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ECOLOGY AND HABITAT SELECTION OF THE MAGELLANIC PLOVER (*PLUVIANELLUS SOCIALIS*): A LITTLE-KNOWN PATAGONIAN SHOREBIRD

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ABSTRACT.—We studied the ecology and habitat selection of the Magellanic Plover (*Pluvianellus socialis*) in southern Patagonia during two austral summers. We searched for the presence of this rare species along the shores of 53 privately-owned lakes and portions of Lago Argentino across 12,000 km^2 of steppe habitat in Santa Cruz Province, southern Argentina and compared characteristics of occupied and unoccupied lakes. Aeolian lunette size was a significant predictor of occupancy. Most lakes had only a single pair of breeding birds, although one had 14 pairs. No lake feature successfully predicted number of breeding pairs per lake. Territories were on cobbled beaches on the side of the lake with Aeolian lunettes, and at sites significantly closer to small streams and further from vegetation than random sites. Nest sites within territories had significantly less clay than unused sites. Clutch size was small (1–2) while hatching success was moderate (70%). Future studies of this species should focus on adult and juvenile survival, and the development of a demographic model that assesses the long-term stability of the population. *Received 12 February 2011. Accepted 21 March 2012.*

Northern tundra and wetland habitats support diverse and, at times, dense populations of breeding shorebirds (Meltofte et al. 2007). Studies of arctic-breeding shorebirds largely inform our understanding of shorebird biology (Colwell 2010). However, shorebirds also breed throughout the world wherever suitable habitats exist (e.g., prairies, steppes, agricultural fields, river beds, beaches). Many of the species that breed outside of arctic habitats occur at low densities and are, partially as a consequence, poorly studied (e.g., Madagascar Plover [*Charadrius thoracicus*]; Long et al. 2008). Habitats of these species are also often inaccessible (e.g., Diademed Plover [*Phegornis mitchellii*] which breeds at altitudes >3,000 m in inaccessible habitats of the central Andean cordillera; Johnson 1964). Few of the 15 species of South American breeding shorebirds have been studied in any detail (Piersma et al. 1997, St. Clair et al. 2010).

The Magellanic Plover (*Pluvianellus socialis*) is a rare shorebird that breeds on the shores of lakes and rivers of Patagonia in southern South America (Jehl 1975, BirdLife International 2012). It is listed as near threatened on the IUCN Red List (BirdLife International 2012). Population estimates suggest fewer than 1,000 individuals (Jehl 1975) with a more recent value of 'fewer than 10,000' (BirdLife International 2012). Few systematic evaluations of this species' breeding success or habitat use have been conducted either at landscape or local scales (Jehl 1975; Piersma et al. 1997; Imberti 2003; Ferrari et al. 2003, 2008).

We report results of a regional survey of the Magellanic Plover in southern Patagonia, Argentina, including a habitat selection study at three scales. We assessed characteristics of this species' habitat within Santa Cruz Province, Argentina at the scale of lakes, territories, and nest sites. Our goal was to provide specific habitat information in the center of the species' geographic range to assist in more accurately assessing global population size. We also compared habitat characteristics between successful and unsuccessful nests, and provide an estimate of detection probability for this species on lakes searched on multiple occasions.

METHODS

Field Procedures.—We studied Magellanic Plovers during two consecutive breeding seasons in austral spring and summer from August 2006 to March 2007 (hereafter 2006) and during the summer, December 2007 (hereafter 2007) in southern Santa Cruz Province, Argentina (48° to 52° S). The semi-arid Patagonian steppe region is characterized by a cold (average 7.2 °C), dry (<200 mm annual rainfall) climate with strong (average 35 km/hr, gusting to 150 km/hr, Ferrari et al. 2003) persistent westerly winds (Soriano 1983). The flat grassland landscape supports many endorheic lakes (i.e., lakes within basins that do not drain to the ocean, hereafter 'lakes') that vary in salinity, size, and geomorphologic

