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Bird diversity in a protected area in the Atlantic Forest-Pampas ecotone of coastal Rio Grande do Sul State, southern Brazil

Diversidade de aves de uma unidade de conservação no ecótono mata atlântica-pampa do litoral do Rio Grande do Sul, sul do Brasil

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ABSTRACT
The subtropical coastal ecosystems of Brazil are located in the ecotone between the Atlantic Forest (MA) and the Pampas. The delimitation of biogeographic boundaries is still debated. In order to improve the understanding of these limits, the diversity of birds in the MA-Pampa ecotone in the Environmental Protection Area (APA) of Lagoa de Itapeva, Rio Grande do Sul, Brazil, and its surroundings was evaluated. A list of APA birds was generated and the occurrence of endemic, threatened and migratory species discussed. A total of 162 species were recorded during the APA surveys and another 38 species in the immediate surroundings, totaling 200 species. The local avifauna has few endangered and endemic species, but the presence of multiple habitats allows the occurrence of a diverse community of wetlands, *restingas,* fields and lowland forests. In terms of biogeographic affinities, MA and Pampa endemic species present in the studied ecotone are few, widely distributed and common, with MA endemics dominating. Long-term monitoring of bird assemblages is recommended, using point counting and mist net capture-recapture protocols, considering native habitats separately, in order to assist in APA management, as birds are highly sensitive to environmental change.
Keywords: Environmental Protection Area; inventory; Itapeva lagoon; species richness; Torres.

RESUMO
Os ecossistemas costeiros subtropicais do Brasil situam-se no ecótono entre a mata atlântica (MA) e os pampas. A divisão dos limites biogeográficos ainda é debatida. Visando melhorar a compreensão desses limites, avaliou-se a diversidade de aves no ecótono MA-pampa na Área de Proteção Ambiental (APA) da Lagoa de Itapeva, Rio Grande do Sul, Brasil, e seu entorno. Uma lista das aves da APA foi gerada, e a ocorrência de espécies endêmicas, ameaçadas e migratórias, discutida. Um total de 162 espécies foi registrado durante os levantamentos na APA, e outras 38 espécies, no entorno imediato, totalizando 200 espécies. A avifauna local possui poucas espécies ameaçadas e endêmicas, mas a presença de múltiplos hábitats possibilita a ocorrência de uma comunidade diversificada de áreas úmidas, restingas, campos e florestas de baixada. Em termos de afinidades biogeográficas, espécies endêmicas da MA e do pampa presentes no ecótono estudado são poucas, amplamente distribuídas e comuns, com dominância de endemismos da MA. Recomenda-se o monitoramento de longo prazo das assembleias de aves, utilizando contagem de pontos e protocolos de captura-recaptura com rede de neblina, considerando os hábitats nativos separadamente, a fim de auxiliar no gerenciamento da APA, já que as aves possuem alta sensibilidade à alteração ambiental.
Palavras-chave: Área de Proteção Ambiental; inventário; Lagoa de Itapeva; riqueza de espécies; Torres.

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INTRODUCTION

Within the Neotropical realm, some portions of the subtropical coastal ecosystems of southern Brazil lie at the point of transition between two major domains, the Atlantic Forest and the Pampas (GUADAGNIN & LAIDNER, 1999; IBGE, 2004). Such region is characterized by a relatively young landscape that became dominated by open and semi-open ecosystems (wetlands, grasslands and woodlands) over the last 8,000 years and was later partially colonized by lowland forests from the Serra do Mar (TOMAZELLI & VILLWOCK, 1991; VAL-PEÓN *et al*., 2019). Currently, it contains a mixture of biotic and abiotic elements from different formations of both Atlantic Forest and Pampas (GUADAGNIN & LAIDNER, 1999). Nonetheless, the interplay between these domains is not consensual and several attempts to delimitate the boundaries of the Atlantic Forest *lato sensu* and its surrounding domains have been made in the last decades (MUYLAERT *et al*., 2018).

As a result, multiple delimitations are available (TEIXEIRA *et al*., 1986; IBGE, 2004; MUYLAERT *et al*., 2018). One such case is the southernmost coastal Atlantic Forest limit with the Pampas domain, as classified by the Brazilian government, which coincides with the Mampituba river that also acts as the geopolitical border between the states of Rio Grande do Sul and Santa Catarina (IBGE, 2004). In other words, even though ecosystems located just north of the Mampituba river are virtually identical to those just to the south (*ca*. 100 m from one margin to other), they are no longer classified as Pampas but Atlantic Forest (IBGE, 2004). Disentangle patterns in the assemblages of fauna and flora at these sites must provide valuable information that should be taken into consideration during further classification of this ecotone.

In Rio Grande do Sul and southern Santa Catarina states, which harbor the largest patches of wetlands and grasslands in southern Brazil (MALTCHIK *et al*., 2004), birds are one of the most studied animal groups (ROSÁRIO-BEGE & MARTERER, 1991; NASCIMENTO, 1995; GUADAGNIN *et al*., 2005, 2009; GUADAGNIN & MALTCHIK, 2007; PEREIRA & POERSCHKE, 2010; HARRISON *et al*., 2013; VIZENTIN-BUGONI *et al*., 2015; DIAS *et al*., 2016; GAVA-JUST *et al*., 2018). This ecotonal region presents a mixing of species typical of the Atlantic Forests and Pampas, according to occurrence maps from WikiAves and Birdlife International, but there is a lack of understanding regarding the diversity patterns at local and regional levels. In the north-eastern coast of Rio Grande do Sul, for example, historical collection efforts made by the naturalists Rudolf Gliesch, Emil Kaempfer and Willian Belton, between 1920-1990, led to a first overall panorama on its avifauna (GLIESCH, 1925; NAUMBURG, 1935; BELTON, 1994).

Currently, sound local inventories of birds are scarce and available only for the Itapeva State Park (SEMA, 2006) and for a mosaic of habitats in Capão da Canoa municipality (SANABRIA, 2009). This lack of inventories prevents the execution of regional diversity studies, as well as may hamper conservation-based decisions. The Environmental Protection Area of Lagoa de Itapeva ("*Área* de Proteção Ambiental" in the Brazilian law) is a poorly explored site in the Torres municipality region and covers almost 450 hectares of a mosaic of coastal ecosystems in the Atlantic Forest-Pampas ecotone. The only records of birds in the area were made during a rapid ecological evaluation carried out in 1996 and additional surveys between November 2007 and January 2008, resulting in 50 species (ABG, 1998; SILVA *et al*., 2008). This is clearly an underestimation, when compared to surrounding regions with similar habitats, which hold up to 180 species (*e.g*., BELTON, 1994; SEMA, 2006; GAVA-JUST *et al*., 2018).

