

Evaluación de la reintroducción de *Crocodylus intermedius* en el Refugio de Fauna Silvestre Caño Guaritico, Venezuela.

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Resumen

En el periodo entre 1990 y 1995, se reportó la reintroducción de un total de 514 Caimanes del Orinoco (*Crocodylus intermedius*) en el Refugio de Fauna Silvestre Caño Guaritico, dentro de un esfuerzo combinado de diferentes organizaciones nacionales y extranjeras. Las reintroducciones se ejecutaron en tres cuerpos de agua: Caño Guaritico, propiamente dentro de los linderos del Refugio y donde se liberaron en dos sectores 283 caimanes (55,1%); Caño Macanillal, lugar donde se realizaron las primeras liberaciones, con total de 227 individuos (44,2%); y Caño Mucuritas, donde solo se han liberado 4 caimanes (0,7%). Estas dos últimas localidades se sitúan en tierras del Hato El Frío. De los 514 caimanes, 271 (42,2%) provinieron del Zoocriadero Masaguaral, 114 (22,2%) del Zoocriadero El Frío, 92 (17,9%) del Zoocriadero de la UNELLEZ y 41 (7,9%) del Zoocriadero Puerto Miranda. Los caimanes liberados son en su mayoría producto de la cría en cautiverio (61,7%), mientras que el restante proviene de la recolección de juveniles producidos en vida silvestre (38,3%). Se conoce el origen de la mayoría de los caimanes, los cuales provienen de reproductores de diferentes localidades, en algunos casos bastante distantes. De los 514 animales, se tienen solo medidas y datos de 411 individuos (80,2 %). En términos de longitud total en 1990 el promedio fue de 151,7 cm (DE= 22,25), en 1991 de 125,2 cm (DE= 30,9), en 1992 de 82,8 (DE= 35.1), 1993 de 79,7 cm (DE= 13,17) y en 1994 de 86,9 cm (DE= 16,08). La disminución de la longitud total se debe a que en los últimos tres años se liberaron ejemplares de 1 año. La proporción de sexos es casi 1:2, con 264 machos (64,07%), 144 hembras (34,95%) y 4 sin determinar (0,97%). Los datos de longitud total y peso se usaron para calcular un índice de condición, con lo cual se encontró que principalmente caimanes con medidas de LT mayores de 100 cm (26 %) y pesos mayores de 2,5 kg (46 %) tienen índices que denotan buena condición física. En este sentido, se propone el uso de tales índices indirectos como criterio adicional para establecer cuando los caimanes criados están en condición de ser liberados al medio natural. El seguimiento de caimanes liberados no ha sido permanente, ejecutándose solo estudios parciales y esporádicos, cuyos resultados arrojan índices promedios de abundancia muy bajos, de 1.8 ind/km en el Caño Macanillal y 0.47 ind/km en Guaritico, que contrasta con una alta concentración de babas (*Caiman crocodilus crocodilus*). Se han practicado 16 recapturas cerca de los sitios de liberación, aunque hay un caso de un ejemplar que emigró una distancia considerable durante un año. Finalmente, se encontró que el crecimiento promedio de caimanes capturados en Macanillal fue menor (0,5 mm/día); al crecimiento de caimanes colectados en el Caño Guaritico (1,38 mm/día). Sin embargo, se requieren mas estudios para corroborar estos resultados y establecer la viabilidad de este programa.

Crocoaylus intermedius is an endemic species of the Orinoco river basin, specially of the flooded savannas of the "Llanos" of Venezuela and Colombia. The commercial harvest of the Orinoco crocodile during the 1930s and 1940s, along with the habitat destruction, keep this species on the verge of extinction. The crocodile has virtually disappeared in Colombia (Lugo and Clavijo, 1991), while in Venezuela there are small isolated populations (Godshalk, 1978, 1982; Ramo y Busto, 1986; Franz *et al.*, 1985; Ayarzagüena, 1987; Thorbjarnarson and Hernández, 1992; Seijas, 1993, 1994). These relicts are located mainly in areas where the human activity is minimal, and in some cases under official protection.

