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# Birds, reptiles and mammals sighted within and surrounding the municipality of Aquidauana, state of Mato Grosso do Sul, Brazil

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**ABSTRACT.** The study aimed to assess species richness and diversity in Aquidauana, State of Mato Grosso do Sul, using six observation points over 12 months. A total of 2,591 individuals among reptiles, birds, and mammals, covering 29 orders and 43 families, were recorded. Columbidae, Furnariidae, and Tyrannidae were prominent families, and Passeriformes was the most representative order. The point with the highest number of observations was near Lagoa Comprida, probably due to minimal human disturbance. The most observed species included Rufous hornero, Wattled jacana, Black-bellied duck, and Whistling-duck. December was the month with the highest number of sightings. Nine feeding guilds were identified, and three species were classified as vulnerable or near threatened. The bootstrap estimator suggested the potential for finding more species with increased sampling. The Shannon index revealed no significant difference between observation points. Aquidauana presents notable urban biodiversity, emphasizing the importance of conserving wetlands and forest areas to preserve diversity.

**Keywords:** pantanal; conservation; IUCN; sustainability.

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## Introduction

Brazil boasts the highest biological diversity of birds throughout its geographic area (Comitê Brasileiro de Registros Ornitológicos [CBRO], 2021). It is home to approximately 1,971 species of birds, both resident and migratory. Due to its vast biomes, such as the Amazon, which houses over 1,300 bird species; the Atlantic Forest (n = 1,020); the Cerrado (n = 837); Caatinga (n = 510); and the Pantanal with more than 462 species (Marini & Garcia, 2005), Brazil exhibits a remarkable richness of avian species. Notably, the Amazon and Atlantic Forest biomes harbor more endemic species (Pereira & Almeida, 2022).

The Pantanal biome, considered one of the world's largest wetlands, covers an area of 140,000 km$^2$ located primarily in Brazil with extensions (plus around 110,000 km$^2$) into Bolivia and Paraguay stands as one of the world's most extensive and diverse wetland ecosystems. Features various vegetation types, including cerrado, cerradão, dry grasslands, semi-deciduous forests, gallery forests, swamps, and flooded fields (Adámoli, 1981; Souza, Silva, Gonçalves, Jardim, & Markwith, 2018; Souza et al., 2022). It spans across the states of Mato Grosso do Sul (MS) and Mato Grosso (MT) (Nunes & Tomas, 2008), with parts extending into Bolivia and Paraguay. It represents the largest and most important freshwater wetland area, dating back 65 million years. Precipitation varies from 1,100 to 1,200 mm between December and February, with the rainy season occurring from November to March. Dry grasslands predominate, followed by cerrado and cerradão, while semi-deciduous forests, flooded fields, and gallery forests are less abundant (Silva et al., 2001). The Pantanal ranks fourth in avian diversity in Brazil, with over 570 recorded species (Tubelis & Tomas, 2003; Nunes & Tomas, 2008; Morrison, Serrano, Antas, & Ross, 2008).

Birds are feathered bipedal vertebrates with forelimbs (wings) and hindlimbs for locomotion (Sick, 1997). They are found in numerous regions worldwide and are endothermic, maintaining a constant body temperature through metabolic heat production (Fontana, Benke, & Reis, 2003). Thus, exhibit high biodiversity and inhabit various ecosystems (Pough, Janis, & Heiser, 2003). Among other functions, they serve as seed dispersers, aiding in forest maintenance and restructuring. This interaction with plants, besides

providing food, secure the population of plant species in diverse global environments. Bird surveys are important as they help identify the species diversity within a specific region. These surveys can be conducted through direct observations, where the observer detects visually or auditorily the animal, or indirectly, using equipment that photographs the passing animal. Such activities allow for the assessment of characteristics like size, feather differentiation, feet, beak shape, habitat, type of diet, and more (Lima, 2014).

Using systematic observation and data collection, the objective was to quantify and analyze the richness and diversity of species occurring in this region. Birds, reptiles, and mammals are integral components of terrestrial ecosystems, each playing unique roles in ecological processes and contributing to overall biodiversity. Avian species are crucial for pollination, seed dispersal, and insect control, thus influencing plant reproduction and community dynamics (Souza et al., 2019). Reptiles, with their diverse array of species and habitats, contribute to ecosystem stability through their roles in prey-predator relationships and nutrient cycling. Mammals display various behavioral and physiological adaptations and also cause significant impacts on ecosystem functioning through seed dispersal, herbivory, and predator-prey interactions (Mosquera-Guerra, Trujillo, Días-Pulido, & Mantilla-Meluk, 2018). Thus, the findings of this research contribute to a broader understanding of biodiversity conservation and management in tropical ecosystems (Souza, 2012; Souza et al., 2022).

The objective of this study was to quantify, identify, and assess the richness and diversity of reptile, bird, and mammal species in the municipality of Aquidauana, state of Mato Grosso do Sul, at five different locations based on geographical features, human presence, and environmental conservation.

## Material and methods

The study was conducted in the municipality of Aquidauana (20º 28' 12.550" S; 55º 46' 18.789" W), with an area of 17,087.021 $km^2$ and a population of approximately 48,184 inhabitants. The population density is 2.74 people $km^{-2}$, and the Municipal Human Development Index (MHDI) is 0.688 (*Instituto Brasileiro de Geografia e Estatística* [IBGE], 2022). This is a transitional region between two biomes, the Cerrado and the Pantanal.

Field trips were carried out from June 2021 to May 2022 every 15 days (twice a month). When each observation point was visited in the morning, the next visit was mandatory in the afternoon to make observations in both periods at all points. In the morning, work started at 7:00 am until 9:30 am; in the afternoon, from 3:00 pm to 5:30 pm. This approach was adopted to ensure equitable and comprehensive sampling, considering temporal variation and the diversity of habitats present at different times of the day.

The work involved visiting 6 pre-determined points (Figure 1) on a bi-weekly basis. These points were identified based on characteristics such as central areas with high or low human traffic, proximity to bodies of water, and an area on the outskirts of the city along the MS170 highway.

