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Killer whale (*Orcinus orca*) sightings and depredation on tuna and swordfish longline catches in southern Brazil

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Abstract

Observations of killer whale (*Orcinus orca*) depredation on tuna and swordfish longline fisheries in southern Brazil were made during nine cruises on board tuna boats, from August 1987 to August 1991. During the astral winter, fisheries occur in south and southeast Brazil, mainly in the latitudes between 30°S and 35°S and from November to March they are carried out off the Brazilian northeast coast. Killer whales and sharks commonly attack hooked tuna (*Thunnus* spp.) but killer whales seem to prefer the swordfish (*Xiphias gladius*) reducing the fishermen's profits. In the southern region, more than 50% of the daily swordfish catch may be lost due to killer whale depredation, and occasionally it may reach almost 100%. Killer whales avoid the head and, on some occasions, the vertebral column and fins, eating preferentially the flesh. They rip the body of the fish and leave torn borders, while sharks leave clear-cut bites which are relatively small. Killer whales were sighted in groups of one to ten animals, the solitary animals being always males.

Introduction

The longline fishery in Brazil

The Brazilian longline tuna fisheries began in the northeast region. Vessels from the commercial Japanese fleet fished in the waters of Brazil from 1956 to 1971. In 1969, the Brazilian fishery began, operating three to nine national vessels per year, until 1988. These vessels worked beyond the continental slope of the south and southeast regions of Brazil (23°S–33°S) (Zavala-Camin, 1987). From 1976 to 1992, Korean and Japanese boats were leased by Brazilian companies, which carried out their activities in the northeastern, and mainly southern region. Until 1994, both Brazilian and leased vessels accounted for 33 working vessels: 16 from the south, 15 from the southeast and 2 from the northeast region. Presently, vessels are operating only from the port of Santos (southeastern Brazil), but the fishing spots remain basically unchanged.

Throughout the austral cold months (April–October) the fishing occurs in the south and southeast, mainly in latitudes 30°S–35°S, corresponding to approximately 73% of the fishing effort for that period. In the spring and summer (November–March), vessels move up to the Atlantic equatorial region off the Brazilian northeast coast to fish in the offspring grounds of the target species (Antero Silva, 1992). Brazilian longliners operate in water depths of 500–3500 m, mainly during the third trimester, when tuna (*Thunnus* spp.) and swordfish (*Xiphias gladius*) are most abundant (Amorim & Arfelli, 1984). These national vessels remain at sea for approximately 18 days, whereas the foreign leased boats fish from four to six months, with a higher than average fishing effort (i.e. hooks per day) than the national vessels.

The killer whale

Killer whales inhabit all major oceans and seas (Dahlheim, 1981; Leatherwood & Reeves, 1983) and are considered opportunistic feeders. However, some killer whale populations are specialized in their foraging strategies (López & López, 1985; Heimlich-Boran, 1988). Diets may vary seasonally and also within a region (Dahlheim, 1981; Matkin & Leatherwood, 1986). Prey species include squid, fish, marine turtles, seabirds, small marine mammals and great whales (Caldwell & Caldwell, 1969; Baldridge, 1972; Shevchenko, 1975; Castello, 1977; Condy *et al.*, 1978; Dolphin, 1987; Lowry *et al.*, 1987; Campbell *et al.*, 1988; Heimlich-Boran, 1988; Silber *et al.*, 1989; Felleman *et al.*, 1991; Jefferson *et al.*, 1991). Studies of recognizable killer whale pods in the coastal waters of the northeastern

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Pacific and southwestern Atlantic have demonstrated that local killer whales learn how to take advantage of seasonally abundant prey within their home range, which may cover an area of many hundreds, or thousands, of square kilometers (Bigg, 1982, Iñiguez, *in press*). Heimlich-Boran (1988) suggests that, in the eastern North Pacific, killer whales use geographic features to maximize feeding efficiency, with transient pods feeding largely on harbor seals (*Phoca vitulina*) and resident pods preying mostly on salmon (*Onchorhynchus* spp.).

