SHARK YEAR (multi-year research) PROGRAM (SharkYP)

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PURPOSE

To provide the Scientific Committee with a draft Shark Year (multi-year research) Program, for its consideration and potential endorsement, so that the requirements of IOTC Resolution 13/06 *on a scientific and management framework on the conservation of shark species caught in association with IOTC managed fisheries*, may be fulfilled by the deadline specified by the Commission (2016 evaluation by the SC).

BACKGROUND

At its 17th Session held in May 2013, the Commission adopted Resolution 13/06 *on a scientific and management framework on the conservation of shark species caught in association with IOTC managed fisheries*. Paragraphs 1, 2 and 9 of Resolution 13/06 state:

1. The Commission shall determine the shark species that are subjected to IOTC Conservation and Management Measures, including prohibition to retain on board, tranship, land or store any part or whole carcass according to the IOTC Scientific Committee's (SC) recommendation or advice.
2. The SC recommendation or advice shall be conducted taking account of:
   a) full stock assessments on sharks, stock assessment and Ecological Risk Assessments (ERAs) by fishing gears, using available best scientific data/information;
   b) trend of fishing effort by fishing gear on each shark species;
   c) effective IOTC Conservation and Management Measures for certain fishing gears with high risk by shark species;
   d) priority in shark species with high risk;
   e) review of practical implementation of prohibition to retain on board of shark species;
   f) feasibility of implementation of prohibition to retain on board including identification of shark species;
   g) impact and bias of IOTC Conservation and Management Measures of sharks on fishing operations and sharks data/information collected and reported by CPCs;
   h) further improvement of level for sharks data/information submitted by CPCs, particularly developing CPCs.
9. The provisional measures stipulated in this Resolution shall be evaluated in 2016 by the IOTC Scientific Committee to deliver more appropriate advice on the conservation and management of the stocks for the consideration of the Commission.

DISCUSSION

Noting paragraphs 1, 2 and 9 of IOTC Resolution 13/06 (detailed above), at its 9th Session held in September 2013, the IOTC Working Party on Ecosystems and Bycatch (WPEB09) made the following comments/recommendation:

- The WPEB **NOTED** the urgent need to improve the collection of fisheries data and develop applied research to fill the major knowledge gaps for sharks that affect the provision of scientific advice to the Commission. Therefore, the WPEB prepared an outline and general objective for a Shark Year Program (SharkYP), which included the following aspects: a) the objectives of the program; b) general background of existing fishery and biological data for the main pelagic sharks in the Indian Ocean, highlighting major gaps of knowledge, as well as the main fisheries impacting sharks; c) priorities in fisheries data collection; d) research priorities on biological information; e) research priorities on mitigation measures; and f) other considerations for the SharkYP. (IOTC–2013–WPEB09–R, para 249)
- The WPEB **RECOMMENDED** that a small working group of shark experts and the IOTC Secretariat further develop the draft Shark Year Program (SharkYP) and to present the proposal at the next SC meeting to be held in December 2013. The overall objective is to: (IOTC–2013–WPEB09–R, para 250)

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> "The Shark Year Program (SharkYP) represents a further step to align with the work of the WPEB with IOTC Conservation and Management Measures (CMMs), particularly to the recently adopted Resolution 13/06 *on a scientific and management framework on the conservation of shark species caught in association with IOTC managed fisheries*. Moreover, the SharkYP aims to provide guidance to WPEB researchers, by prioritising issues related to data collection and research on species biology/ecology, fisheries and mitigation measures. Finally, by promoting cooperation and coordination among WPEB researchers, the SharkYP aims to improve the quality of the scientific advice on sharks provided to the Commission, and to better assess the impact on these species of the current CMMs."

Subsequent to the WPEB09 meeting, a small working group of shark experts and the IOTC Secretariat further developed a draft Shark Year Program (Appendix I) for the consideration, modification and potential recommendation by the Scientific Committee to the Commission.

RECOMMENDATION/S

That the Scientific Committee:

1) **NOTE** paper IOTC–2013–SC16–18, which aimed to provide the SC with a draft outline for a Shark Year (multi-year research) Program, for its consideration and potential endorsement, so that the requirements of IOTC Resolution 13/06 *on a scientific and management framework on the conservation of shark species caught in association with IOTC managed fisheries*, may be fulfilled by the deadline specified by the Commission (2016 evaluation by the SC).
2) **CONSIDER** endorsing a final version of the Shark Year (multi-year research) Program, for the consideration of the Commission at its 18th Session to be held in June 2014, and to consider and budgetary consequence.

