1979 JOURNAL OF HERPETOLOGY 13(2):157–164

Seasonal Activity Ranges and Habitat Preferences of Adult Alligators in a North-Central Florida Lake*

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ABSTRACT—Seasonal movements and habitat preferences of adult alligators were studied in a north-central Florida lake from September 1976 until September 1977. Nine alligators (5 females, 4 males) were outfitted with radio transmitters and monitored on Newnan's Lake, Alachua County, Florida. Study animals were located 627 times via telemetric signals and visual observations. Female alligators were more sedentary than males during all four seasons (winter, spring, summer and fall). Greatest movements and largest seasonal ranges for both sexes occurred during the spring. Females showed no evident preference for either lake or swamp habitat during the spring, while males preferred the open lake. Reduction in activity ranges was noted during the summer for both sexes. Males preferred the open lake during the summer while females restricted themselves to the surrounding swamps. Preference for the swamp during the summer by females was believed to be due primarily to nest construction, egg laying, and attendance at nest sites.

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The American alligator (*Alligator mississippiensis*), is the only crocodilian found in the United States in large numbers. It is especially abundant in Florida and is important in that state for several reasons. Many other animals are dependent upon the presence of alligator holes during periods of drought, especially in the Everglades. From an aesthetic standpoint the alligator is an example of Florida's pristine wildlife. The alligator also shows promise of becoming an economic resource because of the value of its hide. Biologists in Louisiana have shown for several years that the alligator can be harvested on a sustained yield basis (Palmisano et al., 1973).

Significant research completed within Florida is by Jones (1966)—capture and tagging techniques; Fogarty and Albury (1968)—food habits of immature alligators; Hines et al. (1968)—alligator research progress report; Fogarty (1974)—ecology of the Everglades alligator; Forrester and Sawyer (1974)—leech infestations of alligators; and Goodwin and Marion (1978)—nesting ecology of alligators. Most of this research deals with alligators in the Everglades region. In order to manage alligator populations in north-central Florida, knowledge of seasonal movement patterns and habitat preferences of adult alligators is needed. This study has been designed to obtain this information in a previously unstudied habitat and is the first major telemetric study of adult alligators in Florida.

The alligator's habitat of dense swamplands, lakes, and marshes make it a difficult animal to observe in the wild. Radio telemetry was the technique chosen to locate marked individuals in this study. The capture-recapture method (Chabreck, 1965) was not used because radio telemetry was more effective in meeting study objectives.

STUDY AREA

Newnan's Lake, a large (2800 ha) freshwater lake, is approximately 4.8 km east of Gainesville, Alachua County, Florida (29°40'N, 82°25W). It is a tannin-stained, soft water, eutrophic lake fringed by bald cypress (*Taxodium distichum*). The lake is shallow with a gently sloping bottom; the maximum depth is approximately 3.9 m. The bottom is primarily mud and silt, with some sandy shores. The 130,000 ha watershed is largely undeveloped and approximately 85 percent forested (Brezonik and Shannon, 1971).

*Contribution No. 1728 of the Journal Series, Florida Agricultural Experiment Station, Gainesville, Florida 32611.

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Except for portions of the western shoreline which are inhabited by man, the lake is surrounded almost entirely by cypress trees. The hydric swamps bordering most of the lake are predominantly cypress, red bay (*Persea borbonia*), water oak (*Quercus nigra*), and tupelo gum (*Nyssa sylvatica*) in the overstory. Understory vegetation in the swamps and along some shorelines includes buttonbush (*Cephalanthus occidentalis*), Carolina willow (*Salix caroliniana*), primrose willow (*Ludwigia peruviana*), maidencane (*Panicum hemitomon*), dollarwort (*Hydrocotyle umbellata*), arrowhead (*Saggittaria* sp.), waterlily (*Nymphaea odorata*) smartweed (*Polygonum* sp.), and alligatorweed (*Alternanthera philoxeroides*).

METHODS

Surface water and air temperatures were recorded each time the study animals were monitored. A field compass was used in obtaining bearings on the alligators. Activity ranges were calculated with the aid of a modified acreage grid.

Determination of Activity Range Size.—Minimum seasonal activity range was defined as that area included within a line connecting the outermost locations of the alligator during periods of visual and telemetric observations. Activity ranges are considered minimal figures since the alligators could have moved beyond these locations when they were not monitored. Marchinton and Jeter (1966) used a technique in which they connected outermost irregular points to develop the approximate boundaries of the home range of an animal. This technique is similar to the modified minimum area method (Harvey and Barbour, 1965), the main difference being that, in this study knowledge of the alligator's habitat requirements rather than a mechanical procedure was used in determining the minimum range boundaries.

