COASTAL BIRD COMMUNITY CHANGE FOLLOWING AN INCREASE OF PINNIPEDS AT A SITE IN NORTHERN ARGENTINA: A 14-YEAR STUDY

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ABSTRACT

BERÓN, M.P., HERNANDEZ, M.M. & SECO PON, J.P. 2023. Coastal bird community change following an increase of pinnipeds at a site in northern Argentina: A 14-year study. *Marine Ornithology* 51: 217–224.

We report here changes in bird assemblages over a 14-year interval at the Port of Mar del Plata, Argentina, and the adjacent beach before (PRE) and after (POST) South American Sea Lions *Otaria flavescens* increased at a local haul-out. Abundance and number of bird species were compared between periods, between sites (beach, sea lion rookery, and port sheds), and between breeding and non-breeding seasons of the birds' annual cycle. A total of 13 116 birds belonging to 15 species were recorded. Total bird abundance was higher during the POST period compared to the PRE period, regardless of the season. Larids occurred in all sampled areas but with higher abundance at Punta Mogotes beach. The Kelp Gull *Larus dominicanus*, Brown-hooded and Grey-headed gulls *Chroicocephalus* spp., and the Snowy Sheathbill *Chionis albus* dominated assemblages during the PRE sea lion increase period, while Kelp Gulls, Brown-hooded Gulls, and the South American Tern *Sterna hirundinacea* dominated the POST period. Variation in the numbers of birds may be related to changes in feeding opportunity related to increased human activity (e.g., fishery wastes) as well as expansion of the local rookery of South American Sea Lions, another food source.

Key words: abundance, avian richness, bird assemblages, gulls, *Otaria flavescens*, Port of Mar del Plata

INTRODUCTION

The coastal zone supports a large portion of the world's living marine resources, acting as nursery or feeding grounds and making it more biologically diverse than other parts of the sea (Ray *et al.* 1988, Clark 1992, Scialabba 1998). Coastal areas also offer suitable habitat and highly productive breeding and foraging sites for a wide range of marine vertebrates, such as seabirds (Clark *et al.* 1980, Clark 1992, Agardy *et al.* 2005, Rajpar *et al.* 2018). In addition, these areas are important stopover and wintering areas for a variety of migratory birds (Hubbard & Dugan 2003, Silva Rodríguez *et al.* 2005). Coastal habitats are subject to many anthropogenic threats, including sea level rise, climate change, urbanization, and coastal development, all of which have dramatic impact on the availability or quality of coastal habitats and the species that depend on them (Clark 1992, Davenport & Davenport 2006, Morović 2008, Thompson & Schlacher 2008, Huijbers *et al.* 2013, Wong *et al.* 2014).

Marine-coastal birds include a great variety of species that make use of habitats either year-round or seasonally and, in so doing, encounter an abundance of humans and their activities (Myers *et al.* 1987, Foster *et al.* 2009). Coastal zones cover a small percentage (15%) of the Earth's surface (total land and ocean areas combined), yet approximately 50% of the human population lives within 100 km of a coast, bringing a high degree of avian habitat degradation (Agardy *et al.* 2005).

In South America, particularly in Argentina, the coastal zone of the Pampas region has the main tourist cities, the largest and most popular sandy beaches (Bouvet *et al.* 2005, Furlán *et al.* 2012), and the most important ports in the country (Dadón & Matteucci 2006). This marine littoral zone also holds natural areas (e.g., estuaries, bays, sand-dunes, beaches) that function both as breeding and non-breeding grounds for a wide variety of marine and coastal birds (Silva Rodríguez *et al.* 2005, Favero *et al.* 2016, Martínez-Curci *et al.* 2021).

