Report of the 13th Session of the IOTC Working Party on Ecosystems and Bycatch

San Sebastian, Spain 4 – 8 September 2017

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ACRONYMS

ABNJ	Areas Beyond National Jurisdiction
ACAP	Agreement on the Conservation of Albatrosses and Petrels
BPUE	Bycatch Per Unit of Effort
BSH	Blue shark
CITES	Convention on International Trade in Endangered Species
CMM	Conservation and Management Measure (of the IOTC; Resolutions and Recommendations)
CPCs	Contracting Parties and Cooperating Non-Contracting Parties
CPUE	Catch per unit of effort
current	Current period/time, i.e. $F_{current}$ means fishing mortality for the current assessment year.
EEZ	Exclusive Economic Zone
ERA	Ecological Risk Assessment
EU	European Union
EU-DCF	European Union Data Collection Framework
F	Fishing mortality; F_{2015} is the fishing mortality estimated in the year 2015
FAD	Fish Aggregation Device
FAO	Food and Agriculture Organization of the United Nations
F_{MSY}	Fishing mortality at MSY
GAM	Generalised Additive Model
GLM	Generalised liner model
HBF	Hooks between floats
IO	Indian Ocean
IOTC	Indian Ocean Tuna Commission
IOSEA	Indian Ocean - South-East Asian Marine Turtle Memorandum
IO-ShYP	Indian Ocean Shark multi-Year Plan
IPOA	International Plan of Action
IUU	Illegal, Unreported and Unregulated, fishing
LL	Longline
LSTLV	Large-scale tuna longline vessel
MoU	Memorandum of Understanding
MPF	Meeting Participation Fund
MSY	Maximum sustainable yield
n.a.	Not applicable
NDF	Non Detriment Finding
NGO	Non-Governmental Organisation
NOAA	National Oceanic and Atmospheric Administration
NPOA	National Plan of Action
PSA	Productivity Susceptibility Analysis
ROS	Regional Observer Scheme
SC	Scientific Committee of the IOTC
SB	Spawning biomass (sometimes expressed as SSB)
SB_{MSY}	Spawning stock biomass which produces MSY
Taiwan,China	Taiwan, Province of China
UN	United Nations
WPDCS	Working Party on Data Collection and Statistics, of the IOTC
WPEB	Working Party on Ecosystems and Bycatch, of the IOTC

KEY DEFINITIONS

Bycatch	All species, other than the 16 species listed in Annex B of the IOTC Agreement, caught or interacted with by fisheries for tuna and tuna-like species in the IOTC area of competence.
Discards	Any species, whether an IOTC species or bycatch species, which is not retained onboard for sale or consumption.
Large-scale driftnets	Gillnets or other nets or a combination of nets that are more than 2.5 kilometres in length whose purpose is to enmesh, entrap, or entangle fish by drifting on the surface of, or in, the water column.

STANDARDISATION OF IOTC WORKING PARTY AND SCIENTIFIC COMMITTEE REPORT TERMINOLOGY

SC16.07 (para. 23) The SC **ADOPTED** the reporting terminology contained in Appendix IV and **RECOMMENDED** that the Commission considers adopting the standardised IOTC Report terminology, to further improve the clarity of information sharing from, and among its subsidiary bodies.

HOW TO INTERPRET TERMINOLOGY CONTAINED IN THIS REPORT

Level 1: From a subsidiary body of the Commission to the next level in the structure of the Commission:
RECOMMENDED, RECOMMENDATION: Any conclusion or request for an action to be undertaken, from a subsidiary body of the Commission (Committee or Working Party), which is to be formally provided to the next level in the structure of the Commission for its consideration/endorsement (e.g. from a Working Party to the Scientific Committee; from a Committee to the Commission). The intention is that the higher body will consider the recommended action for endorsement under its own mandate, if the subsidiary body does not already have the required mandate. Ideally this should be task specific and contain a timeframe for completion.

Level 2: From a subsidiary body of the Commission to a CPC, the IOTC Secretariat, or other body (not the Commission) to carry out a specified task:
REQUESTED: This term should only be used by a subsidiary body of the Commission if it does not wish to have the request formally adopted/endorsed by the next level in the structure of the Commission. For example, if a Committee wishes to seek additional input from a CPC on a particular topic, but does not wish to formalise the request beyond the mandate of the Committee, it may request that a set action be undertaken. Ideally this should be task specific and contain a timeframe for the completion.

Level 3: General terms to be used for consistency:
AGREED: Any point of discussion from a meeting which the IOTC body considers to be an agreed course of action covered by its mandate, which has not already been dealt with under Level 1 or level 2 above; a general point of agreement among delegations/participants of a meeting which does not need to be considered/adopted by the next level in the Commission's structure.
NOTED/NOTING: Any point of discussion from a meeting which the IOTC body considers to be important enough to record in a meeting report for future reference.

Any other term: Any other term may be used in addition to the Level 3 terms to highlight to the reader of and IOTC report, the importance of the relevant paragraph. However, other terms used are considered for explanatory/informational purposes only and shall have no higher rating within the reporting terminology hierarchy than Level 3, described above (e.g. **CONSIDERED**; **URGED**; **ACKNOWLEDGED**).

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EXECUTIVE SUMMARY

The 13th Session of the Indian Ocean Tuna Commission's (IOTC) Working Party on Ecosystems and Bycatch (WPEB) was held in San Sebastian, Spain from 4 - 8 September 2017. A total of 39 participants (34 in 2016, 37 in 2015) attended the Session. The list of participants is provided in Appendix I. The meeting was opened by the Chairperson, Dr Rui Coelho from IPMA, EU-Portugal, who welcomed participants and formally opened the 13th Session of the IOTC Working Party on Ecosystems and Bycatch (WPEB13). The Chairperson also welcomed the Invited Expert for the meeting, Dr Felipe Carvalho (NOAA) and the stock assessment consultant Dr Joel Rice.

Evaluation of the mitigation measures contained in Resolution 13/06 for Oceanic whitetip shark

The WPEB **NOTED** the ongoing compliance issue for those CPCs reporting nominal catch of oceanic whitetip sharks and **RECOMMENDED** that the Scientific Committee request the Compliance Committee investigate these reported catches further and report the findings to the Commission (para. 4).

Longline hook identification guide

NOTING the continued confusion in the terminology of various hook types being used in IOTC fisheries, (e.g. tuna hook vs. J-hook; definition of a circle hook), the WPEB **REITERATED** its previous **RECOMMENDATIONS** (2013, 2014 and 2016) and the **RECOMMENDATION** from SC19 (SC19.16; para. 55 of IOTC-2016-SC19-R) that the Commission allocate funds in the 2018 IOTC Budget to develop an identification guide for fishing hooks and pelagic fishing gears used in IOTC fisheries (para. 24).

Review of the statistical data available for ecosystems and bycatch species

NOTING the highly aggregated nature of information requested on discards, the WPEB **RECOMMENDED** that the discard reporting form (Form 1DI) is updated to include seasonal (month) and spatial information (5 x 5 or 1 x 1) in a similar format to the catch and effort data reporting forms (para. 28).

Pilot projects under Resolution 16/04

NOTING the increasing number of CPCS that are now submitting observer data in electronic format, the WPEB **RECOMMENDED** the next revision of Resolution 11/04 should consider including the requirement for all observer data to be submitted in an electronically readable format (including historic data) (para. 36).

Biodegradable materials in FAD construction

The WPEB **DISCUSSED** some of the challenges in conducting these studies in view of the limitations on the number of FADs active per purse seine vessel in the Indian Ocean. For example, the limit of active number of FADs at sea in the Indian Ocean hinders the deployment of BIOFAD following experimental sampling designs and the engagement of the fleet to deploy them as they might not be successful for fishing. Thus, WPEB **RECOMMENDED** the Commission consider special allocations for experimental FADs deployed for scientific data collection for vessels willing to participate in biodegradable FAD testing under experimental protocols reviewed and endorsed by the Scientific Committee (para. 85).

CPUE Collaborative study of shark CPUE from multiple Indian Ocean longline fleets

NOTING the conflicting patterns in blue shark CPUE derived from different Indian Ocean longline fleets and **CONSIDERING** the success of using joint analysis of operational catch and effort data to resolve such conflicts in other Working Parties, the WPEB **RECOMMENDED** initiating work on joint analysis of operational catch and effort data from multiple fleets, to further develop methods and to provide indices of abundance for sharks of interest to the IOTC. A consultant should be considered to conduct such work for a budget of around EUR45 000 (para. 130).

Joint analysis of marine turtle mitigation measures

NOTING the findings of the Pacific workshop regarding the effectiveness of large circle hooks, finfish bait and the removal of the first and/or second hooks next to the floats for mitigating sea turtle interactions and mortalities in Pacific longline fisheries, the WPEB **AGREED** that further consideration of these mitigation techniques for Indian Ocean fisheries is warranted. Such a study should attempt to develop findings regarding the consequences of various mitigation techniques, primarily with regard to impacts on target and non-turtle bycatch species catch rates, to the extent possible based on data availability and quality. The WPEB therefore **RECOMMENDED** that the potential for a similar workshop to be held in the Indian Ocean is explored with potential funding from the Commission and/or from the Common Oceans Tuna Project (ABNJ). The WPEB **AGREED** to include this in the WPEB workplan and **REQUESTED** the Chairperson work with the Secretariat to pursue this idea further with potential participants and funding sources (para. 185).

Review of mitigation measures in Resolution 12/04

The WPEB **NOTED** Table 10 (Table14 from the FAO Fisheries and Aquaculture Technical Paper #588t "Bycatch in Longline Fisheries for Tuna and Tuna-like Species: a global review of status and mitigation measures") and, noting that IOTC's current resolution calls for, inter alia, implementation of safe handling practices, encouraging the use of fish bait and reporting sea turtle interactions and mortality annually, **AGREED** that CPCs should review and report on the extent to which their fisheries have implemented this resolution. The WPEB **RECOMMENDED** the following table (Table 11) to be completed by CPCs and submitted to the Secretariat in order to review the effectiveness of Resolution 12/04 as requested by the Commission. This table was suggested as an appropriate format for summarizing the information for the consideration and discussion of the SC, based on the seabird data call carried out in 2016 (para. 188).

The WPEB **REQUESTED** the following changes are made to the table for presentation to the SC (para. 189):

- Inclusion of a column for species name
- Use standard area specification (5 by 5 for LL and 1 by 1 for surface fisheries)
- Effort units that are appropriate for LL (hooks/sets), PS and GN fleets (sets/fishing days)
- The deadline for data submissions should be June 2018

Table 11. Example table for data request as used in the 2016 seabird data call

Fishery:		Observed			
Time period*					
Area[1]	Total effort[2] (hooks/sets)	Total observed effort[2] (hooks/sets)	Captures (number)	Mortalities (number)	Live releases (number)
Total					

*This field can be used to specify a temporal stratification to the data e.g. season.
[1]Spatial stratification at the finest scale possible.
[2] Effort should preferentially be provided in number of hooks, or sets where this is not possible.

Revision of the WPEB Program of Work 2018–2022

The WPEB **RECOMMENDED** that the SC consider and endorse the WPEB Program of Work (2018–2022), as provided in Appendix XIX (para. 234).

Future format of WPEB

The WPEB **NOTED** that this approach has not proved successful, particularly in years when a stock assessment has been undertaken as the large number of papers submitted (~60) cannot be fully considered in the time available. The WPEB therefore **RECOMMENDED** that in future years when a stock assessment is planned, the meeting is extended in length by a number of days to more adequately accommodate the workplan, with some of the days dedicated exclusively to the stock assessment work (para. 215).

Update: Ecosystem Based Fisheries Management (EBFM) joint meeting of tRFMOs in 2016

The WPEB **NOTED** the need for training and capacity building as the first step to moving forward with developing goals and strategies for the implementation of EBFM and therefore **RECOMMENDED** that a workshop is held to explain the key elements of EBFM so that a plan for implementation of EBFM in the IOTC Area of Competence can be developed by 2019 (para. 218).

Election of a Chairperson and Vice-Chairperson for the WPEB for the next biennium

The WPEB **RECOMMENDED** that the SC note the new Chairperson, Dr Sylvain Bonhommeau and Vice-Chairpersons, Dr Ross Wanless and Mr Reza Shahifar, of the WPEB for the next biennium (para. 226).

Review of the draft, and adoption of the Report of the 13th Session of the Working Party on Ecosystems and Bycatch

The WPEB **RECOMMENDED** that the Scientific Committee consider the consolidated set of recommendations arising from WPEB13, provided at Appendix XIX, as well as the management advice provided in the draft resource stock status summary for each of the seven shark species, as well of those for marine turtles and seabirds (para. 227):

Sharks

- Blue sharks (*Prionace glauca*) – Appendix IX
- Oceanic whitetip sharks (*Carcharhinus longimanus*) – Appendix X
- Scalloped hammerhead sharks (*Sphyrna lewini*) – Appendix XI
- Shortfin mako sharks (*Isurus oxyrinchus*) – Appendix XII
- Silky sharks (*Carcharhinus falciformis*) – Appendix XIII
- Bigeye thresher sharks (*Alopias superciliosus*) – Appendix XIV
- Pelagic thresher sharks (*Alopias pelagicus*) – Appendix XV

Other species/groups

- Marine turtles – Appendix XVI
- Seabirds – Appendix XVII
- Marine mammals – Appendix XVIII

A summary of the stock status for some of the most commonly caught shark species caught in association with IOTC fisheries for tuna and tuna-like species is provided in Table 1.

Colour key for Table 1	Stock overfished($SB_{year}/SB_{MSY} < 1$)	Stock not overfished ($SB_{year}/SB_{MSY} \geq 1$)
Stock subject to overfishing($F_{year}/F_{MSY} > 1$)	(red)	(orange)
Stock not subject to overfishing ($F_{year}/F_{MSY} \leq 1$)	(yellow)	(green)
Not assessed/Uncertain	(grey)	

Table 1. Status summary for key shark species caught in association with IOTC fisheries for tuna and tuna-like species.

Stock	Indicators		Prev[1]	2012	2013	2014	2015	2016	2017	Advice to the Commission
Sharks: Although sharks are not part of the 16 species directly under the IOTC mandate, sharks are frequently caught in association with fisheries targeting IOTC species. Some fleets are known to actively target both sharks and IOTC species simultaneously. As such, IOTC Contracting Parties and Cooperating Non-Contracting Parties are required to report information at the same level of detail as for the 16 IOTC species. The following are the main species caught in IOTC fisheries, although the list is not exhaustive.										
Blue shark *Prionace glauca*	Reported catch 2015: Estimated catch 2015: Not elsewhere included (nei) sharks 2015: Average reported catch 2011–15: Average estimated catch 2011–15: Ave. (nei) sharks[2] 2011–15:	29,916 t 54,735 t 57,906 t 29,507 t 54,993 t 49,969 t								Even though the blue shark in 2017 is assessed to be not overfished nor subject to overfishing, maintaining current catches is likely to result in decreasing biomass and the stock becoming overfished and subject to overfishing in the near future (Table 3). If the Commission wishes to increase the probability of maintaining stock biomass above MSY reference levels (B>B_{MSY}) over the next 8 years, then a reduction of a least 10% in catches is advised (Table 3). The stock should be closely monitored. Mechanisms need to be developed by the Commission to improve current statistics, by ensuring CPCs comply with their recording and reporting requirement on sharks, so as to better inform scientific advice in the future. Click below for a full stock status summary: ○ Blue sharks – Appendix IX
	MSY (1,000 t) (80% CI): F_{MSY} (80% CI): SSB_{MSY} (1,000 t) (80% CI): F_{2015}/F_{MSY} (80% CI): SSB_{2015}/SSB_{MSY} (80% CI): SSB_{2015}/SSB_0 (80% CI):	33.0 (29.5-36.6) 0.30 (0.30-0.31) 39.7 (35.5-45.4) 0.87 (0.67-1.09) 1.54 (1.37-1.72) 0.52 (0.46-0.56)								
Oceanic whitetip shark *Carcharhinus longimanus*	Reported catch 2015: Not elsewhere included (nei) sharks[2]: Average reported catch 2011–2015: Not elsewhere included (nei) sharks[2]:	215 t 57,906t 250 t 49,969 t								There is a paucity of information available for these species and this situation is not expected to improve in the short to medium term. There is no quantitative stock assessment and limited basic fishery indicators currently available. Therefore the stock status is highly uncertain. The available evidence indicates considerable risk to the stock status at current effort levels. The primary source of data that drive the assessment (total catches) is highly uncertain and should be investigated further as a priority. Click below for a full stock status summary: ○ Oceanic whitetip sharks – Appendix X ○ Scalloped hammerhead sharks – Appendix XI ○ Shortfin mako sharks – Appendix XII ○ Silky sharks– Appendix XIII ○ Bigeye thresher sharks– Appendix XIV ○ Pelagic thresher sharks– Appendix XV
Scalloped hammerhead shark *Sphyrna lewini*	Reported catch 2015: Not elsewhere included (nei) sharks[2]: Average reported catch 2011–2015: Not elsewhere included (nei) sharks[2]:	44 t 57,906t 72 t 49,969 t								
Shortfin mako *Isurus oxyrinchus*	Reported catch 2015: Not elsewhere included (nei) sharks[2]: Average reported catch 2011–2015: Not elsewhere included (nei) sharks[2]:	1,317 t 57,906t 1,456 t 49,969 t								
Silky shark *Carcharhinus falciformis*	Reported catch 2015: Not elsewhere included (nei) sharks[2]: Average reported catch 2011–2015: Not elsewhere included (nei) sharks[2]:	3,204 t 57,906t 3,702 t 49,969 t								
Bigeye thresher shark *Alopias superciliosus*	Reported catch 2015: Not elsewhere included (nei) sharks[2]: Average reported catch 2011–2015: Not elsewhere included (nei) sharks[2]:	0 t 57,906t 94 t 49,969 t								
Pelagic thresher shark *Alopias pelagicus*	Reported catch 2015: Not elsewhere included (nei) sharks[2]: Average reported catch 2011–2015: Not elsewhere included (nei) sharks[2]:	0 t 57,906t 69 t 49,969 t								

1. OPENING OF THE MEETING

1. The 13th Session of the Indian Ocean Tuna Commission's (IOTC) Working Party on Ecosystems and Bycatch (WPEB) was held in San Sebastian, Spain from 4 - 8 September 2017. A total of 39 participants (34 in 2016, 37 in 2015) attended the Session. The list of participants is provided in Appendix I. The meeting was opened by the Chairperson, Dr Rui Coelho from IPMA, EU-Portugal, who welcomed participants and formally opened the 13th Session of the IOTC Working Party on Ecosystems and Bycatch (WPEB13). The Chairperson also welcomed the Invited Expert for the meeting, Dr Felipe Carvalho (NOAA) and the stock assessment consultant Dr Joel Rice.

2. ADOPTION OF THE AGENDA AND ARRANGEMENTS FOR THE SESSION

2. The WPEB **ADOPTED** the Agenda provided in Appendix II. The documents presented to the WPEB are listed in Appendix III.

3. THE IOTC PROCESS: OUTCOMES, UPDATES AND PROGRESS

3.1 Outcomes of the 19th Session of the Scientific Committee

3. The WPEB **NOTED** paper IOTC–2017–WPEB13–03 which outlined the main outcomes of the 19th Session of the Scientific Committee (SC19) specifically related to the work of the WPEB and **AGREED** to consider how best to progress these issues at the present meeting.

Evaluation of the mitigation measures contained in Resolution 13/06 for Oceanic whitetip shark

*The SC **NOTED** that this Resolution implies a retention ban on oceanic whitetip sharks (Carcharhinus longimanus), with the exception of artisanal fisheries operating exclusively within their respective Exclusive Economic Zone (EEZ). Nevertheless, the SC **NOTED** that catches of oceanic whitetip sharks continue to be reported in the nominal catches for a number of fleets. There are a number of potential reasons for this such as (i) the reported catches are from artisanal fisheries operating in their EEZs; (ii) incorrect reporting as nominal catch rather than discards, (iii) a lack of awareness of the Resolution among fishers and (iv) non-compliance and enforcement issues.*

4. The WPEB **NOTED** the ongoing compliance issue for those CPCs reporting nominal catch of oceanic whitetip sharks and **RECOMMENDED** that the Scientific Committee request the Compliance Committee investigate these reported catches further and report the findings to the Commission.

Review of seabird mitigation measures in Resolution 12/06

***NOTING** the request from the IOTC Commission to analyse the impact of Resolution 12/06 on seabird catch no later than for the 2016 meeting the SC **ACKNOWLEDGED** that key aspects of the data call, notably those relating to data on the seabird bycatch mitigation measures, were in general not provided in sufficient detail. Therefore the SC **NOTED** that assessments of the actual performances of various combinations of mitigation measures could not be undertaken.*

*The SC also **NOTED** that the summary observer data provided through the data call is unlikely to be representative of the full suite of factors which potentially affect seabird bycatch rates.*

5. The WPEB **NOTED** that this work will be continued through the seabird component of the Common Oceans Tuna Project (progress described in paper IOTC-2017-WPEB13-39).

3.2 Outcomes of the 21st Session of the Commission

6. The WPEB **NOTED** paper IOTC–2017–WPEB13–04 which outlined the main outcomes of the 21st Session of the Commission, specifically related to the work of the WPEB and **AGREED** to consider how best to provide the Scientific Committee with the information it needs, in order to satisfy the Commission's requests, throughout the course of the current WPEB meeting.

7. The WPEB **NOTED** the 8 Conservation and Management Measures (CMMs) adopted at the 21st Session of the Commission (consisting of 8 Resolutions and 0 Recommendations) as listed below:

IOTC Resolutions

- Resolution 17/01 *On an interim plan for rebuilding the Indian Ocean yellowfin tuna stock in the IOTC Area of Competence*
- Resolution 17/02 *Working party on the implementation of Conservation and Management Measures (WPICMM).*
- Resolution 17/03 *On establishing a list of vessels presumed to have carried out illegal, unreported and unregulated fishing in the IOTC Area of competence.*
- Resolution 17/04 *On a ban on discards of Bigeye tuna, Skipjack tuna, Yellowfin tuna, and non-targeted species caught by purse seine vessels in the IOTC Area of Competence*
- Resolution 17/05 *On the conservation of sharks caught in association with fisheries managed by the IOTC.*
- Resolution 17/06 *On establishing a programme for transhipment by large-scale fishing vessels*
- Resolution 17/07 *On the prohibition to use large-scale driftnets in the IOTC Area*
- Resolution 17/08 *Procedures on a fish aggregating devices (FADs) management plan, including a limitation on the number of FADs, more detailed specifications of catch reporting from FAD sets, and the development of improved FAD designs to reduce the incidence of entanglement of non-target species*

8. The WPEB **NOTED** that these Conservation and Management Measures shall become binding on Members 120 days from the date of the notification communicated by the IOTC Secretariat in IOTC Circular 2017–061 (i.e. 3 October 2017)[1].

9. The WPEB **NOTED** that the Commission also made a number of general comments and requests regarding the recommendations made by the Scientific Committee in 2016, which have relevance for the WPEB (details as follows: paragraph numbers refer to the report of the Commission IOTC–2017–S21–R).

> *The Commission **CONSIDERED** the list of recommendations made by the SC19 in 2016 (IOTC–2016–SC19–R) that related specifically to the Commission. The Commission **ENDORSED** the list of recommendations as its own, while taking into account the range of issues outlined in this Report (IOTC-2017-S21-R) and incorporated within Conservation and Management Measures adopted during the Session and as adopted for implementation as detailed in the approved annual budget and Program of Work (para. 22).*
>
> ***Consideration of management measures related to ecosystems, bycatch and sharks***
>
> *The Commission noted Resolution 12/06 (On reducing the incidental bycatch of seabirds in longline fisheries), which called for an analysis of the impact of the measures on seabird bycatch by to be prepared by S20 (2016).*
>
> *The Commission acknowledged that there was little information available in 2016 for the SC to fully review the effectiveness of the mitigation measures outlined in Resolution 12/06, and **AGREED** to extend the due date until such a time that more information is available (para.140).*

10. The WPEB **NOTED** that the Commission **AGREED** to defer IOTC–2017–S21–PropC *On the conservation of Mobula and Manta rays caught in association with fisheries in the IOTC Area of competence* and **AGREED** to include rays in the revised Programme of Work for 2017.

11. The WPEB **AGREED** that any advice to the Commission would be provided in the Management Advice section of each stock status summary for the bycatch species detailed in the relevant species sections of this report.

[1] As per Article IX.4 of the IOTC Agreement

3.3 Review of Conservation and Management Measures relevant to Ecosystems and Bycatch

12. The WPEB **NOTED** paper IOTC–2017–WPEB13–05 which aimed to encourage participants to review some of the existing Conservation and Management Measures (CMM) relevant to ecosystems and bycatch, noting the CMMs contained in document IOTC–2017–WPEB13–04; and as necessary to 1) provide recommendations to the Scientific Committee on whether modifications may be required; and 2) recommend whether other CMMs may be required.

3.4 Progress on the recommendations of WPEB12

13. The WPEB **NOTED** paper IOTC–2017–WPEB13–06 which provided an update on the progress made in implementing the recommendations from the previous WPEB meeting, which were endorsed by the Scientific Committee, and **AGREED** to provide alternative recommendations for the consideration and potential endorsement by participants as appropriate given any progress.

14. The WPEB **RECALLED** that any recommendations developed during a Session, must be carefully constructed so that each contains the following elements:
    - a specific action to be undertaken (deliverable);
    - clear responsibility for the action to be undertaken (i.e. a specific CPC of the IOTC, the IOTC Secretariat, another subsidiary body of the Commission or the Commission itself);
    - a desired time frame for delivery of the action (i.e. by the next working party meeting, or other date);
    - if appropriate an approximate budget for the activity, so that the IOTC Secretariat may be able to use it as a starting point for developing a proposal for the Commission's consideration.

15. The WPEB **REQUESTED** that the IOTC Secretariat continue to prepare a paper on the progress of the recommendations arising from the previous WPEB, incorporating the final recommendations adopted by the Scientific Committee and endorsed by the Commission, as well as any updates and requests.

3.4.1 Marine mammal guides

16. The WPEB **NOTED** that development of the marine mammal identification guides is underway. A set of illustrations have been sourced and a consultant is currently working to develop a plan for the species identification guides.

17. The WPEB **THANKED** the Marine Mammal Commission (MMC) for their involvement and support for the printing and translation of the ID guides.

18. The WPEB **AGREED** on the priority languages for translation of the marine mammal identification guides:
    Species names: Japanese, Chinese (Mandarin and Taiwanese), French and Spanish
    Entire booklet: French, Spanish, Persian, Urdu, Sinhalese and Tamil, Hindi, Bahasa Indonesian, Arabic and Swahili

3.4.2 Shark tagging project

19. The WPEB **NOTED** the working group that took place in the margins to further develop the project plan for the tagging of sharks with a no-retention policy (IOTC-2015-WPEB11-INF11 Rev_1). This project will be undertaken alongside the EU-DCF (Data Collection Framework) tagging project and the two will cover the key industrial longline and purse seine fleets catching oceanic whitetip and bigeye thresher sharks.

20. The WPEB **NOTED** the post-release mortality shark tagging project currently underway in the Pacific Ocean (IOTC-2017-WPEB12-INF17).

21. The WPEB **REQUESTED** that an update on project progress is provided at the WPEB14 meeting in 2018.

3.4.3 Longline hook identification guide

22. The WPEB **RECALLED** the *"The WPEB ENCOURAGED all participants to bring examples of the types of hooks used by their domestic longline fisheries to the next WPEB to begin the process of collecting terminal gear information". (IOTC-2016-WPEB12-R, para. 20)*

23. The WPEB **THANKED** the two participants that brought examples of hooks from their fisheries and **REQUESTED** other fleets to send photographs of hooks used in their fleets to the IOTC Secretariat to collate.

24. **NOTING** the continued confusion in the terminology of various hook types being used in IOTC fisheries, (e.g. tuna hook vs. J-hook; definition of a circle hook), the WPEB **REITERATED** its previous **RECOMMENDATIONS** (2013, 2014 and 2016) and the **RECOMMENDATION** from SC19 (SC19.16; para. 55 of IOTC-2016-SC19-R) that the Commission allocate funds in the 2018 IOTC Budget to develop an identification guide for fishing hooks and pelagic fishing gears used in IOTC fisheries.

4. REVIEW OF DATA AVAILABLE ON ECOSYSTEMS AND BYCATCH

4.1 Review of the statistical data available for ecosystems and bycatch species

4.1.1 IOTC database

25. The WPEB **NOTED** paper IOTC–2017–WPEB13–07 which provided an overview of the data received by the IOTC Secretariat for bycatch species, in accordance with IOTC Resolution 15/02 *Mandatory statistical reporting requirements for IOTC Contracting Parties and Cooperating Non-Contracting Parties (CPCs)*, for the period 1950–2015. A summary for sharks is provided in Appendix IV.

26. The WPEB **RECALLED** that presenting data at a working party meeting does not constitute a formal submission to the IOTC Secretariat and **URGED** all CPCs to submit data to the IOTC Secretariat formally as required according to IOTC reporting procedures based on the requested fisheries statistics and data submission forms that can be found on the IOTC website: www.iotc.org/data/requested-statistics-and-submission-forms.

27. The WPEB **NOTED** that information on the status of discards (dead/alive) is rarely provided and **REQUESTED** CPCs to record and report this information through their observer programmes.

28. **NOTING** the highly aggregated nature of information requested on discards, the WPEB **RECOMMENDED** that the discard reporting form (Form 1DI) is updated to include seasonal (month) and spatial information (5 x 5 or 1 x 1) in a similar format to the catch and effort data reporting forms.

29. The WPEB **NOTED** the large proportion of reported shark catches that have not been identified to species level (~50%) and the issues this poses when using species-specific catch series for assessments.

30. The WPEB further **NOTED** the large proportion of blue shark catches by the Indonesian fleet and the sharp increase in catches in recent years which may reflect actual change in catches or may be due to improved reporting over time.

31. The WPEB **NOTED** that the IOTC nominal catches comprise only retained catches. While the reporting of discarded blue sharks is currently very low, this is increasing with improved reporting and so the WPEB **REQUESTED** that these discarded catches are made available for use in the next stock assessment so that total catches (rather than simply retained catches) may be used.

4.2 Regional observer scheme – Update (Resolution 11/04 On a regional observer scheme)

32. The WPEB **NOTED** paper IOTC–2017–WPEB13–08 which provided an update on the national implementation of the IOTC regional observer scheme (ROS) for each IOTC CPC and the development of the pilot scheme.

33. **RECALLING** that the target observer coverage is 5% of all fishing operations, the WPEB **NOTED** that a small number of CPCs have met or exceeded this level in recent years. Although in future it may be possible to meet the observer requirements with a mixture of self-sampling, electronic monitoring and human observers, the current requirement is still currently 5% onboard human observer coverage (Resolution 11/04) and so these methods are considered complementary sources of information.

Pilot projects under Resolution 16/04

34. The WPEB **NOTED** progress with the ROS pilot project and the countries that have volunteered to be involved in the pilot (Iran, Sri Lanka and Tanzania). A workshop for representative of regional observer programmes and other interested parties will meet in early 2018 to review the observer standards and training package.

35. The WPEB **NOTED** the progress made in completing the development of the regional observer database and electronic reporting tool which is now undergoing trials by voluntary CPCs.

36. **NOTING** the increasing number of CPCS that are now submitting observer data in electronic format, the WPEB **RECOMMENDED** the next revision of Resolution 11/04 should consider including the requirement for all observer data to be submitted in an electronically readable format (including historic data).

5. REVIEW OF NATIONAL BYCATCH ISSUES IN IOTC MANAGED FISHERIES AND NATIONAL PLANS OF ACTION (SHARKS; SEABIRDS; MARINE TURTLES)

5.1 Review of applications for 'not applicable' NPOA status

37. The WPEB **RECALLED** that the IPOA-SHARKS is a voluntary instrument that applies to all States engaged in shark fisheries. The text sets out a set of activities which implementing States are expected to carry out, including an assessment of whether a problem exists with respect to sharks, adopting a National Plan of Action for the conservation and management of sharks (NPOA-SHARKS), as well as procedures for national reviews and reporting requirements. The calendar years by when these actions preferably should have been taken are indicated.

38. The WPEB **RECALLED** that the IPOA-SEABIRDS is a voluntary instrument that applies to all States engaged in fisheries. The text sets out a set of activities which implementing States are expected to carry out, including an assessment of whether a problem exists with respect to the incidental catch of seabirds in its longline fishery, adopting a National Plan of Action for reducing the incidental catch of seabirds in longline fisheries (NPOA-SEABIRDS) as well as procedures for national reviews and reporting requirements. The calendar years by when these actions preferably should have been taken are indicated.

39. The WPEB **NOTED** the process for assessing the need for an NPOA by CPCs, as adopted by the SC in 2014, detailed in Appendix VII of the SC17 Report. All CPCs are required to follow that process when requesting the IOTC Secretariat to apply a status of 'Not applicable (n.a.)' for an NPOA, in the 'Table of progress in implementing NPOA-sharks, NPOA-seabirds and the FAO guidelines to reduce sea turtle mortality in fishing operations'.

5.1.1 NPOA implementation overview

40. The WPEB **NOTED** paper IOTC–2017–WPEB13–09 which provided an update on the current status of development and implementation of National Plans of Action for seabirds and sharks, and implementation of the FAO guidelines to reduce marine turtle mortality in fishing operations, by IOTC CPCs.

41. The WPEB **NOTED** that no requests were received by the IOTC Secretariat since the last SC meeting to apply a status of 'Not applicable (n.a.)' for an NPOA, in the 'Table of progress in implementing NPOA-sharks, NPOA-seabirds and the FAO guidelines to reduce sea turtle mortality in fishing operations'. The Scientific Committee recently revoked two statuses of 'not applicable' due to insufficient evidence provided, so the WPEB **REQUESTED** CPCs to continue to review their status periodically and either update this or provide additional supporting information as necessary.

42. The WPEB **REQUESTED** that all CPCs without an NPOA-Sharks and/or NPOA-Seabirds expedite the development and implementation of a NPOA, and to report progress to the WPEB and SC in 2017, **NOTING** that NPOAs are a framework that should facilitate estimation of shark catches, seabird interactions, and development and implementation of appropriate management measures, which should also enhance the collection of bycatch data and compliance with IOTC Resolutions.

43. The WPEB **REQUESTED** that the IOTC Secretariat continue to periodically revise the table summarising progress towards the development of NPOA-Sharks, NPOA-Seabirds, and the implementation of the FAO guidelines to reduce marine turtle mortality in fishing operations, with information provided by each CPC for the consideration at the WPEB and SC meetings. The current status is provided in Appendix VIII.

5.1.2 NPOA IOTC website portal

44. The WPEB **NOTED** that the NPOA portal on the IOTC website (http://iotc.org/science/status-of-national-plans-of-action-and-fao-guidelines) provides details of the most recent updated table of progress in implementing NPOA-Sharks, NPOA-Seabirds and the FAO Guidelines to Reduce Sea Turtle Mortality in Fishing Operations. It also provides other information in support of CPCs

wishing to develop their own NPOAs, such as the guidelines and NPOA documents from all CPCs who have submitted their NPOAs.

6. NEW INFORMATION ON BIOLOGY, ECOLOGY, FISHERIES AND ENVIRONMENTAL DATA RELATING TO ECOSYSTEMS AND BYCATCH SPECIES

6.1 Review new information on environment and ecosystem interactions and modelling, including climate change issues affecting pelagic ecosystems in the IOTC area of responsibility

6.1.1 Madagascar shark fisheries

45. The WPEB **NOTED** paper IOTC–2017–WPEB13–11 which provided an update on shark catches by the national longline fleet of Madagascar, including the following abstract provided by the authors:

“*The national fleet consists of longline vessels less than 24 meters operating in the eastern part of Madagascar. Their number varied from 6 to 8 from 2010 to 2013 but the following three years, it has remained at 7 vessels. They deploy 800 to 1300 hooks per set and do short cruises of 4 to 7 days to maintain their catch fresh. Tuna and swordfish are the main targeted species but they also catch some billfish species and sharks. This paper contains update on the previous document concerning the shark catch characteristics by national fleets in Madagascar. In addition to the evolution of shark catch by these vessels in recent years (from 2010 to 2016), some weight distribution data are presented in this paper. The data have been collected from the catch declarations by the fishing companies and from sampling at the port of landing. The total fish catch of the longline vessels is estimated at 2878 tons from 2010 to 2016 with an average of 411 tons per year. The largest proportion of catches is primarily constituted by the tunas (49%), then billfish (19%). Sharks represented 12% of the catches. Generally, the trend of total catch is decreasing since 2010, the same for sharks from 85 tons in 2010 to 36 tons in 2016. Principally, more than three shark species have been caught in the Malagasy waters by the longline vessels but since 2013, the shark catch data declared in the logbooks only concern blue shark.”*

46. The WPEB **NOTED** that blue shark and shortfin mako represent 61% and 32% of shark catches respectively. The WPEB **ENCOURAGED** Madagascar to collect shark data in length (FL) rather than in wet weight.

47. The WPEB also **NOTED** that while a high percentage of sharks are reported as species aggregates, scientists from Madagascar are working with IRD to improve species identification at the sampling sites. The IOTC guide to pelagic shark identification could also be used to facilitate the work of the samplers.

48. The WPEB also **NOTED** that an observer programme is implemented in the longline fleet of Madagascar, achieving ~ 25% coverage. The WPEB **ENCOURAGED** Madagascar to maintain the observer program even though this is not mandatory for IOTC vessels <24 m LOA operating inside the EEZ.

49. The WPEB **NOTED** that the cross validation of data from logbook, observers and port sampling is complicated by poor coordination of various authorities involved in fisheries regulation and monitoring.

6.1.2 Bycatch in Iranian tuna fisheries

50. The WPEB **NOTED** paper IOTC–2017–WPEB13–12 which provided a summary of the catch of target and by-catch species in Iranian tuna fisheries, including the following abstract provided by the authors:

“In order to assess the level of Iranian tuna fishing vessels By-catch in the IOTC area of competence in 2016, tuna fisheries data which are collected through the Iran Fishery Organization data Collection system are used. Base on the information, about 30 different species of Tuna, Tuna-like and some others are caught by Iranian fishermen through the Tuna fishing activities. Base on the information in total, 250359 tons of different species including, 217675 tons Tuna and Tuna-like species, 14825 tons Billfish, 4797 tons of Sharks and 13062 tons the other species, are caught by Iranian fishing vessels in the IOTC competence of area. According to IOTC list, 92.9% of Iran catch has belonged to target species (16 species covered by IOTC agreement) and only 7.1% of catch has belonged to non-target species, in the 2016.

According to 2016 information, non target species which are caught as by-catch (7.1%) included 1.9% different species of sharks with and some other species with 5.2% in compare with total catch. The vessels CPUE was calculated, base on different gears catch per day (Vessel Catch/Day). According to our estimation, Purse Seiners CPUE is calculated 4191.6 Kg/D, Trolling (Boats) 17.8 Kg/D and gillnetters 321.4 Kg/D. Also the amount of Sharks CPUE was calculated 6.5 Kg/D for gill nets, while there are no reports for other gears".

51. The WPEB **NOTED** that 1810 t of whale shark was reported in the National Statistical Report as bycatch in the Iranian fisheries and requested the authors to clarify this point as this would imply a large number of individual whale sharks caught by the gillnets (e.g. around 100 assuming an individual average weight of ~18 t). The WPEB **NOTED** that it is difficult to estimate the weight of whale sharks and **REQUESTED** the authors report on the bycatch of whale shark by numbers with estimated lengths. After adoption, the authors provided a revised paper (IOTC–2017–WPEB13–12 Rev_1) clarifying that the 1810 t of milk shark (RHA) rather than whale shark (RHN) were caught by the Iranian fleet in 2016.

52. The WPEB also **NOTED** that whale shark interactions, including the fate, are not currently reported through IOTC discard reporting forms, but that fishers make efforts to release incidentally caught whale sharks alive. The WPEB **REQUESTED** that information of the fate of whale shark once released from gillnets is collected and reported to the next WPEB and through the IOTC discard reporting forms.

53. The WPEB further **NOTED** that interactions between gillnet and cetaceans are considered common, based on various papers provided during the current WPEB, but that there are no records of cetacean interactions for the gillnet fleets.

54. The WPEB **NOTED** that a VMS pilot project has recently begun through the use of Thuraya satellite on 10 vessels and this will be extended to the entire offshore fleet.

55. The WPEB **ACKNOWLEDGED** the information provided on the gillnet fishery of I.R.Iran and **ENCOURAGED** the other IOTC CPCs which have gillnet fisheries to present their national data related to ecosystem and bycatch interactions at future meetings.

56. The WPEB **NOTED** paper IOTC–2017–WPEB13–13 which provided estimates of the historical catch of shark species from the Indian Ocean by Iranian fishermen, including the following abstract provided by the authors:

"While sharks are valuable species in any ecosystems with significance importance for marine biologist and ecologist, but their historical data have not registered by species in Iran and there is only limited information about their total catch. This study has tried to introduce an estimation about total sharks catch by Iranian fishermen since 1950, while the recorded sharks catches only are available since 1992 and there is limited information about sharks catch by species. According to available Iran observer reports, most of the sharks are caught in first 30 m depth of the Persian Gulf and Oman Sea as by-catch. Base on available information around 53 species of sharks belong to 10 families, are landing in Iranian fishing harbors where some of them are very rare. Base on available information, Iran total catch including sharks, are recorded separately during 1992-2016. Sharks catch have allocated a distinguished and almost stable quantity and proportion of Iran total catch during the recorded years which it calculated 2.6% in average." (see paper for full abstract)

57. The WPEB **THANKED** the author for the data-mining efforts to provide historic catch estimates for sharks in I.R.Iran given that this is an important issue for WPEB given the sparse nature of shark data in early years in the IOTC database.

58. The WPEB **NOTED** that the Iranian fishery has been relatively stable in terms of fishing practices and gears and so this enabled the authors to develop catch estimates for historic years based on recent catch rates of sharks to target species.

59. The WPEB **NOTED** that the Iranian historic shark catch estimation is not disaggregated to the species level and **REQUESTED** that the authors consider if it would be possible to produce estimates that are disaggregated by species. Nevertheless, the WPEB **NOTED** that this may be difficult due to a lack of sufficient data.

6.1.3 Management of shark fisheries: South Africa

60. The WPEB **NOTED** paper IOTC–2017–WPEB13–14 which described the status and management of shark fisheries in South Africa, including the following abstract provided by the authors:

"In South Africa's diverse fishery sectors, which include artisanal as well as highly industrialised fisheries, 99 (49%) of 204 chondrichthyan species that occur in southern Africa are targeted regularly or taken as bycatch. Total reported dressed catch for 2010, 2011 and 2012 was estimated to be 3 375 t, 3 241 t and 2 527 t, respectively. Two-thirds of the reported catch was bycatch. Regulations aimed at limiting chondrichthyan catches, coupled with species-specific permit conditions, currently exist in the following fisheries: demersal shark longline, pelagic longline, recreational line, and beach-seine and gillnet. Limited management measures are currently in place for chondrichthyans captured in other South African fisheries. Catch and effort data series suitable for stock assessments exist for fewer than 10 species. Stock assessments have been attempted for five shark species: soupfin Galeorhinus galeus, smoothhound Mustelus mustelus, white Carcharodon carcharias, spotted ragged-tooth Carcharias taurus, and spotted gully Triakis megalopterus. Fishery-independent surveys and fishery observer data, which can be used as a measure of relative abundance, exist for 67 species." (see paper for full abstract)

61. The WPEB **ACKNOWLEDGED** the information on the development of the South African National Plan of Action for sharks adopted in 2013.

62. The WPEB **NOTED** that a wide range of data (fishery dependent statistics as well as biological samples) are collected in South Africa from the shark fisheries; sample sizes are dependent on the determined importance of the species, the type of fisheries and goals of the scientific study taking place.

63. The WPEB **NOTED** that shark finning is prohibited and that a fin-attached policy is being discussed with stakeholders, following the precedent set by tRFMOs.

64. The WPEB **NOTED** that despite the implementation of retention bans for a number of species, there has not been a substantial decline in total shark catches since these were only imposed for species for which the catches were already very low (<10 t).

