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Temporal and spatial variation of richness and abundance of the community of birds in the Pantanal wetlands of Nhecolândia (Mato Grosso do Sul, Brazil)

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Abstract: The Pantanal wetlands represent one of the largest flood plains in the World, with extreme climatic variations between dry and wet seasons. The area shelters a high diversity of habitats, representing the main formations found in this sub-region: grasslands, savannah, forested savannah, riparian forests, bays and salines, and Negro river itself. This habitat variability determines the structure and dynamics of the bird community, because most species are closely related to specific habitats. For this, we studied the abundance of bird species from 2001 to 2004 in a Pantanal area of Fazenda Rio Negro, Aquidauana, Brazil. The abundance was compared among those four consecutive years, seasons (dry and wet), time of the day (morning and afternoon), and also between seven different habitats, in order to determine the variation in distribution patterns and habitats used by birds. For this, we used the linear transect method in each of the seven habitats, and recorded bird abundances to obtain richness. The richness registered in the mosaic of habitats was of 201 species for the savannah, 87 in forested savannah, 116 in the riparian forest, 75 in grasslands, 120 in bays, 92 in the salines and 64 in the Negro river, accounting for 348 species in the Pantanal of Rio Negro. Overall, 98 species of migratory birds were registered. The results highlighted some important issues regarding the total abundance of birds in Nhecolândia: Psittacidae was the most abundant family in the region, with prominence in all environments. Recurvirostridae, a monospecific family, showed expressive abundance due to the dominance of *Himantopus mexicanus* in the salinas, followed by Ardeidae, Anatidae and Cracidae. Other families with high abundance were Tyrannidae, Columbidae, Thraupidae and Emberizidae, all in predominantly terrestrial environments. Moreover: a) The highest number of specimens was recorded in the morning period and in the dry season, regardless of the habitat; b) there were no differences in abundance in the same habitat along the years, but the abundance was different among habitats. In general, the results indicated that there is a relatively stable bird population in each habitat along the annual cycle, but there were differences in abundance among habitats. Thus, additional studies on food availability in dry and wet seasons should be better explored in the future, either in this region or in other Pantanal regions. This fact could better explain the seasonal dynamics of the richness and abundance of birds in the Pantanal area in general. Rev. Biol. Trop. 65 (4): 1358-1380. Epub 2017 December 01.

Key words: pantanal, bird community, mosaic of habitats, Mato Grosso do Sul.

The Pantanal wetlands stand out for being one of the largest flood plain in the world, in which extreme climatic variations occur between dry (April to September) and wet seasons (October to March). During the wet season, large areas are flooded (Por, 1995). In the sub-region of Nhecolândia, the terrain, together with the rainfall conditions, is considered a predominant factor, for the formation of permanent or temporary lagoons in low terrains, with transition to grassy formations, fields, savannahs and forest formations in higher numbers when compared to other sub-regions of the Pantanal (Alho, Lacher Jr, & Gonçalves, 1988; Ratter, Pott, Pott, Cunha, & Haridasan, 1988; Rodela, 2006).

The Pantanal is a complex of phyto-physiognomies that comprises numerous types of terrestrial and aquatic formations with the most diverse characteristics. In the terrestrial habitat, seasonal deciduous or semi-deciduous forests (including forest islands known as "capão" and riparian forests), fields of "murundus" (circular or elliptical micro topographies present on drainage slopes and headwaters, that remain temporarily or permanently flooded by rainwater; they are small usually round mounds, that often present with soil and vegetation different from the surrounding level area; Resende, Araújo, Oliveira, Oliveira, & Ávila, 2004) and savannah formations with several levels of arboreal, shrub and graminoid coverings (including flooded monodominant formations) (Pott & Silva, 2015). In the aquatic habitat, rivers, fresh or salty water (salines) of different sizes and limnological conditions, permanent flooded fields, as well as the vast intermittent drainage meshwork – meanders, low levels, oxbow lakes, and "corixos" (seasonal streams) – which act as expansion and contraction shafts of the water during the flood periods (Pott & Silva, 2015). Amongst these characteristics, the number of lagoons and lakes is quite peculiar to this complex, numbering in the tens of thousands along its extension (Por, 1995). In the South-Central region of the Pantanal wetlands, two sub-sections marked by the great occurrence of fresh water (bays) and salty (saline) lagoons stand out: Paiaguás, at the North of the Taquari River, and Nhecolândia, at the South of the same river (Tomás, de Salis, Catella, Santos, & Nunes., 2007).

Although the Pantanal occupies a significant area of South America, there are few avifauna studies throughout its region, perhaps due to transport difficulty during flood periods. Naumburg (1930), Mitchel (1957), Brown (1986), Cintra and Yamashita (1990), Dubs (1992), Tubelis and Tomas (2003), Nunes and Tomas (2004a and 2004b), Nunes, Tizianel & Tomas (2006), Nunes, Silva & Tomas (2008), Figueira, Cintra, Viana & Yamashita (2006) and Donatelli, Posso & Toledo (2014) are among the researchers who investigated the richness of the birds in several regions of Pantanal. Nevertheless, an analysis of the diversity and dynamics of bird species in the Pantanal region is still lacking.

Aiming to broaden the knowledge of the bird community of the Southern region of Pantanal, this work registered the abundance of birds in a mosaic of habitats in the Pantanal of the Rio Negro. It is a pristine area where there is no cattle rising, unlike the other farms in the region; moreover, there is little human influence, and it has become a relevant model area and a unique reference for research. Thus, data from annual, seasonal, time of day, and habitat variation of abundance of the community of birds were collected in order to determine whether there is any variation in the patterns of distribution and use of habitats by birds in the Fazenda Rio Negro, Pantanal de Rio Negro, Nhecolândia, Aquidauana, Mato Grosso do Sul, Brazil.

MATERIAL AND METHODS

Area of study: The study was developed in the Pantanal of Nhecolândia (Fig. 1A and Fig. 1B), in the Fazenda Rio Negro, city of Aquidauana, MS (19º30'00'' S & 56º12'30'' W). The Pantanal of Nhecolândia is a region with lands higher than the surroundings areas, characterized by moderated, localized and of short duration floods, where the bays and salines

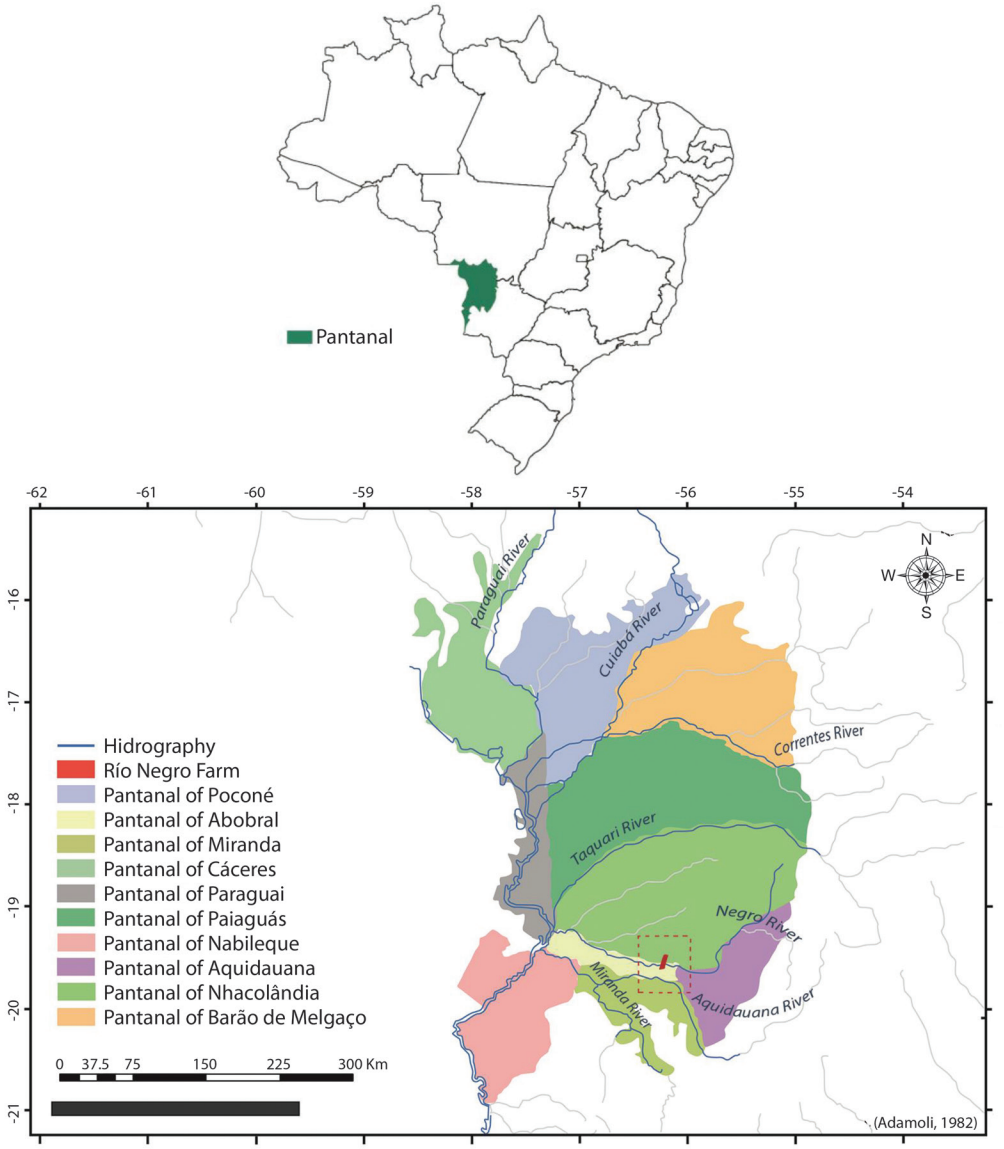

Fig. 1. A. Pantanal area in Brazil (after Reginaldo J. Donatelli). **B.** Different types of Pantanal and localization of the Fazenda Rio Negro (Red spot).

are distributed in a very heterogeneous matrix (Adámoli *apud* Por, 1995). The Fazenda Rio Negro contains 8 004 hectares, of which 7 000 belong to RPPN (Private Natural Heritage Reserve) Fazenda Rio Negro, where the sampling plots were concentrated.

