Report of the 16th Session of the IOTC Working Party on Ecosystems and Bycatch

Microsoft Teams Online, 7 - 10 September 2020

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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)
CMS	Convention on Conservation of Migratory Species of Wild Animals
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
ETP	Endangered, Threatened and Protected Species
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
IWC	International Whaling Commission
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
SMA	Shortfin mako shark
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
WWF	World Wildlife Fund

KEY DEFINITIONS

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

STANDARDISATION OF IOTC WORKING PARTY AND SCIENTIFIC COMMITTEE REPORT TERMINOLOGY

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

HOW TO INTERPRET TERMINOLOGY CONTAINED IN THIS REPORT

Level 1: From a subsidiary body of the Commission to the next level in the structure of the Commission:

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

Level 2: From a subsidiary body of the Commission to a CPC, the IOTC Secretariat, or other body (not the Commission) to carry out a specified task:

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

Level 3: General terms to be used for consistency:

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

NOTED/NOTING: Any point of discussion from a meeting which the IOTC body considers to be important enough to record in a meeting report for future reference.

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

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Executive summary

The 16th Session of the Indian Ocean Tuna Commission's (IOTC) Working Party on Ecosystems and Bycatch (WPEB) was held on Microsoft Teams Online from 7 - 10 September 2020. A total of 108 participants (41 in 2019, 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 16th Session of the IOTC Working Party on Ecosystems and Bycatch (WPEB16). Adoption of the Agenda and arrangements for the Session.

The following are the complete recommendations from the WPEB16 to the Scientific Committee which are also provided at Appendix XX:

Marine Mammals

WPEB16.01 (para 1544): The WPEB **RECOMMENDED** that an intersessional meeting of a subgroup of cetacean bycatch specialists and other interested scientists continue work on these issues prior to the next WPEB meeting.

Revision of the WPEB Program of Work 2021–2025

WPEB16.02 (para 1588): The WPEB **RECOMMENDED** that the SC consider and endorse the WPEB Program of Work (2021–2025), as provided in Appendix XIX

Review of the draft, and adoption of the Report of the 16th Session of the Working Party on Ecosystems and Bycatch

WPEB 16.03 (para 1622): The WPEB **RECOMMENDED** that the Scientific Committee consider the consolidated set of recommendations arising from WPEB16 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		2015	2016	2017	2018	2019	2020	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 2018: Estimated catch 2015: Not elsewhere included (nei) sharks 2018: Average reported catch 2014–18: Average estimated catch 2011–15: Ave. (nei) sharks[2] 2012–16:	22,385t 54,735 t 19,768 t 27,566 t 54,993 t 50,677 t			**72.6%**	**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
	MSY (1,000 t) (80% CI): F_{MSY} (80% CI): SSB_{MSY} (1,000 t) (80% CI): F_{2015}/F_{MSY} (80% CI): SSB_{2015}/SSB_{MSY} (80% CI): SSB_{2015}/SSB_0 (80% CI):	33.0 (29.5 - 36.6) 0.30 (0.30 - 0.31) 39.7 (35.5 - 45.4) 0.86 (0.67 - 1.09) 1.54 (1.37 - 1.72) 0.52 (0.46 - 0.56)							
Oceanic whitetip shark *Carcharhinus longimanus*	Reported catch 2018: Not elsewhere included (nei) sharks: Average reported catch 2014–2018: Not elsewhere included (nei) sharks 2014-2018:	35 t 19,768 t 201 t 38,511 t							
Scalloped hammerhead shark *Sphyrna lewini*	Reported catch 2018: Not elsewhere included (nei) sharks: Average reported catch 2014–2018: Not elsewhere included (nei) sharks 2014-2018:	45 t 19,768 t 62 t 38,511 t							

