Ardeola 60(2), 2013, 327-343

YEAR-ROUND ABUNDANCE, RICHNESS AND NESTING OF THE BIRD ASSEMBLAGE OF TALL GRASSLANDS IN THE SOUTH-EAST PAMPAS REGION, ARGENTINA

VARIACIÓN ESTACIONAL, RIQUEZA Y NIDIFICACIÓN DEL ENSAMBLE DE AVES DE LOS PASTIZALES ALTOS DEL SUDESTE DE LA REGIÓN PAMPEANA, ARGENTINA

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SUMMARY.—One of the most extensive grassland ecosystems in the Neotropics is located in the southeastern South America region. Here grasslands once dominated the Pampas but these are now mostly reduced to a mosaic of patches with different land-uses, largely croplands and pasturelands. Native *Cortaderia selloana* grasslands are widely distributed in the eastern Pampas region but relatively little is known of the bird assemblage inhabiting this habitat. We studied this bird assemblage addressing the overall richness and presence of species of conservation concern, seasonal variation in species composition, breeding phenology and the importance of *C. selloana* habitats for birds. Species richness was high: 54 species belonging to 22 families, including six species of conservation concern: three classified as vulnerable to extinction (dot-winged crake *Porzana spiloptera*, black-and-white monjita *Xolmis dominicanus* and pampas meadowlark *Sturnella defilippii*), and three near threatened (greater rhea *Rhea americana*, bay-capped wren-spinetail *Spartonoica maluroides* and Hudson's canastero *Asthenes hudsoni*). The highest species richness was observed in spring and summer, with peaks in spring and marked drops in autumn. The insectivore guild was the most numerous throughout the year. We identified 21 nesting species, four of which were of conservation concern, with a peak of reproductive activity during November. Owing to the high species richness and of the large number of threatened species, *C. selloana* grasslands should be considered of outstanding conservation priority in the Pampas region.

Key words: *Cortaderia selloana*, grassland birds, Pampas Grass, seasonality, South America, threatened species, trophic guilds.

RESUMEN.—Los pastizales del sureste de Sudamérica conforman uno de los mayores ecosistemas de pastizales en el Neotrópico. La vastedad de pastizales que una vez dominó la región actualmente es un mosaico de parcelas sometidas a diferentes usos de la tierra, especialmente destinadas a cultivos

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y pastos. Los pastizales nativos de *Cortaderia selloana* se encuentran ampliamente distribuidos al este de la región pampeana; sin embargo, a pesar de su dominancia, es relativamente poco lo que se conoce sobre el ensamble de aves que utilizan este hábitat. Hemos estudiado el ensamble de aves que utilizan los pastizales de *C. selloana*, describiendo la riqueza total, la presencia de especies de interés de conservación, la variación estacional de las especies, la fenología de la reproducción y la importancia de este hábitat para las aves pampeanas. Encontramos una alta riqueza específica conformada por 54 especies pertenecientes a 22 familias, entre las cuales hay seis especies con interés de conservación: la polluela overa *Porzana spiloptera*, la loica pampeana *Sturnella defilippii* y la monjita dominicana *Xolmis dominicanus*, clasificadas como vulnerables a la extinción, y el ñandú común *Rhea americana*, el canastero enano *Spartonoica maluroides* y el canastero pampeano *Asthenes hudsoni* como cercanos a la amenaza. Los mayores valores de riqueza fueron observados durante la primavera y el verano, con picos de abundancia en primavera, y un marcado descenso en otoño. El gremio insectívoro fue dominante en abundancia durante todo el año. Identificamos 21 especies anidando, cuatro de ellas con interés de conservación. La mayor actividad de reproducción se concentró durante noviembre. Debido a su elevada riqueza específica, y particularmente por el número de especies de interés de conservación, el pastizal de *C. selloana* debería ser destacado por su prioridad de conservación para la región pampeana.

Palabras clave: aves de pastizal, *Cortaderia selloana*, especies amenazadas, estacionalidad, gremios tróficos, Sudamérica.

Introduction

Grasslands in the southeastern South America (SESA) region are one of the most extensive grassland ecosystems in the Neotropics (see Azpiroz *et al*., 2012). This region (c. 700,000 km^2), which is included within the Pampas biome, is dominated by temperate subhumid grasslands and covers the plains of east-central Argentina, Uruguay and southern Brazil (Soriano *et al*., 1991).

The vast grasslands that once dominated the Pampas of SESA are now mostly reduced to a mosaic of patches with different land-uses, largely croplands and pasturelands (Baldi *et al*., 2006; Baldi and Paruelo, 2008). The proportion of land used for crop and pasture in a particular location depends on the soil conditions and areas dominated by natural grasslands are confined to soils unsuitable for agriculture because they flood or are sandy or salty (León *et al*., 1984; Viglizzo *et al*., 2001; Baldi *et al*., 2006). These soils dominate along the coastal strip of the southeastern Pampas region in Argentina (Soriano *et al*., 1991), where extensive patches of tall grasslands are dominated by *Paspalum quadrifarium*, *Spartina densiflora* and *Cortaderia selloana* grasses (Vervoorst, 1967). In the last decade, the expansion of agriculture has replaced and degraded even these marginal plant formations, especially for *P. quadrifarium*, whose original distribution has been drastically reduced (Herrera *et al*., 2005, 2009). *C. selloana* grasslands are still widely distributed, because they grow on sandy soils, with limited possibilities for agriculture development (Correa, 1978). However, these grasslands are being increasingly threatened by forestry or urban developments, which have rapidly increased in the region in the last few decades (Faggi *et al*., 2010; Faggi and Dadon, 2011).

