Update on
recent modifications of fishing gear and fishing procedures to reduce bycatch of sea turtles in longline fishery

Thomas Moth-Poulsen
FAO
Fishery Industry Officer (Fish Technology)
Fishing Technology Service
Fishery Industries Division

INTRODUCTION

In connection with the Expert Consultation on Interactions between Sea Turtles and Fisheries within an Ecosystem Context held in Rome, Italy, 9-12 March 2004, a review of existing and potential longline gear modifications to reduce sea turtle mortality was undertaken (Løkkeborg, 2004). That review was largely based on the preliminary results of the experiments conducted in the Northwest Atlantic (Grand Banks) by the US National Oceanic and Atmospheric Administration (NOAA) in cooperation with the US pelagic longline fishing industry in 2001-2003 (Watson *et al*, 2004a). Since the Expert Consultation, the data collected on the Grand Banks were further analysed and new research findings have become available, including the reaction of different wanted and unwanted bycatch species (tuna, sharks and sea turtles) to parameters such as bait type, dyed bait, hook size, water temperature, daylight and to different configurations of the longline. Research has also been conducted in the Gulf of Mexico longline fishery for yellowfin tuna, including tests with different sizes of circle hooks for catch efficiency of target species. The present note is an update of the information presented at the Expert Consultation and an attempt to summarize some of the rather complicated findings.

SUMMARY OF RECENT RESEARCH RESULTS

The preliminary and the more recent research findings, based on the comprehensive Grand Banks trials in 2001-2003, can be summarized as follows:

1. Circle hooks reduce catches of sea turtles. They also reduce swordfish catches but increase catches of bigeye tuna and bluefin tuna (although increases in bigeye and bluefin were nominal - not statistically significant).
2. Mackerel bait catches more swordfish and fewer turtles (loggerheads in particular) and blue shark than squid bait. The higher catch of swordfish on mackerel bait appears to occur primarily in colder waters (<18°C). Mackerel bait substantially reduces the catch of bigeye tuna but tends to increase catches of bluefin tuna (increase is not statistically significant).
3. Ninety-seven percent of swordfish/hook interactions happened at night, between sunset and sunrise.
4. Leatherback interactions also occur primarily at night.

The traditional hook for swordfish is a J-hook (9/0) with 25°-30° offset[1] (Figure 1). A traditional tuna hook is similar to the shape of a circle hook or is a true circle hook. In the Grand Banks study, 16/0, 18/0 and 20/0 circle hooks with 10° offset and an 18/0 circle hook without offset were tested. Controls in the 2001 experiment were 8/0, 9/0 and 10/0 J-hooks with 25-30° offset. In the 2002 experiment, controls were 7/0 J-hooks with 25-30° offset, while 9/0 J-hooks with 25-30° offset were used as controls in the 2003 experiments. US Federal regulations now prescribe an 18/0 circle hook with not more than 10° offset to reduce the bycatch of sea turtles for longline fisheries in the Grand Banks and a 16/0 circle hook with no offset elsewhere (Federal Register, 2004a & b). The Federal Register (Federal Register, 2004c, Pacific) also prints stakeholder questions and Federal answers to suggested regulations at the beginning of a new Federal change of regulation. Many of these questions (and answers) could be of common interest for stakeholders in other parts of the world.
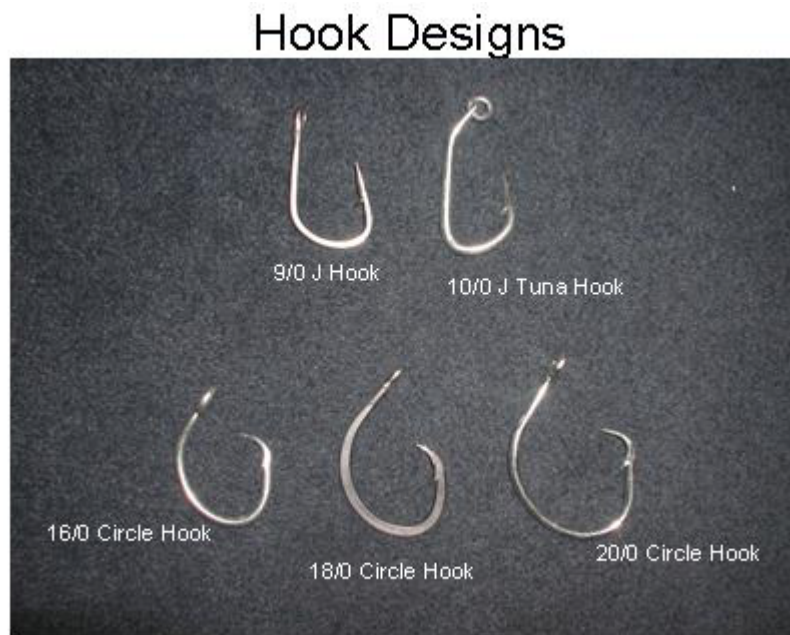

