

INVESTIGATIONS INTO THE STATUS OF MORELET'S CROCODILE
(CROCODYLUS MORELETII) IN BELIZE, 1980.

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ABSTRACT: In this paper we present a report of our investigations into the status of Morelet's Crocodile (Crocodylus moreletii) in Belize, Central America. The research was carried out in May and June 1980 under the sponsorship of the World Wildlife fund. Assistance was also received from the Fauna Preservation Society (London), as well as from numerous private individuals in Belize, especially Bader Hassan and Mary Ann Boggess (Orange Walk Town).

The report is divided into three sections. The first deals with crocodile populations, the second discusses the dynamics of Belizean crocodile exploitation, and the third lists our recommendations for the conservation of C. moreletii. There is also an appendix.

INTRODUCTION

General impressions.-- Over the past three years we have observed crocodiles at 17 different locations in Belize. We believe that their distribution is country-wide, and we have seen them in a variety of habitats ranging from brackish mangrove lagoons to swiftly flowing mountain streams. Morelet's crocodiles are difficult to find near areas of human settlement and large animals (2 m) have become very scarce in all but the most remote parts of Belize. On the other hand, individuals between 0.5 and 1.5 m are reasonably common (in densities ranging from 2 to 10 animals/km of shoreline) in shallow freshwater lagoons with even partial protection from human exploitation.

Areas examined.-- On previous trips to Belize (summers of 1978 and 1979) we visited four locations of reasonable crocodile abundance which we wished to examine once more. These were Laguna Seca, Rio Bravo, Cox Lagoon, and some swampy ponds near Kate's Lagoon (for approximate locations, see Fig. 1). There were, in addition, several new areas which local informants had suggested we check. Finally, personnel in the Belizean Forest Office had requested that, if possible, we survey a portion of the upper Macal River which an FAO report had suggested as one possible site for a crocodile refuge.

STUDY AREAS

Laguna Seca (Location 1).-- This is a large, shallow lagoon in the western interior of Belize. As the name indicates, a considerable part of the lagoon may dry into flat savanna; during the wet season, however, a large area (approximately 3.5 km² with perhaps 15 km of shoreline) floods completely, and even during some "dry" seasons, the greater part of the lagoon may remain under water. Although crocodiles in Laguna Seca have been hunted occasionally for years, they have long been protected from frequent exploitation by the remoteness of the lagoon. In the summers of 1978 and 1979 we were able to survey only a small portion of the lagoon, in which, nevertheless, we saw 14 and 9 animals in the respective years. In 1980 we examined a much larger area and saw only three animals. This apparent scarcity may be attributed in part to the greater flooding of the lagoon (and consequent dispersal of its crocodiles). However, we believe it is largely due to greatly increased hunting pressure. During our stay at this lagoon, we saw numerous hunters, and we also found the remains of four recently killed crocodiles. The rapid improvement of road access to Laguna Seca was also very much in evidence. On our way in we forded the Rio Bravo; on our way out we were able to cross a brand-new bridge. While a few crocodiles will survive here for quite some time, we do not believe Laguna Seca will long maintain a really important population of C. moreletii.