The region has a tropical semiarid climate, with an average annual rainfall of 1 180 mm and average temperature varying between 21 and 28 ºC (Marengo, Oliveira, & Alves, 2016). In the Fazenda Rio Negro, the average annual temperature is 26.6 ºC, with a defined dry season between the months of April and September. The Fazenda Rio Negro shelters seven types of habitats, representing the main formations found in the sub-region of Pantanal wetlands:

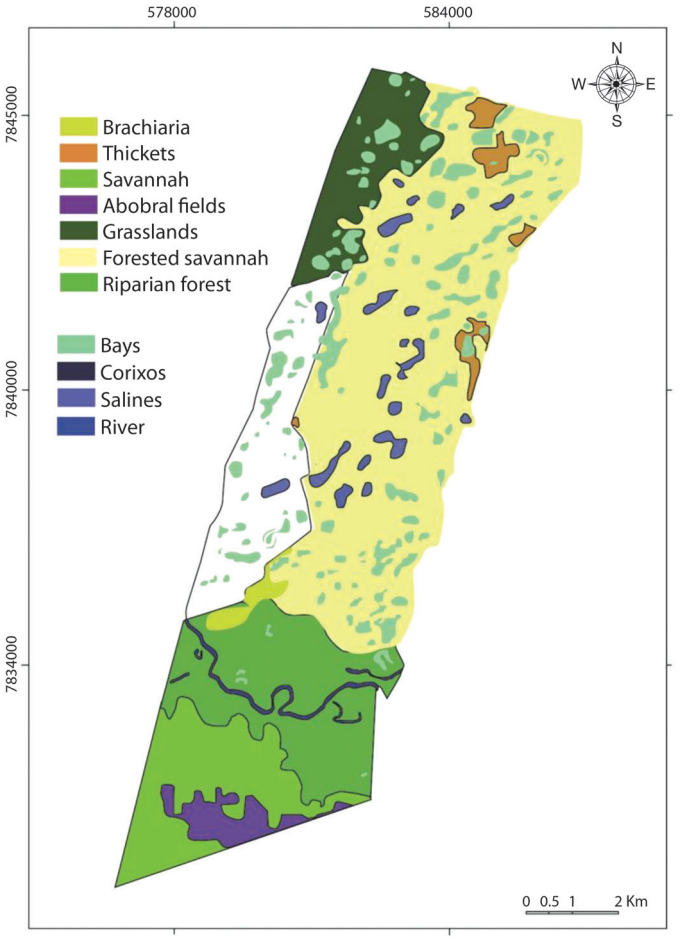

Fig. 2. Habitats found in the Fazenda Rio Negro, Pantanal of Nhecolândia (after D. Eaton).

riparian forests, savannah, forested savannah, grasslands, bays, salines and Negro river (Fig. 2). Riparian forests occur along watercourses throughout the drier regions of the Neotropics. These forests contain a diverse association of deciduous and semi-deciduous trees and are seldom larger than 100 m wide. Savannah is the widely used name for the non-forested vegetation that covers much of the Brazilian shield and ranges from open grasslands ("campo sujo") to dense woodlands (forested savannah, treated in this paper as a separate habitat type). Forested savannah is dense woodland consisting of trees and shrubs with thick, fire-resistant bark, twisted trunks and large leaves; it contains a nearly continuous ground cover of grasses, sedges and forbs and is designated as dry forest or "cordilheiras" in the Pantanal region. Grasslands support a rich variety of herbaceous vegetation of more than 200 species of grasses and graminoid species; grasslands cover vast areas of Northern and Southeastern Bolivia and adjacent Brazil. Salines are small, rounded ponds, or typical "soda lakes" in which the predominant salt is sodium carbonate, with pH values that may reach 10, and nitrogen that occurs almost exclusively in the form of ammonia (Por, 1995). Bays are natural freshwater spots, circular or elongated shaped and isolated by small elevations on ground, covered or not by vegetation. Waters from various bays connect to each other through small

passages ("corixos" and "vazantes"), forming a coalescent system during the flood. The Rio Negro is a tributary of the Paraguay river, with 30 km extension that is between 10 and 50 m wide along its course.

Bird sampling: We used the linear transect method (Bibby, Burgess, & Hill, 1992) for each of the seven habitats (riparian forest, savannah, forested savannah, grassland, bays, salines and river) from 2001 to 2004. During the 17 expeditions to the Fazenda Rio Negro, each habitat was visited twice. At each visit, we conducted two surveys (one in the morning and one in the afternoon), for two hours each period, for a total of 952 hours of linear transects performed in all habitats, (*i.e*., 4 hours per survey, seven habitats, two surveys per visit, 17 expeditions). Transects were distributed as follows: 2001 (January, April, June and August); 2002 (January, February, April, June, September); 2003 (January, August, November, December); 2004 (April, August, October and December). The transect methodology is widely used in bird studies in a variety of habitats and for different purposes. In general, transects are used in areas of easy access and locomotion as shown by Barrantes, Ocampo, Ramírez-Fernández and Fuchs (2016) in fragments of forest in Costa Rica. Silva and Rodrigues (2015) measured density and spatial distribution of shorebirds in the Brazilian Amazonian coast. Devault, Kubel and Rhodes (2009) monitored birding communities at small airports in the United States. Whitaker and Montevecchi (1996) surveyed breeding bird assemblages in riparian edge, nonriparian edge (clearcut or access road) and in forests in Canada. Herkert (1994) researched the influence of area and vegetation structure on breeding bird communities associated with grassland fragments in Illinois; and the transect method is also used in areas with intensive agriculture as studied by Atkinson, Fuller, Gillings and Vickery (2006).

Some general patterns were followed to develop the transects: 1) Routes were selected according to accessibility and were of a fixed length (2 km each) so each could be covered in a session of fieldwork (two hours); 2) surveys were done since dawn (around 6:00) and in late afternoon (from 05:00) to sunset; 3) they were fixed so that we could have replicas of each transect effected; 4) they were performed on consecutive days for each environment twice, totaling 10 days (with two separate teams to develop the samplings); 5) Each team was composed of six to ten participants depending on the location of the transect (the transect in the river was always composed by six participants according to the places available on the boat). 6) Care was taken not to record more than one contact for the same individual by monitoring location and dislocation. 7) Migratory species may be summer (wet season from October to March) or winter (dry season from April to September) visitors. 8) Equipment: we used 8X30, 10X40 and 12X40 binoculars from Swarovski, Nikon and Bushnell brands; Swarovski ATS-65 HD 2.6 "/ 65 mm Spotting Scope and Ecotone 16.5-75X 80 mm for bird registration in salines and bays; Sony TCM 5000 EV, and TC-D5 Prof II for recordings of vocalizations with microphones Sennheiser M66 and ME67. We used ten mist-nets ranging from 20 to 36 mm and length ranging from 8, 12 and 18 m. The mist-nets were used as a complement to the qualitative study so that we could obtain maximum richness, particularly in closed environments where it was not possible to observe/listen to certain birds. It is a complementary study to the transect method, and was carried out simultaneously with another team. Classification of the species followed the official list of Brazilian birds, ruled by the Brazilian Committee of Ornithological Records (Piacentini et al., 2015).

Repeated measures ANOVAs were used to compare total abundance of birds among years, season and times of day because we repeated the surveys each year. A total of four repeated measures two-way ANOVAs were performed: 1) to evaluate the effect of the year, the time of day (morning or afternoon) and the interaction between year and time of day in the total abundance; 2) the effect of the year, the season (dry or wet) and the interaction

between the year and the season in total abundance; 3) the effect of the year, the habitat and the interaction between year and habitat in the total abundance; and 4) the effect of the year, the categorized habitat (open, i.e., areas with fewer tree cover as grasslands; and closed, i.e., areas with greater tree cover, such as riparian forests and forested savannah) and the interaction between habitat and year in the total abundance. Once a statistically significant effect was identified, we used Tukey post-hoc test (for multiple comparison of measures). All tests were two-tailed, and the differences were considered significant at $P < 0.05$.

RESULTS

Richness: The richness registered was 201 species for the savannah, 87 in forested savannah, 116 in the riparian forest, 75 in grasslands, 92 in the salines, 120 in the bays and 64 in Rio Negro, accounting for 348 species in the Pantanal do Rio Negro (Appendix 1). About 80 % of these species occurred in one or two habitats, 7 % in three, 9 % in four, 1 % in five and less than 1 % in all of them. There were still 2 % of the species that did not belong to any specific habitat, because they generally occupied the air space (Appendix 1). The savannah showed the highest number of exclusive species (67 species), while only four exclusive species were recorded for the forested savannah. A total of 22 exclusive bird species were recorded in the grasslands, 25 in the riparian forests, 14 species in the river, nine in the salines and only two species at bays (Appendix 1).

