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BIRD COMMUNITIES IN URBAN HABITAT: THE IMPORTANCE OF VEGETATION IN CITY SQUARES

COMUNIDADE DE AVES EM AMBIENTE URBANO: A IMPORTÂNCIA DA VEGETAÇÃO EM PRAÇAS

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Abstract: Urbanization changes the structure and composition of the environment, altering the quality and quantity of resources provided by it, thus affecting the richness and composition of birds. In this study, we investigated the relation of the bird communities and bird trophic guilds with a gradient of plant structure in an urban area, in the southern Goiás state, Brazil. We surveyed bird communities in ten city squares of Quirinópolis, between months March and October 2013. We found 62 bird species distributed in 24 families, being omnivores (n = 20 spp.) and insectivores (n = 18 spp.) comprised the most richness trophic guilds. For plant structure, we found 754 plant individuals, distributed in 17 families with 37 species. Bird composition and the richness of frugivorous species were relationship with the gradient of plant richness in city squares. While, the abundance of omnivorous and granivorous species were related by the gradient of plant abundance. We conclude that different aspect of vegetation structure are essential to harbor a rich and diverse bird community in city squares. We highlighted that programs of afforestation should consider the diversity of plant species.
Key words: Urban area. Trophic guilds. Bird composition. Species richness.

Resumo: A urbanização modifica a estrutura e a composição do ambiente, alterando a qualidade e a quantidade dos recursos que são providos pelo mesmo, afetando, dessa forma, a riqueza e a composição de aves. Neste estudo nós testamos a relação da comunidade de aves e das guildas tróficas com a estrutura vegetacional em uma área urbana no sul de Goiás, Brasil. A coleta de dados ocorreu entre março e outubro de 2013, durante dez dias consecutivos em dez praças e um esforço amostral de 25 horas em cada. Nós registramos 62 espécies de aves distribuídas em 51 gêneros e 24 famílias. As categorias tróficas mais representativas foram onívoras (n = 20) e insetívoros (n = 18). Nas praças nós encontramos 754 plantas, distribuídas em 37 espécies e 17 famílias. Não foi encontrada associação da abundância e riqueza de aves com a abundância e riqueza de plantas. A riqueza de plantas explicou a composição de aves. A riqueza de frugívoros foi dependente da riqueza de plantas, enquanto que a abundância de onívoros e granívoros foi dependente da abundância de plantas. Nectarívoros, insetívoros e carnívoros não obtiveram resultados significantes. Baseado em nosso estudo, nós sugerimos a implementação de programas de arborização com vegetação nativa em praças, ruas e avenidas, permitindo que a vegetação (arbustos, ervas e flores) propaguem-se em áreas restritas a pedestres.
Palavras-chave: Área urbana. Guildas tróficas. Composição de aves. Riqueza de espécies.

Introduction

The urbanization process modifies the physical and biotic structure of the habitat, providing different conditions and resources to bird communities that will occur in this new environment (MENDONÇA; ANJOS, 2000). This modification can reduce the habitat quality, affecting bird structures in different ways, such as, decreasing the richness of forest specialist-species and increasing the abundance of synanthropic bird species (MCKINNEY, 2006; ORTEGA-ÁLVAREZ; MACGREGOR-FORS, 2009). In this scenario, urban green areas become an important refuge for sensitive species (GODDARD et al., 2010). Further, the bird composition in urban environment are highly dependent on the spatial distribution of green areas, causing a non-uniformity in the bird assemblage (WHITE et al., 2005). Thus, habitat urbanization affect the structure and composition of bird communities.

