Preferred Aquatic Habitats of the Painted Turtle (*Chrysemys picta*) and the Implications for Nest Site Choice

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Abstract

The painted turtle (*Chrysemys picta*) is commonly found throughout a variety of habitats, but availability of food and presence of basking sites may affect the habitat preferences and thus the population density. During the nesting season, female painted turtles must also choose habitats that provide them with suitable nesting sites within close proximity. Nesting preferences were investigated through a road survey of nesting painted turtles, and habitat preferences were tested by trapping turtles at three different habitat types (lakes, creeks, and beaver ponds). I found that, although turtles were not choosing aquatic habitat types preferentially. Their nesting sites along roads were located significantly farther from wetland habitats than by chance alone. Results for the trapping data showed no significant differences in relative abundance, size, or gender across habitat types. My results suggest that turtles on the UNDERC property are not preferentially choosing among possible aquatic habitats based on either their suitability for habitation or their distance from a potential nesting site.

Introduction

The painted turtle (*Chrysemys picta*) is a common freshwater turtle that lives in a variety of aquatic habitats across North America (Bowne and White 2004, Marchand and Litvaitis 2004, Rowe 2003, Lagler 1943). Although individual painted turtles do not always remain in one aquatic environment throughout a season, habitats that can provide them with more suitable resources for survival are more likely to have greater population densities of turtles (Rowe 2003). Many factors can affect the survival and successful reproduction of painted turtles within a habitat, such as the number of predators, food availability, and temperature of the water (Gamble and Simons 2004, Rowe 2003). Previous research suggested that painted turtles often choose habitats that have many basking sites, surface vegetation, and a muddy substrate (Bowne and White 2004). Gamble et al. (2004) indicated that the size of an aquatic environment also affects the size of painted turtles in a population, because there are often more resources available in larger habitats.

While many environmental features influence painted turtle populations and their habitat preferences, finding a suitable nesting locale is an important factor in turtle location during the nesting period. In Michigan, painted turtles nest from late May to late June, usually in the early morning and late afternoon hours (Tinkle et al. 1981). During this time, female painted turtles actively search the surrounding terrestrial habitats for appropriate nest sites (Steen and Gibbs 2004). On average, females travel 122 m from the nearest source of water to find a nesting site, although some travel as far as 600 m (Rowe et. al 2005). Therefore, it is likely that female painted turtles will nest in areas that are closest to the habitat in which they live. When searching for nesting sites, female painted turtles often choose locations with an overstory that can create a suitable temperature and a substrate to provide the optimal environment for offspring development (Spencer 2003). It is critical that females choose appropriate sites for their nests due to the high rate of nest predation (Bowen 2005). Therefore, during the nesting season, it likely that female painted turtles will be found in areas closest to optimal nesting sites.

Understanding which habitats in an area best suit this species, particularly during the nesting season, is an important aspect of conservation and preservation of painted turtles. While several studies have investigated habitat preferences of the painted turtle in other areas of the country or within a single habitat (e.g. St. Croix River Donner et al. 1999, Mississippi River Anderson et al. 2002) a comprehensive study of turtle preference in a variety of aquatic environments has yet to be carried out in the Upper Peninsula of Michigan. Additionally, a study conducted in an area with minimal human activity would provide a more accurate indication of natural painted turtle activity.

My research project investigated several questions: 1) Is there a difference in the number of painted turtles found at each aquatic habitat type? 2) Is there a difference in the gender and size of the painted turtles found in each habitat? 3) Is there a relationship between the size of nesting female turtles and their distance from the nearest appropriate habitat? 4) Is there a difference between number of turtles that are found closest to particular habitats and the distances they travel? Based on previous research about painted turtle habitats and nesting, I hypothesized that of three different habitat types (creeks, lakes, and beaver ponds/wetlands), there would be significantly more turtles in the beaver ponds habitats, where there might be a greater density of vegetation mats and basking sites, than in lake and creek habitats. I also predicted that there would be larger turtles in the wetlands where there is greater productivity and more sources of food (vegetation mats). Because of the male-bias of trapping (Steen and Gibbs 2004), I predicted that a greater number of males than females would be caught at each site, but that the proportion of males across the sites would not differ. Finally, I predicted that during the nesting season, there would be no difference across habitat types in the distances that female turtles travel from the closest habitat.

Methods

Nesting Turtle Location

All work was completed at the University of Notre Dame Environmental Research Center (UNDERC) in Vilas Co., Wisconsin and Gogebic Co., Michigan. Data were collected on the location and density of nesting turtles in order to examine the differences between nesting location and distance from the nearest suitable habitats. Road surveys were conducted because painted turtles often choose to nest in the gravel roads at UNDERC because of its suitable substrate. The UNDERC property roads (53 km total length) were divided into four survey areas for testing (Figure 1). During the morning (0700-1000 CDT) and late afternoon (1500 – 2000 CDT) of the nesting period, the roads of one of the areas were driven to look for nesting turtles. If the turtle was not nesting at the time of observation or had left the nest upon the approach of the vehicle, the turtle was caught, marked, sexed, and measured. Turtles that were nesting at the time of observation were not disturbed. The location of all turtles observed (nesting and not nesting) was documented with a GPS (UTM Datum NAD27, Zone 16N). All GPS data were plotted and viewed using ArcView 3.3 (ESRI, Inc., Redlands, CA)(Figure 2A), Distances of nesting turtles from the nearest aquatic habitats (measurements for both distance to any open water, including wetlands, and distance to permanent water habitats) were determined by using the “measure” tool in ArcView.