6.1.4 Bycatch of IOTC species: Thailand

65. The WPEB **NOTED** paper IOTC–2017–WPEB13–15 which described the by-catch in tuna longline and coastal purse seine fisheries in Thailand, including the following abstract provided by the authors:

"*This paper summarizes bycatch landing in Thailand from both IOTC area and the coastal water under Thailand jurisdiction where neritic tunas have been caught. The bycatch from IOTC area were mainly from foreign fishing vessels landing in Phuket ports of the last 15 years, during 2001-2016. The catch trend and bycatch composition during this period have been figured. For the coastal fisheries in the area under Thailand jurisdiction, the bycatch were from purse seines which this gear mainly target the coastal pelagic fish including neritic tunas. Sharks and rays bycatch from this fishery was explored and explained. So, the information included in this paper will give an overview of the bycatch situation in Thailand relating to the IOTC species, particularly on sharks and rays. The relevant information, existing actions or inactions, as well as obstacles of accommodation of the sharks' issues are also included. Lastly, the paper concludes with the information on the development of the NPOA-sharks that crucially reflects the engagement of Thailand in the international agenda on shark conservation."*

66. The WPEB **NOTED** that Thailand has collected data from foreign longliners at landing sites in the past and that the sampling of frozen fish has led to problems in identification at the species level. The WPEB also **NOTED** that Thailand has not sampled foreign longline vessels at the point of landing since 2012 and so recent information available is instead based on customs declarations.

67. The WPEB **NOTED** that whileThailand currently has no observer programme in place, 8 observers have been trained and there are plans to deploy them on-board vessels fishing operating on the high seas once those vessels become active again.

68. The WPEB also **NOTED** that all shark bycatch is retained and landed for domestic markets and that no discarding of sharks takes place.

6.1.5 Habitat model: skipjack

69. The WPEB **NOTED** paper IOTC–2017–WPEB13–16 which described the relationship between the location of purse seine skipjack catches and preferred feeding habitat, including the following abstract provided by the authors:

"A single Ecological Niche model was developed for skipjack tuna (SKJ) in the Eastern Central Atlantic Ocean (AO) and Western Indian Ocean (IO) using data from the European purse seine fleet. Chlorophyll-a fronts were used as proxy for food availability while selected physical variables defined the abiotic preferences. SKJ feeding habitat spanned from latitudinal occurrence of eddy-type productive features at mesoscale in the IO to large-scale upwelling systems that seasonally shrink and swell in the AO. About 83% of FSC sets and 75% of dFAD sets were done within 25 km distance of preferred habitat while, in the AO, 34% of dFAD sets occurred at distances greater than 100 km, mostly in the relatively food-poor Guinea Current, which is questioned to correspond to a spawning and larvae favourable area. Results emphasized higher SKJ accessibility to purse seiners in months when the habitat is reduced" (see paper for full abstract)

70. The WPEB **NOTED** that the opportunistic nature of skipjack tuna predation, high energetic requirements of individual fish and migratory nature means there is high plasticity in habitat use and so this study identifies 'preferred' or 'optimal' feeding habitats.

6.1.6 Comparison of E-monitoring and observer data: non-target species and discards

71. The WPEB **NOTED** paper IOTC–2017–WPEB13–17 which compared estimates of non-target species and discards based on electronic monitoring and observer data from the same trips, including the following abstract provided by the author:

"Electronic monitoring system (EMS) was recently implemented on French tropical tuna purse seiners to complement the current observer program and to increase observer coverage both in the Indian and Atlantic Oceans. The main objective was to test the efficiency and the potential of the EM system compared to regular observer programs. Trips involving both EMS and on-board observers were conducted over 2015-2016. In this study, we analyzed non-target species and discard data from six trips and compared EMS to observer estimations using generalized linear models (GLMs). Good matches between both methods were observed for tuna discards, including for skipjack and for the bigeye/yellowfin discard group. However divergences between estimations and methods were noted for non-target catch and the difference appeared to depend on the species. For species with high occurrence such as triggerfish and mackerel scad which are systematically discarded, EMS provided similar estimates as on-board observation. EMS could actually be more efficient than observers to describe the discarded volume of these species as it allows exhaustive counts on the discard belt. However, for larger species such as sharks and billfishes or for high commercial value species such as dolphinfish, EMS systematically underestimated occurrence and discards volume compared to observers." (see paper for full abstract)

72. The WPEB **NOTED** that EMS can provide important information to complement human observer-based sampling programs.

73. The WPEB **NOTED** the differences between the results obtained by EMS and human observers that may be related to discard handling practices and location of observers (usually at lower deck) and cameras (accurate data for the upper deck). The WPEB also **NOTED** that this difference might be specific to certain fleets/vessels so it may be important to consider fish handling practices and vessel particularities.

74. The WPEB **NOTED** that the paper recommended the installation of five cameras on-board purse seine vessels, however, for tropical tuna purse seiners, six cameras could be more suitable for covering all catch handling areas and activities from the set. The view of the crow-nest camera should include starboard side and bycatch release operation.

75. The WPEB **NOTED** the increasing use of EMS to collect fisheries data, especially noticeable in the purse seine fleet and the positive outcomes of comparisons between human data collection and EMS data and their utility for estimating catch and bycatch.

76. **NOTING** that the development of minimum standards for EMS is currently part of the ROS Pilot Project as requested by the SC (IOTC-2016-SC19-R, para.164), the WPEB **REQUESTED** that the

WPDCS consider also establishing standards for incorporating EMS data into the IOTC database. The WPEB **REQUESTED** document(s) be submitted to WPDCS from CPCs specifying the current data elements recorded in the EMS systems currently employed in the Indian Ocean and other Oceans, as appropriate, and that the Secretariat consult with the other t-RFMO Secretariats and report to WPDCS upon progress being made in this regard.

6.1.7 Spanish Best Practices Program

77. The WPEB **NOTED** paper IOTC–2017–WPEB13–42 which reports on the results of the first two years of implementation of a code of fishing practice on the Spanish purse seine fishery using non-entangling FADs, including the following abstract provided by the author:

"Since 2012, Spanish tuna freezer organizations OPAGAC and ANABAC have a voluntary self-regulated code for responsible tuna fishing. The code promotes best fishing practices by reducing mortality of incidental catch of sensitive species (sharks, rays, mantas, whale sharks, and sea turtles) and the use of non-entangling FADs. In addition to that, the agreement is based on the following points: 100% observer coverage, continuous training of fishing crew and scientific observers, implementation of a FAD logbook, creation of a Steering Committee and continuous monitoring and data analysis by the independent scientific body AZTI. In order to monitor and assess the level of compliance of these good practices, a system of monitoring and verification has being implemented since late 2014, and is continuously evaluated. The verification is based on specifically designed data-collection forms and in-situ observations recorded by trained scientific observers, and more recently, also by electronic monitoring. Significant results of the first two years of the Code of conduct are presented and discussed in this document." (see paper for full abstract)

78. The WPEB **NOTED** the data on the use of non-entangling FADs and the application of best practices for safe release of FAD-associated fauna in the Indian Ocean and **AGREED** that this information is useful in the review of Resolution 12/04 on the Conservation of Marine Turtles.

79. The WPEB **ENCOURAGED** the authors to continue their research on non-entangling FADs use and bycatch handling practice.

6.1.8 Ecosystem report card

80. The WPEB NOTED paper IOTC–2017–WPEB13–INF05 on the selection of ecosystem indicators for fisheries targeting highly migratory species, including the following abstract provided by the author:

"Several international instruments have set the minimum standards and key principles to guide the implementation of an ecosystem approach for the management and conservation of marine living resources. While the IOTC Convention Agreement does not make reference to the principles of the precautionary or ecosystem approach, since its creation it has had the ability to assimilate these principles in the form of adoption of formal management measures. Yet these management measures have not provided practical guidance on how to make operational an Ecosystem Approach to Fisheries Management (EAFM) within IOTC. The Specific Contract N0 2 under the Framework Contract EASME/EMFF/2016/008 provisions of Scientific Advice for Fisheries Beyond EU Waters addresses the current impediments and provides solutions that shall support the implementation of an EAFM through collaboration and consultation with the key tuna RFMOs". (See paper for full abstract)

81. The WPEB **NOTED** that the ecosystem report card case study results will be available next year and **ENCOURAGED** the authors to provide another update on the work at the next WPEB.

82. The WPEB **NOTED** the issues with data availability and the data mining that will be undertaken as part of this study and **REQUESTED** the authors provide specific recommendations about where new data collection initiatives may be required when key gaps are identified through the project.

6.1.9 Biodegradable materials in FAD construction

83. The WPEB **WELCOMED** the presentations of ongoing work related to development of biodegradable FADs as a method to further reduce environmental impacts of this gear, which is documented in IOTC–2017–WPEB13–INF12 and IOTC-2017-WPEB13-INF13, including the following abstracts provided by the authors:

"The present study summarizes the results of a project to test biodegradable ropes, to be used at FADs, in a controlled environment. Three types of biodegradable ropes were tested following their

evolution for one year at sea: (i) twisted 100 % cotton rope; (ii) twisted 50% cotton and 50% sisal rope; and (iii) cotton, sisal and linen rope with loops. Samples were deployed in June 2016 in 2 different sites simultaneously, in offshore waters attached to a mooring rope, simulating a FAD in oceanic waters and in a shallow lagoon close to the reef in Maniyafushi island, simulating the arrival of a FAD to the coast. Results show different robustness of the ropes, being the strongest the one made of sisal and cotton. Other considerations for the successful use of biodegradable ropes at FADs are discussed." [IOTC–2017–WPEB13–INF12]

"The present study summarizes the results of a pilot project to test biodegradable ropes at FADs in real fishing conditions. One of the difficulties when testing experimental FADs in purse seine fishery is that fishers fish on any FAD found at sea, so that FADs change hands very often making difficult to revisit experimental FADs to collect data and get significant results. The main objective of the pilot was learning from this experience to develop a large-scale deployment of biodegradable FADs at sea, by detecting potential difficulties and issues related mainly to effective data gathering on FADs under test. In order to compare the performance of biodegradable and non-biodegradable FADs, International Seafood Sustainability Foundation (ISSF) deployed in collaboration with 6 purse seiners from INPESCA fleet in Western Indian Ocean, a total of 174 FADs, 89 non-biodegradable and 85 biodegradable. Two different FAD designs were tested working at different depths (10m, 30m, 50m and 70 m). A total of 74.913 biomass samples were collected using echo-sounder buoys attached to those FADs. Our results show similar aggregative patterns of fish (tuna and non-tuna species) for non-biodegradable and biodegradable FADs. Life-time of FADs and implications of our results for future experiments are discussed". [IOTC-2017-WPEB13-INF13]

84. The WPEB **ACKNOWLEDGED** the activity under taken by ISSF and partners is important to minimize the environment footprint of FAD fishing and **ENCOURAGED** further, large scale testing of biodegradable FADs in the Indian Ocean. The large scale experiment in real conditions with the collaboration of the whole Purse seiner fleet will assure tracking the experimental BIOFAD during its lifetime (i.e. follow the BIOFAD when buoy of the BIOFAD is changed by other vessel).

85. The WPEB **DISCUSSED** some of the challenges in conducting these studies in view of the limitations on the number of FADs active per purse seine vessel in the Indian Ocean. For example, the limit of active number of FADs at sea in the Indian Ocean hinders the deployment of BIOFAD following experimental sampling designs and the engagement of the fleet to deploy them as they might not be successful for fishing. Thus, WPEB **RECOMMENDED** the Commission consider special allocations for experimental FADs deployed for scientific data collection for vessels willing to participate in biodegradable FAD testing under experimental protocols reviewed and endorsed by the Scientific Committee.

7. GILLNET FISHERIES: PROBLEMS AND NEEDS

7.1 Regional review of the data available for gillnet fleets operating in the Indian Ocean

86. The WPEB **NOTED** paper IOTC–2017–WPEB13–18 which describes the tuna gillnet capacity and bycatch in the IOTC Convention area, including the following abstract provided by the authors:

    "Fisheries in the Indian Ocean are dominated by artisanal activities. Most of the coastal developing nations bordering the Indian Ocean rely on artisanal fisheries for the provision of food and income. The dominance of artisanal fleets in the region brings about, however, large uncertainty in data collection. The need to assess the extent of gillnet fisheries has been remarked by the IOTC WPEB, which has recommended to freeze or reduce gillnet fishing capacity and effort until sufficient information is available to assess the impact of this fishing modality on target and non-target resources. The present study aims at describing and analysing the situation of fishing capacity and bycatch of gillnet fisheries in the IOTC area of competence. It conducts a comprehensive revision of the scientific and technical literature, the IOTC reports of the scientific and compliance committees, national reports, Conservation and Management Measures (CMM) and statistical data on nominal catches and available data on fishing capacity." (see paper for full abstract)

87. The WPEB **NOTED** that marine mammal entanglements have been observed in the coastal tuna gillnet fisheries of countries such as Madagascar and Tanzania. These vessels are not registered on the IOTC Active Vessel List as they are generally small (<24m) operating gillnets within the EEZ and use with small mesh sizes.

88. The WPEB **NOTED** that any active vessels registered in the IOTC record of authorised vessels must be monitored and controlled by the member countries who must report their catch and activities according to IOTC resolutions.

89. The WPEB **NOTED** abstract IOTC–2017–WPEB13–19 describing the use of subsurface gillnets to reduce bycatch of cetaceans and marine turtles:

"Pakistan has a large tuna gillnet fleet that operates in coastal waters, Exclusive Economic Zone as well as in the Area Beyond National Jurisdiction. Gillnet being used for catching tuna and tuna like species is generally about more than 7 km and is known for extremely high bycatch including turtles, whales, dolphins, whale sharks, mobulids, requiem sharks and sunfish. In order to reduce entanglement of megafauna, pilot scale alternate gears are being introduced but conversion of fleet to any such change will take many years before it is fully adopted by fishermen. WWF-Pakistan, therefore, has convinced the tuna gillnet fishermen to use subsurface gillnetting (placing gillnet about 1.5 to 1.8 m below surface) which requires only minor modification in the fishing operation. Such subsurface gillnets (locally known as "tilo mahore") were used by fishermen in Balochistan a few decades back if they intended to target yellowfin tuna. Through WWF-Pakistan''s crew based observer programme, this modification was readily accepted by fishermen. Since the start of modification in August 2014, about 63 % of the fishermen have fully changed their fishing operation through subsurface gears whereas about 27 % have changed about 60 % of their nets into subsurface type whereas remaining part of the net is still deployed on surface. About 6 % of fleets have only 40 % subsurface and 60 % surface gillnets whereas only about 4 % have not changed their mode of operation". (see document for full abstract)

90. The WPEB **NOTED** that the results of the study exploring potential bycatch mitigation measures based on simple gear setting techniques are potentially very promising and **REQUESTED** the authors submit a paper detailing the full results next year so that the work can be fully reviewed by the WPEB.

91. The WPEB **NOTED** that developing new sources of data collection, such as through self-reporting schemes such as this, is very important and **ENCOURAGED** WWF-Pakistan to explore methods of validating the information collected.

8. BLUE SHARK

8.1 Review new information on blue shark biology, stock structure, bycatch mitigation measures, fisheries and associated environmental data

8.1.1 Growth of blue sharks

92. The WPEB **NOTED** paper IOTC–2017–WPEB13–20 which describes the growth of blue shark in the Indian Ocean, based on band counts from sectioned vertebrae, including the following abstract provided by the authors:

"The blue shark, Prionace glauca, is frequently caught in pelagic fisheries, being the most captured shark by the Portuguese pelagic longline fishery in the Indian Ocean. The biology of blue sharks has been extensively studied in the Atlantic and Pacific oceans. However, high levels of uncertainty still persist regarding many of its biologic aspects in the Indian Ocean region, specifically in terms of age estimation and growth modelling. A total of 818 vertebral samples were collected from blue sharks between March 2013 and September 2016, with sizes ranging from 82 to 301 cm fork length (FL). The age of individuals was estimated through counting growth band pairs in sectioned vertebrae. Two growth models were fitted to the age data, a three-parameter von Bertalanffy growth function (VBGF) re-parameterized to calculate L_0 (size at birth) and a two- parameter VBGF with a fixed L_0. The latter was the most adequate to describe the growth of the species, with the estimated parameters being L_{inf} = 272.2 cm FL, k = 0.15 year^{-1} for males and L_{inf} = 283.2 cm FL, k = 0.13 year^{-1} for females. The maximum age estimated was 25 years, this being the highest attributed age to this species so far. Further work is needed regarding blue sharks in the Indian Ocean, but this study adds important life-history information that can contribute for the management and conservation of the species."

93. The WPEB **NOTED** the new ageing study to describe the growth of blue sharks in the Indian Ocean and **AGREED** that the key growth parameters (maximum observed age, k and L_∞) should be used in the current Indian Ocean blue shark stock assessment.

94. The WPEB **NOTED** paper IOTC–2017–WPEB13–21 Rev_1 which estimated population dynamics parameters using a Leslie matrix model with Indian Ocean specific biological parameters, including the following abstract provided by the authors:

"The study conducted demographic analysis to estimate population growth rate and steepness of stock-recruitment relationship by Leslie matrix method for the Indian Ocean blue shark (Prionace glauca). Monte Carlo simulation was used to integrate uncertainty of biological information. The results indicated that blue shark productivity was high, with the intrinsic rate of increase γ=0.25-0.33 y^{-1} based on a one-year reproductive cycle (RC) assumption; However, the productivity was lower, with γ=0.19-0.20 y^{-1}based on a two-year RC assumption. The steepness of Beverton-Holt stock-recruitment model was estimated to be 0.76-0.81 in most scenarios, except for one scenario (steepness was 0.85) in which constant natural mortality at age was assumed."

95. The WPEB **NOTED** that M was estimated using five different empirical estimation methods, only two of which were age-specific.

96. The WPEB **AGREED** that the estimate of steepness determined in the study (0.79), based on a one-year reproductive cycle and updated age and growth information from the previous paper would be used in the updated stock synthesis assessment model run. The one-year reproductive cycle was chosen as being more consistent with current knowledge of the reproduction biology of the species.

8.1.2 Catch reconstruction for Indian Ocean blue shark

97. The WPEB **NOTED** paper IOTC–2017–WPEB13–22 which presented a catch history for Indian Ocean blue shark from 1971 determined using the ratio of sharks to main species catches, including the following abstract provided by the authors:

"The reconstruction of shark catch time series is particularly important for stock assessments, as the nominal catch data on sharks is usually very limited and a major source of uncertainty. This document provides an alternative hypothesis for the reconstruction of shark catches in the Indian Ocean (IOTC fisheries) based on a method developed for the EUPOA-Sharks (EU Plan of Action for Sharks). The estimation method is based on ratios of sharks:main species catches, obtained from observer programs, literature revision and/or personnel communications. In this paper we present the average estimations by fleet/métier for the Indian Ocean (2000-2015) as well as time series for 1971-2015. These time series (stock level) can be considered for use as alternative catch histories in the 2017 IOTC BSH stock assessment, both for production models (stock level estimations) and integrated models (fleet specific estimations)."

98. The WPEB **NOTED** the blue shark catches estimated by the ratio method were lower than the reported estimates for some fleets. The WPEB further **NOTED** the use of static catch ratios (blue sharks:target species by métier) which do not reflect the changes in species composition over time or changes within metiers which may be driving this trend.

99. The WPEB **NOTED** that while this method may perform well for the fleets for which observer information was available, it may not perform so well when expert knowledge has been based on logbooks recording only retained catches and therefore not accounting for discards.

100. The WPEB **AGREED** to consider the results as an optional catch series to be used in the blue shark stock assessment.

101. The WPEB **NOTED** paper IOTC–2017–WPEB13–23 which presented alternative catch histories for Indian Ocean blue shark from 1950 determined using a range of methods of reconstruction, including the following abstract provided by the authors:

"This paper uses the available nominal catch data currently held in the IOTC database and explores the use of a disaggregation method followed by a ratio based method and a GAM statistical approach to reconstructing historic blue shark catches in the Indian Ocean. The methods described in this paper attempt to account for two key sources of error in reported catches: (i) not reporting to species, and (ii) not reporting at all. A rule-based method to identify proxy fleets was used to disaggregate reports of 'sharks NEI' to address the limited reporting to species level, while ratio and GAM based models using target catches were used to predict the expected catches where there are zero reported catches. The GAM series produced higher estimated catches in early years and was still increasing at the end of the time period (2015) while the ratio estimates based on the disaggregated catches followed the disaggregated catch trend more closely and peaked in 2011. While a range of approaches have been explored, if a preferred catch series is to be used as an alternative series for the assessment, then it is recommended that the GAM estimated catch is used."

102. The WPEB **NOTED** that all of the reconstruction methods presented in papers IOTC-2017-WPEB13-22 and IOTC-2017-WPEB13-23, were undertaken because the nominal catches are considered highly incomplete. The estimation methods are based on the same original data source; the IOTC nominal catches. The trade-based estimates presented in 2015[2] were instead based on trade information from the Hong Kong shark fin trade auctions, scaled by target catch, and so originate from a fishery-independent data source. These catches were considered plausible and of similar trend although much greater in terms of magnitude.

Summary of catch reconstruction discussions

103. The WPEB **NOTED** the following catch series available: nominal, disaggregated, ratio, gam, EUPOA and trade (Figure 1).

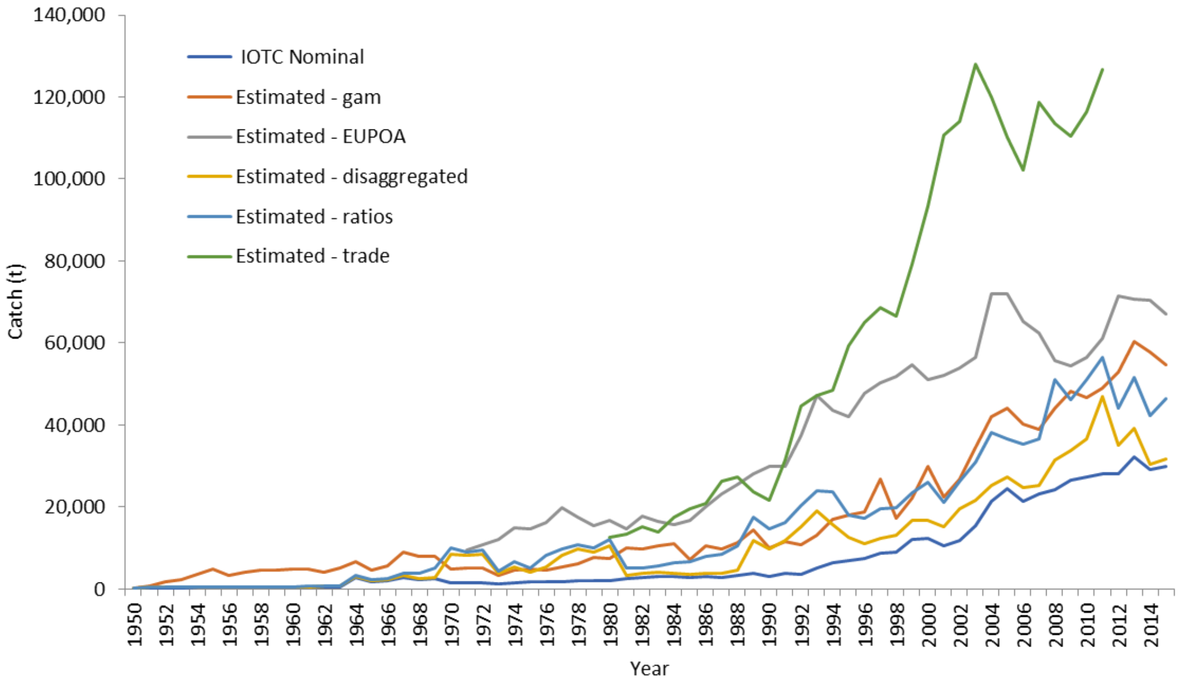

Figure 1. IOTC nominal catches and a range of alternative estimated catch histories for Indian Ocean blue shark, noting the high uncertainty associated with the reported catches.

104. The WPEB **NOTED** that the disaggregated and ratio catch series were not considered to be plausible series. The nominal catches are considered to be severe underestimates. The trade based time series (1980-2011) is incomplete and so presents difficulties for some models as it does not extend to 2015 and there are complications when assigning catches among fleets for the SS model. The EUPOA method start in 1971 and resulted in some fleet estimates which were lower than the reported values.

105. The WPEB **AGREED** to use the catch series recommended in the paper (GAM-based estimates from paper IOTC-2017-WPEB13-23) as the catch series applied for the base-case assessment scenario, but also **AGREED** to examine the sensitivity of outcomes to the EUPOA and trade based catch series as well as the nominal catches for illustrative purposes (Figure 1).

8.2 Review of new information on the status of blue sharks

8.2.1 Nominal and standardised CPUE indices

106. The WPEB **NOTED** paper IOTC–2017–WPEB13–24 which presented catches and standardized CPUE of blue shark in the Indian Ocean from the Portuguese longline fleet from 2000 to 2016, including the following abstract provided by the authors:

"The Portuguese pelagic longline fishery in the Indian Ocean started in the late 1990's, targeting mainly swordfish in the southwest region. This working document analyses catch,

[2] Clarke, S., 2015. Historical Catch Estimate Reconstruction for the Indian Ocean based on Shark Fin Trade Data. IOTC–2015–WPEB11–24

effort and standardized CPUE trends for blue shark captured by this fishery. Nominal annual CPUEs were calculated in biomass (kg/1000 hooks), and were standardized with Generalized Linear Mixed Models (GLMMs) using year, quarter, season and targeting as fixed effects, and vessel as random effects. The standardized CPUE trends shows a general decrease in the initial years between 2000 and 2005, followed by an increase until 2008, and then another general decrease in the most recent years until 2016." (see paper for full abstract)

107. The WPEB **NOTED** the use of the ratio of swordfish to blue shark and swordfish as a proxy for targeting behaviour on each set. Analyses using species clusters or ratios gave the same results so the simpler ratio proxy was used. When this variable was excluded from the model, the resulting CPUE showed a steeper decline; the impact of the ratio variable seems to flatten out the time series of CPUE to some extent and may introduce bias to the standardised CPUE.

108. The WPEB **NOTED** that the proportion of zero sets with BSH catches was low (3% of the total) and that the years 1998 and 1999 were not included because there were only a few vessels operating in those initial years of the fishery.

109. The WPEB **NOTED** that the analysis used biomass rather than numbers and the potential difference in results between these two catch units due to the spatial size-differential in the distribution of blue shark with larger sharks caught at tropical latitudes and smaller sharks found at more southerly latitudes.

110. The WPEB **NOTED** paper IOTC–2017–WPEB13–25 which presented standardized catch rates for blue shark from the Spanish surface longline fleet from 2001 to 2015, including the following abstract provided by the authors:

*"Based on 2,049 trips by vessels in the Spanish surface longline fleet in the Indian Ocean during the period 2001-2015, standardised CPUE catch rates were obtained for the blue shark (Prionace glauca) using General Linear Modelling. The main factors considered were year, quarter, area, ratio, gear and the interaction quarter*area. The basic significant model obtained explained 81% of CPUE variability observed and suggests a stable trend for this blue shark stock in the Indian Ocean. Most of the variability in CPUE was explained by the targeting factor, as represented by the ratio between catch levels for the two most valued and prevalent species landed: swordfish and blue shark."* (see paper for full abstract)

111. The WPEB **NOTED** that the standardised blue shark CPUE for the Spanish longline fleet resulted in a relatively stable index over time in contrast to the Portuguese CPUE, despite the expectation that they should show similar results, as the fleets use similar fishing strategies and operate in the same overall areas.

112. The WPEB **NOTED** that the targeting proxy (ratio) variable used for the Portuguese CPUE was also used for the Spanish fleet but at the level of the trip rather than the individual set. The WPEB **NOTED** the study[3] conducted to explore the ratio effect on this fleet.

113. The WPEB **NOTED** IOTC–2017–WPEB13–26 which presented standardized CPUE of blue shark from the Indonesian pelagic longline fishery in the Eastern Indian Ocean from 2005 to 2016, including the following abstract provided by the authors:

"Nominal annual CPUEs were calculated as number (N)/1000 hooks and were estimated with Generalized Linear Models (GLM) and Generalized Linear Mixed Models (GLMM). Using year, quarter, area, the environment variables (sea surface temperature, chlorophyll-a concentration, eddy kinetic energy, sea level anomaly, and absolute dynamic topography) and Operational characteristics of the gear. The results showed the factors that contributed most for the deviance were the Area, followed by Year, SST, NHBF and Quarter, followed by the other effects and the interactions. In general, there were no noticeable trends, with the series varying along the period." (see paper for full abstract)

114. The WPEB **THANKED** the authors for producing this first time series of standardized blue shark from the Indonesia tuna longline fleet and **ENCOURAGED** them to continue this work in the future.

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[3] *Mejuto, J. and De la Serna, J.M. 2000. Standardized catch rates by age and biomass for the North Atlantic swordfish (Xiphias gladius) from the Spanish longline fleet for the period 1983-1998 and bias produced by changes in the fishing strategy. Collect. Vol. Sci. Pap. ICCAT, 51(5): 1387-1410.*

115. The WPEB **NOTED** the inclusion of a number of environmental variables in the CPUE analysis. There was a large proportion of sets with zero blue shark catches (67%) and so a Tweedie GLM model was used in the analysis. The resulting index showed very large inter-annual differences, including a very low value in 2011 which appeared to be an anomaly, and so suggested that some further work could be done to improve the standardisation.

116. The WPEB **NOTED** paper IOTC–2017–WPEB13–27 which presented standardized CPUE of blue shark from the French swordfish longline fishery in the southwest Indian Ocean from 2007 to 2016, including the following abstract provided by the authors:

    "The blue shark Prionace glauca is the main bycatch of the French swordfish-targeting longline fishery operating in the south-west Indian Ocean. Using observer and self-reported data collected aboard commercial longliners between 2007 and 2016, we propose for the first time a standardized CPUE series for blue shark for this fishery estimated with a lognormal generalized linear mixed model (GLMM) to be used for stack assessment."

117. The WPEB **NOTED** that blue shark is common as the main bycatch species in this fishery, and is always discarded or released. The proportion of zero sets was relatively low at 11%. There are large differences between the nominal and standardized CPUE at the beginning of the time series and the pros and cons of retaining the first year were discussed. The WPEB **AGREED** to maintain the entire time series.

118. The WPEB also **NOTED** that the vessel ID was used as a random effect within the model in order to represent fisher preferences and experience as well as area fished. While including boat size as a fixed effect may be simpler and more informative, it would be correlated with area so could not be used in this analysis.

119. The WPEB **REQUESTED** the authors investigate the assumption of linearity for the continuous variables and whether there might instead be any non-linearity in some of these.

120. The WPEB **NOTED** paper IOTC–2017–WPEB13–29 which presented revised standardized catch rates for blue shark from Japanese observer data in the Indian Ocean from 1992 to 2016, including the following abstract provided by the authors:

    "We updated the standardized CPUE of blue shark (Prionace glauca) based on the Japanese observer data, collected in the Indian Ocean between 1992 and 2016. We also modified the area stratification as well as model structures in the CPUE standardization. We compared four candidate models and we selected the zero-inflated negative binomial model as the most parsimonious model using AIC. The trends in the CPUE was increased in 1990s and reached to the peak in 1999 followed by sharp decline in 2000. After that the trend in the CPUE has been constant or slightly increasing with a large fluctuation".

121. The WPEB **NOTED** that blue shark is not targeted at all by the Japanese tuna longline fleet and is considered bycatch of the target tuna fisheries.

122. The proportion of sets with zero blue shark catches varied between about 5 and 30% over the time series and so a range of appropriate models were explored to account for this, including negative binomial and the zero-inflated negative binomial models which resulted in very similar outcomes.

123. The WPEB **NOTED** the strong impact of the standardisation on the time series with standardised values being lower that nominal CPUE in the earlier years but much higher than the nominal CPUE in the last 2 years.

124. The WPEB **NOTED** that there are differences in the gear configuration for the areas (tropical and temperate) where the Japanese fleet operates. The CPUE analysis this year used an area split north/south at 35°S while the previous analyses had used an east/west split at 90°E. The reason was to account for differences in size distribution of blue shark between the core areas of the Japanese longline fisheries, specifically the southern bluefin tuna fishery in southern latitudes and the tropical tuna fishery in tropical waters.

125. The WPEB **REQUESTED** the authors provide more diagnostic plots to explore the effects of each covariate used in the model, such as fitted values vs residuals. The WPEB further **REQUESTED** the authors provide some exploratory plots of whether the model is sensitive to the specification of the explanatory variables, e.g. area and hooks between floats.

126. The WPEB **NOTED** paper IOTC–2017–WPEB13–INF08 which provided an updated and revised standardized catch rate of blue sharks caught by the Taiwanese longline fishery in the Indian Ocean, including the following abstract provided by the authors:

"The blue shark catch and effort data from observers' records of Taiwanese large longline fishing vessels operating in the Indian Ocean from 2004-2016 were analyzed. To cope with the large percentage of zero shark catch, the catch per unit effort (CPUE) of blue shark, as the number of fish caught per 1,000 hooks, was standardized using a two-step delta-lognormal model that treats the proportion of positive sets and the CPUE of positive catches separately. Each model includes the main variables year, quarter, area, hooks per basket (HPB), and all two-way interactions between quarter, area and HPB. Standardized indices with 95% bootstrapping confidence intervals were reported. The standardized CPUE showed a stable trend for blue sharks from 2004 to 2008 and increased steadily thereafter with peaks in 2014. The results obtained in this study can be improved if longer time series observers' data are available."

127. The WPEB **NOTED** that the final model explained around 13% of the CPUE variability and **ENCOURAGED** the authors to explore the inclusion a wider range of covariates in future studies to attempt to explain a greater proportion of the variability.

Synthesis of CPUE discussions

128. The WPEB **AGREED** to explore the use of all available CPUE series in the stock assessment (Figure 2).

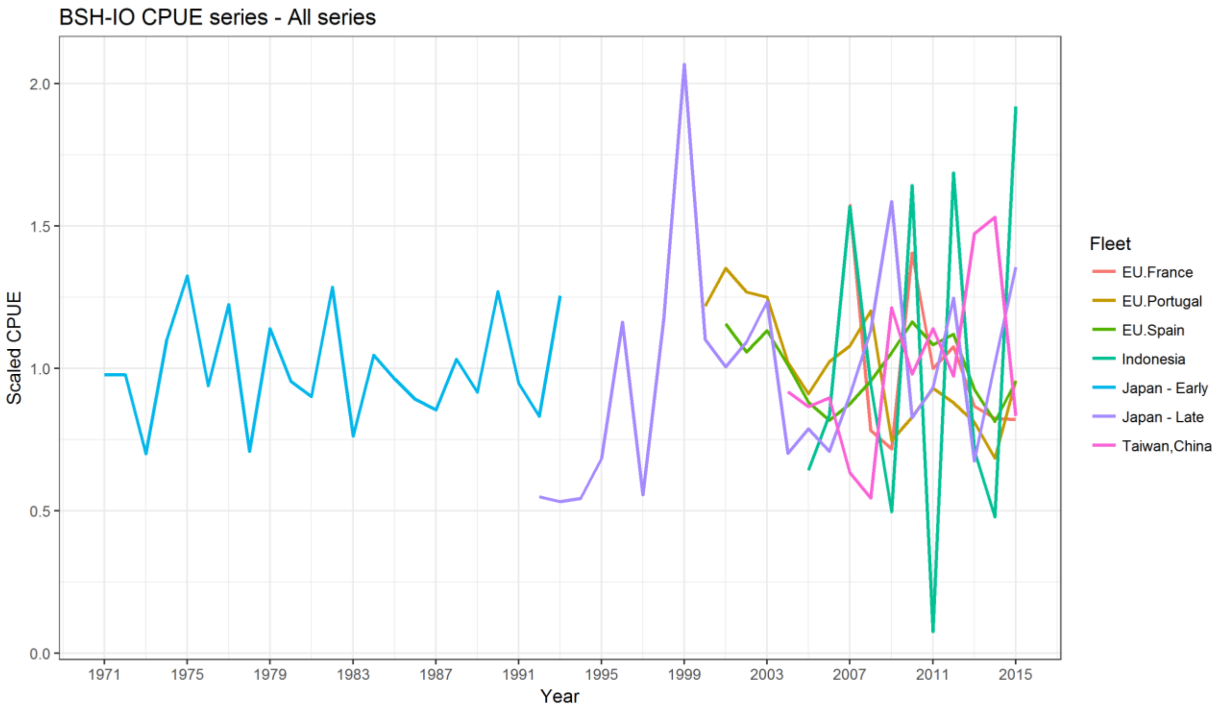


Figure 2. Blue shark standardised CPUE series available and run in the various stock assessment models and sensitivity analysis.

129. The WPEB **NOTED** that there are conflicting trends among some CPUE series and that the inclusion of conflicting data would result in a mis-specified model. A hierarchal cluster analysis showed that the most highly correlated CPUE series were EU,Portual (PRT) and EU,France (La Reunion fleet - REU); these two series showed similar declining trends. These two CPUE series were therefore selected for the base case assessment run with the further inclusion of the late Japanese CPUE which was also slightly positively correlated with the PRT and REU series. Sensitivity trials were run using combinations of the other CPUE time series. The WPEB **NOTED** that the early and late Japanese CPUE series would likely have been affected by the changes in market demand for fins and blue shark meat over time (Figure 3).

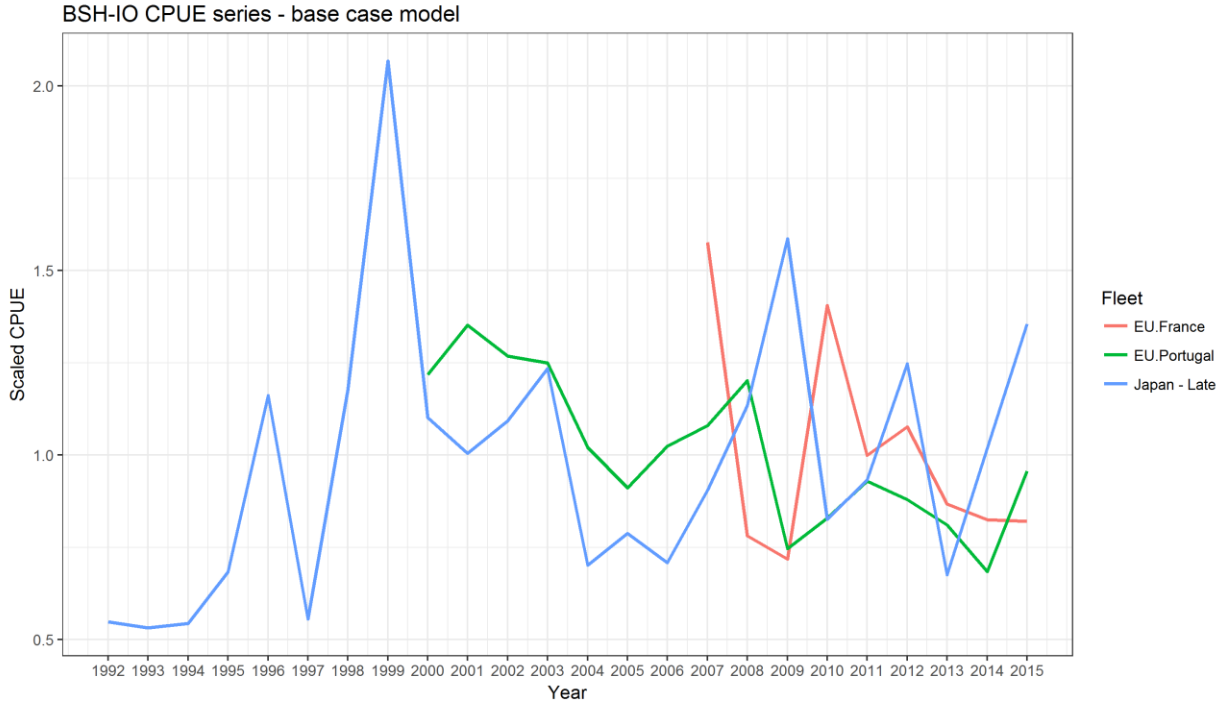


Figure 3. Blue shark standardised CPUE series used in the final base case model

CPUE Collaborative study of shark CPUE from multiple Indian Ocean longline fleets

130. **NOTING** the conflicting patterns in blue shark CPUE derived from different Indian Ocean longline fleets and **CONSIDERING** the success of using joint analysis of operational catch and effort data to resolve such conflicts in other Working Parties, the WPEB **RECOMMENDED** initiating work on joint analysis of operational catch and effort data from multiple fleets, to further develop methods and to provide indices of abundance for sharks of interest to the IOTC. A consultant should be considered to conduct such work for a budget of around EUR45 000.

8.2.2 Stock assessments

Stock Reduction Analysis (SRA)

131. The WPEB **NOTED** paper IOTC–2017–WPEB13–30 which describes a Stock Reduction Analysis (SRA) approach to estimate the parameters of a Schaefer surplus production model for blue shark in the Indian Ocean, including the following abstract provided by the authors:

    "In this paper a Stock Reduction Analysis (SRA) based on catch data and on prior information concerning the intrinsic growth rate (r) was used to estimate maximum sustainable yield of blue shark (Prionace glauca) caught in the Indian Ocean. The uncertain concerning catch is high. Six different catch time series were considered. Results indicate that catches have increased fast after 1990 and were higher than maximum sustainable yield (MSY) since the beginning of 2000's. The uncertain concerning the status of the stock in 2015 is high. Probabilities that the stock was not overfished, was subject to overfishing, or was overfished were 24.3%, 36.7% and 39.0% respectively in the base case run. However if the catch increase, or if it remain as high as in 2015, likely the stock will be overfished in the near future."

132. The WPEB **NOTED** that the final depletion level was fixed between 0.2 and 0.7 and is highly influential on the model results.

133. The WPEB **NOTED** that the density distribution of intrinsic growth rate (r) used in the runs convey the current available information about the parameter, and the sensitivity runs proved to be useful to assess the uncertainty concerning the six different catch time series.

134. The WPEB **NOTED** that results are sensitive to the choices of the upper limit of the distribution of carrying capacity (k) and **ENCOURAGED** further studies on alternative approaches to select the upper limit of k are explored.

135. The WPB **NOTED** the key assessment results for the SRA as shown below (Table 2, Table 3, Figure 4, Figure 5, Figure 6).

Table 2. Blue shark: Key management quantities from the SRA assessment, assuming the base case model using GAM estimated catches for the Indian Ocean.

Management Quantity	Indian Ocean
2015 catch estimate	54,735
Mean catch from 2011–2015	54,994
MSY (t) (80% CI)	39,544 (32,093 - 48,395)
Data period used in assessment	1950—2015
F_{MSY} (80% CI)	0.13 (0.12 - 0.15)
B_{MSY} (t) (80% CI)	295,695 (241,644 - 355,855)
F_{2015}/F_{MSY} (80% CI)	1.37* (0.88 - 2.43)
B_{2015}/B_{MSY} (80% CI)	1.01* (0.70 - 1.29)
SB_{2015}/SB_{MSY}	n.a.
B_{2015}/B_{1950} (80% CI)	0.50 (0.35 - 0.65)
SB_{2015}/SB_{1950}	n.a.
$B_{2015}/B_{1950,\ F=0}$	n.a.

*median values

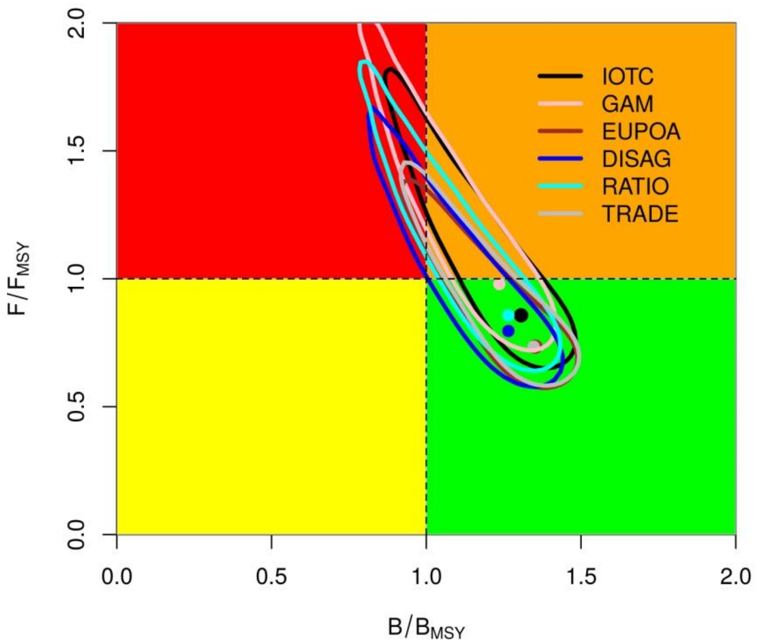


Figure 4. Blue shark: SRA aggregated Indian Ocean Kobe plot. Sensitivity runs using six catch time series: IOTC, GAM, EUPOA, DISAG, RATIO and TRADE. Contour lines represent 0.5 of the highest density. Circles represent the modes of the joint distributions of F/F_{MSY} and B/B_{MSY} ratios.