In this article, we provide an updated list of birds from the Environmental Protection Area of Lagoa Itapeva and describe, in a qualitative manner, aspects of diversity and conservation of the local avifauna, giving focus to the threatened, endemic and migratory species.

MATERIAL AND METHODS

STUDY SITE

The Environmental Protection Area of Lagoa Itapeva (29°24'35''S and 049°48'24''W) is a protected area of sustainable use, located in and administered by the municipality of Torres, in the coastal region of north-eastern Rio Grande do Sul state, southern Brazil (Figure 1). It covers an area of 436.99 ha, adjacent to the Itapeva State Park, and was created in 7 December 1999 (Municipal Law n. 3.372/1999), as a way to mitigate the environmental impacts caused by the construction of a local airport and to protect the natural ecosystems surrounding the Itapeva lagoon. This freshwater lagoon lies between the municipalities of Torres, Arroio do Sal, Dom Pedro de Alcântara and Três Cachoeiras in Rio Grande do Sul, integrating a large chain of coastal lagoons of Holocene origin that lie along the Atlantic coast from southern Santa Catarina state south to Uruguay. Together, they are considered a region of extreme ecological importance (GUADAGNIN & LAIDNER, 1999).

The landscape found in the Environmental Protection Area and its immediate surroundings is composed by a mosaic of habitats typical of the Atlantic Forest-Pampas ecotone, including native wetland, *restinga*, grassland and dense lowland forest (Figure 2). Human-derived habitats, including plantations of exotic trees and cattle pastures, are also present (TEIXEIRA *et al*., 1986; GUADAGNIN & LAIDNER, 1999). Detailed descriptions of each local habitat may be found in Gava-Just *et al*. (2018).

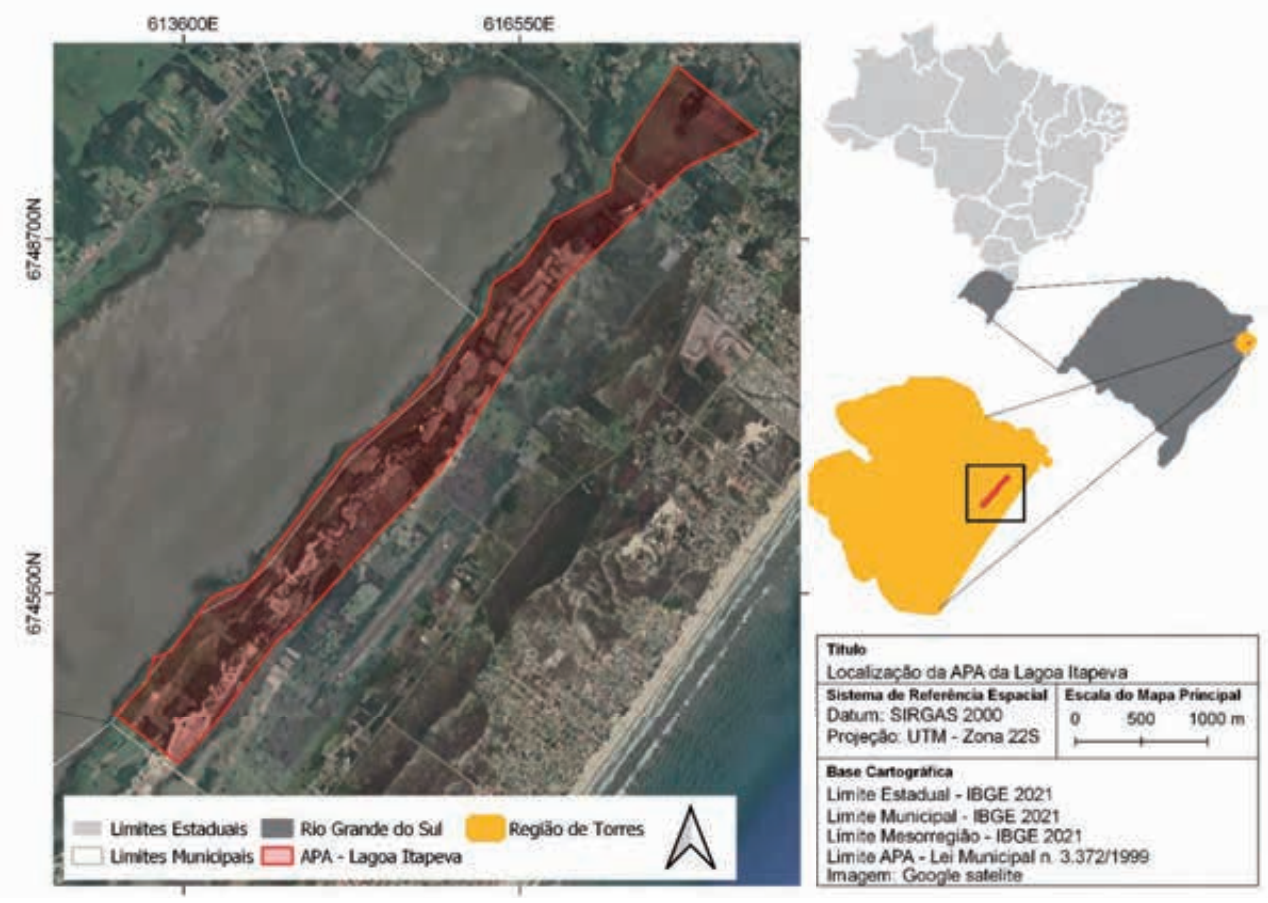

Figure 1 – Location of the Environmental Protection Area of Lagoa de Itapeva, Torres municipality, state of Rio Grande do Sul. Source: Jéssica Patrício dos Santos.

Figure 2 – Aerial view of landscape configuration within the Environmental Protection Area of Lagoa de Itapeva. Source: Ricardo Dossa Colvero.

DATA COLLECTION

To ensure the quality, utility and accuracy of our bird inventory, we followed the steps laid out by LEES *et al*. (2014). These consisted primarily of field surveys and was complemented by searches for additional historical and recent records in museum collections, scientific literature and online databases (including citizen science-based). We made a total of 100 hours of field surveys from 07:00-11:00h and 15:00-19:00h over 15 non-consecutive days, between September 2015 and March 2016 and September 2019 and May 2021, on two private properties in the north-eastern portion of Environmental Protection Area of Lagoa de Itapeva (29°25'06"S and 49°49'23"W). During the surveys, we tried to employ equal effort to each of the four main habitat types (forest, *restinga,* grassland and wetland). In each survey, we applied the line transects method, on which we walked slowly along pre-existing trails and roads, noting all bird species that were seen or heard and the habitats (see above) in which each one occurred. Digital reference material (bird's photos and voices recorded) obtained during fieldwork, was archived in the website WikiAves (http://www.wikiaves.com.br).

