

FINAL REPORT



Status and Distribution of the American Crocodile (*Crocodylus acutus*) in Biscayne Bay

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ABSTRACT

Habitat loss has been identified as the primary cause of endangerment of the American crocodile in Florida. The distribution, growth, and survival of crocodiles has been linked to the regional hydrologic conditions, especially water levels and salinities. A goal of Biscayne Bay restoration and management is to provide more natural timing and distribution of freshwater to southern Biscayne Bay. The objectives of this project were to determine the status and habitat relation of crocodiles in southern Biscayne Bay, and to make management recommendations.

The American crocodile has made a comeback in southern Biscayne Bay in areas where suitable habitat remains, or in some cases where an area has been modified by humans to make it more attractive to crocodiles. Inadvertently creating nesting habitat through dredge and fill activities at the Turkey Point Power Plant site and the Basin Hills area of Crocodile Lakes National Wildlife Refuge has to some extent compensated for the loss of nesting habitat elsewhere in the Bay. Adult crocodiles are clustered around, but not restricted to, these nesting areas. The shoreline, canals, and ponds of the southern Biscayne Bay/Card Sound/Barnes Sound area provide essential habitat for juvenile and subadult crocodiles and along with the nesting areas meet all of the life stage requirements to support the continued recovery of this endangered species. The Biscayne Bay study area contains the fastest growing, and possibly the densest, component of the Florida population of American crocodiles.

Biscayne Bay provides the unique opportunity to integrate habitat enhancement for an endangered species with ecosystem restoration and management. Crocodiles would benefit from a restored freshwater flow into the estuary. This includes directing flows through mangrove swamps instead of canals when possible, and maintaining freshwater flow into the beginning of

the dry season. Biscayne Bay should be considered as part of the South Florida estuarine ecosystem along with Florida Bay and the Gulf Coast, and should benefit mutually from restoration and management planning.

It is likely that the number of crocodiles will continue to increase in the study area even if no habitat enhancement takes place. This will exacerbate a growing problem concerning interactions between humans and crocodiles. The challenge of integrating a recovering population of the American crocodile with an ever increasing use of coastal areas by humans will require a proactive education program and will be the final challenge in the successful recovery of this once critically endangered species.

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INTRODUCTION

The American crocodile (*Crocodylus acutus*) is the most widely distributed New World crocodile (Thorbjarnarson, 1988). It ranges along both coasts of Central and South America and Cuba, Hispaniola, and Jamaica in the West Indies, with the northern limit of its range in southern Florida (Kushlan and Mazzotti, 1986; Kushlan, 1988; Thorbjarnarson, 1988). In 1975 the Florida population of the American crocodile was listed as endangered by the United States Fish and Wildlife Service (Ogden, 1978).

Research on *C. acutus* (Thorbjarnarson, 1988; Rhodda, 1984; King et al., 1982) has shown that restricted distributions, small population sizes, as well as hunting and habitat loss have endangered populations throughout its range. Habitat loss and the concomitant decrease in range are major factors in the decline of many crocodilian populations; and the Florida population of *C. acutus* has been no exception (Lang, 1975; Kushlan and Mazzotti, 1989a).

Historically, the American crocodile has never been common or widely distributed in Florida (Mazzotti, 1983). However, they have been reported throughout Biscayne Bay and as far north as Palm Beach on the East Coast and Naples and Sanibel Island on the West Coast (Hornaday, 1875; Hornaday, 1904; Kushlan and Mazzotti, 1989a). By the 1980's, the majority of sightings were concentrated around North Key Largo, northeastern Florida Bay, and the southern extent of Biscayne Bay at the Turkey Point Power Plant (Kushlan and Mazzotti, 1989a). Recently, the number of reported sightings in Biscayne Bay north of Turkey Point have been increasing.

Historically, nesting occurred in Biscayne Bay, Florida Bay, and the Keys; however, nesting today is not as widespread. Smith (1896) reported the last nesting effort in northern Biscayne Bay in 1896. This has been attributed to the loss of critical nesting habitat due to human influence. Nesting still occurs along Florida Bay within Everglades National Park, along Barnes Sound within Crocodile Lakes National Wildlife Refuge, and along Card Sound at the southern extent of Biscayne Bay at Turkey Point Power Plant (Brandt et al., 1995; Kushlan and Mazzotti, 1989a; 1989b; Moler 1991). Nesting has recently been observed on Sanibel Island and at the Marco Island Airport (pers. obs.).

The American crocodile prefers brackish water and is typically found in ponds, coves and creeks in mangrove swamps. These areas are characterized by deeper water, low wave action, and intermediate salinities, which in Florida average 14 ppt. (Kushlan, 1982; Mazzotti, 1983; Kushlan and Mazzotti, 1986; 1989b; Thorbjarnarson, unpublished).

The purpose of this project is to provide a basis for evaluating the impacts of hydrological restoration plans in Biscayne Bay on the American crocodile. The objectives of the project are:

- (1) to determine the status (relative abundance, size, sex, and nesting effort), distribution (location), and habitat relations (type of water body or wetland, vegetation, water depth, and salinity) of crocodiles; and
- (2) to make recommendations on how the ecosystem restoration planning process can be used to integrate hydrological and habitat restoration efforts with endangered species protection.

STUDY AREA

The study was conducted in southern Biscayne Bay, Dade County, Florida, between the Coral Gables Waterway and US Highway 1 at the C-111 canal (Figure 1). Biscayne Bay is a shallow subtropical estuary along the southeastern coast of Florida. The bay is characterized by a bedrock basinal area bound on the west by the Atlantic Coastal Ridge, composed of Miami limestone, and a low platform forming the Everglades. A narrow ridge of Key Largo Limestone underlies Miami Beach and Key Biscayne which rises above sea level forming the Florida Keys and delimits the basinal area to the east (Alleman et al., 1995; Hoffmeister, 1974).

Although some freshwater wetlands were present in the study area, most wetlands were saline. Mangroves form extensive saltwater wetlands along parts of the bay. The dominant mangrove species in Biscayne Bay and adjacent sounds were red mangroves (*Rhizophora mangle*), white mangroves (*Laguncularia racemosa*), black mangroves (*Avicennia germinans*), and buttonwood (*Conocarpus erecta*) (Craighead, 1971; Alleman et al., 1995; Sonntag, 1987). Mangroves dominated the shoreline from Matheson Hammock south along the mainland through most of Biscayne National Park, Card Sound, and Barnes Sound (Alleman et al., 1995; Fish and Stewart, 1991). Red mangroves as well as two exotics species, Australian pine (*Casuarina glauca*) and Brazilian pepper (*Schinus terebinthifolius*) dominated the canals and inland bodies of water within the bay.