APPENDICES

Appendix I: Shark Year (multi-year research) Program (SharkYP)

APPENDIX I

DRAFT: SHARK YEAR (MULTI-YEAR RESEARCH) PROGRAM

1. Introduction

2. General background of existing fishery and biological data

3. Objectives of the SharkYP

4. Priorities in fisheries data collection

- 4.1. Fleet and gear characterisation
- 4.2. Fleet dynamics
- 4.3. Data needs [Catch (landings+discards), effort, CPUEs series; gear selectivity; catch-at-size/age; Data mining/recover of historical data sets for sharks]
- 4.4. Trade data
- 4.5. Observer programs (design and implementation)

5. Research priorities on biology/ecology

- 5.1. Life history traits (Age and growth; reproduction; mortality)
- 5.2. Stock delimitation
- 5.3. Habitat use and migrations
- 5.4. Morphometrics and conversion factors for shark products

6. Research priorities on mitigation measures

- 6.1. Operational and technological aspects (Gillnets; Longlines; Purse seines)
- 6.2. Best practices
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7. Revision of data poor assessment models

8. Other considerations for the SharkYP

- 8.1. Capacity building
- 8.2. Collaboration and coordination
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SHARK YEAR PROGRAM (SharkYP)

AIMING THE IMPROVEMENT OF DATA COLLECTION AND RESEARCH

1. Introduction

A great variety of sharks species are found within the IOTC area of competence, from coastal to oceanic species. Forty-four species or groups of shark species are currently present in the IOTC databases, which show very diverse biological strategies and as active predators occupy a very high position in the trophic chain. Although diverse, the biological characteristics of these species share some general patterns that make them potentially more susceptible to overfishing than other species, namely because they generally have a low reproductive potential, are slow growing and mature late compared to other species.

Even though sharks have been impacted by commercial and recreational fisheries in the IOTC area of competence for many years, there is still very limited information and severe gaps in the available catch, effort and discard data, as consistently noted in IOTC reports and recently highlighted by Murua et al. (2013). These gaps currently preclude any sensible stock assessment for sharks and the accurate estimation of fishery impacts on shark populations in the IOTC area of competence. Moreover, shark species life cycles, biological parameters, movement patterns and habitat utilisation are poorly understood due to the lack of specific studies on those aspects in the Indian Ocean. Therefore, the current state of knowledge on IOTC fisheries capturing sharks is a cause for concern, particularly on their conservation status and management.

The WPEB has consistently recognised the urgent need to improve the collection of fisheries data and develop applied research to fill the major knowledge gaps that affect the provision of scientific advice to the Commission. Moreover, the Commission has recently established the scientific and management framework for the conservation of sharks (Resolution 13/06 *on a scientific and management framework on the conservation of shark species caught in association with IOTC managed fisheries*).

Therefore, during the WPEB09 the general guidelines for a Shark Year Program (SharkYP) were presented, which included the following aspects: a) general background of existing fishery and biological data for the main pelagic sharks in the Indian Ocean, highlighting major gaps of knowledge, as well as the main fisheries impacting sharks and the most sensitive species; b) the objectives of the Program; c) priorities in fisheries data collection; d) research priorities on biological information; e) research priorities on mitigation measures; and f) other considerations for the SharkYP. The WPEB09 agreed that a proposal for the SharkYP to be presented to the 16th Session of the IOTC Scientific Committee.

It is worth noting that similar initiatives have been successfully developed by other fisheries and fisheries related organisations (i.e. ICCAT; WCPFC). Moreover, the ICCAT Shark Group (equivalent to the WPEB with regards to sharks), is currently working/preparing a Shark Research and Data Collection Program, to overcome similar data gaps and improve the provision of scientific advice for Atlantic pelagic shark stocks. Several researchers involved in this ICCAT Program have also been recently involved in the WPEB, which therefore represents an advantage to a future IOTC multi-year shark program.

