PREFERENCE FOR COVERED NEST SITES AND BREEDING SUCCESS IN KELP GULLS *LARUS DOMINICANUS*

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SUMMARY

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Kelp Gull *Larus dominicanus* preferences for covered nest sites and breeding success as a function of vegetation cover were quantified at Punta León, Argentina, during 1990 and 1991. Kelp Gulls showed a strong preference for nest sites which were covered or close to vegetation cover. Hatching success in nests with and without cover was similar. Similarly, hatching success and chick survival to five days of age were similar in nests with live and dead vegetation cover. The probability of raising at least one chick was higher for pairs in covered nests. However, even though breeding success was higher for covered than for exposed nests, differences between categories were significant only during 1990. Breeding success was significantly higher in nests with live cover and in nests from territories with vegetation cover. Heat stress and distance to cover appear to be the most important factors implicated in the observed differences.

INTRODUCTION

In most bird species, selection for a nesting site within a particular habitat is one of the main determinants of breeding success (Partridge 1978, Cody 1985). Several seabird studies have shown that selection for different nest sites can result in differences in breeding success (Nettleship 1972, Dexheimer & Southern 1974, Montevecchi 1978, Potts *et al*. 1980, Burger & Gochfeld 1985, Frere *et al*. 1992, Gandini 1993). Ideally, a nest site should provide protection against factors such as extreme weather conditions, predators and intra or inter-specific social interference (Buckley & Buckley 1980).

Kelp Gulls *Larus dominicanus* are abundant and broadly distributed in the Southern Hemisphere, and nest in a wide variety of habitats (Fordham 1964, Burger & Gochfeld 1981). Burger & Gochfeld (1981) analysed Kelp Gull nesting characteristics in South Africa, and showed that vegetation cover is one of the main variables in nest site selection. However, these authors did not analyze the relationship between the quality of selected sites and the pair's breeding success.

Even though Kelp Gulls have a broad geographical distribution in South America, little is known about their habitat requirements and nest site preferences. The goals of this study were to: 1) determine the existence of Kelp Gull preferences for covered nest sites, and 2) quantify breeding success as a function of vegetation cover at Punta León, Chubut, Argentina. Vegetation cover should affect breeding success, nests with higher cover being more successful. Therefore, we expected that more Kelp Gull nests should be located under or closer to bushes than expected by chance, and nests under or close to vegetation cover should have higher hatching and breeding success than exposed nests or nests located far from vegetation cover.

METHODS

Study area

Punta León (43°04'S, 64°29'W) is a Provincial reserve located 10 km south of the mouth of Golfo Nuevo (Fig. 1), and extends along 3 km of coastline. Within the reserve, about 700 m of shoreline are separated from cliffs of variable height, from less than 30–100 m, by a silt platform. This platform, of approximately 5 ha, is covered by vegetation consisting mainly of Jume *Suaeda divaricata*, Zampa *Atriplex lampa* and Yaoyin *Lycium chilense*. Average ambient temperatures from September to January, covering the breeding period of the Kelp Gull, vary between 10.3°C and 20.5°C, with minimum and maximum temperatures of –4.8°C and 41.3°C in September and January, respectively (Beeskow *et al.* 1987). Prevailing winds come from the southwest, west and northwest, with average speeds of 34 km/h (Beeskow *et al.* 1987). Average annual rainfall varies from 200–225 mm.

Several other species nest in association with Kelp Gulls: Imperial Cormorants *Phalacrocorax atriceps*, Olivaceous Cormorants *P. olivaceus*, Royal Terns *Sterna maxima* and Cayenne Terns *S. eurygnatha*. The Kelp Gull is the most abundant seabird at Punta León, with about 9000 breeding pairs. Mean nest density was 0.109 nests/m^2 in 1991 (±0.04 SD, range 0.002–0.75/m^2, n=85) (Yorio *et al.* 1994). Nests are built on open ground, under or on top of bushes, on the gravel beach or on cliffs (Malacalza 1987, unpubl. data). Less than 3% of nests are placed on top of bushes (Malacalza 1987) and were not included in this study.

