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A Comparative Spotting-Scope Study of the Distribution and Relative Abundance of River Cooters (*Pseudemys concinna*) in Western Kentucky and Southern Mississippi

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ABSTRACT. – A spotting scope with 22–60x zoom magnification was used to conduct eight replicated counts of basking turtles at fixed sites on three river drainages in Kentucky, Mississippi, and Louisiana. Less formal counts were also conducted on a fourth drainage in Kentucky. River cooters (*Pseudemys concinna*) were observed at 10 of 15 Kentucky Lake sites, at densities ranging from 0.09–0.87 individuals/100 m of shoreline, and comprised from 1.7 to 7.3% of all turtles seen at these sites. No river cooters were among the 175 emydid turtles identified at sites below Kentucky Lake Dam on the Tennessee River, where rapid changes in river level may adversely affect river cooter habitat. In surveys on the Pearl and Pascagoula drainages, river cooters occurred at only slightly higher densities but comprised a much higher percentage of all emydids surveyed. The ratio of slider turtles (*Trachemys scripta*) to river cooters was 18:1 in Kentucky Lake surveys. Ratios computed for basking surveys conducted on the Pearl, Pascagoula, and Tradewater Rivers indicate that this ratio is greater for northern populations and for populations in lentic habitats such as reservoirs. Trapping results at three sites on Kentucky Lake correspond to spotting-scope counts, suggesting that use of a spotting scope may be an economical way to gather data on the distribution and population status of basking emydids.

KEY WORDS. – Reptilia; Testudines; Emydidae; *Pseudemys concinna*; *Trachemys scripta*; turtle; ecology; status; distribution; methodology; Kentucky; Mississippi; Louisiana; USA

The river cooter, *Pseudemys concinna* (Fig. 1), is a large (to 437 mm carapace length) aquatic herbivorous emydid turtle of riverine habitats of the southeastern USA (Ernst et al., 1994). Although it has never been a candidate for federal listing, it has received attention, particularly in northern portions of its range, from agencies responsible for state listings. It is currently listed as Endangered in Illinois (Morris and Smith, 1981) and Indiana (Whitaker and Gammon, 1988). Moll and Morris (1991) discussed recent collections and sightings for Illinois. In Indiana, M. Ewert (*pers. comm.*) made two observations of a single (possibly the same) *P. concinna* at one of 37 sites surveyed during 1989. River cooters are listed as a Species of Special Concern in West Virginia, where Buhlmann and Vaughan (1991) studied a small population isolated by an impoundment of the New River.

In Kentucky, which does not have state legislation regarding vulnerable species but does maintain a list compiled by an advisory group of biologists, *P. concinna* was originally listed as a Species of Special Concern (Branson et al., 1981). It was later dropped from this designation without comment (Warren et al., 1986; Kentucky State Nature Preserves Commission, 1996). Recent trapping results show the species to be in low abundance relative to other emydid turtles in southeastern Kansas (7 of 1503 emydids captured in baited hoopnets; Fuselier and Edds, 1994) and southwestern Missouri (101 of 758 emydids captured in fykenets; D. Moll, B. Thomas, and L. Turner, *pers. comm.*). In the Kansas study some of the trapping was conducted outside of the known range of *P. concinna* (see Caldwell and Collins, 1981) and the use of baited traps probably biased numbers downward.

During 1994 and 1995, I conducted spotting-scope surveys of basking turtles in Kentucky Lake and the Tennessee River below Kentucky Lake Dam in western Kentucky, as well as two river drainages in Mississippi and an unimpounded river in western Kentucky. Here I present data on *P. concinna* distribution, basking density, and relative abundance and compare data from the regions surveyed. I emphasize the data from Kentucky Lake and the lower Tennessee River, due to the species' conservation status in northern portions of its range and the fact that the Tennessee drainage encompasses a major portion of the species' range in Kentucky. I also compare spotting-scope and trapping data for selected sites on Kentucky Lake to examine the efficacy of using a spotting scope to determine the status of populations of basking emydids.