Vegetation structures (e.g. native vegetation patch size, shrub and tree species richness, tree height and canopy cover) have been positively associated to urban bird species richness and abundances (CHACE; WALSH, 2006; MACGREGOR-FORS, 2008). The vegetation structure of urban areas also affect the trophic guilds of birds, for example nectarivorous and frugivorous bird species that occur in places with low degree of anthropization (ORTEGA-ÁLVAREZ; MACGREGOR-FORS, 2009), have a narrow gradient of food resource to exploit in this environments (BONIER et al, 2007; MENDONÇA; ANJOS, 2005; PAUW; LOUW, 2012). On contrary, omnivorous and granivorous bird species, tolerant to disturbed areas, are less affected by habitat urbanization (BLAIR, 1996). These species can exploit a wide food resource gradient, increasing in abundance in places with high food resource availability (SHOCHAT, 2004), and areas with higher degree of anthropization (ORTEGA-ÁLVAREZ; MACGREGOR-FORS, 2009). Nevertheless, bird community and its trophic guild have been poorly investigated about the of vegetation structure gradient in city squares.

In this study, we investigated how bird communities and bird trophic guild respond to a gradient of vegetation structure in an urban area in southern Goiás state, Brazil. Our question are: i) does the bird structure and composition change across gradients of vegetation structure (e.g. plant abundance and plant richness)? ii) How trophic guild of birds response to vegetation structure in city squares? We hypothesized that: i) the abundance, richness and composition of birds will be positively related to the abundance and richness of plant species in city squares; and that ii) the abundance and richness of trophic guild also will be positively related to the abundance and richness, respectively of plant communities.

Material and methods

Study area

We surveyed birds in 10 city square in the municipality of Quirinópolis, southern Goiás state, Brazil (Figure 1). The city cover a 3,789.084 km^2 area, with a human population of 49.416 inhabitants (IBGE, 2019). The climate is Tropical with dry winter (Aw, according Köppen classification) markedly seasonal, observed in almost all state of Goiás where rainfall is between 1,600 to 1,900 mm, and annual mean temperature between 19 to 20 °C (ALVARES et al., 2014).

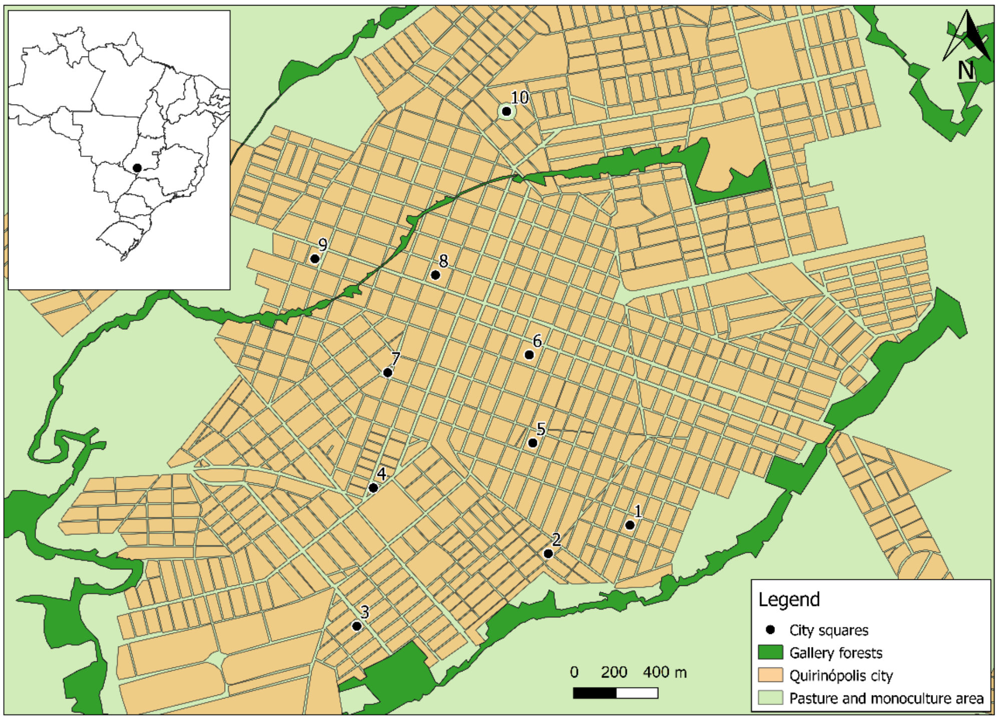

Figure 1: Location of the municipality of Quirinópolis, southern Goiás, Brazil and the 10 city squares marked along urban area. The green colours show the gallery forests along of the city.