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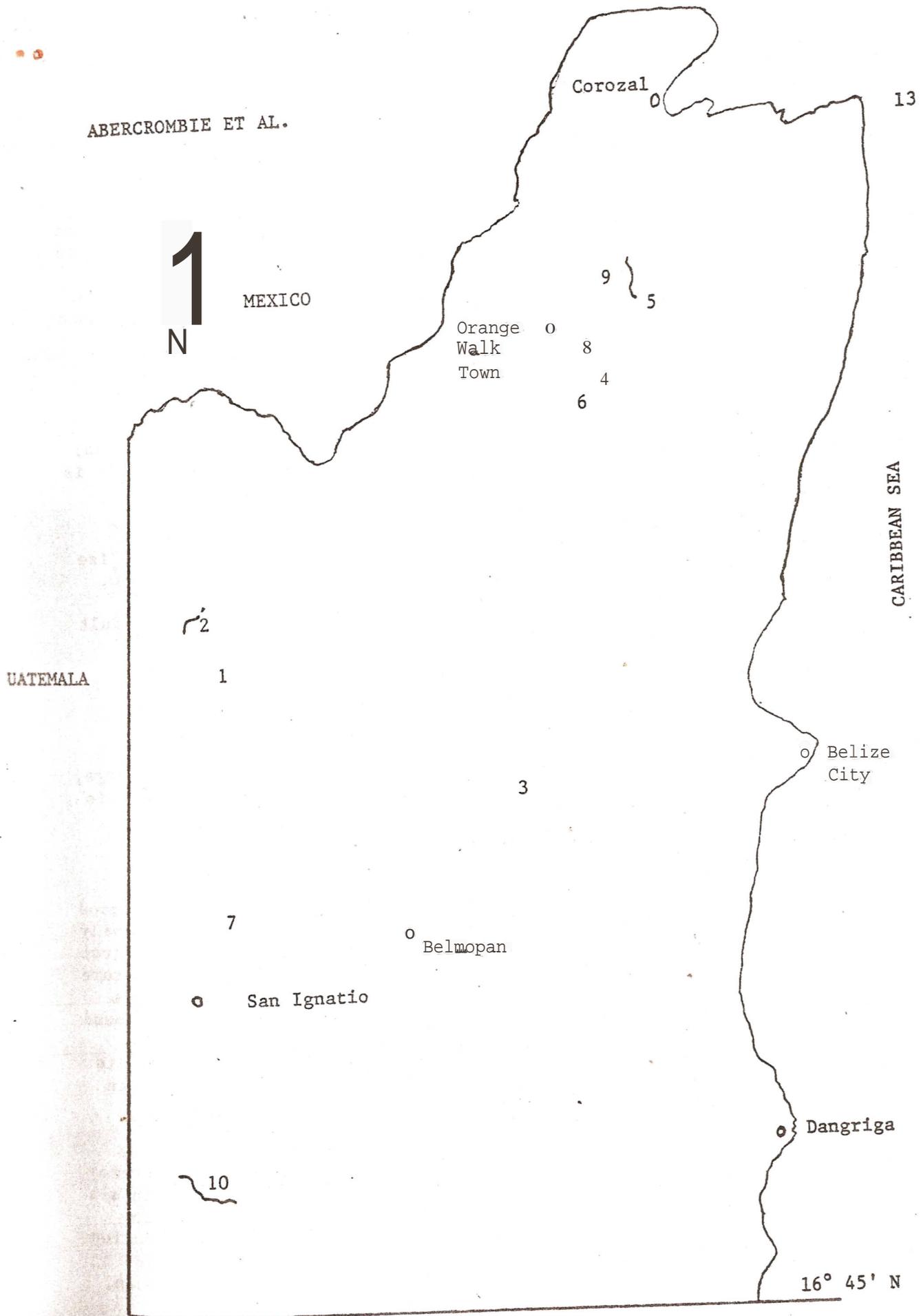


Figure 1. Southern Limit of 1980 Investigations.

Rio Bravo (Location 2).-- Again, this is a location we examined during three successive summers. In 1980 improved road access allowed us to survey a larger portion of the river (ca. 3 km) than before, and again we found crocodiles less in evidence--presumably due to hunting. We do not, however, expect the crocodile populations of Rio Bravo to suffer so much as those of Laguna Seca. First, the Morelet's crocodile populations in rivers are obviously less dense than those of lagoons, and river hunting is consequently less rewarding economically. Second, the Rio Bravo is frequently broken with stretches of long, shallow rapids. Combined with the great weight of native boats, such rapids render crocodile hunting on the Bravo quite difficult. We expect that all animals on river stretches with road or trail access will be extirpated; others will probably survive. The question we cannot presently answer is how many new roads and trails will reach Rio Bravo.

Cox Lagoon (Location 3).-- This is a long, narrow lagoon (0.6 km² in area with approximately 8 km of shoreline) about 50 km west of Belize City. We surveyed this lagoon in the summers of 1978, 1979, and 1980, and observed 27, 60, and 38 crocodiles respectively. Most of these animals are in the 0.5-1.5 m size range, but we saw at least three adult individuals in the summer of 1980. We believe Cox Lagoon is seldom exploited; indeed, although local hunters consider it something of a promised land, they realize the lagoon is property of Big Falls Ranch (a rice-producing farm) and generally respect the "posted" signs (see Recommendations).

Kate's Lagoon swamps (Location 4).-- Kate's Lagoon itself is a large, very shallow body of water about 20-km south of Orange Walk Town. It is a pleasant place, with cow pastures and large shade trees along its eastern border, and large numbers of Belizeans swim in it and picnic along its banks. As one would expect, the lagoon is not running over with crocodiles; the locals, in fact, have told us it harbors none at all. In the swamps extending roughly from the western part of the lagoon (Location 6), there are a number of small ponds, very shallow and heavily choked with sawgrass. We surveyed this area in 1979 and 1980. Our first visit disclosed approximately a dozen crocodiles (the labyrinthine nature of the swampy area makes it extremely difficult to know how many times one may be counting the same individual), and a similar number were found in 1980. We know this location is frequently hunted, but cover is so heavy and so well placed that it will be very difficult to extirpate its populations entirely. Indeed, we have even seen large adult animals in this area.

