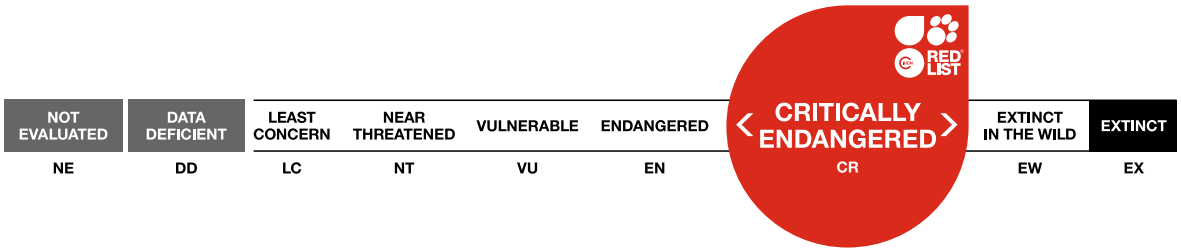
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Crocodylus rhombifer, Cuban Crocodile

Assessment by: McMahan, W., Targarona, R., Soberon, R. & Alonso Tabet, M.



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Taxonomy

Kingdom	Phylum	Class	Order	Family
Animalia	Chordata	Reptilia	Crocodylia	Crocodylidae

Scientific Name: *Crocodylus rhombifer* Cuvier, 1807

Common Name(s):

- English: Cuban Crocodile
- French: Crocodile de Cuba
- Spanish; Castilian: Cocodrilo, Cocodrilo de Cuba, Cocodrilo perla, Criollo, Legitimo, Pinto

Taxonomic Source(s):

Uetz, P. (ed). 2022. The Reptile Database. Available at: http://www.reptile-database.org. (Accessed: 5 May 2022).

Taxonomic Notes:

For *Crocodylus rhombifer*, there is strong evidence, based on morphology and genetic analyses, that widespread hybridization is taking place with *Crocodylus acutus* in the Cuban Archipelago (Milian-Garcia *et al.* 2014).

Assessment Information

Red List Category & Criteria: Critically Endangered A2cde ver 3.1

Year Published: 2022

Date Assessed: February 28, 2022

Justification:

Crocodylus rhombifer is endemic to Cuba. The species is assessed as Critically Endangered (CR A2cde), keeping the same status as in the previous assessment (2008). Population decline is still estimated at >80% over the last three generations (approximately 75 years). This reduction in population size is based on the decline in habitat extent and quality (which is continuing) and exploitation of the species, although the largest risk appears to be hybridization with *Crocodylus acutus*. Conservation measures are in place, however, reducing the rate of hybridization requires the foremost action. Further actions are also required to reduce the illegal hunting that occurs within this species' range.

The Cuban Crocodile also qualifies for Endangered under criteria B and C (EN (B1ab(i,ii,iii,iv,v)+2ab(i,ii,iii,iv,v)). The species occurs in only one location (Zapata Swamp in southwestern Cuba), with an area of occupancy (AOO) smaller than 500 km² and an extent of occurrence (EOO) smaller than 5,000 km². It is undergoing continuing decline in its EOO, AOO, habitat extent and quality, and population size, and it has been extirpated from one of its recently known locations. There are only 2,400 mature individuals remaining in the wild, with 100% of these individuals occurring within one population, which is undergoing continuing decline.

Previously Published Red List Assessments

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2008 – Critically Endangered (CR)
https://dx.doi.org/10.2305/IUCN.UK.1996.RLTS.T5670A11516438.en

1996 – Endangered (EN)

1994 – Endangered (E)

1990 – Endangered (E)

1988 – Endangered (E)

1986 – Endangered (E)

1982 – Endangered (E)

