The Auk 124(4):1201–1212, 2007

BREEDING HABITAT REQUIREMENTS AND SELECTION BY OLROG'S GULL (*LARUS ATLANTICUS*), A THREATENED SPECIES

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Abstract.—We studied habitat requirements and selection of Olrog´s Gulls (*Larus atlanticus*) breeding at six colonies along 2,500 km of coastline in central Argentina that encompasses its entire distributional range. Colonies were located only on islands that ranged in size between 0.4 and 125.8 ha, and the islands' distance to the mainland varied from 0.12 to 16.7 km. Colonies ranged in size between 12 and 341 nests. In three of the colonies, gulls nested in subcolonies (range: 8–239 nests). They nested at relatively high densities, with a mean inter-nest distance of 0.66 ± 0.25 m. Logistic regression analysis to compare nest and random-site characteristics at each colony showed that Olrog´s Gulls selected sites that were close to the high-tide line, at a lower height above sea level, far from available vegetation, and had lower vegetation cover over the nest. Olrog´s Gulls showed a significant positive association with Kelp Gulls (*L. dominicanus*), an expanding generalist species that also nests in similar habitats. Current trends in coastal development, particularly in the Olrog's Gulls' main breeding grounds of southern Buenos Aires, indicate the urgent need for habitat-protection guidelines for this threatened species. Moreover, its breeding association with Kelp Gulls suggests a potential spatial conflict and highlights the need for increased monitoring and management actions. *Received 8 June 2006, accepted 1 November 2006.*

Key words: Argentina, habitat requirements, *Larus atlanticus*, nest-site selection, Olrog´s Gull, Patagonia.

Selección y Requerimientos de Hábitat Reproductivo en *Larus atlanticus*, una Especie Amenazada

Resumen.—Estudiamos la selección y requerimientos de hábitat en *Larus atlanticus* en seis colonias reproductivas a lo largo de 2,500 km de costa en el centro de Argentina, área que comprende la totalidad de su ámbito de distribución. Las colonias sólo se encontraron en islas con tamaños entre 0.4 y 125.8 ha, y la distancia de las islas al continente varió entre 0.12 y 16.7 km. Las colonias tuvieron entre 12 y 341 nidos. En tres de las colonias, las aves nidificaron en subcolonias (rango: 8–239 nidos). Estas gaviotas nidificaron a densidades altas con una distancia promedio entre nidos de 0.66 ± 0.25 m. Un análisis de regresión logística utilizado para comparar las características de los nidos con las de sitios escogidos al azar en cada colonia, mostró que *L. atlanticus* seleccionó sitios que se encontraron más cerca de la línea de la marea alta, a una menor altitud sobre el nivel del mar, más lejos de la vegetación disponible y con una menor cobertura de vegetación sobre el nido. *Larus atlanticus* mostró una asociación positiva con *L. dominicanus*, una especie generalista en expansión que nidifica en hábitats similares. Las tendencias actuales del

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desarrollo costero, particularmente en las áreas de reproducción de *L. atlanticus* del sur de Buenos Aires, indican la necesidad urgente de delinear pautas de protección de hábitat para esta especie amenazada. Además, la asociación reproductiva con *L. dominicanus* sugiere un posible conflicto espacial y resalta la necesidad de aumentar el monitoreo y las acciones de manejo.

Colonial birds select breeding habitat according to several factors that determine its quality, including food resources, microclimate, substrate, protection against predators, and presence of other species (Buckley and Buckley 1980, Fasola and Canova 1992, Bried and Jouventin 2002). Habitat selection is a hierarchical decision-making process that results in animals living in a restricted set of environmental conditions (Partridge 1978, Block and Brennan 1993). Therefore, the influence of each factor will depend on the habitat scale at which the bird is making the selection (Orians and Wittenberger 1991, Block and Brennan 1993).

Olrog's Gull (*Larus atlanticus*) is an endemic species of the Atlantic coast of Argentina. Its breeding range is restricted to only two areas separated by 700 km: southern Buenos Aires Province and northern Golfo San Jorge, Chubut Province. The entire breeding population has been estimated to be ~2,300 pairs (Yorio et al. 1997, Delhey et al. 2001b): >90% reproduce in Buenos Aires, whereas only 5% nest in Golfo San Jorge. Both coastal areas are exposed to anthropogenic activities. In Buenos Aires, the Bahía Blanca Estuary is an area where industrial, fishing, agricultural, and recreational activities take place (Yorio et al. 1997); San Blas presents an intensive recreational activity where egg collection has also been reported; and in Chubut, different extractive activities occur in proximity to the colonies (Yorio et al. 1999). Because of its low population size, restricted distributional range, trophic specialization, and conservation threats, Olrog's Gull has been internationally recognized as "vulnerable" (Birdlife International 2000) or "highly threatened" (Parker et al. 1996) and listed in Appendix I of the Convention on Migratory Species.