In addition to these old, familiar areas, in the summer of 1980 we also examined six new locations, including two lagoons, two small, swampy ponds, and two river sections. We found at least a few crocodiles in all these sites. In the two swampy ponds (Locations 5 and 6) we found one and two animals respectively. The two lagoons (Aquacate Lagoon, Location 7, and Kate's Lagoon, Location 4) had easy human access, and we could discover only one Morelet's in each. The two rivers, on the other hand, deserve more extensive comment. The first (Location 9) is an

approximately 5.5 km section of Freshwater Creek. The stream itself is broad and swampy, almost devoid of current. The northern and southern ends of the section we paddled are closed by mangrove swamps. On this section we observed 26 animals, all in the 0.5-1.5 m size range. The area "enjoys" easy human access, and local informants indicated that it is hunted rather frequently. We confirmed this by finding the partial skeleton of a Morelet's crocodile; extrapolation from skull size indicated it was a juvenile of about 0.75 m long. (The taking of so small an animal clearly suggests extremely heavy hunting pressure.) Furthermore, we saw no adult crocodiles, though one informant suspected at least two might still inhabit the area. We believe it unlikely that significant crocodile populations will long survive on such stretches of river unless action is taken to ensure their conservation.

Macal River (Location 10). As indicated above, a report by the United Nations' FAO suggested that the upper reaches of the Macal River might provide an appropriate area for the establishment of a crocodile refuge. In the summer of 1980, we talked with personnel in the Belizean Forest Office (see The Crocodile Hide Business in Belize) who indicated some interest in this project, but who said they first needed some survey data on how many crocodiles the area might actually contain. And indeed some difficulties do attend any survey of the upper Macal. The only available access is at the Guacamallo Bridge (ca. 14 km south of Augustine), and in that vicinity there are a number of significant rapids. We spent five nights in the Guacamallo area, and we managed to explore just over 13 km of the river (approximately 5 km were covered twice). Our technique involved scouting a river section in daylight and then surveying it for crocodiles after nightfall. By this method, a total of 11 animals was observed, and while this may sound like a rather small number, two considerations should be held in mind. First, nine of the animals were adults, and one was very large (approximately 3 m); nowhere else in Belize have we seen so great a density of breeding-size Morelet's. Second, while night survey is an effective method of counting crocodiles, there are two reasons we believe it may seriously underestimate the number of animals on the Macal. To begin with, crocodiles there may reverse the typical Belizean pattern of diurnal secrecy and nocturnal activity. Hunting pressures are minimal, and while daytime temperatures are quite pleasant (about 27° C), the nights in those mountains can be rather cool (about 22° C). We observed three adults in broad daylight (it seems probable that we missed seeing others); we were not always able to locate these same animals after dark. More important, in our night surveys we were able to search effectively only the broad, flat stretches of the river. On the other hand, over half of the crocodiles we saw were near or actually in the poorly searched rapids zones. Although the demands of nighttime white water work precluded extensive observations, we did notice that some of the animals appeared to be searching for food: Specifically, one crocodile (ca. 2 m in length) was located immediately below a long series of rapids. Its head was oriented upstream, and, taking no notice of us, it made repeated sideswipes of its snout into the churning water that flanked the eddy in which it lay. A second animal, slightly smaller, was

seen working upstream in the midst of an approximately 10 m stretch of rapids. We agreed that this animal made use of eddies and cross-currents to aid its upstream progress, but we also noticed that it frequently stopped and probed around with its snout. We have noted similar probing behavior (though not in rapid water) among feeding alligators.

We do not know whether the above behavior is a common feeding strategy of C. moreletii, and indeed we did not actually see any of the animals catch and eat any prey. In this connection, we hope to make more extended observations in the summer of 1982. Our point for the present, however, is that we quite possibly missed seeing a number of crocodiles in the rapids, and if so, our observations would underestimate the density of crocodiles in the Macal River.

PART I: THE CROCODILE POPULATION OF BELIZE

We attempted to estimate very roughly the total number of crocodiles in the northern half (north of 16° 45' N lat.) of Belize for 31 May 1980 (a time shortly before the emergence of any 1980 hatchlings). We derived our estimates by two independent methods. Both are rather complex and we have therefore relegated the details to a methodological appendix.

Estimate 1.-- We have night survey data on density of crocodiles per unit of certain habitat types. By looking at 1/50,000 topographic maps, we count units of various habitats and estimate 2500 crocs age 9 months.

Estimate 2.-- We have rough data on hide exports for three years. Assuming that hunting effort is constant from year to year and that a constant proportion of the crocodile population is taken per unit effort, we estimate 2200 crocs age 9 months. (We believe that both of the above methods underestimate the total croc population: the first method counts animals observed as total density per unit of habitat; the second method is subject to more complex biases listed in the appendix.)