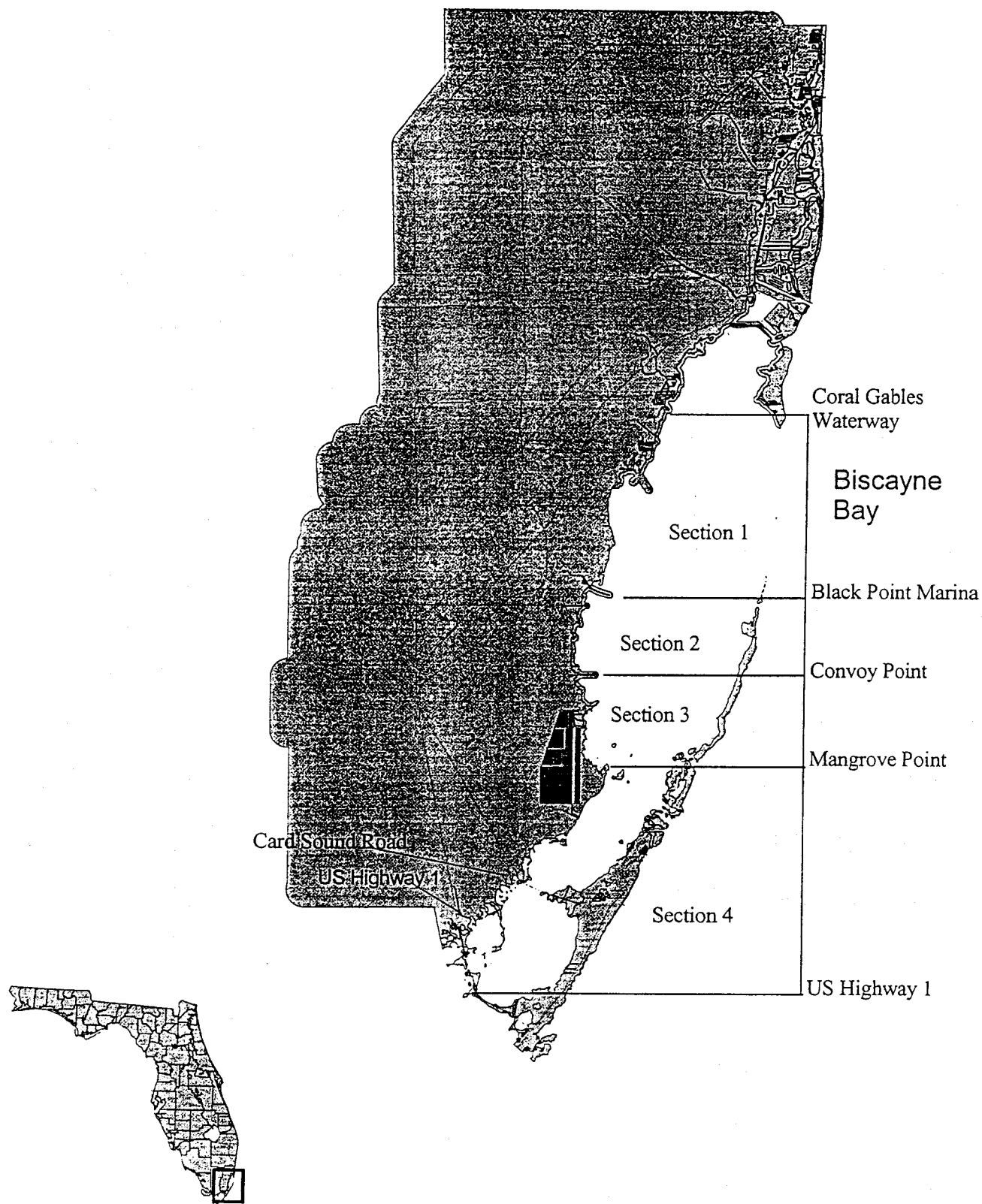


Figure 1. Location of Biscayne Bay study area in southeastern Miami-Dade County, Florida. Sections delineate survey routes.

Saltmarshes comprised much of the area inland from the mangrove forest, and cover most of the region between US Highway 1 and Turkey Point. Seagrass communities, both with and without a hardbottom matrix, and hardbottom communities are the dominant aquatic communities within the areas of the bay surveyed (Alleman et al., 1995; Fish and Stewart, 1991). The depth of the water along the survey route ranged from 0.3 to 2.0 m, with depths greater than 1.25 m found at both the northern and southern extremes of the area.

METHODS

For surveying purposes, the study area was subdivided into four routes (Figure 1): (1) Coral Gables Waterway to Black Point Marina; (2) Black Point Marina to Convoy Point; (3) Convoy Point to Midnight Pass; and (4) Midnight Pass to Manatee Bay, including the shoreline of North Key Largo, along the boundary of the Crocodile Lakes National Wildlife Refuge. Within these areas there were three Miami-Dade County Parks (Matheson Hammock, Black Point, and Homestead Bayfront), Biscayne National Park, and Crocodile Lakes National Wildlife Refuge.

Nocturnal spotlight surveys were conducted quarterly of the shoreline, canals, and county parks that front Biscayne Bay, within the boundaries of the Coral Gables Waterway and US Highway 1, from September 1996 through May 1998. Potential crocodile habitat was identified during daylight surveys and by reports of crocodile sightings. Spotlight surveys of the shoreline and canals were conducted from a 15-foot skiff, powered by a 70 hp outboard engine. The surveys of the smaller inland bodies of water were conducted from a jonboat powered either by a 4 hp outboard or by paddle. Observers used a 200,000 candlepower blue spotlight for the

shoreline and a less powerful 50,000 candlepower head lamp for canals and smaller inland bodies of water.

The night spotlight count method was chosen because of its effectiveness in habitats where other survey methods are logistically impractical (Woodward and Moore, 1990). The reflective tapetum of a crocodilian's eye glows red in a spotlight (eyeshine) and can be seen from a considerable distance and in situations where the animal might otherwise go unnoticed (Magnusson, 1982; O'Brien, 1990).

The boat was launched at one end of each survey route and motored to the opposite end to await sunset. Surveys began approximately one half to one hour after sunset to insure that it was sufficiently dark to detect eyeshine (Woodward and Marion, 1978).

The distance from the shoreline and the speed of the boat varied according to the tidal period and habitat type. A distance of 50 m was maintained off the shoreline whenever the water depth permitted, and the boat was run at 2000 rpm. In canals, the boat was centered and maneuvered at idle speed, allowing the observer to spotlight both banks. The smaller inland bodies of water were surveyed around the perimeter at either idle or paddle speed.

Each of the four sections (Figure 1) was generally completed in one or two nights, unless the water was extremely shallow, weather conditions turned foul, or numerous animals were sighted--all of which slowed down the survey. The shoreline and canals within each section were completed on one survey, and the corresponding inland areas were completed on a separate survey.

To maintain similar conditions, surveys were begun at approximately the same time after sundown each night, weather permitting. Woodward and Marion (1978) stated that it is likely

that rough water conditions, rain, or fog substantially limit visibility and produce unrepresentative counts. Therefore, surveys were not performed under rainy conditions or when wind speed exceeded 15 knots.

All crocodilians were approached as closely as possible to positively identify the species and to attempt capturing. Crocodiles were captured either by hand, with tongs, or with a self-locking wire noose. When possible, size estimates were made for animals that could not be caught. For each crocodile sighted the following data were recorded: time of sighting; location with a global positioning system (GPS); water salinity (measured with a hand refractometer on a scale of 0 – 100 ppt); air and water temperature; and habitat description (canal, lake/pond/borrow pit, shoreline and presence of vegetation). The following information was recorded for animals that were captured: previous tail marking, (if none was found the animal was marked according to system described by Mazzotti, 1983); total length (TL); and snout vent length (SVL), measured from the tip of the snout to the posterior end of the vent, were measured with a plastic ruler and recorded in centimeters; weight was measured using an appropriate spring scale ranging from 100 g to 50 kg depending on size of the animal and recorded in grams; and sex was determined. Upon completion of data collection, the crocodile was released into the water at the site of capture.