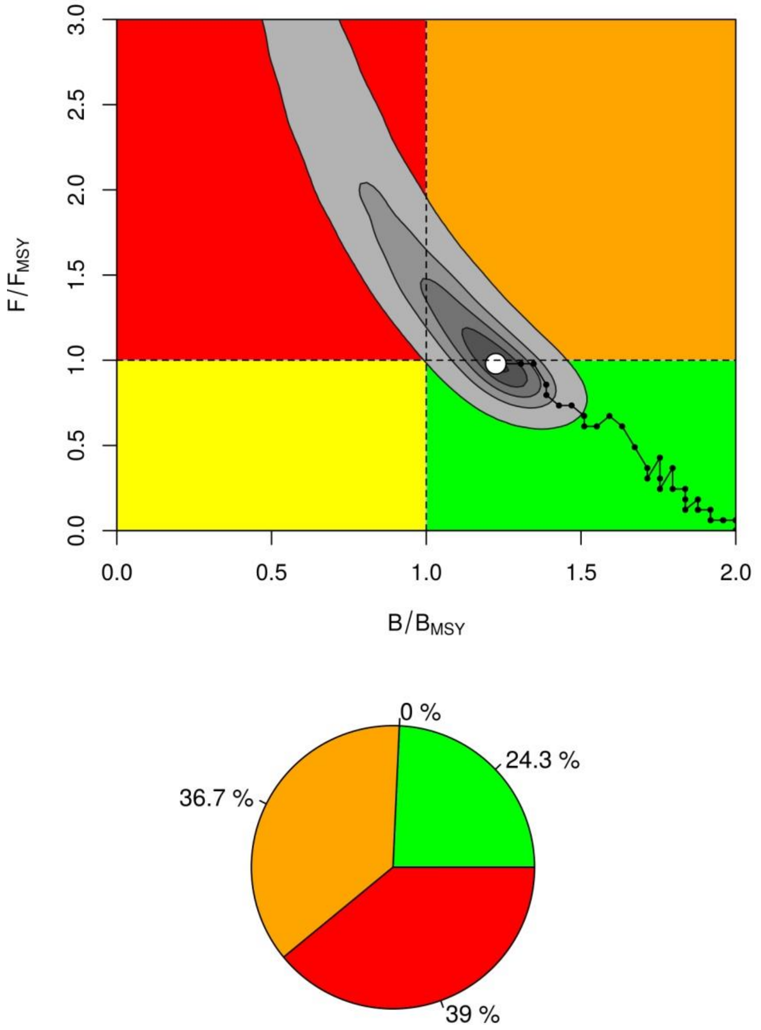
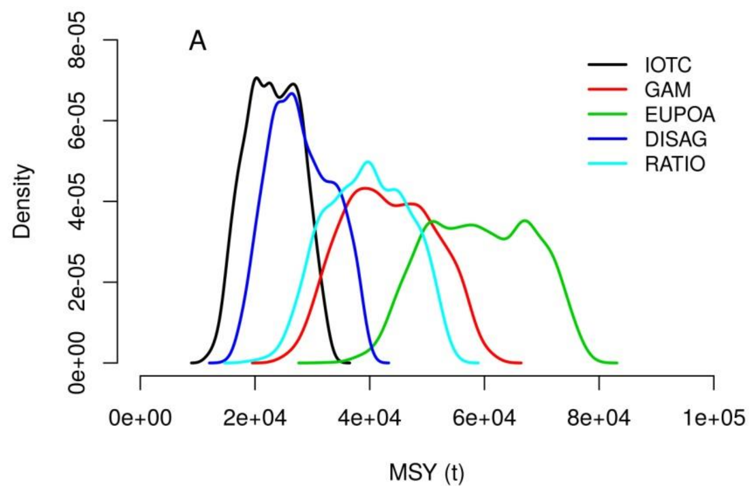
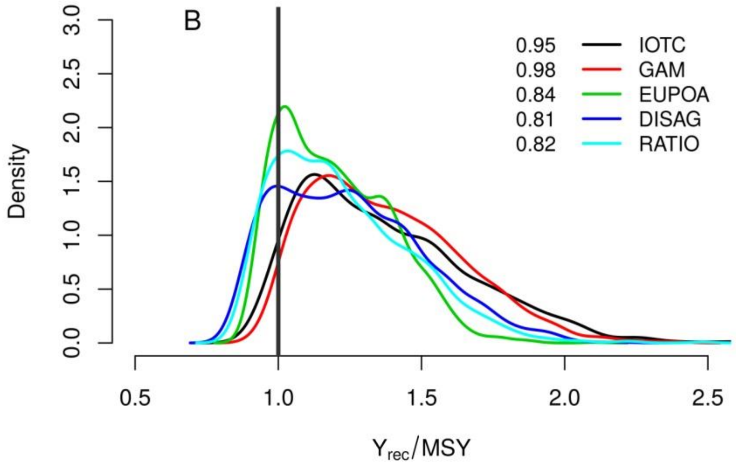


Figure 5. Blue shark: SRA Indian Ocean assessment Kobe plot. The results are from the preferred base case SRA model, using the GAM estimated catches (trajectory represents modal values).



a)



b)
Figure 6. Empirical density distributions of estimates of MSY of blue shark (a) and of ratios between the average catch of recent years (2013-2015) (Yrec) and MSY (b) calculated based on six catch time series (IOTC, GAM, EUPOA, DISAG, RATIO, TRADE). Numbers in panel b stand for empirical probability that average catches were higher than MSY.

Table 3. Blue shark: SRA aggregated Indian Ocean assessment Kobe II Strategy Matrix.Probability (percentage) of violating the MSY-based reference points for nine constant catch projections (average catch level from 2013–15 (57,668 t) ± 10%, ± 20%, ± 30% and ± 40%) projected for 3 and 10 years.

Reference point and projection timeframe	Alternative catch projections (relative to the average catch level from 2013–2015) and probability (%) of violating MSY-based target reference points ($B_{targ} = B_{MSY}$; $F_{targ} = F_{MSY}$)								
	60%	**70%**	**80%**	**90%**	**100%**	**110%**	**120%**	**130%**	**140%**
$B_{2018}<B_{MSY}$	44	48	52	56	61	66	71	76	80
$F_{2018}>F_{MSY}$	36	50	64	78	90	97	100	100	100
$B_{2025}<B_{MSY}$	37	50	63	78	91	98	100	100	100
$F_{2025}>F_{MSY}$	34	51	69	87	98	100	100	100	100

136. The WPB **NOTED** the uncertainty associated with stock status is high, but the results indicate that blue shark stock of Indian Ocean will likely be overfished in the near future if the catches are not reduced to values lower than those estimated for 2015.

137. The WPB **NOTED** that the differences among the results of sensitivity runs using different catch time series were mainly due to differences in the scale of the catches, which translate into a wide range of estimated absolute values of MSY, Bmsy and expected population response to absolute catch levels. Nevertheless, the estimated stock status (in relative terms) was similar across all model runs.

138. The WPB **NOTED** that although the modelling approach is simple and reliant on a few key assumptions, it proved to be a useful method to assess the status of the stock and results were comparable with those of the more complex models used.

Pella-Tomlinson Surplus Production Model

139. The WPEB **NOTED** IOTC–2017–WPEB13–32 Rev_1 which describes incorporating life history parameters in a Pella-Tomlinson surplus production model for blue shark in the Indian Ocean, including the following abstract provided by the authors:

"In this study, we applied Bayesian approach to develop a Pella-Tomlinson production model (PTPM) for Indian Ocean blue shark (Prionace glauca) and used demographic analysis to inform prior information for key parameters. Matrix population model was used to derive informative prior distributions for the intrinsic growth rate (γ) and the shape parameter (p) of the PTPM. Eleven scenarios were considered to cover the main uncertainties in biological assumptions and initial population depletions. The impacts of informative and no-informative

priors for parameters were also investigated. The models were fit to five abundance indices derived from main longline fisheries. The results are sensitive to the choices of CPUE indices. Most of the scenarios suggest that, at the beginning of 2015, the Indian Ocean blue shark was safe ($B_{curr}/B_{msy}>1.0$, $F_{curr}/F_{msy}<1.0$).” (see paper for full abstract)

140. The WPEB **NOTED** that the base case for this model used the IOTC nominal catch series, scenario 6 represents a sensitivity run exploring a two-year reproductive cycle, and scenario 10 represents a sensitivity run exploring a uniform distribution for the fecundity.

141. The WPEB **NOTED** the results of fitting the model to each of the 5 separate CPUE indices using the nominal catch history for blue shark in the Indian Ocean. The study used demographic parameters available from the literature to determine a prior for the intrinsic rate of increase (r).

142. The WPEB **NOTED** that the prior did not appear to be updated much by the model and **SUGGESTED** that sensitivity to the prior on r could be assessed through a priors-only run.

143. The WPB **NOTED** the key assessment results for the Pella-Tomlinson Surplus Production Model (PTSPM) as shown below (Table 4, Figure 7).

Table 4. **Blue shark: Key management quantities from the PTSPM assessment, assuming the base case model using nominal blue shark catches for the Indian Ocean.**

Management Quantity	Indian Ocean
2015 catch estimate	29,916
Mean catch from 2011–2015	29,507
MSY (t) (80% CI)	34,870 (22,810 – 57,900)
Data period used in assessment	1980 – 2015 JPN_L (1992 – 2015) EU,ESP (2001 – 2015) TWN,CHN (2004 – 2015) EU,PRT (2000 – 2015) IDN (2005– 2015)
F_{MSY} (80% CI)	0.14
SB_{MSY} (t) (80% CI)	258,620
F_{2015}/F_{MSY} (80% CI)	0.55
B_{2015}/B_{MSY} (80% CI)	1.62
SB_{2015}/SB_{MSY}	n.a.
B_{2015}/B_{1950} (80% CI)	n.a.
SB_{2015}/SB_{1950}	n.a.
$B_{2015}/B_{1950, F=0}$	n.a.
$SB_{2015}/SB_{1950, F=0}$	n.a.

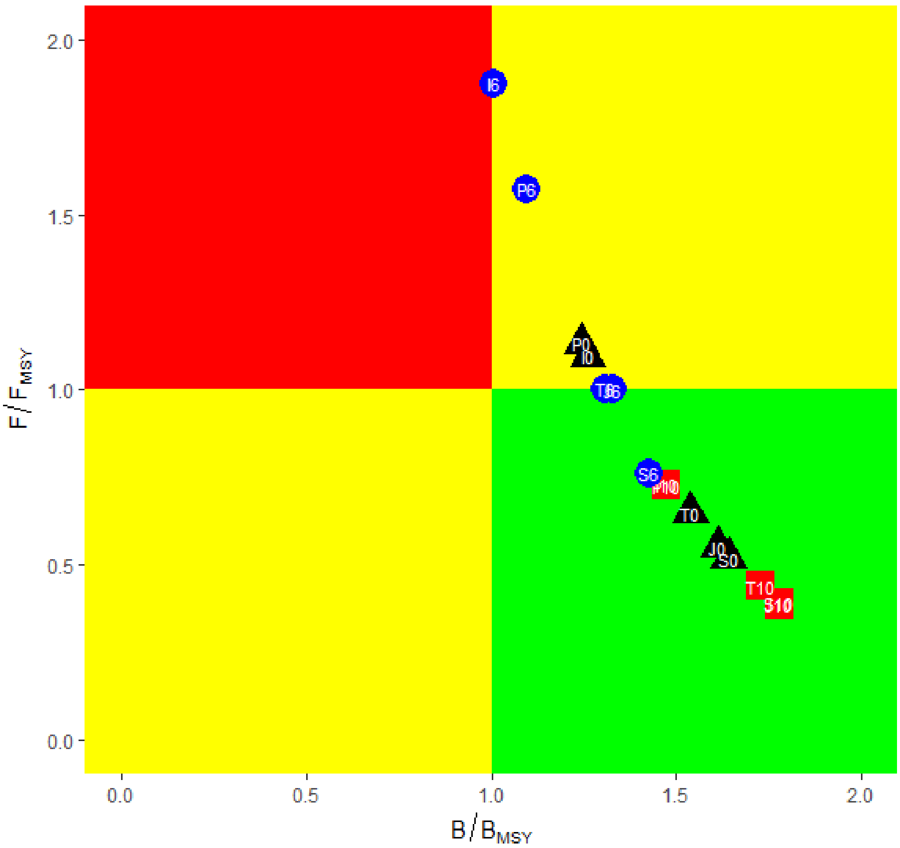


Figure 7. Kobe plot for the median of B/Bmsy and F/Fmsy under different CPUEs for the Base-case (black triangular, J0,S0,T0,P0 and I0), Scenario 6(blue circle, J6,S6,T6,P6 and I6) and Scenario 10(red square, J10, S10, T10, P10 and I10), where, J: Japan; S: EU, Spain; T: Taiwan, China; P: EU, Portugal; I: Indonesia.

Just Another Bayesian Biomass Assessment (JABBA)

144. The WPEB **NOTED** paper IOTC–2017–WPEB13–31 which describes a Bayesian state-space approach to estimate the parameters of a Schaefer surplus production model for blue shark in the Indian Ocean, including the following abstract provided by the authors:

*"The stock assessment software 'Just Another Bayesian Biomass Assessment' JABBA was applied in the 2017 Indian Ocean blue shark stock assessment. A Base-case model was developed using the GAM catch series and the following CPUEs: Japan late, EU-Portugal, EU-France. An alternative run including all CPUE (Base-case + Chinese Taipei + Indonesia + EU-Spain + Japan early) indices was developed for comparison. Both JABBA model runs showed robust convergence diagnostics. The MSY estimate for the Base-case was estimated at 47,355.8 metric tons (32,333.6 – 83,741.8 95% C.I.) (Table 1). Stock status estimates (B/B_{MSY} and F/F_{MSY}) for the Base-case are provided together with the model parameter estimates in Table 1. Degrees of stock depletion and overfishing in both models were illustrated using the "Kobe plot" (*Figure 9*). Compared to MSY-based reference points, for the Base-case model, the current biomass (B_{2015}) is 33.3% above B_{MSY} and the value for current fishing mortality (F_{2015}) is 13.1% below F_{MSY}. The historical trajectories of stock status for both models revealed that Indian Ocean blue shark had experienced some level of depletion in previous years, however, the stock condition still remains in the Kobe Plot green zone with probabilities of 53-65% (Figure 9). By the standard terminology, this would indicate that the stock is not in an overfished state, and that overfishing is not occurring".*

145. The WPEB **NOTED** that the base case model used the GAM catch series and the following CPUEs: Japan late, EU-Portugal, EU-France, while the alternative run used the base case catches and CPUEs as well as CPUE series for Taiwan-China, Indonesia, EU-Spain and Japan early.

146. The WPEB **NOTED** the sensitivity analysis of the complete set of CPUE indices demonstrated that the stock status estimates for B/B_{MSY} and F/F_{MSY} were fairly insensitive to excluding any one CPUE series at a time (Figure 8). The most sensitive CPUE indices were JPN early and JPN late. Excluding the JPN early index only affected the B/B_{MSY} trajectory, showing more optimistic values over the

period 1968-1993.The exclusion of the JPN late index had notable effects on current stock status estimates, which were more pessimistic in terms of both B/B_{MSY} and F/F_{MSY}. Although excluding the Indonesian index had no discernible influence on either B/B_{MSY} or F/F_{MSY}, it resulted in a substantial decrease in the residual-mean-squared-error, thus indicating an overall improvement of the goodness-of-fit.

147. The WPEB **NOTED** the evaluation of prior and posterior distributions indicated that data contained information to estimate *K* with relative precision. However, the choice of prior distribution for *r* was narrow, so this key resilience estimate was mainly influenced by the prior and to a lesser extent by the data as evident by the close to 100% overlap between prior and posterior. In optimal circumstances the prior for *r* should be specified as broad enough to accommodate uncertainty for a wide spectrum of compensatory and depensatory processes, including variation in individual growth rates, maturity, age-dependent natural mortality and recruitment.

148. The WPB **NOTED** the key results for the JABBA assessment as shown below (Table 5, Figure 9, Figure 9).

Table 5. **Blue shark: Key management quantities from the JABBA assessment, assuming the base case model using GAM estimated catches for the Indian Ocean.**

Management Quantity	Indian Ocean
2015 catch estimate	54,735
Mean catch from 2011–2015	54,994
MSY (t) (95% CI)	47,356 (32,334 – 83,742)
Data period used in assessment	1950 - 2015
F_{MSY} (95% CI)	0.14 (0.12 - 0.16)
B_{MSY} (t) (95% CI)	349,243 (238,295 - 616,823)
F_{2015}/F_{MSY} (95% CI)	0.87 (0.40 - 1.74)
B_{2015}/B_{MSY} (95% CI)	1.33 (0.92 - 1.72)
SB_{2015}/SB_{MSY}	NA
B_{2015}/B_{1950} (95% CI)	0.81 (0.51 – 1.26)
SB_{2015}/SB_{1950}	NA
$B_{2015}/B_{1950,\ F=0}$	NA
$SB_{2015}/SB_{1950,\ F=0}$	NA

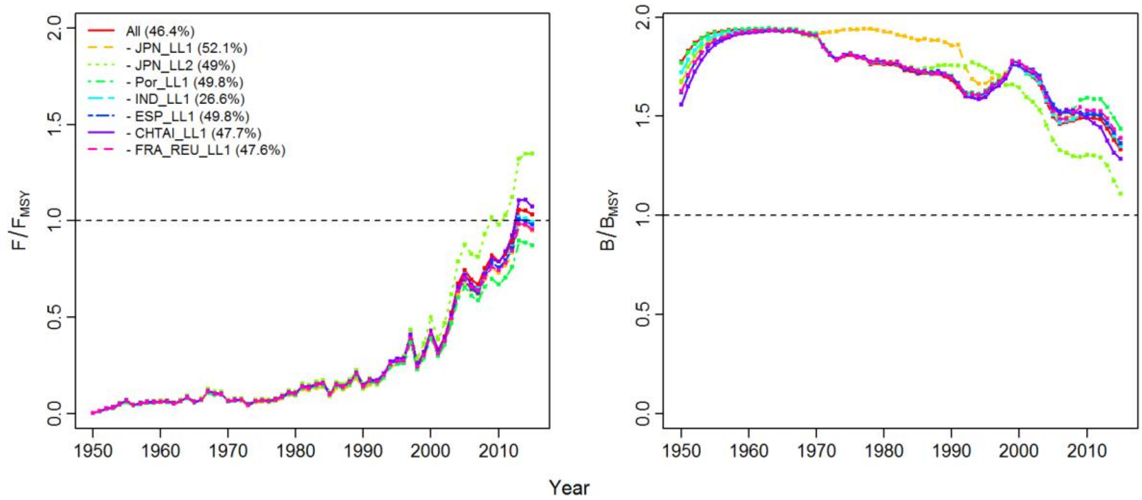


Figure 8. Sensitivity analysis of the CPUE series, showing the effects of excluding one index at the time on the stock status estimates of F/F_{MSY} and B/B_{MSY}. Residual-mean-squared errors (RMSE) as statistic for the goodness-of-fit are provided in brackets.

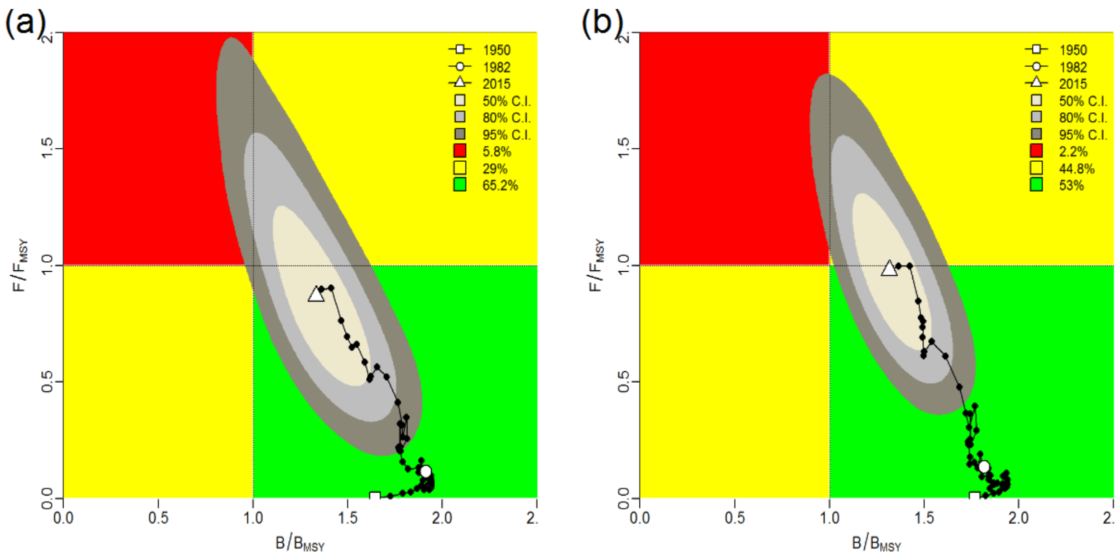


Figure 9. Blue shark: JABBA Indian Ocean assessment Kobe plot. The results are from the base-case model (a), and alternative run (b).

Stock synthesis assessment

149. The WPEB **NOTED** IOTC–2017–WPEB13–33 which describes a stock assessment using Stock Synthesis of the blue shark population in the Indian Ocean, including the following abstract provided by the authors

"This paper presents stock assessment of blue shark in the Indian Ocean using Stock Synthesis (version 3.24f http://nft.nefsc.noaa.gov/Download.html). The blue shark assessment model is an age structured (30 years), spatially aggregated (1 region) and two sex model. The catch, effort, and size composition of catch, are grouped into 8 fisheries covering the time period from 1950 through 2015. Seven indices of abundance, all from longline fisheries, were available as well as three estimates of total catch. The base case model is parametrized using indices of abundance from the Portugal, Reunion and the Japanese late series, along with estimates of catch using a generalized additive model. The estimated abundance trend is decreasing throughout the time frame of the model, and spawning stock abundance has decreased to approximately 1.502 times SSBMSY, (80% CI is 1.32-1.68). The fishing mortality has increased steadily over the model time frame with F2015/FMSY= 0.905 (80% CI =0.679 to 1.132)." (see paper for full abstract)

150. The WPEB **NOTED** that the selected growth CV (empirical estimates) may have resulted in maximum sizes that were outside the range of observed lengths. The value of steepness used (0.79) was higher than the value used in the 2015 assessment (0.5) but appropriate based on the new growth and population dynamics estimates from the Indian Ocean.

151. The WPEB **NOTED** that the selectivity assumption (logistic) used for the F1 and F2 fisheries may be appropriate to ensure that the model does not estimate a cryptic biomass of large fish, but that little information regarding the selectivity of these fisheries exists.

152. The WPEB **NOTED** that the assessment results differed in the final stock status estimates depending on the inclusion of alternative CPUE and catch series, however, all models showed a similar stock trajectory moving towards higher F values and lower SSB values. The key assessment results for the Stock Synthesis assessment as shown below (Table 6, Figure 10) indicate that the stock is currently not overfished and that overfishing is not occurring, assuming the base case scenario.

153. The WPEB **NOTED** that the two major uncertainties of the assessment are the catch history and CPUE series. These differences are shown in the Kobe plots for various CPUE runs and different catch histories for the base case in relative terms (Figure 11). The main impact of catch uncertainty is in estimates of blue shark productivity (MSY, B_{MSY}) (IOTC–2017–WPEB13–33 Rev_1), although there is also some sensitivity regarding relative status statistics.

154. The WPEB **NOTED** that the projections of gam estimated 2015 catch levels (54,735 t) would result in an approximate 50% decrease in SSB to approximately SSB_{MSY}, by 2025 due to projected F exceeding F_{MSY} (Table 7, Figure 12). The WPEB **NOTED** that while projections of future stock

status are currently based on variable TAC levels, it could also be desirable, in the future, to project for other metrics (e.g. fishing mortality levels).

Table 6. Blue shark: Key management quantities from the SS3 assessment, assuming the base case model using GAM estimated catches for the Indian Ocean.

Management Quantity	Indian Ocean
2015 catch estimate (t)	54,735
Mean catch from 2011–2015 (t)	54,993
MSY (t) (80% CI)	33,100 (29,500 – 36,700)
Data period used in assessment	1950 - 2015
F_{MSY} (80% CI)	0.30 (0.30 - 0.31)
SB_{MSY} (t) (80% CI)	38,800 (34,200 – 43,600)
F_{2015}/F_{MSY} (80% CI)	0.90 (0.68 – 1.13)
B_{2015}/B_{MSY} (80% CI)	
SB_{2015}/SB_{MSY}	1.50 (1.33 - 1.63)
B_{2015}/B_{1950} (80% CI)	
SB_{2015}/SB_{1950}	0.52 (0.46 - 0.56)
$B_{2015}/B_{1950,\ F=0}$	
$SB_{2015}/SB_{1950,\ F=0}$	1.02

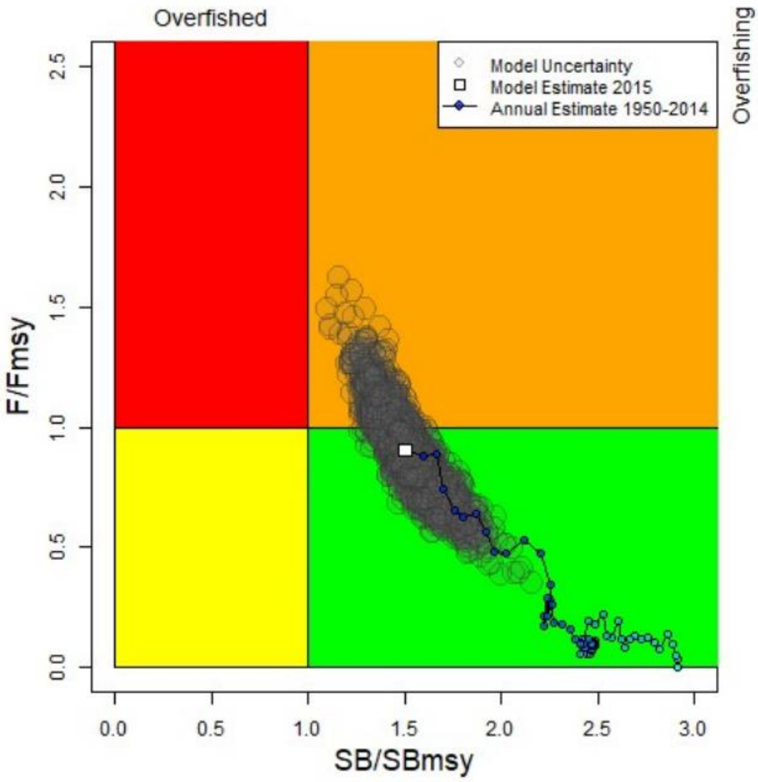


Figure 10. Blue shark: SS3 Indian Ocean assessment Kobe plot. The results are from the final base case SS3 model.

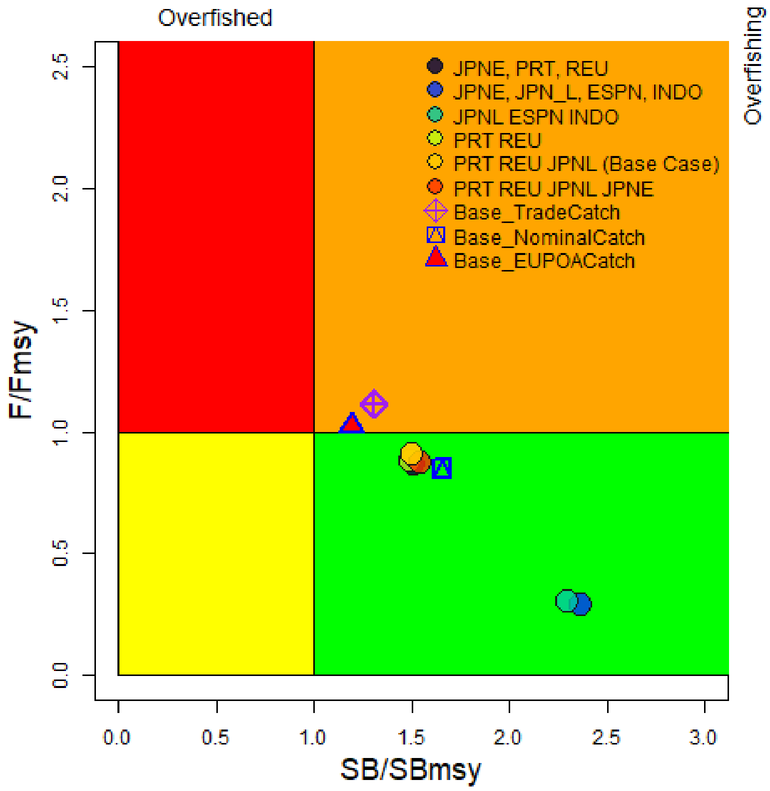


Figure 11. Blue shark: SS3 Indian Ocean assessment Kobe plot. The results are from the grid of sensitivity results showing changes in the inclusion of CPUE series and alternative Catch Series. CPUE series are identified by the following abbreviations; Japanese Early (JPNE), Japanese Late (JPL)

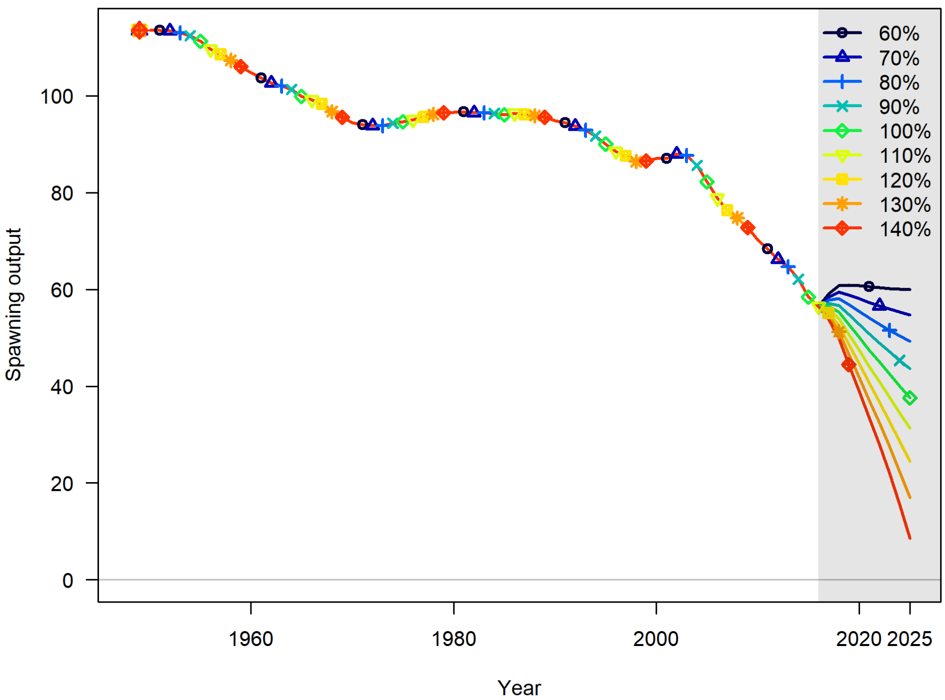


Figure 12. Projections of spawning biomass relative to virgin spawning biomass based on estimated (GAM based) 2015 catch levels. Catch levels projected for nine constant catch projections based on the average catch level from 2015 (54,735 t, ± 10%, ± 20%, ± 30% and ± 40%).

Table 7. Blue shark: SS3 Indian Ocean assessment Kobe II Strategy Matrix. Probability (percentage) of violating the MSY-based reference points for nine constant catch projections (2015 catch level; 54,735 t, ± 10%, ± 20%, ± 30% and ± 40%) projected for 3 and 10 years.

Reference point and projection time frame	**Alternative catch projections (relative to the catch level from 2015) and probability (%) of violating MSY-based reference points (Btarg=Bmsy; Ftarg=Fmsy)**								
Catch Relative to 2015	60%	70%	80%	90%	100%	110%	120%	130%	140%
Catch (t)	(32,841)	(38,315)	(43,788)	(49,262)	(54,735)	(60,209)	(65,682)	(71,156)	(76,629)
$B_{2018} < B_{MSY}$	0%	0%	0%	0%	0%	0%	1%	1%	3%
$F_{2018} > F_{MSY}$	0%	1%	7%	25%	49%	69%	83%	91%	95%
$B_{2025} < B_{MSY}$	0%	1%	8%	25%	48%	68%	82%	89%	92%
$F_{2025} > F_{MSY}$	0%	7%	35%	67%	87%	95%	97%	94%	90%

Blue shark: Summary of stock assessment models in 2017

155. The WPB **AGREED** that the final advice for the executive summary should be provided for a base case model using the GAM-based catch history estimates and CPUE series from Portugal, EU-France (Reunion) and Japan (late). The major axes of uncertainties identified in the current model are catches and CPUE indices of abundance. Model results were explored with respect to their sensitivity to the major axes of uncertainty identified. If the alternative CPUE groupings were used then the stock status was somewhat more positive ($B>>B_{MSY}$ and $F<<F_{MSY}$), while if the alternative catch series (trade and EUPOA) were used then the estimated stock status resulted in $F>F_{MSY}$.

156. The WPEB **AGREED** to prepare the Kobe II Strategy Matrix inter-sessionally with probabilities estimated from MCMC for the final advice (Table 7).

157. The WPB **NOTED** Table 8 which provides an overview of the key features of each of the blue shark stock assessments presented in 2017 for the Indian Ocean-wide assessments (4 model types). Similarly, Table 9 provides a summary of the assessment results.

158. The WPB **NOTED** that B_{MSY} was estimated at approximately 0.35 of SSB_0 in the SS3 model, 0.39 (of B_0) in the JABBA model and was fixed at 0.5 (of B_0) in the SRA. For the SS3 model the assumption about steepness determines the SSB_{MSY} reference point.

Table 8. Blue shark: Indian Ocean-wide assessments. Summary of final stock assessment model features as applied to the Indian Ocean blue shark resource in 2017.

Model feature	**SS3 (Doc #33 Rev1)**	**SRA (Doc #30)**	**JABBA (Doc #31)**	**PTPM (Doc #32)**
Software availability	NOAA toolbox	H.A. Andrade/ code at IOTC Secretariat	https://github.com/Henning-Winker/JABBA	
Population spatial structure / areas	1	1	1	1
Number CPUE Series	3	0	3	5 separately
Catch time series	3	6	1	1
Catch series used (base case)	GAM	GAM	GAM	nominal
Uses Catch-at-length/age	Yes	No	No	No
Age-structured	Yes	No	No	No
Sex-structured	Yes	No	No	No
Number of Fleets	8	1	1	1
Stochastic Recruitment	Yes	No	No	No

Table 9. Blue shark: Indian Ocean-wide summary of key management quantities from the assessments undertaken in 2017 (note that the PPTM uses a different base case; IOTC nominal catches).

Management quantity	**SS3 (Doc #33 Rev_1)**	**SRA (Doc #30)**	**JABBA (Doc #31)**	**PPTM (Doc #32 Rev_1)**
Most recent catch estimate (t) (2015) (GAM based estimates or nominal catches for PPTM)	54,735	54,735	54,735	29,916
Mean catch over last 5 years (t) (2011–2015) (GAM based estimates or nominal catches for PPTM)	54,994	54,994	54,994	29,507
h (steepness)	0.79	n.a.	n.a.	n.a.
MSY (1,000 t) (80% CI) [plausible range of values]	33.1 (29.5 – 36.7)	39.5 (32.1 – 48.4)	47.3 (32.3 – 83.7)	34.9 (22.8-57.9)
Data period (catch)	1950 – 2015	1950 - 2015	1950 – 2015	1980 - 2015
CPUE series	EU-PRT, EU-REU, JPN_L	n.a.	JPN_L, EU-PRT, EU-REU	JPN_L, EU-ESP, TWN-CHN, EU-PRT, IDN
CPUE period	JPN_L (1992 – 2015) EU-PRT (2000 – 2015) EU-REU (2007 – 2015)	n.a.	JPN_L (1992 – 2015) EU-PRT (2000 – 2015) EU-REU (2007 – 2015)	JPN_L (1992 – 2015) EU-ESP (2001 – 2015) TWN-CHN (2004 – 2015) EU-PRT (2000 – 2015) IDN (2005– 2015)
F_{MSY}	0.31 (0.30 – 0.31)	0.13 (0.12 – 0.15)	0.14 (0.12 – 0.16)	0.14
SB_{MSY} or $*B_{MSY}$ (1,000 t)	38.8 (34.2 – 43.6)	295.70 (241.64 – 355.86)	349.24 (238.30 – 616.82)	258.62
F_{2015}/F_{MSY} (80% CI) [plausible range of values]	0.904 (0.678 – 1.13)	1.37 (0.88 – 2.43)	0.87 (0.40 – 1.74)	0.55
B_{2015}/B_{MSY} (80% CI) [plausible range of values]	n.a.	1.01 (0.7 – 1.29)	1.33 (0.92 – 1.72)	1.62
SB_{2015}/SB_{MSY} (80% CI) [plausible range of values]	1.50 (1.33 – 1.63)	n.a.	n.a.	n.a.
B_{2015}/B_{1950} (80% CI) [plausible range of values]	n.a.	0.5 (0.35 – 0.65)	0.81 (0.51 – 1.26)	n.a.
SB_{2015}/SB_{1950} (80% CI) [plausible range of values]	0.52 (0.46 – 0.56)	n.a.	n.a.	n.a.
$SB_{2015}/SB_{1950,\ F=0}$	1.02	n.a.	n.a.	n.a.

n.a. = not available

8.2.3 Selection of Stock Status indicators for blue shark

159. The WPEB **NOTED** that the SRA is interesting as an exploratory tool, particularly as a method for directly comparing the effect of the different catch histories. The production models (JABBA and PTSPM) have the advantage of incorporating CPUE information. While the indices are not perfect, they provide more information which is useful to incorporate. Finally, the SS model further allows for the incorporation of more detailed biological information, including the size data available and given there is some biological information which SS can take advantage of, the WPEB **AGREED** that this is the preferred model to be used for management advice.

8.3 Development of management advice for blue shark and update of blue shark Executive Summary for the consideration of the Scientific Committee

160. The WPEB **ADOPTED** the management advice developed for blue shark, as provided in the draft status summary and **REQUESTED** that the IOTC Secretariat update the draft stock status summary with the latest 2016 interaction data and the results from the MCMC projections in the Kobe II Strategy Matrix, and for the summary to be provided to the SC as part of the draft Executive Summary, for its consideration:
    - Blue Shark (Appendix IX).

9. OTHERS SHARKS AND RAYS

9.1 Review new information on other shark and ray biology, stock structure, bycatch mitigation measures, fisheries and associated environmental data

Silky shark habitats

161. The WPEB **NOTED** paper IOTC–2017–WPEB13–34 which described the distribution of silky sharks in the Atlantic Ocean in relation to environmental variables, based on the Spanish observer data from the purse seine fishery for tropical tunas, including the following abstract provided by the author:

    "This work aims to provide the first insights into the environmental preferences of silky sharks (Carcharhinus falciformis) by modelling their abundance from observer data with a set of biotic and abiotic oceanographic factors, spatial-temporal terms and fishing operation variables. This work considers Spanish observer data (IEO and AZTI database) from 2003 to 2015, and comprising ~7500 fishing sets for the Atlantic Ocean. Oceanographic data (SST, SST gradient, salinity, SSH, CHL, CHL gradient, oxygen, and current information such as speed, direction and kinetic energy) were downloaded and processed for the study period and area from the MyOcean- Copernicus EU consortium. Results provide information on the dynamics and hotspots of silky shark abundances as well as the most significant habitat preferences of the species. Models detected a significant relationship between seasonal upwelling events, mesoscale features and shark abundance and suggested strong interaction between productive systems and the spatial-temporal dynamics of sharks." (see paper for full abstract)

162. The WPEB **NOTED** the distribution of silky shark related to the environmental and mesoscale features and the presence of potential hot spots for silky shark. There appeared to be strong correlation between the environmental variables and it was suggested that season might also be included in the model.

163. The WPEB **NOTED** that despite including the interaction terms in the model only a small proportion of the variance had been explained and therefore the model appeared to be over-parameterised. Given this possible overparameterisation, the WPEB **SUGGESTED** the authors consider constraining degrees of freedom in the GAM, especially for smooth terms such as the interaction between the latitude and longitude, and **ENCOURAGED** the authors to try using year and month as categorical covariates in the GAM.

9.2 Review of new information on the status of other sharks

Sharks, rays and chimaeras in the Arabian Sea and aadjacent waters

164. The WPEB **NOTED** paper IOTC–2017–WPEB13–INF15 describing the results of a workshop where the status of sharks in the Arabian Sea area were evaluated, including the following abstract provided by the author:

"This report provides an overview of the conservation status of chondrichthyans (sharks, rays, and chimaeras) in the Arabian Seas Region (ASR) and describes the results of a regional Red List workshop held in Abu Dhabi, United Arab Emirates, in February 2017. It identifies those species that are threatened with extinction at the regional level, so that appropriate conservation action can be taken to improve their status. A regional overview of chondrichthyan fisheries, management and conservation is also presented."

165. Given the number of species included in this report that are not listed as mandatory for data collection in logbooks for IOTC fisheries (Resolution 15/01), the WPEB **REQUESTED** that a small, remote working group is established to work intersessionally to prepare a document reviewing the appropriateness of the shark species lists in Resolution 15/01 (including rays. Given that a similar study is due to take place in 2018 for the southwestern Indian Ocean, this group should ideally meet in 2018 and prepare the document for submission to WPEB14. Any suggestions should be mindful of the practical difficulties fishers might have with species identification and avoid recommending requirements that could result in unreliable data reporting.

166. The WPEB **NOTED** the IUCN listings of a number of rays likely to interact with pelagic fisheries:

(i) *Mobula mobular* (formerly *Mobula japanica*) **-** listed as **EN** for the Arabian Seas.
(ii) *Mobula tarapacana* **-** listed as **EN** for the Arabian Seas.
(iii) *Mobula thurstoni* **-** listed as **EN** for the Arabian Seas.
(iv) *Mobula birostris* (formerly *Manta birostris*) **-** listed as **VU** for the Arabian Seas.

167. There was some discussion regarding the potential for developing a retention ban for these species, however, given the lack of new information provided on fisheries interactions, the WPEB **REQUESTED** that a working paper on rays is produced next year for the WPEB to consider further.

Southern hemisphere stock status assessment of porbeagle shark

168. The WPEB **NOTED** paper IOTC–2013–WPEB13–41 Rev_1, which presented a summary of the consultant's draft report (attached) on the southern hemisphere porbeagle (*Lamna nasus*) shark assessment which has been prepared for the WCPFC. The summary included the following:

"The Southern hemisphere porbeagle shark status assessment was a collaborative study involving many countries, with New Zealand, Japan, Argentina, Uruguay, and Chile providing standardized CPUE and other types of indicators. The population structure, considered unlikely to comprise a well-mixed stock, was subdivided into five subpopulations or regions by longitude. The Western Indian/Eastern Atlantic, Eastern Indian, and Western Pacific regions were assessed using indicators and a spatially explicit sustainability risk assessment. The Eastern Pacific and Western Atlantic regions were assessed with indicators only. Catch rate indicators were short, variable, and uncertain, with most either stable or increasing. Only the Argentinian size and sex indicators showed trends, with a small decline in sizes for both sexes, and a slight trend towards less female bias. The quantitative risk assessment estimated the highest fishing mortalities in the Western Indian/East Atlantic Oceans, and lowest in the Western Pacific Ocean. Risk was determined from the relationship between F estimates and the Limit Reference Point (LRP), for three alternative values of the LRP, $F_{msm} = r/2$, $F_{lim} = 0.75r$, and $F_{crash} = r$. For all assessed regions and in all years assessed (1992-2014), combined F was less than 9% of the F_{crash}, less than 12% of F_{lim}, and less than 18% of F_{msm}, and fell to half those levels in more recent years. There was at most a 6% probability of exceeding the F_{msm} in 2010-2014. This scenario is based on 100% capture mortality, and assuming that some porbeagles survive their encounter with the fishery would reduce the estimated risk levels even further".

