Bird communities in three forest types in the Pernambuco Centre of Endemism, Alagoas, Brazil

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ABSTRACT. The Pernambuco Center of Endemism (PCE) in northeastern Brazil is highly fragmented and degraded. Despite its potential conservation importance the bird fauna in this area is still relatively unknown and there are many remnant fragments that have not been systematically surveyed. Here, we report the results of bird surveys in five forest fragments (one pioneer, two ombrophilous and two seasonal). In total, 162 taxa were recorded, 12 of which are endemic to the PCE. The frequency of endangered species was lower than what has been reported in studies from the same area and most of the taxa considered to be at risk of extinction were sub-species of uncertain taxonomic validity. The comparatively low number of endemic/threatened species may be due to the small size of the fragments in the present study – a consequence of the high levels of habitat loss in this region. Analysis of species richness patterns indicates that ombrophilous forest fragments are acting as refuges for those bird species that are most sensitive to environmental degradation.

KEYWORDS. Avifauna, ombrophilous forest, restinga, seasonal forest, species richness.

RESUMO. Comunidade de aves em três tipos florestais no Centro de Endemismo Pernambuco. O Centro de Endemismo Pernambuco (PCE), a área de Floresta Atlântica ao norte do rio São Francisco no nordeste do Brasil é altamente fragmentado e degradado. Apesar de sua importância nacional e global, a avifauna desta área é relativamente pouco estudada e há muitos fragmentos remanescentes que não foram sistematicamente pesquisados. Aqui, nós relatamos os resultados de pesquisas com a avifauna de cinco fragmentos florestais (um de floresta pioneira, dois de floresta ombrófila e dois de floresta sazonal). No total, 162 taxa foram registrados, 12 dos quais são endêmicos do PCE. No geral a frequência de espécies ameaçadas foi mais baixa do que em estudos similares e a maioria dos taxa considerados em risco de extinção foram subespécies de validade taxonômica incerta. Os principais fatores desse contraste podem ser o tamanho relativamente pequeno dos fragmentos do presente estudo e o elevado nível de fragmentação e degradação do habitat. A análise do padrão de riqueza de espécies pode indicar que os fragmentos de floresta ombrófila estão atuando como refúgio importante para espécies de aves que são sensíveis à degradação ambiental.

PALAVRAS-CHAVE. Avifauna, floresta ombrófila, restinga, floresta sazonal, riqueza de espécies.

Information on the geographic distribution of species is essential for predicting the consequences of environmental change for populations and communities. However, such information is frequently lacking, a deficit known as Wallacean shortfall (Lomolino, 2004; Ladle & Whittaker, 2011). Reducing the Wallacean shortfall is especially difficult in geographically large, biodiverse countries such as Brazil where resources and capacity for systematic surveys are limited. For example, there are many areas in Brazil where even comparatively well known taxa such as mammals and birds are poorly documented and surveys are desperately needed to inform conservation and environmental planning (Marini & Garcia, 2005; Jetz *et al.*, 2012).

One of the potentially most important areas for birds in Brazil is also one of the least known. The Pernambuco Center of Endemism (PCE), an area of Atlantic Forest north of São Francisco River in the northeast of the country (Prance, 1982; Brown, 1982), is both highly fragmented and poorly studied compared to other areas of the Atlantic Forest (Heyer, 1988; Collar *et al*., 1994; Coimbra-Filho & Câmara, 1996; Lima & Capobianco, 1997; Silva & Tabarelli, 2001; Silveira *et al.*, 2003; Roda *et al*., 2011). Based on existing information, there are at least 434 bird species in the PCE, of which 35 species/subspecies are endemic to this region (Silveira *et al*., 2003) and 27 are endemic to the Atlantic forest in general (Stotz *et al*., 1996; Roda *et al*., 2003). In addition to endemic species, the region also hosts the largest number of endangered bird species in the Americas (Wege & Long, 1995). Moreover, several of the most threatened endemic Atlantic Forest species have been recorded in the PCE: Gray-breasted Parakeet *Pyrrhura griseipectus* Salvadori, 1900, Alagoas Foliage-gleaner *Philydor novaesi* Teixeira & Gonzaga, 1983, Alagoas Antwren *Myrmotherula snowi* Teixeira & Gonzaga, 1985, Orange-bellied Antwren *Terenura sicki* Teixeira & Gonzaga, 1983 and Alagoas Tyrannulet *Phylloscartes ceciliae* Teixeira, 1987 (Olmos, 2005). In total, 40 species/subspecies appear on the Brazilian Ministry of the Environment's (MMA) threatened species list (Roda *et al.*, 2011) and 22 species/subspecies are on the IUCN Red List (IUCN, 2011).

The PCE provides an ideal "backdrop" for local extinction due to its combination of agricultural encroachment, deforestation, over-hunting and environmental change (TABARELLI & PERES, 2002). Additional surveys of bird communities of the forest are therefore a priority before rare endemics are eliminated (SILVEIRA *et al*., 2003) and to ensure that all species have been discovered. The potential for new discoveries was recently highlighted by the first record of a new species of pigmy owl, the critically endangered Pernambuco Pygmy-owl *Glaucidium mooreorum* Silva, Coelho & Gonzaga, 2002 in the Saltinho Biological Reserve, Pernambuco (SILVA *et al*., 2002). This owl may have a population size of less than 50 individuals (BIRDLIFE INTERNATIONAL, 2011).

The main objective of the present study is to describe the bird species composition of five forest remnants of Atlantic Forest in the PCE, covering three distinct vegetation types: pioneer forest, ombrophilous forest and seasonal forest. Our results are discussed in the context of regional conservation planning and the need for further assessments.

