# **Orinoco Crocodile** Crocodylus intermedius

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Common Names: Orinoco crocodile, caimán del Orinoco, caimán llanero

Range: Venezuela, Colombia



Figure 1. Distribution of Crocodylus intermedius.

**Conservation Overview** 

CITES: Appendix I

2018 IUCN Red List: Critically Endangered (Criteria A1c, inferred decline of >80% in 3 generations, reduced area of

occurrence. C2a. Wild adult population may be less than 250 individuals, with continuing declines and fragmentation) (last assessed in October 2017; Balaguera-Reina *et al.* 2018).

CSG Action Plan:

- Availability of survey data: Adequate
- Need for wild population recovery: Highest
- Potential for sustainable management: Moderate

<u>Principal threats</u>: limited distribution, habitat loss, illegal egg poaching, hunting

# **Ecology and Natural History**

The Orinoco crocodile is a large, relatively long-snouted crocodile (Fig. 2) restricted to the middle and lower reaches of the Orinoco River and its tributaries in Venezuela and Colombia (Thorbjarnarson and Franz 1987). Although found in a wide variety of habitats, including rivers in tropical evergreen forest and piedmont streams in the foothills of the Andes, it reached its greatest numbers in the seasonal rivers of the Llanos savanna region (Medem 1981, 1983). Based on a Species Distribution Model, Balaguera-Reina *et al.* (2017) obtained a suitable area probability of 23,621 km<sup>2</sup> in both countries of origin. Colombia has 1643 km<sup>2</sup> of its habitat within protected areas, while Venezuela has 919 km<sup>2</sup>; this represents only 11% of the species potential range.



Figure 2. Adult male Orinoco crocodile at El Frio Biological Station, Venezuela. Photograph: Ariel Espinosa-Blanco.

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The Orinoco crocodile is a hole-nesting species. Females mature at approximately 2.5 m TL (Thorbjarnarson and Hernández 1993a), laying eggs in seasonally exposed sandbars and riverbanks early in the annual dry season (January-February) (Figs. 3 and 4). Average clutch size in wild populations varies between 38 and 49 eggs, with a reported maximum of 66 eggs (Jiménez-Oraá *et al.* 2007; Navarro 2007; Antelo 2008; Espinosa-Blanco *et al.* 2013). Hatchlings emerge during the rise in river levels associated with the wet season (Thorbjarnarson and Hernández 1993a; Seijas and Chávez 2002; Antelo 2008).



Figure 3. Female Orinoco crocodile guarding her hatchlings inside a cave at Garza Ranch, Apure, Venezuela. Photograph: Alberto Blanco Davila.



Figure 4. Female Orinoco crocodile guarding her nest on a Capanaparo River sand bank, Venezuela. Photograph: Omar Hernandez.

Reported dry season densities of *C. intermedius* were very high (Fig. 5), a factor that facilitated hunting for skins (Medem 1981, 1983). In smaller rivers that are reduced to a series of interconnected or isolated pools during the dry season, *C. intermedius* aestivate in burrows dug into riverbanks (Medem 1981; Antelo 2008). Information about ecology, population status and reproductive behavior of the Orinoco crocodile in Venezuela has been accumulating over the last 30 years (Thorbjarnarson and Hernández 1992, 1993a,b; Seijas and Chávez 2000, 2002; Llobet and Seijas 2003; Seijas 2007; Ávila-Manjón 2008; Antelo 2008; Espinosa-Blanco *et al.* 2010; Espinosa-Blanco and Seijas 2012; Espinosa-Blanco

*et al.* 2017a,b); in a review done by Seijas (2017), 27 publications were documented for the species in Venezuela up to 2014 (excluding notes in the Crocodile Specialist Group Newsletter) and around 20 more were published between 2014 and 2017; whereas in Colombia, knowledge on population status has improved (Bonilla and Barahona 1999; Ardila-Robayo *et al.* 2002; Merchan *et al.* 2011; Anzola and Antelo 2015). Morales-Betancourt *et al.* (2013) and Merchan *et al.* (2011) compile information on the species' biology and conservation.



Figure 5. Juvenile Orinoco crocodiles sharing habitat with an adult Common caiman in Venezuela. Photograph: Alvaro Velasco Barbieri.

