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Movements and Habitat Use of Subadult Alligator Snapping Turtles (Macroclemys temminckii) in Louisiana

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Abstract.—We conducted a telemetry study of subadult alligator snapping turtles (*Macroclemys temminckii*) to investigate movement and habitat use. Available habitat consisted of baldcypress forest (*Taxodium distichum*) (69.1%) and open channel (30.9%). Twelve (three male, nine female) turtles from Bayou Desiard in northeast Louisiana were each equipped with an ATS external radio transmitter and returned to the capture location within 2 h. A total of 1327 location fixes were recorded from March 1992 to June 1993. At each fix location the date, time, water temperature and depth, direction from last fix and capture site, and nearest shoreline, and habitat were recorded. Significant differences were noted between male and female mean fix distance (males = 352.2 m, females = 160.3 m), mean percentage of movement fixes (males = 62.7%, females = 42.7%) and mean home range length (males = 3495.1 m, females = 1423.2 m). The percentage of movement fixes and fix distance was highly correlated with water temperature but not with the size of the turtle. Turtles preferred the baldcypress forest to open channel. Males and females had significant differences in microhabitat use; 56.1% of male fixes were associated with structures (*e.g.,* logs) compared to 79.7% for females. Turtles returned to specific microsites and there were no overland movements. Subadult and adult alligator snapping turtles in Bayou Desiard have similar movement patterns and habitat use.

Introduction

Alligator snapping turtles (*Macroclemys temminckii*) are secretive, highly aquatic and difficult to study. This species is listed as a threatened, protected or restricted species in most states because of overharvest, dredging, pollution and depletion of its wetland habitat (Pritchard, 1989). Sloan and Taylor (1987) found that movements of adult *M. temminckii* varied and that bald cypress (*Taxodium distichum*) forest, vegetation mats, and buttonbush (*Cephalanthus occidentalis*) were used extensively. Shipman (1993) reported similar results from one adult female in Kansas. The turtle had "core sites" containing much cover and debris in which she would remain inactive for at least 1 h. She also moved upstream 6.5 km in 11.5 mo.

There has been no research on subadult *Macroclemys temminckii.* Subadults are an important size class to study, as they represent potential breeders. Subadults may have different movement patterns or varied habitat use because of habitat partitioning, size, sexual immaturity, juvenile dispersal (Diemer, 1992) or diet. Information concerning movements and habitat use is vital for better understanding of the ecology of North America's largest freshwater turtle. The objective of this study was to determine the movements and habitat use of subadult *M. temminckii* in a Louisiana bayou.

STUDY AREA

Approximately 9.7 km of the northern portion of Bayou Desiard, located ca. 10 km N of Monroe, Louisiana, served as the study area. Bayou Desiard is a slow-flowing, winding bayou that partially drains Lake Bartholomew through culverts to the N and empties into the larger Ouachita River to the S. The central and southern portion of the bayou are partitioned by several control structures with underwater culverts allowing control of water flow. An open channel, almost devoid of emergent vegetation, runs through the center of the bayou. Between the open channel and the bayou shoreline is a baldcypress forest. Numerous small breaks exist in the baldcypress forest consisting of either open water, thickets of buttonbush or floating mats of herbaceous vegetation (*Ludwigia glandulosa, L. peploides, Hydrocotyle ranunculoides, Myriophyllum brasiliense, Eichornia crassipes, Azolla caroliniana* and *Lemna* spp.). The underwater habitat varies from open (bare sand, mud bottom or leaf debris) to dense areas of logs, stumps, branches or submergent vegetation composed primarily of *Cabomba caroliniana, Ceratophyllum demersum, Uricularia* spp. and *Najas guadalupensis.* Sixty circular (4 m radius = 50 m^2) sampling plots were used to determine tree/shrub/sapling ($>$1.37 m all) density and size (DBH). The plots were located at 30 points, 315 m apart (upstream/downstream) in the study area in the midpoint of the baldcypress forest on either side of the stream channel. The baldcypress forest had a mean density of 4.3 trees/shrubs/saplings per sample plot (876 per ha) and a mean DBH of 26.8 cm per individual. The water depth of the open channel and baldcypress forest and the width of open channel, baldcypress forest and total bayou were measured at 75 points. The points were located an equal distance apart (upstream/downstream) in the study area. The mean water depth of the open channel was 193.7 cm and in the baldcypress forest was 121.9 cm. The mean bayou width was 81.6 m, the baldcypress forest width was 56.4 m, and width of the open channel was 25.2 m.

