



Birds of a wildlife reserve in the South American Pampa (Córdoba, Argentina)

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Abstract: In the Pampa ecoregion of South America, the intensification of agriculture has led to the almost total replacement of pristine vegetation by agroecosystems. This has caused a great loss of biodiversity and a decline of bird assemblages. We monitored birds in Dos Hermanas Wildlife Reserve, an integrated ecosystem-based management area in preserved natural saline wetland relicts (grasslands and shrublands) with a cultivated sector (sustainable grazing and organic crops). We recorded a total of 170 species, including altitudinal migrants, Nearctic migrants, migrants of the temperate-tropical and cold-temperate systems, and residents. Seven are globally threatened species and three are exotic species. The high diversity of birds recorded at Dos Hermanas Wildlife Reserve highlights the importance of this reserve for the conservation of the regional biota. The application of ecosystem-based management allows the presence of contrasting vegetation structures with positive effects on the diversity of bird assemblages in the Pampa region.

Key words: grassland birds; agroecosystems; biodiversity; Pampa ecoregion; South America

INTRODUCTION

The Río de la Plata grasslands are the largest complex of temperate grasslands ecosystems in South America, covering an area of approximately 750,000 km² (Soriano et al. 1991). These grasslands include the Pampa ecoregion of Argentina (540,000 km²) and the Campos ecoregion of Uruguay, northeastern Argentina

and southern Brazil (Miñarro and Bilenca 2008). The Pampa ecoregion is dominated by grasslands with few or no trees, together with wetlands and agroecosystems. During the last 40 years, this ecoregion has been facing growing human intervention, marked by a considerable increase in the proportion of cultivated area (45% between 1990 and 2006), mainly for annual crops such as genetically modified soybean (Viglizzo et al. 2006; Gavier-Pizarro et al. 2012). This expansion of intensive agricultural activities replaced extensive livestock grazing—a practice considered less detrimental for the grasslands and therefore for birds (Marino et al. 2013).

On a global scale, several once common grassland bird populations have rapidly declined or undergone reduction in their distribution, with evidence indicating that these declines are associated with intensified agricultural production (Fuller et al. 1995; Shi et al. 1999; Renfrew and Ribic 2001; Vickery et al. 2001). At the same time, in southern South America, the degradation of natural habitats as a consequence of expansion of the agricultural frontier has led to the almost complete disappearance of pristine grasslands and natural wetlands (De la Fuente and Suárez 2008; Brandolin et al. 2013). Relicts of natural vegetation of the Pampa ecoregion remain only in protected areas, on embankments and areas surrounding railroads, or in landscapes not suitable for agriculture (e.g., saline wetlands and flooding areas) (Soriano et al. 1991; Cantero et al. 2013). These relicts provide an opportunity to evaluate the effects of diversity loss due to land use changes (Isacch et al. 2003) and contribute to the conservation of similar habitats that are threatened by similar transformations.

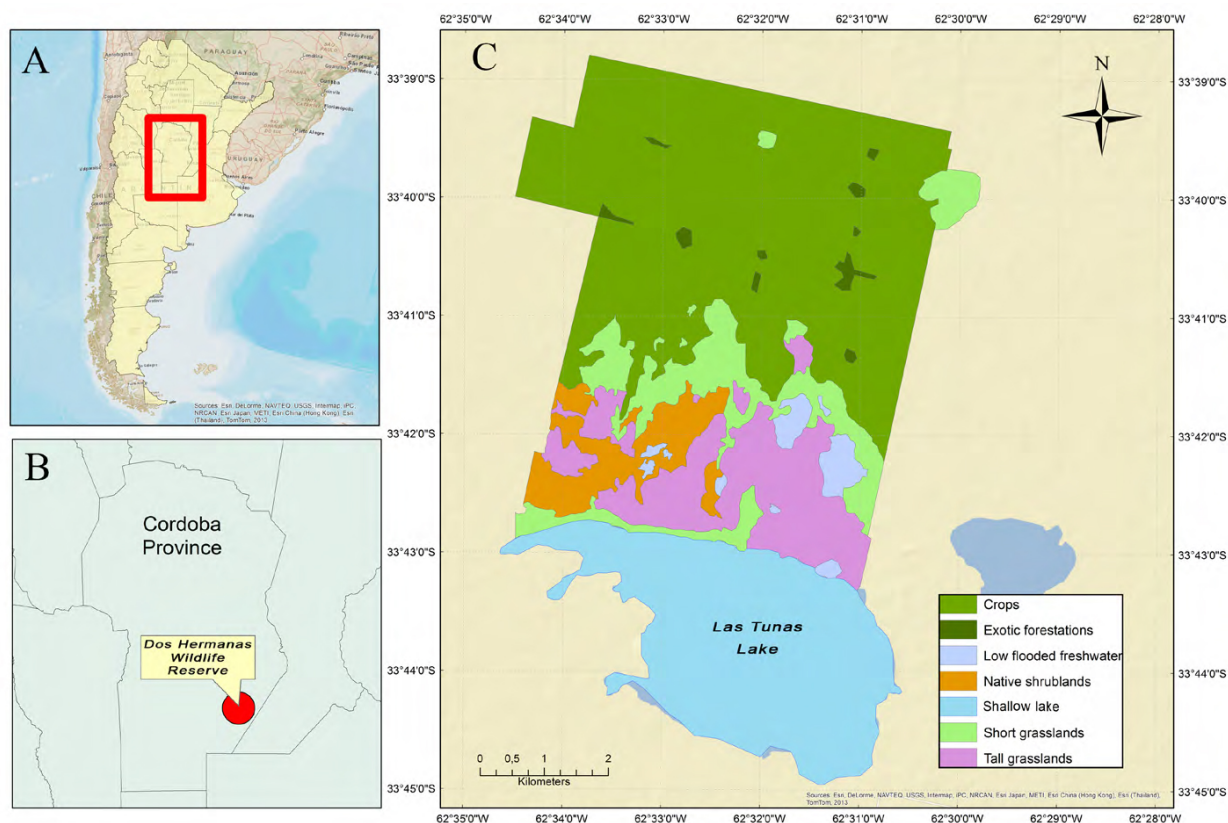


Figure 1. Location of the Dos Hermanas Wildlife Reserve in central Argentina (A) and southeastern Córdoba province (B). The different types of habitats present within DHWR are indicated (C).

