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DIVERSITY, SEASONALITY AND STRUCTURE OF BIRD ASSEMBLAGES ASSOCIATED WITH THREE WETLANDS IN THE SOUTHEASTERN PAMPAS, ARGENTINA

DIVERSIDAD, ESTACIONALIDAD Y ESTRUCTURA DE ENSAMBLES DE AVES ASOCIADOS A TRES HUMEDALES DEL SUDESTE DE LA REGIÓN PAMPEANA, ARGENTINA

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SUMMARY.—Los Padres, La Brava and Nahuel Rucá lakes are typical wetlands of the Pampean region. These three shallow lakes share certain limnological features (size, mean depth, littoral macrophytes, among others) and the land usage in their basins (e.g. agriculture, cattle ranching and/or touristic activities). We surveyed the bird community at these three wetlands over three years (May 2006-May 2009), using transects and point counts to characterise their species richness, abundance, community composition and seasonality. We recorded a total of 135 species belonging to 41 families. The Relative Importance Index showed that the neotropic cormorant *Phalacrocorax olivaceus*, the cattle egret *Bubulcus ibis*, the white-tufted grebe *Rollandia rolland* and the white-faced ibis *Plegadis chihi* are the most representative species. Species richness, species composition and abundance differed between wetlands. Such differences could be attributed to particular factors such as proximity to urban centres or other wetlands, and to the impact of recreational activities. Considering that the Pampean region is currently under strong anthropogenic impacts, the present study contributes to the improvement of management plans that are currently in place or under development.

Key words: land use, Pampean region, seasonality, shallow lakes, species composition.

RESUMEN.—Las lagunas de Los Padres, La Brava y Nahuel Rucá son humedales representativos de la región pampeana. Estos tres ambientes comparten ciertos aspectos limnológicos (tamaño de la cubeta, profundidad media, macrófitas litorales, entre otros), y el uso del suelo aplicado a sus cuencas (por ejemplo, agricultura, ganadería y/o turismo). Durante tres años (mayo del 2006 a mayo del 2009) se estudió la avifauna de estos tres humedales, utilizando para ello censos de transecta y de punto, con el objetivo de caracterizar su abundancia, diversidad, composición de especies y estacionalidad. Se registró un total de 135 especies pertenecientes a 41 familias. El Índice de Importancia Relativa mostró

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que el cormorán biguá *Phalacrocorax olivaceus*, la garcilla bueyera *Bubulcus ibis*, el zampullín pimpollo *Podiceps rolland* y el morito cariblanco *Plegadis chihi* fueron las especies más representativas. La riqueza, la composición y abundancia de especies fue diferente entre lagunas. Tales diferencias pueden ser atribuidas a factores particulares como la proximidad a centros urbanos, a otros humedales y a actividades recreativas. Considerando que la región pampeana está actualmente bajo un fuerte impacto antrópico, el presente estudio contribuye a la mejora y actualización de los planes de manejo de estas áreas.

*Palabras clav*e: composición de especies, estacionalidad, lagos someros, región pampeana, uso del terreno.

INTRODUCTION

The southeastern Pampean region of Argentina is dominated by permanent and temporary wetlands of different sizes, referred to as shallow lakes (Gómez and Toresani, 1999; Dangavs, 2005). Birds are one of the most conspicuous faunal components that participate, directly or indirectly, in the general dynamics of these ecosystems (Hurlbert and Chang, 1983; Beltzer and Quiroga, 2007). Even though shallow lakes are well represented in the Pampean region, studies of their bird communities and their seasonal variations have only been conducted at a few locations (e.g., Canevari *et al.*, 1991; Filipello and Lopez de Casenave, 1993; Bucher *et al.*, 2000; Romano *et al.*, 2005; Guichón and Cassini, 2007; Josens *et al.*, 2009a, b). Intense human activity has meant that the southeastern Pampean wetlands are complex habitats within a highly fragmented agricultural mosaic (Ghersa and León, 2001). As a consequence, numerous bird species congregate in this region (Martínez, 1993; Blanco and Carbonell, 2001), especially for foraging, reproduction and resting (Martínez, 1993; Josens *et al.*, 2009b).

Several aspects of bird ecology in aquatic environments make avian communities useful for understanding wetland dynamics (Crozier and Gawlik, 2002; Romano *et al.*, 2005). Birds associated with aquatic habitats have been shown to track changes in such environmental variables as water level and lake productivity, both on short (months) and long (years) temporal scales and at both the species and community levels (Murkherjee and Borad, 2001; Abraham and Sydeman, 2004; Almaraz and Amat, 2004; Rendón *et al.*, 2008; Josens *et al.*, 2009a). Estimating species richness, i.e. the number of species present in a given area, is a basic objective of many field studies in community ecology and is also an essential concern when dealing with the conservation and management of biodiversity (Walther and Martin, 2001). Since Pampean wetlands are naturally eutrophic and share similar water composition (Grosman and Sanzano, 2008; Dangavs, 2005), we predicted that community attributes such as richness, assemblage abundances and seasonality, would be most clearly associated with such variables as the precipitation regime (David, 1994; Canepuccia *et al.*, 2007), which directly affects lake depths (Quirós *et al.,* 2002; Coops *et al.*, 2003), and/or the surrounding land use, such as extensive agriculture, ploughing or recreation (Hoyer and Candfield, 1994; Traut and Hostetler, 2003; Guichón and Cassini, 2007; Cardoni *et al.*, 2008; Josens *et al.,* 2009a).

