

Behaviour of Southern sea lions in presence of killer whales during fishing operations in Central Chile*

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SUMMARY: The killer whale is an opportunistic top-predator of ecosystems worldwide and its diet varies locally and seasonally, which is reflected in diverse feeding behaviours associated with its prey. We report the occurrence of killer whales presumably preying on southern sea lions associated with the jack mackerel fishing fleet in central Chile. The presence of killer whales was recorded during 4 fishing sets. All sightings consisted of 3-5 individual pods of females and calves. The number of sea lions was not significantly affected by the presence of killer whales, but their behaviour was, by reducing the number of behavioural displays, as they stopped feeding and resting activities and stayed close to the hull of the vessel after net retrieval ended. We propose that killer whales could be using the fishery as an indirect source of prey to benefit from the aggregation of sea lions around the vessel, far away from land.

Key words: *Orcinus orca*, killer whale, *Otaria flavescens*, southern sea lion, purse seine fishery, central Chile.

RESUMEN: COMPORTAMIENTO DEL LOBO MARINO COMÚN DEL SUR ANTE LA PRESENCIA DE ORCAS DURANTE OPERACIONES DE PESCA EN CHILE CENTRAL. – La orca es un depredador tope de hábitos oportunistas que habita diversos ecosistemas de todo el mundo y cuya dieta varía en forma local y estacional, lo que se refleja en la diversidad de comportamientos alimentarios asociados con sus presas. En este trabajo, reportamos la presencia de orcas presumiblemente cazando lobos marinos comunes del sur, en asociación con la flota pesquera de jurel en Chile Central. Se registró la presencia de orcas en cuatro lances de pesca. Todos los avistamientos fueron de grupos compuestos por 3-5 individuos, hembras y crías. Si bien la presencia de orcas no afectó significativamente el número de lobos marinos, sí tuvo un efecto en el comportamiento de los lobos marinos reduciendo el número de conductas, cesando las actividades de alimentación y descanso y permaneciendo cercanos al casco del barco pesquero hasta después de finalizada la recuperación de la red. Se propone que las orcas podrían estar utilizando la pesquería como una fuente indirecta de presas, beneficiándose así de la agregación de lobos marinos alrededor del barco pesquero, lejos de tierra.

Palabras clave: *Orcinus orca*, orca, *Otaria flavescens*, lobo marino común del sur, pesquería de cerco, Chile central.

INTRODUCTION

Killer whales (*Orcinus orca*) are considered to be opportunistic top-predators, feeding on a wide variety of prey from fishes and cephalopods to seabirds, marine turtles and marine mammals, including baleen whales (Heimlich-Boran, 1988; Heyning and Dahlheim, 1988; Jefferson *et al.*, 1991; Ford *et al.*,

1998; Pauly *et al.*, 1998; Secchi and Vaske, 1998; Saulitis *et al.*, 2000). The composition of the diet of killer whales varies locally and seasonally (Heyning and Dahlheim, 1988), which is reflected in diverse feeding behaviours associated with prey (IWC, 1982).

According to Jefferson *et al.* (1991), pinnipeds apparently comprise an important item of the diet of some populations of killer whale, and among these the southern sea lion (*Otaria flavescens*) has been

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frequently reported as a prey. Indeed, there are reports of predation on southern sea lions by killer whales, specifically from Argentinean Patagonia, where killer whales strand themselves while attempting to take prey in shallow waters (Lopez and Lopez, 1985; Hoelzel, 1991).

Killer whales have been reported from Pisagua (13°35'S) to the Bellinghausen Sea (70°23'S), including the Juan Fernandez Islands (Aguayo-Lobo *et al.*, 1998) but the population size in Chilean waters is unknown. Southern sea lions occur along the entire coast of Chile with a population size of *ca.* 100,000 individuals (Vaz-Ferreira, 1979; Sielfeld *et al.*, 1977; Venegas *et al.*, 2002).

Southern sea lions interact with the jack mackerel (*Trachurus symmetricus*) industrial fishing fleet off central Chile (Hückstädt and Antezana, 2003). Here, we report the occurrence of changes in sea lion behaviour in the presence of killer whales associated with the Chilean jack mackerel purse seine fleet in central Chile.

MATERIALS AND METHODS

Research cruises were carried out to study the interaction between sea lions and the jack mackerel fishing fleet between 36° and 39°S during October 1999, totalling 32 fishing sets.

Observations of sea lions were made every 10 min during fishing operations in a circle of *ca.* 500 m radius around the vessel by means of 10-30 × 30 binoculars, and checked by video camera records. The behaviour of sea lions was observed during 10-min periods focused on single animals, and all observed displays were recorded until they dived, according to Hückstädt and Antezana (2003). This is a qualitative approach, since it considers only the presence of specific displays.

