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TEMPORAL PATTERNS OF ABUNDANCE AND WASTE USE BY KELP GULLS (*LARUS DOMINICANUS*) AT AN URBAN AND FISHERY WASTE SITE IN NORTHERN COASTAL PATAGONIA, ARGENTINA

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Resumen. – Patrones temporales en la abundancia y uso de residuos por Gaviotas cocineras (*Larus dominicanus*) en un basural urbano y pesquero de la costa norte de Patagonia, Argentina. – Cuantificamos el uso por la Gaviota cocinera (*Larus dominicanus*) de los basurales urbanos y pesqueros en Puerto Madryn, Argentina, durante 1996 y 1997. La Gaviota cocinera estuvo presente en todos los censos mensuales efectuados en ambos basurales durante los dos años. Los números totales de gaviotas en cada mes fueron altos y variables, con una media de 4724 y 4612 individuos en 1996 y 1997, respectivamente. El número medio de gaviotas en el basural pesquero fue significativamente mayor que en el basural urbano (3767 vs 901). En todos los conteos en los basurales pesquero y urbano, las gaviotas adultas fueron significativamente más abundantes que las no adultas (media = 811 vs 91 y 3147 vs 628, respectivamente). Entre las clases de edad más jóvenes, los individuos del tercer año fueron los menos abundantes. La proporción de adultos respecto al total de gaviotas presentes fue alta en todas las visitas a ambos basurales, aunque mostró una leve disminución en el basural pesquero durante la temporada reproductiva. Durante la temporada reproductiva, el número de gaviotas varió significativamente a lo largo del día en ambos basurales, mientras que en la temporada no reproductiva los números variaron significativamente solo en el basural urbano. El basural pesquero de Puerto Madryn constituye una fuente de alimento más atractiva que el basural urbano, probablemente debido a la mayor cantidad y calidad de los residuos depositados. El uso de los basurales en Puerto Madryn podría estar favoreciendo el éxito reproductivo de las gaviotas y la supervivencia individual durante el invierno, particularmente de aves jóvenes. Los conflictos potenciales resultantes del uso por la Gaviota cocinera de los basurales y los efectos sobre sus poblaciones podrían ser minimizados con un adecuado manejo de los residuos urbanos y pesqueros.

Abstract. – We quantified the use by Kelp Gulls (*Larus dominicanus*) of urban and fishery waste sites at Puerto Madryn, Argentina, during 1996 and 1997. Kelp Gulls were present at all monthly counts made at both waste sites throughout the two years of the study. Total numbers of gulls in each month were high and variable, with a mean of 4724 and 4612 individuals in 1996 and 1997, respectively. The mean number of gulls at the fishery waste site was significantly larger than at the urban waste site (3767 vs 901). Adult Kelp Gulls were significantly more abundant than non-adult gulls at every count at both the urban and fishery waste sites (mean = 811 vs 91 and 3147 vs 628, respectively). Among the younger age classes, individuals in their third year were the least abundant. The proportion of adults with respect to total gulls present was high during all visits to both sites, although it showed a slight decrease in the fishery waste site during the breeding season. During the breeding season, the number of gulls varied significantly

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throughout the day at both sites while, during the non-breeding season, numbers varied significantly only in the urban waste site. The Puerto Madryn fishery waste site constitutes a more attractive food source than the urban waste site probably due to the higher quality and quantity of discarded food. The use of waste sites at Puerto Madryn may be enhancing gull breeding success and individual survival during the winter, particularly of young birds. Potential conflicts due to Kelp Gull use of waste sites and the effects on their populations could be minimized by adequate urban and fish waste management. *Accepted 30 March 2003*.

Key-words: Waste sites, feeding, Kelp Gull, *Larus dominicanus*, Patagonia.

