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South American sea lions (*Otaria flavescens*) and killer whales (*Orcinus orca*) attending chub mackerel (*Scomber japonicus*) commercial trawl fisheries over the Patagonian Shelf: a first report

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On innumerable occasions, sea lions and killer whales (*Orcinus orca*) have been observed in close proximity to fishing activities and their attendance have been reported for almost all fisheries globally (see review in Jefferson *et al.*, 1991). In particular, the South American sea lion (*Otaria flavescens*) is the species of pinniped most frequently observed along the Argentine coast, with numerous rookeries located in Patagonia, Tierra del Fuego and the Malvinas (Falkland) Islands (Bastida and Rodríguez, 2003). The diet of South American sea lions is based mainly on fish, squid and crustaceans depending on local abundance[1,2] (Koen-Alonso *et al.*, 2000; Suarez *et al.*, 2005; Romero *et al.*, 2011; Bustos *et al.*, 2012). This pinniped is typically found in shallower waters though some individuals are capable of performing movements over 200km from shore (see Campagna *et al.*, 2001). On the other hand, killer whales frequent the waters off the coast of Argentina between La Plata River (35°S) and Tierra del Fuego (53-55°S), including the Malvinas Islands (Bastida and Rodríguez, 2003). This dolphin preys on several items including fish, seabirds, marine mammals (*e.g.* sea lions, elephant seals, dolphins), and occasionally sharks and southern right whale (*Eubalanea australis*) calves[3] (Bastida and Rodríguez, 2003; Reyes and García-Borboruglu, 2004). However, the available data suggest that the seasonal near-shore distribution of killer whales is linked to the breeding cycle of pinnipeds, and their main prey (Iñíguez, 2001).

The literature on offshore attendance of killer whales and to some extent sea lions in trawl fisheries is rare for this area (but see Grandi *et al.*, 2012). Here we report South American sea lions and killer whales attending commercial fishing vessels targeting chub mackerel (*Scomber japonicus*) in offshore Argentine waters. These observations were made during an ongoing survey to assess seabird-fisheries interactions in the commercial trawl fishery off Argentina.

While studying the abundance of pelagic seabirds attending commercial trawl fisheries we conducted observations to quantify the number of contacts (and fate) of birds with fishing gear from stern commercial ice-trawlers ('freshies') operating within waters of the Patagonian Shelf (Favero *et al.*, 2011). Normally, the monitored fleet includes vessels in which fishermen do not process the catch onboard, but preserve the catch in ice within plastic cubes during trips, on vessels which operate a minimum of 130-150 days per year, performing some 600 hauls per year. The fishing effort is distributed over the Patagonian Shelf and the shelf break

[1]Rivero, L., Bastida, R., Rodríguez, D. and Westergaard, G. (1999) Hábitos tróficos de los lobos marinos de un pelo (*Otaria flavescens*) en el apostadero de Puerto Quequén - Argentina. Pages 265-266 *in* Resúmenes expandidos, *VIII Congreso Latinoamericano de Ciencias del Mar I*, 17-21 October 1999, Trujillo, Peru.

[2]Giardino, G., Mandiola, M.A., Denuncio, P., Bastida, J., Bastida, R. and Rodríguez, D. (2012) Comparación de los hábitos tróficos de dos loberías portuarias de *Otaria flavescens* del norte de Argentina. No. 50 *in* Libro de resumenes, *15ª Reunión de Trabajo de Expertos en Mamíferos Acuáticos de América del Sur-9ºCongreso SOLAMAC,* 16-20 September 2012, Puerto Madryn, Argentina.

[3]Sironi, M., Lopez, J.C., Bubas, R., Carribero, A., García, C., Harris, G., Intrieri, E., Iñíguez, M.A. and Payne, R. (2008) Predation by killer whales (*Orcinus orca*) on southern right whales (*Eubalaena australis*) off Patagonia, Argentina: effects on behavior and habitat choice. Paper SC/60/BRG29 presented at the 60th annual meeting of the Commission Committee of the International Whaling Scientific, Santiago, Chile, 23-27 June 2008.

between 37° and 48°S, and is particularly concentrated between 42° and 46°S (Favero *et al.*, 2011). Our observations were conducted primarily over the continental shelf (< 200m depth) between 39° and 48°S from late 2009 to mid-2011, totaling 122 fishing days, 221 hours of observation and 254 trawl sets.

