Population assessment of *Crocodylus acutus* Cuvier, 1807 (Crocodilia: Crocodylidae) and *Caiman crocodilus* Linnaeus, 1758 (Crocodilia: Alligatoridae) in the Bay of Cispatá, Córdoba, Colombia.

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Resume

The American crocodile (*Crocodylus acutus*) and the Spectacled caiman (*Caiman crocodilus*) are the only two species of crocodilians that inhabit the Colombian Caribbean. However, the populations of this species face important challenges, such as the lack of knowledge regarding their population characteristics, which impedes effective management and conservation efforts, and various anthropogenic pressures that have contributed to their depletion.

In this study, we evaluate the current population characteristics of this species in the Bay of Cispatá, located north of the department of Córdoba, Colombia, an area of importance for the conservation of *C. acutus* and for the study of *C. crocodilus*. We assessed relative abundance, population size structure and spatial distribution.

Two seasons of nocturnal sampling were conducted, covering 18 bodies of water. A total of 288 observations of *C. acutus* and 354 of *C. crocodilus* were recorded. The relative abundances, expressed as encounter rates, were up to 2.10 ind/km for *C. acutus* and 4.54 ind/km for *C. crocodilus*. There were no significant differences between the seasons for either species.

The population size structure of *C. acutus* was representative of all size classes in both seasons. Class I (neonates) and V (adults) individuals were equally abundant in both seasons. *For C. crocodilus*, there was a predominance of Class I (neonates) and an absence of Class IV (adults) individuals. Additionally, there were differences between seasons in Class II (juveniles). Additionally, both species showed an aggregate distribution pattern in both seasons.

Introduction

Colombia, along with Brazil, has the largest number of crocodilian species, with six species (Morales et al., 2013), which represents 24% of global diversity. These species are distributed in the five river basins of the country, with the Amazon having the most diversity, with four species (Hrbek et al., 2008).

The wetlands of the Colombian Caribbean are home to two species: the spectacled caiman, locally known as “babilla” (*Caiman crocodilus*) and the American crocodile, locally known as “caiman aguja” (*Crocodylus acutus*). Currently, these ecosystems are undergoing transformation and degradation due to increased activities such as cattle ranching, deforestation, agriculture, urban expansion associated with tourism, and decreased water quality (Senhadji et al. 2017; Ruiz, 2014). These activities put at risk the optimal environmental conditions necessary for the maintenance of wild populations of these species.

The spectacled caiman (*C. crocodilus*) is the most widely distributed species of crocodilian in the Neotropics (Balaguera et al., 2021), with a range that extends from southern Mexico to Brazil (Velasco and Ayarzagüena, 2010; Medem, 1983). It is the most variable species, with four recognized subspecies (Medem, 1981). The subspecies *Caiman crocodilus fuscus* is distributed from El Salvador to Ecuador (Rueda-Almoncid et al. 2007), and it’s the species found in the Caribbean.

This species is classified as 'least concern' by the IUCN and is listed in CITES Appendix II, primarily due to its extensive distribution (Velasco and Ayarzagüena, 2010) and the large number of animals in captivity (Ulloa-Delgado and Cavanzo-Ulloa, 2004). However, there is insufficient and inadequate information on the wildlife population ecology of this species, both globally and locally (Ulloa-Delgado and Cavanzo-Ulloa, 2004). It is recognized that certain local populations may be facing pressures that have resulted in their impoverishment (Ulloa-Delgado and Cavanzo-Ulloa, 2003; Balaguera-Reina et al., 2019).

Similarly, *C. acutus* has a wide distribution, occurring in 18 countries (Thorbjarnarson, 2010). Despite this, it is globally considered Vulnerable (VU) by the IUCN (Thorbjarnarson, 2010). In Colombia, it was previously considered critically endangered (CR) due to reduced populations (Castaño-Mora, 2002). However, with the discovery of new populations and the recovery of others, it is currently classified as endangered (EN) (Morales-Betancourt et al. 2015). it is also included in CITES Appendix I, except for populations in Cuba, Mexico, and the integrated Management District of Mangroves of the Bay of Cispatá, Tinajones, La Balsa and Surrounding Areas, Department of Córdoba (CITES, 2023)

The status of *C. acutus* in Colombia is poorly known, and some populations are believed to be nearing extinction (Thorbjarnarson, 2010). The most reliable information on the population status of this species has been provided by community conservation programs, such as the one in the Bay of Cispatá (Ulloa-Delgado, 2004; Ulloa-delgado and Sierra-Diaz, 2002; Ulloa-Delgado and Sierra-Diaz, 2006).

The Bay of Cispatá, located in the Colombian Caribbean, is the largest and most representative mangrove area in the department of Córdoba. It is considered one of the most valuable natural areas in the country due to its ecological importance and biodiversity

(OAS, 2015). This mangrove forest has a management plan in place, and for the past 18 years, a program has been implemented to recover and conserve *C. acutus*. The program is aimed at promoting sustainable use by a community of ex-poachers organized as ASOCAIMAN, which has successfully led to the recovery of this population (Ulloa-Delgado and Sierra-Díaz, 2006). Previous studies have also conducted population characterizations of C. crocodilus (Ulloa-Delgado and Cavanzo-Ulloa, 2003; Cavanzo-Ulloa, 2004).

