

The Birds of the Talhado do São Francisco Natural Monument in the Semi-Arid Brazilian Northeast

Rachel Maria de Lyra-Neves^{1,2,4}, Severino Mendes de Azevedo Júnior^{2,3}, Wallace Rodrigues Telino Júnior^{1,2}, and Maria Eduarda Lacerda de Larrázabal³

¹ UFRPE - Unidade Acadêmica de Garanhuns, Av. Bom Pastor s/n, Boa Vista, 55.292-970, Garanhuns, Pernambuco, Brasil.

² UFRPE – Departamento de Biologia, Área de Zoologia, Programa de Pós-Graduação em Ecologia e Pós-Graduação em Etnobiologia e Conservação da Natureza, Av. Dom Manoel de Medeiros, s/n, Dois Irmãos, 52.171-900, Recife-PE, Recife, Pernambuco, Brasil.

³ UFPE – Centro de Ciências Biológicas, Departamento de Zoologia, Pós-Graduação em Biologia Animal. Av. Prof. Moraes Rego 1235, Cidade Universitária, 50670-420, Recife, Pernambuco, Brasil.

⁴ Corresponding Author: rmlneves@uag.ufrpe.br.

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ABSTRACT: The Talhado do São Francisco Natural Monument is located within the mesoregion of the lower São Francisco River, in the Brazilian states of Alagoas, Sergipe, and Bahia. Data were collected at six study sites during field campaigns of three months' duration. Visual surveys were conducted in areas of arboreal *caatinga* and at local aquatic environments. Specimens were also captured using 20 ornithological mist-nets, which were set in the early part of the morning. A total of 190 species were recorded, with estimated total species richness of 204 ± 8 (CHAO2) and 208 ± 4 species (Jack1). The families represented by the largest numbers of species were Tyrannidae, Accipitridae, Emberizidae, and Thraupidae. Five of the species were classified as *caatinga* endemics, while a further 29 species were considered to be typical of the Brazilian Northeast, or representatives of distinct subspecies. Overall, 187 species were classified as residents, *Falco peregrinus* and *Tringa solitaria* as migrants from the northern hemisphere, and *Elaenia chilensis* as a migrant from the southern hemisphere. In all, 30 species were dependent on forest habitats. A total of 1558 specimens representing 86 species were captured in the mist-nets. The most common species captured (representing more than 25% of the total number of specimens) were *Lanio pileatus*, *Columbina minuta*, and *Columbina picui*. This inventory of the bird fauna of the Talhado do São Francisco Natural Monument represents an important advance in the scientific knowledge of the bird communities of the *caatinga* biome, and in particular of the bird faunas of the states of Alagoas and Sergipe, which are still relatively poorly-known.

KEY-WORDS: Bird community; *caatinga*; diversity; species richness.

INTRODUCTION

The Talhado do São Francisco Natural Monument is a Brazilian conservation unit created on June 5th, 2009, by federal decree 12057 (Brasil 2009). This protected area is located within the mesoregion of the lower São Francisco River, between the town of Paulo Afonso and the mouth of the river (CBHSF 2011). This is the easternmost extreme of the river basin, located between 8-11° South, and 36-39° West (Costa, 2003). The lower São Francisco basin encompasses a total area of 30,337 km², which is equivalent to 5% of the whole basin, and is thus the smallest of its four main subdivisions (Junqueira 2000). The western portion of the lower São Francisco is dominated by the Xingó reservoir, which covers parts of the municipalities of Paulo Afonso, in the state of Bahia, Olho D'água do Casado, Piranhas, and Delmiro Gouveia in Alagoas, and Canindé de São Francisco, in Sergipe (CBHSF 2011). The reservoir covers a total area of approximately 60 km², and holds 3.8 billion cubic meters

of water. The main geological feature of this stretch of the river is the canyon extending from Paulo Afonso 100 km downriver before being interrupted by the Xingó dam (Silva 2009).

Until recently, the native fauna of the *caatinga* biome was thought to be relatively species-poor, although Araújo & Rodrigues (2011) found evidence of a much richer biota in their review of the recent literature (Nascimento 2000, Nascimento *et al.* 2000, Silva *et al.* 2003, Olmos 2005, Olmos *et al.* 2005, Roos *et al.* 2006, Farias 2007, Lyra-Neves & Telino-Júnior 2010, Araújo & Rodrigues 2011, Pereira & Azevedo Júnior 2011). Silva *et al.* (2003) recorded a total of 510 bird species in the *caatinga*, corresponding to 27.84% of the 1832 species catalogued for Brazil as a whole (CBRO 2011). In addition to this considerable species richness, 15 species and 45 subspecies are endemic to the biome (Pacheco *et al.* 2004), which is thus an important South American center of endemism (Cracraft 1985, Haffer 1985, Rizzini 1971).

Relatively few data are available from the São Francisco basin, although Olmos *et al.* (2005) and Roos *et al.* (2006) have surveyed the bird communities along the middle stretch of the river. Virtually no ornithological data are available from the lower São Francisco, however, except for the studies of Cabral *et al.* (2006), in the Piaçabuçu Environmental Protection Area at the mouth of the river in Alagoas, Ruiz-Esparza *et al.* (2011a), in the Grotta do Angico Natural Monument in Sergipe, and Araújo & Rodrigues (2011), in the municipalities of Canapi, Alagoas, and Inajá, Pernambuco. The present study reports on the bird fauna of a fourth area in the lower São Francisco basin, the Talhado do São Francisco Natural Monument, which includes parts of Alagoas, Bahia, and Sergipe. Data are provided on species richness and abundance.

MATERIAL AND METHODS

Description of the study area

The basin of the São Francisco River can be divided into sedimentary and crystalline geological formations (Silva 2009). The lower stretches of the river run through a region of crystalline bedrock, with soils ranging from sandy to clays. This region is characterized by two distinct pedological profiles, to the west and the east. The former, known as the Talhado do São Francisco, is dominated by three main types of soil (Junqueira 2002).

The local climate is arid or semi-arid, with irregular precipitation, marked by a distinct rainy season, which generally occurs between March and August, but long dry periods are common. Mean annual precipitation is 500 mm, with temperatures varying between 17°C and 28°C (Souza & Lima 2000 *apud* Medeiros 2007, Santos 2000, CBHSF 2011). The vegetation is dominated by spiny and deciduous plants, which form a steppe savanna, with areas of ecological tension and some pastures (Sá *et al.* 2009). The structure of the hyperxerophilous *caatinga* vegetation ranges from shrubby to arboreal, with varying proportions of open (grassland) habitats. The topography of the margins of the Xingó reservoir ranges from gently sloping hillsides to much steeper gradients, including rocky cliffs of up to 50 m in height, with varying amounts of vegetation cover (Santos 2000).

Six sites were selected for the sampling of the region's bird fauna (Figure 1), of which, three are located in Alagoas, on the left margin of the Xingó reservoir, with two in Sergipe and one in Bahia, all located on the right margin of the reservoir. Four of the sites (1-4) are located within the limits of the Talhado do São Francisco Natural Monument, while the other two, in Piranhas (Alagoas) and Canindé de São Francisco (Sergipe), are adjacent to this protected area. Two excursions of six consecutive

days were conducted at each site. Data were collected at the sites described below using visual observations and auditory cues (during five days), while specimens were captured in mist-nets during four days.

Site 1 – Fazenda Baixa da Quixaba, Paulo Afonso, Bahia (9°26'26"S, 38°04'05"W): low, sparse arboreal *caatinga*, poorly-preserved, with evidence of logging and extraction of firewood (E. L. Araújo & E. M. N. Ferraz *in litt.*). The local vegetation is characterized by the presence of *Cnidocolus phyllacanthus* and *Spondias tuberosa*, *Schinopsis brasiliensis*, *Mimosa tenuiflora*, *Caesalpinia pyramidalis*, and *Commiphora leptophloeos*. Pastures and plots for subsistence agriculture can be found at a number of locations.

Site 2 – Fazenda Luna, Delmiro Gouveia, Alagoas (9°29'32"S, 38°04'10"W): highly degraded area of *caatinga* with reduced diversity of plant species (E. L. Araújo & E. M. N. Ferraz *in litt.*). The original vegetation was shrubby *caatinga* with occasional trees. All the *Aspidosperma pyriformis* trees within the study area had been cut down. The predominant tree species were the *M. tenuiflora*, *Mimosa* sp., *Anadenanthera colubrina*, and *C. phyllacanthus*. A number of permanent and temporary pools are found within the study area, at which aquatic and semi-aquatic bird species could be observed.

Site 3 – Fazenda Mundo Novo, Canindé de São Francisco, Sergipe (9°33'28"S, 37°59'43"W): dense, well-preserved *caatinga*, with no evidence of ranching activities. This site presents a unique feature not observed at any of the other sites, where the tree species range from typical *caatinga* forms, such as the *S. brasiliensis*, *Pilosocereus pachycladus* and *M. tenuiflora*, to those more typical of rainforest ecosystems, such as the *Hymenaea courbaril*, *Tabebuia impetiginosa*, *Stigmaphyllon* aff. *Paralias*, *Barnebya* cf. *harleyi*, *Tocoyena formosa*, *Cordia insignis*, as well as *Ximenia americana*, *Caesalpinia ferrea*, *Anadenanthera columbrina*, and *Mimosa* sp. (E. L. Araújo & E. M. N. Ferraz *in litt.*). The site also encompasses a transition zone dominated by a large area of sandy *caatinga*, dominated by *Caesalpinia microphyla*, *Piptadenia moniliformis*, *Jatropha mutabilis*, *Cnidocolus bahianus*, *Arrojadoa rhodantha*, *Thiloa glaucocarpa*, and *C. leptophloeos*.

Site 4 – Fazenda Olho d'Águinha, Olho d'Água do Casado, Alagoas (9°30'12"S, 37°54'50"W): late regrowth arboreal-shrubby *caatinga* with areas either logged or burned off recently (E. L. Araújo & E. M. N. Ferraz *in litt.*). Additional area of late regrowth arboreal *caatinga* adjacent to a large hill and a small watercourse, mainly on sandy soils. This vegetation appears to have been more diverse in the past, with a higher canopy, based on the set of species and the size of the trees observed in the present day (E. L. Araújo & E. M. N. Ferraz *in litt.*). The most predominant trees are *C. leptophloeos*, *Chloroleucon foliolosum*, *P. moniliformis* and *S. brasiliensis*, with the