169. The WPEB **NOTED** the large amount of work that had been completed on the porbeagle risk assessment and **CONGRATULATED** the authors of the study on their work.

170. The WPEB **NOTED** that although it is mandatory for fleets to report porbeagle shark interactions in IOTC fisheries, there is no IOTC Executive Summary or management advice produced for porbeagle given that, based on its southern distribution, it falls under the mandate of the CCSBT.

171. **ACKNOWLEDGING** the limited interactions between porbeagle and fisheries in IOTC area of competence but **NOTING** the vulnerability of this species, the WPEB **ENCOURAGED** CPCs to continue to report interactions to IOTC, especially for fisheries operating in more southern areas.

9.2.1 Nominal and standardised CPUE indices

Shortfin mako shark

172. The WPEB **NOTED** paper IOTC–2017–WPEB13–35 which detailed the catch, standardised CPUE and size data for smallfin mako shark from the Portuguese pelagic longline fishery from 1998 to 2016, including the following abstract provided by the author:

> *"This working document provides fishery indicators for the shortfin mako shark captured by the Portuguese pelagic longline fishery in the Indian Ocean, in terms of catches, effort, standardized CPUEs and size distribution. The analysis was based on data collected from fishery observers, skipper's logbooks (self sampling) and official logbooks collected between 1998 and 2016. The mean sizes were compared between years and seasons (quarters). The CPUEs were analyzed for the Indian Ocean and compared between years, and were modeled with Tweedie GLM models for the CPUE standardization procedure. In general, there was a large variability in the nominal CPUE trends with the standardized CPUEs relatively similar to the nominal trends. In terms of size distributions there were some spatial trends with larger specimens tending to occur in the central and eastern areas and smaller specimens in the southwest Indian Ocean. The size distribution time series showed slight increases in mean sizes through time."*

173. **NOTING** the low level of deviance explained by the standardisation model for shortfin mako (<10%) which was mostly explained by the year effect, and hence that the standardised CPUE closely follows the nominal CPUE, the WPEB **SUGGESTED** that the authors investigate the potential inclusion of additional covariates.

174. The WPEB also **NOTED** the size distribution data shown, in this case likely correlated with the longitudinal distribution of the fleet.

175. Given the availability of CPUE series and size information for some fleets, the WPEB discussed the appropriateness of a shortfin mako shark stock assessment in the future and **AGREED** to incorporate this in the WPEB workplan.

9.2.2 Selection of Stock Status indicators for other sharks

176. The WPEB **AGREED** that the species Executive Summary for shortfin mako would be updated with the new CPUE series. As no new information was presented for other shark species in 2017, the WPEB **AGREED** that previous indicators (if any), as well as the most recent catch estimates, would be used to update the management advice from last year.

9.3 Development of management advice on the status of other shark stocks and update of other shark species Executive Summaries for the consideration of the Scientific Committee

177. The WPEB **ADOPTED** the management advice developed for a subset of other shark species commonly caught in IOTC fisheries for tuna and tuna-like species, as provided in the draft resource stock status summaries and **REQUESTED** that the IOTC Secretariat update the draft stock status summary for sharks with the latest 2016 catch data, and for the summary to be provided to the SC as part of the draft Executive Summary, for its consideration:
    - Oceanic whitetip sharks (*Carcharhinus longimanus*)– Appendix X
    - Scalloped hammerhead sharks (*Sphyrna lewini*) – Appendix XI
    - Shortfin mako sharks (*Isurus oxyrinchus*) – Appendix XII
    - Silky sharks (*Carcharhinus falciformis*) – Appendix XIII
    - Bigeye thresher sharks(*Alopias superciliosus*) – Appendix XIV
    - Pelagic thresher sharks(*Alopias pelagicus*) – Appendix XV

10. MARINE TURTLES

10.1.1 Review new information on marine turtle biology, ecology, fisheries interactions and bycatch mitigation measures

Marine turtle mortality in Sri Lanka

178. The WPEB **NOTED** paper IOTC–2017–WPEB13–36 which provided an overview of the status, issues, threats and conservation strategies used to minimise marine turtle mortality in Sri Lanka, including the following abstract provided by the authors:

"Of the seven living sea turtle species recorded in the world, five species were reported in the coastal belt of Sri Lanka coming for nesting: Green Turtle (Chelonia mydas),Olive Ridley (Lepidochelys olivacea), Hawksbill (Eretmochelys imbricata), Loggerhead (Caretta caretta) and Leatherback (Dermochelys coriacea). Incidental by-catch, illegal poaching of eggs, natural predation on eggs and hatchlings and habitat change and destruction are some of obvious threats faced by marine turtles in Sri Lanka. Number of strategies and measures are being applied to minimize the interactions with sea turtles through modifications of fishing gear and fishing practices. In Sri Lanka, marine turtles are protected under the Fauna and Flora Protection Ordinance administered by the Department of Wildlife Conservation since 1st March 1937 (Amended 20th July 1972) and the Fisheries Aquatic Resources Act of 1996. In 1979.Sri Lanka entered into the CITES agreement." (see paper for full abstract)

179. The WPEB **NOTED** that the main turtle nesting areas in Sri Lanka are located in the southwestern and southern part of the country and, although the paper presents data on sea turtle eggs in aggregate, there are species-specific data available.

Marine turtle bycatch recorded by Japanese observers

180. The WPEB **NOTED** paper IOTC–2017–WPEB13–37 Rev_1 which provided a summary of turtle bycatch from the Japanese Observer programme in the IOTC Area of Competence, including the following abstract provided by the authors:

"This document overviewed sea turtle bycatch occurred in the IOTC Convention Area obtained through Japanese Observer Program. The fishing areas covered in IOTC and CCSBT from 2010 to 2015 and 1992 and 2015, respectively. In total, 28 and 4 million hooks were observed by on-board observers for shallower-set and deeper-set longlines, respectively. Geographical distribution of bycatch changed not only among set types but also among species. Olive ridley occurred the most frequently in the bycatch data, followed by loggerhead and leatherback. There were no observations of green, hawksbill and flatback turtle in those data. Almost all the loggerheads were by-caught around the South African waters by shallower-sets. No olive ridley was caught in the south of 20^{o} S. Leatherbacks were caught around South African and equatorial waters by both set types. Bycatch rate (per 1,000 hooks) of shallower-sets for leatherback, loggerhead, olive ridley, and unidentified turtle were 0.00009, 0.0003, 0, and 0.0001, respectively. Mean bycatch rate of deeper-sets were 0.001, 0.0003, 0.011, and 0.012 for leatherback, loggerhead, olive ridley, and unidentified turtle, respectively". (see paper for full abstract)

181. The WPEB **NOTED** the explanation that the floatlines used in the shallower and deeper set fisheries are approximately the same length and therefore using hooks between floats is considered the most appropriate way of accounting for the variability in hook depth. Japanese longliners fishing on the high seas operate deep set longlines, but these were separated into slightly deeper (>14 hbf) and slightly shallower (6-13 hbf) in this study.

182. The WPEB **NOTED** the high proportion (50%) of interactions that are not reported to species level. Observers on Japanese vessels take photographs which are used by the Japan Fisheries Research Agency personnel to identify the sea turtle species, so the unidentified turtles are those for which no photograph was available. The WPEB **ENCOURAGED** use of the IOTC species identification guides by observers to assist with species-specific reporting in future, although the greater difficulty of identifying juvenile sea turtles was acknowledged. The WPEB also **DISCUSSED** the possibility of exploring modelling approaches to predict the species of the unidentified turtles using multinomial models based on spatial and seasonal effects; trials in the Atlantic have shown relative accuracy using this method.

183. The WPEB also **NOTED** that both de-hookers and line cutters are carried onboard these vessels, and that observers record the condition (dead or alive) of sea turtles with many being recorded as alive.

Joint analysis of marine turtle mitigation measures

184. The WPEB **NOTED** paper IOTC–2017–WPEB13–38 describing a joint analysis of sea turtle mitigation effectiveness recently conducted for the Pacific Ocean under the Common Ocean (ABNJ) Tuna Project, including the following abstract provided by the authors:

"Representatives from 21 countries and organizations convened twice in 2016 to assess the effectiveness of mitigation in Pacific longline fisheries. Over 2,300 leatherback, loggerhead, olive ridley and green sea turtle interactions with longline fishery gear across the Pacific were analysed. The effects of various gear types such as hook type, bait type, soak time and depth of hooks, as well as environmental variables such as sea surface temperature and distance to land, on sea turtle interactions (hookings) and mortalities were estimated. These results were used to construct a baseline (2010-2015) of sea turtle interactions and mortalities representing the current implementation status of the WCPFC's sea turtle management measure (CMM 2008-03). The workshop then compared the baseline to a series of scenarios testing the degree to which additional mitigation would further reduce interactions and mortalities. Modelling of mitigation measures included use of large (16/0 or larger) circle hooks, finfish bait, and removal of the first, or first and second, hook positions closest to the float – the shallowest hooks – in each basket (and combinations of two or more of these measures). The scenarios also explored the effects of applying the mitigation to different sectors of the longline fishery – shallow swordfish targeting, shallow non-swordfish targeting and/or deep sectors. The workshop conclusions were presented as proportional increases or decreases in interactions or mortalities relative to the baseline."

185. **NOTING** the findings of the Pacific workshop regarding the effectiveness of large circle hooks, finfish bait and the removal of the first and/or second hooks next to the floats for mitigating sea turtle interactions and mortalities in Pacific longline fisheries, the WPEB **AGREED** that further consideration of these mitigation techniques for Indian Ocean fisheries is warranted. Such a study should attempt to develop findings regarding the consequences of various mitigation techniques, primarily with regard to impacts on target and non-turtle bycatch species catch rates, to the extent possible based on data availability and quality. The WPEB therefore **RECOMMENDED** that the potential for a similar workshop to be held in the Indian Ocean is explored with potential funding from the Commission and/or from the Common Oceans Tuna Project (ABNJ). The WPEB **AGREED** to include this in the WPEB workplan and **REQUESTED** the Chairperson work with the Secretariat to pursue this idea further with potential participants and funding sources.

186. The WPEB **NOTED** the Pacific workshop's recommendations for additional data collection by observers, but expressed concerns about the practicality of the proposed additional workload for observers as well as whether the data could be obtained in alternative ways (e.g. through electronic monitoring or determining minimum hook width from hook catalogues). The author clarified that some changes to WCPFC observer data collection protocols were agreed in 2015 and thus it may be too soon to propose the new workshop recommendations as another round of changes.

10.2 Review of mitigation measures in Resolution 12/04

187. The WPEB **NOTED** paragraph 11 of IOTC Resolution 12/04 states:

(para. 11) The IOTC Scientific Committee shall request the IOTC Working Party on Ecosystems and Bycatch to:

- *a) Develop recommendations on appropriate mitigation measures for gillnet, longline and purse seine fisheries in the IOTC area;*
- *b) Develop regional standards covering data collection, data exchange and training;*
- *c) Develop improved FAD designs to reduce the incidence of entanglement of marine turtles, including the use of biodegradable materials.*

188. The WPEB **NOTED** Table 10 (Table14 from the FAO Fisheries and Aquaculture Technical Paper #588t "Bycatch in Longline Fisheries for Tuna and Tuna-like Species: a global review of status and mitigation measures") and, noting that IOTC's current resolution calls for, inter alia, implementation of safe handling practices, encouraging the use of fish bait and reporting sea turtle interactions and mortality annually, **AGREED** that CPCs should review and report on the extent to which their fisheries have implemented this resolution. The WPEB **RECOMMENDED** the following table (Table 11) to be completed by CPCs and submitted to the Secretariat in order to review the effectiveness of Resolution 12/04 as requested by the Commission. This table was suggested as an appropriate format for summarizing the information for the consideration and discussion of the SC, based on the seabird data call carried out in 2016.

189. The WPEB **REQUESTED** the following changes are made to the table for presentation to the SC:

- Inclusion of a column for species name

- Use standard area specification (5 by 5 for LL and 1 by 1 for surface fisheries)
- Effort units that are appropriate for LL (hooks/sets), PS and GN fleets (sets/fishing days)
- The deadline for data submissions should be June 2018

Table 10. Comparison of currently active tRFMO conservation and management measures pertaining to sea turtles

t-RFMO	CMM	Major provisions relevant to longline fisheries	A	B	C	D	E	F	G
CCSBT*	Oct 2011	Implement FAO Guidelines; comply with all ICCAT, IOTC and WCPFC measures; report data on interactions to the Commission which is authorized to exchange it with other t-RFMOs	X	X					
IATTC	Resolution 04-05 (Rev 2)	Prompt release unharmed; voluntarily provide bycatch data; training and equipment for safe release		X	X		X		
	Resolution 04-07	Voluntarily provide data on interactions; bycatch mitigation research; informational materials for fishers		X		X	X		
	Resolution 07-03	Implement the FAO Guidelines; require vessels to carry and use safe release equipment; continue mitigation research; Secretariat to further consider mitigation measures	X		X	X		X	
ICCAT	Recommendation 03-11	Encourage provision of data on interactions; encourage safe handling and release		X	X				
	Recommendation 05-08	Undertake trials of circle hooks; exchange information on safe release techniques			X	X			
	Recommendation 10-09	Starting in 2012 report annually on interactions; carry and use safe handling equipment; ICCAT to conduct impact assessment by 2013 and consider additional mitigation measures; members to report on implementation including FAO guidelines annually	X	X	X		X	X	
IOTC	Resolution 12/04	Implement the FAO Guidelines; report interactions and mortalities annually; carry and use safe handling equipment; identification cards for fishers; encourage use of finfish bait; report all interactions in logbooks; continue bycatch mitigation research; Commission to consider additional mitigation measures	X	X	X	X	X	X	X
WCPFC	CMM 2008-03	Implement the FAO Guidelines; report interactions annually; safe handling and release guidelines for fishers; carry and use safe handling equipment; shallow-set longlines must either (i) use large circle hooks, (ii) use whole finfish bait, or (iii) employ another measure approved by the Scientific Committee; all interactions to be recorded in logbooks and reported to Commission; continue mitigation research; Commission to consider additional mitigation measures.	X	X	X	X	X	X	X

* The CCSBT's convention area overlaps with those of ICCAT, IOTC and WCPFC in the higher latitudes of the Southern Hemisphere, where it has been suggested that sea turtle interactions are less problematic than in other areas (FAO, 2010).

Notes: A = implement FAO Guidelines; B = reporting of interactions; C = safe handling and release; D = conduct bycatch mitigation research; E = information for fishers; F = impact assessment and consideration of further mitigation; G = reference to specific mitigation measures.

Table 11. Example table for data request as used in the 2016 seabird data call

Fishery:		Observed			
Time period*					
Area[1]	Total effort[2] (hooks/sets)	Total observed effort[2] (hooks/sets)	Captures (number)	Mortalities (number)	Live releases (number)
Total					

*This field can be used to specify a temporal stratification to the data e.g. season.

[1]Spatial stratification at the finest scale possible.

[2] Effort should preferentially be provided in number of hooks, or sets where this is not possible.

190. The WPEB **NOTED** that completing such a summary table would not replace the need for CPCs to formally submit data to the IOTC Secretariat as required by IOTC Resolutions.

10.3 Development of management advice on the status of marine turtle species and update of the Executive Summary for the consideration of the Scientific Committee

191. The WPEB **ADOPTED** the management advice developed for marine turtles, as provided in the draft status summary and **REQUESTED** that the IOTC Secretariat update the draft stock status summary with the latest 2016 interaction data, and for the summary to be provided to the SC as part of the draft Executive Summary, for its consideration:
    - Marine turtles (Appendix XVI).

11. OTHER BYCATCH AND BYPRODUCT SPECIES INTERACTIONS

11.1 Review new information on other bycatch and byproduct, in terms of biology, ecology, fisheries interactions and bycatch mitigation measures

192. The WPEB **NOTED** the information paper (IOTC-2017-WPEB13-INF18) describing the Bycatch Management Information System (BMIS) and **ENCOURAGED** CPCs to provide feedback on the initiative **(**www.bmis-bycatch.org**).**

11.2 Review of new information on the retention of non-target species by purse seiners (Resolution 17/04)

193. The WPEB **AGREED** that this item should be given a higher priority ranking in the WPEB programme of work.

11.3 Seabirds

11.3.1 Review new information on seabird biology, ecology, fisheries interactions and bycatch mitigation measures

194. The WPEB **NOTED** paper IOTC–2017–WPEB13–39 which provided an update on the seabird component of the FAO Common Oceans Tuna Project (ABNJ), implemented by BirdLife South Africa, including the following abstract provided by the authors:

    "This paper provides the outcomes of two Regional Seabird Bycatch Pre-assessment Workshops held in early 2017, together with some explanatory background. An agreed next step is that a data preparation workshop, along the lines of stock assessment workshops and CPUE standardisation processes, will be held in February 2018." (see paper for full abstract)

195. The WPEB **NOTED** that this project component involves undertaking the first ever global assessment of seabird bycatch from tuna longline fisheries in waters south of 25°S across all three oceans and all five tuna RFMOs.

196. The WPEB **NOTED** that fisheries logbook and observer data are required for this evaluation, and will be convened along the lines of stock assessment and CPUE standardisation processes. Therefore the WPEB **ENCOURAGED** scientists from CPCs with fisheries relevant to this project to prepare datasets and participate in the planned data preparation workshop, to be held in February 2018.

South Georgia albatrosses and petrels

197. The WPEB **NOTED** paper IOTC–2017–WPEB13–43 which identified the areas, season and fleets with the highest probability of bycatch of South Georgia albatrosses and petrels, including the following abstract provided by the authors:

    "This paper presents an analysis of tracking data for 4 procellariiform seabirds from South Georgia, and calculates overlap with pelagic longline fisheries in the Southern Ocean for the period 1990-2009. We used an unusually comprehensive tracking dataset from all major life-history stages (including juvenile stages), weighted according to the proportion of the population they represented (based on demographic models), in order to generate population-level distributions by month. This analysis confirms that the IOTC area is important for grey-headed and wandering albatrosses, and to a lesser extent black-browed albatrosses, with hotspots of overlap with fisheries in the southwest Indian Ocean, between the Prince Edward Islands and South Africa, and in the southeast Indian Ocean. Overlaps were particularly high with fleets from Japan and Chinese Taipei, and to a lesser extent South Korea and Spain, and highest during

winter months (May–September; when fishing effort south of 30°S is greatest). The areas identified here largely match areas where high rates of bycatch have been recorded, emphasizing the need for use of bycatch mitigation measures."

198. The WPEB **NOTED** that juvenile mortality was assessed based on demographic studies that took place prior to the expansion of the tuna fisheries, and that the main source of mortality for these seabirds is currently from the tuna longline fleets.

11.3.2 Review of mitigation measures in Resolution 12/06

199. No new advice on mitigation measures was proposed.

11.3.3 Development of management advice on the status of seabird species

200. The WPEB **ADOPTED** the management advice developed for seabirds, as provided in the draft status summary and **REQUESTED** that the IOTC Secretariat update the draft stock status summary with the latest 2016 interaction data, and for the summary to be provided to the SC as part of the draft Executive Summary, for its consideration:
    - Seabirds (Appendix XVII).

11.4 Marine mammals

11.4.1 Review new information on marine mammal biology, ecology, fisheries interactions and bycatch mitigation measures

201. The WPEB **NOTED** paper IOTC–2017–WPEB13–40 which provided an updated review on the bycatch of marine mammals in the western Indian Ocean, including the following abstract provided by the authors:

"Here we review available information on cetacean bycatch in all commercial fisheries known to occur in the western Indian Ocean. In coastal waters of the region, the magnitude of bycatch has only been quantified for driftnets targeting large pelagic fish off Zanzibar. Based on bycatch levels and abundance of coastal dolphins, it has been shown that the removals are unsustainable, particularly for Indo-Pacific bottlenose dolphins (Tursiops aduncus) and Indian Ocean humpback dolphins (Sousa plumbea). Elsewhere in the region, bycatch is known to involve other species as well, including coastal, oceanic and migratory species such as humpback whales (Megaptera novaeangliae), mostly in bottom-set and drift gillnets. In open-ocean fisheries, bycatch in pelagic longlines has particularly involved small and medium-sized delphinids (Globicephala macrorhynchus, Grampus griseus, Tursiops truncatus, Pseudorca crassidens, Stenella spp., etc.) although data are sparse. In tuna purse-seine fisheries, captain logbooks (1980-2011) and observer data (1995-2011) recorded high co- occurrence with cetaceans, particularly east of the Seychelles (December to March) and in the Mozambique Channel (April and May). However, few cetacean deaths were reported. Captures of large whales (Balaenoptera spp.) in purse-seines in the western tropical Indian Ocean have been reported. This review also presents information on bycatch in coastal and offshore tuna gillnets from various locations. Overall, cetacean bycatch is very poorly documented in the region and more systematic assessment is critical, particularly for those fisheries that use gear known to entangle or entrap cetaceans." (see paper for full abstract)

202. The WBEP **RECALLED** Resolution 13/04 *On the conservation of cetaceans*, which includes data collection and reporting requirements at the species-specific level, where possible, and the banning of intentional sets on marine mammals. Although these are mandatory requirements for all CPCs there is still a lack of data regarding species-specific marine mammal bycatch in the IOTC Area of Competence, particularly for tuna gillnet fisheries where interactions are of particular concern.

203. The WBEP **NOTED** the vulnerability of marine mammals to population decline after relatively few fishery interactions due to their highly conservative life histories and, at times, demographic isolation.

204. The WBEP **NOTED** that limited data indicate declines for several marine mammal species in the Indian Ocean (e.g. Indian Ocean humpback dolphins *Sousa plumbea*, Indo-Pacific humpback dolphin *Sousa chinensis*, Indo-Pacific bottlenose dolphin *Tursiops aduncus*) and that capture in tuna gillnet fisheries is an important source of mortality. The WBEP **REQUESTED** that CPCs collect data on the effectiveness of mitigation techniques intended to reduce bycatch in these fisheries and implement successful mitigation strategies.

205. The WBEP **NOTED** the likelihood of gillnet entanglement on the high seas, particularly during IUU fishing, where gillnets of greater than 2.5 km could still be in use.

206. The WBEP **REQUESTED** the Chair and the IOTC Secretariat begin discussions on the potential for collaboration with the International Whaling Commission and other national and international institutions to facilitate capacity building within CPCs regarding the establishment of marine mammal bycatch mitigation programs.

11.4.2 Development of management advice on the status of marine mammal species

207. The WPEB **NOTED** that to-date there has been no advice developed by the WPEB for marine mammals, however, the WPEB **AGREED** that cetacean bycatch assessment and mitigation is an important issue for consideration.

208. Therefore the WPEB **ADOPTED** the management advice developed for cetaceans, as provided in the draft status summary and **REQUESTED** that the IOTC Secretariat update the draft stock status summary with the latest 2016 interaction data, and for the summary to be provided to the SC as part of the draft Executive Summary, for its consideration:
    - Cetaceans (Appendix XVIII).

12. WPEB PROGRAM OF WORK

12.1 Revision of the WPEB Program of Work 2018–2022

209. The WPEB **NOTED** paper IOTC–2013–WPEB13–10 which provided the WPEB13 with the latest Program of Work (2018-2022) with an opportunity to consider and revise this by taking into account the specific requests of the Commission and Scientific Committee, given the current status of resources available to the IOTC Secretariat and CPCs.

210. The WPEB **RECALLED** the request of the Scientific Committee in 2015 (SC17. para. 178) that: "*during the 2015 Working Party meetings, each group not only develop a Draft Program of Work for the next five years containing low, medium and high priority projects, but that all High Priority projects are ranked. The intention is that the SC would then be able to review the rankings and develop a consolidated list of the highest priority projects to meet the needs of the Commission. Where possible, budget estimates should be determined, as well as the identification of potential funding sources*."

211. The WPEB **RECOMMENDED** that the SC consider and endorse the WPEB Program of Work (2018–2022), as provided in Appendix XIX.

12.2 Development of priorities for an Invited Expert/s at the next Working Party on Ecosystems and Bycatch meeting

212. The WPEB **NOTED,** with thanks, the excellent contributions of the Invited Expert for the meeting, Dr Felipe Carvalho, particularly his excellent inputs and contributions to the stock assessments for blue shark, and **ENCOURAGED** him to maintain links with IOTC scientists to aid in the improvement of approaches to assess ecosystem and bycatch issues in the IOTC area of competence.

213. The WPEB **AGREED** to the following core areas of expertise and priority areas for contribution that need to be enhanced for the next meeting of the WPEB in 2018, by the Invited Expert:
    - **Expertise:** Ecological Risk Assessments (priority area), including from regions other than the Indian Ocean; Ecosystem Based Fisheries Management; indicator-based analysis.

13. OTHER BUSINESS

13.1 Future format of WPEB

214. The WPEB **RECALLED** its previous recommendation to the Scientific Committee:
*"The WPEB **RECOMMENDED** that the SC note the following:*
    - *The WPEB **DISCUSSED** the future format in order to focus the efforts of scientists working on different groups of bycatch species to address more efficiently, the mandate of the group.*
    - *The WPEB **CONSIDERED** a range of options which the SC is asked to consider:*

- *Option 1: The current WPEB be split into two; A dedicated Working Party on Sharks (WPS) and a Working Party on Ecosystems and Bycatch (WPEB).*
- *Option 2: Retaining the WPEB in its current form, with alternating focus of sharks in one year, followed by other ecosystem and bycatch issues in the next year.*
- *Option 3: Maintaining the WPEB with clear guidelines to deal with sharks every year, as well as other issues and bycatch groups in alternate years or as required.*

- *The WPEB **AGREED** that shark issues were important to address on a yearly basis". (Para. 253, IOTC-2013-WPEB09-R)*

and the response of the Scientific Committee:

"The SC AGREED that the WPEB should be maintained as a single working party for the next few years, to deal with sharks every year, as well as other issues, especially ecosystem related matters, and bycatch groups in alternate years or as required by the Commission". (Para. 58, IOTC-2013-SC)

215. The WPEB **NOTED** that this approach has not proved successful, particularly in years when a stock assessment has been undertaken as the large number of papers submitted (~60) cannot be fully considered in the time available. The WPEB therefore **RECOMMENDED** that in future years when a stock assessment is planned, the meeting is extended in length by a number of days to more adequately accommodate the workplan, with some of the days dedicated exclusively to the stock assessment work.

13.2 Update: Ecosystem Based Fisheries Management (EBFM) joint meeting of tRFMOs in 2016

216. The WPEB **NOTED** paper IOTC–2017–WPEB13–INF09 which reported on the joint meeting of tuna RFMOs on the Implementation of the Ecosystem Approach to Fisheries Management, including the following abstract provided by the authors:

"The joint meeting of tuna RFMOs on the Implementation of the Ecosystem Approach to Fisheries Management represented an opportunity to better understand common challenges and opportunities in advancing the EAF and EBFM, and to bring this shared knowledge to the attention of the memberships of each t-RFMO. This meeting, initiated by ICCAT and supported by the Common Oceans ABNJ Tuna Project implemented by FAO and funded by the GEF, brought together scientists from the five t-RFMOs and national experts. The goals of the meeting were to (1) establish a sustained dialogue across t-RFMOs on the issues of EAF and its implementation, (2) understand common challenges in its implementation and (3) identify case specific solutions during the meeting, participants from each of the t-RFMOs presented a summary of the progress towards implementation of the EAF and EBFM and FAO presented the work of the organization on EAF". (see paper for full abstract)

217. The WPEB **NOTED** the report from the meeting held at FAO Headquarters in December 2016 on the implementation of ecosystem approaches to fisheries management. There are three main steps involved, firstly determining the management objectives, secondly developing the indicators for and finally the management responses to the results of the evaluation. The implementation of EAF/ EBFM should not only result in the sustainable utilisation of healthier marine ecosystems, but also bring several gains including socio-economic benefits.

218. The WPEB **NOTED** the need for training and capacity building as the first step to moving forward with developing goals and strategies for the implementation of EBFM and therefore **RECOMMENDED** that a workshop is held to explain the key elements of EBFM so that a plan for implementation of EBFM in the IOTC Area of Competence can be developed by 2019.

13.3 Date and place of the 14th and 15th Sessions of the Working Party on Ecosystems and Bycatch

219. The WPEB **AGREED** on the importance of having IOTC working party meetings within key CPCs catching species of relevance to the working party. Following a discussion on who would host the 14th and 15th Sessions of the WPEB in 2017 and 2018 respectively, the WPEB **NOTED** that the IOTC Secretariat would liaise with potential hosts intersessionally to determine who might be able to host the 14th Session in conjunction with the Working Party on Billfish. The meeting locations will be communicated by the IOTC Secretariat to the SC for its consideration at its next session in December 2017 (Table 12).

Table 12. Draft meeting schedule for the WPEB (2018 and 2019), proposed to continue to be held back-to-back with WPB.

	2018			2019		
Meeting	**No.**	**Date**	**Location**	**No.**	**Date**	**Location**
Working Party on **Billfish** (WPB)	16th	4-8 September (5d)	South Africa?	17th	9-13 September (5d)	?
Working Party on **Ecosystems and Bycatch** (WPEB)	14th	10-14 September (5d)	South Africa?	15th	3-7 September (5d)	?

220. The WPEB **NOTED** the importance of having a degree of stability in the participation of CPCs to each of the working party meetings and **ENCOURAGED** participants to regularly attend each meeting to ensure as much continuity as possible.

13.4 Election of a Chairperson and Vice-Chairperson for the next biennium

221. The WPEB **NOTED** that the second term of the current Chairperson, Dr Rui Coelho is due to expire at the end of the current WPEB meeting and as per the IOTC Rules of Procedure (2014), participants are required to elected a new Chairperson for the next biennium.

222. The WPEB **THANKED** Dr Rui Coelho for his Chairmanship over the past four years and looked forward to his continued engagement in the activities of the WPEB in the future.

223. **NOTING** the Rules of Procedure (2014), the WPEB **CALLED** for nominations for the newly vacated position of Chairperson of the IOTC WPEB for the next biennium. Dr Sylvain Bonhommeau was nominated, seconded and elected as Chairperson of the WPEB for the next biennium.

224. The WPEB **NOTED** that the first term of the current Vice-Chairpersons, Dr Ross Wanless and Mr Reza Shahifar are due to expire at the closing of the current WPEB meeting and as per the IOTC Rules of Procedure (2014), participants are required to elected a new Vice-Chairperson/s for the next biennium.

225. **NOTING** the Rules of Procedure (2014), the WPEB **CALLED** for nominations for the position/s of the Vice Chairperson of the IOTC WPEB for the next biennium. Dr Ross Wanless and Mr Reza Shahifar were nominated, seconded and re-elected as Vice-Chairpersons of the WPEB for the next biennium.

226. The WPEB **RECOMMENDED** that the SC note the new Chairperson, Dr Sylvain Bonhommeau and Vice-Chairpersons, Dr Ross Wanless and Mr Reza Shahifar, of the WPEB for the next biennium.

13.5 Review of the draft, and adoption of the Report of the 13th Session of the Working Party on Ecosystems and Bycatch

227. The WPEB **RECOMMENDED** that the Scientific Committee consider the consolidated set of recommendations arising from WPEB13, provided at Appendix XIX, as well as the management advice provided in the draft resource stock status summary for each of the seven shark species, as well of those for marine turtles and seabirds:

Sharks
- Blue sharks (*Prionace glauca*) – Appendix IX
- Oceanic whitetip sharks (*Carcharhinus longimanus*) – Appendix X
- Scalloped hammerhead sharks (*Sphyrna lewini*) – Appendix XI
- Shortfin mako sharks (*Isurus oxyrinchus*) – Appendix XII
- Silky sharks (*Carcharhinus falciformis*) – Appendix XIII
- Bigeye thresher sharks (*Alopias superciliosus*) – Appendix XIV
- Pelagic thresher sharks (*Alopias pelagicus*) – Appendix XV

Other species/groups
- Marine turtles – Appendix XVI
- Seabirds – Appendix XVII
- Marine mammals - Appendix XVIII

228. The report of the 13th Session of the Working Party on Ecosystems and Bycatch (IOTC–2017–WPEB13–R) was **ADOPTED** on the 8th September 2017.

APPENDIX I
LIST OF PARTICIPANTS

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APPENDIX II
AGENDA FOR THE 13TH WORKING PARTY ON ECOSYSTEMS AND BYCATCH

Date: 4 - 8 September 2017
Location: San Sebastián, Spain
Venue: AZTI Tecnalia, Pasaia
Time: 09:00 – 17:00 daily
Chair: Dr Rui Coelho (EU,Portugal); **Vice-Chair**: Dr Reza Shahifar (I.R. Iran) & Dr Ross Wanless (South Africa)

1. **OPENING OF THE MEETING** (Chairperson)

2. **ADOPTION OF THE AGENDA AND ARRANGEMENTS FOR THE SESSION** (Chairperson)

3. **THE IOTC PROCESS: OUTCOMES, UPDATES AND PROGRESS**
   - 3.1 Outcomes of the 19th Session of the Scientific Committee (IOTC Secretariat)
   - 3.2 Outcomes of the 21st Session of the Commission (IOTC Secretariat)
   - 3.3 Review of Conservation and Management Measures relevant to Ecosystems and Bycatch (IOTC Secretariat)
   - 3.4 Progress on the recommendations of WPEB12 (IOTC Secretariat)

4. **REVIEW OF DATA AVAILABLE ON ECOSYSTEMS AND BYCATCH**
   - 4.1. Review of the statistical data available for ecosystems and bycatch species (IOTC Secretariat)

5. **REVIEW OF NATIONAL BYCATCH ISSUES IN IOTC MANAGED FISHERIES AND NATIONAL PLANS OF ACTION** (sharks; seabirds; marine turtles) (CPCs and IOTC Secretariat)
   - 5.1. Review of applications for '*not applicable*' NPOA status (IOTC Secretariat)
   - 5.2. Updated status of development and implementation of National Plans of Action for seabirds and sharks, and the implementation of the FAO guidelines to reduce marine turtle mortality in fishing operations (CPCs).

6. **NEW INFORMATION ON BIOLOGY, ECOLOGY, FISHERIES AND ENVIRONMENTAL DATA RELATING TO ECOSYSTEMS AND BYCATCH SPECIES**
   - 6.1. Review new information on environment and ecosystem interactions and modelling, including climate change issues affecting pelagic ecosystems in the IOTC area of responsibility (all)

7. **GILLNET FISHERIES: PROBLEMS AND NEEDS** (recommendations from the SC / decisions of the Commission)
   - 7.1. Regional review of the data available for gillnet fleets operating in the Indian Ocean (all)
   - 7.2. Training on species identification, bycatch mitigation and data collection for gillnet fleets – updates, plans of action and identification of other potential sources of assistance (all)

8. **BLUE SHARK**
   - 8.1. Review new information on blue shark biology, stock structure, bycatch mitigation measures, fisheries and associated environmental data (all)
   - 8.2. Review of new information on the status of blue shark (all)
     - Nominal and standardised CPUE indices
     - Stock assessments (including data poor approaches)
     - Selection of Stock Status indicators for blue shark
   - 8.3. Development of management advice for blue shark and update of blue shark Executive Summary for the consideration of the Scientific Committee (all)
     - Consideration of options for alternative management measures for blue shark in the IOTC area of competence

9. OTHER SHARKS AND RAYS

9.1. Review new information on other shark and ray biology, stock structure, bycatch mitigation measures, fisheries and associated environmental data (all)

9.2. Review of new information on the status of other sharks (all)
- Nominal and standardised CPUE indices
- Selection of Stock Status indicators for other sharks

9.3. Development of management advice on the status of other shark stocks and update of other shark species Executive Summaries for the consideration of the Scientific Committee (all)
- Consideration of options for alternative management measures for other sharks in the IOTC area of competence

10. MARINE TURTLES

10.1. Review new information on marine turtle biology, ecology, fisheries interactions and bycatch mitigation measures (all);

10.2. Review of mitigation measures in Resolution 12/04 (all);

10.3. Development of management advice on the status of marine turtle species and update of the Executive Summary for the consideration of the Scientific Committee (all).

11. OTHER BYCATCH AND BYPRODUCT SPECIES INTERACTIONS

11.1. Review new information on other bycatch and byproduct, in terms of biology, ecology, fisheries interactions and bycatch mitigation measures (all)

11.2. Review of new information on the retention of non-target species by purse seiners (Resolution 17/04) (all)

11.3. Seabirds
- Review new information on seabird biology, ecology, fisheries interactions and bycatch mitigation measures (all);
- Review of mitigation measures in Resolution 12/06 (all);
- Development of management advice on the status of seabird species (all).

11.4. Marine mammals
- Review new information on marine mammal biology, ecology, fisheries interactions and bycatch mitigation measures (all);
- Development of management advice on the status of marine mammal species (all).

12. WPEB PROGRAM OF WORK

12.1. Revision of the WPEB Program of Work 2018–2022 (Chairperson and IOTC Secretariat)

12.2. Development of priorities for an Invited Expert/s at the next Working Party on Ecosystems and Bycatch meeting (Chairperson)

13. OTHER BUSINESS

13.1. Update: Southern hemisphere stock status assessment of porbeagle shark (all)

13.2. Update: Ecosystem Based Fisheries Management (EBFM) joint meeting of tRFMOs (Chairperson)

13.3. Date and place of the 14th and 15th Sessions of the Working Party on Ecosystems and Bycatch (Chairperson and IOTC Secretariat)

13.4. Election of a Chairperson and Vice-Chairperson for the next biennium (IOTC Secretariat)

13.5. Review of the draft, and adoption of the Report of the 13th Session of the Working Party on Ecosystems and Bycatch (Chairperson)

APPENDIX III
LIST OF DOCUMENTS

Document	Title	Availability
IOTC–2017–WPEB13–01a	Agenda of the 13th Working Party on Ecosystems and Bycatch	✓ 16 February
IOTC–2017–WPEB13–01b	Annotated agenda of the 13th Working Party on Ecosystems and Bycatch	✓ 14 August
IOTC–2017–WPEB13–02	List of documents of the 13th Working Party on Ecosystems and Bycatch	✓ 14 August
IOTC–2017–WPEB13–03	Outcomes of the 19th Session of the Scientific Committee (IOTC Secretariat)	✓ 14 August
IOTC–2017–WPEB13–04	Outcomes of the 21st Session of the Commission (IOTC Secretariat)	✓ 14 August
IOTC–2017–WPEB13–05	Review of Conservation and Management Measures relevant to ecosystems and bycatch (IOTC Secretariat)	✓ 14 August
IOTC–2017–WPEB13–06	Progress made on the recommendations and requests of WPEB12 and SC19 (IOTC Secretariat)	✓ 16 August
IOTC–2017–WPEB13–07	Review of the statistical data and fishery trends for ecosystems and bycatch species (IOTC Secretariat)	✓ 14 August
IOTC–2017–WPEB13–08	Update on the implementation of the IOTC Regional Observer Scheme (IOTC Secretariat)	✓ 21 August
IOTC–2017–WPEB13–09	Status of development and implementation of National Plans of Action for seabirds and sharks, and implementation of the FAO guidelines to reduce marine turtle mortality in fishing operations (IOTC Secretariat)	✓ 21 August
IOTC–2017–WPEB13–10	Revision of the WPEB Program of Work (2018–2022) (IOTC Secretariat & Chairperson)	✓ 21 August
IOTC–2017–WPEB13–11	Update on shark catch characteristics by national longliner fleets in Madagascar (2010-2016) (Y. Razafimandimby)	✓ 21 August
IOTC–2017–WPEB13–12	Iranian fishing vessels By-catch in IOTC competence of area in 2016 (R. Shahifar)	✓ 21 August
IOTC–2017–WPEB13–13	Estimation Iran sharks catch historical data 1950-2016 (R. Shahifar)	✓ 21 August
IOTC–2017–WPEB13–14	The current status and management of South Africa's Chondrichthyan fisheries (C. Da Silva, A.J. Booth, S.F.J. Dudley , S.E. Kerwath, S. J. Lamberth, R. W. Leslie, M.E. McCord, W.H.H. Sauer, T. Zweig)	✓ 19 July
IOTC–2017–WPEB13–15	The review of bycatch in Thailand in relation to IOTC species (S. Panjarat, K. Mehroh and S. Rodpradit)	✓ 21 August
IOTC–2017–WPEB13–16	Skipjack tuna (Katsuwonus pelamis) feeding habitat dynamics and accessibility to purse seine fisheries in the Atlantic and Indian Oceans (D. Jean-Noël, E. Chassot, H. Murua, J.Lopez)	✓ 3 August
IOTC–2017–WPEB13–17	Comparing electronic monitoring system with observer data for estimating bycatch and discards on French tropical tuna purse seine vessels (CAT OOE program)(K. Briand, A. Bonnieux, W. Le Dantec, S. Le Couls, P. Bach, A. Maufroy, A. Relot-Stirnemann, P. Sabarros, A.-L. Vernet, F. Jehenne, M. Goujon)	✓ 21 August
IOTC–2017–WPEB13–18	Description of the tuna gillnet capacity and bycatch in the IOTC convention area (M. Aranda and J. Santiago)	✓ 29 August
IOTC–2017–WPEB13–19	Major bycatch reduction of cetaceans and marine turtles by use of subsurface gillnets in Pakistan (M. Moazzam and R. Nawaz)	✓ 25 August (Abstract only)
IOTC–2017–WPEB13–20	Age and growth of blue shark in the Indian Ocean (I. Andrade, D. Rosa, R. Lechuga and R. Coelho)	✓ 21 August
IOTC–2017–WPEB13–21	Estimating population growth rate for Indian Ocean blue shark (Prionace glauca) using demographic method (Z. Geng, J. Zhu)	✓ 21 August
IOTC–2017–WPEB13–22	Catch reconstruction for the Indian Ocean blue shark: an alternative hypothesis based on ratios (R.Coelho & D. Rosa)	✓ 25 July
IOTC–2017–WPEB13–23	Approaches to the reconstruction of catches of Indian Ocean blue shark (J.Rice, S.Martin, F.Fiorellato)	✓ 21 August

Document	Title	Availability
IOTC–2017–WPEB13–24	Blue shark catches and standardized CPUE for the Portuguese pelagic longline fleet in the Indian Ocean (R. Coelho, P. G. Lino & D. Rosa)	✓ 25 July
IOTC–2017–WPEB13–25	Standardized catch rates in biomass for the Blue shark (Prionace glauca) caught by the Spanish surface longline fleet in the Indian ocean during the 2001-2015 period (Fernández-Costa, J., Ramos-Cartelle, A., García-Cortés, B. and Mejuto, J.)	✓ 21 August
IOTC–2017–WPEB13–26 Rev_1	Standardized CPUE of blue shark in Indonesian tuna longline fishery estimated from scientific observer data period 2005 – 2016 (Dian	✓ 21 August ✓ 31 August
IOTC–2017–WPEB13–27	Standardized CPUE of Blue shark caught by the French swordfish longline fishery in the south-west Indian Ocean (2007-2016)) (P.S. Sabarros, R. Coelho, P. Bach)	✓ 28 August
IOTC–2017–WPEB13–28	Bycatch of the European purse-seine tuna fishery in the Indian Ocean for the 2008-2016 period (P. S. Sabarros, F.J. Abascal Crespo, M.J. Amandè, P. Cauquil, J. Lope, H. Murua, P.J. Pascual Alayon, M.L. Ramos Alonzo, J. Ruiz Gondra, Pascal Bach)	withdrawn
IOTC–2017–WPEB13–29 Rev_1	Revised standardized CPUE of blue shark (Prionace glauca) in the Indian Ocean estimated from Japanese observer data collected between 1992 and 2016 (Y. Semba)	✓ 21 August
IOTC–2017–WPEB13–30	Stock Reduction Analysis of Blue Shark (Prionace glauca) caught in the Indian Ocean (H. Andrade)	✓ 16 August
IOTC–2017–WPEB13–31	Application of JABBA (Just Another Bayesian Biomass Assessment) to Indian Ocean blue shark (H.Winker and F.Carvalho)	✓ 7 September
IOTC–2017–WPEB13–32 Rev_1	Stock assessment of Indian Ocean blue shark *(Prionace glauca)* using Bayesian Pella-Tomlinson production model (Z. Geng and J. Zhu)	✓ 16 August ✓ 21 August
IOTC–2017–WPEB13–33	Stock assessment blue shark (Prionace glauca) in the Indian Ocean using Stock Synthesis (J.Rice)	✓ 21 August
IOTC–2017–WPEB13–34 Rev_1	Modelling the oceanic habitats of Silky shark (Carcharhinus falciformis), implications for conservation and management (J. Lopez, D. Alvarez-Berastegui, M. Soto, H. Murua)	✓ 21 August ✓ 30 August
IOTC–2017–WPEB13–35	Fishery indicators for shortfin mako shark *(Isurus oxyrinchus)* caught by the Portuguese pelagic longline fishery in the Indian Ocean: Catch, effort, size distribution and standardized CPUEs (R. Coelho, D. Rosa and P. Lino)	✓ 21 August
IOTC–2017–WPEB13–36	Marine Turtles of Sri Lanka; Status, Issues, Threats and Conservation Strategies (R.A.M. Jayathilaka, H.A.C.C. Perera and S.S.K. Haputhanthri)	✓ 21 August
IOTC–2017–WPEB13–37 Rev_1	Bycatch records of sea turtles obtained through Japanese Observer Program in the IOTC Convention Area (K, Okamoto and K. Oshima)	✓ 30 August
IOTC–2017–WPEB13–38	Joint Analysis of Sea Turtle Mitigation Effectiveness: Final Report (Common Oceans ABNJ Tuna Project)	✓ 4 August
IOTC–2017–WPEB13–39	Update on the seabird component of the Common Oceans Tuna Project – seabirds bycatch assessment workshops (Birdlife South Africa)	✓ 26 July
IOTC–2017–WPEB13–40 Rev_1	Cetacean bycatch in the western Indian Ocean: an updated review of available information in coastal gillnets, tuna purse-seine and pelagic longline fisheries (J.J. Kiszka, P. Berggren, G. Minton, T. Collins, G. Braulik & R. Reeves)	✓ 21 August
IOTC–2017–WPEB13–41 Rev_1	Southern Hemisphere porbeagle shark *(Lamna nasus)* stock status assessment	✓ 4 August