### **Conservation and Status**

The Orinoco crocodile is one of the most endangered New World crocodilians. Commercial overexploitation began at the end of the 1920s in Colombia and Venezuela, with intensive hunting from 1930 to 1935 (Mondolfi 1965). A population of at least 3 million individuals (Antelo 2008) was completely decimated by the 1960s (Medem 1981, 1983).

Thirty-four critical areas were identified for the conservation of *C. intermedius*; 16 in Colombia, 17 in Venezuela, and one that is shared by the two countries. The river systems in Venezuela [Cojedes, Capanaparo, Caño Guaritico, Caño Macanillal, La Ramera lagoon and surrounding areas of El Frío Biological Station (EFBS) and the Manapire] and Colombia (Ele, Lipa, Cravo Norte River System, Tomo River, Guayabero River and La Aurora Natural Reserve) are the areas with the most optimal conditions for the long-term conservation of the species populations (Balaguera-Reina *et al.* 2017).

Colombia

Explicit legal resolutions to protect the species were enacted at the end of the 1960s (Alberto Donadío, in Medem 1981) and through the 1970s. Medem (1981) surveyed the Colombian llanos in 1974 and 1976, and found evidence of only 280 adult *C. intermedius* throughout a large part of the Departments of Arauca, Casanare, Meta and Vichada, but estimated that 500 individuals more (sub-adults and adults) may have remained undetected - these were the

same areas where the species reached its highest densities in the past. Surveys conducted in 1994-1995 (Lugo 1996) indicated that the species' status had worsened. In that study, four areas with relict populations of the species were identified: 1) drainages of the Lipa, Cuiloto, Ele and Cravo Norte Rivers; 2) Santo Domingo, Duda, Lozada and Alto Guayabero Rivers (Macarena hills); 3) middle reaches of the Meta River; and, 4) the Vichada River. The total number of adults in these four areas was estimated to be 123. Barahona and Bonilla (1999) re-surveyed the first mentioned area (1. above) and found only 29 crocodiles, but estimated a total of 51, most of which were adults. Ardilla-Robayo *et al.* (2002), based on surveys (2000-2001), confirmed the depleted situation of the population in the Arauca River, with only 54 individuals remaining.

On a survey of 166.7 km of river, Anzola and Antelo (2015) found 24 nests (Lipa River, 1 nest, 0.03 nests/km; Ele River, 10 nests, 0.28 nests/km; Cravo Norte River, 13 nests, 0.13 nests/km). Five of the nests were poached by humans, one partially predated by pigs, four flooded, and four were collected for artificial incubation, and 11 had hatched. On the basis of eggshells remaining in the nests, an estimated 510 hatchlings were produced from the nests. These data suggest that the *C. intermedius* population in the Ele, Lipa, and Cravo Norte Rivers has recovered in recent years without direct management. The population in the Arauca basin is the most important in Colombia and one of the most important over the entire range of the species (Clavijo and Anzola 2013).

Over the same 166.7 km, Anzola (2017) observed 102 adult *C. intermedius* between 2014 and 2015 (Ele River, 0.9/km; Lipa River, 0.5/km; Cravo Norte River, 0.5/km). These data indicate a moderate recovery compared to data from Medem (1981), Lugo (1996) and Barahona and Bonilla (1999). There are no published data on the Arauca River, but in 2017 a dead adult male *C. intermedius* was found floating in the river in front of Arauca city. This could be the first report of the species in this river since Medem's surveys in 1978 (L. Anzola, pers. comm. 2017).

Merchan *et al.* (2011) spotlight surveyed 218 km of the Meta River basin, and hundreds of kilometres during the day searching for basking crocodiles, nests and/or their tracks, but could not find any. Informal interviews with local people living near the water bodies provided varying accounts, ranging from "crocodiles have not been seen in decades" to precise descriptions of basking, nesting and poaching. There should be Orinoco crocodiles in the Meta River, but they may be wary due to the presence of boats. Downstream from the mouth of the Casanare River, on the Meta River, some adult crocodiles remain (R. Antelo, unpublished data).

Merchan *et al.* (2011) also carried out aerial surveys over Casanare Department but could not see any crocodiles on shores, beaches or in the water. On the Vichada River the residents of Cumaribo and surrounding communities confirmed the presence of the species in some oxbow lakes formed by the river. In one of these oxbow lakes, "Pozo Caiman", they confirmed the presence of a pair of Orinoco crocodiles through daylight sightings and nesting tracks; the nest was opened and eggs collected for human consumption. Over 760 km of the Vichada River they only saw one Common caiman. Finally, Merchan *et al.* (2011) concluded the population of the Vichada River is in a critical situation with less crocodile sightings than reported in surveys in the mid-1990s.

