Seasonal dynamics of waterbirds from a relict wetland in the central Monte Desert, Argentina

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Abstract

Wetlands currently have high rates of degradation, with more than 70% lost globally. In the central Monte Desert, Argentina, they are a scarce and limited resource for the biodiversity which depends on them. Waterbirds have been used as biological indicators of wetlands because they respond to fluctuations in food resources and to environmental changes in the short term. Here we analyse the seasonal variations in the structure of the waterbird assemblage from a relict wetland in this region. We carried out censuses of waterbirds in a 6-year period (between 2009 and 2019) during the southern summer and winter. We recorded 1875 individuals of 33 species of waterbirds during the summer and 677 individuals of 29 species during the winter. The grouping patterns of the waterbird assemblages differed between seasons ($R = 0.35; p < 0.01$). Taxonomic diversity profiles showed greater diversity
for all indexes ($^\text{4}D$) during the summer. The guild of invertivorous and omnivorous waders had a greater abundance of individuals during the summer ($p < 0.05$) and, together with the surface-feeding herbivores, contributed to the 87% of the dissimilarity of the assemblages between seasons. *Phoenicopterus chilensis* was the only species registered as threatened with national and international extinction. Relict wetlands, such as Laguna del Viborón, still have attributes of community diversity and represent the last refuges for waterbirds of the central Monte Desert. The information gathered in this study will contribute to the guidelines for integrated management plans and monitoring programmes for the conservation of the wetland and its biodiversity.

**Keywords**

Argentina, biodiversity conservation, guilds, Laguna del Viborón, non-passerines, seasonality

**Introduction**

In arid and semi-arid areas, the scarcity and variability of the water resources condition the settlement and development of aquatic organisms (Castañeda et al. 2005). Therefore, the wetlands of these areas are highly variable ecosystems with a great diversity of organisms in an environmental matrix of less diversity (Sabo et al. 2005; Minckley et al. 2013). These environments are significant in the hydrological and ecological processes taking place within them, such as water storage, nutrient cycling and retention, climate regulation and refuge for biodiversity (Bezabih and Mosissa 2017; Serran et al. 2018). Wetlands are estimated to provide 40% of the ecosystem goods and services of all ecosystems worldwide (Costanza et al. 1997). Despite their ecological and socioeconomic importance, wetlands have been significantly declining in size and quality globally (Bolpagni and Piotti 2016; Young et al. 2016).

Agriculture is the world’s largest user of freshwater and the main factor in degradation of surface and groundwater resources (Baigún et al. 2008). Changes in land use by agriculture degrade habitat quality and influence the hydrological cycle of wetlands physically and chemically (Asselen et al. 2013; Sica et al. 2016). Thus, there are changes in the species composition, abundance and distribution, resulting in changes in the community structure (Rayfield et al. 2009; Hagen et al. 2012). In the central Monte Desert of Argentina, the development of irrigated agriculture produced loss and degradation of wetlands (Prieto et al. 2008; Benzaquen et al. 2017). This is mainly due to the use of water for oases (i.e. areas cultivated by artificial irrigation) and the weather conditions which increase the water deficit in the Central Andes (Masiokas et al. 2019). Although the total loss rate of the wetlands in this region is unknown (Benzaquen et al. 2017), it was found that for the Ramsar site named Lagunas de Guanacache, Desaguadero, y del Bebedero, there was a loss of 80% of the coverage in the last 30 years at a rate of -5.9 km$^2$/year (Abrahan 2019).

Waterbirds include several species which have a strong influence on the structure and dynamics of wetlands (Andrade et al. 2018; Michel et al. 2020). This group plays a key role in controlling the populations of the lower trophic levels, influencing the energy flow and the nutrient cycling (de Arruda Almeida et al. 2019). Birds are the group of vertebrates in which the greatest spatial movements of species and individuals take place (Wiens 1989). The high mobility of birds allows them to
respond quickly to environmental fluctuations, such as those associated with annual cycles (Rubenstein and Hobson 2004; Jahn et al. 2020). Therefore, they maintain connectivity amongst wetlands by using watercourses as biological corridors for their movements and dispersal (Naiman et al. 1993). The structure of bird assemblages is directly associated with spatial and temporal variations in the availability, abundance and diversity of food resources (Marateo and Arturi 2013). Moreover, at a local scale, it depends on the habitat characteristics (e.g. wetland size and depth, vegetation heterogeneity and structure) and the availability of sites for resting or reproduction (Ma et al. 2010). In this way, each type of wetland can be described in terms of its characteristic avifauna and its composition will depend largely on the environmental attributes of the site. Despite their importance to the ecosystem, waterbird populations have been declining globally in relation to the degradation of wetlands (Kingsford et al. 2017; Amano et al. 2018).

Taking into account the value of wetlands for arid areas and the current high degradation rate (Minckley et al. 2013), there are scarce studies on the seasonal dynamics of waterbirds in the central Monte Desert (Contreras and Fernández 1980; Blendinger and Alvarez 2002). Bird species are used in conservation programmes under the assumption that the responses of individual species may represent the response of other taxa within the community, such as those belonging to lower trophic levels (e.g. invertebrates and fish; Vanni et al. 1990; Caro and O’Doherty 1999; Ikin et al. 2016). Bird species can respond independently to environmental variation and the presence or absence of one of them can show specific ecological characteristics of the habitat (Canterbury et al. 2000). The aim of this study is to analyse the structure of the waterbird assemblage of the wetland Laguna del Viborón, Argentina, during two seasons (summer and winter). Thus, we determined the assemblage of waterbirds, based on the species and guild diversity according to their diet and foraging behaviour. Nowadays, it is essential to quantify diversity in order to develop integrated management plans and make decisions in favour of the conservation of waterbirds and their habitats (Ma et al. 2010; Moreno et al. 2018).

Methods

Study area

The research was carried out in Laguna del Viborón, Mendoza, Argentina (32°53’18”S, 68°36’44”W). This site is part of the wetland system of the Leyes-Tulumaya streams (Rubio 2018). The Lake has a maximum surface area of 38 ha during the austral summer season and it shows variations throughout the year, mainly during the periods of water deficit (winter). It has an arid to semi-arid climate, with an average temperature of 25.4 °C in summer and 7.2 °C in winter and an average annual temperature of 16 °C (Rubio 2018). The average annual rainfall is 250 mm, concentrated in the summer. The hydrophilic vegetation is made up of cattails (Typha dominguensis), Southern Bulrush (Schoenoplectus californicus, Juncus spp.), Common Reed (Phragmites australis) and Pampas Grass (Cortaderia spp.) (Benzaquen et al.
The surrounding vegetation consists of shrub plants, xerophytes and halophytes, with plant associations characterised mainly by *Cyclolepis genistoides*, Seep-weeds (*Suaeda divaricata*), *Allenrolfea vaginata* and Saltbush plants (*Atriplex* spp.) (Burkart et al. 1999).