Shortfin mako *Isurus oxyrinchus*	Reported catch 2018: 1,499 t Not elsewhere included (nei) sharks: 19,768 t Average reported catch 2014–2018: 1,582 t Not elsewhere included (nei) sharks 2014-2018: 38,511 t							There is a paucity of information available for these species and this situation is not expected to improve in the short to medium term. There is no quantitative stock assessment and limited basic fishery indicators currently available. Therefore the stock status is highly uncertain. The available evidence indicates considerable risk to the stock status at current effort levels. The primary source of data that drive the assessment (total catches) is highly uncertain and should be investigated further as a priority. Click below for a full stock status summary: • Oceanic whitetip sharks – Appendix X • Scalloped hammerhead sharks – Appendix XI • Shortfin mako sharks – Appendix XII • Silky sharks – Appendix XIII • Bigeye thresher sharks – Appendix XIV • Pelagic thresher sharks – Appendix XV
Silky shark *Carcharhinus falciformis*	Reported catch 2018: 1,815 t Not elsewhere included (nei) sharks: 19,768 t Average reported catch 2014–2018: 2,442 t Not elsewhere included (nei) sharks 2014-2018: 38,511 t							
Bigeye thresher shark *Alopias superciliosus*	Reported catch 2018: 2 t Not elsewhere included (nei) sharks: 19,768 t Average reported catch 2014–2018: 1 t Not elsewhere included (nei) sharks 2014-2018: 38,511 t							
Pelagic thresher shark *Alopias pelagicus*	Reported catch 2018: 401 t Not elsewhere included (nei) sharks: 19,768 t Average reported catch 2014–2018: 348 t Not elsewhere included (nei) sharks 2014-2018: 38,511t							

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 16th Session of the Indian Ocean Tuna Commission's (IOTC) Working Party on Ecosystems and Bycatch (WPEB) was held Online on Microsoft Teams from 7 - 10 September 2020. A total of 108 participants (41 in 2019, 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 16th Session of the IOTC Working Party on Ecosystems and Bycatch (WPEB16). 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, requests, and research priorities to be made during each of the IOTC working party meetings to ensure they are more achievable.

3.1 Outcomes of the 22nd Session of the Scientific Committee

4. The WPEB **NOTED** paper IOTC–2020–WPEB16–03 which outlined the main outcomes of the 22nd Session of the Scientific Committee (SC22) specifically related to the work of the WPEB and **AGREED** to consider how best to progress these issues at the present meeting.

5. The WPEB **NOTED** that the SC had endorsed the advice of the WPEB in 2019 regarding the need to improve data collection and reporting for shark species and that the SC recommended that several initiatives be implemented, 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) developing alternative tools to improve species identification (e.g. genetic analyses, machine learning, and artificial intelligence).

3.2 Progress on the recommendations of WPEB15

6. The WPEB **NOTED** paper IOTC–2020–WPEB16–06 which provided an update on the progress made in implementing the recommendations from the previous WPEB meeting WPEB15 which were endorsed by the Scientific Committee at meeting SC22.

7. The WPEB **NOTED** that good progress had been made on these Recommendations. The WPEB participants were **ENCOURAGED** to review IOTC-2020-WPEB16-06 during the meeting and report back on any progress in relation to requests or actions by CPCs that have not been captured by the report, and to note any pending actions for attention before the next meeting (WPEB17).

3.3 Outcomes of the 23rd Session of the Commission

8. The WPEB **NOTED** paper IOTC–2020–WPEB16–04 which outlined the main outcomes of the 23rd Session of the Commission, specifically related to the work of the WPEB. The WPEB **NOTED** that this document has not been updated since 2019 due to the delay in the S24 meeting as a result of the CoVid-19 pandemic.

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

9. The WPEB **NOTED** paper IOTC–2020–WPEB16–05 which aimed to encourage participants to review some of the existing Conservation and Management Measures (CMM) relevant to ecosystems and bycatch. The WPEB **NOTED** that this document has not been updated since 2019 due to the delay in the S24 meeting as a result of the CoVid-19 pandemic.

4. Review of data available on ecosystems and bycatch

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

10. The WPEB **NOTED** paper IOTC–2020–WPEB16–07 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 1950–2018. A summary for sharks is provided in Appendix IV.

11. The WPEB **RECALLED** again the definition of "bycatch species" as currently adopted by the IOTC, i.e. all species other than the 16 IOTC species, regardless of their being the target of some specific fisheries or being incidentally caught.

