Report of the 15thSession of the IOTC Working Party on Ecosystems and Bycatch

La Saline Les Bains, Reunion Island, 3 – 7 September 2019

DISTRIBUTION:
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BIBLIOGRAPHIC ENTRY
IOTC–WPEB15 2019. Report of the 15th Session of the IOTC Working Party on Ecosystems and Bycatch.
La Saline Les Bains, Reunion Island 3 – 7 September 2019
IOTC–2019–WPEB15–R[E]: 112 pp.

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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
FOB	Floating Object
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**).

TABLE OF CONTENTS

Executive summary

The 15th Session of the Indian Ocean Tuna Commission's (IOTC) Working Party on Ecosystems and Bycatch (WPEB) was held in La Saline Les Bains, Reunion Island from 3 - 7 September 2019. A total of 41 participants (40 in 2018, 39 in 2017, 34 in 2016) attended the Session. The list of participants is provided in Appendix I. The meeting was opened by the Chairperson, Dr Sylvain Bonhommeau from Ifremer, France, who welcomed participants and formally opened the 15th Session of the IOTC Working Party on Ecosystems and Bycatch (WPEB15). Adoption of the Agenda and arrangements for the Session.

The following are the complete recommendations from the WPEB15 to the Scientific Committee which are also provided at Appendix XX:

Conservation and Management Measures

WPEB15.01 (para 14): The WPEB **RECOMMENDED** that several initiatives be implemented to address this problem, including: (i) holding regional workshops to improve shark species identification, shark data sampling and collection (fisheries and biological) and IOTC data reporting requirements; (ii) data mining to fill historical data gaps; (iii) develop alternative tools to improve species identification (genetic analyses, machine learning, and artificial intelligence).

Revision of the WPEB Program of Work 2020–2024

WPEB15.02 (para 221): The WPEB **RECOMMENDED** that the SC consider and endorse the WPEB Program of Work (2020–2024), as provided in Appendix XIX

Review of the draft, and adoption of the Report of the 15th Session of the Working Party on Ecosystems and Bycatch

WPEB 15.03 (para 232): The WPEB **RECOMMENDED** that the Scientific Committee consider the consolidated set of recommendations arising from WPEB15 provided at Appendix XX, 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

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.

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

Stock	Indicators	2014	2015	2016	2017	2018	2019	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 2017: 27,288 t Estimated catch 2015: 54,735 t Not elsewhere included (nei) sharks 2017: 52,487 t Average reported catch 2013–17: 29,293 t Average estimated catch 2011–15: 54,993 t Ave. (nei) sharks[2] 2012–16: 50,677 t MSY (1,000 t) (80% CI): 33.0 (29.5 - 36.6) F_{MSY} (80% CI) : 0.30 (0.30 - 0.31) SSB_{MSY} (1,000 t) (80% CI) : 39.7 (35.5 - 45.4) F_{2015}/F_{MSY} (80% CI) : 0.86 (0.67 - 1.09) SSB_{2015}/SSB_{MSY} (80% CI) : 1.54 (1.37 - 1.72) SSB_{2015}/SSB_{0} (80% CI) : 0.52 (0.46 - 0.56)				**72.6%**	**72.6%**	**72.6%**	Even though the blue shark in 2017 is assessed to be not overfished nor subject to overfishing, current catches are likely to result in decreasing biomass and making the stock become overfished and subject to overfishing in the near future. If the Commission wishes to maintain stocks above MSY reference levels ($B>B_{MSY}$ and $F<F_{MSY}$) with at least a 50% probability over the next 10 years, then a reduction of 20% in catches is advised. 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
Oceanic whitetip shark *Carcharhinus longimanus*	Reported catch 2017: 45 t Not elsewhere included (nei) sharks: 52,487 t Average reported catch 2013–2017: 232 t Not elsewhere included (nei) sharks: 50,678 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
Scalloped hammerhead shark *Sphyrna lewini*	Reported catch 2017: 118 t Not elsewhere included (nei) sharks: 52,487 t Average reported catch 2013–2017: 76 t Not elsewhere included (nei) sharks: 50,678 t							
Shortfin mako *Isurus oxyrinchus*	Reported catch 2017: 1,680 t Not elsewhere included (nei) sharks: 52,487t Average reported catch 2013–2017: 1,601 t Not elsewhere included (nei) sharks: 50,678 t							
Silky shark *Carcharhinus falciformis*	Reported catch 2017: 1,491 t Not elsewhere included (nei) sharks: 52,487 t Average reported catch 2013–2017: 2,577 t Not elsewhere included (nei) sharks: 50,678 t							

Bigeye thresher shark *Alopias superciliosus*	Reported catch 2017: Not elsewhere included (nei) sharks: Average reported catch 2013–2017: Not elsewhere included (nei) sharks:	0 t 52,487 t 0 t 50,678 t							• Bigeye thresher sharks– Appendix XIV • Pelagic thresher sharks– Appendix XV
Pelagic thresher shark *Alopias pelagicus*	Reported catch 2017: Not elsewhere included (nei) sharks: Average reported catch 2013–2017: Not elsewhere included (nei) sharks:	0 t 52,487 t 0 t 50,678t							

Colour key for Table 1	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		

1. Opening of the meeting

1. The 15th Session of the Indian Ocean Tuna Commission's (IOTC) Working Party on Ecosystems and Bycatch (WPEB) was held in La Saline Les Bains, Reunion Island from 3 - 7 September 2019. A total of 41 participants (40 in 2018, 39 in 2017, 34 in 2016) attended the Session. The list of participants is provided in Appendix I. The meeting was opened by the Chairperson, Dr Sylvain Bonhommeau from Ifremer, France, who welcomed participants and formally opened the 15th Session of the IOTC Working Party on Ecosystems and Bycatch (WPEB15). Adoption of the Agenda and arrangements for the Session.

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. The WPEB **NOTED** the suggestions by the IOTC Executive Secretary to reduce and streamline the number of recommendations and requests to be made during each of the IOTC working party meetings to ensure they are more achievable.

3.1 Outcomes of the 21st Session of the Scientific Committee

4. The WPEB **NOTED** paper IOTC–2019–WPEB15–03 which outlined the main outcomes of the 21st Session of the Scientific Committee (SC21) specifically related to the work of the WPEB and **AGREED** to consider how best to progress these issues at the present meeting.

Bycatch species identification and data issues

*Despite identification cards being available, the SC noted ongoing issues around species identification data for sea turtles, sharks, cetaceans and other bycatch species and **AGREED** that improvements to the collection of data for all bycatch species is required. The Secretariat noted that these data are currently collected through national reports and observer data submissions, but were often limited. Consequently, the SC **RECOMMENDED** to the Commission that the species reporting of turtles (as a first step) is improved through an amendment to Annexes II and III in Resolution 15/01.*

5. The WPEB **NOTED** that this issue was not addressed by the Commission in 2019 and could be reiterated to the SC.

Resolution 17/05 and the conservation of sharks in IOTC fisheries

6. *(Para. 39) The Commission AGREED to the requests made to the Compliance Committee and Scientific Committee in working paper IOTC-2018-S22-06Rev1:*

   • to analyse and document, wherever possible, whether the practice of shark finning still takes place in IOTC and to what extent, despite the adoption of Resolution 17/05, and to review the compliance with the requirements contained in Res 17/05, including the shark finning prohibition and the fins naturally attached requirement adopted by IOTC (Compliance Committee);

   • to identify possible means to improve the submission of complete, accurate and timely catch records for sharks, as well as the collection of species-specific data on catch, biology, discards and trade. (Scientific Committee).

   The SC acknowledged that this document covers both points requested by the Commission, however, the SC only has the mandate to address the second point as the first point is expressly aimed at the Compliance Committee.

7. The WPEB **NOTED** that this issue was again reiterated by the Commission in 2019 and that the WPEB will need to provide a response for the next SC meeting.

Progress towards Ecosystem Approach to Fisheries (EAF) in IOTC – Preliminary Ecosystem Report Cards

*Acknowledging the potential benefits of a climate-ocean web portal and regular updates on these influences to the SC and WPs, the SC **RECOMMENDED** a scoping study into how ocean-climate information as described in the proposal could be made available through the IOTC webpage and how this information would be presented to the WPs and SC. The scoping study should also consider the currency and quality of the information sources to be used*

8. The WPEB **NOTED** that this request has not yet been implemented and that it would need to be carefully addressed in coordination with the Secretariat and the data providers. CPC scientist guidance would also be required to determine what information could be provided.

3.2 Outcomes of the 23rd Session of the Commission

9. The WPEB **NOTED** paper IOTC–2019–WPEB15–04 which outlined the main outcomes of the 23rd 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.

10. The WPEB **NOTED** the 7 Conservation and Management Measures (CMMs) adopted at the 23rd Session of the Commission (consisting of 7 Resolutions and 0 Recommendations) as listed below:

IOTC Resolutions

- Resolution 19/01 *On an interim plan for rebuilding the Indian Ocean yellowfin tuna stock in the IOTC Area of competence*.
- Resolution 19/02 *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*.
- Resolution 19/03 *On the conservation of mobulid species caught in association with fisheries in the IOTC Area of Competence*.
- Resolution 19/04 *Concerning the IOTC Record of Vessels Authorised to operate in the IOTC Area of Competence*.
- Resolution 19/05 *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 19/06 *On establishing a programme for transhipment by large-scale fishing vessels.*
- Resolution 19/07 *On vessel chartering in the IOTC Area of Competence*.

11. 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.

12. The WPEB **NOTED** that the Commission also made a number of general comments and requests regarding the recommendations made by the Scientific Committee in 2018, which have relevance for the WPEB (details as follows: paragraph numbers refer to the report of the Commission IOTC–2019–S23–R).

*The Commission **NOTED** the stock status summaries for species of tuna and tuna-like species under the IOTC mandate, as well as other species impacted by IOTC fisheries (Appendix 6) and considered the recommendations made by the Scientific Committee to the Commission. The Commission **ENDORSED** the Scientific Committee's 2018 list of recommendations as its own (para. 29).*

Conservation and management measures

*113. The Commission **RECALLED** its requests in 2018 to the Compliance Committee and Scientific Committee (IOTC-2018-S22-R, paragraph 39):*

- *to analyse and document, wherever possible, whether the practice of shark finning still takes place in IOTC and to what extent, despite the adoption of Resolution 17/05, and to review the compliance with the requirements contained in Res 17/05, including the shark finning*

prohibition and the fins naturally attached requirement adopted by IOTC (Compliance Committee);

- *to identify possible means to improve the submission of complete, accurate and timely catch records for sharks, as well as the collection of species-specific data on catch, biology, discards and trade. (Scientific Committee). (para 113)*

*The Commission **NOTED** that in 2019 the WPICMM considered the results of an analysis on the status of compliance with the shark measures. The WPICMM noted there is currently a lack of data to undertake any meaningful assessment on how CPCs are implementing these measures. In 2018, both the WPDCS and SC discussed possible means to improve the submission of complete, accurate and timely catch records for sharks. This matter has been deferred to the next meeting of the WPEB, noting that the focus would be on data improvement. (para 114).*

13. The WPEB **NOTED** the request from the Commission to identify possible means to improve the submission of complete, accurate and timely catch records for sharks, as well as the collection of species-specific data on catch, biology, discards and trade and **DISCUSSED** methods to address this issue.

14. The WPEB **RECOMMENDED** that several initiatives be implemented to address this problem, including: (i) holding regional workshops to improve shark species identification, shark data sampling and collection (fisheries and biological) and IOTC data reporting requirements; (ii) data mining to fill historical data gaps; (iii) develop alternative tools to improve species identification (genetic analyses, machine learning, and artificial intelligence).

15. The WPEB **NOTED** that the Commission adopted Resolution 19/03 *On the conservation of mobulid species caught in association with fisheries in the IOTC Area of Competence*.

16. 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.

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

17. The WPEB **NOTED** paper IOTC–2019–WPEB15–05 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–2019–WPEB15–04; 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 WPEB14

18. The WPEB **NOTED** paper IOTC–2019–WPEB15–06 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.

19. The WPEB **RECALLED** that any recommendations developed 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 (e.g 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 (e.g. by the next working party meeting, or other date);
    - if appropriate and required 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.

20. 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.

4. Review of data available on ecosystems and bycatch

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

21. The WPEB **NOTED** paper IOTC–2019–WPEB15–07 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 1950–2017. A summary for sharks is provided in Appendix IV.

22. The WPEB **NOTED** the large proportion of reported shark catches that have not been identified to species level (~55% in 2017) and the issues this poses when using species-specific catch series for assessments.

23. The WPEB also **NOTED** that data for all bycatch species (including raised catches and discards, time-area catches and size-frequency data) is often incomplete or not reported according to IOTC standards, and has an impact on the ability of this group to undertake its work, and **REQUESTED** the IOTC Compliance Committee to take this in due consideration.

24. The WPEB **RECALLED** that presenting data at a working party meeting does not constitute a formal submission to the IOTC Secretariat and **URGED** all involved 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.

25. The WPEB **ACKNOWLEDGED** that catch levels provided in the document are based on non-raised data (i.e. data exactly as reported by CPCs, with no further estimation applied by the Secretariat) and **NOTED** that the different grid resolutions used to display information on the provided time-area maps depend on the reporting requirement by gears as expressed by Resolution 15/02.

26. The WPEB also **NOTED** the results of the preliminary analysis conducted on the information currently available within the ROS regional database (in particular, the recorded interactions, fate and condition at release by species groups and gears) and **ACKNOWLEDGED** that, given the low level of coverage, it is not yet possible nor advised that the Secretariat raises the information at its availability to provide estimations of total discards.

27. The WPEB **ACKNOWLEDGED** that the provision of yearly total discards should preferably come directly by CPCs, and that notwithstanding the availability of a data reporting form specifically designed for this purpose (Form 1-DI) very little information is received every year.

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

28. The WPEB **NOTED** paper IOTC–2019–WPEB15–08 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.

29. In particular, the WPEB **NOTED** recent improvements in the submission of ROS information in an electronic format suitable for automated data extraction, and that data from 1053 over 1410 total trips is now incorporated within the ROS Regional Database and publicly accessible in accordance with the provisions set forth by Resolution 12/02.

30. **NOTING** that the EU indicates a 100% level of coverage for what concerns its purse seine fleet, the WPEB **ACKNOWLEDGED** that this level of coverage results from a combination of human observers (around 40% coverage) and electronic monitoring systems (EMS), and that not all information – in particular the one collected through EMS – has yet been incorporated in the IOTC Regional Database.

31. **RECALLING** that the target observer coverage is 5% of all fishing operations for affected vessels and fleets, the WPEB **NOTED** that a small number of CPCs have met or exceeded this level in recent years. The WPEB **NOTED** that the current requirement is to reach at least 5% of onboard human observer coverage (Resolution 11/04) and that alternative data collection methods are still considered as complementary sources of information.

Pilot projects under Resolution 16/04

32. The WPEB **NOTED** progress with the ROS pilot project and that a workshop for representative of regional observer programmes and other interested parties was held in Seychelles at the end of

September 2018 to review the data collection requirements and the minimum programme standards, **ACKNOWLEDGING** that the results of this review are expected to further streamline and rationalize the data collection and reporting requirements.

33. The WPEB **NOTED** the progress made in updating the ROS electronic data collection, reporting and dissemination tools to the new ROS data requirements, and that further training workshops on their adoption were delivered or are in the process to be delivered to a number of CPCs (Mauritius and Sri Lanka).

34. Also, the WPEB **NOTED** that, following an unexpected delay due to socio-political issues in the country, a trial study for the implementation of EMS onboard six coastal longline / gillnet vessels in Sri Lanka (including the delivery of specific training) is going to be finalized by the end of September 2019, and that results from this study will be used to assess the feasibility of extending this approach to other fleets with comparable logistical issues in deploying independent human observers onboard.

35. The WPEB **NOTED** that the development of the observer training programme package has been awarded to *CapMarine* and is in the process to be delivered to six CPCs (Sri Lanka, Tanzania, Kenya, Indonesia, Malaysia and one CPC yet to be identified) between Q4 2019 and following months, and that this also include a set of new data collection forms and e-learning tools designed in accordance with the revised ROS specifications.

36. While **ACKNOWLEDGING** the importance of port sampling to fulfil data collection requirements where all other approaches could not be effectively implemented, the WPEB **NOTED** that no funding source has yet been identified for this specific work stream, notwithstanding the continued interest shown for this activity by a number of CPCs.

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 **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'.

5.2 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).

38. The WPEB **NOTED** paper IOTC–2019–WPEB15–09 which provided the 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.

39. 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.

40. 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.

41. 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.

42. 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. The WPEB **REQUESTED** the secretariat provide links from the portal to the actual Plan documents so that the detailed information in the plans can be accessed.

43. The WPEB **NOTED** paper IOTC–2019–WPEB15–11 which provided an update on the National Plan of Action for Sharks, Kenya.

"*Sharks and rays form part of Kenya's fish landings for a long period with records dating back to the 1980s (Marshall, 1997). Out of a total of 45 species of sharks and rays that have a geographic range including Kenyan waters and have been assessed by the International Union for Conservation of Nature (IUCN), 19 are classified as threatened globally in the Red List (IUCN, 2018) amounting to ~ 40% while 9 species representing ~20% are categorised as near threatened. The remainder of species assessed and whose distribution spans Kenyan waters are either data deficient or of least concern in the IUCN Red list contributing to ~25% and ~15% of sharks and rays assessed in the country (IUCN, 2018)*." – see paper for full abstract

44. The WPEB **NOTED** the update to the Kenyan NPOAs for sharks and **THANKED** the authors for this comprehensive review of its status. The comprehensive work done by Kenya towards developing an NPOA was welcomed.

45. The WPEB **NOTED** that informal collection of photos and samples by the public can be a useful complimentary tool for collecting information on shark populations.

46. The WPEB **RECOGNISED** that when developing an NPOA, all relevant national bodies who interact with sharks should be taken into consideration and included in the plan, (eg. Research institutes, government bodies and even maritime authorities) not just the fisheries focused organisations.

47. **NOTING** that the information related to catch of target and bycatch species presented by Kenya is not yet available in the IOTC database, the WPEB **ENCOURAGED** Kenya to liaise with the IOTC Secretariat to ensure that historical and current data from the CAS could be successfully incorporated and disseminated to the public.

5.3 Species identification tools

The WPEB **NOTED** paper IOTC–2019–WPEB15-12 describing fishIDER, a new fish identification and training tool for Indonesia, including the following abstract provided by the authors:

> "*Accurate species identification is the fundamental requirement for fisheries assessments. As a result, improving the ability of fisheries staff to accurately identify fish species is a high priority for RFMOs. Standard identification guides are useful resources, but they do not show fish in the condition that data collectors are likely to see them in. We developed fishIDER, fish Identification Database & Educational Resource (www.fishider.org) as a tool to assist with identification of fisheries resources in Indonesia as well as providing a learning platform for users. fishIDER is bilingual, freely accessible, and includes images of species in the condition that data collectors will be encountering at landing sites or fish markets. We aim to expand fishIDER more broadly in the Indian Ocean region, particularly in South-east Asia, and are currently investigating Artificial Intelligence technology to facilitate the identification process*"

48. The WPEB **THANKED** the authors for the presentation and the development of this potentially very useful tool which could help improve species identification which is an identified problem for IOTC data submissions.

49. The WPEB **NOTED** that future work on this tool is to include an Artificial Intelligence component to assist in speeding up the identification process. The author clarified that this is not useful for identification to a species level at this stage, but could be useful for identifying the specimens to a family or genus level, after which the species can be identified from the key.

6. Indicators for Oceanic Whitetip and shortfin mako sharks and stock assessment of silky sharks

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

Elasmobranchs in the Arabian Sea

50. The WPEB **NOTED** paper IOTC-2019-WPEB15-13 which provided information on Species composition of elasmobranchs in the surface and subsurface gillnet operation in the Northern Arabian Sea, including the following abstract provided by the authors.

"Sharks form important part of bycatch of the tuna gillnet operations in Pakistan. WWF-Pakistan introduced subsurface gillnetting in 2014 in which gillnet are placed 1.4 to 2 m below the sea surface. Fishing fleet engaged in tuna gillnetting adopted subsurface gillnetting and by January 2016 entire tuna fleet was converted in subsurface gillnetting. Catch of endangered, threatened and protected (ETP) species such as dolphins and sea turtles were observed to be much lower in subsurface gillnet as compared to surface operations. Sharks are among the other ETP species whose catches were dropped in subsurface gillnet as compared to surface operations. . It was observed that overall shark catches were 15.06 % lower in the subsurface gillnet operation as compared to surface placement of gillnets. A marked seasonality was observed in case of dominating species including mako and silky shark. Catches of mako sharks was observed to be about 8.65 % higher in subsurface gillnets as compared to surface gillnets."

51. The WPEB **NOTED** that the authors could not be present, and therefore the paper was presented by the Secretariat on their behalf and comprehensive discussions could not be held regarding the paper.

52. The WPEB **SUGGESTED** that the authors should present number of individuals rather than weights by month, as well as size distributions of shark species caught by Pakistani gillnetters.

At-haulback mortality for sharks

53. The WPEB **NOTED** paper IOTC-2019-WPEB15-14 which provided information regarding drivers of at-haulback mortality of sharks caught during pelagic longline fishing experiments, including the following abstract provided by the authors:

"*Elasmobranchs (sharks and rays) are a critical part of the bycatch in tropical pelagic fisheries (longline, purse seine, gillnet). The induced mortality can be a major threat to populations especially for vulnerable or endangered pelagic elasmobranchs. Even though retention bans are enforced for some species, it is crucial to reduce the mortality before individuals are released (at-haulback mortality) in longline fisheries. So far, little is known about the drivers of this at-vessel mortality for elasmobranchs. We used data collected during longline fishing experiments (ECOTAP program) in French Polynesia (Central South Pacific Ocean) between 1993 and 1997."* – see paper for full abstract

54. The WPEB **ENCOURAGED** that shark species key habitat studies should be conducted and it was **NOTED** that some work was presented in previous sessions of the WPEB. The WPEB **AGREED** that species habitat studies that rely on PSAT tagging data would be more useful to achieve this goal than other fishing experiments studies.

55. The WPEB **NOTED** that GAMs and multivariate analyses were used to investigate the effect of factors affecting at-haulback mortality of sharks prior to using GLMs presented in this paper

Japanese logbook data filtering

56. The WPEB **NOTED** paper IOTC-2019-WPEB15-15 which described data filtering of Japanese logbook data in the Indian Ocean for analysis of species-specific sharks' data from 1993 to 2018, including the following abstract provided by the authors:

"*Japanese logbook data have high spatial and temporal coverages in the Indian Ocean compare to those of observer data. However, the logbook data may include a large number of under-reporting catches for sharks in particular for the period up to 2007 when the shark reporting was not*

mandatory, which makes it difficult to use directly the logbook data for the estimation of annual catch rates for sharks in the Indian Ocean. In order to solve the issue, the author used a statistical data method to filter Japanese logbook data and removed the systematic annual trends by reducing the set-by-set data with low reporting rates of catch for sharks using information on observer data. The reliability of the filtering method was validated using annual nominal CPUEs of tunas and sharks."

57. The WPEB **NOTED** that the analysis was conducted to respond to the problem that the spatial-temporal distribution monitored by observers is not representative of the whole fishing operations carried out by Japan.

58. The WPEB **SUGGESTED** the simultaneous use of both filtered logbook and observer data might have an advantage to increase the number of set-by-set information, but that the latter present issue of lower data coverage (and of lower coverage of the total number of hooks for each operation).

59. **NOTING** that the approach of filtering logbook data may be useful and that the CPUEs derived from observer data and those derived from filtered logbook data show differences in the estimated shark CPUEs only (not in tuna CPUEs), non-reporting in the historical period examined could be expected.

60. The WPEB **ENCOURAGED** the Japanese scientists to compare the CPUE derived from observer data with a subsampled CPUE derived from filtered logbook data of comparable spatio-temporal distribution (collected for the same trips) in order to validate the CPUE derived from filtered logbook data.

Pelagic shark bycatch in India

61. The WPEB **NOTED** paper IOTC-2019-WPEB15-45 regarding Pelagic sharks by-catch in Indian tuna fishery in 2018, including the following abstract provided by the authors:

"*Barring the Government owned research vessels conducting exploratory surveys, India has negligible fishing fleet exclusively targeting tunas round the year. However, small-scale and artisanal sectors deploying both mechanized and motorized boats (all <24 m OAL) using a variety of gear largely contribute to the tuna fishery. This fishery, fishing exclusively within the Exclusive Economic Zone (EEZ), occasionally records pelagic sharks as bycatch. The total catch of pelagic sharks by this fishery during 2018 was 3314.59 t. Gillnet was the main gear contributing the pelagic shark bycatch (61.83%), followed by longline (31.32), handline (0.94) and other gears (5.90). The status of pelagic shark stocks in the Indian seas are constantly monitored employing four research vessels of Fishery Survey of India (FSI).*" – see paper for full abstract

62. **ACKNOWLEDGING** the usefulness of the information presented in this paper, the WPEB **NOTED** discrepancies between this and the official data submitted by the Indian administration and therefore **ENCOURAGED** India to liaise with the Secretariat to resolve these discrepancies and eventually provide updates to their official data.

