Project Report to Wildlife Conservation Society

Nesting ecology, juvenile and subadult food habits, and status of Morelet's crocodile (*Crocodylus moreletii*) in Belize

Steven G. Platt and Richard R. Montanucci

November 1993

Department of Biological Sciences, 132 Long Hall, Clemson University, Clemson, South Carolina, 29634-1903, USA

1. Summary

This project, a continuation of a study initiated in 1992, has the following objectives: to gather data on the nesting ecology of Morelet's crocodile (Crocodylus moreletii), to determine wet-season food habits of juveniles and subadults, and to assess the population status of this species in northern Belize.

Fieldwork was conducted from May through September 1993. Study sites included areas examined in the 1992 season, as well as a number of additional sites. Nesting activity appears to begin with the onset of the wet season. No evidence was found of dry-season nesting. Fifteen active nests and one inactive nest were located this season. Average clutch size was 25.4 eggs with an average of 4.5 infertile eggs per clutch. Small islands seem to be the preferred nest sites. Nests were monitored throughout the incubation period. Only five nests produced viable hatchlings. The remainder were lost to a variety of causes, primarily flooding and predation.

The stomach contents of 46 additional crocodiles were examined in 1993. Preliminary analysis suggests that juveniles consume primarily insects, apple snails and crayfish, while subadults consume an increasing amount of vertebrate prey. Limited data have been collected opportunistically on the feeding habits of adult crocodiles.

Spotlight surveys were conducted in wetlands throughout northern Belize. Crocodiles were encountered in various habitats, but the largest numbers are found in heavily vegetated freshwater wetlands. Lesser numbers were found in rivers and coastal mangroves. Gold Button Ranch supports one of the largest and least disturbed crocodile populations in Belize. Other large populations were located in Cox Lagoon, Mucklehenny Lagoon, Habenero Lagoon, Sapote Lagoon, the wetlands surrounding Gallon Jug, and the New River and New River Lagoon system.

The data gathered in this study will assist in the preparation of management plans for the conservation of Morelet's crocodile in Belize. We propose that a final season of fieldwork be conducted in 1994. A full proposal will be forthcoming.

2. Statement of Objectives

The objectives of this project are:

1. To continue collecting data on the nesting ecology of Morelet's crocodile in Belize.

2. To determine the wet-season food habits of juveniles and subadult crocodiles, and to gather data, when possible, on adult food habits.

3. To assess the population status of Morelet's crocodile in northern Belize.

3. Research Accomplishments

This project was a continuation of a study initiated in 1992 (Platt 1992). Fieldwork commenced on 18 May 1993 and continued through September 1993. Initial field~ork was conducted at Gold Button Ranch (GBR), a 24,000 acre cattle ranch approximately 30 Km southwest of Orange Walk along the Orange Walk to Blue Creek Rd. Additional study sites were located through inquiries and local infOlmants, and pelmission was obtained from landowners before entellng any property.

Nest searches were conducted on foot and by canoe or motorboat.. Nests were often not visible from offshore, but tracks and slides along the shoreline frequently indicated the presence of a nest. Areas of suitable habitat and islands were thorougWy searched whenever encountered, regardless of the presence of crocodile sign. All 1992 nest sites were searched with the exception of the Cox Lagoon Site. This site was no longer accessible due to recent formation of mats of floating vegetation.

Nest construction in 1993 was initiated about two weeks later than in 1992. During both years nest construction seemed to be linked to heavy rains at the onset of the wet-season. The methods of Hall (1984) and Ferguson (1987) were us'ed to estimate the age of crocodile embryos and date of nest 'Construction.

Nesting effol1 at GBR in 1993 was d~pressed when compared with 1992. In 1992, seven nests were found on Gold Button Lagoon (GBL) and three along Gold Button Creek (GBC), while in 1993 only five nests were located on GBL and none were found on GBC.. This may have been the result of heavy rains early in

the nesting season which flooded many potential nest sites. At three sites, nest construction was begun, but later abandoned following the rains.

