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Fish waste as an alternative resource for gulls along the Patagonian coast: availability, use, and potential consequences

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Abstract

We evaluated the volumes of waste from fish processing plants in Chubut Province, Argentina, and discuss its potential consequences for Kelp Gull (*Larus dominicanus*) population dynamics and coastal management. Mean volume of waste produced between 1989 and 2001 in three coastal cities was 49.8 ± 10.9 thousand tons y^{-1}. The amount of waste varied between years and cities, being larger at Puerto Madryn and Comodoro Rivadavia than at Rawson (24.1, 19.3 and 6.4 thousand tons y^{-1}, respectively). Waste was disposed at the three cities during all months of the sampled years. Large numbers of Kelp Gulls have been recorded taking advantage of fish waste disposed at these waste sites throughout the year. Considering its energetic content, waste generated at processing plants may support a population of between 101 000 and 209 000 Kelp Gulls. Fish waste could be contributing to their population expansion through increased survival and breeding success. Conflicts due to the use of waste and derived effects on other coastal species and human populations could be minimized by adequate fish waste management.

Keywords: Fish waste; Fish processing plants; Kelp Gull; *Larus dominicanus*; Patagonia; Argentina

Waste sites constitute predictable and abundant food sources widely used by many gull populations around the world (Furness and Monaghan, 1987). It has been argued that the use of these food sources have been implicated in the growth of several gull populations at many regions in both the northern and southern hemisphere (Spaans and Blokpoel, 1991; Belant, 1997). Fisheries, particularly, have long provided alternative food for seabirds in the form of fish waste from processing plants and discards from fishing operations at sea (Oro, 1999; Montevecchi, 2002; Yorio and Giaccardi, 2002). Fish waste, in contrast to urban waste, may greatly benefit individual survival and breeding success due to the higher nutritional value of fish (Annett and Pierotti, 1999).

Along the Patagonian coast of Argentina, 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). As with the urban waste, fish waste is only occasionally covered at some tips (Giaccardi et al., 1997). This waste is extensively used by Kelp Gulls (*Larus dominicanus*) which are widely distributed in the Southern Hemisphere (Burger and Gochfeld, 1996). On the Patagonian coast, the Kelp Gull is the third most abundant seabird, with a population currently estimated at >70 000 pairs distributed in about 100 colonies (Yorio et al., 1998a). Many of its colonies have shown a significant increase during the last decades (Yorio et al., 1999). Opportunistic feeding habits have allowed Kelp Gulls to include in their diet food derived from human activities, including waste from fish processing plants at several coastal cities (Bertellotti and Yorio, 1999; Yorio and Caille, 1999; Yorio and Giaccardi, 2002).

Despite the importance of this latter supplementary food resource for Kelp Gulls, little is known about the magnitude of available fish waste throughout the Argentine coast. In this paper we present an evaluation of the amount of fish waste derived from the processing of fish landings at ports in the Province of Chubut, Argentina and discuss its potential consequences for Kelp Gull population dynamics and coastal management.

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1. Study area and methods

1.1. Fisheries operating at Chubut ports

The number of fishing vessels operating from Chubut ports has varied between 70 and 140 throughout the decade, but currently 140 are operated. Of these, 50 are coastal trawl vessels 12–24 m long, which operate up to 12 nautical miles offshore and harvest 10–20 thousand tons of fish and invertebrates per year. The main target species of coastal trawlers are Argentine Hake (*Merluccius hubbsi*) and Argentine Red and Patagonian Shrimps (*Pleoticus muelleri* and *Artemesia longinaris*), although more than 30 fish and invertebrate species of commercial interest are also landed. The rest of the fishing vessels, 20 ice trawlers and 70 freezer trawl vessels, are 35–50 m long and operate mainly at Golfo San Jorge as well as on the Patagonian shelf north of 48 °S, harvesting 100–120 thousand tons per year. The main target species of these vessels are Argentine Red Shrimp and Argentine Hake.

