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Utilisation of fishery waste by Kelp Gulls attending coastal trawl and longline vessels in northern Patagonia, Argentina

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Utilisation of fishery waste by Kelp Gulls was studied onboard trawl and longline vessels in Golfo San Matías, Patagonia, Argentina, between November 1996 and May 1997. Individuals of all age-classes were present in all counts and in similar proportions in both fisheries, although flocks consisted mainly of adults. Mean maximum number per day was significantly larger in the trawl than in the longline fishery (299.2 vs 197.6). In both fisheries, the number of gulls increased as the fishing operation progressed, with maximum numbers observed during discarding and/or gutting. Kelp Gulls consumed a fraction (67.0%) of the experimental discards as they selected prey according to species, size and shape. The Argentine Hake (*Merluccius hubbsi*) was the preferred fish. Longtail Hake (*Macruronus magellanicus*), Sea Salmon (*Pseudopercis semifasciata*) and flounders (*Paralictchys isosceles* and *Xystreurys rasile*) were negatively selected. Rejected species were deep bodied with respect to their length, had strong dorsal fin spines, were flat shaped or had caudal spines, making them more difficult to handle and swallow. The proportion of fish consumed for all species decreased with increasing fish length. Kelp Gull selection of discards according to species and size suggests that care should be taken when evaluating the availability of this food source for seabirds. Considering the fraction of fishery waste consumed by gulls obtained in this study, fish discards produced by coastal fisheries at Golfo San Matías may support a population of more than 30 000 Kelp Gulls. This abundant and high quality food source could have an important effect on the population expansion of the Kelp Gull.

1. Introduction

Fishing operations can benefit seabirds by providing food in the form of fishery waste that is not normally available or which cannot be obtained by usual feeding methods (Furness & Monaghan 1987). The consumption of fishing discards at sea is an important component of the feeding ecology of many gulls (Camphuysen 1994a, Furness et al. 1992, Oro et al. 1996), and it has been suggested that it has contributed to the population expansion of some species in the

Northern Hemisphere (Furness et al. 1992). Seabird use of fish waste has been quantified at several fishing areas, particularly in the North Sea (e.g. Hudson & Furness 1988, Camphuysen et al. 1995, Walter & Becker 1997) and the Mediterranean Sea (Oro & Ruiz 1997), but except for work conducted on Black-browed albatrosses *Diomedea melanophris* around the Malvinas (Falkland) Islands (Thompson 1992, Thompson & Riddy 1995), discard selection and consumption has not been assessed for any other seabird in the south-western Atlantic Ocean.

The Kelp Gull *Larus dominicanus* is one of the main species associated with coastal fisheries in Patagonia, Argentina (Yorio & Caille 1999). Several of its colonies have increased in size during the last decade, and the use of artificial food sources, including fishing waste, may be contributing to the observed expansion (Yorio et al. 1998), as has been also suggested for other seabird species in the northern hemisphere (Camphuysen 1994a, Oro et al. 1996). Despite the important association between Kelp Gulls and coastal fisheries in Patagonia (Yorio & Caille 1999), little is known about the quantity and type of food provided by fishing operations and the way gulls use discards. This sort of information is needed to understand the way it can affect their foraging ecology and population dynamics. Recently, Annett and Pierotti (1999) showed that the principal trait influencing both survival and reproduction in the Western Gull (*Larus occidentalis*) was individual diet, which consisted of a mix of human refuse and fish. They found that a positive relationship existed among the amount of fish taken, breeding life-span, reproductive performance, and recruitment.

Knowledge of how gulls make use of artificial food sources is necessary to start understanding its effects on their population dynamics and the potential conflicts with human activities. Our aims were to describe how Kelp Gulls take advantage of fishing waste at sea, quantify their consumption of discards, and determine their preferences for species and sizes of discarded fish at coastal trawl and longline fisheries operating in northern Patagonia, Argentina.

2. Methods

2.1. Study species, study area and characteristics of coastal fisheries

Kelp Gulls are included in the group of large gulls (900–1335 g and a wing span of 128–142 cm), and are widely distributed in the Southern Hemisphere (Burger & Gochfeld 1996). In Argentina, they nest in a great variety of habitats along the sea coast and at continental wetlands (Bo et al. 1995) and, in coastal Patagonia, they have been recorded breeding at more than 100 sites in colonies that range between a few and several thousands pairs (Yorio et al. 1998). The Kelp Gull is a generalist and opportunist seabird that feeds on a wide variety of prey, including garbage and fish discarded from coastal fisheries (Bertellotti & Yorio 1999, Yorio & Caille 1999). Kelp Gulls in the Golfo San Matías area breed between October and January.