Presence of killer whales was recorded during four sets: on October 10 (1 set), 18 and 19 on successive purse seine settings. The number and composition of killer whale pods was recorded and comparisons of the number and behaviour of sea lions in the presence or absence of killer whales were made.

The U-test (Zar, 1999) was used in order to discriminate the effect of killer whales on the number of sea lions around the purse seiner. The Wilcoxon matched pairs test (Zar, 1999) was employed to discriminate the effect of killer whales on the number of behavioural displays, since comparisons were conducted only for those periods of the set for which

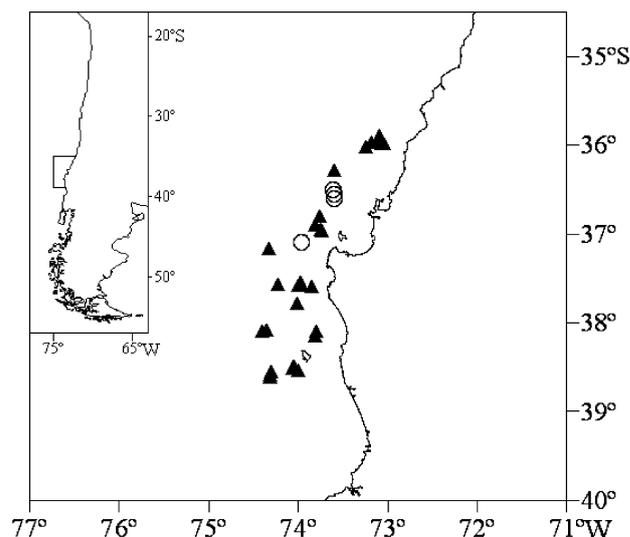


FIG. 1. – Location of fishing sets with (○, $n = 4$) and without killer whales (▲, $n = 28$) during purse seining for jack mackerel off central Chile.

data were available for both conditions (i.e. presence and absence of killer whales, $n = 7$). Behaviours were grouped into four functional categories (Hückstädt and Antezana, 2003): feeding (behaviours associated with pursuing, handling and catching prey), movement (behaviours that led to individual displacement), predator avoidance (evasive behaviours displayed to avoid attacks by killer whales, mainly observed during the last phases of the fishing sets), and resting (leisure and playing behaviour and non-aggressive individual interactions).

RESULTS AND DISCUSSION

The presence of sea lions was observed in 30 out of 32 fishing sets sampled, while killer whales were recorded during 4 fishing sets (Fig. 1). All sightings of killer whales consisted of pods with a minimum of three and a maximum of five individuals; only females and calves were observed (Table 1).

Killer whales approached the vessel once the purse seine set began, and remained there until it ended. The whales swam near the vessel as close as *ca.* 300 m from the vessel, or swam toward other nearby vessels.

Numbers of sea lions were not significantly affected by the presence of killer whales ($U = 31.5$, $p = 0.48$); in fact, sea lions were absent from the set on just one occasion when killer whales were observed. The presence of the cetaceans around fishing vessels did affect the overall behaviour of the sea lions (Table

TABLE 1. – Composition of pods of killer whales sighted during purse seine fishing operations in Central Chile.

Pod	Number of individuals	Date of sighting	Time of sighting
A	5 (not identified)	October, 10	07:00
B	3 (1 adult female; 2 calves)	October, 18	13:30
C	3 (1 adult female; 2 calves)	October, 18	16:30
D	4 (2 adult females; 2 calves)	October, 19	07:30

2), as well as movement displays (see Hückstädt and Antezana, 2003), but no effect was observed on the other behavioural categories (Fig. 2).

When killer whales were present, the sea lions stayed close to the hull of the vessel after net retrieval. In the presence of killer whales, sea lions swam alongside the moving vessel, “porpoising” close to the vessel’s hull as other pelagic otariids do when travelling (Thompson *et al.*, 1998). When they could keep up with the speed of the vessel no longer, groups of sea lions swam away from the killer whales. Further on, killer whales swam toward these groups, but we did not observe direct hunting. Significant differences found in the frequency of movement displays could be related to avoidance of killer whales, and was clearly different to sea lion behaviour in the absence of the cetaceans.