INTRODUCTION

Many gulls are feeding generalists taking advantage of artificial food sources resulting from human activities such as refuse sites, fisheries bycatch, sewage outfalls, and slaughter houses (Furness & Monaghan 1987). Gull populations of several species have increased throughout the world and the use of artificial food sources has been suggested as one of the causes of the observed population expansion (Furness & Monaghan 1987, Spaans & Blokpoel 1991). As a result of their concentration close to cities when using these alternative food sources, gulls may result in hazards to aircrafts and a threat to human health (Butterfield *et al.* 1983, Burger 1985, Blokpoel & Tessier 1986, Belant 1997).

The Kelp Gull (*Larus dominicanus*) is an abundant and widely distributed species throughout the southern hemisphere (Burger & Gochfeld 1996), though recent studies suggest it may be a species complex. In the Patagonian coast of Argentina, it breeds along the 3000 km coastline and has a total population estimated at more than 70,000 pairs breeding in about 100 colonies (Yorio *et al.* 1999). Kelp Gulls are feeding generalists, taking advantage of artificial food sources resulting from human activities (Bertellotti & Yorio 1999, 2000) and have shown an important population expansion during the last decades (Yorio *et al.* 1998). The use of waste provided by human activities may be affecting Kelp Gull feeding ecology and population dynamics. At many coastal cities, Kelp Gulls take advantage of urban waste (Yorio *et al.* 1996), which may be both abundant and predictable. In addition, fish processing plants at several of these cities produce large quantities of fishery waste which is discarded within or close to urban waste sites. Fishery waste sites constitute a source of food that is also abundant and predictable but, in contrast to food at urban waste sites, it is of high nutritional value.

Despite being a common species in coastal Argentina and the existence of potential conflicts due to its population expansion (Yorio *et al.* 1998), little is known about the patterns of use of waste sites by Kelp Gulls. Giaccardi *et al.* (1997) documented that Kelp Gulls were regularly present in high numbers at a urban and fishery waste site in Rawson, Chubut, and that gull numbers at that site were related to waste availability. Urban and fishery waste sites at the city of Puerto Madryn, Chubut (Fig. 1), are located close to large colonies of Kelp Gulls which make extensive use of artificial food both during and outside the breeding season (Bertellotti & Yorio 1999, Bertellotti *et al.* 2001). Baseline information at this coastal sites is needed to assess their importance for gulls throughout the year and to evaluate future changes in both the magnitude of use and of disposal practices. In this study, we quantified the use of the Puerto Madryn urban and fishery waste sites by Kelp Gulls, a) to assess their importance for this gull species, b) to analyze the age distribution of individuals using both sites, and c) to analyze the difference in the

