



# A bird survey in a transitional area between two major conservation hotspots in southeastern Brazil

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## Abstract

Transitional areas may have higher species richness than those located within established environments, as these ecotones provide a variety of resources that facilitate the maintenance of specific fauna. However, they tend to be overlooked in wildlife surveys. In this context, the western region of the state of São Paulo in Brazil is important because it contains areas of ecological transition between 2 major conservation hotspots in Brazil: the Atlantic Forest and the Cerrado. We surveyed the avifauna in a transitional area between these domains, using qualitative and quantitative methods between December 2016 and February 2019. We documented 220 species, of which 7 are endemic to the Atlantic Forest and 4 are endemic to the Cerrado. In addition, we documented 9 species that are threatened at some level (regional, national, or global), demonstrating the high conservation value of this area for birds. Therefore, our results show the potential of transitional areas for maintaining regional biodiversity.

## Keywords

Avian community, Atlantic Forest, bird assemblage, Cerrado, ecotone.

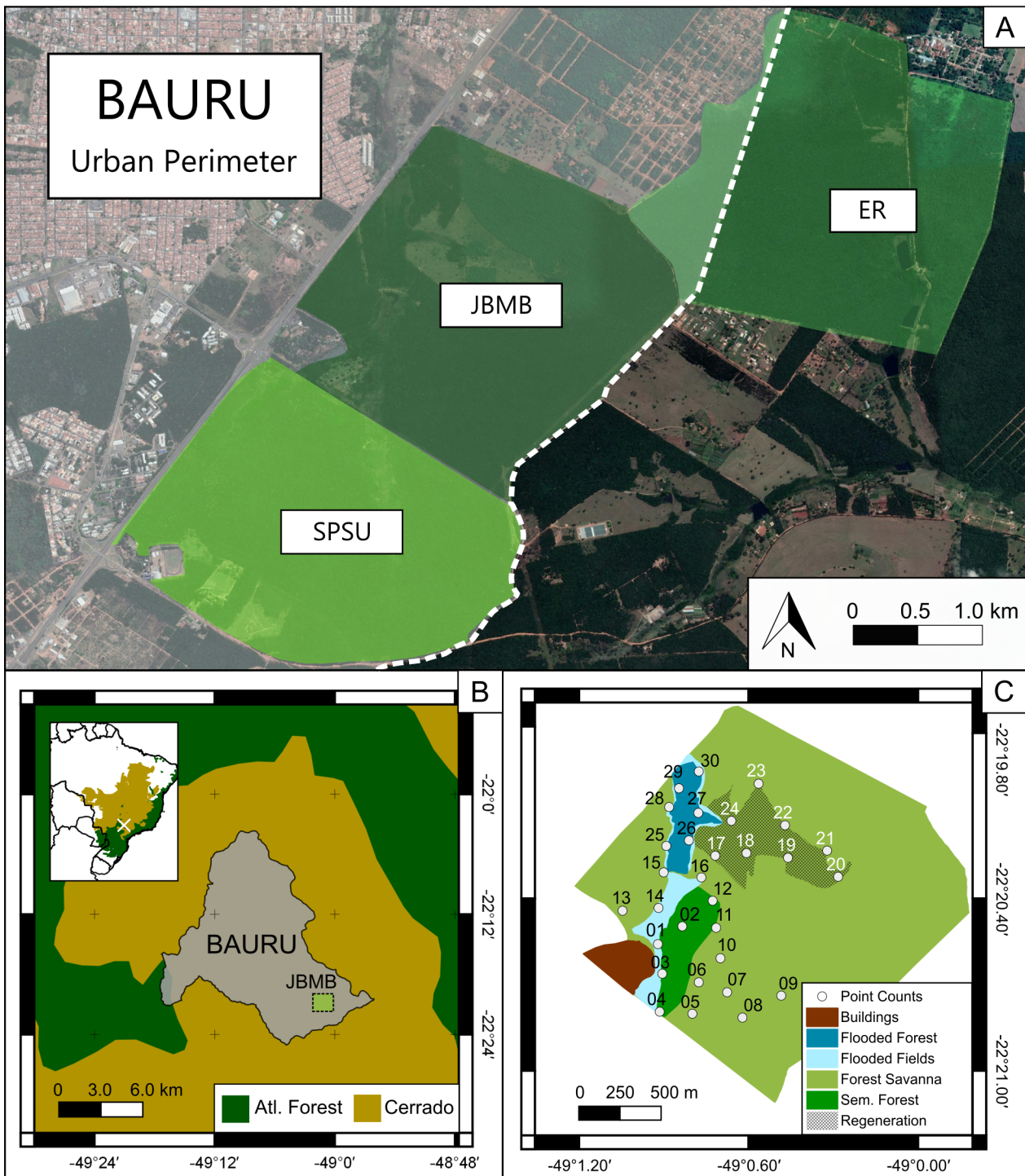
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## Introduction

Transitional areas between communities tend to receive less attention in biodiversity research than distinct ecosystems. Studies at the global level tend to assess biodiversity across delimited areas to manage resources efficiently (Myers et al. 2000). However, this approach overlooks transitional areas as valuable biodiversity refuges, despite the relevance of such areas as centers of ecological variability and speciation (Schilthuizen 2000).

Transitional areas (or ecotones) are defined as areas of abrupt transition along an environmental gradient, where abiotic and/or biotic factors change quickly at a small geographic scale (Kark and Van Rensburg 2006). The steep gradient between 2 or among more environments exerts a significant influence on local biodiversity. Such areas tend to have higher species richness and abundance, because they support overlapping communities that would normally be restricted to isolated ecosystems (Kunin 1998, Lloyd et al. 2000, Kucherova and



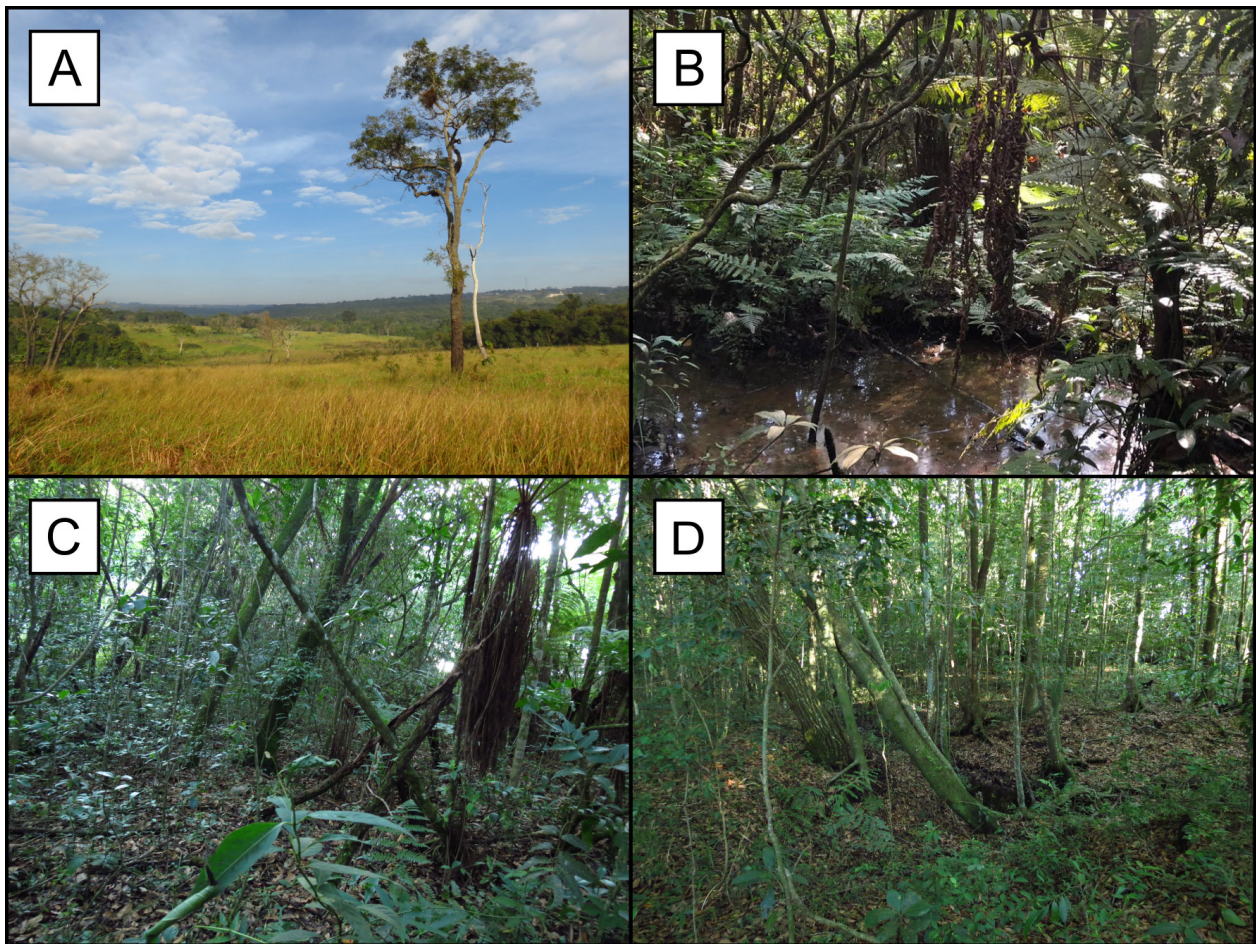
**Figure 1.** Maps of “Jardim Botânico Municipal de Bauru” (JBMB) region. **A.** Satellite image of the region, displaying the urban perimeter of Bauru (white shaded area) and the two JBMB’s adjacent fragments (SPSU = São Paulo State University legal reserve, ER = Ecological Reserve of “Sociedade Beneficente Enéas Carvalho de Aguiar”). **B.** Area of Bauru. The city is inserted in a transitional region between Atlantic Forest (green) and *Cerrado* (yellow). **C.** Area of JBMB, including the locations of point counts (white dots), and the predominant physiognomies found in JBMB. Each number corresponds to a different point count. White numbers refer to the points located inside the regenerating area

Mirkin 2001, Baker et al. 2002, Dangerfield et al. 2003, Kark et al. 2007). In addition, transitional areas may contain unique richness (Odum 1953) because the combined diversity of adjacent sites facilitates the maintenance of rare morphological, genetic, and ecological features of biological taxa (Kark and van Rensburg 2006). In addition, some authors hypothesized that transitional areas

are zones where new species could emerge more quickly (Moritz et al. 2000), especially in bird taxa (Kark et al. 2007).

In this context, the southeastern region of Brazil plays an important role in the maintenance of bird diversity because it contains several ecotones of Cerrado and Atlantic Forest ecoregions (São Paulo 2017). Both





**Figure 2.** Vegetal physiognomy and vegetal structure variation in JBMB. **A.** regenerating area. **B.** Semideciduous Flooded Forest. **C.** Semideciduous Forest. **D.** Forest Savanna (“Cerradão”).

ecoregions support high biodiversity and high degree of endemisms, with several species being threatened by the high rates of habitat loss in them (Myers et al. 2000). Consequently, this region could be fundamental for the conservation of both ecoregions biodiversity. Information on bird distribution and community structure in such environments is crucial to conservation and management (Kark and van Rensburg 2006) and fauna inventories are critical for understanding the composition and dynamics of such communities (Santos 2003). Therefore, our work presents a detailed inventory of avian taxa in an important ecotone of southeastern Brazil and emphasizes the occurrence of those species that present high conservation value, such as endemic, threatened, or migratory species.

## Methods

The Jardim Botânico Municipal de Bauru (hereafter JBMB) is located at Bauru Municipality (22°19'S, 049°04'W) in the midwestern region of São Paulo state (Fig. 1). According to Alvares et al. (2013), this region climate is defined as Cwa by Köppen classification, with 2 well-defined seasons of hot and wet summers versus cold and dry winters. JBMB covers a total area of 321 ha and is one of three conservation units that integrates

the Vargem Limpa-Campo Novo Area of Environmental Protection (Bauru 2000), along with the São Paulo State University Legal Reserve (265 ha) and the Ecological Reserve of “Sociedade Beneficente Enéas Carvalho de Aguiar” (217 ha). Together, these three conservation units encompasses more than 800 ha of native vegetation (Cavassan 2013).

There are different vegetal formations (or phytophysiognomies) in JBMB that belong to the Atlantic Forest and Cerrado domains (Cavassan 2013). For instance, Forest Savanna (which is known locally as Cerradão) occupies 280 ha; Semideciduous Forest (Veloso 1992) occupies 7 ha; and Riparian Semideciduous Forest with permanent fluvial influence (which is known as Semideciduous Flooded Forest) occupies 11 ha (Rodrigues 2000). In addition, the JBMB contains about 15 ha Regenerating Forest Savanna (Weiser 2007) (Fig. 2). All these phytophysiognomies are distributed in an area of more than 300 ha, which makes this remnant one of the most important fragments of high priority for conservation in the midwestern state of São Paulo (Kronka et al. 1998, Durigan et al. 2004).

To document avifauna in the JBMB, we used 10-min point counts, which had no sampling distance limit (Blondel et al. 1981) and were adapted to tropical regions (Vielliard and Silva 1990). We sampled 30 points

separated by a minimum distance of 200 m from each other, distributing them between the phytophysio-  
nomies of JBMB (Table 1). We surveyed the points twice a  
month, in the mornings (06:00–10:00) and in the after-  
noons (15:00–19:00). Sampling was conducted monthly  
in 2 stages. Stage 1 was conducted from December 2016  
to December 2017 in the Forest Savanna, Semideciduous  
Forest, and Regenerating area. Stage 2 was conducted  
from February 2018 to February 2019 in the Riparian  
Forest. In total, we completed 120 h of avian surveys.

Visual records were made using Nikon PROSTAFF  
7S 10 × 42 binoculars, while sound records were made  
with a Marantz PMD-667 recorder coupled to a Yoga  
HT-81 directional microphone. Photographic records  
of the species were obtained using a Canon Powershot  
Superzoom 40× digital camera whenever possible. Pairs  
of researchers (GSC, RMV, RWG) carried out the obser-  
vations to avoid observation bias. To complement the  
bird survey, we recorded sporadic contacts occurring  
outside sampling period, both within the JBMB and  
adjacent areas. We did not record the abundance of spe-  
cies, because this survey was descriptive in nature. In  
addition, we integrated the internal database of JBMB  
species to our list to complement our own recordings.

Patterns of migratory activity were classified accord-  
ing to Somenzari et al. (2018), with some changes. We

considered migratory species (MGT) as those that leave  
their territory after the reproductive season and return to  
the same area after a cyclical period. Partially migratory  
species (MPR) included populations with some migra-  
tory individuals, while others remained resident in certain  
regions. The endemism status of each species was based  
on Bencke et al. (2006) for the Atlantic Forest and on Silva  
and Bates (2002) for the Cerrado. The Red List category  
of each species was defined at a global level based on the  
International Union for Conservation of Nature (IUCN  
2019), at a national level based on Livro Vermelho da  
Fauna Brasileira Ameaçada de Extinção (ICMBIO/MMA  
2018), and at a regional level based on the State Decree No.  
63.853 (São Paulo 2018). We also identified species sub-  
jected to capture and traffic pressure according to Costa  
and Monteiro (2016). Taxonomic ordering and nomencla-  
ture followed the recommendations of the Brazilian Orni-  
thological Records Committee (Piacentini et al. 2015).