We found significant variation on richness among years ($F_{3,219} = 14.757$, $P < 0.001$), among habitats ($F_{6,219} = 30.886$, $P < 0.001$), and in the interaction between different years and habitats ($F_{17,219} = 3.505$, $P < 0.001$). The post-hoc Tukey test displayed clusters of habitats based on richness: one composed only by the grasslands, one composed by bays, forested savannah, salines and gallery forest, and the last one composed by savannah and river. When we examined variation between seasons, we found differences among years ($F_{3,221} = 3.576$, $P = 0.015$) and on the interaction between different years and seasons ($F_{3,221} = 6.070$, $P = 0.001$), but we did not find any variation between seasons ($F_{1,221} = 3.116$, $P = 0.078$). Once again variation occured in 2004 ($t = -3.337$, $P = 0.002$). We found no differences on richness among years ($F_{3,219} = 1.200$, $P = 0.311$), between times of day ($F_{1,219} = 3.752$, $P = 0.054$) and in the interaction between different years and times of day ($F_{3,219} = 2.491$, $P = 0.061$) (Fig. 3 and Table 1).

Considering all the environments sampled, the families with the highest richness were Tyrannidae and Psittacidae, with 32 and 16 species, respectively, followed by Columbidae, Picidae and Emberizidae, each with 13 species. Twenty-five families were represented by only one or two species. The highest species richness of Tyrannidae (Passeriformes) and Psittacidae (non-Passeriformes) was recorded in the savannah, forested savannah and gallery forests. In the grasslands, more species of Emberezidae were registered. Ardeidae and Threskiornithidae were dominant in number of species in salinas, in the bays and in the river. Momotidae was restricted to the gallery forest, Alcedinidae standing out in the river and bays. Some tyrannids were restricted to one

TABLE 1
Richness of birds in the Pantanal for times of day and seasons between 2001 and 2004

Year	Morning	Afternoon	Dry	Wet
2001	35.34 ± 20.20	27.09 ± 13.08	32.81 ± 16,17	30.57 ± 18.34
2002	35.85 ± 12.81	28.40 ± 13.80	32.89 ± 13,55	37.35 ± 12.19
2003	32.88 ± 11.80	38.35 ± 4.30	36.27 ± 9,24	31.87 ± 12.15
2004	39.90 ± 14.23	28.62 ± 21.52	32.29 ± 14,72	48.87 ± 13.23

Values represent mean species number ± SD.

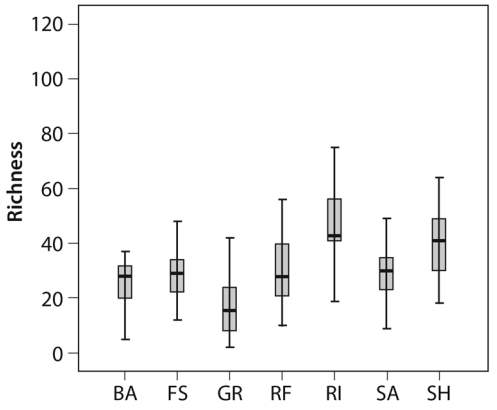

Fig. 3. Richness of birds for each different habitat in the Pantanal. Values represent mean ± SD. BA – bays; FS – forested savannah; SH – savannah; RP– riparian forest; GR– grasslands; RI – river; SA – salines.

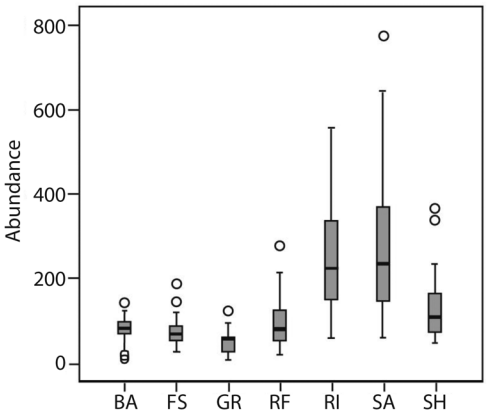

Fig. 4. Abundance of birds in the Pantanal. Values represent mean ± SD. BA – bays; FS – forested savannah; SH – savannah; RP– riparian forest; GR– grasslands; RI – river; SA – salines.

or two environments, such as *Cnemotriccus fuscatus* and *Lessonia rufa* in the forested savannah, *Gubernetes yetapa, Camptostoma obsoletum* and *Megarynchus pitangua* in the savannah, *Xolmis velatus* in the grasslands, *Philohydor lictor* in the river and *Machetornis rixosa* in the salinas. *Pitangus sulphuratus*, on the other hand, was well distributed in the all environments.

Abundance: Total abundance of birds was not different among years ($F_{3,219}$ = 1.999, P = 0.115), times of day ($F_{1,219}$ = 2.066, P = 0.152) and between times of day when it was dependent upon the years ($F_{3,219}$ = 0.252, P = 0.680). However, it showed significant variation in the interaction between years and seasons ($F_{3,219}$ = 3.685, P = 0.013) since 2004 showed significant differences in abundance between both seasons (t = -3.224, P = 0.002). Thus, it could be said that the dry season would attract more visiting birds to better exploit the resources in aquatic environments (rivers, bays, and salines) when the water level drops in these environments. On the other hand, the rain would delay this process, allowing the birds to be less concentrated in these aquatic environments. Another relevant factor in relation to the dry season is that many species of aquatic visiting birds nest on the edges of aquatic environments and food is more easily obtained with the decrease of water.

Total abundance of birds was different among years ($F_{3,219}$ = 6.549, P < 0.001), among habitats ($F_{6,219}$ = 32.798, P < 0.001) and in the interaction between different years and habitats ($F_{17,219}$ = 3.115, P < 0.001). The post-hoc Tukey test showed two major groups: one composed by habitats with low abundance, such as grasslands, forested savannah, savannah, bays and riparian forests, and another one formed by salines and river, that have higher abundance (Fig. 4 and Table 2).

Psittacidae was the most abundant family in the region, with prominence in all environments. Recurvirostridae, a monospecific family, showed expressive abundance due to the dominance of *Himantopus mexicanus* in the salinas, followed by Ardeidae, Anatidae and Cracidae. Other families with high abundance were Tyrannidae, Columbidae, Thraupidae and Emberizidae, all in predominantly terrestrial environments. Among the most abundant species we registered *Brotogeris chiriri* standing out in all the sampled environments. Other species with great abundance in the different environments were *Ortalis canicollis*, *Amazona aestiva*, *Dendrocygna viduata*, *Cantorchilus leucotis* and *Pitangus sulphuratus*. The 30 most

TABLE 2
Abundance of birds in the Pantanal for times of day and seasons between 2001 and 2004

Year	Morning	Afternoon	Dry	Wet
2001	182.82 ± 95.04	153.95 ± 162.86	202.15 ± 190.93	145.67 ± 156.94
2002	181.14 ± 127.71	135.60 ± 78.28	194.62 ± 151.20	161.81 ± 110.32
2003	176.09 ± 113.07	151.87 ± 77.24	182.86 ± 112.52	164.27 ± 122.6
2004	160.20 ± 109.41	172.25 ± 173.01	120.11 ± 84.82	250.03 ± 144.03

Values represent mean of number of birds detected ± SD.

abundant species together represented 61 % of all records. *Dendrocygna autumnalis* was preferentially concentrated in the rivers and salines while *Cairina moschata* was frequently distributed in the bays. *Anhinga anhinga* and *Nannopterum brasilianus* were recorded almost exclusively in the river, except for some records of the second in the bays and salines. The Ardeidae were more frequent in the river, followed by the salines and expressively less common in the bays. Treskiornithidae were more frequent in the salinas while the Ciconiidae stood out in the river. The distribution of limnic species was heterogeneous among the three aquatic environments. *Vanellus chilensis* (N = 206), *H. mexicanus* (N = 1712), *Tringa flavipes* (N = 241), *T. melanoleuca* (N = 149) and *Phaetusa simplex* (N = 197) were abundant in the salines. *Jacana jacana* (N = 210) was abundant in bays, salines and grasslands. *P. simplex* was abundant in saline and common in the river, while *S. superciliary* and *Chlidonias niger* (N = 130) had ample abundance only in the river.

Migratory species: A total of 98 species of migratory birds were registered in Pantanal of Rio Negro (Appendix 1). The vast majority of migratory species were recorded between June and September. The following were exceptions: *Crotophaga major*, a summer migratory species recorded only during the wet season; *Anhinga anhinga*, normally recorded in large numbers during summer (small numbers in winter); *Nannopterum brasilianus*, present in summer and the early dry season (winter in the Pantanal); and *Phaetusa simplex* (Gmelin, 1789), another species that migrates in summer. There is also *Hirundo rustica* Linnaeus, 1758, seen usually in large flocks during summer (wet season). Those typical of the rainy period (summer), with more than 100 recordings were *N. brasilianus*, *P. simplex, Tachybaptus dominicus, C. major* and *Mesembrinibis cayennensis* (Gmelin, 1789). At some time, any of these species can be recorded in small numbers in different seasons.