Bird surveys

We surveyed bird community monthly between March and October 2013, during ten consecutive days (7 days: 6:30 to 9:00 h and 3 days: 16:00 to 18:30 h), adding a sample effort of 25 hours for each city square. We used binoculars 10x40 for observe and record bird species. We used personal observation and scientific literature (MOTTA-JÚNIOR, 1990; SICK, 1997; TELES; DIAS, 2010) for allocated each species according its trophic guild. For taxonomic classification, we followed Piacentini et al. (2015).

Vegetation structure

We used abundance and richness of plant communities for evaluate vegetation structure on each city squares. For this, we count number of tree and shrub species, and its taxonomic classification, following APG III system for angiosperms (FLORA DO BRASIL, 2020; LORENZI; SOUZA, 2001; LORENZI, 2009; MBOT, 2019; SOUZA et al, 2013). For some species, leaves, fruits, and flowers were collected to taxonomic classification, and voucher on Herbarium José Ângelo Rizzo (HERBJAR) of the Universidade Estadual de Goiás, Câmpus Sudoeste.

Data analyses

To investigate if our sampling effort was sufficient to represent the bird community in urban area of Quirinópolis city, we made a sample-based estimates using Jackknife 1 through the function specpool of the R package *vegan* (OKSANEN et al, 2018). Before comparison, we test the auto-correlation between abundance and richness of plant species using Pearson's linear correlation analysis ($\rho = 0.35$, $df = 8$, $P = 0.32$). Therefore, we test the relation between abundance and richness of birds with abundance and richness of plant community, respectively, using the linear regression analyses. To ordinate bird species composition in the city squares, we applied a Non-Metric Multidimensional Scaling (NMDS) analysis, supported by the Jaccard similarity index, considering a maximum stress of 0.2. We used the "envifit" function (R package *vegan*, OKSANEN et al. 2018) to test the relationship between the NMDS axes (response variable: species composition) and the abundance and richness of the plant communities (predictor variables). For investigate the association between trophic guild with plant structure, we compared abundance and richness of frugivore, granivore, insectivore, and omnivores species with abundance and richness of plant by the linear regression. All analyses were conducted in R Program (R CORE TEAM, 2018).

Results

We recorded 2.733 contacts with birds, distributed in 62 bird species (six migratory habit), 51 genera and 24 families (Appendix I). Our sampling covered about 82.1% of the estimated richness by jackknife 1 = 75.5 species. *Crotophaga ani*, *Eupetomena macroura*, *Passer domesticus*, *Patagioenas picazuro* and *Pitangus sulphuratus* were registered in all city squares, and were the most abundant (higher number of contacts). We found six bird trophic guild on city squares: omnivores 32% (20 spp.), insectivores 29% (18 spp.), frugivorous 15% (9 spp.), granivores 11% (7 spp.), nectarivores 8% (5 spp.), and carnivores 5% (3 spp.). The most abundant trophic guilds were omnivores and frugivorous with 1,058 and 730 contacts, respectively (Appendix I). In all city squares, we recorded 754 arboreal plant individuals, distributed in 37 plant species, belonging to 17 family.

We didn't find any evidence of association of abundance and richness of birds with the abundance and richness of plants (Table 1).

Table 1: Results of linear regression between bird community structure and trophic guilds (response variable) with abundance and richness of plants (predictor variables) recorded in ten city squares in the Quirinópolis municipality, southern Goiás, Brazil.