Between November 1996 and May 1997, observations were conducted onboard coastal fishing vessels operating in Golfo San Matías, Río Negro, Argentina (Fig. 1). Two fishing methods, trawling and setting of longlines, are employed in this area. Both fisheries operate in nearby fishing grounds at about the same time, mostly during daylight hours. Seven or eight coastal trawl vessels operate throughout the year. These vessels are 19–24 m long and tow bottom nets (150–200 mm mesh size and 12–20 m mouth opening) at two-three knots. Trawls last between one and three hours. Total annual catch (1993–1996) was estimated at 13 800 tons, of which 9 700 tons were landed (Caille & González 1998). In addition, between 26 and 44 longline vessels (lines with between 3 000 and 4 000 hooks) operate in this fishing ground. The main target species for both fisheries is the Argentine hake (*Merluccius hubbsi*). Vessels operate up to 30 km from shore, although longline vessels generally operate closer to the coast than trawl vessels. Trips by trawlers last between three and six days (3–4 hauls per day), while trips by longline vessels last less than a day.

Fish captured by trawlers are sorted on deck

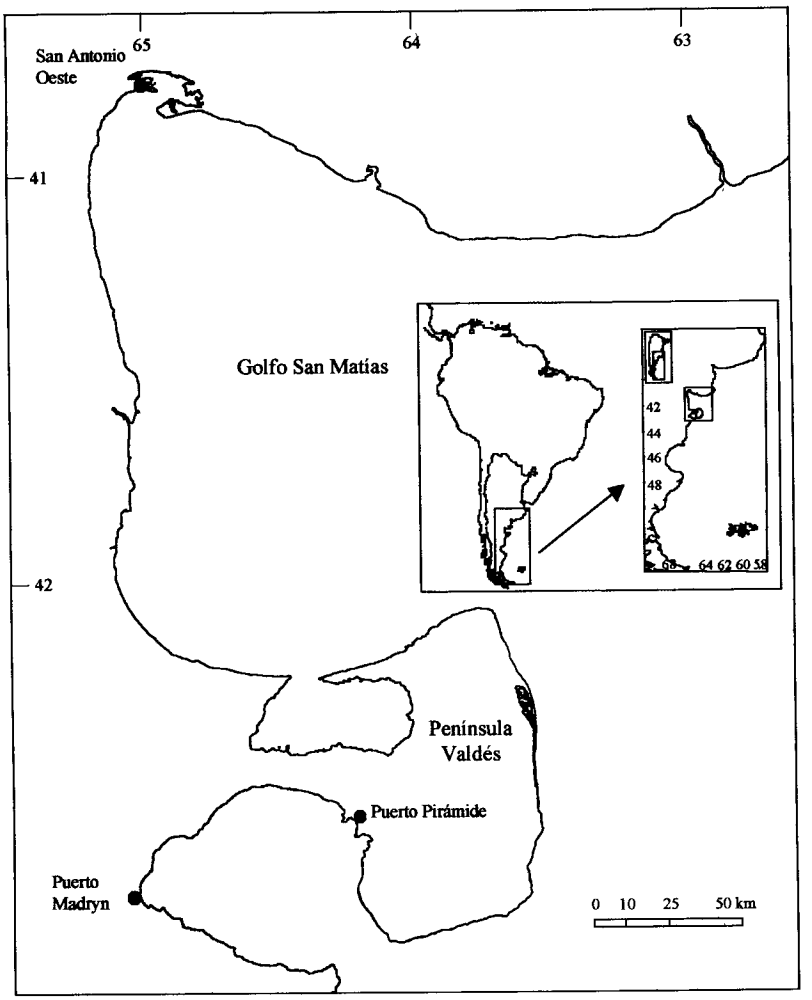

Figure 1. Map of the study area (Golfo San Matías).

and non-commercial sizes and bycatch are discarded overboard. Most fishery waste consists of fish but, on occasion, offal from Argentine hake large enough to be gutted (> 60 cm) is also discarded. Total biomass discarded per year (1993–1996) by the Golfo San Matías trawl fisheries was estimated at 4 100 tons (Caille & González 1998). A total of 23 fish species are discarded, with an average of seven species per haul (Caille & González 1998). Fish captured by longline vessels are all gutted and the resulting offal discarded overboard. Occasionally, large (> 50 cm) non-commercial fish are also discarded. The total biomass of offal discarded per year by the Golfo San Matías longline fisheries was estimated to be a few hundred tons (G. Caille, pers. comm.).