Geographic Range

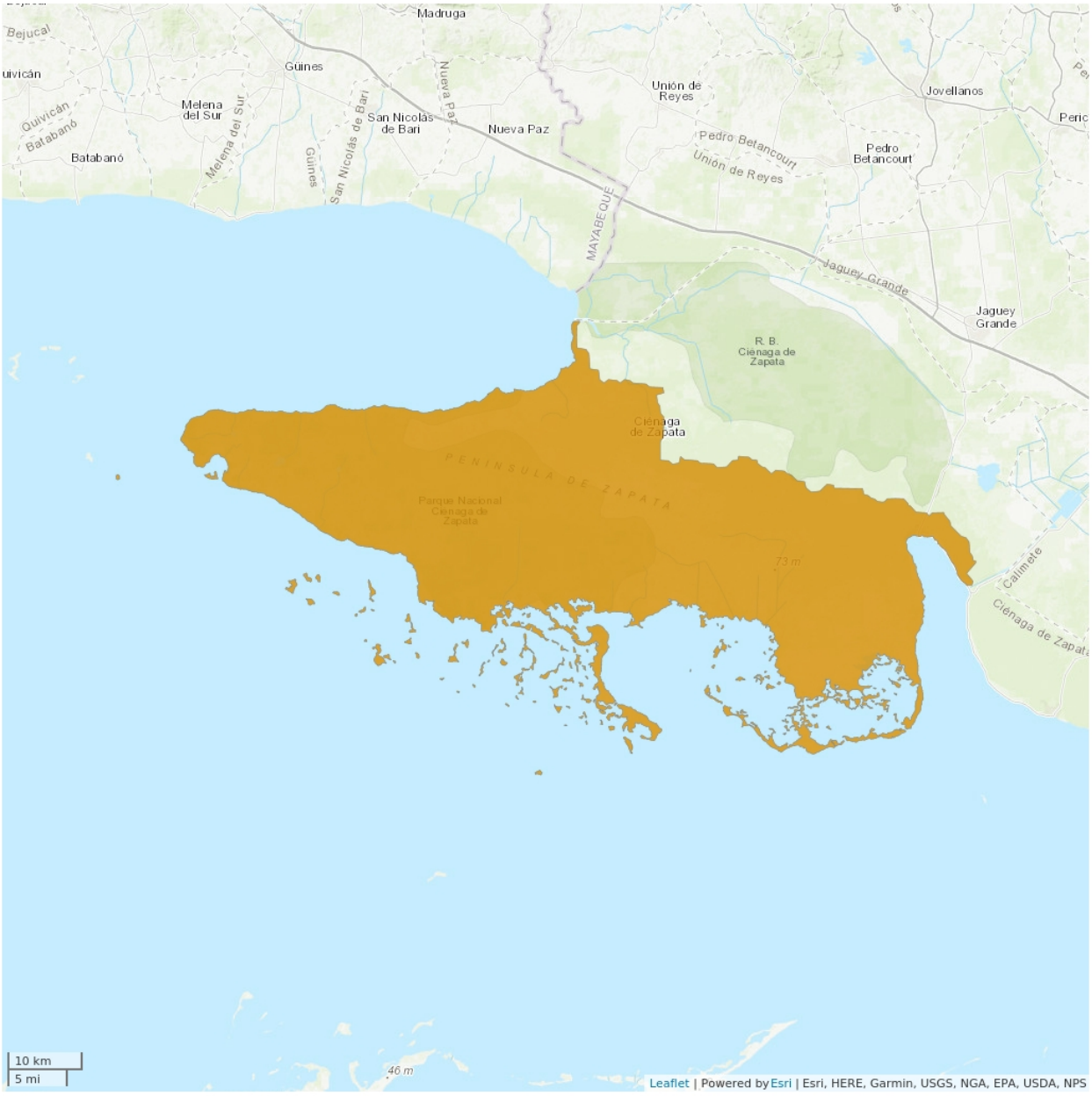
Range Description:

This species is no longer found in most of its historic range and is believed to have been extirpated from Lanier Swamp on the Isla de la Juventud (formerly Isle of Pines; Ramos and Rodriguez-Soberón 2020). The remaining population is located in Zapata Swamp in southwestern Cuba, where it occupies an area of 300 km² (its area of occupancy).

Country Occurrence:

Native, Extant (resident): Cuba

Distribution Map



Legend

EXTANT (RESIDENT)

Compiled by:

McMahan, W., Targarona, R., Soberon, R. and Alonso Tabet, M. 2022 2022





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Population

The Cuban Crocodile (*Crocodylus rhombifer*) is a Pleistocene relict. During Quaternary periods of continental glaciation, sea levels were 80–100 m lower than today. Consequently, much greater Caribbean island landmasses were exposed above sea level (Steadman *et al.* 2015). Pleistocene *C. rhombifer* fossils indicate 5–6 m long individuals, considerably larger than contemporary specimens. Today, *C. rhombifer* has one of the smallest known distributions of any extant crocodilian (<300 km²). Since the last assessment in 2008, no confirmed sightings of *C. rhombifer* in Lanier Swamp (Isla de la Juventud) has led to the belief that the species is now extirpated in that location (Ramos and Rodriguez-Soberón 2020). This leaves the sole location restricted to Zapata Swamp on mainland Cuba although, in the recent past, the species was more widely distributed on the main island of Cuba (Leidy 1868, Gundlach 1880, Brown 1913, Matthew 1918, Varona 1966, Neill 1971, McMahan 1993). Skeletal material shows that this species was present on the Cayman Islands (Morgan *et al.* 1993), in the Bahamas (Franz *et al*. 1995) and the Dominican Republic (Morgan *et al*. 2018).

Zapata Swamp, with an approximate area of 6,579 km², is located on the Zapata Peninsula, south of Matanzas Province, western Cuba. Most of this territory has protected area status, under the categories of Protected Area of Managed Resources, Wildlife Refuge, and National Park. The Zapata Swamp Biosphere Reserve was established in 2000, and since 2001 has been designated a Ramsar Site. Zapata Peninsula also holds the status of Special Region of Sustainable Development (Decree 197/96, Plan Turquino-Manati). The Cuban Crocodile population of Zapata Swamp is restricted to a small area of approximately 300 km², on the southwestern portion of the peninsula (Ramos *et al*. 1994, Ramos 2000), where the species is sympatric with the American Crocodile (*Crocodylus acutus*).

The status of *C. rhombifer* in Zapata Swamp has been the subject of research since 1976 (Ramos 1987, 1999, 2000, 2008; Ramos Targarona 2006; Ramos *et al*. 1994; Rodriguez-Soberón *et al*. 2000). Assessments of status and trends were carried out in a Population and Habitat Viability Analysis (PHVA) workshop at the Isla de la Juventud in 2000 (Rodríguez-Soberón *et al*. 2000) and in two national workshops on the Status of the Cuban Crocodile in Zapata Swamp in 2006 and 2008 (Ramos Targarona 2006, Ramos 2008 unpubl.). The IUCN SSC Crocodile Specialist Group conducted a review with recommendations on crocodile conservation and management in Cuba in 2008 (Larriera *et al*. 2008).