Despite the diversity of studies on different aspects of grassland birds in the SESA (see Azpiroz *et al*., 2012) no systematic study on bird assemblages of *C. selloana* grasslands has been performed. As examples, Martínez (2001) mentioned that *C. selloana* and *Juncus acutus* grasslands have high rela-

tive species richness because of their structural complexity, and Cozzani and Zalba (2009) found that native tall grasslands, specifically those covered by *P. quadrifarium* and *C. selloana*, are used as a nesting habitat by some grassland birds. However, detailed information on bird assemblage composition and its seasonal changes is lacking in this habitat, which is indeed well represented along the coast of the Pampas. Bird species richness in the tall grasslands of the Pampas depends strongly on the cover and height of grasses, which are used for foraging and nesting (Comparatore *et al*., 1996; Isacch and Martínez, 2001; Zalba and Cozzani, 2004; Isacch *et al*., 2004; Isacch and Cardoni, 2011). The relatively well-preserved conditions of vast areas of *C. selloana* grasslands in the south-east Pampas region; specifically in two large protected areas, the Faro Querandí Reserve (5,575 ha, Bilenca and Miñarro, 2004) and the Mar Chiquita Biosphere Reserve (26,488 ha, Isacch, 2008), are ideal for studying the importance of these grasslands for birds in general and, specifically, for species of conservation concern.

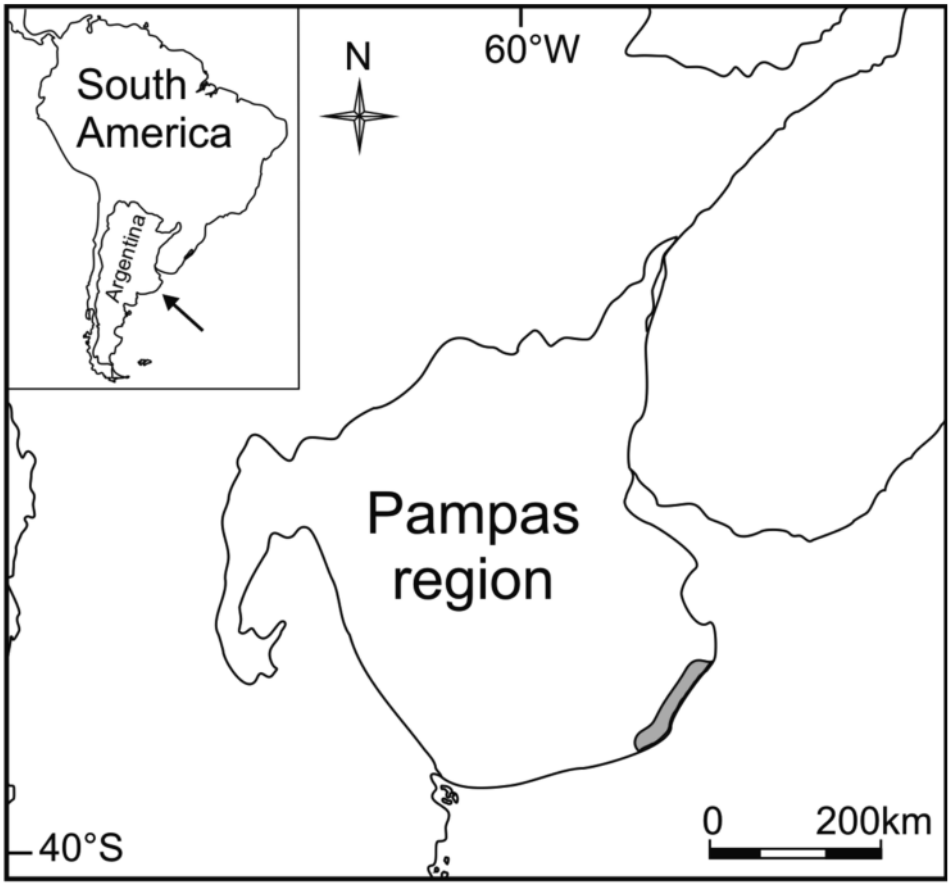

FIG. 1.—The Pampas region of Argentina, with the study area shown in grey.
[Región pampeana Argentina, con el área de estudio indicada en color gris.]

The aim of this study was to characterize the bird assemblage of *C. selloana* grasslands in the southeastern Pampas region, considering the overall species richness, the presence of species of conservation concern, seasonal variation in species richness, the composition of trophic guilds and nesting phenology.

Methods

Study area

The study was conducted in the southeast of the Pampas region (Cabrera, 1976) covering a 180 km-long coastal strip of approximately 920 km^2. The northernmost sampling site was located close to Pinamar (37° 2' S, 56º 50' W), and the southern end was near Mar del Sud (38º 19' S, 57º 56' W), both sites located in Buenos Aires province, Argentina (fig. 1). The region is almost flat, with a very slight slope towards the Atlantic Ocean, and a few hills and rocky outcrops in isolated sites. The mean annual temperature is ~15º C, with warm summers and cool winters (January mean temperature range: 21.5-23.5º C, July mean temperature range: 7.5-9.5º C) (Soriano *et al*., 1991). The mean annual precipitation is 800-1.000 mm, with more intense precipitations in summer (December-March) and less in winter (June-July) (Martos *et al*., 2004). *C. selloana* is well represented species in the study area, growing in dense stands of tall tussocks. *C. selloana* is a tall perennial grass of the pampas of South America, whose feathery inflorescences (i.e. spikes) grow up to 2-3 m in height in late summer (Correa, 1978). Our study system is represented by patches of varying size, from large and uniform extensions growing in nature reserves (i.e., Faro Querandí and Mar Chiquita Biosphere Reserve) to reduced patches within heterogeneous landscape matrices that also include sand dunes and suburban and agricultural areas.