Vegetation cover and nest site preferences

We estimated vegetation cover by quantifying the percentage cover (line-intercept method, Canfield 1941) on 7-m long transects (n=15). For each transect, we calculated the percentage vegetation cover, distinguishing between live and dead plants. We considered as live cover those bushes with functional leaves and dead cover those without leaves. To determine preferences for covered nest sites or nests close to vegetation cover, we sampled all nests (n=64) within a 300-m^2 area located in the central section of the colony. For each nest, we measured to the nearest cm the distance from the nest to the closest vegetation cover. We took the same measurements for an equal number of random points, which were randomly located along a 1x1-m grid within the same area.

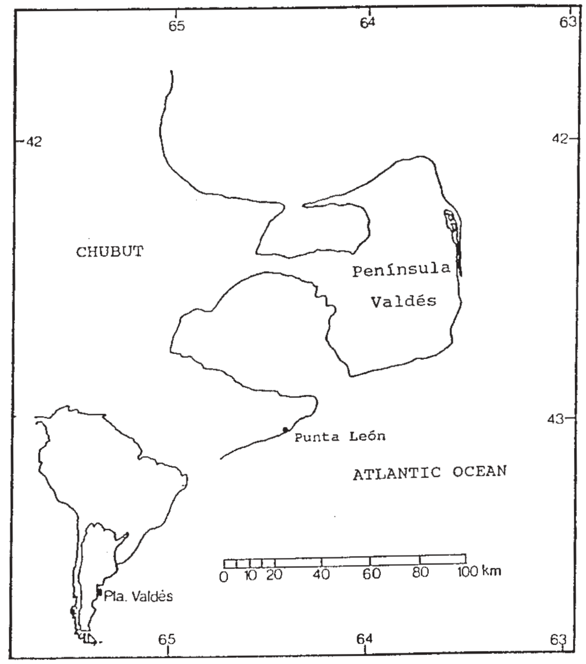

Figure 1. *Geographical location of Punta León.*

Breeding success

To determine breeding parameters we selected samples of 28 and 40 nests in 1990 and 1991 respectively, in an area located at a central section of the gull colony with a nesting density of approximately 0.3 nests/m^2. We marked all nests with plastic tags and checked them two to three times per week, recording for each the laying date, clutch size, hatching date and breeding success.

We defined hatching success as the number of chicks hatched per nest where eggs were laid. We surrounded the study area with nets 0.60 m high and marked chicks at hatching with a numbered fibre tape. We defined breeding success as the number of chicks surviving to the fourth week of age per nest.

Nest categorization

For the analysis of Kelp Gull breeding success as a function of vegetation cover, we categorized nests within the study area as “exposed” and “covered”, excluding from the original sample all nests with partial cover. We defined "exposed" nests as those placed on the ground and without vegetation cover above them. The access to shade or protection against predators for chicks from exposed nests located in territories with vegetation should be easier than for chicks which have to go through neighboring territories to reach protection. Therefore, we divided "exposed" nests into "close to cover", in the cases where there were no nests between them and a bush, and "distant from cover", when a nest existed between them and the closest vegetation.

We defined "covered" nests as those placed on the ground and totally protected by vegetation. We divided this category into "covered with live vegetation" and "covered with dead vegetation", as dead vegetation allows more solar radiation to reach the nest cup whereas live bushes provide shade and, thus, reduce heat stress.

The effects of predators and weather variables depend on the amount of vegetation cover (e.g. Frere *et al*. 1992). Therefore, we compared hatching and breeding success between "exposed" and "covered" nests. Additionally, as the effects of some weather factors (e.g. solar radiation) depend on the presence of foliage on the vegetation cover, we compared during 1991 the hatching and breeding success between nests "covered with live vegetation" and nests "covered with dead vegetation" grouped with "exposed" nests.

We made the same comparisons between nest categories to analyse the differences in chick survival to five days of age (approximate age at which Kelp Gull chicks start to wander more frequently away from the nest, pers. obs.), as the high mobility chicks attain could have implications for their survival in the face of predation and weather factors.