MATERIALS AND METHODS

Size criteria and capture.—Macroclemys temminckii can be divided into three ontogenetic classes: adults, subadults and hatchlings. Dobie (1971) considered turtles to be sexually mature based on the following criteria: for males, skull length = 11.5 cm and carapace length = 37.0 cm; for females, skull length = 11.2 cm and carapace length = 33.0 cm. Subadult turtles were classified by a skull length of 8.0–11.0 cm and a carapace length of 18.0–32.0 cm.

We trapped from 16 March–2 June 1992 for a total of 38 trapping days. Seventeen black, three-hoop, 91.4-cm hoop nets were used to capture turtles. Captured turtles were removed immediately from nets; those that did not meet the size criteria were measured, marked and released. Subadults were placed in a plastic container, weighed on a Hanson (860) scale, and then strapped to a board for further measurement and transmitter attachment. Measurements taken with calipers included carapace length and width, plastron length and width, precloacal length and head length. Environmental data such as water depth, temperature and habitat type were also recorded at the time of capture. The capture per unit effort (CPUE) was 0.042 per day and was calculated by dividing the number of turtles (27 = 14 subadults and 13 adults) by the number of trapping days (38) multiplied by the number of traps (17) (Bagenal, 1978; Neilson and Johnson, 1983).

Transmitter placement and telemetry equipment.—Advanced Telemetry Systems (ATS, Isanti, Minn.) transmitters were attached to the posterior marginal scute of the carapace of 12 subadult turtles by two, 1.6-mm self-locking nuts and bolts. Transmitters were 48 mm × 29 mm × 19 mm, weighed 66 g, had a pulse rate of 57–62 ppm, a pulse width of 17–19 msec, and were hermetically sealed in 3M Scotchcase electrical resin. A 45.7-cm transmitter antenna trailed behind the turtle. A TR-2 receiver (TELONICS, Mesa, Ariz.) and a Yagi 2-element "H" antenna were used to monitor the turtles (Kenward, 1987). Following attachment of the transmitter, each turtle was photographed and assigned a color corresponding to plastic flagging ribbon, which was used to mark fix locations (for example, 151.560 MHz = RED).

Monitoring and data collection.—The 12 turtles (nine females, three males) had the following mean measurements at the time of recapture: weight 4.10 kg (SD 0.62); carapace length 26.48 cm (SD 1.42); carapace width 22.50 cm (SD 1.30); plastron length 19.81 cm (SD 0.94); plastron width 19.02 cm (SD 1.13); precloacal length 6.04 cm (SD 0.87); and head length 9.03 cm (SD 0.56). Of the 15 turtles that were caught but not used, 10 were adult females, three were adult males, and two were too small for sex determination.

All turtles were released at the exact spot of capture within 2 h after capture. The release site was marked by colored ribbons. A turtle's capture location was the reference point for measuring up and down stream movement. Telemetry fixes were made on each turtle irregularly during the study. Fixes were from a boat, which made it possible to get directly above each turtle in order to determine its exact location and eliminated the need for triangulation. Fix locations were marked with colored ribbons (Reinert, 1992). The date and time of the fix were recorded on the colored ribbon.

Each time a fix was taken, the following data were recorded: date, time, air temperature, weather condition, water depth, water temperature, water color (secchi disk), location up or down stream from previous fix, up or down stream from capture site, distance traveled from previous fix, distance from capture site, distance from shoreline, azimuth from capture site, azimuth from last fix, macrohabitat and microhabitat type, and same or opposite side of bayou (Reinert and Kodrich, 1982; Slip and Shine, 1988; Brown *et al.*, 1990; Secor, 1992). Distances were measured in feet with a hand-held Ranging 600 range finder which has a margin of error of ±6″ at 100′, ±5′ at 300 , and ±20′ at 600′. Feet were later converted to meters. Water depth was recorded in cm and all temperature measurements were in degrees Celsius.

