

American Crocodile *Crocodylus acutus*

John B. Thorbjarnarson

Wildlife Conservation Society, PO Box 357625, Gainesville, FL 32635-7625, USA (Jthorbjarnarson@wcs.org)

Common Names: American crocodile, Cocodrilo, Lagarto, Caimán de la costa, Caimán aguja, Cocodrilo del río

Range: Belize, Cayman Islands, Colombia, Costa Rica, Cuba, Dominican Republic, Ecuador, El Salvador, Guatemala, Haiti, Honduras, Jamaica, Nicaragua, Mexico, Panama, Peru, United States, Venezuela



Figure 1. Distribution of *Crocodylus acutus*.

Conservation Overview

CITES: Appendix I, except for Cuban population transferred to Appendix II in 2007.

CSG Action Plan:

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

2009 IUCN Red List: VU (Vulnerable. Criteria A1ac. inferred decline >20% in 3 generations, inferred from reduction in extent of occurrence; IUCN 2009) (last assessed in 1996).

Principal threats: Habitat loss, illegal hunting, hybridization.

Ecology and Natural History

The American crocodile is the most widely distributed of the New World crocodiles, ranging from the southern tip of Florida, along both the Atlantic and Pacific coasts of southern

Mexico, Central America, and northern South America, as well as the Caribbean islands of Cuba, Jamaica, and Hispaniola.

The habitat of *C. acutus* consists largely of brackish water coastal habitats such as the saltwater sections of rivers, coastal lagoons, and mangrove swamps. However, populations are known from freshwater areas located well inland, including a number of reservoirs. A significant population is known from Lago Enriquillo, a landlocked hypersaline lake situated 40 m below sea level in the arid southwestern Dominican Republic.

The American crocodile is a relatively large species, with males reaching maximum lengths of 5-6 m, although some individuals may reach 7 m (Schmidt 1924; Medem 1981). Adult females are generally no more than 3-3.5 m TL, but individuals up to 4.4 m have been reported (Dominguez-Laso 2009). The species is characterized by the most reduced and irregular dorsal armor (osteoderms) of any crocodylian (Ross and Mayer 1983).



Figure 2. *Crocodylus acutus*. Photograph: Jemeema Carrigan.

Crocodylus acutus is a hole-nesting species, but is adaptable in terms of nesting ecology, in some areas creating elevated mounds of substrate into which eggs are deposited (Thorbjarnarson 1989). Clutch size is typically 30 to 60 eggs, although in some populations mean clutch size is in the low 20s (Platt and Thorbjarnarson 2000). As with most hole-nesting species, *C. acutus* nests during the annual dry season, with eggs hatching around the beginning of the annual rainy

Thorbjarnarson, J.B. (2010). American Crocodile *Crocodylus acutus*. Pp. 46-53 in Crocodiles. Status Survey and Conservation Action Plan. Third Edition, ed. by S.C. Manolis and C. Stevenson. Crocodile Specialist Group: Darwin.

period (Thorbjarnarson 1989; Casas-Andreu 2003). The American crocodile is adept at using man-made areas for nesting, and this is one of the reasons behind its population recovery in parts of its range (Mazzotti *et al.* 2007a).

Studies of aspects of the population ecology of the species have been carried out in Florida (Kushlan and Mazzotti 1989a,b; Ogden 1978, Moler 1991; Moler and Abercrombie 1992), Belize (Platt and Thorbjarnarson 2000; Platt 2003), Colombia (Balaguera-Reina and Gonzalez-Maya 2008), Cuba (Soberon *et al.* 2002), Dominican Republic (Schubert 2002), Mexico (Cupul-Magaña *et al.* 2004; Brandon-Pliego 2007; Garcia-Grajales *et al.* 2007), Haiti (Thorbjarnarson 1988a), Ecuador (Carvajal *et al.* 2005) and Venezuela (Seijas 1988). Behavioral studies in captivity have been carried out and published by Garrick and Lang (1977). Rainwater *et al.* (2007) examined the effects of environmental contaminants on *C. acutus* in Belize and Costa Rica.

A preliminary phylogeographic analysis of *C. acutus* indicates a significant degree of geographic variation in the genetic structure of populations (M. Anaya-Venegas, in prep.) that may warrant a taxonomic revision of the species. Recent genetic studies have confirmed that significant hybridization is occurring between *C. acutus* and *C. moreletii* in Belize (Hekkala 2004) and Mexico (Cedeño-Vasquez *et al.* 2008; Rodriguez *et al.* 2008; Machkour-M'Rabet *et al.* 2009) as well as with *C. rhombifer* in Cuba (Milián-García *et al.* in prep.). The ecological and evolutionary consequences of this hybridization are poorly understood but are a priority for future work.