Observation locations:

1. Behind the Casa dos Padres [20° 28' 23.6" S, 55° 47' 52.9" W]: Located near the city center, this area is classified as a remnant riparian forest, crossed by the Joao Dias stream, near the Aquidauana River. Highly devastated, it receives a large amount of waste. The street that passes behind has heavy traffic and a high number of pedestrians (intense pedestrian flow on the street that crosses the location).

2. Lagoa Comprida (behind) [20° 27' 26.5" S, 55° 46' 09.6" W]: Located opposite to the front part of the lagoon (but connected), it is close to Vila Eliane, with the same characteristics as mentioned in the previous item.

3. Lagoa Comprida (front) [20° 27' 53.9" S, 55° 46' 43.8" W]: Point in the Municipal Natural Park of Lagoa Comprida. Created in 2001, it covers approximately 74 hectares entirely within the urban area for environmental protection purposes. It includes a water surface of 26.9 hectares and a recreational area of 12.5 hectares. Located in Vila Cidade Nova, it is open to the public and features both remnant and secondary vegetation.

4. Ponte Boiadeira [20° 28' 09.4" S, 55° 48' 29.0" W]: It marks the border between the municipalities of Aquidauana and Anastácio (right bank of the Aquidauana River). This area is classified as a remnant riparian forest. Due to its riverside location, there is a high incidence of people fishing and engaging in various activities at the site. Animals in this area are somewhat more wary, possibly due to human predation.

5. Near Fazenda Buritizal [20° 25' 20.0" S, 55° 48' 45.2" W]: Located on the MS 170 – Retirinho Road. This is characterized as a water body near the highway but isolated from everything else, with a high volume of vehicles but a low incidence of humans in the area – rural area.

6. Near the Quartel [20° 28' 42.7" S, 55° 47' 10.1" W]: Located near the Guanandy neighborhood, this is a highly populated area within the urban area. It has lush trees that provide shelter and shade.

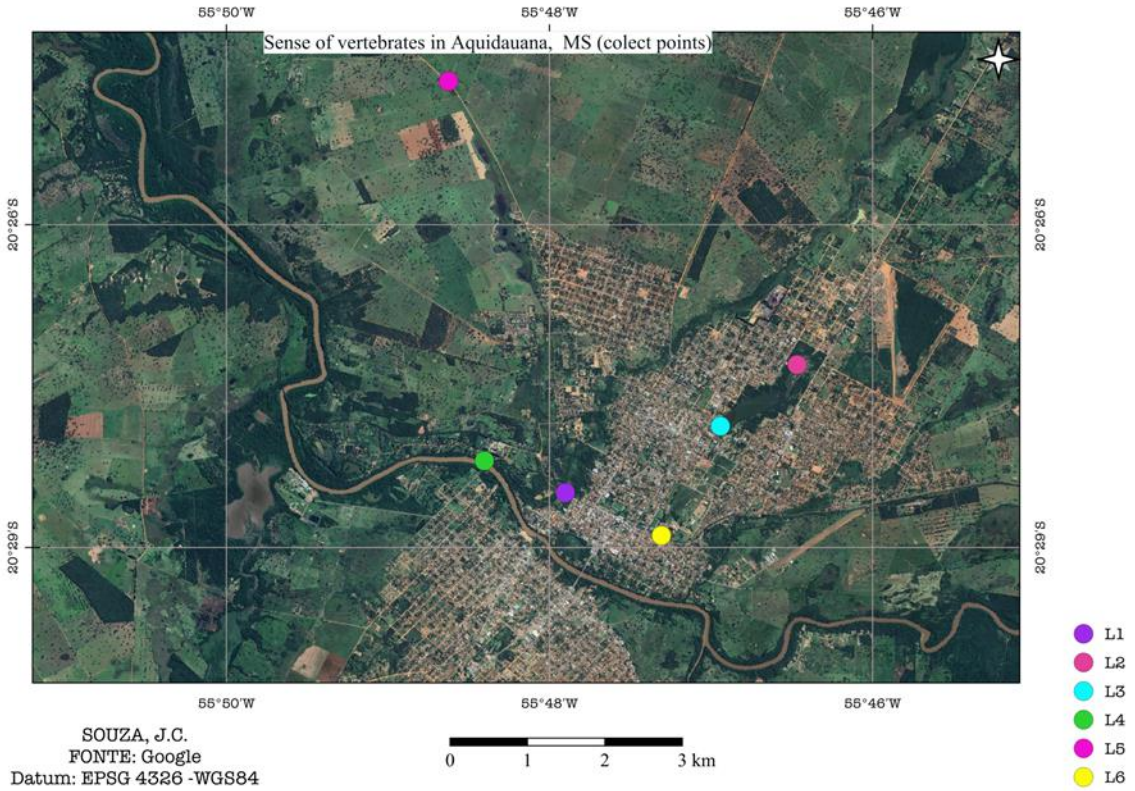


**Figure 1.** Location of the municipality of Aquidauana, state of Mato Grosso do Sul, Brazil: (L1) Behind the Casa dos Padres; (L2) Behind Lagoa Comprida; (L3) In front of Lagoa Comprida; (L4) Ponte Boiadeira; (L5) Near Fazenda Buritizal; (L6) Near the Quartel.

The sighted animals were meticulously counted, and the species were identified through direct observation using field guides, consulting the Wikiaves platform, and often with the aid of images captured during field expeditions. To identify various birds, the recognition of their characteristic calls was also considered.

Average Temperature in Aquidauana: Aquidauana is a municipality considered hot, with a maximum temperature of 35°C and a minimum of 24°C on average, which can exceed 40°C. The milder months, the cooler season, are between May and July 20, with daily average temperatures around 25°C (a minimum of 19°C and a maximum of 31°C, on average). Figure 2 illustrates the maximum temperatures in red and the minimum temperatures in purple.

Precipitation: Variation in rainfall throughout the year reaches its peak in December, with over 160 mm of rainfall, and its lowest value in July, with rainfall averaging around 25 mm (Figure 3).