The aim of this research is to determine the current population status of both species in Cispatá Bay. This will provide information for decision-making on the management and sustainable use of the *C. acutus* population, as well as demonstrate the effectiveness of the recovery and conservation plan. Also, this work aims to provide updated information on the population status of *C. crocodilus* and identify potential threats.

Materials and methods

Study area

The study was conducted in the Bay of Cispatá, located in the Colombian Caribbean, north of the department of Córdoba. This mangrove ecosystem corresponds to the former Sinú River delta (Cavanzo-Ulloa, 2004) (Fig. 1) and covers an area of approximately 11,513 hectares. Of this area, 12% (1,436 ha) is identified as a body of water (Ulloa-Delgado and Sierra-Díaz, 2012). Since 2006, this area has been designated as an Integrated Resource Management District, a protected area figure that provides both protection and possibilities for use and exploitation.

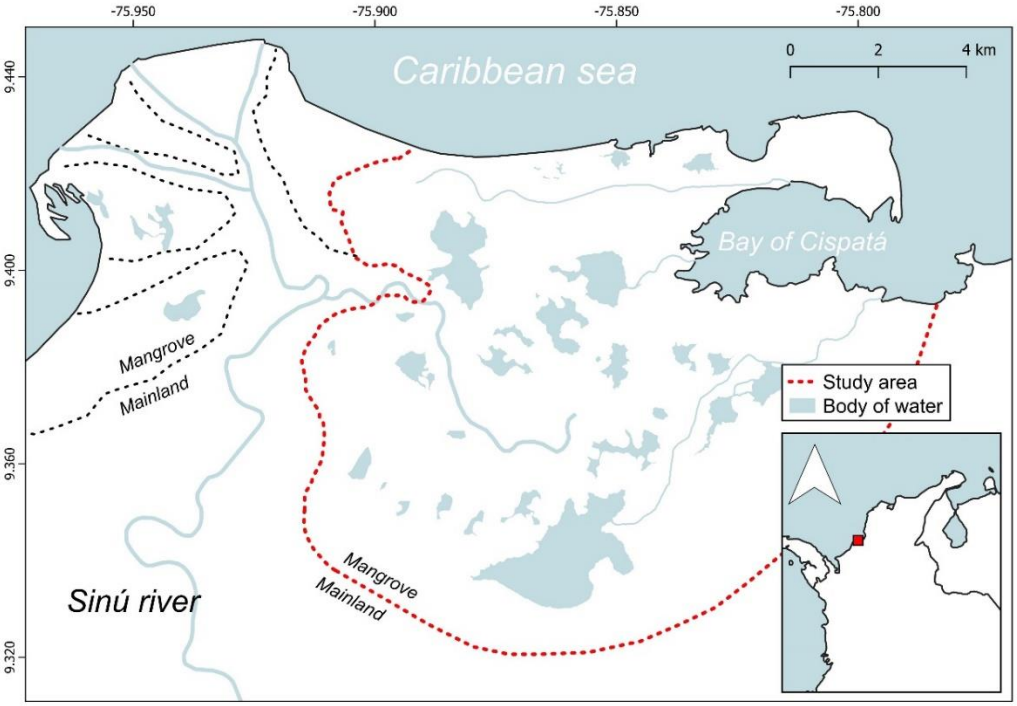


Figure 1. North of the Department of Córdoba, bodies of water, study area and important elements such as the Caribbean Sea and the Sinú River are indicated.

This zone has average temperatures above 27°C, with higher values in the month of May (29°C-33°C), and an average annual rainfall of 1,425 mm. The rainfall regime is moderately adapted to the bimodal tetra-seasonal, common in the Caribbean region. The rainy season begins in April and lasts until December, with two maximum peaks in April-May and October-November, interrupted by the "Veranillo de San Juan" in the middle of the year, when precipitation decreases, marking the second dry season (Ulloa-Delgado and Cavanzo-Ulloa, 2003).

Population sampling

Considering the sites used in previous years for the population assessment of *C. acutus* and *C. crocodilus* (Ulloa-Delgado and Sierra-Díaz, 2002; Ulloa-Delgado and Cavanzo-Ulloa, 2003), 18 sites were considered, 16 lagoons and two streams where it was possible to find both species (Fig.1). Two 10-day sampling seasons were carried out, the first from 28 November to 7 December 2022 (T1) and the second from 13 July to 22 July 2023 (T2), during which nocturnal boat trips were made with a 15 hp outboard motor or a rowing boat in sites with limited accessibility. A maximum speed of 7 km/h was considered, navigating in the middle of the streams, or bordering the lagoons. The work team consisted of three people, being the same on each sampling day to standardize the error in observing individuals. During the nighttime surveys, individuals were located using ocular illumination (Chabreck, 1966), which allows detection up to approximately 200 m (Salas-Araya, 1985). Q-beam spot lamps of 700 lumens were used with an 800 AHm automotive battery power supply and auxiliary headlamps of 400 lumens.

