

HIGH AVIAN SPECIES RICHNESS IN A MINUTE CERRADO REMNANT IN SOUTHEASTERN BRAZIL¹

RIQUEZA ELEVADA DE ESPÉCIES DE AVES EM UM PEQUENO REMANESCENTE DE CERRADO NO SUDESTE DO BRASIL¹

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ABSTRACT - The Cerrado is the most diverse tropical savanna in the world, and it is threatened due to land conversion for agriculture and urban expansion. We inventoried the birds in Botucatu State Forest (FEB), a 33-ha legally protected (but without good management) Cerrado remnant in southeastern Brazil, to evaluate its potential for the creation of a totally protected reserve. We conducted monthly visits to the area from 2019 to 2020 (with additional sporadic observations from 2018 to 2024) and searched for bird records provided by the literature and online ornithological platforms. We compared the presence of Cerrado species to another 14 protected cerrado areas in the state while accounting for area size with a Bayesian logistic regression model. An Unweighted Pair Group Method with Arithmetic Mean was employed to analyze the hierarchical relationships among species based on their dissimilarities. Area size did not account for differences in species richness, but Itirapina Ecological Station was the only remnant that showed higher probabilities of harboring more birds than FEB, which clustered with very large (> 2,000 ha) remnants. We found that of the 251 species mentioned for FEB and surroundings, three are Cerrado endemics and four are globally Vulnerable. Nonetheless, because this small area is as speciose as protected and larger grasslands, and because it is one of the last strongholds for threatened grassland physiognomies and as many as 13 threatened bird species at state level, we strongly recommend that FEB be declared an integrally protected reserve, thereby gaining proper management under Brazilian legislation.

Keywords: Bird species richness; Ecotourism; Grasslands; Public policy; Threatened avian species; Savanna.

RESUMO - O Cerrado é a savana tropical mais diversa do mundo, e está ameaçado devido à conversão de terras para a agricultura e expansão urbana. As aves da Floresta Estadual de Botucatu (FEB), um remanescente de Cerrado de 33 hectares legalmente protegido no sudeste do Brasil, foram inventariadas para avaliar seu potencial para a criação de uma unidade de conservação de proteção integral. Visitas mensais foram realizadas entre 2019 e 2020 (com observações esporádicas adicionais de 2018 a 2024). Foram verificados registros através de revisão bibliográfica e plataformas ornitológicas online. A presença de espécies de Cerrado foi comparada com outros 14 cerrados paulistas, controlando o tamanho da área, por meio de modelo de regressão logística bayesiana. Foi utilizado o Método de Agrupamento Não Ponderado com Média Aritmética para analisar as relações hierárquicas entre as espécies com base em suas dissimilaridades. O tamanho da área não explicou as diferenças na riqueza de espécies. A Estação Ecológica de Itirapina foi o remanescente com maior probabilidade de abrigar mais espécies em comparação à FEB, que agrupou com grandes remanescentes (> 2000 ha). Das 251 espécies da FEB e arredores, três são endêmicas de Cerrado e quatro estão globalmente vulneráveis. Devido ao fato de uma área muito pequena ser tão rica em espécies quanto cerrados maiores e protegidos, e por ser o último refúgio para fisionomias campestres e para até 13 espécies de aves ameaçadas em nível estadual, recomenda-se que a FEB seja declarada unidade de conservação de proteção integral.

Palavras-chave: Riqueza de espécies de aves; Ecoturismo; Campos naturais; Políticas públicas; Aves ameaçadas; Savana.

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1 INTRODUCTION

Ecosystems in the Neotropics are being destroyed due to urbanization and agriculture, presenting significant challenges for conservation (García-Moreno et al. 2007, Soto-Saravia et al. 2021). Anthropogenic activities have led to the reduction and isolation of habitats, causing a concomitant decrease in resource availability, functional diversity, and gene flow among the now-isolated populations (Bregman et al. 2014, Ceballos et al. 2015, Mariano-Neto and Santos 2023). In these fragmented habitats, most bird species are forest-dependent and are particularly vulnerable to the adverse effects of habitat fragmentation (Şekercioğlu and Sodhi 2007, Şekercioğlu et al. 2023). However, there are non-forest formations that are considered highly biodiverse and severely threatened, such as the only tropical savanna recognized as a global biodiversity hotspot and the second largest vegetation domain in South America: the Cerrado (Ab'Sáber 1977, Myers et al. 2000).

The Cerrado encompasses one of the most diverse and endangered tropical ecosystems in the world. Within the Cerrado, a variety of vegetation types are found, including gallery forests, marshes, cerradão woodlands (closed-canopy forests within a typical savanna matrix), seasonal semideciduous and deciduous forests, and four types of savanna (Cerrado *sensu stricto*, campo cerrado, campo sujo, and campo limpo) (Eiten 1972, Coutinho 2016). The climate, characterized by seasonal wet and dry periods, is the primary factor determining these vegetation formations (Silva 1996, Alvares et al. 2013). The Cerrado harbors a species-rich avifauna, with approximately 900 species, including 19 endemics and at least 50 globally threatened species. Many of these species are exclusively found in specific types of vegetation (Silva 1995, Marini and Garcia 2005). The most threatened formation within the Cerrado are the grasslands which are easily converted to arable land, and the least protected Cerrado physiognomy (Pilon et al. 2017). The Cerrado is annually consumed by arson fires, but the most significant threat today is habitat modification, primarily due to agricultural activities, particularly soy and cattle production (Eiten 1972, Durigan 2004).

Establishing legally protected areas is among the most crucial conservation strategy to mitigate or prevent the conversion of land to agriculture, regardless of the type of vegetation (Joppa and Pfaff 2011), and both public and private protected properties are of paramount importance for maintaining biodiversity in the Cerrado (Resende et al. 2021). They are also relevant for serving

educational purposes by connecting people with nature, thereby raising awareness among citizens about conservation efforts close to home (Silva and Santos 2005, Viveiros de Castro et al. 2021). Even non-protected areas can play a significant role in preserving natural habitats, especially before they are converted to agricultural use. This can be achieved by the study of little-known environments, which eventually will promote the sustainable development in emerging countries with biodiversity hotspots (Avigliano et al. 2019).

In the 1980s, a groundbreaking experiment aimed to understand the dynamics of Amazonian Forest bird communities by observing changes in species composition and abundance before and after the fragmentation of pristine forests. These 1 and 10 ha fragments allowed researchers to study these responses (Bierregaard and Lovejoy 1989). They hypothesized that smaller fragments would experience greater adverse effects than larger ones due to their limited area, a prediction that was ultimately confirmed. Given the extensive habitat modification in the Cerrado (Projeto MapBiomias 2024), it is expected that most of the remaining native vegetation outside major protected areas will consist of small, fragmented, and altered environments.

In this study, we aimed to determine the bird community in one of the last remaining grasslands in central-western São Paulo state, southeastern Brazil. This area is a 33-ha mosaic of Cerrado surrounded by sugar cane plantations and urban areas. Due to its isolation and small size, we compared its bird community with larger and protected Cerrado remnants in the state to assess whether this Cerrado remnant possesses characteristics that could qualify it for legal protection under the Brazilian legislation. We hypothesized that endemic or threatened Cerrado bird species would be absent due to the area's isolation and small size.

2 MATERIAL AND METHODS

2.1 Study areas

The Botucatu State Forest (hereafter FEB; 22°55'55" S, 48°27'19" W and 22°56'39" S, 48°27'33" W), in the municipality of Botucatu, in central-western São Paulo (Appendix 1), has one of the last grassland remnants in the state (Pilon et al. 2017). The climate is considered tropical with a dry winter (Aw in Köppen's classification), with a pronounced dry season during the colder months, with August being the driest month (Franco et al. 2023). Although property of the state, the FEB has

never been assigned for integral protection nor sustainable use area. The land tenure is intitled to the municipality, but the area (State Forest) is not the same formal category considered by the Brazilian National Conservation Units System (SNUC, Brasil 2000). The area includes a 33-ha Cerrado mosaic remnant with humid grasslands (campo úmido, 8 ha), dry grasslands (campo sujo,

21 ha) and flooded gallery forests (mata-de-galeria, 4 ha) along the Pinheirinho tributary, in the Pardo River watershed, at 819 to 864 m above sea level (Pilon et al. 2017). There are trails in each habitat, and a trail outside of, but adjacent to, the FEB (Figure 1). Bird survey effort hours are presented in Table 1 separately according to trail.

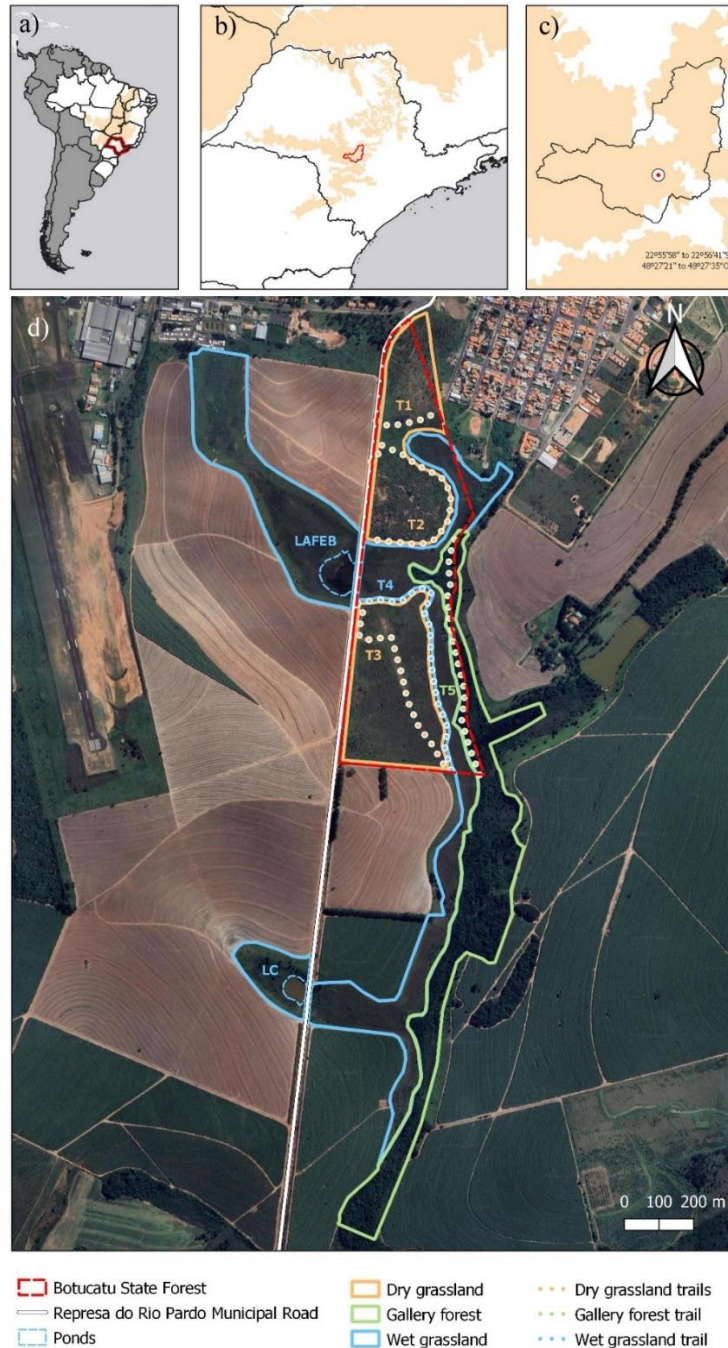


Figure 1. (a) The state of São Paulo, in southeastern Brazil; (b) The municipality of Botucatu in the state of São Paulo; (c) Botucatu State Forest location within Botucatu; (d) Botucatu State Forest and the trails used for bird censuses.

Figura 1. (a) Estado de São Paulo, sudeste do Brasil; (b) Município de Botucatu no estado de São Paulo; (c) Floresta Estadual de Botucatu no município de Botucatu; (d) Floresta Estadual de Botucatu e as trilhas utilizadas para os censos.

Table 1. Trails used to survey the birds of the Botucatu State Forest, São Paulo, southeastern Brazil, from 2019-2020. For each trail the number of field effort (h), trail route (m), as well number of accumulated 10-species lists are provided. Number of species (S), including birds flying over (F) or at the border of other habitats (B), estimated (Chao) species richness, and Shannon-Wiener Diversity Indexes (H') are also given.

Tabela 1. Trilhas utilizadas para realizar o censo das aves da Floresta Estadual de Botucatu, São Paulo, sudeste do Brasil, entre 2019 e 2020. Para cada trilha é fornecido o esforço amostral (h), o comprimento da trilha (m) e o número acumulado de listas de 10 espécies. Número de espécies (S), incluindo aves em sobrevoo (F) ou registradas nas bordas de outros ambientes (B), riqueza estimada (Chao) e Índices de diversidade de Shannon-Wiener (H') são fornecidos.

| Habitat | Trail | Effort | Route | Lists | S (F B) | Chao | H' |
|----------------|-------|--------|-------|-------|--------------|------|------|
| Dry grassland | T0 | 7.4 | 1.300 | 22 | 74 (29 29) | 149 | 3.89 |
| | T1 | 3.5 | 200 | 16 | 39 (13 7) | | |
| | T2 | 10.8 | 600 | 22 | 53 (14 12) | | |
| | T3 | 5.3 | 660 | 24 | 55 (13 19) | | |
| Wet grassland | T4 | 20.6 | 700 | 61 | 61 (22 44) | 153 | 3.79 |
| Gallery forest | T5 | 27,4 | 710 | 77 | 77 (23 3) | 172 | 3.93 |

2.1.1 Trails 0-3 - Dry grassland

Of the 151 plant species identified in the area, 139 are exclusive to these dry grasslands, where Fabaceae and Asteraceae are

predominant. Most species ($n = 67$) are herbaceous, and the remainder includes trees (including one palm), shrubs, and vines (Pilon et al. 2017) (Figure 2a).



Figure 2. Habitats at Botucatu State Forest, southeastern Brazil. (a) Dry grassland in the foreground, in the middle, wet grassland, and the gallery forest in the background; (b) Gallery Forest; (c) Pond adjacent to the Botucatu State Forest (sugarcane in the background); (d) Cabocla pond.

Figura 2. Ambientes da Floresta Estadual de Botucatu, sudeste do Brasil. (a) Campo sujo em primeiro plano, campo úmido na porção central e mata ciliar no plano de fundo; (b) Mata ciliar; (c) Lagoa adjacente à Floresta Estadual de Botucatu (cana-de-açúcar no plano de fundo); (d) Lagoa Cabocla.

2.1.2 Trail 4 - Wet grassland

Of the 71 plant species, 59 are exclusive to this habitat. Herbaceous species are predominant ($n = 61$), with few trees and shrubs, most in the Cyperaceae and Xyridaceae (Pilon et al. 2017) (Figure 2a).

2.1.3 Trail 5 - Gallery Forest

We found no floristic studies carried out in this habitat (Pilon et al. 2017). Low canopy riparian forest divided by the perennial Pinheirinho tributary is subject to flooding during the rainy season. Relevant species include *Cyathea atrovirens* (Cyatheaceae), *Podocarpus sellowii* (Podocarpaceae), *Magnolia ovata* (Magnoliaceae), *Drimys brasiliensis* (Winteraceae), *Geonoma schottiana* (Arecaceae), *Pera glabrata* (Peraceae), *Calophyllum brasiliense* (Calophyllaceae), *Erythrina speciosa*, *Copaifera langsdorffii* (Fabaceae), *Tapirira guianensis* (Anacardiaceae), and *Protium heptaphyllum* (Burseraceae, H. Cassola per. com.) (Figure 2b).