In 1984 it was included by the IUCN in the list of the twelve animal species more threatened with extinction in the world. The conservation of the Orinoco crocodile have been a collaborative effort by many national and international, both non-governmental and government organizations, among which are: the Fundación para la Defensa de la Naturaleza (FUDENA), the Sociedad de Ciencias Naturales La Salle, the Universidad Nacional Experimental de los Llanos Ezequiel Zamora (UNELLEZ), the Ministerio del Ambiente y los Recursos Naturales Renovables (MARNR), the Servicio Autónomo de Fauna (PROFAUNA), the Instituto Nacional de Parques (INPARQUES), the Masaguaral, Puerto Miranda and El Frío ranches, the Agencia Espanola de Cooperación Internacional (AECI), the Wildlife Conservation Society (WCS), the World Wildlife Fund (WWF-USA), World Wide Fund for Nature (WWF), the National Geographic Society, and the Smithsonian Institution.

The aim of this paper is to present the results of the evaluation of the reintroduction of Orinoco crocodiles in the Caño Guaritico Wildlife Refuge, using FUDENA's database as the main source of information. This evaluation is part of the Action Plan for the Survival of this species, proposed by the Venezuelan Crocodile Specialist Group (GECV) between 1993 and 1994 (Arteaga, 1993; Seijas y Chávez, 1994).

CAÑO GUARITICO WILDLIFE REFUGE

This Refuge was created the 11 of January of 1989, for the official protection of endangered species of the "Llanos" ecosystem, specially the Orinoco crocodile. This is the reason it was chosen as the main area for reintroduction of captive bred crocodiles. The Caño Guaritico is a tributary of the Apure river and is located between the towns of Samán de Apure and Bruzual in the Apure State, and it has a total area of 9300 has (Fig. No. 1).

RESULTS

Numbers and Localities

Between 1990 and 1995 were reintroduced approximately 514 captive bred crocodiles, all of them from the Masaguaral, UNELLEZ, El Frío and Puerto

Miranda Breeding Centers, as shown in Table 1. The number of crocodiles reintroduced increased every year between 1990 and 1993, mainly by the contributions of the Masaguaral Breeding Center, see Fig. 2. Between 1994 and 1995 the number decreased, and in 1995 were released only 80 animals from El Frío Breeding Center.

The firsts reintroductions were in two small tributaries: caño Macanillal and caño Mucuritas, being the first where most of the animals have been released, specifically at the Tapa de la Ramera site. As seen in Table 1, in 1992 crocodiles were reintroduced directly into the caño Guaritico, in the site of Las Ventanas in El Frío ranch, and at the site of Tres Ceibas in the Turagua ranch. To summarised, out of a total of 514 crocodiles reintroduced, 283 have been released in caño Guaritico (55.1%), 227 in caño Macanillal (44.2%) and 4 in caño Mucuritas (0.7%), see Fig. 3.

Number per Breeding Center and Origin

Of the 514 crocodiles reintroduced, 267 (51.9%) came from the Masaguaral Breeding Center, 114 (22.2%) from El Frío, 92 (17.9%) from UNELLEZ and 41 (7.9%) from Puerto Miranda, as seen in Fig. 4. Only for 491 crocodiles there is certainty about their origins, being 303 animals (61.7%) captive bred, and 188 animals (38.3%) collected in 4 rivers and one reservoir in the Llanos. The specific origin of the 491 animals is: 238 (48.5%) Masaguaral, 131 (26.7%) Cojedes river, 60 (12.2%) UNELLEZ, 38 (7.7%) Capanaparo river, 8 (1.6%) unknown, 6 (1.2%) Camatagua reservoir, 4 (0.8%) Portuguesa river, 3 (0.6%) FONAIAP-Puerto Ayacucho and 1 (0.2%) Orinoco river, see Fig. 5.

Sizes

Using data from only 411 (80.2%) reintroduced crocodiles, a comparison of their total length (TL) was done, which shows a decrease from 1990 to 1992, leveling till 1994, as seen in Fig. 6. In 1990 the mean TL was 151.7 cm (SD=22.25 cm), in 1991 was 125.2 cm (SD=30.9 cm), in 1992 was 82.8 cm (SD=35.1 cm), in 1993 was 79.7cm (SD=13.17 cm) and in 1994 was 86.9 cm (SD=16.08 cm). The decrease in TL is due to the fact in 1990 and 1991 animals of up to three years of age were released, and in the last three years only animals of one year of age have been released into this area.

