



Kelp Gulls (*Larus dominicanus*) killed and injured by discarded monofilament lines at a marine recreational fishery in northern Patagonia



Pablo Yorio^{a,b,*}, Cristian Marinao^a, Nicolás Suárez^a

^a Centro Nacional Patagónico (CONICET), Boulevard Brown 2915, 9120 Puerto Madryn, Chubut, Argentina

^b Wildlife Conservation Society Argentina, Amenábar 1595, Piso 2, Of. 19, Ciudad Autónoma de Buenos Aires, Argentina

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ABSTRACT

Among marine debris, monofilament fishing lines often result in negative impacts on marine organisms. We characterized marine debris and incidence of lost and discarded monofilament lines along beaches used by recreational fishers, and report the impact of lines on Kelp Gulls (*Larus dominicanus*) at the Bahía San Blas protected area, site of one of the main shore-based recreational fisheries of the southwestern Atlantic. Over 55% of the marine debris recorded originated from recreational fishing activities. Balls of tangled monofilament lines were found at a rate of 40.5 items per km. A total of 27 adult Kelp Gulls were found entangled with monofilament. All individuals were tangled to vegetation within colony boundaries. Four of the gulls had a monofilament line protruding from the bill, showing that they may be also killed when trying to obtain bait. Our results indicate that lost or discarded monofilament lines in the Bahía San Blas recreational fishing area result in undesired impacts on coastal wildlife.

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1. Introduction

Marine debris has been recognized as one of the key environmental problems faced by coastal and marine environments worldwide (Gregory and Ryan, 1997; Derraik 2002). Among marine debris, fishing gear such as nets, ropes and monofilament lines often result in negative impacts on many marine organisms (Laist 1987, 1997). For example, over 190 species, including marine mammals, seabirds, marine turtles, fish and invertebrates have been reported to be affected by entanglement with such marine debris (Secretariat of the Convention on Biological Diversity, 2012).

Monofilament lines lost or discarded in coastal environments have become a growing concern (Allsopp et al., 2006; Butterworth et al., 2012). Monofilament is used as fishing gear by recreational fishing, a growing activity of great socioeconomic importance in many countries (Arlinghaus and Cooke, 2009; Ihde et al., 2011). It is non-biodegradable and is difficult for birds or other marine organisms to see, and as a result they often become entangled. Particularly in birds, entanglement may lead to starvation, injury, limb amputation or death, and if the hook attached to the line is ingested, it may result in esophageal tear and internal

* Corresponding author at: Centro Nacional Patagónico (CONICET), Boulevard Brown 2915, 9120 Puerto Madryn, Chubut, Argentina. Tel.: +54 280 4883184; fax: +54 280 4883543.

E-mail address: yorio@cenpat.edu.ar (P. Yorio).

bleeding (Taylor, 1996; Gregory, 2009; Dau et al., 2009; Berón and Favero, 2009). Despite recreational fishing takes place at many marine coastal areas in Argentina (Caille et al., 1997; Dadón, 2002), its effects on wildlife have remained largely unquantified. The only study on the effects of lost or discarded fishing gear on birds has been conducted along the northern coasts of Buenos Aires province, and has shown that lines and hooks can negatively affect the threatened Olog's Gull (*Larus atlanticus*) (Berón and Favero, 2009). The Bahía San Blas protected area, located in southern Buenos Aires Province, is the site of one of the main shore-based marine recreational fisheries of the southwestern Atlantic coast (Llompert et al., 2012). Fishing takes place mostly during spring and summer, with an average of over 40 thousand fishers per year (Llompert, 2011). Several seabirds, including the threatened Olog's Gull, nest in islets close to the shores frequented by recreational fishers (Yorio et al., 1998; Zalba et al., 2008). In this paper we (a) characterize the marine debris and the incidence of lost and discarded monofilament lines along main beaches used by recreational fishers, and (b) report the impact of monofilament line on Kelp Gulls (*Larus dominicanus*).