2. General background of existing fishery and biological data

Numerous aspects of fishery statistics and biology of the shark species caught in association with tuna fisheries in the IOTC area of competence are still poorly understood or unknown. In general, there is a scarcity of data and even for major fleets and CPCs there is limited data being reported, and therefore available in the IOTC database. With regards to historical data, several countries have not collected and shark fishery statistics, especially in the years prior to the major development of tuna and tuna-like fisheries in the Indian Ocean, in the early 1970s. At present, most industrial fisheries provide limited data, while artisanal and small scale fisheries data is almost non-existent due to monitoring difficulties. Most CPCs are not reporting shark statistics to the IOTC Secretariat, despite the mandatory reporting requirements of the IOTC. The catches recorded in other cases might not represent the total catches of sharks, but simply the amounts retained on board (e.g. dressed weights instead of live weights). Although finning is prohibited, it still occurring but the catches of sharks for which only the fins are kept on board are rarely recorded. Therefore, the information on the catch of sharks provided by most CPCs is thought, for this reason, to be incomplete and/or inaccurate.

Moreover, the catches of sharks are not recorded by gear and/or species. The catches of sharks are not disaggregated at the required level for each species by area and fleet. Generally major sharks are better reported than other species but still there are inconsistencies. Misidentification of shark species is also common. The identification of sharks in port is usually compromised by the way in which the different species of sharks are processed before landed. Generally, no indication is given on the type of processing that the different specimens underwent. Then, the identification of sharks unloaded as shark carcasses, shark fins or other shark products is difficult.

There is scarce data on discards, incomplete and heterogeneous: some CPCs report discards in weight, while others provide discard numbers. Moreover, discards differ depending on the aggregations behavior (FADs, free schooling). These aspects makes it difficult to merge the data. Data from the IOTC regional observer scheme is not yet available or only available for a few fishing trips each year, and the observer coverage varies substantially by fishery, although it is generally considered very low in most of the fleets, while there are no observer schemes implemented in some coastal country fleets (i.e. gillnets fisheries).

Very little information about shark catches length frequencies is available both for landings and catches recorded by observers. There is a general lack of biological and ecological knowledge for pelagic sharks in the Indian Ocean. Port sampling could in theory provide additional fishery-specific biological data but this is hampered by the fact that most sharks are landed as processed carcasses, resulting in half of the samples collected so far not being identified to species.

Information on the activities of fleets capturing sharks (by targeting or as an incidental bycatch), the reporting level of catch data (although improvements have been made in recent years), is still insufficient to permit the provision of quantitative advice on stock status with sufficient precision to guide fishery management toward optimal harvest levels for any of the species. Nominal catches from the IOTC database, as well as the estimations carried out by Murua et al. (2003), provides as comprehensive picture as possible of what are the main fleets capturing shark species in the IOTC area of competence (Table 1). These estimates also help to identify the different species for which greater focus is needed, as well as those for which resources should not be applied in the near future. However, a detailed analysis of the information available in needed, with the aim of prioritizing which fleets require immediate monitoring, so as to design specific and representative data collection programs, as well as scientific observer schemes for those fleets, to facilitate a comprehensive assessment of the status of the shark stocks impacted by IOTC fisheries for tuna and tuna-like species.

Table 1. Summary of the main fisheries impacting shark species, and summary of the most impacted shark species in the IOTC area of competence according to IOTC database and to Murua et al. (2013).

IOTC	IOTC database	Murua *et al.* (2013)
Fisheries most impacting Sharks (% of total catch)	Gillnet (68%) Longline (16 %) Other gears (12 %) Line (4 %) Purse-seine (< 1 %)	Gillnet (61%) Longline (18%) Other gears (12%) Purse-seine (1%)
Shark most impacted (for the gear most impacting each species in IOTC)		Blue shark (32%) Silky shark (21%) Threshers (16%) Oceanic whitetip (11%) Shortfin mako (10%) Hammerheads (6%)

Therefore, it is essential that CPCs urgently improve data collection and research on sharks, namely on life history traits and interactions with IOTC fisheries. The overall objective is to assess the status of the shark stocks and provide adequate scientific advice on sustainable management of elasmobranch fisheries in the IOTC area of competence to the Commission. This proposal is a step forward for the provision of scientific advice and the evaluation of the efficacy of the management measures adopted by the Commission in recent years (Table 2).

Table 2. Summary of current Conservation and Management Measurements for sharks in the IOTC area of competence.