In northern Argentina, Buenos Aires province, several studies of differing methods have focused on spatial habitat use by seabirds and shorebirds (Martínez *et al.* 2000, Mauco & Favero 2005, Silva Rodríguez 2006, Berón *et al.* 2007, Berón *et al.* 2011, Mariano-Jelicich *et al.* 2011, Hernandez *et al.* 2021). However, the extent to which birds use artificial structures such as ports and the neighboring beaches/coast has scarcely been studied. Located in the southeastern Buenos Aires province, the Port of Mar del Plata is the most important coastal port in Argentina, judged from the number of fishing vessels based there (around 200 vessels) and its significant contribution to the national coastal fishery catch (around 80%) (Perrotta *et al.* 2007). Thus, fishery waste is a significant issue in the area. In addition, anthropogenic activities associated with tourism may cause negative environmental impacts chiefly affecting the beaches, causing the disappearance of local fauna and the alteration of the landscape (Dadón 2010).

Within this port resides the northernmost Argentine haul-out of South American Sea Lions *Otaria flavescens* (hereafter "sea lions"), composed solely of non-breeding males. It dates from the 1960s, when animals began settling on the breakwater of the Mar del Plata Yacht Club (Rodríguez & Bastida 1998); the area has since exhibited changes in sea lion settlement distribution and size (Giardino 2013). Since 2010, this sea lion settlement expanded from a hard substrate (i.e., orthoquartzite rock) to include an artificial sandy strand created in 2002 on the northern end of the southern breakwater (Area B in Fig. 1). The large sandy beach, known locally as Punta Mogotes (Area D in Fig. 1), functions as an important roosting and resting area for marine-coastal birds (Savigny & Favero 2005).

The changed distribution of the sea lions may have altered marine bird use of the area, which is the subject of our investigation. In this context, the aims of our study were to assess changes in abundance and number of bird species attending the Port of Mar del Plata and the adjacent natural sandy beach before and after the sea lion expansion, over a 14-year interval.

METHODS

Study area

This study was conducted within the Port of Mar del Plata (38°02′S, 057°32′W), Buenos Aires province, in northern Argentina. Data was collected using point counts performed in three different settings within the local port: the sea lion rookery, the port sheds, and an adjacent sandy beach (Fig. 1). The sea lion rookery (referred to as "the rookery") is a relatively small, semi-enclosed area where a permanent settlement of male South American Sea Lions exists. The current population is 500–600 individuals in size and chiefly comprises juvenile (3–5 years of age) and subadult (5–7 years) males (Giardino *et al.* 2017). In the early 2000s, the rookery occupied a small area (approximately 90 m × 25 m) composed of exposed land (upper platform) and rocks (Fig. 1). More recently in the late 2010s, the rookery expanded to 230–330 m × 20 m, including a lower level that includes a soft sandy beach (Fig. 1). This adjacent beach (referred to as "the beach"), locally known as Punta Mogotes beach, is also an avian roost. In the northern sector of this beach are the port sheds, where small-scale fishing vessels moor, get enlisted, and off-load their fish to the processing sheds (Perrotta *et al.* 2007, Giardino *et al.* 2017).

Data collection

Censuses were carried out 14 years apart (2005 and 2019) and captured the entire annual avian cycle, i.e., breeding (October–March) and non-breeding (April–September) periods. Counts were done between 08h00 and 16h00, always during low tide. At each sampling site (i.e., rookery, beach, and port sheds), bird abundance was determined on a weekly basis by means of two counts lasting five minutes each. Counts were performed from a distance varying from 5 to 100 m between the observers and the bird assemblages, a range of distances that would not disturb the birds but would allow species identification. Birds in the rookery were counted at a distance of 20 m and an altitude of 4 m above sea level (Hernandez *et al.* 2021). The point-count radius included the first 100 m of water adjacent to each area. The abundance of birds within the counting