MATERIAL AND METHODS

Study area. The study sites are located in Atlantic forest fragments in state of Alagoas, northeast Brazil (Fig. 1). This area includes four main habitats: pioneer formations (restinga, mangrove and lowland), seasonal forest, ombrophilous forest and cerrado (savannoid vegetation) (ASSIS, 2000). Although the study sites are limited to the first three habitat types (Tab. I), one of the areas (Catolé Forest) is strongly influence by an enclave of Cerrado. Details of the sites are as follows:

Francês and Barra de São Miguel Restinga (FBR): despite being classified as a Brazilian Permanent Preservation Area (APP), this forest is relatively degraded. It includes floristic elements of the Atlantic Forest and the Caatinga, creating a habitat mosaic of closed vegetation, open vegetation, exposed sandbanks, beaches and marshes. The survey took place in the Dunas do Cavalo Russo and the largest block of continuous forest remnant (180 ha) of this mosaic, known as Francês and Barra de São Miguel Restinga.

Matão Forest (MTF): this fragment has been proposed as a Wildlife Refuge and is the property of Usina Porto Rico, a sugar cane and alcohol agribusiness. This is the most extensive area of Atlantic Forest on flat terrain in state of Alagoas. The trees have a height of approximately 30 m. The climate within the site is seasonal, with approximately 90 dry days per year. The vegetation within the central part of the forest is in good condition and normally shows no adverse effects of drought, even late in the summer (ASSIS, 2000).

Catolé Forest (CTF): This forest is part of the Environmental Protection Area (APA) of Catolé and Fernão Velho. The fragment is connected to a Cerrado enclave (90 ha) and has patches of vegetation at various stages of regeneration. An area of forest that once covered the space around the plateau has now been replaced by the urban expansion of Maceió (ASSIS, 2000).

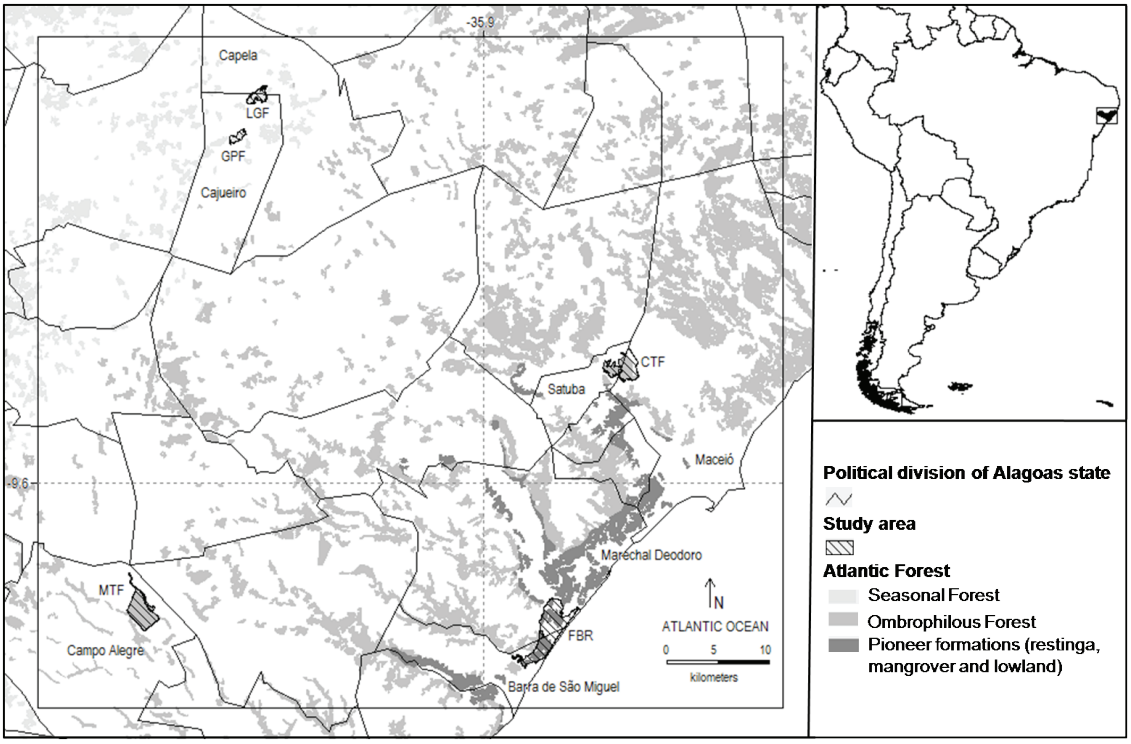

Fig. 1. Location of study areas (FBR, Francês and Barra de São Miguel Restinga; MTF, Matão Forest; CTF, Catolé Forest; LGF, Lagartixa Forest; GPF, Guardiana-Pitimijú Forest) in three habitats of Atlantic Forest in Pernambuco Centre of Endemism, state of Alagoas, Brazil (Source: vegetation cover and mangroves of the state of Alagoas, Alagoas Environment Institute's/PETROBRAS).

Tab. I. Sites where bird surveys were conducted in state of Alagoas (*, largest remaining fragment of restinga habitat in study area).