Telemetry Equipment.—The 9 VHF transmitters were supplied by Wildlife Materials, Inc., Carbondale, Illinois and by Dav-Tron, Minneapolis, Minnesota. Three different transmitter antenna arrangements were used. Two were equipped with dual whip antennae 30.4 cm long; 6 had single 30.4 cm whip antennae and 1 had the antenna incorporated into the collar. Transmitters emitted pulsed signals between 150.830–151.375 MHz. The transmitter packages weighed 300 g and included heavy nylon web collars approximately 5 cm wide that were adjustable from 50 to 91 cm in circumference.

Most transmitters were painted with high visibility paints for easy visual identification and all were waterproofed and coated with a clear marine acrylic lacquer to prevent deterioration of the paint. Transmitters were powered by lithium batteries with a life expectancy of approximately 18 months.

Two portable VHF tracking receivers were used with a hand-held 4 element Yagi directional antenna and earphones.

Capture and Tagging Techniques.—Study animals were caught at night by spotlighting from an outboard motor boat with the aid of a wire noose attached to a long pole (Chabreck, 1963; Jones, 1966). On animals larger than 2.4 m, a break-away noose attached to the bow of the boat was used. The break-away noose consisted of a standard wire snare attached by a small clip to the end of a long pole. Approximately 15 m of nylon rope was attached from the bow of the boat to the wire noose. Once the noose was placed over the head of an alligator, the movement of the animal away from the boat tightened the snare. The alligator was allowed to wear itself out while ensnared and was then pulled into the boat. This technique was more successful and is recommended on large alligators as it allowed a greater freedom of movement and reduced injuries to the animal. Physical measurements were obtained for all study animals (Table 1). Sex of the alligator was determined by cloacal examination (Chabreck, 1963). The study animals were marked with a numbered metal tag placed in the web of the right hind foot. All alligators in this study were considered to be adults (Chabreck, 1965; Hines, et al. 1968; McIlhenny, 1935).

TABLE 1. Sexes and measurements of adult alligators monitored on Newnan's Lake, Florida.

Alligator Number	Sex	Total Length(cm)	Weight (kg)
1	Female	203	51.7
2	Male	200	50.8
3	Female	221	53.0
4	Female	220	51.7
5	Female	228	60.0
6	Female	238	59.0
7	Male	286	110.0
8	Male	254	67.2
9	Male	248	65.0

Transmitter Attachment.—Most transmitters were attached in the field at the point of capture. Following the advice of T. Joanen (1977 pers. comm.), small wooden strips were attached to the collar to fit laterally along the nuchal scutes and prevent the collar from slipping around the animal's neck. The radio collar was attached to the animal's neck with the transmitter sitting atop the nuchal scutes and fastened together with marine hardware. The collaring procedure took approximately 15 to 20 minutes.

Tracking Procedure.—Alligators were located 3 or 4 times per week during the study. The majority of the fixes were obtained during mid-morning when the alligators could usually be observed basking or at night when they were noticeably more active.

Alligators were located by radio triangulation and/or visual contact, using an outboard motorboat or airboat. Once an animal was located, the following data were recorded: date, time of day, exact location, water and air temperatures, wind velocity, and comments on activity. Fixed-wing aircraft were used when the animals moved too far from their previous vicinities to be located via surface craft.

Results and Discussion.—Minimum seasonal activity ranges were calculated for all animals under observation (Table 1). In most cases, the minimum fall, winter, and summer ranges were portions of the larger spring ranges. This was true for both sexes. The ranges were determined from 627 visual and telemetric fixes obtained on the study animals between 12 September 1976 and 20 September 1977 (491 radio fixes and 136 by visual contact).

It has generally been assumed that some area within the home range of an animal or social group is used more frequently than any other and this area which usually contains the principal home site, refuge, and most dependable food source is referred to as the "core area" (Kaufmann, 1962). The data collected during this study lend credence to this concept because the majority of the animals limited most of their activities to a smaller, central portion of their seasonal ranges. This was especially true of females, for most of their activities were confined to an area near the winter den or nest site.

Difficulties Encountered with Telemetry Equipment.—Signal strength was significantly lower when an animal was below the surface of the lake or in its den as opposed to swimming on the surface. On 1 transmitter the antenna was incorporated into the collar; poorer transmission was noted compared to the whip antennae used on the other units. Maximum surface radio range was approximately 500 m as compared to .8 km for single antenna transmitters used during the study. This range was increased to nearly 2.4 km when using an omni-directional antenna attached to the wing strut of a low-flying aircraft. Transmitters equipped with dual antennae were found to be the most effective units, as signal strength generally was superior to all other units having single or internal antennae. Signals were received when the animals were underwater, but only up to a distance of approximately 200 m. Submerged alligators were thought to be no deeper than 2 m below the surface based on water depth in the study area. Stronger signals were received when the animals were swimming on the surface or basking with the antennae out of the water. Maximum reception range from the surface, using a hand-held 4 element Yagi antenna, was approximately 1.6 km for the transmitters with dual whip antennae.