The current complex of wetlands of the Leyes-Tulumaya system is one of the last relicts of the great lacustrine extensions of the central Mont Desert (Rubio 2018). This area was known as the Ciénaga del Bermejo in the eighteenth century and it was drained after the construction of channels and drainage in order to prepare the lands for agricultural production (Prieto et al. 2008). Nowadays, few wetlands make up the Leyes-Tulumaya system (Prieto and Rojas 2012). Water fluctuations of this system are subject to the hydrological cycle of the Central Andes and to the use of water in the agricultural areas of the northern oasis of Mendoza. Moreover, it receives water surplus from the rain run-off of the urban area, as well as from industrial and agricultural wastewater. The Leyes-Tulumaya system is an area with a high anthropogenic impact and does not have any environmental protection laws (Rubio 2018).

**Bird survey**

The samplings were carried out between 2009 and 2019 during two seasons: summer (February) and winter (July). The censuses were conducted by tracing a line-transect of 1.2 km in length per 100 m strip width. In this way, 12 censuses (6 in each season) were carried out, corresponding to six years (2009–2011 and 2017–2019). The transects were traversed at a constant minimum speed and were carried out during the morning (between 7 am and 10 am) in order to coincide with the highest peak of bird activity (Bibby et al. 2000). To identify the waterbirds, transects were simultaneously monitored by two observers using binoculars (10 × 50) and the Narosky and Yzurieta (2003) field guide was used. We identified the waterbird species seen or heard (species of the non-passerine order, which are totally or partially dependent on wetlands) and their abundance was recorded.

The species of waterbirds, registered in this study, were classified in guilds according to their foraging behaviour and diet (López de Casenave and Filipello 1995; Echevarria et al. 2014). The conservation status of the species was determined at a global level, using the International Union for Conservation of Nature’s Red List of Threatened Species (IUCN 2020) and at a national level, the report of Ministerio de Ambiente y Desarrollo Sustentable y Aves Argentina (MAyDS and AA 2017). The scientific nomenclature of birds follows the classification of the American Ornithological Society (Remsen et al. 2020).

**Statistical analysis**

The abundance of each species was expressed as individuals per square kilometre (ind/km²). We used a non-metric multidimensional scaling analysis (NMDS) to
define the general differences in the structure and composition of bird assemblages between seasons. Ordinations were carried out using quantitative data (abundance, Bray-Curtis Index). We used an analysis of similarity (ANOSIM) to evaluate significant differences in the community structure between seasons. The statistical significance of the ANOSIM was assessed with a permutation test at a significance level of $\alpha = 0.05$. We used a similarity percentage analysis (SIMPER) to determine the contribution made by species and guilds to distinguish differences in the quantitative structure of the community between seasons (Clarke 1993). The Wilcoxon signed-rank test was conducted to determine whether or not there were significant differences in abundance of species and guilds.

To compare the taxonomic diversity between seasons, diversity profiles were obtained using the family of diversity indices proposed by Chao and Jost (2015). This method is based on the statistical estimation of the Hill numbers of any order $q \geq 0$. This estimator includes the three most used species diversity profiles ($CD$): species richness ($q = 0$), Shannon Diversity ($q = 1$, the exponential of Shannon Entropy) and Simpson Diversity ($q = 2$; the inverse of Simpson Dominance). These diversity estimators are designed to take into account the effect of undetected species in the samples, removing most of the biases associated with the empirical profiles. Estimated values of the order 0, 1 and 2 were analysed (Moreno et al. 2017). The analyses were performed using the vegan, iNEXT and ggplot2 packages, for R version 4.0.1 (R Development Core Team 2020).

**Results**

During the sampling period, we detected a total of 38 species of birds from 11 families and seven orders (see Suppl. material: Table S1). The most representative families in relation to the number of species were Anatidae (37%), Ardeidae (16%), Rallidae (13%) and Podicipedidae (10%). We recorded a total of 1875 individuals of 33 species of waterbirds during the summer and 677 individuals of 29 species during the winter. The waterbird assemblages revealed grouping detections according to the season from axis 1 (Stress = 0.13; Fig. 1) and they were different in composition and abundance of species (ANOSIM, $R = 0.35$; $p < 0.01$). *Phoenicopterus chilensis* was the only species registered as nationally threatened (vulnerable; MADyDS and AA 2017) and globally threatened (near threatened; IUCN 2020).

The dissimilarity between both seasons was 73.84% and 13 species of birds contributed to 90% of the existing dissimilarity (Table 1). The bird species which contributed most to the assemblages in percentage were *Plegadis chihi* (20.8%), *Himantopus mexicanus* (20.7%), *Anas flavirostris* (12.5%) and *Fulica armillata* (10.8%). In total, five species of waterbirds increased their abundance significantly during the summer compared to the winter (Table 1): *Himantopus mexicanus* ($W = 2.20; p < 0.01$), *Netta peposaca* ($W = 1.58; p < 0.05$), *Fulica rufifrons* ($W = 1.99; p < 0.01$), *Egretta thula* ($W = 2.01; p < 0.05$) and *Butorides striatus* ($W = 1.58; p < 0.05$).
Table 1. Average abundance of waterbird species (ind/km²) and its contribution to the average dissimilarity between seasons (summer and winter) in Laguna del Viborón, Mendoza, Argentina. The species are arranged in descending order according to the percentage contribution of the SIMPER analysis. Diss. = Average dissimilarities; Cont. % = percentage contribution; % acum. = cumulative distribution. * indicates significant differences between seasons: ** = \( p < 0.01 \); * = \( p < 0.05 \) (Wilcoxon signed-rank test).