Observations of all non-hatchling crocodilians were categorized as a sighting (observation of a crocodile), a capture of a crocodile, an eyeshine (that of an unidentified crocodilian) or as an alligator. Crocodiles were divided into four size categories based upon difference in mortality rate between size class, and the difference in both movements and habitat use between younger and older animals. The four categories are: hatchling (<0.65 m TL),

juveniles (0.65 to <1.5 m TL), subadults (1.5 to <2.25 m TL), and adults (>2.25 m TL).

Suitable nesting habitat within the study area was searched on foot during daylight hours beginning in March (1997 and 1998) during the period of nest preparation (Mazzotti, 1983). Areas where signs of a nest were reported, including a mound, eggshells, or digging activity, were also investigated. Confirmed nest sites were visited from July 15 until hatching. Hatchlings were located at night by flashlight or during the day by searching the immediate vicinity of the nest. Hatchlings were captured by hand or with tongs. The same data were recorded for hatchlings as were previously described for non-hatchling crocodiles observed during the spotlight surveys.

RESULTS

A total of 132 crocodile observations were made during the study period: 80 sightings, 30 captures of non-hatchlings, and 22 captures of hatchlings at a nest. Of the 30 captures, 12 were recaptures, 12 were unmarked individuals caught during the surveys and 6 were caught on North Key Largo by Paul Moler (Florida Game and Freshwater Game and Fish Commission). Five of the recaptures were marked during this study, five were originally marked at the Turkey Point Power Plant site, and two were marked at the Crocodile Lakes NWR on North Key Largo. Three alligators (*Alligator mississippiensis*) were sighted during this study.

The 110 non-hatchling crocodile observations made during the study period were distributed throughout the bay (Figure 2). The northern most section, the area from the Coral Gables Waterway south to Black Point, had the overall highest density of crocodiles with 1.923/km. The average relative density was 0.183/km (Table 1).

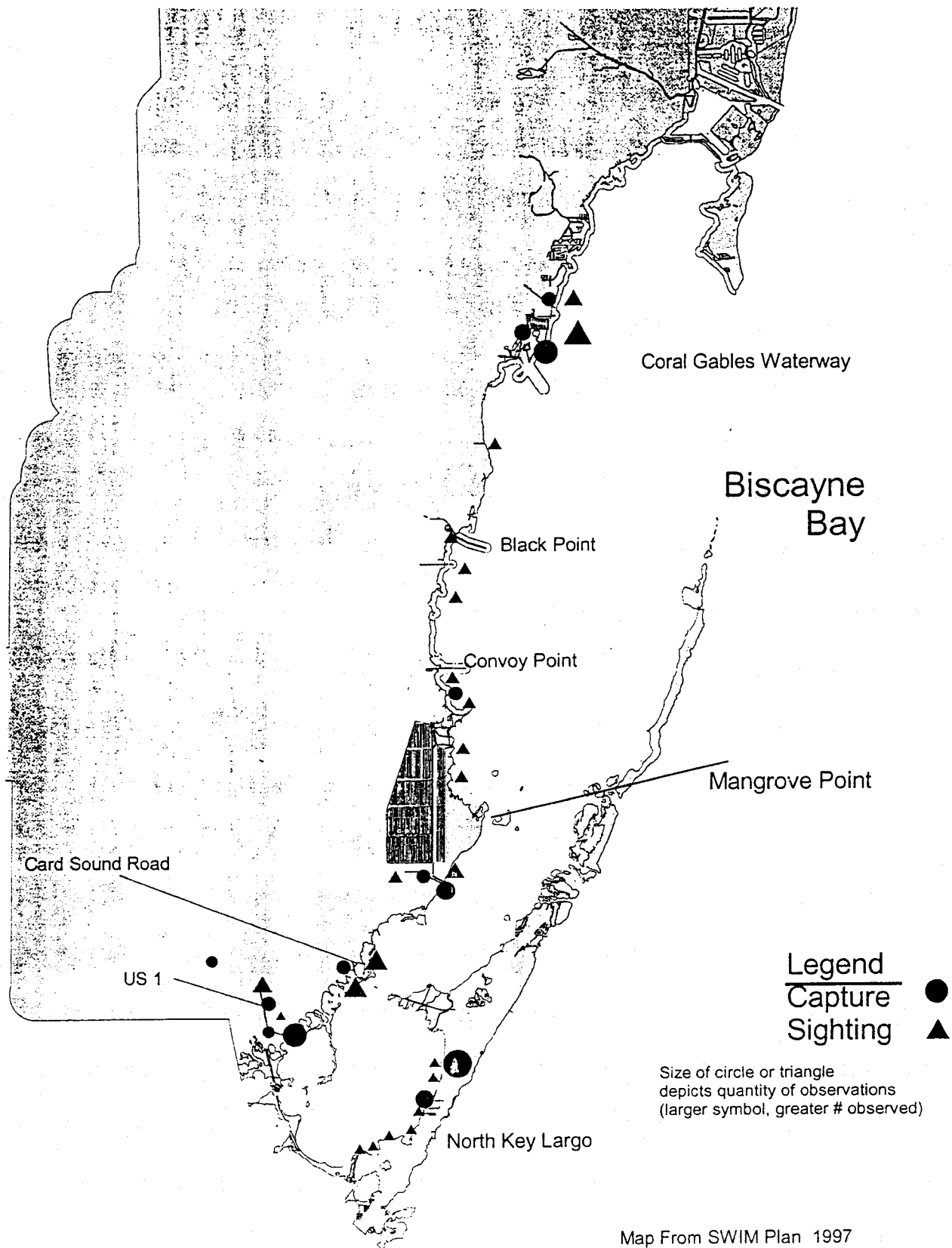


Figure 2. Distribution of crocodile sightings in Biscayne Bay

Table 1. Relative density of crocodiles in different sections of Biscayne Bay

Section	12/96-2/97	3/97-5/97	6/97-8/97	9/97-11/97	12/97-2/98	3/98-5/98	Distance
	Survey 1	Survey 2	Survey 3	Survey 4	Survey 5	Survey 6	(km)
Coral Gables - Black Point	2	1	1	25	7	11	24.44
Black Point - Convoy Point	0	0	2	1	0	0	9.46
Convoy Point-Mangrove Point	2	0	0	0	0	3	13.36
Mangrove Point-Card Sound	5	4	1	4	4	3	17.52
Barnes Sound	2	0	6	0	5	8	23.44
Total observed	11	5	10	30	16	25	88.22
Total observed/km	0.125	0.057	0.113	0.340	0.181	0.283	

Population Structure

A total of 52 crocodiles were captured during the study period: 22 were captured at the Chapman Field nest site as hatchlings, 12 were unmarked individuals, six were captured by Paul Moler on Key Largo, and the remaining 12 were animals previously marked. Eighty crocodiles were sighted but not captured. The Fisher's Exact Test showed no difference in the size frequency distributions of captured vs. sighted crocodiles ($p = .605$) (Figure 3). When all captured crocodiles were put into size classes, 71.2% of the animals were young of the year (yoy), 19.2% were juveniles, and 7.7% subadults, and one adult 1.9%.

