

## Distribution and conservation of three important bird groups of the Atlantic Forest in north-east Brazil

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### Abstract

The Pernambuco Endemism Center in north-east Brazil has the most fragmented forest cover and the largest number of threatened birds of the whole Atlantic Forest. We analyzed the distribution of three groups of bird species: forest-dependent, endemic and/or threatened using the interpolation method of Inverse Distance Weighting. We also checked the concentration of these birds in protected and unprotected areas, suggesting new sites that need to be protected. The richness concentration of forest-dependent, endemic and/or threatened birds in 123 sites were analysed. There was a greater concentration of the three groups in north Alagoas, south and north Pernambuco, and north and west Paraíba. The distribution of the three groups was almost regular in different vegetation types, although a lower concentration was found in the pioneer formation. There was a greater concentration of birds from all three groups between Pernambuco and Alagoas, and this must be due to the presence of more forest fragments with better structure and vegetation heterogeneity. The protected and unprotected areas hosted important records of endemic and/or threatened birds. We suggested some important places for implementation of new protected areas due to the larger concentrations of the target birds and because they are located within the boundaries of the Important Bird Areas.

*Keywords:* neotropical birds, threatened birds, endemism, Atlantic Forest, conservation.

## Distribuição e conservação de três importantes grupos de aves na Floresta Atlântica do Nordeste do Brasil

### Resumo

O Centro de Endemismo Pernambuco, situado no Nordeste do Brasil, é o setor mais fragmentado e com o maior número de aves ameaçadas de extinção de toda a Mata Atlântica. Foram analisadas as distribuições das aves florestais, endêmicas e/ou ameaçadas de extinção através do método da interpolação ‘Inverse Distance Weighting’. Também foi verificada a concentração dessas aves em áreas protegidas e não protegidas, sugerindo novas áreas que necessitam ser protegidas. Foi verificada a concentração da riqueza das espécies de aves florestais, endêmicas e ameaçadas em 123 locais. Houve uma maior concentração dos três grupos no norte de Alagoas, sul e norte de Pernambuco, e norte e oeste da Paraíba. A distribuição dos três grupos foi regular nos distintos tipos vegetacionais, apesar de uma menor concentração nas áreas de formação pioneira. Houve maior concentração das aves dos três grupos entre Pernambuco e Alagoas, devido, provavelmente a presença de uma maior quantidade de fragmentos florestais com melhor estrutura e heterogeneidade vegetal. Tanto as áreas protegidas como as não protegidas possuem importantes registros de aves endêmicas e ameaçadas. Sugerimos alguns locais importantes para a implementação de novas áreas protegidas, tendo como base as áreas com maiores concentrações dos três grupos de aves e dentro dos limites das Important Bird Areas.

*Palavras-chave:* aves neotropicais, aves ameaçadas, endemismos, Mata Atlântica, conservação.

### 1. Introduction

The Brazilian Atlantic Forest in the states of Alagoas, Pernambuco, Paraíba and Rio Grande do Norte, known as Pernambuco Endemism Center (henceforth PEC)

(Silva et al., 2004) retains just only 11.45% of its original vegetation cover (SOSMA, 2015), and is currently one of the most degraded areas of the whole dominium, considered

a hotspot within another hotspot (Tabarelli et al., 2006), the entire Atlantic Forest (Myers et al., 2000).

Despite the high level of fragmentation, 434 bird species persist in the region (Roda et al., 2011), which has the highest number of threatened birds in Brazil, according to the last updated list of threatened birds (Brasil, 2014; IUCN, 2015). Then, some research related to the conservation of threatened birds was carried out in the region, e.g. *Pauxi mitu*, *Glaucidium mooreorum*, *Terenura sicki*, *Philydor novaesi*, *Tangara fastuosa*, etc (Silveira et al., 2003b, 2008; Roda et al., 2011).

This current alarming situation of the PEC has occurred due to the removal of the native vegetation (Olmos, 2005; Silveira et al., 2003a). Currently there are only 157 protected areas in the region (Paula, 2012), and probably many of these are not functional for conservation of endemic and/or threatened birds, as noted by Giorgi et al. (2014) in southeastern Atlantic Forest. There are also the Important Bird Areas (IBA henceforth) which are places of great importance due to the significant number of endemic and/or threatened bird species, and they ensure the long-term conservation of these birds and areas (Bencke et al., 2006). Throughout the region there are 42 IBAs, many of which overlap protected areas.

The understanding of the biogeographic aspects of birds in fragmented areas is a challenge, given the adverse factors caused by fragmentation (Lees and Peres, 2008), such as the consequent loss of habitat that leads many species to local extinction, mainly those restricted to certain habitats (Moura et al., 2014). Thus to evaluate the application of biogeographic principles related to the dynamics of avian distribution is an extremely useful tool in conservation planning (Whittaker et al., 2005; Giorgi et al., 2014).

The distribution of a living being in a region can be checked through the methods of ecological modeling. The Inverse Distance Weight (IDW henceforth) interpolation modeling technique has been shown to be very effective due to its accuracy in providing a real picture of actual and potential distribution (see Roberts et al., 2004; Abdi and Nandipati, 2009). Besides, this method is very accessible, easy to use, and uses linear combinations of weights at known points to estimate unknown localities values (Roberts et al., 2004).

Therefore, the aims of this study were: 1) Analyze the distribution of forest-dependent, endemic and/or threatened birds along the entire length of the PEC using the IDW technique; 2) Verify how is the distribution of three groups of birds in the different vegetation types in the region; 3) Check the protected and unprotected areas that have higher concentrations of endemic and/or threatened birds; 4) suggest new areas within the limits of IBAs that could be turned into new protected areas according to the amount of endemic and/or threatened birds.

## 2. Material and Methods

### 2.1. Study area

The study was conducted in 123 sites of the Atlantic Forest of the Brazilian states of Alagoas, Pernambuco, Paraíba and Rio Grande do Norte, known as PEC. This sector

is covered by five vegetation type: open ombrophilous forest, dense ombrophilous forest, ecological tension zone, seasonal semideciduous forest and pioneer formation (IBGE, 2004) (Figure 1). The altitude reaches more than 900 m; the average temperature ranges from 24 to 26 °C, and the average annual rainfall is of 1,1180 mm, with the rains being more consistent in the west and in the highlands (IBGE, 1985).

### 2.2. Sampling

The database used in this work was provenient from the literature, authors' fieldwork and records provided by other researchers. The target species are those dependent on forest environments (Roda, 2003, 2006), endemics of the PEC (Roda, 2003; Silveira et al., 2003a) and/or threatened birds mentioned in the Brazilian and global red list (Brasil, 2014; IUCN, 2015). The nomenclature of species follows the Brazilian Ornithological Records Committee (Piacentini et al., 2015).

### 2.3. Data analysis

We utilized the deterministic IDW interpolation modeling technique to determine areas with higher concentrations (densities) of the target species. This method determines cell values using a linear-weighted combination set of sample points. The weight assigned is a function of the distance of an input point from the output cell locations (Childs, 2004). Thereby, weights diminish as the distance increases from the point sampled (Childs, 2004; Roberts et al., 2004; Abdi and Nandipati, 2009).

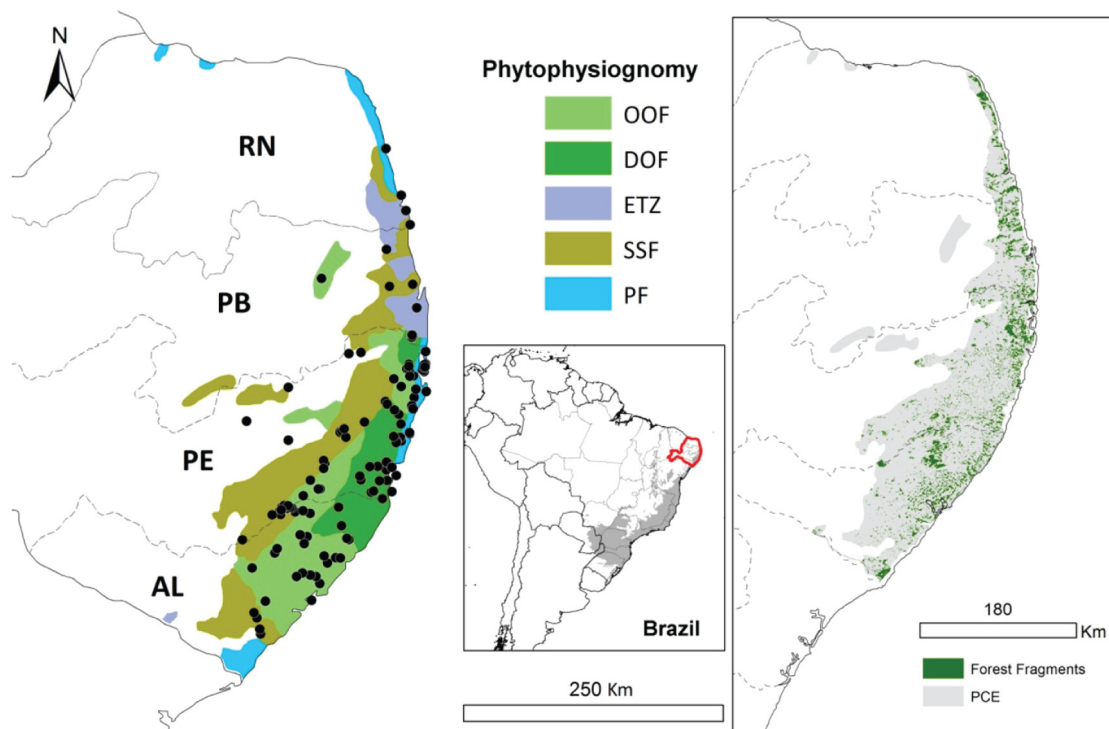
We used Environmental System Research Institute's (ESRI) ArcGis 10.2.1 to create the density of the three bird groups' distribution maps through the data provided by IDW technique. An analysis of variance (ANOVA) and the Tukey post-hoc test were utilized to compare the species richness of forest-dependent, endemic and/or threatened birds with the different phytophysiologicals.

