Surveys

The Aquatic Turtle Assemblage Inhabiting a Highly Altered Landscape in Southeast Missouri

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Abstract

Turtles are linked to energetic food webs as both consumers of plants and animals and prey for many species. Turtle biomass in freshwater systems can be an order of magnitude greater than that of endotherms. Therefore, declines in freshwater turtle populations can change energy transfer in freshwater systems. Here we report on a mark–recapture study at a lake and adjacent borrow pit in a relict tract of bottomland hardwood forest in the Mississippi River floodplain in southeast Missouri, which was designed to gather baseline data, including sex ratio, size structure, and population size, density, and biomass, for the freshwater turtle population. Using a variety of capture methods, we captured seven species of freshwater turtles (snapping turtle *Chelydra serpentina*; red-eared slider *Trachemys scripta*; southern painted turtle *Chrysemys dorsalis*; river cooter *Pseudemys concinna*; false map turtle *Graptemys pseudogeographica*; eastern musk turtle *Sternotherus odoratus*; spiny softshell *Apalone spinifera*) comprising four families (Chelydridae, Emydidae, Kinosternidae, Trinoychidae). With the exception of red-eared sliders, nearly all individuals captured were adults. Most turtles were captured by baited hoop-nets, and this was the only capture method that caught all seven species. The unbaited fyke net was very successful in the borrow pit, but only captured four of the seven species. Basking traps and deep-water crawfish nets had minimal success. Red-eared sliders had the greatest population estimate (2,675), density (205/ha), and biomass (178 kg/ha). Two species exhibited a sex-ratio bias: snapping turtles *C. serpentina* in favor of males, and spiny softshells *A. spinifera* in favor of females.

Keywords: agriculture; Big Oak Tree State Park; hydrology; population demography; red-eared slider; *Trachemys scripta*

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Introduction

Historically, bottomland hardwood forests occurred nearly contiguously over an estimated 10 million ha throughout the Lower Mississippi Alluvial Valley (Putnam et al. 1960; Hefner and Brown 1985). The nutrient-rich alluvial soil within the floodplain of large rivers like the Mississippi has encouraged people to convert native forests to agriculture (Twedt and Best 2004). By the late 1940s <50% of the floodplain remained forested (Twedt and Loesch 1999). Since that time, an additional 2–3 million ha have been converted to agriculture (Forsythe 1985), facilitated by flood control projects that alter the natural hydrology of the landscape (Galloway 1980). An estimated 96% of bottomland hardwood forest losses can be attributed to conversion into agricultural production (MacDonald et al. 1979). The remaining bottomland forest (25%) are most often small patches,