For each sighting, an approach as close as possible to the individual was made to determine the species and the total length. Species were determined by identifying morphological characteristics, such as the presence of the interocular crest in *C. crocodilus*, intraocular distance, cranial morphology, and total length, which vary considerably among species. When possible, captures by hand were made to measure the Total length of the individuals with a metric tape. Total length was also estimated visually, mostly in large individuals, given that due to the characteristics of a mangrove ecosystem, the capture and measurement would require to be done on the boat, which results both overly complicated and hazardous for the work team and the individual.

Estimation of the total length of the individuals allows the determination of the population size structure by grouping into size classes already established for both species. For *C. acutus*, five size classes were considered, as proposed by De la Ossa (2002) (Class I, neonates: <60 cm; Class II, Juveniles I: 61-120 cm; Class III, Juveniles II: 121-180 cm; Class IV, Subadults: 181-240; Class V, adults: > 241 cm), four size classes were considered for *C. crocodilus*, following that proposed by Ayarzagüena (1983) (Class I, Neonates: <50 cm; Class

II, Juveniles: 51-120; Class III, Subadults: 121-180; Class IV, adults: >181). Similarly, for each observation, additional notes were made on the activity and site where the individual was recorded. The position of each individual and the distance traveled at each site were also georeferenced using GPS of reference Garmin eTrex 32.

Data analysis

The distance traveled at each sampling site was used to calculate relative abundance, understood as the encounter rate (E.R), which was determined based on the number of individuals observed per kilometer traveled (ind/km). Having spatially structured populations for both species, the encounter rate was recorded for each sampled site (Table 1). This was done to determine if the abundance was homogeneously distributed throughout the mangrove system, which, if not, would allow the identification of key sites for the maintenance of populations of both species.

The distribution pattern of the populations throughout the study area was determined using an average nearest neighbor analysis in QGIS 3.34.0 "Lima" software (QGIS, 2023). To compare whether there were significant differences in encounter rates recorded per site between seasons, the Wilcoxon test was used as a non-parametric alternative to the paired t-test. To determine whether the size structure of both species varied between seasons, a chi-squared test was used.

Results

A total of 642 observations were recorded across both sampling seasons. Of these, 288 (44.85%) corresponded to *Crocodylus acutus* and 354 (55.14%) to *Caiman crocodilus*. During T1, a greater number of individuals of both species were detected, with 154 individuals of *C. acutus* and 198 individuals of *C. crocodilus*, compared to 134 individuals of *C. acutus* and 156 individuals of *C. crocodilus* in T2.

During T1, both species had a higher encounter rate: 2.10 ind/km for *C. acutus* and 4.54 ind/km for *C. crocodilus*, compared to 1.85 ind/km and 3.65 ind/km, respectively, at T2 (Table 1). The highest encounter rate for *C. acutus* was consistently found in the streams, at Caño Salao and Caño Remedia Pobre during both seasons (Table 1; Fig. 5). The lagoons with the highest encounter rates for *C. acutus* were Utria, La Honda, and La Garza, all located near Caño Salao on the border with the Caribbean Sea. There was no significant difference in encounter rates for *C. acutus* among the sites when compared statistically by season ($W=74.5$; $p=0.169$).

For *C. crocodilus*, the highest encounter rate occurred in Coroza during both sampling seasons (Table 1). Notably, no individuals were recorded in any of the streams of the mangrove complex. Significant encounter rates were recorded in Soledad during both seasons, Ostional in T1, and Tapao and Tapaito in T2 (Table 1). When statistically comparing

the encounter rates recorded at the sites for *C. crocodilus*, by season, no significant difference was found (W=16 p=0.734).

Table 1. Population characteristics evaluated for each species in Cispatá Bay. Dist= distance traveled in each season, N= number of individuals of each species seen in that season. E.R= encounter rate, (L)=lagoon, (S)=stream.