| Species               | Average abundance | Diss. | Cont. % | % acum. |
|-----------------------|-------------------|-------|---------|---------|
|                       | Summer             | Winter|         |         |
| Plegadis chihi        | 498.0             | 41.5  | 15.39   | 20.84   |
| Himantopus mexicanus  | 549.0             | 37.5  | 15.34   | 20.78   |
| Anas flavirostris     | 347.0             | 356.0 | 9.25    | 12.53   |
| Fulica armillata      | 345.0             | 93.0  | 8.01    | 10.85   |
| Netta peposaca        | 236.0             | 2.8   | 4.75    | 6.43    |
| Anas geórgica         | 140.0             | 104.0 | 4.09    | 5.54    |
| Dendrocygna viduata   |                   | 106.0 | 2.22    | 3.00    |
| Fulica rufrrons       | 86.8              | 2.8   | 2.20    | 2.99    |
| Egretta thula         | 51.3              | 15.2  | 1.58    | 2.14    |
| Cygnus melanoryphus   | 30.5              | 1.3   | 1.49    | 2.02    |
| Calidris bairdi       | 45.8              | 1.3   | 1.33    | 1.81    |
| Ardea alba            | 21.0              | 15.2  | 0.77    | 1.04    |
| Podilymbus podiceps   | 23.2              | 23.7  | 0.72    | 0.97    |
| Fulica leucoptera     | 30.0              | 1.3   | 0.71    | 0.96    |
| Spatula cyanoptera    | 6.3               | 25.0  | 0.64    | 0.87    |
| Batorides striata     | 18.7              | 1.3   | 0.61    | 0.83    |
| Rollandia rolland     | 18.2              | 15.3  | 0.53    | 0.72    |
| Phalacrocorax brasiensis |              | 10.3  | 8.3     | 0.49    |
| Anas bahamensis       | 4.2               | 16.7  | 0.45    | 0.61    |
| Podiceps major        | 11.8              | 13.8  | 0.41    | 0.56    |
| Pandirallus sanguinolentus |          | 16.7  | 13.7   | 0.41    |
| Vanellus chilensis    | 24.3              | 14.0  | 0.40    | 0.55    |
| Coscoroba coscoroba   | 11.8              | 5.5   | 0.39    | 0.53    |
| Heteronetta atricapilla |          | 11.2  | 2.8     | 0.24    |
| Tringa flavipes       | 6.3               |       | 0.23    | 0.31    |
| Nycticorax nycticorax | 6.2               |       | 0.18    | 0.25    |
| Dendrocygna autumnalis|                   | 8.3   | 0.18    | 0.24    |
| Spatula versicolor    | 1.3               | 4.2   | 0.13    | 0.18    |
| Phoenicoptrerus chilensis |          | 4.2   | 0.13    | 0.17    |
| Ardea cocoi           | 1.3               | 2.8   | 0.12    | 0.16    |
| Podiceps occipitalis  | 1.3               | 2.8   | 0.10    | 0.14    |
| Tringa melanoeca      | 3.5               |       | 0.08    | 0.11    |
| Gallinula galeata     | 2.7               |       | 0.08    | 0.11    |
| Ixobrychus involucris | 2.7               |       | 0.07    | 0.09    |
| Chroicocephalus serranus |          |       | 1.3     | 0.04    |
| Spatula plataea       | 1.3               |       | 0.04    | 0.05    |
| Mareca sibilatrix     | 0.7               |       | 0.02    | 0.02    |
| Oxyura vittata        | 0.7               |       | 0.02    | 0.02    |

The registered species belonged to a total of eight trophic guilds (Table 2; see Suppl. material: Table S1) and were different in composition and abundance of species between the seasons (ANOSIM, \( R = 0.48 \); \( p < 0.01 \)). The dissimilarity of the assemblage in relation to the guilds between both seasons was 63.67%. The guild of invertivorous waders (\( W = 1.99 \); \( p < 0.05 \)) and omnivorous waders (\( W = 1.99 \); \( p < 0.05 \)) had a greater abundance of individuals during the summer (\( p < 0.05 \)) and contributed
Figure 1. Ordination diagram using a non-metric multidimensional scaling (NMDS) of the waterbird assemblages in two seasons (summer and winter), in Laguna del Viborón, Mendoza, Argentina. Waterbirds: anabah = Anas bahamensis, anafla = Anas flavirostris, ardbal = Ardea alba, ardcoc = Ardea cocoi, calbai = Calidris bairdii, chrs = Chroicocephalus serranus, coscos = Coscoroba coscoroba, denaut = Dendrocygna autumnalis, denvid = Dendrocygna viduata, egrthu = Egretta thula, fularl = Fulica armillata, fulleu = Fulica leucoptera, fulruf = Fulica rufifrons, galgal = Gallinula gallinula, hetatr = Heteronetta atricapilla, himmex = Himantopus mexicanus, ioxinv = Ixobrychus involucris, ntcpep = Netta peposaca, nycnyc = Nycticorax nycticorax, oxyvit = Oxyura vittata, parsan = Pardirallus sanguinolentus, phabra = Phalacrocorax brasilienis, phochi = Phoenicopterus chilensis, plechi = Plegadis chihi, podmaj = Podiceps major, podocc = Podiceps occipitalis, podpod = Podilymbus podiceps, rorol = Rollandia rolland, spacya = Spatula cyanoptera, trfla = Tringa flavipes, trimel = Tringa melanoleuca, vanchi = Vanellus chilensis.

Table 2. Abundance (mean ± standard error) and species richness (S) of waterbirds during two seasons (summer and winter), based on the guilds according to their foraging behaviour and diet, in Laguna del Viborón, Mendoza, Argentina. The guilds are arranged in descending order according to the percentage contribution of the SIMPER analysis. Diss. = Average dissimilarities; Cont. % = percentage contribution; % acum. = cumulative distribution. *indicates significant differences between seasons (Wilcoxon signed-rank test; p < 0.05).