Dos Hermanas Wildlife Reserve (DHWR), at the western border of the Pampa ecoregion, can be used as a model to assess the effectiveness of practices that are compatible with the conservation of birds. This Reserve is a unique example in which ecosystem-based management is practiced (i.e., combined and integrated land use for organic agriculture, ranching and areas of natural habitat under protection) for the purpose of ensuring the physical (biotic and abiotic components) and economic sustainability of the system. This type of management—including crop rotation, controlled grazing, soil and tillage conservation and absence of chemicals like biocides, fertilizers and veterinary products—seems to promote the diversity of birds and benefit conservation in agricultural environments. The variety of activities performed at DHWR allows us to examine the diversity of land uses of the Pampa ecoregion, from natural environments to the current agricultural and livestock production system. Moreover, DHWR offers the ideal conditions to study bird assemblages and the effects of management practices on biodiversity, thereby providing a conceptual basis for the conservation of threatened habitats in the Pampa ecoregion. In this study, we report the results of three years of ornithological monitoring conducted in DHWR.

MATERIALS AND METHODS

Study site

The study was carried out at Dos Hermanas Wildlife Reserve (33°40'36" S, 062°31'11" W), a privately owned protected area managed by sustainable use of natural resources (Category VI, IUCN 2015a). DHWR is located in the Department Marcos Juárez, southeastern Province of Córdoba, Argentina (Figure 1). The Reserve is situated in the Flat Inland Pampa (Soriano et al. 1991), and occupies an area of approximately 4,200 ha, with approximately 1,000 ha set aside for the strict conservation of natural saline wetland relicts embracing natural grasslands and shrublands. Some natural grasslands in DHWR are undisturbed while other areas are used for grazing in an ecosystem-based management system. DHWR also has a crop sector on high well-drained soils (Figure 1).

DHWR has a slightly undulating relief associated with a depressed area, with plant communities of contrasting structure and floristic composition and a shallow lake (Las Tunas Lake). The saline wetlands complex is subject to periodically recurring flooding-salinization (Cantero et al. 1996). In the lower, poorly drained areas are patches of halophytic tall grasslands composed primarily of *Spartina densiflora* and short halophytic grasslands of *Distichlis spicata*. The highest elevations, with slightly

undulating relief are dominated by tall grasslands composed mainly of *Nassella* spp., *Paspalum dilatatum*, *Bromus catharticus* and *Jarava ichu*, as well as exotic weed species such as *Cynodon dactylon*, *Viola arvensis* and *Carduus acanthoides*. In the depressed areas, which receive surface runoff of low salinity and are temporarily flooded, the representative community is tall grassland of *Schoenoplectus californicus*. Areas with very saline soils are dominated by a low, deciduous shrubland composed of woody and succulent halophyte species such as *Cyclolepis genistoides*, *Atriplex undulate* and *Heterostachys ritteriana*. In a large area of DHWR, (~56%) the native vegetation has been replaced by organically farmed cereal and legume monocultures, and by perennial pastures. Exotic trees, mainly Eucalyptus (*Eucalyptus* sp.), Poplars (*Populus* sp.) and Persian lilac (*Melia azedarach*) associated with buildings are located in the non-saline highest topographical sectors.

Data collection

We surveyed birds using two complementary approaches: 1) point counts, following Bibby et al. (2000), during which two or three observers recorded all birds heard or seen during five minutes within a defined radius of 100 m. Counts were made during the first four hours after sunrise and we did not carry out point counts under strong wind or rain conditions (Ralph et al. 1995); 2) unsystematic observations carried out in areas different from those covered by point counts, such as forested areas (*Eucalyptus* sp., *Melia* sp. and *Populus* sp.) roadsides and habitation. We walked these areas looking mainly for particularly inconspicuous or silent species.

Ten surveys, of five days each, were carried out in all seasons, from the summer of 2012 to the winter of 2015. Birds were detected and identified using 8 × 40 binoculars and field identification guides (Narosky and Yzurieta 2010; Azpiroz 2012). For secretive species we played bird sound recordings and compared vocalizations with confirmed recordings (Narosky and Yzurieta 2010). Nomenclature follows the South American Classification Committee (Remsen et al. 2016). Records were documented, whenever possible, with photographs or recordings of sounds, deposited at www.ecoregistros.org (Vizentin-Bugoni et al. 2015). Documented records can be accessed online using the voucher numbers listed in Table 1.

Birds were categorized according to their residency in two ways: first we established categories according to our field data as residents, winter or summer visitors and occasional. Second, we used information on the migratory status obtained from the literature on each bird species and the following categories defined by Cueto et al. (2008): (1) “Migrant from the Temperate-Tropical system”, species that nest in the study area and move to tropical humid latitudes to spend the austral

winter; (2) “Migrants from the Cold-Temperate system”, species that nest in cold regions from south and central Argentina and spend the austral winter in the center and north of the country; (3) “Nearctic Migrant”, species that nest in the northern hemisphere and migrate to the southern hemisphere in the austral summer; (4) “Altitudinal Migrant”, species that nest in the high Andes and move to low regions in the austral winter. We identified the principal habitat used by each species through field observations. The general habitat types were: tall grasslands, short grasslands, native shrublands, low flooded freshwater, shallow lake, crops and exotic tree plantations (Figure 2). For conservation status, we followed López-Lanús et al. (2008) and IUCN (2015b).

RESULTS

We recorded 170 species in 41 families: 114 species were residents, 23 winter visitors, 25 summer visitors and eight were occasional. We provided documentation for 136 species (Table 1). According to their migratory status, 13 species were considered as temperate-tropical, 16 as cold-temperate, 10 species were migratory Nearctic, and only the Andean Flamingo (*Phoenicoparrus andinus* Philippi, 1854) was an altitudinal migrant. The Cinereous Harrier (*Circus cinereus* Vieillot, 1816) exhibited seasonal variation but is not considered a migratory species. The Cinnamon Teal (*Anas cyanoptera* Vieillot, 1816) and the Rosy-billed Pochard (*Netta peposaca* Vieillot, 1816) are considered species with regular movements between sites, but in DHWR were recorded during the entire study period. The Dark-throated Seedeater (*Sporophila ruficollis* Cabanis, 1851) is considered a Temperate-tropical migrant, but was only recorded in DHWR during the winter.

The highest species richness (60 species) was recorded at exotic forestations, followed by native shrubland and shallow lake (54 and 48 species respectively), cultivated fields (37 species), freshwater-flooded grasslands (34 species), short grasslands (30 species) and tall grasslands (18 species). Four species used more than 5 habitats: the Southern Caracara (*Caracara plancus* Miller, 1777), the Chimango Caracara (*Milvago chimango* Vieillot, 1816), the Fork-tailed Flycatcher (*Tyrannus savana* Vieillot, 1808) and the Grassland Yellow-Finch (*Sicalis luteola* Sparrman, 1789), and *M. chimango* was the only species recorded in all habitats. Ninety-three species, representing 54% of the total, were recorded in only one habitat and 60 species (35%) were recorded in two.