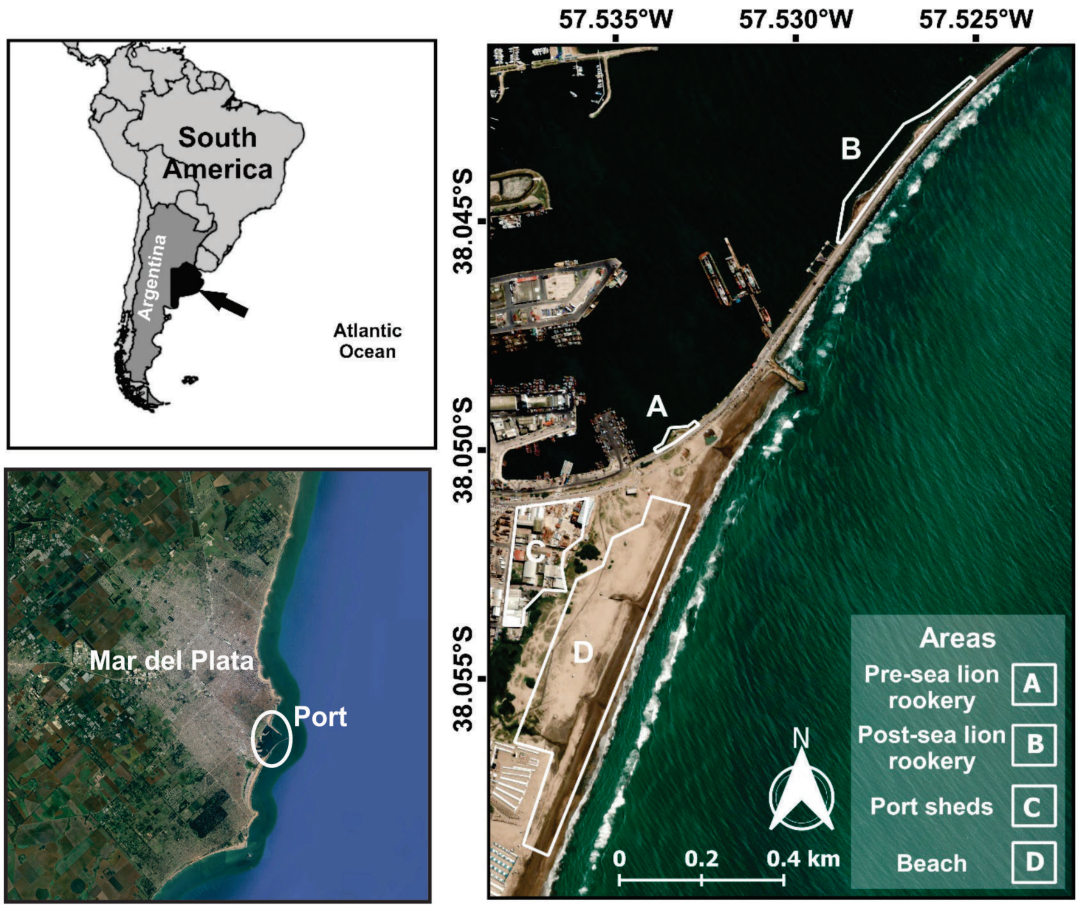

Fig. 1. Study area and sampling sites in the Port of Mar del Plata, Argentina: Rookery for South American Sea Lions *Otaria flavescens* (A pre- and B post-sea lion population increase), Port Sheds (C), and Beach (D). Image credits: © 2021 Google Earth, Image Landsat/Copernicus, Data SIO, NOAA, US Navy, NGA, GEBCO.

radius were recorded aided by binoculars (10×, 50 mm) and/or spotting scope (12×, 60 mm), as well as field guides (Narosky & Yzurieta 2010). For statistical purposes, the maximum numbers of individuals per species were recorded per five-minute count.

Data analysis

Two temporal periods were considered. Period 1 (surveys conducted in 2005) occurred before the development of the sea lion rookery (hereafter referred to as "PRE"). This period was characterized by few attending sea lions, which, at that time, hauled out chiefly on rocky outcrops, artificial rocky jetties, and artificial breakwaters (Fig. 1). Period 2 (surveys conducted in 2019) occurred after the development of the sea lion rookery (hereafter referred to "POST") at a site that has been strongly selected by sea lions as a resting and roosting place since 2010 (Giardino *et al.* 2017).