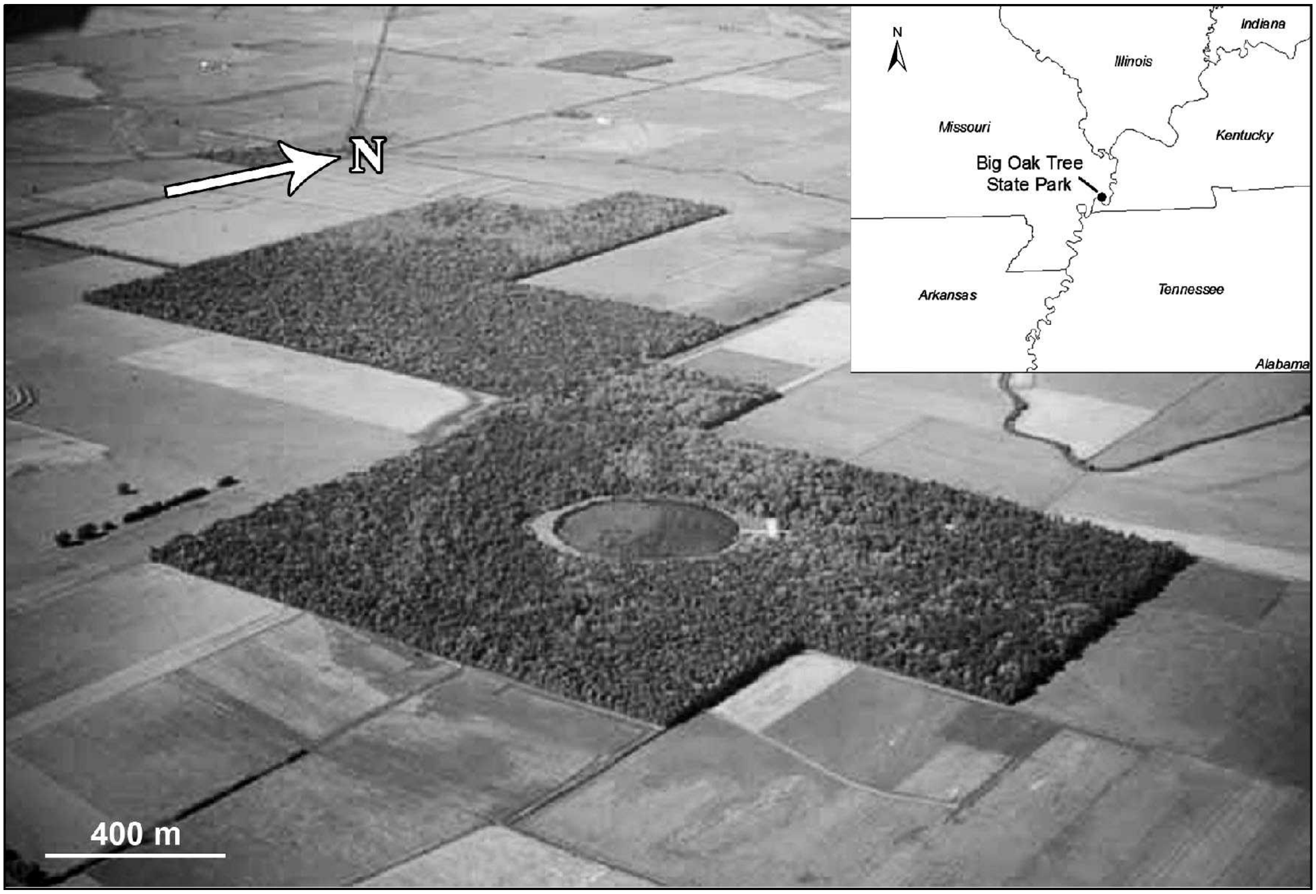

Figure 1. Aerial view of Big Oak Tree State Park, Missouri, showing the approximately 400-m-diameter manmade circular lake, which is surrounded by a levee over which the borrow pit lies.

≤1,012 ha, and highly fragmented, separated from each other by nonforest land cover (Rudis 1995; Twedt and Loesch 1999). One such example is Big Oak Tree State Park (BOTSP), located in the northernmost extent of the Lower Mississippi Alluvial Valley in the boot-heel of southeast Missouri (Figure 1).

A far-ranging effort by local citizens to protect an exceptionally large bur oak *Quercus macrocarpa* culminated in the purchase of approximately 408 ha of land dedicated in 1938 as BOTSP. In 1977, nearly the entire park (ca. 380 ha) was designated as a Missouri Natural Area, including the approximately 32-ha virgin wet–mesic bottomland forest surrounding the aforementioned bur oak. Trees in the park today are unequaled in the state for their size, with a canopy averaging 36.5 m and several trees >40 m tall. Due to the small size of the park and land management practices that negatively altered the park's forest and hydrology, regeneration of oaks is nearly nonexistent and many of the trees are old and dying. The park is currently in the planning process of hydrological restoration, and in conjunction with this effort, studies have commenced to gather baseline data on the natural history of the park, including surveys and studies of fungi, plants, insects, crawfish, fish, and birds. The data acquired from these investigations will allow for posthydrological restoration comparisons, and provide insight into restoration effectiveness.

In union with these efforts, we examined the freshwater turtle assemblage at BOTSP. Turtles play a very important role in ecosystems because they are linked to energetic food webs both as consumers of plants and animals and as prey species for a variety of organisms (Mitchell and Buhlmann 2003). Iverson (1982) showed turtle biomass in populations can be quite large, typically at least an order of magnitude greater than that of endotherms. Declines in a turtle population will, therefore, affect ecosystem health in terms of changes in energy transfer. In this mark–recapture study, we examined sex ratio and size structure, and estimated population size, density, and biomass for turtles captured at BOTSP.