2. Methods

The study was conducted in the southwestern sector of the Bahía San Blas protected area in Buenos Aires Province, Argentina

(Fig. 1). The coastal sector is characterized by extensive mudflats and marshes of *Spartina* spp. and *Sarcocornia perennis* with crab beds (Zalba et al., 2008). Vegetation in the area consists of bushes – mainly *Cyclolepis genistoides*, *Atriplex undulata* and *Allenrolfea patagonica*–, psammophytes such as *Hyalis argentea*, *Panicum urvilleanum* and *Sporobolus rigens*, and halophytes such as *Heterostachys* spp. and *Suaeda divaricata* (Zalba et al., 2008). The town of San Blas is located in the Isla del Jabalí (Fig. 1) and has about 600 inhabitants. The main economic activity in this area is recreational fishing (Zalba et al., 2008). This activity is both shore- and boat-based and is concentrated during the spring and summer months. Main target species include stripped weakfish *Cynoscion guatucupa*, white-mouth croaker *Micropogonias furnieri*, narrownose smooth-hound *Mustelus schmitti*, silversides *Odontesthes* sp., and the flounders *Paralichthys orbignyanus*, *Paralichthys patagonicus* and *Oncopterus darwini* (Llompart, 2011).

Several seabirds regularly breed on islands and islets of this coastal sector, including the Kelp Gull (3,600 breeding pairs), Olog's Gull (360 pairs), Royal Tern (*Thalasseus maximus maximus*; 840 pairs), and Cayenne Tern (*T. sandvicensis eurygnathus*; 200 pairs) (Yorio et al., 1998; Suárez et al., unpubl. data). Gull and tern colonies are located at less than six kilometers from the town of San Blas (Fig. 1). Kelp and Olog's gulls nest in adjacent areas at four locations: Islote Arroyo Jabalí Oeste ($40^{\circ}32'43''\text{S}$, $62^{\circ}17'24''\text{W}$), Islote Arroyo Jabalí Este ($40^{\circ}32'50''\text{S}$, $62^{\circ}16'46''\text{W}$), Banco Nordeste ($40^{\circ}32'49''\text{S}$, $62^{\circ}09'59''\text{W}$) and Islotes del Fondo ($40^{\circ}37'29''\text{S}$, $62^{\circ}14'17''\text{W}$). They both start laying in late September, eggs start hatching in late October and chicks start fledging in early December (Yorio et al., 2005). Both terns nest at Banco Nordeste; they start laying in mid October, chicks start hatching in mid November and start fledging during mid December (unpubl. data).

A beach survey was conducted on 17 October 2013 along the eastern coast of Isla del Jabalí. A total of 6 km (70% of the main beach sectors used by fishers) were surveyed during mid tide, from the water edge to the upper end of the beach and start of vegetation. The surveyed coastline was divided into three 2 km sectors

differing in their degree of anthropogenic impact: northern, urban and southern sectors. The northern sector consisted of a pebble beach which is only occasionally used for recreational fishing during the months encompassing the study period; the urban sector was defined by the waterfront and is primarily used for anchoring recreational fishing boats; the southern sector consisted of a sandy beach which is heavily used by recreational fishers during the months encompassing the study period. On the same date, an additional 0.3 km of coast was surveyed at Isla Arroyo Jabalí Este. All debris items found were counted and classified into the following 12 categories: monofilament lines, plastic bottles, plastic trays, plastic bags, other plastic items (caps, glasses, spoons, etc.), food wrapping, glass, cans, cloth, cigarette boxes, paper/cardboard, and others. Monofilament lines were removed and appropriately disposed, and the two kilometers of the southern sector of Isla del Jabalí were surveyed again on 8 December to quantify the number of monofilament lines accumulated on the beach since the first survey.

Kelp and Olog's gull colonies were visited during the late part of their incubation period (Banco Nordeste on 4 November, Islote Arroyo Jabalí Este and Islotes del Fondo on 5 November, and Islote Arroyo Jabalí Oeste on 14 November), and the whole area of all colonies was surveyed by three observers. Additional visits were made to these colonies on 6, 15 and 16 October, 6, 13, 15 and 30 November, and 1 and 3 December, during which small sections of the colony were surveyed. In all visits, the presence of individual gulls entangled with a monofilament line and balls of tangled line were recorded.