63. **NOTING** that India has information on shortfin mako and oceanic whitetip caught by gillnetters and longliners, the WPEB **ENCOURAGED** India to develop standardized CPUE for these species and especially for shortfin mako which will be assessed in 2020.

64. The WPEB **NOTED** that India is working on a shark NPOA.

65. Concerns were raised regarding shortfin mako identification considering the distribution of the data shown but the WPEB **NOTED** that shortfin mako is present in the temperate, subtropical and tropical regions.

6.2 Review of new information on the status of sharks

IOTC BTH PRM project

66. The WPEB **NOTED** paper IOTC-2019-WPEB15-16 regarding the progress of the IOTC bigeye thresher shark post-release mortality study project, including the following abstract provided by the authors:

"*We present the progress report of the IOTC bigeye thresher shark post-release mortality study project (IOTC BTH PRM Project). The goal of the study is to evaluate the efficiency of the IOTC Conservation and Management Measure on non-retention of thresher sharks of the genus Alopias (Resolution 12/09). The summary of the collective efforts since the 13th and 14th IOTC WPEB are presented here, including development of formal documents, operating standard manuals, training, PSATs distribution, and field operations. Further steps for the project implementation are also described*."

67. The WPEB **NOTED** that the sharks that are tagged by observers are handled and treated the same as in regular commercial fishing operations. Observers record the condition of the shark at release and the protocol specifies that according to the shark condition, whether it is in relatively good or bad condition, miniPAT or sPAT should be used respectively.

68. **NOTING** the high mortality rate for bigeye thresher at-haulback, the WPEB **REQUESTED** the authors to examine the effect of factors such as longline soaking time and hooking position on the animal.

Status of sharks in Sri Lanka fisheries

69. The WPEB **NOTED** paper IOTC-2019-WPEB15-17 regarding the status of sharks in Sri Lankan fisheries, including the following abstract provided by the authors:

70. "*Sharks (superorder: Selachii) are incredibly diverse with many pelagic species having circumglobal distributions. While some targeted deep-sea shark fisheries exist at small scales in Sri Lanka, the majority of landings are from bycatch in tuna and billfish fisheries by single and multi-day vessels from coastal waters all the way into the high seas. These species are retained for their highly valued fins that are exported, and for domestic consumption of meat. In Sri Lanka, over 540 days of survey across 19 landing sites, a total of 214 blue sharks (Prionace glauca); 553 silky sharks (Carcharhinus falciformis); 40 shortfin mako sharks (Isurus oxyrinchus); 27 longfin mako sharks (Isurus paucus); 43 scalloped hammerhead sharks (Sphyrna lewini); 15 smooth hammerhead sharks (Sphyrna zygaena); and 5 oceanic white tip sharks (Carcharhinus longimanus) were recorded*." – see paper for full abstract.

71. **NOTING** that genetic samples have been collected, the WPEB **SUGGESTED** that genetic studies like close-kin genetic may help with future assessment of shark species.

72. **NOTING** that retention ban for the silky shark is in place in ICCAT, WCPFC and IATTC, the author recommended that retention bans be enforced as a precautionary measure for the silky shark as well as other shark species until a stock assessment is available.

73. The WPEB **NOTED** that Sri Lanka is currently revising its NPOA Shark and that it will be updated soon.

74. The WPEB **NOTED** that the number of oceanic whitetip sharks may be increasing due to current management actions, acknowledging that no fleet is currently targeting any IOTC protected shark species including oceanic whitetip.

75. Following concerns raised about shortfin mako identification, considering its temperate distribution, the authors stated that observers are well trained and that identification was confirmed by genetics, therefore the WPEB **AGREED** that shortfin mako does occur in tropical waters.

Blue shark CPUE from Indonesia

76. The WPEB **NOTED** paper IOTC-2019-WPEB15-18 which provided Standardized CPUE of blue shark (Prionace glauca) caught by Indonesian longline fleet in the Eastern Indian Ocean, including the following abstract provided by the authors:

"*Standardized catch per unit effort (CPUE) as calculated based on commercial catches are the input data to run stock assessment models to gather useful information for decision making in fishery management. In this paper a Generalized Linear Model (GLM) was used to calculate relative abundance indices and effect of longline fishing gear configuration. The parameters used for standardization of CPUE were quarter, year, number of hooks between floats, latitude and longitude. Data were collected by a scientific observer program from August 2005 to December 2018. Most of the boats monitored were based in Benoa Port, Bali. Catches are often equal to zero*

because blue shark is a bycatch for Indonesian longline fleets. A tweedie model was selected because it has flexibility to the sample distributions. The results showed that the average scaled CPUE was 1.19. The CPUE pattern showed fluctuated during periods and reached the peak on 2006 with 2.09 and the lowest on 0.33 in 2011. The results from this study can demonstrate the catch variation of blue shark by Indonesian tuna longline fleets."

77. **NOTING** that Indonesian data cover multiple species hotspots in the northeast Indian Ocean, the WPEB **SUGGESTED** that the authors attempt similar standardized CPUE for other shark species.

78. The WPEB **NOTED** that spatio-temporal effects (in interaction) should be considered in the standardization noting that the distribution of the effort and population can be different among years.

6.3 Review of the indicators for the oceanic whitetip shark

79. The WPEB **NOTED** paper IOTC-2019-WPEB15-19 which provided a Second progress report on the post release mortality of the oceanic whitetip shark (POREMO project) discarded by EU purse seine and pelagic longline fisheries, including the following abstract provided by the authors:

"*In this second progress report we present briefly again the context of the project POREMO funded by EU France (FEAMP Mesure 77, Data Collection Framework) for the development of appropriate IOTC conservation measures for both targeted and non-targeted large pelagic resources exploited by open ocean fisheries. The POREMO project specifically aims to quantify the post release mortality of the oceanic whitetip shark caught as a bycatch in the EU tuna purse seine and pelagic longline fisheries in order to assess the retention ban measure taken as conservation and management measure (CMM) for this species as specified in the IOTC resolution 13/06. In this working paper we present activities done since the last WPEB-14 (2018) regarding in particular the deployment of both miniPATs and sPATs as well as some results on the survival of sharks after release reported by tags*."

80. The WPEB **NOTED** that the preliminary survival rate for LL-caught fish is 100% and for PS-caught fish is 91.2%.

81. The WPEB **NOTED** that post-release mortality may take place several days after release and that 30 days was used as a limit to consider 'delayed' mortality.

82. The WPEB **NOTED** that it is difficult to estimate soaking time (i.e. time since hooking) for tagged sharks, and that this may also be an important variable for post-release survival.

83. WPEB **ACKNOWLEDGED** this valuable work and **ENCOURAGED** all parties involved to continue the project and obtain final results on the post-release mortality study for oceanic whitetip sharks in the European Union LL and PS fisheries in the Indian Ocean.

6.4 Review of the indicators for the shortfin mako skark

Japanese CPUE

84. The WPEB **NOTED** paper IOTC-2019-WPEB15-21 which provided a Standardized CPUE of shortfin mako caught by Japanese longline fishery in the Indian Ocean from 1993 to 2018, including the following abstract provided by the authors:

"*Annual catch rates and catches are important fishery data to assess fish population dynamics. However, these data of sharks have a possible issue of under-reporting. To solve the issue, we standardized nominal CPUEs of shortfin mako caught by Japanese longline fisheries in the Indian Ocean from 1993 to 2018 using three observation error models (zero-inflated Poisson model: ZIP, negative binomial model: NB, and Poisson model: PO) with logbook data after filtering the data. The NB with full explanatory variables was selected by AIC as the most parsimonious model. The estimated annual catch rates (standardized CPUE) showed a decreasing trends with large fluctuations from the beginning of 1990s until 2009, and then they showed a slight increase trends*." – see paper for full abstract.

85. The WPEB **RECOGNISED** the interest of this study on the standardisation of the CPUE of the shortfin mako shark in relation to the stock assessment of the species which must be done next year as mentioned in the Work Plan

86. The WPEB **NOTED** that CPUE increase may indicate population recovery that is still very slow due to life history traits of shortfin mako shark.

87. The WPEB **NOTED** marked differences between the official catches reported to Secretariat and the re-estimations presented in this study for years prior to 2007 and **ACKNOWLEDGING** that data used for stock assessment may differ from those officially submitted, as for stock assessment purposes usually the best available data is used that may not cover the entire fleet, the WPEB **AGREED** that these re-estimations could be adopted as a separate, complementary data set for the scheduled assessment of the species in 2020 after proper validation from the group.

88. The WPEB **ENCOURAGED** the authors to explore the potential effect of the model over-parametrisation on the model results.

Taiwanese CPUE

89. The WPEB **NOTED** paper IOTC-2019-WPEB15-22 which detailed the Standardized CPUE of shortfin mako shark by Taiwanese large-scale tuna longline fishery in the Indian Ocean, including the following abstract provided by the authors:

"*In the present study, the shortfin mako shark catch and effort data from the logbook data of Taiwanese large longline fishing vessels operating in the Indian Ocean from 2005-2018 were analyzed. Based on the effort distribution, four areas, namely, A (north of 10ºS, east to 70ºE), B (north of 10ºS, 70ºE-120ºE), C (south of 10ºS, 20ºE-60ºE), D (south of 10ºS, 60ºE-120ºE) were categorized. To cope with the large percentage of zero shark catch, the catch per unit effort (CPUE) of shortfin mako shark, as the number of fish caught per 1,000 hooks, was standardized using zero-inflated negative binomial model (ZINB) that allows for "extra" zeros. ZINB model includes the main variables year, quarter, area, hooks per basket (HPB), and CTNO. The standardized CPUE showed a stable and slightly increasing trend for shortfin mako sharks. The results obtained in this study can be improved if longer time logbook data are available and environmental factors are included in the model*."

90. The WPEB **NOTED** that the authors could not be present, and therefore the paper was presented by the Secretariat on their behalf and comprehensive discussions could not be held regarding the paper.

91. The WPEB **NOTED** that CPUE trend of Taiwan is rather consistent with Japanese trend for recent years and that it would be important to see CPUE data for early years of the fishery. However, observed trend reflects changes over a short time and an exploration of the data collected at the beginning of the fishery may provide more insights on CPUE evolution.

92. The WPEB **ENCOURAGED** Taiwan to present a CPUE data including early years of fisheries if such data are available and **REQUESTED** that the Secretariat contact the authors to determine the discrepancy between the values for the nominal and standardised CPUE series provided in the document figures and the tables.

Intrinsic rate of natural increase

93. The WPEB **NOTED** paper IOTC-2019-WPEB15-20 which estimated intrinsic rate of natural increase (r) of shortfin mako (*Isurus oxyrinchus*) based on life history parameters from Indian Ocean, including the following abstract provided by the authors:

"*Intrinsic rate of natural increase (r) of certain species is important parameter in the analysis of population dynamics, thus have large impact on the estimation of stock status and future projection of the stock. We applied a two-sex age-structured matrix population model developed by Yokoi et al. (2017) to the estimation of r for shortfin mako (Isurus oxyrinchus) based on the life history parameter obtained in the Indian Ocean as much as possible. As a result of 80 combinations of life history parameter (sex ratio, litter size, reproductive cycle, sex-specific maturity age, sex-specific estimated longevity, sex-specific growth curve, sex-specific length-weight relationship, and estimator of natural mortality), median r was estimated to be 0.113 with a range of minimum and maximum values of 0.060 and 0.132, respectively. This estimate can be used as a prior which uncertainty included in each parameter was taken into consideration or re-estimated value based on selected parameter would be another candidate for the input parameter in the stock assessment model*."

94. The WPEB **NOTED** the estimate of the intrinsic rate of natural increase of the shortfin mako in the Indian Ocean based on 80 combinations of several life history parameters.

95. The WPEB **NOTED** the average value of 0.113 obtained for the r parameter within a range of minimum and maximum values of 0.06 and 0.132. Although this value may be slightly changed depending on the parameters selected as a result of discussion by WG, the WPEB **SUGGESTED** to use this approach as one possible method to estimate the r prior of Bayesian surplus production model.

96. The WPEB **SUGGESTED** to follow up this study of the estimation of the r parameter to explore the method developed by Then (2015) for the estimation of the natural mortality and the impact which can be observed on the r estimates.

6.5 Review of the proposed stock assessment of silky shark

Taiwanese catch rate

97. The WPEB **NOTED** paper IOTC-2019-WPEB15-24 which provided a preliminary standardized catch rate of silky sharks caught by the Taiwanese large-scale longline fishery in the Indian Ocean, including the following abstract provided by the authors:

"*The silky shark catch and effort data from the logbook data of Taiwanese large longline fishing vessels operating in the Indian Ocean from 2005-2018 were analyzed. Based on the effort distribution, four areas, namely, A (north of 10ºS, east to 70ºE), B (north of 10ºS, 70ºE-120ºE), C (south of 10ºS, 20ºE-60ºE), D (south of 10ºS, 60ºE-120ºE) were categorized. Due to the large percentage of zero shark catch, the catch per unit effort (CPUE) of silky shark, as the number of fish caught per 1,000 hooks, was standardized using zero-inflated negative binomial model (ZINB) that allows for "extra" zeros. ZINB model includes the main variables year, quarter, area, hooks per basket (HPB), and CTNO. The standardized CPUE showed a stable trend for silky sharks from 2005 to 2014 and increased steadily thereafter with peaks in 2014. The results obtained in this study can be improved if longer time series logbook data are available*."

98. The WPEB **NOTED** that the authors could not be present, and therefore the paper was presented by the Secretariat on their behalf and comprehensive discussions could not be held regarding the paper.

99. The WPEB **ACKNOWLEDGED** that the data from Taiwan,China shows a relatively flat trend in standardized CPUE and that these data should be treated with caution and used as preliminary indicators.

100. The WPEB **NOTED** significant differences in the data presented in the Table 3 and Fig. 5 and **REQUESTED** Taiwan,China to explain these differences.

Silky shark population trend

101. The WPEB **NOTED** paper IOTC-2019-WPEB15-23 which described the Silky Shark Population Trend in the Indian Ocean Derived from its Associative behaviour with Floating Objects, including the following abstract provided by the authors:

"*Silky sharks (Carcharhinus falciformis) figure among the main pelagic shark species caught by the industrial tropical tuna purse-seine fisheries. However, this data was not used so far for estimating their population trends. In this study, using data from the European tropical tuna purse seine fishery, we provide an abundance trend for the silky shark, based on the associative behavior of this species with floating objects (FOBs). Two models were used, describing the dynamics of sharks associated to floating objects (FOBs) in a social and in a non-social case. The parameters estimates of the models were obtained by fitting the distribution of the number of sharks caught per set. The relative abundance indices were derived for the Seychelles area and the Mozambique Channel. For both areas, an upward trend was observed. In the Seychelles area, the abundance index increased by a factor of 3 from 2006 to 2018 and in the Mozambique Channel the increase reached a factor of 15. This modeling approach could be extended to other bycatch species to generate population trends and could be useful for future stock assessment analyses*."

102. The WPEB **ACKNOWLEDGED** that both silky and oceanic whitetip shark catches show an apparent increasing trend, and that without knowledge of baseline data it is impossible to judge the real situation of the stock for both species.

103. The WPEB **NOTED** that changes in FAD numbers are an important variable in the model and that it was incorporated into the estimations.

104. The WPEB **NOTED** that the separation between Mozambique Channel and Seychelles Equatorial area is based on natural separation based on FAL movements.

6.6 Recommendations and executive summary for silky shark

105. The WPEB **NOTED** that there is very little information available for this species and few papers were submitted in 2019 regarding silky sharks. As such this has rendered any form of assessment impossible. The WPEB strongly **ENCOURAGES** CPCs to provide information to alleviate this problem.

7. Ecosystem modelling and report cards

106. The WPEB **NOTED** the need for having operational objectives for Ecosystem indicators.

107. The WPEB **NOTED** that the development goal of EAF is to provide scientific information which is complementary to single-species stock assessments where important ecosystem considerations are often ignored.

108. The WPEB **NOTED** that eight IOTC papers were presented in relation to the development of the ecosystem report cards. These papers covered six of the eleven ecosystem components contemplated in the ecosystem report card. The WPEB **ENCOURAGED** to further develop the rest of the ecosystem components.

109. The WPEB **NOTED** that ecosystem report cards can be a powerful tool, provided that they are utilised properly, and that while they can be fundamental in picking up signals regarding ecosystem functioning, however the prioritisation and identification of appropriate monitoring components is fundamental.

Ecosystems Based Fisheries Management in the Southeast USA

110. The WPEB **NOTED** a presentation (IOTC-2019-WPEB15-INF16) provided by the invited expert, Dr Clay Porch (NOAA, USA), regarding an overview of the US experience regarding Ecosystems Based Fisheries Management, Including the following abstract provided by the author:

> "*NOAA Fisheries has long recognized the importance of ecosystem-based fisheries management (EBFM), but recently began requiring more deliberate steps in this regard with the development of an Ecosystem-Based Fishery Management Policy and regional 'Road Maps'. The Southeast Region of the United States has different EBFM 'Road Maps' for four, ecologically and economically diverse large marine ecosystems: Gulf of Mexico, Subtropical Atlantic Coastal areas, Caribbean Sea and Atlantic high seas. Each plan describes how EBFM will be implemented with clear, actionable steps over the next 5 years. The plans prioritize research on ecosystem components (e.g., harmful algal blooms) where increased knowledge is likely to have important fisheries implications. The plans specifically recognize that NOAA Fisheries has a limited capacity in the Southeast region and will need to collaborate with other Federal, state and academic partners in order to make significant progress. The plans also emphasize engagement with fishermen and other members of the public to take advantage of local ecological knowledge as well as gain support for future endeavors. The presentation focuses on aspects of the Road Maps such as improving baseline monitoring to better support EBFM in the future, identifying economic, social, ecological factors that might suggest optimum yield targets that are less than the maximum sustainable yield, potential key drivers that merit special attention, and measures taken in the U.S. Atlantic and Gulf of Mexico to reduce bycatch of sea turtles, marine mammals and sharks are discussed.*"

111. The WPEB **THANKED** the invited expert for his interesting presentation which provided very beneficial information and principles which are applicable to the work of the WPEB.

112. The WPEB **NOTED** the differences between establishing an Ecosystems Based Fisheries Management plan at a national level as opposed to a regional level. The WPEB **NOTED** that it may

be simpler and easier to establish an EAF at national level with a common legal system and policy rather than at international level.

7.1 Report of the "Identification of regions in the IOTC convention area to inform the implementation of the ecosystem approach to fisheries management" Workshop.

Report of the ecoregions workshop

113. The WPEB **NOTED** paper IOTC–2019–WPEB15–INF01 which provided main outcomes from the 2019 IOTC Ecoregions Workshop, including the following abstract provided by the authors:

"WPEB14 recommended to convene a workshop in 2019 to provide advice on the identification of draft ecoregions to foster discussions on the operationalization of the ecosystem approach to fisheries management (EAFM) in the Indian Ocean Tuna Commission (IOTC) convention area. This workshop took place the 30th, 31st of August and 1st of September in La Reunion Island and gather 17 participants with a wide range of expertise in IOTC species, fisheries and oceanography in the Indian Ocean. Prior to the workshop, a consultant was hired to prepare a baseline draft proposal of ecoregions to be presented and discussed at the workshop by all the participants. During the workshop, the group discussed the potential benefits and uses of ecoregions in the context of IOTC species and fisheries. The group also provided feedback on the technical aspects, data and methods used in the derivation of draft ecoregions. Three baseline ecoregion classifications were reviewed by the group, which in combination with expert knowledge, were used to derive draft ecoregions within the IOTC convention area. The draft ecoregions are not intended to be used for management purposes. At this stage, the benefits and potential uses (e.g. development of ecosystem report card, ecosystem status overview, etc.) of the draft ecoregions should be tested as a tool to facilitate the operationalization of the EAFM in IOTC."

114. The WPEB **NOTED** that there is general support for the identification of ecoregions as this provides a structured way to organise the ecosystems data and investigate ecosystem functioning. The WPEB **STRESSED** that the initiative being carried out in IOTC should build on other studies that have already been conducted and possibly avoid duplicating those efforts.

115. The WPEB **REQUESTED** that other IOTC WPs review and comment on the draft ecoregions for future development as a tool to progress towards EAF.

116. The WPEB **NOTED** that the regions discussed during the workshop incorporated the information from previous studies on biogeochemical classifications (eg. Longhurst provinces, MEOWs and PPOWs) to develop the proposed preliminary ecoregions which are considered of relevance for IOTC fisheries.

117. The WPEB **ACKNOWLEDGED** that species distributions were utilised for developing the ecoregions in preference to fisheries distribution in the clustering analysis and **NOTED** that this was indeed the case in the proposed preliminary ecoregions.

118. The WPEB **NOTED** a concern on a potential usage of the term "ecoregion". Currently, these proposed regions are being developed to capture distribution of main target species and IOTC fisheries, and therefore a different term might be needed.

119. The WPEB **ENDORSED** the draft ecoregions for further development as a tool to progress EAF implementation (e.g. ecosystem report cards, ecosystem overviews, fishery overviews).

120. The WPEB **STRESSED** that at this stage ecoregions cannot be used as management units, but can be used for investigating and monitoring the properties and dynamics of a system at the ecosystem level, and for facilitating the communication of this information between scientists and managers.

121. The WPEB **SUGGESTED** using precise terminology in the EU proposal with regards to the definition of temperate region. It was acknowledged that the referred temperate region is actually comprised by both subtropical and temperate regions.

122. The WPEB **NOTED** that ecosystem models have a potential to contribute to the development of EAF and **ENCOURAGED** further participation of modelling specialists to future sessions of the WPEB, although these models would need to be approached cautiously due the scarce information available.

Ecosystem indicators for highly migratory species

123. The WPEB **NOTED** paper IOTC–2019–WPEB15–29 which detailed selecting ecosystem indicators for fisheries targeting highly migratory species: An EU project to advance the operationalization of the EAF in ICCAT and IOTC, including the following abstract provided by the authors:

"*Several international legal agreements and guidelines have set the minimum standards and key principles to guide the implementation of an ecosystem approach to fisheries management (EAFM). However, the implementation of an EAFM in tuna Regional Fisheries Management Organizations (RFMOs) has been patchy and lack a long-term plan, vision and guidance on how to operationalize it. The Specific Contract N02 "selecting ecosystem indicators for fisheries targeting highly migratory species-" (SC02 project) under the Framework Contract - EASME/EMFF/2016/008 provisions of Scientific Advice for Fisheries Beyond EU Waters- addresses several scientific challenges and provides insights to support the implementation of an EAFM through collaboration and consultation with the International Commission for the Conservation of Atlantic Tunas (ICCAT) and the Indian Ocean Tuna Commission (IOTC)*." – see paper for full abstract.

124. The WPEB **NOTED** the need to include fishermen, managers and other stakeholders in the process of establishing EAF.

125. The WPEB **NOTED** that the aim of the current initiative was to organize all the existing information in the study area, compiling the data, using it to understand the main processes in the ecosystem, from oceanographic features up to species distribution and ecosystem functioning.

Monitoring foodweb and trophic relationships

126. The WPEB **NOTED** paper IOTC–2019–WPEB15–30 which described advances in monitoring the impacts on and the state of the "foodweb and trophic relationships" ecosystem component, including the following abstract provided by the authors:

"*In support of the development of the IOTC ecosystem report card, this paper addresses the "food web/trophic relationships" ecosystem component and specifically it contributes towards developing the following elements: (1) We describe the importance of this ecosystem component and explain the potential risks of not monitoring it, and make a proposal of a conceptual and an operational objective to measure progress towards monitoring the impacts of IOTC fisheries on and the state of this ecosystem component. (2) We present candidate ecological indicators that could be estimated to capture and describe changes in multiple ecosystem attributes of the marine ecosystem derived from the impacts of fisheries, and discuss main challenges in indicator developmen*t." – see paper for full abstract

127. The WPEB **NOTED** the concern that the current scope of this study is too wide and that the proposed objective is aiming for the management of trophic levels that are not under the IOTC mandate. In addition, the data utilised are limited to those obtained from the IOTC fisheries and due to their selective nature they are not suitable to provide an overall picture of the ecosystem status. The WPEB **ACKNOWLEDGED** that FAO Code of Conduct for Responsible Fisheriesrequests to ensure that fisheries do not have a substantial adverse impact on ecosystem components. The WPEB **ACKNOWLEDGED** that the indicator in this component is just a tool to help understand the ecosystem functioning.