Generalized linear models were used to compare the total abundance of birds and the total number of bird species between sampling sites for the PRE and POST periods. The same approach was used to compare the total abundance of birds and the number of bird species for (a) the breeding and non-breeding season, and (b) each sampling site (beach-pre vs. beach-post, rookery-pre vs. rookery-post, port sheds-pre vs. port sheds-post). Due to high overdispersion ($\hat{c} > 3$) a negative binomial error structure with log link function was used for modelling total avian abundance and species richness as the response variables.

To determine differences among levels of the fixed factor, multiple-comparisons tests (Tukey Contrasts) were performed using the "multcomp" package (Hothorn *et al.* 2008). The fit of the models was checked using DHARMa diagnostic plots employing the "DHARMa" package (see Hartig 2022). Statistical analysis of the

TABLE 1
Mean abundance of bird species compared before and after an increase in the population of South American Sea Lions *Otaria flavescens* for each sampling site (*n* = number of counts). Values in parentheses represent maximum number of sighted individuals. For all species, the minimum number of individuals recorded was 0.

	Beach		Rookery		Port sheds	
Taxon	**Pre (*n*=12)**	**Post (*n*=10)**	**Pre (*n*=12)**	**Post (*n*=18)**	**Pre (*n*=12)**	**Post (*n*=10)**
Kelp Gull *Larus dominicanus*	56.17 (480)	801 (1921)	27.67 (70)	31.7 (280)	34.17 (250)	32.3 (66)
Olrog's Gull *Larus atlanticus*	2.33 (21)	1.60 (7)	0.75 (4)	0.22 (1)	0.17 (2)	-
Brown-hooded Gull *Chroicocephalus maculipennis*	3.92 (17)	4.90 (23)	1.67 (20)	12.90 (77)	17.92 (160)	7.60 (23)
Grey-headed Gull *Chroicocephalus cirrocephalus*	11.67 (86)	-	-	0.06 (1)	3.50 (17)	2.30 (22)
South American Tern *Sterna hirundinacea*	7.25 (73)	98.4 (350)	0.33 (4)	-	0.33 (4)	0.10 (1)
Snowy-crowned Tern *Sterna trudeaui*	4.25 (28)	5.80 (18)	-	0.06 (1)	-	-
Royal Tern *Thalasseus maximus*	-	0.70 (7)	-	-	-	-
Great Grebe *Podiceps major*	0.08 (1)	-	-	0.61 (3)	-	-
Southern Giant Petrel *Macronectes giganteus*	0.08 (1)	-	-	0.06 (1)	-	-
Neotropic Cormorant *Nannopterum brasilianum*	-	-	0.25 (2)	-	-	-
Snowy Sheathbill *Chionis albus*	-	-	15.25 (46)	18.70 (41)	-	-
Southern Lapwing *Vanellus chilensis*	-	1.10 (11)	-	0.11 (2)	-	-
Black-winged Stilt *Himantopus himantopus*	0.83 (4)	-	-	-	-	-
Chimango Caracara *Milvago chimango*	1.08 (4)	9.10 (20)	0.17 (2)	0.89 (4)	-	1.40 (5)
Red-gartered Coot *Fulica armillata*	0.17 (2)	-	-	-	-	-

data was performed using R software, Version 4.2.2 (R Development Core Team 2022). In all cases, differences were considered significant where P value was < 0.05.

Changes in relative abundances (mean of total bird abundance per count) of all bird species tallied between sampling sites and, controlling for PRE and POST periods, were analyzed using multivariate techniques (Clarke 1993) via the software package PRIMER version 6.1 (Clarke & Gorley 2006). For this, a hierarchical and multidimensional clustering of raw data (without transformation) using the Bray-Curtis similarity index was applied (Clarke *et al.* 2006). One-way analysis of similarity (ANOSIM) was used to test the differences in bird assemblages between sampling sites, considering the variation within and between studied periods (Clarke 1993). The SIMPER routine was applied to assess mean dissimilarities between sampling sites within each period and between periods, as well as to identify the species responsible for differences between bird groups. The similarities among samples (counts) were estimated by means of the Bray-Curtis similarity index (Bray & Curtis 1957).

