CONSERVATION STATUS OF THE COMMON MAP TURTLE IN KANSAS

A Report to the

Kansas Department of Wildlife and Parks

by

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INTRODUCTION

The common map turtle, Graptemys geographica (Le Sueur), was formerly abundant in many parts of its range from eastern Kansas, north to eastern Minnesota, east to southern Quebec, and south to central Alabama. However, pollution and other habitat-damaging human effects have drastically impacted populations (Ernst and Barbour, 1972). This semi-aquatic turtle usually frequents large bodies of water, such as rivers, lakes and oxbows (Caldwell and Collins, 1981; Ernst and Barbour, 1989). Suitable habitat includes areas with abundant basking sites, slow to moderate current, and soft substrate with much aquatic vegetation (Ernst and Barbour, 1989). Gordon and MacCulloch (1980) studied the ecology of the common map turtle in a Quebec lake, and discussed the effects of human recreational activity on the population. In Missouri, the decline of this species has been attributed to water pollution, siltation, and unlawful shooting (Johnson, 1987).

The common map turtle is a historical component of the biota of eastern Kansas (Smith, 1956; Collins, 1982), with documented records dating to 1911 (Appendix 1). However, the species was not observed locally from 1952-1990, suggesting that this turtle had been eliminated from Kansas. This led to its categorization by the Kansas Department of Wildlife and Parks as "extirpated" from the state. But, in an extensive survey during the summer of 1990, my students and I collected ten common map turtles at six sites in four counties of southeast Kansas (Edds et al., 1990). Here I document specific areas of occurrence and habitat use by the common map turtle in the state, and discuss the conservation status of the species in Kansas.

Little information is available regarding the diversity and population status of semi-aquatic turtle communities in Kansas, and how environmental factors affect species' distributions. To address this paucity of data, we surveyed turtles in the southeastern portion of the state, and measured habitat variables at each site. I present here analysis of relative and absolute abundance of turtle species, and environmental correlates of turtle community structure in rivers and streams of Kansas' Marais des Cygnes, Neosho, and Verdigris river drainages.

Recent press accounts of deformed turtles in Kansas waters (e.g., Brown 1989; Mansur 1990) have heightened general concern for the well-being of the state's nongame aquatic wildlife. Public sentiment has been fueled by reports of "deformities in about five of every ten turtles...in certain rivers of southeast Kansas" (Hays 1989). Agricultural and industrial pollution have been implicated as factors leading to increased rates of deformities in these aquatic animals. Reports of deformities in turtles are especially frightening since this ancient group is relatively resilient and pollution-tolerant. Thus, another goal of this study was to investigate the incidence of turtle anatomical abnormalities in southeast Kansas.

MATERIALS AND METHODS

Sampling

We sampled turtle communities in southeast Kansas rivers, streams, and oxbows from April-November, 1990, with 87 collections at 81 sites in 21 counties (Figure 1). Sample sites were in the Marais des Cygnes (52), Neosho (22), and Verdigris (13) river drainages. These included the five sites of historical occurrence of the common map turtle in Kansas (Appendix 1). Collection localities and general descriptive narratives of the sample sites are provided in Appendix 2. Local drainage unit and dates of each collection are given in Appendix 3.

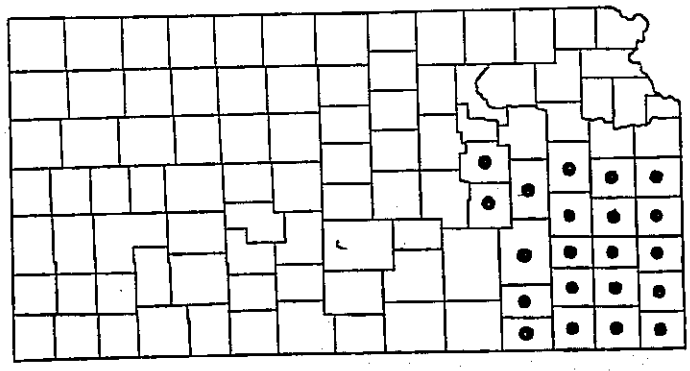

Figure 1. Counties sampled in this study.

We used commercially available three-hoop turtle traps, 6-feet in length, 2.5-feet in diameter, with 1-inch nylon mesh. We baited nets with various foods, including fresh mussel, fish, crayfish, grasshoppers, mulberries, frozen shrimp, frozen chicken liver, canned smoked clams, and canned creamed corn. Two to six nets were set at each site. Collection effort for each sample was quantified for standardization by noting the number of net nights sampled (Appendix 3), where one net night equals one turtle trap set overnight for one night. Effort consisted of 559 net nights in the Marais des Cygnes, 211 in the Neosho, and 122 in the Verdigris drainage, for a total sample of 892 net nights.

At each collection site, we measured 32 habitat variables, which I have grouped into four categories: structural, water, substrate, and vegetation. Structural variables include: availability of basking sites, coded from 0-4 for visual estimates of none, few, some, common, and plentiful, respectively; visual estimates of percentage of shore bare, covered by grass, shrubs, and trees; and estimated percentage of site covered by shade at noon. Water variables include: surface water temperature (°C); mean current speed (calculated from measurements made with a Teledyne Gurley pygmy current meter no. 625) (count/30=feet per second); water clarity (cm) (measured with current meter pole); mean water depth (cm) (calculated from meter stick measurements); estimated permanency of the water regime, coded 1 for intermittent and 2 for permanent; estimated mean width; estimated percentage of site comprised of riffle, pool, and run; and the following water quality factors measured with a Hach kit (model AL-36B) -- dissolved oxygen (mg/l); dissolved carbon dioxide (mg/l); pH; free acidity and total acidity (grains/gallon calcium carbonate -- gpg $CaCO_3$); free alkalinity and total alkalinity (gpg $CaCO_3$); total hardness (gpg $CaCO_3$); and nitrate nitrogen (mg/l) (measured by Hach DREL NitraVer method). Substrate was quantified with a modification of the Wentworth scale (Cummins, 1962); measured variables include: estimated percentage of substrate composed of clay, mud, sand, gravel, rock, and boulder/bedrock. Vegetation variables include: estimated percentage of site covered by submerged and emergent vegetation.

Data Analysis

Percentage species abundances in each collection were arcsin$\sqrt{x}$ transformed. $Log_{10}(x+1)$ transformation of habitat variables markedly improved normality (reduced skewness and kurtosis) for current speed, width, clay, sand, boulder/bedrock, riffle, shrubs, hardness, nitrate, submerged and emergent vegetation. These 11 transformed variables were used in t-test and ordination analyses, while the remaining 19 variables were input as untransformed values. Transformation of non-normal data allows a closer approximation to the normality assumption on which these statistical analyses are based, and also decreases the chance that analyses will be unduly affected by extreme but infrequent values (Sokal and Rohlf, 1981).

I analyzed environmental correlates of turtle community structure with detrended canonical correspondence analysis (DCCA) from the CANOCO software package of ter Braak (1988a). Such direct gradient analysis relates species occurrences directly to the environment (Gauch, 1982; ter Braak and Prentice, 1988). This technique produces community ordinations with an environmental basis by searching for the patterns of variation in assemblage structure that are most closely associated with variation in measured environmental variables (ter Braak, 1986; 1987). In resulting ordination diagrams, sites and species are represented by points, and environmental variables are represented by arrows. The trajectory and length of these arrows represent the direction and magnitude of correlations between environmental variables and assemblage composition along the gradient (ter Braak, 1988a; 1988b; ter Braak and Prentice, 1988). Thus, axes can be interpreted directly from the pattern of community variation along environmental gradients. Also visible in these diagrams are the approximate distributions of species with respect to plotted variables. By superimposing plots of samples, environmental variables, and species, one can interpret the response of individual species as well as species assemblages to environmental gradients.

Sixteen samples that produced no turtles were excluded from the analysis of turtle communities. Two habitat variables, free acidity and free alkalinity, were invariant, and were also omitted. Hence, my analysis of environmental correlates of turtle community structure is based on 30 habitat variables measured for each of 71 collections at 68 sites.

RESULTS

Turtle abundance

We captured 473 turtles belonging to nine species, listed here in order of abundance in collections: red-eared slider, Trachemys scripta elegans; Ouachita map turtle, Graptemys pseudogeographica ouachitensis; common snapping turtle, Chelydra serpentina; western painted turtle, Chrysemys picta bellii; western spiny softshell, Apalone spinifera hartwegi; Mississippi map turtle, Graptemys kohnii; common musk turtle, Stenotherus odoratus; common map turtle, Graptemys geographica; and Missouri river cooter, Pseudemys concinna metteri (Table 1). Numbers of each species captured in our sample are given in Appendix 4.

Table 1. Relative abundance of semi-aquatic turtle species in 87 samples from southeast Kansas during the summer of 1990.

	Number	Percent
Red-eared slider	163	34.4
Ouachita map turtle	120	25.4
Common snapping turtle	48	10.1
Western painted turtle	43	9.1
Western spiny softshell	34	7.2
Mississippi map turtle	30	6.3
Common musk turtle	18	3.8
Common map turtle	10	2.1
Missouri river cooter	7	1.5
TOTAL	473	

Turtles were most abundant in the Neosho river drainage, both in terms of absolute numbers collected and number captured per net night (Table 2).

Table 2. Abundance of semi-aquatic turtles in 87 samples from southeast Kansas during the summer of 1990.

Drainage	Number	Net Nights	Number/Net Night
Neosho	207	211	0.98
Verdigris	86	122	0.70
Marais des Cygnes	180	559	0.32
TOTAL	473	892	0.53

One hundred fifty-one specimens were marked by notching marginal scutes with a small triangular file, and then released, in an attempt to estimate population size through mark-recapture methods. However, despite repeated efforts at some sites, none was recaptured.

Community Structure

Ordination analysis by DCCA indicates that turtle community structure in southeast Kansas is best predicted by a suite of factors that can be attributed to size of the water course. DCCA axis 1 (DCCA 1) spans 4.9 standard deviation units along a gradient from small stream to large river sites (Figure 2). Nineteen of the first 22 sites with lowest ordination scores on DCCA 1 are small streams, such as Dragoon, Long, Salt, Duck, and Appanoose creeks, while 18 of the first 21 sites with highest scores are large rivers, such as the Verdigris, Neosho, Big Caney, Marais des Cygnes, Cottonwood, Fall and Elk (Figure 2).