Using 10x40 binoculars, we covered a 200m radius sampling area (200m astern and 200m on the starboard and port sides). Mean trawling time of the monitored fleet is around three hours and, depending on the sea local conditions and season, trawlers can conduct between three to five sets per active fishing day. During one hourly observation on 25 October 2009 at 40°53'S, 61°14'W, JPSP observed an adult female sea lion (according to the features described in Bastida and Rodríguez, 2003) swimming about 2m from the stern ramp of the vessel. The sea lion swam vigorously, 'porpoising' into the wake of the vessel during almost five minutes. Sea conditions at the time were Beaufort scale 5-6, over one meter of swell, and strong winds (> 40kt) blew from the east. With the help of a wave, the sea lion suddenly slithered up to the upper part of the ramp. Although the deck doors (width = 2.5m, length = 1.6m) were open due to the trawling operation, thus connecting the deck ramp with the principal deck of the vessel, the animal rapidly descended the ramp into the sea astern and was lost to sight. About five minutes later, an adult female killer whale and her calf surfaced rather close (< 30m) astern of the vessel. When surfacing, killer whales were speeding parallel to the vessel with respect to the hauling area (in line with the vessel axle centerline). They surfaced only once. Observations were registered while the vessel was actively trawling for chub mackerel (*Scomber japonicus*) using a demersal net (multifilament nylon, mean mesh size = 10cm) at about 4.3kt. At the moment of these observations, there were no fishery discards being released by the vessel.

After three and half hours, JPSP noticed probably the same sea lion (according to body size) climbing onto the net during the hauling operation while the gear (net) became afloat. The animal remained on the net for at least 10 seconds and then jumped into the water. About five minutes later, an adult female killer whale and her calf surfaced relatively close (< 10m) to the starboard side of the vessel. When surfacing, killer whales were speeding adjacent to the vessel and formed a 45° angle with respect to the hauling area. They surfaced only once. This occurred at 40°46'S, 61°21'W, or 21km from the first sighting (Figure 1). After that observation, no sea lion or killer whale interactions with the fishery were seen during several hours of watching the next day, nor were any interactions observed during the subsequent fishing trips.

We saw no killer whales or sea lions being retrieved alive or dead in 254 trawls. However, incidental mortality of South American sea lions (and of small cetaceans) has been registered for most fishing gear, both active and passive, by the trawl fleet that operates off Patagonia (see review in Crespo *et al.*, 2007). Between 175 and 602 sea lions, but no killer whales,

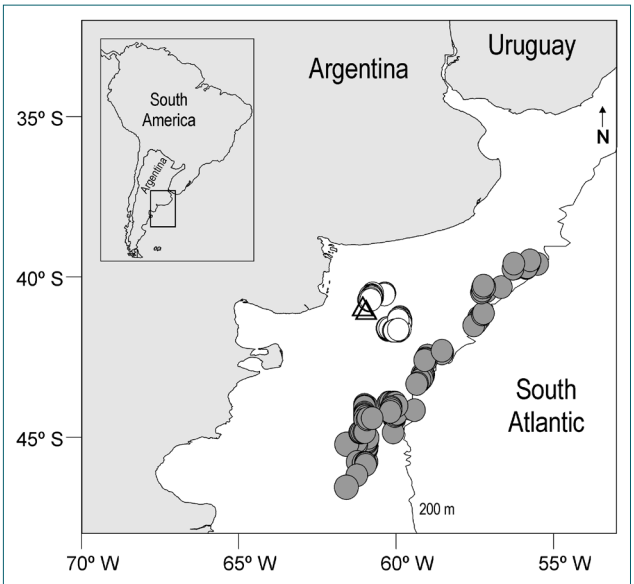

Figure 1. Sightings of South American sea lions and killer whales (open white triangles) recorded from observations aboard high-seas ice trawlers targeting chub mackerel (open white circles) within Argentine waters from late 2009 to mid-2011 (solid grey circles corresponded to hauls aimed at other target species; i.e. Argentine hake (*Merluccius hubbsi*)).