Habitat Sampling

The trapping portion of this experiment investigated patterns in painted turtle populations on the UNDERC property in three habitat types: beaver ponds/wetlands, creeks, and lakes. Three sites of each habitat type were chosen throughout the property for trapping during each of three research periods (Table 1, Figure 2B). The surface area and maximum depth data for the lakes were gathered from a previous study's measurements (U.S. Forest Service 1997, Carpenter 1987). The maximum depth for the creek and wetland habitats was determined by measuring the greatest depth within 10 m along the shoreline from either side of the trapping area and 5 m away from the shore. Three beaver ponds (maximum depth < 2 m) were used as sites to represent wetland habitats because their water levels remain high enough to effectively set traps for all research periods. Three first- and second-order creeks were also chosen because they were deep enough to effectively set traps throughout the trapping time. Three lakes of similar surface area and depth were chosen as sites for trapping. In each nine-day research period, three hoop net traps were set at each site for three consecutive days and spaced ca. 10-30 m apart along the shoreline. Hoop nets were baited with partially-opened 6-oz cans of tuna in oil, and one-gallon empty plastic bottles were placed in the nets to ensure that the turtles had a place to surface for air (Steen and Gibbs 2004).

Nets were checked every afternoon between 1300-1800 CDT, and all non-target species were identified and released into the water immediately. Painted turtles were transported to the nearest terrestrial location for data collection and marking. The gender of each turtle was determined (Rowe 2003, Gamble et al. 2004), and the mass and plastron length were measured. Identification of individual turtles was made by creating triangular notches in specific marginal scutes with a file, with each individual having a unique notch combination (Ernst 1971). At the completion of all measurements and identification, the turtles were released into the water within 20 m of the location of capture.

Statistical Analysis – Nesting Data

Before any analyses could be performed, all distance data were log-transformed ($\log_{10}[x + 1]$) to ensure normalization. To examine which bodies of water turtles were nesting closest to, observed data were compared with 87 random points whose distances to nearest bodies of water were measured. A chi-squared analysis examined turtle preferences, based on available habitat distribution (expected) vs. habitats nearest to which turtles were observed. Pearson's correlation analyses were conducted to examine relationships between the turtle's length and weight and its distance from the nearest suitable habitat. An ANOVA was performed to investigate whether differences existed in distance moved (dependent) versus habitat type (independent).

Statistical Analysis – Trapping Data

Relative abundances of painted turtles were compared using two ANOVA tests, which looked at differences in the number of unique individuals and the total number of individuals caught across habitat types. An ANOVA was also used to examine possible differences in turtle size among the habitat types. A Pearson's correlation between the length and weight of the turtles captured was also conducted.

Results

Nesting Data

No nesting turtles were observed during the morning road surveys; all data were collected during the afternoon surveys. A chi-squared analysis showed no difference in the number of turtles found closest to a particular aquatic habitat relative to the number of available habitats (df = 3, $\chi^2 = 0.05$, $p >> 0.05$, Figure 3A). A second chi-squared test showed no significant difference between the number of turtles found closest to each type of permanent water habitats relative to the measured random points (df = 2, $\chi^2 = 0.04$, $p >> 0.05$, Figure 3B).

An ANOVA examined the distance that turtles traveled from their habitats to a nesting site. For all aquatic habitats, there was a significant difference between the distances traveled from each possibility (df = 2, F = 3.111, $p = 0.05$, Figure 4A). A Tukey's post-hoc test showed that no values were individually significant ($p < 0.05$) from one another, but that there was a trend that turtles may be moving farther from creeks than from wetlands ($p = 0.09$). A two-way ANOVA compared the observed distances traveled among habitats with the distances of random points, which showed a significant difference between traveled distances among both habitats and between observed and random data (df = 4, F = 10.599, $p < 0.001$). However, no interaction term could be determined because of an unequal number habitats between observed (3 habitats) and random (points only closest to 2 habitat types—lakes and creeks). When only permanent water sources were taken into consideration, there was also a significant difference between the distance traveled from each source (df = 2, F = 6.86, $p = 0.002$, Figure 4B).

A Tukey's post-hoc test indicated that the distance traveled from beaver ponds was significantly greater than the distance traveled from other sources. Another two-way ANOVA was performed to look at differences between observed and random distance data among the three habitat types. The results indicated that there is a significant difference between observed and random points ($p = 0.001$), with a greater average distance for random points. This test also showed distances differed significantly among habitats ($p = 0.034$). There was a significant interaction value between the trend in average distance between the observed factor and the habitat type ($p = 0.003$). This suggests that the trend that was seen among habitat types for the observed data was significantly different from the trend that was seen for the random distance data.

