

Conservation Program of Orinoco Caiman (*Crocodylus intermedius*) in Venezuela: captive breeding situation

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The Venezuelan Program of Conservation of the Orinoco Caiman (*Crocodylus intermedius*) started on the decade of 1970 (Quero *et al.* 1995), and early consisted in ranching of specimens collected in the wild environment, reintroduced together with these originated through captive breeding (Ayarzagüena 1990).

In Colombia and Venezuela, there is a wide bibliography on the Program. Several authors had published data and descriptions of the Venezuelan program. Among these, can be cited the works by Ayarzagüena (1990), Arteaga *et al.* (1994), Quero *et al.* (1995), Thorbjarnarson & Arteaga (1995), Velasco (1999), and more recently Seijas (2000), who analyzed the program of captive breeding and reintroduction, and made proposals for its reformulation. On the other hand, Naranjo *et al.* (2000) published a “Proposal for the conservation program in Colombia “.

Most of the published works, however, are concerning on the wild population status in Venezuela (Goldshalk 1978, 1982; Ramo & Busto 1986; Franz *et al.* 1985; Ayarzagüena 1987; Seijas 1992, 1993, 1994^a, 1994^b; Thorbjarnarson & Hernández 1992; Seijas & Chavez 1996, 2000; Seijas 1998), and studies on reproductive ecology in the Capanaparo River (Thorbjarnarson & Hernández 1993^a, 1993^b). For Colombia, the following works on abundance and ecology can be cited: Lugo (1995, 1996, 1997), Barahona *et al.* (1996^a, 1996^b), Barahona & Bonilla (1994, 1999), and Bonilla & Barahona (1999).

Muñoz & Thorbjarnarson (1998) carried out radio telemetry studies with captive breed animals reintroduced in the Capanaparo River, Apure State, with evaluation of survival, pattern of habitat use and displacement, and growth rate. Arteaga & Hernández (1996), and Lugo (1998), evaluated reintroduction, characterization before reintroduction and data on recapture and mobility of specimens delivered to the wild environment.

On 1996, a Workshop on Analysis of Population Viability and Habitat of Orinoco Caiman was held in Caracas (Arteaga *et al.* 1997). In this workshop, distribution, population status, and menaces to the species were emphasized, and several recommendations were indicated on different matters as wild populations, danger and management, captive breeding and application of mathematical models (Vortex) for management enhancement.

It is important to point out that no publications had appeared on the expertise of than 26 years of captive breeding. Only two scientific works can be cited: one on different types of diets of captive breed animals with data on monthly growth rates (Perez 1999), and the other by Boede (2000) in which a summary of veterinary works on three captive breeding establishments is presented, analyzing different diet types offered and several problems observed in the parents, detecting that 41% of the diseases are caused by nutritional handicaps, 53% by scares and wounds, and 6% by shock situations caused by wrong handling.

In Colombia, a similar situation of lack of studies can be found. There are the works performed in the Estación Biológica Tropical Roberto Franco by Ramírez-Perilla (1999, 2000), concerning on egg collection and captive breeding techniques, Ardilla *et al.* (1999^a) on reproduction, embryology and handling, Ardilla *et al.* (1999^b) on growth, and Ardilla *et al.* (1999^c) on skull allometry.

Captive breeding in Venezuela

The earlier attempts of captive breeding started in the decade of 1970 at the Loeffling Zoo Park, Bolívar State (Ramírez *et al.* 1977), with a parent group of 26 specimens (Gorzula 1979). Since 1974, the captive breeding with reintroduction purposes started at the private Hato El Frío, Apure State, and in 1984 in private Finca Masaguaral, Guárico State (Thorbjarnarson & Arteaga 1995), with animals generated in an establishment located at Camatagua. Lately, other private establishments were created by the Universidad Experimental de los Llanos Ezequiel Zamora (Unellez), Vice Rectorado de Guanare, Portuguesa State, and Agropecuaria Puerto Miranda, Apure State.