3. Results

3.1. Marine debris and recreational fishing related items

A total of 468 items were recorded, an important proportion of which originated from recreational fishing activities (e.g. monofilament lines, plastic trays and bags used for bait packaging)

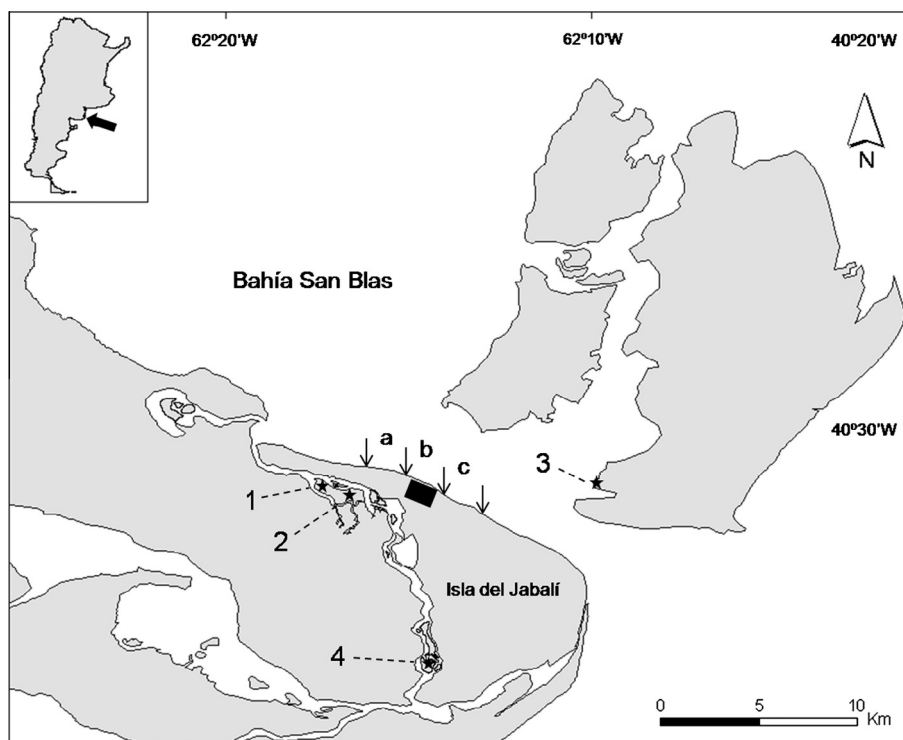


Fig. 1. Map of the study area showing the location of the Olog's gull and Kelp gull colonies (black stars) and the town of San Blas (black box). (1) Islote Arroyo Jabalí Oeste; (2) Islote Arroyo Jabalí Este; (3) Banco Nordeste; (4) Islotes del Fondo. (a) Northern sector; (b) urban sector; (c) southern sector.

Table 1
Type and number of marine debris items found along a six-km long sector of coastline at Isla del Jabalí, Buenos Aires, Argentina.

Marine debris	Gravel beach	Town beach	Sand beach	Total items (%)
Balls of tangled line	27	12	204	243 (24.4)
Plastic trays	60	0	83	143 (14.3)
Plastic bags	64	0	108	172 (17.3)
Plastic bottles	60	0	7	67 (6.7)
Other plastic items	66	32	15	113 (11.3)
Cardboard and paper	17	0	16	33 (3.3)
Food wrapping	98	0	4	102 (10.2)
Cans	10	0	4	14 (1.4)
Cigarette packages	11	0	21	32 (3.2)
Cloth	13	0	5	18 (1.8)
Styrofoam	24	0	0	24 (2.4)
Glass	11	0	9	20 (2.0)
Other	8	0	8	16 (1.6)
	469	44	484	997

(Table 1). Balls of tangled lines were found throughout the surveyed coastline; 243 items were recorded along the east coast of Isla del Jabalí (rate = 40.5 items/km) and 3 items along the 0.3 km long east coast of Isla Arroyo Jabalí Este (rate = 10 items/km). Ratio of lost and discarded lines differed between sectors, with higher numbers along the sandy beach ($X^2 = 281.5$, $p < 0.0001$). A total of 243 balls of tangled lines were recorded during the second survey conducted at the southern sector, which results in an estimated 2.4 new monofilament lines lost or discarded per kilometer per day. An additional 51 balls were recorded within the four Kelp Gull colonies (22 items at Islote Arroyo Jabalí Este, 11 at Islote Arroyo Jabalí Oeste, and 18 at Banco Nordeste).

