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ARTIGO

Effects of habitat fragmentation on grassland bird communities in a private farmland in the Pampa biome

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RESUMO: Efeitos da fragmentação de capinzais sobre a comunidade de aves campestres em uma propriedade particular no Bioma Pampa. A fragmentação e a degradação do habitat estão entre as principais causas do declínio de populações de aves campestres na América do Sul. No Bioma Pampa, a pecuária e a expansão das monoculturas de grãos são as principais ameaças à avifauna associada a paisagens abertas, como campos e capinzais. Neste estudo foi avaliada a presença de espécies de aves campestres em quatro fragmentos de capinzal de diferentes tamanhos (20 ha, n = 1; 1 ha, n = 3) em uma propriedade privada na região centro-oeste do Rio Grande do Sul, Brasil. Seis pontos de amostragem foram estabelecidos (três no maior fragmento e um cada um dos menores). As amostragens foram realizadas através de pontos fixos mensais (três no maior fragmento e um em cada menor) entre abril de 2005 e março de 2006. Foi avaliada também a similaridade entre os pares de fragmentos e a utilização dos ambientes que circundam os capinzais (monoculturas de grãos e pastagens). Foram registradas 55 espécies de aves, sendo 31 espécies apenas no maior fragmento, onde a riqueza foi maior (n = 53) do que nos fragmentos menores (n = 16, 18 e 15). Espécies ameaçadas e com deficiência de dados, como *Porzana albicollis, Culicivora caudacuta, Gubernetes yetapa* e *Sporophila bouvreuil* foram registradas principalmente no maior fragmento. Adicionalmente, *Synallaxis albescens, Polystictus pectoralis, Sporophila cinnamomea, Sporophila palustris* e *Cistothorus platensis* foram registradas no maior fragmento fora do período de estudo. Os maiores índices de similaridade foram encontrados entre os pontos de amostragem do maior fragmento. Nos ambientes vizinhos às áreas de capinzal foram registradas 35 espécies, incluindo *Bartramia longicauda* e *G. yetapa.* Grande parte destas freqüentemente move-se entre os ambientes vizinhos e os fragmentos de capinzal enquanto forrageiam.

PALAVRAS-CHAVE: aves, campos, fragmentação, Bioma Pampa.

ABSTRACT: Habitat fragmentation and degradation are the main causes of decline in grassland bird populations in South America. In the Pampa biome cattle raising and agriculture expansion are the main threats to the avifauna associated to open habitats. In this study I assess the presence of grassland bird species in four grassland patches of different sizes (20 ha, n = 1; 1 ha, n = 3) in a farmland in the west-central State of Rio Grande do Sul, Brazil. I established six sampling points (three in the largest patch and one in each of the small patches) and conducted monthly samplings from April 2005 to March 2006. Cattle were excluded from these fragments for four years to enable habitat restoration. I also calculated similarity indexes between pairs of sampling points and made some observations on the use of adjacent agricultural fields by birds. Fifty five bird species were recorded, 31 of them exclusively in the largest patch, which harbored more species (n = 53) than the smaller ones (n = 16, 18 and 15). Threatened and data deficient species, such as *Porzana albicollis, Culicivora caudacuta, Gubernetes yetapa* and *Sporophila bouvreuil* were recorded mainly in the largest patch during the survey. Additionally, in this same patch, *Synallaxis albescens¸ Polystictus pectoralis, Sporophila cinnamomea, Sporophila palustris* and *Cistothorus platensis* were recorded outside surveys. Highest similarity indexes were found among sampling points of the larger patch. Finally I observed 35 species using agricultural fields in the vicinity of grasslands patches, including *Bartramia longicauda* and *G. yetapa.* Most of them frequently move between grassland patches and agricultural fields.

KEY-WORDS: Birds, grassland, fragmentation, Pampa biome.

