# Richness, composition and trophic groups of an avian community in the Pernambuco Endemism Centre, Alagoas, Brazil

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## ABSTRACT

In northeastern Brazil, the reduction of the natural forest cover to a series of small, isolated fragments has had negative consequences for the local avian fauna, in particular, a loss of the more specialized species, while the populations of some generalists have tended to increase. The present study focuses on the composition and trophic groups of a bird community on a farm in the northeastern Brazilian state of Alagoas. Monthly surveys were conducted between November 2008 and October 2009, based on mist-netting and systematic observations. Overall, 112 species were recorded, of which 76 were associated with the two forest fragments surveyed, while all the others were observed exclusively in the surrounding matrix of pasture and orchards. The bird community presented a predominance of insectivorous species, followed by omnivores. However, specialized trunk-creeping and understory insectivores accounted for only around 15% of the species in this feeding category. The reduced diversity of other guilds and species with more specialized diets, and the complete absence of sensitive species such as large parrots and raptors, reflects the severe fragmentation and degradation of the local forests, which has greatly reduced the availability of dietary resources and breeding sites.

**Key words:** Atlantic Forest, birds, Northeastern Brazil, trophic groups.

## INTRODUCTION

The Atlantic Forest is distributed among 17 states in eastern Brazil, encompassing a wide latitudinal amplitude, and a range of climatic and edaphic conditions (Moura 2006, Ribeiro et al. 2009). The

northernmost sector of the Atlantic Forest, in the Brazilian Northeast, is the most threatened part of the biome, with only 2% of its original forest cover remaining. The colonization of this region and its long history of anthropogenic impact have resulted in the loss of much of its forest cover (Teixeira 1985, Silva and Tabarelli 2000, Menezes et al. 2004, Araujo and Moura 2011). The reduction of

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the original forest cover to a series of small, isolated fragments has had negative consequences for the local bird fauna, in particular the loss of the more specialized species, with a concomitant increase in the proportion of more opportunistic species, such as omnivores and generalized insectivores (D'Angelo-Neto et al. 1998, Sodhi et al. 2011).

Understanding the trophic structure of a bird assemblage – in particular the presence or absence of specific guilds – may offer important insights into the conservation status of a given area. This information provides important guidelines for conservation and management projects in ecosystems such as those of the Atlantic Forest (Motta-Junior 1990, Donatelli et al. 2004, Rodrigues et al. 2007). The ecological diversity of birds, their sensitivity to impacts, and the wealth of data, all combine to render these animals extremely useful as bio-indicators of natural or anthropogenic impacts (Verner 1981, Reynaud and Thioulouse 2000, Primack and Rodrigues 2001).

Some 434 known bird taxa are found in the Pernambuco Endemism Centre, as the Atlantic Forest north of the São Francisco River is known (Roda 2006), of which, 38 are endemic (Silveira et al. 2003a), 45 are classified as threatened (IUCN 2008, MMA 2008), and one – the Alagoas Curassow, *Pauxi mitu* (Silveira and Straube 2008) – is extinct in the wild. While a number of surveys have been conducted in this region (Silveira et al. 2003a, Lyra-Neves et al. 2004, Barnett et al. 2005, Roda 2006, Farias et al. 2007), few data are available on the trophic structure of the local communities (Telino-Júnior et al. 2005, Rodrigues et al. 2007).

This lack of data is most emphatic in the case of the Brazilian state of Alagoas. In the present study, data are provided on the composition and trophic groups of an Atlantic Forest bird community from this state, with the main aim of obtaining new insights into the ecological processes that underpin the diversity of these animals in the region.

## MATERIALS AND METHODS

The study was conducted at the Fazenda Santa Fé, located in the municipality of Tanque d'Arca in central Alagoas, northeastern Brazil. Tanque d'Arca covers an area of 129.5 km$^2$, of which, 30.7 km$^2$ is covered with its original vegetation (Menezes 2010). The climate is dry subhumid and megathermic with a pronounced hydrological deficit in the austral summer months (December–February). Average temperatures range between around 21.6°C in July and August, to 26.3°C in January, while total annual precipitation is generally between 900 and 1000 mm, concentrated mainly in the austral autumn and winter months, i.e. March through August (Lima 2012).

This rural property encompasses a number of small forest fragments isolated by a matrix of pasture. The two largest fragments have been transformed into private natural heritage reserves ("RPPNs"), known as Santa Fé (area 1) and Cachoeira (area 2), located approximately 600 m from one another. Both areas are covered in semi-deciduous forest, adapted to the rainy/dry cycle of the local climate (Veloso 1992, Assis 2000).