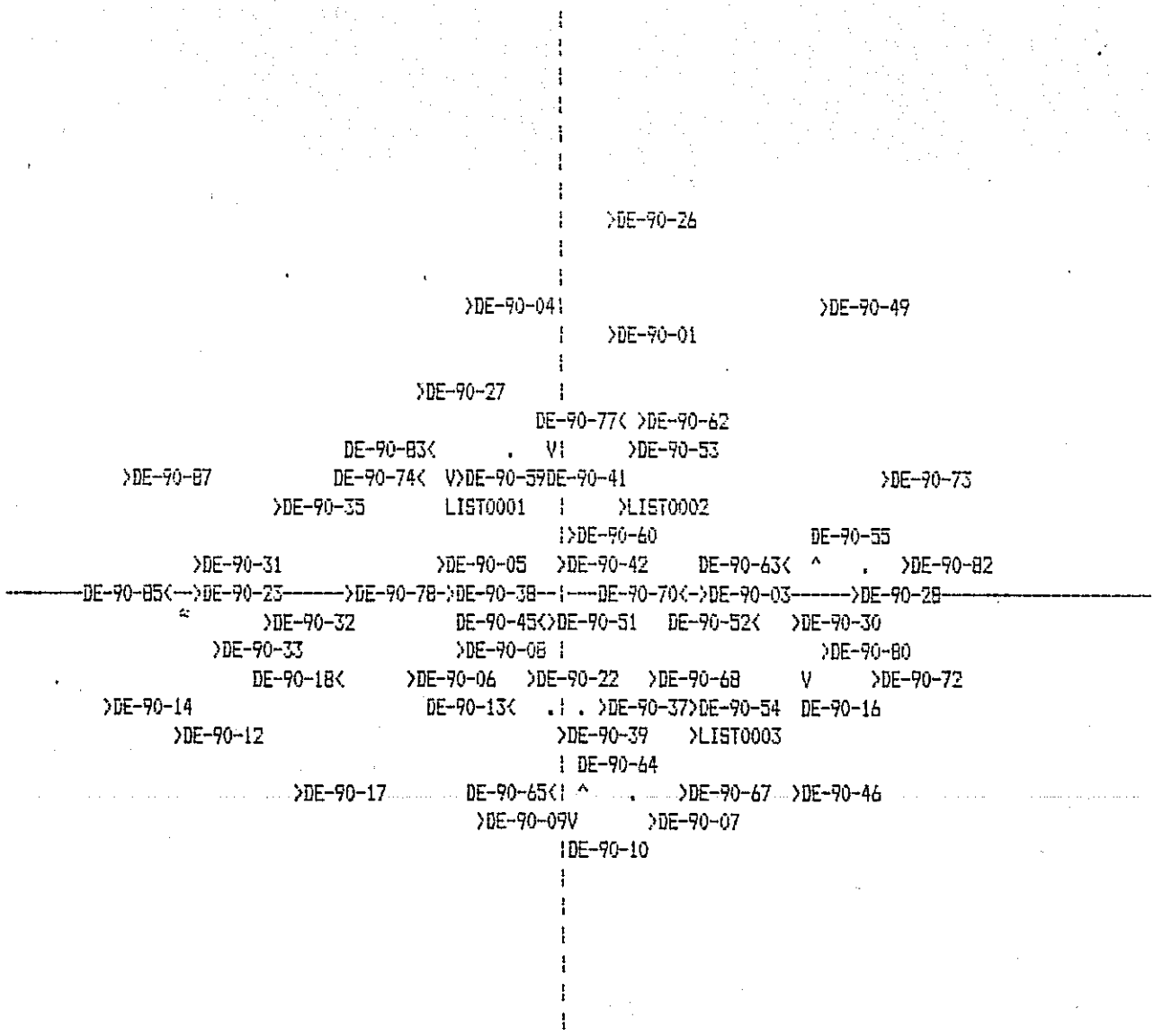

Figure 2. DCCA ordination of samples. Scale: 1 SD unit = 2.8 cm. Location of samples in the plane are denoted by:
> if the name is printed on the right,
< if the name is printed on the left,
V if the name is printed under,
^ if the name is printed above, and
- if the name cannot be printed.
Printing of names is impossible for the following items (positions in line (left=1, right=118) and line number (bottom of plot=1, top=38): DE-90-02 (67,10); DE-90-15 (59,13); DE-90-21 (55,22); DE-90-25 (62,13); DE-90-57 (90,18). The following items are close together, so they are indicated as lists in the plot: DE-90-11, DE-90-43 (list 0001); DE-90-50, DE-90-56 (list 0002); DE-90-61, DE-90-81 (list 0003).

DCCA 1 is statistically significant (Monte Carlo test, p=.02), and explains 26.7% of the variability in species scores. The DCCA 1 species-environment correlation of 0.864 indicates the extracted variation in turtle community composition is well explained by the measured environmental variables. DCCA 2 explains 16.3% of the variability in species scores, and appears to represent a mesohabitat component, from sites with considerable run habitat to sites dominated by pools (Figure 3).

Habitat variables represented by arrows in Figure 3 can be superimposed on Figure 2 to illustrate the effect of environmental factors on DCCA axes. The importance of water course size factors on DCCA 1 is demonstrated by noting that sites with low scores (smaller streams) were shadier, with substrates having a greater percentage of gravel, and had higher levels of total acidity and dissolved carbon dioxide, while sites from larger waters (high DCCA 1 scores) had more basking sites, were deeper, wider, and had higher mean current speeds. Figure 3 also demonstrates the mesohabitat component of DCCA 2, showing highest negative correlations with samples having a higher percentage of rocky run areas, while highest positive correlations were with sites dominated by sandy pool habitat.

The approximate distribution of turtle species with respect to these environmental gradients can be inferred from their position in Figure 4 if it is superimposed on Figures 2 and 3. Turtle species loading highest on DCCA 1, and thus "big river turtles" are the Ouachita map turtle and Missouri river cooter. Species with lowest scores on DCCA 1, and thus "small stream turtles" are the western painted turtle and the common map turtle. The highest loading on DCCA 2 was for the red-eared slider, a species more common in pools, while the lowest DCCA 2 score, and thus more common in areas with a greater percentage of runs, was for the Mississippi map turtle.

Appendix 5 provides, for each sample, $\arcsin\sqrt{x}$ transformed percentage values of relative abundance for the nine species of turtles captured in this study. Appendix 6 gives values of the 32 habitat variables measured for each collection.

of Beto Junction, Osage County. One of these (KU color slides 8872-8873) measured 226 mm carapace length, a new maximum size record for this species in Kansas (Collins, 1990). On 11 July (DE-90-11), we caught a single female common map turtle (KU color slide 8903) in the South Fork of Pottawatomie Creek, 4 miles south and 0.5 miles west of Garnett, Anderson County, another site of historical occurrence. The species had last been captured at this site in 1931 (KU 15881, KU 15882).

A new Kansas county record for the common map turtle was collected from the Marmaton River, 3 miles south and 3 miles east of Moran, Allen County, on 29 July (DE-90-17). The lone specimen was a 213 mm female, and was deposited as a voucher in the KU Natural History Museum (KU 217260). We captured one male and two female common map turtles in a single net at a second site in Long Creek, 2 miles south and 1.8 miles west of Melvern, Osage County, on 1 August (DE-90-25). On 9 August (DE-90-33), we collected one male common map turtle from Appanoose Creek, 5 miles north of Pomona on Highway 260, Franklin County (KU color slide 8904). We captured one female common map turtle at the historical site of occurrence in Long Creek, 0.5 miles south of Melvern, Osage County, on 6 October (DE-90-83).

Habitat

Seven of 71 samples in which we caught turtles contained G. geographica. Sites where we found common map turtles ranged from 5-20 meters in width. They typically had a shoreline dominated by trees; these areas were often shady, and basking sites were few. Mesohabitat was primarily pool and run, and current speed ranged from 0-0.5 feet/second. Substrate at these sites was usually dominated by rock, gravel, and mud. Vegetation was emergent, when present, with coverage ranging from 0-50%. Ranges for water chemistry measures were: dissolved oxygen 4-8 mg/l; CO_2 30-70 mg/l; pH 6.5-8.0; total acidity 51.3-68.4 gpg $CaCO_3$; total alkalinity 2.8-8.4 gpg $CaCO_3$; total hardness 7-17 gpg $CaCO_3$; and nitrate nitrogen 0.1-0.8 mg/l. Minima, maxima, means, and standard deviations of habitat variables at the seven sites where we collected G. geographica (group 1) are given in Table 3. Table 4 lists these summary statistics for the 64 collections in which no common map turtles were captured (group 2).

Table 4. Minimum, maximum, mean, and standard deviation of habitat variables at 64 sites without common map turtles.

	DEPTH	CURRENT	WIDTH	CLAY	MUD
N OF CASES	64	64	64	64	64
MINIMUM	18.000	0.000	5.000	0.000	0.000
MAXIMUM	222.000	54.000	250.000	100.000	100.000
MEAN	92.797	7.141	31.875	13.203	38.563
STANDARD DEV	38.322	11.636	42.165	26.997	34.036

	SAND	ROCK	BEDROCK	GRAVEL	SHADE
N OF CASES	64	64	64	64	64
MINIMUM	0.000	0.000	0.000	0.000	0.000
MAXIMUM	100.000	100.000	100.000	70.000	100.000
MEAN	2.609	27.359	7.906	10.359	33.391
STANDARD DEV	13.448	29.768	20.745	19.864	25.113

	BASKING	POOL	RIFFLE	RUN	BARE
N OF CASES	64	64	64	64	64
MINIMUM	0.000	0.000	0.000	0.000	0.000
MAXIMUM	4.000	100.000	30.000	100.000	50.000
MEAN	2.125	57.969	2.531	39.500	16.828
STANDARD DEV	1.215	31.682	6.539	31.200	14.695

	GRASS	SHRUBS	TREES	DO	PH
N OF CASES	64	64	64	64	64
MINIMUM	0.000	0.000	20.000	4.000	7.000
MAXIMUM	75.000	60.000	90.000	12.000	9.000
MEAN	23.344	12.563	47.266	7.797	7.902
STANDARD DEV	14.565	11.996	14.273	1.887	0.380

	TOTACID	TOTALK	HARDNESS	CO2	NITRATE
N OF CASES	64	64	64	64	64
MINIMUM	5.700	1.600	6.000	10.000	0.100
MAXIMUM	96.900	9.200	34.000	70.000	1.400
MEAN	44.620	5.413	14.047	37.609	0.518
STANDARD DEV	20.578	1.914	4.456	14.581	0.217

	TEMP	REGIME	CLARITY	SUBMERGE	EMERGE
N OF CASES	64	64	64	64	64
MINIMUM	9.000	1.000	5.000	0.000	0.000
MAXIMUM	33.000	2.000	61.000	50.000	50.000
MEAN	24.563	1.953	24.922	1.141	3.750
STANDARD DEV	4.608	0.213	13.510	6.439	9.179