Historically, *C. rhombifer* was abundant on both the eastern and the western portions of Zapata Swamp. Before 1959, significant, though undetermined, numbers of crocodiles were killed for commercial purposes, and large sectors of marsh, mangrove and hardwood tropical forest were transformed (canal digging, forest clearing, land drainage, roads). This was followed by the capture of several hundred adults that were relocated to the newly constructed crocodile farm at Laguna del Tesoro in 1959 and 1960. As a result of these actions, by the early 1960s the wild *C. rhombifer* population had been drastically reduced. After 1959, the eastern portion of Zapata Swamp and the northern periphery of the western portion were almost totally transformed into agricultural and grazing land (Ramos Targarona 2006). This meant an irreversible loss of more than 30% of the habitat for both Cuban and American crocodiles in the Zapata area, but the western portion of the swamp remained almost untouched and became the core area of distribution for the species. According to Ramos (2000), by the final decade of the 20th Century, the wild *C. rhombifer* population in Zapata Swamp was confined to a core area of approximately 300 km², situated on the southwestern portion of the peninsula. The population size was estimated as a minimum of 3,000 individuals, with a high probability of being between 5,000 and 6,000

individuals and with a breeding component of around 1,000 breeding females. The estimated total mature population is estimated to be 2,400 *C. rhombifer*.

In the PHVA Workshop (Rodríguez-Soberón *et al.* 2000), this population was considered to be "viable, stable and healthy". Population surveys conducted in Zapata Swamp by Ramos and collaborators between 1994 and 2000 (Ramos 2000) indicated that the *C. rhombifer* population remained stable over that period, with a slight shift in size structure towards larger animals, an average density of 18.1 crocodiles/km (14.2–26.8) with a slight increase in the presence of hybrids (Ramos 2000). Since then, in a previously undocumented brackish water portion in the southwest of the swamp, a density of 14 *C. rhombifer*/km was reported (Ramos, pers. comm. 2008). Surveys conducted between 2002 and 2007 in a 60 km² area on the northern periphery of the core area indicated a very low densities, and 59.2% of captured individuals were obvious hybrids. The surveys also found evidence of a considerable increase in illegal harvest (Ramos Targarona 2006, Ramos 2008).

Lanier Swamp is a small wetland of approximately 100 km², situated on a west-east axis, across the central portion of Isla de la Juventud. Although the local *C. acutus* population prefers brackish and saltwater habitats such as mangrove swamps, coastal lagoons and estuarine watercourses, individuals occasionally venture deep into the freshwater habitats of Lanier Swamp, enabling hybridization with *C. rhombifer* to occur. Also, a relatively large population of the introduced brown caiman (*Caiman crocodilus fuscus*) is in Lanier Swamp (Berovides *et al*. 2000; Varona 1976, 1983). Other than young *C. rhombifer* being found in the stomach contents of adult *C. crocodilus* at the Isla de la Juventud, no other evidence of negative impacts on *C. rhombifer* by Caimans has been reported (Rodríguez-Soberón *et al*. 2000, Varona 1983).

Six hundred farm-bred *C. rhombifer* of different age classes were released into Lanier Swamp from nearby Cayo Potrero Crocodile Farm in 1994, as part of an ongoing restocking program carried out by the Empresa Nacional para la Protección de la Flora y la Fauna (ENPFF) - Ministry of Agriculture (Rodríguez-Soberón *et al*. 1996). Monitoring of the restocked population between 1994 and 2004 showed that the reintroduced crocodiles settled down and reproduced successfully, despite the strong pressure of illegal hunting exerted on this population by local people. Modelling of the illegal hunting pressure using a Population and Habitat Viability Analysis (PHVA) by Rodríguez-Soberón *et al*. (2000) showed that a removal of 30–40 sub-adult and adult crocodiles per year, over the next 20 years, would result in negative population growth, and that if continued, it would eventually lead to extinction (although this would not become apparent in the next 40 years). It appears that this analysis severely underestimated the degree of illegal hunting. In less than eight years since the workshop, no *C. rhombifer* have been reported in Lanier Swamp, although it must be recognized that after 2002 no regular population monitoring of the area has been carried out (Ramos and Rodríguez-Soberón 2020). As such, *C. rhombifer* are now considered extirpated in Lanier Swamp, representing a population loss of 600 mature individuals.

The persistence of *C. rhombifer* is entirely due to the activities of Cuban authorities, and continuation of active protection, monitoring and community outreach will be a vital component of the species' future survival. Relaxation or abandonment of these activities might quickly lead to severe decline. *C. rhombifer* is now subject to a perfect storm of environmental and anthropogenic effects. Despite efforts to mitigate these factors, none of the problems facing the species have been resolved. In fact, several of these threats, such as a dwindling relictual range, hybridization and rising sea level, are not reversible.

Consequently, in this assessment, *C. rhombifer* is listed as Critically Endangered, a listing which underscores that *C. rhombifer* is now facing a high risk of extinction in the wild.