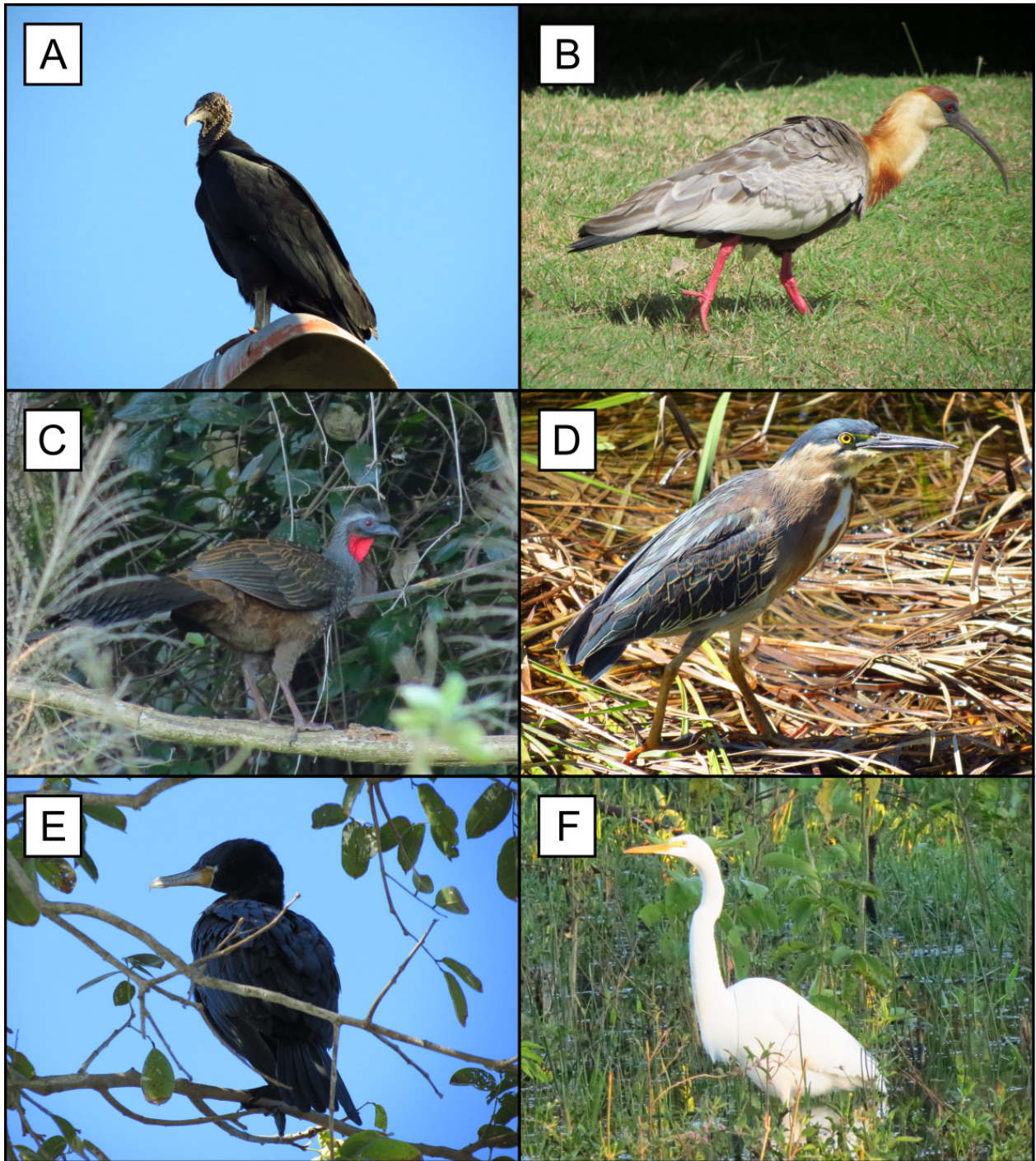
## Results

Across all surveys and data sources, we recorded 220  
species (Table 2) belonging to 22 orders and 54 fami-  
lies. Thirty-six species (16.4% of the total) were docu-  
mented by photographs (Figs 3–8). Of the 54 families,  
23 belonged to the order Passeriformes and 31 belonged

**Table 1.** List of point counts used in the avifaunal survey of the Jardim Botânico Municipal de Bauru (JBMB), with the sampling period, the geographic coordinates and the predominant vegetation of each point.

Point no.	Sampling period	Latitude	Longitude	Vegetation
01	Dec. 2016–Dec. 2017	22° 20' 35" S	49° 00' 57" W	Semideciduous Forest
02	Dec. 2016–Dec. 2017	22° 20' 35" S	49° 00' 50" W	Semideciduous Forest
03	Dec. 2016–Dec. 2017	22° 20' 40" S	49° 00' 55" W	Semideciduous Forest
04	Dec. 2016–Dec. 2017	22° 20' 48" S	49° 00' 55" W	Semideciduous Forest
05	Dec. 2016–Dec. 2017	22° 20' 48" S	49° 00' 48" W	Forest Savanna
06	Dec. 2016–Dec. 2017	22° 20' 41" S	49° 00' 46" W	Forest Savanna
07	Dec. 2016–Dec. 2017	22° 20' 43" S	49° 00' 40" W	Forest Savanna
08	Dec. 2016–Dec. 2017	22° 20' 48" S	49° 00' 37" W	Forest Savanna
09	Dec. 2016–Dec. 2017	22° 20' 44" S	49° 00' 29" W	Forest Savanna
10	Dec. 2016–Dec. 2017	22° 20' 36" S	49° 00' 42" W	Forest Savanna
11	Dec. 2016–Dec. 2017	22° 20' 31" S	49° 00' 41" W	Semideciduous Forest
12	Dec. 2016–Dec. 2017	22° 20' 28" S	49° 00' 47" W	Semideciduous Forest
13	Dec. 2016–Dec. 2017	22° 20' 28" S	49° 01' 02" W	Forest Savanna
14	Dec. 2016–Dec. 2017	22° 20' 26" S	49° 00' 55" W	Flooded Field
15	Dec. 2016–Dec. 2017	22° 20' 18" S	49° 00' 54" W	Flooded Field
16	Dec. 2016–Dec. 2017	22° 20' 21" S	49° 00' 46" W	Flooded Field
17	Dec. 2016–Dec. 2017	22° 20' 15" S	49° 00' 44" W	Regenerating Area
18	Dec. 2016–Dec. 2017	22° 20' 14" S	49° 00' 36" W	Regenerating Area
19	Dec. 2016–Dec. 2017	22° 20' 15" S	49° 00' 27" W	Regenerating Area
20	Dec. 2016–Dec. 2017	22° 20' 19" S	49° 00' 17" W	Regenerating Area
21	Dec. 2016–Dec. 2017	22° 20' 14" S	49° 00' 19" W	Regenerating Area
22	Dec. 2016–Dec. 2017	22° 20' 08" S	49° 00' 28" W	Regenerating Area
23	Dec. 2016–Dec. 2017	22° 19' 60" S	49° 00' 34" W	Regenerating Area
24	Dec. 2016–Dec. 2017	22° 20' 07" S	49° 00' 39" W	Regenerating Area
25	Feb. 2018–Feb. 2019	22° 20' 12" S	49° 00' 53" W	Riparian Forest
26	Feb. 2018–Feb. 2019	22° 20' 12" S	49° 00' 48" W	Riparian Forest
27	Feb. 2018–Feb. 2019	22° 20' 08" S	49° 00' 48" W	Riparian Forest
28	Feb. 2018–Feb. 2019	22° 20' 05" S	49° 00' 53" W	Riparian Forest
29	Feb. 2018–Feb. 2019	22° 20' 01" S	49° 00' 50" W	Riparian Forest
30	Feb. 2018–Feb. 2019	22° 19' 57" S	49° 00' 46" W	Riparian Forest





**Figure 3.** Birds recorded during our survey at the JBMB. **A.** Black Vulture *Coragyps atratus* (point no. 12). **B.** Buff-necked Ibis *Theristicus caudatus* (point no. 01). **C.** Rusty-margined Guan *Penelope superciliaris* (point no. 03). **D.** Striated Heron *Butorides striata* (point no. 3). **E.** Neotropic Cormorant *Nannopterum brasilianus* (point no. 14) **F.** Great Egret *Ardea alba* (point no. 14).

to other orders. We observed 190 species (86.3% of the total) in quantitative surveys and 26 species (11.8% of the total) in qualitative surveys. Just 4 species (1.9% of the total) were only found in the JBMB database. Among non-Passeriformes families, the Accipitridae, Columbidae, and Trochilidae had the highest richness (9 species each, 4.1% of the total), followed by Ardeidae and Rallidae (7 species each, 3.2% of the total). Among the Passeriformes, 30 species represented the Tyrannidae (13.7% of the total) and 27 species represented the Thraupidae (12.4% of the total) families. We recorded 31 species

(14.2% of the total) with migratory activity, with 2 species being considered migratory and 29 species being considered partially migratory. In addition, we documented 36 species (16.5 % of the total) subjected to capture and traffic pressure (Costa and Monteiro 2016). We also documented 2 exotic species, *Estrilda astrild* (Common Waxbill) and *Passer domesticus* (House Sparrow).

Some species that were documented are considered of conservation relevance. Among the species classified as endemic, we recorded 7 taxa restricted to the Atlantic Forest and 4 restricted to the Cerrado.

**Table 2.** List of birds recorded at Jardim Botânico Municipal de Bauru (JBMB), with the scientific name and English names. We also display the method of detection (Quan. = Quantitative survey, Qual. = Qualitative survey, Data. = JBMB databases); the predominant physiognomy (Phys.) where the taxa have been found (SEM = Semideciduous Forest, REG = Regenerating area, SAV = Forest Savanna, WET = Wetlands, UBQ = Ubiquitous); the migratory behavior (Mig.) of each taxa (MGT = migratory species, MPR = partially migratory species); the conservation status at the global (IUCN 2019), national (ICMbio/MMA 2018) and regional (São Paulo 2018) levels, respectively (LC = least concern, NT = near threatened, VU = vulnerable, EN = endangered); and the taxa that suffers from risk of capture and traffic pressures (Traf.) according to Costa and Monteiro (2016).

Taxon	English name	Quan.	Qual.	Data.	Phys.	Mig.	Conserv. status	Traf.
<b>TINAMIFORMES</b>								
<b>Tinamidae</b>								
<i>Crypturellus obsoletus</i> (Temminck, 1815)	Brown Tinamou	X			SEM		LC/ LC/ LC	
<i>Crypturellus parvirostris</i> (Wagler, 1827)	Small-billed Tinamou	X			REG		LC/ LC/ LC	
<i>Crypturellus tataupa</i> (Temminck, 1815)	Tataupa Tinamou	X			SEM/REG		LC/ LC/ LC	
<i>Rhynchotus rufescens</i> (Temminck, 1815)	Red-winged Tinamou		X		REG		LC/ LC/ EN	
<b>ANSERIFORMES</b>								
<b>Anatidae</b>								
<i>Cairina moschata</i> (Linnaeus, 1758)	Muscovy Duck	X			WET		LC/ LC/ LC	
<i>Amazonetta brasiliensis</i> (Gmelin, 1789)	Brazilian Teal		X		WET		LC/ LC/ LC	
<b>GALLIFORMES</b>								
<b>Cracidae</b>								
<i>Penelope superciliosa</i> Temminck, 1815	Rusty-margined Guan	X			SEM		LC/ LC/ NT	
<b>PODICIPEDIFORMES</b>								
<b>Podicipedidae</b>								
<i>Podilymbus podiceps</i> (Linnaeus, 1758)	Pied-billed Grebe		X		WET		LC/ LC/ LC	
<b>SULIFORMES</b>								
<b>Phalacrocoracidae</b>								
<i>Nannopterum brasilianus</i> (Gmelin, 1789)	Neotropic Cormorant		X		WET		LC/ LC/ LC	
<b>Anhingidae</b>								
<i>Anhinga anhinga</i> (Linnaeus, 1766)	Anhinga	X			WET		LC/ LC/ LC	
<b>Ardeidae</b>								
<i>Tigrisoma lineatum</i> (Boddaert, 1783)	Rufescent Tiger-Heron	X			WET		LC/ LC/ LC	
<i>Butorides striata</i> (Linnaeus, 1758)	Striated Heron		X		WET		LC/ LC/ LC	
<i>Bubulcus ibis</i> (Linnaeus, 1758)	Cattle Egret		X		WET		LC/ LC/ LC	
<i>Ardea cocoi</i> Linnaeus, 1766	Cocoi Heron		X		WET		LC/ LC/ LC	
<i>Ardea alba</i> Linnaeus, 1758	Great Egret	X			WET		LC/ LC/ LC	
<i>Syrigma sibilatrix</i> (Temminck, 1824)	Whistling Heron	X			WET		LC/ LC/ LC	
<i>Egretta thula</i> (Molina, 1782)	Snowy Egret	X			WET		LC/ LC/ LC	
<b>Threskiornithidae</b>								
<i>Mesembrinibis cayennensis</i> (Gmelin, 1789)	Green Ibis	X			WET		LC/ LC/ LC	
<i>Phimosus infuscatus</i> (Lichtenstein, 1823)	Bare-faced Ibis	X			WET		LC/ LC/ LC	
<i>Theristicus caudatus</i> (Boddaert, 1783)	Buff-necked Ibis	X			UBQ		LC/ LC/ LC	
<b>CATHARTIFORMES</b>								
<b>Cathartidae</b>								
<i>Cathartes aura</i> (Linnaeus, 1758)	Turkey Vulture	X			REG		LC/ LC/ LC	
<i>Coragyps atratus</i> (Bechstein, 1793)	Black Vulture	X			UBQ		LC/ LC/ LC	
<b>ACCIPITRIFORMES</b>								
<b>Accipitridae</b>								
<i>Chondrohierax uncinatus</i> (Temminck, 1822)	Hook-billed Kite		X		WET		LC/ LC/ LC	
<i>Gampsonyx swainsonii</i> Vigors, 1825	Pearl Kite	X			SAV/SEM		LC/ LC/ LC	
<i>Elanus leucurus</i> (Vieillot, 1818)	White-tailed Kite	X			SAV/SEM		LC/ LC/ LC	
<i>Ictinia plumbea</i> (Gmelin, 1788)	Plumbeous Kite	X			SAV/SEM	MPR	LC/ LC/ LC	
<i>Rostrhamus sociabilis</i> (Vieillot, 1817)	Snail Kite		X		WET	MPR	LC/ LC/ LC	
<i>Heterospizias meridionalis</i> (Latham, 1790)	Savanna Hawk		X		REG		LC/ LC/ LC	
<i>Rupornis magnirostris</i> (Gmelin, 1788)	Roadside Hawk	X			UBQ		LC/ LC/ LC	
<i>Geranoaetus albicaudatus</i> (Vieillot, 1816)	White-tailed Hawk		X		REG		LC/ LC/ LC	
<i>Buteo brachyurus</i> Vieillot, 1816	Short-tailed Hawk	X			SAV/SEM		LC/ LC/ LC	
<b>GRUIFORMES</b>								
<b>Aramidae</b>								
<i>Aramus guarauna</i> (Linnaeus, 1766)	Limpkin	X			WET		LC/ LC/ LC	
<b>Rallidae</b>								
<i>Aramides cajaneus</i> (Statius Müller, 1776)	Gray-necked Wood-Rail	X			WET		LC/ LC/ LC	
<i>Laterallus viridis</i> (Statius Müller, 1776)	Russet-crowned Crane	X			WET		LC/ LC/ LC	
<i>Laterallus melanophaius</i> (Vieillot, 1819)	Rufous-sided Crane	X			WET		LC/ LC/ LC	