Large and continuous ecosystems are subdivided into small and isolated patches as a consequence of human activities (Bennett 1998, Temple 2001). Habitat fragmentation and degradation are the main causes of grassland bird population declines in North and South America (Collar *et al.* 1992, Knopf 1994, Stotz *et al.* 1996, Vickery *et al.* 1999). South American grassland habitats are likely to experience significant biodiversity loss due to inappropriate land use (Sala *et al.* 2000). Furthermore, all grassland habitats found in the neotropics are threatened to some extent and only a few portions of these habitats are under protection (Stotz *et al.* 1996).

Grassland vegetation region in the southern half of the state of Rio Grande do Sul is included in the Pampa biome (IBGE 2004), in which cattle raising is the most traditional practice (Vickery *et al.* 1999). Recently, land use in the region has changed and uplands have been converted into soybean and corn plantations during the spring and summer, and artificial pastures (oat and ryegrass) during autumn and winter. Lowlands are in general wet and used for rice plantation. In the last few years forestry has become a widespread activity with largely unknown but potentially negative impacts on the Pampa's avifauna. Tall grassland patches are found in non-used lowlands among grazed and agricultural fields.

Although cattle are present in the Pampa since the sixteenth century, the most profound environmental changes occurred after 1890, with increasing agriculture expansion in South America (Vickery *et al.* 1999). The omnipresence of the cattle and non-native land uses in the state of Rio Grande do Sul (RS) has pushed to extinction's edge 22 open habitat bird species, including grasslands dependent species as *Culicivora caudacuta, Polystictus pectoralis* and *Sporophila* spp. (Bencke *et al.* 2003). These obligate grassland birds are likely to become extinct without appropriate grassland habitat (Vickery *et al.* 1999).

The Pampas' avifauna has been poorly studied (Straube and Di Giácomo 2007). Effects of habitat fragmentation on the avifauna and the suitability of reduced open habitats patches to grassland birds need to be understood for guiding conservation efforts and management policies. Considering that bird species conservation can be conceived in a metapopulation dynamics (Hanski 1998), this study aims to evaluate the richness and composition of grassland bird communities in isolated grasslands patches of different sizes within a matrix of different cultures. Observations on the use of surrounding habitats by the species are also given as additional information.

METHODS

I studied grassland patches from April 2005 to March 2006 in a private farmland (29°36'S, 54°54'W) located in the municipality of São Francisco de Assis, west-central state of Rio Grande do Sul, Brazil, in the northern edge of the Pampa. In this region, lowlands and uplands are part of a landscape mosaic of open areas, which are interspersed with small natural woodlands and gallery forests. Lowland areas are composed of natural grasslands and rice cultures. Upland fields when converted are composed of soybean and corn fields during spring and summer (October-March), and artificial pastures during autumn and winter (April-September).

Natural fields covered uplands of the study area until 2002. Cattle were raised year-round in the natural fields, hindering grassland patches vegetation to grow and thicken due to direct effects of grazing and trampling. Since 2002-2003 uplands have been converted into agricultural fields and artificial pastures. In such a system cattle are kept in the area only for a short period of time, grazing on artificial pastures mainly during the winter, while direct disturbance on lowland grassland patches has almost completely halted. Fire was never used to manage uplands and lowlands in the study area. The matrix in which grassland patches are inserted changes spatially and temporally, since there is a rotation system of cultures in the uplands surrounding the patches every year (soybean/corn and oat/ryegrass).

I established sampling points in four different lowland grassland patches (patch A = 20 ha, n = 3 sampling points; patches B, C and D = 1 ha, n = 1 sampling point each), surrounded by soybean and corn fields or artificial pastures. Vegetation in the patches is dominated by tall tussock grasses. Some scattered shrubs (*e.g.* Asteraceae), small trees and *gravatás* (Apiaceae) are present in much greater proportion in patch A than in the other patches. Patch A is also much wetter year-round than the other patches and is near a small forest patch of approximately one hectare. I recorded the presence of all bird species in a 100-m radius during 20 min at each sampling point. Observations on the species occupying surroundings habitats were performed in the same period and were merely qualitative along the study. I started the observations up to one hour after sunrise. Points were sampled monthly, following a random order. Data could not be collected in November 2005.

