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Spatial and temporal variation in population trends of Kelp Gulls in northern Patagonia, Argentina

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Abstract. Many populations of seabird species with opportunistic or generalist feeding habits have expanded worldwide, possibly because they are using additional food resources provided by human activities. The Kelp Gull (*Larus dominicanus*) is a generalist feeder that often feeds on urban and fish waste and its populations have been expanding in several regions of the southern hemisphere. In Patagonia, Argentina, it is the most abundant species of gull. However, population trends have been reported for only a few colonies and there has been no evaluation of population changes at a regional scale. In this study we provide an update on the distribution and size of Kelp Gull colonies along 1800 km of coastline of northern Patagonia, and assess population trends over a period of 15 years (1994–2008) at different spatial scales (colony, coastal sector, region). In northern Patagonia, Kelp Gulls currently breed in 68 colonies, which range in size from a few to 11 000 breeding pairs. Ten new sites were colonised in the study period. Most colonies (74%) are increasing and the overall population increased by 37% (from 52 784 to 72 616 pairs), at an annual growth rate of 2.7%. Two of the four coastal sectors showed significant annual increases (5%), whereas the other two remained stable. Our results confirm the expansion of populations of Kelp Gulls along a long section of the coast of northern Patagonia, although the observed trends varied with the spatial scale considered.

Additional keywords: *Larus dominicanus*, breeding numbers.

Introduction

Knowledge of fluctuations in wildlife abundance is important for the development of adequate management and conservation strategies (Sutherland 2000). Many populations of seabird species with opportunistic or generalist feeding habits have expanded in several regions worldwide, and it has been suggested that these increases may be related to their use of food resources provided by human activities (Furness and Monaghan 1987; Camphuysen and Garthe 2000). Refuse tips and fish waste constitute food sources that are abundant and fairly predictable, and which often include food items that are not normally available to birds (Furness and Monaghan 1987). In particular, many *Larus* gulls are generalist and opportunistic foragers (Burger and Gochfeld 1996), and in many cases this has allowed them to take advantage of new supplementary food sources, resulting in population expansions (Harris 1970; Blokpoel and Spaans 1991; Vidal *et al*. 1998). These population increases have promoted the development of monitoring programs (Vermeer *et al*. 1993; Barbraud and Gélinaud 2005) and motivated the implementation of management actions (Thomas 1972; Coulson 1991; Brooks and Lebreton 2001; but see Oro and Martínez-Abraín 2007).

Kelp Gulls (*Larus dominicanus*) are widely distributed in the southern hemisphere, breeding in South America, southern Africa, Australia, New Zealand, on the subantarctic islands, and the Antarctic Peninsula (Burger and Gochfeld 1996). Along the coast of Argentina it is the most abundant species of gull, with the population estimated at >70 000 pairs, distributed in ~100 colonies, in the 1990s (Yorio *et al*. 1998*a*). Population trends are available for only a few colonies, but show a significant increase during recent decades (Yorio *et al*. 1998*a*, 2005), similar to trends reported in other regions (Coulson and Coulson 1998; Whittington *et al*. 2006; Crawford *et al*. 2009). However, there has been no evaluation of population changes at the regional scale in Argentina.

Several studies in coastal Argentina confirm that the Kelp Gull is a generalist feeder that often utilises urban and fish waste (Giaccardi *et al*. 1997; Bertellotti and Yorio 1999; Yorio and Caille 1999; Yorio and Giaccardi 2002; Petracci *et al*. 2004; Silva Rodríguez *et al*. 2005). The use of artificial food sources has been suggested as one of the main factors contributing to the observed population expansion (Yorio *et al*. 1998*a*), although this relationship has not been assessed. The increase in Kelp Gull

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populations may result in negative effects on other coastal species through predation, competition for breeding space and kleptoparasitism, and their activity at or near cities may result in hazards to aircraft and threats to human health (see review in Yorio *et al*. 2005). Knowledge of fluctuations in Kelp Gull abundance, both in particular colonies and in the population as a whole, is essential to understand the demography of the species and to implement appropriate management actions at different scales. Our goals were to: (1) update the information on the distribution and size of Kelp Gull colonies in a wide coastal sector in northern Patagonia (~1800 km) and (2) assess population trends over the 15 years from 1994 to 2008 at different spatial scales.