Taxon	English name	Quan.	Qual.	Data.	Phys.	Mig.	Conserv. status	Traf.
<i>Mustelirallus albicollis</i> (Vieillot, 1819)	Ash-throated Crane	X			WET		LC/ LC/ LC	
<i>Pardirallus nigricans</i> (Vieillot, 1819)	Blackish Rail	X			WET		LC/ LC/ LC	
<i>Gallinula galeata</i> (Lichtenstein, 1818)	Common Gallinule	X			WET		LC/ LC/ LC	
<i>Porphyrio martinicus</i> (Linnaeus, 1766)	Purple Gallinule		X		WET	MPR	LC/ LC/ LC	
<b>Heliornithidae</b>								
<i>Heliornis fulica</i> (Boddaert, 1783)	Sungrebe		X		WET		LC/ LC/ EN	
<b>CHARADRIIFORMES</b>								
<b>Charadriidae</b>								
<i>Vanellus chilensis</i> (Molina, 1782)	Southern Lapwing	X			REG		LC/ LC/ LC	
<b>Jacanidae</b>								
<i>Jacana jacana</i> (Linnaeus, 1766)	Wattled Jacana			X	WET		LC/ LC/ LC	
<b>COLUMBIFORMES</b>								
<b>Columbidae</b>								
<i>Columbina talpacoti</i> (Temminck, 1810)	Ruddy Ground-Dove	X			REG		LC/ LC/ LC	
<i>Columbina squammata</i> (Lesson, 1831)	Scaled Dove	X			REG		LC/ LC/ LC	
<i>Claravis pretiosa</i> (Ferrari-Perez, 1886)	Blue Ground-Dove	X			SEM		LC/ LC/ LC	
<i>Patagioenas picazuro</i> (Temminck, 1813)	Picazuro Pigeon	X			UBQ		LC/ LC/ LC	
<i>Patagioenas cayennensis</i> (Bonnaterre, 1792)	Pale-vented Pigeon	X			SAV/REG		LC/ LC/ LC	
<i>Zenaida auriculata</i> (Des Murs, 1847)	Eared Dove	X			UBQ		LC/ LC/ LC	
<i>Leptotila verreauxi</i> Bonaparte, 1855	White-tipped Dove	X			SAV/REG		LC/ LC/ LC	
<i>Leptotila rufaxilla</i> (Richard & Bernard, 1792)	Gray-fronted Dove	X			SAV/REG		LC/ LC/ LC	
<i>Geotrygon montana</i> (Linnaeus, 1758)	Ruddy Quail-Dove	X			SEM		LC/ LC/ LC	
<b>CUCULIFORMES</b>								
<b>Cuculidae</b>								
<i>Piaya cayana</i> (Linnaeus, 1766)	Squirrel Cuckoo	X			UBQ		LC/ LC/ LC	
<i>Crotophaga major</i> Gmelin, 1788	Greater Ani			X	WET		LC/ LC/ NT	
<i>Crotophaga ani</i> Linnaeus, 1758	Smooth-billed Ani	X			REG		LC/ LC/ LC	
<i>Guira guira</i> (Gmelin, 1788)	Guira Cuckoo	X			REG		LC/ LC/ LC	
<i>Tapera naevia</i> (Linnaeus, 1766)	Striped Cuckoo	X			REG		LC/ LC/ LC	
<b>STRIGIFORMES</b>								
<b>Tytonidae</b>								
<i>Tyto furcata</i> (Temminck, 1827)	American Barn Owl			X	SAV/REG		LC/ LC/ LC	
<b>Strigidae</b>								
<i>Megascops choliba</i> (Vieillot, 1817)	Tropical Screech-Owl		X		SAV/REG		LC/ LC/ LC	
<i>Bubo virginianus</i> (Gmelin, 1788)	Great Horned Owl		X		SAV/REG		LC/ LC/ EN	
<i>Athene cunicularia</i> (Molina, 1782)	Burrowing Owl	X			REG		LC/ LC/ LC	
<i>Asio stygius</i> (Wagler, 1832)	Stygian Owl			X	SAV		LC/ LC/ LC	
<b>NYCTIBIIFORMES</b>								
<b>Nyctibiidae</b>								
<i>Nyctibius griseus</i> (Gmelin, 1789)	Common Potoo		X		SAV		LC/ LC/ LC	
<b>CAPRIMULGIFORMES</b>								
<b>Caprimulgidae</b>								
<i>Lurocalis semitorquatus</i> (Gmelin, 1789)	Short-tailed Nighthawk		X		REG	MPR	LC/ LC/ LC	
<i>Nyctidromus albicollis</i> (Gmelin, 1789)	Common Pauraque	X			REG		LC/ LC/ LC	
<i>Hydropsalis parvula</i> (Gould, 1837)	Little Nightjar		X		SAV	MPR	LC/ LC/ LC	
<i>Chordeiles minor</i> (Forster, 1771)	Common Nighthawk		X		SAV	MGT	LC/ LC/ LC	
<b>APODIFORMES</b>								
<b>Apodidae</b>								
<i>Chaetura meridionalis</i> Hellmayr, 1907	Sick's Swift	X			REG	MGT	LC/ LC/ LC	
<b>Trochilidae</b>								
<i>Phaethornis pretrei</i> (Lesson & Delattre, 1839)	Planalto Hermit	X			UBQ		LC/ LC/ LC	
<i>Eupetomena macroura</i> (Gmelin, 1788)	Swallow-tailed Hummingbird	X			UBQ		LC/ LC/ LC	
<i>Florisuga fusca</i> (Vieillot, 1817)	Black Jacobin	X			UBQ	MPR	LC/ LC/ LC	
<i>Colibri serrirostris</i> (Vieillot, 1816)	White-vented Violetear	X			SEM		LC/ LC/ LC	
<i>Chlorostilbon lucidus</i> (Shaw, 1812)	Glittering-bellied Emerald	X			UBQ		LC/ LC/ LC	
<i>Thalurania glaucopis</i> (Gmelin, 1788) <sup>ATL</sup>	Violet-capped Woodnymph		X		SEM		LC/ LC/ LC	
<i>Hylocharis chrysura</i> (Shaw, 1812)	Gilded Hummingbird		X		SEM		LC/ LC/ LC	
<i>Amazilia lactea</i> (Lesson, 1832)	Sapphire-spangled Emerald	X			UBQ		LC/ LC/ LC	
<i>Heliomaster squamosus</i> (Temminck, 1823)	Stripe-breasted Starthroat				REG		LC/ LC/ LC	
<b>CORACIIFORMES</b>								
<b>Alcedinidae</b>								
<i>Megaceryle torquata</i> (Linnaeus, 1766)	Ringed Kingfisher	X			WET		LC/ LC/ LC	

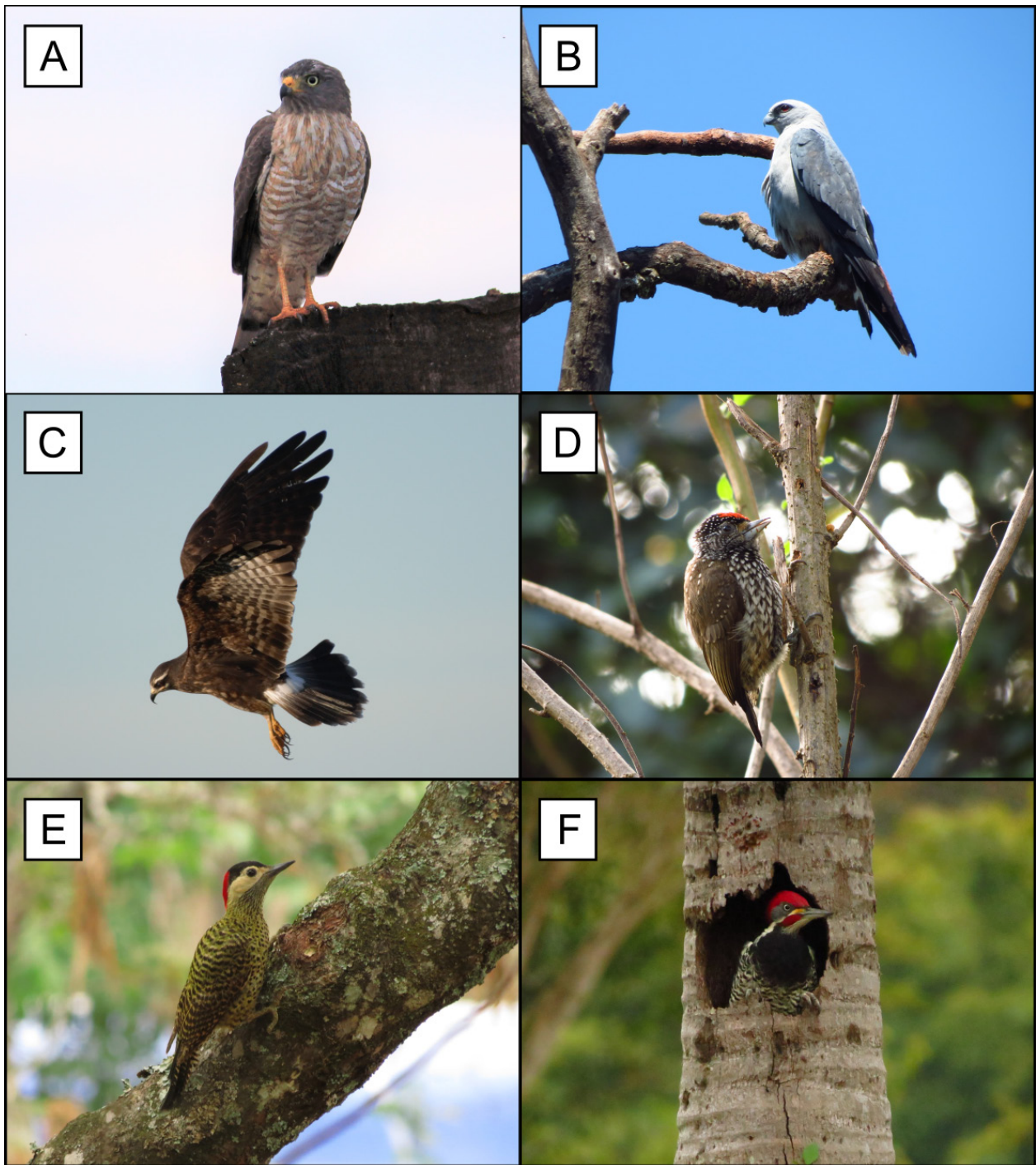
Taxon	English name	Quan.	Qual.	Data.	Phys.	Mig.	Conserv. status	Traf.
<i>Chloroceryle amazona</i> (Latham, 1790)	Amazon Kingfisher	X			WET		LC/LC/LC	
<i>Chloroceryle americana</i> (Gmelin, 1788)	Green Kingfisher		X		WET		LC/LC/LC	
<b>Momotidae</b>								
<i>Baryphthengus ruficapillus</i> (Vieillot, 1818) <sup>ATL</sup>	Rufous-capped Motmot	X			SEM		LC/LC/LC	
<b>GALBULIFORMES</b>								
<b>Galbulidae</b>								
<i>Galbula ruficauda</i> Cuvier, 1816	Rufous-tailed Jacamar	X			UBQ		LC/LC/LC	
<b>Bucconidae</b>								
<i>Nystalus chacuru</i> (Vieillot, 1816)	White-eared Puffbird	X			REG		LC/LC/LC	
<b>PICIFORMES</b>								
<b>Ramphastidae</b>								
<i>Ramphastos toco</i> Statius Müller, 1776	Toco Toucan	X			UBQ		LC/LC/LC	X
<b>Picidae</b>								
<i>Picumnus albosquamatus</i> d'Orbigny, 1840	White-wedged Piculet	X			UBQ		LC/LC/LC	
<i>Melanerpes candidus</i> (Otto, 1796)	White Woodpecker	X			UBQ		LC/LC/LC	
<i>Veniliornis passerinus</i> (Linnaeus, 1766)	Little Woodpecker	X			UBQ		LC/LC/LC	
<i>Colaptes melanochloros</i> (Gmelin, 1788)	Green-barred Woodpecker	X			UBQ		LC/LC/LC	
<i>Colaptes campestris</i> (Vieillot, 1818)	Campo Flicker	X			REG		LC/LC/LC	
<i>Dryocopus lineatus</i> (Linnaeus, 1766)	Lineated Woodpecker	X			REG		LC/LC/LC	
<b>CARIAMIFORMES</b>								
<b>Cariamidae</b>								
<i>Cariama cristata</i> (Linnaeus, 1766)	Red-legged Seriema	X			REG		LC/LC/LC	
<b>FALCONIFORMES</b>								
<b>Falconidae</b>								
<i>Caracara plancus</i> (Miller, 1777)	Southern Caracara	X			REG		LC/LC/LC	
<i>Milvago chimachima</i> (Vieillot, 1816)	Yellow-headed Caracara	X			REG		LC/LC/LC	
<i>Herpetotheres cachinnans</i> (Linnaeus, 1758)	Laughing Falcon	X			REG		LC/LC/LC	
<i>Micrastur semitorquatus</i> (Vieillot, 1817)	Collared Forest-Falcon	X			SAV		LC/LC/LC	
<i>Falco sparverius</i> Linnaeus, 1758	American Kestrel		X		REG		LC/LC/LC	
<b>PSITTACIFORMES</b>								
<b>Psittacidae</b>								
<i>Primolius maracana</i> (Vieillot, 1816)	Blue-winged Macaw	X			SEM		NT/NT/VU	X
<i>Psittacara leucophthalmus</i> (Statius Müller, 1776)	White-eyed Parakeet	X			UBQ		LC/LC/LC	X
<i>Forpus xanthopterygius</i> (Spix, 1824)	Blue-winged Parrotlet	X			UBQ		LC/LC/LC	X
<i>Brotogeris chiriri</i> (Vieillot, 1818)	Yellow-chevroned Parakeet	X			UBQ		LC/LC/LC	X
<i>Pionus maximilliani</i> (Kuhl, 1820)	Scaly-headed Parrot	X			SEM		LC/LC/LC	X
<i>Amazona aestiva</i> (Linnaeus, 1758)	Turquoise-fronted Parrot	X			SEM		LC/NT/NT	X
<b>PASSERIFORMES</b>								
<b>Thamnophilidae</b>								
<i>Herpsilochmus atricapillus</i> Pelzeln, 1868	Black-capped Antwren	X			SAV/SEM		LC/LC/LC	
<i>Herpsilochmus longirostris</i> Pelzeln, 1868 <sup>CER</sup>	Large-billed Antwren	X			SEM		LC/LC/NT	
<i>Thamnophilus doliatus</i> (Linnaeus, 1764)	Barred Antshrike	X			UBQ		LC/LC/LC	
<i>Thamnophilus pelzelni</i> Hellmayr, 1924	Planalto Slaty-Antshrike	X			CER		LC/LC/LC	
<i>Taraba major</i> (Vieillot, 1816)	Great Antshrike	X			SAV/SEM		LC/LC/LC	
<b>Conopophagidae</b>								
<i>Conopophaga lineata</i> (Wied, 1831) <sup>ATL</sup>	Rufous Gnateater	X			SEM		LC/LC/LC	
<b>Dendrocolaptidae</b>								
<i>Sittasomus griseicapillus</i> (Vieillot, 1818)	Olivaceous Woodcreeper	X			SEM		LC/LC/LC	
<i>Lepidocolaptes angustirostris</i> (Vieillot, 1818)	Narrow-billed Woodcreeper	X			UBQ		LC/LC/LC	
<b>Furnariidae</b>								
<i>Furnarius rufus</i> (Gmelin, 1788)	Rufous Hornero	X			UBQ		LC/LC/LC	
<i>Automolus leucophthalmus</i> (Wied, 1821) <sup>ATL</sup>	White-eyed Foliage-gleaner	X			SEM		LC/LC/LC	
<i>Certhiaxis cinnamomeus</i> (Gmelin, 1788)	Yellow-chinned Spinetail	X			WET		LC/LC/LC	
<i>Synallaxis frontalis</i> Pelzeln, 1859	Sooty-fronted Spinetail	X			REG		LC/LC/LC	
<i>Synallaxis albescens</i> Temminck, 1823	Pale-breasted Spinetail		X		CER		LC/LC/LC	
<b>Pipridae</b>								
<i>Neopelma pallescens</i> (Lafresnaye, 1853)	Pale-bellied Tyrant-Manakin	X			CER		LC/LC/NT	
<i>Antilophia galeata</i> (Lichtenstein, 1823) <sup>CER</sup>	Helmeted Manakin	X			CER/SEM		LC/LC/LC	
<b>Tityridae</b>								
<i>Pachyramphus viridis</i> (Vieillot, 1816)	Green-backed Becard	X			REG		LC/LC/LC	
<i>Pachyramphus validus</i> (Lichtenstein, 1823)	Crested Becard	X			REG	MPR	LC/LC/LC	