Additionally, several ANOVA were performed to see if length and weight of a turtle are related to the distances it is able to travel from the nearest suitable habitat or permanent water source. There was no significant relationship between the length of the turtle and the distance it traveled from either any habitat ($df = 1$, $p=0.331$) or from any permanent water source ($df = 1$, $p = 0.131$). Because a significant correlation between turtle length and weight was observed ($r = 0.788$, $p < 0.001$), it was assumed that there was no significant relationship between weight and the distance traveled from either the closest possible aquatic habitat or the closest permanent water source.

Trapping Data

To examine trends the relative abundance of turtles at each type of habitat, both the number of unique individuals caught and the total number of individuals caught at each habitat were examined. ANOVAs indicated that there was no statistical difference between the number of *unique* individuals caught in any of the three habitats examined (df = 2, F = 0.797, p = 0.493), or between the *total* number of captures at each habitat type (df = 2, F = 0.687, p = 0.539)(Figure 5).

Several additional analyses were performed to look at possible differences in size of turtles found at each site. There was no significant difference in the mean length of turtles found among the three types of habitats (df = 2, F = 0.441, p = 0.646, Figure 6). Additionally, an ANOVA was performed to look at the differences in the proportion of males caught at each site, which found no significant difference among habitats (df = 2, F = 0.797, p = 0.493).

Discussion

Because I observed no nesting turtles during the morning surveys, I speculate that temperature may have an influence on the nesting activity of turtles, which is supported by previous study (Bowen et al. 2005). My results indicated that there was no difference between the number of individuals observed nesting closest to any particular habitat for either all possible habitats or permanent bodies of water, when compared with randomly chosen points. If turtles do not prefer to nest closer to any particular body of water, but are instead nesting closer to bodies of water with the same abundance that they occur in nature, the results suggest that painted turtles are not preferentially choosing habitats in which to live, particularly during the nesting season at UNDERC.

Because I found turtles closest to wetlands (including beaver ponds) are traveling a farther average distance than from lakes and creeks, I suspect that nutritional quality of available food sources in a habitat may be a factor in turtle movement. Only additional analyses of pre-nesting season diet comparison among habitat types might support this conclusion. Because I found no significant difference between the trends in distance from habitats that were observed and those that occurred when random points were used was not supported. These results further suggest that a characteristic of wetland habitats, such as more nutritious prey, allows turtles to expend more energy when traveling farther distances to nesting sites and could be investigated in additional studies. In this survey, the greatest distance from the nearest possible habitat was 360 m, a value that is well below the maximum distance of travel by a nesting painted turtle female (600 m) as observed by Rowe et al. (2005). However, when only permanent bodies of water were considered, three of 87 locales were markedly well above this maximum value (891 m, 921 m, 991 m). This may indicate that turtles are using wetlands that do not have permanent bodies of water as their habitats during the nesting season. Because water levels are higher during the time of nesting than at other points in the summer, painted turtles may only use these habitats during nesting periods and move to permanent bodies of water in the fall months. Rowe et al. (2005) found that turtles may nest at the same location every year, regardless of fluctuations in wetland water level that may change the presence of painted turtles in that habitat. Thus in drier years, turtles that live in wetland habitats may actually be traveling a farther distance from permanent water sources such as lakes and creeks. The use of wetlands during nesting could be further studied by using radio-telemetry to track several female turtles caught in wetland habitats during the nesting season and their movements afterwards. This would indicate if the distance traveled by nesting females was underestimated or if turtles are utilizing wetland habitats, possibly as a temporary base during the nesting season.

When nesting painted turtles travel long distances from their habitats, they are unable to replenish their energy because they are strictly aquatic feeders (Lagler 1943). Because of the energy cost of travel on land, a possible relationship between length or weight of a turtle and the distance from the nearest suitable habitat was tested. However, my results did not support this hypothesis. A bias in these results, as well as the results for distance from suitable habitats, may have occurred because of inconsistencies in the road system at UNDERC. Because lakes and creeks were historically more frequently studied on the property, it is likely that the roads at UNDERC were created closer to these habitats. Painted turtles are commonly found nesting on the roads at UNDERC because of the appropriate substrate and possibly due to the shade created by the overstory. Therefore, it may be that the turtles need to travel farther from wetlands than from lakes and creeks in order to find a suitable nesting site, such as the roads. If this study were conducted in a less disturbed area with fewer roads, there might be a different trend in both the distance traveled from the habitat and the size of the individuals who are traveling the farthest.

Both the size and gender of turtles were further examined among habitat types using trapping. My prediction that there would be larger turtles in the beaver ponds because of a greater number of vegetation mats and food sources was not supported. It may be that all habitats had the same relative productivity or potential food source for the turtles. This could be examined further by investigating the stomach contents of painted turtles to determine what they are eating at each site and in what proportion. If turtles are maintaining the same level of carnivory among all sites, it is likely that they will have the same growth rates and thus similar sizes (Cooley et al. 2003). Additionally, it may be that the larger habitats, such as lakes and creeks, support larger turtles and thus balances the affects of greater food abundance of wetland habitats (Gamble and Simons 2004). Other analyses showed that there was no significant difference in the proportion of males caught at each site. Although it was expected that there would be more males caught in the traps than females due to male-bias in trapping (Gamble and Simons 2004), it was predicted that the ratio of males to females trapped would be consistent across habitat types, and was thus supported by the results.