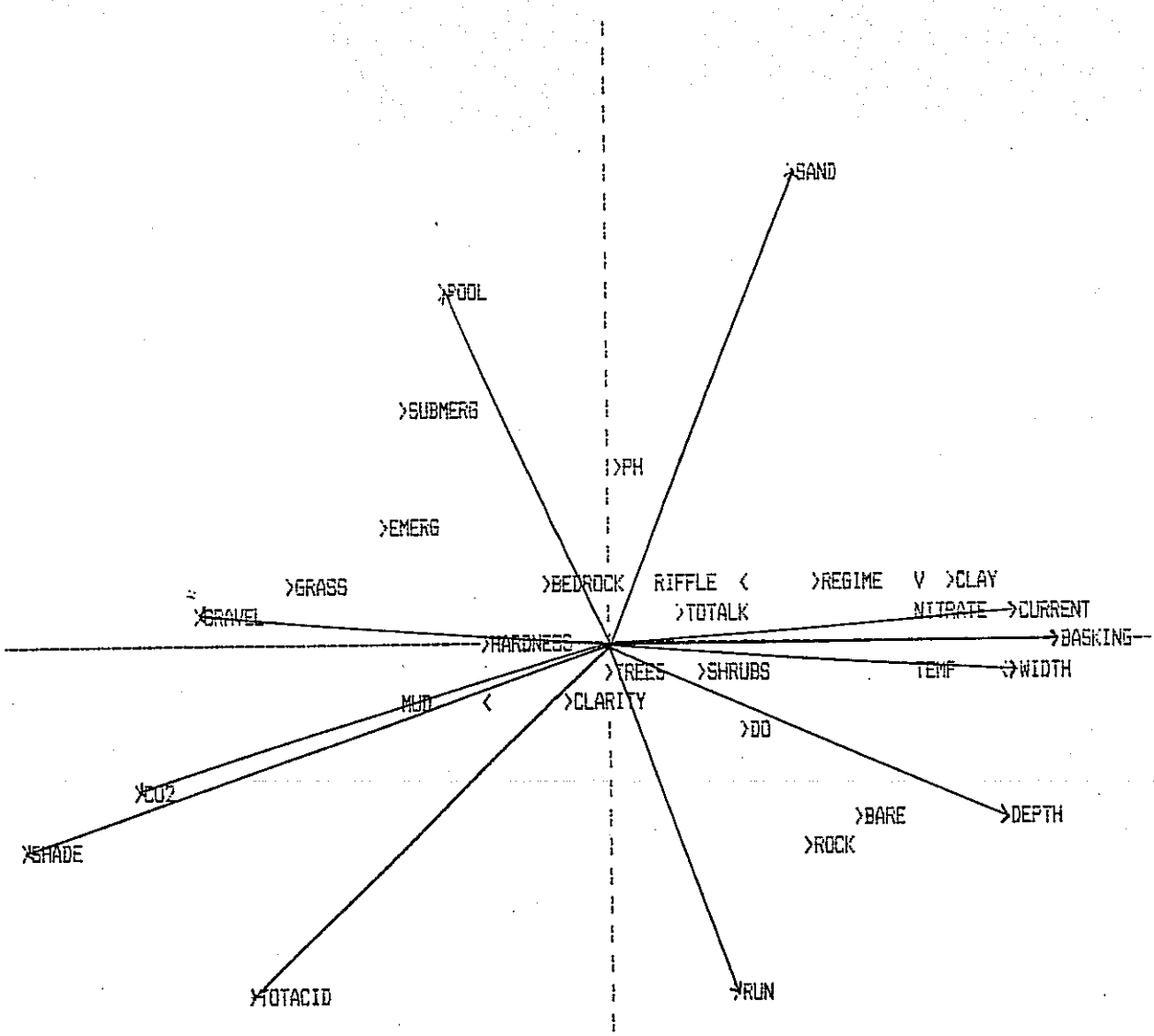

Figure 3. Vectors of dominant habitat variables on DCCA ordination. Scale: 1 SD unit = 29.4 cm.

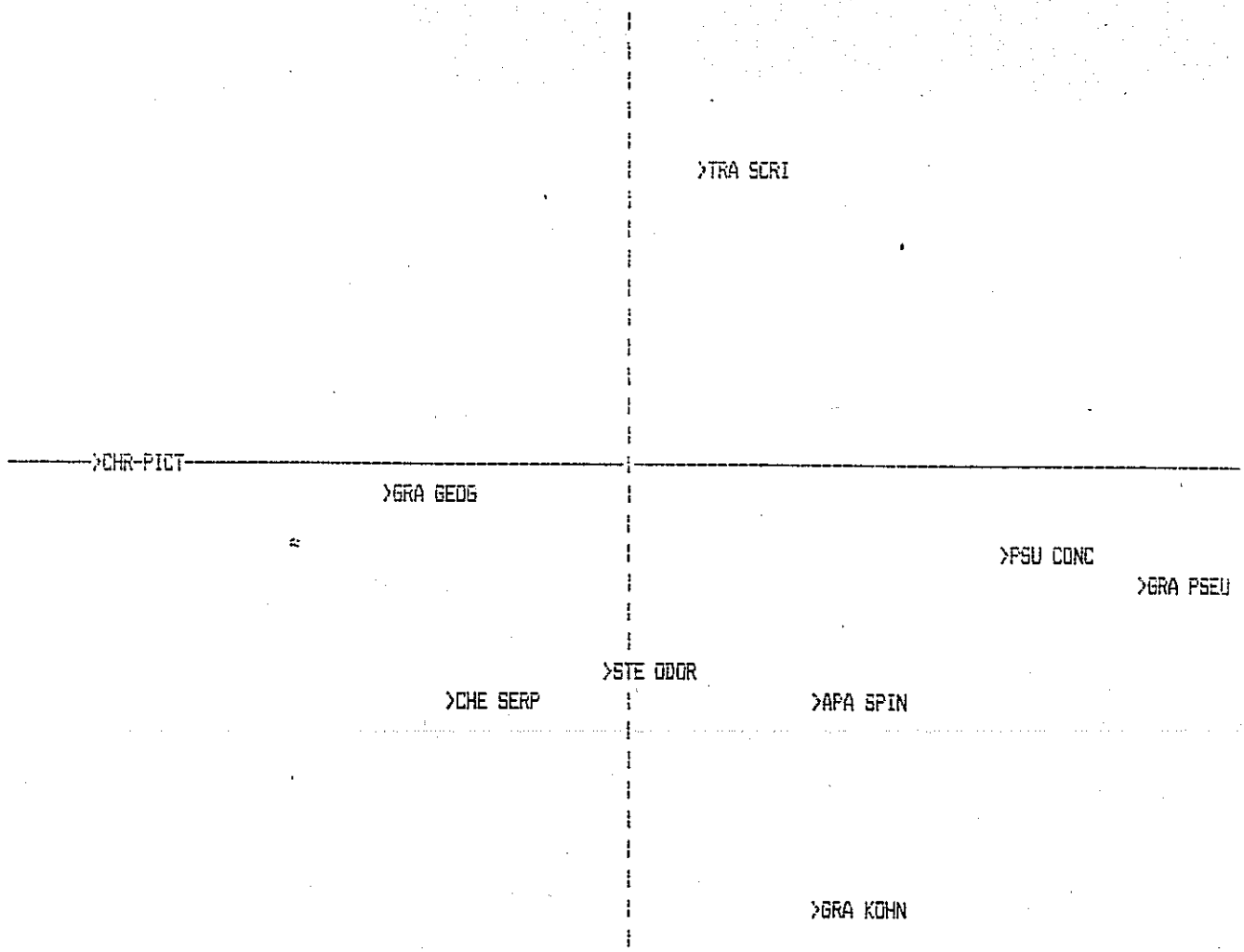

Figure 4. DCCA ordination of species scores. Scale: 1 SD unit = 2.8cm. See Appendix 8 for key to species' abbreviations.

Turtle Deformities

All turtles captured were examined for deformities. Abnormal specimens were retained for potential pathological examination at a later date. Anatomical abnormalities were noted on 24 of the 473 turtles collected (5.1%). Incidence of abnormality was highest in the Marais des Cygnes drainage (12/180 = 6.7%), followed by the Neosho (11/207 = 5.3%), and Verdigris (1/86 = 1.2%).

Appendix 7 documents deformities for each of these 24 specimens. The most common abnormalities were deformed shells, feet, and jaws. Some of these abnormalities were undoubtedly due to injury, thus the 5.1% incidence is likely an overestimation of the actual deformity rate in these populations.

State distribution and size records

We documented seventeen Kansas county records for six turtle species, including: western spiny softshell in Morris and Chautauqua; common snapping turtle in Morris; common map turtle in Allen; Mississippi map turtle in Morris, Chase, Greenwood, and Cherokee; Ouachita map turtle in Chase, Greenwood, Chautauqua, Labette, Cherokee, Allen, Franklin and Miami; and common musk turtle in Allen (Collins, 1990). We also collected Kansas maximum size records of the common map turtle (226 mm) and Mississippi map turtle (243 mm) (Collins, 1990). We deposited voucher specimens and/or color slides of these 19 turtles in the University of Kansas Museum of Natural History.

Common map turtle

Distribution

We collected seven female and three male Graptemys geographica in seven collections at six sites. On 24 June (DE-90-6), we captured a single common map turtle at the historical site of occurrence in Long Creek, 0.5 miles south of Melvern, Osage County. The specimen was an adult male, and was deposited as a voucher in the Museum of Natural History at the University of Kansas (KU 217149). On 3 July (DE-90-8), we captured two large female common map turtles in Frog Creek, a tributary to Long Creek, 1 mile north and 2 miles east

Table 3. Minimum, maximum, mean, and standard deviation of habitat variables at the 7 sites with common map turtles.

	DEPTH	CURRENT	WIDTH	CLAY	MUD
N OF CASES	7	7	7	7	7
MINIMUM	30.000	0.000	5.000	0.000	0.000
MAXIMUM	107.000	15.000	20.000	0.000	70.000
MEAN	68.143	3.714	11.143	0.000	27.143
STANDARD DEV	27.757	5.707	4.880	0.000	25.472

	SAND	ROCK	BEDROCK	GRAVEL	SHADE
N OF CASES	7	7	7	7	7
MINIMUM	0.000	10.000	0.000	0.000	25.000
MAXIMUM	0.000	90.000	50.000	75.000	100.000
MEAN	0.000	36.429	10.000	26.429	56.429
STANDARD DEV	0.000	26.412	18.257	31.197	27.646

	BASKING	POOL	RIFFLE	RUN	BARE
N OF CASES	7	7	7	7	7
MINIMUM	0.000	25.000	0.000	0.000	5.000
MAXIMUM	2.000	100.000	20.000	75.000	30.000
MEAN	1.000	52.857	3.571	43.571	14.286
STANDARD DEV	0.816	31.472	7.480	35.557	8.381

	GRASS	SHRUBS	TREES	DO	PH
N OF CASES	7	7	7	7	7
MINIMUM	5.000	0.000	15.000	4.000	6.500
MAXIMUM	30.000	40.000	85.000	8.000	8.000
MEAN	22.857	18.571	44.286	6.000	7.571
STANDARD DEV	9.063	15.999	22.440	1.414	0.607

	TOTACID	TOTALK	HARDNESS	CO2	NITRATE
N OF CASES	7	7	7	7	7
MINIMUM	51.300	2.800	7.000	30.000	0.100
MAXIMUM	68.400	8.400	17.000	70.000	0.800
MEAN	61.886	4.914	12.286	48.571	0.514
STANDARD DEV	6.925	2.163	3.251	13.452	0.219

	TEMP	REGIME	CLARITY	SUBMERGE	EMERGE
N OF CASES	7	7	7	7	7
MINIMUM	16.000	2.000	13.000	0.000	0.000
MAXIMUM	27.000	2.000	35.000	0.000	50.000
MEAN	23.286	2.000	19.143	0.000	8.000
STANDARD DEV	3.546	0.000	8.335	0.000	18.610

Differences between group 1 and group 2 habitats were statistically significant for six variables (pooled t-tests, df=69). Dissolved oxygen was lower at group 1 sites than at group 2 sites (p=.017). Mean width of the water course was less for collections with G. geographica than for collections without (p=.019). Basking sites were less abundant at group 1 sites compared to group 2 sites (p=.02), and group 1 areas were shadier than group 2 areas (p=.025). Total acidity was greater for collections with common map turtles than for collections without (p=.032), and pH was also less at these sites (p=.044).

Group 1 samples were invariant for four variables. The water regime in these areas was always permanent, and none of the seven sites had clay or sand substrate, or submerged vegetation. Two other variables were marginally significant. The percentage of substrate composed of gravel was greater for collections with G. geographica (p=.06) and dissolved carbon dioxide was greater at these sites (p=.061).