Methods

Distribution and size of colonies

In order to determine the population of known colonies and to identify new colonies, we surveyed the mainland coast and islands of the Provinces of Río Negro and Chubut, northern Patagonia, Argentina, during the three breeding seasons (September to February of 2006–07, 2007–08 and 2008–09). We surveyed 1770 km of the cost, from San Antonio Oeste (40°47′S, 64°53′W) south to the boundary between the Chubut and Santa Cruz Provinces (46°S) (Fig. 1). The size of colonies was determined by full counts of nest except at five colonies, where, owing to the large size of the colony and habitat, we estimated colony size using counts in circular plots of 100 m^2 (Bibby *et al*. 1992). Plots were placed randomly throughout the colony, so as to capture differences in density of nests and habitat (Yorio *et al*. 1998*a*). We considered a nest active when it contained an egg, chick or signs of recent use, such as fresh nesting material. We used the same techniques as previous studies (Yorio *et al*. 1998*a*, 1998*b*; García Borboroglu and Yorio 2004; Yorio *et al*. 2005) and conducted all counts during late incubation (October to December, depending on the breeding phenology of each colony) under similar environmental conditions.

Changes in population

We evaluated trends from 1994 to 2008 at different spatial scales (colony site, coastal sector, and region) using the counts conducted during this study (2006–08) and previous studies (1994–2005) from published literature (Yorio *et al*. 1998*a*, 1998*b*; García Borboroglu and Yorio 2004; Yorio *et al*. 2005) and unpublished information (P. Yorio, P. Garcia Borborolgu, F. Quintana, M. Bertellotti and A. Gatto, pers. comm.). Four coastal sectors, encompassing the whole study area, were defined based on differences in availability of fish waste and refuse tips (Table 1, Fig. 1): (1) Río Negro sector (40°47′–42°S): includes the coastal zone under the jurisdiction of the Río Negro Province, including the San Matías Gulf. The coastal waters are used by a trawl fishery and a small long-line fishery targeting mainly Argentine Hake (*Merluccius hubbsi*), which provides variable amounts of fishery waste (Romero *et al*. 2009). There are also open urban and fish-waste tips. Of the breeding population of this sector, 90% breeds on Complejo Islote Lobos, located 80 and 30 km from the two cities in this sector; (2) Northern Chubut sector: includes the coastal sector from 42°S to the city of Rawson (43°20′S). No fisheries operate in this area, although there are fisheries and urban waste tips, 60 km from the nearest colonies, on Islote Notable and Punta León, which encompass 75% of the breeding population of this sector; (3) Central Chubut sector: corresponds to the central coast of the Chubut Province, from Rawson to 44°38′S. This sector is used by a coastal trawl fishery targeting Argentine Hake and Argentine Red Shrimp (*Pleoticus muelleri*) providing variable amounts of fishery waste (Marinao and Yorio, in press). There are no fishery and urban waste tips. The closest cities are located >80 km from colonies of Gulls; (4) Southern Chubut sector (44°38′–46°S): includes the southern coast of this province. Hake and shrimp fisheries operate in this sector, providing variable amounts of fishery waste (Dato *et al*. 2006). There are also open urban and fish waste tips. In this coastal sector, only 13% of Kelp Gull colonies are closer than 50 km from the nearest city.

To analyse the trend in overall population, we combined the time series of counts from all the colonies, incorporating the missing observations, and made a log-linear regression model with Poisson error terms using the program TRIM version 3.53 (Trends and Indices for Monitoring Data; Pannekoek and van Strien 2001). We incorporated the coastal sector as a covariate and tested if trends differed significantly between coastal sectors based on the Wald test for significance of covariate ($P < 0.05$). We started the analysis with a model with change-points at each time-point, and used the stepwise selection procedure to identify those with significant changes in slope, based on Wald tests with a significance-level threshold value of 0.05. We applied the same procedure to analyse trends for each of the four coastal sectors previously described. For all runs, we took into account overdispersion. We also took into account serial correlation when sufficient counts were available, which was the case for the overall population and the northern Chubut sector.

We obtained breeding numbers for the overall population and for each coastal sector from the TRIM analysis. We estimated annual population growth rates for each colony by simple log-linear regression of counts against time, based on the population model $N_t = N_0 e^{rt}$, where the slope of the regression line corresponds to the population growth rate (Caughley 1977).