Additional nests were located at Shipstern Nature Reserve, Bill Hasse Farm (Mile 30, W. Hwy), Laguna Verde (Gallon Jug), Habanero Lagoon (program for Belize), Sapote Lagoon (San Narcisso), and Danny Rabino Farm (Guinea Grass Rd. at Tower Hill).

Sixteen nests were located in 1993 (see Table1). Fifteen of these nests contained eggs and one nest was inactive. All nests were mound nests constructed of soil and vegetation except one nest on GBL which was a modified hole nest. A hole approximately 20 cm deep was constructed, but the female neglected to cover the eggs and the entire clutch was lost to overheating. A similar nest was found in 1992 on a nearby island. Clutch size in both nests was similar and the eggs may have been produced by the same female. Mean clutch size in 1993 was 25.4 (SE=2.05, Range=11 to 37). Mean number of infertile eggs per clutch in 1993 was 4.53 (SE=1.36, Range=O to 15).

Previous reports of dry season nesting (platt 1992b) are now believed to be erroneous. Nests originally thought to have been constructed during the dry season may have been mounds persisting from the previous wet season. All evidence to date indicates nesting is solely an early wet-season activity.

Nests were monitored throughout the nesting season and most were visited on a weekly basis. Due to limited accessibility, the nest at Gallon Jug was visited twice monthly, and the nest at Shipstern Nature Reserve was visited only once.

Data on flooding, predation, presence or absence of the female, etc., were collected. Five (33%) of the active nests were successful (defined as producing at least one viable hatchling) and ten (66%) were unsuccessful. Nesting failure was attributed to a variety of causes: three nests were lost to flooding, two nests to predators (raccoons and gray fox); another clutch was composed of abnormally large eggs which failed to develop, and one clutch hatched successfully, but the female did not return to open the nest and the hatchlings were killed by ants. The fate of one clutch is unknown.

All nests located during 1992 and 1993 were constructed on a solid substrate. No nests have been found on floating mats of aquatic vegetation, cattail

mounds, soft mud, or other unstable substrates. Canopy closure varied from 0 to 100%. Vegetative composition surrounding the nest does not seem imponant in site selection, a,lthough crocodiles were not observed nesting in completely exposed sites.

Small islands surrounded by open water or cattail marsh seem to be the preferred nesting habitat.. All but four nests located in 1993 were constructed on islands, and two of these were constructed on the tip of narrow peninsulas. Islands and peninsulas probably offer some degree of protection from predators by limiting access and allowing the female to remain in attendance.

Nest defense behavior was observed in only one female in 1993, although females were occasionally observed in the vicinity of nests. It is likely that females selectively avoid humans while still defending nests against other predators.

Juvenile and subadult. crocodiles were captured and stomach contents were obtained using the methods of Taylor et a1. (1978). In 1993, osteoderms were removed from all crocodiles captured (46) and will be used to age these animals (Hutton 1987). Care was taken not to stress the animals during capture, and no animals have been lost.. A total of 122 crocodiles have been captured to date.

Preliminary analysis of stomach contents reveals that small crocodiles (TL<90 cm) feed primarily on insects, crayfish, and apple snails, while few fish are consumed by this size class. Larger crocodiles (TL>90 cm) consume the same prey items, and an increasing amount of vertebrate prey such as small mammals, tultles, lizards, and fish.

The food habits of adult crocodiles are poorly known. One adult was observed feeding on a cattle egret, and two large aggregatiops of crocodiles were observed feeding on cattle carcasses. Additionally, the stoITJachof a dead female recovered in 1993 contained apple snail opercula.