The Santa Fé reserve (09°31'16" S, 36°26'42" W) covers an area of 18 ha and is located at 370 m above sea level, while Cachoeira (09°32'02" S, 36°26'45" W) covers 35 ha at 320 m. Both areas are characterized by patches of secondary forest, and have been protected from selective logging and hunting by the owner of the property for nearly 20 years.

The study was conducted between November 2008 and October 2009, with monthly excursions of two consecutive days, and a total of 12 samples. The bird fauna of each study area was surveyed by the simple list method (Ribon 2010), in which existing trails within the pasture, forest, and mixed habitats were walked at 05:00–10:00 h and 15:00–18:00 h. Visual observations and sound recordings were logged in a field notebook, over a total of 192 hours of monitoring. Observations were

conducted using a pair of 7 x 35 binoculars, while vocalizations were recorded with a digital recorder and unidirectional microphone.

In addition to observations, birds were captured using eight mist-nets (12 m x 2.5 m) installed in pairs along transects both within and at the edges of the reserves. The nets were set in the mornings, from 06:00 h to 11:00 h, and afternoons, between 15:00 h and 17:00 h, with a total effort of 40,320 h.m² (Straube and Bianconi 2002). The captured birds were marked with aluminum leg bands provided by CEMAVE/ICMBio and had their biometric data collected using a millimeter-scale steel ruler, calipers, and dynamometer.

Bird species were identified using field guides, as well as consultations with taxonomic specialists and archives in sound libraries for comparison with the vocalizations recorded in the field. The popular and scientific nomenclature follows the scheme of the Brazilian Ornithological Records Committee (CBRO 2011). Observed species richness was represented using a rarefaction curve produced by the EstimateS 8.2 software (Colwell 2011), and estimates of total richness were obtained using the Chao2 and Jackknife 1 estimators, nonparametric methods recommended by H.F.P. de Araujo (unpublished data) for the analysis of bird faunas.

All species were assigned to one of the following trophic categories – carnivore, detritivore, frugivore, granivore, insectivore, nectarivore, omnivore or piscivore. This classification was based on field observations and on available literature (Moojen et al. 1941, Motta-Junior 1990, Sick 1997, Telino-Júnior et al. 2005).

The relative frequency of each species was calculated according to Dajoz (1983), that is, the proportion of samples in which the species was recorded. Naka et al. (2002) classified the frequencies as: common, ≥ 75%; fairly common, 50%–74%; uncommon, 25%–49%; and rare, ≤ 24%.

Jaccard's similarity index (Krebs 1989) was used to compare the two bird communities. This index divides the number of shared species by the sum of the species recorded at the two sites.

## RESULTS

A total of 112 bird species were identified during the present study, representing 39 families in 18 orders. The family with the largest number of species was the Tyrannidae (13.4% of the total), followed by Thraupidae (9.8%) and Trochilidae (6.3%). However, only 76 (67.9%) of these species were recorded in the forest fragments (areas 1 and 2), with the other 36 being observed in the surrounding matrix (pasture) and other habitats, such as orchards and flower plantations. Area 1 presented the highest species richness, with a total of 66 species, while 59 were recorded in area 2, and there was 64% similarity between the two sites.

The number of species recorded per month ranged from 24 to 60, with the lowest numbers being recorded during the rainy season (March-July) and the highest in the dry season. The species rarefaction curve had not reached the asymptote by the end of the survey period, indicating that the total number of species occurring in the study area was underestimated during the surveys. This conclusion was reinforced by the Chao2 and Jackknife 1 estimators, which indicated mean (± SD) richness at approximately 118±6.4 and 125±3.4 species, respectively (Figure 1).