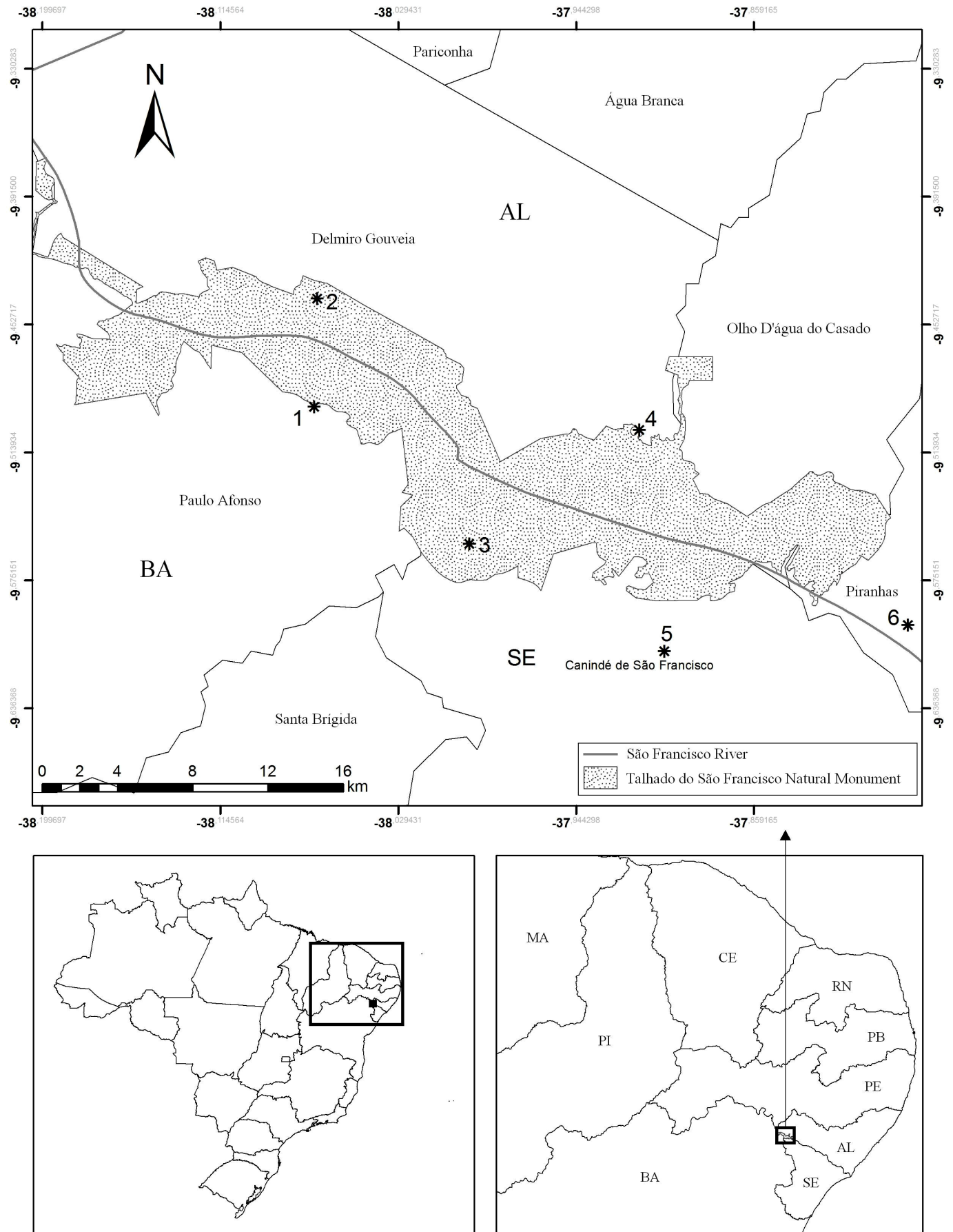


FIGURE 1. Location of the study sites at the Talhado do São Francisco Natural Monument in the semi-arid Brazilian Northeast.

latter two species forming an almost continuous canopy. Other trees recorded at the site include *T. glaucocarpa*, *B. gardneriana*, *P. pachycladus*, *Cereus jamacaru*, *C. phyllacanthus*, *Guapira noxia*, and *C. microphylla*.

Site 5 – Fazenda Santa Rosa, Canindé de São Francisco, Sergipe (9°36'33"S, 37°54'02"W): poorly-preserved arboreal-shrubby *caatinga* (E. L. Araújo & E. M. N. Ferraz *in litt.*) impacted by logging and ranching, but still containing a number of tree species that are typical of pristine arboreal *caatinga*. A number of areas present evidence of selective logging in the past (E. L. Araújo & E. M. N. Ferraz *in litt.*). The most prominent tree species include *Schinopsis brasiliensis*, *C. leptophloeos*, *Sideroxylum obtusifolium*, *Myracrodruon urundeuva*, *P. pachycladus*, *C. jamacaru*, *Maytenus rigida*, *A. macrocarpa*, and *C. pyramidalis*.

Site 6 – Fazenda Mecejana, Piranhas, Alagoas (9°35'48"S, 37°47'05"W): low, open arboreal *caatinga*, with evidence of logging in the past, characterized by the low height of the canopy, indicating late regrowth (E. L. Araújo & E. M. N. Ferraz *in litt.*). Tree species include *S. tuberosa*, *S. obtusifolium*, *G. laxa*, *M. rigida*, *S. brasiliensis*, *S. obtusifolium*, *Erythrina velutina*, *C. leptophloeos*, *C. ferrea* and *Tocoyena formosa*. The vegetation at this site is threatened by the expansion of ranching activities and the extraction of firewood for use in local bakeries. This site also includes a lake, at which aquatic and semi-aquatic bird species could be observed.

Methods

Basic surveys – the dense and open *caatinga*, and aquatic and anthropogenic habitats were surveyed by walking along pre-existing trails between 05:00 h and 11:00 h, and 15:00 h and 17:00 h, the periods of the day when diurnal birds are most active in this semi-arid region, especially during the dry season, when daytime temperatures are at their highest. The pools (temporary and permanent) were investigated by walking round their margins, whereas the Xingó reservoir, in the São Francisco Canyon, was surveyed using a motorboat, which provided access to the remotest parts of the lake.

Birds were observed with a pair of binoculars (8 x 30 mm), and their vocalizations were recorded with a Sony TCM5000 recorder and external Lesson MP68 microphone. Whenever necessary, the analysis of the recorded vocalizations was aided by comparisons with the authors' own archives and those of other researchers, for the reliable identification of the species. Total sampling time was 256 hours at each site.

In addition to these records, birds were captured in mist-nets for the collection of complementary data, in particular on the abundance of each species. These two approaches were combined to provide the most reliable

possible inventory of the bird species of the Talhado do São Francisco Natural Monument.

Capture of specimens – birds were caught at each of the *caatinga* study sites in 20 12 m x 2.5 m mist-nets with a 36 mm mesh, which were set along two transects, each containing 10 nets (Bierregaard Jr. & Lovejoy 1989). Birds were captured during four consecutive days, during which the nets were opened between 05:00 h and 10:00 h, the daylight period during which birds are most active, resulting in a total sampling effort of 1200 hours per site. Each specimen captured was identified and tagged with a metallic ring provided by the Brazilian federal Avian Research and Protection Agency, CEMAVE (Authorization: Project 1098 SNA.Net). Species were identified according to basic references and the field guides of Hyman (1986), Madge & Burn (1988), Dunning (1987), Ridgely & Tudor (1994a, b), and Sick (1997).

Data analysis

The bird species classified as endemic and/or game were identified based on the reviews of Sick (1997), Pacheco (2004), and CBRO (2011). The species were also classified in terms of their degree of dependence on forested areas and their habitat use, according to the scheme of Silva *et al.* (2003). In the specific case of the Talhado do São Francisco Natural Monument, species were also classified in accordance with their occurrence pattern (Almeida *et al.* 1999) as: abundant residents (occurrence of $\geq 75\%$), common residents (50-69%), uncommon residents, with an occurrence $< 50\%$ (species which are commonly found in *caatinga* habitats, and are not known to migrate seasonally), rare residents (uncommon species which are difficult to observe), and seasonal migrants, which move among areas according to the annual variation in precipitation patterns.

The frequency of occurrence (FO) was calculated for the species observed during the basic surveys. This parameter is the percentage of surveys in which the species was recorded, independently of the number of individuals observed. Species with FO $\geq 75\%$ were considered to be abundant residents (Almeida *et al.* 1999). The relative abundance of the species captured in the mist-nets was calculated by dividing the number of individuals of species *i* captured by the total number of specimens captured in the nets.

Jaccard's index of similarity (Magurran 2004) was used to compare the composition of species between sites. Total species richness was estimate using CHAO 2 and Jackknife 1, which were run in the EstimateS program, version 8.2.0 (Cowell 2005). These estimators are based on the incidence of species and use the number of species recorded in only one or two samples to estimate the total number of species present within the study area.

RESULTS

A total of 190 bird species were recorded in the Talhado do São Francisco Natural Monument, representing 48 families. The rarefaction curve did not reach the asymptote, and the statistical estimators CHAO2 (204±8 species) and Jack1 (208±4 species) indicated that the number of species was underestimated slightly during data collection (Figure 2). The families represented by the largest numbers of species were the Tyrannidae, Accipitridae, Emberizidae, and Thraupidae (Figure 3, Table 1). Sites 3, 5, and 6 returned the highest estimates of species richness (Figure 4), with site 3 having the largest number of species recorded during the study (160). However, the estimates of species richness are still increasing at all six sites (Figure 4). Sites 5 and 6 had the most similar sets of species (Table 2).

Sixteen of the species were identified as Brazilian endemics (Table 1), of which, five are endemic to the *caatinga*, while a further 29 species were represented by forms typical of the Brazilian Northeast, some of which are recognized as subspecies. Twenty-six of the 190 recorded species were considered to be abundant residents, with a frequency of occurrence (FO) equal to or above 75%. A further 31 species were considered to be common residents (FO = 50-69%), while 15 were recorded rarely. Overall, 29 species were classified as being dependent on forest habitats, of which, 24 occurred at site 3, and 17 at site 5. Site 2 had the smallest number of species in this category (Table 1).

Some of the species recorded in this study can be classified as migrants, which move between sites according to the seasonal variation precipitation. Ten of these species are aquatic, including the anatids, and species such as

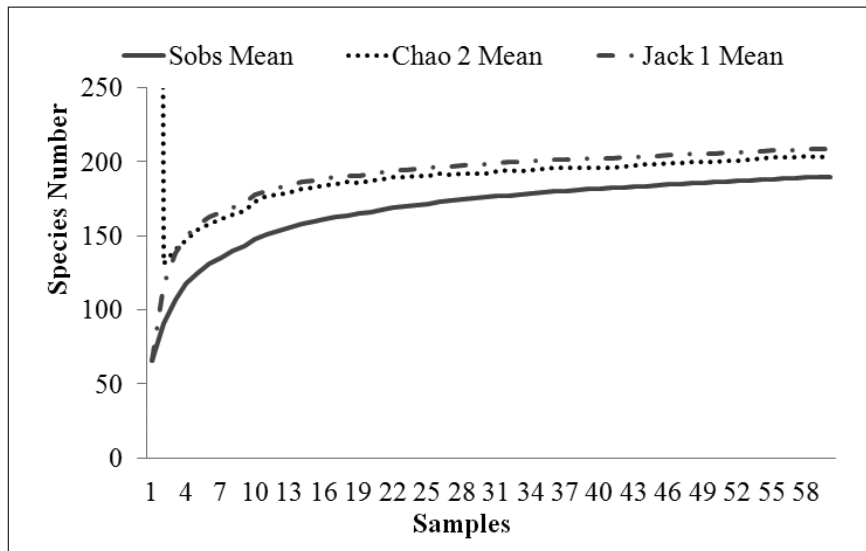


FIGURE 2. Rarefaction curve (Sobs) and species richness estimated by CHAO2 and Jackknife 1, by all methods combined in this research.

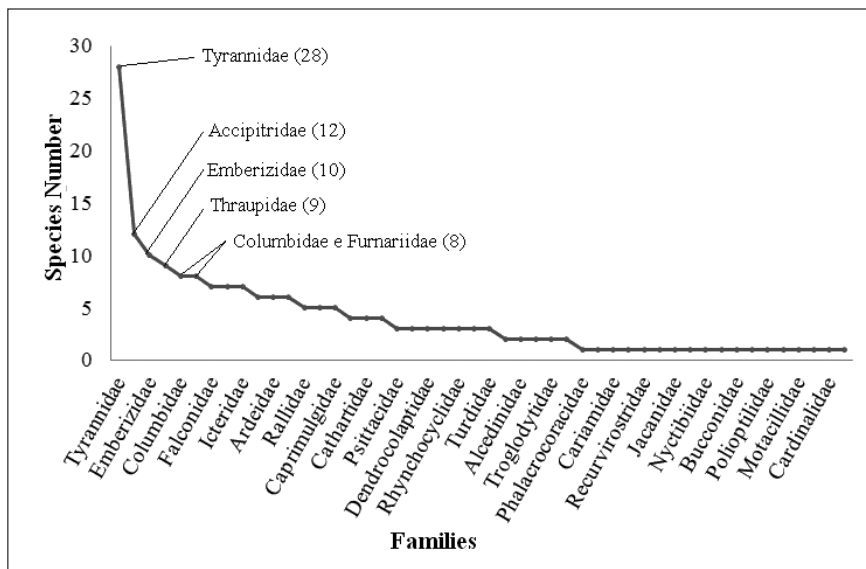


FIGURE 3. Species richness of the bird families recorded in the Talhado do São Francisco Natural Monument.