Study Area

Big Oak Tree State Park is located in the northernmost section of the Mississippi Alluvial Valley in the St. James Bayou Clayey Lowland land type association (Figure 1). The park's elevation ranges from 87 to 88.5 m above sea level, with the lowest elevation occurring in the shrub swamp. Due to a small land acquisition (16 ha) since the original purchase, BOTSP now encompasses 423.5 ha, and is representative of the northern boundary of the Mississippi Embayment, a land formation created when the ancestral seas retreated for the last time during the

Cretaceous Period. The park rests in an early meander belt of the Mississippi River, which is significant to the hydrology. The topography is characterized as a ridge and swale complex with higher ground inundated only during significant river flooding, and lower elevations holding water for most of the growing season. The climate, topography, floral, and faunal associations at BOTSP more closely resemble those of the southeastern states than anywhere else in Missouri.

Big Oak Tree State Park is essentially an island of trees, separated from any other wooded corridors by thousands of ha of agriculture (Figure 1). The park's hydrology is directly compromised by an elaborate ditch system built to expedite water removal from agricultural lands. Access to the Mississippi River has been closed by a levee system, but during extreme high-water events, floodwaters occasionally back through the ditches, bringing water and agricultural pesticides into the park. Backwater flooding did not occur during the duration of our turtle survey. With the exception of the manmade lake, which is pumped full with groundwater each spring, rainwater is the primary source of the park's water. Yearly rainfall ranges from 68 to 203 cm (mean = 130 cm), with most rainfall occurring in the early autumn and spring months. The mean monthly temperature is 29.4°C in July, though temperatures during the survey reached 37.8°C in August.

The park contains a bottomland hardwood forest and the remains of a bald cypress (*Taxodium* spp.) swamp, formally categorized as a shrub swamp. A 9-ha manmade recreational lake built in the 1960s on the historic Grassy Pond (a large swamp system dominated by sedges and cypress trees) is located in the center of the park. Surrounding the circular lake, which is choked with coontail *Ceratophyllum demersum*, is a borrow pit from which the levee around the lake was built. The borrow pit connects to the shrub swamp and water levels in both of these areas varied during the survey. During a 7-wk drought in August and September, when <2.5 cm of rain fell, water levels in the borrow pit fell to about 45 cm in the center, from a high of at least 122 cm at the start of the survey. The shrub swamp completely dried during this drought.

Methods

In this survey we used 76-cm and 91-cm three-ring hoop-nets with 2.5-cm mesh baited with sardines. At any given time during the study, between 7 and 17 hoop-nets were set out in the park for 1–3-d intervals. We checked the hoop-nets on 37 occasions from 10 June to 27 September 2007. There were three other days not coincident with hoop-net trapping (22 April, 2 June, and 23 June) where we used other capture methods (described below), giving 40 total trap-sampling events from 22 April to 27 September.

We used an unbaited seven-ring fyke net with 7.6-m leads and 6.4-cm mesh in both the borrow pit and lake. We also used two basking traps, one small (ca. 117 × 91 × 30 cm) and one large (ca. 152 × 152 × 51 cm), to capture turtles in both the borrow pit and the lake. We used deep-water crawfish nets baited with chicken leg quarters to capture turtles on three occasions (Glorioso and Niemiller 2006). Lastly, a few turtles were captured by hand in the shallows or on land. The trapping success of the hoop-nets and fyke net was measured using catch per unit effort (CPUE), where the total number of turtles captured was divided by the total number of trap-nights for each capture method.

We identified each captured turtle to species and individually marked them with unique three-letter identification by filing the marginal scutes (Cagle 1939; Dorcas 2005). We modified the marking scheme for eastern musk turtles *Sternotherus odoratus* to compensate for the reduced number of marginal scutes in kinosternid turtles. We marked spiny softshells *Apalone spinifera* by cutting shallow pie-shaped pieces at the margins of the epidermis. We also examined red-eared slider *Trachemys scripta* males for the presence of melanism on the shell and skin.