Habitats, recapture and data processing.—The study area included two macrohabitats: baldcypress forest and open channel. The baldcypress forest could be subdivided into forest, open water, floating aquatic vegetation mat, or dense buttonbush thicket habitats. Microhabitat was the area within 2 m^2 of a fix location and was divided into three major categories: structures, open water and undetermined. Structures included logs, stumps, branches, cypress tree roots, debris (leaf and other natural litter), vegetation mat, buttonbush, submerged vegetation or man-made structures (duckblinds). Undetermined microhabitats occurred at fix sites with high water turbidity.

Each turtle was recaptured by hand collection or by gill webbing approximately 1 yr (mean = 370.9 days) from the date of initial capture. Each turtle was remeasured, and its sex was determined surgically (Owens *et al.*, 1978; Wood *et al.*, 1983; Rostal *et al.*, 1990; Mahmoud and Cyrus, 1992). The transmitters were removed and a Louisiana Department of Wildlife and Fisheries tag was attached. The turtles were taken to their last known location and released.

An unpaired student's t-test was used to compare fix distance, percent of movement fixes, water depth and distance from shoreline between males and females. Home range length of males and females was compared using a Mann-Whitney U-test. Pearson Correlation (r) was used to correlate size and percent of movement fixes, fix distance, home range, distance from shoreline, and water depth. This test was also used to correlate water temperature and percent of movement fixes, fix distance, distance from shoreline and water depth. Goodness

TABLE 1.—Telemetry and activity data for male and female subadult *M. temminckii*

Number of fixes	Movement fixes (%)	Mean fix[1] distance (m)	Home range (m)	Mean dist. from shoreline (m)	Mean water depth (cm)
		Females (n = 9)			
112	26.8	106.5	267.0	11.8	154.1
111	28.8	213.5	737.3	25.6	123.8
107	30.8	138.6	239.0	14.9	81.3
123	37.4	41.1	124.2	17.3	136.3
102	41.2	146.9	299.9	8.9	80.4
110	45.5	271.7	732.4	17.6	108.7
120	50.8	189.3	306.0	20.6	122.5
98	59.2	267.4	593.4	14.3	151.4
115	64.3	68.1	200.7	9.1	166.2
Mean 110.9	42.8	160.3	388.9	15.6	125.0
SD 7.5	12.6	77.3	220.8	5.1	28.9
		Males (n = 3)			
110	58.2	415.7	1221.3	12.3	93.5
103	65.0	314.9	789.6	15.2	130.4
116	65.5	326.0	647.9	20.9	110.2
Mean 109.7	62.9	352.2	886.3	16.2	111.4
SD 5.3	3.4	45.1	243.9	3.6	15.1

[1] Movement fixes only

of fit (chi-square) with Yates correction for continuity was used to compare observed use of macrohabitat to available macrohabitat (Ludwig and Reynolds, 1988; White and Garrott, 1990).

RESULTS

Movements.—The total number of fixes was 1327, a mean of 110.6 per turtle. The mean time between fixes was 3.3 days. the percent of fixes in which turtles had moved since the last fix (movement fixes) was significantly greater in males than females (Table 1) (t = 2.506, P = 0.031). The mean distance between movement fixes was longer for males than females (Table 1) (t = 3.718, P = 0.004). Males were in shallower water than females (Table 1) (t = 4.278, P = 0.001). There was no significant difference between males and females in distance from shoreline (Table 1) (t = 0.731, P = 0.465).

Home-range length was calculated by adding the farthest upstream movement distance to the farthest downstream movement distance (Pluto and Bellis, 1988; Rowe and Moll, 1991). The bayou is nearly the same width throughout the study area and no overland movements were recorded, so home range length was used rather than area. Mean home range length for male turtles was longer than that of females (Table 1) (U = 27.000, P = 0.014). Nine of the 12 home ranges overlapped.

The mean percentage of fixes in which turtles moved upstream from the previous fix was 22.8; downstream from the previous fix was also 22.8, and the percent of lateral movements from the previous fix was 2.5. The percentage of fixes in which the turtle moved upstream from the capture site was 18.5 and downstream from the capture site was 29.2.