When habitat preferences were examined with trapping, there was no significant difference in both the number of unique individuals and the number of total individuals that were captured among the sites. This indicates that there is no preference among turtles in the types of habitats that are chosen at UNDERC, and that the abundance of turtles in each habitat is relatively the same. This data is consistent with the nesting data, which also pointed to a lack of habitat preference. If all of the aquatic habitats at UNDERC have relatively the same characteristics that affect turtle suitability, these results would not be completely unexpected. Because all of the habitats were formed by glaciers on a similar substrate, it is possible that these environments are similar enough that painted turtles do not prefer one over the other, with the exception of bog habitats where acidity and low prey levels would likely limit turtle populations. However, an analysis of differences among the sites for similarity in suitability for turtles would need to be further analyzed. For example, the number and density of basking sites or presence of vegetation mats are some factors that could be investigated. In addition to further exploration of differences among habitat sites, increased replication of trapping could be conducted. Additional sites and traps should be used to trap turtles over longer time periods, so that a greater number of replicates can be analyzed and the error reduced. This would also be useful because it would increase the number of recaptured individuals, whose numbers are needed in order to estimate the population density and could not be performed with the few number of turtles that were caught in this study.

This study might shed more light onto turtle habitat preferences if it were conducted over several years. The movements of painted turtles across both time and space could be examined, providing information about the distribution of this animal. Additional captures would allow for a better estimate of population, as well as a greater number of measurements for statistical analysis. Turtle movements and preferences would better understood if observations of where turtles nest year after year, whether they change habitat type, how much they move from place to place, and what factors affect where they are choosing to live and nest, were made.

By continuing this research over time, several important things could be accomplished. Understanding the preferences of habitats by painted turtles could be used to develop an HSI (habitat suitability index) model, which does not currently exist for painted turtles. This could aid scientists not only understanding this species, but also developing formulas for predicting population size based on habitat characteristics.

Understanding these factors is critical step in conservation and preservation of this species.

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Tables

Name	Habitat Type	Surface Area (ha)	Maximum Depth (m)	UTM E	UTM N
Beavergate Pond	Wetland	.28 ha	1.18	305312	5125863
Beaverbat Pond	Wetland	0.78	1.05	308312	5119733
Peyton Pond	Wetland	TBD	0.60	307422	5125847
Tenderfoot Creek	Creek	NA	1.18	304950	5122534
Plum Creek	Creek	NA	0.85	307784	5121204
Brown Creek	Creek	NA	0.90	308312	5119733
Morris Lake	Lake	5.93 ha	22 m	305602	5125422
Raspberry Lake	Lake	4.53 ha	20 m	306670	5124803
Kickapoo Lake	Lake	7.87 ha	9 m	307316	5121819

Table 1. Summary of habitats surveyed for painted turtles in summer 2006. UTM coordinated (NAD27 Zone 16N) listed for each site.

