Venezuela en cuanto a este aspecto (Thorbjarnarson, 1991; Thorbjarnarson y Velasco, 1998, 1999).

Tabla 9. Cocientes sexuales (% de machos) por años en caimanes capturados en la Isla de la Juventud.

Años	Total	Machos	%
1995	281	195	69.39
1996	534	433	81.10
1997	590	398	67.45
1998	129	86	66.60
G=32.03 (p<0.001)			

Tabla 10. Frecuencias de clases de largo total (cm) por sexos en el caimán de la Isla de la Juventud, al inicio de su explotación (1995) y tres años después (1998).

Clases de largo total	Machos				Hembras			
	1995		1998		1995		1998	
	N	%	N	%	N	%	N	%
110	1	1.1	4	5.9	0	0	3	12.5
120	34	38.2	19	27.9	14	42.4	16	66.6
130	33	37.1	18	26.4	8	24.2	3	12.5
140	11	12.3	12	17.6	5	15.1	1	4.1
150	4	4.5	4	5.9	1	3.0	1	4.1
160	5	5.6	5	7.3	4	12.1	0	0
170	1	1.1	2	2.9	0	0	0	0
180	0	0	4	5.9	1	3.0	0	0
G	4.91 (p<0.10)				8.55 (p<0.05)			

Tabla 11. Medias (x) y desviación estándar (S) del largo total (cm) de caimanes de la Isla de la Juventud, al inicio de su explotación (1995) y tres años después (1998).

Sexos	Años	N	Largo total		
			X	S	t
Machos	95	89	133.22 a	11.95	2.69 (p<0.01)
	98	69	140.50 b	19.82	
Hembras	95	33	136.48 ab	16.36	3.41 (p<0.01)
	98	24	125.20 c	8.18	

F.V	F
Sexo	6.38 (p<0.001)
Año	0.66 ns
Interacción	15.09 (p<0.001)

Medias con índices diferentes difieren a p<0.05 por una prueba Duncan

Tabla 5. Animales capturados por meses y sexo, en un estudio de la explotación del caimán, Isla de la Juventud. Año 1997. Simbología como en la tabla 3.

		MESES											
		M	A	M	J	J	A	S	O	N	D	Total
M	F	67	35	8	26	16	11	6	0	32	24	398
H	F	40	24	4	23	8	9	4	2	10	6	192
T	E	107	59	12	49	24	20	10	2	42	30	590
D	E	11	8	5	4	6	7	6	1	7	3	82
L	E	7	7	4	4	6	7	5	1	6	3	26
I	E	1.38	1.05	0.60	3.06	0.66	0.40	0.33	2.00	1.00	3.33	0.27

Tabla 6. Animales capturados por meses y sexo, en un estudio de la explotación del caimán, Isla de la Juventud. Año 1998. Simbología como en la tabla 3.

		MESES										
		M	M	J	A	S	O	N	D	Total		
M	F	7	13	5	2	16	13	13	4	86		
H	F	2	5	4	0	9	4	1	14	43		
T	E	9	18	9	2	25	17	14	18	129		
D	E	1	5	3	1	6	5	3	3	33		
L	E	1	3	2	1	6	3	1	2	11		
I	E	9.00	1.20	1.5	2.00	0.69	1.13	4.66	3.00	0.35		

El efecto de la explotación de las babillas durante tres años (1995 a 1998) sobre su estructura de tamaño se evidencian en las tablas 10 y 11. Cada sexo se analizó por separado, dado su [redacted] dimorfismo en largo total. Para los machos, la tendencia fue al aumento de las frecuencias de las clases de tamaño iguales o mayores de 140 cm, lo que se refleja en el valor medio del largo total para 1998, muy superior al de 1995. Para las hembras, la tendencia fue opuesta a la de los machos, ocurriendo un aumento de las frecuencias de las clases iguales o menores a 129 cm, lo que también se refleja en el valor medio del largo total para este sexo en 1998, muy inferior al de 1995. La prueba G (tabla 10) para hembras y machos fue significativa o casi significativa y al análisis de varianza bifactorial (tabla 11) no reveló diferencias significativas entre años pero sí entre sexos como era de esperar. La interacción significativa explica por qué no hay efecto de los años para el largo total, simplemente las tendencias opuestas de los sexos se combinan para dar valores promedios anuales del largo total muy similares. Sin embargo, un análisis para cada sexo por separado sí revela diferencias significativas. En este caso utilizamos la prueba t ajustada para heterogeneidad de varianzas (t´), ya que estas diferían significativamente entre años dentro de sexos.

Por supuesto, estos cambios en estructura de tamaños pueden deberse a simples errores de muestreo o ser un efecto real que puede ser explicado por varias hipótesis alternativas. Nosotros nos inclinamos por la hipótesis de que tales cambios son atribuidos fundamentalmente a los cambios en las localidades de capturas, de más antrópicas en 1995, donde predominan individuos pequeños a menos antrópicas en 1998, donde predominan individuos grandes (Méndez et al, 1994) que son fundamentalmente machos. Esto último a su vez quizá produjo un sesgo en las capturas de hembras hacia tamaños más pequeños. Independiente de qué causó tales cambios, la captura de machos más grandes en parte beneficia a la población pero las capturas de hembras más pequeñas la perjudica, pues se estarían tomando hembras potencialmente reproductivas, que aún no han contribuido con sus descendientes a la población. Este es un aspecto que debe ser analizado más a fondo, si se quiere mantener de forma sostenible la explotación de la babilla en la Isla.

En resumen, nuestros datos sugieren que en relación con la sostenibilidad demográfica, la explotación de la babilla en la Isla de la Juventud, no parece afectar por el momento al tamaño de sus poblaciones ni a su cociente sexual, pero sí a su estructura de tamaños. Que la explotación de la babilla fuera sostenible era un resultado a esperar si se consideran las características de dicha explotación y la ecología reproductiva de la especie (Thorbjarnarson, 1991). En primer lugar, muchas hembras posiblemente maduran a longitudes totales de cuerpo muy bajas, por lo que no son consideradas en las capturas, que en teoría solo toman animales mayores de 90 cm. En segundo lugar, la mayor proporción de machos en las capturas no afecta grandemente la población, dado el sistema probablemente poligino de la especie. Por otra parte, las tasas de extracción en relación a la población total que realmente se efectuaron (entre 0.51 y 2.31%) estuvieron por debajo de lo inicialmente propuesto (7.8%) y muy alejados del potencial de extracción máximo de la población, calculado como 20%(Méndez et al, 1994). Todo esto, unido a la

falta de recursos materiales que ponían límites a los esfuerzos de captura, explican muy bien la existencia de la sostenibilidad demográfica encontrada en nuestro estudio.

Tabla 12. Medias (x) y desviaciones estándar (S) del ancho de piel relativo (%) en caimanes de la Isla de la Juventud, durante dos años.

Años	Estación	N	Ancho de piel relativo	
			X	S
1997	Seca	85	22.76 a	2.51
	Lluvia	55	20.53 b	3.60
1998	Seca	28	20.52 b	2.50
	Lluvia	51	21.53 b	3.56

FV	F
Estación	1.85 ns
Año	1.88 ns
Interacción	12.99 (p<0.001)

Medias con índices diferentes difieren a p<0.05 por una prueba de Duncan

En la tabla 12 se presentan los valores promedios del ancho de piel relativo de los caimanes capturados en dos años consecutivos (1997 y 1998). Al menos para estos dos años de explotación sus valores medios no difieren significativamente, según la F del ANOVA, así como tampoco los valores medios entre seca y lluvia. Sin embargo, se registró una interacción altamente significativa año x estación, motivada por los cambios de valores medios entre estaciones dentro de años. En 1997 el ancho de piel relativo fue mayor y significativo en seca y en 1998 lo fue en lluvia, pero sin significación estadística.

Tabla 13. Medias (x) y desviaciones estándar (S) del rendimiento en canal (%) en caimanes de la Isla de la Juventud. Año 1996.

Estaciones	Sexos	N	Rendimiento en canal	
			X	S
Seca	Machos	55	56.07	7.93
	Hembras	15	58.46	7.65
Lluvia	Machos	50	56.82	6.20
	Hembras	30	56.43	6.58

FV	F
Estación	0.23 ns
Sexo	0.55 ns
Interacción	1.09 ns
X=56.64%	S=7.11

La tabla 13 presenta, a manera de información, el rendimiento en canal de los caimanes capturados en 1996. Esta variable fue muy estable entre sexos y estaciones, al menos para este año, no siendo significativos ninguno de los dos anteriores efectos. Esto sugiere que también los años de explotación posiblemente afectaron poco esta variable. Así un caimán rinde en promedio cerca del 60% de su peso en carcasa para la utilización de su carne, un valor algo superior (50%) al de las razas de ganado de carne de mejor rendimiento.
Aunque la piel de la babilla no puede competir con la de cocodrilo, las que se obtuvieron en los años 1996 y 97 fueron en un 77.8% de primera calidad (N=796). Desconocemos si dicha proporción se ha mantenido estable a lo largo de los cuatro años de explotación.
Los datos anteriores sobre ancho y calidad de piel y rendimiento en canal de las babillas, aunque fragmentarios, sugieren que también en el aspecto económico, la explotación de esta especie fue sostenible, en lo que se refiere al ancho de la piel y posiblemente también en cuanto a su calidad y rendimiento en canal.
Otros aspectos de la sostenibilidad económica en esta especie fueron tratados por Savón (1998) donde especifica que todos los indicadores de fuerza y salario se comportaron favorablemente en cuanto a la producción mercantil obtenida (carne y piel) y de haberse cumplido el total de capturas planificadas se hubiera obtenido un ahorro significativo en cuanto a los gastos planificados.
No disponemos de datos cuantitativos para valorar la sostenibilidad ecológica de la explotación de la babilla en la Isla de la Juventud, la que a diferencia de la llevada a cabo en Venezuela, que se realiza solo en áreas antropizadas (ganadería), aquí se lleva a cabo tanto en este tipo de zona (presas y micropresas en nuestro caso) como en la zona natural de la ciénaga de Lanier. Es este último ecosistema el que nos interesa en cuanto al aspecto de la sostenibilidad ecológica. La opinión general de los técnicos y capturadores de babillas es que los métodos empleados para capturar los animales y todas las infraestructuras que los sostienen son tan simples que no afectan seriamente el ecosistema donde se llevan a cabo. Esto, unido al poco tiempo relativo de la explotación (4 años) nos hace plantear, al menos para ese período, que la explotación de las babillas ha sido también sostenible en lo que se refiere al ecosistema natural en donde se realiza dicha explotación.

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THE EFFECT OF EGG COLLECTION WITH REPATRIATION ON THE POPULATION DYNAMICS OF FLORIDA ALLIGATORS

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Abstract: Egg harvests are implemented extensively by the Florida Fish and Wildlife Conservation Commission (FWC) to monitor the effects of contaminants on American alligator [*Alligator mississippiensis*] populations. However, egg collection may influence population dynamics of alligators resulting in changes of growth and survival rates. Egg collection and incubation was conducted on Lake Apopka, Lake Griffin, and Orange Lake in summer, 1998. After hatching, 1,676 hatchlings were individually measured, weighed, marked, and released back at nest sites and in suitable habitats away from nests. Growth and survival rates of 10 month-old hatchlings were analyzed to investigate if there was a difference between wild and repatriated hatchling alligators. Repatriated hatchling alligators grew at rates similar to wild alligators but did not survive as well. Growth increment of animals from different localities varied considerably among Lake Apopka, Lake Griffin, and Orange Lake ($P \leq 0.001$). In general, no difference was found between growth rates and survival rates of repatriated hatchlings released at nest sites or in suitable habitat. Survival rate of tagged wild alligators (0.29) was 41% greater than that of repatriated alligators (0.21) ($P = 0.028$). Although the survival rate of repatriated hatchling alligators was apparently less than that of wild alligators that were naturally hatched, this added mortality may have been compensated for by increased survival of collected eggs by protecting them from flooding and depredation. Therefore, the net effect of egg collections with repatriation on the population dynamics of these alligator populations would be negligible.

Key words: American alligator, *Alligator mississippiensis*, egg collection, population dynamics, repatriation

Introduction

It is a common practice around the world to remove crocodilian eggs and hatchlings from the wild for commercial use and restocking of endangered species. In Florida, however, FWC alligator biologists collect a proportion of alligator eggs and incubate them in captivity for research purposes and the hatchlings released. A key question is whether this practice affects growth and survival rates of repatriated hatchlings. Growth rates of numerous reptiles including alligators are known to vary geographically as well as by habitat and individual (Andrews 1982). It is evident that different pods (groups of siblings) have different growth and survival rates, which could be due to many factors. The logarithmic relationship between total length or snout-vent length and body mass is used to evaluate condition factors (Taylor 1979). Condition factors are an index of animal's health (Le Cren 1951). The factors have been used to make seasonal and habitat comparisons (Taylor 1979, Elsey et al. 1992).

Deitz (1979) was the first to provide quantitative data of these complex behaviors by finding that maternal presence, which involves regular maternal attendance or defense, was observed for 34% of all pods in central Florida lakes. This leads to the question of whether growth and survival of naturally hatched pods is different from that of repatriated pods. Adult alligators, presumably maternal females, were observed readopting the pods released at the nest site (Woodward, FWC, pers. commmun.). Understanding the reasons of early age mortality will aid in the management and conservation of the species. The objectives of this study are, first, to determine if growth and survival of hatchling American alligators is different between wild and repatriated hatchlings across several locales in central Florida. Second, to find out whether hatchlings released at the nest site have a greater chance of survival and faster growth rate than those released at suitable habitat away from the nest site. This was accomplished by comparing relative growth rate, body condition factor, and survival rate between wild and repatriated pods.