were reported incidentally killed in 5761 sampling days from 1992 to 1994 by a bottom trawl fishery (Crespo *et al.*, 1997). The incidental mortality of South American sea lion could be the result of its generalist and opportunistic diet as the species preys on several items of commercial importance (*e.g.* Argentine hake *Merluccius hubssi*, Argentine anchovy *Anchoita engraulis*, striped weakfish *Cynoscion guatucupa*, among others) (see Koen-Alonso *et al.*, 2000; Suarez *et al.*, 2005; Romero *et al.*, 2011; among others). Not surprisingly, this pinniped is suggested to be a direct competitor with fishing activities with interactions registered throughout its entire area of distribution (Bastida and Rodríguez, 2003). On the contrary, while reports of killer whales interacting with fisheries are abundant in the Southwest Atlantic Ocean[4] (Crespo *et al.*, 1997; Secchi and Vaske Jr., 1998; Nolan *et al.*, 2000; Dalla Rosa and Secchi, 2007; Passadore *et al.*, 2012; among others) and its surrounding maritime areas (*e.g.* South Georgia: Ashford *et al.*, 1996; Purves *et al.*, 2004), scarce information is available off Patagonia.

According to our results, sea lions and killer whales interacting with commercial fisheries were registered infrequently during the period of this research. Further, a single sea lion and a small killer whale pair comprised only

[4]Brum, F.L. and Marín, Y.H. (2000) *Interacciones entre mamíferos marinos y la pesquería de pez espada,* Xiphias gladius, *con palangre pelágico en el Atlántico Sudoccidental.* Capturas de grandes pelágicos en el Atlántico Sudoccidental y su interacción con otras poblaciones. INAPE, Proyecto URU/92/003, PNUD. 96 pp.

of a female and her calf were observed directly interacting close to the fishing vessel. This is in line with previous studies conducted on other mackerel fisheries along the central Chilean coast (Hückstädt and Antezana, 2004) and other trawl fisheries off Patagonia (Grandi *et al.*, 2012) at least for killer whales. The few observations of marine mammals interacting with commercial fisheries may be the result of the little observer coverage on the fishing fleet of Argentine flag. However, in previous studies of the diet of South American sea lion near the study area there is no record of chub mackerel as prey item (see Koen-Alonso *et al.*, 2000; Suarez *et al.*, 2005; Romero *et al.*, 2011; Bustos *et al.*, 2012; among others). It is possible that sea lions and to some extent killer whales occasionally take advantage of chub mackerel and bycatch species as prey while attending trawl fisheries off Argentina. For example, in the North Atlantic, killer whales were reported to interact with Atlantic mackerel (*S. scombrus*) purse seine and the Atlantic herring (*Clupea harengus*) fisheries (Bloch and Lockyer, 1988).

The sighting of both species in a short time frame may also be interpreted further than the casual attendance of both mammals to a food source. Other types of interaction include a possible harassment of the killer whales towards the sea lion (see for example Grandi *et al.*, 2012). In this sense, the latter may have climbed the stern ramp of the trawler as an anti-predator behavior. On the contrary the sea lion might be trying to keep up with the killer whales.

To our knowledge there is little data with regard to the offshore distribution of South American sea lions and killer whales and their interactions with other marine taxa and fisheries in the vast marine region off Argentina. It is of some concern that killer whales and sea lions could be interacting with high-seas fisheries, since both species may be affected by fishing operations during their attendance at trawlers. Killer whales and South American sea lions are considered 'Data Deficient' and 'Lower Risk' by the International Union for Conservation of Nature respectively[5]. Further studies that monitor and give more precise data on sea lions and killer whale interactions with coastal and high-seas fishing vessels should be encouraged.

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[5]International Union for Conservation of Nature (IUCN) (2008) Cetacean update of the 2008 IUCN Red List of Threatened Species. Available online at <www.iucn.org/search.cfm?uSearchTerm=cetacean>. Consulted on 18 September 2011.

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