USE OF ARTISANAL FISHERY DISCARDS BY SEABIRDS ON THE PARANÁ COAST IN BRAZIL

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SUMMARY

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During January to December 2005 we evaluated interactions between birds and artisanal fishery discards on three beaches on the Coast of the Paraná, Paraná State, southern Brazil. During the study we counted 20 species of birds, of which nine consumed discards. The Kelp Gull *Larus dominicanus* was the most frequent species at all sites and all times of year, and obtained most discards. Adult gulls tended to dominate younger gulls and other scavengers. Use of trawl nets behind boats created the most discards. During moratoria, when trawling was not permitted, fewer discards were available to birds. The three study areas had similar numbers of scavenging species, but larger numbers of birds congregated where, and when, amounts of discards were highest. Gull numbers peaked in March–April, which coincided with the trawling moratorium, and also with the period immediately before the gull breeding season.

Key words: seabirds, interaction, discards, artisanal fisheries

INTRODUCTION

Fisheries around the world show a wide diversity of fishing vessel sizes, motors, fishing gear and methods used. In spite of this diversity, all fisheries have a common characteristic, the production of discards. Waste discards may be in the form of material removed from fish to prepare them for the market (e.g. intestines and liver, and some heads), or whole fish without commercial value (Krul 2004). Around the world the role of fishery discards as a supplementary food supply for scavenging seabirds has been widely studied (Garthe *et al.* 1996, Walter & Becker 1997, Furness 2003). However, in Brazil there are few studies of the interaction between seabirds and fisheries (Rezende 1987, Chiaradia 1991, Branco 2001, Branco 2004, Krul 2004). Because discards constitute an additional food source, they can benefit seabirds in many ways. Discards may be responsible for better body condition when larger amounts of fishery waste are available (Garthe & Hüppop 1994), and for increases in population sizes of scavenging seabirds; they may affect their breeding success (Oro *et al.* 1996, Krul 2004). Furness (1982) and Yorio & Caille (2004) considered that high volumes of discards not only affected the diet and behaviour of seabirds, but also influenced the abundance and distribution of seabirds.

The Brazilian coast extends approximately 8500 km; fishing activities are very traditional and predominantly artisanal, except for three states (São Paulo, Santa Catarina and Rio Grande do Sul), where there are industrialised fisheries. The artisanal fisheries in Brazil can be characterized by the use of canoes (2–10 meters in length and motors of 8206–17 904 W [11–24 horsepower]) and vessels of medium size (10–14 m and motors of 13 428–35 808 W [18–48 horsepower]). In the artisanal fisheries, small trawling nets, driftnets and gillnets predominate, and the discards are mainly fish and crustaceans. On the other hand, industrialised fisheries use larger vessels (16–30 m and motors of 74 600–522 200 W [100–700 horsepower]), and larger nets are predominant. The discards of industrialised fisheries comprise mainly whole fish and offal (Isaac *et al.* 2006). There are few data about fisheries production in Brazil, but recent studies have reported a mean production of 58 000 tonnes per year (Issac *et al.* 2006).

The aims of the present study were to identify which species of birds use the discards made available by the artisanal fisheries on the shoreline, and to assess seasonal differences and the influence of a moratorium period.

STUDY AREA

The study was carried out on the Paraná coast (Fig.1), which extends approximately 107 km, with limits to the north at the Canal of the Varadouro (25°12'S) and to the south at the estuary of the River Saí-Guaçu (25°58'S). This area is characterized by the great extension of the continental shelf, which is mostly covered by sandy substrate. The marine system on the shallow platform of the Paraná Coast is influenced by platform water, continental water, and in some periods, by intrusions of South Atlantic Central Waters (SACW) (Brandini 1990).

Fishing, for shrimp and for fish equally, is highly developed in Pontal do Paraná, Paraná State, Brazil. This artisanal fishery is small scale, widespread, and provides jobs for many fishermen. It involves a modest per capita capitalization and supplies fish mainly for direct human consumption (Caddy & Griffiths 1995).