DISCUSSION

Naumburg (1930) was one of the pioneers in describing birds of the Pantanal, followed by Mitchell (1957). Cintra and Yamashita (1990) went a step further and described the habitats, distribution, and abundance of bird species in the Northern Pantanal. Brown (1986) analyzed the distribution and biogeographic affinities of over 650 bird species in the Pantanal. Dubs (1992) presented a catalogue of birds from Southwestern Brazil and bordering regions in the Pantanal region with almost 700 species of birds. The avifauna from Pantanal wetlands has the highest species richness among the wet areas in the World, sheltering approximately 460 species (Nunes & Thomas, 2004a). Moreover, new species are added every year to the Pantanal list (Nunes et al., 2008). Figueira et al. (2006) found more bird species richness in forest areas, followed by savannahs and grasslands and floodable or aquatic fields. In terms of aquatic habitats, the diversity of bird community in the dry season varies significantly in the salines, followed by the bays and more stable in the Negro river. The Negro river, regardless of large annual amplitude of flow, is more seasonally stable since

its riparian vegetation is continuous (not isolated) and constant (Donatelli et al., 2014). Our results showed the same pattern recorded by these authors in relation to aquatic habitats but this work, the first of its kind, will be a reference for further studies of birds in Pantanal, for various fields of research.

The temporal and spatial variation in the abundance of birds in the tropics has already been highlighted by several authors (Blake & Loiselle, 1991) and the fluctuations in bird abundance are already known in Pantanal (Nunes & Thomas, 2004a). Thus, as registered in the present work, in the dry season the abundance of birds was higher than in the wet period. The dry season is related to high availability of food and decrease in the volume of water in the wetland system (Por, 1995). On the other hand, Poulin, Lefebvre and McNeil (1993) registered lower abundances of birds at the beginning of the reproductive period in deciduous and dry forests in Venezuela, associating this to the low availability of food.

The spatial distribution of the animal diversity has also been explained in climate and vegetational structure (Cueto & Casenave, 1999; Veech & Crist, 2007). According to Farley, Ellis, Stuart & Scott (2004) habitat variability is a determinant part of the structure and dynamics of a community of birds, because most of the species are closely related to specific habitats. We found that there was no significant variation in the abundance of birds in the same habitat in four years of data collection, but a great significant variation between different habitats was observed; this fact was expected, considering the peculiar characteristics of each habitat. So, in a regional scale, the factors that seem to influence bird abundance are habitat type, size, and diversity of habitats existing in a specific place (Rafe, Usher, & Jefferson, 1985), being the heterogeneity of habitats a predominant factor in the determination of the number of birds' species (Rafe et al., 1985; Farley et al., 1994; Bailey et al., 2004; Blake, 2007). Figueira et al. (2006) found more bird species richness in forest areas, followed by savannahs and grasslands and floodable or aquatic fields. On the other hand, in terms of abundance, we observed that the open habitats, such as the salines and rivers had a higher abundance of birds than the other habitats (categorized as closed); a possible reason for this was a large concentration of species of shorebirds exploring food in these environments.

Figueira et al. (2006) analysed bird diversity of Pantanal wetlands in Mato Grosso and found three types of habitats with similar diversity: 1) forested habitats (forested savannah and riparian forests); 2) savannah (savannah *sensu strict* and grasslands); and 3) aquatic habitats (rivers, bays, corixos). Species which share distinct habitats may also indicate, indirectly, the potential flow of individuals and species among the different habitats and consequently, the complexity, the interconnectivity and the flexibility of interactions in the food chain. Thus, the heterogeneity of habitats is fundamental for the maintenance of the diversity of both aquatic and terrestrial birds (Figueira et al., 2006). On the other hand, our results also indicated that it seems quite remote that Pantanal wetlands share bird species with other habitat, except in particular conditions (river and riparian forests, salines and rivers). Results of abundance showed specificity and each habitat has its own importance in the whole context, notwithstanding the sharing of habitats.

Considering migratory species, Nunes and Tomas (2004b) listed 133 species of migratory birds with occurrence in the plains of the Pantanal wetlands. In this study 98 species, approximately 74 % of all the migratory birds that occur in the plains of the Pantanal were registered. According to the reference chart from these authors, we have the following profile regarding the migratory birds in the Pantanal do Rio Negro: 1) Most of these species have aquatic habits; 2) approximately 40 % are migrant from the American continent, and 32 % from national territory; 3) approximately 15 % come from Central America, North of South America and North America and 13 % from the extreme South of South America; 4) None of them has been considered in situation that requires attention regarding

conservation and 5) the vast majority has got unknown destination.

The results highlight some important issues regarding the abundance of birds in this region of Pantanal wetlands: a) The morning period and the dry season register the highest number of birds, regardless of the habitat; b) there are no significant differences in abundance in the same habitat along the years, but the habitats among themselves showed different total abundances.

In general, the results indicated that there is a relatively stable abundance in each habitat along years, but there is a clear difference in abundance among the habitats yearly, associated with their particularities. Pantanal of Rio Negro is an enormous complex of interconnected habitats on which the local community of birds depends. This diversity of habitats contributes to the high abundances recorded, as well as to the biome as a whole. Thus, additional studies on food availability in dry and wet seasons should be better explored in the future, either in this region or in other Pantanal regions. This fact could better explain the seasonal dynamics of the richness and abundance of birds in the Pantanal in general.

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RESUMEN

Variación temporal y espacial en la riqueza y abundancia de la comunidad de aves del humedal Pantanal de Nhecolândia (Mato Grosso do Sul, Brazil). Los humedales del Pantanal representan una de las mayores llanuras de inundación del mundo, con variaciones climáticas extremas entre las estaciones seca y húmeda. La zona alberga una gran diversidad de hábitats, representando las principales formaciones encontradas en esta subregión de humedales del Pantanal: pastizales, sabanas, sabanas boscosas, bosques ribereños, bahías y salinas, y el propio Río Negro. La variabilidad del hábitat es una parte determinante de la estructura y dinámica de la comunidad de aves, ya que la mayoría de las especies están estrechamente relacionadas con hábitats específicos. Estudiamos la abundancia de especies de aves de 2001 a 2004 en la Fazenda Río Negro, Aquidauana, Brasil. La abundancia se comparó entre los cuatro años consecutivos, las estaciones (seca y húmeda), la hora del día (mañana y tarde) y también entre siete hábitats diferentes, para determinar la variación en los patrones de distribución y hábitats utilizados por las aves. Para ello, se utilizó el método de transectos lineales en cada uno de los siete hábitats, y se registraron las abundancias de aves para obtener la riqueza. La riqueza registrada en el mosaico de hábitats fue de 201 especies para la sabana, 87 sabana boscosa, 116 bosque ribereño, 75 en pastizales, 120 en bahías, 92 en salinas y 64 en el río Negro, con 348 especies en el Pantanal de Río Negro. En total, se registraron 98 especies de aves migratorias. Los resultados destacaron algunas cuestiones importantes con respecto a la abundancia total de aves en Nhecolândia: Psittacidae fue la familia más abundante en la región, con prominencia en todos los ambientes. Recurvirostridae, una familia monoespecífica, mostró abundancia significativa debido a la dominancia de *Himantopus mexicanus* en las salinas, seguido por Ardeidae, Anatidae y Cracidae. Otras familias con gran abundancia fueron: Tyrannidae, Columbidae, Thraupidae y Emberizidae, todas en ambientes predominantemente terrestres. Además: a) Se registró el mayor número de ejemplares en el período de la mañana y en la estación seca, independientemente del hábitat; B) no hubo diferencias en la abundancia en el mismo hábitat a lo largo de los años, pero la abundancia fue diferente entre los hábitats. En general, los resultados indicaron que hay una población de aves relativamente estable en cada hábitat a lo largo del ciclo anual, pero hubo diferencias en la abundancia entre los hábitats.

Palabras clave: pantanal, comunidad de aves, mosaico de hábitats, Mato Grosso do Sul.

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APPENDIX 1

Bird species recorded in the Pantanal, Fazenda Rio Negro, from 2001 to 2004

Rheidae	RF	SH	FS	BA	SA	GR
Rhea americana Greater Rhea (Linnaeus, 1758)		X			X	X
Tinamidae						
Crypturellus undulatus Undulated Tinamou (Temminck, 1815)	X	X	X	X		
Crypturellus parvirostris Small-billed Tinamou (Wagler, 1827)		X		X		X
Rhynchotus rufescens Red-winged Tinamou (Temminck, 1815)						X
Podicipedidae						
Tachybaptus dominicus Least Grebe[M] (Linnaeus, 1766)				X	X	
Podilymbus podiceps Pied-billed Grebe[V] (Linnaeus, 1758)				X	X	
Phalacrocoracidae						
Nannopterum brasilianus Neotropic Cormorant[M] (Gmelin, 1789)				X	X	
Anhingidae						
Anhinga anhinga Anhinga (Linnaeus, 1766)				X	X	
Ardeidae						
Ardea cocoi White-necked Heron Linnaeus, 1766				X	X	
Ardea alba Great Egret Linnaeus, 1758				X	X	
Egretta thula Snowy Egret[M] (Molina, 1782)				X	X	
Egretta caerulea Little Blue Heron (Linnaeus, 1758)					X	
Butorides striata Striated Heron (Linnaeus, 1758)				X	X	
Agamia agami Chestnut-bellied Heron (Gmelin, 1789)						
Bubulcus ibis Cattle Egret (Linnaeus, 1758)		X				X
Syrigma sibilatrix Whistling Heron (Temminck, 1824)				X	X	
Pilherodius pileatus Capped Heron (Boddaert, 1783)						
Nycticorax nycticorax Black-crowned Night-Heron (Linnaeus, 1758)				X		
Tigrisoma lineatum Rufescent Tiger-Heron (Boddaert, 1783)				X	X	
Botaurus pinnatus Pinnated Bittern[M] (Wagler, 1829)						
*Cochlearius cochlearius*Boat-billed Heron (Linnaeus, 1766)						
Threskiornithidae						
*Theristicus caerulescens*Plumbeous Ibis (Vieillot, 1817)				X	X	X
Theristicus caudatus Buff-necked Ibis (Boddaert, 1783)				X	X	X
Mesembrinibis cayennensis Green Ibis[M] (Gmelin, 1789)				X	X	
Phimosus infuscatus Whispering Ibis[M] (Lichtenstein, 1823)				X	X	
Plegadis chihi White-faced Ibis[M] (Vieillot, 1817)				X	X	
Platalea ajaja Roseate Spoonbill Linnaeus, 1758				X	X	
Ciconiidae						
Mycteria americana Wood Stork Linnaeus, 1758				X	X	X
Ciconia maguari Maguari Stork (Gmelin, 1789)				X	X	X
Jabiru mycteria Jabiru (Lichtenstein, 1819)				X	X	X
Cathartidae						
Coragyps atratus Black Vulture (Bechstein, 1793)				X		
Cathartes aura Turkey Vulture (Linnaeus, 1758)				X		
Cathartes burrovianus Lesser yellow-headed Vulture Cassin, 1845						
Sarcoramphus papa King Vulture (Linnaeus, 1758)						
Anatidae						
Dendrocygna bicolor Fulvous Whisting-Duck[M] (Vieillot, 1816)				X	X	
Dendrocygna viduata White-faced Whistilig Duck[M] (Linnaeus, 1766)				X	X	
Dendrocygna autumnalis Black-bellied Whistling Duck[M] (Linnaeus, 1758)				X	X	