In 1990 was carried out the reintroduction of 30 specimens into the Wild Fauna and Fishery Reserve of Caño Guaritico, Apure State, a protected area specially created by the government for the conservation of the Orinoco crocodile. Other protected areas for the species were created at The National Park Cinaruco-Capanaro and Hato El Cedral (Apure State), National Park Aguaro-Guariquito and the Manapire River (Guárico State), Tucupido River (Portuguesa State), and Cojedes River (Cojedes State) (Table 1).

Table 1. Reintroduced Caimans to the wild environment, year and location

Year	Caño Guaritico	National Park Cinaruco-Capanaro	National Park Aguaro-Guariquito	Hato Cedral	ElTucupido River	Cojedes River	Manapire River	Total
1990	30							30
1991	56	13						69
1992	99	258			18			375
1993	247	197		4				448
1994	64		30					94
1995	128		69			19		216
1996			76					76
1997	10		43					53
1998	250			15				265
1999	168							168
2000	233			10				243
2001	173	54*	160	20			20	427
Total	1458	522	378	49	18	19	20	2464

* from Masaguaral and Puerto Miranda farms.

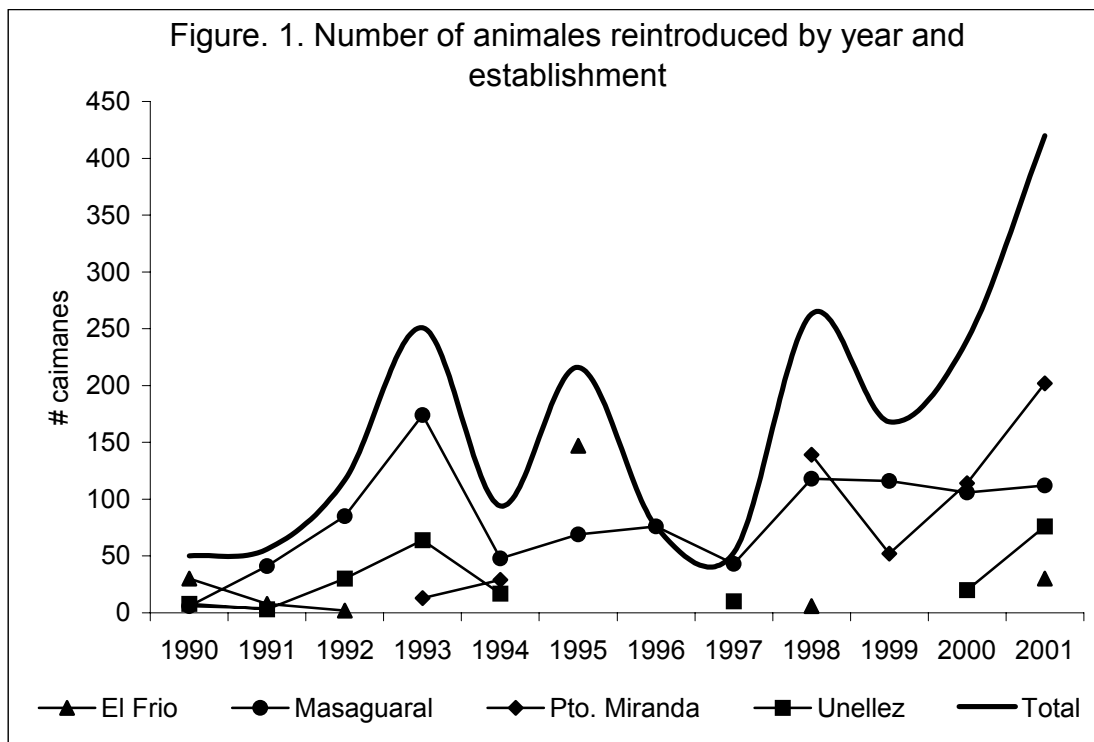
Currently, there are a total of 42 adult specimens in four captive breeding establishments (Table 2).

