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The Nesting Ecology of the Ornate Box Turtle, *Terrapene ornate* at Carlyle Lake

Final Report

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Prepared for:

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UI Grant Code: D7668, Sponsor # 09-030-W

Restricted Access T&E Species Locations

Date of issue: 23 February 2010



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INTRODUCTION

The most researched aspects of *Terrapene* reproductive ecology cover mating behaviors and egg production (Dodd 2001). Nesting ecology and nest success, however, are largely understudied (Converse *et al.* 2002). Doroff and Keith (1990) studied these topics in the Ornate Box Turtle, *Terrapene ornata*, in south central Wisconsin. Converse *et al.* (2002) also studied the nesting ecology of a small population of ornate box turtles in Nebraska. It is likely that the lack of box turtle nesting data is a result of the unpredictable nesting behaviors of this species.

Terrapene carolina and *T. ornata* are two of the four North American box turtle species (Dodd 2001). The Eastern Box Turtle, *T. carolina*, inhabits the eastern half of the United States, from the Atlantic coast to the eastern Great Plains, excluding the more northern portions. The Ornate Box Turtle is found throughout the Great Plains and Tallgrass Prairie. The ranges of the two species overlap in eastern Texas, Oklahoma, Kansas and Nebraska, plus parts of Louisiana, Arkansas, Missouri, Iowa, Wisconsin, Indiana, and Illinois; including South Shore State Park at Carlyle Lake, Illinois (Khuns 2004; Converse and Savidge 2003; Dodd 2001; Ernst *et al.* 1994). Although these species occasionally have overlapping habitats, *T. carolina* is found more often in woodlands, whereas *T. ornata* is found more often in open grasslands and prairies (Ernst *et al.* 1994; Dodd 2001; Doroff and Keith 1990).

The reproductive cycles of *T. carolina* and *T. ornata* are very similar. Nesting can occur between early May and the middle of July, depending on seasonal advance conditions (Legler 1960; Dodd 2001). Legler (1960) observed the peak of the nesting season of an Ornate Box Turtle population in Kansas to be mid-June. The time of day at which nesting occurs varies depending on temperature and other weather conditions. *Terrapene carolina* will generally nest just after, before, or during a rainfall (Congello 1978; Dodd 2001). *Terrapene ornata* has been reported to begin nesting at dusk and deposits eggs later in the evening (Legler 1960; Dodd 2001). The duration of nesting activities is highly variable; sometimes lasting up to five hours, and likely depends on environmental conditions (Ewing 1935; Stickel 1950; Legler 1960; Dodd 2001).

Nest site selection influences the development and survival of young turtles (Dodd 2001; Kolbe and Janzen 2001). Substrate type, temperature, and the amount of water dictate hatching success (Dodd 2001). Stickel (1989) found that female *T. carolina* will move to dry upland areas to nest. Few studies have been conducted on the nesting of *T. ornata*. Legler (1960) observed females to nest on dry, bare slopes where digging may be less difficult. Prior to oviposition, females moved sporadically around the general nesting site. Both *T. carolina* and *T. ornata* lay between one and seven eggs per clutch. The number of eggs deposited depends on the population's geographic location (Dodd 2001). For example, *T. carolina* will deposit four or more eggs in northern populations and one to three eggs in southern populations (Dodd 2001; Ernst *et al.* 1994). Geographic location and temperature will also influence the emergence time of *T. carolina* and *T. ornata*.

Warmer temperatures may increase development rate and cause eggs to hatch sooner (Dodd 2001). Legler (1960) approximates the field incubation period to be 65 days, but lab incubation periods have ranged from 46 to 81 days for *T. carolina* and 50 to 76 days for *T. ornata* (Ewert 1985).

Investigations on reproductive ecology are important when investigating causes of a population decline. Dependence on diminishing grassland ecosystems is already a known reason for the decline of the Ornate Box turtle in Illinois. However, previous research at Carlyle Lake suggests that there may be other contributing factors (Kuhns 2004). Only a few adult female *Terrapene ornata* have been documented at Carlyle. Low numbers of reproductive females may reflect a demographically extinct population, because it may lack the capacity to generate enough recruitment to combat a decline. However, data on recruitment is lacking and is necessary to make this distinction. Studying the reproductive ecology of *T. ornata* may help determine if the population is reproducing and how many females contribute to the recruitment rate. This data may resolve questions concerning this population's capability of rebounding and if any factors can be managed to ease the decline.