2.2. Experimental discards

Information on discard use by Kelp Gulls was gathered for a total of 14 days (56 hauls) in the trawl fishery and five days (5 hauls, equivalent to 19 000 hooks) in the longline fishery. Fishing operations were divided into five activities: (1) Travelling: transit to and from fishing grounds,

(2) Towing: towing of the net by trawl vessels, (3) Longline setting: deployment of longlines; (4) Haulback: lifting of the net to the vessel; (5) Discarding: sorting, gutting and discarding of fish and offal.

Counts of gulls associated with vessels were made from the top deck every 30 minutes throughout the entire fishing operation. A total of 237 counts was made at the trawl fishery (mean = 16.9, SD = 4.3, counts per day) and 104 counts at the longline fishery (mean = 20.8, SD = 4.1, counts per day). Gulls were identified into four age classes on the basis of plumage characteristics (Grant 1986, Bo et al. 1995): juveniles (1st-winter and 1st-summer), immatures 1 (2nd-winter and 2nd-summer), immatures 2 (3rd-winter and 3rd-summer), and adults (from 4th-winter on). Maximum numbers of gulls were recorded for each haul. Comparisons between both fishing methods and stages of the fishing operation were made using the mean maximum number of gulls per fishing day. A fishing day was defined as a day when at least one haul was made.

Prey selection was studied through experimental discarding of fish obtained from the discard-fraction of each catch. Fish species were selected on the basis of their frequency of occurrence and abundance in the discards using data obtained during the fishing season of 1995–1996 by the On-board Observer Program, Patagonian Coastal Zone Management Plan. A total of 23 fish species was discarded during that season, and the main discarded species were Argentine Hake (roundfish: R), Longtail Hake (R) *Macruronus magellanicus*, Flounders (flatfish: F) *Paralicthys isosceles* and *Xystreurys rasile*, Skate (F) (*Raja flavirostris*), and Brazilian Codling (R) *Urophycis brasiliensis*. Another three species that were common in the discards during the present study were Butterfish (deep bodied fish) *Stromateus brasiliensis*, Blackbelly Rosefish (R) *Helicolenus dactylopterus*, and Sea Salmon (R) *Pseudopercis semifasciata* and were included in the experiments. The nine fish species selected represented more than 85% of the total discarded biomass in 1995–1996 (G. Caille, pers. comm.). Fish were identified and measured (total length in cm) and experimentally discarded singly at 10 second intervals from the stern during daylight hours while the vessel trawled for the next catch and after fishermen finished discarding. In each case, it was recorded if the fish was ignored or was picked up by a gull, and if so, the age-class of the individual. Prey selection was analysed using the Savage selectivity index

$$w_i = U_i / p_i \quad (1)$$

where U_i is the proportion of observations recorded for each fish species and p_i is the proportion of each fish species against total available discarded fish. This selectivity index varies from 0 (maximum negative selection) to infinity (maximum positive selection), 1 being the central value and defining the value expected by chance. The statistical significance of this index was tested comparing the statistic

$$(w_i - 1)^2 / se(w_i)^2 \quad (2)$$

with the corresponding critical value of a chi-square distribution with one degree of freedom (Manly et al. 1993). The standard error of the index [$se(w_i)$] was calculated by

$$\sqrt{(1 - p_i) / (u \times p_i)} \quad (3)$$

u being the total number of fish swallowed. Levels of statistical significance were obtained applying the ordinary Bonferroni correction for the number of statistical tests (Rice 1989). Additionally, offal from gutted Argentine hake at both fisheries was discarded singly at 10 second intervals from the stern of the vessel.

The proportion of discards consumed was defined as the percentage of discarded fish and offal consumed by Kelp Gulls with respect to the total numbers discarded during experiments. Small numbers of other seabird species, mainly Black-browed albatrosses *Diomedea melanophris*, attended vessels during discarding and gutting. However, less than 3% of experimentally discarded fish were taken and this only by Black-browed albatrosses, and therefore such cases were excluded from subsequent analyses.