Taxon	English name	Quan.	Qual.	Data.	Phys.	Mig.	Conserv. status	Traf.
<b>Platyrrhynchidae</b>								
<i>Platyrrhynchus mystaceus</i> Vieillot, 1818	White-throated Spadebill	X			SEM		LC/LC/LC	
<b>Rhynchocyclidae</b>								
<i>Leptopogon amaurocephalus</i> Tschudi, 1846	Sepia-capped Flycatcher	X			SEM		LC/LC/LC	
<i>Corythopis delalandi</i> Tschudi, 1844	Ringed Antpipit	X			SEM		LC/LC/LC	
<i>Tolmomyias sulphurescens</i> (Spix, 1825)	Yellow-olive Flycatcher		X		SEM		LC/LC/LC	
<i>Todirostrum poliocephalum</i> (Wied, 1831) <sup>ATL</sup>	Gray-headed Tody-Flycatcher	X			SEM		LC/LC/LC	
<i>Todirostrum cinereum</i> (Linnaeus, 1766)	Common Tody-Flycatcher	X			UBQ		LC/LC/LC	
<i>Poecilotriccus latirostris</i> (Pelzeln, 1868)	Rusty-fronted Tody-Flycatcher	X			CER		LC/LC/LC	
<i>Hemitriccus margaritaceiventer</i> (d'Orbigny & Lafresnaye, 1837)	Pearly-vented Tody-tyrant	X			CER		LC/LC/LC	
<b>Tyrannidae</b>								
<i>Hirundinea ferruginea</i> (Gmelin, 1788)	Cliff Flycatcher	X			REG		LC/LC/LC	
<i>Camptostoma obsoletum</i> (Temminck, 1824)	Southern Beardless-Tyrannulet	X			UBQ		LC/LC/LC	
<i>Elaenia flavogaster</i> (Thunberg, 1822)	Yellow-bellied Elaenia	X			UBQ		LC/LC/LC	
<i>Elaenia mesoleuca</i> (Deppe, 1830)	Olivaceous Elaenia	X			REG		LC/LC/LC	
<i>Elaenia obscura</i> (d'Orbigny & Lafresnaye, 1837)	Highland Elaenia	X			CER		LC/LC/LC	
<i>Myiopagis viridicata</i> (Vieillot, 1817)	Greenish Elaenia	X			SEM	MPR	LC/LC/LC	
<i>Phaeomyias murina</i> (Spix, 1825)	Mouse-colored Tyrannulet	X			CER		LC/LC/LC	
<i>Serpophaga subcristata</i> (Vieillot, 1817)	White-crested Tyrannulet	X			UBQ		LC/LC/LC	
<i>Legatus leucophaius</i> (Vieillot, 1818)	Piratic Flycatcher	X			REG	MPR	LC/LC/LC	
<i>Myiarchus swainsoni</i> Cabanis & Heine, 1859	Swainson's Flycatcher	X			UBQ	MPR	LC/LC/LC	
<i>Myiarchus ferox</i> (Gmelin, 1789)	Short-crested Flycatcher	X			UBQ		LC/LC/LC	
<i>Sirystes sibilator</i> (Vieillot, 1818)	Sibilant Sirystes	X			REG		LC/LC/LC	
<i>Casiornis rufus</i> (Vieillot, 1816)	Rufous Casiornis	X			REG	MPR	LC/LC/LC	
<i>Pitangus sulphuratus</i> (Linnaeus, 1766)	Great Kiskadee	X			UBQ	MPR	LC/LC/LC	
<i>Myiodynastes maculatus</i> (Stadius Müller, 1776)	Streaked Flycatcher	X			UBQ	MPR	LC/LC/LC	
<i>Megarynchus pitangua</i> (Linnaeus, 1766)	Boat-billed Flycatcher	X			UBQ		LC/LC/LC	
<i>Myiozetetes similis</i> (Spix, 1825)	Social Flycatcher	X			UBQ		LC/LC/LC	
<i>Tyrannus melancholicus</i> Vieillot, 1819	Tropical Kingbird	X			UBQ	MPR	LC/LC/LC	
<i>Tyrannus savana</i> Daudin, 1802	Fork-tailed Flycatcher	X			REG/CER	MPR	LC/LC/LC	
<i>Griseotyrannus aurantioatrocristatus</i> (d'Orbigny & Lafresnaye, 1837)	Crowned Slaty Flycatcher	X			REG	MPR	LC/LC/LC	
<i>Empidonomus varius</i> (Vieillot, 1818)	Variagated Flycatcher	X			REG/CER	MPR	LC/LC/LC	
<i>Colonia colonus</i> (Vieillot, 1818)	Long-tailed Tyrant	X					LC/LC/LC	
<i>Myiophobus fasciatus</i> (Stadius Müller, 1776)	Bran-colored Flycatcher	X			SEM	MPR	LC/LC/LC	
<i>Pyrocephalus rubinus</i> (Boddaert, 1783)	Vermilion Flycatcher	X			REG/CER	MPR	LC/LC/LC	
<i>Fluvicola nengeta</i> (Linnaeus, 1766)	Masked Water-Tyrant	X			WET		LC/LC/LC	
<i>Gubernetes yetapa</i> (Vieillot, 1818)	Streamer-tailed Tyrant	X			WET		LC/LC/LC	
<i>Cnemotriccus fuscatus</i> (Wied, 1831)	Fuscous Flycatcher	X			REG/CER		LC/LC/LC	
<i>Lathrotriccus euleri</i> (Cabanis, 1868)	Euler's Flycatcher	X			REG/CER	MPR	LC/LC/LC	
<i>Xolmis cinereus</i> (Vieillot, 1816)	Gray Monjita	X			REG		LC/LC/LC	
<i>Xolmis velatus</i> (Lichtenstein, 1823)	White-rumped Monjita	X			REG		LC/LC/LC	
<b>Vireonidae</b>								
<i>Cyclarhis gujanensis</i> (Gmelin, 1789)	Rufous-browed Peppershrike	X			UBQ		LC/LC/LC	
<i>Hylophilus amaurocephalus</i> (Nordmann, 1835)	Gray-eyed Greenlet	X			CER		LC/LC/LC	
<i>Vireo chivi</i> (Vieillot, 1817)	Chivi Vireo	X			UBQ	MPR	LC/LC/LC	
<b>Corvidae</b>								
<i>Cyanocorax cristatellus</i> (Temminck, 1823) <sup>CER</sup>	Curl-crested Jay	X			CER		LC/LC/LC	X
<i>Cyanocorax chrysops</i> (Vieillot, 1818)	Plush-crested Jay	X			UBQ		LC/LC/LC	X
<b>Hirundinidae</b>								
<i>Pygochelidon cyanoleuca</i> (Vieillot, 1817)	Blue-and-white Swallow	X			UBQ		LC/LC/LC	
<i>Stelgidopteryx ruficollis</i> (Vieillot, 1817)	Southern Rough-winged Swallow	X			REG	MPR	LC/LC/LC	
<i>Progne tapera</i> (Vieillot, 1817)	Brown-chested Martin	X			REG	MPR	LC/LC/LC	
<i>Progne chalybea</i> (Gmelin, 1789)	Gray-breasted Martin	X			REG	MPR	LC/LC/LC	
<b>Troglodytidae</b>								
<i>Troglodytes musculus</i> Naumann, 1823	Southern House Wren	X			REG		LC/LC/LC	
<b>Donacobiidae</b>								
<i>Donacobius atricapilla</i> (Linnaeus, 1766)	Black-capped Donacobius	X			WET		LC/LC/LC	
<b>Turdidae</b>								
<i>Turdus leucomelas</i> Vieillot, 1818	Pale-breasted Thrush	X			UBQ		LC/LC/LC	X

Taxon	English name	Quan.	Qual.	Data.	Phys.	Mig.	Conserv. status	Traf.
<i>Turdus rufiventris</i> Vieillot, 1818	Rufous-bellied Thrush	X			SEM		LC/LC/LC	X
<i>Turdus amaurochalinus</i> Cabanis, 1850	Creamy-bellied Thrush	X			UBQ		LC/LC/LC	X
<i>Turdus subalaris</i> (Seebohm, 1887) <sup>ATL</sup>	Eastern Slaty Thrush	X			SEM	MPR	LC/LC/LC	
<i>Turdus albicollis</i> Vieillot, 1818	White-necked Thrush	X			SEM	MPR	LC/LC/LC	X
<b>Mimidae</b>								
<i>Mimus saturninus</i> (Lichtenstein, 1823)	Chalk-browed Mockingbird	X			REG		LC/LC/LC	
<b>Passerellidae</b>								
<i>Zonotrichia capensis</i> (Statius Müller, 1776)	Rufous-collared Sparrow	X			REG		LC/LC/LC	X
<i>Ammodramus humeralis</i> (Bosc, 1792)	Grassland Sparrow	X			REG		LC/LC/LC	X
<i>Arremon flavirostris</i> Swainson, 1838	Saffron-billed Sparrow	X			SEM		LC/LC/LC	X
<b>Parulidae</b>								
<i>Setophaga pitiayumi</i> (Vieillot, 1817)	Tropical Parula	X			SEM		LC/LC/LC	
<i>Geothlypis aequinoctialis</i> (Gmelin, 1789)	Masked Yellowthroat	X			WET		LC/LC/LC	
<i>Basileuterus culicivorus</i> (Deppe, 1830)	Golden-crowned Warbler	X			UBQ		LC/LC/LC	
<i>Myiothlypis flaveola</i> Baird, 1865	Flavescent Warbler	X			UBQ		LC/LC/LC	
<b>Icteridae</b>								
<i>Cacicus haemorrhous</i> (Linnaeus, 1766)	Red-rumped Cacique	X			SEM		LC/LC/LC	X
<i>Icterus pyrrhopterus</i> (Vieillot, 1819)	Variable Oriole	X			REG		LC/LC/LC	X
<i>Gnorimopsar chopi</i> (Vieillot, 1819)	Chopi Blackbird	X			REG		LC/LC/LC	X
<i>Amblyramphus holosericeus</i> (Scopoli, 1786)	Scarlet-headed Blackbird	X			WET		LC/LC/LC	
<i>Chrysomus ruficapillus</i> (Vieillot, 1819)	Chestnut-capped Blackbird	X			WET		LC/LC/LC	X
<i>Pseudoleistes guirahuro</i> (Vieillot, 1819)	Yellow-rumped Marshbird	X			REG/WET		LC/LC/LC	X
<i>Molothrus bonariensis</i> (Gmelin, 1789)	Shiny Cowbird	X			REG		LC/LC/LC	X
<b>Thraupidae</b>								
<i>Pipraeidea melanonota</i> (Vieillot, 1819)	Fawn-breasted Tanager	X			SEM		LC/LC/LC	
<i>Schistochlamys melanopsis</i> (Latham, 1790)	Black-faced Tanager	X			REG		LC/LC/LC	X
<i>Schistochlamys ruficapillus</i> (Vieillot, 1817)	Cinnamon Tanager	X			REG		LC/LC/LC	X
<i>Paroaria capitata</i> (d'Orbigny & Lafresnaye, 1837)	Yellow-billed Cardinal	X			REG		LC/LC/LC	X
<i>Tangara sayaca</i> (Linnaeus, 1766)	Sayaca Tanager	X			REG		LC/LC/LC	X
<i>Tangara palmarum</i> (Wied, 1821)	Palm Tanager	X			UBQ		LC/LC/LC	X
<i>Tangara cayana</i> (Linnaeus, 1766)	Burnished-buff Tanager	X			UBQ		LC/LC/LC	X
<i>Nemosia pileata</i> (Boddaert, 1783)	Hooded Tanager	X			UBQ		LC/LC/LC	
<i>Conirostrum speciosum</i> (Temminck, 1824)	Chestnut-vented Conebill	X			UBQ		LC/LC/LC	
<i>Sicalis flaveola</i> (Linnaeus, 1766)	Saffron Finch	X			REG		LC/LC/LC	X
<i>Hemithraupis guira</i> (Linnaeus, 1766)	Guira Tanager	X			SEM		LC/LC/LC	
<i>Volatinia jacarina</i> (Linnaeus, 1766)	Blue-black Grassquit	X			REG		LC/LC/LC	X
<i>Eucometis penicillata</i> (Spix, 1825)	Gray-headed Tanager	X			SEM		LC/LC/LC	
<i>Trichothraupis melanops</i> (Vieillot, 1818)	Black-goggled Tanager	X			SEM		LC/LC/LC	
<i>Coryphospingus cucullatus</i> (Statius Müller, 1776)	Red-crested Finch	X			REG		LC/LC/LC	X
<i>Tachyphonus coronatus</i> (Vieillot, 1822) <sup>ATL</sup>	Ruby-crowned Tanager	X			SEM		LC/LC/LC	X
<i>Ramphocelus carbo</i> (Pallas, 1764)	Silver-beaked Tanager	X			SEM/CER		LC/LC/LC	X
<i>Tersina viridis</i> (Illiger, 1811)	Swallow Tanager	X			UBQ	MPR	LC/LC/LC	
<i>Dacnis cayana</i> (Linnaeus, 1766)	Blue Dacnis	X			UBQ		LC/LC/LC	X
<i>Coereba flaveola</i> (Linnaeus, 1758)	Bananaquit	X			UBQ		LC/LC/LC	
<i>Sporophila lineola</i> (Linnaeus, 1758)	Lined Seedeater	X			REG	MPR	LC/LC/LC	X
<i>Sporophila caerulea</i> (Vieillot, 1823)	Double-collared Seedeater	X			REG	MPR	LC/LC/LC	X
<i>Sporophila leucoptera</i> (Vieillot, 1817)	White-bellied Seedeater	X			WET		LC/LC/LC	X
<i>Sporophila angolensis</i> (Linnaeus, 1766)	Chestnut-bellied Seed-Finch	X			REG		LC/LC/LC	X
<i>Emberizoides herbicola</i> (Vieillot, 1817)	Wedge-tailed Grass-Finch	X			REG		LC/LC/LC	
<i>Saltatricula atricollis</i> (Vieillot, 1817) <sup>CER</sup>	Black-throated Saltator	X			REG		LC/LC/LC	X
<i>Saltator similis</i> d'Orbigny & Lafresnaye, 1837	Green-winged Saltator	X			SEM		LC/LC/LC	X
<b>Fringillidae</b>								
<i>Spinus magellanicus</i> (Vieillot, 1805)	Hooded Siskin	X			REG		LC/LC/LC	X
<i>Euphonia chlorotica</i> (Linnaeus, 1766)	Purple-throated Euphonia	X			UBQ		LC/LC/LC	X
<i>Euphonia violacea</i> (Linnaeus, 1758)	Violaceous Euphonia	X			SEM		LC/LC/LC	X
<b>Estrildidae</b>								
<i>Estrilda astrild</i> (Linnaeus, 1758) <sup>EX</sup>	Common Waxbill	X			REG		LC/LC/LC	
<b>Passeridae</b>								
<i>Passer domesticus</i> (Linnaeus, 1758) <sup>EX</sup>	House Sparrow	X			REG		LC/LC/LC	





**Figure 4.** Birds recorded during our survey at the JBMB. **A.** Roadside Hawk *Rupornis magnirostris* (point no. 16). **B.** Plumbeous Kite *Ictinea plumbea* (point no. 19). **C.** Snail Kite *Rostrhamus sociabilis* (point no. 14). **D.** White-wedged Piculet *Picumus albosquamatus* (point no. 06). **E.** Green-barred Woodpecker *Colaptes melanochloros* (point no. 22). **F.** Lineated Woodpecker *Dryocopus lineatus* (point no. 19).