Sex Ratios

The sex ratio is close to 1:2, with 264 males (64.07%), 144 females (34.95%) and 4 undetermined (0.97%). In Fig. 7 are presented the sex ratios of animals released per breeding center, showing for Masaguaral (1:3), El Frío (1:4) and Puerto Miranda (1:4), indicating that these centers have produced mainly males, while on the other hand. UNELLEZ have produced mainly females, with a sex ratio of 3:1.

Condition Index

Seijas (1993), proposed the calculation of a condition index using the total length and weight data for Orinoco crocodiles greater than 50 cm, assuming that below this size and for about six months after they hatch, the animals still have reserves, therefore not reflecting their adaptation to the new environment. According to this author the mathematical expression of this index is the following: $CI = a \cdot W \cdot TL^{-b}$, where a and b are the coefficients calculated in the lineal regression of $\ln W$ on $\ln TL$.

According to the indicated by Seijas (1993) the CI is a measure of the relative "fatness" of the animals, so animals with a $CI < 1$ would be relatively "skinny", and animals with a $CI > 1$ would be relatively "fat".

Using the TL and W data for 411 crocodiles released between 1990 and 1994, a regression analysis of $\ln W$ on $\ln TL$ was done, resulting in the following equation:

$$\ln W = -5.376950 + 2.911783 \ln TL$$

($r^2 = 0.84608$, $p < 0.00001$, 404 d.f.)

For the calculation of the CI of each crocodile the following equation was used:

$CI = 216.351 W TL^{-2.911783}$. In the Graps. 8 and 9 it can be observed the tendencies of CI with respect to TL and W of the group of reintroduced crocodiles. The values of $CI > 1$ correspond to animals in a good condition and mostly greater than 100 cm in TL and 2500 g in W.

Night Surveys in Reintroduction Areas

A few sporadic night surveys have been conducted, most of them previous to the release of animals each year. In Table 2 are summarized the surveys completed mainly in two sectors of the caños Macanillal and Guaritico, indicating the relative water level, the number of surveyed kilometers, the number of crocodiles observed and an abundance index, presented in number of crocodiles per kilometer.

In 1991 approximately 7.8 km of the caño Macanillal were surveyed, counting 14 crocodiles and capturing 4. The number of crocodiles observed represented 25% of the total reintroduced crocodiles (62) to that date, in that caño. The survey also included the mouth of the caño Guaritico, where two adult animals were found.

Approximately 20 km of the caño Guaritico were surveyed in 1992, locating only 3 juvenile crocodiles. The low water level of that month made the study very difficult, due to the fact that there was a very high concentration of spectacled caymans in the caño. By the end of 1993 a series of surveys were conducted in the caño Guaritico, upstream and downstream of Las Ventanas site. Close to 17 km were surveyed and 8 crocodiles were observed and captured, most of them had been released in the Turagua ranch, about 50 km upstream, in June of the same year. It is important to note, besides the distance traveled by the crocodiles, that these animals grew at a higher rate than that reported for crocodiles in other areas (see table of recaptures).

Finally, in December 1994, 22 km upstream from Las Ventanas were surveyed and only one crocodile was observed amongst a high concentration of spectacled caymans, most of those between 120-180 cm and >180 cm of TL. Also were surveyed La Ramera lagoon and caño Macanillal, that were connected because of the high water level. An estimated 25 km were surveyed, observing only 3 adult crocodiles.

Recaptures

As it can be observed in the recaptures Table, 16 animals have been caught in 5 years, by different researchers. There are evidences that some crocodiles stay in the same river where they were released: the recapture in august 1991 in caño Macanillal of a crocodile released in that river in 1990; an animal recaptured in the Tres Ceibas site of caño Guaritico in 1994, this was released in 1993 in the same area; and the 8 animals previously mentioned that moved about 50 km within six months of their release in the caño Guaritico. Although in one instance, a crocodile recaptured in December 1992 at Las Ventanas site of the caño Guaritico had been released in 1991 in caño Macanillal, might indicate the possibility that some animals would move from one river to another.