To complement data, we searched specimen records in scientific collections in Vertnet Portal (http://www.vertnet.org), SpeciesLink (http://www.splink.org.br) and Coleções PUCRS (http://www.pucrs.br/mct/colecoes/ornitologia). Specimens mentioned in this manuscript are housed in the American Museum of Natural History (AMNH), New York, USA, and in the Museu de Ciências e Tecnologia (MCP), Pontifícia Universidade Católica do Rio Grande do Sul, Porto Alegre, Brazil. We also searched for digital records (photographs and voice-recordings) in online databases of WikiAves (WA; http://www.wikiaves.com.br), Xeno-canto (XC; https://xeno-canto.org/) and Macaulay Library (ML; https://www.macaulaylibrary.org), before 7 March 2020.

We included all records from within a 15 km buffer around the Environmental Protection Area, to include species that were unrecorded during our surveys but that presumably occur within the

area. This resulted in the inclusion of records from the municipalities of Torres, Arroio do Sal and Dom Pedro de Alcântara, in Rio Grande do Sul. Records were only included when a locality could be attributed to it and when the required habitat for the species was present at the Environmental Protection Area of Lagoa de Itapeva. For instance, we excluded several marine and forest-dwelling species that occurred within the buffer zone but whose habitat was unavailable in the Environmental Protection Area.

STATUS AND NOMENCLATURE OF TAXA

Nomenclature, systematics and portuguese names follow the Brazilian Ornithological Records Committee (PACHECO *et al*., 2021). The presence of endemic species was determined by comparison with the lists of bird's endemic to the Atlantic Forest (VALE *et al*., 2018) and Pampas (BENCKE *et al*., 2006) and migratory species from the list of the migratory birds of Brazil (SOMENZARI *et al*., 2018). Threatened species were verified in state (RIO GRANDE DO SUL, 2014), national (ICMBIO/MMA, 2018) and global (IUCN, 2021) redlists.

We further classified migratory species as follows: "Nearctic": species that breed in the Northern Hemisphere and move southward for the austral winter; "Austral": species that breed in austral regions of South America and move northward for the austral winter; "Neotropical": species that breed in southern temperate and subtropical regions of South America and then move northward to spend the austral winter in tropical humid regions; "Western": species that perform west-east migrations between the wetlands and rivers in Argentina and Paraguay and coastal wetlands in southern Brazil. It is important to note that some species classified as migrants may have populations that are only partially migratory in the region (SOMENZARI *et al*., 2018).

RESULTS

We recorded a total of 162 species during field surveys inside the Environmental Protection Area of Lagoa Itapeva, of which 97 (59%) possessed digital vouchers (Table 1, Figure 3). Only a single species was added to the list after conference in online database, namely *Tachybaptus dominicus* (Linnaeus, 1766) (see record in http://wikiaves.com.br/046605). Museum searches, in turn, resulted in no specimens recorded. Other 38 species were recorded within the 15 km buffer of the Environmental Protection Area and are considered of likely occurrence within the protected area (Table 1). Therefore, we presume that there are 200 species to occur within the Environmental Protection Area, of which we recorded 81%. In terms of habitats and their bird richness, 76 species were recorded in *restingas,* 71 in wetlands, 61 in grasslands, 54 in forests and three are only flying-over species.

Figure 3 – Some bird species photographed during surveys in the Environmental Protection Area of Lagoa de Itapeva, highlighting mainly wetland and grassland-dwellers. A – *Tachuris rubrigastra*; B – *Circus buffoni*; C – *Serpophaga nigricans*; D – *Pseudocolopteryx flaviventris*; E – *Pitangus sulphuratus*; F – *Mustelirallus albicollis*; G – *Coryphospingus cucullatus*; H – *Anumbius annumbi*; I – *Geothlypis aequinoctialis*; J – *Phleocryptes melanops*; K – *Sporophila collaris*; L – *Tachycineta leucorrhoa*. Source: Gustavo Piletti Plucenio (A-G, I, J and L), João Paulo Gava-Just (H) and Ricardo Dossa Colvero (K).

ENDEMIC SPECIES

Seven of the species recorded during field surveys are endemic to the Atlantic Forest, namely *Aramides saracura* (Spix, 1825), *Ramphastos dicolorus* Linnaeus, 1766 *Chiroxiphia caudata* (Shaw & Nodder, 1793), *Phylloscartes kronei* Willis & Oniki, 1992, *Haplospiza unicolor* Cabanis, 1851, *Tachyphonus coronatus* (Vieillot, 1822) and *Euphonia pectoralis* (Latham, 1801). No Pampas endemic species was recorded within the Environmental Protection Area. Three other endemic species were recorded only in the buffer zone in the surroundings of the Environmental Protection Area, including *Megascops sanctaecatarinae* (Salvin, 1897) and *Thalurania glaucopis* (Gmelin, 1788) from the Atlantic Forest and *Limnornis curvirostris* Gould, 1839 from the Pampas.

THREATENED SPECIES

Two threatened species were recorded inside the Environmental Protection Area, namely *Phylloscartes kronei* Willis & Oniki, 1992 and *Manacus manacus* (Linnaeus, 1766), which are classified in the “vulnerable” category in the redlist of Rio Grande do Sul state. The first species was recorded

once on 7 September 2015, at the edge of arboreal *restingas* within the northeastern portion of the Environmental Protection Area. In addition, this species is locally common at the surrounding Itapeva State Park (29°21'05.89"S and 49°45'26.89"O). The latter species was recorded twice through detection of adult and juvenile individuals on 7 September 2015 and 19 June 2016, also at the edge of arboreal *restingas* within the northeastern portion of the Environmental Protection Area. Additional records of *M. manacus* in the immediate surroundings of the Environmental Protection Area were made in Vila São João (29°18'24.41"S and 49°45'59.19"O; G.P. Plucenio), Itapeva State Park (29°21'05.89"S and 49°45'26.89"O; M. Giotto and C.N. Kuhn) and Centenário (29°19'19.04"S and 49°45'24.38"O; R.D. Colvero), all of them in Torres municipality (Figure 4).

Sporophila collaris (Boddaert, 1783), on its turn, deserves certain conservation concern as it is classified as a 'near threatened' species in the same state redlist. Two individuals, an adult male and an adult female, were photographed once by us on 18 February 2019, in marshes surrounding the Itapeva lagoon within the Environmental Protection Area (Figure 3).

