

"Updating population status of Caiman Llanero (*Crocodylus intermedius*) in the Departamento de Arauca (Colombia)"

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INTRODUCTION

The evaluation of *Crocodylus intermedius* populations in Colombia was initiated by Medem, who sampled the basins of Arauca, Casanare, Meta and Vichada Rivers in the Colombian llanos between 1974 and 1976, founding evidence of the existence of 280 mature individuals (and 800 estimated). From those observed, 180 were in the department of Arauca (Medem, 1981).

Recently, between 1990 and 1993 biologist Joaquín Clavijo carried out a population evaluation in the center-eastern sector of the Department of Arauca, estimating 70 individuals (Documentos URPA, Secretaria de Agricultura de Arauca).

Other studies on the population status of the species in the Colombian Llanos, have been carried out by the Station of Tropical Biology Roberto Franco of the National University of Colombia (EBTRF), Villavicencio, and the Ministry of the Environment. Between 1993 and 1995, the EBTRF, in agreement with COLCIENCIAS and the Wildlife Conservation Society, developed the project "Program for the Conservation of the Caimán Llanero (*Crocodylus intermedius*)" which gave as results the existence of 32 mature individuals and 4 juveniles in the wild and 127 adults estimated by surveys. Four (4) areas were identified as population relicts: Arauca (1) the fluvial system formed by the rivers Lipa, Ele and Cravo Norte; Meta (2) the rivers Duda, Lozada and upper Guayabero; (3) the middle part of the river Meta between La Primavera and La Culebra; Vichada: (4) the middle-low part of the Vichada River (Ardila *et al.*, 1998).

In 1994, the Ministry of Environment began the project "Distribution, Systematic and Conservation of the Colombian Crocodylia". Between 1994 and 1995, the information of censuses of Arauca was updated, surveying in the basin of the river Casanare, that includes the rivers Lipa, Ele, Cravo Norte and Casanare, a total of 29 mature individuals (some contemplated in the report of the EBTRF) and estimating another 51 (Barahona & Bonilla, 1996,1999). In the census carried out in 1995 and 1996 in the Lipa River, only two mature individuals were observed, and seven nests in the rivers Ele and Cravo Norte, Barahona and Bonilla (1996, 1999).

Taking into account all these studies, the Government declared the Caiman as a species under extinction danger in the whole national territory, through Resolution 0676, July 21, 1997. On this basis, the Institute

of Investigations Alexander von Humboldt and the National University of Colombia, with the support of the Ministry of the Environment, presented the proposal of the "National Program for the Conservation of the Caiman Llanero"; with the objective of prevent the extinction of the species in Colombia and promote its recovery in the distribution range (Ramírez *et al.*, 1998).

Barahona and Bonilla (1995) studied the population relict of the Departamento de Arauca, emphasizing the need of further studies on this group to establish its trend (if its number is decreasing, steady, or increasing), and to evaluate the survival possibilities of the species in this area and in the country.

In order to attend this problem, a project was proposed during 2000 with the general objective of updating the population status of the species and, on this basis, to define the management strategies and conservation *in situ* in the Departamento de Arauca. As specific objectives, the project includes the location of population relicts and isolated individuals (males and females) of the species in the study area; to determine the current population status, in terms of distribution, abundance, density and size structure; to locate the beaches appropriated for nesting and places of animal concentration during the summer; to observe and recording reproductive habits; to describe and evaluate the current state of the habitat; to identify and categorize the factors that put under danger the biological continuity of the individuals in the area and to carry out activities of environmental education.

Once carried out the field phase and studied the same population relict, the population was evaluated after six years and its results are presented in the present work.

AREA OF STUDY

The study area is located in the center-oriental part of the department of Arauca (Fig. 1) and covers ca. 325 Km². In this area were studied the rivers Lipa, Ele and Cravo Norte. The Lipa River from Fundo Alcalá (06° 36 ' 51.9"N - 07° 43 ' 33.0 "W) until the mouth on the Ele River (06° 35 ' 23.4"N - 07° 43 ' 42.5"W); the Ele River from Fundo Managua (06° 34 ' 38.0"N - 07° 47 ' 25.0"W) until the mouth on the Cravo Norte River (06° 29 ' 13.3"N - 07° 39 ' 32.4"W); the Cravo Norte River before the mouth on the Cuiloto River (06° 31 ' 40.5"N - 07° 52 ' 38.9"W) until Fundo Palo Herrado (06° 28 ' 09.4"N - 07° 36 ' 42.2"W). The journey in rivers was of 100.2 kilometers.

METHODS

Fieldwork methods includes:

Direct counts, favored because in dry season the animals are not able to swim large distances, and remain in the same places like wells (deep parts of the river)

Indirect counts with recording of:

- Foot prints leaved by the animals during sunbath and females moving to the beaches searching appropriate places for nesting or during opening the nest in the hatch time.
- Nests.
- Hatchlings.
- Surveys to corroborate data and estimate population size.
- Contact local residents for educational lectures.

- Observations and gathering of data on reproductive issues: nests, hatchling birth, nesting places, etc.
- Measurement of environmental variables: conductivity, dissolved solids, pH, air and water temperatures.

RESULTS AND ANALYSES

The field study was carried out in two times:

- During November and December 2000, when the rain season concluded and begins the dry season.
- During March and April 2001, dry season and reproductive period of the species.

Population Evaluation

Total number of animals

Table 1 show that in the population relict there were 24 specimens, from which 11 were female (deduced from observation and/or nest reports) (Fig. 2).

Population Structure

The Fig. 3 histogram revealed an unbalanced population relict, with 20 adults (83.3%), 2 juveniles and 2 subadults (8.3% each one). This structure can be caused by a low incorporation of hatchlings, with high mortality rate in the first two years of life (up to 95%, Thorbjarnarson, 1987), and also egg predation by man. The night counts were affected by social problems in the area. The juveniles were difficult to count, generally hidden during the day as reported for *Crocodylus acutus* by Thorbjarnarson (1989).

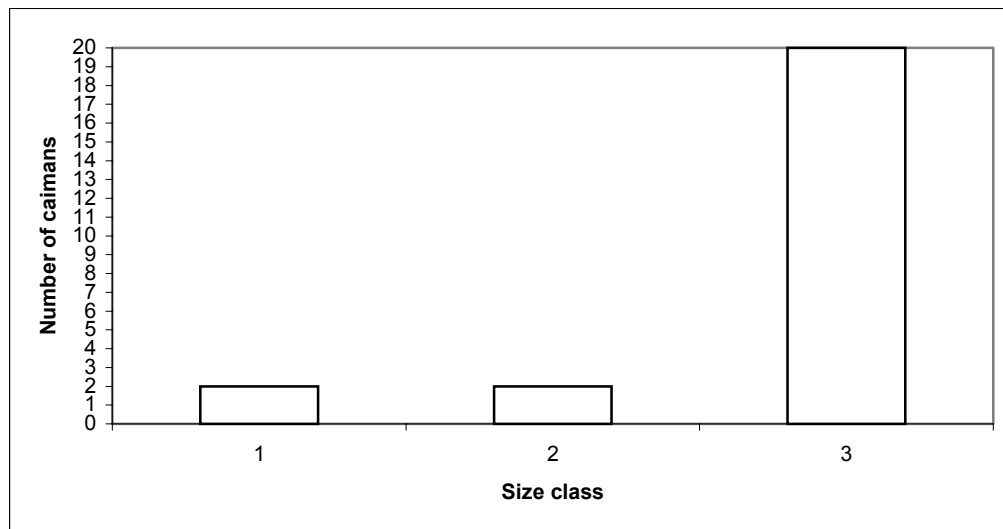


Fig. 3. Size structure.

Density

A total density of 0.24 individuals was calculated for kilometer of river. The data show that the animals are distributed in a similar way in most of the sectors, with exception of the third segment of the Ele River where there is a high concentration (1.2 individuals/ km); in this place, possibly best environmental conditions exist so that the population is growing (Fig. 2).

Estimated Number

A total of 20 residents reported 54 caimans in 30 places of the area. The results of the surveys were compared with those of the censuses (Table 2). From the 30 places, the data were confirmed in 13 (43,3%); the estimated number generally is equally or smaller than the reported in censuses (Fig. 2).

Places outside of the study area where caimans were reported

There are a total of 24 caimans reported outside of the studied area (Fig. 1)

Comparison of the censuses of 1995 and 2000-2001

River	1995							2000-2001						
	Size class			No. Caimans	Females	Density	Estimated Number	Size Class			No. Caimans	Females	Density	Estimated Number
	J	Sa	A					J	Sa	A				
Lipa				0							1			
Ele				13	5						13	5		
II1a-II1c						0							0,1	
I3-II4						0,95							0,82	
II4-II7						0,5							0,6	
II7-3 Km.						0,33							0	
(II7-3 Km.) -III9						0							0,09	
Cravo Norte				15	5						10	6		
III5-III6						2,16							0,33	
III7-III8						0							0,31	
III9-III11						0,21							0,32	
Total	0	6	22	28	10		38	2	2	20	24	11		54
Population Structure (%)	0	21.4	78.6					8.3	8.3	83.3				

REPRODUCTIVE ASPECTS

System of mating

There are possibly 11 reproductive groups in the area. The composition was deduced in 4 groups, and only the females were identified in another 5 groups. Two potential places were identified by reference of births in passed years and the presence of several caimans.

Reproductive effort

A reproductive effort of 55% was calculated in the population relict (11 active females). The number of females is possibly higher, because there is always a fraction that does not nest every year in Crocodylia.

Nesting Time

For 2001 the females nested in Ele River from beginnings of January until beginnings of February, data coincident with Medem report (1981); in the Cravo Norte River there is one nest registration in the third week of February.

Nesting Areas

There were 11 nesting areas (5 in the Ele river and 6 in the Cravo Norte River); two beaches are considered as potential areas (no nests were located in the summer).

Nests

Generally were located in the summit or in the slope near the summit of the banking and beaches of the area. For 2001 were registered 11 nests in total (5 in Cravo Norte River and 6 in Ele River). Total density is 0,1 nests / kilometer of river. More than one female used two of the posture places. In one posture place two nests were located at a distance of 43 m., and these areas could be considered as of common nest zones.

Number of eggs per nest

The number of eggs directly counted in the Ele River was 56. Hatchlings counted were 40 Ele River and 30 in the Cravo Norte River. The number of eggs probably was higher in both cases.

Hatch time

The incubation period for the study area was calculated between 85 and 92 days. For the Ele River the hatchlings birth was registered during the first period of April 2001. There are no data for Cravo Norte River.

For the Ele and Cravo Norte rivers in 1995, the hatchlings were born in middle of March and beginnings of April; there were no births in March 2001.

Four nests hatched in Ele River, indicating that the hatchlings were born after the first hard rains.

Parental care

Female aggressive behavior was not observed in the area to the eggs extraction by residents; it is necessary to report that a mature caiman suddenly emerged near the boat when some hatchlings were caught, something unusual since adults do not come closer so easily to us; it is deduced that the female exercises parental care, because there were also foot prints and no hatchlings were sighted again after this event.