Of all the species, seven face some degree of threat at an international level. The Dot-winged Crake (*Porzana spiloptera* Durnford, 1877) is categorized as vulnerable; the Greater Rhea (*Rhea americana* Linnaeus, 1758), Andean Flamingo (*Phoenicoparrus andinus* Philippi, 1854), Bay-capped Wren-Spinetail (*Spartonoica maluroides* d’Orbigny and Lafresnaye, 1837), Hudson’s Canastero (*Asthenes*



Figure 2. General habitat types in DHWR. (A) Tall grasslands, (B) Short grasslands, (C) Native shrublands, (D) Low flooded freshwater, (E) Shallow lake and (F) Cultivated fields and exotic tree plantations.

hudsoni Sclater, 1874), Bearded Tachuri (*Polystictus pectoralis* Vieillot, 1817) and Dark-throated Seedeater (*Sporophila ruficollis* Cabanis, 1851) are categorized as near threatened. Two additional species are vulnerable at the national level, the Upland Sandpiper (*Bartramia longicauda* Bechstein, 1812) and the Rusty-backed Monjita (*Xolmis rubetra* Burmeister, 1860). Three species recorded at the DHWR are exotic: the Rock Pigeon (*Columba livia* Gmelin, 1789), the House Sparrow (*Passer domesticus* Linnaeus, 1758) and the European Starling (*Sturnus vulgaris* Linnaeus, 1758).

Species Accounts

Particularly noteworthy records and the explanations of the diagnostic characters used for the identification of cryptic and rare species are presented below:

Rhynchotus rufescens Temminck, 1815: Very elusive and difficult to observe but presents a characteristic song, different from the other Tinamidae species present in the area (*Nothura maculosa*).

Rollandia rolland Quoy & Gaimard, 1824: Formerly placed in genus *Podiceps* (e.g., Meyer de Schauensee 1970), but recently the name *Rollandia* was erected for this species (Remsen et al. 2016).

Table 1. Birds recorded in 50 survey-days (summer 2012 to winter 2015) at Dos Hermanas Wildlife Refuge, southeastern Córdoba Province, with conservation status (CS), residency status (RS), migratory status (MS), general habitat type (GHT) and voucher detail (photo or sounds). RS: OC - occasional, RE - resident, WV - winter visitor and SV - summer visitor; MS: CTS - cold-temperate system, TTS - temperate-tropical system, NM - Nearctic migrant and AM - altitudinal migrant; CS: NT - Near Threatened and VUL - Vulnerable; GHT: TG - tall grasslands, SG - short grasslands, NS - native shrublands, LFF - low flooded freshwater, SL - shallow lake, CR - cultivated fields and EG - exotic groves. The systematic order follows Remsen et al. (2016).

Family / scientific name	English name	Photo / sound	RS	MS	CS	GHT
Rheidae						
<i>Rhea americana</i> (Linnaeus, 1758)	Greater Rhea	http://goo.gl/59fQQ9	OC		NT	SG, CR
Tinamidae						
<i>Rhyncotus rufescens</i> (Temminck, 1815)	Red-winged Tinamou	http://goo.gl/uubfHe	RE			TG, NS
<i>Nothura maculosa</i> (Temminck, 1815)	Spotted Nothura	http://goo.gl/w8qFU7	RE			TG, NS, CR
Anhimidae						
<i>Chauna torquata</i> (Oken, 1816)	Southern Screamer		OC			SG
Anatidae						
<i>Dendrocygna bicolor</i> (Vieillot, 1816)	Fulvous Whistling-Duck	http://goo.gl/lwqYDP	WV			SL
<i>Dendrocygna viduata</i> (Linnaeus, 1766)	White-faced Whistling-Duck	http://goo.gl/zPjE0k	RE			SL
<i>Cygnus melancoryphus</i> (Molina, 1782)	Black-necked Swan	http://goo.gl/zmMYuV	RE			SL
