses on the movement records of ten turtles that were selected to be representative of the various patterns of movement observed in all of the turtles we monitored. In our analysis, we have distinguished between daily movements within a marsh in which an individual turtle was resident for some period of time (>5 days) and inter-marsh movements; inter-marsh movements were typically long distance movements to a new residence in another marsh.

An inter-marsh movement would usually be followed by a period in residence in the "new" marsh, before making another long distance movement. Consequently, a characteristic spatial pattern for a turtle would be restricted movements within wetlands, punctuated by brief forays overland, sometimes long distance, from one marsh to another. Regardless of season, daily movements within marshes were almost exclusively aquatic, with little or no terrestrial activity. During the winter, a turtle selected a site within a marsh and remained inactive. Finally, the tendency for nesting females to move overland during the nesting period resulted in another category of movement that appeared to be sex-specific.

Summer movements: During the summer, daily movement patterns varied widely among individual turtles. The spatial and temporal components of the movement patterns are shown for ten selected turtles in Figures 11-20. Mean daily movements ranged from 7 - 61 m/ day as shown in Table 11. First of all, there is considerable variability among individual turtles in mean daily movement. However, mean daily movement is positively correlated to the areal extent of the wetland in which the turtle resides. As wetland size increases, mean daily movement increases until the size of the wetland reaches 0.2- 0.3 ha. In larger wetlands, mean daily movement levels off at about 15m (Fig. 21). Further details regarding movements and the wetlands utilized are listed for each of the ten representative turtles in Table 12.

Movements between marshes (=inter-marsh movements) also varied among individuals, without regard to age and/ sex. Inter-marsh movements did not typically follow established roads or utilize transitional wetlands. During the study period, the observed inter-marsh movements per turtle ranged from 1- 5, with travel distances ranging up to 2900 meters. The average inter-marsh movement was 426m: In some instances, individual turtles did not make any inter-marsh movements; for example, one juvenile and one female at XXXXXX2 Marsh did not show any inter-marsh movements during the time each was monitored (Table 12).

Turtles spent relatively little time making inter-marsh movements, and consequently these made up only a small proportion of the active period. The ten turtles whose records were examined in detail spent from 0 - 26 days moving between marshes; this amounted to 0-12.15% of the active season which totaled 214 days. The mean and range of inter-marsh movements for each turtle are shown in Table 13; the proportion of time (in days) that each turtle spent ranking inter-marsh movements is shown in Figure 14. Juveniles made more inter-marsh movements at the beginning and end of each activity season, male's moved throughout the season, and females moved mainly during June and July and then during the early fall (Figure 22).

Many turtles used familiar areas from one season to the next. Often turtles returned from overwintering sites to areas occupied the previous season, and then moved back to the same overwintering marsh. Examples include six of the ten representative turtles whose records are presented in detail. In the XXXXXX1 area, a male, female, and juvenile showed such a pattern (Fig.11-13). In the intervening region between the XXXXXX1 and XXXXXX2 areas, a female had a similar pattern (Fig. 15). In the XXXXXX2 area, a juvenile and female exhibited this pattern (Fig.19-20).

The length of time individuals in each age/ size class tended to remain in a wetland varied. Females resided in wetland for either brief or long periods relative to the typical male pattern; juveniles remained in wetlands longer that males or females (Figure 23). We also observed that the duration of wetland residence was related to the size of the wetland (Fig. 24), and especially the type of wetland. Turtles appear to prefer shrub swamp for extended stays: 14 out of 15 extended residences (>50 days) were in this type of wetland (Fig. 25). In addition to influencing a magnitude of daily movements, the size of the wetland appeared to influence how long a turtle remained in residence. For shrub swamps, as wetland size increased, the duration of residence increased (Fig. 26). For each turtle, the initial and subsequent wetlands selected, the type and size of wetland, and the average daily movement within each wetland as well as the duration of stay is shown in Table 15. During the winter of 1996-97, when the turtles were inactive, no movement was observed for any of the 27 turtles monitored.

Nesting movement: Distances that monitored females moved from nearby marshes to nest sites varied and ranged from 125 -1566 m. In 1996, the mean nesting movement was 92m; in 1997, the mean nesting distance was 895m. Durations of nesting-associated movements ranged from 1-3 days. Details of nesting movements for individual females are summarized in Table 16. Nesting forays commonly occurred along roads. Turtles either returned to a wetland or retired underneath dense shrubbery or vegetation late in the evening during forays lasting more than a single day. To visualize the relationship of a female's nest site to her year-rd pattern of activity and movement, the locations where each female nested are indicated on Figures 12, 15, 16, and 20. To visualize the relationship among nest sites, the nest locations are plotted for each of the three areas in each of the three areas where nesting was observed on the CRTS (Fig. 8-10).

5.5 Reproductive Ecology

Seasonal Aspects of Reproduction

Reproductive activities were divided into spring courtship/ mating, nesting/ incubation, hatchling emergence, fall courtship /mating. The approximate seasonal timelines for these activities are shown in Figure 27, based on two field seasons with an intervening overwintering period. Details of each activity are summarized below.

Spring courtship/mating: We inferred the likelihood of courtship and mating activities from the frequent capture of male and female turtles in the same trap during the early spring of 1997 between 1 May -19 May.

Nesting/ Incubation: We found 31 turtle nests at CRTS during the 1996-97 field seasons (Table 17). We observed nesting activities during 10 June -11 July and 12 June - 21 June during the 1996 and 1997 field seasons. In both seasons, nesting typically peaked between 10 - 20 June (~87%; 27 of 31 nests). During both rusting seasons, we noted that reproducing turtles produced only, a single clutch of eggs deposited into a single nest. Once the eggs were deposited in the nest cavity, clutches incubated for a mean of 83 days (range 77 - 89 days), based on two seasons of monitoring natural nest temperatures and using mean nest temperatures to estimate incubation periods in the field.

Incubation periods of eggs incubated at known temperatures in the lab were used to estimate field incubation periods. In the field, turtle nests had three possible fates: predation (by raccoons, skunks, etc.), failure to emerge from the nest (due to infertile eggs, sufficiently cool nest temperatures to inhibit development etc.), or the successful development and emergence of hatchlings.

Hatchling emergence: Hatchlings emerged between 28 August through 10 September, in the two seasons natural nests were monitored. No hatchlings were observed to overwinter in the nests as described for painted turtles.

Fall courtship /mating: In the fall, courtship and mating activities were observed from 15 August through 17 October. This activity was inferred from finding males and females together in baited traps, and from periodic captures of telemetered males and females in close proximity. In one instance, a male was recovered as he embraced a female and appeared to be attempting to mate with her. Other mating attempts were observed as late as 17 October on a clear, bright day in water at 6 C.

Daily Time Line of Nesting Behavior: Nesting behaviors were initiated as early as mid-afternoon, but the majority of nesting activity occurred between 1900 - 0000 hr (Figure 28). Initially, nesting turtles engaged in searching movements, which involved slow walking with frequent halts. Once the turtle stopped, it often extended its head and rubbed its lower jaw along the substrate or poked its snout into the substrate. Sometimes there was a wagging movement of the extended head and neck just above the sand or soil, accompanied by occasional scratching of the soil with the front feet. These behaviors began before nightfall.

Once the turtle selected a site, she turned around so that the back feet were positioned to excavate a nest cavity. She then created the flask-shaped nest by slow and careful digging with one hind leg, followed by a repositioning so that the other hind leg alternated in the digging movements. Occasionally a female was encountered that was missing a back foot. Several of these turtles successfully completed nests, but the entire process of nesting was prolonged. Females occasionally excreted fluids from her cloaca during the digging process. If the soil substrate was too compact or if she encountered an immovable rock, the female typically abandoned the nest site before oviposition commenced. Once the nest flask was complete, the female began to lay her eggs at the rate of one egg every 1-1.5 minutes. The females' rear quarters rose and fell slightly as each egg was laid, and she occasionally arranged eggs already in the nest with her hind feet.

The duration of egg laying was typically from 30-60 minutes. After all of the eggs have been deposited in the nest, the female covered the nest, using each hind leg alternately to gather excavated substrate and push it into the nest cavity. Periodically the female compacted the nest cavity with her hind feet. The duration of the covering phase can be quite variable, and lasted from 30 minutes to several hours. Once the turtle completed nesting she either moved directly back to a wetland or moved away from the nest and spent the night sheltered nearby in vegetation. While the sequence of nesting was predictable, the durations of the various behaviors varied with each individual turtle (Table 18).

Nest Sites

Concentrated vs. dispersed nest sites: In each area in which turtles were monitored, there were one or more localities where nesting was concentrated. As noted in previous surveys at CRTS, there was nesting activity (15 nests during '96 - '97; ~48% of all nests detected) on the roads and armor trails that surround XXXXXX in the XXXXXX study region (Fig. 8). We found a second nesting concentration (6 nests during '96 -'97; ~19% of all the nests detected) in the

XXXXXX 2area (Fig. 8). A third nesting concentration (5 nests during 1997; ~16% of all nests detected) was located at the XXXXXX in the XXXXXX region (Fig. 10). Other nests appeared to be dispersed, relative to these concentrations, notably in the XXXXXX region (Fig. 10) as will as those located away from concentrations in the XXXXXX region (Fig. 91,). In 1997, at least 7 turtles returned to nest in the same approximate locations (within 200 meters) where they had nested in 1996.

Nest Site Characteristics: Nests were located in predominately open, exposed areas characterized by loose sandy soils (19 of 31 nests; ~61%) and were typically located in or within 10 meters of roads or armor trails (22 of 31 nests; ~71%). Most nests were in sunlight for most of the daylight hours on clear days, and canopy cover was minimal. When a circle with a radius of 25 meters was projected from each nest site, a mean value of 16% canopy cover was observed.

Nest temperatures at the date of oviposition ranged from 16.2 - 24.7C. Mean nest temperatures during the middle of incubation (when sex is determined) rang from 22.4 to 26.7 C. Mean nest temperatures just prior to hatchling emergence (or predicted hatchling emergence) ranged from 19.7 - 25.7 C. After the first week of September, nest temperatures decline quickly. A graphic representation of the seasonal soil temperature monitored in a turtle nest is shown for two summer seasons and the intervening winter period (Figure 29).

Egg/Hatchling/Female Characteristics

Clutch size/ mass: For the 1996 and 1997 field seasons, the mean number of eggs laid per clutch was 17.7 eggs (n = 31 nests). Clutch sizes between 1996 and 1997 were not significantly different (1996 mean =18.7 eggs; 1997 mean =17.1 eggs; p = 0.113). However, clutch mass was reduced in 1997 relative to that observed in 1996 (1996 mean = 261.4 g.; 1997 mean = 207.4 g.; p = 0.05). Similarly, egg size in 1997 was smaller (1996 mean =13.8 g.;1997 mean =13.0; p«0.001). The mean mass of hatchlings was 9.2g, and ranged from 5.8 to 11.3g. Additional data on clutch size, clutch mass, egg mass, and hatchling mass is shown in Table 19.

Female/ clutch/ hatchling: Data analysis on clutch measurements suggested several trends between female size, clutch and egg parameters, and hatchling characteristics. The first trend was that as female size increased, clutch size, clutch mass, and mean egg size also increased as shown in Figures 30-32. For instance, the smallest female (C.L. = 221 mm.; mass =1610 g.) produced a clutch of 4 eggs whose total mass was 172.7 g., while the largest female (C.L. = 279, mass = 2900 g.) produced a clutch of 23 eggs whose total clutch mass was 307.3 g.. Similarly, a small female (mass =1610 g.) produced a mean egg size of 11.5 g., as where a large female (mass= 2750 g.) produced a mean egg size of 16.3 g.

Another trend related egg size to resultant hatchling size. Small eggs (mass = 10.0 g.) generally produced small hatchlings (mass = 7.6 g.), and large eggs (mass = 15.0 g.) produced large hatchlings (mass = 10.7 g.) (Figure 33). Lastly, large females may produce slightly smaller hatchlings relative to small females; however, this last trend is based on a limited sample (n = 7) (Fig. 34).

5.6 Growth/ size/ feeding

Growth: Juvenile turtles appear to grow faster than adults, but juvenile growth is Variable. Mean growth rates for juveniles (0.016 mm/ day) are approximately 5 tines faster than those for males (0.0026 mm/ day) or females (0.0021 mm/ day). Growth rates for males, females, and juveniles as well as estimated minimum size and age at sexual maturity in the CRTS population are shown in Figure 35. Variability of juvenile growth is indicated by differences of body size among similarly aged juveniles. For example, carapace lengths of five 7-year-old Blanding's turtles were observed to be 121, 153, 156, 160, and 173 mm, respectively. Observed growth increments of male, female and juvenile turtles during the study period are summarized in Table 20.

Size: Turtles at CRTS were large, particularly with reference to sizes reported in other parts of the species' range. Adult males had a mean carapace length of 260, mm (range = 228 - 277 mm), whereas adult females had a mean carapace length of 245 mm (range = 221- 279). Plastron measurements and body mass were comparably large for both sexes (Table 21). Within CRTS, no differences in body measurements were observed between XXXXXX areas.

Mature males from XXXXXX areas were similar in body size. Mean carapace lengths, plastron lengths, and masses of XXXXXX males and females did not significantly different from their respective XXXXXX counterparts.

A comparison of carapace length and mass of adult male and female turtles at CRTS indicate dimorphism in body size. Males tended to be larger and heavier than females; these differences were evident in mean carapace length (p «0.001) and mean mass (p = 0.003). The distribution of carapace lengths for adult males: and females at CRTS is shown in Figure 36. Although dimorphism is indicated by these data; we were notable, to assign known age to body size for most adults'. Based on observed secondary sex features and/ or reproductive behavior, we determined that the smallest adult male in our study had a carapace length of 228mm, and a mass of 1650g, whereas the smallest adult female had a carapace length of 221mm, and a mass of 1680g.

Feeding Ecology: Our data on feeding is based on flushing stomachs of recently captured turtles, and on observing the feeding behavior of captive turtles. We flushed remains of snails and aquatic insects from turtle stomachs, observed turtles eating small fish, tadpoles, and crayfish. Vegetation in the stomach flushing samples was minimal, and likely ingested accidentally with other food items. Turtles were found to have food in their stomachs throughout the day, and thus appear to feeding continually, on a daily basis, and opportunistically, based on our limited sampling (Table 22).

5.7 Thermal Ecology and Activity Patterns:

Seasonal Variation in Body Temperature: Turtle body temperatures range seasonally from 0.2 C in January to 35 C in early August. During the months of December trough March, monitored body temperatures were just above freezing, between 0 -1 C. In the spring, turtles were able to achieve body temperatures of 29 -34 C by late April. Body temperatures were elevated to daily levels that ranged from 30-35 C when environmental conditions permitted, throughout the period from May through September. By mid October, some turtles were still able to maintain body temperatures above 25 C.

A represent record of the body temperature of a monitored turtle during an annual cycle, from spring 1996 through summer 1997 is illustrated in Figure 37.

Mid-Winter Body Temperature: We observed differences in the body temperatures of three turtles overwintering in the same marsh within 30 meters of one another. The magnitude of these differences was about 0.7 C at any point in time, and changed less than 2 C over the period monitored. We were not able to precisely locate telemetered turtles through the ice layer.

The observed variations in body temperature may be attributed to microhabitat selection by turtles moving from area to area under the ice, or alternately to overall changes in the thermal conditions experienced by turtles that remained inactive it the same location. Temperature variation from the ice/water interface to 10 cm into the soft, muddy bottom ranged from 0.1 C to 2 C, respectively. Thus, changes in body temperature (>0.5 C) may reflect changes in location.

Daily Pattern of Body Temperature: Turtle body temperatures are the result of available solar radiation, air and water temperatures, interacting with the behavior of the turtle. A turtle's body temperature typically shows a slow decline in the early morning hours as it parallels or converges with crater temperature. When the turtle basks (0700 -1100 hr.), body temperatures rise rapidly from 10-20 to 30 - 32 C Body temperatures at these high levels are actively maintained throughout the afternoon and early evening (1100 -1700 hr.). Thereafter, body temperatures decline sharply. By 1900 - 2100, the turtle's body temperature is within several degrees of water temperature and closely parallels the gradual decline in water temperature throughout the night. A detailed synopsis of the, thermal ecology of representative turtles, with further details of the methodology, results, and significance of this aspect of the study is presented as Appendix A.

Activity inferred from body temperature records

Seasonal Pattern of Activity: Turtles are active about 60% of the annual cycle, beginning in early April and ending in late November. During this period, we observed turtles to be active across a wide range of body temperatures (2.8 - 34.7 C). In the spring, emergence from overwintering was determined on the basis of increased activity associated with changes in body temperature consistent with the increased activity. In 1997, turtles emerged between 28 March and 17 April. Based on trapping success, turtles are feeding as early as 26 April. During late April, monitored body temperatures were above 20 C and in the range where digestive efficiency is enhanced as temperature increases. During May through August, a wide range of body temperatures were available, especially temperatures consistently above 28C. At these body temperatures, turtles forage, move; grow; and engage in reproductive activities. By September and October, activities such as growth, feeding and long distance movements decrease. In the fall, turtles remain active at low body temperatures. For instance, mating behavior was observed on 17 October at body temperatures of 7 C in water at 5C.

Daily Pattern of Activity: The daily activity of turtles was monitored indirectly via body temperature records and directly with activity circuits built into the radio transmitters of some turtles. Daily activity begins at sunrise, and is consistently high from 0800 to 1600 hr. From 1600 - 2100 hr., turtles were active intermittently. By 2200 hrs, most turtles were inactive. In our study, turtles conformed to a diurnal pattern of activity, with peak activity occurring primarily from morning through midday.

6. DISCUSSION

6.1 Distribution

Previous information about turtles at Camp Ripley

Prior to our study, the status of the Blanding's turtle at the Camp Ripley Training Site (CRTS) was uncertain. Previous information on the species was based primarily on infrequent sightings / observations, augmented by several road surveys (Erickson 1995, Zellmer 1995), a habitat survey (Brown 1995), and a basewide inventory that involved limited tracking of turtles by telemetry and intermittent trapping (Dorff and Nordquist 1993; included here as Appendix B). These findings were summarized in a composite-map of known locations in which priority habitat at CRTS was tentatively identified (Figure 8 in Merrill, 1995; included here in Appendix C).

Thus, attention was initially focused on the XXXXXX of the CRTS, in the region we refer to in this study as the XXXXXX1 and XXXXXX2 areas (or the XXXXXX region). Preliminary data suggested that 1) there were at least two areas in the region where turtle activities were concentrated, areas that correspond to the XXXXXX1 and XXXXXX2 areas identified in our study, 2) nesting and overwintering sites were located within this region, possibly dose together and/or possibly separated by the CRTS boundary, and 3) there was suitable habitat and a substantial number of turtles located outside the base perimeter, to the XXXXXX of the CRTS.

Elsewhere on the CRTS, prior to our study, turtles had been observed or trapped in several XXXXXX wetlands and primarily XXXXXX; these localities are included in the XXXXXX region, as designated in our study. No information was available on nesting, overwintering, and/or movements across base boundaries in these areas prior to our study.

Present distribution of turtles at Camp Ripley

On the basis of recent surveys and turtle captures, Blanding's turtles appear to be distributed along an axis that runs from the XXXXXX of the CRTS across the XXXXXX region through the XXXXXX of the base. XXXXXX are the extensive wetlands associated with XXXXXX in the XXXXXX of the CRTS to the XXXXXX drainage and associated wetlands (outside the XXXXXX of CRTS) . Within this broad distribution, we identified three areas where the turtles were encountered regularly, and concentrated our investigations initially in the

XXXXXX region, in the XXXXXX 1 and XXXXXX2 areas, and expanded our studies into the XXXXXX region during the second season of field work.

To date, we have documented established, viable concentrations of turtles, that include successfully reproducing females as well as juvenile and adult males utilizing wetland habitats throughout the year in the XXXXXX regions of the CRTS. Although we were unable to document a similar concentration of turtles in the intervening habitats in the XXXXXX region of the CRTS, all indications are that, substantial numbers of turtles inhabit this area, based on the limited data available. Because there are no obvious barriers to movement across this broad corridor (from the XXXXXX) and because suitable habitats occur throughout the corridor, we tentatively conclude that the present distribution of turtles is XXXXXX, XXXXXX. From a management perspective, it seems prudent to consider that the turtles inhabiting the CRTS, particularly those in the concentration areas, are members of a large continuous population, rather than being partitioned into subpopulations.

The current paucity of information about turtles in the XXXXXX region is due largely to the inaccessibility of the XXXXXX region due to frequent military activity and the presence of two active ranges. When we consider that the turtles elsewhere on the CRTS are heavily reliant on wetland habitats throughout most of the year, and venture into upland habitats only infrequently, it seems very likely that the existing level of military activity is not a major threat to turtles inhabiting the XXXXXX5 region.

Little is currently known about the presence of turtles in the XXXXXX and in the XXXXXX of the CRTS. Apparently suitable habitats exist in these regions, particularly XXXXXX, but well documented turtles occurrences in these areas are rare.

Distribution of turtles off-base

At present, based on our intensive investigations in the XXXXXX1 area, the XXXXXX of the CRTS is transparent to a number of turtles that nest and spend a substantial period of each season in wetlands within the CRTS, but are overwintering in wetlands offbase XXXXXX. We have circumstantial evidence that suggests a similar situation may characterize at least some of the turtles inhabiting the XXXXXX, because suitable wetlands are located on either side of the XXXXXX.

There are two points relevant to the management of turtles in these boundary areas. First, it is important to stress that the turtle occurrences on either side of the boundary XXXXXX are, in fact, individual turtles (that we tracked for two seasons) whose living space is presently divided by the present boundary line. Consequently, threats to either the turtles and/or their habitats on either side of the border would jeopardize the turtles inhabiting these areas. Second, loss of turtles on either side of the border would probably be mitigated in part by immigration of turtles from nearby areas over an appropriately long period of time. But the loss of habitats on either side of the boundary would likely have negative effects on turtles living in these areas, and could jeopardize their continued presence. In short, maintaining viable concentrations of turtles on base will require that special attention be paid to ensuring favorable conditions off-base in these border areas.

6.2 Abundance

In this section, we discuss estimates of turtle numbers in concentration areas, expand our estimate across the CRTS, and relate this information to the status of turtles regionally, as well as elsewhere in the species range. Several factors, if ignored, are likely to confound estimates of population numbers, 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 a strong female bias (29 females: 2 males: 0 juveniles), while trapping surveys revealed many more males and juveniles in proportion to females (16 females: 18 males: 13 juveniles). In our study, the mix of both survey techniques, particularly in the concentration areas, provided us with a different composite view of turtle abundance, than that provided by either method alone. As noted previously, 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.

Total number of turtles in concentration areas

We are cautiously optimistic that most of the adult females in the XXXXXX1 and XXXXXX2 areas were captured, i.e., the actual numbers of adult females in these areas are not much larger than our surveys indicate. In the XXXXXX1 area, 13 new females were marked in 1996, but only three new females were found in 1997. We estimated the total female population at 22 in 102 ha of summer wetland habitat. In the XXXXXX2 area, two new females were marked in 1996, whereas four new females were marked in 1997. The small numbers of females captured overall by either method in the XXXXXX2 area suggests that there are fewer adult females in this concentration, as indicated by our density estimates. We estimated the total female population at 8 in 17 ha of summer wetland habitat.

In the XXXXXX3 area in 1997, we captured 17 reproductive females, which exceeds the number of reproductive animals captured during a single nesting season for the XXXXXX2 and XXXXXX1 areas combined. Because we primarily relied on nesting surveys during only one season in the XXXXXX region, the XXXXXX3 concentration area likely contains many more adult females than those documented in the XXXXXX region. The estimated number of females for the XXXXXX3 area, based on our studies in the XXXXXX region, range from 71-150 females inhabiting 321 ha of wetland habitat.

The largest observed demographic component of each concentration of Blanding's turtles are adult females (see table 4). Therefore, observed sex ratios at CRTS were female-biased, ranging from 1.2 (XXXXXX2 area) to 1.6 (XXXXXX1 area) females per male. Because both nesting surveys and trapping effort in these areas was intensive, these observed sex ratios approximate the apparent sex ratio of 1.1 female per male, based on the Lincoln estimates of population size in the combined XXXXXX1 and XXXXXX2 areas. The skewed sex ratio in the XXXXXX3 area (2.8 females per male) undoubtedly reflects a female bias, produced in large part by the reliance on nesting surveys to locate turtles. Sex ratios reported for other populations do not provide additional insight as they range from male-biased (Graham and Doyle 1979) to female-biased populations (Congdon and van Loben Sels 1991).

The number of adult male and juvenile turtles that remain unmarked is unknown for all region at CRTS. There are likely to be fewer unmarked males and juveniles in the XXXXXX2 and XXXXXX1 areas than the XXXXXX3 area because of the longer duration of trapping surveys. Juveniles could be especially under represented in all areas if they occupy habitats not surveyed by researchers (Congdon et al. 1983, Kofron and Schreiber 1985, Ross 1989) or have different habitat utilization patterns than adults (Pappas and Brecke 1992).

Total Number of turtles on CRTS

The estimated total number of turtles in the XXXXXX region at CRIS is 30 females and 27 males for the XXXXXX1 and XXXXXX2 areas combined. Using the lower estimates for females in the XXXXXX3 area of 71 and an apparent sex ratio of 1.1, the corresponding estimated number of males is 65. Summing the estimates from these three areas yields a total population count of 101 females and 92 males, or approximately 200 adult turtles. If we then conservatively add in another 100 adults that may inhabit other suitable wetlands on the CRTS, particularly in the understudied XXXXXX region, we estimate that the turtle population base-wide numbers about 300 adults.

At CRTS, we observed the juvenile component of the population to be 10 of 52 animals for the relatively well-studied XXXXXX areas, or about 20% of the population. If we use this proportion to estimate juveniles base-wide, at 75, then the total population including juveniles rises to 375. Other authors have used values closer to 40% for the juvenile cohort, or 200 juveniles in a total estimated population of 500 turtles base-wide.

The size of the juvenile cohort has consistently been an enigma in studies of Blanding's turtles. Many researchers have noted the rarity or absence of juveniles (Ross 1989, Congdon and van Loben Sels 1991), while others have observed large juvenile cohorts (Butler 1995). The lack of large juvenile cohorts has been attributed to 1) researchers not sampling wetlands inhabited by juveniles (Congdon et al. 1983, Ross 1989), 2) a true lack of juveniles due to high nest predation rates (Congdon et al 1983), or 3) higher relative predation of juvenile versus adult turtles (Frazer et al. 1990). Of the 10 juveniles captured in the XXXXXX areas, 9 utilized similar habitats as adult turtles, so we believe that the documented differences in habitat utilization by juveniles vs. adults in populations elsewhere (Butler and Graham 1995, Pappas and Brecke 1992) is not strictly applicable at CRTS.

Densities and Regional Importance

Blanding's turtle densities, calculated on the basis of inhabited wetlands, at CRTS are lower than all other described populations (max. density 1.4 turtles/ha). In other localities, densities for the species 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 the turtles at CRTS may be particularly sensitive to loss of habitat as well as to factors such as road mortality and nest predation.

The present widespread distribution of the turtles across the CRTS, particularly in two border regions, coupled with estimated population sizes of 375-500 turtles base-wide, indicates that the CRTS represents one of the largest intact, undeveloped tracts of Blanding's turtle habitat in Minnesota. This feature together with the presence of significant turtles and habitats off-base as well as within the region, and its location on the northern periphery of the species' range, suggest to us that the long term survival and well being of the species in central Minnesota may well depend on the successful management of the species on the CRTS.

6.3 Critical Habitats

Seasonal Activities in Wetland Habitats and Usage Patterns

In general, Blandings turtles prefer shallow wetlands with a soft organic bottom, and abundant emergent vegetation (Ernst et al.1994). 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). Similarly, turtles at CRTS were found to occupy a variety of wetland types and sizes for summer activities. Wetland habitat types selected throughout the species' range include pond habitats (Kofron and Schreiber 1985, Rowe 1987) and marsh habitats (Congdon et al. 1983, Gibbons 1968, Graham and Doyle 1977). It has been argued that Blanding's turtles in other populations use shrub swamps less than expected based on their availability (Ross and Anderson 1990). However, at CRTS we observed turtles to preferentially utilize shrub swamp habitats for extended periods (>50 days), even when deeper, less vegetated habitats are nearby, or found in a contiguous wetland.

For example, in the XXXXXX1 area, juvenile ABV (see Figure 13), which overwintered in XXXXXX, passed by XXXXXX, an 18.5 ha. inland fresh water wetland (type 5 wetland), which was only 220 meters distant. Instead, this turtle moved 690 meters to XXXXXX, a 3.5 ha. shrub swamp (type 6 wetland). Similarly turtles in the XXXXXX (XXXXXX2 area) have access to a 3 ha. area categorized as inland open fresh water wetland (type 5 wetland). However, trap captures and telemetry locations suggest that they avoid this open area, in favor of the shallower, more heavily vegetated periphery.

Despite the preference for shrub swamps for extended inhabitations, a variety of other wetland types were utilized during the summer (Ross and Anderson 1990, Rowe and Moll 1991, Butler and Graham 1995). At CRIS, an array of wetlands was used by nesting females as transition, or staging, wetlands. These wetlands ranged in size from 0.1-16 ha. and included shallow, fresh marshes (type 3), inland, deep, fresh marshes (type 4), inland, open, freshwater (type 5), and shrub swamps (type 6). These wetlands were generally used as temporary wetlands and occupied for short periods of time (<7 days).

Adult male turtles at CRTS also utilize a variety of wetlands during the activity season including those listed above for nesting females. We observed a slight difference between adult males and females: females typically used smaller wetlands other than shrub swamps for a short duration (<7 days), while males will use the same types of wetlands, but for a longer duration (10 – 49 days). The nature of this observed difference in habitat utilization is not at all clear.

Moriarty (pers. comm.) has suggested that Blanding's turtles utilize small vernal pools as feeding sites since they typically contain abundant amphibian larvae. We did not observe turtles to use vernal pools at CRTS. In fact we were only aware of one truly "ephemeral" wetland (that dried completely by mid-late summer) during two years of observation, and none of the tracked turtles used it. While vernal pools were largely absent from CRTS, we did observe that some adult males lived in small wetlands that were not "typical" turtle habitat. For example, male ABC (see Figure 17) inhabited a tiny (0.01 ha.), but deep pool for 27 days in July. The pool contained no conspecifics and no emergent vegetation, but did contain abundant tadpoles of various species.

Studies of Blanding's turtles in Wisconsin (Ross and Anderson 1990) and northern Illinois (Rowe and Moll 1991) have observed substantial variability in mean daily distance moved. Ross and Anderson observed a significant difference between the mean daily movements of male (48.4 41.2 m.) and female turtles (95.1 79.0 m.), as where Rowe and Moll dill not (males: 48.9 41.7 m.; females: 32.4 28.7 m.). At CRTS, we similarly observed wide variability in daily movements of individual Blanding's turtles: mean daily movements of males, females, and juveniles ranged from 0 - 113, 13 - 99, and 32 - 72 meters, respectively.

The wide variation in mean daily distance reported earlier prompted us to investigate how the areal extent of the wetland affected a turtle's daily movements. At CRTS, daily movements of Blanding's turtles inhabiting small wetlands (<8 hectares) corresponded to the boundaries of wetlands (see Figure 24). Rowe (1987) and Ross and Anderson (1991) reported that daily aquatic movements appeared to conform to the boundaries of wetland habitats. As a consequence, comparisons among turtles occupying variously sized wetlands must be made cautiously.

We observed 7 of 10 telemetered turtles to have made at least 2 intermarsh movements between June 1996 - July 1997. Additionally, further analysis indicates differences in the timing of inter-marsh movements between age and sex classes (see Figure 22). Males appear to move between marshes throughout ; the activity season (Apr. - Oct.), whereas females move between marshes during nesting and just prior to overwintering. Juveniles move mainly before and after overwintering. The observed movement patterns indicate the times when turtles might be commonly observed on land; hence, turtles were found on land throughout the summer.

Rowe and Moll (1991) observed that Blanding's turtles in northern Illinois changed activity centers two to four times during a season. The duration of "activity center" or wetland residence averaged 25 days (range= 8 - 55 days). At CRTS, we found duration of wetland residence varied, and was influenced by the size of the particular wetland (especially shrub swamps). All age and sex classes took up extended residences (>50 days). But, short residences (<10 days; usually associated with nesting) were characteristic of adult females. In contrast, intermediate residence times (11- 49 days) were typical of adult males (see Figure 23).

Overwintering in Wetland Habitats and Usage Patterns

In general, sites selected by overwintering turtles are characterized by shallow water depths (>1 meter), abundant vegetation, and a soft, organic bottom (Kofron and Schreiber 1985, Ross 1985, Rowe 1987). At CRTS, we did observe small groups of turtles to overwinter in the same marsh, but we did not observe any indications of turtle aggregations. We found that turtles overwintered by themselves or with one other turtle (9 of 24 observations of overwintering). In other wetlands containing multiple turtles, most turtles were separated by a minimum distance of 30 meters.

At CRTS, we observed overlap between summer and overwintering habitats; this feature has been noted elsewhere within the species' range (Ross 1985, Rowe 1987). However, while turtles at CRTS used a variety of wetland types during the summer activity season, shrub swamps were used almost exclusively for overwintering sites. The observed dual use of certain wetlands during both summer and winter by some turtles, but not by others, emphasizes the point that management strategies must identify wetlands that support a diversity of individual turtles and their activities.

Nesting in Upland Habitats and Usage Patterns

In addition to wetlands, upland habitats that include nesting areas are utilized by turtles at CRTS. Sites of recent soil disturbance at CRTS, such as roads and armor trails, have commonly been the sites for nesting turtles at CRTS. In the XXXXXX1 area, we observed 19 of 20 (95%) nests occurred within 25 meters of a roads or armor trail, including 11 radio-tracked turtles. In the XXXXXX2 area, four nests we located on roads and armor trails, 1 nest was located in an old gravel pit, while only 1 nest was observed in an old field. Five of the six nests in the XXXXXX2 area were located with telemetry. All nests found in the XXXXXX3 area occurred on the sides of roads. While our results could be biased by out nesting survey technique, it cannot be disputed that Blanding's turtles at CRTS are heavily using roads and armor trails for nesting. This attraction to roads is a potential cause of mortality in the CRTS population. While selected nest sites in undisturbed areas includes old fields and areas of exposed sandy loam soil (Ross and Anderson 1990, Butler 1995), nest sites in more heavily-disturbed areas were frequently found to occur along exposed road cuts, and also in the roads themselves.