Site	Location	Altitude (m)/ size (ha)	Habitat	Method	Period	Visits (days)/ field hours
Francês/Barra de São Miguel	09°46'10"S 35°50'37"W	5/1270(180)*	Pioneer Formations (restinga + lowland)	Line transects	February to September 2006	15/61
Matão	09°46'00"S 36°14'00"W	160/690	Ombrophilous Forest	Fixed point counts	September 2007 to August 2008	48/100
Catolé	09°33'08"S 35°47'44"W	80/590	Ombrophilous Forest + Cerrado	Line transects	September 2005 to November 2006	15/80
Lagartixa	09°18'39"S 36º07'49"W	402/180	Seasonal Forest	Line transects	January 2003 to January 2004	7/52
Guardiana-Pitimijú	09°20'57"S 36º09'09"W	39/110	Seasonal Forest	Line transects	January 2003 to January 2004	27/108

Lagartixa Forest (LGF): this site is one of the best preserved forest fragments in the region and retains many characteristics of primary forest. For example, the understory is generally less dense than in surrounding fragments, the canopy is mainly closed, and there are emergent trees of up to 30 m. The surrounding agricultural matrix consists of sugar cane plantations and cattle pasture.

Guardiana-Pitimijú Forest (GPF): this site contains two fragments, Pitimijú and Guardiana Forests, which were recently (within the past six years) connected. Pitimijú is the smallest fragment, and predominantly consists of secondary forest with small trees (10-15 m), open canopy and a thick understory. The larger Guardiana Forest site is restricted to an area of hillside and, unlike Pitimijú, contains numerous older trees that may be up to 20 m in height. The surrounding agricultural matrix consists of sugar cane plantations, fruit trees, pasture and fields of cassava.

Bird Sampling. Between January 2003 and August 2008, were conducted quantitative surveys of the birds associated with the five forest remnants, collecting data in the form of visual and/or auditory records. CTF and FBR were usually visited in the early hours of the day and sometimes at dusk. In the GPF and LGF the study period extended from January 2003 to January 2004 with periodic visits (Tab. I) usually between 5:30 and 11:00 a.m. and sometimes until 3:00 p.m. The trails were covered with constant speed and all contacts with birds, visual or auditory, were noted. The Pitimijú forest was visited 14 times, Guardiana forest 13 times and the Lagartixa forest seven times (Tab. I). The MTF was visited for two consecutive days twice a month from September 2007 to August 2008, totaling 48 field days (Tab. I).

Two survey methods for counts of species and individuals were adopted: unlimited distance transects (Bibby *et al.*, 2000) for FBR, CTF, LGF and GPF (Bibby *et al.*, 2000) and fixed point counts (Vielliard, 2000) for MTF. Where transects were used, the surveyor utilized existing forest tracks within the first hour of daylight and for an hour before sunset. This transects/ trails were repeated one or more times during the sample period. Sampling was sometimes extended past sunset in order to survey crepuscular and nocturnal birds. For the fixed point method, twelve equidistant points (200 m) were marked along a track that traversed the fragment. Once again, the census took place in the first hours of daylight and 20 minutes were spent at each fixed point. Sampling points were chosen at random for each visit. Birds were identified with the aid of binoculars and, where appropriate, micro-recorder for analysis of calls and/or songs.

We adopt the taxonomic classification system adopted by CBRO (2011) and Silveira *et al.* (2003). Data on species and subspecies conservation threat categories were obtained from Machado *et al.* (2008) and IUCN (2011).

Data Analysis. As two distinct methods of data collection were used, sampling units could not be directly compared using a standard rarefaction analysis. Thus, our rarefaction analysis (Hurlbert, 1971) considered each individual as the basic unit of sampling effort, thereby accounting for the influence of the different sampling methods (Gotelli & Colwell, 2001). This analysis was made with the Analytic Rarefaction 1.3 software (available in http://strata.uga.edu/software/anRareReadme.html), considering groups of five individuals as a basis for randomization. The comparison of species richness between areas was performed using the number of individuals in the area with less sampling effort as a reference. Statistical inferences about which areas are statistically different with regard the richness was made from the 95% confidence intervals generated by the rarefaction method. Following Cumming *et al*. (2007), overlaps between 95% confidence bars are statistically significant (at $p \leq 0.05$) as long as the bigger overlap between bars is lesser than 50% the size of the bar.

When the sampling efforts were different, the number of records of each species was converted into an Abundance Index (estimated number of individuals per species in relation to 100 h of observation) (Willis, 1979; Willis & Oniki, 1981; Silveira *et al*., 2003).

Tab. II. Abundance Index of species and subspecies endemic to the PCE. Conservation threat status according to the system developed by the Brazilian Ministry of the Environment (MACHADO *et al.*, 2008) [Status (EN, endemic; VU, vulnerable); Study areas (FBR, Francês and Barra de São Miguel Restinga; MTF, Matão Forest; CTF, Catolé Forest; LGF, Lagartixa Forest; GPF, Guardiana-Pitimijú Forest); *, current IUCN Red List category].

		Pioneer	Ombrophilous		Seasonal	
Species/Subspecies	Status	FBR	CTF	MTF	LGF	GPF
Penelope superciliaris alagoensis	EN	9.8	0.0	6.0	0.0	0.0
Picumnus exilis pernambucensis	VU	0.0	1.3	6.0	0.0	0.0
Thamnophilus caerulescens pernambucensis	VU	0.0	0.0	4.0	0.0	0.0
Thamnophilus aethiops distans	EN	0.0	1.3	52.0	17.3	29.6
Pyriglena leuconota pernambucensis	VU	0.0	0.0	22.0	15.4	5.6
Dendrocincla fuliginosa taunayi	EN	0.0	0.0	8.0	0.0	0.0
Xenops minutus alagoanus	EN	0.0	0.0	25.0	0.0	0.0
*Synallaxis infuscata**	EN	0.0	0.0	0.0	0.0	8.3
Schiffornis turdinus intermedius	VU	0.0	1.3	0.0	0.0	0.0
Platyrinchus mystaceus niveigularis	VU	0.0	1.3	13.0	1.9	1.9
Tangara fastuosa	VU	0.0	2.5	0.0	17.3	11.1
Tangara cyanocephala corallina	VU	0.0	0.0	0.0	28.8	1.9