CURRENT HABITAT CONDITION AND ACTIVITIES THAT ENDANGER THE RELICT POPULATION

Hydrodynamic alteration and its relationship with the distribution of caimans in the department of Arauca.

The caiman habitat corresponds to courses of water (rivers and caños) in the basins of the Arauca, Capanaparo, Cinaruco and Casanare Rivers.

It is necessary to emphasize that there is an evident reduction of habitat of the species, caused indirectly by human activities like those reported by Clavijo (1991), which consists basically in the loss of water levels of caños (and hence rivers) in the central area of the Department. The loss of hydraulic mass in those courses of water is caused, in principle, by the formation of great vegetation and mud obstacles on its mouths (or points where they came off).

These obstacles are the sad effect of the sedimentation and deposition of large volumes of muds (sands and slimes) and trunks, branches and even whole trees crawled during the rainy seasons in the Arauca River and the Caño Agualimón, from the end of the '70 decade and the beginnings of the '80 decade.

The great contribution of silts and large plant material, accordingly with Clavijo and Zárate(1990), are product of the uncontrolled pruning in the whole western side of Arauca (a colonized area) that caused hydraulic and linear erosion which washed off many arboreal elements from the right bank of the Arauca River.

The tree dykes formed since then have altered the regional hydrodynamic, because they were formed at the intermediate courses and mouths of the rivers, so at the present time there are reproductive viability only on ecosystems and habitats associated to:

- low basin of the Capanaparo River.
- low basin of the Cinaruco River (inside Venezuelan territory).
- Caño Juriepe.
- Rivers and large caños belonging to the sub-basin of the Casanare River (basin of the Meta River): Rivers Lipa, Ele, Cuiloto, Cravo Norte, Casanare, Caño Enmedio, and the Araucan fraction of the Meta River.

Man intervention and interference on the caiman habitat

The population group of *C. intermedius* is located in an area with rural human population whose main activity is cattle raising. During the last decades it has carried out the uncontrolled extraction of fauna and

flora. The following human activities are presented: subsistence cultivations, cattle raising, pruning and burns (deforestation), fishery and hunt of wild fauna.

Man activities that affect directly the caiman

The factors associated to human activity that put under risk the species survival in the area in more degree are: death of mature animals, pillaging of nests every summer and capture of hatchlings and juvenile. A reduced population group subjected to these practices every year can be lead to their disappearance in future. Also, other human activities as fluvial transport and fishery affect the caiman.

CONCLUSIONS

After six years from the first study (1995), the population relict of *Crocodylus intermedius* fortunately has stayed and our pessimistic vision of its disappearance in future did not occur in this lapse of time. Although the observed number of caiman is still being low, there were possible to register all the size classes.

1. A total of 24 specimens of *Crocodylus intermedius* were sighted in 100 kilometers of river, with an absolute density of 0,24 caimans/Km of river. The relative density in sectors of 10 km length is uniform, with values of 0,1-0,3 caimans/Km of river, with the exception of a sector with a high value (1,2).
2. Most of the individuals are mature and reproductively active, with only two juvenile and sub-adult animals. The population relict presents an imbalanced structure.
3. It is considered for the studied area a total value of 54 caimans in 2001.
4. Presence of caimans in other places outside of the studied area were reported in the rivers: Ele, Lipa, Cravo Norte, Arauca and the caños: Cabuyare, Clarito, Limón and Jesús.
5. The caimans in Ele River nested in one period between the first week of January and the first week of February. One report from Cravo Norte River indicates that there was a posture in middle February.
6. Eleven posture places were located, from which in nine there was confirmed that the females nested, and two places are potentially available for nesting. Also, in the present year at least eleven females were reproductively active and nested in Ele and Cravo Norte Rivers. In two places, more than two nests were observed.
7. A total of 11 caiman nests were located (six in the Cravo Norte River and five in Ele River), with a total density for the area of 0,1 nests/km of river, from which seven were predated by the humans.
8. Egg number in three nests (30, 40 and 56 eggs) from Ele River was obtained.
9. Births were recorded in river Ele River in the first and second weeks of April. Four nests hatch in Ele River (some 120 hatchlings).
10. Human activity caused the disappearance of good part of the habitat of the caiman and therefore the disappearance of the species in northwestern part of the department.

RECOMMENDATIONS

First, it is indispensable to establish and standardize a monitoring of the population relict every year in the area.

Second, conservation measures and management should be implemented, like:

- Protection of posture beaches during dry season (December - April).
- Collect hatchlings to captive breeding.
- To perform an educational campaign in the area

BIBLIOGRAPHY

Ardila, M.C., G. Galvis y L. M. Lugo. 1998. Informe Final Proyecto “Programa para la Conservación del caimán del Orinoco (*Crocodylus intermedius*)”. Estación de Biología Tropical “Roberto Franco” de Villavicencio. Instituto de Ciencias Naturales-Museo de Historia Natural. Facultad de Ciencias, sede Bogotá. Santafé de Bogotá. pp 55 . (Mimeografiado).

Barahona, S. & O. Bonilla 1996. Evaluación del *status* poblacional y aspectos ecológicos del caimán llanero (*Crocodylus intermedius*, Graves 1819) en subareal de distribución en el departamento de Arauca. Tesis de Grado. Universidad Nacional de Colombia. pp 110.

Barahona, S. & O. Bonilla.1999. Evaluación del *status* poblacional del caimán llanero (*Crocodylus intermedius*) en un subareal de distribución en el departamento de Arauca (Colombia). Rev. Acad. Colomb. Cienc. Vol. XXIII, suplemento especial.

Clavijo, J. & M. Zárate. 1990. Los Recursos Naturales de la Intendencia Nacional de Arauca: potencialidades y restricciones. Documentos URPA -Arauca, Secretarías de Agricultura y Planeación de la Intendencia de Arauca. 30 pp, 3 mapas.

Clavijo, J. 1991. Del porque se deben tomar las condiciones naturales y los recursos naturales renovables como factores fundamentales en el proceso de planificación del futuro araucano a las puertas del siglo XXI. Documentos URPA - Arauca, Secretarías de Agricultura y Planeación de la Intendencia de Arauca.

Medem, F. 1981. Los Crocodylia de Sur América. Vol. I. Los Crocodylia de Colombia. Colciencias, Bogotá. 354pp.

Ramírez, J., G. Andrade y A. Franco. 1998. Programa Nacional para la Conservación del caimán llanero *Crocodylus intermedius*. Universidad Nacional de Colombia. Instituto de investigaciones de recursos biológicos Alexander von Humboldt. Santafé de Bogotá. (Mecanografiado). 22 pp.

Thorbjarnarson, J., 1987. Status, ecology and conservation of the Orinoco crocodile (*Crocodylus intermedius*) in Venezuela. Report to WWF.74pp.

_____. 1989. Ecology of the American crocodile, *Crocodylus acutus*. In Crocodiles. Their Ecology, management, and conservation. Special Publ.of the Crocodile Specialist Group.. IUCN- The World Conservation Union Publ. N. S.,Gland, Switzerland. 228-258 pp.

_____ & G. Hernández. 1993. Reproductive ecology of the Orinoco crocodile (*Crocodylus intermedius*) in Venezuela. I. Nesting ecology and egg an clutch relationships. Journal of Herpetology. 27(4): 363-370.

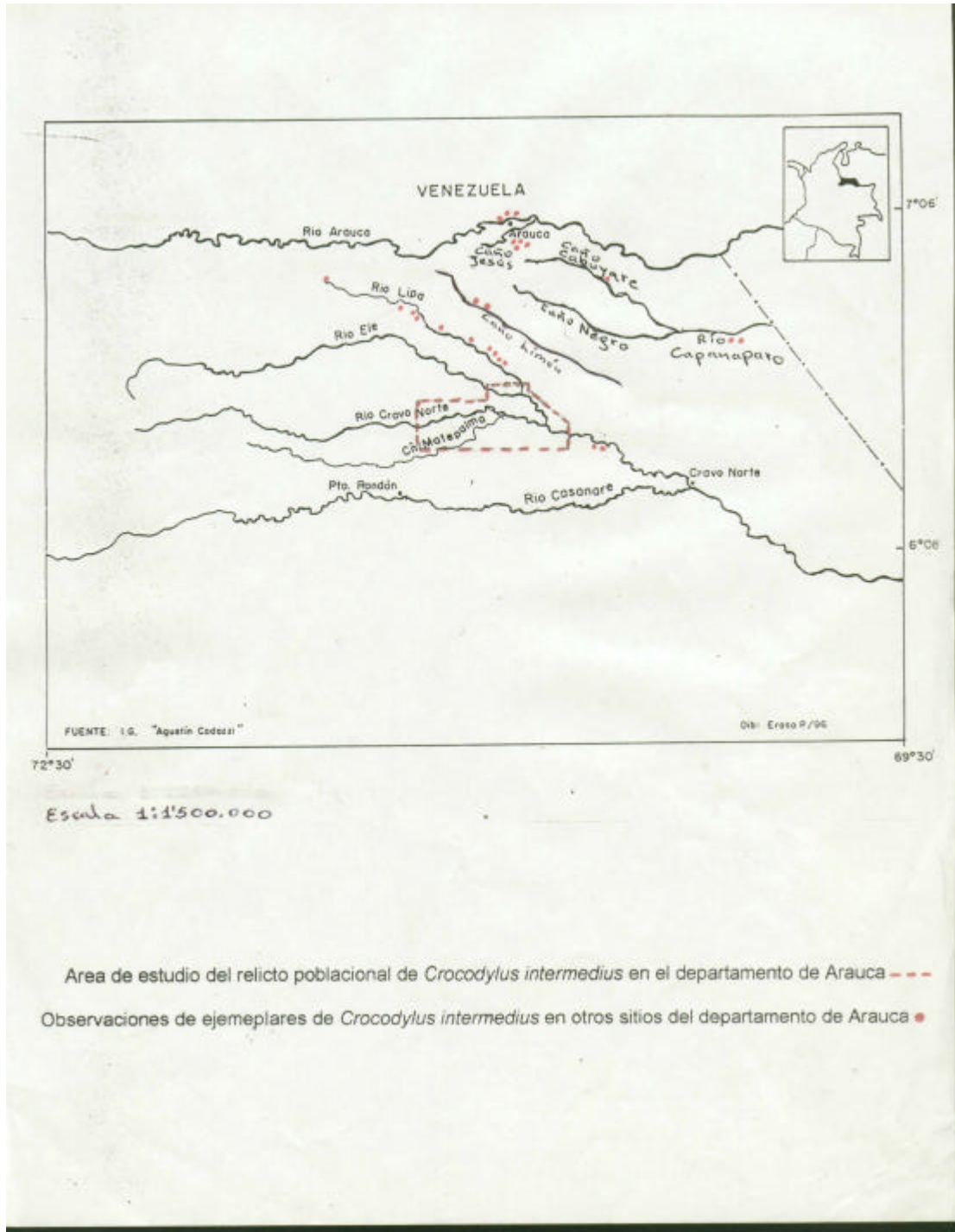


Figure 1.