We determined the sex of turtles by examining secondary sexual characteristics such as elongated foreclaws and tails in males. We determined the sex of snapping turtles *Chelydra serpentina* by taking a ratio of the distance from the cloaca to the posterior tip of the plastron and the distance from the posterior tip of the plastron to the anterior edge of the femoral scute (Dorcas 2005). If the ratio was >0.86 we considered it male, and if it was <0.86 we considered it female. In addition, we attempted to extract the penis of all snapping turtles. Most individuals that we determined to be males by the above ratio were confirmed by presence of the penis, and no individuals that we determined to be female by the above ratio were shown to be male by the presence of a penis. We performed *G*-tests in Program R (R Development Core Team 2008) to detect differences in sex ratios. The level of significance for all analyses was set at $\alpha = 0.05$.

We took measurements of straight-line carapace and plastron lengths at the midline using digital calipers (±0.1 mm) for smaller turtles (<160 mm), tree calipers (±1 mm) for larger turtles (>160 mm), and a measuring tape (±1 mm) for softshell turtles. We measured body mass with hanging spring scales of various sizes. We performed a two-tailed Kolmogorov–Smirnov test in Program R (R Development Core Team 2008) to test the null hypothesis that the samples of male and female carapace lengths came from the same distribution.

We estimated the population abundance of turtle species in the assemblage at BOTSP using closed-population capture–recapture models that assume full demographic and geographic closure of the population during the study period (i.e., no births, deaths, immigration, or emigration). We deemed it reasonable to assume closure for the duration of this short-term study due to the isolated nature of the location, lack of aquatic migration routes outside the park, and the commencement of trapping occurring after peak hatching times. Models based on those described by Otis et al. (1978) were fit using maximum-likelihood estimation in Program MARK (White and Burnham 1999). The four models analyzed for each species were: 1) constant capture

Table 1. Number of total individuals captured, total recaptures, and individuals recaptured (%) for seven turtle species captured at Big Oak Tree State Park, Missouri, from 22 April to 27 September 2007.

Species	Total individuals	Total recaptures	Individuals recaptured (%)
Red-eared slider (*Trachemys scripta*)	785	172	131 (17)
Snapping turtle (*Chelydra serpentina*)	69	23	13 (19)
Southern painted turtle (*Chrysemys dorsalis*)	53	12	9 (17)
Eastern musk turtle (*Sternotherus odoratus*)	31	3	1 (3)
Spiny softshell (*Apalone spinifera*)	20	12	6 (30)
River cooter (*Pseudemys concinna*)	2	0	0 (0)
False map turtle (*Graptemys pseudogeographica*)	1	3	1 (100)
Totals	961	225	161 (17)

probability (M_0), 2) capture probability varying with time (M_t), 3) behavioral response where probability or recapture is different from probability of first capture (M_b), and 4) a combination of the effects of time and behavior (M_{tb}).

Capture data on individuals from the 40 total trap-sampling events were summarized into four sampling occasions for analysis in MARK. We conducted model selection using information-theoretic techniques based on Akaike's Information Criterion adjusted for small sample sizes, and all abundance estimates reported are model-averaged to account for model selection uncertainty (Burnham and Anderson 1998). To compute density, the abundance of each species was divided by 13 ha, the approximate combined aquatic area of the lake and borrow pit. We calculated the biomass by multiplying the overall mean body mass (in kg) of all individuals at first capture by the density.

Results

We captured 961 individual turtles of 7 species at BOTSP in 2007 (Table 1; *Supplemental Material*, Data S1, http://dx.doi.org/10.3996/072010-JFWM-020.S1). The most abundant turtle species, the red-eared slider, represented nearly 82% of all individuals captured. Due to few river cooter *Pseudemys concinna* and false map turtle *Graptemys pseudogeographica* captures these two species were excluded from all statistical analyses.

There were 975 captures with hoop-nets of seven species, with 634 captures in the borrow pit and 341 captures in the lake. The overall CPUE of hoop-nets in both water bodies was 0.95, with the borrow pit having twice the capture success of the lake. The CPUE for the borrow pit was nearly twice the CPUE of the lake for red-eared sliders, and three times the CPUE for snapping turtles. The largest differences in CPUE between the two trapped areas involved southern painted turtles *Chrysemys dorsalis* and eastern musk turtles, with the borrow pit having approximately 10 and 6 times the CPUE of the lake, respectively. Capture success of spiny softshells was equal between the borrow pit and lake.