Earlier reports of depredation by killer whales on longline fisheries have been made in the Indian Ocean (Sivasubramanian, 1965). Nemoto (1968) and Nakamura (1985) noted similar fishery interactions in the North Atlantic. Studies on killer whale/fishery interactions have also been carried out in the North Pacific (Matkin, 1986; Matkin *et al.*, 1987*a,b*; Dahlheim, 1988; Matkin, 1988; Leatherwood *et al.*, 1990).

In contrast, very little is known of the ecology and feeding habits of killer whales in Brazilian waters (Castello, 1977; Bittencourt, 1983; Geise & Borobia, 1988). In southern Brazil, they are commonly found near longliners where their attacks on tuna and tuna-like fish are extensive, particularly on swordfish. To date, no assessments have been made on the magnitude of such depredation and its impact on the economy of the Brazilian fisheries. In this study we address the problem by focusing on the interactions between killer whales and the tuna longline fishery and also report sightings of these whales in the region.

Materials and methods

Observations on the interactions were made during nine cruises, between August 1987 and August 1991, on board national longline tuna boats from the ports of Rio Grande and Santos, southern and southeastern Brazil respectively. Each fishing cruise lasted 15–20 days, in the area 26°S–34°S, beyond the Brazilian continental slope (Fig. 1), where depth ranged from 250–3500 m. There were no summertime cruises, due to the fact that during this season the longliners change their fishing grounds to lower latitudes.

Losses of swordfish were estimated by counting the number of damaged fish hauled out per day. Attacks of killer whales were distinguished from those of sharks by the shape and size of bites. Killer whale bites leave torn borders on the fish, while sharks leave clear-cut bites which are smaller than those made by orcas. Despite longline length, which may vary from 40–120 km, sightings occurred in an incidental manner, whenever the killer whales were passing close to the vessel. Additional data were obtained by interviewing fishermen both on board vessels and nearby boats, the latter via VHF radio.

Results

The fisheries

During our cruises on Brazilian boats, the daily average fishing effort was about 1500 hooks per day per vessel. The hooks were set in depths of 50–150 m. The longlines ranged from 35–90 km long and were released early in the dawn. After four to five hours hauling of the gear was started. The catch per unit effort rates for swordfish ranged from 0.8–10.5 fish/1000 hooks per cruise, with an average of approximately 3.5 fish/1000 hooks.

Killer whale/longline fishery interactions

In the southern region, mainly during winter, more than 50% of the daily swordfish catch may be lost to killer whale depredation. According to fishermen this loss may occasionally reach almost 100%. Skippers sometimes change the fishing areas, advance the longline casting time and even shoot at the whales, but these procedures did not stop depredation. Often killer whales would continue following the boats and attacking the catch. Carcharhinid sharks (*Carcharhinus* spp.), blue sharks (*Prionace glauca*), shortfin makos (*Isurus oxyrinchus*) and hammerhead sharks (*Sphyrna* spp.) commonly prey on fish taken by longlines, leaving clear-cut bites which are relatively small (Fig. 2a). On the other hand, killer whale bites leave torn borders, largely ripping the body of the fish, avoiding the head and sometimes the vertebral column and fins (Fig. 2b). Generally, when killer whales attack during fishing, the percentage of fish damages is higher than that caused by sharks. The fish damaged by sharks seem to be found at random along the whole longline, while attacks by killer whales may be in an orderly manner, as was observed in the Indian Ocean (Sivasubramanian, 1965).

Cumulative sightings of killer whales in southern Brazil are shown in Fig. 1. No pairs of whales were seen; they occurred in herds of 3–10 animals or sometimes alone (Fig. 3). These single animals were always adult males. If swordfish are caught in great numbers, killer whales may appear more frequently, waiting for the longline sometimes as close as 50 m from the vessel. The sightings reported here occurred only during the afternoon and evening hours, but it is difficult to assume that killer whales feed on fish only at this time of the day, while the longline has been out since day-break.