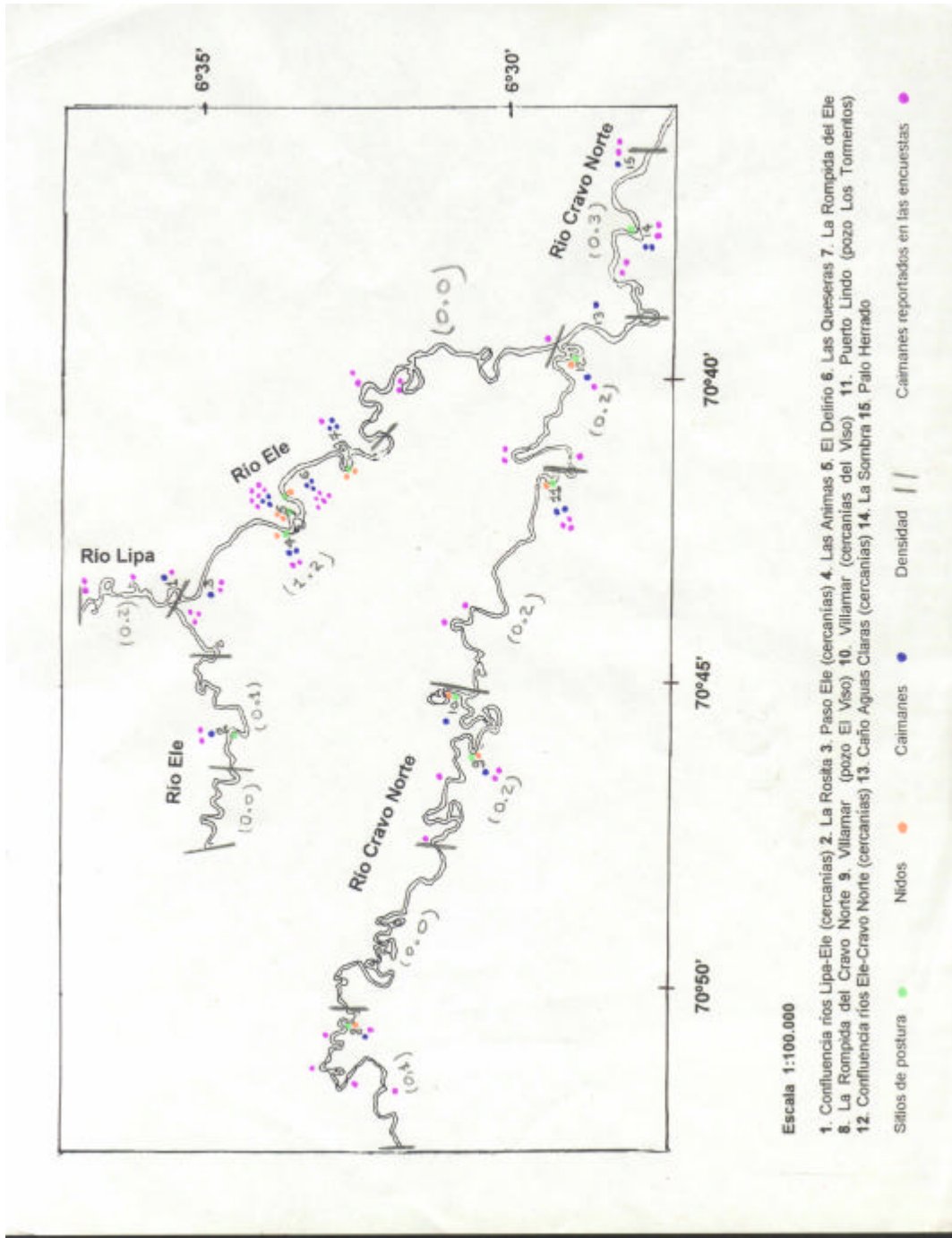


Figure 2.

Evaluations of Orinoco Caiman (*Crocodylus intermedius*) reintroduced in the wild fauna Refuge "Caño Guaritico" and its surroundings

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Abstract

Between 1990 and 1995, several institutions delivered more than 600 Orinoco caimans (Group I) in the Wild Fauna Refuge "Caño Guaritico" (RFS) and its surroundings, and between May and June 1998, other 258 specimens (Group II). Both groups were originated in captive breeding establishments. Caimans were captured in night using a boat, by hand or with a metallic loop. Taking into account that the standard length (LHCf) was not measured in some specimens of Group I, for the present study the total length (LT, cm) was used for calculations of growth rate (TcLT, cm/year). The standard length (in cm) was used for the Group II in the calculation of the growth rate (TcLHCf, cm/month) and then was extrapolated to cm/year. In addition, the weight increase was calculated for the Group II (Tweight, g/month). For Group I, the LT of reintroduced and captured caimans ranged between 50-154 cm; for Group II, LHCf ranged between 44 and 53 cm. The time elapsed from liberation to capture for Group I oscillated between 1,8 and 7,9 years, and for Group II between 5,0 y 7,3 months. Belonging to Group I, 17 specimens were captured (7 males and 10 females), with LT variations between 173 and 350 cm; from Group II, 31 specimens were captured with LHCf between 44 and 68 cm. The TcLT of Group I specimens oscillated between 19,4 and 46,5 cm/year, with mean of 33,3 cm/year. These values would be underestimated, because some specimens presented a truncated tail. The mean of TcLT for Group I was similar in males and females (34 and 32 cm/year, respectively). From the Group I approximately 50 specimens (8,3%) were observed, all of them sub-adults and adults (180 to ≥ 240 cm LT). Less than 30 adult specimens were observed. No hatchlings or small-sized juveniles were observed in the RFS between 1996 and beginning of 1998. On the surroundings, specifically at the Caño Macanillal, the species have been reproduced on artificial sand hillocks during 1997 and 1998. Approximately 40 juveniles (16% of total reintroduced caimans) belonging to Group II were observed in both studied environments. In the surroundings of the RFS, 14 specimens from the Group II were recaptured (13% of all reintroduced caimans in these sector), from which 13 moved upstream the site of liberation and 10 of them presented wounds or mutilations. Inside the RFS, 17 specimens were recaptured (10,8% of all reintroduced caimans in the sector), from which 13 moved downstream and 9 of them had wounds or mutilations. The TcLHCf of the Group II inside the RFS oscillated between 0,41 and 3,15, with a mean of 1,65 cm/mes, higher than inside the surroundings (0,6 and 1,3 with mean of 1,0 cm/month). For the same group, the Tweight (total mean) was higher inside RFS than in the surroundings (142 and 5,5 g/month). Accordingly to the recaptures, some specimens of Group I are moving between the RFS and the surroundings, but it is not the case for the Group II, probably due to its small sizes, although some crocodiles of the group II (liberated in the RFS) were mobilized approximately 40 Km waters under the liberation place.

STUDIES ON VENEZUELAN WILD POPULATIONS OF ORINOCO CAIMANS (ANTECEDENTS)

Goldshalk (1978, 1982) carried out the first studies on estimations of the population status of Orinoco caiman (*Crocodylus intermedius*) in Venezuela. Field samplings were made in the main rivers of the Llanos, together with interviews to local residents about the existence of the species. He estimated less than 300 adult caimans in 3.500 km of navigation. Ramo & Busto, during the 1980-decade, made flights over the Portuguesa and Tucupido Rivers, and Franz et al. (1985) over the Caura River (Bolívar State).

Thorbjarnarson & Hernández (1987, 1992) made flights and night counts in water bodies of the States Bolívar, Apure, Guárico, Aragua and Portuguesa. Ayarzagüena (1987) did the same in the Hydrological System of the Cojedes River, reporting the menace of contamination and habitat destruction to the caiman populations. During the 1990-decade, Seijas & Chávez carried out night counts in the mentioned system, reporting the higher caiman densities of Venezuela, oscillating in some sectors (5 to 9 km) between 2 to 9 no-hatchlings individuals / km observed. Lugo (1998) performed night counts, telescopic observations and captures in the RFS “Caño Guaritico” and adjacent zones. Chávez (2000) followed these studies in the same RFS and its surroundings, including Caño Macanillal, lagoons of La Ramera and Casa del Hato El Frío. All these researches indicated a low population density and great dispersion of the species.

INTRODUCTION

The Orinoco Caiman (*Crocodylus intermedius*) is one of the crocodylian species most menaced of extinction in the world. Currently, a program for the recovery of this species is carried out. The species was irrationally exploited since the 1920-decade until 1960 (Mondolfi, 1965; Medem, 1981). Between 1940 and 1950, the population begun to be scarce and become less profitable as natural resource, but the hunting still persisted until 1960. In the present time, there are wild populations only in Venezuela, and in Colombia it is virtually extinct with only few disperse animals in the environment (Lugo & Clavijo, 1991; PHVA, 1996). For this situation, it is important to study the population in the Refuge of Wild Fauna, Protected Zone and Fishery Reserve “Caño Guaritico” (RFS) of the Apure State (created by Decree N° 2702 del 11-01-1989).

Since 1984 started the captive breeding of this species in some private farms, with reintroduction purposes to increase the wild population levels. Currently, a Conservation Program is developed in Venezuela (care and feeding of reproducer specimens or adult caimans, artificial incubation of eggs, captive breeding of hatchlings and liberation to the wild environment), involving directly or indirectly several national and international institutions.

The Orinoco caimans after approximately one year of captive breeding, are liberated in places in which the species existed accordingly to historical records. Some of these sites are: Capanaparo River, RFS Caño Guaritico, Hato El Frío near to the RFS (Caño Macanillal, La Ramera lagoon and other small ponds), Hato El Cedral (Apure State); Mocapra River (inside the National Park Aguaro-Guariquito (Guárico State), Tucupido Reservoir (Portuguesa State), among others.

The geographical distribution area of the Orinoco caiman embraces the Venezuelan and Colombian Orinoquia. There are two important natural populations in Venezuela, with reproductive capacity, in the Hydrological System of the Cojedes River (Cojedes and Portuguesa States), and in the Capanaparo River (Apure State). Both populations has low density of individuals. There are relicts of populations and isolated individuals in the Tucupido Reservoir, some rivers inside the National Park Aguaro-Guariquito, the RFS Caño Guaritico and its surroundings (Caño Macanillal, La Ramera lagoon and other adjacent small ponds); Camatagua Reservoir (Aragua State), among others.

The objective of the present study was to evaluate the effort carried out during almost ten years in the program of reintroduction of Orinoco caimans, originated in captive breeding establishments, into the RFS “Caño Guaritico” and its Surroundings.

AREA OF STUDY

The present work was done in the RFS “Caño Guaritico” and its surroundings (Caño Macanillal, La Ramera lagoon and adjacent small ponds) in the Apure State.

