AN ABSTRACT OF THE THESIS OF

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Title: Alligator Snapping Turtle (Macroclemys temminckii) Habitat Selection, Movements, and Natural History in Southeast Kansas.

Abstract Approved: David R. Edds

I studied the behavior, habitat selection, and diel/seasonal movements of the only known living wild alligator snapping turtle (Macroclemys temminckii) in Kansas via biotelemetry. After an adult female specimen was captured by anglers in a small southeast Kansas creek in 1991, I fitted this 24.7 kg turtle with ultrasonic transmitters and released it at the site of capture. The turtle moved upstream 6.5 km during the one year study, occupying ten different core sites. I measured habitat characteristics to evaluate hydrological, substratum, structural, and cover aspects at core sites, at 35 other available sites with cover, and at 361 systematically located transect sites in the creek. Habitat used by the turtle was significantly different from available habitat. Core sites had more cover, mud, detritus, and pool habitat than did transect sites, and more mud than other available sites with cover. Possible behavioral interactions with the common snapping turtle (Chelydra serpentina) were also noted.

I also investigated conservation status of the alligator snapping turtle in Kansas by sampling 12 historical sites and 72 other possible sites of occurrence in southeast Kansas rivers and streams. Although I collected 1002 turtles of eight different species, I captured no alligator snapping turtles. Herein, I review natural history information pertaining to alligator snapping turtles in Kansas, and make recommendations concerning the conservation status of this species in the state.

ALLIGATOR SNAPPING TURTLE (Macroclemys temminckii) HABITAT SELECTION, MOVEMENTS, AND NATURAL HISTORY IN SOUTHEAST KANSAS

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By

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PREFACE

This thesis consists of four chapters. Each should be considered a separate manuscript. Chapter 1 documents habitat selection and diel/seasonal movements of the only known living wild alligator snapping turtle (*Macroclemys temminckii*) in Kansas, and will be submitted to the *Journal of Herpetology* as a feature article. Chapter 2 will be submitted to the University of Kansas Natural History Museum as an Occasional Paper. It reports the results of a research expedition to capture *M. temminckii* in Kansas, and discusses natural history information pertaining to the conservation of this species in the state. Chapter 3 notes interaction of alligator snapping turtles with the common snapping turtle (*Chelydra serpentina*), and will be submitted to the *Journal of Herpetology* as a note. Chapter 4 is an expanded abstract of this thesis and a review of *M. temminckii* natural history information, and will be submitted to the *Kansas Herpetological Society Newsletter*. All chapters are written in the style of the publications to which they will be submitted.

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CHAPTER 1

ALLIGATOR SNAPPING TURTLE (*Macroclemys temminckii*) HABITAT SELECTION AND MOVEMENTS IN SOUTHEAST KANSAS

ABSTRACT—I studied habitat selection and diel/seasonal movements of the only known living wild alligator snapping turtle in Kansas. After an adult female specimen was captured by anglers in a small southeast Kansas creek in 1991, I fitted this 24.7 kg turtle with ultrasonic transmitters and released it at the site of capture. The turtle moved upstream 6.5 km, occupying ten different core sites during the one year study. I measured habitat characteristics to evaluate hydrological, substratum, structural, and cover aspects at core sites, at 35 other available sites with cover, and at 361 systematically located transect sites in the creek. Habitat used by the turtle was significantly different from available habitat. Core sites had more cover, mud, detritus, and pool habitat than did transect sites, and more mud than other available sites with cover.

The alligator snapping turtle, Macroclemys temminckii, is by far the largest freshwater turtle in North America (Pritchard, 1989). Males of this species can attain weights over 100 kg (Pritchard, 1979a). Its large size, powerful bite, and unique ability to lure fishes to its mouth with a vermiform buccal structure (Allen and Neill, 1950) make it well known. Despite its notoriety, however, alligator snapping turtle habitat use and movement remain poorly understood.

The alligator snapping turtle historically has been most abundant throughout the southeastern coastal area of the United States, Mississippi Valley drainages, and Gulf-draining rivers, becoming increasingly rare north to Illinois and west to Kansas (Pritchard, 1989). Recently, exploitation by commercial turtle trappers and habitat alteration resulting from the damming of rivers has raised concern about the survival of natural populations of this species (George, 1988; Pritchard, 1989). The U. S. Fish and Wildlife Service (USFWS) considers M. temminckii a "candidate species" for listing as threatened under the Endangered Species Act. A 1983 petition to list this animal was denied for lack of scientific data (USFWS, 1984). The latest status review of this species recommended that individual states be responsible for the conservation of alligator snapping turtles (USFWS, 1991).

In Kansas, this turtle has likely always been rare, with only 19 published reports in the last century (Chapter 2). The alligator snapping turtle is currently listed as a "species in need of conservation" by the Kansas Department of Wildlife and Parks (KDWP). Two recent research expeditions mounted to capture alligator snapping turtles in Kansas were unsuccessful (Irwin, 1985; Capron, 1987).

Most of what little is known about the behavioral ecology of M. temminckii exists in incidental observations by herpetologists (Wickham, 1922; Allen and Neill, 1950; Dobie, 1971; Ewert, 1976; Johnson, 1987; Ernst and Barbour, 1989). Commercial turtle trappers have also contributed to existing ecological information (Pritchard, 1989). These sources provide anecdotal data on where specimens have been captured, but do not address specific habitat use or movements of this species with empirical data. Sloan and Taylor (1987) studied habitat use of M. temminckii in a northeast Louisiana lake and adjacent bayou, however potentially influential habitat variables such as substratum, structural aspects, cover, and hydrological characteristics were not measured. There has been no previous research of the behavioral ecology of M. temminckii in lotic systems, nor have there been studies of this species in the northern periphery of its range, where vastly different habitats exist. I investigated habitat selection and diel/seasonal movements of the only known living wild alligator snapping turtle in Kansas.

MATERIALS AND METHODS

An adult female alligator snapping turtle was captured on 31 May 1991 in Onion Creek, Montgomery County, Kansas, by three fishermen (Shipman et al., 1991). The anglers found the turtle snagged under the cervical scute by an unbaited 6/0 hook on a bank line in 0.5 m deep water. This turtle had previously been captured in April 1986, and had been the subject of a radio telemetry study, however equipment failure and inclement weather caused the turtle to be lost after three days of tracking (Capron, 1986).

After the 1991 capture, the turtle was maintained in a stock tank by the KDWP until it was released for biotelemetry. I counted carapace scute annuli (Dobie, 1971) and estimated the turtle's age to be 45 years; I made nine annuli counts on three different readable pleural scutes: 37, 41, 41, 45, 45, 47, 47, 50, and 51.; mean = 44.9, median = 45. I took body measurements and compared them to measurements taken in 1986. I obtained a fecal sample one day after capture and its contents were identified. The turtle was x-rayed and it was not gravid, as was concluded after an x-ray in 1986 (Capron, 1986).

I fitted the turtle with two ultrasonic transmitters and released it at the exact site of capture on 19 June 1991. The transmitters, purchased from Sonotronics Inc., Tuscon, Arizona, were an ST-71 standard uncoded tag and a CHP-87 high power coded tag. The ST-71 has a life expectancy of one year, weighs 20 g dry (8 g in water), is 60 mm long, and has a 16 mm diameter. The CHP-87 has a predicted two-year life expectancy, weighs 32 g dry (13 g in water), is 100 mm long, and has a 18 mm diameter. Both tags transmit at 75 kHz. The transmitters were attached with nichrome wire and nylon tie straps on top of the left posterior carapace in marginal scutes. Two holes that had been drilled in the previous study (Capron, 1986) were used for anchor points.

The Onion Creek study site is a third order stream that joins the Verdigris River three miles south of the Kansas-Oklahoma border. Riparian vegetation is a thin belt of trees typical of eastern Kansas floodplain forest, bordered by agricultural fields and pastures. Onion Creek is prone to flooding, and water levels drastically fluctuate within short periods of time.

I monitored the turtle's movements from 19 June 1991 to 27 May 1992. The turtle's exact location was determined by triangulation with a Sonotronics directional hydrophone, model DH-2, and digital ultrasonic receiver, model US-5B. I located the turtle from a flat-bottom boat, from the bank, or by wading.

Monitoring was most intense during the first fifteen days; I located the turtle 254 times during day and night, averaging 17 checks every 24 hours. I monitored the turtle an additional 31 times during the remainder of the study for an average of one check per week, with decreased monitoring in the winter months as the turtle became sedentary, and increased effort in the spring with increased turtle activity (Appendix 1).

I recorded time, location, and activity of the turtle during each check. I employ the term core site to denote locations where the turtle remained inactive for at least one hour. I measured distance between core sites with metered rope, and categorized turtle movements as one of two types. I defined short-term movements as movements when the turtle moved from a core site, was active, then later returned to the original site. Relocation movements were when the turtle moved from a core site to a new location and did not return to the previous site.

I recorded habitat information at core sites and 66 systematically located transects. Data at core sites were collected only after the turtle had vacated the site. Transects were located every 100 m along the length of the creek that encompassed the total movement of the turtle throughout this study. At each transect location, habitat variables were recorded at every 1 m point across the width of the stream, beginning one meter from the right bank, for a total of 361 transect sites. I also recorded habitat information at 35 sites having observable cover in the portion of the creek used by the turtle, but that were sites not used by the turtle.

I used 13 habitat variables evaluating hydrological, substratum, structural, and cover aspects to compare habitat utilized by the turtle (core sites) with available habitat (transect sites): water depth; stream width; mesohabitat score of riffle = 1, run = 2, and pool = 3; estimated percentage of clay, mud, sand, gravel, and rock in the substratum, quantified by a modification of the Wentworth scale (Cummins, 1962); estimated percentage of shade covering the site at noon; estimated detritus covering the site scored as none = 0, little = 1, some = 2, and much = 3; type of cover at the site scored as none = 0, overhanging bank or beaver den = 1, brush pile = 2, log = 3, and log jam = 4; stream meander estimated from approximately 50 m upstream to 50 m downstream of the site as straight = 0 if the stream did not bend, slight = 1 if the stream curved less than 20°, some = 2 if the stream curved more than 20° but less than 45°, and much = 3 if the stream curved more than 45°; and estimated beaver activity near each site with none = 0, little = 1 with evidence of trees on the bank fallen by beaver, some = 2 with evidence of fresh slides, and much = 3 with the presence of a beaver den.

I added five habitat variables that deal specifically with cover characteristics when I compared core sites with observed sites having cover, but that were not used by the turtle: length of cover; width of cover; percentage of stream width filled with cover; damming effect of cover, scored as none = 0, little = 1 if cover orientation was parallel with stream flow, or much = 2 if cover was perpendicular to stream flow; and compactness of cover, estimated as loose = 1 with little substratum on the cover, moderate = 2 if there was no space between the cover and stream bottom, or compact = 3 if at least 50% of the cover was buried in the substratum.

I classified habitat data (Appendix 2) into three groups: core sites, transect sites, and sites with observed cover, but that were not used by the turtle. All percentage data were arcsine square root transformed. All other data were $\log_{10}(x+1)$ transformed if that allowed for better normality as determined by Bartlett's test for homogeneity of group variances available in STATS module of SYSTAT (Wilkinson, 1988).

I used the MGLH module of SYSTAT (Wilkinson, 1988) to test the null hypothesis that no differences exist between core sites and available habitat in Onion Creek. I compared core sites with transect sites and core sites with sites observed to have cover, but that were not used by the turtle. I employed Wilks' lambda multivariate test to analyze overall difference between groups, e.g., core sites and transect sites. I used univariate F-tests to contrast independent variables between groups, e.g., cover at core sites vs. cover at transect sites. I applied discriminant function analysis to determine the relative importance of independent variables in characterizing groups. Canonical loadings from discriminant analysis are standardized coefficients that show the magnitude of correlation between individual variables and groups, e.g., cover at core sites and transect sites. To control table-wise Type I error, I applied the standard Bonferroni correction (Darlington and Carlson, 1987) to determine significance of *P*-values.

