

4.10 Information on Crocodiles in Hispaniola Island for Crocodile Conservation Units CCU in the Greater Antilles, Andreas Schubert (unpublished, 2006)

Population Status in Hispaniola

Historically, American crocodiles were known to be widely distributed around the coast of the island of Hispaniola or Quisqueya as the island was called by its indigenous Taíno inhabitants (Mañon Arredondo 1971). Today, the island is shared by two countries, Haiti and the Dominican Republic, and crocodile populations have disappeared from most of their former ranges. Coastal populations have all but disappeared from the Dominican Republic. Crocodiles were known from the region of Samaná Bay into the 1950s, but are now extirpated. A tiny remnant population of crocodile is still reported by local residents near the mouth of the Rio Massacre, including the freshwater lagoon Laguna Saladillo and the brackish Laguna Yabacoa along the northern border between the Dominican Republic and Haiti. However, in a study of the Rio Massacre area (SEA/DVS, 1993), no crocodiles or signs of their presence were found, despite intense searching. The most recent crocodile surveys in Haiti date back to the early 1980s. Thorbjarnarson (1984) found small coastal populations of crocodiles, restricted to mangrove areas of along the southern coast of the Tiburon Peninsula in the region to the east of Les Cayes and the nearby Ile-a-Vache, along the north-central coast of the Ile de la Gonâve and in the l'Ester-Artibonite estuarine mangroves. Current information on the status of these crocodile populations is lacking. However, by far the largest numbers of crocodiles on Hispaniola are found in two landlocked lakes, Lago Enriquillo in the Dominican Republic and Etang Saumatre (Lac Azuei) in Haiti. These two lakes share a similar origin and are adjacent to one another in the Cul-de Sac – Valle de Neiba area. Together they form the one CCU identified in Hispaniola.

CCU DR-1: Lago Enriquillo and Etang Saumâtre

These twin lakes are located only 15 km from one another in a tectonic basin, remain of a former marine channel that divided the two paleo-islands which merged some 10 million years ago to form modern Hispaniola. As the area was uplifted, water bodies have remained in the valley's two main depressions, creating the endorheic and hypersaline Enriquillo and brackish Saumâtre. The surface of Lago Enriquillo is located about 40 m below sea level, but its surface level, size (170-300 km²), and salinity (35-115 ppt) water vary greatly depending on highly varying rainfall patterns in the Enriquillo watershed. Etang Saumatre is located above sea level (15 m), in terms of surface, level and salinity it is more stable. It smaller than Lago Enriquillo (113 km²) and has brackish water (8-10 ppt) Both lakes are connected to other bodies of water; Etang Saumatre with Trou Caiman, a relatively small and shallow freshwater lake 10 km to the west, and Lago Enriquillo with Laguna del Rincón , 40 km to the east, through the Cristóbal canal. There are also two seasonal lagoons, Laguna de Limón and Laguna del Medio, located 5 and 10 km to the south of Lago Enriquillo. (SEA/DVS 1993, Schubert 2002, Thorbjarnarson 1988). Historically, all these lakes also had crocodile populations, which were extirpated.

The population of *C. acutus* in Lago Enriquillo was studied from 1975 - 1984 by the National Museum of Natural History (NMNH) in Santo Domingo and after that by the Wildlife Department (DVS) of the State Secretary of Agriculture (SEA) from 1990 - 1997. The NMNH

project found a large population of crocodiles, with an estimated number of 300-600 adults and 70-110 nests annually in the early 1980s. This number had greatly declined by the early 1990s, principally as a result of hunting or killing of crocodiles for food and folk medicine (the penis was considered a powerful aphrodisiac and the fat as a cure for rheumatism). Surveys during this period found very few crocodile nests: 1990- 30, 1991- 10, 1992- 3. The maximum number of crocodiles seen during four aerial surveys of the lake in 1992-93 was 63. In 1996-1997 the population of adult and subadult crocodiles in Lago Enriquillo was estimated to be 227 individuals with a sighting fraction (Messel et.al 1981) of 58.4% (SD 15.3%), based on nocturnal spotlight counts (Schubert & Méndez, 2000). For juveniles, a population estimate was based on mark-recapture studies, carried out in 1994 and 1995, indicating a total of 217 juveniles. Based on this estimate, the sighting fraction for juveniles was considered to be 33.3% (Schubert & Méndez, 2000). Over a 9-year period from 1993-2001 an average of 37 nests were found at nesting beaches in Lago Enriquillo; this was estimated to be at least 80% of the total nests in the lake.