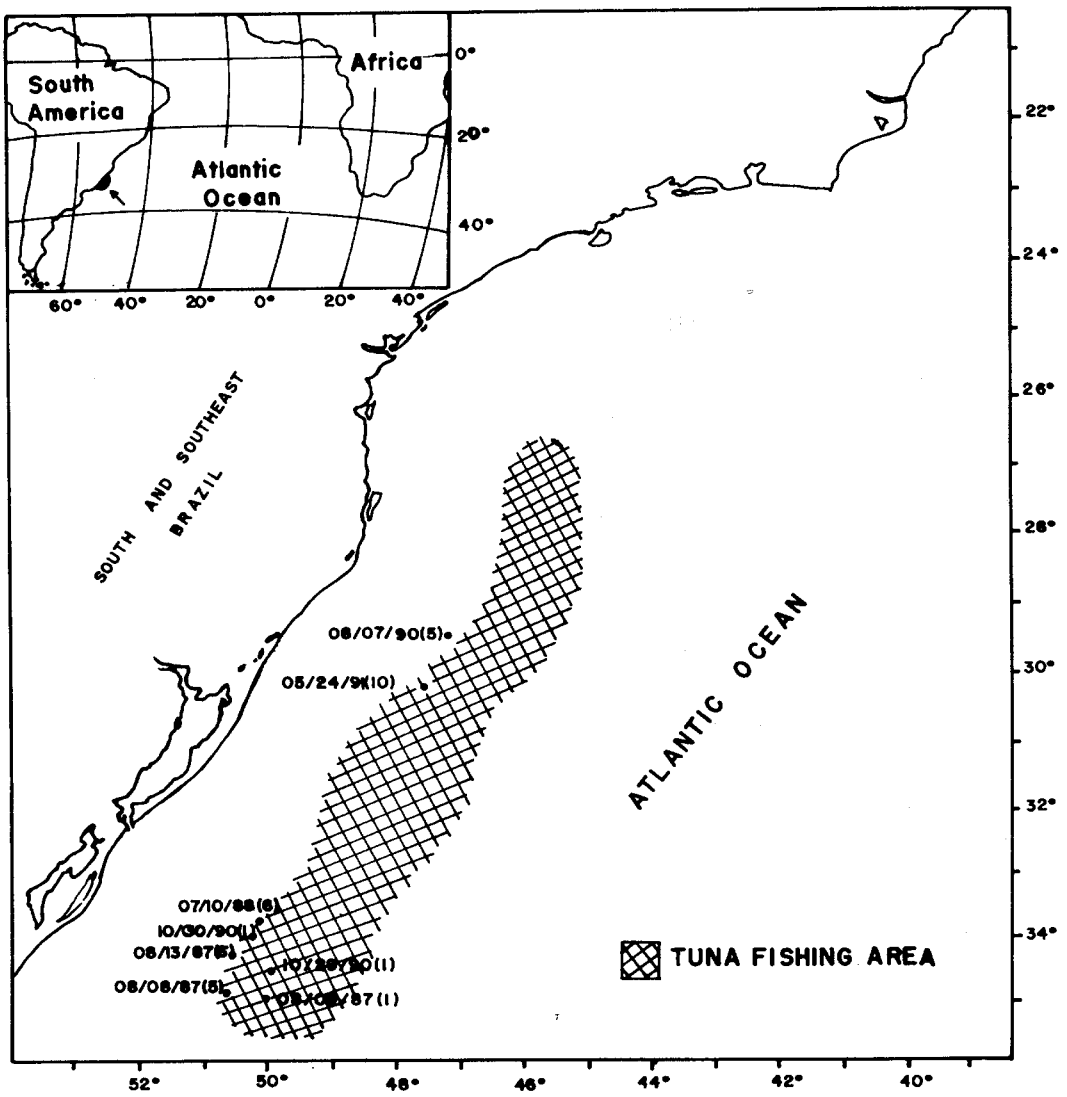

Figure 1. Sighting points of killer whales with dates and individual numbers.

Discussion

Sivasubramanian (1965) states that killer whales are often found around tuna longline boats in the Indian Ocean where, together with sharks, they damage up to 4% of the annual catch and may scare fish away from, or into, the hooks. Leatherwood *et al.* (1991) pointed out that the behavior of orcas described by Sivasubramanian (1965) is typically displayed by false killer whales (*Pseudorca crassidens*) in many areas. The possibility that false killer whales are also taking hooked fish in southern Brazil is not discarded. At the same time, in all opportunities in which killer whales were sighted near the vessel, damaged fish were hauled up.