Table 2. Number of adult Caimans in captive breeding establishments

Establishment	Females	Males	Total
Masaguaral	10	6	16
El Frío	2	2	4
Unellez	4	3	7
Puerto Miranda	9	6	15
Total	27	16	42

Most of the 1.996 reintroduced caimans were produced by the 27 females which are living in the establishments, with the exception of the Hato El Frío, which collected hatchlings from the Cojedes River mainly in 1995, because there are only two females in this establishment from which only one was reproductive, and the 468 animals reintroduced into the Capanaparo River, originated from the same river.

There is an increasing trend of caiman production with reintroduction purposes (Fig. 1), but only one establishment (Masaguaral) had continuously delivered caimans to the environment in 11 years. For different reasons (i.e. reduction in the number of hatchlings, or lack of animals with optimal size for reintroduction), the other establishments could not constantly provide animals for the reintroduction program.



Not all the captive females have been reproduced on the same year. If all females had reproduction in the same year, the egg potential could be 1260 per year with a birth success of 75%, and 1215 animals could be bred with a yearly mortality of 10%. With this calculations, there is a reintroduction potential of approx. 1093 caimans per year from the 4 captive breeding establishments.

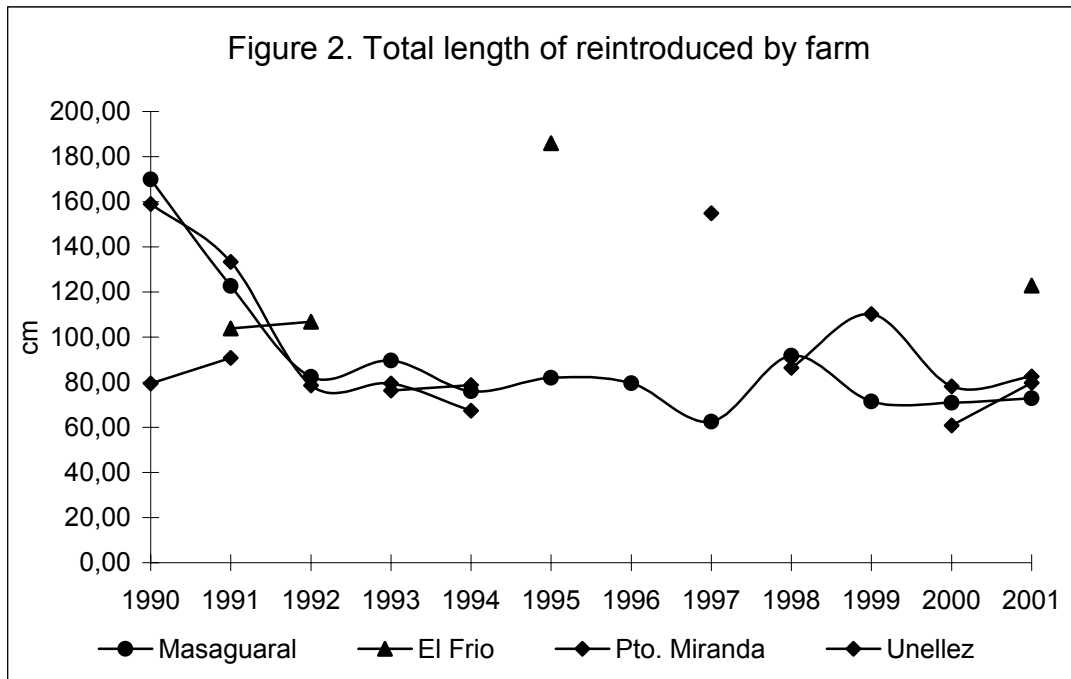
One of the most important problems is the cost of the caiman captive breeding until they reach the optimal size to be reintroduced in the wild environment.

Production cost

As an example, the results of a captive breeding establishment will be used, the Instituto Limnológico de Caicara del Orinoco, Bolívar State, Universidad de Oriente (UDO), in charge of Lic. Aldeima Pérez.

