



**MEMORANDUM OF UNDERSTANDING ON
THE CONSERVATION OF MIGRATORY
SHARKS**

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**Review and gap analysis of shark and ray bycatch mitigation measures
employed by fisheries management bodies**

(Prepared by S L Fowler)

Review and gap analysis of shark and ray bycatch mitigation measures employed by fisheries management bodies

S L Fowler, October 2016

1. Introduction

In the preamble of the CMS Sharks MOU, Signatories express their concern “about the significant mortality of sharks from a range of impacts and threats including fisheries by-catch”. The Conservation Plan calls for the development of programmes to monitor directed shark fisheries and shark bycatch and, to the extent practicable, to develop and/or use selective gear, devices, and techniques to ensure that the take of sharks in fisheries is sustainable and appropriately managed, and that mortality of non-utilized catches is minimized to the greatest extent possible.

The 1995 Code of Conduct for Responsible Fisheries (the Code) of the Food and Agriculture Organization of the United Nations (FAO) calls for the sustainable use of aquatic ecosystems and requires that fishing be conducted with due regard for the environment. The Code also promotes the maintenance, safeguarding and conservation of biodiversity of ecosystems by minimizing fisheries impacts on non-target species and the ecosystem in general.

Several RFMOs have bycatch mitigation programmes for seabirds, turtles, marine mammals, and sharks and rays and have adopted Recommendations or Resolutions for bycatch mitigation and/or avoidance. Most RFMOs require their CPCs to release unwanted or prohibited sharks alive (with particular emphasis on juveniles and gravid females), to research improved gear selectivity, and to identify shark nursery areas.

Promoting bycatch mitigation measures for some of the sharks and rays listed in Annex 1 of the CMS Sharks MOU can be more difficult than for seabirds, turtles and mammals; the latter are an unwanted bycatch that fishers do not want to have to handle, while some sharks and rays may be a retained by-product of fisheries targeting other species. There is also potential for new mitigation proposals for one taxonomic group to compromise mitigation measures for other taxa (e.g. Gilman et al. 2016); it is important to harmonise bycatch mitigation measures across species groups in order to maximise the survival of all threatened species.

Furthermore, the success of mitigation measures largely depends on the compliance of skippers in implementing the range of measures available, and that these have to be cost-effective and practical to undertake, if they are to be widely accepted. It is encouraging to note that industry bodies (such as the International Sustainable Seafood Foundation 2016, and the EU Purse seine fleet in the Indian Ocean) are taking the lead in developing mitigation measures; industry-led initiatives are more likely to be successful than measures imposed from outside.

2. Fishing gears

Several different fisheries and gear types must be considered when reviewing mitigation measures to reduce bycatch. The four most important are trawls (bottom and midwater), gill nets (set or drifting), longlines, and purse seines. Bycatch rates and bycatch species vary considerably between these different fishing methods, and can also vary within these major gear types, depending upon how when and where the gears are set.

2.1. Trawl nets

Bottom trawls are widely recognised as the most environmentally damaging of fishing methods, because they damage benthic habitats and take such a high proportion of bycatch species – the ratio of bycatch biomass to target biomass can be over 10:1. Since trawls are usually dragged for several hours at a time, bycatch mortality is very high in the cod end. The sawfishes are the Annex 1 species most severely threatened by bottom trawling, which poses among the greatest threats to their survival (Harrison and Dulvy 2014). Catches of juvenile sharks (e.g. hammerheads) whose nursery grounds are trawled can be significant in some fisheries.

Pelagic or mid water trawls are far less damaging because they do not come into contact with seabed habitats and usually target large single-species schools; this means that catches contain only a small proportion of bycatch species. There have been records of basking sharks taken in midwater trawls targeting deepwater fish spawning aggregations off New Zealand, perhaps because they were feeding on fish eggs, but the numbers involved are very small.

Mitigation measures for trawl bycatch focus upon preventing non-target species from ending up squashed into the trawl cod end, where mortality is almost inevitable. Exclusion devices and escape panels can be very effective in avoiding turtle bycatch and may also be feasible for sharks and rays, particularly when the target catch is of much smaller bodied animals. Because these methodologies are not currently the focus of RFMO mitigation activities, they will not be considered further in this document, although they are extremely important for the survival and recovery of some Annex 1 species, particularly the sawfishes.