We observed feeding behavior at three beaches, Shangrilá, Barrancos and Pontal do Sul (Fig.1). In Shangrilá and Barrancos, the type of boat that is used most is the canoe, but in Pontal do Sul a diverse range of boats are used. In the study area the trawling net is the fishing method most commonly used with canoes. During a moratorium

period enforced to reduce impact of trawl fishing on fish stocks, when fishermen could not use this type of net, they changed to gillnets, driftnets, purse seine and other artisanal fishing methods.

The small Archipelago of Currais (25°44'S, 48°22'W, Fig.1), consisting of three islands, represents the main breeding area for Kelp Gulls *Larus dominicanus* (Carniel & Krul 2010), Magnificent Frigatebirds *Fregata magnificens* and Brown Boobies *Sula leucogaster*, which are resident in the study area, with over 5 000 pairs breeding along the Paraná coast (Krul 2004). These colonies are in close proximity to fishing areas (Carniel 2008).

METHODS

Bird counts and observations of feeding behaviour

We observed feeding behaviour of seabirds from January to December 2005. The three beaches selected are representative of the artisanal fishing in Paraná State. We collected data on birds from fixed points where fish were unloaded and we could observe approximately 150 m in each direction. Bird counts were made weekly in each sample area, starting when the fishermen ended the process of cleaning and selling fish and discarding the species of non-commercial sizes and bycatch on the shoreline. A moratorium on the use of trawling nets was in effect during March, April and May, 2005.

The duration of the observations of bird behaviour varied, depending on the fishermen and their fishing activities. When trawling, fishermen tended to arrive early on the beach to sell the fish and shrimp, but when using other methods, such as driftnets (white-shrimp and fish), fishermen spent more time on the open sea to increase their catch. The volume of discards on the shoreline was also correlated with the fishing methods that were used, and this determined our time in the area. For example, during use of trawling nets, we conducted more counts because we had more discards in the study area; by contrast, during the activities of purse seine, gillnet, driftnet and other artisanal fisheries, we conducted fewer counts, as there were fewer discards.

We made a total of 144 counts during the year (four counts per area per month). These counts recorded total numbers of birds of each species that were present and the number of birds feeding on the discards. These point censuses were accomplished with aid of binoculars (15 × 60). Age groups of Kelp Gulls were classified on

