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USE OF TIPS BY NESTING KELP GULLS AT A GROWING COLONY IN PATAGONIA

MARCELO BERTELLOTTI[1]
Centro Nacional Patagónico (CONICET). Bvard Brown 3700, 9120 Puerto Madryn Chubut, Argentina, and Universidad Nacional de la Patagonia Bvard Brown s.n. 9120 Puerto Madryn, Chubut, Argentina

PABLO YORIO
Centro Nacional Patagónico (CONICET), Bvard Brown 3700, 9120 Puerto Madryn Chubut, Argentina, and Wildlife Conservation Society, 2300 Southern Boulevard, Bronx New York, New York 10460 USA

GUILLERMO BLANCO[2]
Department of Biology, University of Saskatchewan Saskatoon, Saskatchewan S7N 5E2, Canada

MARICEL GIACCARDI
Dirección de Conservación de Áreas Naturales (Organismo Provincial de Turismo) 9 de julio 280, (9103) Rawson, Chubut, Argentina

Abstract.—We evaluated the magnitude of use of waste tips by Kelp Gulls (*Larus dominicanus*) nesting at Isla de los Pájaros, a large and growing colony in Patagonia, Argentina, and we assessed the difference in use between tips with urban and fishery waste. We marked with color dye 1347 adult breeding Kelp Gulls to determine if they fed in urban and fishery tips and to estimate the number of birds which used those tips during incubation. Kelp Gulls were present during 100% and 64% of counts at the fishery waste tip and the urban waste tip, respectively. The number of adult gulls was always larger at the fishery waste tip (mean ± SD = 1694 ± 664) than in the urban waste tip (mean ± SD = 59 ± 68). Considering the total number of gulls flying from the colony to the tips and the proportion of marked gulls in the tips, we estimated that at least 54–69% of the birds of the colony were present at the tips. The use of fishery waste may have contributed to the increase in the number of Kelp Gulls breeding at Isla de los Pájaros, and the quality, abundance, and predictability of food disposed at the fishery waste tip could foster the use of this site relative to natural food sources located closer to their breeding colony. Removal of artificial food sources may be assessed at the Puerto Madryn and other Patagonian waste tips to reduce conflicts between human and gull populations.

USO DE VERTEDEROS POR *LARUS DOMINICANUS* ANIDANDO EN UNA COLONIA CRECIENTE EN LA PATAGONIA

Sinopsis.—Evaluamos la magnitud del uso de vertederos de desechos de una colonia grande y en creciemiento de *Larus dominicanus* anidando en la Isla de los Pájaros, en la costa de Patagonia, Argentina, y exploramos las diferencias entre el uso de vertederos de desechos urbanos o de desechos de pescadería. Marcamos con tintes de color 1347 aves adultas para determinar si se alimentaban en vertederos urbanos y de pescaderías y para estimar el número de aves que usaron estos vertederos durante la incubación. Estas aves estuvieron presente durante el 100% y el 64% de los conteos en los vertederos de pescaderías y de los urbanos, respectivamente. El número de aves adultas siempre fué mayor en el vertedero de

[1] *Current address: Department of Applied Biology, Estación Biológica de Doñana. Av. de Mª Luisa s. n. 41013 Sevilla, Spain.*
[2] *Current address: Instituto de Investigación en Recursos Cinegéticos (C.S.I.C.), Libertad 7A, 13004 Ciudad Real, Spain.*

pescadería (promedio = 1694, SD = 664) que en el vertedero urbano (promedio = 59, SD = 68). Considerando el número total de aves volando de la colonia a los vertederos y la proporción de aves marcadas en los vertederos, estimamos que al menos el 54–69% de las aves de la colonia estaba presente en los vertederos. El uso de los desechos de pescadería puede haber contribuído al aumento en el número de aves anidando en la Isla de los Pájaros. La calidad, abundancia, y predictabilidad de alimentos disponibles en el vertedero de pescadería podría estimular el uso de esta localidad relativo a las fuentes de recursos alimenticios localizados cercanos a su colonia reproductiva. La remoción de fuentes artificiales de alimentos pudiera llevarse a cabo en el Puerto Madryn y en otros vertederos de Patagonia para reducir conflictos entre poblaciones humanas y de las gaviotas.