2.2. Gill nets

Gill nets may be set to drift on the high seas, catching fish and squid until retrieved, or anchored at one or both ends in shallower water, or used as tangle nets and set directly onto the sea bed to catch demersal fish and crustacea. The very long high seas ‘wall of death’ nets are now prohibited by RFMOs (e.g. IOTC Resolution 12.12) and some fishing States, because they led to such an enormous bycatch of marine mammals, turtles and sharks. Nets of 4km to 7km long are still used inside EEZs in the IOTC area, and probably other oceans, and may drift out into high seas areas. Indonesia’s drift gillnet fishery takes a large number of thresher sharks, juveniles and adults, and Pakistan has around 700 gillnet vessels fishing inside its EEZ and in ABNJ (IOTC-WPEB 2016). (IOTC-2016-WPEB12-17). These gears are a major concern for sustainable fisheries and bycatch survival.

Coastal gill nets are still used in huge numbers in most parts of the world, in commercial, artisanal and subsistence fisheries and are responsible for massive bycatch mortality of sharks and rays. They are probably the greatest single threat to the survival of sawfishes, because it is so easy for the toothed rostrum to become entangled and so hard for fishers to release the animal once captured. Gillnets also capture many other Annex 1 species, particularly juveniles.

Waugh et al (2013) conducted a study on the impacts of gillnet fishing on species listed in the CMS Appendices (all now Sharks MOU Annex I species). The review concluded that gillnet fisheries are too poorly documented to enable analyses of fishery activity or characterisation of the fishing fleets using gillnets. Instead, the authors examined the relative exposure of species to gillnet activity and weighted this by their IUCN Red List assessment. Highest gill net fishing risk occurred in Myanmar, Vietnam, Peru, India, Russia (Pacific), Chile, South Africa, China, Namibia, Greece, Galapagos, Bangladesh, Japan (Main Islands), Western Indonesia, Eastern Indonesia, Norway, Mauritania, United Kingdom, Algeria, and Morocco, with the shark species most exposed to risk being Basking Shark, Longfin Mako, Porbeagle, Whale Shark, and White Shark. The study recommended that, in relation to mitigation, fishery- and species-specific solutions needed to be examined and prioritised. It provided some guidance on data needs and further research. While area and seasonal closures may come near to resolving all cross-cutting species issues, these are unlikely to be a feasible option to implement, given the high reliance of communities on fish from gillnet fishing as a food source.

Mitigation measures for sharks and rays caught in gill nets include shorter soak times, to enable bycatch to be released alive, and avoidance of critical habitats such as nursery grounds either seasonally or permanently. As with trawl mitigation, shark and ray gill net bycatch mitigation is not the subject of action by RFMOs, so this is not considered further here despite its importance.

2.3. Purse seines

Purse seines are used in the open ocean to harvest some of the world's largest and most productive fisheries; those for small schooling pelagic species such as herring and anchovies. They are also the gear type responsible for about 70% of the world's tuna landings, and up to 90% of global landings of skipjack, yellowfin and bigeye tuna. Purse seines are therefore a major component of the fisheries managed by the five large 'tuna RFMOs' and mitigation of their bycatch is an important area of study for RFMO 'Bycatch' and/or 'Ecologically Related Species' working groups.