<i>Coscoroba coscoroba</i> (Molina, 1782)	Coscoroba Swan	http://goo.gl/xPkzTZ	RE			LFF, SL
<i>Anas sibilatrix</i> (Poeppig, 1829)	Chiloe Wigeon		WV	CTS		SL
<i>Anas flavirostris</i> (Vieillot, 1816)	Yellow-billed Teal	http://goo.gl/K0Yqur	RE			LFF, SL
<i>Anas georgica</i> (Gmelin, 1789)	Yellow-billed Pintail	http://goo.gl/kS5AhK	RE			LFF, SL
<i>Anas bahamensis</i> (Linnaeus, 1758)	White-cheeked Pintail	http://goo.gl/QO9P92	RE			SL
<i>Anas versicolor</i> (Vieillot, 1816)	Silver Teal	http://goo.gl/5OeXZe	RE			LFF, SL
<i>Anas cyanoptera</i> (Vieillot, 1816)	Cinnamon Teal	http://goo.gl/3otLBJ	RE			LFF, SL
<i>Anas platalea</i> (Vieillot, 1816)	Red Shoveler	http://goo.gl/swqpOI	RE			LFF, SL
<i>Netta peposaca</i> (Vieillot, 1816)	Rosy-billed Pochard	http://goo.gl/zRIs8F	RE			LFF, SL
<i>Heteronetta atricapilla</i> (Merrem, 1841)	Black-headed Duck	http://goo.gl/5odYaE	RE			LFF, SL
<i>Oxyura vittata</i> (Philippi, 1860)	Lake Duck	http://goo.gl/u6p6ZK	RE			SL
Podicipedidae						
<i>Rollandia rolland</i> (Quoy & Gaimard, 1824)	White-tufted Grebe	http://goo.gl/bcsvxP	RE			LFF, SL
<i>Podilymbus podiceps</i> (Linnaeus, 1758)	Pied-billed Grebe		RE			SL
<i>Podiceps major</i> (Boddaert, 1783)	Great Grebe		RE			SL
<i>Podiceps occipitalis</i> (Garnot, 1826)	Silvery Grebe	http://goo.gl/YndCt4	RE	CTS		SL
Phoenicopteridae						
<i>Phoenicopterus chilensis</i> (Molina, 1782)	Chilean Flamingo	http://goo.gl/ud1Ppz	RE			SL
<i>Phoenicoparrus andinus</i> (Philippi, 1854)	Andean Flamingo	http://goo.gl/1RfFok	WV	AM	NT	SL
Ciconiidae						
<i>Ciconia maguari</i> (Gmelin, 1789)	Maguari Stork	http://goo.gl/AxqeS4	RE			LFF
Phalacrocoracidae						
<i>Phalacrocorax brasilianus</i> (Gmelin, 1789)	Neotropic Cormorant		RE			SL
Ardeidae						
<i>Nycticorax nycticorax</i> (Linnaeus, 1758)	Black-crowned Night-Heron		RE			SL
<i>Bubulcus ibis</i> (Linnaeus, 1758)	Cattle Egret	http://goo.gl/TmOE7Y	RE			SG, CR
<i>Ardea cocoi</i> (Linnaeus, 1766)	Cocoi Heron	http://goo.gl/qWF20U	RE			SL
<i>Ardea alba</i> (Linnaeus, 1758)	Great Egret	http://goo.gl/sQgiMZ	RE			LFF, SL
<i>Syrigma sibilatrix</i> (Temminck, 1824)	Whistling Heron	http://goo.gl/2f3Ekc	RE			CR, EG
<i>Egretta thula</i> (Molina, 1782)	Snowy Egret		RE			LFF, SL
Threskiornithidae						
<i>Plegadis chihi</i> (Vieillot, 1817)	White-faced Ibis	http://goo.gl/vErfhu	RE			SG, CR
<i>Phimosus infuscatus</i> (Lichtenstein, 1823)	Bare-faced Ibis	http://goo.gl/dZ10Lo	OC			SL
<i>Theristicus melanopis</i> (Gmelin, 1789)	Black-faced Ibis	http://goo.gl/84Jp0k	WV	CTS		SG, CR
<i>Platalea ajaja</i> (Linnaeus, 1758)	Roseate Spoonbill	http://goo.gl/N93Dgc	RE			SL
Cathartidae						
<i>Coragyps atratus</i> (Bechstein, 1783)	Black Vulture		OC			NS
Accipitridae						
<i>Elanus leucurus</i> (Vieillot, 1818)	White-tailed Kite	http://goo.gl/t9SzNP	RE			TG, CR, EG
<i>Rostrhamus sociabilis</i> (Vieillot, 1817)	Snail Kite	http://goo.gl/onhFOZ	RE			LFF
<i>Circus cinereus</i> (Vieillot, 1816)	Cinereous Harrier	http://goo.gl/UKT0az	WV			TG, SG
<i>Circus buffoni</i> (Gmelin, 1788)	Long-winged Harrier	http://goo.gl/SYbQsp	RE			TG, SG
<i>Rupornis magnirostris</i> (Gmelin, 1788)	Roadside Hawk	http://goo.gl/FnshSo	RE			EG
<i>Geranoaetus polyosoma</i> (Quoy & Gaimard, 1824)	Variable Hawk	http://goo.gl/izPvRQ	OC			NS

