SEASONAL DECLINE IN BREEDING PERFORMANCE OF THE KELP GULL *LARUS DOMINICANUS*

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SUMMARY

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The effects of timing of breeding on reproductive parameters of Kelp Gulls *Larus dominicanus* were studied in Patagonia, Argentina, during 1998 and 1999. Yearly and spatial variation in the study were assessed by sampling nests during two field seasons and in different areas within the colony, and accounted for variation with respect to breeding synchrony and breeding density. In both years and in three study areas, individuals laying earlier had higher hatching success, a larger number of chicks fledged, heavier chicks at one month and higher breeding success. Significant variation between study areas within the colony and between years was observed only for breeding success and number of chicks fledged. No effects of breeding synchrony on breeding parameters were detected. Timing of breeding, independent of study year and area, had no effect on either clutch size or egg size. Our results document for the first time the seasonal decline in breeding performance in the Kelp Gull, a species widely distributed in the southern hemisphere.

Key words: Kelp Gull, *Larus dominicanus,* breeding performance, seasonal decline, Argentina

INTRODUCTION

Timing of breeding has been shown to have significant effects on breeding success in many bird species (Perrins 1970). Seasonal changes in reproductive performance are characteristic of birds breeding in seasonal environments (Svensson 1997, Nilsson 1999), including several seabirds (Moreno 1998). Many studies have reported changes in fitness components with laying date in species belonging to the four seabird orders (Boersma & Ryder 1983, Ollason & Dunnet 1988, Wanless & Harris 1988, Moreno *et al.* 1997). For example, seasonal declines in breeding performance with respect to clutch size, egg size, hatching success, growth rates and breeding success have frequently been reported, although mixed evidence exists for some variables (see review by Moreno 1998).

The Kelp Gull *Larus dominicanus* is distributed throughout the southern hemisphere (Burger and Gochfeld 1996). In Argentina, the Kelp Gull is the most widely distributed and the third most abundant seabird breeding along the coast, and it has shown a major population expansion during recent decades (Yorio *et al.* 1999). Several studies throughout the range of this species have reported on the birds' breeding biology (Fordham 1964a, 1964b; Williams *et al.* 1984; Malacalza 1987; Yorio & García Borboroglu 2002). However, despite the well-known influence of timing of breeding on individual breeding success for other seabird species (Moreno 1998), information concerning the effects of breeding timing on Kelp Gull reproductive performance is currently lacking. In the present paper, we examine the effects of breeding schedule on several reproductive parameters at a large Kelp Gull colony in the north of San Jorge Gulf, Patagonia, Argentina. We included yearly and spatial variation in the study by sampling nests during two field seasons and in several different areas within the study colony. We also assessed variation resulting from breeding synchrony and breeding density, because these factors may also affect breeding success in colonial seabirds (Gochfeld 1980, Stokes & Boersma 2000 and references therein). Although seasonal effects on breeding in seabirds have been well studied, new information on different species may help to confirm the generality of the observed patterns and to contribute to an improved understanding.

METHODS

Study area

Vernacci Sudoeste Island (45°11′S, 66°31′W) is located near the mouth of Caleta Malaspina, San Jorge Gulf, Chubut, Argentina. It is a low island of approximately 6.4 ha, 500 m long and less than 200 m wide. The Kelp Gull is the most abundant seabird at Vernacci Sudoeste Island, with 8200 breeding pairs (Yorio & García Borboroglu 2002).

Data collection

All nests located in three different areas within the colony, separated by at least 100 m, were followed throughout the 1998 and 1999 breeding seasons. In total, 92 nests were studied in each of the study seasons. Each of the study areas was surrounded with nets 0.6 m in height to minimize chick movement among areas and to facilitate counting of chicks at each visit. Study areas were large enough to avoid constraining the ability of chicks to search out shelter and to allow us to check and measure chicks with minimal disturbance. We marked all nests with stones wrapped with numbered tape.

During both seasons, the colony was visited every two to three days from the beginning of October to late December, and then every two to five days (2.6 ± 1.4 days) until mid-February.

