

Fate of the fish caught on longline gears and potential mitigation measures

Working Party on Ecosystems and Bycatch (WPEB) 12– 14 October Mombasa, Kenya

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Abstract:

In the last decade, bycatch and its management have become an important issue in the global fisheries management and the search for solutions to bycatch problems has intensified. This document summarises the major results already published or in review obtained during experiments conducted in collaboration of the Reunion longline fishing industry. These studies may aid fishermen to modify fishing operations and selecting a fishing strategy to increase economic benefits and also to reduce the impact on by-catch mortality. Firstly, we investigated the behaviour of the fishes when caught on the longline gear and the survivorship of fish hooked, using longline gears instrumented with hook time recorders (HT) and temperature depth recorders (TDR). We found that individuals of the major species caught can stay alive hooked on the gear during several hours exhibiting signals of distress. The stressed fish could attract the predators and also for some species the side effect of the stress could ruin the quality of the flesh. The percentages of fish recovered alive at hauling and alive up to 8 h after capture gives a rough idea of the resistance of each species to the capture process, varied among species. The higher rates were recorded for the blue shark (*Prionace glauca*), the oceanic whitetip shark (*Carcharhinus longimanus*) and for the bigeye tuna (*Thunnus obesus*) and were respectively 29% , 23 % and 27% while this rate was lower for the swordfish (8%). Moreover, as the major portion of the catch occurred in the first few hours of the fishing operation, we suggested that shortening the soaking time during the fishing operation could be beneficial. In addition, live release of bycaught is by far the best management measure thus far but it is still insufficient to minimize fishing mortality and the post release survivorship should be assessed carefully. A study on the reproduction dynamic of the swordfish in the vicinity of Reunion Island showed that the Big Old Fat Fecund Female Fish (BOFFFF) hypothesis could effectively applied to this species. The removal of the larger, older individuals could be detrimental for the stock and the current results should be used to support new policies to preserve population age structure and to allow the escape of unwanted sized fish. In parallel, we investigated the stress response of large pelagic fish resulting from the hooking capture process. Prototypes of a “sleeping hook” were developed and tested around moored fish aggregating devices (FAD’s) off on the west coast of Reunion Island (France) (20°-22°N and 53°-57°N). During the fishing experiments a total of 162 fish comprising 3 main species were caught including: yellowfin tuna (*Thunnus albacares*), skipjack tuna (*Katsuwonus pelamis*), and dolphinfish (*Coryphaena hippurus*). Analyses of blood chemistry stress indicators from the fish were conducted to assess the fish stress relative to struggling behaviour and exposure to air. The results revealed the “sleeping hook” method to be successful in reducing the fish stress. The favourable results suggest that additional research should be conducted to evaluate the feasibility of implementating such a device on commercial longliners. This approach could yield important perspectives and could contribute to the development of alternative fishing technology. This new tool could bring financial benefits to fishers, improve the survivorship of released unwanted catches and improve the success of tagging operations and generally enhance the welfare of fish caught on longline fishing gears. Before their implementation, mitigation measures proposed must be tested in collaboration with the fishing industry and their effect on target species and other species of economical value must be evaluated.

Keywords: Selectivity, mitigation measure, management, Longline, hooking time, post-release survival , sentience, hooking mortality.

Introduction

In the last decade the bycatch and its management have become an important issue in the global fisheries management and the search for solutions to bycatch problems has intensified. There has been a growing evidence of the negative impact on commercial longline fisheries of catching unwanted species (Buencuerpo et al., 1998, Campana et al., 2005, Francis et al., 2001, Lewison and Crowder, 2007, Petersen et al., 2009, Pinedo and Polacheck, 2004, Bonfil, 1994).

This document presents briefly the major results obtained during experiments conducted in collaboration with the Reunion longline fishing industry (PPR¹ project) while studying behaviour of fish hooked on longline and the reproduction dynamics of swordfish (*Xiphias gladius*). These studies may aid fishermen in modifying fishing operations and selecting a fishing strategy to increase economic benefits and also to reduce the impact on bycatch mortality. These results led us to formulate general recommendations regarding future research directions.

Objectives of the studies

Behaviour and survivorship of the fish hooked on longline gear

In order to investigate the impact of the capture process on fishes, portions of the longlines were instrumented with hook timers to estimate fish capture time and time-depth recorders (TDR) attached in the middle position between two consecutive floats to monitor the behaviour of the fish caught. Thirty-three trips deployed 28,974 hook timers during 160 sets and caught 822 fish and one sea turtle (Poisson et al., Manuscript submitted for publication-a).

Reproductive traits of the swordfish

The objectives of the study were to identify the reproductive traits of the swordfish of the southwest Indian Ocean stock and propose management and conservation measures to ensure long-term sustainable yield (Poisson and Fauvel, 2009a, Poisson and Fauvel, 2009b).

Stress response of large pelagic to the hooking capture process

The last study aimed at investigating the possibility of developing a method to sedate fish during the hooking phase. Prototypes of “sleeping hooks” were designed and tested during fishing trips around FADs anchored on the west coast of Reunion Island (Poisson et al., Manuscript submitted for publication-b).