To assess similarity indexes between sampling points and grassland patches I used Sørensen's Index of Similarity considering the whole set of bird species and only species associated to grasslands habitats (Belton 1994, Stotz *et al.* 1996, Sick 1997, Bencke *et al.* 2003), hereafter grassland bird species. To compare the number of species among patches I performed a Chi-square test using BioEstat 4.0 (Ayres and Ayres-Jr. 2005).

Since this study regards only on the monthly presence/absence of the species in each sampling point I created an Index of Frequency of Occurrence (IFO) multiplying the sum of sampling points in which a given species was recorded each month during the study by the number of months the study lasted and then obtained a relative percentage of the total. For instance, a species recorded in all samplings points every month would have an IFO of 1.0 [6 (sampling points) x 11 (every month) x 11 (all months of the study) = 726; 726/726 (maximum possible outcome) = 1.0]. I also created an IFO considering each sampling separately. In this case the maximum possible outcome is 121 [1 (sampling point) x 11 (every month) x 11 (all months of the study) = 121; 121/121 = 1.0]. An index of frequency calculated as above may be more reliable to evaluate the frequency of the species along the study. Indexes of frequency of occurrence were only created for grassland bird species. I arbitrarily categorized the species according to the IFO as common (> 0.6), intermediate (0.6-0.3) and rare (< 0.3) in both overall and individually sampling points.

RESULTS

A total of 55 bird species was recorded in the four grassland patches during the survey (Table 1). Sampling points in the largest grassland patch A recorded more species (A1 = 41, A2 = 39, A3 = 46 species; mean = 42) than sampling points in the smaller patches B, C and D individually (n = 16, 18 and 15; mean = 16.3) (see Figure 1 for the cumulative number of species in all sampling points). Also, putting together all sampling points, patch A had a total of 53 species, which is significantly greater than the total amount of species recorded in patches B, C and D together (n = 22 species; $\chi^2 = 12.813$; $P = 0.0003$). Thirty one species were recorded exclusively in patch A, 56.36% of the total (Table 1). Patches B and C had only one exclusive species each, *Milvago chimango* and *Pardirallus nigricans,* respectively. All species found in patch D were also recorded in the other patches. Eight species were common to all sampling points (Table 1).

Highest similarity indexes were found among sampling points from patch A and among sampling points from small patches B, C and D (Table 2). Lowest similarity indexes were found when sampling points from the largest patch were compared to smaller patches ones (Table 2). Patterns of similarity indexes among patches did not change when only grassland species were considered (Table 2). In this case there were lower similarity indexes among sampling points from patch A.

Threatened species were recorded primarily in the largest patch A. The same was observed for species for which information on the conservation status is lacking or insufficient. Globally and regionally threatened as well as data deficient species recorded (Bencke *et al.* 2003, IUCN 2008) were *Porzana albicollis* (DD-RS), *C. caudacuta* (VU-IUCN; CR-RS), *Gubernetes yetapa* (DD-RS) and *Sporophila bouvreuil* (DD-RS). These species had higher IFO's in the sampling points of patch A in relation the other patches (Table 1).

The most common species, according to the overall IFO, were *Ammodramus humeralis* and *Emberizoides herbicola.* Both were present in all months of the study and were recorded in all sampling points. Among grassland species with intermediate overall IFO were *P. albicollis, Sicalis luteola, Volatinia jacarina* and *Pseudoleistes guirahuro. Nothura maculosa, C. caudacuta, G. yetapa, Zonotrichia capensis, Sicalis flaveola* and *Embernagra platensis* were among the rare grassland species, with low IFO. *Ammodramus humeralis* and *E. herbicola* had the highest IFO in almost every sampling individually. On the other hand, *P. albicollis, Anumbius annumbi, Pitangus sulphuratus, S. luteola, V. jacarina, Geothlypis aequinoctialis* and *P. guirahuro* were in general common/intermediate in the sampling points of patch A and intermediate/rare in smaller patches B, C and D. Twenty two species were considered rare in all sampling points (see Table 1).