Figure 4 – Some photographic records of *Manacus manacus* (*rendeira*) in the Environmental Protection Area of Lagoa de Itapeva and its immediate surroundings, municipality of Torres, Rio Grande do Sul. A: Adult male within *restinga* at the Environmental Protection Area; B-C: Adult female in lowland forest remnant at Vila São João. Source: Ricardo Dossa Colvero (A) and Gustavo Piletti Plucenio (B and C).

MIGRATORY SPECIES

We also recorded 33 migratory species in the study area, some 17% of the total species richness (Table 1). From this, 21 are Neotropical migrants, seven Western migrants, four Nearctic migrants and two Austral migrants (Table 1). Neotropical are mainly small-bodied insectivore passerines (76% of the total), but there are some few exceptions from Cuculidae (cuckoos), Rallidae (gallinules), Nyctibiidae (potoos) and Sternidae (terns). Nearctic are two shorebirds from Scolopacidae and two grassland-dwelling swallows from Hirundinidae. Western migrants are represented by large-bodied aquatic birds from Anatidae (teals and swans), Ciconiidae (woodstorks), Threskiornithidae (ibises) and Accipitridae (snail kites). Finally, Austral ones are two small-bodied passerines from Mimidae and Tyrannidae that inhabit *restingas* and/or marshes.

Table 1 – Bird species recorded within the Environmental Protection Area of Lagoa Itapeva and immediate surroundings, Torres municipality, Rio Grande do Sul state, southern Brazil, with habitat preference and reference voucher numbers. Species names given in square parentheses represent taxa recorded only in the immediate surroundings of the Environmental Protection Area and that are presumed to also occur within this protected area. Status refers to endemism (atl = Atlantic Forest, pam = Pampas) or migration (am = Austral migrant, nm = Nearctic migrant, tm = Neotropical migrant, we = Western migrant). Habitats in which species were recorded during field surveys include forest (for), grassland (gra), *restinga* (res) and wetland (wet). WikiAves (http://www.wikiaves.com.br) catalogue numbers of photographs and voice-recordings obtained during surveys are given as voucher reference numbers. The symbol – means that there is no information about this topic.

Scientific name	Portuguese name	Status	Habitat	Voucher
Tinamidae				
Nothura maculosa (Temminck, 1815)	codorna-amarela	-	gra	WA1875503, WA1966996
Anhimidae				
Chauna torquata (Oken, 1816)	tachã	-	wet	WA183436, WA1834022
Anatidae				
Dendrocygna viduata (Linnaeus, 1766)	irerê	-	wet	WA1826810
[*Cygnus melacoryphus* (Molina, 1782)]	cisne-de-pescoço-preto	-	wet	-
Coscoroba coscoroba (Molina, 1782)	capororoca	we	wet	-
Amazonetta brasiliensis (Gmelin, 1789)	marreca-ananaí	-	wet	WA1834037
Spatula versicolor (Vieillot, 1816)	marreca-cri-cri	we	wet	WA1826786
Anas georgica Gmelin, 1789	marreca-parda	we	wet	-
Cracidae				
Ortalis squamata (Lesson, 1829)	aracuã-escamado	atl	res	-
Caprimulgidae				
[*Rollandia rolland* (Quoy & Gaimard, 1824)]	mergulhão-de-orelha-branca	-	wet	-
Tachybaptus dominicus (Linnaeus, 1766)	mergulhão-pequeno	-	wet	WA046605
[*Podilymbus podiceps* (Linnaeus, 1758)]	mergulhão-caçador	-	wet	-
[*Podicephorus major* (Boddaert, 1783)]	mergulhão-grande	-	wet	-
Columbidae				
Patagioenas picazuro (Temminck, 1813)	pomba-asa-branca	-	for, gra, res	-
Leptotila verreauxi Bonaparte, 1855	juriti-pupu	-	for, res	-
Zenaida auriculata (Des Murs, 1847)	avoante	-	gra, res	WA1826811
Columbina talpacoti (Temminck, 1810)	rolinha-roxa	-	gra, res	-
Columbina picui (Temminck, 1813)	rolinha-picuí	-	gra, res	-

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Continuação da tabela 1

Scientific name	Portuguese name	Status	Habitat	Voucher
Cuculidae				
Guira guira (Gmelin, 1788)	anu-branco	-	gra, res	-
Crotophaga ani Linnaeus, 1758	anu-preto	-	gra, res, wet	-
Tapera naevia (Linnaeus, 1766)	saci	-	res	WA1823654
[*Micrococcyx cinereus* (Vieillot, 1817)]	papa-lagarta-cinzento	tm	res	-
Piaya cayana (Linnaeus, 1766)	alma-de-gato	-	for, res	WA1826625
[*Coccyzus melacoryphus* Vieillot, 1817]	papa-lagarta-acanelado	tm	res	-
Nyctibiidae				
[*Nyctibius griseus* (Gmelin, 1789)]	urutau	tm	for	-
Caprimulgidae				
Nyctidromus albicollis (Gmelin, 1789)	bacurau	-	res	WA2047054
Hydropsalis torquata (Gmelin, 1789)	bacurau-tesoura	-	res	WA1966979
[*Podager nacunda* (Vieillot, 1817)]	corucão	-	gra	-
Apodidae				
Streptoprocne zonaris (Shaw, 1796)	taperuçu-de-coleira-branca	-	fly	WA2083945
Trochilidae				
[*Florisuga fusca* (Vieillot, 1817)]	beija-flor-preto	-	for	-
[*Anthracothorax nigricollis* (Vieillot, 1817)]	beija-flor-de-veste-preta	-	res	-
Chlorostilbon lucidus (Shaw, 1812)	besourinho-de-bico-vermelho	-	gra, res	WA2052774
[*Thalurania glaucopis* (Gmelin, 1788)]	beija-flor-de-fronte-violeta	atl	for, res	-
[*Eupetomena macroura* (Gmelin, 1788)]	beija-flor-tesoura	-	res	-
[*Leucochloris albicollis* (Vieillot, 1818)]	beija-flor-de-papo-branca	-	for, res	-
Chionomesa fimbriata (Gmelin, 1788)	beija-flor-de-garganta-verde	-	for, res	WA1834353
Hylocharis chrysura (Shaw, 1812)	beija-flor-dourado	-	res	-
Aramidae				
Aramus guarauna (Linnaeus, 1766)	carão	-	wet	WA1838227
Rallidae				
Porphyrio martinica (Linnaeus, 1766)	frango-d'água-azul	tm	wet	-
Laterallus melanophaius (Vieillot, 1819)	sanã-parda	-	wet	WA1834367
Mustelirallus albicollis (Vieillot, 1819)	sanã-carijó	-	wet	WA1889433, WA4309628
Pardirallus nigricans (Vieillot, 1819)	saracura-sanã	-	wet	-
Pardirallus sanguinolentus (Swainson, 1838)	saracura-do-banhado	-	wet	-
Aramides ypecaha (Vieillot, 1819)	saracuruçu	-	wet	WA1966991
Aramides cajaneus (Statius Muller, 1776)	saracura-três-potes	-	for	WA1889434
Aramides saracura (Spix, 1825)	saracura-do-mato	atl	for, res	-
Gallinula galeata (Lichtenstein, 1818)	frango-d'água	-	wet	WA1826784