RESULTS

The 1991 recapture of this turtle provided information about movement, foods, and growth of *M. temminckii*. This specimen had moved 7.0 km upstream from where it was last located in 1986, as measured by a digital planimeter from Soil Conservation Service aerial photographs of the study site. The fecal sample obtained one day after capture contained remnants of crayfish and muskrat. Carapace length remained the same as in 1986, 50.8 cm straight-line maximum; midline 46.4 cm. Weight was 24.7 kg compared to 26.9 kg in 1986.

Biotelemetry indicated the turtle relocated to different core sites nine times from June, 1991 to May, 1992, for a total movement of 6.5 km from the site of its release. All nine relocation moves were in an upstream direction. Mean distance traveled during observed relocation moves was 719 m; median = 570 m, max. = 1750 m, min. = 5 m. No relocation movements were observed from 11 November 1991 to 6 March 1992; I assume this was the period of winter dormancy. Mean time between observed relocations, discounting this assumed period of dormancy, was 36 days; median = 26 days, max. = 54 days, min. = 1 day (Fig. 1). Water depth at the winter dormancy core site was 1.5 m, and the site was adjacent to an undercut bank. This was the deepest core site observed to be occupied by the turtle, and differed from other core sites by having relatively more sand substratum and having no observable cover.

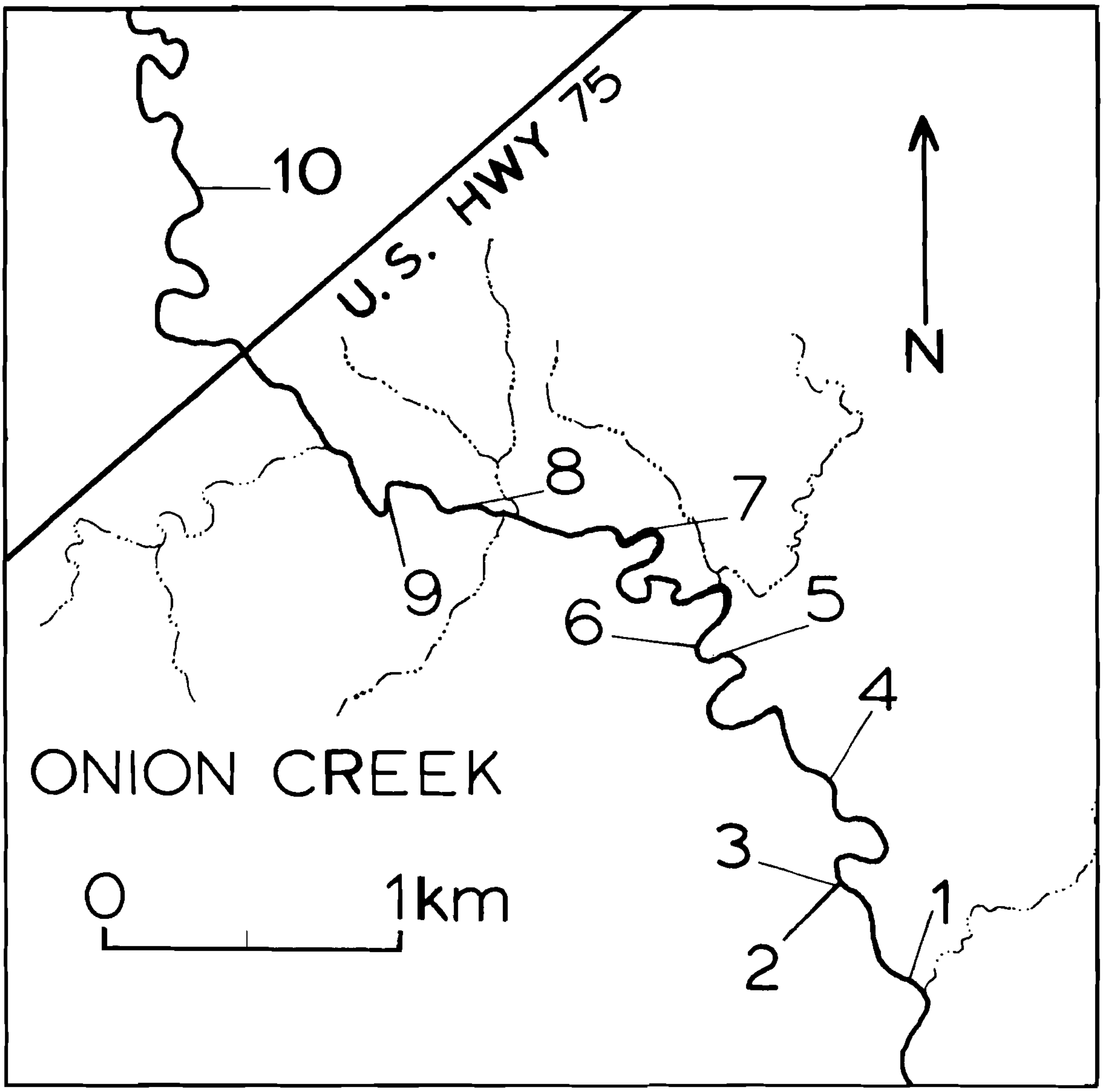

FIG. 1. Alligator snapping turtle relocation movements in Onion Creek 19 June 1991 - 27 May 1992. The turtle was at core site 1 on 19 June; site 2 on 21 June (distance from previous core site = 381 m); site 3 on 22 June (distance = 5 m); site 4 on 18 July (distance = 430 m); site 5 on 10 September (distance = 1392 m); site 6 on 13 October (distance = 50 m); site 7 on 11 November (distance = 930 m); site 8 on 24 March (distance = 965 m); site 9 on 25 April (distance = 570 m); and site 10 on 17 May (distance = 1750 m).

In addition to relocation moves, I observed two short-term moves; these occurred on 20 June and 25 June. Both short-term movements lasted less than one hour and were for total distances of 71 m and 227 m, respectively (Fig. 2). All observed movements, relocation and short-term, occurred between 0200 and 0700 h.

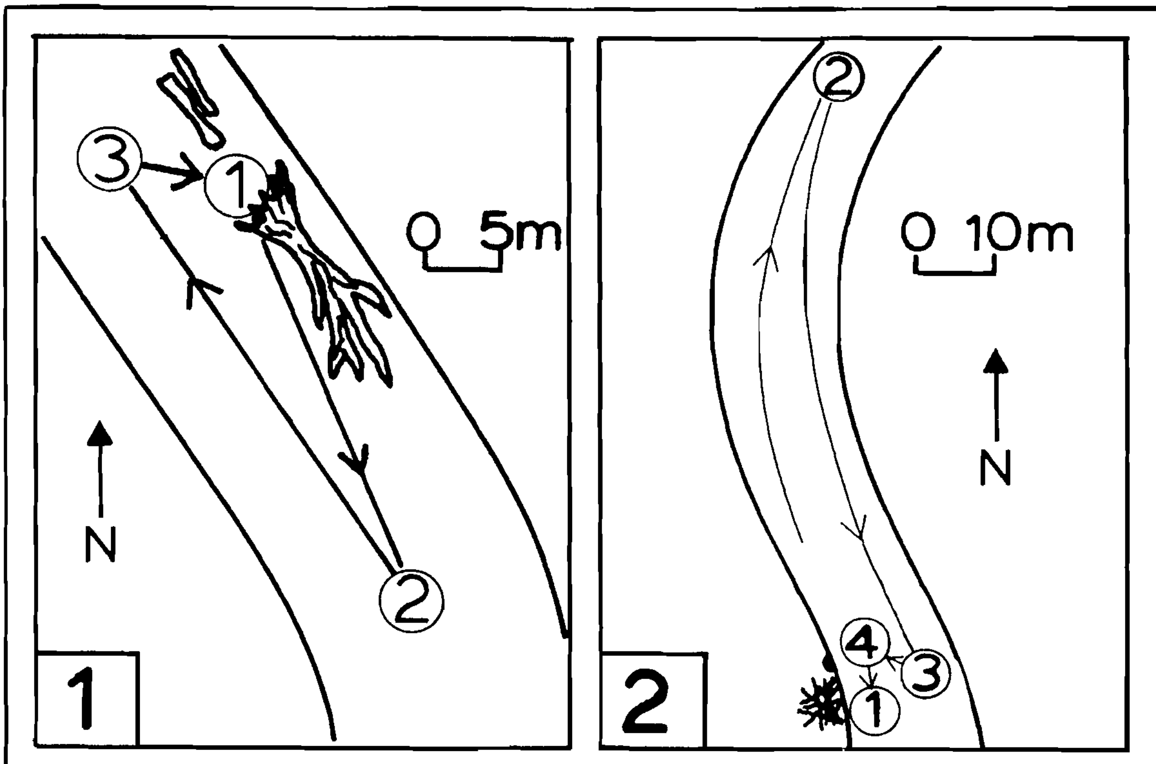

FIG. 2. Alligator snapping turtle short-term movements in Onion Creek. 1. 20 June 1991: The turtle was inactive at position 1 next to log at 0130 h; active at position 2 from 0200 - 0215; active at position 3 from 0230 - 0245; and returned to position 1 by 0300. 2. 25 June 1991: The turtle was inactive at position 1 next to beaver den at 0100; active at position 2 at 0300; active at position 3 at 0332; active at position 4 at 0335; and returned to position 1 at 0336.

On 25 June, the date of the turtle's second observed short-term movement, I made the only visual observation of the turtle since its release when the turtle briefly raised its head out of the water. I had earlier seen beaver active in the vicinity, and the core site was located 5 m from a beaver den. Immediately after the short-term movement had ended, I heard splashing in the vicinity of the beaver den. The turtle relocated to a new core site within the entrance of the den 15 min. after the splashing began, and remained there until at least 7 July 1991.

Ten core sites were used by the turtle throughout this study. Excluding the site of winter dormancy, all had some type of cover. These were nine of a possible 44 sites having some type of observable cover in this 6.5 km section of Onion Creek. Upon investigation after the turtle had vacated these core sites, eight of ten had depressions in the substrate where the turtle had been located.

Core site habitat was significantly different from that of transect sites (Wilks' lambda $F_{13, 357} = 22.18$); $\underline{P} < 0.001$); thus the turtle selected specific habitats. Four variables were significantly different for core sites in comparison with available habitat (Table 1). In order of importance, according to canonical loading coefficients, core sites had significantly more cover, detritus, mud substratum, and pool habitat than did transect sites (Table 1).

TABLE 1. Canonical loading coefficients, means (SD), and univariate F-test P-values for comparison of habitat variables of core sites with available habitat at sites in Onion Creek, Montgomery County, KS (P to reject $H_0 = 0.004$).

Variable	Canonical Loading	Core Sites Mean(SD)	Available Habitat Mean(SD)	P
Cover type	0.779	2.6 (1.3)	0.1 (0.5)	<0.001*
Detritus	0.579	1.4 (1.1)	0.1 (0.4)	<0.001*
Mud	0.248	68.5 (43.1)	23.1 (33.4)	<0.001*
Mesohabitat	0.179	2.8 (0.4)	2.3 (0.6)	0.002*
Beaver activity	0.128	1.1 (1.4)	0.4 (0.7)	0.027
Depth	0.112	74.7 (49.2)	46.9 (26.8)	0.054

Cont.

Table 1 continued.