Most observed nesting is localized at CRTS. Nesting was clustered in roads around the XXXXXX1 area, XXXXXX2 area, and the XXXXXX vicinity in the XXXXXX3 area. Obviously this result could be attributed to our survey methods, but it identifies roads and armor trails as important nesting habitat. These observed nesting concentrations are spatially proximate (<1700 meters) to known turtle concentrations. Future surveys at CRTS, particularly in the XXXXXX region, can infer the approximate locations of other turtle concentrations from concentrations of nesting.

We have every indication that predation on turtle nests is very high at CRTS. During a single year in central Wisconsin, Ross and Anderson observed 16 of 16 (100%) of known Blanding's turtle nests to be predated. Because some of the nests we followed were excavated and the eggs re-buried to obtain clutch measurements, predation rates on nests at CRTS cannot be viewed as natural nest predation rates. Of these, we observed that 5 of 17 (29%) nests were eventually predated. Based on observations of nest predation on other turtle species at CRTS, we expect nest predation rates at CRTS are higher than observed from the nests we disturbed.

Nesting Blanding's turtles have been reported to move long distances over several days to selected nest sites (Rowe and Moll 1991, Congdon et al. 1983). We observed nesting females to move a mean distance of 640 meters to selected nest sites. This distance was traversed over a mean time of 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 between 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), habitat unsuitability (Dorff 1995), hatchling emergence (Butler and Graham 1995), and seasonal changes in activity centers (Ross and Anderson 1990, Rowe and Moll 1991). Setting aside long distance movements associated with nesting and hatchling emergence, hurtles at CRTS were observed to move similar distances as reported for other populations (see Figure 13). Rowe and Moll (1991) also observed "exploratory sallies" where individual turtles would travel up to 895 meters through various' aquatic habitats over the course of 14 days. These "exploring" turtles would not spend more than 2 - 3 days in any particular place, and eventually return to its original marsh: The turtles we tracked at CRIS did not exhibit these "exploratory sallies."

Long term residency and lifetime shifts in habitat usage

We have limited data to suggest that the turtles we studied are long term residents of the areas they inhabited during our study. During 1991-1992, Dorff and Nordquist (1993) captured 13 Blanding's turtles and gave permanent identification codes to 10 turtles in the XXXXXX2 and XXXXXX1 areas. We recaptured 4 of 7 turtles previously marked by Dorff and Nordquist from the XXXXXX2 area. None of the three XXXXXX1 area turtles marked by Dorff/Nordquist were recaptured; however, they may have moved off base into the XXXXXX, since a number of our newly marked turtles did. Zellmer (1995) reported several road killed turtles in these areas during his surveys, but markings were not noted.

The frequency and distances of Blanding’s turtles movement and long lifespan 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 inter-marsh movements (725 meters) of turtles at CRTS, it is conceivable that a turtle could traverse a distance of 33 km during its lifetime. Or alternately, if more liberal estimates of life span (70 years) and inter-marsh movements (2500 meters) are applied, based on our study, a turtle at CRTS could move 175 km, or move down to the Twin Cities during its life time.

These examples illustrate the point that while Blanding's turtles at CRTS did not move between areas, it is certainly possible given the density and distribution of wetlands at CRTS and turtles' propensity for movement. These examples also highlight the likelihood of continued movements of turtles onto and off of CRTS properties. Congdon (pers. comm.), Butler (1995), and Emrich (1991) have similarly observed Blanding's turtles to move out of their study areas over the course of several years.

Fortunately, Blanding's turtles are not likely to move as far as indicated above. Blanding's turtles appear to exhibit varying degrees of fidelity to familiar wetlands (Rowe and Moll 1991, Butler 1995, this study) and general nesting locations (Congdon et al. 1983, this study). 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 3 turtles were found nesting as far as 1.3 km away from previous nest sites.

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 wetlands. It is likely the wetlands used by turtles during our study will continue to be utilized into the foreseeable future. As wetland succession proceeds, currently utilized wetlands will eventually fill in, and new wetlands will be created (i.e. new beaver impoundments). Turtles can be expected to move into and out of these habitats as these processes occur. In other studies on the species, turtles have adopted artificial nesting areas, created specifically for this purpose, when traditional nesting sites were incorporated into housing subdivisions (Emrich, 1991). Elsewhere, Blanding's turtles living on a military base surrounded by development in eastern Massachusetts apparently have increased in numbers while utilizing new wetland impoundments and nesting in old fields periodically disturbed by military activities (Butler, 1995).

6.4 Reproductive Ecology

Seasonal Aspects of Reproduction

Courtship and mating behaviors in Minnesota have been most commonly reported during March through May (Oldfield and Moriarty 1994, Pappas and

Brecke, unpublished data). We observed indications of males seeking females during both spring and fall including finding male turtles, attracted to traps baited with female turtles and finding males clamped on top of females during telemetry locations. On October 17, 1997 when water temperatures were between 6 - 7 C, we found two pairs of courting turtles (males clamped on top of females). However, cloacal flushes of the females involved did not indicate the presence of sperm.

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 season in southern Minnesota (Oldfield and Moriarty 1994, Pappas and Brecke, unpublished study) has ranged from 30 May to 13 June. At CRTS, we observed reproductive females to have had enlarged ovarian follicles by as early as 28 May during 1997, however the earliest nesting began during our study was 10 June. We observed the peak of nesting season to have occurred from 15 - 20 June during both years of the study. Because the start of nesting is related to ambient air temperatures in April (Congdon et al. 1983), it is likely that the yearly nesting peaks will also vary from year to year depending on ambient temperature variation. The nesting season ended by 26 June during 1997, but lasted until mid-July during 1996.

Incubation time of Blanding's turtle eggs in the field and the laboratory varies with temperature (Ewert 1979). The mean incubation times of Blanding's turtle eggs incubated in our laboratory incubated at 27, 28, and 29 C were 60, 55, and 54 days respectively. 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 the time from egg laying to hatchling emergence to range from 77 - 89 days, which is similar to durations reported from New York (mean = 97, range 82 -110 days; Emrich 1991) and Michigan (mean = 84, range 73 -104 days; Congdon et a1.1983). The dates of hatchling emergence elsewhere ranges from mid-August to early October (Ernst et al. 1994), and is similar to our observations at CRTS (28 August through 20 September). Despite reports of Blanding's turtles overwintering in the nest in southern Minnesota (Pappas and Brecke, unpublished report), we did not observe any hatchlings to overwinter in the nest.

Daily Patterns of Nesting

Nesting at CRTS typically began by 2030 hours and lasted 3.4 hours. Actual nesting was preceded by directed movements to likely nesting sites that were often initiated hours before nesting commenced. In southern Minnesota, Pappas and Brecke (unpublished report) similarly reported observing a peak of movement to nesting grounds between 1800 - 2100 hours. In Michigan, Congdon et al. (1983) observed 45 of 50 nests to have been completed between 1700 - 0045 with an average duration of 2.5 hours, however the exact end times of late evening nests were not always known. He suggested that as nesting lasts later into the evening, the more likely it was to require more time to complete due to rapidly cooling ambient temperatures. One turtle at CRIS, whose nesting activities lasted until 0220, ceased all activities after completion of egg laying (between 2345 - 0045 hours) for an hour. The subsequent completion of the nest then took another 1.5 hours.

Congdon et al (1983) also observed 3 nests to have been completed between 0815 - 0930, and 2 additional nests to have been completed between 1145 -1230 hours. Similarly, movements towards nesting grounds in southern Minnesota (Pappas and Brecke, unpublished study) were also observed to occur from 0600 - 0900 hours. While we did not observe any morning nesting at CRTS, we were not actively surveying for nesting turtles during this time. Nesting surveys were commonly run from 1700 - 0000 hours.

Reproductive Features

A suite of reproductive attributes of the Blanding's turtles at CRTS differ from those studied in other areas. These include: large clutch size, large clutch mass, large egg size, and clutch production by individual turtles annually rather than less frequently. Gibbons and Greene (1990) observed that for many species of aquatic turtles, larger individuals are more likely to have more eggs in a clutch than smaller individuals. Because Blanding's turtles at CRTS are substantially larger than other studied populations (see Body Sizes below), it logically follows that CRTS Blanding's turtles should exhibit larger clutch sizes, clutch masses, and egg sizes.

In fact, Blandings turtles at CRTS do produce larger clutch sizes, clutch masses, and egg sizes than other studied populations (Rowe 1992, Congdon and van Loben Sels 1993, DePari et al. 1987, Petokas 1986, Pappas and Brecke, unpublished report, Herman et al. 1994) A comparison of the CRTS parameters in relation to those previously reported is shown in Table 23. The mean clutch size at CRTS for 1996-1997 was 17.7 eggs, almost double that of any other population Surprisingly, clutch sizes at Weaver Dunes, Minnesota, located 240 km south of CRTS, were more similar to clutch sizes reported for more southerly populations than to the clutch sizes we report. Similar patterns were observed for clutch mass and egg size. Only mean hatchling mass at CRTS was similar to other populations. Thus, the individual reproductive output of a turtle at CRTS is approximately double that of individuals in other populations.

In addition, our limited data on reproductive frequency strongly suggests that most adult females in the population at CRTS reproduce every year. We observed 7 of 11(63%) females to be reproductive during both the 1996 and 1997 nesting seasons, but this does not include several females that likely nested in undetected localities in 1997. In contrast, in Michigan, Congdon et al. (1983) estimated that only 48% of sexually mature females nested in any given year during a 6 year period.

Gibbons et al. (1982) recognized that the clutch size-body size relationship within species is highly variable, but generally, larger individuals produce larger clutches. Within the CRTS Blanding's turtle population, we observed that larger females produce larger clutches and eggs than smaller females. We also found that larger eggs tended to produce larger hatchlings.

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

6. 5 Growth, Body size, and Maturation

In addition to the reproductive features noted above, the turtles we studied exhibited a suite of life history characteristics that distinguish this population from populations elsewhere. These include: rapid growth, large body size, and accelerated maturation. We also include here comments on hatchling /juvenile habitats.

Rapid Growth

While we only observed one year of growth and could not sex juvenile turtles less than 200 mm (C.L.), we were able to make limited comparisons of similarly aged juveniles with respect to growth. Despite small sample size, our data indicate a very high average growth rate relative to that reported by Pappas and Brecke (ms) for a high density population in southern Minnesota. In their study, a ten-year old juvenile had an average carapace length of <150mm vs. >200mm for the same aged turtle at CRTS. Such rapid growth in the cooler climate at CRTS, in turn, suggests that juveniles are able to exploit a rich food resource as well as thermoregulate at sufficiently high body temperatures to process food quickly. The marked variation in growth rates suggests similar variation in age at maturity, assuming maturation at a given body size. Congdon and van Loben Sels (1993) observed considerable variation in growth rates of adult female Blanding's turtles in Michigan resulting in variation in age at sexual maturity.

Suitable Hatchling/juvenile habitats

Unfortunately, our observations on the specific habitats or habits of hatchlings and juveniles are very limited. Other studies in which small turtles appear to be absent from habitats frequented by adults have suggested that small turtles are selecting different habitats (Pappas. and Brecke 1992). In contrast, at CRTS, larger juveniles appear to inhabit many of the wetlands frequented by adults, based on trapping data. Presumably, adequate microhabitats exist in these wetland complexes to provide sufficient cover and refuge for small turtles, including hatchlings.

Large Body Size

Blanding's turtles at CRTS are much larger than turtles in other localities (see table of comparative body sizes) (Pappas and Brecke unpublished report, Ross and Anderson 1990, Petokas 1986, Congdon et al. 1983, Rowe 1987, Kofron and Schreiber 1985). A comparison of CRTS parameters with those from previous studies is presented in Table 24. We also observed considerably larger minimum sizes at sexual maturity; the smallest male to display secondary sexual characteristics was 228 mm carapace length, and the smallest gravid female was 221 mm carapace length. A comparison of CRTS parameters with those from, previous studies is presented in Table 25. Our age estimates for these sizes, based on limited data, are 13 year for males and 16 years for females. We observed size dimorphism between adult male and female Blanding's turtles, with adult male being larger than adult females. These data suggest that the CRTS turtles are maturing at larger size and an earlier age than those reported for other populations, and may be indicative of an overall pattern of accelerated growth, possibly associated with abundant food resources and/or reduced competition. Regardless, Blanding's turtles at CRTS exhibit long maturation periods (10+ years), and long generation times (20+ years).

Mortality on adults

Natural mortality of adults due to predation is presumably low, but mortality associated with human activities has been documented at CRTS. Zellmer (1995) reported two road mortalities of Blanding's turtles noted during his nesting surveys. Highways off-base are likely a primary contributor to adult turtle mortality in the region.

6.6 Activity patterns, Thermal ecology, and Feeding

In our study, we utilized implanted body temperature loggers to provide a continuous record of body temperature for individual turtles throughout the annual cycle. The resultant patterns of body temperature when correlated to known patterns of activity provide an indirect, but very accurate, record of overall turtle activity. We have utilized this information to verify the reliance of turtles on features of the aquatic environments they inhabit, i.e., summer and winter wetlands, on both a seasonal as well as daily basis.

Seasonal Variation in Body Temperature

Body temperatures during the activity season ranged from 2 - 34C. The lower limit of daily body temperatures varies throughout the activity season, and is closely associated with water temperatures. The upper limit of daily body temperatures is relatively constant throughout the activity season and is probably related to individual preferred temperature ranges. The range of overwintering body temperatures is between 0.2 - 2.1C.

Seasonal Activity from April thru November

The overall pattern of seasonal activity inferred from the temperature records underscores the importance of wetlands, particularly the aquatic environment, as both long term summer and winter residences. It is dear from these records that turtles are spending much of the time each day in the water regardless of the time of year.

At CRTS turtles initiate activity in April, at relatively cool water temperatures of 4 to 5C. The beginning of the activity season coincides with the disappearance of winter ice sheets. In northern Illinois, Rowe and Moll (1991) first observed Blanding's turtles to be active on 29 March at water temperatures of 19 C.

Soon after emergence, turtles at CRTS elevate their body temperatures above 20C by aerial basking. Turtles were responding to baited traps as early as 26 April. Rowe and Moll (1991) reported capturing turtles in baited traps from May through August, whereas at CRTS we captured turtles in traps from late April through early November. Body temperatures in November suggest some limited activity, but this was not confirmed with telemetry observations.

Overwintering, as evidenced by inactivity, commenced in late November at CRTS. In Illinois, Rowe and Moll (1991) observed radio-tracked turtles to enter winter dormancy between mid October through mid November. At CRTS, no significant movements (>5m) were observed from December through March. Based on trapping records and body temperature inferences of seasonal activity, the best times for trapping surveys occur from April through August. However, trap success appeared to peak during late April and early May.

Daily Activity

At CRTS, turtles are active during the day, and inactive at night. The pattern of daily activity summarized below illustrates how dependent the turtles are on a mosaic of aquatic/ thermal environments, necessary for adequate thermoregulation as well as other activities such as feeding. Various components of wetlands, such as basking sites, vegetation in and around the water, floating mats, margins, etc. contribute to the diversity of aquatic habitats.

On a typical day during the summer at CRTS, turtles begin a cycle of daily activity around 0700 hours with aerial basking (=movement out of the water) that continued for 2-3 hours. At CRTS, while actual observations of basking turtles were infrequent, we inferred that most turtles were basking whenever conditions permitted it during the morning throughout the summer months. In contrast, aerial basking was observed rarely from March through late August in an Illinois population (Rowe and Moll 1991).

Mid-day is when we observed turtles to be most active. Temperature records and activity transmitters suggested that Blanding’s turtles were moving into and out of the water frequently (2-4X/hour) during the late morning and early afternoon. Turtles appear to feed throughout the day during the active season, based on trap data and stomach flushing. Activity appears to wane by 1900 hours when turtles are in the water. Inactivity is apparent by 2000 - 2200 hours and lasts throughout the night; we have no evidence that turtles are moving around during the night. The common observation of turtles basking during the morning hours suggests a possible time when visual sightings might be feasible. However, at CRTS, turtles were easily disturbed and often reentered the water quickly when they detected an observer.

Opportunistic Feeding

Blanding's turtles are opportunistic carnivores (Kofron and Schreiber 1985). While captive turtles ate crayfish when these were offered, stomach flushing did not support the notion that turtles at CRTS were selectively feeding on them, as suggested in other populations (Kofron and Schreiber 1985, Lagler 1943). At CRIS, turtles apparently feed on aquatic snails, as well as aquatic insect larvae. The diversity of prey items from stomach flushing suggests that they are eating any small animals that they encounter. Small amounts of plant matter appear to have been ingested incidentally with prey items.

In Missouri, Kofron and Schreiber (1985) observed feeding for 4.5 months during the activity season. In contrast, the turtles at CRTS appear to feed for a longer period, from mid April thru mid October (5.5 to 6 months), during the times when they are active. Thus, in comparison with populations in Illinois and in Missouri, the turtles at CRTS remain active for a longer period each year at considerably cooler ambient temperatures, and continue to feed throughout the period.

7. MANAGEMENT RECOMMENDATIONS

INTRODUCTION

Based on our study, Blanding's turtles require three general habitats:

1) **activity season wetlands**, encompassing a variety of wetland types and sizes occupied during spring, summer, and fall,
2) **overwintering wetlands**, predominantly shrub swamps, occupied from November through April, and
3) **nesting uplands**, characterized by exposed well-drained soils, utilized largely during the reproductive season from June through September.

At the Camp Ripley Training Site (CRTS), we identified and characterized two areas of turtle concentrations in the XXXXXX6 region, the XXXXXX1 and XXXXXX2 areas located in the Natural Resource Management Areas XXXXXX (XXXXXX1 area), and XXXXXX (XXXXXX2 area). These areas were studied intensively during two field seasons and the intervening winter. In addition, we located another concentration area in the XXXXXX region, located in Natural Resource Management Areas XXXXXX, and XXXXXX; this was studied only during the second field season Consequently, the more extensive XXXXXX region is not as well studied as is the XXXXXX region. The intervening XXXXXX region contains turtles, but due to military activity, has not been investigated systematically. For management purposes, the recommendations that follow have been developed as guidelines specific to the XXXXXX4, XXXXXX5, and XXXXXX6 regions.

The stated purposes of the Natural Heritage Program and the Waters Management Program as cited in the Integrated Natural Resource Management Plan for CRTS (1994) are the "continued existence" of threatened species and "production of high quality aquatic ecosystems for the maintenance of diverse fish and wildlife populations," respectively. Under the current Integrated Natural Resource Management Plan for CRTS (1994), only two wetland complexes containing Blanding's turtle habitat have been recommended as Special Management Areas under the Natural Heritage Program: the XXXXXX and XXXXXX. These designated areas presently include little of the adjacent upland habitats that are utilized by turtle for nesting activities.

GENERAL RECOMMENDATION AND CONDITIONS

It is our recommendation that a Blanding's Turtle Conservation Area (BTCA) be established at CRTS and receive listing as a "High Protection Priority" Special Management Area under the Natural Heritage Program. Because even the most stringent governmentally-mandated wetland buffer zones (including the 100 meter buffer zone mandated by the CRTS Environmental Office) do not adequately protect essential upland habitats of most turtle species (Burke and Gibbons, 1995), we recommend the BTCA be based on the frequency and distance of turtle movements observed at CRTS (see Results section, Inter-marsh movements and nesting movements). Adult female turtles were often observed to move up to 1700 meters away from residence marshes to selected nesting sites. Similarly, all age and sex classes were observed moving up to 2900 meters overland between preferred residence wetlands.

A boundary of 2000 meters from 8 sites of frequent and prolonged residences in the XXXXXX6 region encompasses all known wetlands and uplands utilized by turtles for essential activities (i.e. feeding, basking, overwintering, nesting, etc.) (Figure 38). The area enclosed by the 2000-meter boundary is recommended as the BTCA. Other, possible boundaries that are more restrictive (2500m., 3000m.) and less restrictive (1500m.) of the BTCA are detailed in Figure 39 and in Table 26: In addition to encompassing actual habitats turtles utilized during our study, the proposed BTCA includes potential habitats of turtles in the XXXXXX6 region, based on observation of movement distances (see results section) and the long lifespan of Blanding's turtles (Brecke and Moriarty, 1992).

The proposed BTCA is predicated on existing or reduced levels of military activity. Should the level of military activity increase, the criteria for establishing the BTCA and its ultimate utility in protecting turtles and associated habitats will need to be reevaluated.

SPECIFIC MANAGEMENT RECOMMENDATIONS

XXXXXX6 Region Wetlands (see Figure 5)

Threats: Blanding's turtles rely heavily on shallow swamps and marshes, including many hectares of wetland habitat outside the boundaries of CRTS, such as the XXXXXX wetland XXXXXX of CRTS. Loss or alteration of wetlands on private property could severely impact turtles at CRTS. While wetlands on CRTS are exempted from military activities (except XXXXXX), road construction and water-level regulation still pose lesser threats to turtle wetlands area-wide.

General Strategies: Concerted efforts must be made to protect and preserve any wetlands that fall within the BTCA, regardless of size or type. The top priority of preservation efforts in the BCTA should be shrub swamps (type 6 wetlands) of any size because of their extensive use as summer-activity and overwintering sites by turtles. However, wetlands of other types (types 3, 4, and 5) in the BTCA provide essential habitats also. The following guidelines apply to all wetlands in the BTCA:

- Do not alter water levels or drainage patterns.
- Wetlands should be protected from road or lawn chemical run-off, and other forms of pollution.
- No additional roadways should be constructed through existing wetlands.

Specific Strategies: Within the BTCA, specific wetlands merit special attention due to their frequent and extended use by Blanding's turtles. Important wetlands are found outside the boundaries of CRTS, including XXXXXX.

- **Off Base Wetlands** Voluntary protection strategies for off-base turtle wetlands must be discussed with property owners adjacent to the XXXXXX6 region of CRIS, especially the owners of land bordering XXXXXX. Landowners should also consider protecting adjacent uplands that might be utilized by nesting turtles. Additionally, resource managers should consider land acquisition, set-aside agreements, and conservation easements in critical off-base areas under threat. Any off-base sightings of Blanding's turtles should be reported to the CRTS Environmental Office and logged in a database (details in Section 3.1).
- **On Base Wetlands** Wetlands that receive frequent or extended use by Blanding's turtles within the BTCA on base should be absolutely protected. All military activities should be excluded within 200 meters of these wetlands, including bivouacking, and artillery placement.

XXXXXX6 Region Uplands

Threats: Because of high levels of military traffic on roadways throughout the XXXXXX6 region, road mortality presents a serious threat to Blanding's turtles in this region. All age and sex classes (adult males and females, juveniles, hatchlings and nests) have been found to utilize roads at CRTS, but road mortality poses a special threat for nesting females (see below). In addition, road maintenance (i.e. grading and mowing) may alter nest environments that in turn may have detrimental effects on eggs and hatchlings.

General Strategies: Turtles of all ages and sexes were observed to move long distances during May through October. Guidelines to eliminate road mortality should be implemented from 1 May through 15 October:

- Signs at XXXXXX and XXXXXX.
- Reduce speed limits to below designated speed limit in BTCA.
- Eliminate all off-road driving.
- Road maintenance, including road-grading, roadside grass mowing, and dust-control chemical spraying, should occur only from15 October -1 May.
- Clear roadside ditches in the BTCA when turtles are not using these areas (between 15 October -1 May) to provide attractive open environments for turtles to use during the next season.
- Inform Range Control of BTCA guidelines, instruct them to inform vehicle drivers to slow down in and/or detour around BTCA especially during the nesting season (see below). Instruct troops down range not to disturb any turtle found on roads; let them pass, or slowly drive around them, or better yet, avoid nesting areas.

- Development of specific educational materials, including instructional video, slides, posters, leaflets, etc. for use by Range Control and Env. Office.

Nesting Season Strategies: Nesting females turtles are the most likely to be encountered, injured and/or killed on roads. As nesting females are eliminated, turtle populations, already constrained by high nest predation and long maturation times, may decline in number. The following recommendations apply during the nesting season, 1 June -1 5 July, and specifically from 1200 - 0600 hours each day:

- Detour traffic around XXXXXX and the XXXXXX and/or XXXXXX. Traffic should also be detoured around the XXXXXX to minor armor trails and/ or XXXXXX, and XXXXXX.
- Install roadblocks on roads and armor trails commonly utilized by nesting turtles: XXXXXX, and XXXXXX. Roadblocks can be removed during the morning for vehicular traffic.
- Reduce speed limits to after-dark speed limits beginning at 1700 hours each day during the nesting season.

XXXXXX4 Region Wetlands (see Figure 6)

Threats: As in the XXXXXX6 region, maintenance of intact wetlands in the XXXXXX4 region is the most important component of a conservation strategy. However, the wetlands utilized by turtles in the XXXXXX4 region are not well delineated. Threats to habitat can be identified regardless, such as off base habitat loss and fragmentation of continuous tracts of existing wetland by expanding existing roads and the construction of new roads.

General Strategies: The wetland recommendations for the XXXXXX6 region are applicable to the XXXXXX4 region, including no alteration of water levels / drainage patterns, and wetland protection from road / lawn run-off and pollution We would additionally recommend that new roads should not bisect any existing wetlands.

Specific Strategies: The selected overwintering wetland of 6 monitored turtles in the XXXXXX3 region is the large sprawling marsh/ swamp complex located XXXXXX. This wetland and the adjacent upland habitats utilized for nesting should minimally be incorporated into the proposed XXXXXX Management Area.

XXXXXX4 Region Uplands

Threats: Road maintenance activities such as road grading and roadside grass mowing can have substantial, if indirect, effects on Blanding's turtle nests. Turtle nests and hatchlings can be destroyed by direct contact with road maintenance activities, or indirectly harmed by alterations of the thermal environment of the nest caused by the addition or subtraction of soil or vegetation over the nest.

General Strategies: In the immediate future, plans have been initiated to develop roads and armor trails in the XXXXXX3 region. Major road improvements should be undertaken in the spring and fall rather than in the summer to avoid possible interactions with turtles. In particular, these activities should be avoided during the nesting season (1 June -15 July). Despite current low levels of traffic in the XXXXXX4 region, we advocate the same general strategies identified for the XXXXXX6 region be applied to the XXXXXX4 region, such as eliminating off road driving, ditch clearing, re-scheduling road maintenance activities, and Range Control education. Sign locations include XXXXXX.

Nesting Season Strategies: Because traffic levels in the XXXXXX4 region are currently low, we do not believe that roadblocks around nesting areas are needed. Should traffic levels increase, or road-killed turtles be observed in the XXXXXX4 region, then roadblocks should be used. We support the "after-dark speed limits" from 1700 hours each day during the nesting season.

XXXXXX5 Region Wetlands and Uplands

Threats: We would suggest that the threats to XXXXXX5 region habitats are likely to be similar to those in the XXXXXX6 and XXXXXX4 regions.

General Strategies: Little is known about the specific distribution and abundance of Blanding's turtles in the XXXXXX 5 region of CRTS. The guidelines described for the XXXXXX6 region may be generally applicable to the XXXXXX5 region, pending detailed information on turtles and their habitats in this region.

Specific Strategies: Blanding's turtles were found in only two wetlands during the 1996-97 surveys. These included XXXXXX and XXXXXX; these areas should be maintained. Nesting season surveys are suggested on accessible roadways adjacent to wetlands and/or open fields.

MONITORING BLANDING'S TURTLES

Areawide/ Regional Monitoring of Blanding's Turtles

A master database, should be developed by CRTS Environmental personnel in conjunction with the Regional Non-Game Specialist (Pam Perry) at the Brainerd DNR Office to catalogue all known record of Blanding's turtle occurrences and sightings for the entire region. This database can then serve as a foundation for planning future Blanding's turtle surveys and monitoring programs for the entire central region of Minnesota.

XXXXXX6 Region Monitoring

Annual Nesting Surveys - General Procedures: Annual nesting surveys should be focused on one area per year (XXXXXX1, XXXXXX 2 or XXXXXX3 area). The focus should be alternated from one area in the XXXXXX (XXXXXX1 or XXXXXX2) the first year, to the XXXXXX3 area in the second year, to the other XXXXXX area in the third year, and again to the XXXXXX3 area in the fourth year. The suggested schedule will permit an intensive survey in each area to maximize success in locating nesting females.

The annual nesting surveys can be done with inexperienced volunteers on a yearly schedule between 10 - 30 June. Surveys should be conducted, every night during this period, with a 10 night minimum should less frequent sampling be done. Survey areas should be covered on a nightly basis by 2 trucks (minimum) that are occupied by 2 people (at least 1 person per truck should be familiar with sexing, marking, and identifying turtles). (see methods section for details of nesting surveys)

- **Nesting Survey Routes:** Survey routes for the XXXXXX1 and XXXXXX2 areas are outlined in Table 27.
- **Data Collection:** Marked vs. unmarked, identification code, carapace length, plastron length, mass, and date and time observed. Unmarked turtles should be given individual identification code according to protocols outlined in the methods section. If 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).
- **Nest Protection Protocols:** Identified turtle nests should be protected with lm. x lm. sheet of staked hardware cloth until 1 August. Thereafter, remove the hardware cloth and allow hatchlings to emerge naturally, or nests can be caged to collect hatchlings and release in suitable shrub swamp (see methods section).
- **Questions Addressed:** How many turtles are reproducing every year? Are numbers of nesting females consistent from year to year? What is the rate of road mortality at CRTS?

Follow- up Studies--General: 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 these surveys can be determined by analysis of data collected from annual surveys in the XXXXXX6 and XXXXXX4 regions.

- **Procedures:** These surveys may include nesting, trapping, and telemetry surveys.
- **Questions Addressed:** How many previously marked turtles remain in the XXXXXX4 region? Are shifts in habitats occurring in the XXXXXX4 areas? Other questions of long term population status?

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XXXXXX4 Region Monitoring

Annual Nesting Surveys: The same general procedures and data collection categories are appropriate for use in the XXXXXX4 region as in the XXXXXX6 region. However, questions will be different because the current body of information is not as complete as for the XXXXXX6 region. As the habitat requirements of the XXXXXX3 area population become more established by monitoring programs, an additional BTCA can be established or the boundaries of the XXXXXX Management Area can be extended to encompass known turtle wetlands and uplands.

- **Questions Addressed:** What is the extent of off-base habitat utilization in the XXXXXX4 region? How large is the adult female cohort in the XXXXXX ?

Follow-up Studies It is recommended that the initial follow-up study be focused in the XXXXXX4 region, since detailed information about turtle distribution and abundance is not available.

- **Questions Addressed**: Which wetlands are utilized by XXXXXX4 region turtles during the activity season? Overwintering? How is the XXXXXX4 population structured? How large is the juvenile cohort? Are XXXXXX4 region turtles utilizing off base habitats?

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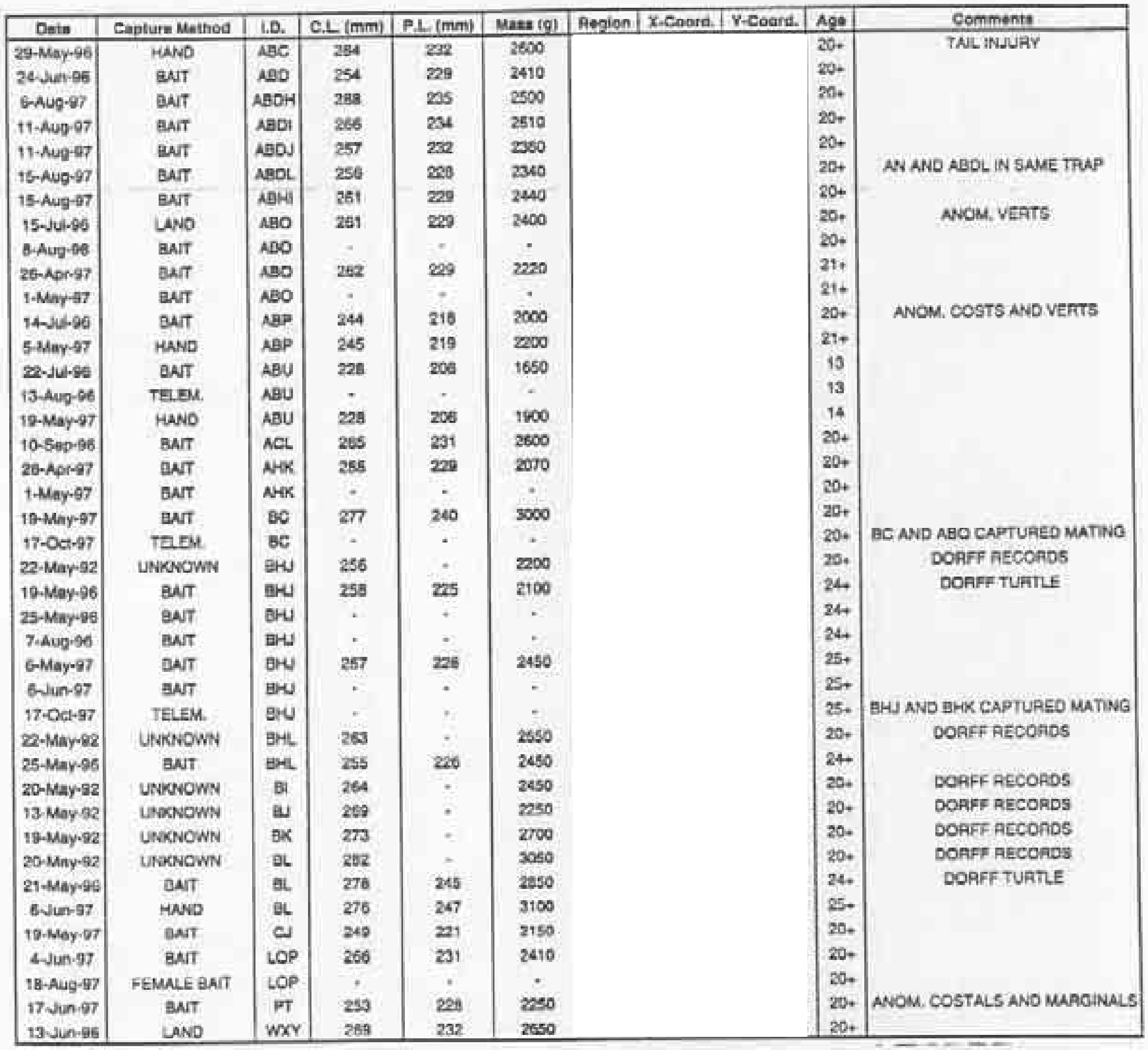
Date	Capture Method	I.D.	C.L. (mm)	P.L. (mm)	Mass (g)	Repro ?	Region	X-Coord.	Y-Coord.	Time	Age	Comments
13-Aug-97	BAIT	ABDK	225	213	1900	NO				-	16	
24-Jun-96	LAND	ABG	237	223	1700	YES				1330	20+	
9-Jun-96	LAND	ABI	240	225	2220	YES				930	20+	
27-Jun-96	LAND	ABK	235	225	2009	YES				1830	20+	
26-Jul-97	BAIT	ABKL	235	225	2040	NO				-	20+	
16-Jul-96	BAIT	ABQ	251	232	2200	NO				-	20+	
19-May-97	BAIT	ABQ	252	232	2530	NO				-	21+	
17-Oct-97	TELEM.	ABQ	-	-	-	N/A				1300	21+	BC AND ABQ CAPTURED MATING
10-Jun-96	LAND	ADJ	239	232	1900	YES				2015	20+	
1-May-97	BAIT	ADJ	240	232	2110	NO				-	21+	
7-Jul-96	BAIT	ADL	242	231	2600	NO				-	20+	
26-May-97	N/A	ADL	242	231	2240	YES				-	21+	
17-Oct-97	TELEM.	ADL	-	-	-	NO				1300	21+	
1-May-97	BAIT	AHL	226	217	1610	NO				-	20+	
6-May-97	BAIT	AKW	265	259	2750	NO				-	20+	
17-Oct-97	TELEM.	AKW	-	-	-	NO				1300	20+	
14-Jun-96	LAND	AN	237	220	1990	YES				2000	20+	
15-Aug-97	BAIT	AN	237	222	1940	NO				-	21+	AN AND ABDL FOUND IN SAME TRAP
14-Jun-96	LAND	AO	240	227	1800	YES				2058	20+	
14-Jun-96	LAND	AP	244	232	2180	YES				2132	20+	
5-May-97	HAND	AP	241	232	2200	NO				1500	21+	
14-Jun-96	LAND	AQ	239	220	2100	YES				1945	20+	
5-May-97	BAIT	AQ	238	220	2100	NO				1410	21+	
24-May-97	HAND	AQ	-	-	-	NO				-	21+	
20-May-92	UNKNOWN	B	267	-	2850	YES				-	20+	DORFF RECORDS
22-May-92	UNKNOWN	BHK	269	-	3000	YES				-	20+	DORFF RECORDS
6-Jun-97	BAIT	BHK	266	255	2750	YES				-	25+	DORFF TURTLE
17-Oct-97	TELEM	BHK	-	-	-	NO				1300	25+	BHJ AND BHK CAPTURED MATING
8-Jun-97	BAIT	BNO	260	242	2550	YES				-	20+	
8-Jun-92	LAND	BY	238	-	1950	YES				-	20+	DORFF RECORDS
13-Jun-97	LAND	JK	256	239	2600	YES				2120	20+	
11-Jun-96	LAND	JKL	238	227	1920	YES				2135	20+	
3-Jun-97	HAND	JKL	242	226	2200	YES				1045	21+	

Table 1 Female Blandings turtle capture records for 1996-1997 field seasons.