Most resident grassland species (32 out of 41) had an IFO lower than 0.3 and may be considered occasional in the study area. The neotropical migrant *S. bouvreuil* was the most common migratory species. From October to March, *S. bouvreuil* was found in every sampling points. Species non-associated to grassland habitats as the migratory tyrant flycatchers *Myiophobus fasciatus, Tyrannus* spp. and *Myiarchus swainsoni,* as well as the occasional heron *Butorides striata,* were found mainly in the largest patch.

Seven long-distance migratory species (12.7% of the total) were recorded in the grassland patches. Highest species numbers were recorded from October to March in all patches (minimum = 23 species; maximum = 29; average = 24.8), when migratory species were present, while from April to September less species were recorded (minimum = 19; maximum = 27; average = 22.2). The highest number of species was found in October and January (29 species; data from November lacking, see above) and the lowest in April and June (20 species). On average 24 species were recorded each month (Figure 2).

I observed 35 species using agricultural fields in the vicinity of lowland grasslands during the surveys, eight of which were not recorded in the sampling points survey (Table 3). Most species frequently moved between grasslands (lowlands) and agricultural fields (uplands). Passerine species were observed foraging in agricultural fields mainly in the early stages of growth or just after

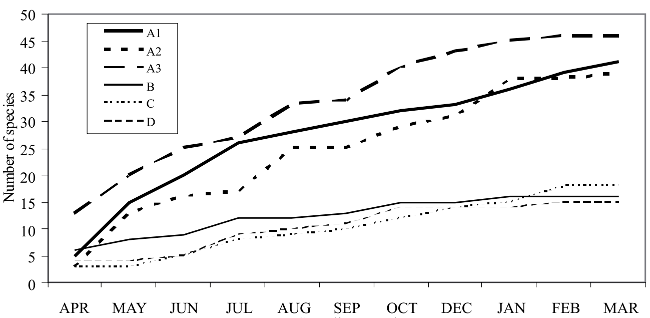

FIGURE 1: Cumulative number of species recorded in all sampling points along the study.

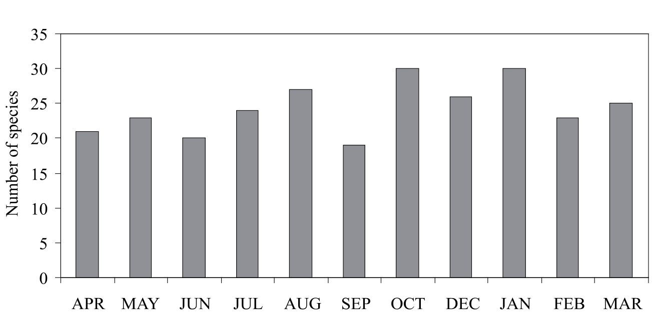

FIGURE 2: Number of species recorded in all sampling points by month along the study period.

TABLE 1: Bird species recorded in six sampling points (A1, A2, A3, B, C and D) established in four different tall grassland patches in a private farmland in the municipality of São Francisco de Assis, state of Rio Grande do Sul, in the Pampa biome. Species records by sampling points (SP) and by month (Months), and Index of Frequency of Occurrence (IFO) in each sampling point individually and overall.