To analyse the effects of distance between the nest and vegetation cover, we compared the breeding success of nests from territories with vegetation, where chicks had

TABLE 1

NUMBER OF CHICKS WHICH HATCHED AND CHICK SURVIVAL TO FIVE DAYS OF AGE IN COVERED AND EXPOSED KELP GULL NESTS AT PUNTA LEON DURING 1990 AND 1991 (MEAN ± SD)

	Nest type		
	Covered	**Exposed**	**Mann-Whitney test**
		1990	
Chicks hatched	2.25 ± 0.70 (N = 8)	1.71 ± 0.75 (N = 7)	Z = 1.31 P = 0.18
Survival to five days	2.00 ± 0.92 (n = 8)	1.00 ± 0.81 (n = 7)	Z = 2.03 P = 0.042
		1991	
Chicks hatched	1.58 ± 0.66 (n = 12)	2.00 ± 0.75 (n = 15)	Z = -1.60 P = 0.10
Survival to five days	1.58 ± 0.66 (n = 12)	1.73 ± 0.96 (n = 15)	Z = –0.54 P = 0.58

direct access to cover ("covered" nests and nests "exposed close to cover"), with that of nests "exposed distant from cover", where chicks had to go through neighboring territories to reach protection.

Control area

As a control for our disturbance while checking the study area, we marked 28 and 13 nests in 1990 and 1991, respectively, in an area with habitat characteristics similar to the study area. We also categorized these control nests as "exposed" and "covered", and checked them from the cliff at a distance of approximately 50 m with 20x telescopes and 8x30 binoculars, recording clutch size, hatching and breeding success.

RESULTS

Selection for nest sites

Average vegetation cover in the study area was 35% (±19.6 SD, n=15). The percentage for live vegetation cover was higher than for dead vegetation cover (28% vs. 7%).

Nests were placed at a significantly shorter distance from vegetation cover (mean = 7.5 ±13.9 cm SD, range = 0–90 cm, n=64) than random points (mean = 38.2 ±38 cm SD, range = 0–145 cm, n=64), showing a significant preference for nest sites close to vegetation (Mann-Whitney, Z = –4.5, P = 0.0001). The percentage of nests placed under vegetation cover (67%) was significantly higher than random points (33%) (χ^2 = 13.78, with Yates' correction, P = 0.0002).

Breeding cycle

Kelp Gulls started arriving to the colony in late August, although they spent only part of the day at the colony during that period. Egg laying was asynchronous, extending over four and six weeks in 1990 and 1991, respectively, from the second week of October to mid December. First eggs were recorded on 12 October in 1990 and on 10 October in 1991, with peak laying during the last week of October.

Mean clutch size was 2.39 (±0.62 SD, n=28) and 2.32 (±0.61 SD, n=40) in 1990 and 1991, respectively. Chicks started to hatch by the end of the first week of November. Average hatching success was 2.07 (±0.81

TABLE 2

NUMBER OF CHICKS WHICH HATCHED, CHICK SURVIVAL TO FIVE DAYS OF AGE AND CHICK SURVIVAL TO THE FOURTH WEEK OF AGE IN KELP GULL NESTS WITH AND WITHOUT PROTECTION AGAINST WEATHER FACTORS (E.G. SOLAR RADIATION) AT PUNTA LEON DURING 1991 (MEAN ± SD)

	Nest type		
	Live cover	**Dead cover + exposed**	**Mann-Whitney test**
Chicks hatched	2.00 ± 0.50 (N = 9)	1.83 ± 0.85 (N = 18)	Z = –0.45 *P* = 0.64
Survival to five days	1.88 ± 0.60 (n = 9)	1.61 ± 0.97 (n = 18)	Z = –0.61 *P* = 0.53
Survival to 4th week	1.77 ± 0.44 (n = 9)	0.83 ± 0.85 (n = 18)	Z = –2.64 *P* = 0.008

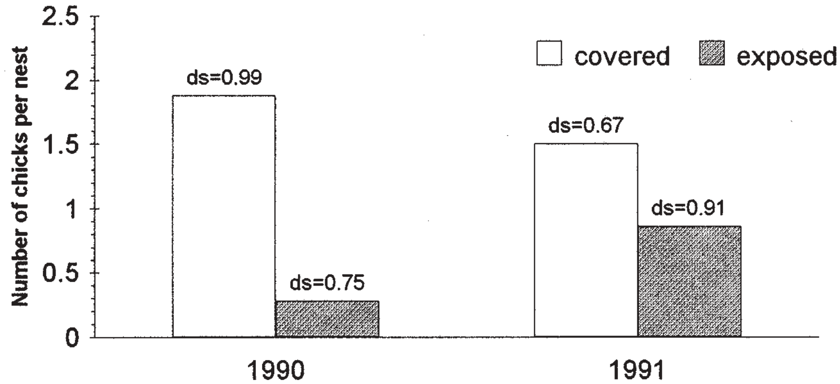

Figure 2. *Kelp Gull chick survival to the fourth week of age in covered and exposed nests at Punta León during 1990 and 1991.*