Conservation and Status

The American crocodile is found in 18 countries in the northern Neotropics. As *C. acutus* produces a commercially valuable skin, the principal reason for past declines in population size can be attributed to the extensive commercial overexploitation that occurred from the 1930s into the 1970s. Current threats are habitat destruction and in some areas continued hunting.

A review of the status and distribution of *C. acutus* throughout its range was carried out relatively recently (Thorbjarnarson *et al.* 2006), and found the species to be recovering in most parts of its historic range. There were a few areas where population recovery appears to be limited (eg Colombia), or non-existent (eg Ecuador), but populations of *C. acutus* in areas such as Cuba, USA and Costa Rica appear to be very healthy.

It was estimated that by 2002 *C. acutus* had been extirpated from 8.9% of its historical range (Thorbjarnarson *et al.* 2006), but there is also evidence that the species is re-colonizing the one country from which it had been extirpated, the Cayman Islands, with three individuals being sighted over a period of 12 months in 2008 and 2009 (M. DaCosta-Cottam, pers. comm.). The review by Thorbjarnarson *et al.* (2006) quantified current information and classified 69 areas in 8 distinct crocodile bioregions as Crocodile Conservation Units (CCUs), the most important areas for the conservation of this

species. The relative importance of the CCUs in each bioregion was quantified using an algorithm that weighted factors that the experts considered to be most important for the long-term conservation of viable populations of crocodiles. Two bioregions in particular were identified where the creation of protected areas should be given a high priority, the Dry Pacific South America (northern Peru and southern Ecuador) and the Northwest and Central Pacific Mexico.



Figure 3. *Crocodylus acutus* on tidal mudflat, Everglades, Florida, USA. Photograph: Jemeema Carrigan.

Mexico

American crocodiles are found in areas of suitable habitat along the Pacific coast of Mexico from the Guatemala border to the State of Sinaloa (Alvarez del Toro 2001; Sigler 2002; Muñiz 2004). Relatively recent reports are available on crocodiles in Jalisco (Huerta Ortega *et al.* 2002; Cupul-Magaña *et al.* 2002), Sinaloa (Navarro Serment 2003), and Oaxaca (Brandon-Pliego 2007). The three top priority CCUs in this bioregion were either coastal habitats characterized by relatively small mangrove areas that are typically associated with the mouths of rivers (Jalisco-Colima coast), or coastal lagoon/mangrove complexes with very seasonal inputs of freshwater (Bahía de Petualco and Costa de Oaxaca) (Thorbjarnarson *et al.* 2006). Crocodiles are widespread in these patchy habitats, with animals being found in 38 of 52 waterbodies along the Jalisco coast (P. Ponce-Campos and S. Huerta-Ortega, pers. comm.). Crocodiles are also known from reservoirs (Presa Adolfo Lopez Mateos, also identified as a CCU) as well as in freshwater sections of some of the region's larger rivers (Rio Santiago CCU). Human-crocodile conflict is a growing problem in the Pacific region (Huerta Ortega and Ponce Campos 2002).

In the Yucatan region, *C. acutus* is widespread but found at very low densities throughout much of the coastal region of Belize. The most important populations are found on offshore islands, particularly the Turneffe Atoll (Platt 2003; Platt *et al.* 2004). A similar situation exists in the Yucatan of Mexico, with the most significant populations found in the Banco Chinchorro and on Cozumel (Charruau *et al.* 2004; Cedeno *et al.* 2006; Gonzalez Cortes 2007). Along the Yucatan mainland

there is extensive hybridization between *C. moreletii* and *C. acutus* (Cedeño-Vasquez *et al.* 2008; Rodríguez *et al.* 2008; Machkour-M'Rabet *et al.* 2009). An isolated population of *C. acutus* remains in the Rio Grijalva, the only known Gulf of Mexico drainage from which the species is known. In the Grijalva, crocodiles inhabit a series of reservoirs, as well as riverine habitats between reservoirs (Sigler 2002; Mandujano 2003).

Central America

In the 1980s and 1990s populations were reported to be greatly depleted in Guatemala (Enrique Fernandez, pers. comm.) but there is little new information from this country. Crocodiles similarly are rare in El Salvador; spotlight surveys by Escobedo *et al.* (2004) in some of the best remaining coastal habitats observed 28 crocodiles, mostly juveniles, over a total of 157.5 km. In Honduras, most of the major rivers of the Atlantic drainage support small populations, although these may be depleted (King *et al.* 1990; King and Cerrato 1990). Surveys by Cerrato (2002) in northern coastal Honduras in wetlands associated with the Laguna Guaimoreto, Rio Chapagua, Laguna El Lirio and the lower 15 km of the Rio Aguan reported a mean encounter rate of 2 crocodiles/km which represent an increase from similar surveys conducted in the same area in 1989. Perhaps the largest crocodile population in Honduras is located in the El Cajon reservoir where Espinal (2005) counted 1082 crocodiles, with a large number of hatchlings (536) confirming successful reproduction. Crocodiles are also known to be breeding in some of the Bay Islands off the northern coast of Honduras (Kaiser *et al.* 2001).