Sasaki (1985) (mentioned by Dahlheim, 1988), Nemoto (1968) and Nakamura (1985) reported tuna longline interactions with killer whales in the northern Atlantic. Matkin (1986), Matkin *et al.* (1987*a*) and Dahlheim (1988) pointed out that the killer whale depredation on the longline fisheries of Pacific blackcod (*Anoplopoma fimbria*) in Alaskan waters may reduce their commercial value. In those cases, fish showed extensive rake marks made be killer whale teeth. Fishermen attempted to resolve this problem by moving to other areas, using sonic waves, momentarily stopping fishing operations, discharging electric currents and shooting or throwing explosives to frighten the killer whales away from their gear. Occasionally, fishermen will also change their target species which seems to show the best results.

Although Nakamura (1985) has considered it very improbable that the killer whale would commonly prey on large pelagic fish in the environment, it is known that *Orcinus* preys on bluefin tuna regularly in the northwest Atlantic (T. Jefferson, pers. comm.). Nevertheless, longline hooked fish

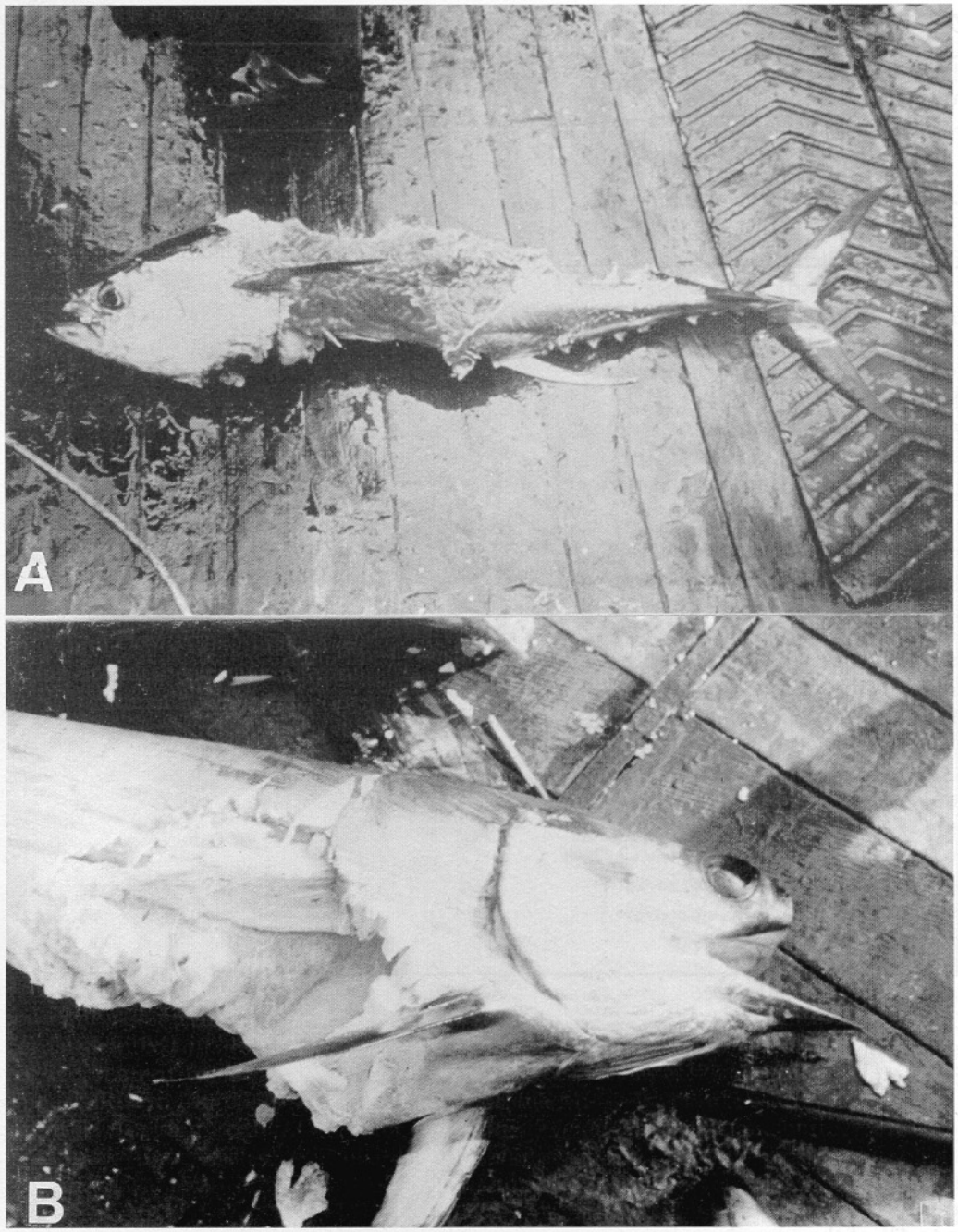

Figure 2. a. Yellowfin tuna (*Thunnus albacares*) damaged by shark. b. Swordfish (*Xiphias gladius*) damaged by killer whale.