Date	Capture Method	I.D.	C.L. (mm)	P.L. (mm)	Mass (g)	Repro ?	Region	X-Coord.	Y-Coord.	Time	Age	Comments
13-Jun-97	LAND	JL	253	232	2450	YES				2100	20+	
12-Jun-96	LAND	JNOP	246	229	2260	YES				2002	20+	
11-Jun-96	LAND	KLN	234	224	1930	YES				-	20+	
6-Jun-97	HAND	KLN	234	217	2150	YES				1330	21+	
10-Jun-97	LAND	NO	277	255	2900	YES				1830	20+	INJURED RT REAR FOOT/ VERT. INJURY/SCARRED PLAST.
12-Jun-96	LAND	NOP	221	217	1680	YES				2010	20+	
10-Jun-97	LAND	NP	239	225	2100	YES				1845	20+	
11-Jun-97	LAND	NV	239	227	2000	YES				1900	20+	ANOM. PLASTRON/ 13 MARG. RT. SIDE
11-Jun-97	LAND	NW	279	259	2900	YES				2033	20+	
12-Jun-97	LAND	NX	240	224	2000	YES				2000	20+	
14-Jun-97	LAND	OP	240	230	2200	YES				2100	20+	11 RT. MARGINALS
6-Aug-97	BAIT	OP	-	-	-	NO				-	20+	
14-Jun-97	LAND	OT	247	231	2450	YES				2030	20+	
14-Jun-97	LAND	OV	227	222	1950	YES				1750	20+	
8-Jul-97	BAIT	OV	-	-	-	NO				-	20+	
14-Jun-97	LAND	OW	236	216	1850	YES				1730	20+	
15-Jun-97	LAND	OX	255	233	2110	YES				2035	20+	ANOM. NUCAL SCUTE
17-Jun-97	BAIT	OY	234	225	1900	YES				-	20+	ANOM. MARGINALS
17-Jun-97	BAIT	PV	253	246	1950	NO				-	20+	
17-Jun-97	BAIT	PW	250	233	2300	YES				-	20+	
15-Jun-97	LAND	PX	247	232	2450	YES				1905	20+	DOUBLE NOTCHED "I" SCUTE
15-Jun-97	LAND	PY	233	217	1900	NO				2110	20+	
13-Jun-96	LAND	QTU	246	234	2280	YES				1908	20+	
3-Jun-97	HAND	QTU	249	234	2350	YES				1030	21+	
15-Jun-97	LAND	UV	248	234	2150	NO				2015	20+	
19-Jun-97	LAND	UW	248	234	2500	NO				2330	20+	



Date	Capture Method	I.D.	C.L. (mm)	P.L. (mm)	Mass (g)	Region	X-Coord.	Y-Coord.	Age	Comments
29-May-96	HAND	ABC	284	232	2600				20+	TAIL INJURY
24-Jun-96	BAIT	ABD	254	229	2410				20+	
6-Aug-97	BAIT	ABDH	288	235	2500				20+	
11-Aug-97	BAIT	ABDI	266	234	2610				20+	
11-Aug-97	BAIT	ABDJ	257	232	2360				20+	
15-Aug-97	BAIT	ABDL	256	228	2340				20+	AN AND ABDL IN SAME TRAP
15-Aug-97	BAIT	ABHI	261	229	2440				20+	
15-Jul-96	LAND	ABO	261	229	2400				20+	ANOM. VERTS
8-Aug-96	BAIT	ABO	-	-	-				20+	
26-Apr-97	BAIT	ABO	262	229	2220				21+	
1-May-97	BAIT	ABO	-	-	-				21+	
14-Jul-96	BAIT	ABP	244	218	2000				20+	ANOM. COSTS AND VERTS
5-May-97	HAND	ABP	245	219	2200				21+	
22-Jul-96	BAIT	ABU	228	206	1650				13	
13-Aug-96	TELEM.	ABU	-	-	-				13	
19-May-97	HAND	ABU	228	206	1900				14	
10-Sep-96	BAIT	ACL	265	231	2600				20+	
28-Apr-97	BAIT	AHK	265	229	2070				20+	
1-May-97	BAIT	AHK	-	-	-				20+	
19-May-97	BAIT	BC	277	240	3000				20+	
17-Oct-97	TELEM.	BC	-	-	-				20+	BC AND ABQ CAPTURED MATING
22-May-92	UNKNOWN	BHJ	256	-	2200				20+	DORFF RECORDS
19-May-96	BAIT	BHJ	258	225	2100				24+	DORFF TURTLE
25-May-96	BAIT	BHJ	-	-	-				24+	
7-Aug-96	BAIT	BHJ	-	-	-				24+	
6-May-97	BAIT	BHJ	257	226	2450				25+	
6-Jun-97	BAIT	BHJ	-	-	-				25+	
17-Oct-97	TELEM.	BHJ	-	-	-				25+	BHJ AND BHK CAPTURED MATING
22-May-92	UNKNOWN	BHL	263	-	2650				20+	DORFF RECORDS
25-May-96	BAIT	BHL	255	226	2450				24+	
20-May-92	UNKNOWN	BI	264	-	2450				20+	DORFF RECORDS
13-May-92	UNKNOWN	BJ	269	-	2250				20+	DORFF RECORDS
19-May-92	UNKNOWN	BK	273	-	2700				20+	DORFF RECORDS
20-May-92	UNKNOWN	BL	282	-	3060				20+	DORFF RECORDS
21-May-96	BAIT	BL	278	245	2850				24+	DORFF TURTLE
6-Jun-97	HAND	BL	276	247	3100				25+	
19-May-97	BAIT	CJ	249	221	2150				20+	
4-Jun-97	BAIT	LOP	266	231	2410				20+	
18-Aug-97	FEMALE BAIT	LOP	-	-	-				20+	
17-Jun-97	BAIT	PT	253	228	2250				20+	ANOM. COSTALS AND MARGINALS
13-Jun-96	LAND	WXY	269	232	2650				20+	

Table 2 Male Blandings turtle capture records for 1996-1997 field seasons.

Date	Capture Method	I.D.	C.L. (mm)	P.L. (mm)	Mass (g)	Region	X-Coord.	Y-Coord.	Age	Comments
16-Jul-96	BAIT	ABL	153	150	640				7	ANNULI DATA
25-Aug-96	BAIT	ABL	-	-	-				7	
19-May-97	BAIT	ABL	159	151	630				8	
25-May-97	HAND	ABL	-	-	-				8	
18-Jul-96	BAIT	ABN	191	179	1120				8	ANNULI DATA
21-May-97	HAND	ABN	193	184	1040				9	
26-Jul-97	BAIT	ABNO	133	124	385				8	ANNULI DATA
7-Aug-96	BAIT	ABT	173	167	770				7	ANNULI DATA
25-Aug-96	BAIT	ABT	-	-	-				7	
28-May-97	BAIT	ABT	173	169	780				8	
7-Aug-96	BAIT	ABV	120	116	250				6	ANNULI DATA
8-Aug-96	BAIT	ACJ	156	143	540				7	ANNULI DATA
5-Jun-97	HAND	ACJ	158	144	550				8	
8-Aug-96	BAIT	ACK	114	109	219				3	ANNULI DATA
1-Nov-96	BAIT	ACX	148	140	465				5	
6-May-97	BAIT	AKY	160	154	630				7	
29-Sep-97	NEST	BGNOU	55.3	50.7	28.6				1	LAB RAISED
20-May-92	UNKNOWN	BH	217	-	1650				11	DORFF RECORDS
29-Sep-97	NEST	BKLNOT	37.2	33.8	9.9				1	LAB RAISED
29-Sep-97	NEST	CDHILNOT	45.7	40.6	15.2				1	LAB RAISED
17-Oct-97	HAND	CDHILNOT	-	-	-				1	WATER BASKING
29-Sep-97	NEST	CDILNOT	57.5	52.3	30.6				1	LAB RAISED
29-Sep-97	NEST	CHLNOT	35.6	31.1	7.8				1	LAB RAISED
29-Sep-97	NEST	CINOT	44	39.5	13.7				1	LAB RAISED
29-Sep-97	NEST	CJNOT	45.2	39.7	16.3				1	LAB RAISED
29-Sep-97	NEST	CKNOT	47.8	43.1	19.4				1	LAB RAISED
29-Sep-97	NEST	CLNOT	41.2	37.2	12.1				1	LAB RAISED
30-May-97	HAND	LNP	125	121	275				5	
8-Jul-97	BAIT	UX	180	168	600				8	ANNULI DATA
8-Jul-97	BAIT	UY	121	115	280				7	ANNULI DATA

Table 3 Juvenile Blandings turtle capture records for 1996-1997 field seasons.

		[redacted]				
					1992 Totals:	
1992 (new):	male	2	4	0	male	6
	female	1	2	0	female	3
	juvenile	0	1	0	juvenile	1
	total	3	7	0	1992 total:	10
					1996 Totals:	
1996 (new):	male	5	1	1 (Frog Lake)	male	7
	female	13	2	0	female	15
	juvenile	3	4	0	juvenile	7
	total	21	7	1 (Frog Lake)	96 new total:	29
1996 (recaptures):	male	0	3	n/a	male	3
	female	0	0	n/a	female	0
	juvenile	0	0	n/a	juvenile	0
	total	0	3	n/a	96 recapture total:	3
					1997 Totals:	
1997 (new):	male	4	1	5	male	10
	female	3	4	17	female	24
	juvenile	1	1	3	juvenile	5
	total	8	6	25	97 new total:	39
1997 (recaptures):	male	1	3	0	male	4
	female	6	3	0	female	9
	juvenile	1	2	0	juvenile	3
	total	8	8	0	97 recapture total:	16
Total # Marked					Total # Marked	
Animals:	male	11	6	6	Animals at Ripley	
	female	18	7	17	male	23
	juvenile	4	8	3	female	42
	total	32	20	26	juvenile	13
Apparent Sex Ratio:		1 male: 1.6 females	1 male: 1.2 females	1 male: 2.8 females	Grand Total:	76
96 - '97 Lincoln Index:	male	21	6	n/a		
	female	22	8	n/a		
	juvenile	5	10	n/a		
	total	48	24	n/a		

Table 4 Demography of marked Blandings turtles in the [redacted] and [redacted]. Both new and recaptured turtles in each area are shown for 1996 and 1997. Data from a previous study (Dorff, 1992) is also included. The Lincoln index shown is the estimated population size for the [redacted] Areas.

	[redacted] Lake Area			[redacted] Area	
Lincoln Estimates of Population Size	Overwintering Habitat Area (50.7 ha.)	Summer Habitat Area (102.2 ha.)	Lincoln Estimates of Population Size	Overwintering Habitat Area (16.5 ha.)	Summer Habitat Area (17.0 ha.)
Female (n=22)	0.43 turtles/ha.	0.22 turtles/ha.	Female (n=8)	0.48 turtles/ha.	0.47 turtles/ha.
Male (n=21)	0.42 turtles/ha.	0.21 turtles/ha.	Male (n=6)	0.36 turtles/ha.	0.35 turtles/ha.
Juvenile (n=5)	0.099 turtle/ha.	0.049 turtle/ha.	Juvenile (n=10)	0.61 turtles/ha.	0.59 turtles/ha.
Total (n=48)	0.95 turtle/ha.	0.47 turtles/ha.	Total (n=24)	1.45 turtles/ha.	1.41 turtles ha.

Table 5 Estimated densities for each sex/age class of Blandings turtle in the [redacted] and [redacted] Areas for both summer and winter habitats. This was based on the Lincoln Estimate of Population Size for each area.

# of Estimated Turtles for 321 ha. of Available [redacted] Area Habitat	Lower Estimate of [redacted] Pop. Size from Summer [redacted] Area Density	Upper Estimate of [redacted] Pop. Size from Summer Range Area Density
# Estimated Females for 321 ha. of Available [redacted] Area Habitat	71 females	150 females
# Estimated Males for 321 ha. of Available [redacted] Area Habitat	67 males	112 males
# Juveniles for 321 ha. of Available [redacted] Area Habitat	16 juveniles	189 juveniles
Estimated Total Turtles for 321 ha. of Available [redacted] Area Habitat	151 Blandings turtles	453 Blandings turtles

Table 6 Upper and lower estimates of population size in the [redacted] Area for each age and sex class. Estimates are based on the [redacted] Area summer density (=lower estimate) and the [redacted] Area summer density (upper estimate).

Identification	Sex	Location	Transmitter #	Start Date	End Date	Transmitter #	Start Date	End Date	Duration (days)
ABDK	female		151.05	8/13/97	12/31/97				140
ABI	female		151.06	6/9/96	7/8/97				394
ABK	female		151.09	6/28/96	6/23/97				360
ABKL	female		151.04	8/11/97	12/31/97				142
ABQ	female		151.10	7/16/97	5/20/97	150.09A	5/20/97	12/31/97	168
ADJ	female		151.11	6/10/96	5/2/97				326
ADL	female		151.08	7/5/96	6/1/97	151.04R	6/6/97	12/31/97	539
AHL	Female		151.10	5/1/97	8/15/97				106
AKW	Female		150.11A	5/6/97	12/31/97				239
AN	female		151.02	6/14/96	6/17/97				368
AP	female		151.15	6/14/96	6/23/97				374
AQ	female		151.16	6/14/96	8/15/97				427
BHK	female		151.02R	6/7/97	8/18/97	151.09	8/18/97	12/31/97	207
BNO	female		150.12	6/8/97	7/29/97	151.01	8/11/97	12/31/97	193
JKL	female		151.05	6/11/96	7/6/97				390
JNOP	female		151.04	6/12/96	7/18/97				401
KLN	female		151.12	6/11/96	6/15/97				369
NO	female		150.14	6/10/97	12/31/97				204
NOP	female		151.13	6/12/96	6/15/97				368
NP	female		151.08	6/10/97	8/15/97				66
NV	female		150.04	6/13/97	8/8/97				56
NW	female		151.08R	6/13/97	12/31/97				201
OP	female		151.02	8/11/97	12/31/97				142
QTU	female		151.14	6/13/96	6/20/97				372
ABL	juvenile		150.04	7/16/96	5/20/97	150.13A	5/20/97	12/31/97	533
ABN	juvenile		150.06	7/18/96	5/22/97				308
ABT	juvenile		151.02R	8/7/96	6/4/97				301
ABV	juvenile		150.05	8/7/96	6/4/97				301
ACJ	juvenile		151.08R	8/8/96	6/7/97				303
ACK	juvenile		150.01	8/8/96	1/1/97				146
AKY	juvenile		150.03A	5/6/97	12/31/97				239
ABC	male		151.07	5/29/96	7/5/97				402
ABD	male		151.01	6/24/96	7/8/97				379
ABDH	male		151.03	8/11/97	12/31/97				142
ABDI	male		151.06	8/14/97	12/31/97				139
ABDJ	male		151.073	8/15/97	12/31/97				138

Table 7 Turtles tracked from May 1996 to December 1997 at Camp Ripley.

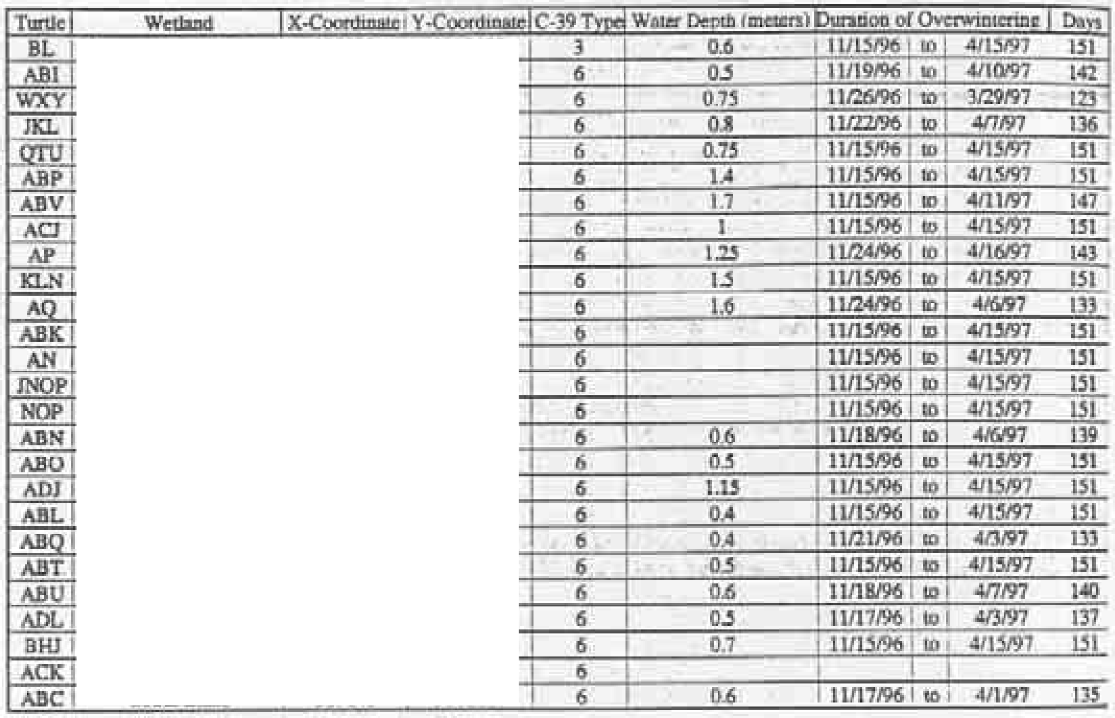
ABO	male		151.06R	7/15/96	4/26/97	151.10R	4/26/97	7/25/97	375
ABP	male		150.08	7/14/96	7/29/97				380
AHK	male		151.12R	4/26/97	7/29/97				94
BC	male		150.15A	5/21/96	12/31/97				589
BHJ	male		151.10	5/19/96	5/6/97	150.07A	5/7/97	12/31/97	590
BHL	male		151.09	5/25/96	6/29/96				35
BL	male		151.08	5/21/96	6/30/96	150.12	6/30/96	6/7/97	382
CJ	male		151.11	6/5/97	8/15/97				71
WXY	male		151.03	6/13/96	7/8/97				390
ABU	male/juve		150.14	7/22/96	5/20/97	151.06R	6/4/97	12/31/97	512

Wetland	X-Coordinate	Y-Coordinate	C-39 Classification	Acreage	Hectares	Season	Sex	Turtle	Species Present
			3	0.65	0.0043	W	M	BL	EB, CP
			4	1.34	0.0089	S,W	M	ABC	EB, CP
			6	3.82	0.0253	S,W	M	ABO	EB, CP
			6	8.63	0.0572	S,W	All	ABP,QTU,ABV	EB, CP
			6	9.77	0.0647	S,W	F	ABI	EB, CP
			6	11.44	0.0758	S,W	F	QTU	EB, CP
			6	19.22	0.1274	S,W	All	AN,ABV,ABP	EB, CP, CS
			6	40.11	0.2659	S,W	F,J	ABU, ADL	EB, CP
			6	895.15	5.9328	S,W	F	AN	EB, CP, CS
			4	0.15	0.0010	S	M	BL	EB
			4	0.16	0.0011	S	M	ABC	EB, CP, CS
			3	0.19	0.0013	S	M	ABC	EB
			6	0.43	0.0029	S	M	ABP	EB
			4	0.61	0.0040	S	M	BL	EB, CP
			4	0.71	0.0047	S	M	ABC	EB, CP
			5	1.02	0.0068	S	M	ABO	EB, CP
			4	1.07	0.0071	S	M	BL	EB, CP
			6	2.54	0.0168	S	F	QTU, ABI	EB, CP, CS
			6	3.14	0.0208	S	M	ABO	EB, CP
			6	4.64	0.0308	S	F	QTU	EB, CP
			5	16.04	0.1063	S	F	QTU,ABI	EB,CP, CS
			6	26.40	0.1750	S	F	QTU	EB, CP, CS
			5	45.59	0.3021	S	M,F	QTU,AN,ABO	EB, CP, CS
Circular-39 Wetland Classification Scheme					EB			Emydoidea blandingii	
	Type 3: Inland shallow fresh marshes				CP			Chrysemys picta	
	Type 4: Inland deep fresh marshes				CS			Chelydra serpentina	
	Type 5: Inland open fresh water								
	Type 6: Shrub swamps								

Table 8 Wetlands and their characteristics utilized by ten selected turtles.

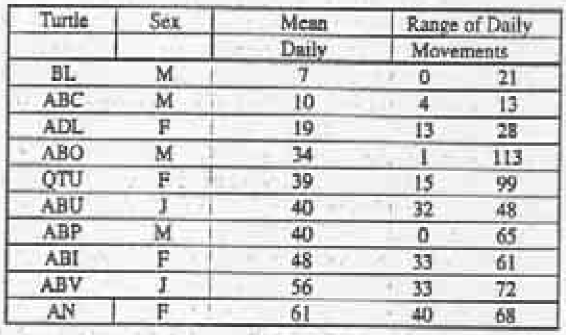
Marsh	X- Coordinate	Y-Coordinate	Type	Acres	Hectares	Turtles Observed
			3	0.19	0.001	ABC
			3	0.65	0.004	BL
			4	0.15	0.001	BL
			4	0.16	0.001	ABC
			4	0.47	0.003	ABN
			4	0.61	0.004	BHI, BL, BHL
			4	0.71	0.005	ABC, NV
			4	1.07	0.007	BL
			4	1.34	0.009	ABC
			4	11.2	0.074	ABK, NP
			5	1.02	0.007	ABO
			5	1.43	0.009	ABI, WXY
			5	16.04	0.106	ABI, QTU
			5	23.99	0.159	ACL
			5	45.59	0.302	ADI, KLN, JNOP, NOP, QTU, AN, ABD, ABO, AHK, AHL, NP
			6	0.43	0.003	ABP
			6	2.54	0.017	QTU, ABI
			6	3.14	0.021	AQ, ABO
			6	3.82	0.025	ADI, ABO, AHK, AHL, NP
			6	4.64	0.031	QTU, WXY
			6	5.8	0.038	NV
			6	7.31	0.048	ABI, WXY
			6	8.63	0.057	QTU, AP, AQ, ABP, ABV, ACJ
			6	11.44	0.076	JKL, QTU
			6	19.22	0.127	KLN, JNOP,NOP, AN, AP, ABP, ABV, ACJ, AHK
			6	26.40	0.175	JKL, QTU
			6	40.11	0.266	BHI, BL, ADL, ABL, ABQ, ABU, ABT, ACK, AKW, AKY, BC, BNO, NO, NW
			6	895.15	5.933	JNOP, NOP, AN, ABD, ABK
			3,4,5,6	1497	9.922	OP, ABDH, ABKL, ABDK, ABDI, ABDJ

Table 9 All wetlands utilized by all tracked turtles. Characteristics include the location, size, type and which turtles utilized each one.



Turtle	Wetland	X-Coordinate	Y-Coordinate	C-39 Type	Water Depth (meters)	Duration of Overwintering			Days
BL	[redacted]	[redacted]	[redacted]	3	0.6	11/15/96	to	4/15/97	151
ABI	[redacted]	[redacted]	[redacted]	6	0.5	11/19/96	to	4/10/97	142
WXY	[redacted]	[redacted]	[redacted]	6	0.75	11/26/96	to	3/29/97	123
JKL	[redacted]	[redacted]	[redacted]	6	0.8	11/22/96	to	4/7/97	136
QTU	[redacted]	[redacted]	[redacted]	6	0.75	11/15/96	to	4/15/97	151
ABP	[redacted]	[redacted]	[redacted]	6	1.4	11/15/96	to	4/15/97	151
ABV	[redacted]	[redacted]	[redacted]	6	1.7	11/15/96	to	4/11/97	147
ACJ	[redacted]	[redacted]	[redacted]	6	1	11/15/96	to	4/15/97	151
AP	[redacted]	[redacted]	[redacted]	6	1.25	11/24/96	to	4/16/97	143
KLN	[redacted]	[redacted]	[redacted]	6	1.5	11/15/96	to	4/15/97	151
AQ	[redacted]	[redacted]	[redacted]	6	1.6	11/24/96	to	4/6/97	133
ABK	[redacted]	[redacted]	[redacted]	6		11/15/96	to	4/15/97	151
AN	[redacted]	[redacted]	[redacted]	6		11/15/96	to	4/15/97	151
JNOP	[redacted]	[redacted]	[redacted]	6		11/15/96	to	4/15/97	151
NOP	[redacted]	[redacted]	[redacted]	6		11/15/96	to	4/15/97	151
ABN	[redacted]	[redacted]	[redacted]	6	0.6	11/18/96	to	4/6/97	139
ABO	[redacted]	[redacted]	[redacted]	6	0.5	11/15/96	to	4/15/97	151
ADJ	[redacted]	[redacted]	[redacted]	6	1.15	11/15/96	to	4/15/97	151
ABL	[redacted]	[redacted]	[redacted]	6	0.4	11/15/96	to	4/15/97	151
ABQ	[redacted]	[redacted]	[redacted]	6	0.4	11/21/96	to	4/3/97	133
ABT	[redacted]	[redacted]	[redacted]	6	0.5	11/15/96	to	4/15/97	151
ABU	[redacted]	[redacted]	[redacted]	6	0.6	11/18/96	to	4/7/97	140
ADL	[redacted]	[redacted]	[redacted]	6	0.5	11/17/96	to	4/3/97	137
BHJ	[redacted]	[redacted]	[redacted]	6	0.7	11/15/96	to	4/15/97	151
ACK	[redacted]	[redacted]	[redacted]	6					
ABC	[redacted]	[redacted]	[redacted]	6	0.6	11/17/96	to	4/1/97	135

Table 10 Features of overwintering wetlands.



Turtle	Sex	Mean Daily	Range of Daily Movements	
BL	M	7	0	21
ABC	M	10	4	13
ADL	F	19	13	28
ABO	M	34	1	113
QTU	F	39	15	99
ABU	J	40	32	48
ABP	M	40	0	65
ABI	F	48	33	61
ABV	J	56	33	72
AN	F	61	40	68

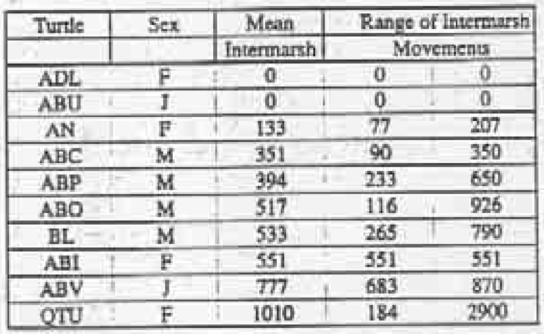
Table 11 Daily movements for each of the 10 selected turtles.

Turtle	Sex	Date	Distance (meters)	Movement Type	Wetland	C-39 Type	Acreage
ABC	Male	6/3/96-6/28/96	7	Daily		4	0.16
		6/28/96-6/29/96	350	Intermarsh			
		7/1/96-7/28/96	11	Daily		3	0.19
		7/28/96-7/29/96	780	Intermarsh			
		7/29/96-9/7/96	11	Daily		4	0.71
		9/8/96-9/10/96	90	Intermarsh			
		9/17/96-11/15/96	14	Daily		4	1.34
		11/15/96-4/15/97	0	Overwinter		4	1.34
		4/15/97-5/20/97	4	Daily		4	1.34
		5/22/97-5/28/97	185	Intermarsh			
		5/29/97-7/3/97	13	Daily		4	0.71
BL	Male	5/23/96-10/20/96	21	Daily		4	0.61
		10/20-10/21/96	265	Intermarsh			
		10/21/96-11/15/96	3	Daily		3	0.65
		11/15/96-4/15/97	0	Overwinter		3	0.65
		4/15/97-4/21/97	0	Daily		3	0.65
		4/21/97-4/23/97	545	Intermarsh			
		4/23/97-5/22/97	3	Daily		4	0.15
		5/22/97-5/23/97	790	Intermarsh			
		5/23/97-6/6/97	8	Daily		4	1.07
ABP	Male	7/15/96-8/10/96	55	Daily		6	8.63
		8/10/96-8/12/96	245	Intermarsh			
		8/12/96-8/16/96	471	Intermarsh			
		8/16/96-11/15/96	65	Daily		6	19.22
		11/15/96-4/15/97	0	Overwinter		6	19.22
		4/15/97-5/1/97	61	Daily		6	19.22
		5/1/97-5/5/97	650	Intermarsh			
		5/5/97-7/11/97	40	Daily		6	8.63
		7/11/97-7/14/97	233	Intermarsh			
		7/14/97-7/16/97	8	Daily		6	0.43
		7/16/97-7/22/97	370	Intermarsh			
		7/22/97-7/29/97	14	Daily		6	19.22

Table 12 Observed daily, inter-marsh and nesting movements for each of the 10 selected turtles.