Figures

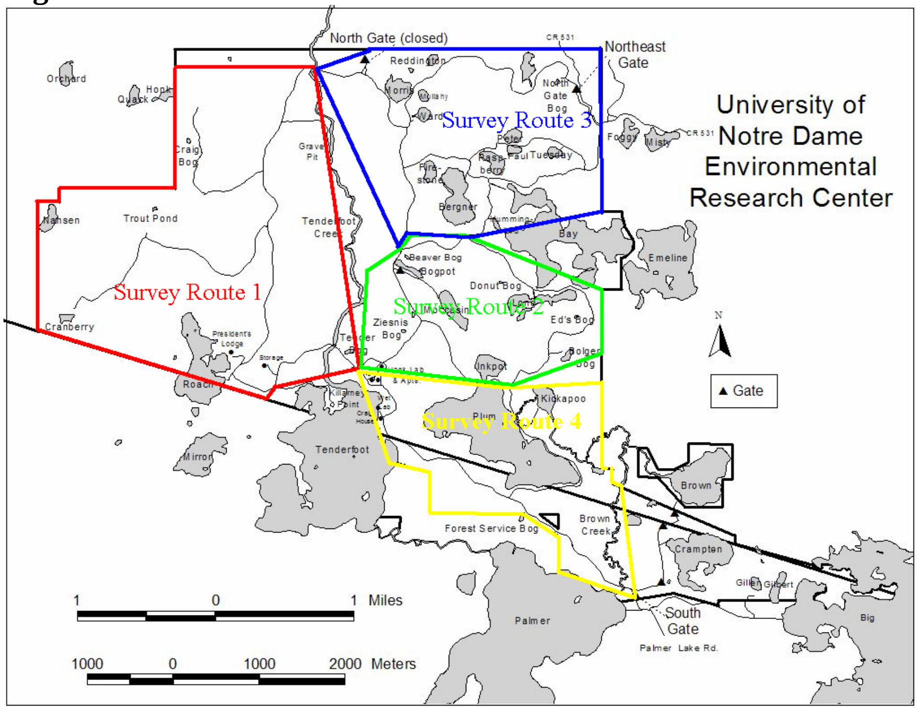
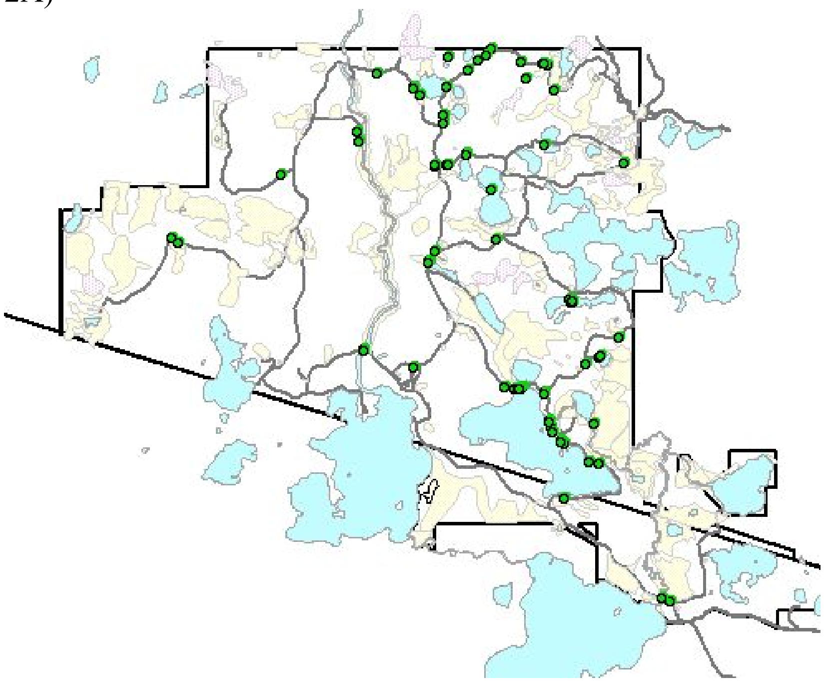


Figure 1. Road survey routes for nesting turtle observation. UNDERC property road were divided into four survey routes, one of which was driven during each testing period (morning or afternoon).

2A)



2B)

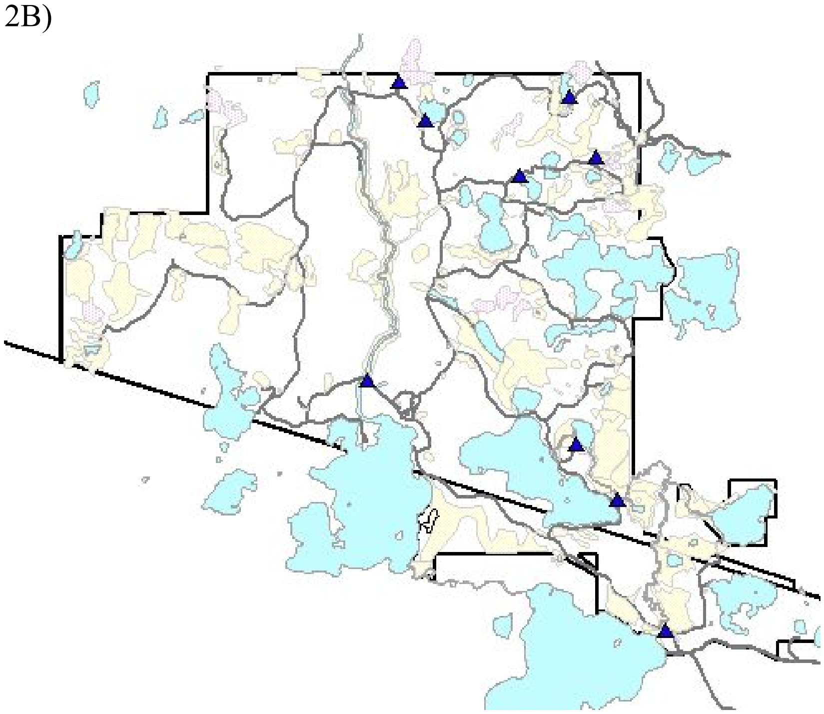


Figure 2. Locations of captured turtles on UNDERC property. A. Map shows locations of all turtles observed or captured during the nesting road survey. B. Map shows locations of all sites where trapping was conducted.