The fyke net was only successful in the borrow pit; one red-eared slider was captured in the lake in 14 d of trapping. In the borrow pit, the fyke net captured 185 turtles of four species in 20 trapping days. Red-eared sliders comprised 92% of fyke net captures in the borrow pit for a CPUE of 8.50. Species also captured by fyke net included snapping turtles (10), southern painted turtles (4), and false map turtles (1). The false map turtle was escaping when the net was being checked because it could fit through the mesh, as could all eastern musk turtles and smaller size classes of other species.

Basking-trap success was minimal, with only 19 total captures of two species (red-eared sliders and southern painted turtles). Both basking traps did poorly in the borrow pit, with only two southern painted turtle captures. In the lake, there were 13 red-eared sliders and 4 southern painted turtles captured, with both traps having similar success. Deep-water crawfish nets were used to capture turtles on three occasions, but had very little success overall and were not further pursued as a capture method.

The three most frequently captured turtle species were recaptured in similar percentages of overall individuals (Table 1). Excluding the lone false map turtle individual that was captured multiple times, the species with the largest return rate was the spiny softshell at 30%. Across all species, the majority of individuals were recaptured in the same primary water body as the initial capture. With the exception of three snapping turtles and one spiny softshell, all overland movements were made by red-eared sliders. About one in four recaptured red-eared sliders was found to have moved between primary water bodies. Of the 36 red-eared sliders that moved, 34 (94%) moved from the borrow pit to the lake. The majority of this movement coincided with the drought that brought water levels down in the borrow pit to extremely low levels.

Of the five most numerous species captured, sex ratios did not differ significantly from 1:1 for red-eared sliders, southern painted turtles, and eastern musk turtles. There was a significant male-biased sex ratio for snapping turtles, and a significant female-biased sex ratio for spiny softshells (Table 2).

The red-eared slider population was well-represented by adult and subadult size classes (Figure 2). Carapace length distribution in red-eared sliders appears bimodal; there were many adult turtles in the sample, with younger individuals between 110 and 140 mm also being well-represented (Figure 2). A Kolmogorov–Smirnov *Z*-test indicated that the carapace lengths of males

Table 2. Number (*n*) of males (m) and females (f), results of *G*-tests (*G*-stat) for equal sex ratios in the five most abundant turtle species captured at Big Oak Tree State Park, Missouri, from 22 April to 27 September 2007. Asterisk denotes significantly different from 1:1 ratio at α = 0.05.

Species	*n* (m:f)	*G*-stat	*P*
Red-eared slider (*Trachemys scripta*)	387:392	0.03	0.8578
Snapping turtle (*Chelydra serpentina*)	46:23	7.82	0.0052*
Southern painted turtle (*Chrysemys dorsalis*)	20:33	3.22	0.0727
Eastern musk turtle (*Sternotherus odoratus*)	19:12	1.59	0.2067
Spiny softshell (*Apalone spinifera*)	5:15	5.23	0.0222*

and females were sexually dimorphic (i.e., did not come from the same distribution; Kolmogorov–Smirnov D = 0.37, $P < 0.001$). The population of both snapping turtles and spiny softshells consisted of nearly all adults (Figure 2), and both species were sexually dimorphic in carapace length (Kolmogorov–Smirnov D = 0.61, $P < 0.001$ and D = 1.0, $P < 0.001$, respectively). The southern painted turtle population showed a near-uniform distribution of carapace lengths in males, but adults between 135 and 150 mm dominated the distribution in females (Figure 2), and only a few juveniles of southern painted turtle were captured. Carapace length was sexually dimorphic in southern painted turtles (Kolmogorov–Smirnov D = 0.74, $P < 0.001$). The eastern musk turtle population was represented by nearly all adults, but many smaller size class captures would have been precluded by the larger mesh size of the nets (Figure 2). There was no evidence of sexual dimorphism in carapace length in eastern musk turtles (Kolmogorov–Smirnov D = 0.34, P = 0.371).