Taxon	SP	Months											IFO						
		A	M	J	J	A	S	O	D	J	F	M	A1	A2	A3	B	C	D	TOTAL
Tinamidae																			
Nothura maculosa	A2A3BCD	A			J			O	D			M	0.00	0.09	0.09	0.18	0.09	0.09	0.09
Anatidae																			
Amazonetta brasiliensis	A2									J									
Ardeidae																			
Butorides striata	A3								D										
Accipitridae																			
Rupornis magnirostris	A1										F								
Falconidae																			
Milvago chimango	B	A											0.00	0.00	0.00	0.09	0.00	0.00	0.02
Rallidae																			
Porzana albicollis	A1A2A3BCD	A	M	J	J	A	S	O	D	J		M	0.55	0.55	0.64	0.55	0.09	0.36	0.45
Pardirallus nigricans	C					A							0.00	0.00	0.00	0.00	0.09	0.00	0.02
Pardirallus sanguinolentus	A3			J		A	S						0.00	0.00	0.27	0.00	0.00	0.00	0.05
Scolopacidae																			
Gallinago paraguaiae	A1A2A3CD			J	J	A		O					0.09	0.09	0.09	0.00	0.18	0.27	0.12
Columbidae																			
Columbina talpacoti	A1A2A3	A	M	J		A		O	D	J	F		0.45	0.27	0.36	0.00	0.00	0.00	0.18
Zenaida auriculata	A1A2A3		M		J	A	S	O	D	J	F	M	0.55	0.36	0.18	0.00	0.00	0.00	0.18
Leptotila verreauxi	A1A2D							O			F								
Psittacidae																			
Pyrrhura frontalis	A1								D										
Cuculidae																			
Piaya cayana	A2									J									
Crotophaga ani	A1A2A3	A			J	A			D	J	F		0.27	0.27	0.18	0.00	0.00	0.00	0.12
Guira guira	A3			J									0.00	0.00	0.09	0.00	0.00	0.00	0.02
Trochilidae																			
Chlorostilbon lucidus	A2A3C								D	J			0.00	0.09	0.09	0.00	0.09	0.00	0.05
Picidae																			
Colaptes campestris	A1A3D						S			J			0.09	0.00	0.09	0.00	0.00	0.09	0.05
Thamnophilidae																			
Thamnophilus ruficapillus	A1A2A3		M		J	A		O	D	J			0.45	0.27	0.09	0.00	0.00	0.00	0.14
Furnariidae																			
Furnarius rufus	A1A2A3	A								J	F	M	0.09	0.18	0.09	0.00	0.00	0.00	0.06
Schoeniophylax phryganophilus	A1A2A3BC	A	M	J	J	A	S	O		J	F	M	0.36	0.18	0.27	0.09	0.09	0.00	0.17
Synallaxis spixi	A1A3	A				A	S						0.09	0.00	0.18	0.00	0.00	0.00	0.05
Anumbius annumbi	A1A2A3BCD	A	M	J	J	A	S	O	D	J		M	0.36	0.64	0.36	0.09	0.27	0.09	0.30
Tyrannidae																			
Camptostoma obsoletum	A3							O											
Serpophaga subcristata	A1A2A3		M		J	A			D			M							
Culicivora caudacuta	A1A2A3BC			J	J	A	S	O	D	J		M	0.18	0.18	0.27	0.18	0.09	0.00	0.15
Myiophobus fasciatus	A1A3							O				M	0.09	0.00	0.18	0.00	0.00	0.00	0.05
Satrapa icterophrys	A1A2A3		M		J	A		O	D	J			0.27	0.18	0.36	0.00	0.00	0.00	0.14
Gubernetes yetapa	A1A2A3B			J	J	A				J	F	M	0.18	0.18	0.27	0.09	0.00	0.00	0.12
Machetornis rixosa	A1A2A3	A	M		J	A	S						0.18	0.18	0.27	0.00	0.00	0.00	0.11
Pitangus sulphuratus	A1A2A3D	A	M	J		A	S	O	D	J	F	M	0.73	0.45	0.36	0.00	0.00	0.18	0.29
Tyrannus melancholicus	A1A2A3							O		J	F	M							
Tyrannus savana	A1A2A3BD							O	D	J			0.27	0.27	0.18	0.09	0.00	0.18	0.17
Myiarchus swainsoni	A3										F								
Troglodytidae																			
Troglodytes musculus	A1A2A3		M	J		A							0.18	0.09	0.09	0.00	0.00	0.00	0.06
Turdidae																			
Turdus rufiventris	A1A2	A	M									M							
Turdus amaurochalinus	A1A3				J			O											