The occurrence of protected areas was consulted in the National Register of Protected Areas (<http://www.mma.gov.br/areas-protetidas/cadastro-nacional-de-ucs>), which is an updated database of the National System of Conservation Units (SNUC). The categories mentioned were: Biological Reserves (REBIO), State Parks (PE), Ecological Stations (ESEC), Municipal Parks (PM), Wildlife Refuges (RVS), Environmental Protection Area (APA), Private Reserves of Natural Heritage (RPPN) and Urban Forest Reserve (FURB) (SNUC, 2000). This last category was included in the system by law No. 14.324/2011 (Paula, 2012).

The IBAs of the northeastern Atlantic Forest cited in this work were those presented in Bencke et al. (2006).

## 3. Results

The species richness concentration of 171 forest-dependent, 26 endemic and 46 threatened birds were analysed (Table 1). The presence data of these bird groups were collected from 123 sites: 69 in Pernambuco, 40 in Alagoas, 11 in Paraíba and 03 in Rio Grande do Norte (see Figure 1).



**Figure 1.** Localities (black dots) where bird surveys, vegetation types and forest fragments of the Pernambuco Endemism Center were conducted. Phytophysiognomies: OOF – Open Ombrophilous Forest; DOF – Dense Ombrophilous Forest; ETZ – Ecological Tension Zone; SSF – Stational Semideciduous Forest; and PF – Pioneer Formation.

The information of these sites, phytophysiognomies and richness of the three groups are listed in the Table 2.

The map created through the interpolation method showed greater concentration of forest-dependent birds between the states of Pernambuco and Alagoas, as well as some isolated spots in east and north Pernambuco and in north and west Paraíba (Figure 2a). The maps of the endemic and threatened birds showed similar patterns, but with less representation in the state of Paraíba. Moreover, all three groups of birds had very low densities in the state of Rio Grande do Norte (mainly in the far north) and in the south of the state of Alagoas (Figure 2b, c).

There was virtually no difference in the distribution of the species richness of the groups of birds between the phytophysiognomies, with the exception of the areas of pioneer formations (restingas), which presented lower species richness than all other formations (Figure 3; Table 3).

Only 32.5% of the forest fragments analysed was found into the boundaries of officially protected areas. The ESEC de Murici is the protected area with the highest number of species of the three bird groups, followed by RPPN Frei Caneca/RPPN Pedra D’Anta, REBIO de Salinho and RPPN Eco Fazenda Morim (Figure 4a). The non-protected areas that had the largest concentrations of birds from all three groups were: Engenho Coimbra, Mata de Xanguá, Engenho Cachoeira Linda and Mata do Estado (Figure 4b). The protected and non-protected areas with the highest number of species of the three groups overlapped with

the following IBAs: Murici, Serra do Urubu, Guadalupe, Engenho Coimbra, and Mata do Estado.

#### 4. Discussion

The maps of the target birds made through the information generated by the IDW modeling technique were pretty accurate and showed higher densities in the areas between the states of Alagoas and Pernambuco. Roda et al. (2011) found a distribution more concentrated in that same area for seven endemic and threatened birds. This same pattern of distribution with highest densities of records between the states of Pernambuco and Alagoas was found for some species of forest raptors (Roda and Pereira, 2006).

As the richness concentration of the target species is distributed almost regularly in all vegetation types, then other variables must be acting on the distribution of these birds. It is known that the bird distribution occurs due to a set of several biotic and abiotic variables, and other factors such as movement and interaction (see Newton, 2003). Owing to the fact that the vegetation heterogeneity and complexity also contribute effectively to the species richness and distribution (Karr, 1990), then, this can be the answer to the great richness of bird groups in Pernambuco and Alagoas that have more quantities of forest fragments in later successional stages. Conversely, northern Paraíba and Rio Grande do Norte have low floristic diversity and are

**Table 1.** List of the forest, endemic and/or threatened birds of the Pernambuco Endemism Center with their respective English names, vegetation types and threat categories. The names in bold represent the endemic birds of the Pernambuco Endemism Center.

Taxon	English Name	Vegetation type	Category of threat	
			MMA	IUCN
<i>Tinamus solitarius</i> (Vieillot, 1819)	Solitary Tinamou	OOF		
<i>Crypturellus soui</i> (Hermann, 1783)	Little Tinamou	OOF,DOF,SSF,ETZ		
<i>Crypturellus strigulosus</i> (Temminck, 1815)	Brazilian Tinamou	OOF		
<b><i>Penelope superciliaris alagoensis</i> Nardelli, 1993</b>	Rusty-margined Guan	OOF,DOF,SSF,ETZ,PF	CR	
<i>Ortalis araucuan</i> (Spix, 1815)	East Brazilian Chachalaca	OOF,DOF,SSF,ETZ,PF		
<i>Odontophorus capueira plumbeicollis</i> Cory, 1915	Spot-winged Wood-quail	OOF,SSF,ETZ	CR	
<i>Leptodon forbesi</i> (Swann, 1922)	White-collared Kite	OOF,DOF,SSF,ETZ	EN	CR
<i>Chondrohierax uncinatus</i> (Temminck, 1822)	Hook-billed Kite	OOF,DOF,SSF,ETZ,PF		
<i>Harpagus bidentatus</i> (Latham, 1790)	Doubled-toothed Kite	OOF		
<i>Harpagus diodon</i> (Temminck, 1823)	Rufous-thighed Kite	DOF,ETZ		
<i>Accipiter bicolor</i> (Vieillot, 1817)	Bicolored Hawk	OOF,SSF,ETZ		
<i>Pseudastur polionotus</i> (Kaup, 1847)	Mantled Hawk	OOF, DOF, SSF		
<i>Buteo albonotatus</i> Kaup, 1847	Zone-tailed Hawk	OOF,DOF,SSF,ETZ,PF		
<i>Spizaetus tyrannus</i> (Wied, 1820)	Black Hawk-Eagle	OOF,SSF,ETZ		
<i>Spizaetus melanoleucus</i> (Vieillot, 1816)	Black-and-White Hawk-Eagle	SSF		
<i>Patagioenas speciosa</i> (Gmelin, 1789)	Scaled Pigeon	OOF,DOF,SSF,ETZ		
<i>Patagioenas cayennensis</i> (Bonnaterre, 1792)	Pale-vented Pigeon	OOF,DOF,SSF,ETZ,PF		
<i>Leptotila rufaxilla</i> (Richard & Bernard, 1792)	Grey-fronted Dove	OOF,DOF,SSF,ETZ,PF		
<i>Geotrygon violacea</i> (Temminck, 1809)	Violaceous Quail-Dove	OOF		
<i>Geotrygon montana</i> (Linnaeus, 1758)	Ruddy Quail-Dove	OOF,DOF,SSF,ETZ		
<i>Megascops atricapilla</i> (Temminck, 1822)	Black-capped Screech-Owl	OOF		
<i>Pulsatrix perspicillata</i> (Latham, 1790)	Spectacled Owl	OOF,DOF,SSF,ETZ,PF		
<i>Strix virgata</i> (Cassin, 1849)	Mottled Owl	OOF,DOF,SSF,ETZ		
<b><i>Glaucidium mooreorum</i> (Silva, Coelho &amp; Gonzaga, 2002)</b>	Pernambuco Pygmy-Owl	DOF	EX	CR
<i>Nyctiphrynus ocellatus</i> (Tschudi, 1844)	Ocellated Poorwill	OOF,DOF,SSF,ETZ		
<i>Lurocalis semitorquatus</i> (Gmelin, 1789)	Short-tailed Nighthawk	OOF,DOF,SSF,ETZ		
<i>Glaucis hisurtus</i> (Gmelin, 1788)	Rufous-breasted Hermit	OOF,DOF,SSF,ETZ		
<i>Phaethornis ruber</i> (Linnaeus, 1758)	Reddish Hermit	OOF,DOF,SSF,ETZ,PF		
<b><i>Phaethornis margaritae camargoi</i> (Grantsau, 1988)</b>	Margaretta's Hermit	OOF,DOF,SSF	CR	
<i>Florisuga fusca</i> (Vieillot, 1817)	Black Jacobin	OOF,DOF,SSF,ETZ,PF		
<i>Lophornis magnificus</i> (Vieillot, 1817)	Frilled Coquette	OOF,SSF		
<i>Discosura longicaudus</i> (Gmelin, 1788)	Racket-tailed Coquette	OOF		
<i>Chlorestes notata</i> (Reich, 1793)	Blue-chinned Sapphire	OOF,DOF,SSF,ETZ,PF		

Vegetation types: OOF – Open Ombrophilous Forest; DOF – Dense Ombrophilous Forest; ETZ – Ecological Tension Zone; SSF – Seasonal Semideciduous Forest; and PF – Pioneer Formation. Category of threat: EX – Extinct; CR – Critically Endangered; EN – Endangered; VU – Vulnerable.