In Etang Saumâtre no surveys have been carried out since 1983-1984, when Thorbjarnarson (1986, 1988) estimated a relatively healthy population of 450 individuals, with > 70 adults and sub-adults, and approximately 20 nests per year. However, subsequent to this study in the early 1990s the eastern shore of Etang Saumâtre, primary crocodile nesting area, was partly settled and is being used since then to smuggle goods from the Dominican Republic to Haiti, especially in times of political unrest and UN embargos. In 1994 the DVS team could find no signs of crocodiles during a brief survey, and again in 2002 the Trans-border Environmental Program (PMT) found no evidence of crocodiles during an early morning boat survey along the eastern lake shore. When interviewing the owner of the boat, he admitted that the fishermen had killed almost all the crocodiles for food and that it was extremely difficult to find crocodiles in the lake.

Table 1: Number of crocodile nests found at nesting beaches in Lago Enriquillo 1993-2001. (Schubert 2002)

| | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | Mean |
|------------------------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-------------|
| Los Cucuces | 5 | 11 | 2 | 6 | 3 | 5 | 16 | 11 | 7 | 7.3 |
| La Azufrada | 10 | 8 | 2 | 10 | 10 | 6 | 4 | 3 | 4 | 6.3 |
| La Islita | 2 | 5 | 3 | 6 | 6 | 1 | 2 | 7 | 3 | 3.9 |
| La Playita | 8 | 9 | 2 | 13 | 12 | 5 | 11 | 11 | 7 | 8.7 |
| Caimanera Sur | 4 | 8 | 3 | 13 | 9 | 2 | 7 | 8 | 7 | 6.8 |
| Los Borbollones | 3 | 2 | 1 | 2 | 1 | 4 | 5 | 1 | 5 | 2.7 |
| Isla Barbarita | 2 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.6 |
| Playa Najayo | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.2 |
| Rio Guayabal | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.1 |
| Oeste Cabritos | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0.2 |
| Norte Cabritos | 0 | 0 | 0 | 1 | 2 | 0 | 0 | 0 | 0 | 0.3 |
| Total | 36 | 48 | 14 | 51 | 43 | 23 | 45 | 41 | 33 | 37.1 |

Management

As throughout the northern Neotropics, there was commercial skin hunting of crocodiles on Hispaniola in the early part of the 20th century, however it has been poorly documented. Crocodiles are legally protected in the Dominican Republic since 1978 (Thorbjarnarson 1992) but this was rarely enforced. Prior to the establishment of Isla Cabritos National Park (1974) in Lago Enriquillo, crocodiles were reported to be hunted and trapped regularly. However, the population appears to have recovered fairly rapidly and by the 1980s the crocodile population in Lago Enriquillo was considered to be one of the largest known for the species worldwide. Protection broke down again in the late 1980s resulting in a population crash by the early 1990s (Schubert and Santana 1996). In March 1992 the former Dominican Wildlife Department DVS initiated the project "Study and Protection of the American Crocodile (*Crocodylus acutus*) in the Dominican Republic", and in 1996 the entire lake was protected as Lago Enriquillo National Park (Decree 233/96). Since 1993, DVS, together with other government agencies, non-governmental organizations and local groups, promoted the establishment of a biosphere reserve, which was finally declared by UNESCO in 2002. The Jaragua-Bahoruca-Enriquillo Biosphere Reserve includes Lago Enriquillo as one of its three core areas. In 2002 Lago Enriquillo was also recognized as the first Dominican Wetland of international importance under the Ramsar Convention and in 2005 as Important Bird Area IBA.

Between 2001 and 2005 the lake's level went down and its surface shrank with an alarming velocity, after several years of low precipitation and high evaporation rates. Since 2006 lake level has been rising again, mainly due to several tropical storms, rupture of irrigation and flood control infrastructure in the Río Yaque del Sur / Laguna del Rincón area and saturation processes in the porous limestone of the two 2000 m high mountain ranges that border Lago Enriquillo. The lake's water is penetrating far into agricultural areas, pastures, mangroves and dry forest areas, lately even threatening human settlements. Almost all the crocodile nesting beaches are submerged, except for the beaches on Isla Cabritos. It has become difficult to spot crocodiles in the last years.

Some of the remaining coastal habitat along the north coast has been protected in the Monte Cristi National Park, but does not include Laguna Saladillo and the presence of crocodiles has not been confirmed throughout the last two decades (SEA/DVS 1993).

Officially Etang Saumatre is a Nature Reserve and forms part of the Haitian protected area system. However, this reserve only exists on paper. It does not count with any personnel, infrastructure or documents of planification. Since 2006 the Haitian government intends to establish a biosphere reserve, which would include Etang Saumatre.

There is no legal protection of crocodiles in Haiti, but outside of border areas with the Dominican Republic, folk beliefs prevented crocodiles from being eaten (Thorbjarnarson 1988).