Male red-eared sliders exhibited melanism on their shells as well as their skin, whereas females sometimes showed melanism on their shells, but never on the skin. The smallest male captured that showed signs of melanism was 172 mm carapace length. There were 201 male red-eared sliders individuals captured with

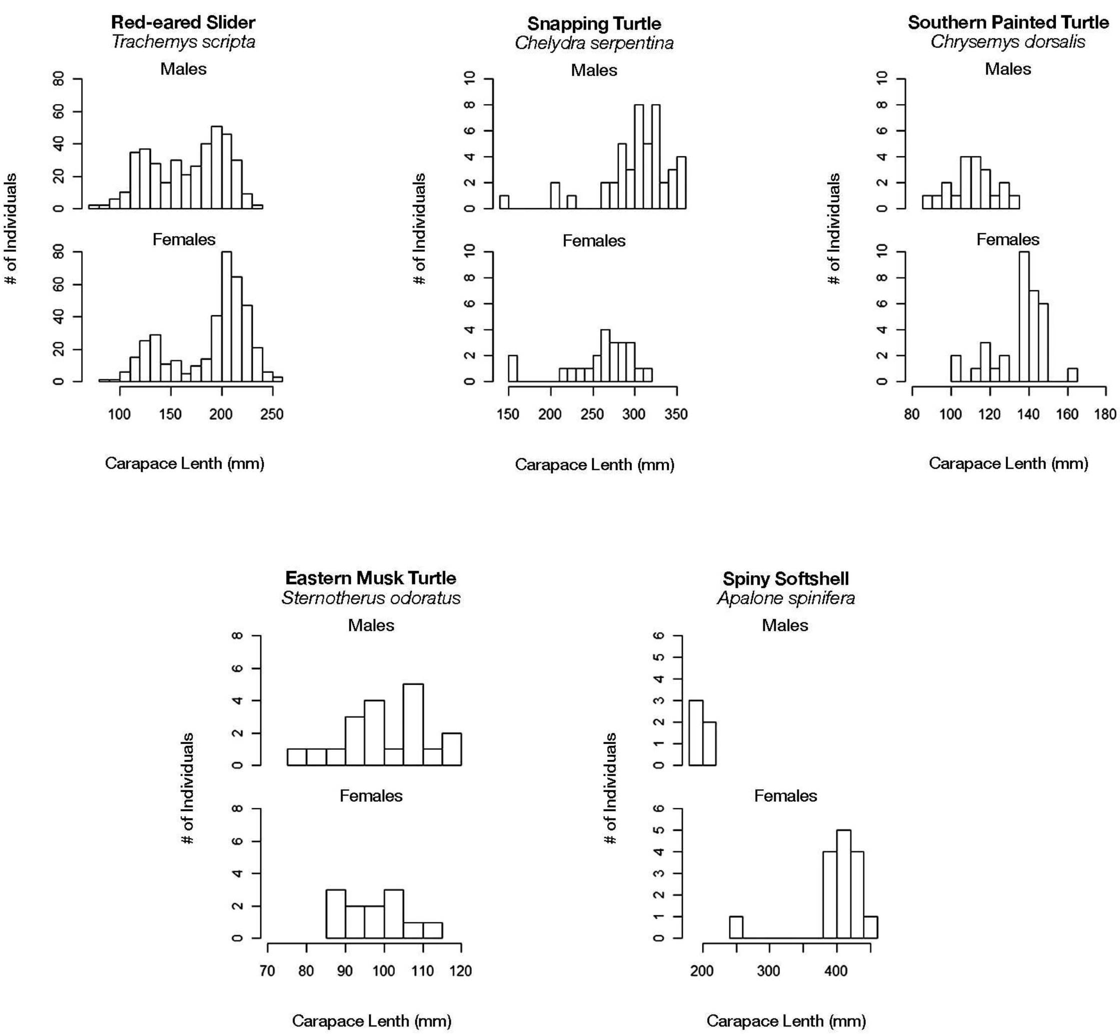

Figure 2. Size-class distributions by carapace length of the five most abundant turtle species captured at Big Oak Tree State Park, Missouri, from 22 April to 27 September 2007.