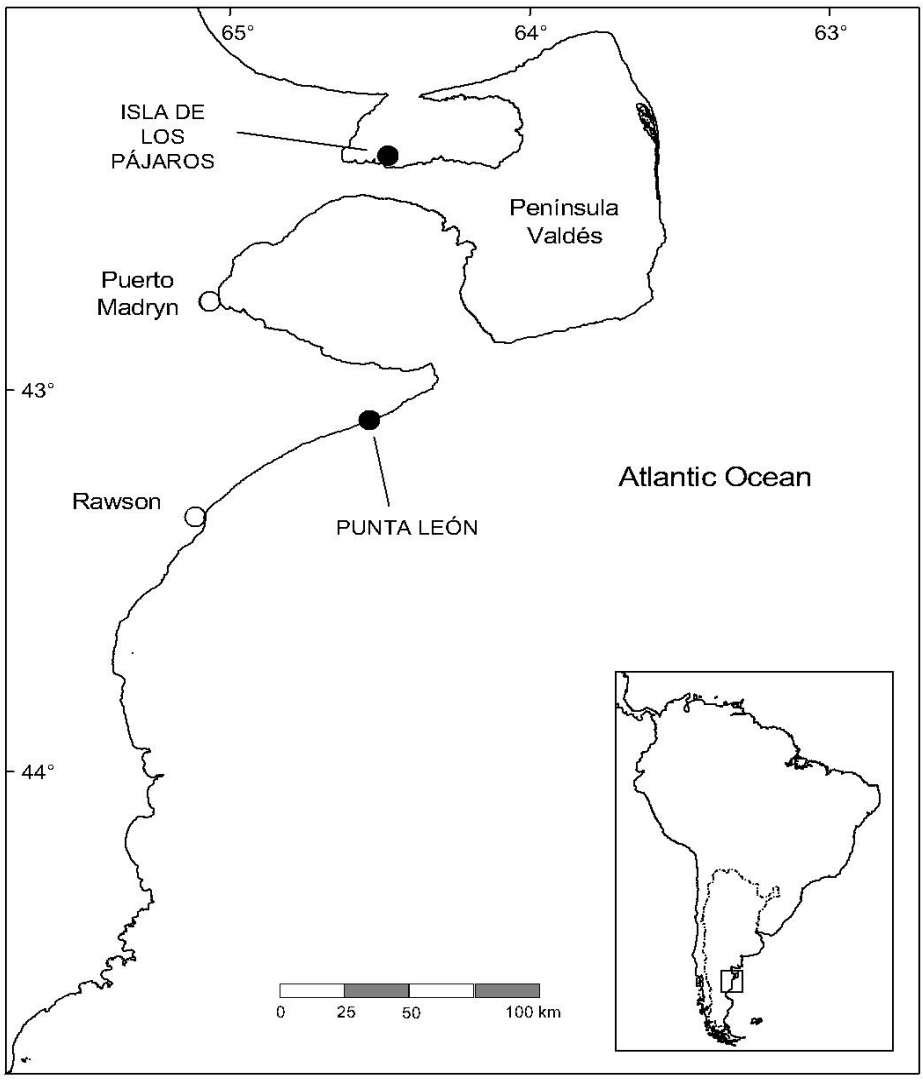

FIG. 1. Geographical location of the cities of Puerto Madryn and Rawson, and of the Kelp Gull colonies of Isla de los Pájaros and Punta León.

use by gulls of the urban and fishery waste sites.

METHODS

The two Puerto Madryn waste sites are 3 km north of the city and are separated by 1 km. The urban waste site received during the study period an average of 16.5 metric tons of garbage per day, consisting mainly of domestic waste, which was generally distributed in an area of approximately 0.4 ha. The sorting of materials by people, the burning of remains, and the presence of dogs resulted in regular

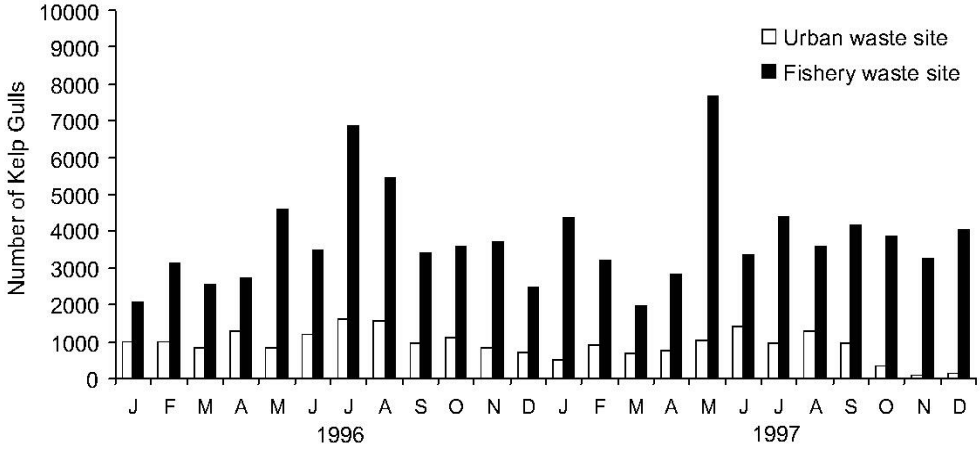

FIG. 2. Monthly variation in Kelp Gull abundance at the urban and fishery waste sites in Puerto Madryn, Argentina, during 1996 and 1997.

disturbance to the gulls. The fishery waste site received waste produced by local fish processing plants, sewage, and bilge waste from ships. An average of two metric tons of fish waste, mainly offal (stomachs, livers, and intestines), heads, fins, spines, and fillets were discarded per day during the study years, although during some months (e.g., November 1997), up to 54 tons of waste were discarded on a single day. This waste was generally discarded in one to three large piles. Until recently, fish wastes were not used as fertilizer or for fish meal as in other regions. However, after the end of this study, some processing plants at Puerto Madryn have occasionally begun using waste for fish meal.