MATERIALS AND METHODS

Kentucky Lake is a reservoir formed in 1945 by a dam constructed at river mile 22.4 (35.8 km) of the Tennessee River (Fig. 2). To the east the Cumberland River was impounded in 1966 at river mile 30.0 (48.0 km), as Lake Barkley. The two reservoirs are largely parallel to one another and form a 68,826 ha region 8.8–18.8 km in width and 61.1 km long known as Land Between the Lakes (LBL). This uninhabited region is managed by the Tennessee Valley Authority primarily for recreational use, and shoreline de-

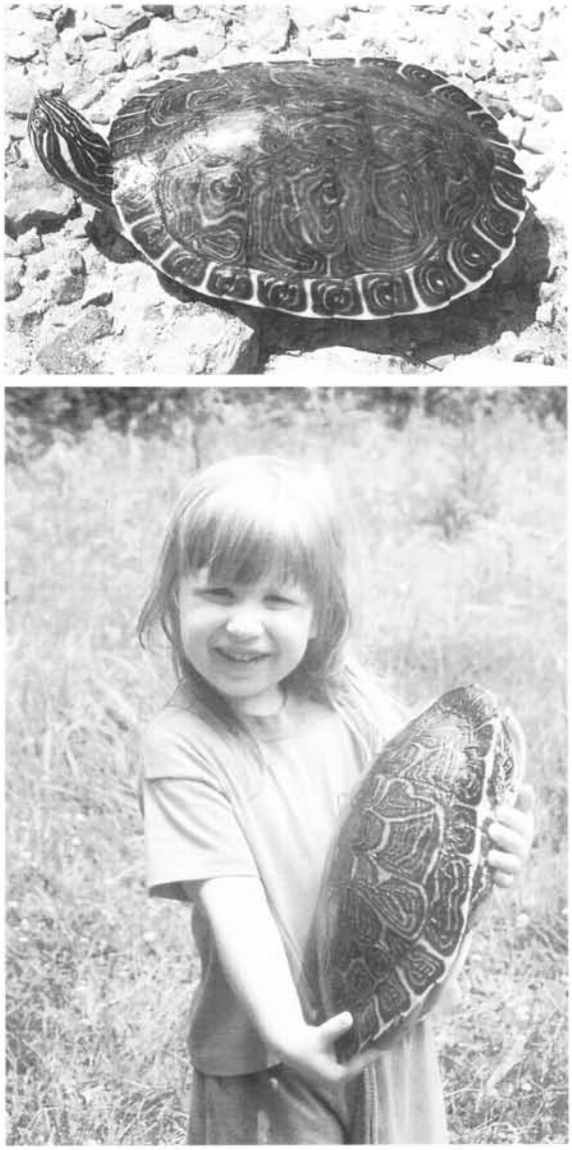

Figure 1. Female river cooters (*Pseudemys concinna*) from Kentucky Lake, Kentucky. **Top:** plastron length (PL) 149 mm, **bottom:** PL 301 mm, held by author's 3-year-old daughter.

velopment is minimal on LBL shorelines. Development on the west shoreline of Kentucky Lake consists primarily of scattered marinas and houses; there are no municipalities directly on the shoreline. The lake consists of a deep lake channel and several shallower lateral coves and embayments formed by old creek beds (Fig. 2). Water level is managed at a summer pool level of ca. 359 feet (109 m) above sea level from May to August. It is dropped just over a meter in winter, although both levels fluctuate as flood control dictates. Maintenance of relatively constant lake levels results in rapid changes in discharge below the dam. Spotting-scope surveys were conducted at 15 fixed sites on the LBL side of Kentucky Lake north of the Tennessee–Kentucky border and five fixed sites on the lower Tennessee River below Kentucky Lake Dam (Fig. 2).

Replicated surveys were conducted concurrently on the Pearl ($n = 20$ sites) and Pascagoula ($n = 21$ sites) drainages in Mississippi and St. Tammany Parish, Louisiana (see map in Lindeman, 1996). Both drainages have primarily sandy banks with medium to fast currents. Three sites on the Pearl drainage were on Ross Barnett Reservoir, an impoundment in Madison and Rankin Counties; one was on Mayes Lake, an oxbow lake in Hinds County; 11 were on the mainstem Pearl River; and five were on tributaries of the Pearl. Four sites on the Pascagoula drainage were on the mainstem Pascagoula, five were on the Leaf River, eight were on the Chickasawhay River, and four were on other smaller tributaries.

I also counted basking turtles periodically at four sites on the upper Tradewater River near Dawson Springs, Kentucky, during 1994 and 1995. The Tradewater is a small river (width 15–20 m, maximum depth rarely > 2 m) with steep vegetated banks and scattered limestone outcroppings.