It can be hard for fishing vessels to locate free-swimming schools of tuna, which may be swimming a long way below the surface. Purse seines are therefore usually set onto surface objects that are known often to have shoals of tuna associated with them. These objects could be schools of dolphins, whales or whale sharks, or simply floating logs. Free-swimming schools of tuna have a low bycatch of sharks, as do sets made on dolphins (excluding the dolphins – which can be allowed to escape using a 'back down' technique before the net is hauled). Once tuna derived from dolphin sets became unacceptable in western markets, fishers adopted other techniques. These included setting nets on tuna schools associated with whale sharks (an Annex 1 species); some RFMOs now prohibit whale shark sets. Most purse seines are now set on inanimate floating objects, however these have a very high bycatch of a wide range of species, of which sharks are the most vulnerable. Because natural objects are scarce, the use of artificial Fish Aggregating Devices (FADs) became widespread, and FAD structures became more complex, often with entangling nets hung beneath them to encourage fouling and attract greater fish biomass. The use of artificial FADs has greatly increased silky shark bycatch mortality in the purse seines and, to a greater extent, hidden mortality from silky sharks entangled beneath the FADs (e.g. Filmlalter et al. 2013). The use of non-entangling and/or biodegradable FADs is now mandatory in the Atlantic and Indian Oceans (IOTC Resolution 15/08 and ICCAT recommendation 15/01), which will reduce silky shark mortality once implemented.

Peatman and Pilling (2016) describe a recent experiment to investigate the impacts of purse seine fisheries on silky sharks (an Annex 1 species) and oceanic whitetip sharks (a prohibited species). They tested the result of moving away from setting on FAD-associated schools and returning to setting on free-swimming tuna schools in the Western and Central Pacific. Redistribution of effort from FADs to free schools resulted in substantial reductions in estimated catches of silky shark (by 83%) and oceanic whitetip shark (by 57%) compared to the ‘status quo’. There was large uncertainty in total catch estimates due to low confidence in assumed estimates of non-zero shark catches. However, another study in the Eastern Central Pacific found that purse seines set on free tuna schools take a much larger bycatch of mobulid rays (Annex 1 species) than when nets set on FADs.

Mitigation of unavoidable purse seine bycatch is certainly possible, but relies heavily upon minimising the physical damage to sharks and rays brought on board, and the time that they spend out of the water. IATTC Resolution C-2016-05 specifies safe release requirements for all sharks except those intentionally retained aboard the vessel, to take effect from 1 January 2018:

2.4. Long lines

Longlines can be among the most selective fishing methods, if hook size and shape, leaders, bait, gear configurations, depths set, time of day or night, and locations are carefully selected for the target species. Longline mitigation usually focuses upon some combination of these factors, but there are so many variables (Gilman et al. 2016) that it is important to evaluate different forms of mitigation for each case and every fishery, particularly when other bycatch species (such as turtles or seabirds) are taken in the same fishery. Producing a single set of mitigation guidelines that will suit all situations is unrealistic.

Common mitigation measures include the size and shape of hooks (to reduce deep hooking) and the composition of hooks (to allow them to corrode if not removed from a shark before release). However, circle hooks baited with fish are more likely to catch and deep-hook sharks, but will reduce turtle bycatch. ‘J hooks’ baited with squid take a lower catch of sharks but more turtles.

The type of leader (the line attached to the hook) is also important: Harley and Pilling (2016) found that fishing related mortality for silky shark could be reduced by up to 24% and oceanic whitetip shark by up to 37% depending upon whether monofilament or wire traces or shark lines were used. Monofilament traces reduce shark catches, but may increase seabird bycatch if baited hooks take longer to sink.

Provided that soak times are not too long, it’s possible to release unwanted shark bycatch in good condition, provided that handling is sensitive (Hutchinson 2016).

Another problems associated with proposals for shark bycatch reduction in longline fisheries, is that some fishers don’t actually want to avoid sharks – they can be a valuable component of the catch from longline tuna and swordfish fisheries. This has caused considerable debate when some RFMO Members wish to adopt shark bycatch mitigation measures that are not welcomed by other Members. For example, IATTC Resolution C-2016-05 – Management of sharks, which requires CPCs to prohibit longline vessels flying their flag and targeting tuna or swordfish in the Convention Area from using “shark lines” (individual lines attached to the floatline or to the floats directly, and used to target sharks), was contentious because some CPCs were reluctant to stop targeting sharks in this way.

Pole and line fisheries take a very ‘clean’ catch of tuna and are not addressed here.