RESULTS

Pre-rookery increase period

A total of 2280 individuals belonging to 13 species of birds were counted during this period (Table 1). There was no significant difference in either the number of individuals or the number of species between sampling sites (χ^2_2 = 0.90, P = 0.64 and χ^2_2 = 2.74, P = 0.25, respectively; Fig. 2). The composition of seabird assemblages significantly differed between sampling sites (ANOSIM P = 0.001); this was true for contrasts such as port sheds-rookery (R = 0.331, P = 0.001) and rookery-beach (R = 0.434, P = 0.001). These differences were mainly driven by the relative contributions of the Kelp Gull *Larus dominicanus* (48.2% of the average dissimilarity; port sheds-rookery and rookery-beach contrasts combined) and the Brown-hooded Gull *Chroicocephalus maculipennis* (16.1%). Other species than contributed to the dissimilarity between sites like port sheds-rookery and rookery-beach included the Snowy Sheathbill *Chionis albus* (27.5%) and the Grey-headed Gull *Chroicocephalus cirrocephalus* (18.9%). The composition of seabird assemblages for the contrast port sheds-beach was non-significant (R = −0.021, P = 0.559).

Post-rookery increase period

A total of 10 836 individuals comprising 12 species of birds were counted during this period (Table 1). The number of individuals was different between sampling sites (χ^2_2 = 53.35, P < 0.001), with more birds counted on the beach compared to the rookery (z = 5.98, P < 0.001) and the port sheds (z = 6.06, P < 0.001); there was no difference between the rookery and port sheds (z = 0.90, P = 0.63; Fig. 2). Regarding the number of species, no differences were evident between sampling sites (χ^2_2 = 3.95, P = 0.138).

The composition of seabird assemblages significantly differed between sampling sites (ANOSIM P = 0.001). This was true for all comparisons (port sheds-rookery: R = 0.219, P = 0.001; rookery-beach: R = 0.704, P = 0.017; port sheds-beach: R = 0.404, P = 0.001). Most important were the relative contribution of species like Kelp Gull (58.1% of the average dissimilarity, all paired contrasts combined), South American Tern *Sterna hirundinacea* (19.9% of the average dissimilarity, port sheds-beach and rookery-beach contrasts combined), and Brown-hooded Gull (17.9% of the average dissimilarity, port sheds-rookery and rookery-beach contrasts combined).

Comparisons of birds' parameters between pre- and post-rookery increase periods

Total bird abundance (entire annual cycle and all sampling sites combined) was higher during the POST than the PRE period (z = −3.87, P < 0.001; Fig. 3). This metric was also higher when considering both seasons (breeding: z = −2.44, P < 0.02; non-breeding: z = −2.99, P < 0.01; Fig. 3). Regarding sampling sites, bird abundance tallied at the beach was higher during the