Food availability acts as a proximate factor determining the number of breeding pairs in seabirds (Birkhead and Furness 1985; Croxall and Rothery 1991) and can have a direct effect on breeding success (Anderson et al. 1982; Uttley et al. 1994). However, few studies have demonstrated the association of changes in food availability and reproductive performance or demographic life history traits (Pons and Migot 1995; Oro et al. 1996). For most seabirds, availability of food is spatially and temporally unpredictable. In contrast, food sources of human origin such as waste tips usually offer resources that are relatively abundant and predictable. Urban waste tips frequently attract numerous birds, particularly gulls (e.g., Coulson et al. 1987; Patton 1988; Giaccardi et al. 1997), and it has been argued that use of these food sources has resulted in an increase of some gull populations (Furness and Monaghan 1987; Pons and Migot 1995; Belant 1997).

Use of artificial food supplies by breeding gulls has been extensively analyzed in the Holarctic region (Hunt 1972; Pons 1992). In contrast, little information is available for other regions, such as the Patagonian coast of Argentina, where the current increase in coastal development, including human settlements and fisheries activities (SAGPYA 1996), may be affecting gull feeding ecology and population dynamics. In several Patagonian coastal cities, fish processing plants produce large quantities of fishery waste, which are disposed in some cases within or close to urban waste tips (Yorio et al. 1996). Although food in urban waste tips is both abundant and predictable, it is of low nutritional value (Pierotti and Annett 1990, 1991; Annett and Pierotti 1999). Moreover, is not continually available due to disposal activities (Coulson et al. 1987; Giaccardi et al. 1997), and is dispersed and mixed with inedible materials, which may increase search time and cause injuries (Blanco 1997). In contrast, tips with fishery waste such as those located in the Patagonian coast constitute a source of food that is abundant, predictable, and of high quality (Giaccardi et al. 1997).

The Kelp Gull (*Larus dominicanus*) is an abundant and widely distributed species on the Patagonian coast, with an expanding population currently estimated at >70,000 pairs distributed in about 100 colonies (Yorio et al. 1998). This is also the most abundant species at waste tips in this area, with thousands of individuals recorded during counts at some sites (Yorio et al. 1996). Despite the importance waste tips may have for Kelp

Gull populations in Patagonia, little is known about how these sources of food are used by breeding adults. We evaluated the magnitude of use of artificial food sources by Kelp Gulls nesting at a large and expanding colony, and assessed the difference in use between tips with urban and fishery waste. Food of human origin can be an important diet component during breeding (Pons 1992; Oro et al. 1996). Fish waste, in particular, should be an attractive food source for nesting gulls because of its high nutritional value. In addition, because of the high food quality of fishery waste we expected that a large proportion of gulls nesting at the nearest colony would forage at the fishery waste tip.

MATERIALS AND METHODS

We assessed the use of waste as food by Kelp Gulls breeding at the Isla de los Pájaros colony (42°25′S, 64°31′W), located on the south shore of Golfo San José (Península Valdés, Argentina), 60 km from the city of Puerto Madryn (Fig. 1). The city of Puerto Madryn has two tips where urban and fishery waste, respectively, are disposed. The abundance of gulls at both waste tips varies throughout the year, with between 1000 and 6000 gulls, depending on the census date (Yorio et al. 1996). During the breeding season thousands of adult plumaged individuals use these tips, although their colony of origin is unknown. The Isla de los Pájaros Kelp Gull colony is the nearest breeding colony to the city of Puerto Madryn and is one of the largest found in northern Patagonia. This colony increased from 1920 nests in 1979 to >5800 nests in 1997 (Bertellotti 1998). Commercial fisheries have shown a significant growth during the last three decades and, therefore, the availability of fish waste for gulls has greatly increased.