MATERIALS AND METHODS

In the spring of 2008 and 2009, box turtles were located and captured through visual encounter surveys. Each individual was uniquely marked by notching marginal scutes (Cagle 1939). Individuals were weighed on an electronic balance and aged by counting the annuli on their left pectoral scute (Sexton 1959). Carapace length and width, shell height, left pectoral scute length, anterior plastron length and width, and posterior plastron length and width were measured. All adult females were x-rayed to determine clutch sizes (Gibbons and Greene 1979). A small radio transmitter was glued to the carapace of gravid females and they were tracked twice daily until oviposition occurred. During nesting events, the following environmental data was measured: relative humidity, wind speed, air temperature, substrate temperature, and percent canopy cover. GPS coordinates were also taken.

RESULTS

We encountered two male and two female Ornate Box Turtles in 2008 (Table 1), and one male and three females in 2009 (Table 2). Both female *Terrapene ornata* found in 2008 were gravid, but only one was observed nesting (3L 9L 11L). One gravid *Terrapene carolina* x *ornata* hybrid was also observed nesting in 2008 (9L 10L 11L). Kuhns (2004) encountered twenty-two *T. ornata* between April 1999 and November 2002 at Carlyle Lake. The decrease in numbers and our recent findings are obviously disappointing. The morphometric variables measured for each turtle are given in Appendix I.

Search Effort

Search effort in 2008 consisted of 175 hours between 10 May and 20 June. The four *T. ornata* found resulted in a 0.02 catch per unit effort (turtle/search hour) and a density

estimate of 0.2 turtles/ha. Six *T. carolina* x *ornata* hybrids were found, resulting in a 0.03 catch per unit effort. Hybrids were identified by observing a combination of characteristics of the two parent species; carapace, plastral, and head markings and a bridge and axillary element on the fifth marginal scute (Smith 1955). The catch per unit effort for *T. carolina* was 1.09, with 190 individuals found (Table 1). Search effort in 2009 consisted of 195.08 hours between the dates of 7 March and 30 April, resulting in four individual *T. ornata* for a CPU of 0.02. One individual hybrid was found for a CPU of 0.01, and 42 *T. carolina* were found for a CPU of 0.22 (Table 2).

Table 1. Numbers and CPU for box turtles encountered at Carlyle Lake in 2008.

Species	CPU: turtles/ search hour	# of Females	# of Males
<i>Terrapene ornata</i>	0.02	2	2
<i>Terrapene carolina</i> x <i>ornata</i>	0.03	1	5
<i>Terrapene carolina</i>	1.09	85	105

Table 2. Numbers and CPU for box turtles encountered at Carlyle Lake in 2009.

Species	CPU: turtles/ search hour	# of Females	# of Males
<i>Terrapene ornata</i>	0.02	3	1
<i>Terrapene carolina</i> x <i>ornata</i>	0.01	1	0
<i>Terrapene carolina</i>	0.22	23	19

Clutch Sizes

In 2008, all female *Terrapene* found before June 20th were x-rayed. The first group of females was x-rayed on May 20th and the second group was x-rayed on 25 May; however, no females were found to be gravid before the third x-ray session on 3 June. *Terrapene ornata* 9L10R was x-rayed and gravid with 3 eggs on 3 June. A smaller female *T. ornata* (3L9L11L) was palpated after found and never x-rayed. A clutch size of 4 was determined after oviposition occurred (see below). The *Terrapene* hybrid 9L10L11L was x-rayed on 3 June and was gravid with 6 eggs (Appendix I). In 2009, the three female *T. ornata* were x-rayed on 3 June, but none were found to be gravid.