CONFORMATION AND SIZE OF MORELET'S CROCODILES

Table 1 supplies size data on 17 crocodiles we captured, marked, and released. In conformation, all these animals were quite similar; their color, however, varied noticeably from the black and yellow pattern characteristic of C. moreletii to a dull greenish-gray more nearly typical of C. acutus. These color differences appeared to be correlated with neither size nor location. Indeed, we have found animals of both color extremes within 100 m of each other.

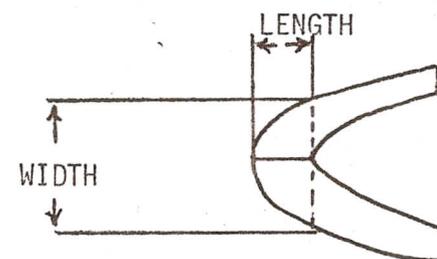
On several occasions we have been asked to estimate the probable lengths of crocodiles from skulls in various collections. For this purpose we have derived a least-squares formula from the data on our crocodiles. If X is taken to represent the length (in mm, from the

TABLE 1. Characteristics of animals captured

ANIMAL NUMBER	TOTAL LENGTH	S-V LENGTH	HEAD LENGTH	HEAD WIDTH	HEAD DEPTH	SNOUT LENGTH	SYMPH. LENGTH	SYMPH. WIDTH	X-BANDS BODY	X-BANDS TAIL	1-CREST WHORLS	2-CREST WHORLS
1	1759	902	273	129	105	174	43	54	?	?	18	16
2	1651	845	232	139	95	152	41	57	4	11	17	17
3	1001	517	150	62	50	93	19	30	?	la	19	18
4	749	362	111	52	41	66	16	24	5	9	21	17
5	610	286	91	35	30	57	17	19	5	la	20	18
6	590	270	90	33	28	53	14	19	?	8	21	18
7	560	260	87	29	27	51	13	17	6	la	22	17
8	521	253	81	28	26	46	10	14	5	10	19	18
9	505	241	78	35	24	44	12	16	4	?	22	17
10	489	229	73	27	24	43	15	16	4	9	20	18
11	480	225	80	28	24	45	11	15	?	?	22	17
12	473	235	73	32	26	40	9	15	4	10	21	17
13	466	219	69	31	24	38	10	13	5	la	22	17
14	400	203	70	32	22	38	13	13	4	9	21	18
15	351	165	60	22	17	32	11	13	?	la	21	17
16	347	165	61	21	19	29	8	11	5	11	20	17
17	541*	265	84	31	27	50	13	16	?	9	16*	18

* No tail tip

NOTES ON THE TABLE: (A) All sizes are in mm. (B) Snout-vent length runs to anterior margin of vent. (C) Head width is width at the eyes. (D) Head depth is depth immediately posterior to eyes. (E) Snout length is length to anterior margin of eyes. (F) Number of crossbands was not always clear; attempts were made to give a number where possible, even with some guessing. On animals for which it was impossible even to guess, we have indicated "?". (G) Mandibular symphysis lengths and widths were measured as shown in the at right.



Partial diagram of mandibles, ventral view.

anterior of the premaxilla to the posterior of the parietal) of an animal's head and Y represents the estimated total length (mm) of the animal, then the total length is best estimated by the formula

$$Y = -39.8 + 6.89X.$$

The correlation coefficient associated with this equation is, for our sample, $r = 0.996$. It must be remembered that all our data were taken from animals less than 2 m long. Therefore, anyone using the above formula to estimate animal lengths from the size of especially large skulls should carefully note the usual caveats against projecting linear relationships beyond the range of available data. This question of size may be particularly relevant to the problem of protecting Morelet's crocodile. It has somehow entered the literature (*viz.* Schmidt and Inger 1957) that *C. moreletii* is a small crocodile. Therefore, it might erroneously be thought that a policy protecting, say, all crocodiles under 1220 mm would preserve at least a small number of breeding-size animals. (Incidentally, several years ago the Belizean government apparently considered just such a conservation measure--assuming that *C. moreletii* gained sexual maturity "at something less than four feet.") We are convinced, however, that such would not be the case, for *C. moreletii* appears to us to be a rather large beast. Only at about 1750-mm do these Belizean animals begin to attain the heavy girth usually characteristic of breeding-size crocodilians. We have seen animals in the field whose length we estimated at 3 m. We have also examined a skull that we believe came from a crocodile over 2700 mm long. Furthermore the Atlanta (Georgia) Zoo currently maintains a male *C. moreletii* approximately 3 m long, plus 7 other adults averaging 2.25 m.