During visits, egg-laying dates, clutch size, hatching success and breeding success were recorded. Egg width and length and tarsus length of chicks at 31 ± 3 days of age were measured with calipers to the nearest 0.1 mm. Egg volumes (V) were calculated as

$$V = \text{length} \times \text{width}^2 \times 0.000467 \qquad \text{(Hoyt 1979) [1].}$$

Chick sizes were obtained in 1998. Tarsus length was used as an indicator of size because this chick measurement is the only one that reaches an asymptote before fledging (Yorio & García Borboroglu 2002). At hatching, a labelled fibre-tape band was used to mark chicks with their nest number and hatching order.

"Hatching success" is defined as the proportion of eggs laid that hatch per nest, and "breeding success" as the proportion of eggs that result in fledged chicks per nest. The number of fledged chicks was taken as the number surviving to at least the fourth week of age. To determine nesting density, a tape measure was used to record nearest-neighbour distance (± 1 cm) for each nest right after the peak of the egg-laying period. Very few early nests were lost before, or new nests built after, we obtained this measurement. The laying date of the first egg in the clutch was used as an indicator of timing of breeding (day 1 = 10 November1998 and 13 November 1999 for the two study seasons). Breeding synchrony of each nest with respect to its neighbours was measured as the difference in number of days between the laying of the first egg in the clutch and the annual mean laying date.

Table 1
Effects of laying date and nearest-neighbour distance on Kelp Gull *Larus dominicanus* breeding variables at San Jorge Gulf, Argentina

Variable	Covariate[a]	Parameter estimate	F (P)	Model[b] r^2	F	P	df
Clutch size	Laying date	–0.16	3.88 (0.051)	0.037	1.65	NS	129
	Distance	–0.18	4.09 (0.04)				
Egg size							
First				0.012	0.80	NS	127
Second	Distance	–0.20	4.67 (0.03)	0.006	1.09	NS	120
Third				0.057	0.57	NS	56
Hatching success	Laying date	–0.36	18.7 (<0.001)	0.150	4.05	<0.001	129
Chicks fledged	Laying date	–0.35	6.00 (0.02)	0.240	3.89	<0.01	50
Breeding success	Laying date	–0.48	30.9 (<0.001)	0.280	7.85	0.001	101
	Distance	–0.20	5.16 (0.02)				
Chick size	Laying date	–0.41	12.7 (0.001)	0.370	4.7	<0.01	26

[a] Only significant effects of covariates are presented, even in cases of nonsignificant models.
[b] Models also include year and study area within the colony as factors.
NS = nonsignificant.