Figure 4. Hatchling *C. acutus*. Photograph: Jemeema Carrigan.

Surveys in Nicaragua by King *et al.* (1994) reported *C. acutus* to be rare but still present in the Atlantic drainage, and several viable populations were identified on the Pacific coast (Estero Real, Las Salinas) and near Managua. A similar conclusion was made by Buitrago (2000, 2001). Incidental illegal take of crocodiles in association with the legal caiman harvest is a problem (Buitrago 2001). In Costa Rica, a low density of

crocodiles is found in wetlands along the Atlantic coast, and larger ones reported from mangroves and river habitats along the Pacific coast. A population of over 300 individuals was reported from the Rio Grande de Tarcoles (Sasa and Chaves 1992) and another of around 35 individuals in Estero Roto (Chaves 1993). Substantial populations of crocodiles are also known from the Rio Tempisque (Sanchez 2001) and the vicinity of the Osa Peninsula (Boston *et al.* 2005), and it is likely that crocodiles inhabiting habitat patches along the Pacific coast exist as a metapopulation (Porrás 2007). Growing populations of crocodiles and people have resulted in several instances of human-crocodile conflict, including fatal attacks (Ross and Larriera 2001).

In the regional analysis carried out by Thorbjarnarson *et al.* (2006), the highest priority CCUs in the Caribbean drainage of Central America are three very different habitats, an extensive region of eastern Nicaragua that contains a vast complex of coastal lagoons and rivers that extend inland (Costa Miskito and Rio Coco), a section of the largest lake in Central America (Lago de Nicaragua), and a region of central Caribbean Panama that includes the enormous Gatun Lake reservoir (Bahia de Panama-Este). The second level of priority CCUs is represented by a large river (Rio San Juan, Nicaragua), an extensive coastal lagoon complex (Laguna de Chiriqui, Panama), and a large reservoir (Embalse El Cajon, Honduras). Along the Pacific coast the highest priority CCUs are coastal mangrove patches and short estuarine sections of rivers. Puerto Sandino is a tidal mangrove complex that receives fresh water from the Izapa and Tamarindo Rivers. The Estero Real is the largest estuarine system of the Golfo de Fonseca and is in the driest region of Nicaragua, receiving less than 500 mm of rain annually. This CCU is comprised principally of a mangrove forest within which a number of commercial shrimp farms have been established, causing significant damage to the ecosystem. Isla Coiba in Panama is a national park comprised of 40 islands in Veraguas Province. There are also good populations of *C. acutus* associated with rivers and coastal mangroves on the Pacific side of Costa Rica (Rio Terraba, Rio Tempisque) that came out at the second CCU priority level.

South America

The status of *C. acutus* in Colombia remains poorly known. Populations on the Atlantic coast are thought to be severely depleted or extirpated and those in the Magdalena River drainage may be close to extinction. Two areas of the upper Magdalena and a relict group of American crocodiles has been reported by Barrera (2004) from an area in the middle Magdalena. Community-based conservation programs in two areas of the Colombian Caribbean coast have provided the most detailed information on crocodile status. In the Cispatá Bay region (Ulloa Delgado 2004, 2005; Ulloa Delgado and Sierra Diaz 2002, 2006), a group of 15 ex-hunters, known as “caimaneros” have become active participants in a program for the conservation of *C. acutus*. This community group formed ASOCAIMAN (Asociación para la Conservación de los Caimanes de la Bahía de Cispatá), with its main objective being the conservation of this species. Aside from increasing

the protection of crocodiles, the project has included the creation of artificial nesting beaches in the mangroves of Cispata Bay, and the headstarting of juvenile crocodiles. Nocturnal spotlight counts in the region suggest that the population is stable or increasing (Ulloa and Sierra 2002) with encounter rates of approximately 1 crocodile/km in mangrove habitats. A somewhat similar community-based program to protect crocodiles, crocodile nests, and headstart crocodiles is underway in the Portete Bay in northeastern Colombia (Gomez *et al.* 2009).