The two Puerto Madryn waste tips are 3 km north of the city and are separated by 1 km. The urban waste tip occupies an area of about 50 ha and receives an average of 16.5 metric tons of garbage per day, consisting mainly of domestic waste (Yorio et al. 1996). The sorting of materials by people, the burning of remains, and the presence of dogs result in regular disturbance to the gulls. The fishery waste tip has an area of approximately 70 ha and receives the waste produced by local fish processing plants, sewage, and bilge waste from ships. Approximately 2 metric tons of fish waste, mainly offal (stomachs, livers, and bowels), heads, fins, spines, and fillets. This waste is disposed in large piles, distributed in an area of approximately 3 ha. Fish waste produced at the Puerto Madryn processing plants is used during some years, and then only part of it, for fish meal.

During 3–4 November 1997, we marked adult Kelp Gulls breeding at Isla de los Pájaros to determine if they fed in the Puerto Madryn tips and to estimate the number of birds from this colony that used those tips during incubation. We used a dye mixture (Belant and Seamans 1993) to mark the birds. The dye mixture consisted of 75 g of β-hodamine dye with 100 ml of 70% isopropyl alcohol. This preparation was then mixed with an oil-based silica gel carrier, consisting of 120 g of silica gel (20–50

μm particle size) and 900 ml heavy mineral oil (SAE 90). The dye mixture was applied to domestic chicken eggs, and each dyed egg was placed in a Kelp Gull nest that contained a clutch of ≥1. We left dyed eggs in each nest for 15–20 min during early morning, a time sufficient to ensure that gulls returned to the nest to resume incubation and got the breast and/or abdominal feathers marked. After this time had elapsed, we retrieved dyed eggs to avoid the marking of the nest mate. We placed 1347 dyed chicken eggs in different nests distributed throughout the colony, resulting in a visible red mark on the breast and abdominal feathers of one gull per nest. During peak egg laying (30 October), we estimated the number of Kelp Gull pairs breeding at this colony using 21 circular plots (100 m^2) randomly located within the colony and distributed equally within areas with different habitat characteristics influencing nesting density (Bertellotti et al. 1995).

We made observations at both urban and fishery waste tips in Puerto Madryn during 5–11 November 1997, seven consecutive days following the last day of gull marking at the Isla de los Pájaros colony. We made four censuses per day at both urban and fishery waste tips (0600, 1030, 1530, and 2000 h). We recorded in each census the total number of adult individuals. The proportion of gulls marked in each group was determined as the ratio between the number of marked gulls and the total number of gulls whose breast and abdominal feathers could be observed. We made observations with 25× telescope throughout the waste tip area, from a distance (about 100 m) that allowed us to distinguish Kelp Gull breast and abdominal feathers and avoid disturbance to the birds.

We estimated the mean daily number of gulls flying to the waste tips by counting individuals that passed through a vantage ''observation point'' (42°38′S, 64°58′W) located 10 km from the tips and 45 km from the colony (Fig. 1). As Kelp Gull flocks pass this place following the coastline both over land and water, two observers recorded gulls that flew inland and over the water, respectively. During 5, 8 and 11 November 1997, we made 117 5-min observations with 10 min between consecutive observations. Observations were made from 0700–2000 h. During each 5-min observation, we counted all adult gulls that passed in the direction of the waste tips. We confirmed that gulls recorded at the observation point flew in the direction of the tips through observations made at intermediate points along a road. The total number of gulls per hour was obtained by extrapolating the average of the focal samplings obtained in every hour, grouping the three days. We also calculated the proportion of marked individuals flying in the direction of the waste tips. Because in some cases the observation angle did not allow us to evaluate the presence of color marks, we only considered those cases in which the gull's abdominal and breast feathers could be observed accurately. Results are given as mean ± 1 SD.