Management Requirement	IOTC resolution
Report catch	Res. 05/05
Full utilisation of sharks	Res. 05/05
No more fins than 5 % ratio	Res. 05/05
Mitigation research	Res. 05/05
Reporting in logbooks	Res. 08/04 & Res. 10/03
Observers	Res. 11/04
Research Programme	Res. 13/06
Prohibition of retention	
Thresher sharks	Res. 12/09
Oceanic whitetip shark	Res. 13/06
Prohibition of setting on whale sharks	Res. 13/05

3. Objective of the SharkYP

Although efforts have been made in recent years to improve shark data collection and research, the current state of knowledge on many fisheries and basic biological traits of pelagic sharks remains limited. These gaps in data and knowledge preclude any stock assessments and have caused constraints to the provision of scientific advice. Therefore, the present proposal for the Shark Year Program (SharkYP) represents a further step to align the work of the WPEB with current IOTC Resolutions, particularly with the recently adopted Res.13/06 *on a scientific and management framework on the conservation of shark species caught in association with IOTC managed fisheries*. Moreover, the SharkYP aims to develop specific tasks for the coming year, including improvements in capacity building and collaboration amongst researchers, and the development (and presentation to the SC in 2014) of a detailed proposal for the implementation of an IOTC multi-annual shark program. This initiative will provide guidance to researchers working in IOTC fisheries, by prioritising issues related to data collection and research on species biology traits, fisheries and mitigation measures.

Thus, the primary objective is to:

> "promote cooperation and coordination among IOTC researchers, to improve the quality of the scientific advice on sharks provided to the Commission, namely by conducting quantitative stock assessments for selected species by 2016, and to better assess the impact on shark stocks of the current IOTC Conservation and Management Measures."

4. Priorities in fisheries data collection

Particular emphasis should be dedicated to those fisheries which have the greatest impact on shark populations sharks in the Indian Ocean, namely gillnet and longline fisheries which catch an estimated 80% of the overall shark landings in the IOTC area of competence.

For example, Murua et al., (2013) found that 17 fisheries amongst the 195 fisheries in IOTC database generate 92% of potential investigated shark catches (Table 3). Those authors identified that most of the shark catch may be impacted by 4 métiers, which generate more than 60 % of the estimated shark species: Gillnet from Iran, Sri Lanka, Indonesia and Taiwanese longliners. Gillnet (GN) and a composition of Gillnet and Longline (GN-LL) are the most impacting fleets with 61% of the total estimated shark catches (97,000 t); followed by longlines with 18% and other métiers with 12%, which precise gear composition is unknown.

Table 3. Estimated shark catches by fleet (tons/year), according to Murua et al. (2013).

Fleet/Métier	Studied shark estimated catch	Cumulated Studied shark estimated	% Cumulated Studied shark estimated
IRN-GN	34,375	34,375	22.8
LKA-GN-LL	32,141	66,516	44.1
IDN-GN	13,760	80,276	53.2

TWN-LL	9,075	89,352	59.2
YEM-OTH	6,074	95,426	63.2
IDN-OTH	6,039	101,464	67.2
PAK-GN	5,966	107,430	71.2
MDG-OTH-shark	5,690	113,120	75.0
IDN-LL	5,026	118,147	78.3
JPN-LL-jpn	4,116	122,263	81.0
OMN-GN	3,912	126,175	83.6
COM-OTH	2,952	129,127	85.6
IND-GN	2,870	131,997	87.5
ESP-LL-swo	2,536	134,533	89.2
MDV-OTH	1,774	136,306	90.3
IND-LL	1,338	137,645	91.2
OMN-OTH	997	138,641	91.9

At the WPEB09, participants agreed that the following list covers the main issues affecting the quality of the shark statistics available at the IOTC, by type of dataset and type of fishery.