The research consisted of observing and identifying the incidence of vertebrates at the mentioned points using direct and/or indirect observation methods. Field notebooks, cameras (2) from Sony DSC-W570 and Canon PC1560 brands, and the GPS from a Motorola© Moto E5 Play-Gold-16 cell phone were used. Identifications were made using the Field Guide and through visual and auditory records.

Feeding habits and beak shapes were classified according to Sick (1997) and the Wikiaves website. Statistical analyses and graphs were performed using the R Program (R Core Team, 2022), with packages tidyverse, ggplot2, psych, dplyr, and vegan.

## Results and discussion

Understanding the biodiversity and species richness of birds, reptiles, and mammals in Aquidauana is essential for effective conservation strategies and ecosystem management. By elucidating the distribution patterns and ecological interactions of these taxa, this study provides valuable insights into the conservation priorities and ecological dynamics of this region.

In the six observation points, a total of 2,591 individuals were documented, categorized into three classes: birds (2,496 individuals), mammals (67 individuals), and reptiles (28 individuals). These comprised 85 species belonging to 43 families and 29 orders. The total number observed during sampling in all visits, per observation point, was as follows: 229 individuals at the Ponte Boiadeira, 336 behind Lagoa Comprida, 359

Behind the Casa dos Padres, 386 near the Quartel, 502 near Fazenda Buritizal, and 779 in front of Lagoa Comprida. The aim was to determine which individuals could be sighted at those points, assess the similarity of species cohabiting simultaneously in the areas, and count the individuals sighted per visit. Subsequently, the number of species sighted was obtained, regardless of the number of individuals per species, and whether this repetition occurred or not was noted.

The variation in individuals at Ponte Boiadeira likely occurred due to an increase in fishermen and locals dismantling trees and expanding their properties.

In the area Behind the Casa dos Padres, there was a decrease in sightings probably due to improvements in the road, which increased the number of vehicles in the region. In this specific case, development ended up harming the local fauna and flora. There does not appear to have been an environmental impact assessment or conservation efforts for the different habitats that are home to wildlife in the municipality. There is a need for more studies conducted by the government to preserve these habitats for various species to prevent their disappearance in the near future.

Near the Quartel, within the municipality, there was also an increase in vehicular and pedestrian traffic, which disturbed the animals. Some species are still observed in the tops of eucalyptus trees, but those living closer to the ground, below the canopy, have seen their habitat compromised. They are often forced to relocate. The constant noise from human activities is present throughout the landscape. Some authors claim that noise from vehicles and airplanes makes it difficult for certain species to develop their singing, alters their behavior, reduces communication and reproduction, and changes bird population dynamics (Brumm, 2004).

The area in front of Lagoa Comprida (across the street), where there used to be a large wetland, has been taken over by the population and turned into a human habitation area. There is great concern about the siltation of the lagoon, which could dry up and disappear in the future. This is worrisome because a large number of species depend on the lagoon for food and survival. Failure to conserve it would result in habitat loss for many species and yet another habitat for hundreds of wildlife species. Actions aimed at preserving this environment must be implemented by the government. There are large trees where birds prefer to seek shelter at night to hide from predators. Diaz and Arnesto (2003) report that parks and green areas serve as refuges for species when their habitats have been destroyed by humans.

In the Ponte Boiadeira area, deforestation and landscape modification have been occurring, requiring public policies that can propose a management plan aimed at conserving green areas and preventing the destruction of the habitats for wild animals. Such human actions may eventually make the area a haven for wildlife conservation.

The observed species (n = 85) are consistent with the records of Rocha (2010), n = 76, Codignola (2017), n = 42, Arguelho (2017), n = 24, Fleitas, Almeida, Pinheiro, Souza, and Aoki (2022) n = 135, for the municipality of Aquidauana. These studies were conducted at Fazenda Santa Virginia, Retiro Velho, and Novo Horizonte, in the Pirizal and João Dias stream region.

The species observed in all points are shown in Figure 4. Species such as *Columbina talpacoti* (Rolinha-roxa), *Crotophaga ani* (Anu-preto), and *Passer domesticus* (House Sparrow) presented an increase in their populations caused by human activity that altered natural landscapes. The expansion of contact zones between species from different habitats (birds from the Cerrado and riparian forests) leads to competition and habitat selection.

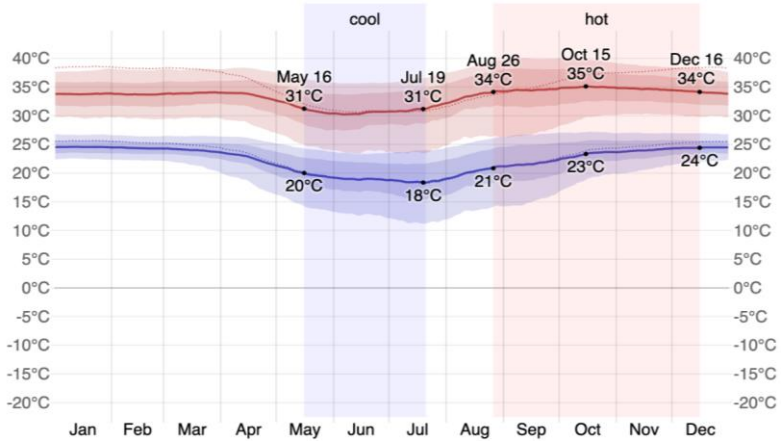


**Figure 2.** Temperature variation (average maximum and minimum) throughout the year in Aquidauana, state of Mato Grosso do Sul. Source: ©Weather Spark (2023).