We determined the seasonal abundance of Kelp Gulls at both sites through monthly counts of individuals between January 1996 and December 1997. We made counts with spotting scopes 20–45x and binoculars 10x50 from vantage points and from inside a vehicle at both the urban and fishery waste sites. Gulls were distributed throughout the site in groups which generally did not exceed 200 individuals. The number of gulls on the ground was obtained from the average of two successive counts of all individuals by the same observer, while the number of gulls which were either flying over food sources or actively foraging concentrated in large groups on waste piles was estimated by counting by twenties. Total numbers were obtained by adding all counts made with both methods. Gulls habituated to vehicles and continued with their regular activities unless closely approached. We made monthly counts at approximately the same time (14:00–16:00 h). In each visit, we estimated all Kelp Gulls present at the site. Gulls were identified into four age classes on the basis of plumage characteristics: juveniles (1st-winter and 2nd-summer), immatures (2nd-winter and 3rd-summer), subadults (3rd-winter and 4th-summer), and adults (from 4th-winter on). We estimated the number of gulls of each age-class by counting the number of individuals of each age-class at different gull groups distributed throughout the site, and then extrapolating the average proportion to the total count for that date. To analyze abundance patterns in relation to the breeding season, we grouped "juveniles" and both "immature" age-classes into a "non-adult" category.

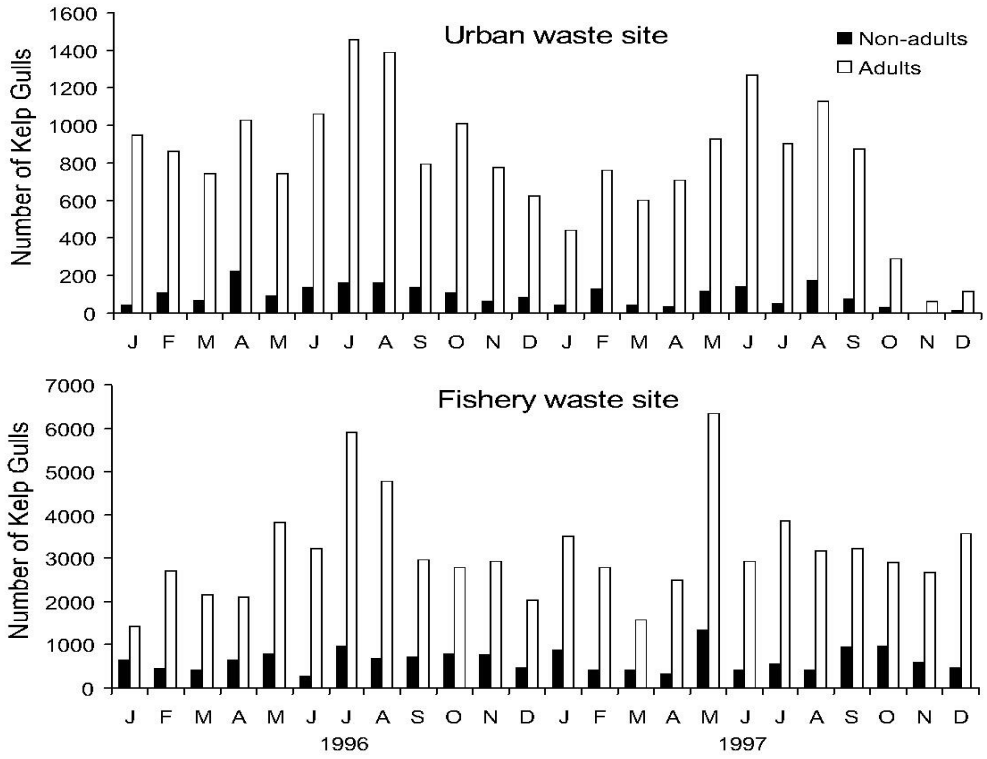

FIG. 3. Monthly variation in abundance of adult and non-adult Kelp Gulls at the Puerto Madryn urban and fishery waste sites during 1996 and 1997.