Between Jul 16 1997 and Jun 30 1998 (a period of about 11 months), 60 Orinoco caimans born in Masaguaral were bred in the Caicara's establishment. The caimans arrived with mean values of 34,4 cm length and 101,8 g weight, and after the breed, when the animals were delivered into Caño Guaritico, they

shown mean values of 99,5 cm length and 3,73 kg weight, relatively higher than the values obtained in other establishments during almost one year of breed (Fig. 2).



Caimans were feed with a mixture of cattle meat, chicken eggs, fish meat, and a surplus of vitamins and minerals.

The production costs are show in Table 3. The higher cost item was the payment to one technical university graduated and one worker, followed by food costs and services as electricity, phone and office materials, and finally the low costs of cleaning materials and storage of food.

Table 3. Production costs of 60 caimans breeding during 11 months.

Item	Annual Cost (Bs.)	Annual Cost (US\$) (1 Bs. 512.31 US\$)	Percent (%)
Personnel	5.529.338,80	10,796.03	67,14
Food	2.064.305,00	4,029.45	25,07
Services	561.000	1.095.05	6,81
Cleaning	67.030,00	130.84	0,81
Storage	13.925,00	27.18	0,17
Total	8.235.598,80	16,075.58	

From the total cost of the establishment, the yearly cost of each breed animal is Bs. 137.259,98 (US\$ 267.93)

It is important to point out, however, that these production costs does not include the construction of facilities and infrastructure, with an amount of Bs. 1.187.798,50 (14,307.38 US\$) and laboratory equipments with cost of Bs. 499.731,00 (5,409.76 US\$) installed in 1992-1993. These figures increase the production costs and could be used to calculate their current price lost.

In 2002, (FUDECI) began a research project in two establishments, Masaguaral and Puerto Miranda, on the effect of the crocodile density per pond in the growth rate. This project is carried out on a population born in the same year of 302 hatchlings, together with the parents of both establishments (21 specimens). The project was funded by the National Biological Diversity Office of MARN with Bs. 40 millions in two years. This fund is used exclusively to pay the food of the animals and one worker in each establishment (Hernández, com. pers.).

Using the example of the UDO establishment as reference, the personnel and food costs represented 92,21% of the total yearly cost. Taking the cost per animal obtained in the UDO establishment, the total cost of the project is approximately of Bs. 22 millions per year and the cost of each animal to be released is approximately Bs. 67.150,53 (89.53 US\$)

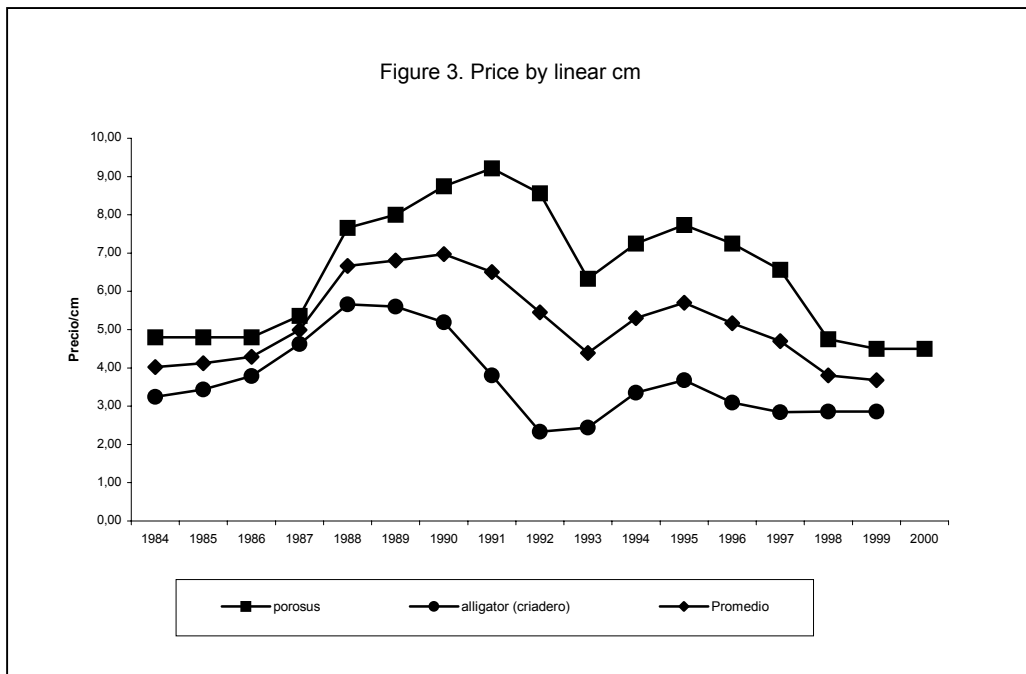
This preliminary analysis of production cost of Orinoco crocodile captive breeding, first indicates that is better to breed a large number of animals to reduce the costs. Nevertheless, the Venezuelan program is suffering another problem because great amount of money have been invested and it have no return. In other words, it is not profitable. If there is not enough funds, the first affected item is the food and its variety, and also vitamins and mineral supply.