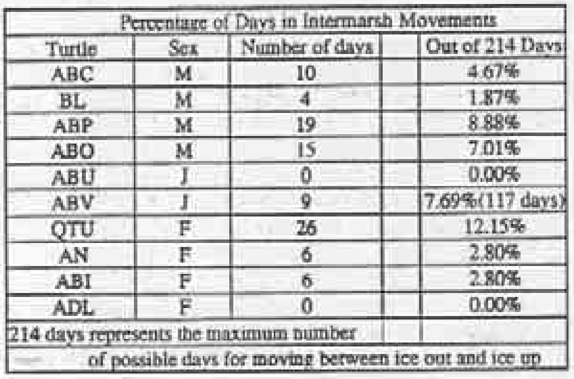
Turtle	Sex	Date	Distance (meters)	Movement Type	Wetland	C-39 Type	Acreage
ABO	Male	7/15/96-8/23/96	19	Daily		6	9.77
		8/23/96-8/24/96	868	Intermarsh			
		8/24/96-9/10/96	9	Daily		5	1.02
		9/10/96-9/11/96	926	Intermarsh			
		9/11/96-10/28/96	61	Daily		5	45.6
		10/28/96-11/1/96	159	Intermarsh			
		11/1/96-11/15/96	1	Daily		6	3.82
		11/15/96-4/15/97	0	Overwinter		6	3.82
		4/15/97-6/8/97	14	Daily		6	3.82
		6/8/97-6/10/97	116	Intermarsh			
		6/10/97-6/25/97	113	Daily		5	45.6
		6/25/97-7/2/97	517	Intermarsh			
		7/2/97-7/25/97	19	Daily		6	3.14
QTU	Female	6/17/96-6/18/96	440	Nesting			
		6/19/96-6/26/96	48	Daily		6	8.63
		6/26/96-7/7/96	2900	Intermarsh			
		7/7/96-10/7/96	58	Daily		6	26.4
		10/7/96-10/14/96	232	Intermarsh			
		10/14/96-11/15/96	22	Daily		6	11.44
		11/15/96-4/15/97	0	Overwinter		6	11.44
		4/15/97-6/7/97	24	Daily		6	11.44
		6/7/97-6/8/97	184	Intermarsh			
		6/8/97-6/11/97	11	Daily		6	2.54
		6/12/96-6/13/96	680	Nesting(intermarsh)		5	16.04
		6/13/97-6/14/97	759	Nesting(intermarsh)		5	45.6
		6/14/97	127	Nesting			
		6/15/97-6/16/97	1405	Intermarsh			
		6/16/97-6/18/97	99	Daily		6	2.54
		6/19/97-6/20/97	327	Intermarsh			
		6/21/97-6/25/97	15	Daily		6	4.64
ABI	Female	6/10/96-6/20/96	55	Daily		5	16.04
		6/20/96-6/22/96	551	Intermarsh			
		6/22/96-7/1/96	61	Daily		6	9.77

Turtle	Sex	Date	Distance (meters)	Movement Type	Wetland	C-39 Type	Acreage
ABI		7/1/96-7/2/96	152	Nesting			
continued		7/2/96-11/15/97	50	Daily		6	9.77
		11/15/96-4/15/97	0	Overwinter		6	9.77
		4/15/97-6/11/97	33	Daily		6	9.77
		6/11/97-6/14/97	125	Nesting			
		6/15/97-7/6/97	41	Daily		6	9.77
AN	Female	6/14/96-7/3/96	70	Daily		5	45.6
		7/3/96-7/5/96	114	Intermarsh			
		7/5/96-9/2/96	73	Daily		6	19.22
		9/2/96-9/3/96	77	Intermarsh			
		9/3/96-11/15/96	40	Daily		6	895.15
		11/15/96-4/15/97	0	Overwinter		6	895.15
		4/15/97-6/5/97	51	Daily		6	895.15
		6/5/97-6/8/97	207	Intermarsh			
		6/8/97-6/13/97	68	Daily		6	19.22
		6/13/97-6/14/97	117	Nesting			
		6/14/97-6/16/97	226	Nesting			
ADL	Female	7/5/96-7/9/96	28	Daily		6	40.11
		7/10/96	660	Nesting			
		7/11/96-11/15/96	17	Daily		6	40.11
		11/15/96-4/15/97	0	Overwinter		6	40.11
		4/15/97-9/2/97	13	Daily		6	40.11
ABU	Juvenile	7/28/96-11/15/96	48	Daily		6	40.11
		11/15/96-4/15/97	0	Overwinter		6	40.11
		4/15/97-9/1/97	32	Daily		6	40.11
ABV	Juvenile	8/10/96-10/4/96	50	Daily		6	8.63
		10/4/96-10/8/96	870	Intermarsh			
		10/8/96-11/15/96	33	Daily		6	19.22
		11/15/96-4/15/97	0	Overwinter		6	19.22
		4/15/97-4/28/97	70	Daily		6	19.22
		4/28/97-5/3/97	683	Intermarsh			
		5/3/97-5/5/97	72	Daily		6	8.63



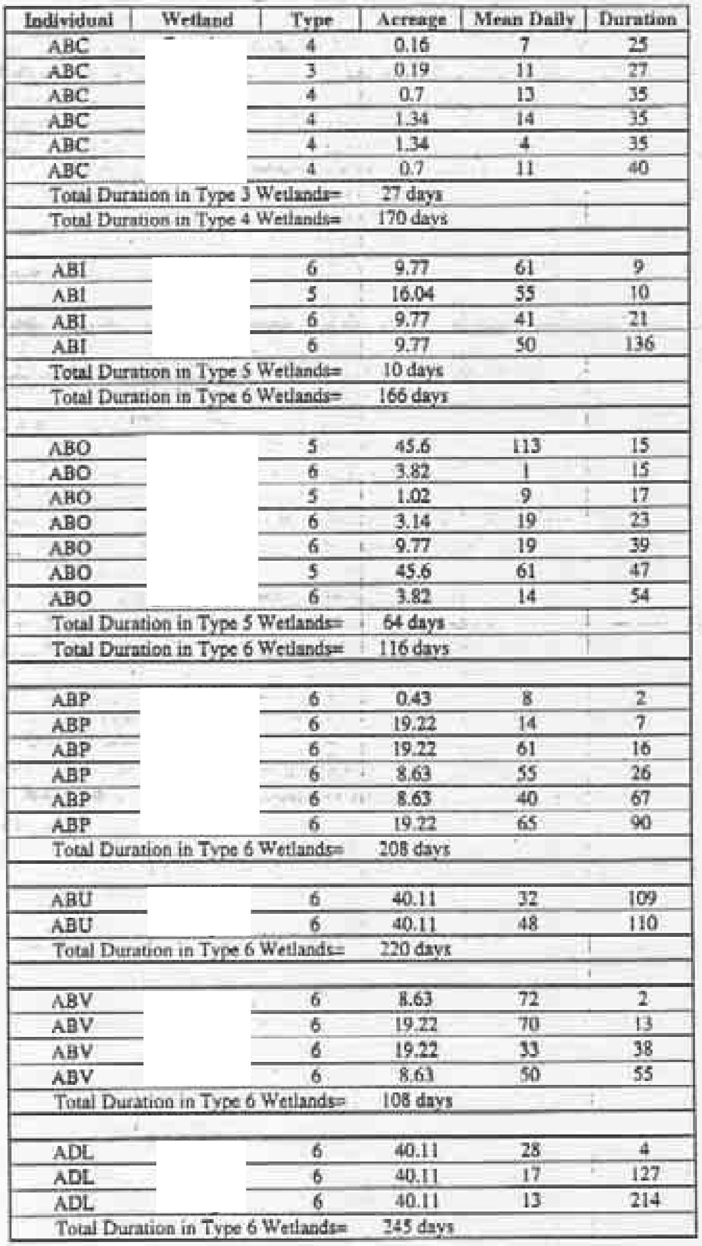
Turtle	Sex	Mean	Range of Intermarsh	
		Intermarsh	Movements	
ADL	F	0	0	0
ABU	J	0	0	0
AN	F	133	77	207
ABC	M	351	90	350
ABP	M	394	233	650
ABO	M	517	116	926
BL	M	533	265	790
ABI	F	551	551	551
ABV	J	777	683	870
QTU	F	1010	184	2900

Table 13 Inter-marsh movements for each of the 10 selected turtles.



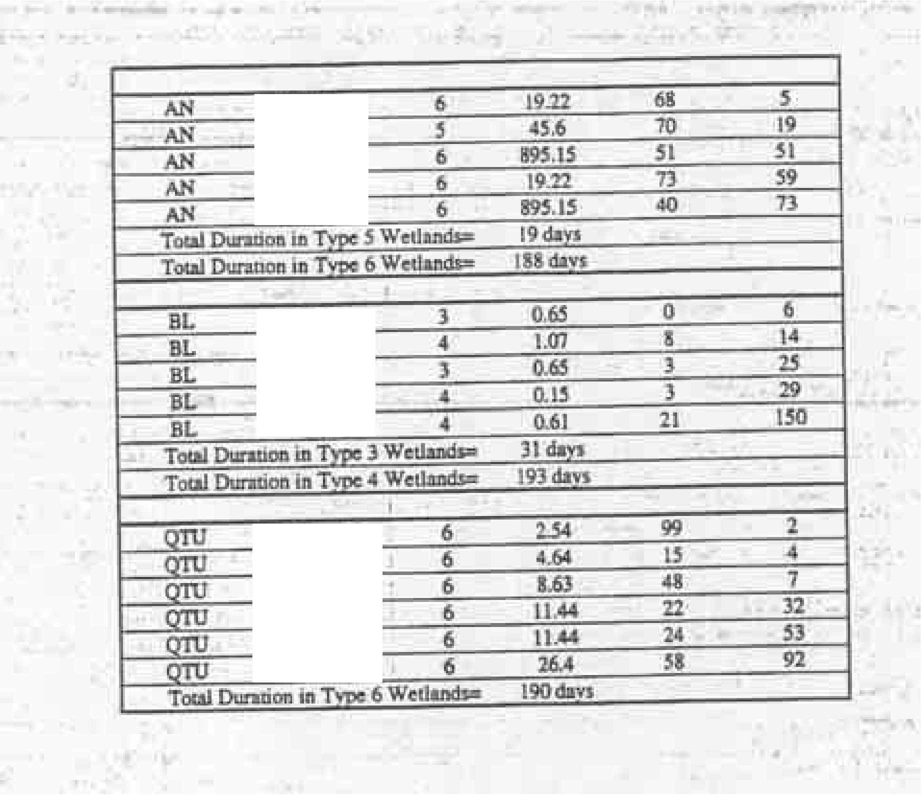
Percentage of Days in Intermarsh Movements				
Turtle	Sex	Number of days		Out of 214 Days
ABC	M	10		4.67%
BL	M	4		1.87%
ABP	M	19		8.88%
ABO	M	15		7.01%
ABU	J	0		0.00%
ABV	J	9		7.69%(117 days)
QTU	F	26		12.15%
AN	F	6		2.80%
ABI	F	6		2.80%
ADL	F	0		0.00%
214 days represents the maximum number				
of possible days for moving between ice out and ice up				

Table 14 Number and percentage of days that each selected turtle spent in inter-marsh movements. Numbers represent the number of actual days of movement out of 214 day activity season.

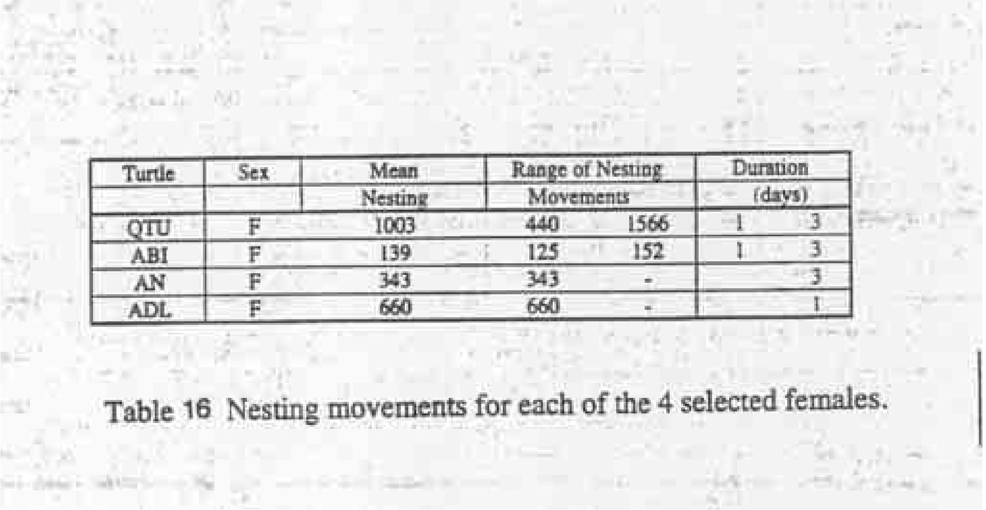


Individual	Wetland	Type	Acreage	Mean Daily	Duration
ABC	[redacted]	4	0.16	7	25
ABC	[redacted]	3	0.19	11	27
ABC	[redacted]	4	0.7	13	35
ABC	[redacted]	4	1.34	14	35
ABC	[redacted]	4	1.34	4	35
ABC	[redacted]	4	0.7	11	40
Total Duration in Type 3 Wetlands=			27 days		
Total Duration in Type 4 Wetlands=			170 days		
ABI	[redacted]	6	9.77	61	9
ABI	[redacted]	5	16.04	55	10
ABI	[redacted]	6	9.77	41	21
ABI	[redacted]	6	9.77	50	136
Total Duration in Type 5 Wetlands=			10 days		
Total Duration in Type 6 Wetlands=			166 days		
ABO	[redacted]	5	45.6	113	15
ABO	[redacted]	6	3.82	1	15
ABO	[redacted]	5	1.02	9	17
ABO	[redacted]	6	3.14	19	23
ABO	[redacted]	6	9.77	19	39
ABO	[redacted]	5	45.6	61	47
ABO	[redacted]	6	3.82	14	54
Total Duration in Type 5 Wetlands=			64 days		
Total Duration in Type 6 Wetlands=			116 days		
ABP	[redacted]	6	0.43	8	2
ABP	[redacted]	6	19.22	14	7
ABP	[redacted]	6	19.22	61	16
ABP	[redacted]	6	8.63	55	26
ABP	[redacted]	6	8.63	40	67
ABP	[redacted]	6	19.22	65	90
Total Duration in Type 6 Wetlands=			208 days		
ABU	[redacted]	6	40.11	32	109
ABU	[redacted]	6	40.11	48	110
Total Duration in Type 6 Wetlands=			220 days		
ABV	[redacted]	6	8.63	72	2
ABV	[redacted]	6	19.22	70	13
ABV	[redacted]	6	19.22	33	38
ABV	[redacted]	6	8.63	50	55
Total Duration in Type 6 Wetlands=			108 days		
ADL	[redacted]	6	40.11	28	4
ADL	[redacted]	6	40.11	17	127
ADL	[redacted]	6	40.11	13	214
Total Duration in Type 6 Wetlands=			345 days		

Table 15 Wetland size and type, mean daily movement and duration of residence for each of the 10 turtle's selected wetlands.



AN	[redacted]	6	19.22	68	5
AN	[redacted]	5	45.6	70	19
AN	[redacted]	6	895.15	51	51
AN	[redacted]	6	19.22	73	59
AN	[redacted]	6	895.15	40	73
Total Duration in Type 5 Wetlands=			19 days		
Total Duration in Type 6 Wetlands=			188 days		
BL	[redacted]	3	0.65	0	6
BL	[redacted]	4	1.07	8	14
BL	[redacted]	3	0.65	3	25
BL	[redacted]	4	0.15	3	29
BL	[redacted]	4	0.61	21	150
Total Duration in Type 3 Wetlands=			31 days		
Total Duration in Type 4 Wetlands=			193 days		
QTU	[redacted]	6	2.54	99	2
QTU	[redacted]	6	4.64	15	4
QTU	[redacted]	6	8.63	48	7
QTU	[redacted]	6	11.44	22	32
QTU	[redacted]	6	11.44	24	53
QTU	[redacted]	6	26.4	58	92
Total Duration in Type 6 Wetlands=			190 days		

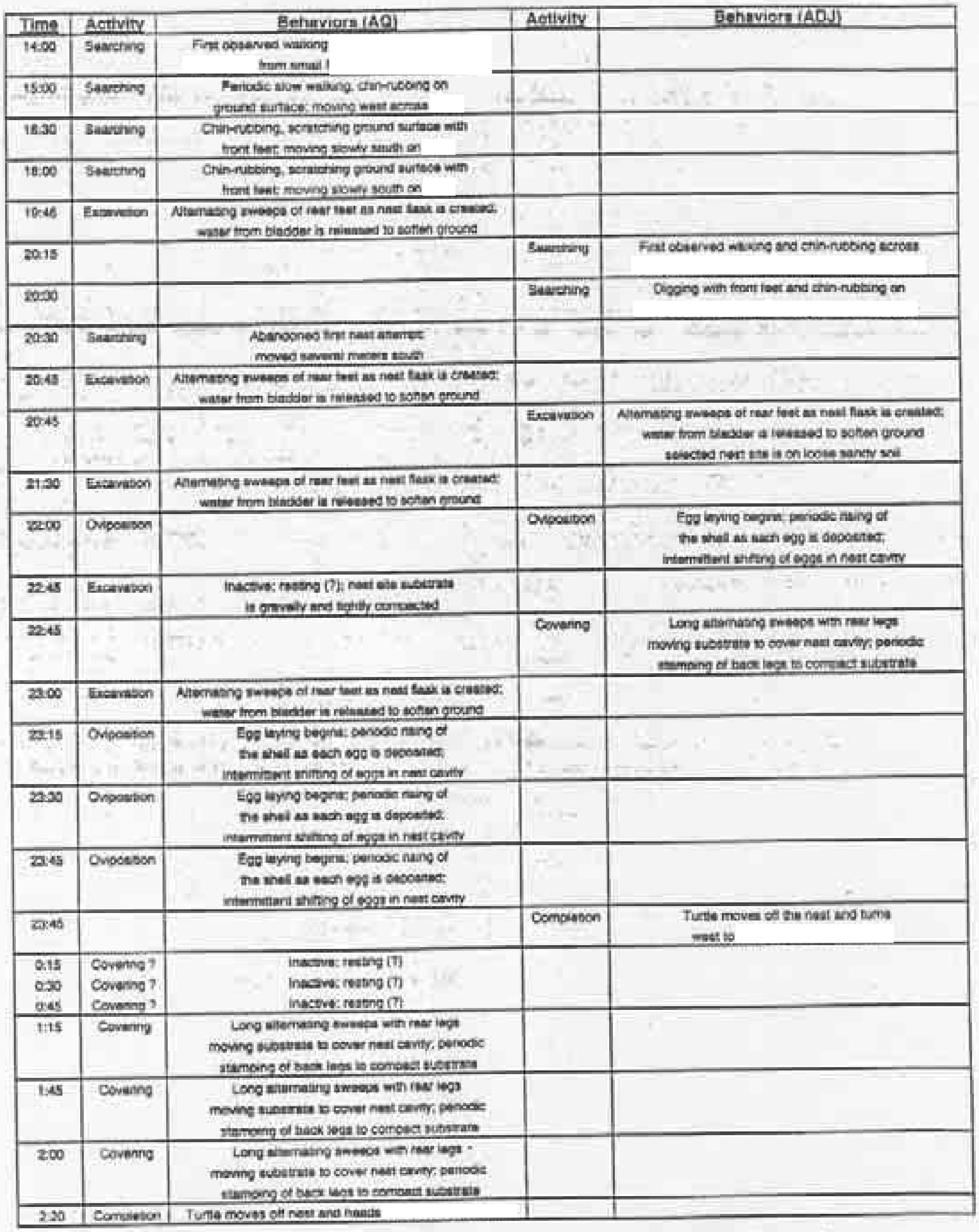


Turtle	Sex	Mean	Range of Nesting		Duration	
		Nesting	Movements		(days)	
QTU	F	1003	440	1566	1	3
ABI	F	139	125	152	1	3
AN	F	343	343	-		3
ADL	F	660	660	-		1

Table 16 Nesting movements for each of the 4 selected females.

Year	I.D.	X - Coord.	Y - Coord.	Dist. To Road	Veg. Cover	Soil Text./Compaction	% Canopy Cover	Nest Depth	Init./Mid./Fin. Inc. Temp.	# Hatchlings
1996	ADJ			3 meters	Sparse	Loose Sand	0	14 cm.	21.2 C 26.7 C 21.8 C	22
1996	JKL			In Road	None	Loose Sand	6	13 cm.	22.9 C 26.7 C n/a	n/a
1996	JNOP			18.5 meters	None	Loose Sand	38	12 cm.	19.8 C 25.3 C 23.1 C	9
1996	AO			19 meters	None	Loose Sand	28	14 cm.	20.2 C 25.4 C 22.9 C	19
1996	AQ			Roadside	None	Compacted Roadbed	3	12 cm.	-	n/a
1996	OTU			Roadside	None	Loose Sand	36	10 cm.	20.7 C 24.8 C 20.9 C	n/a
1996	AP			21 meters	None	Loose Sand	28	14 cm.	20.2 C 25.3 C 23.1 C	20
1996	KLN			Roadside	Sparse	Lightly Compacted Soil	18	12 cm.	20.6 C 25.8 C 24.0 C	n/a
1996	ABI			2 meters	Sparse	Compacted Roadbed	37	13 cm.	20.5 C 23.5 C 19.7 C	0
1996	ABK			In Road	None	Compacted Roadbed	0	14 cm.	19.8 C 25.7 C 24.1 C	n/a
1996	ADL			In Road	None	Compacted Roadbed	35	11 cm.	24.7 C 26.6 C 25.7 C	n/a
1997	PY			Roadside	Sparse	Loose Sand	0	unknown	-	n/a
1997	UV			In Road	None	Lightly Compacted Soil	7	13 cm.	-	n/a
1997	PW			Roadside	Sparse	Loose Sand	16	13 cm.	-	n/a
1997	UW			Roadside	None	Loose Sand	1	12 cm.	-	n/a
1997	NX			Roadside	None	Loose Sand	6	unknown	-	n/a
1997	AKW			In Road	Sparse	Lightly Compacted Soil	46	12 cm.	21.6 C 22.4 C 21.1 C	n/a
1997	AHL			199 meters	Light	Loose Sand	26	11 cm.	-	n/a
1997	KLN			1 meter	Sparse	Lightly Compacted Soil	13	destroyed	22.1 C 24.5 C 27.3 C	n/a
1997	ABI			Roadside	Sparse	Lightly Compacted Soil	12	13 cm.	23.1 C 24.2 C 22.6 C	n/a
1997	JKL			Roadside	None	Loose Sand	47	11 cm.	-	n/a
1997	QTU			22 meters	Light	Loose Sand	0	13 cm.	21.0 C 23.7 C 20.7 C	n/a
1997	BHK			66 meters	Light	Loose Sand	0	14 cm.	16.2 C 24.6 C 22.7 C	n/a
1997	NOP			20 meters	Sparse	Loose Sand	9	11cm.	-	n/a
1997	AN			15 meters	Sparse	Loose Sand	31	12 cm.	19.4 C 23.7 C 21.2 C	n/a
1997	AQ			17 meters	Sparse	Loose Sand	9	13 cm.	19.4 C 24.9 C 22.4 C	n/a
1997	BNO			Roadside	None	Lightly Compact Soil	24	13 cm.	17.5 C 25.4 C 23.5 C	n/a
1997	NO			In Road	None	Compacted Roadbed	13	14 cm.	-	n/a
1997	NP			6.5 meters	Sparse	Loose Sand	10	destroyed	23.7 C 24.0 C 22.3 C	n/a
1997	NW			116 meters	Light	Lightly Compacted Soil	4	destroyed	20.7 C 25.3 C 23.4 C	n/a
1997	ABK			Roadside	None	Loose Sand	20	12 cm.	20.7 C 23.2 C 22.1 C	n/a

Table 17 Nest site characteristics for nests observed at CRTS, 1996 – 1997.

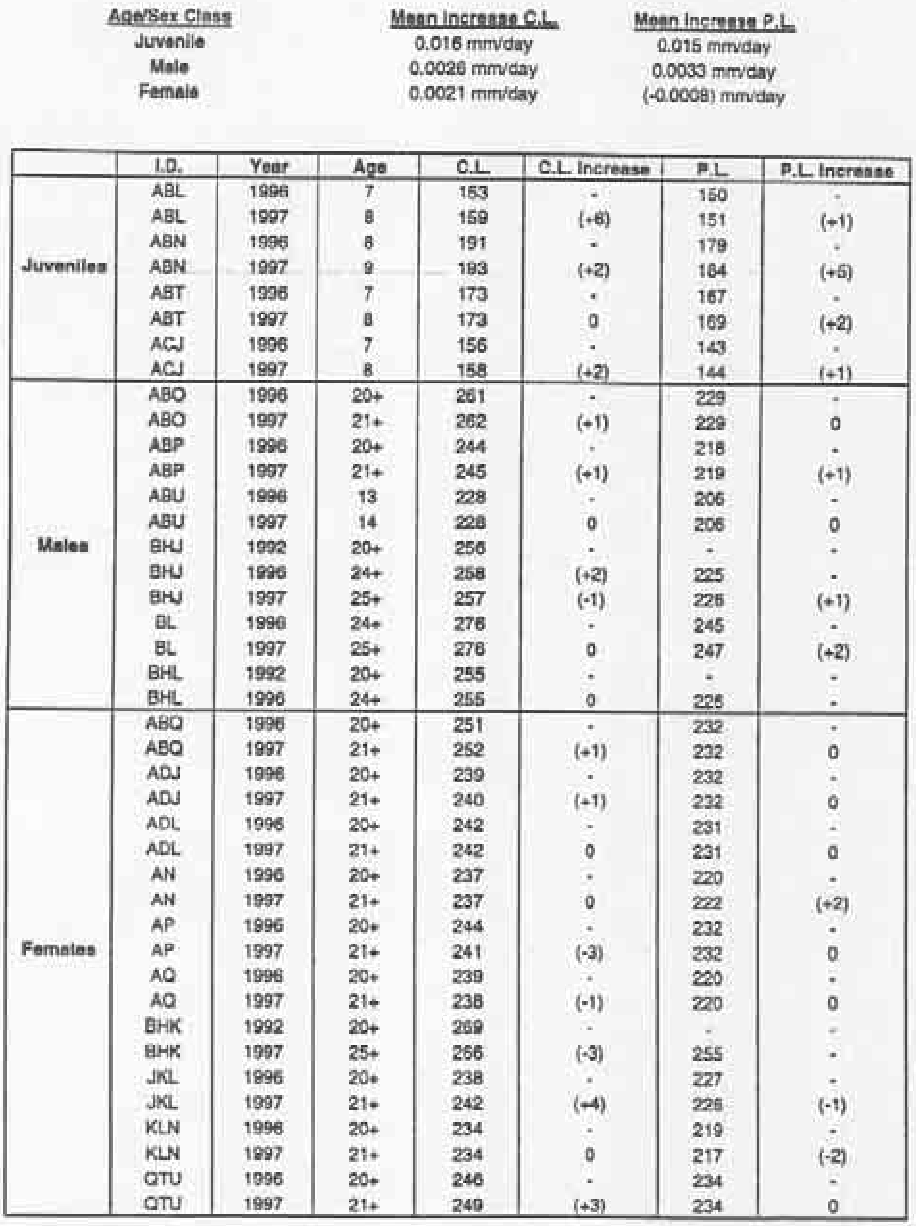


Time	Activity	Behaviors (AQ)	Activity	Behaviors (ADJ)
14:00	Searching	First observed walking [redacted] from small I[redacted]		
15:00	Searching	Periodic slow walking, chin-rubbing on ground surface; moving west across [redacted]		
16:30	Searching	Chin-rubbing, scratching ground surface with front feet; moving slowly south on [redacted]		
18:00	Searching	Chin-rubbing, scratching ground surface with front feet; moving slowly south on [redacted]		
19:46	Excavation	Alternating sweeps of rear feet as nest flask is created; water from bladder is released to soften ground		
20:15			Searching	First observed walking and chin-rubbing across [redacted]
20:30			Searching	Digging with front feet and chin-rubbing on [redacted]
20:30	Searching	Abandoned first nest attempt; moved several meters south		
20:45	Excavation	Alternating sweeps of rear feet as nest flask is created; water from bladder is released to soften ground		
20:45			Excavation	Alternating sweeps of rear feet as nest flask is created; water from bladder is released to soften ground selected nest site is on loose sandy soil
21:30	Excavation	Alternating sweeps of rear feet as nest flask is created; water from bladder is released to soften ground		
22:00	Oviposition		Oviposition	Egg laying begins; periodic rising of the shell as each egg is deposited; intermittent shifting of eggs in nest cavity
22:45	Excavation	Inactive; resting (?); nest site substrate is gravelly and tightly compacted		
22:45			Covering	Long alternating sweeps with rear legs moving substrate to cover nest cavity; periodic stamping of back legs to compact substrate
23:00	Excavation	Alternating sweeps of rear feet as nest flask is created; water from bladder is released to soften ground		
23:15	Oviposition	Egg laying begins; periodic rising of the shell as each egg is deposited; intermittent shifting of eggs in nest cavity		
23:30	Oviposition	Egg laying begins; periodic rising of the shell as each egg is deposited; intermittent shifting of eggs in nest cavity		
23:45	Oviposition	Egg laying begins; periodic rising of the shell as each egg is deposited; intermittent shifting of eggs in nest cavity		
23:46			Completion	Turtle moves off the nest and turns west to [redacted]
0:15 0:30 0:45	Covering ? Covering ? Covering ?	Inactive; resting (?) Inactive; resting (?) Inactive; resting (?)		
1:15	Covering	Long alternating sweeps with rear legs moving substrate to cover nest cavity; periodic stamping of back legs to compact substrate		
1:45	Covering	Long alternating sweeps with rear legs moving substrate to cover nest cavity; periodic stamping of back legs to compact substrate		
2:00	Covering	Long alternating sweeps with rear legs - moving substrate to cover nest cavity; periodic stamping of back legs to compact substrate		
2:20	Completion	Turtle moves off nest and heads [redacted]		

Table 18 Comparison of nesting behaviors for two female Blandings turtles.

Location	Clutch Size				Total Clutch Mass				Egg Mass				Hatchling Mass			
	n	Mean	S.E.	Range	n	Mean	S.E.	Range	n	Mean	S.E.	Range	n	Mean	S.E.	Range
Camp Ripley:																
1996	12	18.7	0.97	11 - 22 eggs	7	261.40	27.70	119 - 328 g	133	13.8 g	0.12	9.4 - 15.5 g	177	9.2 g	0.06	5.8 - 11.3 g
1997	19	17.1	0.81	12 - 24 eggs	14	207.4 g	13.22	143 - 310 g	224	13.0 g	0.12	7.7 - 20.8 g	-	-	-	-
Combined '96-'97	31	17.7	0.63	11 - 24 eggs	21	225.5 g	13.50	119 - 310 g	357	13.30	0.09	7.7 - 20.8	177	9.2 g	0.08	5.8 - 11.3 g

Table 19 Clutch/egg/hatchling parameters for 1996 and 1997 nests.



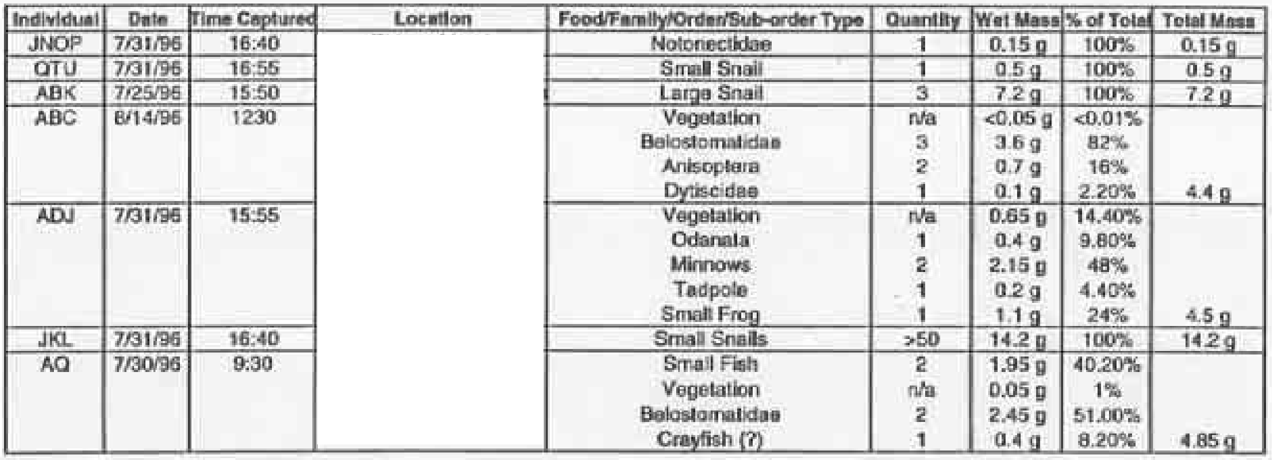
Age/Sex Class	Mean Increase C.L.	Mean Increase P.L.
Juvenile	0.016 mm/day	0.015 mm/day
Male	0.0028 mm/day	0.0033 mm/day
Female	0.0021 mm/day	(-0.0008) mm/day

	I.D.	Year	Age	C.L.	C.L. Increase	P.L.	P.L. Increase
Juveniles	ABL	1996	7	153	-	150	-
	ABL	1997	8	159	(+6)	151	(+1)
	ABN	1996	8	191	-	179	-
	ABN	1997	9	193	(+2)	184	(+5)
	ABT	1996	7	173	-	167	-
	ABT	1997	8	173	0	169	(+2)
	ACJ	1996	7	156	-	143	-
	ACJ	1997	8	158	(+2)	144	(+1)
Males	ABO	1996	20+	261	-	229	-
	ABO	1997	21+	262	(+1)	229	0
	ABP	1996	20+	244	-	218	-
	ABP	1997	21+	245	(+1)	219	(+1)
	ABU	1996	13	228	-	206	-
	ABU	1997	14	228	0	206	0
	BHJ	1992	20+	256	-	-	-
	BHJ	1996	24+	258	(+2)	225	-
	BHJ	1997	25+	257	(-1)	226	(+1)
	BL	1996	24+	276	-	245	-
	BL	1997	25+	276	0	247	(+2)
	BHL	1992	20+	255	-	-	-
	BHL	1996	24+	255	0	226	-
Females	ABQ	1996	20+	251	-	232	-
	ABQ	1997	21+	252	(+1)	232	0
	ADJ	1996	20+	239	-	232	-
	ADJ	1997	21+	240	(+1)	232	0
	ADL	1996	20+	242	-	231	-
	ADL	1997	21+	242	0	231	0
	AN	1996	20+	237	-	220	-
	AN	1997	21+	237	0	222	(+2)
	AP	1996	20+	244	-	232	-
	AP	1997	21+	241	(-3)	232	0
	AQ	1996	20+	239	-	220	-
	AQ	1997	21+	238	(-1)	220	0
	BHK	1992	20+	269	-	-	-
	BHK	1997	25+	266	(-3)	255	-
	JKL	1996	20+	238	-	227	-
	JKL	1997	21+	242	(+4)	226	(-1)
	KLN	1996	20+	234	-	219	-
	KLN	1997	21+	234	0	217	(-2)
	QTU	1996	20+	246	-	234	-
	QTU	1997	21+	249	(+3)	234	0

Table 20 Growth of marked Blandings turtles at Camp Ripley.

Area	Carapace Length			Plastron Length			Mass		
	Mean	S.E.	Range	Mean	S.E.	Range	Mean	S.E.	Range
[redacted]									
Males (n=17)	258.1 mm	3.4	228 - 277 mm	229.3 mm	2.6	206 - 247 mm	2430 g	89	1900 - 3100 g
Females (n=25)	245.4 mm	3.1	221 - 279 mm	232.1 mm	2.7	217 - 259 mm	2220 g	76	1610 - 3000 g
[redacted]									
Males (n=6)	261.7 mm	2.4	253 - 268 mm	231.5 mm	1.1	228 - 235 mm	2460 g	57	2250 - 2610 g
Females (n=17)	242.6 mm	2.4	225 - 256 mm	228.6 mm	2.1	213 - 246 mm	2160 g	61	1850 - 2600 g
Combined [redacted]									
Males (n=23)	260.3 mm	2.3	228 - 277 mm	231.8 mm	1.8	206 - 247 mm	2440 g	57	1650 - 3100 g
Females (n=42)	244.6 mm	2	221 - 279 mm	230.7 mm	1.8	217 - 259 mm	2210 g	52	1610 - 3000 g

Table 21 Blandings turtles in each age and sex class [redacted] region.