Captive Management

Captive management of *C. rhombifer* through captive breeding began in Zapata Swamp (Laguna del Tesoro) Crocodile Farm in 1959, where hundreds of wild-caught adults of both *C. rhombifer* and *C. acutus* were confined. When the crocodiles were first placed into pens, *C. rhombifer* were mixed with *C. acutus*, resulting in hybridization. Since then, the two species have been separated and presumably pure *C. rhombifer* have been isolated. The degree of genetic introgression remaining in the captive Cuban stock is unknown. The Zapata Swamp farm has mastered important aspects of captive crocodile management, with achievements on physiology, ethology, haematology, animal husbandry and veterinary science. The farm also provided the founding stock for the Lanier Swamp restocking program. The farm is registered as a CITES captive breeding operation (since 1994), but commercial operations to date have been very minor. Farm production has comprised almost exclusively of crocodile meat and stuffed animals, with the skins remaining unexploited. The farm has a fluctuating population of 3,000–4,000 individuals, including 150 (1M:3F) breeding stock.

The ENPFF established the Cayo Potrero Crocodile Farm at the Isla de la Juventud in 1986, with the primary objective of providing farm-bred *C. rhombifer* for restocking program in Lanier Swamp (Rodriguez *et al.* 1996). This facility began operating with 50 stock donated by the Havana Zoo and 650 adults and 80 sub-adults from the Zapata Swamp farm. Captive breeding began in 1987, and has remained uninterrupted since then, despite many disruptions, escapes and destruction caused by hurricanes on several occasions.

The Cuban crocodile has been maintained in a Species Survival Plan (SSP) by the Association of Zoos & Aquariums (AZA) in the USA since 1993. It is easy to propagate and manage in captivity and displays well in zoos (McMahan 2008). As in Cuba, the SSP specimens were initially assessed and identified by morphological characters and phenotype. In 2017, there were 74 (14 males, 36 female, 24 unknown sex) animals in the Cuban Crocodile SSP Master Plan (McMahan *et al*. 2017). A molecular assay conducted on the SSP population by the American Museum of Natural History's Genomics Lab (2021), indicated SSP specimens were the purest remaining animals. The SSP population also included rare alleles no longer found in the other known, assayed, remaining populations. AZA maintains both an SSP Master Plan and Studbook for the Cuban crocodile (W. McMahan, pers comm, 2022). Outside of the New World, the European Association of Zoos and Aquaria (EAZA) maintains a studbook at Paignton Zoo (England) for 25 (2 males, 19 females, 4 unknown sex) *C. rhombifer* (M. Dainty, pers. comm. 2017). There are also three females and one male held at the Madras Crocodile Bank Trust in India, as well as a pair in Saigon Zoo, Viet Nam.

Current Population Trend: Decreasing

Habitat and Ecology **(see Appendix for additional information)**

Cuban Crocodile habitat is composed of a limestone base characterized by deeply eroded edges (diente del perro) and karst, overlain with mud (tembladera) and dense vegetation. Sawgrass (*Cladium jamaicensis*) and cattail (*Typha domingensis*) dominate open, shallow water areas. Buttonwood (*Conocarpus erecta*) is found throughout the freshwater environment and is almost an indicator species for *C. rhombifer*. Densely vegetated hammocks are scattered across slightly higher ground throughout

both swamps. Some low, pitted limestone escarpments harbour Caribbean dry forest communities, with trees like poisonwood (*Metopium toxiferum*), known locally as guao. Animal species found in association with *C. rhombifer* include apple snails (*Pomacea* spp.), mosquito fish (*Gambusia* spp.), catfish (*Clarias* spp.), a primitive endemic gar (*Lepisosteus tristochus*), an endemic boa (*Epicrates angulifer*), turtles, endemic woodpecker (*Xiphidiopicus percussus*), hutia (*Capromys pilorides*)—a 6 kg semi-arboreal rodent—as well as introduced African cichlids (*Tilapia* spp.).

Although some fossil crocodilians possessed horn-like squamosals, it is not a morphological character in modern crocodilians - except for *C. rhombifer*. The Cuban Crocodile is the most heavily armoured extant member of the genus *Crocodylus*. It has also been suggested that the dentition of *C. rhombifer* is unusual among modern *Crocodylus* because it can have 12 maxillary teeth, and possesses a carnassial, which differentiates it from other living *Crocodylus* species (Ross 1998). Although *C. rhombifer* is physically smaller than *C. acutus*, it is behaviorally dominant over the latter in captive situations (Gundlach 1880; Varona 1966, 1986; Neill 1971; Thorbjarnarson 1992).

The Cuban Crocodile is an aggressive, athletic species. It is an adept leaper, quite capable on land, frequently using its muscular, strongly keeled limbs to rise rapidly and propel its body along the ground. It is capable of galloping (W. McMahan, pers. obs. 1997). Tail drag marks have been observed in proximity to hutia trails in seasonal dry forest, some distance from water. Stomach contents have revealed the importance of this prey item. From 20 *C. rhombifer* in Zapata Swamp, ranging in size from 1.40 to 2.05 m TL, hutia accounted for over 90% of the total recovered stomach contents by mass. The other prey items included fish [minnows (*Gambusia*, *Cubanichtis* and *Giraldinus*), biajaca (*Chichlasoma tetracanthus*), gar (*Atractosteus tristoechus*), and the invasive, recently introduced *Clarias gariepinus*], crustaceans [land crabs (*Cardisoma* spp.), jaiba (*Calinectres* spp.)], gastropods [apple snail (*Pomacea* spp.)], reptiles [hicotea (*Pseudemys decussata*)], birds (Varona 1966), mammals [feral pigs (*Sus scrofa*), dogs (*Canis familiaris*) and whitetail deer (*Odocoileus virginianus*] (Ramos 1999). On very rare occasions, humans are also taken (Gundlach 1880, R. Ramos pers. comm. 1997).