Document	Title	Availability
IOTC–2017–WPEB13–42 Rev_1	Main results of the Spanish Best Practices program: evolution of the use of Non-entangling FADs, interaction with entangled animals, and fauna release operations (J. Lopez, N. Goñi, I. Arregi, J. Ruiz, I. Krug, H. Murua, J. Murua, J. Santiago)	✓ 21 August ✓ 30 August
IOTC–2017–WPEB13–43	Identifying areas, seasons and fleets of potential highest bycatch risk to South Georgia Albatrosses and Petrels (T.A. Clay, C. Small, A. P. B. Carneiro, B. Mulligan, D. Pardo, A. G. Wood, R. A. Phillips)	✓ 18 August
Information papers		
IOTC–2017–WPEB13–INF01	Final summary report of the stock status of oceanic whitetip sharks and CITES-listed hammerhead sharks based on the results of the IOTC/CITES Shark Data Mining Workshop (J.Rice)	✓ 14 August
IOTC–2017–WPEB13–INF02	A guide to landing shark species with fins naturally attached (S.J.B.Gulak, H.E. Moncrief-Cox, T.J. Morrell, A.N. Mathers and J.K. Carlson)	✓ 16 August
IOTC–2017–WPEB13–INF03	A review of capture and post-release mortality of elasmobranchs (J. R. Ellis, S. R. McCully Phillips and F. Poisson)	✓ 16 August
IOTC–2017–WPEB13–INF04	Technical mitigation measures for sharks and rays in fisheries for tuna and tuna-like species: turning possibility into reality F. Poisson, F.A. Crespo, J.R. Ellis, P. Chavance, P. Bach, M. N. Santos, B. Séret, M. Korta, R. Coelho, J. Ariz and H. Murua)	✓ 16 August
IOTC–2017–WPEB13–INF05	Selecting ecosystem indicators for fisheries targeting highly migratory species (M. Juan-Jorda)	✓ 21 August
IOTC–2017–WPEB13–INF06	Bycatch trends observed in Spanish tuna purse seine fishing (Báez JC, Ramos ML, Pascual, P & Abascal, F.)	withdrawn
IOTC–2017–WPEB13–INF07	An estimation of depredation of purpleback flying squid (*Sthenoteuthis oualaniensis*) on tuna caught by gillnet fisheries of Pakistan (M. Moazzam)	withdrawn
IOTC–2017–WPEB13–INF08	Updated and revised standardized catch rate of blue sharks caught by the Taiwanese longline fishery in the Indian Ocean (Tsai W-P & Liu K-M)	✓ 4 September
IOTC–2017–WPEB13–INF09	Report of the joint meeting of tuna RFMOs on the implementation of the ecosystem approach to fisheries management (Common Oceans)	✓ 23 August
IOTC–2017–WPEB13–INF10	Arabian humpback and baleen whale sightings along the Pakistan coast: information generated through WWF-Pakistan’s fishing crew observer programme (M.Moazzam and R. Nawaz)	✓ 23 August
IOTC–2017–WPEB13–INF11	Colonization of drifting fish aggregating devices (DFADs) in the Western Indian Ocean, assessed by fishers’ echo sounder buoys (B. Orúe, J. Lopez, G. Moreno, J. Santiago, M. Soto, H. Murua)	✓ 1 September
IOTC–2017–WPEB13–INF12	Moving away from synthetic materials used at FADs: evaluating biodegradable ropes to be used at FADs (G. Moreno, R. Jauhary, S. Adam, V. Restrepo)	✓ 3 September
IOTC–2017–WPEB13–INF13	Pilot project to test biodegradable components at FADs in real fishing conditions in the western Indian Ocean (G. Moreno, B. Orue, V. Restrepo)	✓ 3 September
IOTC–2017–WPEB13–INF14	Sea turtle bycatch by Taiwanese longline vessels in the Indian Ocean between 2009 and 2016 (J. Hsiang-Wen Huang)	✓ 4 September
Data sets		
IOTC–2017–WPEB13–DATA01	Bycatch datasets available	✓ 7 June
IOTC–2017–WPEB13–DATA02	Data Catalogue	✓ 7 June
IOTC–2017–WPEB13–DATA03	Data for the assessment of Indian Ocean Blue Shark	✓ 7 June
IOTC–2017–WPEB13–DATA05	Nominal Catches per Fleet, Year, Gear, IOTC Area and species	✓ 7 June
IOTC–2017–WPEB13–DATA06	Catch and Effort - longline fisheries	✓ 7 June
IOTC–2017–WPEB13–DATA07	Catch and Effort - vessels using pole and lines or purse seines	✓ 7 June
IOTC–2017–WPEB13–DATA08	Catch and Effort - coastal fisheries	✓ 7 June
IOTC–2017–WPEB13–DATA09	Catch and Effort - all vessels	✓ 7 June
IOTC–2017–WPEB13–DATA10	Catch and Effort - reference	✓ 7 June
IOTC–2017–WPEB13–DATA11	Size Frequency - Sharks	✓ 7 June
IOTC–2017–WPEB13–DATA12	Data Shark Equations	✓ 2 August
IOTC–2017–WPEB13–DATA13	Standardised blue shark CPUE (EU-Portugal)	✓ 21 July

Document	Title	Availability
IOTC–2017–WPEB13–DATA14	Standardised blue shark CPUE (Japan)	✓ 27 July ✓ 22 August
IOTC–2017–WPEB13–DATA15	Standardised blue shark CPUE (EU-France,Reunion)	✓ 2 August
IOTC–2017–WPEB13–DATA16	Standardised blue shark CPUE (Indonesia)	✓ 4 August
IOTC–2017–WPEB13–DATA17	Standardised blue shark CPUE (EU-Spain)	✓ 7 August
IOTC–2017–WPEB13–DATA18	Alternative BSH catch series for assessemnent	✓ 25 July
IOTC–2017–WPEB13–DATA19	Standardised blue shark CPUE (Taiwan,China)	✓ 11 August

APPENDIX IV
THE STANDING OF A RANGE OF INFORMATION RECEIVED BY THE IOTC SECRETARIAT FOR BYCATCH (INCLUDING BYPRODUCT) SPECIES

Extract from IOTC–2017–WPEB13–07

(Table, figure and appendix references in this Appendix, refer only to those contained in this appendix)

The nominal catch data for all shark species are presented in Fig. 13 by fleet. Very few fleets reported catches of sharks in the 1950s, but the number of fleets reporting has increased over time. Total reported shark catches have also increased over time with a particularly dramatic increase in reported catches in the 1990s, reaching a peak of approximately 120 000 mt in 1999. Since then, nominal catches have fluctuated and are currently around 114 000 mt. Notably, India reported particularly high catches of unidentified shark species in 2015 (22 829 mt).
The nominal catch data should be considered with caution given the historically low reporting rates. In addition to the low level of reporting, catches that have been reported are thought to represent only those species that are retained onboard without taking in to account discards. In many cases the reported catches refer to dressed weights while no information is provided on the type of processing undertaken, creating more uncertainty in the estimates of catches in live weight equivalents. Nevertheless, reporting rates in recent years have improved substantially (Appendix 4) following the adoption of new measures by the Commission on sharks and other bycatch, which call for IOTC CPCs to collect and report more detailed statistics on bycatch species to the IOTC Secretariat.

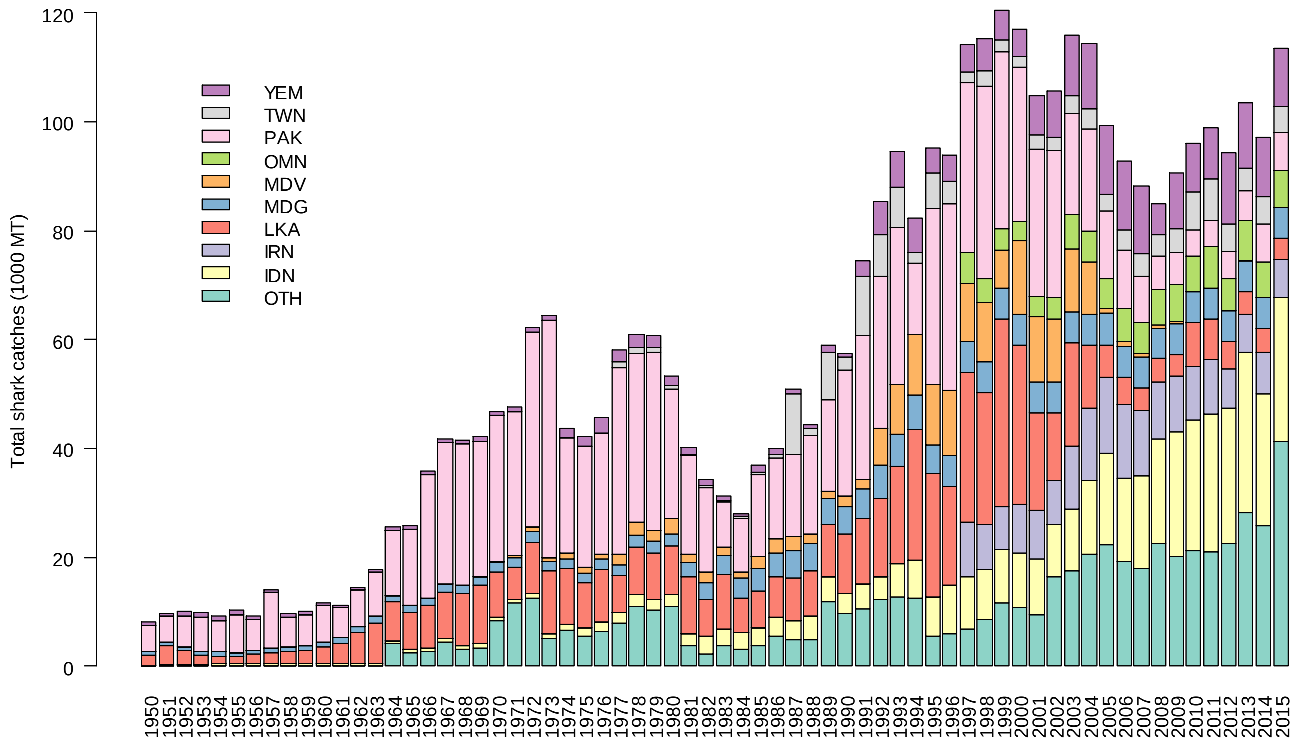


Fig. 13. Total reported nominal catches of sharks by fleet from 1950–2015 (YEM = Yemen, TWN = Taiwan,China, PAK = Pakistan, OMN = Oman, MDV = Maldives, MDG = Madagascar, LKA = Sri Lanka, IRN = I.R.Iran, IDN = Indonesia, OTH = all others).

Main reported gear types associated with shark bycatch for IOTC fisheries

Figure 3 shows the distribution of catches across gear type. Gillnets are associated with the highest reported nominal catches of sharks, historically and are currently responsible for over 40% of reported catches. This is followed by the longline fleets which contributed substantially to shark catches from the 1990s, and handline and troll line fisheries in more recent years. Of the gillnet fisheries, the majority comprise standard, unclassified gillnets, followed by combinations of gillnets, handlines and troll lines and gillnet/longline combinations. Figure 15 shows the main gear types used by fleets over the last 16 years.

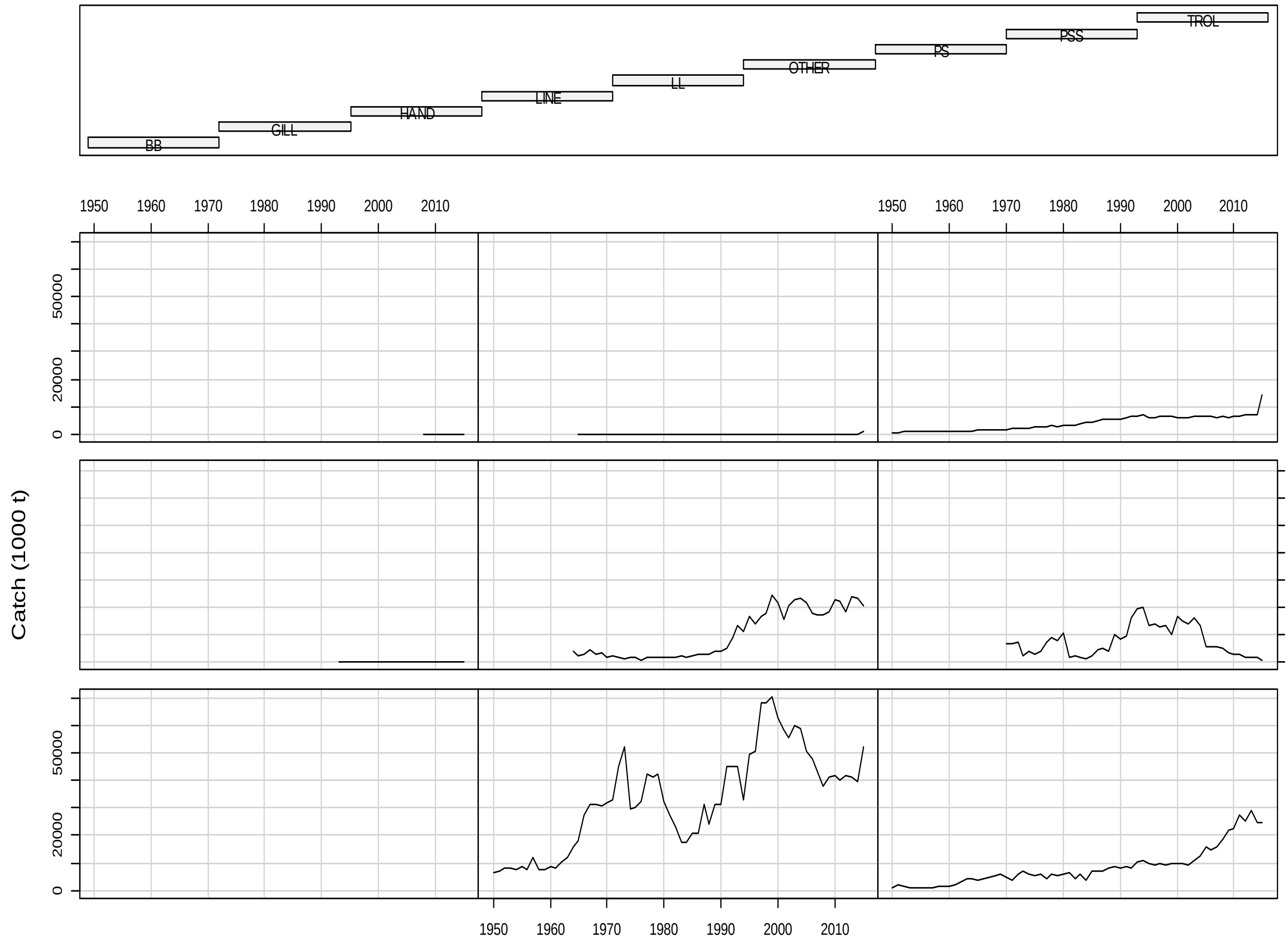


Figure 14. Nominal catches of sharks reported by gear type (1950–2015). Gears are listed in rows from bottom left to top right: Bait boat/pole and line (BB), gillnet (GILL), Handline (HAND), Line (LINE), Longline (LL), Purse seine (PS), Small purse seines/Ring nets (PSS), Troll lines (TROLL) and all other gear types (OTHER).

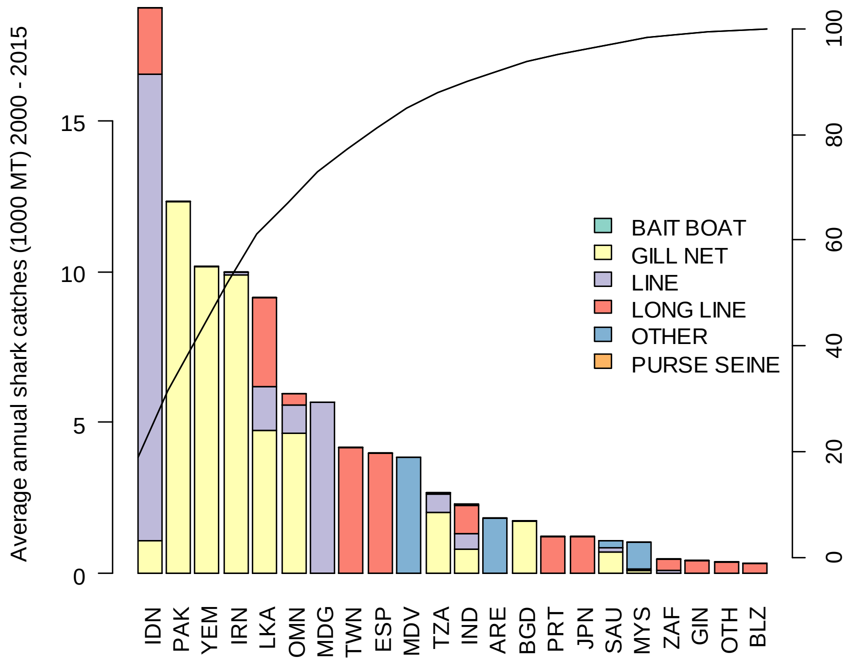


Figure 15. Average annual shark catches by gear type and reporting country in recent years (2000-2015)

Main species of sharks caught in IOTC fisheries

A list of all species of sharks that are known to occur in Indian Ocean fisheries directed at IOTC species (IOTC fisheries) or pelagic sharks is provided in Appendix 2. In addition to an increase in reporting of shark catches over time, the resolution of the data provided has been improving with an increased proportion of reported shark catches provided identified to species/genus (Fig.5a). Of the shark catches reported by species, the blue shark forms the greatest proportion, comprising over 60% of total catches, with silky, threshers, hammerheads and mako sharks forming a smaller percentage (Fig. 5b).

The increase in reporting by species is apparent in the species-specific catch series (Fig. 17a) with steadily increasing trends in reporting since the 1970s seen for blue sharks, thresher sharks, hammerhead sharks and mako sharks. The oceanic whitetip shark nominal catch series has changed in recent years due to a reallocation of catches reported by India and is now dominated by the Sri Lankan longline-gillnet fisheries for which catches peaked just prior to 2000. The reported catches of silky shark show a similar trend with a peak just prior to 2000 followed by a steady decline, again based almost exclusively on data from the Sri Lankan longline-gillnet combination fisheries. Fig.6b highlights how the catch series of each species is dominated by very few fleets which are reporting by species and may therefore not be fully reflective of the ocean-wide trend.

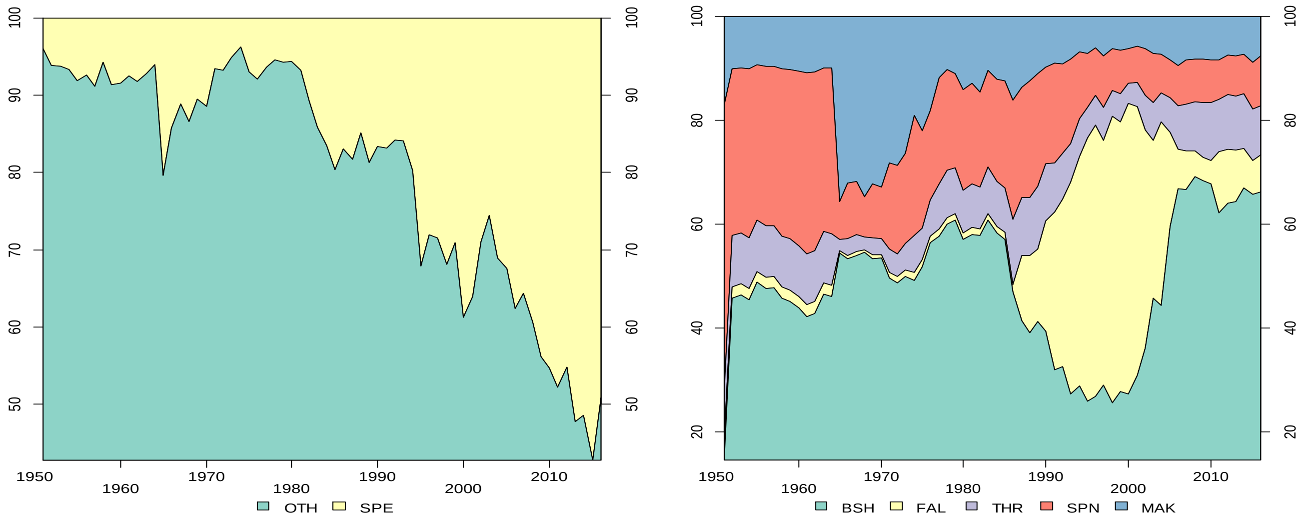


Fig. 16. a) Proportion of shark catches reported by species and as aggregate catch (OTH) and b) proportion of nominal shark catches by species

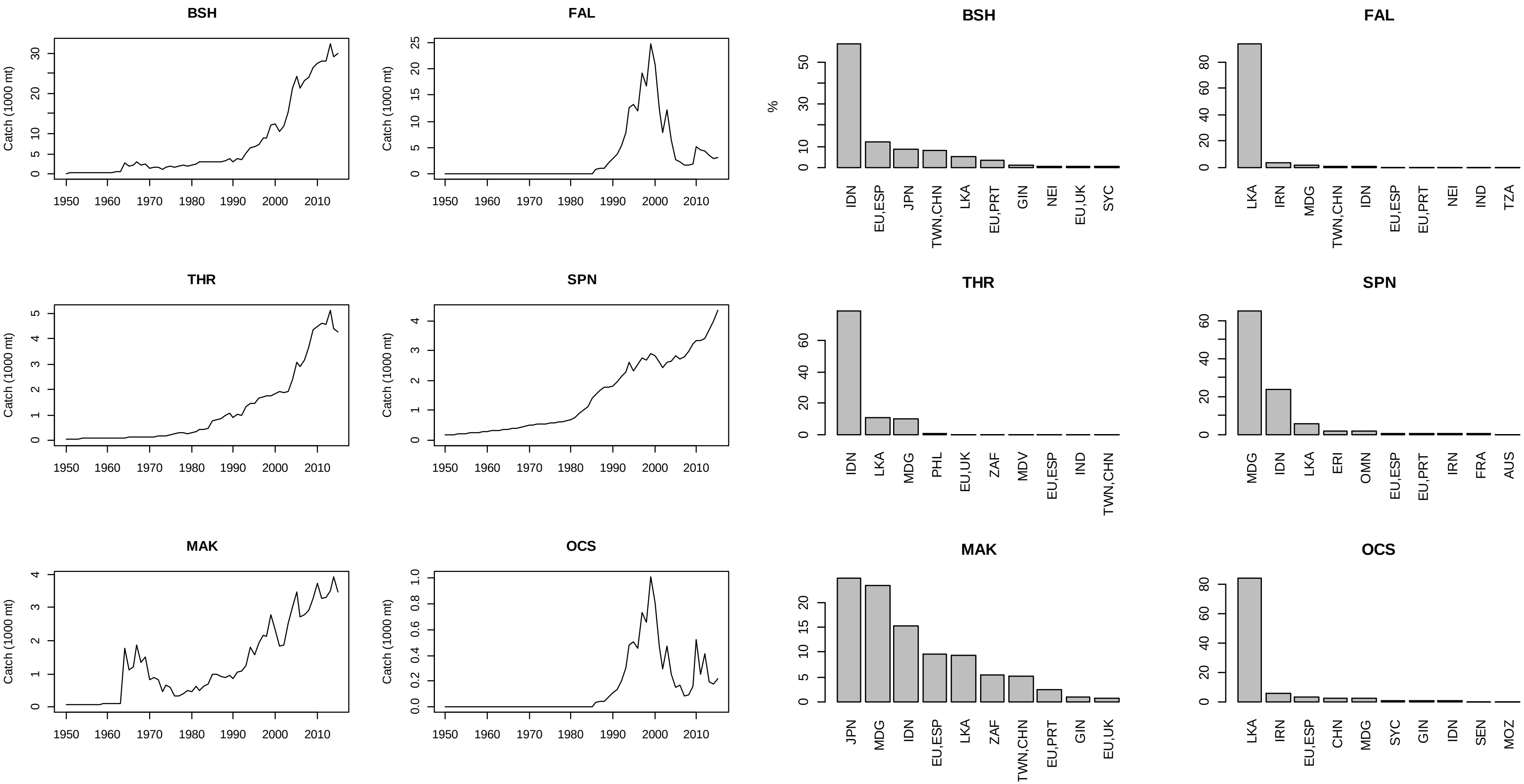


Fig. 17. a) Total nominal catches by species for all fleets (1950-2015) and b) contribution of each fleet to the total data series

Trends in species catches by gear types are summarised in Table 13. Longline fleets reported predominantly blue shark catches, followed by mako and silky sharks, while catches of handline gears are also dominated by blue shark, followed by thresher sharks. Purse seine catches are dominated by silky shark while troll lines reported relatively high catches of hammerhead sharks. Reporting by species is very uncommon for gillnet fleets, where the majority of shark catches are reported as aggregates. Nevertheless, this is improving as shown in Fig. 18 by the level of species-specific reporting by the gillnet fleet of I.R. Iran. This figure highlights the relatively high catches of the Indonesia line fisheries (including troll lines, hook and line, hand line and coastal longlines[4]) and the gillnet fisheries of Pakistan, Yemen and I.R. Iran.

Table 13. Species-specific catches by gear type from 2005–2015 (Bait boat/pole and line (BB), gillnet (GILL), Handline (HAND), Line (LINE), logline (LL), Purse seine (PS), small purse seines/ring nets (PSS) and troll lines (TROL).

	BB	GILL	HAND	LINE	LL	PS	PSS	TROL
OTH	100%	92%	14%	100%	21%	28%	93%	65%
BSH	0%	3%	59%	0%	62%	0%	0%	0%
FAL	0%	4%	0%	0%	6%	72%	7%	2%
THR	0%	0%	17%	0%	0%	0%	0%	3%
SPN	0%	0%	6%	0%	0%	0%	0%	23%
MAK	0%	0%	3%	0%	10%	0%	0%	7%
OCS	0%	0%	0%	0%	1%	0%	0%	0%
RMB	0%	0%	0%	0%	0%	0%	0%	0%

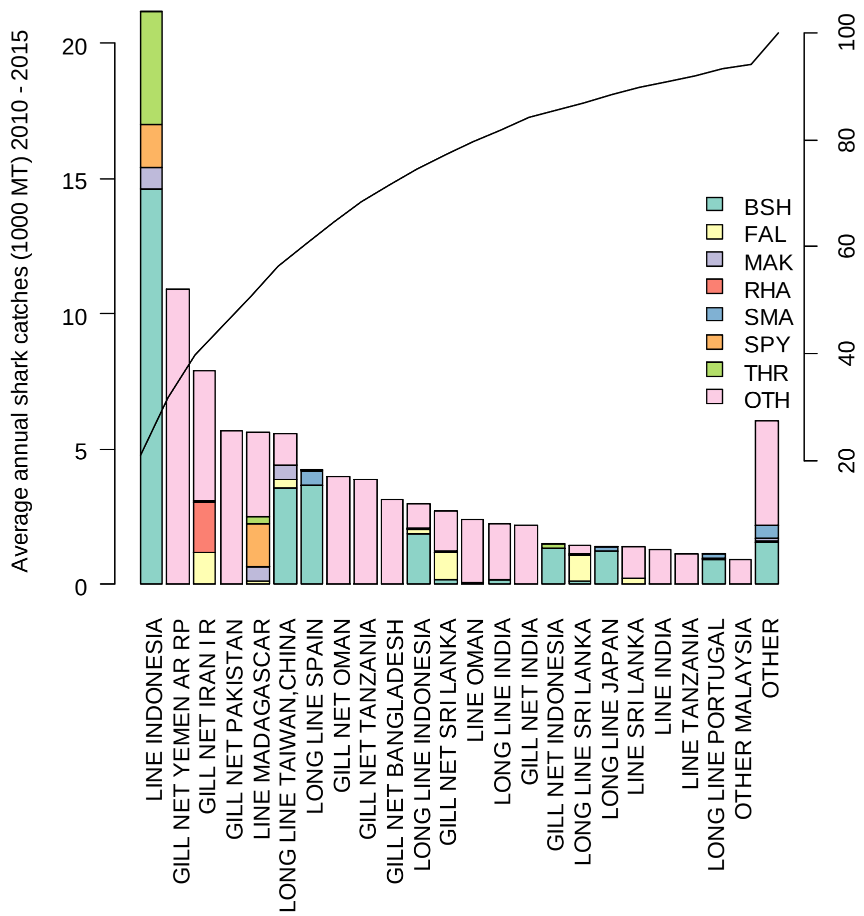


Fig. 18. Annual average shark catches reported by fleet and species from 2010–2015

[4] These are longlines which are operated by smaller vessels (<15m) and generally deployed within the EEZ.

Catch rates of IOTC fleets

While industrial longliners and drifting gillnets harvest important amounts of pelagic sharks, industrial purse seiners, pole-and-lines and most coastal fisheries are unlikely to harvest important quantities of pelagic sharks.

- **Pole and line fisheries:** The shark catches reported for the pole and line fisheries of Maldives are very low and none are reported for India. The extent of shark catches taken by these fisheries, if any, is not thought to be significant.

- **Gillnet fisheries:** The species of sharks caught are thought to vary significantly depending on the area of operation of the gillnets:
    - Gillnets operated in areas having low concentrations of pelagic sharks: The gillnet fisheries of most coastal countries operate these gears in coastal waters. The abundance of pelagic sharks in these areas is thought low.
    - Gillnets operated in areas having high concentrations of pelagic sharks: Gillnets operated in Sri Lanka, Indonesia and Yemen (waters around Socotra), in spite of being set in coastal areas, are likely to catch significant amounts of pelagic sharks.
- **Gillnets operated on the high seas:** Vessels from Taiwan,China were using drifting gillnets (driftnets) from 1982 to 1992, when the use of this gear was banned worldwide. The catches of pelagic sharks were very high during this period. Driftnet vessels from I.R. Iran and Pakistan have been fishing on the high seas since, but with lower catch rates. This was initially in waters of the Arabian Sea but covering a larger area in recent years as they expanded their range to include the tropical waters of the western Indian Ocean and Mozambique Channel. The quantity of sharks caught by these fleets is thought to be relatively high, representing between 25–50% of the total combined catches of sharks and other species.

- **Gillnet/longline fishery of Sri Lanka:** Between 1,200 and 3,200 vessels (12 m average length) operating gillnets and longlines in combination have been harvesting important amounts of pelagic sharks since the mid-1980s. The longlines are believed to be responsible for most of the catches of sharks. Catches of sharks comprised ~45% of the total combined catch for all species in 1995 and declined to <2% in the late 2000s. The fleet has been shifting towards predominantly longline gear in recent years but most catches are still reported as aggregates of the combination gear.

- **Fisheries using handlines:** The majority of fisheries using hand lines and trolling in the Indian Ocean operate these gears in coastal waters, so although the total proportion of sharks caught has been high historically, the amount of pelagic sharks caught are thought to be low. The proportion of other species of sharks might change depending on the area fished and time of the day.

- **Deep-freezing tuna longliners** and **fresh-tuna longliners**: Catches of sharks are thought to represent between 20–40% of the total combined catch for all species. However, the catches of sharks recorded in the IOTC database only make up a small proportion of the total catches of all species by longline fleets. These catches series for sharks are, therefore, thought to be very incomplete. Nevertheless, levels of reporting have improved in recent years, following the implementation of catch monitoring schemes in different ports of landing of fresh-tuna longliners[5], and the recording of catches of main species of sharks in logbooks and observer programmes. The catches estimated, however, are unlikely to represent the total catches of sharks for these fisheries due to the paucity of information on levels of discards of sharks, which are thought high in some areas and for some species.
- **Freezing (fresh) swordfish longliners**: Catches of sharks are thought to represent between 40–60% of the total combined catch for all species. The amount of sharks caught by longliners targeting swordfish in the IOTC area of competence has been increasing since the mid-1990s. The catches of sharks recorded for these fleets are thought more realistic than those recorded for other longline fisheries. The high catches are thought to be due to:
    - Gear configuration and time fished: The vessels targeting swordfish use surface longlines and set the lines at dusk or during the night. Many pelagic sharks are thought to be abundant at these depths and most active during dusk or night hours.

[5] The IOTC-OFCF (Overseas Fisheries Cooperation Foundation of Japan) Project implemented programmes in cooperation with local institutions in Thailand and Indonesia.

  - Area fished: The fleets targeting swordfish have been deploying most of the fishing effort in the Southwest Indian Ocean, in the vicinity of South Africa, southern Madagascar, Reunion and Mauritius. High amounts of sharks are thought to occur in these areas.
  - Changes in the relative amounts of swordfish and sharks in the catches: Some of the vessels are known to alternate between targeting swordfish and sharks (particularly blue sharks) depending on the season, or when catch rates of swordfish are poor.
- **Industrial tuna purse seiners:** Catches of sharks are thought to represent less than 0.5% of the total combined catch for all species. Limited nominal catch data have been reported for the purse seine fleets.
- **Trolling fisheries:** The majority of fisheries trolling in the Indian Ocean operate in coastal waters so the amounts of pelagic sharks caught are thought to be low. The amount that other species of sharks make out of the catches of tuna and tuna-like species might change depending on the area fished and time of the day.

Length frequency data

Due to the different types of length measurement reported, a number of conversions were performed to standardise the length-frequency information. Given the increasing amount of data reported and the need for standardisation, a set of species-specific conversion factors and proxies that have been agreed by the Working Party on Ecosystems and Bycatch could help improve the estimates. Conversion factors currently used are provided in Appendix 4. Size frequency data are reported using different length classes ranging from 1cm to 10cm intervals. In addition to this, there appears to be rounding taking place when the smaller size intervals are used, creating abnormal peaks in the distributions. The graphs shown below have been aggregated to 5cm intervals in order to smooth this effect.

Fig. 19 shows the aggregated fork length frequency distribution for the longline fleets reporting size information on blue sharks for all areas between 2005 and 2015. The data reported for vessels flagged for China, Japan, Rep. of Korea and EU,Portugal include data reported for longline fleets with observers onboard. The results highlight the difference in size of the individuals caught by different fleets, with the EU fleets, on average, catching larger blue sharks than the other fleets. Fig. 20 shows the length distributions for the other shark species with reported size frequency data aggregated across all fleets and all years given the more limited amount of data available for these species.

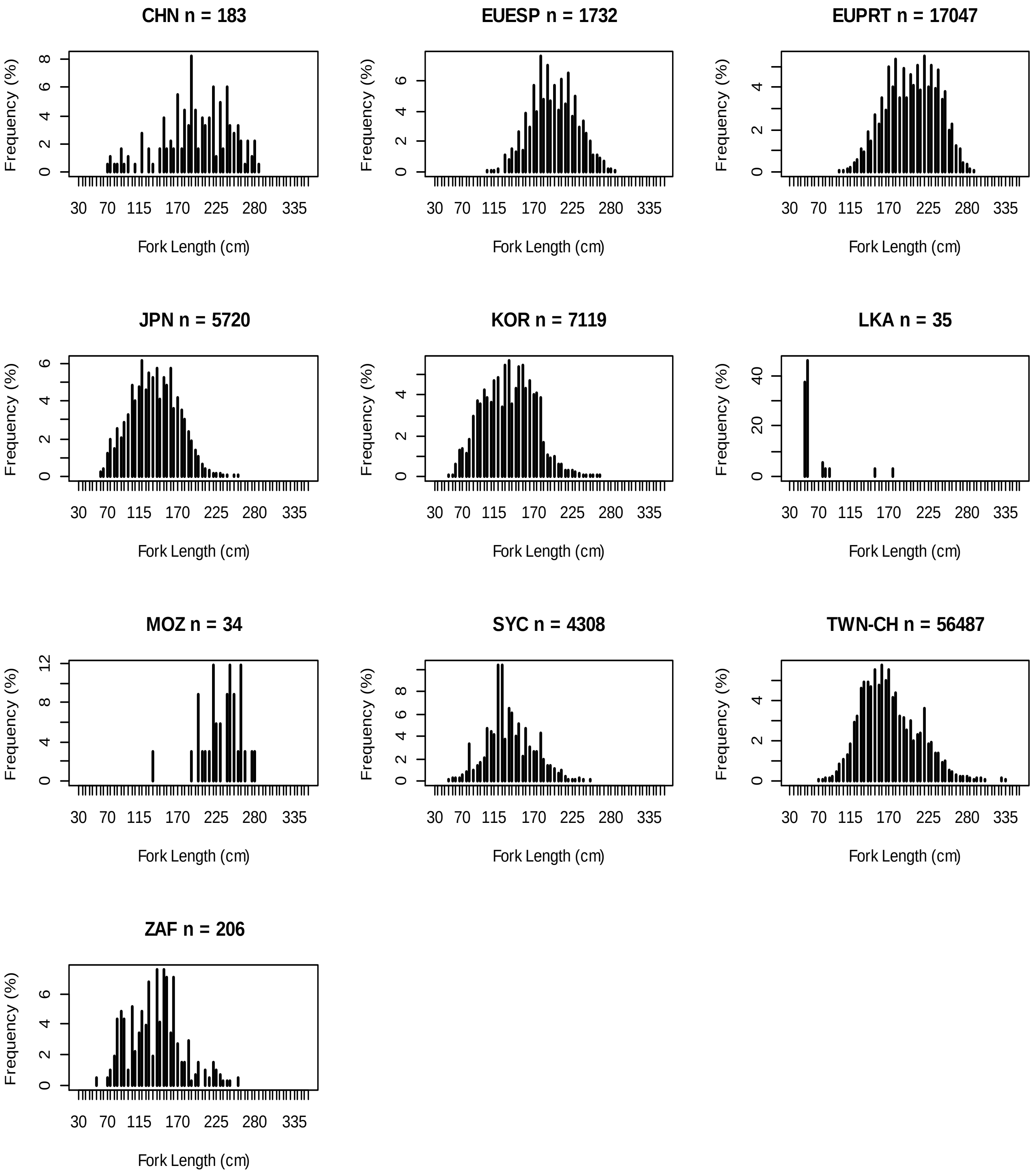


Fig. 19. Fork length frequency distributions (%) of blue shark derived from the samples reported for the longline fleets of China (CHN LL), EU,Spain (EUESP ELL), EU,Portugal (EUPRT ELL), Japan (JPN LL), Korea (KOR LL), Sri Lanka LKA (G/L), Mozambique (MOZ HAND) Seychelles (SYC LL), Taiwan,China (TWN-CHN FLL/LL) and South Africa (ZAF ELL) between 2005 and 2015 in 5 cm length classes.

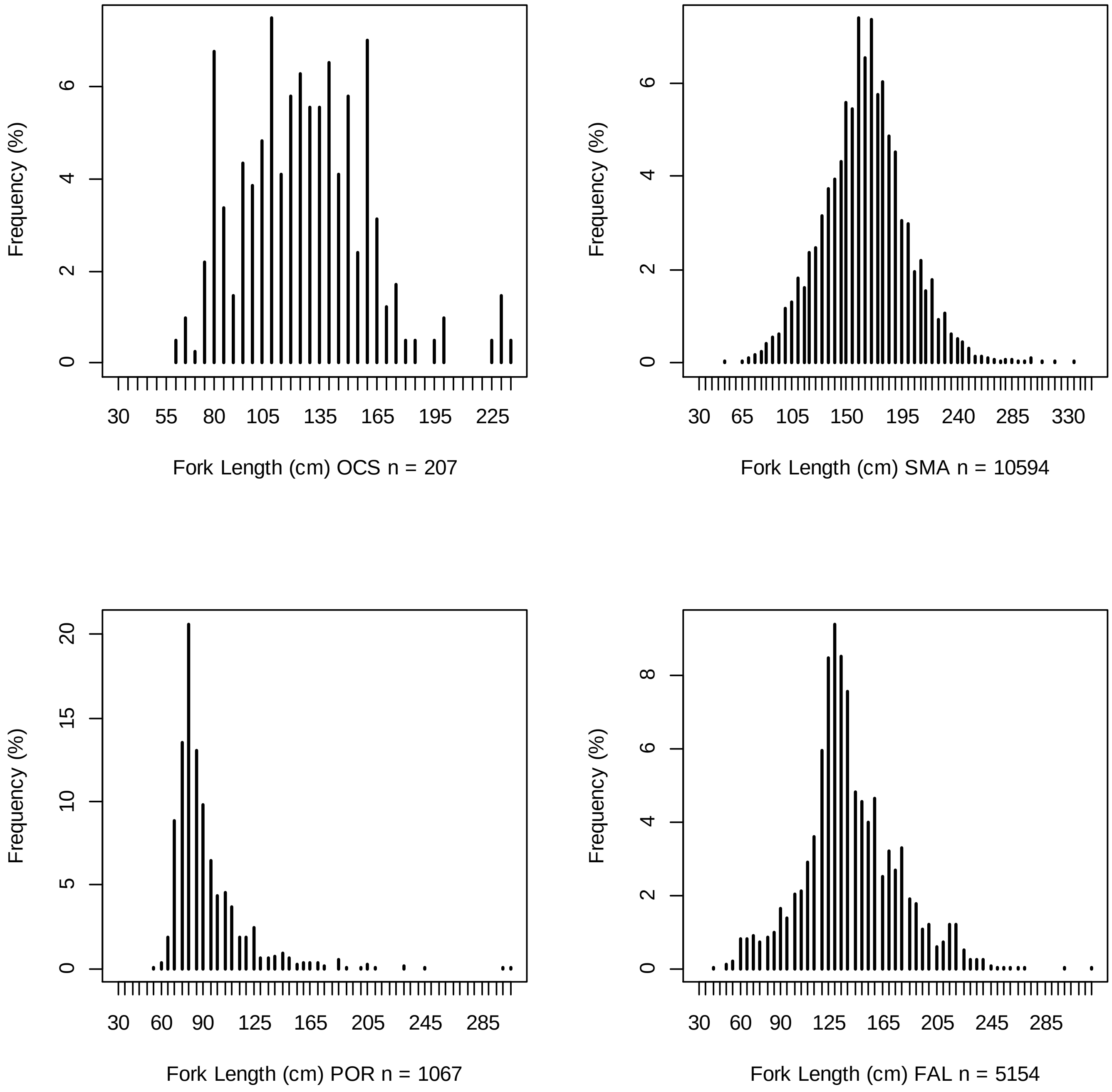


Fig. 20. Fork length frequency distributions (%) for oceanic whitetip shark (OCS), shortfin mako shark (SMA), porbeagle shark (POR) and silky shark (FAL) between 2005 and 2015.

SUMMARY OF FISHERIES DATA AVILABLE FOR SEABIRDS

Main species and fisheries concerned

The main species of seabirds likely to be caught as bycatch in IOTC fisheries are presented in Table 14[6].