The mean growth rate of crocodiles recaptured in caño Macanillal was 0.05 cm/day, much lower than that registered for crocodiles recaptured in caño Guaritico, which was 0.138cm/day. It is necessary to conduct further studies to verify these differences, considering a much bigger sample size.

Discussion

In order to accelerate the recovery of crocodile populations in the wild in Venezuela, in recent years have been promoted and carried out the captive breeding and release of these animals into the wild. Restocking has taken place in localities where still exist the species although in low numbers, and reintroduction has been conducted where the populations have been extirpated.

Seijas et al (1990) argue that this strategy has been tested in several parts of the world, and the ecological basis for such activity is that during the early life stages of crocodylians (eggs & hatchlings), a very high mortality occurs due to predators and other environmental factors. The collection of eggs or hatchlings in the wild, for their artificial incubation and raising, eliminates this high mortality and improves their survival probabilities. When these animals are about 1 year old and with a mean TL of 80-90 cm, are released back into the wild.

The effect of the release size of Orinoco crocodiles on their success in adapting to the conditions in the wild has not been determined. However, the results of the population surveys seem to indicate that larger animals stay close to the release sites, while juveniles and subadults tend to disperse. Thorbjarnarson (1989) suggests that the dispersion phase of juveniles and subadults, might be an integral part of the population dynamic of the American crocodile (*Crocodylus acutus*) as well as other

frequently in marginal habitats. Mazzoti (1983) and Gaby *et al* (1981, 1985) indicate that intermediate size crocodiles tend to be found in inaccessible areas, isolated from the areas where hatchlings and adults are found, probably an effect of territoriality from adult or dominant adults. Such effect is even more significant if it is also considered the possible pressures from adult spectacled caymans, found in high densities in the release areas.

At first, the animals were released in caño Macanillal and caño Mucuritas with the idea that these would migrate to the caño Guaritico, which is the Refuge properly, while the management plan was written and facilities were built for the regulation of fishing and hunting activities. So far, none of these expectations have been fulfilled. Under these conditions, since 1992 the animals were released directly into caño Macanillal, because it was thought that the animals released in caño Macanillal would go to the Apure river in times of maximum floods, therefore outside the protected area of the Refuge.

Apparently, the caño Guaritico offers better conditions for the crocodiles, if it is considered that the growth rates are higher than those reported for the caño Macanillal. However, it is very important to conduct a more detailed study in order to confirm or deny this idea, because there are other factors involved, for instance, in caño Guaritico there is a very high density of spectacled caymans, which are certainly playing an important role, specially in regard to competition and predation. All this is important to fine tune the reintroduction program, which in the particular case of caño Guaritico seems to be the release of animals of the same size of the spectacled caymans found there, which is between 120-180 cm and > 180 cm of TL. This would mean that the animals to be release there should be more than one year old, which would increase the costs, both for operation and building of new facilities in the breeding centers.

The crocodile reintroduction program in the Refuge was initially planned *a priori* for the release of 300 animals in a 5 year period, with the aim to establish a viable population with a stock of 10% of that total, that is 30 animals. Until now, 514 animals have been released which exceeds the established goal, all this indicates the necessity of implementing detailed follow-up studies that will answer the present questions and doubts.

Finally, it can be said that one of the major problems this reintroduction program faces today is the lack of information regarding: survival and growth rates, adaptability to the wild, movements and reproduction, among others. Although the program is 6 years old, there are no specific projects aimed to establish the present situation of the species in the area. In 1992, Eddie Escalona from the Venezuelan Wildlife Service (PROFAUNA) presented a proposal to the consideration of the GECV, but the funds could not be obtained. This year, one of the authors, Gustavo Hernández, will begin a follow-up project jointly funded by FUDENA and WCS, and it is hoped that this project will receive the collaboration of national and international organizations interested in the conservation of the highly endangered Orinoco crocodile.