Results

Soaking time and mortality

We found that 60% to 80% of swordfish were caught after the initial fourth and the sixth hours of the fishing operation; respectively and that the overall soak time duration in longline fishing is a very important parameters affecting the fish mortality. The percentages of fish alive when the longline was retrieved to the vessel varied widely among species.

¹ The “Programme Palangre Réunion” (PPR) project was an IFREMER programme financed by the European Union (FEDER), Conseil Régional and Conseil Général de La Réunion.

Survival was high for the species such as dolphinfish and black marlin which strike the line mainly during the last phase of the fishing operation. Nevertheless, over 40% of the main elasmobranch species (Blue shark, Oceanic whitetip shark and Pelagic stingray) as well as the sailfish were alive upon retrieval. The percentage of 20% for swordfish could be considered low, moreover we did not find any relationship between the length of the individuals and the maximum survival time after hooking. The percentages of fish recovered alive up to 8 h after capture provides a rough idea of the resistance of each species to the capture process. The higher rates were recorded for the blue shark, the oceanic whitetip shark and for the bigeye tuna were respectively 29% , 23 % and 27% while this rate was lower for the swordfish (8%).

Maternal effect (swordfish) into consideration

Our results outlined the important role of the older/larger in the reproductive capacity of the population and as a consequence, the swordfish population could be negatively affected if the new hypotheses on maternal effects and genetic diversity would apply to the species (according to the Big Old Fat Fecund Female Fish (BOFFFF) hypothesis (Berkeley et al., 2004, Conover and Munch, 2002)).

Development of the "sleeping hook"

During the fishing experiments, a total of 162 fish comprising 3 main species were caught including: yellowfin tuna (*Thunnus albacares*), skipjack tuna (*Katsuwonus pelamis*), and dolphinfish (*Coryphaena hippurus*). Analyses of blood chemistry stress indicators from the fish were conducted to assess the fish stress relative to struggling behaviour and exposure to air. Our results revealed the "sleeping hook" method to be successful in reducing the fish stress. The levels of cortisol and glucose for yellowfin tuna, and the levels of cortisol and lactate for dolphin fish were significantly lower in sedated fish in comparison with the fish caught without sedation on regular hooks.

Discussion and future research needs

Improving gear selectivity (i.e., reducing threatened species, unwanted size fish, depredation and loss at sea) is considered a high priority in pelagic longline fisheries because of its ecological and economic benefits (Brill et al., 2009, Gilman et al., 2008, Mandelman et al., 2008). These results led to the consideration of several issues:

- We suggested that shortening the soaking time during the fishing operation should be beneficial as it could reduce at the same time (1) the catches of minor commercial species,(2) the depredation rates (3) the loss at sea, (4) the hooking and post release mortality and improve the quality of the flesh of the target species.
- Live release of by-caught sharks (Moyes et al., 2006) and billfish (Kerstetter and Graves, 2006, Kerstetter and Graves, 2008) is by far the best management measure to reduce longline fishing mortality of these species up to now but it is still insufficient to minimize fishing mortality and the post release survivorship should be assessed carefully
- A series of options for protecting juvenile swordfish were already considered in some areas (Cramer, 1996, Cramer, 1997, Cramer, 2003). Scientists should take into account now the crucial biological characteristic of the female swordfish and take into consideration potential mitigation measures to protect the older/larger individuals.
- The concept of the sleeping hook represents an important basis for planning future fish stress-related experiments, it shows promise for reducing post hooking mortality of bycatch species and to damage to target species caught in longline and other fishing operations using

hooks (i.e. tagging operation). There are now challenges of developing this device on a large scale at a reasonable price that will be easy to implement longliners and other commercial fishing operations.

- the last study raised also the problem of “fish welfare²”, concept already widely studied and promoted in the field of aquaculture (Borski and Hodson, 2003, Ferrante et al., 2008), and fish farmers use anaesthetic to minimise stress when they handle them. Stress of reared fish is well documented (Iversen and Eliassen, 2009, Orban et al., 2008). A device like the ‘sleeping hook’ could possibly become necessary if in the future, commercial fisheries are required to consider sentience or animal welfare as discussed in a recent report of experts (Anon, 2009).

Before their implementations, mitigation measures must be tested in close collaboration with the fishing industry and their effect on target species and other species of economical value must be evaluated.

Acknowledgements

We wish to express our gratitude to Louis and Philippe, owners of the F/V Portus Veneris. We thank all the captains of the Reunion domestic swordfish longline fishery who participated in discussions of the concept of the “sleeping hook” and the fishery industry of Reunion Island for their outstanding support of the «Programme Palangre Réunion» (PPR) project. This Project was an IFREMER programme financed by the European Union (FEDER), Conseil Régional and Conseil Général de la Réunion.

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² Institutional Animal Care and Use Committees ; <http://www.iacuc.org/>

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