The goals of this study were to explore variation in the richness, species composition, assemblage structure and seasonality of the bird assemblages at three Pampean shallow lakes and to analyse the relationships between changes in assemblage abundance and precipitation. We predicted that

there would be no differences in community attributes between the wetlands and that a negative relationship would exist between assemblage abundance and precipitation.

METHODS

Study area

The study was conducted at three Pampean shallow lakes: Los Padres, La Brava and Nahuel Rucá, located in the southeast of Buenos Aires Province, Argentina. Each of these lakes has only one inflow stream, at the highest point of its basin and one outflow, both streams providing a through-flow system (fig. 1). The area is characterised by intensive land use, including agriculture, cattle ranches and semi-natural grassland (Baccaro *et al.*, 2006). Los Padres Lake Integral Reserve is the only wetland in the area with a current management plan. La Brava Lake, however, is part of a complex area of

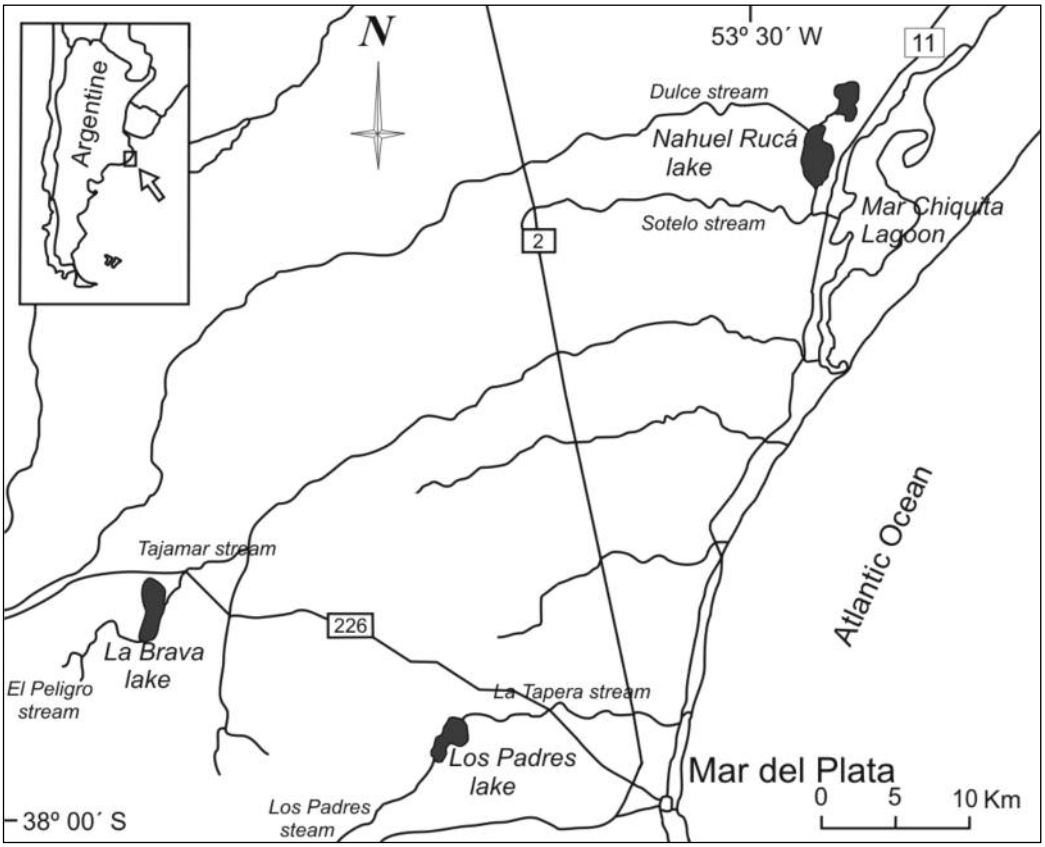

FIG. 1.—Location of Los Padres, La Brava and Nahuel Rucá lakes in the southeastern Pampean plain, Argentina.
[Localización de las lagunas de los Padres, La Brava y Nahuel Rucá en el sudeste de la llanura pampeana, Argentina.]