1. **Catch-and-Effort data from gillnet fisheries:**
   - **Drifting gillnet** fisheries of **Iran** and **Pakistan**: To date, Iran and Pakistan have not reported catches (retained and discarded) of sharks, by species, for their gillnet fisheries.
   - **Gillnet/longline** fishery of **Sri Lanka**: Sri Lanka has not reported catch-and-effort data for sharks as per the IOTC standards.
   - **Driftnet fishery of Taiwan,China** (1982–92): Catch-and-effort data does not include catches of sharks by species.
2. **Catch-and-Effort data from Longline Fisheries:**
   - **Historical catches of sharks from major longline** fisheries: To date, **Japan**, **Taiwan,China**, **Indonesia** and **Rep. of Korea,** have not provided estimates of catches of sharks, by species, for years before 2006.
   - **Fresh-tuna longline** fisheries of **Indonesia** and **Malaysia**: Indonesia and Malaysia have not reported catches of sharks by IOTC standards for longliners under their flag. In addition Indonesia has not reported catch-and-effort data for its longline fishery to date.
   - **Freezing longline** fisheries of **EU-Spain**, **India**, **Indonesia**, **Malaysia**, and **Oman:** These countries have not reported catch-and-effort data of sharks by IOTC standards for longliners under their flag.
3. **Catch-and-Effort data from coastal fisheries:**
   - **Coastal** fisheries of **India**, **Indonesia**, **Madagascar**, **Sri Lanka** and **Yemen**: To date, these countries have not provided detailed catches of sharks to the IOTC, in particular Thresher and other pelagic shark species caught by their coastal fisheries.
4. **Discard levels from surface and longline fisheries:**
   - **Discard levels of sharks from major longline** fisheries: To date, **European Union**, **Japan**, **Indonesia** and **Rep. of Korea,** have not provided estimates of discards of sharks, by species, in particular Thresher sharks and oceanic whitetip shark.
   - **Discard levels of sharks for industrial purse seine** fisheries: To date, the **European Union** (before 2003), **Iran**, **Japan**, **Seychelles**, and **Thailand**, have not provided estimates of discards of sharks, by species, for industrial purse seiners under their flag.
5. **Size frequency data:**
   - **Gillnet** fisheries of **Iran** and **Pakistan:** To date, Iran and Pakistan have not reported size frequency data for their driftnet fisheries.

- **Longline** fisheries of **China**, **Taiwan,China**, **India, Indonesia, Malaysia, Oman** and **Philippines:** To date, these countries have not reported size frequency data for their longline fisheries, including length frequency of discards of thresher sharks.
- **Coastal** fisheries of **India, Indonesia, Madagascar, Sri Lanka** and **Yemen**: To date, these countries have not reported size frequency data for their coastal fisheries.

6. Biological data:

- Surface and longline fisheries, in particular **China**, **Taiwan,China**, **Indonesia** and **Japan**: The Secretariat had to use length-age keys, length-weight keys, ratios of fin-to-body weight, and processed weight-live weight keys, for sharks from other oceans due to the general paucity of biological data available from the Indian Ocean.

4.1.Fleet and gear characterisation

Accurate information about the gear characteristics and specifications at which species are captured is fundamental to understanding the impacts of fisheries. The fishing power, selectivity and catchability of fishing gears are variables that would help to understand the evolution of catches.

4.2.Fleet dynamics

As sharks are mostly caught as bycatch in IOTC fisheries (and are defined as bycatch by the Scientific Committee), any change in the dynamics of the fleets is likely to have implications on catches and subsequent landings. Such changes may be related to different aspects such as: technological development; shifts on target species as a result of their abundance; markets changes, management or piracy; fleet movement between fishing areas throughout the year.

4.3.Data needs

Data gaps are the main constraints to assess shark species population and the improvement of data collection for shark species should be a major goal of the SharkYP.

This process may be qualified as:

- **Species oriented** because at the end it is expected to have data with required level of precision for particular shark species which will allow assessing fishing impact on those populations;
- **Fishery/métier** based because the impact is different by métier, data collection has specific operational constraints and are set in place on a fishery/métier basis;

The 3 step framework or process can described as follows:

Listing most impacted shark species and impacting fleets)

✓ Estimation of shark catch by species and fleets based on ratios: this will allow identifying highly impacted species and the fisheries impacting most the priority species by major geographical areas.

Identify most vulnerable species and métiers impacting sharks

✓ Status of the stock:

i. Fishery indicators;
ii. Ecological Risk Assessment rank with high vulnerability to a given gear;
iii. Species identified as at risk by other entities (CITES, etc.).

At the end of 2 first steps, a list of priorities for species and fleets should be established.

✓ For species listed and for which data required for assessment are available, assessment should be conducted;
✓ For species suffering data gaps in specific and/or major fleets identified in step 1, the third step would be to proposed ways to specifically improve data collection.

Prioritize data collection in term of most vulnerable species and métiers impacting sharks

The final step is defining a data collection program for species by métier to improve the data quantity and quality for the assessment. This strategy would guarantee that data collection is adequate for the most priority sharks species impacted by the major fisheries/métier. The SharkYP should be a combination of improvement of data collection through logbooks, observer programs including alternative method such as selfsampling and/or electronic monitoring, but also include the improvement of current knowledge on the biology of sharks and mitigation measures for their catch. This step does not preclude taking management actions based on the results of step 1 and 2.