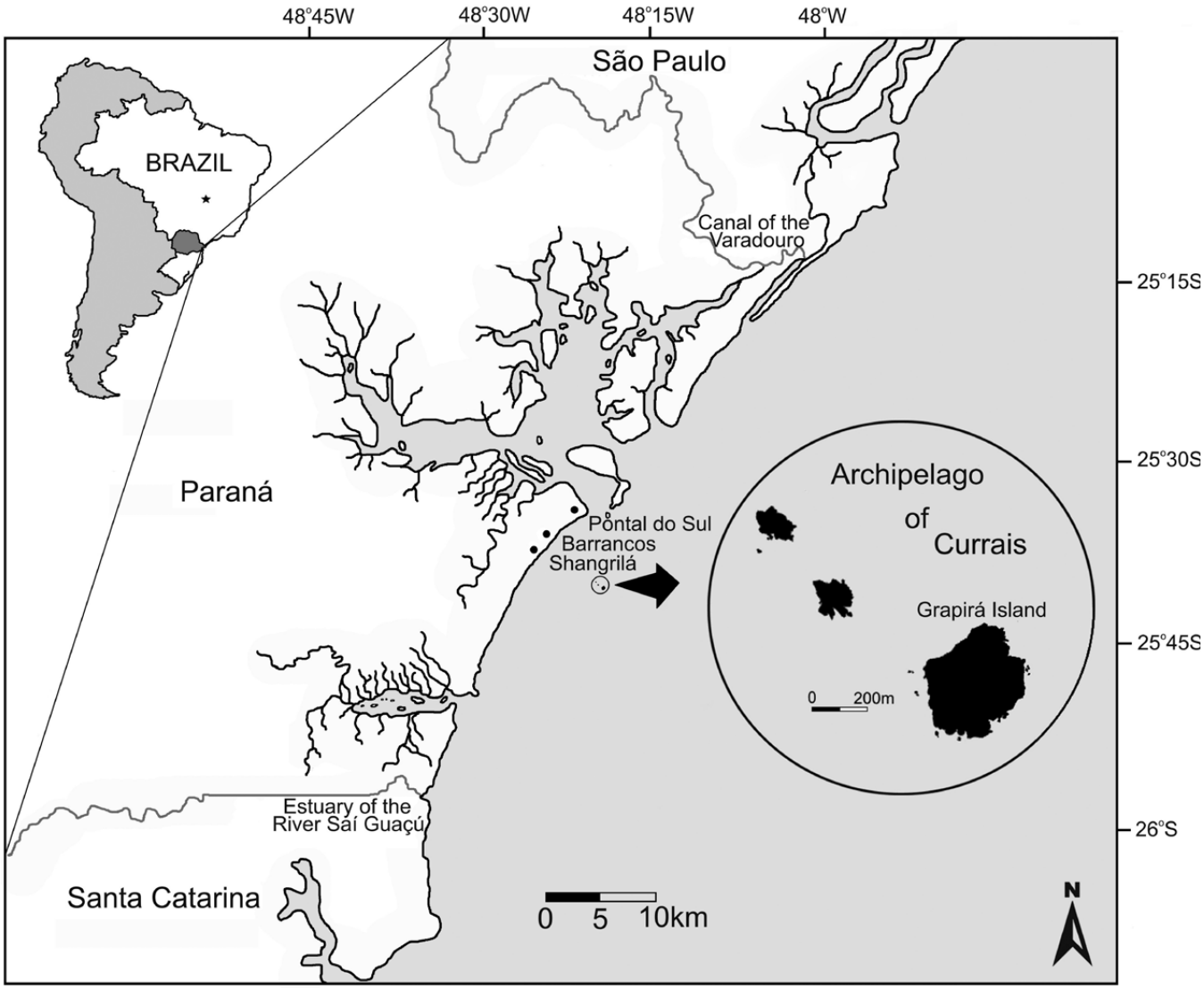

Fig. 1. The Paranaense coast of Brazil showing the study areas. Map design by Ana Paula Chiaverini.

the basis of plumage: (1) juveniles (1st year), (2) immature (2nd year), (3) immatures (3rd year) and (4) adults.

Statistical analyses

Underlying assumptions of the statistical tests were verified in all cases. ANOVA was used for normally distributed data. When we observed significant differences in ANOVA tests, post-hoc comparisons were made using LSD tests. Significance was considered $P < 0.05$. The number of seabird species that had interacted with discards in the study area was represented by absolute number. Differences in species composition and numbers in the study area were represented by mean ± SD and their contribution in percentages. Differences in the average number of species in each area, seasonal differences and comparison between periods with and without trawling activity (moratorium period) were tested using ANOVA.

RESULTS

Out of the 20 species with potential to use discards that were observed in the study area, nine were seen to do so. Kelp Gull was the predominant species during periods of discards on the shoreline, followed by Snowy Egret and Black Vulture (Table 1).

The three areas differed in species composition and numbers, with six species consuming discards in each area (Table 1).

Analysis of the average of number of species in each area during the counts showed significant differences among the areas (ANOVA: $F = 16.19$, $P < 0.001$). Post-hoc comparisons showed that the average of number of species recorded at Shangrilá (3 ± 0.18) was significantly higher than at Barrancos (1.67 ± 0.19) or Pontal do Sul (1.80 ± 0.16) (LSD: $P < 0.001$). Similarly, the mean number of individuals (ANOVA: $F = 21.98$, $P < 0.001$) per count in Shangrilá was 88.01 ± 9.04, significantly higher (LSD: $P < 0.001$) than in the other two areas. The highest number of scavenging species was recorded in winter (ANOVA: $F = 8.33$, $P < 0.001$, LSD: winter versus summer: $P < 0.001$, winter versus autumn $P = 0.043$, winter versus spring: $P = 0.001$; Fig. 2).

