Nesting Habitat of American Alligators in Coastal South Carolina

Philip M. Wilkinson, *South Carolina Wildlife and Marine Resources Department, Star Route 1, Box 226, Georgetown, SC 29440*

Walter E. Rhodes, *South Carolina Wildlife and Marine Resources Department, P.O. Drawer 190, Bonneau, SC 29431*

Abstract: We determined nest occurrence and density among habitats and described physical factors associated with nesting sites for American alligators (*Alligator mississippiensis*) in coastal South Carolina. Nests were located in managed impoundments more than expected, remnant impoundments less than expected, and unaltered wetlands as expected. Nest densities averaged 1/83 ha, 1/225 ha, and 1/286 ha in impoundments, unaltered wetlands, and remnant impoundments, respectively. Most (96%) nests were found in fresh to brackish wetland types. Salinity of nearest water to the nest averaged 6.74 ppt. Nests were built an average of 4.35 m from water. Impoundments may provide economic incentives to landowners through egg and hatchling collections.

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The alligator was classified as an endangered species in 1967, and subsequently protected under the Endangered Species Act of 1973. The recovery of the alligator population has resulted in the reclassification to the category "threatened due to similarity of appearance" throughout the Southeast in 1987 (Fed. Register 52(107), 4 Jun 1987). During this period of recovery, studies were conducted to monitor the response of the alligator population to protection (Chabreck 1976, Wood et al. 1985) and to collect baseline reproductive data (Joanen 1969, Joanen and McNease 1970, Bara 1976, Metzen 1977, Deitz and Hines 1980).

An understanding of reproductive biology is essential if alligator populations are to be managed scientifically. However, information about alligator nesting ecology is mainly derived from studies in Louisiana (Joanen 1969), Florida (Goodwin and Marion 1978, Deitz and Hines 1980), and in Georgia (Ruckel and Steele 1984). Only Bara (1976) and Fuller (1981) have described nesting ecology at the northern periphery of the range of American alligators. Objectives of this study were to compare alligator nesting occurrence and density among marsh habitats in

South Carolina and to describe the physical factors associated with nesting sites.

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Methods

Investigations were conducted in the coastal marsh floodplain of the following 14 river drainages: Waccamaw, Pee Dee, Black, Sampit, Santee, Wando, Cooper, Ashley, North Edisto, South Edisto, Ashepoo, Combahee, New, and Savannah rivers. Six coastal islands were surveyed: Cape, Bulls, Capers, Kiawah, St. Phillips, and Hilton Head. Surveys to describe nesting microhabitat were conducted along the northern edge of the Santee River Delta (2,376 ha). Climatic conditions are mild with a mean annual temperature of 17° C and a mean annual precipitation of 127 cm. There are 260–290 frost free days/year.

Most coastal wetlands are classified as salt marsh (Tiner 1977). Smooth cordgrass (*Spartina alterniflora*) dominates the lower elevations of the salt marsh and a mixed plant community of saltmeadow cordgrass (*Spartina patens*), salt grass (*Distichlis spicata*), sea ox-eye (*Borrichia frutescens*), marsh elder (*Iva frutescens*), black needlerush (*Juncus roemerianus*), and glassworts (*Salicornia* sp.) occur at higher elevations. Brackish tidal wetlands are characterized by giant cordgrass (*Spartina cynosuroides*), smooth cordgrass, saltmarsh bulrush (*Scirpus robustus*), and black needlerush. Dominant plants in the tidal freshwater marshes include southern wild rice (*Zizaniopsis miliacea*), sawgrass (*Cladium jamaicense*), cattails (*Typha* sp.), alligator weed (*Alternanthera philoxeroides*), and sedges (*Cyperus* sp. and *Carex* sp.).

Tidal fluctuations range from 1.37 m along the north coast to 2.19 m near the South Carolina-Georgia border. Salinity in the study area ranged from fresh (0 ppt) to full sea strength (35 ppt).

Aerial surveys for alligator nests were conducted in early July from 1978 to 1982. Nests were located using 4 observers (including the pilot) from a Hughes 500 helicopter flying at low altitudes (15.3 m–30.6 m) and an average speed of 64 km/hour. Nest locations were plotted on aerial photographs (scale 1 cm = 158.4 m). The entire coastal marsh of each drainage was searched between the upland borders from the mouth of each river to the treeline of the freshwater swamp.

Habitats were delineated as: (1) coastal impoundments (area contained by dikes), (2) remnant impoundments (area with breached dikes), and (3) unaltered wetlands. These delineations were further characterized by plant species which exhibited different tolerances to water salinity. Marsh salinity types were: (1) freshwater (<1 ppt), (2) fresh/brackish (1–5 ppt), (3) brackish (5–20 ppt), (4) brackish/salt (20–30 ppt), and (5) salt marsh (>30 ppt) (Gordon et al. 1989).

Nests observed in the Santee River Delta during aerial surveys were later

inspected on the ground. Distance to (m) and salinity (ppt) of nearest water to each nest was measured. Plants in the immediate vicinity of nests were listed in order of their estimated relative occurrence and predominant plants were used to determine wetland type.

A chi-square goodness-of-fit test and the Bonferroni procedure were used to determine if the proportion of alligator nests within each habitat occurred in proportion to their expected occurrence for all habitats surveyed (Neu et al. 1974, Byers et al. 1984). Data for all years were pooled because of small sample sizes. Distance to and salinity of nearest water were tested for differences among years using analysis of variance (ANOVA) and Duncan's multiple range test.