During 1994 and 1995 I conducted eight replicated surveys (four each year) of basking turtles at fixed sites on the Tennessee, Pearl, and Pascagoula drainages, using a Merlin spotting scope (The Nature Company) with 22–60x zoom magnification. During each count I identified turtles to species and estimated the shoreline surveyed to the nearest 25 m. *Pseudemys* was distinguished from *Graptemys* primarily by shell morphology and from *Trachemys* primarily by head, neck, and shell markings (Ernst et al., 1994). Some turtles could not be identified to species (usually because I could not see their heads, but sometimes because they left basking sites prior to being identified); these were recorded either as unidentified *Graptemys* or unidentified emydids. The maximum amount of shoreline I could survey from a fixed point standing on shore was 125 m in either direction, but the shoreline length actually surveyed was often less than this because of shoreline irregularities and occasional disturbances by boaters and swimmers. All surveys were conducted on warm (> 20°C) sunny days between 0900 and 1500 hrs during May and June to insure relatively high and uniform basking densities.

I calculated densities for individual sites and for sets of sites by dividing the total number of turtles seen by the sum of the shoreline lengths surveyed. This is equivalent to calculating an average density as weighted by meters of shoreline scanned during each survey.

During 1992 basking counts were made at several sites on Kentucky Lake under a variety of climatic conditions and at a variety of times of day. Site G (Fig. 2) was also surveyed frequently with the spotting scope during all months of the year except January during 1993–95, with most counts conducted between May and August. These counts and the counts at Tradewater River sites were made without recording shoreline length surveyed, so no densities could be computed.

Spotting-scope data for ratios of *Pseudemys concinna* to its closest relative in Kentucky, *Trachemys scripta*, were compared to capture data in z-tests of binomial proportions. Trapping was conducted at Kentucky Lake using basking traps (MacCulloch and Gordon, 1978) and baited traps from

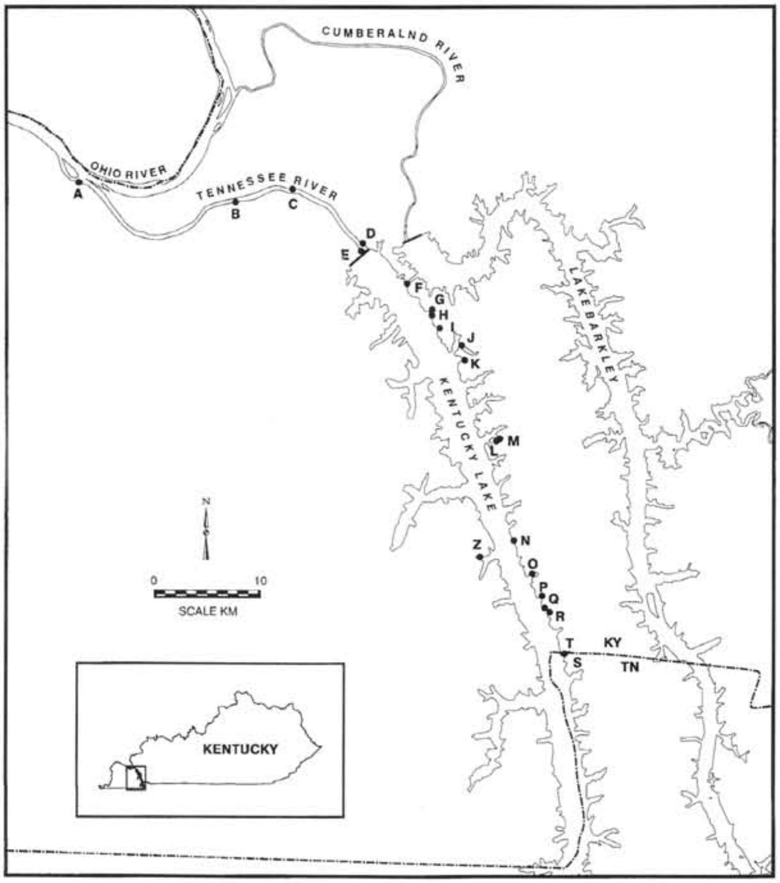

Figure 2. Map of Kentucky Lake and the lower Tennessee River showing fixed survey sites (A–T) for basking surveys conducted during 1994 and 1995, plus one site (Z) at which basking counts and trapping surveys were conducted in 1992.

1992–95, and a fykenet in 1995. Trapping from 1993–95 was carried out primarily at site G, but results from site P (1995) and site Z (1992; Fig. 2) are also compared in the present study.