3.2. Gull injuries and mortality

A total of 27 adult Kelp Gulls were found entangled with monofilament, 13 at Islote Arroyo Jabalí Este, 13 at Banco Nordeste and one at Islote Arroyo Jabalí Oeste. All of these individuals were tangled to vegetation within colony boundaries. Of the entangled gulls, 22 were found freshly dead with the line tangled around the body, wings and/or legs, and five were found alive with the line tangled around the wing or around the wing and leg (Fig. 2a). All entangled live gulls were released, although several of their outer primaries were severely damaged by the line. On two occasions, two individuals were found entangled to a bush by the same line, and in one of these cases a single leg was also found in the same tangled ball of monofilament suggesting that a third gull had been trapped. Four of the dead gulls had swallowed a fishing hook and

line (Fig. 2b) and one of the freshly dead gulls had the line tangled around its body and wing and with the fishing hook stuck near the carpal joint. No Olog's Gulls or terns were observed entangled with fishing lines.

4. Discussion

As in most coastlines around the world, the eastern coastline at Isla del Jabalí in the Bahía San Blas protected area showed important amounts of marine debris. Quantification of this debris indicated that it was mainly derived from recreational fisheries. Over half of the items found corresponded to pieces of fishing monofilament lines and to plastic trays and bags used to commercialize fish bait. In addition, a large percentage of food related waste, such as bottles and wrapping, was very likely the result of recreational fishing activities as the number of beach users other than fishers is generally low throughout the spring months. Almost all fishing line debris consisted of tangled balls of monofilament, which originate when line brakes and gets lost mainly in the water or when lines in reels become entangled and fishers cut and dispose the monofilament balls directly on beach. It should be noted that tangled balls of monofilament line can also reach the beach after being discarded at sea from recreational fishing boats, which regularly operate in nearby areas (Llompert, 2011). The proportion of fishery related debris was significantly higher in the southern sector, which encompasses the sandy beach more heavily used by recreational fishers during the months encompassing the study period. Neither management guidelines nor awareness campaigns are currently in place in the Bahía San Blas protected area to avoid or minimize littering the coastline with fishing lines or any other waste.

Previous studies have recorded the mortality and injury of different species of gulls by monofilament lines (Dau et al., 2009; Moore et al., 2009; Berón and Favero, 2009; Butterworth et al., 2012; Hong et al., 2013), including Kelp Gulls in New Zealand (Taylor, 1996; Gregory, 2009). Kelp Gulls at Bahía San Blas were affected in different ways by lost and discarded monofilament lines. Most entangled gulls were found dead, but several individuals found alive with the line tangled around the wing showed many damaged primary feathers which could impair flight. Entanglement may also result in negative effects that may go unnoticed or which cannot be easily allocated to damage from monofilaments. For example, as lines are strong and thin, they can easily cut through soft tissue resulting in infection, and when entangled in legs may result in limb amputation (Berón and Favero, 2009; Butterworth et al., 2012). A Kelp Gull missing its tarsus and foot observed at the Banco Nordeste colony during the study period (pers. obs.) may have been affected by line entanglement. Gulls may be also severely affected by fishing hooks (Taylor, 1996;