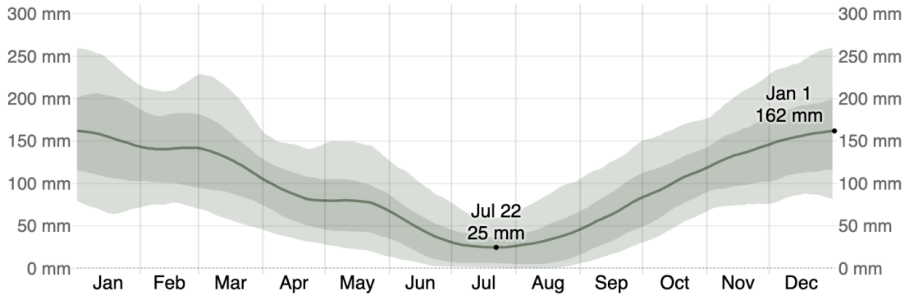


**Figure 3.** Annual rainfall per month in Aquidauana, state of Mato Grosso do Sul. Source: ©Weather Spark (2023).

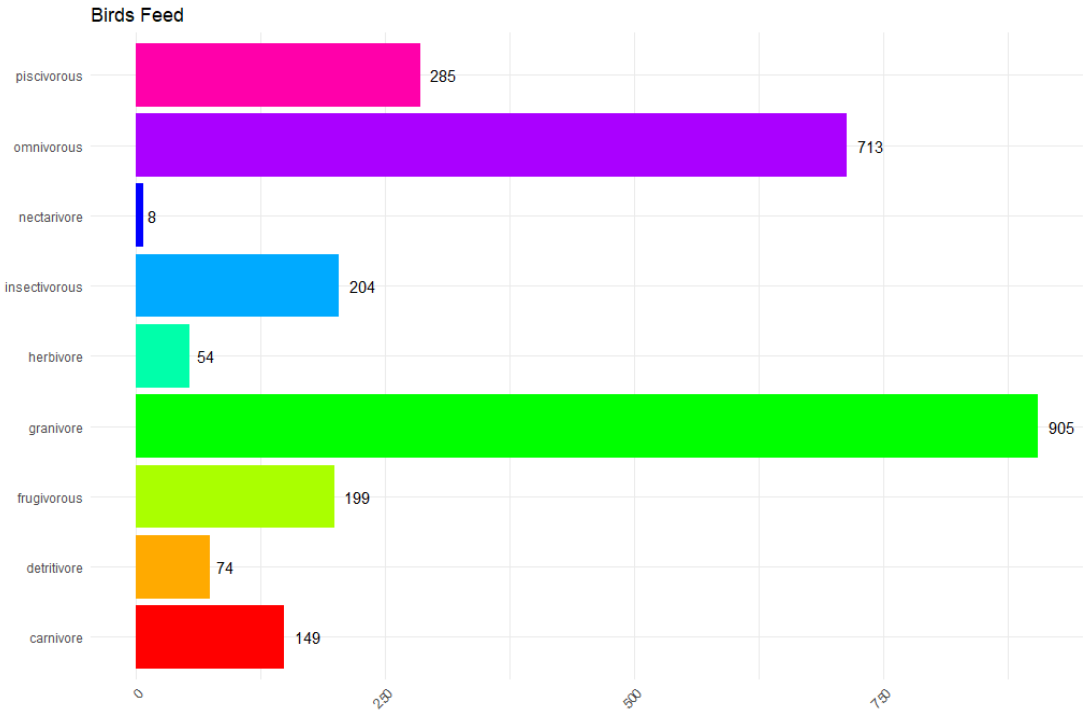


**Figure 4.** Different food guilds and the respective numbers of species.

There was a fluctuation in the number of individuals over the years. During rainy periods, with a high abundance of fruit and the presence of insects, there was a higher frequency of birds in urban areas. The most representative family was Columbidae (N = 378), followed by Furnariidae (N = 309) and Tyrannidae (N = 278).

Domestic pigeons have adapted to urban environments to find food and shelter and because they have few predators in cities, such as the Collared Falcon (*Falco femoralis*), American Kestrel (*Falco sparverius*), Roadside Hawk (*Rupornis magnirostris*), and Southern Caracara (*Carcara Plancus*). They find urban areas to be the perfect environment to thrive. Family Columbidae has grown due to the abundance of food and a strong adaptation to human presence, as humans do not have the habit of consuming them. The species recorded in this study, such as *Columbina talpacoti* (Rolinha-roxa), *Columbina livia* (Domestic Pigeon), *Columbina picui* (Picui Ground-Dove), and *Columbina squamata* (Scaled Dove), are also frequently seen in urban environments where they have adapted and live without any problems The standout species in urban areas are pigeons and doves Sick (1997), Souza et al. (2019).

Considering the method of counting individuals without distinguishing between observed individuals or conducting identifications of the same individuals, instead, only sightings were quantified (number of observed individuals) per observation, regardless of whether they were repeated or not (active species). Table 1 provides valuable insights into the diversity and abundance of avian, mammalian, and reptile species observed in the studied areas. The method employed for counting individuals, without differentiating between unique individuals or conducting individual identifications, offers a broad perspective on the overall presence of species in the region. By quantifying sightings per observation, the table indicates the relative activity of different species rather than providing an absolute count of individuals.

**Table 1.** Scientific and English names, order, and family of the observed individuals, number in the different observation points in the municipality of Aquidauana, State of Mato Grosso do Sul.