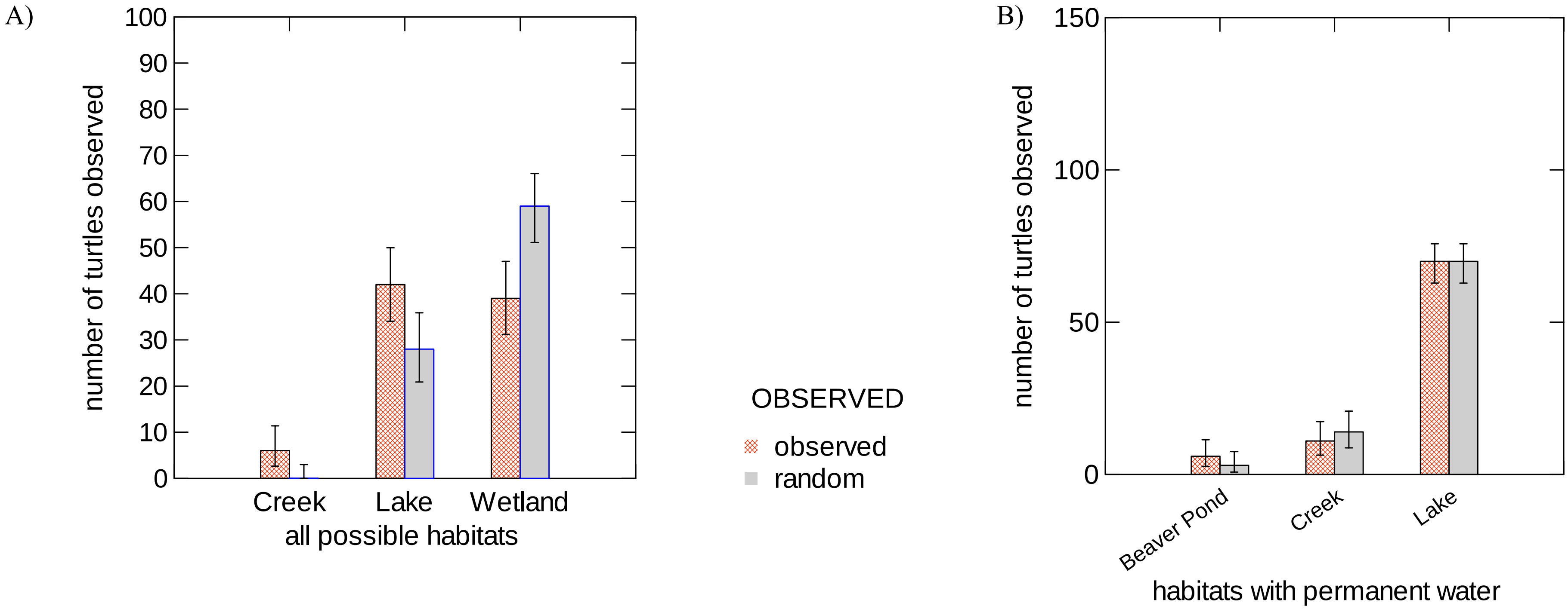
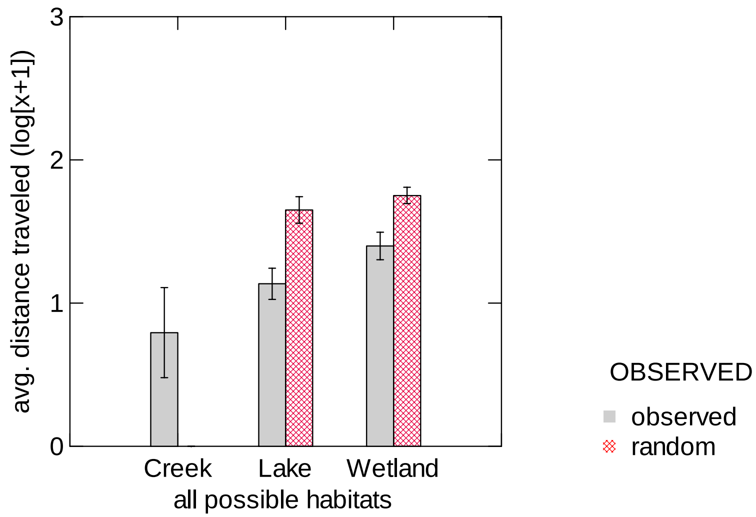


Figure 3. Number of nesting turtles closest to each habitat type. A. Figure shows number of turtles nesting closest to all aquatic habitats for observed and random points, having no significant difference between values (df = 3, χ^2= 0.05, p >> 0.05). B. Figure shows number of turtles nesting closest to permanent water for observed and random points, having no significant difference df = 2, chi-squared value = .04).

A)