Crocodylus acutus						
Site	**Dist T1 (km)**	**Dist T2 (km)**	**n T1**	**n T2**	**E.R T1 (ind/km)**	**E.R T2 (ind/km)**
Los Cocos (L)	3.32	2.7	4	2	1.20	0.74
Soledad (L)	12.71	12.96	8	5	0.63	0.39
Manuel Vicente (L)	1.43	1.58	2	3	1.40	1.90
Galo (L)	3.6	3.56	3	3	0.98	0.84
El Garzal (L)	5.62	5.2	3	4	0.53	0.77
Navío (L)	5.43	5.67	7	2	1.29	0.35
Utria (L)	2.14	2.21	12	12	5.61	5.43
La Honda (L)	2.12	1.86	9	5	4.25	2.69
La Garza (L)	2.58	1.87	7	8	2.71	4.28
Mangones (L)	2.40	2.12	4	3	1.67	1.42
Remedia Pobre (L)	5.76	5.93	4	7	0.69	1.18
El Tapao (L)	3.73	3.81	1	0	0.27	0
Tapaito (L)	2.44	2.5	3	0	1.23	0
Sequería (L)	1.65	1.53	3	0	1.82	0
Caño Remedia pobre (S)	9.49	9.16	45	33	4.74	3.60
Caño Salao (S)	9.39	9.66	39	47	4.15	4.87
Total	**73.27**	**72.32**	**154**	**134**	**2.10**	**1.85**
Caiman crocodilus						
Site	**Dist T1 (km)**	**Dist T2 (km)**	**n T1**	**n T2**	**E.R T1 (ind/km)**	**E.R T2 (ind/km)**
Coroza (L)	2.66	2.93	117	75	43.98	25.60
Los Cocos (L)	3.32	2.7	1	1	0.30	0.37
Ostional (L)	7.36	6.7	34	6	4.62	0.90
Tapao (L)	3.73	3.81	3	14	0.80	3.67
Tapaito (L)	2.44	2.5	8	26	3.28	10.40
Remedia pobre (L)	5.76	5.93	0	1	0	0.17
Soledad (L)	12.71	12.96	32	33	2.52	2.55
El Garzal (L)	5.62	5.2	3	0	0.53	0
Total	**43.6**	**42.73**	**198**	**156**	**4.54**	**3.65**

In terms of population size structure of *C. acutus* (Fig. 2), observations reveal a consistent trend across both seasons, with a notable prevalence of individuals of Class V (adults) and a sparse presence of individuals of Class II (juveniles). The highest proportion of individuals of Class V was observed in Caño Remedia Pobre in both seasons, constituting the 48.8% (n=22) of individuals in T1 and 40.1% (n=18) in T2. Similarly, in Caño Remedia Pobre, the highest number of class IV individuals (sub-adults) was documented during both seasons, accounting for 50% (n=15) of individuals in T1 and 38% (n=8) in T2.

Caño Salao had the highest number of individuals of classes I (Neonates), II (Juveniles I) and III (Juveniles II) in both seasons. In T1, 35% (n=14) of class I individuals were observed in Caño Salao, while this percentage increased to 60% (n=15) in T2. Regarding class II individuals, 50% (n=10) were documented in Caño Salao during T1, and 36.8% (n=7) during T2. For class III, 26.3% (n=5) of individuals were recorded in Caño Salao during T1, with a notable rise to 52% (n=13) during T2.

In both seasons, the sites showcasing representation across all classes were Utria, Navío, Caño Salao, and Caño Remedia Pobre in T1, while in T2, they were Utria, La Garza, and Caño Salao. In addition, the population size structure of *C. acutus* did not vary significantly between seasons (X2=8.84; g.l=4; p=0.05).