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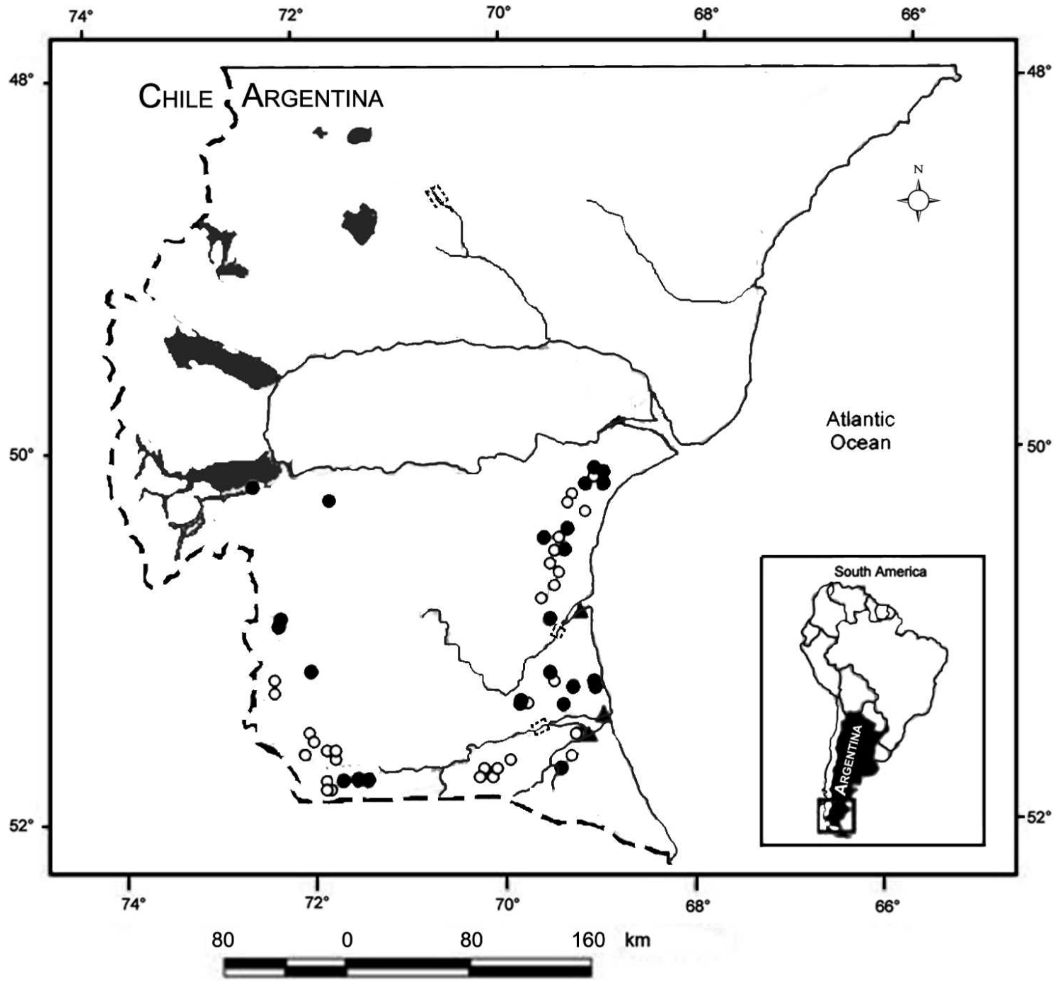

FIG. 1. Locations of searched endorheic lakes in southern Argentina during the breeding season (circles) and three wintering sites of Magellanic Plovers (triangles). Rivers (thick lines) are shown with dotted rectangles around areas searched in 2006. Unused lakes: (○), Occupied lakes (●).

development (Soriano 1983, Quirós and Drago 1999). Many lakes have a large area devoid of vegetation on the windward side of the lake basin. Fifty-three lakes were surveyed, and 35 of these were searched in both seasons. In addition, 4 km of the shoreline of Lago Argentino (50° 19′ S, 72° 15′ W; a ~700 km^2 freshwater lake that accumulates from Andean glaciers) was searched east of the city of Calafate. All lakes in the study had clay bottoms and unvegetated shorelines, and all but one, within Parque Nacional Monte León, were on privately-owned sheep ranches. The second season, 2007, was particularly dry and ~40% of lakes inundated throughout the 2006 season were dry. Surveys were also conducted along 12.5 km of the banks of three rivers (Fig. 1): 6 km of the Gallegos River (51° 37′ S, 69° 36′ W) west from the ruta 3 bridge at Güer Aike, 2 km of the Santa Cruz River (50° 00′ S, 68° 55′ W) west from the village of Cmdte Luis Piedra Buena, and 4.5 km of the Chico River (48° 46′ S, 70° 15′ W) southeast of the village of Gobernador Gregores.