| Guilds                  | Summer ind/km² | S (%) | Winter ind/km² | S (%) | Diss. | Cont. % | % acum. |
|------------------------|----------------|-------|----------------|-------|-------|---------|---------|
| Invertivorous wader *  | 187.9 ± 46.2   | 6 (18.2) | 15.5 ± 6.1     | 3 (10.3) | 35.8 | 53.0    | 53.0    |
| Surface-feeding herbivores | 100.8 ± 34.6 | 10 (30.3) | 58.3 ± 19.8 | 9 (31.0) | 15.5 | 23.0    | 76.0    |
| Surface-feeding omnivores | 35.1 ± 30.0 | 5 (15.2) | 20.8 ± 19.7 | 5 (17.2) | 7.6 | 11.2    | 87.2    |
| Omnivorous wader *     | 16.9 ± 5.8     | 7 (21.2) | 6.9 ± 4.0      | 5 (17.2) | 3.1 | 4.6     | 91.8    |
| Piscivorous diver      | 11.3 ± 2.8     | 3 (9.1) | 12.2 ± 5.3     | 4 (13.8) | 2.4 | 3.6     | 95.3    |
| Omnivorous diver       | 9.4 ± 3.8      | 2 (6.1) | 7.6 ± 3.3      | 1 (3.4) | 1.9 | 2.8     | 98.2    |
| Filter-feeding omnivores | 4.2 ± 4.2     | 1 (3.4) | 4.2 ± 4.2     | 1 (3.4) | 0.9 | 1.4     | 99.5    |
| Omnivorous plunge-divers | 1.4 ± 1.4    | 1 (3.4) | 1.4 ± 1.4     | 1 (3.4) | 0.3 | 0.5     | 100.0   |
together with the surface-feeding herbivores to the 87% dissimilarity of the total assemblage between seasons (Table 2). In both seasons, most of the species belonged to surface-feeding herbivores, omnivorous and invertivorous waders in summer and to omnivorous waders and surface-feeding omnivores in winter (Table 2).

The diversity profiles showed a significant difference between the seasons for all indices ($q$) and the summer was the season with the greatest diversity (Fig. 2). For the summer, the diversity of zero order was $D_0 = 33 \pm 1.42 (30.98–36.15, \text{with } 95\% \text{ Confidence Intervals})$, the diversity of first order $D_1 = 10.57 \pm 0.11 (10.32–10.76)$ and the diversity of second order $D_2 = 7.46 \pm 0.09 (7.31–7.64)$. For the winter, it was $D_0 = 29 \pm 1.01 (27.77–30.76)$, $D_1 = 9.90 \pm 0.23 (9.41–10.28)$ and $D_2 = 5.42 \pm 0.16 (5.11–5.70)$.

Discussion

Waterbirds assemblages in Laguna del Viborón showed seasonal variation in their structure. These changes are reflected both in the variation of individual abundance and in the species richness between summer and winter. These differences can be related mainly to seasonal variation in food resource availability, as well as seasonal movements patterns associated with migration and reproductive behaviour (Ronchi-Virgolini et al. 2013; Kopij and Paxton 2018). The seasonal variation in waterbirds’ abundance has been documented in wetland located at high latitudes (Pedrana et al. 2018) and altitude (Caziani et al. 2001) in Argentina.

The increase in richness and abundance of certain guilds during the summer is related to the increase in food resources. Summer temperatures and the increased water flow favour the development of plant biomass in wetlands (Rivera et al. 2017). Thus, there is an increase in the supply and availability of food resources for birds, mainly of invertebrates, fish and plants (Minckley et al. 2013). Therefore, there are species which are favoured: herbivores, such as coots (Fulica spp.) and invertivorous and omnivorous waders, such as ibises and herons, respectively (Safran et al. 2000). Moreover, richness during the summer is also increased by the arrival of
invertivorous waders which migrate from the Nearctic (i.e. *Calidris bairdii* and *Tringa* spp.; Blanco et al. 2006). Moreover, the continental location of the wetland may explain the occurrence of certain species which make annual regional movements. This is due to the fact that, in the central Monte Desert, the latitudinal movements of southern (Patagonia) and northern bird populations converge in relation to seasonal changes (Chesser 1994; Jahn et al. 2020). In turn, this site is also a refuge for high Andean species, such as the Andean gull, which descend to lower altitude lands during unfavourable weather conditions in winter (e.g. snowfalls; Barcante et al. 2017).

In addition, the increase in the density of gregarious species is also due to the reproductive season. Inland wetlands in arid areas show a marked increase in the density of individuals during the reproductive season, in response to the hydrological cycle (Blendinger and Alvarez 2002; Alvarez et al. 2018). This is mainly due to the congregation of gregarious species in large flocks which usually concentrate in wetlands for breeding (Romano et al. 2005). Species such as *Netta peposaca* make seasonal migrations and increase significantly their abundance on the site during the summer (Antas 1994). The congregation of common species in large flocks (i.e. those with a large number of individuals compared to species of the same taxonomic group), such as ibises, coots and lapwings, may have a strong influence on the wetland dynamics. This is due to the fact that common bird species are key elements of the biomass, structure, functioning of the ecosystems and, therefore, the supply of ecosystem services (Sekercioglu 2006; Gaston et al. 2018). Although we did not carry out reproductive biology studies, we recorded nests and nestlings of *Fulica* spp., which were very abundant species during the summer.

The wetland may represent a resting and roosting site for individuals foraging in agricultural areas. Ibises, lapwings, herons and shorebirds usually move during the day in search of foraging sites (Lorenzón et al. 2017). Part of the population of these species may use the wetland as a resting and roosting place and move during the day to irrigated crops, using agro-ecosystems for feeding (Czech and Parsons 2002). There are certain anatids (*Anas flavirostris* and *A. georgica*) which also have a greater breadth of trophic niche and plasticity to exploit resources in agricultural areas, such as irrigation canals (Fox et al. 2017). At this site, such types of behaviour may be facilitated because the wetland is within an agricultural matrix which probably provides a sustained food supply (Contreras and Fernández 1980; Prieto and Rojas 2012). Waterbird use of irrigated agricultural areas as feeding sites has increased as natural wetlands continue to decline worldwide (Kingsford and Thomas 2004; Bellio et al. 2009).

In summer, the increase in water volume has an influence on a landscape scale, producing an increase in flooded areas. Flooded areas provide new habitats for waterbirds (Kushlan 1986). Water level fluctuations influence habitat physical structure (e.g. vegetation zonation), food availability and accessibility and presence of resting and breeding sites (Clausen 2000; Maleki et al. 2016). Long periods of flooding increase prey production (e.g. fish and aquatic macro-invertebrates; Ruetz et al. 2005). Nevertheless, in the last decade, water level shows a negative trend resulting in severe droughts (Masiokas et al. 2019), which may affect the dynamics of
the relict wetlands in the central Monte Desert (Benzaquen et al. 2017). The water deficit in wetlands of arid regions could cause negative cascading effects associated with widespread mortality of aquatic organisms (Ruetz et al. 2005), salinisation of soils (Rubio 2018) and eutrophication phenomena (Brinson and Malvárez 2002).