Seven of the species recorded in the present study are endemic to Brazil, according to the CBRO (2011): Pygmy Nightjar (*Hydropsalis hirundinacea*), Tawny Piculet (*Picumnus fulvescens*), Gray-eyed Greenlet (*Hylophilus amaurocephalus*), Long-billed Wren (*Cantorchilus longirostris*), Seven-colored Tanager (*Tangara fastuosa*), Red-cowled Cardinal (*Paroaria dominicana*), and White-Throated Seedeater (*Sporophila albogularis*). Of these, the Tawny Piculet and Seven-colored Tanager are classified as threatened species by the IUCN (2008) and MMA (2008).
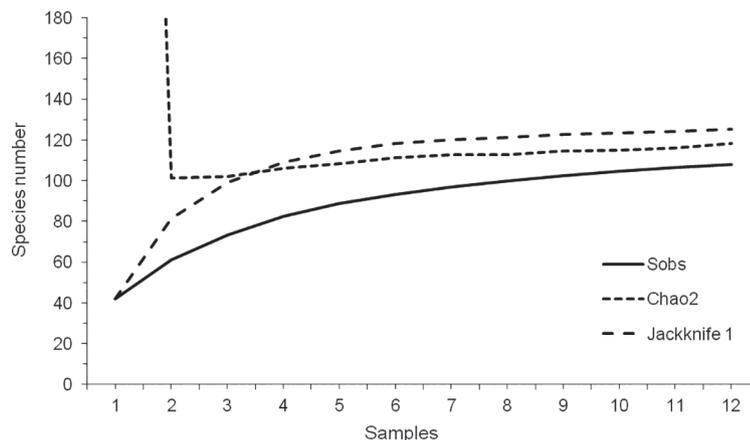
**Figure 1 -** Species rarefaction curve (Sobs) and estimated richness (Chao2 and Jackknife 1) of the bird community in Fazenda Santa Fé, Tanque d'Arca - AL.

Three species, the Scaled Dove (*Columbina squammata*), Saffron Finch (*Sicalis flaveola*) and Red-cowled Cardinal were recorded regularly throughout the study period, although as individuals of these species were being released into the wild at both sites by the owner of the property and other local residents, their frequencies were not included in the analyses. The full species list and their relative frequencies are presented in Appendix.

The trophic structure of the bird community at the study site was characterized by a predominance of insectivorous species, followed by omnivores (Table I). These categories are well represented by tyrannids and thraupids, such as the Tropical Kingbird (*Tyrannus melancholicus*), Gray Elaenia (*Myiopagis caniceps*), Sayaca Tanager (*Tangara sayaca*), and Burnished-buff Tanager (*Tangara cayana*), which were common or fairly common in the study area. However, specialized insectivores, such as those that forage on tree trunks or in the understory (Picidae, Dendrocolaptidae, and Thamnophilidae) were rare in the forested areas.

The carnivores (Accipitridae, Falconidae, Strigidae, and Tytonidae) were the third richest species, especially those adapted for foraging in open areas and at forest edges. The dispersal potential of these raptor species probably determined an increased likelihood of encounters within the study area,

**TABLE I**
**Trophic groups recorded at Fazenda Santa Fé, Tanque d'Arca, AL.**

| Feeding Habits | Proportion of species | |
| --- | --- | --- |
| | N | (%) |
| Carnivore | 9 | 8 |
| Detritivore | 3 | 2.7 |
| Frugivore | 6 | 5.4 |
| Granivore | 7 | 6.3 |
| Insectivore | 47 | 42 |
| Nectarivore | 8 | 7.1 |
| Omnivore | 27 | 24.1 |
| Piscivore | 5 | 4.5 |
| **Total** | **112** | **100** |

in particular diurnal species, such as Roadside Hawk (*Rupornis magnirostris*), Southern Caracara (*Caracara plancus*) and Yellow-headed Caracara (*Milvago chimachima*).

The frugivores were represented mainly by small passerines such as White-bearded Manakin (*Manacus manacus*), which were restricted to areas of secondary vegetation or shrubby growth, and the endangered Seven-colored Tanager and Violaceous Euphonia (*Euphonia violacea*), which were observed typically in orchards. Larger frugivores, such as toucans, cotingas, and bellbirds, were absent, although the Speckled Chachalaca (*Ortalis guttata*) and Red-shouldered Macaw (*Diopsittaca nobilis*) were recorded in both forest reserves.

## DISCUSSION

The number of species recorded in the present study was relatively low in comparison to previous surveys, especially those of forest communities in similar habitats. For example, Lobo-Araújo et al. (2013) inventoried the bird fauna in three forest fragments at a site located approximately 40 km from Tanque d'Arca, recording 91 species, in contrast to the 76 found in the present study. This discrepancy is probably due to the relatively small size of the forest reserves surveyed in the present study, and also their isolation from potential source areas. Silveira et al. (2003a) recorded even lower species richness in similar dry forests in Alagoas (24–53 species), although in this case, sampling efforts were greatly reduced – 17 hours – in comparison to the present study (40,320 h.m² of mist-netting and 192 h of monitoring) and that of Lobo-Araújo et al. (2013), based on 160 hours.