Table 1. Continued...

Taxon	English Name	Vegetation type	Category of threat	
			MMA	IUCN
<i>Thalurania watertonii</i> (Bourcier, 1847)	Long-tailed Woodnymph	OOF,DOF,SSF,ETZ	EN	EN
<i>Hylocharis sapphirina</i> (Gmelin, 1788)	Ruphous-throated Sapphire	OOF,DOF, SSF		
<i>Hylocharis cyanus</i> (Vieillot, 1818)	White-chinned Sapphire	OOF,DOF,SSF		
<i>Heliothryx auritus</i> (Gmelin, 1788)	Black-eared Fairy	OOF,DOF,SSF,ETZ		
<i>Heliothryx squamosus</i> (Temminck, 1823)	Stripe-breasted Starthroat	OOF,SSF		
<i>Calliphlox amethystina</i> (Bodaert, 1783)	Amethyst Woodstar	OOF,SSF		
<i>Trogon viridis</i> Linnaeus, 1766	White-tailed Trogon	OOF,DOF,SSF		
<i>Trogon curucui</i> Linnaeus, 1766	Blue-crowned Trogon	OOF,DOF,SSF,ETZ,PF		
<i>Trogon rufus</i> Gmelin, 1788	Black-throated Trogon	OOF		
<b><i>Momotus momota marcgravianus</i> Pinto &amp; Camargo, 1961</b>	Amazonian Motmot	OOF,DOF,SSF,ETZ	EN	
<i>Galbula ruficauda</i> Cuvier, 1816	Rufous-tailed Jacamar	OOF,DOF,SSF,ETZ,PF		
<i>Ramphastos vitellinus ariel</i> Vigors, 1826	Channel-billed Toucan	OOF,DOF,SSF,ETZ		EN
<i>Pteroglossus inscriptus</i> Swainson, 1822	Lettered Aracari	OOF,DOF,SSF,ETZ		
<i>Pteroglossus aracari</i> (Linnaeus, 1758)	Black-nacked Aracari	OOF,DOF,SSF		
<b><i>Picumnus pernambucensis</i> Zimmer, 1947</b>	Pernambuco Piculet	OOF,DOF,SSF,ETZ,PF		
<i>Veniliornis affinis</i> (Swainson, 1821)	Red-stained Woodpecker	OOF,DOF,SSF,ETZ		
<i>Piculus flavigula</i> (Bodaert, 1783)	Yellow-throated Woodpecker	OOF,DOF,SSF		
<i>Piculus chrysochloros</i> (Vieillot, 1818)	Golden-green Woodpecker	OOF,DOF		
<i>Micrastur ruficollis</i> (Vieillot, 1817)	Barred Forest-Falcon	OOF,DOF,SSF,ETZ		
<i>Micrastur semitorquatus</i> (Vieillot, 1817)	Collared Forest-Falcon	OOF,DOF,SSF,ETZ		
<i>Brotoyeris tirica</i> (Gmelin, 1788)	Plain Parakeet	OOF,DOF,SSF		
<i>Touit surdus</i> (Kuhl, 1820)	Golden-tailed Parrotlet	OOF,DOF,SSF,ETZ	VU	VU
<i>Pionus reichenowi</i> Heine, 1844	Blue-headed Parrot	OOF,DOF,SSF	VU	
<i>Pionus maximiliani</i> (Kuhl, 1820)	Scaly-headed Parrot	OOF,DOF		
<i>Amazona amazonica</i> (Linnaeus, 1766)	Orange-winged Parrot	OOF,DOF,SSF,ETZ		
<b><i>Terenura sicki</i> Teixeira &amp; Gonzaga, 1983</b>	Orange-bellied Antwren	OOF,DOF,SSF,ETZ	CR	EN
<i>Myrmotherula axillaris</i> (Vieillot, 1817)	White-flanked Antwren	OOF,DOF,SSF,ETZ,PF		
<b><i>Myrmotherula snowi</i> Teixeira &amp; Gonzaga, 1985</b>	Alagoas Antwren	OOF,SSF,ETZ	CR	CR
<i>Thamnomanes caesioides</i> (Temminck, 1820)	Cinereous Antshrike	OOF,DOF,SSF	VU	
<i>Dysithamnus mentalis</i> (Temminck, 1820)	Plain Antwren	OOF,DOF,SSF,ETZ		
<i>Herpsilochmus atricapillus</i> Pelzeln, 1868	Black-capped Antwren	OOF,DOF,SSF,ETZ,PF		
<i>Herpsilochmus pectoralis</i> Sclater, 1857	Pectoral Antwren	SEMIDEPENDENT		VU

Vegetation types: OOF – Open Ombrophilous Forest; DOF – Dense Ombrophilous Forest; ETZ – Ecological Tension Zone; SSF – Seasonal Semideciduous Forest; and PF – Pioneer Formation. Category of threat: EX – Extinct; CR – Critically Endangered; EN – Endangered; VU – Vulnerable.



Table 1. Continued...

Taxon	English Name	Vegetation type	Category of threat	
			MMA	IUCN
<i>Herpsilochmus rufimarginatus</i> Vieillot, 1816	Rufous-winged Antwren	OOF,DOF,SSF,ETZ		
<i>Thamnophilus pelzelni</i> Hellmayr, 1924	Planalto Slaty-Antshrike	OOF,DOF,SSF,ETZ,PF		
<b><i>Thamnophilus caerulescens pernambucensis</i> Naumburg, 1937</b>	Variable Antshrike	OOF,DOF,SSF,ETZ,PF	VU	
<b><i>Thamnophilus aethiops distans</i> Pinto, 1954</b>	White-shouldered Antshrike	OOF,DOF,SSF,ETZ	EN	
<i>Hypoedaleus guttatus</i> (Vieillot, 1816)	Spot-backed Antshrike	OOF		
<b><i>Myrmoderus ruficauda soror</i> (Pinto, 1940)</b>	Scalloped Antbird	OOF,DOF,SSF,ETZ	EN	EN
<b><i>Pyriglena pernambucensis</i> Zimmer, 1931</b>	Pernambuco Fire-eye	OOF,DOF,SSF,ETZ	VU	
<b><i>Cercomacroides laeta sabinoi</i> (Pinto, 1939)</b>	Willis's Antbird	OOF,DOF,SSF,ETZ		
<i>Dryophila squamata</i> (Lichtenstein, 1823)	Scaled Antbird	OOF,SSF		
<i>Conopophaga cearae</i> Cory, 1916	Ceara Gnatcatcher	OOF,DOF,SSF,ETZ,PF	EN	
<b><i>Conopophaga melanops nigrifrons</i> Pinto, 1954</b>	Black-cheeked Gnatcatcher	OOF,DOF,SSF,ETZ	VU	
<i>Formicarius colma</i> Boddaert, 1783	Rufous-capped Anthrush	OOF,DOF,SSF,ETZ		
<i>Chamaeza campanisona</i> (Lichtenstein, 1823)	Short-tailed Anthrush	SSF		
<i>Sclerurus macconnelli bahiae</i> Chubb, 1919	Tawny-throated Leaf-tosser	SSF,ETZ	VU	
<b><i>Sclerurus caudacutus calligineus</i> Pinto, 1954</b>	Black-tailed Leaf-tosser	OOF	CR	
<b><i>Dendrocincla taunayi</i> Pinto, 1939</b>	Pernambuco Woodcreeper	OOF,DOF,SSF,ETZ	EN	
<i>Sittasomus griseicapillus</i> (Vieillot, 1816)	Olivaceous Woodcreeper	OOF,DOF,SSF,ETZ,PF		
<i>Xiphorhynchus atlanticus</i> (Cory, 1916)	Northern Lesser Woodcreeper	OOF,DOF,SSF,ETZ	VU	
<i>Xiphorhynchus guttatus</i> (Lichtenstein, 1820)	Buff-throated Woodcreeper	OOF,DOF,SSF,ETZ		
<i>Campylorhamphus trochilirostris trochilirostris</i> (Lichtenstein, 1820)	Red-billed Scythebill	OOF	EN	
<i>Dendrocolaptes medius</i> (Todd, 1920)	Todd's Woodcreeper	OOF	EN	
<i>Dendrocolaptes platyrostris</i> Spix, 1825	Planalto Woodcreeper	OOF		
<b><i>Xenops minutus alagoanus</i> Pinto, 1954</b>	Plain Xenops	OOF,DOF,SSF,ETZ	VU	
<i>Xenops rutilans</i> Temminck, 1821	Streaked Xenops	OOF,DOF,SSF,ETZ		
<i>Automolus lammi</i> Zimmer, 1947	Pernambuco Foliage-Gleaner	OOF,DOF,SSF	EN	VU
<b><i>Philydor novaesi</i> Teixeira &amp; Gonzaga, 1983</b>	Alagoas Foliage-Gleaner	OOF,SSF	EX	CR
<b><i>Cichlocolaptes mazarbarnetti</i> (Mazar-Barnett &amp; Buzzetti, 2014)</b>	Cryptic Treehunter	OOF,SSF	EX	
<b><i>Synallaxis infuscata</i> Pinto, 1950</b>	Pinto's Spinetail	OOF,DOF,SSF,ETZ	EN	EN

Vegetation types: OOF – Open Ombrophilous Forest; DOF – Dense Ombrophilous Forest; ETZ – Ecological Tension Zone; SSF – Seasonal Semideciduous Forest; and PF – Pioneer Formation. Category of threat: EX – Extinct; CR – Critically Endangered; EN – Endangered; VU – Vulnerable.