The species and fleets identified in step 1 and 2, the data collection should be the focused of the following actions:

- ✓ Improvement of data collections:
  - i) Historic data mining;
  - ii) Estimation based on ratios from observer programs;
  - iii) Inclusion of the species in the mandatory requirements for the logbooks;
  - iv) Improve observer coverage including alternative methods for observer programs (e.g. self sampling, electronic monitoring);
  - v) Biological research;
- ✓ Stock assessment and management;
- ✓ Application of some management measures (e.g. prohibition of retention);
- ✓ Identification of mitigation measures.

4.4.Trade data

Trade data are a potentially useful complementary source of information for the management and assessment of shark species caught in association with IOTC fisheries. Identifying trends and changes in the trade of shark products (e.g., routes, volumes and products) may in turn help our understanding of the dynamics of fisheries capturing sharks. In the specific context of shark assessments, historical and current trade data may be used to identify potential gaps in reported catches and to develop proxy indices for estimating historical catches.

4.5.Observer programs (design and implementation)

The IOTC the observer coverage laid out in Resolution 11-04 is set at 5%. However, this is considered below the minimum level of 20 % required for a good level of precision. The observer programs should be focused on the main fleets and species impacted, using possible methodologies to increase the observer coverage such as self-sampling, pilot observer programs in artisanal gillnet fisheries, or electronic monitoring as well as observers onboard.

5. Research priorities on biology/ecology

5.1. Life history traits

Parameters that are needed for population dynamics studies include: age, growth and reproduction. These parameters can then be used to estimate mortalities and intrinsic population growth rates.

Age and growth – knowledge on age structure and growth dynamics of a population is essential for age-structured stock assessment models. These parameters are often used to estimate natural or total mortality that are important for the calculation of important population and demographic parameters, such as population growth rates and generation times.

Reproduction – Knowledge on the reproductive biology is essential for stock assessment models that attempt to accurately capture the biology of a species, such as age- and sex-structured models. Size-at-maturity is usually set after consideration of the size at which most individuals (usually 50%) become sexually mature. This is particularly important for sharks, as females tend to mature at a later age and larger size, and reach a larger size and older age than their male counterparts. Other important reproductive parameters include fecundity, seasonality and periodicity.

Mortality – The majority of population modelling studies for elasmobranchs relies on indirect estimates of mortality obtained through methods based on predictive equations of life history traits. However, it is possible to estimate

instantaneous natural mortality rates (M) or instantaneous total mortality rates (Z) for sharks based on mark-recapture techniques or catch curves.

5.2. Stock delimitation

Studying the genetic structure of shark populations is a very useful tool for determining stock boundaries, existence of mixing areas and migration between geographic areas within the Indian Ocean or between Oceans.

5.3. Habitat use and migrations

Improve the current knowledge on the different shark species habitat use and migrations are essential for better management of these resources. Conventional tagging (based on mark-recapture) can provide patterns of movement, growth and mortality rates and assisting in inferring the degree of mixing among stocks. On the other hand, the use of satellite tagging technology can provide insights on migration patterns, habitat use (both spatial and in terms of depth) and post-release mortality.

5.4.Morphometrics and conversion factors for shark products

A review is needed on the definitions of the different shark products in order to develop a set of product code categories which are clearly defined and mutually exclusive. This will allow standard conversion factors to be applied to specific product types and direct further research into conversion factors for the less well studied product types.

6. Research priorities on mitigation measures

6.1.Operational and technological aspects (Gillnets; Longlines; Purse seines)

Several research projects are being developed to mitigate bycatch on tuna fisheries worldwide, primarily for seabirds, marine turtles and marine mammals. However, only a few have focused on the mitigation of shark bycatch on tuna fisheries. Therefore, there is an urgent need to further develop ongoing studies and define priorities for additional research. Examples of operational and technological aspects that can be studied as possible mitigation measures for the impact of IOTC fisheries on shark populations include:

- Gillnets: net mesh sizes, net operations (e.g. setting lower-profile nets to avoid entanglement), altering fishing methods (e.g. driftnets *versus* demersal nets), spatial/seasonal restriction on essential coastal habitats.
- Longlines: hook-style design and material, bait types, gangion material, post-capture practices to improve post-release survival, spatial/seasonal restrictions on mating and nursery habitats.
- Purse-seines: attraction of sharks out of the net before setting the net, post-release survival of sharks, modification of the gear for allowing sharks to escape through an escape panel on the PS, etc.