Even though the species is highly important in terms of conservation, knowledge of its ecological requirements is very limited. Olrog's Gull breeding habitat has been described only in two colonies in southern Buenos Aires Province (Yorio et al. 2001), and the cues used by this species to select its breeding habitat along its entire distribution are unknown. Many studies of habitat selection in gulls have analyzed only one or a few colonies (e.g., Burger and Shisler 1978, Montevecchi 1978), which hampers our ability to identify the habitat requirements that gulls use for colonies and nest habitats (Burger and Gochfeld 1981a, b; Orians and Wittenberger 1991). The goals of the present study were (1) to evaluate Olrog's Gull breeding-habitat requirements at different spatial scales (colony and nest site) and (2) to determine the environmental factors that affect nest-site selection along the species' entire distributional range.

Methods

Olrog's Gull breeding habitat was studied along 2,500 km of Argentine coastline—from Canal Ancla Islet (38°56'S, 62°11'W) to Vernaci Noroeste Island (45°10'S, 66°31'W)—which encompasses its entire breeding distributional range (Fig. 1). Six colonies were visited (Canal Ancla Islet, Arroyo Jabalí Oeste Islet, Banco Nordeste, Felipe Island, Vernaci Noroeste Island, and Vernaci Oeste Noroeste Island). Information was gathered on colony size and habitat composition during late incubation and early chick stage between 1998 and 2001. Complete nest counts were made at the six colonies. A nest was considered active if it was well formed, contained nesting material, or contained an egg. At each locality visited, in the areas occupied by Olrog's Gull nests, we obtained each habitat's general characteristics. To evaluate size and distance to the mainland of islands used by gulls, we evaluated all localities where gulls bred for at least one season in the past 15 years. Lack of additional data precludes the use of this long-term information on colony location and size for other habitat analyses. Information was obtained using nautical charts