Methods

Alligator eggs were collected in summer 1998 as a part of an ongoing FWC clutch viability investigation from perimeter marshes and swamps on Lake Apopka, Lake Griffin, and Orange Lake in central Florida (Figure 1). Global Positioning System (GPS) coordinates were taken at the nest sites to assist navigation when returning back to release hatchlings. We collected twenty-five clutches from Lake Apopka, thirty clutches from Lake Griffin, and forty-one clutches from Orange Lake. Alligator eggs were artificially incubated as described by Woodward et al. (1989) to examine inherent egg viability. Number 1 monel tags (Natl. Band and Tag Co., Newport, Ky.) were used to identify individual. Each hatchling was tagged on the web of right-rear foot. All pods were measured TL (total length) and SVL (snout-vent length), weighed, tagged, and relocated into the wild following treatments described below. TL and SVL were measured to the nearest 0.1cm. Hatchlings remained in captivity for approximately 2 weeks before releasing due to the large number of clutches needed to be released. Only pods with at least 8 hatchlings were selected as experimental units. The number of pods used in this study is shown in Table 1.

Repatriated pods were released at known nest sites and in suitable habitat away from the nest site. The word "Nest Site" defines the same site as egg collection site, while the word "Suitable Habitat" means an area that appeared to be suitable for hatchling alligators (Deitz 1979, Woodward et al. 1987) but separated from the nest site. Hatchlings released at nest sites were assumed to have associated maternal female alligators, whereas, hatchlings released in suitable habitats, were assumed to not be associated with maternal females. With this treatment design, differences in growth and survival could be influenced by the differences in treatments. In addition, naturally hatched animals were located and captured at night. They were caught by hand or by Pillstrom Tong (Pillstrom Tong Co., Ft. Smith, Ark.). We conducted periodic observations of pods after releasing them to monitor pod movements. Attempts to follow marked hatchlings were made every three months in October, January, and April to make sure they did not disperse a great distance. The last recapture was in May-July 1999 except for 3 Apopka pods that were checked in September 1999. All pods were recaptured with the best and equal effort. Hatchlings were captured, weighed, measured TL and SVL for analyses of growth rate and body condition. Individual data on capture-history used in the analysis, and estimates of the TL of attending alligators were also estimated if applicable. Recapture and data collection for each pod was accomplished as fast as possible to reduce stress and then all animals were released at the site of capture. Sexes were identified by cloacal examination. Sexes were determined by comparing color, turgidity and dimensions of the clitero-penis (Allsteadt and Lang 1995).

Growth rate was calculated as a total length (TL) change per growth day (cm/day). Growth days were referred to Temsiripong's thesis (1999) as the period prior to and after the cooler months when no growth occur. During no-growth period the water temperature dropped below 20°C (Coulson and Hernandez 1983). The length of this period is different across the lakes. Orange Lake had the shortest estimated growth period (365-120 = 245 days), whereas it was 265 and 285 days in Lake Apopka and Lake Griffin respectively. Condition factors are derived from the relationship between length and weigh in the population, $K = W \times L^{-b}$. K is a condition factor, W is mass (g), L can be either snout-vent length or total length (cm), and b is the slope of the regression of the natural log (ln) of TL on the natural log of mass. The constant "b" is dependent upon mean growth characteristics of individuals in the population and equals the slope of regression equation where lnTL is plotted against lnW. An individual relative condition factor (a_l) is then calculated as $a_l = W_l(L_l)^{-b}$ (Taylor 1979). Survival rate was calculated by using Minimum-Known-Alive (MKA), which has been used extensively by crocodilian researchers because of its simplicity and for single recaptures. MKA survival rates represent the proportion of marked hatchlings known to survive to a certain age from an initial sample of marked animals. Even though MKA estimates are negatively biased (Nichols and Pollock 1983), it is still qualified for this study because we are concerned more with relative rather than absolute survivorship of alligators. All analyses of growth and survival rate were performed on SPSS version 9.0 for Windows (Voelkl and Gerber 1999). Our statistical design was a factorial analysis of variance to test effects of factors influencing growth and survival rates. It allowed for 2-way interactions between the effects of treatment and study areas on each response variable.

Results and discussion

Post-hatching observation

Post-Hatching observation was implemented to reveal where the pod would be after releasing. After hatching, American alligators formed pods and remained among aquatic vegetation. Hatchlings frequently vocalized while concealed in vegetation. From diurnal observation, adult alligators were occasionally observed near pods, but made no attempt to defend them. Hatchlings were often observed foraging in non-vegetated shallows and occasionally lying on logs in open water. Movement of hatchlings following their first winter was documented by

monthly recaptures of one hatchling from each pod. We found that hatchling alligators moved little throughout the winter and were mostly inactive except on warm, sunny days. Pods remained at nests for at least ten months. Most pods (77%) stayed at the original site even after the first winter. There were 3 Lake Apopka pods, 3 Lake Griffin pods, and 6 Orange Lake pods scattering along the shorelines, representing 15% of all tagged hatchlings (Table 2). Average distance travel of these 12 pods from the three lakes was 83.5 m. Dispersed pods usually display a one-dimensional spreading along the lake or marsh fringe. Six repatriated pods (1 Lake Griffin and 5 Orange Lake pods) or 8% were not found.

Sixty-four hours diurnal observation was not sufficient to draw a detailed conclusion on parental behavior. However, recapture at night gave us additional opportunities to observe them. The size of all adult alligators observed near hatchlings fell in the range of adult female alligators. Seventy percent of female-sized alligators observed near nursery pond were very persistent (Table 3). Even though they submerged as the airboat approached, they resurfaced to observe us working up hatchlings. In presence of the female, non-distress grunting of hatchlings occurred in continuous and apparently random fashion. Hatchlings grunted frequently when searching for food or exploring their environment. Such behaviors happened more often in the presence of the female and this agrees with the findings of Deitz (1979).

Growth rate

Of 1,676 wild and repatriated hatchling alligators from 78 clutches marked and released during the study, 372 (214 females, 157 males) or 22.2% were recaptured and used for growth analysis (Table 4). The sex ratio for 372 hatchlings was 1:1.36 (males:females). The difference in length gain was not detected ($P = 0.916$) between male ($n = 157$) and female hatchlings ($n = 214$). In Louisiana, differences in growth rates of alligators were not significant until juveniles reach 60 cm SVL (Nichols et al., 1976). As described in Deitz (1979), Wilkinson and Rhodes (1997), Brandt (1991), and Elsey et al. (1992), male and female hatchling alligators have equal growth rate in their early years. There was no correlation (Figure 2) between initial size of hatchlings and change in TL per day ($P = 0.213$). No correlation was obtained for initial hatchling size and % increase in body weight. The results indicated that size based dominance is not an important factor determining hatchling growth. Similarly, growth rate was not correlated with clutch size ($P = 0.417$). Change in length did not correlate with the rate of survival ($P = 0.054$, $R^2 = 0.052$). No difference was detected between hatchlings released at nest site and in suitable habitat ($P = 0.226$). The difference in TL change/day between wild and repatriated hatchlings was not significant ($P = 0.580$). There was no interaction among LAKE x TREATMENT effects ($P = 0.063$) on growth rate.

However, growth rate differed among Lake Apopka, Lake Griffin, and Orange Lake ($P \leq 0.001$) (Table 5). Differences in growth rates among study areas were determined primarily by differences in the thermoregulatory behavior of individuals, which appeared to be inherited (Sinervo 1990). Water temperatures differed among lakes and, thus, affected growth period. Therefore, differences in growth rate of hatchling alligators may be related to temperature differences. Nonetheless, the growth rate in this study (26.5 cm/yr) was higher than that reported by Fuller (1981) in North Carolina (12.4 cm/yr) and Dalrymple (1996) in south Florida (13.6 cm/yr). Ambient temperature in North Carolina was very low compared to Florida. Consequently, the period of growth days was limited to six months while it is at least eight months in central Florida. In an earlier study on captive-reared hatchling alligators, growth rates of 0.2 cm/day for the first year were recorded (Joanen and McNease 1970).

Body condition factor

As hatchlings grew they showed a slight but significant reduction in mass relative to length. When growth is isometric, the factor b will be equal to 3; therefore, the K factor for all animals can be calculated for each individual based on the equation $K = M \times 10^{2.69}/TL^b$ (Table 6). The condition factor (K) showed that Orange Lake alligators have a greater K (K = 2.78), meaning that alligators in Orange Lake have more mass relative to length than those in Lake Apopka (K = 2.48) and Lake Griffin (K = 2.38). Because body condition factors can be used to make habitat comparisons (Taylor 1979, Elsey et al. 1992), the greatest body condition factor was found in alligators from Orange lake indicating that Orange Lake hatchlings were heavier than Lake Apopka and Lake Griffin animals at the same size. Perhaps, one of the most important reasons for the difference is food availability because Orange Lake alligators not only grew at the faster pace, but they were heavier as well. The effects of habitat on growth rates of hatchling alligator were presumably related to food availability. Prey of hatchling alligators consists largely of macroinvertebrates and fish (Fogarty and Albury 1967, Chabreck 1971). The abundance and availability of these items varies considerably with water temperature, water depth and trophic state of the habitat. For example, alligators in Everglades National Park have an extremely low growth rate (Kushlan and Jacobsen 1990). Kushlan and Jacobsen suggested that the lower growth rate of Everglades alligators was due to seasonal shortages of food combined with the prolonged growing season with high ambient temperatures. The limited amount of emergent

vegetation, predominantly cattails (*Typha* sp.), in Lake Apopka may limit insect biomass. The smallest growth rates of animals among the three lakes were found in Lake Apopka hatchlings, perhaps because of low food availability.

Survival rate

Survival rate was determined by the number of marked hatchlings that survived through the date of last recapture. We recaptured at least 1 member of 92.3% of pods tagged and released. Although 72 out of 78 pods were found after 10-month study periods, only 372 out of 1,676 hatchlings (22.2%) were actually recaptured (Table 4). The six missing pods were all repatriated pods even though the best efforts focused on every pod while recapturing. Survivorship was not different ($P = 0.589$) across the three lakes. No LAKE x TREATMENT interaction ($P = 0.722$) was detected indicating that there was no difference in survival rate among treatments across lakes. No relationship was detected between survival rate and clutch size ($P = 0.113$, $R^2 = 0.033$, $n = 78$) (Figure 3). No difference in survivorship was detected ($P = 0.546$) between repatriated hatchlings released at nest site and in suitable habitat. Therefore, both repatriated treatments were combined to test for the difference between survivorship of wild and repatriated hatchlings. The survivorship of wild hatchlings pods (mean = 0.29, SD = 0.14, $n = 22$) was greater ($P = 0.028$) than repatriated pods (mean = 0.21, SD = 0.16, $n = 56$).

The survival rate was not as high as any other studies in Florida lakes (Deitz 1979, Woodward et al. 1987), possibly because losses of entire pods were also included in the mortality rate estimate. Survival estimates of 12 month-old wild hatchlings on Orange Lake was 41% (Woodward et al. 1987), and 30% (Deitz 1979). Most hatchling pods remained near nest sites for at least 10 months following hatching as described by (Deitz 1979). In this study, six missing pods were never found, although over 200 m around the original release location was intensively searched. All of the missing pods were repatriated pods although the best and equal effort was put on every pod during recapture attempts. Mark-recapture data indicated that survival rate of tagged wild alligators (0.29) was 41% greater than that of repatriated alligators (0.21).

It was possible that either emigration, or mortality, was responsible for the missing 6 pods. Note that all missing pods were repatriated hatchlings. Though three out of the six were the pods released at nest sites, other extraneous factors may cause them to disperse; i.e., water level, habitat suitability, and food availability. Droughts are thought to increase mortality of marsh alligators above that of lake alligators (Nichols et al. 1976). Twelve hatchling pods were observed travelling significant distances at the onset of winter season probably due to low water level. This behavior was viewed as increasing hatchling mortality because of desiccation and predation (Nichols et al. 1976). Fluctuating water levels concentrate alligator populations and increase social conflict with consequent injuries (Deitz 1979).

Different survival rates among lakes could be due to differences in population density, which may be regulated by intraspecific predation. Crocodilians have long been known to be cannibalistic. For example, in the first canal of Haines Creek, east of Lake Griffin, several 4-5 years old alligators were observed at the nest site of one missing pod (GR-21N) just after the first winter (Table 2). Cannibalism was suspected as a cause of some mortality in juvenile alligators (Woodward et al. 1987). Similarly cannibalism may remove 7.4-10.1% of juvenile alligator population on Orange Lake annually (Delany et al. unpubl. report).

Since survival of tagged wild alligators was 41% greater than that of repatriated alligators, we hypothesized that parental association contributed to survival of hatchlings in their 1st year. Maternal behavior seems to be more likely during incubation and early post-hatching period. Female presence was observed either by chance or because she attempted to attend her young although it was difficult to estimate the size of big alligators as well as telling the gender. Besides, repatriated hatchlings remained in captivity for approximately 2 weeks, their survival skills such as searching behavior is thought to be affected resulting in greater chance of mortality.

Preliminary data in this study clearly indicate that it is feasible to release artificially hatched alligators back into the wild to supplement natural loss from embryonic death, and that repatriated alligators will grow as well as wild alligators, which presumably would enhance survivorship. Future studies should try to genetically match up mother and/or father alligator and their young to verify that an observed adult alligator is the parent of the pod. This work requires an extensive field experience to handle large alligators as well as knowledge in microsatellite techniques.

Conclusion

Growth rates can be experimentally manipulated fairly easily in laboratory determinations of growth dynamics, but in wild animals the factors, which determine access to food, and hence growth, can be very complex. Growth of hatchling alligators from different locales varied considerably. This study showed that repatriated hatchlings grow as well as wild alligators. This can be advantageous, as growth can greatly affect survivorship. If

an alligator grows slower, it will take longer to reach sexual maturity, and increase its susceptibility to predation, disease and cannibalism.