3. Results

3.1. Abundance of gulls at fishing vessels

Kelp Gulls were present at all hauls. The highest overall number of gulls per day was 425 and 243

for the trawl and longline fisheries, respectively. Mean maximum number per day was significantly larger in the trawl fishery (299.2, SD = 73.38, n = 14) than in the longline fishery (197.6, SD = 17.26, n = 5) (Mann-Whitney Test U = 0.5, $P < 0.002$). Individuals of all age-classes were present in all counts and in similar proportions in both fisheries (Fig. 2), although flocks consisted mainly of adult individuals in both fisheries (Kruskal-Wallis Test, trawl fishery: $H_{(3, n=874)} = 406.8$, $P < 0.0001$; longline fishery: $H_{(3, n=317)} = 92.9$, $P < 0.0001$) (Fig. 2).

The mean maximum number of Kelp Gulls per day varied significantly depending on the fishing activity in both the trawl fishery (Kruskal-Wallis test: $H_{(4,n=68)} = 52.43$, $P < 0.001$) and the longline fishery (Kruskal-Wallis test: $H_{(3,n=15)} = 11.60$, $P < 0.005$) (Table 1). In both fisheries, the number of gulls increased as the fishing operation progressed, with maximum numbers observed during discarding and/or gutting (Table 1).

3.2. Consumption of discards and prey selection

Kelp Gulls obtained prey during discarding mostly by plunge-diving and surface seizing and by stealing them from other gulls. Kelp Gulls consumed a fraction (67.0%, n = 2 504) of the experimentally discarded fish. Some fish were ignored while others were handled and dropped (23.5 and 9.5 %, respectively; n = 2504). The numbers of consumed fish of each discarded species were significantly different from expected values based on numbers offered during experimental discards ($\chi^2 = 427.8$, df = 7, $P < 0.001$). The Argentine Hake was the preferred species, being positively selected by gulls. The Brazilian Codling was consumed according to that expected given its relative abundance whereas the Longtail Hake, the Flounders and the Sea Salmon were consumed less often than expected. Butterfish, Blackbelly Rosefish, and Skate were never eaten by Kelp Gulls (Table 2). The proportion of consumed discards varied between 0 and 95% (Table 2). Fish species handled were not dropped equally by gulls ($\chi^2 = 371.4$, df = 6, $P < 0.001$) (Table 3). Argentine Hake were dropped the least (2.8%) while all Butterfish and Blackbelly Rosefish were dropped. Kelp Gulls consumed similar proportions of discarded offal in both the trawl (89%, n = 1 533) and longline (91 %, n = 1 000) fisheries ($\chi^2 = 2.54$, df = 1, $P > 0.05$).

The length of the fish experimentally discarded varied between 14 and 57 cm, with a mean of 27.8 cm (SD = 7.3, n = 2 504) (Table 4). Mean length of ignored and dropped fish was similar (Two-tailed t-test for independent samples, $t_{825} = 1.95$, $P > 0.05$) (Table 4). Kelp Gulls selected fish according to the length of the discarded item. Except for the Sea Salmon, mean length of consumed fish was significantly smaller than that of fish not swallowed (ignored and dropped pooled together) (Table 4). The proportion of consumed discards for all species decreased with increasing fish length (Fig. 3). Even though a slight decrease in the consumption of larger Argentine Hake was recorded, the proportion of individuals of this fish taken by Kelp Gulls was always over 70%. In contrast, the proportion of consumed flounders decreased sharply (to less than 20%) with fish larger than 20 cm. Almost all Longtail Hake up to 40 cm were consumed, although individuals larger than 30 cm of other fish species were less swallowed or rejected (Fig. 3).

4. Discussion

Kelp Gulls were always associated with trawl and longline fishing operations in Golfo San Matías. Individuals of all age-classes were recorded at all counts, although adult gulls were always more abundant than immatures and juveniles, probably reflecting the age structure of the population. The number of gulls associated with vessels was of the same order of magnitude as that reported by Yorio and Caille (1999) in the same area the year before this study. The Kelp Gull is one of the most important seabird species associated with trawl vessels in Golfo San Matías and at other coastal fisheries in Patagonia (Yorio & Caille 1999) and regularly attends trawlers in South African and New Zealand fishing grounds (Fordham 1970, Abrams 1983, Steele & Hockey 1990), indicating its ability to take advantage of food made available by fisheries throughout its range and the importance of discards as an alternative food source for this species.