The decrease in the water level during winter favours certain species which forage in shallow waters (Dimalexis and Pyrovetsi 1997). Drought periods and water level fluctuations differentially affect bird species (Blendinger and Alvarez 2002; Vanausdall and Dinsmore 2019). Thus, during the winter, flamingos benefit from the decrease in the water level, since there are more foraging opportunities (Alvarez et al. 2018). Although this wetland is not the habitat preference of flamingos, it may constitute a resting place during their migratory movements (Caziani et al. 2007). Moreover, anatids of the genus *Dendrocygna* were recorded during the winter, species which occasionally visit the area (Martínez et al. 2009; Zanotti 2020). These birds usually forage in shallow wetlands and may arrive at the site due to migratory movements which deserve more consideration (Antas 1994).

The wetland is under the management by Cristobal Colón Fishing Club. It controls activities, such as illegal hunting and visitor access and they also divided the wetland into sectors, maintaining an area where people are not allowed to enter and this would be beneficial for birds (Cardoni et al. 2008). This could explain why this wetland has maintained its richness over time, since we register 10% more waterbird species than Contreras and Fernández (1980). Furthermore, the lack of identification of other species by records in the site (Contreras and Fernández 1980) can be limited to the sampling effort and also to the transformation of perilacustrine areas into cultivated lands (Rubio 2018). Human presence and habitat degradation affect the occupation of specialist species which have more habitat requirements, such as shorebirds (Blanco et al. 2006; Brandis et al. 2018). In addition, it has been found that the lack of management by the government regarding the conservation of wetlands led to the loss of waterbird diversity (Amano et al. 2018). Therefore, the current role of the social club may be positively significant in the conservation of waterbirds, given the lack of government policies for a sustainable management of the site.

**Conclusions**

The seasons showed different waterbird assemblages, with greater diversity during the summer. Guild structure was also different between seasons. Invertivorous waders and omnivorous waders showed greater abundance of individuals during the summer and, together with surface-feeding herbivores, they were the guilds which contributed most to the dissimilarity of assemblages. The structural characteristics and the environmental heterogeneity of the site are reflected in the presence of species with different habitat requirements. This can be observed in the presence of birds which make use of deep-water wetlands (*Cygnus melancoryphus*), shorelines (shorebirds), environments with dense vegetation (rails) and birds with specialist foraging behaviour (*Phoenicopterus chilensis*), amongst others.
The relict wetlands of the central Monte Desert, such as the Laguna del Viborón, still have a high diversity of species in relation to its surface area. In addition to functioning as wildlife refuges, they act as biological corridors to high-productivity wetlands which have large waterbird populations. Nevertheless, the wetlands which concentrate a large part of the populations of certain bird species (Alvarez et al. 2018) are sometimes affected by intense disturbances (e.g. pollution, drainage and drought; Abrahan 2019); therefore, the wetlands with smaller surface area, such as Laguna del Viborón, become relevant, functioning as a network of alternative emergency refuges. Due to the fact that the central Monte Desert in Argentina has lost almost the entire surface area of wetlands, relict wetlands should be a conservation priority for government agencies. To ensure the conservation of the waterbirds of Laguna del Viborón, integrated management plans should be implemented with an approach based on multiple spatial scales and temporal variability, allowing the protection of both the water resource and the different types of habitats for birds.

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References

Abrahan VA (2019) Fluctuación espacio-temporal del complejo de Lagunas de Guanacache, Divisadero y Bebedero durante 1987–2018. Boletín de Estudios Geográficos 112: 161–180. http://revistas.uncu.edu.ar/ojs3/index.php/beg/article/view/3396
Alvarez LM, Meglioli PA, Rivera JA, Bianchi LO, Martín S, Sosa HJ (2018) Efectos de la variación hidrológica sobre la dinámica poblacional del flamenco austral (Phoenicopterus chilensis) en el Sitio Ramsar Laguna de Llancanelo, Mendoza, Argentina. Ornitología Neotropical 29: 275–280. https://journals.sfu.ca/ornneo/index.php/ornneo/article/view/328
Amano T, Székely T, Sandel B, Blanco D, Soykan CU, Sutherland WJ (2018) Successful conservation of global waterbird populations depends on effective governance. Nature 553(7687): 199–202. https://doi.org/10.1038/nature25139
Andrade R, Bateman HL, Franklin J, Allen D (2018) Waterbird community composition, abundance, and diversity along an urban gradient. Landscape and Urban Planning 170: 103–111. https://doi.org/10.1016/j.landurbplan.2017.11.003
Antas PTZ (1994) Migration and other movements among the lower Paraná River valley wetlands, Argentina, and the south Brazil/Pantanal wetlands. Bird Conservation International 4(2–3): 181–190. https://doi.org/10.1017/S0959270900002768
Asselen S van, Verburg PH, Vermaat JE, Janse JH (2013) Drivers of wetland conversion: A global meta-analysis. PLoS ONE 8(11): e81292. https://doi.org/10.1371/journal.pone.0081292
Baigún CR, Puig A, Minotti PG, Kandus P, Quintana R, Vicari R, Bo R, Oldani NO, Nestler JA (2008) Resource use in the Parana River Delta (Argentina): Moving away from an ecohydrological approach? Ecohydrology & Hydrobiology 8(2–4): 245–262. https://doi.org/10.2478/v10104-009-0019-7

Barcante LM, Vale M, Alves SMA (2017) Altitudinal migration by birds: A review of the literature and a comprehensive list of species. Journal of Field Ornithology 88(4): 321–335. https://doi.org/10.1111/jfo.12234

Bellio MG, Kingsford RT, Kotagama SW (2009) Natural versus artificial-wetlands and their waterbirds in Sri Lanka. Biological Conservation 142(12): 3076–3085. https://doi.org/10.1016/j.biocon.2009.08.007

Benzaquen L, Blanco DE, Bo R, Kandus P, Lingua G, Minotti P, Quintana R (2017) Regiones de Humedales de la Argentina. Ministerio de Ambiente y Desarrollo Sustentable, Fundación Humedales/Wetlands International, Universidad Nacional de San Martín y Universidad de Buenos Aires. https://www.argentina.gob.ar/sites/default/files/regiones_de_humedales_de_argentina_final.pdf

Bezabih B, Mosissa T (2017) Review on distribution, importance, threats and consequences of wetland degradation in Ethiopia. International Journal of Water Resources and Environmental Engineering 9(3): 64–71. https://doi.org/10.5897/IJWREE2016.0697

Bibby CJ, Burgess ND, Hill DA, Mustoe S (2000) Bird Census Techniques. Elsevier, Academic Press, 278 pp.