This study showed that survival rate of repatriated hatchlings was lower than wild hatchlings. However, while significant, this difference is small and is unlikely to have any effect on the population dynamics of these alligators. Supplementing natural loss from embryonic death by restocking hatchlings appears to be a valuable management tool for Florida alligators. Although survivorship of naturally hatched alligators is greater than that of repatriated hatchlings, the initial number of repatriated hatchlings is more than wild hatchlings and equal growth rate may enhance survival of repatriated hatchlings to sexual maturity. This study also showed that repatriated hatchlings released at nest site and suitable habitat had similar growth and survival rates. Therefore, management of Florida alligators may adjust releasing procedures to be more practical by releasing hatchlings at suitable habitats. Continuation of this study plus genetic characterization to individuate alligator families over the next several years should provide data to further refine management practices, with emphasis on recommendations for techniques in selecting repatriating sites and optimum size at which to release juveniles.

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Table 1. Number of pods (groups of sibling alligators) released in central Florida lakes in 1998.

Treatment	Lake			Total
	Apopka	Griffin	Orange	
Repatriated at nest site	10	6	9	25
Repatriated at suitable habitat	7	5	19	31
Wild	8	8	6	22
Total	25	19	34	78

Table 2. Dispersal distances during recapture of hatchling American alligators in central Florida lakes.

Lake	Pod No.	Original location	Last location	Dispersal (m)
Apopka	AP-508W	28'37.310"/81'41.070"	28'37.269"/81'41.067"	75.1
Apopka	AP-601W	28'40.770"/81'38.710"	28'40.771"/81'38.724"	25.1
Apopka	AP-12N	28'37.240"/81'41.010"	28'37.264"/81'40.979"	125.4
Griffin	GR-28N	28'55.870"/81'49.990"	28'55.844"/81'49.978"	26.5
Griffin	GR-21N	28'53.590"/81'49.560"	N/A	Missing pod
Griffin	GR-13S	28'53.400"/81'49.760"	28'53.365"/81'49.766"	52.9
Griffin	GR-34S	28'56.320"/81'49.730"	28'56.342"/81'49.745"	74.8
Orange	OR-506W	29'29.066"/82'10.580"	29'29.058"/82'10.603"	94.9
Orange	OR-510W	29'28.137"/82'10.069"	29'28.189"/82'10.056"	105.3
Orange	OR-6N	29'25.566"/82'11.140"	N/A	Missing pod
Orange	OR-20N	29'26.619"/82'07.896"	29'26.682"/82'07.936"	118.2
Orange	OR-44N	29'26.000"/82'08.580"	N/A	Missing pod
Orange	OR-106N	29'28.880"/82'10.100"	29'28.855"/82'10.039"	112.8
Orange	OR-9S	29'25.750"/82'11.610"	N/A	Missing pod
Orange	OR-13S	29'26.421"/82'09.026"	29'26.427"/82'09.035"	63.5
Orange	OR-36S	29'25.722"/82'10.667"	N/A	Missing pod
Orange	OR-38S	29'27.270"/82'11.970"	N/A	Missing pod
Orange	OR-110S	29'28.730"/82'10.010"	29'28.763"/82'09.970"	127.1

W = Wild hatchlings
N = Repatriated hatchlings at the nest site
S = Repatriated hatchlings into suitable habitat away from the nest site

Table 3. Behavioral summary of attendant alligators observed at the pod sites.

Pod No.	Locale	Time	Adult alligator behavior
AP-20N	Apopka	0015	7'-8' alligator at location, fled upon approach
GR-402W	Griffin	2210	7.5' alligator stayed afloat all the time we were present
GR-10N	Griffin	0009	7' alligator observed our activities 15 m away from airboat
OR-506W	Orange	2320	7'-8' alligator submerged as we approached, kept 10 m observation distance
OR-45N	Orange	2345	7' alligator submerged immediately as we approached
OR-126N	Orange	2125	7' alligator submerged shortly after we shined light on her
OR-4S	Orange	0015	7.5' alligator submerged as we approached, resurfaced briefly as we were working
OR-25S	Orange	2205	7'-8' alligator observed our activities, responded to hatchling grunts
OR-27S	Orange	0015	7.5' alligator submerged as we approached, resurfaced briefly as we were working
OR-117S	Orange	2250	7.5' alligator in midst of pod, submerged promptly and resurfaced during work up

W = Wild hatchlings
N = Repatriated hatchlings at the nest site
S = Repatriated hatchlings into suitable habitat away from the nest site

Table 4. Recapture rates of hatchling American alligators on central Florida lakes in 1999.

Lake	No. capture, tag and release	No. of recapture	Recapture rate
Apopka	525	119	0.23
Griffin	429	80	0.19
Orange	722	173	0.24
Overall	1,676	372	0.22

Table 5. Ten-month growth increment in total length change and Change of total length per day for alligator hatchlings on central Florida lakes during 1998-1999.

			Wild hatchlings		Repatriated hatchlings			
					Nest site		Suitable habitat	
Lake	Median recapture date	No. of pod	TL (cm)[a]	TL (cm/day)[b]	TL (cm)[a]	TL (cm/day)[b]	TL (cm)[a]	TL (cm/day)[b]
Apopka	June 25th	25	15.67	0.076	15.24	0.075	15.64	0.079
Griffin	June 14th	19	19.88	0.081	19.98	0.083	18.99	0.080
Orange	July 2nd	34	40.73*	0.159*	19.41	0.103	22.51	0.107
Average			24.03	0.100	17.65	0.086	20.16	0.095

* ($P \leq 0.001$)
[a] Average 10 month increase in total length (TL)
[b] Average 10 month increase in total length change per growth day

Table 6. Regression equations and standard error of the regression for predicting weight (W) from total length (TL) across three central Florida lakes.

Lake	Predictor	Estimated Value	Equation	R^2	SE
Overall	lnTL	lnW	Y = 2.693lnTL – 4.843	0.92*	0.09
Apopka	lnTL	lnW	Y = 2.481lnTL – 4.077	0.86*	0.08
Griffin	lnTL	lnW	Y = 2.381lnTL – 3.630	0.79*	0.10
Orange	lnTL	lnW	Y = 2.778lnTL – 5.167	0.95*	0.09

* ($P \leq 0.001$)

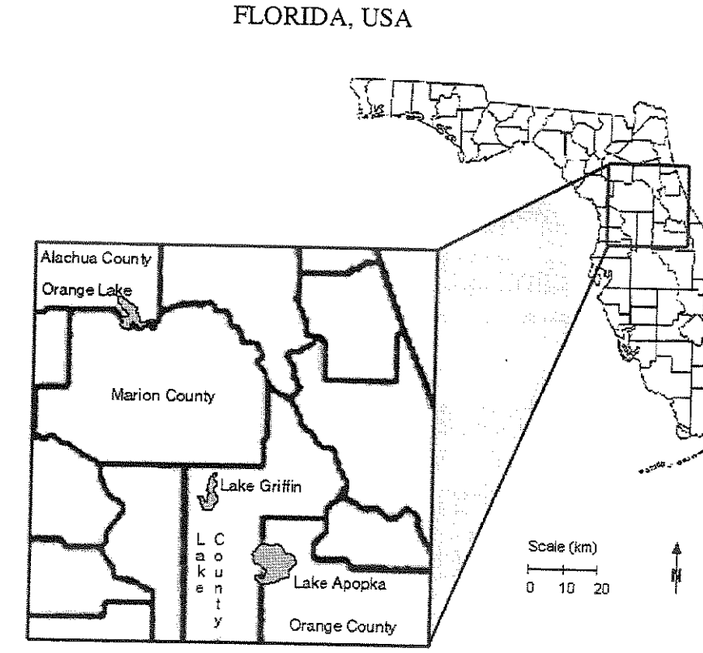

Figure 1. Study areas in central Florida, Lake Apopka, Lake Griffin, and Orange Lake

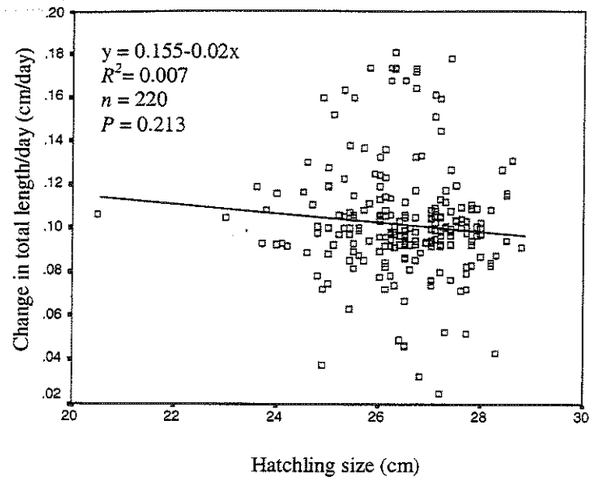

Figure 2. Relationship between hatching size and growth rate of hatchling alligators in central Florida lakes.

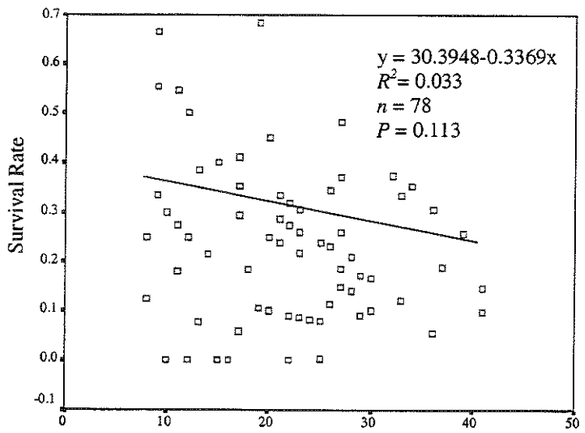

Figure 3. Relationship between survival rate and clutch size of hatchling American alligators in central Florida lakes.

CONSERVATION OF THE ORINOCO CROCODILE IN VENEZUELA. A BLIND ALLEY?

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ABSTRACT

Ten years after the first release of captive reared Orinoco crocodiles (*Crocodylus intermedius*) into the wild and with more than 1700 of them released into their natural habitat, the Program for the Conservation of the Orinoco Crocodile (PCOC) in Venezuela seems to have lost its way. New areas for the liberation of captive-reared individuals have not been evaluated and selected. The four captive rearing facilities in the country are able to rear more than 300 individuals a year but their final destiny is not determined in advance, which results in improvisation at the time of each annual release. The PCOC, that in the past was coordinated by FUDENA and the Venezuelan Crocodile Specialist Group (VCSG), is now withouit leadership and the strategic goals once prepared by PROFAUNA and FUDENA have not been reached. The goals and strategies of the PCOC must be redefined in order to achieve the recovery of the species. The prestige of the management program of the Venezuelan crocodilians should not be based solely on the success obtained with a widely distributed and abundant species like the spectacled caiman (*Caiman crocodilus*). The complete recovery of species as the Orinoco crocodile, and the American crocodile (*Crocodylus acutus*) should be used as a criterion of the success of that program

CONSERVACIÓN DEL CAIMÁN DEL ORINOCO EN VENEZUELA. ¿UN CALLEJÓN SIN SALIDA?

RESUMEN

Después de casi diez años de la primera liberación de caimanes y más de 1700 caimanes liberados en su medio natural, el programa de conservación del caimán del Orinoco *(Crocodylus intermedius*) de Venezuela parece haberse estancado. Las nuevas áreas para la liberación de más individuos no han sido localizadas y evaluadas. Los cuatro zoocriaderos existentes están en capacidad de producir cerca de 300 caimanes al año cuyo destino final no está definido de antemano, lo que se traduce en improvisación a la hora de planificar las liberaciones anuales. El programa, que en el pasado fue coordinado por FUDENA y el Grupo de especialistas de Cocodrilos de Venezuela, está acéfalo y las metas estratégicas, plasmadas en los planes preparados por FUDENA y PROFAUNA no se han cumplido. Es necesario una redefinición de las metas y estrategias para lograr la definitiva recuperación de la especie. El prestigio del programa de manejo de crocodílidos de Venezuela (PMCV) no debe basarse exclusivamente en los logros alcanzados con una especie abundante y de amplia distribución como la baba (*Caiman*

crocodilus). La recuperación plena de una especie como el caimán del Orinoco (y también del caimán de la costa, *C. Acutus*) debería ser usado como criterio de éxito del PMCV.

The efforts for the conservation of the Orinoco crocodile in Venezuela could be dated back to the decade of the 70s of the last century, when the initial proposals in that direction were made (Blohm 1973) and the first evaluation of the population status of the species was completed (Godshalk 1978, 1980), after many years of commercial exploitation (Mondolfi 1965, Medem 1983). Is not until the 80s when the first captive breading and rearing facilities were established and the only protected area for the species was legally declared. Many of the initial steps for the conservation of the Orinoco crocodiles were due to the personal initiative of Cecilia and Tomas Blohm and the organizational effort of the Fundación para la Defensa de la Naturaleza (FUDENA) which coordinated the support of private and governmental organizations such as the Ministry of the Environment (through PROFAUNA), the World Wildlife Fund-US, the New York Zoological Society, the Agencia Española de Cooperación Internacional and many other institutions and individuals.

In 1990 the first captive reared Orinoco crocodiles were released into their natural habitat in the Caño Guaritico Wildlife Refuge in Apure State. That event was the initial step of a very intense process of discussion and proposal of initiatives that culminated with the presentation of two documents: ACTION PLAN (FUDENA 1993) and STRATEGIC PLAN (PROFAUNA 1994) that articulated the strategies and goals to reach, at the middle term, the complete recovery of the species.

In the ACTION PLAN, the main spheres of actions of the PCOC were defined as:

a. WILD POPULATIONS AND THEIR HABITATS: To declare new protected areas for the species; To evaluate .. [the population status and feasibility for incorporation into a system of protected areas of ..] the existing protected areas within the species historical range; Protection of the species in private lands; Population status of existing populations; and Studies on the ecology of the species.

b. CAPTIVE REARING: Optimize the functioning of breeeding and rearing facilities. To foment the creation of new rearing facilities.

c. REINTRODUCTION: Reintroduction and monitoring of released animals and Establishment of precise guidelines for the reintroductions.

d. ENVIRONMENTAL EDUCATION. Community participation. Education.

e. LAW ENFORCEMENT.