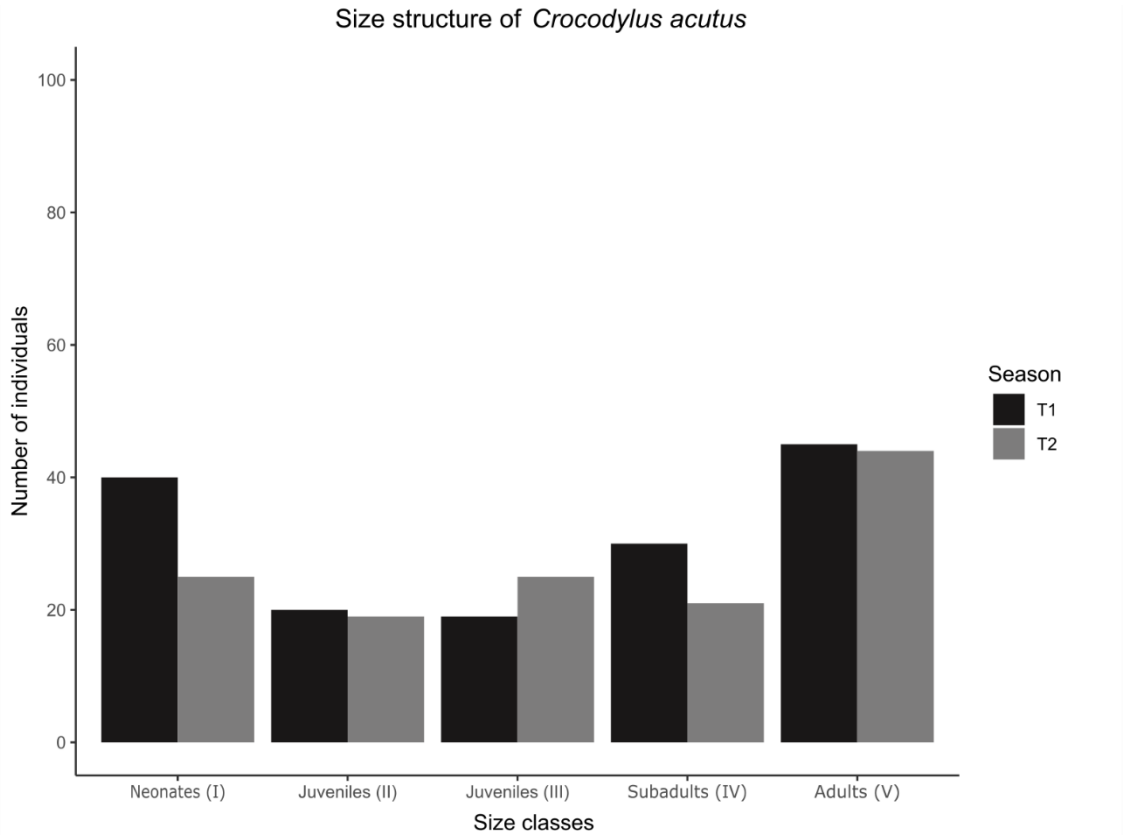


Figure 2. Population size of *C. acutus* from bay of Cispatá for both seasons.

Regarding the population size structure of *C. crocodilus*, in both seasons a greater number of individuals belonging to class I (neonates) and few individuals of class IV (adults) were recorded (Fig. 3). La Coroza had the highest number of class I individuals in both seasons, with 87.5% (n=112) in T1 and 66.36% (n=73) in T2, with an increase of class I individuals in Ciénaga Soledad in T2.

In T1, the highest count of individuals of class II was observed in Soledad, comprising 46.4% (n=26) of the total, with Ostional closely behind at 33.9% (n=19). Conversely, during T2, the majority (41%, n=12) of class II individuals were recorded in Tapaito. Similarly, most class III individuals (69%, n=13) were also documented in Tapaito during this season. Regarding class IV, individuals were only recorded in T2, with 75% (n=3) found in Ciénaga Tapaito, and the remaining individual in Ciénaga de Soledad. When comparing the size structures of *C. crocodilus* between seasons, significant differences were found solely in class II (X2=13.133; g.l=3; p=0.05). However, for all other classes, including class IV, no significant differences were observed (X2=7.105; g.l=3; p=0.05), indicating relatively stable population size structures across seasons, except for class II.

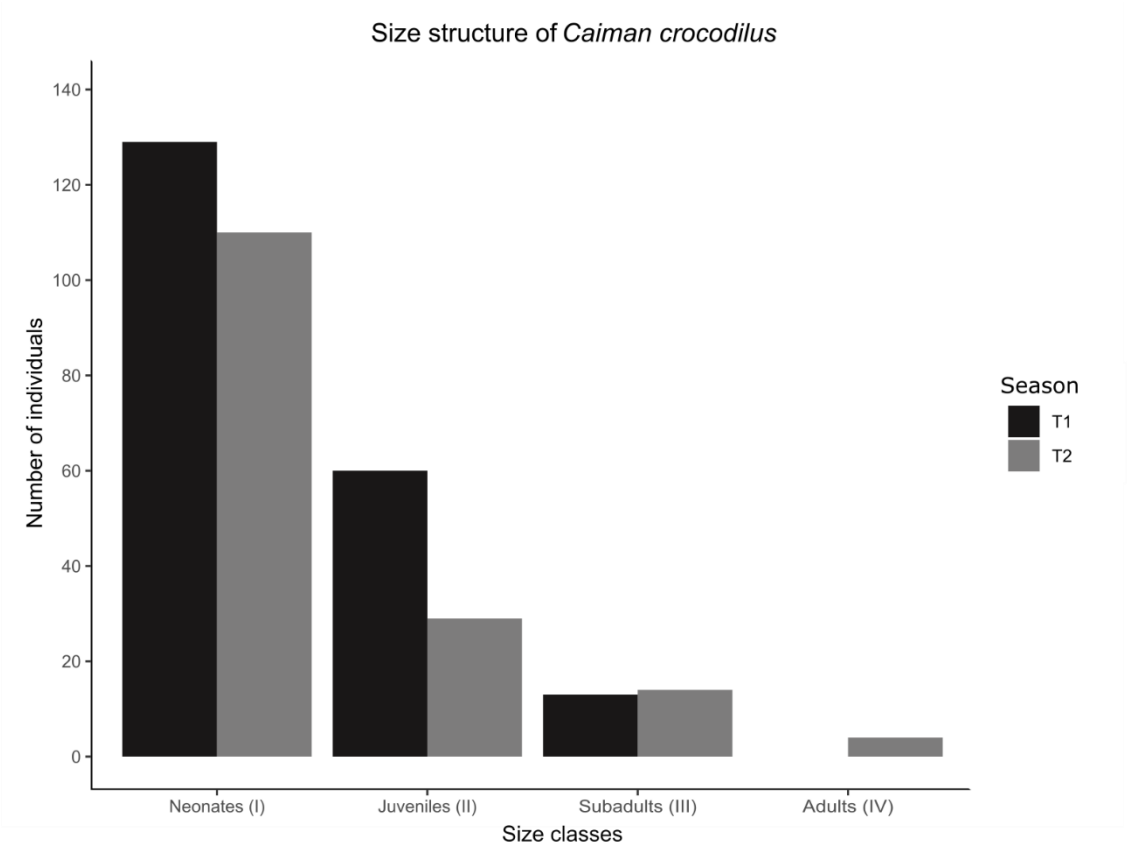


Figure 3. Population size structure of *C. crocodilus* from bay of Cispatá for both seasons.