The average size at sexual maturity of captive-hatched female *C. rhombifer* was 1.90 ± 0.20 m total length at 6–7 years of age. Captive males are thought to reach sexual maturity at the same age and about 1.97 ± 0.08 m TL (Ramos-Targarona 2000, 2013). Growth in the wild in the Zapata Swamp appears to be slower than in captivity, so that time to sexual maturity may be longer. Wild growth rates in the Zapata Swamp appear incremental, compared to captive animals (R. Ramos, pers. comm. 2000). The Cuban crocodile has an annual reproductive cycle, with its timing affected by factors such as rainfall, water level and environmental temperatures. Adult males are polygamous and territorial. Courtship and mating extend from November to May, when the water level in the marsh is lowest. Nesting coincides with the beginning of the rainy season and extends from mid-April to late May and early June, when rains increase (Ramos 2000). The Cuban Crocodile is a mound-nesting species, but in unsuitable captive environments which lack ample vegetation or loose soil, it may resort to hole-nesting (W. McMahan, pers. obs. 1999, Ramos-Targarona 2013). Nests may be more than 2.7 m in diameter and 1 m high. Average clutch size is 25.4 eggs in captivity and 14.5 eggs in the wild (Ramos-Targarona 2000, 2013) and hatching occurs in August and early September.

Hybridization between *C. rhombifer* and *C. acutus* has been confirmed using molecular genetics, both in the wild and in captivity (Varona 1966; Brazaitis 1973; Gonzalez 1975; Ramos 1987; Milian-Garcia *et al.* 2014), resulting not only in the risk of losing a unique evolutionary lineage, but also a species considered

morphologically and ethologically distinct in the genus *Crocodylus* (Thorbjarnarson, pers. comm. 2007). R. Ramos (pers. comm. 2018) reports fertile hybrids from the crossing of male *C. acutus* with female *C. rhombifer*, and has obtained viable offspring from the crossing of male *C. rhombifer* with female *C. acutus* (Ramos *et al.* 1994), but it is still unknown whether the latter are fertile or not. A *C. rhombifer* x *C. acutus* hybrid was recently found in Cancun, México (Cedeño-Vázquez *et al.* 2008). Hybridization with *C. porosus* (Fitzsimmons *et al*. 2002 and *C. siamensis* (Thang 1994, Fitzsimmons *et al.* 2002) has also been reported in Cambodia and Viet Nam (Jelden *et al*. 2005 2008), raising concerns for the Critically Endangered *C. siamensis*.

Systems: Terrestrial, Freshwater (=Inland waters)

Use and Trade

Illegally harvested *Crocodylus rhombifer* for local meat is the main reason for illegal poaching.

Because it is the most heavily armoured of the extant *Crocodylus* species, the skins are not highly sought compared to other *Crocodylus* species (e.g., *C. porosus* or *C. acutus*). That said, its ossified osteoderms and surrounding pearl-like scales are quite dramatic and perhaps a novel, speciality market could be created to develop a sustainable-use model which has worked in many other crocodilian species.

Threats (see Appendix for additional information)

The main threats to the wild *Crocodylus rhombifer* population are associated with the limited distribution of the species. Habitats are affected by water pollution from chemical run-off, habitat transformation due to changing water regimes, uncontrolled fires, construction of roads, introduction of invasive alien species of fish and plants, as well as climate change (temperature, precipitation and sea level). Issues of concern at the species level include genetic integrity of the species by hybridization with *C. acutus*, increased illegal harvest, and global climate change. In addition, conservation efforts are hampered by a lack of recognition of the conservation status of *C. rhombifer*, poor protection, lack of opportunities for community involvement, insufficient knowledge on population biology, and shortage of human and material resources for research, management and protection.

Habitat alteration:
The Cuban Crocodile is now limited to Zapata Swamp, which hosts an extensive series of man-made canals, constructed from the marine coast, which penetrate into the swamp's freshwater interior. This anthropogenic series of features is thought to have been constructed around the time of the Spanish-American War in 1898, but eliminated a natural ecological barrier which had served to separate *C. rhombifer* and *C. acutus* for some 2+ million years. These man-made canals allowed for the immigration of the widespread *C. acutus* into and throughout *C. rhombifer*'s entire Zapata Swamp habitat. Both species are now completely sympatric there (Ramos *et al.* 1994), a situation that is totally at odds with the historic, allopatric descriptions reported by Humboldt (1827), Gundlach (1880), Barbour and Ramsden (1919), Varona (1966) and Neill (1971). It is also noteworthy that no *C. acutus* material has been found at any of the *C. rhombifer* fossil sites in Cuba, the Cayman Islands, the Bahamas (Ross 1998) or the Dominican Republic (Morgan *et al*. 2018).