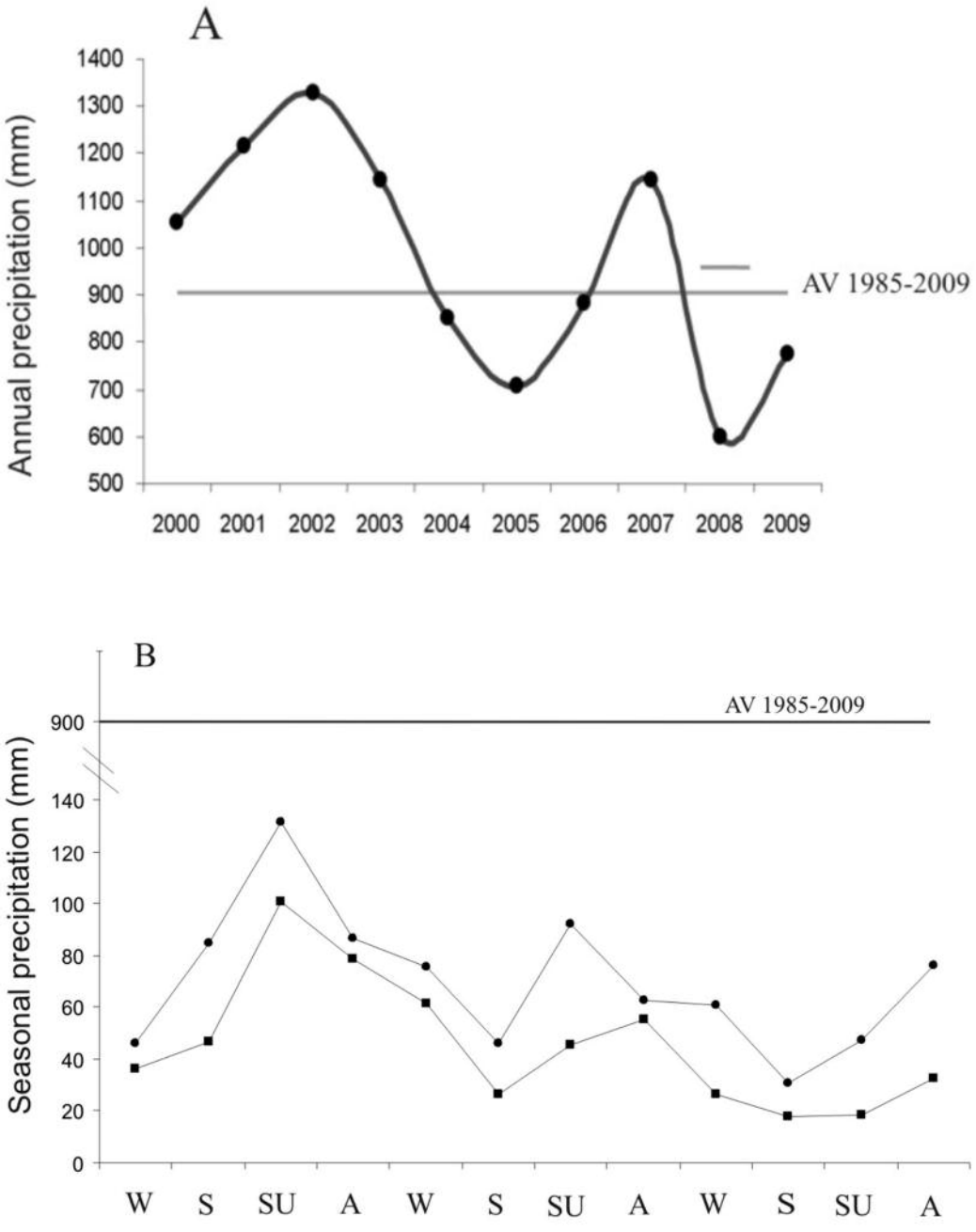

FIG. 2.—Annual (A) and seasonal (B) precipitation (mm) for the southeastern Buenos Aires Province. (●) average, (■) standard deviation. W: winter; S: spring; SU: summer and A: autumn (2006-2009). *[Régimen de precipitaciones anual (A) y estacional (B) (en mm) para el sudeste de Provincia de Buenos Aires. (●) promedio, (■) desvío estándar. W: invierno; S: primavera; SU: verano y A: otoño (2006-2009).]*

private and public zones and, as such, no management plan is currently in place. Both lakes are in the vicinity of large urban centres, the cities of Mar del Plata and Balcarce respectively. Finally, Nahuel Rucá Lake is located on private land in the vicinity of the Mar Chiquita coastal lagoon, an UNESCO 'Man and the Biosphere' Reserve. This lagoon is an important wintering site for migratory birds (Martínez, 2001).

We considered some limnological features, including lake size, mean depth and the cover of littoral emergent macrophytes, to characterise Los Padres, La Brava and Nahuel Rucá lakes. Landsat satellite composite images of bands 3, 4 and 7 (2007, 27.5 m. of spatial resolution) and field visits were used to determine land use in the surrounding area. We explored the area near each lake using ArcGIS 9.2 (ESRI, 2007) and digitalised the relative area of the different land uses considered (e.g., woodlands, reserve zones, farmland cattle ranches, recreational areas). Precipitation records for the past decade show that considerable variation in precipitation was registered during this study, with a rainy period during 2006 and the driest one in 2008. Average annual rainfall during the whole study period was lower than the historical mean for the area (fig. 2). Daily rainfall data were obtained from the National Meteorological Service, for Mar del Plata city station. We used monthly accumulated data for the analysis. The Southern Hemisphere seasons were defined as autumn (April, May and June), winter (July, August, September), spring (October, November, December) and summer (January, February, March).

Censuses

Bird data was recorded monthly at each shallow lake, from May 2006 to May 2009. Five 100 m transects (Bibby *et al.*, 1997) parallel to the coastline and 100m apart, and two point counts, were established at each waterbody. All bird observations were made by the same individual. The point counts were conducted within a semicircle of 50 m radius extending into the lake and located at the inflow and outflow streams. Both transect and point counts lasted approximately ten minutes.

Birds were classed into assemblages based on coarse-scale habitat use within the wetland (modified from Jacksic, 1981). Strictly aquatic species comprised wading birds (referred as W), a group that forages in shallow waters (e.g., herons, ibises); swimming birds (S) that forage in vegetated littoral zone (e.g., rails, coots, ducks), and diving birds (D) that forage in deep waters (e.g., cormorants). Other groups consisted of birds that primarily use terrestrial environments, but also are associated with wetlands. For example, gulls frequently forage in terrestrial environments such as farmland and landfills but they rest and reproduce in wetlands. These groups were aerial birds (A) that generally patrol the water-land interface (e.g., gulls, raptors), and passerine birds (P) that primarily use vegetated patches near wetland shorelines.