Several transmitters were noted emitting very weak signals, especially when midday temperatures were greater than approximately 33 C. Complete transmitter failure was noted on 3 occasions for short periods of time during the hottest portions of the day. These same 3 units were found to be functioning properly later in the evening when temperatures were considerably lower. This same phenomenon has been noted by other research biologists engaged in wildlife radio telemetry studies in Florida (C. Belden, S. Nesbitt, and W. Frankenberger, 1977 pers. comm.). The coating of radio transmitters with white or lightly colored paint may help reduce this problem through solar reflection. The three units that periodically malfunctioned were not painted with light reflective colors, but instead were left with their original black plastic housing.

TABLE 2. Minimum seasonal ranges (ha) for adult alligators monitored on Newnan's Lake as determined by 627 visual and telemetric Fixes.

Females	Winter	Spring	Summer	Fall
No. 1	4.0	8.0	*	*
No. 3	7.6	12.1	11.2	10.2
No. 4	5.6	8.1	12.0	8.3
No. 5	—	18.2	12.1	*
No. 6	—	31.7	14.8	11.2
$\bar{X}$ ± SD	5.7 ± 1.8	15.6 ± 9.9	12.7 ± 1.5	9.9 ± 1.6
Males	**Winter**	**Spring**	**Summer**	**Fall**
No. 2	9.2	283.0	121.3	*
No. 7	—	316.0	98.4	40.2
No. 9	—	202.0	79.6	33.6
No. 9	—	226.0	83.4	38.9
$\bar{X}$ ± SD	9.2	256.7 ± 51.6	95.4 ± 19.2	37.5 ± 9.8

*Radio inoperative; insufficient visual sightings to calculate range.

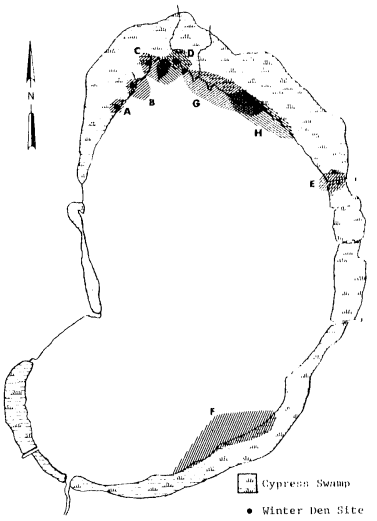

FIGURE 1. Fall-winter activity ranges (ha) of adult alligators on Newnan's Lake, Alachua County, Florida. A. Radio #1 (Female) Winter (4.0). B. Radio #2 (Male) Winter (9.2). C. Radio #3 (Female) Fall/Winter (17.8). D. Radio #4 (Female) Fall/Winter (13.9). E. Radio #6 (Female) Fall (11.2). F. Radio #7 (Male) Fall (40.2). G. Radio #8 (Male) Fall (33.6). H. Radio #9 (Male) Fall (38.9).

Complete failure of 3 other transmitters was experienced during the study. Two of the units provided telemetric data for over 6 months each while the third unit functioned for 8 months (Table 2).

Fall-Winter Movements and Activity Ranges (September-February).—Four alligators (3 females and 1 male) were monitored on Newnan's Lake from 12 September 1976 through 28 February 1977 (Table 2). A total of 152 telemetric and visual fixes was obtained on these animals during the entire period (137 by radio, 15 visual); only 1 animal (the male) moved more than 300 m from its initial capture site. Female alligators had activity ranges covering approximately 9.9 (±1.6) ha during the fall while ranges for the males during this same period were calculated at 37.5 (±9.8) ha (Fig.1). It is likely that the alligators had already chosen their winter den sites prior to attachment of radio collars. McIlhenny (1935) reported that construction of winter dens in Louisiana begins in September. Movement of wintering study animals at Newnan's Lake was largely confined to the vicinity of the winter den. This has also been reported for alligators in Louisiana (Chabreck, 1965; Joanen and McNease, 1972; McIlhenny, 1935).