2.1.2 Adjacent areas

Agriculture is the predominant form of land use around the FEB and is mostly sugarcane. There is a small pond dominated by wet grassland vegetation on the western border. To the north it is delimited by the urban region around the airport. We included two nearby areas in our surveys because they were contiguous, have similar vegetation, and, on several occasions, we saw birds flying to and from these areas from the other habitats we surveyed.

2.1.2.1 Pond adjacent to FEB (LAFEB)

The pond adjacent to FEB (22°56' 22.98"S; 48° 27' 35.16"W) is encircled by wet grasslands, which in turn are bordered by sugarcane plantations (Figure 2c).

2.1.2.2 Cabocla pond (LC)

Another small water body (22° 57' 1.6"S; 48° 27' 39.94"W, 600 m to the south) surrounded by shrubby gallery forest, sugarcane and invasive pine, strongly impacted by human activity (Figure 2d).

2.2 Primary data

The FEB was visited monthly from March 2019 - February 2020, with censuses approximately every two weeks, beginning at 15 min before local sunrise until noon, with subsequent visits at 16:00 h until sunset. Incidental sightings were also noted. The 10-species-list method was used, in which observers walked slowly through roads, trails, and paths in the vegetation, noting all birds seen (and how many), and the habitat type in which they were detected (Ribon 2010). The locations for beginning the sequence of counting birds among the trails was chosen at random each day. Only birds noted that were clearly within the environments of the FEB were used in the analysis (that is, flyovers were noted but not included). During sampling we assumed and used a detection radius of 50 m. In practice, species observed on a given trail, but farther than 50 m away, were noted, and we noted that they were at the edge of a different vegetation type. Bird species were identified visually with the aid of binoculars, and aurally. Audio and visual records were incorporated into the online ornithological platform eBird (<https://ebird.org>) under the location identity "Floresta Estadual de Botucatu" (L8384638).

2.2.1 Qualitative surveys

Non-systematized, qualitative inventories were conducted by the authors from December 2018 - August 2024 in FEB, including nocturnal observations between 18:00-21:00 h, considering adjacent areas, incorporated in eBird under the names Botucatu--Lagoa Adjacente à FEB (L9033058) and Botucatu--Lagoa Cabocla (L9349395).

2.3 Secondary data

2.3.1 Literature review

Birds recorded in FEB were also listed based on published records from the area (Hasui et al. 2018; Rodrigues et al. 2019) and one book whose authors searched for bird specimens collected at São Paulo state and deposited in worldwide museums (Willis and Oniki 2003). A bibliographic review of the birds of Botucatu was conducted in Google Scholar (<https://scholar.google.com>), with no Boolean operators, and with the words "ave*", "bird*", "ornitol*", "ornithol*" and "Botucatu". This search resulted in eight studies published from 1977 to 2021 (Appendix 2).

2.3.2 Ornithological platforms

We searched all record for birds observed in FEB until 27 November 2024 in eBird and Wikiaves (under Floresta Estadual de Botucatu) (https://www.wikiaves.com.br/wiki/areas:fe_botucatu:inicio#:~:text=Possui%2033%2C88%20hectares%20localizados,%C3%A9%20mesot%C3%A9rmico%20de%20inverno%20seco.)

2.4 Data and analyses

We classified birds according to Cerrado endemism (Silva 1995, Silva and Santos 2005), conservation status (São Paulo 2018; Brasil 2022; IUCN 2024) and migrant status (Somenzari et al. 2018). Cerrado species were classified according to habitat of preference (N4 – Cerrado, N5 – Campo grasslands, N6 – Low, seasonally wet grassland) following Stotz et al. (1996). Taxonomy and nomenclature were standardized according to the Brazilian Ornithological Records Committee (Pacheco et al. 2021).

Species richness (Chao estimator) and cumulative species curves as a function of the number of lists were estimated using the package *vegan* (Oksanen et al. 2013). Only species detected within the 50 m radius (or flying over during the counts) were used to calculate the Jaccard Similarity Index to compare the three habitat types, as well as the Shannon-Wiener Diversity Index (Krebs 1999).

We evaluated if the composition of the FEB avifauna was likely to differ from the bird communities of 14 other protected Cerrado remnants in the state (Table 2). Such areas were chosen among all Cerrado protected areas in São Paulo (Appendix 1) for being the only ones with well-inventoried bird communities. Each site was characterized by the presence or absence of bird species and the area of the fragment. To assess the influence of area on the presence of bird species, we employed a Bayesian logistic regression model. The model was specified with the Response Variable, the binary outcome variable representing the presence (1) or absence (0) of species, and the Predictors. In this case we used the grasslands

as categorical variables with 15 levels. FEB was determined as the reference category. Site area was treated as a continuous variable representing the size of the Cerrado remnant. We used a Bayesian approach to estimate the logistic regression model, which provides a probabilistic interpretation of the model parameters and incorporates prior distributions to account for uncertainty. The model was fitted using the `stan_glm` function from the *rstanarm* package in R (Goodrich et al. 2023). Default priors were used for the regression coefficients, which assume normal distributions with mean zero and variance set to accommodate the scale of the predictors. The model was estimated using Markov Chain Monte Carlo (MCMC) methods, which generated samples from the posterior distributions of the model parameters. Convergence of the MCMC chains was assessed using the *rhat* statistic, with values close to 1 indicating adequate convergence. The median and the Median Absolute Deviation of the Standardized Deviation (MAD_SD) were reported for each parameter to summarize the central tendency and variability of the posterior distributions. The model was fit using a binomial family with a logit link function. The logit function was used to model the probability of species presence as a function of the predictors (Gelman et al. 2013).

Unweighted Pair Group Method with Arithmetic Mean (UPGMA) was employed to analyze the hierarchical relationships among species based on their dissimilarities. A Bray-Curtis dissimilarity matrix was computed from presence-absence data to quantify the pairwise dissimilarities among Cerrado remnants. The distance matrix was utilized as input for the UPGMA clustering algorithm implemented in R using the `hclust` function with the average method. The resulting dendrogram was visualized and color-coded according to the following area classes, in hectares: <100, 101-1000, 1001-2000, and >2000.

The spectrogram was created with the *warbleR* package (Araya-Salas and Smith-Vidaurre 2017). All analyses were carried out in R Version 4.1.3 (R Core Team 2023).

Table 2. Categories of ornithologically well-inventoried protected areas found within the Cerrado in the state of São Paulo, southeastern Brazil, ordered by the number of Cerrado bird species. The total species richness and size of each remnant are provided. Begin and end dates of surveys, when available, are also indicated.

Tabela 2. Categorias de unidades de conservação bem inventariadas ornitologicamente situadas dentro do Cerrado no estado de São Paulo, sudeste do Brasil, ordenadas de acordo com o número de espécies características do Cerrado (Cer. S). A riqueza total (S) de cada remanescente é fornecida. Datas de início e fim de inventários são fornecidas, quando disponíveis.

| Category | Name | Cer. S | S | Area (ha) | Begin | End |
|-----------------------------------|----------------|--------|-----|-----------|-------|-------|
| Ecological Station | Itirapina | 63 | 264 | 2211 | 1982 | 2020? |
| Ecological Station | Santa Bárbara | 49 | 247 | 2712 | 1981 | 2013 |
| State Forest | Botucatu | 44 | 225 | 33 | 2018 | 2024 |
| State Park | Furnas | 43 | 296 | 2069 | 1903 | 2022 |
| Ecological Station | Jataí | 38 | 299 | 9024 | 1993 | 2002 |
| Ecological Station | Mogi-Guaçu | 35 | 234 | 991 | 1981 | 2010 |
| Ecological Station | Santa Maria | 26 | 140 | 1316 | 2015 | 2022 |
| Ecological Station | Parapanema | 23 | 192 | 636 | 2014 | 2014 |
| Relevant Ecological Interest Area | Pé-de-gigante | 23 | 143 | 1200 | 1996 | 1997 |
| Ecological Station | Assis | 22 | 170 | 1752 | 1981 | 2007 |
| Ecological Station | São Carlos | 21 | 146 | 82.9 | ? | ? |
| Ecological Station | Itapeva | 21 | 145 | 99.5 | 1984 | 2008 |
| Ecological Station | Avaré | 17 | 123 | 720 | 2014 | 2014 |
| Ecological Station | Angatuba | 15 | 188 | 1366 | 1984 | 2007 |
| State Park | Porto Ferreira | 15 | 175 | 607 | 2002 | 2003 |

3 RESULTS

3.1 Primary data

3.1.1 Inventories

Over a total of 222 lists, we identified 176 species in 46 families and 20 orders (Appendix 3) in the FEB, with a Chao estimate of 229 (SD \pm 3.8) species (Figure 3). We found 12 threatened species (in the state) in the wet

grasslands, while three and four species are threatened at national and global levels, respectively. Overall, more species were detected (and estimated) in the Gallery Forest (Table 3). The mean Jaccard Similarity Index among habitats was $J' = 0.36$. The greatest similarity was only 50% between both types of grasslands, followed by 31% between Gallery Forest and Dry grassland, and 27% between Gallery Forest and Wet grassland.

Table 3. Number of threatened species at state (SP), national (BR) and global (IUCN) levels, recorded by habitat type. Threat categories are Critically Endangered (CR), Endangered (EN), and Vulnerable (VU). NT = Near Threatened.

Tabela 3. Número de espécies ameaçadas em nível estadual (SP), nacional (BR) e global (IUCN), registrados de acordo com o tipo de ambiente. Categorias de ameaça incluem Criticamente em Perigo (CR), Em Perigo (EN) e Vulnerável (VU). NT = Quase Ameaçada.

| Habitat | CR | EN | VU | NT |
|----------------|--------|----------------|--------------------------|--------|
| Dry grassland | 1 (SP) | 2 (SP), 1 (BR) | 1 (SP), 1 (IUCN) | 2 (SP) |
| Wet grassland | 4 (SP) | 1 (SP), 1 (BR) | 4 (SP), 1 (BR), 3 (IUCN) | 1 (SP) |
| Gallery forest | 0 | 0 | 0 | 0 |

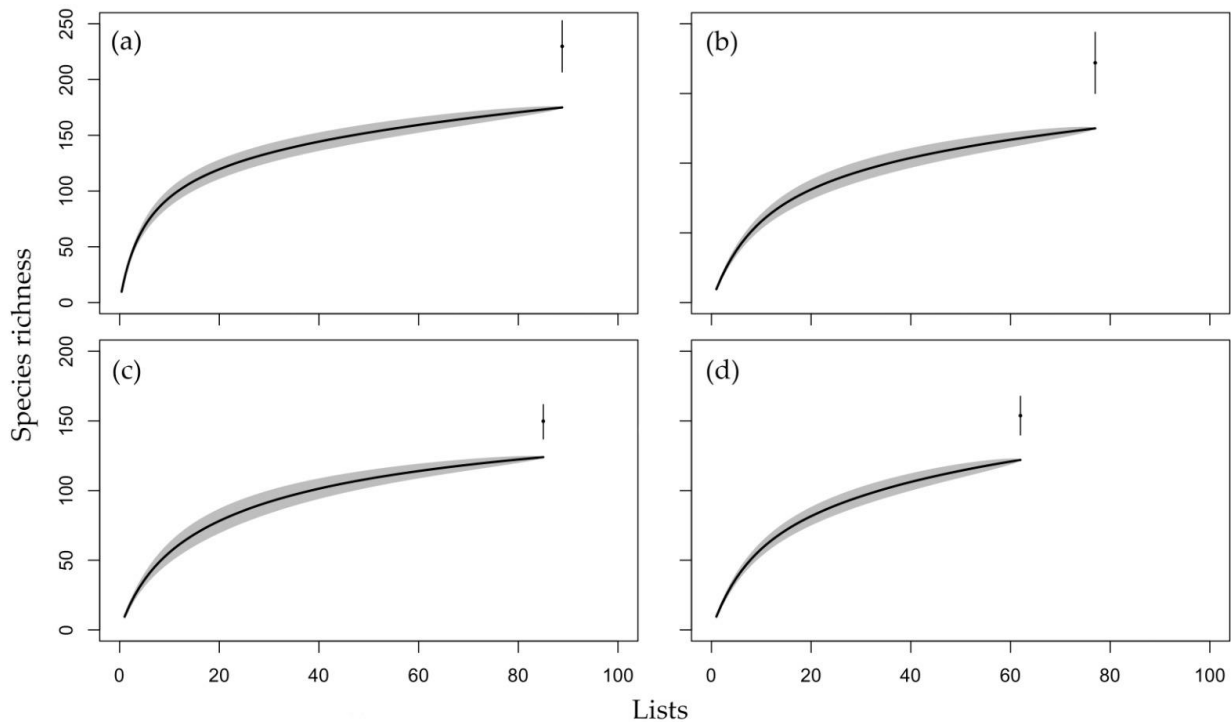


Figure 3. Cumulative curve of bird species richness as a function of the number of lists; gray shading corresponds to upper and lower 95% confidence intervals. A dot indicates the number of estimated species (Chao estimator), and vertical lines show \pm SE. (a) All environments; (b) Dry grassland; (c) Wet grassland; (d) Gallery Forest.

Figura 3. Curva de acumulação de espécies em função do número de listas; sombras cinza correspondem aos limites de 95% de intervalos de confiança. O ponto indica o número de espécies estimada (estimados Chao), e as linhas verticais mostram \pm EP. (a) Todos os ambientes; (b) Campo sujo; (c) Campo úmido; (d) Mata ciliar.

3.1.2 Qualitative surveys

LAFEB with 122, followed by LC had 118 species, and FEB with 37 (Appendix 3). Although most species were common to all sites, aquatic predators, including ducks, grebes, and egrets, were only present on habitats with clear water surface, case of LAFEB and LC. Other species including the Tawny-crowned Scrub-Tyrant *Euscarthmus meloryphus* Wied, 1831 and the White-lined Tanager *Tachyphonus rufus* (Boddaert 1783) were only found in the latter.

3.2 Secondary data

3.2.1 Literature review

There were 251 reports (variety of authors, without known abundances) and 110 mist-netting records of 147 and 91 species, respectively, with a total of 180 species mentioned from Botucatu in a compilation of Atlantic Forest bird species (Hasui et al. 2018). In another compilation, two individuals of one species were mentioned for the municipality (Rodrigues et al. 2019). No record, however, was

indicated as from the FEB. Willis and Oniki (2003) mentioned 215 species from Botucatu; the dirt road that limits the FEB to the west (Mandacarú [sic] = Represa do Rio Pardo Municipal Road) is indicated, but no record was associated with that locality.

We found eight field studies in Botucatu that mentioned birds. These include stomach contents (Hempel 1949), and genetic analyses (Lucca 1977, 1985, Lucca and Rocha 1985). At two localities at the São Paulo State University (UNESP) campus in Botucatu there were 94 species recorded (Guzzi and Donatelli 2003), and as many as 194 were detected at a third locality in UNESP a few years later (Antonelli and Fonseca 2019). The vocalizations of the Rufous-collared Sparrow *Zonotrichia capensis* (Statius Muller 1776) was studied (Avelino and Vielliard 2004), while three other species were recorded in a linear park downtown (Ribas et al. 2021). Overall, literature records accounted for 292 species from Botucatu, but there were no specific indications of species detected within the FEB in any of those studies.

Two unpublished monographs were found, one of which mentioned 61 species, three exclusives (Ciambelli 2008), and another with 194, 16 exclusive (Risso 2023) (Appendix 3).

3.2.2 Ornithological platforms

Until 22 November 2024, from 715 complete checklists elaborated for the area, we found that 229 species were listed in eBird under Floresta Estadual de Botucatu, 76 from LAFEB in 57 lists, and 103 species in 57 lists from LC, while Wikiaves listed 121 species (Appendix 3).