Taxon	SP	Months											IFO						
		A	M	J	J	A	S	O	D	J	F	M	A1	A2	A3	B	C	D	TOTAL
Emberizidae																			
Zonotrichia capensis	A1A2A3	A		J	J		S		D				0.27	0.09	0.18	0.00	0.00	0.00	0.09
Ammodramus humeralis	A1A2A3BCD	A	M	J	J	A	S	O	D	J	F	M	0.82	0.73	0.82	1.00	0.91	0.73	0.83
Poospiza nigrorufa	A3		M										0.00	0.00	0.09	0.00	0.00	0.00	0.02
Sicalis flaveola	A1A2			J								M	0.09	0.09	0.00	0.00	0.00	0.00	0.03
Sicalis luteola	A1A2A3BCD	A	M	J	J	A	S	O	D	J	F	M	0.36	0.55	0.73	0.18	0.36	0.09	0.38
Emberizoides herbicola	A1A2A3BCD	A	M	J	J	A	S	O	D	J	F	M	0.82	0.36	0.64	0.73	0.64	0.64	0.64
Embernagra platensis	A1A2A3C		M		J	A	S		D	J	F	M	0.36	0.55	0.09	0.00	0.09	0.00	0.18
Volatinia jacarina	A1A2A3BCD	A	M		J	A	S	O	D	J	F	M	0.45	0.45	0.64	0.55	0.45	0.18	0.45
Sporophila caerulescens	A1A2A3							O	D	J	F		0.18	0.18	0.18	0.00	0.00	0.00	0.09
Sporophila bouvreuil	A1A2A3BCD							O	D	J	F	M	0.36	0.36	0.45	0.36	0.18	0.36	0.35
Coryphospingus cucullatus	A3								D										
Paroaria coronata	A1A2A3									J	F	M	0.09	0.09	0.18	0.00	0.00	0.00	0.06
Parulidae																			
Parula pitiayumi	A3		M					O											
Geothlypis aequinoctialis	A1A2A3BC	A	M	J	J	A	S	O	D	J	F	M	0.82	0.36	0.73	0.27	0.27	0.00	0.41
Icteridae																			
Pseudoleistes guirahuro	A1A2A3BCD		M	J	J	A	S	O	D		F	M	0.45	0.36	0.27	0.27	0.09	0.36	0.30
Agelaioides badius	A1A2A3CD	A	M	J	J	A		O		J	F		0.45	0.27	0.36	0.00	0.09	0.27	0.24
Molothrus rufoaxillaris	A1A2A3	A		J				O		J	F		0.27	0.09	0.09	0.00	0.00	0.00	0.08
Sturnella superciliaris	A1A2A3BC		M		J	A	S	O					0.09	0.27	0.09	0.18	0.09	0.00	0.12

harvesting. However, some passerines such as *V. jacarina, A. humeralis* and *S. luteola* were common in the agricultural fields along the year. Non-passerines, such as *Syrigma sibilatrix, Falco sparverius, M. chimango, Vanellus chilensis* and pigeons, were also observed foraging in agricultural fields especially during the early stages and just after harvesting.

Relevant notes on some species follow: *Bartramia longicauda* (Scolopacidae): observed in October and December foraging in the narrow strips between lowland grasslands and soybean fields. In these areas grasses are still short and scarce due to desiccation. *Gubernetes yetapa* (Tyrannidae): briefly foraging in soybean and corn fields. *Anthus lutescens* (Motacillidae): from August to December foraging in soybean, oat and ryegrass fields, in early development stages. Also found in soybean fields after harvesting. *Sturnella superciliaris* (Icteridae): large flocks, with males frequently displaying, were observed mainly in oat fields just before cropping or desiccation. Found in soybean, corn and ryegrass fields as well.

DISCUSSION

As expected, larger habitat patches harbor a greater number of species when compared to smaller ones. Highest numbers of species were recorded in the sampling points of patch A and most species (56.4%) were only recorded in these sampling points. High indexes of similarity found for pairs of sampling points of patch A are a consequence of the higher number of species shared among them (> 50%). On the other hand, high indexes of similarity among patches B, C and D could be due to the amount of species shared by sampling points of patch A and not recorded in the sampling points of the smaller patches (> 20% of the species). This could be explained by the species-area relationship, where bird species richness increases progressively with increasing habitat size (McGuiness 1984, Temple 2001). Or, because of structural heterogeneity, which increases with increasing patch size, providing suitable habitats to a wider set of species (James 1971, McArthur and McArthur 1961), as well as by the proximity of patch A to a small forest patch.