Variable	Canonical Loading	Core Sites Mean(SD)	Available Habitat Mean(SD)	P
Stream meander	0.089	1.0 (0.9)	0.6 (0.9)	0.127
Shade	0.081	48.0 (41.3)	33.8 (33.6)	0.165
Width	0.051	9.6 (5.3)	8.0 (2.9)	0.380
Gravel	-0.047	3.0 (9.5)	10.5 (27.0)	0.418
Rock	-0.052	0.0 (0.0)	6.7 (23.7)	0.369
Clay	-0.068	2.0 (6.3)	16.8 (37.1)	0.238
Sand	-0.069	27.0 (40.0)	43.0 (40.4)	0.232

* = significant

Core sites were also significantly different from all observed sites having cover (Wilks' lambda $F_{18, 26} = 3.46$; P = 0.002). Mud substratum was significantly greater at core sites (Table 2).

TABLE 2. Canonical loading coefficients, means (SD), and univariate F-test P-values for comparison of habitat variables of core sites with other available sites that had cover (P to reject H_0 = 0.003).

Variable	Canonical Loading	Core Sites Mean(SD)	Available Cover Sites Mean(SD)	P
Mud	0.541	68.5 (43.1)	10.0 (26.1)	<0.001*
Beaver activity	0.296	1.1 (1.4)	0.2 (0.5)	0.004
Cover width	0.267	2.5 (2.0)	1.2 (1.1)	0.010
Width	0.235	9.6 (5.3)	6.0 (2.4)	0.022
Mesohabitat	0.180	2.8 (0.4)	2.4 (0.7)	0.074
Cover angle	0.144	1.8 (1.0)	1.3 (0.7)	0.152
Depth	0.111	74.7 (49.2)	60.0 (32.0)	0.265
Detritus	0.078	1.4 (1.1)	1.1 (1.1)	0.435
Stream meander	0.015	1.0 (0.9)	0.9 (1.1)	0.878
Shade	0.008	48.0 (41.3)	47.3 (39.3)	0.935
Compactness	-0.042	1.0 (0.7)	1.2 (1.0)	0.673
Cover type	-0.058	2.6 (1.3)	2.8 (0.8)	0.556
Rock	-0.096	0.0 (0.0)	0.1 (0.2)	0.336
Sand	-0.104	27.0 (40.0)	43.0 (42.0)	0.298
Cover length	-0.118	4.9 (3.4)	6.8 (4.90)	0.239
Damming effect	-0.120	28.0 (30.4)	42.4 (34.6)	0.231
Clay	-0.121	2.0 (6.3)	17.4 (36.2)	0.227
Gravel	-0.148	3.0 (9.5)	20.7 (36.0)	0.141

* = significant

DISCUSSION

Transect sites represent habitat available to the alligator snapping turtle as it moved through Onion Creek. Similarly, observed sites that had cover but that were not used by the turtle also represent available habitat. By statistically comparing core sites with available habitat in the creek, I have demonstrated habitat selection by this turtle.

In their study of 11 alligator snapping turtles in Bayou Desiard and connected Black Bayou Lake in northeast Louisiana, Sloan and Taylor (1987) assessed depth and vegetation, and compared the amount of time each turtle spent in a particular habitat relative to its availability. These authors concluded that turtles in the bayou used deep channel habitat in proportion to its availability, but that turtles in the adjacent lake used shallow, heavily vegetated waters in excess of availability. However, these results were not tested statistically, nor did the study address substratum, structural, or cover characteristics of the habitat.

Sloan and Taylor (1987) compared movement and home range size of six native with five introduced *M. temminckii*, and found no differences (*t*-test; $P > 0.05$). The grand mean of daily distances traveled for all turtles, calculated from reported average daily distances for each turtle, was 62.5 m, which is far greater amount of activity than that exhibited by the subject of my study. The grand mean of the minimum home ranges reported by Sloan and Taylor (1987) was 1.2 km^2, however I was unable to calculate minimum home range for the Onion Creek turtle because its relocation movements were linear. Sloan and Taylor (1987) introduced the idea that alligator snapping turtles utilize specific core areas from which they make journeys that are short in distance and duration. My results are consistent with this hypothesis. The Onion Creek alligator snapping turtle used specific core sites and made at least two short-term movements from those core sites that were brief in distance and duration.

The Onion Creek turtle chose habitat that had a predominance of cover, detritus, mud substratum, and pool habitat. The turtle also selected habitat that had more mud substratum than other available sites with cover. However, the turtle may have chosen specific core sites not because of any one variable, but by assessment of several variables in the habitat. The top seven variables that correlate with core sites in the comparison with transect sites, i.e., that have positive canonical loadings in Table 1, are characteristic of low energy depositional zones in streams -- areas with finer sediments such as mud substratum, accumulation of detritus, more pool habitat, and a slower meandering flow (Cummins, 1972; Curry, 1972). In contrast, variables correlating with transect sites are characteristic of high energy erosional zones in streams -- coarser substrate and steeper gradient. Though clay is usually regarded as fine sediment, all clay substratum encountered in this study was hard packed and analogous to bedrock. Comparison of core sites with other available habitat having cover exhibits the same trend, with core sites again representing depositional zones and the available sites with cover representing more erosional zones (Table 2).

Animals optimize net energy yield by using complex behavior and morphology best suited to gather food in a particular environment (Schoener, 1971). Alligator snapping turtles use the sit-and-wait predation strategy, being sedentary and having morphological adaptations of camouflage and a vermiform lure. Under this premise, I hypothesize it would optimize net energy yield of alligator snapping turtles to utilize low energy areas of streams that require minimum maintenance energy between feeding events.

More direct benefits may have influenced habitat selection by this turtle. Prey species may have also been attracted to the same sites the turtle selected. Fish is a documented prey item of alligator snapping turtles (Pritchard, 1989), and many species of fish are associated with cover. Crayfish, found in the fecal pellet of this turtle, may also be attracted to such habitat to feed on detritus and other dead organic material that collects in these areas. Other aquatic turtles may also be attracted to sites with cover to bask, or to seek food and cover for themselves. In July 1991, I noted two common snapping turtles, Chelydra serpentina, that had emerged from a core site one day apart with bites presumably inflicted upon them by the alligator snapping turtle (Chapter 3).

Though not statistically significant, beaver activity had the next highest canonical loading coefficient in both comparisons. Beaver are typically found in pool habitat, and may even modify streams by building dams to create pools. Beier and Barrett (1987) demonstrated that beaver preferred habitat in streams that are deep, wide, and have low gradient, habitat common in low energy depositional zones. Beaver have been found in the stomach contents of alligator snapping turtles captured by professional trappers (Pritchard, 1989). The Onion Creek turtle may use beaver as a food item.

The short-term movements exhibited by this turtle are consistent with Carr's (1952) hypothesis that this species uses its lure reservedly during the day and scavenges and stalks its prey during the night. Capron (1986) noted this specimen became more active between 0200 and 0300 h, moving around in its tank while in captivity prior to release, and I made the same observation while the turtle was in captivity prior to release for my study.

Pritchard (1979b, 1989) advanced the hypothesis of upstream migration in alligator snapping turtles, suggesting that "certain alligator snappers may wander upstream for decades, ultimately arriving in the uppermost reaches of the Mississippi system by which time they are very large, old and rare". The recapture and observed movements of the Onion Creek alligator snapping turtle are consistent with this hypothesis. The only previously published record of migration in the alligator snapping turtle is from Wickham (1922), who documented a specimen taken from the Washita River, Oklahoma in 1915. The turtle was held in captivity for 34 months, then tagged and released into the Blue River, Oklahoma in 1918, and recaptured approximately 30 km upstream in 1921. Soundness of Wickham's observation has been questioned because the specimen had been held in captivity for so long, and because it was eventually liberated in a river other than that in which it was captured. Recapture of the Onion Creek specimen is consistent with the upstream migration hypothesis by documenting 7 km movement upstream from 1986 - 1991 in the upper reaches of the Mississippi River system. From 1991 - 1992, this turtle moved an additional 6.5 km upstream in 11 months, making the total upstream migration 13.5 km in 6 years. This may be the best example of upstream movement to date. Also consistent with the upstream migration hypothesis is the size of this specimen -- very large for a female alligator snapping turtle. Pritchard (1989) noted the largest female on record was 29 kg, with a carapace

Missouri alligator snappers with a mean of 47.0 kg; and Pritchard (1989) noted two Kentucky captures with a mean weight of 32.6 kg. Weights of seven previous Kansas captures documented in the literature show the same trend: 15.4, 26.8, 26.9, 29.5, 39.9, 47.6, and 60.1 kg; mean = 35.2 kg.

My research represents the first study of diel/seasonal movements and habitat selection of an alligator snapping turtle in a lotic environment, and is the first study of the ecology of this species in the northern part of its distribution. My conclusions provide a working hypothesis for year-round habitat selection and diel/seasonal movements of alligator snapping turtles for future studies. If alligator snapping turtles in lotic environments do migrate upstream, this would have implications concerning conservation of this species, particularly in the northern periphery of its distribution.

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CHAPTER 2

CONSERVATION STATUS OF THE ALLIGATOR SNAPPING TURTLE (*Macroclemys temminckii*) IN KANSAS

ABSTRACT

During the spring and summer of 1991 I investigated conservation status of the alligator snapping turtle (*Macroclemys temminckii*) in Kansas by sampling 12 historical sites and 72 other possible sites of occurrence in southeast Kansas rivers and streams. Though I collected 1002 turtles of eight different species, I captured no alligator snapping turtles. Herein, I compile documented records of the alligator snapping turtle in Kansas, review natural history information pertaining to the conservation of the species in the state, and make recommendations concerning the conservation status of this turtle in the state, based upon previously known and new ecological information.

INTRODUCTION

Due to the rarity and apparent decline in alligator snapping turtle (Macroclemys temminckii) sightings in Kansas, this species is currently listed as a species in need of conservation by the Kansas Department of Wildlife and Parks (KDWP). Concerning sightings of this species in Kansas, Clarke (1981) stated that fishermen can distinguish between two kinds of snapping turtles they catch in the Cottonwood River. The "mossy back", a large snapping turtle with a pronounced beak and prominent carapace ridges, is distinct from other large, rather smooth-shelled snappers. Clarke noted alligator snapping turtles have turned up occasionally on fishing lines. He also noted that this turtle's predilection for bottoms of large, deep water courses keeps it from discovery through conventional collecting techniques.

The alligator snapping turtle was originally listed as threatened in Kansas in 1978, and was delegated its current status as a species in need of conservation in 1987. Lack of sufficient biological documentation was the reason given for not maintaining the species as threatened (KDWP, 1986). More recently, a 1991 petition to list the alligator snapping turtle as endangered in Kansas was not successful because there is no evidence of a breeding population; therefore it does not qualify for endangered status (Ken Brunson, KDWP, pers. comm.).

There also appears to be a decline of this turtle throughout the heart of its range in the southeastern United States, due to exploitation by commercial trappers and habitat alteration resulting from the damming of rivers (Pritchard, 1989). M. temminckii is presently a "candidate species" being considered for listing by the U. S. Fish and Wildlife Service (USFWS) as endangered or threatened under the Endangered Species Act. Listing of this animal has been delayed because of lack of data concerning its conservation status (USFWS, 1984).

The purpose of my study was to explore the conservation status of the alligator snapping turtle in Kansas, and to provide data required for its conservation. To do this, I sampled rivers and streams in southeast Kansas for alligator snapping turtles, compiled documented records of this species in Kansas, and collected natural history information regarding this turtle in the state.