While they were relatively close to one another, the two reserves differed considerably in terms of species richness and composition. This may be related to the fact that the two fragments have suffered distinct patterns of anthropogenic impact. In particular, area 2 is adjacent to an urban area, which facilitates encroachment by local residents for the collection of firewood, selective logging, and the hunting and trapping of birds. Area 1 is not only further away from the urban area, but adjacent to the farmhouse, which probably contributes to the prevention of, or at least the limitation of activities such as hunting and logging. D'Angelo-Neto et al. (1998) identified similar factors determining the reduced similarity of the bird communities of adjacent forests. An additional factor in the present study may have been the inaccessibility of parts of area 2, which could not be surveyed adequately, and may have contained a number of less conspicuous species, that were not recorded during the study.

During the breeding (dry) season, many species may become more conspicuous due to their more intense vocalizations, whereas they tend to become less active (and thus more cryptic) during the rainy season (Lyra-Neves et al. 2004). This seasonal variation in detectability, together with the regional migrations observed in some species, such as the Black-throated Mango (*Anthracothorax nigricollis*) and Ruby-topaz Hummingbird, *Chrysolampis mosquitus* (Ruschi 1982, Sick 1997) contributed to the observed fluctuations in species richness in the study area. In a semi-deciduous forest in southeastern Brazil, Aleixo and Vielliard (1995) also recorded a larger number of species in the dry season, with the highest species richness being recorded in September and the lowest in March, as found in the present study.

Tawny Piculet, Red-cowled Cardinal and White-throated Seedeater are endemic to the Caatinga, and are rarely observed in the adjacent biomes (Pacheco 2004). The presence of these species in the study area may thus be related to the fact that it was originally located within the transition zone between the Atlantic Forest and the semi-arid Caatinga. Recent anthropogenic impacts have established a mosaic of habitats, in which the bird communities typical of the two biomes may coexist. An additional potential factor may be the local tradition of maintaining songbirds, such as the White-throated Seedeater and Red-cowled Cardinal, in captivity. That may have increased species ranges through illegal trafficking and uncontrolled releases, since these species are able to adapt to anthropogenic habitats (Olmos et al. 2005, Araujo and Rodrigues 2011, Araujo et al. 2012).

The Seven-colored Tanager is endemic to the Pernambuco Endemism Centre and is classified as vulnerable by the IUCN (2008) and MMA (2008). In the present study, the species was recorded mainly in the dry season, when young individuals were observed feeding on mango (*Mangifera indica*) and cashew fruits (*Anacardium occidentale*) in February. The species has also been recorded in Alagoas by Silveira et al. (2003a) and Lobo-Araújo et al. (2013). Studying 17 forest fragments in the state, Silveira et al. (2003b) did

not observe this species in the dry southern forests, where the reduced abundance of plants of the Melastomataceae family may limit the occurrence of this tanager. In the present study, the species was only observed in orchards and open woodland, rich in epiphytic bromeliads, and never in the forests, which lacked Melastomataceae plants. Further data are required, however, in order to confirm the species' habitat preferences and requirements.

The predominance of insectivorous and omnivorous species is consistent with the results of Willis (1979), Motta-Junior (1990), Aleixo (1999), Anjos (2001), Telino-Júnior et al. (2005), and Catian et al. (2011). While insectivores have access to a relatively stable resource throughout the year, omnivores are able to adapt to prevailing conditions and resource availability (Scherer et al. 2005). These groups contain many tyrannids and thraupids, which tend to be relatively tolerant of anthropogenic impacts and seasonal fluctuations in the abundance of resources without resorting to migration.

However, the insectivores specialized in foraging on trunks, branches and in the understory accounted for only approximately 15% of this feeding category. These species may become locally extinct not only through the loss of forest habitat, but also due to the disturbance of the vegetation. The degree of isolation of a forest fragment and the characteristics of the matrix that separates it from possible source areas are also factors limiting recolonization by these guilds (Aleixo and Vielliard 1995, Stouffer and Bierregaard 1995). It thus seems likely that species such as White-shouldered Antshrike (*Thamnophilus aethiops*), White-backed Fire-eye (*Pyriglena leuconota*) and Plain Antvireo (*Dysithamnus mentalis*), which were not recorded during the present study, are locally extinct. Trunk-creeping insectivores were represented by the Little Woodpecker (*Veniliornis passerinus*) Olivaceous Woodcreeper (*Sittasomus griseicapillus*), Straight-billed Woodcreeper (*Dendroplex picus*) and Tawny Piculet, of which the latter two species are

relatively common and habitat generalists, being found in environments ranging from dense forest to open woodland. Other members of this guild known to occur in forest fragments in Alagoas and Pernambuco, such as Plain-brown Woodcreeper *Dendrocincla fuliginosa* and Buff-throated Wood-creeper *Xiphorhynchus guttatus*, were all absent from the study area.