Competitive exclusion and hybridization:
The American Crocodile is an ecologically adaptable species found in marine, brackish and freshwater

environments in 18 New World countries. By contrast, the Cuban Crocodile is limited to one-third of one percent (<400 km²) of a single New World country (110,860 km²).

Hybrids, known locally as “mixturados” or “cruzados”, were first reported by Cuban Crocodile hunters more than half a century ago (Varona 1966, Neill 1971). Ramos *et al.* (1994) stated that *C. rhombifer* and *C. acutus* could be literally captured, side by side. At the three principal study sites (Rinconada del Canal Diez, Emetario and Jamon) surveyed at that time (1993), 2.5% of sampled crocodiles were deemed phenotypic hybrids. However, in 1996, phenotypic hybrids comprised 8% of captured animals in those areas; and by 2012 and 2013, 37.5% and 27.7% respectively, were identified as phenotypic hybrids (R. Ramos, pers. comm. 2018). In 2014, molecular analysis indicated 49.1% of wild *C. rhombifer* in Zapata Swamp were hybrids (Milian-Garcia *et al.* 2014). These differences may reflect the complex hydrology of that peninsular system, which allows varying degrees of introgression based on locality. The relict distribution of *C. rhombifer* is so small now, that its entire range is essentially part of this hybrid zone. Hybrids are fertile and perhaps even better adapted to current environmental conditions than *C. rhombifer* because hybrid numbers continue to increase and genetically swamping *C. rhombifer* in the wild. Whether *C. rhombifer* can maintain its genetic integrity *in-situ* remains to be seen, but the current rate of hybridization suggests it may soon cease to exist as a distinct species in the wild. This has proven to be an especially insidious factor in the Cuban crocodile’s *in-situ* survival and its Critically Endangered status.

Introduced species:
In 1959, nine Brown Caimans (*Caiman crocodilus fuscus*) were introduced to Isla de la Juventud from the El Dique Fluvial Repopulation Center (Varona 1976, Thorbjarnarson 1992). By the late 1990s, Cuban biologists estimated the population of *C. c. fuscus* in Lanier to be in excess of 40,000 animals (D. Lopez, pers. comm. 1999). The degree of competitive exclusion imposed by this exotic alligatorid in Lanier Swamp is unknown, but resource competition with a decidedly freshwater form may have, in combination with illegal hunting, adversely affected *C. rhombifer* and any reintroduction prospects into this freshwater ecosystem.

Illegal hunting:
Hunting crocodiles in Cuba for a burgeoning exotic leather industry began in earnest shortly after the construction of Zapata Swamp’s man-made canals. Cosculluela (1918) noted that during a single 10-year period, more than 90,000 crocodiles were harvested from Zapata Swamp. It has been illegal to hunt *C. rhombifer* in Cuba since 1967. However, excessive hunting by local communities for food has been a chronic problem for the species for more than a century and caused the extinction of the Cuban crocodile from Lanier Swamp in the early 20th Century. This appears to have been repeated in the early 21st Century, despite a purposeful, large-scale reintroduction of *C. rhombifer* in Lanier Swamp in the 1990s. Workers at Cayo Potrero’s farm have not found any wild *C. rhombifer* in the swamp since 2010, which is now considered extirpated as a result (Ramos and Rodríguez-Soberón 2020). This is despite conservation education programs, literature in local schools and a community *C. rhombifer* festival accompanying the reintroduction effort (Gianelloni 2002, Mohan *et al.* 2004).

A public relations effort was made for *C. rhombifer* in Zapata, but illegal hunting continues virtually unabated there also. Packed boatloads of poached crocodiles could be seen on a video leaving the Zapata Swamp on YouTube in 2017 (C. Harbsmeier, pers. comm. 2017). The Cuban Crocodile is more highly sought after as food than either *C. acutus* or *C. c. fuscus*, perhaps a result of the dietary

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preferences for each species, as well as the less wary nature of *C. rhombifer*. This hunting for food has been exacerbated in the last couple of decades in order to supply "paladares", small family restaurants very cheap for international tourism.

It seems possible that the combined effect of habitat alteration in Zapata, coupled with excessive hunting during the early 20th Century, may have exacerbated hybridization problems for *C. rhombifer* by selectively removing prime adult *C. rhombifer*. Constantly depleting the pool of animals that use the most selective behavioural, reproductive isolating mechanisms, may have created an environment which fostered less active reproductive discrimination, resulting in increased hybridization.

Rising sea level:
Although freshwater marshes were far more prevalent throughout the western Caribbean during the Pleistocene, they are a rare habitat there today. Current Holocene climate models indicate rising temperatures across portions of the globe, and as the planet warms, sea levels will rise and encroach on coastal marshland and freshwater ecosystems (M. Eaton pers. comm. 2017). Rising sea levels in Cuba's Zapata Peninsula and Lanier Swamp could create brackish or saltwater marshes, which may create unfavourable environmental conditions for *C. rhombifer*. Using warming climate models, Ramos *et al.* (2008) predicted more optimal conditions for *C. acutus* in Cuba, assisting in its competitive advantage, suggesting *C. rhombifer* may be particularly susceptible to extinction.

Conservation Actions **(see Appendix for additional information)**

This species is listed under Appendix I of CITES. There are captive breeding programs in place, although reintroductions into "protected areas" have not helped increase population numbers. Illegal hunting continues to occur, therefore further harvest management is required to reduce the rate of population decline currently occurring. Further research and monitoring of the population, taxonomy, harvest levels, and threats to this species should be carried out.