Foods

The specimen captured on 24 June was caught in a net baited with canned creamed corn, while the individual collected on 11 July was in a net baited with canned smoked clams. All other common map turtles were caught in nets baited with fresh mussel.

Laboratory analysis of fecal pellets of one of the females caught in Frog Creek on 3 July indicated it had been feeding on mulberries and insects. The individual captured on 11 July had eaten mussel. Common map turtles held in the lab for observation fed on mussel and crayfish, but would not eat chicken liver or fish. Analysis of bait preferences of all species captured is in progress (Voorhees et al., in prep.).

Recommendations

Conservation status of the common map turtle in Kansas has generated considerable public interest, reflecting support for non-game wildlife research and conservation programs. I presented the results of this survey at three scientific meetings in 1990, and rediscovery of the species in the state was chronicled in the Kansas Herpetological Society Newsletter.

Statewide and national press coverage of this research has included local radio and newspaper coverage, as well as articles in the Kansas City Star, Wichita Eagle, Independence Daily Reporter, Pittsburg Morning Sun, Winfield Daily Courier, Columbus Daily Advocate, Parsons Sun, McPherson Sentinel, Hays Daily News, Joplin (Mo.) Globe and Contra Costa (Calif.) Times.

Graptemys geographica is not "extirpated" from Kansas, but still exists in at least six sites. Where it still occurs, however, it does so in small numbers, as evidenced by our collection of only 10 specimens in 892 net nights targeted for this species. Water pollution, habitat destruction, and decline of the state's freshwater mussel populations bode ill for this and other mollusk-eating species. The common map turtle is rare in Kansas, and should be listed as endangered in the state, under the Kansas Nongame and Endangered Species Conservation Act.

We found G. geographica at only two of the five historical locations, but discovered four additional sites, including one new county record (Allen Co.). The greatest numbers appear to be in the Long Creek/Frog Creek system in Osage County. Rather than inhabiting large bodies of water with abundant basking sites and much aquatic vegetation, as it does throughout much of its range, the common map turtle in Kansas frequents smaller creeks and rivers with few basking areas and little or no vegetation. Consideration should be given to designating at least portions of the Long Creek/Frog Creek system as "critical habitat" for this species in Kansas.

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Appendix 1. Historical sites of occurrence of the common map turtle in Kansas, University of Kansas Museum of Natural History catalog number, and date of collection.

1. Montgomery County, Verdigris River
   KU 3267 July 1911

2. Franklin County, Ottawa, Marais des Cygnes River
   KU 3265 summer 1911
   KU 3225 summer 1912

3. Wilson County
   KU 3285 summer 1911

4. Anderson County, 4-5 miles south of Garnett (probably South Fork of Pottawatomie Creek)
   KU 3543 26 June 1927
   KU 3742 28 June 1927
   KU 15881 20 Dec 1931
   KU 15882 20 Dec 1931

5. Osage County, Long Creek, 0.4 km south of Melvern
   KU 187861 (ESU 1580) 31 Aug 1952

Appendix 2. County, legal location and general descriptive narrative for sites sampled in this study.

COLLECTION #	COUNTY	LEGAL LOCATION	GENERAL DESCRIPTION
DE-90-1	Lyon	T19S,R11E,Sec4	King Lake, north of ESU campus, North of I-35, Emporia
DE-90-2	Lyon	T19S,R10E,Sec17,18	Cottonwood R. 1 mi E I-35, S Emporia
DE-90-3	Osage	T18S,R13E,Sec6,7	Marais des Cygnes R. 3 mi NE Reading
DE-90-4	Osage	T18S,R14E,Sec17	Melvern Reservoir,1 mi W Arvonia & Sun Dance rec. area
DE-90-5	Linn	T20S,R24E,Sec27 T21S,R25E,Sec5,6 T21S,R24E,Sec1	Marais des Cygnes R. 7 mi E, 7 mi S La Cygne
DE-90-6	Osage	T18S,R16E,Sec9 T18S,R16E,Sec10 T18S,R16E,Sec16	Long Creek, 1/2 mi S Melvern
DE-90-7	Osage	T18S,R16E,Sec9 T18S,R16E,Sec10 T18S,R16E,Sec16	Long Creek, 1/2 mi S Melvern
DE-90-8	Osage	T18S,R15,16E,Sec 25,30 19	Frog Creek, 1 mi N, 2 mi E Beto Junction
DE-90-9	Anderson	T20S,R19E,Sec33	North Cedar Creek, 3 mi W Garnett
DE-90-10	Anderson	T20S,R20E,Sec6	Pottawatomie Creek, 4 mi N Garnett
DE-90-11	Anderson	T21S,R20E,Sec18,19	S. Fork Pottawatomie Creek, 4 mi S, 1/2 mi W Garnett
DE-90-12	Lyon	T17S,R12E,Sec 23,24,25	Duck Creek, 3 mi W, 2 mi N Reading
DE-90-13	Lyon	T19S,R12E,Sec22	Oxbow, Cottonwood R., 3 mi E, 2 mi S, 1.5 mi E Emporia
DE-90-14	Osage	T15S,R14E,Sec24	Dragoon Creek, 2 mi S, 3 mi W, 1/2 mi N Burlingame

DE-90-15	Osage	T15S,R16E,Sec6,7 T15S,R15E,Sec1	Dragoon Creek , 4 mi N Lyndon, on Hwy 75
DE-90-16	Franklin	T16S,R19E,Sec 33,34,36 T16S,R20E,Sec6	Marais des Cygnes R., downtown Ottawa
DE-90-17	Allen	T25S,R12E,Sec16	Marmaton R., 3 mi S, 3 mi E Moran
DE-90-18	Allen	T23S,R25E,Sec23,24	Middle Fork Little Osage R., 4 mi N Moran
DE-90-19	Anderson	T23S,R21E,Sec5,8	North Fork Little Osage R., 1 mi S, 1.5 mi E Kincaid
DE-90-20	Linn	T21S,R22E,Sec20,21	Sugar Creek, 3 mi E, 2 mi S Centerville
DE-90-21	Anderson	T23S,R21E,Sec16,17	North Fork Osage R., 4 mi N Garnett
DE-90-22	Osage	T18S,R15E,Sec34,35	Frog Creek, 1 mi N Beto Junction Hwy 75
DE-90-23	Coffey	T19S,R15E,Sec7,18	Frog Creek, 2 mi S, 3 mi E Beto Junction
DE-90-24	Osage	T18S,R16E,Sec30,31	Frog Creek, 1 mi N, 4 mi E Beto Junction
DE-90-25	Osage	T18S,R16E,Sec17,20	Long Creek, 2 mi S, 1.8 mi W Melvern
DE-90-26	Coffey	T19S,R15E,Sec4	Frog Creek, 1 mi W Beto Junction on I-35
DE-90-27	Lyon	T19S,R13E,Sec11	Badger Creek, 5 mi E Emporia
DE-90-28	Montgomery	T33S,R16E,Sec11	Verdigris R., 4 mi E, 3 mi S, 1/2 mi E Independence
DE-90-29	Montgomery	T32S,R16E,Sec30	Verdigris R., Below city dam at Independence
DE-90-30	Wilson	T28S,R16E,Sec31 T29S,R16E,Sec6	Verdigris R., 2 mi E, 2 mi N Altoona
DE-90-31	Osage	T17S,R15E,Sec4,5	Salt Creek, 3 mi E, 1.1 mi S Osage City

DE-90-32	Osage	T17S,R15E,Sec2,3	Salt Creek, 2 mi W, 1/2 mi W Lyndon
DE-90-33	Franklin	T16S,R18E,Sec8	Appanoose Creek, 5 mi N Pomona on Hwy 260
DE-90-34	Franklin	T14S,R19E,Sec31	Eight Mile Creek, 4 mi N, 3 mi E Ottawa
DE-90-35	Franklin	T15S,R20E,Sec25,36	W. Fork Tauy Creek, 4 mi N, 2.5 mi E Ottawa
DE-90-36	Osage	T18S,R16E,Sec17,20	Long Creek, 2 mi S, 1.8 mi W Melvern
DE-90-37	Osage	T18S,R16E,Sec20	Long Creek, 2 mi S, 2.5 mi W Melvern
DE-90-38	Osage	T18S,R16E,Sec30	Long Creek, 2 mi S, 2 mi W, 1/5 mi S Melvern
DE-90-39	Bourbon	T25S,R22E,Sec27	Marmaton R., 1 mi S Uniontown
DE-90-40	Bourbon	T23S,R25S,Sec30	Unnamed tributary Little Osage R., 1 mi E Fulton
DE-90-41	Bourbon	T23S,R25E,Sec33	Little Osage R., 3 mi E, 1/2 mi S Fulton
DE-90-42	Bourbon	T25S,R25E,Sec28,29	Marmaton R., 1 mi E, 2 mi N Fort Scott
DE-90-43	Crawford	T27S,R24E,Sec33	W. Fork Dry Wood Creek, 2 mi E, 3 mi N Farlington
DE-90-44	Crawford	T31S,R25E,Sec21	Cow Creek, 1.5 mi W of Junction 37 & Hwy 160
DE-90-45	Cherokee	T31S,R25E,Sec21	Cow Creek, 1.5 mi W of Junction 57 & Hwy 160
DE-90-46	Cherokee	T34S,R25E,Sec35	Shoal Creek, 1 mi S Galena at Schermerhorn Park
DE-90-47	Cherokee	T33S,R25E,Sec25	Spring R., 3 mi N Galena
DE-90-48	Woodson	T23S,R15E,Sec26,27	Turkey Creek, 10 mi N Yates Center

DE-90-49	Woodson	T24S,R16E,Sec26,27	Cherry Creek, 3 mi N, 2 mi E, 1/2 mi S Yates Center
DE-90-50	Woodson	T24S,R15E,Sec34,35	Owl Creek, 2 mi N Yates Center
DE-90-51	Woodson	T25S,R15E,Sec2,3	Owl Creek, 2 mi N Yates Center
DE-90-52	Woodson	T23S,R17E,Sec28,29	Neosho R., 1/2 mi N Neosho Falls
DE-90-53	Franklin	T16S,R20E,Sec27,28	Ottawa Creek, 2 mi E of I-35 on Hwy 68
DE-90-54	Miami	T18S,R22E,Sec3	Marais des Cygnes R., 1/4 mi N of power plant John Brown Park Osawatomie
DE-90-55	Miami	T18S,R24E,Sec30,31	Marais des Cygnes R., 1 mi N, 2 mi E Fontana
DE-90-56	Linn	T21S,R25E,Sec6	Marais des Cygnes R., 7 mi E, 7 mi S La Cygne
DE-90-57	Lyon	T18S,R11E,Sec30	Neosho R., 1.5 mi N, 1 mi W Prairie St., Emporia
DE-90-58	Greenwood	T22S,R11E,Sec11,12	Verdigris R., 1/2 mi N Madison on Hwy 99
DE-90-59	Greenwood	T25S,R13E,Sec7,8	West Creek, 1 mi W, 1/2 mi N Quincy
DE-90-60	Greenwood	T26S,R11E,Sec29,30	Bachelor Creek, 4 mi E, 1.3 mi N Eureka
DE-90-61	Greenwood	T25S,R10E,Sec30	Fall R., 2.5 mi W, 0.8 mi N Eureka
DE-90-62	Greenwood	T27S,R10E,Sec13	Otter Creek, 1.9 mi W, 1/2 mi S Climax
DE-90-63	Chase	T14S,R9E,Sec20	Cottonwood R., 1 mi S Saffordville
DE-90-64	Morris	T17S,R9E,Sec14	Neosho R., 1 mi W Dunlap
DE-90-65	Morris	T17S,R9E,Sec23,24	Neosho R., 1 mi S Dunlap
DE-90-66	Lyon	T17S,R10E,Sec31	Neosho R., 4 mi W, 3 mi N Americus