RESULTS

We estimated the breeding population of Kelp Gulls at the Isla de los Pájaros colony at 5821 ± 705 pairs (10,232–13,052 breeding individuals,

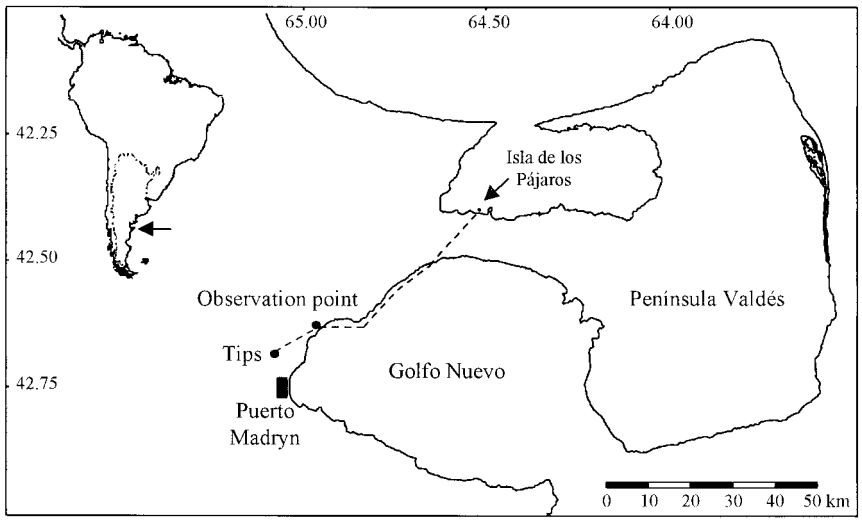

FIGURE 1. Location of the Isla de los Pájaros Kelp Gull breeding colony and the waste tips at Puerto Madryn, Chubut. The dotted line shows the estimated route used by gulls when flying from the colony to the waste tips.

n = 21 plots). The proportion of gulls marked at the colony, assuming that all marking attempts were successful, would be 11.8% (range = 10.3–13.2%) of the incubating individuals in the colony.

Kelp Gulls were observed more frequently (Fisher's exact test, $P <$ 0.001) at the fishery waste tip (100% of the counts; 1694 ± 664 individuals, range = 707–3571, n = 28 counts), than at the urban waste tip (64.3% of the counts; 59 ± 68 individuals, range = 0–256, n = 28). More adult gulls were observed at the fishery waste tip at each of the 4 daily censuses made during the seven days (Wilcoxon test: Z = 4.62, $P <$ 0.00001, n = 28; Fig. 2). The number of gulls varied significantly throughout the day, both at the fishery waste tip (Kruskal-Wallis: H = 14.19, df = 3, $P <$ 0.005, n = 28) and at the urban waste tip (H = 10.54, df = 3, $P <$ 0.05, n = 28; Fig. 2). If morning and afternoon numbers are compared, grouping censuses made within each period, there were significantly more gulls during the afternoon than in the morning censuses at the fishery waste tip (Mann-Whitney U test: U = 22.0, $P <$ 0.0005) while numbers were similar in the urban waste tip (U = 71.5, $P >$ 0.05).

Kelp Gulls were recorded flying toward the waste tips throughout all daylight hours (from 700 until 2000 h), with a mean of 541 ± 349 individuals per hour. Although the number of gulls per hour was similar among days (Kruskal-Wallis: H = 0.69, df = 2, $P >$ 0.05, n = 117), there were significant differences among the different hours of the day (H = 75.08, df = 12, $P <$ 0.0001, n = 117), with a maximum recorded at noon and a minimum during the evening. The estimated mean daily total num-