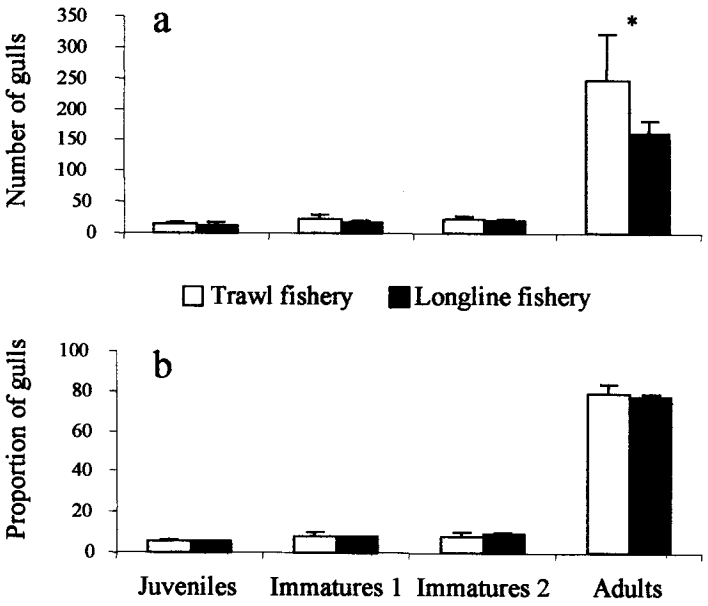

Figure 2. (a) Mean maximum number per fishing day (± SD) and (b) mean percentage per day (± SD) for each Kelp Gull age-class foraging at trawl and longline fisheries in Golfo San Matías. All comparisons were made with Mann-Whitney U test (all $P > 0.05$, except * $P < 0.05$).

The number of gulls associated with vessels varied depending on the food made available by different activities during the fishing operation. Trawling and haulback activities generated small amounts of food, mostly consisting of marine organisms brought to the surface and as a result few birds attended vessels. In contrast, during discarding and gutting the number of gulls increased significantly as a result of the great abundance of food offered. The high variability in the number of gulls in relation with the different fishing activities also suggests that gulls move among vessels, taking advantage of the food resource when it is more available. Between 6 and 12 vessels were operating at about the same time and relatively close to each other in the same fishing area.

Gulls associated with fishing operations were also more abundant at trawl than at longline vessels, even when trawl vessels generally operated further away from the coast than longline vessels, possibly because both the number of discarded species and the amount of discards are larger in the former fishery. Trawl vessels throw overboard large quantities of fish of different sizes, many of which can be easily handled and consumed by gulls. In contrast, longline vessels discard less fish-

Table 1. Mean maximum number (± SD) of gulls per day recorded during the different stages of the fishing operations by the trawl fishery (n = 14 fishing days, except for the Travel category for which 12 days were averaged) and longline fishery (n = 5 days) at Golfo San Matías.

Activity	Juveniles	Immatures 1	Immatures 2	Adults	Total
Trawl fishery					
Travelling	1.2 ± 0.4	1.7 ± 0.5	1.4 ± 0.5	9.8 ± 4.0	12.7 ± 4.3
Trawling	7.8 ± 3.0	14.5 ± 7.0	14.5 ± 7.4	92.1 ± 30.9	123.3 ± 44.1
Haulback	11.9 ± 3.3	13.9 ± 6.0	16.0 ± 6.7	124.2 ± 41.8	163.3 ± 45.0
Discarding	15.2 ± 2.5	23.1 ± 7.3	21.9 ± 5.6	248.6 ± 73.9	299.2 ± 73.4
Longline fishery					
Travelling	4.0 ± 1.4	4.0 ± 1.9	4.2 ± 2.3	19 ± 8.0	29.8 ± 12.1
Longline setting	4.6 ± 0.5	7.4 ± 0.9	10.6 ± 4.8	30.8 ± 4.1	51.2 ± 18.0
Discarding	11.8 ± 5.4	17.4 ± 2.3	19.8 ± 2.7	161.0 ± 20.0	197.6 ± 17.3

ing waste, mostly offal, and are highly selective, catching large fish (Elias 1998); they discard few fish, mostly large sharks that cannot be handled by the birds. Differences in the number of Kelp Gulls attending trawl and longline vessels appear to be, therefore, related to the amount of food provided by each fishing method.