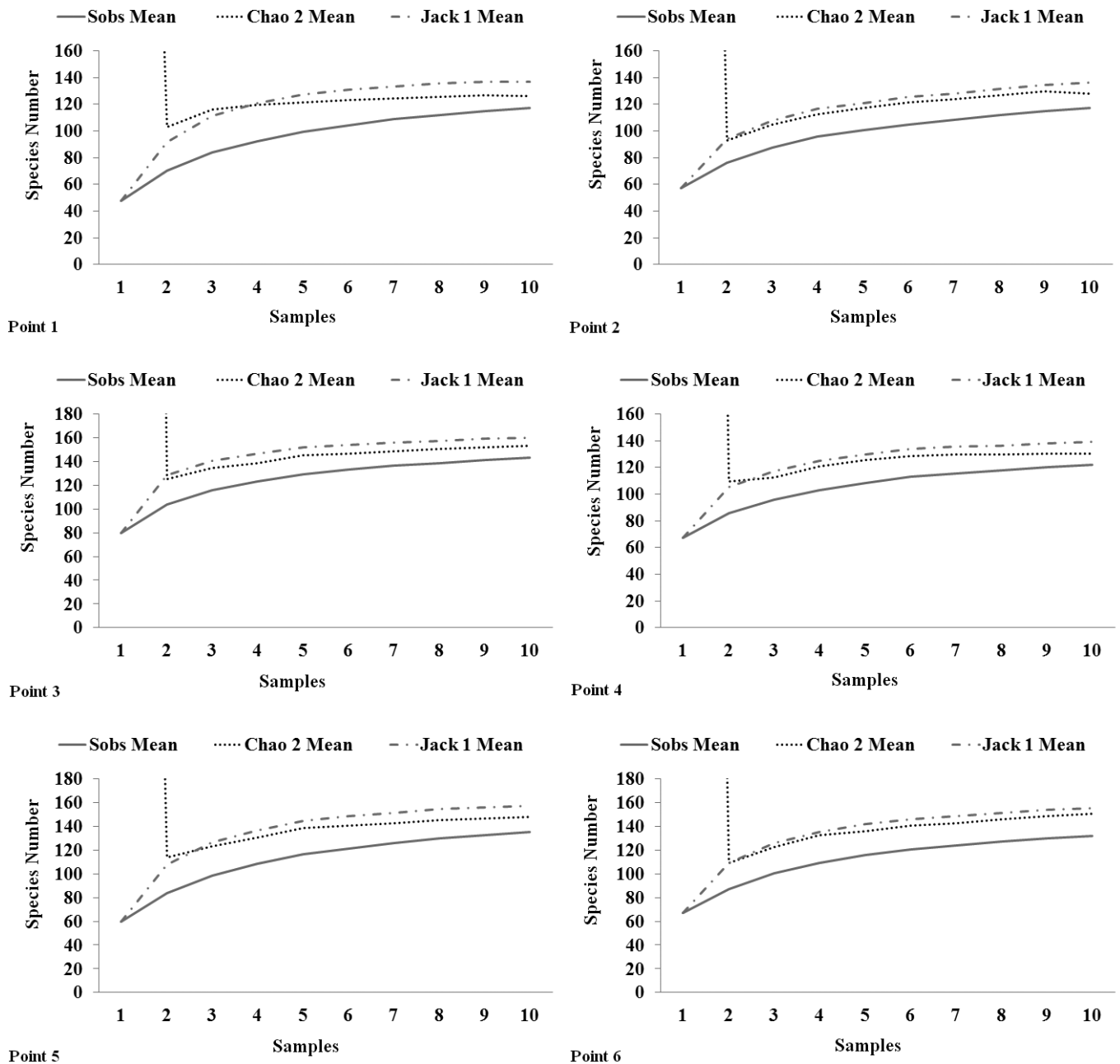


FIGURE 4. Rarefaction curves (Sobs) and estimated species richness (CHAO2 and Jackkine 1) for the six sites at the Talhado do São Francisco Natural Monument, obtained by all methods combined in this research.

Podilymbus podiceps, *Phalacrocorax brasilianus*, *Gallinula galeata*, and *Himantopus mexicanus* (Table 1). A further eight species were considered to be migrants, including *Micrococcyx cinereus*, *Myiodynastes maculatus*, *Empidonomus varius*, and *Turdus amaurochalinus* (Table 1).

Visual observations and recordings (excluding bodies of water) resulted in the confirmation of 181 species, which correspond to approximately 95% of the total number recorded in this study. However, the species richness estimators (Figure 5) indicated a total of 193 (CHAO 2) or 198 species (Jack1). While a larger number of species was expected in theory, in practice, the rarefaction curve for this sampling method had virtually stabilized by the end of the study.

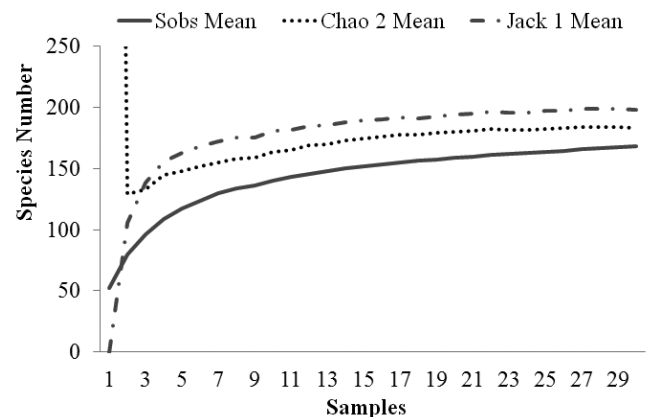


FIGURE 5. Rarefaction curve (Sobs) and estimated species richness (CHAO2 and Jackknife 1) for the results of the visual and auditory surveys recorded in the Talhado do São Francisco Natural Monument.

A total of 32 aquatic species were recorded in the Xingó reservoir and adjacent bodies of water. All of these species were observed during the dry season, but only 72% during the rainy season. *Dendrocygna bicolor*, *Anas bahamensis*, *Nomonyx dominica*, *Podilymbus podiceps*, *Laterallus viridis*, *Porzana albicollis*, *Porphyrio martinica*, *Himantopus mexicanus*, and *Tringa solitaria* were recorded only during the dry season.

Site 1 had the greatest species richness for aquatic birds, corresponding to 71% of the total number of aquatic species recorded in this study, followed by sites 5 and 6 (Table 1). *Dendrocygna bicolor*, *Nomonyx dominica*, *Porzana albicollis*, and *Porphyrio martinica* were recorded exclusively at site 1, *Laterallus viridis* only at site 4, *Anas bahamensis* at site 5, while *Podilymbus podiceps* and *Rostrhamus sociabilis* were exclusive to site 6 (Table 1). The most abundant species recorded in the surveys were *Bulbucus ibis* (N = 2000), *Egretta thula* (N = 128), *Tachycineta albiventer* (N = 192), and *Nycticorax nycticorax* (N = 26).

A total of 1558 specimens were captured in the mist-nets, representing 86 different species. Total species richness estimated by CHAO2 and Jack1 was 92 and 99 species, respectively (Figure 6A). Relatively similar

numbers of species were captured at each site – 45 species representing 23 families at site 1, 41 species in 20 families at site 2, 55 species in 20 families at site 3, 50 species representing 23 families at site 4, 41 species in 17 families at site 5, and 41 species in 20 families at site 6. Overall, the family with the largest number of species was Tyrannidae.

The most abundant species captured (representing more than 25% of the specimens netted) were *Lanio pileatus* (N = 147; Ar = 0.0944), *Columbina minuta* (N = 145; Ar = 0.0931), and *Columbina picui* (N = 105; Ar = 0.0674) (Figure 6B). There were some differences between the margins of the river/reservoir, with *Columbina picui* (N = 74; Ar = 0.0875), *Lanio pileatus* (N = 69; Ar = 0.0816), *Elaenia chilensis* (N = 51; Ar = 0.0603), and *Columbina minuta* (N = 50; Ar = 0.0591) being the most abundant species on the right bank (Figure 6C), representing almost 29% of the birds captured. On the left bank, the most abundant species were *Columbina minuta* (N = 95; Ar = 0.1334), *Lanio pileatus* (N = 78; Ar = 0.1096), *Hemitriccus margaritaceiventer* (N = 38; Ar = 0.0534), and *Myiarchus tyrannulus* (N = 32; Ar = 0.0449). Together, these species account for just over one third (34%) of the sample from this margin (Figure 6D).

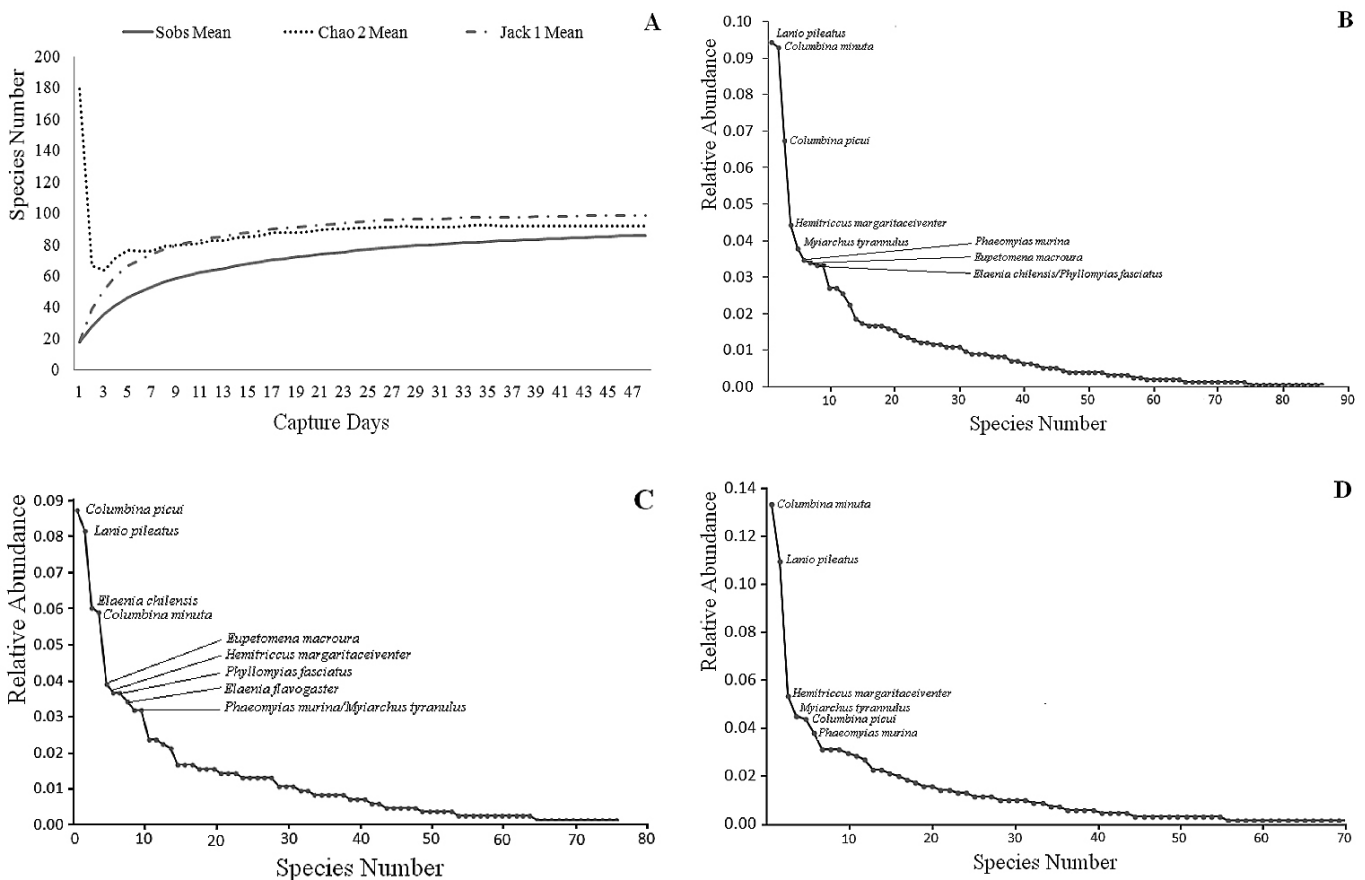


FIGURE 6. A - Rarefaction curves (Sobs) and estimated species richness (CHAO2 and Jack 1) calculated based on mist-nets captures obtained at the six study sites. B- Relative abundance of the species recorded in the Talhado do São Francisco Natural Monument based on mist-nets captures obtained at the six study sites. C- Relative abundance of the species recorded on the right margin and D- Relative abundance of the species recorded on the left margin, based on mist-nets captures obtained at the six study sites.