MATERIALS AND METHODS

I sampled 12 historical sites and 72 other possible sites of occurrence in the Neosho, Verdigris, lower Arkansas, Walnut, and Spring river drainages of Kansas from April - September, 1991, in search of extant populations of M. temminckii (Appendices 3 and 4). My sampling effort consisted of 600 trap nights, where one trap night equals one turtle trap set overnight for one night: 285 at historical sites and 315 at other sites. I set three to six commercially available hoop turtle traps at each site. Traps were baited with one or more of the following items: fresh fish, mussel, chicken liver, and dry dog food. Two sizes of turtle traps were used: three-hoop turtle traps were 1.8 m in length and 0.8 m in diameter, with 2.5 cm nylon mesh; four-hoop turtle traps measured 2.1 m in length and 1.1 m in diameter, with 2.5 cm nylon mesh. At seven historical sites I used setlines with 9/0 treble hooks and 200 lb. test line baited with fish, mussel, or chicken liver for a total of 115 hook nights, where one hook night equals one hook set overnight for one night (Appendix 3).

To gain information on possible sightings of alligator snapping turtles, I attempted to draw upon the knowledge and experience of local fishermen and trappers by disseminating an informational flyer and talking to individuals who spend much time on the rivers and streams of Kansas. The flyer provided information to educate individuals using Kansas waters about differences between the alligator snapping turtle and common snapping turtle, called for conservation of the alligator snapping turtle, and provided anglers the means to report sightings (Appendix 5).

RESULTS

No alligator snapping turtles were captured by my efforts. The flyers I distributed elicited several reports, but all credible accounts investigated proved to be false. My methods were, however, successful in capturing several other species of turtles. I captured a total of 1022 turtles in traps, representing eight species including red-eared slider, *Trachemys scripta elegans* (525); western spiny softshell, *Apalone spinifera hartwegi* (226); midland smooth softshell, *Apalone m. mutica* (85); common snapping turtle, *Chelydra s. serpentina* (75); western painted turtle, *Chrysemys picta bellii* (55); Ouachita map turtle, *Graptemys o. ouachitensis* (48); Mississippi map turtle, *G. pseudogeographica kohnii* (6); and common musk turtle, *Stenotherus odoratus* (2). No turtles were captured by setline.

On 31 May 1991, an adult female 24.7 kg alligator snapping turtle was captured by three anglers in Onion Creek, Montgomery County (Shipman et al., 1991). This turtle had previously been captured and studied in 1986 (Capron, 1986). Newspaper accounts of the first capture were summarized in the *Kansas Herpetological Society Newsletter* No. 65 (1986). After its recapture in 1991, I conducted a one-year biotelemetry study of this turtle's movements and habitat use (Chapter 1).

DISCUSSION

In addition to my investigations, there have been two other unsuccessful recent research expeditions to capture *M. temminckii* in Kansas. The first study (Irwin, 1985) focused on the lower Arkansas, Neosho, and Verdigris rivers. In 24 days of field work employing 16 live traps, investigators found no sign of the alligator snapping turtle. In the second study (Capron, 1987), as many as 22 hoop nets were set at sites in the Arkansas and Verdigris river drainages. This research also proved inconclusive, however, in that no evidence of *M. temminckii* was found.

Irwin (1985) sampled with an effort of at least 152 trap nights for alligator snapping turtles at three locations in southeast Kansas. Capron (1987) sampled in southeast Kansas for at least 108 trap nights at five locations. My study was the third attempt to find this species in Kansas, and my effort of 600 trap nights at 84 locations makes the collective total effort among the three studies 860 trap nights. In addition to nets, setlines were used in all three studies.

Whereas these sampling techniques have been very effective for commercial turtle trappers capturing alligator snapping turtles in the southeastern United States (Al Redmond, professional turtle trapper, Dawson, Georgia, pers. comm.), an anecdotal observation of the Onion Creek turtle during my biotelemetry study (Chapter 1) suggests these methods may not be as effective in Kansas. On 21 June 1991, the Onion Creek turtle made an upstream movement past an area where I had set eight baited turtle traps. I located the turtle within three hours of its move and immediately removed all nets from the area. It may be that these traps were unsuccessful because the turtle simply had not had enough time to investigate its surroundings and find the baited nets after arriving at the site, and it may be that they would have eventually captured this specimen. Other than this observation, however, there is no reason to doubt that this capture method would not work in Kansas.

The alligator snapping turtle historically has been most abundant throughout the southeastern coastal area of the United States, Mississippi Valley drainages, and Gulf-draining rivers, becoming increasingly rare north to Illinois and west to Kansas (Pritchard, 1989). In Kansas, the distribution of alligator snapping turtle records are restricted to drainages in the southeast part of the state (Fig. 1). Nineteen captures and sightings of the alligator snapping turtles at 12 locations have been reported in literature in Kansas, most of them from the early part of this century (Table 1). Five of these records are documented by voucher specimens or photographs, and all are retained by the University of Kansas Natural History Museum: KU 46902; KU 197329; KU 20415; KU 7406 (photo); and KU 204880 (photo).

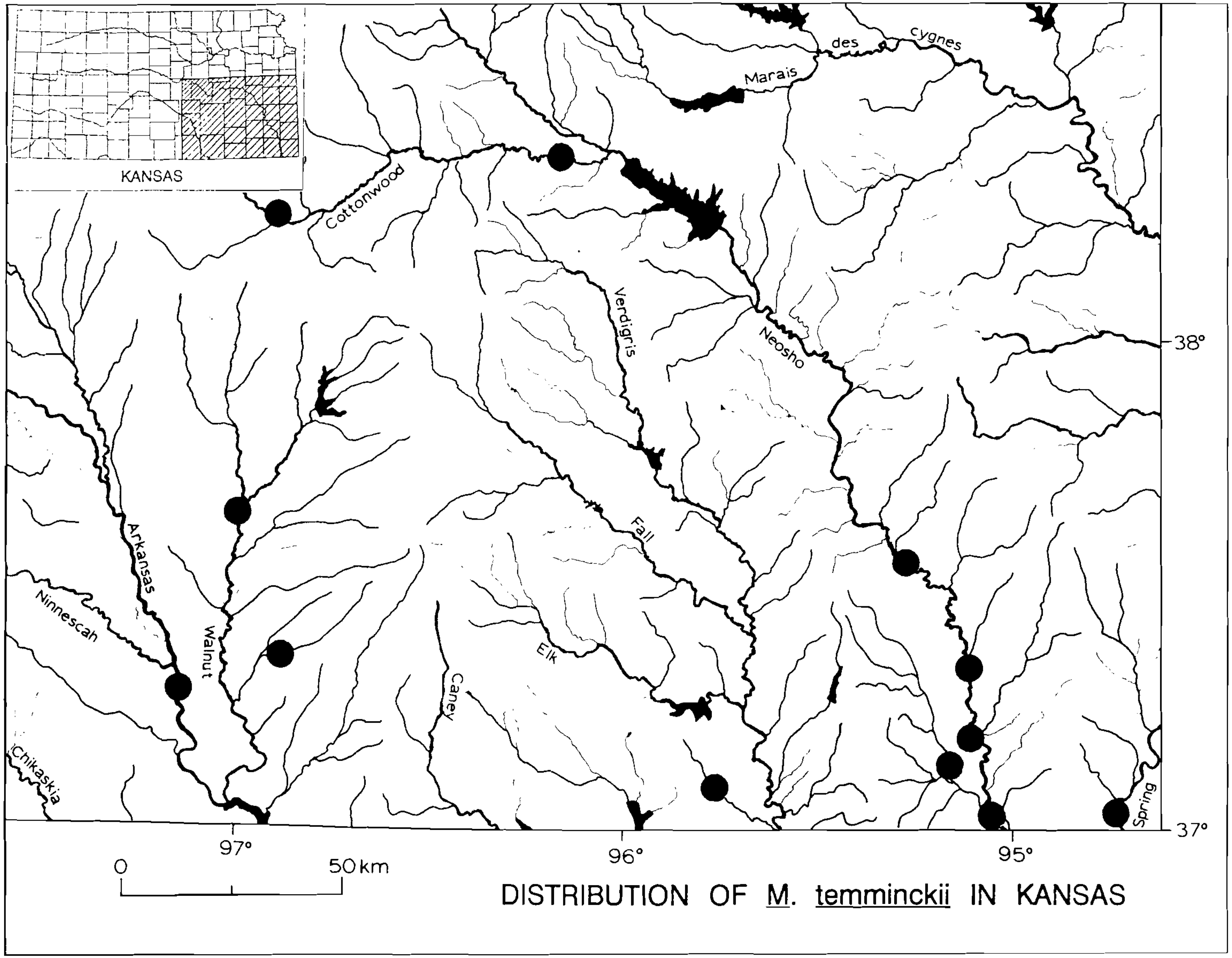

FIG. 1. Alligator snapping turtle historical sites in Kansas.

Table 1. Historical records of M. *temminckii* in Kansas.

Date	Number Captured	Location	Source of Record
1885	1	NEOSHO RIVER	CRAGIN 1886
1886[1]	1	NEOSHO RIVER	" "
1895	1	SPRING RIVER	HOUSHOLDER 1916
1897	1	NEOSHO RIVER	" "
1911	1	NEOSHO RIVER	" "
1912	1	WALNUT RIVER	" "
1912	1	COTTONWOOD RIVER	" "
1937	2	NEOSHO RIVER	HALL AND SMITH 1947
1938[2]	1	LABETTE CREEK	CAPRON 1987
1938	1	LABETTE CREEK	" "
1940	1	ARKANSAS RIVER	" "
1958[1]	1	TIMBER CREEK	LEGLER 1960
1967[1]	1	COTTONWOOD RIVER	CLARKE 1981
1973	3	ARKANSAS RIVER	CAPRON 1975
1974	1	ARKANSAS RIVER	" "
1986[2]	1	ONION CREEK	CAPRON 1986

[1] = voucher specimen

[2] = photograph

Irwin (1985) reported a capture of an alligator snapping turtle from below the dam of Toronto Reservoir on the Verdigris River via personal communication. Mystery shrouds details of this capture and the disposition of the specimen, therefore it is not included in these historical records.

Based upon a survey of turtle trappers and fishermen along the Mississippi River in Illinois, Moll (1988) professed that all records of alligator snapping turtles north of St. Louis should be examined critically, due to the possibility that some turtles may have been brought from southern locations and released or reported as being captured further north for publicity purposes by bait houses. His report indicates that records from newspaper accounts should be particularly scrutinized.

CONSERVATION

Moll (1988) stated reasons for listing this species in Illinois that may also apply to Kansas. He contended that the alligator snapping turtle should be listed as endangered in Illinois for the following reasons:

1. "Considering the low numbers which have been taken in Illinois over the past century, it would presumably require very little to extirpate Macroclemys in the state. It thus satisfies the criterion of 'endangered' that the species be in imminent danger of extinction."

2. "The endangered category would provide maximum protection for the species. If and when any additional specimens are captured in the state, I would not want to see them kept in captivity as tourist attractions or even as educational exhibits for the state fair. This species is relatively slow growing and slow maturing and thus the loss of any adults to the already meager numbers would be a serious if not critical blow to its continued survival."

3. "In 1982 Peter Pritchard prepared a report on the status of the alligator snapper in the country. He recommended that the turtle be given federal threatened status. This is currently under consideration. Among the states within the turtle's range, Illinois likely has one of the smallest populations. Hence if the turtle is considered threatened nationally, it certainly should be listed as endangered within this state."

Other than Capron's (1975) observation of a supposed mating in the Arkansas River, there is no evidence of a breeding population in Kansas. No instances of oviposition or juveniles in Kansas have ever been reported. The smallest alligator snapping turtle recorded in Kansas was 15.4 kg, a size likely well into sexual maturity (Pritchard, 1989). A 17.7 kg female captured in Illinois contained 32 eggs (Galbreath, 1961). These data indicate the possibility of reproduction in Kansas should not be precluded due to the state's northern latitude alone.