High priority
1. Current status in Zapata: New surveys are needed to review the current population status of *C. rhombifer* in order to assist the development of conservation strategies and management programs. A formal survey should also be conducted in Lanier Swamp to confirm the extirpated status.

2. Protection of the wild population: Due to increased illegal hunting of crocodiles for local meat consumption and commercialization, effective mechanisms of control need to be identified and implemented, along with programs for community education and activism that include the community participation in sustainable use.

3. Captive breeding: The captive population of *C. rhombifer* is extremely important to ensure the future of the species, although ensuring pure *C. rhombifer* is critical (Milian-Garcia *et al.* 2014). A molecular assay conducted on the Species Survival Plan (SSP) population by the American Museum of Natural History's Genomics Lab (2021), indicated SSP specimens were the purest remaining animals. The SSP population also included rare alleles no longer found in the other known, assayed, remaining populations. AZA maintains both an SSP Master Plan and Studbook for the Cuban crocodile (W. McMahan, pers. comm., 2022) and in 2017 there were 74 individuals (14 males, 36 females and 24 of unknown sex). Although not yet genotyped, those animals held in European zoos (25 in total; two males, 19 females and four unknown sex) could also be valuable additions to genetic diversity. Similarly,

those specimens in India, Viet Nam and Cambodia as long as no hybridization with *C. siamensis* and/or *C. porosus* can be confirmed (see Jelden *et al.* 2005, 2008). This would require a coordination between countries to ensure optimum purity of mate selection to maximize genetic diversity.

In addition, improving farming technologies to increase and optimize production, and to seek ways to integrate local communities with the farm and conservation efforts is also critical.

Credits

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External Resources

For Supplementary Material, and for Images and External Links to Additional Information, please see the Red List website.

Appendix

Habitats

(http://www.iucnredlist.org/technical-documents/classification-schemes)

Habitat	Season	Suitability	Major Importance?
1. Forest -> 1.6. Forest - Subtropical/Tropical Moist Lowland	Resident	Suitable	No
1. Forest -> 1.7. Forest - Subtropical/Tropical Mangrove Vegetation Above High Tide Level	Resident	Suitable	Yes
1. Forest -> 1.8. Forest - Subtropical/Tropical Swamp	Resident	Suitable	Yes
4. Grassland -> 4.6. Grassland - Subtropical/Tropical Seasonally Wet/Flooded	Resident	Suitable	Yes
5. Wetlands (inland) -> 5.3. Wetlands (inland) - Shrub Dominated Wetlands	Resident	Suitable	Yes
5. Wetlands (inland) -> 5.4. Wetlands (inland) - Bogs, Marshes, Swamps, Fens, Peatlands	Resident	Suitable	Yes
5. Wetlands (inland) -> 5.5. Wetlands (inland) - Permanent Freshwater Lakes (over 8ha)	Resident	Suitable	No
5. Wetlands (inland) -> 5.7. Wetlands (inland) - Permanent Freshwater Marshes/Pools (under 8ha)	Resident	Suitable	Yes
5. Wetlands (inland) -> 5.18. Wetlands (inland) - Karst and Other Subterranean Hydrological Systems (inland)	Resident	Suitable	Yes

Use and Trade

(http://www.iucnredlist.org/technical-documents/classification-schemes)

End Use	Local	National	International
2. Food - animal	Yes	No	No
10. Wearing apparel, accessories	No	Yes	No
17. Other (free text)	No	Yes	No

Threats

(http://www.iucnredlist.org/technical-documents/classification-schemes)

Threat	Timing	Scope	Severity	Impact Score
5. Biological resource use -> 5.1. Hunting & trapping terrestrial animals -> 5.1.1. Intentional use (species is the target)	Ongoing	Majority (50-90%)	Rapid declines	Medium impact: 7
	Stresses:	2. Species Stresses -> 2.1. Species mortality		

		2. Species Stresses -> 2.3. Indirect species effects -> 2.3.1. Hybridisation -> 2.3.2. Competition -> 2.3.3. Loss of mutualism		
5. Biological resource use -> 5.4. Fishing & harvesting aquatic resources -> 5.4.2. Intentional use: (large scale) [harvest]	Ongoing	Majority (50-90%)	Rapid declines	Medium impact: 7
	Stresses:	2. Species Stresses -> 2.1. Species mortality 2. Species Stresses -> 2.3. Indirect species effects -> 2.3.1. Hybridisation -> 2.3.2. Competition -> 2.3.3. Loss of mutualism		
8. Invasive and other problematic species, genes & diseases -> 8.1. Invasive non-native/alien species/diseases -> 8.1.2. Named species (Caiman crocodilus)	Ongoing	Majority (50-90%)	Negligible declines	Low impact: 5
	Stresses:	2. Species Stresses -> 2.3. Indirect species effects -> 2.3.2. Competition		
8. Invasive and other problematic species, genes & diseases -> 8.2. Problematic native species/diseases -> 8.2.2. Named species (Crocodylus acutus)	Ongoing	Majority (50-90%)	Slow, significant declines	Medium impact: 6
	Stresses:	2. Species Stresses -> 2.2. Species disturbance 2. Species Stresses -> 2.3. Indirect species effects -> 2.3.1. Hybridisation -> 2.3.2. Competition -> 2.3.7. Reduced reproductive success		
11. Climate change & severe weather -> 11.1. Habitat shifting & alteration	Ongoing	Whole (>90%)	Slow, significant declines	Medium impact: 7
	Stresses:	1. Ecosystem stresses -> 1.2. Ecosystem degradation 1. Ecosystem stresses -> 1.3. Indirect ecosystem effects 2. Species Stresses -> 2.1. Species mortality 2. Species Stresses -> 2.2. Species disturbance 2. Species Stresses -> 2.3. Indirect species effects -> 2.3.1. Hybridisation -> 2.3.2. Competition -> 2.3.3. Loss of mutualism -> 2.3.7. Reduced reproductive success		