Table 1. Continued...

Taxon	English Name	Vegetation type	Category of threat	
			MMA	IUCN
<i>Cranioleuca semicinerea</i> (Reichenbach, 1853)	Grey-headed Spinetail	OOF,DOF,SSF,ETZ		
<i>Neopelma pallescens</i> (Lafresnaye, 1853)	Pale-bellied Tyrant-Manakin	OOF,DOF,SSF,ETZ,PF		
<i>Ceratopipra rubrocapilla</i> (Temminck, 1821)	Red-headed Manakin	OOF,DOF,SSF,ETZ		
<i>Manacus manacus</i> (Linnaeus, 1766)	White-bearded Manakin	OOF,DOF,SSF,ETZ,PF		
<i>Chiroxiphia pareola</i> (Linnaeus, 1766)	Blue-backed Manakin	OOF,DOF,SSF,ETZ,PF		
<i>Oxyruncus cristatus</i> Swainson, 1821	Sharpbill	OOF,SSF		
<i>Myiobius barbatus</i> (Gmelin, 1789)	Whiskered Flycatcher	OOF,DOF,SSF,ETZ		
<i>Myiobius atricaudus</i> Lawrence, 1863	Black-tailed Flycatcher	DOF,SSF,ETZ		
<b><i>Schiffornis turdina intermedia</i> Pinto, 1954</b>	Thrush-like Schiffornis	OOF,DOF,SSF,ETZ	VU	
<b><i>Iodopleura pipra leucopygia</i> Salvin, 1885</b>	Buff-throated Purpletuft	OOF,DOF,SSF,ETZ	CR	
<i>Tityra inquisitor</i> (Lichtenstein, 1823)	Black-crowned Tityra	OOF		
<i>Tityra cayana</i> (Linnaeus, 1766)	Black-tailed Tityra	OOF,DOF,SSF		
<i>Pachyrampus marginatus</i> (Lichtenstein, 1823)	Black-capped Becard	OOF,DOF,SSF		
<i>Pachyrampus validus</i> (Lichtenstein, 1823)	Crested Becard	OOF,SSF		
<i>Lipaugus vociferans</i> (Wied, 1820)	Screaming Piha	OOF,DOF		
<i>Xipholena atropurpurea</i> (Wied, 1820)	White-winged Cotinga	OOF,DOF,SSF,ETZ	VU	EN
<i>Procnias averano</i> (Hermann, 1783)	Bearded Bellbird	OOF,SSF,ETZ		
<i>Procnias nudicollis</i> (Vieillot, 1817)	Bare-throated Bellbird	OOF		VU
<i>Carpornis melanocephala</i> (Wied, 1820)	Black-headed Berryeater	OOF	VU	VU
<i>Piprites chloris</i> (Temminck, 1822)	Wing-barried Piprites	DOF		
<b><i>Platyrinchus mystaceus niveigularis</i> Pinto, 1954</b>	White-throated Spadebill	OOF,DOF,SSF,ETZ	VU	
<i>Mionectes oleagineus</i> (Lichtenstein, 1823)	Ochre-bellied Flycatcher	OOF,DOF,SSF,ETZ		
<i>Leptopogon amaurocephalus</i> Tschudi, 1846	Sepia-capped Bellbird	OOF,DOF,SSF,ETZ,PF		
<i>Corythopsis delalandi</i> (Lesson, 1830)	Southern Antpipit	OOF		
<b><i>Phylloscartes ceciliae</i> Teixeira, 1987</b>	Alagoas Tyrannulet	OOF,SSF,ETZ	CR	EN
<i>Rhynchocyclus olivaceus</i> (Temminck, 1820)	Olicaceous Flatbill	OOF,DOF,SSF		
<i>Tolmomyias poliocephalus</i> (Taczanowski, 1884)	Gray-crowned Flycatcher	OOF,DOF,SSF		
<i>Tolmomyias flaviventris</i> (Wied, 1831)	Yellow-breasted Flycatcher	OOF,DOF,SSF,ETZ,PF		
<i>Poecilotriccus plumbeiceps</i> (Lafresnaye, 1846)	Ochre-faced Tody-Flycatcher	OOF,SSF		
<i>Myiornis auricularis</i> (Vieillot, 1818)	Eared Pygmy-Tyrant	OOF,SSF		

Vegetation types: OOF – Open Ombrophilous Forest; DOF – Dense Ombrophilous Forest; ETZ – Ecological Tension Zone; SSF – Seasonal Semideciduous Forest; and PF – Pioneer Formation. Category of threat: EX – Extinct; CR – Critically Endangered; EN – Endangered; VU – Vulnerable.

Table 1. Continued...

Taxon	English Name	Vegetation type	Category of threat	
			MMA	IUCN
<i>Hemitriccus griseipectus naumburgae</i> (Zimmer, 1945)	White-bellied Tody-Tyrant	OOF,DOF,SSF,ETZ	VU	
<i>Hemitriccus mirandae</i> (Sneathlaga, 1925)	Buff-breasted Tody-Tyrant	OOF,DOF,ETZ	VU	VU
<i>Ornithion inerme</i> Hartlaub, 1853	White-lored Tyrannulet	OOF,DOF,SSF,ETZ		
<i>Elaenia mesoleuca</i> (Deppe, 1830)	Olivaceous Elaenia	OOF,DOF,SSF,ETZ		
<i>Myiopagis gaimardii</i> (d'Orbigny, 1839)	Forest Elaenia	OOF,DOF,SSF,ETZ		
<i>Myiopagis caniceps</i> (Swainson, 1835)	Gray Elaenia	OOF,DOF,ETZ		
<i>Myiopagis viridicata</i> (Vieillot, 1817)	Greenish Elaenia	OOF,DOF,SSF		
<i>Attila spadiceus uropygiatus</i> (Wied, 1831)	Bright-rumped Attila	OOF,DOF,SSF	VU	
<i>Legatus leucophaeus</i> (Vieillot, 1818)	Piratic Flycatcher	OOF,DOF,SSF,ETZ,PF		
<i>Myiarchus tuberculifer</i> (d'Orbigny & Lafresnaye, 1837)	Dusky-capped Flycatcher	OOF,DOF,SSF		
<i>Rhytipterna simplex</i> (Lichtenstein, 1823)	Grayish Mourner	OOF,DOF,SSF		
<i>Casiornis fuscus</i> Sclater & Salvin, 1873	Ash-throated Casiornis	OOF,DOF,SSF		
<i>Myiodynastes maculatus</i> (Stadius Muller, 1776)	Streaked Flycatcher	OOF,DOF,SSF,ETZ,PF		
<i>Megarynchus pitangua</i> (Linnaeus, 1766)	Boat-billed Flycatcher	OOF,DOF,SSF,ETZ,PF		
<i>Cnemotriccus fuscatus</i> (Wied, 1831)	Fuscous Flycatcher	OOF,DOF,SSF,ETZ,PF		
<i>Lathrotriccus eulerei</i> (Cabanis, 1868)	Euler's Flycatcher	OOF,DOF,SSF,ETZ		
<i>Contopus cinereus</i> (Spix, 1825)	Tropical Pewee	OOF,SSF,ETZ		
<i>Vireo chivi</i> (Vieillot, 1817)	Chivi Vireo	OOF,DOF,SSF,ETZ,PF		
<i>Pheugopedius genibarbis</i> (Swainson, 1838)	Moustached Wren	OOF,DOF,SSF,ETZ,PF		
<i>Cantorchilus longirostris</i> (Vieillot, 1819)	Long-billed Wren	OOF,DOF,SSF,ETZ,PF		
<i>Ramphocaenus melanurus</i> Vieillot, 1819	Long-billed Gnatwren	OOF,DOF,SSF,ETZ,PF		
<i>Turdus flavipes</i> Vieillot, 1818	Yellow-legged Thrush	OOF,DOF,SSF,ETZ		
<i>Turdus fumigatus</i> Lichtenstein, 1823	Cocoa Thrush	OOF,DOF,SSF		
<i>Turdus albicollis</i> Vieillot, 1818	White-necked Thrush	OOF,DOF,SSF,ETZ		
<i>Arremon taciturnus</i> (Hermann, 1783)	Pectoral Sparrow	OOF,DOF,SSF,ETZ,PF		
<i>Setophaga pitiayumi</i> (Vieillot, 1817)	Tropical Parula	OOF,DOF,SSF,ETZ		
<i>Geothlypis aequinoctialis</i> (Gmelin, 1789)	Masked Yellowthroat	OOF,SSF,PF		
<i>Basileuterus culicivorus</i> (Deppe, 1830)	Golden-crowned Warbler	OOF,DOF,SSF,ETZ,PF		
<i>Myiothlypis flaveola</i> Baird, 1865	Flavescent Warbler	OOF,DOF,SSF,ETZ,PF		
<i>Anumara forbesi</i> (Sclater, 1886)	Forbes's Blackbird	SEMIDEPENDENT	VU	EN
<i>Saltator maximus</i> (Stadius Muller, 1776)	Buff-throated Saltator	OOF,DOF,SSF,ETZ		

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Table 1. Continued...