Ecosystem Indicators to Monitor the Ecological Impacts of Purse Seine Fisheries

128. The WPEB **NOTED** paper IOTC–2019–WPEB15–26 which outlined Three Ecosystem Indicators to Monitor the Ecological Impacts of Purse Seine Fisheries Operating in the Indian Ocean, including the following abstract provided by the authors:

"*In support of the IOTC ecosystem report card, we estimated several indicators which could be used to measure progress towards monitoring the impacts of IOTC fisheries on and the state of the "Food web/Trophic relationships" ecosystem component. An ecosystem approach requires understanding the ecological effects of removing all animals through fishing. In addition to the monitoring of the total biomass removed, it is also necessary to know the species composition of the total catch and whether they are retained or not, their life history traits and their ecological role in the food web.*

We used the available fishery statistics and observer data from the EU and Seychelles' purse seine fishery targeting tropical tunas in the western Indian Ocean to examine the potential ecological effects of this fishery on the food web structure and functioning of this ecosystem. We estimated the total biomass removed by the fishery in terms of weight, trophic level and replacement time by purse seine fishing method (sets on floating objects-FOBs and sets on free schools-FSCs) across different areas in the Indian Ocean."

129. The WPEB **NOTED** the difficulties related to monitoring of food webs, largely due to the limited capacities to collect and analyse fine-scale diet information in the area, and **RECOGNISED** that this work could still continue, at least as an exploratory exercise.

130. The WPEB also **NOTED** substantial discrepancies in the interpretation of the indicators presented in this study.

Indicators for Non-Retained Sharks and Rays

131. The WPEB **NOTED** paper IOTC–2019–WPEB15–25 which described Indicators for Non-Retained Sharks and Rays, including the following abstract provided by the authors:

"*In this working paper, we address the ecosystem component consisted of "non-retained sharks and rays" to support the development of an ecosystem report card in the IOTC region. This group includes sharks and ray species that are not retained due to retention bans or due to their low or no commercial value. The interaction between these non-retained species and IOTC fisheries needs to be monitored because, in most cases, stock assessments have not yet been conducted due to lack of data and their status remain unknown or poorly known. The conceptual objective of this work is to reduce the interactions and mortality induced by IOTC fisheries to levels that would be sustainable for these species*" – see paper for full abstract.

The seabird component of the IOTC ecosystem report card

132. The WPEB **NOTED** paper IOTC–2019–WPEB15–28 which described the development of the seabird component of the IOTC ecosystem report card, including the following abstract provided by the authors:

"*This paper serves as a contribution to the development of the IOTC Ecosystem Report Card by outlining the context and providing proposals for the seabird bycatch component of the report card. We highlight that bycatch is considered one of the main impacts of IOTC fisheries on seabirds and emphasise the importance of monitoring seabird bycatch associated with IOTC fisheries. We note that IOTC fisheries may also have indirect impacts on seabirds through overexploitation of large subsurface predators (e.g. tuna and billfish), leading to reductions in the accessibility of seabird prey. Although this aspect is not considered further in the document, we highlight the need to develop appropriate indicators. Following the format adopted at WPEB14, we propose conceptual and operational objectives, and a list of candidate indicators*." – see paper for full abstract.

133. The WPEB **NOTED** that the IOTC needs to monitor the bycatch of seabirds in IOTC fisheries. In order to assess the overall impact on associated seabird populations, a broader assessment on a global scale would be needed since many populations are globally distributed in the southern temperate and polar regions. This IOTC initiative would serve as a continuous regional approach to the monitoring of fisheries impacts that would ideally provide input into a wider scale assessment periodically.

134. The WPEB **ACKNOWLEDGED** that the effectiveness of mitigation measures are strongly influenced by the vessel effect: observer feedback is required to determine how effectively the mitigation measures are being implemented by each vessel. In addition, suitable methods for quantitatively assessing the mitigation measures implementation are yet to be identified.

135. The WPEB **NOTED** that ideally, the indicators should be provided at a species level: as several species of seabird are extremely vulnerable and need to be monitored closely, correct species identification is therefore critical for these indicators.

Ecosystem approach indicators, for assessing Tuna fishing pressure

136. The WPEB **NOTED** paper IOTC–2019–WPEB15–27 which described a method for developing ecosystem approach indicators, for assessing Tuna fishing pressure component in the IOTC area of competence, including the following abstract provided by the authors:

"*In support of the development of the IOTC ecosystem report card, this paper addresses the "fishing pressure" component and how it cans contribute towards implementing the Ecosystem Approach of Fishery Management (EAFM). At first we illustrate what are main principles of the EAFM and what the fishing pressure component means within the context of the EAFM implementation. We also make a proposal of a conceptual and an operational objective which to be used to measure progress towards management of this component. Then we give briefed information about Current status of Tuna and Tuna like species stocks in IOTC area of competence and propose candidate fishing pressure related indicators that could be estimated to monitor this component*." – see paper for full abstract.

137. The WPEB **NOTED** that integrated indicators would be preferable for this component, that ICCAT are investigating combined F values across multiple species as a form of integrated indicator and **ACKNOWLEDGED** that the progress made in that RFMO should be followed by the group.

138. The WPEB also **NOTED** that developing integrated indicators in the Indian Ocean is further complicated due to the high level of coastal fisheries (and in particular gillnet fisheries) for which little data is available.

Monitoring the status of the ocean climate and environment

139. The WPEB **NOTED** paper IOTC–2019–WPEB15–32 which described the Monitoring of the status of the ocean climate and environment, variability and trends, including the following abstract provided by the authors:

"*In support of the development of the IOTC ecosystem report card, this paper addresses the "ocean climate and environmental" ecosystem component and specifically it contributes towards developing the following elements: (1) We describe the importance of this ecosystem component from which we can understand the potential risks of not monitoring it, and make a proposal of a conceptual and an operational objective to measure progress towards monitoring the potential impacts of the ocean climate and environment on the state of IOTC species and associated ecosystems. (2) We present a candidate list of climate and environmental indicators that could be estimated to capture and describe changes in the habitat of large pelagic fishes and open-ocean ecosystems, and (3) we discuss main challenges in indicator development. (4) Finally, we draft a work plan to guide our future work. We invite the IOTC community and others to contribute towards the development of the IOTC ecosystem report card. If interested, contact the corresponding authors to find out how you can contribute to this initiative*."

140. The WPEB **NOTED** that the authors could not be present, and therefore the paper was presented by the Secretariat on their behalf and comprehensive discussions could not be held regarding the paper.

141. The WPEB **NOTED** that oceanographic information is relatively data rich and its immediate impacts are relatively simple to understand when compared to processed fisheries information such as CPUEs. However, some additional steps are required to develop indicators that are suitable for the ecosystem report cards.

142. **NOTING** the request from the SC that the Secretariat dedicates a section of the IOTC website to the dissemination of oceanographic data (provided by third parties) the WPEB **AGREED** that the exact content of the section as well as its updating and maintenance would need to be further discussed and planned.

Indicators for Marine Debris

143. The WPEB **NOTED** paper IOTC–2019–WPEB15–50 which provided Indicators for Marine Debris, including the following abstract provided by the authors:

"*This document addresses the "marine debris" ecosystem component to support the development of an indicator-based ecosystem report card at the IOTC. The goal of the document is to point out the importance of identifying the marine debris produced by the fishing activities of the major IOTC*

fisheries and its potential impact on the marine ecosystem in the Indian Ocean. With this objective the following points have been developed: (1) We describe the "marine debris" ecosystem component, highlight its importance and the need of monitoring it. We also make a proposal of a conceptual and an operational objective to measure progress towards the management of this component. (2) We propose candidate indicators, which are shared by all fishing gears, that could be measured to monitor the extend of marine debris both on the open ocean and coastal ecosystems produced by IOTC fisheries.(3) We chose to initiate our work by identifying the potential sources of the different fishery activities to marine debris and examine data availability and sources to support indicators development, and (4) Finally, a draft work plan to guide the future work is defined. If interested, contact the corresponding authors to find out how you can contribute to this initiative."

144. The WPEB **WELCOMED** the work of the authors for bringing this subject to this working party, noting for example the large quantity of FADs currently deployed in the area. The authors acknowledged that marine debris originate form a variety of sources but they limited the indicator to abandoned fishing gear due to data availability.

145. The WPEB **NOTED** Resolution 19/02 requiring the development of DFAD-marking scheme to be proposed by 2020. DFAD-marking could enable the identification of the origin of the abandoned fishing gear.

Ecosystem report card summary and future work

146. The WPEB **NOTED** that at the 2018 meeting (WPEB14), a core group of components and corresponding collaborators were identified to continue to advance the work on developing ecosystem report cards (the outcomes from many of those collaborations have been presented in 2019). The WPEB **ACKNOWLEDGED** that this work is very preliminary and requires substantial additional effort to advance this process and many key inputs and discussions are required to improve the current proposals.

147. The WPEB **NOTED** that many of the proposed indicators for ecosystem report cards are still very preliminary or in their initial exploration phase, and that a continuation of this work would be needed. The WPEB updated the participants list provided in Annex XXI.

148. **ACKNOWLEDGING** that the group did not want to lose momentum, the WPEB **REQUESTED** that another workshop be held to continue the work on ecoregion classification.

SIOTI support for an ecosystem approach to fisheries management

149. The WPEB **NOTED** paper IOTC–2019–WPEB15–31 which provided information on SIOTI support for the development of an ecosystem approach to fisheries management for Indian Ocean tuna fisheries, including the following abstract provided by the authors:

"*The Sustainable Indian Ocean Tuna Initiative (SIOTI) is a large-scale FIP comprising the major purse seine fleets and tuna processors in the Indian Ocean. As part of its Action Plan, SIOTI supported this study with the overall objective of examining the core requirements of an ecosystem approach to fisheries management (EAFM) resulting from the ecosystem impacts of tuna purse seine fishing in the Indian Ocean. To do so, this study summarizes the current progress of IOTC in implementing the EAFM and proposes several research avenues and options to facilitate its operationalization. It also reviews the key risk areas associated with the ecosystem impact of purse seine fisheries on the foodweb structure and function, and identifies potential options to improve fisheries management that explicitly accounts for ecosystem impacts. Ultimately, this study aims to inform the actions and activities planned in the SIOTI Action Plan established under the three critical and non-critical Improved Performance Goals (IPG6, IPG15 and IPG16) related to the ecosystem impacts of purse seine tuna fishing*."

150. The WPEB **NOTED** that this work focuses on sustainability. Broadly speaking, sustainability has three main components (ecology, economy and social) and the WPEB **NOTED** that this group has only been addressing ecological concerns.

8. Bycatch, species interactions and ecosystem risk assessments

8.1 Review new information on other bycatch and by-product, in terms of biology, ecology, fisheries interactions and bycatch mitigation measures

Good practice for tuna purse seine

151. The WPEB **NOTED** paper IOTC–2019–WPEB15–33 which presents progress on the Code of Good Practices on the Tropical Tuna Purse Seine Fishery in the Indian Ocean, including the following abstract provided by the authors:

"The two Spanish tuna purse seiner associations, ANABAC and OPAGAC, established a voluntary agreement for the application of good practices to minimize the ecosystem impacts of purse seine fishing, by reducing mortality of incidental catch of sensitive species and the use of non-entangling FADs. This paper presents results on the use of FADs and sensitive fauna release for the period 2015 and 2017 in the Indian Ocean. More than 500 trips were monitored in 25 purse seiners and 17 support vessels by human observers onboard or by electronic monitoring system. Results show that the percentage of entangling FADs has been reduced significantly since 2015, being in 2017 the 78% of the FADs left at sea non-entangling FADs (i.e. totally constructed with not meshed material or ≤7 cm mesh size if open net is present). Overall, 56,504 vulnerable specimens were registered using the specific data collection protocol on Good Practices in 2015-2017 period on 10,019 sets, and a predominance of sharks was observed (98% of the interactions). Sharks (other than whale sharks), mantas, rays and turtles are mainly released by hand from the deck. For mantas specific releasing tools are also used. Bycatch release time has been reduced since 2015, which is an indicator of the increased commitment of the crew and could contribute to higher post-release survival rates."

152. The WPEB **NOTED** this interesting study and recognised its benefits for addressing best practice in purse seine fisheries.

153. The WPEB **NOTED** that dividing the number of tons by 1000 tons could be misleading in terms of understanding the absolute values that were being reported. It was noted that both the relative amount and the absolute amount are important to present.

BIOFAD project

154. The WPEB **NOTED** paper IOTC–2019–WPEB15–34 which described preliminary Results of the BIOFAD Project: Testing Designs and Identifying Options to Mitigate Impacts of Drifting Fish Aggregating Devices on the Ecosystem, including the following abstract provided by the authors:

"The EU project BIOFAD was launched in August 2017. This 28-months EU project is coordinated by a Consortium comprising three European research centers: AZTI, IRD (Institut de recherche pour le développement) and IEO (Instituto Español de Oceanografía). The International Seafood Sustainability Foundation (ISSF) is also actively collaborating by providing the biodegradable materials needed to test biodegradable dFADs (drifting FADs). Following IOTC, along with other tuna RFMOs, recommendations and resolutions to promote the use of natural or biodegradable materials for dFADs, this project is seeking to develop and implement the use of dFADs with both characteristics, non-entangling and biodegradable, in the IOTC Convention Area.." - see paper for full abstract.

155. The WPEB **INQUIRED** on the degree of investment and acceptance of the industry in the BIOFAD project. It was clarified that there is good participation by the fleet. The authors stated that after the first experiments, the fleet was not convinced by the cotton cover because they believed it degraded too fast, but they agreed to continue with the deployments.

156. The WPEB **NOTED** that the study indicated a higher accumulation of biomass under conventional FADs than in biodegradable FADs. These results were found surprising as fish are known to concentrate around anything that floats (e.g. logs, debris). There is no current hypothesis, but the different FAD designs were compared by pairs released at the same time, therefore the difference would not be due to sample size.

157. The WPEB **NOTED** that the biomass between the conventional FADs and the bio-FADs were different, but that the catch rate was similar. It was noted that biomass data are derived from echosounders and catch data is driven by fishers' behaviours; therefore the two indices are not the same indicator. However, it was noted that the difference in biomass were not considered large, and that this might be the reason why catch rates were similar.

Squid depredation

158. The WPEB **NOTED** paper IOTC–2019–WPEB15–35 which described depredation of purpleback flying squid (*Sthenoteuthis oualaniensis*) on tuna caught by gillnet fisheries in Pakistan which is a major cause of concern for fishermen, including the following abstract provided by the authors:

"Major concentrations of purpleback flying squid (Sthenoteuthis oualaniensis) are known in the Arabian sea and other parts of the Indian Ocean. This squid is considered to be important part of the diet of tuna species in the area especially in the mesopelagic zone it constitutes a major part of the diet of tuna species. A very few cases of depredation by cetaceans and sharks were reported from tuna gillnet fisheries of the Arabian Sea, however, oceanic squid (Sthenoteuthis oualaniensis) are observed to be heavily depredating on tuna caught in the gillnets especially in the Pakistani offshore waters. Tuna fleet that operates in offshore waters during winter (December to March) reported heavy depredation by purpleback flying squid" - see paper for full abstract

159. The WPEB **NOTED** that the authors could not be present, and therefore the paper was presented by the Secretariat on their behalf and comprehensive discussions could not be held regarding the paper

160. The WPEB **NOTED** that the apparent seasonal signal in depredation events is most likely a change in fishing operations, which move offshore in the winter when depredation events are reported to occur. Fishing moves closer inshore in the summer and there are fewer events reported. It was noted that changes in the fishery operation is a more likely driver than squid migration.

161. The WPEB **NOTED** other experiences with squid depredation also have been recorded in other areas around the Indian Ocean, and that several events occurred on tunas in Indonesian waters but not to the degree reported in this paper. It was noted that squid depredations have also been reported to occur in the NW coast of India. It was noted that the squid are oceanic species, but that depredation events are not reported in the central basin.

Status of threatened species in Sri Lanka

162. The WPEB **NOTED** paper IOTC–2019–WPEB15–36 which provided the present Status of threatened and conserved species entanglement in multiday tuna fishery in Sri Lanka, including the following abstract provided by the authors:

"Sri Lanka is one of the oldest and most important tuna producing island nations in the Indian Ocean. Multiday fishing crafts in Sri Lanka are mainly operated targeting tuna and tuna like species and this is a multi-gear, multi-species fishery. Certain threatened and conserved species are protected in Sri Lanka by the existing law notably oceanic white tip shark, three species of thresher sharks, whale shark, marine mammals and turtles. It has been reported that accidental catching of above species to fishing gears frequently operate in tuna fishery such as gillnets, longline and ring net. The present study was undertaken with the aim of studying the present status of threatened and conserved species recorded in tuna fishery for improving the conservation and management of them." - see paper for full abstract.

163. The WPEB **ACKNOWLEDGED** that Sri Lanka provided information on several bycatch species. The WPEB **ENCOURAGED** all CPCs to conduct post-release mortality studies for sharks, sea turtles and other bycatch species caught in gillnet fisheries in order to investigate potential mitigation measures of these bycatch species. Post-release mortality studies as well as proposals of potential mitigation measures to reduce the impacts of gillnet on bycatch species would be a useful contribution from Sri Lanka.

164. The WPEB **NOTED** the high level of interactions between gillnet fishery and marine mammals in the Sri Lanka fishery, and it suggested that the use subsurface gill nets could be used as mitigation measure to reduce the number of interactions. The WPEB **NOTED** that there are ongoing projects and collaborations with other partners testing the use of acoustic sounders (pingers) as a potential

mitigation measures to reduce incidental catches of gillnet fisheries and that Sri Lanka is in the process of reducing gillnet from their fleet.

165. The WPEB **NOTED** that there was an increase in the number of entanglements which might be due to increased observer rate or improved reporting. It was noted that the logbook reporting rate relative to the total fishery was high. All multiday vessels comply log book reporting, as their annual license rely on this. Due to the implementation of regulations on protected species, the presence of these species in fishing grounds is increasing causing high level of entanglements.

FAD monitoring and reporting

166. The WPEB **NOTED** paper IOTC–2019–WPEB15–37 which described a method of moving towards improvement in monitoring, reporting and management of Fish Aggregating Devices in the Indian Ocean Purse Seine Tuna Fishery, including the following abstract provided by the authors:

"*The Sustainable Indian Ocean Tuna Initiative (SIOTI) has been established in a collaborative effort by key governments in the Indian Ocean, fishing companies, tuna processors and WWF. They have launched a Fisheries Improvement Project (FIP) to support improvements towards the sustainable management of purse seine tuna fishing, with the ultimate goal of certification by the highest standards for sustainable fishing, the Marine Stewardship Certification (MSC) standard. SIOTI commissioned a pre-assessment of the fishery as part of its FIP, which has identified several areas where action should be taken in order to achieve MSC certification, i.e., their Improved Performance Goals (IPGs)*." – see paper for full abstract.

167. The WPEB **HIGHLIGHTED** the importance of CPCs reporting the data collected for the FAD management plans to the Secretariat in a way that information can be easily extracted and combined with other data sets. The WPEB **ENCOURAGED** CPCs attending the meeting to look at the observer coverage rates summary tables prepared by the Secretariat and contact the Secretariat to correct any inconsistencies.

FAD degradability

168. The WPEB **NOTED** paper IOTC–2019–WPEB15–38 described a preliminary evaluation of degradability for natural material ropes potentially used on fish aggregating devices (FADs) in tuna purse seine fishery, including the following abstract provided by the authors:

"Purse seiners deploy thousands of drifting fish aggregation devices (DFADs) in all tropical oceans to catch tropical tunas. Nowadays these FADs were constructed with synthetic netting, which are explicitly considered responsible for incidental mortality of sea turtles and sharks through entanglement, even causing ghost fish if they are lost and abandoned. The use of natural and/or biodegradable materials to build FADs can effectively mitigate marine pollution and bycatch issues so that they are currently made efforts to promote by fisheries management organizations. This paper presents the degradability of three natural material ropes (3-ply 96-thread cotton, 3-ply 13-thread jute, and 3-ply 8-thread sisal) on the basis of an experiment measurement on breaking strength (N/ktex)." - see paper for full abstract

169. The WPEB **NOTED** that the durability of ropes for greater than 3 months was unusual for FADs made out of biodegradable material. It was clarified the desired lifetime of the FAD is about 6 months, so resistance up to this time range is preferred.

170. The WPEB **NOTED** there is a trade-off between using resistant materials with a longer life span which might reduce the cost of the fishing operation, and using more biodegradable material with a lower life span that might have a lower environmental impacts, i.e., whether more resistant material will have a larger environmental impact as it degrades more slowly.

Hook and bait type effects on pelagic longline retention and hooking rates

171. The WPEB **NOTED** paper IOTC–2019–WPEB15–39 which provided information Hook and bait type effects on surface pelagic longline retention and hooking mortality rates: A meta-analysis for target, bycatch and vulnerable fauna interactions, including the following abstract provided by the authors:

"*A meta-analysis of 24 publications was conducted to assess effects of hook, bait and leader type on retention and at-haulback mortality rates of target, bycatch and vulnerable species of the*

pelagic longline fishery. Turtles and swordfish had lower retention rates with circle hooks. In contrast, retention rates of 3 sharks and 2 tuna species were greater with circle hooks. Bait type did not seem to significantly influence the retention rates of most of the species examined. Wire leader lead to a decrease in retention rates of bony fishes and a mix for elasmobranchs. For at-haulback mortality, hook type was the most influential, with 5 elasmobranch species and 6 bony fishes having a significantly lower at-haulback mortality rates when using circle hooks. Bait type and leader type did not have a significant effect on at-haulback mortality rates for most species. The results presented here should be considered preliminary. Future work will consider expanded information on fishery characteristics."

172. The WPEB **NOTED** that the authors could not be present, and therefore the paper was presented by the Secretariat on their behalf and comprehensive discussions could not be held regarding the paper. The WPEB further **NOTED** that the study is preliminary.

Bycatch taxonomic structure

173. The WPEB **NOTED** paper IOTC–2019–WPEB15–40, provided an analysis of the bycatch taxonomic structure changes from observers data on board Spanish purse seiners in the Indian Ocean, including the following abstract provided by the authors:

"There are global diversity pattern such as Latitudinal and deep gradients affecting marine species richness. In this line there is a global latitudinal taxonomic structure, where the species-genus ratio or genus-family ratio are maximum in the equator. The main aim of the present study was to test the taxonomic structure pattern of Spanish purse seine (PS) bycatch from Indian Ocean in the last 15 years, we do not expected any change in the time series. Our results indicated that there are two different periods 2004-2008 versus 2015-2018. Moreover, we observed a significant temporal trend of the taxonomic structure. We concluded that during the period of study there is an increment in the number of species recorded and increase to the species/family ratio. Therefore, we deduce that there has been a change in the structure of the pelagic ecosystem of the Indian Ocean in recent years. We have not found an unique explanation to explains these changes (changes in fishing technique, overfishing, or global warming), perhaps because there is more than one factor interacting"

174. The WPEB **NOTED** that there was not an increase in the number of species, but instead an increase in the ratio of species within each genera or family groups.

Phuket bycatch landings

175. The WPEB **NOTED** paper IOTC–2019–WPEB15–46 which provided information on Bycatch landings in Phuket Ports by foreign tuna longline fishing vessel, 2018, including the following abstract provided by the authors:

"*All bycatch species which caught by foreign tuna long-line fishing vessel and uploaded at Phuket ports, Thailand in 2018 was 29.20 tons (2.60% of total catch). There were 7 species comprised, oil-fish (Ruvettus pretiosus) 65.68%, followed by Wahoo (Acanthocybium solandri) 14.69%, Mahi-fish (Coryphaena hippurus) 7.41%, Skipjack (Katsuwonus pelamis) 6.45%, Albacore (Thunnus alalunga) 4.26%, Barracuda (Sphyraena spp.) 1.38% and promfret (Taractichthys steindachneri) 0.98 %. Most of them were exported while a few were used in Thailand*"

176. The WPEB **NOTED** that landings by foreign tuna longline fleet entering Phuket have decreased considerably in the last few years. It was explained that the fishing fleet operates in distant waters far from the Phuket ports, and that the foreign fishing fleet might be landing elsewhere. The recent stringent monitoring by Thailand government to decrease the IUU fishing might be deterring foreign vessels from landing their catches in Phuket.

177. The WPEB **NOTED** there were no landings of sharks species in the statistics reported by the study, and **QUERIED** if sharks finning could be explaining those lack in shark landings. The authors were not sure of the reason for the lack of shark information.

Pakistan subsurface gillnet bycatch

178. The WPEB **NOTED** paper IOTC–2019–WPEB15–48 which outlined issues related to adoption of subsurface gillnetting to reduce bycatch in Pakistan, including the following abstract provided by the authors:

"*Gillnet is a popular fishing method used for catching tuna and tuna like fishes especially by small scale fisheries of coastal states of the Indian Ocean. However, gillnets are known for extremely high bycatch which includes not only commercially important fish species but also a large number of non-target endangered, threatened and protected (ETP) species. Information about gillnet bycatch is not well known from major coastal states, however, studies initiated by WWF-Pakistan provide comprehensive information about bycatch of gillnet fisheries of Pakistan. It is estimated that more than 12,000 cetaceans and 29,000 sea turtles used to be annually entangled in the gillnet fisheries of Pakistan alone*" - see paper for full abstract

179. The WPEB **NOTED** that the authors could not be present, and therefore the paper was presented by the Secretariat on their behalf and comprehensive discussions could not be held regarding the paper.

180. The WPEB **NOTED** that the number of sea turtle and cetacean bycatch (i.e. 29,000) reported in this paper are equivalent or very similar to the numbers officially reported for the whole of the Indian Ocean. The WPEB **NOTED** that the numbers reported in this study are not in the official IOTC fisheries statistics.