Carnivores were represented predominantly by widely-distributed species such as the Tropical Screech-Owl (*Megascops choliba*), Roadside Hawk, Southern Caracara and Yellow-headed Caracara, which were recorded frequently throughout the study area, but especially in the pasture and forest edge. The latter three species have been classified by Azevedo et al. (2003), Loures-Ribeiro and Anjos (2006) and Carvalho and Marini (2007) as habitat generalists, which may even be relatively common in anthropogenically-impacted habitats, in particular the Roadside Hawk and the Southern Caracara (Carvalho and Marini 2007). The tolerance of these species to human impact, combined with their ample resource base, ranging from invertebrates and small vertebrates to carrion (livestock carcasses), may contribute to their abundance within the study area (Moojen et al. 1941, Sick 1997, Carvalho and Marini 2007).

Of the least diverse feeding groups, the frugivores were represented by only six species, most of which were small passerines, such as the Violaceous Euphonia and Seven-colored Tanager. The local orchards were important feeding sites for these species, where fruiting trees like *M. indica* and *A. occidentale* were visited frequently during the dry season months. Larger, less adaptable frugivores, such as parrots, toucans, and cotingas, were absent from the study area. Forest-dwelling frugivores generally depend on relatively large areas of habitat in order to guarantee a year-round supply of food, and tend to occur at low densities in small fragments, travelling long distances to find fruiting trees (D'Angelo-Neto et al. 1998, Telino-Júnior et al. 2005). Many of these frugivores also

require specific resources such as cavities in large trees for nesting (Silveira et al. 2003a), which tend to be scarce in disturbed forests, such as those of the present study area, which have suffered selective logging in the past.

The frugivores recorded in the present study included the Speckled Chachalaca and Red-shouldered Macaw, which, while being rare overall, were observed in small bands. The Speckled Chachalaca is a habitat generalist and appears to be the cracid best adapted to the anthropogenic landscape of present-day northeastern Brazil (del Hoyo 1994, Parker III et al. 1996, Silveira et al. 2003a). During the dry season, groups of five to nine Red-shouldered Macaws were observed moving between palms (Arecaceae) in the pasture and also in the forest canopy. This species may still be observed flying between remnant forests in the Alagoas state capital, Maceió, and surrounding areas, and it is in fact able to inhabit agricultural environments, especially where palm trees are found (Collar 1997). Clearly, then, the species' tolerance of human interference may guarantee its long-term survival in the region.

A large proportion (32%) of all the species recorded was observed exclusively in anthropogenic habitats, indicating reduced sensitivity to habitat disturbance in these species. The present-day composition of the bird fauna in the forest fragments reflects the impacts they have suffered in the past. The reduced abundance of some more specialized species, such as understory insectivores, and the complete absence of large raptors, parrots, and bellbirds, appear to reflect the severe degradation of the local forests, which has greatly reduced the diversity and availability of dietary resources and, for some species, breeding sites.

In this context, the Tawny Piculet and Seven-colored Tanager, species considered by some authors as being intolerant, seem to have coped with local impacts, and appear to be breeding within the study area. As suggested above, further data on the ecology of these and some other species will be required in order to fully understand their habitat preferences and feeding behavior.

The establishment of the forest reserves surveyed in the present study was of vital importance for the survival of the remnant bird communities, and will provide a sound platform for the development of long-term conservation measures, such as the establishment of forest corridors and the controlled reintroduction of species that have become locally extinct. The creation of protected areas on private properties should be encouraged throughout the region, given the importance of these fragments for the survival of remaining forests and the protection of their natural resources, including their bird populations.

**RESUMO**

No Nordeste do Brasil, a redução da cobertura florestal original a pequenos fragmentos isolados tem trazido

consequências negativas para a avifauna local, em particular, uma perda de espécies mais especializadas e o aumento populacional de algumas espécies generalistas. O presente estudo foca na composição e nos grupos tróficos de uma comunidade de aves de uma propriedade rural em Alagoas, nordeste do Brasil. Amostragens mensais foram realizadas entre novembro de 2008 e outubro de 2009, através de capturas com redes-de-neblina e observações de campo. De forma geral, foram identificadas 112 espécies, das quais 76 estiveram associadas aos dois fragmentos florestais estudados, com as demais ocorrendo apenas na matriz de pasto e pomares. A avifauna da área de estudo demonstrou um predomínio de espécies insetívoras seguidas por onívoras. No entanto, insetívoros especialistas como os forrageadores de troncos e de subosque, corresponderam a apenas ~15% dos insetívoros como um todo. A baixa diversidade de algumas guildas e espécies com dietas mais específicas e a total ausência de outras espécies sensíveis, tais como grandes rapineiros e papagaios, é reflexo da fragmentação acentuada e degradação das florestas locais, o que reduziu a disponibilidade de recursos alimentares e eliminou seus sítios reprodutivos.