Mechanisms must be searched to allow profits for the establishment owners, in order to recover a part of their investment. In this scenery, several proposals can be done in order to make the captive breeding a profitable activity:

1. To increase the production of specimens born in captivity, to obtain more crocodilians to breed.
2. To allow the egg or hatchlings collection in the environment for ranching, based upon wild population studies. This alternative implies a management program with participation of local residents and indigenous communities, associating the collection with economic profit.
3. To allow the sustainable use with commercial purposes of a fraction of the captive breed specimens in order to obtain economic profit for the establishment.

The proposal scenery can be analyzed in the framework of the marketing of products with commercial value. The key point is to determine how much animals can be sustainable used, to allow the recovery of captive breeding establishment investments and costs, with the final result of increasing the number of specimens.

An interesting exercise can be done. In Fig. 3 the sell prices of two classic skins, *C. porosus* and *A. missipiensis*, in a period of 10 years are shown. If a mean value between both species is assigned to the Orinoco crocodile, which is classified as a classic skin, and a size accepted in the market (120 cm total length) is obtained in one year and half of breeding, each specimen could cost approximately Bs. 78.342,29 (104.46 US\$). If it can be sell by Bs. 110.400,00 (147.20 US\$), the profit margin could be approximately 40.92% of the investment per animal.



If this economical analysis of the captive breeding is adjusted to the real situation and the market behavior can be predicted in the proposed way, the recovery of investment is possible with a yearly sustainable use of 199 specimens from a total of 323 breed crocodilians, in the case of the FUDECI project.

Bibliography

Ardilla, R. M. C., S. Barahona, O. P. Bonilla & D. R. Cárdena. 1999^a. Aportes al conocimiento de la reproducción, embriología y manejo de *Crocodylus intermedius* en la Estación de Biología Tropical Roberto Franco de Villavicencio. Revista de la Academia Colombiana de Ciencias Exactas, Físicas y Naturales (Rev. Acad. Col.) Suplemento Especial XXIII: 417-424.

Ardilla, R. M. C., S. Barahona, O. P. Bonilla & D. R. Cárdena. 1999^b. Evaluación del crecimiento de *Crocodylus intermedius* nacidos en la Estación de Biología Tropical Roberto Franco de Villavicencio. Revista de la Academia Colombiana de Ciencias Exactas, Físicas y Naturales (Rev. Acad. Col.) Suplemento Especial XXIII: 425-435.

Ardilla, R. M. C., S. Barahona, O. P. Bonilla & D. R. Cárdena. 1999^c. Análisis morfométrico craneal asociado con la edad de *Crocodylus intermedius* nacidos en la Estación de Biología Tropical Roberto Franco de Villavicencio. Revista de la Academia Colombiana de Ciencias Exactas, Físicas y Naturales (Rev. Acad. Col.) Suplemento Especial XXIII: 417-424.