### Species endemic to the Atlantic Forest

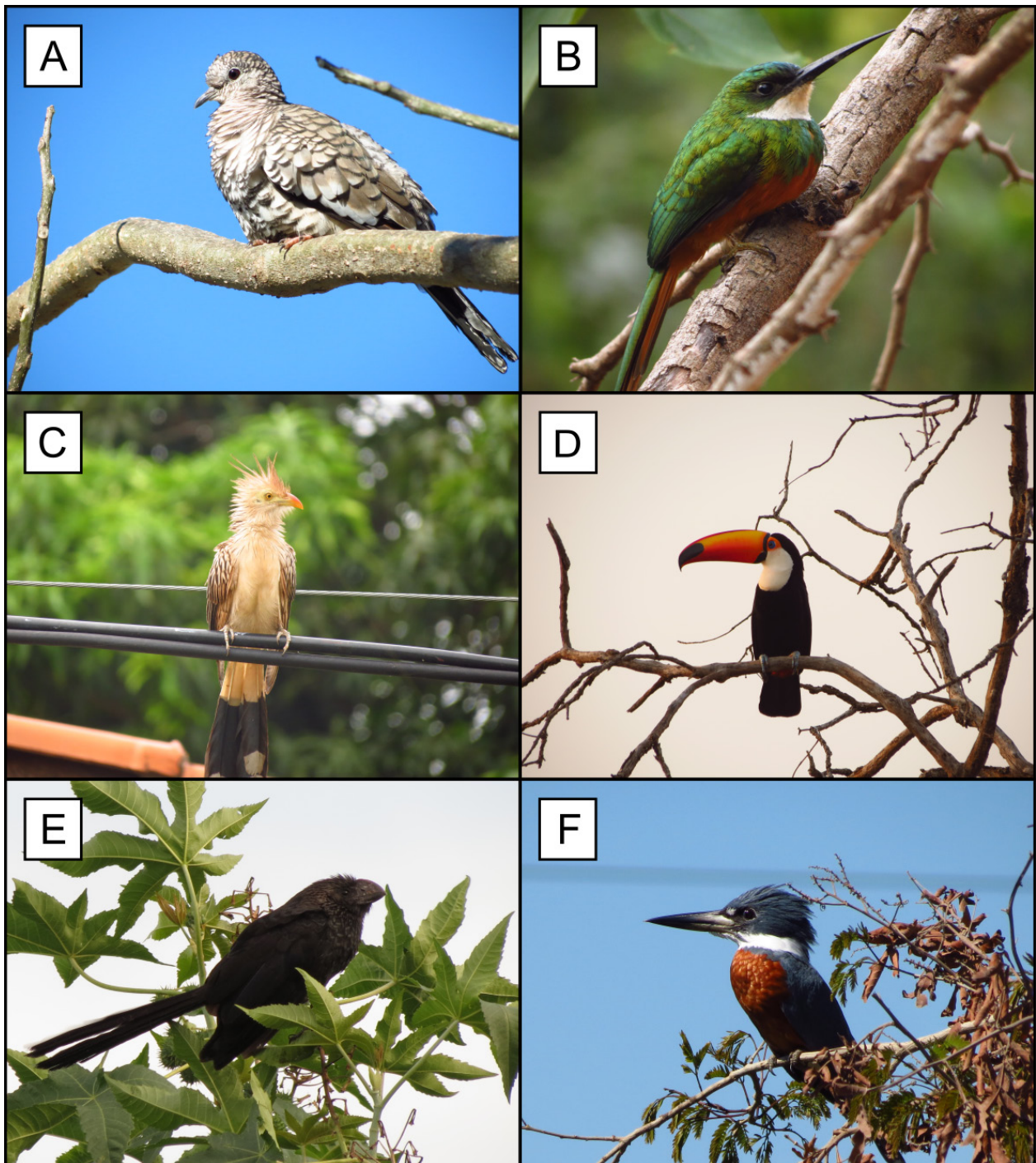
***Thalurania glaucopis* (Gmelin, 1788).** This species inhabits primary forest, forest edges, scrub, and suburban areas, such as parks and gardens (Weller 2018). It is an active nectarivore hummingbird and its presence is associated with the phenology of several plant species. During our surveys, we had only documented this species once, in April 2017, in a Semideciduous Forest area, at point no. 02.

***Baryphthengus ruficapillus* (Vieillot, 1818).** *B. ruficapillus* is associated with primary and Gallery Forests, and

is usually found in pairs or mixed flocks (Snow and Kirwan 2018). We documented it in a Semideciduous Forest near the Vargem Limpa River. Although there is evidence of population decline (BirdLife International 2018), it is abundant in the Semideciduous Forests of the surveyed area. We recorded it at points no. 02, 03, and 04.

***Conopophaga lineata* (Wied, 1831).** The species is mostly associated with Ombrophilous Forest, and is regularly found in well-developed secondary growth and Gallery Forests. In São Paulo state, it is associated with humid





**Figure 5.** Birds recorded during our survey at the JBMB. **A.** Scaled Dove *Columbina squammata* (point no. 19). **B.** Rufous-tailed Jacamar *Galbula ruficauda* (point no. 04). **C.** Guira Cuckoo *Guira guira* (point no. 01). **D.** Toco Toucan *Ramphastos toco* (point no. 12). **E.** Smooth-billed Ani *Crotophaga ani* (point no. 22). **F.** Ringed Kingfisher *Megasceryle torquata* (point no. 15).

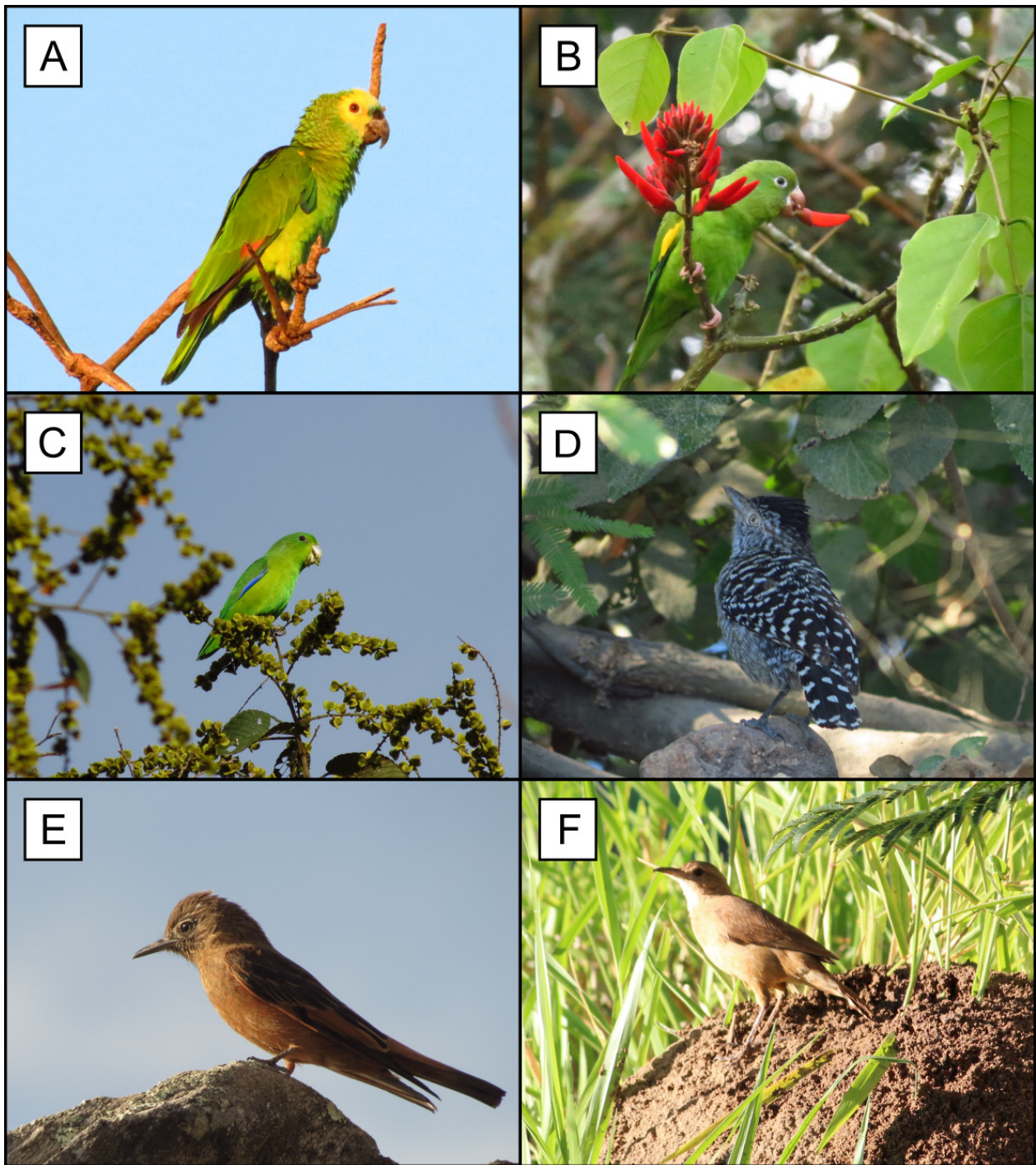
forests and preferentially inhabits bamboo thickets and dense growth (Whitney 2018). In the JBMB, we observed a pair of birds near a nest next to the main trail, which were observed for several months in 2017 at point no. 03.

***Automolus leucophthalmus* (Wied, 1821).** This species inhabits closed and humid areas, and is found in understory branches near the ground up to the midcanopy. *A. leucophthalmus* plays an important role in the formation of mixed flocks, and it is one of the species responsible for the maintenance of group cohesion (Remsen Jr and

Kirwan 2018). It is quite common in Brazil, Paraguay, and Argentina (Sick 1997) and it was observed over several months during our surveys, mostly in the humid areas of the Semideciduous Forest, at points no. 02, 25, and 26.

***Todirostrum poliocephalum* (Wied, 1831).** *T. poliocephalum* inhabits the canopy (Sick 1997) and the edges of humid forests, adjacent clearings, and even gardens (Walther 2018). It forages near the ground and in the canopy of low-growing trees. It is not dependent on





**Figure 6.** Birds recorded during our survey at the JBMB. **A.** Turquoise-fronted Parrot *Amazona aestiva* (point no. 16). **B.** Yellow-chevrons Parakeet *Brotogeris chiriri* (point no. 13). **C.** Blue-winged Parrotlet *Forpus xanthopterygius* (point no. 17). **D.** Barred Antshrike *Thamnophilus doliatus* (point no. 06). **E.** Cliff Flycatcher *Hirundinea ferruginea* (point no. 01). **F.** Rufous Hornero *Furnarius rufus* (point no. 19).

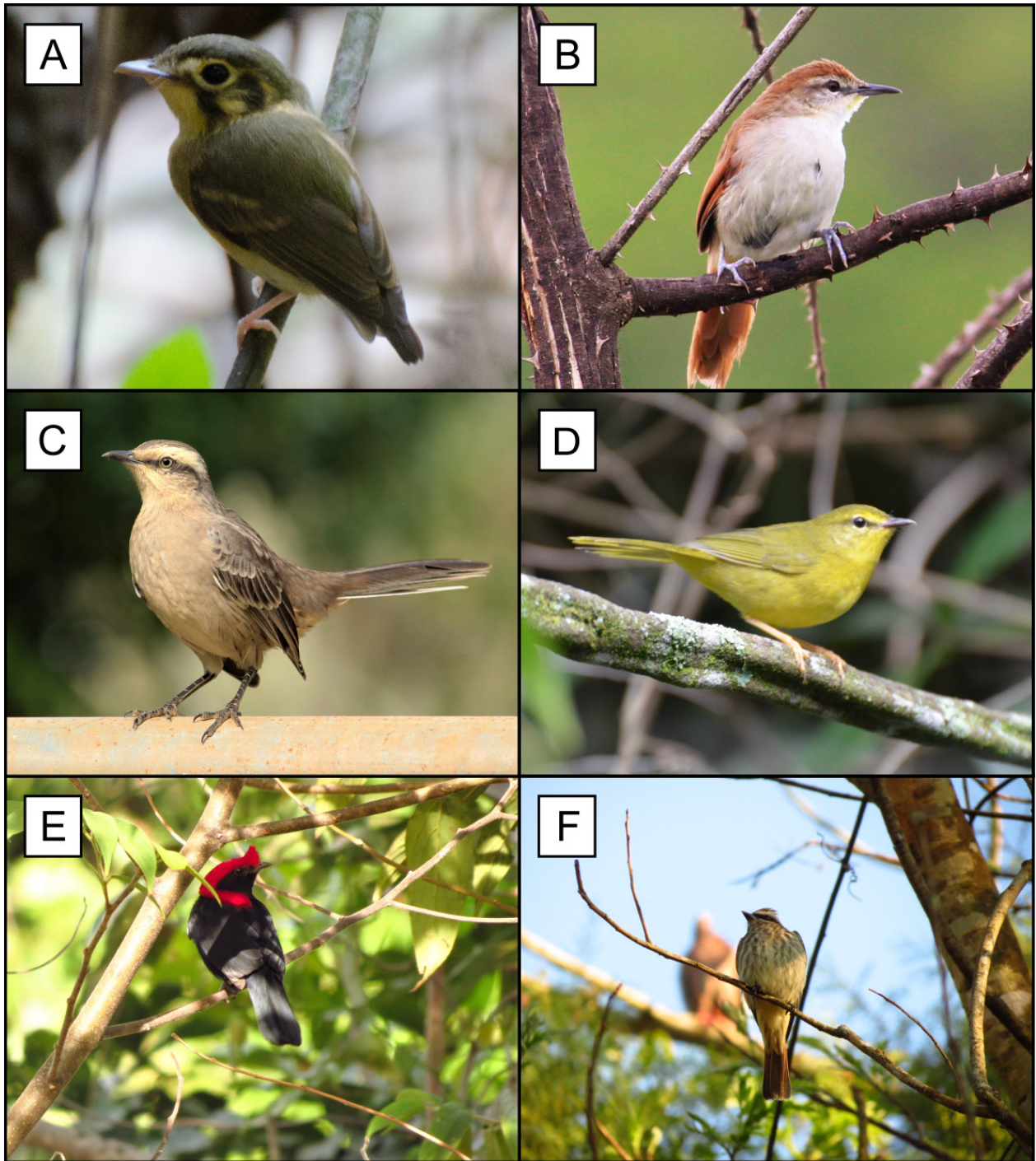
preserved environments, and it might inhabit human-dominated areas with significant tree cover (Sick 1997). We observed it in the JBMB once (December 2016), near flooded fields associated with the Vargem Limpa River. It was recorded at point no. 03.

***Turdus subalaris* (Seebohm, 1887).** *T. subalaris* inhabits Subtropical Humid Forests, secondary forests, eucalyptus plantations with understory native vegetation, and Riparian Forests with dense shrub vegetation (Sick 1997). This species is omnivorous, feeding mainly on

fruits and supplement its diet with insect prey. It is a migratory species, arriving in southeastern Brazil in mid-September and departing in April (del Hoyo and Collar 2018). In the JBMB, we observed this species in Semideciduous Forest and Forest Savanna during March and April of 2016 and 2017. The species was recorded at points no. 05 and 06.

***Tachyphonus coronatus* (Vieillot, 1822).** This is a species typical from southeastern Brazil, and inhabits humid forests, clearings, and parks. This species visits





**Figure 7.** Birds recorded during our survey at the JBMB. **A.** Eastern White-throated Spadebill *Platyrinchus mystaceus* (point no. 03). **B.** Yellow-chinned Spinetail *Certhiaxis cinnamomeus* (point no. 13). **C.** Chalk-browed Mockingbird *Mimus saturninus* (point no. 19). **D.** Flavescent Warbler *Myiothlypis flaveola* (point no. 5). **E.** Helmeted Manakin *Antilophia galeata* (point no. 08). **F.** Variegated Flycatcher *Empidonomus varius* (point no. 18).

fruiting plants and lives near them, avoiding the need for long flights. It forages both in the higher strata and close to the ground (Hilty 2018). This species was observed in the Riparian Forest near the entrance to the main trail and was recorded at point no. 03.