would likely be a new and effortless food option to the predator. This interaction is an example of how a new fishing gear introduced in southern Brazilian waters, affects the food supply of another member of the ecosystem, although interfering with fisheries.

The attacks are particularly noticeable toward swordfish, but it is difficult to know if the damage does not occur significantly on tuna. Because these fish do not have the 'sword' of *X. gladius*, killer whales may eat the tuna whole, without leaving evidence. Losses may not be confined just to fish damage. When a predator is present on the fishing ground the target species may be frightened away, forcing fishermen to change location, looking for areas where attacks do not occur. This displacement wastes time, fuel and food supplies for the crew. Further studies on killer whale depredation on the tuna longline fishery is necessary to verify the extent to which the killer whales have been responsible for the decline in the hooked rate of fish and to

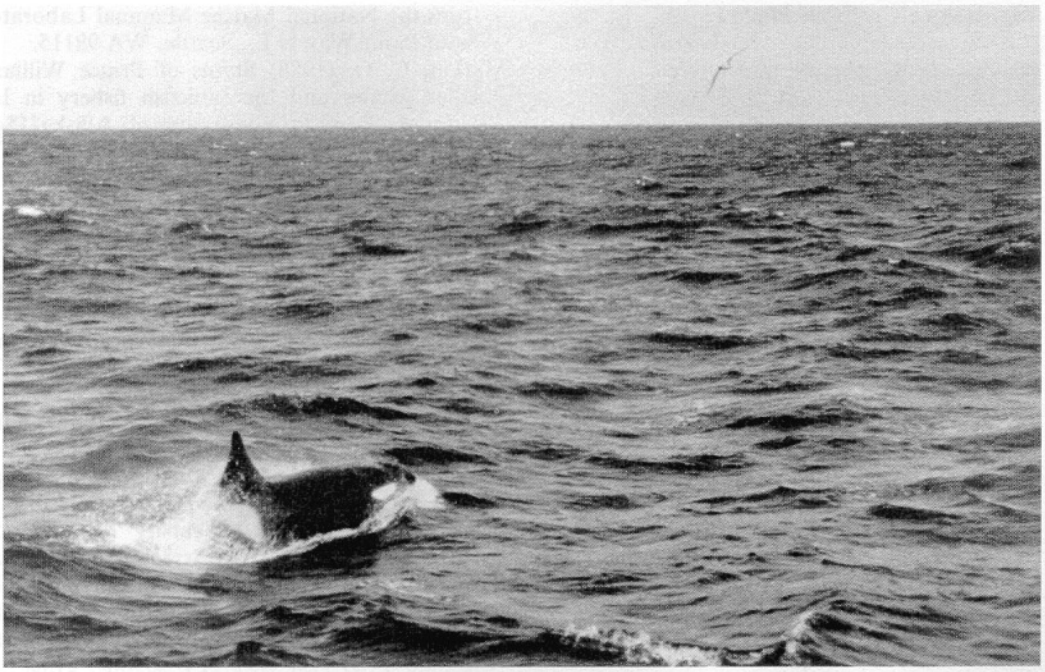

Figure 3. Solitary male killer whale swimming near longline vessel in Southern Brazil.

investigate methods that aim to minimize or prevent losses.

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