Commercial vessels operate from five fishing ports in the Province of Chubut: Puerto Madryn, Rawson, Camarones, Caleta Córdova, and Comodoro Rivadavia (Fig. 1). There are 35 fish processing plants in this province, located at three of the above mentioned coastal cities. Puerto Madryn, with 18 plants, concentrates most of the activity, while Rawson and Comodoro Rivadavia have 11 and 8 plants respectively. Fish landed at Caleta Córdova is processed at plants located at Comodoro Rivadavia, while fish landed at Camarones is mostly processed at Rawson. The city of Trelew, located a few kilometres inland, has two processing plants which operate irregularly and which we have not considered in the present analysis.

Fish waste is disposed in open waste tips within (Rawson) or close to (Puerto Madryn and Comodoro Rivadavia) urban waste tips. Fish waste consists mainly of offal (stomachs, livers, and intestines), heads, fins, spines, and pieces of fillet. Preliminary observations on gulls feeding at the fishery waste site indicate that more than 90% of the ingested food consists of offal and pieces of fish fillet (Bertellotti et al., 2001). Only small amounts of fish wastes were irregularly used for fish meal during most of the study period, and only two fish processing plants started to regularly produce fish meal in 2001. Therefore, this activity was not considered as being significant in our estimation of fish waste available to gulls.

1.2. Sources and analysis of information

Information on fish volumes landed and processed at fishing plants along the Chubut coast from 1989 to 2001 was obtained from official statistics of the Subsecretaría de Intereses Marítimos y Pesca Continental of the

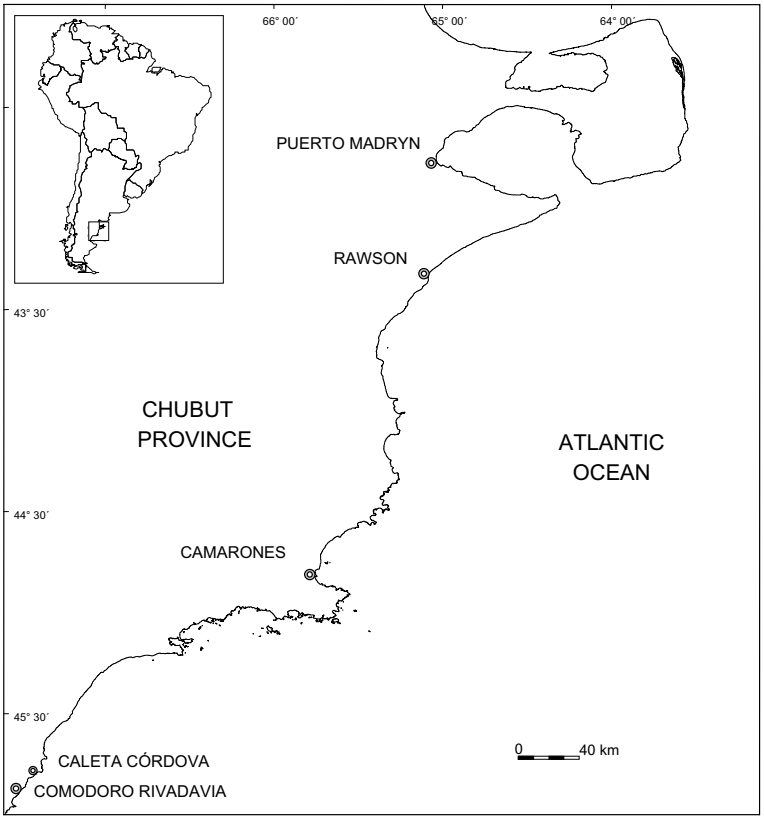

Fig. 1. Geographic location of fishing ports and fish waste sites in Chubut Province, Argentina.

