SRAS Final Report

Abundance and distribution of the broad-snouted caiman (*Caiman latirostris* Daudin, 1802) in an urban fragment of the Atlantic Forest in Northeastern Brazil.

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ABSTRACT

Crocodilians play vital roles in aquatic and terrestrial ecosystems, acting as apex predators and environmental engineers. In Brazil, the broad-snouted caiman (*Caiman latirostris*) exhibits high plasticity in inhabiting anthropized environments. This study, originating from the Caiman Paraibano Project, analyzed the population ecology of the species in the Mata do Buraquinho Wildlife Refuge. The methodology was based on systematized sighting and capture, marking, and recapture expeditions. In 2024, monitoring was carried out bimonthly to establish the seasonal baseline, while in 2025 the effort was intensified to monthly periodicity, aiming at refining the population parameters. With a sampling effort of 3,454 linear km, an accumulated abundance of 344 individuals was recorded, presenting an average density of 14.18 individuals/km. The population structure proved to be demographically stable and balanced among juveniles (n=97), subadults (n=84), and adults (n=84), evidencing active recruitment. Abiotic data confirmed the influence of water temperature and humidity on detectability, highlighting the importance of vegetation cover (58.7% of records) for population maintenance. The relevance of these results is strategic for environmental management in urban fragments. The observed stability and full occupancy of age classes confirm the Refuge as a critical habitat for the species' survival. These data support the proposition of evidence-based management protocols, essential for mitigating anthropogenic pressures and ensuring the continuity of ecosystem services provided by these reptiles. The continuation of this monitoring becomes imperative for the conservation of local biodiversity and for supporting new public policies aimed at the harmonious coexistence between wildlife and urban development in the region.

INTRODUCTION

The order Crocodylia represents a lineage sharing an ancestor with birds, the Archosauria (Green et al., 2014). Currently, 26 species are recognized across three families: Gavialidae, Crocodylidae, and Alligatoridae (Vliet et al., 2024). Crocodilians are generalist predators of high ecological importance, serving as "ecosystem engineers" by regulating prey populations and nutrient cycling in aquatic-terrestrial interfaces (Somaweera et al., 2020). Despite their status, population monitoring is complex due to nocturnal behavior and "submersion bias," where a portion of the population remains undetected (Magnusson, 1987). Spotlight surveys, relying on the tapetum lucidum reflection, are essential for estimating density and distribution (Cherkiss et al., 2006; Barão-Nóbrega et al., 2022). Population dynamics are influenced by abiotic factors, including temperature and vegetation cover (Da Silveira et al., 2008; Bassetti et al., 2014).

The broad-snouted caiman (*Caiman latirostris*) occupies diverse hydrographic basins in South America (Bassetti et al., 2021). Although listed as "Least Concern" (Siroski et al., 2020), urbanization imposes new challenges for survival and reproduction (Wilson et al., 2020). Remaining forest fragments function as vital refuges and ecological corridors (Tee Sze Ling et al., 2018). Research demonstrates that fragmentation restricts suitable nesting sites and thermoregulation zones (Campos et al., 2010; Soberón & Peterson, 2005). In Brazil, recent studies by Mascarenhas-Júnior (2024) offer robust data on population ecology in lentic urban environments. Continuous monitoring remains the gold standard for predicting population viability (Borteiro et al., 2006). Consequently, this study aims to analyze the population dynamics of *C. latirostris* in the Mata do Buraquinho Wildlife Refuge. By quantifying the species' response to urban pressures, this research provides technical support for management strategies in a critical transitional habitat.

MATERIAL AND METHODS

Study Area- The research was conducted in the Mata do Buraquinho Wildlife Refuge (RVS), a fully protected conservation unit located in the urban area of the municipality of João Pessoa, Paraíba, Brazil (7.1356° S, 34.8602° W). Established by State Decree No. 35,195/2014, the area comprises 5.15 km² of remaining Atlantic Forest, with 3.43 km² integrated into the Benjamin Maranhão Botanical Garden (Paraíba,

2014; Souza et al., 2019). The ecosystem is characterized by dense ombrophilous forest in a secondary stage of regeneration and riparian vegetation associated with the Jaguaribe River. The local climate is hot and humid, with average temperatures between 21°C and 30°C and relative humidity ranging from 73% to 82% (Souza et al., 2016). The area (**Figure 1**) has a strategic location within the urban fabric of the capital of Paraíba.