SD, n=28) and 1.82 (±0.78 SD, n=40) eggs per nest in 1990 and 1991, respectively.

Kelp Gull breeding success was 1.21 (±0.95 SD, n=28) and 1.05 (±0.87 SD, n=40) chicks per nest in 1990 and 1991, respectively, and was not significantly different between years (Mann-Whitney test, Z = –0.67, P = 0.49). Chicks started to fledge during the first week of January in both seasons.

Nest cover and breeding success

Clutch size did not vary significantly between covered and exposed nests (Mann-Whitney test, 1990: Z = 0.06, *P* = 0.94; 1991: Z = -0.19, P = 0.84). Therefore, differences in chick survival between categories (see below) were not a consequence of differences in the number of eggs laid in nests within each of the categories.

During both breeding seasons, hatching success in nests with and without cover was similar (Table 1). On the other hand, chick survival to five days of age was similar between covered and exposed nests only during 1991 (Table 1). We did not find significant differences during 1991 in the hatching success and chick survival to five days of age between nests with live and dead vegetation cover (Table 2).

For both seasons, the probability of raising at least one chick was higher for pairs in “covered” than “exposed” nests (Fisher exact test, 1990: P = 0.01; 1991: P = 0.043). However, even though in both years breeding success of the sample was higher for nest with vegetation cover than for exposed nests (Fig. 2), only in 1990 was the difference in breeding success between categories significant (Mann-Whitney test, 1990: Z = 2.55, P = 0.01; 1991: Z = 1.80, P = 0.07). During 1991, breeding success was significantly higher in nests with “live” cover than nests with “dead” cover and “exposed” nests (Table 2). Similarly, breeding success in 1991 was significantly higher in nests from territories with vegetation cover than from nests in territories without any protection (Table 3).

Control area

Clutch size, number of chicks hatched per nest and chick survival to the fourth week of age were similar between study and control areas in 1990 and 1991(Table 4). In both years, breeding success of covered nests in study and control areas was similar (1990: Mann-Whitney test, Z = 1.10, P = 0.26; 1991: Mann-Whitney test, Z = –1.34, P = 0.17). Similarly, differences in breeding success between exposed nests in study and control areas for both seasons were not significant (1990: Mann-Whitney test, Z = –1.82, P = 0.07; 1991: Z = 0, P = 1).

DISCUSSION

For many seabirds, nest cover is an important factor favoring egg and chick survival (Lemmetynen 1973, Burger 1979, de Bary Pareda 1990, Frere *et al*. 1992, Gandini 1993) and, therefore, natural selection should favour the selection of covered nest sites. Kelp Gulls at Punta León showed a strong preference for nest sites which were covered or were close to vegetation cover. These results agree with Burger & Gochfeld's (1981) observations on the same species in South African colonies.

In both seasons, the likelihood of successfully raising at least one chick was higher for nests with vegetation cover. The observed differences in reproductive success between different nest categories at Punta León may have been a consequence of the negative effects of weather factors. Extreme weather conditions have been shown to affect breeding success (Burger & Shisler 1978, Burger 1980, Salzman 1982), and in this respect exposed nests or nests with dead cover should be more affected than covered nests. Much of the chick mortality in the study area was apparently due to the effects of weather, because most chicks were found dead without any indication of starvation, predator attacks or conspecific aggression (pers. obs.). At Punta León, where ambient temperatures during the late chick stage can reach 38°C, the effects of heat stress may be critical for pairs which breed at exposed nests. The higher breeding success of nests under live cover also suggests the importance of heat stress effects.