Results

Distribution and size of colonies

During the 2006–08 surveys, 68 Kelp Gull colonies were identified in the study area (Fig. 1, Appendix), and 64 were visited to estimate breeding numbers. Number of nests ranged from 1 to 11 296 pairs (median = 454, $n = 64$ colonies) (Appendix). Of the visited colonies, 72% had <1000 pairs and only 6% had >5000 pairs (Fig. 2). The four largest colonies (Isla Quintano, Isla Vernacci Sudoeste, Punta Tombo and Punta León) comprised 43% of the 72 618 breeding pairs counted in the study area. Most colonies (66%) and most breeding pairs (62%) were concentrated within a 470 km long sector in the southernmost part of the study area, between Islas Blancas and Isla Quintano, northern San Jorge Gulf (Fig. 1, and Appendix).

Population changes

Ten new colonies were identified along the coast of Chubut Province during the last 15 years (Appendix). Four of them appeared between 2001 and 2004 (Punta Tombo Norte, in 2001; Estancia San Lorenzo, 2002; Isla Ezquerra, 2003; and

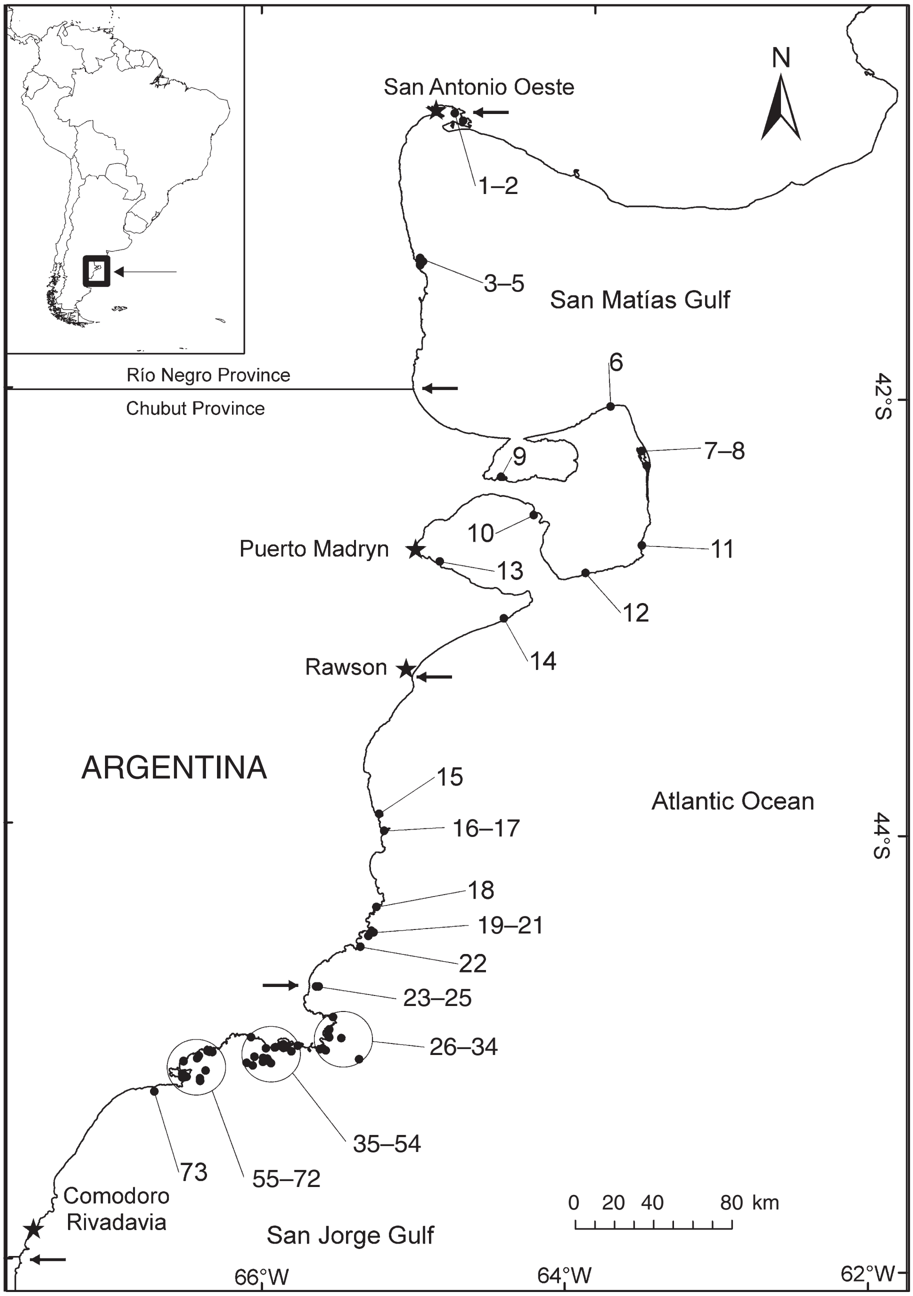

Fig. 1. Distribution of Kelp Gull colonies along the northern coast of Patagonia, Argentina. Numbers correspond to site numbers in the Appendix. Arrows indicate the boundaries of defined coastal sectors.