RFS “Caño Guaritico” and its Surroundings

The study was carried out during end of November and December 1996; mid January and December 1997; January (beginning), March (beginning), November (end), and December (beginning and mid) 1998; and January (beginning) 1999.

Caño Guaritico springs are located near the town of Flor Amarillo, 90 km upstream of the RFS. The RFS “Caño Guaritico” begin in the crossing (bridge) of the caño with the national road Mantecal-Bruzual and finish in the mouth of the caño on the Apure River, including the traditionally navigable segment of other stream, Caño 70. Also is included the margin gallery forest inside described in Decree 2702 dated on 01-11-89. The Caños Caicara, Bejuquero, Bandolero, Garcerito, and 70, among others, are effluents to the RFS.

It is geographically located in the following coordinates: 07° 54' 00" - 07° 42' 58" North and 69° 19' 40" - 68° 52' 37" West (Fig. 1). Accordingly to meteorological data of the Mantecal Station (MARNR, 1988), the mean yearly rainfall is 1.627 mm, with a dry period extended from November to March, a rainy season from May to October, with April as a transitional month. The mean yearly temperature is 26,6 °C, with maximum of 32,1 °C and minimum of 22,6 °C.

This marked seasonality causes inundation during the rainy season of the plains adjacent to the RFS. During the dry season, the stream is broken into fragments and it is impossible to navigate, also by the presence of submerged trees. This protected area is located at north of Apure State, in the Municipio Muñoz, with an extension of 9300 Ha. From the crossing with the national road Mantecal-Bruzual to the mouth on the Apure River (not including the Caño 70), the hasta la desembocadura al Río Apure (sin incluir el Caño 70) it has a length of about 120 km (Blanco, Pers. Comm.).

In the surroundings of RFS Caño Guaritico is located the Caño Macanillal, La Ramera lagoon and other small ponds, inside the private Hato El Frío dedicated to cattle raising. Caño Macanillal and La Ramera lagoon are covered by large amounts of floating plants (*Eichhornia* sp). Both aquatic systems are connected through a channel, which are also covered in its two extremes by large amounts of floating plants. The margins generally have no trees. The surface of the lagoon during the beginning of the dry season is about 50 hectares, and floating plants covers a great proportion. The sampled segment in the Caño Macanillal was approximately of 3-4 km, with a variable width of 80-100 m maximum in some sectors.

The RFS Caño Guaritico was sampled from the crossing of the national road (bridge) to the mouth on the Apure River. Also, some sectors of the Caño 70 included in the protected area and other sectors not included, as the Apure River and Caño Guaritico upstream the crossing-bridge, were sampled.

In RFS Caño Guaritico, some reference points were taken (generally ranch houses) with the aim of support the fieldwork. These points are consecutively located along the Caño from the crossing bridge to mouth on the Apure River. The points are: Matadero and Tres Ceibas (near the bridge), between the bridge and Caño Bejuquero; Sombrerito and Médano Blanco, between Caño Bejuquero and Caño Caicara; Dividivi and Las Ventanas, few kilometers from the confluence with Caño 70; and the mouth of Caño Guaritico in the Apure River (Fig. 1).

Also, not protected adjacent zones were sampled: Caño Macanillal, La Ramera Lagoon, Casa del Hato lagoon and small ponds.

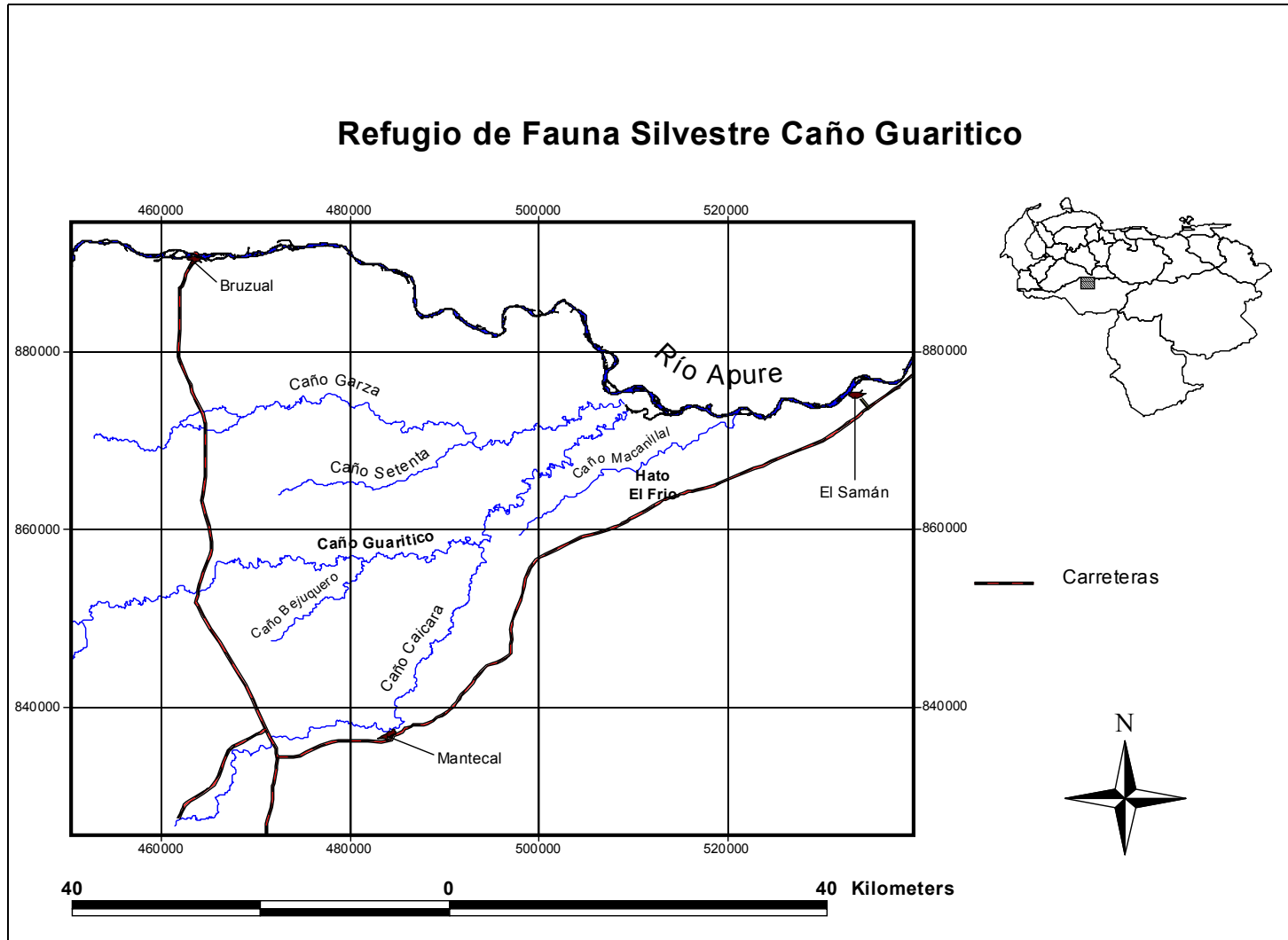


Fig. 1 Location of RFS "Caño Guaritico" and its surroundings.

VEGETATION

Accordingly with Holdridge (1967), cited by Ewel & Madriz (1976), the region in which is located the RFS is classified as Tropical Dry Forest. Huber & Alarcon (1986) reported river forests (semi-deciduous) with periodical floods and open grass flooding savannas.

The dominant trees in the river margins are *Coccoloba obtusifolia*, and *Nectandro duquetietum*, which are part of the galley forest subjected to flooding. The Caño also presented shrubs which invades the main channel. This species offer habitats and refuges to the fauna, in special to the Orinoco caiman. At the middle and mouth of the Caño, near the Apure River, the width of the channel increases and sand beaches without vegetation are formed. There are also numerous meanders with the margins covered by *Coccoloba*, ravines of different sizes with or without trees, nude soils or covered only by grasses. These habitat units have variations in its extension along the Caño.

METHODOLOGY USED IN RFS CAÑO AND ITS SURROUNDINGS

The crocodylians (*Crocodylus intermedius* and *Crocodylus tigris*, *Caiman crocodylus*) were censused and captured by night from a 4 m long boat with 9.9 HP engine. To reduce errors, the teamwork approached to the animals to verify if there were caimans or babas. The animals were located by the eye reflection of lantern light. The largest caimans were captured with metallic loops and the smallest (less than 80-90 cm length) by hand.

From the boat, caimans and babas were counted (number of not hatchlings individuals) in order to estimate its abundance. Also the size was estimated accordingly with the head length. The size was expressed as total length in cm (from the snout to the tail). Four categories of size were defined: 1) between 60-119 cm, 2) between 120-179 cm, 3) between 180-239 cm, 4) more or equal to 240 cm (Seijas, 1999). Another category was defined for animals that could not be measured (no data).

Some caimans were captured for growth rate estimations expressed in cm/year or cm/month, using total length (LT) and standard length (LHCf) (from the snout to the cloaca), measured on a table. Also, the single tail crests (CCS) were counted in order to establish the grade of mutilation.

Inside the RFS Guaritico and its Surroundings, more than 600 Orinoco caimans originated in captive breeding establishments have been reintroduced more or less systematically since 1990 to 1995, and another 258 specimens during May and June 1998. The recaptured caimans from 1990-95 were defined as Group I. Its body size growth rate in cm/year was calculated using the total length; also the capture percent and sex proportion were estimated. The recaptured caimans from May-June 1998 were defined as Group II. Its body size growth rate in cm/month was calculated using the standard length (LHC), and then extrapolated to cm/year. Also, the weight growth rate in g/month, the dispersal percent (location of the individual upstream or downstream), percent of wounded or mutilated animals, and recapture percent, among other variables, were estimated.

Group I was separated from Group II because for the second one the time between reintroduction and capture was less than 8 months, but for the first one this time oscillated between 2 and 8 months.

The growth rate of Group I was estimated using the total length, because the standard length was not measured in some animals at the reintroduction time. This was not the case for the Group II.

RESULTS

Abundance and size structure

From the 258 liberated specimens of the Group II, 142 were reintroduced in RFS Caño Guaritico, 15 in Caño Caicara (Hato El Cedral), and 101 in the Surroundings (Caño Macanillal, Hato El Frío). Tables 1, 2, 3, 4 and 5 (annex) show the abundance of caimans, babas and not identified crocodilians. The Tables 6, 7, 8, 9, 10 y 11 (annex) show the size structure of caimans since the end of 1996 to the beginning of 1999. In the RFS, 12 sub-adult and adult caimans were observed in 1996 (Tables 1 and 6), Also, 4 caimans of the same categories were observed toward the end of 1997 (Table 8). At the beginning of 1997 (Tables 2 and 7), the same number of caimans (sub-adults and adults) counted in 1996 was observed between the bridge and Sombrerito. The water depth (more than 3 m in 1996) probably influenced the caiman counts, although in 1997, with minor depth, fewer specimens were observed. The counting of babas is favored with minor depths. In these years, no juvenile caimans were reported.