| Scientific name | N | English name | Ordem | Family |
|---|---|---|---|---|
| *Alouatta caraya* | 6 | Black howler | Primates | Atelidae |
| *Amazona aestiva* | 15 | Turquoise-fronted parrot | Psittaciformes | Psittacidae |
| *Anodorhynchus hyacinthinus* | 4 | Hyacinth macaw | Psittaciformes | Psittacidae |
| *Ara ararauna* | 37 | Blue-and-yellow macaw | Psittaciformes | Psittacidae |
| *Ara chloropterus* | 13 | Red-and-green macaw | Psittaciformes | Psittacidae |
| *Aramus guarauna* | 7 | Limpkin | Gruiformes | Aramidae |
| *Aratinga nenday* | 11 | Nanday parakeet | Psittaciformes | Psittacidae |
| *Ardea alba* | 37 | Great egret | Pelecaniformes | Ardeidae |
| *Ardea cocoi* | 2 | Cocoi heron | Pelecaniformes | Ardeidae |
| *Arundinicola leucocephala* | 19 | White-headed marsh tyrant | Passeriformes | Tyrannidae |
| *Brotogeris chiriri* | 11 | Yellow-chevroned parakeet | Psittaciformes | Psittacidae |
| *Caiman yacare* | 28 | Swamp alligator | Crocodylia | Alligatoridae |
| *Cairina moschata* | 2 | Muscovy duck | Anseriformes | Anatidae |
| *Caracara plancus* | 3 | Crested caracara | Falconiformes | Falconidae |
| *Cariama cristata* | 2 | Red-legged seriema | Cariamiformes | Cariamidae |
| *Cathartes aura* | 15 | Turkey vulture | Cathartiformes | Cathartidae |
| *Chauna torquata* | 54 | Southern screamer | Anseriformes | Anhimidae |
| *Chloroceryle americana* | 4 | Green kingfisher | Coraciiformes | Alcedinidae |
| *Ciconia maguari* | 1 | Maguari stork | Ciconiiformes | Ciconiidae |
| *Colaptes campestris* | 22 | Campo flicker | Piciformes | Picidae |
| *Columba livia* | 10 | Rock pigeon | Columbiformes | Columbidae |
| *Columbina picui* | 1 | Picui ground-dove | Columbiformes | Columbidae |
| *Columbina squammata* | 40 | Scaled dove | Columbiformes | Columbidae |
| *Columbina talpacoti* | 63 | Ruddy ground-dove | Columbiformes | Columbidae |
| *Coragyps atratus* | 59 | Black vulture | Cathartiformes | Cathartidae |
| *Crotophaga ani* | 45 | Smooth-billed ani | Cuculiformes | Cuculidae |
| *Dasyprocta azarae* | 18 | Azaras agouti | Rodentia | Dasyproctidae |
| *Dendrocygna autumnalis* | 238 | Black-bellied whistling-duck | Anseriformes | Anatidae |
| *Egretta thula* | 1 | Snowy egret | Pelecaniformes | Ardeidae |
| *Eupetomena macroura* | 8 | Swallow-tailed hummingbird | Apodiformes | Trochilinae |
| *Eupsittula aurea* | 4 | Peach-fronted parakeet | Psittaciformes | Psittacidae |
| *Fluvicola albiventer* | 1 | Black-backed-water-tyrant | Passeriformes | Tyrannidae |
| *Forpus xanthopterygius* | 1 | Blue-winged parrotlet | Psittaciformes | Psittacidae |
| *Furnarius rufus* | 312 | Rufous hornero | Passeriformes | Furnariidae |
| *Gnorimopsar chopi* | 1 | Chopi blackbird | Passeriformes | Icteridae |
| *Guira guira* | 7 | Guira cuckoo | Cuculiformes | Cuculidae |
| *Heterospizias meridionalis* | 1 | Savanna hawk | Accipitriformes | Accipitridae |
| *Himantopus melanurus* | 1 | White-backed stilt | Charadriiformes | Recurvirostridae |
| *Hydrochoerus hydrochaeris* | 42 | Capybara | Rodentia | Caviidae |
| *Icterus croconotus* | 11 | Orange-backed troupial | Passeriformes | Icteridae |
| *Jacana jacana* | 255 | Wattled jacana | Charadriiformes | Jacanidae |
| *Lepidocolaptes angustirostris* | 2 | Narrow-billed woodcreeper | Passeriformes | Dentrocolaptidae |
| *Leptotila verreauxi* | 185 | White-tipped dove | Columbiformes | Columbidae |
| *Machetornis rixosa* | 42 | Cattle tyrant | Passeriformes | Tyrannidae |
| *Melanerpes candidus* | 6 | White woodpecker | Piciformes | Picidae |
| *Mimus saturninus* | 1 | Chalk-browed mockingbird | Passeriformes | Mimidae |
| *Molothrus oryzivorus* | 10 | Giant cowbird | Passeriformes | Icteridae |
| *Molothrus rufoaxillaris* | 2 | Screaming cowbird | Passeriformes | Icteridae |
| *Myiarchus tyrannulus* | 1 | Brown-crested flycatcher | Passeriformes | Tyrannidae |
| *Myiodynastes maculatus* | 2 | Streaked flycatcher | Passeriformes | Tyrannidae |
| *Myrmecophaga tridactyla* | 1 | Anteater_flag | Pilosa | Myrmecophagidae |
| *Nannopterum brasilianum* | 5 | Neotropic cormorant | Suliformes | Phalacrocoracidae |
| *Ortalis canicollis* | 12 | Chaco chachalaca | Galliformes | Cracidae |
| *Paroaria capitata* | 5 | Yellow-billed cardinal | Passeriformes | Thraupidae |
| *Paroaria dominicana* | 2 | Red-cowled cardinal | Passeriformes | Thaupidae |
| *Passer domesticus* | 26 | House sparrow | Passeriformes | Passeridae |
| *Patagioenas cayennensis* | 74 | Pale-vented pigeon | Columbiformes | Columbidae |
| *Patagioenas picazuro* | 4 | Picazuro pigeon | Columbiformes | Columbidae |
| *Phimosus infuscatus* | 46 | Bare-faced ibis | Pelecaniformes | Threskiornithidae |
| *Piaya cayana* | 1 | Squirrel cuckoo | Cuculiformes | Cuculidae |
| *Pitangus sulphuratus* | 189 | Great kiskadee | Passeriformes | Tyrannidae |
| *Platalea ajaja* | 4 | Roseate spoonbill | Pelecaniformes | Threskiornithidae |
| *Primolius auricollis* | 2 | Yellow-collared macaw | Psittaciformes | Psittacidae |