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Continuação da tabela 1

Scientific name	Portuguese name	Status	Habitat	Voucher
Charadriidae				
Vanellus chilensis (Molina, 1782)	quero-quero	-	gra, wet	-
[*Charadrius collaris* Vieillot, 1818]	batuíra-de-coleira	-	wet	-
Scolopacidae				
[*Gallinago undulata* (Boddaert, 1783)]	narcejão	-	wet	-
Gallinago paraguaiae (Vieillot, 1816)	narceja	-	wet	-
[*Actitis macularius* (Linnaeus, 1766)]	maçarico-pintado	nm	wet	-
[*Tringa flavipes* (Gmelin, 1789)]	maçarico-de-perna-amarela	nm	wet	-
Jacanidae				
Jacana jacana (Linnaeus, 1766)	jaçanã	-	wet	-
Laridae				
Chroicocephalus cirrocephalus (Vieillot, 1818)	gaivota-de-cabeça-cinza	-	wet	WA1837786
[*Rynchops niger* Linnaeus, 1758]	talha-mar	-	wet	-
Sterna trudeaui Audubon, 1838	trinta-réis-de-coroa-branca	tm	wet	WA1834021
Ciconiidae				
Ciconia maguari (Gmelin, 1789)	maguari	-	wet	WA1826787
[*Mycteria americana* Linnaeus, 1758]	cabeça-seca	we	wet	-
Phalacrocoracidae				
Nannopterum brasilianus (Gmelin, 1789)	biguá	-	wet	WA1823743
Ardeidae				
[*Tigrisoma lineatum* (Boddaert, 1783)]	socó-boi	-	wet	-
[*Botaurus pinnatus* (Wagler, 1829)]	socó-boi-baio	-	wet	-
[*Nycticorax nycticorax* (Linnaeus, 1758)]	socó-dorminhoco	-	wet	-
Butorides striata (Linnaeus, 1758)	socozinho	-	wet	-
Bubulcus ibis (Linnaeus, 1758)	garça-vaqueira	-	gra	WA1834024
Ardea cocoi Linnaeus, 1766	garça-moura	-	wet	WA1879555
Ardea alba Linnaeus, 1758	garça-branca	-	wet	-
Syrigma sibilatrix (Temminck, 1824)	maria-faceira	-	gra	-
Egretta thula (Molina, 1782)	garça-pequena	-	wet	-
[*Egretta caerulea* (Linnaeus, 1758)]	garça-azul	-	wet	-
Threskiornithidae				
Plegadis chihi (Vieillot, 1817)	caraúna	we	wet	WA1826376
Phimosus infuscatus (Lichtenstein, 1823)	tapicuru	-	gra, wet	-
Theristicus caudatus (Boddaert, 1783)	curicaca	-	gra	WA1826633, WA1823764
Platalea ajaja Linnaeus, 1758	colhereiro	we	wet	-
Cathartidae				
Coragyps atratus (Bechstein, 1793)	urubu-de-cabeça-preta	-	fly	-
Cathartes aura (Linnaeus, 1758)	urubu-de-cabeça-vermelha	-	fly	WA1834020
Cathartes burrovianus Cassin, 1845	urubu-de-cabeça-amarela	-	gra	-

continua...

Continuação da tabela 1

Scientific name	Portuguese name	Status	Habitat	Voucher
Accipitridae				
Rostrhamus sociabilis (Vieillot, 1817)	gavião-caramujeiro	we	wet	WA1823761
Circus buffoni (Gmelin, 1788)	gavião-do-banhado	-	gra, wet	WA1837776, WA4309623
Heterospizias meridionalis (Latham, 1790)	gavião-caboclo	-	gra, wet	-
[*Urubitinga urubitinga* (Gmelin, 1788)]	gavião-preto	-	gra, wet	-
Rupornis magnirostris (Gmelin, 1788)	gavião-carijó	-	for, res	-
Strigidae				
[*Megascops sanctaecatarinae* (Salvin, 1897)]	corujinha-do-sul	atl	for	-
Bubo virginianus (Gmelin, 1788)	jacurutu	-	for	WA1834360, WA1879580
Athene cunicularia (Molina, 1782)	coruja-buraqueira	-	gra	-
Alcedinidae				
Megaceryle torquata (Linnaeus, 1766)	martim-pescador-grande	-	wet	WA1823646
Chloroceryle amazona (Latham, 1790)	martim-pescador-verde	-	wet	-
Ramphastidae				
Ramphastos dicolorus Linnaeus, 1766	tucano-de-bico-verde	atl	for	-
Picidae				
Picumnus temminckii Lafresnaye, 1845	pica-pau-anão-de-coleira	-	for	-
Melanerpes candidus (Otto, 1796)	pica-pau-branco	-	res	WA1826616
Veniliornis spilogaster (Wagler, 1827)	pica-pau-verde-carijó	-	for	-
Celeus flavescens (Gmelin, 1788)	pica-pau-de-cabeça-amarela	-	for	-
Colaptes melanochloros (Gmelin, 1788)	pica-pau-verde-barrado	-	res	-
Colaptes campestris (Vieillot, 1818)	pica-pau-do-campo	-	gra	-
Falconidae				
Herpetotheres cachinnans (Linnaeus, 1758)	acauã	-	res	WA1826613, WA2050873
Caracara plancus (Miller, 1777)	carcará	-	gra	WA1826374
Milvago chimachima (Vieillot, 1816)	carrapateiro	-	res	WA1826378
Milvago chimango (Vieillot, 1816)	ximango	-	gra	-
Falco sparverius Linnaeus, 1758	quiri-quiri	-	gra	-
Psittacidae				
Myiopsitta monachus (Boddaert, 1783)	caturrita	-	gra	WA1826379, WA1826621
Thamnophilidae				
Thamnophilus ruficapillus Vieillot, 1816	choca-de-chapéu-vermelho	-	res	WA1823656
Thamnophilus caerulescens Vieillot, 1816	choca-da-mata	-	for, res	-
Conopophagidae				
[*Conopophaga lineata* (Wied, 1831)]	chupa-dente	-	for, res	-
Dendrocolaptidae				
Dendrocolaptes platyrostris Spix, 1825	arapaçu-grande	-	for	WA2042263