**Palavras-chave:** Floresta Atlântica, aves, Nordeste do Brasil, grupos tróficos.

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**APPENDIX**

**Bird species registered at Fazenda Santa Fé, municipality of Tanque d' Area,
state of Alagoas, during the sampling period – Nov/2008 to Oct/2009.**

| Taxa | Environment[1] | Frequency (%) | Feeding habits[2] | Record[3] |
|---|---|---|---|---|
| **Tinamiformes** | | | | |
| **Tinamidae** | | | | |
| *Rhynchotus rufescens* | OE | 33.3 | ONI | V, S |
| **Galliformes** | | | | |
| **Cracidae** | | | | |
| *Ortalis guttata* | FO | 16.7 | FRU | V, S |
| **Pelecaniformes** | | | | |
| **Ardeidae** | | | | |
| *Tigrisoma lineatum* | OE | 16.7 | PIS | V |
| *Butorides striata* | OE | 16.7 | PIS | V |
| *Bubulcus ibis* | OE | 25.0 | INS | V |
| *Ardea alba* | OE | 8.3 | PIS | V |
| **Cathartiformes** | | | | |
| **Cathartidae** | | | | |
| *Cathartes aura* | OE | 58.3 | DET | V |
| *Cathartes burrovianus* | OE | 25.0 | DET | V |
| *Coragyps atratus* | OE | 75.0 | DET | V |
| **Accipitriformes** | | | | |
| **Accipitridae** | | | | |
| *Rupornis magnirostris* | OE | 75.0 | CAR | V, S |
| *Geranoaetus albicaudatus* | OE | 25.0 | CAR | V |
| **Falconiformes** | | | | |
| **Falconidae** | | | | |
| *Caracara plancus* | OE | 41.7 | CAR | V, S |
| *Milvago chimachima* | OE | 41.7 | CAR | V, S |
| *Herpetotheres cachinnans* | FO | 8.3 | CAR | V |
| **Gruiformes** | | | | |
| **Rallidae** | | | | |
| *Aramides cajanea* | FO | 33.3 | ONI | V |
| *Pardirallus nigricans* | OE | 25.0 | ONI | V |
| **Charadriiformes** | | | | |
| **Charadriidae** | | | | |
| *Vanellus chilensis* | OE | 25.0 | ONI | V, S |
| **Jacanidae** | | | | |
| *Jacana jacana* | OE | 25.0 | ONI | V, S |
| **Columbiformes** | | | | |
| **Columbidae** | | | | |
| *Columbina talpacoti* | OE | 66.7 | GRA | V, S, CP |
| *Columbina squammata*[*] | OE | — | ONI | V, S, CP |
| *Leptotila verreauxi* | OE, FO | 25.0 | GRA | V, S, CP |
| **Psittaciformes** | | | | |
| **Psittacidae** | | | | |
| *Diopsittaca nobilis* | OE, FO | 25.0 | FRU | V, S |
| *Forpus xanthopterygius* | OE | 66.7 | FRU | V, S |
| **Cuculiformes** | | | | |
| **Cuculidae** | | | | |
| **Cuculinae** | | | | |
| *Piaya cayana* | OE, FO | 25.0 | INS | V, S |