At the end of 1998, 23 caimans were counted in RFS (Table 4). Most of these (at least 16) belong to the Group II reintroduced during May-June 1998, and the others to the Group I reintroduced between 1990-1995.

Few sub-adult and adult animals dominated the size structure in the RFS before the reintroduction in May-June 1998. Fishermen and hunters reported an important population of sub-adult and adult caimans upstream the crossing bridge, outside the protected zone, probably conformed by specimens reintroduced in the protected zone. At the end of 1998 approximately 3 km of the not protected zone were sampled, but any specimen was observed.

The Surroundings of the RFS (Caño Macanillal, La Ramera lagoon, some adjacent ponds and the Casa del Hato lagoon) were sampled since the end of 1997 until the beginning of 1999.

The abundance and size structure in a 3 km length sector (Bote) of Caño Macanillal was similar in all the years of sampling: some 14-15 sub-adult and adult specimens were observed. In other sector of the same Caño (Tapa Jobo) of about 400 m, divided by a dyke, 4 sub-adults and adult caimans were observed in March 1988. The same sector was sampled after the reintroduction of May-June 1998 with similar results. A juvenile belonging to the Group II was captured, 3 km upstream of the place of reintroduction. In the site La Carretilla a specimen of approx. 4.5 m length was observed (probably belonging to Group I). Samplings in Caño Macanillal (Bote) in the beginning of 1999, reported 21 specimens from which at least 11 belongs to Group II and the others to the Group I.

Like in Caño Macanillal, the abundance and size structure in La Ramera lagoon tend to be the same in several years of sampling, oscillating between 8-12 specimens (Table 11), more adults than sub-adults. On the last year of sampling fewer specimens were observed than in other years, probably related with a depth increase.

The lagoon is partially covered by floating plants, affecting the visual detection of caimans. In RFS "Caño Guaritico", during flooding or beginning of dry season when there are still a large water volume, it reach the highest areas and the emergent bushes or branches of trees reduce the visibility for counting, and the crocodilians use the flooded habitats. In the middle of the water bodies, there are spaces free of floating plants in which observers can see many eyes of crocodilians, but it is difficult its identification at species level if the caimans are mixed with babas.

In Caño Macanillal, usually the large adult caimans were observed occupying the middle of the navigation channel, while juvenile were located mainly in the margins. Babas were sighting in the border of the floating plants and on the free surfaces near the margins.

A fraction of the not identified crocodylians probably are Orinoco caimans, and perhaps its populations are underestimated (see Tables).

Captured Caimans in RFS “Caño Guaritico” and its Surroundings Group I

From the Group I (reintroduced between 1990-1995), 21 specimens were captured, from which 20 were marked with numbered metallic labels located at the interdigital membranes of the rear legs or cuts in scales of the tail. One male specimen did not show any mark. From the 20 marked specimens, 17 were registered in the database of reintroduced animals. In the RFS “Caño Guaritico”, caimans only were recaptured from the reference point Matadero to Médano Blanco. In the Surroundings, caimans were recaptured in all the sampling sites (Caño Macanillal, La Ramera lagoon and Casa del Hato lagoon).

On Dec 12 1996 a sub-adult specimen was recaptured (2,05 m LT) upstream of Médano Blanco (RFS), which was reintroduced at Caño Macanillal on March 15 1995 with 139 cm LT. It is probably that many Group I specimens could move between the RFS and the Surroundings during the rainy season, when the Caño Guaritico is flooded and the water covered the savannas.

For the 17 recaptured caimans, 7 males and 10 females, the time between reintroduction and recapture oscillated between 1,75 and 7,88 years. The LT range of the animals when they were reintroduced was 48-154 cm, and 173-343 cm when they were recaptured (Table 12, annex).

The mean growth rate is similar between males and females (34 and 32 cm/year, respectively). The yearly TcLT varied between 19,4 and 46,5, with mean of 33,3 cm/year, but possibly these values could be higher because many animals showed truncated tails. The largest recaptured caiman was a male with 350 cm, mean TcLT of 27 cm/year, but its tail was cut at the 9th single caudal crest (CCS). Two sub-adult males presented growth rates of 22 and 35 cm/year, respectively, although its tails were truncated at the 10th and 11th CCS when they were recaptured. Usually, the normal number of CCS is 18-22. Two females, one of them sub-adult and other adult, with mean TcLT relatively high (39 and 40 cm/year, respectively) presented truncated tails at 14th CCS (Table 12).

Group II

From Group II, 16 specimens were recaptured in “Caño Guaritico”, another one in Caño Caicara (Hato el Cedral), and 14 in the Surroundings (Tables 13 y 14). The specimen from Caicara was incorporated into the total of the RFS (Table 13), because this animal moved about 4 km upstream from the reintroduction site. Accordingly to the recapture record, the animals did not move between the RFS and the Surroundings, maybe because the time between reintroduction and capture was short.

From the 31 recaptured specimens in both places (RFS and Surroundings), the time between reintroduction and capture oscillated between 5,03 and 7,27 months. The LHCf for captured animals ranged between 33,9 and 53,3 cm, and the LHCf for recaptured ones was 43,9-67,5 cm.

The monthly growth rate (TcLHCf) in RFS was 0.41-3,15, with mean of 1,65 cm/month, being higher in the Surroundings (0,6-1,33 with mean of 1,01 cm/month).

The mean yearly projection of TcLHCf in RFS was 19,84 cm/year, equivalent to a TcLT of 38,60 cm/year, being higher than in the Surroundings (TcLHCf of 12 cm/year, equivalent to TcLT of 23,0 cm/year).

The weight increase rate (Tweight) in the RFS ranged between -1100 and 763 g/month, with mean of 142 g/month and a mean of zero or positive growth of 331g/month. These values were higher than those of Surroundings (-150 and 69,7, with total mean of 5,5 g/month and mean of zero or positive growth of 23,1 g/month) (Tables 13 and 14). It indicates that caimans won more length and weight in the RFS than in the Surroundings.

At the RFS, 17 specimens were captured (12 % of 141 reintroduced), from which 13 were found downstream from the site of liberation and 9 of them (more than a half) showed wounds and mutilations. In the Surroundings, 14 ejemplares were recaptured (13,9 % of 101 reintroduced), and 10 of them were wounded or mutilated. It is worth to mention that, in the Surroundings, the specimens were reintroduced near one extreme of the Caño Macanillal, and were recaptured in the other extreme upstream the liberation site.

Some specimens in the RFS were found approximately 40 km or more downstream from the site of reintroduction, between the reference points Médano Blanco-Dividue, and 14 km upstream near the crossing bridges, on the northwestern border of the RFS.

REINTRODUCTION PROGRAM

About 600 caimans were reintroduced during 1990-1995 in RFS and its Surroundings originated in the following captive breeding establishments: Fundo Pecuario Masaguaral and Agropecuaria Puerto Miranda (Guárico); Estación Biológica El Frío-Hato El Frío (Apure), and UNELLEZ (Portuguesa). From these reintroduced caimans, only 8% have been observed and identified, although possibly some of the not identified crocodilians sighted could be Orinoco caimans.

Some animals moved from the RFS to the Surroundings and even more far away. Residents from El Samán (Apure) reported sightings in the Apure River near the Caño Guaritico mouth and also the death of one adult specimen of approx. 4 m LT. This specimen was reintroduced on March 9 1991 in the Surroundings (Caño Macanillal).

The RFS have not a permanent watching system, and only from time to time some control is applied on illegal fisheries. During the flooding, caimans and babas can invade new habitat units that present difficulties to the observation, and during the dry season the navigation through the stream is interrupted. About 16 ponds are formed in the Caño, and the caimans search for protection in caves and deepest zones. The illegal fisheries are performed using large nets affecting the availability of food resources and even the capture and death of some specimens, which affects the population levels.

The low abundance of caimans detected, compared with the reintroduced amount, can be explained by death caused by intra- and inter-specific interactions, illegal fishery or hunting, but also by dispersal of animals to other environments not studied yet, hide of specimens in caves, extraction of juveniles by local residents to be sell or used as pets, and finally for underestimation in the counts. For comparison, between 1975 and 1984 were reintroduced in protected zones of India 552 Mugger crocodiles (*Crocodylus palustris*), 1183 gavials (*Gavialis gangeticus*), and 408 saltwater crocodiles (*Crocodylus porosus*), of approx. 1 m length and 3-4 years old (Anonymous author, 1987). The three species were successful adapted in the reintroduction site, but some specimens of *Gavialis* migrated hundreds of kilometers downstream, crossed the limits of the protected area and killed by the local residents in the adjacent areas.

The migrations and dispersal from the reintroduction sites and its accidental or provoked death is a common phenomenon.

Total length was measured to a sample of 489 specimens reintroduced during 1990-1995 in the RFS and its Surroundings, ranging between 40 and 225 cm. From this sample, 13,9% were caimans with less than 70 cm LT, 21,3% less than 80 cm, 32,3% less than 90 cm, 47,2% less than 100 cm, and 52,8% between 100 y 225 cm of LT.

From 258 caimans reintroduced in May-June 1998, 16% were observed in the samplings performed between December 1998 and January 1999. The LT of these animals ranged between 65 and 107 cm. The time between reintroduction and sampling was 5-7 months. The amount of observed caimans could be higher, taking into account the not identified crocodiles. Compared with other studies the proportion is not so low, i.e. the juveniles of the Nilo crocodile (*Crocodylus niloticus*) (Pooley; 1971; Blake & Loveridge, 1975; Graham, 1968; Hutton & Woolhouse, 1989), and probably the amount of observed crocodiles in the present study is influenced by the short time between reintroduction and observation.

From the 258 reintroduced caimans, 3,5% were less than 70 cm LT; 16,7 % less than 80 cm; 54,7 % less than 90 cm; 85,3 % less than 100 cm, and 14,73 % were between 100 and 107 cm.

The Venezuelan program of captive breeding and reintroduction is carried out with the cooperation of several public and private institutions, without commercial purposes. Perhaps the establishments perform the most important role, which cares the reproductive animals, the artificial egg incubation and the captive breeding with reintroduction purposes. In 1993, FUDENA, a no governmental institution, proposed an action plan for the survival of the Orinoco caiman. Paralelly, PROFAUNA (MARN) elaborated in 1994 a strategic plan supported in a population study on the species carried out in the Hydrological System of Cojedes. The studies developed in the RHC and literature review, helped to define guidelines for the plan and the effective recovery in middle and long-term of the species in Venezuela.

Accordingly to scientific reports, the hatchling predation is high and the juvenile predation is moderated. The probability of natural survival of reintroduced caimans with 90 cm LT or more is higher than for small specimens. It would be advisable to keep the juveniles in captive breeding during 18-24 months until reach size of 100 cm or more, which is appropriated for its reintroduction, but most captive breeding establishments have not enough facilities and funds to breed the animals for more than one year.

Taking into account the critical situation of the species, it is required to reintroduce the higher possible number of animals with size of 90-100 cm LT. To achieve this, the construction of new facilities and captive breeding establishments is needed to increase the size of animals with reintroduction purposes, together with appropriated food and time, controlling sickness and stress that delay the growth in captivity.