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Continuação da tabela 1

Scientific name	Portuguese name	Status	Habitat	Voucher
Furnariidae				
Furnarius rufus (Gmelin, 1788)	joão-de-barro	-	gra	WA1834023
Phleocryptes melanops (Vieillot, 1817)	bate-bico	-	wet	WA3506408
[*Limnornis curvirostris* Gould, 1839]	joão-da-palha	pam	wet	-
[*Phacellodomus ferrugineigula* (Pelzeln, 1858)]	joão-botina-do-brejo	-	wet	-
Anumbius annumbi (Vieillot, 1817)	cochicho	-	gra	WA2042655
Certhiaxis cinnamomeus (Gmelin, 1788)	curutié	-	wet	WA1837787
Schoeniophylax phryganophilus (Vieillot, 1817)	bichoita	-	gra	WA1823650, WA1823742
Synallaxis spixi Sclater, 1856	joão-teneném	-	for, res	WA1823651
Pipridae				
Chiroxiphia caudata (Shaw & Nodder, 1793)	tangará	atl	for	WA1826603
Manacus manacus (Linnaeus, 1766)	rendeira	-	for	WA1825868, WA1826628
Tityridae				
Pachyramphus polychopterus (Vieillot, 1818)	caneleiro-preto	tm	for	-
Platyrinchidae				
Platyrinchus mystaceus Vieillot, 1818	patinho	-	for	WA1834374
Tachurisidae				
Tachuris rubrigastra (Vieillot, 1817)	papa-piri	-	wet	WA4457885
Rhynchocyclidae				
Phylloscartes kronei Willis & Oniki, 1992	maria-da-restinga	atl	for	WA1826623
[*Tolmomyias sulphurescens* (Spix, 1825)]	bico-chato-de-orelha-preta	-	for, res	-
[*Todirostrum cinereum* (Linnaeus, 1766)]	ferreirinho-relógio	-	res	-
Poecilotriccus plumbeiceps (Lafresnaye, 1846)	tororó	-	for, res	-
Tyrannidae				
[*Euscarthmus meloryphus* (Wied, 1831)]	barulhento	-	res	
Camptostoma obsoletum (Temminck, 1824)	risadinha	-	for, res	WA1826600
Elaenia flavogaster (Thunberg, 1822)	guaracava-de-barriga-amarela	-	gra, res	WA1879178
Elaenia parvirostris Pelzeln, 1868	tuque-pium	tm	res	WA1879181
[*Elaenia mesoleuca* (Deppe, 1830)]	tuque	-	for, res	-
Elaenia obscura (d'Orbigny & Lafresnaye, 1837)	tucão	-	res	WA1823642, WA1837792
Pseudocolopteryx flaviventris (d'Orbigny & Lafresnaye, 1837)	amarelinho-do-junco	am	wet	WA1875505, WA4309611
Serpophaga nigricans (Vieillot, 1817)	joão-pobre	-	wet	WA1826785, WA4309620
Serpophaga subcristata (Vieillot, 1817)	alegrinho	-	res	-
Legatus leucophaius (Vieillot, 1818)	bem-te-vi-pirata	tm	res	WA1879593
Myiarchus swainsoni Cabanis & Heine, 1859	irré	-	for	WA1875207

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Continuação da tabela 1

Scientific name	Portuguese name	Status	Habitat	Voucher
Pitangus sulphuratus (Linnaeus, 1766)	bem-te-vi	-	for, gra, res, wet	WA1826370
Machetornis rixosa (Vieillot, 1819)	suiriri-cavaleiro	-	gra	WA1834038
[*Myiodynastes maculatus* (Statius Muller, 1776)]	bem-te-vi-rajado	tm	for, res	-
Megarynchus pitangua (Linnaeus, 1766)	nei-nei	-	for, res	WA2045061
Tyrannus melancholicus Vieillot, 1819	suiriri	tm	gra, res	-
Tyrannus savana Daudin, 1802	tesourinha	tm	gra, res	-
Empidonomus varius (Vieillot, 1818)	peitica	tm	res	-
Arundinicola leucocephala (Linnaeus, 1764)	feirinha	-	wet	WA1826380
Pyrocephalus rubinus (Boddaert, 1783)	príncipe	tm	gra	WA1879584
Myiophobus fasciatus (Statius Muller, 1776)	filipe	-	res	-
Lathrotriccus euleri (Cabanis, 1868)	enferrujado	tm	for	WA1834370
Satrapa icterophrys (Vieillot, 1818)	suiriri-pequeno	-	gra	-
Xolmis irupero (Vieillot, 1823)	noivinha	-	gra	WA1826788
Vireonidae				
Cyclarhis gujanensis (Gmelin, 1789)	pitiguari		for, res	WA1823641
Vireo chivi (Vieillot, 1817)	juruviara	tm	for, res	WA1875209
Hirundinidae				
Pygochelidon cyanoleuca (Vieillot, 1817)	andorinha-pequena-de-casa	-	gra	-
Alopochelidon fucata (Temminck, 1822)	andorinha-morena	-	gra	WA1823741
[*Stelgidopteryx ruficollis* (Vieillot, 1817)]	andorinha-serradora	-	gra	-
Progne tapera (Vieillot, 1817)	andorinha-do-campo	tm	gra	-
Progne chalybea (Gmelin, 1789)	andorinha-grande	-	gra	-
Tachycineta leucorrhoa (Vieillot, 1817)	andorinha-de-sobre-branco	-	gra, wet	WA1838226
[*Riparia riparia* (Linnaeus, 1758)]	andorinha-do-barranco	nm	gra	-
Hirundo rustica Linnaeus, 1758	andorinha-de-bando	nm	gra	-
Troglodytidae				
Troglodytes musculus Naumann, 1823	corruíra	-	gra, res	-
Turdidae				
Turdus leucomelas Vieillot, 1818	sabiá-barranco	-	for	WA1834378
Turdus rufiventris Vieillot, 1818	sabiá-laranjeira	-	for, gra, res	-
Turdus amaurochalinus Cabanis, 1850	sabiá-poca	tm	for, gra, res	-
Turdus subalaris (Seebohm, 1887)	sabiá-ferreiro	-	res	WA1826636
Turdus albicollis Vieillot, 1818	sabiá-coleira	-	for	WA1834385
Mimidae				
Mimus saturninus (Lichtenstein, 1823)	sabiá-do-campo	-	gra, res	WA1837794, WA1826620
Mimus triurus (Vieillot, 1818)	calhandra-de-três-rabos	am	res	WA1837775
Motacillidae				
Anthus chii Vieillot, 1818	caminheiro-zumbidor	-	gra	WA1838228