Conservation Actions in Place

(http://www.iucnredlist.org/technical-documents/classification-schemes)

Conservation Action in Place
In-place research and monitoring
Action Recovery Plan: Yes
Systematic monitoring scheme: No
In-place land/water protection
Conservation sites identified: Yes, over part of range
Percentage of population protected by PAs: 100
Area based regional management plan: No
Occurs in at least one protected area: Yes
Invasive species control or prevention: Not Applicable
In-place species management

Conservation Action in Place
Harvest management plan: No
Successfully reintroduced or introduced benignly: No
Subject to ex-situ conservation: No
In-place education
Subject to recent education and awareness programmes: No
Included in international legislation: Yes
Subject to any international management / trade controls: Yes

Conservation Actions Needed

(http://www.iucnredlist.org/technical-documents/classification-schemes)

Conservation Action Needed
1. Land/water protection -> 1.1. Site/area protection
1. Land/water protection -> 1.2. Resource & habitat protection
2. Land/water management -> 2.1. Site/area management
2. Land/water management -> 2.2. Invasive/problematic species control
2. Land/water management -> 2.3. Habitat & natural process restoration
3. Species management -> 3.1. Species management -> 3.1.1. Harvest management
3. Species management -> 3.2. Species recovery
3. Species management -> 3.3. Species re-introduction -> 3.3.1. Reintroduction
3. Species management -> 3.4. Ex-situ conservation -> 3.4.1. Captive breeding/artificial propagation
3. Species management -> 3.4. Ex-situ conservation -> 3.4.2. Genome resource bank
4. Education & awareness -> 4.1. Formal education
4. Education & awareness -> 4.2. Training
4. Education & awareness -> 4.3. Awareness & communications
5. Law & policy -> 5.1. Legislation -> 5.1.2. National level
5. Law & policy -> 5.1. Legislation -> 5.1.3. Sub-national level
5. Law & policy -> 5.2. Policies and regulations
5. Law & policy -> 5.4. Compliance and enforcement -> 5.4.2. National level
5. Law & policy -> 5.4. Compliance and enforcement -> 5.4.3. Sub-national level
6. Livelihood, economic & other incentives -> 6.1. Linked enterprises & livelihood alternatives
6. Livelihood, economic & other incentives -> 6.2. Substitution

Conservation Action Needed
6. Livelihood, economic & other incentives -> 6.4. Conservation payments
6. Livelihood, economic & other incentives -> 6.5. Non-monetary values

Research Needed

(http://www.iucnredlist.org/technical-documents/classification-schemes)

Research Needed
1. Research -> 1.1. Taxonomy
1. Research -> 1.2. Population size, distribution & trends
1. Research -> 1.4. Harvest, use & livelihoods
1. Research -> 1.5. Threats
1. Research -> 1.6. Actions
2. Conservation Planning -> 2.1. Species Action/Recovery Plan
2. Conservation Planning -> 2.2. Area-based Management Plan
2. Conservation Planning -> 2.3. Harvest & Trade Management Plan
3. Monitoring -> 3.1. Population trends
3. Monitoring -> 3.2. Harvest level trends
3. Monitoring -> 3.3. Trade trends

Additional Data Fields

Distribution
Estimated area of occupancy (AOO) (km²): 300
Continuing decline in area of occupancy (AOO): Yes
Extreme fluctuations in area of occupancy (AOO): No
Estimated extent of occurrence (EOO) (km²): 4342
Continuing decline in extent of occurrence (EOO): Yes
Extreme fluctuations in extent of occurrence (EOO): No
Number of Locations: 1
Continuing decline in number of locations: Yes
Extreme fluctuations in the number of locations: No
Lower elevation limit (m): 0
Upper elevation limit (m): 50

Distribution
Lower depth limit (m): 0
Upper depth limit (m): 40
Population
Number of mature individuals: 2,400
Continuing decline of mature individuals: Yes
Extreme fluctuations: No
Population severely fragmented: No
No. of subpopulations: 1
Continuing decline in subpopulations: No
Extreme fluctuations in subpopulations: No
All individuals in one subpopulation: Yes
No. of individuals in largest subpopulation: 2400
Habitats and Ecology
Continuing decline in area, extent and/or quality of habitat: Yes
Generation Length (years): 25
Movement patterns: Not a Migrant
Congregatory: Congregatory (year-round)

The IUCN Red List Partnership



The IUCN Red List of Threatened Species™ is produced and managed by the IUCN Global Species Programme, the IUCN Species Survival Commission (SSC) and The IUCN Red List Partnership.

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