The Universidad Nacional de Colombia (UNC) carried out surveys in the Santo Domingo, Duda, Lozada and Alto Guayabero Rivers, and the estimated total (direct counts, indirect counts and surveys) in all rivers was 65 individuals (Duda River 35.7%, Guarrojo 30.1%, Guayabero 19.3%, Guarimena 7.3%, Güira 2.9%, Manacacías 2.2%, Yucao 1.6%, Meta 1%). The study found the highest proportion of forest on the banks of the Duda, Guayabero, Guarrojo and Guarimena Rivers, followed by the Yurimena, Güira, Manacacias, Yucao and Meta Rivers. The largest proportion of banks for nesting was in the Duda, Guayabero, Güira and Yucao Rivers, followed by the Meta, Guarrojo, Manacacias, Yurimena and Guarimena Rivers. Finally, regarding anthropic intervention, it was high in most rivers except the Duda, Guayabero, Guarrojo and Manacacías Rivers (Ardila-Robayo et al. 2010).

The only increase in relative abundance for the species in Colombia, over a 13-year period, was in the Ele, Lipa and Cravo Norte Rivers on the basis of nest surveys (Anzola and Antelo 2015).

On 21 July 1997, *C. intermedius* was declared a species "endangered of extinction" in Colombia, according to Resolution 0676 of the Ministry of the Environment (Ministerio del Medio Ambiente; MMA). MMA, together with the Alexander von Humboldt Institute (IAvH), UNC and other public and private organizations, prepared the "Programa Nacional para la Conservación del Caimán Llanero" (PROCAIMAN) in 1998. The goal of the program was, over a 10-year period, to prevent the extinction of *C. intermedius* in Colombia and to promote its recovery and integrate it into regional economic and cultural systems. Some of the proposed actions of the program were to:

- a. rescue eggs and hatchlings in the wild;
- b. increase to 2500 individuals the rearing capacity of the breeding-rearing facilities in the country;
- c. identify potential habitats for reintroductions;
- d. define protocols for reintroduction;
- e. monitor reintroduced populations; and,
- f. promote international exchange.

Many of the goals were achieved, but PROCAIMAN is no longer operational. One of the greatest achievements was breeding and rearing the species in captivity. As of December 2017, there were approximately 743 captive *C. intermedius* in Colombia, of which 420 are at the Estación de Biología Tropical Roberto Franco (EBTRF) in Villavicencio, under direction of Pedro Sanchez Palomino from UNC (Martínez, pers. comm. 2018) and 309 at Bioparque Wisirare, under direction of Fundación Palmarito, in Orocué, Casanare. Some of the crocodiles at Bioparque Wisirare were obtained from: pairs held in captivity; from 150 wild eggs collected in January 2015 from the Ele River (Arauca) and artificially incubated; and 159 wild hatchlings collected in May 2016 from the Cravo Norte River (Arauca). Additional adults are held at Piscilago Zoo (9) and Bioparque Los Ocarros (5).

Another goal completed by Colombia was the identification of potential habitats and protocols for reintroduction (Moreno-Arias *et al.* 2014). There are two official reintroduction protocols, one from the National Parks of Colombia (2014), and another for the jurisdiction of Corporinoquia (2015). To date, 121 *C. intermedius* have been released into the wild. These releases can be summarized as:

- In May 2015, the first release of 21 (7M, 14F) young *C. intermedius* was carried out by Fundación Palmarito in Laguna Caiman, adjacent to the Tomo River (Fig. 6) and within the Tuparro National Natural Park in Vichada Department (Antelo 2015) (Fig. 7). The released crocodiles were tracked by radio-telemetry (Fig. 8).
- In November 2015, EBTRF released 4 (2M, 2F) adult *C. intermedius* in the Guayabero and Lozada Rivers in La Macarena Municipality and tracked them by satellite telemetry (Moreno-Arias *et al.* 2016).
- In December 2015, 12 (6M, 6F) *C. intermedius* were released in La Aurora, a private nature reserve by Fundación Palmarito.
- In February 2016, 20 crocodiles were released in Laguna Caiman by Fundación Palmarito.
- In November 2017, 15 (3M, 12F) adults were released in the Manacacías River in Puerto Gaitán Municipality by EBTRF, and 29 (15M, 14F) were released in Cravo Norte River (Arauca Department) by Fundación Palmarito.
- In December 2017, 20 young *C. intermedius* were released by Fundación Palmarito in La Aurora Nature Reserve.