In Venezuela, crocodiles are known from a number of coastal areas and river systems along the Caribbean coast. Restocking with ranched stock has been conducted in Falcon Province in the northeast of the country (Arteaga 1993; Velasco 2004; Velasco and Lander 1998) and in Aragua Province (Lander and Bisbal 1994; Velasco 2004). These are the most important populations, with an active conservation program including surveys. Comparative surveys between 1986 and 1993 suggest that populations in several locations are stable or growing as a result of protection and restocking, although residual problems of illegal killing for medicinal products is reported (Arteaga 1994). De Sola *et al.* (2004) and Lander and Bermudez (2005) reported on surveys around the Venezuelan coast and demonstrated that in some areas the status of populations have improved since previously reported. Velasco *et al.* (2000) presented a National Recovery Plan for the species in Venezuela, and Villarroel *et al.* (2005) presented the results of a workshop evaluating the Venezuelan *C. acutus* population and habitats, and proposed 11 CCUs for the country.

All three highest priority CCUs along the Caribbean coast of Venezuela and Colombia are coastal lagoon systems (Thorbjarnarson *et al.* 2006). Two of the three are mangrove systems in seasonally dry areas, one in Colombia (Alta Guajira, comprised of the Bahia Portete and Bahia Hondita), and one in Venezuela (Laguna Tacarigua). The Bahia Cistapa CCU is an extensive mangrove swamp associated with the old delta of the Rio Sinú. The second priority level of CCUs includes additional habitat types such as an inland, freshwater riverine site in dry forest habitat (Rio Bache, Colombia) over 1200 km from the coast, a coastal river/lagoon/reservoir complex (Rios Yaracuy y Aroa), as well a reservoir (Embalse Pueblo Viejo).

One of the areas where populations of *C. acutus* are most threatened is along the Pacific coast of South America. In Ecuador, crocodiles were formerly abundant in the Rio Guayas system but appear to have been all but extirpated (although population surveys are needed to confirm this). A small number of crocodiles remain in the coastal region of the Gulf of Guayaquil (Carvajal *et al.* 2005; Carvajal and Alava 2005) but coastal mangrove destruction for the construction of shrimp aquaculture facilities is removing crocodile habitat. A small population remains in the Rio Tumbes region, in northern Peru, at the southernmost extreme of the species' range (Trelancia 2001). Two areas were identified as CCUs (Thorbjarnarson *et al.* 2006), both associated with the Rio Tumbes drainage that forms the boundary between Peru and Ecuador. The Amotape CCU is a freshwater section of the Tumbes in a region of dry forest with few human pressures. The Estero Corrales is a tidal mangrove system associated with the Tumbes delta complex and is adjacent to a protected



Figure 5. Captive adult *C. acutus* at Criadero de Manzanillo, Cuba. Photograph: Tom Dacey.

area (Santuario de los Manglares), but is threatened by shrimp and rice farming.



Figure 6. Captive *C. acutus*, Colombia. Photograph: Grahame Webb.

USA

In the USA, *C. acutus* is found only in the southern, subtropical tip of the State of Florida. Since the 1970s, when it was listed as Endangered under the US Endangered Species Act, the population has steadily grown (Mazzotti *et al.* 2007a,b), and in 2007 the species was officially reclassified as Threatened (Stansell 2007) reflecting the successful population recovery. Today, one of the most significant sources of mortality for crocodiles in Florida is being run over by cars (Brien *et al.* 2008).

As *C. acutus* produces a commercially valuable skin, there has been interest in commercial utilization programs. Commercial farms in Honduras and Colombia have been registered with CITES as captive breeding operations. However, as of 2006 there had been few exports of skins from Colombia and none from Honduras (Caldwell 2008). With the recent downlisting of its *C. acutus* population to CITES Appendix II, Cuba is developing plans for exports based on commercial farming and ranching.



Figure 7. Problem *C. acutus* at Biscayne Bay, Florida, USA. Photograph: Jemeema Carrigan.

West Indies

On the island of Hispaniola, a few small coastal populations of crocodiles were reported in Haiti by Thorbjarnarson (1988), but by far the largest populations were in two landlocked lakes, Lago Enriquillo in the Dominican Republic and Etang Saumatre in Haiti. Lago Enriquillo is an unusual habitat, a hypersaline lake well below sea level, and crocodile populations have fluctuated widely since the 1980s as a result of changes in lake salinity and illegal hunting (Schubert and Santana 1996). Thorbjarnarson (1989) reported on the population in Etang Saumâtre in Haiti and some other coastal locations, but no systematic surveys have been carried out in Haiti since the 1980s. Recent informal surveys indicate the Etang Saumatre population is greatly reduced (A. Schubert, pers. comm.).