Response	**Predictor**	**$R^2_{adj.}$**	**t-value**	**P**
Bird abundance	Plant abundance	0.30	2.19	0.06
Bird richness	Plant richness	0.23	1.94	0.08
Bird composition	Plant abundance	0.36	permutation	0.23
Bird composition	Plant richness	0.61	permutation	0.03*
Frugivore abundance	Plant abundance	0.12	1.49	0.17
Frugivore richness	Plant richness	0.45	2.84	0.02*
Gramnivore abundance	Plant abundance	0.35	2.42	0.04*
Gramnivore richness	Plant richness	0.09	1.40	0.20
Insectivore abundance	Plant abundance	0.05	1.21	0.26
Insectivore richness	Plant richness	0.01	0.28	0.78
Omnivore abundance	Plant abundance	0.38	2.56	0.03*
Omnivore richness	Plant richness	0.26	2.04	0.07

* Statistic significant value $p < 0.05$. Number of permutations: 999

The NMDS analysis of the composition of the bird communities was considered adequate, with a stress of 0.06. However, only plant species richness was associated with first NMDS axis, explaining bird composition ordination ($R^2_{adj.} = 0.61$, $P = 0.03$, Figure 2).

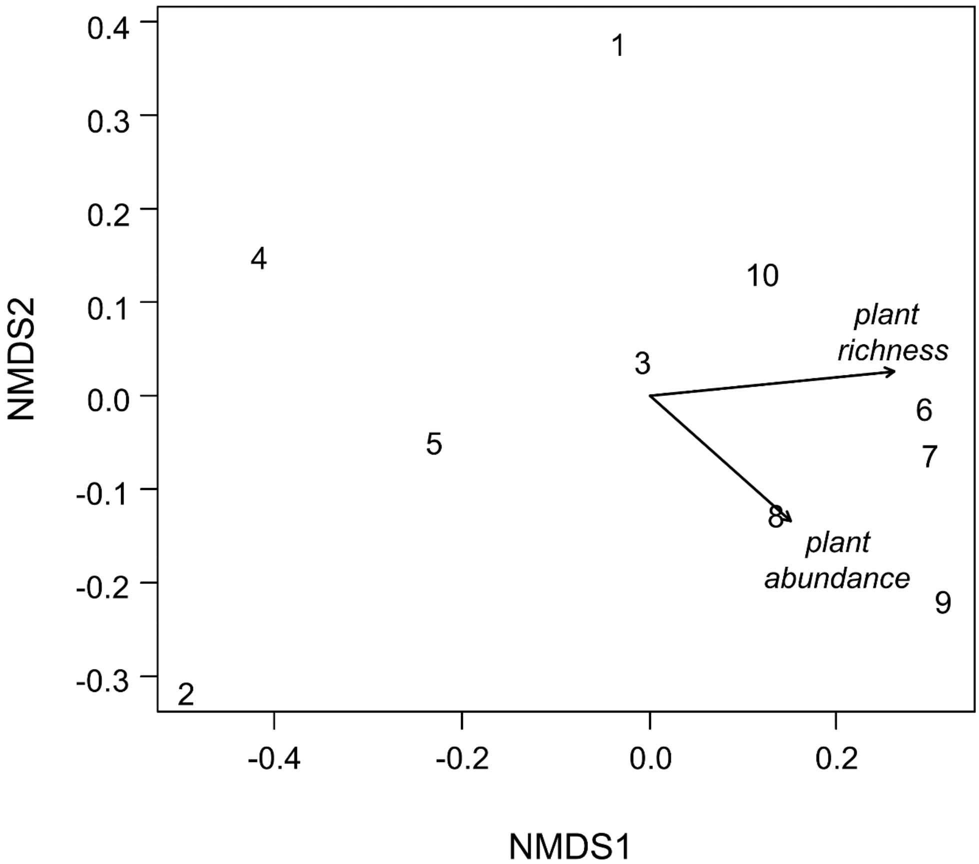

Figure 2: Non-Metric Multidimensional Scaling of the similarity (Jaccard) between the bird communities in ten city squares (numbers inside plot) in Quirinópolis municipality, southern Goiás, Brazil. Arrow represent predictor variables abundance and richness of plant communities measured in the city squares.