Although, there were more females captured than males, the sex ratio did not differ significantly from 1:1 (Table 2). The only adult captured was a male from Card Sound. The presence of a nest in the northern part of the study area demonstrates the presence of one adult female in the area. A table containing the data recorded for each animal captured and observed is in Appendix 1.

Nesting

One nest was discovered at Chapman Field County Park during both the 1997 and 1998 nesting seasons (Figure 4). The nest was built along the bank of a borrow pit. Vegetation included Australian pine and Brazilian pepper. Twelve and ten hatchlings were captured and marked from the nests in 1997 and 1998, respectively. The data from these individuals are in Appendix 2. The number of nests and hatchlings marked at the Turkey Point Power Plant and on North Key Largo are shown in Table 3. The presence of unmarked yoy near US 1 and Manatee Bay suggests an unknown nest.

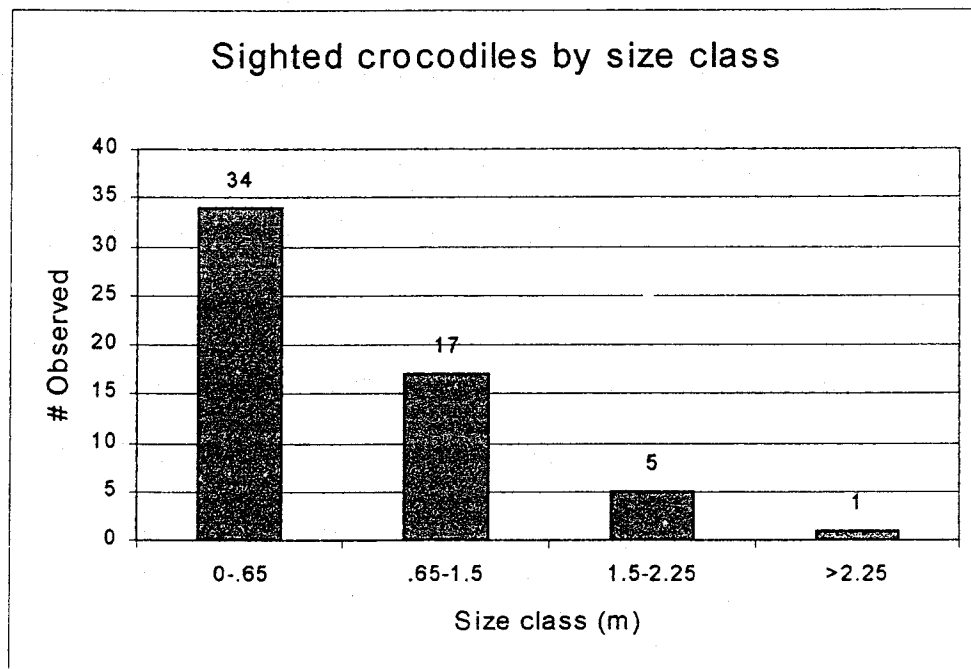
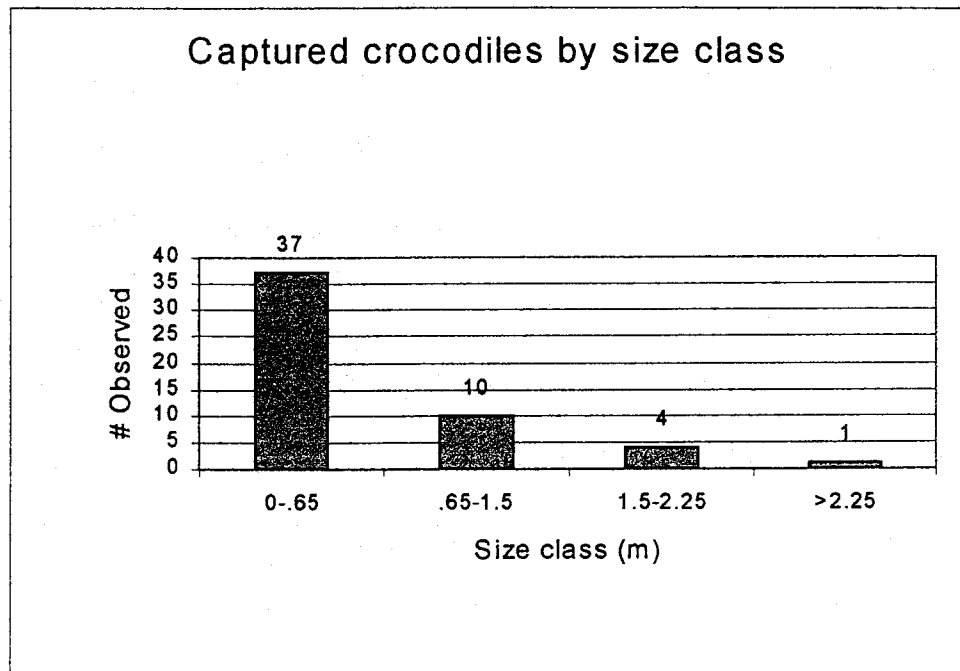


Figure 3. Size frequency diagrams for captured and sighted crocodiles.

Table 2. Sex of captured crocodiles

Age Class	Unknown	Male	Female
Juvenile	4	3	5
Subadult	1	1	2
Adult	0	1	0
Total	5	5	7

Table 3. Crocodile nesting efforts

Year	Location	# Nests	# Hatchlings marked
1997	Chapman Field	1	12
1998	Chapman Field	1	10
1997	North Key Largo	6	62
1998	North Key Largo	6	40
1997	Turkey Point	15	278
1998	Turkey Point	11	103