Populations of *C. acutus* in Cuba are widespread and locally abundant (Soberón *et al.* 2006). In 2007 Cuba became the only country to successfully petition CITES for a transfer of its *C. acutus* population to Appendix II, based on a program of managed use including ranching and closed-cycle captive breeding.

Priority Projects

High priority

Thorbjarnarson *et al.* (2006) listed a number of specific areas containing some of the most important populations of *C. acutus*, and where greater habitat protection is needed. From this list three areas have been selected here as the highest priority for conservation action.

1. **Conservation in Peru and Ecuador:** The Guayas River system in Ecuador historically supported a large population of *C. acutus*, which appears to have all but disappeared following intensive commercial hunting and habitat destruction in the 20th century. Surveys are needed to determine if crocodiles still remain in the Guayas River, and to develop population recovery plans. The small population in the Tumbes area of northern Peru is also extremely vulnerable. Preliminary studies suggest that the *C. acutus* in Ecuador/Peru are genetically distinctive from other populations (M. Anaya-Venegas, pers. comm.) - the genetic status of these populations merits further investigation.
2. **Population evaluation and conservation in the Magdalena/Cauca River basin:** Crocodiles are reported from several areas in the Magdalena/Cauca River basin up to 1200 km from the coast. This area is considered a high priority not only due to the lack of information and apparent endangered population status, but also because of the extraordinary riverine nature of the crocodiles. In a 2004 review by the CSG (Larriera *et al.* 2005), the implementation of a national program for rebuilding depleted populations of *C. acutus* was seen as a major priority, and could be promoted by better linkage of

commercial crocodile farming operations in Colombia with *ex-situ* conservation efforts (Larriera *et al.* 2005).

- 3. Development of a conservation program in Jamaica:** American crocodiles were until recently reasonably abundant in areas along Jamaica's southern coast. However, coastal development appears to have destroyed many of the fragile wetlands habitats and nesting areas used by crocodiles. A nation-wide population evaluation and habitat assessment is needed as a first step towards developing a crocodile conservation plan for Jamaica.

Moderate priority

- 4. Genetic evaluations:** The American crocodile is a wide-ranging and ecologically plastic species. Preliminary genetic evidence suggests that there are substantial genetic differences among populations in different parts of the species' range. American crocodiles are known to hybridize with *C. moreletii* and *C. rhombifer* and the conservation/evolutionary implications of this hybridization are poorly understood, and require further investigation.
- 5. Investigation on ecology:** Information on genetic diversity, home range and habitat use by *C. acutus* would assist decision-makers dealing with problem animals and human-crocodile conflict, and for developing management programs in general.

Acknowledgements

Alvaro Velasco and Miryam Venegas-Anaya provided valuable input into this plan.

References

Balaguera-Reina, S.A. and Gonzalez-Maya, J.F. (2008). Population structure, density, and habitat of *Crocodylus acutus* Cuvier 1807 in the Via Parque Isla de Salamanca, Magdalena Department, Colombia. *Herpetotropicos* 4: 59-63.

Barrera, L.F. (2004). Estado actual de un relicto poblacional del caimán aguja (*Crocodylus acutus* Cuvier) en una zona del Magdalena medio. ProAves-Fundacion Omacha: Bogota.

Boston, M., Porras Murillo, L.P., Connors, S., Harris, M. and Wasilewski, J. (2005). Recent surveys of the American Crocodile (*Crocodylus acutus*) in the Osa Peninsula Region of southwestern Costa Rica: Justification for long-term studies and conservation. *Crocodile Specialist Group Newsletter* 24: 10-12.

Brandon-Pliego, J.D. (2007). Estudio poblacional de *Crocodylus acutus* (Cuvier, 1807) (Reptilia: Crocodylia) en Jamiltepec, Oaxaca. *Ciencia y Mar* 11: 29-37.

Brien, M.L., Cherkiss, M.S. and Mazzotti, F.J. (2008). American crocodile, *Crocodylus acutus*, mortalities in southern Florida. *Florida Field Naturalist* 36: 55-59.

Buitrago Vannini, F. (2001). Comercio de los Crocodylia de Nicaragua. Pp. 109-135 in *Memorias Primer Seminario-Taller: Capacitación y actualización en el manejo sostenible de los cocodrilos en Panamá*, ed. by M. d. Anaya, Y. Morán de Gotti and N.V. Martínez Grajales. Asociación Panameña de Manejadores y Especialistas de Crocodylia: Panama.

Buitrago V.F. (2000). Conservation status of the American crocodile in Nicaragua. Pp. 392 in *Crocodiles. Proceedings of the 15th Working Meeting of the IUCN-SSC Crocodile Specialist Group*. IUCN: Gland.