APPENDIX 1 (Continued)

Rheidae	RF	SH	FS	BA	SA	GR
Coscoroba coscoroba Coscoroba Swan[V] (Molina, 1782)				X	X	
Callonetta leucophrys Ringed Teal[M] (Vieillot, 1816)					X	
Amazonetta brasiliensis Brazilian Teal (Gmelin, 1789)				X	X	
Sarkidiornis sylvicola Comb Duck[M] Ihering & Ihering, 1907					X	
Cairina moschata Muskovy Duck (Linnaeus, 1758)	X	X	X	X	X	
Anhimidae						
Chauna torquata Southern Screamer (Oken, 1816)	X			X	X	
Accipitridae						
Elanus leucurus White-tailed Kite (Vieillot, 1818)	X	X				
Gampsonyx swainsoni Pearl Kite[V] Vigors, 1825	X	X				
Elanoides forficatus Swallow-tailed Kite (Linnaeus, 1758)	X	X				
Leptodon cayanensis Gray-headed Kite (Latham, 1790)	X					
Chondrohierax uncinatus Hook-billed Kite[V] (Temminck, 1822)		X				
Ictinia plumbea Plumbeous Kite (Gmelin, 1788)	X	X		X		
Rostrhamus sociabilis Snail Kite (Vieillot, 1817)				X	X	
Geranoaetus albicaudatus White-tailed Hawk (Vieillot, 1816)		X				
Buteo albonotatus Zone-tailed Hawk Kaup, 1847		X				
Buteo brachyurus Short-tailed Hawk Vieillot, 1816		X				
Buteo nitidus Gray Hawk (Latham, 1790)		X				
Rupornis magnirostris Roadsipe Hawk (Gmelin, 1788)	X	X	X	X	X	X
Parabuteo unicinctus Harris's Hawk[V] (Temminck, 1824)		X				
Busarellus nigricollis Black-collared Hawk (Latham, 1790)	X	X	X	X	X	X
Heterospizias meridionalis Savannah Hawk (Latham, 1790)		X	X	X	X	X
Urubitinga urubitinga Great Black Hawk (Gmelin, 1788)						
Urubitinga coronata Crowned Solitary Eagle[VU/V] (Vieillot, 1817)		X				
Geranospiza caerulescens Crane Hawk (Vieillot, 1817)		X				
Pandionidae						
Pandion haliaetus Osprey[M] (Linnaeus, 1758)	X					
Falconidae						
Herpetotheres cachinnans Laughing Falcon (Linnaeus, 1758)	X	X		X		
Micrastur semitorquatus Collared Forest-Falcon (Vieillot, 1817)	X					
Micrastur ruficollis Barred Forest-Falcon (Vieillot, 1817)	X					
Milvago chimachima Yellow-headed Caracara (Vieillot, 1816)	X	X	X	X	X	X
Caracara plancus Crested Caracara (Miller, 1777)	X	X	X	X	X	X
Falco rufigularis Bat Falcon (Daudin, 1800)					X	
Falco femoralis Aplomado Falcon (Temminck, 1822)		X				
Falco sparverius American Kestrel (Linnaeus, 1758)						X
Cracidae						
Ortalis canicollis Chaco Chachalaca (Wagler, 1830)	X		X	X	X	
Aburria cumanensis Blue-throated Piping-Guan (Jacquin, 1784)	X		X	X		
*Crax fasciolata*Bare-faced Curassow (Spix, 1825)	X	X	X	X	X	
Aramidae						
Aramus guarauna Limpkin (Linnaeus, 1766)				X	X	X
Rallidae						
*Pardirallus nigricans*Blackish Rail (Vieillot, 1819)						X
*Aramides cajaneus*Grey-necked Wood-Rail (Statius Muller, 1776)	X			X		
Mustelirallus albicollis Ash-throated Crake (Vieillot, 1819)						X

APPENDIX 1 (Continued)

Rheidae	RF	SH	FS	BA	SA	GR
Coturnicops notatus Speckled crake (Gould, 1841)						X
Gallinula galeata Common Moorhen (Lichtenstein, 1818)						X
*Porphyrio martinicus*Purple Gallinule (Linnaeus, 1766)						X
Porphyrio flavirostris Azure Gallinule (Gmelin, 1789)						X
Heliornithidae						
Heliornis fulica Sungreebe (Boddaert, 1783)						
Cariamidae						
Cariama cristata Red-legged Seriema (Linnaeus, 1766)		X		X		X
Jacanidae						
Jacana jacana Wattled Jacana (Linnaeus, 1766)				X	X	X
Charadriidae						
*Vanellus chilensis*Southern Lapwing (Molina, 1782)	X	X		X	X	X
Vanellus cayanus Pied Lapwing[M] (Latham, 1790)				X		
Charadrius collaris Collared Plover (Vieillot, 1818)						X
Scolopacidae						
*Tringa solitaria*Solitary Sandpiper (Wilson, 1813)				X	X	
Tringa flavipes Lesser Yellowlegs (Gmelin, 1789)					X	
*Tringa melanoleuca*Greater Yellowlegs (Gmelin, 1789)				X	X	
Actitis macularius Spotted Sandpiper (Linnaeus, 1766)					X	
Calidris melanotos Pectoral Sandpiper[M] (Vieillot, 1819)					X	
Bartramia longicauda Upland Sandpiper[M] (Bechstein, 1812)					X	
*Gallinago paraguaiae*Magellan Snipe (Vieillot, 1816)					X	
Phalaropus tricolor Wilson's Phalatrope[M] (Vieillot, 1819)					X	
Recurvirostridae						
Himantopus melanurus White-backed Stilt Vieillot, 1817					X	
Sternidae						
*Phaetusa simplex*Large-billed Tern (Gmelin, 1789)				X	X	
*Sternula superciliaris*Yellow-billed Tern (Vieillot, 1819)				X	X	
Rynchopidae						
Rynchops niger[b]Black Skimmer[M] Linnaeus, 1758						
Columbidae						
Patagioenas picazuro Picazuro Pigeon (Temminck, 1813)	X	X	X	X		X
Patagioenas cayennensis Pale-vented Pigeon (Bonnaterre, 1792)	X	X	X	X		X
Zenaida auriculata Eared Dove (Des Murs, 1847)		X				X
Columbina minuta Blue Ground-Dove (Linnaeus, 1766)	X	X				X
Columbina talpacoti[b]Ruddy Ground-Dove (Temminck, 1811)		X		X		X
Columbina picui Picui Ground Dove (Temminck, 1813)		X				X
Claravis pretiosa Blue-eyed Groud-Dove (Ferrari-Perez, 1886)	X	X				
Uropelia campestris Long-Tailed Ground Dove (Spix, 1825)		X				X
Columbina squammata Scaled Dove (Lesson, 1831)		X		X		X
Leptotila verreauxi[b]White-tipped Dove Bonaparte, 1855	X	X		X		
Leptotila rufaxilla Grey-fronted Dove (Richard & Bernard, 1792)	X	X				
Psittacidae						
Anodorhynchus hyacinthinus Hyacinthine Macaw[VU] (Latham, 1790)	X	X	X	X	X	
Ara ararauna Blue-and-yellow Macaw (Linnaeus, 1758)	X	X	X	X	X	
Ara chloropterus Red-and-green Macaw Gray, 1859	X	X	X	X	X	
Primolius auricollis Yellow-collared Macaw (Cassin, 1853)	X	X	X	X	X	

APPENDIX 1 (Continued)