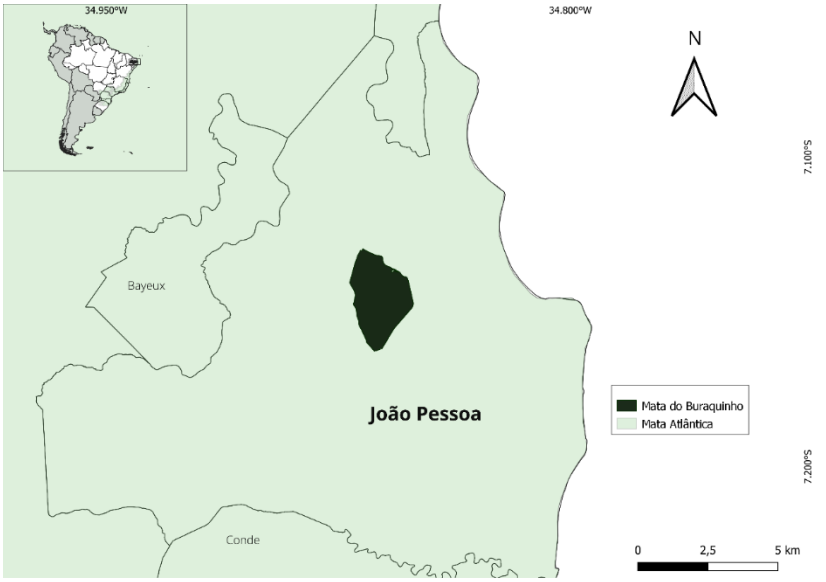


Figure 1. Location of Mata do Buraquinho Wildlife Refuge, located in the state of Paraíba, in João Pessoa, Northeast Brazil. Geographic Coordinate System. DATUM: SIRGAS 2000, data source: IBGE.

Sampling Effort

Population monitoring comprised eight field expeditions, conducted **bimonthly in 2024 and monthly in 2025**, between May 2024 and April 2025. Activities took place at night (6:30 PM to 11:30 PM), the time window of greatest specimen activity. The average sampling effort per expedition was 2.91 km (min. = 2.07 km; max. = 5.05 km) with an average duration of 3 hours and 12 minutes. The predominant method consisted of walking along trails and the banks of water bodies within the unit.

Night Counts (*Spotlight Surveys*)

Individual detection was based on the spotlight survey technique, which uses focused beam flashlights to locate the light reflection of the tapetum lucidum—the ocular layer responsible for night vision in crocodilians (Herman & Steinberg, 1982). Counts were performed by a single experienced observer to reduce methodological bias. Specimens were categorized according to estimated size class: juvenile (≤ 25 cm), subadult (25–67.9 cm), and adult (≥ 68 cm). Individuals sighted but of undetermined size were recorded as "eyes only" and included in the total abundance, although excluded from specific statistical analyses by class. All records were georeferenced via GPS and supplemented with air/water temperature (°C) and relative humidity (%) data, measured hourly with a digital thermohygrometer. Figure 2 shows photographic records of the nighttime monitoring stages.



Figure 2. Photographic record of the night monitoring stages. (1) Biometric measurement of a *Caiman latirostris* specimen. (2) Systematization and collection of data on a field sheet. (3) Night sighting and capture technique using a flashlight (spotlight survey). (4) Handling procedures and collection of morphological data.

RESULTS

Sampling Effort and Field Records

Between May 2024 and April 2025, 344 sightings of *C. latirostris* were recorded across 8 systematic field expeditions. Given the nature of the nocturnal sighting methodology, which does not allow for definitive individual identification, the records were treated as indicators of the species' occupancy. The sampling effort totaled 25 hours and 32 minutes in the field, with an average of 3 hours and 12 minutes (± 33 minutes) per expedition, varying between a minimum of 2 hours and 30 minutes and a maximum of 4 hours and 15 minutes. The average distance traveled per sampling was 2.91 km, resulting in an average linear abundance of 14.8 individuals per kilometer (ind./km).

Descriptive statistics of environmental variables

A moderate temperature range was observed, with air temperatures varying by 7.1°C and water temperatures by 7.2°C. Relative air humidity showed significant variations, oscillating between 68% and 99%. The distribution of these variables, illustrated by the histograms in Figure 3, showed patterns of asymmetry and dispersion, which justified the adoption of non-parametric statistical tests for subsequent inferential analyses.