Water temperature was highly correlated with percentage of movement fixes (r = 0.955) and fix distance (r = 0.937), but less correlated to distance from shoreline (r = 0.749) and

TABLE 2.—Monthly telemetry and activity data for subadult *M. temminckii*

			(n = 12)			
Month	Mean water temp (C)	Number of fixes	Movement fixes (%)	Mean fix[1] distance (m)	Mean dist. from shoreline (m)	Mean water depth (cm)
Jan	9.1	113	7.1	12.0	13.9	135.9
Feb	10.3	108	4.6	11.1	14.8	130.4
Mar	13.8	128	21.9	136.1	16.2	128.1
Apr	19.1	87	75.9	224.4	16.6	117.4
May	24.7	88	76.1	306.1	16.3	120.9
Jun	27.2	73	76.7	312.3	21.1	125.0
Jul	29.1	114	82.5	257.6	18.3	120.3
Aug	27.1	116	78.4	180.6	18.0	110.9
Sep	25.9	121	75.2	274.1	14.8	112.2
Oct	19.9	132	61.4	182.5	15.7	122.1
Nov	13.3	131	29.8	88.7	13.1	116.5
Dec	9.3	116	6.0	31.2	13.6	124.4

[1] Movement fixes only

water depth (r = 0.634). There was little correlation of size to any variable: distance to shoreline (r = 0.507), home range (r = 0.495), fix distance (r = 0.437), water depth (r = 0.274) and percentage of movement fixes (r = 0.133). The smallest percent of movement fixes (4.6) and shortest mean fix distance (11.1 m) for all turtles occurred in February (Table 2). The largest percent of movement fixes was in July (82.4) and the month with the longest mean fix distance was June (312.3 m). Only 82 (6.2%) of the fixes represented a turtle crossing the bayou. All the turtles stayed within the bayou except for one female which ventured over 800 m up a small adjoining creek. The turtle overwintered there and then returned to within 36.0 m of its capture site the following spring. Two other turtles (a male and a female) moved over 1850 m within the bayou and overwintered at a new location. The male returned close to its capture site after winter was over but the female did not.

Habitat use.—Macrohabitats available to the turtles in the study area included 30.9% open channel and 69.1% baldcypress forest. Almost all of the fixes (males = 99.7%, females = 98.9%, total = 99.1%) were in the baldcypress forest. The observed macrohabitat preference is significantly different from the expected (sample chi-square = 41.13, sample g-statistic = 63.7, $P < 0.001$).

The microhabitat occupied by subadults in 73.8% of the fixes was a structure. The most often used structures were log/logs (39.5% of the fixes), buttonbush (9.2%), stump/stumps (8.8%) and branches (8.0%). For all subadult turtles, the lowest percentage of fixes with a structure occurred in spring (63.0) and summer (70.5). Males were found in open water microhabitat more often than females (t = 4.694, P = 0.003), especially during the spring. There were no substantial differences in overwintering microhabitats.

Turtles returned to within 1.5 m of a previously occupied site on 135 occasions, 97 of them to a microstructure of log/logs. One area of logs was visited by five turtles during the year. At six different fixes two turtles were present, and at two fixes three turtles were present. Forty-six fixes were made at a site where a different turtle had been before. Thirty-three of the 46 fixes were male/female combinations and the other 13 were male/male. No female/female combinations were observed. There was no mortality during the study.