Bird sampling and nest location

We selected 39 patches of *C. selloana*, nine located in nature reserves (Faro Querandí and Mar Chiquita), ten in sand dunes, ten in suburban areas, and ten in field margins along secondary unpaved roads. The size of the sampled patches ranged from 0.56 to 20 ha. We systematically selected patches of *C. selloana* that were as far as possible from one another, in order to cover the entire sampling area evenly. Patches had not been burned for at least three years. Survey effort was evenly distributed among seasons from October 2010 to late August 2011 to characterise the complete bird assemblage of *C. selloana* grasslands. Spring surveys were distributed from 22 October to 7 December, summer surveys from 10 January to 11 February, autumn surveys from 5 to 18 June and winter surveys from 13 July to 17 August. At each patch, we surveyed birds along two or three strip transects, 116 transects in total, which were walked and repeated in each season by the same observer. Data of each transect were not pooled within each patch. Transects were 100 m long × 60 m wide, spaced 100 m apart; all birds seen or heard within this area were recorded (Recher, 1988). Transects were conducted within 4 hours after sunrise. No surveys were conducted in bad weather conditions. Birds recorded searching for food in flight, or using the grassland but outside the transect or outside the sampling period were also noted. Survey data were then used to describe the composition and seasonality of the bird assemblage of the grasslands.

We assigned species to three categories of residence status: residents, summer residents and winter visitors. Bird species were also classified into trophic guilds: herbivore, carnivore, insectivore, granivore and omnivore (granivore-insectivore), according to known feeding habits. Information on the migratory status and diet in the Pampas of different

species was obtained from literature (e.g., Canevari *et al*., 1991; Narosky and Di Giacomo, 1993; Chesser, 1994; Cueto and Lopez de Casenave, 2000).

We searched for nests during two breeding seasons (from October 2010 to January 2011 and from October 2011 to January 2012) to describe the assemblage of nesting birds. Nest searching was performed by haphazard walking and behavioural observations (see Winter *et al*., 2003) during a five-hour period, twice a week throughout the whole breeding season. The search effort was evenly distributed across the breeding season and between both years. Two researchers searched for nests while walking eight times within the same patches where transects were performed. Nests that were found by chance outside these patches were also incorporated into the list of species nesting in *C. selloana* grassland.

Statistical Analyses

One-way analyses of variance (ANOVAs; Zar, 1999) were performed to test for differences in bird species richness and density (number of individuals per hectare) among (i) the four seasons, and (ii) the three trophic guilds in each season. Post-hoc Tukey tests were performed for pairwise comparisons. Data were square-root transformed to accomplish assumptions of normality and homoscedasticity (Zar, 1999).

RESULTS

We recorded a total of 54 bird species belonging to 22 families in *C. selloana* grasslands (table 1). Three of these species are globally threatened: the black-and-white monjita *Xolmis dominicanus*, dot-winged crake *Porzana spiloptera*, and pampas meadowlark *Sturnella defilippii*, and three are globally near threatened: the bay-capped wren-spinetail *Spartonoica maluroides*, greater rhea *Rhea americana* and Hudson's canastero *Asthenes hudsoni* (BirdLife International, 2013). Within the study area, which is 180 km long, we could identify a small area where these six species of conservation concern were recorded. This area covers a strip approximately 55 km long (37° 21' S, 57° 5' W; 37° 43' S, 57° 30' W) and corresponds to two large patches of *C. selloana*, within the Faro Querandí reserve and Mar Chiquita Biosphere Reserve.

The frequency and abundance of species of conservation concern was relatively low but, in view of their conservation status, we provide details of the records. On July 15, we observed a group of 16 individuals of the pampas meadowlark in pastures with *C. selloana* field margins, and on July 21 we observed a group of 12 individuals on a sorghum field *Sorghum* sp. with edges of *C. selloana*. On 7 November 2010 a breeding pair of black-and-white monjitas was recorded nesting in mixed grassland dominated by *C. selloana* and *P. quadrifarium*. Two individuals were recorded in the same place on 21 June 2011. We observed Hudson's canasteros, dot-winged crakes and bay-capped wren-spinetails in *C. selloana* grasslands surrounded by *S. densiflora* grasslands, in summer. Bay-capped wren-spinetails were also recorded in winter in a *C. selloana* patch bordering a pastureland. Greater rheas were recorded year-round in *C. selloana* grasslands, and nesting was recorded in December 2011.

The bird species richness and number of individuals per hectare differed between seasons (ANOVA: $F_{3, 460} = 65.22$, $P < 0.001$; $F_{3, 460} = 86.43$, $P < 0.001$, respectively). In spring the species richness and number of individuals was higher than in the other seasons (Tukey's post hoc test: $P < 0.001$ for all comparisons between spring and summer, autumn, and winter; fig. 2). Autumn and

TABLE 1

Density (individuals/ha), frequency (percent of transects in which the species was recorded; in parentheses), residence status (RS), trophic guild (TG) and total active nests of bird species (those parasitised by the shiny cowbird *Molothrus bonariensis* in parentheses), and mean clutch size (SD, number of nests found during the incubation period; in parentheses) of bird species recorded in *Cortaderia selloana* grasslands in the south-east Pampas region, Argentina.