Statistical analyses

The analyses considered each lake separately. The five transect counts and the two point counts for each lake were pooled, giving 84 data sets for each year. Differences in bird richness between lakes were tested using the Kruskall-Wallis (H) test (Zar, 1999). For each shallow lake we estimated the Relative Importance Index (RII, Gatto *et al.*, 2005), as follows: $RII = (N_i/N_t) * (M_i/M_t) * 100$, where N_i is the number of individuals of species 'i' in all samples, N_t is the total individuals of all species, M_i is the number of samples in which 'i' was present and M_t is the sum of samples. This index shows the relative importance of each species across the study period.

An analysis of similarity (ANOSIM, Clarke and Warwick, 2001) was used to analyze differences in species composition and assemblage structure. ANOSIM is a non-parametric permutation procedure that is combined with a Monte Carlo test to determine whether the level of similarity among samples within a group is greater than expected by chance when compared to the level of similarity among samples across the groups (Blake, 2007). For species composition and structure assemblages, we created abundance matrices of bird species or assemblages, per site and per sampled month. Throughout the similarity percentage procedure (SIMPER) (Clarke and Warwick, 2001) was used to explore the structure of assemblage among lakes.

A two-way analysis of variance and a Tukey test for *post hoc* comparisons (Zar, 1999) were performed to analyze seasonality. Simple regressions were used to explore the relationships between the abundance of swimming, diving and wading birds and the precipitation regime (Zar, 1999).

RESULTS

Land use

Farmland was the most important land use at Los Padres Lake Integral Reserve, covering approximately 79% of the total area. Cattle ranches occupied the largest area at the other two lakes, 41% and 61% for La Brava and

TABLE 1

Limnological characteristics and land use at Los Padres, La Brava and Nahuel Rucá lakes.
[Características limnológicas y uso del suelo en las lagunas de Los Padres, La Brava y Nahuel Rucá.]

Characteristics	**Los Padres Lake**	**La Brava Lake**	**Nahuel Rucá Lake**
Lake surface (ha)	216 [(c)]	400 [(b)]	245 [(d)]
Maximum depth (m)	2.4 [(c)]	4.57 [(b)]	0.14 [(d)]
Width (km)	1.7 [(a)]	0.97 [(b)]	1.3
Coastline development	1.19 [(e)]	1.58 [(b)]	1.59
Distance to nearest lake (m)	14242	5934	1341
% of cover by littoral macrophytes	20% [(f)]	1.28% [(g)]	23% [(d)]
% Woodlands	10.3	19.4	1.3
% Reserve zones	6.1	0	10.2
% Farmlands	79	33.8	27.5
% Cattle ranches	0	40.9	61
% Recreation areas	4.2	5.8	0

(a) Pozzobon and Tell (1995); (b) Cordini (1942); (c) Bocanegra and del Río (1991); (d) Romanelli (unpubl. data); (e) Romanelli and Massone (2009); (f) del Río *et al.* (1992); (g) Romanelli *et al.* (2010)

Nahuel Rucá lakes, respectively. This land use was absent within Los Padres Lake Integral Reserve, as well as in the reserve zones of La Brava Lake and the recreational areas at Nahuel Rucá Lake. Woodlands occupied a considerable area (> 10% of total area) at Los Padres and La Brava lakes (table1).

Species composition, assemblage structure and seasonality

A total of 135 species belonging to 41 families was identified at the three sites over the three study years. The best-represented families were the Anatidae (17 species), the Tyrannidae (14 species) and Emberizidae (nine species). Significant differences in species richness were found between Los Padres (LP), La Brava (LB) and Nahuel Rucá (NR) lakes ($H_{2,108} = 16.717$, $P = 0.001$). Fifty-two species were found at LP, 55 at LB and 57 at NR during the austral summer; and 11 species were found at LP, 20 at LB and 25 at NR during the austral winter. The RII values showed that the neotropical cormorant *Phalacrocorax olivaceus*, the cattle egret *Bubulcus ibis*, the white-tufted grebe *Rollandia rolland* and the white-faced ibis *Plegadis chihi* were the most representative species for the three lakes (appendix I).

The analysis of species composition indicated that overall differences between lakes were significant (ANOSIM: Global $R = 0.264$, $P = 0.001$ number of permutations out of 1,000). The results of comparisons were: LB *vs.* NR Global $R = 0.271$; LP *vs.* NR Global $R = 0.336$; LP *vs.* LB Global $R = 0.189$, P = 0.001. For assemblage structure, we found that the three lakes differed significantly from each other (ANOSIM Global $R = 0.085$, $P = 0.001$: LB *vs.* NR Global $R = 0.047$ $P = 0.002$; LP *vs.* NR Global $R = 0.143$ $P = 0.001$; LP *vs.* LB Global $R = 0.069$, $P = 0.006$), with swimming and wading birds being the more representative assemblages (table 2).

Seasonality was similar at the three lakes for swimming and passerine birds, where no differences were found ($P > 0.05$). However, we found differences for wading and diving birds ($F_{2, 252} = 6.437$ $P = 0.002$; $F_{2, 252} = 4.616$

TABLE 2

Percentage of dissimilarity between lakes and assemblage contribution at Los Padres (LP), La Brava (LB) and Nahuel Rucá (NR) lakes. S = swimming birds, W = wading birds, D = diving birds, A= aerial birds and P = passerine birds.
[Porcentaje de disimilitud entre lagunas y contribución de los ensambles en las lagunas de Los Padres (LP), La Brava (LB) y Nahuel Rucá (NR). S = aves nadadoras, W = aves vadeadoras, D = aves buceadoras, A = aves aéreas y P = aves paseriformes.]