Figure 6. Tomo River in the peak of the rainy season, El Tuparro National Park, Colombia. Photograph: Rafael Antelo.



Figure 7. First Orinoco crocodile release at El Tuparro National Park, Vichada, Colombia. Photograph: Milton Diaz.



Figure 8. Tracking of released adult Orinoco crocodile by the Universidad Nacional de Colombia. Photograph: Javier Silva.

All efforts to release *C. intermedius* into the wild have been coordinated with the Regional Autonomous Corporations (CORMACARENA and CORPORINOQUIA) and in conjunction with the Ecosystem Division of the Ministry of the Environment, and the National Natural Parks of Colombia office. Some interviews with locals are conducted while surveying *C. intermedius* habitats, and many of them are in favor of conservation of the species (Anzola 2017).

The Ministry of Environment and Sustainable Development and the National University of Colombia-Genetics Institute developed the molecular characterization of DNA from populations of *C. intermedius*. Two haplogroups were recognized in the *ex-situ* population kept at EBTRF - Haplogroup I (Cint1) and Haplogroup II (Cint2, Cint3, Cint4). Haplotypes Cint2 and Cint3 are those with the greatest geographical distribution, while haplotypes Cint1 and Cint4 represent genetic forms of distribution restricted to the Metica River (Meta) and the Cravo Norte River (Arauca) (Cuervo-Alarcón and Burbano-Montenegro 2012). This study looked for the presence of more than one distinct evolutionary lineage in the *ex-situ* population of *C. intermedius* at EBTRF. The haplotypic diversity detected was higher than in other species of crocodilians from populations studied in their natural habitat. This result could be the consequence of the origin of multiple geographic locations of the founders of *C. intermedius*. The levels of haplotypic divergence do not indicate the need to establish more than one management unit in the current *ex-situ* population of *C. intermedius* at EBTRF (Bloor 2013).

Well-intentioned approaches between the environment authorities of Colombia and Venezuela have not translated into any concrete action to integrate the conservation programs of the two countries.

• Venezuela

The Orinoco crocodile is legally protected in Venezuela (Resolution No. 95, 1979, Presidential Decree 1.486, 1996). In the early 1990s, members of the Venezuela Crocodile Specialist Group developed the Orinoco Crocodile Action Plan (OCAP) for the country (FUDENA 1992; PROFAUNA 1994). The Ministry of Environment (MARN) also developed an action plan for the conservation of *C. intermedius* (Velasco 2003). The OCAP stressed the need to:

- a. assess the current status of wild populations and their habitats;
- b. identify and legally protect areas containing viable wild populations;
- c. promote the establishment of protected areas on private lands;
- d. promote more in-depth bio-ecological studies;
- e. optimize the functioning of the captive breeding centers and establish a long-term strategy for the reintroduction and restocking of crocodiles;
- f. promote environmental education and community participation programs; and,
- g. strengthen inter-institutional cooperation and coordination of work.

The final goal of this plan was to consolidate, in 15 years, at least 10 viable *C. intermedius* populations. The degree to which these goals have been achieved is discussed below:

1. The current status of *C. intermedius* in Venezuela is relatively well known. Surveys covering 3500 km of river in the late 1970s (Godshalk 1978, 1982) reported the presence of at least 273 adult crocodiles, most of them (81%) in just three rivers (Cojedes, Capanaparo and Meta Rivers, with 76, 78 and 67 adults, respectively). In the 1980s, surveys by Franz *et al.* (1985), Ramo and Busto (1986), Ayarzagüena (1987) and Thorbjarnarson and Hernández (1992) confirmed the depleted status of the species, and the relative importance of the Cojedes and Capanaparo Rivers.

There are four important populations of *C. intermedius* in Venezuela: a) Capanaparo River; b) Guaritico-Macanillal creek system, Ramera Lagoon and surrounding areas of El Frío Biological Station (EFBS) in Apure State; c) Manapire River in Guárico State; and, d) Cojedes River system between Cojedes and Portuguesa States.