Figure 1. Hooks used on the Grand Banks trials (from NOAA Fisheries).

Although visual stimuli and sufficient light have been considered as particularly important for sea turtles, the study found that there was no correlation between daytime soak time and catch of leatherbacks. There was a correlation with total soak time and the results indicated that the catch of loggerhead turtles might be reduced by avoiding daytime soaks. It also showed that blue-dyed squid bait did not reduce sea turtle bycatch in this area, and that moving the branch lines away from the buoy had no or even a negative effect on reducing bycatch of leatherbacks. The hooks on the branch lines hanging under the buoy are normally much closer to the surface than hooks on branch lines hanging from the mainline midway between the buoys, and therefore the hooks under the buoys were considered more likely to catch sea turtles.

The use of 20/0 circle hooks compared to 18/0 circle hooks resulted in lower catches of loggerhead, leatherback, bigeye tuna, bluefin tuna and blue shark.

[1] The hook offset indicates the extent (angle) of sideways bending of the end of the hook in relation to the hook shaft.

Table 1 is a simplified overview of the 2001-2003 Grand Banks experiments and results.

Table 1
Summary of the 2001-2003 Grand Banks experiments
(+ indicates increased catch, - reduced catch)

2001	Leatherbacks	Loggerheads	Swordfish	Bigeye Tuna
Blue-dyed squid	0	0		
Branch line away from buoy	+	0		
Daylight soak time	0	(−)*		
2002	Leatherbacks	Loggerheads	Swordfish	Bigeye Tuna
Daylight soak time	0	0		
18/0 circle hook	−	−	−	+
Mackerel Bait	−	−	+	−
Water temperature	+ (>20°C)	+ (>22°C)	+ (<20°C)	
2003	Leatherbacks	Loggerheads	Swordfish	Bigeye Tuna
18/0 circle hook 0° offset, squid	−	−	−	+
18/0 circle hook 10° offset, mackerel	−	−	+	−
20/0 circle hook 10° offset, mackerel	−	−	+	−

*(Data indicate reducing daylight soak time might reduce loggerhead catch, but this was not statistically tested)

2004 Gulf of Mexico experiments

From February to April 2004 experiments were carried out in the Gulf of Mexico in order to evaluate the effect on target catch of 16/0 or 18/0, 0° offset circle hooks in the yellowfin tuna fishery. This fishery traditionally uses 7/0 and 8/0 J-hooks, but some vessels have recently switched to 14/0 and 16/0 circle hooks (Watson *et al.*, 2004b). Sardine was used as bait for both hooks.

The 18/0 circle hook caused a 25.7% reduction (by weight) of marketable yellowfin tuna (25.5% by total numbers) when compared to the 16/0 circle hook. Only three leatherback turtles were caught during the experiment; two on 18/0 circle hooks and one using a 16/0 circle hook. No significant difference in the bycatches could be detected based on such a small catch.

Japanese trials

The shape of a tuna longline is such that the horizontal mainline hangs down in a curve between the floats so the hooks near the buoys are considerably closer to the surface than the hooks midway between the buoys (Shiode *et al.*, 2004). This pattern of depth distribution has led to the hypothesis that more sea turtles may be caught near the buoys, as turtles normally are not caught in deep water.

Shiode *et al.* (2004) altered the geometry of the longline by adding one or two intermediate (midwater) floats directly attached to the mainline between the surface buoys. This gave a more uniform depth for the hooks (more horizontal mainline), and enabled the mainline to be positioned deeper under the surface buoys. The depth fished was documented using small

depth sensors on the line. The study was a pure gear geometry study and no catch results were analysed.

Other trials

Mexico has recently conducted 17 experimental cruises using three kinds of hooks and two types of bait. The report on the results is not yet available.