Punta Loma, 2004). The precise year of establishment of the other six new colonies is not known, although we know that the colony on Isla Vernacci Oeste Noroeste was established between 1995 and 1998, that of Isla Leones between 1996 and 2001, that of Isla Cayetano between 2001 and 2007, and that of Isla Aguilón del Sur between 2002 and 2005. There are no details of the establishment of the colonies on Isla Viana Menor and Isla Sin Nombre. No new colonies were identified in Río Negro Province in the last 15 years. Seven out of these 10 new colonies were in the southern Chubut sector. During the last survey (2006–08) we found that five previously existing colonies had disappeared (Appendix). Of these, two were established between 2001 and 2002 (Punta Tombo Norte and Estancia San Lorenzo respectively), whereas the three other (Isla Gaviota, Islote frente a Patria and Isla Lobos Oeste) existed at least since the early 1990s.

From 1994 to 2008 the overall breeding population increased 37%, at an annual rate of 2.7% ($\lambda = 1.027 \pm 0.006$, C.I. 95% 1.015–1.039). The estimated total number of breeding pairs increased from $52\,784 \pm 2496$ to $72\,616 \pm 3965$ between 1994 and 2008 (Fig. 3*a*). Growth rates for individual colonies with

Table 1. Characterisation of anthropogenic food sources in each of the four coastal sectors studied in the northern coast of Patagonia, Argentina
Sources: 1, Caille and González (1998); 2, González and Esteves (2008); 3, Romero *et al.* (2009); 4, INDEC (2001); 5, Marinao and Yorio, in press; 6, Góngora *et al.* (2009); 7, Góngora, pers. comm.; 8, Cordo (2005)

Coastal sector	Mean number of fishing vessels per year	Seasonality of fishing activity	Mean catch ($t\ year^{-1}$)	Estimated discards ($t\ year^{-1}$)	Number of urban refuse tips (human population)	Number of fishery waste tips	Source
Río Negro	13	Year-round	4000–14 000	1500–4100	2 (23 300)	1[A]	1, 2, 3, 4
Northern Chubut	0	None	0	0	2 (84 000)	2[A]	2, 4
Central Chubut	35–40	November–March	11 200–13 600	1100–4900	0	0	2, 5
Southern Chubut	130	Year-round	>50 000	23 000–>60 000	4 (180 400)	1[A]	2, 4, 6, 7, 8

[A]The availability of fish waste varied during the study period depending on their use for fish meal (Yorio and Caille 2004).

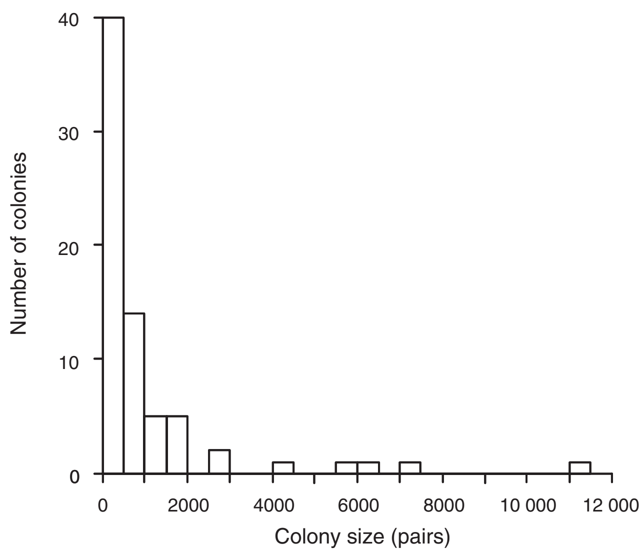

Fig. 2. Size of Kelp Gull colonies (number of breeding pairs) along the northern coast of Patagonia, Argentina.