181. The WPEB **NOTED** that countries neighbouring Pakistan also use gillnets but not all are adopting sub-surface gillnet gear setting. The WPEB were **INFORMED** that I.R. Iran set gillnets are sometimes set 1.5-2m below the surface. India is not aware of the use of subsurface gillnetting occurring in their waters, including its NW coast. This was postulated to be due to difficulties in mounting the net. Similarly, Sri Lanka is not aware of the use of subsurface gillnetting occurring in their waters.

182. The WPEB **NOTED** paper IOTC–2019–WPEB15–51 which provided information on Ecological Impacts of Tuna Fisheries of Lakshadweep, the Archipelagic Territory of India Situated in the Central Indian Ocean, including the following abstract provided by the authors:

"*Tuna fishing is the mainstay of the inhabitants of the archipelagic territory of India, Lakshadweep. Pole and line skipjack tuna fisheries constitute nearly 70% of the fish landing in the islands followed by handline caught yellowfin tuna. Though there have been advancements in both these fisheries with the live chumming for yellowfin handlining being the latest, the ecological impacts of fishing has been minimal. However, there isn't much scientific information in the public domain on this aspect so far. Ecological impacts in the form of incidental catch of non-target resources including sensitive organisms in skipjack and yellowfin tuna fisheries both in free school and anchored Fish Aggregation Devices associated schools as well as the associated bait fishery; and physical impacts of bait fishing on the reef system were quantified based on the observations from 105 fishing operations during May, 2018 and April, 2019. Spatially explicit information on the species composition of non-target resources across the seasons has been generated. Results indicate minimal ecological impacts by both the tuna fishing practices with no incidence of sensitive species caught except seabirds accidentally hooked on 3 occasions and total bycatch including discards at less than 0.5%. The Bait fishing encountered turtle interaction on 11 occasions, but was waded out of the bait net safely in all cases. Physical damage of varying magnitude to the coral reef was observed in nearly 15% of the bait fishing operations. The study recommends management interventions to reduce or avoid interactions of bait fisheries with non-target resources, corals and other ETPs*"

183. The WPEB **NOTED** that there are shark catches reported in these pole and line fisheries, which is very unusual. It was clarified that sharks are generally not caught in pole and line gear, but rather opportunistically by handline near the associated flotsams.

184. The WPEB **NOTED** that there is offshore fishing and queried whether the government of India supports fishing in offshore areas through subsidies. It was clarified that the Lakshadweep islands are oceanic islands where the fishing is naturally offshore. The Government of India promotes tuna fishing in the offshore areas of the EEZ along the mainland of India in order to relieve the fishing pressure in the more inshore areas.

8.2 Seabirds

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

185. The WPEB **NOTED** paper IOTC–2019–WPEB15–41 which provided the ACAP advice for reducing the impact of pelagic fishing operations on seabirds, including the following abstract provided by the authors:

"*Bycatch in pelagic longline fisheries is one of the greatest threats to seabirds, particularly albatrosses and petrels. The Agreement on the Conservation of Albatrosses and Petrels (ACAP https://acap.aq/) provides a range of advice, guidelines and resources aimed at advancing the conservation of albatrosses and petrels. ACAP routinely reviews and updates its advice, most recently in May 2019, at the Ninth Meeting of the ACAP Seabird Bycatch Working Group and the Eleventh Meeting of its Advisory Committee, and this paper outlines the latest advice and resources available. ACAP Parties noted with concern the continuing conservation crisis facing albatrosses and petrels, and the need for urgent and increased efforts to counter this crisis."* - See paper for full abstract.

186. The WPEB **RECALLED** that it, and the IOTC Scientific Committee (SC), had previously (2016) considered and endorsed ACAP's updated advice regarding line-weighting specifications and hook-shielding devices.

187. The WPEB **NOTED** updated advice from ACAP on improving safety when hauling weighted branchlines, and guidelines for handling and removing hooks from seabirds.

188. The WPEB **NOTED** that the updated guidelines and advice developed by ACAP are available on the ACAP website, with links provided in IOTC-2019-WPEB15-41, and thanked ACAP for these resources, which it is hoped will help contribute to addressing the continuing conservation crisis faced by albatrosses and petrels.

189. The WPEB **NOTED** paper IOTC–2019–WPEB15–47, which was the report of the Final Global Seabird Bycatch Assessment Workshop: Seabird Component (ABNJ/Birdlife), including the following abstract provided by the authors:

"The Final Global Seabird Bycatch Assessment Workshop was held from 25 February to 1 March 2019. Participants at the workshop are listed in Annex 1; the workshop agenda is shown in Annex 2. The workshop comprised presentations, data analysis and discussion. Workshop participants agreed to a report format that was focused on Background/Methods/Results/Discussion, in order to present the results of the analyses in the clearest way." - see paper for full abstract

190. The WPEB **NOTED** that the project had initially aimed to derive a global estimate of seabird bycatch associated with these fisheries, and also to assess the effectiveness of conservation measures (bycatch mitigation measures) adopted by tRFMOs to reduce seabird bycatch. However, the latter objective was not considered further due to the complexity of the issues (including data deficiencies).

191. The WPEB also **NOTED** that the inclusion of seabirds' density distribution would largely improve the consistency and level of confidence intervals of bycatch estimates among different modelling approaches.

192. The WPEB **WELCOMED** the outputs of the assessment and the collaborative approach undertaken, and encouraged a strengthening of this approach. The WPEB **ACKNOWLEDGED** the intention to conduct a similar assessment in the future to investigate trends in bycatch and the effectiveness of bycatch mitigation measures.

193. The WPEB **HIGHLIGHTED** the importance of efforts aimed at improving the identification of seabirds bycaught, to better enable an assessment of the potential impacts of bycatch on seabird species and populations**.**

194. The WPEB **NOTED** presentation IOTC–2019–WPEB15–INF13 which evaluated the process towards mitigation of seabird bycatch in longline pelagic fisheries, including the following abstract provided by the authors:

"Bycatch in industrial pelagic longline fleets has long been identified as a significant source of mortality and a conservation concern for many threatened seabird species. Despite recent efforts

to develop and refine seabird bycatch mitigation measures in pelagic longline fisheries, the effect of these practices based on global observer information remains undescribed. Here we analyse about 15,800 longline sets and 36.4 million hooks observed during 583 trips aboard 132 pelagic longline vessels operating in the south Atlantic and southwestern Indian Oceans over a period of 15 years (2002-2016)."

195. The WPEB **THANKED** the authors and welcomed the collaboration between CPCs in undertaking such a study.

196. The WPEB **NOTED** the absence of line-weighting information in the study and encouraged future work to include line-weighting and also to consider including some assessment of the influence of seabirds' density distribution on bycatch, and the impact of bycatch on seabirds population.

197. Noting that seabird bycatch rate was lower during night-setting than daytime, the WPEB **DISCUSSED** whether night-setting should be recommended as a mandatory measure for vessels fishing in areas overlapping with albatrosses and petrels, combined with one of the other two measures listed in Resolution 12/06.

198. The WPEB **ACKNOWLEDGED** that when Resolution 12/06 is formally reviewed, the practicalities of all mitigation measures should be considered, including the results of this study which show night-setting to be the most effective.

8.3 Marine turtles

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

199. The WPEB **NOTED** paper IOTC–2019–WPEB15-INF15 regarding collaboration between longline fisheries and a sea turtle care centre in Reunion Island, including the following abstract provided by the authors:

"*Animal movement is crucial to the ecology of spatially structured population. Marine turtles' life cycle is indeed closely related to spatial and environmental factors. Depending on species and life stages, spatial patterns largely rely on biological and ecological needs and potential interactions with fisheries vary greatly. Latest research conducted on sea turtles crossing French EEZs of the Indian Ocean has provided valuable understanding of the spatial fate of marine turtles from regional management units from the southwest Indian Ocean, green turtle Chelonia mydas, loggerhead turtle Caretta caretta and hawksbill turtle Eretmochelys imbricata, but also from the northwest Indian Ocean loggerhead turtle. The results identified and characterized migratory corridors and spatial developmental cycles which highlight important traits of the species biogeography and as well as areas of ecological importance. In Reunion Island, a long-term collaboration between the longline fishing fleet and the local marine turtle care center has allowed a mitigation of the fisheries impacts and a better understanding of the interactions with the fisheries. A release protocol and marine turtle release kit have been developed and deployed on board. When required and possible, bycaught animals are conducted to the care center for hook removal and animal rehabilitation in order to reduce post capture mortality. The results presented provide ecological insights and a practical example of mitigation measures.*"

200. The WPEB **THANKED** the authors and noted that the loggerhead sea turtles brought in for rehabilitation were mostly juveniles, and therefore difficult to sex based on external features. Consequently, the sex of the majority of the individuals tracked following release is unknown.

201. The WPEB **NOTED** paper IOTC–2019–WPEB15-42 which described a machine learning approach to estimate species composition of unidentified sea turtles that were recorded on the Japanese longline observer program, including the following abstract provided by the authors:

"Unidentified species is the major source of uncertainties to evaluate the impact of bycatch on sea turtle populations, so we tried to estimate species composition of unidentified sea turtles from operational circumstance via machine learning approach. We used bycatch data from the Japanese scientific observer program, which includes 10,490 operations and catch records of 141 loggerheads, 75 olive ridleys, and 152 unidentified turtles. The random forest, which is a machine learning approaches, was conducted to estimate probability of the species identities (loggerhead or olive ridley). As training datasets, species-identified sea turtle bycatch number including set

date, location, sea surface temperature and catch number of target and non-target species such as tunas, billfishes, other teleost fishes, sharks, and sea turtles. As a result, the probabilities of species identity were calculated. When the species was defined as identified (the probability larger than 0.7), the identified 111 turtles were identified as 16 loggerheads and 95 olive ridleys, and 41 could not be identified. We conclude that random forest approach will be helpful to improve the species estimation.."

202. Noting the importance of obtaining species-specific information on sea turtle interactions with fisheries, the WPEB **WELCOMED** the investigation into mechanisms that could help facilitate the taxonomic resolution of bycatch events involving unidentified sea turtles.

203. The WPEB **NOTED** the importance of improving the spatial overview of sea turtle interactions with longline fisheries and **ENCOURAGED** the researchers to extend their investigation from the Atlantic, where the pilot took place, to the Indian Ocean in order to test the applicability of the approach to IOTC fisheries.

8.4 Marine mammals

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

204. The WPEB **NOTED** paper IOTC–2019–WPEB15–44 which provided Guidelines for best practice in the safe and humane handling and release of bycaught small cetaceans from fishing gear, including the following abstract provided by the author:

"These guidelines, in their full text format, are intended to provide fisheries managers at any level, as well as those who work with fisheries to improve their sustainability, with best-practice methodology on the safe and humane handling and release of small cetaceans accidentally bycaught in fishing gear. They are intended to enable managers and 'trainers', as well as anyone involved with fisheries policy or management to understand the rationale and need for 'best practice', as well as the science that supports the recommended practices. The illustrations provided with these guidelines, as well as the bullet-pointed handling notes, can be used to develop 2-page laminated fisher-friendly 'Flips' (ready reckoners) that contain clear, concise, bullet-pointed instructions pertinent to each specific fishery." - see paper for full abstract

205. The WPEB **NOTED** that the document deals with gillnet, trawl and longline gear and tries to balance animal welfare, crew safety and practical aspects of implementation for fishers. The illustrations provided with these guidelines, as well as the bullet-pointed handling notes, can be used to develop 2-page laminated fisher-friendly 'Flips' (ready reckoners) that contain clear, concise, bullet-pointed instructions pertinent to each specific fishery.

206. The WPEB **ACKNOWLEDGED** receipt of this document and the need to provide feedback to the authors.

207. The WPEB **REQUESTED** the authors to clarify if improved animal welfare translates into decreased post-release mortality, as the latter is important to fisheries.

208. The WPEB **REQUESTED** that CPCs help facilitate the distribution of this document to fishers so that they can provide feedback of the practicality of the guidelines**.**

Report on the IWC meeting on bycatch

209. The WPEB **NOTED** paper IOTC–2019–WPEB15–43, which was a Report of the IWC Workshop on Bycatch Mitigation Opportunities in the Western Indian Ocean and Arabian Sea, including the following abstract provided by the authors:

"*The International Whaling Commission (IWC) held a technical workshop on Bycatch Mitigation Opportunities in the Western Indian Ocean and Arabian Sea from 8-9 May 2019 in Nairobi, Kenya. The workshop was attended by 50 participants working in 17 different countries, with half of the participants coming from within the Indian Ocean region. Workshop participants included national government officials working in marine conservation and fisheries management, cetacean and fisheries researchers, fisheries technologists, socio-economists and representatives from Regional Fisheries Management Organisations (RFMOs), inter- and non-governmental organisation*s" – see paper for full abstract.

210. The WPEB **NOTED** that bycatch associated with set and drifting gillnet fishing gear comprises one of the greatest threats to cetaceans in the Western Indian Ocean. Not only does bycatch in gillnets pose a major threat to cetaceans, but options for mitigating this threat are still in the process of being investigated. Potential options include operational measures, such as subsurface setting, when nets are set 1.5 – 2 metres below the surface, and technical mitigation measures, including the use of LED lights and acoustic deterrents. The technical mitigation measures remain largely in the development and testing phase and their success is species and area dependent. The IWC drew on local expertise from those attending the workshop, as well as literature, to identify gillnet bycatch issues and define high bycatch areas that require attention.

211. The WPEB **NOTED** that the workshop represented the beginning of a process to work collaboratively to better understand and address bycatch of cetaceans in the Western Indian Ocean.

212. The WPEB **ENCOURAGED** active collaboration and data sharing between the IWC, IOTC and other stakeholders to achieve this goal.

Globally Important Marine Mammal Areas (IMMA)

213. The WPEB **NOTED** paper IOTC-2019-WPEB16-INF17 which provided information on important Marine Mammal Areas in the Western and North East Indian Ocean, South East Asian Seas and Arabian Seas. No abstract was provided as it was a presentation only.

214. WPEB **NOTED** that in some cases more recent data are available than the datasets used to delineate candidate IMMAs, and **ENCOURAGED** stakeholders to share this information with the IMMA project proponents. In this regard, India and Sri Lanka offered to provide the initiative with updated information. India informed that the Ministry Of Environment, Forest and Climate Change is the agency that might have the data of important marine mammal areas in Indian waters. India can provide the initiative with updated information in consultation with the MOEFCC.

9. WPEB Program of work

9.1 Revision of the WPEB Program of Work 2020–2024

215. The WPEB **NOTED** paper IOTC–2019–WPEB15–10 which provided the WPEB15 with the latest Program of Work (2020-2024) 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.

216. 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*."

217. The WPEB **CLARIFIED** the meanings of "indicator analysis", "full stock assessment" and "data preparatory" for sharks and these are included in the footnotes to the Program of Work table.

218. The WPEB **AGREED** that the indicator analysis is conducted if sufficient data for the full stock assessment is not prepared at the data-preparatory meeting.

219. The WPEB **CLARIFIED** that the full stock assessment is generally every four years and **AGREED** that the assessment schedule may be changed depending on the annual reviews of fisheries indicators or SC and Commission requests.

220. The WPEB **AGREED** that at its next session the main focus would be on the shark stock assessments, however other issues will be facilitated possibly through break-out sessions.

221. The WPEB **RECOMMENDED** that the SC consider and endorse the WPEB Program of Work (2020–2024), as provided in Appendix XIX.

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

222. 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 2020, by the Invited Expert:
    - **Expertise:** Shark assessment expert (possibly with data poor experience).

10.Other business

10.1 Other tRFMO meetings

Joint tuna RFMO bycatch WG

223. The WPEB **NOTED** that a joint tuna RFMO bycatch meeting would be held in Porto, Portugal from the 16 – 18 December. The focus of the meeting would be on shark issues. Interested participants were **ENCOURAGED** to review the meeting information.

ABNJ Joint tuna RFMO Ecosystems WG

224. The WPEB **NOTED** that a joint tuna RFMO workshop on "Options to Operationalize the Ecosystem Approach to Fisheries Managements in tuna RFMO" will be held at FAO Headquarters in Rome on the 17th - 19th of September 2019. The aim of the workshop is to explore options for advancing the operationalization of the Ecosystem Approach to Fisheries Management (EAFM) in tuna Regional Fisheries Management Organizations (RFMOs) by inviting a small number of stakeholders with ample experience in the RFMO processes to share their views about the opportunity for envisaging an EAFM road map.

10.2 TORs for WWF bycatch study

225. The WPEB **NOTED** that Terms of Reference for a new Bycatch study had been provided by WWF. Although the WPEB felt it was inappropriate to endorse the Terms of Reference, participants were **ENCOURAGED** to review them and provide feedback directly to the authors.

10.3 Date and place of the 16th and 17th Sessions of the Working Party on Ecosystems and Bycatch

226. 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 16th and 17th Sessions of the WPEB in 2020 and 2021 respectively, the WPEB **NOTED** that China had offered to host the 16th session of the WPEB in 2020. With regards to 2021, the IOTC Secretariat would liaise with potential hosts intersessionally to determine who might be able to host the 17th 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 2019 (

227. Table **2**).

Table 2. Draft meeting schedule for the WPEB (2020 and 2021), proposed to continue to be held back-to-back with WPB.

	2020			2021		
Meeting	**No.**	**Date**	**Location**	**No.**	**Date**	**Location**
Working Party on **Billfish** (WPB)	18th	1-5 September (5d, TBC)	China, Shanghai (TBC)	19th	(TBC)	(TBC)
Working Party on **Ecosystems and Bycatch** (WPEB)	16th	7-11 September (5d, TBC)	China, Shanghai (TBC)	17th	(TBC)	(TBC)

228. 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.

10.4 External expert

229. The WPEB **ACKNOWLEDGED** the valuable input provided by the invited expert, Dr Clay Porch and thanked him for his time and effort to attend the meeting.

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

Chairperson

230. The WPEB **CONSIDERED** candidates for the position of Chairperson of the WPEB for the next biennium. Dr. Sylvain Bonhommeau was nominated and re-elected as Chairperson of the WPEB for the next biennium.

Vice-Chairpersons

231. The WPEB **NOTED** that the second term of the current Vice-Chairperson, Dr Reza Shahifar, is due to expire at the closing of the current WPEB meeting. The WPEB further **NOTED** that the other Vice-Chairperson Ross Wanless had resigned prior to the meeting. As per the IOTC Rules of Procedure (2014), participants are required to elect new Vice-Chairpersons for the next biennium.

232. **NOTING** the Rules of Procedure (2014), the WPEB **CALLED** for nominations for the two positions of Vice Chairperson of the IOTC WPEB for the next biennium. Dr. Mohamed Koya (India) and Dr. Mariana Tolotti (EU,France) were nominated, seconded and elected as Vice-Chairpersons of the WPEB for the next biennium

10.6 Review of the draft, and adoption of the Report of the 15th Session of the Working Party on Ecosystems and Bycatch

233. The WPEB **RECOMMENDED** that the Scientific Committee consider the consolidated set of recommendations arising from WPEB15, 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

234. The report of the 15th Session of the Working Party on Ecosystems and Bycatch (IOTC–2019–WPEB15–R) was **ADOPTED** on the 7th September 2019.

APPENDIX I
LIST OF PARTICIPANTS

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APPENDIX II
AGENDA FOR THE 15TH WORKING PARTY ON ECOSYSTEMS AND BYCATCH

Date: 3 - 7 September 2019
Location: La Saline Les Bains, REUNION ISLAND
Venue: TAMARUN, 8 rue des Argonautes, La saline Les Bains, La Reunion
Time: 09:00 – 17:00 daily
Chair: Dr Sylvain Bonhommeau (EU, France); **Vice-Chair**: Dr Reza Shahifar (I.R. Iran) & Dr

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 21st Session of the Scientific Committee (IOTC Secretariat)
   - 3.2 Outcomes of the 23rd 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 WPEB14 (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).
   - 5.3. Species identification tools

6. **INDICATORS FOR OCEANIC WHITETIP AND SHORTFIN MAKO SHARKS AND STOCK ASSESSMENT OF SILKY SHARK**
   - 6.1. Review new information on shark and ray biology, stock structure, bycatch mitigation measures, fisheries and associated environmental data (all);
   - 6.2. Review of new information on the status of sharks (all);
   - 6.3. Review of the indicators for the oceanic whitetip shark
   - 6.4. Review of the indicators for the shortfin mako skark
   - 6.5. Review of the proposed stock assessment of silky shark
   - 6.6. Recommendations and executive summary for silky shark

7. **ECOSYSTEM MODELING AND REPORT CARDS** (recommendations from the SC / decisions of the Commission)
   - 7.1. Report of the "Identification of regions in the IOTC convention area to inform the implementation of the ecosystem approach to fisheries management" Workshop..

8. **BYCATCH, SPECIES INTERACTIONS, AND ECOSYSTEM RISK ASSESSMENTS**
   - 8.1. Review new information on other bycatch and by-product, in terms of biology, ecology, fisheries interactions and bycatch mitigation measures (all)
   - 8.2. Seabirds

- Review new information on seabird biology, ecology, fisheries interactions and bycatch mitigation measures (all);

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

8.4. Marine mammals (all)
- 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).
- Report on the IWC meeting on bycatch

9. WPEB PROGRAM OF WORK

9.1. Revision of the WPEB Program of Work 2020–2024 (Chairperson and IOTC Secretariat)

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

10. OTHER BUSINESS

10.1. Other tRFMO meetings

10.2. TORs for WWF bycatch study

10.3. Date and place of the 16th and 17th Sessions of the Working Party on Ecosystems and Bycatch (Chairperson and IOTC Secretariat)

10.4. External expert

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

10.6. Review of the draft, and adoption of the Report of the 15th Session of the Working Party on Ecosystems and Bycatch (Chairperson)

APPENDIX III
LIST OF DOCUMENTS

Document	Title
IOTC-2019-WPEB15-01a_Rev1	Agenda of the 15th Working Party on Ecosystems and Bycatch
IOTC-2019-WPEB15-01b_Rev4	Annotated agenda of the 15th Working Party on Ecosystems and Bycatch
IOTC-2019-WPEB15-02_Rev5	List of documents of the 15th Working Party on Ecosystems and Bycatch
IOTC-2019-WPEB15-03	Outcomes of the 21st Session of the Scientific Committee (IOTC Secretariat)
IOTC-2019-WPEB15-04	Outcomes of the 23rd Session of the Commission (IOTC Secretariat)
IOTC-2019-WPEB15-05	Review of Conservation and Management Measures relevant to ecosystems and bycatch (IOTC Secretariat)
IOTC-2019-WPEB15-06	Progress made on the recommendations and requests of WPEB14 and SC21 (IOTC Secretariat)
IOTC-2019-WPEB15-07_Rev2	Review of the statistical data and fishery trends for ecosystems and bycatch species (IOTC Secretariat)
IOTC-2019-WPEB15-08 _Rev1	Update on the implementation of the IOTC Regional Observer Scheme (IOTC Secretariat)
IOTC-2019-WPEB15-09	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)
IOTC-2019-WPEB15-10	Revision of the WPEB Program of Work (2020–2024) (IOTC Secretariat & Chairperson)
IOTC-2019-WPEB15-11	The National Plan of Action (NPOA)-Sharks Development Progress In Kenya: Status and Challenges (Oddenyo, R. M., Mueni, E., Kiilu, B., Wambiji, N., Abunge, C., Kodia, M. A., Obota, C., Musembi, P., Muthiga, N. And Bernard, J.)
IOTC-2019-WPEB15-12	fishIDER, a new fish identification and training tool for Indonesia (White W)
IOTC-2019-WPEB15-13	Species composition of elasmobranchs in the surface and subsurface gillnet operation in the Northern Arabian Sea (Moazzam M)
IOTC-2019-WPEB15-14_Rev1	Drivers of at-haulback mortality of sharks caught during pelagic longline fishing experiments (Massey, Sabarros P, Rabearisoa, Bach P)
IOTC-2019-WPEB15-15	Data filtering of Japanese logbook data in the Indian Ocean for analysis of species-specific sharks's data from 1993 to 2018. (Kai M)
IOTC-2019-WPEB15-16_Rev1	The second progress report on the implementation of the IOTC bigeye thresher shark post-release mortality study project (IOTC BTH PRM Project)
IOTC-2019-WPEB15-17	Status of sharks in Sri Lankan fisheries (Fernando D)
IOTC-2019-WPEB15-18	Standardized CPUE of blue shark (*Prionace glauca*) caught by Indonesian longline fleet in the Eastern Indian Ocean. (Jatmiko I)
IOTC-2019-WPEB15-19	Second progress report on the post release mortality of the oceanic whitetip shark (POREMO project) discarded by EU purse seine and pelagic longline fisheries (Bach P, Sabarros P, Coelho R, Murua H, Krug I, Romanov E)
IOTC-2019-WPEB15-20	Estimate of intrinsic rate of natural increase (r) of shortfin mako (*Isurus oxyrinchus*) based on life history parameters from Indian Ocean.(Semba Y, Yokoi H, and Kai M)
IOTC-2019-WPEB15-21	Standardized CPUE of shortfin mako caught by Japanese longline fishery in the Indian Ocean from 1993 to 2018. (Kai M and Semba Y)
IOTC-2019-WPEB15-22	Standardized CPUE of shortfin mako shark by Taiwanese large-scale tuna longline fishery in the Indian Ocean (Tsai W-P)
IOTC-2019-WPEB15-23_Rev1	Silky Shark Population Trend in the Indian Ocean Derived from its Associative beviour with Floating Objects (Tolotti M et al.)
IOTC-2019-WPEB15-24	Preliminary standardized catch rate of silky sharks caught by the Taiwanese large-scale longline fishery in the Indian Ocean (Tsai W-P)