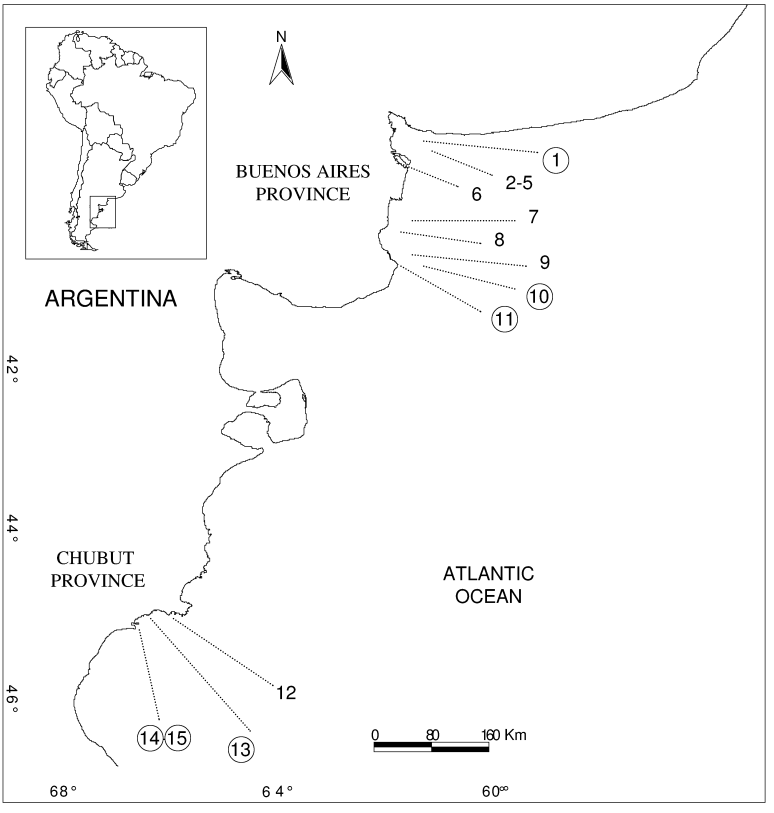

FIG. 1. Map of northern and central coastal Patagonia, Argentina, showing the location of the Olrog´s Gull colonies. Locations: (1) Canal Ancla Islet, (2–5) islets of Trinidad Island, (6) Brightman Island, (7) Morro de Indio Islet, (8) Puestos Island, (9) Gamma Island, (10) Banco Nordeste, (11) Arroyo Jabalí Oeste Islet, (12) Laguna Island, (13) Felipe Island, (14) Vernaci Noroeste Island, and (15) Vernaci Oeste Noroeste Island. The number of the colonies visited in the present study are circled.

(Servicio de Hidrografía Naval Argentina) and published literature (Yorio et al. 1998). In this analysis, we evaluated 15 colonies, including the 6 colonies that were visited and another 9 colonies: islets of Isla Trinidad (Norte, Bastón, Redondo, and Sur), an islet at the north of Isla Morro de Indio, Puestos Island, Gama Island, Brightman Island, and Laguna Island (Fig. 1).

To study microhabitat selection and requirements, we quantified 13 habitat variables at 336 nest sites (representing 15% of the total number of nests estimated for the species) and at 139 random points at the six colonies visited. Nests and random points were selected using tables of random numbers to generate the *x*- and *y*-coordinates (Burger and Gochfeld 1985, Bosch and Sol 1998). At each nest site and random point, we estimated the percentage of substrate components in the surface layer (top 5 cm). Substrate components were classified as (1) silt-clay, (2) sand, (3) shell (shell fragments), (4) gravel and rock fragments, and (5) rock (exposed bedrock) (see Stokes and Boersma 1991). We measured the slope of the substrate using a Suunto type PM-5/060 PG clinometer. We recorded the percentage of vegetative cover within a 1- and 5-m radius around the nest or random point. We measured the distance to the nearest vegetation and its height, and the distance to the nearest clearing from which gulls could take flight when threatened. Finally, we measured the distance to the nearest high-tide line and height above sea level.

To characterize the nests built by this species, we measured nest dimensions at 198 nest sites. We measured each nest's external and internal diameters and external height, which is defined as the vertical distance from the ground to the top edge of the external side of the nest. At each locality where Olrog's Gulls bred, we also recorded the presence of other breeding seabirds.

Statistical analyses.—To determine the most important nest-site factors that were selected by Olrog's Gulls for each colony, nest and random data were subjected to logistic regression analysis. The binary dependent variable was nest versus random site. The 13 independent habitat variables described above included both nominal and continuous variables. Percentage variables were transformed using the arcsine transformation. Independent variables were entered into the equations using the forward stepwise likelihood-ratio method, with order of entry determined by significance and removal by the likelihood-ratio statistic. We ran a separate analysis for each colony because we needed to compare nest sites with the available characteristics at that specific colony, and if we performed a single analysis pooling all the colonies, these differences might not be detected. Differences in habitat characteristics between nest and random sites were tested using the univariate Mann-Whitney *U*-test. All statistical procedures were performed in SPSS (SPSS, Chicago, Illinois), and the alpha level of significance was set at $\alpha = 0.05$.

To determine whether there was a pattern to Olrog´s Gull nest-site choices, we examined the relationship between nest sites and random points among colonies. To do so, we plotted the mean nest values against the mean random-point values for the most important variables in the differentiation of nest sites and random points for each colony (Burger and Gochfeld 1985). In each figure, we show the line where the nest-site value is equivalent to the random-point value. The strength of the association between Olrog´s Gulls and other seabird species was analyzed using the phi association coefficient (ϕ) (Krebs 1978).

RESULTS

Breeding habitat characteristics.—All colonies were located on islands or islets. Islands and islets ranged in size between 0.40 and 125.80 ha (mean ± SD = 13.14 ± 31.52), whereas their distance to the mainland varied from 0.12 to 16.7 km (6.12 ± 6.53) (n = 15 colonies). Five of the six colonies we visited were on islands or islets with sedimentary substrates and with low height above sea level (<3 m), except for Felipe Island, which is mainly composed of volcanic rock, with a maximum height of 7 m above sea level.