3.3 Bayesian Logistic Regression

The 15 areas harbor 466 species. The median of the posterior distribution for the intercept for the entire community was low and, on average, the log-

odds of presence are 0.5 when all predictors are at their baseline. The positive value means the species are more likely to be present in the reference area than not, though this is marginally significant ($p = 0.061$). The model explained some of the variation in species presence, as indicated by the reduced deviance (1297.9) compared to the null model (1469.7). Several remnants were significantly less likely to have the species present compared to the reference site and Itirapina Ecological Station is the only Cerrado remnant where the species are significantly more likely to be present. Several grasslands, such as Angatuba, Avaré, Itapeva, Paranapanema, Porto Ferreira, and São Carlos, show a lower likelihood of species presence compared to the FEB, with varying degrees of uncertainty. Itirapina is the only grassland where the species are more likely to be present. In addition, fragment size does not seem to influence species presence based on this model. Some sites, such as Jataí and Santa Bárbara, have very high uncertainty, making conclusions about species presence there less reliable (Appendix 4).

3.4 UPGMA

The UPGMA clustering analysis of the 15 Cerrado remnants revealed two distinct clusters based on the Bray-Curtis dissimilarity matrix. The dendrogram illustrates these clusters with areas color-coded according to area classes. The first cluster encompassed all the very large Cerrados, while the second cluster included smaller Cerrados in which forested formations predominate. The FEB was united with two very large grasslands, within a clade entirely composed of very large areas (Figure 4). Among habitat-specialists, there were two Cerrado endemic species recorded in Itirapina, but none in the other areas. Of the eight globally threatened species, all were found in Itirapina, four in Santa Bárbara and four in FEB.

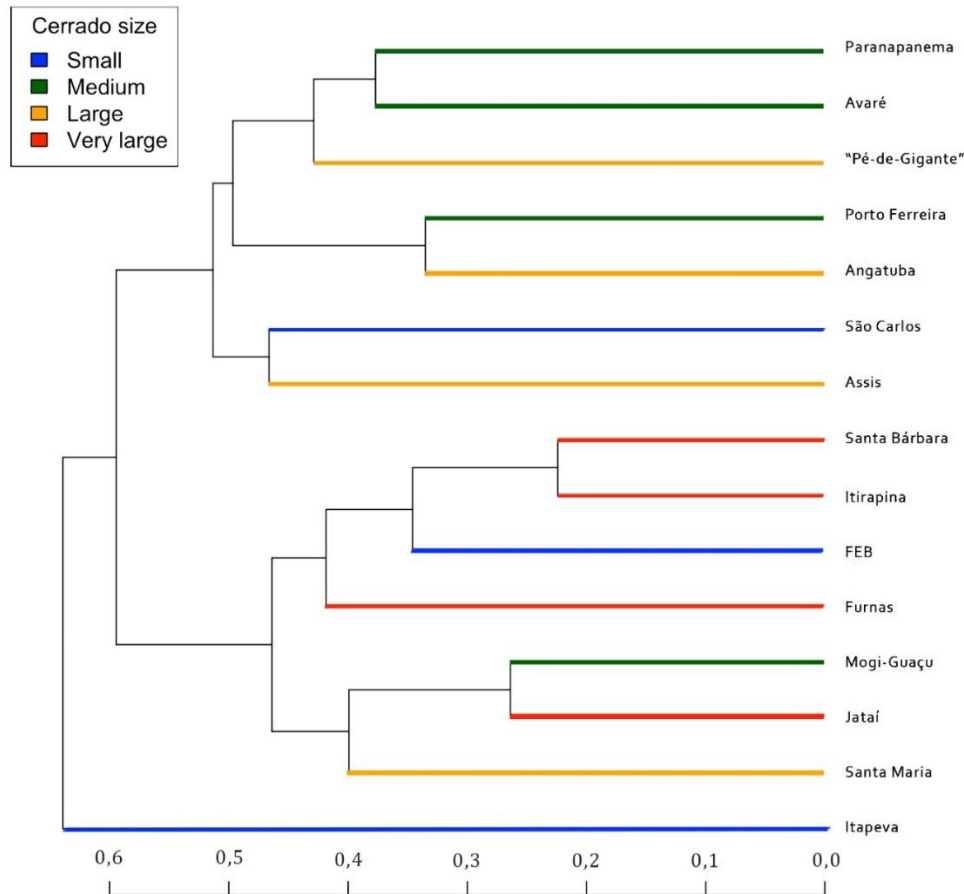


Figure 4. UPGMA clustering analysis of 15 Cerrado remnants in southeastern Brazil. Colors represent the following area classes: less than 100 ha (small), between 101 and 1000 ha (medium), between 1001 and 2,000 ha (large), and greater than 2,000 ha (very large).

Figura 4. Análise de UPGMA de 15 remanescente de Cerrado no sudeste do Brasil. Cores representam classes de áreas: menos de 100 ha (pequeno), entre 101 e 1.000 ha (médio), entre 1.001 e 2.000 ha (grande), e maior do que 2.000 ha (muito grande).

4 DISCUSSION

The surprising number of overall bird species found in this 33-ha area is striking, even compared to larger and protected Cerrado remnants in the state (e.g., Develey et al. 2013, Lucindo et al. 2015, Motta-Junior et al. 2020). Some 238 bird species were recorded at the FEB, but another thirteen species occur in the nearby areas (eight exclusive species in LAFEB and another two in LC), for a total of 251 species for all habitats inventoried. Eight of these are associated with aquatic environments (White-cheeked Pintail *Anas bahamensis* Linnaeus 1758, Pied-billed *Podilymbus podiceps* (Linnaeus 1758) and Least Grebes *Tachybaptus dominicus* (Linnaeus 1766), Wattled Jacana *Jacana jacana* (Linnaeus 1766), Cocoi Heron *Ardea cocoi* Linnaeus 1766, Snowy Egret *Egretta thula* (Molina 1782), and Amazon Kingfisher *Chloroceryle amazona* (Latham 1790),

while the remaining six – Picui Ground-Dove *Columbina picui* (Temminck 1813), Dark-billed Cuckoo *Coccyzus melacoryphus* Vieillot 1817, Fulvous-crowned Scrub-Tyrant, Yellowish Pipit *Anthus chii* Vieillot 1818, White-lined Tanager, and Stripe-tailed Yellow-Finch *Sicalis citrina* Pelzeln 1870 are expected to be detected in FEB with increasing field effort. Other forest-dependent species are expected to be found in LC, with more effort over that patch of the Pinheiro tributary, not visited by us. Three species observed in an inventory conducted between February-October 2008 on FEB were not found again: Plumbeous Pigeon *Patagioenas plumbea* (Vieillot 1818) and Barred Forest-Falcon *Micrastur ruficollis* (Vieillot 1817), both lacking recent records from Botucatu; and the Gray Elaenia *Myiopagis caniceps* (Swainson 1835) is commonly found in other forests of the municipality (e.g., Antonelli and Fonseca 2019).

The overall species richness represents almost a quarter of the birds of São Paulo (Silveira and Uezu 2011), and FEB alone harbors 13 threatened species at state level (and four Near Threatened taxa), three at the national level (one Endangered and two Vulnerable species) and four Vulnerable species at the global level. Threatened species in the state include five Critically Endangered species. FEB falls short of the requirements for the selection criteria of Important Bird Areas (IBA), as it harbors small population-size thresholds for a Vulnerable globally threatened species, the Sharp-tailed Tyrant *Culicivora caudacuta* (Vieillot 1818), and other species of global conservation concern, the Rufous-faced Crake *Laterallus xenopterus* Conover 1934, Tropeiro Seedeater *Sporophila beltoni* Reppening and Fontana 2013, and Chestnut Seedeater *S. cinnamomea* (Lafresnaye 1839), which fall under criterion A1 (Bencke et al. 2006). Lastly, 10 Atlantic Forest endemic species meet criterion A2 (Bencke et al. 2006). Thus, FEB is a hotspot within two biodiversity hotspots (Cerrado and Atlantic Forest) and stands as one of the few remnants of native Cerrado grasslands in the state, home to a significant species richness of threatened and restricted-range species. Some are strictly associated to Cerrado physiognomies, such as White-rumped Tanager *Cypsnagra hirundinacea* (Lesson, 1831) and Sharp-tailed Tyrant *Culicivora caudacuta* (Vieillot, 1818), yet only three of the species reported on FEB are endemic to the domain, unlike larger protected areas, such as in Itirapina Ecological Station (2,211 ha), which harbors the Lesser nothura *Nothura minor* (Spix 1825) and Campo Miner *Geositta poeciloptera* (Wied 1830), although both supposedly extinct in the area (Motta-Junior et al. 2020). The Saffron-billed Sparrow *Arremon flavirostris* Swainson 1838 and White-striped Warbler *Myiothlypis leucophrys* (Pelzeln 1868), are Cerrado endemic forest birds (Silva 1995, Silva and Santos 2005).

At least 27 are long distance migrants well documented in the literature (Somenzari et al. 2018) and the remaining is resident. Based on published studies, Botucatu has 292 bird species. Considering all sources of evidence, our results added another 48 species to the municipality, for a total of 340. Some records require thorough evaluation, which will be comprehensively addressed elsewhere, but

noteworthy records are further discussed (Appendix 5).

About 14% of the state of São Paulo is Cerrado, of which today 7.253 fragments, or 239.312 ha (4% of the remaining natural vegetation in the state) remains (Nalon et al. 2022). The protected area system is responsible for 32 reserves and legal reserve areas (Durigan and Ratter 2006), but leaves small and newly recovering habitats unprotected. Thus, FEB should likely be a candidate for a protected area under the sustainable use protection category as acknowledged by the SNUC (Brasil 2000) as the endemic and threatened species would clearly benefit from legally establishing FEB as an integrally protected area.

A predicted result was that area per se was not a main driver of species richness, including regarding habitat-specialist Cerrado and grasslands species. Although the species-area effect plays a major influence on species occurrence (Rosenzweig 1995), this was not the case for FEB. It has been suggested that the size of forest fragments found in Cerrado is positively correlated with bird species richness, and that this trend varies according to ecological guilds such as trophic categories and forest dependence (Marini 2001). However, we failed to find studies which report the effects of grassland area on the presence and non-detection of birds. There may be a bias regarding how well inventoried each Cerrado remnant is, but because most of the 15 areas we analyzed were inventoried by experienced ornithologists, we consider most species were detected in those areas.

We found that, relative to FEB and the other Cerrado remnants with which it shares similar vegetation composition, Itirapina (2,211 ha) is more likely to support a greater diversity of Cerrado and grasslands species. We hypothesize that these differences are attributable to the occupation and conservation histories of the regions in question, rather than merely their fragment sizes. Since the mid-19th century, inland São Paulo has experienced extensive environmental degradation, primarily due to the expansion of coffee plantations. By the 1920s, most native vegetation had been cleared, although some remnants persisted (Victor et al. 2005). Itirapina appears to be an exception to this trend, as the high transportation costs associated with coffee cultivation limited its large-scale expansion in the municipality (Zanchetta et al. 2006).

Therefore, evaluating bird composition solely based on fragment size, without considering the area's historical context, should be avoided.

FEB, as a peri urban Cerrado fragment, is not only impacted by its small size but also by its specific conservation challenges. Despite facing limited size and several pressures, FEB's high species richness enhances its conservation value. The UPGMA analysis also indicated that, despite its smaller size, the FEB clusters with very large (>2,000 ha) Cerrado remnants, which highlights the significance of the area as no other study could detect as many species as we compiled for a Cerrado remnant <100 ha. Finally, thirty-seven percent of the grassland bird species in the Cerrado are experiencing population declines and are underrepresented in the existing protected areas (Braz et al. 2023), making FEB, one of the last remaining grasslands in São Paulo, a strong candidate for

a formal protected area under the Brazilian legislation despite its diminutive size. Thus, FEB serves as further evidence of the significance of the marginal areas of the Cerrado (De Sordi et al. 2022).

4.1 Threats to the FEB

The area is affected by uncontrolled cattle grazing, arson fires, illegal hunting, exotic invasive species (both plants, with Signal grass *Urochloa* sp. scattered throughout all physiognomies), as well as domestic mammals, such as cats and dogs, removal of native orchids, pollution, and incorrect land use for disposal of waste and tourism (Table 3). Fire eliminates most herbaceous and grass strata until natural regeneration, but some portion closer to the gallery forest remain humid most part of the year.

Table 3. Summary of pressures posing threats to the biodiversity in the study area. Threat levels are listed according to our perception in the field or to threats mentioned in the literature.

Tabela 3. Resumo de pressões que ameaçam a biodiversidade da área de estudo. Níveis de ameaçada estão listadas de acordo com a percepção dos autores, ou à interpretação de autores na literatura.

| Pressure | Threat | Impact |
|------------------|---|----------|
| Grazing | Significant number of underrepresented species in collections, and the presence of grassland physiognomies, virtually extinct in the state (Pilon et al. 2017) | Moderate |
| Arson | Arson destroys the vegetation, and expel and kill native animal species | High |
| Illegal hunting | Use of bird traps | High |
| Invasive species | <i>Urochloa</i> spp. grasses take over the native species, and cover most of the soil in the grassland areas Domestic animals, which dwell through the region threatens most small- to medium-sized native fauna | High |
| Municipal road | The dirt road that limits the FEB to the west was elevated and prevents the passage of land animals, as well as can cause great impact from running over animals, in addition to birds | Moderate |

5 CONCLUSIONS

The small size and presence of Cerrado species illustrate that this region is an important area for birds, meriting conservation. The FEB needs immediate attention to control anthropogenic threats. It preserves highly threatened Cerrado habitats and regionally and globally threatened bird species, making it a hotspot within hotspots. Thus, the establishment of this area as a fully protected reserve with a safe zone against the effects of spillover, plantations and urban expansion and pressure is extremely urgent. There are unexplored areas nearby (with similar vegetation) that also deserve due consideration regarding the avifauna (e.g., 22°57'0"S; 48°27'4"W). Because some species were also observed crossing the Represa do Rio Pardo Municipal Road to LAFEB, we strongly recommend this latter habitat be incorporated into the area of the FEB, which would add some 12 ha. Lastly, because FEB is mostly represented by savanna vegetation, we suggest its formal name be updated to “Cerrado Botucatu”, instead of “Floresta Estadual”, which, in Portuguese, translates to “State Forest”, which refers to a distinct type of landscape and denotes an area protected at the state level, rather than at the municipal level.

6 APPENDIX

The data collected and generated during this study are also publicly available in Zenodo at <http://doi.org/10.5281/zenodo.13893470>.

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8 AUTHOR CONTRIBUTIONS

Conceptualization, all authors; methodology, all authors; software, V.R.A. and V.C.; validation, all authors; formal analysis, V.R.A. and V.C.; investigation, all authors; writing—original draft preparation, all authors; writing—review and editing, all authors; supervision, R.C.B.F. and V.C.; project administration, V.R.A. and S.M.N. All authors have read and agreed to the published version of the manuscript.

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Appendix 1. Location of the Botucatu State Forest, southeastern Brazil.

Apêndice 1. Localização da Floresta Estadual de Botucatu, sudeste do Brasil.