Focus on trophic guilds, we found significant association only between richness of frugivorous with plant richness ($R^2_{adj.} = 0.45$, t = 2.86, p = 0.02), abundance of granivorous with plant abundance ($R^2_{adj.} = 0.35$, t = 2.42, p = 0.04), and abundance of omnivorous with plant abundance ($R^2_{adj.} = 0.38$, t = 2.56, p = 0.03, Figure 3). All others association between trophic guilds with abundance and richness of plants were not significant (Table 1).

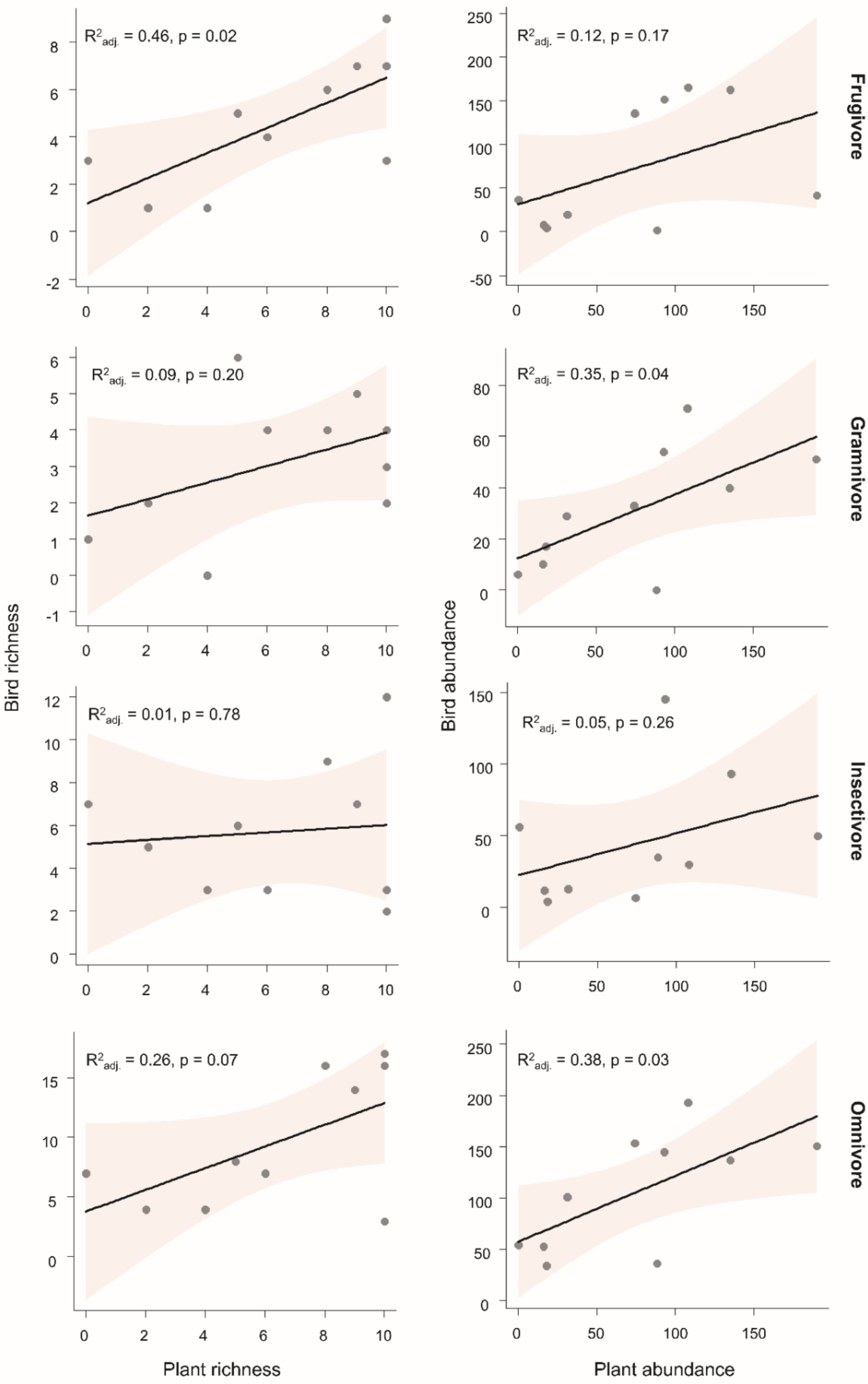

Figure 3: Relation between richness and abundance of bird guilds (frugivore, gramnivore, insectivore and omnivore) with richness and abundance of plant in ten city squares in Quirinópolis municipality, southern Goiás, Brazil.

Discussion

We found a representative bird community expected to occur in urban area of Quirinópolis municipality, southern Goiás state, central Brazil. The patterns in abundance of generalist species like *C. ani*, *E. macroura*, *P. domesticus*, *P. picazuro* and *P. sulphuratus*, and the species richness in omnivores and insectivores trophic guilds already are expected in urban areas (CRUZ; PIRATELLI, 2011; FRANCHIN; MARÇAL-JUNIOR, 2004; LEVEAU; LEVEAU, 2004; MATARAZZO-NEUBERGER, 1995; RODRIGUES et al, 2018; SCHERER et al, 2005; TELES et al, 2012), being described as an effect of urbanization (CHACE; WALSH 2006). Considering ours hypotheses, for the component of bird community in urban areas, only the composition was associated to plant richness, and for the trophic guilds components, the richness of frugivorous was associated to plant richness and the abundances of granivorous and omnivorous were associated to plant abundances. We discussed below these patterns and the mechanism that could determine them.