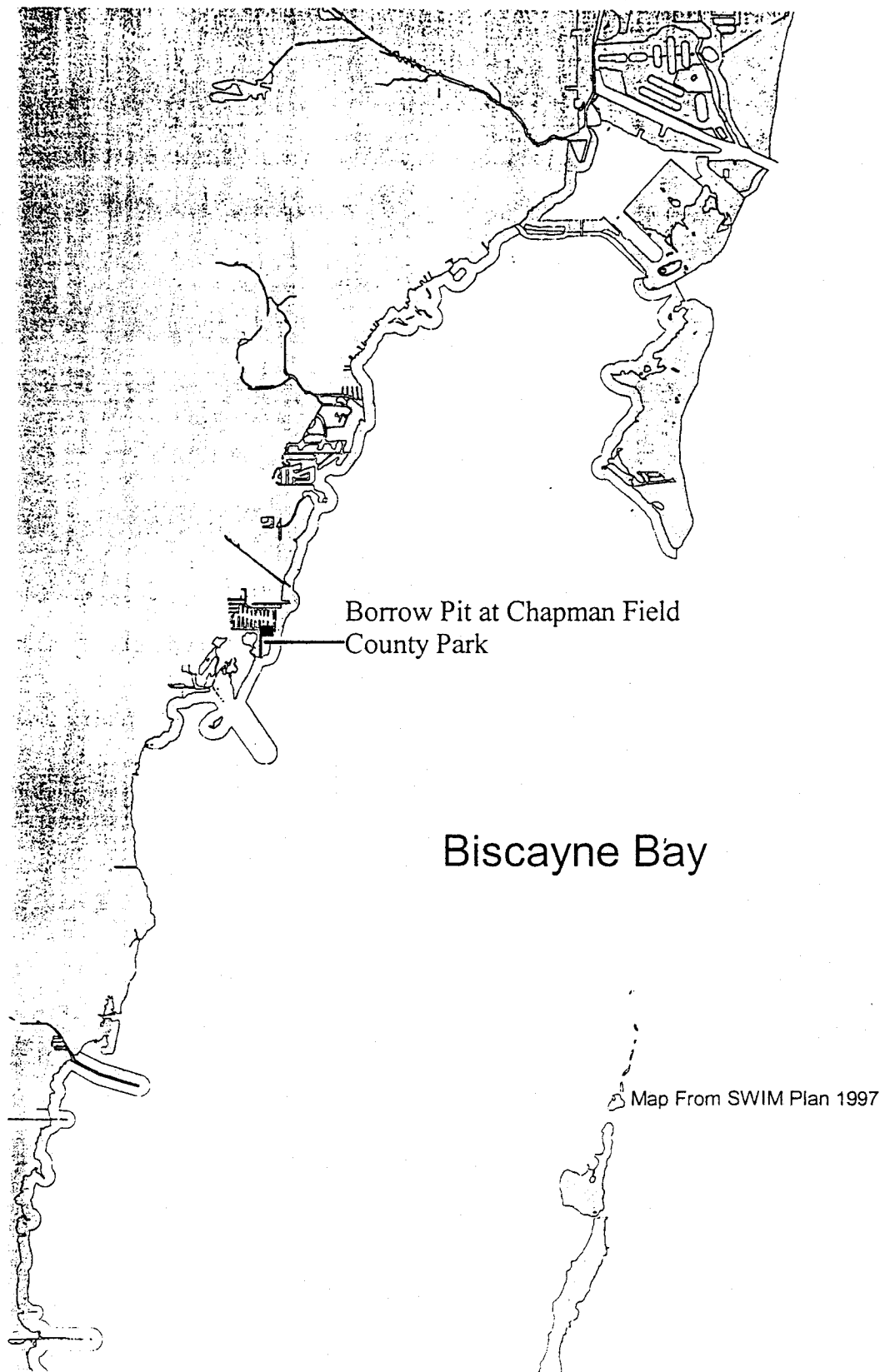


Figure 4. Location of crocodile nest along Biscayne Bay

Habitat Use

Crocodiles were found in a variety of habitat types throughout Biscayne Bay. Approximately equal numbers were found in pond (lake) habitats (45) as in canals (43) during this study (Figure 5). One crocodile was captured within a freshwater marsh. Crocodiles were observed only in areas with vegetation. The size class distribution for 30 non-hatchling crocodiles showed that crocodiles up to one year old were the most abundant in canals, ponds, and along the shoreline. Juveniles were the next most abundant within these habitat types (Figure 6).

Crocodiles were found in a wide range of salinities (Figure 7). Forty-five percent of all non-hatchling crocodile observations were in water with salinity between 0 and 5 ppt. Only five crocodiles out of the 110 observed was in full-strength seawater with a salinity of 35 ppt or greater. Except for hatchlings found in freshwater, the size of the individual did not appear to be related to the salinity in which it was found in (Figure 8).

Canals were euryhaline, while pond habitats were oligohaline. Chapman Field County Park was the one known nesting site within the study area where hatchlings were observed. Salinity at this site was 0 ppt at each visit.

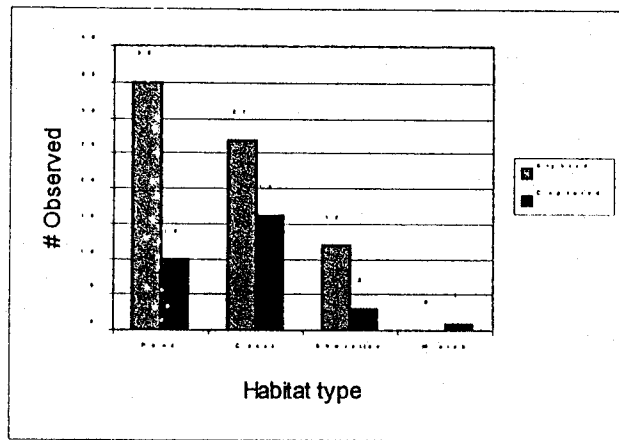


Figure 5. Frequency of occurrence of crocodiles in different habitats.

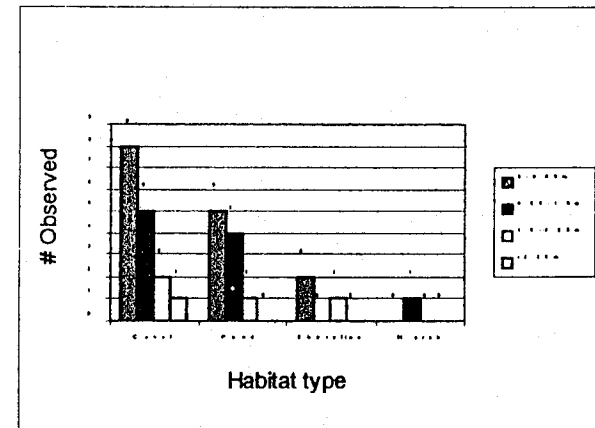


Figure 6. Frequency of occurrence of captured non-hatchling crocodiles of different sizes in different habitats

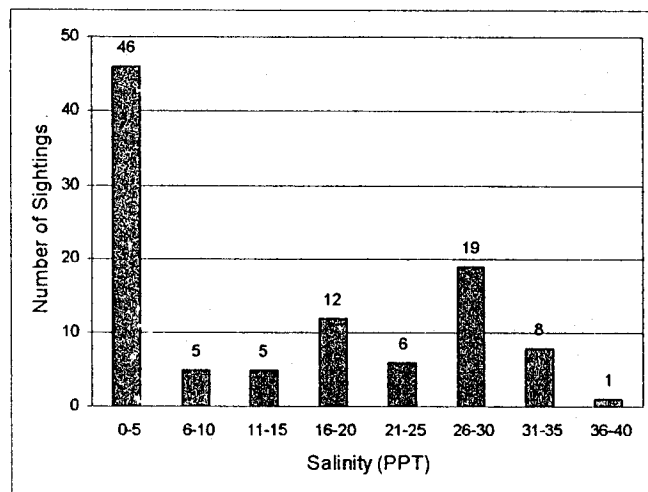


Figure 7. Frequency of occurrence of crocodile sightings in relation to salinity

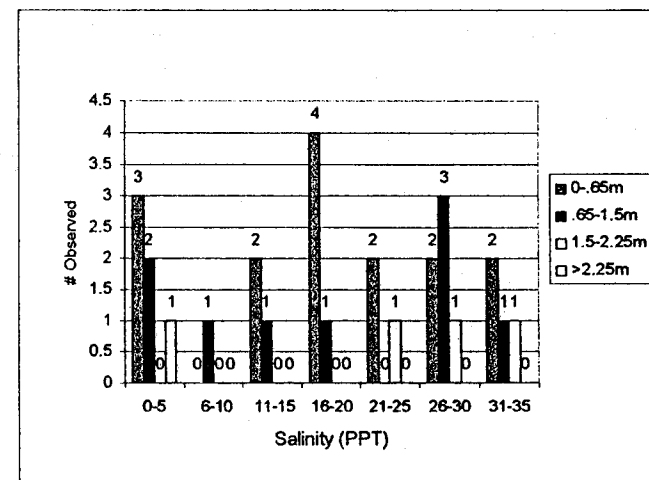


Figure 8. Frequency of occurrence of captured non-hatchling crocodiles of different sizes in different salinities

Alligators

The three alligators observed during the surveys were in canals. Three surveys of the canals and roadside ditches west of the control structures in Homestead, Florida between Goulds Canal and Florida City Canal were conducted to provide additional data for comparisons of habitat use between alligators and crocodiles. Twenty alligators less than one meter in total length and 16 alligators between one and two meters, were observed in the freshwater canals. Several caimans (*Caiman crocodilus*), an exotic species, also were observed.