Lakes	Dissimilarity (%)	Assemblage contribution (%)				
		S	W	D	A	P
LP vs. LB	53.1	41.5 ± 1.2	20.2 ± 1.09	14.2 ± 0.7	14.9 ± 0.96	9.2 ± 1.4
LP vs. NR	49.8	38.8 ± 1.16	26 ± 0.99	9.9 ± 0.81	17 ± 0.95	8.3 ± 1.3
NR vs. LB	49.5	45.8 ± 1.26	22.6 ± 0.91	12 ± 0.84	10 ± 0.58	9.4 ± 0.99

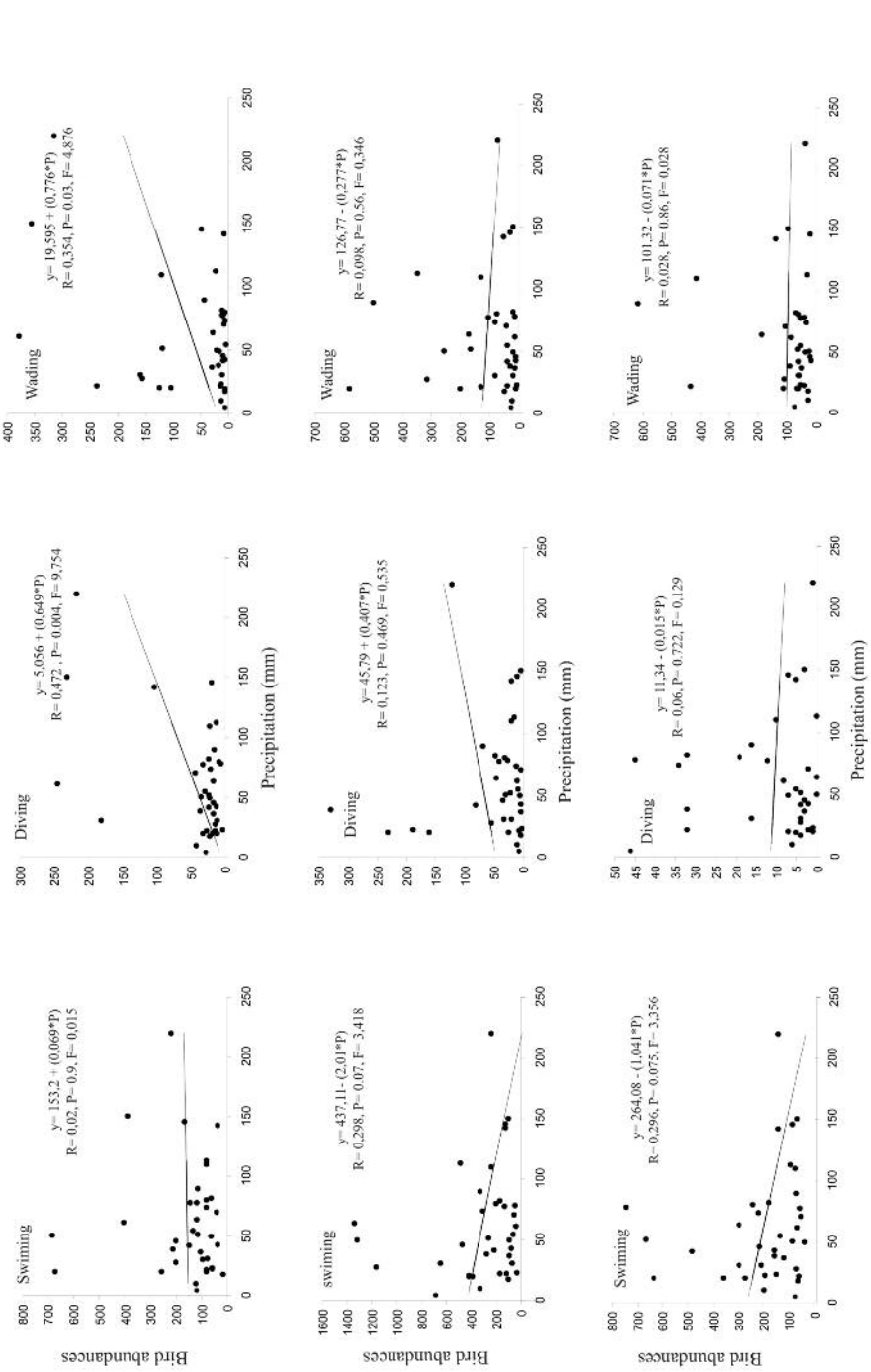

FIG. 3.—Relationships between the abundances of the swimming, diving and wading assemblages and precipitation for Los Padres, La Brava and Nahuel Rucá lakes.
[Relaciones entre la abundancia de los ensambles de aves nadadoras, buceadoras y vadeadoras y el régimen de precipitación para las lagunas Los Padres, La Brava y Nahuel Rucá.]

$P = 0.003$ respectively); these being especially significant in summer ($P < 0.05$). Correlations between assemblage abundances and precipitation regime showed a positive relationship at Los Padres lake for wading ($r = 0.47$, $P = 0.03$) and diving birds ($r = 0.35$, $P = 0.004$). Correlations were not significant for La Brava and Nahuel Rucá lakes (fig. 3).

Discussion

The present study shows the importance of the shallow lakes for birds on the southeastern Pampean plain. Bird diversity, species composition and assemblage structure there differ according to spatial and temporal variables. The lake avifauna is diverse, including many species of nearby grassland habitats as well as aquatic species. These findings highlight the importance of shallow lakes for the maintenance of bird diversity.