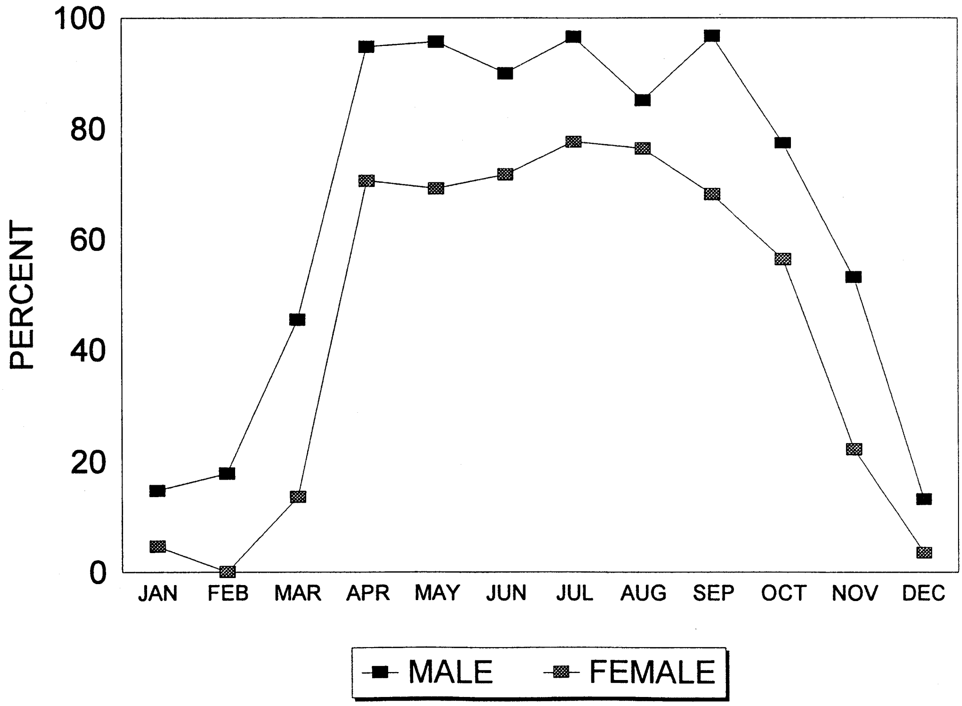

FIG. 1.—Percent of movement fixes by month for male and female subadult *M. temminckii*

DISCUSSION

Movements.—Gibbons (1990) listed four reasons for turtle movements: (1) basking; (2) reproduction; (3) feeding and (4) favorable hiding places (cover). *Macroclemys temminckii* seldom if ever bask (Pritchard, 1989) and we observed no basking. Turtles used in this study were nonreproductive subadults and no reproductive behavior was observed. However, there were 33 fixes where a male moved into a microsite where a female had been. We observed no feeding activity during the study, but fixes were made near large bream beds (*Lepomis* spp.). Cover was a major factor for turtle movements in our study; 99.1% of fixes were in baldcypress forest and 73.8% were associated with a structure.

In addition to cover, water temperature also affected turtle movement. The water temperature was about the same in November (mean = 13.3 C) and March (mean = 13.8 C); however, the distance between fixes was longer in March (mean = 136.1 m) than in November (mean = 88.7 m) (Table 2). Perhaps photoperiod as well as temperature affect movement. Movement began to increase drastically in April for all turtles, particularly for males (Fig. 1). There was a sharp decline in movement by males in August (mean fix distance July = 453.8 m, August = 208.4 m, September = 328.2 m), a trend that has also been noted in other turtle species (Meeks and Ultsch, 1990; Lovich *et al.*, 1992; Brown and Brooks, 1993). The maximum mean water temperature during our study was 29.1 C in July, however, our turtles did not move to the deeper cooler waters of the open channel during the hot summer months. This could be because of a lack of structures in the open channel.

Habitat.—The baldcypress forest occupies 69.1% of the bayou and the open channel occupies 30.9%. The preference (99.1% of the fixes) for the baldcypress forest habitat shows the importance of forested wetlands to this species. The high preference for structure was similar to common snapping turtles (*Chelydra serpentina*) (Froese, 1978). Obbard (1977) stated that common snapping turtles preferred areas with cover because they were "ambush predators"; this is also the case with *Macroclemys temminckii.*

On numerous occasions we could see and photograph the turtles that were often not only under logs but inside them. Additional observations were made of the turtles in shallow depressions at the base of cypress trees or stumps. These depressions apparently were constructed by the turtles. In some instances, the turtles were covered by loose leaf litter with only their head and a small portion of their carapace exposed. Galbraith *et al.* (1987) observed similar activity in *chelydra serpentina.* Burrowing in the bottom was especially evident during winter months. In addition to cover, the structures also may be used as climbing aids in obtaining air since these turtles are bottom-walkers and are relatively poor swimmers compared to other aquatic turtles.

There were limited observations of aggregation or interaction by the turtles. However, during recapture efforts, a small *Macrolemys temminckii* without a transmitter that we had captured the year before was recaptured within 30 cm of the targeted transmittered turtle. Also, after the turtles were returned to their recapture location, we placed traps (hoop nets) in locations that were "highly preferred" and additional *M. temminckii* (subadults and adults) were captured. Two nights of trapping with a single trap in one particular "highly preferred area" yielded three additional adult *M. temminckii* weighing 12.7, 26.4 and 32.7 kg.

Our results show similarities to adult *Macrolemys temminckii* in their frequent use of cypress forest and in their tendency to return to the same microsite or core areas (Sloan and Taylor, 1987; Shipman, 1993). Since the baldcypress forest and structured microhabitats within this forest are very important to the subadult *M. temminckii,* this should add impetus to the efforts to protect these wetlands, especially from dredging.

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