DISCUSSION

Status and Habitat Relations

Once thought to be generally absent from Biscayne Bay north of Convoy Point and Mowry Canal and rare along the mainland shoreline south of there to US1, crocodiles now occur throughout southern Biscayne Bay, including Key Biscayne, the mainland shoreline of Card Sound and both the mainland and Key Largo shorelines of Barnes Sound. In addition to known nesting areas at the Turkey Point Power Plant site and Crocodile Lakes National Wildlife Refuge, nesting was discovered at Chapman Field. The presence of small unmarked crocodiles suggests that not all nests have been located. The most likely location for an undiscovered nest is the Manatee Bay/US 1 area. The Biscayne Bay study area contains the fastest growing, and possibly the densest, component of the Florida population of American crocodiles.

Most of the non-hatchling crocodiles observed in this study were juveniles and sub-adults. All size classes favor intermediate salinity (<20 ppt) water bodies, free from the effects of wind and wave action and lined with vegetation. Juveniles and subadults prefer areas without

adults. During nesting females seek out relatively well drained high ground, even if they have to leave low salinity, protected water bodies to find the comparatively high and dry conditions. In the study area adults are concentrated near nesting areas at Turkey Point and North Key Largo (Barnes Sound) leaving the rest of the mangrove shorelines as habitat for juvenile crocodiles dispersing from these nesting areas. The shoreline, canals, and ponds of the southern Biscayne Bay/Card Sound/Barnes Sound provide essential habitat for juvenile and subadult crocodiles and along with the nesting sites meet all of the life stage requirements to support the continued recovery of this endangered species.

The pattern of habitat use observed here, that of using quiet, protected bodies of water with vegetated shorelines and generally low salinities, is the usual pattern for most populations of crocodilians, especially American crocodiles. Although we surveyed all accessible water bodies on public property in the study area we know we missed crocodiles in similar bodies of water on private property. As a result we have underestimated the presence of crocodiles in Biscayne Bay. We expect our understanding of the status of crocodiles to continue to change rapidly over the next several years.

The widespread occurrence of smaller crocodiles throughout Biscayne Bay and Card and Barnes Sound environs is good news and has two important management implications: habitat management, especially salinity and vegetation, and interactions with humans.

Management Implications

Although the presence of crocodiles throughout the Biscayne Bay study area is good news for this endangered species, it does present challenges for land and water managers.

Biscayne Bay provides the unique opportunity to integrate habitat enhancement for an endangered species with ecosystem restoration and management. Perhaps a more difficult challenge will be to educate a public, whose knowledge of crocodiles is provided by Tarzan movies and hysterical news reporters, to accept the recovery of this feared and revered endangered species.

Crocodiles benefit from restoration and maintenance of freshwater flows into their estuarine habitat. Location, timing, and amount of flow is important. For example, when possible freshwater flows should be directed through the remaining fringing mangrove swamp rather than simply discharged through canals. In general flow should peak at the end of the rainy season and continue discharging into the dry season. Freshwater flow should be adequate to maintain estuarine conditions (< 20 ppt salinity) into December in most years. Maintaining freshwater flow into Biscayne Bay has the same ecological importance for this estuary as restoring flow in Taylor and Shark Sloughs does for Florida Bay and the Gulf coast. On a broader scale denying an adequate freshwater supply to Biscayne Bay to solve problems in central or southern Everglades sloughs should be avoided, as it would create as much of a problem as it would solve.

Crocodiles like vegetated shorelines with an occasional bare spot for basking. Hence, restoring and maintaining native vegetation, while removing non-native species should be undertaken when opportunities present themselves.

As crocodiles continue to increase and spread out in Biscayne Bay and environs encounters with humans are increasing. Many people unaware of the mild temperament of this species of crocodilian (they are less aggressive than alligators) and its endangered status, feel

that their lives and well-being are being actively threatened when a crocodile of any size turns up in their neighborhood or at their golf course. Calls to the Florida Game and Fresh Water Fish Commission to remove crocodiles constitute the number one nuisance endangered species problem in the state. This presents an interesting quandary; a goal of recovery is more crocodiles in more places, and more crocodiles in more places means more crocodile human encounters and more complaints. The solution is twofold: first, instead of waiting and dealing with a concerned, if not frightened, citizen calling in to ask about the crocodile that just showed up in their backyard, there should be a proactive educational program describing the recovery progress of this endangered species and explaining its natural history, and, especially, to respect but not fear crocodiles. Second, management and educational activities should minimize any risk to human safety. For example, nest sites should not be created in areas of human use, and any educational program should emphasize that feeding crocodiles is illegal and dangerous.

SUMMARY AND RECOMMENDATIONS

The American crocodile has made a comeback in southern Biscayne Bay in areas where suitable habitat remains, or in some cases where an area has been modified by humans to make it more attractive to crocodiles. Inadvertently creating nesting habitat through dredge and fill activities at the Turkey Point Power Plant site and the Basin Hills area of Crocodile Lakes National Wildlife Refuge has to some extent compensated for the loss of nesting habitat elsewhere in the Bay. Adult crocodiles are clustered around, but not restricted to, these nesting areas. The shoreline, canals, and ponds of the southern Biscayne Bay/Card Sound/Barnes Sound area provide essential habitat for juvenile and subadult crocodiles and along with the nesting

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Biscayne Bay provides the unique opportunity to integrate habitat enhancement for an endangered species with ecosystem restoration and management. Crocodiles would benefit from a restored freshwater flow into the estuary. This includes directing flows through mangrove swamps instead of canals when possible, and maintaining freshwater flow into the beginning of the dry season. Biscayne Bay should be considered as part of the South Florida estuarine ecosystem along with Florida Bay and the Gulf Coast, and should benefit mutually from restoration and management planning.

It is likely that the number of crocodiles will continue to increase in the study area even if no habitat enhancement takes place. This will exacerbate a growing problem concerning interactions between humans and crocodiles. The challenge of integrating a recovering population of the American crocodile with an ever increasing use of coastal areas by humans will require a proactive education program and will be the final challenge in the successful recovery of this once critically endangered species.