Pritchard (1979, 1989) advanced the hypothesis of upstream migration in alligator snapping turtles, suggesting that "certain alligator snappers may wander upstream for decades, ultimately arriving in the uppermost reaches of the Mississippi system by which time they are very large, old and rare". I documented 13.5 km upstream movement of the Onion Creek alligator snapping turtle over six years, providing support for this hypothesis (Chapter 1). Wickham (1922) noted a specimen in the Blue River, Oklahoma, that migrated upstream approximately 30 km in three years.

Possible upstream migration by certain individuals of this species has consequences pertaining to the conservation of this species in Kansas and other areas in the upper reaches of the Mississippi drainage. While there are fossil records of the genus Macroclemys from as far north as Nebraska and South Dakota (Pritchard, 1989), it is possible that in more recent history, there has not been a sustained breeding population of this turtle in Kansas. The rarity of this species, combined with the fact that there are no historical records of juvenile alligator snapping turtles in Kansas, lends even greater support to this view. It is possible that recent alligator snapping turtles documented in Kansas are individuals that wandered upstream into Kansas from areas where there are breeding populations, such as Oklahoma, where this species is apparently more abundant (Glass, 1949; Black, 1982; Secor and Carpenter, 1984). This concept suggests that a small population of alligator snapping turtles has been sustained in Kansas by naturally migrating individuals, and not by breeding individuals within the state.

Pritchard (1989) listed commercial turtle trapping and impoundment of rivers as the most serious threats to the conservation of alligator snapping turtles. In Kansas, the most serious threats are probably major impoundments on rivers which may impede the upstream migration of individuals into the state, and incidental take of this species by anglers that do not recognize the turtle as a rare species.

CONCLUSIONS

M. temminckii is a part of the natural heritage of Kansas, based upon past historical records. Much effort has been spent by herpetologists in the last nine years to capture alligator snapping turtles in Kansas, with no success. This species qualifies to be listed as endangered as defined by KDWP, with the exception of there being no evidence of a breeding population. I contend that regardless of the reproductive status of this species, *M. temminckii* should be listed endangered in Kansas. I base this argument on the following reasons: rarity of this animal; the possibility that turtles migrating into Kansas, rather than reproduction, is the source of recruitment for a Kansas population; and consideration by the USFWS to give this animal federal protection. Listing this animal as endangered would give priority to informing Kansas anglers of its presence, thus decreasing chances this rare turtle would be mistakenly killed.

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Chapter 3

INTERACTIONS OF *Macroclemys temminckii* WITH *Chelydra serpentina*

In July 1991, I documented two common snapping turtles, *Chelydra serpentina*, that had emerged from a partially submerged brush pile in Onion Creek, Montgomery County, Kansas. The turtles, both probably juveniles (Bury, 1979), were found one day apart with bites presumably inflicted upon them by a 24.7 kg female alligator snapping turtle, *Macroclemys temminckii*, occupying the brush pile, and the subject of a biotelemetry study (Chapter 1).

The first common snapping turtle was found lying on the bank of the creek opposite the brush pile at 2000 h on 8 July. The inferred interaction was not directly observed, however a blood trail from the common snapping turtle led to the location of the alligator snapping turtle in the brush pile 10 m away. A field assistant passed this site less than one hour earlier, and the common snapping turtle had not been there at that time (Doug Blex, pers. comm.). The second turtle was found at approximately the same time and location on the following day. Pattern and size of both bite marks matched those of a museum specimen *M. temminckii* skull of like proportions to that of the alligator snapping turtle in the creek. The bites were also similar in their location on the left posterior margin of the carapace (Fig. 1).

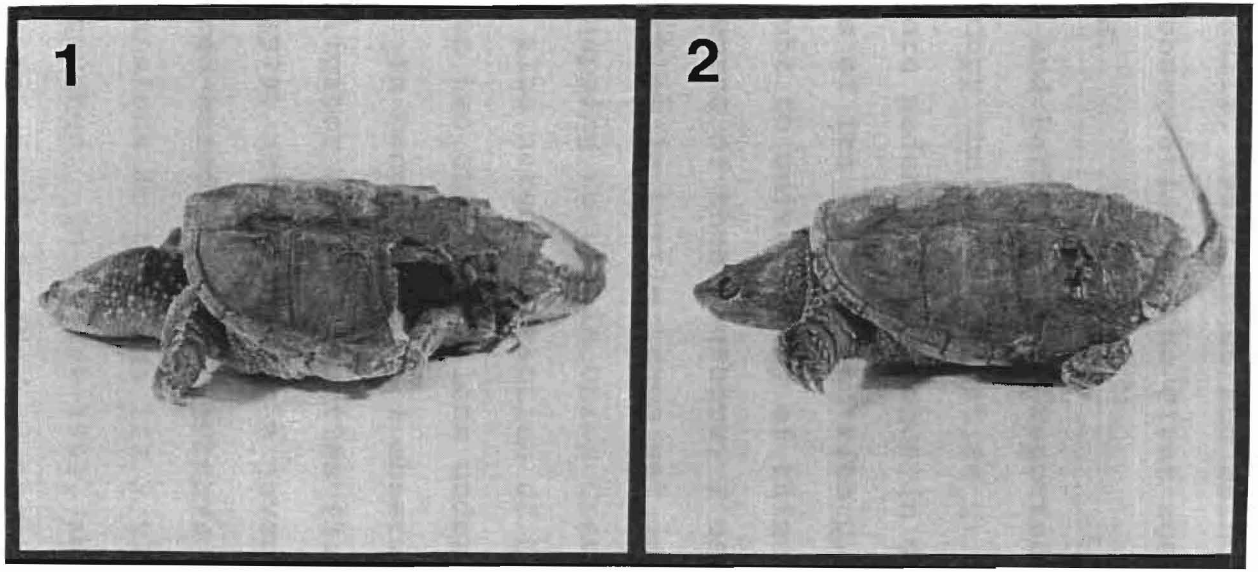

FIG. 1. Common snapping turtles presumably bitten by alligator snapping turtle, Montgomery County, Kansas. 1. Carapace length = 155 mm straight-line maximum, post-mortem weight = 670 g. 2. Carapace length = 178 mm straight-line maximum, post-mortem weight = 975 g.

Alligator snapping turtles in captivity have been observed to stalk and eat live turtles of the genera Deirochelys, Kinosternon, Graptemys, Chrysemys, and Chelydra (Allen and Neill, 1950; Ernst and Barbour, 1989; Pritchard, 1989). My observation is the first such interaction noted in the field.

Ernst and Barbour (1989) reported that M. temminckii does not occupy the same habitat as C. serpentina, but prefers a more sedentary existence in deeper waters. My observations of its interaction with C. serpentina bring possible doubt to universality of this claim. Also contrary to the statement of these authors, I captured six common snapping turtles in turtle traps set in areas used by the alligator snapping turtle in Onion Creek.

I have also noted interaction of M. temminckii with C. serpentina on two other occasions under laboratory conditions. In December 1991, I observed two captive female juvenile alligator snapping turtles (3.3 kg and 2.9 kg; Pritchard, 1979) attack and eat a juvenile common snapping turtle. A red-eared slider, Trachemys scripta elegans, of similar dimensions in the same 122 x 51 x 31 cm tank remained untouched. In August 1992, an adult common snapping turtle received a triangular-shaped bite from a 32 kg male captive alligator snapping turtle while two smaller red-eared sliders and a western spiny softshell, Apalone spinifera hartwegi, maintained in the same 1.5 x 1.5 x 1.5 m tank were not harmed. In both of these cases, the bites were also delivered to the rear margin of the common snapping turtle carapace.

If alligator snapping turtles and common snapping turtles are not separated in habitat use, they may be separated by time of activity. Obbard and Brooks (1981) found common snapping turtles were diurnal, whereas the wild alligator snapping turtle I investigated was active only at night (Chapter 1). Allen and Neill (1950) placed *M. temminckii* with *C. serpentina* in captivity in Florida, and study results indicated that the alligator snapping turtle could not compete for live fish with the more aggressive common snapping turtle that pursued prey and ate it before the alligator snapping turtle could use its angling techniques. Based upon my observations, it is impossible to determine if the purpose of the presumed interactions was for the alligator snapping turtle to acquire the common snapping turtles as food or if it was agonistic territorial behavior. My observations suggest *M. temminckii* and *C. serpentina* may utilize similar habitats. Additionally, possible competition between *M. temminckii* and the more prolific *C. serpentina* may have implications concerning conservation of the alligator snapping turtle, which is currently a candidate species for protection by the U.S. Fish and Wildlife Service (1991).

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Chapter 4

NATURAL HISTORY OF THE ALLIGATOR SNAPPING TURTLE (*Macroclemys temminckii*) IN KANSAS

I studied habitat selection and diel/seasonal movements of the only known living wild alligator snapping turtle in Kansas for my M.S. thesis at Emporia State University. After an adult female specimen was captured by anglers on 31 May 1991 in Onion Creek, Montgomery County, I fitted this 24.7 kg turtle with two ultrasonic transmitters and released it at the site of capture on 19 June 1991 (Shipman et al., 1991). This turtle had previously been captured and studied in 1986 by Marty Capron (Capron, 1986). Newspaper accounts of the first capture were summarized in the Kansas Herpetological Society Newsletter No. 65 (1986).

During my one-year study, the turtle moved 6.5 km upstream, occupying ten different "core sites", or locations where it remained inactive for at least one hour. To assess habitat selection by the turtle, I evaluated hydrological, substratum, structural, and cover aspects of core sites, of 35 other available sites with cover, and of 361 systematically located transect sites in this 6.5 km section of Onion Creek. Transect sites and other sites with cover were sampled to characterize habitat available to the turtle in the creek. I found habitat used by the turtle was significantly different from that available; thus I demonstrated this turtle selected specific habitats in Onion Creek. Core sites had significantly more cover, mud, detritus, and pool habitat than did transect sites, and more mud than other available sites with cover (Chapter 1).

I concluded my study after I lost contact with the turtle on 16 June 1992. My last contact with the Onion Creek alligator snapping turtle was on 27 May 1992. I made three subsequent attempts to relocate the turtle by checking several thousand meters upstream and downstream of the last known location, but to no avail.

The transmitters purchased from Sonotronics Inc., Tuscon, Arizona, were an ST-71 standard uncoded tag and a CHP-87 high power coded tag. The ST-71 has an advertised life expectancy of one year and the CHP-87 has a predicted two-year life expectancy. The transmitters were attached with nichrome wire and nylon tie straps on top of the left posterior carapace in marginal scutes. Two holes that had been drilled by Capron (1986) were used for anchor points. The standard tag lost power on 25 April 1992 and on 27 May 1991, I noted the output of the high power tag had slowed considerably. I contacted Sonotronics and they informed me that the high power tag CHP-87 has a much shorter life expectancy than originally thought, even as little as 12 months. I was also told that after a noticeable reduction of power, it can be a matter of days until transmitter failure. I am confident that the reason for lost contact is due to unexpected power loss of the high power transmitter.

NATURAL HISTORY

Reviews of the natural history of M. temminckii (George, 1988; Pritchard, 1989) are not sufficient to provide information required for the conservation of this species (U.S. Fish and Wildlife Service, 1991). I have compiled ecological information about this species in Kansas not included in these reviews. Herein, I review natural history of the alligator snapping turtle, with emphasis on information pertaining to this species in Kansas.