Continued

Table 1. Continued.

Family / scientific name	English name	Photo / sound	RS	MS	CS	GHT
Rallidae						
<i>Porzana spiloptera</i> (Durnford, 1877)	Dot-winged Crake	http://goo.gl/NL5rNt	RE		VUL	LFF
<i>Pardirallus maculatus</i> (Boddaert, 1783)	Spotted Rail	http://goo.gl/h4SUXb	OC			LFF
<i>Pardirallus sanguinolentus</i> (Swainson, 1838)	Plumbeous Rail	http://goo.gl/9A7h4w	RE			LFF
<i>Fulica armillata</i> (Vieillot, 1817)	Red-gartered Coot	http://goo.gl/kU4fNI	RE			SL
<i>Fulica ruffrons</i> (Philippi & Landbeck, 1861)	Red-fronted Coot	http://goo.gl/mDI0E4	RE			LFF, SL
<i>Fulica leucoptera</i> (Vieillot, 1817)	White-winged Coot		RE			LFF, SL
Charadriidae						
<i>Vanellus chilensis</i> (Molina, 1782)	Southern Lapwing	http://goo.gl/gZrYuF	RE			SG, SL, CR
<i>Charadrius collaris</i> (Vieillot, 1818)	Collared Plover	http://goo.gl/HXcyzr	WV	CTS		SL
Recurvirostridae						
<i>Himantopus mexicanus</i> (Müller, 1776)	Black-necked Stilt	http://goo.gl/6ZQJTA	RE			SG, SL
Scolopacidae						
<i>Bartramia longicauda</i> (Bechstein, 1812)	Upland Sandpiper	http://goo.gl/u6ug0P	SV	NM	VUL	SG, CR
<i>Limosa haemastica</i> (Linnaeus, 1758)	Hudsonian Godwit	http://goo.gl/XbTGV3	SV	NM		SL
<i>Calidris fuscicollis</i> (Vieillot, 1819)	White-rumped Sandpiper	http://goo.gl/CBzJ0x	SV	NM		SL
<i>Calidris bairdii</i> (Coues, 1861)	Baird's Sandpiper		SV	NM		SL
<i>Calidris melanotos</i> (Vieillot, 1819)	Pectoral Sandpiper	http://goo.gl/AKtdm6	SV	NM		SL
<i>Calidris himantopus</i> (Vieillot, 1819)	Stilt Sandpiper		SV	NM		SL
<i>Phalaropus tricolor</i> (Vieillot, 1819)	Wilson's Phalarope	http://goo.gl/WfrnoY	SV	NM		SL
<i>Tringa melanoleuca</i> (Gmelin, 1789)	Greater Yellowlegs	http://goo.gl/9AlWe0	SV	NM		SL
<i>Tringa flavipes</i> (Gmelin, 1789)	Lesser Yellowlegs	http://goo.gl/DxkWqU	SV	NM		SL
Rostratulidae						
<i>Nycticryphes semicollaris</i> (Vieillot, 1816)	South American Painted-snipe	http://goo.gl/z0nG4W	RE			LFF
Laridae						
<i>Chroicocephalus maculipennis</i> (Lichtenstein, 1823)	Brown-hooded Gull	http://goo.gl/c0orhN	WV	CTS		SG, SL, CR
<i>Chroicocephalus cirrocephalus</i> (Vieillot, 1818)	Gray-hooded Gull		WV	CTS		SL
<i>Larus dominicanus</i> (Lichtenstein, 1823)	Kelp Gull	http://goo.gl/D9UqTE	OC			SL
<i>Gelochelidon nilotica</i> (Gmelin, 1789)	Gull-billed Tern		RE			SL
<i>Sterna trudeaui</i> (Audubon, 1838)	Snowy-crowned Tern		RE			SL
Columbidae						
<i>Columba livia</i> (Gmelin, 1789)	Rock Pigeon		RE			EG
<i>Patagioenas picazuro</i> (Temminck, 1813)	Picazuro Pigeon	http://goo.gl/B51K8t	RE			NS
<i>Patagioenas maculosa</i> (Temminck, 1813)	Spot-winged Pigeon	http://goo.gl/JwfDpC	RE			NS, EG
<i>Zenaidura macroura</i> (Des Murs, 1847)	Eared Dove	http://goo.gl/bmpMRV	RE			NS, EG
<i>Columbina picui</i> (Temminck, 1813)	Picui Ground Dove	http://goo.gl/EGf6Pi	RE			EG
Cuculidae						
<i>Coccyzus cinerea</i> (Vieillot, 1817)	Ash-colored Cuckoo	http://goo.gl/CVxVvx	RE			NS
<i>Coccyzus melacoryphus</i> (Vieillot, 1817)	Dark-billed Cuckoo	http://goo.gl/8cceVg	RE			NS, EG
<i>Guiraca guiraca</i> (Gmelin, 1788)	Guiraca Cuckoo	http://goo.gl/nmf4gE	RE			EG
<i>Tapera naevia</i> (Linnaeus, 1766)	Striped Cuckoo		SV	TTS		NS
Tytonidae						
<i>Tyto alba</i> (Scopoli, 1769)	Barn Owl	http://goo.gl/45scXZ	RE			EG
Strigidae						
<i>Megascops choliba</i> (Vieillot, 1817)	Tropical Screech-Owl	http://goo.gl/w7DvqY	RE			EG
<i>Athene cunicularia</i> (Molina, 1782)	Burrowing Owl	http://goo.gl/Pj8iso	RE			SG, CR
<i>Pseudoscops clamator</i> (Vieillot, 1807)	Striped Owl	http://goo.gl/fkVi2y	RE			EG
<i>Asio flammeus</i> (Pontoppidan, 1763)	Short-eared Owl	http://goo.gl/kzSygo	RE			TG
Trochilidae						
<i>Chlorostilbon lucidus</i> (d'Orbigny & Lafresnaye, 1838)	Glittering-bellied Emerald	http://goo.gl/4PnlQq	RE			EG
Picidae						
<i>Colaptes melanochloros</i> (Gmelin, 1788)	Green-barred Woodpecker	http://goo.gl/4JGrv3	RE			CR, EG
<i>Colaptes campestris</i> (Vieillot, 1818)	Campo Flicker	http://goo.gl/qWF9PP	RE			NS, CR, EG
Falconidae						
<i>Caracara plancus</i> (Miller, 1777)	Southern Caracara	http://goo.gl/Doa0yM	RE			TG, SG, NS, LFF, CR, EG
<i>Milvago chimango</i> (Vieillot, 1816)	Chimango Caracara	http://goo.gl/k99pjL	RE			TG, SG, NS, LFF, SL, CR, EG
<i>Falco sparverius</i> (Linnaeus, 1758)	American Kestrel	http://goo.gl/iiAgBo	RE			SG, NS, EG
<i>Falco femoralis</i> (Temminck, 1822)	Aplomado Falcon	http://goo.gl/BjhtV7	RE			TG, SG, EG
<i>Falco peregrinus</i> (Tunstall, 1771)	Peregrine Falcon		OC			CR