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<i>Year</i>	<i>N° crocodiles</i>	<i>Breeding Center</i>	<i>Locality</i>
1990	30	Masaguaral (16) UNELLEZ (14)	Caño Macanillal (26) C. Mucuritas (4)
1991	53	Masaguaral (39) UNELLEZ (6) El Frio (8)	C. Macanillal (53)
1992	78	Masaguaral (55) UNELLEZ (6) El Frio (17)	C. Macanillal (59) C. Guaritico (19)
1993	155	Masaguaral (98) UNELLEZ (45) El Frio (9) Puerto Miranda (3)	C. Macanillal (9) C. Guaritico (146)
1994	118	Masaguaral (59) UNELLEZ (21) Puerto Miranda (38)	C. Guaritico (118)
1995	80	El Frio (80)	C. Macanillal (80)
Totals	514	Masaguaral = 267* UNELLEZ = 92 El Frio = 114 Puerto Miranda = 41	RFS Caño Guaritico = 5 C. Macanillal = 227 C. Guaritico = 283 C. Mucuritas = 4

Table No. 1: Description of the reintroduction program of Orinoco crocodiles, from the Masaguaral, UNELLEZ, El Frio and Puerto Miranda breeding centers, in the Caño Guaritico Wildlife Refuge (Caños Macanillal, Mucuritas y Guaritico) between 1990 and 1995. Source: Database GECV-FUDENA.

<i>Date</i>	<i>Locality</i>	<i>Water level</i>	<i>Kilometers</i>	<i>Nº crocodiles</i>	<i>Croc/km</i>
August 91	Macanillal ¹	medium	7,8	14	1,80
May 92	Guaritico ²	low	20,0	3	0,15
Dec. 93	Guaritico ²	high	17,0	8	0,47
Dec. 94	Guaritico ²	high	22,0	1	0,05
Dec. 94	Macanillal ³	high	15,0	3	0,20

Table 2: Night Surveys summary of two sectors of the Caños Macanillal and Guaritico, between 1991 and 1994. ¹ Tapas La Ramera-El Jobo, ² Las Ventanas, ³ Laguna La Ramera-Caño Macanillal. Source: Database GECV-FUDENA.