The association between bird composition to plant richness could indicated a specific relationship between bird communities to the gradient of plant species richness, with one part of bird community occurring in city squares with higher plant richness, and another part of community occurring in the gradient with lower plant richness. This pattern differ of the reported in the scientific literature, for example, in Paris city, the spatial distribution of city squares, or the level of urbanization in the surrounding, was more important for determining bird community composition than vegetation structure (HUSTÉ; BOULINIER, 2011).

The relation between frugivorous bird species with plant richness can be explained for the higher number of fruited ornamental plants (e.g. palms) in the Quirinópolis city squares, which may be benefiting some frugivorous species, a behavior commonly observed in other urban areas (REICHARD et al., 2001). Further, species more specialist like frugivorous tend to be more common on urban forest remnants, which are rich in food resource in cities (BONIER et al., 2007). For example, on the temperate secondary forest of the Cantabrian Range (north Spain) the frugivorous bird species richness was positively correlated with the quantity and variety of seeds dispersed by birds (GARCIA; MARTINEZ, 2012). The abundance of omnivorous and granivorous were dependent of plant abundances. This result is unexpected, considering that species of these groups are abundant in residential areas independent of green areas (ORTEGA-ALVAREZ; MACGREGOR-FORS, 2009).

Habitat degradation can contribute to predation rate (EVANS, 2004), in this sense, the plant abundance could be used for to reduce this interaction by improving crypsis (WHITTINGHAM; EVANS, 2004). In urban areas, the influence of human traffic and domesticated animal affected bird survival (KARK et al, 2007; LIM; SODHI, 2004), then, urban green areas comprise place where human disturbance is lower compared to other urban land-uses (DEVICTOR et al, 2008).