To determine the patterns of abundance during the day, we made observations at both urban and fishery waste sites from 11 to 17 April 1997 (non-breeding season) and from 5 to 11 November 1997 (breeding season). In both seasons, we made four counts per day at both sites (07:30, 11:30, 15:30 and 18:30 h in April, and 06:00, 10:30, 15:30, and 20:00 h in November). We recorded in each count the total number of individuals. Parametric tests have been used whenever their assumptions were met. Results are given as mean ± SD.

RESULTS

Kelp Gulls were present at all counts made at both the urban and fishery waste sites throughout the two years of the study. The total number of Kelp Gulls counted each month at both sites was high and variable, with a mean number of gulls of 4724 ± 1594 (n = 12) for 1996 and 4612 ± 1508 (n = 12) for 1997. The number of gulls increased in early fall, reaching a maximum number of 8472 individuals in July 1996 and 8690 individuals in May 1997.

The abundance of Kelp Gulls at the fishery waste site was higher than at the urban waste site in all counts during both years (Fig. 2). Gull numbers at the fishery waste site (mean = 3767 ± 1350, n = 24) were significantly larger than at the urban waste site (mean= 901 ± 394, n = 24) (Paired t-test, t = –10.94, $P < 0.001$).

Adult Kelp Gulls were significantly more abundant than non-adult gulls at every count

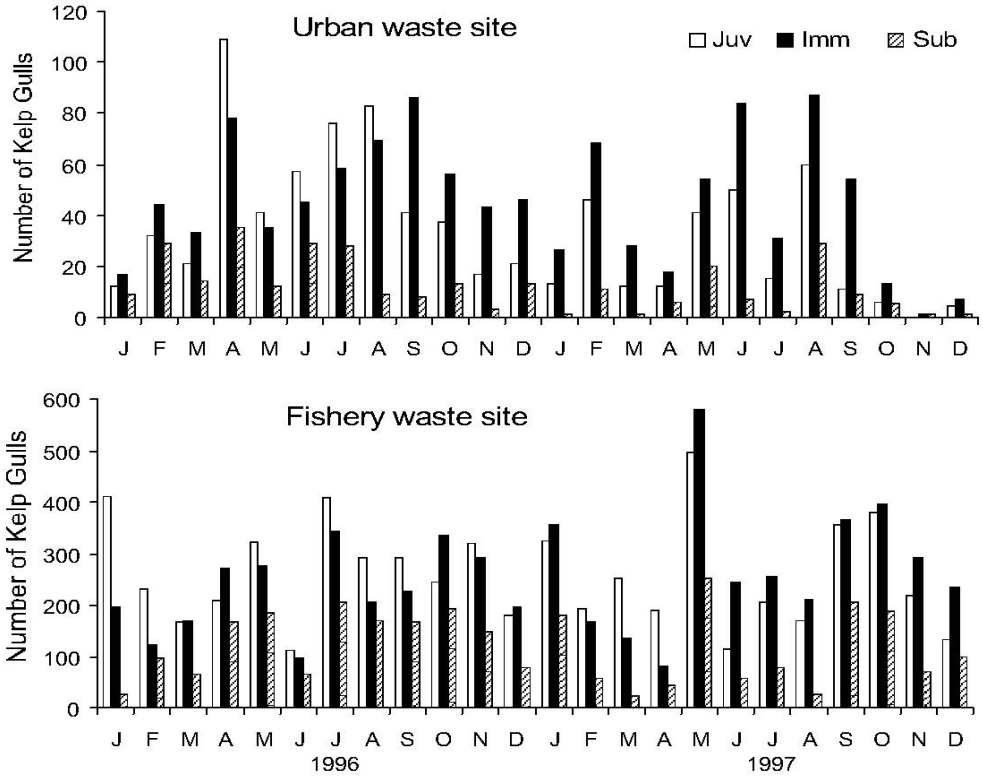

FIG. 4. Monthly variation in age-class distribution of non-adult Kelp Gulls at the Puerto Madryn urban and fishery waste sites during 1996 and 1997. Juv: juveniles (1st-winter and 2nd-summer), Imm: immatures 1 (2nd-winter and 3rd-summer), Sub: subadults (3rd-winter and 4th-summer).