**APPENDIX (continuation)**

| Taxa | Environment[1] | Frequency (%) | Feeding habits[2] | Record[3] |
|---|---|---|---|---|
| **Crotophaginae** | | | | |
| *Crotophaga ani* | OE | 25.0 | INS | V, S |
| *Guira guira* | OE | 50.0 | INS | V, S |
| **Taperinae** | | | | |
| *Tapera naevia* | FO | 8.3 | INS | V |
| **Strigiformes** | | | | |
| **Tytonidae** | | | | |
| *Tyto Alba* | OE | 8.3 | CAR | V |
| **Strigidae** | | | | |
| *Megascops choliba* | OE, FO | 25.0 | CAR | V, S |
| *Pulsatrix perspicillata* | OE, FO | 8.3 | CAR | V |
| *Athene cunicularia* | OE | 16.7 | CAR | V, S |
| **Caprimulgiformes** | | | | |
| **Nyctibiidae** | | | | |
| *Nyctibius griseus* | OE | 41.7 | INS | V |
| **Caprimulgidae** | | | | |
| *Antrostomus rufus* | OE | 16.7 | INS | V |
| *Hydropsalis albicollis* | OE | 50.0 | INS | V, S |
| *Hydropsalis hirundinacea* | OE | 8.3 | INS | V |
| **Apodiformes** | | | | |
| **Trochilidae** | | | | |
| **Phaethornithinae** | | | | |
| *Phaethornis pretrei* | OE, FO | 33.3 | NEC | V, S |
| **Trochilinae** | | | | |
| *Eupetomena macroura* | OE | 16.7 | NEC | V, S, CP |
| *Anthracothorax nigricollis* | OE | 8.3 | NEC | V |
| *Chrysolampis mosquitus* | OE | 16.7 | NEC | V |
| *Chlorostilbon notatus* | OE | 8.3 | NEC | V |
| *Chlorostilbon lucidus* | OE | 50.0 | NEC | V |
| *Amazilia fimbriata* | OE | 33.3 | NEC | V |
| **Coraciiformes** | | | | |
| **Alcedinidae** | | | | |
| *Megaceryle torquata* | OE | 8.3 | PIS | V |
| *Chloroceryle americana* | OE | 8.3 | PIS | V |
| **Galbuliformes** | | | | |
| **Galbulidae** | | | | |
| *Galbula ruficauda* | FO | 25.0 | INS | V, S, CP |
| **Piciformes** | | | | |
| **Picidae** | | | | |
| *Picumnus fulvescens* | OE, FO | 58.3 | INS | V, S ,CP |
| *Veniliornis passerinus* | OE, FO | 25.0 | INS | V, S |
| **Passeriformes** | | | | |
| **Thamnophilidae** | | | | |
| **Thamnophilinae** | | | | |
| *Formicivora grisea* | FO | 25.0 | INS | V, S |
| *Herpsilochmus atricapillus* | FO | 41.7 | INS | V, S |
| *Taraba major* | FO | 41.7 | INS | V, S |
| **Dendrocolaptidae** | | | | |
| **Sittasominae** | | | | |
| *Sittasomus griseicapillus* | FO | 8.3 | INS | V |

**APPENDIX (continuation)**

| Taxa | Environment[1] | Frequency (%) | Feeding habits[2] | Record[3] |
|---|---|---|---|---|
| **Dendrocolaptinae** | | | | |
| *Dendroplex picus* | OE, FO | 58.3 | INS | V, S |
| **Furnariidae** | | | | |
| **Furnariinae** | | | | |
| *Furnarius leucopus* | OE, FO | 50.0 | INS | V, S, CP |
| **Synallaxinae** | | | | |
| *Phacellodomus rufifrons* | OE | 58.3 | INS | V, S ,CP |
| *Synallaxis frontalis* | OE, FO | 58.3 | INS | V, S |
| *Synallaxis scutata* | FO | 66.7 | INS | V, S, CP |
| **Pipridae** | | | | |
| **Neopelminae** | | | | |
| *Neopelma pallescens* | FO | 8.3 | ONI | V |
| **Piprinae** | | | | |
| *Manacus manacus* | FO | 8.3 | FRU | V, S |
| **Tityridae** | | | | |
| **Tityrinae** | | | | |
| *Pachyramphus viridis* | OE | 50.0 | INS | V, S, CP |
| *Pachyramphus polychopterus* | OE, FO | 41.7 | INS | V, S, CP |
| **Rhynchocyclidae** | | | | |
| **Pipromorphinae** | | | | |
| *Leptopogon amaurocephalus* | FO | 8.3 | INS | CP |
| **Rhynchocyclinae** | | | | |
| *Tolmomyias flaviventris* | FO | 50.0 | INS | V, S, CP |
| **Todirostrinae** | | | | |
| *Todirostrum cinereum* | OE | 75.0 | INS | V, S |
| *Poecilotriccus plumbeiceps* | FO | 25.0 | INS | V |
| *Hemitriccus margaritaceiventer* | FO | 25.0 | INS | V, S |
| **Tyrannidae** | | | | |
| **Hirundineinae** | | | | |
| *Hirundinea ferruginea* | OE | 8.3 | INS | V |
| **Elaeniinae** | | | | |
| *Euscarthmus meloryphus* | OE | 16.7 | INS | V |
| *Camptostoma obsoletum* | OE | 41.7 | INS | V, S, CP |
| *Elaenia flavogaster* | OE | 41.7 | ONI | V, S, CP |
| *Myiopagis caniceps* | OE, FO | 58.3 | INS | V, S |
| *Capsiempis flaveola* | OE, FO | 16.7 | INS | V, S |
| *Phyllomyias fasciatus* | OE | 25.0 | INS | V, S |
| **Tyranninae** | | | | |
| *Myiarchus ferox* | FO | 16.7 | INS | V, S, CP |
| *Pitangus sulphuratus* | OE | 50.0 | ONI | V, S |
| *Machetornis rixosa* | OE | 16.7 | INS | V |
| *Megarynchus pitangua* | OE | 41.7 | ONI | V, S, CP |
| *Myiozetetes similis* | OE | 41.7 | ONI | V, S |
| **Tyranninae** | | | | |
| *Tyrannus melancholicus* | OE | 66.7 | INS | V, S, CP |
| **Fluvicolinae** | | | | |
| *Fluvicola nengeta* | OE | 58.3 | INS | V, S |
| *Arundinicola leucocephala* | OE | 8.3 | INS | V |
| **Vireonidae** | | | | |
| *Cyclarhis gujanensis* | OE, FO | 75.0 | INS | V, S |
| *Vireo olivaceus* | FO | 25.0 | INS | V, S, CP |