RESULTS

In total, 162 bird taxa (13 identified to subspecies level) were recorded at five locations and three habitats of the Atlantic Forest. These taxa were distributed between 44 families and 18 orders. The four most represented families were the Tyrannidae (n = 20), Thraupidae (n = 15), Trochilidae (n = 10) and Thamnophilidae (n = 9), corresponding to approximately one third of records. Ten subspecies and two species (*Synallaxis infuscata* Pinto, 1950 and *Tangara fastuosa* Lesson, 1831) were identified as endemic to the PCE (Tab. II), with another six species or subspecies that are regarded as being restricted to the Atlantic forest (Appendix 1).

The raw number of recorded species varied considerably by habitat type. In the pioneer/restinga forest 62 species were found, three of which are Atlantic Forest or PCE endemics or threatened (Appendix 1). In the seasonal forest 91 species were registered and 131 species in the ombrophilous forest sites. The ombrophilous forest contained the most endemic and threatened taxa (n =10), five of which are exclusively found in this type of forest: *Picumnus exilis pernambucensis* Zimmer, 1947, *Thamnophilus caerulescens pernambucensis* Naumburg, 1937, *Dendrocincla fuliginosa taunayi* Pinto, 1939, *Xenops minutus alagoanus* Pinto, 1954 and *Schiffornis turdinus intermedius* Pinto, 1954.

Rarefaction analysis indicated that the Catolé forest site had the greatest species richness, followed by Guardiana-Pitimijú, Matão, Lagartixa forests and finally the pioneer/restinga site, Francês and Barra de São Miguel (Tab. III; Fig. 2). When the data is collated by habitat type, the ombrophilous forest has the highest richness, followed by seasonal forest and pioneer/resting forest (Tab. III; Fig. 2).

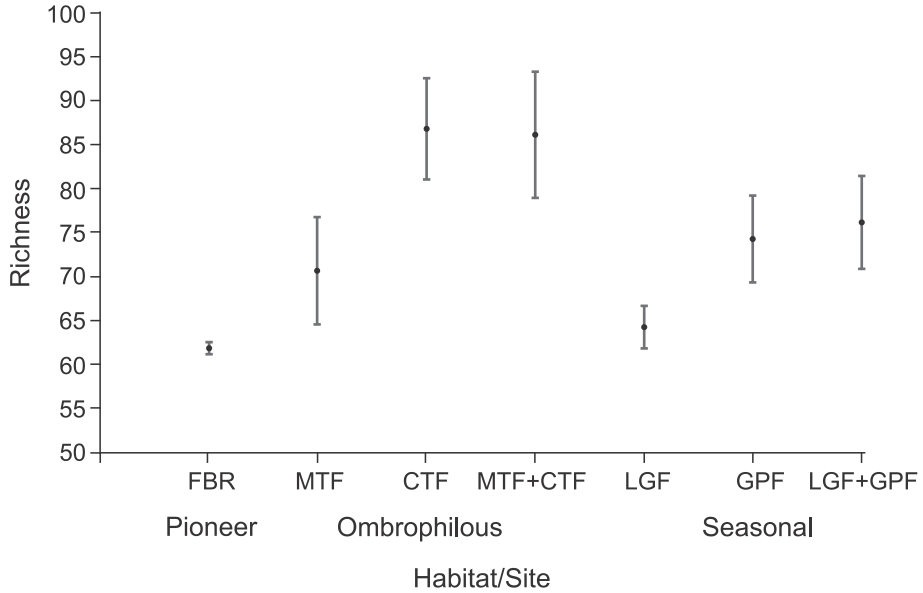

Fig. 2. Species richness of study sites and forest habitats, with average values (points) and 95% confidence intervals (whiskers) from the rarefaction analysis (see text for details).

Tab. III. Average values and 95% confidence intervals species richness per site from the rarefaction analysis performed to account for different sampling methods (see text for details) (*, largest remaining fragment of restinga habitat in study area).

Site	Species richness (rarefacted)	Richness 95% CI lower bound	Richness 95% CI upper bound
Francês/Barra de São Miguel*	61.9	61.26	62.52
Matão	70.8	64.58	76.95
Catolé	86.8	81.11	92.58
Lagartixa	65.3	61.85	66.65
Guardiana-Pitimijú	74.3	69.31	79.26
Ombrophilous forest	86.2	79.01	93.36
Seasonal forest	76.2	70.9	81.43
Pinoneer / Resting forest	61.9	61.26	62.52

DISCUSSION

We recorded 37.3% of the total number of bird species registered in the PCE (Roda *et al*., 2011). Despite this low percentage, the fragments studied are important for bird conservation in this area. Among the species recorded, some are restricted to the northeast Brazilian states (*e.g. Thalurania watertonii*; Las-Casas & Azevedo-Júnior 2009). Others are specialist species with high sensitivity to disturbance (*e.g. Thamnophilus aethiops distans* and *Dendrocincla fuliginosa taunayi*; Parker *et al*., 1996). It also hosts generalist species that are more able to cope with deforestation (*e.g. Penelope superciliaris alagoensis*; Silveira *et al*., 2003).

The sampled communities are composed mainly of insectivores (Tyrannidae, Trochillidae, Thamnophilidae) and small frugivores (Thraupidae). These species are mainly semi and forest independents, demonstrating the high degree of disturbance in the region due to the direct and indirect effects of habitat loss and fragmentation (Ranta *et al*., 1998; Schulte & Niemi, 1998; Watson *et al*., 2005).