Province of Chubut. To estimate the amounts of waste generated during processing we used a mean yield of between 42% and 45% in weight when fish processing equipment is used to obtain headed and gutted fish and fish fillets. For the analysis of fish waste generated at processing plants, we have grouped fish landed at Caleta Córdova with those at Comodoro Rivadavia and fish landed at Camarones with those landed at Rawson (see above). Amounts of fish waste produced per month at Puerto Madryn, Rawson and Comodoro Rivadavia were analysed for only three years distributed throughout the study period (1993, 1997 and 2001). Results are given as mean ± 1 SD.

The amount of Kelp Gulls that could be supported by fish waste generated by processing plants in Chubut was estimated using energetic values obtained from the literature on Argentine Hake and on a similar gull species, as information for the Kelp Gull in Patagonia is lacking. Calorific value for Argentine Hake waste was estimated at 0.49 kcal g^{-1}, obtained by subtracting the average energy value for processed Argentine Hake (0.84 kcal g^{-1}; Mazzei et al., 1995) from the average value for whole individuals (1.33 kcal g^{-1}; Eder, 2003). Daily energy expenditure of an individual Kelp Gull was estimated at about 1550 kJ, applying the equation developed by Birt-Friesen et al. (1989) and adapted for the yellow-legged Gull (*Larus cachinnans*) by Munilla (1997). We considered an assimilation efficiency for fish of 75% (Furness et al., 1988; Garthe et al., 1996).

2. Results

Between 1989 and 2001, an average of 85.84 ± 18.85 thousand tons of finfish were landed at Chubut ports, ranging between a maximum of 132.55 thousand tons in 1998 and a minimum of 64.11 thousand tons in 1992 (Table 1). Total amounts of finfish landed at Chubut ports have remained stable throughout the decade ($r^2 = 0.054$; $p > 0.05$).

Between 14 and 29 finfish species, depending on the year, were landed at Chubut ports (mean = 23.2 ± 3.7, $n = 13$) (Table 1). Number of landed species varied among fishing ports (Table 1), with the highest number being landed at Puerto Madryn. The main finfish species landed was the Argentine Hake, with volumes ranging between 47.1 and 121.9 thousand tons in 2000 and 1998, respectively (mean = 76.8 ± 19.3). This represented an average of 90 ± 11% ($n = 13$) of total landings declared at fishing ports.

Mean volume of waste generated by the fishing industry in the Province of Chubut was 49.8 ± 10.9 thousand tons y^{-1} ($n = 13$), ranging between 37 and 77 thousand tons in 1992 and 1998, respectively (Fig. 2). Fish waste generated varied between years and cities with fish processing plants, being higher the volumes discarded at Puerto Madryn and Comodoro Rivadavia than at Rawson (Fig. 3). The average number of tons of waste produced annually were 24.1 ± 8.9, 6.4 ± 3.0 and 19.3 ± 8.2 thousand at Puerto Madryn, Rawson and Comodoro Rivadavia, respectively ($n = 13$). During the last two years (2000 and 2001), Puerto Madryn concentrated most of the landings and therefore the amounts of waste generated at this city increased while it decreased at the other two sites (Fig. 3). Waste was generated and disposed at waste sites in Puerto Madryn, Rawson and Comodoro Rivadavia at all months throughout the sampled years (Fig. 4). Volumes of disposed waste per month were high and variable during the three years analysed (Fig. 4).

Table 1
Amounts of fish landed, number of fish species landed, and waste generated at processing plants at five coastal cities with fishing ports of the Chubut Province, Argentina