Caldwell, J. (2008). *World Trade in Crocodilian Skins, 2004-2006*. UNEP-WCMC: Cambridge.

Carvajal, R.I., Saavedra, M. and Alava, J.J. (2005). Ecología poblacional, distribución y estudio de hábitat de *Crocodylus acutus* (Cuvier, 1807) en la "Reserva de producción de fauna manglares El Salado" del estuario del Golfo de Guayaquil, Ecuador. *Revista de Biología Marina y Oceanografía*: 141-150.

Carvajal, R. and Alava, J.J. (2005). American crocodiles still remain in mangroves of the Guayaquil Gulf, Ecuador. *Crocodile Specialist Group Newsletter* 24(3): 6-7.

Casas-Andreu, G. (2003). Ecología de la anidación de *Crocodylus acutus* (Reptilia: Crocodylidae) en la desembocadura del Río Cuitzmala, Jalisco, México. *Acta Zoológica Mexicana* (n.s.) 89: 111-128.

Cedeño-Vázquez, J.R., Rodriguez, D., Calmé, S., Ross, J.P., Densmore, L.D. and Thorbjarnarson, J.B. (2008a). Hybridization between *Crocodylus acutus* and *Crocodylus moreletii* in the Yucatan Peninsula: I. Evidence from mitochondrial DNA and morphology. *J. Exp. Zool.* 309A: 661-673.

Cedeño-Vázquez, J.R., Ross, J.P. and Calmé, S. (2006). Population status and distribution of *Crocodylus acutus* and *C. moreletii* in southeastern Quintana Roo, México. *Herpetological Natural History* 10: 53-66.

Cerrato, C. (2002). Honduras. Inventory of crocodiles in the Trujillo Bay Conservation Area. *Crocodile Specialist Group Newsletter* 21: 16.

Charruau, P., Cedeño Vázquez, J.R. and Rojo, R. (2004). *Crocodylus acutus* in Banco Chinchorro Biosphere Reserve, Quintana Roo. *Crocodile Specialist Group Newsletter* 23: 20.

Cupul-Magaña, F.G., Niz-Villaseñor, A.D., Reyes-Juárez, A. and Rubio-Delgado, A. (2004). Historia Natural del cocodrilo americano (*Crocodylus acutus*) en el Estero