Observers (2–3) walked parallel transects around the perimeter of a lake, or along the banks of a river to locate breeding pairs of plovers stopping every 100–150 m to complete a 360° scan using a 40× spotting scope. Behavioral cues were used to ascertain breeding status when individual plovers were located. We observed two different sets of behavioral patterns. Transient birds would walk or fly long distances (e.g., 500 m to 2 km) within the lake area, forage for extended periods of time (>2 hrs), and neither associate with other birds, nor exhibit territorial behaviors. Territorial birds vocalized in the presence of an observer or conspecific, were aggressive with conspecifics and, at times with other species (*Charadrius falklandicus*; but see Jehl 1975), associated strongly with a mate (copulating, following, or giving joint territorial displays), and/or incubated a nest or brooded and fed a chick.

We recorded the location of each plover encountered on the shoreline of lakes, using a Global Positioning System (GPS) (Garmin International Inc., Olathe, KS, USA). The spatial distribution of observations of territorial birds was examined using Program Garmin Mapsource©. Locations within 200 m of one another were classified as a single territory, based on previous observations that pairs were spaced along lakeshores every 200–300 m (Jehl 1975, Ferrari et al. 2008). The validity of classifying clumps of observations as a territorial pair was confirmed by observations of territorial disputes at territory boundaries and by stability of territory locations on successive visits within and between the two field seasons. The number of territories per lake was calculated for 18 occupied lakes that were searched thoroughly in both seasons.

Nests were considered successful if one or more eggs hatched, young were seen, or small eggshell fragments were found in the nest cup (Mabee 1997) and the parents were still on territory. They were considered unsuccessful if we found no eggs or adults on territory (Mabee 1997). We presumed predation was the cause of failure if eggs and young were absent. Eggs crushed inside the scrape were considered trampled. We used the Mayfield (1961) method and Johnson's (1979) alternative to incorporate exposure days (days between nest visits) and number of total nest losses to calculate daily nest survival.

Magellanic Plover habitat was described at three spatial scales: lake, putative territory, and nest (microhabitat). We did not measure actual territory sizes and assume our measurements at the scale of 200-m radius around nest sites and/or feeding areas of pairs of plovers, represent broadly, territories of this species, given the average distance between adjacent pairs. We considered all endorheic lakes in the known geographic distribution in Santa Cruz Province, Argentina (Ferrari et al. 2003) as available at the lake scale and searched 53, based on road accessibility. Lakes were considered occupied if individual Magellanic Plovers were observed at least once during the 2006 and/or 2007 breeding season. We used data from 22 lakes searched on five occasions (Aug, Oct, Nov, and Dec 2006, and Dec 2007) to estimate monthly detection probability, using the occupancy model of Program MARK (White and Burnham 1999).

We examined satellite images from Google Earth© and measured lake perimeter, total area and size of aeolian lunettes using the 'distance ruler'. The high water line of the lakes, clearly visible on satellite images, delineated the lake perimeter. The aeolian lunette's shape was approximated to that of a rectangle. Lunette area was calculated using the equation: area (in ha) $=$ length (m) $\times$ width (m) $\times$ 0.0001 ha/m^2. Elevation of the shoreline was taken from the digital elevation model (DEM) provided by Google Earth©.

Electrical conductivity was measured by CL to approximate salinity on a subset of 22 lakes that were visited from 14 to 20 December 2007 using a Eutech ECTestr 10 high™ tester (Oakton Instruments, www.instrumart.com/Oakton) to the nearest 0.1 mS/cm. Measurements >19.9 mS/cm were not detected by this device. The measurement was taken by directly immersing the device's probe in the lake water at the shoreline on 12 lakes. Lakes that were dry ($n = 10$) were measured by dissolving 100-ml lake bottom sediment in 100 ml distilled water and immersing the probe in this solution. Salinity metrics were binomial in distribution with all readings between 0 and 0.8 mS/cm (freshwater) or >19.9 mS/cm (saline). Salinity measurements were confirmed by taste.

A 300-m buffer at the high water line of the lake delineated the available area at the territory scale. We measured 33 sites within that area used by Magellanic Plover and 33 available sites along the lake shores (used and available, respectively). A territory was considered used if a nest or chick was found and the location of the nest or chick defined the center of the used territory. Unused sites at this scale were chosen using randomly-selected angles and distances (0–200 m) from the center of evenly spaced points around the perimeter of the lake. The next appropriate randomly generated distance was used if the unused site was outside of the designated available area (i.e., >300 m from the waterline or inside the inundated area of the lake).