Nesting

In 2008, *Terrapene ornata* 9L10R was never observed nesting. *Terrapene ornata* 3L9L11L was observed nesting at 21:23 on 2 July. This female nested on a small slope in an open-canopy oldfield habitat. The nest was approximately 20 meters from a road. The air temperature was 26.4 degrees Celsius and the relative humidity was 70%. At the time of nesting, the substrate was 23.2 degrees Celsius. Most of the ground at the nest site was covered by vegetation consisting of tall fescue (*Festuca pratensis*), horseweed (*Conyza canadensis*), tall goldenrod (*Solidago canadensis*), and Spanish needles (*Bidens bipinnata*) (Khuns 2004). *Terrapene carolina* x *ornata* 9L10L11L was observed nesting at 21:10 on 13 June. This female nested on a small closed-canopy grassy patch between the edge of a road and an open-canopy old field habitat. The environmental conditions during this nesting event was similar the conditions when 3L9L11L nested. The air temperature was 23.2 degrees Celsius, the substrate was 23.9 degrees and the relative

humidity was 83%. Nesting movements were not analyzed because there was little time between discovering the gravid females and the occurrences of the nesting events. No nesting activity was observed in 2009. Nest locations and canopy cover measurements are given in Table 3.

Table 3. GPS coordinates and canopy cover measurements for the Ornate Box turtle nests observed in 2008 at Carlyle Lake.

ID	Location	Densiometer	N	S	E	W
[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]
[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]
[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]
[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]
[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]
[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]
[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]

Predation Rates

In 2008, both the nest of *Terrapene ornata* 3L9L11L and *T. carolina x ornata* 9L10L11L were depredated within 24 hours. Both nests were completely excavated. Four egg shells were found near the nest site of *Terrapene ornata* 3L9L11L and six egg shells were found at *T. carolina x ornata* 9L10L11L's nest site. There were no predator tracks found near the excavated nests, however the Virginia opossum (*Didelphis virginiana*), raccoon (*Procyon lotor*), and the striped skunk (*Mephitis mephitis*) were frequently seen at the site. No predated nests were observed in 2009.

DISCUSSION

It is clear that the Ornate Box Turtle population at Carlyle Lake has decreased over the past four years. From April 1999 to November 2002, the density estimate was 1.2 turtles/ha (Khuns 2004). A study in South-Central Wisconsin estimated density between 2.9 and 5.0 turtles/ha (Doroff and Keith 1990). Kuhns (2004) suggested that diminishing grassland habitat is likely the main cause of the population decline at South Shore State Park. Overlapping ranges and habitats of *T. carolina* and *T. ornata*, and the ability for these species to hybridize may also be contributing to the decline (Smith 1955; Ernst et al. 1994; Dodd 2001; Doroff and Keith 1990). The unique characteristics that are typically used in the identification of *T. ornata* may be disappearing as the species continues to hybridize with *T. carolina* (Smith 1955).

Predation may also be a cause for the decline of the *Terrapene ornata* population at Carlyle Lake South Shore State Park (SSSP). SSSP is actively used for recreation by tourists and campers throughout the spring and summer months. Human activity is known to attract mammalian pests. Opossums (*Didelphis virginiana*), raccoons (*Procyon*

lotor), and skunks (*Mephitis mephitis*) were frequently seen at the park and likely predate upon box turtle nests (Temple 1987). Both nest sites in 2008 were near the edge of oldfield habitats and relatively close to roads. Turtles that nest closer to habitat edges have a higher risk of predation (Temple 1987; Kolbe and Janzen 2002). With a decrease in undisturbed, unaltered habitat, box turtles are forced to nest in habitats where farms and roadways are located.

Our disappointing results obviously preclude in depth analysis of the original objectives of this project. The low number of individuals and small population density estimates lead us to believe this population cannot be recovered. Thus, we have no management recommendations.

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Appendix I. Morphometric variables measured for the gravid box turtles encountered in 2008 at Carlyle Lake.

Species	ID	Sex	Weight	CL	CW	SH	LPECT	APL	APW	PPL	PPW	Clutch Size
<i>Terrapene ornata</i>	3L 9L 11L	F	388	111	92	63	15.26	46.31	60.80	66.83	70.35	4
<i>Terrapene ornata</i>	9L 10R	F	458	134	100	65	20.64	55.51	72.93	77.00	85.11	3
<i>Terrapene carolina x ornata</i>	9L 10L 11L	F	424	134	105	63	16.07	53.63	67.65	79.21	82.40	6