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Appendix 1. All non-hatchling observations

Date	DL/DR/S	Status	TL cm/m	Weight (g)	Sal (PPT)	Water Temp (C)	Air Temp. (C)	Habitat	Location
12/20/96		Capture	144.0 cm	13640				canal	Snapper creek canal
12/24/96		Sighting	2 m		26			shoreline	Shoreline by power plant
12/24/96		Eyeshine			26			shoreline	Shoreline by power plant
12/24/96		Sighting	1 m		30			shoreline	Turtle point
2/3/97	/3,5,7/2	Capture	113.7 cm	4200	20	24	22	canal	South Dade Marina
2/21/97		Sighting	2.5 m		0	25	27	canal	Card Sound Canal
2/21/97		Sighting	1-2 m		0	25	25	canal	Card Sound Canal
2/21/97		Sighting	1 m		12	26	24	canal	Card Sound Canal
2/21/97		Sighting	2 m		30	26	24	canal	Card Sound Canal
2/21/97		Sighting			30	26	24	canal	Card Sound Canal
2/23/97	/3,5,7/3	Capture	112.8 cm	5350	14	25	26	canal	Snapper creek canal
2/24/97	1,7/8/3	Capture	60.6 cm	625	20	25	26	pond	Crocodile Lake
2/27/97		Sighting			20	25	26	pond	Crocodile Lake
2/28/97		Capture	31.5 cm	110	30			pond	Basin Hills
2/28/97		Capture	129.7 cm	5650	30			pond	Basin Hills
2/28/97		Capture	74.8 cm	950	30			pond	Basin Hills
2/28/97		Capture	99.2 cm	2550	30			pond	Basin Hills
3/22/97		Sighting	1m		35	21	25	canal	Canal in Card Sound
3/22/97		Eyeshine			35	25	21	canal	Canal in Card Sound
3/22/97		Sighting			35	25	20	canal	Card Sound Canal
3/22/97		Sighting	1.5m		35	25	19	canal	Card Sound Canal
3/22/97		Sighting			10	24	20	canal	Card Sound Canal
4/30/97		Capture	170 cm	2179				pond	Crocodile Lake
5/1/97		Sighting			17	28	27	canal	Kings Bay
6/28/97	7/5,9/3	Capture	192 cm	27000	30	32	30	canal	Canal in Card Sound
6/29/97		Sighting	1.25 m		15	32	27	shoreline	North of Convoy Point
6/30/97		Sighting	1.25 m		0	32	25	canal	Snapper creek canal
6/30/97		Eyeshine			15	33	26	shoreline	Coral Bay
7/2/97		Sighting			16	29	31	creek	Black Point
7/2/97		Gator	1.25 m		16	29	31	canal	Biscayne Bay
7/2/97		Gator	1.5 m		16	29	31	canal	Biscayne Bay
7/8/97		Sighting	1 m		0	36	31	canal	By canal C111
7/8/97	1/3,5,7/6	Capture	94.0 cm	2350	2	31	28	canal	Canal C111

Appendix 1. All non-hatchling observations

Date	DL/DR/S	Status	TL cm/m	Weight (g)	Sal (PPT)	Water Temp (C)	Air Temp. (C)	Habitat	Location
8/2/97		Eyeshine			25	33	31	shoreline	Barnes Sound
8/2/97		Eyeshine			25	33	31	canal	Barnes Sound
8/2/97	4,5/1,8/3	Capture	27.5 cm	55	25	33	31	shoreline	Barnes Sound
8/2/97	9/2,5,7/9	Capture	27.4 cm	59	25	33	31	shoreline	Barnes Sound
8/2/97		Sighting			25	33	31	shoreline	Barnes Sound
8/2/97		Sighting	.75 m		25	33	31	shoreline	Barnes Sound
8/2/97		Eyeshine			22	33	27	canal	Card Sound Canal
9/6/97	1/3,5,7/7	Capture	35.0 cm	95	0	26	27	borrow pit	Chapman Field
9/6/97	1/3,5,7/6	Capture	38.5 cm	112	0	26	27	borrow pit	Chapman Field
9/6/97	1/3,5,7/9	Capture	34.0 cm	81	0	26	27	borrow pit	Chapman Field
9/6/97	9/3,5,7/8	Capture	78.9 cm	1350	0	26	27	borrow pit	Chapman Field
9/6/97		Sighting			0	26	27	borrow pit	Chapman Field
9/6/97		Sighting			0	26	27	borrow pit	Chapman Field
9/6/97		Sighting			0	26	27	borrow pit	Chapman Field
9/6/97		Sighting			0	26	27	borrow pit	Chapman Field
9/6/97		Sighting			0	26	27	borrow pit	Chapman Field
9/6/97		Sighting	yoy		0	26	27	borrow pit	Chapman Field
9/6/97		Sighting	yoy		0	26	27	borrow pit	Chapman Field
9/6/97		Sighting	yoy		0	26	27	borrow pit	Chapman Field
9/6/97		Sighting	yoy		0	26	27	borrow pit	Chapman Field
9/6/97		Sighting	yoy		0	26	27	borrow pit	Chapman Field
9/6/97		Sighting	yoy		0	26	27	borrow pit	Chapman Field
9/6/97		Sighting	yoy		0	26	27	borrow pit	Chapman Field
9/6/97		Eyeshine			0	26	27	borrow pit	Chapman Field
9/6/97		Eyeshine			0	26	27	borrow pit	Chapman Field
10/3/97		Sighting	1.5 m		0	27	27	canal	Snapper Creek Canal
10/3/97		Eyeshine			15	30	27	shoreline	By Black Point
10/3/97		Sighting			10	29	25	canal	By Black Point
10/4/97		Eyeshine			27	30	26	shoreline	Biscayne Bay
10/24/97	9/7,9/7	Capture	41.5 cm	146	34	24	25	canal	Card Sound
10/24/97	5/4,5,7/1	Capture	91.5 cm	2000	34	24	25	canal	Card Sound
10/24/97	1/1,8/8	Capture	285 cm		0	24	25	canal	Card Sound Canal
10/24/97		Sighting			0	24	25	canal	Card Sound Canal