Crocodile surveys were conducted in wetlands throughout northern Belize (Table 2). Attempts were made to revisit sites originally smveyed in the late 1970's by Abercrombie et al. (1980). Spotlight coun-ts using a 12-volt headlight (Bayliss 1987) were conducted at most sites in a canoe. Lagoons and ponds were completely surveyed. In creeks and rivers, standard practice was to paddle upstream for two to three hours before dark and then return downstream after

nightfall, counting all crocodiles observed. New River, New River Lagoon, and Southern Lagoon were surveyed by boats equipped with outboard motors and a 250,000 candlepower spotlight.. All crocodiles observed were classified as yearlings (TL<30 cm), juveniles (fL=30-90 cm), subadults (TL=90-150 cm), or adults (TL>90 cm). When total length could not be determined, crocodiles were classified as "eyeshine only". Some sites were surveyed during the day because dense aquatic vegetation precluded the use of spotlight techniques. The presence of crocodiles at these sites was verified by sighting swimming or basking animals, or finding tracks, nests, or other sign.

Several large populations of crocodiles that would probably benefit from protection, have been located in northern Belize. Cox Lagoon was surveyed by Platt (1992a) and Hunt and Tamarack (1993), and is proposed for national park status. Mucklehenny Lagoon which contains a large population of crocodiles should be included within the park boundaries. Evidence of intensive fishing was noted in Mucklehenny Lagoon which may negatively impact the crocodile population through accidental drownings.

Gold Button Ranch supports one of the largest and least disturbed crocodile populations in Belize. Using methods of King et al. (1990) and Messel et al. (1979) it was estimated that GB Lagoon contains 143 non-yearling crocodiles. Furthermore, crocodiles were observed in almost every wetland on the property, including stock ponds and seasonal marshes (platt 1993). A viability analysis will be preformed on this population.

Few crocodiles were observed in Sapote Lagoon (ca. 5 km. W. San Narcisso). Much of this lagoon is dominated by sawgrass (Cladium sp.) marsh, making spotlight surveys difficult. However, five nests were located here, and if the proportion of nesting females in a population is somewhat constant,, this suggests a population similar in size to that of GBL..

Crocodiles were present in all wetlands surveyed in the vicinity of Gallon Jug. The largest population was found in Laguna Seca. Crocodiles were abundant in open water, however, much of this lagoon is densely vegetated making observation difficult.. Historically the lagoon was reputed to contain a large number

of crocodiles. A professional hunter reported killing over 40 crocodiles here in a single night about 20 years ago (Donald Rhaburn, pers. comm.).

The New River Lagoon and the New River (New River Lagoon to Tower Hill) were sw-veyed during the wet season. Water levels were elevated at this time and most crocodiles had dispersed into the adjacent flooded savannah and forest Despite these conditions, 39 were observed. The area is currently used by a number of ecotour operators and a national park has been established surrounding the Mayan ruins at Lamani. Populations in this area would likely benefit if some degree of protection was afforded this wetland system.

Habenero Lagoon, a heavily vegetated lagoon owned by Program for Belize contains a large number of crocodiles. Thirty-nine were observed. Several large adults allowed a close approach (within two meters) indicating that this population is relatively free from human harassment..

Marshes, known locally as "reed ponds", along the Northern and Western Highways were sw-veyed. Some of these sites were visited during the day as shallow water and dense vegetation made spotlight surveys impractical.. These habitats typically supported small numbers «5) of crocodiles. Evidence of breeding was found at one site (Tillet farm, Mile 15, Northern Hwy.). These marshes may be important breeding habitats as they are widespread and are not subject to extreme water level fluctuations during the wet season.

Surprisingly, no crocodiles were observed in the Crooked Tree Wildlife Sanctuary. Howard Hunt (pers. comm.) reported observing no crocodiles in a survey during March 1993. Local residents have also commented on the scarcity of crocodiles there. A small number of crocodiles were observed in Black Creek, linking Crooked Tree Lagoon with the Belize River.

Pull Trouser swamp was not surveyed during 1993 because landowner permission to enter the swamp could not be obtained. However, a tentative agreement was reached with the landowner that will allow access in 1994. This swamp appears to be excellent habitat and max support a large crocodile population.