RESULTS

Basking *Pseudemys concinna* were seen at least once at 10 of the 15 Kentucky Lake sites and comprised 2.8% (45 of 1582) of all emydid turtles identified at least to genus at sites on Kentucky Lake. *Pseudemys concinna* was seen at densities of 0.09–0.87 turtles/100 m of shoreline and comprised 1.7–7.3% of the emydids identified at the 10 sites where it was observed (Table 1). River cooter density and relative abundance were highly significantly correlated ($r = 0.92$, $p < 0.001$), and the total number of river cooters seen at a site was also significantly correlated with the total number of emydids seen ($r = 0.77$, $p < 0.01$). No *P. concinna* were seen at the five sites on the lower Tennessee River, where 161 total emydids were identified to species and 14 *Graptemys* were identified to genus.

The most abundant species in Kentucky Lake and Tennessee River basking surveys was the slider turtle (*Trachemys scripta*), which accounted for 843 of 1757 (48.0%) emydids identified at least to genus at the 20 sites. Other emydids observed were 505 Ouachita map turtles (*Graptemys ouachitensis*; 28.7% of all emydids), 289 Mississippi map turtles (*G. pseudogeographica kohnii*; 16.4%), 3 painted turtles (*Chrysemys picta*; 0.2%), 1 common map turtle (*G. geographica*; 0.06%), and 71 *Graptemys* I could not identify to species (4.0%). I also recorded 46 emydids I could not identify to genus.

Pseudemys concinna occurred at 19 of 20 sites on the Pearl River drainage and 15 of 21 sites on the Pascagoula River drainage. In the Pearl drainage the species was sighted 108 times and comprised 8.4% of all emydids seen. Other emydids included 997 *Graptemys oculifera* (77.6% of the total), 103 *G. gibbonsi* (8.0%), 31 *T. scripta* (2.4%), and 45 *Graptemys* not identified to species (3.5%). Thirty-five emydids were seen but not identified to genus. In the Pascagoula drainage, *P. concinna* was sighted 126 times and comprised 20.6% of all emydids seen. Other emydids included 333 *G. flavimaculata* (54.3%), 137 *G. gibbonsi* (22.3%), and 6 *T. scripta* (1.0%). Six emydids were not identified to genus.

Trachemys scripta and *P. concinna* are close relatives and ecologically similar turtles, although the former is more generalized in habitat preference (Ernst et al., 1994). In Kentucky Lake the ratio of *T. scripta* to *P. concinna* was 18:1. In the Pearl and Pascagoula drainages, *P. concinna* occurred at densities only slightly higher than those calculated for Kentucky Lake, but formed a much higher percent-

Table 1. Numbers seen, basking density per 100 m shoreline, and percentage of total emydids seen, for *Pseudemys concinna* at 10 sites on Kentucky Lake (Fig. 2) where it was observed during eight replicated spotting-scope surveys. Percentage of all emydids is calculated by including *Graptemys* that were not identified to species, but excluding emydids not identified to genus.

Site	Total *P. concinna*	Density per 100 m	Percentage of all Emydids
G	12	0.87	5.0
I	6	0.67	5.4
K	2	0.12	1.7
L	5	0.44	4.5
N	4	0.53	5.2
O	2	0.25	1.9
P	5	0.47	3.1
R	1	0.09	1.7
S	2	0.16	1.7
T	6	0.86	7.3

age of the total emydid fauna and was much more abundant than *T. scripta* (Table 2). The comparison of Kentucky Lake sites to Pearl and Pascagoula drainage sites is a comparison of relatively lentic embayments to sites that are predominantly lotic, and this probably influences the abundance of *P. concinna* relative to *T. scripta*. Fig. 3 compares ratios of these two species for lotic and lentic habitats in Kentucky (including the Tradewater River) and the two southern river drainages, for which lotic and lentic sites have been separated. Separate Mantel-Haenszel X^2-tests revealed significant differences between southern and northern sites ($X^2_{MH} = 332.4$, d.f. = 1, $p < 0.001$) and between lotic and lentic habitats ($X^2_{MH} = 95.5$, d.f. = 1, $p < 0.001$).

Temporal variation in abundance of *P. concinna* was noted at a few sites during the course of this study. No *P. concinna* were observed among 88 emydids identified at site F during the 1994–95 surveys, but during 1992 the species comprised 4.9% of 182 emydids identified in 12 counts at the site. Hatchlings were included among the *P. concinna* seen at site F in 1992 (Lindeman, 1993), suggesting that the site may be near a nesting area. At site L all five *P. concinna* observed were recorded during the same survey in 1994; this was the highest single-count incidence of the species for all Kentucky surveys. One site on the lower Bowie River, Pascagoula drainage, yielded five *P. concinna* (26% of all emydids seen at the site) during 1994 and 53 *P. concinna* (62% of all emydids) during 1995. Overall, 42% of all Pascagoula drainage river cooters observed over two years were seen at this site during 1995 surveys, a fact which strongly influences the relatively high *P. concinna* to *T. scripta* ratio I report for the Pascagoula drainage (Fig. 3).