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Continuação da tabela 1

Scientific name	Portuguese name	Status	Habitat	Voucher
Fringillidae				
Euphonia chlorotica (Linnaeus, 1766)	fim-fim	-	for, res	WA1826608
Euphonia violacea (Linnaeus, 1758)	gaturamo	-	for, res	-
Euphonia pectoralis (Latham, 1801)	ferro-velho	atl	for	WA1879583
Passerellidae				
Ammodramus humeralis (Bosc, 1792)	tico-tico-do-campo	-	gra	WA1966992
Zonotrichia capensis (Statius Muller, 1776)	tico-tico	-	gra, res	-
Icteridae				
Leistes superciliaris (Bonaparte, 1850)	polícia-inglesa-do-sul	-	gra, wet	WA1826813
Icterus pyrrhopterus (Vieillot, 1819)	encontro	-	res	-
Molothrus bonariensis (Gmelin, 1789)	chupim	-	gra, res	WA1837793
Amblyramphus holosericeus (Scopoli, 1786)	cardeal-do-banhado	-	wet	-
Agelaioides badius (Vieillot, 1819)	asa-de-telha	-	gra, res	WA1826369
Agelasticus thilius (Molina, 1782)	sargento	-	wet	WA1826815
Chrysomus ruficapillus (Vieillot, 1819)	garibaldi	-	wet	-
Pseudoleistes guirahuro (Vieillot, 1819)	chupim-do-brejo	-	res	-
Pseudoleistes virescens (Vieillot, 1819)	dragão	-	gra, wet	WA1823762, WA1823648
Parulidae				
Geothlypis aequinoctialis (Gmelin, 1789)	pia-cobra	-	gra, res, wet	WA1875500
Setophaga pitiayumi (Vieillot, 1817)	mariquita	-	for, res	-
Basileuterus culicivorus (Deppe, 1830)	pula-pula	-	for, res	WA1823632
Thraupidae				-
Embernagra platensis (Gmelin, 1789)	sabiá-do-banhado	-	gra, wet	WA1834036, WA1823643
Emberizoides ypiranganus Ihering & Ihering, 1907	canário-do-brejo	-	gra, wet	WA1826373, WA1826606
Tersina viridis (Illiger, 1811)	saí-andorinha	tm	res	-
Dacnis cayana (Linnaeus, 1766)	saí-azul	-	for	-
Saltator similis d'Orbigny & Lafresnaye, 1837	trinca-ferro	-	for	WA1826879
Coereba flaveola (Linnaeus, 1758)	cambacica	-	for, res	WA1826372, WA1826604
Coryphospingus cucullatus (Statius Muller, 1776)	tico-tico-rei	-	res	WA1826615
Tachyphonus coronatus (Vieillot, 1822)	tiê-preto	atl	for	WA1823652
Sporophila collaris (Boddaert, 1783)	coleiro-do-brejo	-	wet	WA3284741
Sporophila caerulescens (Vieillot, 1823)	coleirinho	tm	gra, res	WA1879554, WA1879188
Donacospiza albifrons (Vieillot, 1817)	tico-tico-do-banhado	-	wet	-
Sicalis flaveola (Linnaeus, 1766)	canário-da-terra	-	gra, res	WA1823760
Sicalis luteola (Sparrman, 1789)	tipio	-	gra, wet	WA1966990
Haplospiza unicolor Cabanis, 1851	cigarra-bambu	atl	for	-
[*Pipraeidea melanonota* (Vieillot, 1819)]	saíra-viúva	-	for, for	-
[*Rauenia bonariensis* (Gmelin, 1789)]	sanhaço-papa-laranja	-	res	-

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Continuação da tabela 1

Scientific name	Portuguese name	Status	Habitat	Voucher
[*Stephanophorus diadematus* (Temminck, 1823)]	sanhaço-frade	-	for, res	-
Paroaria coronata (Miller, 1776)	cardeal	-	gra	WA1826377
Thraupis sayaca (Linnaeus, 1766)	sanhaço-cinzento	-	for, res	-

DISCUSSION

The total number of bird species occurring in the Environmental Protection Area and its immediate surroundings represents 40% of the total number recorded for the coasts of Santa Catarina and Rio Grande do Sul states (JPG Just *pers. obs.*). Surely, this diverse avifauna currently observed here is derived from the complex structure of local habitats mosaic present in the Environmental Protection Area (*i.e*, wetlands, restingas, lowland forests and grasslands). That is to say, local landscapes with multiple habitats tend to harbor diversified animal communities (TEWS *et al*., 2004). However, direct comparisons with bird diversity from other sites in the region are hampered by a set of methodological and biological aspects, as well as a lack of robust inventories in the area. Just for the record, current species richness observed for the Environmental Protection Area of Lagoa de Itapeva is greater than that of surrounding sites such as Capão da Canoa coastal area (111 species; SANABRIA, 2009) and ten sites in southern Santa Catarina coastal lagoons (72-156 species; GAVA-JUST *et al*., 2018), but lower than in Itapeva State Park (177 species; SEMA, 2006).

Previous to our study, 50 species were listed to the Environmental Protection Area, with special reference to common and widely distributed birds, as *Pitangus sulphuratus* (Linnaeus, 1766)*, Furnarius rufus* (Gmelin, 1788)*, Vanellus chilensis* (Molina, 1782) and *Syrigma sibilatrix* (Temminck, 1824) (ABG, 1998; SILVA *et al*., 2008). We added 112 species to the list of this protected area, an improvement of almost 230%. Most species unrecorded in previous surveys are wetland-dwellers that present low detectability as *Mustelirallus albicollis* (Vieillot, 1819), *Sporophila collaris* (Boddaert, 1783), *Phleocryptes melanops* (Vieillot, 1817), *Tachuris rubrigastra* (Vieillot, 1817), *Pseudocolopteryx flaviventris* (d'Orbigny & Lafresnaye, 1837) and *Donacospiza albifrons* (Vieillot, 1817), as well as forest-dwellers as *Euphonia pectoralis* (Latham, 1801), *Chiroxiphia caudata* (Shaw & Nodder, 1793), *Platyrinchus mystaceus* Vieillot, 1818, *Phylloscartes kronei* Willis & Oniki, 1992 and *Xiphocolaptes albicollis* (Vieillot, 1818). Hence, we distress here the importance of rigorous bird inventories in protected areas, conducted by experienced ornithologists, combining adequate field surveys with searches in museums, literature and citizen-science databases (see LEES *et al*., 2014).