**APPENDIX (continuation)**

| Taxa | Environment[1] | Frequency (%) | Feeding habits[2] | Record[3] |
|---|---|---|---|---|
| **Vireonidae** | | | | |
| *Hylophilus amaurocephalus* | FO | 41.7 | INS | V |
| **Troglodytidae** | | | | |
| *Troglodytes musculus* | OE, FO | 41.7 | INS | V, S |
| *Cantorchilus longirostris* | FO | 33.3 | INS | V, S |
| **Polioptilidae** | | | | |
| *Polioptila plumbea* | OE, FO | 91.7 | INS | V, S, CP |
| **Turdidae** | | | | |
| *Turdus rufiventris* | FO | 8.3 | ONI | V |
| *Turdus leucomelas* | OE, FO | 33.3 | ONI | V, S, CP |
| **Motacillidae** | | | | |
| *Anthus lutescens* | OE | 16.7 | ONI | V, S |
| **Coerebidae** | | | | |
| *Coereba flaveola* | OE, FO | 83.3 | NEC | V, S, CP |
| **Thraupidae** | | | | |
| *Nemosia pileata* | OE, FO | 66.7 | ONI | V, S, CP |
| *Thlypopsis sordida* | OE, FO | 16.7 | ONI | V, S |
| *Tachyphonus rufus* | FO | 16.7 | ONI | V |
| **Thraupidae** | | | | |
| *Tangara fastuosa* | OE | 50.0 | FRU | V |
| *Tangara sayaca* | OE | 100.0 | ONI | V, S, CP |
| *Tangara palmarum* | OE, FO | 75.0 | ONI | V, S |
| *Tangara cayana* | OE, FO | 100.0 | ONI | V, S, CP |
| *Paroaria dominicana** | OE | — | GRA | V, S, CP |
| *Dacnis cayana* | OE, FO | 25.0 | ONI | V, S |
| *Hemithraupis guira* | OE, FO | 58.3 | ONI | V, S |
| *Conirostrum speciosum* | OE | 33.3 | ONI | V, S |
| **Emberizidae** | | | | |
| *Ammodramus humeralis* | OE | 8.3 | GRA | V |
| *Sicalis flaveola** | OE | — | GRA | V, S, CP |
| *Emberizoides herbicola* | OE | 8.3 | GRA | V, S |
| *Sporophila albogularis* | OE | 25.0 | GRA | V |
| *Arremon taciturnus* | FO | 58.3 | ONI | V, S, CP |
| **Cardinalidae** | | | | |
| *Piranga flava*** | OE | — | ONI | — |
| **Parulidae** | | | | |
| *Basileuterus culicivorus* | FO | 66.7 | INS | V, S, CP |
| *Basileuterus flaveolus* | FO | 66.7 | INS | V, S |
| **Fringillidae** | | | | |
| *Euphonia chlorotica* | OE | 33.3 | ONI | V, S |
| *Euphonia violacea* | OE, FO | 25.0 | FRU | V, S |
| **Passeridae** | | | | |
| *Passer domesticus* | OE | 25.0 | ONI | V |

[1]Environment: (OE) open environments, such as pasture and orchard; (FO) forested areas.

[2]Feeding habits: (ONI) omnivore, (FRU) frugivore, (PIS) piscivore, (INS) insectivore, (DET) detritivore, (CAR) carnivore, (GRA) granivore and (NEC) nectarivore; according Moojen et al. (1941), Motta-Junior (1990), Sick (1997) and Telino-Júnior (2005).

[3]Record: (V) visual, (S) sound and (CP) captured.

*Species that were being released into the wild at the reserves.

**Species recorded occasionally between samples.