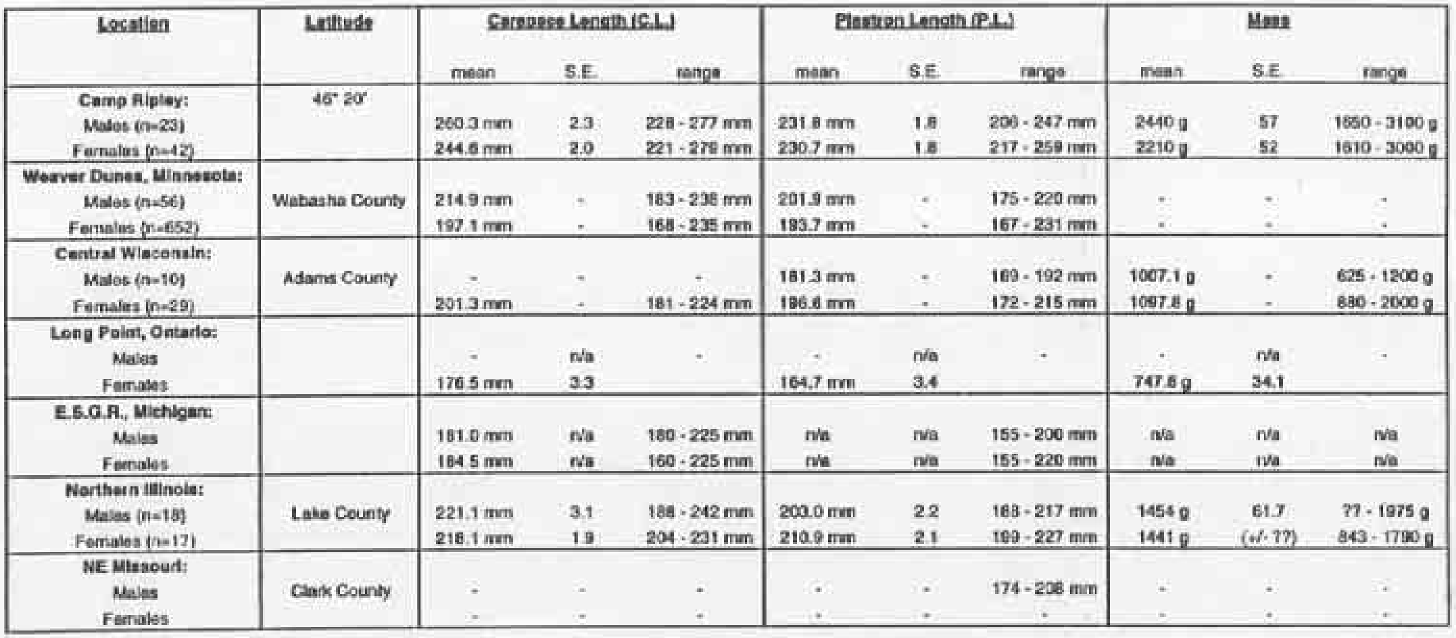


Individual	Date	Time Captured	Location	Food/Family/Order/Sub-order Type	Quantity	Wet Mass	% of Total	Total Mass
JNOP	7/31/96	16:40	[redacted]	Notonectidae	1	0.15 g	100%	0.15 g
QTU	7/31/96	16:55	[redacted]	Small Snail	1	0.5 g	100%	0.5 g
ABK	7/25/96	15:50	[redacted]	Large Snail	3	7.2 g	100%	7.2 g
ABC	8/14/96	1230	[redacted]	Vegetation	n/a	<0.05 g	<0.01%	
				Belostomatidae	3	3.6 g	82%	
				Anisoptera	2	0.7 g	16%	
				Dytiscidae	1	0.1 g	2.20%	4.4 g
ADJ	7/31/96	15:55	[redacted]	Vegetation	n/a	0.65 g	14.40%	
				Odanata	1	0.4 g	9.80%	
				Minnows	2	2.15 g	48%	
				Tadpole	1	0.2 g	4.40%	
				Small Frog	1	1.1 g	24%	4.5 g
JKL	7/31/96	16:40	[redacted]	Small Snails	>50	14.2 g	100%	14.2 g
AQ	7/30/96	9:30	[redacted]	Small Fish	2	1.95 g	40.20%	
				Vegetation	n/a	0.05 g	1%	
				Belostomatidae	2	2.45 g	51.00%	
				Crayfish (?)	1	0.4 g	8.20%	4.85 g

Table 22 Prey from the stomach flushing trials.

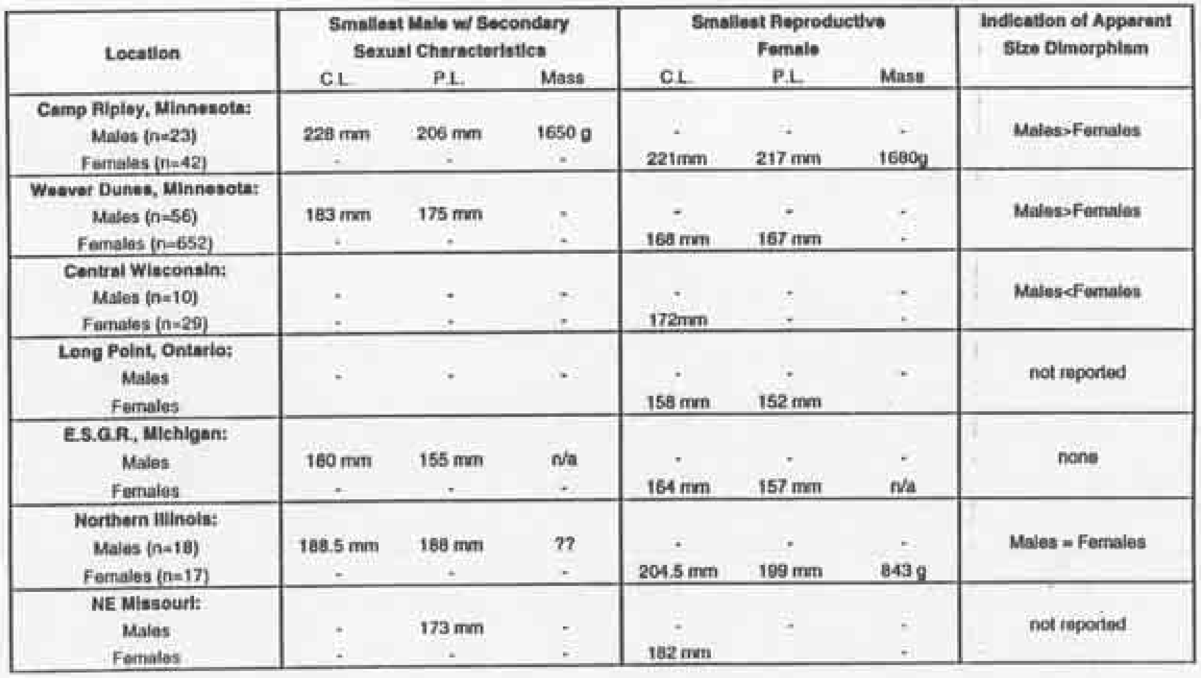
	Clutch Size				Total Clutch Mass				Egg Mass				Hatchling Mass			
Location	n	Mean	S.E.	Range	n	Mean	S.E.	Range	n	Mean	S.E.	Range	n	Mean	S.E.	Range
Camp Ripley, MN	31	17.7	0.63	11 - 24 eggs	21	225.5 g	13.50	119 - 310 g	357	13.30	0.09	7.7 - 20.8	177	9.2 g	0.06	5.8 - 11.3 g
Weaver Dunes, MN	-	9.3	-	6 - 13 eggs	-	121 g	-	79 - 174 g	-	13.1 g	-	11.4 - 14.5 g	-	-	-	-
Nova Scotia	-	9.4	-	1 - 15 eggs	-	-	-	-	-	-	-	-	-	-	-	-
Ontario	-	12.6	-	8 - 16 eggs	-	-	-	-	-	11.8 g	-	-	-	-	-	-
Michigan	-	10.0	-	3 - 19 eggs	-	-	-	-	-	12.2 g	0.15	11.0 - 13.9 g	-	9.2 g	0.07	6.0 - 13.0 g

Table 23 A comparison of CRTS clutch characteristics versus clutch characteristics of other studied populations of Blanding's turtles.



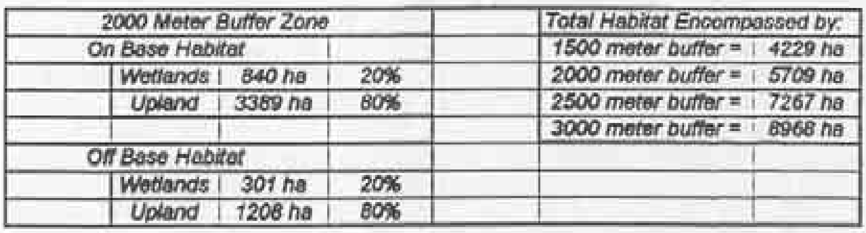
Location	Latitude	Carapace Length (C.L.)			Plastron Length (P.L.)			Mass		
		mean	S.E.	range	mean	S.E.	range	mean	S.E.	range
Camp Ripley:	46° 20'									
Males (n=23)		260.3 mm	2.3	228 - 277 mm	231.8 mm	1.8	206 - 247 mm	2440 g	57	1650 - 3190 g
Females (n=42)		244.6 mm	2.0	221 - 278 mm	230.7 mm	1.8	217 - 259 mm	2210 g	52	1610 - 3090 g
Weaver Dunes, Minnesota:	Wabasha County									
Males (n=56)		214.9 mm	-	183 - 238 mm	201.9 mm	-	175 - 220 mm	-	-	-
Females (n=652)		197.1 mm	-	168 - 235 mm	193.7 mm	-	167 - 231 mm	-	-	-
Central Wisconsin:	Adams County									
Males (n=10)		-	-	-	181.3 mm	-	169 - 192 mm	1007.1 g	-	625 - 1200 g
Females (n=29)		201.3 mm	-	181 - 224 mm	186.6 mm	-	172 - 215 mm	1097.8 g	-	880 - 2000 g
Long Point, Ontario:										
Males		-	n/a	-	-	n/a	-	-	n/a	-
Females		176.5 mm	3.3		164.7 mm	3.4		747.8 g	34.1	
E.S.G.R., Michigan:										
Males		181.0 mm	n/a	180 - 225 mm	n/a	n/a	155 - 200 mm	n/a	n/a	n/a
Females		184.5 mm	n/a	160 - 225 mm	n/a	n/a	155 - 220 mm	n/a	n/a	n/a
Northern Illinois:	Lake County									
Males (n=18)		221.1 mm	3.1	188 - 242 mm	203.0 mm	2.2	183 - 217 mm	1454 g	61.7	77 - 1975 g
Females (n=17)		218.1 mm	1.9	204 - 231 mm	210.9 mm	2.1	199 - 227 mm	1441 g	(+/- 77)	843 - 1790 g
NE Missouri:	Clark County									
Males		-	-	-	-	-	174 - 208 mm	-	-	-
Females		-	-	-	-	-	-	-	-	-

Table 24 A comparison of CRTS male and female body sizes versus body sizes reported for other populations of Blanding's turtles.



Location	Smallest Male w/ Secondary Sexual Characteristics			Smallest Reproductive Female			Indication of Apparent Size Dimorphism
	C.L.	P.L.	Mass	C.L.	P.L.	Mass	
Camp Ripley, Minnesota:							
Males (n=23)	228 mm	206 mm	1650 g	-	-	-	Males>Females
Females (n=42)	-	-	-	221mm	217 mm	1680g	
Weaver Dunes, Minnesota:							
Males (n=56)	183 mm	175 mm	-	-	-	-	Males>Females
Females (n=652)	-	-	-	168 mm	167 mm	-	
Central Wisconsin:							
Males (n=10)	-	-	-	-	-	-	Males<Females
Females (n=29)	-	-	-	172mm	-	-	
Long Point, Ontario:							
Males	-	-	-	-	-	-	not reported
Females				158 mm	152 mm		
E.S.G.R., Michigan:							
Males	160 mm	155 mm	n/a	-	-	-	none
Females	-	-	-	164 mm	157 mm	n/a	
Northern Illinois:							
Males (n=18)	188.5 mm	188 mm	??	-	-	-	Males = Females
Females (n=17)	-	-	-	204.5 mm	199 mm	843 g	
NE Missouri:							
Males	-	173 mm	-	-	-	-	not reported
Females	-	-	-	182 mm		-	

Table 25 A comparison of minimum body sizes at sexual maturity and the direction of apparent size dimorphism for CRTS turtles versus other studied populations.



2000 Meter Buffer Zone					Total Habitat Encompassed by:	
On Base Habitat					1500 meter buffer =	4229 ha
	Wetlands	840 ha	20%		2000 meter buffer =	5709 ha
	Upland	3389 ha	80%		2500 meter buffer =	7267 ha
					3000 meter buffer =	8968 ha
Off Base Habitat						
	Wetlands	301 ha	20%			
	Upland	1208 ha	80%			

Table 26 The percentage and area of wetland and upland habitats protected by the BTCA.

Table 27 REMOVED FROM DOCUMENT:
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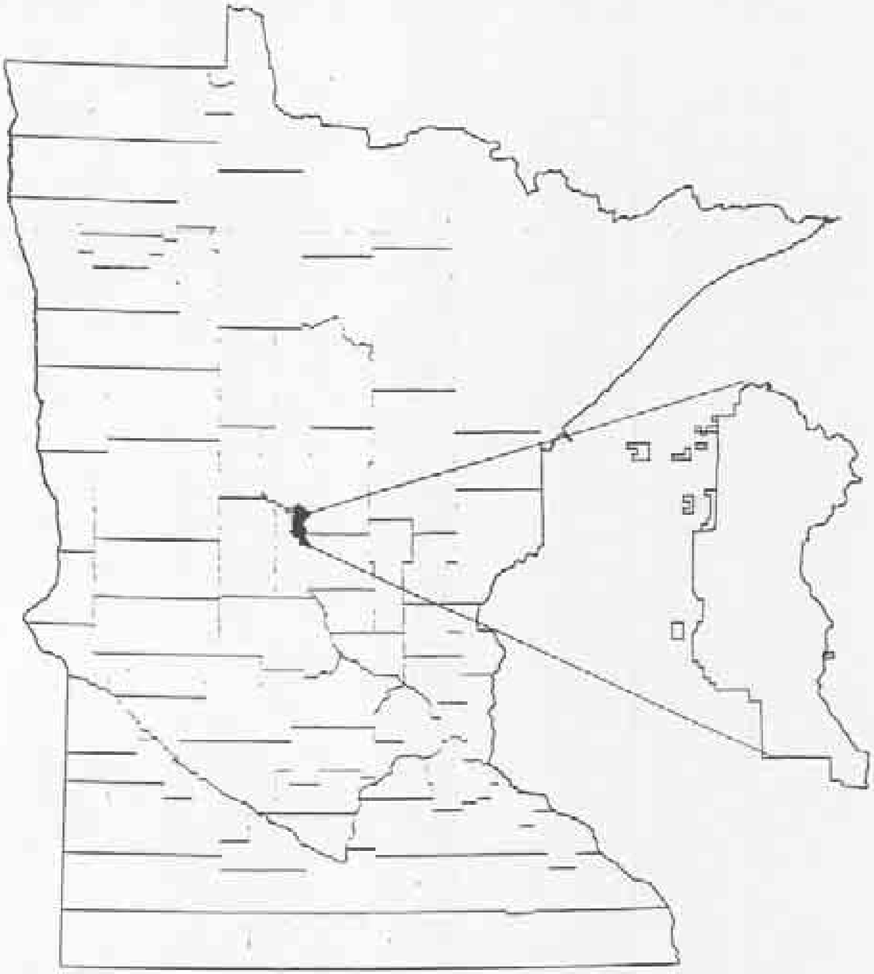

Figure 1. Location of Camp Ripley Army National Guard Training Site, Morrison County, Minnesota

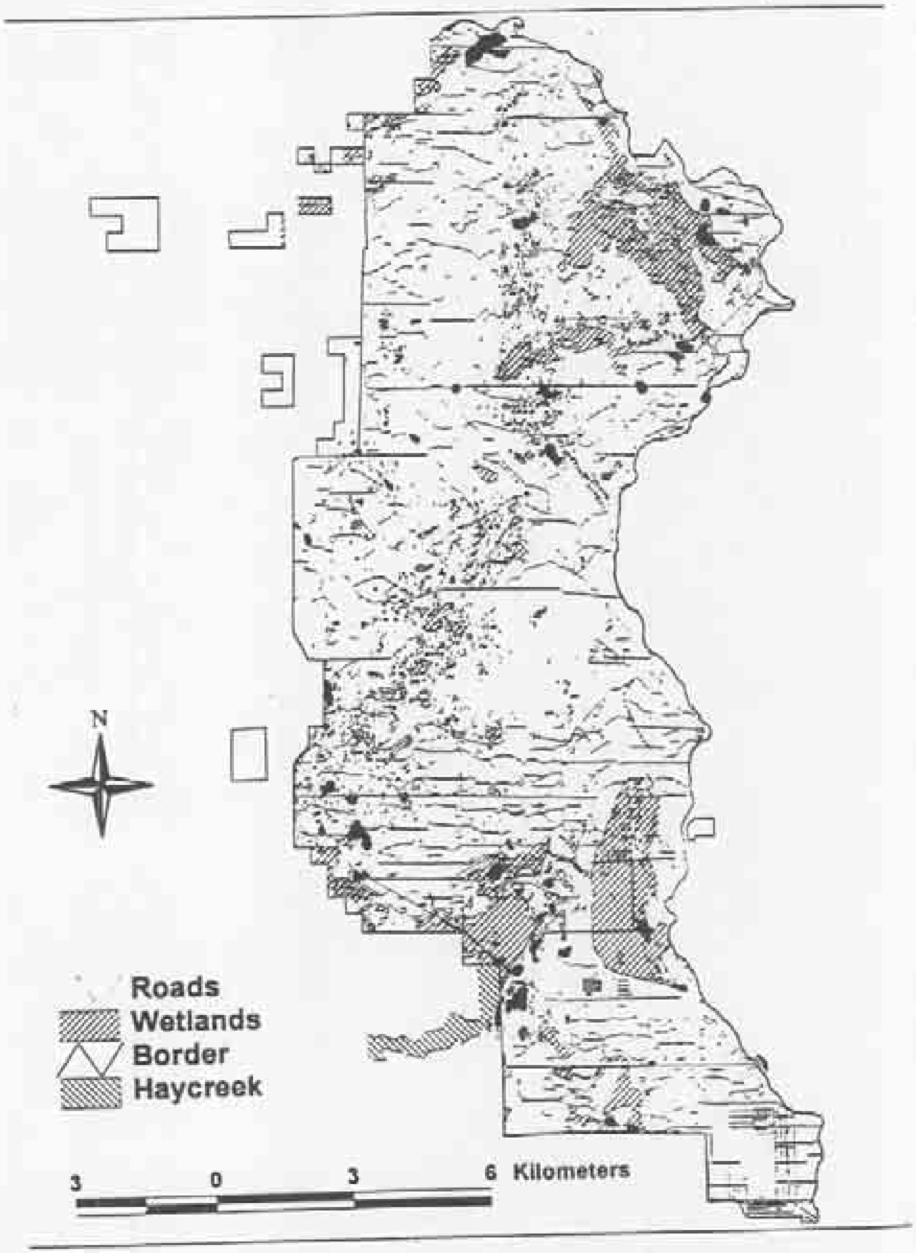

Figure 2. Wetlands surveyed from May 1996 to August 1997 are represented by the black areas. Many of the wetlands are not apparent due to their small size.

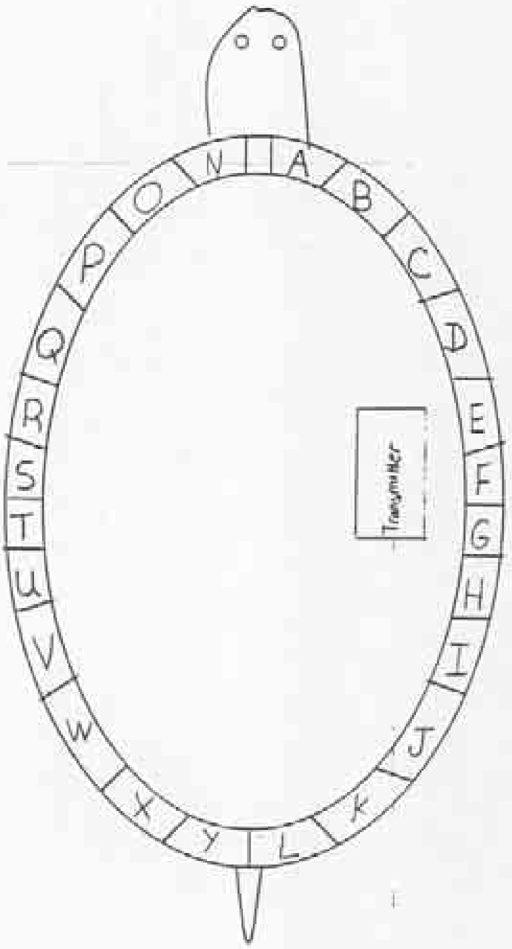

Figure 3. Coding scheme and transmitter placement used during this study.

FIGURES 4 – 21 REMOVED FROM THIS DOCUMENT: CONTAIN SPECIFIC LOCATION INFORMATION

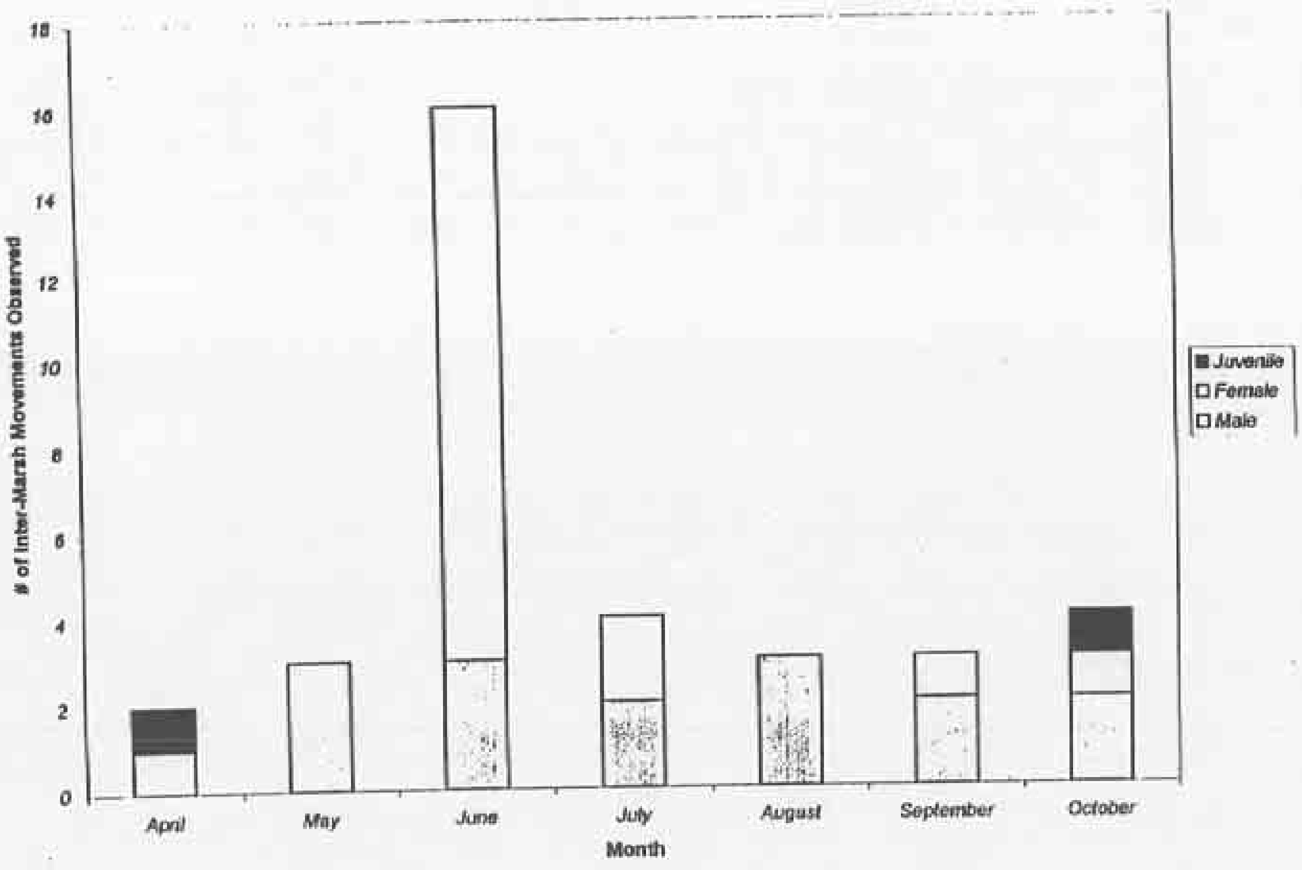

Figure 22 Seasonal frequency of observed inter-marsh movements for adult males, adult females, and juvenile turtles.

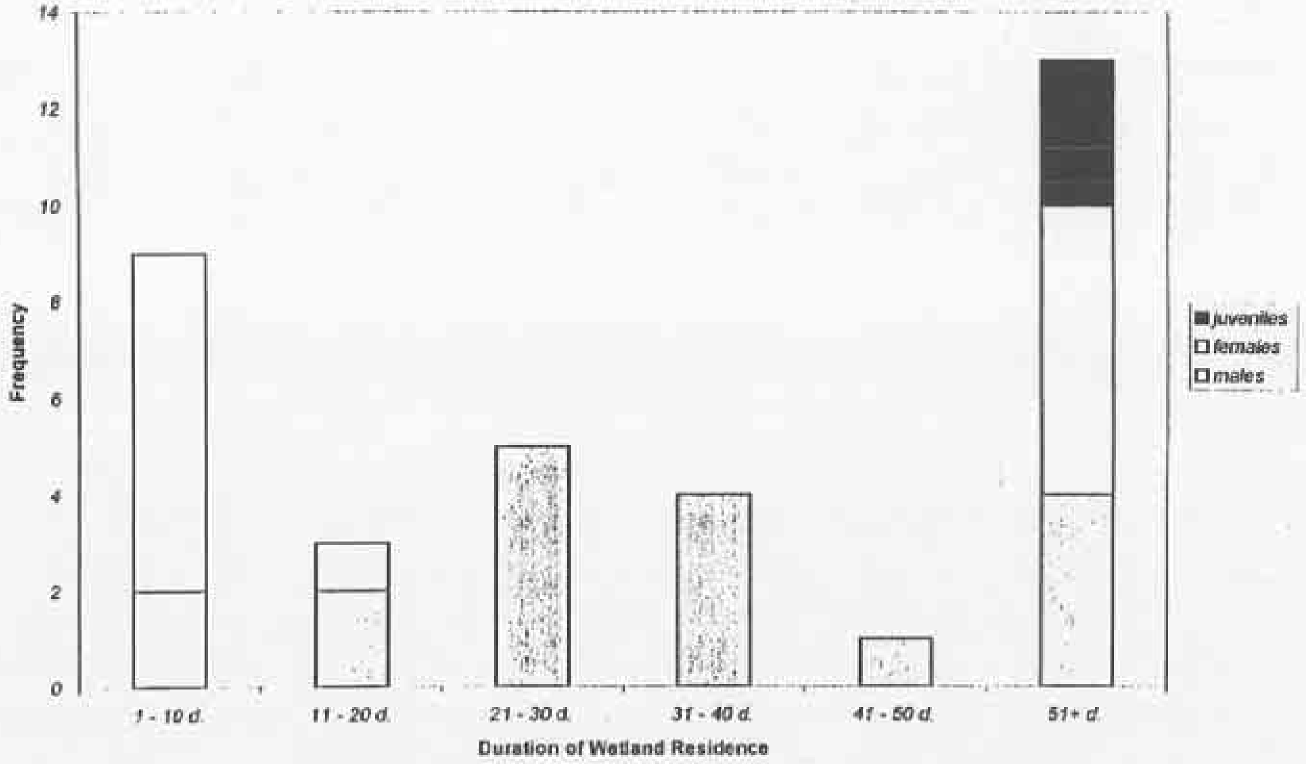

Figure 23 Frequency of wetland inhabitation durations for adult males, adult females, and juveniles.

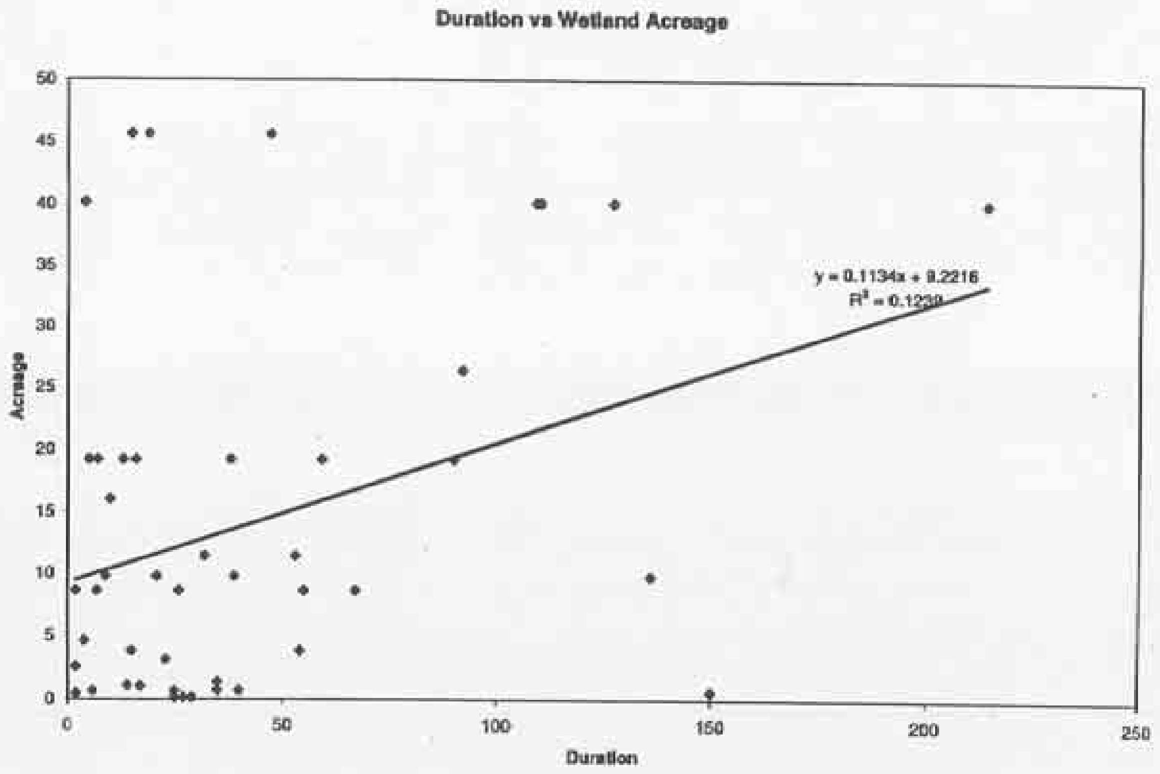

Figure 24 Effect of wetland size on the duration of residence for Blandings turtles. Duration of residence is related to wetland size.

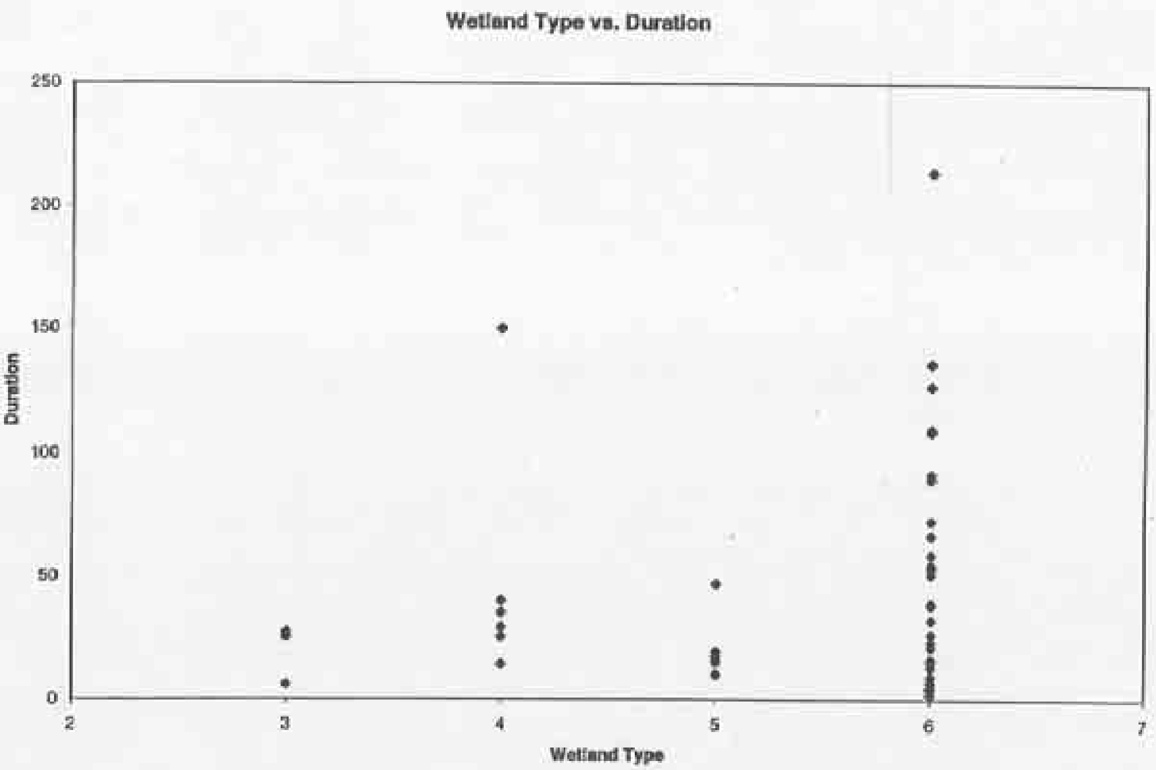

Figure 25 Effect of wetland type on the duration of residence for Blandings turtles. Duration of residence is related to wetland type: 14 out of 15 residences over 50 days occurred in shrub swamps.

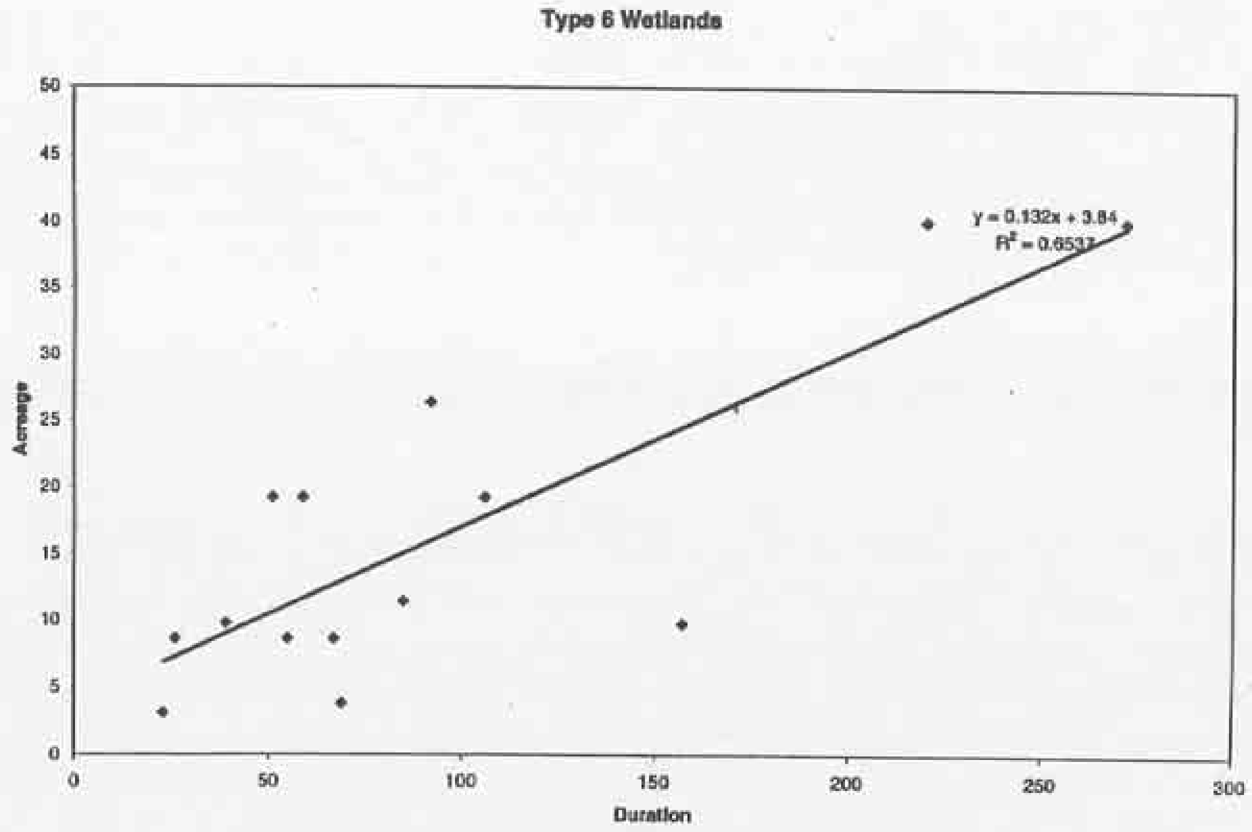

Figure 26 Effect of shrub swamp size on the duration of residence for Blandings turtles. Duration of residence is related to type 6 wetland size.