Our study provided an exploratory look on the responses of bird guilds with relation the urbanization process. The bird community of Quirinópolis city exhibit a higher number of generalist species and a lower number of specialist-species, a common pattern in urban areas. These results can be reflex of the lower quality and heterogeneity of urban areas of Quirinópolis, which has streets and avenues little wooded and city-squares with a little representative plant species. City square are designed primarily for the benefit of humans, thus, the presence of birds and vegetation contribute to human-welfare, beside to provide an opportunity to learn about the wildlife. Therefore, actions to promote the increase bird diversity in urban areas should be applied in all cities.

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Appendix I. Recorded bird species. Scientific names and taxonomic sequence follow Piacentini et al. (2015). Study area: (1) Praça da Bíblia, (2) Praça Cícero Joaquim de Medeiros, (3) Praça dos Perus, (4) Praça Célio Moraes Andrade, (5) Praça do Circo, (6) Praça dos Três Poderes, (7) Praça das Crianças, (8) Praça José Ferreira de Jesus, (9) Praça Coronel Jacinto Honório, (10) Praça Airosa Martins Parreira. Feeding habits (F.H): (ONI) omnivorous, (CAR) carnivorous, (FRU) frugivorous, (INS) insectivorous, (GRA) granivorous, (NEC) nectarivorous.

Family	Specie	Study area	F.H.	Contact**
Accipitridae	*Rupornis magnirostris* (Gmelin, 1788)	9	CAR	1
Charadriidae	*Vanellus chilensis* (Molina, 1782)	1, 2 , 3, 4, 5, 8, 10	ONI	58
Columbidae	*Columbina talpacoti* (Temminck, 1810)	1, 3, 6, 7, 8, 9, 10	GRA	100
	Columbina squammata (Lesson, 1831)	10	GRA	1
	Columba livia Gmelin, 1789	6	GRA	21
	Patagioenas picazuro (Temminck, 1813)	1, 3, 4, 5, 6, 7, 8, 9, 10	FRU	159
	Patagioenas cayennensis (Bonnaterre, 1792)	1, 3, 5, 6, 7, 8, 9, 10	FRU	125
	Patagioenas plumbea (Vieillot, 1818)	9	FRU	1
	Zenaida auriculata (Des Murs, 1847)	1, 3, 4, 5, 6, 7, 8, 10	GRA	89
Cuculidae	*Crotophaga ani* Linnaeus, 1758	2, 3, 4, 5, 6, 7, 8, 9, 10	INS	124
	Guira guira (Gmelin, 1788)	1, 2, 3, 5, 6, 8, 9, 10	INS	67
Strigidae	*Glaucidium brasilianum* (Gmelin, 1788)	6	CAR	1
	Athene cunicularia (Molina, 1782)	2, 5, 8	INS	24
Caprimulgidae	*Podager nacunda* (Vieillot, 1817)	5	INS	1
Trochilidae	*Phaethornis pretrei* (Lesson & Delattre, 1839)	1	NEC	1
	Eupetomena macroura (Gmelin, 1788)	1, 2, 3, 4, 5, 6, 7, 8, 9, 10	NEC	74
	Chlorostilbon lucidus (Shaw, 1812)	1, 3, 6, 7, 8, 9, 10	NEC	52
	Thalurania furcata (Gmelin, 1788)	10	NEC	2
Momotidae	*Momotus momota* (Linnaeus, 1766)	6, 7, 9	ONI	7
Ramphastidae	*Ramphastos toco* Statius Muller, 1776	6, 7, 8, 9	ONI	22
	Pteroglossus castanotis Gould, 1834	8, 9	ONI	6
Picidae	*Colaptes melanochloros* (Gmelin, 1788)	9	INS	1
Falconidae	*Falco sparverius* Linnaeus, 1758	3, 4, 5, 10	CAR	12
Psittacidae	*Ara ararauna* (Linnaeus, 1758)	6, 7, 9	FRU	30
	Diopsittaca nobilis (Linnaeus, 1758)	6, 7, 8, 9, 10	FRU	56
	Psittacara leucophthalmus (Statius Muller, 1776)	5, 6, 7, 8, 9, 10	FRU	68
	Eupsittula aurea (Gmelin, 1788)	2, 3, 6, 7, 8, 9	FRU	59
	Brotogeris chiriri (Vieillot, 1818)	1, 3, 6, 7, 8, 9, 10	FRU	230
Thamnophilidae	*Herpsilochmus longirostris* Pelzeln, 1868	9	INS	4
	Thamnophilus doliatus (Linnaeus, 1764)	6, 7	INS	3
	Thamnophilus pelzelni Hellmayr, 1924	9	INS	2
Rhynchocyclidae	*Todirostrum cinereum* (Linnaeus, 1766)	8, 9	INS	15