Arteaga, A., A. E. Seijas, C. Chavez & J. Thorbjarnarson. 1994. Status and Conservation of the Orinoco Crocodile: An Update. pp 143-150. In: Crocodiles. Proceeding of the 12th Working Meeting of the Crocodile Specialist Group. IUCN – The World Conservation Union, Gland, Switzerland. Volume 1. ISBN 2-8317-0239-0. xii + 309 p.

Arteaga, A. & G. Hernández. 1996. Evaluation of the reintroduction of *Crocodylus intermedius* in the Caño Guaritico Refuge (Apure state, Venezuela). pp 207-222. Proceeding of the 13th Working Meeting of

the Crocodile Specialist Group. IUCN- The World Conservation Union, Gland, Switzerland. ISBN 2-8317-0327-1. 516 p.

Arteaga, A., Cañizales, I., Hernández, G., Cruz Lamas, M., De Luca, A., Muñoz, M., Ochoa, A., Seijas, A., Thorbjarnarson, J., Velasco, A., Ellis, S. & Seal, U. 1997. Taller de análisis de la viabilidad poblacional y del hábitat del Caimán del Orinoco (*Crocodylus intermedius*). Reporte del Taller. UICN/SSC Conservation Breeding Specialist Group: Appley Valley, MN. 53 pp.

Ayarzagüena, J. 1987. Conservación del Caimán del Orinoco (*Crocodylus intermedius*) en Venezuela. Parte I: Río Cojedes. Fundación La Salle de Ciencias Naturales. 24 pp.

Ayarzagüena, J. 1990. An update of the recovery program for the Orinoco Crocodile. Crocodile Specialist Group, Newsletter. 9(3):16-18.

Barahona, S., P. Bonilla, H. Naranjo & A. Martínez. 1996^a. Estado, distribución, sistemática y conservación de los Crocodylia Colombianos. pp 32-51. Proceeding of the 13th Working Meeting of the Crocodile Specialist Group. IUCN- The World Conservation Union, Gland, Switzerland. ISBN 2-8317-0327-1. 516 p.

Barahona, S., P. Bonilla, H. Naranjo & A. Martínez. 1996^b. Estado, distribución, sistemática y conservación de los Crocodylia Colombianos. Censos 1994-1996. Ministerio del Medio Ambiente, Colombia. 39 pp.

Barahona, S. & P. Bonilla. 1994. Registros de *Crocodylus intermedius*. Trianea. 5:420.

Barahona, S. L. & O. P. Bonilla. 1999. Evaluación poblacional del caimán llanero (*Crocodylus intermedius*) en el subareal de distribución en el Departamento de Arauca. Revista de la Academia Colombiana de Ciencias Exactas, Físicas y Naturales (Rev. Acad. Col.) Suplemento Especial XXIII: 448-451.

Boede, E. 2000. Sanitary considerations and diseases in Orinoco crocodiles breeders *Crocodylus intermedius* from the venezuelan captive breeding program. Pp 168-176. In: Crocodiles. Proceeding of the 15th Working Meeting of the Crocodile Specialist Group. IUCN- The World Conservation Union, Gland, Switzerland and Cambridge UK. ISBN 2-8317-0549-5.

Bonilla, O. P., & S. L. Barahona. 1999. Aspectos ecológicos del caimán llanero (*Crocodylus intermedius*) en el subareal de distribución en el Departamento de Arauca. Revista de la Academia Colombiana de Ciencias Exactas, Físicas y Naturales (Rev. Acad. Col.) Suplemento Especial XXIII. 86:40-48.

Franz, R., S. Reid & C. Puckett. 1985. Discovery of a population of Orinoco Crocodile (*Crocodylus intermedius*) in Southern Venezuela. Biol. Conser. 32:137-147.

Goldshalk, R. E. 1978. El Caimán del Orinoco *Crocodylus intermedius*, en los Llanos Occidentales Venezolanos con observaciones sobre su distribución en Venezuela y recomendaciones para su conservación. Reporte final a Fudena (WWF/Ven.). 58 pp.