Family/species	Spring	Summer	Autumn	Winter	RS[a]	TG[b]	Nest	Clutch Size
Accipitridae								
Cinereous harrier *Circus cinereus*	+	+	–	–	Re	C	–	–
Long-winged harrier *Circus buffoni*	+	+	+	+	Re	C	–	–
Red-backed hawk *Geranoaetus polyosoma*	–	–	–	+	Wv	C	–	–
Anatidae								
Yellow-billed pintail *Anas georgica*	+	–	–	–	Re	H	3	6.3 (1.5, 3)
Charadriidae								
Southern lapwing *Vanellus chilensis*	+	+	+	+	Re	I	–	–
Columbidae								
Eared dove *Zenaida auriculata*	0.09 (5.2)	0.03 (3.4)	0.02 (1.7)	0.04 (3.4)	Re	G	13	1.54 (0.5, 11)
Cuculidae								
Guira cuckoo *Guira guira*	–	–	<0.01 (0.9)	–	Re	O	–	–
Emberizidae								
Black-and-rufous warbling-finch *Poospiza nigrorufa*	0.08 (5.2)	0.04 (4.3)	0.01 (1.7)	<0.01 (0.9)	Re	O	1	2
Double-collared seedeater *Sporophila caerulescens*	+	0.17 (13.0)	–	–	Sr	G	–	–
Grassland yellow-finch *Sicalis luteola*	1.63 (53.4)	0.70 (29.3)	0.06 (3.4)	0.12 (4.3)	Re	G	13 (3)	3.4 (1.1, 13)
Great pampa-finch *Embernagra platensis*	0.87 (55.1)	0.76 (50.8)	0.50 (39.6)	0.52 (37.0)	Re	O	3 (2)	2.3 (0.57, 3)
Long-tailed reed-finch *Donacospiza albifrons*	0.05 (4.3)	0.24 (7.7)	0.11 (5.2)	0.02 (1.7)	Re	G	1	2
Rufous-collared sparrow *Zonotrichia capensis*	1.08 (60.3)	0.50 (34.5)	0.38 (25.8)	0.40 (22.4)	Re	G	3 (1)	3.5 (2.1, 2)

TABLE 1 (cont.)

[Densidad (ind/ha), frecuencia (porcentaje de transectas en las cuales la especie fue registrada; entre paréntesis), estatus de residencia (RS), gremio trófico (TG) y nidos activos totales (parasitados por Molothrus bonariensis*; entre paréntesis), y tamaño medio de puesta (SD, número de nidos hallados durante el período de incubación; entre paréntesis) de especies de aves registradas en pastizales de* Cortaderia selloana *en el sudeste de la región pampeana, Argentina.]*

Family/species	Spring	Summer	Autumn	Winter	RS[a]	TG[b]	Nest	Clutch Size
Falconidae								
Chimango caracara *Milvago chimango*	0.02 (0.09)	+	+	+	Re	C-I	1	2
Crested caracara *Caracara plancus*	+	+	+	+	Re	C	–	–
Fringillidae								
European goldfinch *Carduelis carduelis*	+	–	–	–	Re	G	–	–
Hooded siskin *Sporagra magellanica*	0.05 (2.6)	0.06 (2.6)	0.05 (0.9)	0.07 (2.6)	Re	G	–	–
Furnariidae								
Bar-winged cinclodes *Cinclodes fuscus*	–	–	<0.01 (0.9)	<0.01 (0.9)	Wv	I	–	–
Bay-capped wren-spinetail *Spartonoica maluroides** (VU/NT)	<0.01 (0.9)	0.09 (5.2)	–	0.02 (0.9)	Sr	I	3	3 (0, 2)
Firewood-gatherer *Anumbius annumbi*	–	0.02 (1.7)	–	–	Re	I	–	–
Freckle-breasted thornbird *Phacellodomus striaticollis*	0.12 (9.4)	0.18 (14.0)	0.08 (8.6)	0.14 (11.2)	Re	I	15	4.2 (1.5, 5)
Hudson's canastero *Asthenes hudsoni** (VU/NT)	<0.01 (0.9)	–	–	–	Re	I	1	–
Rufous hornero *Furnarius rufus*	0.02 (0.9)	<0.01 (0.9)	–	–	Re	I	–	–
Sulphur-bearded spinetail *Cranioleuca sulphurifera*	0.19 (15.5)	0.35 (22.4)	0.35 (26.7)	0.32 (25.0)	Re	I	2	2 (0, 2)
Hirundinidae								
Barn swallow *Hirundo rustica*	+	+	–	–	Sr	I	–	–
White-rumped swallow *Tachycineta leucorrhoa*	+	+	–	–	Sr	I	–	–

TABLE 1 (cont.)

Family/species	Spring	Summer	Autumn	Winter	RS[a]	TG[b]	Nest	Clutch Size
Icteridae								
Bay-winged cowbird *Agelaioides badius*	0.02 (1.7)	+	+	+	Re	O	–	–
Brown-and-yellow marshbird *Pseudoleistes virescens*	0.95 (38.8)	0.04 (2.6)	14 (6)	0.10 (1.7)	Re	I	75 (20)	3 (1.34, 47)
Long-tailed meadowlark *Sturnella loyca*	0.12 (6.9)	0.05 (3.4)	0.12 (5.2)	<0.01 (0.9)	Re	O	–	–
Pampas meadowlark *Sturnella defilippii** (EN/VU)	–	–	–	0.05 (1.7)	Wv	O	–	–
Scarlet-headed blackbird *Amblyramphus holosericeus*	+	+	+	+	Re	I	–	–
Shiny cowbird *Molothrus bonariensis*	0.17 (7.7)	0.14 (6.0)	0.04 (2.6)	<0.01 (0.9)	Re	O	28	1.48 (0.6, 27)
White-browed blackbird *Sturnella superciliaris*	+	+	–	+	Re	I	–	–
Yellow-winged blackbird *Agelasticus thilius*	0.07 (5.2)	0.06 (3.4)	–	0.02 (1.7)	Re	I	1 (1)	4 (0, 1)
Mimidae								
Chalk-browed mockingbird *Mimus saturninus*	0.02 (1.7)	–	–	–	Re	I	–	–
Motacillidae								
Correndera pipit *Anthus correndera*	0.35 (25.0)	0.19 (15.5)	0.08 (5.2)	0.15 (13.0)	Re	I	2	3 (0, 2)
Ploceidae								
House sparrow *Passer domesticus*	–	0.02 (0.9)	–	–	Re	O	–	–
Rallidae								
Dot-winged crake *Porzana spiloptera** (VU/VU)	–	<0.01 (0.1)	–	–	Re	I	–	–
Rheidae								
Greater rhea *Rhea americana** (T/NT)	+	+	+	+	Re	H	1	11
Strigidae								
Burrowing owl *Athene cunicularia*	+	+	+	+	Re	C-I	–	–
Short-eared owl *Asio flammeus*	+	–	–	–	Re	C	–	–