at both the urban (mean = 811 ± 350 vs 91 ± 57, n = 12; paired t-test, t = –11.51, $P < 0.0001$) and fishery waste site (mean = 3147 ± 1177 vs 628 ± 254, n = 24; paired t-test, t = –11.86, $P < 0.0001$) (Fig. 3). The number of adults at the urban waste site varied from a minimum of 61 individuals (November 1997) to a maximum of 1453 individuals (July 1996). At the fishery waste site, numbers varied between 1407 (January 1996) and 6324 (May 1997). Adult abundance at the urban waste site increased in the fall and winter months and decreased as the breeding season progressed (from September to January) while, at the fishery waste site, adult abundance increased in late fall and winter but remained relatively stable during the breeding season (Fig. 3).

Adult gull abundance with respect to total number of individuals remained relatively constant throughout the year in both the urban waste site (mean = 90.7 ± 3.9%; $\chi^2 = 2.9$, $P > 0.05$) and the fishery waste site (mean = 83.0.± 5.5%; $\chi^2 = 8.2$, $P > 0.05$). However, the mean percentage of adult gulls in the fishery waste site was significantly smaller during the breeding than the non-breeding season (79.8 ± 5.5% vs 85.5 ± 4.1%, Mann-Whitney $U = 27$, $Z = 2.52$, $P < 0.012$, n = 10, 14).

Among the younger age classes, individuals in their third year were the least abundant (Fig. 4). As in the adult age-class, the number

of individuals in each of the younger age-classes were higher in the fishery than in the urban waste site. The numbers in each of these age-classes varied throughout the year (Fig. 4).

During the breeding season, the number of gulls varied significantly throughout the day, both at the fishery waste site (Kruskal-Wallis: $H = 15.20$, df = 3, $P = 0.002$, n = 28) and at the urban waste site (Kruskal-Wallis: $H = 10.90$, df = 3, $P < 0.012$, n = 28). Numbers increased towards the end of the day at the former site, while they were highest during mid morning at the latter. During the non-breeding season, gull numbers significantly decreased towards the end of the day in the urban waste site (Kruskal-Wallis: $H = 12.80$, df = 3, $P < 0.005$, n = 28), but were similar throughout the day in the fishery waste site (Kruskal-Wallis: $H = 1.15$, df = 3, $P = 0.76$, n = 28).

DISCUSSION

Kelp Gulls were present at the Puerto Madryn urban and fishery waste sites throughout the year and in numbers that could reach several thousands individuals. Although all age-classes were present, adult Kelp Gulls were always more abundant than the younger age-classes. Our data show that the number of Kelp Gulls taking advantage of waste was highly variable at both temporal scales analyzed. This variability in numbers indicates that, in order obtain results that may be comparable, care should be taken when designing monitoring programs.

The proportion of adults with respect to the total number of gulls present was high in all visits to both sites, although it showed a slight decrease in the fishery waste site during the breeding season. The abundance of Kelp Gull adults in this site, however, remained high throughout the spring and summer months, suggesting that gulls from nearby colonies continue using fishery waste during the breeding season. Recent studies have shown that a large proportion of breeding gulls from Isla de los Pájaros, a small island off Península Valdés and the closest and largest colony in the area (Fig. 1), forage extensively at the Puerto Madryn sites, at least during the incubating stage (Bertellotti *et al.* 2001). The observed decrease in the number of adult birds may be due to colony attendance by one member of each pair, and a result of dispersion towards natural food sources by individuals of other colonies further away from the Puerto Madryn waste sites.