PART II: THE CROCODILE-HIDE BUSINESS IN BELIZE

In gathering the information contained in this part of our report, we talked with hunters and hide dealers in areas surrounding the towns of San Ignacio, Orange Walk, and Dangriga, with officials of the Forestry Office in Belmopan, and with Audubon Society members in Belize City. We had prior contacts in some of the locations. These contacts were approached first when possible; they provided us with an up-to-date assessment of the situation and often led us to other knowledgeable people. In places where we had not established prior contacts, we asked people we encountered on the road or in other public places for information about "alligators" (the local terminology) and/or those who hunted them. This "snowball sampling" technique usually worked quite well in directing us to informants.

We wished to learn about (1) the social characteristics of those who hunt crocodiles and those who deal in hides and (2) the economic stake each group has in crocodile exploitation. We were also interested in the perceptions of each group regarding the current status of crocodiles in the wild and the desirability of protecting them. Finally, we wanted to examine the relevant laws and possibilities for change.

Hunters

Crocodiles are hunted at night, mostly during the dry season (approximately January-June). They are sought in Belize solely for their hides, although we received several reports that the Guatemalans enjoy eating the tail. There seem to be two basic types of hunter. The "master hunter" spends most of his time during the dry season hunting and fishing. This person is an expert hunter and woodsman. He knows the area and the animals he hunts very well. He often goes out for days or even weeks fita time to very remote areas. On a "successful" trip, he may kill as many as 25 or 30 crocodiles. Although some of these hunters seem to know more about crocodiles than others, they are not known specifically as "crocodile (or 'alligator') hunters," for they also hunt other commercially valuable species (jaguar, ocelot) as well as "food" species (deer, gibnut, turtle, peccary, etc.). These hunters have a~ther occupation (usually farming or some craft) which they practice during the wet season when the usual hunting places are inaccessible. It was our impression that most of the men who match this description are of the older generation. Several of the "master hunters" have retired because of poor health and old age; those still active are in their late fifties and early sixties. Although these men have sometimes passed their skills on to their sons and nephews, members of the younger generaton are less committed to hunting as a way of life and are generally less skilled.

The other type of hunter can be characterized roughly as "part-time." These men continue to work at another job during the dry season and go hunting after work, on holidays, or when their work takes them into wild areas (as in the case of the chicle workers). Like the master hunters, they hunt animals of all typ~s; however, the part-time hunters typically stick to areas close to home (within easy walking or bicycling distance) or to areas easily accessible by road. This type of hunter is much more common than the first type and may include, at one time or another, most of the adult male population of rural Belize. A hunter of this type probably gets a crocodile or two ev~ry couple of years.

In addition, people who do not ordinarily hunt are likely to kill any crocodile that ventures near their homes, fields, or ponds. Crocodiles are feared by most people in Belize (although a few Belizeans keep them as pets) and will be shot on sight. A Good Friday incident in which a ma~ was allegedly killed and eaten by a crocodile in a roadside pond near Orange Walk received widespread publicity ana has exacerbated anti-crocodile feeling.

On the whole, though, it is probably safe to say that crocodile hunting in Belize is less important today than it was five or six years ago. Although some nonmonetary rewards of hunting remain important, the decision to go after crocodiles is primarily economic: hunters speak Wistfully of "\$1000 nights" and of avoiding small animals "because they only bring a dollar." Furthermore" the current economic situation in

Belize provides an increasing number of alternatives to hunting. Work is generally available, and it pays well. The sugar cane industry and several road-building projects were specifically mentioned as more lucrative and dependable sources of income than hunting. Several of the young and middle-aged men we talked to said that they had given up crocodile hunting in recent years because (even at \$10* a foot--the highest price ever in Belize) it simply didn't pay enough.

It is probably also the case that crocodiles are more difficult to find than they have been in some period of the past. The older hunters acknowledged that crocodiles are scarcer than when they began hunting them in the 1940's. One hunter noted, "You used to get 2\$ or 30 in a night. Now you get \$, 10, maybe only 2." Overall, however, both hunters and hide dealers felt that there were still plenty of crocodiles left in Belize, especially in its "inaccessible" regions. Some people believe the number of crocodiles has actually increased in recent years due to the decline in hunting. There is little sentiment on the part of the hunters for protection of crocodiles. First of all, they do not feel such protection is necessary since "there are still plenty of alligators." Even if crocodiles were near extinction in the country, the native hunters do not feel that they are animals worthy of protection: "Why should they be protected when they are dangerous, when they kill people"? Many hunters we talked to claimed that they would not take crocodiles under 4 or 5 feet in length. This, however, was less for conservation than for short-term economic reasons; small crocodiles simply did not pay. (Incidentally, the evidence we found at campsites and hide-dealing establishments indicates that small animals are indeed being taken by somebody.)