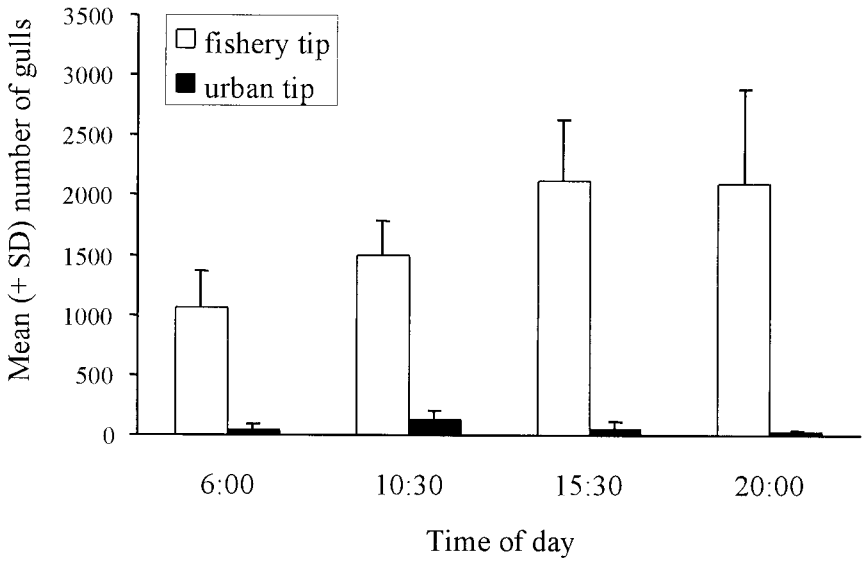

FIGURE 2. Number of adult Kelp Gulls (n = 7), present by time of day at the urban and fishery waste tips in Puerto Madryn during the incubation stage of 1997.

ber of adult Kelp Gulls, which flew from the colony toward the waste tips, was 7028.

The percentage of marked adults flying toward the waste tips was 8.4 ± 3.7% (72 groups, 2777 individuals). No differences were found in the proportion of marked individuals by hour of day (H = 20.14, df = 12, $P > 0.05$, n = 72) or across days (H = 0.20, df = 2, $P > 0.05$, n = 72).

Marked gulls were recorded in all censuses made at both waste tips. The mean percentage of marked individuals observed at the fishery waste tip was 7.4 ± 2.3%, (n = 226 groups, 13,823 individuals). No differences in the proportion of marked gulls were found among days (H = 5.24, df = 6, $P > 0.05$, n = 226) or among the four censuses made during the day (H = 1.47, df = 3, $P > 0.05$, n = 226). The average percentage of marked gulls observed in the urban waste tip was 7.1 ± 2.3% (n = 31 groups, 1395 individuals) and was similar among days (H = 4.20, df = 5, $P > 0.05$, n = 31) and among the four censuses made during the day (H = 0.47, df = 3, $P > 0.05$, n = 31).

The proportion of marked gulls in the colony and those observed in the "observation point" and the tips differed by 3–4% (Fig. 3). Considering the total number of gulls passing by the "observation point" (7028 individuals, see above), we estimated that ≥54–69% of the breeding birds in the Isla de los Pájaros colony were travelling toward the tips, which corresponded with the percentage of the maximum and minimum number of breeding gulls at the colony, respectively. The proportion of