DE-90-67	Lyon	T19S,R12E,Sec8	Neosho R., 3 mi E Emporia on Hwy 50
DE-90-68	Elk	T29S,R10E,Sec8	Elk R., 4 mi W Howard
DE-90-69	Chautauqua	T32S,R10E,Sec14	Spring Creek, 14 mi N Sedan on Hwy 94
DE-90-70	Chautauqua	T34S,R11E,Sec3	Mule Creek, 1/2 mi S Sedan on Hwy 99 & 166
DE-90-71	Chautauqua	T34S,R11E,Sec4	Mule Creek, 2 mi W of Sedan on Hwy 166
DE-90-72	Chautauqua	T34S,R8E,Sec12	Big Caney R., 1 mi E Cedar Vale on Hwy 166
DE-90-73	Allen	T24S,R18E,Sec35	Neosho R., West side of Iola Park
DE-90-74	Allen	T25S,R21E,Sec28,33	Marmaton R., 3.5 mi E, 5.5 mi S Moran
DE-90-75	Allen	T26S,R21E,Sec3	Marmaton R., 2 mi E, 1 mi S, 1.5 mi E Elsmore
DE-90-76	Anderson	T21S,T21S,Sec19	South Fork Pottawatomie Creek, 6 mi S Garnett on Hwy 59
DE-90-77	Anderson	T21S,R19E,Sec20	Cedar Creek, 6 mi E, 5 mi S Garnett
DE-90-78	Bourbon	T26S,R21E,Sec14	Wolfpen Creek, 3.5 mi E Elsmore
DE-90-79	Labette	T31S,R18E,Sec1	Little Labette Creek, 2 mi W, 2 mi N, 1.5 mi W Parsons
DE-90-80	Labette	T33S,R21E,Sec8	Neosho R., 1.5 mi N, 1 mi E, Oswego
DE-90-81	Cherokee	T34S,R21E,Sec36	Neosho R., 1/4 mi E Chetopa
DE-90-82	Neosho	T28S,R19E,Sec15,22	Neosho R., 1/4 mi W Shaw
DE-90-83	Osage	T18S,R16E,Sec9,10,16	Long Creek, 1/2 mi S Melvern
DE-90-84	Osage	T18S,R16E,Sec17,20	Long Creek, 2 mi S, 1.8 mi W Melvern

DE-90-85	Osage	T18S,R16E,Sec9,10,16	Long Creek, 1/2 mi S Melvern
DE-90-86	Osage	T18S,R16E,Sec17,20	Long Creek, 2 mi S, 1.8 mi W of Melvern
DE-90-87	Coffey	T19S,R15E,Sec11	Long Creek, 0.5 mi S, 1 mi E Beto Jct.

Appendix 3. Counties, drainage basins, dates and net nights sampled in this study.

COLLECTION #	COUNTY	RIVER DRAINAGE	BEGIN DATE	END DATE	NET NIGHTS
DE-90-1	Lyon	Neosho	28Apr90	05May90	14
DE-90-2	Lyon	Cottonwood	28Apr90	04May90	12
DE-90-3	Osage	Marais des Cygnes	05May90	07May90	4
DE-90-4	Osage	Marais des Cygnes	12May90	14Jul90	62
DE-90-5	Linn	Marais des Cygnes	17Jun90	17Jun90	11
DE-90-6	Osage	Marais des Cygnes	20Jun90	24Jun90	14
DE-90-7	Osage	Marais des Cygnes	28Jun90	01Jul90	18
DE-90-8	Osage	Marais des Cygnes	02Jul90	05Jul90	15
DE-90-9	Anderson	Marais des Cygnes	06Jul90	08Jul90	8
DE-90-10	Anderson	Marais des Cygnes	06Jul90	08Jul90	8
DE-90-11	Anderson	Marais des Cygnes	08Jul90	11Jul90	12
DE-90-12	Lyon	Marais des Cygnes	09Jul90	11Jul90	8
DE-90-13	Lyon	Cottonwood	13Jul90	16Jul90	24
DE-90-14	Osage	Marais des Cygnes	16Jul90	19Jul90	12
DE-90-15	Osage	Marais des Cygnes	16Jul90	19Jul90	18
DE-90-16	Franklin	Marais des Cygnes	23Jul90	25Jul90	20
DE-90-17	Allen	Marmaton	27Jul90	29Jul90	8
DE-90-18	Allen	Little Osage	27Jul90	29Jul90	4
DE-90-19	Anderson	Little Osage	27Jul90	29Jul90	8
DE-90-20	Linn	Marais des Cygnes	28Jul90	29Jul90	4
DE-90-21	Anderson	Marais des Cygnes	28Jul90	29Jul90	4
DE-90-22	Osage	Marais des Cygnes	30Jul90	01Aug90	12

DE-90-23	Coffey	Marais des Cygnes	30Jul90	01Aug90	6
DE-90-24	Osage	Marais des Cygnes	30Jul90	01Aug90	8
DE-90-25	Osage	Marais des Cygnes	30Jul90	01Aug90	8
DE-90-26	Coffey	Marais des Cygnes	30Jul90	01Aug90	6
DE-90-27	Lyon	Neosho	30Jul90	01Aug90	6
DE-90-28	Montgomery	Verdigris	02Aug90	04Aug90	16
DE-90-29	Montgomery	Verdigris	03Aug90	06Aug90	11
DE-90-30	Wilson	Verdigris	03Aug90	05Aug90	16
DE-90-31	Osage	Marais des Cygnes	07Aug90	09Aug90	8
DE-90-32	Osage	Marais des Cygnes	07Aug90	09Aug90	12
DE-90-33	Franklin	Marais des Cygnes	07Aug90	09Aug90	8
DE-90-34	Franklin	Marais des Cygnes	08Aug90	10Aug90	8
DE-90-35	Franklin	Marais des Cygnes	08Aug90	10Aug90	8
DE-90-36	Osage	Marais des Cygnes	10Aug90	12Aug90	20
DE-90-37	Osage	Marais des Cygnes	10Aug90	12Aug90	4
DE-90-38	Osage	Marais des Cygnes	10Aug90	12Aug90	8
DE-90-39	Bourbon	Marmaton	13Aug90	15Aug90	8
DE-90-40	Bourbon	Little Osage	14Aug90	15Aug90	4
DE-90-41	Bourbon	Little Osage	14Aug90	17Aug90	12
DE-90-42	Bourbon	Marmaton	14Aug90	17Aug90	12
DE-90-43	Crawford	Marmaton	14Aug90	17Aug90	9
DE-90-44	Crawford	Marmaton	15Aug90	17Aug90	4
DE-90-45	Cherokee	Marmaton	15Aug90	17Aug90	4
DE-90-46	Cherokee	Spring	15Aug90	17Aug90	8
DE-90-47	Cherokee	Spring	16Aug90	17Aug90	3

DE-90-48	Woodson	Neosho	21Aug90	23Aug90	8
DE-90-49	Woodson	Neosho	21Aug90	23Aug90	8
DE-90-50	Woodson	Neosho	21Aug90	23Aug90	8
DE-90-51	Woodson	Neosho	21Aug90	23Aug90	8
DE-90-52	Woodson	Neosho	21Aug90	23Aug90	8
DE-90-53	Franklin	Marais des Cygnes	25Aug90	28Aug90	12
DE-90-54	Miami	Marais des Cygnes	25Aug90	28Aug90	15
DE-90-55	Miami	Marais des Cygnes	25Aug90	28Aug90	18
DE-90-56	Linn	Marais des Cygnes	25Aug90	28Aug90	21
DE-90-57	Lyon	Neosho	30Aug90	01Sep90	8
DE-90-58	Greenwood	Verdigris	02Sep90	03Sep90	4
DE-90-59	Greenwood	Verdigris	02Sep90	03Sep90	4
DE-90-60	Greenwood	Elk	02Sep90	03Sep90	4
DE-90-61	Greenwood	Elk	02Sep90	03Sep90	4
DE-90-62	Greenwood	Elk	02Sep90	03Sep90	4
DE-90-63	Chase	Cottonwood	05Sep90	07Sep90	10
DE-90-64	Morris	Neosho	05Sep90	07Sep90	6
DE-90-65	Morris	Neosho	05Sep90	07Sep90	4
DE-90-66	Lyon	Neosho	05Sep90	07Sep90	4
DE-90-67	Lyon	Neosho	05Sep90	11Sep90	12
DE-90-68	Elk	Elk	16Sep90	20Sep90	16
DE-90-69	Chautauqua	Caney	16Sep90	20Sep90	4
DE-90-70	Chautauqua	Caney	16Sep90	20Sep90	24
DE-90-71	Chautauqua	Caney	16Sep90	20Sep90	8
DE-90-72	Chautauqua	Caney	16Sep90	20Sep90	16

DE-90-73	Allen	Neosho	21Sep90	23Sep90	8
DE-90-74	Allen	Marmaton	21Sep90	23Sep90	6
DE-90-75	Allen	Marmaton	21Sep90	23Sep90	4
DE-90-76	Anderson	Marais des Cygnes	21Sep90	23Sep90	6
DE-90-77	Anderson	Marais des Cygnes	22Sep90	27Sep90	16
DE-90-78	Bourbon	Marmaton	21Sep90	23Sep90	6
DE-90-79	Labette	Neosho	28Sep90	01Oct90	6
DE-90-80	Labette	Neosho	28Sep90	01Oct90	18
DE-90-81	Cherokee	Neosho	28Sep90	01Oct90	18
DE-90-82	Neosho	Neosho	28Sep90	01Oct90	12
DE-90-83	Osage	Marais des Cygnes	06Oct90	07Oct90	6
DE-90-84	Osage	Marais des Cygnes	06Oct90	07Oct90	6
DE-90-85	Osage	Marais des Cygnes	10Nov90	12Nov90	12
DE-90-86	Osage	Marais des Cygnes	10Nov90	12Nov90	12
DE-90-87	Coffey	Marais des Cygnes	21Nov90	24Nov90	18

Appendix 4. Turtles captured in each collection.