Rheidae	RF	SH	FS	BA	SA	GR
Diopsittaca nobilis Red-shoultered Macaw (Linnaeus, 1758)	X	X	X	X	X	
Thectocercus acuticaudata Blue-crowned Parakeet (Vieillot, 1818)	X	X	X	X	X	
*Psittacara leucophthalmus*White-eyed Parakeet (Statius Muller, 1776)		X		X		
Eupsittula aurea Peach-fronted Parakeet (Gmelin, 1788)	X	X	X	X	X	
Aratinga nenday Nanday Parakeet (Vieillot, 1823)		X	X	X	X	
Myiopsitta monachus Monk Parakeet (Boddaert, 1783)		X				
Brotogeris chiriri Canary-winged Parakeet (Vieillot, 1818)	X	X	X	X	X	
Pionus menstruus Blue-headed Parrot[V] (Linnaeus, 1766)		X	X			
Pionus maximiliani Scaly-headed Parrot (Kuhl, 1820)		X	X	X		
Alipiopsitta xanthops Yellow-faced Parrot[VU/V] (Spix, 1824)		X	X			
Amazona aestiva Blue-fronted Parrot (Linnaeus, 1758)	X	X	X	X	X	
Amazona amazonica Orange-winged Parrot (Linnaeus, 1766)	X	X	X		X	
Cuculidae						
Coccyzus melacoryphus Dark-billed Cuckoo[M] Vieillot, 1817		X				
Micrococcyx cinereus Ash-colored Cuckoo[M] Vieillot, 1817		X				
Coccyzus americanus Yellow-billed Cuckoo[M] (Linnaeus, 1758)		X				
Piaya cayana Squirrel Cuckoo (Linnaeus, 1766)	X	X	X	X	X	
Coccycua minuta Little Cuckoo[V] (Vieillot, 1817)	X					
Crotophaga ani Smooth-billed Ani Linnaeus, 1758		X		X	X	X
Crotophaga major Greater ani[M] Gmelin, 1788	X					
Guira guira[b] Guira Cuckoo (Gmelin, 1788)		X		X	X	X
Tapera naevia Striped Cuckoo (Linnaeus, 1766)		X	X			
Dromococcyx pavoninus Pavonine Cuckoo Pelzeln, 1870		X	X			
Tytonidae						
*Tyto furcata*Barn Owl (Scopoli, 1769)		X				
Strigidae						
Megascops choliba Tropical Screech-Owl (Vieillot, 1817)		X				
Bubo virginianus Great Horned Owl (Gmelin, 1788)		X				
Glaucidium brasilianum[b] Ferruginoum Pigmy-Owl (Gmelin, 1788)	X	X				
Athene cunicularia Burrowing Owl (Molina, 1782)		X				X
Pulsatrix perspicillata Spectacled Owl (Latham, 1790)		X				
Strix huhula Black-banded Owl Daudin, 1800		X				
Nyctibiidae						
Nyctibius grandis Great potto (Gmelin, 1789)		X				X
Nyctibius griseus Grey Potoo (Gmelin, 1789)		X	X			X
Caprimulgidae						
Lurocalis semitorquatus Short-Tailed Nighthawk (Gmelin, 1789)	X	X				
Chordeiles acutipennis Lesser nighthawk (Hermann, 1783)	X					
Nyctiprogne leucopyga Band-tailed Nighthawk (Spix, 1825)		X				
Podager nacunda Nacunda Nighthawk (Vieillot, 1817)		X				X
Nyctidromus albicollis Pauraque (Gmelin, 1789)		X				X
Antrostomus rufus Rufous Nightjar (Boddaert, 1783)		X				X
Hydropsalis parvula Little Nightjar (Gould, 1837)		X				X
Hydropsalis torquata Scissor-tailed Nightjar (Gmelin, 1789)		X				X
Apodidae						
Chaetura meridionalis Ashy-tailed Swift[V] Hellmayr, 1907						
Trochilidae						

APPENDIX 1 (Continued)

Rheidae	RF	SH	FS	BA	SA	GR
Phaethornis pretrei Planalto Hermit (Lesson & Delattre, 1839)	X	X				
*Eupetomena macroura*Swallow-tailed Hummingbird (Gmelin, 1788)		X				
Anthracothorax nigricollis Black-throated Mango (Vieillot, 1817)		X				
Chlorostilbon lucidus Glittering-bellied Emerald (Shaw, 1812)		X		X		
Thalurania furcata Fork-tailed Woodnymph (Gmelin, 1788)		X				
Hylocharis chrysura Gilded Hummingbird (Shaw, 1812)	X	X				
Amazilia versicolor Versicoloured Emerald (Vieillot, 1818)		X				
Amazilia fimbriata Glittering-throated Emerald (Gmelin, 1788)		X				
Trogonidae						
Trogon curucui[b] Blue-crowned Trogon Linnaeus, 1766	X	X	X	X		
Alcedinidae						
Megaceryle torquata Ringed Kingfisher (Linnaeus, 1766)	X			X		
Chloroceryle amazona[b] Amazon Kingfisher (Latham, 1790)	X			X		
Chloroceryle americana[b] Green Kingfisher (Gmelin, 1788)	X			X		
Chloroceryle inda[b] Green-and-Rufous Kingfisher (Linnaeus, 1766)	X					
Chloroceryle aenea American Pygmy Kingfisher (Pallas, 1764)	X					
Momotidae						
Momotus momota Blue-crowned Motmot (Linnaeus, 1766)	X					
Galbulidae						
Galbula ruficauda[b] Rufous-tailed Jacamar Cuvier, 1816	X	X				
Bucconidae						
Nystalus maculatus Spot-backed Puffbird (Gmelin, 1788)		X				
Ramphastidae						
Pteroglossus castanotis Chestnut-eared Araçari Gould, 1834		X				
Ramphastos toco Toco Toucan Statius Muller, 1776	X	X		X		
Picidae						
Picumnus albosquamatus White-wedged Piculet d'Orbigny, 1840	X	X	X			
Colaptes campestris[b] Campos Flicker (Vieillot, 1818)		X		X	X	X
Colaptes melanochloros Green-barred Woodpecker (Gmelin, 1788)		X	X			
Piculus chrysochloros Golden-green Woodpecker (Vieillot, 1818)		X	X			
Celeus flavescens Blond-crested Woodpecker (Gmelin, 1788)		X	X			
Celeus lugubris Pale-crested Woodpecker (Malherbe, 1851)	X	X	X		X	
Dryocopus lineatus Lineated Woodpecker (Linnaeus, 1766)	X	X	X		X	
Melanerpes candidus White Woodpecker (Otto, 1796)		X	X	X	X	
Melanerpes cactorum White-fronted Woodpecker (d'Orbigny, 1840)		X				
Veniliornis passerinus Little Woodpecker (Linnaeus, 1766)	X	X	X		X	
Campephilus melanoleucos Crimson-crested Woodpecker (Gmelin, 1788)		X	X			
Campephilus leucopogon Cream-backed Woodpecker (Valenciennes, 1826)		X	X			
Melanerpes flavifrons Yellow-fronted Woodpecker (Vieillot, 1818)		X	X			
Thamnophilidae						
Taraba major[b] Great Antshrike (Vieillot, 1816)	X	X	X	X	X	
Thamnophilus doliatus[b] Barred Antshrike (Linnaeus, 1764)	X	X	X	X		
Thamnophilus pelzelni Planalto Slaty Antshrike Hellmayr, 1924	X					
Thamnophilus caerulescens Variable Antshrike Vieillot, 1816	X		X			
Dysithamnus mentalis Plain Antvireo (Temminck, 1823)	X					
Formicivora rufa[b] Rusty-backed Antwren (Wied, 1831)		X		X		
Cercomacra melanaria[b] Mato Grosso Antbird (Ménétriès, 1835)	X					

APPENDIX 1 (Continued)

Rheidae	RF	SH	FS	BA	SA	GR
Furnariidae						
Furnarius rufus[b] Rufous Hornero (Gmelin, 1788)						
Furnarius leucopus[b] Pale-legged Hornero Swainson, 1838		X		X	X	X
Schoeniophylax phryganophilus Chotoy Spinetail (Vieillot, 1817)						X
Synallaxis frontalis Sooty-fronted Spinetail Pelzeln, 1859		X				
Synallaxis albescens Pale-breasted Spinetail Temminck, 1823		X				
Synallaxis albilora[b] Plain-crowned Spinetail Pelzeln, 1856	X	X		X		
Certhiaxis cinnamomeus Yellow-chinned Spinetail (Gmelin, 1788)	X			X		
Cranioleuca vulpina[b] Rusty-backed Spinetail (Pelzeln, 1856)	X					
Phacellodomus rufifrons Plain Thombird (Wied, 1821)		X	X			
Phacellodomus ruber Greater Thombird (Vieillot, 1817)		X	X			
Pseudoseisura unirufa[b] Grey-crested Cachalote (d'Orbigny & Lafresnaye, 1838)		X	X			
Dendrocolaptidae						
Sittasomus griseicapillus[b] Olivaceus Woodcreeper (Vieillot, 1818)	X					
Xiphocolaptes major Great Rufous Woodcreeper (Vieillot, 1818)	X	X	X	X		
Dendrocolaptes platyrostris[b] Planalto Woodcreeper Spix, 1825	X					
Dendroplex picus Straight-billed Woodcreeper (Gmelin, 1788)	X					
Lepidocolaptes angustirostris[b] Narrow-billed Woodcreeper (Vieillot, 1818)		X		X		
Campylorhamphus trochlirostris[b] Red-billed Scyhebill (Lichtenstein, 1820)	X	X				
Tityridae						
Xenopsaris albinucha White-naped Xenopsaris (Burmeister, 1869)	X					
Pachyramphus viridis[b] Green-backed Becard (Vieillot, 1816)		X				
Pachyramphus polychopterus White-winged Becard (Vieillot, 1818)	X					
Pachyramphus validus Crested Becard (Lichtenstein, 1823)		X				
Tityra cayana Black-tailed Tityra (Linnaeus, 1766)		X	X	X		
Tityra inquisitor Black-crowned Tityra (Lichtenstein, 1823)		X	X			
Rynchocyclidae						
Leptopogon amaurocephalus Sepia-capped Flycatcher Tschudi, 1846	X					
Hemitriccus margaritaceiventer[b] Pearly-vented Tody-Tyrant (d'Orbigny & Lafresnaye,1837)			X			
Todirostrum cinereum Common Tody-Flycatcher (Linnaeus, 1766)		X	X			
Poecilotriccus latirostris[b] Rusty-fronted Tody-Flycatcher (Pelzeln, 1868)		X				
Tolmomyias sulphurescens[b] Yellow-olive Flycatcher (Spix, 1825)	X		X			
Tyrannidae						
Phyllomyias fasciatus Planalto Tyrannulet (Thunberg, 1822)		X				
Camptostoma obsoletum[b] Southern Beardless Tyrannulet (Temminck, 1824)		X				
Phaeomyias murina Mouse-coloured Tyrannulet (Spix, 1825)		X	X			
Sublegatus modestus Southern Scrub Flycatcher (Wied, 1831)		X	X			
Suiriri suiriri Chaco Suiriri (Vieillot, 1818)		X				
Myiopagis viridicata[b] Greenish Elaenia (Vieillot, 1817)			X			
Elaenia flavogaster Yellow-bellied Elaenia (Thunberg, 1822)		X				
Elaenia parvirostris Small-billed Elaenia Pelzeln, 1868		X				
Elaenia cristata[b] Plain-crested Elaenia Pelzeln, 1868		X				
Elaenia chiriquensis Lesser Elaenia Lawrence, 1865		X				
Serpophaga subcristata White-crested Tyrannulet (Vieillot, 1817)		X				
Euscarthmus meloryphus Tawny-crowned Pigmy-Tyrant[V] Wied, 1831		X				
*Capsiempis flaveola*Yellow Tyrannulet (Lichtenstein, 1823)		X				
Myiophobus fasciatus Bran-coloured Flycatcher (Statius Muller, 1776)		X				