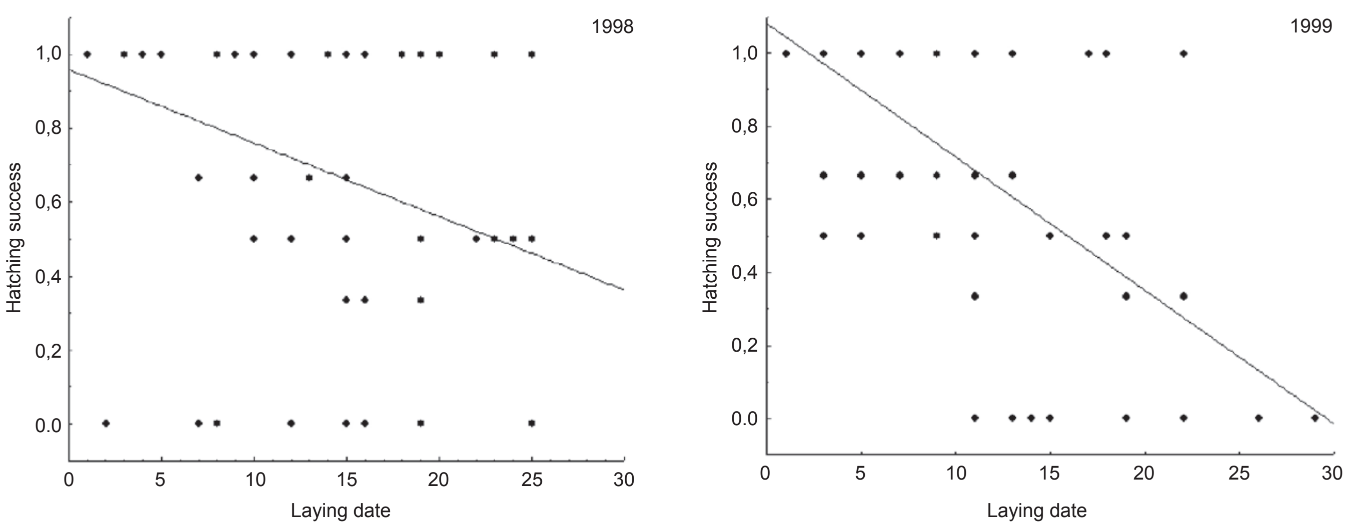

Fig. 1. Effect of laying date on hatching success in Kelp Gulls *Larus dominicanus* breeding at San Jorge Gulf, Argentina. Day 1 = 10 November in 1998 and 13 November in 1999.

Statistical treatment

The effects of timing of breeding on each reproductive variable was analysed using analysis of covariance (ANCOVA) tests, treating nearest-neighbour distance and breeding synchrony as covariates. The analysis also accounted for spatial and temporal variability considering the study area and study year and their interaction. Log and arcsine transformations were used to meet ANCOVA assumptions. Sample sizes may vary among the variables because of the loss of nests or of other nest-checking problems.

RESULTS

Timing of breeding, independent of year and area, had no effect on either clutch or egg size (Table 1). Clutch size and size of the second egg were significantly related only to the distance to the nearest neighbour, although in neither case did the whole model show a significant relationship (Table 1). The effect of laying date on clutch size in the model was not significant, although it bordered on significance ($P = 0.05$). Hence, we evaluated the effect of laying

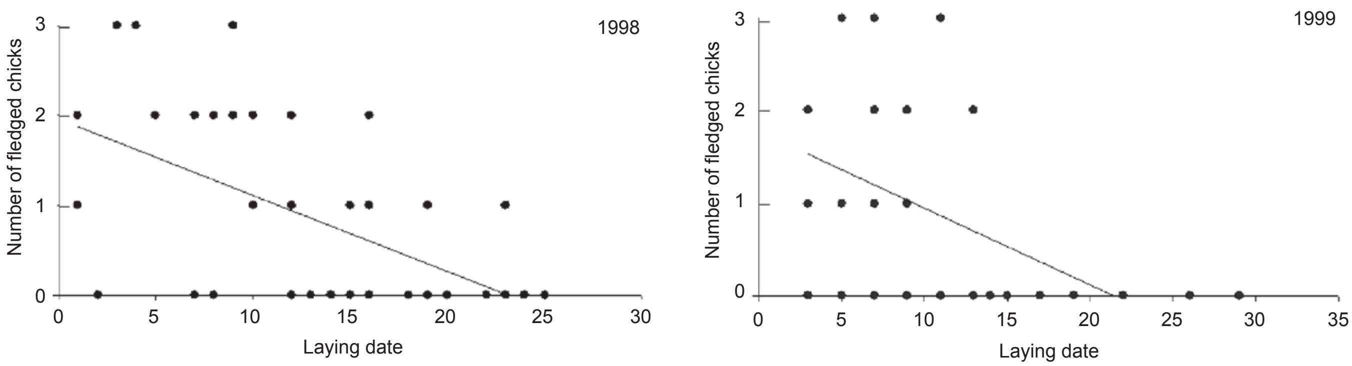

Fig. 2. Relationship between laying date and number of fledged chicks in Kelp Gulls *Larus dominicanus* breeding at San Jorge Gulf, Argentina. Day 1 = 10 November in 1998 and 13 November in 1999.