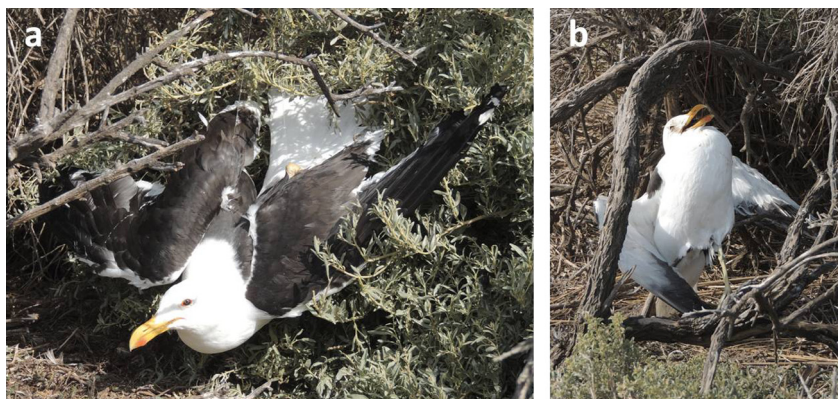


Fig. 2. Kelp Gulls affected by monofilament lines in their breeding grounds at the Bahía San Blas protected area, Buenos Aires, Argentina. (a) Adult Kelp Gull with line entangled in body and wing (photo: C. Marinao), (b) Adult Kelp Gull that swallowed a baited hook showing a monofilament line protruding from the bill (photo: C. Marinao).

Gregory, 2009; Berón and Favero, 2009; Moore et al., 2009; Hong et al., 2013). One Kelp Gull had a hook embedded in the wing and four had a monofilament line protruding from the bill, showing that at Bahía San Blas they may be also killed by swallowing hooks when trying to obtain bait.

Kelp Gulls breeding in Bahía San Blas regularly forage along the coastline to take advantage of discarded waste from recreational fishers (Yorio et al., 2013), increasing their vulnerability to entanglement with fishing lines. Monofilament lines can be then carried by gulls to their colonies, where they can get tangled and caught in vegetation resulting in mortality from starvation. Kelp Gulls in coastal Argentina nest in a wide variety of habitats, although they show a preference for areas with vegetation cover (García Borboroglu and Yorio, 2004). Thus, nesting habitat preferences may increase their risk of severe injury and mortality. In line with this, all of the dead Kelp Gulls with lines were found entangled to bushes at their colonies, suggesting that the occurrence of mortality due to entanglement could be underestimated or even overlooked if it is only assessed along the shoreline where gulls interact with fishing related items. Tangled Kelp Gulls caught in bushes could subsequently trap additional gulls, as shown by two cases where two individuals were entangled to a bush by the same monofilament.

No terns or Olog's Gulls were recorded entangled with monofilament fishing lines. Olog's Gulls breeding at Bahía San Blas are less likely to encounter lines and hooks as they feed almost exclusively on intertidal crabs and only rarely take advantage of fish discarded by recreational fishers (Suarez et al., 2011; Yorio et al., 2013). It should be considered, however, that Olog's Gulls were reported to be killed or injured as a result of hook ingestion and entanglements with monofilament lines at their wintering grounds in the Mar Chiquita area, north of the study area (Berón and Favero, 2009). At their wintering grounds, Olog's Gulls show a more generalized feeding strategy, often associating to commercial and recreational fishing activities (Martínez et al., 2000; Berón et al., 2007; Seco Pon and Favero, 2011). In addition, most of the affected individuals at Mar Chiquita were juveniles (Berón et al., 2007), suggesting that young gulls may be more vulnerable to fishing activities, as has been shown along the coast of California, USA, where juvenile gulls (*Larus* spp.) were more commonly injured by fishing gear than adults (Dau et al., 2009). In Bahía San Blas, few Olog's Gull juveniles are present during October and November, when our survey took place. Therefore, further studies are needed later in the season after fledglings disperse from their colonies to allow a better assessment of the impact of recreational fishing on this threatened species.

Our results indicate that discarded monofilament lines in the Bahía San Blas recreational fishing area result in undesired impacts on coastal wildlife. A program aimed at monitoring marine debris and the impact of monofilament lines on birds should be readily implemented, as well as a recycling program and a public awareness campaign to help minimize the impact of this activity on gulls or other coastal wildlife.

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