TABLE 1. List of the bird species recorded at the Talhado do São Francisco Natural Monument. CBRO (2011)- residence status (R- Brazilian resident, E- Brazilian endemic, *- endemic to the *caatinga* biome (Pacheco 2004), *- typical of the Brazilian Northeast or subspecies (Pacheco 2004), VN- migrant from the northern hemisphere, VS- migrant from the southern hemisphere) and Brazilian endemics (CBRO 2011); TR- Type of record (v- visual, a- auditory, m- captured in mist-net, p- photographic); Vegetation (Sc- shrubby *caatinga*, Ac- arboreal *caatinga*, Ic- impacted *caatinga*, Ah- anthropogenic habitats such as pastures and plantations, Aq- aquatic, Cc- canyon cliff); S- Sites (1,2,3,4,5,6); StM- status of the birds recorded in the Talhado do São Francisco Natural Monument (AR- abundant resident species Almeida *et al.* 1999, CR- resident species common within the study area, RUC- resident species recorded infrequently in the samples, RR- rare species recorded infrequently in the samples, SM- seasonal migrant, VN- migrant from the northern hemisphere, VS- migrant from the southern hemisphere); FO- frequency of occurrence; UH- use of habitat in relation to the dependence of the species on forest habitats (1- independent, 2- semi-dependent, 3- dependent).

Taxon	English Name	CBRO	TR	Vegetation	S1	S2	S3	S4	S5	S6	StM	FO	UH
Tinamiformes Huxley, 1872													
Tinamidae Gray, 1840													
<i>Crypturellus parvirostris</i> (Wagler, 1827)	Small-billed Tinamou	R	va	Sc, Ic	x	x	x	x	x	x	CR	53.3	1
<i>Crypturellus tataupa</i> (Temminck, 1815)	Tataupa Tinamou	R*	va	Sc, Ac	x	x	x	x	x	x	CR	53.3	3
<i>Nothura borinquina</i> (Spix, 1825)	White-bellied Nothura	R	va	Sc, Ic, Ah	x	x	x	x	x	x	RUC	26.7	2
<i>Nothura maculosa</i> (Temminck, 1815)	Spotted Nothura	R*	va	Sc, Ic, Ah					x		RUC	3.3	1
Anseriformes Linnaeus, 1758													
Anatidae Leach, 1820													
<i>Dendrocygna bicolor</i> (Vieillot, 1816)	Fulvous Whistling-Duck	R	v	Aq	x						SM	6.7	1
<i>Dendrocygna viduata</i> (Linnaeus, 1766)	White-faced Whistling-Duck	R	va	Aq	x		x			x	SM	18.3	1
<i>Sarkidornis sylvicola</i> Ihering & Ihering, 1907	Comb Duck	R	v	Aq					x	x	SM	3.3	1
<i>Amazonetta brasiliensis</i> (Gmelin, 1789)	Brazilian Teal	R	v	Aq	x				x	x	SM	21.7	1
<i>Anas bahamensis</i> Linnaeus, 1758	White-cheeked Pintail	R	v	Aq					x		SM	1.7	1
<i>Nomonyx dominica</i> (Linnaeus, 1766)	Masked Duck	R	v	Aq	x						SM	6.7	1
Podicipediformes Fürbringer, 1888													
Podicipedidae Bonaparte, 1831													
<i>Tachybaptus dominicus</i> (Linnaeus, 1766)	Least Grebe	R	v	Aq	x	x	x	x	x	x	RUC	38.3	1
<i>Podilymbus podiceps</i> (Linnaeus, 1758)	Pied-billed Grebe	R	v	Aq						x	SM	3.3	1
Suliformes Sharpe, 1891													
Phalacrocoracidae Reichenbach, 1849													
<i>Phalacrocorax brasilianus</i> (Gmelin, 1789)	Neotropic Cormorant	R	v	Aq			x	x	x		SM	10.0	1
Pelecaniformes Sharpe, 1891													
Ardeidae Leach, 1820													
<i>Tigrisoma lineatum</i> (Boddaert, 1783)	Rufescent Tiger-Heron	R	v	Aq	x	x			x	x	RUC	16.7	1
<i>Nycticorax nycticorax</i> (Linnaeus, 1758)	Black-crowned Night-Heron	R	v	Aq	x	x			x	x	RUC	18.3	1
<i>Butorides striata</i> (Linnaeus, 1758)	Striated Heron	R	va	Aq	x	x	x	x	x	x	RUC	43.3	1

Taxon	English Name	CBRO	TR	Vegetation	S1	S2	S3	S4	S5	S6	StM	FO	UH
<i>Bubulcus ibis</i> (Linnaeus, 1758)	Cattle Egret	R	v	Sc, Ic, Aq	x	x	x	x	x	x	CR	53.3	1
<i>Ardea alba</i> Linnaeus, 1758	Great Egret	R	v	Aq	x	x	x	x	x	x	CR	53.3	1
<i>Egretta thula</i> (Molina, 1782)	Snowy Egret	R	v	Aq	x	x	x	x	x	x	RUC	30.0	1
Cathartiformes Seebohm, 1890													
Cathartidae Lafresnaye, 1839													
<i>Cathartes aura</i> (Linnaeus, 1758)	Turkey Vulture	R	v	Sc, Ic, Ac, Ah	x	x	x	x	x	x	AR	76.7	1
<i>Cathartes burrovianus</i> Cassin, 1845	Lesser Yellow-headed Vulture	R	v	Sc, Ic, Ac, Ah	x	x	x	x	x	x	CR	53.3	1
<i>Coragyps atratus</i> (Bechstein, 1793)	Black Vulture	R	v	Sc, Ic, Ac, Ah	x	x	x	x	x	x	CR	56.7	1
<i>Sarcophagus papa</i> (Linnaeus, 1758)	King Vulture	R	v	Cc			x				RR	3.3	2
Accipitriformes Bonaparte, 1831													
Accipitridae Vigors, 1824													
<i>Gampsonyx swainsonii</i> Vigors, 1825	Pearl Kite	R	vamp	Sc, Ic, Ac		x	x		x	x	RUC	23.3	1
<i>Elanus leucurus</i> (Vieillot, 1818)	White-tailed Kite	R	v	Sc, Ic, Ac, Ah						x	RUC	1.7	1
<i>Accipiter striatus</i> Vieillot, 1808	Sharp-shinned Hawk	R	vamp	Sc, Ic, Ac	x	x					RUC	5.0	2
<i>Rostrhamus sociabilis</i> (Vieillot, 1817)	Snail Kite	R	v	Aq						x	RUC	3.3	1
<i>Genusospiza caerulescens</i> (Vieillot, 1817)	Crane Hawk	R	v	Sc, Ac			x	x			RR	8.3	2
<i>Heterospizias meridionalis</i> (Latham, 1790)	Savanna Hawk	R	va	Sc, Ic	x	x	x	x	x	x	RUC	23.3	1
<i>Urubitinga urubitinga</i> (Gmelin, 1788)	Great Black-Hawk	R	v	Ac			x				RR	1.7	2
<i>Rupornis magnirostris</i> (Gmelin, 1788)	Roadside Hawk	R*	vamp	Sc, Ic, Ac, Ah	x	x	x	x	x	x	AR	90.0	1
<i>Parabuteo unicinctus</i> (Temminck, 1824)	Harris's Hawk	R	v	Ac	x						RR	1.7	1
<i>Geranoaetus albicaudatus</i> (Vieillot, 1816)	White-tailed Hawk	R	v	Ac					x		RR	1.7	1
<i>Geranoaetus melanoloeus</i> (Vieillot, 1819)	Black-chested Buzzard-Eagle	R	v	Cc	x	x			x		RR	5.0	1
<i>Buteo nitidus</i> (Latham, 1790)	Gray Hawk	R	v	Ac			x			x	RR	5.0	2
Falconiformes Bonaparte, 1831													
Falconidae Leach, 1820													
<i>Caracara plancus</i> (Miller, 1777)	Southern Caracara	R	v	Sc, Ic, Ac, Ah	x	x	x	x	x	x	CR	73.3	1
<i>Milvago chimachima</i> (Vieillot, 1816)	Yellow-headed Caracara	R	va	Sc, Ic, Ac, Ah				x	x	x	RUC	13.3	1
<i>Herpethotes cachinnans</i> (Linnaeus, 1758)	Laughing Falcon	R	va	Sc, Ic, Ac, Ah	x	x	x	x	x	x	RUC	48.3	2
<i>Micranastur ruficollis</i> (Vieillot, 1817)	Barred Forest-Falcon	R	va	Ac			x				RR	6.7	3
<i>Falco sparverius</i> Linnaeus, 1758	American Kestrel	R	v	Sc, Ic, Ah	x	x	x	x	x	x	CR	55.0	1
<i>Falco femoralis</i> Temminck, 1822	Aplomado Falcon	R	v	Sc, Ic, Ah	x	x	x	x	x	x	CR	56.7	1
<i>Falco peregrinus</i> Tunstall, 1771	Peregrine Falcon	VN	v	Sc, Ic, Ah			x				VN	1.7	1