The FUDENA Action Plan, and the set of general proposals contained in it, should have beeen carried out under the coordination and supervision of PROFAUNA and the VCSG. Two of the proposals contained in them were to formalize and legalize the VCSG and to

establish a permanent mechanism to coordinate its actions with PROFAUNA. Other important proposal was to prepare triennial plans, with goals evaluated every year and under the supervision of the VCSG.

The STRATEGIC PLAN prepared by PROFAUNA had as goals:

a. To reestablish and/or consolidate, in a 15 years term, at least 10 viable populations of Orinoco crocodile in the country, in localities of optimum or good habitat quality of the states Barinas, Apure, Cojedes, Portuguesa and Guarico (at least one population per state).

b. To design a strategy to guarantee the survival of individuals or populations found in localities of poor habitat quality, small extension or very conflictive from a human standpoint (for example reservoirs or some private lands).

The document by PROFAUNA presented the first Triennial Operation Plan (1994-1996)

SUCCESSES AND FAILURES

The PCOC has had, without doubt, some successes. The more relevant among them are the creation of a Wildlife Refuge in Caño Guaritico (Apure state) and the release, up to 1999, of more than 1700 captive reared crocodiles into the wild (Tables 1 and 2) most of them in the mentioned refuge. The monitoring of the released crocodiles have been very limited (Lugo 1998) due to financial constraints but there exists some evidences that the species is now reproducing in the Guaritico Wildlife Refuge. The current better knowledge of the population status and ecology of the species (Ramo et al 1992, Thorbjarnarson and Hernandez 1992, 1993a,b) could be also credited to the PCOC.

Notwithstanding the successes, there are a series of negative aspects that need to be analyzed. The first of them is the disappearance of the VCSG. The last activity of the group took place in 1996 when a Viability Analysis Workshop was held at Caracas (Arteaga et al 1997). On the other hand, even though the Orinoco crocodile rearing facilities continue in operation, all of them with serious financial difficulties, and that the number of crocodiles to be released increase year after year, there are not efforts to coordinate their activities. Another negative aspect worth mention is that no new areas have been incorporated to the system of protected areas for the species and that population in the Cojedes River system (the most numerous known to date, Seijas 1998) remains without legal protection.

Both the Action Plan (FUDENA 1993) and the Strategic Plan (PROFAUNA 1994) have been abandoned without any review or substitution with an alternative plan. Several of the objectives of those plans were partially accomplished but the inertia and lack of organization could take us back to levels already overcome in the past.

Only the Orinoco crocodile populations in Caño Guaritico and Cojedes River have been monitored in a permanent way, but the population in the Capanaparo River (Thorbjarnarson and Hernandez 1992, 1993a,b) have not bee evaluated since 1992.

ONGOING PROJECTS

The four captive breeding-rearing facilities continue in operation, with ups and downs, due to the economic limitations. Released of captive animals have taken place, without interruption, since 1990 (Table 2).

At the Universidad Nacional Experimental de los Llanos Ezequiel Zamora (UNELLEZ) and with the support of the Wildlife Conservation Society (John Thorbjarnarson) four projects are now in the phase of fieldwork.

1. Population status of the Orinoco crocodile in the Manapire River, state Guárico. (Graduated student Magddy Jim,nez-Oráa.).
2. Potential of the Anaro River (State Barinas) for the release of captive reared crocodiles. (Graduated student Fredy Garavito).
3. Monitoring of the population status of the Orinoco crocodile in the Tucupido.reservoir (Undergraduated student Yamile Teran).
4. Monitoring of the reproductive status of the Orinoco crocodile in the Cojedes River. (Andrés E. Seijas, UNELLEZ, and Carlos Chávez, PROFAUNA)

SUGGESTIONS

Reactivate the VCSG or create a new coordinating mechanism to review and supervise the PCOC and that establish new priorities and lines of actions.

Promote the selection of new areas for the release of captive reared crocodiles and incorporate new localities to the system of protected areas for the conservation of the species.

To reinitiate monitoring activities at the Capanaparo River and to continue the exploration of localities with potential for their incorporation to the system of protected areas.

Venezuela is frequently mentioned as an example of good implementation of a management program of crocodilians (Ross 1998). That prestige is solely based on the success obtained with the spectacled caiman (*Caiman crocodilus*) a species widespread and abundant. The full recovery of species like the Orinoco crocodile and the American crocodile (*Crocodylus acutus*) should be used as an additional criteria for the success of that program.

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Table 1. Rearing facility of origin and place of releasing of Orinoco crocodiles (*Crocodylus intermedius*) in Venezuela.

		Rearing facility			
		El Frío	Masaguaral	Pto. Miranda	UNELLEZ
Place of releasing	Caño Guaritico (Apure)	151	556	205	104
	Río Capanaparo (Apure)	--	342	117	--
	Río Cojedes (Cojedes)	19	--	--	--
	Hato El Cedral (Apure)	--	4	15	--
	Caño Mocapra (Guárico)	--	188	--	--
	Embalse Tucupido (Portuguesa)	--	--	--	28
	All	170	1090	337	132

Table 2. Rearing facility of origin and year of releasing of Orinoco crocodiles *(Crocodylus intermedius)* in Venezuela

Year	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
El Frío	--	15	2	--	--	147	--	--	6	--
Masaguaral	16	41	316	185	58	69	76	43	118	116
Pto. Miranda	--	--	--	121	75	--	--	--	141	52
UNELLEZ	15	6	24	47	20	0	0	10	10	--
ALL	31	62	365	353	153	216	76	53	275	168

Programa Nacional para la Conservación Del Caimán Llanero

(Crocodylus intermedius)

PROCAIMÁN

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MINISTERIO DEL MEDIO AMBIENTE
DIRECCIÓN GENERAL DE ECOSISTEMAS
SUBDIRECCIÓN DE FAUNA

MINAMBIENTE

INSTITUTO DE INVESTIGACIÓN
DE RECUROS BIOLÓGICOS
ALEXANDER VON HUMBOLDT

INSTITUTO HUMBOLDT COLOMBIA

UNIVERSIDAD NACIONAL DE COLOMBIA
FACULTAD DE CIENCIAS
DEPARTAMENTO DE BIOLOGÍA
Estación de Biología Tropical "Roberto Franco"

Santafé de Bogotá, D.C.
1998

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CONSERVACIÓN INTERNACIONAL COLOMBIA	JOSE VICENTE RODRIGUEZ
CORPES ORINOQUIA	NELSON RUIZ GARZON

DESCRIPCIÓN DEL PROGRAMA

1 Criterio General

El programa del plan de conservación del caimán llanero se desarrollará atendiendo los criterios establecidos por la IUCN para especies del orden Crocodylia. De acuerdo con ello, se pretende en una primera fase pasar la especie del Estado Crítico al de En Peligro de Extinción; y en el largo plazo llevarla a la categoría de Bajo Riesgo.

2 Duración

Para la primera fase el programa tendrá una duración de 10 años como mínimo, estando sujeto al, éxito de los eventos reproductivos y la tendencia de las poblaciones en procesos de reintroducción.

3 Objetivos

1 Objetivo General: Prevenir la extinción del caimán llanero *Crocodylus intermedíus* en Colombia y promover su recuperación en el área natural de distribución, para así contribuir a la conservación en el largo plazo de la especie, integrándola a los sistemas económicos y culturales regionales.

2 Objetivo Específico: Se considerará el alcance de las metas propuestas definidas en los criterios establecidos por la UICN para las especies del orden Crocodylia. Para la especie en estado de peligro se buscará un incremento de la población al menos de un 50%; un aumento de extensión de ocurrencia en más de 500 km^2 y contar con más de 2.500 individuos maduros.

4 Acciones

La primera fase incluye el desarrollo de seis acciones específicas que se describen a continuación:

1. Recuperación de huevos y neonatos.
2. Implementar 1.200 m^2 de infraestructura para el levante de 2.500 individuos.
3. Identificación de hábitats potenciales para la reintroducción.
4. Definir protocolo de reintroducción.
5. Realizar monitoreos de poblaciones reintroducidas.
6. Intercambio internacional.

Cuadro 2 Acciones

6 Acciones Instrumentales

El desarrollo de estas acciones está a cargo de la Secretaría Técnica y del grupo de instituciones del programa.

1. Componente institucional

La Secretaría técnica del programa estará a cargo del instituto de lnvestigaciones -Alexander Von Humboldt. El programa contará con una persona coordinadora adscrita al instituto, la que se encargará de asumir responsabilidades definidas para el desarrollo del mismo. De esta forma se establecerán esquemas de disponibilidad de recursos y apoyos logísticos con las corporaciones y organizaciones regionales comprometidas, considerando en primera instancia la inclusión del programa en los planes de desarrollo de entidades como el CORPES, La Unidad Administrativa Especial de Parques Nacionales, la Red de Reservas Privadas, El Instituto Sinchi, Las Fundaciones Omacha y Bachaqueros y las Secretarias de Agricultura de los departamentos Arauca, Vichada, Casanare y Meta, que permitan proyectar el desarrollo del mismo.

2. Financiación

A nivel Internacional se buscará el apoyo de CITES y del Grupo de Especialistas de Cocodrilos. A nivel nacional se cuenta con contrapartidas y recursos existentes en las Instituciones y organizaciones regionales comprometidas cuyo monto se definirá posteriormente. En el desarrollo del programa también se preveen ingresos asociados con el desarrollo de las actividades de zoocría, esto enmarcado dentro de una reforma legal estructurado sobre el concepto de desarrollo sostenible.

3. Comunicación

En la primera etapa este aspecto lo asume el Instituto Humboldt a través de sus medios de comunicación (Boletines BIO, Biosíntesis y Hoja lnternet www.humboldt.org.co). Se desarrollará una estrategia de comunicación para apoyar el programa, haciendo uso de medios de información locales, utilizando los recursos institucionales de cada región.

4. Educación ambiental

Los programas de educación ambiental se integraran a las corporaciones e instituciones regionales. A corto plazo se dirigirán principalmente a las personas activas laboralmente por las implicaciones mismas del programa.

5. Investigación

El desarrollo del componente de investigación estará a cargo de la Estación de Biología Tropical Roberto Franco, con el apoyo del Instituto Alexander Von Humboldt. El componente de investigación apoyará la estructura de las actividades en cada Acción. Dentro de un proceso de optimización se considerarán inicialmente aspectos pertinentes que aseguren el éxito y viabilidad del programa. Así, se incluirá el estudio de parámetros fisiológicos asociados a eventos reproductivos, aspectos de patología, aspectos bioecológicos y de educación ambiental. Lo anterior implicará procesos de transferencia a diferentes niveles.

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Conservation Status of Wild Populations of the Chinese Alligator

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In collaboration with the Anhui Forestry Bureau, we carried out a survey of the status of wild groups of Chinese alligators in the 433 km2 National Chinese Alligator Reserve in southeastern Anhui Province. We visited all 13 sites designated for the protection of the alligator, plus other sites where alligators have been reported. The results of this survey can be summarized as follows:

1. Alligators are only known from a small region in southeastern Anhui province, a tiny fraction of its former distribution.
2. While an alligator reserve of 433 km^2 has been declared, it only contains 13 officially designated sites that total 41 ha.
3. None of these sites offers what can be termed natural habitat, but consist of small ponds that are located either within or adjacent to villages, are completely surrounded by rice fields, or are biologically marginal oligotropic water bodies set in low hills.
4. While considered to be alligator refuges administered by the Anhui Province Forest Department, the ponds remain under the control of the local villages which use them for a variety of activities (crop irrigation, buffalo wallows, fish farms, duck rearing).
5. Alligators are only present at 10 of the 13 designated sites, and the total population of alligators at these sites is estimated to be 60, with the largest groups being 10-11 animals and a maximum of one adult female.
6. Reproduction is only taking place at two of the designated sites, but these eggs are routinely collected and the resulting hatchlings retained in the Anhui alligator breeding center.
7. Alligators are still found in a small number of areas outside the designated sites, including one area where nesting is still taking place, but the situation in these area is even worse than at the designated sites.
8. The total population of wild Chinese alligators is estimated to be 130-150 and is declining at an annual rate of 4-6%.

The present Chinese government conservation program is based on the legal protection of alligators and captive breeding, but not habitat protection. While the number of alligators in captive breeding centers in China has boomed, the wild population has continued its steady slide towards extinction. The existing National Chinese Alligator Reserve is inadequate to ensure the long-term survival of alligators at any of the 13 designated sites. The future of wild alligators will hinge on efforts to rehabilitate habitat to create reserves where viable alligator populations can be established by releasing captive-bred individuals. A draft management plan for alligators, which places considerable emphasis on alligators re-introductions, has been developed by the Chinese government. We urge that this plan be refined, incorporating IUCN guidelines for re-introductions, and be undertaken as part of a larger program to conserve wetlands in the lower Chang Jiang valley. Failure to undertake habitat conservation actions will result in the last remaining wild individuals entirely disappearing within the next few decades.

POTENTIALITY AND CURRENT USE OF THE POPULATIONS OF SPECTACLED CAIMAN SUBJECT TO COMMERCIAL USE IN VENEZUELA

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INTRODUCTION

Of the Venezuelan crocodiles the spectacled caiman (*Caiman crocodilus*) is the species of more abundance and wide distribution in the national territory. This species besides being an important element inside the animal communities that constitute the llanero ecosystem, has a high commercial value, reason for which was object of an irrational exploitation during the decade in between 1960 and 1970.

The Ministry of Agriculture and Ranching, competent organ at that time, decreed a ban that extended for a ten year period (1972-1982) with the purpose to protect their natural populations and to allow them to recover. During this same period a great part of the basic information required for sustainable management of its populations was generated (Ayarzagüena, 1983; Macellini, 1979; Staton & Dixon, 1975, 1977; Woodward & David, 1985). Beginning in the year 1983, the Program of Commercial Use of the spectacled caiman (*Caiman crocodilus*) was executed by the management authority, Ministry of the Enviroment and the Natural Resourses (MARN) until the present.