COLLECTION #	SPECIES	NUMBER
DE-90-1	Red-eared slider	1
DE-90-2	Mississippi map turtle	14
	Ouachita map turtle	1
	Western spiny softshell	1
	Red-eared slider	1
DE-90-3	Red-eared slider	1
DE-90-4	Red-eared slider	5
DE-90-5	Common snapping turtle	3
	Common musk turtle	2
	Western painted turtle	12
	Red-eared slider	14
DE-90-6	Common snapping turtle	2
	Common map turtle	1
	Red-eared slider	1
DE-90-7	Common snapping turtle	10
	Red-eared slider	1
DE-90-8	Common snapping turtle	1
	Common map turtle	2
DE-90-9	Common musk turtle	1
DE-90-10	Common snapping turtle	1
	Western spiny softshell	1
DE-90-11	Common map turtle	1
DE-90-12	Common snapping turtle	3
DE-90-13	Mississippi map turtle	1
	Western painted turtle	3
	Red-eared slider	9
DE-90-14	Western painted turtle	1
DE-90-15	Ouachita map turtle	1
	Western painted turtle	5
	Western spiny softshell	1

DE-90-16	Ouachita map turtle	1
DE-90-17	Common snapping turtle	10
	Common map turtle	1
	Western painted turtle	2
DE-90-18	Common snapping turtle	3
DE-90-19	No turtles	-
DE-90-20	No turtles	-
DE-90-21	Red-eared slider	1
DE-90-22	Common snapping turtle	1
	Red-eared slider	1
	Western spiny softshell	1
DE-90-23	Western painted turtle	2
DE-90-24	No turtles	-
DE-90-25	Common map turtle	3
	Red-eared slider	1
DE-90-26	Red-eared slider	4
DE-90-27	Red-eared slider	1
DE-90-28	Common snapping turtle	1
	Ouachita map turtle	8
	Red-eared slider	2
DE-90-29	Mississippi map turtle	1
	Ouachita map turtle	8
DE-90-30	Common snapping turtle	2
	Ouachita map turtle	2
	Red-eared slider	1
DE-90-31	Western painted turtle	2
DE-90-32	Western painted turtle	5
DE-90-33	Common snapping turtle	2
	Common map turtle	1
	Western painted turtle	1
DE-90-34	No turtles	-

DE-90-35	Common snapping turtle	1
	Red-eared slider	1
DE-90-36	No turtles	-
DE-90-37	Western spiny softshell	1
DE-90-38	Common snapping turtle	2
DE-90-39	Common musk turtle	1
DE-90-40	No turtles	-
DE-90-41	Red-eared slider	3
	Western spiny softshell	1
DE-90-42	Common snapping turtle	1
	Red-eared slider	11
DE-90-43	Western painted turtle	2
	Red-eared slider	12
DE-90-44	No turtles	-
DE-90-45	Common musk turtle	1
	Red-eared slider	1
	Western spiny softshell	1
DE-90-46	Common snapping turtle	1
DE-90-47	No turtles	-
DE-90-48	No turtles	-
DE-90-49	Red-eared slider	1
DE-90-50	Red-eared slider	2
DE-90-51	Common musk turtle	1
DE-90-52	Western spiny softshell	1
DE-90-53	Red-eared slider	1
DE-90-54	Ouachita map turtle	2
	Western painted turtle	2
DE-90-55	Ouachita map turtle	3
	Red-eared slider	1

DE-90-56	Common musk turtle	1
	Red-eared slider	2
DE-90-57	Ouachita map turtle	1
	Red-eared slider	1
	Western spiny softshell	2
DE-90-58	No turtles	-
DE-90-59	Red-eared slider	1
DE-90-60	Common musk turtle	2
	Red-eared slider	6
DE-90-61	Mississippi map turtle	1
	Ouachita map turtle	1
	Red-eared slider	3
DE-90-62	Red-eared slider	2
	Common snapping turtle	1
DE-90-63	Mississippi map turtle	2
	Ouachita map turtle	4
	Red-eared slider	7
	Western spiny softshell	7
DE-90-64	Common snapping turtle	1
	Mississippi map turtle	1
	Red-eared slider	1
	Western spiny softshell	1
DE-90-65	Mississippi map turtle	1
DE-90-66	No turtles	-
DE-90-67	Mississippi map turtle	2
	Ouachita map turtle	1
	Western spiny softshell	7
DE-90-68	Common musk turtle	4
	Red-eared slider	3
DE-90-69	No turtles	-
DE-90-70	Common musk turtle	4
	Red-eared slider	16
	Western spiny softshell	7
	Missouri river cooter	4
DE-90-71	No turtles	-

DE-90-72	Ouachita map turtle	6
DE-90-73	Ouachita map turtle	2
	Red-eared slider	1
DE-90-74	Common snapping turtle	1
	Common musk turtle	1
	Western painted turtle	1
DE-90-75	No turtles	-
DE-90-76	No turtles	-
DE-90-77	Red-eared slider	1
DE-90-78	Common snapping turtle	1
	Western painted turtle	1
	Red-eared slider	1
DE-90-79	No turtles	-
DE-90-80	Mississippi map turtle	1
	Ouachita map turtle	30
	Red-eared slider	20
	Missouri river cooter	1
DE-90-81	Mississippi map turtle	5
	Ouachita map turtle	29
	Red-eared slider	4
	Western spiny softshell	1
	Missouri river cooter	1
DE-90-82	Mississippi map turtle	1
	Ouachita map turtle	20
	Red-eared slider	11
	Western spiny softshell	1
	Missouri river cooter	1
DE-90-83	Common map turtle	1
	Western painted turtle	2
	Red-eared slider	6
DE-90-84	No turtles	-
DE-90-85	Western painted turtle	1
DE-90-86	No turtles	-
DE-90-87	Western painted turtle	1

Appendix 5. Arcsin$\sqrt{x}$ transformed abundance of turtles in each sample. Each line has the sample number, followed by abundance for common snapping turtle, common musk turtle, common map turtle, Mississippi map turtle, Ouachita map turtle, western painted turtle, red-eared slider, western spiny softshell, and Missouri river cooter, respectively.

1	00.00	00.00	00.00	00.00	00.00	00.00	90.00	00.00	00.00
2	00.00	00.00	00.00	65.16	14.04	00.00	14.04	14.04	00.00
3	00.00	00.00	00.00	00.00	00.00	00.00	90.00	00.00	00.00
4	00.00	00.00	00.00	00.00	00.00	00.00	90.00	00.00	00.00
5	18.12	14.71	00.00	00.00	00.00	38.47	42.22	00.00	00.00
6	45.00	00.00	30.00	00.00	00.00	00.00	30.00	00.00	00.00
7	72.45	00.00	00.00	00.00	00.00	00.00	17.54	00.00	00.00
8	35.26	00.00	54.73	00.00	00.00	00.00	00.00	00.00	00.00
9	00.00	90.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00
10	45.00	00.00	00.00	00.00	00.00	00.00	00.00	45.00	00.00
11	00.00	00.00	90.00	00.00	00.00	00.00	00.00	00.00	00.00
12	90.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00
13	00.00	00.00	00.00	16.10	00.00	28.71	56.30	00.00	00.00
14	00.00	00.00	00.00	00.00	00.00	90.00	00.00	00.00	00.00
15	00.00	00.00	00.00	00.00	22.20	57.68	00.00	22.20	00.00
16	00.00	00.00	00.00	00.00	90.00	00.00	00.00	00.00	00.00
17	61.28	00.00	16.10	00.00	00.00	23.09	00.00	00.00	00.00
18	90.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00
19	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00
20	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00
21	00.00	00.00	00.00	00.00	00.00	00.00	90.00	00.00	00.00
22	35.26	00.00	00.00	00.00	00.00	00.00	35.26	35.26	00.00
23	00.00	00.00	00.00	00.00	00.00	90.00	00.00	00.00	00.00
24	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00
25	00.00	00.00	60.00	00.00	00.00	00.00	30.00	00.00	00.00
26	00.00	00.00	00.00	00.00	00.00	00.00	90.00	00.00	00.00
27	00.00	00.00	00.00	00.00	00.00	00.00	90.00	00.00	00.00
28	17.54	00.00	00.00	00.00	58.51	00.00	25.23	00.00	00.00
29	00.00	00.00	00.00	19.47	70.52	00.00	00.00	00.00	00.00
30	39.23	00.00	00.00	00.00	39.23	00.00	26.56	00.00	00.00
31	00.00	00.00	00.00	00.00	00.00	90.00	00.00	00.00	00.00
32	00.00	00.00	00.00	00.00	00.00	90.00	00.00	00.00	00.00
33	45.00	00.00	30.00	00.00	00.00	30.00	00.00	00.00	00.00
34	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00
35	45.00	00.00	00.00	00.00	00.00	00.00	45.00	00.00	00.00
36	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00
37	00.00	00.00	00.00	00.00	00.00	00.00	00.00	90.00	00.00
38	90.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00
39	00.00	90.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00
40	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00
41	00.00	00.00	00.00	00.00	00.00	00.00	60.00	30.00	00.00
42	16.77	00.00	00.00	00.00	00.00	00.00	73.22	00.00	00.00

43	00.00	00.00	00.00	00.00	00.00	23.09	73.89	00.00	00.00
44	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00
45	00.00	35.26	00.00	00.00	00.00	00.00	35.26	35.26	00.00
46	90.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00
47	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00
48	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00
49	00.00	00.00	00.00	00.00	00.00	00.00	90.00	00.00	00.00
50	00.00	00.00	00.00	00.00	00.00	00.00	90.00	00.00	00.00
51	00.00	90.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00
52	00.00	00.00	00.00	00.00	00.00	00.00	00.00	90.00	00.00
53	00.00	00.00	00.00	00.00	00.00	00.00	90.00	00.00	00.00
54	00.00	00.00	00.00	00.00	45.00	45.00	00.00	00.00	00.00
55	00.00	00.00	00.00	00.00	60.00	00.00	30.00	00.00	00.00
56	00.00	35.26	00.00	00.00	00.00	00.00	54.73	00.00	00.00
57	00.00	00.00	00.00	00.00	30.00	00.00	30.00	45.00	00.00
58	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00
59	00.00	00.00	00.00	00.00	00.00	00.00	90.00	00.00	00.00
60	00.00	30.00	00.00	00.00	00.00	00.00	60.00	00.00	00.00
61	00.00	00.00	00.00	26.56	26.56	00.00	50.76	00.00	00.00
62	35.26	00.00	00.00	00.00	00.00	00.00	54.74	00.00	00.00
63	00.00	00.00	00.00	18.43	26.56	00.00	36.27	36.27	00.00
64	30.00	00.00	00.00	30.00	00.00	00.00	30.00	30.00	00.00
65	00.00	00.00	00.00	90.00	00.00	00.00	00.00	00.00	00.00
66	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00
67	00.00	00.00	00.00	26.56	18.43	00.00	00.00	56.79	00.00
68	00.00	49.10	00.00	00.00	00.00	00.00	40.89	00.00	00.00
69	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00
70	00.00	21.05	00.00	00.00	00.00	00.00	45.92	28.37	21.05
71	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00
72	00.00	00.00	00.00	00.00	90.00	00.00	00.00	00.00	00.00
73	00.00	00.00	00.00	00.00	54.73	00.00	35.26	00.00	00.00
74	35.26	35.26	00.00	00.00	00.00	35.26	00.00	00.00	00.00
75	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00
76	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00
77	00.00	00.00	00.00	00.00	00.00	00.00	90.00	00.00	00.00
78	35.26	00.00	00.00	00.00	00.00	35.26	35.26	00.00	00.00
79	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00
80	00.00	00.00	00.00	07.97	49.42	00.00	38.32	00.00	07.97
81	00.00	00.00	00.00	20.70	58.37	00.00	18.43	09.09	09.09
82	00.00	00.00	00.00	09.87	50.08	00.00	34.66	09.87	09.87
83	00.00	00.00	19.47	00.00	00.00	28.12	54.73	00.00	00.00
84	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00
85	00.00	00.00	00.00	00.00	00.00	90.00	00.00	00.00	00.00
86	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00
87	00.00	00.00	00.00	00.00	00.00	90.00	00.00	00.00	00.00

Appendix 6. Habitat variables for each collection. Each group of three lines has the sample number, followed by day of the year, turtle species richness, number of turtles, net nights, depth (cm), current speed (/30=feet per second), width (m), % clay, % mud, % sand, % rock, % bedrock/boulder, % gravel, % shade, basking sites, % pool, % riffle, % run, % bare, % grass, % shrubs, % trees, dissolved oxygen, pH, free acidity, total acidity, free alkalinity, total alkalinity, total hardness, dissolved carbon dioxide, nitrate nitrogen, water temperature, water regime, water clarity (cm), % submerged vegetation, and % emergent vegetation, respectively. See Materials and Methods section for explanation of units, and how each variable was measured.