Table 3. Estimates of population size (*N*), standard error (SE), lower and upper 95% confidence interval (CI), density, and biomass for the five most abundant turtle species captured at Big Oak Tree State Park, Missouri, from 22 April to 27 September 2007.

Species	*N*	SE	Lower 95% CI	Upper 95% CI	Density (per ha)	Biomass (kg/ha)
Red-eared slider (*Trachemys scripta*)	2,675	233.10	2,218	3,132	205.8	178.5
Snapping turtle (*Chelydra serpentina*)	121	22.93	76	166	9.3	57.4
Southern painted turtle (*Chrysemys dorsalis*)	103	28.96	46	160	7.9	2.3
Eastern musk turtle (*Sternotherus odoratus*)	326	314.66	0	942	25.1	4.2
Spiny softshell (*Apalone spinifera*)	24	4.69	14	33	1.9	7.1

≥172 mm carapace length, and 81% of those individuals were melanistic. Nearly 90% of individual males with ≥185 mm carapace lengths were melanistic.

We obtained population size estimates for five turtle species (Table 3). The results of all four closed-population models were used for model-averaging of the abundance estimate of each species with the exception of model M_{tb} on red-eared sliders and eastern musk turtles where that model failed to converge. The estimated standard error and the associated 95% confidence interval were large for those species with relatively few captures or recaptures.

The red-eared slider was by far the most abundant turtle species at BOTSP and, therefore, had the highest density of the turtle species (ca. 205 individuals/ha), with all other species considerably lower (Table 3). Due to the moderate mean mass and the high abundance, red-eared sliders also had the largest biomass of the turtle species at 178 kg/ha, followed by snapping turtles at 57 kg/ha, with the other three species combined at <14 kg/ha (Table 3).

Discussion

In addition to the seven turtle species captured, there are four other aquatic turtle species whose range overlaps BOTSP, which were not found in this study: smooth softshell *Apalone mutica*, alligator snapping turtle *Macrochelys temminckii*, western chicken turtle *Deirochelys reticularia* and Mississippi mud turtle *Kinosternon subrubrum*. Not capturing smooth softshells at BOTSP is understandable because its typical habitat is riverine, but alligator snapping turtles and western chicken turtles were probably historically abundant in the area (Briggler and Johnson 2006). Unfortunately, these two species are now listed as rare in Missouri primarily due to habitat loss, but also due to over-collection for the food and pet trade in the case of alligator snapping turtles. It is unlikely that a viable population of either occurs in the highly altered aquatic habitats of the park.

More perplexing is the nondetection of Mississippi mud turtles from the waters of BOTSP. This species is typically found in or near swamps, sloughs, and canals. It can also be found in habitats that have been highly modified, including highly urbanized areas. Missouri Department of Conservation state herpetologist Jeff Briggler stated the Mississippi mud turtle to be one of the most commonly trapped turtle species at conservation areas in the boot-heel of Missouri (personal communication, 29 September 2007). It is certainly possible that this species may be present at the park, but no explanation can be given as to our failure to detect them in our sampling.

Ream and Ream (1966) found that different turtle trapping methods introduced considerable bias in sex ratios and size-class distribution due to differences in individual behavior related to size and sex. Therefore, several trapping techniques were used during this study in an effort to maximize overall catch and diversity of species while reducing bias. The fyke net in the borrow pit had the greatest CPUE of any capture technique, even while precluding capture of smaller turtles, but the hoop-nets performed best with respect to overall catch and diversity.

The two primary bodies of water in this study are quite different and it was not surprising to see that some species appear to prefer one over the other. Most southern painted turtles were captured early in the study in the ditch that empties into the borrow pit. This ditch gets more shallow the further one gets from the borrow pit, and at the commencement of this study it retained water for only about 50 m from the borrow pit. The ditch became completely dry halfway through the study. The lack of southern painted turtles captured at BOTSP and the location of most of their captures was surprising. At Reelfoot Lake, approximately 20 km to the south, the southern painted turtle was the codominant emydid species with the red-eared slider, and was captured most often in the main bodies of the lake, and seldom in backwater areas (B. Glorioso, unpublished data). Southern painted turtles and eastern musk turtles at BOTSP especially preferred the murky shallow waters of the borrow pit to the clear vegetation-choked water of the lake.