Year	Puerto Madryn	Rawson	Camarones	Caleta Córdova	Comodoro Rivadavia	Total landed (tons)	No. of species	Total waste (tons)
1989	36 680	8423	6156	4125	35 628	91 012	25	52 786.96
1990	48 093	9035	2408	2125	28 142	89 803	22	52 085.74
1991	36 679	8423	6156	4125	35 628	91 011	22	52 786.38
1992	29 324	5053	1141	2268	26 328	64 114	23	37 186.12
1993	26 175	9189	2590	2436	27 657	68 047	14	39 467.26
1994	34 283	10 407	691	4157	22 120	71 658	21	41 561.64
1995	34 187	10 746	101	3902	19 920	68 856	26	39 936.48
1996	22 403	18 149	348	2780	30 127	73 807	20	42 808.06
1997	45 910	18 732	0	2151	43 020	109 813	26	63 691.54
1998	57 648	6715	3818	2168	62 203	132 552	29	76 880.16
1999	32 957	7674	2361	1854	43 017	87 863	23	50 960.54
2000	62 111	2204	1179	1107	15 690	82 291	25	47 728.78
2001	74 609	1480	78	255	8644	85 066	25	49 338.28
Mean	41 619.92	8940.77	2079.00	2573.31	30 624.92	85 837.92	23.15	49 786.00
SD	15 322.46	5077.69	2151.90	1218.93	13 787.87	18 855.12	3.67	10 935.97
No. of species	20–22	10–12	10–12	4–6	8–10			

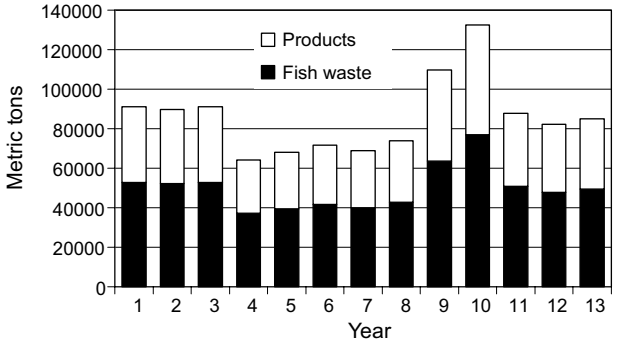

Fig. 2. Amounts of products and waste derived from the processing of finfish landed at Chubut ports between 1989 and 2001. Year 1: 1989; Year 13: 2001.

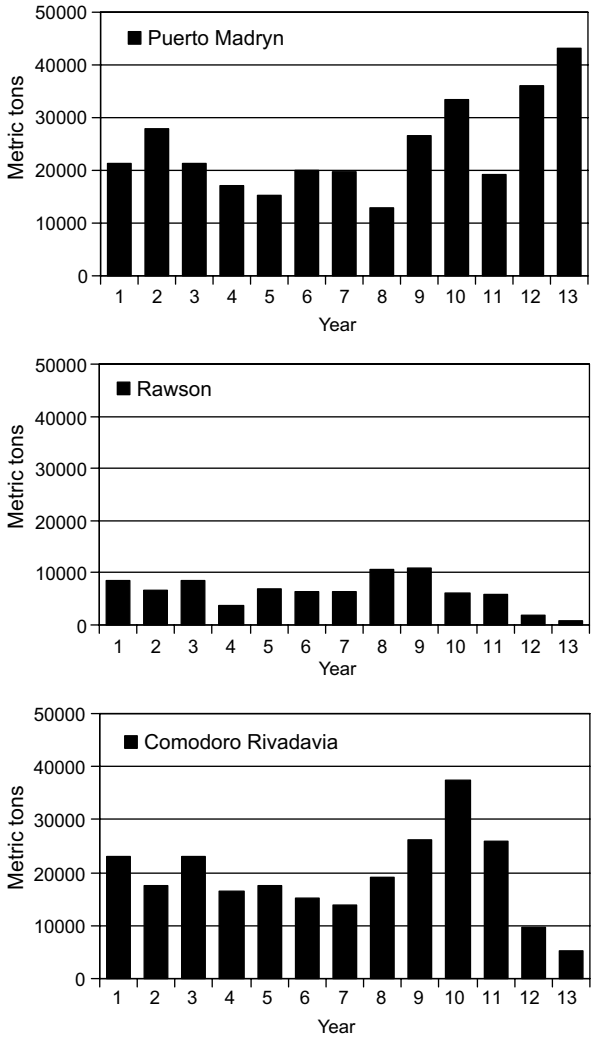

Fig. 3. Waste generated at fish processing plants at the cities of Puerto Madryn, Rawson, and Comodoro Rivadavia between 1989 and 2001. Year 1: 1989; Year 13: 2001.