Taxon	English Name	Vegetation type	Category of threat	
			MMA	IUCN
<i>Saltator fuliginosus</i> (Daudin, 1800)	Black-throated Grosbeak	OOF,DOF,SSF		
<i>Ramphocelus bresilius</i> (Linnaeus, 1766)	Brazilian Tanager	OOF,DOF,SSF,ETZ		
<i>Lanio cristatus</i> (Linnaeus, 1766)	Flame-crested Tanager	OOF,DOF,SSF,ETZ,PF		
<i>Tangara cyanomelas</i> (Wied, 1830)	Silver-breasted Tanager	OOF,DOF,SSF		
<b><i>Tangara fastuosa</i> (Lesson, 1831)</b>	Seven-colored Tanager	OOF,DOF,SSF,ETZ	VU	VU
<i>Tangara cyanocephala</i> (Statius Muller, 1776)	Red-necked Tanager	OOF,DOF,SSF,ETZ		
<i>Cissopis leverianus</i> (Gmelin, 1788)	Magpie Tanager	DOF		
<i>Tersina viridis</i> (Illiger, 1811)	Swallow Tanager	OOF,DOF,SSF,ETZ,PF		
<i>Dacnis cayana</i> (Linnaeus, 1766)	Blue Dacnis	OOF,DOF,SSF,ETZ,PF		
<i>Cyanerpes cyaneus</i> (Linnaeus, 1766)	Red-legged Honeycreeper	OOF,DOF,SSF,ETZ,PF		
<i>Chlorophanes spiza</i> (Linnaeus, 1758)	Green Honeycreeper	OOF,DOF,SSF,ETZ		
<i>Hemithraupis guira</i> (Linnaeus, 1766)	Guira Tanager	OOF,DOF,SSF,ETZ		
<b><i>Hemithraupis flavicollis melanoxantha</i> (Liechtenstein, 1823)</b>	Yellow-backed Tanager	OOF,DOF,SSF,ETZ		
<i>Conirostrum speciosum</i> (Temminck, 1824)	Chestnut-vented Conebill	OOF,DOF,SSF,ETZ		
<i>Tiaris fuliginosus</i> (Wied, 1830)	Sooty Grassquit	OOF,DOF,SSF,ETZ		
<i>Habia rubica</i> (Vieillot, 1817)	Red-crowned Ant-Tanager	OOF,DOF,SSF		
<i>Caryothraustes canadensis frontalis</i> (Hellmayr, 1905)	Yellow-green Grosbeak	OOF,DOF,SSF	EN	
<i>Spinus yarrellii</i> (Audubon, 1839)	Yellow-faced Siskin	SEMIDEPENDENT	VU	VU
<i>Euphonia cyanocephala</i> (Vieillot, 1818)	Golden-rumped Euphonia	OOF,SSF		
<i>Euphonia pectoralis</i> (Lathan, 1801)	Chestnut-bellied Euphonia	OOF,DOF,SSF,ETZ		

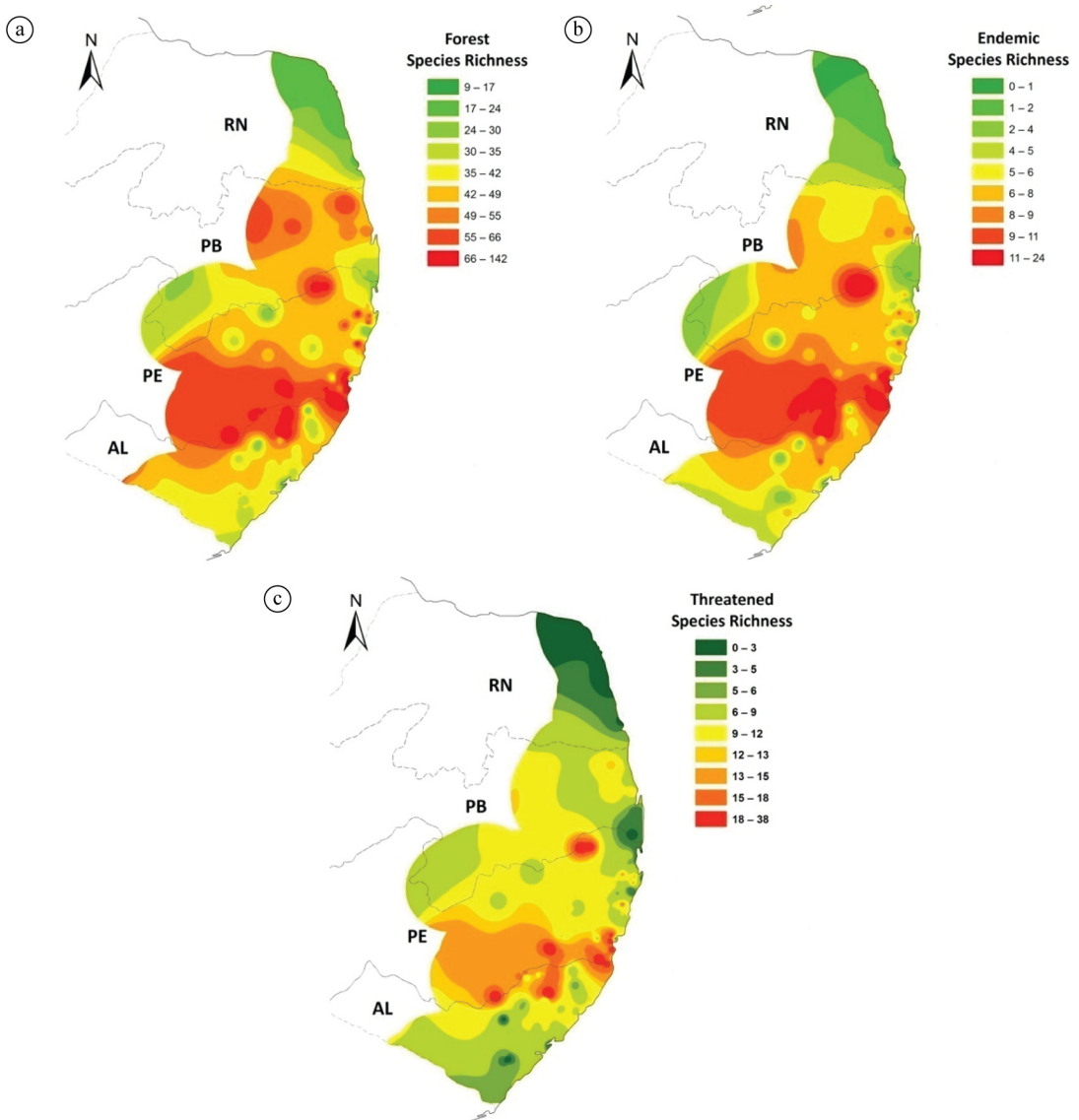
Vegetation types: OOF – Open Ombrophilous Forest; DOF – Dense Ombrophilous Forest; ETZ – Ecological Tension Zone; SSF – Seasonal Semideciduous Forest; and PF – Pioneer Formation. Category of threat: EX – Extinct; CR – Critically Endangered; EN – Endangered; VU – Vulnerable.

lower and drier compared to areas further south (Cestaro, 2002; Olmos, 2003), leading to the lower concentration of birds. Another factor that may be affecting the results is the small number of sampling points further north, although the variables mentioned above may be responsible for the larger concentration of the target birds in Pernambuco and Alagoas.

Among all areas, protected or not protected, the ESEC of Murici was the site that presented the greatest concentration of birds from all three groups. The importance of this reserve (and IBA Murici) is already well known, being considered the place with the largest number of threatened birds of the Americas (Wege and Long, 1995; Bencke et al., 2006). Furthermore, Murici also deserves attention by unique bird records that are absent in other parts of the PEC, such as *Geotrygon violacea* (Temminck, 1809), *Trogon rufus* Gmelin, 1788, *Hypoedaleus guttatus* (Vieillot, 1816), *Carpornis melanocephala* (Wied, 1820), and *Corythopis delalandi* (Lesson, 1830).