| Scientific name | N | English name | Ordem | Family |
|---|---|---|---|---|
| *Pyrocephalus rubinus* | 23 | Vermilion flycatcher | Passeriformes | Tyrannidae |
| *Ramphastos toco* | 50 | Toco toucan | Piciformes | Ramphastidae |
| *Ramphocelus carbo* | 6 | Silver-beaked tanager | Passeriformes | Thraupidae |
| *Rostrhamus sociabilis* | 9 | Snail kite | Accipitriformes | Accipitridae |
| *Sicalis flaveola* | 19 | Saffron finch | Passeriformes | Thraupidae |
| *Sporophila lineola* | 2 | Lined seedeater | Passeriformes | Thraupidae |
| *Syrigma sibilatrix* | 2 | Whistling heron | Pelecaniformes | Ardeidae |
| *Tachycineta leucorrhoa* | 3 | White-rumped swallow | Passeriformes | Hirundinidae |
| *Theristicus caerulescens* | 2 | Plumbeous ibis | Pelecaniformes | Threskiornithidae |
| *Theristicus caudatus* | 30 | Buff-necked ibis | Pelecaniformes | Threskiornithidae |
| *Thraupis sayaca* | 34 | Sayaca tanager | Passeriformes | Thraupidae |
| *Tigrisoma lineatum* | 30 | Rufescent tiger-heron | Pelecaniformes | Ardeidae |
| *Trogon curucui* | 2 | Blue-crowned trogon | Trogoniformes | Trogonidae |
| *Turdus amaurochalinus* | 3 | Eastern slaty thrush | Passeriformes | Turdidae |
| *Turdus rufiventris* | 136 | Eastern slaty thrush | Passeriformes | Turdidae |
| *Turdus subalaris* | 1 | Eastern slaty thrush | Passeriformes | Turdidae |
| *Tyrannus savana* | 1 | Southern fork-tailed-flycatcher | Passeriformes | Tyrannidae |
| *Uropelia campestris* | 1 | Long-tailed-ground-dove | Columbiformes | Columbidae |
| *Urubitinga urubitinga* | 1 | Great-black-hawk | Accipitriformes | Accipitridae |
| *Vanellus chilensis* | 196 | Southern lapwing | Charadriiformes | Charadriidae |
| *Xiphocolaptes major* | 5 | Great rufous woodcreeper | Passeriformes | Dentrocolaptidae |
| *Xolmis velatus* | 1 | White-rumped monjita | Passeriformes | Tyrannidae |

One notable aspect of Table 1 is the range of species observed, spanning various orders and families. This highlights the ecological richness of the surveyed area, accommodating diverse habitats and supporting a wide array of wildlife. The presence of species such as Capybara (*Hydrochoerus hydrochaeris*), Southern screamer (*Chauna torquata*), and Rufous hornero (*Furnarius rufus*) underscores the importance of the region for both terrestrial and aquatic species.

Additionally, the table reveals variations in species abundance, with some species more frequently observed than others. For instance, the Ruddy ground-dove (*Columbina talpacoti*) and Great kiskadee (*Pitangus sulphuratus*) exhibited higher sighting counts compared to less frequently observed species like the Chopi blackbird (*Gnorimopsar chopi*) and Snowy egret (*Egretta thula*). These differences in abundance may reflect species-specific habitat preferences, foraging behaviors, or responses to environmental factors.

Furthermore, the inclusion of taxonomic information, such as order and family, enhances our understanding of the ecological relationships among the observed species. Identifying the taxonomic affiliations of species provides insights into their evolutionary history, ecological roles, and potential conservation implications. For example, the clustering of species within the same order or family may indicate shared evolutionary traits or ecological niches (Sick, 1997).

Overall, while the table shows valuable information on species presence and abundance in the surveyed area, it also underscores the need for further research to elucidate the factors influencing species distribution and activity patterns. Long-term monitoring efforts coupled with detailed behavioral studies and habitat assessments can provide a more comprehensive understanding of the dynamics driving wildlife populations in the region. Such insights are crucial for informing effective conservation strategies and promoting the sustainable management of biodiversity-rich ecosystems.

In the context of Table 1, if observations were made without distinguishing between individual specimens and only quantifying sightings per observation, it becomes difficult to draw definitive conclusions about the abundance or representativeness of each species. For example, a species with a high sighting frequency may appear to be more abundant or representative in the area, but this could be related to factors such as its diurnal activity pattern, conspicuous behavior, or habitat preference rather than its actual population size.

*Columbina livia* (Domestic pigeon) and *Columbina picui* (Picui ground-dove) had limited sightings, primarily observed in the region behind Lagoa Comprida, while *Columbina squamata* (Scaled dove), *Leptotila verreauxi* (Scaled pigeon), and *Patagioenas cayennensis* (Pale-vented pigeon) were more frequently encountered. Family Furnariidae, known for its role in pest control in agricultural areas, was observed nesting atop trees and power poles in urban settings, drawn to cities due to deforestation and resource availability. Specifically, *Furnarius rufus* (Rufous hornero) was observed in all points, primarily foraging on insects attracted by artificial lights at night. Additionally, Tyrannidae emerged as the third most prevalent avian family, known for insectivorous habits and adept foraging in vegetation, with recorded species including

*Pitangus sulphuratus* (Great kiskadee), *Xolmis velatus* (White monjita), and *Pyrocephalus rubinus* (Vermilion flycatcher). Among observed species, Passeriformes prevailed, followed by Charadriiformes and Columbiformes, Great kiskadee, Rufous hornero and Rufous-bellied thrush (Sick, 1997; Nunes & Tomas, 2008; Rocha, 2010; Lima, 2014; Souza, Godoi, & Aoki, 2015; Arguelho, 2017; Souza et al., 2019; *Laboratório de Pesquisas Interdisciplinares sobre Tecnologias e Educação* [Ábaco], 2023; Delfino, 2023; Cobasi, 2023).

Beak Shape: Bird beaks serve various functions, including cleaning feathers, building nests, foraging, and defense (Parque das Aves, 2019). Each beak type varies in size and shape, influencing feeding habits (Nutrópica, 2022). Beaks, composed of a bony structure covered with keratin, are evolutionary adaptations for survival (Cubas, Silva, & Catao-Dias, 2006). Different beak types correspond to birds' diets and foraging behaviors (Arent, 2010), affecting food ingestion (Prazeres, 2013). In the present study, small, slender, flattened, and long slender beaks were prominent (n = 935, 419, 279, respectively). Birds with short, conical beaks, like pigeons and sparrows, catch and break seeds, while those with long beaks, such as ducks and geese, filter water. Long, slender beaks are characteristic of woodpeckers for pecking into cavities, while hooked beaks tear prey apart in raptors. Hummingbirds use fine, slender beaks for nectar extraction, aiding in pollination, whereas toucans create holes with their long beaks for accessing nests. Aquatic birds possess long, strong beaks to catch fish (Parque das Aves, 2019; Nutrópica, 2022). Duck species featuring beaks lined with corneous lamellae were recorded, including *Dendrocyna autumnalis* (Brazilian teal), *Cairina moschata* (Muscovy duck), and *Dendrocygna viduata* (White-faced whistling duck).