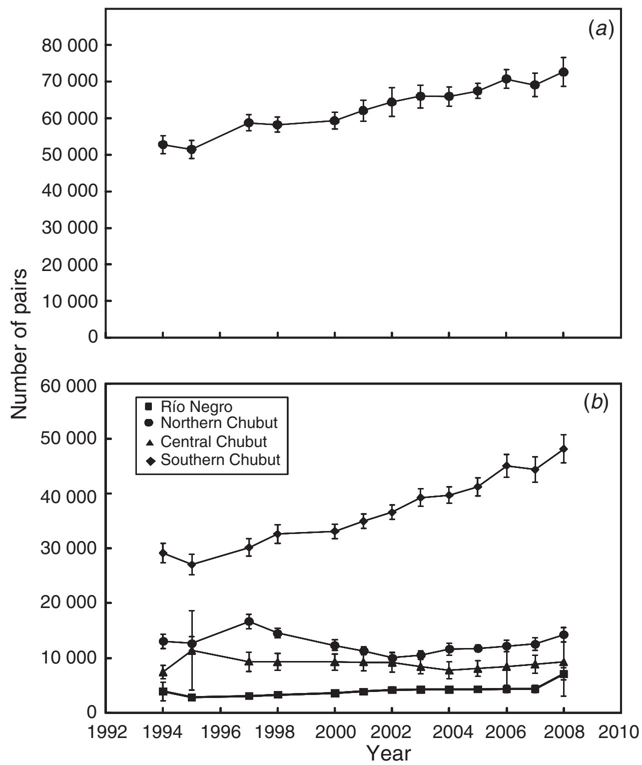

Fig. 3. Estimates of annual breeding population of Kelp Gulls along the northern coast of Patagonia from1994 to 2008 in: (*a*) the whole study area and (*b*) each of the four coastal sectors. Estimates are imputed estimates computed from a model for (*a*) the whole population and (*b*) a model for each coastal sector, using the program TRIM (see Methods). Error bars are ±s.e.

at least two counts ranged from 0.42 to 1.56 (median = 1.04, $n = 66$), being >1.0 in 49 colonies (74%), equal to 1.0 in three colonies (5%) and <1 in 14 colonies (21%) (Appendix). The population trends computed with the linear model including the four coastal sectors as covariate categories indicated that the trends differed significantly between coastal sectors (Wald test for significance of covariate, $P < 0.001$).

(1) Río Negro sector: Between 1994 and 2008 the number of breeding pairs in this sector increased at an annual rate of 5.3% ($\lambda = 1.053 \pm 0.015$, CI 95% 1.023–1.084). No stepwise procedure was applied in this sector because we had few data. The overall estimated number of breeding pairs computed from this model indicated an increase of 82% between 1994 and 2008, from 3898 ± 1713 to 7096 ± 1086 breeding pairs (Fig. 3*b*).
(2) Northern Chubut sector: The stepwise procedure for the selection of change-points indicated three significant change-points (1995, 1997 and 2002; $P < 0.02$ for Wald tests), defining three main periods: (a) a strong increase from 1995 to 1997 ($\lambda = 1.284 \pm 0.140$, CI 95% 1.008–1.559); (b) a decrease between 1997 and 2002 ($\lambda = 0.882 \pm 0.026$, CI 95% 0.831–0.934); and (c) a significant increase from 2002 to 2008, although slower than that of 1995–97 ($\lambda = 1.056 \pm 0.024$, 0.024, CI 95% 1.088–1.104). Although this sector showed important annual fluctuations in the number of breeding birds, there was no significant trend between 1994 and 2008 ($\lambda = 0.991 \pm 0.010$, CI 95% 0.972–1.011). Peak abundance was reached in 1997 (16 652 ± 1324 breeding pairs), abundance then declining to an estimated 14 222 ± 1349 breeding pairs in 2008 (Fig. 3*b*).
(3) Central Chubut sector: No significant trend was detected in this sector for the overall study period ($\lambda = 0.994 \pm 0.028$, CI 95% 0.940–1.047). No stepwise procedure to estimate

change-points was applied in this sector because we had few data.

(4) Southern Chubut sector: From 1994 to 2008, the breeding population increased at an annual rate of 4.7% ($\lambda = 1.047 \pm 0.009$, CI 95% 1.030–1.063). The stepwise procedure indicated one significant change-point (1995; $P < 0.01$ for Wald test). The estimates of population size computed from this model indicated no change from 1994 to 1995 and a trend of increasing population for the rest of the period ($\lambda = 1.048 \pm 0.009$, CI 95% 1.031–1.065). The estimated total number of breeding pairs in the sector increased by 65%, from 29 138 ± 1735 to 48 126 ± 2593 between 1994 and 2008 (Fig. 3*b*).

