Marine mammal depredation and pelagic longline fishery: Second trials to assess the efficiency of a scaring mitigating device in Saint-Paul Bay (Reunion Island)

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- March-May 2011 -

Dolphin trying to attack a protected bait

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Citation :

Rabearisoa N., J.P. Lamoureux, P. Cotel & P. Bach, 2011 - Marine mammal depredation and pelagic longline fishery: Second trials to assess the efficiency of a scaring mitigating device in Saint-Paul Bay (Reunion Island), March – May 2011. IRD/SWIOFP Report, 11 p.

1 Introduction

Depredation is defined as the removal of fish or bait from fishing gear by marine predators such as in priority sharks and toothed whales and is opposed to predation, which is the catch of free ranging fish (Donoghue et al., 2003). It is documented worldwide and is known in many fisheries but opposite to bottom longline fishery targeting toothfish (*Dissostichus eleginoides*), pelagic longline fisheries targeting tuna (*Thunnus* spp) and swordfish (*Xiphias gladius*) received less interest from the scientific community regarding this issue. In the Indian Ocean, this phenomenon is characterized by a lack of data. Only a few papers deal with this problem (Nishida and Shiba, 2004 ; Sivasubramanian, 1964 ; Poisson et al., 2001 ; Romanov et al., 2007)

In tropical areas, depredation on pelagic longline capture involves false-killer whales (*Pseudorca crassidens*), pilot whales (*Globicephala macrorynchus*) and pelagic sharks, and depredation on bait involves small delphinids, such as spinner dolphins (*Stenella longirostris*) or Risso's dolphins (*Grampeus griseus*).

The monitoring of the extent and magnitude of depredation is of a great importance since it leads to many negative consequences affecting commercial aspects (expenditure of extra money when fixing damaged gear and/or moving away to avoid areas of high depredation rate, loss of fish), biological aspects (change in hunting behavior of cetaceans, risks of injury or mortality when interacting with fishing gear, threats by fishermen) and assessment aspects (increase of fishing effort, fish loss not taken into account in stock analysis) (Donoghue et al, 2002).

Many mitigation measures have been tested so far but none of them proved to be efficient speaking of long term (Jefferson and Curry, 1995). Most research are currently focusing on the use of active and passive acoustic means to deter depredation from cetaceans. They can be efficient at short term but are found to create opposite effect at medium term as they are used as an acoustic attractor by cetaceans (Mooney et al., 2009; Brotons et al., 2008; Franse, 2005).

There are good evidences that cetaceans use their sight and their echolocation abilities to locate the gear and/or the boat, follow them and depredate the fish caught. In order to mitigate depredation events and then reduce interactions between toothed whales and longline close to the gear, we propose to develop the physical protection of capture. The goal of this study is to test the efficiency of scaring devices protecting physically catches and frightening predators. The development of those devices ensue from two preliminary surveys undertaken in Seychelles in 2007 and 2008, and aiming at testing the efficiency of two older devices regarding physical protection of capture on a commercial longliner (Rabearisoa et al, 2010). In August 2010, as a first step of those experiments, we worked at a small scale by conducting surveys in Saint-Paul Bay, located in the south-western of La Reunion Island (Rabearisoa et al, 2010). In March and May 2011, we improved our devices and we worked at a larger scale in the same study area. We tested those devices on two coastal species of small delphinids, the bottlenose dolphin (*Tursiops aduncus*) and the spinner dolphin (*Stenella longirostris*), which are known to be resident within the study area (Dulau-Druot et al, 2008).

2 Materials and methods

2.1 Study area and biological material

Our surveys started on March 2nd, 2011, lasted 20 days and ended on June 1st, 2011. These surveys aimed at searching for dolphins and assessing the efficiency of our devices on them. The study area extended from L'Hermitage to Saint-Paul Bay, and was restricted to the coastal waters (up to 300 m deep). Surveys started at 07.00 am and ended around mid-afternoon.

Before testing those depredation mitigating devices at a larger scale on pelagic longliners operating in open waters, we chose to work at a small scale with resident dolphins. In the case we obtain positive results, we will develop those experiments at a larger scale onboard fishing vessels and in real fishing conditions on the species involved in catch depredation.

2.2 Experimental protocol

Surveys were undertaken onboard an artisanal fishing boat, Le Rapace (Fig 1.a). They started by baiting the branchlines with mackerel (Fig 1.b) (40 ones were protected by devices, 40 others were not), together with an area prospection to search for dolphins. Using both types of branchlines allowed us to compare the dolphins' behaviour towards the presence and the absence of devices, and assess their efficiency regarding bait protection.

We then set the 80 baited branchlines on a 500 meters long experimental longline (Fig 1.c). A branchline was set every 5 meters and a buoy was set every 4 branchlines to maintain the line at the water surface (Fig. 1.d). We set alternatively 20 protected and 20 unprotected branchlines. A camera was used to record some underwater images of the devices.

Data collection consisted in recording the geographical position of the set, the characteristics of each dolphins group (size and species) we encountered (whether they interacted with the line or not), and the status of each bait after the retrieval of the branchline (whether it was damaged or not).