The following mangrove habitats were survey~d during 1993 : Almond Hill Lagoon, Burdon Canal, Fabers Lagoon, Haulover Creek, Jones Lagoon, Pond at Mile 2, N. Hwy., Potts Creek, and Southern Lagoon. Nesting was noted at one

site (Shipstern Nature Reserve), but in general, mangrove swamps appear to support low densities of Morelet's crocodiles. Similar observations were reported by Meerman (1992) and Meerman and Boomsma (1993). In the past Morelet's crocodile may h'ave been excluded from mangrove habitats by the American crocodile (Crocodylus ~). With the elimination of the American crocodile from the mainland, Morelet's crocodile may now be dispersing into these habitats.

In summary, the results of this survey support the conclusions of Abercrombie et al. (1980). Morelet's crocodile is widely distributed throughout northern Belize, but except in remote or protected areas, occurs at lOw densities. Highest densities are reached in heavily vegetated freshwater wetlands. Rivers provide good habitat, but little reproduction occurs there due to extreme water level fluctuations. Crocodiles are often perceived by local residents to be much more abundant than they actually are (S. Platt, pers. obs., Howard Hunt, pers. comm., Meerman 1992).

While the status of the American crocodile was not the subject of this investigation, some mention should be made of this species. Survey data for Belize are currently lacking. The American crocodile is rare in Shipstern Nature Reserve, and may be partly sympatric with Morelet's crocodile (Meerman 1992). However, the American crocodile is reported by residents to be common in the Turneffe Islands. Meerman (1992) observed 10 individuals in a flooded garbage dump on Cay Caulker, and the Belize Zoo has specimens originating from an offshore island. Locals also report American crocodiles on Ambergis Cay. During the Burdon Canal survey, an adult crocodile was observed that may have been an American crocodile. Clearly the status of this species in Belize warrants further investigation.

4. Conservation Accomplishments

Prior to this project, little information Qther than anecdotal repol1s was available concerning the life history and status of Morelet's crocodile in Belize. The Wildlife Depal1ment has received numerous nuisance crocodile complaints, and is currently developing a management plan for the species. Furthermore, some

interest has been expressed by landowners in headstart and ranching programs that would involve removing eggs from nests, incubating them, and rearing the hatchlings to a certain size before releasing them into protected habitats. This study will provide basic information for any proposed management program.

Some interest has been expressed by the owner of GBR in setting aside a portion of the ranch as a nature reserve with Morelet's crocodile as the flagship species. A wildlife survey was conducted for the landowner with management recommendations for ecotourism. Future plans for the ranch, however, remain unresolved.

A liaison was established with the Amigos de Sian Kaan, a non-governmental organization in Cancun, Mexico. This organization is initiating a similar research project on Morelet's crocodile in the Sian Kaan Biosphere Reserve. Mr. Platt met with biologists from this organization in May. In September, Mr. Gonzalo Merediz Alonso, a project biologist,, spent several days in Belize assisting in fieldwork.. Arrangements were made to continue mutual assistance, and reciprocal study site visits are planned for 1994.

This project is the subject of Mr. Platt's Ph.D. dissertation at Clemson University. Upon completion, copies will be distributed to the Belize Office of Forestry, Ministry of Tourism and the Environment, Belize Audubon Society, Belize Zoo, interested landowners, and Mexican researchers. Copies of a technical report (platt 1992b) detailing fieldwork completed in 1992, have already been distributed to these parties.

5. Proposed Activities Over the Next Six Months

This project was funded as a short-term study, and !ieldwork was completed in the time allotted. It is our intention to seek funding for a final field season (May to October 1994) to complete the project.. A full research proposal will be forthcoming in December 1993.

LITERATURE CITED

Abercrombie, c.L., D. Davidson, c.A. Hope and D.E. Scatt. 1980. Status of Morelet's crocodile (Crocodylus moreletii) in Belize. BioI. Conserv. 17:103-113.

Bayliss, P. 1987. Survey methods and monitoring within crocodile management programs. Pp 157-175 In: Wildlife Management: Crocodiles and alligators. Webb, G. J. W., S. C. Manolis and P. J. Whitehead (eds.). Surrey Beatty and Sons Pty. Ltd., Sydney. 552 pp.