6.2.Best practices

For the major gears impacting sharks and rays, good practices identified should be transferred to fishers, namely within the scope of observer programs. It is therefore necessary to prepare and/or further develop existing guides and provide translate version for the different languages used in the most important fisheries impacting pelagic sharks. An example is the guide "*Good practices to reduce the mortality of sharks and rays caught incidentally by tropical tuna purse seiners*" developed by Poisson et al. (2013) for purse seine fisheries.

7. Revision of data poor assessment models

The major goal of modern stock assessment methods is to determine the status of a stock in relation to certain reference points, and in case of overfishing to estimate how quickly the stock can be rebuilt. Due to the current gaps in fisheries data and key biological information for most shark species, traditional stock assessment models (e.g.

production models, virtual population analysis, etc.) cannot yet be applied to any shark stocks in the Indian Ocean. Therefore there is a need for development of innovative methods of assessment of pelagic shark stocks, namely by reviewing currently available methods applicable to data-poor situations, which have recently been developed by several fisheries Agencies and RFMOs.

One possible alternative approach is using catch-free methods, which can estimate reference points, stock status, and recovery times in situations where catch data and other measures of absolute abundance are unavailable. Other alternative approaches are Ecological Risk Assessments (ERA), which can determine the relative vulnerability of a stock to a fishery in function of the productivity and susceptibility. This approach is particularly useful for helping the management bodies to identify the stocks that are more vulnerable to overfishing, so that they can monitor and assess their management measures. It can also be used to prioritise research efforts, by identifying species with high susceptibility to a certain fishery but where biological information is still lacking.

8. Other considerations for the SharkYP

8.1. Capacity building

Although there have been improvements in recent years, data collection remains limited or is incorrectly being gathered in several areas of the Indian Ocean. A concerted action/effort to enhance data gathering abilities in these regions should be a priority with the goal of bringing the quality and quantity of data up to currently accepted standards, aiming to fulfil to current IOTC Resolutions:

- Resolution 13/03 *on the recording of catch and effort by fishing vessels in the IOTC area of competence* sets out the minimum logbook requirements for purse seine, longline, gillnet, pole and line, handline and trolling fishing vessels over 24 metres length overall and those under 24 metres if they fish outside the EEZs of their flag States within the IOTC area of competence. As per this Resolution, catch of all sharks must be recorded (retained and discarded).
- Resolution 13/06 *on a scientific and management framework on the conservation of shark species caught in association with IOTC managed fisheries* prohibits, as an interim pilot measure, the retention onboard, transhipment, landing or storing any part or whole carcass of oceanic whitetip sharks (*Carcharhinus longimanus*) (and requests for all other species) by all vessels on the IOTC record of authorised vessels or authorised to fish for tuna or tuna-like species, with the exception of observers who are permitted to collect biological samples (vertebrae, tissues, reproductive tracts, stomachs) from oceanic whitetip sharks that are dead at haulback and artisanal fisheries for the purpose of local consumption, and will conduct a review and an evaluation of the interim measure in 2016.
- Resolution 11/04 *on a Regional Observer Scheme* requires data on blue shark interactions to be recorded by observers and reported to the IOTC within 150 days. The Regional Observer Scheme (ROS) started on 1st July 2010.
- Resolution 05/05 *Concerning the conservation of sharks caught in association with fisheries managed by IOTC* includes minimum reporting requirements for sharks, calls for full utilisation of sharks and includes a ratio of fin-to-body weight for shark fins retained onboard a vessel.
- Resolution 10/02 *Mandatory statistical requirements for IOTC Members and Cooperating Non-Contracting Parties (CPC's)* indicated that the provisions, applicable to tuna and tuna-like species, are applicable to shark species.

8.2.Collaboration and coordination

Collaboration and cooperation are essential actions that build the base of any transnational research activity. In the case of pelagic sharks species occurring in the Indian Ocean any research plan and efficient data collection focused on these widely distributed species requires the enforcement of mechanisms to strengthen relations between the scientific teams involved in the process. The areas of collaboration that should be reinforced within this collective action that were identified include:

- capacity building and training in data collection and analysis
- elaboration of protocols for the collection, storage, preservation and exchange of biological samples

- protocols for the analysis of biological samples
- equitable distribution of the biological sampling effort framed in a predefined scientifically sampling scheme
- promotion of visiting and interchanges opportunities for scientists at national laboratories
- prioritise multilateral collaboration for specific studies, aiming the promotion of collaboration among scientific teams consistently involved in sharks research within the Scientific Committee of IOTC and other t-RFMOs.