Appendix 1. All non-hatchling observations

Date	DL/DR/S	Status	TL cm/m	Weight (g)	Sal (PPT)	Water Temp (C)	Air Temp. (C)	Habitat	Location
10/25/97		Sighting	yoy		0	27	26	borrow pit	Chapman Field
10/25/97		Sighting	yoy		0	27	26	borrow pit	Chapman Field
10/25/97		Sighting	yoy		0	27	26	borrow pit	Chapman Field
10/25/97		Sighting	yoy		0	27	26	borrow pit	Chapman Field
10/25/97		Sighting	yoy		0	27	26	borrow pit	Chapman Field
10/25/97		Sighting	yoy		0	27	26	borrow pit	Chapman Field
10/25/97		Sighting	yoy		0	27	26	borrow pit	Chapman Field
10/25/97		Sighting	yoy		0	27	26	borrow pit	Chapman Field
11/20/97	5/4,5,7/2	Capture	56.5 cm	490	20	24	26	canal	Canal C111
11/20/97		Eyeshine			20	24	26	canal	Canal C111
11/20/97		Eyeshine			0	23	25	canal	Card Sound Canal
11/20/97		Eyeshine			0	23	25	canal	Card Sound Canal
1/26/98		Sighting	yoy		0	22	21	borrow pit	Chapman Field
1/26/98		Sighting	yoy		0	22	21	borrow pit	Chapman Field
1/26/98		Sighting	yoy		0	22	21	borrow pit	Chapman Field
1/26/98		Sighting			0	22	21	borrow pit	Chapman Field
1/26/98		Sighting			0	22	21	borrow pit	Chapman Field
1/26/98		Sighting			0	22	21	borrow pit	Chapman Field
2/5/98		Sighting	1 m		5	22	16.5	canal	Snapper Creek Canal
2/17/98		Sighting	1.5 m		17	24.5	25	canal	next to C111
2/17/98	5/4,5,7/2	Capture	57.2 cm	500	16	24.5	25	canal	Canal C111
2/17/98		Sighting	yoy		17	24.5	25	canal	next to C111
2/17/98	5/4,5,7/3	Capture	40.1 cm	155	17	24.5	25	canal	next to C111
2/18/98	5/4,5,7/4	Capture	189 cm	23000	22	25	23.5	canal	Card Sound Canal
2/24/98		Eyeshine			28	23	17	canal	Card Sound
2/24/98		Sighting	1.25 m		28	23	17	canal	Card Sound
2/24/98		Sighting	1 m		28	23	17	canal	Card Sound
2/24/98		Eyeshine			28	23	17	canal	Card Sound
2/24/98		Eyeshine			28	23	17	canal	Card Sound
2/24/98		Sighting	1.25 m		28	23	17	canal	Card Sound
4/10/98	6/4,5,7/	Capture	39.5 cm	175	15	26	25	canal	Chapman Field
4/10/98	7/3,5,7/9	Capture	44.1 cm	285	15	26	21	canal	Chapman Field
4/10/98		Sighting	yoy		0	25	17	borrow pit	Chapman Field

Appendix 1. All non-hatchling observations

Date	DL/DR/S	Status	TL cm/m	Weight (g)	Sal (PPT)	Water Temp (C)	Air Temp. (C)	Habitat	Location
4/10/98		Sighting	yoy		0	25	17	borrow pit	Chapman Field
4/10/98		Sighting	yoy		0	25	17	borrow pit	Chapman Field
4/10/98		Sighting	yoy		0	25	17	borrow pit	Chapman Field
4/10/98		Sighting	yoy		0	25	17	borrow pit	Chapman Field
4/10/98		Sighting	yoy		0	25	17	borrow pit	Chapman Field
4/10/98		Sighting	yoy		0	25	17	borrow pit	Chapman Field
4/10/98		Sighting	yoy		0	25	17	borrow pit	Chapman Field
4/11/98	6/4,5,7/1	Capture	110.0 cm	3700	0	25	21	marsh	Canal C109
4/11/98		Sighting	.5 m		20	24	18	canal	Canal C111
4/11/98		Gator	1 m		20	24	18	canal	Canal C111
4/11/98		Sighting	1 m		10	24	14	canal	South dade marina
4/11/98		Eyeshine			2	25	21	canal	next to C111
5/6/98		Eyeshine			27	30	28	canal	Card Sound
5/6/98		Eyeshine			27	30	28	canal	Card Sound
5/6/98		Eyeshine			27	30	28	canal	Card Sound
5/6/98		Eyeshine			27	30	28	canal	Card Sound
5/6/98	3,9/3/3,4	Capture	57.4 cm	480	27	30	28	canal	Card Sound
5/6/98	4/5,9/7	Capture	199.8 cm	25000	32	28	27	shoreline	Card Sound
5/6/98		Sighting	1 m		29	28	25	shoreline	North Key Largo
5/6/98		Sighting			29	28	25	shoreline	North Key Largo
5/6/98		Sighting			29	28	25	shoreline	North Key Largo
5/6/98		Sighting			29	28	25	shoreline	North Key Largo
5/6/98		Sighting	.5 m		29	30	25	shoreline	North Key Largo
5/6/98		Sighting	.5 m		28	28	25	shoreline	North Key Largo
5/10/98		Sighting	1.5 m		32	28	25	canal	Near power plant
5/10/98	6,9/4,5,7,9/2,7	Capture	60.7 cm	710	32	28	25	canal	Near power plant
5/10/98		Sighting			38	31	25	shoreline	Homestead bayfront park
5/15/98		Eyeshine			22	30	25	canal	Card Sound Canal
5/15/98		Sighting	2m		22	30	25	canal	Card Sound Canal
5/19/98		Sighting	1.5-2m		19	27	26	canal	Snapper creek canal

Appendix 2. All hatchling crocodile observations

Date	DL/DR/S	Status	TL cm	Weight (g)	Sal (PPT)	W Temp C.	A Temp. C	Habitat
8/12/97	13,5,7/4	Capture	32.50	62.00	0			Borrow pit
8/12/97	13,5,7/5	Capture	32.80	67.00	0			Borrow pit
8/12/97	13,5,7/6	Capture	35.00	81.00	0			Borrow pit
8/12/97	13,5,7/7	Capture	32.40	76.00	0			Borrow pit
8/12/97	13,5,7/8	Capture	33.50	72.00	0			Borrow pit
8/12/97	13,5,7/9	Capture	34.20	72.00	0			Borrow pit
8/12/97	9/3,5,7/2	Capture	34.50	76.00	0			Borrow pit
8/12/97	9/3,5,7/3	Capture	34.20	71.00	0			Borrow pit
8/12/97	9/3,5,7/4	Capture	32.70	69.00	0			Borrow pit
8/12/97	9/3,5,7/5	Capture	32.80	64.00	0			Borrow pit
8/12/97	9/3,5,7/6	Capture	32.70	67.00	0			Borrow pit
8/14/97	9/3,5,7/7	Capture	34.80	77.00	0			Borrow pit
7/19/98	6/4,5,7/3	Capture	29.50	76.00	0	33	31	Borrow pit
7/19/98	6/4,5,7/4	Capture	28.30	67.00	0	33	31	Borrow pit
7/19/98	6/4,5,7/5	Capture	28.00	63.50	0	33	31	Borrow pit
7/19/98	6/4,5,7/6	Capture	29.00	68.00	0	33	31	Borrow pit
7/19/98	6/4,5,7/7	Capture	28.80	70.00	0	33	31	Borrow pit
7/19/98	6/4,5,7/8	Capture	29.80	70.00	0	33	31	Borrow pit
7/19/98	6/4,5,7/9	Capture	28.50	68.50	0	33	31	Borrow pit
7/19/98	7/4,5,7/1	Capture	29.00	72.50	0	33	31	Borrow pit
7/19/98	7/4,5,7/1	Capture	28.10	67.50	0	33	31	Borrow pit
7/19/98	7/4,5,7/2	Capture	29.20	72.00	0	33	31	Borrow pit
7/19/98		Sighting	Hatchling		0	33	31	Borrow pit
7/19/98		Sighting	Hatchling		0	33	31	Borrow pit
7/19/98		Sighting	Hatchling		0	33	31	Borrow pit
7/19/98		Sighting	Hatchling		0	33	31	Borrow pit
7/19/98		Sighting	Hatchling		0	33	31	Borrow pit
7/19/98		Sighting	Hatchling		0	33	31	Borrow pit