Attacks by crocodiles on people are extremely rare and none have been reported in the Dominican Republic for over 10 years.

Due to the very low nesting success in 1992, in 1993 a total of 178 eggs plus 53 neonates were collected from 8 nests and taken to the Santo Domingo Zoo for the establishment of a head-

starting program. However, this program experienced numerous problems and none of the crocodiles were ever returned to the lake until 10 years later when in 2003 a total of 30 10-years old crocodile were released in the lake. In 1994, a program was initiated to transport hatchlings from nesting beaches on islands to mainland areas adjacent to sources of freshwater where it was assumed survival would be higher. In April and May 1994, 255 neonates were translocated, this number declined to 53 in 1995 and in 1996-7 only a few neonates were translocated.

The crocodile, along with the two species of iguanas, the endemic and critically endangered species of *Cyclura ricordi* and the vulnerable *C. cornuta*, have been the driving force behind small-scale ecotourism based on day trips to Isla Cabritos and to the Los Borbollones area in Lago Enriquillo.

Ecology

In the great lakes of Hispaniola, crocodiles nest in the abundant sand beaches around the lakeshore and on islands. In Lago Enriquillo, approximately 32 km or 30% of the lakeshore are sandy beaches, and crocodiles nest along 22% (7 km) of these beaches. There are a total of eleven nesting beaches in the lake; six of them have been used regularly, on an annual basis. The use of different beaches is strongly influenced by lake level as some of these nesting areas are submerged when lake levels are high.



Figure 1: Location of the nesting beaches and juvenile habitat in Lago Enriquillo, Dominican Republic.

Nesting beaches ranged from 150 m to 1200 m in length, with the average being 605 m. The smallest beaches are Caimanera Sur (150 m) and La Playita (200 m) long and the two largest were La Azufrada and Los Cucuces (both 1200 m). During the 11 years of study there were significant changes in the width of the beaches, due to changes in the lake level.

In Lago Enriquillo crocodiles tend to nest gregariously. In the 1990s 50% of the nests were located < 10 m from one another, 38 % were 10-100 m apart, and only 12% were isolated nests, > 100 m from the nearest nest (Schubert 2002). Some nesting beaches had up to 8-10 nests; whereas in the 1980s, beaches with 20-30 nests were reported (Thorbjarnarson 1988). There is considerable nest fidelity, with 90 of 192 recorded nests being located at a site previously used. The use of particular beaches for nesting varies according to lake level. Some beaches are flooded in years with heavy precipitation or are located too far away from the shore in dry periods when the shoreline retreats. Nevertheless, as the lake level drops, many crocodiles have to nest further away from the lakeshore, in some cases up to 200 m at Los Borbollones (Schubert 2002).

Most nests are located in open areas and receive direct sun. Temperature measurements were made of 6 nests in 1996-97 using data loggers (Schubert 2002), and recorded temperature variability between 29° and 35° C. Females appear to select areas for nesting based on soil moisture levels; they pick relatively dry areas to nest in locations with high soil moisture levels and the opposite (relatively moist sites) in areas with dry soils (Schubert 2002). Overall mean temperatures recorded for six clutches in Etang Saumâtre over a 30 hour period was 29.3 C°. Nest temperatures were remarkably constant, with a maximum variation of 1.8 C°, while air temperature over the same period varied 8.9 C° (Thorbjarnarson 1988).

Nesting in Etang Saumâtre was almost entirely restricted to a 6.6 km stretch of the uninhabited eastern lakeshore as (Thorbjarnarson 1988). Colonial nesting was not in evidence. Nevertheless, several nesting beaches had more than one nest. Single nests also were located on a small island along the north shore (the only island in the lake). Location of nesting beaches on the lake was primarily determined by three factors: (1) suitability of the terrestrial habitat for nesting, (2) human population density, and (3) the presence of nearby aquatic habitats protected from wave action. Nests are exclusively of the hole type, generally dug in beaches associated with moderate gradient shoreline promontories. Soil moisture was the most important factor determining selection of nest sites. The mean height of nests was 1.2 m (SD=0.5 m, n=25) above lake level. The bottom of the average nest cavity was approximately 80 cm above lake level, as the mean hole depth is 37.9 cm.