The program for commercial use of the spectacled caiman has been executed for a seventeen years period in which two pauses have been decreed, (1986 and 1996) denominated ecological, with the purpose of evaluating the execution of the program as well as the state of the wild populations.

Among the activities that are carried out during the execution of the Program for Commercial Use of the spectacled caiman (*Caiman crocodilus*), the one that generates most concern is the number of animals to be authorized and its distribution among regions and different ranch properties based on the population values estimated from large ecological regions, (Velasco and Ayarzagüena, 1995) or for states. Usually, these values are known only after all the licenses have been assigned, which are, in all the cases, a smaller number than the total of applications that are processed in each season.

Another aspect of concern in these assignments, is that the harvest at some times could be bigger than the potential of the ecological region on which the assignment is done, which could end up being interpreted as an over exploitación of the species in some areas.

The present work has the purpose of giving an answer to these questions, considering the limitations of the accuracy of the data, given the constant change in the number of applications that are processed in each season.

OBJECTIVES

1.- To determine for each ecological region the maximum crop harvestable, taking in consideration the number of properties and the type of them, assuming that in a particular season all of the potentiall properties participate.

2.- To compare the values of maximum crop with those really obtained during the execution of the Program of Commercial Use of the spectacled caiman for each ecological region and each executed season.

MATERIALS AND METHODS

.-We use d as our sample the total of the properties that have participated in at least one season starting from the season 1991, until the last one executed, 1999. (De Sola, 1999. MAEBA).

.- With the known information for each one of the contained properties in the sample (surface in hectares and location in ecological regions) we proceeded to calculate the crops to be assigned, taking as assignment approaches those employed in the season 1994, (Velasco & De Sola, 1997). The required information was extracted of the master list which is a database file that contains all the information related with the participant properties in the program from the year 1991, which is up-dated annually. (De Sola, 1999. MAEBA)

.- After having calculated the crops of each property they were reorganized within the sample for ecological region and for property type, and calculated in all the cases the total population and the population class IV employed.

.- The information for the different seasons (1991-1999), are in independent databases and reported in different papers (De Sola, 1994; 1995; 1997; 1998; 1999).

RESULTS AND DISCUCION:

The total of properties considered for the present analysis is 1,013, of those only 900, possess licenses of commercial hunt at least in some of the considered seasons, the remaining ones (113), for technical reasons or legal ones (missing requisite), were not worthy of license of commercial huntand have been eliminated from the subsequent calculations.

In the following Table the distribution of the properties with caiman cropping

is presented by ecological region and within each region for property type according to the classification carried out by Velasco and Ayarzagüena (1995).

Table N° 1. Number of properties for type and ecological region in the sample.

		ECOLOGICAL REGION					
	AA	BA	CA	AC	LLB	AR	GU
TYPE GH	12	3	3	9	16	2	6
TYPE HH	28	5	2	7	17	3	4
TYPE FO	73	16	6	29	70	40	24
TYPE FI	140	29	7	25	59	83	33
TYPE PF	52	12	2	2	13	48	20

Were

AA=> Alto Apure	GH=> Big Hatos	>25,000 ha
BA=> Bajo Apure	HH=> Hatos	12,500 ha - 25,000 ha
CA=> Cajón de Arauca	FO=> Fundos	3,500 ha - 12,500 ha
AC=> Aguas Claras	FI=> Funditos	1.000 ha - 3.500 ha
LLB=> Llanos Boscosos	PF=> Little Funditos	< 1000 ha
GU=> Guárico		
AR=> Arismendi		

Once the known distribution of the properties for ecological region and the type in which they qualify, we proceeded to calculate for each one of them, making use of the surface value in hectares, the following parameters:

1.- **Estimated population**: product of the density corresponding to each ecological region reported firstly in the study MARNR-CITES (Velasco and Ayarzagüena, 1995) and monitoring carried out to the different ecological regions in successive years (Colomine et. al. 1995, Velasco et. al. 1997, a, b). For the present work the densities were those from the 1997 season, the same ones are presented in the following table:

Table N°2. Densities reported for each ecological region

Ecological region	Density
Alto Apure	0.22 ind/ha
Bajo Apure	0.39 ind/ha
Cajón de Arauca	0.19 ind/ha
Aguas Claras	0.10 ind/ha
Llanos Boscosos	0.15 ind/ha
Arismendi	0.14 ind/ha
Guárico	0.10 ind/ha

The densities used for the calculation of the population for each property

depend on the type of it, as it is pointed out next:

Table N°3. Density used by property type.

Type of property	Density employed
Big Hatos and Hatos	Density of the region
Fundos and Funditos	0.5 ind/ha
Little Funditos	1.0 ind/ha

The reason for which are used different densities of those reported for the ecological regions, to the properties that qualify according to its surface in fundos, funditos and little funditos, rests primarily in the social character of the program, being based on the increment of the standard deviation of the mean density for each region as the surface of the property diminishes (Velasco and Ayarzagüena,1995; De Sola, 1996). It is considered that those properties that qualify as big hatos and hatos possess representative surfaces for the region in which they are located.

2.-**Population Class IV**: the population's fraction conformed by individuals belonging to the group class IV, mature males with ventral longitude bigger than 90 cm (Ayarzaguena, 1983). The percentages of individuals belonging to thes class IV reported for each ecological region in the studies mention before and employed for the present work and applied since the 1997 season, are present in the following table:

Table N° 4. Percentage of individuals belonging to the class IV reported for each ecological region.

Ecological region	% individuals class IV
Alto Apure	24.00
Bajo Apure	23.30
Cajón de Arauca	24.40
Aguas Claras	20.00
Llanos Boscosos	18.00
Arismendi	16.80
Guárico	24.70

The values before indicated were applied to the populations considered for each property obtaining this way, the total number of individuals belonging to this class.

3.-**Harvest**: the number of individuals to be assigned for harvest of the total calculated as population class IV. The regulation that controls the program since the beginning, allows the extraction of up to 25% of the individuals that conform to the class IV. For the present study and as has been the practice from 1993 season (De Sola,1996) we the calculated crop as 20% of the individuals that

conform the class IV.

The following tables contain the calculations pointed out before by ecological region for the total of the sample:

Table N° 5. Estimated population, population class IV and Harvest assigned for each ecological region

A.- ALTO APURE REGION

TYPE	SURFACE	Estimated POPULATION	POPULATION CLASS IV	Harvest 20%
GH	583,019	128,264	30,783	6,157
HH	500,483	110,106	26,426	5,285
FO	435,306	217,653	52,237	10,447
FI	288,305	144,153	34,597	6,919
PF	36,136	36,136	8,673	1,735
TOTAL	1843,249	636,312	152,715	30,543

B.- BAJO APURE REGION

TYPE	SURFACE	Estimated POPULATION	POPULATION CLASS IV	Harvest 20%
GH	101,295	39,505	9,205	1,841
HH	71,941	28,057	6,537	1,307
FO	117,809	58,905	13,725	2,745
FI	59,212	29,606	6,898	1,380
PF	7,203	7,203	1,678	336
TOTAL	357,460	163,276	38,043	7,609

C.- AGUAS CLARAS REGION

TYPE	SURFACE	Estimated POPULATION	POPULATION CLASS IV	Harvest 20%
GH	476,811	47,681	9,536	1,907
HH	111,623	11,162	2,232	446
FO	219,982	109,991	21,998	4,400
FI	58,251	29,126	5,825	1,165
PF	1,335	1,335	267	53
TOTAL	868,002	199,295	39,859	7,972

D.- CAJON DE ARAUCA REGION

TYPE	SURFACE	Estimated POPULATION	POPULATION CLASS IV	Harvest 20%
GH	116,556	22,146	5,404	1,081
HH	34,975	6,645	1,621	324
FO	41,043	20,522	5,007	1,001
FI	23,005	11,503	2,807	561
PF	1,890	1,890	461	92
TOTAL	217,469	62,705	15,300	3,060

E.- ARISMENDI REGION

TYPE	SURFACE	Estimated POPULATION	POPULATION CLASS IV	Harvest 20%
GH	182,194	25,507	4,285	857
HH	54,065	7,569	1,272	254
FO	278,938	139,469	23,431	4,686
FI	156,059	78,030	13,109	2,622
PF	37,099	37,099	6,233	1,247
TOTAL	708,355	287,674	48,329	9,666

F.- LLANOS BOSCOSOS REGION

TYPE	SURFACE	Estimated POPULATION	POPULATION CLASS IV	Harvest 20%
GH	689,217	103,383	18,609	3,722
HH	288,066	43,210	7,778	1,556
FO	454,295	227,148	40,887	8.177
FI	127,443	63,722	11,470	2,294
PF	9,367	9,367	1,686	337
TOTAL	1,568,388	446,828	80,429	16,086

G.- GUARICO REGION

TYPE	SURFACE	Estimated POPULATION	POPULATION CLASS IV	Harvest 20%
GH	682,723	68,272	16,863	3,373
HH	65,725	6,573	1,623	325
FO	158,433	79,217	19,566	3,913
FI	73,860	36,930	9,122	1,824
PF	12,670	12,670	3,129	626
TOTAL	993,411	203,661	50,304	10,061

Of the previous calculations comes out that the total population of

spectacled caiman estimated for all the properties that make up the sample, reaches the figure of 1.999.751 individuals, of which, 424.979, belong to the fraction of individuals that conform to the class IV, which implies that the crop for a particular year in which all the properties used in the sample participate, would give a figure of 84.997 individuals as the estimated potential harvest.

The ecological regions were defined by Velasco and Ayarzagüena (1995). The region Guárico, was redefined in what concerns to the surface that occupies after having been reevalueted in the year 1995 (Colomine et.al 1995; Velasco et. al. 1997, a and b).

The following table, shows the surface for each ecological region according to that pointed out by these authors, which represents the area potentially profitable or, said in another way, the defined regional environment for the program, according to the resolution N° 23 dated 25/01/99, and published in the Official Gazette of the Republic of Venezuela N°36.653 dated 03/03/99 where the norms are pointed out for the rational management of the spectacled caiman in the states Apure, Barinas, Cojedes, Guárico and Portuguese and the surface corresponding to the sum of all the properties in the sample for each region.

Table N° 5. Surface reported for each ecological region and for each region in the sample

Ecological Region	Surface (ha) reported	Surface(ha) in the sample
Alto Apure	2.662.296	1.843.249
Bajo Apure	571.389	357.460
Aguas Claras	1.009.890	868.002
Cajón de Arauca	252.189	217.469
Llanos Boscosos	3.114.384	1.568.388
Guárico	2.620.800	993.411
Arismendi	615.342	708.355
Total	10.846.290	6.556.334

If the number of hectares reported for each ecological region are compared with thouse potentialy employed for a given season when all the propierties in the sample participated at once, we would have the following figure:

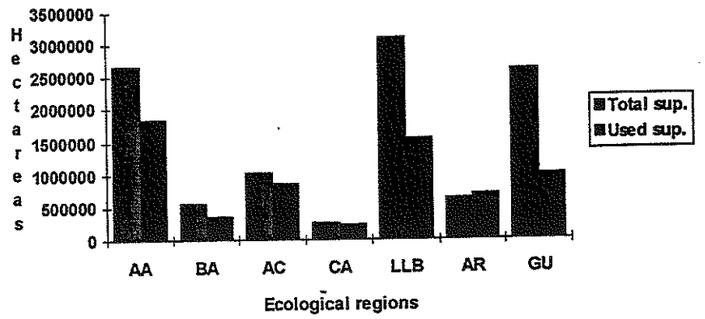


Figure N° 1. Total surface and surface used for each ecological regions.

As can be seen for all the cases with the exception of the region Arismendi, the used surface doesn't exceed the total of the available area for the program. The peculiar situation of the region Arismendi can be due to the fact that this represents the second region of smaller extension and in turn it is third in number of properties in the sample, the same ones, could be being considered more than once, due to the division of properties and assignment of new codes, what would imply a bigger number of properties with a concomitant increment in the surface that these occupy. This situation, still when it is not evidenced in the other regions, it is feasible that it happens. Later on, an analysis will be presented by season where this point will be disscus again.

The following figure presents the percentage area used respect the total for each ecological region.

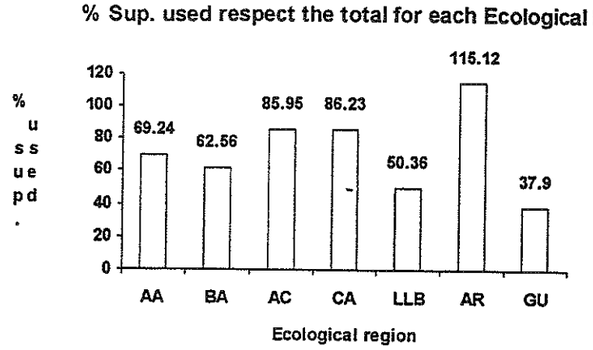


Figure N°2. Percentage of the surface used of the total for each Ecological Region.

As can be seen for all the regions if all the properties in the sample, except for the Región Arismendi, participate, a smaller fraction would be used than the total area available, considering exclusively as profitable that previously indicated and not the total of the area that represent the states where the program is executed. The presumed excess that is observed for the Región Arismendi (15.12%) it could also be explained as product of the border effect, properties that are located in contiguous ecological areas are assigned to that region in which the biggest part of the surface occurs.