Hummingbirds have long beaks to reach the nectar of flowers. The species recorded was *Eupetomena macroura* (Swallow-tailed hummingbird).

Parrots have strong, curved beaks to break seeds and fruit. The recorded species were *Anodorhynchus hyacinthinus* (Hyacinth macaw), *Ara ararauna* (Blue-and-yellow macaw), *Ara chloropterus* (Red-and-green macaw), *Primolius auricollis* (Yellow-collared macaw), *Eupsittula aurea* (Peach-fronted parakeet), *Brotogeris chiriri* (Yellow-chevroned parakeet), *Aratinga nenday* (Nanday parakeet), and *Amazona aestiva* (Blue-fronted parrot).

The beaks of insectivorous birds are wide and flat or in the shape of a small hook, which helps them capture insects and arthropods. Falcons and hawks have strong, small, and curved beaks for cutting and tearing their prey. The notable species here included *Heterospizias meridionalis* (Savanna hawk), *Rostrhamus sociabilis* (Snail kite), *Urubitinga urutinga* (Great black-hawk), and *Heterospizias meridionalis* (Savanna hawk).

Birds of prey help control the population of prey species of human interest, such as scorpions, snakes, pigeons, rodents, and spiders; vultures are responsible for the removal of 95% of animal carcasses in nature (Menq, 2016).

Food Guilds: Feeding habits in birds reflect specific adaptations and behaviors. For instance, insectivorous birds capture prey in flight, on tree trunks, or on the ground, while those with keen vision hunt over water surfaces (Sick, 1997). Birds are categorized into trophic guilds based on their feeding habits, with carnivores preying on other animals, frugivores consuming fruits, granivores eating grains and seeds, and insectivores feeding on insects (Lima, 2014). Additionally, scavengers consume carrion, nectarivores feed on nectar, omnivores utilize both animal and plant resources, and piscivores prey on fish (Dário & Almeida, 2000). Understanding trophic guilds is vital for comprehending a biological community's feeding dynamics (Sabino & Duca, 2011). The identification of nine food guilds in the studied areas, with the prevalence of granivores, insectivores, and omnivores, highlights their adaptability to urban environments, frequently attracting them to such habitats (Sick, 1997; Lima, 2014). Despite the sensitivity of nectarivores, carnivores, and frugivores to environmental disturbances, their presence in the urban region of Aquidauana suggests a degree of conservation and underscores the need for biodiversity-focused public policies in the area.

Wetland environments in the municipality should be better preserved, and government authorities should prevent their disappearance. Expanding the city to highland areas without the need for landfilling, such as in front of Lagoa Comprida, would help conserve wetlands for the various species that inhabit them and future generations. Frugivorous birds are essential for seed dispersal, a process known as ornithochory. Nectarivores species are of extreme importance for ecosystems as they pollinate plants. Sick (1997) already emphasized their importance. The observed insectivorous species feed on the ground, such as *Theristicus caudatus* (Buff-necked ibis), *Furnarius rufus* (Rufous hornero), and *Machetornis rixosa* (Cattle tyrant), capturing insects. Other species observed on tree trunks include *Melanerpes candidus* (White woodpecker), *Colaptes campestris* (Campo flicker), and *Lepidocolaptes angustirostris* (Narrow-billed woodcreeper). Individuals at rest in trees were also observed, such as *Fluvicola albiventer* (Black-crowned monjita) and *Piaya cayana* (Squirrel cuckoo).

Reptiles and Mammals: During the research, in addition to the richness of birds, other vertebrate species were observed, highlighting the importance of conservation policies for the municipality of Aquidauana.

Considering the classes studied, 2,496 birds, 67 mammals, and 28 reptiles were observed, demonstrating the rich wildlife in the region.

Among the mammals, *Alouatta caraya* (Black howler monkey) was observed Behind the Casa dos Padres. These monkeys primarily feed on leaves but can also eat fruits, flowers, bark, and stems. They exhibit sexual dimorphism, with males being black and females a light yellow.

*Dasyprocta azarae* (Azara agouti), a small rodent, is of great importance because it is responsible for the seed dispersal of various tree species. These terrestrial animals occupy areas ranging from 1 to 3 hectares for feeding and resting. They inhabit forests near streams, rivers, and tree hollows (Dubost, 1988). They have diurnal habits, being active around 4 to 8 o'clock in the morning. They were sighted in the areas Behind the Casa dos Padres and near the Quartel (Mosquera-Guerra et al., 2018).

*Caiman yacare* (Yacare caiman), distributed throughout the Pantanal Plain, is a top-of-the-food-chain species that helps regulate the size of other populations. Their diet includes invertebrates and vertebrates, mainly fish. When water levels and temperatures are high (January to March), they feed on larger animals. During the cooler months (April to June), they primarily consume invertebrates. They were observed near Fazenda Buritizal and in front of Lagoa Comprida.

*Myrmecophaga tridactyla* (Giant anteater) was observed once near Fazenda Buritizal. They inhabit cerrado and grassland areas and can also be found in forests. Giant anteaters can reach up to 2 meters in length. The large claws on their front limbs are used for feeding, as they can open termite and ant nests and serve as a defense mechanism (Braga, 2010).