DESCRIPTION—The alligator snapping turtle is, by far, the largest freshwater turtle in North America and is among the largest freshwater turtles in the world. Several male specimens have weighed over 100 kg (Pritchard, 1979a; Ernst and Barbour, 1989). M. temminckii can be distinguished anatomically from the only other living member of the family Chelydridae, C. serpentina, by three to five supramarginal laminae on each side of the carapace between the first three laterals and the marginal series of scutes, three prominent longitudinal ridges on its carapace, and a pronounced hooked beak. The alligator snapping turtle has hard plates on top of its head, while the common snapping turtle's head is covered soft flesh. Also, the lower side of the tail of the covered soft flesh. Also, the lower side of the tail of the alligator snapping turtle has numerous small scales, whereas the common snapping turtle has two rows of hard plates on the lower side of its tail (Clarke, 1956). The eyes of M. temminckii are located more laterally and are surrounded by star-shaped fleshy filamentous skin (Pritchard, 1979b).

The alligator snapping turtle is among the most distinctive turtles in the world, given its ability to "fish" with a vermiform buccal process (Allen and Neill, 1950). The turtle appears to have control over this worm-like structure and wriggles it to lure fish within easy reach of its mouth to acquire a meal (Mahmoud and Klicka, 1979).

DISTRIBUTION—The alligator snapping turtle occurs only in the U. S., and historically has been most abundant throughout the southeastern coastal area, Mississippi Valley drainages, and Gulf-draining rivers, becoming increasingly rare north to Illinois and west to Kansas (Pritchard, 1989). The distribution of alligator snapping turtle records in Kansas is restricted to southeastern river drainages. Nineteen captures and sightings of alligator snapping turtles at 12 locations in Kansas have been reported, most of them from the early part of this century (Chapter 2). Five of these records are documented by voucher specimens or photographs: KU 46902; KU 197329; KU 20415; KU 7406 (photo); and KU 204880 (photo).

SIZE, GROWTH, AND REPRODUCTION—The largest verified weight for an alligator snapping turtle was a 251 lbs for a captive male specimen at the Chicago Brookfield Zoo, although unofficial weights exceeding 300 lbs have been reported (Pritchard, 1989). Alligator snapping turtles are extremely sexually dimorphic in size, as the largest female recorded is 62 lbs. Verified weights from seven previous Kansas captures documented in literature are 15.4, 26.8, 26.9, 29.5, 39.9, 47.6, and 60.1 kg; mean = 35.2 kg. Hall and Smith (1947) reported to have seen a 182 kg specimen taken from the Neosho River near Chetopa, Kansas in Cherokee County, but after correspondence with Hobart Smith, Pritchard (1989) discounted the reported weight.

Dobie (1971) noted that growth is rapid but variable for both males and females the first 11-13 years, by which time they are sexually mature. At this age, carapace length is approximately 35.5 cm and the turtles weigh between 6.8 and 9.1 kg (Pritchard, 1979b). After this age, males continue to grow to much larger sizes, while the growth rate of females slows. I found no change in carapace dimensions of the Onion Creek alligator snapping turtle after its release by Capron in 1986. The turtle had lost 2.2 kg since 1986, but otherwise appeared to be in good health.

Alligator snapping turtle copulation occurs between February and April in Florida, but probably occurs later in the Mississippi Valley (Ernst and Barbour, 1989). Nesting takes place from April through June, with nesting in the northern latitudes of the species range occurring later than in the South (Dobie, 1971; George, 1988). Dobie (1971) found female alligator snapping turtles in Louisiana lay only one clutch per year, with some females laying eggs only once every two years. Despite seasonality of nesting, live spermatozoa have been found in alligator snapping turtle testes throughout the year (Dobie, 1971). Pritchard (1989) suggested fertilization could take place at any time and that females may be able to store viable sperm until nesting season.

In Kansas, Capron (1975) observed a mating pair of alligator snapping turtles in early May in the Arkansas River. A captive pair in Florida mated on 28 February, and the female deposited 44 eggs on 20 April (Allen and Neill, 1950). Copulation in captivity in Florida was observed to last five to 25 minutes (Allen and Neill, 1950). Observations of oviposition by Allen and Neill (1950) in Florida included that by a captive female which laid 29 eggs on 3 June, with the first young appearing on 11 September. Other reports of oviposition by nesting captive alligator snapping turtles in Florida include 15 June, with 16 eggs; 2 May, with 17 eggs; 11 June, with 22 eggs; and 19 eggs on 28

April (Allen and Neill, 1950). Dobie (1971) described M. temminckii eggs as tough, chalky-white, granular in appearance but smooth to the touch, spheroidal, and having diameters ranging from 34.0 to 51.8 mm. Nests in Florida are always on dry land, yet close to water, elevated, and well drained (Allen and Neill, 1950). Ewert (1976) noted M. temminckii may travel as far as 72 m from water to nest.

Other than Capron's (1975) observation of a supposed mating in the Arkansas River, there is no evidence of a breeding population in Kansas. No instances of oviposition or juveniles in Kansas have been reported. The smallest alligator snapping turtle documented in Kansas was 15.4 kg, which would indicate that it was well into sexual maturity (Pritchard, 1989). The Onion Creek alligator snapping turtle was submitted to radiography after both of its captures, and was twice determined not to be gravid (Capron, 1986; Shipman et al., 1991). However, a 17.7 kg female captured in Illinois was found to contain 32 eggs (Galbreath, 1961); this indicates that the possibility of reproduction in Kansas should not be precluded due to its northern latitude alone.

DIET—An adult captive 93 lb alligator snapping turtle was reported by Allen and Neill (1950) to eat fish, beef, pork, frogs, snakes, snails, worms, freshwater mussels, and various aquatic grasses. Allen and Neill (1950) also reported that fecal material of newly captured individuals contained snail and mussel fragments. Stomach contents reported by turtle trappers include fish, turtles, crayfish, tupelo fruit, acorns, and remnants of alligators, raccoons, ducks, and beaver (Pritchard, 1989). Additionally, alligator snapping turtles have in captivity been observed to stalk and eat live turtles of the genera *Deirochelys*, *Kinosternon*, *Graptemys*, *Chelydra*, and *Chrysemys* (Allen and Neill, 1950; Ernst and Barbour, 1989; Pritchard, 1989).

In Kansas, the only information pertaining to foods is the remnants of muskrat and crayfish found in excrement of the Onion Creek specimen (Chapter 1). My observations of the Onion Creek turtle add the possibility of two additional prey items, beaver and common snapping turtles (Chapters 1 and 3).

BEHAVIORAL ECOLOGY—Habitat use and movement of the Onion Creek alligator snapping turtle was typified by its utilization of specific core sites, upstream migration, and short-term nocturnal movements (Chapter 1). The turtle was relatively sedentary. Mean time between observed relocations, discounting an assumed period of dormancy from

11 November 1991 to 6 March 1992, was 36 days; median = 26 days, max. = 54 days, min. = 1 day.

The observed activity by the Onion Creek alligator snapping turtle agrees with Carr's (1952) proposal that this species may use its "lure" reservedly during the day and scavenge and stalk its prey during the night. Capron (1986) noted that the Onion Creek turtle became more active during the early morning hours between 0200 and 0500 h, moving around in its tank while in captivity prior to its release. The same observation was made for this turtle while in captivity prior to its release for my study.

The turtle was presumably dormant between 11 November 1991 and at least 6 March 1992 near an undercut bank. No movement from the core site was observed during this time. This area was the deepest of the 10 core sites that this turtle used during the study. In the southern part of this species' range, winter dormancy may begin in mid-October and last until mid-March (Pritchard, 1989). Group hibernacula of up to fifteen alligator snapping turtles beneath undercut banks have been reported in Georgia (Pritchard, 1989).

The observed movement of the Onion Creek alligator snapping turtle lends support to the upstream migration hypothesis (Pritchard, 1989) that "certain alligator snappers may wander upstream for decades, ultimately arriving in the uppermost reaches of the Mississippi system by which time they are very large, old and rare". The recapture of the Onion Creek specimen itself supports the upstream migration hypothesis by documenting 7 km movement upstream over five years in the upper reaches of the Mississippi system. In my study, the turtle moved an additional 6.5 km upstream in 11.5 months, with not a single case of downstream migration, making the total upstream movement by this turtle 13.5 km within a six-year period. The only previously published record of migration in the alligator snapping turtle is from Wickham (1922), who documented a specimen taken from the Washita River, Oklahoma in 1915. The turtle was held in captivity for 34 months, then tagged and released into the Blue River, Oklahoma in 1918, and recaptured 27-29 km upstream in 1921.

CONSERVATION—There have been three attempts to capture _M. temminckii_ in Kansas in the last nine years, and in all three, the species has eluded investigators. Irwin (1985) sampled for alligator snapping turtles with an effort of at least 152 trap nights at three locations in southeast Kansas. (One trap night equals one turtle trap set overnight for one night.) Capron (1987) sampled in southeast Kansas with at least 108 trap nights at five locations. My study (Chapter 2) was the third recent attempt to find this species in Kansas, and my effort of 600 trap nights at 84 locations makes the total effort of the three studies 860 trap nights. In addition to turtle traps, setlines were used in all three studies.

The latest status review of the alligator snapping turtle by the U.S. Fish and Wildlife Service (1991) recommended that individual states be responsible for conservation of this species. The Kansas Department of Wildlife and Parks' Nongame Task Force recommended against a 1991 petition to list the alligator snapping turtle as an endangered species. The species met all criteria to be listed as endangered except no evidence of a breeding population was available (Ken Brunson, KDWP Nongame Biologist, pers. comm.).

I contend that regardless of the reproductive status of this species, *M. temminckii* should be listed as endangered in Kansas. I base this argument on the following grounds: rarity of this animal in the state; the possibility that turtles migrating into Kansas, rather than reproduction, is the source of recruitment for a Kansas population; consideration by the USFWS to give this animal federal protection; and listing this animal as endangered would give priority to informing Kansans of its status, thus decreasing chances that this rare turtle would be mistakenly killed.

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APPENDICES

APPENDIX 1. Date and number of biotelemetry checks.

DATE	NUMBER OF CHECKS
19 JUN 1991	39
20 JUN	35
21 JUN	19
22 JUN	11
23 JUN	8
24 JUN	8
25 JUN	24
26 JUN	15
27 JUN	14
28 JUN	16
29 JUN	12
30 JUN	12
1 JUL	15
2 JUL	16
3 JUL	10
4 JUL	1
5 JUL	1
6 JUL	1
18 JUL	1
20 JUL	1
21 JUL	2
22 JUL	4
6 AUG	1
8 AUG	1
20 AUG	1
31 AUG	1
10 SEP	1
15 SEP	1
25 SEP	1
4 OCT	1
13 OCT	2
11 NOV	1
16 DEC	1
12 JAN 1992	1
11 FEB	1
6 MAR	1
24 MAR	1
10 APR	1
25 APR	1
17 MAY	1
27 MAY	1
TOTAL	285

APPENDIX 2. Habitat data for core sites, transect sites, and other available sites with cover. Each line has, from left to right, sample number, followed by depth, mesohabitat classification, % shade, cover type, % clay, % mud, % sand, % gravel, % rock, width of stream (cm), estimated amount of detritus covering the site, beaver activity, cover length (cm), cover width (cm), stream angle, % coverage of cover, damming effect of cover, and compactness of cover. See Materials and Methods for explanation of how variables were measured.