1 118 001 001 014 058 000 250 000 100 000 000 000 000
001 000 100 000 000 00 33 00 67 09 9.00 00 05.7 00 02.0 09
15 0.25 15 2 15 00 01
2 118 004 017 012 120 001 040 000 100 000 000 000 000
010 002 010 000 090 20 20 10 50 09 8.50 00 11.4 00 03.2 20
10 0.20 14 2 15 00 00
3 125 001 001 006 132 001 035 100 000 000 000 000 000
020 001 040 000 060 10 30 20 40 11 8.00 00 45.6 00 06.0 22
10 0.30 20 2 15 00 00
4 132 001 005 062 030 000 060 020 040 040 000 000 000
025 002 100 000 000 45 05 20 30 09 8.50 00 05.7 00 02.8 15
10 0.20 25 2 15 50 00
5 166 004 031 011 093 000 250 000 100 000 000 000 000
006 002 100 000 000 05 75 00 20 10 8.25 00 51.3 00 04.0 20
12 0.35 25 2 32 12 12
6 171 003 004 014 061 000 015 000 050 000 050 000 000
050 000 025 000 075 20 30 00 50 05 6.50 00 62.7 00 02.8 10
60 0.50 25 2 13 00 00
7 179 002 011 018 091 000 016 015 080 000 003 002 000
050 002 035 015 050 10 20 20 50 08 7.50 00 68.4 00 03.2 11
40 0.30 27 2 13 00 01
8 183 002 003 015 030 015 005 000 000 000 090 010 000
075 001 080 020 000 10 30 10 50 08 8.00 00 57.0 00 03.2 13
30 0.50 25 2 13 00 05
9 187 001 001 008 069 000 005 020 000 000 080 000 000
100 000 090 010 000 20 20 10 50 06 7.50 00 96.9 00 01.6 06
45 0.50 27 2 13 00 10
10 187 002 002 008 018 031 017 000 000 000 100 000 000
025 001 020 000 080 50 00 20 30 06 7.50 00 51.3 00 01.6 09
50 0.60 27 2 08 00 00

```
   11 189 001 001 012 107 008 010 000 000 000 025 000 075
025 001 075 005 020 30 20 20 30 06 7.50 00 68.4 00 06.8 17
50 0.70 27 2 13 00 00
   12 190 001 003 008 080 000 009 000 035 000 000 030 035
075 002 060 000 040 10 40 05 45 06 7.50 00 68.4 00 05.2 11
50 0.40 26 2 25 00 00
   13 194 003 013 024 167 000 050 000 100 000 000 000 000
015 003 100 000 000 00 75 05 20 06 8.00 00 68.4 00 04.0 17
30 0.50 25 2 13 00 00
   14 197 001 001 012 072 012 015 000 030 000 000 000 070
050 001 080 000 020 30 15 10 45 09 8.50 00 51.3 00 04.4 18
60 0.50 29 2 25 00 00
   15 197 003 007 018 140 001 050 000 100 000 000 000 000
010 004 095 000 005 50 10 00 40 09 8.50 00 51.3 00 04.4 18
60 0.50 28 2 13 00 00
   16 204 001 001 020 067 015 036 000 000 000 050 000 050
025 004 050 025 025 30 05 10 55 08 8.00 00 57.0 00 03.6 15
50 0.40 27 2 13 00 00
   17 208 003 013 008 046 001 010 000 020 000 030 000 050
100 000 040 000 060 10 20 40 30 07 7.00 00 68.4 00 02.8 07
70 0.50 24 2 20 00 50
   18 208 001 003 004 053 001 015 000 050 000 030 000 020
050 002 080 000 020 10 30 15 45 08 8.00 00 96.9 00 03.6 12
40 0.60 22 2 13 00 00
   19 208 000 000 008 061 001 030 000 025 000 010 000 065
075 001 050 010 040 10 40 30 20 09 8.00 00 91.2 00 09.2 15
50 0.70 25 2 20 00 50
   20 209 000 000 004 091 001 040 000 010 000 000 040 050
025 001 080 000 020 10 30 30 30 09 8.00 00 57.0 00 08.4 12
55 0.60 26 2 30 00 30
   21 209 001 001 004 052 019 030 000 020 000 010 000 070
025 000 070 020 010 00 40 30 30 09 8.00 00 68.4 00 08.0 15
45 0.60 25 2 20 00 30
   22 211 003 003 012 222 001 010 010 060 000 020 002 008
020 001 025 005 070 05 20 05 70 08 8.00 00 62.7 00 08.4 14
70 0.10 25 2 15 00 01
   23 211 001 002 006 048 000 007 000 065 000 035 000 000
065 003 080 005 015 05 35 10 50 12 8.00 00 51.3 00 04.4 16
55 0.20 27 1 20 00 20
   24 211 000 000 008 000 000 000 000 000 000 000 000 000
000 000 000 000 000 00 00 00 00 00 0.00 00 00.0 00 00.0 00
00 0.00 00 0 00 00 00
   25 211 002 004 008 076 001 020 000 070 000 010 010 010
030 002 025 000 075 05 05 05 85 07 8.00 00 51.3 00 08.4 15
40 0.10 24 2 35 00 01
   26 211 001 004 006 069 001 015 000 075 005 003 002 015
010 002 095 002 003 00 20 60 20 10 8.00 00 57.0 00 03.2 12
60 0.20 33 1 13 00 10
   27 211 001 001 006 061 001 007 000 070 010 005 000 015
035 002 060 005 035 00 25 25 50 10 8.00 00 51.3 00 03.6 11
50 0.20 25 1 13 00 20
```

28 214 003 011 016 213 016 050 050 023 002 003 020 002
025 004 020 000 080 02 10 20 68 07 8.00 00 57.0 00 04.0 10
50 1.40 28 2 20 01 01
29 215 002 009 011 112 015 050 030 030 010 020 000 010
020 003 025 025 050 35 01 04 60 07 7.50 00 34.2 00 02.0 09
45 0.75 25 2 05 00 00
30 215 003 005 016 100 001 040 030 040 000 002 025 003
040 004 025 000 075 00 10 20 70 06 7.75 00 22.8 00 02.0 09
20 0.40 26 2 08 00 01
31 219 001 002 008 075 001 015 000 025 000 005 000 070
075 002 025 000 075 05 25 20 50 05 7.50 00 62.7 00 04.8 15
70 0.60 22 2 20 00 00
32 219 001 005 012 053 001 026 000 020 000 030 000 050
025 002 050 000 050 25 30 05 40 08 8.00 00 57.0 00 04.8 17
55 0.60 24 2 61 00 00
33 219 003 004 008 058 001 009 000 025 000 025 000 050
075 001 025 000 075 10 25 15 50 04 8.00 00 57.0 00 04.8 12
50 0.50 22 2 25 00 00
34 220 000 000 008 000 000 000 000 000 000 000 000 000
000 000 000 000 000 00 00 00 00 08 7.50 00 34.2 00 02.8 10
50 0.00 00 0 00 00 00
35 220 002 002 008 091 001 010 050 030 000 015 000 005
050 002 035 000 065 15 35 00 50 08 7.50 00 34.2 00 03.2 10
50 0.50 22 2 20 00 00
36 222 000 000 020 000 000 000 000 000 000 000 000 000
000 000 000 000 000 00 00 00 00 00 0.00 00 00.0 00 00.0 00
00 0.00 00 0 00 00 00
37 222 001 001 004 084 001 017 000 075 000 010 000 015
025 002 020 000 080 05 05 10 80 08 8.00 00 39.9 00 07.6 13
35 0.20 23 2 30 00 00
38 222 001 002 008 084 000 020 000 050 000 025 000 025
080 000 080 000 020 20 30 00 50 08 8.00 00 51.3 00 08.0 14
35 0.20 24 2 20 00 00
39 225 001 001 008 091 010 040 000 080 000 010 000 010
010 002 030 000 070 05 30 15 50 07 8.00 00 51.3 00 05.2 11
40 0.60 23 2 20 00 10
40 226 000 000 004 000 000 000 000 000 000 000 000 000
000 000 000 000 000 00 00 00 00 00 0.00 00 00.0 00 00.0 00
00 0.00 00 0 00 00 00
41 226 002 004 012 071 038 030 000 015 000 050 000 035
025 001 075 000 025 20 30 00 50 08 8.00 00 39.9 00 06.8 12
40 0.30 23 2 30 00 00
42 226 002 012 012 076 040 025 000 050 000 050 000 000
025 001 075 000 025 25 25 00 50 07 8.00 00 45.6 00 06.4 10
45 0.70 24 2 30 00 00
43 226 002 014 009 038 000 015 000 005 000 095 000 000
075 002 025 000 075 25 25 00 50 11 8.00 00 51.3 00 05.2 09
40 0.90 28 2 30 00 00
44 227 000 000 004 000 000 000 000 000 000 000 000 000
000 000 000 000 000 00 00 00 00 00 0.00 00 00.0 00 00.0 00
00 0.00 00 0 00 00 00

45 227 003 003 004 122 000 030 050 025 000 025 000 000 075 002 010 000 090 25 25 00 50 05 7.50 00 62.7 00 04.8 34 55 0.80 25 2 46 00 00

46 227 001 001 008 066 054 038 000 000 000 100 000 000 020 002 010 000 090 40 10 10 40 11 8.00 00 45.6 00 06.8 11 35 0.70 27 2 36 00 00

47 228 000 000 003 160 100 050 050 000 000 050 000 000 010 004 000 000 100 05 05 40 50 00 0.00 00 00.0 00 00.0 00 00 0.00 25 2 33 00 00

48 233 000 000 008 060 000 015 040 040 000 020 000 000 050 002 080 000 020 20 20 10 50 07 7.50 00 17.1 00 06.4 16 20 0.70 25 2 30 00 05

49 233 001 001 008 069 010 010 000 000 100 000 000 000 010 001 090 000 010 20 25 05 50 04 7.50 00 39.9 00 04.4 09 15 0.60 27 2 18 00 00

50 233 001 002 008 048 000 010 050 000 000 050 000 000 090 002 080 000 020 10 20 20 50 07 7.00 00 28.5 00 06.8 11 25 0.60 28 2 27 00 00

51 233 001 001 008 051 000 010 020 030 000 050 000 000 060 002 075 000 025 30 20 05 45 06 7.00 00 28.5 00 05.6 11 25 0.60 27 2 30 00 00

52 233 001 001 008 165 015 030 100 000 000 000 000 000 010 004 080 000 020 15 30 05 50 10 8.00 00 28.5 00 05.6 19 25 0.50 32 2 27 00 00