Table 2. Comparison of three river drainages for density of *Pseudemys concinna* per 100 m of shoreline or riverbank, percentage of emydids that were *P. concinna*, total emydid density per 100 m, and *P. concinna* as a percentage of *Trachemys scripta*. Percentage of emydids that were *P. concinna* was calculated as in Table 1, while total emydids per 100 m was calculated by including emydids not identified to genus.

River drainage	Median latitude	*P. concinna* per 100 m	*P. concinna* as a % of all Emydids	Total Emydids per 100 m	*P. concinna* as a % of *T. scripta*
Tennessee	37°N	0.223	2.6	8.94	5
Pearl	31°N	0.255	8.4	3.12	348
Pascagoula	31°N	0.298	20.6	1.47	2100

Trapping and spotting-scope data for three sites on Kentucky Lake are compared in Table 3. *Trachemys scripta* was more abundant than *P. concinna* at all three sites. The ratio of *T. scripta* to *P. concinna* did not differ at any of the sites in comparisons of trapping and spotting data (Table 3).

DISCUSSION

Spotting-scope observations and trapping results indicate that river cooters (*P. concinna*) are rare in Kentucky Lake, especially in comparison to their close relatives, sliders (*T. scripta*). Although the results of the present study should be viewed as preliminary, river cooter rarity appears to be a function both of the northern location of the population and habitat modifications. The location near the species' northern range periphery may naturally depress river cooter abundance, which was greater (relative to other emydid species) in the two southern river drainages studied (Table 2). Lentic reservoir coves may also favor sliders to a greater extent than river cooters, since the former inhabit a greater diversity of lentic habitats than the latter (Ernst et al., 1994). Data from the Tradewater River in western Kentucky, and from Mayes Lake within the Pearl drainage in Mississippi, support this hypothesis (Fig. 3). The data that fit this pattern of a lower slider to river cooter ratio in southern and lotic habitats most poorly are those from the Tennessee River below Kentucky Lake Dam (Fig. 3). If river cooter relative abundance in the lower river equalled the proportion of emydids observed in the lake above the dam that were river cooters (0.028), then the probability of identifying 175 emydids without seeing a river cooter would be 0.972^{175}, or 0.007. Thus my failure to record a river cooter at these five sites was probably not due to small sample size. The Tennessee River differs from all other rivers considered in Fig. 3 in the degree of anthropogenic modification of its flow regime. Perhaps the dramatic fluctuations in discharge as mediated by the dam have an adverse effect on the aquatic vegetation that forms the bulk of the species' diet (Buhlmann and Vaughan, 1991; Lindeman, unpubl. data for Kentucky Lake turtles), causing river cooters to be very rare or possibly even absent. It would be interesting to know whether the species' status in Lake Barkley and the lower Cumberland River parallels its status in Kentucky Lake and the lower Tennessee River.

Buhlmann and Vaughan (1991) conducted basking surveys of *P. concinna* in three disjunct populations. Surveys were conducted on warm sunny days (K. Buhlmann, *pers. comm.*) and turtles were marked to allow visual identification of turtles that had been captured. During May and June the average percent of marked turtles observed basking ranged from 15.5 to 27.1% of the total marked turtles known to exist. If it is assumed that I saw on average 20% of the *P. concinna* present at Kentucky Lake sites during my May and