Kelp Gulls consumed a fraction of the total fish biomass thrown overboard as a result of the selection of both the species and size of discarded fish. The proportion of the most important components of the discarded biomass consumed by Kelp Gulls was very variable, ranging between 17 and 95%, with some species being totally rejected. Gulls showed a preference for Argentine Hake, a species that is also the most important in frequency of occurrence and quantity in discarding operations at the Golfo San Matías coastal fisheries. Almost all Argentine Hake experimentally discarded were taken, although there was a slight decrease in the consumption of larger fish. The selection for Argentine Hake appears to be because the shape and size of this species make it "suitable" for consumption. The lower proportion of consumed Longtail Hake and both flounder species may be because of the large size of the former and the shape of the latter species, making them more difficult to handle and swallow. Longtail Hakes discarded were relatively large in comparison with the rest of discarded fish. However, Longtail Hakes, which were larger in size than rejected individuals from other fish species, were never the less taken by Kelp Gulls. Total consumption of flounders was 17% and, in general, individuals larger than 20 cm were ignored or dropped. More than half of all flounders, which were handled, was dropped again. The flat shape of fish species has been shown to affect their selection by scavenging seabirds (Camphuysen 1994b). Flatfish have been also found to be less preferred species in studies of discard use by seabirds in other regions, showing in general a lower consumption rate with respect to roundfish (Hudson & Furness 1988, Camphuysen 1994b, Garthe et al. 1996, Walter & Becker 1997, but see Oro & Ruiz 1997). Butterfish may have been rejected because they are deep bodied with respect to their length, while Blackbelly Rosefish have strong dorsal fin spines. Skates were the only fish completely ignored, very likely due to both their shape and the presence of caudal spines, which could injure the birds.

The selection of smaller sizes among discarded fish suggests that fish consumption could be restricted by the bird's capacity to manipulate and swallow certain prey sizes. Selection of small discarded fish could also allow a reduction in the handling time, decreasing the probability of the prey being stolen. Several studies have shown that an increase in prey size and handling time also increases kleptoparasitism frequency and success (Hulsman 1984, Hackl & Burger 1988, Steele & Hockey 1995). Kleptoparasitism is a common behaviour in Kelp Gulls foraging around trawlers

Table 2. Preferences for species of discarded fish by Kelp gulls foraging at trawl vessels in Golfo San Matías during 1996–97.

Species	Consumed fish		Savage index w_i	Percentage consumed (sample size)
	Observed	Expected		
Argentine hake	1168	825	1.41**	94.8 (1232)
Brazilian codling	289	260	1.11$^{n.s.}$	74.5 (388)
Longtail hake	143	203	0.70**	47.2 (303)
Sea salmon	32	58	0.55*	36.8 (87)
Flounders[1]	45	174	0.26**	17.3 (260)
Butterfish	0	57	0.13**	0 (85)
Blackbelly rosefish	0	56	0.13**	0 (84)
Skate	0	44	0.15**	0 (65)
Total	1677	1677		67.0 (2504)

* $P < 0.006$, ** $P < 0.0001$, n.s. $P > 0.006$. P values determined according to Bonferroni correction.

[1] Includes *Paralicthys isosceles* and *Xystreurys rasile*

in Patagonia (Yorio & Caille 1999) and, during experimental discards at Golfo San Matías, the size of fish stolen by Kelp Gulls was found to be larger than that of fish directly lifted out of the water (Bertellotti 1998).

The proportion of offal consumed by gulls was high both in the longline fishery, where it is the main fishing waste produced, and in the trawl fishery, where offal is not regularly discarded and is often a small proportion of the discarded biomass. Similarly, a high proportion of offal consumed by seabirds has been reported at discarding experiments in the North Sea (Camphuysen et al. 1995).

Part of the fishery waste thrown overboard is used by other seabirds (Yorio & Caille 1999). Seventeen species have been recorded scavenging at trawl vessels in Golfo San Matías (Yorio & Caille 1999). However, except for Black-browed Albatrosses and White-chinned Petrels (*Procellaria aequinoctialis*) which regularly attend vessels in smaller numbers than Kelp Gulls, other seabird species are observed infrequently and/or only in very low numbers (Yorio & Caille 1999). The extent of overlap between Kelp Gulls and other seabirds in the selection of discarded fish and the existence of competition is unknown. Further studies are needed to understand the way food behind vessels is partitioned among components of the scavenging seabird guild.