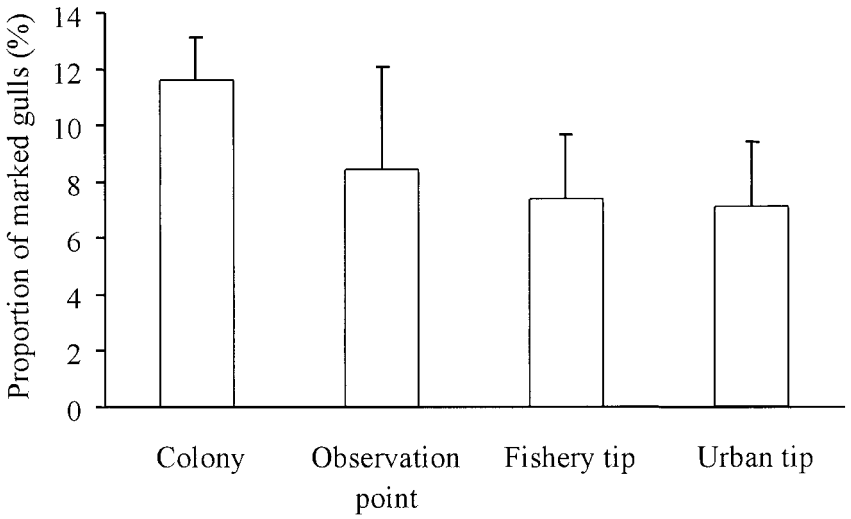

FIGURE 3. Mean (±SD) proportion of breeding Kelp Gulls marked in the Isla de los Pájaros colony, and proportion of marked gulls observed at the Puerto Madryn waste tips and the observation point (see text) during the incubation stage of 1997.

marked gulls observed in the "observation point" and in both tips was similar (*G*-test: $G_2 = 0.76$, $P > 0.05$).

DISCUSSION

Kelp Gulls marked at Isla de los Pájaros were regularly observed feeding at both urban and fishery waste tips. The similarity between the percentage of marked gulls recorded at the observation point, both waste tips, and at the colony, could indicate that a large proportion of Kelp Gulls breeding at Isla de los Pájaros feed at the Puerto Madryn tips, mostly the fish waste tip, during incubation. The observation of a large number of gulls and the high proportion of marked gulls flying from the colony toward the waste tips support this hypothesis. In addition, the constant proportion of marked individuals observed in successive censuses suggests these food sources are being used by a constant number of gulls, both within and across days.

Isla de los Pájaros is the nearest breeding location to the Puerto Madryn waste tips, and most adult individuals feeding at these sources could be nesting at this colony. However, a breeding Kelp Gull marked in a preliminary assay to test the marking technique at the Punta Pirámide colony, a small colony also located in Península Valdés, was recorded at the Puerto Madryn fishery waste tip during the study (M. Bertellotti, unpubl. data). Thus, gulls from this and other nearby colonies may also use these waste tips during incubation. The presence of adult gulls from other colonies or of nonbreeding individuals with adult plumage could explain the difference (about 3–6%) between the proportion of marked Kelp

Gulls observed at the waste tips and at the observation point relative to the proportion of gulls marked at the colony. However, other colonies in Peninsula Valdés are comparatively small, totaling 1975 breeding pairs in six colonies, and are located > 100 km from the studied tips (Bertellotti 1998). Therefore, our estimation of the proportion of breeding gulls using the tips is conservative.

More Kelp Gulls were recorded flying toward the waste tips at noon than during the evening. However, an increase in the number of gulls toward the afternoon was observed in all days at the waste tip, indicating that individuals accumulate throughout the day. These results indicate that not all breeding individuals return to the colony at the end of the day, as also demonstrated by the presence of marked adult gulls communally roosting among several hundred individuals at a dry lagoon located a few kilometers northwest of the tips (M. Bertellotti, unpubl. data).

Although gulls breeding at Isla de los Pájaros used both the urban and fishery waste tips, the number of individuals recorded at the fishery waste tip was at least an order of magnitude larger. This difference is probably due to the difference in quality and quantity of food disposed at each tip (Pierotti and Annett 1990, 1991; Annett and Pierotti 1999). At the fishery tip, gulls feed on abundant and nutritional fish waste. Thus, gulls would be investing less time searching for edible materials there than at the urban waste tip. However, differences observed between tips may be also due to other factors. In the urban waste tip, humans searching for recyclable materials and setting fires to incinerate waste directly or indirectly harass gulls. This disturbance may have resulted in fewer gulls present at the urban waste tip. Displaced gulls could have also readily flown to the fishery waste tip where they were undisturbed.