Richness and species composition of bird assemblages differed more than we expected between lakes, despite their shared limnological characteristics and land uses, and their location in the same region. However, such differences may be attributed to different factors. For example, species may show different degrees of susceptibility to human activities, and differences in species composition in wetlands could be affected by the human use of these areas and their proximity to urban centres (Traut and Hostetler, 2003). In our study, the most disturbed wetland, Los Padres Lake, also had the lowest bird species richness. Cardoni *et al.* (2008) found that recreational activities affected the diversity and habitat use of waterbirds in this wetland, with the most vulnerable assemblages being those that use shallow waters and the shoreline: e.g. Rallidae, Anatidae and Ardeidae. On the other hand, Nahuel Rucá lake, which had the greatest bird species richness, is a pristine wetland, more distant from urban centres and clearly linked with the Mar Chiquita coastal lagoon (Isla and Gaido, 2001).

Assemblage structure differed between lakes in relation to spatial and/or temporal variations. We did not detect seasonality among passerines, perhaps because some migratory passerine species are present at the three lakes year-round, with particular species being replaced by others so that there are no significant changes in total abundances (Filipello and Lopéz de Casenave, 1993; Romano *et al.*, 2005). However, for other assemblages, the variability can be related to changes in relative abundance during the year rather than to a partial replacement of species. This variability could be linked to seasonality, at least for some assemblages, such as wading and diving birds. Wading birds, especially herons and ibises, tend to forage in terrestrial, usually agricultural environments, but rest and reproduce in aquatic ones (Madsen *et al.*, 1999; van Eerden *et al.*, 2005). The changes observed in this group could therefore be related to their breeding cycles being concurrent at all Pampean shallow lakes during summer (Martínez, 1993; Josens *et al.*, 2009b). The variation in the structure of diving assemblages could be related to the rainfall regime. Variation in water level is known to affect the availability of suitable environments for feeding, reproduction and resting, thus affecting bird abundance (Romano *et al.*, 2005). Regression analysis showed that diving birds congregate during the dry months, in summer. Finally, aerial assemblages were uniform at all lakes across all seasons, which may be at least partly explained by the similarity of land use near each lake (Ghersa and León, 2001). Community diversity and species abundance can be affected by land use and agricultural practices (Parish *et al.*, 1994). Such species as the brown-hooded and kelp gulls, and the chimango caracara, are strongly associated with agriculture (Ghys and Favero, 2004; Josens *et al.*, 2009a).

The present study allowed us to evaluate the shallow lakes' bird species diversity and its variability over a short temporal scale. Given that the Pampean region is currently under strong anthropogenic impacts, our results may contribute to the improvement of existing or future management plans. It is certainly clear that the Pampean plain is undergoing constant and rapid transformation. Management plans should pay special attention to those species that are particularly affected, monitoring potential local extinctions and the expansion of those species that are adapted to human disturbance.

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APPENDIX I

List of species (following Narosky and Yzurieta, 2003), their status (ST) and relative importance index (RII), at Los Padres (LP), La Brava (LB) and Nahuel Rucá (NR) lakes. Status categories are: (R) resident, (MA) migratory birds that breed in North Hemisphere and stay in the South Hemisphere in spring-summer, (MB) birds that breed in Argentina and winter in the north, and (MC) birds that breed in Patagonia and winter in the north.

[Lista de especies (según Narosky e Yzurieta, 2003), su estatus (ST) e índice de importancia relativa (RII), en las lagunas de Los Padres (LP), La Brava (LB) y Nahuel Rucá (NR). Las categorías de estatus son: (R) residente, (MA) aves migradoras que nidifican en el hemisferio norte y permanecen en el hemisferio sur durante primavera-verano, (MB) aves que nidifican en Argentina e invernan en el norte, y (MC) aves que nidifican en Patagonia e invernan en el norte.]

				RII		
Family	**Species**		**ST**	**LP**	**LB**	**NR**
Rheidae	greater rhea	*Rhea americana*	R	0	0	<0.05
Tinamidae	spotted nothura	*Nothura maculosa*	R	0	<0.05	<0.05
Podicipedidae	white-tufted grebe	*Podiceps rolland*	R	3.85	4.71	0.59
	great grebe	*Podicephorus major*	R	0.27	0.07	<0.05
	pied-billed grebe	*Podylimbus podiceps*	R	<0.05	0	<0.05
	silvery grebe	*Podiceps occipitales*	R	0	<0.05	<0.05
Phalacrocoracidae	neotropic cormorant	*Phalacrocorax olivaceus*	R	4.91	0.88	0.79
Ardeidae	snowy egret	*Egretta thula*	R	0.56	<0.05	0.2
	great egret	*Egretta alba*	R	0.25	<0.05	0.95
	cattle egret	*Bubulcus ibis*	R	2.16	1.08	0.08
	white-necked heron	*Ardea cocoi*	R	<0.05	0.17	2.6
	black-crowned night-heron	*Nycticorax nycticorax*	R	0.39	<0.05	<0.05
	striated heron	*Butorides striatus*	R	<0.05	<0.05	<0.05
	whistling heron	*Syrigma silbilatrix*	R	0	<0.05	<0.05
	stripe-backed bittern	*Ixobrychus involucris*	R	0	0	<0.05
Ciconiidae	maguari stork	*Ciconia maguari*	R	0	0.06	1.71
Threskiornithidae	white-faced ibis	*Plegadis chihi*	R	1.69	7.24	5.89
	bare-faced ibis	*Phimosus infuscatus*	R	0.06	0.13	<0.05
	roseate spoonbill	*Platalea ajaja*	R	0.13	<0.05	1.41
	black–faced ibis	*Theristicus melanosis*	M	0	<0.05	<0.05
Phoenicopteridae	chilean flamingo	*Phoenicopterus chilensis*	R	<0.05	<0.05	0.45
Anhimidae	southern screamer	*Chauma torquata*	R	<0.05	0.05	1.02

APPENDIX I (cont.)