TABLE 1 (cont.)

Family/species	Spring	Summer	Autumn	Winter	RS[a]	TG[b]	Nest	Clutch Size
Tinamidae								
Red-winged tinamou *Rhynchotus rufescens*	0.13 (13.0)	0.02 (2.6)	—	0.02 (2.6)	Re	O	—	—
Spotted nothura *Nothura maculosa*	0.04 (4.3)	0.03 (3.4)	<0.01 (0.9)	<0.01 (0.9)	Re	O	—	—
Trochilidae								
Glittering-bellied emerald *Chlorostilbon aureoventris*	—	0.02 (0.09)	—	—	Sr	N	—	—
White-throated hummingbird *Leucochloris albicollis*	—	0.02 (1.7)	—	—	Re	N	—	—
Troglodytidae								
House wren *Troglodytes aedon*	0.07 (6.0)	0.21 (18.1)	0.20 (19.8)	0.22 (20.7)	Re	I	—	—
Sedge wren *Cistothorus platensis*	0.17 (15.5)	0.23 (17.2)	0.07 (6.9)	0.09 (8.6)	Re	I	1	5
Tyrannidae								
Black-and-white monjita *Xolmis dominicanus** (EN/VU)	+	—	—	+	Re	I	1	3
Fork-tailed flycatcher *Tyrannus savana*	0.02 (1.7)	0.04 (1.7)	—	—	Sr	I	—	—
Great kiskadee *Pitangus sulphuratus*	0.02 (0.9)	0.02 (1.7)	0.03 (3.4)	0.02 (0.9)	Re	O	—	—
Spectacled tyrant *Hymenops perspicillatus*	2.00 (82.7)	0.55 (34.5)	<0.01 (0.9)	0.04 (4.3)	Sr	I	89 (1)	2.1 (0.4, 69)
Tropical kingbird *Tyrannus melancholicus*	—	<0.01 (0.9)	—	—	Sr	I	—	—
Warbling doradito *Pseudocolopteryx flaviventris*	0.23 (16.3)	0.27 (23.3)	—	—	Sr	I	4	2 (0, 3)
Tytonidae								
Barn owl *Tyto alba*	+	—	—	—	Re	C	—	—
Total species	43	43	28	34				

[a] Residence status: year-round resident, Re; summer resident, Sr; winter visitor, Wv.
[b] Trophic guild: C = carnivore, G = granivore, H = herbivore; I = insectivore; N = nectarivore; O = omnivore.
* Species considered of "conservation concern" (López-Lanús *et al*., 2008 / BirdLife International, 2013). EN: Endangered, VU: Vulnerable, NT: Near Threatened and T: Threatened.
\+ Species that were recorded searching for food in flight, or using the grassland outside the transect area or outside the sampling period.

[[a] Estatus de residencia: residente permanente, Re; residente estival, Sr; visitante invernal, Wv.
[b] Gremios tróficos: C = carnívoros, G = granívoros, H = herbívoros; I = insectívoros; N = nectívoro; O = omnívoro.
** Especies consideradas bajo amenaza (López-Lanús* et al.*, 2008 / BirdLife International, 2013). EN: En peligro, VU: Vulnerable, NT: Cercana a la amenaza, y T: Amenazada.*
\+ Especies que fueron registradas buscando alimento en vuelo, o haciendo uso el pastizal fuera de las transectas o del período de muestreo.]

winter showed the lowest values for richness and number of individuals and no differences were found between these values (Tukey's test: P = 0.99 and P = 0.99, respectively; fig. 2).

The spectacled tyrant *Hymenops perspicillatus* and the grassland yellow-finch *Sicalis luteola* were the most abundant species in spring (23% and 18%, respectively), while the great pampa-finch *Embernagra platensis* and the grassland yellow-finch were the most abundant in summer (15% and 14%, respectively). The great pampa-finch (23% and 21%), the rufous-collared sparrow *Zonotrichia capensis* (17% and 16%) and the sulphur-bearded spinetail *Cranioleuca sulphurifera* (16% and 13%) were the most common species in autumn and winter. The spectacled tyrant was the most frequently observed species in spring, while the great pampa-finch was most commonest during the rest of the year (table 1).

Four species (the spectacled tyrant, warbling doradito *Pseudocolopteryx flaviventris*, bay-capped wren-spinetail, and double-collared seedeater *Sporophila caerulescens*) showed high seasonality: they were abundant during spring and summer, and occasional or absent during the rest of the year (table 1).