Pellets consisting of mollusks and crustaceans are commonly encountered in most Kelp Gull colonies in Patagonia (Bertellotti and Yorio 1999), although they may represent a low proportion of the ingested biomass. However, pellets were rarely observed during the census and marking of gulls at the Isla de los Pájaros; only some fish remains, mainly scales and cranial bones, were recorded among nests (M. Bertellotti, pers. obs.). Preliminary observations on gulls feeding at the fishery waste tip indicate that more than 90% of the ingested food consists of offal and pieces of fish fillet (340 observations of feeding individuals). Because this food lacks hard parts, pellet production would be scarce in this study colony and other colonies (M. Bertellotti, pers. obs.). These observations support the hypothesis that Kelp Gulls that breed at Isla de los Pájaros and other colonies are highly dependent on fishery waste. Even though Kelp Gulls feed on a wide variety of prey (Bertellotti and Yorio 1999), they can also be selective foragers showing individual specialization on higher quality food such as fish, as has been shown in other gull studies (Annett and Pierotti 1999).

The use of artificial food sources, such as garbage and fishing discards, has been suggested as one of the main causes of gull population expansion at some locations (e.g., Pons 1992; Oro et al. 1996), including Kelp

Gulls in New Zealand (Fordham 1967) and South Africa (Steele and Hockey 1990). Kelp Gull populations at six locations in Patagonia have increased in the last two decades with a mean annual growth rate of 10.6 ± 6.7% (range 3.7–18.8%; Bertellotti 1998), and it has been argued that the increase of Kelp Gull populations in Patagonia may result in conflicts with human activities and with the conservation of other coastal species (Rowntree et al. 1998; Yorio et al. 1998). The use of fishery waste might have contributed to the increase in the number of Kelp Gulls breeding at the Isla de los Pájaros, and probably at other growing colonies located close to fish waste tips in coastal Patagonia. Waste tips at Puerto Madryn are used by Kelp Gulls of all age classes throughout the year (Yorio et al. 1996; M. Giaccardi, unpubl. data) probably enhancing gull survival during the winter, particularly of young birds. The consumption of fish waste is probably advantageous in energy and nutritional terms. Fish is important for egg formation and chick growth (Annett and Pierotti 1989; Pierotti and Annett 1991; Bolton et al. 1992) and may increase life-span and long-term breeding performance (Annett and Pierotti 1999). Therefore, the consumption of fish at predictable and abundant artificial food sources at Puerto Madryn may also enhance breeding success. The Isla de los Pájaros is surrounded by relatively rich intertidal areas with a high diversity and abundance of molluscs, crustaceans, and other invertebrates (Ciocco 1988; Bala 1989), which are numerically important components of the Kelp Gull's diet at other locations in Chubut (Bertellotti and Yorio 1999). The quality, abundance, and predictability of the food disposed at the fishery waste tip could then foster the use of this site in relation to other natural food sources located closer to their breeding colony.

The present study shows that most breeding Kelp Gulls nesting at a large and growing colony distant 60 km from an important urban area, feed extensively on artificial food sources, particularly fish waste. We suggest similar patterns of association should be observed at other locations along the Argentinean coast. Although gulls may be serving to clean up fish waste that would otherwise generate smells and bacterial growth, poor management of waste could result in gull population growth and increased threats to coastal wildlife and humans. Certain management techniques, such as the removal of artificial food sources (Belant 1997), may be effectively assessed at the Puerto Madryn and other Patagonian waste tips. For example, the reduction in fish discards available to gulls, as a result of both the covering of waste at the tip and its processing for fish meal, has resulted in a decrease in the abundance of Kelp Gulls at the urban and fishery waste tips at Rawson, Chubut (Giaccardi et al. 1997). Any management activities should take into account possible changes in Kelp Gull foraging behavior that could affect other coastal species through predation and parasitism.

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