Table 14. Main species of seabirds likely to be incidentally caught on longline operations

Common Name	Status*	Scientific Name
Amsterdam Albatross	Critically Endangered	*Diomedea amsterdamensis*
Antipodean Albatross	Vulnerable	*Diomedea antipodensis*
Black-browed Albatross	Endangered	*Thalassarche melanophrys*
Buller's Albatross	Near Threaten	*Thalassarche bulleri*
Campbell Albatross	Vulnerable	*Thalassarche impavida*
Chatham Albatross	Vulnerable	*Thalassarche eremite*
Grey-headed Albatross	Vulnerable	*Thalassarche chrysostoma*
Light-mantled Albatross	Near Threatened	*Phoebetria palpebrata*
Northern Royal Albatross	Endangered	*Diomedea sanfordi*
Southern Royal Albatross	Vulnerable	*Diomedea epomophora*
Salvin's Albatross	Vulnerable	*Thalassarche salvini*
Shy Albatross	Near Threatened	*Thalassarche cauta*
White-capped Albatross	Near Threatened	*Thalassarche steadi*
Sooty Albatross	Endangered	*Phoebetria fusca*
Tristan Albatross	Critically Endangered	*Diomedea dabbenena*
Wandering Albatross	Vulnerable	*Diomedea exulans*
Atlantic Yellow-nosed Albatross	Endangered	*Thalassarche chlororhynchos*
Indian Yellow-nosed Albatross	Endangered	*Thalassarche carteri*
Northern Giant Petrel	Least Concern	*Macronectes halli*
Southern Giant Petrel	Least Concern	*Macronectes giganteus*
White-chinned Petrel	Vulnerable	*Procellaria aequinoctialis*
Westland Petrel	Vulnerable	*Procellaria westlandica*
Short-tailed Shearwater	Least Concern	*Puffinus tenuirostris*
Sooty Shearwater	Near Threatened	*Puffinus griseus*

*****Source IUCN 2006, BirdLife International 2004b.

[6] As in IOTC–2007–WPEB–22, Appendix 2, page 24. Paper submitted on behalf of the Agreement for the Conservation of Albatrosses and Petrels (ACAP)

Longline vessels fishing in southern waters

The interaction between seabirds and IOTC fisheries is likely to be significant only in Southern waters (south of 25° degrees South), an area where most of the effort is exerted by longliners. Incidental catches are, for this reason, likely to be of importance only for longline fleets having vessels operating in these areas. The main fleets reporting longline fishing effort since 1955 in this area are those of Japan (accounting for 61%) and Taiwan,China (accounting for 35%) (Figure 21). Figure 22 shows the spatial distribution of reported effort exerted by longliners for fleets fishing south of 25° south. These figures indicate reported effort, but this is incomplete for some reporting fleets, i.e. for Malaysia, South Africa, Seychelles, Rep. of Korea and China(Taiwan) the effort is likely to be higher. It is also important to note that these are only the countries that are reporting some information on effort, while it is expected that a number of other longline fleets also fish in this area based on the presence of temperate species in their catch data. These include Indonesia, Madagascar, Tanzania, Philippines, Mozambique and Belize. The effort from some of these CPCs is also likely to be substantial, given the catch quantities of temperate species (e.g. Indonesia National Report Fig; 3b IOTC-2016-SC19-NR01).

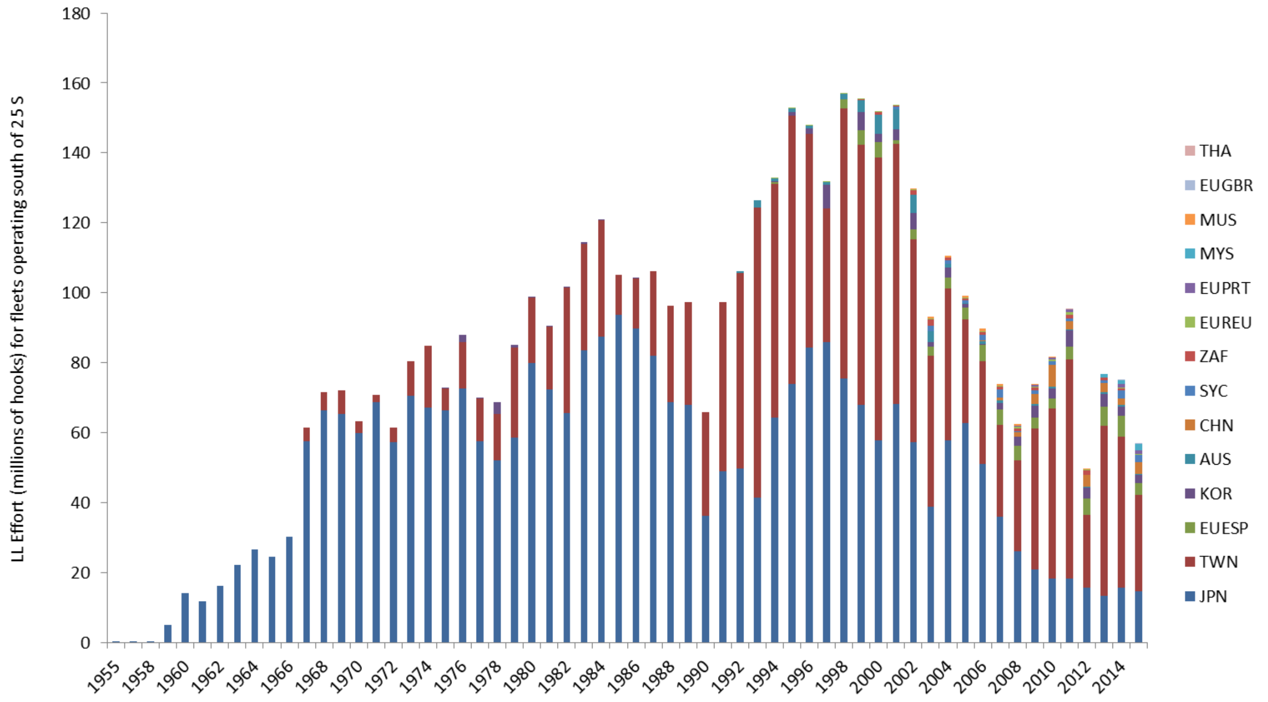


Figure 21. Reported longline effort for fleets operating south of 25° south between 1955 and 2015. (THA = Thailand, EUGBR = EU,UK, MYS = Malaysia, EUPRT = EU,Portugal, EU,REU = EU,France, MUS = Mauritius, ZAF, = South Africa, SYC = Seychelles, CHN = China, AUS = Australia, EUESP = EU,Spain, KOR = Rep. of Kora, TWN = Taiwan,China, JPN = Japan).

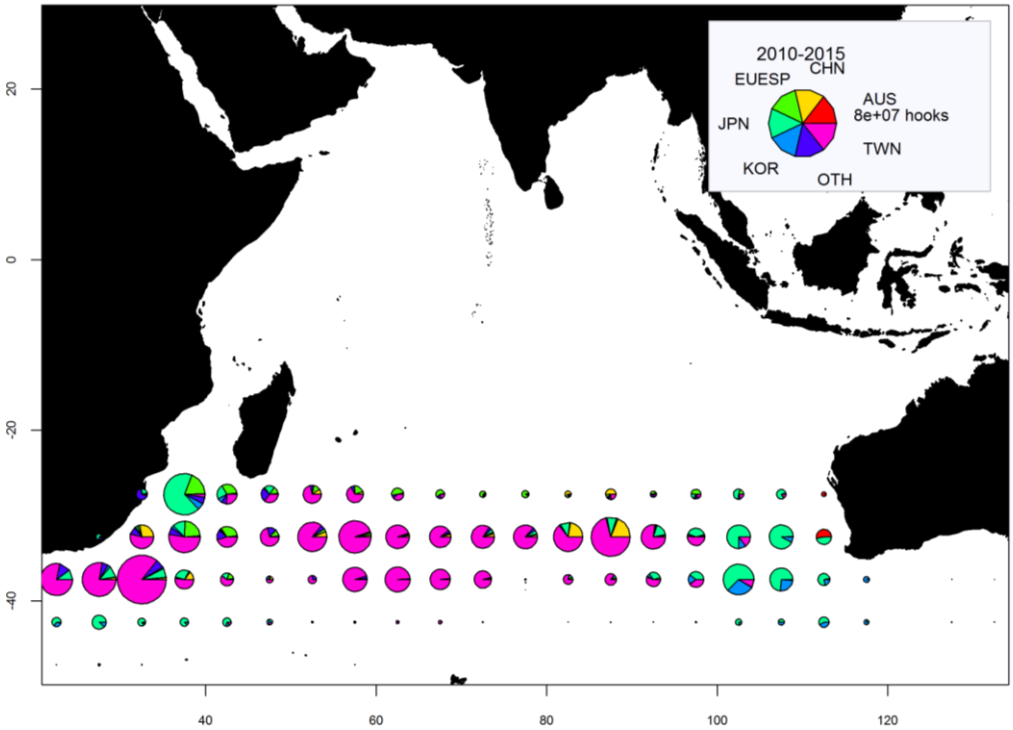


Figure 22. Reported longline effort for fleets operating south of 25° south between 2010 and 2015.

Status of data on seabird bycatch

The reported data available on seabirds caught in the IOTC area of competence are generally fairly limited. In 2016 six CPCs (Australia, EU-Portugal, EU-Spain, EU-France, Japan, Rep. of Korea, Taiwan,China and South Africa) of the 15 CPCs which report effort or are likely to exert longline fishing effort south of 25°S to IOTC submitted data in response to a call for data submission on seabirds.[7] In addition, three CPCs submitted substantive papers on seabird bycatch to the WPEB12: China[8], EU-Spain[9]), and Japan[10].

The information provided highlighted some general trends in seabird bycatch rates across the Indian Ocean with higher catch rates at higher latitudes, even within the area south of 25°S and higher catch rates in the coastal areas in the eastern and western parts of the southern Indian Ocean (Figure 23). Because the reporting of effort has been low (some CPCs fishing south of 25°S in the Indian Ocean did not report any effort while for others it was incomplete), and the observer coverage is relatively low (though improving) for many fleets, data submitted through the data-call is unlikely to be able to provide reliable estimates of total bycatch of seabirds from the longline fishery south of 25°S latitude in the Indian Ocean and so extrapolations of the information to total Indian Ocean captures were not undertaken. Bycatch mortality, where reported, was high but there is a lack of information on post release mortality/survival as well as total effort which means that the total fishery induced mortality on the seabird populations cannot be estimated.

[7] IOTC-2016-SC19-INF02

[8] Gai, C.; Dai, X. (2016). Estimating the composition and capture status of bycatch using Chinese longline observer data in the Indian Ocean. IOTC–2016–WPEB12–16.

[9] Fernández-Costa J.; Ramos-Cartelle, A.; Carroceda, A.; Mejuto, J. (2016). Interaction between seabirds and Spanish surface longline targeting swordfish in the Indian Ocean (≥ 25º South) during the period 2011-2015. IOTC–2016–WPEB12–29.

[10] Inoue, Y.; Kanaiwa, M.; Yokawa, K.; Oshima, K. (2016a). Examination of factors affecting seabird bycatch occurrence rate in southern hemisphere in Japanese longline fishery with using random forest. IOTC–2016–WPEB12–INF07.

Inoue, Y.; Kanaiwa, M.; Yokawa, K.; Oshima, K. (2016b). MODELING OF BYCATCH OCCURRENCE RATE OF SEABIRDS FOR JAPANESE LONGLINE FISHERY OPERATED IN SOUTHERN HEMISPHERE. IOTC–2016–WPEB12–INF08.

Yokawa, K.; Oshima, K.; Inoue, Y.; Katsumata, N. (2016). Operational pattern of Japanese longliners in the south of 25S in the Atlantic and the Indian Ocean for the consideration of seabird bycatches. IOTC–2016–WPEB12–INF09.

Katsumata, N.; Yokawa, K.; Oshima, K. (2016). Information of seabirds bycatch in area south of 25 S latitude in 2010 from 2015. IOTC–2016–WPEB12–INF10.

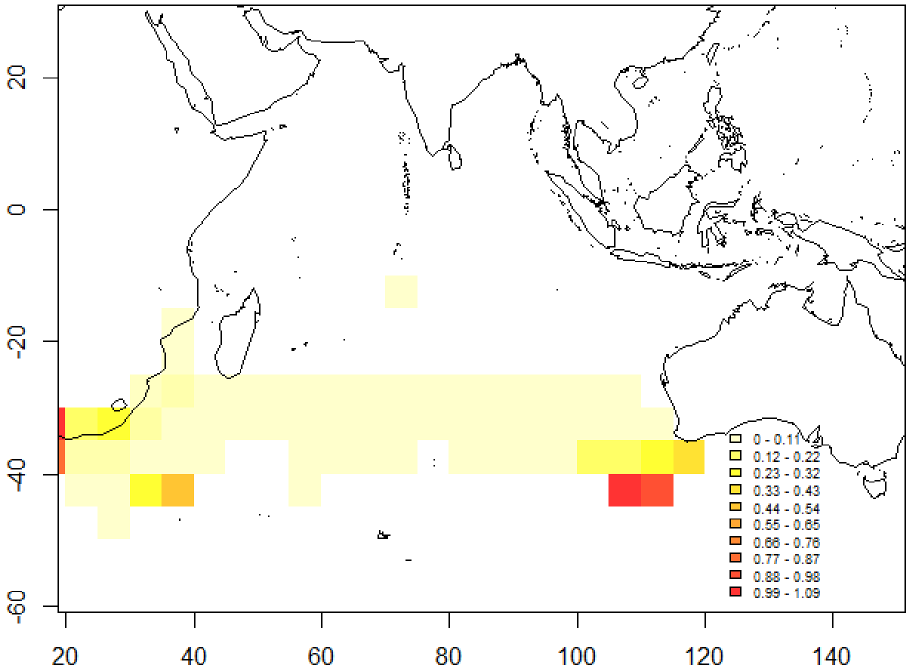


Figure 23. Average reported BPUE of seabirds (per 1000 hooks) for fleets operating south of 25° south between 2010 and 2015 (EU,France, EU,Portugal, Japan, Rep. of Korea, South Africa and Taiwan,China).

SUMMARY OF FISHERIES DATA AVILABLE FOR MARINE TURTLES

Main species and fisheries concerned

The main species of marine turtles likely to be caught as bycatch by IOTC fisheries are listed in Table 15**.**

Table 15. Main species of Indian Ocean marine turtles[11].

Common Name	Scientific Name
Loggerhead turtle	*Caretta caretta*
Olive ridley turtle	*Lepidochelys olivacea*
Green turtle	*Chelonia mydas*
Hawksbill turtle	*Eretmochelys imbricata*
Leatherback turtle	*Dermochelys coriacea*
Flatback turtle	*Natator depressus*

The interaction between marine turtles and IOTC fisheries is likely to be significant only in tropical areas, involving both industrial and artisanal fisheries, notably for:

- Industrial purse seine fisheries, in particular on sets using fish aggregating devices (EU, Seychelles, I.R. Iran, Thailand, Japan)
- Gillnet fisheries operating in coastal waters or on the high seas (Sri Lanka, I.R. Iran, Pakistan, Indonesia)
- Industrial longline fisheries operating in tropical areas (China, Taiwan,China, Japan, Indonesia, Seychelles, India, Oman, Malaysia and the Philippines)

[11] Memorandum of Understanding on the Conservation and Management of Marine Turtles and their Habitats of the Indian Ocean and South-East Asia

Extract from IOTC–2017–WPEB13–07

APPENDIX V
MAIN ISSUES IDENTIFIED CONCERNING DATA ON NON-IOTC SPECIES
GENERAL ISSUES

There are a number of key issues with the data that are apparent from this summary. The main points are discussed below.

Sharks

- Unreported catches

Although some fleets have been operating since 1950, there are many cases where historical catches have gone unreported as many countries were not collecting fishery statistics in years prior to 1970. It is therefore thought that important catches of sharks might have gone unrecorded in several countries. There are also a number of fleets which are still not reporting on their interactions with bycatch species, despite fleets using similar gears reporting high catch rates of bycatch.

Some fleets have also been noted to report catches by species only for those that have been specifically identified by the Commission and do not report catches of other species even in aggregate form. This creates problems for the estimation of total catches of all sharks and for attempts to apportion aggregate catches into species groups at a later date. The changing requirements for species-specific reporting also complicates the interpretation of these data.

- Errors in reported catches

For the fleets that do report interactions, there are a number of issues with these estimates. The estimates are often based on retained catches rather than total catches, and so if discarding is high then this is a major source of error where discards are not reported. Errors are also introduced due to the processing of the retained catches that is undertaken. This creates problems for calculating total weight or numbers, as sometimes dressed weight might be recorded instead of live weights. For high levels of processing, such as finning where the carcasses are not retained, the estimation of total live weight is extremely difficult.

- Poor resolution of data

Historically, shark catches have not been reported by species but simply as an aggregated total, however, the proportion of catches reported by species has increased substantially in recent years. Misidentification of shark species is also common. Processing creates further problems for species identification, requiring a high level of expertise and experience in order to be able to accurately identify specimens, if at all. The level of reporting by gear type is much higher and catches reported with no gear type allocated form a small proportion of the total.

The main consequence of this is that the estimation of total catches of sharks in the Indian Ocean is compromised by the paucity of the data available.

1. **Catch-and-Effort data from gillnet fisheries:**
   - Drifting gillnet fisheries of I.R. Iran and Pakistan: To date, I.R. Iran and Pakistan have not reported catches of sharks, by species, for the gillnet fisheries to IOTC standards (i.e. including spatial information).
   - 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.
   - Freezing longline fisheries of EU,Spain, India, Indonesia, Malaysia, and Oman: These countries have not reported catch-and-effort data of sharks by species for longliners under their flag.
3. **Catch-and-Effort data from coastal fisheries:**
   - Coastal fisheries of India, Indonesia and Yemen: to date, these countries have not provided detailed catches of sharks to the IOTC.
4. **Discard levels from surface and longline fisheries:**
   - Discard levels of sharks from major longline fisheries: to date the EU (Spain, UK), Japan, Taiwan,China and Indonesia, have not provided estimates of total discards of sharks, by species, in particular thresher sharks and

oceanic whitetip sharks, although Japan, Taiwan,China and Indonesia are now reporting discards in their observer data.

- Discard levels of sharks for industrial purse seine fisheries: to date, the EU,Spain, I.R. Iran, Japan, Seychelles, and Thailand have not provided estimates of total quantities of discards of sharks, by species, for industrial purse seiners under their flag, although EU, Spain and Seychelles are now reporting discards in their observer data.

5. **Size frequency data:**
   - Gillnet fisheries of I.R. Iran and Pakistan: to date, I.R. Iran and Pakistan have not reported size frequency data for their driftnet fisheries.
   - Longline fisheries of India, Malaysia, Oman and Philippines: to date, these countries have not reported size frequency data for their longline fisheries.
   - Coastal fisheries of India, Indonesia, Madagascar 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 IOTC Secretariat has 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 limited amount of biological data available.

Other bycatch species groups

The reporting of non-IOTC species other than sharks is extremely poor and where it does occur, this is often in the form of patchy information which is not submitted according to IOTC data reporting procedures, is unstandardized and often lacking in clarity. Formal submissions of data in an electronic and standardized format using the available IOTC templates will considerably improve the quality of data obtained and the type of regional analyses that these data can be used for.

1. **Incidental catches of SEABIRDS:**
   - Longline fisheries operating in areas with high densities of seabirds. Seychelles, Malaysia, Mauritius, EU(UK) have not reported incidental catches of seabirds for longliners under their flag.

2. **Incidental catches of MARINE TURTLES:**
   - Gillnet fisheries of Pakistan and Indonesia: to date, there have been no reported incidental catches of marine turtles for the driftnet fisheries.
   - Longline fisheries of Malaysia, Oman, India, Philippines and Seychelles: to date, these countries have not reported incidental catches of marine turtles for their longline fisheries.
   - Purse seine fisheries of Japan, Seychelles, I.R. Iran and Thailand: to date these countries have not reported incidental catches of marine turtles for their purse seine fisheries, including incidental catches of marine turtles on Fish Aggregating Devices.

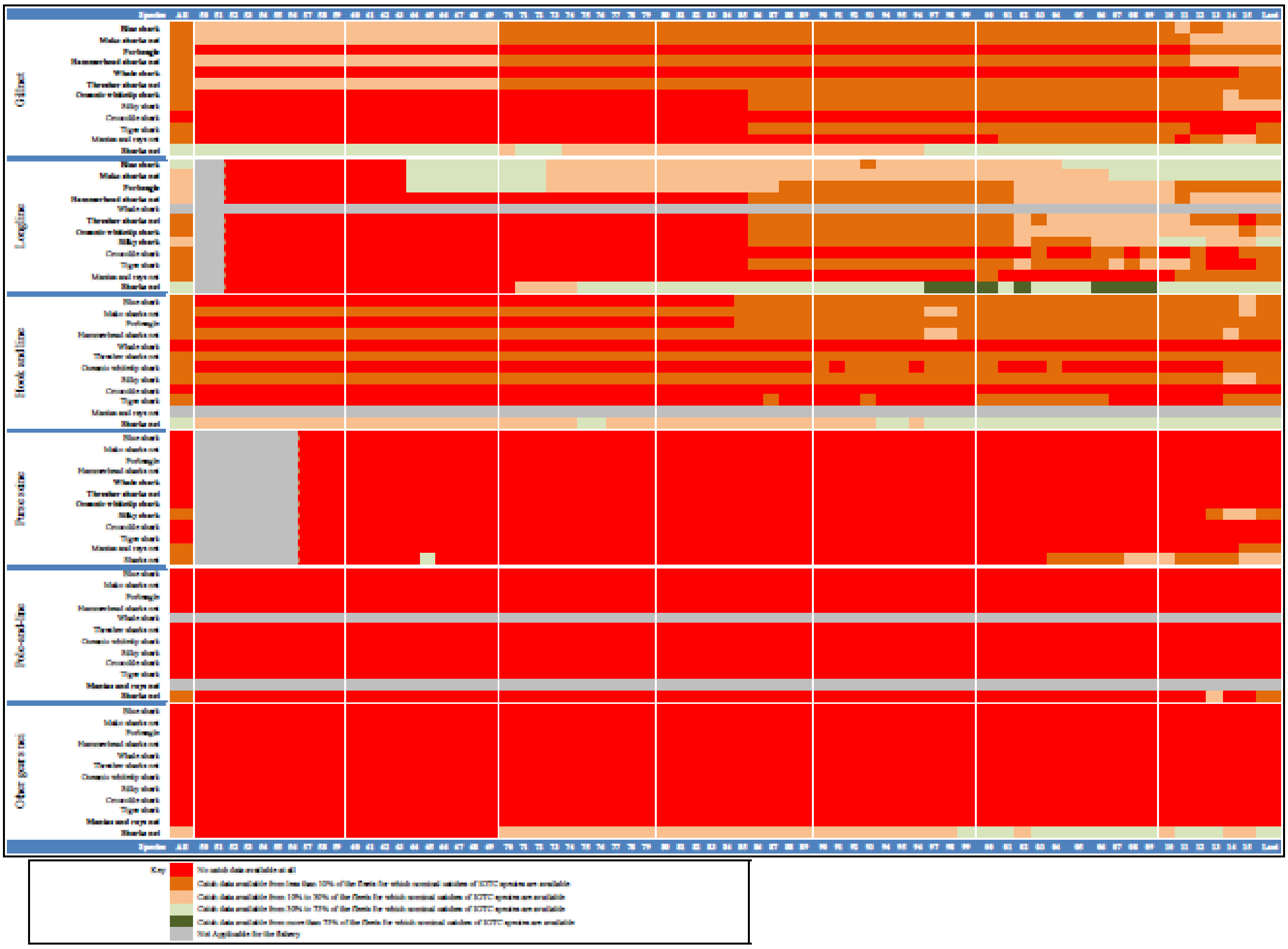
While a number of CPCs have been mentioned specifically here as they have important fisheries or have not provided any information, there are still many CPCs that are providing data that are not consistent with the IOTC minimum reporting standards. This includes not reporting bird bycatch data by species (as required by Resolution 12/06) and not providing an estimation of the total mortality of marine turtles incidentally caught in their fisheries (as required by Resolution 12/04).

APPENDIX VI
AVAILABILITY OF CATCH DATA FOR SHARKS BY GEAR

Availability of catch data for the main shark species expressed as the proportion of fleets for which catch data on sharks are available out of the total number of fleets[12] for which data on IOTC species are available, by fishery, species of shark, and year, for the period 1950–2015.

- Shark species in bold are those identified as mandatory for reporting by each fleet, for which data shall be recorded in logbooks and reported to the IOTC Secretariat; reporting of catch data for other species can be done in aggregated form (i.e. all species combined as ***sharks nei*** or ***mantas and rays nei***).
- ***Hook and line*** refers to fisheries using handline and/or trolling and ***Other gears nei*** to other unidentified fisheries operated in coastal waters.
- Catch rates of sharks on pole-and-line fisheries are thought to be nil or negligible.

Average levels of reporting for 1950–2015 and 2010–2015 are shown in columns ***All*** and ***Last***, respectively.



[12] The definition of fleets has changed since the previous report. Previously a fleet fishing in two areas were considered as two separate fleets, whereas here they are considered as one.

APPENDIX VII
IMPLEMENTATION OF THE REGIONAL OBSERVER SCHEME

(Updated September 2017)

CPCs	Active Vessels LOA≥24m or High Seas vessels[13]				Progress	List of accredited observers submitted	Number of observer reports provided[14]						
	LL	PS	GN	BB			2010	2011	2012	2013	2014	2015	2016
MEMBERS													
Australia	2	6		1	Australia has implemented an observer programme for the longline fleet	**YES: 21**	2(O)	1(O)	3(O)	No	2(O) + 3(E)	No	No
Belize					No information received by the Secretariat.	**No**	No	No	No	No	No	No	No
China –Taiwan,China	67 233				China has implemented an observer programme	**YES: 3** **YES: 54**	1(O) No	No No	1(O) 1(O)	1(O) 19(O)	2(O) 17(O)	1(O) 13(O)	No 14(O)
Comoros					Comoros does not have vessels ≥ 24m. Two observers have been trained under the IOC Regional Monitoring Project, and 5 by SWIOFP.	**YES: 7**	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Eritrea	No information received				No information received by the Secretariat.	**N/A**	N/A	N/A	N/A	N/A	N/A	N/A	N/A
European Union	17 0 7 19 1	12 1 0 18 0			EU has an observer programme on-board its purse seine and longline fleets. To date, no information has been received from EU,UK.	Partial: **EU,France: 64** **EU,Italy : No** **EU,Portugal: 4** **EU,Spain : 9** **EU,UK : 1**	FRA 6(O) N/A No No No	FRA 12(O) N/A PRT 1(O) No No	FRA 17 (O) N/A PRT 1(O) No No	FRA 15(O) N/A PRT 1(O) ESP 1(O) No	FRA 32(O) N/A PRT 1(O) ESP 2(O) No	FRA 30(E+O) N/A PRT 1(O) ESP 23(E) No	FRA 106(E) ITA 4(O) PRT 1(O) No No
France (OT)					N/A	**N/A**	No	9(O)	7(O)	7(O)	N/A	N/A	N/A
Guinea					Guinea has had no vessels operating in the Indian Ocean since 2006	**N/A**	N/A	N/A	N/A	N/A	N/A	N/A	N/A
India					India has not yet developed an observer programme.	**No**	**No**	**No**	**No**	**No**	**No**	**No**	**No**
Indonesia	246	11	13		Indonesia has 13 registered IOTC observers and a number of initiatives in place and has recently begun reporting to IOTC.	**YES:9**	**No**	**No**	**No**	**No**	**5(E)**	**No**	**No**
Iran, Isl. Rep. of	5	8	1192		IOTC observer training took place in 2015. 30 observers have now been selected and are due to be deployed in 2016.	**No**	**No**	**No**	**No**	**No**	**No**	**No**	**No**
Japan	43	2			Japan started its observer programme on the 1st of July 2010.	**YES: 19**	**8(E)**	**11(E)**	**10(E)**	**7(E)**	**8(E)**	**No**	**No**

[13] The number of active vessels is given for 2016
[14] Year in which the observed trip has started (E: Electronic; O: Other)

CPCs	Active Vessels LOA≥24m or High Seas vessels[13]				Progress	List of accredited observers submitted	Number of observer reports provided[14]						
	LL	PS	GN	BB			2010	2011	2012	2013	2014	2015	2016
Kenya					Kenya has had no vessels listed in the active vessel registry since 2010, however, Kenya is developing an observer programme and 5 observers have been trained by SWIOFP.	**YES: 5**	**No**	N/A	N/A	N/A	N/A	N/A	**No**
Korea, Rep. of	13	6			Korea has had an observer programme since 2002 and has 28 observers registered in the Indian Ocean.	**YES: 28**	**2(O)**	**No**	**2(O)**	**3(O)**	**3(O)**	**No**	**No**
Madagascar	7				Madagascar has developed an observer programme. Five and three observers have been trained through SWIOFP and IOC respectively. However, observer data reported are not to IOTC standards.	**YES: 7**	**No**	**No**	**18(O)** [15]	**7+1(O)**	**2+5(O)**	**No**	**No**
Malaysia	10				Malaysia is developing plans for the implementation of an observer programme.	**No**	**No**	**No**	**No**	**No**	**No**	**No**	**No**
Maldives	47			325	Maldivian vessel landings are monitored by field samplers at landing sites. Maldives is currently developing an at-sea observer programme.	**YES: 4**	**No**	**No**	**No**	**No**	**No**	**No**	**No**
Mauritius	5	2			Mauritius has developed an observer scheme and started submitting data for 2015.	**YES: 8**	**No**	**No**	**No**	**No**	**No**	**3(O)**	**5(O+E)**
Mozambique	11				Mozambique has an observer programme and has submitted one trip report, but did not have any active vessels ≥24m in 2013.	**YES: 11**	**No**	**No**	**1(O)**	N/A	**No**	**7(E)**	**No**
Oman	1				IOTC observer training took take place in 2015, however no observer reports have been submitted as yet.	**No**	**No**	**No**	**No**	**No**	**No**	**No**	**No**
Pakistan					IOTC observer training took take place in 2015 and Pakistan is committed to establishing an observer scheme. A crew-based observer scheme has already been initiated by WWF-Pakistan, however no data has yet been submitted to the IOTC Secretariat.	**No**	**No**	**No**	**No**	**No**	**No**	**No**	**No**
Philippines					No information received by the Secretariat.	**No**	**No**	**No**	**No**	**No**	**No**	**No**	**No**
Seychelles	47	13			Seychelles initiated an observer programme in 2014 and has started to report observer data	**YES: 78**	**No**	**No**	**No**	**No**	**6(O)**	**46(O)**	**No**
Sierra Leone	No information received				No information received by the Secretariat.	**N/A**	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Somalia	No information received				No information received by the Secretariat.	**N/A**	N/A	N/A	N/A	N/A	N/A	N/A	N/A
South Africa	13				South Africa operates an observer programme for foreign vessels operating within the EEZ as well as for national vessels (since 2014).	**YES: 16**	**No**	**12(O)**	**10(O)**	**13(O)**	**8+2(O)** [16]	**7+9(O)**	**No**

[15] Reports from Madagascar include observers onboard foreign vessels
[16] Reports submitted for foreign vessels operating in the EEZ of South Africa between 2011 and 2013, and foreign + national flagged vessels for 2014 and 2015.

CPCs	Active Vessels LOA≥24m or High Seas vessels[13]				Progress	List of accredited observers submitted	Number of observer reports provided[14]						
	LL	PS	GN	BB			2010	2011	2012	2013	2014	2015	2016
Sri Lanka	1		1455		Sri Lanka has begun an observer initiative and submitted observer data from pilot trips in 2014 and 2015.	**No**	**No**	**No**	**No**	**No**	**2(O)**	**2(O)**	**No**
Sudan	No information received				No information received by the Secretariat.	**N/A**	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Tanzania, United Rep.of	3				Tanzania does not currently have an observer programme in place.	**No**	**No**	**No**	**No**	**No**	**No**	**No**	**1(O)**
Thailand		1			Thailand conducted observer training in 2015 and is due to begin deployment in 2017 as there were no active vessels in 2016	**YES: 8**	**No**	**No**	**No**	**No**	**No**	**No**	**No**
United Kingdom (OT)					The UK(OT) does not have any active vessels in the Indian Ocean.	**N/A**	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Yemen	No information received				No information received by the Secretariat.	**No**	**No**	**No**	**No**	**No**	**No**	**No**	**No**
COOPERATING NON-CONTRACTING PARTIES													
Bangladesh					No information received by the Secretariat.	**N/A**	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Djibouti					No information received by the Secretariat.	**N/A**	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Liberia					No information received by the Secretariat.	**N/A**	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Senegal					Senegal has not had any active vessels in the Indian Ocean since 2007.	**N/A**	N/A	N/A	N/A	N/A	N/A	N/A	N/A

APPENDIX VIII

2015: STATUS OF DEVELOPMENT AND IMPLEMENTATION OF NATIONAL PLANS OF ACTION FOR SEABIRDS AND SHARKS, AND IMPLEMENTATION OF THE FAO GUIDELINES TO REDUCE MARINE TURTLE MORTALITY IN FISHING OPERATIONS

(*updated September 2017*)

CPC	Sharks	Date of Implementation	Seabirds	Date of implementation	Marine turtles	Date of implementation	Comments
MEMBERS							
Australia		1st: April 2004 2nd: July 2012		1st: 1998 2nd: 2006 3rd: 2014		2003	**Sharks:** 2nd NPOA-Sharks (Shark-plan 2) was released in July 2012, along with an operational strategy for implementation: http://www.daff.gov.au/fisheries/environment/sharks/sharkplan2 **Seabirds:** Has implemented a Threat Abatement Plan [TAP] for the Incidental Catch (or Bycatch) of Seabirds During Oceanic Longline Fishing Operations since 1998. The present TAP took effect from 2014 and largely fulfills the role of an NPOA in terms of longline fisheries. http://www.antarctica.gov.au/__data/assets/pdf_file/0017/21509/Threat-Abatement-Plan-2014.pdf Australia is developing an NPOA to address the potential risk posed to seabirds by other fishing methods, including longline fishing in state and territory waters, which are not covered by the current threat abatement plan. **Marine turtles:** Australia's current marine turtle bycatch management and mitigation measures fulfill Australia's obligations under the FAO-Sea turtles Guidelines.
Belize		12 March 2015					**Sharks:** NPOA available at: http://www.fao.org/3/a-be841e.pdf **Seabirds:** No information received by the Secretariat. **Marine turtles:** No information received by the Secretariat.
China		–		–			**Sharks:** Development has not begun. **Seabirds:** Development has not begun. **Marine turtles:** No information received by the Secretariat.
–Taiwan,China		1st: May 2006 2nd: May 2012		1st: May 2006 2nd: Jul 2014			**Sharks:** No revision currently planned. **Seabirds:** No revision currently planned. **Marine turtles:** Wildlife Protection Act introduced in 2013, Protected Wildlife shall not be disturbed, abused, hunted, killed, traded, exhibited, displayed, owned, imported, exported, raised or bred, unless under special circumstances recognized in this or related legislation. *Cheloniidae spp*., *Caretta Caretta*, *Chelonia mydas*, *Eretmochelys imbricate*, *Lepidochelys olivacea* and *Dermochelys coriacea* are listed into List of Protected Species. Domestic Fisheries Management Regulation on Far Sea Fisheries request all fishing vessels have to carry line cutters ,de-hookers and hauling net in order to facilitate the appropriate handling and prompt release of marine turtles caught or entangled.
Comoros		–		–			**Sharks:** Shark fishing is prohibited **Seabirds:** There is no fleet in operation south of 25 degrees south. **Marine turtles:** According to the Comoros Fisheries Code Article 78, fishing, capture, possession and marketing of turtle and marine mammals or of protected aquatic organisms is strictly forbidden in accordance with national legislation in force and International Conventions applicable to the Comoros.

Eritrea							**Sharks:** No information received by the Secretariat. **Seabirds:** No information received by the Secretariat. **Marine turtles:** No information received by the Secretariat.
European Union		5 Feb 2009		16-Nov-2012		2007	**Sharks:** Approved on 05-Feb-2009 and it is currently being implemented. **Seabirds:** The EU adopted on Friday 16 November an Action Plan to address the problem of incidental catches of seabirds in fishing gears. **Marine turtles**: European Union Council Regulation (EC) No 520/2007 of 7 May 2007 lay down technical measures for the conservation of marine turtles including articles and provisions to reduce marine turtle bycatch. The regulation urges Member States to do their utmost to reduce the impact of fishing on sea turtles, in particular by applying the measures provided for in paragraphs 2, 3 and 4 of the resolution.
France (territories)		5 Feb 2009		2009, 2011		2015	**Sharks:** Approved on 05-Feb-2009. **Seabirds:** Implemented in 2009 and 2011. 2009 for Barrau's petrel and 2011 for Amsterdam albatross. **Marine turtles:** Implemented in 2015 for the five species of marine turtles that are present in the southwest Indian Ocean.
Guinea							**Sharks:** No information received by the Secretariat. **Seabirds:** No information received by the Secretariat. **Marine turtles:** No information received by the Secretariat.
India							**Sharks:** In preparation. In June 2015, India published a document entitled "Guidance on National Plan of Action for Sharks in India" which is intended as a guidance to the NPOA-Sharks, and seeks to (1) present an overview of the currents status of India's shark fishery, (2) assess the current management measures and their effectiveness, (3) identify the knowledge gaps that need to be addressed in NPOA-Sharks and (4) suggest a theme-based action plan for NPOA-Sharks. **Seabirds:** India has determined that seabird interactions are not a problem for their fleets. However, a formal evaluation has not yet taken place which the WPEB and SC require. **Marine turtles:** No information received by the Secretariat.
Indonesia		–		–			**Sharks:** Indonesia has established an NPOA for sharks and rays in 2015-2019 **Seabirds:** An NPOA was finalized in 2016 **Marine turtles:** Indonesia has established an NPOA for Marine Turtle but does not fully conform with FAO guidelines, Indonesia had been implementing Ministerial Regulation 12/2012 regarding captured fishing business on high seas to reduce turtle bycatch.
Iran, Islamic Republic of		–		–		–	**Sharks:** Have communicated to all fishing cooperatives the IOTC resolutions on sharks. Have in place a ban on the retention of live sharks. **Seabirds:** I.R. Iran determined that seabird interactions are not a problem for their fleet as they consist of gillnet vessels only. i.e. no longline vessels. **Marine turtles:** No information received by the Secretariat.
Japan		03-Dec-2009		03-Dec-2009			**Sharks:** NPOA–Shark assessment implementation report submitted to COFI in July 2012 **Seabirds:** NPOA–Seabird implementation report submitted to COFI in July 2012. **Marine turtles:** All Japanese fleets fully implement Resolution 12/04.
Kenya			n.a.	–			**Sharks:** A National Plan of Action for sharks is being developed and shall put in place a framework to ensure the conservation and management of sharks and

							their long-term sustainable use in Kenya. Preliminary meetings have been held and there are plans to finalise the NPOA by 2017. **Seabirds:** Kenya does not have any flagged longline vessels on its registry. There is no evidence of any gear seabird interaction with the current fishing fleet. Kenya does not therefore consider developing NPOA seabirds as necessary for the time being. **Marine turtles:** The Kenyan fisheries law prohibits retention and landing of turtles caught incidentally in fishing operations. Public awareness efforts are conducted for artisanal gillnet and artisanal longline fishing fleets on the mitigations measures that enhance marine turtle conservation.
Korea, Republic of		08-Aug-11		2014 – domestic fisheries		–	**Sharks:** Currently being implemented. **Seabirds:** This has already been applied in domestic fisheries and there are plans to submit an IPOA-seabirds to FAO by the end of 2016. **Marine turtles:** All Rep. of Korea vessels fully implement Res 12/04.
Madagascar		–		–			**Sharks:** Development has not begun. **Seabirds:** Development has not begun. Note: A fisheries monitoring system is in place in order to ensure compliance by vessels with the IOTC's shark and seabird conservation and management measures. **Marine turtles:** There is zero capture of marine turtle within the logbook. All the longliners use the circular hooks since. Declaration confirmed by the onboard observers and the on-landing samplers.
Malaysia		2008 2014		–		2008	**Sharks:** A revised NPOA-sharks was published in 2014. **Seabirds:** To be developed **Marine turtles:** A NPOA For Conservation and Management of Sea Turtles had been published in 2008. A revision will be published in 2017.
Maldives, Republic of		Apr 2015	n.a.	–			**Sharks:** Maldives has developed the NPOA-Sharks with the assistance of Bay of Bengal Large Marine Ecosystem (BoBLME) Project. A stakeholder consultation for the NPOA-Sharks was held in April of 2014. The NPOA-Sharks is in the finalization process and is expected to be published in November of 2014. The longline logbooks ensure the collection of shark bycatch data to genus level. Maldives would be reporting on shark bycatch to the appropriate technical Working Party meetings of IOTC. **Seabirds:** Article 12 of IPOA states that if a 'problem exists' CPCs adopt an NPOA. IOTC Resolution 05/09 suggests CPCs to report on seabirds to the IOTC Scientific Committee if the issue is appropriate'. Maldives considers that seabirds are not an issue in the Maldives fisheries, both in the pole-and-line fishery and in the longline fishery. The new longline fishing regulations has provision on mitigation measures on seabird bycatch. **Marine turtles:** Longline regulation has provisions to reduce marine turtle bycatch. The regulation urges longline vessels to have dehookers for removal of hook and a line cutter on board, to release the caught marine turtles as prescribed in Resolution 12/04.
Mauritius		2016					**Sharks:** The NPOA-sharks has been finalised; it focuses on actions needed to exercise influence on foreign fishing through the IOTC process and licence conditions, as well as improving the national legislation and the skills and data handling systems available for managing sharks. **Seabirds:** Mauritius does not have national vessels operating beyond 25^0S. However, fishing companies have been requested to implement all mitigation measures as provided in the IOTC Resolutions.