During the moratorium on trawling, there was an intense modification in the availability of discards on the beach. During that period we

TABLE 1
Birds using discards in each area and their contribution (%) to the total for the three areas combined

Species/Area	Common name	Mean±SD; total number; area studied			Contribution (%)
		Pontal do Sul	Barrancos	Shangrilá	
Egretta thula	Snowy egret	2.25±1.38	3.13±2.26	10.47±7.22	6.41
Ardea alba	Great egret	0	0	1.47±0.51	0.20
Egretta caerulea	Little blue heron	1	0	0	0.007
Coragyps atratus	Black vulture	7.4±9.22	3.50±3.53	6.43±6.05	1.43
Cathartes aura	Turkey vulture	0	5.5±6.36	1	0.09
Fregata magnificens	Magnificent frigatebird	2	7.57±5.15	4.06±2.89	0.90
Larus dominicanus	Kelp gull	12.92±12.39	69.60±52.19	77.40±68.60	90.70
Thalasseus sandvicensis	Sandwich tern	0	5	0	0.03
Phalacrocorax brasilianus	Neotropic cormorant	1.73±1.62	0	0	0.23

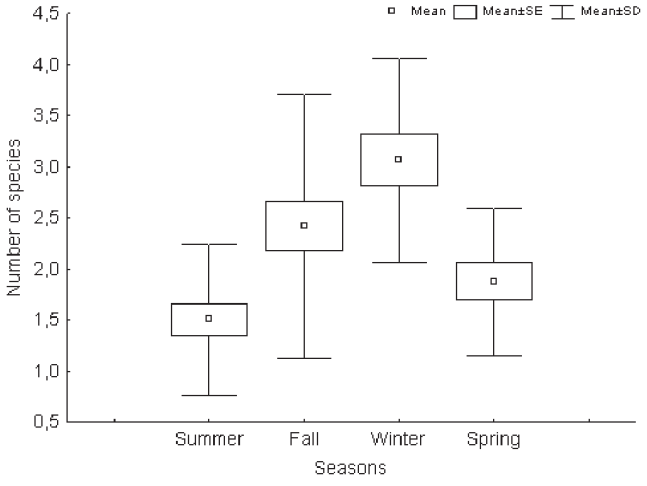

Fig. 2. Number of species interacting with artisanal fisheries discards, by season.

TABLE 2
Kelp Gulls *Larus dominicanus* numbers during discard events on the beach in relation to different fishing methods

Fishing method	Total number (and %)			
	Adults	Juvenile 1st year	Immature 2nd year	Immature 3rd year
Trawling net	2938 (87.12)	165 (4.89)	92 (2.72)	177 (5.25)
Driftnet (fish)	721 (91.26)	32 (4.05)	17 (2.15)	20 (2.53)
Driftnet (shrimp)	4140 (86.62)	186 (3.89)	114 (2.38)	339 (7.09)
Cambau (gear)	32 (64)	6 (12)	1 (2)	11 (22)
Purse seine	100 (68.96)	18 (12.41)	3 (2.06)	24 (16.55)
Gillnet	518 (80.81)	56 (8.73)	26 (4.05)	41 (6.39)

observed a mean of 1.89 ± 0.16 species interacting during counts on the shoreline, compared with 0.92 ± 0.18 before and 1.42 ± 0.14 after the moratorium period (ANOVA: F = 5.04, P = 0.007; LSD: P = 0.002, P = 0.03) . Similarly, a mean of 77.12 ± 9.96 individuals were recorded during the moratorium period, compared with 53.69 ± 15.34 before it and 43.26 ± 6.08 after it (ANOVA: F = 4.60, P = 0.011; LSD: moratorium period versus period after the moratorium period: P = 0.002).

Kelp Gull was the most numerous species recorded, being frequently observed during events originating from trawl nets (N = 52) and driftnets (N = 67). The largest interaction levels on the beaches were observed during events of discards originating from the driftnets (shrimp) and trawl net, accounting for 48.9% and 34.5% of interactions, respectively, while the smallest was observed during discards originating from an artisanal fishing art called *cambau*, accounting for only 0.5% of the interactions between seabirds and discards on the beaches. All age classes of gulls were represented, but adults (86%) predominated (Table 2).