From our observations, it appears that no hunter in Belize depends exclusively on the hunting of crocodiles to make a living. All the hunters we spoke to or heard about had another occupation which could be practiced year round. The sale of crocodile hides undoubtedly brings appreciated money into some poor Belizean households, but the impression we obtained was that such money was not depended upon for subsistence. It was a good source of "extra" income--to be spent on hunting equipment or new things for the house. Intensive crocodile hunting does not seem to involve many people at the present time. However, this is a situation which could change rather rapidly if Belize experiences an economic recession with resulting unemployment, if the price of crocodile hides goes up, if good roads are built into presently inaccessible hunting areas, or if there are several long, consecutive dry seasons.

* All prices are given in Belizean currency; at the time of the study \$2 Belize was approximately equal to \$1 U.S. Note also that crocodile hides in Belize are priced by length, not by width across the belly.

Hide Dealing and Exportation

It is clear that if hides were not commercially valuable, most crocodile hunting in Belize would cease. Thus, any protection program must at some point or another deal with those who purchase the hides. In Belize, there are quite a number of people who buy crocodile hides from hunters. Nearly every fair-sized community seems to have at least one such person. These hide dealers are most often also storekeeper~; they all seem to engage in hide-buying as a sideline; they all also buy cat skins. The local hide dealers have a very loose, informal relationship with one another and also with the exporter in Orange Walk, the one man licensed to ship hides out of Belize. The exporter says he will buy hides from anyone who brings them in--hunter or dealer. In the summer of 1980, he was paying \$10 a foot for hides 5 feet or longer.* The local hide buyers set their own prices--in 1980, these ranged from \$7 to \$10 a foot. We have circumstantial evidence that some hides may be bought and sold several times before reaching the exporter. In such cases, of course, the hunter would receive much less than the price being paid by the exporter.

The hide dealers share the feelings of the hunters regarding crocodile abundance and the foolishness of protection. They are more openly hostile toward, and much more aware of protectionist activities. They feel (and are probably instrumental in passing on such views to the hunters) that to forbid hunting would quickly bring about a surplus of crocodiles, which would invade settled areas and threaten human lives. There is evidence that at least some hide dealers actively encourage hunting by offering to transport hunters to the bush. Hunters with hides are never turned away and, apparently, are not made aware of quotas (see below) and other governmental controls. Hide dealers deny that losing the hide business would have any great economic effect on them. This seems to be a correct assessment; the hide dealers, as a group, are solidly middle-class and have at least one other way of making a living.

The man licensed to export hides is clearly the most important figure in Belize in respect to crocodile exploitation. Like the local hide dealers, this exporter does not depend solely upon the skin business for livelihood. The exporter sees himself as providing a living for many hunters and their families. He once told us that if hide exportation were prohibited, the men he currently buys from would "become involved in drug exportation to make a living." Since our research indicates that most hunters do not in fact depend even primarily upon the hide trade for their livelihoods, we disagree with the exporter over his conclusion.

* As far as we could tell, he pays the same price to both hunters and dealers. One dealer claimed he received \$14 a foot from the exporter but this man's testimony is disputed on other points and may be on this one.

Crocodile hides from Belize go initially to the Andre Fontaine Company in Belgium.* This arrangement has been in effect for several years; the Belgians have visited Belize three times. The exporter adjusts his prices to hunters so that he can make a profit; from hints he gave us, he has been receiving between \$10 and \$15/foot recently. The exporter told us that the number of hides exported has decreased year by year since the early 1970's when the government imposed a quota on the exporter. He further told us that the quota had been decreased each year until it currently stands at 1500 total hides and skins (both crocodile and cat).**

Governmental Action

Current laws relevant to wildlife in Belize are contained in the "Wildlife Protection Regulations," written and passed in 1945. Under these regulations, animals may be placed on a protected list by ministerial decree. Animals on the list may not be hunted. Neither the Morelet's crocodile nor the American crocodile (*C. acutus*) was included on the list we were able to review. In addition to protecting certain animals entirely, the Regulations (1) require a license for hunters, (2) prohibit hunting on Crown lands, and (3) ban the use of artificial lights in hunting. Enforcement of this last provision would reduce the number of crocodiles taken to near zero, since virtually all commercial hunting is done at night with headlamps. (It is also clear that such enforcement would be extremely difficult.) As it is, few of the hunters we talked to admitted any knowledge of the ban on headlamps; licensing requirements and Crown lands regulations were more widely known, but it appears that these provisions too are often violated.

The government has taken several steps recently which indicate a willingness to support wildlife preservation efforts. After the November 1979 elections, the cabinet was reorganized and the Ministry of Forestry

* According to K. Fuchs (pers. comm.) the hides are not processed in Belgium but are resold to a tannery in Italy. Attempts in Brussels to trace this economic connection were soundly rebuffed.