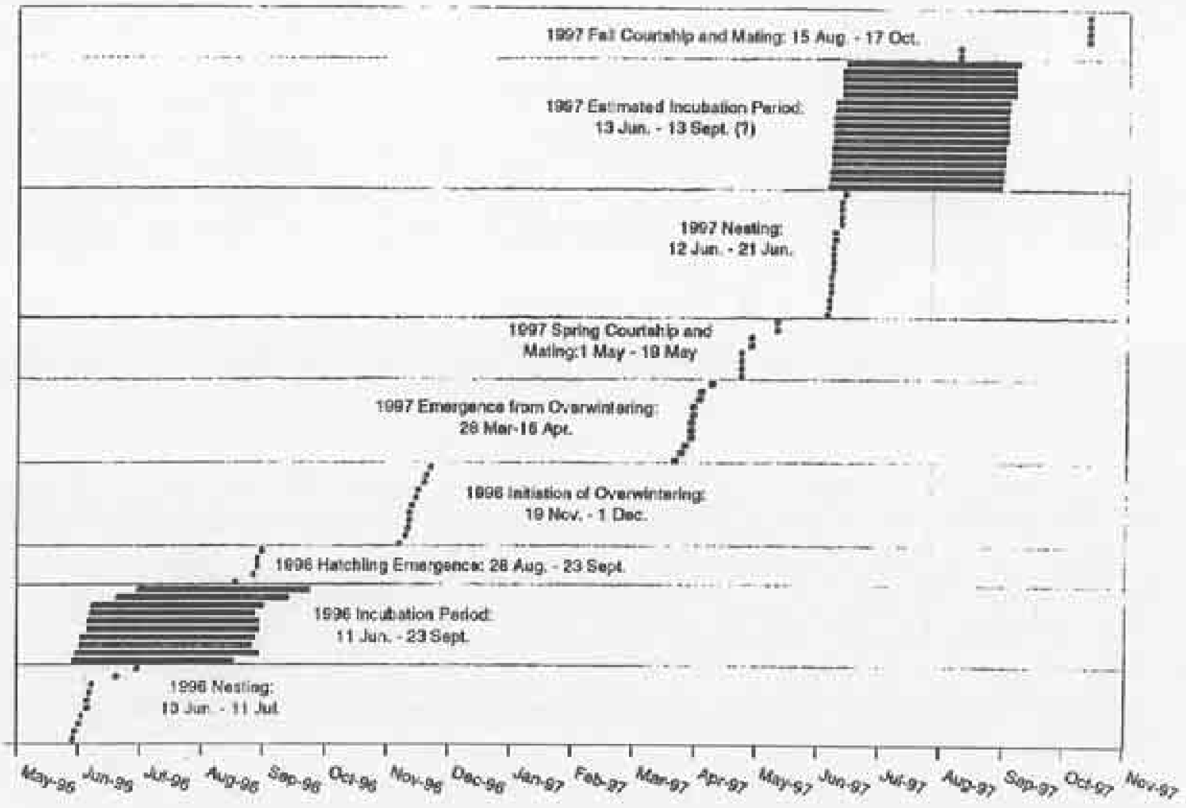

Figure 27 Seasonal timeline of reproductive behaviors.

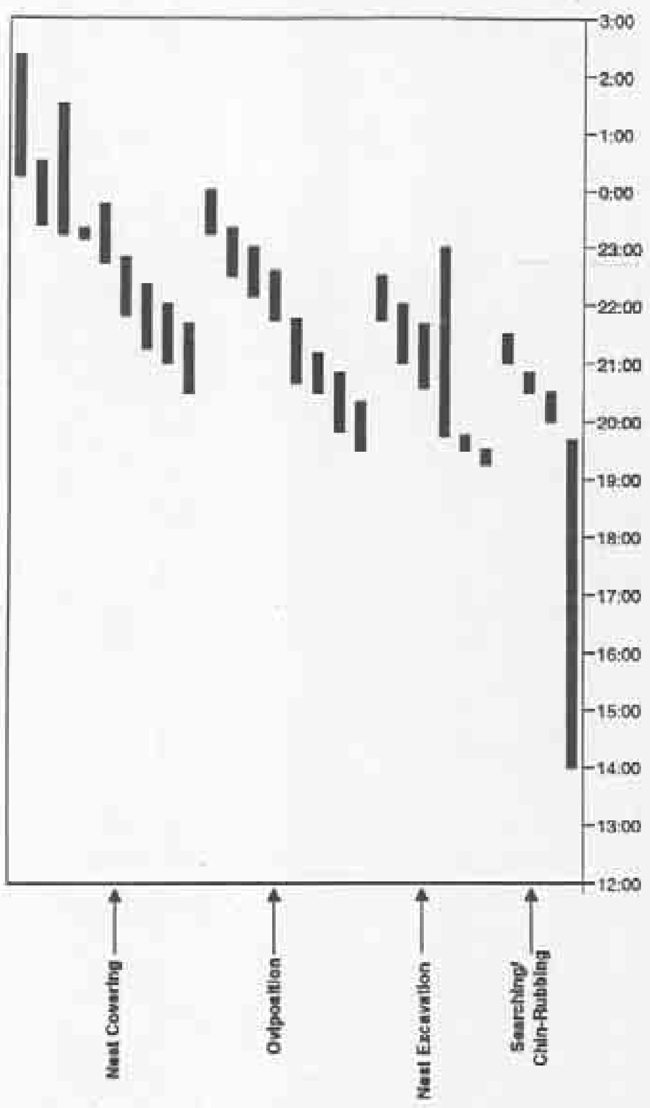

Figure 28 Timeline of nesting behaviors and activities.

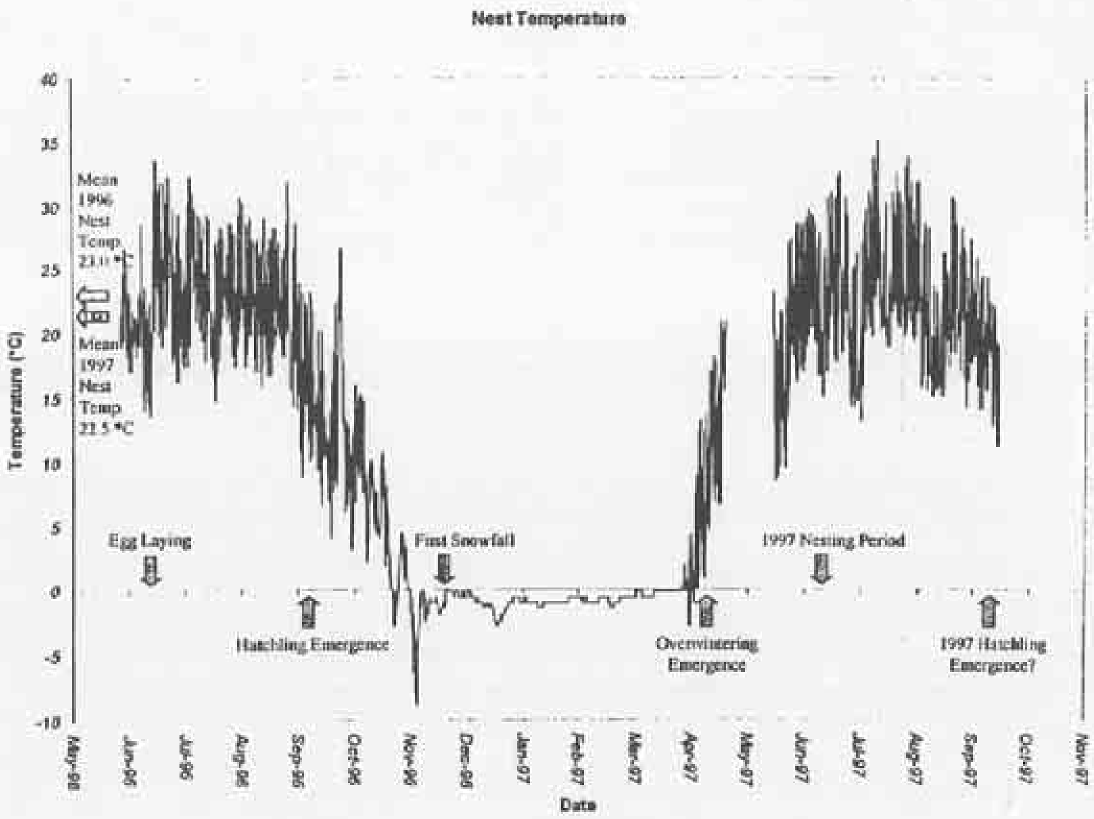

Figure 29 Seasonal temperature regime in a Blandings turtle's nest

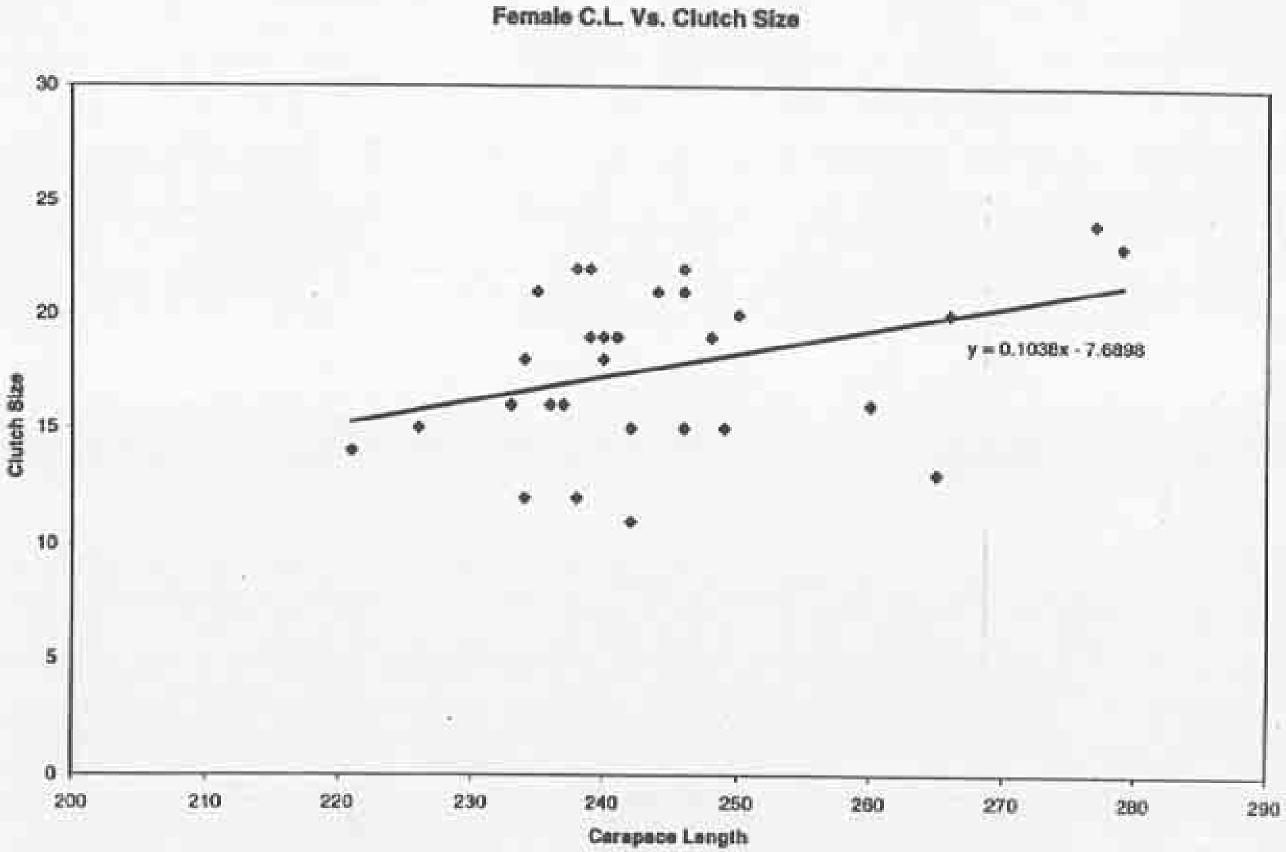

Figure 30 Relationship of female Blandings turtle carapace length to clutch size.

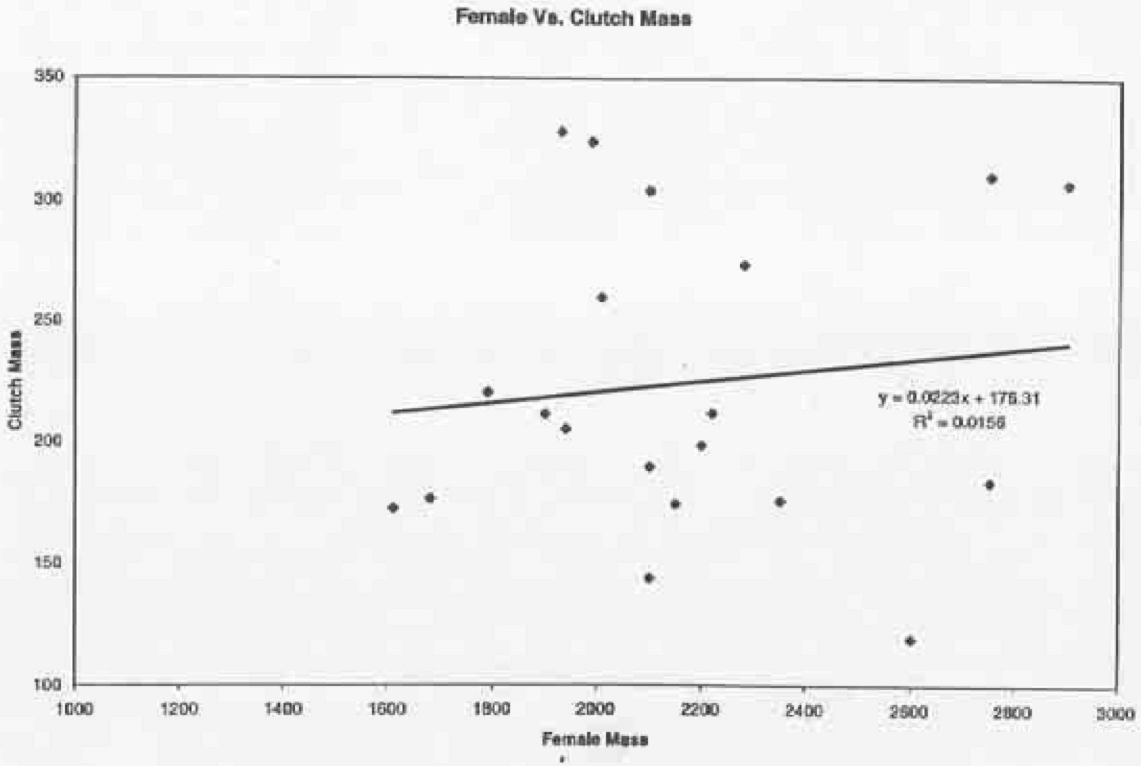

Figure 31 Relationship of female Blandings turtle mass to clutch mass.

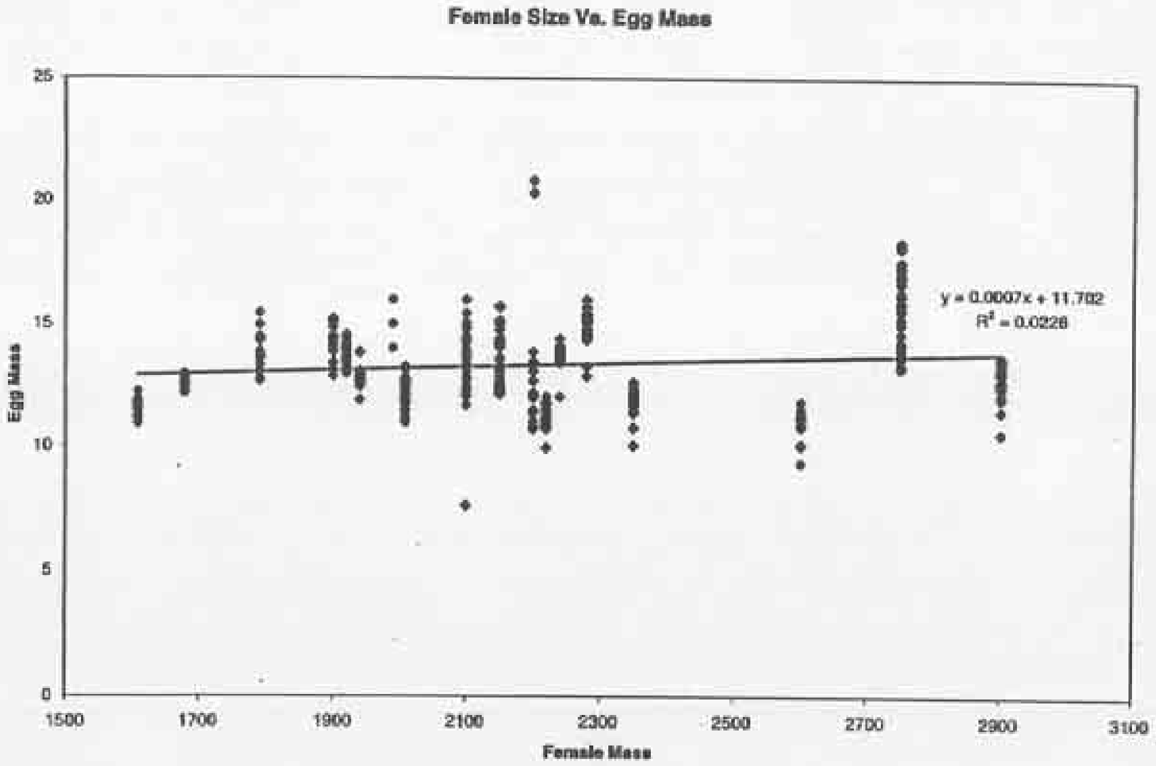

Figure 32 Relationship of female mass to egg mass.

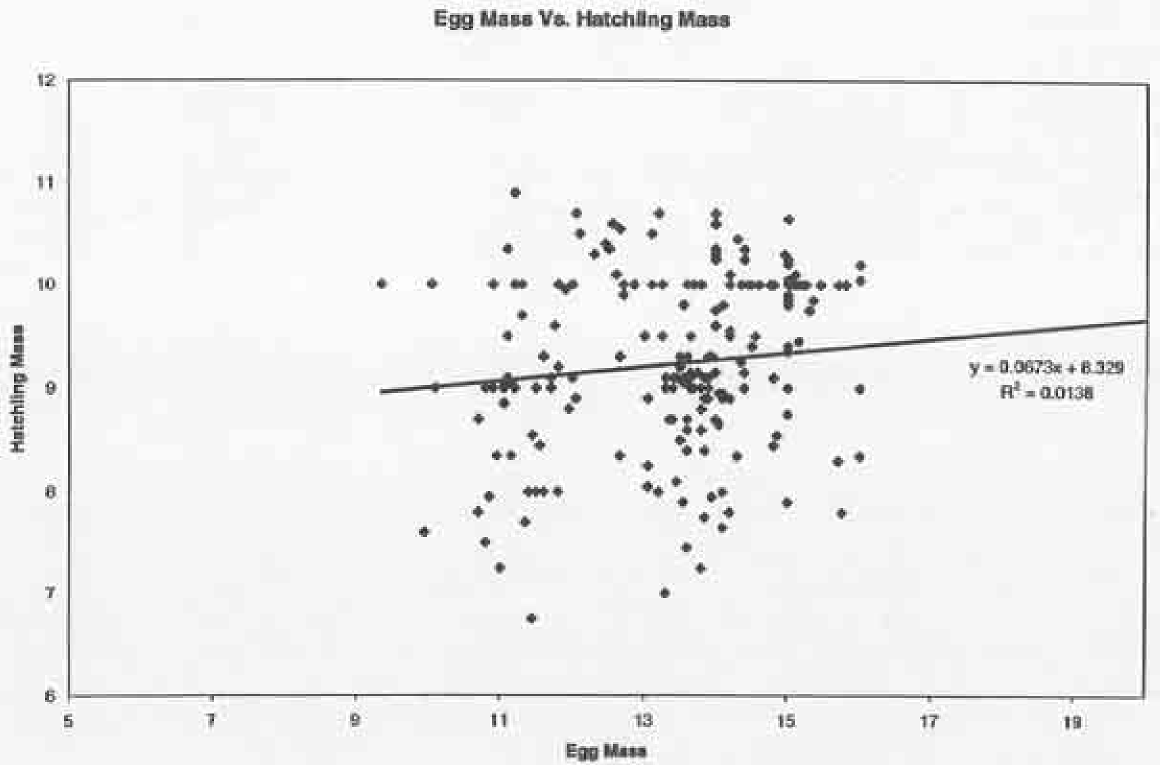

Figure 33 Relationship of Blandings turtle egg mass to hatchling mass.

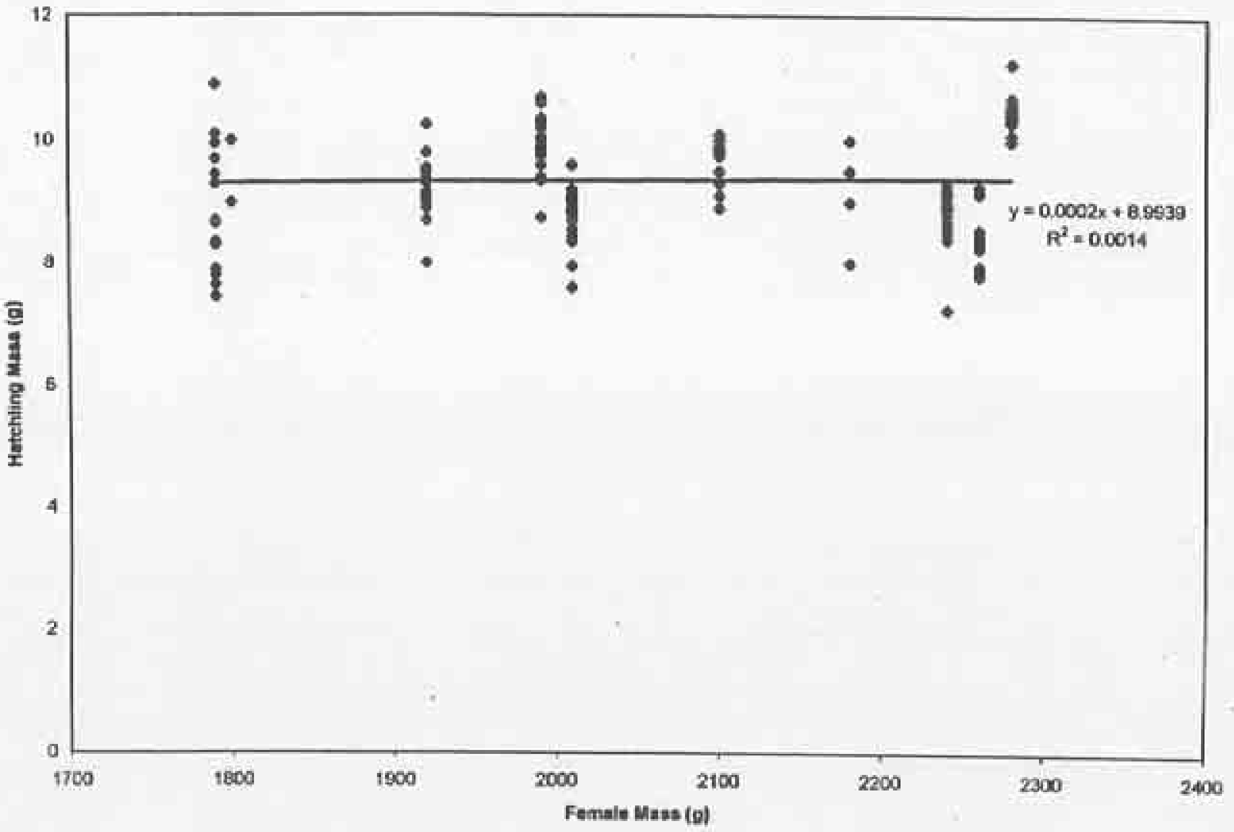

Figure 34 Relationship of female Blandings turtle mass to hatchling mass.

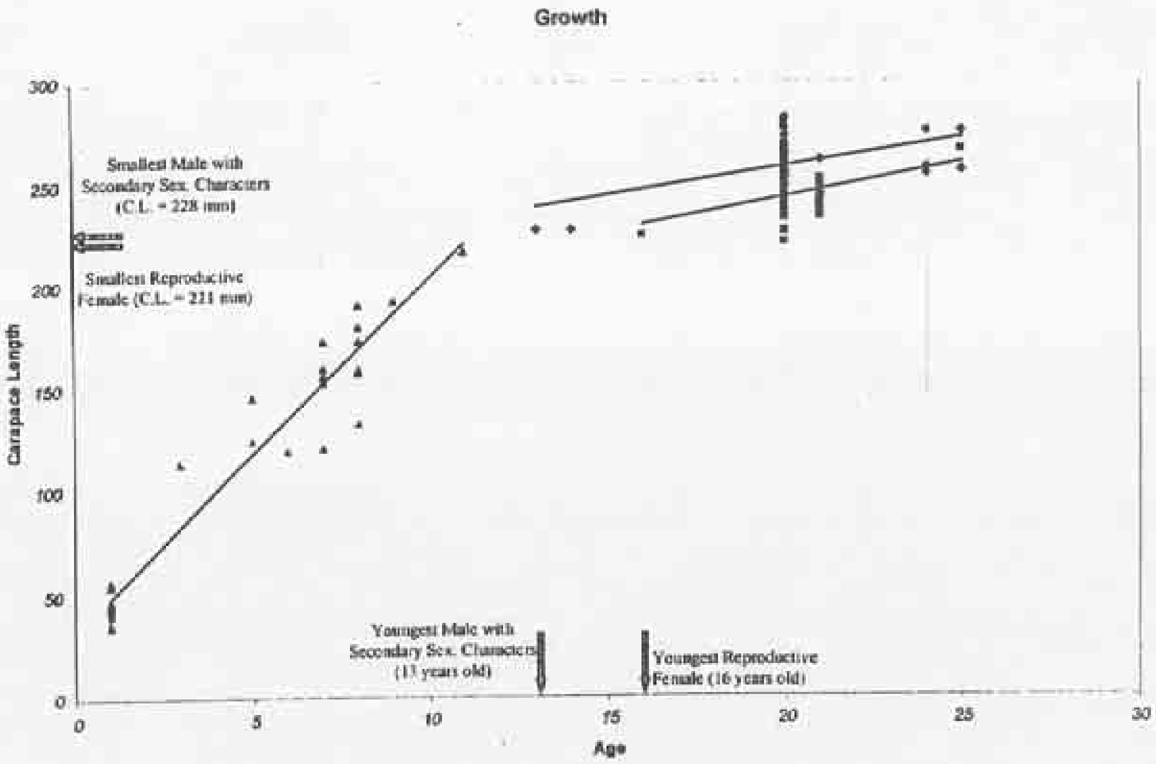

Figure 35 Differences in observed growth rates between juvenile, male and female Blandings turtles at Camp Ripley.

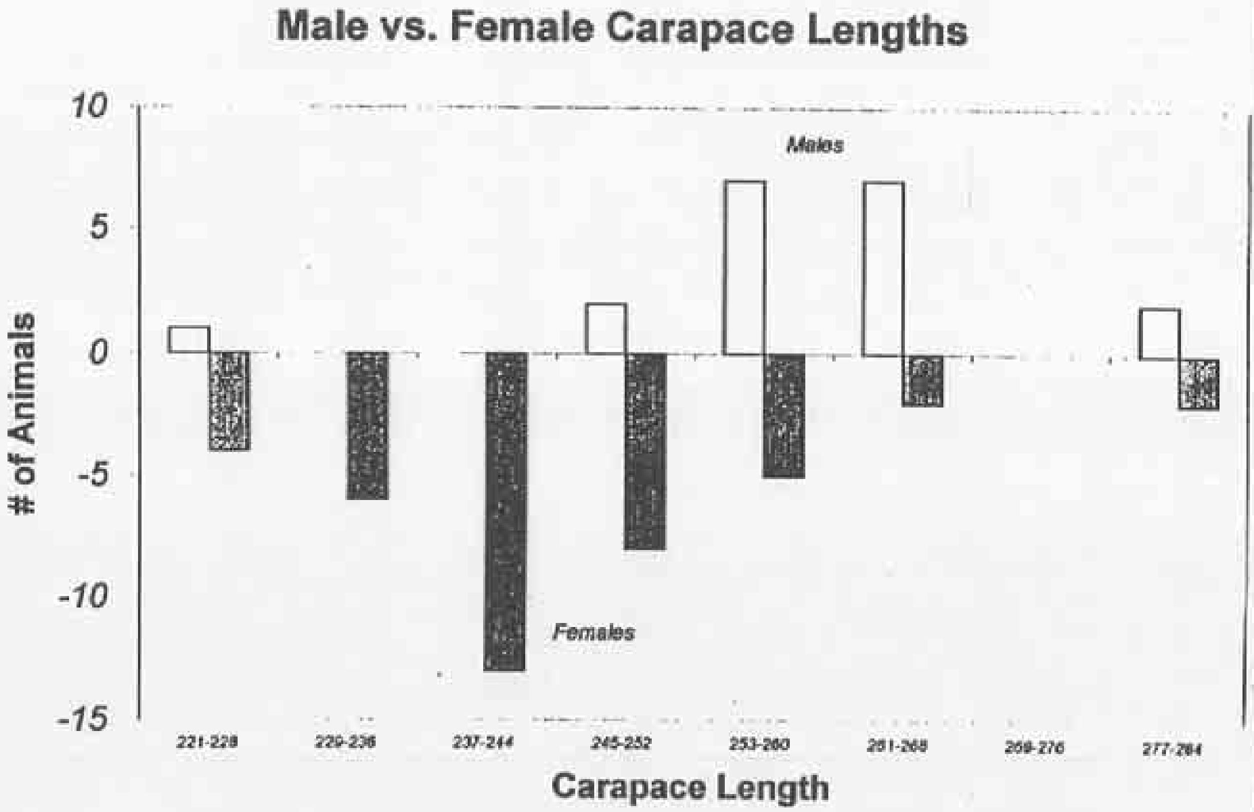

Figure 36 Apparent sexual size dimorphism in Blandings turtles at Camp Ripley based on carapace lengths.

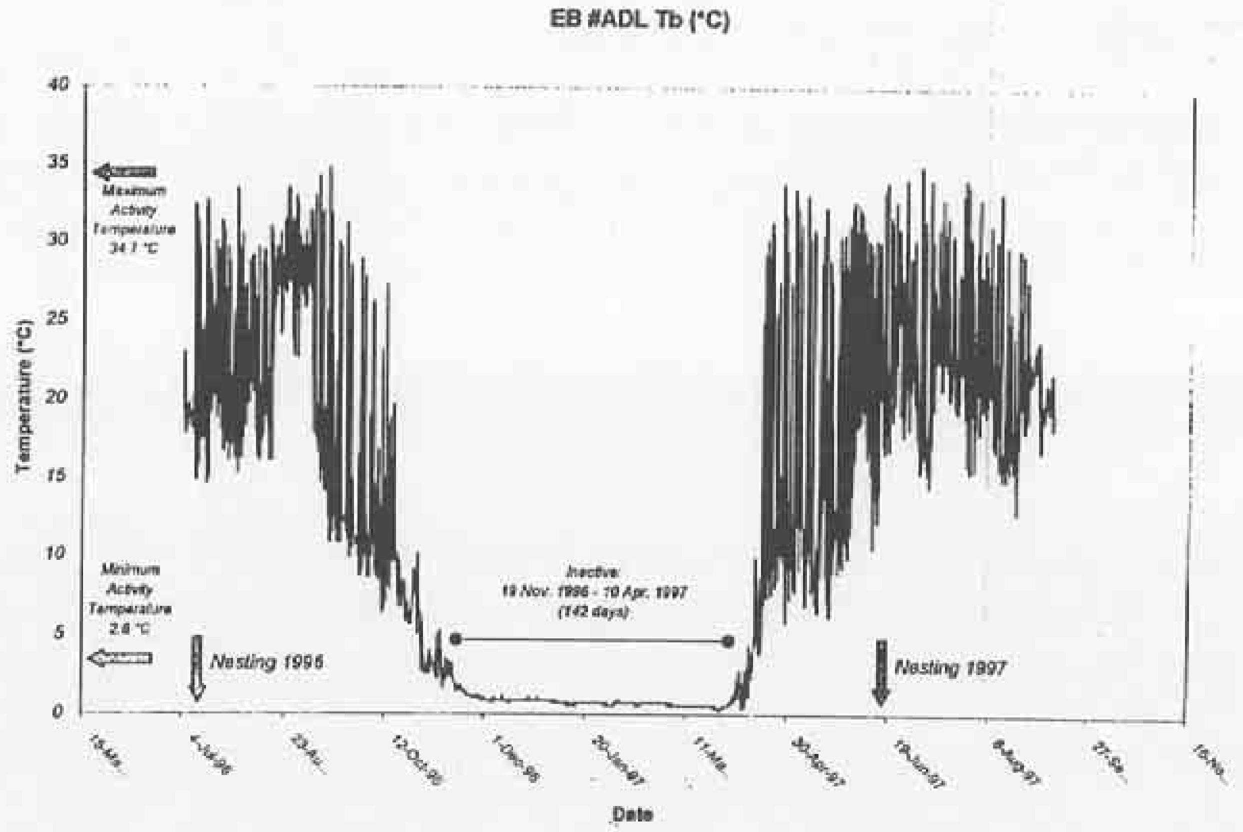

Figure 37 Annual body temperature record for female ADL.