The patterns of relative abundance between age-classes at Puerto Madryn differed from that observed at the Rawson urban and fishery waste site. At the latter location, the relative proportion between adults and non-adults varied depending on season as, while adult gulls were highly represented during the non-breeding season compared to younger ones (82 vs 18%), the proportions of adults and non-adults were similar during the breeding season (59 vs 41%) (Giaccardi *et al.* 1997). In Rawson, as the breeding season progresses, the proportion of adults may decrease as breeders from colonies located 60–110 km away disperse towards natural food sources, of probably better quality, closer to their colonies. Kelp Gulls breeding at a large colony (over 10,000 individuals) at Punta León, the closest to the city of Rawson (50 km), feed mostly on mollusks and fish, although they include urban waste in their diet, particularly during incubation (Bertellotti & Yorio 1999).

Even though Kelp Gulls used both of Puerto Madryn sites, abundance at the fishery waste site was at least an order of magnitude larger. This is probably due to differences in quality and quantity of food discarded at each site. Quantities of waste may be often larger at the fishery waste site but, more importantly, gulls at this site can feed on highly nutritional

waste (Pierotti & Annett 1991, Annett & Pierotti 1999). A higher abundance of Kelp Gulls feeding on fishery waste than on urban waste has been recorded at sites throughout the coasts of northern Patagonia (Yorio & Giaccardi 2002. The preference for fish over urban waste has also been shown at the mixed-waste site of Rawson (Giaccardi *et al.* 1997). Our results show that the Puerto Madryn fishery waste site constitutes a more attractive food source than the urban waste site, particularly during the breeding season; gull abundance remained similar at the fishery waste site during the breeding season, but decreased at the urban waste site. In addition to being of lower nutritional value than fishery waste, urban waste is dispersed and mixed with inedible materials, which may increase search time, and may not be continually available due to disposal activities (Coulson *et al.* 1987, Giaccardi *et al.* 1997). Differences observed between sites, however, may be also due to other factors. Gulls at the urban waste site may be directly or indirectly harassed by humans searching for recyclable material and setting fires to burn waste. This disturbance may have resulted in fewer gulls at the urban waste site and displaced gulls could have also flown to the fishery waste site where they were undisturbed.

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 (see Spaans & Blokpoel 1991, Pons 1992, Oro *et al.* 1996), including Kelp Gulls in New Zealand (Fordham 1967) and South Africa (Steele & Hockey 1990). Kelp Gull populations in Patagonia have increased in the last two decades, and it has been argued that this increase may result in conflicts with human activities and with the conservation of other coastal species (Rowntree *et al.* 1998, Yorio *et al.* 1998, Frere *et al.* 2000). The use of waste sites at Puerto Madryn may be enhancing gull survival during the winter, particularly of young birds. In addition, the consumption of fish at predictable and abundant fish waste sources such as Puerto Madryn may be enhancing breeding success, as fish is important for egg formation and chick growth (Annett & Pierotti 1989, Pierotti & Annett 1991, Bolton *et al.* 1992) and may increase life-span and long-term breeding performance (Annett & Pierotti 1999).

The removal or reduction of artificial food sources may be an effective management technique to minimize the negative effects of waste use by gulls (Belant 1997). A reduction in the waste available to gulls can lead to a decrease in their abundance at sites and their dispersion to traditional foraging sites (Pons 1992). This could be attained by the reduction of waste discarded at sites, its covering with soil at the end of each working day, and the burning of waste. Partially burn waste is less attractive or unusable to gulls (Monaghan *et al.* 1986, Patton 1988). A reduction in fish discards available to gulls, as a result of both the covering of waste at the site and its processing for fish meal, has resulted in a decrease in the abundance of Kelp Gulls at the urban and fishery waste site of Rawson, Chubut (Giaccardi *et al.* 1997). Therefore, potential conflicts due to Kelp Gull use of waste sites and the effects on populations could be minimized by adequate urban and fish waste management.

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