Continued

Table 1. Continued.

Family / scientific name	English name	Photo / sound	RS	MS	CS	GHT
Psittacidae						
<i>Myiopsitta monachus</i> (Boddaert, 1783)	Monk Parakeet	http://goo.gl/8klx60	RE			EG
Furnariidae						
<i>Drymornis bridgesii</i> (Eyton, 1849)	Scimitar-billed Woodcreeper		RE			EG
<i>Tarphonomus certhioides</i> (d'Orbigny & Lafresnaye, 1838)	Chaco Earthcreeper		RE			NS
<i>Furnarius rufus</i> (Gmelin, 1788)	Rufous Hornero	http://goo.gl/LdwI6Z	RE			NS, EG
<i>Phleocryptes melanops</i> (Vieillot, 1817)	Wren-like Rushbird	http://goo.gl/xoWCOQ	RE			LFF
<i>Upucerthia dumetaria</i> (Geoffroy Saint-Hilaire, 1832)	Scale-throated Earthcreeper	http://goo.gl/N2s4Qu	WV	CTS		NS
<i>Cinclodes fuscus</i> (Vieillot, 1818)	Buff-winged Cinclodes	http://goo.gl/eeFGe8	WV	CTS		NS
<i>Leptasthenura platensis</i> (Reichenbach, 1853)	Tufted Tit-Spintail	http://goo.gl/TxxDBr	RE			EG
<i>Phacellodomus sibilatrix</i> (Sclater, 1879)	Little Thornbird		RE			NS
<i>Phacellodomus striaticollis</i> (d'Orbigny & Lafresnaye, 1838)	Freckle-breasted Thornbird	http://goo.gl/41ayAB	RE			NS
<i>Anumbius annumbi</i> (Vieillot, 1817)	Firewood-gatherer	http://goo.gl/mStuAF	RE			NS
<i>Asthenes baeri</i> (Berlepsch, 1906)	Short-billed Canastero		RE			NS
<i>Asthenes hudsoni</i> (Sclater, 1874)	Hudson's Canastero	http://goo.gl/ZBPV8I	RE		NT	TG
<i>Asthenes pyrrholeuca</i> (Vieillot, 1817)	Sharp-billed Canastero	http://goo.gl/a0MWIL	RE	CTS		TG, NS
<i>Cranioleuca pyrrhophia</i> (Vieillot, 1818)	Stripe-crowned Spintail		RE			NS
<i>Spartonoica maluroides</i> (d'Orbigny & Lafresnaye, 1837)	Bay-capped Wren-Spintail	http://goo.gl/2zJNn2	RE		NT	LFF
<i>Pseudoseisura lophotes</i> (Reichenbach, 1853)	Brown Cacholote		RE			EG
<i>Schoeniophylax phryganophila</i> (Vieillot, 1817)	Chotoy Spintail	http://goo.gl/FZocQH	RE			NS
<i>Synallaxis albescens</i> (Temminck, 1823)	Pale-breasted Spintail	http://goo.gl/1Alztw	RE			NS, EG
<i>Synallaxis frontalis</i> (Pelzeln, 1859)	Sooty-fronted Spintail	http://goo.gl/anJOJd	RE			NS, EG
Tyrannidae						
<i>Elaenia parvirostris</i> (Pelzeln, 1868)	Small-billed Elaenia	http://goo.gl/MB9jjY	SV	TTS		NS, EG
<i>Suiriri suiriri</i> (Vieillot, 1818)	Suiriri Flycatcher	http://goo.gl/w1CHKM	SV	TTS		EG
<i>Serpophaga nigricans</i> (Vieillot, 1817)	Sooty Tyrannulet		RE			SG
<i>Serpophaga subcristata</i> (Vieillot, 1817)	White-crested Tyrannulet	http://goo.gl/ePU2UK	RE			NS, EG
<i>Serpophaga griseicapilla</i> (Straneck, 2007)	Straneck's Tyrannulet		RE			NS, EG
<i>Polystictus pectoralis</i> (Vieillot, 1817)	Bearded Tachuri	http://goo.gl/Q3RrNg	SV	TTS	NT	TG, NS
<i>Pseudocolopteryx acutipennis</i> (Sclater & Salvin, 1873)	Subtropical Doradito	http://goo.gl/PcnllM	SV			EG
<i>Pseudocolopteryx flaviventris</i> (d'Orbigny & Lafresnaye, 1837)	Warbling Doradito	http://goo.gl/gwQgCK	SV			LFF
<i>Tachuris rubrigastra</i> (Vieillot, 1817)	Many-colored Rush Tyrant	http://goo.gl/KTgm7U	RE			LFF
<i>Myiophobus fasciatus</i> (Müller, 1776)	Bran-colored Flycatcher	http://goo.gl/Tvuv4w	SV	TTS		EG
<i>Pyrocephalus rubinus</i> (Boddaert, 1783)	Vermilion Flycatcher	http://goo.gl/FKrhzX	SV	TTS		NS, EG
<i>Lessonia rufa</i> (Gmelin, 1789)	Austral Negrito	http://goo.gl/Fcl10P	WV	CTS		SG, SL, CR
<i>Knipolegus aterrimus</i> (Kaup, 1853)	White-winged Black-Tyrant	http://goo.gl/i7VQSm	WV			TG
<i>Hymenops perspicillata</i> (Gmelin, 1789)	Spectacled Tyrant	http://goo.gl/0gK8Gh	RE			NS, LFF
<i>Agriornis micropterus</i> (Gould, 1839)	Gray-bellied Shrike-Tyrant	http://goo.gl/u2x3ni	WV	CTS		NS
<i>Agriornis murinus</i> (d'Orbigny & Lafresnaye, 1837)	Lesser Shrike-Tyrant	http://goo.gl/qv6csl	WV	CTS		NS
<i>Xolmis coronatus</i> (Vieillot, 1823)	Black-crowned Monjita	http://goo.gl/tTkj0i	WV	CTS		CR, EG
<i>Xolmis irupero</i> (Vieillot, 1823)	White Monjita		SV	TTS		NS, CR, EG
<i>Xolmis rubetra</i> (Burmeister, 1860)	Rusty-backed Monjita		WV	CTS	VUL	CR
<i>Machetornis rixosa</i> (Vieillot, 1819)	Cattle Tyrant	http://goo.gl/hNI4GL	RE			CR, EG
<i>Pitangus sulphuratus</i> (Linnaeus, 1766)	Great Kiskadee	http://goo.gl/qjh06R	RE			NS, LFF, CR, EG
<i>Empidonomus aurantioatrocristatus</i> (d'Orbigny & Lafresnaye, 1837)	Crowned Slaty Flycatcher		SV	TTS		NS
<i>Tyrannus savana</i> (Vieillot, 1808)	Fork-tailed Flycatcher	http://goo.gl/YjYOaN	SV	TTS		TG, SG, NS, CR, EG
<i>Tyrannus melancholicus</i> (Vieillot, 1819)	Tropical Kingbird	http://goo.gl/PTyxt3	SV	TTS		CR, EG
Cotingidae						
<i>Phytotoma rutila</i> (Vieillot, 1818)	White-tipped Plantcutter	http://goo.gl/HxETE8	RE			NS, EG
Hirundinidae						
<i>Pygochelidon cyanoleuca</i> (Vieillot, 1817)	Blue-and-white Swallow		SV	TTS		SG, CR
<i>Alopochelidon fucata</i> (Temminck, 1822)	Tawny-headed Swallow	http://goo.gl/2rPddx	SV	TTS		SG, CR
<i>Tachycineta leucorroha</i> (Vieillot, 1817)	White-rumped Swallow	http://goo.gl/KES1H1	RE			SG, LFF, CR
<i>Tachycineta meyeni</i> (Meyen 1834)	Chilean Swallow	http://goo.gl/rwL3xg	WV	CTS		SG, CR
<i>Petrochelidon pyrrhonota</i> (Vieillot, 1817)	Cliff Swallow	http://goo.gl/Q4YjsB	SV	NM		SG, CR
Troglodytidae						
<i>Troglodytes aedon</i> (Vieillot, 1809)	House Wren	http://goo.gl/Qf76sE	RE			NS, EG
<i>Cistothorus platensis</i> (Latham, 1790)	Sedge Wren	http://goo.gl/S4DNhl	RE			TG, LFF

Continued

Table 1. Continued.