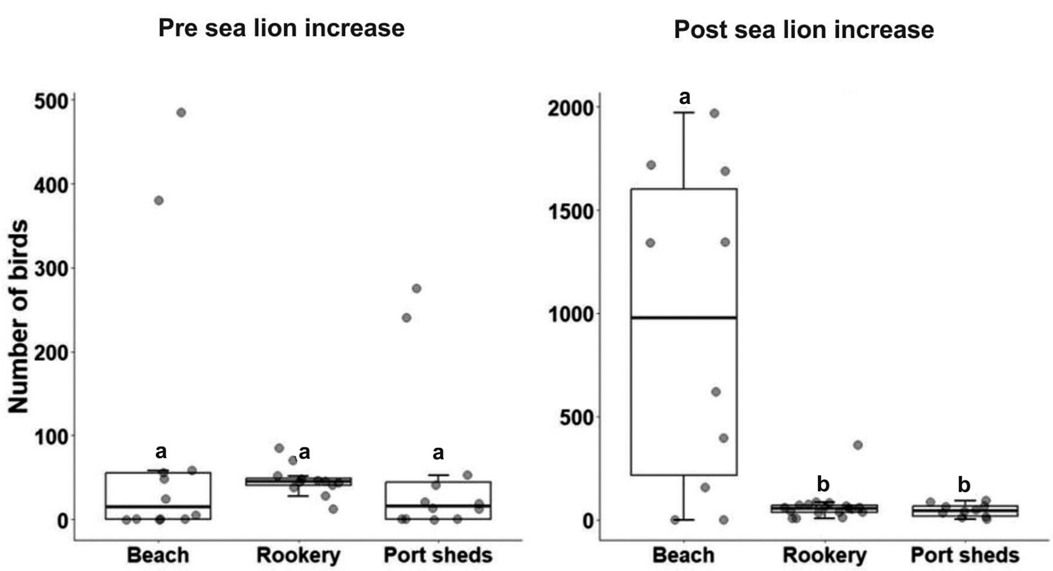

Fig. 2. Number of birds before (pre) and after (post) the population increase of South American Sea Lions *Otaria flavescens* per sampling site. Each dot represents an observed value. Different letters represent significant differences (P < 0.05).

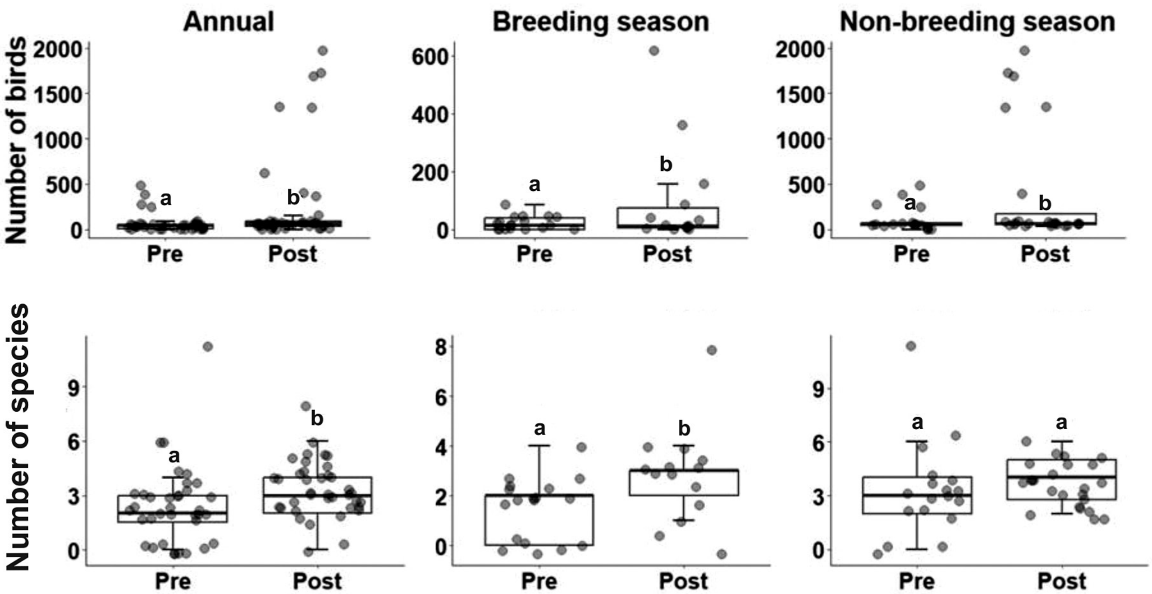

Fig. 3. Number of birds and species before (pre) and after (post) the population increase of South American Sea Lions *Otaria flavescens* according to season. Each dot represents an observed value. Different letters represent significant differences ($P < 0.05$).