It is important to notice that bird assemblages in the ecotonal habitats of Environment Protection Area of Lagoa de Itapeva contain few threatened and endemic species (STRAUBE & DI GIACOMO, 2007). Endemic species recorded in the Environment Protection Area, for instance, represent only 0.03% of the whole Atlantic Forest endemics (223 species; VALE *et al*., 2018) and 0.0% of the whole Pampas endemics (8 species; BENCKE *et al*., 2006). For comparison, nearby coastal lagoons in southern Santa Catarina also holds low Atlantic Forest (4.48%) and Pampas endemics (25%), but have more threatened taxa due to the presence of sea beach-dwelling taxa (GAVA-JUST *et al*., 2018). Itapeva State Park, on its turn, located just *ca*. 5 km of distance from the Environmental Protection Area, harbors relatively more threatened (14 species) and endemic species from the Atlantic Forest (18 species) (SEMA, 2006). Such pattern should be attributed to the *ca*. 300 ha lowland forest remnant in the State Park and consequent presence of several regional threatened forest taxa, as *Attila rufus* (Vieillot, 1819), *Myrmoderus squamosus* (Pelzeln, 1868) and *Eleoscytalopus indigoticus* (Wied, 1831) (SEMA, 2006).

Indeed, in a descriptive manner, there are clear patterns in the avifauna from the Atlantic Forest-Pampas ecotone in the Environmental Protection Area region. Firstly, the richness and abundance of Atlantic Forest endemic species seems to decrease on a southward trajectory due to biogeographical issues copped with gradual shifts in variables such as temperature, precipitation and geomorphology

(SILVA *et al*., 2004; BENCKE, 2010). In addition, the intense fragmentation of lowland forests in the region may have also reduced the number of Atlantic Forest endemics present, as it is highly likely that species sensitive to deforestation may have become locally extinct. This includes examples such as *Platyrinchus leucoryphus* Wied, 1831, *Celeus galeatus* (Temminck, 1822) and *Selenidera maculirostris* (Lichtenstein, 1823), already proven to be extincted in coastal Rio Grande do Sul (RIO GRANDE DO SUL, 2014). Simultaneously, species previously associated with open environments in the Pampas, such as *Phimosus infuscatus* (Lichtenstein, 1823) and *Myiopsitta monachus* (Boddaert, 1783), have thrived and expanded their ranges northwards in Atlantic Forest degraded areas (PIACENTINI *et al*., 2009; VIANA *et al*., 2016). As a result, the endemic species from both the Atlantic Forest and the Pampas present in the local ecotone are few widespread and common taxa, with dominance of endemisms from the Atlantic Forest.

In wetlands and other open environments of the Environmental Protection Area, besides the dominance of widely distributed species, there is an influence of bird elements from the southern Pampean and Patagonian zoogeographical provinces, particularly with regards to waterfowl like *Coscoroba coscoroba* (Molina, 1782) and *Podicephorus major* (Boddaert, 1783), as well as passerines like *Pseudocolopteryx flaviventris* and *Mimus triurus* (Vieillot, 1818). In contrast, the forest and *restinga* assemblages are highly influenced by the occurrence of birds typical of northern lowland forests from the Paraná and Serra do Mar zoogeographical provinces, such as *Chionomesa fimbriata tephrocephala* (Vieillot, 1818), *Celeus flavescens flavescens* (Gmelin, 1788) and *Chiroxiphia caudata* (Shaw & Nodder, 1793).

These assemblages of resident species are further supplemented by a set of migratory species of variable migratory systems that seasonally inhabit the local grasslands, *restingas*, forests, and shallow lakes (GAVA-JUST *et al*., 2018). As detected in surrounding areas with similar habitats, such migrants are mainly represented by passerines from Tyrannidae and Hirundinidae families, shorebirds from Scolopacidae and Charadriidae and waterfowl from Anatidae and Podicipedidae (BELTON, 1994; GAVA-JUST *et al*., 2018). Migratory routes used by birds that arrive in the Environmental Protection Area include mainly the Atlantic route for shorebirds and interior neotropical route for passerines (CEMAVE/ICMBIO, 2016; SOMENZARI *et al*., 2018). In fact, the Environmental Protection Area may act as a stopover site for birds. *Restingas* and lowland forests, for instance, hold at least 14 species of migratory passerines with regular occurrence, as *Pachyramphus polychopterus* (Vieillot, 1818), *Myiodynastes maculatus* (Statius Muller, 1776), *Tyrannus melancholicus* Vieillot, 1819, *Elaenia parvirostris* Pelzeln, 1868 and *Lathrotriccus euleri* (Cabanis, 1868). However, the importance as a stopover sitedeserves further sistematic field surveys to be confirmed or not.

In fact, the coastal region of Rio Grande do Sul is traditionally recognized as a crucial stopover site for a number of migratory birds coming from different routes, with special reference to shorebirds (Charadriiformes) and *flamingos* (Phoenicopteridae) that spend some periods of their lifes in the globally important Lagoa do Peixe National Park (CEMAVE/ICMBio, 2019). Ultimately, the long-term preservation of local patches of adequate habitats for migratory birds, such as those present in the Environmental Protection Area, may benefit a permanent migratory corridor that connects the chain of lagoons and other marine-influenced environments in Rio Grande do Sul.

Finally, it is worthy to mention some conservation issues depicting the Environmental Protection Area of Lagoa de Itapeva. Ultimately, a key step for bird conservation in this protected area is preservation of the local mosaic of wetlands, grasslands, lowland forests and *restingas*. However, during field surveys, we detected some human-derived impacts that may hamper bird conservation there. In fact, Environmental Protection Area category permits some human interventions such as livestock raising and low-scale agriculture, while it prohibits others as mining and hunting (Federal Law n. 4.340 of 2002). However, if not controlled, local bird assemblages may suffer impacts by such permitted activities.

A program containing frequent inspection routines is recommended in order to prevent environmental crimes, such as the recurring fragmentation and degradation of woodlands (lowland forests and *restingas*) and drainage of wetlands. A restoration program of native habitats, inside the Environmental Protection Area and in its buffer zone, copped with sustainable economic practices (like agroforestry systems), is also paramount.

We also recommend long-term monitoring of bird assemblages using point-counts and mist-net capture-recapture protocols in the Environmental Protection Area of Lagoa de Itapeva, considering native habitats separately, as it may aid protected area management, since birds experience fine and rapid sensitivity to environmental alteration.

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