Family	Species		ST	RII		
				LP	LB	NR
Anatidae	yellow-billed pintail	*Anas georgica*	R	1.71	4.07	3.42
	black-necked swan	*Cygnus melancoryphus*	R	0.46	0.08	3.23
	silver teal	*Anas versicolor*	R	0.85	0.44	3.18
	lake duck	*Oxyura vittata*	R	0.95	1.58	0.31
	coscoroba swan	*Coscoroba coscoroba*	R	0.35	<0.05	0.64
	speckled teal	*Anas flavirostris*	R	10.4	9.58	16.7
	rosy-billed pochard	*Netta peposaca*	R	0.19	1.04	0.99
	white-faced whistling-duck	*Dendrocygna viduata*	R	4.72	10.5	1.09
	fulvous whistling-duck	*Dendrocygna bicolor*	R	0.27	0.26	<0.05
	southern wigeon	*Anas sibilatrix*	R	<0.05	0.27	0.7
	blue-winged teal	*Anas discors*	MA	0	<0.05	<0.05
	black-headed duck	*Heteronetta atricapilla*	R	0.09	<0.05	0.64
	cinnamon teal	*Anas cyanoptera*	R	0.27	0.36	0.08
	white-cheeked pintail	*Anas bahamensis*	R	<0.05	0.23	<0.05
	red shoveler	*Anas platalea*	R	0.73	2.13	2.39
	brazilian duck	*Amazonetta brasiliensis*	R	0	0	<0.05
	ringed teal	*Callonetta leucophrys*	R	<0.05	0	<0.05
Accipitridae	long-winged harrier	*Circus buffoni*	R	0.05	0.07	0.06
	roadside hawk	*Buteo magnirostris*	R	<0.05	<0.05	<0.05
	snail kite	*Rostrhamus sociabilis*	R	<0.05	<0.05	<0.05
	white-tailed kite	*Elanus leucurus*	R	0	<0.05	0
	sharp-shinned hawk	*Accipiter striatus*	R	0	<0.05	0
Falconidae	chimango caracara	*Milvago chimango*	R	0.32	0.26	0.28
	southern crested-caracara	*Polyborus plancus*	R	<0.05	<0.05	0.31
	american kestrel	*Falco sparverius*	R	<0.05	0	0
	peregrine falcon	*Falco peregrinus*	MA	<0.05	<0.05	0
Aramidae	limpkin	*Aramus guarauna*	R	0.15	<0.05	<0.05
Rallidae	white-winged coot	*Fulica leucoptera*	R	8.3	14.4	7.5
	red-fronted coot	*Fulica rufifrons*	R	1.77	0.93	0.58
	spot-flanked gallinule	*Porphyriops melanops*	R	0	<0.05	<0.05
	plumbeous rail	*Rallus sanguinolentus*	R	<0.05	0.1	0.11
	common gallinule	*Gallinula chloropus*	R	<0.05	<0.05	0
Jacanidae	wattled jacana	*Jacaca jacana*	R	0	0	<0.05
Rostratulidae	south american painted-snipe	*Nycticryphes semicollaris*	R	0	<0.05	0

APPENDIX I (cont.)

Family	Species		ST	RII		
				LP	LB	NR
Charadriidae	southern lapwing	*Vanellus chilensis*	R	<0.05	0.63	0.81
	american golden plover	*Pluvialis dominica*	MA	0	0	0.24
	rufous-chested dotterel	*Zonibyx modestus*	MC	0	0	<0.05
	two-banded plover	*Charadrius falklandicus*	MC	0	0	<0.05
Scolopacidae	greater yellowlegs	*Tringa melanoleuca*	R	<0.05	<0.05	0.55
	common snipe	*Gallinago gallinago*	R	0	0.11	<0.05
	hudsonian godwit	*Limosa haemastica*	R	0	0	<0.05
	pectoral sandpiper	*Calidris melanotos*	R	0	0	<0.05
Recurvirostridae	south american stilt	*Himantopus melanurus*	R	0.12	1.02	0.37
Laridae	brown-hooded gull	*Larus maculipennis*	R	13.8	7.03	2.13
	kelp gull	*Larus dominicanus*	R	<0.05	0.23	<0.05
	gray-hooded gull	*Larus cirrocephalus*	R	1.12	<0.05	0
Sternidae	snowy-crowned tern	*Sterna trudeaui*	R	<0.05	<0.05	0.05
Columbidae	picazuro pigeon	*Columba picazuro*	R	0.65	0.73	<0.05
	spot-winged pigeon	*Columba maculosa*	R	<0.05	<0.05	0
	eared dove	*Zenaida auriculata*	R	<0.05	<0.05	0
	picui ground-dove	*Columbina Picus*	R	<0.05	0	0
Psittacidae	monk parakeet	*Myiopsitta monachus*	R	<0.05	<0.05	0
Cuculidae	guira cukoo	*Guira guira*	R	<0.05	0	0
Strigidae	short-eared owl	*Asio flammeus*	R	0	<0.05	0
	burrowing owl	*Athene cunicularia*	R	0	<0.05	0
	great horned owl	*Bubo virginianus*	R	<0.05	0	<0.05
Trochilidae	glittering-bellied emerald	*Chlorostilbon aureoventris*	R	<0.05	<0.05	0
	white–throated hummingbird	*Leucochloris albicollis*	R	<0.05	0	0
Alcedinidae	ringed kingfisher	*Ceryle torquata*	R	<0.05	0	0
Picidae	golden-breasted woodpecker	*Colapses melanolaimus*	R	0	<0.05	<0.05
	field flicker	*Colapses campestris*	R	0	<0.05	<0.05
Furnariidae	wren-like rushbird	*Phleocryptes melanops*	R	0.66	0.84	0.97
	bar-winged cinclodes	*Cinclodes fuscus*	R	0.02	0.12	0.44
	rufous hornero	*Furnarius rufus*	R	<0.05	<0.05	<0.05
	red-capped wren-spinetail	*Spartonoica maluroides*	R	<0.05	<0.05	<0.05
	freckle-breasted thornbird	*Phacellodomus striaticollis*	R	0	0	<0.05

APPENDIX I (cont.)