Taxon	English Name	CBRO	TR	Vegetation	S1	S2	S3	S4	S5	S6	StM	FO	UH
Gruiformes Bonaparte, 1854													
Aramidae Bonaparte, 1852													
<i>Aramus guarana</i> (Linnaeus, 1766)	Limpkin	R	va	Aq	x	x					RUC	6.7	1
Rallidae Rafinesque, 1815													
<i>Aramides cajaneus</i> (Statius Muller, 1776)	Gray-necked Wood-Rail	R	a	Sc, Ac					x		RUC	1.7	2
<i>Laterallus viridis</i> (Statius Muller, 1776)	Russet-crowned Crane	R	a	Aq			x				RUC	1.7	2
<i>Porzana albicollis</i> (Vieillot, 1819)	Ash-throated Crane	R	va	Aq	x						RUC	6.7	1
<i>Gallinula galeata</i> (Lichtenstein, 1818)	Common Gallinule	R	va	Aq	x		x	x	x		SM	18.3	1
<i>Porphyrio martinica</i> (Linnaeus, 1766)	Purple Gallinule	R	va	Aq	x						RUC	1.7	1
Cariamiformes Furbinger, 1888													
Cariamidae Bonaparte, 1850													
<i>Cariama cristata</i> (Linnaeus, 1766)	Red-legged Seriema	R	va	Sc, Ic	x	x	x	x	x		CR	53.3	1
Charadriiformes Huxley, 1867													
Charadriidae Leach, 1820													
<i>Vanellus chilensis</i> (Molina, 1782)	Southern Lapwing	R	va	Sc, Ic, Aq, Ah	x	x	x	x	x		AR	85.0	1
Recurvirostridae Bonaparte, 1831													
<i>Himantopus mexicanus</i> (Statius Muller, 1776)	Black-necked Stilt	R	v	Aq		x					SM	3.3	1
Scolopaciidae Rafinesque, 1815													
<i>Tringa solitaria</i> Wilson, 1813	Solitary Sandpiper	VN	v	Aq					x		VN	10.0	1
Jacanidae Chenu & Des Murs, 1854													
<i>Jacana jacana</i> (Linnaeus, 1766)	Wattled Jacana	R	va	Aq	x	x	x	x	x		RUC	45.0	1
Columbiformes Latham, 1790													
Columbidae Leach, 1820													
<i>Columbina minuta</i> (Linnaeus, 1766)	Plain-breasted Ground-Dove	R	vamp	Sc, Ic, Ac, Ah	x	x	x	x	x		AR	96.7	1
<i>Columbina talpacoti</i> (Temminck, 1811)	Ruddy Ground-Dove	R	vamp	Sc, Ic, Ah						x	RUC	6.7	1
<i>Columbina squammata</i> (Lesson, 1831)	Scaled Dove	R	vamp	Sc, Ic, Ac	x	x	x	x	x		CR	50.0	1
<i>Columbina picui</i> (Temminck, 1813)	Picui Ground-Dove	R*	vamp	Sc, Ic, Ac, Ah	x	x	x	x	x		AR	100.0	1
<i>Patagioenas picazuro</i> (Temminck, 1813)	Picazuro Pigeon	R	vap	Sc, Ic, Ac	x	x	x	x	x		RUC	38.3	2
<i>Zenaidura auriculata</i> (Des Murs, 1847)	Eared Dove	R*	vap	Sc, Ic, Ac	x		x	x	x		RUC	43.3	1
<i>Leptotila verreauxi</i> Bonaparte, 1855	White-tipped Dove	R*	vamp	Sc, Ic, Ac	x	x	x	x	x		RUC	31.7	2
<i>Geotrygon montana</i> (Linnaeus, 1758)	Ruddy Quail-Dove	R	v	Sc, Ac						x	RR	1.7	3

Taxon	English Name	CBRO	TR	Vegetation	S1	S2	S3	S4	S5	S6	StM	FO	UH
Psittaciformes Wagler, 1830													
Psittacidae Rafinesque, 1815													
<i>Aratinga cactorum</i> (Kuhl, 1820)	Cactus Parakeet	R**	vamp	Sc, Ic, Ac, Ah	x	x	x	x	x	x	CR	53.3	2
<i>Forpus xanthopterygius</i> (Spix, 1824)	Blue-winged Parrotlet	R*	vamp	Sc, Ic, Ac, Ah	x	x	x	x	x	x	AR	85.0	1
<i>Amazona aestiva</i> (Linnaeus, 1758)	Blue-fronted Parrot	R	va	Sc, Ac	x		x		x		RUC	15.0	3
Cuculiformes Wagler, 1830													
Cuculidae Leach, 1820													
<i>Microcoryx cinereus</i> (Vieillot, 1817)	Ash-colored Cuckoo	R	vp	Ac			x				SM	1.7	2
<i>Coccyzus melacoryphus</i> Vieillot, 1817	Dark-billed Cuckoo	R	vamp	Sc, Ac	x	x	x	x	x	x	CR	56.7	2
<i>Crotophaga ani</i> Linnaeus, 1758	Smooth-billed Ani	R	va	Sc, Ic, Ac, Ah	x	x	x	x	x	x	CR	60.0	1
<i>Guira guira</i> (Gmelin, 1788)	Guira Cuckoo	R	va	Sc, Ic, Ac, Ah	x	x	x	x	x	x	AR	91.7	1
<i>Tapera naevia</i> (Linnaeus, 1766)	Striped Cuckoo	R	va	Sc, Ic, Ac	x	x	x	x	x	x	RUC	40.0	1
Strigiformes Wagler, 1830													
Tytonidae Mathews, 1912													
<i>Tyto alba</i> (Scopoli, 1769)	Barn Owl	R	va	Ah			x				RUC	5.0	1
Strigidae Leach, 1820													
<i>Megascops choliba</i> (Vieillot, 1817)	Tropical Screech-Owl	R	a	Sc, Ic, Ac	x	x	x	x	x	x	CR	53.3	2
<i>Glaucidium brasilianum</i> (Gmelin, 1788)	Ferruginous Pygmy-Owl	R	vamp	Sc, Ic, Ac	x	x	x	x	x	x	CR	56.7	2
<i>Athene cunicularia</i> (Molina, 1782)	Burrowing Owl	R	vamp	Sc, Ic	x	x	x	x	x	x	AR	81.7	1
Caprimulgiformes Ridgway, 1881													
Nyctibiidae Chenu & Des Murs, 1851													
<i>Nyctibius griseus</i> (Gmelin, 1789)	Common Potoo	R	a	Sc, Ac	x	x	x		x		RUC	16.7	2
Caprimulgidae Vigors, 1825													
<i>Lurocalis semitorquatus</i> (Gmelin, 1789)	Short-tailed Nighthawk	R	a	Ac			x				RR	6.7	3
<i>Hydropsalis albicollis</i> (Gmelin, 1789)	Pauraque	R	a	Sc, Ic			x	x	x		RUC	13.3	2
<i>Hydropsalis parvula</i> (Gould, 1837)	Little Nighthjar	R	a	Sc, Ic, Ac			x	x	x	x	RUC	35.0	1
<i>Hydropsalis torquata</i> (Gmelin, 1789)	Scissor-tailed Nighthjar	R	amp	Sc, Ic, Ac	x	x	x	x			RUC	26.7	1
<i>Chordeiles pusillus</i> Gould, 1861	Least Nighthawk	R*	am	Sc, Ic, Ac, Ah	x	x	x	x	x	x	RUC	45.0	1
Apodiformes Peters, 1940													
Trochilidae Vigors, 1825													
<i>Anopetia gounellei</i> (Boucard, 1891)	Broad-tipped Hermit	R**	vmp	Sc, Ac			x	x			RR	8.3	3
<i>Eupetomena macroura</i> (Gmelin, 1788)	Swallow-tailed Hummingbird	R*	vamp	Sc, Ic, Ac, Ah	x	x	x	x	x	x	CR	66.7	1

Taxon	English Name	CBRO	TR	Vegetation	S1	S2	S3	S4	S5	S6	StM	FO	UH
<i>Chrysolampis mosquitus</i> (Linnaeus, 1758)	Ruby-topaz Hummingbird	R	vamp	Sc, Ac	x	x	x	x	x		SM	20.0	1
<i>Chlorostilbon notatus</i> (Reich, 1793)	Blue-chinned Sapphire	R	vmp	Sc, Ac		x			x		RUC	5.0	3
<i>Chlorostilbon lucidus</i> (Shaw, 1812)	Glittering-bellied Emerald	R	vamp	Sc, Ic, Ac, Ah	x	x	x	x	x	x	AR	76.7	2
<i>Heliomaster squamosus</i> (Temminck, 1823)	Stripe-breasted Starthroat	RE	vamp	Sc, Ac	x		x	x	x	x	RUC	36.7	3
Trogoniformes A. O. U., 1886													
Trogonidae Lesson, 1828													
<i>Trogon curucui</i> Linnaeus, 1766	Blue-crowned Trogon	R	vamp	Ac			x				RR	8.3	3
Coraciiformes Forbes, 1844													
Alcedinidae Rafinesque, 1815													
<i>Megascyle torquata</i> (Linnaeus, 1766)	Ringed Kingfisher	R	va	Aq	x	x	x	x	x	x	RUC	36.7	1
<i>Chloroceryle americana</i> (Gmelin, 1788)	Green Kingfisher	R	vam	Aq	x	x	x	x	x	x	RUC	28.3	2
Galbuliformes Fürbringer, 1888													
Bucconidae Horsfield, 1821													
<i>Nystalus maculatus</i> (Gmelin, 1788)	Spot-backed Puffbird	R	vamp	Sc, Ic, Ac, Ah	x	x	x	x	x	x	AR	90.0	2
Piciformes Meyer & Wolf, 1810													
Picidae Leach, 1820													
<i>Veniliornis passerinus</i> (Linnaeus, 1766)	Little Woodpecker	R	vamp	Sc, Ic, Ac	x	x	x	x	x	x	CR	61.7	2
<i>Colaptes melanochloros</i> (Gmelin, 1788)	Green-barred Woodpecker	R	vamp	Sc, Ac	x		x	x			RUC	13.3	2
Passeriformes Linnaeus, 1758													
Thamnophilidae Swainson, 1824													
<i>Myrmorchilus strigilatus</i> (Wied, 1831)	Stripe-backed Antbird	R*	vamp	Sc, Ic, Ac	x	x	x	x	x	x	AR	81.7	2
<i>Formicivora melanogaster</i> Pelzelin, 1868	Black-bellied Antwren	R*	vamp	Sc, Ic, Ac	x	x	x	x	x	x	CR	68.3	2
<i>Herpilochmus atricapillus</i> Pelzelin, 1868	Black-capped Antwren	R	va	Sc, Ac					x	x	RR	5.0	3
<i>Thamnophilus capistratus</i> Lesson, 1840	Caatinga Antshrike	R*	vamp	Sc, Ac	x	x	x	x			RUC	46.7	2
<i>Thamnophilus torquatus</i> Swainson, 1825	Rufous-winged Antshrike	R	va	Sc, Ac				x	x		RUC	5.0	1
<i>Thamnophilus pelzelni</i> Hellmayr, 1924	Planalto Slaty-Antshrike	RE	va	Sc, Ac			x	x	x		RUC	11.7	3
<i>Taraba major</i> (Vieillot, 1816)	Great Antshrike	R*	vamp	Sc, Ic, Ac	x	x	x	x	x	x	RUC	43.3	2
Dendrocolaptidae Gray, 1840													
<i>Sittasomus griseicapillus</i> (Vieillot, 1818)	Olivaceous Woodcreeper	R*	vamp	Sc, Ac	x		x		x	x	RUC	16.7	3
<i>Campylorhynchus trochilostrius</i> (Lichtenstein, 1820)	Red-billed Scythebill	R	vamp	Ac			x				RR	1.7	3
<i>Lepidocolaptes angustirostris</i> (Vieillot, 1818)	Narrow-billed Woodcreeper	R	vamp	Sc, Ic, Ac	x	x	x	x	x	x	AR	83.3	1