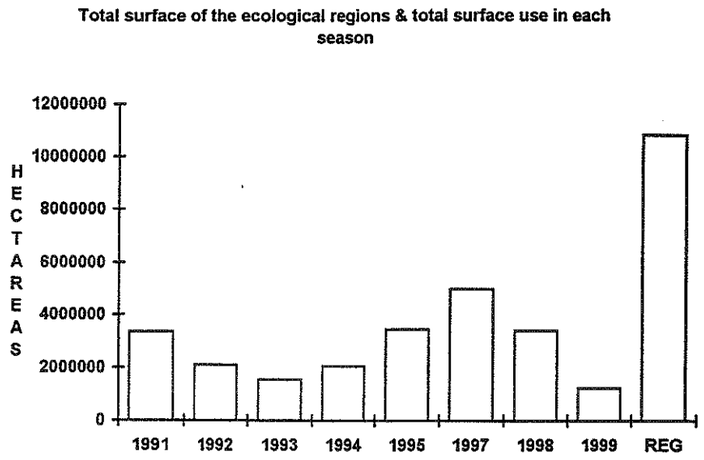
Next a summary table is presented, where it is indicated by season, the surface used for each ecological region, with aim of standing out the situation that is presented with the Arismendi region.

Table N° 6. Surface used in hectares for each ecological region and season from 1991 up to 1999.

	1991	1992	1993	1994	1995	1997	1998	1999
AA	1,124,279	638,434	523,613	681,251	1,222,412	1,448,065	1,118,853	236,136
BA	231,962	213,049	105,916	179,803	296,171	285,823	223,575	757,044
AC	609,426	442,105	190,730	256,519	654,739	694,802	325,879	150,308
CA	134,509	35,613	18,922	45,587	59,090	144,652	124,107	20,854
LLB	674,690	492,721	384,517	633,607	859,440	992,544	854,898	10,500
AR	208,280	278,784	326,700	254,362	353,751	597,648	413,445	40,522
GU	376,588	0	0	0	0	841,656	356,273	28,068
TOTAL	3,361,725	2,102,698	1,552,391	2,053,123	3,447,598	5,007,187	3,417,030	1,243,432

When comparing the hectares used for each season in the region Arismendi, we can observe that the same one is always smaller to the defined hectareaje for this region of 615,342 has, this same situation is observed for the

rest of the ecological regions.



Figures N° 3. Total surface of the ecological region & Total surface use in each season.

In the previous graph it is shown for each seasons the total of hectares corresponding to the total of participant properties in each one of them and the total of hectares that represent the ecological regions, as you can evidence, in any case it is surpassed of 50% of the total area for the ecological regions these implies that the program is able to support a bigger number of properties without this affecting the censed spectacled caiman populations. It shown as well, the progressive increment of the area employed starting from the 1992 season, season in which a fix number of animals were assigned (De Sola, 1996), what reduced the number of participant properties in the following season. This situation has been improving product of significant changes in the administration of the resource. The decrease in the number of hectares used in the seasons 1998 and 1999 follows a decrease in the number of licenses requested, which is a product of a depression in the international market of crocodiles skins.

Lastly, if the maximum crop is compared, being this the sum of all the crops calculated for each region and type of present property in the sample, with those really granted in the last five seasons (1994 -1999), for which the crop assignment is comparable, it is observed that for all the seasons the authorized crop in licenses elaborated never exceeded the value of maximun crop of 85.426 individuals. In addition in none of the seasons is the total of issued licenses, is equal to the authorized ones and not the whole issued crop is mobilized, that is to say effectively harvest, (Table N° 7).

Table N°7. Number of licenses authorized and issued, authorized crop, issued and mobilized for the seasons 1994 - 1999.

Season	Licenses		Authorized	Issued	Mobilized
	Authorized	Issued			
1994	295	292	26.010	25.924	25.621
1995	488	484	48.976	48.767	48.592
1997	640	610	64.220	61.069	59.882
1998	465	161	45.834	15.553	15.419
1999	100	79	11.790	8.788	8.112

The decrease in the number of licenses issued for the last two seasons (1998 and 1999) is a response to a decrease primarily in the requirements of the international market of skins of this reptile, in accordance with the information given by the industry in the field and traders as was pointed out previously.

Another aspect to be considered is the constant increment of the value of the liceses fee from Bs. 1,000 in 1995 to Bs. 7,400 for 1999, which results in an increase in the production cost against a stable or declining market, which makes particpation in the harvest less attractive to landowners.

CONCLUSIONS

1.- The program of commercial use of the spectacled caiman based on harvest assignments for ecological regions, has stayed far below the potential harvest for these regions. From this we infer that the caiman resource is not being overexploited in this area.

2.- The maximum crop calculated starting from the sample used in this work of 85.426 individuals was not exceeded in any of the executed seasons whose assignments are comparable.

3.- The situation that detected in the Arismendi Región by this analysis, indicates that it should be revised and tuned in the next seasons. This doesn't imply that the region should be retired from the program, since, as was pointed out in the analysis by seasons, in any moment the potentiality of the region is overcome.

4.- The assignment method used in the program of commercial use of the spectacled caiman, continues being the most suitable and equitable, taking into consideration both the populational values reported by region land the social character of each region.

5.- The constant increase of the value of the license fee affects the number of licenses issued, and is reflected in recent smaller harvest values.

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CONSERVATION STATUS OF THE AMERICAN CROCODILE IN NICARAGUA.

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In Nicaragua two only species of crocodiles have being reported: *Crocodilus acutus* and *Caiman crocodilus*. The international commerce of these has been under control since the subscription of Nicaragua to the CITES convention in the 70´s. The government has not been able yet to control the domestic market of products of the two species. The skins of both species are brought from every place of the country to the pacific coast, where the tanning and taxidermy houses are located; after tanned and manufacture, the products are taken to the national markets where they are sold freely to every one.

With all this in mind, the objective of this paper is to evaluate some aspects of the conservation status of the American crocodile in Nicaragua: distribution of the main populations, identify the principal threats and evaluate generally the domestic commerce of the products of the specie.

To achieve the proposed objective the reports of investigations where compiled to locate the specific locations where the sightings have occurred and the main threats mentioned by the authors. Also, some interviews where conducted with sellers, tanners, taxidermists, hunters and environment politicians. The product of this interviews where the identification of the principal products sold in the national market, the main products buyers, the selling places and a general estimation of the sales volume.

Four populations where reported in the Caribbean coast, three in the lakes and five in the pacific coast of the country. The main threats to the crocodiles are the illegal hunting, land use change, absence if a legal frame, need of financial and humane resources by the government, absence of sustainable development alternatives, and the hunting of inappropriate size classes. The principal products found in the markets are bags, purses, belts, brief cases, dissected animals, shoes and boots. The buyers are mainly from Europe, Asia and the United States. The existence of three large markets has being reported.

An annual illegal hunt of at least 100 animals has been estimated.

Successful Nesting and Status of the American Crocodile Crocodylus acutus at the Turkey Point Power Plant in South Florida

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ABSTRACT

We present data that suggests the American crocodile (Crocodylus acutus) population at FPL's Turkey Point Power Plant (Miami-Dade County, Florida, USA) may be increasing. Surveys for crocodiles were conducted from 1978 to 1999. Since 1978, an increased number of nests and hatchlings was observed. Since 1992, a size distribution shift in the interceptor ditch and a slight increase in the number of crocodiles per survey per year was observed. These observations suggest that the population is increasing, but additional data are needed to support this conclusion. Alternative conclusions for these data and directions for future studies are discussed.

INTRODUCTION

In this report, we discuss the American crocodile (Crocodylus acutus) population at the Florida Power and Light Company's Turkey Point Power Plant (hereafter TP) in South Florida (Miami-Dade County, Florida, USA). This C. acutus population inhabits the cooling canals and adjacent areas surrounding the power plant. The population is monitored regularly as part of the power plant's crocodile management program and has been monitored nearly continuously since 1978 when the first nest was discovered (reviewed in Gaby et al. 1985). Some aspects of the power plant's monitoring program consist of general surveys to document the occurrence of

crocodiles at TP, the location of nests, and the capture, marking, and measurement of hatchlings. This population of crocodiles has been reported on previously (Brandt et al. 1995, Gaby et al. 1985) and the purpose of this report is to present an update on changes observed in this population since Brandt et al.'s (1995) study. Here we discuss (1) changes in the numbers of nests and hatchlings at TP, and (2) shifts in the size distribution of crocodiles observed in a particular canal, the interceptor ditch (see METHODS).

METHODS

The Study Site

This study was conducted at the Florida Power and Light Company's Turkey Point Power Plant (TP) in Miami-Dade County, Florida, USA. This site has been previously described in detail by Brandt et al. (1995) and Gaby et al. (1985). In general, the study site is composed of a grid of cooling canals interspersed at regular intervals with earthen berms over a 2388ha area (Brandt et al. 1995). The cooling canal system represents approximately 270 linear kilometers of canals (Gaby et al. 1985). A number of canals are located adjacent to the cooling canal system. One of these, the interceptor ditch (hereafter ID), is approximately 9.0km long and forms a barrier that separates the saline cooling canal system from the adjacent freshwater marsh to the west. The entire system is bordered on the east by Biscayne Bay National Park and Card Sound, to the south by red mangrove-dominated tidal estuary, and to the north and west by freshwater marsh.

Nest Surveys

The crocodile monitoring program at TP attempts to document all nesting and hatching activity. In South Florida, nesting of C. acutus occurs between mid-April to mid-May and hatching occurs in late-June through August. Potential nest sites were located during daylight surveys prior to the nesting season. After nesting had occurred and prior to the start of hatching season, night surveys for crocodiles >2.25m (the size at which female C. acutus reach maturity) were conducted. Subsequent daylight surveys searched for nesting activity where potential breeders were located. Later, hatchling capture efforts focused on sites where potential breeders and nesting activity had been documented. The hatchling capture efforts were conducted from late June to mid-September. All captured individuals were measured for total length (TL), snout-vent length (SVL, measured to the posterior end of the vent), head length (HL) and mass. In addition, capture locality was recorded and all individuals were given unique identification marks. Currently, all newly captured individuals have microchips (AVID Identification Systems, Inc. Norco, CA) implanted for individual identification.

Interceptor Ditch (ID) Surveys

Day and night surveys were conducted throughout the year to document all crocodiles within and surrounding the cooling canal system. One of these surveys concentrated on the interceptor ditch (ID), an approximately 9.0km long ditch that separates the cooling canal system from the adjacent marsh. Since 1992, ID surveys have been conducted in the late morning to early afternoon by driving slowly along-side the ID and recording all individuals seen. Location and estimated size (total length) was recorded for each crocodile observed. Total length was estimated to the nearest 0.25m when possible. Occasionally, wary animals or poor viewing angles resulted in categorical estimates of unknown, small, medium, or large size categories; these data were omitted from this analysis and comprise less than 3% of the total number of observations. All ID surveys were conducted by an experienced observer, primarily by one of the authors (JAW).

RESULTS AND DISCUSSION

The number of nests and hatchlings collected from within the cooling canal system of TP increased from 1978 to 1995, and appears to have stabilized from 1995 to the present. Figure 1 shows a fairly steady increase in the number of nests from one in 1978 to 16 in 1995. Similarly, the number of hatchlings increased from 19 in 1978 to 307 in 1995, excepting some years (1980-1982) where survey effort was minimal. The number of nests and hatchlings varied from 1995 to the present, but did not noticeably increase. We believe that the low 1998 nesting season numbers may have been affected by unseasonable dryness, but the causes for the low numbers remain unknown.

The results of the ID surveys suggest that the total number of animals observed per survey may be increasing (Figure 2), and that there has been a shift in the distribution of size classes over the study period (Figure 3). To examine whether there has been an increase in the number of crocodiles observed per ID survey since 1992, we fit a linear regression to the number of individuals observed by survey date ($Y = 4.16 + 0.00113*X$, $R^2 = 0.098$, $df=282$, $p<0.001$) as shown in Figure 2. However, the shallow slope and large sample size (n=284), combined with a small R^2, makes it difficult for us to conclude that there has been an increase in the number of crocodiles observed in the ID since 1992.

The ID survey data also shows the distributions of size classes has shifted during the study (Figure 3). The years 1992 and 1999 are highlighted by bold lines in Figure 3 for better visualization of the trend. The shift consists of a greater proportion of individuals observed in the larger size classes over time (e.g., in 1992 2% of the individuals belonged to the 3.0m size class whereas in 1999 20% of the individuals belonged

to the 3.0m size class). Gaby et al. (1985) and Brandt et al. (1995) noted that the ID was primarily used by non-juvenile crocodiles (>1.5m). Examination of the 1992-1999 ID survey data shows support for the observation of non-juvenile use of the ID, and we are now seeing a greater percentage of large animals in the ID. In other words, there are more large crocodiles in the ID currently than were present in 1992.

The population dynamics and movement of crocodiles between the Turkey Point Power Plant site and other nearby crocodile habitats (e.g., Biscayne Bay and Key Largo) is unclear. Turkey Point may function as either a source or a sink habitat for crocodiles relative to the Biscayne Bay, Key Largo, and Everglades National Park populations. An increased number of C. acutus have been noted in Biscayne Bay, and an increase in the number of "nuisance" crocodiles removed has increased. Some of these individuals have originated from TP and from other populations. For example, a 81.5cm (TL) individual captured in January 2000 on a golf course approximately 30km north of TP was originally captured in May of 1999 at TP with a TL of 55cm. Brandt et al. (1995) also noted the movement of crocodiles between the TP, Everglades National Park, and Key Largo sites. What remains unstudied is how the crocodiles are moving. Perhaps crocodiles are moving from these other areas into the TP site for suitable nesting areas as suggested by Brandt et al. (1995) and thus the TP site serves as a source of hatchling crocodiles that move out to other areas. Future studies may radio-track marked individuals long-term to address these and other questions regarding the movement and population dynamics of South Florida C. acutus.