POST period, while the rookery and the port sheds did not show differences between studied periods ($z = -2.57$, $P < 0.01$; $z = -1.28$, $P = 0.20$; $z = 0.38$, $P = 0.70$, respectively; Fig. 4).

When considering the number of bird species, values were higher during the POST period compared to the PRE period (all sampling sites combined): $z = -2.08$, $P < 0.04$ (Fig. 3). During the breeding season, the number of species was higher during the POST period, but no difference was apparent during the non-breeding period ($z = -2.21$, $P = 0.03$; $z = -0.59$, $P = 0.55$, respectively; Fig. 3). Regarding sampling sites, none of them showed differences in the number of species between the PRE and POST periods (beach: $z = -0.64$, $P = 0.52$; rookery: $z = -1.25$, $P = 0.21$; port sheds: $z = -1.20$, $P = 0.23$; Fig. 4).

DISCUSSION

Our study revealed variation in the assemblage of birds present over a 14-year interval in the Port of Mar del Plata and adjacent beaches. After sea lions became more abundant, the biggest proportional

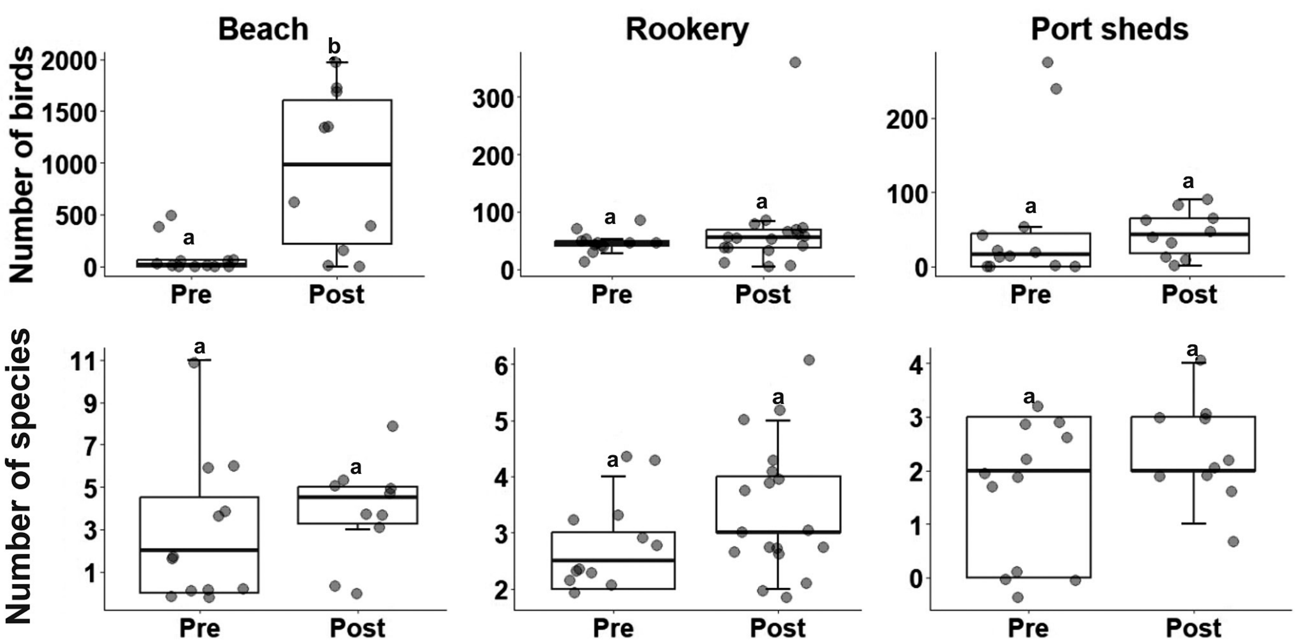

Fig. 4. Number of birds and species analyzed before (pre) and after (post) the population increase of South American Sea Lions *Otaria flavescens* and by site. Each dot represents an observed value. Different letters represent significant differences ($P < 0.05$).