Because the lake only fluctuates only 0.3-0.4 m annually (excluding years with hurricanes), egg mortality from rising lake water is minimal. The only flooding found to occur was associated with surface inundation from heavy rainfall (one nest, 1983). Along the eastern lakeshore, nests were located on coralliferous limestone outcrops that extend down to the lakeshore. These outcrops often were separated from one another by low-lying salt pans that supported little vegetation other than frequently dense *Conocarpus* stands along the lakeshore. Old beaches, formed when the lake level was higher, provided suitable nesting habitat. Besides furnishing sand beaches close to the lakeshore, these outcroppings provided deep-water approaches to the nesting area. Although apparently suitable nesting areas were located behind the salt pans, these were farther away from the lake (usually more than 50 m), and water approaches were frequently through shallow water or over mudflats. Nests generally were located near the ecotone between the *Conocarpus*-dominated riparian strip and the xeric upland flora, the species assemblage being a mixture of both communities. Besides using the deep sand of old beaches, crocodiles would frequently nest in the remains of former charcoal

mounds, usually located on the same raised, well-drained banks where sand nests were found. The term "mound" refers to the fact that when the charcoal is being made, the slowly burning wood is covered with a layer of soil, creating a mound. Upon finishing, the charcoal makers scatter the remains of the mound, a mixture of soil and charcoal fragments, more or less evenly with the surrounding terrain. Out of 26 nest sites active in 1983 and 1984, 15 (57.7%) were either in or adjacent to an old charcoal mound (Thorbjarnarson 1988). Crocodiles will frequently nest at the same sites from one year to the next; 46% of the 1984 nests in Etang Saumâtre were at sites used the previous year. In Etang Saumâtre, an estimated 64% of adult females nested in 1983 (Thorbjarnarson 1988).

Over a period of five years in Lago Enriquillo a total of 3987 eggs from 188 nests were examined. Of these 513 (13%) were inviable (no egg band), 95 (2.4%) had observable dead embryos (resulting from excessive soil moisture) and in 64 cases (1.6%) the hatchlings was found dead outside of its shell but near the nest. Overall, 17% of the eggs did not produce viable hatchlings (Schubert 2000b and 2002). Egg mortality was estimated to be 5.8-20.8 % in Etang Saumâtre (Thorbjarnarson 1988).

In Lago Enriquillo and Etang Saumâtre, females remain in the vicinity of the nesting beaches during the incubation period. This was confirmed by radio-telemetry of two nesting females in Lago Enriquillo from 1996 to 1998 (Schubert, unpublished). Females transport neonates in their mouth to the lakeshore in several trips where they hide in *Conocarpus* root mats (Etang Saumâtre) or dead emergent vegetation (Lago Enriquillo). In Lago Enriquillo hatchlings at first are in hypersaline water, and may climb up on emergent woody vegetation to get out of the water. Of 41 pods of hatchlings observed from 1994 at 1997, only nine (22%) were not accompanied by an adult crocodile (presumably the female). On the islands (La Isleta and Cabritos) females took 1 to 3 days to transport hatchlings to areas of freshwater. In the case of the Caimanera Sur and La Playita, the female has to move between five and ten kilometers, crossing the lake, to reach freshwater habitat. On several occasions adult crocodiles were seen with hatchlings in their snout or on their back crossing the lake toward the places with fresh water (Schubert, unpublished). Once in areas of freshwater, females remained with the pods for up to 80 days (Schubert 2002).

In Etang Saumâtre, the smallest female captured near the nesting beaches, and presumed reproductively active, was 2.30 m, the largest was 2.39 m (Thorbjarnarson 1988). In 1983-84, the total population of crocodiles in Etang Saumâtre was estimated to be ca 450 individuals, with a predominance of juveniles. Adult crocodiles (> 1.8 m TL) comprised 16 % of the population and subadults (0.9-1.8 m TL) a further 10%. The overall encounter rate was 6.3 crocodiles/km of shore, but if unsuitable habitats (rocky and high wave energy shores) are eliminated the encounter rate was 9.6/km. This was equivalent to an estimated biomass of 66.6 kg/km over the entire lake (Thorbjarnarson 1988). In Lago Enriquillo, the number of crocodiles in the mid-1990s was estimated to be approximately 400, of which half were adult or subadult crocodiles (Schubert and Méndez 2000). Crocodile size class distribution was estimated from four nocturnal counts conducted in the months February, April and May of the years 1994 through 1997 (Fig. x). Although animals up to 3.5 m TL were observed in Lago Enriquillo in the 1980s, no crocodiles over 2.7 m TL were seen during nocturnal counts in the 1990s.

Preliminary information on growth rates of juvenile crocodiles was obtained from recaptures of animals marked as hatchlings up to five years of age (Figure 11). From a sample of 48 marked mean monthly growth rate was 0.72 cm SVL (SD = 0.22) (average annual growth = 8.6 cm SVL) and an average annual increment in mass was 27.7 g (SD = 23.53). Mean growth rates of juvenile (< 90 cm TL) in Etang Saumâtre were estimated to be 0.058 cm TL/day. The slow growth of the Etang Saumâtre crocodiles is manifested in the relatively small size of adults. Males and females only reach lengths of 3.5 m and 2.4 m respectively (Thorbjarnarson 1988).