							Marine turtles: Marine turtles are protected by the national law. Fishing companies have been **requested** to carry line cutters and de-hookers in order to facilitate the appropriate handling and prompt release of marine turtles caught or entangled.
Mozambique		–		–			**Sharks**: Drafting of the NPOA-Shark started in 2016. At this stage, a baseline assessment was performed and the relevant information of coastal, pelagic and demersal shark species along the Mozambican coast was gathered. The ongoing process is expected to be completed by the end of 2017. **Seabirds**: Mozambique is regularly briefing the Masters of their fishing vessels on the mandatory requirement to report any seabird interaction with longliner fleet. **Marine turtles**: see above.
Oman, Sultanate of							**Sharks:** An NPOA-sharks is currently being drafted and is due to be finalized in 2017 **Seabirds:** Not yet initiated **Marine turtles:** The law does not allow the catch of sea turtles, and the fishermen are requested to release any hooked or entangled turtle. The longline fleet are required to carry out the line cutters and de-hookers.
Pakistan							**Sharks:** Sharks are landed with the fins attached and each and every part of the body of sharks are utilised. A stakeholder consultation workshop was conducted from 28-30 March 2016 to review the actions of the draft NPOA - Sharks. The draft NPOA was circulated to the key stakeholders and comments were received with an end-date of 30 June 2016. The final version of the NPOA - Sharks has been submitted to the provincial fisheries departments for endorsement. Meanwhile, the provincial fisheries departments have passed notification on catch, trade and/or retention of sharks including Thresher sharks, hammerheads, oceanic whitetip, whale sharks, guitarfishes, sawfishes, wedgefishes and mobulids. **Seabirds:** Pakistan considers that seabird interactions are not a problem for the Pakistani fishing fleet as the tuna fishing operations do not include longline vessels. **Marine turtles:** Pakistan has already framed Regulations regarding the prohibition of catching and retaining marine turtles. As regards to the reduction of marine turtle bycatch by gillnetters; presently Marine Fisheries Department (MFD) in collaboration with International Union for Conservation of Nature (IUCN) Pakistan, is undertaking an assessment. Stakeholder Coordination Committee Meeting was conducted on 10th September 2014. The “Turtle Assessment Report (TAR)” will be finalized by February 2015 and necessary guidelines / action plan will be finalized by June 2015. As per clause-5 (c) of Pakistan Fish Inspection & Quality Control Act, 1997, “Aquatic turtles, tortoises, snakes, mammals including dugongs, dolphins, porpoises and whales etc” are totally forbidden for export and domestic consumption.
Philippines		Sept. 2009		–			**Sharks:** Under periodic review. **Seabirds:** Development has not begun. **Marine turtles:** No information received by the Secretariat.
Seychelles, Republic of		Apr-2007		–			**Sharks:** Seychelles has developed and is implementing a new NPOA for Sharks for years 2016-2020 **Seabirds:** SFA is collaborating with Birdlife South Africa to develop an NPOA for sea bird. A consultant will be recruited to start development in December 2017

							Marine turtles: An NPOA for turtles is planned to start in 2018.
Sierra Leone							**Sharks:** No information received by the Secretariat. **Seabirds:** No information received by the Secretariat. **Marine turtles:** No information received by the Secretariat.
Somalia							**Sharks:** Somalia is currently revising its fisheries legislation (current one being from 1985) and will consider the development of NPOAs as part of this revision process. **Seabirds:** See above. **Marine turtles:** The Somali national fisheries law and legislation was reviewed and approved in 2014. This incudes Articles on the protection of marine turtles. Further review of the National Law is underway to harmonize this with IOTC Resolutions and is expected to be presented to the new parliament for endorsement in 2017.
South Africa, Republic of		–		2008			**Sharks**: The NPOA-sharks was approved and published in 2013. **Seabirds**: Published in August 2008 and fully implemented. The NPOA-seabirds has been earmarked for review. **Marine turtles**: The permit conditions for the longline fishery prohibits landing of turtles. Vessels have to carry a de-hooker on board and instructions on turtle handling and release in line with the FAO guidelines are included in the permit conditions. Trained observers are present on 100% of the trips of foreign vessels that fish under South African jurisdiction and all turtle interactions on these trips are recorded. Since 2013 recording of turtle interactions in the log books is mandatory and each vessel is provided with a species identification guide.
Sri Lanka							**Sharks:** An NPOA-sharks has been finalized and is currently being implemented. **Seabirds:** Sri Lanka has determined that seabird interactions are not a problem for their fleets. However a formal review has not yet taken place which the WPEB and SC have approved. **Marine turtles:** Implementation of the FAO Guideline to Reduce Sea Turtle Mortality in Fishing Operation in 2015 was submitted to IOTC in January 2016. Marine turtles are legally protected in Sri Lanka. Longliner vessels are required to have dehookers for removal of hooks and a line cutter on board, to release the caught marine turtles. Gillnets longer than 2.5 km are now prohibited in domestic legislation. Reporting of bycatch has made legally mandatory and facilitated via logbooks.
Sudan							**Sharks:** No information received by the Secretariat. **Seabirds:** No information received by the Secretariat. **Marine turtles:** No information received by the Secretariat.
Tanzania, United Republic of		–		–			**Sharks:** Initial discussions have commenced. **Seabirds:** Initial discussions have commenced. Note: Terms and conditions related to protected sharks and seabirds contained within fishing licenses. **Marine turtles:** Sea turtles are protected by law. However as there is a national turtle and Dugong conservation committee that oversee all issues related to sea turtles and dugongs. There is no information so far with regards to interaction between sea turtles and long line fishery.

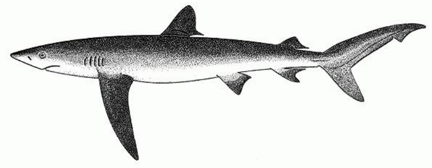
Thailand		23-Nov-2005		–			**Sharks:** Second NPOA-sharks currently being drafted. **Seabirds:** Development has not begun. **Marine turtles:** Not yet implemented.
United Kingdom	n.a.	–	n.a.	–		–	British Indian Ocean Territory (Chagos Archipelago) waters are a Marine Protected Area closed to fishing except recreational fishing in the 3nm territorial waters around Diego Garcia. Separate NPOAs have not been developed within this context. **Sharks/Seabirds:** For sharks, UK is the 24th signatory to the Convention on Migratory Species 'Memorandum of Understanding on the Conservation of Migratory Sharks' which extends the agreement to UK Overseas Territories including British Indian Ocean Territories; Section 7 (10) (e) of the *Fisheries (Conservation and Management) Ordinance* refers to recreational fishing and requires sharks to be released alive. No seabirds are caught in the recreational fishery. **Marine turtles:** No marine turtles are captured in the recreational fishery. A monitoring programme is taking place to assess the marine turtle population in UK (OT).
Yemen							**Sharks:** No information received by the Secretariat. **Seabirds:** No information received by the Secretariat. **Marine turtles:** No information received by the Secretariat.
COOPERATING NON-CONTRACTING PARTIES							
Bangladesh							**Sharks:** No information received by the Secretariat. **Seabirds:** No information received by the Secretariat. **Marine turtles:** No information received by the Secretariat.
Djibouti							**Sharks:** No information received by the Secretariat. **Seabirds:** No information received by the Secretariat. **Marine turtles:** No information received by the Secretariat.
Liberia							**Sharks:** No information received by the Secretariat. **Seabirds:** No information received by the Secretariat. **Marine turtles:** No information received by the Secretariat.
Senegal		25-Sept-2006		–			**Sharks:** The Sub-Regional Fisheries Commission supported the development of a NPOA-sharks for Senegal in 2005. Other activities conducted include the organization of consultations with industry, the investigation of shark biology and social -economics of shark fisheries). The NPOA is currently being revised. Consideration is being made to the inclusion of minimum mesh size, minimum shark size, and a ban on shark finning. **Seabirds:** The need for a NPOA-seabirds has not yet been assessed. **Marine turtles:** No information received by the Secretariat.

Colour key	
NPOA Completed/ FAO Guidelines fully implemented	
NPOA Drafting being finalized / FAO Guidelines partially implemented	

NPOA Drafting commenced / FAO Guidelines being communicated	
Not begun	

APPENDIX IX
EXECUTIVE SUMMARY: BLUE SHARK

Indian Ocean Tuna Commission
Commission des Thons de l'Océan Indien
iotc ctoi



Status of the Indian Ocean blue shark (BSH: *Prionace glauca*)

TABLE 1. Blue shark: Status of blue shark (*Prionace glauca*) in the Indian Ocean.

Area[17]	Indicators		2017 stock status determination
Indian Ocean	Reported catch 2015:	29,916 t	72.6%
	Estimated catch 2015:	54,735 t	
	Not elsewhere included (nei) sharks[18] 2015:	57,906 t	
	Average reported catch 2011–15:	29,507 t	
	Average estimated catch 2011–15	54,993 t	
	Ave. not elsewhere included (nei) sharks[2] 2011–15:	49,969 t	
	MSY (1,000 t) (80% CI)[3]:	33.0 (29.5 - 36.6)	
	F_{MSY} (80% CI)[3]:	0.304 (0.298 - 0.311)	
	SSB_{MSY} (1,000 t) (80% CI)[3]:	39.7 (35.5 - 45.4)	
	F_{2015}/F_{MSY} (80% CI)[3]:	0.866 (0.670 - 1.093)	
	SSB_{2015}/SSB_{MSY} (80% CI)[3]:	1.541 (1.368 - 1.721)	
	SSB_{2015}/SSB_0 (80% CI)[3]:	0.515 (0.461 - 0.556)	

[1]Boundaries for the Indian Ocean = IOTC area of competence

[2]Includes all other shark catches reported to the IOTC Secretariat, which may contain this species (i.e., SHK: sharks various nei; RSK: requiem sharks nei).

3 Estimates refer to the base case model using estimated catches.

Colour key	Stock overfished (SB_{year}/SB_{MSY}< 1)	Stock not overfished (SSB_{year}/SB_{MSY}≥ 1)
Stock subject to overfishing(F_{year}/F_{MSY}> 1)	0%	27.4
Stock not subject to overfishing (F_{year}/F_{MSY}≤ 1)	0%	72.6
Not assessed/Uncertain		

TABLE 2. Blue shark: IUCN threat status of blue shark (*Prionace glauca*) in the Indian Ocean.

Common name	Scientific name	IUCN threat status[3]		
		Global status	WIO	EIO
Blue shark	*Prionace glauca*	Near Threatened	–	–

The process of the threat assessment from IUCN is independent from the IOTC and is presented for information purpose only IUCN = International Union for Conservation of Nature; WIO = Western Indian Ocean; EIO = Eastern Indian Ocean
Sources: IUCN 2007, Stevens 2009

INDIAN OCEAN STOCK – MANAGEMENT ADVICE

Stock status. Considerable progress was made since the last Indian Ocean blue shark assessment on the integration of new data sources and modelling approaches. Uncertainty in data inputs and model configuration were explored through sensitivity analysis. Four stock assessment models were applied to the blue shark in 2017, specifically a data-limited catch only model (SRA), two Bayesian biomass dynamic models (JABBA with process error and a Pella-Tomlinson production model without process error) and an integrated age-structured model (SS3) (Fig. 1). All models produced similar results suggesting the stock is currently not overfished nor subject to overfishing, but with the trajectories showing consistent trends towards the overfished and subject to overfishing quadrant of the Kobe plot (Fig 1). A base case model was selected based on the best Indian Ocean biological data, consistency of CPUE standardized relative abundance series, model fits and spatial extent of the data (Fig. 1, Table 1). The major change in biological parameters since the previous stock assessment is the stock recruitment relationship, i.e., steepness = 0.79 due to the update of the key biological parameters calculated specific to the Indian Ocean. The major axes of uncertainties identified in the current model are catches and CPUE indices of abundance. Model results were explored with respect to their sensitivity to the major axes of uncertainty identified. If the alternative CPUE groupings were used then the stock status was somewhat more positive (B>>Bmsy and F<<Fmsy), while if the alternative catch series (trade and EUPOA) were used then the estimated stock status resulted in F>Fmsy. The ecological risk assessment (ERA) conducted for the Indian Ocean by the WPEB and SC in 2012 (IOTC–2012–SC15–INF10 Rev_1) consisted of a semi-quantitative risk assessment analysis to evaluate the resilience of shark species to the impact of a given fishery, by combining the biological productivity of the species and its susceptibility to each fishing gear type. Blue sharks received a medium vulnerability ranking (No. 10) in the ERA rank for longline gear because it was estimated as the most productive shark species, but was also characterised by the second highest susceptibility to longline gear. Blue shark was estimated as not being susceptible thus not vulnerable to purse seine gear. The current IUCN threat status of 'Near Threatened' applies to blue sharks globally (Table 2). Information available on this species has been improving in recent years. Blue sharks are commonly taken by a range of fisheries in the Indian Ocean and in some areas they are fished in their nursery grounds. Because of their life history characteristics – they live until at least 25 years, mature at 4–6 years, and have 25–50 pups every year and are considered to be the most productive of the pelagic sharks. On the weight-of-evidence available in 2017, the stock status is determined to be not overfished and not subject to overfishing (Table 1).

Outlook. Increasing effort could result in declines in biomass. The Kobe II Strategy Matrix (Table 3) provides the probability of exceeding reference levels in the short (3 years) and long term (10 years) given a range of percentage changes in catch.

Management advice. Even though the blue shark in 2017 is assessed to be not overfished nor subject to overfishing, maintaining current catches is likely to result in decreasing biomass and the stock becoming overfished and subject to overfishing in the near future (Table 3). If the Commission wishes to increase the probability of maintaining stock biomass above MSY reference levels ($B>B_{MSY}$) over the next 8 years, then a reduction of a least 10% in catches is advised (Table 3). The stock should be closely monitored. Mechanisms need to be developed by the Commission to improve current statistics, by ensuring CPCs comply with their recording and reporting requirement on sharks, so as to better inform scientific advice in the future.

The following key points should be noted:

- **Maximum Sustainable Yield (MSY)**: estimate for the whole Indian Ocean MSY is 33.0 thousand t.
- **Reference points**: The Commission has not adopted reference points or harvest control rules for any shark species.
- **Main fishing gear** (2011–15): Coastal longline; longline targeting swordfish; longline (deep-freezing).
- **Main fleets** (2011–15): Indonesia; EU,Spain; Taiwan, China; Japan; EU,Portugal.

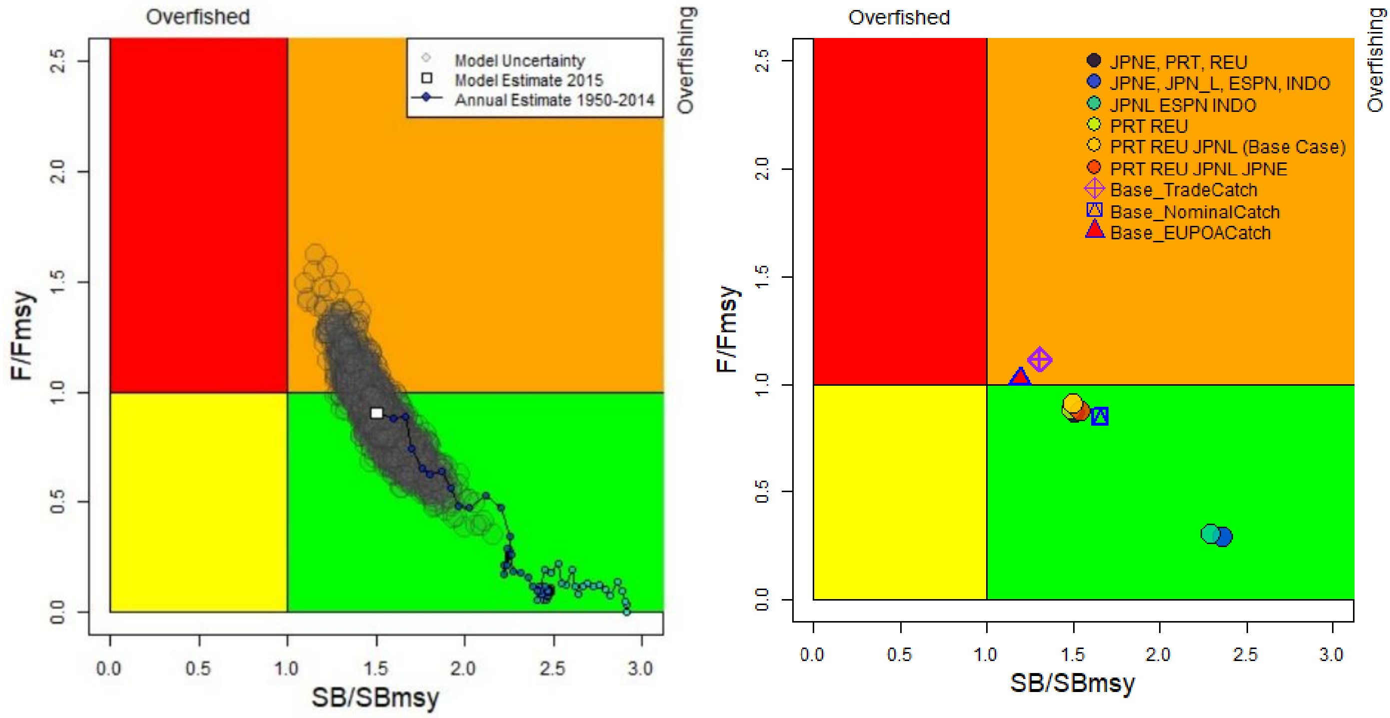


Fig. 1. Blue shark: Aggregated Indian Ocean stock assessment Kobe plot for the 2017 estimate based on the base case model and a range of sensitivity models explored with several catch reconstructions and fits to CPUE series. (Left panel: base case model with trajectory and MCMC uncertainties in the terminal year; Right panel: terminal year estimates of the sensitivity model runs). All models shown are run using SS3 - Stock Synthesis III.

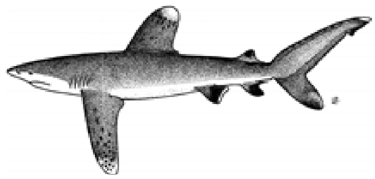
TABLE 3. Blue shark: Aggregated Indian Ocean assessment Kobe II Strategy Matrix. Probability (percentage) of violating the MSY-based reference points for nine constant catch projections using the base case model (catch level from 2015* (54,735t), ± 10%, ± 20%, ± 30% and ± 40%) projected for 3 and 10 years.

Reference point and projection time frame	**Alternative catch projections (relative to the catch level* from 2015) and probability (%) of violating MSY-based reference points (Btarg=Bmsy; Ftarg=Fmsy)**								
Catch Relative to 2015	60%	70%	80%	90%	100%	110%	120%	130%	140%
Nominal Catch (t)	(17,950)	(20,941)	(23,933)	(26,924)	(29,916)	(32,908)	(35,899)	(38,891)	(41,882)
Estimated Catch (t)	(32,841)	(38,315)	(43,788)	(49,262)	(54,735)	(60,209)	(65,682)	(71,156)	(76,629)
$B_{2018} < B_{MSY}$	0%	0%	0%	0%	0%	0%	1%	1%	3%
$F_{2018} > F_{MSY}$	0%	1%	7%	25%	49%	69%	83%	91%	95%
$B_{2025} < B_{MSY}$	0%	1%	8%	25%	48%	68%	82%	89%	92%
$F_{2025} > F_{MSY}$	0%	7%	35%	67%	87%	95%	97%	94%	90%

*: average catch level and respective % changes refer to the estimated catch series used in the final base case model (IOTC-2017-WPEB13-23)

APPENDIX X
EXECUTIVE SUMMARY: OCEANIC WHITETIP SHARK

Indian Ocean Tuna Commission
Commission des Thons de l'Océan Indien
iotc ctoi



Status of the Indian Ocean oceanic whitetip shark (OCS: *Carcharhinus longimanus*)

CITES APPENDIX II species

TABLE 1. Oceanic whitetip shark: Status of oceanic whitetip shark (*Carcharhinus longimanus*) in the Indian Ocean.

Area[1]	**Indicators**		**2017 stock status determination**
Indian Ocean	Reported catch 2015: Not elsewhere included (nei) sharks[2] 2015: Average reported catch 2011–2015: Av. not elsewhere included 2011-2015 (nei) sharks[2]:	215 t 57,906t 250 t 49,969 t	
	MSY (1,000 t) (80% CI): F_{MSY} (80% CI): SB_{MSY} (1,000 t) (80% CI): F_{2014}/F_{MSY} (80% CI): SB_{2014}/SB_{MSY} (80% CI): SB_{2014}/SB_0 (80% CI):	unknown	

[1]Boundaries for the Indian Ocean = IOTC area of competence
[2]Includes all other shark catches reported to the IOTC Secretariat, which may contain this species(i.e., SHK: sharks various nei; RSK: requiem sharks nei)

Colour key	Stock overfished(SB_{year}/SB_{MSY}< 1)	Stock not overfished (SB_{year}/SB_{MSY}≥ 1)
Stock subject to overfishing(F_{year}/F_{MSY}> 1)		
Stock not subject to overfishing (F_{year}/F_{MSY}≤ 1)		
Not assessed/Uncertain		

NOTE: IOTC Resolution 13/06 *on a scientific and management framework on the conservation of shark species caught in association with IOTC managed fisheries*, prohibits retention onboard, transhipping, landing or storing any part or whole carcass of oceanic whitetip sharks.

TABLE 2. Oceanic whitetip shark: IUCN threat status of oceanic whitetip shark (*Carcharhinus longimanus*) in the Indian Ocean.

Common name	**Scientific name**	**IUCN threat status**[3]		
		Global status	**WIO**	**EIO**
Oceanic whitetip shark	*Carcharhinus longimanus*	Vulnerable	–	–

IUCN = International Union for Conservation of Nature; WIO = Western Indian Ocean; EIO = Eastern Indian Ocean
Sources: IUCN 2007, Baum et al. 2006
CITES - In March 2013, CITES agreed to include oceanic whitetip shark to Appendix II to provide further protections prohibiting the international trade; which will become effective on September 14, 2014.
[3]The process of the threat assessment from IUCN is independent from the IOTC and is presented for information purpose only

INDIAN OCEAN STOCK – MANAGEMENT ADVICE

Stock status. There remains considerable uncertainty about the relationship between abundance, standardised CPUE series and total catches over the past decade (Table 1). The ecological risk assessment (ERA) conducted for the Indian Ocean by the WPEB and SC in 2012 (IOTC–2012–SC15–INF10 Rev_1) consisted of a semi-quantitative risk assessment analysis to evaluate the resilience of shark species to the impact of a given fishery, by combining the biological productivity of the species and its susceptibility to each fishing gear type. Oceanic whitetip shark received a high vulnerability ranking (No. 5) in the ERA rank for longline gear because it was estimated as one of the least productive shark species, and was also characterised by a high susceptibility to longline gear. Oceanic whitetip shark was estimated as being the most vulnerable shark species to purse seine gear, as it was characterised as having a relatively low productive rate, and high susceptibility. The current IUCN threat status of 'Vulnerable' applies to oceanic whitetip sharks globally (Table 2). There is a paucity of information available on this species in the Indian Ocean and this situation is not expected to improve in the short to medium term. Oceanic whitetip sharks are commonly taken by a range of fisheries in the Indian Ocean. Because of their life history characteristics – they are relatively long lived, mature at 4–5 years, and have relativity few offspring (<20 pups every two years), the oceanic whitetip shark is likely vulnerable to overfishing. Despite the Despite the limited amount of data, recent studies (Tolotti et al., 2016) suggest that oceanic whitetip shark abundance has declined in recent years (2000-2015) compared to historic years (1986-1999). Available pelagic longline standardised CPUE indices from Japan and EU,Spain indicate conflicting trends as discussed in the full Executive Summary for oceanic whitetip sharks. There is no quantitative stock assessment and limited basic fishery indicators currently available for oceanic whitetip sharks in the Indian Ocean therefore the stock status is **uncertain** (Table 1).

Outlook. Maintaining or increasing effort with associated fishing mortality can result in declines in biomass, productivity and CPUE. The impact of piracy in the western Indian Ocean has resulted in the displacement and subsequent concentration of a substantial portion of longline fishing effort into certain areas in the southern and eastern Indian Ocean. It is therefore unlikely that catch and effort on oceanic whitetip sharks will decline in these areas in the near future, and may result in localised depletion.

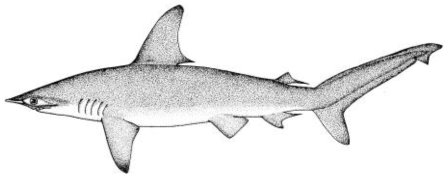
Management advice. A precautionary approach to the management of oceanic whitetip shark should be considered by the Commission, noting that recent studies suggest that longline mortality at haulback is high (50%) in the Indian Ocean (IOTC-2016-WPEB12-26), while mortality rates for interactions with other gear types such as purse seines and gillnets may be higher. Mechanisms need to be developed by the Commission to encourage CPCs to comply with their recording and reporting requirement on sharks, so as to better inform scientific advice.

The following key points should be noted:

- **Maximum Sustainable Yield (MSY)**: Not applicable. Retention prohibited.
- **Reference points**: Not applicable.
- **Main fishing gear** (2011–15): Gillnet; gillnet-longline.
- **Main fleets** (2011–15): I.R. Iran; Sri Lanka; Madagascar; (Reported as discarded by China, Australia, France, Maldives, Korea, Japan, South Africa).

APPENDIX XI
EXECUTIVE SUMMARY: SCALLOPED HAMMERHEAD SHARK

Indian Ocean Tuna Commission
Commission des Thons de l'Océan Indien
iotc ctoi



Status of the Indian Ocean Scalloped Hammerhead Shark (SPL: *Sphyrna lewini*)

CITES APPENDIX II species

TABLE 1. Status of scalloped hammerhead shark (*Sphyrna lewini*) in the Indian Ocean.

Area[1]	Indicators		2017 stock status determination
Indian Ocean	Reported catch 2015: Not elsewhere included (nei) sharks[2]2015: Average reported catch 2011–2015: Av. not elsewhere included (nei) sharks[2] 2011–15:	44 t 57,906t 72 t 49,969 t	
	MSY (1,000 t) (80% CI): F_{MSY} (80% CI): SB_{MSY} (1,000 t) (80% CI): F_{2014}/F_{MSY} (80% CI): SB_{2014}/SB_{MSY} (80% CI): SB_{2014}/SB_0 (80% CI):	unknown	

[1]Boundaries for the Indian Ocean = IOTC area of competence
[2]Includes all other shark catches reported to the IOTC Secretariat, which may contain this species (i.e., SHK: sharks various nei; RSK: requiem sharks nei).

Colour key	Stock overfished(SB_{year}/SB_{MSY}< 1)	Stock not overfished ($SB_{year}/SB_{MSY}\geq$ 1)
Stock subject to overfishing(F_{year}/F_{MSY}> 1)		
Stock not subject to overfishing ($F_{year}/F_{MSY}\leq$ 1)		
Not assessed/Uncertain		

TABLE 2. IUCN threat status of scalloped hammerhead shark (*Sphyrna lewini*) in the Indian Ocean.

Common name	Scientific name	IUCN threat status[3]		
		Global status	WIO	EIO
Scalloped hammerhead	*Sphyrna lewini*	Endangered	Endangered	–

IUCN = International Union for Conservation of Nature; WIO = Western Indian Ocean; EIO = Eastern Indian Ocean
[3]The process of the threat assessment from IUCN is independent from the IOTC and is presented for information purpose only
Sources: IUCN 2007, Baum 2007

INDIAN OCEAN STOCK – MANAGEMENT ADVICE

Stock status. The current IUCN threat status of 'Endangered' applies to scalloped hammerhead sharks globally and specifically for the western Indian Ocean (Table 2). The ecological risk assessment (ERA) conducted for the Indian Ocean by the WPEB and SC in 2012 (Murua et al., 2012) consisted of a semi-quantitative risk assessment analysis to evaluate the resilience of shark species to the impact of a given fishery, by combining the biological productivity of the species and its susceptibility to each fishing gear type. Scalloped hammerhead shark received a low vulnerability ranking (No. 14) in the ERA rank for longline gear because it was estimated as one of the least productive shark species, but was also characterised by a lower susceptibility to longline gear. Scalloped hammerhead shark was estimated as the sixth most vulnerable shark species in the ERA ranking for purse seine gear, but with lower levels of vulnerability compared to longline gear, because the susceptibility was lower for purse seine gear. There is a paucity of information available on this species and this situation is not expected to improve in the short to medium term. Scalloped hammerhead sharks are commonly taken by a range of fisheries in the Indian Ocean. They are extremely vulnerable to gillnet fisheries. Furthermore, pups occupy shallow coastal nursery grounds, often heavily exploited by inshore fisheries. Because of their life history characteristics – they are relatively long lived (over 30 years), and have relativity few offspring (<31 pups each year), the scalloped hammerhead shark is vulnerable to overfishing. There is no quantitative stock assessment or basic fishery indicators currently available for scalloped hammerhead shark in the Indian Ocean therefore the stock status is **uncertain** (Table 1).

Outlook. Maintaining or increasing effort can result in declines in biomass and productivity. The impact of piracy in the western Indian Ocean has resulted in the displacement and subsequent concentration of a substantial portion of longline fishing effort into certain areas in the southern and eastern Indian Ocean. It is therefore unlikely that catch and effort on scalloped hammerhead shark will decline in these areas in the near future.

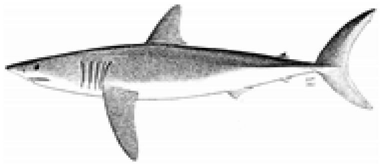
Management advice. A precautionary approach to the management of scalloped hammerhead shark should be considered by the Commission. Mechanisms need to be developed by the Commission to encourage CPCs to comply with their recording and reporting requirement on sharks, so as to better inform scientific advice.

The following key points should be noted:

- **Maximum Sustainable Yield (MSY)**: Unknown.
- **Reference points**: Not applicable.
- **Main fishing gear** (2011–15): Gillnet-longline; longline-gillnet; longline (fresh).
- **Main fleets** (2011–15): Sri Lanka; NEI-Fresh (report as discarded by EU-France, South Africa)

APPENDIX XII
EXECUTIVE SUMMARY: SHORTFIN MAKO SHARK

Indian Ocean Tuna Commission
Commission des Thons de l'Océan Indien
iotc ctoi



Status of the Indian Ocean shortfin mako shark (SMA: *Isurus oxyrinchus*)

TABLE 1. Shortfin mako shark: Status of shortfin mako shark (*Isurus oxyrinchus*) in the Indian Ocean.

Area[1]	**Indicators**		**2017 stock status determination**
Indian Ocean	Reported catch 2015:	1,317 t	
	Not elsewhere included (nei) sharks[2] 2015:	57,906t	
	Average reported catch 2011–15:	1,456 t	
	Av. not elsewhere included (nei) sharks[2] 2011–15:	49,969 t	
	MSY (1,000 t) (80% CI): F_{MSY} (80% CI): SB_{MSY} (1,000 t) (80% CI): F_{2014}/F_{MSY} (80% CI): SB_{2014}/SB_{MSY} (80% CI): SB_{2014}/SB_0 (80% CI):	unknown	

[1]Boundaries for the Indian Ocean = IOTC area of competence
[2]Includes all other shark catches reported to the IOTC Secretariat, which may contain this species (i.e., SHK: sharks various nei; RSK: requiem sharks nei).

Colour key	Stock overfished(SB_{year}/SB_{MSY}< 1)	Stock not overfished (SB_{year}/SB_{MSY}≥ 1)
Stock subject to overfishing(F_{year}/F_{MSY}> 1)		
Stock not subject to overfishing (F_{year}/F_{MSY}≤ 1)		
Not assessed/Uncertain		

TABLE 2. Shortfin mako shark: IUCN threat status of shortfin mako shark (*Isurus oxyrinchus*) in the Indian Ocean.

Common name	**Scientific name**	**IUCN threat status[3]**		
		Global status	**WIO**	**EIO**
Shortfin mako shark	*Isurus oxyrinchus*	Vulnerable	–	–

IUCN = International Union for Conservation of Nature; WIO = Western Indian Ocean; EIO = Eastern Indian Ocean
[3]The process of the threat assessment from IUCN is independent from the IOTC and is presented for information purpose only
SOURCES: IUCN 2007, Cailliet 2009

INDIAN OCEAN STOCK – MANAGEMENT ADVICE

Stock status. There remains considerable uncertainty about the relationship between abundance, the standardised CPUE series, and total catches over the past decade (Table 1). The ecological risk assessment (ERA) conducted for the Indian Ocean by the WPEB and SC in 2012 (Murua et al., 2012) consisted of a semi-quantitative risk assessment analysis to evaluate the resilience of shark species to the impact of a given fishery, by combining the biological productivity of the species and its susceptibility to each fishing gear type. Shortfin mako sharks received the highest vulnerability ranking (No. 1) in the ERA rank for longline gear because it was characterised as one of the least productive shark species, and with a high susceptibility to longline gear. Shortfin mako shark was estimated as the third most vulnerable shark species in the ERA ranking for purse seine gear, but with lower levels of vulnerability compared to longline gear, because the susceptibility was lower for purse seine gear. The current IUCN threat status of 'Vulnerable' applies to shortfin mako sharks globally (Table 2). Trends in the Japanese standardised CPUE series from its longline fleet suggest that the biomass has declined from 1994 to 2003, and has been increasing since then. Trends in EU,Portugal longline standardised CPUE series suggest that the biomass has declined from 1999 to 2004, and has been increasing since then. There is a paucity of information available on this species, but this situation has been improving in recent years. Shortfin mako sharks are commonly taken by a range of fisheries in the Indian Ocean. Because of their life history characteristics – they are relatively long lived (over 30 years), females mature at 18–21 years, and have relativity few offspring (<25 pups every two or three years), the shortfin mako shark can be vulnerable to overfishing. There is no quantitative stock assessment currently available for shortfin mako shark in the Indian Ocean therefore the stock status is **uncertain**.

Outlook. Maintaining or increasing effort can result in declines in biomass, productivity and CPUE. The impact of piracy in the western Indian Ocean has resulted in the displacement and subsequent concentration of a substantial portion of longline fishing effort into certain areas in the southern and eastern Indian Ocean. It is therefore unlikely that catch and effort on shortfin mako shark will decline in these areas in the near future, and may result in localised depletion.

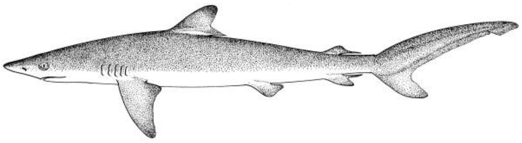
Management advice. A precautionary approach to the management of shortfin mako shark should be considered by the Commission. Mechanisms need to be developed by the Commission to ensure CPCs comply with their recording and reporting requirement on sharks, so as to better inform scientific advice.

The following key points should also be noted:

- **Maximum Sustainable Yield (MSY)**: Unknown.
- **Reference points**: Not applicable.
- **Main fishing gear** (2011–15): Longline targeting swordfish; longline (deep-freezing); longline (targeting sharks); gillnet.
- **Main fleets** (2011–15): EU,Spain; South Africa; EU,Portugal; Japan, Iran.

APPENDIX XIII
EXECUTIVE SUMMARY: SILKY SHARK

Indian Ocean Tuna Commission
Commission des Thons de l'Océan Indien
iotc ctoi



Status of the Indian Ocean silky shark (FAL: *Carcharhinus falciformis*)

TABLE 1. Silky shark: Status of silky shark (*Carcharhinus falciformis*) in the Indian Ocean.

Area[1]	**Indicators**		**2017 stock status determination**
Indian Ocean	Reported catch 2015: Not elsewhere included (nei) sharks[2] 2015: Average reported catch 2011–15: Av. not elsewhere included (nei) sharks[2] 2011–15:	3,204 t 57,906t 3,702 t 49,969 t	
	MSY (1,000 t) (80% CI): F_{MSY} (80% CI): SB_{MSY} (1,000 t) (80% CI): F_{2014}/F_{MSY} (80% CI): SB_{2014}/SB_{MSY} (80% CI): SB_{2014}/SB_0 (80% CI):	unknown	

[1]Boundaries for the Indian Ocean = IOTC area of competence
[2]Includes all other shark catches reported to the IOTC Secretariat, which may contain this species (i.e., SHK: sharks various nei; RSK: requiem sharks nei).

Colour key	Stock overfished($SB_{year}/SB_{MSY} < 1$)	Stock not overfished ($SB_{year}/SB_{MSY} \geq 1$)
Stock subject to overfishing($F_{year}/F_{MSY} > 1$)		
Stock not subject to overfishing ($F_{year}/F_{MSY} \leq 1$)		
Not assessed/Uncertain		

TABLE 2. Silky shark: IUCN threat status of silky shark (*Carcharhinus falciformis*) in the Indian Ocean.

Common name	**Scientific name**	**IUCN threat status**[3]		
		Global status	**WIO**	**EIO**
Silky shark	*Carcharhinus falciformis*	Near Threatened	Near Threatened	Near Threatened

IUCN = International Union for Conservation of Nature; WIO = Western Indian Ocean; EIO = Eastern Indian Ocean
[3]The process of the threat assessment from IUCN is independent from the IOTC and is presented for information purpose only
Sources:IUCN 2007, 2012

INDIAN OCEAN STOCK – MANAGEMENT ADVICE

Stock status. There remains considerable uncertainty about the relationship between abundance and the nominal CPUE series from the main longline fleets, and about the total catches over the past decade (Table 1). The ecological risk assessment (ERA) conducted for the Indian Ocean by the WPEB and SC in 2012 (IOTC–2012–SC15–INF10 Rev_1) consisted of a semi-quantitative risk assessment analysis to evaluate the resilience of shark species to the impact of a given fishery, by combining the biological productivity of the species and its susceptibility to each fishing gear type. Silky shark received a high vulnerability ranking (No. 4) in the ERA rank for longline gear because it was estimated as one of the least productive shark species, and with a high susceptibility to longline gear. Silky shark was estimated as the second most vulnerable shark species in the ERA ranking for purse seine gear, due to its low productivity and high susceptibility for purse seine gear. The current IUCN threat status of 'Near Threatened' applies to silky sharks in the western and eastern Indian Ocean and globally (Table 2). There is a paucity of information available on this species but several recent studies have been carried out for this species in the recent years. Silky sharks are commonly taken by a range of fisheries in the Indian Ocean. Because of their life history characteristics – they are relatively long lived (over 20 years), mature relatively late (at 6–12 years), and have relativity few offspring (<20 pups every two years), the silky shark can be vulnerable to overfishing. Despite the lack of data, there is some anecdotal information suggesting that silky shark abundance has declined over recent decades, including from Indian longline research surveys, which is described in the full Executive Summary for silky shark sharks. There is no quantitative stock assessment or basic fishery indicators currently available for silky shark in the Indian Ocean therefore the stock status is **uncertain**.

Outlook. Maintaining or increasing effort can probably result in declines in biomass, productivity and CPUE. The impact of piracy in the western Indian Ocean has resulted in the displacement and subsequent concentration of a substantial portion of longline fishing effort into certain areas in the southern and eastern Indian Ocean. It is therefore unlikely that catch and effort on silky shark will decline in these areas in the near future, and may result in localised depletion.

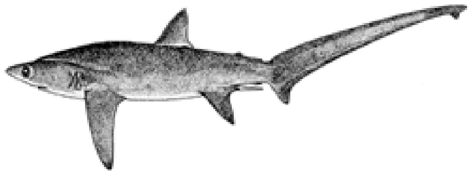
Management advice. A precautionary approach to the management of silky shark should be considered by the Commission. Mechanisms need to be developed by the Commission to encourage CPCs to comply with their recording and reporting requirement on sharks, so as to better inform scientific advice.

The following key points should also be noted:

- **Maximum Sustainable Yield (MSY)**: Unknown.
- **Reference points**: Not applicable.
- **Main fishing gear** (2011–15): Gillnet; gillnet-longline; longline (fresh); longline-gillnet.
- **Main fleets** (2011–15): Sri Lanka; I.R. Iran; Taiwan,China.

APPENDIX XIV
EXECUTIVE SUMMARY: BIGEYE THRESHER SHARK

Indian Ocean Tuna Commission
Commission des Thons de l'Océan Indien
iotc ctoi



Status of the Indian Ocean bigeye thresher shark (BTH: *Alopias superciliosus*)

TABLE 1. Bigeye thresher shark: Status bigeye thresher shark(*Alopias superciliosus*) in the Indian Ocean.

Area[1]	**Indicators**		**2017 stock status determination**
Indian Ocean	Reported catch 2015: Not elsewhere included (nei) sharks[2] 2015: Average reported catch 2011–15: Av. not elsewhere included (nei) sharks[2] 2011–15:	0 t 57,906t 94 t 49,969 t	
	MSY (1,000 t) (80% CI): F_{MSY} (80% CI): SB_{MSY} (1,000 t) (80% CI): F_{2014}/F_{MSY} (80% CI): SB_{2014}/SB_{MSY} (80% CI): SB_{2014}/SB_0 (80% CI):	unknown	

[1]Boundaries for the Indian Ocean = IOTC area of competence
[2]Includes all other shark catches reported to the IOTC Secretariat, which may contain this species (i.e., SHK: sharks various nei; RSK: requiem sharks nei).

Colour key	Stock overfished(SB_{year}/SB_{MSY}< 1)	Stock not overfished (SB_{year}/SB_{MSY}≥ 1)
Stock subject to overfishing(F_{year}/F_{MSY}> 1)		
Stock not subject to overfishing (F_{year}/F_{MSY}≤ 1)		
Not assessed/Uncertain		

TABLE 2. Bigeye thresher shark: IUCN threat status of bigeye thresher shark (*Alopias superciliosus*) in the Indian Ocean.

Common name	**Scientific name**	**IUCN threat status**[3]		
		Global status	**WIO**	**EIO**
Bigeye thresher shark	*Alopias superciliosus*	Vulnerable	–	–

IUCN = International Union for Conservation of Nature; WIO = Western Indian Ocean; EIO = Eastern Indian Ocean
[3]The process of the threat assessment from IUCN is independent from the IOTC and is presented for information purpose only
Sources: IUCN 2007, Amorim et al. 2009

NOTE: IOTC Resolution 12/09 *On the conservation of thresher sharks (family Alopiidae) caught in association with fisheries in the IOTC area of competence*, prohibits retention onboard, transhipping, landing, storing, selling or offering for sale any part or whole carcass of thresher sharks of all the species of the family Alopiidae[19].

INDIAN OCEAN STOCK – MANAGEMENT ADVICE

Stock status. There remains considerable uncertainty in the stock status due to lack of information necessary for assessment or for the development of other indicators of the stock (Table 1). The ecological risk assessment (ERA) conducted for the Indian Ocean by the WPEB and SC in 2012 (Murua et al., 2012) consisted of a semi-quantitative risk assessment analysis to evaluate the resilience of shark species to the impact of a given fishery, by combining the biological productivity of the species and its susceptibility to each fishing gear type. Bigeye thresher shark received a high vulnerability ranking (No. 2) in the ERA rank for longline gear because it was characterised as one of the least

[19]Scientific observers shall be allowed to collect biological samples from thresher sharks that are dead at haulback, provided that the samples are part of the research project approved by the Scientific Committee (or the Working Party on Ecosystemsand Bycatch).

productive shark species, and highly susceptible to longline gear. Despite its low productivity, bigeye thresher shark has a low vulnerability ranking to purse seine gear due to its low susceptibility for this particular gear. The current IUCN threat status of 'Vulnerable' applies to bigeye thresher shark globally (Table 2). There is a paucity of information available on this species and this situation is not expected to improve in the short to medium term. Bigeye thresher sharks are commonly taken by a range of fisheries in the Indian Ocean. Because of their life history characteristics – they are relatively long lived (+20 years), mature at 9–3 years, and have few offspring (2–4 pups every year), the bigeye thresher shark is vulnerable to overfishing. There is no quantitative stock assessment and limited basic fishery indicators currently available for bigeye thresher shark in the Indian Ocean therefore the stock status is **uncertain**.

Outlook. Current longline fishing effort is directed to other species, however bigeye thresher sharks is a common bycatch in these fisheries. Hooking mortality is apparently very high, therefore IOTC regulation 10/12 prohibiting retaining of any part of thresher sharks onboard and promoting life release of thresher shark may be largely ineffective for species conservation. Maintaining or increasing effort, with associated fishing mortality, can result in declines in biomass, productivity and CPUE. However there are few data to estimate CPUE trends, in view of IOTC Resolution 12/09 and reluctance of fishing fleet to report information on discards/non-retained catch. The impact of piracy in the western Indian Ocean has resulted in the displacement and subsequent concentration of a substantial portion of longline fishing effort into other areas in the southern and eastern Indian Ocean. It is therefore unlikely that catch and effort on bigeye thresher shark will decline in these areas in the near future, which may result in localised depletion.

Management advice. The prohibition on retention of bigeye thresher shark should be maintain. Mechanisms need to be developed by the Commission to encourage CPCs to comply with their reporting requirement on sharks, so as to better inform scientific advice.

The following key points should also be noted:

- **Maximum Sustainable Yield (MSY)**: Not applicable. Retention prohibited.
- **Reference points**: Not applicable.
- **Main fishing gear** (2011–15): Gillnet-longline; longline-gillnet.
- **Main fleets** (2011–15): Sri Lanka.

APPENDIX XV
EXECUTIVE SUMMARY: PELAGIC THRESHER SHARK

Indian Ocean Tuna Commission
Commission des Thons de l'Océan Indien
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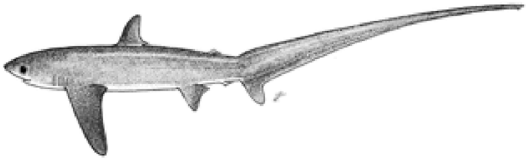

Status of the Indian Ocean pelagic thresher shark (PTH: *Alopias pelagicus*)

TABLE 1. Pelagic thresher shark: Status pelagic thresher shark (*Alopias pelagicus*) in the Indian Ocean.

Area[1]	Indicators		2016 stock status determination
Indian Ocean	Reported catch 2015: Not elsewhere included (nei) sharks[2] 2015: Average reported catch 2011–15: Av. not elsewhere included (nei) sharks[2] 2011-15:	0 t 57,906t 69 t 49,969 t	
	MSY (1,000 t) (80% CI): F_{MSY} (80% CI): SB_{MSY} (1,000 t) (80% CI): F_{2014}/F_{MSY} (80% CI): SB_{2014}/SB_{MSY} (80% CI): SB_{2014}/SB_0 (80% CI):	unknown	

[1]Boundaries for the Indian Ocean = IOTC area of competence
[2]Includes all other shark catches reported to the IOTC Secretariat, which may contain this species (i.e., SHK: sharks various nei; RSK: requiem sharks nei).