increase in the bird population was observed mainly in gulls, particularly the Kelp Gull, one of the most abundant and widely distributed larid species in the southern hemisphere (Hockey *et al.* 2005, Yorio *et al.* 2005, Yorio *et al.* 2016). The Kelp Gull population has shown a considerable growth in recent decades (Lisnizer *et al.* 2011, BirdLife International 2021), a result of this species taking advantage of waste and various by-products of human activities, such as the fishing industry (Giaccardi & Yorio 2004, Yorio & Caille 2004).

Among larids, gulls were distributed throughout the studied area but mostly used the Punta Mogotes beach. This area had been previously identified as an important resting site for gulls, chiefly during twilight, night, and early morning hours (Savigny & Favero 2005). From there, gulls probably forage at the port sheds and adjacent ocean areas, also taking advantage of the discards from coastal fishing in adjacent waters (Martínez *et al.* 2000, Seco Pon *et al.* 2013). Gulls are known for gathering on factory roofs in the Mar del Plata Harbor, particularly when there is no boat fishing activity (Martínez *et al.* 2000). Regardless, the dimensions of the Punta Mogotes beach provide larids with a less disturbed resting place, at least during the winter season, when human use of the beach is minimal (Savigny & Favero 2005).

The Kelp Gull along with Brown-hooded Gull, Grey-headed Gull, South American Tern, and Snowy Sheathbill dominated the assemblages, and they were species that regularly attended the study area throughout the year (Martínez *et al.* 2000, Savigny & Favero 2005). Though the Snowy Sheathbill is considered a winter migrant along the study area (Narosky & Yzurieta 2010), a few individuals were present during the breeding season. Regarding the South American Tern, its non-breeding diet in Buenos Aires province shows a significant influence of coastal fisheries, particularly individuals settled in Port of Mar del Plata; this highlights the use of discards as feeding resource (Favero *et al.* 2000). Our result shows the highest tallies (100–350 individuals) of South American Tern in September and October—i.e., early to mid-austral spring—in accord with the presence of anchovy schools, one of their main feeding resource (Mariano-Jelicich *et al.* 2011) in the adjacent marine-coastal area. By this period, the terns could be using this area as a refueling site for the pre-breeding exodus to breeding grounds in Patagonia.

The available literature indicates that marine-coastal birds, chiefly gulls, interact in many different ways with marine mammals, mainly whales and sea lions (Ryder 1957, Schreiber 1970, Baltz & Morejohn 1977, Bayer 1983, Suárez & Yorio 2005, Seguel *et al.* 2017, Agrelo *et al.* 2023). Non-breeding rookeries of sea lions, like the one studied here, does not provide dead pups and afterbirth materials, which can serve as food for scavengers such as gulls (Schreiber 1970). On the other hand, the local sea lion rookery does function as a feeding and resting site for the Snowy Sheathbill, a winter migrant that feeds on sea lion faeces (Favero 1998, Hernandez *et al.* 2021).

Variations related to the total numbers of individuals throughout the POST period, particularly during the breeding season, may be due to the larids breeding at nearby sites yet to be discovered and reported. While we cannot state that the variations in bird abundance observed in this study are strictly due to changes in the port's architectural structure, such as the construction of new port sheds and the expansion of the local sea lion rookery, these changes may have favored the increase in the numbers of birds due to increased food from increased human activities (Yorio & Giaccardi 2002).

Future studies should address the long-term trends exhibited by the resident and visiting avifauna attending the study area, complemented by studies to evaluate anthropic activity and the impacts of increased larid numbers (Yorio *et al.* 2016, Agrelo *et al.* 2023). Long-term monitoring is a fundamental tool for ornithologists and conservation managers for the development of an integrated management plan addressing the spatial and temporal variation in the use of space by birds attending these areas.

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