

AMERICAN CROCODILE NEST SURVEY AND MONITORING

by

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Final Report

Study Number: 7533

Federal Number: E-1 II-C-2

Study Period: 1 January 1978 - 30 June 1991

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FINAL REPORT
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Study No. 7533
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Project Title: Florida's Endangered Wildlife/Reptile and Amphibian Research

Project Subtitle: American Crocodile Recovery Plan Implementation

Study Title: American Crocodile Nest Survey and Monitoring

Period Covered: 1 January 1978 - 30 June 1991

Prepared by: Paul E. Moler, Biological Administrator I

Abstract-- During the period 1978-1991, 76 nesting events were recorded on Key Largo. Of the 71 nests for which fate is known, 37 (52 %) were successful. For the years for which complete data are available (1979-1990), 373 hatchlings were produced from 34 successful nests. This represents only about 32.4 % of the theoretical reproductive potential from these nests. Nest depredation occurred only rarely on Key Largo, and does not appear to be a significant problem. Seemingly the greatest constraint on American crocodile reproductive success on Key Largo is embryonic mortality resulting from desiccation in years of low rainfall.

Known nesting of the American crocodile (Crocodylus acutus) in the United States is restricted to North Key Largo, the cooling canal system of Florida Power and Light's Turkey Point electrical generating facility, and the northeast Florida Bay portion of Everglades National Park,. As part of the monitoring of crocodile status outside Everglades National Park and as part of an effort to identify factors limiting crocodile numbers, annual crocodile nest surveys were initiated on Key Largo in 1978 with the objective of locating all crocodile nests and monitoring hatching success. Florida Power and Light has independently funded surveys and monitoring of crocodile nesting activity at Turkey Point since 1978 (Gaby et al. 1985, F. Mazzotti pers. comm.). Everglades National Park (ENP) personnel conducted surveys within ENP from 1977 to 1982 (Kushlan and Mazzotti

1989), but, due to Federal budget cuts, surveys were discontinued for several years beginning in 1982 (J. Kushlan, pers. comm.). In recent years, surveys in Everglades National Park have been conducted by Frank Mazzotti and his assistants.

American crocodiles typically nest in areas above normal high water but adjacent to deeper water. Nests are constructed of the available soil: sand, marl, or peat. Unlike alligators, crocodiles make no effort to incorporate vegetation into the nest. Sometimes the female crocodile simply digs a hole, deposits the eggs, and covers them; these "hole nests" may be unrecognizable after rains have obliterated the signs of soil disturbance. More typically, the female works the soil into a broad nest mound prior to laying the eggs. This process of nest preparation may continue for 3-4 weeks prior to egg deposition. Observed number of eggs within a single nest varies between 8 and 81 eggs (Ogden 1978, pers. obs.), but extremely high counts probably result from the occasional use of a nest site by more than one female. Average clutch size is 38 eggs (Kushlan and Mazzotti 1989). Many crocodiles exhibit a high degree of nest site fidelity, using the same nest mound year after year. One nest on Key Largo was active for 12 of 14 years during this observation period.

After the eggs are laid, the female crocodile remains in the general vicinity of the nest, although there are no known cases in which a Florida crocodile has attempted to defend a nest against human presence. Hatching occurs following an incubation period of 85-90 days. At hatching, the female opens the nest to release the young (Ogden and Singletary 1973). Such successful nests have a characteristic appearance in which one entire side of the nest mound has

been removed or a broad crater is left in the center of the mound. The female abandons the young soon after they hatch. All Key Largo nests are in areas of quiet water sheltered from wind and wave action. In such areas, the hatchling crocodiles tend to remain together near the nest for the first 4-5 weeks, but they then disperse. Hatchlings from nests along shorelines exposed to wind and wave action disperse more rapidly (Kushlan and Mazzotti 1989).

METHODS

Study area. Key Largo is a fossil coral reef that, at its highest point, reaches a height of about 18 feet above present sea level (White 1970). South of its juncture with U.S. Highway 1, Key Largo is largely developed, and crocodile sightings are infrequent. North of U.S. 1 the island is largely undeveloped, with the exception of Ocean Reef at the north end, and the upland portions support the best stands of tropical hardwood hammock remaining in the United States. The Atlantic Ocean side shoreline of much of North Key Largo consists of jagged, eroded coral bordering shallow marine flats, and crocodiles are seen only infrequently there. However, the Barnes Sound shoreline consists of extensive swamps of mangrove (Rhizophora mangle, Avicennia germinans, Laguncularia racemosa) on deep peat soils. Attempts at development of the area in the 1920's and again in the early 1970's resulted in a series of canals bordered by levees of peat. Crocodile nesting on Key Largo is restricted to levees and spoil associated with these areas of former dredging or construction activities.

Levees and spoil areas were searched by foot during the crocodile nesting season (the last week of April and first week of May). Nests were revisited

irregularly during incubation to assess the extent of nest depredation and at hatching to determine nest success. A nest was classified as "successful" if it appeared to have been opened by an adult crocodile. In all but one case, hatchling crocodiles were tagged near each successful nest. In 1989, one nest which had been opened still contained one dead hatchling and 24 eggs that either were nonviable or contained dead, full-term young. No hatchlings were found in association with this "successful" nest.

Initial hatchling capture efforts were conducted on or about August 1 each year. Most clutches had hatched by this date; it appeared from the size and umbilical closure of some hatchlings that they had likely hatched as much as a week or two earlier. Canoes were used to search for hatchlings in the canal systems adjacent to each nest. Crocodile hatchlings were captured by hand and each individual was uniquely marked by removing a series of caudal scutes. Although most hatchlings were marked during these initial capture efforts, totals include some hatchlings that were first captured during follow-up surveys later in the fall.