CORE SITES

0002	115	2	050	3	000	095	005	000	000	1650	1	0	1300	300	0	010	1	1
0005	050	3	000	3	000	100	000	000	000	1609	0	3	0400	025	1	005	2	1
0010	012	3	000	1	000	100	000	000	000	1802	1	3	0500	100	1	010	3	1
0011	030	3	100	2	020	020	030	030	000	1110	3	1	0500	500	1	050	3	1
0012	035	3	100	4	000	100	000	000	000	0490	1	0	0300	300	0	030	3	1
0013	050	2	100	3	000	100	000	000	000	0500	1	0	0500	075	0	005	2	1
0014	150	3	050	0	000	005	095	000	000	0700	0	0	0000	000	3	000	0	0
0015	085	3	050	3	000	000	100	000	000	0600	2	3	0400	300	1	040	1	0
0016	070	3	000	3	000	100	000	000	000	0500	2	0	0300	300	2	030	1	2
0017	150	3	030	4	000	065	035	000	000	0650	3	1	0650	600	1	100	2	2

TRANSECT SITES

0101	010	1	050	0	000	000	050	050	000	0150	0	0	0000	000	0	000	0	0
0102	005	1	050	0	000	000	050	050	000	0150	0	0	0000	000	0	000	0	0
0201	015	2	075	0	000	000	020	080	000	0575	0	0	0000	000	0	000	0	0
0202	020	2	075	0	000	000	020	080	000	0575	0	0	0000	000	0	000	0	0
0203	025	2	075	0	000	000	020	080	000	0575	0	0	0000	000	0	000	0	0
0204	025	2	075	0	000	000	020	080	000	0575	0	0	0000	000	0	000	0	0
0301	010	1	050	0	100	000	000	000	000	0250	0	0	0000	000	0	000	0	0
0302	005	1	050	0	100	000	000	000	000	0250	0	0	0000	000	0	000	0	0
0401	010	2	000	0	000	050	050	000	000	0325	0	0	0000	000	0	000	0	0
0402	025	2	000	0	000	050	050	000	000	0325	0	0	0000	000	0	000	0	0
0403	025	2	000	0	000	050	050	000	000	0325	0	0	0000	000	0	000	0	0
0501	010	3	010	0	000	000	000	100	000	0600	0	1	0000	000	2	000	1	0
0502	050	3	010	0	000	000	000	100	000	0600	0	1	0000	000	2	000	1	0
0503	110	3	010	0	000	000	000	100	000	0600	0	1	0000	000	2	000	1	0
0504	150	3	010	1	000	000	000	100	000	0600	3	1	0300	020	2	050	1	0
0600	010	2	025	0	000	000	050	050	000	0400	0	0	0000	000	0	000	0	0

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0603 020 2 025 0 000 000 050 050 000 0400 0 0 0000 000 0 000 0 0
0701 030 2 000 0 000 075 025 000 000 0500 0 0 0000 000 2 000 0 0
0702 030 2 000 0 000 075 025 000 000 0500 0 0 0000 000 2 000 0 0
0703 050 2 000 0 000 075 025 000 000 0500 0 0 0000 000 2 000 0 0
0704 025 2 000 0 000 075 025 000 000 0500 0 0 0000 000 2 000 0 0
0801 025 2 090 0 000 100 000 000 000 0650 0 2 0000 000 1 000 0 0
0802 050 2 090 0 000 100 000 000 000 0650 0 2 0000 000 1 000 0 0
0803 060 2 090 0 000 100 000 000 000 0650 0 2 0000 000 1 000 0 0
0804 075 2 090 0 000 100 000 000 000 0650 0 2 0000 000 1 000 0 0
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0905 020 3 000 0 000 000 000 000 100 0800 0 0 0000 000 0 000 0 0
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0907 020 3 000 0 000 000 000 000 100 0800 0 0 0000 000 0 000 0 0
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1004 060 2 040 0 000 050 050 000 000 0500 0 0 0000 000 1 000 1 0
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1605 035 2 000 0 100 000 000 000 000 0850 0 1 0000 000 0 000 1 0
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2107	075	3	000	0	000	000	100	000	000	1000	0	0	0000	000	0	000	0	0
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2302	060	2	040	0	000	000	100	000	000	0800	0	0	0000	000	0	000	0	0
2303	100	2	040	0	000	000	100	000	000	0800	0	0	0000	000	0	000	0	0
2304	100	2	040	0	000	000	100	000	000	0800	0	0	0000	000	0	000	0	0
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3307	065	2	000	0	000	050	050	000	000	1100	0	2	0000	000	0	000	0	0
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3402	060	2	010	0	000	060	040	000	000	1200	0	1	0000	000	0	000	0	0
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3404	075	2	010	0	000	060	040	000	000	1200	0	1	0000	000	0	000	0	0
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3601	030	2	005	0	000	050	050	000	000	0800	0	0	0000	000	2	000	0	0
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6103	025	2	080	0	000	000	100	000	000	0550	0	0	0000	000	1	000	0	0
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6201	055	3	010	0	100	000	000	000	000	0600	0	2	0000	000	1	000	0	0
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AVAILABLE SITES WITH COVER

1000	050	3	025	4	100	000	000	000	000	0600	3	0	0600	500	0	100	2	3
1100	020	2	000	2	050	000	000	050	000	0200	2	0	0200	050	0	100	2	1
1200	025	2	050	3	000	050	050	000	000	0400	2	0	0500	050	0	010	1	2
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1800	070	2	000	4	000	050	050	000	000	1000	2	0	1000	400	0	015	1	0
1900	075	2	005	3	000	050	050	000	000	1100	2	0	1100	100	0	005	1	1
2000	050	2	040	2	000	000	100	000	000	0700	0	0	0400	100	1	010	0	3
2100	075	3	000	3	000	000	050	050	000	0500	0	1	2500	300	0	050	2	1
2200	025	2	100	2	000	000	070	030	000	0400	0	0	0600	050	2	080	2	3
2300	050	2	080	2	080	000	020	000	000	0600	0	0	0500	050	0	010	2	0
2400	050	3	010	3	080	000	020	000	000	0600	0	0	1500	200	2	040	2	1
2500	020	1	090	2	000	000	000	090	010	0300	2	0	0900	100	1	050	2	0
2600	075	3	050	1	000	000	100	000	000	0400	0	0	0300	100	1	020	0	0
2700	025	1	100	3	000	000	000	100	000	0200	1	0	0600	075	1	050	1	1
2800	060	3	100	3	000	000	100	000	000	0500	0	0	0700	050	3	100	1	1
2900	050	3	100	3	100	000	000	000	000	0300	1	0	0400	200	3	050	1	1
3000	075	3	090	3	100	000	000	000	000	0300	0	0	0100	100	2	030	1	1
3100	090	3	050	4	000	000	095	005	000	0800	0	0	0600	250	2	050	1	2
3200	075	2	010	4	000	000	050	050	000	0600	1	0	1000	100	1	100	1	1

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3400	060	2	030	3	000	000	000	100	000	0600	0	0	0300	075	1	010	1	2
3500	075	3	040	3	000	000	000	000	000	0600	3	1	0800	100	0	050	1	1
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APPENDIX 3. Historical sites sampled, ESU sample number, (DE-T-X), date (1991), location, trap nights, and hook nights.

SAMPLE NUMBER	DATE	COUNTY AND LOCATION	TRAP NIGHTS	HOOK NIGHTS
95[1]	27APR	Lyon T19S,R11E,Sec22 Cottonwood R. at Emporia	10	
96	9MAY	Marion T21S,R4E,Sec1 Cottonwood R. at Florence	10	
97[1]	11MAY	Lyon T19S,R11E,Sec22 Cottonwood R. above Soden's Grove Dam in Emporia	8	2
98	20MAY	Labette T33S,R21E,Sec19,30 Labette Creek, 2 miles S and 2 miles W of Oswego	39	8
99*	22MAY	Montgomery T34S,R15E,Sec9,10 Onion Creek 0.75 miles S of Jefferson	50	
101*	19JUN	Montgomery T33S,R15E,Sec32 Onion Creek, 3.75 miles NW Sample site 99	96	
108	9JUL	Sumner T32S,R2E,Sec1 Arkansas R., 1.5 miles N and 0.5 miles E of Oxford	5	
133	23JUL	Labette T31S,R12E,Sec21, 22, & 28 Neosho Park, Neosho R., 8 miles E of Parsons	10	31
134	24JUL	Cherokee T35S,R21E,Sec1,12 Neosho R., below dam at Chetopa	10	50
135	25JUL	Cherokee T34S,R24E,Sec36 & T35S,R24E,Sec1 Spring R., 1 mile E of Baxter Springs Dam	11	12
142[2]	30JUL	Cowley T31S,R5E,Sec17,18 Timber Creek, 0.3 miles S of Floral	4	

APPENDIX 3 continued.

143[2]	30JUL	Cowley T32S,R4E,Sec2 Timber Creek, 1.5 miles N of Winfield	4	
168[3]	14AUG	Sedgwick T27S,R1W,Sec1 Arkansas R., in N Wichita, under I-235	2	
169[3]	14AUG	Sedgwick T27S,R1E,Sec20 Arkansas R., Indian Cultural Center, below confluence with Little Arkansas R.	3	
171[3]	14AUG	Sedgwick T27W,R1E,Sec18 Arkansas R., at Old Cowtown at water treatment plant	4	
172[3]	14AUG	Sedgwick T28S,R1E,Sec5 Arkansas R., at Herman Hill Park	3	
173[3]	15AUG	Sedgwick T28S,R1E,Sec15 Arkansas R., 2 miles E of I-35, N side of bridge on 47th Street in Wichita	4	
176	19AUG	Labette T33S,R21E,Sec9 Neosho R., above dam at NE corner of Oswego	6	6
177	19AUG	Neosho T28S,R19E,Sec35 Neosho R., 2.25 miles W of Erie	6	6

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* = sites of capture and recapture respectively of Onion Creek turtle were counted as one historical site.

1, 2, 3 = samples grouped together because only approximate locations were known for these historical sites.

APPENDIX 4. Non-historical sites sampled, date (1991), location, and trap nights.

SAMPLE NUMBER	DATE	COUNTY AND LOCATION	TRAP NIGHTS
102	29JUN	Harvey T23S,R2W,Sec21 Little Arkansas R., 2 miles N, 2 miles W of Halstead on Hwy. 50	4
103	29JUN	Reno T25S,R8W,Sec2 N. Fork of Ninnescah R., at E edge of Arlington on Hwy. 61	4
104	29JUN	Reno T23S,R5W,Sec Arkansas R. at SE edge of Hutchinson, at Hwy. 50/61 bridge	4
105	6JUL	Rice T21S,R8W,Sec2 Arkansas R., 3 miles S, 2.5 miles E of Sterling	5
106	6JUL	Reno T23S,R6W,Sec8,9 Arkansas R., 1.5 miles N of Hutchinson	5
107	6JUL	Reno T22S,R5W,Sec11 1st bridge over Little Arkansas R., N of Medora on Hwy. 61	5
109	9JUL	Cowley T32S,R4E,Sec29 Walnut R., 0.5 W of Winfield on Hwy 160 at bridge.	7
110	9JUL	Butler T29S,R4R,Sec7 Little Walnut R., at bridge on Hwy. 77, 1.75 miles N of Douglass	4
111	9JUL	Butler T27S,R4E,Sec26 Walnut R., 1 mile S of Augusta	4

APPENDIX 4 continued.