B

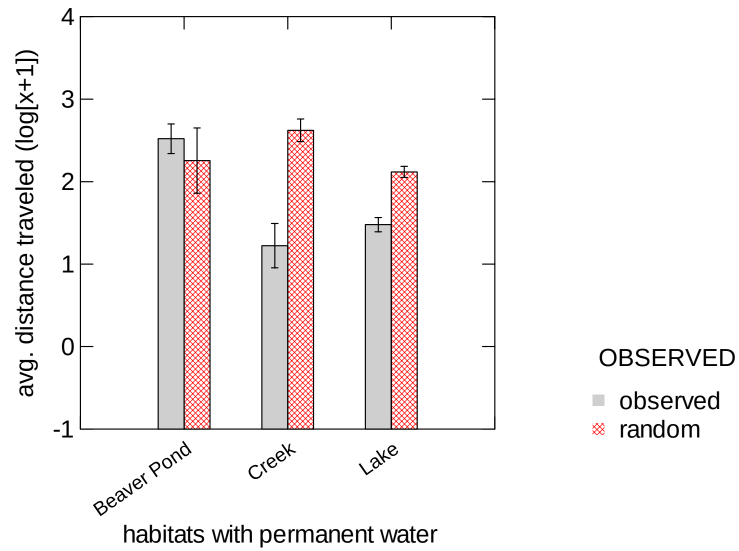


Figure 4. Distance of nesting turtles from closest possible habitat. A. Figure shows the average distance of turtles from the closest of all aquatic habitats for observed and random points, showing a significant difference between habitats (df = 2, F = 3.111, p = 0.05). A two-way ANOVA indicated that there was a significant difference between the observed and random points, and among habitat types (df = 4, F = 10.599, p < 0.001) but an interaction term could not be determined. B. Figure shows average distance of turtles from the closest source of permanent water, showing a significant difference (df = 2, F = 6.86, p = 0.002); beaver pond differed from creeks and lakes (p < 0.05). A two way ANOVA showed a significant difference between observed and the random points (p = 0.001), among habitats (p = 0.034), and between both factors together (p = 0.003).

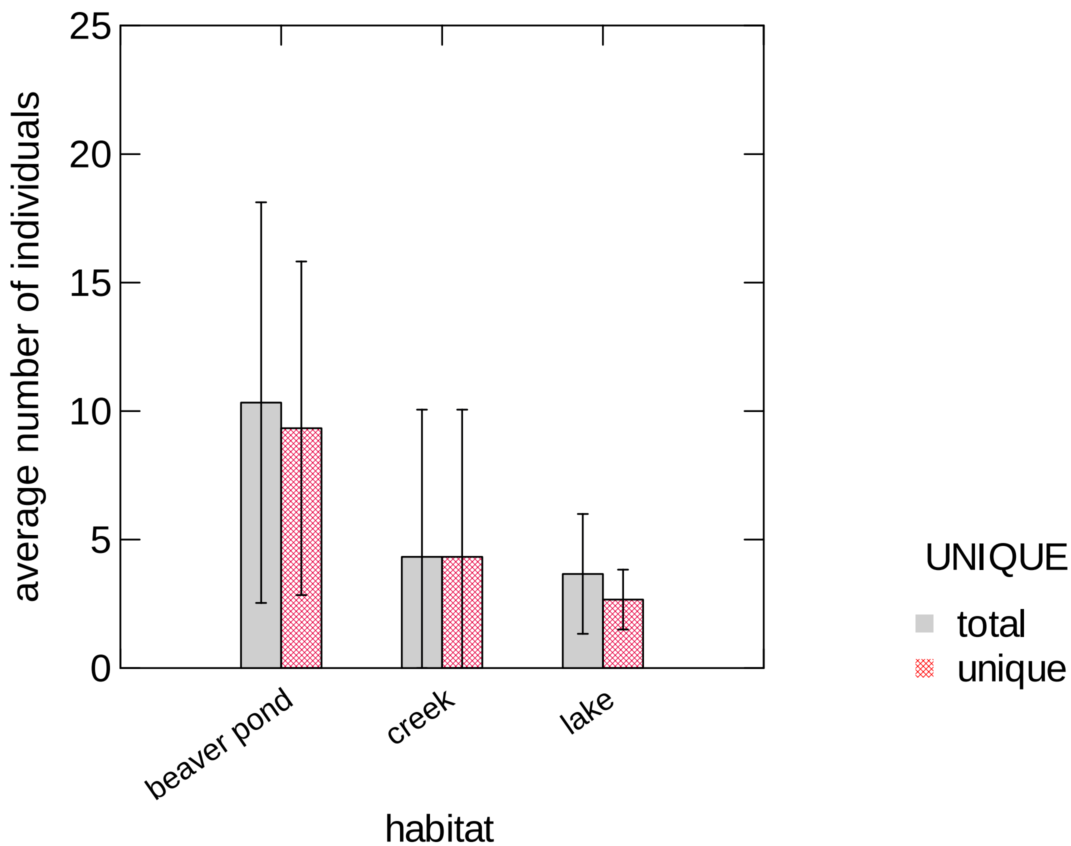


Figure 5. Relative turtle abundance among trapping habitats. Figure shows the average number of unique individuals and total captures among habitat types. There was no significant difference among habitat types for both unique individuals (df = 2, F – 0.797, p = .493) and total captures (df = 2, F = 0.687, p = 0.539).

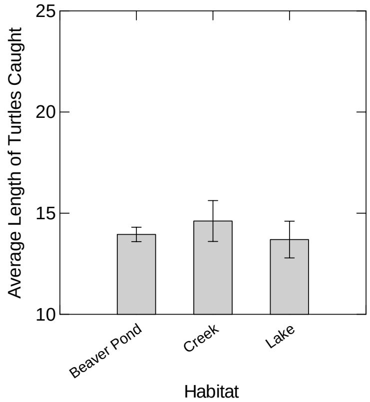


Figure 6. Length of trapped turtles among habitats. Figure shows the average length of turtles caught at each habitat type, showing no significant difference between (df = 2, F = 0.441, p = 0.646).