A recent report by Babarro (2017) indicates the species' status remains Critically Endangered, and the most important populations show a marked decreasing trend over the past 10 years. In the analysis by Balaguera-Reina *et al.* (2017), there are locations in Venezuela that show increases in population abundance, such as Chigüchigüe Lagoon (2.35 to 10 crocodiles/km) and Larga Lagoon (3.5 to 6.5 crocodiles/km) in the Manapire region. Velasco *et al.* (2017) initiated a national survey for the Orinoco crocodile in Venezuela, with a goal to survey 27 localities, 12 of which have historic records and 11 of which are Conservation Priority localities.

The population in the Cojedes River system has been repeatedly surveyed since 1996 (Seijas and Chávez 2000; Chávez 2000; Mendoza 2003; Navarro 2007; Ávila-Manjón 2008; Espinosa-Blanco and Seijas 2012; Espinosa-Blanco et al. 2017). The population in this river was estimated to be around 547 non-hatchlings, but analysis of recent data indicates that numbers may be declining (Seijas et al. 2008; Espinosa-Blanco et al. 2017). In the river sections that have been most surveyed, such as La Batea-Merecure and Merecure-Caño Amarillo, the population has decreased, from 106 individuals reported in 1991-1996 (Seijas 1998), to 82 individuals in 2006 (Ávila-Manjón 2008), to 72 individuals in 2009 (Espinosa-Blanco and Seijas 2012), and to 53 in 2016 (Espinosa-Blanco et al. 2017a). Most nesting females are concentrated in one branch of the Cojedes River, Caño de Agua, where at least 29 successful nests were located in 2006 (Ávila-Manjón 2008), but sadly, only 12 nests were located in 2016 (Espinosa-Blanco et al. 2017a). Nonetheless, the Cojedes River system maintains one of the higher density populations. Different studies have described the population of the Orinoco crocodile of the Cojedes River system as one of the most important for the conservation of C. intermedius in Venezuela (Balaguera-Reina et al. 2017; Espinosa-Blanco et al. 2017a).

In the section of the Meta River that defines the border with Colombia, the last surveys were conducted in 1998 (Rios and Trujillo 2004). During spotlight surveys that covered 60.5 km, only two crocodiles were observed. However, according to interviews with local inhabitants, there were 24 adults over 290 km of river - still well below the 67 reported by Godshalk (1982) and indicating a severe decline in the population. It is interesting to note that Godshalk (1978) mentioned that the *Caiman crocodilus* population in the Meta River had been decimated by commercial hunters, and only 4 *C*.

*crocodilus* were observed during 10 hours of spotlight surveys. In contrast, Ríos and Trujillo (2004) observed 335 *C. crocodilus* in 60.5 km, a river length that could be easily traveled in a fraction of the time employed by Godshalk (1978). The response to hunting by *C. crocodilus* in the Meta River appears to have been very different to that of *C. intermedius*.

There is a small C. intermedius population in the Manapire River (Guárico State), which was intensively surveyed in the early 2000s (Jiménez-Oraá 2002; Heredia-Azuaie 2005; Castillo 2009). Thirty crocodiles, most of them sub-adults or adults, are scattered in different parts of the river. The population is under a heavy pressure, because people collect crocodile eggs as they are looking for nests of the river turtle Podocnemis unifilis. In 2016 and 2017, surveys confirmed that the population is still small, but with an increasing trend (Espinosa-Blanco et al. 2017b), despite evidence of hunting of adult crocodiles and egg collection for local community consumption (Espinosa-Blanco, pers. comm. 2018). In contrast, Balaguera-Reina et al. (2017) detected a significant decrease in relative abundance for the Manapire River since 2015.

Other isolated *C. intermedius* populations are known to exist in areas of low human population density and at least two smaller populations are in reservoirs (Thorbjarnarson and Hernández 1992; Seijas *et al.* 2002). Neither of the latter appears to offer suitable habitat for the long-term survival of *C. intermedius* populations. In 2011 and 2012, night surveys were conducted in the Tucupido Dam and no Orinoco crocodiles were sighted; nevertheless, the National Program has released juvenile crocodiles in the dam, but no night survey were conducted to assess postrelease survival (A. Espinosa-Blanco, pers. comm. 2018).

2. In Apure State, crocodile habitat has been set aside in the Santos Luzardo National Park (also known as Cinaruco-Capanaparo NP) and in the Caño Guaritico Wildlife Refuge. There are also two protected areas in Guárico State - the Aguaro-Guariquito NP and the Esteros de Camaguán Wildlife Reserve. Only in the former area was there a viable *C. intermedius* population prior to its declaration as "protected". Although captive-reared crocodiles have been released in all of these areas, no management plan has yet been implemented for the species and the areas are severely understaffed.