Family / scientific name	English name	Photo / sound	RS	MS	CS	GHT
Poliopitidae						
<i>Poliopitila dumicola</i> (Vieillot, 1817)	Masked Gnatcatcher	http://goo.gl/3RBMNg	RE			NS, EG
Turdudidae						
<i>Turdus amaurochalinus</i> (Cabanis, 1850)	Creamy-bellied Thrush	http://goo.gl/zS4FxS	RE			EG
Mimidae						
<i>Mimus saturninus</i> (Lichtenstein, 1823)	Chalk-browed Mockingbird	http://goo.gl/htrAZb	RE			NS, EG
<i>Mimus triurus</i> (Vieillot, 1818)	White-banded Mockingbird	http://goo.gl/2nso7C	WV	CTS		NS, EG
Sturnidae						
<i>Sturnus vulgaris</i> (Linnaeus, 1758)	European Starling	http://goo.gl/ivXcxg	RE			CR, EG
Motacillidae						
<i>Anthus furcatus</i> (Lafresnaye & d'Orbigny, 1837)	Short-billed Pipit	http://goo.gl/JbwBLt	RE			SG, CR
<i>Anthus correndera</i> (Vieillot, 1818)	Correndera Pipit	http://goo.gl/JkfmAl	RE			SG, CR
<i>Anthus hellmayri</i> (Hartert, 1909)	Hellmayr's Pipit	http://goo.gl/PqzAB9	RE			SG, NS
Thraupidae						
<i>Pipraeidea bonariensis</i> (Gmelin 1789)	Blue-and-yellow Tanager		RE			NS, EG
<i>Donacospiza albifrons</i> (Vieillot, 1817)	Long-tailed Reed Finch	http://goo.gl/rK1KvB	RE			NS
<i>Poospiza torquata</i> (d'Orbigny & Lafresnaye, 1837)	Ringed Warbling-Finch	http://goo.gl/Ben3uX	WV			EG
<i>Poospiza melanoleuca</i> (d'Orbigny & Lafresnaye, 1837)	Black-capped Warbling-Finch		WV			EG
<i>Sicalis flaveola</i> (Linnaeus, 1766)	Saffron Finch		RE			EG
<i>Sicalis luteola</i> (Sparrman, 1789)	Grassland Yellow-Finch	http://goo.gl/OQsAK7	RE			TG, SG, NS, LFF, CR, EG
<i>Embernagra platensis</i> (Gmelin, 1789)	Great Pampa-Finch	http://goo.gl/usDuvG	RE			TG, NS, LFF
<i>Sporophila ruficollis</i> (Cabanis, 1851)	Dark-throated Seedeater	http://goo.gl/gUbWkU	WV	TTS	NT	LFF
<i>Sporophila caeruleascens</i> (Vieillot, 1823)	Double-collared Seedeater	http://goo.gl/XHMss8	RE			EG
<i>Coryphospingus cucullatus</i> (Müller, 1776)	Red-crested Finch		WV			EG
Incertae sedis						
<i>Saltator aurantirostris</i> (Vieillot, 1817)	Golden-billed Saltator	http://goo.gl/aKRLbT	RE			NS
Emberizidae						
<i>Ammodramus humeralis</i> (Bosc, 1792)	Grassland Sparrow	http://goo.gl/xkU5hW	RE			CR, EG
<i>Zonotrichia capensis</i> (Müller, 1776)	Rufous-collared Sparrow	http://goo.gl/DlsBmJ	RE			NS, CR, EG
Icteridae						
<i>Agelasticus thilius</i> (Molina, 1782)	Yellow-winged Blackbird	http://goo.gl/3q63tc	RE			LFF
<i>Chrysomus ruficapillus</i> (Vieillot, 1819)	Chestnut-capped Blackbird	http://goo.gl/vgoSQk	RE			LFF
<i>Agelaioides badius</i> (Vieillot, 1819)	Grayish Baywing	http://goo.gl/shCrX3	RE			NS, EG
<i>Molothrus rufoaxillaris</i> (Cassin, 1866)	Screaming Cowbird	http://goo.gl/m3hUfK	RE			EG
<i>Molothrus bonariensis</i> (Gmelin, 1789)	Shiny Cowbird	http://goo.gl/Y708V9	RE			SG, NS, CR, EG
<i>Sturnella superciliaris</i> (Bonaparte, 1851)	White-browed Meadowlark	http://goo.gl/j0FZkm	SV			TG, CR
Fringillidae						
<i>Spinus magellanicus</i> (Vieillot, 1805)	Hooded Siskin		WV			EG
Passeridae						
<i>Passer domesticus</i> (Linnaeus, 1758)	House Sparrow	http://goo.gl/V4neAc	RE			EG

Podiceps major Boddaert, 1783: Formerly placed in genus *Aechmophorus* (e.g., Peters 1931; Pinto 1938), but see Wetmore and Parkes (1954). Bochenki (1994) proposed that this species be placed in the monotypic genus *Podicephorus* Bochenki, 1994 based on morphological differences. Because this proposal has not been published, we use the name suggested in Remsen et al. (2016).

Phoenicoparrus andinus Philippi, 1854: This species has been recorded frequently in DHWR (Brandolin and Avalos 2010). In photographs it is possible to see the characteristic violet tint on the upper breast and the black on the posterior third of the body.

Phimosus infuscatus Lichtenstein, 1823: Although this species can be confused with *Plegadis chihi*, *Phimosus infuscatus* looks darker and more opaque with a very characteristic rosy bare face.

Theristicus melanopis Gmelin, 1789: Often considered conspecific with *T. caudatus*. However, it was considered a separate species by Steinbacher (1979), Fjeldsa and Krabbe (1990), Matheu and del Hoyo (1992) and Ridgely and Greenfield (2001). Morphological differences make it easy to identify it in the field (gray pectoral collar and black only on belly and vent). We use the name proposed in Remsen et al. (2016) until a formal publication clarifies the taxonomy.

Platalea ajaja Linnaeus, 1758: Formerly placed in the monotypic genus *Ajaia* (e.g., AOU 1998), but see Amadon and Woolfenden (1952), Snow (1978), Hancock et al. (1992), Banks et al. (2002), and Chesser et al. (2010) for inclusion in *Platalea*, as it is now typically treated (Remsen et al. 2016).

Rupornis magnirostris Gmelin, 1788: synonyms:

Buteo magnirostris. Riesing et al. (2003) and Raposo do Amaral et al. (2009) recommended the use of the monotypic genus *Rupornis*, used for this species in earlier literature (e.g., Pinto 1938). Remsen et al. (2016) restored *Rupornis* for this species.

Porzana spiloptera Durnford, 1877: synonyms: *Lateralus spilopterus*. This is a poorly known species. Individuals were identified by the characteristic dotted coverts and confirmed by sound recordings. The brownish streaked back differentiates it from *Lateralus jamaicensis* apart from having different geographical distribution (Narosky and Yzurieta 2010).

Tringa melanoleuca Gmelin, 1789: Often misidentified with its congener *Tringa flavipes*, but substantial differences in body size makes them distinguishable when in mixed species groups (which they usually are). In cases where isolated individuals were found, bill proportions and vocalizations were used for identification.

Nycticryphes semicollaris Vieillot, 1816: Very elusive species. It was identified from photographs by the striking design of the dorsal plumage.

Chroicocephalus maculipennis Lichtenstein, 1823 and *Chroicocephalus cirrocephalus* Vieillot, 1818: synonyms: *Larus maculipennis* and *Larus cirrocephalus*. Remsen et al. (2016) recognized *Chroicocephalus* based on genetic data taken from Crochet et al. (2000) and Pons et al. (2005).

Patagioenas picazuro Temminck, 1813 and *Patagioenas maculosa* Temminck, 1813: synonyms: *Columba picazuro* and *Columba maculosa*. The New World taxa are placed in the genus *Patagioenas* (Remsen et al. 2016).