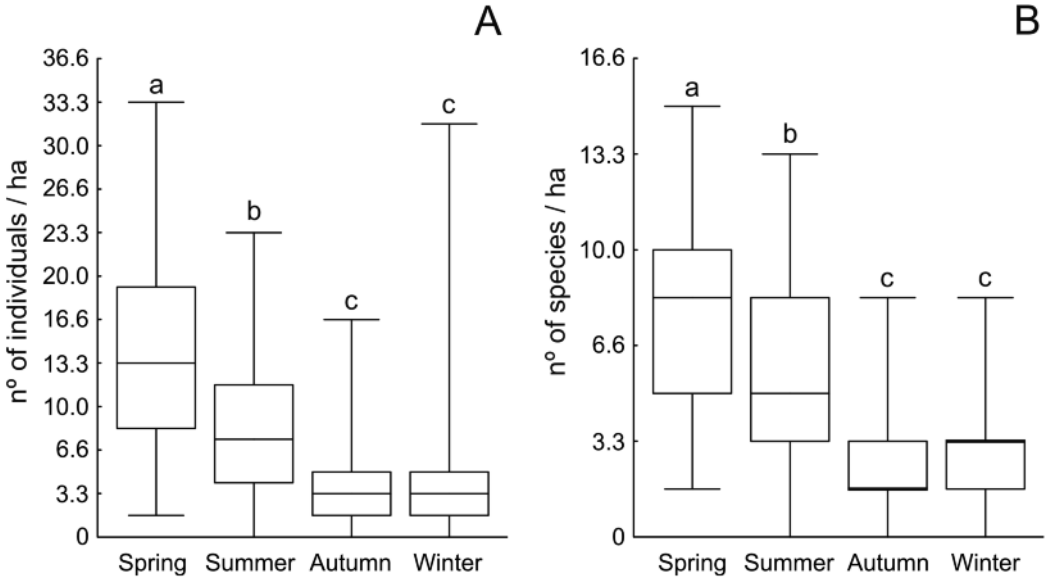

FIG. 2.—Seasonal changes in the number of individuals (A) and species (B) of birds observed per hectare in *Cortaderia selloana* grasslands in the south-east Pampas region. Data were collected between October 2010 and August 2011. Here and in figure 3, limits of the boxes represent 25th and 75th percentiles, lines represent 1st and 99th percentiles, and lines inside boxes represent medians. Letters (a, b, c) indicate significant differences.

[Cambios estacionales en el número de individuos (A) y especies (B) de aves observados por hectárea en pastizales de Cortaderia selloana *en el sudeste de la región pampeana. Los datos fueron obtenidos entre octubre de 2010 y agosto de 2011. Aquí, y en la siguiente figura, los límites de las cajas representan el 25º y 75º percentil, las líneas representan 1er y 99º percentil, y las líneas dentro de las cajas representan las medianas. Las letras (a, b, c) indican diferencias significativas.]*

Trophic guilds

The most represented feeding guilds were insectivores, granivores and omnivores. Seasonal differences in the number of individuals per hectare among trophic guilds were significant in all seasons (one-way ANOVA for spring: $F_{2, 345} = 38.73$, $P < 0.001$; summer: $F_{2, 345} = 12.09$, $P < 0.001$; autumn: $F_{2, 345} = 3.39$, $P = 0.034$; and winter: $F_{2, 345} = 10.54$, $P < 0.001$; fig. 3). Tukey post-hoc comparisons revealed differences among trophic guilds in all seasons (spring: $P < 0.001$ for all comparisons; summer and winter: $P < 0.01$ for comparisons between granivores/omnivores and insectivores; and autumn: $P = 0.02$ for insectivores compared to granivores; fig. 3).

The most abundant insectivorous species were the spectacled tyrant, the brown-and-yellow marshbird *Pseudoleistes virescens* and the sulphur-bearded spinetail, accounting for 60% of all individuals observed. The grassland yellow-finch and the rufous-collared sparrow accounted for 82% of individuals of the granivore guild, and the great pampa-finch was the most abundant omnivore species (70% of omnivores).

Nesting

Over the two breeding seasons, we found a total of 259 nests, 232 of which were active (215 with eggs and 17 with chicks). Nests

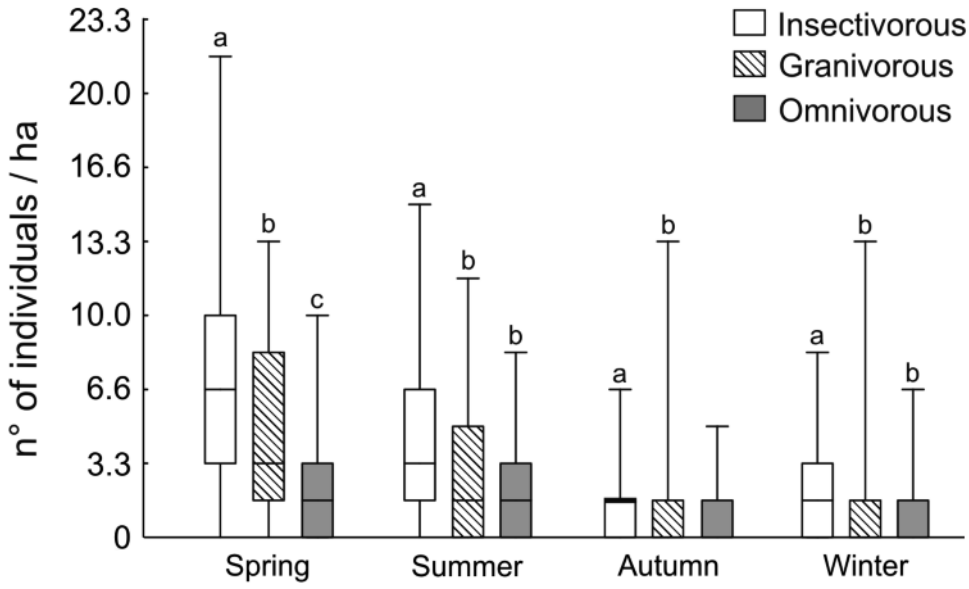

FIG. 3.—Seasonal variation in the number of individuals of birds belonging to different trophic guilds observed per hectare. Surveys of the bird assemblage in *Cortaderia selloana* grasslands at the southeast Pampas region, Argentina were conducted between October 2010 and August 2011. Letters (a, b, c) indicate significant differences.