Colour key	Stock overfished($SB_{year}/SB_{MSY}< 1$)	Stock not overfished ($SB_{year}/SB_{MSY}\geq 1$)
Stock subject to overfishing($F_{year}/F_{MSY}> 1$)		
Stock not subject to overfishing ($F_{year}/F_{MSY}\leq 1$)		
Not assessed/Uncertain		

TABLE 2. Pelagic thresher shark: IUCN threat status of pelagic thresher shark (*Alopias pelagicus*) in the Indian Ocean.

Common name	Scientific name	IUCN threat status[3]		
		Global status	WIO	EIO
Pelagic thresher shark	*Alopias pelagicus*	Vulnerable	–	–

IUCN = International Union for Conservation of Nature; WIO = Western Indian Ocean; EIO = Eastern Indian Ocean
[3]The process of the threat assessment from IUCN is independent from the IOTC and is presented for information purpose only
Sources:IUCN 2007, Reardon et al. 2009

NOTE: IOTC Resolution 12/09 *On the conservation of thresher sharks (family Alopiidae) caught in association with fisheries in the IOTC area of competence*, prohibits retention onboard, transhipping, landing, storing, selling or offering for sale any part or whole carcass of thresher sharks of all the species of the family Alopiidae[20].

INDIAN OCEAN STOCK – MANAGEMENT ADVICE

Stock status. There remains considerable uncertainty in the stock status due to lack of information necessary for assessment or to for the development of other indicators of the stock (Table 1). The ecological risk assessment (ERA) conducted for the Indian Ocean by the WPEB and SC in 2012 (Murua et al., 2012) consisted of a semi-quantitative risk assessment analysis to evaluate the resilience of shark species to the impact of a given fishery, by combining the biological productivity of the species and its susceptibility to each fishing gear type. Pelagic thresher shark received a high vulnerability ranking (No. 3) in the ERA rank for longline gear because it was characterised as one of the least productive shark species, and with a high susceptibility to longline gear. Despite its low productivity, pelagic thresher shark has a low vulnerability ranking to purse seine gear due to its low susceptibility for this particular gear. The current

[20]Scientific observers shall be allowed to collect biological samples from thresher sharks that are dead at haulback, provided that the samples are part of the research project approved by the Scientific Committee (or the Working Party on Ecosystemsand Bycatch).

IUCN threat status of 'Vulnerable' applies to pelagic thresher shark globally (Table 2). There is a paucity of information available on this species and this situation is not expected to improve in the short to medium term. Pelagic thresher sharks are commonly taken by a range of fisheries in the Indian Ocean. Because of their life history characteristics – they are relatively long lived (+ 20 years), mature at 8–9 years, and have few offspring (2 pups every year), the pelagic thresher shark is vulnerable to overfishing. There is no quantitative stock assessment and limited basic fishery indicators currently available for pelagic thresher shark in the Indian Ocean therefore the stock status is **uncertain.**

Outlook. Current longline fishing effort is directed to other species, however pelagic thresher sharks is a common bycatch these fisheries. Hooking mortality is apparently very high, therefore IOTC regulation 10/12 prohibiting retaining of any part of thresher sharks onboard and promoting life release of thresher shark may be largely ineffective for species conservation. Maintaining or increasing effort can result in declines in biomass, productivity and CPUE. However there are few data to estimate CPUE trends, in view of IOTC regulation 10/12 and reluctance of fishing fleet to report information on discards/non-retained catch. The impact of piracy in the western Indian Ocean has resulted in the displacement and subsequent concentration of a substantial portion of longline fishing effort into other areas in the southern and eastern Indian Ocean. It is therefore unlikely that catch and effort on pelagic thresher shark will decline in these areas in the near future, which may result in localised depletion.

Management advice. The prohibition on retention of pelagic thresher shark should be maintain. Mechanisms need to be developed by the Commission to encourage CPCs to comply with their reporting requirement on sharks, so as to better inform scientific advice.

The following key points should also be noted:

- **Maximum Sustainable Yield (MSY)**: Not applicable. Retention prohibited.
- **Reference points**: Not applicable.
- **Main fishing gear** (2011–15): Gillnet-longline; longline-gillnet.
- **Main fleets** (2011–15): Sri Lanka.

APPENDIX XVI
EXECUTIVE SUMMARY: MARINE TURTLES

Indian Ocean Tuna Commission
Commission des Thons de l'Océan Indien
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Status of marine turtles in the Indian Ocean

TABLE 1. Marine turtles: IUCN threat status for all marine turtle species reported as caught in fisheries within the IOTC area of competence.

Common name	Scientific name	IUCN threat status[21]
Flatback turtle	*Natator depressus*	Data deficient
Green turtle	*Chelonia mydas*	Endangered
Hawksbill turtle	*Eretmochelys imbricata*	Critically Endangered
Leatherback turtle	*Dermochelys coriacea*	
	(N. East Indian Ocean subpopulation)	Data deficient
	(S. West Indian Ocean subpopulation)	Critically Endangered
Loggerhead turtle	*Caretta caretta*	
	(N. West Indian Ocean subpopulation)	Critically Endangered
	(S. East Indian Ocean subpopulation)	Near Threatened
Olive Ridley turtle	*Lepidochelys olivacea*	Vulnerable

Sources: Marine Turtle Specialist Group 1996, Red List Standards & Petitions Subcommittee 1996, Sarti Martinez (Marine Turtle Specialist Group) 2000, Seminoff 2004, Abreu-Grobois & Plotkin 2008, Mortimer et al. 2008, IUCN 2014, The IUCN Red List of Threatened species. Version 2015.2 <www.iucnredlist.org>. Downloaded on 15 July 2015.

INDIAN OCEAN STOCK – MANAGEMENT ADVICE

Stock status. No assessment has been undertaken by the IOTC WPEB for marine turtles due to the lack of data being submitted by CPCs. However, the current International Union for Conservation of Nature (IUCN) threat status for each of the marine turtle species reported as caught in IOTC fisheries to date is provided in Table 1. It is important to note that a number of international global environmental accords (e.g. Convention on Migratory Species (CMS), Convention on Biological Diversity (CBD), as well as numerous fisheries agreements obligate States to provide protection for these species. In particular, there are now 35 Signatories to the Memorandum of Understanding on the Conservation and Management of Marine Turtles and their Habitats of the Indian Ocean and South-East Asia (IOSEA MoU). Of the 35 Signatories to the IOSEA MoU, 23 are also members of the IOTC. While the status of marine turtles is affected by a range of factors such as degradation of marine turtle natural habitats and targeted harvesting of eggs and turtles, the level of mortality of marine turtles due to capture by gillnets is likely to be substantial as shown by the relatively recent Ecological Risk Assessment (ERA) (Nel 2013), and an order of magnitude higher than longline and purse seine gears for which mitigation measures are in place. Stock assessments of all species of marine turtles in the Indian Ocean are limited due to data insufficiencies as well as limited data quality (Wallace et al., 2011)[22]. Wallace et al. (2013[23]) also indicates, specific to the Indian Ocean, bycatch and mortality from gillnet fisheries has greater population-level impacts on marine turtles relative to other gear types, such as longline, purse seine and trawl fisheries. Population levels of impacts of leatherback turtles caught in longline gear in the Southwest Indian Ocean were also identified as a conservation priority.

[21] (IUCN, 2017) The process of the threat assessment from IUCN is independent from the IOTC and is presented for information purpose only

[22] Wallace BP, DiMatteo AD, Bolten AB, Chaloupka MY, Hutchinson BJ, et al. (2011) Global Conservation Priorities for Marine Turtles. PLoS ONE 6(9): e24510. doi:10.1371/journal.pone.0024510

[23] Wallace, B. P., C. Y. Kot, A. D. DiMatteo, T. Lee, L. B. Crowder, and R. L. Lewison. 2013. Impacts of fisheries bycatch on marine turtle populations worldwide: toward conservation and research priorities. Ecosphere 4(3):40. http:// dx.doi.org/10.1890/ES12-00388.1 (figure 13)

Outlook. Resolution 12/04 *On the conservation of marine turtles* includes an annual evaluation requirement (para. 17) by the Scientific Committee (SC). However, given the lack of reporting of marine turtle interactions by CPCs to date, such an evaluation cannot be undertaken. Unless IOTC CPCs become compliant with the data collection and reporting requirements for marine turtles, the WPEB and the SC will continue to be unable to address this issue. Notwithstanding this, it is acknowledged that the impact on marine turtle populations from fishing for tuna and tuna-like species will increase as fishing pressure increases, and that the status of the marine turtle populations will continue to worsen due to other factors such as an increase in fishing pressure from other fisheries or anthropological or climatic impacts.

The following should be noted:

- The available evidence indicates considerable risk to marine turtles in the Indian Ocean.
- The high mortality of marine turtles in gillnets and the increasing use of gillnets in the Indian Ocean (Aranda IOTC-2017-WPEB13-18) a need to both assess and mitigate impacts on threatened and endangered marine turtle populations.
- The primary sources of data that drive the ability of the WPEB to determine a status for the Indian Ocean, total interactions by fishing vessels or in net fisheries, are highly uncertain and should be addressed as a matter of priority.
- Current reported interactions are known to be a severe underestimate.
- The Ecological Risk Assessment (Nel et al 2013) estimated that ~3,500 and ~250 marine turtles are caught by longline and purse seine vessels, respectively, per annum, with an estimated 75% of turtles released alive (Bourjea et al. 2014). The ERA (Nel et al 2013) set out two separate approaches to estimate gillnet impacts on marine turtles, based on very limited data. The first calculated that 52,425 marine turtles p.a. and the second that 11,400–47,500 turtles p.a. are caught in gillnets (with a mean of the two methods being 29,488 marine turtles p.a.). Anecdotal/published studies reported values of >5000–16,000 marine turtles p.a. for each of India, Sri Lanka and Madagascar. Of these reports, green turtles are under the greatest pressure from gillnet fishing, constituting 50–88% of catches for Madagascar. Loggerhead, hawksbill, leatherback and olive Ridley turtles are caught in varying proportions depending on the region, season and type of fishing gear.
- Maintaining or increasing fishing effort in the Indian Ocean without appropriate mitigation measures in place, will likely result in further declines in marine turtle populations.
- Efforts should be undertaken to encourage CPCs to investigate means to reduce marine turtle bycatch and mortality in IOTC fisheries.
- That appropriate mechanisms are developed by the Compliance Committee to ensure CPCs comply with their data collection and reporting requirements for marine turtles.

APPENDIX XVII
EXECUTIVE SUMMARY: SEABIRDS

Indian Ocean Tuna Commission
Commission des Thons de l'Océan Indien
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Status of seabirds in the Indian Ocean

TABLE 1. IUCN threat status for all seabird species reported as caught in fisheries within the IOTC area of competence.

Common name	**Scientific name**	**IUCN threat status**[24]
Albatross		
Atlantic Yellow-nosed Albatross	*Thalassarche chlororynchos*	Endangered
Black-browed albatross	*Thalassarche melanophris*	Near Threatened
Indian yellow-nosed albatross	*Thalassarche carteri*	Endangered
Shy albatross	*Thalassarche cauta*	Near Threatened
Sooty albatross	*Phoebetria fusca*	Endangered
Light-mantled albatross	*Phoebetria palpebrata*	Near Threatened
Amsterdam albatross	*Diomedea amsterdamensis*	Critically Endangered
Tristan albatross	*Diomedea dabbenena*	Critically Endangered
Wandering albatross	*Diomedia exulans*	Vulnerable
White-capped albatross	*Thalassarche steadi*	Near Threatened
Grey-headed albatross	*Thalassarche chrysostoma*	Endangered
Petrels		
Cape/Pintado petrel	*Daption capense*	Least Concern
Great-winged petrel	*Pterodroma macroptera*	Least Concern
Grey petrel	*Procellaria cinerea*	Near Threatened
Southern giant petrel	*Macronectes giganteus*	Least Concern
Northern giant-petrel	*Macronectes halli*	Least Concern
White-chinned petrel	*Procellaria aequinoctialis*	Vulnerable
Others		
Cape gannet	*Morus capensis*	Vulnerable
Flesh-footed shearwater	*Puffinus carneipes*	Least Concern

INDIAN OCEAN STOCK – MANAGEMENT ADVICE

Stock status. Following a data call in 2016, the IOTC Secretariat received seabird bycatch data from 6 CPCs, out of the 15 with reported or expected longline effort South of 25ºS (IOTC-2016-SC19-INF02). Due to the lack of data submissions from other CPCs, and the limited information provided on the use of seabird bycatch mitigations, it has not yet been possible to undertake an assessment for seabirds. The current International Union for Conservation of Nature (IUCN) threat status for each of the seabird species reported as caught in IOTC fisheries to date is provided in Table 1. It is important to note that the IUCN threat status for all birds is currently being re-assessed; this process is expected to be completed by the end of 2016. A number of international global environmental accords (e.g. Convention on Migratory Species (CMS), the Agreement on the Conservation of Albatrosses and Petrels (ACAP), Convention on Biological Diversity (CBD)), as well as numerous fisheries agreements obligate States to provide protection for these species. While the status of seabirds is affected by a range of factors such as degradation of nesting habitats and targeted harvesting of eggs, for albatrosses and large petrels, fisheries bycatch is generally considered to be the primary threat. The level of mortality of seabirds due to fishing gear in the Indian Ocean is poorly known, although where there has been rigorous assessment of impacts in areas south of 25 degrees (e.g. in South Africa), very high seabird incidental catches rates have been recorded in the absence of a suite of proven incidental catches mitigation measures.

[24] The process of the threat assessment from IUCN is independent from the IOTC and is presented for information purpose only

Outlook. Resolution 12/06 *On Reducing the Incidental Bycatch of Seabirds in Longline Fisheries* includes an evaluation requirement (para. 8) by the Scientific Committee in time for the 2016 meeting of the Commission. The level of compliance with Resolution 12/06 and the frequency of use of each of the 3 measures (because vessels can chose two out of three possible options) are still poorly known.. Observer reports and logbook data should be analysed to support assessments of the effectiveness of mitigation measures used and relative impacts on seabird mortality rates. Information regarding seabird interactions reported in National Reports should be stratified by season, broad area, and in the form of catch per unit effort. Following the data call in 2016 it was possible to carry out a preliminary and qualitative analysis. The information provided suggests higher sea bird catch rates at higher latitudes, even within the area south of 25°S, and higher catch rates in the coastal areas in the eastern and western parts of the southern Indian Ocean. In terms of mitigation measures, the preliminary information available suggests that those currently in use (Resolution 12/06) may be proving effective in some cases, but there are also some conflicting aspects that need to be explored further. Unless IOTC CPCs become compliant with the data collection, Regional Observer Scheme and reporting requirements for seabirds, the WPEB will continue to be unable to fully address this issue. The following should be noted:

- The available evidence indicates considerable risk from longline fishing to the status of seabirds in the Indian Ocean, where the best practice seabird incidental catches mitigation measures outlined in Resolution 12/06 are not implemented.
- CPCs that have not fully implemented the provisions of the IOTC Regional Observer Scheme outlined in paragraph 2 of Resolution 11/04 shall report seabird incidental catches through logbooks, including details of species, if possible.
- Appropriate mechanisms should be developed by the Compliance Committee to assess levels of compliance by CPCs with the Regional Observer Scheme requirements and the mandatory measures described in Res 12/06.

APPENDIX XVIII
EXECUTIVE SUMMARY: CETACEANS

Indian Ocean Tuna Commission
Commission des Thons de l'Océan Indien
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Status of cetaceans in the Indian Ocean

TABLE 1. Cetaceans: IUCN Red List status and records of interaction (including entanglements and, for purse seines, encirclements) with tuna fishery gear types for all cetacean species that occur within the IOTC area of competence.

Family	Common name	Species	IUCN Red List status	Interactions by Gear Type*
Balaenidae	Southern right whale	*Eubalaena australis*	LC	GN
Neobalaenidae	Pygmy right whale	*Caperea marginata*	DD	-
Balaenopteridae	Common minke whale	*Balaenoptera acutorostrata*	LC	-
	Antarctic minke whale	*Balaenoptera bonaerensis*	DD	-
	Sei whale	*Balaenoptera borealis*	EN	PS
	Bryde's whale	*Balaenoptera edeni/brydei*	DD	-
	Blue whale	*Balaenoptera musculus*	EN	-
	Fin whale	*Balaenoptera physalus*	EN	-
	Omura's whale	*Balaenoptera omurai*	DD	-
	Humpback whale	*Megaptera novaeangliae*	LC**	GN
Physeteridae	Sperm whale	*Physeter macrocephalus*	VU	GN
Kogiidae	Pygmy sperm whale	*Kogia breviceps*	DD	GN
	Dwarf sperm whale	*Kogia sima*	DD	GN
Ziphiidae	Arnoux's beaked whale	*Berardius arnuxii*	DD	-
	Southern bottlenose whale	*Hyperoodon planifrons*	LC	-
	Longman's beaked whale	*Indopacetus pacificus*	DD	GN
	Andrew's beaked whale	*Mesoplodon bowdini*	DD	-
	Blainville's beaked whale	*Mesoplodon densirostris*	DD	-
	Gray's beaked whale	*Mesoplodon grayi*	DD	-
	Hector's beaked whale	*Mesoplodon hectori*	DD	-
	Deranigala's beaked whale	*Mesoplodon hotaulata*	NA	-
	Strap-toothed whale	*Mesoplodon layardii*	DD	-
	True's beaked whale	*Mesoplodon mirus*	DD	-
	Spade-toothed whale	*Mesoplodon traversii*	DD	-
	Shepherd's beaked Whale	*Tasmatecus shepherdi*	DD	-
	Cuvier's beaked whale	*Ziphius cavirostris*	LC	GN
	Long-beaked common dolphin	*Delphinus capensis*	DD	GN

Delphinidae	Short-beaked common dolphin	*Delphinus delphis*	LC	GN
	Pygmy killer whale	*Feresa attenuata*	DD	GN
	Short-finned pilot whale	*Globicephala macrorhynchus*	DD	LL, GN
	Long-finned pilot whale	*Globicephala melas*	DD	-
	Risso's dolphin	*Grampus griseus*	LC	LL, GN
	Fraser's dolphin	*Lagenodelphis hosei*	LC	-
	Irrawaddy dolphin	*Orcaella brevirostris*	VU	GN
	Australian snubfin dolphin	*Orcaella heinshoni*	NT	GN
	Killer whale	*Orcinus orca*	DD	LL, GN
	Melon-headed whale	*Peponocephala electra*	LC	LL, GN
	False killer whale	*Pseudorca crassidens*	DD	LL, GN
Delphinidae	Indo-Pacific humpback dolphin	*Sousa chinensis*	VU	GN
	Indian Ocean humpback dolphin	*Sousa plumbea*	EN	GN
	Australian humpback dolphin	*Sousa sahulensis*	VU	GN
	Pantropical spotted dolphin	*Stenella attenuata*	LC	PS, GN, LL
	Striped dolphin	*Stenella coeruleoalba*	DD	-
	Spinner dolphin	*Stenella longirostris*	DD	GN
	Rough-toothed dolphin	*Steno bredanensis*	LC	GN
	Indo-Pacific bottlenose dolphin	*Tursiops aduncus*	DD	GN
	Bottlenose dolphin	*Tursiops truncatus*	LC	LL, GN
Phocoenidae	Indo-Pacific finless porpoise	*Neophocaena phocaenoides*	VU	GN

* Published bycatch records only (reference at the end of the document)
** Arabian Sea population: EN
The IUCN Red List of Threatened species. Version 2017-01. <www.iucnredlist.org>. Downloaded on 6 September 2017.

INDIAN OCEAN STOCK – MANAGEMENT ADVICE

Stock status. No assessment has been undertaken by the IOTC WPEB for cetaceans due to the lack of data being submitted by CPCs. However, the current International Union for Conservation of Nature (IUCN) Red List status to date for each of the cetacean species reported in the IOTC Area of Competence is provided in Table 1. Information on their interactions with tuna fisheries in the IOTC is also provided. It is important to note that a number of international global environmental accords (e.g. Convention on Migratory Species (CMS), Convention on Biological Diversity (CBD), International Whaling Commission (IWC)), as well as numerous fisheries agreements obligate States to provide protection for these species. The status of cetaceans is affected by a range of factors such as direct harvesting (documented for several countries, e.g. Sri Lanka, Indonesia, Madagascar and the Seychelles) and habitat degradation, but the level of cetacean mortality due to capture in tuna drift gillnets is likely to be substantial and is also a major cause for concern (Anderson 2014). Many reports (e.g. IOTC-2013-WPEB07-37) also suggest some level of cetacean mortality for species involved in depredation of pelagic longlines, and these interactions need to be further documented throughout the IOTC Area of Competence. Recently published information suggests that the incidental capture of cetaceans in purse seines is low (e.g. Escalle *et al.* 2015), but should be further monitored.

Outlook. Resolution 13/04 *On the conservation of cetaceans* highlights the concerns of the IOTC regarding the lack of accurate and complete data collection and reporting to the IOTC Secretariat of interactions and mortalities of cetaceans within tuna fisheries in the IOTC Area of Competence. The IOTC adopted that CPCs shall prohibit their flagged vessels from intentionally setting a purse seine net around a cetacean if the animal is sighted prior to the commencement of the set. The IOTC also adopted that CPCs using other gear types targeting tuna and tuna-like species found in association with cetaceans shall report all interactions with cetaceans to the relevant authority of the flag State. It is acknowledged that the impact on cetacean populations from fishing for tuna and tuna-like species may increase if fishing pressure increases (which is already demonstrated for tuna gillnet fisheries) or if the status of cetacean populations worsens due to other factors such as an increase in external fishing pressure or other anthropogenic or climatic impacts.

The following should be noted:

- The number of fisheries interactions involving cetaceans is highly uncertain and should be addressed as a matter of priority as it is a prerequisite for the WPEB to determine a status for any Indian Ocean cetacean species.
- Available evidence indicates considerable risk to cetaceans in the Indian Ocean, particularly from tuna drift gillnets (Anderson 2014)
- Current reported interactions and mortalities are scattered, but are most likely severely underestimated.
- Maintaining or increasing fishing effort in the Indian Ocean without appropriate mitigation measures in place will likely result in further declines in a number of cetacean species. An increasing effort by tuna drift gillnet fisheries has been reported to the IOTC, which is a major cause of concern for a number of species, particularly in the northern Indian Ocean.
- Appropriate mechanisms should be developed by the Compliance Committee to ensure CPCs comply with their data collection and reporting requirements for cetaceans.

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APPENDIX XIX
WORKING PARTY ON ECOSYSTEMS AND BYCATCH PROGRAM OF WORK (2018–2022)

The Program of Work consists of the following, noting that a timeline for implementation would be developed by the SC once it has agreed to the priority projects across all of its Working Parties:

- **Table 1**: Priority topicsfor obtaining the information necessary to develop stock status indicators for bycatch in the Indian Ocean; and
- **Table 2**: Stock assessment schedule.

Table 1. Priority topics for obtaining the information necessary to develop stock status indicators for bycatch species in the Indian Ocean

Topic	**Sub-topic and project**	**Priority**	**Ranking**	**Lead**	**Est. budget (potential source)**	**Timing**				
						2018	**2019**	**2020**	**2021**	**2022**
	SHARKS									
1. Stock structure (connectivity and diversity)	1.1 Genetic research to determine the connectivity of select shark species throughout their distribution (including in adjacent Pacific and Atlantic waters as appropriate) and the effective population size.	High	17	CSIRO/AZTI/IRD/RITF	Financed (1.3m Euro (EU + 20% additional co-financing)					
	1.1.1 Next Generation Sequencing (NGS) to determine the degree of shared stocks for select shark species (highest priority species: blue shark, scalloped hammerhead shark, oceanic whitetip shark and shortfin mako shark) in the Indian Ocean with the southern Atlantic Ocean and Pacific Ocean, as appropriate. Population genetic analyses to decipher inter- and intraspecific evolutionary relationships, levels of gene flow (genetic exchange rate), genetic divergence, and effective population sizes.									
	1.1.2 Nuclear markers (i.e. microsatellite) to determine the degree of shared stocks for select shark species (highest priority species: blue shark, scalloped hammerhead shark and oceanic whitetip shark) in the Indian Ocean with the southern Atlantic Ocean and Pacific Ocean, as appropriate.									
	1.2 Connectivity, movements and habitat use	High	1							

	1.2.1 Connectivity, movements, and habitat use, including identification of hotspots and investigate associated environmental conditions affecting the sharks distribution, making use of conventional and electronic tagging (PSAT).			AZTI, IRD, Others	Partially funded (153,000€ IOTC + 100.000€ EU/DCF)	BTH OCS	SMA, PTH			
	1.2.2 Whale sharks (RHN): Connectivity, movements, and habitat use, including identification of hotspots and investigate associated environmental conditions affecting distribution, making use of conventional and electronic tagging (P-SAT).				Funded (50,000€ EU/DCF)	RHN				
2. Fisheries data collection	2.1 Historical data mining for the key species and IOTC fleets (e.g. as artisanal gillnet and longline coastal fisheries) including:	High	2							
	2.1.1 Capacity building of fisheries observers (including the provision of ID guides, training, etc.)			WWF-Pakistan/ ACAP (seabirds)	US$20,000 (ID guides)					
	2.1.3 Historical data mining for the key species, including the collection of information about catch, effort and spatial distribution of those species and fleets catching them			TBD						
	2.2 Implementation of the Pilot Project (Resolution 16/04) for the Regional Observer Scheme	High	3							
	2.2.1 Definition of minimum standards and development of a training package for the ROS to be reviewed and rolled out in voluntary CPCs (Sri Lanka, I.R.Iran, Tanzania)				Partially funded (EC)					
	2.2.2 Development of a Regional Observer database and population with historic observer data				Funded (NOAA and EC)					
	2.2.3 Development, piloting and implementation of an electronic reporting tool to facilitate data reporting				Funded (NOAA and EC)					
	2.2.4 Development and trial of Electronic Monitoring Systems for gillnet fleets				Partially funded (EC)					
	2.2.5 Port sampling protocols for artisanal fisheries				Funded (EC)					

3. Biological and ecological information (incl. parameters for stock assessment)	3.1 Age and growth research (Priority species: blue shark (BSH), shortfin mako shark (SMA) and oceanic whitetip shark (OCS); Silky shark (FAL))	High	6		US$?? (TBD)					
	3.1.1 CPCs to provide further research reports on shark biology, namely age and growth studies including through the use of vertebrae or other means, either from data collected through observer programs or other research programs.			CPCs directly	US$?? (TBD)	OCS				
	3.2 Post-release mortality	High	16							
	3.2.1 Post-release mortality (electronic tagging), to assess the efficiency of management resolutions on no retention species (i.e. oceanic whitetip shark (OCS) and thresher sharks), shortfin mako shark SMA) ranked as the most vulnerable species to longline fisheries, and blue shark as the most frequent in catches.			IRD/ NRIFSF	Partially funded (IOTC + EU/DCF)	OCS, BTH	SMA, PTH			
	3.2.2 Post-release mortality (electronic tagging), to assess the efficiency of management resolutions on no retention species (i.e. oceanic whitetip shark (OCS) for purse seine fisheries			IRD/AZTI	Funded (EU/DCF)	OCS				
	3.2.3 Post-release survivorship (electronic tagging) on whale shark to assess the effect of unintended interaction and efficiency of management resolution of non-intentioned encirclement on purse seine			IRD/AZTI	Funded (EU/DCF)					
	3.3 Reproduction research Priority species: blue shark (BSH), shortfin mako shark (SMA) and oceanic whitetip shark (OCS), and silky shark (FAL))	High	7	CPCs directly	US$??(TBF)	OCS				
	3.4 Ecological Risk Assessment (sharks & rays)	High	4		TBD					
4. Shark bycatch mitigation measures	4.1 Develop studies on shark mitigation measures (operational, technological aspects and best practices)	High	14							
	4.1.1 Longline selectivity, to assess the effects of hooks styles, bait types and trace materials on shark catch rates, hooking-				US$?? (TBD)					

	mortality, bite-offs and fishing yield (socio-economics)				
	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)			WWF-Pakistan	US$?? (ABNJ funding to WWF)
	4.1.3 Develop guidelines and protocols for safe handling and release of sharks caught on longlines and gillnets fisheries				
	4.1.4 Biodegradable FADs Biodegradable FADs testing and implementing biodegradable FADs in the IO Purse Seine fleet to reduce environmental footprint of the gear.			EU Consortium + ISSF	Funded
5. CPUE standardisation / Stock Assessment / Other indicators	5.1 Develop standardised CPUE series for each key shark species and fishery in the Indian Ocean	High	13		US$?? (TBD)
	5.1.1 Blue shark: Priority fleets: TWN,CHN LL, EU,Spain LL, Japan LL; Indonesia LL; EU,Portugal LL			CPCs directly	US$??
	5.1.2 Shortfin mako shark: Priority fleets: Longline and Gillnet fleets			CPCs directly	US$??
	5.1.3 Oceanic whitetip shark: Priority fleets: Longline fleets; purse seine fleets			CPCs directly	US$??
	5.1.4 Silky shark: Priority fleets: Purse seine fleets			CPCs directly	US$??
	5.2 Joint CPUE standardization across the main LL fleets, using detailed operational data	High	11	Consult.	30,000 €
	5.3 Stock assessment and other indicators	High	12		
	5.3.1 Develop and compare multiple assessment approaches to determining stock status for key shark species (see Table 2)			TBD	Part of: 600K Euro (European Union)
	MARINE TURTLES				
6. Marine turtle bycatch mitigation measures	6.1 Review of bycatch mitigation measures	High	8		

6.1.1 Res. 12/04 (para. 11) Part I. The IOTC Scientific Committee shall request the IOTC Working Party on Ecosystems and Bycatch to:	CPCs directly	US$??						
a) Develop recommendations on appropriate mitigation measures for gillnet, longline and purse seine fisheries in the IOTC area; [mostly completed for LL and PS]		(TBD)						
b) Develop regional standards covering data collection, data exchange and training;								
c) Develop improved FAD designs to reduce the incidence of entanglement of marine turtles, including the use of biodegradable materials. [partially completed for non-entangling FADS; ongoing or biodegradable FADs)]								
6.1.2 Res. 12/04 (para. 11) Part II. The recommendations of the IOTC Working Party on Ecosystems and Bycatch shall be provided to the IOTC Scientific Committee for consideration at its annual session in 2012. In developing its recommendations, the IOTC Working Party on Ecosystems and Bycatch shall examine and take into account the information provided by CPCs in accordance with paragraph 10 of this measure, other research available on the effectiveness of various mitigation methods in the IOTC area, mitigation measures and guidelines adopted by other relevant organizations and, in particular, those of the Western and Central Pacific Fisheries Commission. The IOTC Working Party on Ecosystems and Bycatch will specifically consider the effects of circle hooks on target species catch rates, marine turtle mortalities and other bycatch species.	CPCs directly	US$?? (TBD)						

	6.1.3 Res. 12/04 (para. 17) The IOTC Scientific Committee shall annually review the information reported by CPCs pursuant to this measure and, as necessary, provide recommendations to the Commission on ways to strengthen efforts to reduce marine turtle interactions with IOTC fisheries.			CPCs directly	Nil					
	6.1.4 ERA (turtles, including LL, PS and GIL)				TBD					
	SEABIRDS									
7. Seabird bycatch mitigation measures	7.1 Review of bycatch mitigation measures	High	10							
	7.1.1 Res. 12/06 (para. 8) The IOTC Scientific Committee, based notably on the work of the WPEB and information from CPCs, will analyse the impact of this Resolution on seabird bycatch no later than for the 2016 meeting of the Commission. It shall advise the Commission on any modifications that are required, based on experience to date of the operation of the Resolution and/or further international studies, research or advice on best practice on the issue, in order to make the Resolution more effective.			Rep. of Korea, Japan, Birdlife Int.	US$?? (TBD)					
	7.1.2 ERA for sea-birds			ACAP, Birdlife						
	CETACEANS									
8.Bycatch assessment and mitigation	8.1 Review and development of cetacean bycatch mitigation measures	High	9							
	8.1.1 Collate all data available on bycatch of key species interacting with all tuna fisheries in the IOTC area (tuna drift gillnets, longlines, purse seines)			Consultancy?	U.S.$??					
	8.1.2 Creation of identification cards for cetacean species in IOTC Area of Competence			IOTC	IOTC / U.S. MM Commission (15k)					

	8.1.3 Conduct an ecological risk assessment for cetaceans in the IOTC area			Consultancy?	?					
	8.1.4 Collaborate with other organisations on the assessment of marine mammal abundance and collect data on marine mammal bycatch interactions with gillnets.			FIU/WWF-Pakistan?	U.S.$? (IWC)					
	8.1.5 Testing mitigation methods for cetacean bycatch in tuna drift gillnet fisheries			WWF Pakistan	U.S. MM Commission? Others?					
	DISCARDS									
9. Bycatch mitigation measures	9.1 Review proposal on retention of non-targeted species	High	5							
	9.1.1 The Commission requested that the Scientific Committee review proposal IOTC–2014– S18–PropL Rev_1, and to make recommendations on the benefits of retaining non-targeted species catches, other than those prohibited via IOTC Resolutions, for consideration at the 19th Session of the Commission. (S18 Report, para. 143). Noting the lack of expertise and resources at the WPEB and the short timeframe to fulfil this task, the SC RECOMMENDED that a consultant be hired to conduct this work and present the results at the next WPEB meeting. The following tasks, necessary to address this issue, should be considered for the terms of reference, taking into account all species that are usually discarded on all major gears (i.e., purse-seines, longlines and gillnets), and fisheries that take place on the high seas and in coastal countries EEZs:			Consultant	US$?? (TBD)					
	i) Estimate species-specific quantities of discards to assess the importance and potential of this new product supply, integrating data available at the Secretariat from the regional observer programs,									

		ii) Assess the species-specific percentage of discards that is captured dead versus alive, as well as the post-release mortality of species that are discarded alive, in order to estimate what will be the added fishing mortality to the populations, based on the best current information,iii) Assess the feasibility of full retention, taking into account the specificities of the fleets that operate with different gears and their fishing practices (e.g., transhipment, onboard storage capacity).									
		iv) Assess the capacity of the landing port facilities to handle and process this catch.									
		v) Assess the socio-economic impacts of retaining non-target species, including the feasibility to market those species that are usually not retained by those gears,									
		vi) Assess the benefits in terms of improving the catch statistics through port-sampling programmes,									
		vii) Evaluate the impacts of full retention on the conditions of work and data quality collected by onboard scientific observers, making sure that there is a strict distinction between scientific observer tasks and compliance issues.									
		ECOSYSTEMS									
10.	Ecosystems	10.1 Develop a plan for Ecosystem Based Fisheries Management (EBFM) approaches in the IOTC, in conjunction with the Common Oceans Tuna Project.	High	15	WPEB	US$?? (TBD)					
		10.1.1 Training workshop for CPCs on EBFM system and discussion on ecological components and the elements that are needed (ideally in 2018).									
		10.1.2 Workshop for CPCs on developing strategic plan for formulized implementation of EBFM (2019).									

	10.1.3 Implementation of EBFM plan according to approved strategies and executive measures by the IOTC commission during 2020.					
	10.1.4 Evaluation of implemented EBFM plan in IOTC area of competence by the secretariat and review its elements, components and making corrective measures in 2021.					

Table 2. Draft: Assessment schedule for the IOTC Working Party on Ecosystems and Bycatch 2018–2022.

Species	2018	2019	2020	2021	2022
Blue shark	Revisit ERA		Indicators	**Full assessment***	Indicators
Oceanic whitetip shark	Revisit ERA	Indicators	**Full assessment***	Revisit ERA	Indicators
Scalloped hammerhead shark	Revisit ERA		–	Revisit ERA	Indicators
Shortfin mako shark	Revisit ERA	Indicators–	**Full assessment*–**	Revisit ERA	–
Silky shark	Indicators; Revisit ERA	**Full assessment***	–	Indicators; Revisit ERA	**Full assessment***
Bigeye thresher shark	Revisit ERA	–	–	Revisit ERA	–
Pelagic thresher shark	Revisit ERA	–	–	Revisit ERA	–
Porbeagle shark	–	–	–	–	–
Marine turtles	Revisit ERA	–	Review of mitigation measures in Res. 12/04	Revisit ERA	–
Seabirds	–	ERA; Review of mitigation measures in Res. 12/06	–	-	Review of mitigation measures in Res. 12/06
Marine Mammals	Indicators; Results from Common Oceans Gillnets project	Report from the IWC	–	ERA	–
Ecosystem Based Fisheries Management (EBFM) approaches	Preliminary report cards	–	–	–	–

*Including data poor stock assessment methods; Note: the assessment schedule may be changed dependant on the annual review of fishery indicators, or SC and Commission requests.

APPENDIX XX
CONSOLIDATED RECOMMENDATIONS OF THE 13TH SESSION OF THE WORKING PARTY ON ECOSYSTEMS AND BYCATCH

Note: Appendix references refer to the Report of the 13th Session of the Working Party on Ecosystems and Bycatch (IOTC–2017–WPEB13–R)

Evaluation of the mitigation measures contained in Resolution 13/06 for Oceanic whitetip shark

WPEB13.01 (para. 4) The WPEB **NOTED** the ongoing compliance issue for those CPCs reporting nominal catch of oceanic whitetip sharks and **RECOMMENDED** that the Scientific Committee request the Compliance Committee investigate these reported catches further and report the findings to the Commission.

Longline hook identification guide

WPEB13.02 (para. 24) **NOTING** the continued confusion in the terminology of various hook types being used in IOTC fisheries, (e.g. tuna hook vs. J-hook; definition of a circle hook), the WPEB **REITERATED** its previous **RECOMMENDATIONS** (2013, 2014 and 2016) and the **RECOMMENDATION** from SC19 (SC19.16; para. 55 of IOTC-2016-SC19-R) that the Commission allocate funds in the 2018 IOTC Budget to develop an identification guide for fishing hooks and pelagic fishing gears used in IOTC fisheries.

Review of the statistical data available for ecosystems and bycatch species

WPEB13.03 (para. 28) **NOTING** the highly aggregated nature of information requested on discards, the WPEB **RECOMMENDED** that the discard reporting form (Form 1DI) is updated to include seasonal (month) and spatial information (5 x 5 or 1 x 1) in a similar format to the catch and effort data reporting forms.

Pilot projects under Resolution 16/04

WPEB13.04 (para. 36) **NOTING** the increasing number of CPCS that are now submitting observer data in electronic format, the WPEB **RECOMMENDED** the next revision of Resolution 11/04 should consider including the requirement for all observer data to be submitted in an electronically readable format (including historic data).

Biodegradable materials in FAD construction

WPEB13.05 (para. 85) The WPEB **DISCUSSED** some of the challenges in conducting these studies in view of the limitations on the number of FADs active per purse seine vessel in the Indian Ocean. For example, the limit of active number of FADs at sea in the Indian Ocean hinders the deployment of BIOFAD following experimental sampling designs and the engagement of the fleet to deploy them as they might not be successful for fishing. Thus, WPEB **RECOMMENDED** the Commission consider special allocations for experimental FADs deployed for scientific data collection for vessels willing to participate in biodegradable FAD testing under experimental protocols reviewed and endorsed by the Scientific Committee.

CPUE Collaborative study of shark CPUE from multiple Indian Ocean longline fleets

WPEB13.06 (para. 130) **NOTING** the conflicting patterns in blue shark CPUE derived from different Indian Ocean longline fleets and **CONSIDERING** the success of using joint analysis of operational catch and effort data to resolve such conflicts in other Working Parties, the WPEB **RECOMMENDED** initiating work on joint analysis of operational catch and effort data from multiple fleets, to further develop methods and to provide indices of abundance for sharks of interest to the IOTC. A consultant should be considered to conduct such work for a budget of around EUR45 000.

Joint analysis of marine turtle mitigation measures

WPEB13.07 (para. 185) **NOTING** the findings of the Pacific workshop regarding the effectiveness of large circle hooks, finfish bait and the removal of the first and/or second hooks next to the floats for mitigating sea turtle interactions and mortalities in Pacific longline fisheries, the WPEB **AGREED** that further consideration of these mitigation techniques for Indian Ocean fisheries is warranted. Such a study should attempt to develop findings regarding the consequences of various mitigation techniques, primarily with regard to impacts on target and non-turtle bycatch species catch rates, to the extent possible based on data availability and quality. The WPEB therefore **RECOMMENDED** that the potential for a similar workshop to be held in the Indian Ocean is explored with potential funding from the Commission and/or from the Common

Oceans Tuna Project (ABNJ). The WPEB **AGREED** to include this in the WPEB workplan and **REQUESTED** the Chairperson work with the Secretariat to pursue this idea further with potential participants and funding sources.

Review of mitigation measures in Resolution 12/04

WPEB13.08 (para. 188) The WPEB **NOTED** Table 10 (Table14 from the FAO Fisheries and Aquaculture Technical Paper #588t "Bycatch in Longline Fisheries for Tuna and Tuna-like Species: a global review of status and mitigation measures") and, noting that IOTC's current resolution calls for, inter alia, implementation of safe handling practices, encouraging the use of fish bait and reporting sea turtle interactions and mortality annually, **AGREED** that CPCs should review and report on the extent to which their fisheries have implemented this resolution. The WPEB **RECOMMENDED** the following table (Table 11) to be completed by CPCs and submitted to the Secretariat in order to review the effectiveness of Resolution 12/04 as requested by the Commission. This table was suggested as an appropriate format for summarizing the information for the consideration and discussion of the SC, based on the seabird data call carried out in 2016.

(para. 189) The WPEB **REQUESTED** the following changes are made to the table for presentation to the SC:

- Inclusion of a column for species name
- Use standard area specification (5 by 5 for LL and 1 by 1 for surface fisheries)
- Effort units that are appropriate for LL (hooks/sets), PS and GN fleets (sets/fishing days)
- The deadline for data submissions should be June 2018

Table 11. Example table for data request as used in the 2016 seabird data call

Fishery:		Observed			
Time period*					
Area[1]	Total effort[2] (hooks/sets)	Total observed effort[2] (hooks/sets)	Captures (number)	Mortalities (number)	Live releases (number)
Total					

*This field can be used to specify a temporal stratification to the data e.g. season.
[1]Spatial stratification at the finest scale possible.
[2] Effort should preferentially be provided in number of hooks, or sets where this is not possible.

Revision of the WPEB Program of Work 2018–2022

WPEB13.09 (para. 234) The WPEB **RECOMMENDED** that the SC consider and endorse the WPEB Program of Work (2018–2022), as provided in Appendix XIX.

Future format of WPEB

WPEB13.10 (para. 215) The WPEB **NOTED** that this approach has not proved successful, particularly in years when a stock assessment has been undertaken as the large number of papers submitted (~60) cannot be fully considered in the time available. The WPEB therefore **RECOMMENDED** that in future years when a stock assessment is planned, the meeting is extended in length by a number of days to more adequately accommodate the workplan, with some of the days dedicated exclusively to the stock assessment work.

Update: Ecosystem Based Fisheries Management (EBFM) joint meeting of tRFMOs in 2016

WPEB13.11 (para. 218) The WPEB **NOTED** the need for training and capacity building as the first step to moving forward with developing goals and strategies for the implementation of EBFM and therefore

RECOMMENDED that a workshop is held to explain the key elements of EBFM so that a plan for implementation of EBFM in the IOTC Area of Competence can be developed by 2019.

Election of a Chairperson and Vice-Chairperson for the WPEB for the next biennium

WPEB13.12 (para. 226) The WPEB **RECOMMENDED** that the SC note the new Chairperson, Dr Sylvain Bonhommeau and Vice-Chairpersons, Dr Ross Wanless and Mr Reza Shahifar, of the WPEB for the next biennium.

Review of the draft, and adoption of the Report of the 13th Session of the Working Party on Ecosystems and Bycatch

WPEB13.13 (para. 227) The WPEB **RECOMMENDED** that the Scientific Committee consider the consolidated set of recommendations arising from WPEB13, provided at Appendix XIX, as well as the management advice provided in the draft resource stock status summary for each of the seven shark species, as well of those for marine turtles and seabirds:

Sharks

- Blue sharks (*Prionace glauca*) – Appendix IX
- Oceanic whitetip sharks (*Carcharhinus longimanus*) – Appendix X
- Scalloped hammerhead sharks (*Sphyrna lewini*) – Appendix XI
- Shortfin mako sharks (*Isurus oxyrinchus*) – Appendix XII
- Silky sharks (*Carcharhinus falciformis*) – Appendix XIII
- Bigeye thresher sharks (*Alopias superciliosus*) – Appendix XIV
- Pelagic thresher sharks (*Alopias pelagicus*) – Appendix XV

Other species/groups

- Marine turtles – Appendix XVI
- Seabirds – Appendix XVII
- Cetaceans – Appendix XVIII