2.3 Description of the scaring device

The device consists of twelve streamers of one meter long made up of tarpaulin material and fixed on a PVC tube. The branchline was inserted into the PVC tube of the device, and the bait was fixed at its end by a simple knot (**no hook was used to avoid risks of injury on dolphins**). The lower strands of the device were leaded so that they covered the bait. The upper ones move more freely in the water column, causing a scary effect on the dolphins and preventing them from taking the bait (Fig. 1.e)

Fig. 1.a: Le Rapace, the artisanal fishing boat rented for the experiments
Fig. 1.b: Baiting of the branchlines
Fig. 1.c: Setting of a protected branchline on the experimental longline
Fig. 1.d: General configuration of the experimental longline
Fig. 1.e: General configuration of the depredation mitigation device

2.4 Expenses report

11,000 Euros were allocated to those surveys within the framework of the component 4 of the SWIOFP project. At the end of the surveys, we spent about 10,200 Euros (Tab.1).

Tab. 1 Expenses report

Designation	Quantity	Total price (euros)
Boat rental	20 days	7750
Baits, tools and diverse materials		2416,63
TOTAL		**10166,63**

3 Results

From March 2nd, 2011 to June 1st, 2011 we conducted 20 surveys in St-Paul Bay (one line setting per survey and per day) (Fig. 2). We made 15 observations of *T. aduncus* (we encountered the same group 9 out of 15 times) and 3 observations of *S. longirostris* during the whole experiment. There were 9 interactions between our experimental line and some dolphins groups (meaning that they damaged one or more baits on the line). 6 of those interactions occurred with *T. aduncus* (Fig. 3.a & 3.b), and 3 occurred with *S. longirostris*. We were able to say that the observed damages were due to dolphins when they were observed evolving in the vicinity of the line and stopping near it for a while. Another particularity of dolphins damages was the successive nature of those attacks on the set (as opposed to the random nature of other fish attacks). This particularity is also common when toothed whales depredation on baits or capture occurs on pelagic longliners.

Fig. 2: Survey area and spatial distribution of device settings (in red: sets with dolphins interactions; in yellow: sets without dolphins interactions)

Based on those observations, we only considered the 9 sets which interacted with dolphins in our analysis (Tab. 2). A total of 339 protected and 330 unprotected baits were set. 47 protected baits and 103 unprotected ones were damaged (partially or fully) (Fig. 3.c). For 8 sets out of 9, there were more damaged unprotected baits than protected ones. The ratio between damaged protected and unprotected baits ranged between 0.11 and 0.73, except for a set on which we observed more damaged protected baits. For this particular set (survey #19), which interacted with a group of about ten *T. truncatus*, there were 1.95 times more damaged protected baits than unprotected ones. Nevertheless, those results showed that our devices are efficient in protecting the bait from dolphins attacks.

Tab. 2: Interactions between dolphins and depredation mitigation devices

N° survey	Nb of protected baits set	Nb of unprotected baits set	Nb of damaged protected baits	Nb of damaged unprotected baits	Species involved
4	40	38	6	19	*T. aduncus*
7	39	40	10	27	*T. aduncus*
12	40	38	3	9	*T. aduncus*
13	40	39	3	4	*T. aduncus*
14	20	20	3	13	*S. longirostris*
16	40	39	4	7	*T. aduncus*
18	40	38	1	9	*S. longirostris*
19	40	39	16	8	*T. aduncus*
20	40	39	1	7	*S. longirostris*

3.a

3.b

3.c

Fig. 3.a & 3.b: Group of *T.truncatus* interacting with the longline
Fig. 3.c: Depredated baits

4 Discussion and perspectives

Those experiments aimed at confirming the results we obtained during the first surveys in August 2010 at a larger scale. This objective was fully reached and our devices proved to be efficient in protecting the baits since the number of damaged unprotected baits was more than twice higher than the number of protected ones. Nevertheless, we remain convinced that this protection rate can still be improved by digging our work.

Since August 2010, most of the time, we encountered the same group of *T. aduncus*. In August 2010, during the first surveys, they showed an obvious curiosity towards our devices, and were not afraid to come and take the unprotected bait. On the contrary, the devices seem to afraid them as the protected bait remained untouched. But after that, they showed a complete disinterest in our experiments.

In March and May 2011, we encountered this particular group 9 times, and 6 times out of 9, it interacted with our line. During the first interactions, they damaged more unprotected baits, but during the last survey, they damaged twice more protected baits than unprotected ones. This result suggests that the behaviour of dolphins evolved as time goes by, and that they can get used to the devices, being not afraid by them at the end.

As for the 3 interactions with *S. longirostris*, there were always more damaged unprotected baits than protected ones. These were the first times that this species interacted with our devices, so, we could not assess their potential habituation to our experiments.

Thanks to the images we recorded, we were able to observe the underwater behaviour of our devices. Many points still need to be improved, but the general conception of our device proved to be efficient regarding the protection of the bait. The results we obtained are more than positive and encourage us to maintain our efforts in this field.

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