Cover types were categorized as: clay, vegetation, gravel (<5 cm), cobble (>5 cm), sand, or wrack (organic material washed up from wave action). Percent cover in a 1-m^2 quadrat was measured at 5-, 15-, 30-, and 45-m distances from the center of the territory. These quadrats were arranged in a spiral pattern, 90° from one another and from the territory center. Distance to lakeshore was measured to the highest waterline of the lake, distance to vegetation was measured to the nearest location with >50% vegetation cover within 1 m^2, and distance to nearest channel was measured to the nearest location where freshwater flowed into the lake (formed by overland flow during precipitation or from a groundwater spring).

The available area for nest placement was delineated as an area ~200 m in diameter centered on a nest site (i.e., within the presumed territory of nesting birds). Potentially available sites at this scale were selected at a random orientation (between 0 and 359°) and distance (between 0 and 100 m) from a nest using two random number lists. A digital photograph of each microsite, including a 1-m^2 quadrat marked at 10-cm intervals centered on the nest, was taken from 1.7 m above the ground. Microsite photographs were digitally overlayed with a 10 × 10-cm grid in Program Jasc Paintshop Pro© by Corel Corporation (www.corel.com). One of the six cover types used in the mesoscale analyses within each grid cell was recorded and summed; the total of all cover types equaled 100%.

Statistical Analyses.—We tested for an association between salinity and occupancy using Fisher's exact test. Multiple logistic regression was used to test candidate models for the separate and combined effects of lake perimeter, aeolian lunette size, and elevation on the binary response variable of lake occupancy (unused = 0, occupied = 1). Akaike's Information Criteria (AIC), corrected for dispersion and small sample size ($QAIC_c$), and Akaike's weights (*wi*) were used to select the most parsimonious model (Burnham and Anderson 2002). The most important parameter was identified by summing Akaike's weights from models including the parameter of interest (Burnham and Anderson 2002).

Territory and nest cover types present in <10% of all quadrats (i.e., sand [9%] and wrack [7%]) were excluded from further analyses. All remaining percent cover variables were transformed using $\arcsin(\sqrt{[x]})$ to minimize non-normal distributions and multi-collinearity. The probability of territory use (0 = available, 1 = used) was modeled as a response variable to the percent cover of four cover types (clay, vegetation, gravel, and cobble) at four distances from the territory centerpoint (total of 16 variables) using a generalized linear mixed-effects model (GLMM) with penalized quasi-likelihood (PQL) estimation (McCullagh and Searle 2000). This method incorporates the repeated measures of four quadrats measured within 100 m of the center of the territory. Several sites at the territory scale were measured on the shorelines of the same lakes, and lake was included as a random effect in the model in the analysis of cover types using a backward stepwise approach. We inspected the parameter estimates of each model and selectively removed non-significant covariates until a final model was reached (McCullagh and Searle 2000).

The territory-scale variables distance-to-lakeshore, distance-to-freshwater channels, and distance-to-vegetation were compared among lakes using one-way ANOVAs. No significant differences in these distance variables between lakes were found (*P* value range = 0.35–0.48), and we did not include lake in subsequent analyses. No significant correlations were found between the variables distance-to-lakeshore, vegetation or channel. We used multiple logistic regressions to construct seven candidate models that explained the effects of these variables on territory use. Variables were included in models separately and in all combinations with the binary dependent variable available (0) and occupied (1). AIC model selection corrected for dispersion and small sample sizes ($QAIC_c$) was used to identify the most parsimonious of all candidate models. Those with a $\Delta QAIC_c$ value <4 were considered the best subset (Burnham and Anderson 2002). Model averaging of this subset was used to calculate parameter estimates. The most important parameters were identified by summing Akaike's weights, *wi* from models (in the subset) including the parameter of interest (Burnham and Anderson 2002).

Used and available nest sites within territories were not independent as they were observed within the same putative territory. Thus, the probability of use at this scale (available = 0, used = 1) was modeled as a response variable to the percent cover of clay, vegetation, gravel, and cobble using conditional (paired), multiple logis-