FIGURES 38 AND 39 HAVE BEEN REMOVED FROM THIS DOCUMENT: CONTAIN SPECIFIC LOCATION INFORMATION

Body and Shell Temperatures of Blanding's Turtles as Indicators of Activity, Behavior, and Energetics

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Abstract: The thermal ecology of *Emydoidea blandingii* is being investigated in north central Minnesota as part of a conservation effort at Camp Ripley, a military training site in forested glaciated terrain. In this preliminary study, we examine the daily thermal patterns of two adult males living in a small marsh. Turtle temperatures were monitored via an implanted data logger and with a temperature-sensitive radio on the carapace. This approach resulted in a continuous record of internal body temperature (Tb) and an intermittent record of external shell temperature (Ts). During sunny days in early summer, four distinct phases of heat exchange characterize the daily Tb of this semi-aquatic turtle. These were rapid heating, an elevated but variable plateau, rapid cooling, and gradual cooling. These phases occurred in late morning, during midday, in late afternoon, and at night, respectively. As ambient temperatures increased seasonally, the daily range of Tb decreased, from 9-31 C in late May to 20-32 C by mid July. External Ts closely tracked internal Tb during gradual cooling at night; but overestimated Tbs during rapid heating and underestimated Tbs during rapid cooling during the day. Interpretation of these records will allow us to infer daily and seasonal patterns of activity, behavior, and energetics otherwise unavailable for this cryptic turtle.

Introduction

Until recently, two primary methods were used for the study of body temperature (Tb) in reptiles: capture temperatures taken using cloacal thermometers, and temperature-sensitive radio transmitters with an internally implanted thermistor. The capture-temperature technique, while inexpensive, provides incomplete Tb information on secretive species, disrupts behavior, and is labor intensive (Peterson et al. 1993). Because thermal telemetry is less intrusive and facilitates collection of Tb data regardless of the animal's location, it has become an invaluable technique in field studies of thermal relations in snakes (Reinart 1992, Peterson 1987), large lizards (Rummery et al. 1994, Christian and Weavers 1996) and crocodilians (Lang 1977). In contrast, field studies of chelonian thermal ecology have focused on capture temperatures (Ernst 1982) and observations of behavioral thermoregulation and operative temperatures (Lefevre and Brooks 1995, Spotila et al. 1990). Brown et al (1990) used an externally mounted, temperature sensitive radio to infer internal body temperature of wild snapping turtles *(Chelydra serpentina).*

As part of a larger study of the thermal ecology and conservation of the Blanding's turtle *(Emydoidea blandingii)* near the northern limit of its range, we outfitted two turtles with dataloggers implanted internally to record body temperatures (Tb) automatically and temperature sensitive radio transmitters mounted externally on the carapace to record shell temperature (Ts). In this poster, our objectives are: 1) to compare the temperature records produced using the two methodologies, 2) to analyze the resultant daily patterns of Tb, especially with respect to periods of heating and cooling, and 3) to infer the daily cycle of thermal selection of this cryptic. secretive turtle. To achieve these objectives, we examined the relationship between external Ts (shell temperature) and internal Tb (body temperature) over a range of ambient temperature for free-ranging turtles during early summer.

Materials and Methods

Our analysis focuses on two adult, male Blanding's turtles, BHL and BL, with respective masses of 2.5 and 2.8 kg. Both turtles inhabited XXXXXX, a small wetland located within Camp Ripley, a military training facility in Morrison County, Minnesota.

In order to monitor internal body temperature (Tb), we surgically implanted a datalogger ("Tidbit", Onset Computer Corporation) in the body cavity of each turtle through a small incision in the skin and underlying muscle layers of the inguinal cavity anterior to the hind leg. These dataloggers are accurate to t 0.1°C. Turtles were monitored for 48 hours after the surgery to insure that the procedure did not impair movement or cause infection.

External shell temperature (Ts) was recorded with temperature-sensitive radio transmitters-designed by Advanced Telemetry Systems (Isanti. MIA, which were accurate to ±O.1C°. The transmitter was glued to the anterior-most costal scute of the carapace with quick setting epoxy similar to the protocol described by Belzer and Reese (1995). The transmitter's thermistor is located within 4 mm of the shell surface. Observations of shell temperature were measured intermittently during the study period with a handheld stopwatch to register the time interval of 11 telemetry pulses. The resultant time (in seconds) was converted into a Ts value specific to each individual transmitter using a second order regression equation provided by A.T.S.

We identified four daily phases of heat exchange: rapid heating, stable plateau, rapid cooling and gradual cooling. These phases were demarcated for the daily records of Tb of each turtle for the study period, which began 28 April and ended 18. July 1996. Individual.. observations of shell, temperature were then classified into a specific heat exchange phase based on the day and time it was recorded. Because Tidbits recorded Tb at regular intervals that did not precisely correspond with measurements of Ts the body temperature at the time of the shell temperature measurement was interpolated. We defined "Ts deviation" as Ts - Tb where positive and negative values indicate over- and underestimation of body temperature, respectively.

Results

Daily Tb Patterns: Four distinct phases of heat exchange were observed in the body temperature records of turtles BHL and BL during sunny days in early summer. Typical examples of the daily Tb records with the identified phases are shown in figures 1 and 2.

- During late morning, a rapid heating phase was characterized by a steep increase in Tb. During this phase turtle BL's Tb rose 16.7°C over 3.2 hours, while turtle BHL's Tb increased 18.4°C over 2.5 hours.
- By mid-afternoon, the turtle's Tbs reached a stable plateau distinguished by near constant body temperature. Turtle BHL maintained a mean body temperature of 32.4°C for 6.4 hours, while turtle BL sustained a mean temperature of 31.8°C for 1.6 hours.
- During the late afternoon and early evening, a rapid cooling phase occurred in which the Tbs of both turtles declined approximately 11°C.
- During the late evening and early morning, the turtles' Tbs exhibited a gradual cooling phase where Tbs dropped only 5 - 6°C over a 12-hour period.

Overcast days produced similar patterns of heat exchange as found in sunny days, however, the magnitude of temperature change was much reduced, and closely paralleled trends in surface water temperature.

Body (Tb) vs. Shell (Ts) Temperature: A total of 324 shell temperature observations from turtles BHL and BL were recorded and individually assigned to one of the daily phases of heat exchange. For each phase, the relationship between internal Tb and external Ts are shown in figures 3 through 6.

- During rapid heating, the mean Ts was +3.6°C warmer than the corresponding Tb. The magnitude of the difference between Ts and Tb was greatest during this phase, and also most variable *(SEM* = 0.622, n = 82; figure 3) relative to the other phases.
- During the stable plateau phase, the mean Ts approximated mean Tb. The mean of the difference between Ts and Tb was minimal during this phase (T, deviation from Tb = 0.6°C). with considerable variation (SEM = 0.413, n = 102; figure 4).

- During the rapid cooling phase, the mean Ts was -2.5°C cooler than the mean Tb. The mean difference exhibited intermediate variability (SEM = 0.449, n = 67; figure 5) relative to the rapid heating and stable plateau phases.

- During the gradual cooling phase, the mean T, approximated mean Tb. The mean of the difference between T, and Tb during this phase (T, deviation from Tb = -0.9°C) was slightly greater than the difference of the stable plateau phase, but with considerably less variability (SEM = 0.123, n = 73; figure 6).

Discussion

Several aspects of Blanding's turtle thermal ecology, including daily activity and daily patterns of thermal selection can be examined using our methodology. Blanding's turtles have been reported as a diurnally active species (Oldfield and Moriarty 1995), which concurs with the absence of movement during the late evening and early morning hours noted in our study. We observed turtles basking and moving predominately during daylight hours. These observations coincide with periods when body temperature was elevated above ambient air and water temperatures.

Body Temperature (Tb) vs. Shell Temperature (Ts): The relationship between Tb and T, varies considerably during the day depending on the daily phase of heat exchange.

- During the rapid heating phase, we typically observed a considerable lag between the initial rise of T, and Tb. We believe this lag is attributable to the disparate rates of heating and cooling between the radio-transmitters (15g) and turtles (2.5kg). We also noted that while the daily initiation time of this phase varied between turtles, the duration of this phase was relatively consistent.
- The beginning time of the stable plateau phase was variable between turtles and between days. Additionally, the duration and mean temperature of the stable plateau phase also differed between turtles and between days.
- The rapid cooling phase also showed variable times of initiation and duration. Typically, the decline in T, is evident before the corresponding decline in Tb. This observation is also due to differences in heating and cooling rates of the turtles and transmitters.
- Because solar radiation is much reduced during the late evening and early morning hours of the gradual cooling phase, the gentle decrease of Tb closely parallels similar declines in surface water temperatures.

Daily cycle of thermal selection: Patterns of thermal selection can be inferred from the combined records of body and shell temperature records shown in figure 7. Between 08:00 - 09:00, shell temperatures are rising quickly and are considerably above corresponding body, air, and water temperatures, indicating that the turtle was engaged in aerial basking. At 10:00 Ts drops off sharply, suggesting the turtle re-entered the water. Throughout the stable plateau phase, Ts undergoes several short cycles in which it rises quickly and then declines rapidly. These Ts cycles indicate a corresponding cycle of aerial basking followed by entry into the water. Figure 4 additionally suggests a narrow range of body temperatures (30 - 32°C) that the turtles are attempting to maintain during the stable plateau phase. By 16:00, Ts is near or below Tb, which indicates that the turtle is in the water again. While not depicted in figure 7, shell temperatures during the gradual cooling phase are typically very near Tb and ambient water temperature. This indicates that the turtle is remaining in the water and inactive.

Daily Minimum and Maximum Tbs: The range of daily body temperatures changed considerably during the study period (figure 8). The daily minimum Tb is shown to rise over the course of the summer, while daily maximum Tbs did not show substantial change. The gradual cooling and stable plateau phases contain the daily minimum and maximum body temperatures. respectively. Therefore, a single shell temperature recorded prior to sunrise and several shell temperature observations noted during early afternoon provide adequate information on seasonally influenced daily minimum and maximum body temperatures.

The data presented here represents two male turtles for a short time during early summer. We era presently collecting similar body temperature records from 23 additional turtles (males. females, and juveniles) which each encompass yearlong cycles of body temperature.

Conclusions

- Internal body temperature (Tb) records from sunny days suggest four phases of daily heat exchange. Shell temperatures (Ts) recorded during the rapid heating and rapid cooling phases typically over- and underestimate body temperature respectively. During the stable plateau phase, Ts varies above and below Tb equally, necessitating caution when interpreting these records. Direct solar radiation is unavailable during the gradual cooling phase, consequently, Ts measurements are closely related to Tb.
- By combining internal and external measures of body temperature, we can now approach questions of activity; thermal selection, and energetics for this cryptic and elusive turtle species.
- Shell temperature records are useful for inferring cycles of -thermal selection and aspects of energetics such as seasonally fluctuating daily maximum and minimum body temperature.

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FIGURE 1: Turtle BHL

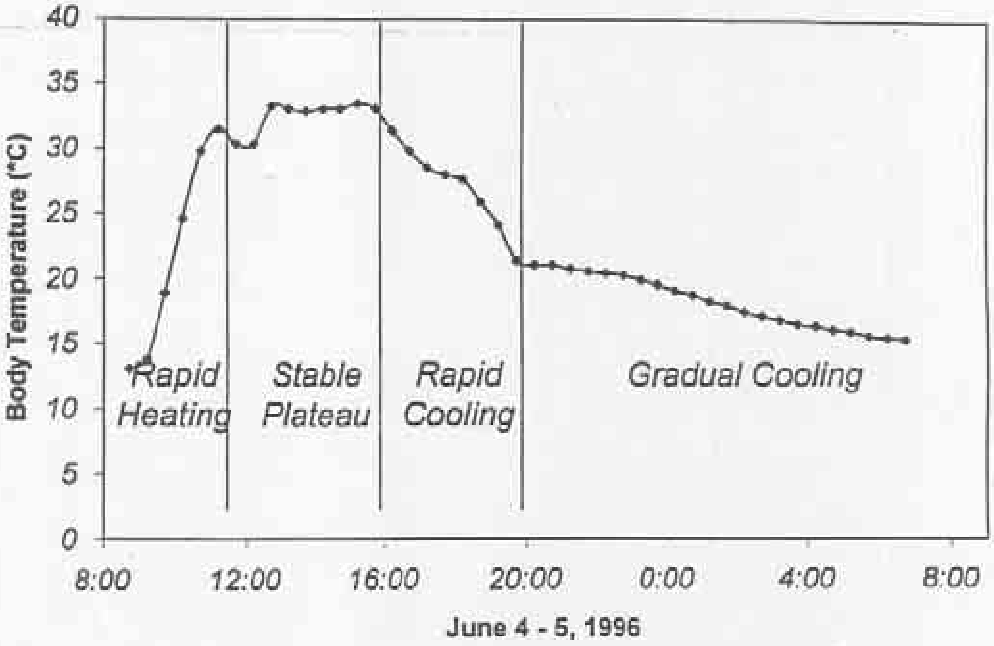


FIGURE 2: Turtle BL

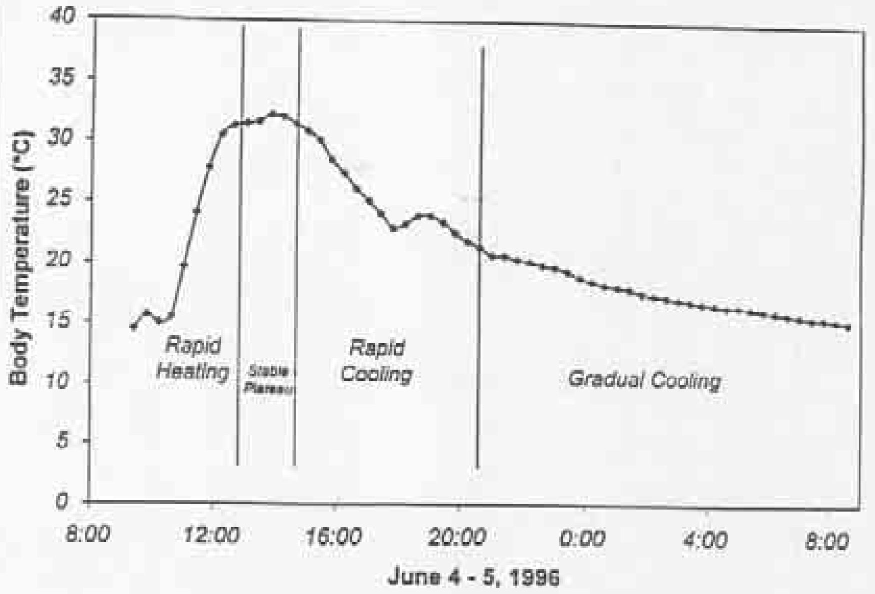
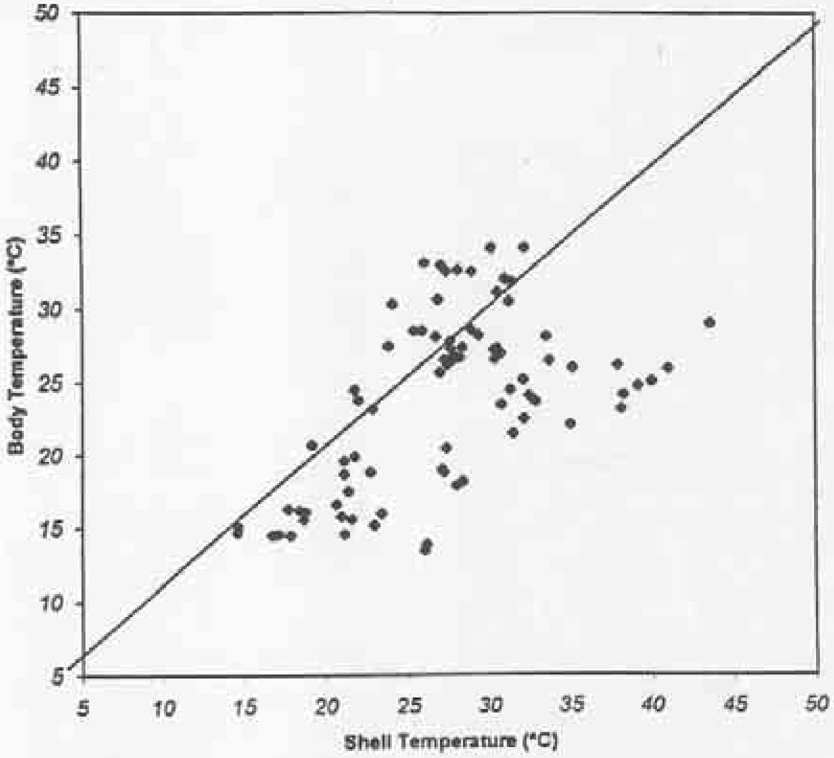


FIGURE 3: Rapid Heating Phase



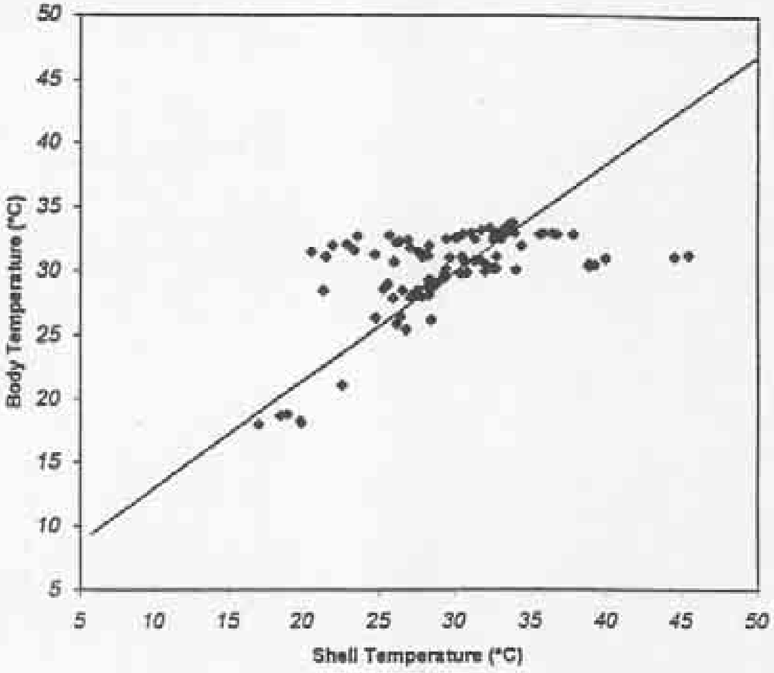


FIGURE 4: Stable Plateau Phase

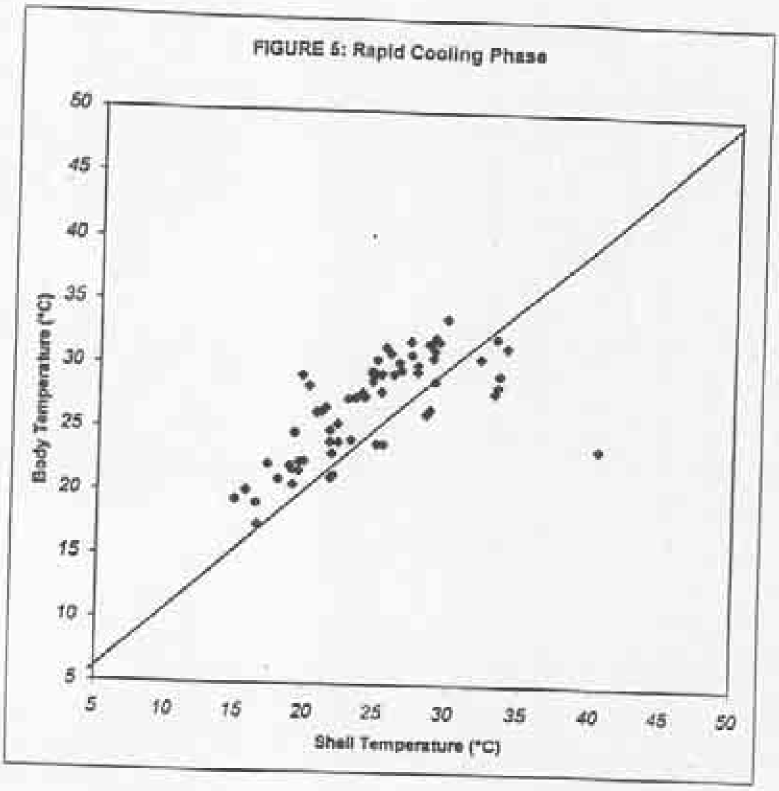


FIGURE 5: Rapid Cooling Phase

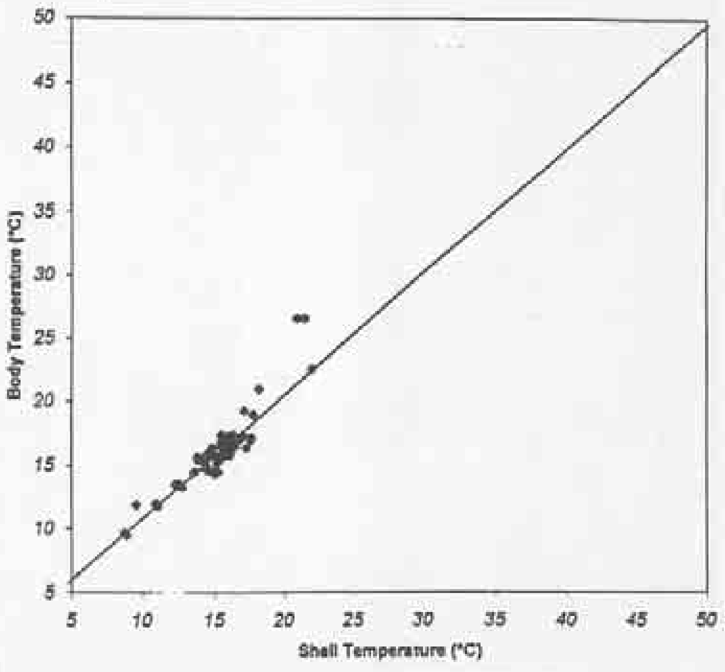


FIGURE 6: Gradual Cooling Phase

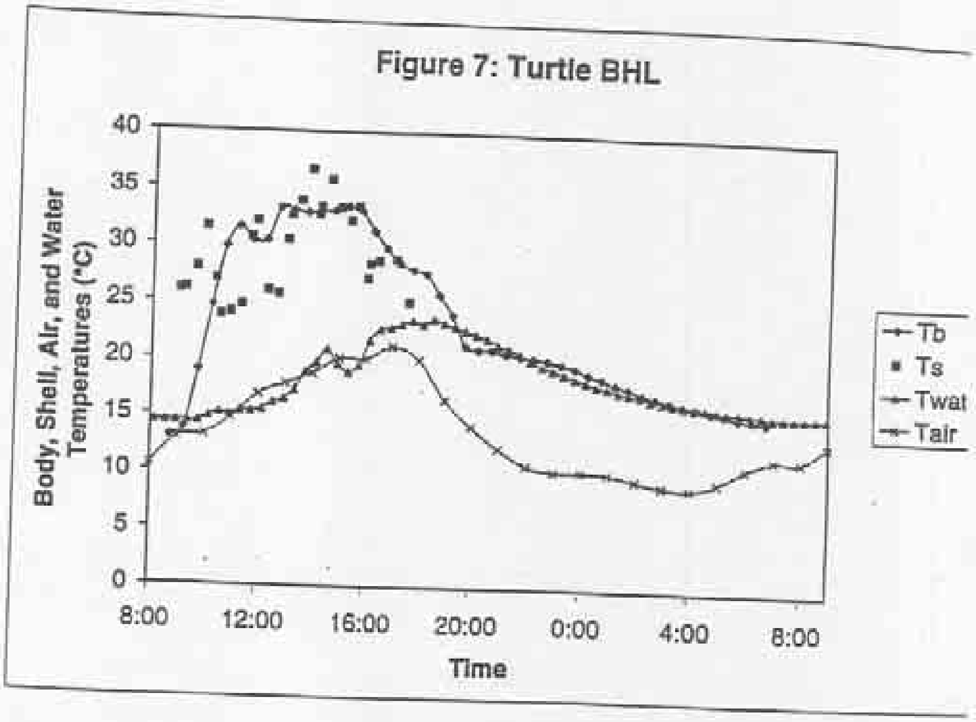
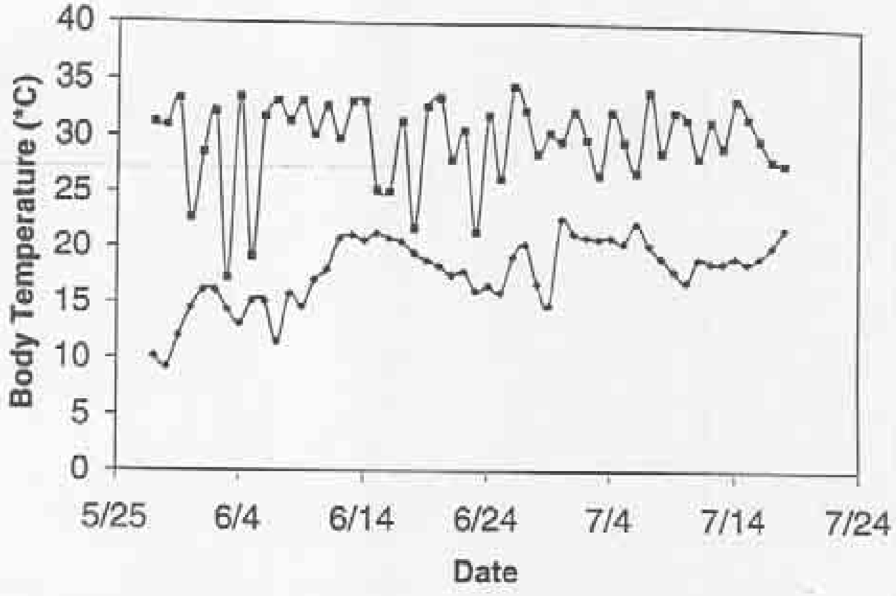


Figure 7: Turtle BHL

FIGURE 8:Turtle BHL Daily Min./Max. Tb (*C)



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Body and Shell Temperatures of Blanding's Turtles as Indicators of Activity. Behavior, and Energetics

The thermal ecology of Emydoidea *blandingii is* being investigated in central Minnesota as part of conservation efforts at Camp Ripley, a military training site in forested glaciated terrain. This preliminary study examines daily thermal patterns of two adult males living in a small marsh. Turtle temperatures were monitored via an implanted data logger and with a temperature-sensitive radio on the carapace. This approach resulted in a continuous record of internal body temperature Ts and an intermittent record of external shell temperature (Ts). During sunny days in early summer; four distinct phases of heat exchange characterize the daily Ts of this semi-aquatic turtle. These were rapid heating. an elevated but variable plateau, rapid cooling. and gratin cooling. These phases occurred in late morning. during midday, in late afternoon. and at night. respectively. As ambient temperatures increased seasonally. he daily range of Ts decreased, from 9-31°C in late May to 20-32°C by mid-July. External Ts closely tracked internal Tb during gradual cooling at night, but overestimated Tbs during rapid heating and underestimated Tbs during rapid cooling during the day. Interpretation of these records will allow us to infer daily and seasonal patterns of ac ivity behavior, and energetics otherwise unavailable for this cryp ic turtle. *(Poster Session 3, Monday 1:30-5. Tuesday 8-5)*

Program and Abstracts

American Society of Ichthyologists and Herpetologists
77th Annual Meeting

Herpetologists' League
45th Annual Meeting

Society for the Study of Amphibians and Reptiles
40th Annual Meeting

American Fisheries Society-Early Life History Section
21st Annual Larval Fish Conference

American Elasmobranch Society
13th Annual Meeting

Gilbert Ichthyological Society
9th Annual Meeting

Hosted by the University of Washington
Seattle, Washington
June 26-July 2, 1997

ANIMAL SURVEYS AT THE MINNESOTA ARMY NATIONAL GUARD
CAMP RIPLEY TRAINING SITE
1991-1992

FINAL REPORT

Carol J. Dorff
Gerda E. Nordquist

Minnesota County Biological Survey

Nongame Wildlife and Natural Heritage Programs
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Department of Natural Resources
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March 1993

EXCERPT:

unable to assess the negative impact of military activities on the resident vole populations. Eight grassland sites have been designated as significant wildlife areas based on the presence of Prairie voles (Fig. 8). Special use plots should be established in the Arno Road and Old Fort Ripley grasslands.

Prairie voles were found in association with the more common Meadow vole at Camp Ripley. Where these two species co-occur, the Prairie vole generally occupies drier grasslands, with more diverse vegetation arid less cover (Jones and Birney 1988). This was found to be the case at Camp Ripley, as well. In addition, Meadow voles prefer heavier cover of dead grass (Birney et al. 1976) and may displace the Prairie voles when litter is allowed to- accumulate. Regular burning should reduce litter build-up, while still retaining an appropriate amount of vegetative cover for Prairie voles. Additional inventory work is recommended to (1) identify other grassland areas in Camp Ripley where Prairie voles occur, (2) to determine the size of Prairie vole populations, and (3) to delineate areas within the larger grassland sites where these voles reside: This detailed locational information can assist Camp personnel with planning training activities on these open lands." Military maneuvers need not be eliminated from these areas, however, <u>minimizing</u> the severity of impact in sectors where the voles are located is recommended.

Another example of range overlap among closely-related species at Camp Ripley was found between the Northern and Southern flying squirrels. Generally, these species occupy separate distributions within mature forest regions of Minnesota. Where they occur together, the Southern flying squirrel often is found in the deciduous forests, while the Northern flying squirrel is restricted to conifer swamps (Hazard 1982). However, at Camp Ripley, this habitat separation was not observed, and both species were recorded throughout the installation from similar tracts of mature forest. Northern flying squirrels were taken from core plots 17, 70, and 78, while Southern flying squirrels were recorded from core plots 8, 15, 40, 41, and 47. While these species are not rare, the observed range overlap at Camp Ripley presents intriguing questions concerning competition and habitat partitioning between these two species. The Camp would be an excellent area to study these questions in more detail.

Summer resident bats at Camp Ripley were not adequately addressed by the mammal surveys. During the two years, bats were regularly observed foraging at night along the shoreline vegetation of the. Mississippi River, smaller water courses, and other wetlands at Camp. Tree bats, including the Red bat, Hoary bat and Silver-haired bat, must certainly utilize the forested areas of Camp Ripley as day roosts and possibly as maternity colony sites. Any of the four cave bats, the Little brown myotis, Northern myotis, Big brown bat, and Eastern pipistrelle, could be found here, as well. This is a group of mammals that merits additional study. Bats have been suggested as potential indicator species for forest quality assessment, however, the difficulty in obtaining information about summer bat populations has deterred many from pursuing this area of research. Despite these reservations, Camp Ripley, with its diversity of habitats and wetlands, would provide an ideal natural laboratory to explore the importance of forested habitats to bats.

<u>Herpetofauna</u>

Camp Ripley supports a diverse herpetofauna, with 22 of the 25 species expected to occur in central Minnesota recorded at the installation (Appendix 3). These species include three salamanders, nine toads and frogs, five turtles, one skink, and four snakes. This may not be a comprehensive list of the herpetofauna at the training site, but it does represent the most common species, as well as some of the uncommon ones. Other species that may occur within the training site include the Western hognose snake found elsewhere in Morrison County, Smooth green snake, and Brown snake. While forest dwelling species clearly dominate the herp community at Camp Ripley, grassland and wetland species are present where suitable habitat exists. Table 13 indicates the relative abundances of amphibian and reptile species documented at Camp Ripley and identifies habitat types where they are likely to occur.

Wetlands are essential for all amphibians and several of the reptiles at Camp Ripley. Although some herps may temporarily utilize wetlands as breeding or overwintering sites, others, such as adult Green frogs and Mink frogs, rarely travel far from the water's edge (Vogt 1981). The five species of turtles found within or adjacent to Camp utilize emergent marshes, sedge meadows, . lakes, and rivers as breeding, feeding, and overwintering sites. The state-listed Snapping turtle is present in emergent marshes, lakes, streams and rivers throughout the Camp.

Blanding's turtles were documented at 14 locations at Camp Ripley. This species is threatened in Minnesota and is being considered for federal listing due, in large part, to the loss and degradation of critical habitat. Blanding's turtles require two habitat types: wetlands that provide food and shelter, and grasslands that serve as nesting sites. Wetlands suitable to Blanding's turtles are typically shallow with thick sediments and emergent vegetation. Nesting sites are commonly located on south-facing slopes of open grasslands. This largely aquatic turtle is unique for its tendency to travel relatively long distances over land to reach traditional nesting sites and overwintering sites. Their tendency to travel long distances makes these turtles particularly vulnerable to a number of hazards, such as being hit by cars as they cross roads or captured by predators.

The XXXXXX portion of Camp Ripley was the focus for Blanding's turtle surveys due to previous reports and the number of suitable wetlands in this area. However, three additional sightings of Blanding's turtles were recorded at the XXXXXX in 1992. Appropriate wetland habitat was found here, including XXXXXX, and suitable nesting habitat was also present. Habitat alteration and fragmentation caused by housing developments, roads, railroad tracks, and fences, act as barriers to the movement of these turtles from wetlands to their nesting sites. The greatest danger to adult Blanding's turtles is during the nesting season (first two weeks of June) and during the spring and fall migration (May and September) when they are moving over land. Emerging hatchlings are most vulnerable in the late summer as they travel from the nesting site to suitable wetlands.

Management for Blanding's turtles should include the protection of wetlands, known nesting sites, and travel corridors. Although threats at Camp Ripley appear to be minimal, wetlands should be buffered against run-off, filling and draining. In addition, during the nesting season and peak emerging period, activities should be minimized near grasslands and roadsides known to be nesting sites and travel corridors. Turtle crossing signs may be beneficial in high use areas. The removal of the bottom section of the fencing around XXXXXX would allow free movement of the Blanding's turtles in that area. All reliable sightings of Blanding's turtles in any portion of Camp should be reported and this information maintained and mapped to provide additional data on travel corridors and population concentrations.

Survey results from 1991 and 1992 indicate that species of forest dwelling frogs and toads are the most abundant herpetofauna within Camp Ripley and are widespread due to the high proportion of forested habitat (Table 13). Wood frogs and American toads dominated forested drift fences, and Spring peepers, a forest wetland species, were the most abundant frogs recorded during anuran call surveys. Although biases inherent with particular survey techniques need to be considered when making population estimates, the results provide some indication of species abundances.