3. Fisheries management bodies

3.1. Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR)

CCAMLR Conservation Measure CM 32-18 2006 prohibited directed fishing for sharks has in the CCAMLR Area, other than for scientific research. Any accidental bycatch of sharks shall, as far as possible, be released alive. CCAMLR has also adopted guidelines for releasing skates to minimize damage, quotas for skate and ray bycatch, and measures to minimize incidental mortality of non-target species, including sharks (CM 33-02, 2012; 33-03, 2015).

CM 33-03 (2015) on the “Limitation of by-catch in new and exploratory fisheries in the 2015/16 season” specifies that, recaptured tagged skates and rays must be retained, but unless otherwise specified by scientific observers, all other skates and rays caught alive and with a high probability of survival should be released alive, by vessels, by cutting snoods, and when practical, removing the hooks, and the number should be recorded and reported to the Secretariat.

3.2. Commission for the Conservation of Southern Bluefin Tuna (CCBST)

CCBST Recommendation ERS 2011 recommends measures to “Mitigate the Impact on Ecologically Related Species of Fishing for Southern Bluefin Tuna”. Its Members are required to comply with all current binding and recommendatory measures aimed at the protection of ecologically related species (including sharks) from fishing, which are adopted from time to time by IOTC, WCPFC, and ICCAT when fishing in those Convention areas, irrespective of whether the CCBST Member or Cooperating Non-Member is a Member of or cooperating with the relevant Commission. These measures are listed below for the other Conventions.

The CCBST Ecologically Related Species Working Group (ERSWG) 2012 provided the following guidance for handling sharks:

“Sharks caught on longlines are often alive and have a good chance of survival if handled correctly and returned to the sea. General guidelines to handling sharks caught on or entangled in longlines are:

- *If possible leave the shark in the water. Hauling them on deck causes stress which reduces the chances of the shark surviving.*
- *Using a linecutter, cut the line as close to the hook as possible when freeing the shark. This will reduce the amount of line the shark will trail behind it.*
- *If the shark must be brought on deck, minimise the time it is out of the water.”*

The Eleventh Meeting of the CCBST ERSWG, 2015, reviewed seabird, shark and sea turtle mitigation measures in CCBST, ICCAT, IOTC and WCPFC. The paper tabled at that meeting, CCSBT-ERS/1503/05, which was subsequently updated, is not available online. A copy has been requested from the CCBST Secretariat. Documents from the September/October 2016 21st meeting of the Scientific Committee and the 23rd Annual meeting of the CCBST are not yet available.

3.3. Inter-American Tropical Tuna Commission (IATTC)

IATTC has a detailed bycatch reduction and mitigation programme, expressed through IATTC Bycatch Resolutions and the Secretariat's activities. The 90th Meeting of the IATTC in 2016, discussed the following recommendations of the Secretariat (section 3 of Doc IATTC-90-04d (Rev)) for conservation measures for sharks and mobulid rays in the Eastern Pacific Ocean:

General recommendations for releasing all sharks and rays caught in purse-seines

- Require that, to the extent possible, sharks and mobulid rays too large to be lifted safely by hand be brailed out of the net or through the use of other methods, such as those recommended by Poisson et al 2012.
- Prohibit the use of gaffs, hooks, or similar instruments for handling sharks and mobulid rays.
- Prohibit lifting sharks and mobulid rays by their gill slits or spiracles.
- Prohibit punching holes in the bodies or fins of sharks and mobulid rays (e.g. to pass a cable through for lifting the animal).
- Require purse-seine vessels that catch sharks and mobulid rays to install equipment, such as ramps, hatches, or doors, to facilitate the release of sharks and mobulid rays without the need to lift them, while providing for the safety of the crew. When sharks or mobulid rays cannot be released safely before being landed on deck, they should be returned to the water as soon as possible. If ramps or escape hatches are not available, the animals should be lowered into the water with a sling or net.
- Ban the use of “shark lines¹” in longlines targeting bigeye or yellowfin tunas or swordfish.
- Change Paragraph 12 of Resolution C-05-03 [...] so that reporting of shark catches, by species, and of fishing effort [...] is mandatory for all vessels engaging in these fisheries.
- Conduct experiments on mitigating shark catches, especially in longline fisheries, and on the survival of sharks captured by all gear types, with priority given to those gears with significant catches. Survival experiments should include studies of the effects on survival of shorter sets and of the use of circle hooks.
- Support research on mitigation of shark bycatches as well as data collection projects, and investigate the feasibility of observers aboard purse-seine vessels not currently covered by the IATTC observer program.
- Request that CPCs share any methods or technology developed on their vessels to improve the release of these species.
- Improve and expand upon mandates to collect and report shark data, consistent with the report on challenges facing the collection of data on shark fisheries in the EPO, prepared as part of the FAO- GEF project.”