The colony at Canal Ancla Islet was located in proximity to a tidal channel, occupying an area of fine sediment and devoid of vegetation. At Banco Nordeste, the colony was placed on a sandy beach, immediately adjacent to the first vegetation line. At Arroyo Jabalí Oeste Islet, the colony was located at the central sector, the only area that is not covered during the high tide. At Vernaci Noroeste Island and Oeste Noroeste Islet, colonies were placed on small headlands composed of sand, gravel, and shell. Finally, the colony at Felipe Island was located on a rocky irregular surface.

Colony description.—At the three colonies in southern Buenos Aires, gulls nested in subcolonies (61.3 ± 62.4, range: 8–239 nests). Two subcolonies were found at Arroyo Jabalí Oeste Islet (89 and 105 nests), four at Canal Ancla Islet (239, 17, 61, and 24 nests), and six at Banco Nordeste (8, 34, 43, 30, 50, and 37 nests). These subcolonies were easily recognized and were separated by a distance that varied between 1.8 and 103.5 m (28.5 ± 30.3 m). On the other hand, colonies at Chubut were formed by only one group of 44, 12, and 56 nests at Vernaci Noroeste Island, Felipe Island, and Vernaci Oeste Noroeste Island, respectively.

Colonies were located on open ground and far from vegetation. This was particularly evident at Vernaci Noroeste and Felipe islands, where peripheral nests were 14 and 21 m distant from the closest bushes, respectively. In only two of the breeding locations, some of the subcolonies had peripheral nests adjacent to vegetation, which consists of low herbaceous or shrub species (<0.2–0.3 m) belonging to the genera *Atriplex*, *Salicornia*, *Franquenia*, *Limonium*, and *Spartina*.

Olrog's Gulls nested at relatively high densities (Table 1), with a mean inter-nest distance of 0.66 ± 0.25 m (range: 0.30–1.93 m; n = 231 nests). Inter-nest distances were significantly different among colonies (analysis of variance [ANOVA], $F = 25.34$, df = 5, $P < 0.001$), and also between the colonies of Chubut and Buenos Aires (Tukey's test, $P < 0.05$; Table 1). Mean inter-nest distance between nests from colonies at Buenos Aires

Table 1. Characteristics of Olrog´s Gull nest sites at the six studied colonies in Argentina (mean ± SD).

	Number of nests	Inter-nest distance (m)	External height (cm)	External diameter (cm)	Internal diameter (cm)
Buenos Aires					
Jabalí Oeste Islet	35	0.50 ± 0.08	9.28 ± 3.68	34.88 ± 3.18	18.08 ± 1.80
Banco Nordeste	60	0.62 ± 0.13	7.62 ± 3.05	40.51 ± 6.81	16.25 ± 6.71
Canal Ancla Islet	59	0.66 ± 0.22	8.73 ± 3.99	37.36 ± 8.12	17.54 ± 2.97
Chubut					
Vernacci Noroeste Island	44	0.95 ± 0.34	3.82 ± 0.83	48.41 ± 5.16	43.48 ± 5.88
Felipe Island	12	0.82 ± 0.13	4.75 ± 0.69	41.42 ± 2.35	37.17 ± 2.55
Vernacci Oeste Noroeste Island	31	0.72 ± 0.27	4.64 ± 0.84	47.03 ± 5.41	42.06 ± 5.91

(0.59 ± 0.19, n = 144 nests) was significantly lower than in Chubut (0.87 ± 0.34, n = 87 nests) (ANOVA, F = 88.25, df = 1, P < 0.001).

At the studied colonies, Olrog´s Gulls reproduced with at least one other colonial bird species, such as the Magellanic Penguin (*Spheniscus magellanicus*), Neotropic Cormorant (*Phalacrocorax brasilianus*), White Egret (*Egretta alba*), Brown Skua (*Catharacta antarctica*), and Chilean Skua (*C. chilensis*, considered *Catharacta* spp. in this study), Kelp Gull (*L. dominicanus*), and Dolphin Gull (*L. scoresbii*). In all cases, Kelp Gulls were breeding adjacent to Olrog´s Gulls, resulting in the only significant positive association found between Olrog´s Gull and any other species (ϕ = 0.21, P (χ^2) = 0.04).

Nest-site characteristics.—At colonies in Chubut, nests were built on the substrate, which was composed of rock at Felipe Island and mainly of gravel and shell at Vernaci Noroeste and Vernaci Oeste Noroeste islands. At Banco Nordeste, they also nested on gravel and sand surfaces. By contrast, at Arroyo Jabalí Oeste and Canal Ancla islets, nests were built on low herbaceous vegetation (<0.3 m), mostly of *Salicornia* spp. and *Franquenia* spp., and also on vegetation debris.