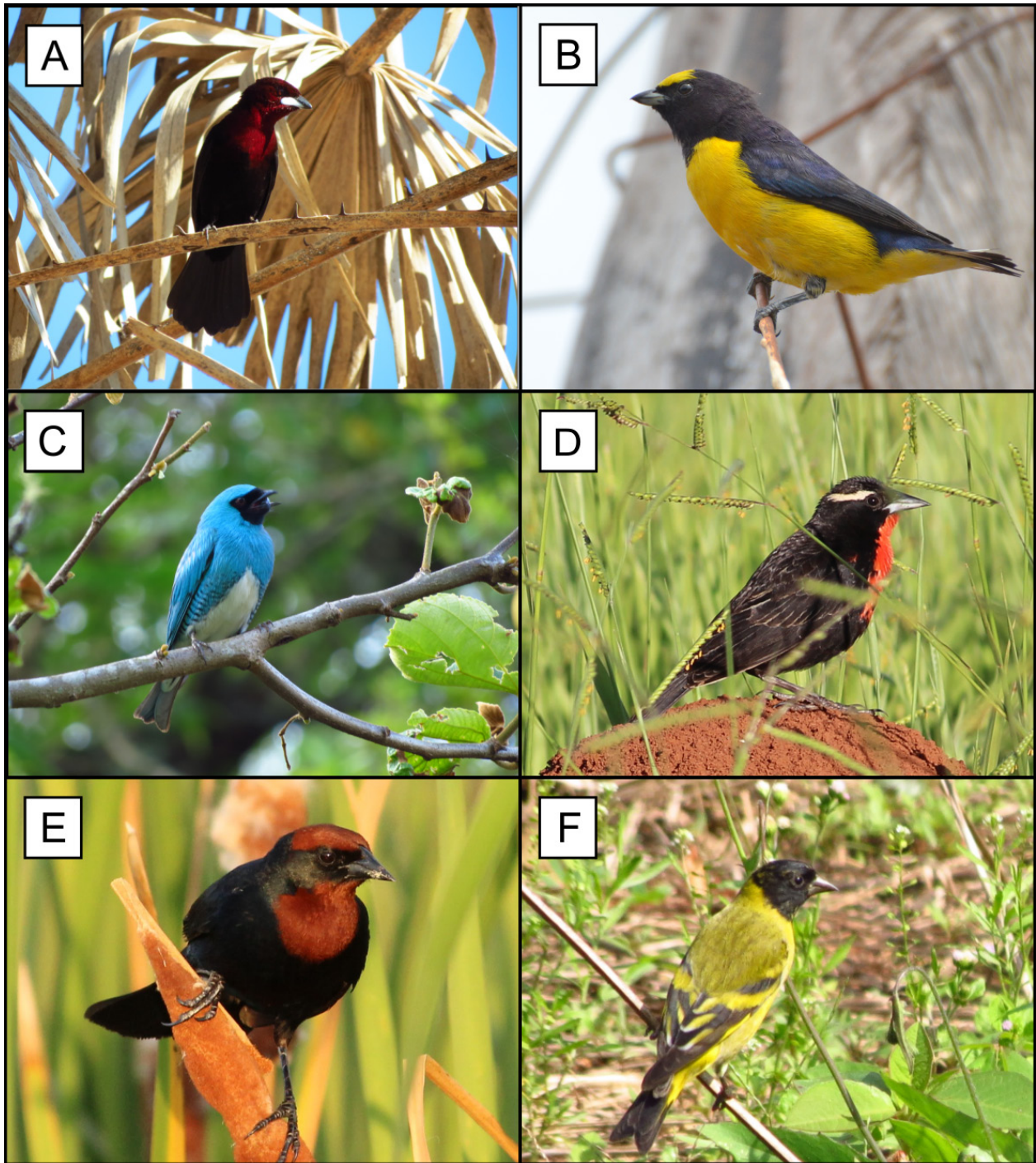
#### Cerrado endemic species

***Herpsilochmus longirostris* Pelzeln, 1868.** This species is found in Bolivia and Brazil, and occupies forests from the understory to canopy in Gallery, Deciduous,

and Semideciduous Forests. It is generally found in fragments surrounded by Savanna vegetation. It forages with mixed flocks and exhibits systematical behavior, searching for insects over a whole tree before moving on to the next one. This species is regionally threatened in São Paulo state (São Paulo 2018). In the JBMB, we observed this species in the Semideciduous Flooded Forest at points no. 26 and 27.

***Antilophia galeata* (Lichtenstein, 1823).** This species is found in Gallery Forests and Savannas, and is





**Figure 8.** Birds recorded during our survey at the JBMB. **A.** Silver-beaked Tanager *Ramphocelus carbo* (point no. 3). **B.** Purple-throated Euphonia *Euphonia chlorotica* (point no. 10). **C.** Swallow Tanager *Tersina viridis* (point no. 06). **D.** White-browed Meadowlark *Sturnella superciliaris* (point no. 16). **E.** Chestnut-capped Blackbird *Chrysomus ruficapillus* (point no. 13). **F.** Hooded Siskin *Spinus magellanicus* (point no. 19).

common in Deciduous Forests, buriti (*Mauritia flexuosa* L.f.) palm grooves, and swampy woodland (Snow and de Juana 2018). It has an abundant population in the JBMB, as it is found from primary forests to regeneration areas. It was recorded at points no. 06, 07, 08, and 09.

***Cyanocorax cristatellus* (Temminck, 1823).** *C. cristatellus* inhabits dry Cerrado forests, but it is also associated with riparian woods, forest edges, and clearing areas with sparse vegetation. It is found in many modified landscapes, including eucalyptus plantations,

borders, and gardens (Anjos 2018). Although it is considered endemic to the Cerrado domain, the distribution of this species has expanded to areas of Atlantic Forest (Dário et al. 2002). We observed this species over several months on Forest Savanna edges at point no. 21.

***Saltatricula atricollis* (Vieillot, 1817).** This is a Cerrado-endemic species that possibly also dwells in the Cerrado enclaves in the Pantanal and Caatinga domains (Pacheco 2003). In São Paulo state, it is mainly threatened by fragmentation and the loss of native areas,



which are transformed into pastures and agricultural areas. This species was found in several different months during our surveys, and was mostly observed in areas undergoing regeneration, near to points no. 20 and 21.

**Threatened species.** We found 1 species threatened at a global (IUCN 2019), 2 at a national (ICMbio/MMA 2018), and 8 at a regional level (São Paulo 2018).

***Primolius maracana* (Vieillot, 1816).** Globally and nationally Near Threatened, and regionally Vulnerable. This species lives in Tropical Evergreen Forests, palm groves, and gallery woodlands (Collar et al. 2018a). However, in São Paulo state, the native forest vegetation is restricted to small fragments (Nunes and Galetti 2007), decreasing its area of occurrence. *P. maracana* also has low genetic variability (Craveiro and Miyaki 2000), which further threatens its survival. Natural habitat loss and traffic activities are the main factors increasing its risk of extinction (Juniper and Parr 1998). In the JBMB, we directly observed and heard the species only once, in a wetland near the Vargem Limpa River in August 2016, outside the point counts (22°20'39"S, 049°00'54"W).

***Amazona aestiva* (Linnaeus, 1758).** Nationally and regionally Near Threatened. This species inhabits Cerrado, Chacos, and subtropical forests, and is restricted to primary forests with sufficiently tall trees for nesting (Collar et al. 2018b). It has been affected by illegal capture and traffic since the 1980s (BirdLife International 2018) and has suffered population decline due to fragmentation and deforestation (Collar et al. 2018b). It was recorded next to the JBMB main trail, at point no. 02.

***Rhynchotus rufescens* (Temminck, 1815).** Regionally Endangered. The species inhabits areas up to 2500 m above sea level. In tropical lowlands, it shows preference for wet grasslands and Savanna woodland. It is primarily an insectivore, but it also feeds on seeds, fruits, roots, and bulbs when insects are scarce. *R. rufescens* is considered sedentary and is subject to poaching for its meat. Populations in Brazil are in steady decline due to hunting pressures associated with habitat loss and poisoning by insecticides (Cabot et al. 2019). In the JBMB, we found this species in open grasslands in the regenerating area, especially at points no. 20–23.

***Penelope superciliaris* (Temminck, 1815).** Regionally Near Threatened. *P. superciliaris* occupies a wide range of vegetal physiognomies, from Cerrado to dense and humid forests. It is a large generalist frugivore that forages in flocks of up to 10 individuals, maintaining a sedentary habit. It exhibits no major movement patterns throughout its life (del Hoyo and Kirwan 2018). In the JBMB, the species is abundant in Semideciduous Forest and was recorded at points no. 02–04.

***Heliornis fulica* (Boddaert, 1783).** Regionally Endangered. This species lives in dense vegetation on the margins of water bodies (Bertram and Kirwan 2018), and

the loss of riparian habitats is the main threat to its survival (Bressan 2009). There are few records of this species in São Paulo state, which makes its presence in the JBMB extremely valuable. We found one individual in a lake located on the western border of the JBMB, in its limit with the Municipal Zoological Garden of Bauri (22°20'31"S, 049°01'02"W).

***Crotophaga major* Gmelin, 1788.** Regionally Near Threatened. This species is relatively demanding regarding habitat quality, with few records existing in the state, because it is commonly found in aquatic macrophytes and hanging vegetation above water (Payne and de Juana 2018). The loss of most Riparian Forests due to construction of hydroelectric power plants in São Paulo state led to a significant decrease in its populations. This species was recorded in the JBMB surveys, in which 2 researchers reported the presence of 3 individuals in an area adjacent to Semideciduous Flooded Forest in November 2016 (22°20'40"S, 049°01'04"W).

***Bubo virginianus* (Gmelin, 1788).** Regionally Endangered. *B. virginianus* occupies forested habitats, such as Semideciduous Forests, secondary forests, and urban city parks. *B. virginianus* usually forages in open areas and feeds on insects, fishes, amphibians, birds, and small mammals. It is a resident species, although it includes some outlier subspecies populations migrating from North America when resources are scarce (Holt et al. 2018). Although it is not threatened at a global scale, it is considered Endangered in São Paulo due to population decline (São Paulo 2018). We recorded this species over several months, both in Forest Savanna and Semideciduous Forest, at points no. 03 and 12.

***Herpsilochmus longirostris* Pelzeln, 1868.** Regionally Near Threatened and a Cerrado endemic. See the previous section on endemic species.

***Neopelma pallescens* (Lafresnaye, 1853).** Regionally Near Threatened. This species is common in dense and tangled vegetation (Snow 2018), especially in Semideciduous and Gallery Forests. It inhabits the midstory stratum of Forest Savanna (1–5 m from the ground) and feeds mainly on insects and fruits (Willis and Oniki 2003). Because the species has narrowly defined habitat preferences, the main threats to it are related to fragmentation and habitat loss in São Paulo state. Therefore, *N. pallescens* is considered Endangered on the São Paulo Red List (São Paulo 2018). We recorded this species over 2 consecutive months (August and September 2017) in Forest Savanna remnants at points no. 08 and 09.

**Discrimination between congeneric taxa.** We recorded some congeneric species that are difficult to differentiate during surveys. Here, we list the diagnostic features that allowed these species to be distinguished, based on Grantsau (2010).

***Crypturellus obsoletus*, *Crypturellus parvirostris*, and *Crypturellus tataupa*.** We identified these species based on song. *C. tataupa* has a vocalization with trilled notes descending in frequency, which tends to be shorter than the songs of the other two species. *C. parvirostris* has long songs with whistled notes that are repeated in acceleration, ending in a decline in frequency and with repeated trilled notes at the end of the vocalization. *C. obsoletus* produces vocalizations with structure similar to *C. parvirostris*, but the final portion of its vocalization ends abruptly, with no repetition of notes. *C. obsoletus* was recorded at point no. 02, *C. parvirostris* was recorded at point no. 12, and *C. tataupa* was recorded at point no. 16.

***Laterallus viridis* and *Laterallus melanophaius*.** Both species were identified by their songs. While *L. melanophaius* has a fast-trilling vocalization, *L. viridis* songs have introductory notes, with a slower pace of elements. *L. melanophaius* was found at point no. 15, while *L. viridis* was found at point no. 01.

***Leptotila verreauxi* and *Leptotila rufaxilla*.** *L. verreauxi* has a crown and neck with a greenish glow, olive-brown upper part, and a pale gray underpart that becomes white on the belly, and vocalizations with 2 low-frequency notes. In contrast, *L. rufaxilla* has a bluish gray crown, nape, and hindneck with a grayish purple glow, dark-brown upper part, and a greyish pink underpart that becomes white on the belly, and low-pitched vocalizations with just 1 descending note. Both species was found at points no. 02–07.

***Crotophaga major* and *Crotophaga ani*.** While *C. ani* has a uniform black color from the bill to the tail, *C. major* has dark-blue underparts and upper parts with a greenish sheen, prominent culmen, and white iris. We found *C. major* in a flooded field (22°20'40"S, 049°01'04" W) and *C. ani* in the open area of Savanna in regeneration, at points 17–24.

***Herpsilochmus atricapillus* and *Herpsilochmus longirostris*.** We found each species in distinct habitats. *H. atricapillus* was only present in Forest Savanna, while *H. longirostris* was only present in a fragment of Semideciduous Flooded Forest. Female individuals of *H. atricapillus* have a black crown streaked with white dots, and a buff tinge on the breast, flank, and crissum. Meanwhile, females of *H. longirostris* have a bright orange head and neck, and bright-cinnamon underparts. We found *H. atricapillus* at points no. 03 and 07, while *H. longirostris* was found at points no. 25–28.

***Todirostrum poliocephalum* and *Todirostrum cinereum*.** Both species are distinguished by the bright yellow supraloral mark, which is present in *T. poliocephalum* and absent in *T. cinereum*. Furthermore, songs of *T. poliocephalum* have slower trill rates than those of *T. cinereum*. We found *T. poliocephalum* at point no. 03 and *T. cinereum* at points no. 03–07.

***Elaenia flavogaster*, *Elaenia mesoleuca*, and *Elaenia obscura*.** These species have similar morphology. *E. obscura* was only found in a forest area, while *E. flavogaster* and *E. mesoleuca* were found in a regeneration area. Morphologically, *E. mesoleuca* and *E. flavogaster* are quite similar, differing in the crest (present only in *E. flavogaster*) and in the color of their underparts (greyish olive breast and pale yellow belly in *E. flavogaster*, and dull olive breast and greyish white belly in *E. mesoleuca*). In contrast, *E. obscura* is noticeably bigger than the other species, and has a remarkably short bill and darker upper parts than the other species. We recorded *E. flavogaster* at points no. 13–24, *E. mesoleuca* at points no. 23–24, and *E. obscura* at point no. 09.

***Myiarchus ferox* and *Myiarchus swainsoni*.** Like the *Elaenia* spp., *Myiarchus* spp. have similar external morphology. Therefore, these congeneric species were distinguished based on their vocalizations. *M. ferox* has trilled elements in its song, while *M. swainsoni* produces short and frequency-modulated notes that sounds like a “hiccup.” We recorded *M. ferox* at the edges of Semideciduous Forest (points no. 01 and 02), in the Forest Savanna (points 05–10), and in the regenerating area (points 17–24). We recorded *M. swainsoni* in the last points of the regenerating area (points 20–24).

***Euphonia chlorotica* and *Euphonia violacea*.** These species are distinguished by the color of their throats. *E. chlorotica* has a dark-metallic blue throat, while *E. violacea* has a golden yellow throat. *E. chlorotica* was found at points no. 02–10, while *E. violacea* was only found at point no. 05.

## Discussion

Our results demonstrate that JBMB have a high species richness, which might be related to its location in the transitional area between the Atlantic Forest and Cerrado domains. We identified 9 species that are subject to some degree of threat and 11 endemic species (7 from Atlantic Forest and 4 from Cerrado). In addition, 31 species exhibited some degree of migratory behavior.

When comparing our results to other surveys in Semideciduous Forests, it is evident that the richness of the JBMB is greater than that in the more extensive areas of the interior Atlantic Forests of São Paulo. Donatelli et al. (2007) reported the presence of 65 and 64 species in fragments of 350 and 480 ha of Semideciduous Forest, respectively. We must take into account that their sampling effort was smaller than ours, as they spent 80 h using point counts in secondary-growth forests. However, our study documented higher richness, even when compared to other studies with longer sampling efforts, such as Aleixo and Vielliard (1995), who recorded 97 species in a 251 ha remnant over 235 h using point counts. The elevated richness (220 bird species) in our study could be due to the diverse habitats of the JBMB, which encompasses Semideciduous Forests and other

Atlantic forest phytophysiognomies. Moreover, the high degree of anthropogenic activities in the surrounding areas might also enhance species richness by the inclusion of some resilient taxa to disturbed environments, especially in tropical environments (Aleixo 1999, Mulwa et al. 2012, Asefa et al. 2017).