Two forest dwelling salamanders, the Central newt and Blue-spotted salamander, were captured in the deciduous forest drift fence on the XXXXXX4 end of Camp. Although this was the only record for the Central newt in Camp, Blue-spotted salamanders were found in several terrestrial searches within forested habitat. The Central newt is an important distributional record, because this species is poorly documented in Minnesota and is difficult to find due to its small size and secretive habits.

The mature forests of Camp Ripley contain prime habitat for forest dwelling amphibians due to the interspersion of small wetlands and an abundance of litter and rotting logs on the forest floor. Forest wetlands provide an essential component in the life cycle of forest dwelling frogs, toads, and salamanders. They serve as breeding sites and support maturation of eggs and tadpoles. Anurans have been shown to be valuable indicators of habitat quality due to their high sensitivity to chemical pollutants and habitat degradation occurring in both terrestrial and aquatic habitats. Concerns about global declines in frog and toad populations have received much attention from the scientific community (Barinaga 1990).

Herp species occupying grassland habitat include Leopard frog, Chorus frog and Northern prairie skink. Although Leopard and Chorus frogs prefer grasslands near aquatic habitats, the Northern prairie skink can occupy dry grasslands far from a water source. The state-listed Eastern hognose snake was frequently documented along roads within Camp. This species typically occurs in grasslands, open woods, and river floodplains. Areas with loose sandy soils are preferred and much of their time is spent underground in small mammal tunnels (Vogt 1981). Their primary food source is toads. Suitable habitat and food is abundant at Camp Ripley and threats to the Eastern hognose snake are fairly minimal. The greatest danger to this species is being hit by vehicles when basking along the roadside or attempting to cross. Also, injury from individuals, who mistake it for a venomous species, is a potential threat on base.

Snakes and turtles are susceptible to physical injury as a result of being struck by vehicles. Education of Camp staff and visiting troops to avoid these animals when encountered on roads will go a long way toward minimizing this problem. However, the greater threat to all herpetofauna at Camp Ripley is the destruction and the degradation of the habitats upon which they depend. Military training activities and resource management practices should avoid impacts to wetlands whenever possible or minimize the impact to these habitats. Changes in herpetofauna due to the impacts of military activities and resource management practices should be monitored and evaluated on a regular basis: Establishment of permanent surveys stations for anuran call surveys and drift fences, especially in areas of intensive use such as bivouac sites, will provide for long-term monitoring of frog and toad populations. The continuation of such surveys will not only improve population estimates, but should detect changes in population levels.

RECOMMENDATIONS

Animal surveys conducted during 1991 and 1992 represent the initial efforts of a long term survey at Camp Ripley. Survey results have provided insight into areas of significant wildlife habitat at Camp Ripley, and the following management recommendations for the protection of rare species reiterate those proposed in the discussion section.

1. Establish and manage significant wildlife areas to protect rare species.

a. Significant forested areas were identified based on the presence of breeding Red-shouldered Hawks, and forest size and structure. Land-use and management of these large forested areas should limit further fragmentation to ensure protection of this rare species as well as other, forest

Table 10. Data recorded from Blanding's turtles captured at Camp Ripley during 1991 and 1992 surveys.

1991

Location	Date	Sex	Age	Carapace L x W	Weight	Notch #
[redacted]	29 May 1991	Male	-	260 x 175 mm	6.7 kg	none
[redacted]	3 June 1991	[illegible] 'Y' [illegible] Female	17	238 x 155 mm	2.3 kg	none
[redacted]	3 June 1991	Female	20+	-	-	none
[redacted]	6 June 1991	Male	-	274 x 175 mm	2.7 kg	none
[redacted]	Gravid 10 June 1991	Female	-	236 x 175 mm	2.2 kg	none

PL=235

Nest Dates

→ probably not our EB from Frog Lake

Gravel Ridge between Bass Lake + Little Goose

1992

Location	Date	Sex	Age	Carapace L x W	Weight	Notch #
[redacted]	15 May 1992	Male	20	269 x 180 mm	2.25 kg	2003
[redacted]	19 May 1992	Male	21	273 x 186 mm	2.70 kg	2002
[redacted]	20 May 1992	Male	20+	282 x 186 mm	3.05 kg	2001
[redacted]	20 May 1992	Juvenile	11	217 x 152 mm	1.65 kg	2005
[redacted]	20 May 1992	Male	19	264 x 180 mm	2.45 kg	2004
[redacted]	20 May 1992	Female	20+	267 x 182 mm	2.85 kg	2000
[redacted]	22 May 1992	Male	S	263 x 174 mm	2.65 kg	2006
[redacted]	22 May 1992	Female	20+	269 x 177 mm	3.00 kg	2007
[redacted]	22 May 1992	Male	18	256 x 175 mm	2.20 kg	2008
[redacted]	9 June 1992	Female	20+	238 x 164 mm	1.95 kg	2010

Overwintering Sites

After Between June 10-14

Nest Date 2 June 1992

**FIGURE 8 REMOVED FROM THIS DOCUMENT:
CONTAINED SPECIFIC LOCATION INFORMATION**

Appendix 1: Poster Abstract

Body and Shell Temperatures of Blanding's Turtles as Indicators of Activity, Behavior, and Energetics

The thermal ecology of *Emydoidea blandingii* is being investigated in north central Minnesota as part of a conservation effort at Camp Ripley, a military training site in forested glaciated terrain. In this preliminary study, we examine the daily thermal patterns of two adult males living in a small marsh. Turtle temperatures were monitored via an implanted data logger and with a temperature-sensitive radio on the carapace. This approach resulted in a continuous record of internal body temperature (Tb) and an intermittent record of external shell temperature (Ts). During sunny days in early summer, four distinct phases of heat exchange characterize the daily Tb of this semi-aquatic turtle. These were rapid heating, an elevated but variable plateau, rapid cooling , and gradual cooling . These phases occurred in late morning, during midday, in late afternoon, and at night, respectively. As ambient temperatures increased seasonally, the daily range of Tb decreased, from 9-31°C in late May to 20-32°C by mid July. External Ts closely tracked internal Tb during gradual cooling at night, but overestimated Tbs during rapid heating and underestimated Tbs during rapid cooling during the day. Interpretation of these records will allow us to infer daily and seasonal patterns of activity, behavior, and energetics otherwise unavailable for this cryptic turtle.

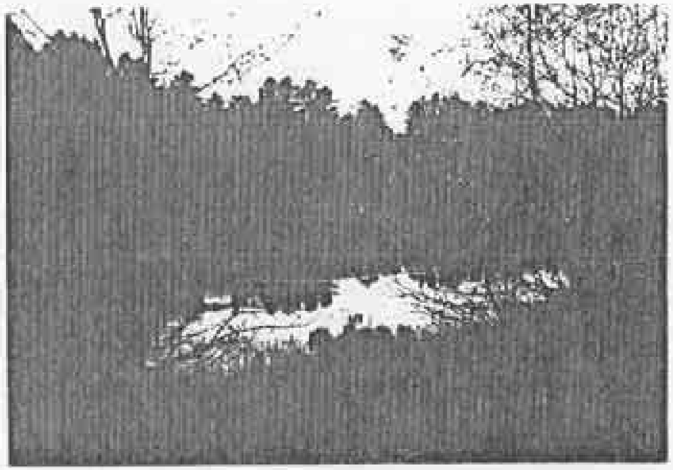


Photo 1. Little Goose [redacted] Area in early June: a typical, frequently utilized wetland by all age/sex classes.

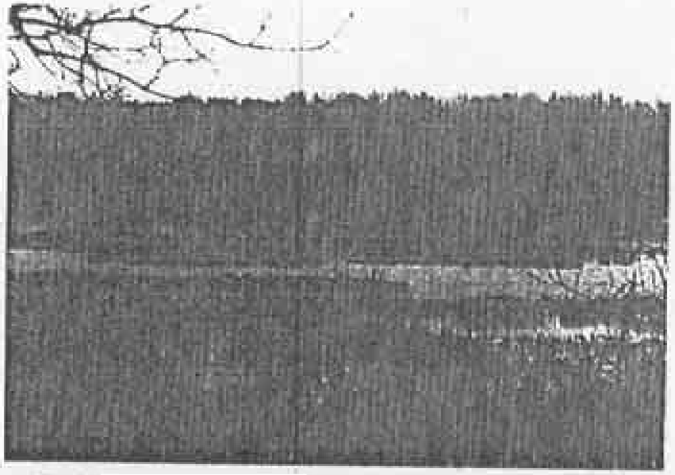


Photo 2. [redacted] in early June: a heavily utilized wetland by all age/sex classes.

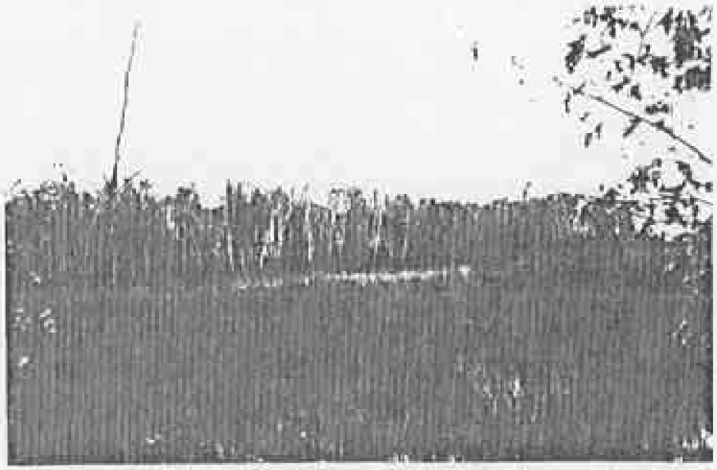


Photo 3. Shrub-swamp (type 6 wetland) habitat in the [redacted]

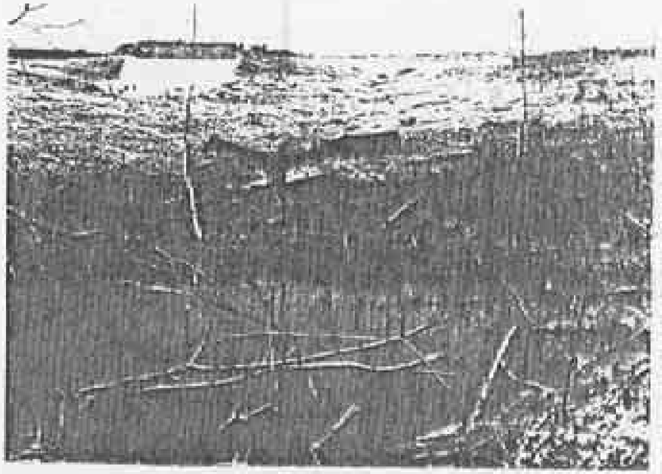


Photo 4. [redacted] in mid-July: atypical habitat utilized by a single adult male turtle.

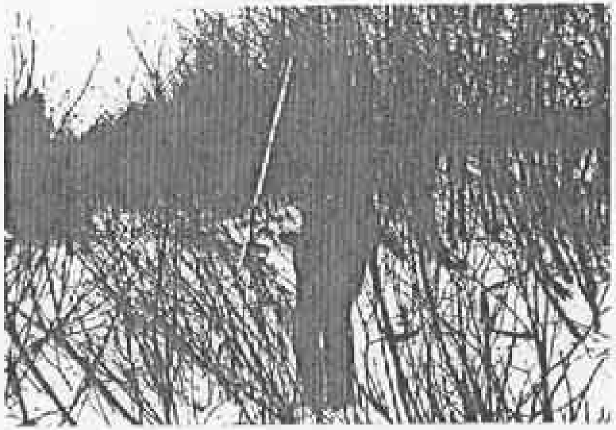


Photo 5. Buddon Pond [illegible] Area in January; the over-wintering site of 2 turtles.

Photo 6. Nesting habitat near Green [redacted] turtle nests were located in this vicinity during 1996-97.

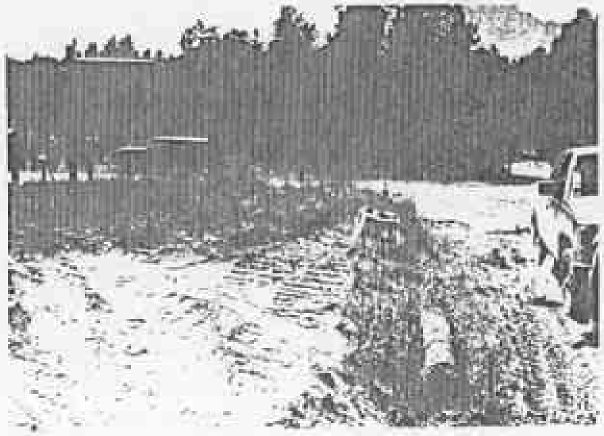


Photo 7. Nesting habitat within [illegible] of the [illegible] Roads & [illegible]

Photo 8. An abandoned Blanding's turtle nest [illegible]

Photo 9. SP attaching a radio transmitter to a restrained turtle

Photo 10. Turtle with affixed radio transmitter

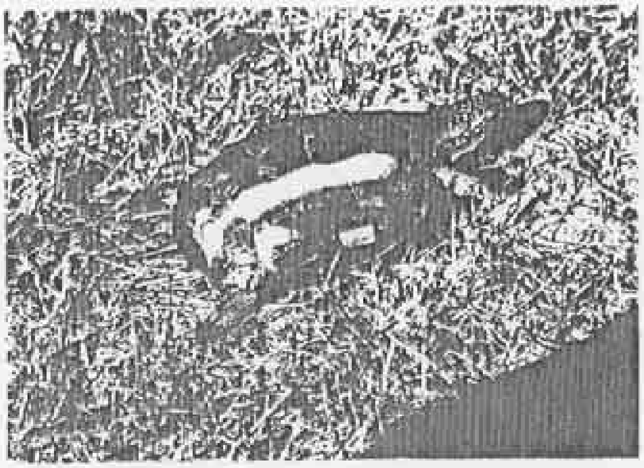


Photo 11. A 1 year-old Blanding's turtle with an affixed radio transmitter

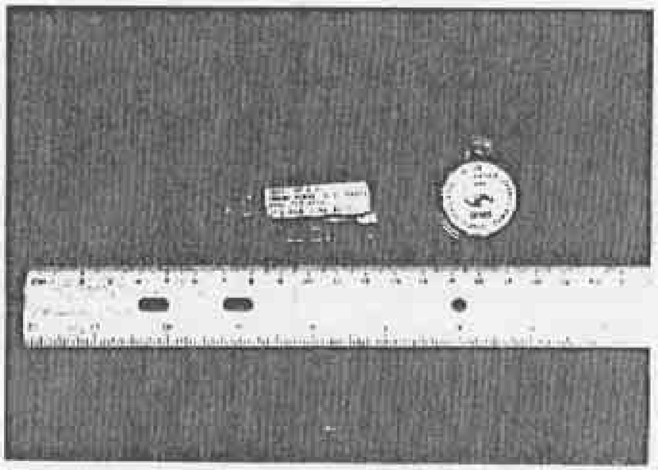


Photo 12. Sizes of radio-transmitter and Tidbit, a datalogger used to monitor internal body temperature

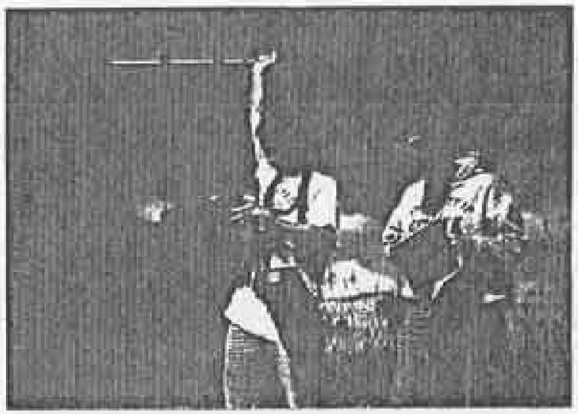
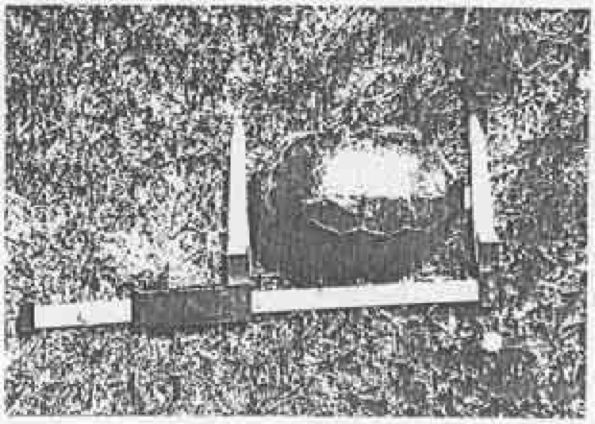


Photo 13: CS and SP acquiring summer telemetry locations of turtles

Photo 14: SP using radio telemetry to locate overwintering turtles at [redacted] Marsh



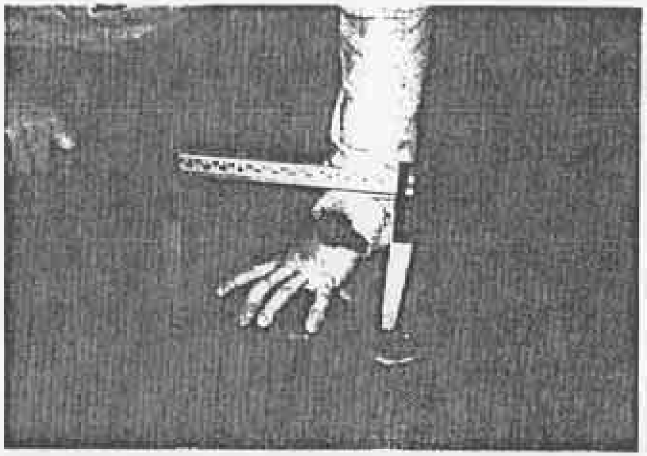


Photo 17 Body size of an adult female turtle

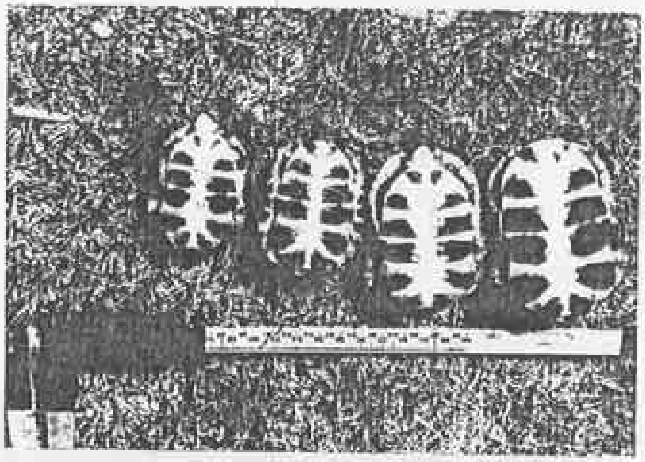


Photo 18 Plastron sizes of 4 juvenile turtles of various ages (1 – 8 years of age)

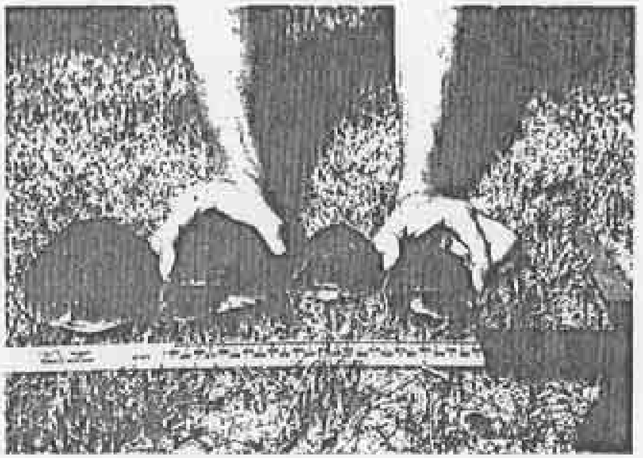


Photo 19 Body sizes of 4 juvenile turtles of various ages (1 – 8 years of age)

Photo 20 The secretive nature of Blanding's turtles makes them difficult to observe in shrub swamp habitats (the turtle's head is just below the lower blades of grass)

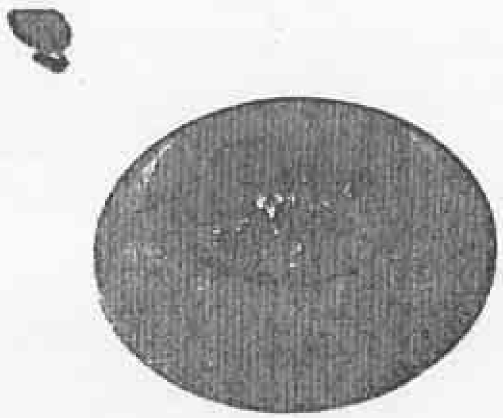
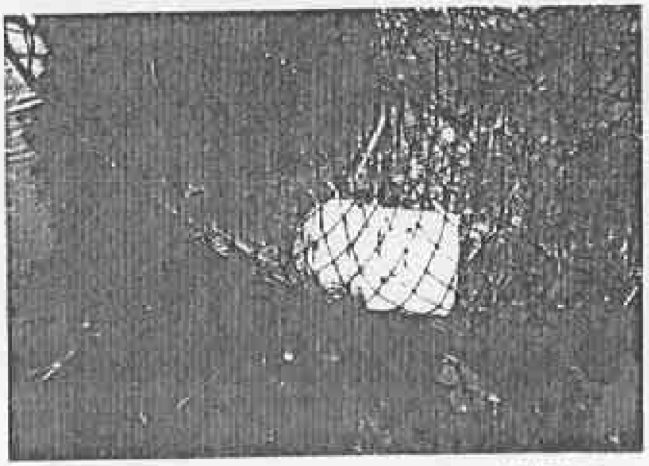
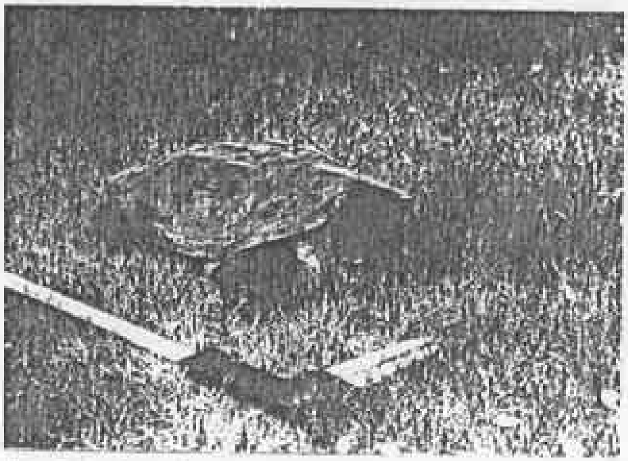


Photo 21. The size of hatchling Blanding's turtles

Photo 22. SP checking traps in [redacted]



[illegible]



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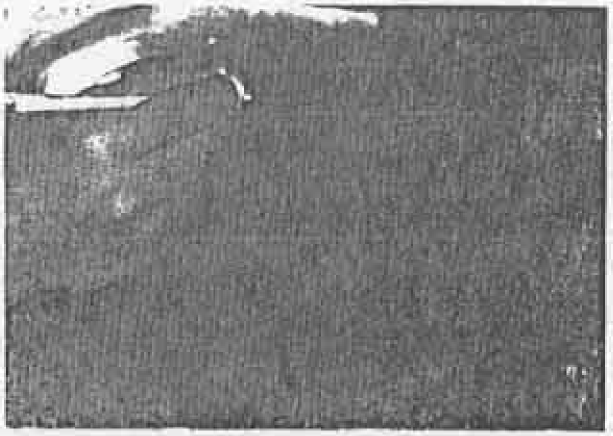

Photo 25. Counting growth annuli (visible rings) of a small snapping turtle to determine age

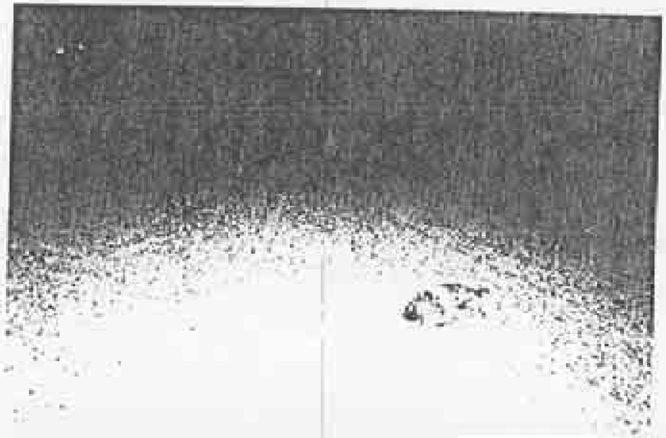

Photo 26. A nesting Blanding's turtle found in the middle of [redacted] [redacted] as she was excavating the nest cavity.

Photo 27. A turtle observed while laying eggs

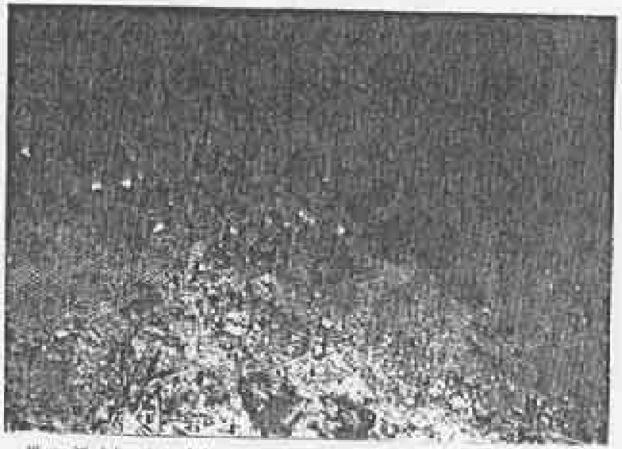

Photo 28. A female turtle beginning to cover her nest on the [redacted] [redacted]

Photo 29. A female turtle moving away from her recently completed nest (evidenced by the darkly colored sand just below the turtle)

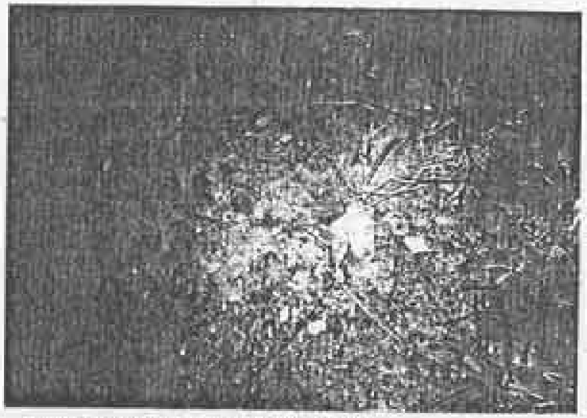

Photo 30. A completed Blanding's turtle nest; by the next morning, the nest site will be virtually indistinguishable

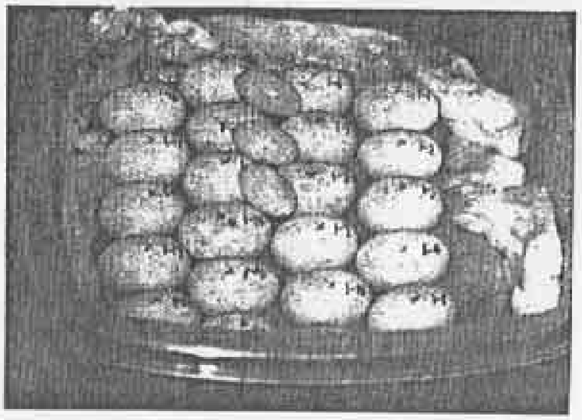

Photo 33. A hatchling turtle completely emerged from a protected nest.

Photo 34. Nest cages protecting and corralling turtle hatchlings near [redacted]
(Goose Area)

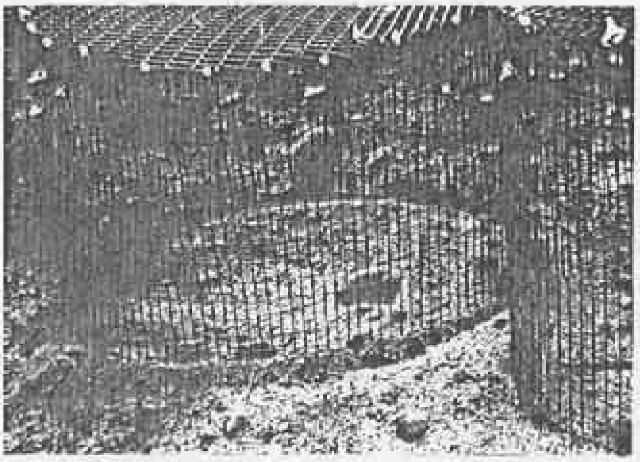

Photo 35. Recently emerged turtle hatchlings (below the pink string) and the
small opening used to exit the nest cavity (to the immediate right of

Photo 36. Turtle hatchlings in an excavated nest, also pictured is the data logger
used to record nest temperatures.

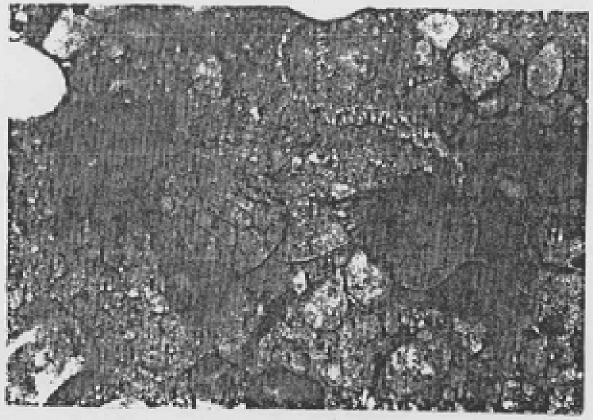

Photo 37 Recently emerged Blanding's turtle hatchlings

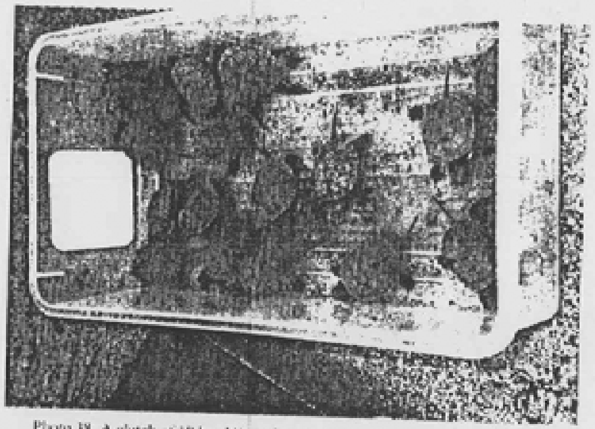

Photo 38 A clutch of 19 hatchlings from a single turtle nest

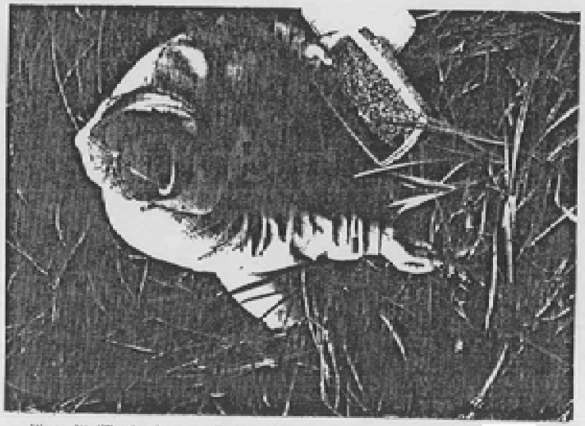

Photo 39 SP releasing corralled hatchlings from a protected nest into [redacted] [redacted]

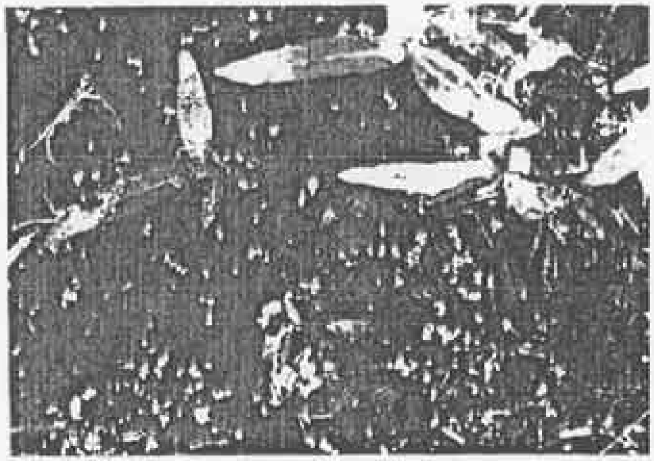

Photo 40. Released turtle hatchlings

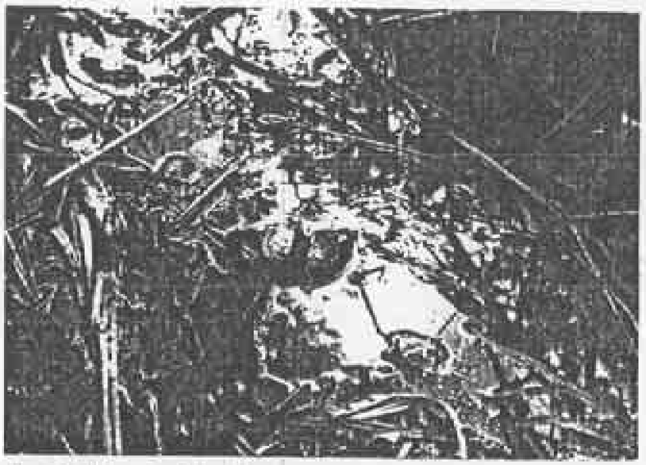

Photo 41. Released turtle hatchlings

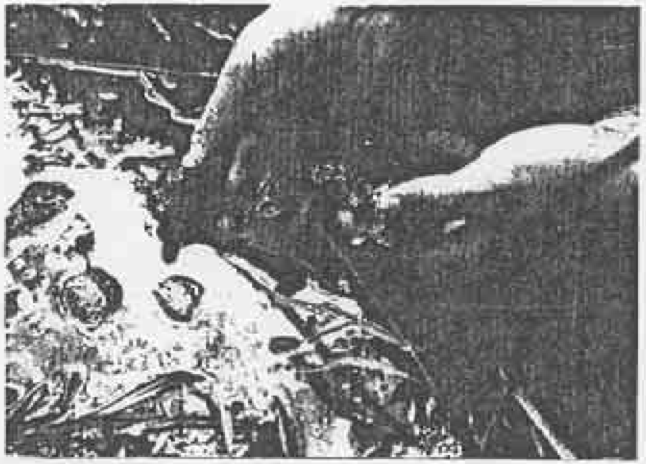

Photo 42. Released turtle hatchlings