8.3.Funding

The WPEB briefly discussed the potential sources of funding to support the SharkYP, namely external funding (e.g. World Bank, WWF, Shark alliance, PEW, GEF-ABNJ). It was agreed that at this stage it is not possible to estimate the required funds to accomplish the different elements of the program. The WPEB considered that the best approach to conduct an appropriate estimation of the required budget is through a group of SC scientists familiarized with shark fisheries that would be responsible to accomplish this task, which should be part of the 2014 action plan.

9. Action plan for 2014

Although the amount of work that can be achieved in the short run is limited, below there are a list of proposed actions to be developed during 2014.

9.1. Capacity building

As mentioned above one of the major constraints is related to the limited means that some CPCs face, namely in terms of their capacity to design and implement data collection systems, including sampling.

As agreed by the WPEB and previously the SC, capacity building efforts should be targeted at those CPCs who have large gillnet fleets (I.R. Iran, Pakistan, India, Sri Lanka). The following are current recommendations from the WPEB09:

WPEB09.08 (para.52) The WPEB reiterated its previous **RECOMMENDATION** that the Commission considers allocating funds to support a regional review of the current and historical data available for gillnet fleets operating in the Indian Ocean. As an essential contribution to this review, scientists from all CPCs having gillnet fleets in the Indian Ocean, in particular those from I.R. Iran, Oman, Pakistan and Sri Lanka, should collate the known information on bycatch in their gillnet fisheries, including sharks, marine turtles and marine mammals, with estimates of the likely order of magnitude where more detailed data are not available. A consultant should be hired for 30 days to assist CPCs with this task (budget estimate: Table 4).

TABLE 4. Estimated costs for the hiring of a consultant to undertake a regional review of gillnet fleets.

Description	Unit price	Units required	Total
Contract days	$350	30	10,500
Travel costs (field)	$3,000	3	9,000
Travel costs to attend WPEB	$5,000	1	5,000
Total estimate (US$)			**24,500**

Training for CPCs having gillnet fleets on species identification, bycatch mitigation and data collection methods and also to identify other potential sources of assistance – Development of plans of action

WPEB09.09 (para.64) The WPEB **RECOMMENDED** that the Commission allocate funds in its 2014 and 2015 budgets for the IOTC Secretariat to carry out training for CPCs having gillnet fleets on bycatch mitigation methods, species identification, and data collection methods (budget estimate: Table 5).

TABLE 5. Estimated costs for CPCs with large gillnet fleets on bycatch mitigation methods, species identification and data collection methods. Two training workshops: I.R. Iran/Oman and Sri Lanka.

Description	Unit price	Units required	Total
Production of training material	$1,000	1	1,000
Travel costs (IOTC Staff) (I.R.Iran/Oman, Sri Lanka)	$4,000	3	12,000
Travel costs (Experts) (I.R.Iran/Oman, Sri Lanka)	$4,000	3	12,000
Workshop venue – to be paid by hosts	$0	2	$0
Total estimate (US$)			**25,000**

9.2. Research

Some CPCs are currently carrying out research projects on the biology traits of sharks and the mitigation of shark bycatch (i.e. effect of the use of different combinations of fishing gear material (on the terminal tackle of the gangion) and bait types for longline; shark escaping grids from PS net, etc. Therefore some results should be available during 2014. However, within the course of 2014 an effort should be made to improve collaboration and coordination, but especially to define research priorities, setup the basis for research projects and get funding.

9.3. Development of a detailed multi-annual program (short meeting of small expert group)

A detailed multi-year shark research program shall be prepared (by a small group of shark experts) covering the different aspects raised above in terms of data collection improvement and research prioritisation. Funding support would be required for allowing a small group of experts to attend a short ad-hoc meeting (budget estimate: Table 6).

TABLE 6. Estimated costs for ad hoc expert meeting to draft detailed SharkYP proposal.

Description	Unit price	Units required	Total (US$)
Meeting room* (3 days)	1,000	3	3,000
Travel costs (flights, DSA) 5 Shark experts plus IOTC Science Manager		6	10,000
Total estimate (US$)			**13,000**

*possible in kind support from host institution

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