112	11JUL	Butler T24S,R6E,Sec35 Durechen Creek, 5.5 miles E and 7 miles N of El Dorado	6
113	11JUL	Barton T25S,R6E,Sec14 Satchel Creek, at Hwy. 177, 4.25 miles S and 5.5 miles E of El Dorado	6
114	11JUL	Butler T23S,R7E,Sec13 E. Walnut R., 0.25 miles S and 1 mile E of Cassoday	2
115	16JUL	Ford T27S,R22W,Sec32 Arkansas R., 1 mile N of Ford on Hwy. 34	15
116	16JUL	Comanche T34S,R17W,Sec16 Salt Fork Arkansas. R., 9 miles E of Buttermilk	15
117	16JUL	Kiowa T30S,R16W,Sec10 Medicine Lodge R., 1 mile E of Belvidere	15
118	26JUL	Edwards T24S,R19W,Sec35 Arkansas R., 1.5 miles E of Kinsley	4
119	26JUL	Pratt T28S,R13W,Sec1 S. Fork of Ninnescah R. 1 mile E of Pratt on Hwy. 64	3
120	29JUL	Kingman T27S,R10W,Sec33,34 S Fork of Ninnescah R. 1 mile W and 1 mile N of Cunningham	3
121	15JUL	Cowley T35S,R4E,Sec3 Arkansas R., 5 miles E of Arkansas City	4
122	15JUL	Cowley T35S,R4E,Sec6 Arkansas R., 0.5 mile S of Arkansas City on Hwy. 77	4

APPENDIX 4 continued.

123	16JUL	Cowley T34S,R4E,Sec31 Walnut R., 1 mile E of Arkansas City on Hwy. 166	6
124	16JUL	Cowley T31S,R4E,Sec6 Walnut R., 4.5 miles E of Udall	6
125	16JUL	Sumner T30S,R1E,Sec23 Ninnescah R., 3 miles W and 2 miles N of Belle Plaine	4
126	17JUL	Sedgwick T25S,R1E,Sec33 Little Arkansas R., in NW Wichita	3
127	17JUL	Sedgwick T29S,R1E,Sec15 Arkansas R., 5 miles S of Hwy. 50, Wichita	4
128	17JUL	Sedgwick T29S,R1E,Sec12 Arkansas R., 1 mile W of Derby	3
129	18JUL	Butler T27S,R6E,Sec31 N. Branch of Walnut R., 1.5 miles S and 1.5 miles W of Leon	3
130	18JUL	Butler T26S,R5E,Sec12 Walnut R., on Hwy. 77/54 at El Dorado	6
131	18JUL	Butler T26S,R5E,Sec27 Walnut R., 4.5 miles S and 2 miles W of El Dorado	4
132	18JUL	Butler T26S,R4E,Sec32 Whitewater R., 4 miles S and 1 mile W of Towanda	4
136	29JUL	Kingman T28S,R8W,Sec6 S. Fork of Ninnescah R., 0.5 mile S and 7 miles E of Kingman	3

APPENDIX 4 continued.

137	29JUL	Kingman T28S,R7W,Sec6 S. Fork of Ninnescah R., 0.5 mile S and 0.5 mile W of Kingman	3
138	30JUL	Kingman T28S,R7W,Sec11 S. Fork of Ninnescah R., 1 mile S and 3.5 miles W of Kingman	3
139	30JUL	Kingman T30S,R7W,Sec9 Chikaskia R., 0.5 mile S of Rago at bridge on Hwy.14	3
140	30JUL	Kingman T30S,R9W,Sec1 Chikaskia R., 1.5 miles N and 1.5 miles E of Zenda	3
141	31JUL	Harper T33S,R6W,Sec23 Silver Creek, 5 miles E of Anthony	2
144	30JUL	Cowley T32S,R7E,Sec31 Grouse Creek, 3.5 miles N of Dexter on dirt road 0.2 miles E of Hwy.15	3
145	31JUL	Cowley T31S,R7E,Sec3 Grouse Creek, 5 miles NW of Cambridge	3
146	30JUL	Cowley T35S,R5E,Sec8 Grouse Creek, 1.6 miles S of Silverdale	3
147	31JUL	Sumner T32S,R1W,Sec16 Slate Creek, NW corner of Wellington at the municipal park	4
148	31JUL	Sumner T32S,R1W,Sec26 Slate Creek, 2 miles S of Wellington on road 1 mile E and parallel to Hwy. 81	4
149	31JUL	Sumner T33S,R2E,Sec23,24 Slate Creek, 7 miles S of Oxford on FAS 160	3

APPENDIX 4 continued.

150	31JUL	Sumner T34S,R2W,Sec36 Chickaskia R., 5 miles W of South Haven, N of bridge on Hwy. 81	4
151	1AUG	Sedgwick T28S,R4W,Sec20 S. Fork of Ninnescah R., 1.2 miles S of Cheney	4
152	1AUG	Sedgwick T28S,R3W,Sec16 Clear Creek, 6.5 miles E of Cheney on FAS 362	3
153	1AUG	Sedgwick T29S,R3W,Sec15 Ninnescah R., 3.5 miles N of Viola on Viola Road	4
154	5AUG	Harvey T24S,R1W,Sec33 Little Arkansas R., 0.5 mile W of Sedgwick	7
155	5AUG	Sedgwick T25S,R1W,Sec36 Little Arkansas R., 0.5 mile W of Valley Center	10
156	7AUG	Barton T20S,R11W,Sec6 Arkansas R., 0.5 mile S of Elinwood	3
157	7AUG	Barton T19S,R13W,Sec33 Arkansas R., 0.5 S of Great Bend on bridge of Hwy. 281	5
158	8AUG	Pawnee T21S,R15W,Sec10 Arkansas R., 2 miles S and 1.75 miles E of Pawnee	4
159	8AUG	Pawnee T23S,R17W,Sec7 Arkansas R., 0.5 miles S and 0.5 miles E on road out of Garfield	Stolen
160	8AUG	Pawnee T22S,R17W,Sec2 Pawnee R., low water bridge W side of Larned State Hospital	3

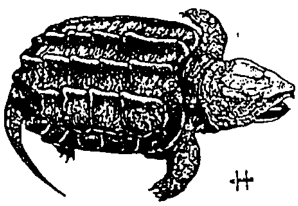
APPENDIX 4 continued.

161	8AUG	Pawnee T22S,R16W,Sec5 Pawnee R., S edge of Larned on Hwy. 19	6
162	10AUG	Rice T19S,R9W,Sec34 and T20S,R9W,Sec2 Cow Creek, 4 miles W of Lyons at bridge	4
163	10AUG	Rice T19S,R6W,Sec22 Little Arkansas R., 2 miles N and 11.5 miles E of Lyons	3
164	13AUG	Sedgwick T25S,R2W,Sec29 Arkansas R., 2 miles S of Bentley at bridge	3
165	13AUG	Sedgwick T25S,R3W,Sec8,9 Arkansas R., 2 miles N of Mount Hope, at bridge on Hwy. 230	3
166	13AUG	Reno T24S,R4W,Sec20 Arkansas R., 2.5 miles N of Haven	3
167	13AUG	Reno T24S,R5W,Sec4,10 Arkansas R., 3 miles N of Yoder	3
170	14AUG	Sedgwick T27S,R1E,Sec17 Little Arkansas R., 0.5 mile above confluence with Arkansas R.	3
174	15AUG	Sumner T30S,R2E,Sec34 Arkansas R., 4.5 miles E of Belle Plaine on Hwy. 55	4
175	15AUG	Cowley T33S,R3E,Sec8 Arkansas R., 5.5 miles W and 4 miles S of Winfield	5
178	22AUG	Cowley T34S,R3E,Sec8 Arkansas R., 1 mile E of Geuda Springs	4
179	22AUG	Cowley T34S,R4E,Sec2,3 Walnut R., N of bridge, 4 miles N and 4 mile E of Arkansas City	5

APPENDIX 4 continued.

180	22AUG	Cowley T34S,R3E,Sec29 Arkansas R., 1 mile W and 0.5 mile N of Arkansas City at bridge	4
181	23AUG	Cowley T32S,R3E,Sec1 Walnut R., 2 miles W and 3.25 miles N of Winfield	6
182	23AUG	Butler T29S,R4E,Sec19 Walnut R., 1 mile W of Douglass at bridge	3
183	23AUG	Butler T28S,R4E,Sec28 Walnut R., 0.5 mile W of Gordon, S of bridge	4
184	7SEP	Stafford T23S,R13W,Sec10 Rattlesnake Creek, 3 miles N of St. John	3
185	7SEP	Barber T31S,R13W,Sec27,34 Medicine Lodge R., 4 miles E and 3 miles S of Lake City	4
186	14SEP	McPherson T21S,R5W,Sec22 Little Arkansas R., 2 miles S and 4.75 miles W of Inman	3

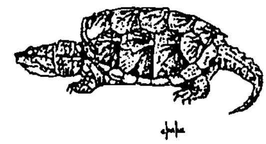
APPENDIX 5. Flyer used to elicit reports of alligator snapping turtles in Kansas.



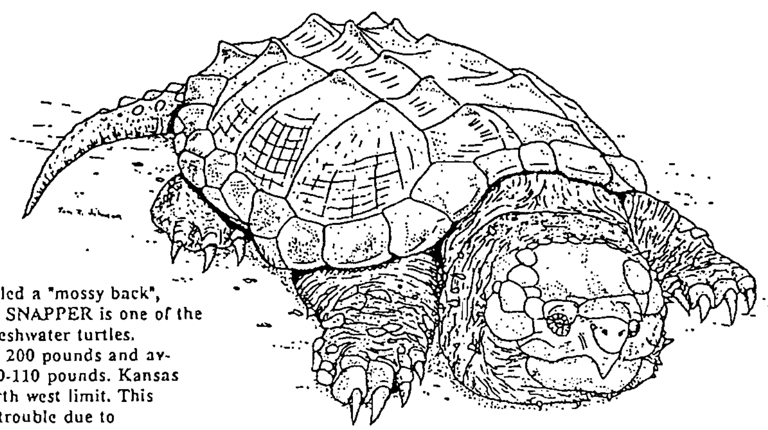
ALLIGATOR SNAPPER

WANTED!

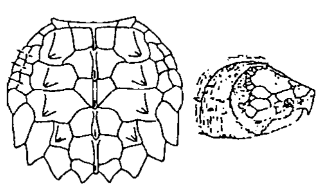
Reports on sightings of the ALLIGATOR SNAPPING TURTLE



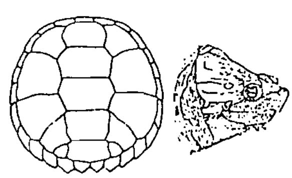
COMMON SNAPPER



Sometimes called a "mossy back", the ALLIGATOR SNAPPER is one of the world's largest freshwater turtles. It can weigh over 200 pounds and averages between 60-110 pounds. Kansas is the turtles' north west limit. This turtle may be in trouble due to loss of habitat and over-harvesting. The ALLIGATOR SNAPPER can be confused with the common snapper.



The ALLIGATOR SNAPPER has a wedge-shaped head with a hooked beak. The shell of the ALLIGATOR SNAPPER has three rows of ridges along its back. It also has extra scales on each side of its shell and the scales on the bottom of its tail are small and pebble-like.



The common snapper has a smaller head in relation to its body size. Its head is also more round in appearance with no large hooked beak. It shell is more domed with no extra scales on the sides. The scales on the bottom of its tail are in two rows of hard plates.

I am looking for proof that the ALLIGATOR SNAPPER still exists in Kansas. It has been caught on trot lines and traps in the past, but there are very few records. If you have seen or caught this turtle and are concerned about the preservation of wildlife in Kansas, I would be grateful if you would call or write to me and tell me about it. The more information, the better. I would especially like to see actual specimens or photographs of the ALLIGATOR SNAPPING TURTLE if you have caught it.

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Paul A Sh

Signature of Graduate Student

David R. Edds

Signature of Major Advisor

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Signature of Author

26 April 1993

Date

Alligator Snapping Turtle (Macroclemys temminckii) Habitat Selection, Movements, and Natural History in Southeast Kansas.

Title of Thesis

Doug Cooper

Signature of Graduate Office Staff Member

April 29, 1993

Date Received