At the three colonies in Buenos Aires, nesting material consisted almost exclusively of vegetation debris, mainly *Spartina* spp. and *Salicornia* spp. Nests at Chubut showed a different composition, because they were built of small bush branches, seaweeds (*Ulva* spp. or *Porphyra columbina* and fragments of *Gigartina skottsbergii* and *Macrocustis pyrifera*), and lower percentages of mollusk shells, feathers, and bones.

The nests' mean external and internal diameters were 41.69 ± 7.31 cm and 27.26 ± 12.42 cm, respectively, whereas mean nest height was 7.10 ± 3.30 (n = 231 nests) (Table 1). Nest structure was different between colonies at Chubut and Buenos Aires. At Chubut, nests were lower than in Buenos Aires (5.14 ± 1.12 cm vs. 8.32 ± 3.61 cm, respectively) (t = –8.03, df = 229, P < 0.001) but with higher external (46.95 ± 5.44 cm vs. 38.43 ± 6.37 cm) (Table 1) and internal diameters (42.10 ± 5.89 cm vs. 19.07 ± 2.58 cm) (t = 10.41, df = 229, P < 0.001; t = 42.52, df = 229, P < 0.001, respectively).

Nest-site selection.—Logistic regression analysis to compare nest and random-site characteristics at each colony showed that Olrog´s Gulls selected sites that were closer to the high-tide line, at a lower height above sea level, farther from the available vegetation, and with lower vegetation cover over the nest (Table 2). The four habitat variables identified by the multivariate analysis showed a strong pattern for most of the studied colonies, except for distance to the closest vegetation, where the pattern is less clear (Figs. 2 and 3).

Discussion

The present study constitutes the most comprehensive analysis of breeding habitat in the threatened and endemic Olrog´s Gull, encompassing the species' entire distributional range. Results show that all studied colonies were located on islands and in open ground or areas with very low vegetation. In addition, these areas were close to the water and at low height above sea level.

Olrog´s Gulls were observed breeding only on islands. Most seabirds nest at sites that are relatively inaccessible to avoid or minimize the risk from ground predators and human disturbance (Partridge 1978, Buckley

Table 2. Microhabitat characteristics of Olrog´s Gull nest and random sites and univariate (Mann-Whitney, M-W) and multivariate logistic regression analysis summary.

	Nests sites		Random sites		M-W	Logistic regression		
Variable	Mean	SD	Mean	SD	(*P*)	Estimate (*P*)	*P*	*R*
Vernaci Noroeste Island (*n* = 44 nest sites, 20 random sites)								
Rock	0.00	0.00	15.00	36.63	0.34		0.08	0.11
Silt–clay	0.00	0.00	26.00	36.33	0.00		0.00	0.29
Shell	15.77	5.98	28.05	33.77	0.40		0.55	0.00
Sand	6.39	5.31	14.80	28.03	0.53		0.92	0.00
Gravel	78.64	4.98	15.40	26.65	0.00		0.00	0.53
Slope	3.70	1.60	3.25	2.15	0.33		0.29	0.00
Cover 1-m radius	0.00	0.00	7.15	12.95	0.03		0.01	0.23
Cover 5-m radius	0.00	0.00	15.15	9.06	0.00		0.00	0.42
Distance to nearest vegetation	17.67	2.27	1.83	1.99	0.00	–0.19 (<0.001)	0.00	0.65
Vegetation height	1.77	0.06	0.96	0.39	0.00		0.00	0.47
Distance to nearest clearing	0.00	0.00	0.04	0.11	0.52		0.16	0.00
Distance to hide-tide line	1.92	0.63	28.10	24.97	0.00		0.00	0.26
Height above sea level	0.69	0.16	1.34	0.60	0.00		0.64	0.00
Felipe Island (*n* = 12 nest sites, 20 random sites)								
Rock	100.00	0.00	14.00	25.16	0.00		0.01	0.31
Silt–clay	0.00	0.00	12.75	20.03	0.00		0.01	0.30
Shell	0.00	0.00	10.50	8.72	0.00		0.00	0.48
Sand	0.00	0.00	5.00	8.89	0.24		0.26	0.03
Gravel	0.00	0.00	57.75	38.40	0.00		0.00	0.52
Slope	1.88	1.25	2.58	3.25	0.74		0.14	0.06
Cover 1-m radius	0.00	0.00	0.00	0.00	1.00			
Cover 5-m radius	0.00	0.00	0.00	0.00	1.00			
Distance to nearest vegetation	24.21	1.47	12.88	7.63	0.00		0.76	0.00
Vegetation height	0.98	0.08	1.01	0.10	0.48		0.14	0.06
Distance to nearest clearing	0.00	0.00	0.00	0.00	1.00			
Distance to hide-tide line	2.31	0.71	25.60	8.38	0.00	0.14 (0.01)	0.00	0.57
Height above sea level	0.63	0.15	1.41	0.25	0.00		0.00	0.41