Blanco DE, Yorio P, Petracci PF, Pugnali G (2006) Distribution and abundance of non-breeding shorebirds along the coasts of the Buenos Aires Province, Argentina. Waterbirds 29(3): 381–390. https://doi.org/10.1675/1524-4695(2006)29[381:DAAONS]2.0.CO;2

Blendinger PG, Alvarez ME (2002) Bird assemblages from Carilauquen Marshes (Llancanelo Lagoon, Mendoza, Argentina): considerations for their conservation. El Hornero 017(02): 071–083. https://bibliotecadigital.exactas.uba.ar/download/hornero/hornero_v017_n02_p071.pdf

Bolpagni R, Piotti A (2016) The importance of being natural in a human-altered riverscape: Role of wetland type in supporting habitat heterogeneity and the functional diversity of vegetation. Aquatic Conservation 26(6): 1168–1183. https://doi.org/10.1002/aqc.2604

Brandis KJ, Bino G, Spencer JA, Ramp D, Kingsford RT (2018)Decline in colonial waterbird breeding highlights loss of Ramsar wetland function. Biological Conservation 225: 22–30. https://doi.org/10.1016/j.biocon.2018.06.022

Brinson MM, Malvárez AI (2002) Temperate freshwater wetlands: Types, status, and threats. Environmental Conservation 29(2): 115–133. https://doi.org/10.1017/S0376892902000085

Burkart R, Bárbaro N, Sánchez RO, Gómez DA (1999) Ecorregiones de la Argentina. Administración de Parques Nacionales y Secretaría de Recursos Naturales y Desarrollo Sustentable, 43 pp. http://repositorio.ub.edu/bitstream/handle/123456789/7567/Eco-Regiones_de_la_Argentina.pdf?sequence=1

Canterbury GE, Martin TE, Petit DR, Petit LJ, Bradford DF (2000) Bird communities and habitat as ecological indicators of forest condition in regional monitoring. Conservation Biology 14(2): 544–558. https://doi.org/10.1046/j.1523-1739.2000.98235.x
Cardoni DA, Favero M, Isacch JP (2008) Recreational activities affecting the habitat use by birds in Pampa’s wetlands, Argentina: Implications for waterbird conservation. Biological Conservation 141(3): 797–806. https://doi.org/10.1016/j.biocon.2007.12.024

Caro TM, O'Doherty G (1999) On the use of surrogate species in conservation biology. Conservation Biology 13(4): 805–814. https://doi.org/10.1046/j.1523-1739.1999.98338.x

Castañeda C, Herrero J, Casterad MA (2005) Landsat monitoring of playa-lakes in the Spanish Monegros desert. Journal of Arid Environments 63(2): 497–516. https://doi.org/10.1016/j.jaridenv.2005.03.021

Caziani SM, Derlindati EJ, Tálamo A, Sureda AL, Trucco CE, Nicolossi G, Talamo A (2001) Waterbird richness in altiplano wetlands of northwestern Argentina. Waterbirds 24(1): 103–117. https://doi.org/10.2307/1522249

Caziani SM, Rocha Olivio O, Rodríguez Ramírez E, Romano M, Derlindati EJ, Talamo A, Ricalde D, Quiroga C, Contreras JP, Valqui M, Sosa H (2007) Seasonal distribution, abundance, and nesting of Puna, Andean, and Chilean Flamingos. The Condor 109(2): 276–287. https://doi.org/10.1093/condor/109.2.276

Chao A, Jost L (2015) Estimating diversity and entropy profiles via discovery rates of new species. Methods in Ecology and Evolution 6(8): 873–882. https://doi.org/10.1111/2041-210X.12349

Chesser RT (1994) Migration in South America: An overview of the austral system. Bird Conservation International 4(2–3): 91–107. https://doi.org/10.1017/S0959270900002690

Clarke KR (1993) Non-parametric multivariate analyses of changes in community structure. Australian Journal of Ecology 18(1): 117–143. https://doi.org/10.1111/j.1442-9993.1993.tb00438.x

Clausen P (2000) Modelling water level influence on habitat choice and food availability for Zostera feeding Brent Geese Branta bernicla in non-tidal areas. Wildlife Biology 6(4): 75–87. https://doi.org/10.2981/wlb.2000.003

Contreras JR, Fernández A (1980) Ecología de la avifauna de la laguna el Viborón, departamento Maipú, provincia de Mendoza. Revista del Museo de Historia Natural de San Rafael (1): 3–14.

Costanza R, d’ Arge R, de Groot R, Farber S, Grasso M, Hannon B, Limburg K, Naeem S, O’Neill RV, Paruelo J, Raskin RG, Sutton P, van den Belt M (1997) The value of the world’s ecosystem services and natural capital. Nature 387(6630): 253–260. https://doi.org/10.1038/387253a0

Czech HA, Parsons KC (2002) Agricultural wetlands and waterbirds: A review. Waterbirds 25(2): 56–65. https://www.jstor.org/stable/1522452

de Arruda Almeida B, Sebastián-González E, dos Anjos L, Green AJ, Botella F (2019) A functional perspective for breeding and wintering waterbird communities: Temporal trends in species and trait diversity. Oikos 128(8): 1103–1115. https://doi.org/10.1111/oik.05903

Dimalexis A, Pyrovetsi M (1997) Effect of water level fluctuations on wading bird foraging habitat use at an irrigation reservoir, Lake Kerkini, Greece. Colonial Waterbirds 20(2): 244–252. https://doi.org/10.2307/1521690
Ever Tallei et al.

Echevarria A, Marano C, Cocimano M, Fanjul M, Cormenzana Méndez A (2014) Composición y variación de la comunidad de aves del embalse El Tunal, Salta, Argentina. Acta Zoológica Lilloana 58(1): 80–93. http://www.lillo.org.ar/journals/index.php/acta-zoologica-lilloana/article/view/172

Fox AD, Elmberg J, Tombre IM, Hessel R (2017) Agriculture and herbivorous waterfowl: A review of the scientific basis for improved management. Biological Reviews of the Cambridge Philosophical Society 92(2): 854–877. https://doi.org/10.1111/brv.12258

Gaston KJ, Cox DT, Canavelli SB, Garcia D, Hughes B, Maas B, Martínez D, Ogada D, Inger R (2018) Population abundance and ecosystem service provision: The case of birds. Bioscience 68(4): 264–272. https://doi.org/10.1093/biosci/biy005