Few studies have been conducted in Forest Savanna and have recorded much lower richness, with fewer than 100 species being associated exclusively with this physiognomy (Caverzere et al. 2011). More species were detected in studies that included other Savanna physiognomies, such as grasslands and shrublands. Manica et al. (2010) recorded 160 bird species in 472 ha Cerrado fragment over 95 h using qualitative surveys. However, of all of these species, only 28 were found in Forest Savanna physiognomy. Other studies encompassing more extensive areas over longer sampling periods obtained a similar number of species to our study. For instance, Motta-Júnior et al. (2008) recorded 231 species over 580 h of sampling in 2,300 ha of Cerrado grasslands using point counts. Lucindo et al. (2015) recorded 226 species in 380 h of sampling 2,712 ha mixed physiognomies of Cerrado using transect counts.

Of the non-passerines, the greatest number of species were represented by the families Trochilidae, Accipitridae, and Columbidae. Their presence is associated with the fragmented areas and their conspicuous behavior makes them easy to be detected during sampling (Sick 1997). Columbidae are predominantly granivores, while Accipitridae are carnivores. Such feeding behaviors are favored in open habitats, such as Forest Savanna and the regenerating areas of the JBMB (Chettri et al. 2004, Winkler et al. 2015). The richness of the Trochilidae is indicative of the abundance of floral resources, because species of this family are predominantly nectarivores (Wilman et al. 2014). The presence of several physiognomies in the study area might provide diverse flowering plants at different times of the year, especially in the transition periods between dry and rainy seasons (Pirani et al. 2009). Finally, the presence of a network of wetlands, lakes, and rivers in the study area favored the presence of species dependent on aquatic environments, such as those of the families Ardeidae and Rallidae (7 species each).

Among Passeriformes, Tyrannidae and Thraupidae had more species than the other families. The greatest number of species were represented by the families Both are typical of Neotropical bird communities, and the family Tyrannidae is one of the largest groups in the region (Ridgely and Tudor 1994, Sick 1997). This phenomenon might be associated with the generalist habit of several species in this family (Sick 1997), which allows them to access several types of habitats. On the other hand, several species of Thraupidae feed on fruits and act as seed dispersers (Ridgely and Tudor 1989) and are important for maintaining plant diversity. The richness of Thraupidae can also be associated with recent taxonomic changes proposed by Piacentini et al. (2015) which subsumed the

formerly separate Emberizidae and Coerebidae as sub-families within Thraupidae. This fusion increased the number of species of Thraupidae from 99 species to 173 species. Nonetheless, the richness of frugivorous and granivorous birds could indicate the variety of the habitats available in the region.

When comparing our survey to a previous survey on Forest Savanna in the JBMB area, we found 28 species that were not reported by Caverzere et al. (2011). Of these, we recorded 8 endemic species (5 to Atlantic Forest and 3 for Cerrado), and 2 threatened taxa, which are noteworthy records. However, these authors reported 10 species that we did not find during our study. Yet, we observed 8 of these species in other environments near the JBMB. The 2 other species unique to the survey by Caverzere et al. (2011) were *Leptodon cayanensis* and *Hylophilus poicilotis*. The absence of records on *L. cayanensis* in our survey might be related to its tends to occupy a large territory (Brown and Amadon 1989). Its movement across the landscape might make it difficult to record this species in the study area. In contrast, the record of *H. poicilotis* seems to be questionable, since we recorded only *Hylophilus amaurocephalus*, a very similar congeneric species. *H. amaurocephalus* was also recorded by Rangel de Almeida et al. (2010) at the Bauru Ecological Station, with this being the only record of the genus in the vicinity of our survey site. In addition, citizen science databases also show records of only *H. amaurocephalus* in Bauru (Wikiaves 2019). The nearest record of *H. poicilotis* is from the city of Campinas, located more than 200 km away from the JBMB (eBird 2019). In comparison, *H. amaurocephalus* is quite common in the meso-region of Bauru, with records in the nearby cities (eBird 2019). Therefore, we suggest that the record of *H. poicilotis* in the JBMB is incorrect, because the songs of these 2 species are similar. Because *H. poicilotis* is endemic to the Atlantic Forest (Bencke et al. 2006), it is not likely to inhabit an area of Forest Savanna, even in a transitional area such as the JBMB.

According to Somenzari et al. (2018), Brazil has 198 migratory species, which corresponds to approximately 10% of all species found in the country. In our surveys, we observed 31 species (14.1%) exhibiting migratory behavior. For species defined as migrants, the records of *Chordeiles minor* and *Chaetura meridionalis* are of note. *C. minor* reproduces in North and Central America, migrates to South America in September, and returns to its locations of origin in April (Cleere 2018). *C. meridionalis* reproduces in Brazil during the austral summer and migrates north to Panama, Venezuela, and French Guiana in the winter (del Hoyo et al., 2018).

Records of endemic species is important because they are negatively affected by habitat fragmentation and loss (Aleixo and Vielliard 1995, Anjos 2001). These species can be considered habitat specialists, and their presence in our survey can be an indicative of the quality of forest remnants. In the Semideciduous Forest, we recorded 7 Atlantic Forest endemics. Few endemic species were



recorded in our survey compared to other surveys: 33 spp. by Faria et al. (2006), 43 spp. by Ubaid (2009), and 22 spp. by Vianna et al. (2017). Antunes (2007) recorded the disappearance of 9 endemic species over 30 years in a fragment of Semideciduous Forest, while the abundance of another 9 species significantly declined. Alternatively, we recorded 4 Cerrado endemic species, which was more than that recorded by Cavarzere et al. (2011) at the same location; Cavarzere et al. recorded only *Antilophia galeata* as endemic to the Cerrado. Both *Cyanocorax cristatellus* and *Saltator atricollis* are Cerrado endemic species that we found exclusively in the regenerating area, which is because they normally inhabit open physiognomies of savanna. Cavarzere et al. (2011) did not find these species because they restricted their survey to closed physiognomies (forest savanna and semideciduous forest). Our study obtained a similar richness of endemic Cerrado taxa when compared to previous studies: 6 spp. by Motta-Júnior et al. (2008), 6 spp. by Manica et al. (2010), and 6 spp. by Lucindo et al. (2015). The presence of such endemic taxa could point to the capacity of the environment to provide sufficient resources across seasons (Antunes 2007) and might be related to the different stages of vegetation regeneration.

The richness of birds recorded in the JBMB might be related to the large area of continuous native forest (803 ha) and the presence of areas at different stages of forest regeneration. The number of species in a given location is associated with habitat heterogeneity, which is an important predictor of bird richness (Stein et al. 2014, Stirnemann et al. 2015) and is important for local community maintenance (Develey et al. 2010). A greater diversity of habitats is related to a greater diversity of resources, which supports a greater number of species. Thus, the regenerating area of the JBMB supports species exclusive to open areas, which dominate such places. Meanwhile, the savanna remnants surrounding the regenerating area could also contribute to increase the number of the species in this location, which could improve the regional richness by landscape supplementation (Dunning et al. 1992). Birds dwelling in closed environments could use the regeneration area to gather supplementary resources in adjacent boundaries (Tubelis et al. 2004, Brotons et al. 2005), which could explain the presence of forest-dwelling species in an open area.

In conclusion, the JBMB is an important area with a richness of bird species higher than other surrounding conservation units. Such richness is attributed to the transition between the Atlantic Forest and Cerrado, as well as to the variety of physiognomies and successional stages in the area favoring the distribution of several taxa within a restricted area. Although we only recorded few endemic and threatened species, these records demonstrate the capacity of the local environment to support species that require specific ecological resources. Our findings also contribute to the knowledge of avian richness in transitional areas, demonstrating the importance of this type of environment for the maintenance of bird diversity.

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## Author Contributions

GSC, RMV, and RWG contributed equally with the study design, data collection, discussion, and writing of the manuscript. RJD contributed with the supervision of this project, and with the correction of the final manuscript.

## References

- Aleixo A (1999) Effects of selective logging on a bird community in the Brazilian Atlantic Forest. *Revista Brasileira de Zoologia* 12 (3): 493–511. <https://doi.org/10.2307/1370183>
- Aleixo A, Vielliard JME (1995) Composição e dinâmica da avifauna da mata de Santa Genebra, Campinas, São Paulo, Brasil. *Revista Brasileira de Zoologia* 12 (3): 493–511. <https://dx.doi.org/10.1590/S0101-81751995000300004>
- Alvares CA, Staple JL, Sentelhas PC, Gonçalves JLM, Sparovek G (2013) Köppen's climate classification map for Brazil. *Meteorologische Zeitschrift* 22 (6): 711–728. <https://doi.org/10.1127/0941-2948/2013/0507>
- Anjos L (2001) Bird communities in five Atlantic Forest fragments in southern Brazil. *Ornitologia Neotropical* 12 (1): 11–27.
- Anjos L (2018) Curl-crested Jay (*Cyanocorax cristatellus*). *Handbook of the Birds of the World Alive*. Lynx Edicions, Barcelona. <https://www.hbw.com/node/60715>. Accessed on: 2018-1-29.
- Antunes AZ (2007) Riqueza e dinâmica de aves endêmicas da Mata Atlântica em um fragmento de floresta estacional semidecidual no sudeste do Brasil. *Revista Brasileira de Ornitologia* 15 (1): 61–68.
- Asefa A, Davies AB, McKechnie AE, Kinahan AA, van Rensburg BJ (2017) Effects of anthropogenic disturbance on bird diversity in Ethiopian Montane forests. *The Condor* 119 (3): 416–430. <https://doi.org/10.1650/CONDOR-16-81.1>
- Baker J, French K, Whelan RJ (2002) The edge effect and ecotonal species: bird communities across a natural edge in south-eastern Australia. *Ecology* 83 (11): 3048–3059. [https://doi.org/10.1890/0012-9658\(2002\)083\[3048:TEEAES\]2.0.CO;2](https://doi.org/10.1890/0012-9658(2002)083[3048:TEEAES]2.0.CO;2)
- Bauru (2000) Lei N° 4605, de 27 de novembro de 2000. Denomina e regulamenta os usos na Área de Proteção Ambiental Municipal Vargem Limpa – Campo Novo. [http://www2.bauru.sp.gov.br/arquivos/sist\\_juridico/documentos/leis/lei4605.pdf](http://www2.bauru.sp.gov.br/arquivos/sist_juridico/documentos/leis/lei4605.pdf). Accessed on: 2018-2-21.
- Bencke GA, Mauricio GN, Develey PF, Goerck JM (2006) Áreas importantes para a conservação das aves no Brasil: parte 1—estados do domínio da Mata Atlântica. *SAVE Brasil*, São Paulo, 494 pp.
- Bertram BCR, Kirwan GM (2018) *Sungrebe (Heliornis fulica)*. *Handbook of the Birds of the World Alive*. Lynx Edicions, Barcelona. <https://www.hbw.com/node/53707>. Accessed on: 2018-1-28.
- Blondel J, Ferry C, Frochot B (1981) Point counts with unlimited distance. *Studies in Avian Biology* 6: 414–420.
- Bressan PM, Kierulff MCM, Sugieda AM (2009) Fauna ameaçada de extinção no Estado de São Paulo. Fundação Parque Zoológico de São Paulo, Secretaria do Meio Ambiente, São Paulo. [http://www.ib.usp.br/~lfsilveira/pdf/l\\_2010\\_faunaextsp.pdf](http://www.ib.usp.br/~lfsilveira/pdf/l_2010_faunaextsp.pdf). Accessed on: 2018-3-15.
- Brewer D (2018) Black-throated Saltator (*Saltator atricollis*). *Hand-*