Table 2. Continued.

Variable	Nests sites		Random sites		M-W	Logistic regression		
	Mean	SD	Mean	SD	(*P*)	Estimate (*P*)	*P*	*R*
Vernaci Oeste Noroeste Island (*n* = 32 nest sites, 21 random sites)								
Rock	0.00	0.00	47.62	51.18	0.00		0.00	0.33
Silt–clay	18.59	12.13	14.29	15.68	0.22		0.30	0.00
Shell	45.16	8.84	21.19	21.38	0.00	–0.42 (0.002)	0.00	0.34
Sand	0.00	0.00	0.00	0.00	1.00			
Gravel	36.25	15.86	16.90	20.70	0.00		0.00	0.34
Slope	3.84	2.08	5.86	2.50	0.05		1.00	0.00
Cover 1-m radius	0.44	0.67	38.81	30.66	0.00		0.01	0.28
Cover 5-m radius	0.13	0.34	34.10	32.44	0.00	1.11 (0.009)	0.00	0.36
Distance to nearest vegetation	2.22	1.19	2.09	2.20	0.34		0.17	0.00
Vegetation height	1.54	0.04	1.60	0.09	0.75		0.00	0.32
Distance to nearest clearing	0.00	0.00	0.35	0.38	0.00		0.00	0.33
Distance to hide-tide line	3.01	3.38	4.55	1.01	0.00		0.98	0.00
Height above sea level	0.39	0.10	0.85	0.14	0.00		0.26	0.00
Jabali Oeste Islet (*n* = 73 nest sites, 32 random sites)								
Rock	0.00	0.00	0.00	0.00	1.00			
Silt–clay	90.90	4.06	90.63	6.19	0.82		0.30	0.00
Shell	5.81	4.13	8.91	6.32	0.05		0.19	0.01
Sand	2.67	3.15	2.34	4.01	0.39		0.27	0.00
Gravel	0.00	0.00	0.00	0.00	1.00			
Slope	1.64	1.62	0.75	0.76	0.05			
Cover 1-m radius	2.48	5.36	16.03	28.54	0.01		0.00	0.24
Cover 5-m radius	0.96	1.15	7.28	11.04	0.01		0.03	0.10
Distance to nearest vegetation	6.11	6.45	17.94	28.24	0.20		0.52	0.00
Vegetation height	0.29	0.08	0.34	0.11	0.13		0.37	0.00
Distance to nearest clearing	0.00	0.00	0.07	0.21	0.20		0.38	0.00
Distance to hide-tide line	43.73	3.11	65.03	12.34	0.04	0.45 (0.0001)	0.00	0.32
Height above sea level	1.87	0.12	1.81	0.10	0.05		0.05	0.11

Table 2. Continued.