Taxon	English Name	CBRO	TR	Vegetation	S1	S2	S3	S4	S5	S6	StM	FO	UH
Furnariidae Gray, 1840													
<i>Furnarius figulus</i> (Lichtenstein, 1823)	Wing-banded Hornero	RE	vamp	Sc, Ic, Ac, Ah	x		x		x	x	RUC	30.0	1
<i>Furnarius leucopus</i> Swainson, 1838	Pale-legged Hornero	R	va	Ac			x				RUC	6.7	2
<i>Pseudoseiura cristata</i> (Spix, 1824)	Caatinga Cacholote	RE*	vamp	Sc, Ic, Ac	x	x	x	x	x	x	AR	88.3	2
<i>Phacelodorus rufifrons</i> (Wied, 1821)	Rufous-fronted Thornbird	R*	va	Sc, Ic, Ac			x		x	x	RUC	8.3	2
<i>Certhiix cinnamomus</i> (Gmelin, 1788)	Yellow-chinned Spinetail	R*	va	Aq					x	x	RUC	15.0	1
<i>Gyalophylax bellinayi</i> (Reiser, 1905)	Red-shouldered Spinetail	R**	vamp	Sc, Ac	x	x	x	x	x		RUC	40.0	1
<i>Synallaxis frontalis</i> Pelzelin, 1859	Sooty-fronted Spinetail	R	va	Sc, Ic, Ac	x	x	x	x	x		RUC	18.3	3
<i>Synallaxis albescens</i> Temminck, 1823	Pale-breasted Spinetail	R	va	Sc, Ac			x	x	x	x	RUC	10.0	1
Tityridae Gray, 1840													
<i>Pachyanamphus polychopterus</i> (Vieillot, 1818)	White-winged Becard	R	vamp	Sc, Ic, Ac, Ah		x	x	x	x	x	CR	50.0	2
<i>Pachyanamphus validus</i> (Lichtenstein, 1823)	Crested Becard	R	vamp	Sc, Ac			x			x	RUC	3.3	3
<i>Xenopsaris albinucha</i> (Burmeister, 1869)	White-naped Xenopsaris	R	va	Sc, Ac	x				x		RUC	6.7	1
Rhynchocyclidae Berlepsch, 1907													
<i>Tolmomyias flaviventris</i> (Wied, 1831)	Yellow-breasted Flycatcher	R	vamp	Sc, Ic, Ac		x	x	x	x	x	RUC	38.3	3
<i>Todirostrum cinereum</i> (Linnaeus, 1766)	Common Tody-Flycatcher	R*	vamp	Sc, Ic, Ac, Ah	x	x	x	x	x	x	CR	71.7	2
<i>Hemitriccus margaritaceiventer</i> (d'Orbigny & Lafresnaye, 1837)	Pearly-vented Tody-tyrant	R	vamp	Sc, Ic, Ac	x	x	x	x	x	x	AR	86.7	2
Tyrannidae Vigors, 1825													
<i>Hirundinea ferruginea</i> (Gmelin, 1788)	Cliff Flycatcher	R	vamp	Cc	x	x	x	x	x	x	RUC	18.3	2
<i>Stigmatura budytoides</i> (d'Orbigny & Lafresnaye, 1837)	Greater Wagtail-Tyrant	R*	vamp	Sc, Ic, Ac	x	x	x	x	x	x	CR	58.3	1
<i>Euscarthmus meloryphus</i> Wied, 1831	Tawny-crowned Pygmy-Tyrant	R	vamp	Sc, Ic, Ac	x	x	x	x	x	x	CR	51.7	2
<i>Camptostoma obsoletum</i> (Temminck, 1824)	Southern Beardless-Tyrannulet	R	vamp	Sc, Ic, Ac	x	x	x	x	x	x	CR	50.0	1
<i>Elaenia flavogaster</i> (Thunberg, 1822)	Yellow-bellied Elaenia	R	vamp	Sc, Ic, Ac, Ah			x	x	x	x	RUC	38.3	2
<i>Elaenia chilensis</i> Hellmayr, 1927	Chilean Elaenia	VS	vamp	Sc, Ic, Ac			x	x	x	x	VS	18.3	1
<i>Elaenia cristata</i> Pelzelin, 1868	Plain-crested Elaenia	R	vamp	Sc, Ic, Ac	x	x	x	x	x	x	RUC	38.3	1
<i>Elaenia chiriquensis</i> Lawrence, 1865	Lesser Elaenia	R	vamp	Sc, Ic, Ac			x	x	x	x	RUC	13.3	1
<i>Suiriri suiriri</i> (Vieillot, 1818)	Suiriri Flycatcher	R*	vamp	Sc, Ic, Ac, Ah	x	x					RUC	31.7	1
<i>Myiopagis viridicatta</i> (Vieillot, 1817)	Greenish Elaenia	R	vamp	Sc, Ic, Ac			x	x	x	x	RUC	36.7	3
<i>Phacomias murina</i> (Spix, 1825)	Mouse-colored Tyrannulet	R	vamp	Sc, Ic, Ac	x	x	x	x	x	x	AR	75.0	1
<i>Phyllomyias fasciatus</i> (Thunberg, 1822)	Planalto Tyrannulet	R*	vamp	Sc, Ic, Ac, Ah	x	x	x	x	x	x	CR	53.3	2
<i>Myiarchus ferox</i> (Gmelin, 1789)	Short-crested Flycatcher	R	vamp	Sc, Ac			x			x	RUC	6.7	2

Taxon	English Name	CBRO	TR	Vegetation	S1	S2	S3	S4	S5	S6	StM	FO	UH
<i>Myiarchus tyrannulus</i> (Statius Muller, 1776)	Brown-crested Flycatcher	R	vamp	Sc, Ac	x	x	x	x	x	x	AR	76.7	2
<i>Casiornis fuscus</i> Sclater & Salvin, 1873	Ash-throated Casiornis	RE	vamp	Sc, Ac			x				RUC	10.0	3
<i>Pitangus sulphuratus</i> (Linnaeus, 1766)	Great Kiskadee	R	vamp	Sc, Ic, Ac, Ah	x	x	x	x	x	x	AR	95.0	1
<i>Machetornis rixosa</i> (Vieillot, 1819)	Cattle Tyrant	R	va	Sc, Ic, Ac, Ah	x	x	x	x	x	x	RUC	30.0	1
<i>Myiodynastes maculatus</i> (Statius Muller, 1776)	Streaked Flycatcher	R	vamp	Sc, Ic, Ac			x				SM	18.3	3
<i>Megarynchus pitangua</i> (Linnaeus, 1766)	Boat-billed Flycatcher	R	vamp	Sc, Ic, Ac, Ah	x	x	x	x	x	x	RUC	16.7	2
<i>Myiozetetes similis</i> (Spix, 1825)	Social Flycatcher	R	va	Sc, Ic, Ac, Ah	x	x	x	x	x	x	RUC	25.0	2
<i>Tyrannus melancholicus</i> Vieillot, 1819	Tropical Kingbird	R	vamp	Sc, Ic, Ac, Ah	x	x	x	x	x	x	AR	95.0	1
<i>Empidonamus varius</i> (Vieillot, 1818)	Variiegated Flycatcher	R	vamp	Sc, Ac	x		x				SM	11.7	2
<i>Sublegatus modestus</i> (Wied, 1831)	Southern Scrub-Flycatcher	R	vamp	Sc, Ac	x		x				RUC	15.0	2
<i>Fluvicola albiventer</i> (Spix, 1825)	Black-backed Water-Tyrant	R	va	Aq	x	x	x	x	x	x	RUC	26.7	1
<i>Fluvicola nengeta</i> (Linnaeus, 1766)	Masked Water-Tyrant	R	vamp	Ic, Ah	x	x	x	x	x	x	AR	76.7	1
<i>Arundinicola leucocephala</i> (Linnaeus, 1764)	White-headed Marsh Tyrant	R	va	Aq	x	x	x	x	x	x	RUC	23.3	1
<i>Cnemotriccus fuscatus</i> (Wied, 1831)	Fuscous Flycatcher	R	vamp	Sc, Ac			x				RUC	1.7	3
<i>Lathrotriccus euleri</i> (Cabanis, 1868)	Euler's Flycatcher	R	va	Sc, Ac			x				RUC	8.3	3
Vireonidae Swainson, 1837													
<i>Cyclarhis gujanensis</i> (Gmelin, 1789)	Rufous-browed Peppershrike	R	vamp	Sc, Ic, Ac, Ah	x	x	x	x	x	x	AR	91.7	2
<i>Vireo olivaceus</i> (Linnaeus, 1766)	Red-eyed Vireo	R	va	Ac			x				RUC	5.0	3
<i>Hypothymis amaurocephalus</i> (Nordmann, 1835)	Gray-eyed Greenlet	RE	vamp	Sc, Ic, Ac	x	x	x	x	x	x	RUC	28.3	3
Corvidae Leach, 1820													
<i>Cyanocorax cyanocephalus</i> (Wied, 1821)	White-naped Jay	RE	vamp	Sc, Ic, Ac	x	x	x	x	x	x	RUC	38.3	2
Hirundinidae Rafinesque, 1815													
<i>Progne tapera</i> (Vieillot, 1817)	Brown-chested Martin	R	v	Ah				x			SM	1.7	1
<i>Progne chalybea</i> (Gmelin, 1789)	Gray-breasted Martin	R	v	Ah		x					SM	5.0	1
<i>Tachycineta albiventer</i> (Boddaert, 1783)	White-winged Swallow	R	v	Aq	x	x	x	x	x	x	RUC	36.7	1
<i>Tachycineta leucorhoa</i> (Vieillot, 1817)	White-rumped Swallow	R	v	Aq	x	x	x	x	x	x	RUC	13.3	1
Troglodytidae Swainson, 1831													
<i>Troglodytes musculus</i> Naumann, 1823	Southern House Wren	R	vamp	Sc, Ic, Ac, Ah	x	x	x	x	x	x	AR	85.0	1
<i>Cantorchilus longirostris</i> (Vieillot, 1819)	Long-billed Wren	RE*	vamp	Sc, Ic, Ac	x	x	x	x	x	x	AR	95.0	3
Poliptilidae Baird, 1858													
<i>Poliptila plumbea</i> (Gmelin, 1788)	Tropical Gnatcatcher	R*	vamp	Sc, Ic, Ac	x	x	x	x	x	x	AR	93.3	2

Taxon	English Name	CBRO	TR	Vegetation	S1	S2	S3	S4	S5	S6	StM	FO	UH
Turdidae Rafinesque, 1815													
<i>Turdus rufiventris</i> Vieillot, 1818	Rufous-bellied Thrush	R	vamp	Sc, Ic, Ac, Ah	x	x	x	x	x	x	CR	56.7	1
<i>Turdus leucomelas</i> Vieillot, 1818	Pale-breasted Thrush	R	va	Sc, Ic, Ac	x	x	x				RUC	11.7	2
<i>Turdus amaurochalinus</i> Cabanis, 1850	Creamy-bellied Thrush	R	vamp	Sc, Ic, Ac	x	x	x	x	x	x	SM	25.0	2
Mimidae Bonaparte, 1853													
<i>Mimus saturninus</i> (Lichtenstein, 1823)	Chalk-browed Mockingbird	R*	vamp	Sc, Ic, Ac, Ah	x	x	x	x	x	x	AR	86.7	1
Motacillidae Horsfield, 1821													
<i>Anthus lutescens</i> Pucheran, 1855	Yellowish Pipit	R		Ic, Ah		x	x	x			RUC	20.0	1
Coerebidae d'Orbigny & Lafresnaye, 1838													
<i>Coereba flaveola</i> (Linnaeus, 1758)	Bananaquit	R	vamp	Sc, Ic, Ac, Ah	x	x	x	x		x	RUC	46.7	2
Thraupidae Cabanis, 1847													
<i>Compothrapis loricata</i> (Lichtenstein, 1819)	Scarlet-throated Tanager	RE	va	Sc, Ac	x					x	RUC	5.0	2
<i>Nemosia pileata</i> (Boddaert, 1783)	Hooded Tanager	R	vamp	Sc, Ic, Ac	x	x	x	x	x	x	RUC	18.3	3
<i>Tachyphonus rufus</i> (Boddaert, 1783)	White-lined Tanager	R	vamp	Sc, Ic, Ac	x	x	x	x	x	x	RUC	31.7	3
<i>Lanio pileatus</i> (Wied, 1821)	Pileated Finch	R	vamp	Sc, Ic, Ac	x	x	x	x	x	x	CR	73.3	2
<i>Tangara sayaca</i> (Linnaeus, 1766)	Sayaca Tanager	R	vamp	Sc, Ic, Ac, Ah	x	x	x	x	x	x	CR	68.3	2
<i>Tangara palmarum</i> (Wied, 1823)	Palm Tanager	R	va	Sc, Ic, Ac, Ah		x	x				RUC	5.0	2
<i>Tangara cayana</i> (Linnaeus, 1766)	Burnished-buff Tanager	R*	vamp	Sc, Ic, Ac, Ah				x			RUC	3.3	1
<i>Paroaria dominicana</i> (Linnaeus, 1758)	Red-cowled Cardinal	R**	vamp	Sc, Ic, Ac, Ah	x	x	x	x	x	x	AR	85.0	1
<i>Conirostrum speciosum</i> (Temminck, 1824)	Chestnut-vented Conebill	R	vamp	Sc, Ac	x		x		x	x	RUC	16.7	3
Emberizidae Vigors, 1825													
<i>Zonotrichia capensis</i> (Statius Muller, 1776)	Rufous-collared Sparrow	R	vamp	Sc, Ic, Ac, Ah	x	x	x	x	x	x	CR	65.0	1
<i>Ammodramus humeralis</i> (Bosc, 1792)	Grassland Sparrow	R	va	Sc, Ic, Ac, Ah	x	x	x	x	x	x	CR	61.7	1
<i>Sicalis flaveola</i> (Linnaeus, 1766)	Saffron Finch	R	va	Sc, Ic, Ac, Ah			x				RR	1.7	1
<i>Sicalis luteola</i> (Sparman, 1789)	Grassland Yellow-Finch	R	va	Sc, Ic, Ac, Ah		x			x	x	SM	6.7	1
<i>Volatinia jacarina</i> (Linnaeus, 1766)	Blue-black Grassquit	R	vamp	Sc, Ic, Ac, Ah	x	x	x	x	x	x	RUC	38.3	1
<i>Sporophila nigricollis</i> (Vieillot, 1823)	Yellow-bellied Seedeater	R	va	Sc, Ic, Ac				x	x		RUC	3.3	1
<i>Sporophila albogularis</i> (Spix, 1825)	White-throated Seedeater	R**	vamp	Sc, Ic, Ac, Ah	x	x	x	x	x	x	CR	61.7	1
<i>Sporophila leucoptera</i> (Vieillot, 1817)	White-bellied Seedeater	R	va	Sc, Ic, Ac				x			RUC	1.7	1
<i>Sporophila bouvreuil</i> (Statius Muller, 1776)	Capped Seedeater	R	va	Sc, Ic, Ac						x	RUC	1.7	1
<i>Sporophila angolensis</i> (Linnaeus, 1766)	Chestnut-bellied Seed-Finch	R	va	Sc, Ic, Ac						x	RUC	1.7	1