Discussion

This study shows that Kelp Gulls in northern Patagonia bred in at least 68 locations, in colonies that ranged in size from 1 breeding pair to 11 000 breeding pairs. The size of colonies are of the same order of magnitude and, in some cases, larger than those reported in New Zealand and South Africa (Taylor 2000; Whittington *et al*. 2006; Crawford *et al*. 2009). In other breeding areas, such as Angola and Namibia in Africa, Antarctica, the subantarctic islands, Brazil and Chile in South America, the numbers of breeding pairs in most colonies are lower, in general <500 pairs per colony (Croxall *et al*. 1984; Higgins and Davies 1996; Simeone *et al*. 2003; Branco 2004; Kemper *et al*. 2007).

Our results confirm the increase in numbers of Kelp Gulls in most of the locations we surveyed along a long section (1800 km) of coast in northern Patagonia. Previous studies in the Península Valdés area (northern Chubut sector of this study) and at the Punta Tombo colony in the 1980s to the mid-1990s showed increasing populations (Yorio *et al*. 1994, 1998*a*; Bertellotti *et al*. 1995). Over the last 15 years, the numbers of breeding Kelp Gulls in the study area increased by 37%, with a total of >72 000 breeding pairs in 2008. This estimate of population is similar to that estimated for the whole breeding population in coastal Argentina (distributed along over 3600 km of coastline) during the mid-1990s (Yorio *et al*. 1998*a*). The observed trend in the overall number of breeding pairs was mostly determined by the growth of only five colonies, particularly Isla Quintano in southern Chubut.

Ten new sites were colonised during the last 15 years. Most of these new colonies (70%) were located on islands in San Jorge Gulf, and were possibly established owing to the availability of food derived from human activities (see below) and the presence of adequate breeding habitat, as this coastal sector has a large number of islands and islets (Yorio *et al*. 1998*a*). Kelp Gulls breeding along the Patagonian coast show a strong preference for nesting on islands, using coastal mainland sites only where islands are not available (García Borboroglu and Yorio 2004). The only new mainland colony that has prospered, Punta Loma, is located a few kilometres south of Puerto Madryn city (Yorio *et al*. 1998*a*). One factor that could have favoured this successful settlement is the proximity to the Puerto Madryn refuse tips, regularly used by Gulls from this colony (M. Ricciardi and P. Yorio, unpubl. data). Although most breeding sites remained active during the study period, a few did not show signs of breeding activity during the last surveys. This pattern of colony formation and abandonment has been also observed for Kelp Gulls (*L. d. vetula*) in South Africa (Whittington *et al*. 2006), and is characteristic of populations which are spatially structured in discrete patches, as occurs in colonially breeding seabirds (Oro 2003).

Changes in Kelp Gull populations in Patagonia accord with those recorded in other regions in the southern hemisphere. Several studies have reported population growth and expansion of geographical range of Kelp Gulls, showing the great expansion potential of the species. In Australia, for example, Kelp Gulls were rarely recorded until the 1950s, but are now established throughout the country's southern coasts (Blakers *et al*. 1984; Coulson and Coulson 1998). In New Zealand, Fordham and Cormack (1970) reported large increases in Kelp Gull populations in the 1940s and 1960s. In South Africa, the total population of Kelp Gull (*L. d. vetula*) increased in the last 20 years but regional trends differed (Steele and Hockey 1990; Whittington *et al*. 2006; Crawford *et al*. 2009). In Chile, Villablanca *et al*. (2007) reported that the Kelp Gull extended its breeding sites from islands to the mainland and buildings in Coquimbo city. During recent decades, the Kelp Gull has also expanded its breeding range to Ecuador and the United States (Haase 1996; Dittman and Cardiff 1998). Some authors argue that an increase in additional food resources, such as urban waste and fishery discards, has been a key factor determining the observed population expansions (Fordham and Cormack 1970; Coulson and Coulson 1998; Whittington *et al*. 2006). A similar scenario has been recorded for other species of gull worldwide (Blokpoel and Spaans 1991; Camphuysen and Garthe 2000).