The three Biological Reserves (Saltinho, Pedra Talhada and Guaribas) also play an important role in the conservation of noteworthy birds, such as *Leptodon forbesi* (Swann, 1922), *Touit surdus* (Kuhl, 1820), *Xipholena atropurpurea* (Wied, 1820), and *Spinus yarrellii* (Audubon, 1839). Moreover, these three biological reserves are inserted in three IBAs (Guadalupe, Mamanguape and Reserva Biológica de Pedra Talhada), confirming the importance of these sites for the conservation of endemic and threatened birds.

The private reserves also are places of great importance for the conservation of endemic and threatened birds in the Atlantic Forest (Oliveira et al., 2010). The RPPN Frei Caneca and the RPPN Pedra D'Anta make up a single forest block, being an area of extreme importance for bird conservation in the Neotropical region (Mazar-Barnett et al., 2005; Roda, 2006). These two reserves are also inserted into an IBA (Serra do Urubu), and have formerly hosted *Philydor novaesi* (Teixeira & Gonzaga, 1983), and *Cichlocolaptes mazarbarnetti* (Mazar-Barnett



**Figure 2.** Geographic distribution maps of the total species richness of forest-dependent (a) endemics (b) and threatened birds (c) of the Pernambuco Endemism Center.

& Buzzetti, 2014), which are now likely to be extinct (Brasil, 2014; Pereira et al., 2014).

Many unprotected forest patches deserve attention in future conservation plans in the region, especially those that were identified with a greater concentration of birds from all three groups, and which are at the same time located in some IBA. Below, we suggest and emphasize that some forest fragments should be turned into protected areas due to two features mentioned earlier:

- The forests of Engenho Coimbra and Mata do Pinto in Alagoas. Both belonging to the Serra Grande mill and are inserted in the IBAs Engenho Coimbra and São José da Laje/Canhotinho, respectively. According to Silveira et al. (2003a), the Engenho

Coimbra comprises one of the most continuous and best-preserved fragments in north-east Brazil. Important birds that can be found there include *Penelope superciliaris alagoensis* Nardelli, 1993, *Terenura sicki* (Teixeira & Gonzaga, 1983), and *Odontophorus capueira plumbeicollis* (Cory, 1915).

- The forest fragments of Engenho Cachoeira Linda and Mata de Xanguá/Usina Trapiche in south Pernambuco. Both of them are situated within IBA Guadalupe and have important bird records, such as *L. forbesi*, *T. sicki*, *Anumara forbesi* (Sclater, 1886), *Myrmoderus ruficauda soror* (Pinto, 1940), and *X. atropurpurea*.

**Table 2.** Localities in the Pernambuco Endemism Center where ornithological surveys were conducted with their respective geographical coordinates, vegetation types, and species richness of forest-dependent, endemic and/or threatened birds.

Locality	Municipality (State)	Coordinates	Vegetation Type	Richness		
				F	E	T
PM de Maceió	Maceió (AL)	9°36'S; 35°45'W	OOF	28	5	6
Mata do Catolé	Satuba/Maceió (AL)	9°33'S; 35°47'W	OOF	42	6	7
Mata do Matão	Campo Alegre (AL)	9°46'S; 36°14'W	OOF	45	7	9
Mata de Guardiania-Pitimijú	Cajueiro (AL)	9°20'S; 36°09'W	OOF	23	4	4
APP Restinga Praia do Francês e Barra de São Miguel	Barra de São Miguel/Marechal Deodoro (AL)	9°45'S; 35°49'W	PF/ OOF	14	1	2
Mata da Lagartixa	Cajueiro/Capela (AL)	9°18'S; 36°07'W	OOF	24	3	4
Fazenda Brejo	Teotônio Vilela (AL)	9°54'S; 36°18'W	SSF	27	0	1
RPPN Madeiras	Junqueiro (AL)	9°51'S; 36°19'W	SSF	44	4	6
Usina Santo Antônio I	Barra de Santo Antônio (AL)	9°23'S; 35°37'W	OOF	52	8	12
Usina Santo Antônio II	Barra de Santo Antônio (AL)	9°23'S; 35°35'W	OOF	47	6	8
Mata do Bamburral II	Maceió (AL)	9°26'S; 35°41'W	OOF	38	8	12
Engenho Coimbra/Usina Serra Grande	Ibateguara (AL)	9°00'S; 35°50'W	OOF	120	21	31
Mata do Pinto/Usina Serra Grande	São José da Laje (AL)	8°58'S; 36°06'W	SSF	95	17	22
Fazenda Riachão/Usina Coruripe	Coruripe (AL)	10°03'S; 36°16'W	SSF	31	7	8
Mata do Capiatã/Usina Coruripe	Coruripe (AL)	10°00'S; 36°16'W	SSF	36	5	6
Mata da Sálvia/Usina Utinga Leão	Rio Largo (AL)	9°32'S; 35°50'W	OOF	39	6	11
Mata do Cedro/Usina Utinga Leão	Rio Largo (AL)	9°31'S; 35°54'W	OOF	45	11	12
ESEC Murici	Murici/Messias (AL)	9°12'S; 35°52'W	OOF	142	25	39
Mata da Sela/Usina Cachoeira	Flexeiras (AL)	9°22'S; 35°43'W	OOF	30	6	6
Mata da Encosta do Grotão/Usina Camaragibe	Matriz de Camaragibe (AL)	9°06'S; 35°34'W	DOF	9	1	1
Mata de Santa Justina/Usina Santo Antônio	Passo de Camaragibe (AL)	9°13'S; 35°30'W	OOF	44	9	10
Grotão do Brás/Mata de Santa Justina/Usina Santo Antônio	Passo de Camaragibe (AL)	9°13'S; 35°31'W	OOF	17	4	5
RPPN Vila d'Água	Murici (AL)	9°16'S; 35°53'W	OOF	31	2	1
Rebio Pedra Talhada	Quebrangulo (AL)/Lagoa do Ouro (PE)	9°14'S; 36°25'W	SSF	89	12	20
Mata do Alto Guzerá/Usina Serra Grande	Ibateguara (AL)	8°59'S; 35°58'W	SSF	48	8	7
Mata do Apolinário/Usina Serra Grande	São José da Laje (AL)	8°57'S; 36°02'W	SSF	50	8	7
Mata de Aquibadã/Usina Serra Grande	Ibateguara (AL)	8°58'S; 35°54'W	OOF	57	10	11
Mata do Bom Jesus 1/Usina Serra Grande	São José da Laje (AL)	9°00'S; 35°50'W	SSF	28	2	4
Mata do Bom Jesus 2/Usina Serra Grande	São José da Laje (AL)	9°00'S; 36°06'W	SSF	41	4	6

Vegetation types: OOF – Open Ombrophilous Forest; DOF – Dense Ombrophilous Forest; ETZ – Ecological Tension Zone; SSF – Seasonal Semideciduous Forest; and PF – Pioneer Formation. Richness of bird groups: F – Forest; E – Endemic; and T – Threatened.

Table 2. Continued...