The bird guilds most affected by habitat loss are large frugivores and understory and ground insectivores (Aleixo, 1999; Pizo, 2001). Changes in habitat quality and biotic interactions caused by fragmentation simplify the original communities (Saunders *et al*., 1991), mainly affecting species more specialized diet. For example, Stouffer & Bierregaard (1995) reported that understory insectivores, mainly followers of army ants (*e.g. P. leuconota*), are the first to disappear in response to fragmentation in Amazonia. A similar pattern of loss has been observed in studies in the Atlantic Forest (Motta, 1990; Donatelli *et al*., 2004).

The presence of forest independent or semi-dependent taxa (*e.g.* Tyrannidae) (cf. Stouffer & Bierregaard, 1995; Parker *et al*., 1996; Ewers & Didham, 2006; Guldemond & van Aarde, 2010) also reflects the loss of large fragments. This is probably because forest dependent species require larger and more complex patches of forest to survive (Turner, 1996; Marini, 2001). In the present study, the greatest richness was found at Catolé forest, the third largest fragment by area. This can be cautiously attributed to its greater diversity of microhabitats including numerous small streams, a large reservoir, flooded areas, a varied topography and an adjacent enclave of the cerrado biome (Auto, 1998). The latter is probably responsible for the records of species more typically found in open areas with sparse vegetation such as *Hemitriccus margaritaceiventer* (d'Orbigny & Lafresnaye, 1837), *Pachyramphus polychopterus* (Vieillot, 1818) and *Sporophila angolensis* (Linnaeus, 1766).

As indicated, Matão forest is the largest remaining fragment on relatively flat terrain in the state of Alagoas. The lack of topographical diversity and the high degree of isolation within an agricultural matrix of sugar cane are probably responsible for the relatively low species richness within this fragment (cf. Williams, 1964; Boecklen, 1986; Terborgh *et al*., 1997). A history of hunting and selective logging may also have reduced the biodiversity within this site, especially the presence of larger species (Johns, 1985; Brown & Brown, 1992; Thiollay, 1997; Ranta *et al*., 1998).

Some species [*e.g. Pteroglossus inscriptus* Swainson, 1822, *Thalurania watertonii* and *Geranospiza caerulescens* (Vieillot, 1817)] were only recorded in the Lagartixa forest (LGF). These species may be dependent on the compositional complexity of trees, shrubs, and herbs specific to this fragment. It should be noted, however, that sampling effort was also lower in this fragment (52 h) and that the log species accumulation curve had not stabilized by the end of the sampling period.

Our data show that ombrophilous forest fragments contain the highest number of endemic and endangered species and the highest levels of species richness. This forest may therefore be acting as refuge for bird species that are sensitive to environmental degradation and greater natural fluctuations encountered in the sites near the caatinga and restinga biomes.

The agricultural matrix that surrounds forest fragments has been identified as a cause of serious negative impacts on animal communities (Lindenmayer & Franklin, 2002; Brotons *et al*., 2003). The FBR site has the largest area, although the largest continuous patch of vegetation within the site is only 180 ha. The relatively low species richness at this site probably reflects its highly fragmented and degraded nature driven by its proximity to neighboring cities, roads and associated human activities. Nevertheless, this site still harbors endemic species and/or endangered species that prefer open

habitats [*Penelope superciliaris alagoensis*, *Ortalis guttata* (Spix, 1825) and *Conopophaga cearae lineata* (Wied, 1831)] suggesting that the site has significant conservation value. The Rusty-margined Guan (*Penelope superciliaris alagoensis*) is a large frugivorous species and probably persists in this site due to the numerous piassava palms (*Attalea funifera* Mart) that occur there.

Given the overall lack of forests specialists, it is not surprising that few of the species recorded in the surveys are considered at global risk of extinction: *Thalurania watertonii* is classified as 'Near Threatened', *T. fastuosa* is classified as 'Vulnerable', and only *Synallaxis infuscata* is considered as 'Endangered' (IUCN, 2011). However, it should be noted that ten species (or subspecies) are classified as Vulnerable and three as Endangered according to the Brazilian Red list (Machado *et al.*, 2008). The Taxa considered as most at risk of extinction (by the IUCN or MMA) are *S. infuscata*, *Penelope superciliaris alagoensis* Nardelli, 1993, *Thamnophilus aethiops distans* Pinto, 1954 and *Xenops m. alagoanus*, which are endemic or which have few known records in the PCE (Silveira *et al*., 2003; Barnett *et al*., 2005; Roda *et al.*, 2011). However, it should be noted that there is a degree taxonomic uncertainty over the latter three taxa (and the other subspecies identified in the study) and that the species complex for each of these is classified as Least Concern by the IUCN red list (IUCN, 2011). Of course, this may be changed in the light of new taxonomic analyses to resolve these uncertainties.

It is clear that despite the very high species richness there are very few (taxonomically accepted) species in the study fragments that are considered as globally threatened. The exception was *Synallaxis infuscata*, classified as Endangered by the IUCN (IUCN, 2011) and recorded at low densities in the GPF seasonal forest site. This species is typically restricted to more open areas within forests and can often be found where trees have been felled – a common practice in the GPF site.

The relatively low levels of threatened species recorded in the present survey are in contrast with the results of Barnett *et al*. (2005), who reported 32 threatened and endemic birds including a new species during surveys of sites situated in the mountains of state of Pernambuco (also within the PCE). The main factors driving this contrast may be the relatively small size of the fragments in the present study and the high level of habitat degradation. Thus, it is quite likely that some endemic and/or threatened birds may have already disappeared from these fragments and, given the prospects for reforestation, are unlikely to return. The potential loss of rare and endemic species from forest fragments in the PCE indicates the urgent need for a greater number of systematic surveys of the bird fauna of this region.