Our study shows that Kelp Gulls of all age classes take advantage of fishing waste provided by coastal trawl and longline fisheries operating in northern Patagonia and that they consume a fraction of the total fish biomass discarded due to the differential selection of species and sizes of discarded fish. In addition, discard experiments may result in an overestimation of food consumption rates (Garthe et al. 1996) and, therefore, when feeding during regular discarding activities Kelp Gulls may be actually using a lower proportion of the discarded biomass than that estimated in the present study. Over four thousand tons of fishing waste are discarded and made available to gulls every year by trawl and longline fisheries at Golfo San Matías (Caille & González 1998). However, Kelp Gull selection of discards and the use of this fishery waste by other seabird species suggest that care should be taken when evaluating the availability of this food source for Kelp Gulls.

Table 3. Percentage of handled and dropped fish by Kelp Gulls foraging at trawl vessels in Golfo San Matías during 1996–97.

Discarded species	Handled fish	Dropped fish (%)
Argentine hake	1201	33 (2.7)
Brazilian codling	326	37 (11.4)
Longtail hake	182	39 (21.4)
Sea salmon	59	27 (45.8)
Flounders*	105	60 (57.1)
Butterfish	10	10 (100)
Blackbelly rosefish	32	32 (100)
Skate	0	0
All species	1915	238 (12.4)

* Includes *Paralicthys isosceles* and *Xystreurys rasile*

Applying the equation developed by Birt-Friesen et al. (1989) and adapted for the Yellow-legged Gull (*Larus cachinnans*) by Munilla (1997), we estimated that the daily energy expenditure of an individual Kelp Gull is about 1 500–1 600 kJ. In terms of biomass of fish ingested, and considering that the most important fish consumed is the Argentine Hake, which has an energetic value of 6.5 kJ/g, each individual gull may consume between 85 and 90 kg of fish per year. Therefore, considering the fraction of fishery waste consumed by gulls obtained in this study, fish discards produced by coastal fisheries at Golfo San Matías may support a population of more than 30 000 Kelp Gulls. However, only a small breeding population is present in the area. The last census of breeding Kelp Gulls made in 1995 (Yorio et al. 1998), showed that less than 8 500 pairs breed in the Golfo San Matías area. Coastal fisheries in Golfo San Matías have shown an exponential growth during the few years previous to this study (G. Caille, pers. com.) and, therefore, fishing waste has only recently become an important potential food source for scavenging seabirds. Given no apparent habitat limitations in the area, we expect that this additional food source may have an important effect on the population expansion of the Kelp Gull. This increase in Kelp Gull populations may result in negative impacts on other coastal species through predation, competition for breeding space, and kleptoparasitism (Yorio et al. 1998). Futures studies must be conducted to assess the importance of

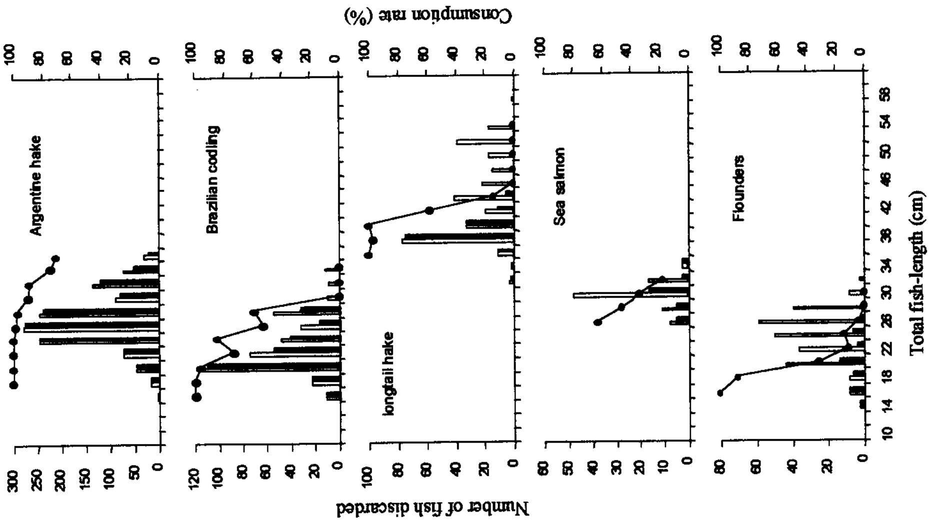

Figure 3. Proportion of consumed discarded fish (line; only if n > 5 offered fish), length distribution of experimentally discarded (white bars) and consumed (black bars) fish at Golfo San Matías during 1996–1997.

this food source in Kelp Gull population dynamics and to understand the factors influencing the seabird scavenging guild at coastal fisheries.

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Table 4. Mean length (± SD) of fish offered, ignored, dropped, consumed and non consumed (ignored + dropped) by Kelp Gulls during experimental discarding at trawl vessels in Golfo San Matías. Sample sizes in parentheses.