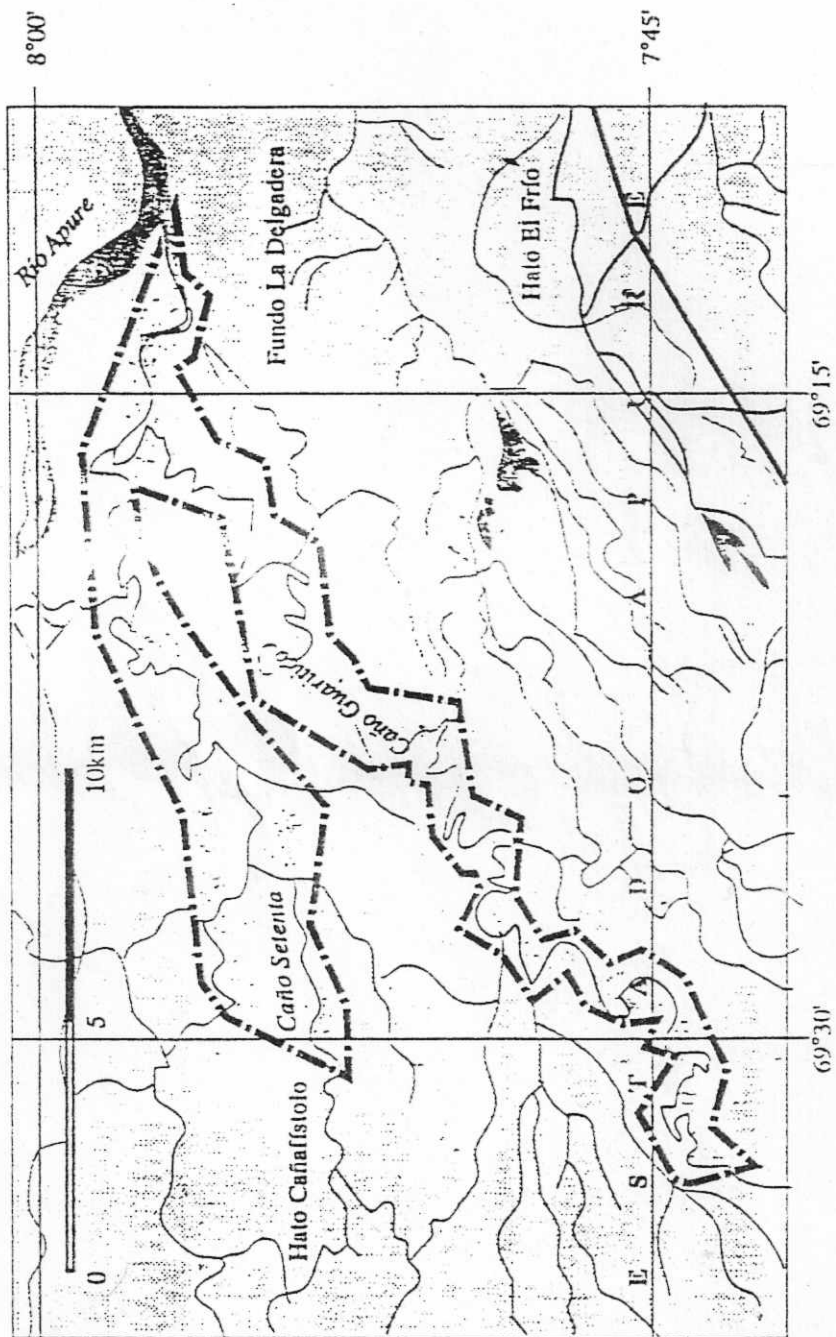


Fig. 1: Area of the Caño Guaritico Wildlife Refuge, where the Orinoco crocodiles have been reintroduced. Apure State, Venezuela. Source: MARNR/DGSP0A/ACM/01

Fig 2: Total number by Breeding Center of Orinoco crocodiles reintroduced in the Wildlife Refuge Caño Guaritico between 1990 and 1995.

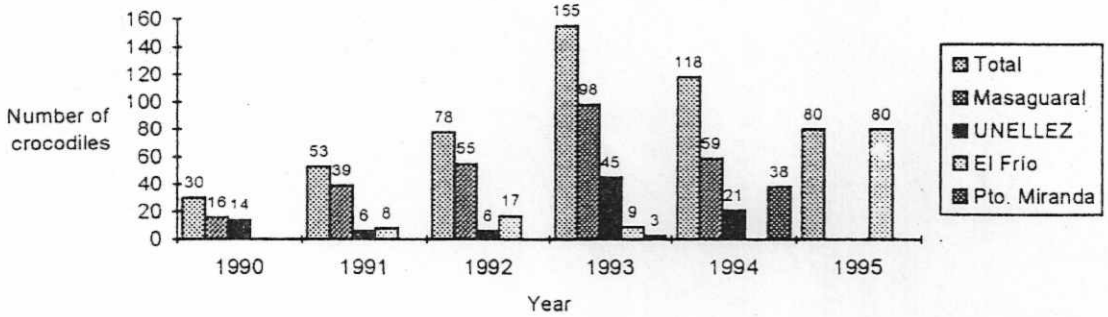


Fig 3: Orinoco crocodiles reintroduced by locality in the Wildlife Refuge Caño Guaritico between 1990 and 1995.

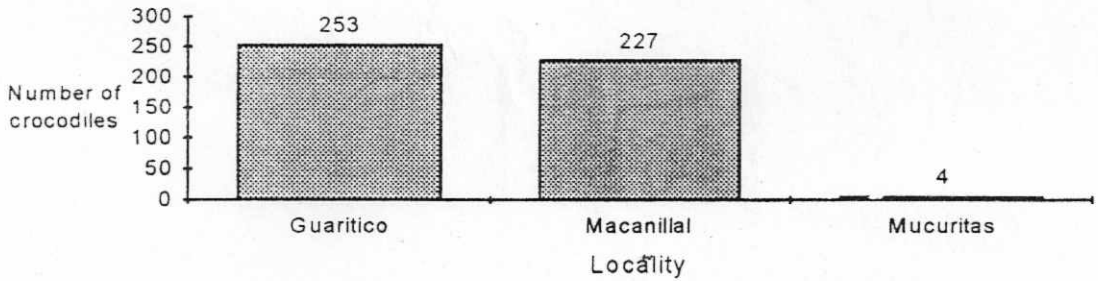


Fig 4: Number of Orinoco crocodiles in the Caño Guaritico Wildlife Refuge by breeding center between 1990 and 1995.