** The export quota system is not easily interpreted, for one is not able to determine from trade statistics how many exported skins are from crocodiles and how many from spotted cats. It is our belief (and perhaps we are wrong) that actual declines in exports have resulted less from lowered quotas than from a decline in the country's population of crocodiles.

Note also that if we have correctly estimated the prices this exporter receives, then he is being paid significantly less for Morelet's hides than is usually given for American Alligator skins--despite the widely recognized superiority of leather from the former species.

and Minerals (the ministry responsible for wildlife) was removed from the jurisdiction of Trade and Industry and combined with Agriculture and Lands to form a new Ministry of Natural Resources. The government expects to submit new legislation regarding wildlife protection and the establishment of a national parks system to the legislature within the next few months. The proposed legislation is based on a 1978 report of FAO consultant William O. Deshler entitled "Proposals for Wildlife Protection and National Parks System Legislation and the Establishment of National Parks and Related Areas in Belize." Under the proposed legislation, both C. acutus and C. moreletii would be placed on the protected list (the list specifying that "no person shall hunt any of the following species on either government or privately owned lands"), and all commercial dealing in wildlife species or parts thereof would be subject to a seven-year moratorium. As presently written, the legislation does not make any specific provisions for crocodile preserves. Deshler's report suggests but does not formally recommend locations for two such preserves: (1) the upper reaches of the Raspaculo Branch, Macal River, and (2) the Big Creek-Independence area near the Savannah Forest Station. Neither site was visited by Deshler and future recommendations are dependent on obtaining information about the current status of crocodiles in these areas. The proposed legislation is supported by the current government and by the Audubon Society. The two officials we talked to in Forestry (the chief Forest Officer and his assistant) believed that the legislation had a good chance of being passed.*

In the meantime, several other measures which may affect the crocodile hide business in Belize have been taken. After receiving a letter from the American consulate (dated 5 May 1980) informing them that C. moreletii and C. acutus were endangered species and could no longer be imported into the U. S., officials in the Forestry department informed the exporter that his license for exporting skins (both crocodile and cat) would not be renewed next year. The exporter himself naturally hopes there will be some change in these plans, and it may therefore be a bit early to make any definite pronouncements about the legal status of Morelet's crocodile next year. In the meantime, the government has recently issued two orders which will make exportation more expensive. One order (dated 2 May 1980) raised export taxes on products of wild animals from 5% to 10% Ad valorem. A second (also 2 May 1980) increased fees for dealer and hunting licenses.

Belizean Audubon Society

Audubon Society members have been almost solely responsible for whatever wildlife education exists in Belize. They are waiting for

* Very recent information from Belize indicates that all crocodiles are now legally protected (see Current Plans under Recommendations, below).

passage of the above mentioned legislation before deciding what type of educational campaign to undertake in regard to crocodiles. They recognize that attitudes toward crocodiles will be difficult to change. Meanwhile, some individual members of the Society prepared and presented an educational radio program on crocodiles to counteract the publicity surrounding the Orange Walk incident. In other words, Audubon Society members are willing to help in crocodile protection but would like to have the force of law behind them before they fully commit themselves.

PART III: GENERAL RECOMMENDATIONS.

The Necessity for Eventual Legal Protection

In the past, exploitation of Morelet's crocodile has been greatly slowed by the inaccessibility of much premium habitat. Such conditions should not, however, be expected to persist, and as Belize continues to expand her road network, more and more areas will become easily accessible to crocodile hunters. Our experiences in the summer of 1980 demonstrated that such changes can be very sudden. We are therefore convinced that C. moreletii must eventually be given some degree of legal protection in order to ensure the long-term survival of the species in Belize.

Current Plans

As our report indicates (see above) the Belizean government intends to prohibit export of crocodile skins by 1981. We would strongly support this plan--with the added proviso that it should not be necessary permanently to cease all commercial exploitation of the species. FAO (see Deshler 1978) recommended a seven-year moratorium on crocodile hunting; even this might be unnecessarily long. We believe Belize's crocodile populations still possess the capacity for rapid recovery; many of the animals we have observed were 1.0-1.5 m long. If Morelet's growth rate is comparable to that in Alligator, we might expect their young to be of breeding size within three to four years. Therefore, if a true moratorium on crocodile hunting had been instituted by the end of 1980, it is possible that C. moreletii could withstand a limited, closely monitored harvest program beginning with the dry season (January) of 1986. We are convinced that the long-term survival of Morelet's crocodile depends upon its perception by the Belizean people as a valuable resource. Therefore, it would be politically advisable to stress the temporary nature of any moratorium as well as the economic benefits expected from it.