Results

Occurrence of alligator nests differed by habitat ($X^2 = 134.32$, df = 2, $P < 0.001$). Nests were located in impoundments more ($P < 0.05$) than expected, remnant impoundments less ($P < 0.05$) than expected, and unaltered wetlands as expected ($P > 0.05$). Nest densities averaged 1/83 ha, 1/225 ha, and 1/286 ha in impoundments, unaltered wetlands, and remnant impoundments, respectively ($N = 408$) (Table 1). Most nests were found in fresh to brackish wetland types (Table 2). Salinity of nearest water varied ($P = 0.0001$) among years, while distance to nearest water did not ($P = 0.1721$) (Table 3).

Discussion

Nesting densities were highest in impoundments, followed by unaltered wetlands and remnant impoundments. Most nesting occurred in fresh to brackish wetland types. Impoundments in South Carolina create a less saline habitat with more stable water levels than the surrounding wetlands. In addition, dikes and berms of impoundments provide areas above water for alligators to nest. Seventy-eight percent of the alligator nests in Georgia were associated with impoundments (Ruckel and Steele 1984); however, this was true for only 20% of the alligator nests in Louisiana (Joanen 1969).

Remnant impoundments and unaltered wetlands are essentially the same habitat. However, old dikes of remnant impoundments provided elevated nest sites that otherwise would not occur. When remnant impoundments and unaltered wetlands occurred in saline areas, alligators nested in these areas when freshwater potholes created by rainwater were available. Once hatchlings leave the nest, they will utilize the freshwater potholes until they can tolerate higher salinities (P. M. Wilkinson, unpubl. data).

Higher quality alligator habitat may have been created as a result of wetlands alteration during the rice growing era. Rice was introduced into Charleston, South Carolina, around 1680 (Salley 1936, Hilliard 1975, Kovacik 1979) resulting in the clearing of forested, tidal swamps (Doar 1936, Heyward 1937). Ditch and dike construction permanently altered natural drainage patterns and caused extensive

Table 1. Average alligator nesting densities by habitat in South Carolina, 1978–82.

Habitat	Area surveyed (ha)	*N* nests located	Nest/ha
Impoundments	24,691	296	1/83
Remnant impoundments	28,364	99	1/286
Unaltered wetlands	2,929	13	1/225

Table 2. Number of alligator nests by wetland type in coastal South Carolina, 1978–82 ($N = 334$).

Wetland type	Habitat type		
	Impoundments	Remnant impoundments	Unaltered wetlands
Fresh	122	25	2
Fresh/brackish	62	35	6
Brackish	52	14	4
Brackish/salt	8	3	0
Salt	0	1	0

Table 3. Habitat variables of alligator nests in the Santee River Delta, South Carolina, 1978–82.

Year	Salinity (ppt) of nearest water			Distance (m) to nearest water		
	N	$\bar{X}$	SD	*N*	$\bar{X}$	SD
1978	57	4.18C[a] (0.000–17.00)[b]	4.59	57	3.08 (0.00–27.43)	4.26
1979	73	8.82AB (0.00–24.00)	6.88	77	3.87AB (0.00–36.58)	5.55
1980	55	9.97A (0.00–30.00)	7.66	56	5.61A (0.61–45.72)	6.98
1981	43	7.19B (0.00–24.00)	6.11	42	4.97AB (0.00–45.72)	8.26
1982	78	4.15C (0.00–11.0)	3.65	81	4.50AB (0.00–18.29)	4.39
$\bar{X}$	306	6.74	6.31	313	4.35	5.83

[a]Column means followed by the same letter are not significantly different ($P > 0.05$) based on Duncan's multiple range test.
[b]Range is listed in parenthesis.

changes in wetland plant communities. After the demise of the rice industry in the early 1900s, abandoned, diked fields began to deteriorate. Some dikes and water-control structures were repaired and maintained by sportsmen as waterfowl hunting areas (Strange 1987). Fresh to brackish water impoundments appear to provide prime nesting habitat for alligators. Nest densities were lower in remnant impoundments and unaltered wetlands. Therefore, deterioration of impoundments would likely result in lower alligator population densities.

Nest densities in impoundments in South Carolina are similar to densities found in 5 freshwater lakes in Florida (1/84 ha) (Woodward et al. 1992) and quality coastal habitat in Louisiana (1/60 ha) (McNease and Joanen 1978). Jennings et al. (1988)

reported that the removal of 50% of the annual alligator production for ranching did not appreciably change population size structures. Thus, impoundments in South Carolina may support adequate populations to allow for such egg and hatchling collections and thereby provide the landowner with economic incentives to maintain impoundments and the alligator population.

Yearly average salinities of water near alligator nests ranged from 4.15–9.97 ppt; however, alligators nested near water with salinities as high as 30.0 ppt if freshwater microhabitats were available. Nesting alligators were found frequently in freshwater habitats behind sand dunes formed by the Atlantic Ocean. Nesting effort and hatchling survival in saline habitats will largely be determined by amount of rainfall. Joanen (1969) reported nesting alligators in salinities as high as 9.6 ppt in Louisiana. Salinities averaged 11.3 ppt in an impoundment used by nesting alligators along the Atlantic Coast of Georgia (Ruckel and Steele 1984).

Fuller (1981) found that alligator nests were located a mean distance of 35.4 m from permanent water in North Carolina. In Georgia alligator nests were 11.5 m and 2.1 m from permanent water (Ruckel and Steele 1984); however, a drought shortly after nest construction may have confounded their results. Our results ($\bar{X}$ = 4.4 m; range = 0.0–45.7 m) agree with these findings.

Characteristics of nest placement generally concur with findings of alligator nests examined elsewhere. However, more research to investigate aspects of nesting ecology is required to facilitate management. The importance of impoundments as alligator nesting habitat should not be overlooked.

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