Goldshalk, R. E. 1982. Status and conservation of *Crocodylus intermedius* in Venezuela. pp. 39-53. In: Crocodiles. Proceeding of the 5th Working Meeting of the Crocodile Specialist Group. Gainesville, FL. IUCN Publications N. S. Gland, Switzerland.

Gorzula, E. 1979. Reporte sobre Caimán del Orinoco (Estado Bolívar). Archivo Comité de Conservación de Cocodrilos de Fudena. Mimeog. 2 pp.

Jenkins, R. W. 1994. Conservation benefits of captive breeding – A CITES perspective. pp 155-161. In: Crocodiles. Proceeding of the 12th Working Meeting of the Crocodile Specialist Group. UICN – The World Conservation Union, Gland, Switzerland. Volume 1. ISBN 2-8317-0239-0. xii + 309 p.

Lugo, M. 1995. Programa para la conservación del Caimán del Orinoco (*Crocodylus intermedius*) en Colombia. Informe presentado a la Estación de Biología Tropical Roberto Franco, Universidad Nacional de Colombia. Mimografiado. 8 pp.

Lugo, M. 1996. Avance en la investigación del estatus del Caimán del Orinoco. Newsletter 15(4):15-16.

Lugo, M. 1997. Programa para la conservación del Caimán del Orinoco (*Crocodylus intermedius*) en Colombia. Informe técnico final. WCS – 290. mimografiado. 42 pp.

Lugo, M. 1998. Evaluación del programa de liberación del Caimán del Orinoco (*Crocodylus intermedius*) en el Refugio de Fauna Silvestre “Caño Guaritico y sus Alrededores” (estado Apure). Trabajo Especial de Grado para obtener el título de Magíster Scientiarum. Unellez. 105 pp.

Muñoz, M. & J. Thorbjarnarson. 1998. Radio-tracking captive-reared Orinoco Crocodile (*Crocodylus intermedius*) released into the Capanaparo river, Venezuela. pp 313-319. Proceeding of the 14th Working Meeting of the Crocodile Specialist Group. IUCN- The World Conservation Union, Gland, Switzerland and Cambridge UK. ISBN 2-8317-0467-7.

Naranjo, H., G. Andrade; A. M. Franco; J. Ramírez; M. Rodríguez; A. Velasco & H. Zambrano. 2000. Programa Nacional para la conservación del Caimán Llanero (*Crocodylus intermedius*) en Colombia. pp 277-283. In Crocodiles: Proceeding of the 15th Working Meeting of the Crocodile Specialist Group. IUCN- The World Conservation Union, Gland, Switzerland and Cambridge UK. ISBN 2-8317-0549-5.

Perez, A. 1999. Dieta y requerimiento nutricionales del Caimán del Orinoco (*Crocodylus intermedius*) en cautiverio. Informe final, Universidad de Oriente – Instituto Limnológico. 57 pp.

Ramírez, C. & C. C. Castillo. 1977. Proyecto venezolano sobre cocodrilos (Venezuelan Crocodile Project) Herp. Rev. 8(4):130.

Ramírez-Perilla, J. 1999. Técnicas de recolección y control de calidad de huevos de tortugas y cocodrilos. Zoodivulgación. 1(1):32 pp.

Ramírez-Perilla, J. 2000. Caimán llanero o Cocodrilo del Orinoco (*Crocodylus intermedius*): Conservación y conocimiento público en la Orinoquia Colombiana. Zoodivulgación. 2(1):71 pp.

Ramo, C. & B. Busto. 1986. Censo aéreo de caimanes (*Crocodylus intermedius*) en el río Tucupido (Portuguesa, Venezuela) con observaciones sobre su actividad de solamiento. pp. 109-119. In: Crocodiles. Proceeding of the 7th Working Meeting of the Crocodile Specialist Group. Caracas, Venezuela. IUCN- The World Conservation Union, Gland, Switzerland.