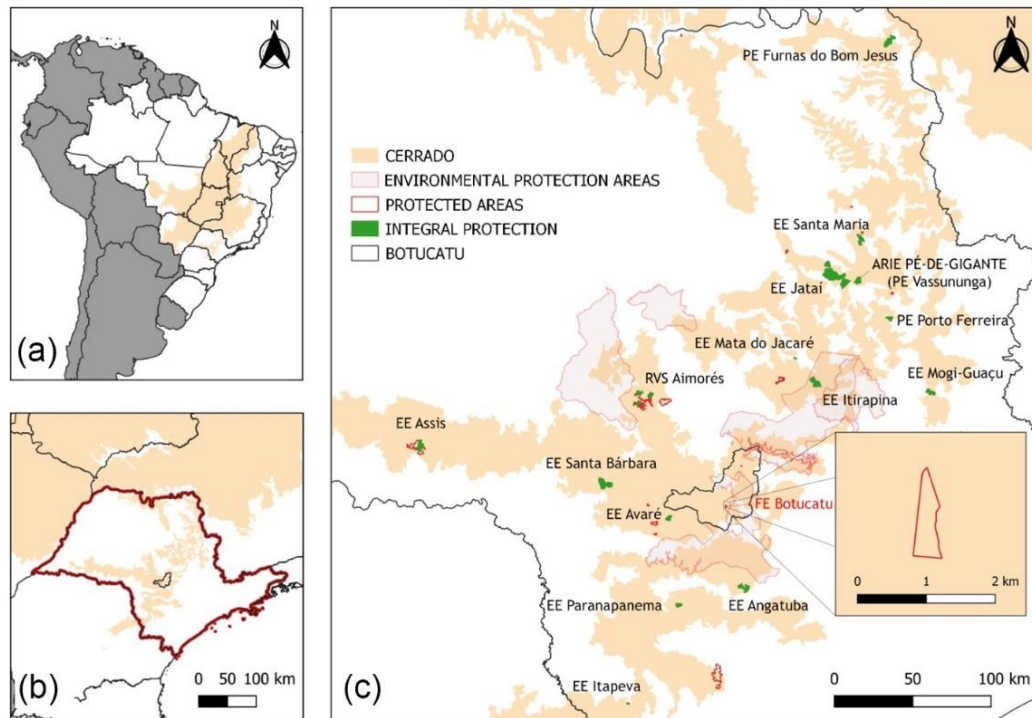


Figure S1. The Brazilian Cerrado in South America (a). The state of São Paulo in southeastern Brazil, highlighting the municipality of Botucatu, central-western São Paulo (b). Protected Cerrado remnants within the state of São Paulo in relation to Botucatu and the Botucatu State Forest (c).

Figura S1. O Cerrado brasileiro na América do Sul (a). O estado de São Paulo, sudeste do Brasil, evidenciando o município de Botucatu, região centro-oeste paulista (b). Remanescentes protegidos de Cerrado no estado de São Paulo em relação à Floresta Estadual de Botucatu (c).

Appendix 2. Published references on the birds of Botucatu, southeastern Brazil.

Apêndice 2. Referências publicadas sobre as aves de Botucatu, sudeste do Brasil.

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Appendix 3. Bird species observed at Botucatu State Forest (FEB), Pond adjacent to FEB (LAFEB), and Cabocla pond (LC), southeastern Brazil. The primary list (1) represents documented (photograph, sound recording, museum specimen) species; the secondary list (2) includes species that lack documentation but are certainly found in the areas; in the tertiary list (3) are species whose range or identification demand proper documentation to be included in the areas. Habitats include: Aq. = Aquatic, DG = Dry grassland, Fly = Flyover, GF = Gallery forest, WG = Wet grassland. Migration status are: MGT = migratory, MPR = partially migratory, ND = not defined. Threat status at state (SP), national (BR) and global (IUCN) levels: CR = Critically Endangered, EN = Endangered, VU = Vulnerable; NT = Near Threatened. Sources stand for A = this study, C = Ciambelli (2008), E = eBird, R = Risso (2023), W = Wikiaves, * = Cerrado endemic species (Silva 1995, Silva and Santos 2005). Taxonomy follows the Brazilian Ornithological Records Committee (Pacheco et al. 2021).

Apêndice 3. Espécies de aves observadas na Floresta Estadual de Botucatu (FEB), Lagoa adjacente à FEB (LAFEB), e Lagoa Cabocla (LC), sudeste do Brasil. A lista primária (1) representa espécies com documentação (fotografia, gravação de vocalização, espécime de museu); a lista secundária (2) inclui espécies que não possuem documentação, porém certamente encontradas nas áreas; na lista terciária (3) estão espécies cujas distribuição ou identificação demandam documentação adequada para que sejam consideradas pertencentes às áreas. Ambientes incluem: Aq. = Aquático, DG = Campo sujo, Fly = Sobrevoos, GF = Mata ciliar, WG = Campo úmido. Status de migração: MGT = migratória, MPR = parcialmente migratória, ND = indeterminada. Status de ameaça em níveis estadual (SP), nacional (BR) e global (IUCN): CR = Criticamente Em Perigo, EN = Em Perigo, VU = Vulnerável; NT = Quase Ameaçada. As fontes correspondem a: A = este estudo, C = Ciambelli (2008), E = eBird, R = Risso (2023), W = Wikiaves, * = Endêmica do Cerrado (Silva 1995, Silva and Santos 2005). A taxonomia está de acordo com o Comitê Brasileiro de Registros Ornitológicos (Pacheco et al. 2021).

| Taxa | English name | List | Site | Habitat | Migration | SP | BR | IUCN | Source |
|--|----------------------------|------|----------------|--------------|-----------|----|----|------|---------------|
| TINAMIFORMES | | | | | | | | | |
| TINAMIDAE | | | | | | | | | |
| <i>Crypturellus obsoletus</i> (Temminck, 1815) | Brown Tinamou | 1 | FEB | GF | - | - | - | - | E |
| <i>Crypturellus parvirostris</i> (Wagler, 1827) | Small-billed Tinamou | 1 | FEB; LAFEB; LC | DG; WG | - | - | - | - | A; E; R; W |
| <i>Crypturellus tataupa</i> (Temminck, 1815) | Tataupa Tinamou | 1 | FEB | GF | - | - | - | - | A; E; R |
| <i>Rhynchotus rufescens</i> (Temminck, 1815) | Red-winged Tinamou | 1 | FEB; LAFEB; LC | DG; WG | - | NT | - | - | A; C; E; R; W |
| <i>Nothura maculosa</i> (Temminck, 1815) | Spotted Nothura | 1 | FEB; LAFEB; LC | DG; WG | - | - | - | - | A; E; R; W |
| ANSERIFORMES | | | | | | | | | |
| ANATIDAE | | | | | | | | | |
| <i>Dendrocygna viduata</i> (Linnaeus, 1766) | White-faced Whistling-Duck | 1 | FEB; LAFEB; LC | Fly; WG (Aq) | - | - | - | - | A; E; R |

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| Taxa | English name | List | Site | Habitat | Migration | SP | BR | IUCN | Source |
|--|------------------------------|-------------|----------------|----------------|------------------|-----------|-----------|-------------|---------------|
| <i>Dendrocygna autumnalis</i> (Linnaeus, 1758) | Black-bellied Whistling-Duck | 1 | FEB; LAFEB; LC | Fly; WG (Aq) | - | - | - | - | A; E; R |
| <i>Cairina moschata</i> (Linnaeus, 1758) | Muscovy Duck | 1 | FEB; LAFEB; LC | Fly; WG (Aq) | - | - | - | - | A; E |
| <i>Amazonetta brasiliensis</i> (Gmelin, 1789) | Brazilian Teal | 1 | FEB; LAFEB; LC | Fly; WG (Aq) | - | - | - | - | A; E; R; W |
| <i>Anas bahamensis</i> Linnaeus, 1758 | White-cheeked Pintail | 1 | LAFEB | Fly; WG (Aq) | - | - | - | - | A; E; R; W |
| GALLIFORMES | | | | | | | | | |
| CRACIDAE | | | | | | | | | |
| <i>Penelope supercilialis</i> Temminck, 1815 | Rusty-margined Guan | 1 | FEB | GF | - | - | - | NT | E |
| <i>Penelope obscura</i> Temminck, 1815 | Dusky-legged Guan | 1 | FEB | GF | - | - | - | - | A; E |
| PODICIPEDIFORMES | | | | | | | | | |
| PODICIPEDIDAE | | | | | | | | | |
| <i>Tachybaptus dominicus</i> (Linnaeus, 1766) | Least Grebe | 1 | LAFEB | WG (Aq) | - | - | - | - | R; W |
| <i>Podilymbus podiceps</i> (Linnaeus, 1758) | Pied-billed Grebe | 1 | LAFEB | WG (Aq) | - | - | - | - | A; E |
| COLUMBIFORMES | | | | | | | | | |
| COLUMBIDAE | | | | | | | | | |
| <i>Columba livia</i> Gmelin, 1789 | Rock Pigeon | 1 | FEB | DG; Fly | - | - | - | - | A; E; R |
| <i>Leptotila verreauxi</i> Bonaparte, 1855 | White-tipped Dove | 1 | FEB; LAFEB; LC | DG; GF; WG | - | - | - | - | A; C; E; R |
| <i>Leptotila rufaxilla</i> (Richard & Bernard, 1792) | Gray-fronted Dove | 1 | FEB | GF | - | - | - | - | A; E; R |

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| Taxa | English name | List | Site | Habitat | Migration | SP | BR | IUCN | Source |
|--|--------------------|------|----------------|-------------|-----------|----|----|------|---------------|
| <i>Zenaida auriculata</i> (Des Murs, 1847) | Eared Dove | 1 | FEB; LAFEB; LC | DG; Fly; WG | ND | - | - | - | A; C; E; R; W |
| <i>Columbina talpacoti</i> (Temminck, 1811) | Ruddy Ground-Dove | 1 | FEB; LAFEB; LC | DG; GF; WG | - | - | - | - | A; C; E; R; W |
| <i>Columbina squammata</i> (Lesson, 1831) | Scaled Dove | 1 | FEB | GF; WG | - | - | - | - | A; C; E |
| <i>Columbina picui</i> (Temminck, 1813) | Picui Ground-Dove | 1 | LAFEB | WG | - | - | - | - | R |
| CUCULIFORMES | | | | | | | | | |
| CUCULIDAE | | | | | | | | | |
| <i>Guira guira</i> (Gmelin, 1788) | Guira Cuckoo | 1 | FEB; LAFEB; LC | DG; WG | - | - | - | - | A; C; E; R; W |
| <i>Crotophaga ani</i> Linnaeus, 1758 | Smooth-billed Ani | 1 | FEB; LAFEB; LC | DG; WG | - | - | - | - | A; C; E; R; W |
| <i>Tapera naevia</i> (Linnaeus, 1766) | Striped Cuckoo | 1 | FEB; LAFEB; LC | DG; GF; WG | - | - | - | - | A; C; E; R; W |
| <i>Piaya cayana</i> (Linnaeus, 1766) | Squirrel Cuckoo | 1 | FEB | GF | - | - | - | - | A; C; E |
| <i>Coccyzus melacoryphus</i> Vieillot, 1817 | Dark-billed Cuckoo | 1 | LAFEB | WG | MGT | - | - | - | A; E; W |
| NYCTIBIFORMES | | | | | | | | | |
| NYCTIBIIDAE | | | | | | | | | |
| <i>Nyctibius griseus</i> (Gmelin, 1789) | Common Potoo | 1 | FEB | DG; GF; WG | - | - | - | - | A; E; R |
| CAPRIMULGIFORMES | | | | | | | | | |
| CAPRIMULGIDAE | | | | | | | | | |
| <i>Nyctidromus albicollis</i> (Gmelin, 1789) | Common Pauraque | 1 | FEB; LAFEB; LC | DG; GF; WG | - | - | - | - | A; E; R |

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| Taxa | English name | List | Site | Habitat | Migration | SP | BR | IUCN | Source |
|--|----------------------------|------|----------------|-------------|-----------|----|----|------|---------------|
| <i>Hydropsalis torquata</i> (Gmelin, 1789) | Scissor-tailed Nightjar | 1 | FEB | DG; GF; WG | - | - | - | - | A; E |
| <i>Podager nacunda</i> (Vieillot, 1817) | Nacunda Nighthawk | 1 | FEB; LAFEB | DG; Fly; WG | MPR | - | - | - | A; E; R; W |
| APODIFORMES | | | | | | | | | |
| APODIDAE | | | | | | | | | |
| <i>Streptoprocne zonaris</i> (Shaw, 1796) | White-collared Swift | 1 | FEB | DG; Fly; WG | - | - | - | - | A; E; W |
| <i>Chaetura meridionalis</i> Hellmayr, 1907 | Sick's Swift | 1 | FEB; LAFEB | DG; Fly; WG | MGT | - | - | - | A; E; R |
| <i>Tachornis squamata</i> (Cassin, 1853) | Fork-tailed Palm-Swift | 1 | FEB; LAFEB | DG; Fly; WG | - | - | - | - | A; E; W |
| TROCHILIDAE | | | | | | | | | |
| <i>Florisuga fusca</i> (Vieillot, 1817) | Black Jacobin | 1 | FEB | GF | - | - | - | - | R; W |
| <i>Phaethornis pretrei</i> (Lesson & Delattre, 1839) | Planalto Hermit | 1 | FEB; LAFEB; LC | DG; GF; WG | - | - | - | - | A; E; R; W |
| <i>Colibri serrirostris</i> (Vieillot, 1816) | White-vented Violetear | 1 | FEB; LAFEB; LC | DG; WG | - | - | - | - | A; E; R; W |
| <i>Polytmus guainumbi</i> (Pallas, 1764) | White-tailed Goldenthrroat | 1 | FEB; LAFEB; LC | DG; WG (Aq) | - | NT | - | - | A; E; R; W |
| <i>Chlorostilbon lucidus</i> (Shaw, 1812) | Glittering-bellied Emerald | 1 | FEB; LAFEB; LC | DG; GF; WG | - | - | - | - | A; E; R; W |
| <i>Thalurania glaucopis</i> (Gmelin, 1788) | Violet-capped Woodnymph | 1 | FEB | GF | - | - | - | - | R |
| <i>Eupetomena macroura</i> (Gmelin, 1788) | Swallow-tailed Hummingbird | 1 | FEB; LAFEB; LC | DG; GF; WG | - | - | - | - | A; C; E; R; W |
| <i>Chrysuronia versicolor</i> (Vieillot, 1818) | Versicolored Emerald | 1 | FEB | GF | - | - | - | - | R |

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| Taxa | English name | List | Site | Habitat | Migration | SP | BR | IUCN | Source |
|---|-----------------------------|------|----------------|------------|-----------|----|----|------|------------|
| <i>Leucochloris albicollis</i> (Vieillot, 1818) | White-throated Hummingbird | 1 | FEB | GF | - | - | - | - | R |
| <i>Chionomesa fimbriata</i> (Gmelin, 1788) | Glittering-throated Emerald | 2 | FEB | GF | - | - | - | - | R |
| <i>Chionomesa lactea</i> (Lesson, 1832) | Sapphire-spangled Emerald | 1 | FEB; LAFEB; LC | DG; GF; WG | - | - | - | - | A; E; R |
| <i>Hylocharis chrysura</i> (Shaw, 1812) | Gilded Hummingbird | 1 | FEB; LAFEB; LC | DG; GF; WG | - | - | - | - | A; E |
| GRUIFORMES | | | | | | | | | |
| RALLIDAE | | | | | | | | | |
| <i>Porphyrio martinica</i> (Linnaeus, 1766) | Purple Gallinule | 1 | FEB | WG (Aq) | MPR | - | - | - | E |
| <i>Laterallus melanophaius</i> (Vieillot, 1819) | Rufous-sided Crake | 1 | FEB; LAFEB; LC | WG (Aq) | - | - | - | - | A; E; R |
| <i>Laterallus leucopyrrhus</i> (Vieillot, 1819) | Red-and-white Crake | 1 | FEB; LAFEB; LC | WG (Aq) | - | - | - | - | A; E; R |
| <i>Laterallus xenopterus</i> Conover, 1934 | Rufous-faced Crake | 1 | FEB | WG (Aq) | - | CR | EN | VU | A; E |
| <i>Mustelirallus albicollis</i> (Vieillot, 1819) | Ash-throated Crake | 1 | FEB; LAFEB; LC | WG (Aq) | - | - | - | - | A; E; R; W |
| <i>Pardirallus nigricans</i> (Vieillot, 1819) | Blackish Rail | 1 | FEB; LAFEB; LC | WG (Aq) | - | - | - | - | A; E; R; W |
| <i>Aramides cajaneus</i> (Statius Muller, 1776) | Gray-necked Wood-Rail | 1 | FEB | GF (Aq) | - | - | - | - | A; E; R |
| <i>Aramides saracura</i> (Spix, 1825) | Slaty-breasted Wood-Rail | 1 | FEB | GF (Aq) | - | - | - | - | A; E; R |