Hagen M, Kissling WD, Rasmussen C, De Aguiar MAM, Brown LE, Carstensen DW, Alves-Dos-Santos I, Dupont YL, Edwards FK, Genini J, Guimarães Jr PR, Jenkins GB, Jordano P, Kaiser-Bunbury CN, Ledger ME, Maia KP, Marquitti FMD, Mclaughlin O, Morelato LPC, O’Gorman EJ, Trojelsgaard K, Tylianakis JM, Vidal MM, Woodward G, Olesen JM (2012) Biodiversity, Species Interactions and Ecological Networks in a Fragmented World. Advances in Ecological Research 46: 89–210. https://doi.org/10.1016/B978-0-12-396992-7.00002-2

Ikin K, Yong DL, Lindenmayer DB (2016) Effectiveness of woodland birds as taxonomic surrogates in conservation planning for biodiversity on farms. Biological Conservation 204: 411–416. https://doi.org/10.1016/j.biocon.2016.11.010

IUCN (2020) The IUCN Red List of Threatened Species. Version 2020-2. https://www.iucnredlist.org

Jahn AE, Cueto VR, Fontana CS, Guaraldo AC, Levey DJ, Marra PP, Ryder TB (2020) Bird migration within the Neotropics. The Auk 137(4): ukaa033. https://doi.org/10.1093/auk/ukaa033

Kingsford RT, Thomas RF (2004) Destruction of wetlands and waterbird populations by dams and irrigation on the Murrumbidgee River in arid Australia. Environmental Management 34(3): 383–396. https://doi.org/10.1007/s00267-004-0250-3

Kingsford RT, Bino G, Porter JL (2017) Continental impacts of water development on waterbirds, contrasting two Australian river basins: Global implications for sustainable water use. Global Change Biology 23(11): 4958–4969. https://doi.org/10.1111/gcb.13743

Kopij G, Paxton M (2018) Seasonal Changes in the Diversity and Numbers of Waterbirds in a Tropical River in Southern Africa. Polish Journal of Ecology 66(3): 257–269. https://doi.org/10.3161/15052249PJE2018.66.3.006

Kushlan J (1986) Responses of wading birds to seasonally fluctuating water levels: Strategies and their limits. Colonial Waterbirds 9(2): 155–162. https://doi.org/10.2307/1521208

López de Casenave J, Filipello AM (1995) Las aves acuáticas de la Reserva Costanera Sur: cambios estacionales en la composición específica y en la abundancia de poblaciones y gremios. El Hornero 14(01–02): 009–014. https://bibliotecadigital.exactas.uba.ar/download/hornero/hornero_v014_n01y02_p009.pdf

Lorenzón RE, Beltzer AH, Peltzer PM, Olguín PF, Leon EJ, Sovrano L, Ronchi-Virgolini AL (2017) Habitat-mediated influence of water-level fluctuations on waterbird occurrence in floodplain wetlands of the Parana River, Argentina. River Research and Applications 33(9): 1494–1505. https://doi.org/10.1002/rra.3199
Ma Z, Cai Y, Li B, Chen J (2010) Managing wetland habitats for waterbirds: An international perspective. Wetlands 30(1): 15–27. https://doi.org/10.1007/s13157-009-0001-6

Maleki S, Soffianian AR, Koupaei SS, Saatchi S, Pourmanafi S, Sheikholeslam F (2016) Habitat mapping as a tool for water birds conservation planning in an arid zone wetland: The case study Hamun wetland. Ecological Engineering 95: 594–603. https://doi.org/10.1016/j.ecoleng.2016.06.115

Marateo G, Arturi M (2013) Dinámica estacional y variación local de gremios tróficos de aves de una selva en galería y un palmar subtropical de sudamérica. Ornitología Neotropical 24: 213–223.

Martínez F, Lucero F, Cali R, Valdés D, Ferrer D, Chébez JC (2009) Registros novedosos de aves para las provincias de Mendoza y San Juan. Nótulas Faunísticas (segunda serie) 35: 1–9. https://www.fundacionazara.org.ar/img/notulas-faunisticas/articulos/notula-35.pdf

Masiokas MH, Cara L, Villalba R, Pitte P, Luckman BH, Toum E, Christie DA, Le Quesne C, Mauget S (2019) Streamflow variations across the Andes (18°–55°S) during the instrumental era. Scientific Reports 9(1): e17879. https://doi.org/10.1038/s41598-019-53981-x

MAyDS and AA [Ministerio de Ambiente y Desarrollo Sustentable y Aves Argentina] (2017) Categorización de las Aves de la Argentina (2015). Informe del Ministerio de Ambiente y Desarrollo Sustentable de la Nación y de Aves Argentinas, edición electrónica. C. A. Buenos Aires, 146 pp. https://avesargentinas.org.ar/sites/default/files/Categorizacion-de-aves-de-la-Argentina.pdf

Michel NL, Whelan CJ, Verutes GM (2020) Ecosystem services provided by Neotropical birds. Condor 122(3): duaa022. https://doi.org/10.1093/condor/duaa022

Minckley TA, Turner DS, Weinstein SR (2013) The relevance of wetland conservation in arid regions: A re-examination of vanishing communities in the American Southwest. Journal of Arid Environments 88: 213–221. https://doi.org/10.1016/j.jaridenv.2012.09.001

Moreno CE, Calderón-Patrón JM, Arroyo-Rodríguez V, Barragán F, Escobar F, Gómez-Ortiz Y, Martín-Regalado N, Martínez-Falcón AP, Martínez-Morales MA, Mendoza E, Ortega-Martínez IJ, Pérez-Hernández CX, Pineda E, Pineda-López R, Lucero Rios-Díaz C, Rodríguez P, Rosas F, Schondube JE, Zuria I (2017) Measuring biodiversity in the Anthropocene: A simple guide to helpful methods. Biodiversity and Conservation 26(12): 2993–2998. https://doi.org/10.1007/s10531-017-1401-1

Moreno CE, Calderón-Patrón JM, Martín-Regalado N, Martínez-Falcón AP, Ortega-Martínez IJ, Rios-Díaz CL, Rosas F (2018) Measuring species diversity in the tropics: A review of methodological approaches and framework for future studies. Biotropica 50(6): 929–941. https://doi.org/10.1111/btp.12607

Nairn RJ, Decamps H, Pollock M (1993) The role of riparian corridors in maintaining regional biodiversity. Ecological Applications 3(2): 209–212. https://doi.org/10.2307/1941822

Narosky T, Yzurieta D (2003) Guía para la identificación de las aves de Argentina y Uruguay. Asociación Ornitológica del Plata, 340 pp.