An evaluation of the Capanaparo River population in 2000 (Llobet 2002; Llobet and Seijas 2003) estimated 536 non-hatchling Orinoco crocodiles, very similar to estimates reported by Thorbjarnarson and Hernández (1992), 10 years earlier. The number of nesting females was estimated to be 28 over the 279 km of the Capanaparo River in Venezuela. Moreno *et al.* (2014) observed 218 Orinoco crocodiles in 162 km

of spotlight survey of the Cinaruco and Capanaparo Rivers in 2011. Hernández et al. (2014) surveyed 193 km of the Capanaparo River and detected 20 active nests - 17 of them hatched successfully and 3 were predated. Five more creches of hatchlings were detected 1 km or further from a nesting site, and these can be considered to reflect 5 more successful nests. Most of the nests were detected in the Lucero-Las Campanas sector, and a total of 251 hatchlings were collected for rearing at the Masaguaral breeding center run by FUDECI. Hernandez et al. (2017) surveyed 169 km of the Capanaparo River between La Macanilla and Las Campanas and found 33 active nests. They suspect the increase between 2013 and 2017 is due to recruitment of adult females from the reinforcement programs (eg 16 3-year-old females hatched at The Dallas World Aquarium were repatriated in 2008 and released in 2009; Sigler 2009).

- There are plans to declare a portion of the Cojedes River system as a protected area for its Orinoco crocodile population (Seijas 2008; Espinosa-Blanco 2010), but until now nothing official has occurred (Babarro 2017).
- 4. There were several medium and large cattle ranches in the Venezuelan llanos with suitable habitat for crocodiles, and which have functioned as efficient wildlife refuges. Captive-reared crocodiles have been released in three ranches (El Cedral, El Frío, Garza). The Government expropriated El Cedral and El Frío to reduce the amount of land in private hands.
- 5. The knowledge on population status, ecology and social behavior of *C. intermedius* has increased substantially in the last 30 years, and there are more than 30 publications available since 2010 (Seijas 2017).
- 6. There were 7 breeding/rearing facilities in Venezuela, 6 of which were devoted to the production of individuals that will eventually be released into the wild (Hernández 2007; Babarro 2008). Babarro (2017) updated the information pointing to the closure of Estación Biológica de Rancho Grande with a capacity to raise more the 800 crocodiles in 2011, and FUDECI's Amazonas Experimental Station with a capacity to raise more than 200 in 2014. Currently, five facilities (Masaguaral, Puerto Miranda, UNELLEZ, El Frío, El Cedral) continue operating with their own adult breeding stock, and also raising hatchlings hatched there or collected from the wild - the facilities have a total capacity of more than 2500 one-year-old crocodiles. The facility at EFBS rears hatchlings from wild-collected eggs, produced by females released at the ranch since 1990. If properly managed, those facilities could rear, if needed, up to 2800 one-yearolds per annum (Hernández 2007). However, some of them are experiencing administrative problems (eg Puerto Miranda, which now belongs to the Ministry of Environment) or are in need of major repairs (eg UNELLEZ). If economic problems continue in

Venezuela, it would be recommended to reduce costs by moving from captive breeding to ranching of eggs/ hatchlings that can be raised and returned to the wild within a year (Hernández *et al.* 2017).

There are seven zoos in Venezuela displaying Orinoco crocodiles; three of them have single animals, or they lack the spaces for breeding. The remaining four (Parque del Este, Parque Zoológico y Botánico de Bararida, Zoológico Metropolitano del Zulia, Zoo de Paya "Leslie Patin") have all together the capacity of producing 350-400 eggs per year (Babarro 2017).