Document	Title
IOTC-2019-WPEB15-25_Rev1	In Support of the IOTC Ecosystem Report Card: Indicators for Non-Retained Sharks and Rays (Tolotti M et al.)
IOTC-2019-WPEB15-26_Rev1	Three Ecosystem Indicators to Monitor the Ecological Impacts of Purse Seine Fisheries Operating in the Indian Ocean (Andonegi E)
IOTC-2019-WPEB15-27	Developing ecosystem approach indicators, for assess Tuna fishing pressure component in the IOTC area of competence (Shahifar R)
IOTC-2019-WPEB15-28	The development of the seabird component of the IOTC ecosystem report card. (Wolfaardt A et al)
IOTC-2019-WPEB15-29	Selecting ecosystem indicators for fisheries targeting highly migratory species: An EU project to advance the operationalization of the EAFM in ICCAT and IOTC (Juan-Jorda M-J)
IOTC-2019-WPEB15-30	In support of the iotc ecosystem report card: advances in monitoring the impacts on and the state of the "foodweb and trophic relationships" ecosystem component (Juan-Jorda M-J)
IOTC-2019-WPEB15-31	SIOTI support for the development of an ecosystem approach to fisheries management for Indian Ocean tuna fisheries (Juan-Jorda M-J)
IOTC-2019-WPEB15-32	In support of the IOTC ecosystem report card: Monitoring the status of the ocean climate and environment, variability and trends (Marsac F and Shahifar R)
IOTC-2019-WPEB15-33	Progress on the Code Of Good Practices on the Tropical Tuna Purse Seine Fishery in the Indian Ocean (Grande M, Ruiz J, Murua J, Murua H, Goñi N, Krug I, Salgado A, Arregui I, Zudaire I, Santiago J.)
IOTC-2019-WPEB15-34	Preliminary Results of the Biofad Project: Testing Designs and Identifying Options to Mitigate Impacts of Drifting Fish Aggregating Devices on the Ecosystem (Tolotti M et al.)
IOTC-2019-WPEB15-35	Depredation of purpleback flying squid (*Sthenoteuthis oualaniensis*) on tuna caught by gillnet fisheries in the Northern Arabian Sea: a major cause of concern for fishermen (Moazzam M)
IOTC-2019-WPEB15-36	Present Status of threatened and conserved species entanglement in multiday tuna fishery in Sri Lanka (Jayasinghe R.P.P.K., Bandaranayake K.H.K., Weerasekera S.J.W.W.M.M.P., and Haputhantri S.S.K.)
IOTC-2019-WPEB15-37	Towards improvement in monitoring, reporting and management of Fish Aggregating Devices in the Indian Ocean Purse Seine Tuna Fishery (Nieblas A-E)
IOTC-2019-WPEB15-38	Preliminary evaluation of degradability for natural material ropes potentially used on fish aggregating devices (FADs) in tuna purse seine fishery (Zhou C)
IOTC-2019-WPEB15-39	Hook and bait type effects on surface pelagic longline retention and hooking mortality rates: A meta-analysis for target, bycatch and vulnerable fauna interactions (Santos C C, Rosa D and Coelho R)
IOTC-2019-WPEB15-40	Analysing the bycatch taxonomic structure changes from observers data on board Spanish purse seiners in the Indian Ocean (Báez J C, Ramos M L and Abascal F)
IOTC-2019-WPEB15-41	ACAP advice for reducing the impact of pelagic fishing operations on seabirds (ACAP Secretariat)
IOTC-2019-WPEB15-42	Machine learning approach to estimate species composition of unidentified sea turtles that were recorded on the Japanese longline observer program (Okamoto K, Kanaiwa M, and Ochi D)
IOTC-2019-WPEB15-43	Report of the IWC Workshop on Bycatch Mitigation Opportunities in the Western Indian Ocean and Arabian Sea (IWC)
IOTC-2019-WPEB15-44	Guidelines for best practice in the safe and humane handling and release of bycaught small cetaceans from fishing gear (Hamer D)
IOTC-2019-WPEB15-45_Rev1	Pelagic sharks by-catch in Indian tuna fishery in 2018 (Mathew A)
IOTC-2019-WPEB15-46	Bycatch landings in Phuket Ports by foreign tuna longline fishing vessel, 2018 (Hoimuk S, Maeroh K and Somkliang N)
IOTC-2019-WPEB15-47	Report of the Final Global Seabird Bycatch Assessment Workshop: Seabird Component (ABNJ/Birdlife)
IOTC-2019-WPEB15-48	Issues related to adoption of subsurface gillnetting to reduce bycatch in Pakistan (Moazzam M and Khan M F)

Document	Title
IOTC-2019-WPEB15-49 WITHDRAWN	Bycatch analysis in Tuna drift gillnet fishery of Pakistan; comparison of shark catches to target catch (Shahid U)
IOTC-2019-WPEB15-50	In Support of the IOTC Ecosystem Report Card: Indicators for Marine Debris (Zudaire I, Grande M, Murua H, Ruiz I and Juan-Jorda M-J)
IOTC-2019-WPEB15-51	Ecological Impacts of Tuna Fisheries of Lakshadweep, the Archipelagic Territory of India Situated in the Central Indian Ocean (Koya M, Abdul Azeez P, Rohit P, Abdussamad E M, and Rajesh K M)
Information papers	
IOTC-2019-WPEB15-INF01	Draft ecoregions for the IOTC convention area and main outcomes from the 2019 IOTC Ecoregions Workshop (Juan-Jorda M-J)
IOTC-2019-WPEB15-INF02	Draft ecoregions for the IOTC convention area, proposed in preparation for the 2019 IOTC Ecoregions Workshop: "Identification of regions in the IOTC convention area to inform the implementation of the ecosystem approach to fisheries management" (Nieblas, A-E, Juan Jorda M-J, Murua H, Fiorellato F and de Bruyn P.)
IOTC-2019-WPEB15-INF03	Global spatial risk assessment of sharks under the footprint of fisheries (Queiroz, N. et al)
IOTC-2019-WPEB15-INF04	A Preliminary Stock Assessment for the Silky Shark in the Indian Ocean Using a Data-Limited Approach (J. Ortiz de Urbina, T. Brunel, R. Coelho, G. Merino, D. Rosa, C. Santos, H. Murua, P. Bach, S. Saber, D. Macias)
IOTC-2019-WPEB15-INF05	A Preliminary Stock Assessment for the Shortfin Mako Shark in the Indian Ocean Using Data-Limited Approaches (T. Brunel, R. Coelho, G. Merino, J. Ortiz de Urbina, D. Rosa, C. Santos, H. Murua, P. Bach, S. Saber, D. Macias)
IOTC-2019-WPEB15-INF06	Potential Indicator for Non-Retained Sharks in Support of an ICCAT Ecosystem Report Card (Coelho R, Santos C, Rosa D and Lino P G.)
IOTC-2019-WPEB15-INF07	IOTC manual for tagging bigeye thresher shark (BTH) with pop-up satellite archival tags (PSAT) to evaluate post-release mortality (PRM) - English
IOTC-2019-WPEB15-INF08	IOTC manual for tagging bigeye thresher shark (BTH) with pop-up satellite archival tags (PSAT) to evaluate post-release mortality (PRM) - Chinese
IOTC-2019-WPEB15-INF09	Crew based observer programme of WWF-Pakistan-a source of data collection on cetacean bycatch (Moazzam M)
IOTC-2019-WPEB15-INF10	Occurrence and Distribution of Leatherback Turtle (*Dermochelys coricea*) in the Coastal and Offshore waters of Pakistan (Moazzam M and Nawaz R)
IOTC-2019-WPEB15-INF11	Distribution and abundance of loggerhead turtles (*Caretta caretta L*.) from Pakistan (Moazzam M and Nawaz R)
IOTC-2019-WPEB15-INF12	The Distribution of Whales in the Northern Arabian Sea along the Coast of Pakistan Obtained through Crew-Based Observer Programme- Results of the 2018 fishing season Pakistan (Moazzam M and Nawaz R).
IOTC-2019-WPEB15-INF13	Towards mitigation of seabird bycatch in longline pelagic fisheries: do current mitigation measures have an effect? (Jimenez S, Domingo A, Winker H, Parker D, Gianuca D, Neves T, Coelho R and Kerwath S)
IOTC-2019-WPEB15-INF14	Important Marine Mammal Areas (IMMAs) in the Indian Ocean (di Sciara G, Hoyt E, Tetley M, Minton G, Martin J and Dulau V)
IOTC-2019-WPEB15-INF15	Collaboration between longline fisheries and a sea turtle care centre in Reunion Island (Barret M, Jean C, Dalleau M, Hoarau L and Ciccione S)
IOTC-2019-WPEB15-INF16	Bycatch and Ecosystem-based management in the Southeast United States (Porch C)
IOTC-2019-WPEB15-INF17	Important Marine Mammal Areas" Western and North East Indian Ocean, South East Asian Seas and Arabian Seas (IMMA team)

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

Extract from IOTC–2019–WPEB15–07

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

Data available on the total nominal catches of sharks in the Indian Ocean

The nominal catch data for all shark species are presented in Fig. 2 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 100 000 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.

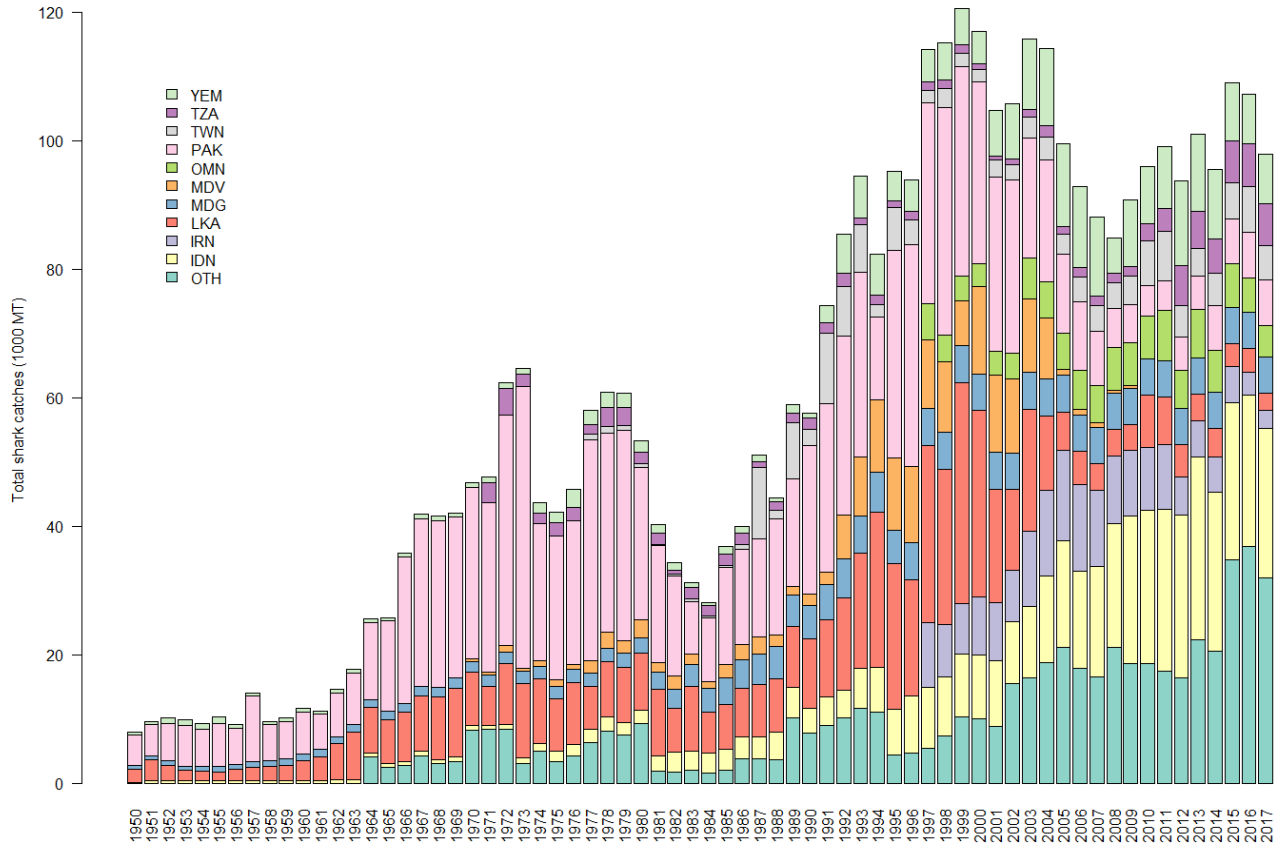


Fig. 1. Total reported nominal catches of sharks by fleet from 1950–2017

[YEM = Yemen, TZA = Tanzania, 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

Fig. 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 which have increased 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. Fig. 4 shows the main gear types used by fleets since 2000.

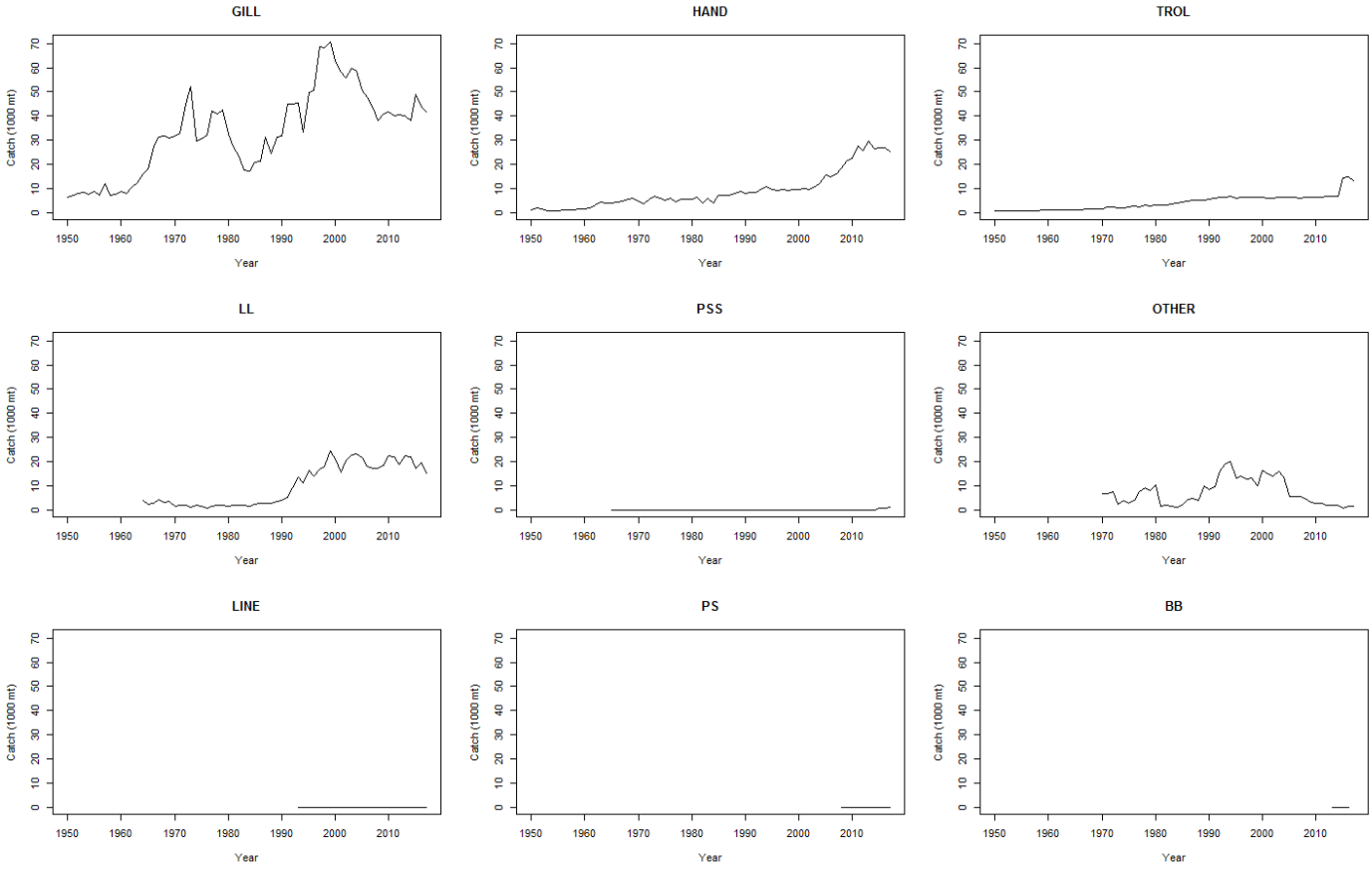


Fig 2. Nominal catches of sharks reported by gear type (1950–2017)

[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)]

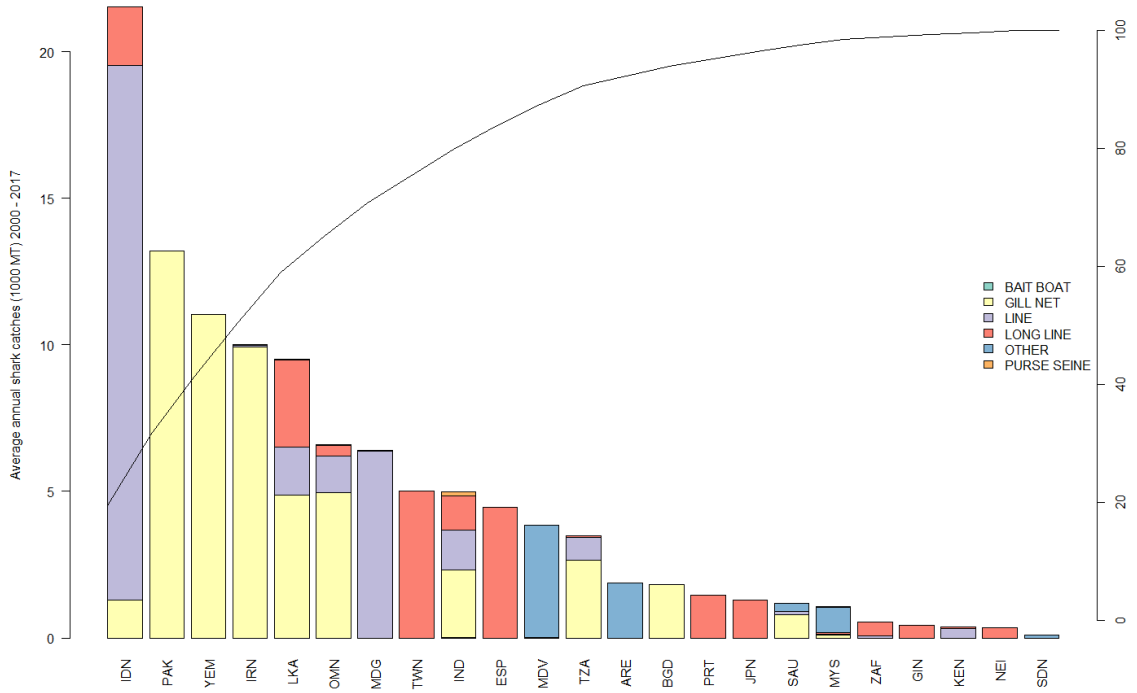
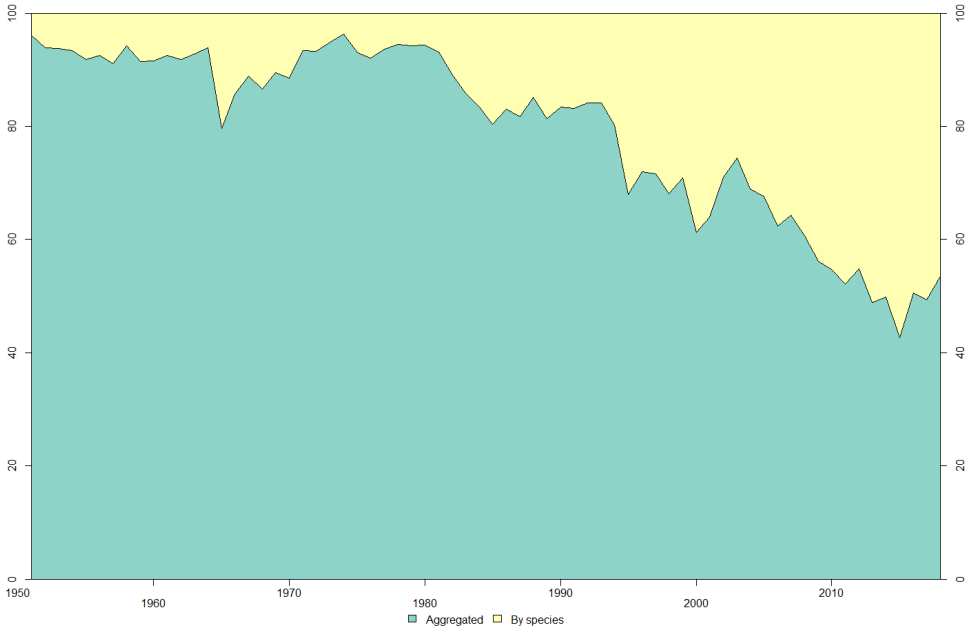


Fig. 3. Average annual shark catches by gear type groups and reporting country in recent years (2000-2017)

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, milk, threshers, hammerheads, makos, oceanic whitetip sharks and manta rays forming a smaller percentage (Fig. 5b).