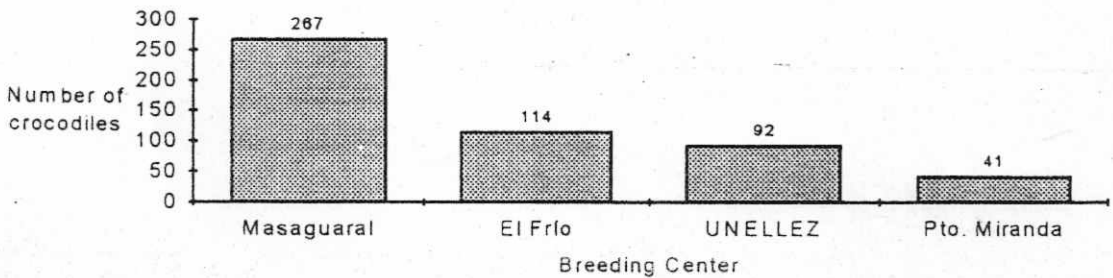


Fig. 5. Specific origins of Orinoco crocodiles reintroduced in the Caño Guaritico Wildlife Refuge between 1990 and 1995.

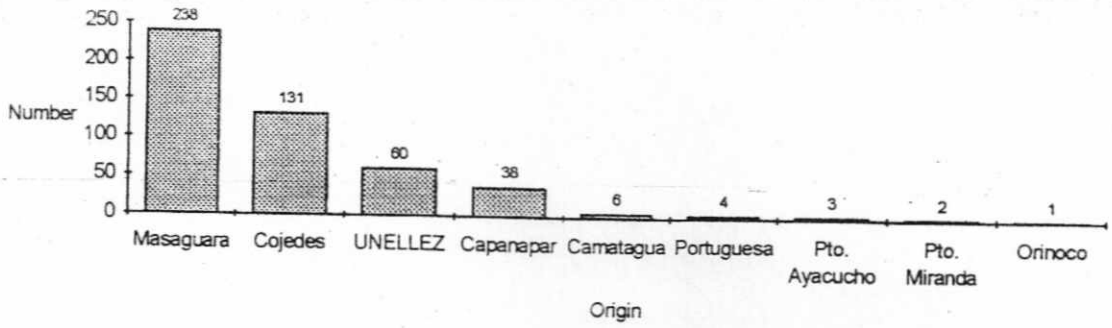


Fig. 6. Mean Total Length and Standard Deviation of Orinoco crocodiles reintroduced in the Caño Guaritico Wildlife Refuge between 1990 and 1994.

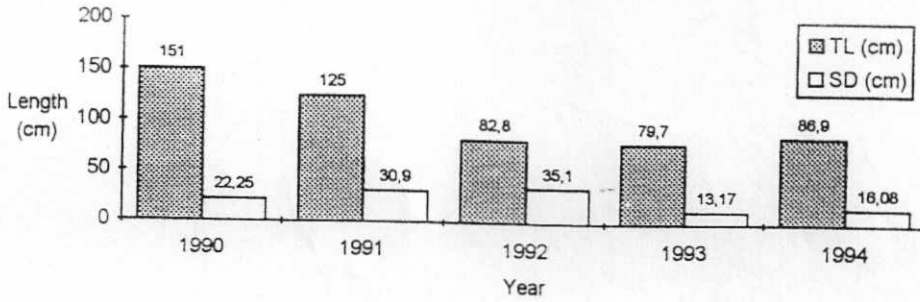


Fig. 7. Sex distribution of Orinoco crocodiles by Breeding Center reintroduced in the Caño Guaritico between 1990 and 1994.