- Boca Negra, Jalisco, México: anidación y crecimiento de neonatos. *Ciencia y Mar* 8(23): 31-42.
- Cupul-Magaña, F.G., Rubio-Delgado, A., Reyes-Juárez, A. and Hernández-Hurtado, H. (2002). Sondeo poblacional de *Crocodylus acutus* (Cuvier, 1807) en el estero Boca Negra, Jalisco. *Ciencia y Mar* 6(16): 45-50.
- De Sola, R., Velasco, A., Villarroel, G. and Colomine, G. (2004). Evaluation of wild populations and habitats of the American crocodile (*Crocodylus acutus*) in Venezuela. Pp. 248-256 *in* Crocodiles. Proceedings of the 17th Working Meeting of the IUCN-SSC Crocodile Specialist Group, IUCN: Gland.
- Domínguez-Laso, J. (2009). Record size for a female *Crocodylus acutus* in the Grijalva River, Chiapas, Mexico. *Crocodile Specialist Group Newsletter* 28: 14-15.
- Escobedo Galván, A.H., Dueñas, C. and Martínez, C. (2004). Notes on crocodiles in El Salvador. *Crocodile Specialist Group Newsletter* 23: 14.
- Espinal, M. (2005). American Crocodiles in Cajon Dam. *Crocodile Specialist Group Newsletter* 24(3): 5-6.
- García-Grajales, J., Aguirre-León, G. and Contreras-Hernández, A. (2007). Tamaño y estructura poblacional de *Crocodylus acutus* (Cuvier 1807) (Reptilia: Crocodylidae) en el Estero la Ventanilla, Oaxaca, México. *Acta Zoológica Mexicana (n.s.)* 23: 53-71.
- Gómez, J.J., Mejía, F., Patiño, E. and Baez, L. (2009). *Crocodylus acutus* conservation program in Bahía Portete, Colombia. *Crocodile Specialist Group Newsletter* 28(2): 10-12.
- González Cortes, H. (2007). Estudio poblacional de *Crocodylus acutus* (Cuvier, 1807) en el Refugio Estatal de Flora y Fauna Laguna de Colombia, Cozumel, Quintana Roo. Unpublished Licenciado Thesis, Universidad Veracruzana, México.
- Hernández-Hurtado, H., Quevedo-Machain, R.G. and Hernández-Hurtado, P.S. (2006). Los cocodrilos de la costa Pacífico occidental (Michoacán, Colima y Jalisco) de México. Pp. 375-389 *in* Los Recursos Pesqueros y Acuícolas de Jalisco, Colima y Michoacán, ed. by M.C. Jiménez Quíroz and E.E. Barr. Instituto Nacional de la Pesca: Mexico.
- Huerta Ortega, S.M., Ponce Campos, P. and Ross, J.P. (2002). Preliminary results of a population study of American crocodile (*Crocodylus acutus*) in Jalisco, Mexico. Pp. 231-238 *in* Crocodiles. Proceedings of the 16th Working Meeting of the IUCN-SSC Crocodile Specialist Group, IUCN: Gland.
- Huerta Ortega, S.M. and Ponce Campos, P. (2002). Interacción hombre-cocodrilo en la costa de Jalisco, Mexico. Pp. 200-203 *in* Crocodiles. Proceedings of the 16th Working Meeting of the IUCN-SSC Crocodile Specialist Group, IUCN: Gland.
- IUCN (2009). IUCN Red List of Threatened Species. Ver. 2009.1 (www.iucnredlist.org; viewed 30 September 2009).
- Kaiser, H., Sihotang, E.J.R., Marson, K.M., Crane, K.M., Dayov, J. and Grismer, L.L. (2001). A breeding population of American crocodiles, *Crocodylus acutus*, on Roatán, Isla de Bahía, Honduras. *Herpetological Review* 32(3): 164-165.
- Lander, A. and Bermudez, S. (2005). Current status of the American crocodile in Venezuela. *Crocodile Specialist Group Newsletter* 24(3): 7-8.
- Larriera, A., Webb, G., Velasco, A., Rodriguez, M. and Ortiz, B. (2005). Mission to Colombia. *Crocodile Specialist Group: Darwin*. (Available at www.iucncsg.org/ph1/modules/Publications/reports.html).
- Machkour-M'Rabet, S., Hénaut, Y., Charruau, P., Gevrey, M., Winterton, P. and Legal, L. (2009). Between introgression events and fragmentation, islands are the last refuge for the American crocodile in Caribbean Mexico. *Marine Biology* 156: 1321-1333.
- Mandujano Camacho, H.O. (2003). Estado de Conservación del Cocodrilo de Río (*Crocodylus acutus*) en la Cuenca del Río Grijalva en Chiapas, México. Unpublished MSc Thesis, Universidad Nacional Costa Rica, Costa Rica.
- Mazzotti, F.J., Brandt, L.A., Moler, P. and Cherkiss, M.S. (2007b). American crocodile (*Crocodylus acutus*) in Florida: Recommendations for endangered species recovery and ecosystem restoration. *J. Herpetol.* 41: 122-132.
- Mazzotti, F.J., Cherkiss, M.S., Parry, M.W. and Rice, K.G. (2007a). Recent nesting of the American crocodile (*Crocodylus acutus*) in Everglades National Park, Florida, USA. *Herpetological Review* 38: 285-289.
- Muñiz, M. (2004). Report on the current status of crocodylians in Mexico. *Crocodile Specialist Group Newsletter* 23: 21-24.
- Navarro Serment, C.J. (2003). Abundance, habitat use, and conservation of the American crocodile in Sinaloa. *Crocodile Specialist Group Newsletter* 22(2): 23.
- Platt, S. 2003. A recent study of the American crocodile in the Turneffe Atoll, Belize. *Crocodile Specialist Group Newsletter* 22(2): 17-20.
- Platt, S.G. and Thorbjarnarson, J. (2000). Nesting ecology of the American crocodile in the coastal zone of Belize. *Copeia* 2000: 869-873.