Locality	Municipality (State)	Coordinates	Vegetation Type	Richness		
				F	E	T
Mata da Cachoeira/Usina Serra Grande	São José da Laje (AL)	8°56'S; 36°03'W	SSF	76	16	18
Mata do Canivete/Usina Serra Grande	São José da Laje (AL)	8°57'S; 36°05'W	SSF	60	10	12
Mata do Capoeirão/Usina Serra Grande	São José da Laje (AL)	8°56'S; 36°04'W	SSF	58	12	13
Mata do Encanamento/Usina Serra Grande	São José da Laje (AL)	8°57'S; 36°00'W	SSF	64	13	15
Mata do Espinho/Usina Serra Grande	São José da Laje (AL)	8°57'S; 36°01'W	SSF	67	15	15
Fragmento X/Usina Serra Grande	São José da Laje (AL)	8°56'S; 36°02'W	SSF	54	10	13
Mata de Ibataguara/Usina Serra Grande	Ibataguara (AL)	8°57'S; 35°36'W	OOF	19	3	3
Mata do Mal Assombro/Usina Serra Grande	São José da Laje (AL)	8°58'S; 36°05'W	SSF	80	15	17
RPPN Boa Sorte	Murici (AL)	9°11'S; 35°55'W	OOF	66	13	17
RPPN Fazenda São Pedro	Pilar (AL)	9°33'S; 35°57'W	OOF	34	6	7
Fazenda Cachoeira	Pindoba (AL)	9°28'S; 36°20'W	OOF	30	2	2
Rebio Guaribas	Mamanguape/Rio Tinto (PB)	6°43'S; 35°11'W	SSF/ ETZ	67	7	12
Mata da Millenium	Mataraca (PB)	6°30'S; 34°58'W	SSF	40	3	7
RPPN Engenho Gargaú	Santa Rita (PB)	7°01'S; 34°57'W	SSF	53	9	11
PE Mata do Pau Ferro	Areia (PB)	6°58'S; 35°44'W	OOF	57	5	8
RPPN Fazenda Pacatuba	Sapé (PB)	7°02'S; 35°09'W	SSF	55	9	12
Fragmento A/Caaporã	Caaporã (PB)	7°28'S; 34°57'W	DOF	33	3	3
Fragmento B/Caaporã	Caaporã (PB)	7°28'S; 34°57'W	DOF	21	1	2
Fragmento C/Caaporã	Caaporã (PB)	7°28'S; 34°57'W	DOF	32	1	2
Fragmento D/Caaporã	Caaporã (PB)	7°27'S; 34°58'W	DOF	32	2	2
Fragmento E/Caaporã	Caaporã (PB)	7°27'S; 34°57'W	DOF	28	2	4
Fazenda Cidade Viva	Conde (PB)	7°13'S; 34°57'W	ETZ	38	3	3
PE Dois Irmãos	Recife (PE)	8°00'S; 34°55'W	OOF	70	10	14
ESEC Caetés	Paulista (PE)	7°55'S; 34°55'W	OOF	61	9	13
Refúgio Ecológico Charles Darwin	Igarassu (PE)	7°48'S; 34°57'W	OOF	52	5	7
Mata do Camocim/ESEC Tapacurá	São Lourenço da Mata (PE)	8°02'S; 35°11'W	SSF	65	9	13
Mata do Toró/ESEC Tapacurá	São Lourenço da Mata (PE)	8°03'S; 35°10'W	SSF/ DOF	50	5	8
RVS Mata do Sistema Gurjaú	Cabo de Santo Agostinho (PE)	8°13'S; 35°03'W	DOF	79	11	17
Mata do Córrego da Mina/ Usina São José	Igarassu (PE)	7°45'S; 35°00'W	OOF	41	6	8
Mata de Zambana/Usina São José	Igarassu (PE)	7°42'S; 34°59'W	DOF	53	9	11
Mata dos Macacos/Usina São José	Igarassu (PE)	7°45'S; 34°59'W	OOF	28	1	3

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Table 2. Continued...

Locality	Municipality (State)	Coordinates	Vegetation Type	Richness		
				F	E	T
Mata da Palmeira/Usina São José	Igarassu (PE)	7°43'S; 34°59'W	DOF/OOF	39	5	7
Mata de Piedade/Usina São José	Igarassu (PE)	7°48'S; 34°59'W	OOF	39	6	7
RVS Mata do Curado	Recife (PE)	8°04'S; 34°57'W	OOF	33	4	6
Mata da Ronda	Pombos (PE)	8°12'S; 35°22'W	SSF	45	8	9
PM João Vasconcelos Sobrinho	Caruaru (PE)	8°22'S; 36°02'W	ETZ	45	7	12
Mata do Estado	São Vicente Férrer (PE)	7°37'S; 35°30'W	ETZ	77	20	22
Torre do Microondas	Taquaritinga do Norte (PE)	7°54'S; 36°02'W	SSF	23	5	4
Jardim Botânico do Recife	Recife (PE)	8°04'S; 34°58'W	OOF	19	2	3
Mata do CMNE	Recife (PE)	8°04'S; 34°58'W	OOF	14	1	2
REBIO Saltinho	Tamandaré/Rio Formoso (PE)	8°43'S; 35°10'W	DOF	106	18	26
Mata de Maria Maior/Usina Serra Grande	Canhotinho (PE)	9°01'S; 36°10'W	SSF	86	15	19
Mata da Gia	Barreiros (PE)	8°49'S; 35°08'W	DOF	34	2	5
RPPN Fazenda Santa Beatriz do Carnijó	Moreno (PE)	8°08'S; 35°04'W	DOF	30	4	4
Engenho Nabuco	Maraial (PE)	8°47'S; 35°45'W	OOF	59	10	15
Engenho Gigante	Maraial (PE)	8°47'S; 35°46'W	OOF	71	13	19
RVS Mata do Amparo	Itamaracá (PE)	7°46'S; 34°51'W	DOF/PF	30	4	3
RVS Mata do Engenho São João	Itamaracá (PE)	7°45'S; 34°52'W	DOF/PF	19	2	1
RVS Mata Engenho Macaxeira	Itamaracá (PE)	7°44'S; 34°51'W	DOF/PF	15	0	0
RVS Mata Lanço dos Caçães	Itamaracá (PE)	7°42'S; 34°50'W	DOF/PF	14	0	0
RVS Mata de Santa Cruz	Itamaracá (PE)	7°42'S; 34°51'W	DOF/PF	15	1	1
RVS Mata do Jaguaribe	Itamaracá (PE)	7°44'S; 34°51'W	DOF/PF	16	1	1
RPPN Frei Caneca/RPPN Pedra D'Anta	Jaqueira/Lagoa dos Gatos (PE)	8°43'S; 35°50'W	SSF/OOF	120	21	32
Mata de Xanguá/Usina Trapiche	Rio Formoso (PE)	8°37'S; 35°11'W	DOF	108	19	28
Mata do Benedito/Engenho Jussará	Gravatá (PE)	8°17'S; 35°35'W	SSF	56	13	15
Mata do Jussará/Engenho Jussará	Gravatá (PE)	8°18'S; 35°35'W	SSF	27	4	5
Mata do Gringo/Engenho Jussará	Gravatá (PE)	8°17'S; 35°34'W	SSF	24	4	5
Engenho Cachoeira Linda	Barreiros (PE)	8°49'S; 35°18'W	DOF	104	18	25
Engenho Roncadorzinho	Barreiros (PE)	8°48'S; 35°17'W	DOF	78	14	20
Engenho Água Azul	Timbaúba (PE)	7°36'S; 35°24'W	SSF	74	18	22
Mata de Aldeia	Abreu e Lima/Camaragibe/Pau D'alho (PE)	7°54'S; 35°03'W	OOF	75	10	13
Mata do CIMNC	Araçoiaba/Igarassu/Paudalho (PE)	7°50'S; 35°07'W	SSF/OOF	44	4	7
RPPN Bituri	Brejo da Madre de Deus (PE)	8°12'S; 36°23'W	SSF	32	3	7
Engenho OpiniOSO	Amaraji (PE)	8°20'S; 35°32'W	SSF	38	7	7
Sítio Vale Verde	Gravatá (PE)	8°16'S; 35°33'W	SSF	28	4	4

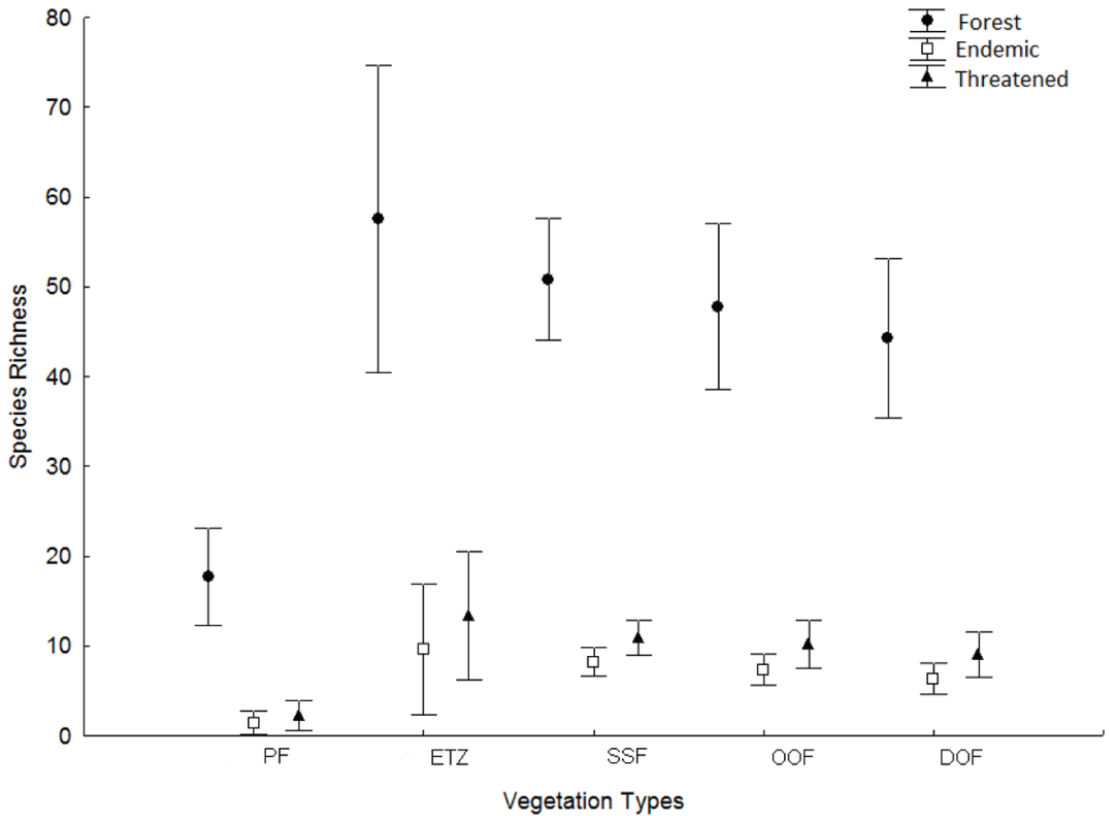
Vegetation types: OOF – Open Ombrophilous Forest; DOF – Dense Ombrophilous Forest; ETZ – Ecological Tension Zone; SSF – Seasonal Semideciduous Forest; and PF – Pioneer Formation. Richness of bird groups: F – Forest; E – Endemic; and T – Threatened.