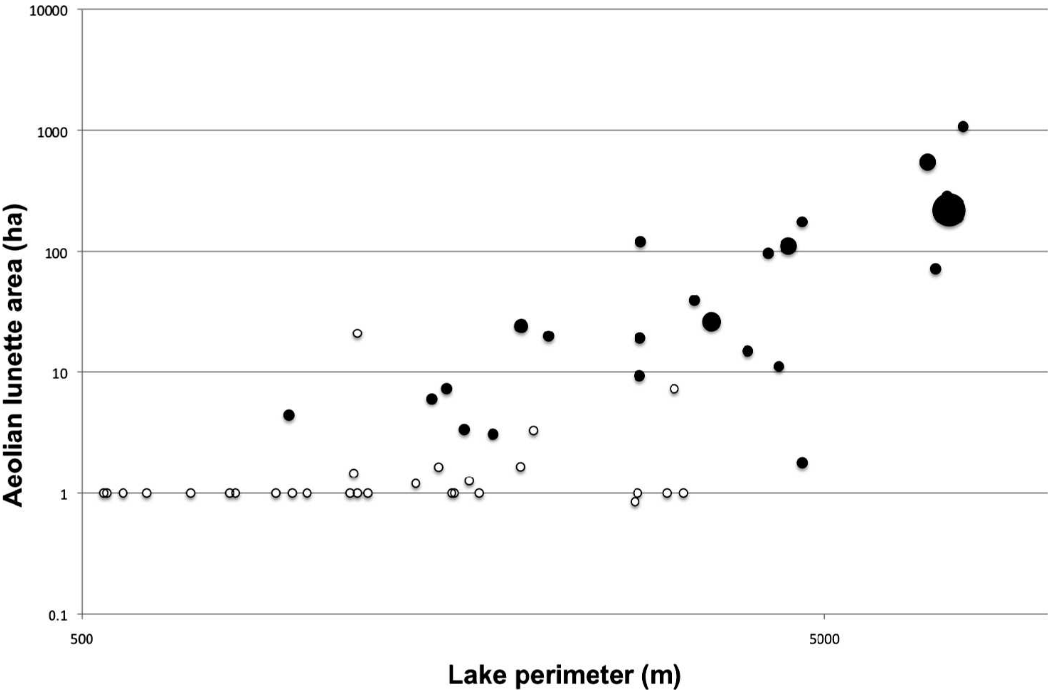

FIG. 2. Lake perimeter (m) and area of aeolian lunette (ha) at endorheic lakes in southern Santa Cruz Province, Argentina. Solid symbols are lakes occupied by Magellanic Plovers and open symbols are unused lakes. The size of solid symbols represents the number of Magellanic Plover pairs breeding on occupied lakes in 2006–2007: small is one pair, followed by one lake with two pairs, two lakes with three pairs, one lake with four pairs, and the largest with 14 pairs. There was no relationship between length of lake perimeter or area of aeolian lunette and number of pairs on a lake.

tic regression (Hosmer and Lemeshaw 2000). Sixteen candidate models were constructed based on all possible combinations; the constant model and AIC model selection were used to identify the most parsimonious models. Models with a ΔAIC_c value <4 were considered the best subset. The most important parameters affecting microsite occupation were calculated by summing Akaike's weights from models including the parameter of interest (Burnham and Anderson 2002).

Nest Success and Habitat Characteristics.—We compared distance to lakeshore, vegetation, and freshwater channel, and percent cover of clay, vegetation, gravel, and cobble between successful and unsuccessful nest sites using MANOVA. All statistical analyses were run using Program R (R Development Core Team 2010).

RESULTS

Lake Occupancy.—We searched 53 lakes (23 occupied, 30 unoccupied) in 2006 (Fig. 1). We returned to 35 of these lakes in 2007 and 19 of those previously occupied were no longer occupied and had dried earlier than usual for that season. The 22 territories visited regularly throughout the 2006 season were revisited in December 2007 and 16 were still occupied. The six territories that were not occupied were on lakes that had dried earlier in the season. We found only one pair of plovers on 4 km of the large Lago Argentino in 2006, while none was found on the 12.5 km of rivers surveyed. We found 40 breeding pairs in both years. Most occupied lakes contained a single territory or pair while one lake had 14 territories (mean = 1.33 territories/occupied lake, 95% CI = 0.106–5.57). Eight of the 22 lakes searched on five occasions during 2006 were occupied on at least one occasion and 14 were not occupied. The monthly detection probability was 0.90 (95% CI = 0.762–0.962).

Aeolian lunette size and lake perimeter (Fig. 2) were moderately positively correlated (R_s = 0.67, P < 0.05). No significant relationships were found between number of territories per lake and lake perimeter, lunette size, or

TABLE 1. Model selection of unconditional multiple logistic regression using Akaike's Information Criteria (AIC). Three variables of endorheic lakes (length of lake perimeter, aeolian lunette size, and elevation) were modeled to assess probability of lake occupation by Magellanic Plovers in Santa Cruz Province, Argentina. Sample size (n), number of parameters (k), AIC values corrected for small sample size (AIC_c), difference in AIC_c (ΔAIC_c), and Akaike's weights (w_i) are presented for top ranking models (<4 ΔAIC_c) and the null model.