53 237 001 001 012 076 000 018 000 080 000 020 000 000 010 004 020 000 080 10 30 30 30 09 8.00 00 22.8 00 08.8 12 25 0.50 27 2 15 00 00

54 237 002 004 015 157 001 050 075 025 000 000 000 000 020 001 000 000 100 30 20 10 40 12 8.50 00 11.4 00 08.8 12 20 0.50 30 2 13 00 00

55 237 002 004 018 099 019 040 050 000 000 050 000 000 010 002 020 000 080 40 10 10 40 06 8.00 00 17.1 00 08.8 15 25 0.60 30 2 13 00 00

56 237 002 003 021 107 000 040 100 000 000 000 000 000 020 002 040 000 060 30 20 05 45 09 8.50 00 11.4 00 06.8 13 15 0.60 31 2 13 00 00

57 242 003 004 008 076 005 008 000 070 000 015 000 015 025 002 000 030 070 00 10 50 40 08 8.00 00 34.2 00 05.2 16 30 0.60 30 2 10 00 00

58 245 000 000 004 000 000 000 000 000 000 000 000 000 000 000 000 000 00 00 00 00 00 0.00 00 00.0 00 00.0 00 00 0.00 00 0 00 00 00

59 245 001 001 004 076 000 009 000 000 000 000 100 000 045 001 080 005 015 00 00 10 90 05 8.00 00 39.9 00 05.6 15 45 0.60 27 2 30 00 15

60 245 002 008 004 084 000 006 000 100 000 000 000 000 040 004 100 000 000 05 00 25 70 05 8.00 00 34.2 00 05.6 17 30 0.60 26 2 20 00 00

61 245 003 005 004 114 000 009 000 070 000 030 000 000 030 002 100 000 000 25 00 25 50 06 8.00 00 39.9 00 06.0 20 25 0.60 26 2 38 00 03

62 245 002 003 004 122 000 008 000 050 000 025 000 025 005 002 095 005 000 00 10 20 70 06 7.75 00 28.5 00 04.8 11 35 0.60 27 2 30 00 05

63 248 004 020 010 135 020 050 075 000 000 025 000 000 000 004 080 000 020 20 30 10 40 08 7.50 00 39.9 00 05.6 12 40 0.60 25 2 20 00 00

64 248 004 004 006 092 005 010 000 060 000 040 000 000 060 004 050 000 050 10 30 10 50 10 8.00 00 68.4 00 05.6 10 25 0.60 27 2 20 00 00

65 248 001 001 004 091 000 050 000 100 000 000 000 000 020 002 010 000 090 10 30 10 50 10 8.00 00 62.7 00 05.6 13 35 0.60 27 2 20 00 00

66 248 000 000 004 000 000 000 000 000 000 000 000 000 000 000 000 000 00 00 00 00 00 0.00 00 00.0 00 00.0 00 00 0.00 00 0 00 00 00

67 248 003 010 012 122 001 035 000 025 000 075 000 000 050 000 050 000 050 10 40 10 40 08 7.50 00 74.1 00 05.6 11 35 0.60 27 2 25 00 00

68 259 002 007 016 114 000 025 000 050 000 050 000 000 040 002 070 000 030 05 35 10 50 07 7.00 00 68.4 00 06.8 13 45 0.60 20 2 38 00 00

69 259 000 000 004 000 000 000 000 000 000 000 000 000 000 000 000 000 00 00 00 00 00 0.00 00 00.0 00 00.0 00 00 0.00 00 0 00 00 00

70 259 004 031 024 122 020 015 000 025 000 075 000 000 050 004 090 000 010 15 25 20 40 08 8.00 00 17.1 00 05.6 13 40 0.60 20 2 36 00 00

71 259 000 000 008 000 000 000 000 000 000 000 000 000 000 000 000 000 00 00 00 00 00 0.00 00 00.0 00 00.0 00 00 0.00 00 0 00 00 00

72 259 001 006 016 130 010 025 000 000 000 100 000 000 020 002 060 000 040 15 30 25 30 10 7.50 00 51.3 00 06.8 11 35 0.60 21 2 46 00 00

73 264 002 003 008 091 020 030 000 075 000 025 000 000 010 004 010 000 090 20 25 05 50 07 8.50 00 34.2 00 05.2 22 35 0.60 19 2 20 00 00

74 264 003 003 006 076 000 010 000 000 000 025 075 000 050 002 100 000 000 00 25 25 50 06 8.00 00 28.5 00 08.4 19 40 0.60 19 2 61 00 20

75 264 000 000 004 000 000 000 000 000 000 000 000 000 000 000 000 000 00 00 00 00 00 0.00 00 00.0 00 00.0 00 00 0.00 00 0 00 00 00

76 264 000 000 006 090 000 010 000 000 000 100 000 000 050 002 025 000 075 00 25 25 50 05 7.50 00 39.9 00 06.0 20 45 0.60 20 2 22 00 00

77 265 001 001 016 083 000 020 000 050 000 050 000 000 020 002 075 000 025 05 35 10 50 05 7.50 00 22.8 00 06.4 13 20 0.60 20 2 22 00 00

78 264 003 003 006 081 000 010 000 050 000 050 000 000 020 000 025 000 075 20 25 05 50 08 7.50 00 34.2 00 05.2 20 35 0.60 18 2 30 00 00

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   79 271 000 000 006 000 000 000 000 000 000 000 000 000
000 000 000 000 000 00 00 00 00 00 0.00 00 00.0 00 00.0 00
00 0.00 00 0 00 00 00
   80 271 004 052 018 112 020 030 000 000 000 075 025 000
000 004 075 000 025 50 25 00 25 08 8.00 00 22.8 00 06.4 13
25 0.60 25 2 61 00 00
   81 271 005 040 018 099 025 035 000 000 000 025 075 000
000 004 080 000 020 50 10 05 35 08 8.00 00 28.5 00 08.4 19
40 0.80 26 2 61 00 00
   82 271 005 034 012 102 022 035 000 000 000 080 020 000
005 004 080 000 020 45 05 00 50 06 7.50 00 34.2 00 05.6 19
40 0.60 25 2 51 00 00
   83 279 003 009 006 099 000 009 000 025 000 025 050 000
040 002 100 000 000 15 30 40 15 05 8.00 00 68.4 00 05.6 12
40 0.80 16 2 15 00 00
   84 279 000 000 006 000 000 000 000 000 000 000 000 000
000 000 000 000 000 00 00 00 00 00 0.00 00 00.0 00 00.0 00
00 0.00 00 0 00 00 00
   85 314 001 001 012 070 000 013 000 070 000 010 020 000
070 002 050 000 050 10 20 00 70 05 8.00 00 39.9 00 04.8 15
50 0.10 09 2 35 05 00
   86 314 000 000 012 000 000 000 000 000 000 000 000 000
000 000 000 000 000 00 00 00 00 00 0.00 00 00.0 00 00.0 00
00 0.00 00 0 00 00 00
   87 325 001 001 018 105 000 006 000 010 000 020 070 000
060 002 100 000 000 10 30 00 60 05 8.00 00 39.9 00 05.2 13
45 0.10 09 2 30 05 00
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Appendix 7. Turtle deformities.

COLL.#	SPECIES	DESCRIPTION
DE-90-2	Mississippi map turtle	plastron scutes deformed
	Mississippi map turtle	jaw deformed
DE-90-3	Red-eared slider	2 deformed scutes on plastron
DE-90-4	Red-eared slider	deformed plastron, lump on one side, depression on mid-line
DE-90-13	Red-eared slider	deformed right foot
	Western painted turtle	carapace with 2 large notches on posterior ends
	Western painted turtle	plastron with large notch by left leg
	Western painted turtle	both front feet clubbed
DE-90-17	Common map turtle	carapace indented on right side
DE-90-25	Red-eared slider	left rear clubfoot
DE-90-26	Red-eared slider	right scute #6 caved in
DE-90-31	Western painted turtle	2 extra scutes on plastron, small bump on right foot
	Western painted turtle	2 extra scutes on plastron
DE-90-33	Common map turtle	notch on 5th scute on right side of carapace, 6th scute on carapace concave

DE-90-54	Ouachita map turtle	carapace deformed at head
	Ouachita map turtle	2 extra scutes on plastron
	Western painted turtle	carapace indented
DE-90-70	Red-eared slider	left rear foot clubbed
DE-90-73	Ouachita map turtle	extra scute on plastron, and misfigured jaw
DE-90-80	Ouachita map turtle	lump on center of carapace
	Red-eared slider	lump on right side of carapace
DE-90-81	Ouachita map turtle	left front foot deformed
	Red-eared slider	left rear leg deformed
	Red-eared slider	no feet on rear legs

Appendix 8. Common names, scientific names and species abbreviations of turtles.

COMMON NAME	SCIENTIFIC NAME	ABBREVIATION
Common snapping turtle	Chelydra serpentina serpentina	CHE SERP
Common musk turtle	Sternotherus odoratus	STE ODOR
Common map turtle	Graptemys geographica	GRA GEOG
Mississippi map turtle	Graptemys kohnii	GRA KOHN
Ouachita map turtle	Graptemys pseudogeographica ouachitensis	GRA PSEU
Western painted turtle	Chrysemys picta bellii	CHR PICT
Red-eared slider	Trachemys scripta elegans	TRA SCRI
Western spiny softshell	Apalone spinifera hartwegi	APA SPIN
Missouri river cooter	Pseudemys concinna metteri	PSU CONC

Edds, D. R. 1991. Conservation status of the common map turtle in Kansas. Kansas Department of Wildlife and Parks Contract No. 259. 45pp.

Abstract: The common map turtle, *Graptemys geographica*, was formerly abundant in many parts of its range from eastern Kansas, north to eastern Minnesota, east to southern Quebec, and south to central Alabama. It is a historical component of the biota of eastern Kansas (Smith, 1956; Collins, 1982), with documented records dating to 1911. However, the species was not observed locally from 1952-1990, suggesting that this turtle had been eliminated from Kansas. This led to its categorization by the Kansas Department of Wildlife and Parks as "extirpated" from the state.

Little information is available regarding the diversity and population status of semi-aquatic turtle communities in Kansas, and how environmental factors affect species' distributions. To address this, turtles were surveyed in the southeastern portion of the state, and habitat variables measured at each site. Another goal of this study was to investigate the incidence of turtle anatomical abnormalities in southeast Kansas.

Turtle communities were sampled at 81 sites in 21 counties in southeast Kansas. Four hundred seventy-three turtles belonging to nine species were captured. The nine species, listed in order of abundance in collections, were redeared slider, *Trachemys scripta elegans*; Ouachita map turtle, *Graptemys pseudogeographica ouachitensis*; common snapping turtle, *Chelydra serpentina*; western painted turtle, *Chrysemys picta bellii*; western spiny softshell, *Apalone spinifera hartwegi*; Mississippi map turtle, *Graptemys kohnii*; common musk turtle, *Stenotherus odoratus*; common map turtle, *Graptemys geographica*; and Missouri river cooter, *Pseudemys concinna metteri*. Ordination analysis by DCCA indicates that turtle community structure in southeast Kansas is best predicted by a suite of factors that can be attributed to size of the water course. All turtles captured were examined for deformities. Abnormal specimens were retained for potential pathological examination at a later date.