Tyrannidae	*Pitangus sulphuratus* (Linnaeus, 1766)	2, 3, 4, 5, 6, 7, 8, 9, 10	ONI	122
	Machetornis rixosa (Vieillot, 1819)	4, 6, 8, 9, 10	INS	43
	Myiodynastes maculatus (Statius Muller, 1776) *	6, 7, 8, 9, 10	ONI	20
	Megarynchus pitangua (Linnaeus, 1766)	6, 7, 9	ONI	6
	Tyrannus albogularis Burmeister, 1856 *	4, 6	INS	2
	Tyrannus melancholicus Vieillot, 1819	3, 4, 5, 6, 7, 8, 9, 10	INS	84
	Tyrannus savana Daudin, 1802 *	1, 5, 8, 9	INS	13
	Griseotyrannus aurantioatrocristatus (d'Orbigny & Lafresnaye, 1837) *	5, 7, 8	ONI	8
	Pyrocephalus rubinus (Boddaert, 1783) *	6, 10	INS	3
	Xolmis cinereus (Vieillot, 1816) *	4, 5, 8, 9	INS	10
Hirundinidae	*Progne tapera* (Vieillot, 1817)	9	INS	11
	Progne chalybea (Gmelin, 1789)	8, 9	INS	37
Turdidae	*Turdus leucomelas* Vieillot, 1818	6, 7, 8, 9	ONI	24
	Turdus rufiventris Vieillot, 1818	6, 7, 8, 9	ONI	26
	Turdus amaurochalinus Cabanis, 1850	6, 7, 8, 9	ONI	10
Mimidae	*Mimus saturninus* (Lichtenstein, 1823)	4, 5, 10	ONI	12
Icteridae	*Icterus cayanensis* (Linnaeus, 1766)	3, 6,7, 8, 9	ONI	32
	Gnorimopsar chopi (Vieillot, 1819)	7	ONI	1
	Molothrus bonariensis (Gmelin, 1789)	2, 3, 5, 6, 7, 8, 9, 10	ONI	61
Thraupidae	*Tangara sayaca* (Linnaeus, 1766)	1, 3, 5, 6, 7, 8, 9, 10	ONI	81
	Tangara palmarum (Wied, 1821)	6, 7, 8, 9	ONI	58
	Tangara cayana (Linnaeus, 1766)	7, 9	ONI	10
	Sicalis flaveola (Linnaeus, 1766)	1,3,4,6,7,8,9,10	GRA	85
	Volatinia jacarina (Linnaeus, 1766)	3, 7, 8, 10	GRA	9
	Cyanerpes cyaneus (Linnaeus, 1766)	9	FRU	1
	Coereba flaveola (Linnaeus, 1758)	3, 6, 7, 8, 9, 10	NEC	47
	Sporophila caerulescens (Vieillot, 1823)	6, 10	GRA	6
Fringillidae	*Euphonia chlorotica* (Linnaeus, 1766)	3, 6, 7, 8, 9, 10	ONI	30
Passeridae	*Passer domesticus* (Linnaeus, 1758)	1, 2, 3, 4, 5, 6, 7, 8, 9, 10	ONI	464

*Migratory species.

**Number of contacts that we had with birds.

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