All eight species found in all four patches are typical of grassland habitats (Belton 1994, Stotz *et al.* 1996, Sick

TABLE 2: Sørensen's similarity indexes between pairs of sampling points, considering all species and only grassland species.

Patches	A1	A2	A3	B	C
All species					
A2	0.88				
A3	0.83	0.80			
B	0.49	0.55	0.48		
C	0.51	0.60	0.53	0.76	
D	0.46	0.52	0.46	0.65	0.67
Grassland species					
A2	0.78				
A3	0.76	0.75			
B	0.49	0.55	0.48		
C	0.51	0.60	0.53	0.76	
D	0.46	0.48	0.46	0.65	0.67

TABLE 3: List of species recorded in agricultural fields adjacent to lowland grasslands patches during the study.

Species	Family	Crop type (land use)
*Nothura maculosa**	Tinamidae	plowed soil, oat, corn
*Syrigma sibilatrix**	Ardeidae	oat, corn
*Falco sparverius**	Falconidae	plowed soil, oat, corn
Milvago chimango	Falconidae	soybean, oat
*Vanellus chilensis**	Charadriidae	soybean, oat, corn
*Gallinago paraguaiae**	Scolopacidae	oat (wet)
*Bartramia longicauda**	Scolopacidae	oat
*Columbina talpacoti**	Columbidae	soybean, oat
*Patagioenas picazuro**	Columbidae	soybean,oat, corn
Zenaida auriculata	Columbidae	plowed soil
Leptotila verreauxi	Columbidae	oat, corn
Pionus maximiliani	Psittacidae	corn
Crotophaga ani	Cuculidae	soybean, oat, corn
Guira guira	Cuculidae	oat, corn
*Colaptes campestris**	Picidae	plowed soil, corn
*Furnarius rufus**	Furnariidae	soybean
Schoeniophylax phryganophilus	Furnariidae	oat, corn
*Anumbius annumbi**	Furnariidae	oat
Gubernetes yetapa	Tyrannidae	soybean
Pitangus sulphuratus	Tyrannidae	soybean, oat
*Tachycineta leucorrhoa**	Hirundinidae	over soybean
Turdus rufiventris	Turdidae	soybean
*Anthus lutescens**	Motacillidae	soybean, ryegrass
*Zonotrichia capensis**	Emberizidae	soybean
*Ammodramus humeralis**	Emberizidae	soybean, oat
Sicalis flaveola	Emberizidae	oat
*Sicalis luteola**	Emberizidae	soybean, oat, corn
Emberizoides herbicola	Emberizidae	oat
*Volatinia jacarina**	Emberizidae	soybean, oat, corn
Sporophila bouvreuil	Emberizidae	corn
Geothlyps aequinoctialis	Parulidae	soybean
*Chrysomus ruficapillus**	Icteridae	corn
*Pseudoleistes guirahuro**	Icteridae	soybean, oat, corn
*Agelaioides badius**	Icteridae	soybean
*Sturnella superciliaris**	Icteridae	soybean, oat, corn, ryegrass

*species that usually inhabit pastures and agricultural fields (Stotz *et al.* 1996)

1997, Bencke *et al.* 2003) and of low conservation concern at the global scale (IUCN 2007). However, in a regional scale, information on *P. albicollis* and *S. bouvreuil* populations are insufficient (Bencke *et al.* 2003). *Porzana albicollis* and *S. bouvreuil* are considered common in some parts of its distribution (Ridgely and Tudor 1989, Belton 1994, Sick 1997), but may have been affected by habitat loss and degradation in Rio Grande do Sul (Bencke *et al.* 2003). Records of the last species agree with the literature in which it is locally abundant in some portions of its range (Ridgely and Tudor 1989).