The interpretation of these data in combination are difficult and may suggest either that the C. acutus population at TP is increasing or that it is stabilizing. In their study of crocodiles at TP, Brandt et al. (1995) discussed the possibility that the population was stabilizing towards the end of their study (their study terminated in 1993). Presumably, this is based, in part, upon their nesting data, but nest data collected since 1993 shows an increase in nest numbers from 11 to 16 by 1995 and then appears to level off (Figure 1). However, we believe that the nesting situation is complicated. Complications include continued modifications to the cooling canal system, such as the digging of ponds in the center of berms, the removal of exotic vegetation, and succession and colonization by native vegetation. Currently, it is unclear how the dynamic nature of this system effects the nesting of crocodiles. But we believe that nest sites may not be a limiting factor at TP since new nest sites continue to be found. In addition, we have observed communal nesting several times and this suggests that nesting sites are not limiting. The ID survey data shows a slight increase in the number of individuals observed in the ID per survey, but this evidence is weak. Alternatively even if the ID was at carrying capacity, this does not mean that the rest of the system has also reached carrying capacity. The size distribution

shift observed suggests that perhaps some individuals have remained in the ID and have merely grown to a larger size. In conclusion, we feel that the combined evidence from all studies of TP crocodiles to date suggest that the population is doing well and will most likely increase and play an important role in the population dynamics of Florida's C. acutus.

ACKNOWLEDGMENTS

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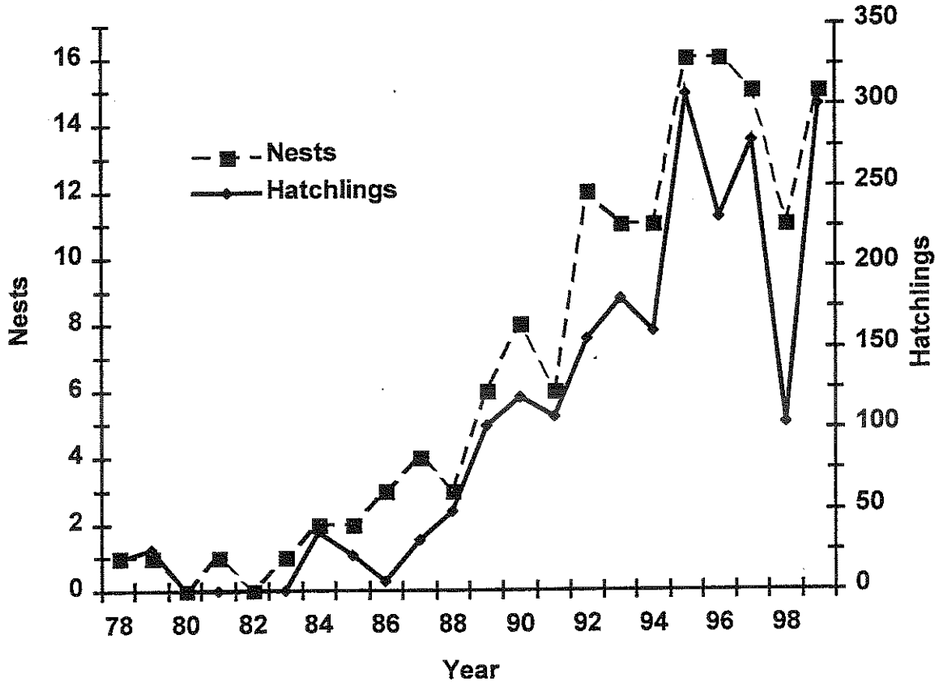

Figure 1: Number of C. acutus nests and hatchlings at Turkey Point 1978-1999.

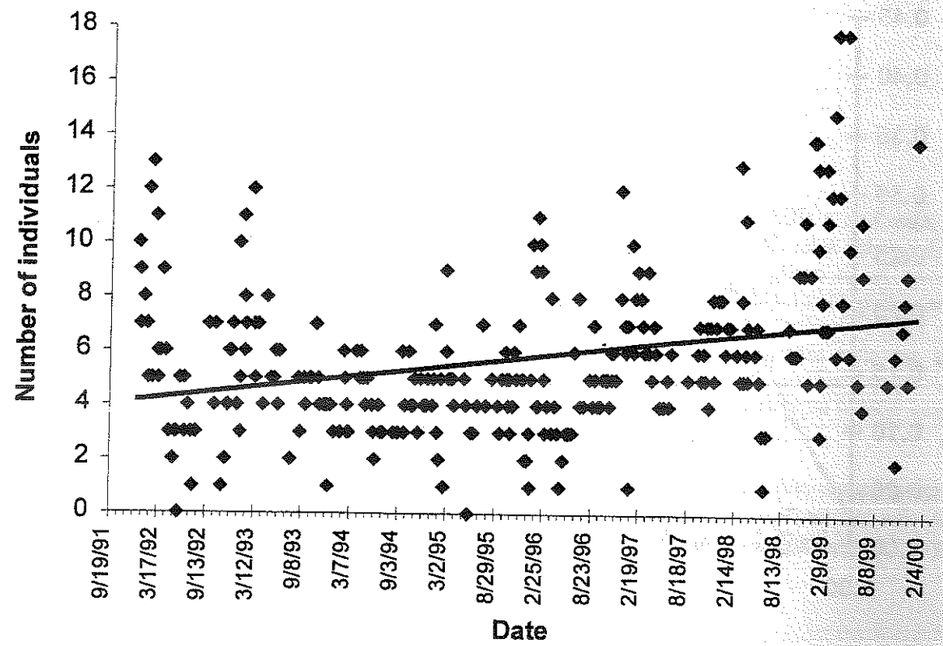

Figure 2: Number of C. acutus observed per survey of the interceptor ditch at Turkey Point. Regression line $Y = 4.16 + 0.00113*X$, $R^2 = 0.098$, df=282, $p<0.001$.

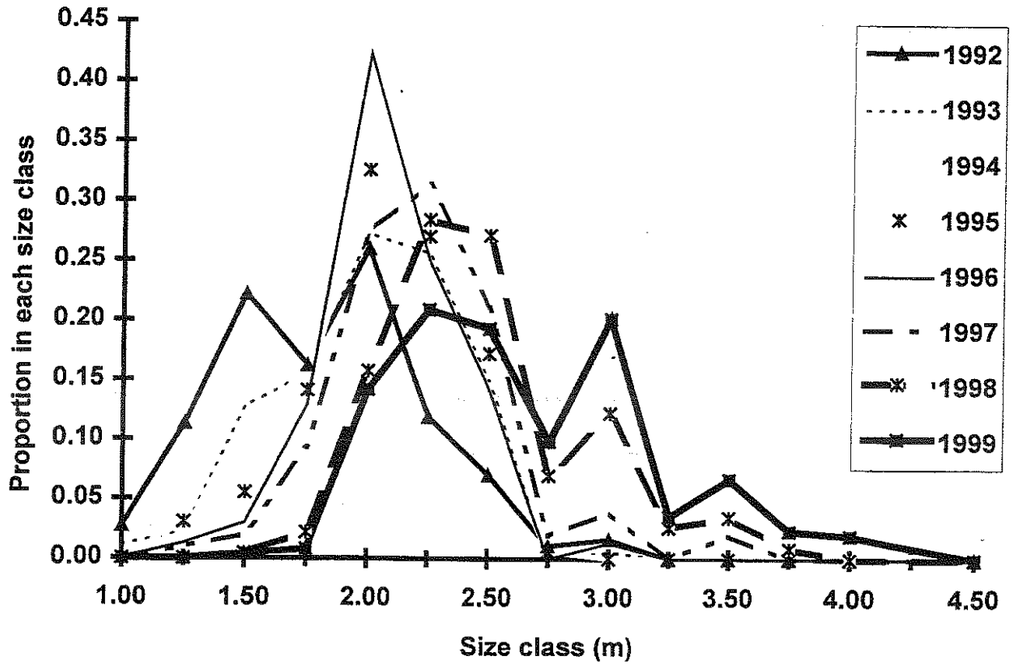

Figure 3: Size distribution of C. acutus in the interceptor ditch by year. Lines are for visualization purposes only linking the proportions of crocodiles found in each size class by year.

EXPERIENCIAS DE CRIANZA DE *Crocodylus acutus* EN EL CENTRO DE ACUICULTURA LA TUNA CARRANZA, PERU: Avances en la conservación de la especie

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1 RESUMEN

En Setiembre de 1996 el Fondo Nacional de Desarrollo Pesquero (FONDEPES) y su Centro de Acuicultura La Tuna Carranza (Tumbes) inició en el desarrollo del Proyecto "Crianza del cocodrilo de Tumbes *Crocodylus acutus*". El objetivo fue instalar un zoocriadero piloto en el que se establezcan las técnicas de manejo cerrado con fines inmediatos de repoblamiento evitando el exterminio de esta especie en nuestro país como consecuencia de cazas indiscriminadas. Se construyó un módulo experimental de 220 m^2 y se acondicionaron tres ambientes cada uno con estanques de concreto de entradas y salidas de agua independientes a fin de confinar cocodrilos silvestres de diferentes tamaños y sexo, recolectados en el Estero Corrales, principal hábitat actual de la especie.

Se han logrado confinar hasta Enero del 2000 veintiocho ejemplares silvestres con una proporción sexual machos:hembras de 1:2, con los cuales se han realizado una serie de observaciones referidas a su adaptación al cautiverio, conducta, alimentación, crecimiento y comportamiento sexual, cuyos resultados son presentados en el presente informe.

2 INTRODUCCION

Desde hace varias décadas se conoce la delicada situación en que se encuentra la población natural de *Crocodylus acutus* en el Perú, especialmente por estar localizada casi únicamente en la cuenca del río Tumbes donde se desarrolla además de actividades agrícolas, cultivos comerciales de camarón de mar, contribuyendo ambas al deterioro progresivo del hábitat de esta especie de reptil. Hace algunos años se reportaba la existencia de ejemplares silvestres en las cuencas de los ríos Zarumilla y Chira; en la actualidad es muy probable la presencia en el río Zarumilla pero no sucede lo mismo para el río Chira, donde su desaparición está prácticamente comprobada (INRENA, 1998).

La relativa información bibliográfica que se tiene acerca del cocodrilo de Tumbes, está orientada principalmente a aspectos de su conservación, habiéndose realizado algunos censos como el de Trelancia en 1984, y el último llevado a cabo en Diciembre de 1996 por el INRENA, en el cual se corrobora la disminución alarmante de la población. En el Estero Corrales, de acuerdo a las versiones de pescadores y agricultores locales era muy común a fines de los setenta observar un buen número de cocodrilos asoleándose entre las ramas de los manglares así como observar varias hembras cuidando sus nidos.

La instalación de empresas camaroneras en esta área desplazó totalmente esta zona de anidación. En la actualidad es muy raro encontrar nidadas en toda la zona del manglar y sería una de las causas de la disminución acelerada de la población. Una causa secundaria, aunque no por eso

menos importante para la disminución de la población de cocodrilos, es la utilización de ejemplares adultos con fines alimenticios. Asimismo, en el medio ambiente donde usualmente se ubican en forma natural se realizan cazas indiscriminadas. Estos ejemplares son mayormente atrapados de manera accidental con las redes cortineras que se extienden en los esteros y el río para la pesca de consumo, pereciendo ahogados al enredarse tratando de alimentarse con los peces enmallados.

No se han registrados estadísticas de comercialización de pieles de *C. acutus* para el Perú (Vásquez, 1983), lo cual corrobora la tesis de los miembros del Crocodyle Specialist Group, SSC/IUCN (Informe de Visita a Tumbes, 1997) de que probablemente las poblaciones de esta especie nunca fueron abundantes en la región, por estar en el límite sur de su área de distribución.

Desde 1950 existe una amplia gama de Normas Legales vigentes (INRENA, 1998) que protegen al cocodrilo de Tumbes, destacándose la Resolución Ministerial N° 01082 del 10 de Setiembre de 1990, en la que se clasifica al *Crocodylus acutus* como especie en vías de extinción.

El FONDEPES, asumió la responsabilidad de sacar adelante el proyecto de Crianza del Cocodrilo de Tumbes en ambientes controlados, teniendo como objetivos principales: i) Desarrollar un modelo para su utilización racional evitando su exterminio, ii) Obtener información básica sobre la biología y ecología de la especie que permita elaborar una estrategia adecuada para su conservación y manejo y, iii) Instalar un zoocriadero piloto para desarrollar técnicas de crianza y manejo cerrado con fines inmediatos de repoblamiento, y fines comerciales a largo plazo. El 15 de Agosto de 1997 FONDEPES obtiene la autorización del Instituto Nacional de Recursos Naturales (INRENA) la misma que luego es refrendada por el Ministerio de Agricultura.

El desarrollo del Proyecto se está llevando a cabo en el Centro de Acuicultura La Tuna Carranza, localizada en el distrito Puerto Pizarro (Tumbes). Para su ejecución se fijaron dos metas a ser cumplidas: i) captura de ejemplares de distintos tamaños para ser confinados en cautiverio y comprobar su adaptación al mismo bajo las condiciones ambientales propias del Centro y, ii) construcción de un zoocriadero en el cual se desarrollarán las experiencias del ciclo cerrado.

El presente informe corresponde a los logros obtenidos en cumplimiento de la primera meta, desarrollada desde Agosto de 1996 hasta Noviembre de 1999, trabajando en un Módulo provisional de crianza con 28 cocodrilos de diferentes tamaños, y se presenta información general acerca de la adaptación al cautiverio, alimentación, costumbres y crecimiento mensual.

3 MATERIALES Y METODOS

3.1 Módulo Experimental

Para el confinamiento inicial de los cocodrilos se construyó un Módulo Experimental de 220 m^2 de tres ambientes construidos en concreto tipo mampostería y con salidas y entradas de agua independientes. El primero (3x3m) fue destinado para albergar ejemplares chicos (>1 m de longitud). El segundo ambiente (3x3m) se destinó para los ejemplares medianos (2m>x>1m) de longitud. El tercer ambiente contó con dos estanques (7x3m) destinado para ejemplares grandes (>2m) de longitud. El llenado se realizaba empleando un canal abastecido por una Motobomba de 3" instalada a orillas del Estero Puerto Rico.