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| Taxa | English name | List | Site | Habitat | Migration | SP | BR | IUCN | Source |
|---|-----------------------|------|----------------|--------------|-----------|----|----|------|---------------|
| CHARADRIIFORMES | | | | | | | | | |
| CHARADRIIDAE | | | | | | | | | |
| <i>Vanellus chilensis</i> (Molina, 1782) | Southern Lapwing | 1 | FEB; LAFEB; LC | DG; Fly; WG | - | - | - | - | A; C; E; R; W |
| SCOLOPACIDAE | | | | | | | | | |
| <i>Gallinago undulata</i> (Boddaert, 1783) | Giant Snipe | 1 | FEB; LAFEB; LC | WG (Aq) | - | VU | - | - | A; E; R; W |
| JACANIDAE | | | | | | | | | |
| <i>Jacana jacana</i> (Linnaeus, 1766) | Wattled Jacana | 1 | LAFEB; LC | WG (Aq) | - | - | - | - | A; E; R; W |
| SULIFORMES | | | | | | | | | |
| PHALACROCORACIDAE | | | | | | | | | |
| <i>Nannopterum brasilianum</i> (Gmelin, 1789) | Neotropic Cormorant | 1 | FEB; LAFEB; LC | Fly; WG (Aq) | - | - | - | - | A; C; E; R; W |
| PELECANIFORMES | | | | | | | | | |
| ARDEIDAE | | | | | | | | | |
| <i>Tigrisoma lineatum</i> (Boddaert, 1783) | Rufescent Tiger-Heron | 1 | FEB; LAFEB; LC | Fly; WG (Aq) | | | | | E |
| <i>Bubulcus ibis</i> (Linnaeus, 1758) | Cattle Egret | 1 | FEB; LAFEB; LC | Fly | - | - | - | - | A; E; R |
| <i>Ardea cocoi</i> Linnaeus, 1766 | Cocoi Heron | 1 | LAFEB | Fly; WG (Aq) | - | - | - | - | R |
| <i>Ardea alba</i> Linnaeus, 1758 | Great Egret | 1 | FEB; LAFEB; LC | Fly; WG (Aq) | - | - | - | - | A; C; E; R; W |
| <i>Syrigma sibilatrix</i> (Temminck, 1824) | Whistling Heron | 1 | FEB; LAFEB; LC | Fly; WG | - | - | - | - | A; C; E; R; W |
| <i>Egretta thula</i> (Molina, 1782) | Snowy Egret | 1 | LAFEB | Fly; WG (Aq) | - | - | - | - | C; R |

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| Taxa | English name | List | Site | Habitat | Migration | SP | BR | IUCN | Source |
|--|---------------------|------|----------------|-----------------|-----------|----|----|------|---------------|
| THRESKIORNITHIDAE | | | | | | | | | |
| <i>Mesembrinibis cayennensis</i> (Gmelin, 1789) | Green Ibis | 1 | FEB; LAFEB; LC | Fly; GF (Aq) | - | - | - | - | A; C; E; R; W |
| <i>Theristicus caudatus</i> (Boddaert, 1783) | Buff-necked Ibis | 1 | FEB; LAFEB; LC | DG; Fly | - | - | - | - | A; E; R |
| CATHARTIFORMES | | | | | | | | | |
| CATHARTIDAE | | | | | | | | | |
| <i>Coragyps atratus</i> (Bechstein, 1793) | Black Vulture | 1 | FEB; LAFEB; LC | DG; Fly; GF; WG | - | - | - | - | A; C; E; R; W |
| <i>Cathartes aura</i> (Linnaeus, 1758) | Turkey Vulture | 1 | FEB | Fly | - | - | - | - | E |
| ACCIPITRIFORMES | | | | | | | | | |
| ACCIPITRIDAE | | | | | | | | | |
| <i>Elanus leucurus</i> (Vieillot, 1818) | White-tailed Kite | 1 | FEB; LAFEB; LC | DG; Fly; WG | - | - | - | - | A; E; R; W |
| <i>Leptodon cayanensis</i> (Latham, 1790) | Gray-headed Kite | 1 | FEB | Fly; GF | - | - | - | - | A; E |
| <i>Spizaetus tyrannus</i> (Wied, 1820) | Black Hawk-Eagle | 1 | FEB | Fly | - | NT | - | - | A; E |
| <i>Ictinia plumbea</i> (Gmelin, 1788) | Plumbeous Kite | 1 | FEB | Fly; GF | MPR | - | - | - | A; E; R |
| <i>Circus buffoni</i> (Gmelin, 1788) | Long-winged Harrier | 1 | FEB | DG; Fly; WG | - | VU | - | - | A; E |
| <i>Accipiter striatus</i> Vieillot, 1808 | Sharp-shinned Hawk | 1 | FEB | DG; Fly | - | - | - | - | A; E |
| <i>Geranospiza caerulescens</i> (Vieillot, 1817) | Crane Hawk | 1 | FEB | Fly | - | - | - | - | R |

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| Taxa | English name | List | Site | Habitat | Migration | SP | BR | IUCN | Source |
|---|----------------------|------|----------------|-----------------|-----------|----|----|------|---------------|
| <i>Heterospizias meridionalis</i> (Latham, 1790) | Savanna Hawk | 1 | FEB; LAFEB; LC | DG; Fly; WG | - | - | - | - | A; E; R; W |
| <i>Rupornis magnirostris</i> (Gmelin, 1788) | Roadside Hawk | 1 | FEB; LAFEB; LC | DG; Fly; GF; WG | - | - | - | - | A; E; R; W |
| <i>Geranoaetus albicaudatus</i> (Vieillot, 1816) | White-tailed Hawk | 1 | FEB; LAFEB; LC | Fly | - | - | - | - | A; E; R; W |
| <i>Buteo brachyurus</i> Vieillot, 1816 | Short-tailed Hawk | 1 | FEB; LAFEB; LC | Fly | - | - | - | - | A; E |
| STRIGIFORMES | | | | | | | | | |
| TYTONIDAE | | | | | | | | | |
| <i>Tyto furcata</i> (Temminck, 1827) | American Barn Owl | 1 | FEB; LAFEB | DG; Fly; GF; WG | - | - | - | - | A; E; R |
| STRIGIDAE | | | | | | | | | |
| <i>Megascops choliba</i> (Vieillot, 1817) | Tropical Screech-Owl | 1 | FEB | GF | - | - | - | - | A; E; R; W |
| <i>Athene cunicularia</i> (Molina, 1782) | Burrowing Owl | 1 | FEB; LAFEB; LC | DG | - | - | - | - | A; C; E; R; W |
| <i>Asio flammeus</i> (Pontoppidan, 1763) | Short-eared Owl | 1 | FEB | DG; Fly; WG | - | NT | - | - | A; E; R; W |
| CORACIIFORMES | | | | | | | | | |
| ALCEDINIDAE | | | | | | | | | |
| <i>Megaceryle torquata</i> (Linnaeus, 1766) | Ringed Kingfisher | 1 | FEB; LAFEB; LC | Fly; WG (Aq) | - | - | - | - | A; E; R; W |
| <i>Chloroceryle amazona</i> (Latham, 1790) | Amazon Kingfisher | 1 | LAFEB; LC | Fly; WG (Aq) | - | - | - | - | A; E; R |

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| Taxa | English name | List | Site | Habitat | Migration | SP | BR | IUCN | Source |
|--|--------------------------|------|----------------|-----------------|-----------|----|----|------|---------------|
| GALBULIFORMES | | | | | | | | | |
| GALBULIDAE | | | | | | | | | |
| <i>Galbula ruficauda</i> Cuvier, 1816 | Rufous-tailed Jacamar | 1 | FEB | GF (Aq) | - | - | - | - | A; E; R; W |
| BUCCONIDAE | | | | | | | | | |
| <i>Nystalus chacuru</i> (Vieillot, 1816) | White-eared Puffbird | 1 | FEB; LAFEB | DG; WG | - | - | - | - | A; E; R; W |
| PICIFORMES | | | | | | | | | |
| RAMPHASTIDAE | | | | | | | | | |
| <i>Ramphastos toco</i> Statius Muller, 1776 | Toco Toucan | 1 | FEB; LAFEB; LC | DG; Fly; GF; WG | - | - | - | - | A; C; E; R; W |
| PICIFORMES | | | | | | | | | |
| <i>Picumnus cirratus</i> Temminck, 1825 | White-barred Piculet | 1 | FEB | GF | - | - | - | - | A; C; E |
| <i>Picumnus albosquamatus</i> d'Orbigny, 1840 | White-wedged Piculet | 1 | FEB; LAFEB; LC | DG; GF; WG | - | - | - | - | A; E; R; W |
| <i>Melanerpes candidus</i> (Otto, 1796) | White Woodpecker | 1 | FEB | DG; Fly; GF | - | - | - | - | A; C; E; R; W |
| <i>Veniliornis passerinus</i> (Linnaeus, 1766) | Little Woodpecker | 1 | FEB | DG; GF | - | - | - | - | A; E; R |
| <i>Veniliornis spilogaster</i> (Wagler, 1827) | White-spotted Woodpecker | 1 | FEB | GF | - | - | - | - | A; E |
| <i>Dryocopus lineatus</i> (Linnaeus, 1766) | Lineated Woodpecker | 1 | FEB | GF | - | - | - | - | A; E |

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| Taxa | English name | List | Site | Habitat | Migration | SP | BR | IUCN | Source |
|--|---------------------------|------|----------------|-----------------|-----------|----|----|------|---------------|
| <i>Colaptes melanochloros</i> (Gmelin, 1788) | Green-barred Woodpecker | 1 | FEB; LC | GF | - | - | - | - | A; E; R |
| <i>Colaptes campestris</i> (Vieillot, 1818) | Campo Flicker | 1 | FEB; LAFEB; LC | DG; Fly; GF; WG | - | - | - | - | A; C; E; R; W |
| CARIAMIFORMES | | | | | | | | | |
| CARIAMIDAE | | | | | | | | | |
| <i>Cariama cristata</i> (Linnaeus, 1766) | Red-legged Seriema | 1 | FEB; LC | DG | - | - | - | - | A; C; E; R |
| FALCONIFORMES | | | | | | | | | |
| FALCONIDAE | | | | | | | | | |
| <i>Micrastur ruficollis</i> (Vieillot, 1817) | Barred Forest-Falcon | 3 | FEB | ? | - | - | - | - | C |
| <i>Herpetotheres cachinnans</i> (Linnaeus, 1758) | Laughing Falcon | 1 | FEB | Fly | - | - | - | - | A; E; R |
| <i>Caracara plancus</i> (Miller, 1777) | Crested Caracara | 1 | FEB; LAFEB; LC | DG; Fly; GF; WG | - | - | - | - | A; C; E; R; W |
| <i>Milvago chimachima</i> (Vieillot, 1816) | Yellow-headed Caracara | 1 | FEB; LAFEB; LC | DG; Fly; GF; WG | - | - | - | - | A; E; R; W |
| <i>Falco sparverius</i> Linnaeus, 1758 | American Kestrel | 1 | FEB; LAFEB; LC | DG; Fly | - | - | - | - | A; E; W |
| <i>Falco femoralis</i> Temminck, 1822 | Aplomado Falcon | 1 | FEB; LAFEB; LC | DG; Fly; WG | - | - | - | - | A; E; R; W |
| <i>Falco peregrinus</i> Tunstall, 1771 | Peregrine Falcon | 1 | FEB | Fly | MGT | - | - | - | A; E; R; W |
| PSITTACIFORMES | | | | | | | | | |
| PSITTACIDAE | | | | | | | | | |
| <i>Brotogeris chiriri</i> (Vieillot, 1818) | Yellow-chevroned Parakeet | 1 | FEB; LAFEB; LC | Fly; GF | - | - | - | - | A; E; R |

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| Taxa | English name | List | Site | Habitat | Migration | SP | BR | IUCN | Source |
|---|---------------------------|------|----------------|------------|-----------|----|----|------|------------|
| <i>Amazona aestiva</i> (Linnaeus, 1758) | Turquoise-fronted Parrot | 1 | FEB | Fly | - | NT | - | - | A; E; R |
| <i>Pionus maximiliani</i> (Kuhl, 1820) | Scaly-headed Parrot | 1 | FEB | Fly | - | - | - | - | A; E |
| <i>Forpus xanthopterygius</i> (Spix, 1824) | Blue-winged Parrotlet | 1 | FEB; LAFEB; LC | Fly; GF | - | - | - | - | A; E |
| <i>Psittacara leucophthalmus</i> (Statius Muller, 1776) | White-eyed Parakeet | 1 | FEB; LAFEB; LC | Fly; GF | - | - | - | - | A; C; E; R |
| PASSERIFORMES | | | | | | | | | |
| THAMNOPHILIDAE | | | | | | | | | |
| <i>Dysithamnus mentalis</i> (Temminck, 1823) | Plain Antvireo | 1 | FEB | GF | - | - | - | - | A; E |
| <i>Thamnophilus doliatus</i> (Linnaeus, 1764) | Barred Antshrike | 1 | FEB; LAFEB; LC | DG; GF; WG | - | - | - | - | A; E; R; W |
| <i>Thamnophilus ruficapillus</i> Vieillot, 1816 | Rufous-capped Antshrike | 1 | FEB; LAFEB; LC | DG; WG | - | - | - | - | A; E; R; W |
| <i>Thamnophilus caeruleus</i> Vieillot, 1816 | Variable Antshrike | 1 | FEB | GF | - | - | - | - | A; C; E; R |
| <i>Taraba major</i> (Vieillot, 1816) | Great Antshrike | 1 | FEB; LC | GF; WG | - | - | - | - | A; E; R; W |
| CONOPOPHAGIDAE | | | | | | | | | |
| <i>Conopophaga lineata</i> (Wied, 1831) | Rufous Gnateater | 1 | FEB | GF | - | - | - | - | A; E; R |
| DENDROCOLAPTIDAE | | | | | | | | | |
| <i>Lepidocolaptes angustirostris</i> (Vieillot, 1818) | Narrow-billed Woodcreeper | 1 | FEB; LAFEB; LC | DG; GF; WG | - | - | - | - | A; E; R; W |