[Variación estacional del número de individuos observados por hectárea perteneciendo a diferentes gremios tróficos. Los muestreos de aves en pastizales de Cortaderia selloana *del sudeste de la región pampeana, Argentina, fueron realizados entre octubre de 2010 y agosto de 2011. Las letras (a, b, c) indican diferencias significativas.]*

belonged to 21 species, four of them of conservation concern (table 1). The first evidence of nest building was on 16 September 2010 and the latest evidence of nest activity was a nest in the laying stage on 27 January 2012. The peak of reproductive activity occurred during November, when most nests were in the incubation stage (fig. 4). Six species were parasitised by the shiny cowbird *Molothrus bonariensis*, with a total of 28 nests parasitised. The brown-and-yellow marshbird had the greatest number of parasitised nests (26%) (table 1).

Discussion

To our knowledge this is the first study characterising the bird assemblages inhabiting *C. selloana* grassland in the Pampas region, Argentina. We found that this grassland supports a high species richness, a finding that is consistent with studies showing that the native tall grasslands of the Pampas region have high biodiversity when compared with other habitats in the same region, such as croplands, pasturelands and short grasslands (Comparatore *et al*., 1996; Isacch and Martínez, 2001; Zalba and Cozzani, 2004; Isacch and Cardoni, 2011; Codesido *et al*., 2012).

Grassland structure (e.g. height and cover of tall grass) has a direct relationship with the pampas grassland-bird community (Isacch and Martínez, 2001; Isacch *et al*., 2004; Isacch and Cardoni, 2011). An increased structural complexity of grassland is often positively correlated with the number of bird species (Vickery *et al*., 2001; Cardoni *et al*., 2011) and the rich and abundant community of grassland specialists observed in *C. selloana* may result from this intrinsic characteristic, in which *C. selloana* reaches an average height of 1.2 m, exceeding 2 m when the spikes appear in late summer (Correa, 1978), creating additional structural complexity in this grassland.

Apart from the high species richness of bird species in *C. selloana* grasslands, we also found a number of species with an unfavorable conservation status. The fact that all the species of conservation concern in our sample occurred in a relatively restricted area emphasises the importance of local reserves, especially since grassland specialist birds are almost absent from other subregions of the Pampas (Rolling Pampa, Soriano *et al*., 1991) and no species of conservation concern have been reported there. Agricultural expansion and intensification is possibly the cause (Cerezo *et al*., 2011) and should therefore be limited in our study area

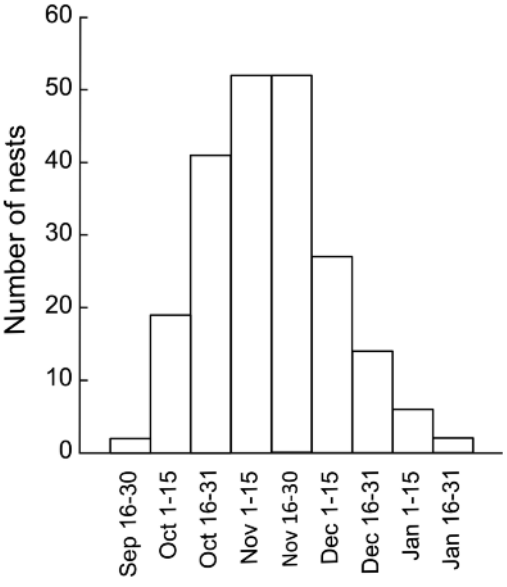

Fig. 4.—Number of nests found at the incubation stage per month. Overall, 215 nests were found through the 2010-2011 and 2011-2012 breeding seasons in *Cortaderia selloana* grasslands in the south-east of the Pampas region, Argentina.
[Número de nidos hallados en etapa de incubación, en base a 215 nidos hallados durante las temporadas reproductivas 2010-2011 y 2011-2012 en pastizales de Cortaderia selloana *en el sudeste de la región pampeana, Argentina.]*

to prevent the further decline of threatened species in the Pampas region.

The pampas meadowlark is one of the pampas grassland birds that is most affected by habitat changes, mainly the replacement of native grasslands by croplands and pasturelands (Tubaro and Gabelli, 1999). There are no previous records from our study area (Narosky and Di Giacomo, 1993) and the period in which the two groups were observed suggests that these individuals were wintering or moving from northern wintering areas to the breeding areas in the south-west of Buenos Aires province (Cozzani *et al*., 2004). This species also inhabited small patches of *C. selloana* in the agroecosystems matrix (pers. obs.), highlighting the role of small habitat fragments as refuges during the species' seasonal movements. Other species benefited from this habitat: mixed *C. selloana* and *P. quadrifarium* grasslands growing on wet soils were a suitable nesting habitat for the black-and-white monjita. Moreover, *C. selloana* tussocks surrounded by short grass probably provide habitat heterogeneity for Hudson's canastero and the greater rhea, species that require patches of short grass within a matrix of tall grass for foraging and nesting (Isacch and Martínez, 2001; Fernández and Reboreda, 2002; Isacch and Cardoni, 2011). The bay-capped wren-spinetail was found in the survey area although it is a typical bird of halophytic tall grasslands of *S. densiflora* (Isacch *et al*., 2004; Cardoni *et al*., 2012), suggesting that *C. selloana* grasslands are an alternative breeding habitat for this species. All in all, the different requirements and the relationships of species of conservation concern with *C. selloana* grasslands show the importance of both small patches and the large protected areas. Further studies should be performed to analyse fine habitat requirements of this bird community, to better define variations occurring within this habitat.