Alligators are normally dormant throughout the winter in north Florida and are believed to spend the majority of their time in dens beneath a bank or clump of trees (T. Hines, 1977 pers. comm.). Signals were received on all study animals throughout this period, even while in their shallow dens. During the winter, alligators become increasingly dependent upon solar radiation, rather than ambient temperatures as a source of heat (Lang, 1976). Thermoregulatory behavior is also dependent upon the size of the alligator; adults rely more heavily upon solar radiation as a source of heat than do juveniles (Lang, 1975). On sunny days when the air temperature was at least 16 C, from 3 to 15 alligators could usually be observed basking near their den sites. Ten percent of the total winter contacts were visual observations of basking alligators. The movement from dens to basking areas was probably the only movement associated with the 4 study animals during the winter. Minimum winter ranges for the 4 alligators averaged 6.5 (±2.2) ha.

Spring Movements and Activity Ranges (March–May).—The number of study animals on Newnan's Lake was increased from 4 to 9 individuals in the spring with the capturing and outfitting of 5 additional adult alligators (2 females, 3 males). The 9 study animals were monitored from 1 March 1977 to 31 May 1977 resulting in a total of 271 fixes; 193 by radio signal and 78 by actual sightings.

Greatest increases in size of range and distances traveled by both males and females occurred during the spring (Table 2). Female alligators expanded their minimum ranges from approximately 5.6 ± 1.6 ha to approximately 15.6 ± 9.9 ha from winter to spring, respectively (Fig. 2). Spring ranges varied from 8 to 31.7 ha. Minimum distances traveled by 5 females over a 24-hour period in May were found to average 430 ± 117.9 m. Adult male alligators had minimum spring activity ranges averaging nearly 256 ± 5.16 ha (Table 2). Minimum daily distance traveled by 4 males being monitored was approximately 720 ± 172.3 m over 2 (24-hour) periods in May and June. The greatest distance traveled by any of the study animals was during the spring by a male that moved over 6 km (straight line distance) from his original point of capture over a period of 225 days.

These increases in both range size and distance traveled by the males in spring were possibly attributable to the onset of the breeding season (Joanen and McNease, 1972; McIlhenny, 1935). Chabreck (1965) and Joanen and McNease (1970, 1972) also documented increased ranges and movements among alligators in the spring in Louisiana's coastal marshes. Increasing air and water temperatures probably contributed to these increased movements as well.

Adult alligators were frequently seen in close association with each other during the spring. Much activity was observed in the open lake, especially on calm days and nights when large alligators could frequently be seen swimming more than 100 m offshore.

Chabreck (1965) noted that adult males have a territory covering about 20 to 40 ha. Territorial defense was not witnessed even though a considerable amount of range overlap occurred between the observed alligators. Groups of 2 to 3 adults were frequently seen in close proximity, especially at night. Joanen and McNease (1972) reported groups of 6 to 8 alligators of various size classes in close association only during the spring. Although no actual combat was witnessed during the courtship and breeding season, a few alligators were observed in the spring with what appeared to be fresh combat wounds on the tail, sides, and belly.

Data relating to habitat preferences of males and females were subjected to Chi-square analysis (Mendenhall 1975). Females showed no significant habitat preference ($P > 0.05$) during the spring while males indicated a significant prefer-

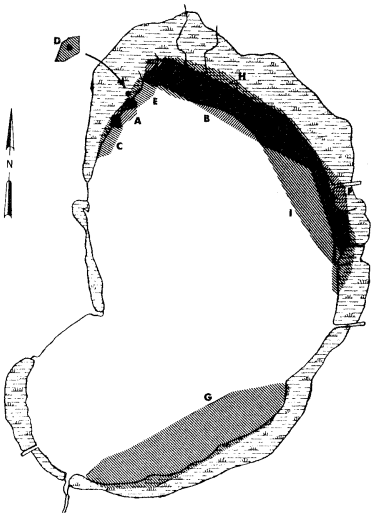

FIGURE 2. Spring activity ranges (ha) of adult alligators on Newnan's Lake, Alachua County, Florida. A. Radio #1 (Female)—8.0 ha. B. Radio #2 (Male)—283.0 ha. C. Radio #3 (Female)—12.1 ha. Radio #4 (Female)—8.1 ha. E. Radio #5 (Female)—18.2 ha. F. Radio #6 (Female)—31.7 ha. G. Radio #7 (Male)—316.0 ha. H. Radio #8 (Male)—202.0 ha. I. Radio #9 (Male)—226.0 ha.

TABLE 3. Habitat preferences of adult alligators as determined by 475 telemetric and visual observations during the spring and summer of 1977 (periods of greatest activity).