The spatial distribution pattern of both species in the mangrove complex during both seasons shows that *C. acutus* tends to cluster (Nearest neighbor index T1= 0.433; p=<0.01; Nearest neighbor index T2=0.375; p=<0.01). *C. crocodilus* exhibits an even greater tendency to cluster in both seasons (Nearest neighbor index T1= 0.332; p=<0.01; Nearest neighbor index T2=0.234; p=<0.01), as evidenced by the distribution map for both seasons (Fig. 5).

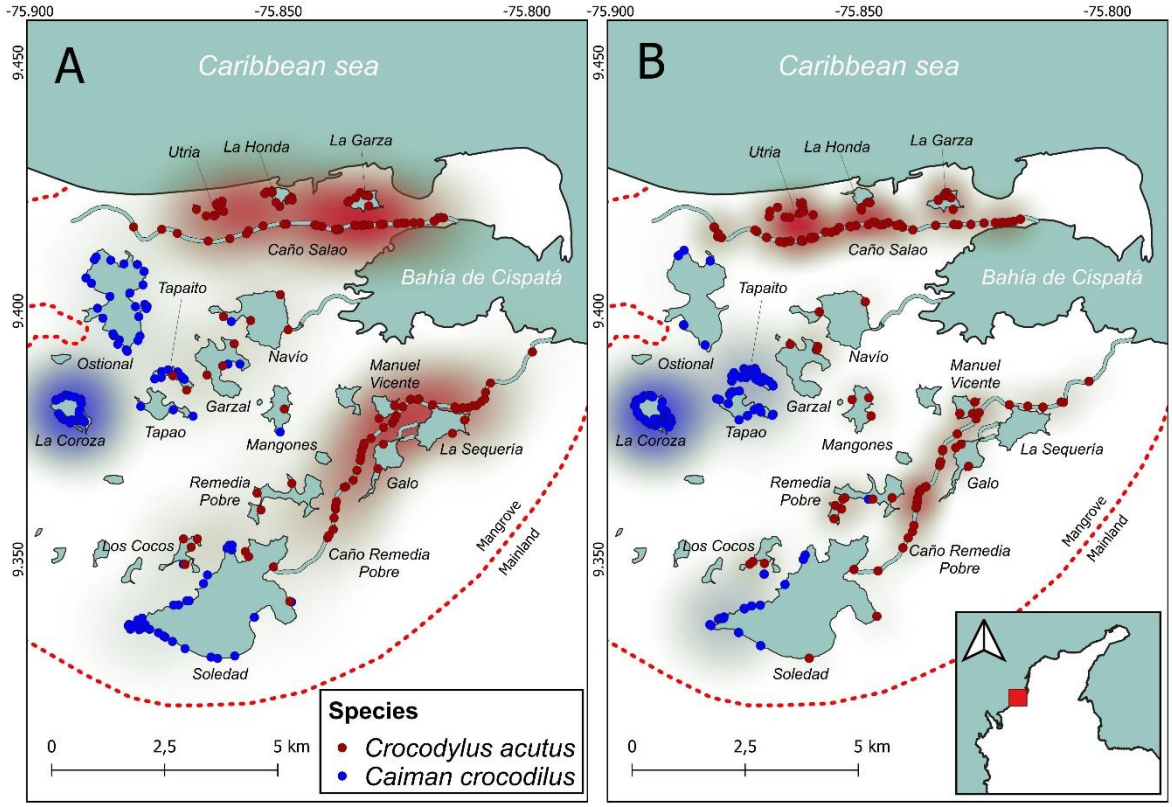


Figure 5. Spatial distribution of *C. acutus* and *C. crocodilus* in the Bay of Cispatá with all recorded observations and heat map to indicate relative abundance. A= season 1 (November and December 2022), B= season 2 (July 2023).

The possibility of these species to occupy areas with differential salinity percentages is spatially evident (Fig. 5). A higher density of *C. acutus* individuals is observed in bodies of water with a higher incidence of salt water due to their proximity to the Caribbean Sea. Conversely, a higher density of *C. crocodilus* individuals is observed in bodies of water with a higher incidence of fresh water due to their proximity to the Sinú River, located to the west of the mangrove complex (Fig. 1). Significant differences were found for both seasons when comparing abundance in relation to salinity between species (T1: U=408585; p=5.191-26; T2: U=7650; p=1.143-39). Additionally, significant differences were found when comparing the same species between seasons (*C. acutus*: U=7528.5; p=0.00024; *C. crocodilus*: U=15198; p=0.0046).