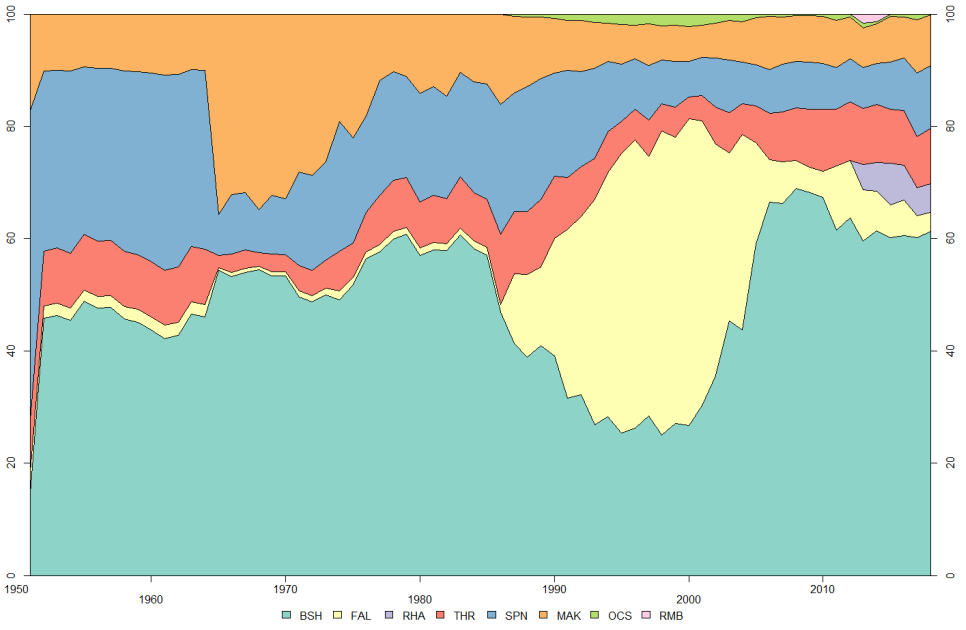
The increase in reporting by species is apparent in the species-specific catch series (**Error! Reference source not found.**a) with steadily increasing trends in reporting since the 1970s seen for blue sharks, thresher sharks, hammerhead sharks and mako sharks, all levelling off in recent years. The oceanic whitetip shark nominal catch series is 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. 4a. Proportion of shark catches reported as aggregated or by species

Fig. 5b. Proportion of nominal shark catches by species



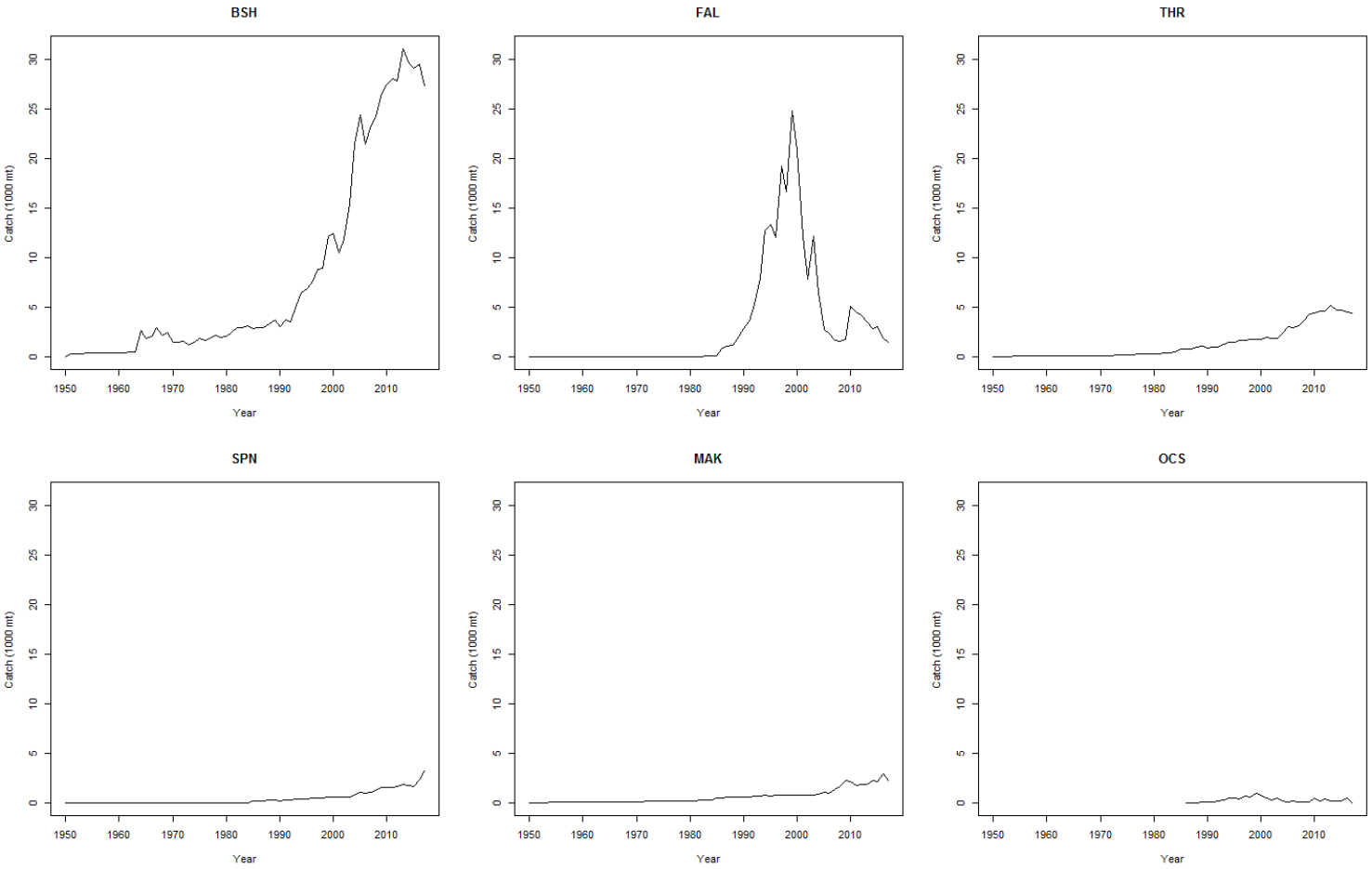


Fig. 6a. Total nominal catches by species for all fleets (1950-2017)

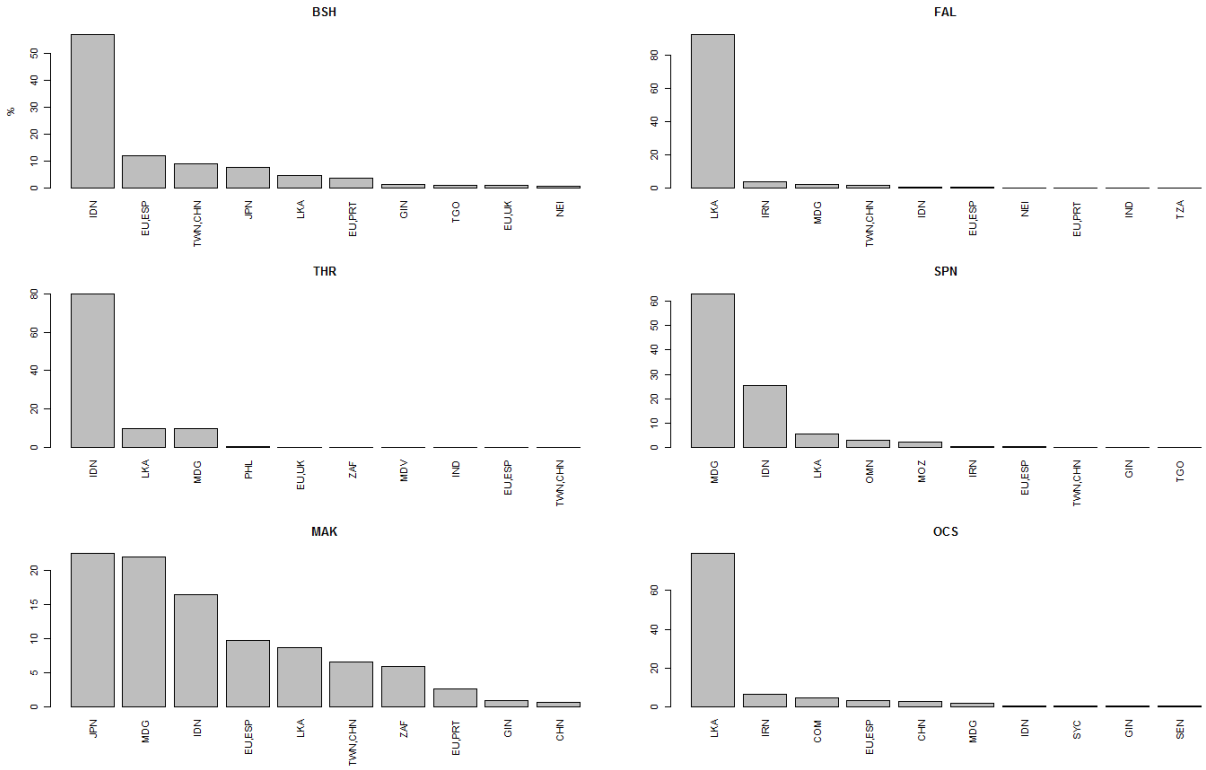


Fig. 7b. contribution of each fleet to the total data series

Trends in species catches by gear types are summarised in **Error! Reference source not found.**. 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 **Error! Reference source not found.** by the level of species-specific reporting, particularly 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[1]) and the gillnet fisheries of Pakistan, Yemen and I.R. Iran.

Table 3. Proportion of species-specific catches by gear type from 2005–2017

[PL = pole and line, GL = gillnet, HAND = Handline, LINE = Line, LL = Longline, PS = Purse seine, PSS = Small purse seines / ring nets, TROL = Troll lines]

	BB	GILL	HAND	LINE	LL	PS	PSS	TROL
OTH	**100%**	**89%**	14%	**98%**	21%	28%	**89%**	**70%**
BSH	0%	3%	**58%**	0%	**62%**	0%	2%	0%
FAL	0%	4%	0%	2%	5%	**72%**	6%	1%
RHA	0%	3%	0%	0%	0%	0%	0%	0%
THR	0%	0%	17%	0%	0%	0%	0%	3%
SPN	0%	1%	7%	0%	0%	0%	3%	20%
MAK	0%	0%	3%	0%	11%	0%	0%	6%

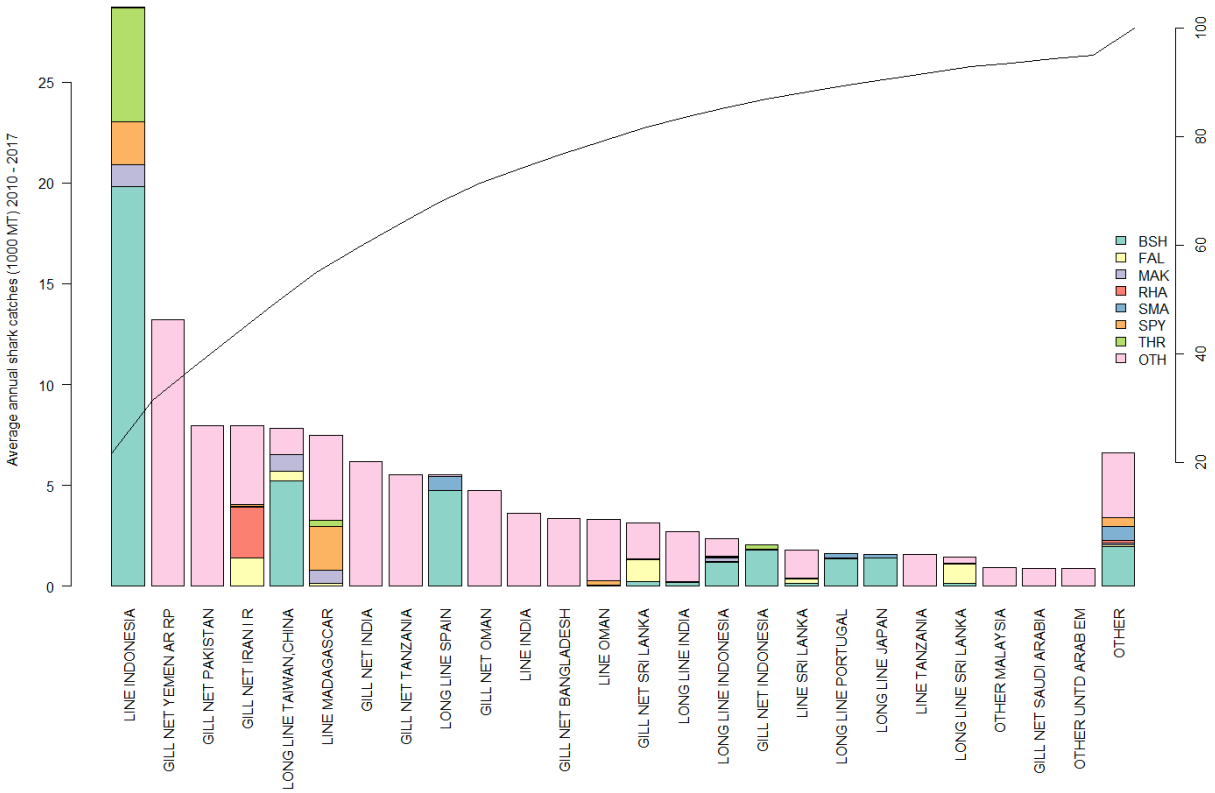


Fig. 8. Annual average shark catches reported by fleet and species from 2010–2017

[1] 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[2], 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:

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

- 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.
- 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.

Fig. 8 shows the catch rates of sharks as a proportion of total catches as reported in the IOTC database. This suggests that some of the reported catch rates for the longline fleet are lower than expected and highlights the patchiness of the data leading to highly variable catch rates over time.

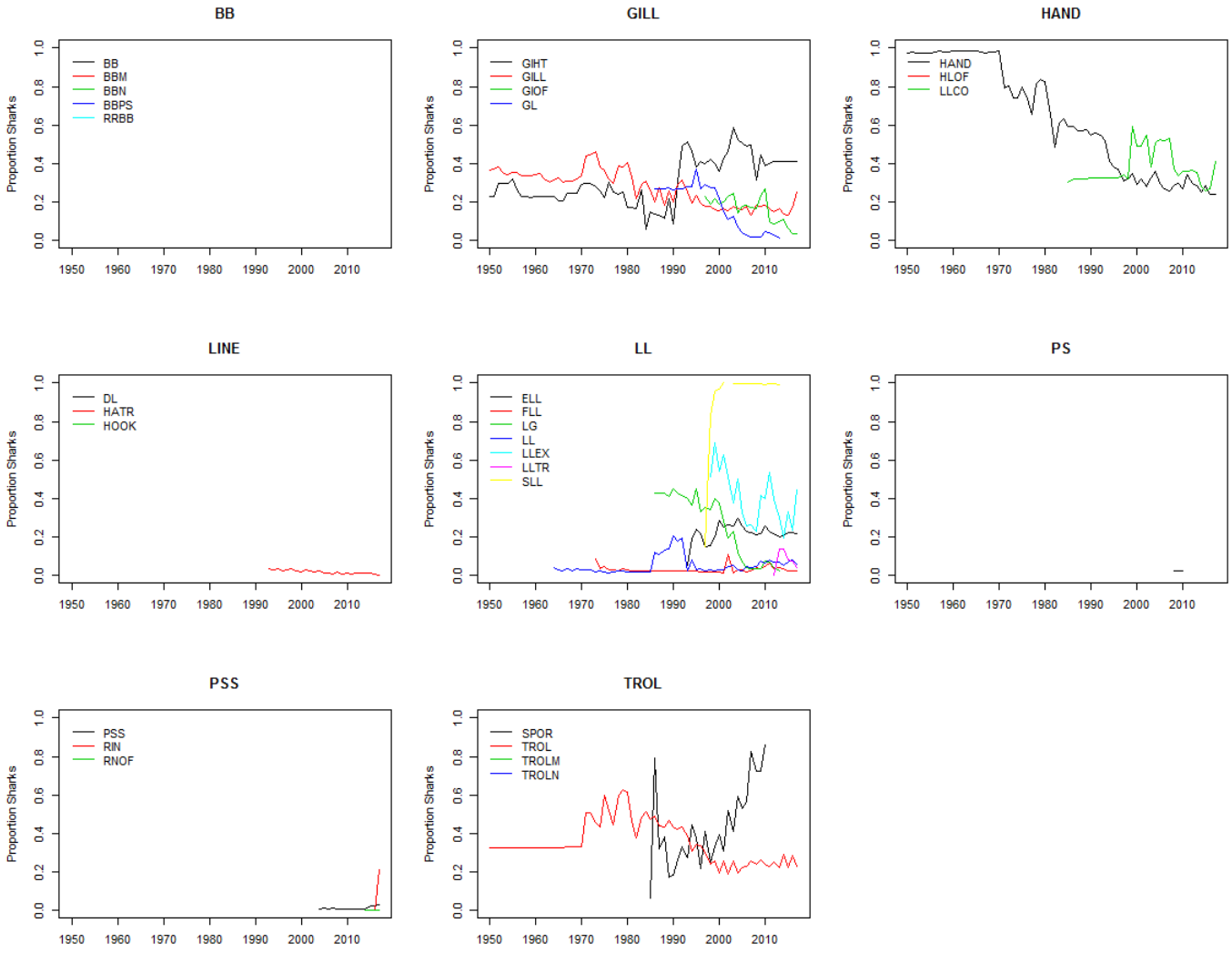


Fig. 9. Proportion of reported shark catch as a fraction of total reported catch by gear type over time

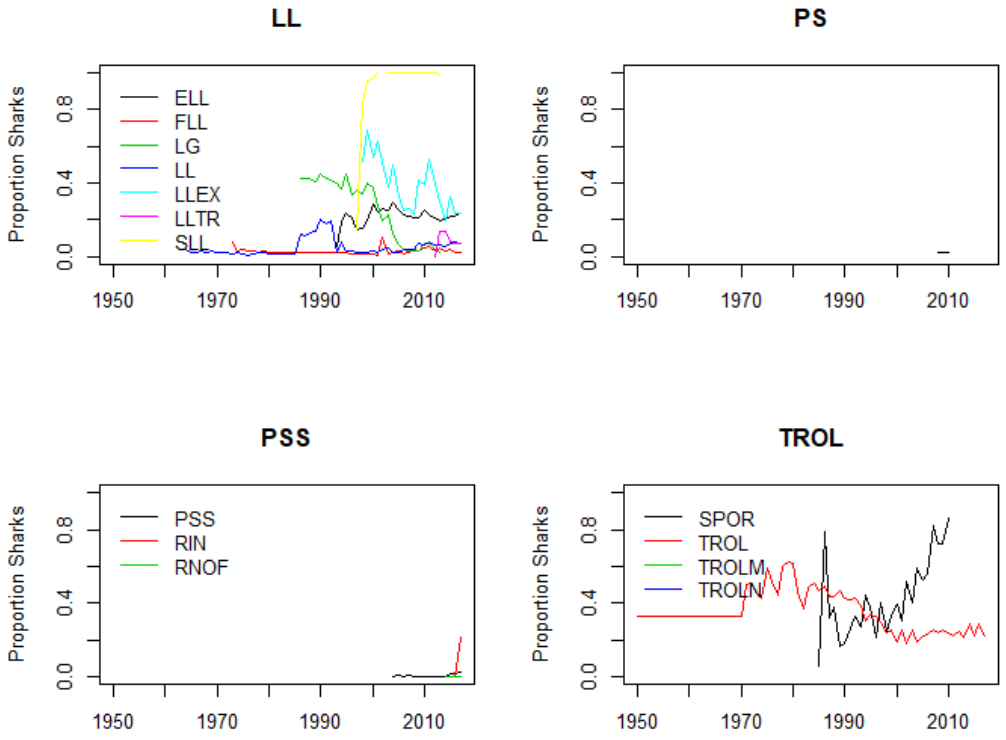


Fig. 10. Proportion of reported shark catch as a fraction of total reported catch by gear type over time

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. 11 shows the aggregated fork length frequency distribution for the fleets reporting size information on silky sharks for all areas between 2005 and 2017. The data reported for vessels flagged for China, Taiwan,China, EU,France, EU,Great Britain, EU,France (Reunion), Rep. of Korea include data reported for fleets with observers onboard. The results highlight the difference in size of the individuals caught by different fleets, with the Chinese, Indian and Sri Lankan fleets, on average, catching larger silky sharks than the other fleets – although the information currently available for all other fleets is particularly poor from a statistical point of view.

Fig. 15 shows the aggregated total length frequency distribution from three purse seine fleets (EU,Spain, EU,France and Seychelles) collected by scientific observers and reported as part of the ROS data submissions: the results highlight the difference in size of individuals caught by the Seychelloise fleet as compared to the two EU fleets.

Fig. 13 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.

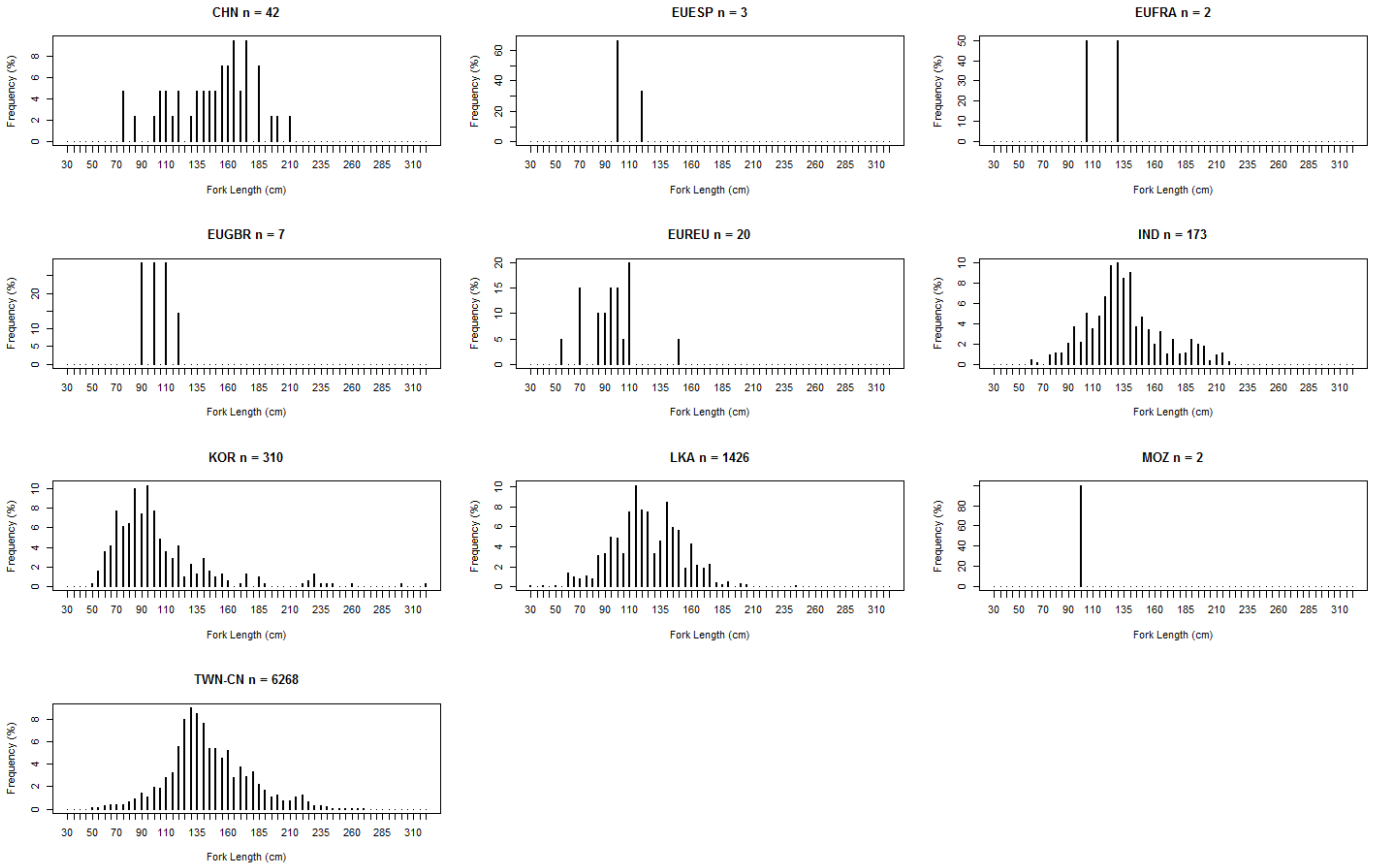


Fig. 11. Fork length frequency distributions (%) of silky shark derived from the samples reported for the fleets of China (CHN LL), EU,Spain (EUESP ELL), EU,France (EUFRA ELL), EU,Great Britain (EUGBR LL), EU,France (Reunion) (EUREU ELL), India (IND LLEX), Korea (KOR LL, PS), Sri Lanka LKA (FLL, G/L, GILL, GIOF, LLCO, RIN, RNOF, UNCL), Mozambique (MOZ ELL, HAND), Taiwan,China (TWN-CHN FLL, LL) between 2005 and 2017 in 5 cm length classes.

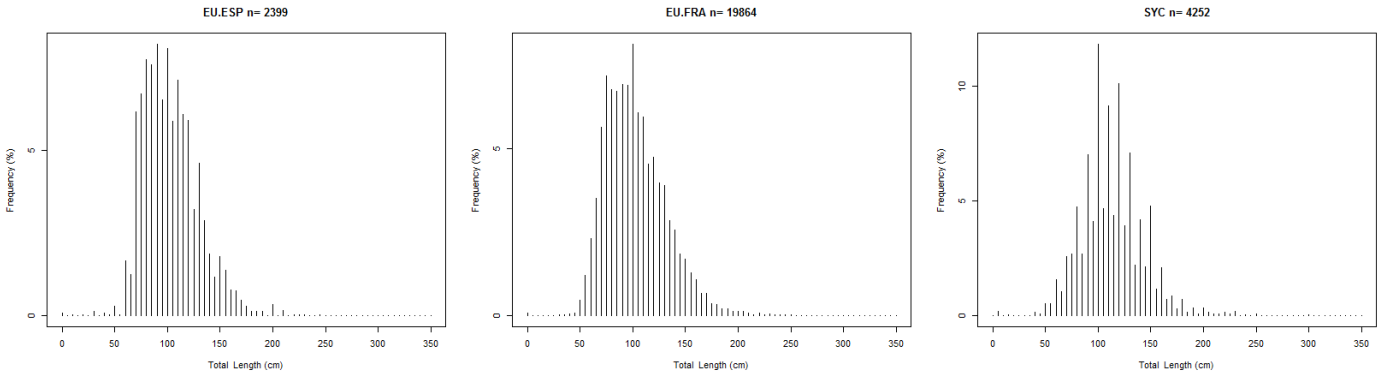


Fig. 12. Total length frequency distributions (%) of silky shark derived from the samples reported by onboard scientific observers (ROS data) for the purse seine fleets of EU,Spain, EU,France and Seychelles between 2005 and 2018 in 5 cm length classes.