¹ Branch lines, or lines attached to buoy lines, at shallow depths, specifically targeting sharks.

Additional recommendations for silky sharks

[Regarding the need for improved shark fishery data collection]... It is critical that shark fishery data collection in the EPO be improved, so that conventional stock assessments and/or other indicators of stock status can be developed to better inform management of silky sharks and other shark species in the EPO. Fishing mortality needs to be reduced in order to promote rapid rebuilding of silky shark stocks in the EPO; therefore, the staff makes the following recommendations:

- For purse-seine vessels, promote the safe release of silky sharks, and require that the sharks be promptly released unharmed, to the extent feasible.
- For vessels other than purse-seiners which catch sharks incidentally, limit non-target shark catch to a maximum allowed limit of 20%² of the total catch by trip in weight.
- Close fisheries directed at silky sharks for a three-month period each year³. Longliners targeting sharks may choose to take their 3-month closure period within any 3 consecutive months of the year, provided that such designations are made before the start of each calendar year. Fisheries not directed at silky sharks, but which catch them incidentally, may continue to operate during the closure, so long the use of steel leaders is prohibited for the duration of the closure.
- Limit the catch of silky sharks of less than 100 cm total length during a trip to 20% of the total number of silky sharks caught during that trip.
- Identify silky shark pupping grounds and prohibit fishing with steel leaders within these areas.

Additional recommendations for hammerhead sharks

- Prohibit retention of hammerhead sharks by purse-seine vessels, and require that they be promptly released unharmed, to the extent feasible.
- Record, through observer programs for purse-seine vessels of all capacity classes, the number and status (dead/alive) of hammerhead sharks caught and released.

Additional recommendations for whale sharks

Adopt a single Resolution to include all measures specific to the conservation of whale sharks.

Conclusions of the June/July 2016 session of the 90th IATTC meeting

The Minutes of the first session of the 90th IATTC meeting (IATTC 2016) record the following decisions regarding the conservation of sharks and rays

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1. ² 20% is proposed as an interim limit in the absence of data and scientific analysis on which to base conservation and management measures. This limit could be revised, based on staff recommendations, once improved species-level catch and composition data are available.
 2. ³ The three-month closure is based on the ratio of the best measure of average catch in 2008-2009 to that in 2011- 2012.

General recommendations

1. For the purse-seine fishery, require vessels to install equipment to facilitate the safe release of sharks and rays, and establish detailed protocols for dealing with captured animals that will avoid injuring them.
2. For the longline fishery, prohibit the use of ‘shark lines’ and make submitting data on catches of sharks (Resolution C-05-03) mandatory.
3. Research: Conduct and support experiments on mitigating shark catches, especially in longline fisheries, data collection projects, and observers aboard purse-seine vessels not currently covered by the IATTC observer program.

Additional recommendations for silky sharks

1. For purse-seine vessels: promote the safe release of silky sharks, and require that the sharks be promptly released unharmed.
2. For other vessels, limit incidental catches of sharks to 20% of the total catch by trip.
3. Close fisheries directed at silky sharks for three months each year.
4. Limit the catch of silky sharks of less than 100 cm to 20% of the total number caught during a trip.
5. Identify silky shark pupping grounds and prohibit fishing with steel leaders within these areas.

In the discussion of the above, contrary positions were expressed regarding the prohibition of fishing with steel leaders. Costa Rica and the European Union announced that they would submit a joint proposal for implementing these recommendations.