The capybara (*Hydrochoerus hydrochaeris*) is the largest rodent on the planet. Endemic to South America, they are well adapted to urban conditions. Their low demand for high-quality food allows capybaras to adapt well to urban environments. They live in groups with a dominant male and several others in the vicinity. The increase in capybara populations in cities has become a reality. These animals find abundant food and lack natural predators (e.g., *Panthera onca* - jaguar, *Puma concolor* - puma, and *Caiman yacare* - yacare caiman). This allows capybara populations to grow disproportionately. When a population lacks natural predators, it tends to grow to the point where food is insufficient, potentially leading to serious consequences. Managing wildlife in this situation becomes interesting to control populations (Massahud, 2019). These animals maintain good body condition, reproduce in this environment, and, without natural predators, their offspring reach adulthood, promoting population growth on a large scale.

## Richness and diversity

The concept of diversity encompasses parameters such as richness and relative abundance. Richness denotes the number of species, while relative abundance refers to the number of individuals of a particular species within a given location or sample. Typically, areas with more trees exhibit higher richness and diversity, as different bird species occupy various strata within gallery forests, thereby increasing overall species diversity (Pianka, 1994). Riparian forests, such as those found near Ponte Boiadeira and behind casa dos padres, are particularly rich in species due to their proximity to streams and rivers, offering abundant food resources and supporting a wide array of bird species, especially during dry seasons (Sachetti, Soler, Bravo-Malca, Souza, & Gómez, 2022).

In our study, the rarefaction curve illustrates comparisons of species diversity (Figure 5) concerning sample size, with the area in front of Lagoa Comprida displaying the highest richness of bird and vertebrate species, including yacare caimans and capybaras. This region, resembling the Pantanal habitat, features partially flooded terrain with swampy characteristics. Moreover, points near Lagoa Comprida (front), Lagoa Comprida (rear), and Fazenda Buritizal share common species, including the Wattled jacana, Blue-winged teal, Rufescent tiger heron, Southern lapwing, Cattle tyrant, Southern screamer, Toco toucan, Black vulture, Bare-faced ibis, Great egret, and Blue-and-yellow macaw. These findings underscore the importance of preserving diverse habitats, such as riparian forests and wetlands, to maintain species richness and promote biodiversity conservation.

When considering the IUCN classification, 2023, some of the observed species were classified as Vulnerable (VU) and Near Threatened (NT). The Hyacinth macaw, VU (n = 4), was observed near Fazenda Buritizal, and a Giant anteater, VU, was also spotted. The Blue-and-yellow macaw, NT (n = 15), was observed behind Casa dos Padres, at Ponte Boiadeira, and near Fazenda Buritizal.

This indicates that each species requires a proper environment that meets its niches, allowing them to establish, reproduce, and perpetuate the species in an integrated and unique space composed of a combination of different habitats. Sustainable life in a conserved and renewed environment.

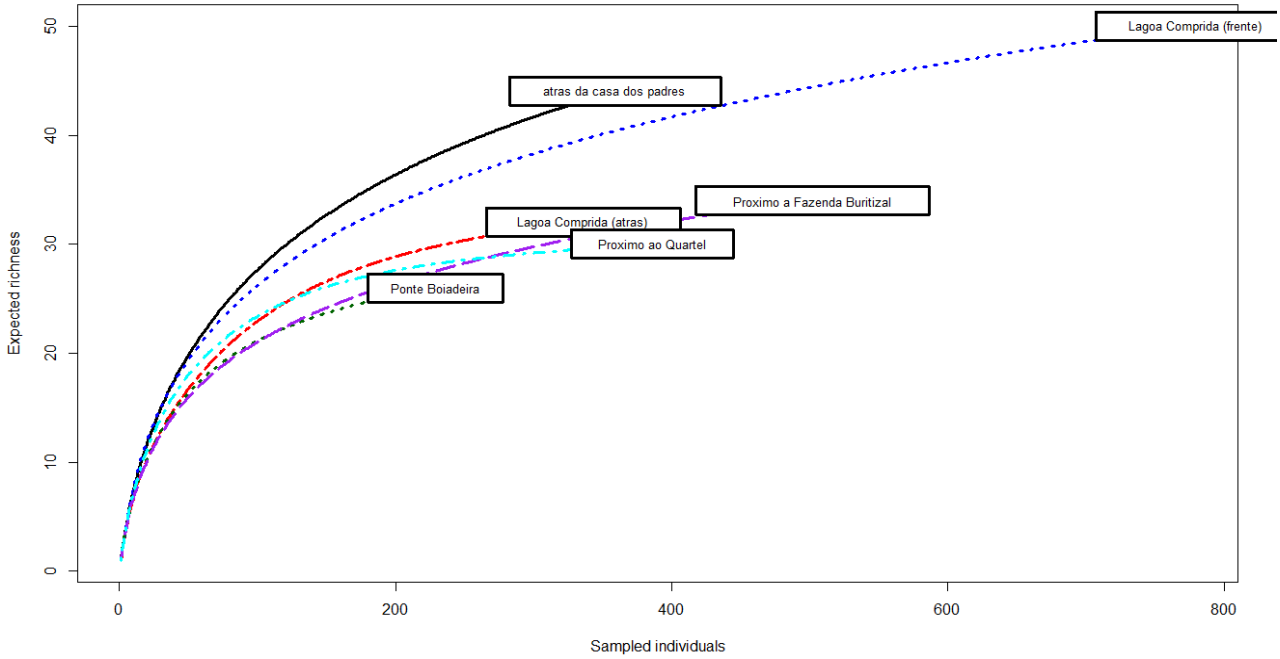


**Figure 5.** Distribution of species richness in different observation points in Aquidauana, in Aquidauana, State of Mato Grosso do Sul.

## Conclusion

In conclusion, the biodiversity study conducted in Aquidauana, state of Mato Grosso do Sul, Brazil, highlights the rich ecosystem in the region, particularly its diverse bird, reptile, and mammal fauna. While the observed abundance of bird species emphasizes the significance of the area for wildlife, caution is advised in interpreting sighting frequency, which may not accurately reflect true population size or density. Additional data, such as population surveys and ecological modeling, are essential for a comprehensive understanding of species abundance. Nevertheless, conserving this diverse wildlife offers potential for ecotourism income generation, emphasizing the need for responsible observation practices and specialized guides to aid conservation efforts.

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