Pedrana J, Pütz K, Bernad L, Pon JPS, Gorosabel A, Muñoz SD, Isacch JP, Matus R, Blank O, Luthi B, Lunardelli M, Rojas P (2018) Migration routes and stopover sites of Upland Geese Chloephaga picta in South America. Avian Biology Research 11(2): 89–99. https://doi.org/10.3184/175815618X15179180488510
Prieto M, Rojas F (2012) Documentary evidence for changing climatic and anthropogenic influences on the Bermejo Wetland in Mendoza, Argentina, during the 16\textsuperscript{th}–20\textsuperscript{th} century. Climate of the Past Discussions 7(4): 3775–3794. https://doi.org/10.5194/cpd-7-3775-2011

Prieto M, Abraham E, Dussel P (2008) Transformaciones de un ecosistema palustre. La Gran Ciénaga del Bermejo, Mendoza, SIGLOS XVIII Y XIX. Multequina (Mendoza) 17: 147–164.

R Development Core Team (2020) R: A Language and Environment for Statistical Computing. R Foundation for Statistical Computing, Vienna. http://www.R-project.org

Rayfield B, Moilanen A, Fortin MJ (2009) Incorporating consumer–resource spatial interactions in reserve design. Ecological Modelling 220(5): 725–733. https://doi.org/10.1016/j.ecolmodel.2008.11.016

Remsen JV, Areta JI, Bonaccorso E, Claramunt S, Jaramillo A, Pacheco JF, Robbins MB, Stiles FG, Stotz DF, Zimmer KJ (2020) A classification of the bird species of South America. American Ornithological Society. http://www.museum.lsu.edu/~Remsen/SACCBaseline.htm [version 4 November 2020]

Rivera JA, Penalba OC, Villalba R, Araneo DC (2017) Spatio-temporal patterns of the 2010–2015 extreme hydrological drought across the Central Andes, Argentina. Water (Basel) 9(9): e652. https://doi.org/10.3390/w9090652

Romano M, Barberis I, Pagano F, Maidagan J (2005) Seasonal and interannual variation in waterbird abundance and species composition in the Melincué saline lake, Argentina. European Journal of Wildlife Research 51(1): 1–13. https://doi.org/10.1007/s10344-005-0078-z

Ronchi-Virgolini AL, Lorenzón RE, Blake JG, Beltzer AH (2013) Temporal variation of bird assemblages in a wetland: Influence of spatial heterogeneity. Avian Biology Research 6(3): 198–206. https://doi.org/10.1084/175815513X13739097841679

Rubenstein DR, Hobson KA (2004) From birds to butterflies: Animal movement patterns and stable isotopes. Trends in Ecology & Evolution 19(5): 256–263. https://doi.org/10.1016/j.tree.2004.03.017

Rubio MC (2018) Servicios ecosistémicos de sistemas de humedales en tierra secas. Su abordaje para el ordenamiento territorial. PhD thesis, Universidad Nacional de Cuyo, Mendoza, 426 pp.

Ruetz CR III, Trexler JC, Jordan F, Loftus WF, Perry SA (2005) Population dynamics of wetland fishes: Spatio-temporal patterns synchronized by hydrological disturbance? Journal of Animal Ecology 74(2): 322–332. https://doi.org/10.1111/j.1365-2656.2005.00926.x

Sabo JL, Sponseller R, Dixon M, Gade K, Harms T, Heffernan J, Jani A, Katz G, Soykan C, Watts J, Welte J (2005) Riparian zones increase regional species richness by harboring different, not more, species. Ecology 86: 56–62. https://doi.org/10.1890/04-0668

Safran RJ, Colwell MA, Isola CR, Taft OE (2000) Foraging site selection by nonbreeding White-faced Ibises. The Condor 102(1): 211–215. https://doi.org/10.1093/condor/102.1.211

Sekercioglu CH (2006) Increasing awareness of avian ecological function. Trends in Ecology & Evolution 21(8): 464–471. https://doi.org/10.1016/j.tree.2006.05.007

Serran JN, Creed IF, Ameli AA, Aldred DA (2018) Estimating rates of wetland loss using power-law functions. Wetlands 38(1): 109–120. https://doi.org/10.1007/s13157-017-0960-y
Sica YV, Quintana RD, Radeloff VC, Gavier-Pizarro GI (2016) Wetland loss due to land use change in the Lower Paraná River Delta, Argentina. The Science of the Total Environment 568: 967–978. https://doi.org/10.1016/j.scitotenv.2016.04.200

Vanausdall RA, Dinsmore SJ (2019) Habitat associations of migratory waterbirds using restored shallow lakes in Iowa. Waterbirds 42(2): 135–153. https://doi.org/10.1675/063.042.0201

Vanni MJ, Luecke C, Kitchell JF, Allen Y, Temte J, Magnuson JJ (1990) Effects on lower trophic levels of massive fish mortality. Nature 344(6264): 333–335. https://doi.org/10.1038/344333a0

Wiens JA (1989) Spatial scaling in ecology. Functional Ecology 3(4): 385–397. https://doi.org/10.2307/2389612

Young HS, McCauley DJ, Galetti M, Dirzo R (2016) Patterns, causes, and consequences of Anthropocene defaunation. Annual Review of Ecology Evolution and Systematics 47(1): 333–358. https://doi.org/10.1146/annurev-ecolsys-112414-054142

Zanotti M (2020) Primeros registros de Sirirí vientre negro (Dendrocygna autumnalis) para la provincia de Mendoza, Argentina. Nótulas Faunísticas (segunda serie) 297: 1–5. https://www.fundacionazara.org.ar/img/notulas-faunisticas/articulos/notula-297.pdf

Supplementary material 1

Table S1
Authors: Ever Tallei, Analía Benavidez, Alejandro Schaaf, Pablo Isola, Marcelo Zanotti
Data type: Species composition table (doc. file)
Explanation note: Composition of the (non-passerines) waterbird assemblage and their foraging behaviour and diet, recorded in Laguna del Viborón, Mendoza, Argentina, during two seasons (summer and winter).
Copyright notice: This dataset is made available under the Open Database License (http://opendatacommons.org/licenses/odbl/1.0/). The Open Database License (ODbL) is a license agreement intended to allow users to freely share, modify, and use this Dataset while maintaining this same freedom for others, provided that the original source and author(s) are credited.
Link: https://doi.org/10.3897/neotropical.16.e61672.suppl1