In the early spring of 1981 we were informed that the Belizean government had indeed declared a moratorium (of indefinite length) upon the taking of any crocodiles. Furthermore, we have more recently learned

that this policy has been continued since Independence. Although it does not currently appear that the protection ordinance has been enforced with uniform effectiveness, we are nevertheless encouraged by the overall program of Belize's new government.

If this ban on crocodile hunting can be maintained (and more rigorously enforced) for even a few years, the Belizean Forest Office should be able to develop a reasonable harvest scheme based on the results of experimental programs in New Guinea and Florida. In the meanwhile, of course, efforts should be made to learn as much as possible about the specific population ecology of C. moreletii.

Hide Exports

If at some future date crocodile hides are legally exported from Belize once more, the Forest Office should attempt to derive useful data from such commerce. For example, trade statistics should distinguish between crocodile and spotted cat hides. Furthermore, the actual number of animals (as opposed to just the number of hide-pounds), preferably broken down by size, should be reported. Monitoring such data over a number of years could provide the Forest Office with valuable information on the status of their crocodile populations. Finally, and most important, we would strongly urge research to determine how a greater percentage of revenues eventually derived from crocodile hides might be kept in Belize.

Crocodile Refuges

Conversations with Forest Office personnel, as well as with members of the Belizean Audubon Society, indicate the possibility of establishing one or perhaps more crocodile refuges. We believe such refuges should be established, whether or not nationwide protection becomes a reality. One of the areas suggested for such a refuge includes the upper reaches of the Macal River (see above). We have examined this river rather carefully between coordinates BP901653 and BP817670 (grid zone designation 16Q), and although it provides less than ideal crocodile habitat, we nevertheless consider it a virtually ideal refuge site for several other reasons.

First, it already enjoys considerable protection. Access is limited to the Chiquibul Road, and that road's traffic is controlled by a Forest Office checkpoint. Hunting is prohibited in the area and is limited to occasional poaching by logging crews and sport hunting practiced by British military forces stationed in the area. (Incidentally, Mr. William Locklair, head of the Augustine Forest Station, said that his most serious hunting problems were caused by the British Army. It would seem that proper command supervision could prevent any such problems.)

Second, the area certainly gives shelter to a large number of interesting vertebrae species other than crocodiles. In our five-day stay, we observed such animals as king vultures, Sarcoramphus papa, deer, Dama (Odocoileus) yucatanensis, ocellated turkey, Agriochar ocellata, iguana, Iguana iguana, parrot (we saw only Amazona--though, as the river's name indicates, macaws, Ara macao, are also present), and cougar, Felis f. mayensis, as well as; large number of smaller reptiles and birds. We have been told that jaguar are reasonably common, and tapir, Tapirus bairdii, are everywhere in evidence. We know from Audubon Society members that the area is already quite popular for birding trips, and the natural scenery of the mountains (which includes an extremely high waterfall and an enormous cave) is unsurpassed in Belize. These factors, together with the climate (which is characterized by warm days and cool nights), clearly indicate real possibilities for tourism. A national park, filled with lots of wildlife, might eventually become an economic asset of some importance. Furthermore, the crocodiles of the Macal River do not seem greatly afraid of human beings. We have observed several during daylight, and we therefore suspect that they might become a visible (and therefore tourist-attractive) part of any park's fauna.

Before a park is formally established, it would be desirable to complete a more extensive survey of this Fiver system. However, since the establishment of a refuge might initially require little more than making a proclamation plus posting a few signs, such a survey is probably not imperative.

In addition to any mountain refuge, it may be necessary to guarantee protection in some more nearly ideal crocodile habitat. The Big Creek-Independence area has already been suggested; this or other locations in central Belize might well be appropriate, though a survey should be done prior to formal designation. We have noted that Cox Lagoon is densely populated with crocodiles. Furthermore, it already enjoys some de facto protection under the administration of Big Falls Ranch. We believe it would be appropriate if the Forest Office would encourage (and aid, if possible) the Big Falls Administration in maintaining this protection. The same would naturally hold for other privately protected areas.

Conservation Education and Public Relations

As we have said before, we believe the long-term future of crocodile populations in Belize depends upon their perception by the Belizean people as an economically valuable natural resource. Clearly the exportation of hides is one possible source of revenue. We have suggested that, along with other Wildlife, crocodiles could help attract some tourist trade to Belize, perhaps especially in the mountains. Finally, data from Africa indicate that the extirpation of crocodiles often results in eventual declines of food-fish populations (see Curry-Lindahl 1972). All these factors might be emphasized in an education program.

We highly commend the Belizean Audubon Society for their long-standing efforts in conservation, and we especially appreciate the work they have done for the less-than-popular crocodiles. We further suggest that any plans the Forest Office makes for crocodile conservation would certainly profit from coordination with the Audubon Society.

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