Model	n	k	AIC_c	ΔAIC_c	wi
Lunette size (ha) + lake perimeter (m) + elevation (m asl)	53	4	26.23	0.000	0.29
Lunette size (ha)	53	2	26.33	0.107	0.28
Lunette size (ha) + elevation (m asl)	53	3	26.35	0.121	0.27
Lake perimeter (m) + lunette size (ha)	53	3	27.47	1.237	0.16
Intercept only	53	1	74.62	21.83	0.00

elevation (all P's > 0.05). Occupancy was significantly associated with lake salinity as only two of 17 freshwater lakes were occupied whereas 12 of 14 saline lakes were occupied (Fisher's exact test, $P < 0.0001$).

The size of the aeolian lunette was important in all top models at the lake scale and had the highest importance variable ($\Sigma wi = 1.00$, Table 1). This variable was the only one to have a parameter estimate that did not include zero (estimate = 1.515, 95% CI = 0.67–2.86), indicating a higher probability of occupancy by Magellanic Plovers on lakes with large than small aeolian lunettes. Generally, occupied lakes had perimeters of 950 m or greater and contained aeolian lunettes of at least 2 ha (Fig. 2).

Territory Use.—Lake was included as a random effect in GLMM models at this scale. The model that resulted from backward stepwise parameter removal included two parameters with significant ($\alpha < 0.05$) P-values: vegetation at 5 m (intercept $\pm$ SE: 2.187 $\pm$ 0.61, parameter estimate: -1.911 ± 0.567, $t = 3.37$, $P < 0.0022$) and vegetation at 15 m (parameter estimate: -3.42 ± 1.155, $t = 2.96$, $P = 0.0049$). Both parameters indicated increasing the percent cover of vegetation within 15 m of the center point decreased the probability of territory use.

The model for distance to vegetation and distance to channel was highest-ranking, alone describing 66% of variation in territory occupation (Table 2). The sum of Akaike's weights for each variable indicated distance to vegetation and distance to channel (both $\Sigma wi = 1.00$) were considerably more important than distance to lake ($\Sigma wi = 0.34$). The parameter estimate for distance to vegetation was positive and distance to channel was negative, indicating the probability of territory use increased with increasing distance from vegetation and decreasing distance to freshwater channels (Fig. 3).

Nest Site Use.—Nests were directly on the substrate, close to the shore, and on the side of the lake with aeolian lunettes. No nests had obstructions (e.g., logs, vegetation) other than cobble near them. The most parsimonious model describing nest site characteristics included the additive effects of percent clay and percent cobble (wi = 0.37, Table 3). The model including percent clay

TABLE 2. Model selection for unconditional logistic regression describing the effect of proximity to three geographic features (lakeshore, vegetation, and freshwater channel) on probability of territory occupancy by Magellanic Plovers. Sample size (n), number of parameters (k), Akaike's Information Criterion (AIC), AIC corrected for dispersion and small sample size ($QAIC_c$), difference in $QAIC_c$ ($\Delta QAIC_c$), and Akaike's weight (wi) are presented for the top ranking models ($\Delta QAIC_c < 4$) of 16 candidate models. Parameter importance values and estimates are also presented.

Model	n	k	$QAIC_c$	$\Delta QAIC_c$	wi
Vegetation, channel	51	3	8.941	0.000	0.66
Lakeshore, vegetation, channel	51	4	10.325	1.383	0.34

Parameter	Importance value (Σwi)	Parameter estimate	−95% CI	+95% CI
Vegetation	1.00	1.072	0.372	1.773
Channel	1.00	−0.123	−0.316	0.070
Lakeshore	0.34	−0.095	−0.287	0.098
Intercept		−2.518	−5.394	0.358