Additional recommendations for hammerhead sharks

1. Prohibit retention of hammerhead sharks by purse-seine vessels, and require that they be promptly released unharmed, to the extent feasible.
2. Record, through observer programs for purse-seine vessels of all capacity classes, the number and status (dead/alive) of hammerhead sharks caught and released.

Additional recommendations for whale sharks

Adopt a stand-alone resolution that would include the measures of Resolution C-15-03 (on FADs) related to whale sharks plus others specific to that species. Data on whale sharks should be collected, to include details on how a whale shark caught in a fishery was released, for purposes of eventually developing best practices for their safe release.

Additionally, reactivation of the IATTC Bycatch Working Group was proposed, to address turtle bycatch issues. It was suggested that bycatch of sharks and mobulid rays also be included.

IATTC Annual meeting continuation, October 2016

Annual meeting discussions continued in October 2016, due to lack of agreement at the first stage. Resolution C-16-05, derived from the recommendations above on the safe release of sharks, was adopted and comes into effect in January 2018. Paragraph 3 of C-16-05 states:

PCs shall require purse-seine vessels flying their flag to follow safe release requirements for all sharks, except those retained aboard the vessel. Any shark (whether alive or dead) caught in the Convention Area that is not retained must be promptly released unharmed, to the extent practicable, as soon as it is seen in the net or on the deck, without compromising the safety of

any persons. If a shark is alive when caught and is not retained, the shark must be released by using the following procedures, or equally effective means:

- a) Sharks must be released out of the net by directly releasing them from the brailer into the ocean. Sharks that cannot be released without compromising the safety of persons or the sharks before being landed on deck must be returned to the water as soon as possible, either utilizing a ramp from the deck connecting to an opening on the side of the vessel, or through escape hatches. If ramps or escape hatches are not available, the sharks must be lowered with a sling or cargo net, using a crane or similar equipment, if available.
- b) The use of gaffs, hooks, or similar instruments is prohibited for the handling of sharks. No shark may be lifted by the head, tail, gill slits, or spiracles, or by using bind wire against or inserted through the body, and no holes may be punched through the bodies of sharks (*e.g.*, to pass a cable through for lifting the shark).
- c) No whale shark (*Rhincodon typus*) may be towed out of a purse-seine net, *e.g.*, using towing ropes.

Other conclusions were not available at the time of writing, but actions on mobulid rays were reported to be progressing. Experiments to release silky sharks from purse seines have not been successful and other methods are being trialled, including using hooks to ‘fish’ sharks out of the nets. Experiments to develop non-entangling biodegradable FADs are underway to reduce silky shark entanglement in FADs, which has caused such high mortality rates in the Indian Ocean (Martin Hall, pers. Comm. October 2016).

3.4. International Commission for the Conservation of Atlantic Tunas (ICCAT)

In 2009, ICCAT commissioned a short term bycatch coordination study (Cotter 2010) that produced a meta-database of reports and publications on bycatch species from tuna and related fisheries, and a database for unprocessed and aggregated bycatch data for priority species such as marine mammals, turtles, seabirds, elasmobranchs and bony fishes not subject to ICCAT stock assessments. ICCAT also requires species-specific data to be collected on species of concern, including Annex 1 Porbeagle and Shortfin mako. ICCAT has also adopted many shark conservation and management measures since 2003. These include prohibiting the retention of seriously depleted species (including Annex I Silky shark, Bigeye thresher shark, and Hammerhead sharks), and requiring live release (Porbeagle). The use of non-entangling FADs is now mandatory in the Atlantic Ocean (ICCAT recommendation 15/01). ICCAT’s CPCs are also encouraged to release unwanted sharks alive and to research improved gear selectivity and shark nursery areas. The report of the most recent (2016) Intersessional meeting of the ICCAT Shark Species Group only mention the subject of bycatch mitigation in relation to the need to assess discard mortality when undertaking stock assessments.