APPENDIX 1 (Continued)

Rheidae	RF	SH	FS	BA	SA	GR
Contopus cinereus Tropical Pewee (Spix, 1825)		X				
Lathrotriccus euleri[b] Euler's Flycatcher (Cabanis, 1868)	X		X			
Cnemotriccus fuscatus[b] Fuscus Flycatcher (Wied, 1831)			X			
Pyrocephalus rubinus Vermilion Flycatcher (Boddaert, 1783)		X				
Xolmis cinereus Grey Monjita (Vieillot, 1816)		X				X
Xolmis velatus White-rumped Monjita (Lichtenstein, 1823)		X		X		X
Fluvicola albiventer Black-backed Water-Tyrant (Spix, 1825)		X				
Colonia colonus Long-tailed Tyrant (Vieillot, 1818)		X				
Gubernetes yetapa Streamer-tailed Tyrant (Vieillot, 1818)		X				X
Satrapa icterophrys Yellow-browed Tyrant (Vieillot, 1818)		X				
Machetornis rixosa Cattle Tyrant (Vieillot, 1819)		X		X		
Casiornis rufus[b] Rufous Casiornis (Vieillot, 1816)			X			
Arundinicola leucocephala White-headed Marsh-Tyrant (Linnaeus, 1764)	X			X		
Myiarchus ferox[b] Short-crested Flycatcher (Gmelin, 1789)	X			X		
Myiarchus tyrannulus[b] Brown-crested Flycatcher (Statius Muller, 1776)		X	X			
Myiarchus swainsoni Swainson's Flycatcher Cabanis & Heine, 1859		X				
Philohydor lictor Lesser kiskadee (Lichtenstein, 1823)	X					
Pitangus sulphuratus[b] Great Kiskadee (Linnaeus, 1766)	X	X	X	X	X	X
Megarynchus pitangua Boat-billed Flycatcher (Linnaeus, 1766)	X	X	X	X	X	
Myiozetetes cayanensis Rusty-margined Flycatcher (Linnaeus, 1766)	X	X				
Conopias trivirgatus Three-striped Flycatcher (Wied, 1831)		X				
Myiodynastes maculatus Streaked Flycatcher (Statius Muller, 1776)		X	X	X		
Legatus leucophaius Piratic Flycatcher (Vieillot, 1818)		X	X			
Empidonomus varius Variegated Flycatcher (Vieillot, 1818)		X	X			
Griseotyrannus aurantioatrocristatus Crowned Slaty-Flycatcher (d'Orbigny & Lafresnaye, 1837)		X	X			
Tyrannus savana Fork-tailed Flycatcher Vieillot, 1808		X				
Tyrannus melancholicus Tropical Kingbird Vieillot, 1819		X		X		
Pipridae						
Pipra fasciicauda[b] Band-tailed Manakin Hellmayr, 1906	X					
Antilophia galeata Helmeted Manakin (Lichtenstein, 1823)	X					
Neopelma pallescens Pale-bellied Tyrant-Manakin (Lafresnaye, 1853)	X					
Hirundinidae						
Tachycineta albiventer White-winged Swallow[M] (Boddaert, 1783)						
Tachycineta leucorrhoa White-rumped Swallow[M] (Vieillot, 1817)						
Progne tapera Brown-chested Martin (Vieillot, 1817)						
Progne chalybea Gray-brasted Martin (Gmelin, 1789)	X	X	X			
Pygochelidon cyanoleuca Blue-and-white Swallow (Vieillot, 1817)	X	X	X			
Alopochelidon fucata Tawny-headed Swallow[M] (Temminck, 1822)						
Stelgidopteryx ruficollis Southern Rough-winged Swallow (Vieillot, 1817)						
Riparia riparia Bank Swallow[M] (Linnaeus, 1758)						
Hirundo rustica Barn Swallow[M] Linnaeus, 1758						
Petrochelidon pyrrhonota Cliff Swallow[M] (Vieillot, 1817)						
Corvidae						
Cyanocorax cyanomelas Purplish Jay (Vieillot, 1818)	X	X	X	X	X	
Cyanocorax cristatellus Curl-crested Jay (Temminck, 1823)	X	X	X			
Cyanocorax chrysops Plush-crested Jay (Vieillot, 1818)	X	X	X	X	X	

APPENDIX 1 (Continued)

Rheidae	RF	SH	FS	BA	SA	GR
Troglodytidae						
Campylorhynchus turdinus[b] Thrush-like Wren (Wied, 1831)	X	X		X	X	
Cantorchilus leucotis[b] Buff-breasted Wren // (Lafresnaye, 1845)		X				
Troglodytes musculus House Wren Naumann, 1823		X				
Donacobiidae						
Donacobius atricapilla Black-capped Donacobius (Linnaeus, 1766)				X		
Polioptilidae						
Polioptila dumicola Masked Gnatcatcher (Vieillot, 1817)		X				
Turdidae						
Turdus rufiventris[b] Rufous-bellied Thrush Vieillot, 1818	X	X	X	X	X	
Turdus leucomelas Pale-breasted Thrush Vieillot, 1818	X	X	X	X	X	
Turdus amaurochalinus[b] Creamy-bellied Thrush Cabanis, 1850	X	X	X	X	X	
Mimidae						
Mimus saturninus[b] Chalk-browed Mockingbird (Lichtenstein, 1823)		X				
Motacillidae						
Anthus lutescens Yellowish Pipit Pucheran, 1855				X		X
Vireonidae						
Cyclarhis gujanensis Rufous-browned Peppershirke (Gmelin, 1789)	X	X	X	X		
Vireo chivi[b] Red-eyed Vireo (Linnaeus, 1766)	X	X	X			
Icteridae						
Psarocolius decumanus Crested Oropendola (Pallas, 1769)	X	X	X	X	X	
Cacicus cela Yellow-rumped Cacique (Linnaeus, 1758)	X	X	X			
Cacicus chrysopterus Golden-winged Cacique (Vigors, 1825)	X	X	X	X	X	
Procacicus solitarius Solitary Cacique (Vieillot, 1816)	X	X	X			
Icterus cayanensis Epaulet Oriole (Linnaeus, 1766)	X	X	X	X	X	
Icterus croconotus Orange-backedTroupial (Wagler, 1829)	X	X	X	X	X	
Agelasticus cyanopus Unicolored Blackbird (Vieillot, 1819)				X	X	X
Chrysomus ruficapillus Chestnut-capped Blackbird (Vieillot, 1819)						X
Sturnella superciliaris White-browed Blackbird (Bonaparte, 1850)				X	X	X
Amblyramphus holosericeus Scarlet-headed Blackbird (Scopoli, 1786)				X	X	X
Gnorimopsar chopi Chopi Blackbird (Vieillot, 1819)		X	X			
Pseudoleistes guirahuro Yellow-rumped Marshbird (Vieillot, 1819)		X				X
Agelaioides badius Bay-winged Cowbird (Vieillot, 1819)		X				
Molothrus bonariensis Shiny Cowbird (Gmelin, 1789)		X				
Molothrus oryzivorus Giant Cowbird (Gmelin, 1788)		X				
Parulidae						
Setophaga pitiayumi[b] Tropical Parula (Vieillot, 1817)		X				
Geothlypis aequinoctialis Marked Yellowthroat (Gmelin, 1789)		X				
Myiothlypis flaveola[b] Flavescent Warbler Baird, 1865	X					
Basileuterus culicivorus White-bellied Warbler Bonaparte, 1830	X					
Coerebidae						
Coereba flaveola Bananaquit (Linnaeus, 1758)		X				
Thraupidae						
Schistochlamys melanopis Black-faced Tanager (Latham, 1790)		X				
Neothraupis fasciata White-banded Tanager (Lichtenstein, 1823)		X				
Nemosia pileata Hooded Tanager (Boddaert, 1783)		X				
Eucometis penicilata[b] Gray-headed Tanager (Spix, 1825)	X					