Our analysis of the consumption of discards by Kelp Gull during one year showed that Shangrilá had the highest mean number of individuals (77.40 ± 68.60), the largest flock of Kelp Gull during a single event being 281 individuals. By contrast, in Pontal do Sul we observed the smallest mean number (12.92 ± 12.39) of individuals.

Evaluating seasonal variation in the number of Kelp Gull during discard events, we found that peak numbers occurred during March (125.05 ± 20.90 individuals per count), with significantly higher numbers than in other months (ANOVA: F = 1.95, P = 0.001; LSD: $P < 0.05$) (Fig. 3).

During the observations of the interactions on the beach, we frequently observed the adults of Kelp Gull forming groups close to the discards, while juveniles were observed farther off and with less access to the discards. We also frequently observed adults chasing juveniles out of central areas with better access to the discards, which reduced the success of those juveniles in capturing discards.

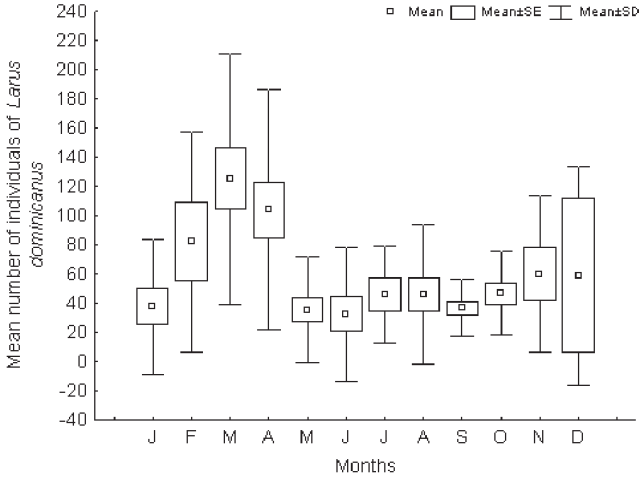

Fig. 3. Number of Kelp Gulls *Larus dominicanus* in the study areas in each month.

DISCUSSION

Our information about interaction between seabirds and artisanal fishery discards on the shoreline is novel, because previous studies evaluated the influence of fishery discards as a supplementary food supply for scavenging seabirds only in relation to industrial fisheries activities at sea. The discarding of fish and fish parts that do not have commercial value can be an important food source for seabirds, and can influence the abundance, distribution and reproduction of seabirds (Garthe *et al.* 1996, Furness 2003).

The number of species of seabirds using discards on the shoreline (nine species in our study) was similar to that observed on the open sea, including the Paraná coast (Krul 2004) and the Catarinense coast (Branco 2001, Branco *et al.* 2006). However, the specific composition of a seabird flock on the shoreline was very different from that on the open sea. Some birds were observed only on the shoreline, e.g. *Egretta thula, E. caerulea, Ardea alba, Coragyps atratus, Cathartes aura* and *Phalacrocorax brasilianus.*

Fregata magnificens fed on discards exclusively during moratorium periods, when there was a reduction in food availability on the open sea (Arcos & Oro 1996, Hüppop & Wurm 2000). In the same way, we observed some individuals of *Phalacrocorax brasilianus* using discards on the shoreline in Pontal do Sul, indicating that this species can use discards; this confirms findings of previous studies (Garthe & Scherp 2003, Krul 2004).

Average numbers recorded in the autumn/winter period were significantly larger than in spring and summer. The larger number of species during this period could be due to the use of a larger diversity of fishing methods: during the spring and the summer, trawl nets were the predominant method, which favoured *Larus dominicanus* to the detriment of the other species. Another factor that contributes to the increase of the number of species during autumn/winter is the breeding season of the predominant species involved. Kelp Gulls are common during discard events throughout the year. However, during the fall/winter period, this species moves to breeding colonies at Archipelago of Currais (Fig. 1), allowing other species, such as *Egretta thula,* to take discards on the beach. However, our data differed from those obtained by Branco *et al.* (2006), who observed the highest abundance of birds interacting during discard events on Santa Catarina State during spring (32.6%) and winter (23.5%).