3.2 Recolección de ejemplares

Para la recolección de ejemplares en la zona de influencia del Estero Corrales se utilizó un bote tipo canoa para dos personas. Las salidas fueron nocturnas en periodos de luna nueva utilizando linternas halógenas para enceguecer a los animales encontrados, Luego de lo cual eran capturados. Otra forma de recolección fue la de recuperar los ejemplares de aquellos pescadores que los habían capturado accidentalmente con sus redes.

3.3 Muestreos biométricos y marcado de ejemplares

Los muestreos de crecimiento se realizaron en forma mensual para los ejemplares pequeños y medianos. Al principio la biometría fue cada tres meses para los más grandes a fin de evitar maltrato por el manipuleo ya que ofrecían resistencia. La longitud se tomó con una regla graduada y el peso se tomó utilizando una balanza reloj (40kg cc) y una tipo romana (<100kg cc).

Los animales son marcados por orden de ingreso. La marcación se realizó sobre la cola en las hileras de las escamas elevadas, ya sean en las dobles o simples.

También se está probando la aplicación del método del mapeado de las manchas que presentan los individuos en todo el cuerpo, específicamente las de la parte de la cola y de un solo lado, las cuales aparentemente son invariables durante toda la etapa de su vida actuando como huellas digitales. Este sistema se está recién proponiendo y se continuará con su evaluación para determinar su validez.

3.4 Sexado de ejemplares

Para el sexado de los animales, fue necesario el asesoramiento del Grupo de Especialistas de Cocodrilos Dr. Alejandro Larriera, Dr Perran Ross y del Ing. Pedro Vásquez, de INRENA (1996). El método utilizado fue el "tracto cloacal" con la ayuda de pinzas dilatadoras.

3.5 Alimentación

Se probaron distintas especies de aves y peces para la alimentación de los cocodrilos. Entre los peces se ensayó con *Dormitator sp.* "monengue" y *Mugil cephalus* "liza" así como variedades locales de bagres. Asimismo, se experimentó con pollo, garza blanca y patos cuervos. La raciones alimenticias se suministraron cada 72 horas y en distintos porcentajes (2,5% - 3,5%) de acuerdo a la biomasa total de cada ambiente. La carne se proporcionó mayormente trozada de acuerdo al tamaño de los ejemplares y solamente en estado fresco.

3.6 Registro de parámetros

Para los registros diarios de temperatura y salinidad en el estero y estanques del módulo se empleó un termómetro graduado a 1°C, y un salinómetro óptico ATAGO. Los registros se tomaron a las 06:00, 13:00 y 18:00 horas.

RESULTADOS

3.7 Módulo Experimental

Como una medida preventiva contra probables inundaciones, se construyó el modulo experimental en la parte más alta del terreno, dándole la seguridad y condiciones necesarias para albergar a los ejemplares. La construcción soportó los embates de las fuertes lluvias originadas por el Fenómeno de El Niño de 1998, y se encuentra en buen estado de conservación hasta la fecha.

3.8 Recolección de Ejemplares

Entre Setiembre de 1996 y Noviembre de 1999 se han logrado recolectar 28 ejemplares de cocodrilos de distintos tamaños y edades. En la Tabla 1 se les agrupa por orden de antigüedad y sexo, consignándose las tallas y pesos iniciales y actuales, así como el incremento mensual promedio de ambos.

El cocodrilo N° 1, fue el único que ingresó en estado de neonato y fue adquirido de un agricultor de la zona San Juan de la Virgen, situado unos 20 Km de la ciudad de Tumbes río arriba. Todos los demás ejemplares fueron capturados en el área de influencia del Estero Corrales y sus tributarios, como son los Esteros La Canela, La Chepa, Barranco Blanco y varios ramales de los mismos. La característica principal del estero Corrales es que nace en la confluencia del río Tumbes con el mar, por lo que sus aguas son mixohalinas (10 - 20‰).

El método de captura manual cegando al lagarto con linternas y capturándolo a mano es el más práctico en el presente caso. El maltrato al animal es mínimo, lo cual no ocurre en la captura con mallas, donde muchas veces el cocodrilo muere por asfixia si es que no se le rescata a tiempo.

3.9 Marcación de ejemplares

Los animales fueron marcados por orden de ingreso. La marcación se realiza sobre la cola en las hileras de las escamas elevadas, ya sean en las dobles o en las simples, según sea el caso. Se emplearon agujas punzantes de 2mm de diámetro. El sistema de marcado se considera eficaz hasta la fecha, ya que es posible la identificación individual de cada cocodrilo.

3.10 Proporción sexual

La proporción sexual de machos a hembras es de 1:2, siendo los ejemplares de mayor tamaño machos. Hay solamente una hembra cercana a los dos metros, que podría considerarse adulta. Todos los demás ejemplares son juveniles y preadultos.

3.11 Domesticación

No se han observado contratiempos de la adaptación del cocodrilo al entrar en contacto con el agua netamente marina teniendo en cuenta que la salinidad en el área de captura está por las 20 ‰. En zonas marinas del Caribe se encuentran ejemplares adultos sin ningún problema de adaptación y los neonatos necesitan por lo menos en su primer año de vida, solamente agua dulce (Ross P. y Arteaga 1997). Se hace referencia a la tolerancia que tiene *C. acutus* a las salinidades marinas, comparándola inclusive con esa misma característica de *C. porosus*.

TABLA 1. Relación de ejemplares confinados en módulo experimental hasta Noviembre de 1999

N°	Meses de Crianza	Longitud Cm			Peso Kg			Sexo
		Inicial	Actual	Increm/mes	Inicial	Actual	Increm/mes	
1	37	29,0	91,0	1,68	0,075	2,900	0,076	M
2	38	57,5	97,8	1,06	0,550	3,600	0,080	H
3	38	63,5	98,3	0,92	0,650	3,200	0,067	H
4	38	64,0	99,3	0,93	0,750	3,600	0,075	H
5	38	65,5	104,7	1,03	0,850	3,700	0,075	H
6	38	66,0	99,0	0,87	0,700	3,700	0,079	H
7	38	68,5	117,5	1,29	1,050	5,700	0,122	H
8	38	80,0	116,5	0,96	1,700	6,900	0,137	H
9	38	88,0	132,0	1,16	1,850	10,000	0,214	H
10	38	100,0	134,0	0,89	2,800	9,000	0,163	H
11	38	101,0	133,8	0,86	3,200	9,500	0,166	H
12	38	118,0	182,0	1,68	4,900	25,500	0.542	H
13	38	120,0	148,4	0,75	5,000	14,500	0,250	M
14	38	125,0	164,5	1,04	5,600	18,000	0,326	H
15	38	129,0	173,7	1,18	6,750	23,000	0,428	H
16	38	162,0	196,0	0,89	15,000	30,000	0,395	H
17	38	219,0	249,0	0,79	45,000	59,000	0,368	M
18	38	221,0	265,0	1,16	38,000	74,500	0,961	M
19	31	100,0	133,0	1,06	2,700	11,200	0,274	H
20	26	113,0	147,0	1,31	4,900	15,000	0,388	H
21	26	167,0	187,0	0,77	15,000	30,000	0,577	H
22	19	127,5	145,0	0,92	8,000	14,200	0,326	M
23	19	126,0	134,8	0,46	6,900	11,000	0,216	H
24	18	78,0	82,8	0,27	1,500	2,400	0,050	M
25	13	101,0	116,0	1,15	3,200	6,600	0,262	M
26	10	100,0	106,6	0,66	2,600	4,300	0,170	M
27	9	83,0	89,1	0,68	1,000	2,800	0,200	M
28	3	240,0	242,0	0,67	54,000	55,000	0,333	H

3.12 Análisis del crecimiento

El crecimiento en promedio de toda la población es de 1cm por mes. Se observa que los incremenos de crecimiento presentan relación directa con las estaciones del año; en el verano el crecimiento es más acelerado que en los meses de invierno. Los individuos menores al metro de longitud incrementaron su peso en menos de 100 g mensuales. Los ejemplares más grandes presentaron variaciones entre 200 y 1000 g por mes. Sin embargo, el cocodrilo capturado en una talla de 219 cm y 45 Kg de peso para los 33 meses de confinamiento solamente ha incrementado en promedio mensual 0,85 cm y 0,37 g de peso. Existió contraste con otro individuo grande capturado con 221 cm y 38 kg. Hoy este ejemplar mide 263 cm y pesa 72,3 kg. Su incremento mensual promedio fue de 1,27 cm en talla y 1,04 kg en peso.

En cuanto a la estructura de tamaños, hasta la fecha se lleva un control por clases, tomando como base la talla de los individuos sugerida por SEMARNAP, 1998 es comos sigue:

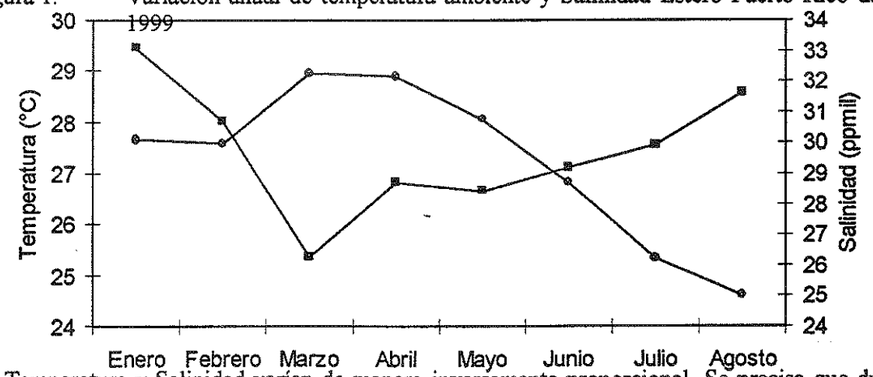
Clase I =	Neonato	< 60 cm
Clase II=	Juveniles 1	60<x<120 cm
Clase III	= Juveniles 2	120<x<180 cm
Clase IV	= Sub-Adultos	180<x<240 cm
Clase V=	Adultos	> 240 cm

Para el año 1997 la Clase I está presente durante todos los meses del año de crianza. En 1998 los individuos de la Clase I solo están representados hasta el mes de marzo, pasando a formar parte de la Clase II. Este aspecto se corrobora con los incrementos de longitud por clases, Tabla 2, donde en los meses de calor (diciembre'97 – mayo'98), se tienen los picos más altos de incremento promedio en longitud para la población.

Tabla 2. Incremento mensual de longitud de cocodrilos en estanques

	1997	1998	1999
Meses	Incremento %	Incremento %	Incremento %
Enero		2.16	0.36
Febrero	2.99	1.97	0.24
Marzo	0.89	6.60	0.73
Abril	2.39	2.51	2.04
Mayo	1.42	1.07	2.50
Junio	1.16	0.12	0.57
Julio	1.22	0.12	0.45
Agosto	0.67	0.15	0.04
Setiembre	0.64	0.09	0.05
Octubre	0.51	0.10	0.56
Noviembre	0.39	0.04	0.61
Diciembre	2.59	0.10	

Figura 1. Variación anual de temperatura ambiente y Salinidad Estero Puerto Rico durante 1999



La Temperatura y Salinidad varían de manera inversamente proporcional. Se precisa que durante

los meses de verano (Diciembre-Marzo) la precipitación pluvial es considerable.

3.13 Observaciones sobre la conducta de cocodrilos en sistemas de crianza

Los primeros días en confinamiento los cocodrilos se muestran bastante huraños. Permancen mayormente sumergidos dentro de los estanques, inclusive sin alimentarse, por las noches salen del agua y se desplazan por todo el contorno del cerco buscando espacios para tratar de escapar. Inclusive, algunos ejemplares trataron de evitar el cerco por alto, por lo que fue necesario tomar una serie de medidas de prevención de fugas.

Conforme pasó el tiempo los ejemplares se van adaptando y salen diariamente a asolearse en el borde los estanques o a tomar baños de agua dulce en los pequeños bebederos adicionales. Este comportamiento se observó mayormente al medio día donde la temperatura es mayor y les permite regular el normal funcionamiento fisiológico de su organismo. Pasado el tiempo, no les causa molestia la presencia del personal encargado del cuidado y alimentación, aceptando muchas veces el alimento directamente en el hocico. No ocurre lo mismo con personas extrañas, y muchas veces solamente con su acercamiento a las instalaciones se lanzan al agua sin volver a emerger hasta su alejamiento.

Otra conducta peculiar es su gregarismo, siempre tratan de mezclarse los individuos más pequeños con los grandes, para lo cual trepan los corrales u horadan las divisiones entre estanques. Esto no pareció incomodar a los ejemplares más grandes, y por el contrario les permitían a los pequeños cobijarse por debajo de su cuerpo en una actitud aparentemente paternalista.
El inconveniente de esta situación se presenta en el momento de la alimentación debido a que es muy improbable que los pequeños tengan una buena opción de conseguir la cantidad de alimento necesario, por lo cual se les separaba. También se ha observado que los ejemplares juveniles se juntan unos sobre otros durante periodos de tiempo regulares (1-2 horas), posiblemente para la transferencia de calor corporal, ya que se ha observado este comportamiento durante días nublados y de temperaturas más bajas.

3.14 Alimentación

Se experimentó con carne de pescado y se determinó su nula aceptación en poco tiempo. Se experimentó luego con carne fresca de pollo y la aceptación fue general.

Este tipo de alimento se ha mantenido mientras se consiga un supletorio de formulación balanceada que pueda ser aceptado y que pueda ser elaborado en el mismo zoocriadero.

Para determinar la frecuencia y dosis de alimentación, se probaron con raciones diarias, interdiarias, etc hasta establecer una frecuencia de alimentación cada 72 horas.

Después de las pruebas correspondientes, se ha fijado cada suministro entre el 2.5 % y 3.5% de la biomasa total a alimentar/ración. Los indicadores se ajustaron de acuerdo al consumo anterior para los meses de verano, donde los individuos se encuentran más activos y el consumo de alimento es total.

En los meses de invierno se determinó que el consumo de alimento es mínimo, lo cual origina que