APPENDIX 1 (Continued)

Rheidae	RF	SH	FS	BA	SA	GR
Tachyphonus rufus White-lined Tanager (Boddaert, 1783)	X					
Ramphocelus carbo[b] Silver-beaked Tanager (Pallas, 1764)	X	X	X	X	X	
Tangara sayaca[b] Sayaca Tanager (Linnaeus, 1766)	X	X	X	X	X	
Tangara palmarum[b] Palm Tanager (Wied, 1823)		X		X	X	
Pipraeidea melanonota Fawn-breasted Tanager (Vieillot, 1819)		X				
Tangara cayana Burnished-buff Tanager (Linnaeus, 1766)		X				
*Dacnis cayana*Blue Dacnis (Linnaeus, 1766)		X				
Conirostrum speciosum Chestnut-vented Conebill (Temminck, 1824)	X					
*Tersina viridis*Swallon Tanager (Illiger, 1811)	X					
Saltator coerulescens Greyish Saltator Vieillot, 1817						X
Coryphospingus cucullatus[b] Red-crested Finch (Statius Muller, 1776)	X	X				X
Paroaria coronata[b] Red-crested Cardinal (Miller, 1776)	X	X				
Paroaria capitata[b] Yellow-billed Cardinal (d'Orbigny & Lafresnaye, 1837)		X		X		X
Saltator maximus Buff-throated Saltator (Statius Muller, 1776)	X					
*Saltator similis*Green-winged Saltator Vieillot, 1817	X	X				
Emberizidae						
Zonotrichia capensis Rufous-collared Sparrow (Statius Muller, 1776)						X
Ammodramus humeralis Grassland Sparrow (Bosc, 1792)						X
Sicalis flaveola[b] Saffron Finch (Linnaeus, 1766)						X
Emberizoides herbicola Wedge-tailed Grass-finch (Vieillot, 1817)						X
Volatinia jacarina Blue-black Grassquit (Linnaeus, 1766)						X
Sporophila plumbea Plumbeus Seedeater (Wied, 1830)						X
Sporophila collaris[b] Rusty-collared Seedeater (Boddaert, 1783)				X		X
Sporophila lineola Lined Seedeater (Linnaeus, 1758)						X
Sporophila nigricollis Yellow-bellied Seedeater (Vieillot, 1823)						X
Sporophila caerulescens[b] Double-collared Seedeater (Vieillot, 1823)				X		X
Sporophila leucoptera White-bellied Seedeater (Vieillot, 1817)						X
Sporophila hypoxantha Tawny-bellied Seedeater[V] Cabanis, 1851						X
Sporophila ruficollis Dark-throated Seedeater[V] Cabanis, 1851						X
Sporophila angolensis Lesser Seed-Finch (Linnaeus, 1766)				X		X
Arremon flavirostris Saffron-billed Sparrow Swainson, 1838	X					
Cardinalidae						
Pheucticus aureoventris Black-backed Grosbeak[V] (d'Orbigny & Lafresnaye, 1837)		X				X
Piranga flava Hepatic Tanager (Vieillot, 1822)						
Fringillidae						
Euphonia chlorotica Purple-throated Euphonia (Linnaeus, 1766)		X	X			

Occasional contacts (V), migrant species (M), vulnerable (VU), or Rare (RA) species, b – banded birds. RI, river; RF, riparian forest; SH, savannah; FS, forested savannah; BA, bays; SA, salines and GR, grasslands.

APPENDIX 2

Number of contacts for the most abundant species (>100 individuals) in the Fazenda Rio Negro between 2001 and 2004

Species	English common name	2001	2002	2003	2004	Totals
Himantopus melanurus	Black-necked stilt	1098	1490	1077	673	4338
Ardea alba	Great egret	1319	591	119	581	2610
Dendrocygna viduata	White-faced whistling duck	369	644	198	496	1707
Ortalis canicollis	Chaco chacalaca	546	479	338	297	1660
Thectocercus acuticaudata	Blue-crowned parakeet	157	874	132	211	1374
Egretta thula	Snowy egret	334	440	62	253	1089
Brotogeris chiriri	Canary-winged parakeet	347	400	155	150	1052
Amazona aestiva	Blue-fronted parrot	322	434	152	110	1018
Phaetusa simplex	Large-billed tern	285	154	237	252	928
Nannopterum brasilianus	Brazilian cormorant	175	640	29	2	846
Dendrocygna autumnalis	Black-bellied whistling duck	309	240	56	127	732
Aburria cumanensis	Blue-throated piping guan	202	218	131	149	700
Leptotila verreauxi	White-tipped dove	195	197	207	97	696
Guira guira	Guira cuckoo	254	208	122	106	690
Ramphocelus carbo	Silver-beaked tanager	168	223	106	189	686
Jacana jacana	Jacana	130	143	105	286	664
Megaceryle torquata	Ringed kingfisher	183	296	157	26	662
Patagioenas picazuro	Picazuro pigeon	281	195	57	122	655
Tachybabtus dominicus	Least grebe	3	554	39	1	597
Crax fasciolata	Bare-faced currasow	164	171	153	86	574
Phimosus infuscatus	Bare-faced ibis	248	169	36	114	567
Crotophaga major	Greater ani	170	147	233	16	566
Cantorchilus leucotis	Buff-necked wren	198	164	109	95	566
Cyanocorax cyanomelas	Purplish jay	162	213	91	98	564
Pitangus sulphuratus	Great kiskadee	176	201	68	117	562
Vanellus chilensis	Southern lapwing	261	133	71	85	550
Rynchops niger	Black skimmer	164	99	53	196	512
Crypturellus undulatus	Undulated tinamous	205	93	116	95	509
Anhinga anhinga	Anhinga	97	252	85	69	503
Tringa melanoleuca	Greater yellowlegs	89	376	35	1	501
Chloroceryle amazona	Amazon kingfisher	124	220	134	23	501
Paroaria capitata	Yellow-billed cardinal	140	204	71	81	496
Vanellus cayanus	Pied plover	144	85	118	78	425
Ardea cocoi	White-faced heron	47	209	111	50	417
Butorides striatus	Striated heron	98	163	79	41	381
Crotophaga ani	Smooth-billed ani	87	135	50	95	367
Stelgidopteryx ruficollis	Southern rough-winged swallow	118	94	144	1	357
Platalea ajaja	Roseate spoonbill	269	51	8	2	330
Furnarius leucopus	Pale-legged hornero	66	57	89	101	313
Amazonetta brasiliensis	Brazilian teal	104	57	44	78	283
Tringa flavipes	Lesser yellowlegs	135	3	123	1	262
Primolius auricollis	Yellow-collared macaw	23	150	25	60	258
Psittacara leucophthalmus	White-eyed parakeet	148	30	17	51	246
Gnorimopsar chopi	Chopi blackbird	99	74	59	5	237
Coragyps atratus	Black vulture	59	111	45	18	233
Psarocolius decumanus	Crested oropendula	93	103	26	2	224

APPENDIX 2 (Continued)

Species	English common name	2001	2002	2003	2004	Totals
Procacicus solitarius	Solitary cacique	71	75	31	41	218
Paroaria coronata	Red-crested cardinal	84	11	41	74	210
Eupsittula aurea	Peach-fronted parakeet	18	130	7	53	208
Cercomacra melanaria	Mato Grosso antbird	49	65	64	27	205
Furnarius rufus	Rufous hornero	101	56	34	6	197
Chloroceryle americana	Green kingfisher	65	45	60	23	193
Philohydor lictor	Lesser kiskadee	118	33	39	2	192
Ara chloroptera	Red-and-green macaw	47	40	46	57	190
Ramphastos toco	Toco toucan	71	75	40	1	187
Patagioenas cayennensis	Pale-vented pigeon	74	29	57	19	179
Eucometis penicilata	Grey-headed tanager	138	2	30	7	177
Taraba major	Great antshrike	41	86	44	1	172
Aramides cajaneus	Grey-necked wood-rail	39	57	12	55	163
Thamnophilus doliatus	Barred antshrike	83	49	27	1	160
Cyanocorax chrysops	Plush-crested jay	37	88	15	16	156
Cairina moschata	Moscovy duck	26	70	18	39	153
Mesembrinibis cayennensis	Green ibis	13	78	55	3	149
Campylorhynchus turdinus	Thrus-like wren	74	8	24	37	143
Syrigma sibilatrix	Whistling heron	61	45	29	1	136
Tigrisoma lineatum	Rufescent tiger heron	30	51	53	1	135
Saltator coerulescens	Greyish saltator	35	51	43	1	130
Galbula ruficauda	Rufous-tailed jacamar	33	51	33	5	122
Cyclarhis gujanensis	Rufous-browed peppershrike	1	62	44	14	121
Myiarchus tyrannulus	Brown-crested flycatcher	28	56	32	2	118
Diopsittaca nobilis	Red-shouldered macaw	58	54	5	0	117
Theristicus caudatus	Buff-necked ibis	62	35	18	1	116
Synallaxis albilora	White-lored spinetail	6	66	41	1	114
Arantiga nenday	Nanday parakeet	23	52	37	2	114
Trogon curucui	Blue-crowned trogon	23	44	45	1	113