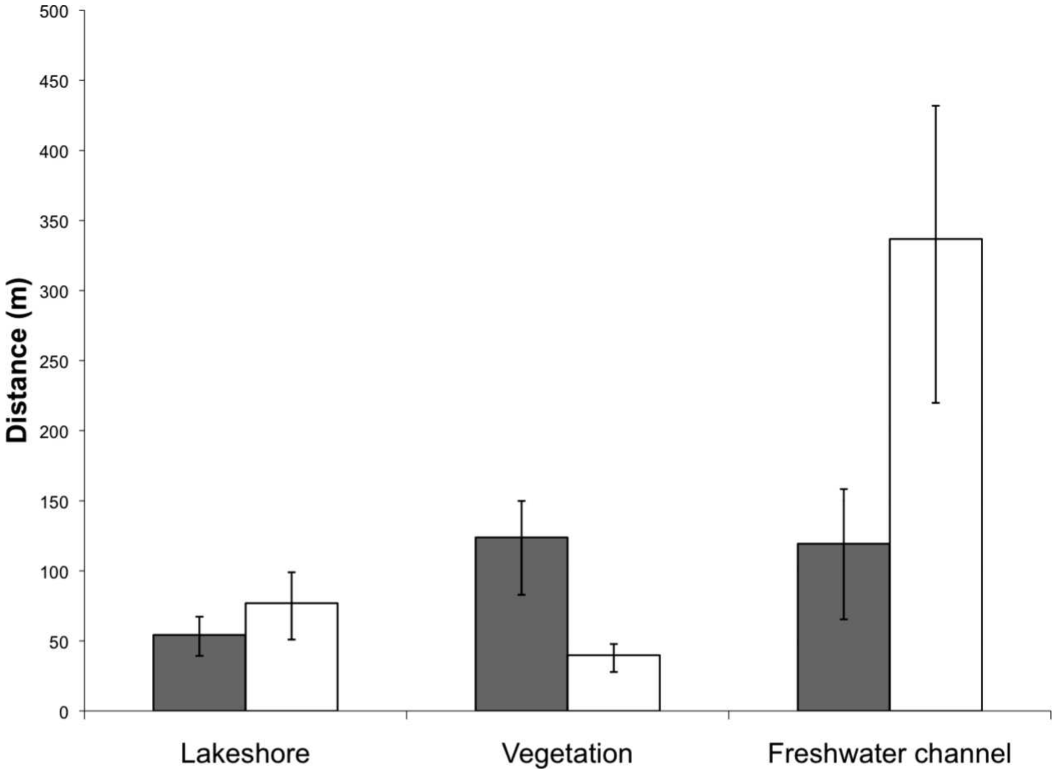

FIG. 3. Mean and 95% confidence intervals of distance to three features (endorheic lakeshore, vegetation, and freshwater channel) of Magellanic Plover*s* comparing used (gray bars) and randomly-selected available territories (open bars).

was second with a weight of 27%, and percent clay cover was present in all of the five most parsimonious models (Table 3, $\Delta AIC_c < 4$). Percent clay had the highest importance value ($\sum wi = 0.73$) with cobble as the next most important value ($\sum wi = 0.37$). Percent clay was lower at used than available sites, and percent cobble was slightly higher (median, 25–75% quartiles) used: clay = 0 (0–3.5), cobble = 2 (0–8); unused: clay = 42.5 (1.5–92.5), and cobble = 0 (0–0).

Nest Success and Habitat.—We found 20 nests in 2006 and four in 2007. Average clutch size was 1.2 eggs (19 nests contained a single egg, 6 contained 2 eggs). Seventeen nests were monitored repeatedly in 2006 by visiting every 2 to 8 days. Seventy percent of monitored nests were successful with one or both eggs hatching (12/17). Four nests were depredated and one nest was trampled, presumably by grazing livestock, which frequented the aeolian lunettes. The Mayfield estimate of daily survival was 0.975 ($n = 17$) with nest success over the 24-day incubation equal to 55.0%. Twenty-six chicks (17 in 2006, 9 in 2007) were banded and followed to fledging (11 fledged of 26 banded, 42.3%). Chicks fledged between 28 and 35 days after hatching. One chick banded in 2006 bred in 2007 on a neighboring lake 12 km distant. One banded chick was observed at the Rio Gallegos mudflats, 30 km from the breeding site, three months after it left the nest area. Successful and unsuccessful nests did not differ in proximity to lakeshore, vegetation, freshwater channel, or in microsite percent cover variables (Wilks' Lambda, $P > 0.05$).