As of November 2017, 10,122 C. intermedius had been released into the wild at 13 localities, and it is considered that the population reinforcement with crocodiles reared in captivity is the main factor preventing the extinction of the species in Venezuela (Babarro 2017). In El Frío Biological Station (that includes the 620 km<sup>2</sup> of Hato El Frío) and in the adjacent Caño Guaritico Wildlife Refuge, population surveys done a decade ago confirmed the success of these reintroductions (Ayarzagüena et al. 2007; Antelo 2008; Velasco et al. 2008), estimated an established population of over 400 non-hatchlings including at least 31 wild breeding females, most of them at El Frío Biological Station. Since April 2009, the facilities and the land of El Frío Biological Station have been under the control of the Venezuelan Government. Some of the wild nests are being collected as part of the conservation program. From 2012 to 2016, 1646 crocodiles hatched from 2319 wild-collected eggs (R. Antelo, unpublished data). Recent reports indicate El Frío continues the protection of the Orinoco crocodile's wild population in its surroundings, and the collection of eggs for artificial incubation in their facilities. The hatchlings produced are reared until they reach 70 cm TL and then released into the wild (R. Antelo, pers. comm. 2018). Nevertheless, recent surveys (2016) indicate that the C. intermedius population in El Frío is decreasing (Espinosa-Blanco et al. 2017b). Rossi et al. (2016) found multiple paternity in 20 clutches laid by crocodiles reintroduced at El Frío; 10 of the clutches were fathered by two or three males.

Two more populations established with released juvenile *C. intermedius* from the National Program are located in Hato El Cedral, where at least seven females are nesting in the area, and in Estero de Camaguán Wildlife Reserve (Velasco *et al.* 2017). Even though a large number of crocodiles have been released in Aguaro-Guaritico NP, there is no clear indication of a population being established. However, there has been insufficient monitoring of this area. A yearlong radio-telemetry study of released crocodiles was carried out by Muñoz and Thorbjarnarson (2000) in the Capanaparo River, and the results of this study suggest that reintroduction can be a viable management technique to speed population recovery, as has been demonstrated in El Frío Biological Station and Caño Guaritico Wildlife Refuge.

7. Probably the most significant flaw in the Orinoco Crocodile Action Plan has been the lack of an environmental education program and the limited participation of local communities. Nevertheless, these activities have been developed in schools and communities nearby in the areas of occurrence of Orinoco crocodiles and the results showed the children have the capacity to retain information about the conservation of the species and its habitat, and the interest of the community to cooperate in the preservation activities (Fig. 9; Jimenez-Oraá *et al.* 2017).



Figure 9. Children participating in an Orinoco crocodile release in Venezuela. Photograph: Ricardo Babarro.

8. The implementation of the conservation program for *C. intermedius* in Venezuela was the result of a joint enterprise of government and non-government organizations, including at the beginning the Wildlife Authority of the Ministry of Environment (PROFAUNA), FUDENA, the Wildlife Conservation Society, the Agencia Española de Cooperación, Hato Masaguaral, the University of the Llanos (UNELLEZ), El Frío Biological Station, and Agropecuaria Puerto Miranda. More recently, it has involved the Fundación para el Desarrollo de las Ciencias (FUDECI), Krokodille Zoo in Denmark, the Dallas World Aquarium, Hato El Cedral and Río Verde, private individuals, cattle ranch owners and many others.

This joint venture formed the Venezuela Crocodile Specialist Group, which makes recommendations to the Ministry of Environment about implementation of the conservation program. This includes strategic guidelines, observed deficiencies, actions needed to be taken urgently and the suitability of the sites to release the captive-bred crocodiles - advice that is not necessarily taken into account (A. Velasco, pers. comm. 2018; G. Babarro, pers. comm. 2018).



Figure 10. Orinoco crocodile hatched at Dallas World Aquarium. Photograph: Luis Sigler.



Figure 11. Pair of young adult Orinoco crocodiles at Crocodile Encounters, Texas, USA. Photograph: Andrew Austin.

In general, it could be said the conservation program for the Orinoco crocodile in Venezuela has had limited success. The good news is that there is a better understanding of the ecology and population status of the species; thousands of individuals have been released into the wild and three new populations have been established in: a) EFBS and surrounding areas; b) Hato El Cedral; and, c) in Estero de Camaguán Wildlife Reserve. But there are signs of population declines in the Meta and Cojedes Rivers. The Cojedes River continues to be severely threatened by contamination from agricultural residues and urban sewage, and plans are also being developed to dam an upstream section. Crocodiles are released in areas with good habitat and legal protection, but without wildlife officials to enforce this protection. In many places crocodiles have been released and the fate of the animals has not been evaluated. In short, we are far from the main goal of consolidating 10 viable populations in the country.

The "National Strategy for the Conservation of the Orinoco Crocodile and its Action Plan" was prepared in 2007. Its main goal is to design and implement a set of actions that will increase the number and size of the *C. intermedius* populations and to restore its ecological, economic and cultural values.