- Porras, L. (2007). Cocodrilos en Costa Rica: ¿poblacion o metapoblación? *Ambientales* 33: 18-22.
- Rainwater, T.R., Wu, T.H., Finger, A.G., Cañas, J.E., Yu, L., Reynolds, K.D., Coimbatore, G., Barr, B., Platt, S.G., Cobb, G.P., Anderson, T.A. and McMurry, S.T. (2007). Metals and organochlorine pesticides in caudal scutes of crocodiles from Belize and Costa Rica. *Science of the Total Environment* 373: 146-156.
- Rodriguez, D., Cedeño-Vázquez, J.R., Forstner, M.R.J. and Densmore, L.D. (2008). Hybridization between *Crocodylus acutus* and *Crocodylus moreletii* in the Yucatan Peninsula: II. Evidence from microsatellites. *J. Exp. Zool.* 309A: 674-686.
- Ross, P. and Larierra, A. (2001). Renewed conflict in Tarcoles River. *Crocodile Specialist Group Newsletter* 20(2): 32-33.
- Sánchez, J. (2001). Estado de la población de cocodrilos (*Crocodylus acutus*) en el río Tempisque, Guanacaste, Costa Rica. Unpublished Report, Área de Conservación Tempisque-Instituto Nacional de Biodiversidad (INBio), Heredia, Costa Rica.
- Schubert, A. (2002). Reproducción del cocodrilo americano (*Crocodylus acutus*) en el Lago Enriquillo, Republica Dominicana. Pp. 244-252 in *Crocodiles. Proceedings of the 16th Working Meeting of the IUCN-SSC Crocodile Specialist Group*, IUCN: Gland.
- Sigler, L. (2002). Conservación y manejo de *Crocodylus acutus* en México. Pp. 167-184 in *Conservação e Manejo de Jacarés e Crocodilos da América Latina*, ed. by L. Verdade and A. Larriera. C.N. Editoria: Piracicaba, Brazil.
- Soberón, R.R., Alonso Tabet, M., Thorbjarnarson, J. and Ramos, R. (2006). Programs for the conservation of the American crocodile in Cuba. Pp. 254-255 in *Crocodiles. Proceedings of the 18th Working Meeting of the IUCN-SSC Crocodile Specialist Group*, IUCN: Gland.
- Soberón, R. R., Alonso Tabet, M. and Berovides Alvarez, V. (2002). Nidificación del cocodrilo Americano (*Crocodylus acutus* Cuvier) en el Refugio de Fauna "Monte Cabaniguan", Cuba. Pp. 135-156 in *Conservação e Manejo de Jacarés e Crocodilos da América Latina*, ed. by L. Verdade and A. Larriera. C.N. Editoria: Piracicaba, Brazil.
- Stansell, K. (2007). Endangered and Threatened Wildlife and Plants; Reclassification of the American Crocodile Distinct Population Segment in Florida from Endangered to Threatened. *Federal Register* 72: 13027-13041.
- Trelancia, M. (2001). Situación de los Crocodilia en el Perú. Pp. 34-43 in *Memorias Primer Seminario-Taller: Capacitación y actualización en el manejo sostenible de los cocodrilos en Panamá*, ed. by M. d. Anaya, Y. Morán de Gotti and N. V. Martínez Grajales. Asociación Panameña de Manejadores y Especialistas de Crocodylia: Panama.
- Ulloa Delgado, G.A. and Sierra Diaz, C.L. (2006). Experimental pilot project for the conservation of *Crocodylus acutus* by local communities in the mangrove of Cispata Bay, Cordoba, Colombia, South America. Pp. 156-154 in *Crocodiles. Proceedings of the 18th Working Meeting of the IUCN-SSC Crocodile Specialist Group*. IUCN: Gland.
- Ulloa-Delgado, G.A. (2005). Experimental pilot project for the conservation of *Crocodylus acutus* by local communities in the mangroves of Cispata Bay, Cordoba. *Crocodile Specialist Group Newsletter* 24(1): 9-11.
- Ulloa Delgado, G.A. (2004). Conservation of *C. acutus* in Cispata Bay, Dept. of Cordoba. *Crocodile Specialist Group Newsletter* 23: 18-19.
- Ulloa Delgado, G.A., and Sierra Diaz, C.L. (2002). Conservation of *Crocodylus acutus* in the Bahía de Cispata. *Crocodile Specialist Group Newsletter* 21: 13-15.
- Velasco A. (2004). Status of crocodylians in South America. Pp. 188-193 in *Crocodiles. Proceedings of the 17th Working Meeting of the IUCN-SSC Crocodile Specialist Group*. IUCN: Gland.
- Velasco, A. and Lander, A. (1998). Evaluation of the reintroduction program for American crocodiles (*Crocodylus acutus*) in the Cuare Wildlife Refuge, Falcon State, Venezuela. Pp. 320-324 in *Crocodiles. Proceedings of the 14th Working Meeting of the Crocodile Specialist Group*. IUCN: Gland.
- Velasco, A., de Sola, R. and Lander, A. (2000). National program for the conservation of the american crocodile (*Crocodylus acutus*) in Venezuela. Pp. 330-335 in *Crocodiles. Proceeding of the 15th Working Meeting of the IUCN-SSC Crocodile Specialist Group*. IUCN: Gland.
- Villarroel, G., de Sola, R., Colomine, G. and Velasco, A. (2005). Evaluación de las poblaciones silvestres y del habitat del Cocodrilo Americano (*Crocodylus acutus*) en Venezuela. Pp. 45-52 in *Reunión Regional de América Latina y el Caribe del Grupo de Especialistas en Cocodrilos (CSG/SSC/IUCN)*. IUCN: Gland. (CD version).