Sex ratios were found to be significantly biased in snapping turtles and spiny softshells. Sex ratio is an important demographic measurement because of the influence that it has on certain aspects of population dynamics (Gibbons 1990). Whereas a single male can fertilize many females, females are much more limited in their reproductive potential and, thus, a skewed sex ratio in favor of males is cause for concern. An unequal sex ratio can occur naturally, but many times it can be attributed to sampling biases and differential catchability of the sexes (Gibbons 1990). Ream and Ream (1966) found differences in sex ratio within a population with respect to capture technique. However, more recent studies have found no change in sex ratios across different capture techniques in the same population (Lovich and Gibbons 1990; Smith and Iverson 2002). Also, short-term studies may be ineffective at truly representing sex ratios within a population (Gibbons 1990). For example, in this study, only female spiny softshells were captured through mid-July. Five males and one female were captured after this date. Thus, we could have observed an even greater skewed sex ratio for this species had we not sampled for the duration we did. It is possible, however, that the significantly different sex ratios observed in snapping turtles and spiny softshells in this study are an artifact of sampling-method bias, small sample sizes, and the limited duration of our study.

Several nests were observed in early June that appeared to have been depredated. Most of these nests were found on the levee around the lake, particularly near the parking lot where the nests were located in areas that receive extended sunlight. At BOTSP, in addition to the limited open area around the levee and parking lot, turtles most likely use the surrounding agricultural fields as nesting sites, much as they do at Reelfoot Lake in northwest Tennessee (B. Glorioso, unpublished data). In these areas, in addition to natural predators, nests may be physically destroyed by agricultural practices, and may be impacted negatively by pesticides that are commonly sprayed upon crops adjacent to the park. There was little evidence of successful reproduction in that only three hatchlings (red-eared sliders) were observed during the study. Apparent below-normal egg or hatchling survival rates at the park may be explained by a lack of suitable nesting sites, heavier than usual predation rates, or a combination of these and other factors.

The occasional backwater flooding that has been responsible for bringing water into the borrow pit, the preferred habitat of most turtle species in this study, is a result of the Mississippi River flowing backwards in high-water events through an approximately 457-m gap in the levee. This gap will be closed by the U.S. Army Corps of Engineers as the main component of the St. John's Bayou and New Madrid Floodway Project (http://www.mvm.usace.army.mil/stjohns/default.asp) aimed at protecting agricultural land and small towns near BOTSP from flooding. As mitigation for the project, the U.S. Army Corps of Engineers has a water management plan in place for southeast Missouri, as well as a proposal to create a vegetative corridor between BOTSP and a nearby conservation area. In addition, the Missouri Department of Natural Resources is planning to construct a $1.2 million water retention project designed to maintain a self-sustaining water system at the park, thus promoting regeneration of the existing dominant species while inhibiting invading understory species. Without these actions, the park would likely transition from a wet bottomland hardwood to a much drier forest type, jeopardizing the survival of the turtle assemblage at BOTSP.

Future studies comparable to this one could be used to evaluate the impact of the Missouri Department of Natural Resources and U.S. Army Corps of Engineers planned actions on the turtle assemblage at BOTSP, using the results of this study as a baseline. Because this study indicated potential problems with reproductive success, future research efforts at BOTSP could incorporate this aspect of turtle ecology. A better understanding of age-specific fecundity and survival, and clutch size as it relates to age and size of adult females, would be beneficial. Also, future studies could use radiotelemetry to track gravid females to their nesting sites, gaining insight into nest survival in the park and among the agricultural lands. In conjunction, recaptures from this study could be used in future investigations to determine growth rates and survivorship as well as derive better population estimates.

Supplemental Material

Please note: The *Journal of Fish and Wildlife Management* is not responsible for the content or functionality of any supplemental material. Queries should be directed to the corresponding author.

Data S1. BOTSP species spreadsheets: *Apalone spinifera, Chelydra serpentina, Chrysemys dorsalis, Graptemys pseudogeographica, Pseudemys concinna, Sternotherus odoratus*, and *Trachemys scripta*.

Found at DOI: 10.3996/072010-JFWM-020.S1 (98.6 KB XLSX).

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