In 2017 the Association of Zoos and Aquariums published the Orinoco Crocodile Regional Studbook (Sigler 2017), the first studbook for the species and containing the data on the origin of 52 *C. intermedius* in US zoo collections. All the founder stock in this studbook came from Venezuela.

# **Priority Projects**

# High priority

- 1. Continue genetic diversity analysis within and among populations. Many of the conservation plans for this species depend on restocking and reintroduction programs. There is a moderate improvement in the genetic knowledge of C. intermedius populations and only four haplotypes where detected in captive animals in Colombia. Conservation strategies have been proposed with only one lineage without geographic restrictions for the species. However, many of the remaining populations exist in peripheral habitats and the possibility of genetic differentiation should be explored as part of an overall conservation plan. There is a possible "founder effect" and "loss of fitness" in reinforced wild populations due to restocking with individuals from relatively few parental captive individuals kept in the breeding centers. Exchanging ranched individuals from one location to another could improve genetic variability among isolated subpopulations.
- 2. Continue reintroduction of crocodiles in Colombia. There is a relatively large number of *C. intermedius* at Estación de Biología Tropical Roberto Franco and Fundación Palmarito. Some animals have been released into the wild, and based on the results obtained, more could be released into areas with conditions that favour their survival. New areas need to be identified for trial releases and monitoring.
- 3. **Continue head-starting program in Colombia.** Some small populations have been identified, from which eggs and hatchlings have been collected. Juveniles produced through this effort should be released back into the wild and a few retained to increase genetic variability in conservation breeding centers. This program should be implemented in conjunction with environmental education and effective protection of adult crocodiles, and with local community involvement (see 7. below).
- 4. Establish another crocodile breeding center in the Arauca Department, Colombia, with animals from the Estación de Biología Tropical Roberto Franco and Wisirare Reserve. The National University of Colombia wants to expand the *ex-situ* management coverage, with more conservation centers within the distribution area of the species. This initiative will result in one or more conservation centers in each department of the Colombian Orinoquia (Meta, Casanare, Arauca and Vichada) that promotes local conservation. The first one is in progress and will be established in the Arauca Department.

- 5. Improved protection in National Parks and Wildlife Refuges in Venezuela. Natural areas where crocodiles have been released, particularly parks and wildlife refuges, do not have or lack completely, the personnel for effective surveillance against poaching or other illegal activities that affect wildlife in general and crocodiles in particular. A comprehensive plan to address this problem should be prepared and implemented in the short-term.
- 6. Monitoring of populations of released crocodiles in Venezuela. Crocodiles have been released into 13 areas, but monitoring has been sporadic. A better-coordinated system of follow-up surveys needs to be developed to assess the efficacy of these releases as a conservation tool.
- 7. Participation of local people in conservation programs. In some areas, significant threats to the species include the collection of eggs for human consumption, capture of hatchlings for sale as pets, killing of large animals as a source of food, and accidental death of individuals entangled in fishing nets. The most direct way to reduce these negative factors is to involve local people, particularly those directly responsible for these activities, in the conservation program. Also important is to consider eco touristic activities carried on by the local communities where they can receive economic incentives to preserve the llanos area. It is necessary to intensify environmental education activities focused directly on people living around areas with remaining populations of C. intermedius or where captive-reared crocodiles are released. Ideally, those programs should be in the hands of local people (eg school teachers or communal leaders).

### Moderate priority

- 8. Surveys in the Meta River, between the Casanare River and Puerto Carreño, in Colombia. There are reports on the presence of *C. intermedius* but nothing is known about the status of the populations.
- 9. Surveys in peripheral areas of the species' range in Venezuela. Surveys have covered much of the llanos region looking for remnant crocodile populations. Surveys in areas where there are historical reports from the last century (eg low Apure, low Arauca, Atamica, Cunaviche and Payara Rivers) may extend the current known range of the species.
- 10. Consider reintroduction of crocodiles in the Zuata (Anzoátegui State) and Suripá (Barinas State) Rivers in Venezuela. There are reports of the presence of *C. intermedius* in these remote parts of its natural range, where the ecological characteristics and low human pressure may guarantee the survival of reintroduced crocodiles.
- 11. Legal protection of the Cojedes River as a Wildlife Reserve. The Government of Venezuela should be urged

to decree legal protection of the Cojedes River.

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