Even though in both seasons gulls that selected covered nest sites had higher breeding success, differences between covered and exposed nests were only significant during 1990. These differences could be due to the more intense weather conditions during 1990 than 1991. Average ambient temperature and wind speed were greatest during the 1990 breeding season (Environmental Physics Department, CENPAT, unpubl. data).

The effects of vegetation cover appeared to be more important during late chick stages, because no differences were found in the hatching success between nest categories nor in chick survival to five days of age between nests with live and dead cover. During 1990, differences between exposed and covered nests were already evident when chicks were five days old, but such differences increased towards the late chick stage. The lack of differences between categories during the early chick period could be due to a higher nest attendance by adults, before peak food demands, or to the possibility that adults at exposed nests provide chicks with shade while they are small. Additionally, ambient temperatures increase during the chick period and, thus, the effects on older chicks should be greater.

In general, vegetation cover protects adults, eggs and chicks against predators and makes nests less visible (Burger 1979, Walsberg 1985). Exposed nests should be more easily found by aerial predators. Because of its mainland location, the colony at Punta León presents no restrictions to the access of land or aerial predators. However, potential predators were rarely seen within or near the colony and direct predation on gull eggs or chicks was never recorded. On the other hand, cannibalism may be one of the factors causing the observed losses. This behaviour, frequent in many gull species (Stanback & Koenig 1992), was observed in Punta León (unpubl. data) and was also recorded by Kelp Gulls in New Zealand (Fordham 1964) and South Africa (Burger & Gochfeld 1981).

During 1991, breeding success of nests whose chicks had easy access to vegetation cover was significantly higher than exposed nests or nests distant from cover. In many gull species, while chicks from covered nests spend a higher proportion of their time near their nests during hot days, chicks from exposed nests seek protection from the sun by moving under bushes (Paynter 1949, Davis & Dunn 1976, Burger & Shisler 1978). While seeking protection against solar radiation and predators, chicks from territories without vegetation

TABLE 3

KELP GULL CHICK SURVIVAL TO THE FOURTH WEEK OF AGE IN NESTS WITHIN TERRITORIES WITH AND WITHOUT VEGETATION COVER AT PUNTA LEON DURING 1991 (MEAN ± SD)

Nests in territories with cover	Nests in territories without cover	Mann-Whitney test
1.61 ± 0.60 (n = 18)	0.22 ± 0.44 (n = 9)	Z = 6.08 P = 0.0001

have to go through neighbouring gull territories, and may in this way be injured or occasionally killed. Aggression to Kelp Gull chicks by adults from neighbouring territories was frequently observed even in the absence of human disturbance (Fordham 1964, unpubl. data).

Both overall breeding success and the breeding success at exposed nests were similar in the study and control areas. This strongly suggests that observed differences were not due to a differential effect of research disturbance on the different nest types.

In summary, Kelp Gulls at Punta León show preferences for covered nest sites. This selection is reflected in a higher breeding success at nests with higher vegetation cover, although the effects are not significant in all cases. Heat stress and distance to cover appear to be the most important factors implicated in the observed differences.

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TABLE 4

CLUTCH SIZE, NUMBER OF CHICKS HATCHED AND CHICK SURVIVAL TO THE FOURTH WEEK OF AGE IN STUDY AND CONTROL KELP GULL NESTS AT PUNTA LEON DURING 1990 AND 1991. (MEAN ± SD)

	Nest type		
	Study	**Control**	**Mann-Whitney test**
		1990	
Clutch size	2.39 ± 0.62 (n = 28)	2.14 ± 0.65 (n = 28)	Z = 0.90 P = 0.36
Chicks hatched	2.07 ± 0.81 (n = 28)	1.67 ± 0.81 (n = 28)	Z = 1.34 P = 0.17
Survival to 4th week	1.21 ± 0.95 (n = 28)	1.42 ± 0.87 (n = 28)	Z = 0.87 *P* = 0.38
		1991	
Clutch size	2.32 ± 0.61 (n = 40)	2.30 ± 0.75 (n = 13)	Z = 0 P = 1
Chicks hatched	1.82 ± 0.78 (n = 40)	1.84 ± 0.55 (n = 13)	Z = 0.10 P = 0.91
Survival to 4th week	1.05 ± 0.87 (n = 40)	1.46 ± 0.77 (n = 13)	Z = –0.68 P = 0.49

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