3.5. Indian Ocean Tuna Commission (IOTC)

IOTC has adopted several Conservation and Management Measures relevant to bycatch, including prohibitions on setting purse seines on whale sharks and making the use of non-entangling FADs mandatory (IOTC Resolution 15/08). IOTC’s Working Party on Ecosystems and Bycatch (WPEB) is the body that provides advice on bycatch mitigation measures for the Commission. Its most recent meeting was held in September 2016 (IOTC-WPEB12, 2016). Although shark bycatch mitigation appears on the agenda and forms part of the WPEB’s

Program of Work (2017-2021, below), there were few concrete recommendations from the WPEB for implementation. *Inter alia*, the WPEB noted difficulties experienced by IOTC Members in distinguishing between the different types of hook recommended for bycatch mitigation and the need to include hook types in identification guides. WPEB also queried the potential for magnetic materials or acoustic pingers to be used as shark deterrents and mitigation measures, and recalled that these techniques were considered by the IOTC Shark Year Plan to still be in an experimental phase and in need of further testing.

Shark bycatch mitigation measures from the WPEB's Program of Work (2017-2021)

4.1 Develop studies on shark mitigation measures (operational, technological aspects and best practices)	Priority (ranking)	Lead
4.1.1 Longline selectivity, to assess the effects of hooks styles, bait types and trace materials on shark catch rates, hooking-mortality, bite-offs and fishing yield (socio-economics)	High (14)	
4.1.2 Gillnet selectivity, to assess the effect of mesh size, hanging ratio and net twine on sharks catches composition (i.e. species and size), and fishing yield (socio-economics)	High (15)	WWF- Pakistan
4.1.3 Develop guidelines and protocols for safe handling and release of sharks caught on longlines and gillnets fisheries	Med (25)	

WPEB NOTED that material is also available on best practice guidelines for the safe handling and release of devil and manta rays, which are currently followed by 100% of the EU and Seychelles purse seine fleets.

From the previous year's meeting: Document IOTC-2015-WPTT17-33 reviewed two initiatives to improve monitoring of FADs and their effects, limiting the number of FADs used in the Indian Ocean and the application of good practices to reduce the mortality of FAD-associated fauna. IOTC-2015-WPEB11-15, Auger et al 2015, noted that, in the Southwest Indian Ocean, setting shallow swordfish longlines at night, between 18pm and 9am, minimized shark bycatch while maximizing swordfish yield.

3.6. Western and Central Pacific Fisheries Commission (WCPFC)

The 12th Regular Session of the WCPFC Scientific Committee (August 2016) reviewed shark bycatch mitigation measures for purse seines and for longlines. As noted above, Peatman and Pilling (2016) found that setting purse seines on free-swimming tuna schools in the Western and Central Pacific, instead of on FAD-associated schools, reduced catches of silky shark by an estimated 83%, and oceanic whitetip shark by 57%. Harley and Pilling (2016) analysed the potential impact of several longline gear restrictions on fishing-related mortality on oceanic whitetip shark and silky shark. Considering wire traces, shark lines, and monofilament: they found that fishing related mortality for silky shark could be reduced by up to 24% and oceanic whitetip shark by up to 37% depending upon choices made.

WCPFC has released Guidelines for the safe release of encircled whale sharks and is prioritizing studies into post-release survival rates of sharks from fishing gears. SC 12 recommended that WCPFC13 considers adopting guidelines for safe release of Manta and Mobula rays caught incidentally in WCPFC fisheries.

3.7. Industry bodies

The purse seine industry is independently taking steps to minimise bycatch of sharks, particularly silkies (which comprise over 90% of the shark bycatch). Restrepo et al 2016 present the International Seafood Sustainability Foundation's (ISSF) research at sea to develop bycatch mitigation actions for bigeye tuna, sharks and turtles in purse seine fisheries. The shark bycatch-to-tuna catch ratio in purse seine fisheries is quite small, on average, less than 0.5% in weight, and that other gear types such as longlines or gillnets have a larger impact on silky sharks than purse seine fisheries do. The contribution of purse seining to the total catch of silky sharks varies from 4% in the Indian and eastern Pacific Oceans, to about 25% in the western and Central Pacific Ocean. Within the purse seine fishery, all set types catch silky sharks, with the highest catch rates being on natural logs (which represent a relatively small fraction of the total number of sets) followed by man-made FADs. Catches on floating object sets (both natural and man-made) tend to be two to six times higher than they are on free swimming schools. The global magnitude of catch of the purse seine fishery is quite large, so reducing the mortality caused by these fisheries can contribute towards global conservation efforts.