	Nests sites		Random sites		M-W	Logistic regression		
Variable	Mean	SD	Mean	SD	(*P*)	Estimate (*P*)	*P*	*R*
Banco Nordeste (*n* = 117 nest sites, 26 random sites)								
Rock	0.00	0.00	0.00	0.00	1.00			
Silt–clay	48.97	26.34	33.46	38.88	0.23		0.53	0.00
Shell	2.95	6.23	1.92	4.02	0.81		0.25	0.00
Sand	20.35	29.78	53.85	34.99	0.07		0.22	0.00
Gravel	27.73	14.48	10.77	20.58	0.72		0.00	0.05
Slope	1.77	2.05	1.38	1.53	0.77		0.36	0.00
Cover 1-m radius	3.03	10.34	38.77	44.30	0.00		0.06	0.09
Cover 5-m radius	3.86	7.40	27.88	30.63	0.00		0.53	0.00
Distance to nearest vegetation	4.72	4.12	1.50	2.91	0.00	7.07 (0.002)	0.00	0.50
Vegetation height	0.75	0.25	0.65	0.23	0.43		0.32	0.00
Distance to nearest clearing	0.01	0.05	0.29	0.45	0.00		0.02	0.14
Distance to hide-tide line	15.45	10.02	40.07	30.09	0.00	0.07 (0.004)	0.00	0.41
Height above sea level	1.47	0.50	1.70	0.18	0.05		0.00	0.21
Canal Ancla Islet (*n* = 59 nest sites, 20 random sites)								
Rock	0.00	0.00	0.00	0.00	1.00			
Silt–clay	91.85	5.85	90.04	7.85	0.89		0.40	0.00
Shell	0.00	0.00	0.00	0.00	1.00			
Sand	10.00	2.58	12.59	5.36	0.87		0.45	0.00
Gravel	0.00	0.00	0.00	0.00	1.00			
Slope	0.00	0.00	0.00	0.00	1.00			
Cover 1-m radius	4.47	7.64	38.90	23.95	0.00		0.03	0.14
Cover 5-m radius	8.66	8.79	65.15	28.33	0.00	0.58 (< 0.001)	0.03	0.16
Distance to nearest vegetation	0.42	0.20	0.29	0.18	0.10		0.07	0.09
Vegetation height	0.64	0.27	0.55	0.20	0.57		0.18	0.02
Distance to nearest clearing	0.06	0.14	0.66	0.66	0.00		0.02	0.17
Distance to hide-tide line	36.71	10.31	52.25	19.66	0.00		0.00	0.24
Height above sea level	1.27	0.11	2.55	5.25	0.00	0.29 (0.02)	0.01	0.23

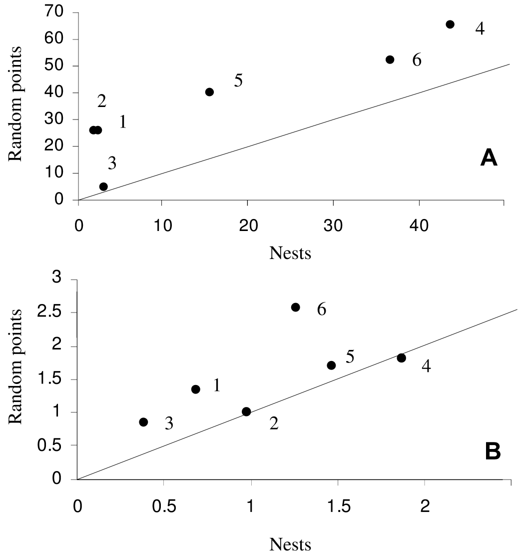

FIG. 2. Habitat variable means at nest sites and random points for Olrog´s Gull colonies: (A) distance to high-tide line and (B) height above sea level. Continued line indicates equivalency. Numbers correspond to sites in Table 1.

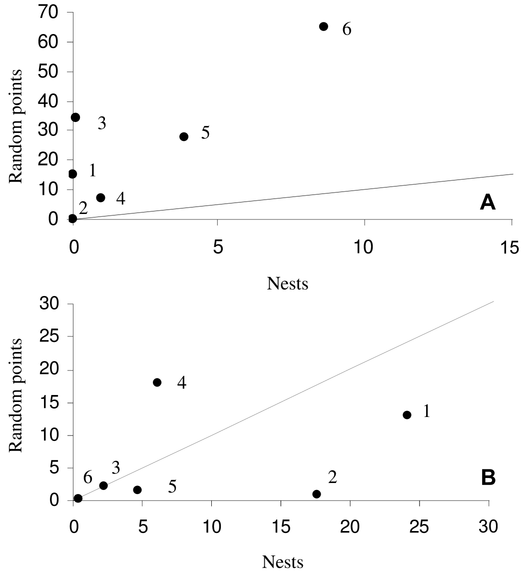

FIG. 3. Habitat variable means at nest sites and random points for Olrog´s Gull colonies: (A) 5-m radius cover and (B) distance to nearest vegetation. Continued line indicates equivalency. Numbers correspond to sites in Table 1.

and Buckley 1980). Several potential native mammalian predators have been recorded in the study area, such as the hairy armadillo (*Chaetophractus villosus*), Argentine gray fox (*Pseudalopex griseus*), Patagonian ferret (*Galictis cuja*), and Geoffroy's cat (*Felis geoffroyi*). Besides, several human activities take place in the adjacent continental coasts, including sport fishing, recreation, tourism, small-scale coastal fishing, and macro-algae harvesting (Yorio et al. 1997, Delhey et al. 2001b). The islands' inaccessibility in the considered coastal sectors, enhanced by the difficult navigation conditions, make them relatively safe locations for breeding sites in comparison with mainland sites.