Family	Species		ST	RII		
				LP	LB	NR
Tyrannidae	many-colored rush-tyrant	*Tachuris rubrigastra*	R	0.15	0.31	0.33
	great kiskadee	*Pitangus sulphuratus*	R	0.51	0.13	0.41
	spectacled tyrant	*Hymenops perspicillatus*	R	<0.05	0.09	0.81
	sooty tyrannulet	*Serpophaga nigricans*	R	<0.05	0.2	0.04
	white-crested tyrannulet	*Serpophaga subcristata*	R	<0.05	<0.05	<0.05
	rufous-backed negrito	*Lessonia rufa*	MC	<0.05	<0.05	<0.05
	cattle tyrant	*Machetornis rixosus*	R	0	<0.05	<0.05
	warbling doradito	*Pseudocolopteryx flaviventris*	R	<0.05	<0.05	<0.05
	yellow-browed tyrant	*Satrapa icterophrys*	R	<0.05	<0.05	<0.05
	tropical kingbird	*Tyrannus melancholicus*	MB	<0.05	<0.05	<0.05
	vermilion flycatcher	*Pyrocephalus rubinus*	MB	0	0	<0,05
	fork-tailed flycatcher	*Tyrannus savana*	MB	<0.05	<0.05	<0.05
	suiriri flycatcher	*Suiriri suiriri*	R	<0.05	0	0
	bran-colored flycatcher	*Myophobus fasciatus*	MB	<0.05	0	0
Hirundinidae	bank swallow	*Riparia riparia*	MA	0	0	<0.05
	southern martin	*Progne modesta*	MB	0	<0.05	0
	white-rumped swallow	*Tachycineta leucorrhoa*	R	<0.05	0.05	0.31
	chilean swallow	*Tachycineta leucopyga*	MC	<0.05	<0.05	0.6
	barn swallow	*Hirundo rustica*	MA	<0.05	<0.05	<0.05
	blue-and-white swallow	*Notiochelidon cyanoleuca*	R	0	<0.05	0
Troglodytidae	house wren	*Troglodytes aedon*	R	0.15	0.07	<0.05
	grass wren	*Cistothorus platenses*	R	0	<0.05	0
Mimidae	chalk-browed mockingbird	*Mimus saturninus*	R	<0.05	0	<0.05
Turdidae	rufous-bellied thrush	*Turdus rufiventris*	R	0.85	0.03	<0.05
Motacillidae	correndera pipit	*Anthus correndera*	R	0	0.07	0.09
Sylviidae	masked gnatcatcher	*Polioptila dumicola*	R	<0.05	<0.05	<0.05
Parulidae	tropical parula	*Parula pitiayumi*	R	<0.05	0	0
Thraupidae	blue-and-yellow tanager	*Thraupis bonaeriensis*	R	0.07	0	<0.05
Emberizidae	rufous-collared sparrow	*Zonotrichia capensis*	R	1.02	0.5	0.92
	great pampa-finch	*Embernagra platenses*	R	0.04	0.45	0.16
	grassland yellow-finch	*Sicalis luteola*	R	0.08	0.63	0.79
	red-rumped warbling-finch	*Poospiza lateralis*	R	<0.05	0	<0.05
	double-collared seedeater	*Sporophila caerulescens*	R	<0.05	0	0
	saffron yellow-finch	*Sicalis flaveola*	R	<0.05	<0.05	<0.05
	black-and-rufous warbling finch	*Poospiza nigrorufa*	R	<0.05	<0.05	0
	long-tailed reed-finch	*Donacospiza albifrons*	R	0	<0.05	0

APPENDIX I (cont.)

Family	Species		ST	RII		
				LP	LB	NR
Fringillidae	hooded siskin	*Carduelis magellanica*	R	0.07	<0.05	<0.05
	european chloris	*Carduelis chloris*	R	<0.05	0	<0.05
Icteridae	bay-winged cowbird	*Agelaioides badius*	R	0.28	0.13	0.16
	shiny cowbird	*Molothrus bonariensis*	R	0	<0.05	<0.05
	scarlet-headed blackbird	*Amblyramphus holosericeus*	R	0	0	<0.05
	chestnut-capped blackbird	*Agelaius ruficapillus*	R	0	0	<0.05
	white-browed blackbird	*Sturnella superciliaris*	R	0	<0.05	<0.05
	long-tailed meadowlark	*Sturnella loyca*	R	0	<0.05	<0.05
	pampas meadowlark	*Sturnella defilippii*	R	0	<0.05	0
	brown-and-yellow marshbird	*Pseudoleistes virescens*	R	<0.05	0.28	0.67
	yellow-winged blackbird	*Agelaius thilius*	R	0.1	0.6	0.9
Sturnidae	crested myna	*Acridotheres cristatellus*	R	<0.05	0	0