Discarded species	Offered	Ignored	Dropped	ConsumedNon	Consumed	t-test **	P
Argentine hake	26.4 ± 3.8 (1 232)	30.6 ± 3.2 (31)	31.7 ± 2.6 (33)	26.1 ± 3.7 (1168)	31.1 ± 2.9 (64)	10.7	0.0001
Brazilian codling	22.5 ± 4.0 (388)	26.7 ± 4.0 (62)	25.9 ± 3.9 (37)	21.1 ± 3.1 (289)	26.4 ± 4.0 (99)	13.7	0.0001
Longtail hake	42.9 ± 5.9 (303)	47.7 ± 3.9 (121)	47.1 ± 4.7 (39)	37.9 ± 2.2 (143)	47.5 ± 4.2 (160)	24.8	0.0001
Sea salmon	29.2 ± 1.7 (134)	30.3 ± 2.4 (75)	29.2 ± 1.4 (27)	28.8 ± 2.2 (32)	29.3 ± 1.3 (55)	1.3	0.19
Flounders*	23.3 ± 3.5 (260)	24.8 ± 2.8 (155)	22.6 ± 2.7 (60)	19.3 ± 3.0 (45)	24.2 ± 3.0 (215)	10.1	0.0001
Butterfish	30.1 ± 2.6 (62)	28.8 ± 1.2 (52)	28.3 ± 3.5 (10)	0	-	-	
Blackbelly rosefish	28.7 ± 1.6 (60)	29.4 ±1.3 (28)	28.6 ± 2.1 (32)	0	-	-	
Skate	27.6 ± 10.5 (65)	27.6 ± 10.5 (65)	0	0	-	-	
All species	27.8 ± 7.3 (2 504)	31.6 ± 9.6 (589)	30.2 ± 8.7 (238)	26.1 ± 5.4 (1677)	31.2 ± 9.3 (827)	17.1	0.0001

* Includes *Paralicthys isosceles* and *Xystreurys rasile*

** Differences in length between consumed and non-consumed fish were analysed using two-tailed t-test for independent samples with Bonferroni correction. Significative P-values < 0.008.

Selostus: **Etelänselkälokki troolia ja pitkäsiimaa vetävien alusten kalajätteiden hyödyntäjänä Argentiinassa**

Suurimittakaavainen kalastus voi vaikuttaa merilintujen ravinnonhankintakäyttäytymiseen monella tavalla, mm. tarjoamalle linnuille uuden ravintokohteen. Kirjoittajat tutkivat, kuinka etelänselkälokki hyödyntää troolia ja pitkäsiimaa vetäviltä kalastusaluksilta poisheitettävää kalastusjätettä. Eri ikäisten lokkien runsauksissa ei ollut eroja eri tyyppistä kalastusmenetelmää käyttävien alusten välillä. Kalastusalusten toiminnasta hyötyvät lokit olivat pääasiassa aikuisia yksilöitä. Lukumäärältään lokkeja oli enemmän troolia vetävien alusten äärellä kuin pitkäsiimaa vetävien alusten ympärillä. Todennäköisesti tähän oli syynä troolialuksilta mereen heitettävän ravinnon suurempi määrä ja sopivampi laatu etelänselkälokeille. Riippumatta kalastusmenetelmästä, lokkien määrä lisääntyi kalastustapahtuman edetessä. Etelänselkälokit käyttivät yli puolet (67 %) niille kokeellisesti heitetystä ravinnosta. Lokit suosivat tiettyjä kalalajeja ja välttivät toisia niille tarjotuista kalalajeista. Lokkien hylkäämät kalalajit olivat muodoltaan (korkeita suhteessa lajin pituuteen), kooltaan (liian suuria) tai muulta rakenteeltaan (esim. piikkisiä) sopimattomia ravintokohteita etelänselkälokille. Kirjoittajat toteavat, että kalastuksen sivutuotteena syntyvät jätteet voivat ylläpitää suurta lokkimäärää. Kirjoittajat esittävät arvion, että alueen kalataloudesta syntyvät jätteet voivat ylläpitää yli 30 000 yksilön suuruista etelänselkkälokki populaatiota. Kirjoittajat huomauttavat, että kalastusjätteitä hyödyntävien etelänselkälokkien ekspansiolla voi olla negatiivisia vaikutuksia alueen muihin lintulajeihin.

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