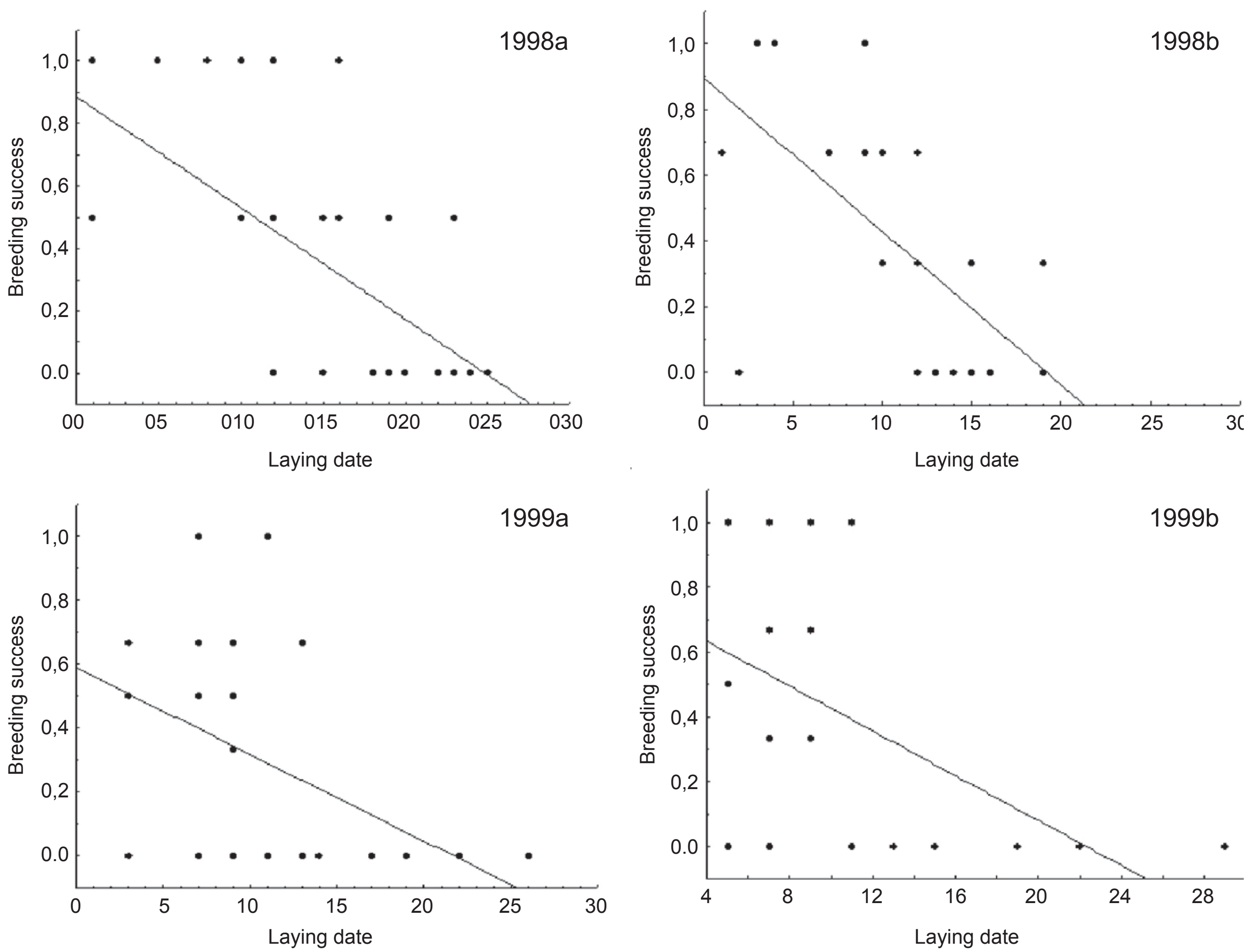

Fig. 3. Effects of laying date on Kelp Gull *Larus dominicanus* breeding success at San Jorge Gulf, Argentina for nests with (a) two-egg and (b) three-egg clutches in 1998 and 1999. Day 1 = 10 November in 1998 and 13 November in 1999. Values are means ± standard error.

date on clutch size in a separate analysis for each year. In 1998, the effect of date was not significant ($r_{86} = -0.18$, NS), but in 1999, it was significant ($r_{85} = -0.36$, $P < 0.001$).

In both years and in three study areas, hatching success, number of chicks fledged and breeding success showed a negative relationship with laying date (Table 1, Figs. 1–3). Study area within the colony and year had significant effects only for breeding success and number of chicks fledged (see Figs. 2–3 for yearly variation). A similar negative relationship with laying date was observed for the size of month-old first chicks (Table 1, Fig. 4).