Seijas, A. E. 1992. Status of Orinoco Crocodiles populations in some localities in the Venezuelan Llanos. Pp 79. In: Crocodiles. Proceeding of the 11th Working Meeting of the Crocodile Specialist Group of the

Species Survival Comisión of the UICN - The World Conservation Union, Gland, Switzerland. Volume 2. ISBN 2-8317-0133-3.

Seijas, A. E. 1993. Estado poblacional y aspectos ecológicos del caimán del Orinoco (*Crocodylus intermedius*) en los ríos Cojedes y Sarare. Unellez. Guanare, Portuguesa. 36 pp.

Seijas, A. E. 1994^a. Ríos Cojedes y Sarare: localidades claves para la conservación del caimán del Orinoco (*Crocodylus intermedius*). Proyecto Código 23191106. Unellez. Guanare, Portuguesa. 45 pp.

Seijas, A. E. 1994^b. El Caimán del Orinoco (*Crocodylus intermedius*) en el Embalse Tucupido. Proyecto Código 23191107. Unellez. Guanare, Portuguesa. 20 pp.

Seijas, A. E. & C. Chávez. 1996. Potencial de la laguna El Eneal, estado Cojedes, para la conservación de la fauna silvestre, especialmente de las especies Baba (*Caiman crocodilus*) y Caimán (*Crocodylus intermedius*). Proyecto Convenio Conicit Gobernación del estado Cojedes No. PC – CO – 009. 52 pp.

Seijas, A. E. 1998. The Orinoco Crocodile (*Crocodylus intermedius*) in the Cojedes river system, Venezuela: population status and ecological characteristics. A dissertation presented to the graduate school of the University of Florida in partial fulfillment of the requirements for the degree of Doctor of Philosophy. University of Florida. 192 pp.

Seijas, A. E. & C. Chávez. 2000. Population status of the Orinoco Crocodile (*Crocodylus intermedius*) in the Cojedes river system, Venezuela. *Biological Conservation*. 94:353-361.

Seijas, A. 2000. Conservation of the Orinoco Crocodile in Venezuela: A blind alley. Pp. 271-276. In *Crocodiles: Proceeding of the 15th Working Meeting of the Crocodile Specialist Group*. IUCN- The World Conservation Union, Gland, Switzerland and Cambridge UK. ISBN 2-8317-0549-5.

Thorbjarnarson, J. & G. Hernández. 1992. Recent investigation of the status of Orinoco Crocodile *Crocodylus intermedius* in Venezuela. *Biol. Conser.* 62:179-188.

Thorbjarnarson, J. & G. Hernández. 1993^a. Reproductive ecology of the Orinoco Crocodile (*Crocodylus intermedius*) in Venezuela. I. Nesting ecology and egg and clutch relationships. *Journal of Herpetology*. 27(4):363-370.

Thorbjarnarson, J. & G. Hernández. 1993^b. Reproductive ecology of the Orinoco Crocodile (*Crocodylus intermedius*) in Venezuela. II. Reproductive and social behavior. *Journal of Herpetology*. 27(4):371-379.

Thorbjarnarson, J. & A. Arteaga. 1995. Estado poblacional y conservación del Caimán del Orinoco en Venezuela. P 159-170. En: Larriera, A. & Verdade, L. M. (Eds.). *La Conservación y el Manejo de Caimanes y Cocodrilos de América Latina*, Vol. 1. Fundación Banco Bica. Santo Tomé, Santa Fe, Argentina. ISBN 950-9632-21-X.

Quero, M; A. Velasco, J. Thorbjarnarson & A. E. Seijas. 1996. El Caimán del Orinoco y otros cocodrilos de Venezuela. Cuadernos Ecológicos Corpoven. 40 pp. ISBN 980-259-748-1.

Velasco, A. 1999. Reintroduction program of the Orinoco Crocodile in Venezuela. *Re-introductions News*. Nº 18:24-25. ISSN:1560-3709.