Conclusions

In a broad sense, this study represents an approach to the current population characteristics of *C. acutus* and *C. crocodilus* in the Bay of Cispatá. In the case of *C. acutus*, the results show an abundant, well-established population with a high probability of increased reproductive potential and good representativeness in its size structure, highlighting the role of the recovery and conservation project led by members of

ASOCAIMAN. In the case of *C. crocodilus*, the results allow us to identify an abundant population, but with different pressures that may affect its maintenance in the future. This highlights the importance of a long-term monitoring program, the study of reproductive ecology, habitat preservation, and community involvement in population recovery and conservation activities that have proven successful in this ecosystem.

Bibliography

Ayarzagüena J. (1983). Ecología del Caimán de anteojos o baba (*Caiman crocodilus L*.) en los llanos de Apure (Venezuela). Doñana Act. vert. Nº especial 10-3: 136.

Balaguera-Reina, S. A., Vargas-Castillo, A. and Densmore, L. D. (2021). Population ecology of the spectacled caiman (*Caiman crocodilus*) in the Apaporis River middle basin. Ecosphere 12(5): e03532. 10.1002/ecs2.3532

Balaguera-Reina, S.A. and Velasco, A. (2019). *Caiman crocodilus*. The IUCN Red List of Threatened Species 2019: e.T46584A3009688. http://dx.doi.org/10.2305/IUCN.UK.2019-1.RLTS.T46584A3009688.en

Castaño-Mora, O. V. (Ed.). (2002). Libro rojo de reptiles de Colombia. Libros rojos de especies amenazadas de Colombia. Instituto de Ciencias Naturales-Universidad Nacional de Colombia, Ministerio de Medio Ambiente, Conservación Internacional- Colombia. Bogotá, Colombia. 160 pp.

Cerrato, C. (1991). Composición y tamaño de poblaciones silvestres de caimanes (*Caiman crocodilus chiapasius*) y cocodrilos (*Crocodylus acutus*) de la costa del Caribe de Honduras, Centro América. San José, Costa Rica: Universidad Nacional Heredia. Tesis de maestría, 121 pp.

Chabreck, R. H. (1963). Methods of capturing, marking, and sexing alligators. Proceedings of the Annual Conference of the Southeast Game and Fish Commission 17:47–50.

CITES. (2023). Apéndices I,II y III. Available in: https://cites.org/sites/default/files/esp/app/2023/S-Appendices-2023-11-25.pdf

De la Ossa, J. (2002). Crecimiento de *Crocodylus acutus* (Crocodylia: Crocodylidae) y su relación con la madurez sexual. Revista de Biología 16 (1): 14-18.

Fittkau, E. J. (1970). The role of caimans in the nutrient regime in the Mouth-lake of Amazon afluents. Journal of Animal Ecology. 30 (1): 4.

Hrbek, T., Vasconcelos, W. R., Rebelo, G., and Farias, I. P. (2008). Phylogenetic relationships 631 of South American Alligatorids and the Caiman of Madeira River. Journal of 632 Experimental Zoology Part A: Ecological Genetics and Physiology, 309A, 588-599

King, F. W., Espinal, M and Cerrato, C. (1990). Distribution and status of the crocodilians of Honduras. Pages 313–354 in Crocodiles. Proceedings of 10th Working Meeting of the IUCN/SSC Crocodile Specialist Group. IUCN- The World Conservation Union, Gland, Switzerland.

Medem, F. (1981). Los Crocodylia de sur America. Volumen I. Los Crocodylia de Colombia. Colciencias, Bogotá, D.C., Colombia

Messel, H., Vorlicek, G. C., Wells, A. G., and Green, W. J. (1981). Surveys of tidal river systems in the Northern Territory of Australia and their crocodile populations. The Blyth-Cadell rivers system study and the status of *Crocodylus porosus* in tidal waterways of northern Australia. Sydney: Monograph No. 1. Pergamon Press, Australia

Morales-Betancourt, M. A., Lasso, C.A., De La Ossa V. and Fajardo-Patiño, A. (Eds.). (2013). VIII. Biología y conservación de los Crocodylia de Colombia. Serie Editorial Recursos Hidrobiológicos y Pesqueros Continentales de Colombia. Instituto de Investigación de Recursos Biológicos Alexander von Humboldt (IAvH). Bogotá, D. C., Colombia, 336 pp.

Morales-Betancourt, M., Balaguera-Reina, S.A., Ulloa-Delgado, G and Lasso, C.A (2015). *Crocodylus acutus.* Pp. 192-197 En: Libro Rojo de Reptiles de Colombia. Morales-Betancourt, M., C. Lasso, V. Páez y B. Bock (Ed.) Instituto de investigación de Recursos Biológicos Alexander von Humboldt (IAvH), Universidad de Antioquia. Bogotá, D.C., Colombia.

Organization of American States (OAS). Department of Sustainable Development. (2015). Guía práctica sobre la CITES y los medios de subsistencia: Estudio de caso: Uso sostenible de Caimán Aguja – *Crocodylus acutus* en Cispatá, Colombia.