The parameter estimate in the model indicates the strength of the effects of laying date on all the breeding parameters considered, showing the stronger relationship with breeding success (Table 1). Breeding success was significantly higher with decreasing distance to the nearest neighbour (Table 1). No effects of breeding synchrony on breeding parameters were detected.

DISCUSSION

Many seabird studies have shown a seasonal decline in reproductive performance (Moreno 1998). Our study shows that, as compared with later-breeding individuals, earlier-breeding Kelp Gulls in Patagonia have a higher hatching success, larger month-old first chicks and higher breeding success. These seasonal effects were observed in both years and at the three study areas. Thus, most parameters related to performance during the incubation and chick stages were strongly associated with laying date. This finding agrees with the results of studies on seasonal declines in breeding performance of other gull species (Brown 1967, Parsons 1975, Spear & Nur 1994, Sydeman *et al.* 1994).

However, timing of breeding had no effects on either clutch or egg size. This finding contrasts with previous information from seabird studies, because a seasonal decline in clutch size has been demonstrated in most seabirds studied, including five gull species (Moreno 1998). On the other hand, no clear trend in egg size related to laying date has been detected in seabirds, particularly in larids (Harris 1969, Parsons 1975, Boersma & Ryder 1983). The weak effect of laying date on clutch size as compared with data for other larids may be related to favourable conditions with respect to food availability during the pre-laying stage. Although parental quality effects may override the consequences of high food availability during the incubation and chick stages, a similar override may not apply during the egg-formation phase.

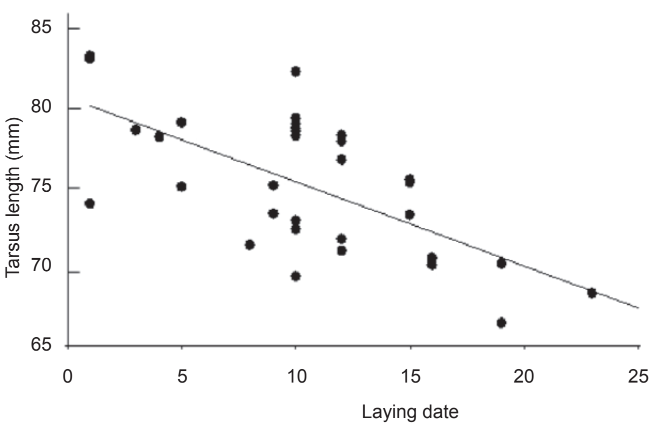

Fig. 4. Relationship between laying date and size of month-old first chicks in Kelp Gulls *Larus dominicanus* breeding at San Jorge Gulf, Argentina, during 1998. Day 1 = 10 November.

Several studies have shown that breeding synchrony has an effect on breeding output (Gochfeld 1980, Murphy & Schauer 1996). In the Herring Gull *L. argentatus,* for example, nesting synchrony affected both hatching and fledging success, with eggs laid later in the peak laying period being the most successful (Parsons 1975). In our study, however, breeding synchrony had no detectable effect on reproductive performance. Breeding success was inversely related to inter-nest distance, a result that is hard to interpret given the potential cannibalistic habits of the Kelp Gull (Fordham 1964b, Yorio & García Borboroglu 2002). However, high nesting densities allowed by habitat structure may be beneficial in terms of reduced predation. Similar results were found in the *L. occidentalis*/*L. glaucescens* hybrid complex, where low levels of neighbour interactions and nest predation resulting in better breeding performance were found in high-density areas (Good 2002).

Several not-mutually-exclusive hypotheses have been put forward to explain seasonal declines in breeding performance (Coulson & White 1956, Lack 1968, Birkhead 1977, Moreno 1998) and may apply depending on the species and environmental characteristics. Unfortunately, the lack of long-term studies at Caleta Malaspina and the absence of experimental treatments make it hard to identify the causes of the observed seasonal decline in Kelp Gull breeding parameters. Future efforts should concentrate on the design of field experiments to elucidate the importance of food availability and age or experience (or both) as determinants of seasonal decline in Kelp Gull reproductive output.

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