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Appendix 1. Abundance Index and conservation risk status of species in the 5 study sites (IUCN categories: LC, least concern; NT, near threatened; V, vulnerable; EN, endangered. *, Atlantic Forest endemic; **, PCE endemic; •, species detected during nocturnal sampling). [1], Conservation threat status of subspecies according to the system developed by the Brazilian Ministry of the Environment (Machado *et al.*, 2008).

		Pioneer	Ombrophilous		Seasonal	
Family/Species	IUCN	FBR	CTF	MTF	LGF	GPF
Tinamidae (4)						
Crypturellus soui	LC	0.0	7.5	4.0	0.0	0.0
Crypturellus strigulosus	LC	0.0	0.0	7.0	0.0	0.0
Crypturellus parvirostris	LC	0.0	0.0	6.0	0.0	1.9
Rhynchotus rufescens	LC	0.0	0.0	0.0	1.9	4.6
Cracidae (2)						
Ortalis guttata[*]	LC	11.5	0.0	0.0	0.0	1.9
Penelope superciliaris alagoensis[**]	EN[1]	9.8	0.0	6.0	0.0	0.0
Ardeidae (2)						
Tigrisoma lineatum	LC	0.0	0.0	1.0	0.0	0.0
Butorides striata	LC	1.6	0.0	0.0	0.0	0.0
Cathartidae (3)						

Appendix 1. Continued.

		Pioneer	Ombrophilous		Seasonal	
Family/Species	IUCN	FBR	CTF	MTF	LGF	GPF
Cathartidae (3)						
Cathartes aura	LC	42.6	21.3	15.0	5.8	26.9
Cathartes burrovianus	LC	4.9	1.3	0.0	0.0	0.0
Coragyps atratus	LC	57.4	35.0	4.0	9.6	17.6
Accipitridae (6)						
Geranospiza caerulescens	LC	0.0	0.0	0.0	1.9	0.0
Rupornis magnirostris	LC	31.1	17.5	16.0	5.8	16.7
Geranoaetus albicaudatus	LC	0.0	5.0	1.0	0.0	0.0
Buteo nitidus	LC	0.0	0.0	3.0	0.0	0.0
Buteo brachyurus	LC	1.6	2.5	1.0	1.9	6.5
Buteo albonotatus	LC	0.0	1.3	0.0	1.9	3.7
Falconidae (4)						
Caracara plancus	LC	55.7	8.8	7.0	3.8	11.1
Milvago chimachima	LC	3.3	2.5	0.0	11.5	1.9
Herpetotheres cachinnans	LC	0.0	1.3	11.0	0.0	1.9
Falco sparverius	LC	0.0	0.0	1.0	0.0	0.9
Rallidae (1)						
Aramides cajanea	LC	0.0	0.0	2.0	0.0	0.0
Charadriidae (1)						
Vanellus chilensis	LC	8.2	3.8	3.0	0.0	0.0
Jacanidae (1)						
Jacana jacana	LC	1.6	0.0	0.0	0.0	0.0
Columbidae (6)						
Columbina minuta	LC	1.6	0.0	0.0	0.0	0.0
Columbina talpacoti	LC	16.4	13.8	5.0	0.0	9.3
Columbina squammata	LC	16.4	1.3	0.0	0.0	2.8
Patagioenas cayennensis	LC	6.6	0.0	17.0	0.0	0.0
Leptotila verreauxi	LC	0.0	7.5	53.0	21.2	13.0
Leptotila rufaxilla	LC	0.0	10.0	1.0	0.0	0.0
Psittacidae (6)						
Diopsitta canobilis	LC	0.0	20.0	25.0	67.3	26.9
Aratinga aurea	LC	1.6	1.3	0.0	0.0	0.0
Forpus xanthopterygius	LC	6.6	0.0	1.0	0.0	8.3
Pionus reichenowi	LC	0.0	1.3	0.0	0.0	0.0
Pionus maximiliani	LC	0.0	0.0	33.0	0.0	0.0
Amazona amazonica	LC	0.0	0.0	74.0	0.0	0.0
Cuculidae (4)						
Piaya cayana	LC	23.0	12.5	34.0	7.7	19.4
Crotophaga ani	LC	18.0	1.3	1.0	25.0	17.6
Guira guira	LC	1.6	0.0	0.0	7.7	2.8
Tapera naevia	LC	0.0	0.0	0.0	1.9	2.8
Tytonidae (1)						
Tyto alba•	LC	1.6	0.0	0.0	0.0	0.0
Strigidae (1)						
Glaucidium brasilianum•	LC	0.0	0.0	0.0	3.8	3.7
Caprimulgidae (3)						
Caprimulgus rufus•	LC	0.0	1.3	0.0	0.0	0.0

Appendix 1. Continued.