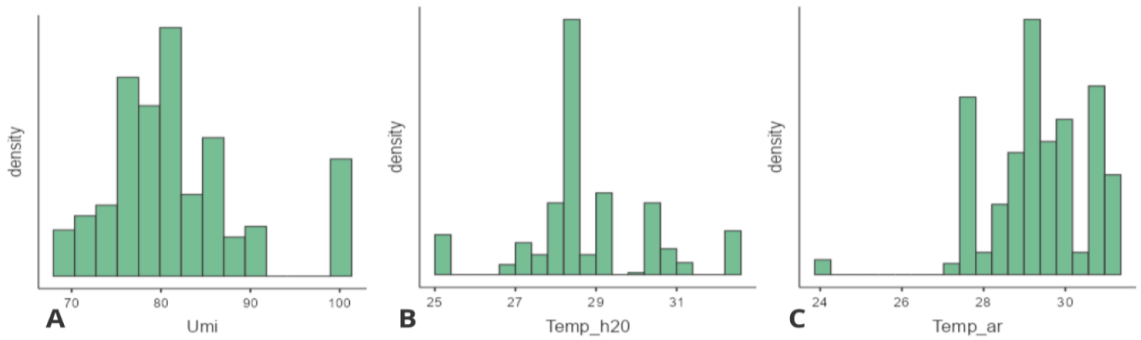


Figure 3. Frequency histograms of environmental variables with the distribution of relative air humidity (%), air temperature (°C) and water temperature (°C) records measured during the eight field expeditions (May 2024 to April 2025).

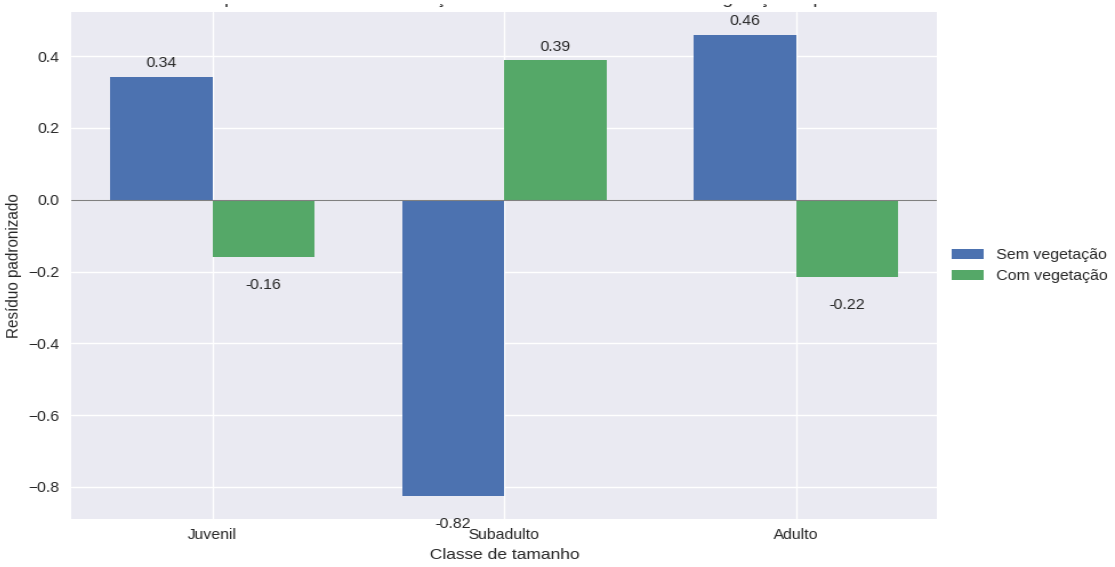
Correlation and multicollinearity analysis

The evaluation of collinearity between abiotic factors indicated that none of the correlations exceeded the critical threshold of |\rho| = 0.7, allowing the maintenance of all variables in the model. Spearman's coefficient revealed a significant negative correlation between humidity and air temperature (rho = -0.275; $p < 0.001$), while the relationship between humidity and water temperature was positive (rho = 0.189; $p < 0.001$). Air temperature also showed a negative correlation with water temperature (rho = -0.130; $p = 0.016$). Due to the absence of severe multicollinearity, all variables were integrated as covariates in the Generalized Linear Model (GLM).

Association between size class and presence of aquatic vegetation

Of the 344 total records, 265 were classified according to microhabitat. Of these, 77.6% were sighted in locations with aquatic vegetation and 22.4% in areas devoid of vegetation. The Chi-square test demonstrated a significant association between age classes and microhabitat use (\chi^2 = 13.2; df = 3; $p = 0.004$), with moderate association strength (V = 0.196). Subadults (Class 2) stood out for presenting the highest proportion of records in vegetated areas (85.7%). Post hoc analysis of standardized residuals , shown in Figura 4, confirmed that this age class occurred in areas with significantly more vegetation than expected, reinforcing the relevance of the resource as a shelter and thermoregulation zone. This habitat use is dynamic, as illustrated in Figura 4. Standardized residues of the association between size class of *Caiman latirostris* and presence of aquatic vegetation. (May 2024 to April 2025).

Figura 5, and corroborates aquatic vegetation as a structuring factor for the spatial occupation of the species in the Mata do Buraquinho Wildlife Refuge.