DISCUSSION

It is difficult to evaluate the real abundance of a population of species that use more the aquatic environment than the terrestrial one, which is the case of the Orinoco caiman. Many specimens can be unseen in the water during the light night counts. Approximately, only 8% of more than 600 caimans reintroduced in 1990-1995 and 16% of 258 specimens liberated in 1998 were sighted in the RFS and its surroundings. Probably, these data are underestimated. Some authors stated that the survival data are based in casual observations (Neill, 1971), in a small sampling size (Modha, 1967; Webb & Messel, 1977), or interpretations regarding population structure. Thus, instead mortality, we must think in disappearance in the case of crocodilians.

In a wild population, not all the individuals reach one year of life and only a fraction of survivors reach the adult stage due to intra- and inter-specific interactions, reducing the population in the case of reintroduced animals.

The RFS Caño Guaritico has the disadvantage of the reduction of depth during the dry season until its interruption towards end of December and beginning of January, limiting research navigation with negative consequences. Probably, the adult specimens are hidden in caves, confined in small ponds along the protected zone, or migrate before the extreme drought to deep aquatic zones adjacent to the RFS.

Although the results are underestimated, the adult caimans observed in the RFS and its Surroundings were scarcely 30 specimens during a continuous sampling from December 1998 to January 1999. The real population is higher than the observed one. Applying the technique of recapture, and surveying the local residents, now we know that the animals had moved from the RFS and its Surroundings several tenths of kilometers off the limits of the protected zone, upstream the crossing bridge or to the Apure River. The population in the Surroundings was also underestimated, probably due to the interference for the observation by the floating plants that serve as refuge to the caimans. Several specimens sighted in the present study could not be clearly identified as caimans, although the way of swimming was correspondent to large sized caimans. Other animals are dispersed during the flood to water bodies far away from the protected area. Webb & Messel (1978) found that some specimens of *Crocodylus porosus* from 2 to 6 years old dispersed 60 and 80 km from the nesting area, probably due to inter-specific competition. Messel et al. (1982) observed that approximately 80% of specimens of *Crocodylus porosus* with 90-180 cm length were inhabiting marginal sites, probably excluded from the main water course by adult specimens.

The growth rate of Group I caimans is relatively high (33 cm/year), and some specimens can reach more than 45 cm/year. Reintroduced animals with average growth rate could reach the adult stage in 6-7 years, and with the maximum growth rate in approximately 5 years (first year after hatch is not included), defining the adult size in 250 cm.

The mean growth rate of Group II specimens, based upon its standard length was 1,4 cm/month, and 2,7 cm/month based upon total length. The extrapolation of the last one value is equal to 32,4 cm/year, although some specimens grown more than 3 cm/month in standard length, equivalent to 6 cm of total length and 73 cm/year. These values of growth rate in the groups I and II are relatively higher than those reported by Seijas (1999) for the species (6,5-33,0 with mean of 17,5 cm/year during a lapse of marking and recapture of 0,7 to 4 years) in the Hydrological System of Cojedes, with problems of urban and industrial pollution. Also, the growth rate of Group II specimens is higher than the rate reported by Graham (1968) (1,7 cm/year) in *Crocodylus niloticus*, the cited by Thorbjarnarson (1988) for juveniles of *Crocodylus acutus* (20,9 cm/year), similar to the reported by Rodda (1984) in juveniles of *C. acutus* (33,6 cm/year), and to the reported by Chávez (2000) for Orinoco caimans of 30,1 cm/year (4,7-49,5 cm/year during a lapse of marking-recapture of 0,47-2,15 years) in Cojedes.

The mean TcLT (32,4 cm/year) of the Group II specimens was similar to the obtained for the Group I (33,3 cm/year), although the Group I specimens were juveniles at the recapture time and smaller than the Group II specimens. Probably, the Group II caimans experimented an adaptation or learning phase; wounds and mutilations affected its growth especially in the Surroundings, and even some specimens lost weight or its gain was around zero.

The RFS has fishes in abundance and probably most of them are available to the species, which could explain its high growth rate. Also, there are many sandy beaches, an important component for its

reproductive habits. These factors should influence positively in increasing the population levels in the adult stage. But also there are some disadvantages: a) occasional surveillance; b) reduction in depth during drought and fragmentation of the channel. Although the species are probably well adapted during hundreds or thousands of years to the life in aquatic bodies which dried, which lost its continuous during the dry season, this is one of the most important problems of the RFS and probably the main cause of migrations and dispersal of a high proportion of reintroduced animals, before the extreme drought, looking for different and more deep aquatic zones far away from the RFS. Generally, the species begin its courting and matching during December-January, the egg laying in February, and the birth on April-May. Thus, the adult caimans probably are hidden in caves during the courting and matching time or confined in ponds, visible to fishermen and hunters. Possibly, this is the reason by which there is no reproduction inside the RFS, although some females made nests without successful births and/or a high egg and hatchling predation occurs, when some sections of the Caño are dried and there is a high interaction between crocodilians in the small ponds. No hatchlings nor juveniles less than 100 cm were seen during the period from 1996 to beginning of 1998, and this fact indicates that there is no successful reproduction of the species.

In the Surroundings (Caño Macanillal) some nests have been observed between 1998 and 1999, on artificial sand hillocks made by personnel of the Biological Station of the Hato El Frio. The Caño Macanillal has no sandy beaches and it need the building of habitats to be used by the species for its reproduction.

Some reintroduced Group II specimens in the RFS migrated approximately 40 km downstream from the site of liberation, and one was captured in the limit of the RFS (crossing bridge). Similar reports were obtained by Webb & Messel (1978) with some small-sized juveniles of *Crocodylus porosus*, one year after birth, which were found at 40 km away from the birth place; however, 90% of survivors after one year were located 5 km away form the nest. Probably in future, the displacement of Group II specimens beyond the limits of the RFS will occur. Similarly, the Group II specimens liberated in the Surroundings could move inside the RFS and even reach the Apure River, outside the protected zone, endangered by fishermen, hunters or local residents.

The recaptured Group II specimens in RFS grown more than in the Surroundings, showing less wounds and mutilations. Wounds in the ventral side of caimans presented circular shape, probably caused by fishes. It is possible that the RFS specimens has more food available (mainly fishes) than those in the Surroundings. The caimans inside the RFS are less concentrated and stressed than in the Surroundings. The Caño Macanillal has some dykes built to keep water during the dry season, so the caimans (specially those of Group II) are under great pressures that increases their inter- and intra-specific interactions. The slow growth and high frequency of wounds and mutilations in the Surroundings specimens can be explained by these facts. Messel et al., (1982) suggested that the mortality of *Crocodylus porosus* between 90-180 cm length was associated to intra-specific interaction (aggressiveness). Canibalism also have been reported for crocodilians by Staton & Dixon (1975) in *Caiman crocodilus*, Cott (1961) in *Crocodylus niloticus*, Schmidt (1924) en *C. acutus*.

CONCLUSIONS AND RECOMMENDATIONS

In spite that more than 600 Orinoco caimans were introduced in this protected zone and its surroundings during 1990-1995 (Group I), less than 30 adult specimens were sighted, although some of the reintroduced caimans have not reached the adult size. Probably the real population size is underestimated by several factors.

The Orinoco caimans reintroduced in 1998 (Group II) in the RFS suffered less wounds and mutilation than the reintroduced specimens in the Surroundings, and also reached higher size and weight growth rates. Probably the RFS has better food availability (mainly fishes) and less stress conditions than the Surroundings.

No hatchlings or low-size juveniles were observed in the RFS during the sampling period 1996-beginning 1998.

The RFS “Caño Guaritico” is a water body fragmented in small ponds during the dry season. This fact probably influenced negatively in reproduction phases (matching, nesting, birth and hatchling care), and the long periods of drought stimulates the migration of specimens to permanent water bodies far away from the protected zone.

Group I caimans are moving between the RFS and its Surroundings, often trespassing the limits of the protected zone. Some Group II specimens were dispersed 40 km downstream of the site of reintroduction, and probably in future they will migrate away from the protected zone.

With the mean growth rate in both aquatic systems (RFS and Surroundings), the caimans could reach its adult stage in a period of 6-7 years, and with the highest growth rate in 5 years (the first year is not included).

It is convenient to apply an effective, permanent surveillance and control system in strategic zones of the RFS , to reduce illegal fishery and hunting which negatively affects the recovery of the Orinoco caiman.

The built of sandy hillocks along the Surroundings (Caño Macanillal) is required for stimulate the reproduction of the species.

The construction of more facilities for captive breeding is recommendable, in order to increase the size of juveniles before reintroduction.

The liberation into the environment must be done on specimens of 90-100 cm length or more to avoid predation and possible cannibalism.

BIBLIOGRAPHY

Anónimus, 1987. Worl Wildlife Fund-India. Conserving our heritage: Madras crocodile bank trust. Documentation of the experience in environmental management. 43 pp.

Ayarzagüena, J. 1987. Conservación del Caimán del Orinoco (*Crocodylus intermedius*) en Venezuela. Parte I. Río Cojedes. FUDENA, WWF-US, Proyecto 6078.

Blake, D. K.y J. P. Loveridge. 1975. The role of commercial crocodile farming in crocodile conservation. Biol. Conserv. 8:265-272.

Cott, H. B. 1961. Scientific results of an inquiry into the ecology and economic status of the Nile (*Crocodylus niloticus*) in Uganda and Northern Rhodesia. Trans. Zool. Soc. London. 29:211-356.

Chávez, C. 1999. Crecimiento Corporal de Caimanes del Orinoco (*Crocodylus intermedius*) liberados en el Refugio de Fauna Silvestre, Zona Protectora y Reserva de Pesca “Caño Guaritico”, y sus Alrededores,

Estado Apure, Venezuela. Convenio PROFAUNA-CORPOVEN. III Congreso Venezolano de Ecología. Puerto Ordáz, Estado Bolívar, Venezuela, 23 al 26 de Marzo de 1999.

Chávez, C. 2000. Conservación de las Poblaciones del Caimán del Orinoco (*Crocodylus intermedius*) en Venezuela. Informe. Convenio PROFAUNA (MARN)-CORPOVEN. Venezuela. 67 pp.

Ewel, J. y A. Madriz. 1976. Zonas de Vidas de Venezuela. Fondo Nacional de Investigaciones Agropecuarias. 265 pp.

FUDENA. 1993. Plan de Acción: Supervivencia del Caimán del Orinoco en Venezuela 1994-1999. Grupo de Especialista en Cocodrilos de Venezuela. Caracas. 24 pp.

Franz, R; S.Reid y C. Puckett. 1985. Discovery of a population of Orinoco crocodile *Crocodylus intermedius* in Southern Venezuela. Biological Conservation. 32:137-147.

Godshalk, R. 1978. El Caimán del Orinoco, *Crocodylus intermedius*, en los Llanos Occidentales de Venezuela con observaciones sobre su distribución en Venezuela y recomendaciones para su conservación. FUDENA, Caracas, 58 pp.