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| Taxa | English name | List | Site | Habitat | Migration | SP | BR | IUCN | Source |
|---|----------------------------|------|----------------|------------|-----------|----|----|------|---------------|
| XENOPIIDAE | | | | | | | | | |
| <i>Xenops rutilans</i> Temminck, 1821 | Streaked Xenops | 1 | FEB | GF | - | - | - | - | A; E |
| FURNARIIDAE | | | | | | | | | |
| <i>Furnarius rufus</i> (Gmelin, 1788) | Rufous Hornero | 1 | FEB; LAFEB; LC | DG; WG | - | - | - | - | A; E; R |
| <i>Lochmias nematura</i> (Lichtenstein, 1823) | Sharp-tailed Streamcreeper | 1 | FEB | GF (Aq) | - | - | - | - | A; E; R; W |
| <i>Automolus leucophthalmus</i> (Wied, 1821) | White-eyed Foliage-gleaner | 1 | FEB | GF | - | - | - | - | A; E; R |
| <i>Phacellodomus ferrugineigula</i> (Pelzeln, 1858) | Orange-breasted Thornbird | 1 | FEB | WG (Aq) | - | - | - | - | A; E; R; W |
| <i>Cranioleuca pallida</i> (Wied, 1831) | Pallid Spinetail | 1 | FEB | GF | - | - | - | - | A; E; R; W |
| <i>Certhiaxis cinnamomeus</i> (Gmelin, 1788) | Yellow-chinned Spinetail | 1 | FEB; LAFEB; LC | WG (Aq) | - | - | - | - | A; E; R; W |
| <i>Synallaxis ruficapilla</i> Vieillot, 1819 | Spix's Spinetail | 1 | FEB; LAFEB; LC | DG; GF; WG | - | - | - | - | A; C; E; R; W |
| <i>Synallaxis spixi</i> Sclater, 1856 | Rufous-capped Spinetail | 1 | FEB | GF | - | - | - | - | R |
| <i>Synallaxis albescens</i> Temminck, 1823 | Pale-breasted Spinetail | 1 | FEB | DG | - | - | - | - | A; E; R; W |
| <i>Synallaxis frontalis</i> Pelzeln, 1859 | Sooty-fronted Spinetail | 1 | FEB | GF; WG | - | - | - | - | A; E |
| PIPRIDAE | | | | | | | | | |
| <i>Chiroxiphia caudata</i> (Shaw & Nodder, 1793) | Swallow-tailed Manakin | 1 | FEB | GF | - | - | - | - | A; E |
| <i>Antilophia galeata</i> (Lichtenstein, 1823)* | Helmeted Manakin | 1 | FEB | GF | - | - | - | - | A; C; E; R; W |

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|---|-------------------------------|------|----------------|------------|-----------|----|----|------|---------------|
| TITYRIDAE | | | | | | | | | |
| <i>Tityra cayana</i> (Linnaeus, 1766) | Black-tailed Tityra | 1 | FEB | DG; GF | - | - | - | - | R |
| <i>Pachyrhamphus polychopterus</i> (Vieillot, 1818) | White-winged Becard | 1 | FEB | GF | MPR | - | - | - | A; E |
| PLATYRINCHIDAE | | | | | | | | | |
| <i>Platyrinchus mystaceus</i> Vieillot, 1818 | White-throated Spadebill | 1 | FEB | GF | - | - | - | - | A; E; R |
| RHYNCHOCYCLIDAE | | | | | | | | | |
| <i>Leptopogon amaurocephalus</i> Tschudi, 1846 | Sepia-capped Flycatcher | 1 | FEB | GF | - | - | - | - | A; E |
| <i>Corythopis delalandi</i> (Lesson, 1830) | Southern Antpipit | 1 | FEB | ? | - | - | - | - | A; E |
| <i>Tolmomyias sulphurescens</i> (Spix, 1825) | Yellow-olive Flycatcher | 1 | FEB | GF | - | - | - | - | A; C; E; R |
| <i>Todirostrum poliocephalum</i> (Wied, 1831) | Gray-headed Tody-Flycatcher | 1 | FEB | GF | - | - | - | - | A; C; E; R |
| <i>Todirostrum cinereum</i> (Linnaeus, 1766) | Common Tody-Flycatcher | 1 | FEB; LC | DG; GF; WG | - | - | - | - | A; C; E; R; W |
| TYRANNIDAE | | | | | | | | | |
| <i>Hirundinea ferruginea</i> (Gmelin, 1788) | Cliff Flycatcher | 1 | FEB | DG | - | - | - | - | R |
| <i>Euscarthmus meloryphus</i> Wied, 1831 | Tawny-crowned Pygmy-Tyrant | 1 | LC | DG; WG | - | - | - | - | A; E |
| <i>Camptostoma obsoletum</i> (Temminck, 1824) | Southern Beardless-Tyrannulet | 1 | FEB; LAFEB; LC | DG; GF; WG | - | - | - | - | A; C; E; R; W |
| <i>Elaenia flavogaster</i> (Thunberg, 1822) | Yellow-bellied Elaenia | 1 | FEB; LAFEB; LC | DG; GF; WG | - | - | - | - | A; E; R; W |

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| Taxa | English name | List | Site | Habitat | Migration | SP | BR | IUCN | Source |
|---|--------------------------|------|----------------|------------|-----------|----|----|------|---------------|
| <i>Elaenia parvirostris</i> Pelzeln, 1868 | Small-billed Elaenia | 1 | FEB | GF | - | - | - | - | R |
| <i>Elaenia mesoleuca</i> (Deppe, 1830) | Olivaceous Elaenia | 1 | FEB | GF | - | - | - | - | A; E; R |
| <i>Elaenia chiriquensis</i> Lawrence, 1865 | Lesser Elaenia | 1 | FEB; LAFEB | DG; WG | MPR | - | - | - | A; E; R; W |
| <i>Elaenia cristata</i> Pelzeln, 1868 | Plain-crested Elaenia | 1 | FEB | DG | - | - | - | - | A; E; R; W |
| <i>Elaenia obscura</i> (d'Orbigny & Lafresnaye, 1837) | Small-headed Elaenia | 1 | FEB; LAFEB; LC | DG; GF; WG | - | - | - | - | A; E; R; W |
| <i>Myiopagis caniceps</i> (Swainson, 1835) | Gray Elaenia | 2 | FEB | ? | - | - | - | - | C |
| <i>Phaeomyias murina</i> (Spix, 1825) | Mouse-colored Tyrannulet | 1 | FEB | DG; GF; WG | ND | - | - | - | A; E |
| <i>Culicivora caudacuta</i> (Vieillot, 1818) | Sharp-tailed Tyrant | 1 | FEB; LAFEB | DG; WG | - | CR | - | - | A; E; R; W |
| <i>Serpophaga subcristata</i> (Vieillot, 1817) | White-crested Tyrannulet | 1 | FEB; LAFEB; LC | DG; WG | - | - | - | - | A; E; R; W |
| <i>Myiarchus swainsoni</i> Cabanis & Heine, 1859 | Swainson's Flycatcher | 1 | FEB | GF | MPR | - | - | - | A; E; R; W |
| <i>Myiarchus ferox</i> (Gmelin, 1789) | Short-crested Flycatcher | 1 | FEB; LAFEB; LC | DG; GF; WG | - | - | - | - | A; E; R |
| <i>Myiarchus tyrannulus</i> (Statius Muller, 1776) | Brown-crested Flycatcher | 1 | FEB; LAFEB; LC | DG; GF; WG | - | - | - | - | A; E; R; W |
| <i>Pitangus sulphuratus</i> (Linnaeus, 1766) | Great Kiskadee | 1 | FEB; LAFEB; LC | DG; GF; WG | MPR | - | - | - | A; C; E; R; W |
| <i>Machetornis rixosa</i> (Vieillot, 1819) | Cattle Tyrant | 1 | FEB; LAFEB; LC | DG; WG | - | - | - | - | A; E; R; W |
| <i>Myiodynastes maculatus</i> (Statius Muller, 1776) | Streaked Flycatcher | 1 | FEB | GF | MPR | - | - | - | A; E; R |

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|--|---------------------------------|-------------|----------------|----------------|------------------|-----------|-----------|-------------|---------------|
| <i>Megarynchus pitangua</i> (Linnaeus, 1766) | Boat-billed Flycatcher | 1 | FEB; LC | GF | - | - | - | - | A; E; R |
| <i>Myiozetetes similis</i> (Spix, 1825) | Social Flycatcher | 1 | FEB; LC | GF | - | - | - | - | A; E; R |
| <i>Tyrannus savana</i> Daudin, 1802 | Southern Fork-tailed Flycatcher | 1 | FEB; LAFEB; LC | DG; WG | MPR | - | - | - | A; E; R; W |
| <i>Tyrannus melancholicus</i> Vieillot, 1819 | Tropical Kingbird | 1 | FEB; LAFEB; LC | DG; GF; WG | MPR | - | - | - | A; E; R; W |
| <i>Empidonomus varius</i> (Vieillot, 1818) | Variegated Flycatcher | 1 | FEB | GF | MPR | - | - | - | A; E; R; W |
| <i>Colonia colonus</i> (Vieillot, 1818) | Long-tailed Tyrant | 1 | FEB | GF | - | - | - | - | A; E; R |
| <i>Arundinicola leucocephala</i> (Linnaeus, 1764) | White-headed Marsh Tyrant | 1 | FEB; LC | WG | - | - | - | - | E |
| <i>Fluvicola nengeta</i> (Linnaeus, 1766) | Masked Water-Tyrant | 1 | FEB; LAFEB; LC | WG (Aq) | - | - | - | - | A; E; R |
| <i>Pyrocephalus rubinus</i> (Boddaert, 1783) | Vermilion Flycatcher | 1 | FEB | DG; WG | MPR | - | - | - | A; E; R |
| <i>Gubernetes yetapa</i> (Vieillot, 1818) | Streamer-tailed Tyrant | 1 | FEB; LAFEB; LC | DG; WG (Aq) | - | - | - | - | A; C; E; R; W |
| <i>Myiophobus fasciatus</i> (Statius Muller, 1776) | Bran-colored Flycatcher | 1 | FEB; LAFEB; LC | GF; WG | MPR | - | - | - | A; C; E; R; W |
| <i>Cnemotriccus fuscatus</i> (Wied, 1831) | Fuscous Flycatcher | 1 | FEB | GF | - | - | - | - | A; E |
| <i>Lathrotriccus euleri</i> (Cabanis, 1868) | Euler's Flycatcher | 1 | FEB | GF | - | - | - | - | A; E; R |
| <i>Satrapa icterophrys</i> (Vieillot, 1818) | Yellow-browed Tyrant | 1 | FEB | DG; WG | - | - | - | - | A; E; R; W |
| <i>Knipolegus lophotes</i> Boie, 1828 | Crested Black-Tyrant | 1 | FEB | DG | - | - | - | - | A; E |

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| Taxa | English name | List | Site | Habitat | Migration | SP | BR | IUCN | Source |
|---|-------------------------------|------|----------------|-------------|-----------|----|----|------|---------------|
| <i>Xolmis velatus</i> (Lichtenstein, 1823) | White-rumped Monjita | 1 | FEB; LAFEB; LC | DG; WG | - | - | - | - | A; E; R; W |
| <i>Nengetus cinereus</i> (Vieillot, 1816) | Gray Monjita | 1 | FEB; LAFEB; LC | DG; WG | - | - | - | - | A; C; E; R; W |
| VIREONIDAE | | | | | | | | | |
| <i>Cyclarhis gujanensis</i> (Gmelin, 1789) | Rufous-browed Peppershrike | 1 | FEB | GF | - | - | - | - | A; E; R |
| <i>Vireo chivi</i> (Vieillot, 1817) | Chivi Vireo | 1 | FEB | GF | MPR | - | - | - | A; E; R |
| CORVIDAE | | | | | | | | | |
| <i>Cyanocorax cristatellus</i> (Temminck, 1823)* | Curl-crested Jay | 1 | FEB | DG; Fly | - | - | - | - | A; E |
| <i>Cyanocorax chrysops</i> (Vieillot, 1818) | Plush-crested Jay | 1 | FEB; LC | GF | - | - | - | - | A; E; R |
| HIRUNDINIDAE | | | | | | | | | |
| <i>Pygochelidon cyanoleuca</i> (Vieillot, 1817) | Blue-and-white Swallow | 1 | FEB; LAFEB; LC | DG; Fly; WG | - | - | - | - | A; C; E; R; W |
| <i>Alopochelidon fucata</i> (Temminck, 1822) | Tawny-headed Swallow | 1 | FEB | DG; Fly; WG | - | - | - | - | A; E |
| <i>Stelgidopteryx ruficollis</i> (Vieillot, 1817) | Southern Rough-winged Swallow | 1 | FEB; LAFEB; LC | DG; Fly; WG | MPR | - | - | - | A; E; R; W |
| <i>Progne tapera</i> (Linnaeus, 1766) | Brown-chested Martin | 1 | FEB; LAFEB; LC | DG; Fly; WG | MPR | - | - | - | A; E; R; W |
| <i>Progne chalybea</i> (Gmelin, 1789) | Gray-breasted Martin | 1 | FEB; LAFEB; LC | DG; Fly; WG | MPR | - | - | - | A; E; R |
| <i>Tachycineta leucorrhoa</i> (Vieillot, 1817) | White-rumped Swallow | 1 | FEB; LAFEB; LC | DG; Fly; WG | - | - | - | - | A; E; R; W |

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|---|--------------------------|------|----------------|------------|-----------|----|----|------|---------------|
| TROGLODYTIDAE | | | | | | | | | |
| <i>Troglodytes musculus</i> Naumann, 1823 | Southern House Wren | 1 | FEB; LAFEB; LC | DG; WG | - | - | - | - | A; E; R; W |
| TURDIDAE | | | | | | | | | |
| <i>Turdus leucomelas</i> Vieillot, 1818 | Pale-breasted Thrush | 1 | FEB; LC | GF | - | - | - | - | A; C; E; R; W |
| <i>Turdus rufiventris</i> Vieillot, 1818 | Rufous-bellied Thrush | 1 | FEB; LAFEB; LC | DG; GF; WG | - | - | - | - | A; E; R |
| <i>Turdus amaurochalinus</i> Cabanis, 1850 | Creamy-bellied Thrush | 1 | FEB; LAFEB; LC | GF | MPR | - | - | - | A; C; E; R; W |
| MIMIDAE | | | | | | | | | |
| <i>Mimus saturninus</i> (Lichtenstein, 1823) | Chalk-browed Mockingbird | 1 | FEB; LAFEB; LC | DG; WG | - | - | - | - | A; C; E; R; W |
| PASSERIDAE | | | | | | | | | |
| <i>Passer domesticus</i> (Linnaeus, 1758) | House Sparrow | 1 | FEB; LAFEB | DG; WG | - | - | - | - | A; C; E; R |
| MOTACILLIDAE | | | | | | | | | |
| <i>Anthus chii</i> Vieillot, 1818 | Yellowish Pipit | 1 | LAFEB | DG; WG | - | - | - | - | A; E; R |
| FRINGILLIDAE | | | | | | | | | |
| <i>Spinus magellanicus</i> (Vieillot, 1805) | Hooded Siskin | 1 | FEB; LAFEB; LC | DG; GF; WG | - | - | - | - | A; E; R; W |
| <i>Euphonia chlorotica</i> (Linnaeus, 1766) | Purple-throated Euphonia | 1 | FEB | GF | - | - | - | - | A; C; E; R |
| <i>Euphonia violacea</i> (Linnaeus, 1758) | Violaceous Euphonia | 1 | FEB | GF | - | - | - | - | A; E; R |