Ferguson, M. W. J. 1987. Post-laying stages of embryonic development for crocodilians. pp. 427-444 In: Wildlife Management: Crocodiles and alligators. Webb, G. 1. W., S. C. Manolis and P. J. Whitehead (eds.). Surrey Beatty and Sons Pty. Ltd., Sydney. 552 pp.

Hall, P. M. 1985. Embryo growth curves as a method of determining the age of clutches of New Guinea crocodiles (Crocodylus novaeguineae). Jour. Herp. 19: 538-541.

Hunt, R. H. and J. Tamarack. 1993. Feasibility study to assess Cox Lagoon, Belize, Central America as a Morelet's crocodile preserve. Unpubl. Rep. to Nixon Griffis Fund for Zool. Res., New York Zool. Soc. 13 pp.

Hutton, J. M. 1987. Techniques for aging wild crocodilians. Pp. 211-216 In: Wildlife Management: Crocodiles and alligators. Webb, G. J. W., S. C. Manolis and P. J. Whitehead (eds.). Surrey Beatty and Sons Pty. Ltd., Sydney. 552 pp.

King, F.W., M. Espinal, and C. A. Cerrato. 1990. Distribution and status of the crocodilians of Honduras. pp. 313-354. In: Crocodiles: Proc. of the 10th Working Meeting of the Croc. Spec. Group, Gainesville, Florida. 1. U. C. N. Publ., Gland, Switzerland.

Meennan, J. C. 1992. The status of crocodiles in the eastern Corozal District. Occas. Papers of the Belize Nat. Hist. Soc. 1: 1-5.

Meennan, J. C. 1993. Survey of Caye Caulker: Insects and reptiles. Unpubl. Rep. to Belize Forestry Dept. 6 pp.

Meerman,1. C. and T. Boomsma 1993. Burden canal Nature Reserve Survey. Unpubl. Rep. to Belize Forestry Dept: 7 pp.

Messel, H., G. C. Vorlieck, A. G. Wells, and W. J. Green. 1981. Surveys of tidal rivers in the Northem Territory of Australia and their crocodile populations. Monograph 1. Pergamon Press, Sydney.

Platt, S. G. 1992a. Nesting ecology, food habits, and population survey of Morelet's crocodile (Crocodylus moreletii) in Belize. Unpubl. Rep. to Wildlife Conservation Society. 10 pp.

Platt, S. G. 1992b. Preliminary investigation of the nesting ecology, and juvenile and subadult food habits of Morelet's crocodile (Crocodylus moreletii) in Belize. Unpubl. Rep. to Belize Forestry Dept. 37 pp.

Platt, S. G. 1993. Wildlife survey of Gold Button Ranch, Belize. Unpub. Rep. to Mr. Robert Noonan, London, U. K. 17 pp.

Taylor, *I.A.*, G.J.W. Webb and W.E. Magnusson. 1978. Methods of obtaining stomach contents from live crocodiles (Reptilia, Crocodilidae). J. Herpetol. 12:415-417.

Table 1 : Summary of Morelet's crocodile nests found in Belize in 1993. (Locations: BHF = Bill Hasse Fann, DRF = Danny Rabino Farm, GJ = Gallon Jug, HL = Habenero Lagoon, GBL = Gold Button Lagoon, SL = Sapote Lagoon, SNR = Shipstern Nature Reserve).

Nest #	Location	Clutch Size	Infertile	&k
1	GBL	25	5	Flooded
2	GBL	32	12	Flooded
3	GBL	37	0	Raccoon Predation
4	GBL	20	12	Flooded
5	GBL	33	2	Eggs not buried
6	BHF	15	2	Grey Fox Predation
7	SNR	18	4	?
8	GJ	27	0	Successful
9	SL	35	0	Ant Predation
10	HL	31	2	Successful
11	SL	28	0	Successful
12	SL	27	0	Successful
13	SL	15	-	Abnormal Eggs
14	SL	28	3	Successful
15	DRF	11	11	Clutch Infertile
16	DRF	-	-	False Nest

Table 2: Morelet's crocodile surveys in northern Belize (May through September 1993). Locality names are based on topographical maps obtained from the Lands and Survey Department, Belmopan, Belize, or the Travellers Reference Map of Belize (International Travel Map Products, Vancouver, British Columbia, Canada, ISBN #09-21463-01-1). The synbol * denotes sites where spotlight counts were not conducted.