Considering the energetic value of fish waste, each individual gull would require about 276 kg of waste per year. Almost all generated waste is available to Kelp Gulls, as waste is not covered after disposed and this gull species is almost the only scavenger at fishery waste tips in Chubut (Yorio and Giaccardi, 2002). Considering that the minimum and maximum amounts of fish waste generated per year during the study period were 37 186 and 76 880 tons, and correcting for the assimilation efficiency for fish, waste generated at processing plants in this coastal sector may support a population of between 101 000 and 209 000 Kelp Gulls.

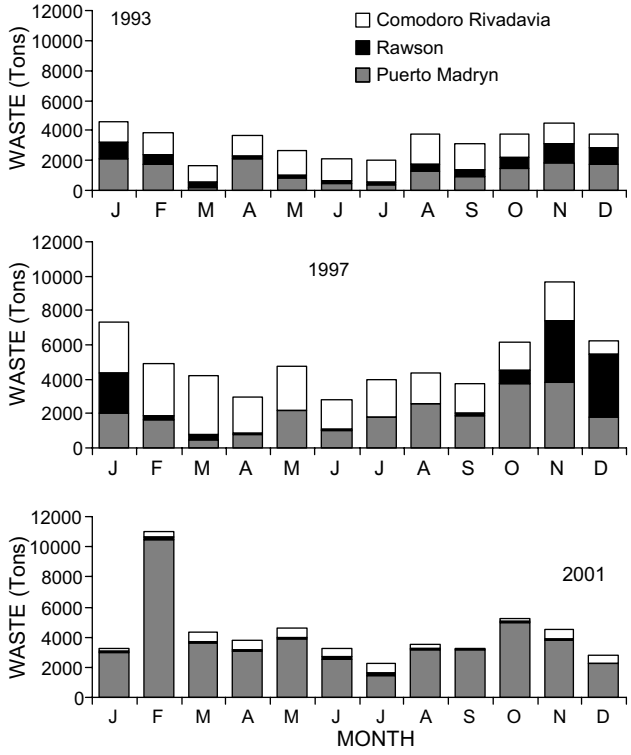

Fig. 4. Monthly variation in abundance of fish waste disposed at Puerto Madryn, Rawson and Comodoro Rivadavia, Argentina, during 1993, 1997 and 2001.

3. Discussion

Argentine Hake was the main landed fish species in this region, and thus was the main contributor to the generated fish waste. Argentine Hake is a demersal species which, given the Kelp Gull's feeding methods, is not normally available to them as natural prey.

Kelp Gulls have been recorded taking advantage of fish waste disposed at the Puerto Madryn, Rawson, and Comodoro Rivadavia waste sites (Yorio and Giaccardi, 2002). Results from this study show that for more than a decade, fish waste has been generated and disposed at open waste sites throughout the year in these coastal cities. As expected, Kelp Gulls have been shown to use this waste during all months. Monitoring of the fishery

and urban waste site in Rawson, for example, has demonstrated that Kelp Gulls were always present in high numbers, sometimes over 10 000 individuals, during monthly counts made between 1992 and 1994 (Giaccardi et al., 1997). At the Puerto Madryn fishery waste tip, Kelp Gulls were also present in variable numbers at all monthly counts made during 1996 and 1997, with a mean of more than 3500 individuals in both years (Giaccardi and Yorio, in press). Both adult and juvenile gulls have been recorded at all fishery waste sites in northern Patagonia throughout the year (Yorio and Giaccardi, 2002). The preference of Kelp Gulls for fishery waste over urban waste both during and outside the breeding season has been shown at Puerto Madryn and Rawson (Giaccardi et al., 1997; Bertellotti et al., 2001; Giaccardi and Yorio, in press). The large amounts of fish waste disposed at coastal waste tips each year could theoretically sustain a high number of Kelp Gulls, estimated at between 100 and 200 000 individuals depending on the year. This is a significant number of individuals, particularly considering that the total breeding population for the study area was estimated in the mid nineties at approximately 90 000 breeding adults (Yorio et al., 1998a).