			Alligator locations	
			Lake	Swamp
	Season	Date	No. Obs (%)	No. Obs (%)
Females	Spring	3/77–5/77	91 (51)	87 (49)
	Summer	6/77–8/77	27 (23)	90 (77)
Males	Spring	3/77–5/77	59 (63)	34 (37)
	Summer	6/77–8/77	66 (76)	21 (24)

ence ($P < 0.05$) for the open lake (Table 3). Activity range data for both sexes (Table 2) were subjected to a 2-way analysis of variance and, as expected, males had significantly ($P < 0.01$) larger activity ranges than the females during the spring.

Summer Movements and Activity Ranges (June–August).—A total of 204 fixes (161 radio, 43 visual) was obtained from the 9 study animals during the summer. Females generally moved little during June, presumably due to their attendance at nests after egg laying had occurred. Peak nesting occurs in Florida during the month of June (Fogarty, 1974; Goodwin and Marion, 1978; Hines, et al. 1968). The minimum average range for females during the summer was 12.7 (±1.5) ha (Table 2) (Fig. 3).

A thorough search of the cypress swamps in the vicinity of each female resulted in the discovery of 2 active nests. Both were in the swamp 100–150 m from the open lake and close to small bodies of permanent water. Activity was generally confined to the area around the nest for those individuals which were found to be nesting. One female was not observed after 11 June 1977 and was probably attending a nest, but since her transmitter had ceased functioning, her exact location was uncertain. No female under observation during this period was observed in the open lake after 13 June 1977.

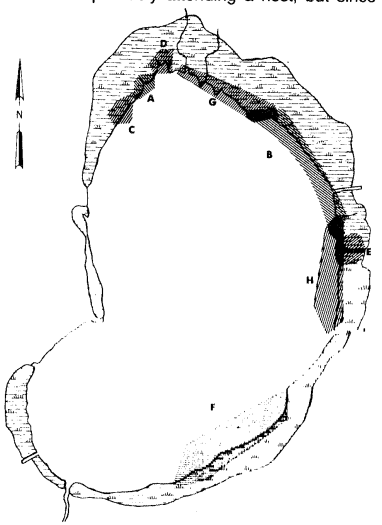

FIGURE 3. Summer activity ranges (ha) of adult alligators on Newnan's Lake, Alachua County, Florida. A. Radio #3 (Female)—11.2 ha. B. Radio #2 (Male)—121.3 ha. C. Radio #4 (Female)—12.0 ha. D. Radio #5 (Female)—12.1 ha. E. Radio #6 (Female)—14.8 ha. F. Radio #7 (Male)—98.4 ha. G. Radio #8 (Male)—79.6 ha. H. Radio #9 (Male)—83.4 ha.

During the summer, the females were located 117 times by visual and telemetric signals (97 radio, 20 visual). Seventy-seven percent (90) of the locations were in the cypress swamp whereas only 23 percent (27) were in the open lake (Table 3), indicating that females show a strong preference for the cypress swamps (Chi square = 10.4, 1 d.f. $P < 0.01$).

The 4 males located 87 times during the summer (64 by radio, 23 by visual contact) were more localized in their movement patterns than in the spring. Minimum activity ranges calculated during this period for the males averaged 95.4 (±19.2) ha (Table 2) (Fig. 3). Male alligators showed a strong preference (Chi square = 8.8, 1 d.f., $P < 0.01$) for the open lake during the summer with 76 percent of the recorded locations in this habitat (Table 3). Males were often observed on calm days swimming approximately 250–350 m offshore. Males were not seen in close association with each other during the summer. During midday when air temperatures reached approximately 32–33 C and water surface temperatures approached 31 C, the alligators retreated to the shaded cypress swamps surrounding the lake.

The findings of this study agree somewhat with those researchers in Louisiana (Joanen and McNeese, 1970, 1972), however the Louisiana studies were performed in an entirely different type habitat (coastal marsh). The data presented in this paper will provide a partial basis for the formulation of a statewide alligator management plan in the near future.

ACKNOWLEDGMENTS

We acknowledge the assistance of the Florida Game and Fresh Water Fish Commission for the use of equipment. Special thanks are due T. Hines, Wildlife Biologist, Florida Game and Fresh Water Fish Commission, for his assistance and suggestions during the study. T. Joanen, Louisiana Wildlife and Fisheries Commission, also offered helpful suggestions relating to the attachment of radio transmitters to the study animals. Thanks are also extended to L. Williams, W. Auffenberg, and R. Labisky for their suggestions and critical review of the manuscript. A. Woodward provided technical assistance in the field capturing and handling the study animals. Financial assistance was provided by the Center for Environmental Programs at the University of Florida and the Florida Game and Fresh Water Fish Commission.

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Accepted 16 Nov 1978