Colonies were located in open ground or with sparse vegetation <30 cm high. Absence of nest cover would allow the early detection of predators or intruders and a quick and effective escape. However, lack of vegetation cover makes Olrog´s Gull nests and their contents more visible and thus more exposed to aerial predators. In this respect, the observed high nesting densities may be an effective antipredator strategy (Wittenberger and Hunt 1985, Yorio and Quintana 1997), particularly against Kelp Gulls with which they nest in association at all studied locations. During the chick stage, the formation of crèches (Devillers 1977) could also contribute to reducing predation risks. Lack of vegetative shade also makes adults and chicks more vulnerable to heat stress, particularly in the northern colonies where maximum ambient temperatures may reach 42°C. As observed in other gull species, nests in sites close to the water may be more exposed to the sea breeze (Jehl and Mahoney 1987) and would allow incubating adults to dissipate heat at sea without leaving their nest unattended for long periods (Hand et al. 1981, Spear and Anderson 1989). Shoreline sites are also beneficial for chicks during the crèche stage, providing easy access to the water and helping them avoid heat stress.

Food is one of the main factors that influence habitat use by birds (Block and Brennan 1993). Olrog´s Gull has a relatively specialized feeding ecology, consuming mainly grapsid crabs (*Chasmagnathus granulata*, *Cyrtograpsus altimanus*, and *C. angulatus*) during the breeding season (Escalante 1984, Delhey et al. 2001a, Herrera et al. 2006). Therefore, the location of gull colonies could be restricted to the proximity of crab habitats. When food is patchily distributed, a species may be restricted to only a portion of its potential habitat (Block and Brennan 1993). It has been suggested that the discontinuous breeding distribution of the Olrog´s Gull is a consequence of its specialized feeding habitat, being restricted to estuaries or marshes where crabs are abundant (Escalante 1984, Spivak and Sánchez 1992). This may explain why the distribution is not continuous, but not why the population is fragmented into two nesting areas (Buenos Aires and Chubut), because large crab burrowing beds exist between both areas, such as at Caleta Valdés (Iribarne et al. 2003) and at Bahía de San Antonio (Spivak and Sánchez 1992). Olrog's Gull colonies analyzed here were all located in proximity to intertidal crab habitats, though variables related to their foraging habitat were unfortunately not quantified. Further studies are needed on the food-source characteristics of this species and its relationship with habitat-selection processes to explain its breeding distribution.

The present study also provides information on Olrog's Gull habitat requirements that may contribute to the identification of priority breeding sites and definition of spatial zoning schemes. Current trends in coastal development, particularly in the Olrog's Gull's main breeding grounds of southern Buenos Aires, indicate the urgent need for habitat-protection guidelines for this threatened species. In addition, Kelp Gulls also nest in the open, despite showing a preference for areas with vegetation cover (García Borboroglu and Yorio 2004), and Kelp Gull populations are expanding throughout most of this species' range (Yorio et al. 2005). This suggests the potential for spatial conflicts as a result of some degree of overlap in habitat use and, thus, increased monitoring and management actions will be required (García Borboroglu 2003).

Acknowledgments

Research was funded by grants from the Wildlife Conservation Society, Consejo Nacional de Investigaciones Científicas y Técnicas, and Agencia de Promoción Científica y Tecnológica, We thank Centro Nacional Patagónico (CONICET) for institutional support and Soriano S.A., Prefectura naval Argentina, and the Municipalidad de Punta Alta for logistical support. The Chubut, Río Negro, and Buenos Aires Provincial governments gave us the permits to work in their jurisdictions. J. Moreno, J. Potti, L. Reyes, M. Bertellotti, and A. Gatto provided helpful comments on the manuscript and field assistance. We thank J. Owen, R. Vera, M. A. Díaz, F. Garay, G. Soria, J. P. Rubinich, and L. Musmeci for field assistance. P.G.B. is deeply grateful to L. Hoffmann for invaluable support of his work.

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Associate Editor: F. M. Jaksic