Godshalk, R. 1982. Status and conservation of *Crocodylus intermedius* in Venezuela. pp. 39-53 in: Crocodiles: Proceedings of the 5th Working Meeting of the IUCN/SS Crocodile Specialist Group, Gainesville, FL. IUCN Publ. N.S; Gland, Switzerland.

Graham, A. 1968. The lake Rudolph crocodile (*Crocodylus niloticus*, Laurenti) population. Report to the Kenya Game Commission, Naibori. 145 pp.

Huber, O. y C. Alarcon. 1988. Mapa de la Vegetación de Venezuela. Edt. Arte. Caracas, Venezuela.

Hutton, J. y M. Woolhouse. 1989. Mark-recapture to assess factors affecting the proportion of a Nile Crocodile population seen during spotlight counts at Ngezi, Zimbabwe, and the use of spotlight counts to monitor crocodile abundance. J. Applied Ecology. 26:381-395.

Lugo. M. y J. Clavijo. 1991. Programa para la conservación del Caimán del Orinoco (*Crocodylus intermedius*) en Colombia. Est. Biología Trop. Roberto Franco. Mimeogr. 10 pp.

Lugo, M. 1998. Evaluación del programa de liberación del Caimán del Orinoco (*Crocodylus intermedius*) en el Refugio de Fauna Silvestre “Caño Guaritico y Alrededores (Edo. Apure, Venezuela). Tesis de Maestría, UNELLEZ, Guanare, Venezuela. 98 pp.

MARNR. 1988. Zonificación Agroclimática del Estado Apure. Volumen 1A - 1B. Caracas. 68 pp.

Medem, F. 1981. Los Crocodylia de Sur América. Vol. I. Los Crocodylia de Colombia. Edt.Carrera 7a. Ltda. Bogotá, 354 pp.

Messel, H; G.C. Vorlicsek; A. G. Wells y W. J. Green. 1982. Status and dynamics of *Crocodylus porosus* populations in the tidal waterways of northern Australia. IUCN Publ. (N.S.) Suppl. Paper. ISBN 2-8032-209-x. pp. 127-173.

Modha, M. L. 1967. The ecology of the Nile crocodile (*Crocodylus niloticus*, Laurenti) on Central Island, lake Rudolph. E. Afr. Wild. J. 6:81-88.

- Mondolfi, E. 1965. Nuestra Fauna. Revista El Farol. 214:2-13.
- Neill, W. T. 1971. The last of the ruling reptiles. Columbia Univ. Press, New York. 486 pp.
- Pooley, A. C. 1971. Crocodile rearing and restocking. Pubs. Inst. Conserv. Nat. Resour. 32:104-130.
- Programa de Conservación del Caimán del Orinoco. 1996. En Taller de Análisis de Viabilidad Poblacional y de Hábitat (PHVA) del Caimán del Orinoco (*Crocodylus intermedius*). Libro de Resúmenes. Ellis (eds). IUCN/SSC. 48 pp.
- Ramo, C. y B. Busto. 1986. Censo aéreo de caimanes (*Crocodylus intermedius*) en el río Tucupido (Portuguesa, Venezuela) con observaciones sobre su actividad de soleamiento. Crocodiles, IUCN Publ. (New Series):109-119.
- Rodda, G. J. 1984. Movements of Juvenile American Crocodiles in Gatun Lake, Panamá. Herpetologica. 40(4):444-451.
- Seijas, A. E. 1993. Estado poblacional y aspectos ecológicos del Caimán del Orinoco (*Crocodylus intermedius*) en los ríos Cojedes y Sarare, Venezuela. Unellez. 36 pp.
- Seijas, A. E. y C. Chávez. 1994. Plan estratégico: Sobrevivencia del Caimán del Orinoco en Venezuela. Servicio Autónomo de Fauna (MARNR), Caracas. Reimpreso en: Taller de Análisis de Viabilidad Poblacional y del Hábitat (PHVA) del Caimán del Orinoco, Caracas, Venezuela.
- Seijas, A. E. 1999. El Caimán del Orinoco (*Crocodylus intermedius*) en el sistema del río Cojedes, Venezuela: Ecología y Estado Poblacional. Trabajo de Ascenso a Categoría de Asociado. UNELLEZ, 133 pp.
- Seijas, A. E. y C. Chávez. 2000. Population status of Orinoco crocodile (*Crocodylus intermedius*) in the Cojedes river system, Venezuela. Biol. Conserv. 94:353-361.
- Schmidt, K. P. 1924. Notes on Central American crocodiles. Field Mus. Nat. Hist. Zool. Ser. 12:77-96.
- Staton, M. y J. R. Dixon. 1975. Studies on the dry season biology of *Caiman crocodilus crocodilus* from the Venezuelan Llanos. Mem. Soc. Cienc. Nat. La Salle. 35(101): 237-266.
- Thorbjarnarson, J. B. 1988. Status and ecology of the American crocodile in Haiti. Bull. Florida St. Mus. (B. S.). 33(1):1-86.
- Thorbjarnarson, J. y G. Hernández. 1992. Recent investigation on the status and distribution of Orinoco crocodile *Crocodylus intermedius* in Venezuela. Biological Conservation. 62:179-188.
- Webb, G. J. y H. Messel. 1977. Abnormalities and injuries in the Estuarine crocodile, *Crocodylus porosus*. Aust. Wildl. Res. 4:311-319.
- Webb, G. J. W. y H. Messel. 1978. Movement and dispersal patterns of *Crocodylus porosus* in some rivers of Arnhem Land, North Australia. Resd. 5:263-283.

Table 1- Number of caimans, babas and not identified crocodilians (no hatchlings) in continuous sections of RFS “Caño Guaritico”.

Sectors/Dates	Caimans	Babas	Not identified crocodilians	Total (N°)
Puente-Matadero (28-11-96)	1	25	2	28
Matadero-3 Ceibas (29-11-96)	2	33	4	39
3 Ceibas-Sombrerito (11-12-96)	3	116	22	141
Sombrerito-Médano Blanco (12-12-96)	3	91	50	144
Médano Blanco-Dividive (13-12-96)	1	160	45	206
Dividive-Las Ventanas (27-12-96)	0	354	16	370
Las Ventanas-(Guarit-Apure) (28-12-96)	1	484	26	511
Caño 70 (29-12-96)	1	371	14	386
Totales	12	1.634	179	1.825

Note. Not identified crocodilians with any size category.

Approximated length of RFS “Caño Guaritico” from the crossing bridge to its mouth in the Apure River is 120 km (not including Caño 70).

Table 2. Number of caimanes, babas and not identified crocodilians (no hatchlings) in continuous sections of RFS “Caño Guaritico”.

Sectors/Dates	Caimans	Babas	Not identified crocodilians	Total (N°)
Aguas abajo del puente hasta 3 Ceibas (15-01-97)	7	411	-	418
3 Ceibas hasta aguas arriba de Sombrerito (17-01-97)	5	969	-	974
Totales	12	1.380	-	1.392

Note. Not identified crocodilians were considered as babas. The depth was so small that unavoid navigation.

Table 3. Number of caimanes, babas and not identified crocodilians (no hatchlings) in continuous sections of RFS “Caño Guaritico”.

Sectors/Dates	Caimans	Babas	Not identified crocodilians	Total (N°)
Matadero 1,5 Km aguas arriba (10-12-97)	0	52	0	52
Matadero-3 Ceibas (10-12-97)	3	456	8	467
3 Ceibas-Sombrerito (12-12-97)	0	964	32	996
Sombrerito-Médano Blanco (13-12-97)	0	577	2	579
Médano Blanco Dividive (14-12-97)	1	1.089	20	1.110
Dividive-Las Ventanas (26-12-97)	0	454	3	457
Las Ventanas-(Guarit-Apure) (27-12-97)	0	449	5	454
Río Apure, 3,0 Km, aguas abajo de la confluencia con el Caño Guaritico (27-12-97)	0	68	1	69
Totales	4	4.109	71	4.184

Note. Not identified crocodilians with any size category.

Approximated length of RFS “Caño Guaritico” from the crossing bridge to its mouth in the Apure River is 120 km (not including Caño 70).

Tabla 4. Número de caimanes, babas y crocodilios no identificados en secciones continuas del Refugio de Fauna Silvestre “Caño Guaritico”.

Sectores y Fechas	Caimanes (No crias)	Babas (No crias)	Crocodilios no identificados	Total (N°)
Puente 2,7 Km aguas arriba (15-12-98)	0	45	18	63
Puente-Matadero (29-11-98)	5	151	33	189
Matadero-3 Ceibas (30-11-98)	5	80	32	117
3 Ceibas-Sombrerito (01-12-98)	4	220	47	271
Sombrerito-Médano Blanco (01-12-98)	4	187	74	265
Médano Blanco-Dividive (14-12-98)	5	513	295	813
Dividive-Las Ventanas (13-12-98)	0	337	165	502
Las Ventanas-Guarit-Apure (16-12-98)	0	299	43	342
Caño 70, (16-12-98)	0	88	0	88
Totales	23	1.920	707	2.650

Nota. Los crocodilios no identificados pueden presentar cualquier clase de tamaño. La longitud aproximada del RFS “Caño Guaritico” desde el puente de la carretera nacional hasta la confluencia Guaritico-Río Apure (sin incluir el Caño 70) es 120 Km. Se muestreó del Caño 70, aproximadamente 6 km, aguas arriba de la confluencia con el Caño Guaritico.

Tabla 5. Número de caimanes, babas y crocodilios no identificados en sectores del Caño Macanilla (Hato El Frio), aledaños al Refugio de Fauna Silvestre “Caño Guaritico”.

Sectores y Fechas	Caimanes (No crias)	Babas (No crias)	Crocodilios no identificados	Total (N°)
Sector Bote (29-12-97)	14	193	1	208
Tapa El Jobo (03-03-98)	4	87	73	164
Sector Bote (08-01-99)	21	104	6	131
Tapa El Jobo y La Carretilla (12-01-99)	5	35	2	42

Nota. Los crocodilios no identificados pueden presentar cualquier clase de tamaño.

Tabla 6. Estructura de tamaño de los caimanes en secciones continuas del Refugio de Fauna Silvestre “Caño Guaritico”.

Clases de Tamaño

Sectores y Fechas	60-119	120-179	180-239	≥240	SD	Caimanes totales (no crias)
Puente Matadero (28-11-96)	0	0	1	0	0	1
Matadero-3 Ceibas (29-11-96)	0	0	2	0	0	2
3 Ceibas-Sombrerito (11-12-96)	0	0	2	0	1	3
Sombrerito Médano Blanco (12-12-96)	0	0	3	0	0	3
Médano Blanco Dividive (13-12-96)	0	0	1	0	0	1
Dividive-Las Ventanas (27-12-96)	0	0	0	0	0	0
Las Ventanas Guarit-Apure (28-12-96)	0	0	0	1	0	1
Caño 70 (29-12-96)	0	0	0	1	0	1
Total	0	0	9	2	1	12

Nota. En la tabla aparecen los sectores y fechas de muestreos. Las clases de tamaño se expresan en intervalos de longitud total en centímetros (cm). SD significa número de caimanes (no crias) sin datos de tamaño.