Table 2. Continued...

Locality	Municipality (State)	Coordinates	Vegetation Type	Richness		
				F	E	T
RPPN Eco Fazenda Morim	São José da Coroa Grande (PE)	8°52'S; 35°13'W	DOF	90	16	22
Mata da Cunha/Fazenda Soberana	São Benedito do Sul (PE)	8°51'S; 35°54'W	OOF	52	11	12
Grota do Inferno/Engenho Sacramento	Água Preta (PE)	8°42'S; 35°24'W	DOF	74	12	17
Mata da Ferrugem/Engenho Sacramento	Água Preta (PE)	8°40'S; 35°25'W	DOF	56	11	14
Mata do Dêra/Usina Trapiche	Sirinhaém (PE)	8°34'S; 35°10'W	DOF	80	14	20
Engenho Jaguaré/Usina Trapiche	Sirinhaém (PE)	8°33'S; 35°11'W	DOF	77	14	18
Complexo do Jaguarão/Usina Cuaú	Rio Formoso/Sirinhaém (PE)	8°35'S; 35°15'W	DOF	68	13	17
Mata de Zefa dos Cahorros/Usina Cuaú	Gameleira (PE)	8°36'S; 35°19'W	DOF	29	5	5
Mata de Duas Bocas/Usina Cuaú e Usina Santo André	Tamandaré (PE)	8°43'S; 35°14'W	DOF	35	8	10
RFU Mata do Janga	Paulista (PE)	7°56'S; 34°50'W	OOF/PF	19	2	1
APA Mata do Engenho Uchôa	Recife (PE)	8°05'S; 34°57'W	OOF/PF	14	2	1
RVS Mata do Engenho Moreninho	Moreno (PE)	8°06'S; 35°06'W	DOF	41	3	4
Engenho Massaranduba do Norte	Goiana (PE)	7°36'S; 34°50'W	DOF/PF	22	2	4
Engenho Bitá/ESEC Bitá e Utinga	Ipojuca (PE)	8°22'S; 35°03'W	DOF	35	3	4
Engenho Utinga/ESEC Bitá e Utinga	Cabo de Santo Agostinho/Ipojuca (PE)	8°20'S; 35°03'W	DOF	48	7	9
Fragmento 1/Usina Ipojuca	Ipojuca (PE)	8°22'S; 35°05'W	DOF	21	3	3
Fragmento 2/Usina Ipojuca	Ipojuca (PE)	8°23'S; 35°06'W	DOF	14	1	0
Engenho Providência	Cabo de Santo Agostinho (PE)	8°20'S; 35°07'W	DOF	37	5	8
Mata/Loteamento/Bonito EcoParque	Bonito (PE)	8°34'S; 35°43'W	SSF/ ETZ	48	6	7
PNM Mucuri-Hymalaia	Bonito (PE)	8°32'S; 35°43'W	SSF/ ETZ	51	8	9
Restinga da Praia do Gamela	Sirinhaém (PE)	8°40'S; 35°05'W	PF	10	0	0
PE Mata de Zumbi	Cabo de Santo Agostinho (PE)	8°18'S; 34°59'W	DOF	62	9	13
PE Mata de Duas Lagoas	Cabo de Santo Agostinho (PE)	8°18'S; 34°59'W	DOF	52	7	8
Mata do Franco	Sirinhaém (PE)	8°36'S; 35°08'W	DOF	14	3	3
Mata do Franco II	Sirinhaém (PE)	8°36'S; 35°08'W	DOF	16	2	2
RPPN Jussaral	Catende (PE)	8°36'S; 35°43'W	SSF	52	9	14
RPPN Mata Estrela Senador Antônio Farias	Baía Formosa (RN)	6°22'S; 35°00'W	SSF/PF	28	4	7
PE Mata da Pipa	Tibau do Sul (RN)	6°14'S; 35°03'W	SSF/PF	20	0	2
Parque das Dunas	Natal (RN)	5°50'S; 35°11'W	PF	19	1	2

Vegetation types: OOF – Open Ombrophilous Forest; DOF – Dense Ombrophilous Forest; ETZ – Ecological Tension Zone; SSF – Seasonal Semideciduous Forest; and PF – Pioneer Formation. Richness of bird groups: F – Forest; E – Endemic; and T – Threatened.



**Figure 3.** Distribution of the values of species richness of forest, endemic and/or threatened birds in each vegetation type of the Pernambuco Endemism Center (bars indicate 95% of confidence intervals). Vegetation types: OOF – Open Ombrophilous Forest; DOF – Dense Ombrophilous Forest; ETZ – Ecological Tension Zone; SSF – Seasonal Semideciduous Forest; and PF – Pioneer Formation.

**Table 3.** Comparison by ANOVA and p values of the Tukey test of species richness of forest-dependent, endemic and threatened birds among the vegetation types of the Pernambuco Endemism Center. The values in bold represent the significant differences with an alpha of 0.05.

	Forest				Endemic				Threatened			
ANOVA	F(4;127) = 2.9023; <b>p = 0.024</b>				F(4;127) = 3.033; <b>p = 0.019</b>				F(4;127) = 2,547; <b>p = 0.042</b>			
Tukey (p)	ETZ	SSF	OOF	DOF	ETZ	SSF	OOF	DOF	ETZ	SSF	OOF	DOF
PF	<b>0.001</b>	<b>0.012</b>	<b>0.030</b>	0.076	<b>0.001</b>	<b>0.013</b>	<b>0.044</b>	0.142	<b>0.002</b>	<b>0.030</b>	0.061	0.151
ETZ		0.966	0.878	0.700	0.000	0.968	0.833	0.554		0.924	0.816	0.593
SSF			0.998	0.970		0.000	0.994	0.908			0.999	0.970
OOF				0.997				0.991				0.996

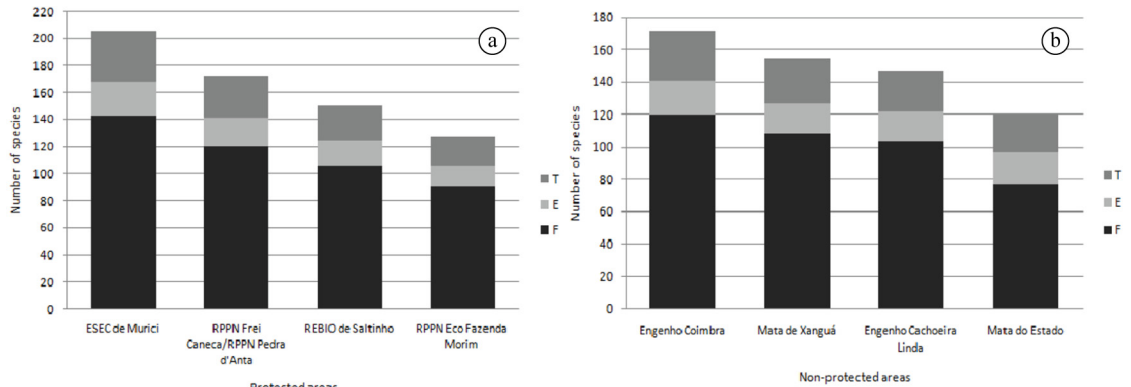
Vegetation types: OOF – Open Ombrophilous Forest; DOF – Dense Ombrophilous Forest; ETZ – Ecological Tension Zone; SSF – Seasonal Semideciduous Forest; and PF – Pioneer Formation.

• The forests in mountainous areas in the municipalities of Bonito and Gravatá. There are still some well-preserved forests; however there are very few protected areas and there is no IBA. There, we can find *L. forbesi*, *Phylloscartes ceciliae* (Teixeira, 1987), *T. sicki*, and *Myrmotherula snowi* (Teixeira & Gonzaga, 1985).

We conclude that, despite the “simplicity” of the IDW method, the information on the distribution pattern of the bird groups studied in this work were presented for the

first time very clearly, concisely and visually, even when comparing it with previous work concerning the distribution pattern of some birds in the region.

In addition, we showed that some protected areas in this region really ensure the conservation of endemic and threatened birds due to the high density of them and being within the limits of the IBAs. Furthermore, we suggested and emphasized the need for the protection of some places of extreme importance for bird conservation. In this way, we hope that these areas may be analyzed with special



**Figure 4.** The four protected (a) and non-protected (b) areas with the highest number of bird species of the three groups in the Pernambuco Endemism Center. T – Threatened with extinction; E – Endemic; and F – Forest-dependent.

attention from now on for the next implementation of protected areas programs in the Atlantic Forest.

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