Threatened and data deficient species, such as *P. albicollis, C. caudacuta, G. yetapa* and *S. bouvreuil* were more frequent in the sampling points of patch A, although also recorded in the sampling points of patches B, C and D. Yet, several other globally/regionally threatened species were recorded outside the sampling points surveys in the largest patch A since 2004, even though smaller patches were regularly visited as well. These species were *Synallaxis albescens* (VU-RS)¸ *Polystictus pectoralis* (NT-IUCN, DD-RS), *Sporophila cinnamomea* (VU-IUCN; EN-RS), *Sporophila palustris* (EN-IUCN; EN-RS), and *Cistothorus platensis* (EN-RS). Additionally, *Xolmis dominicanus* (VU-RS, VU-IUCN) was observed in an adjacent area, just after corn field cropping. Records of threatened species, which show sensitivity to habitat disturbance (Stotz *et al.* 1996), in patch A emphasize the need of a minimum size of grassland patches for some species. *Culicivora caudacuta,* for instance, is usually observed in groups of up to 10 individuals (Parker III and Willis 1997) with home ranges larger than 17.5 ha (Sousa and Marini 2007). Thus, in a mosaic of uplands and lowlands similar to the study area, probably no more than one group could be maintained. However, small patches, as patches B, C and D may be important for providing dispersal corridors for grassland birds (Benton *et al.* 2003), because they can act as stepping-stones and enhance the viability of metapopulations (Bennett 1999).

Species with the highest overall IFO, considered common and intermediate (n = 8 species), can be thought to as those that characterize grassland patches in the study area. Some species not primarily associated to grassland habitats, like *Columbina talpacoti, Z. auriculata* and *P. sulphuratus* were intermediate/common in the sampling points of patch A, as a consequence of its proximity to a small forest patch and higher structural heterogeneity. Otherwise, regionally common grassland species like *N. maculosa, C. campestris, Z. capensis* and *S. superciliaris* (*pers. obs.*) had a low frequency of occurrence in all sampling points. Grassland patches structural features like tall and thicken tussocks grasses in consequence of cattle exclusion may not fill their ecological habitat needs.

Most of the rare species, *i.e.* with low IFO, do not have grasslands as their primary habitat. The only exceptions are *N. maculosa, C. campestris, G. yetapa* and *S. superciliaris.* Of this set of species, only *G. yetapa* is not found frequently in agricultural and natural fields in the study region (*pers. obs.*). Although considered of low conservation concern (IUCN 2008), *G. yetapa* shows medium sensitivity to disturbance (Stotz *et al.* 2003) and the effects of habitat fragmentation and deterioration on the populations of the species are unknown in Rio Grande do Sul (Bencke *et al.* 2003).

Most species observed in the habitats adjacent to grassland patches usually inhabit pasturelands and agricultural fields over their distribution range (Stotz *et al.* 1996). During the study the majority of species was observed foraging in agricultural fields during early stages of growth, when these are similar to natural fields in their physical structure. This, apparently, is an important factor influencing the occasional presence of grassland species in agricultural fields jointly with their proximity. In the other hand, grassland obligate species such as *C. caudacuta* do not tolerate agricultural fields (Stotz *et al.* 1996, Tubelis and Cavalcanti 2000) and were not observed in such areas.

For the effective conservation of grassland birds it is important to combine the goals of avian habitat conservation with those of soil conservation and agriculture (Vickery *et al.* 1999). This has become important considering that grassland habitats are poorly protected in conservation units in Rio Grande do Sul. Habitat can be restored in the Pampa biome in a short time period if disturbance is ceased (Leon and Oesterheld 1982, Leon *et al.* 1984), but in the absence of disturbance are prone to suffer shrub and/or forest vegetation encroachment (Machado 2004, Oliveira and Pillar 2004; Müller *et al.* 2006, Overbeck *et al.* 2007). Therefore, further studies at broader scales are needed to understand how grassland bird communities respond to habitat fragmentation and restoration.

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