Trials have also been initiated in Ecuador, where the National Marine Fisheries Service (NMFS), in collaboration with the World Wide Fund for Nature (WWF), the Inter American Tropical Tuna Commission (IATTC) and the Western Pacific Regional Fishery Management Council (WPRFMC) is providing hooks, dehookers and technical assistance to longline fishermen in testing 14/0 and 15/0 circle hooks in the mahi-mahi fishery and 16/0 and 18/0, with 10º offset circle hooks in the tuna/shark fisheries. Similar trials are also taking place in other countries, such as Brazil, Costa Rica and Peru (NMFS / NOAA, 2004) [2]

Experiences from development of selective trawls and gillnets based on species-specific differences in behaviour show that it is easier to separate species that are evolutionarily far apart because their behaviour also differs more than in closely-related species. These features may be useful with respect to research aimed at developing fishing gear that reduces bycatch of sea turtles.

General information papers

The Blue Ocean Institute, with the support of the United Nations Environment Programme (UNEP) and WWF, among others, has produced a booklet, "Catch fish not turtles using longlines"[3] that, in an easy accessible way, summarizes many of the documented measures and proposes ideas for reducing the mortality of sea turtles in the longline fishery including catch and release.

Handling and release

Closely related to the efforts of reducing the bycatch of sea turtles is also the handling and release of the animals when caught. Although few systematic survival experiments have been conducted, it is likely that sea turtles have a high potential for surviving provided a good catch and release protocol is followed. Examples of existing protocols in use are given at: http://www.sefsc.noaa.gov/PDFdocs/TM_524.pdf and at http://swr.nmfs.noaa.gov/pir/ghhst.htm.
Some of the tools and equipment mentioned in these protocols are shown in Figure 2.

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[2] http://www.nmfs.noaa.gov/by_catch/sea_turtle_longline_bycatch_reduction.pdf

[3] http://worldwildlife.org/turtles/pubs/catching_fish_not_turtles.pdf

Figure 2. Tools used in a "Careful release protocol' (from NOAA Fisheries)

MANAGEMENT ASPECTS

The need to deal urgently with the issue of sea turtle bycatch makes simple measures, such as the use of circle hooks, that can be widely and readily applied, very attractive. However, species behaviour, feeding habits and stimuli may be quite different from one region to another, even when dealing with the same species. Gear modifications aimed at reducing bycatch of unwanted species also affect catches of target species and of wanted bycatch species, in ways that will vary in different regions. For the above reasons, while a measure could be successful in one area, it may fail in another because of different behaviour of target and/or bycatch species and it follows that findings from one region cannot automatically be applied to other regions. Effective management regimes have therefore to take into account knowledge on what gear modifications are most suitable at the local level.

The process of developing appropriate knowledge on the reduction of sea turtle bycatch for informed decision making may be complicated by the inevitability of sea turtle mortality during the research process. For example, measures taken in some fisheries in the US have already changed the fishery in a way that fewer sea turtles are caught now than occurred in the past; this is a positive development but also makes it more difficult to prove statistical differences when comparing current practices to an innovative gear configuration.

The question might arise whether conducting such comprehensive experiments in the future will be possible at all, given that permission may not be granted by relevant authorities or may meet resistance from other stakeholders.

Close collaboration with the fishing industry is highly recommended, both during the development and during the implementation phase of new gear modifications.

CONCLUSIONS

Gear technology can provide valuable solutions to reconcile fisheries and conservation interests. In the specific case of sea turtle bycatch in longline fishing, it seems possible to find viable solutions to reduce bycatch of sea turtles through improved technology standards, and the use of circle hooks appears to be very promising in this respect. However, the most recent analyses of the Grand Banks data and the new experiments in the Gulf of Mexico have also highlighted the complexity of the relationship between hook size and shape, bait type, environmental factors and catchability of target and non-target species. Effective management decisions, that will maintain, as far as possible, the desirable level of catches of target species with minimum environmental impact, will become possible only once reliable scientific advice is available as regards appropriate gear type, gear configuration and appropriate fishing practices at the local level. It is therefore extremely important that the necessary experiments and research efforts take place before management decisions are taken, particularly in those cases where the use of new types of gear is recommended.

In addition to efforts aimed at reducing the capture of sea turtles, reducing mortality of captured animals seems to be a promising way of reducing their overall mortality. Efforts to educate fishermen in turtle releasing techniques should be encouraged as a complementary effort to other management measures.

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