Our results show that populations of Kelp Gulls in the coastal sectors of Río Negro (San Matías Gulf) and southern Chubut (San Jorge Gulf) showed significant growth whereas in the other two sectors populations remained stable. In the former two sectors, waste tips and important trawl fisheries operate year-round and provide significant amounts of supplementary food to Kelp Gull populations (Yorio and Caille 1999; Bertellotti and Yorio 2000; Yorio and Giaccardi 2002; González-Zevallos and Yorio 2006). In contrast to the Río Negro and southern Chubut sectors, there was less supplementary food in the northern and central Chubut sectors, as there were only waste tips in the former and only a small trawl fishery that operates seasonally in the latter (Giaccardi *et al*. 1997; Giaccardi and Yorio 2004; Marinao and Yorio, in press). Future studies along the Patagonian coast should explore the possible relationship between trends in Kelp Gull populations and the differential availability of supplementary food sources. It should be considered that relative changes in food availability in the different coastal sectors may have influenced emigration and immigration patterns of Kelp Gull breeding individuals, contributing to the variability in observed population trends. Oro *et al*. (2004) showed that reduced food availability during the chick-rearing period may favour a higher emigration rate of younger breeders towards other local populations. In addition, the observed increase in Kelp Gull numbers in eastern and southern South Africa coincided with an eastward and southward shift in the distribution of fish prey and trawl fisheries (Crawford *et al*. 2009). However, the complexity of ecological factors affecting seabird population trends (Ainley and Hyrenbach 2010) suggests the need of additional studies in order to adequately understand the mechanisms affecting Kelp Gull demography in Patagonia.

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Appendix. Location of Kelp Gull colonies, including previously abandoned ones, along the northern coast of Patagonia, Argentina, their size (number of breeding pairs) during the 2006–08 survey, and population growth rate (λ) of colonies

Colony numbers refer to locations in Fig. 1; NC, nests not counted

Location		Position	Size	Year	λ	Number of years with counts
Río Negro sector						
1	Isla Novaro	40°45′S, 64°50′W	288	2008	1.111	2
2	Islotes del Canal Escondido	40°47S, 64°47′W	265	2007	0.979	2
3	Islote La Pastosa	41°25S, 65°02′W	2935	2008	1.075	3
4	Islote Redondo	41°26′S, 65°01′W	941	2007	1.009	3
5	Islote de los Pájaros	41°27′S, 65°02′W	1163	2007	1.066	3
Northern Chubut sector						
6	Estancia San Lorenzo[A]	42°05′S, 63°51′W	0	2006	1	2
7	Isla Gaviota de Caleta Valdés	42°17′S, 63°39′W	0	2007	0.42	4
8	Isla Primera de Caleta Valdés	42°21′S, 63°37′W	1917	2008	1.096	7
9	Islote Notable	42°25′S, 64°31′W	4044	2008	0.975	6
10	Punta Pirámide	42°35′S, 64°17′W	453	2008	1.027	7
11	Punta Delgada	42°43′S, 63°38′W	106	2008	1.003	6
12	Playa La Pastosa	42°50′S, 63°59′W	682	2008	1.089	4
13	Punta Loma[A]	42°82′S, 64°47′W	88	2008	1.556	5
14	Punta León	43°04′S, 64°29′W	5813	2007	0.981	7
Central Chubut sector						
15	Punta Clara	43°58′S, 65°15′W	39[B]	1995	–	1
16	Punta Tombo	44°02′S, 65°11′W	6457	2007	1.006	5
17	Punta Tombo Norte[A]	44°02′S, 65°11′W	0	2001	–	1
18	Punta Gutiérrez	44°24′S, 65°16′W	338	2006	0.998	2
19	Cabo San José	44°31′S, 65°17′W	194	2006	1.055	2
20	Isla Sur Cabo San José	44°31′S, 65°18′W	131	2006	0.861	2
21	Isla Acertada	44°32′S, 65°19′W	249	2006	1.093	2
22	Isla Cumbre	44°35′S, 65°22′W	1356	2006	1.011	2
Southern Chubut sector						
23	Isla Blanca Mayor	44°46′S, 65°38′W	1463	2007	1.021	4
24	Isla Blanca Menor Este	44°46′S, 65°38′W	15[C]	2005	1.019	3
25	Isla Blanca Menor Oeste	44°46′S, 65°39′W	287[C]	2005	1.005	3
26	Isla Moreno	44°54′S, 65°32′W	35	2007	0.83	4
27	Isla Sola	44°58′S, 65°33′W	641	2007	0.98	4
28	Isla Aguilón del Norte	45°00′S, 65°34′W	42	2008	1.029	4
29	Isla Aguilón del Sur[A]	45°00′S, 65°34′W	74	2008	–	1
30	Isla Arce	45°00′S, 65°29′W	786	2007	0.978	3
31	Isla Rasa	45°06′S, 65°23′W	NC	–	–	0
32	Península Lanaud	45°03′S, 65°35′W	688	2007	1.031	4
33	Isla Leones[A]	45°03′S, 65°36′W	78	2007	0.954	3
34	Isla Buque	45°03′S, 65°37′W	1323	2007	1.025	4
35	Isla Cayetano[A]	45°02′S, 65°46′W	605	2008	–	1
36	Isla Pan de Azúcar	45°04′S, 65°49′W	1822	2007	1.008	2
37	Islotes Arellano	45°03′S, 65°51′W	182	2007	1.125	4
38	Islotes Massa	45°02′S, 65°51′W	30	2007	0.885	4
39	Islote Laguna	45°02′S, 65°53′W	523	2007	1.01	4
40	Islote Galfráscoli	45°02′S, 65°51′W	37	2007	1.198	4
41	Islote Puente	45°02′S, 65°50′W	118	2007	1.063	3
42	Islote Luisoni	45°02′S, 65°51′W	102	2007	1.12	4
43	Isla Patria	45°03′S, 65°51′W	596	2007	1.046	3
44	Islote frente a Patria	45°02′S, 65°51′W	0	2007	0.882	3
45	Isla Blanca	45°03′S, 65°58′W	1	2007	0.833	3
46	Isla Tova	45°06′S, 66°00′W	152	2007	0.873	2
47	Isla Tovita	45°07′S, 65°57′W	263	2007	1.051	4
48	Isla Gaviota	45°06′S, 65°58′W	1873	2007	1.023	3
49	Isla Este	45°07′S, 65°56′W	981	2007	1.024	3
50	Isla Sur	45°07′S, 65°59′W	724	2007	1.117	4
51	Islotes Goëland	45°05′S, 66°03′W	550	2007	0.975	3
52	Isla Pequeño Robredo	45°07′S, 66°06′W	439	2007	1.029	2
53	Isla Gran Robredo	45°08′S, 66°03′W	1110	2007	1.09	2