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| Taxa | English name | List | Site | Habitat | Migration | SP | BR | IUCN | Source |
|--|---------------------------|------|----------------|------------------|-----------|----|----|------|---------------|
| PASSERELLIDAE | | | | | | | | | |
| <i>Ammodramus humeralis</i> (Bosc, 1792) | Grassland Sparrow | 1 | FEB; LAFEB; LC | DG; WG | - | - | - | - | A; C; E; R; W |
| <i>Zonotrichia capensis</i> (Statius Muller, 1776) | Rufous-collared Sparrow | 1 | FEB; LAFEB; LC | DG; WG | - | - | - | - | A; C; E; R; W |
| ICTERIDAE | | | | | | | | | |
| <i>Leistes superciliaris</i> (Bonaparte, 1850) | White-browed Meadowlark | 1 | FEB | DG; WG | - | - | - | - | A; C; E |
| <i>Psarocolius decumanus</i> (Pallas, 1769) | Crested Oropendola | 1 | FEB | Fly | - | - | - | - | R; W |
| <i>Icterus pyrrhopterus</i> (Vieillot, 1819) | Variable Oriole | 1 | FEB | GF | - | - | - | - | A; C; E; R |
| <i>Molothrus rufoaxillaris</i> Cassin, 1866 | Screaming Cowbird | 1 | FEB; LAFEB; LC | DG; WG | - | - | - | - | A; E; W |
| <i>Molothrus bonariensis</i> (Gmelin, 1789) | Shiny Cowbird | 1 | FEB; LAFEB; LC | DG; WG | - | - | - | - | A; C; E; R |
| <i>Agelasticus atroolivaceus</i> (Wied-Neuwied, 1831) | Unicolored Blackbird | 1 | FEB | WG (Aq) | - | - | - | - | A; E |
| <i>Chrysomus ruficapillus</i> (Vieillot, 1819) | Chestnut-capped Blackbird | 1 | FEB; LAFEB; LC | WG | - | - | - | - | A; E; R; W |
| <i>Pseudoleistes guirahuro</i> (Vieillot, 1819) | Yellow-rumped Marshbird | 1 | FEB; LAFEB; LC | DG; Fly; WG (Aq) | - | - | - | - | A; C; E; R; W |
| PARULIDAE | | | | | | | | | |
| <i>Geothlypis aequinoctialis</i> (Gmelin, 1789) | Masked Yellowthroat | 1 | FEB; LAFEB; LC | DG; GF; WG | - | - | - | - | A; C; E; R; W |
| <i>Setophaga pitayumi</i> (Vieillot, 1817) | Tropical Parula | 1 | FEB; LC | GF | - | - | - | - | A; C; E; R; W |
| <i>Myiothlypis flaveola</i> Baird, 1865 | Flavescent Warbler | 1 | FEB | GF | - | - | - | - | A; E; R |

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| <i>Myiothlypis leucoblephara</i> (Vieillot, 1817) | White-browed Warbler | 1 | FEB | GF | - | - | - | - | A; E; R; W |
| <i>Basileuterus culicivorus</i> (Deppe, 1830) | Golden-crowned Warbler | 1 | FEB | GF | - | - | - | - | A; C; E; R |
| CARDINALIDAE | | | | | | | | | |
| <i>Habia rubica</i> (Vieillot, 1817) | Red-crowned Ant-Tanager | 1 | FEB | GF | - | - | - | - | C; R |
| <i>Cyanoloxia glaucocaerulea</i> (d'Orbigny & Lafresnaye, 1837) | Glaucous-blue Grosbeak | 1 | FEB | DG; WG | MPR | - | - | - | A; E; R |
| <i>Cyanoloxia brissonii</i> (Lichtenstein, 1823) | Ultramarine Grosbeak | 1 | FEB | GF | - | - | - | - | R |
| THRAUPIDAE | | | | | | | | | |
| <i>Nemosia pileata</i> (Boddaert, 1783) | Hooded Tanager | 1 | FEB | GF | - | - | - | - | A; E; R |
| <i>Emberizoides herbicola</i> (Vieillot, 1817) | Wedge-tailed Grass-Finch | 1 | FEB; LAFEB; LC | DG; WG | - | - | - | - | A; E; R; W |
| <i>Emberizoides ypiranganus</i> Ihering & Ihering, 1907 | Lesser Grass-Finch | 2 | FEB | WG | - | VU | - | - | R |
| <i>Tersina viridis</i> (Illiger, 1811) | Swallow Tanager | 1 | FEB | GF | MPR | - | - | - | A; E |
| <i>Dacnis cayana</i> (Linnaeus, 1766) | Blue Dacnis | 1 | FEB | GF | - | - | - | - | A; E; R |
| <i>Saltatricula atricollis</i> (Vieillot, 1817)* | Black-throated Saltator | 1 | FEB; LAFEB | DG; WG | - | - | - | - | A; E; R; W |
| <i>Saltator similis</i> d'Orbigny & Lafresnaye, 1837 | Green-winged Saltator | 1 | FEB | GF | - | - | - | - | R |
| <i>Coereba flaveola</i> (Linnaeus, 1758) | Bananaquit | 1 | FEB | GF | - | - | - | - | A; C; E; R; W |
| <i>Volatinia jacarina</i> (Linnaeus, 1766) | Blue-black Grassquit | 1 | FEB; LAFEB; LC | DG; WG | - | - | - | - | A; C; E; R; W |

to be continued
continua

continuation – Appendix 3

continuação – Apêndice 3

| Taxa | English name | List | Site | Habitat | Migration | SP | BR | IUCN | Source |
|---|---------------------------|------|----------------|-------------|-----------|----|----|------|---------------|
| <i>Coryphospingus cucullatus</i> (Statius Muller, 1776) | Red-crested Finch | 1 | FEB; LAFEB; LC | DG; WG | - | - | - | - | A; E; R; W |
| <i>Tachyphonus rufus</i> (Boddaert, 1783) | White-lined Tanager | 1 | LC | DG; WG | - | NT | - | - | A; E |
| <i>Tachyphonus coronatus</i> (Vieillot, 1822) | Ruby-crowned Tanager | 1 | FEB | GF | - | - | - | - | A; E; R |
| <i>Ramphocelus carbo</i> (Pallas, 1764) | Silver-beaked Tanager | 1 | FEB | GF | - | - | - | - | A; E; R |
| <i>Sporophila lineola</i> (Linnaeus, 1758) | Lined Seedeater | 1 | FEB; LAFEB; LC | DG; WG | MPR | - | - | - | A; C; E; R |
| <i>Sporophila plumbea</i> (Wied, 1830) | Plumbeous Seedeater | 1 | FEB; LAFEB; LC | DG; WG | - | VU | - | - | A; E; R; W |
| <i>Sporophila beltoni</i> Repenning & Fontana, 2013 | Tropeiro Seedeater | 1 | FEB | DG; WG | MGT | CR | VU | VU | A; E; R; W |
| <i>Sporophila collaris</i> (Boddaert, 1783) | Rusty-collared Seedeater | 1 | FEB | WG (Aq) | - | - | - | - | A; E |
| <i>Sporophila caerulescens</i> (Vieillot, 1823) | Double-collared Seedeater | 1 | FEB; LAFEB; LC | DG; WG | MPR | - | - | - | A; C; E; R; W |
| <i>Sporophila leucoptera</i> (Vieillot, 1817) | White-bellied Seedeater | 1 | FEB; LAFEB; LC | DG; WG (Aq) | - | - | - | - | A; E; R; W |
| <i>Sporophila bouvreuil</i> (Statius Muller, 1776) | Copper Seedeater | 1 | FEB | DG; WG | MPR | VU | - | - | A; E |
| <i>Sporophila pileata</i> (Sclater, 1865) | Pearly-bellied Seedeater | 1 | FEB; LAFEB; LC | DG; WG | - | EN | - | - | A; E; R; W |
| <i>Sporophila hypoxantha</i> Cabanis, 1851 | Tawny-bellied Seedeater | 1 | FEB | WG | MPR | CR | VU | - | A; E; R; W |
| <i>Sporophila cinnamomea</i> (Lafresnaye, 1839) | Chestnut Seedeater | 1 | FEB | WG | MGT | CR | - | VU | A; E |
| <i>Sporophila melanogaster</i> (Pelzeln, 1870) | Black-bellied Seedeater | 1 | FEB | WG | MGT | CR | VU | NT | E |

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ANTONELLI, V.R. Birds from a minute Cerrado in southeastern Brazil

continuation – Appendix 3

continuação – Apêndice 3

| Taxa | English name | List | Site | Habitat | Migration | SP | BR | IUCN | Source |
|--|-----------------------------|------|----------------|-------------|-----------|----|----|------|---------------|
| <i>Sporophila angolensis</i> (Linnaeus, 1766) | Chestnut-bellied Seed-Finch | 1 | FEB; LAFEB; LC | GF; WG | - | - | - | - | A; E |
| <i>Thlypopsis sordida</i> (d'Orbigny & Lafresnaye, 1837) | Orange-headed Tanager | 1 | FEB | GF | - | - | - | - | A; E; R |
| <i>Cypsnagra hirundinacea</i> (Lesson, 1831) | White-rumped Tanager | 1 | FEB; LAFEB | DG; WG | - | EN | - | - | A; E; R; W |
| <i>Donacospiza albifrons</i> (Vieillot, 1817) | Long-tailed Reed Finch | 1 | FEB; LAFEB | DG; WG (Aq) | - | VU | - | - | A; E; R; W |
| <i>Sicalis citrina</i> Pelzeln, 1870 | Stripe-tailed Yellow-Finch | 1 | LC | DG; WG | | | | | E |
| <i>Sicalis flaveola</i> (Linnaeus, 1766) | Saffron Finch | 1 | FEB; LAFEB; LC | DG; WG | - | - | - | - | A; E; R; W |
| <i>Sicalis luteola</i> (Sparrman, 1789) | Grassland Yellow-Finch | 1 | FEB; LAFEB; LC | DG; WG | - | - | - | - | A; E; R; W |
| <i>Pipraeidea melanonota</i> (Vieillot, 1819) | Fawn-breasted Tanager | 1 | FEB | GF | - | - | - | - | A; E; R; W |
| <i>Rauenia bonariensis</i> (Gmelin, 1789) | Blue-and-yellow Tanager | 1 | FEB | GF | - | - | - | - | A; E; R; W |
| <i>Schistochlamys melanopis</i> (Latham, 1790) | Black-faced Tanager | 1 | FEB; LAFEB; LC | DG; WG | - | - | - | - | A; E; R; W |
| <i>Schistochlamys ruficapillus</i> (Vieillot, 1817) | Cinnamon Tanager | 1 | FEB; LAFEB; LC | DG; GF; WG | - | - | - | - | A; E; R; W |
| <i>Thraupis sayaca</i> (Linnaeus, 1766) | Sayaca Tanager | 1 | FEB; LAFEB; LC | DG; GF; WG | - | - | - | - | A; C; E; R; W |
| <i>Thraupis palmarum</i> (Wied, 1821) | Palm Tanager | 1 | FEB | GF | - | - | - | - | A; E; R |
| <i>Stilpnia cayana</i> (Linnaeus, 1766) | Burnished-buff Tanager | 1 | FEB; LAFEB; LC | DG; GF; WG | - | - | - | - | A; E; R; W |

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Appendix 4. Results of Bayesian Logistic Regression for 15 Cerrado remnants in São Paulo state, southeastern Brazil.

Apêndice 4. Resultados de regressão logística bayesiana para 15 remanescentes de Cerrado em São Paulo, sudeste do Brasil.

Table S1. Coefficients representing the log-odds show the estimated effect of each level of the factor (Cerrado remnants) on the response variable (species presence), compared to the reference category (Botucatu State Forest). Estimates represent the effect size of the corresponding Cerrado on the likelihood of species presence. A positive estimate indicates a higher likelihood of presence compared to the reference category. The standard error of the estimate represents the variability or uncertainty in the estimate. The z-value is test statistic used to assess the significance of each coefficient. The p-value indicates the significance of each coefficient. A small p-value (< 0.05) suggests that the effect of the Cerrado is statistically significant in predicting presence or absence.

Tabela S1. Coeficientes representando as probabilidades de log mostram o efeito estimado de cada nível do fator (remanescentes de Cerrado) na variável de resposta (presença de espécies), em comparação com a categoria de referência (Floresta Estadual de Botucatu). As estimativas representam o tamanho do efeito do Cerrado correspondente na probabilidade de presença de espécies. Uma estimativa positiva indica uma maior probabilidade de presença em comparação com a categoria de referência. O erro padrão da estimativa representa a variabilidade ou incerteza na estimativa. O valor z é uma estatística de teste usada para avaliar a significância de cada coeficiente. O valor p indica a significância de cada coeficiente. Um pequeno valor p (< 0,05) sugere que o efeito do Cerrado é estatisticamente significativo na previsão da presença ou ausência.

| | Estimate | Standard Error | z | p |
|-----------|-----------------|-----------------------|----------|----------|
| Intercept | 0.5 | 0.2 | 1.7 | 0.081 |
| Angatuba | -1.8 | 0.4 | -4.7 | 0.000 |
| Assis | -1.3 | 0.4 | -3.6 | 0.000 |
| Avaré | -1.7 | 0.4 | -4.6 | 0.000 |
| Furnas | -0.1 | 0.3 | -0.2 | 0.866 |
| Itapeva | -1.3 | 0.4 | -3.8 | 0.000 |

| | Estimate | Standard Error | z | p |
|----------------|-----------------|-----------------------|----------|----------|
| Itirapina | 1.5 | 0.4 | 3.6 | 0.000 |
| Jataí | -0.3 | 0.3 | -1.0 | 0.317 |
| Mogi | -0.5 | 0.3 | -1.5 | 0.133 |
| Paranapanema | -1.2 | 0.3 | -3.5 | 0.000 |
| Pé-de-gigante | -1.2 | 0.3 | -3.5 | 0.000 |
| Porto Ferreira | -1.8 | 0.4 | -4.7 | 0.000 |
| Santa Bárbara | 0.3 | 0.3 | 0.9 | 0.390 |
| Santa Maria | -1.0 | 0.3 | -3.0 | 0.003 |
| São Carlos | -1.3 | 0.4 | -3.8 | 0.000 |

Table S2. Fits of a logistic regression of a Bayesian generalized linear model which predicts species presence based on a categorical (Cerrado remnant) and continuous (remnant size) variables. The median of the posterior distribution is given. The median absolute deviation (MAD) is a robust measure of variability, providing an estimate of uncertainty around the median.

Tabela S2. Ajustes de uma regressão logística de um modelo linear generalizado bayesiano que prevê a presença de espécies com base em variáveis categóricas (remanescente de Cerrado) e contínuas (tamanho do remanescente). A mediana da distribuição posterior é dada. O desvio absoluto mediano (MAD) é uma medida robusta de variabilidade, fornecendo uma estimativa de incerteza em torno da mediana.

| | Median | MAD |
|----------------|---------------|------------|
| Intercept | 0.4 | 0.2 |
| Angatuba | -1.6 | 1.1 |
| Assis | -1.1 | 1.3 |
| Avaré | -1.6 | 0.6 |
| Furnas | 0.2 | 1.6 |
| Itapeva | -1.3 | 0.4 |
| Itirapina | 1.9 | 1.7 |
| Jataí | 0.8 | 6.8 |
| Mogi | -0.4 | 0.8 |
| Paranapanema | -1.1 | 0.6 |
| Pé-de-gigante | -1.1 | 1.0 |
| Porto Ferreira | -1.7 | 0.6 |
| Santa Bárbara | 0.6 | 2.1 |
| Santa Maria | -0.9 | 1.0 |
| São Carlos | -1.3 | 0.4 |
| Remnant size | 0.0 | 0.0 |

Appendix 5. Noteworthy records.

Apêndice 5. Registros notáveis.

In this section, we present detailed information on the most relevant species observed during the study, regarding conservation status from the state level (São Paulo 2018), unless indicated for national and/or global levels. Data obtained within the FEB is presented in the last paragraph of each species.

Rufous-faced Crake *Laterallus xenopterus* - CR; EN (Brasil 2022); VU (IUCN 2024). One of the most poorly known rails. Secretive, mostly heard than seen and reliably known from a few

scattered localities, although a more widespread distribution for the species is speculated. It has allopatric populations in both Paraguay and Bolivia, and is restricted to five Brazilian states, including Goiás, São Paulo, Minas Gerais, Mato Grosso do Sul and Tocantins (Taylor et al. 2020). It inhabits flooded marshes and grasslands, such as wet grasslands, formed in low areas of Paraguay (Clay et al. 1998), and flooding grasslands with tall grasses, surrounded by gallery forest and Cerrado (Sick 1979, Myers and Hansen 1980). A dead individual reported close to a railway in Itirapina Ecological Station suggests hidden populations inside this conservation unit, a suggestion later confirmed (Willis and Oniki 2004; Motta-Junior et al. 2020). Notwithstanding, Vasconcelos et al. (2008) suggest some unknown records of *Laterallus* spp. of the same region belong to the Rufous-faced Crake, recommending censuses use the playback technique to search for the species.