		Pioneer	Ombrophilous		Seasonal	
Family/Species	IUCN	FBR	CTF	MTF	LGF	GPF
Hydropsalis albicollis•	LC	6.6	2.5	1.0	0.0	0.0
Hydropsalis torquata•	LC	0.0	3.8	0.0	0.0	0.0
Apodidae (1)						
Panyptila cayennensis	LC	0.0	0.0	0.0	3.8	1.9
Trochilidae (10)						
Phaethornis ruber	LC	0.0	10.0	72.0	11.5	12.0
Phaethornis pretrei	LC	0.0	3.8	0.0	0.0	0.0
Eupetomena macroura	LC	0.0	10.0	0.0	0.0	0.9
*Florisuga fusca**	LC	0.0	0.0	0.0	0.0	2.8
Anthracothorax nigricollis	LC	0.0	1.3	0.0	0.0	0.0
Chrysolampis mosquitus	LC	0.0	0.0	0.0	0.0	1.9
Chlorostilbon notatus	LC	9.8	15.0	0.0	0.0	0.0
Chlorostilbon lucidus	LC	0.0	0.0	1.0	30.8	8.3
*Thalurania watertonii**	NT	0.0	1.3	0.0	7.7	0.0
Amazilia leucogaster	LC	0.0	5.0	0.0	0.0	0.0
Trogonidae (1)						
Trogon curucui	LC	0.0	0.0	64.0	0.0	0.0
Alcedinidae (1)						
Megaceryle torquata	LC	0.0	2.5	3.0	0.0	3.7
Galbulidae (1)						
Galbula ruficauda	LC	6.6	36.3	72.0	0.0	6.5
Bucconidae (1)						
Nystalus maculatus	LC	1.6	0.0	0.0	0.0	0.0
Ramphastidae (1)						
Pteroglossus inscriptus	LC	0.0	0.0	0.0	11.5	0.0
Picidae (5)						
*Picumnus exilis pernambucensis***	VU[1]	0.0	1.3	6.0	0.0	0.0
Picumnus cirratus	LC	0.0	1.3	4.0	0.0	0.0
Veniliornis affinis	LC	0.0	1.3	0.0	0.0	0.0
Veniliornis passerinus	LC	0.0	0.0	11.0	0.0	0.0
Campephilus melanoleucos	LC	0.0	1.3	19.0	0.0	0.0
Thamnophilidae (9)						
Myrmotherula axillaris	LC	0.0	1.3	147.0	0.0	0.0
Formicivora grisea	LC	65.6	27.5	117.0	1.9	2.8
Dysithamnus mentalis	LC	0.0	0.0	56.0	19.2	2.8
Herpsilochmus rufimarginatus	LC	0.0	11.3	183.0	0.0	0.0
Thamnophilus pelzelni	LC	16.4	2.5	3.0	0.0	0.0
*Thamnophilus caerulescens pernambucensis***	VU	0.0	0.0	4.0	0.0	0.0
*Thamnophilus aethiops distans***	EN[1]	0.0	1.3	52.0	17.3	29.6
Taraba major	LC	0.0	0.0	0.0	1.9	1.9
*Pyriglena leuconota pernambucensis***	VU[1]	0.0	0.0	22.0	15.4	5.6
Conopophagidae (2)						
*Conopophaga lineata cearae**	VU[1]	4.9	0.0	0.0	0.0	0.9
Conopophaga melanops nigrifrons	VU[1]	0.0	3.8	19.0	0.0	0.0
Dendrocolaptidae (4)						
*Dendrocincla fuliginosa taunayi***	EN[1]	0.0	0.0	8.0	0.0	0.0
Sittasomus griseicapillus	LC	0.0	6.3	2.0	25.0	18.5

Appendix 1. Continue.

		Pioneer	Ombrophilous		Seasonal	
Family/Species	IUCN	FBR	CTF	MTF	LGF	GPF
Xiphorhynchus guttatus	LC	1.6	6.3	28.0	0.0	0.0
Dendroplex picus	LC	1.6	7.5	11.0	5.8	13.9
Furnariidae (4)						
*Xenops minutus alagoanus***	VU[1]	0.0	0.0	25.0	0.0	0.0
Phacellodomus rufifrons	LC	0.0	0.0	0.0	0.0	15.7
*Synallaxis infuscata***	EN	0.0	0.0	0.0	0.0	8.3
Synallaxis frontalis	LC	0.0	1.3	1.0	0.0	10.2
Pipridae (4)						
Neopelma pallescens	LC	0.0	1.3	1.0	0.0	0.0
Pipra rubrocapilla	LC	0.0	16.3	74.0	15.4	0.0
Manacus manacus	LC	1.6	15.0	6.0	32.7	17.6
Chiroxiphia pareola	LC	0.0	36.3	273.0	73.1	25.9
Tityridae (3)						
*Schiffornis turdinus intermedius***	VU[1]	0.0	1.3	0.0	0.0	0.0
Pachyramphus viridis	LC	0.0	0.0	0.0	0.0	1.9
Pachyramphus polychopterus	LC	0.0	1.3	0.0	0.0	1.9
Incertae sedis (1)						
*Platyrinchus mystaceus niveigularis***	VU[1]	0.0	1.3	13.0	1.9	1.9
Rhynchocyclidae (7)						
Mionectes oleagineus	LC	0.0	0.0	4.0	0.0	0.0
Leptopogon amaurocephalus	LC	0.0	0.0	21.0	0.0	0.0
Tolmomyias flaviventris	LC	23.0	60.0	100.0	28.8	27.8
Todirostrum cinereum	LC	8.2	28.8	5.0	3.8	26.9
Poecilotriccus plumbeiceps	LC	0.0	0.0	0.0	1.9	13.9
Hemitriccus griseipectus	LC	0.0	8.8	229.0	0.0	0.0
Hemitriccus margaritaceiventer	LC	24.6	16.3	0.0	0.0	0.0
Tyrannidae (20)						
Hirundinea ferruginea	LC	0.0	0.0	0.0	0.0	1.9
Ornithion inerme	LC	0.0	0.0	40.0	0.0	0.0
Camptostoma obsoletum	LC	3.3	12.5	57.0	7.7	25.9
Elaenia flavogaster	LC	11.5	15.0	7.0	13.5	35.2
Myiopagis gaimardii	LC	0.0	1.3	121.0	0.0	0.0
Capsiempis flaveola	LC	3.3	12.5	0.0	13.5	46.3
Phaeomyias murina	LC	3.3	0.0	0.0	0.0	0.0
Attila spadiceus	LC	0.0	0.0	15.0	0.0	0.0
Legatus leucophaius	LC	0.0	0.0	16.0	9.6	0.0
Myiarchus ferox	LC	4.9	7.5	1.0	0.0	9.3
Myiarchus tyrannulus	LC	1.6	0.0	1.0	0.0	0.0
Pitangus sulphuratus	LC	42.6	30.0	41.0	1.9	26.9
Machetornis rixosa	LC	0.0	2.5	0.0	0.0	0.0
Myiodynastes maculatus	LC	0.0	0.0	7.0	0.0	0.0
Megarynchus pitangua	LC	0.0	1.3	8.0	11.5	20.4
Myiozetetes similis	LC	0.0	13.8	19.0	7.7	13.0
Tyrannus melancholicus	LC	29.5	11.3	12.0	5.8	15.7
Fluvicola nengeta	LC	1.6	2.5	1.0	0.0	0.0
Arundinicola leucocephala	LC	1.6	0.0	0.0	0.0	0.0
Lathrotriccus euleri	LC	0.0	1.3	30.0	0.0	0.0