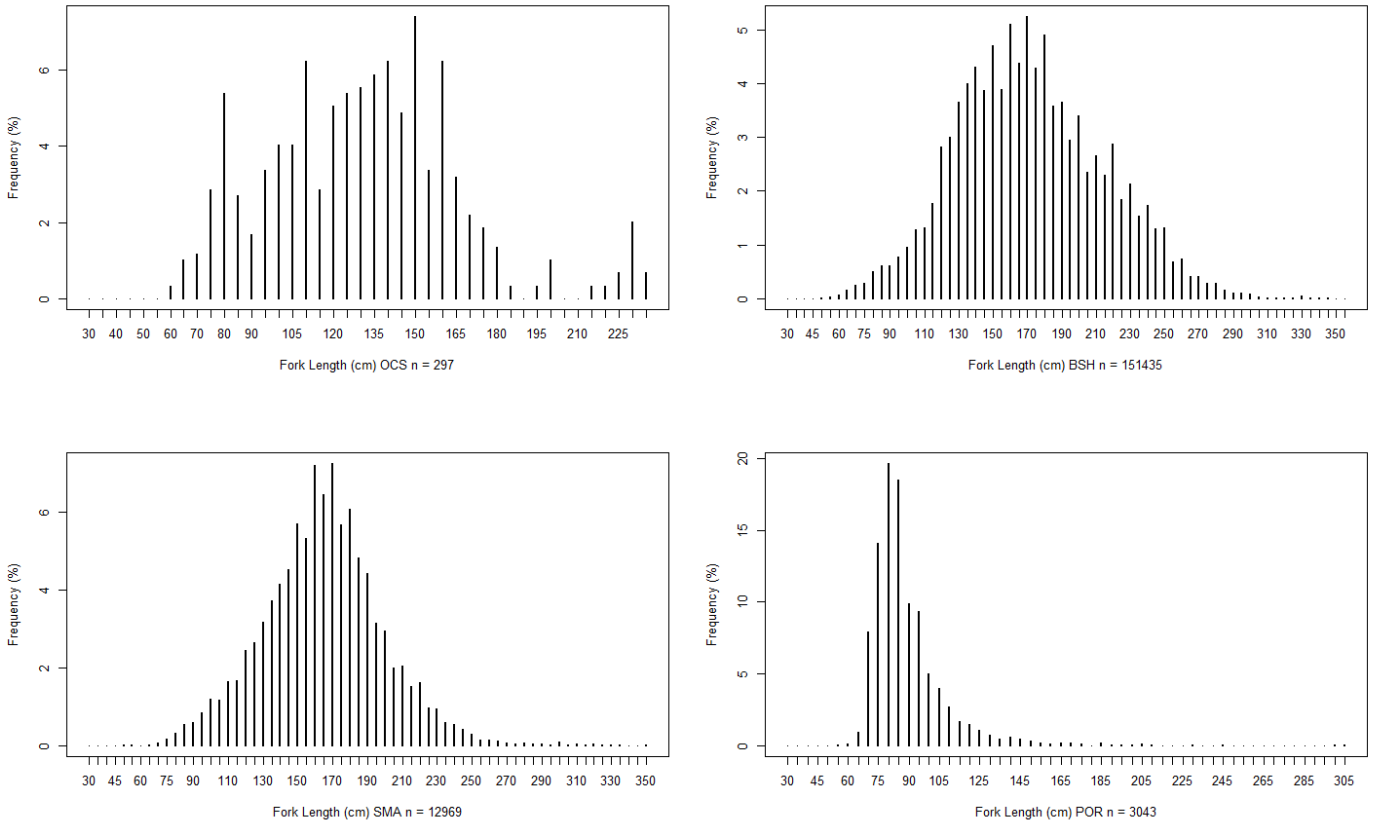


Fig. 13. Fork length frequency distributions (%) for oceanic whitetip shark (OCS), blue shark (BSH), shortfin mako shark (SMA) and porbeagle shark (POR) between 2005 and 2017.

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 4[3].

Table 4. 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 Threatened	*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.

[3] 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 and Taiwan,China, accounting for 13% and 62% of total effort in the area in 2017 (Figure). This summarises total reported effort, however, this is incomplete for some reporting fleets, i.e. for Malaysia, South Africa, Seychelles, Rep. of Korea and Taiwan,China 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).

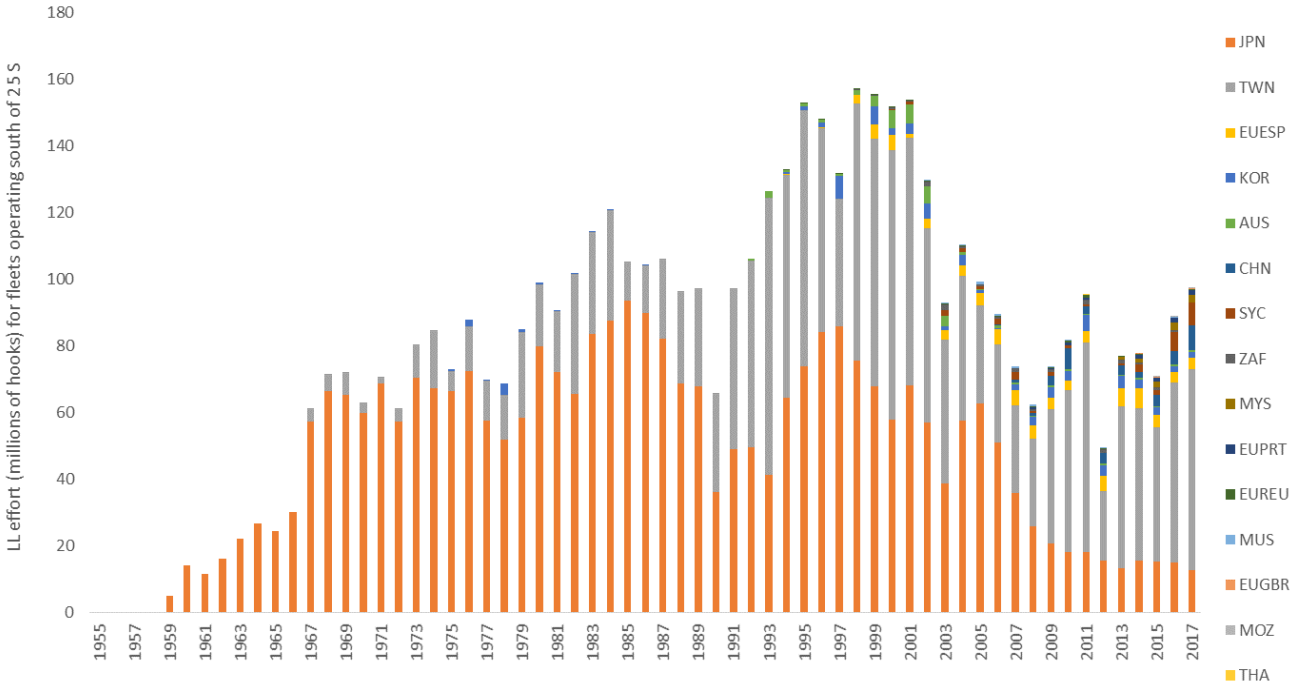


Figure 14. Reported longline effort for fleets operating south of 25° south between 1955 and 2017

[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]

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 which was reported to the SC.[4]

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. 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.

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 **.**

Table 6. Main species of Indian Ocean marine turtles[5].

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:

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

[4] IOTC-2016-SC19-INF02

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

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

Extract from IOTC–2019–WPEB15–07

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

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.

Catch-and-Effort data from gillnet fisheries:

- Driftnet fishery of Taiwan,China (1982–92): data not reported by IOTC standards (no species-specific catches).
- Gillnet fisheries of Pakistan: data not provided;
- Gillnet fisheries of I.R. Iran: spatially disaggregated CE data is now available from 2007 onwards, although not fully reported by IOTC standards (does not include catches by shark species, which are instead available as nominal catches during the same period);
- Gillnet fisheries of Oman: data not reported by IOTC standards.

Catch-and-Effort data from longline fisheries:

- Historical catches of sharks from major longline fisheries (Japan, Taiwan,China, Indonesia and Rep. of Korea): data not reported by IOTC standards for years before 2006 (no species-specific catches);
- Fresh-tuna longline fisheries (Indonesia, Malaysia): data not provided or not reported by IOTC standards;

- Deep-freezing longline fisheries (EU,Spain, India, Indonesia and Oman): data not provided or not reported by IOTC standards (for the periods during which these fisheries were known to be active).

Catch-and-Effort data from coastal fisheries:

- Coastal fisheries of India, Indonesia, Madagascar and Yemen: data not provided;
- Coastal fisheries of Oman: data not reported by IOTC standards.

Discard levels from surface and longline fisheries:

- Discard levels of sharks from major longline fisheries: to date the EU (Spain, UK), Japan and Taiwan,China, have not provided estimates of total discards of sharks, by species, although all are now reporting discards in their observer data.
- Discard levels of sharks for industrial purse seine fisheries: 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 and EU, Spain started reporting total discards for its PS fleet in 2018.

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: 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.

Biological data:

- 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: this situation could be potentially addressed in the medium term to long term with the steady increase in scientific observer data submissions according to ROS standards and requirements.

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, in combination with observer data reported in the context of the ROS programme, will considerably improve the quality of data obtained and the type of regional analyses that these data can be used for.

Incidental catches of SEABIRDS:

- Longline fisheries operating in areas with high densities of seabirds. Seychelles, Malaysia and Mauritius have not reported incidental catches of seabirds for longliners under their flag.

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

Extract from IOTC–2019–WPEB15–07

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

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[6] for which data on IOTC species are available, by fishery, species of shark, and year, for the period 1950–2017.

- 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 1950–2017 and 2010–2017 are shown in columns ***All*** and ***Last***, respectively.

[6] 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

Extract from IOTC–2019–WPEB15–08

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

(Updated September 2019)

CPCs		Vessels on active list (2018)					Accredited observers		Number of observer reports provided																				Totals
		LL	PS	GN	BB	Tot	Number	Last update	2010		2011		2012		2013		2014		2015		2016		2017		2018				
									O	E	O	E	O	E	O	E	O	E	O	E	O	E	O	E	O	E		
MEMBERS																													
Australia		4	6		1	11	21		2		1		3				2	4		11		28							51
China	CHN	85				85	5	2019-07	1				1		1		2		1		4		4		5				19
	TWN, CHN	286				286	54						1		19		18		26		18		20		5				107
Comoros						0	7		N/A		N/A		N/A		N/A		N/A		N/A		N/A		N/A		N/A				N/A
Eritrea		No information received																											0
European Union	FRA	18	12			30	64		6		12		17			89		94		109		106		119		110			662
	ITA					0			N/A		N/A		N/A		N/A		N/A		6		4				10				20
	PRT	5				5	5				1		1		1		1		1		1			1		1			8
	ESP	14	14			28	9								1		2			23		15		2	3				46
	GBR	2				2	1																	2					2
France (OT)						0	N/A	N/A			9		7		7		N/A		N/A		N/A		N/A		N/A				23
Guinea						0	N/A	N/A	N/A		N/A		N/A		N/A		N/A		N/A		N/A		N/A		N/A				N/A
India		4				4																							0
Indonesia		258	65			323	9											5				7							12
Iran, Isl. Rep. of			5	1215		1220																							0
Japan		45	2			47	19			8		11		10		6		14		12		9							70
Kenya		3				3	5				N/A		N/A		N/A		N/A		N/A			1							1
Korea, Rep. of		12	2			14	40		2				2		3		3		4		11		4						29
Madagascar		5				5	7						18		7		7		5										37
Malaysia		19				19																							0

CPCs	Vessels on active list (2018)					Accredited observers		Number of observer reports provided																				Totals
								2010		2011		2012		2013		2014		2015		2016		2017		2018				
	LL	PS	GN	BB	Tot	Number	Last update	O	E	O	E	O	E	O	E	O	E	O	E	O	E	O	E	O	E		
Maldives	33			358	391	4																	1		2		3
Mauritius	8	2			10	6	2019-04											5		8		4		9			26
Mozambique	2				2	11						1		N/A					7		3		2				13
Oman					0																			N/A			0
Pakistan					0																						0
Philippines					0													N/A		N/A		N/A		N/A			0
Seychelles	70	13			83	78										6		46		47	39	3	64				205
Sierra Leone	No information received																											0
Somalia	No information received																											0
South Africa	20			4	24	33	2019-08			12		10		13		10		16		5		8						74
Sri Lanka	30		1306		1336											2		2							2		6
Sudan	No information received																											0
Tanzania, United Rep.of					0															1		N/A		N/A			1
Thailand					0	18																		N/A			0
United Kingdom (OT)					0	N/A	N/A	N/A		N/A		N/A		N/A		N/A		N/A		N/A		N/A		N/A			N/A
Yemen	No information received																											0
COOPERATING NON-CONTRACTING PARTIES																												
Bangladesh					0	N/A	N/A	N/A		N/A		N/A		N/A		N/A		N/A		N/A		N/A		N/A			N/A
Liberia					0	N/A	N/A	N/A		N/A		N/A		N/A		N/A		N/A		N/A		N/A		N/A			N/A
Senegal					0	N/A	N/A	N/A		N/A		N/A		N/A		N/A		N/A		N/A		N/A		N/A			N/A
																											1410

Year = year in which the observed trip began (E: data reported in processable electronic format, O: data reported in non-processable format)
Reports from Madagascar include observers onboard foreign vessels
Reporting status for Japan and South Africa (2018) will be provided once observer data is available and in accordance to provisions from Resolution 18/10 (superseded by Resolution 19/07, yet to enter in force)

	Not applicable (N/A) or information not received
	Data provided according to standards
	Data only partially provided according to standards
	Data not provided

APPENDIX VIII

2018: 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 2019*)

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 NPOA in 2018.		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 developed in 2018, 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. 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.
Bangladesh							**Sharks:** No information received by the Secretariat. **Seabirds:** No information received by the Secretariat. **Marine turtles:** No information received by the Secretariat.
China		–		–			**Sharks:** China is currently considering developing an NPOA for sharks. **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.
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 Turtles but this does not fully conform with FAO guidelines. Indonesia has also 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 (Revised in 2016) **Seabirds:** NPOA–Seabird implementation report submitted to COFI in July 2012 (Revised in 2016). **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 2018. **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 recorded in logbooks. All longliners use circle hooks. This has been confirmed by onboard observers and port 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.

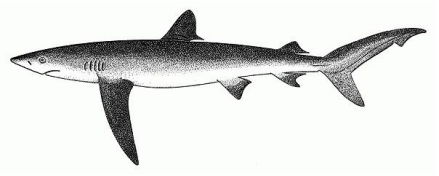
Mozambique		–		–			**Sharks**: Drafting of the NPOA-Shark started in 2016. At this stage, a baseline assessment was performed and the relevant information of coastal, pelagic and demersal shark species along the Mozambican coast was gathered. The ongoing process is expected to be completed by the end of 2018. **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 first approved and published in 2013. An update of the NPOA was provided in 2018. **Seabirds**: Published in August 2008 and fully implemented. The NPOA-seabirds has been earmarked for review. **Marine turtles**: The South African permit conditions for the large pelagic longline fishery prohibits landing of turtles. All interactions with turtles are recorded, by species, within logbooks and in observer reports, including data on release condition. Vessels are required to carry a de-hooker on board and instructions on turtle handling and release in line with the FAO guidelines are included in the South African Large Pelagic permit conditions. All turtle interactions in respective areas of competence are reported to the respective RFMOs. Recent South African led studies on impact of marine debris on turtles have been published in the scientific literature (Ryan et al. 2016). Marine turtle nesting sites in South Africa are protected by coastal MPAs since 1963.
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 been provided to the WPEB and SC for approval. **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							
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.

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	Indicators		2018 stock status determination
Indian Ocean	Reported catch 2017:	27,288 t	72.6%
	Estimated catch 2015:	54,735 t	
	Not elsewhere included (nei) sharks 2017:	52,487 t	
	Average reported catch 2013-17:	29,293 t	
	Average estimated catch 2011–15:	54,993 t	
	Ave. not elsewhere included (nei) sharks[2] 2012-16:	50,677 t	
	MSY (1,000 t) (80% CI)[3]:	33.0 (29.5 - 36.6)	
	F_{MSY} (80% CI) [3]:	0.30 (0.30 - 0.31)	
	SB_{MSY} (1,000 t) (80% CI) [3,4]:	39.7 (35.5 - 45.4)	
	F_{2015}/F_{MSY} (80% CI) [3]:	0.86 (0.67 - 1.09)	
	SB_{2015}/SB_{MSY} (80% CI) [3]:	1.54 (1.37 - 1.72)	
	SB_{2015}/SB_0 (80% CI) [3]:	0.52 (0.46 - 0.56)	

[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.
[4]Refers to fecund stock biomass

Colour key	Stock overfished ($SB_{2015}/SB_{MSY}< 1$)	Stock not overfished ($SB_{2015}/SB_{MSY}\geq 1$)
Stock subject to overfishing($F_{2015}/F_{MSY}> 1$)	0%	27.4%
Stock not subject to overfishing ($F_{2015}/F_{MSY}\leq 1$)	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	–	–

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, 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 2018 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 – they 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 was 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 catches are reduced at least 10%, the probability of maintaining stock biomass above MSY reference levels ($B>B_{MSY}$) over the next 8 years will be increased (Table 3). The stock should be closely monitored. While mechanisms exist for encouraging CPCs to comply with their recording and reporting requirements (Resolution 16/06), these need to be further implemented by the Commission, so as to better inform scientific advice in the future.

The following key points should also be noted:

- **Maximum Sustainable Yield (MSY)**: estimate for the Indian Ocean stock is 33,000 t.
- **Reference points**: The Commission has not adopted reference points or harvest control rules for any shark species.
- **Main fishing gear** (2013–17): Coastal longline; longline targeting swordfish; longline (deep-freezing).
- **Main fleets** (2013–17): Indonesia; EU,Spain; Taiwan, China; Japan; EU,Portugal.

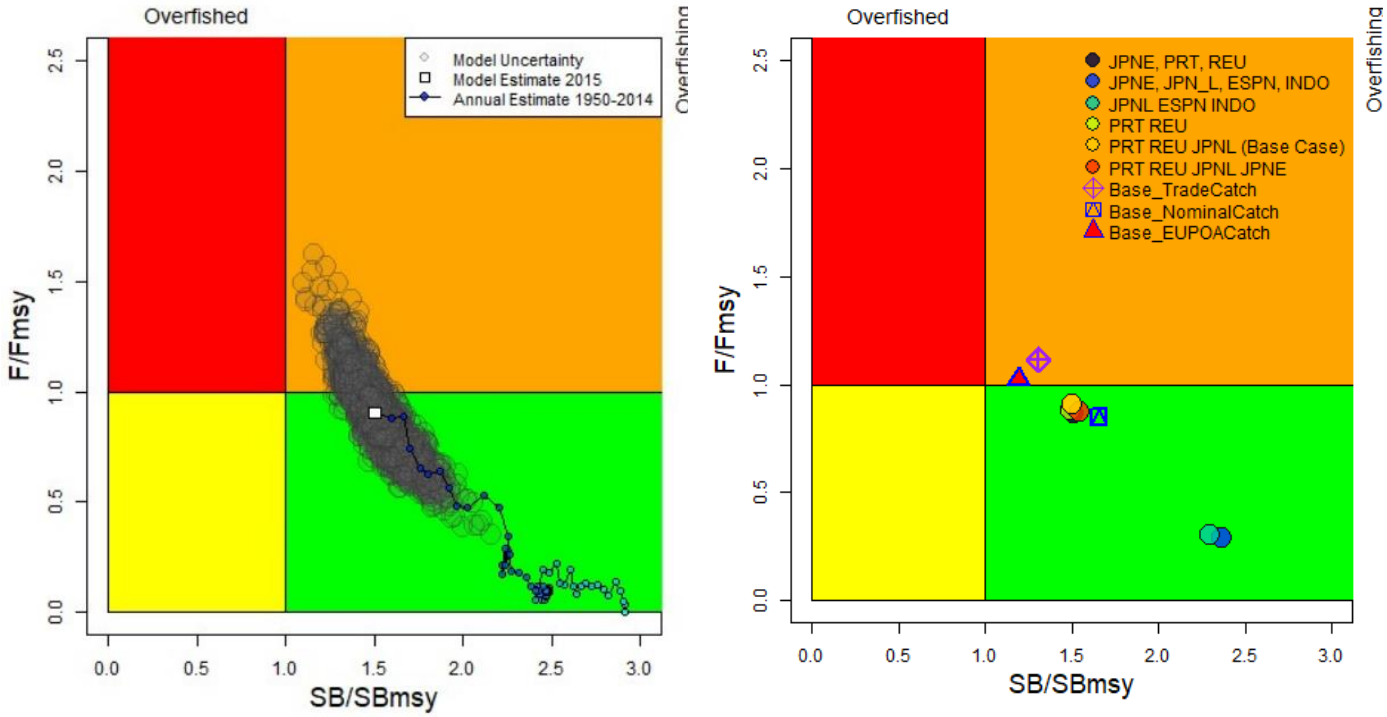


Fig. 1. Blue shark: Aggregated Indian Ocean stock assessment Kobe plot for the 2017 estimate based on the base case model and a range of sensitivity models explored with several catch reconstructions and fits to CPUE series.

(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.

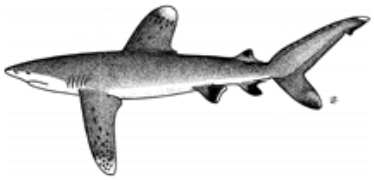
TABLE 3. Blue shark: Aggregated Indian Ocean assessment Kobe II Strategy Matrix. Probability (percentage) of violating the MSY-based reference points for nine constant catch projections using the base case model (catch level from 2015* (54,735t), ± 10%, ± 20%, ± 30% and ± 40%) projected for 3 and 10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

*: 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		2018 stock status determination
Indian Ocean	Reported catch 2017:	45 t	
	Not elsewhere included (nei) sharks[2] 2017:	52,487 t	
	Average reported catch 2013-17:	232 t	
	Av. not elsewhere included 2013-2017 (nei) sharks[2]:	50,678 t	
	MSY (1,000 t) (80% CI):	unknown	
	F_{MSY} (80% CI):		
	SB_{MSY} (1,000 t) (80% CI):		
	$F_{current}/F_{MSY}$ (80% CI):		
	$SB_{current}/SB_{MSY}$ (80% CI):		
	$SB_{current}/SB_0$ (80% CI):		

[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. 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

[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 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.

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 2018 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 medium vulnerability ranking (No. 9) in the ERA rank for longline gear because it was estimated as one of the least productive shark species, but was only characterised by a medium susceptibility to longline gear. Oceanic whitetip shark was estimated as being the 11th most vulnerable shark species to purse seine gear, as it was characterised as having a relatively low productive rate, and

medium susceptibility to the gear. 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 relatively few offspring (<20 pups every two years), the oceanic whitetip shark is likely vulnerable to overfishing. 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 with historic years (1986-1999). Available pelagic longline standardised CPUE indices from Japan and EU,Spain indicate conflicting trends as discussed in the IOTC Supporting Information 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 **unknown** (Table 1).

Outlook. Maintaining or increasing effort with associated fishing mortality can result in declines in biomass, productivity and CPUE. Piracy in the western Indian Ocean 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. Some longline vessels have returned to their traditional fishing areas in the northwest Indian Ocean, due to the increased security onboard vessels, with the exception of the Japanese fleet which has still not returned to the levels seen before the start of the piracy threat. It is therefore unlikely that catch and effort on oceanic whitetip sharks declined in the southern and eastern areas, and may have resulted in localised depletion there.

Management advice. A cautious 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. While mechanisms exist for encouraging CPCs to comply with their recording and reporting requirements (Resolution 18/07), these need to be further implemented by the Commission, so as to better inform scientific advice. 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. Given that some CPCs are still reporting oceanic whitetip shark as landed catch, there is a need to strengthen mechanisms to ensure CPCs comply with Resolution 13/06.

The following key points should be also noted:

- **Maximum Sustainable Yield (MSY)**: Not applicable. Retention prohibited.
- **Reference points**: Not applicable.
- **Main fishing gear** (2013-17): Gillnet; gillnet-longline.
- **Main fleets** (2013-2017): Comoros; I.R. Iran; Sri Lanka; India; and Maldives; (Reported as discarded/released alive by China, Maldives, Korea, France, Mauritius, Australia, South Africa, Sri Lanka, Japan).

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APPENDIX XI
EXECUTIVE SUMMARY: SCALLOPED HAMMERHEAD SHARK

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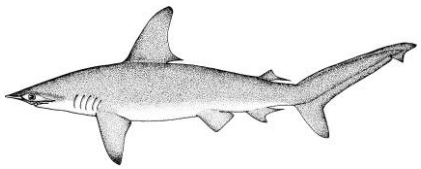

Status of the Indian Ocean Scalloped Hammerhead Shark (SPL: *Sphyrna lewini*)

CITES APPENDIX II species

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

Area[1]	Indicators		2018 stock status determination
Indian Ocean	Reported catch 2017:	118 t	
	Not elsewhere included (nei) sharks[2] 2017:	52,487 t	
	Average reported catch 2013-17:	76 t	
	Av. not elsewhere included (nei) sharks[2] 2013-2017:	50,678 t	
	MSY (1,000 t) (80% CI):	unknown	
	F_{MSY} (80% CI):		
	SB_{MSY} (1,000 t) (80% CI):		
	$F_{current}/F_{MSY}$ (80% CI):		
	$SB_{current}/SB_{MSY}$ (80% CI):		
	$SB_{current}/SB_0$ (80% CI):		

[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. 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 2018 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. 17) in the ERA rank for longline gear because it was estimated to be 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 twelfth 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 **unknown** (Table 1).

Outlook. Maintaining or increasing effort can result in declines in biomass and productivity. 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. Some longline vessels have returned to their traditional fishing areas in the northwest Indian Ocean, due to the increased security onboard vessels, with the exception of the Japanese fleet which has still not returned to the levels seen before the start of the piracy threat. It is therefore unlikely that catch and effort on scalloped hammerhead shark declined in the southern and eastern areas during this time period, and may have resulted in localised depletion there.