The greater abundance and richness of birds during the warmer months coincides with the patterns observed for other grassland bird assemblages of the region (Isacch and Martínez, 2001; Isacch *et al*., 2003; Codesido *et al*., 2008; Azpiroz and Blake, 2009; Isacch and Cardoni, 2011). This pattern would be explained, at least in part, by the arrival of summer migrants (e.g. the spectacled tyrant and warbling doradito), and an increase in the abundance of resident species that use the tall grass to nest (e.g., the brown-and-yellow marshbird and grassland yellow-finch; Isacch and Martínez, 2001; Cozzani and Zalba, 2009). Likewise, insects, a major food source for many grassland bird species, are more abundant in spring and summer (Isacch *et al*., 2005; Canepuccia *et al*., 2009).

The most abundant species during the year were the great pampa-finch, the grassland yellow-finch, the spectacled tyrant and the rufous-collared sparrow. The first two are abundant in the whole region (Comparatore *et al*., 1996; Isacch and Martínez, 2001; Isacch *et al*., 2004). Other species, such as the spectacled tyrant and brown-and-yellow marshbird (abundant during spring) have declined because of changes in land-use, especially due to agriculture intensification and the consequent loss of native grasslands (Filloy and Bellocq, 2007; Codesido *et al*., 2011).

In *C. selloana* grassland we also found species typically associated with riparian and wetland vegetation, such as the sulphur-bearded spinetail, the warbling doradito, the freckle-breasted thornbird *Phacellodomus striaticollis*, the black-and-rufous warbling-finch *Poospiza nigrorufa* and the long-tailed reed-finch *Donacospiza albifrons* (Canevari *et al*., 1991; Narosky and Di Giácomo, 1993; Azpiroz *et al*., 2012). These species need the grassland to complete their life-cycles, and *C. selloana* grasslands occupy potentially flooded areas such as interdune areas and the upper reaches of saltmarshes (Correa, 1978; Isacch *et al*., 2006). Therefore, these

grasslands are offering habitat not only for typical grassland birds but also for species associated with wetlands, as also observed by other studies (Azpiroz *et al*., 2012).

Trophic guilds and nesting

Insectivores were the most abundant guild throughout the year, especially during the spring when insects are active, followed by granivores and omnivores. *C. selloana* tussocks are inhabited by a wide variety of insects (Farina and Cicchino, 2011) and insectivorous birds (e.g., tyranids, furnarids and wrens) use different feeding strategies to prey upon them.

With respect to nesting, *C. selloana* grasslands are used by a diversity of breeding species, including 21 species that make direct use of tussocks to nest. The breeding season (~135 days, with a peak in November) was similar to that reported for other native grasslands in the region (Cozzani and Zalba, 2009). The observed incidence of brood-parasitism (26%) was higher than that described by Cozzani and Zalba (2009) in native grasslands (8%), even comparing only those species that were parasitised at both sites (i.e. the brown-and-yellow marshbird, grassland yellow-finch and rufous-collared sparrow; 26% *v* 15%). Brood-parasitism is usually higher in fragmented habitats (Johnson and Temple, 1990; Vander Haegen, 2007), and fragmentation may partly explain the differences between these sites, although more studies are necessary to prove it.

Conservation implications

Cortaderia selloana grasslands in the southeastern Pampas region represent one of the last remnants of native tall grasslands. They comprise a critical habitat for the pampas grassland birds, as highlighted by the high abundance and species richness of birds, including 38 species of grassland birds (~34% of SESA birds, Azpiroz *et al*., 2012) with at least 18 grassland-nesting species: three of them globally threatened and three more globally near-threatened (BirdLife International, 2013) (~27% of SESA threatened birds). The structural complexity of *C. selloana* tussocks, offering shelter, foraging and nesting sites, probably makes the habitat more attractive for grassland birds than the surrounding open matrix of anthropogenic habitats, such as short grass pastures and croplands (Baldi *et al*., 2006; Baldi and Paruelo, 2008).

It is worth noting that in the future *C. selloana* grasslands could be threatened not only by agriculture but also by the expansion of tourist resorts and the consequent introduction of invasive exotic plant species (e.g., *Pinus* spp. and *Acacia melanoxylon*), which would increase disturbance and habitat loss and fragmentation, and may benefit generalist birds but be detrimental for grassland specialists (Faggi *et al*., 2010). *C. selloana* grasslands should therefore be an outstanding conservation priority for the Pampas region, in view of their high bird species richness and the presence of a number of species of conservation concern.

ACKNOWLEDGEMENTS.—We thank A. Di Giacomo, M. Codesido, and two anonymous reviewers for their comments and constructive criticism leading to the improvement of this manuscript. We also appreciate the improvements in English usage made by Becky Cramer through the Association of Field Ornithologists' programme of editorial assistance. The research received financial support from the Neotropical Grassland Conservancy (NGC), Beca "Conservar la Argentina" (Aves Argentinas), Universidad Nacional de Mar del Plata and Consejo Nacional de Investigaciones Científicas y Técnicas (CONICET, Argentina). MGP was supported by a doctoral scholarship from CONICET.

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Received: 14 March 2013
Accepted: 3 July 2013

Editor: Paola Laiolo