Appendix 1. Continue.

		Pioneer	Ombrophilous		Seasonal	
Family/Species	IUCN	FBR	CTF	MTF	LGF	GPF
Vireonidae (3)						
Cyclarhis gujanensis	LC	4.9	5.0	0.0	42.3	45.4
Vireo olivaceus	LC	4.9	16.3	77.0	25.0	25.9
Hylophilus amaurocephalus	LC	13.1	0.0	0.0	0.0	0.0
Hirundinidae (3)						
Stelgidopteryx ruficollis	LC	9.8	15.0	38.0	5.8	8.3
Progne tapera	LC	0.0	0.0	3.0	0.0	0.0
Tachycineta albiventer	LC	1.6	1.3	0.0	0.0	0.0
Troglodytidae (2)						
Troglodytes musculus	LC	1.6	11.3	32.0	15.4	25.9
Pheugopedius genibarbis	LC	27.9	13.8	230.0	13.5	43.5
Polioptilidae (2)						
Ramphocaenus melanurus	LC	0.0	10.0	98.0	7.7	19.4
Polioptila plumbea	LC	29.5	25.0	13.0	3.8	25.0
Turdidae (1)						
Turdus leucomelas	LC	0.0	50.0	2.0	65.4	25.9
Mimidae (2)						
Mimus gilvus	LC	36.1	0.0	0.0	0.0	0.0
Mimus saturninus	LC	0.0	1.3	0.0	0.0	0.0
Coerebidae (1)						
Coereba flaveola	LC	0.0	2.5	76.0	1.9	0.9
Thraupidae (15)						
Saltator maximus	LC	0.0	1.3	0.0	0.0	0.0
Nemosia pileata	LC	0.0	2.5	26.0	1.9	17.6
Thlypopsis sordida	LC	0.0	0.0	0.0	0.0	5.6
Tachyphonus rufus	LC	23.0	16.3	1.0	3.8	21.3
Ramphocelus bresilius[*]	LC	0.0	2.5	0.0	0.0	0.0
Lanio cristatus	LC	0.0	2.5	7.0	0.0	0.0
Tangara fastuosa[**]	VU	0.0	2.5	0.0	17.3	11.1
Tangara cyanocephala corallina[**]	VU[1]	0.0	0.0	0.0	28.8	1.9
Tangara sayaca	LC	0.0	6.3	0.0	3.8	5.6
Tangara palmarum	LC	0.0	7.5	63.0	151.9	120.4
Tangara cayana	LC	6.6	26.3	6.0	11.5	57.4
Tersina viridis	LC	0.0	3.8	0.0	0.0	0.0
Dacnis cayana	LC	45.9	46.3	24.0	30.8	31.5
Cyanerpes cyaneus	LC	0.0	8.8	0.0	0.0	10.2
Hemithraupis guira	LC	0.0	31.3	5.0	40.4	24.1
Emberizidae (5)						
Emberizoides herbicola	LC	1.6	0.0	0.0	0.0	0.9
Volatinia jacarina	LC	4.9	1.3	12.0	17.3	16.7
Sporophila nigricollis	LC	0.0	0.0	3.0	0.0	4.6
Sporophila angolensis	LC	0.0	1.3	0.0	0.0	0.0
Arremon taciturnus	LC	0.0	17.5	50.0	19.2	24.1
Cardinalidae (1)						
Caryothraustes canadenses frontalis[*]	VU[1]	0.0	0.0	35.0	0.0	0.0
Parulidae (3)						
Geothlypis aequinoctialis	LC	1.6	0.0	0.0	0.0	0.0

Appendix 1. Continue.

		Pioneer	Ombrophilous		Seasonal	
Family/Species	IUCN	FBR	CTF	MTF	LGF	GPF
Basileuterus culicivorus	LC	0.0	35.0	3.0	0.0	0.0
Basileuterus flaveolus	LC	8.2	8.8	0.0	0.0	0.0
Icteridae (2)						
Procacicus solitarius	LC	0.0	0.0	0.0	0.0	0.9
Icterus cayanensis	LC	0.0	0.0	1.0	3.8	1.9
Fringillidae (2)						
Euphonia chlorotica	LC	4.9	6.3	12.0	1.9	4.6
Euphonia violacea	LC	0.0	30.0	30.0	25.0	20.4

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