Appendix A. Measurements and marking data for all individual turtles captured at each trapping location. "Marking" column indicates permanent marginal scute notching pattern.

Week	Day of Trapping	Site	Trap No.	Marking	Sex	Length (cm)	Weight (kg)
1	1	Kickapoo	1	R3	Male	10.7	0.38
1	4	Plum	2	L3R2	Female	16.3	0.6
1	4	Plum	3	L3R3	Female	15.3	0.5
1	4	Raspberry	2	L3R4	Male	12.9	0.4
1	4	Beaver Gate	1	L3R11	Female	16.3	0.7
1	4	Beaver Gate	3	L3R8	Female	15.8	0.6
1	4	Beaver Gate	3	L3R9	Male	15.2	0.5
1	4	Beaver Gate	3	L3R10	Female	11	0.25
1	5	Plum	2	L4R2	Female	15.3	0.6
1	5	Plum	3	L4R3	Female	15	0.55
1	5	Plum	3	L4R4	Male	12.7	0.4
1	6	Plum	3	L4R12	Female	16	0.65
1	6	Plum	3	L8R2	Male	12.1	0.35
1	6	Plum	3	L8R3	Male	24.9	0.45
1	6	Beaver Gate	3	L8R4	Female	12	0.3
1	7	Morris	3	L8R10	Female	13	0.35
2	13	Beaver Bat	1	R2R2	Male	14.5	0.5
2	13	Beaver Bat	1	R2R3	Male	14.7	0.65
2	13	Beaver Bat	1	R2R4	Male	13.5	0.4
2	13	Beaver Bat	3	R2R8	Male	13.7	0.4
2	13	Beaver Bat	3	R2R9	Male	13.9	0.4
2	13	Beaver Bat	3	R2R10	Male	13.6	0.45
2	13	Plum	1	R2R11	Male	13.3	0.45
2	14	Raspberry	1	R2R12	Female	16.1	0.55
2	14	Beaver Bat	1	R3R3	Male	12.5	0.3
2	14	Beaver Bat	1	R3R4	Female	18	0.8
2	14	Beaver Bat	1	R3R8	Male	13.3	0.35
2	15	Beaver Bat	1	R3R9	Female	16.9	0.6
2	18	Beaver Gate	2	R3R10	Male	12.1	0.3
3	20	Peyton	2	.	.	.	.
3	21	Peyton	1	R3R11	Female	15	0.5
3	21	Peyton	1	R3R12	Male	12.8	0.35
3	22	Raspberry	3	R4R4	Male	13.8	0.4

App. A (cont.)							
Week	Day of Trapping	Site	Trap No.	Marking	Sex	Length (cm)	Weight (kg)
3	22	Beaver Bat	3	R4R8	Male	12.9	0.35
3	23	Plum	1	R4R9	Male	13.1	0.4
3	23	Plum	1	R4R10	Female	11.7	0.3
3	23	Plum	1	R4R11	Male	11.8	0.3
3	23	Plum	1	R4R12	Male	12.5	0.35
3	23	Raspberry	3	R8R8	Female	18	0.75
3	23	Beaver Bat	1	R3R8	Male	13.3	0.35
3	23	Beaver Bat	1	R3R3	Male	12.5	0.3
3	23	Beaver Bat	1	R2R3	Male	14.7	0.65
3	23	Beaver Bat	1	R8R9	Male	10.8	0.25
3	23	Beaver Bat	1	R8R10	Male	13.8	0.4
3	23	Beaver Bat	1	R8R11	Male	13.5	0.4
3	23	Beaver Bat	1	R8R12	Male	15	0.6
3	23	Beaver Bat	1	R9R9	Male	13.6	0.35
3	24	Beaver Bat	1	R9R10	Male	13.5	0.4
3	24	Beaver Bat	1	R9R11	Female	17.1	0.75
3	24	Beaver Bat	1	R9R12	Male	11.7	0.3
3	25	Morris	2	R10R10	Male	13.7	0.45
3	25	Morris	2	R10R11	Female	11.4	0.25

Appendix B. Total number of individuals of non-target species captured in hoop nets over entire trapping effort in 2006.

	Herps			Fish								Invertebrates
Site	Snapping turtle	Wood turtle	Bullfrog tadpole	Pike	Bluegill	Pumpkin-seed	Red-eared sunfish	Rock bass	Yellow perch	Small-mouth bass	Large-mouth bass	Crayfish
Beaverbat Pond	1								1			
Beavergate Pond					2	5	9					
Brown Creek					2		6	2	2	1		
Kickapoo Lake			1	1	3		4	1	3			1
Morris Lake				5			2					
Peyton Pond												
Plum Creek	2			1	4			2	1			
Raspberry Lake	5				25	30	6		1	8	3	
Tenderfoot Creek	1	1				2	11	21		1		