A short summary prepared by ISSF (2016) summarizes mitigation techniques that can be used in this fishery, with an indication of which work (or not) and which have not yet been tested. See Draft Best Practice guidelines for the mitigation of shark and ray bycatch, developed from this review and presented in a separate document.

4. Conclusions

Shark and ray bycatch avoidance and mitigation has not been addressed for two of the most widely used fishing gears: bottom trawling and gill netting. The fisheries using these gear types do not fall under the remit of the tuna RFMOs, but are the most damaging to benthic habitats and to shark and ray populations. The Conservation Working Group may wish to consider whether and how to address these issues at a future meeting.

The tuna RFMOs are focused on mitigation of shark and ray bycatch in purse seine and longline fisheries. The two main elements to successful bycatch mitigation are to avoid catching sharks in the first place, then to develop methods to release in the best possible condition those that have still been caught. The success of the latter techniques must be confirmed through the evaluation of post-release mortality; techniques are available for this, but they are expensive.

Bycatch avoidance:

Good progress appears to have been made on avoiding shark bycatch in purse seines, at least partly due to initiatives of industry bodies that are genuinely interested in minimising interactions with sharks. The two main elements of this are to address the high levels of unseen bycatch mortality, primarily of silky sharks, in entangling FADs, and to avoid setting purse seine nets in situations that will result in a high level of bycatch. Guidelines have been developed for this.

Bycatch avoidance in longline gears is a far more complicated issue. There are so many variables that influence the probability of catching sharks on longline gear, and these can vary from fishery to fishery. Furthermore, reducing catch of sharks may result in an increased catch of other threatened species, such as turtles and seabirds. There is probably a need to test and

develop different guidance for the majority of fisheries, depending upon target species, location, time of day, and the presence of other unwanted bycatch.

Finally, there appears to be less willingness by some longline industry sectors to reduce shark bycatch, because it is a valuable component of the landings from these fisheries. Other considerations, like the incentive of Marine Stewardship Council certification may be deciding factors for industry.

Live release of bycatch:

While live release of bycatch is mandated by several regional fisheries bodies, techniques are still under development and survival rates are unclear. For purse seine fisheries, the objective is firstly to release sharks from the net before the net is hauled and then, if that fails, to release the sharks from the deck. Several techniques have been tried unsuccessfully for releasing the sharks from the net; the industry is currently testing the use of hooks and lines to fish the sharks out of the net in order to release them. Survival rates will be higher for sharks released after only a short time on a line, than for sharks that are released from the deck.

Techniques have been developed to increase the ease of live release of sharks from longlines, and their survivorship, but the latter needs further verification. One of the problems is the mismatch between maximising shark release and survival while minimising bycatch of other vulnerable species.

5. Topics for discussion

The first meeting of the Conservation Working Group may wish to consider the following issues, and where the Sharks MOU may be able to contribute to efforts to resolve bycatch problems:

- Which mitigation measures (avoidance and live release), by gear type and by RFMO, are likely most useful for sharks?
- Where and in which fisheries is it most important to assess post-release survival?
- Where are RFMOs having the greatest difficulties with the adoption and implementation of desired mitigation measures, and can assistance be provided through the Sharks MOU?
- Is it possible to recommend some measures that will work across all fisheries for all the major bycatch taxa (sharks, marine mammals, turtles, and seabirds)?
- Which mitigation measures need to be adapted for different fisheries, depending upon circumstances?
- How can such adaptations be developed? Can the CMS Secretariat and the CMS Family Bycatch Group assist by recommending harmonization of bycatch mitigation measures?
- What additional research, data collection, conservation and management measures do CWG1 recommend, to accompany bycatch avoidance and release?

- Interest in obtaining Marine Stewardship Council certification has been a powerful influence in persuading CPPs to accept more stringent bycatch avoidance and mitigation measures in, for example, the IATTC. Can the CWG suggest other incentives, or methods for strengthening the MSC process?

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