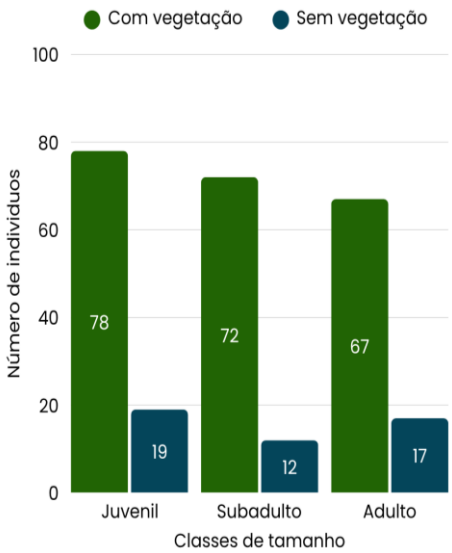


Figura 4. Standardized residues of the association between size class of *Caiman latirostris* and presence of aquatic vegetation. (May 2024 to April 2025).

Figura 5. Distribution of size classes of Caiman latirostris according to the availability of aquatic vegetation. (May 2024 to April 2025).

Effect of environmental variables on abundance (GLM)

To investigate the influence of abiotic factors, a GLM with a Quasi-Poisson distribution was fitted, correcting for the overdispersion of the data ($\chi 2$=DF \approx. 1.87). The model explained approximately 54% of the variance in abundance (R^2 = 0.540). Although the individual predictors did not reach absolute statistical significance ($p > 0.05$), water temperature showed a marginally significant trend ($p = 0.056$), suggesting that abundance tends to increase as the water body temperature increases. When stratifying the models by age class, it was observed that juveniles (Class 1) showed a positive trend of increasing abundance in relation to water temperature, although without statistical significance. In contrast, subadults (Class 2) and adults (Class 3) maintained stable prediction curves, indicating greater behavioral homeostasis or lower thermal sensitivity compared to juveniles. These results suggest that environmental responses in *C. latirostris* may be heterogeneous according to the ontogenetic developmental stage.

DISCUSSION AND CONCLUSION

The presence of *C. latirostris* in the Mata do Buraquinho Wildlife Refuge (RVS), with a linear abundance of 14.8 individuals/km, corroborates the thesis that urban forest fragments, when preserved, can function as "islands" of biodiversity essential for the conservation of crocodilians (Bassetti et al., 2021). Urbanization frequently results in the degradation of water quality and the removal of riparian vegetation; however, the status of Integral Protection Conservation Unit conferred by State Decree No. 35.195/2014 guarantees RVS a level of ecological resilience that enables the maintenance of the species.

One of the most relevant findings of this research is the microhabitat selectivity of the population, with 77.6% of the records associated with the presence of aquatic vegetation. The significant association ($\chi 2$= = 13.2; $p = 0.004$) between size class and microhabitat use reveals a dynamic where vegetation acts as a structuring resource. As pointed out by Mascarenhas-Júnior et al. (2024), the preference of subadults for areas with dense vegetation (85.7% in this class) indicates that this age group uses the environment as a critical refuge against disturbances and as a thermoregulation zone. While juveniles and adults exhibited a more equitable distribution, the greater selectivity of subadults suggests a "risk allocation" strategy (Mascarenhas-Júnior et al., 2024). In urban environments, where anthropogenic pressure is constant, the occupation of vegetated areas reduces visual exposure and increases the probability of survival to adulthood. This result reinforces that the management of the unit should prioritize the maintenance of vegetated banks, avoiding interventions to clean watercourses (Somaweera et al., 2020).

The marginally significant trend ($p = 0.056$) observed in the relationship between water temperature and population abundance points to the thermal sensitivity of the specimens. As ectothermic animals, the thermal dependence of *C. latirostris* regulates its metabolic rate, foraging, and reproductive activity (Coutinho et al., 2021). The greater abundance of juveniles at higher temperatures, observed in this study, is aligned with the observations of Verdade et al. (2002), who highlight how thermal factors structure the age distribution in water bodies. On the other hand, the stability of adults, which did not show significant variation according to temperature, suggests greater behavioral plasticity. Adults, with greater body mass, possess more flexible thermal strategies, allowing them to explore varied zones without the physiological restrictions imposed on juveniles (Mascarenhas-Júnior et al., 2024).

The results confirm that *C. latirostris* is capable of sustaining stable populations in urban fragments, provided that the integrity of water bodies is preserved. Unlike scenarios in degraded areas, where the species is forced to inhabit suboptimal environments, the availability of vegetation in FVS offers a functional conservation scenario. In short, the robustness of the observed abundance patterns attests to the viability of the local population. Continuous monitoring is recommended to support management plans that consider the protection of aquatic vegetation, ensuring that the Mata do Buraquinho Wildlife Refuge remains a reference for the conservation of the broad-snouted caiman in urban contexts in Northeast Brazil (Siroski et al., 2020).

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