The rail was only seen once in T4 on 16 August 2019, 09:00 h, in response to playback. When startled it flew just above the grass and landed nearby in dense grass, showing its characteristic black tail and undertail-coverts. Further interactions were through spontaneous vocalization and playback, some recorded (Figure S2). It responds to vocalizations of the Red-and-white Crake, one of several syntopic rails. Restricted to wet grassland and only reported from a single location in Botucatu, an extra effort was spent without success to find more individuals in other areas after its discovery. Possibly the only pair disappeared after a criminal fire in August 2019 that eliminated most grass cover. The pair was last recorded in 2021 in its former habitat. Its rapid recovery and recolonization support the fire-resistance nature described for the rail, as observed in Cristalina, state of Goiás, central Brazil (Clay et al. 1998, De Castro et al. 2014).

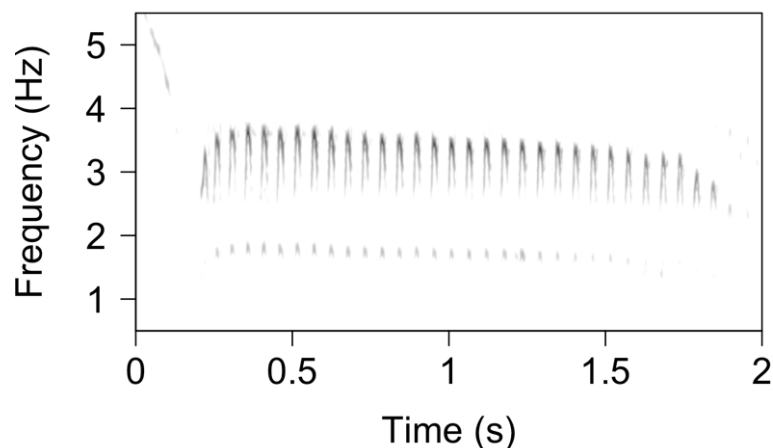


Figure S2. Natural song of one visualized individual of the Rufous-faced Crake recorded by Victor Antonelli on 16 August 2019.

Figura S2. Canto espontâneo de um indivíduo visualizado de sanã-de-cara-ruiva gravado por Victor Antonelli em 16 de agosto de 2019.

Giant Snipe *Gallinago undulata* - VU. The Giant Snipe is found in northernmost South America but is more commonly found in the central-south and avoids the Amazon and semi-arid regions of Brazil. This crepuscular and nocturnal insectivore can be common in flooded tall grasslands and is occasionally seen roosting in dry savannah. The snipe is widespread, but with a spotty distribution. Found up to 2000 m, its local and migratory movement patterns are unknown. Most threatened by hunting, they are easy targets in comparison with other snipes because they are large. This snipe is relatively poorly known and infrequently observed, and difficult to follow, and is more often heard than seen. It apparently flies at the beginning of the day, at twilight or when accidentally flushed (Van Gils et al. 2020). The Giant Snipe breeds in the study area. A nest of two eggs was found in wet grassland near the gallery forest on 16 February 2020 (Figure S3). The eggs were laid in sunken grass. The area was revisited ten days later, and the eggs remained unhatched. Additional natural history information requires additional study, including nocturnal observations, for this poorly known species.



Figure S3. Giant snipe nest with two eggs photographed at the Botucatu State Forest, southeastern Brazil, on 16 February 2020 by Lorena Patrício Silva.

Figura S3. Ninho de narcejão com dois ovos fotografado na Floresta Estadual de Botucatu, sudeste do Brasil, em 16 de fevereiro de 2020 por Lorena Patrício Silva.

Long-winged Harrier *Circus buffoni* - VU. The harrier is a large raptor common in South America but avoids forested areas of the Amazon and semi-arid Caatinga of Brazil. This species is abundant in natural and semi-natural and agricultural grasslands, often near moderately wet areas. Southernmost populations seem to be migratory and although more frequent in southern Brazil, its distribution is not well-defined and may breed in appropriate habitat year-round. It may cross the Andes, observed at up to 2000 m, but it is usually found in lowlands below 690 m. Mostly threatened by wetland conversion (Bierregaard and Kirwan 2020). The harrier is thought to be migratory because it can be absent for long periods, with most observations between December-February and June-August. As with most harriers, it is mostly seen flying above wet, dry and agricultural grasslands, including those near the LAFEB.

Sharp-tailed Tyrant *Culicivora caudacuta* - CR. Mostly found in central Brazil, including nearby Bolivia, Paraguay, and Argentina, typically in central Cerrado grasslands. In Brazil, recently reported in Tocantins, Humaitá fields, in central Amazonia, Bahia, and central Minas Gerais (Moura et al. 2011). Favors mature natural fields with shrubby vegetation lower than 1 m and unburned for at least a year (Tubelis and Cavalcanti 2001; Kanegae et al. 2012), occasionally syntopic with the Cock-tailed Tyrant *Alectrurus tricolor*. Gregarious, lives in groups of up to 10 individuals, with territory size up to 17 ha (Sousa and Marini 2007). In situ population is around 9.6 individuals km⁻², similar to continuous Cerrado patches (Kanegae et al. 2012). Land conversion to soy monoculture and *Eucalyptus sp.* has been severely impacting its habitat and distribution. Resident, the Sharp-tailed Tyrant is easily spotted and responds quite well to playback (Figure S4a). Often near roads. Typically observed as pairs, less often with additional individuals that are likely to be recently fledged young. It is somewhat resistant to fire and was found soon after five fires. Two adults were observed together twice, in October and November 2022 (S. M. Nishida pers. obs.). More recently, only one adult was observed, which highlights the urgency for banding, and perhaps for translocation projects, given its current exclusiveness to the region and threat status.



Figure S4. Bird records from Botucatu State Forest, southeastern Brazil. (a) An adult Sharp-tailed Tyrant photographed by Victor Antonelli on 19 March 2020. (b) A male Copper Seedeater photographed by Miriam Akiti Rodrigues on 31 March 2024. (c) A male Plumbeous Seedeater photographed by Bruno Oliani de Risso on 10 February 2019. (d) A young male Tropeiro Seedeater photographed by Victor Antonelli on 29 February 2020. (e) A male Pearly-bellied Seedeater photographed by Victor Antonelli on 27 December 2018. (f) A young male Pearly-bellied Seedeater photographed by Victor Antonelli on 20 February 2020. (g) An adult White-rumped Tanager photographed by Victor Antonelli on 19 February 2020. (h) A juvenile of White-rumped Tanager photographed by Victor Antonelli on 8 July 2019.

Figura S4. Registros de aves da Floresta Estadual de Botucatu, sudeste do Brasil. (a) Um adulto de papamoscas-do-campo fotografado por Victor Antonelli em 19 de março de 2020. (b) Um macho de caboclinho fotografado por Miriam Akiti Rodrigues em 31 de março de 2024. (c) Um macho de patativa fotografado por Bruno Oliani de Risso em 10 de fevereiro de 2019. (d) Um macho jovem de patativa-tropeira fotografado por Victor Antonelli em 29 de fevereiro de 2020. (e) Um macho de caboclinho-coroado fotografado por Victor Antonelli em 27 de dezembro de 2018. (f) Um macho jovem de caboclinho-coroado fotografado por Victor Antonelli em 20 de fevereiro de 2020. (g) Um indivíduo adulto de bandoleta fotografado por Victor Antonelli em 19 de fevereiro de 2020. (h) Um indivíduo jovem de bandoleta fotografado por Victor Antonelli em 8 de julho de 2019.

Plumbeous Seedeater *Sporophila plumbea* - VU. This seedeater avoids densely forested and semi-arid regions, although it can be found in Amazonian Brazil. Often found near water along other *Sporophila* species, preferring grassy areas. At least in some parts of its range is migratory, recorded in the north only during austral winters. Although fairly common, it is threatened by habitat loss, especially in Cerrado grasslands remnants, disappearing from pasture and sugarcane (Jaramillo and Kirwan 2020b). In some areas of Botucatu, year-around alongside other *Sporophila* species, such as the Rusty-collared *Sporophila collaris* and Pearly-bellied Seedeater *S. pileata*, although it lacks records from August-September, which may indicate a local migratory movement for the Plumbeous Seedeater. Recognized by its song, which incorporates most local birds sounds in the repertory, including Southern lapwing *Vanellus chilensis*, Smooth-billed ani *Crotophaga ani*, Pale-breasted spinetail, *Synallaxis albescens*, Campo flicker *Colaptes campestris*, Southern rough-winged swallow *Stelgidopteryx ruficollis* and Yellow-bellied Elaenia *Elaenia flavogaster* (V. R. Antonelli per. obs.).

Copper Seedeater *Sporophila bouvreuil* - VU. This seedeater is mostly found in central-east Brazil, with a few records west, including South Suriname and French Guiana. Inhabits open Cerrado, savannas, tall-grass plains, from sea level to altitudes of at least 600 m. Year-round in most parts of its range, with some migratory behavior, usually driven by seeding grass. Despite having a relatively large distribution, it faces several important threats: its natural habitat is susceptible to agriculture for soybeans or sunflowers (Jaramillo and Kirwan 2020b). A single male was recently reported on FEB during March 2024 (Figure S4b).

Tropeiro Seedeater *Sporophila beltoni* - CR. Endemic to Brazil, this seedeater migrates to breed (November-March) in the south (Paraná, Santa Catarina, Rio Grande do Sul). While not breeding found in more central regions of Brazil including the Cerrado and other tall-grass habitats. Can be seen during migration, sometimes in mixed flocks with other seedeaters. Inhabits “guamirinzal” and “vassoural” grasslands and other shrub-grasslands formations (del Hoyo et al. 2020a). In the FEB, we confirmed the presence of an adult male and juveniles from February-March and May-June 2020. The first contact with the species was on 29 February (Figure S4d), when a juvenile was found near the road, with consecutive observations until 1st March, and later from 22 May, when an adult male was spotted (Figure S4c), to 10 June, with more sights of a juvenile in the area. Dates converge with migration period for the species, which leaves from northern Rio Grande do Sul in January, reaching northern Minas Gerais and Goiás for the winter, between June-September (Repenning and Fontana 2013, del Hoyo et al. 2020b).

Pearly-bellied Seedeater *Sporophila pileata* - EN. This seedeater is found in central-south Brazil, Paraguay, Argentina, and Uruguay. Inhabits diverse landscapes, including open Cerrado, savannas, tall-grass plains, and lightly grazed pastures, from sea level to altitudes of at least 1,200 m. Year-round in most parts of its range, with some migratory behavior in the southern portion of its distribution from late February, to which they return in November. Some reported far north as southern Tocantins during the austral winter. Abundance is a consequence of seed availability. Despite having a relatively large distribution, it faces several important threats: its natural habitat is susceptible to agriculture for soybeans or sunflowers (del Hoyo et al. 2020b). The lack of records in the FEB from August and September, similar to the Plumbeous Seedeater, suggests local migratory movements during the period. In the FEB, we confirmed both the presence of adults and juveniles. An adult was photographed in December 2018 (Figure S4e), while a juvenile was found in February 2020 (Figure S4f).

Tawny-bellied Seedeater *Sporophila hypoxantha* - CR; VU (Brasil 2022). Similar to its counterparts, this seedeater thrives in tall grassy vegetation, often close to water. Following the breeding season, it departs north to more central regions of Brazil, including São Paulo, Minas Gerais, Goiás, Mato Grosso, and Mato Grosso do Sul. During migration, it sometimes associates with other *Sporophila* species. Recent studies found low reproductive success (40% success). This is closely linked to microhabitat preferences of the species, which tends to favor plain areas with dense shrubbery within a grassland landscape. The presence of Asteraceae plants seems crucial as nests support (Franz and Fontana 2013). The primary threats faced by this species are the conversion of grasslands and wetlands, and wildlife trafficking (Jaramillo 2020c). In FEB a male was first reported on 26 October 2019, in a mixed flock including the Chestnut Seedeater.

On 20 November 2019 another male was found. Both were in wet grassland close to gallery forest. The last record of a male was on 13 October 2023, foraging in dry grasslands.

Chestnut Seedeater *Sporophila cinnamomea* - CR; VU (IUCN 2024). Inhabits grasslands, wetlands, and borders, also common to “vassoural” formations. It is specialized on seeds of native grasses, especially *Paspalum* sp. It breeds in Argentina, Paraguay, Uruguay, and the region of Bagé, in the state of Rio Grande do Sul, the only reproduction site known for Brazil. Recent records there are restricted to wetlands with dense shrubs (*Ludwigia* sp.) surrounded by grasslands without cattle. Loss of native grasses, introduction of exotic flora and reforestation with *Pinus* sp. and *Eucalyptus* sp., in addition to fires and cattle trampling, are among the main threats to the species (Jaramillo 2020a). Illegal trafficking, especially of males, can cause population decline; however, it is common in Rio Grande do Sul, and is no longer included in the state Red List (Rio Grande do Sul 2014). Only a single male was reported in T4 on 26 November 2019. The species, alongside the Plumbeous, Pearly-bellied and Tawny-bellied Seedeaters was briefly reported in a marsh in Monte Alegre, 10 km away, in October 2017.

Black-bellied Seedeater *Sporophila melanogaster* – CR; VU; NT (IUCN 2024). This species is primarily found in southeastern Brazil at elevations between 800 and 1600 meters, inhabiting natural grasslands and the grassy margins of marshes dominated by saw grasses, particularly *Eryngium pandanifolium*, as well as swampy swales within the highland grasslands of Rio Grande do Sul and Santa Catarina (Fontana and Repenning 2020). It breeds regularly in Rio Grande do Sul and Santa Catarina, and occasionally in Paraná, dispersing northward after the breeding season to regions as far as Minas Gerais and southern Goiás in central Brazil. On November 10, 2024, two juvenile males (a young-plumaged male and a juvenile male with female-like plumage) were observed singing in FEB (<https://ebird.org/checklist/S202129688>), likely during migration toward southern Brazil, where the majority of the population congregates for the breeding season.

White-rumped Tanager *Cypsnagra hirundinacea* - EN. Mostly found in east central South America in Bolivia, Paraguay and Brazil, at elevations of up to 1000-1100 m in Brazil, in the Cerrado and grasslands (Stotz et al. 1996, Isler and Isler 1999). Can be found in agricultural landscapes, and at the periphery of settlements with relatively few trees and shrubs. Often seen in groups of 3-6 individuals, even while breeding, when territory typically spans around 5 ha (Isler and Isler 1999). Frequently in mixed flocks in the open Cerrado (Ragusa-Netto 2000, 2002). In FEB, the first detection of the species was on 5 January 2019 of an adult perched on a power line on a municipal road (Figure S4g). It has been observed alone ever since (Figure S4c), until March 2019 when an immature was spotted accompanying the adult (Figure S4h). In February 2020, probably the same juvenile reached maturity showing the characteristic adult plumage, now joining the adult in duets during vocalization (V. R. Antonelli per. obs.). The pair continued to inhabit the region until December 2020 with no further sightings and apparently absent after arsons. A single adult was seen later on 31 October 2023, with no further sightings until present.

Long-tailed Reed Finch *Donacospiza albifrons* - VU. Mostly present in south-eastern parts of South America, this reed finch inhabits tall wet grasslands and marshes with tall emergent vegetation, including *Typha*, *Eryngium*, *Scirpus*, and *Iris*, up to 900 m of altitude. It breeds between October-February, building nests near or on the ground in thick grass clumps. Common in well preserved tall-grass marshes, the reed finch is impacted by draining of wetlands (Jaramillo 2020b). Probably a resident, although there is lack of records between January and March, as well as from July and August.

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