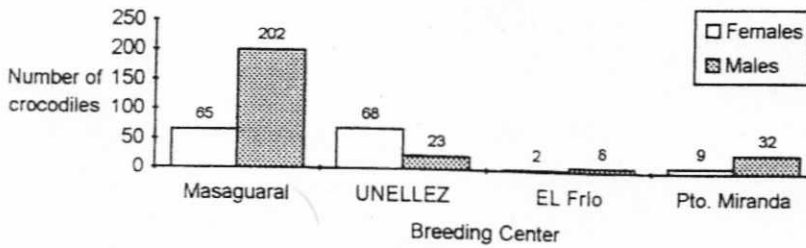
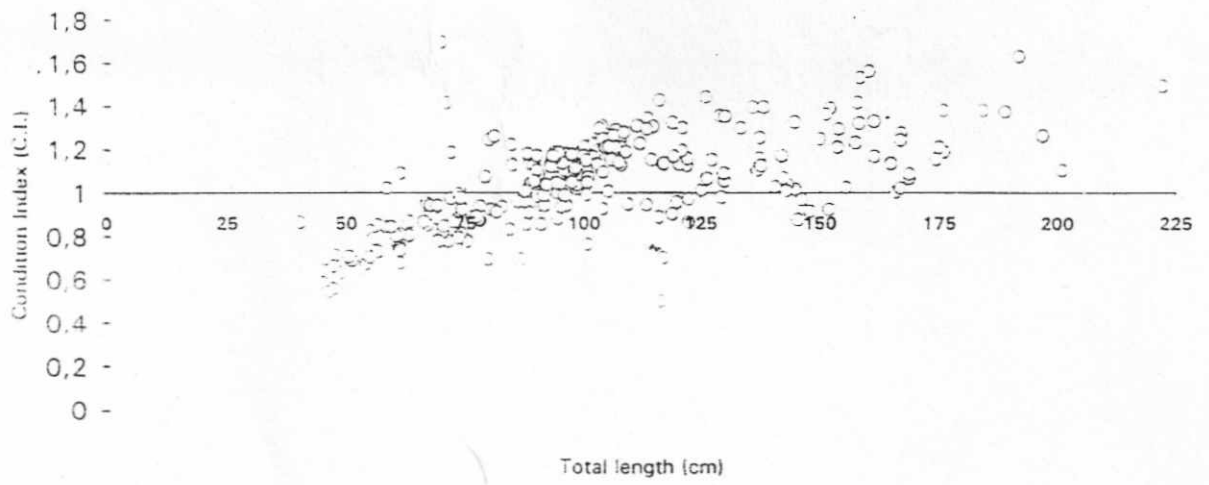


Fig. 8: Relationship between C.I. and TL of *C. intermedius* reintroduced in the Caño Guaritico Wildlife Refuge between 1990 and 1994.



RECAPTURES OF ORINOCO CROCODILES IN CAÑO GUARITICO WILDLIFE REFUGE

DATE	AREA	RECAPTURE	INCREASE TL
2 AUG 1991	Caño Macanillal	2 Masaguaral 1991 1 UNELLEZ 1990 1 El Frio	0.04 cm/day 0.06 cm/day ND ND
21 DEC 1992	Caño Guaritico	1 Masaguaral 1991	0.05 cm/day
17 NOV 1993	Caño Guaritico	2 Masaguaral 1993	0.08 cm/day 0.15 cm/day
13 DEC 1993	Caño Guaritico	4 Masagaural 1993	0.041 cm/day 0.169 cm/day 0.142 cm/day 0.148 cm/day
14 DEC 1993	Caño Guaritico	2 Masaguaral 1993 1 Pto. Miranda 1993 1 El Frio	0.175 cm/day 0.169 cm/day 0.148 cm/day ND
3 JUN 1994	Caño Guaritico	1 Masaguaral 1993	0.134 cm/day
		16 Recaptures	
ND: no data Source: database FUDENA			

Fig. 9: Relationship between C.I. and Weight of *C. intermedius* reintroduced in the Caño Guaritico Wildlife Refuge