Management advice. Despite the absence of stock assessment information, the Commission should consider taking a cautious approach by implementing some management actions for scalloped hammerhead sharks. While mechanisms exist for encouraging CPCs to comply with their recording and reporting requirements (Resolution 18/07), these need to be further implemented by the Commission 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** (2013-2017): Ringnet, Gillnet, longline (fresh), longline-coastal.
- **Main fleets** (2013-17): Sri Lanka; Seychelles; NEI-Fresh (report as released alive/discarded by EU-France, South Africa, Indonesia, Japan).

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APPENDIX XII
EXECUTIVE SUMMARY: SHORTFIN MAKO SHARK

Indian Ocean Tuna Commission
Commission des Thons de l'Océan Indien
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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		2018 stock status determination
Indian Ocean	Reported catch 2017: Not elsewhere included (nei) sharks[2] 2017: Average reported catch 2013-17: Av. not elsewhere included (nei) sharks[2] 2013-17:	1,680 t 52,487t 1,601 t 50,678 t	
	MSY (1,000 t) (80% CI): F_{MSY} (80% CI): SB_{MSY} (1,000 t) (80% CI): $F_{current}/F_{MSY}$ (80% CI): $SB_{current}/SB_{MSY}$ (80% CI): $SB_{current}/SB_0$ (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*	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, 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 2018 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 has a high susceptibility to longline gear. Shortfin mako sharks were estimated to be the fourth most vulnerable shark species in the ERA ranking for purse seine gear, but had lower levels of vulnerability than to longline gear, because of the lower susceptibility of the species to 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 (see IOTC Supporting Information). 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 **unknown**.

Outlook. Maintaining or increasing effort can result in declines in biomass, productivity and CPUE. 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. Some longline vessels have returned to their traditional fishing areas in the northwest Indian Ocean, due to the increased security onboard vessels, with the exception of the Japanese fleet which has still not returned to the levels seen before the start of the piracy threat. It is therefore unlikely that catch and effort on shortfin mako shark has declined in the southern and eastern areas, and may have resulted in localised depletion there.

Management advice. Despite the absence of stock assessment information, the Commission should consider taking a cautious approach by implementing some management actions for shortfin mako sharks. While mechanisms exist for encouraging CPCs to comply with their recording and reporting requirements (Resolution 18/07), these need to be further implemented by the Commission 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** (2013-17): Longline targeting swordfish; longline (fresh); longline (targeting sharks); gillnet.
- **Main fleets** (2013-17): EU,Spain; South Africa; EU,Portugal; Japan, Iran, China, Sri Lanka, (Reported as discarded/released alive: Australia, EU-France, Indonesia, Japan, Korea, South Africa).

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APPENDIX XIII
EXECUTIVE SUMMARY: SILKY SHARK

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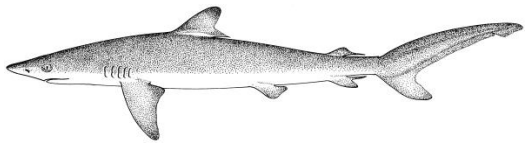

Status of the Indian Ocean silky shark (FAL: *Carcharhinus falciformis*)

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

Area[1]	Indicators		2018 stock status determination
Indian Ocean	Reported catch 2017: Not elsewhere included (nei) sharks[2] 2017: Average reported catch 2013-17: Av. not elsewhere included (nei) sharks[2] 2013-17:	1,491 t 52,487 t 2,577 t 50,678 t	
	MSY (1,000 t) (80% CI): F_{MSY} (80% CI): SB_{MSY} (1,000 t) (80% CI): $F_{current}/F_{MSY}$ (80% CI): $SB_{current}/SB_{MSY}$ (80% CI): $SB_{current}/SB_0$ (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. 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 2018 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. 2) in the ERA rank for longline gear because it was estimated to be one of the least productive shark species, and with a high susceptibility to longline gear. Silky shark was estimated to be the fifth most vulnerable shark species in the ERA ranking for purse seine gear, due to its low productivity and high susceptibility to purse seine gear. The current IUCN threat status of 'Near Threatened' applies to silky shark in the western and eastern Indian Ocean and globally (Table 2). There is a paucity of information available on this species but several studies have been

carried out for this species in the recent years. CPUE derived from longline fishery observations indicated a decrease from 2009 to 2011 with a stable pattern onward. A preliminary stock assessment was run in 2018 but could not be updated in 2019. This assessment is extremely uncertain, however, and so the population status of silky sharks in the Indian Ocean is considered uncertain. 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 are described in the IOTC Supporting Information 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 **unknown**.

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. Some longline vessels have returned to their traditional fishing areas in the northwest Indian Ocean, due to the increased security onboard vessels, with the exception of the Japanese fleet which has still not returned to the levels seen before the start of the piracy threat. It is therefore unlikely that catch and effort on silky shark has declined in the southern and eastern areas, and may have resulted in localised depletion there.

Management advice. Despite the absence of stock assessment information, the Commission should consider taking a cautious approach by implementing some management actions for silky sharks. While mechanisms exist for encouraging CPCs to comply with their recording and reporting requirements (Resolution 18/07), these need to be further implemented by the Commission 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** (2013-17): Gillnet; longline (fresh), longline-coastal, longline (deep-freezing)
- **Main fleets** (2013-17): Sri Lanka; I.R. Iran; Taiwan,China.

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APPENDIX XIV
EXECUTIVE SUMMARY: BIGEYE THRESHER SHARK

Indian Ocean Tuna Commission
Commission des Thons de l'Océan Indien
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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		2018 stock status determination
Indian Ocean	Reported catch 2017: Not elsewhere included (nei) sharks[2] 2017: Average reported catch 2013–17: Av. not elsewhere included (nei) sharks[2] 2013–17:	0 t 52,487 t 0 t 50,678 t	
	MSY (1,000 t) (80% CI): F_{MSY} (80% CI): SB_{MSY} (1,000 t) (80% CI): $F_{current}/F_{MSY}$ (80% CI): $SB_{current}/SB_{MSY}$ (80% CI): $SB_{current}/SB_0$ (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

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 2018 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. 4) in the ERA rank for longline gear because it was characterised as one of the least 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 to 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 has been no quantitative stock assessment and limited basic fishery indicators are available for bigeye thresher shark in the Indian Ocean. Therefore the stock status is **unknown**.

Outlook. Current longline fishing effort is directed at other species, however, bigeye thresher sharks are commonly taken as bycatch in these fisheries. Hooking mortality is apparently very high, therefore IOTC Resolution 12/09 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 and a reluctance of fishing fleets to report information on discards/non-retained catch. Piracy in the western Indian Ocean 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. Some longline vessels have returned to their traditional fishing areas in the northwest Indian Ocean, due to the increased security onboard vessels, with the exception of the Japanese fleet which has still not returned to the levels seen before the start of the piracy threat. It is therefore unlikely that catch and effort on bigeye thresher shark declined in the southern and eastern areas over that time period, potentially resulting in localised depletion.

Management advice. The prohibition on retention of bigeye thresher shark should be maintained. While mechanisms exist for encouraging CPCs to comply with their recording and reporting requirements (Resolution 18/07), these need to be further implemented by the Commission, so as to better inform scientific advice. 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[7].

The following key points should also be noted:

- **Maximum Sustainable Yield (MSY)**: Not applicable. Retention prohibited.
- **Reference points**: Not applicable.
- **Main fishing gear** (2013–17): ~~Gillnet-longline; longline-gillnet~~. No report after 2012. (reported as discard from gillnet and longline).
- **Main reporting fleets** (2013–17): ~~Sri Lanka~~ (reported as discarded/released alive: South Africa, Sri Lanka, Japan, Korea, EUFRA, Indonesia).

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[7] 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 Ecosystems and Bycatch).

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		2018 stock status determination
Indian Ocean	Reported catch 2017:	0 t	
	Not elsewhere included (nei) sharks[2] 2017:	52,487 t	
	Average reported catch 2013-17:	0 t	
	Av. not elsewhere included (nei) sharks[2] 2013-17:	50,678t	
	MSY (1,000 t) (80% CI):	unknown	
	F_{MSY} (80% CI):		
	SB_{MSY} (1,000 t) (80% CI):		
	$F_{current}/F_{MSY}$ (80% CI):		
	$SB_{current}/SB_{MSY}$ (80% CI):		
	$SB_{current}/SB_0$ (80% CI):		

[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. 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

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 (Table 1). The ecological risk assessment (ERA) conducted for the Indian Ocean by the WPEB and SC in 2018 consisted of a semi-quantitative analysis to evaluate the resilience of shark species to the impact of a given fishery, by combining the biological productivity of the species and susceptibility to each fishing gear type. Pelagic thresher shark received a medium vulnerability ranking (No. 12) in the ERA for longline gear because it was characterised as one of the least productive shark species, and with a medium susceptibility to longline gear. Due to its low productivity, pelagic thresher shark has a high vulnerability ranking (No. 2) to purse seine gear due to its high availability for this particular gear. The current 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 are currently available for pelagic thresher shark in the Indian Ocean. Therefore the stock status is **unknown.**

Outlook. Current longline fishing effort is directed at other species, however, pelagic thresher sharks are commonly taken as bycatch in these fisheries. Hooking mortality is apparently very high, therefore IOTC Resolution 12/09 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, and a reluctance of fishing fleets to report information on discards/non-retained catch. Piracy in the western Indian Ocean 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. Some longline vessels have returned to their traditional fishing areas in the northwest Indian Ocean, due to the increased security onboard vessels, with the exception of the Japanese fleet which has still not returned to the levels seen before the start of the piracy threat. It is therefore unlikely that catch and effort on pelagic thresher shark declined in the southern and eastern areas over that time period, potentially resulting in localised depletion there.

Management advice. The prohibition on the retention of pelagic thresher shark should be maintained. While mechanisms exist for encouraging CPCs to comply with their recording and reporting requirements (Resolution 18/07), these need to be further implemented by the Commission, so as to better inform scientific advice. 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[8].

The following key points should also be noted:

- **Maximum Sustainable Yield (MSY)**: Not applicable. Retention prohibited.
- **Reference points**: Not applicable.
- **Main fishing gear** (2013-17): ~~Gillnet-longline; longline-gillnet~~ .(reported as discard/ released from gillnet and longline).
- **Main fleets** (2013-17): Sri Lanka (reported as discarded/released alive: Japan, Korea, Sri Lanka, South Africa, Indonesia).

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[8]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 Ecosystems and Bycatch).

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[9]
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 Ecological Risk Assessment (ERA)[10] presented in 2018. Stock assessments of all species of marine turtles in the Indian Ocean are limited due to data insufficiencies as well as limited data quality[11]. 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 in the Indian Ocean[12]. Population levels of impacts of leatherback turtles caught in longline gear in the Southwest Indian Ocean were also identified as a conservation priority.

[9] IUCN, 2017. The process of the threat assessment from IUCN is independent from the IOTC and is presented for information purpose only
[10] A.J. Williams, L. Georgeson, R. Summerson, A. Hobday, J. Hartog, M. Fuller, Y. Swimmer, B. Wallace, and S.J. Nicol 2018 Assessment of the vulnerability of sea turtles to IOTC tuna fisheries. WPEB14-40.
[11] 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
[12] 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. So far, reporting of sea turtle interactions are not described at the species level. It is recommended that CPCs now declare interactions indicating the sea turtle species. Guides for species identification are available at http://iotc.org/science/species-identification-cards. 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 also be noted:

1. The available evidence indicates considerable risk to marine turtles in the Indian Ocean.
2. Given the high mortality rates associated with marine turtle interactions with gillnet fisheries and the increasing use of gillnets in the Indian Ocean[13] there is a need to both assess and mitigate impacts on threatened and endangered marine turtle populations.
3. 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.
4. Current reported interactions are known to be a severe underestimate.
5. The Ecological Risk Assessment[14] 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[7]. The ERA 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.
6. 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.
7. Efforts should be undertaken to encourage CPCs to investigate means to reduce marine turtle bycatch and mortality in IOTC fisheries.
8. That appropriate mechanisms are developed by the Compliance Committee to ensure CPCs comply with their data collection and reporting requirements for marine turtles.

[13] IOTC-2017-WPEB13-18

[14] R. Nel, R.M. Wanless, A. Angel, B. Mellet & L. Harris, 2013. Ecological Risk Assessment and Productivity -Susceptibility Analysis of sea turtles overlapping with fisheries in the IOTC regionIOTC–2013–WPEB09–23

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[15]
Albatross		
Atlantic Yellow-nosed Albatross	*Thalassarche chlororynchos*	Endangered
Black-browed albatross	*Thalassarche melanophris*	Least Concern
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*	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*	Endangered
Flesh-footed shearwater	*Puffinus carneipes*	Near Threatened

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

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

Africa), very high seabird incidental catches rates have been recorded in the absence of a suite of proven incidental catches mitigation measures.

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 choose 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 also 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
Delphinidae	Long-beaked common dolphin	*Delphinus capensis*	DD	GN
	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. The current[16] International Union for Conservation of Nature (IUCN) Red List status for each of the cetacean species reported in the IOTC Area of Competence is provided in Table 1. Information on their interactions with IOTC fisheries 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 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[17]. Many reports[18] 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[19], but should be further monitored.

[16] October 2017

[17] Anderson 2014

[18] e.g. IOTC-2013-WPEB07-37

[19] e.g. Escalle *et al.* 2015

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 in association with tuna fisheries in the IOTC Area of Competence. In this resolution, the IOTC have agreed 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 agreed 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 and that these will be reported to the IOTC Secretariat by 30 June of the following year. 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 clear for tuna gillnet fisheries from IOTC data) 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[20].
- 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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[20] Anderson 2014

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APPENDIX XIX
WORKING PARTY ON ECOSYSTEMS AND BYCATCH PROGRAM OF WORK (2020–2024)

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 topics for 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				
						2020	2021	2022	2023	2024
	Connectivity, movements, habitat use, and post-release (tagging activities)									
1. Connectivity, movements, and habitat use, including identification of hotspots and investigate associated environmental conditions	For rays and sharks (including whale shark) distribution (conventional and electronic tagging (PSAT))	High	2	AZTI, IRD, Others	Partially funded (for PTH, SMA) (153,000€ IOTC + 100.000€ EU/DCF) Funded for RHN (50,000€ EU/DCF) Further funding needed for other shark species and rays					

2. Post-release mortalities of by-catch species	Post-release mortality (electronic tagging), to assess the efficiency of management resolutions on no retention species ranked as the most vulnerable species to longline fisheries, and blue shark as the most frequent in catches, and for marine turtles and rays (especially for gillnet and PS fisheries)	High	1	IRD/ NRIFSF / AZTI / IPMA/ CITEB	Partially funded for BTH and OCS (IOTC + EU/DCF) TBD for SMA and PTH Funded for OCS and RHN (EU/DCF) TBD for marine turtles and rays					
	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.			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.								
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 (Workshops – leader?):	High	4						
	2.1.1 Capacity building of fisheries observers (including the provision of ID guides, training,			WWF-Pakistan/ ACAP (seabirds)	US$20,000 (ID guides)				

	etc. Fishing gear guides from SPC)									
	2.1.2 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			CPCs with assistance from secretariat	TBD					
	2.2 Implementation of the Pilot Project (Resolution 16/04) for the Regional Observer Scheme									
	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)				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				to be funded					
	2.3 Review the status of manta and mobula rays and their interaction with IOTC fisheries. Evaluation of data availability and data gaps. Include ID guide revision and translation. ID guides to be updated with help	High	5	Manta Trust MSc student with support required for attending WP	US$?? (TBD)					

	of CPC scientists (Daniel/manta trust)							
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))		US$?? (TBD)					
	3.1.1 CPCs to provide further research reports on shark biology, namely age and growth studies including through the use of vertebrae or other means, either from data collected through observer programs or other research programs. Research started in Sri Lanka. Could look at IOTC priority species	CPCs directly (led by Sri Lanka?)	US$?? (TBD)	OCS				

	3.3 Reproduction research Priority species: blue shark (BSH), shortfin mako shark (SMA) and oceanic whitetip shark (OCS), and silky shark (FAL))	CPCs directly	US$??(TBF)					
	3.4 Ecological Risk Assessment (sharks & rays)	AZTI	Funded (EU/DCF)					
	3.5 Close kin feasibility study for sharks	AZTI/CSIRO	TBD					
4. Shark bycatch mitigation measures	4.1 Develop studies on shark mitigation measures (operational, technological aspects and best practices)							
	4.1.1 Longline selectivity, to assess the effects of hooks styles, bait types and trace materials on shark catch rates, hooking-mortality, bite-offs and fishing yield (socio-economics)		US$?? (TBD)					
	4.1.2 Gillnet selectivity, to assess the effect of mesh size, hanging ratio and net twine on sharks and rays 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 and rays caught on longlines and gillnets fisheries							
	4.1.4 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	CPCs directly	US$?? (TBD)						
	5.1.1 Development of CPUE guidelines for standardisation of CPC data.	TBD	TBD						
	5.1.2 Blue shark: Priority fleets: TWN,CHN LL, EU,Spain LL, Japan LL; Indonesia LL; EU,Portugal LL	CPCs directly							
	5.1.3 Shortfin mako shark: Priority fleets: Longline and Gillnet fleets	CPCs directly							
	5.1.4 Oceanic whitetip shark: Priority fleets: Longline fleets; purse seine fleets	CPCs directly							
	5.1.5 Silky shark: Priority fleets: Purse seine fleets	CPCs directly							
	5.2 Joint CPUE standardization across the main LL fleets for SLK?, using detailed operational data	Consult.	30,000 €						
	5.3 Stock assessment and other indicators								
	MARINE TURTLES								
6. Marine turtle bycatch mitigation measures	6.1 Review of bycatch mitigation measures								
	6.1.1 Res. 12/04 (para. 11) Part I. The IOTC Scientific Committee shall request the IOTC Working Party on Ecosystems and Bycatch to:	CPCs directly	US$??						

	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	CPCs directly					
	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,	CPCs directly						

	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.							
	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 Regional workshop to review the effectiveness of marine turtle mitigation measures (Recommendation SC20.23)		TBD					
	SEABIRDS							

7. Seabird bycatch mitigation measures	7.1 Review of bycatch mitigation measures							
	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$?? (TBD)					
	7.1.2 Bycatch assessment for seabirds taking into account the information from the various ongoing initiatives in the IO and adjacent oceans	ACAP, Birdlife						
	7.1.3 Study on cryptic mortality of seabirds in tuna LL fisheries.							
	7.1.4 Post release survival rates for seabirds and review of safe release techniques.	CPCs/ACAP						
	CETACEANS							
8.Bycatch assessment and mitigation	8.1 Review and development of cetacean bycatch mitigation measures	Liaise with IWC						
	8.1.1 Collate all data available on bycatch of key species interacting with all tuna fisheries	Consultancy/CPCs/Other organisations	U.S.$??					

	in the IOTC area (tuna drift gillnets, longlines, purse seines)							
	8.1.3 Conduct an ecological risk assessment for cetaceans in the IOTC area	CPCs directly						
	8.1.4 Collaborate with other organisations on the assessment of marine mammal abundance and collect data on marine mammal bycatch interactions with gillnets across the IOTC region	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							
	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:					
	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 Approach to Fisheries (EAF) approaches in the IOTC, in	WPEB	US$?? (TBD)					

	conjunction with the Common Oceans Tuna Project.									
	10.1.2 Workshop for CPCs on continuing efforts to the development of an EAF including delineation of candidate eco regions within IOTC.	High	3	Workshop (2020)	TBD					
	10.1.3 Practical Implementation of EBFM with the development and testing of ecosystem report cards.									
	10.1.4 Evaluation of EBFM plan in IOTC area of competence by the WPEB to review its elements components and make any corrective measures.									
	10.2 Assessing the impacts of climate change and socio-economic factors on IOTC fisheries			CPCs (possible end to end models)	TBD					
	10.3 Evaluate alternative approaches to ERAs to assess ecological risk			Australia (contact to be made)	TBD					

Table 2. Draft: Assessment schedule for the IOTC Working Party on Ecosystems and Bycatch 2020–2024 (adapted from IOTC–2018–SC21–R).

Working Party on Ecosystems and Bycatch					
Species	**2020**	**2021**	**2022**	**2023**	**2024**
Blue shark	Data preparation	Full assessment	-	–	–
Oceanic whitetip shark	Indicator analysis	–	-	–	Data preparation
Scalloped hammerhead shark	–	–	Assessment*	–	–
Shortfin mako shark	Full assessment	–	–	Data preparation	Full assessment
Silky shark	-	Assessment*;	-	–	Assessment*;
Bigeye thresher shark	–	–	–	Assessment*	–
Pelagic thresher shark	–	–	–	Assessment*	–
Porbeagle shark	–	–	–	Assessment*	–
Mobulid rays	Interactions/Indicators				Interactions/Indicators
Marine turtles	Review of mitigation measures in Res. 12/04	–	–	Indicators	–

Seabirds	–	–	Review of mitigation measures in Res. 12/06	–	–
Marine Mammals	–	ERA	–	–	–
Ecosystem Based Fisheries Management (EBFM) approaches	ongoing	ongoing	ongoing	ongoing	ongoing

*Method to be determined; Note: the assessment schedule may be changed dependent on the annual review of fishery indicators, or SC and Commission requests.

NOTE: (i) the "indicator analysis" is a simple analysis to provide guidance on the stock status based on fishery data such as CPUE, catch, and size frequency data ;(ii) the "full stock assessment" is an assessment to provide the stock status and fishing pressure based on a stock assessment model such as stock synthesis or production model; (iii) the "data preparatory" is a the submission and review by the WP of the fishery data as well as biological parameters for the upcoming stock assessment.

APPENDIX XX
CONSOLIDATED RECOMMENDATIONS OF THE 15TH SESSION OF THE WORKING PARTY ON ECOSYSTEMS AND BYCATCH

Note: Appendix references refer to the Report of the 15th Session of the Working Party on Ecosystems and Bycatch (IOTC–2019–WPEB15–R)

Conservation and Management Measures

WPEB15.01 (para 14): The WPEB **RECOMMENDED** that several initiatives be implemented to address this problem, including: (i) holding regional workshops to improve shark species identification, shark data sampling and collection (fisheries and biological) and IOTC data reporting requirements; (ii) data mining to fill historical data gaps; (iii) develop alternative tools to improve species identification (genetic analyses, machine learning, and artificial intelligence).

Revision of the WPEB Program of Work 2020–2024

WPEB15.02 (para 221): The WPEB **RECOMMENDED** that the SC consider and endorse the WPEB Program of Work (2020–2024), as provided in Appendix XIX

Review of the draft, and adoption of the Report of the 15th Session of the Working Party on Ecosystems and Bycatch

WPEB 15.03 (para 232): The WPEB **RECOMMENDED** that the Scientific Committee consider the consolidated set of recommendations arising from WPEB15 provided at Appendix XX, 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

APPENDIX XXI
COLLABORATORS FOR ADVANCING THE DEVELOPMENT OF AN ECOSYSTEM REPORT CARD AT IOTC

ECOSYSTEM COMPONENTS TO REPORT	COLLABORATORS *tentative team leader bolded
Retained fish species (including only assessed species)	**Maria Jose Juan Jordá** Hilario Murua Henning Winker Zhe Geng Francis Marsac Eider Andonegi
Retained fish species (including not assessed species)	Maria Jose Juan Jordá Pascal Bach Philippe Sabarros Mariana Tolotti **Umair Shahid** Zhe Geng Sandamali Herath Eider Andonegi
Non-retained sharks and rays	**Mariana Tolotti** Rui Coelho Pascal Bach Philippe Sabarros Umair Shahid Zhe Geng Sandamali Herath Daniel Fernando Jon Ruiz Maitane Grande Hilario Murua Francisco Abascal Jose Carlos Baez Pedro Pascual Maria Lourdes Ramos
Sea turtles	Umair Shahid **Jana Yonat Swimmer** Mayeul Dalleau Muhammad Khan Jose Carlos Baez
Seabirds	**Anton Wolfaardt** Daisuke Ochi Stephani Prince Cleo Small
Marine mammals	**Jeremy Kiszka** Muhammad Khan
Foodweb and trophic relationships	**Eider Andonegi** Maria José Juan Jordá Philippe Sabarros Pascal Bach Jon Ruiz Maria Lourdes Ramos Muhammad Khan Reza Shahifar Jeremy Kiszka

	Evgeny Romanov Francisco Abascal
Habitats of ecological significance	Maria José Juan Jordá Muhammad Khan Reza Shahifar Francis Marsac Maitane Grande Iker Zudaire Pascal Thoya
Fishing pressure	**Reza Shahifar** Maria Jose Juan Jorda Pascal Thoya Hilario Murua Mohammed Koya Sandamali Herath Umair Shahid Eider Andonegi Jose Carlos Baez
Marine debris	**Iker Zudaire** Maitane Grande Hilario Murua Muhammad Khan Irene Ruiz Oihane Cabezas
Ocean climate and environment	**Francis Marsac** Reza Shahifar