Location	Yearlings	Juveniles	Subadults	Adults	Eyes Only	Total
Almond Hill Lagoon	-	-	-	-	1	1
Altun Ha Pond	-	2	-	1	-	3
Banana Banks						
Lagoon	-	8	1	1	-	10
Lily Pad Pond	-	2	-	-	3	5
Maya Ruin Pond	-	1	1	1	-	3
Bill Hasse Farm	-	-	-	1	-	1
Black Creek	-	-	1	-	2	3
Black Lagoon	-	-	-	-	1	1
Blue Creek (At La Union)	-	1	1	1	4	7
Burdon Canal	-	-	-	2	-	2
Carmelita Lagoon	-	1	-	I	-	2
Castillo Pond*	-	-	-	1	-	1
Cox Lagoon	-	12	10	7	9	38
Crooked Tree	-	-	-	-	-	0
Dawson Creek	1	-	1	1	-	3
Easier Lagoon	-	4	2	1	-	7
Fabers Lagoon	-	-	1	1	-	2
Gallon Jug						
Cacao Pond	-	-	1	-	1	2
Chari Chich Creek	-	1	-	-	-	1
Laguna Seca	3	1	0	9	3	16
Laguna Verde	-	6	2	1	-	9
Rio Bravo at Cedar Crossing	-	-	2	-	2	4
Tapir Hole	-	4	-	2	2	8

Table 2 (Continued) : Crocodile surveys in northern Belize (May through September 1993).

Location	Yearlings	Juveniles	Subadults	Adults	Eyes Only	Total
Gold Button Ranch						
Gold Button Lagoon (Mean of 10 surveys)	4.7	11.1	18.2	7.4	72.5	113.5
Hattieville Prison Lagoon	-	1	-	-	-	1
Habanero Lagoon	-	5	11	11	12	39
Haulover Creek	-	-	-	-	-	0
Jones Lagoon	-	-	-	1	-	1
Mexico Lagoon	-	1	-	-	-	1
Mucklebenny Lagoon	-	8	3	-	10	21
Mussell Creek Tributary	-	-	-	1	-	1
New River Lagoon	-	1	1	6	8	16
New River Survey						
Main Channel	-	3	3	4	6	16
First Creek	-	-	-	-	2	2
Deep Creek	-	1	-	-	-	1
Doctor Creek	-	-	1	-	2	3
Back Creek	-	-	1	-	-	1
Orange Stump Lagoon	-	1	-	1	4	6
Parrot Hill Pond	-	1	-	-	-	1
Pond (Mile 2, W. Hwy.)	-	-	-	1	-	1
Pond (Mile 2.5, W. Hwy.)	-	1	-	-	-	1
Pond (Mile 27.5, W. Hwy.)	-	-	-	1	-	1
Potts Creek	-	-	-	-	-	0
Rabino Lagoon	-	-	-	-	-	0
Reinland Lagoon	-	-	-	1	-	1
Rio Bravo (At Blue Creek)	-	-	2	-	2	4
Rio Hondo						
At Blue Creek	-	-	-	2	-	2
At San Antonio	-	2	2	-	4	8

Table 2 (Continued) : Morelet's crocodile surveys in northern Belize (May through September 1993).

Location	Yearlings	Juveniles	Subadults	Adults	Eyes Only	Total
Sand Hill Pond*	-	2	-	-	-	3
Sallys Lagoon*	-	-	1	1	-	2
Salt Creek Pond	-	-	2	-	-	2
Sapote Lagoon	-	-	1	-	7	8
Shawfield	-	4	1	2	-	6
Southern Lagoon (Gales Point)	-	1	-	1	1	3
Trash House Lagoon	-	-	-	-	1	1
Yo Creek Lagoon	-	-	-	-	-	6