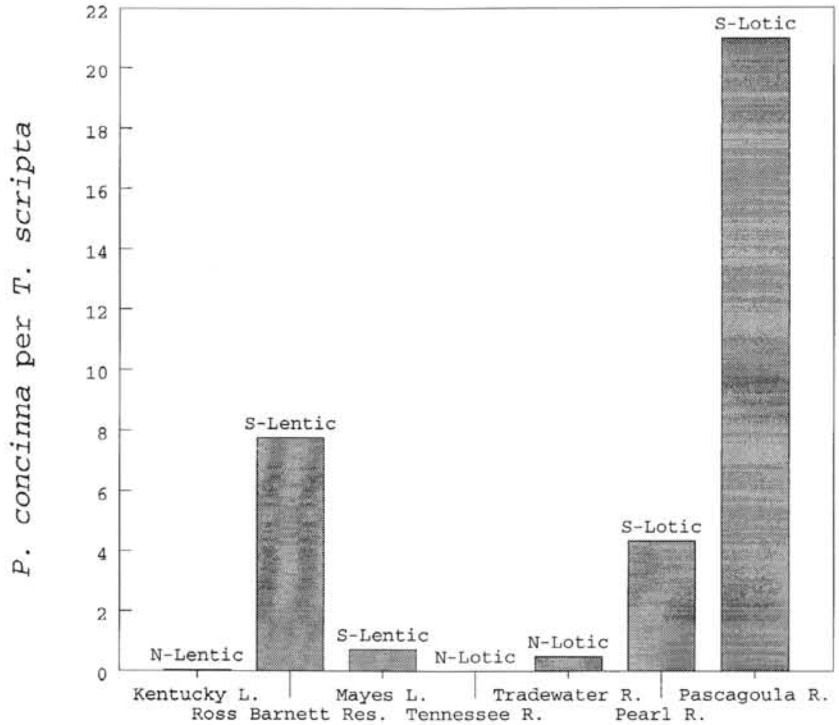

Figure 3. Number of *Pseudemys concinna* per *Trachemys scripta* for basking counts at northern (N) and southern (S) sites, divided into lotic and lentic habitats.

June surveys, and if it is assumed that my sites were representative of *P. concinna* density for the entire shoreline of the reservoir, then a rough estimate of total population size may be calculated. There are 125.31 km of shoreline between the Kentucky-Tennessee border and Kentucky Lake Dam on the LBL side of the reservoir (Fig. 2). Basking density at reservoir sites averaged 0.316 river cooters/100 m. Under the assumptions stated above (i.e., total density of 1.58/100 m for the entire length of the shoreline), an estimated 1979 river cooters occur on the LBL side of the reservoir in Kentucky. If the west shoreline (187.53 km, measured northward from a point directly across the reservoir from points S and T; Fig. 2) also has this density, total population size for the reservoir north of the Kentucky–Tennessee border in LBL (Fig. 2) would be estimated at 4942 individuals. These estimates are obviously very preliminary as they rely upon untested assumptions regarding what average proportion of Kentucky Lake river cooters bask in May and June and how representative my survey sites were for the entire reservoir.

Table 3. Comparison of trapping and spotting-scope data for three sites on Kentucky Lake, with *Pseudemys concinna* (*P.c.*) as a percent of *Trachemys scripta* (*T.s.*). A z-statistic is given for each site for the null hypothesis of no difference in this percentage between trapping and spotting-scope data. All differences were not significant ($p > 0.75$).

Site	Years	Method	Unit effort[a]	*P.c.*	*T.s.*	*P.c.* as a % of *T.s.*	z
G	1993-95	trapping	322[b]	7	107	6.5	-0.31
		spotting	181	75	990	7.6	
P	1992-95	trapping	2[c]	1	38	2.6	0.31
		spotting	21	6	246	2.4	
Z	1992	trapping	4[d]	2	9	22.2	0.08
		spotting	6	4	26	15.4	

[a] Number of trap-nights or spotting-scope counts
[b] 264 basking-trap nights, 27 fykenet nights, and 31 baited-trap nights
[c] One fykenet set and left for two nights
[d] Four basking-trap nights

Although river cooter abundance in Kentucky Lake is low relative to the unimpounded rivers studied, the total number of river cooters in the Kentucky Lake region may be higher than it was historically because of the increased shoreline created by the inundation of 42.9 km of river. If 4942 river cooters (estimated above) inhabited the river prior to its impoundment, this would mean a total density of 5.76 individuals per 100 m riverbank, or a May–June average basking density of 1.15 individuals per 100 m, assuming that 20% bask. This estimate is considerably higher than the observed values in the Pearl and Pascagoula drainages (Table 2).

Data in Table 3 demonstrate the utility of a spotting scope in censusing populations of basking aquatic emydids. Larger data sets may be compiled using a spotting scope with less expense of time and effort. Results of my spotting-scope surveys of *P. concinna* and *T. scripta* did not differ from results of my trapping surveys. Jones and Hartfield (1995) found that replicated basking counts of *Graptemys oculifera* were an index of population size estimates from mark-recapture studies. While trapping is, of course, necessary to obtain more detailed information, such as population structure, life history, and diet, replicated basking counts should be considered as a research tool in any widespread survey of the status of a basking emydid.

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