DISCUSSION

The breeding range of the Magellanic Plover extends over 7° of latitude in southern South America. The major breeding area appears to be centered in southeastern Santa Cruz Province based on our observations and those of others (Jehl 1975, Ferrari et al. 2008). We found pairs with evidence of breeding on about a third of the

TABLE 3. Model selection for conditional logistic regressions describing the effect of percent substrate cover on probability of microsite use by breeding Magellanic Plovers. Sample size (n), number of parameters (k), Akaike's Information Criterion (AIC), AIC corrected for small sample size (AIC_c), difference in AIC_c (ΔAIC_c), and Akaike's weight (wi) are reported for the top five models ($\Delta AIC_c < 4$) and constant model of 16 candidate models describing the effect of substrate cover on microsite occupancy of the Magellanic Plover.

Model	n	k	AIC	AICc	ΔAIC_c	wi
Clay, cobble	50	3	14.186	20.708	0.000	0.37
Clay	50	2	17.055	21.310	0.602	0.27
Clay, vegetation	50	3	17.040	23.562	2.854	0.09
Clay, gravel, cobble	50	4	15.492	24.381	3.673	0.06
Clay, cobble	50	3	18.065	24.587	3.879	0.05
Constant	50	1	34.657	36.741	16.033	0.00

lakes throughout the accessible portion of this area. The inaccessible interior of the province is likely to have similar proportions of occupied lakes. Lakes with plovers were large (with large perimeters), and contained large aeolian lunettes. All nests were on the windswept shorelines of lakes with lunettes, and on the side of the lake with the lunette. The substrate created by strong winds was predominantly clay and cobble and, on these shorelines, both adults and their nests were extremely cryptic.

Plovers occupied sites further from vegetation than unused sites at the territory scale allowing for good visibility by breeding pairs. Thus, like *Charadrius* plovers (Nguyen et al. 2003), this species probably nests in open habitats to maximize predator detection, while minimizing visibility of adults, nests, and eggs (Graul 1973, Solis and De Lope 1995, Nguyen et al. 2007). Most occupied lakes were saline, although we did find nests and successfully fledged young on two freshwater lakes, suggesting the species can nest successfully using food derived from freshwater sources.

We did not find any pairs nesting on river banks. Previous reports of their occurrence there (Ferrari et al. 2003) suggest a larger sample of rivers, as well as a thorough survey of potentially suitable habitats on Tierra del Fuego needs to be conducted to modify current estimates of population size. Our lack of ability to find a relationship between number of territories (e.g., abundance) and any lake measure that we used suggests predicting which lakes might be occupied will be aided by our research, but predicting abundance will remain difficult. For example, two lakes in close proximity had 14 and 1 pair, respectively, and we were unable to visually assess any difference in lake characteristics (i.e., size, lunette size, salinity, shape or major ecological differences). One variable we did not quantify and was unavailable on the satellite image was the number of small streams entering occupied lakes. Plovers at the territory scale nested near freshwater sources, and we often observed breeding plovers feeding where streams entered the lakes; this may be an important variable for future study. Ideally, finding a characteristic that can be measured via remote sensing that correlates with abundance, will allow more accurate estimates of population size. Currently, we are unable to refine the global population estimates of between 1,000 (Jehl 1975) and 10,000 (BirdLife International 2012) individuals.

Magellanic Plovers within occupied territories avoided placing nests on clay substrates. Avoidance of vegetation in nest-site selection and placement of the one or two eggs directly on gravel or cobble rather than clay are probably additional anti-predator adaptations (Solis and De Lobe 1995; Nguyen et al. 2003, 2007). Clay retains moisture better than gravel or cobble, and nests on this substrate could cool unnecessarily when adults are not in attendance.

Poor detection due to a highly cryptic plumage has been a critical issue for research on this species (Ferrari et al. 2003). Surveys using our technique of parallel walking, repeated monthly, detected 90% of pairs, in part, due to vocalizations given by breeding individuals.

We documented reproductive success at 20 nests. Hatching success was higher than those reported for other under-studied South American shorebirds (11.6%, *Charadrius wilsonia*, Ruiz-Guerra et al. 2008; 46%, *C. falklandicus*, St. Clair et al. 2010), and may be a result of the highly cryptic nests of the Magellanic Plover. None of the habitat variables that we measured were linked to nest success, but our sample size was small, reflecting low densities of this rare species across a large geographic area. The species also has low fecundity (<1 fledgling/adult female/nest attempt). Further demographic research should be conducted to estimate annual nest success (e.g., with marked populations to learn if birds renest), and both juvenile and adult survivorship. These data can be supplemented with broader geographic surveys to estimate population size and stability. Identifying the characteristics that promote high abundance at particular lakes, and protecting these sites will be critically important to this species' conservation.

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