- book of the Birds of the World Alive. Lynx Edicions, Barcelona. <https://www.hbw.com/node/62206>. Accessed on: 2018-1-29.
- Brewer D (2018) Red-eyed Vireo (*Vireo olivaceus*). Handbook of the Birds of the World Alive. Lynx Edicions, Barcelona. <https://www.hbw.com/node/61266>. Accessed on: 2018-2-26.
- Brotons L, Wolff A, Paulus G, Martin JL (2005) Effect of adjacent agricultural habitat on the distribution of passerines in natural grasslands. *Biological Conservation* 124 (3): 407–414. <https://doi.org/10.1016/j.biocon.2005.01.046>
- Brown L, Amadon D (1989) Eagles, Hawks and Falcons of the World. Wellfleet, New York, 946 pp.
- Cabot J, Christie DA, Jutglar F, Sharpe CJ, Garcia EFJ (2019) Red-winged Tinamou (*Rhynchotus rufescens*). Handbook of the Birds of the World Alive. Lynx Edicions, Barcelona. <https://www.hbw.com/node/52438>. Accessed on: 2019-3-28.
- Cavazere V, Moraes GP, Dalbeto AC, de Maciel FG, Donatelli RJ (2011) The birds of the cerrado woodland, an overlooked forest of the Cerrado region. *Papéis Avulsos de Zoologia* 51 (17): 259–273. <http://dx.doi.org/10.1590/S0031-10492011001700001>
- Cavassan O (2013) Bauru: terra de cerrado ou floresta? *Ciência Geográfica* 17 (17): 46–54.
- Chettri N, Deb DC, Sharma E, Jackson R (2005) The relationship between bird communities and habitat. *Mountain Research and Development* 25 (3): 235–243. [https://doi.org/10.1659/0276-4741\(2005\)025\[0235:TRBBCA\]2.0.CO;2](https://doi.org/10.1659/0276-4741(2005)025[0235:TRBBCA]2.0.CO;2)
- Cleere N (2018) Common Nighthawk (*Chordeiles minor*). Handbook of the Birds of the World Alive. Lynx Edicions, Barcelona. <https://www.hbw.com/node/55166>. Accessed on: 2018-2-27.
- Collar N, Boesman P, Sharpe CJ (2018a) Blue-winged Macaw (*Prioniturus maracana*). Handbook of the Birds of the World Alive. Lynx Edicions, Barcelona. <https://www.hbw.com/node/54626>. Accessed on: 2018-1-29.
- Collar N, Kirwan GM, Boesman P (2018b) Turquoise-fronted Amazon (*Amazona aestiva*). Handbook of the Birds of the World Alive. Lynx Edicions, Barcelona. <https://www.hbw.com/node/54749>. Accessed on: 2018-2-26.
- Costa FJV, Monteiro KRG (2016) Guia de identificação das aves traficadas no Brasil. BECONN, Florianópolis, 200 pp.
- Craveiro RB, Miyaki CY (2000) Analysis of the genetic variability of *Propyrrhura maracana* (Psittaciformes, Aves) using DNA fingerprinting. *Ararajuba* 8 (2): 79–84.
- Dangerfield JM, Pik AJ, Britton D, Holmes A, Gillings M, Oliver I, Briscoe D, Beattie AJ (2003) Patterns of invertebrate biodiversity across a natural edge. *Austral Ecology* 28 (3): 227–236. <https://doi.org/10.1046/j.1442-9993.2003.01240.x>
- Dário FR, Vincenzo MCV, Almeida AF (2002) Avifauna em fragmentos da Mata Atlântica. *Ciência Rural* 32 (6): 989–996. <https://doi.org/10.1590/S0103-84782002000600012>
- del Hoyo J, Collar N (2018) Eastern Slaty Thrush (*Turdus subalaris*). Handbook of the Birds of the World Alive. Lynx Edicions, Barcelona. <https://www.hbw.com/node/1344026>. Accessed on: 2018-1-29.
- del Hoyo J, Collar N, Kirwan GM (2018) Southern Swift (*Chaetura meridionalis*). Handbook of the Birds of the World Alive. Lynx Edicions, Barcelona. <https://www.hbw.com/node/467189>. Accessed on: 2018-2-27.
- del Hoyo J, Kirwan GM (2018) Rusty-margined Guan (*Penelope superciliosus*). Handbook of the Birds of the World Alive. Lynx Edicions, Barcelona. <https://www.hbw.com/node/53285>. Accessed on: 2018-2-26.
- Develey PF, Pongiluppi T (2010) Impactos potenciais na avifauna decorrentes das alterações propostas para o Código Florestal Brasileiro. *Biota Neotropica* 10 (4): 43–46. <https://doi.org/10.1590/S1676-06032010000400005>
- Donatelli RJ, Ferreira CD, Dalbeto AC, Posso SR (2007) Análise comparativa da assembleia de aves em dois remanescentes florestais no interior do Estado de São Paulo, Brasil. *Revista Brasileira de Zoologia* 24 (2): 362–375. <https://doi.org/10.1590/S0101-81752007000200015>
- Dunning JB, Danielson BJ, Pulliam HR (1992) Ecological processes that affect populations in complex landscapes. *Oikos* 65 (1): 169–175. <https://doi.org/10.2307/3544901>
- Durigan G, Baitello JB, Franco GADC, Siqueira MF (2004) A vegetação dos remanescentes de cerrado no Estado de São Paulo. In: Bittencourt MD, Mendonça RR (Eds) Viabilidade de conservação dos remanescentes de Cerrado no Estado de São Paulo. Anna-blume, São Paulo, 29–56.
- eBird (2019) Verdinho-coroado *Hylophilus poicilotis*. Available in: <https://ebird.org/species/rucgrel>. Accessed on: 2019-3-20.
- Faria CMA, Rodrigues M, Amaral FQ, Módena E, Fernandes AM (2006) Aves de um fragmento de Mata Atlântica no Alto Rio Doce, Minas Gerais: colonização e extinção. *Revista Brasileira de Zoologia* 23 (4): 1217–1230. <http://dx.doi.org/10.1590/S0101-81752006000400032>
- Grantsau RKH (2010) Guia completo para identificação das aves do Brasil. Vento Verde, São Carlos, 624 pp.
- Hilty S (2018) Black-faced Tanager (*Schistochlamys melanopsis*). Handbook of the Birds of the World Alive. Lynx Edicions, Barcelona. <https://www.hbw.com/node/61572>. Accessed on: 2018-1-29.
- Holt DW, Berkley R, Deppe C, Enriquez Rocha P, Petersen JL, Rangel Salazar JL, Segars KP, Wood KL, Marks JS (2018) Great Horned Owl (*Bubo virginianus*). Handbook of the Birds of the World Alive. Lynx Edicions, Barcelona. <https://www.hbw.com/node/55006>. Accessed on: 2018-2-26.
- ICMBIO/MMA (2018) Livro vermelho da fauna ameaçada de extinção: Volume 1. Instituto Chico Mendes de Conservação da Biodiversidade, Brasília, 492 pp.
- IUCN (2019). The IUCN Red List of Threatened Species. <https://www.iucnredlist.org/> Accessed on: 2018-1-22
- Juniper T, Parr M (1998) Parrots: a Guide to the Parrots of the World. Christopher Helm Publisher, London, 584 pp.
- Kark S, Van Rensburg BJ (2006) Ecotones: marginal or central areas of transition? *Israel Journal of Ecology & Evolution* 52 (1): 29–53. <https://doi.org/10.1560/IJEE.52.1.29>
- Kark S, Allnutt TF, Levin N, Manne LL, Williams PH (2007) The role of transitional areas as avian biodiversity centres. *Global Ecology and Biogeography* 16 (2): 187–196. <https://doi.org/10.1111/j.1466-8238.2006.00274.x>
- Kronka FJN, Nalon MA, Matsukuma CK, Pavão M, Guillaumon JR, Cavalli AC, Gianotti E, Ywane MSSI, Lima LMPR, Montes J, Cali IHD, Haack PG (1998) Áreas de domínio do Cerrado no estado de São Paulo. Instituto Florestal, São Paulo, 84 pp.
- Kucherova SV, Mirkin BM (2001) On methods for analyzing ecotones of forest margins. *Russian Journal of Ecology* 32 (5): 310–314. <https://doi.org/10.1023/A:1011918025846>
- Kunin WE (1998) Biodiversity at the edge: a test of the importance of spatial “mass effects” in the Rothamsted Park Grass experiments. *Proceedings of the National Academy of Sciences of the United States of America* 95 (1): 207–212. <https://doi.org/10.1073/pnas.95.1.207>
- Lloyd KM, McQueen AAM, Lee BJ, Wilson RCB, Walker S, Wilson JB (2000) Evidence on ecotone concepts from switch, environmental and anthropogenic ecotones. *Journal of Vegetation Science* 11 (6): 903–910. <https://doi.org/10.2307/3236560>
- Lucindo AS, Antunes AZ, Kanashiro MM, Dias MM (2015) Birds at Santa Bárbara Ecological Station, one of the last Cerrado remnants in the state of São Paulo, Brazil. *Biota Neotropica* 15 (4): e0155. <http://doi.org/10.1590/1676-06032015015514>
- Manica LT, Telles M, Dias MM (2010) Bird richness and composition in a Cerrado fragment in the State of São Paulo. *Brazilian Journal of Biology* 70 (2): 243–254. <https://doi.org/10.1590/S1519-69842010005000001>
- Moritz C, Patton JL, Schneider CJ, Smith AR (2000) Diversification of rainforest faunas: an integrated molecular approach. *Annual Review of Ecology and Systematics* 31: 533–563. <https://doi.org/10.1146/annurev.ecolsys.31.1.533>

- Motta-Junior JC, Granzinoli MAM, Develey PF (2008) Aves da estação ecológica de Itirapina, estado de São Paulo, Brasil. *Biota Neotropica* 8 (3). <http://doi.org/10.1590/S1676-06032008000300019>
- Mulwa RK, Böhning-Gaese K, Schleuning M (2012) High bird species diversity in structurally heterogeneous farmland in western Kenya. *Biotropica* 44 (6): 801–809. <https://doi.org/10.1111/j.1744-7429.2012.00877.x>
- Myers N, Mittermeier RA, Mittermeier CG, Fonseca GAB, Kent J (2000) Biodiversity hotspots for conservation priorities. *Nature* 403 (6772): 853–858. <https://doi.org/10.1038/35002501>
- Nunes MFC, Galetti M (2007) Use of forest fragments by blue-winged macaws (*Primolius maracana*) within a fragmented landscape. *Biodiversity and Conservation* 16 (4): 953–967. <https://doi.org/10.1007/s10531-006-9034-9>
- Odum EP (1953) *Fundamentals of ecology*. W.B. Saunders Company, Philadelphia, 383 pp.
- Pacheco JF (2003) As aves da Caatinga: uma análise histórica do conhecimento. In: Silva JMC, Tabarelli M, Fonseca MT, Lins LV (Eds) *Biodiversidade da Caatinga: áreas e ações prioritárias para a conservação*. Ministério do Meio Ambiente, Brasília, 189–250.
- Payne R, de Juana E (2018) Greater Ani (*Crotophaga major*). *Handbook of the Birds of the World Alive*. Lynx Edicions, Barcelona. <https://www.hbw.com/node/54906>. Accessed on: 2018-1-29.
- Piacentini VDQ, Aleixo A, Agne CE, Maurício GN, Pacheco JF, Bravo GA, Brito GRR, Naka LN, Olmos F, Posso S, Silveira LF, Betini GS, Carrano E, Franz I, Lees AC, Lima LM, Pioli D, Schunck F, Amaral FR, Bencke GA, Cohn-Haft M, Figueiredo LFA, Straube FC, Cesari E (2015) Annotated checklist of the birds of Brazil by the Brazilian Ornithological Records Committee. *Revista Brasileira de Ornitologia* 23 (2): 90–298.
- Pirani FR, Sanchez M, Pedroni F (2009) Fenologia de uma comunidade arbórea em cerrado sentido restrito, Barra do Garças, MT, Brasil. *Acta Botanica Brasílica* 23 (4): 1096–1109. <http://doi.org/10.1590/S0102-33062009000400019>
- Rangel de Almeida EM, Toniato MTZ, Durigan G (2010) Estação Ecológica de Bauru: plano de manejo. Fundação Florestal da Secretaria do Meio Ambiente do Estado de São Paulo, São Paulo. 200 pp.
- Remsen Jr JV, Kirwan GM (2018) White-eyed Foliage-gleaner (*Automolus leucophthalmus*). *Handbook of the Birds of the World Alive*, Lynx Edicions. Barcelona. <https://www.hbw.com/node/56573>. Accessed on: 2018-1-29.
- Ridgely RS, Tudor G (1989) *The Birds of South America: the oscine passerines*. University of Texas Press, Austin, 516 pp.
- Ridgely RS, Tudor G (1994) *The Birds of South America: the subsoscine passerines*. Texas, University of Texas Press, Austin, 814 pp.
- Rodrigues RR (2000) Florestas ciliares: uma discussão nomenclatural das formações ciliares. In: Rodrigues RR, Leitão Filho HF (Eds) *Matas ciliares: conservação e recuperação*. Editora da Universidade de São Paulo, São Paulo, 91–99.
- Santos AJ (2003) Estimativas de riqueza em espécies. In: Cullen Jr L, Rudran R, Valladares-Padua C (Eds) *Métodos de estudos em biologia da conservação e manejo da vida silvestre*. Editora da Universidade Federal do Paraná, Brasil, 19–41.
- São Paulo (2017) Resolução SMA N° 146, de 08 de novembro de 2017. Instituto o Mapa de Biomas do Estado de São Paulo, e dá outras providências. <http://arquivo.ambiente.sp.gov.br/legislacao/2017/11/resolucao-sma-146-2017.pdf>. Accessed on: 2018-2-22.
- São Paulo (2018) Decreto N° 63.853, de 27 de novembro de 2018. Declara as espécies da fauna silvestre no Estado de São Paulo regionalmente extintas, as ameaçadas de extinção, as quase ameaçadas e as com dados insuficientes para avaliação, e dá providências correlatas. [http://arquivos.ambiente.sp.gov.br/fauna/2016/12/Decreto.Estadual.60133.14.fauna\\_ameaçada.pdf](http://arquivos.ambiente.sp.gov.br/fauna/2016/12/Decreto.Estadual.60133.14.fauna_ameaçada.pdf). Accessed on: 2018-2-21.
- Schilthuizen M (2000) Ecotone: speciation prone. *Trends in Ecology & Evolution* 15 (4): 130–131. [https://doi.org/10.1016/S0169-5347\(00\)01839-5](https://doi.org/10.1016/S0169-5347(00)01839-5)
- Sick H (1997) *Ornitologia brasileira*. Nova Fronteira, Rio de Janeiro, 862 pp.
- Silva JMC, Bates JM (2002) Biogeographic patterns and conservation in the South American Cerrado: a tropical savanna hotspot. *BioScience* 52 (3): 225–233. [https://doi.org/10.1641/0006-3568\(2002\)052\[0225:BPACIT\]2.0.CO;2](https://doi.org/10.1641/0006-3568(2002)052[0225:BPACIT]2.0.CO;2)
- Snow D (2018) Pale-bellied Tyrant-manakin (*Neopelma pallescens*). *Handbook of the Birds of the World Alive*. Lynx Edicions, Barcelona. <https://www.hbw.com/node/57108>. Accessed on: 2018-2-20.
- Snow D, de Juana E (2018) Helmeted Manakin (*Antilophia galeata*). *Handbook of the Birds of the World Alive*. Lynx Edicions, Barcelona. <https://www.hbw.com/node/57079>. Accessed on: 2018-2-26.
- Snow D, Kirwan GM (2018) Rufous-capped Motmot (*Baryphthenus ruficapillus*). *Handbook of the Birds of the World Alive*. Lynx Edicions, Barcelona. <https://www.hbw.com/node/55824>. Accessed on: 2018-1-29.
- Somenzari M, Amaral PP, Cueto VR, Guaraldo AC, Jahn AE, Lima DM, Lima PC, Lugarini C, Machado CG, Martínez J, Nascimento JLX, Pacheco JF, Paludo D, Prestes NP, Serafini PP, Silveira LF, Sousa AEBA, Sousa NA, Souza MA, Telino-Júnior WR, Whitney BM (2018) An overview of migratory birds in Brazil. *Papéis Avulsos de Zoologia* 58: e20185803. <https://doi.org/10.11606/1807-0205/2018.58.03>
- Stein A, Gerstner K, Kreft H (2014) Environmental heterogeneity as a universal driver of species richness across taxa, biomes and spatial scales. *Ecology Letters* 17 (7): 866–880. <https://doi.org/10.1111/ele.12277>
- Stirnemann IA, Ikin K, Gibbons P, Blanchard W, Lindenmayer DB (2015) Measuring habitat heterogeneity reveals new insights into bird community composition. *Oecologia* 177 (3): 733–746. <https://doi.org/10.1007/s00442-014-3134-0>
- Tubelis DP, Cowling A, Donnelly C (2004) Landscape supplementation in adjacent savannas and its implications for the design of corridors for forest birds in the central Cerrado, Brazil. *Biological Conservation* 118 (3): 353–364. <https://doi.org/10.1016/j.biocon.2003.09.014>
- Ubaid FK (2009) *Dinâmica da avifauna em dois remanescentes florestais do interior do Estado de São Paulo, Brasil*. MSc dissertation. Universidade Estadual Paulista Júlio de Mesquita Filho, Botucatu, 144 pp.
- Veloso HP (1992) Sistema fitogeográfico. In: Veloso HP, Oliveira-Filho LD, Vaz AMSF, Lima MPM, Marquete R, Brazao JEM (Eds) *Manual técnico da vegetação brasileira*. Fundação Instituto Brasileiro de Geografia e Estatística, Rio de Janeiro, 9–38.
- Vianna RM, Donatelli RJ, Whitacker R, Martins RM, Sementili-Cardoso G (2017) Dynamics of the bird communities in two fragments of Atlantic Forest in São Paulo, Brazil. *Biologia* 72 (8): 913–926. <https://doi.org/10.1515/biolog-2017-0101>
- Vielliriant JEM, Silva WR (1990) Nova metodologia de levantamento quantitativo de avifauna e primeiros resultados no interior do Estado de São Paulo, Brasil. In: Mendes S (Ed) *Anais do IV Encontro Nacional de Anilhadores de Aves*, Recife, 117–151.
- Walther B (2018) Yellow-lored Tody-lycatcher (*Todirostrum poliocephalum*). *Handbook of the Birds of the World Alive*. Lynx Edicions, Barcelona. <https://www.hbw.com/node/57300>. Accessed on: 2018-1-29.
- Weiser VL (2007) *Árvores, arbustos e trepadeiras do cerrado do Jardim Botânico Municipal de Bauru, SP*. PhD dissertation, Instituto de Biologia, Campinas, 100 pp.
- Weller AA, Kirwan GM, Boesman P (2018) Violet-capped Woodnymph (*Thalurania glaucopis*). *Handbook of the Birds of the World Alive*. Lynx Edicions, Barcelona. <https://www.hbw.com/node/55463>. Accessed on: 2018-1-29.
- Whitney B, de Juana E, Kirwan GM (2018) Rufous Gnateater (*Conopophaga lineata*). *Handbook of the Birds of the World Alive*. Lynx Edicions, Barcelona. <https://www.hbw.com/node/56925> Accessed on: 2018-1-29.
- Wikiaves (2019) *Espécies em Bauru/SP*. <https://www.wikiaves.com>.



- br/especies.php?t=c&c=3506003. Accessed on: 2019-2-22.
- Willis EO (2006) Protected cerrado fragments grow up and lose even metapopulational birds in central São Paulo, Brazil. *Brazilian Journal of Biology* 66 (3): 829–837. <http://doi.org/10.1590/S1519-69842006000500008>
- Willis EO, Oniki Y (2003) *Aves do Estado de São Paulo*. Editora Divisa, Rio Claro, 398 pp.
- Wilman H, Belmaker J, Simpson J, de la Rosa C, Rivadeneira MM, Jetz W (2014) EltonTraits 1.0: Species-level foraging attributes of the world's birds and mammals. *Ecology* 95 (7): 2027–2027. <https://doi.org/10.1890/13-1917.1>
- Winkler DW, Billerman SM, Lovette IJ (2015) *Bird Families of the World: an Invitation to the Spectacular Diversity of Birds*. Lynx Edicions, Barcelona, 600 pp.
- Zimmer K, Isler ML (2018) Large-billed Antwren (*Herpsilochmus longirostris*). *Handbook of the Birds of the World Alive*. Lynx Edicions, Barcelona. <https://www.hbw.com/node/56757>. Accessed on: 2018-2-26.