Appendix. (*continued*)

Location		Position	Size	Year	λ	Number of years with counts
54	Isla Sin Nombre[A]	45°00′S, 66°04′W	118[D]	2008	–	1
55	Isla Lobos Oeste	45°05′S, 66°18′W	0	2006	1.044	4
56	Isla Felipe	45°04′S, 66°19′W	836	2006	1.045	4
57	Isla Ezquerra[A]	45°04′S, 66°20′W	42	2006	1.518	2
58	Isla Galiano Norte	45°05′S, 66°24′W	654	2006	1.209	4
59	Isla Galiano Central	45°06′S, 66°25′W	317	2006	1.164	4
60	Isla Galiano Sur	45°06′S, 66°25′W	317	2006	1.254	4
61	Isla Isabel Norte	45°07′S, 66°30′W	227	2006	1.086	4
62	Isla Isabel Sur	45°07′S, 66°30′W	144	2006	1.076	4
63	Isla Ceballos	45°09′S, 66°22′W	1911	2006	1.054	3
64	Isla Vernaci Este	45°11′S, 66°29′W	2762	2006	1.09	4
65	Isla Vernaci Norte 1	45°11′S, 66°30′W	260	2006	1.098	3
66	Isla Vernaci Norte 2	45°11′S, 66°30′W	628	2006	1.526	4
67	Isla Vernaci Oeste Noroeste[A]	45°11′S, 66°30′W	79	2006	1.111	3
68	Isla Vernaci Sudoeste	45°11′S, 66°31′W	7445	2006	1.016	4
69	Isla Vernaci Noroeste	45°10′S, 66°31′W	455	2006	1.185	4
70	Isla Vernaci Oeste	45°11′S, 66°31′W	106	2006	1.06	4
71	Isla Viana Mayor	45°11′S, 66°24′W	1819	2006	1.116	2
72	Isla Viana Menor[A]	45°12′S, 66°24′W	26	2006	–	1
73	Isla Quintano	45°15′S, 66°42′W	11 296	2006	1.183	2

[A]Colonies established between 1995 and 2008.
[B]From Yorio *et al*. (1998).
[C]From P. Yorio and F. Quintana (unpubl. data).
[D]From M. L. Agüero (pers. comm.).