Food availability acts as a proximate factor determining the number of breeding pairs in seabirds and can have a direct effect on breeding success (Croxall and Rothery, 1991; Uttley et al., 1994). Fish waste sites offer relatively abundant and predictable resources. Because fish is valuable in energy and nutritional terms, the consumption of fish waste is probably advantageous for gull survival and breeding success. It has been shown that fish is important for both egg formation and chick growth (Pierotti and Annett, 1991; Bolton et al., 1992) and may increase life-span and long-term breeding performance (Annett and Pierotti, 1999). Monitoring of breeding Kelp Gulls along the coasts of Chubut have shown that 22 of the 25 colonies analysed have increased in size during the last two decades, with a mean annual growth rate of between 2% and 63% (García Borboroglu et al., unpublished data), and new sites have been colonized. Although we still lack studies demonstrating the effects of alternative food sources on Kelp Gull population dynamics, current information on their feeding ecology and population trends strongly suggest that the use of fish waste may be enhancing breeding success and gull survival during the winter, particularly of young birds. It has to be also considered that in addition to the fish waste provided by processing plants, an unknown amount of fish is made available by discarding operations at sea and is widely used by Kelp Gulls at least at coastal fishing grounds (Yorio and Caille, 1999; Bertellotti and Yorio, 2000).

The increase in Kelp Gull populations may result in negative effects on other coastal species through predation, competition for breeding space, and kleptoparasitism (Yorio et al., 1998b; Rowntree et al., 1998). The increase in the number of gulls and their activity at or near cities may also result in conflicts with human populations, as pathogens such as *Klebsiella*, *Salmonella* and *Shigella* have been identified in Kelp Gull faeces sampled in garbage dumps at Puerto Madryn, Rawson, and Puerto Deseado (Yorio et al., 1996; Frere et al., 2000). Kelp Gulls have been also reported to affect airport traffic at some coastal cities (Yorio et al., 1999).

This study shows that the availability to gulls of fish waste from processing plants can be significant along the Chubut coasts, and is very likely as significant at other sites in Argentina. Disposal of fish waste at open tips also occurs in at least five other cities with fishing ports along the Argentine coast, and, at some of these, Kelp Gulls have been recorded to take advantage of waste (Yorio et al., 1996; pers. obs.). Although no significant trend in the amount of generated waste was observed throughout the study period, it is likely to increase in the future with the current growth of commercial fisheries in the region and the plans for setting up new processing plants. Therefore, management techniques to reduce gull use of waste need to be implemented in the short term.

The reduction or removal of artificial food sources has been shown to minimize the negative effects of waste use by gulls (Belant, 1997). Until recently, fish wastes in Patagonia were not used for fertilizer or fish meal as in other regions due to economic reasons or to the relatively lower quality of the end products. However, some processing plants at Puerto Madryn occasionally used waste for fish meal during the study period, although not in significant volumes. Given the recent changes in the Argentine economy resulting in greater benefits from exporting products, an interest in the production of fish meal has increased. Two of the eighteen plants at Puerto Madryn, have started to produce fish meal in the last three years, and finfish is now being processed on-board some ice trawler vessels operating at the Chubut ports. Waste landed and disposed consists then mainly of head and fins, and is therefore less attractive to gulls. These recent changes in fisheries activities may lead to a reduction of waste available to gulls at coastal waste sites. Covering of waste has been also implemented at some sites, although only occasionally. Covering waste and its processing for fish meal during a short time period have proved successful in reducing gull numbers at least at one Patagonian site (Giaccardi et al., 1997). These and other management techniques (Belant, 1997) should be implemented, or at least assessed, at fishery waste sites on the Patagonian coast. Conflicts due to the use of waste by Kelp Gulls and the derived effects on other coastal species and human populations could be minimized by adequate fish waste management.

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