We estimated annual discard production of 4 223 kg for the study area based on field samples in 2005 from 31 canoes and two larger boats (Carniel 2008). Shangrilá is the area responsible for most of the discard production in the study region, with an annual production of 2 591 kg (21 canoes, operating during 20 days per month). In Barrancos, Carniel (2008) observed an annual discard production of 538 kg (10 canoes, operating during 20 days per month). In contrast with the other two areas, in Pontal do Sul most of the discards were generated on the open sea (Carniel 2008), with a lower rate of discard production on the shoreline (198 kg per year for two larger boats).

Moratorium periods led to a decrease or even absence of discards in the area. In that context, Carniel (2008) observed that during moratorium period Shangrilá, Barrancos and Pontal do Sul together had an annual discards production of 895 kg, which represent just 26.9% of the discards produced in the study sites. During the period when trawling activities were forbidden, fishermen used other fishing

methods such as driftnets and gillnets; although these produce fewer discards, they serve as a great attraction for seabirds. As well, the moratorium greatly modified the patterns of distribution of the seabirds. During the moratorium we observed an increase in the interaction levels in Barrancos and Shangrilá, but the same pattern was not observed in Pontal do Sul, probably because birds in that area use other methods to obtain food. Another factor that contributed to the increase in interactions on the shoreline during the moratorium period was the decrease in food availability on the open sea; some species that take discards mainly at sea, such as *F. magnificens*, moved to the shoreline, increasing take on the shoreline. This pattern was observed by Arcos & Oro (1996), who noted an increase in *Larus audouinii* during a moratorium period and suggested that this event determined the distribution of scavenging birds (Arcos & Oro 1996, Hüppop & Wurm 2000, Arcos *et al.* 2001, Mañosa *et al.* 2004).

During the discard events, Kelp Gull was the dominant species on the beach, being the most abundant in all the counts. The individuals of that species were the first to locate the discards, and there was a hierarchy apparent among adults and juveniles. The adults were closer to the discards than juveniles, as previously described (Steele & Hockey 1995, Giaccardi *et al.* 1997, Bertellotti & Yorio 2000, Giaccardi & Yorio 2004). This difference was probably related to different levels of skill in capturing prey between adults and juveniles, which results in higher levels of success by adults during discard events (Yorio & Caille 1999, Bertellotti & Yorio 2001, Bertellotti *et al.* 2001, Martínez-Abraín *et al.* 2002, Giaccardi & Yorio 2004).

This study confirms the widespread use of discards by Kelp Gull in the study area, corroborating other studies in the region (Krul 2004). The use of discards by gulls is well known and studied globally on the open sea (Bertelloti & Yorio 2000, Garthe & Scherp 2003, Krul 1999). This suggests that Kelp Gulls would take fisheries discards on the shoreline on Paraná Coast, but our data are the first to confirm this hypothesis and to report the dominance of Kelp Gulls in using fisheries discards on the shoreline. This species is the main scavenging bird present during discard events due to its generalistic and opportunistic behaviour (Bertellotti & Yorio 1999).

Kelp Gulls showed seasonal variation in numbers on the shoreline, with a decrease during the reproductive period (Krul 1999). The increase during the nonbreeding period could be influenced by trawling activities that were responsible for the most part of the discards in the study area (also observed by Mañosa *et al.* 2004). By contrast, subadults showed little seasonal variation in numbers, being independent of the breeding season (Giaccardi *et al.* 1997).

The high levels of discards produced act as an attractant to seabirds, determining the increase in the number of species and individuals at discard events, as previously indicated by Furness (2002), Abelló *et al.* (2003) and Schwemmer & Garthe (2005), but more research is needed to understand the influence of fisheries discards in the diet of seabirds, in their reproductive success and in determining their populations.

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