Taxon	English Name	CBRO	TR	Vegetation	S1	S2	S3	S4	S5	S6	StM	FO	UH
Cardinalidae Ridgway, 1901													
<i>Cyanoloxia brissonii</i> (Lichtenstein, 1823)	Ultramarine Grosbeak	R*	vamp	Sc, Ic, Ac			x	x			RUC	15.0	3
Icteridae Vigors, 1825													
<i>Icterus pyrrhopterus</i> (Vieillot, 1819)	Variable Oriole	R	va	Sc, Ic, Ac, Ah		x	x	x		x	RUC	25.0	2
<i>Icterus jamaicai</i> (Gmelin, 1788)	Campo Troupial	RE*	va	Sc, Ic, Ac, Ah	x	x	x	x		x	RUC	18.3	2
<i>Gnorimopsar chopi</i> (Vieillot, 1819)	Chopi Blackbird	R*	va	Sc, Ic, Ac, Ah			x				RUC	3.3	1
<i>Chrysomus ruficapillus</i> (Vieillot, 1819)	Chestnut-capped Blackbird	R	va	Sc, Ic, Ac, Ah				x			RUC	1.7	1
<i>Agelaioides fringillarius</i> (Spix 1824)	Pale Baywing	RE*	va	Sc, Ic, Ac, Ah	x		x	x	x	x	RUC	35.0	1
<i>Molothrus bonariensis</i> (Gmelin, 1789)	Shiny Cowbird	R	va	Sc, Ic, Ac, Ah	x	x	x	x	x	x	RUC	40.0	1
<i>Sturnella superciliosa</i> (Bonaparte, 1850)	White-browed Blackbird	R	va	Sc, Ic, Ac, Ah	x	x	x	x	x	x	RUC	21.7	1
Fringillidae Leach, 1820													
<i>Euphonia chlorotica</i> (Linnaeus, 1766)	Purple-throated Euphonia	R	vamp	Sc, Ic, Ac, Ah	x	x	x	x	x	x	AR	81.7	2
<i>Euphonia violacea</i> (Linnaeus, 1758)	Violaceous Euphonia	R	va	Sc, Ic, Ac, Ah					x		RUC	3.3	3
Passeridae Rafinesque, 1815													
<i>Passer domesticus</i> (Linnaeus, 1758)	House Sparrow	R	va	Aa					x	x	RUC	15.0	1
Total number of species at each sampling point					117	117	143	122	135	132			

TABLE 2. Jaccard's index of similarity for the pairwise comparisons of the sites surveyed in the Talhado do São Francisco Natural Monument. S - Site.

	S1	S2	S3	S4	S5	S6
P1	100%					
P2	72,05%	100%				
P3	65,61%	65,61%	100%			
P4	63,70%	69,50%	70,97%	100%		
P5	64,71%	64,71%	64,50%	62,66%	100%	
P6	64,90%	66,00%	66,67%	66,01%	72,26%	100%

DISCUSSION

The number of species recorded in the present study was relatively high, corresponding to almost two-thirds of the 348 *caatinga* species recorded by Pacheco (2004). Similar numbers of species have been recorded at a number of *caatinga* sites, such as Serra da Capivara, Piauí, where Olmos (1993) reported 208 species, and Ceará and Pernambuco, where Olmos *et al.* (2005) identified 209 species. Similarly, Lyra-Neves & Telino Júnior (2010) listed 186 bird species from the *caatinga* of the state of Paraíba, while Farias *et al.* (2006) recorded 193 species at Serra das Almas, and Nascimento (2000) found 158 species in the Aiuaba Ecological Station (both sites in Ceará).

Lower numbers of species have been reported from other *caatinga* sites, however. Araújo & Rodrigues (2011) recorded only 105 at a site in Alagoas, while Santos (2004) found 115 species in southern Piauí. Ruiz-Esparza *et al.* (2011a) recorded a total of 140 species in the Grota do Angico Natural Monument in Sergipe, also on the lower São Francisco River, while Farias (2007) listed 141 species in Pernambuco. However, all the other studies were also based on relatively limited sampling effort, with Santos (2004) and Ruiz-Esparza *et al.* (2011a) collecting data only during the rainy season, and the results of Araújo & Rodrigues (2011) and Farias (2007) being based on a rapid survey approach. In addition, while Olmos *et al.* (2005) recorded the highest total species richness, the largest number of species recorded at any given locality was 125, with the values at other sites ranging from 72 to 109, reflecting the relatively short duration of the sampling effort at each site. It seems likely, then, that the number of species has been underestimated at most, if not all of the *caatinga* sites surveyed to date.

The rarefaction curve indicated that the collection of additional data would further expand the number of species recorded for the Talhado do São Francisco Natural Monument, a conclusion also supported by the CHAO2 and Jack1 estimators. The total number of species would increase to 196-212 according to CHAO2, and to 204-212, based on Jack1, indicating that the true number of species was underestimated by no more than 10%. With some variations, the richest families in terms of the number of species were the same as those recorded at other *caatinga* sites (Santos 2004; Olmos *et al.* 2005; Roos *et al.* 2006; Farias 2007, Lyra-Neves & Telino Junior (2010), Araújo & Rodrigues (2011), Pereira & Azevedo Júnior (2011) e Ruiz-Esparza *et al.* (2011a). The Tyrannidae corresponded to almost 15% of the species recorded in the present study, and this family was the most species-rich in all other studies.

Site 3 presented the highest species richness (143), which was expected due to the relatively well-preserved and heterogeneous habitat found at this site, where

the vegetation included not only arboreal *caatinga* interspersed with tree species typical of more humid forest, but also shrubby-herbaceous *caatinga* on sandy soils. With 135 and 132 species, respectively, sites 5 and 6 were also relatively species-rich, despite local anthropogenic impacts, probably because of the availability of some well-preserved habitats at both sites. Pereira & Azevedo Júnior (2011) recorded 138 species in the *caatinga* of the municipality of Altinho (Pernambuco), and emphasized the negative effects of deforestation (for cattle pasture) for the conservation of the local avian fauna.

The lowest species richness was recorded at sites 1 and 2, which have suffered extensive anthropogenic impacts, resulting in the disturbance of most of their areas of natural vegetation. Even so, the smallest number of species (117) recorded at these sites was still larger than the total number reported by Santos (2004) and Araújo & Rodrigues (2011), although it seems likely that the difference was related to variations in sampling procedures and effort, and the duration of the study period, given that, as mentioned above, these studies were based on a single sampling method and were restricted to the rainy season.

Only five endemic species were recorded in the present study, just a third of the total number (15) recorded for the *caatinga* by Pacheco (2004). This number was nevertheless much higher than the values recorded in some other *caatinga* studies, such as that of Santos (2004), who reported an endemism rate of 15.5% in southern Piauí. The endemic *caatinga* species include *Aratinga cactorum* and *Anopetia gounellei*, which are classified as semi-dependent and dependent on forest habitats, respectively. Araújo & Rodrigues (2011) recorded seven of the species classified here as typical of the Brazilian Northeast. Some of these forms are recognized as subspecies (Pacheco 2004), and 29 species were included in this category in the present study.

Based on the classification of Almeida *et al.* (1999), abundant resident species are those which have a frequency of at least 75%, and 26 species (13.7%) were included in this category in the present study. A further 31 species returned frequencies of between 50% and 69%, and were classified as common residents. An additional 96 species were identified as uncommon residents, with a frequency of less than 50%. These species are typical of the *caatinga*, and do not present distinct seasonal movements which would warrant their classification as seasonal migrants, nor can they be considered to be rare within the study area. In many cases, the reduced frequency of occurrence may simply be the result of random sampling effects.

Some of the species recorded in the present study are more dependent on well-preserved *caatinga* habitats, and are difficult to observe in disturbed vegetation. In this case, 15 species were classified as rare residents, in particular

Sarcoramphus papa, *Urubitinga urubitinga*, *Lurocalis semitorquatus*, *Trogon curucui*, and *Campylorhynchus trochilirostris*, which were recorded only at site 3, and *Geranospiza caerulescens*, *Micrastur ruficollis*, *Geotrygon montana*, *Anopetia gounellei*, and *Herpsilochmus atricapillus*, which were observed only in the well-preserved forest habitats found at sites 4, 5, and 6.

Many species can be observed in the semi-arid Brazilian Northeast only during specific periods, and the occurrence of most seems determined by precipitation levels (Azevedo Júnior & Larrazábal 2002, Pereira & Azevedo Júnior 2011). These species were classified as seasonal migrants in the present study, and include *Tachybaptus dominicus*, *Podilymbus podiceps*, *Gallinula chloropus*, *Zenaida auriculata*, and *Chrysolampis mosquitus*. Whereas some aquatic species were absent from the study area during the rainy season, the opposite pattern was recorded for the terrestrial species, which tended to emigrate during the dry season. Some species, such as *Dendrocygna bicolor*, *D. viduata*, *D. autumnalis*, *Sarkidiornis sylvicola*, *Tachybaptus dominicus*, *Podilymbus podiceps*, *Phalacrocorax brasilianus*, and *Gallinula galeata*, may migrate within the South American continent during the flooding cycle of the Brazilian Pantanal wetlands (Nunes & Tomas 2008). Species such as *Myiodynastes maculatus*, *Empidonomus varius*, *Progne tapera*, *P. chalybea*, *Turdus amaurochalinus*, and *Sicalis luteola*, present a similar pattern of behavior. These same authors identified *Amazonetta brasiliensis*, *Nomonyx Dominica*, and *Chrysolampis mosquitus* as nomads. This category refers to species that migrate between areas or sub-regions, based on the availability of resources, in particular the supply of nutrients.