On one occasion one pod (D) was observed for *ca.* 20 min at a steady distance of *ca.* 300 m from the vessel, flapping their tails against the water surface. An adult flapped its tail violently and calves then performed the same action. Tail-flapping, which is not a well-understood display (Heyning and Dahlheim, 1988), has been suggested to be a strategy for capturing small pelagic fishes (Domenici *et al.*, 2000). However, this behaviour has also been

TABLE 2. – Behavioural differences observed in southern sea lions around operating purse seiners in presence of killer whales (Wilcoxon test). Highlighted values indicate significant differences at a 95% confidence level. Comparisons were conducted for those periods of the fishing set for which data were available for both presence and absence of killer whales (n = 7).

Behaviour	p value
All categories *	0.042
Feeding *	0.076
Movement *	0.018
Predator avoidance †	0.068
Resting *	0.249

* Behaviour decreased in presence of killer whales

† Behaviour increased in presence of killer whales

observed in killer whales hunting southern sea lions in Argentinean waters (Hoelzel, 1991). We did not observe killer whales feeding on fishes. Rather they waited until fishing was completed and then swam towards the sea lions when these were not able to swim by the side of the vessel.

In British Columbia waters (the northeast Pacific), two forms of killer whales which differ in diet composition have been identified: one form predaes almost exclusively on fishes while the other consumes exclusively marine mammals or birds (Baird and Dill, 1995; Ford *et al.*, 1998). Individual populations of killer whales appear to specialise in particular types of prey, such as marine mammals or fishes (Baird, 2000). Along the Chilean coast, killer whales have been reported to prey on southern sea lions, South American fur seal (*Arctocephalus australis*), and fishes in southernmost waters (Capella *et al.*, 1999). In the study area, according to the fishermen’s experience, killer whales often approach fishing boats to prey on sea lions (LAH, unpublished data).

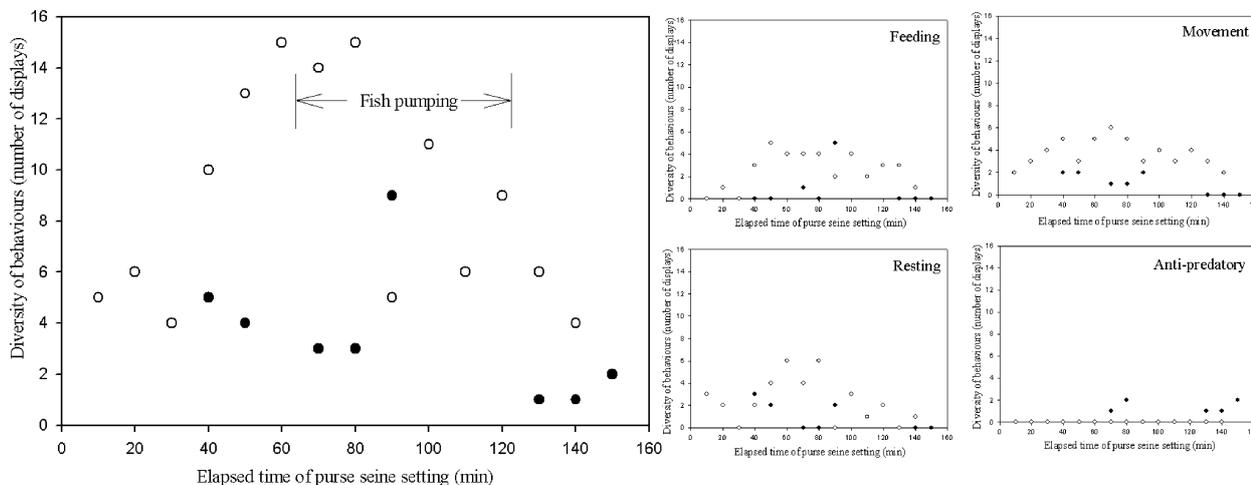


Fig. 2. – Overall displays of southern sea lions, and partitioning among behavioural categories in the presence (black dots) and absence (open dots) of killer whales. The figure shows the combined data on the total number of displays observed for the whole study period.

Reports on killer whales interacting directly with fisheries are not new on the South American coast, but our observation is the first ever on killer whales using the fishery as a presumed indirect source of prey. Killer whales fed directly on seabass (*Dissostichus eleginoides*) caught in longlines around South Georgia (Ashford and Martin, 1996), and have been sighted near the Falkland Islands associated with the same fishery (Nolan *et al.*, 2000), and with tuna and swordfish longlines in southern Brazil (Secchi and Vaske, 1998).

Killer whales have probably developed a hunting strategy to benefit from the aggregation of sea lions around the fishing fleet in the open ocean, far away from their land refuges, with the corresponding advantages in searching and pursuing. This particular example of opportunistic adaptation by learning, which seems to be a notable element of the development of feeding strategies of this species (Lopez and Lopez, 1985), seems quite recent as industrial jack mackerel fishery did not develop until the late 1960s in central Chile.

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