Tabla 7. Estructura de tamaño de los caimanes en secciones continuas del Refugio de Fauna Silvestre “Caño Guaritico”.

Clases de Tamaño						
Sectores y Fechas	60-119	120-179	180-239	≥240	SD	Caimanes totales (no crías)
Aguas Abajo del Puente hasta-3 Ceibas (15-01-97)	0	0	4	1	2	7
3 Ceibas hasta-Aguas Arriba de Sombrerito (17-01-97)	0	0	2	1	2	5
Total	0	0	6	2	4	12

Nota. En la tabla aparecen los sectores y fechas de muestreos. Las clases de tamaño se expresan en intervalos de longitud total en centímetros (cm). SD significa número de caimanes (no crías) sin datos de tamaño.

Tabla 8. Estructura de tamaño de los caimanes en secciones continuas del Refugio de Fauna Silvestre “Caño Guaritico”.

Clases de Tamaño						
Sectores y Fechas	60-119	120-179	180-239	□240	SD	Caimanes totales (no crías)
1.5 Km						
Aguas arriba de Matadero (10-12-97)	0	0	0	0	0	0
Matadero 3 Ceibas (10-12-97)	0	0	2	1	0	3
3 Ceibas Sombrerito (11-12-97)	0	0	0	0	0	0
Sombrerito Médano Blanco (13-12-97)	0	0	0	0	0	0
Médano Blanco Divide (13-12-97)	0	0	1	0	0	1
Divide Las Ventanas (26-12-97)	0	0	0	0	0	0
Las Ventanas Guarit-Apure (27-12-97)	0	0	0	0	0	0
Caño 70 (27-12-97)	0	0	0	0	0	0
Total	0	0	3	1	0	4

Nota. En la tabla aparecen los sectores y fechas de muestreos. Las clases de tamaño se expresan en intervalos de longitud total en centímetros (cm). SD significa número de caimanes (no crías) sin datos de tamaño.

Tabla 9. Estructura de tamaño de los caimanes en secciones continuas del Refugio de Fauna Silvestre “Caño Guaritico”.

Clases de Tamaño.						
Sectores y Fechas	60-119	120-179	180-239	≥240	SD	Caimanes totales (no crías)
3,0 Km Aguas						
Arriba del Puente (15-12-98)	0	0	0	0	0	0
Puente-Matadero (29-11-98)	4	1	0	0	0	5
Matadero-3 Ceibas (30-11-98)	4	0	0	1	0	5
3 Ceibas						
Sombrerito (01-12-98)	2	1	0	1	0	4
Sombrerito Médano (01-12-98)	2	2	0	0	0	4
Médano Blanco						
Dividive (14-12-98)	4	0	0	1	0	5
Dividive						
Las Ventanas (13-12-98)	0	0	0	0	0	0
Las Ventanas Guarit- Apure (16-12-98)	0	0	0	0	0	0
Caño 70 (16-12-98)	0	0	0	0	0	0
Total	16	4	0	3	0	23

Nota. En la tabla aparecen los sectores y fechas de muestreos. Las clases de tamaño se expresan en intervalos de longitud total en centímetros (cm). SD significa número de caimanes (no crías) sin datos de tamaño.

Tabla 10. Estructura de tamaño de los caimanes en sectores del Caño Macanillal (Hato El Frio), aledaño al RFS “Caño Guaritico”.

Clases de Tamaño.						
Sectores y Fechas	60-119	120-179	180-239	≥240	SD	Caimanes totales (no crias)
Sector Bote (29-12-97)	0	0	6	5	3	14
Sector Bote (07-01-98)	0	0	3	8	4	15
Sector Tapa El Jobo (03-03-98)	0	0	1	2	1	4
Sector Bote (08-01-99)	11	1	0	9	0	21
Sector Tapas El Jobo Carretilla (12-01-99)	1	0	0	2	2	5

Nota. En la tabla aparecen los sectores y fechas de muestreos. Las clases de tamaño se expresan en intervalos de longitud total en centímetros (cm). SD significa número de caimanes (no crias) sin datos de tamaño.

Tabla 11. Estructura de tamaño de los caimanes en la laguna La Ramera, laguna de la Casa del Hato y otros sectores (Hato El Frio), aledaños al Caño Macanillal.

Clases de Tamaño.						
Sectores y Fechas	60-119	120-179	180-239	≥240	SD	Caimanes totales (no crias)
Laguna La Ramera (28-12-97)	0	0	2	8	0	10
Laguna La Ramera (08-01-98)	0	0	0	10	2	12
Laguna La Ramera (10-01-99)	2	0	0	6	0	8
Laguna de la casa del Hato (09-01-98)	0	0	0	4	0	4
Laguna de la casa del Hato (12-12-98)	0	0	0	4	0	4
Pozo Ceiba (Enero 99)	1	3	0	0	0	4

Nota. En la tabla aparecen los sectores y fechas de muestreos. Las clases de tamaño se expresan en intervalos de longitud total en centímetros (cm). SD significa número de caimanes (no crias) sin datos de tamaño.

Tabla 12. Tasa de crecimiento de los caimanes del Orinoco (grupo I) liberados y recapturados en el RFS “Caño Guaritico” y los Alrededores (Caño Macanillal y la laguna La Ramera).

Marca del ejemplar (corte de escamas) o placa metálica.	Longitud total en cm.	CCS (N° filas)	Tiempo entre liber-recapt. (años)	Tasa de crecimiento (cm/año)
	Liber-recaptura.			
VII-8-G	114,0-211,5	15	2,92	33,4
VI-7-i	116,0-188,6	cc	2,92	24,9 *
VI-6-i	108,0-172,5	10	2,92	22,1
VI-1-D	97,1-181,0	cc	2,58	32,5 *
VII-6-G	139,0-205,0	cc	1,75	37,7 *
III-8-H	108,0-204,0	cc	2,75	35,0 *
II-6	114,0-209,0	11	2,75	34,5 *
VIII-8-F	139,0-232,0	cc	2,80	33,2 *
8-H	67,0-207,0	14	3,63	38,6
II-G	104,2-264,0	14	3,58	44,6
I-1-B	105,4-245,0	cc	3,58	39,0
2-A	66,2-240,5	15	3,75	46,5
C-90	104,5-291,0	16	6,33	29,5
III-H	153,7-303,2	cc	7,70	19,4
III-V-H	47,8-249,5	16	5,79	34,8
V-G	129,2-343,0	9	7,88	27,1 *
II-E	100,8-284,0	15	5,45	33,6
Promedio				33,3

Nota. En la tabla aparece la identificación del ejemplar (marca de corte de escamas de la región caudal y/o placas metálicas numeradas). La tasa de crecimiento se calculó en cm/año. CCS significa el número de crestas caudales sencillas, y cc son los ejemplares que tienen su cola completa (sin truncamientos). Los ejemplares marcados con asteriscos (*) son machos.

Tabla 13. Tasa de crecimiento y de peso de los caimanes del Orinoco (grupo II) liberados y recapturados en el RFS “Caño Guaritico”.

Marca del Ejemplar de escamas)	Longitud standard (LHC) en cm.	Tasa de crecimiento (cm/mes)	de Tasa de crecimiento (cm/año)	de Tasa de peso (g/mes)
	Liber.-recaptura			
I-III-10	45,8-60,9	2,28	27,36	422
I-II-2-10	47,2-57,6	1,57	18,84	347
2-10-A	49,5-58,0	1,28	15,36	136
VI-8-A-J	45,1-57,0	1,94	23,28	440
I-10	47,0-50,6	0,59	7,08	-200 *
I-II-III-10	41,4-43,9	0,41	4,92	0
II-3-B-J	46,1-51,6	0,79	9,48	105 *
11-8-J	47,9-52,8	0,86	10,32	26 *
VI-9-J	38,7-49,5	1,89	22,68	166
VI-4-J	42,2-60,4	3,15	37,80	563
1-3-10-B	43,9-63,3	3,14	37,68	486
II-B-J	50,7-67,5	2,91	34,92	763 *
VI-3-J	48,2-63,7	2,69	32,28	589
VI-1-J	58,0-61,2	0,63	7,56	-1100
I-2-A-J	53,2-64,4	2,62	31,44	263
II-7-C-J	43,0-46,6	0,71	8,52	-300
I-10-C	52,0-56,0	0,64	7,68	-300
Promedio		1,65	19,84	

Nota. En la tabla aparece la identificación del ejemplar como marca de corte de escamas de la región caudalia. Los ejemplares identificados con * son machos. LHC significa la longitud hocico-cloaca. El tiempo entre la liberación y la recaptura osciló entre 5,03 y 6,63 meses. La tasa de crecimiento se calculó en cm/mes, además se extrapoló a cm/año. Algunos ejemplares perdieron peso entre los dos eventos (liberación-recaptura).

Tabla 14. Tasa de crecimiento y peso de los caimanes del Orinoco (grupo II) liberados y recapturados en los Alrededores (Caño Macanilla y la laguna La Ramera), aledaños al RFS “Caño Guaritico”.

Marca del Ejemplar de escamas)	Longitud standar (LHC) en cm.	Tasa de crecimiento (cm/mes)	Tasa de crecimiento (cm/año)	Tasa de peso (g/mes)
	Liber.-recaptura			
10-8	39,1-45,6	0,90	10,80	0
II-10	39,6-47,9	1,15	13,80	6,9
IV-10-A	49,0-57,7	1,20	14,40	13,8
10-7-F	39,6-48,4	1,22	14,64	41,5
10-7-E	39,9-44,2	0,60	7,20	(-150)
10-4-B	48,0-56,2	1,14	13,68	69,7
V-10-3-ABC	44,5-52,4	1,10	13,20	41,8
10-4-J	48,9-55,5	0,92	11,04	13,9
10-7-G	53,3-62,8	1,33	15,96	6,3
10-1-B-D	46,2-53,3	1,00	12,00	7,0
10-6-G	40,5-48,0	1,05	12,60	21,0
10-7-H	41,5-46,5	0,70	8,40	(-50) *
I-II-10-3	44,1-50,5	0,90	10,80	28,1
II-IV-2-3BD	43,2-50,2	0,96	11,52	27,5
Promedio		1,01	12,15	

Nota. En la tabla aparece la identificación del ejemplar como marca de corte de escamas de la región caudalia. LHC significa la longitud hocico-cloaca. El tiempo entre la liberación y la recaptura osciló entre 7,13 y 7,27 meses. La tasa de crecimiento se calculó en cm/mes, además se extrapoló a cm/año. Algunos ejemplares perdieron peso entre los dos eventos (liberación-recaptura). Todos los ejemplares son hembras a excepción del marcado con asterisco (*), identificado como “10-7-H”.