Some aquatic species migrate at the beginning of the rainy season, when temporary bodies of water start to form, attracting a variety of species (Pereira 2010, Passos Filho 2012). This process may be related to the availability of refuges in the area surrounding these lakes, in which the birds can reproduce. This is especially important for the anatids, which also molt during this process.

Most of the species recorded during the present study are either independent or only semi-dependent of forest habitats. A similar pattern was observed by Santos (2004), Silva *et al.* (2003), and Pereira & Azevedo Júnior (2011). This is typical of most *caatinga* species, which also tend to be relatively tolerant of habitat disturbance (Stotz *et al.* 1996, Santos 2004 e Silva *et al.* 2003). Of the 29 species classified as dependent of forest habitats, almost 83% were recorded at site 3, followed by sites 5 and 6, which are characterized by tracts of relatively dense, undisturbed arboreal-shrubby *caatinga*, which is favorable to these species.

The combined use of visual observations and the recording of vocalizations proved to be a useful approach for the collection of data on the occurrence of bird species

in the present study, given that 95% (181) of the species were recorded through these methods. However, the capture of specimens in mist-nets was also essential for the confirmation of the occurrence of less conspicuous species, which are often difficult to observe in dense forested habitats. The capture of specimens also provided additional biological data that can only be obtained from the manipulation of the animals. The estimated species richness based on mist-nets captures – 193 (CHAO2) and 198 species (Jack1) – was similar to the number recorded during observations.

The 32 aquatic species recorded in the present study represents a species richness similar to that recorded by Lyra-Neves & Telino Júnior (2010) and Passos-Filho (2012) in the *caatinga* of Paraíba state. While Olmos *et al.* (2005) recorded a much larger number of species (49), this number includes species associated with aquatic environments, such as *Columbina* spp., rather than truly aquatic species. Considering only these aquatic species, the total recorded by these authors was 34, a number similar to that obtained in the present study. In comparison with other sites, however, a relatively large number of aquatic species was recorded at Talhado do São Francisco, especially at other reservoirs on the São Francisco River. Ross *et al.* (2006), for example, recorded 18 species at the Sobradinho hydroelectric reservoir, while Farias (2007) recorded 16 at the Itaparica reservoir. Pereira (2010) recorded 18 aquatic species associated with natural lakes in Rio Grande do Norte.

In the present study, the sites with the largest numbers of aquatic species – 1, 5, and 6 – were those adjacent to inlets of the reservoir, characterized by relatively flat terrain, virtually at the same level as the water. Fewer aquatic species were recorded at the sites which included canyon cliffs, which appear to be an unfavorable environment for many of these species, in particular because of the lack of aquatic vegetation along the margins of the body of water, which is used as a refuge by some species, in particular the rallids, which were absent from these sites, and the anatids, which were represented by a single species, *Sarkidiornis sylvicola*.

Some species were recorded only during the dry season. Olmos *et al.* (2005) recorded an increase in the number of aquatic species during the rainy season, although other studies, such as those of Alves & Pereira (1998) and Passos Filho (2012) recorded the opposite tendency, that is, increased species richness during the dry season, a pattern also observed in the present study. This may be related primarily to two factors (Passos Filho 2012). One is methodological – as water levels decrease, the area of the lake margin increases, resulting in better conditions for the observation of birds. The other is the fact that many temporary bodies of water dry out completely, forcing many species to migrate to more permanent sites, such as lakes and reservoirs. An additional factor is the

seasonal migrations observed in many species, which are determined by precipitation patterns.

The relatively large numbers of *Bubulcus ibis* recorded during the present study were due to the presence of a breeding colony of this species in May, 2005, on the right bank of the São Francisco, near the Fazenda Santa Rosa. The species *Egretta thula* and *Nycticorax nycticorax* were observed in the vegetation bordering the reservoir, whereas other species, such as *Certhiaxis cinnamomeus*, *Megaceryle torquata*, and *Chloroceryle americana* were also observed in the vegetation on the cliffs.

A total of 86 species were captured in the mist-nets, corresponding to approximately 45% of the species richness of the study area. The rarefaction curve had virtually stabilized, although the estimators indicated that an additional 13 species would, theoretically, be recorded if additional captures had been carried out. The estimate of 99 species reinforces the conclusion that mist-netting provides a potentially important complementary approach to the surveying and monitoring of bird species, together with observations and the recording of vocalizations.

The largest numbers of bird species were captured at sites 4 and 5. At all sites, the family with the most species captured was the Tyrannidae, followed by the Thraupidae, Trochilidae, and Columbidae. A very similar taxonomic composition, with some minor variation, has been recorded at other sites in the region (Nascimento 2000, Roos *et al.* 2006, Ruiz-Esparza *et al.* 2011a). The most abundant species at all the sites were generalists that are relatively tolerant of habitat disturbance, once again, a pattern observed at other sites (Nascimento 2000, Roos *et al.* 2006). Species dependent on forest habitats were captured rarely, and their relative abundance was low.

Some of the species recorded in the present study are of special interest, for a number of different reasons. For example, *Urubitinga urubitinga*, *Parabuteo unicinctus*, *Geranoaetus albicaudatus*, *Amazona aestiva*, *Sarcoramphus papa*, *Micrastur ruficollis*, *Micrococcyx cinereus*, *Lurocalis semitorquatus*, *Trogon curucui*, and *Campylorhynchus trochilirostris* were recorded exclusively on the left bank of the Xingó reservoir, primarily at sites 3 and 5, which are located in the state of Sergipe. The *caatinga* habitats at these sites are relatively well-preserved, which appears to be a requirement for the presence of these species, which are dependent or semi-dependent on forest habitats.

A number of species were also associated with the rocky cliffs of the São Francisco canyon. These included *Sarcoramphus papa*, *Buteo melanoleucus*, and *Hirundinea ferruginea*. In the case of *S. papa*, nests and a nestling were observed.

A number of other species are migrants, coming from either the southern or the northern hemisphere. *Falco peregrinus* and *Tringa solitaria* are migrants from the North. *Falco peregrinus* was recorded in May, 2006, while

T. solitaria was observed between February and March, 2006, which coincides with the overwintering period of this species in Brazil. *Elaenia chilensis*, a southern visitor, was captured in large number in May, 2006, and was sighted between May and August, indicating that it migrates to the Brazilian Northeast during the local rainy season. The species was recorded on a similar time scale at other sites in the region, such as the Raso da Catarina, in Bahia, where Lima *et al.* (2003) reported the greatest numbers of this species between April and June, and the Grota do Angico Natural Monument, in Sergipe, where Ruiz-Esparza *et al.* (2011b) also recorded increased numbers of *E. chilensis* between March and July. In both cases, the period coincides with the rainy season. Marini & Cavalcante (1990) reported that *E. chilensis* migrates to northern Brazil, including the Northeast, between May and July.

One other species, *Himantopus mexicanus*, is associated with aquatic environments, and during the present study, it was recorded only during the dry season. This species is not considered to be a migrant by many authors, but the distinct seasonal pattern of occurrence recorded in the present study indicates that it disperses seasonally within the *caatinga*. Nunes & Tomas (2008) have classified the species as an intercontinental migrant.

Two other species, *Myiodynastes maculatus* and *Empidonomus varius*, also presented an apparently seasonal pattern of abundance, with the vast majority of specimens being captured between May and August, although there were two records of *E. varius* in November, and one of *M. maculatus* in February. *Turdus amaurochalinus* was also abundant between May and the end of August, but absent during all other months, except for two specimens captured at the end of February and beginning of March. During the region's rainy season months (May-August), the specimens captured had completely yellow beaks, which is a breeding trait, whereas during the other months, the beaks of the specimens were plain brown. A similar seasonal reproductive pattern was recorded in the same region of the lower São Francisco River by Ruiz-Esparza *et al.* (2011b), who emphasized the presence of migrant populations of *Turdus amaurochalinus* during the rainy season in the *caatinga*. Nunes & Tomas (2008) classified all three species as intracontinental migrants, which move to and from the Pantanal wetlands according to the flooding cycle and variation in water levels. The results of the present study confirm the role of these three species as seasonal migrants in the semi-arid Brazilian Northeast.

Micrococcyx cinereus was recorded on only one occasion in May, 2006, at site 3, in Canindé de São Francisco, Sergipe. This cuculid species is distributed primarily in central Brazil, ranging as far east as the *caatinga* habitats of western Bahia (Sick, 1997). Prior to the present study, this was the eastern limit of the

geographic range of the species (Mata *et al.* 2006, Sigrist 2009, Van Perlo 2009). Sick (1997) classified this species as a migrant, which occurs as far North as the Amazon basin. This species is associated with more humid arboreal *caatinga* habitats, including upland enclaves of humid forest (*brejos de altitude*), a type of vegetation found at site 3.

The species *Zenaida auriculata* presented a reduced frequency of occurrence between March and August, which coincides with the rainy season in the study area, when seeds are more available, supporting the reproductive process, and resulting in larger numbers of individuals moving within the study area, facilitating the observation of the species. This species migrates seasonally within the *caatinga*, accompanying precipitation patterns and the availability of *Croton* spp. seeds (Azevedo Júnior & Antas 1990, Souza *et al.* 2007).

Sites 3 and 5, which are located in the municipality of Canindé de São Francisco, in the state of Sergipe, were characterized by the highest species richness and the largest number of species dependent on forest habitats (*e.g.* *Anopetia gounellei*, *Trogon curucui*, and *Campylorhamphus trochilirostris*). These sites are characterized by relatively well-preserved tracts of arboreal *caatinga*, which is an essential prerequisite for the occurrence of these birds. The principal plant resources include the murici (*Byrsonima gardneriana*), baraúna (*Schinopsis brasiliensis*), imburana (*Commiphora leptophoes*), quipembe (*Piptadenia moniliformis*), aroeira (*Myracrodruon urundeuva*), and angico de caroço (*Anadenanthera macrocarpa*), trees which provide both feeding resources and breeding sites.

While the other sites were less well-preserved in general, and some have suffered considerable anthropogenic impact, a few forest-dependent bird species were still present at all sites. This reinforces the need for the implementation of effective measures for the conservation of these species within the study area.

The Xingó reservoir, located within the São Francisco Canyon, and the permanent lakes and temporary pools found in adjacent areas, form a network of bodies of water appropriate for resident and migratory species of aquatic and semi-aquatic birds, including some, such as *Amazonetta brasiliensis* and *Aramides cajanea*, which are highly sensitive to habitat disturbance (Parker III *et al.* 1996).

The loss of the original vegetation cover is a consequence of extensive ranching (cattle, sheep, and goats), agriculture, and the extraction of firewood for the production of charcoal. These anthropogenic pressures are less intense at the two sites in Sergipe (3 and 5), in comparison with those in Bahia (site 1) and Alagoas (sites 2, 4, and 6), although site 4 still has some relatively well-preserved tracts of *caatinga* habitat. The conservation of the local bird species is directly related to the preservation of these natural habitats. In addition to the recently-

created Talhado do São Francisco Natural Monument, a state protected area, the Grota do Angico Natural Monument was decreed in 2007 in Sergipe. These two units undoubtedly constitute a major step towards the conservation of the natural ecosystems of the lower São Francisco River. However, the maintenance and management of such protected areas is more important than their creation. In particular, pristine habitats require intense monitoring and protection, while impacted areas need effective recuperative measures.

The inventory of the bird fauna provided by the present study (190 species) provides a baseline for the development of biological surveys and monitoring in the areas being restored around the margins of the reservoir. These studies will provide important insights into the colonization of the *caatinga* biome by different bird species or groups. The analysis of these data in the context of the different stages of habitat regeneration can provide important insights for the development of effective policies for the recuperation of areas of anthropogenic impact throughout the region.

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