Upucerthia dumetaria Geoffroy Saint-Hilaire, 1832 and *Tarphonomus certhioides* d'Orbigny & Lafresnaye, 1838: synonyms: *Upucerthia certhioides*. See Chesser and Brumfield (2007). These two similar species may be distinguished by the curved bill of *U. dumetaria*. Furthermore, *T. certhioides* has a conspicuous white throat and a characteristic repeated song.

Phacellodomus sibilatrix Sclater, 1879: A rare species in the region. We could identify it and confirm its presence in DHWR through recorded vocalizations.

Asthenes hudsoni Sclater, 1874: Elusive and rare species for the region.

Spartonoica maluroides d'Orbigny & Lafresnaye, 1837: Elusive and difficult to observe. We identified its presence by its characteristic song and from photographs.

Synallaxis albescens Temminck, 1823 and *Synallaxis frontalis* Pelzeln, 1859: The elusive behavior and enclosed habitat of these two species may lead to misidentification. They may be distinguished by their vocalizations.

Serpophaga subcristata Vieillot, 1817 and *Serpophaga griseicapilla* Straneck, 2007: Morphologically very similar and almost indistinguishable. Straneck (2007) described *S. griseicapilla*, based on substantial differences in vocalization. Comparisons of songs allowed

assignment of individuals to the correct species.

Pseudocolaptes flaviventris d'Orbigny & Lafresnaye, 1837: Ábalos and Areta (2009) provided evidence that *P. flaviventris* includes two cryptic species (*P. flaviventris* and *P. citreola*) that differ in vocalization and display. With playback experiments we were able to identify which species corresponded to our observations in DHWR. We identified those individuals that responded to the call of the species *P. citreola* in DHWR, but since the responses were not very loud, these records were not included in this work.

Tachycineta leucorrhoa Vieillot, 1817 and *Tachycineta meyeri* Meyen, 1834: These two species were identified according to their differences in the color of the underwing coverts (white for *T. leucorrhoa* and ashy-gray for *T. meyeri*). The presence of a white forehead and white half eyebrows facilitated the identification of *Tachycineta leucorrhoa*.

Sturnus vulgaris Linnaeus, 1758: An exotic species. Identification was made through photographs.

Anthus spp.: Species of this genus are difficult to identify visually because of their similar plumage. Identification of the species in DHWR was made by comparing their songs with the recordings (Narosky and Yzurieta 2010).

DISCUSSION

In this study we generated an exhaustive list of bird species found in different habitats in a highly heterogeneous region of the Pampa of Argentina. The diversity recorded here accounts for about 45% of the total bird species identified by Nores (1996) in the Province of Córdoba, and 61% of the species that Azpiroz (2012) recognized as having probable distribution in the study area. These results indicate that DHWR is a very important site for bird conservation.

DHWR is located in the geographical center of Argentina, and provides a step in the migratory flow of temperate-tropical and cold-temperate systems. Both Patagonian and northern Argentinian species were observed, explaining the high diversity recorded. Also, DHWR offers wintering grounds for one altitudinal migratory species and many Nearctic ones. The Andean Flamingo nests in summer (December to January) in the highlands of northwestern Argentina and moves to lower latitudes within the Andes and to lower altitudes in winter (Brandolin and Avalos 2010; HBW 2015). Generally, there is considerable agreement between residency status observed in DHWR and the migratory status of most species. Species that behave differently than expected in terms of residency are likely to be because of local movements due to various factors such as the availability of food resources and nesting, or because they are species with low population densities and are not easily detected in the field. The Dark-throated

Seedeater is rare in winter for this area and probably the records correspond to individuals which did not migrate to the north. For birds in highly modified environments, it is likely that relict of natural grasslands has a quasi-insular behavior within the surrounding agricultural matrix, as birds find this habitat preferable to agricultural environments where they do not find a suitable habitat (Carrascal and Tellería 1988).

The European Starling is a species with major invasive potential and it is expanding its population in central Argentina. It competes with native bird species and in large numbers it can become a significant pest for agricultural production (Klavins and Álvarez 2012). So far, this introduced species had been reported only in urban areas in the Pampa ecoregion, but our records confirm its presence in agroecosystems, highlighting a concern about the expansion of the species.

Given the fragmentation of natural ecosystems of the Pampa in recent decades, the high diversity of birds at DHWR, including nine species threatened at national and international level shows that this reserve represents an important place for the conservation of the regional biota. The species recorded in DHWR showed a high specificity in the use of habitat which is consistent with a close relationship between bird species and structural and floristic characteristics of the vegetation (Graham and Blake 2001; Naugle et al. 2001; Skowno and Bond 2003; Wakeley et al. 2007; Di Giacomo and Lopez De Casenave 2010). This suggests that increasing complexity in habitat structure (horizontal, vertical and qualitative variation of elements present) generates greater resources for birds, allowing the persistence of a greater number of species and guilds than in less complex habitats (MacArthur and MacArthur 1961; Tews et al. 2004; Codesido et al. 2013).

In general, natural and less-modified habitats in the Pampa are more frequently used by birds than highly modified habitats (Filloy et al. 2010). On the other hand, any disturbances in the landscape that increase structural complexity and plant diversity (e.g. selective grazing) promote greater bird species richness (Isacch et al. 2003). In terms of planning and management, the spatial coexistence of contrasting vegetation structures (e.g., grassland-shrubland-crops), generates high landscape diversity values and has a positive effect on the diversity of bird assemblages in the Pampa ecoregion (Brandolin et al. in press). Our results are supporting the hypothesis that land management with mixed farming (agriculture and livestock) using certified organic methods, long cycles of crop and pasture rotation, restrictions on the use of chemical fertilizers and fumigants and the sparingly grazed lakeside (considered to be one of the last relicts of the original Pampa environments) can generate a highly desirable patchy habitat structure and thus support a wide variety of birds.

The advance of the agricultural frontier is a common threat to all temperate grasslands in South America, including the southeast of Córdoba province. Due to this growing trend of agricultural expansion on natural environments in Argentina and worldwide, there is a clear need for a change in conservation strategies. Organic land management, as at DHWR, or other systems that ensure environmental sustainability (e.g., multifunctional landscapes) would offer promising alternative scenarios for long-term stability between human activity and bird populations (Petit et al. 1995). The generation of knowledge about the functioning of environments in relict sites and in agroecosystems, especially in threatened environments such as the grasslands and wetlands of the Pampa ecoregion, is essential for establishing a point of comparison and baseline for future research and evaluation of management practices.

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