Rueda-A., J. V., Carr, J. L., Mittermeier, R. A., Rodríguez-M, J. V., Mast, R. B., Vogt, R. C., Rhodin, A. G., J. De la Ossa, A. G. Rueda, J. N. and Mittermeier, C. G. (2007). Las tortugas y los crocodilianos de los países andinos del Trópico. Conservación Internacional. 537p. Bogotá.

Ruiz, D.C. (2014). Análisis histórico y prospectiva del humedal Tierra Blanca. Perspectiva Geográfica, 19(1), 125-144.

Salas-Araya, C.E. (1985). *Contribución al conocimiento sobre el manejo del Crocodylus acutus Cuvier (Crocodylia, Crocodylidae) en el Refugio Nacional de Fauna Silvestre Dr.* Rafael Lucas Rodríguez Caballero. San José, Costa Rica: Universidad de Costa Rica. Tesis de grado, 49 pp.

Sánchez, J. (2001). Estado de la población de cocodrilos (*Crocodylus acutus*) en el río Tempisque, Guanacaste, Costa Rica. Reporte Final. Instituto Nacional de Biodiversidad. San José, Costa Rica. 49pp.

Senhadji-Navarro, K., Ruiz-Ochoa, M. A., and Rodríguez Miranda, J. P. (2017). ESTADO ECOLÓGICO DE ALGUNOS HUMEDALES COLOMBIANOS EN LOS ÚLTIMOS 15 AÑOS: UNA EVALUACIÓN PROSPECTIVA. Colombia Forestal, 20(2), 181-191.

Thorbjarnarson J., F., Mazzotti, E., Sanderson, F., Buitrago, M., Lazcano, K., Minkowski, M., Muñiz, P., Ponce, L., Sigler, R., Soberon, et al. (2006). Regional habitat conservation priorities for the American Crocodile. Biological Conservation 128:25–36.

Thorbjarnarson, J.B. (1992). Crocodiles: An action plan for their conservation.

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.

Ulloa-Delgado, G.A. 2004. Conservation of *C. acutus* in Cispatá Bay, Dept. of Cordoba. Crocodile Specialist Group Newsletter 23: 18-19.

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, Córdoba, 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. and Cavanzo-Ulloa, D. (2003). Conservación, manejo y uso sostenible de la babilla (*Caiman crocodilus fuscus*) en la Bahía de Cispata. Etapa I: caracterización y diagnóstico de las poblaciones de *Caiman crocodilus fuscus* y su hábitat natural. Corporación Autónoma Regional de los Valles del Sinú y de San Jorge (CVS): Departamento de Córdoba.

Ulloa-Delgado and Cavanzo-Ulloa. (2004). Caracterización y diagnóstico de las poblaciones de *Caimán Crocodilus fuscus* y su hábitat natural en la Bahía de Cispatá, Departamento de Córdoba. CVS. Colombia, Montería, 120 p.

Ulloa-Delgado, G. and C. Sierra-Díaz. (2002). Cocodrilos y manglares de la bahía de Cispatá, departamento de Córdoba-Colombia. Fase I: Caracterización y diagnóstico de las poblaciones de *Crocodylus acutus* y su hábitat natural. Informe final. Cartagena de Indias, Bolívar

Ulloa-Delgado, G.A. and Sierra-Díaz, C. (2012). Proyecto de conservación del *Crocodylus acutus* de la Bahía de Cispatá con la participación de las comunidades locales. San Antero, Colombia: Corporación Autónoma Regional de los Valles del Sinú y del río San Jorge, Ministerio de Ambiente y Desarrollo Sostenible, Instituto de Investigaciones Biológicas Alexander Von Humboldt y Asociación comunitaria para la conservación del caimán de la Bahía de Cispatá, Documento de apoyo técnico para la solitud de la Enmienda del Apéndice 1 al 2 de la CITES.

Cavanzo-Ulloa, D. (2004). Caracterización y diagnóstico de las poblaciones de *Caiman crocodilus fuscus* y su hábitat natural. bahía de Cispatá – departamento de córdoba [Trabajo de grado para optar por el título de Biólogo]. Pontificia Universidad Javeriana.

Velasco, A. and Ayarzagüena, J. (2010). Spectacled *Caiman crocod*ilus. Pp. 10-15 in Crocodiles. Status Survey and Conservation Action Plan. Third Edition, ed. by S.C. Manolis and C. Stevenson. Crocodile Specialist Group: Darwin.

Velasco, A., and J. Ayarzagüena. (1995). Situación actual de las poblaciones de Baba (*Caiman crocodilus*) sometidas a aprovechamiento comercial en los llanos venezolanos. Publicaciones Asociación Amigos de Doñana 5:14–19

Venegas-Anaya, M., Escobedo-Galvan, A., Balaguera-Reina, S.A., Lowrance, F. Sanjur, O. I. and Densmore, L. D. III. (2015). Population ecology of American crocodile (*Crocodylus acutus*) in Coiba National Park, Panama. Journal of Herpetology 49:349–357.

Whitaker, R. (1978). The beneficial role of the mugger (*Crocodylus palustris*) in aquatic habitat. Informe técnico. 3 pp.