RESULTS

Annual nest production within the principal nesting area varied between 4 and 8 clutches. In December of 1989, a severe freeze hit Florida, and at least 4 crocodiles are known to have been killed in Florida Bay. Mortality may have been substantially higher, since most animals which died in the interior mangrove swamps would not have been detected. For the 4 years prior to the 1989 freeze, nest production on Key Largo varied between 6 and 8 nests; only 5 nests were located on Key Largo in each of the two years following the freeze. No

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direct mortality was reported for Key Largo, and the slight decline may or may not have been related to the freeze. However, total Florida nest production was 30 in the summer preceding the freeze, but only 22 in the summer which followed (Mazzotti pers. comm., GFC data). Most of the decline was recorded for Everglades National Park, where the known cold mortalities from the freeze occurred.

A total of 76 crocodile nesting events (77 clutches) was recorded on Key Largo during the period 1978-1991. Of the 71 nests for which fate is known, 37 (52 %) were successful. Only two (2.8 %) nests were depredated; in both cases depredation occurred late in the season, perhaps after the female had abandoned the site. Raccoons were likely responsible for both depredations, but clear tracks were not discernible in the loose peat soil.

Data on hatchling production are incomplete or not yet available for 1978 and 1991. For the 12 year period 1979-1990, 34 of 65 nests (52.3%) were successful and 373 hatchlings were marked. Results are summarized in Table 1.

DISCUSSION AND CONCLUSIONS

Nest predation has been suggested as a possible factor limiting crocodile recovery (U.S. Fish and Wildlife Service, 1979). During the period 1978-1990, only 2 of 71 (2.8 %) Key Largo crocodile nests were depredated. Nest depredation occurs more frequently in the sand nests typical of Everglades National Park (Ogden 1978, Kushlan and Mazzotti 1989). Kushlan and Mazzotti reported that for the period 1971-1982, 14 of 99 (14 %) nests were depredated. Although nest

predation is somewhat higher in sandy soils, it would not appear to be a significant constraint on crocodile recovery.

Despite the low depredation rate on Key Largo, hatching success has been erratic. The years 1983, 1984, and 1987 were each especially good, with 66, 56, and 74 hatchlings tagged, but there was a complete nest failure in 1981, a year characterized by an unusually dry spring. The springs of 1985, 1986, and 1989 also were exceptionally dry, and 7 of the 11 "successful" nests in 1985, 1986, and 1989 produced very few hatchlings (1-5). Embryonic mortality as a result of egg desiccation was responsible for the poor hatching success. A record 74 crocodile hatchlings was produced on Key Largo in 1987, despite another relatively dry spring, but this record number of hatchlings was attributable more to an increase in the number of successful nests than to increased hatching success within the individual nests.

Hatchling production was also very low in 1988. The winter of 1988 had been exceptionally dry, but, unlike the poor production years of 1981, 1985, 1986, and 1989, the summer of 1988 was unusually rainy. In contrast to the nests of alligators, crocodile nests are constructed of soil rather than vegetation, and it is solar heat which maintains incubation temperatures in crocodile nests. The low nest success in 1988 may have been caused by low nest temperatures resulting from a very overcast and rainy summer, or the rains may have saturated the nest soils and interfered with gas exchange within the nest. It is also possible that the eggs were adversely affected by the desiccated condition of the nest matrix into which the eggs were deposited; there had been very little rain in the months immediately preceding nesting in 1988.

Even in the best years (1983-1984) hatchling production has seemingly been mediocre. Assuming a clutch size of 38 eggs per nest and a fertility rate of 89% (Kushlan and Mazzotti 1989), potential production from 8 nests would be about 270 hatchlings. The production of 124 hatchlings from 8 successful nests in the period 1983-1984 thus represents only about 15.5 young per nest (45.9 % of the theoretical potential). This value, while seemingly low, is apparently typical for other portions of the species' Florida range. Ogden (1978) reported that about 48% of the eggs in successful nests hatch, and by applying the same clutch and fertility assumptions to the data of Gaby et al. (1985), the calculated "hatching efficiency" for nests at Turkey Point is 59%. For the 12 years (1979-1990) for which full data are available, only 373 hatchlings were produced from 34 successful nests on Key Largo, about 32.4 % of the potential 1150 young. Kushlan and Mazzotti (1989) suggested flooding and desiccation as the primary causes of embryonic loss. Although flooding has been demonstrated as a major cause of embryonic mortality in Everglades National Park (Mazzotti 1983), most Key Largo nests are built on relatively high ground, and flooding is probably not responsible for most embryonic mortality in Key Largo crocodile nests. Desiccation appears a more likely cause of embryonic death in Key Largo nests.

In summary, it appears that year-to-year reproductive success of the American crocodile is strongly influenced by environmental conditions, particularly rainfall. A "boom or bust" pattern is probably typical for the species in Florida.

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Table 1. Results of Key Largo nest surveys, 1978-1991.

Year	Number Nests	Number Nests Successful	Number Hatchlings	Hatchlings/ Nest
1978	6 (7) ¹	3	15 ²	
1979	6	2	16	2.67
1980	4	2	35	8.75
1981	4	0	0	0
1982	6	4	35	8.75
1983	5	4	66	13.20
1984	5	3	58	11.60
1985	4	4	26	6.50
1986	6	3	24	4.00
1987	6	6	74	12.33
1988	8	1	16	2.00
1989	6	4 ³	16	2.67
1990	5	1	7	1.40
1979-90 TOTAL	65	34	373	
1991	5			

¹ Number clutches; one nest contained two clutches.

² These hatchlings were captured in August 1979. This is not a reliable estimate of production in 1978.

³ Includes one nest which had been opened but from which no hatchlings were found.