12. The WPEB **NOTED** a decrease in the proportion of reported shark catches that have not been identified to species level (~30% in 2018 when compared to ~50% in 2017) and the issues this still poses when using species-specific catch series for assessments.

13. 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 this has an impact on the ability of this group to undertake its work, and **REQUESTED** the IOTC Compliance Committee to take this into due consideration.

14. **NOTING** a sudden drop in total retained shark catches between 2017 (92,892 Mt) and 2018 (64,072 Mt) the WPEB **ACKNOWLEDGED** that this could be explained by issues in reporting by several fleets and fisheries that contributed significant catches of sharks in 2017, rather than by an actual decrease in overall captures.

15. For this reason, the WPEB **ENCOURAGED** all concerned CPCs (India, Indonesia and Mozambique in particular) to liaise with the IOTC Secretariat and to further investigate the nature and cause of this recent reduction in reported shark catches.

16. The WPEB **NOTED** that the revised catch series from the Pakistani gillnet fishery covering the years between 1987 and 2018, as endorsed in December 2019 by the IOTC WPDCS, has introduced a generalized decrease in yearly catches of shark species during the period concerned, resulting in a reduction of yearly shark catches of as much as 30,000 Mt for some years (mostly during the late '90s).

17. The WPEB **ACKNOWLEDGED** that catch levels provided in the document are based on non-raised data (i.e. information exactly as reported by CPCs, with no further estimation applied by the Secretariat) except for some non-reporting CPCs that have fisheries thought to heavily interact with shark species (e.g. Yemen) the information is derived from statistics published by FAO.

18. 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 each year.

19. The WPEB **NOTED** that the different grid resolutions used to display information presented through time-area maps depend on the reporting requirement by gears, as expressed by Resolution 15/02, and also **ACKNOWLEDGED** that the time-area maps only show information that is available with the proper level of resolution straight from the source, therefore excluding catches from several important fisheries (mostly artisanal / small scale) that do not provide the details required.

20. Also, the WPEB **NOTED** that the summary chart presenting the availability of catch data for shark species (by gear) in Appendix IV of the document could be further improved by removing those shark species that are known not to interact with some of the fisheries listed.

21. The WPEB **ENCOURAGED** the IOTC Secretariat to continue providing its support to all CPCs that are willing to further improve the quality of their reported statistical information (for bycatch as well as all other IOTC species) such as Pakistan and India, **NOTING** that a data compliance mission to the latter, originally planned for Q1 of 2020, had to be postponed until further notice.

22. The WPEB **ACKNOWLEDGED** that an informal meeting between the International Whaling Commission (IWC) and the IOTC Secretariat was held in the days prior to the working party, and **NOTED** that this meeting focused – among other things – on CMMs specific to bycatch species, in particular those (such as 13/04 and 13/05) that introduce an exemption from reporting data to the Secretariat for those CPCs with national regulations in place.

23. The WPEB **RECALLED** the paucity of information with regards to interactions between IOTC fisheries and seabirds, marine turtles and marine mammals, and that while several detailed reports exist in the scientific literature (including papers presented at the IOTC working parties) these do not constitute a formal submission to the IOTC Secretariat and therefore cannot be included in the IOTC databases.

24. The WPEB also **NOTED** the results of the updated 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 advisable for the Secretariat to raise the available information to provide estimations of total discards.

25. Furthermore, the WPEB **NOTED** that - in the case of marine turtles - the available ROS data show that individuals are sometimes being retained onboard, and that this is a well-known consequence of the protocols established at local level by EU,France concerning the longliners from La Réunion island, whose fishermen are instructed to recover injured individuals and bring them back to the Kélonia recovery centre in Saint-Leu, La Réunion.

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

26. The WPEB **NOTED** paper IOTC–2020–WPEB16–08 which provided an update on the national implementation of the IOTC regional observer scheme (ROS) for each IOTC CPC, as well as progress on the development of the pilot scheme.

27. The WPEB **ACKNOWLEDGED** that the IOTC Scientific Committee at its 22nd session in 2019 made explicit recommendations for all purse seine fleets to report the number of sets as the primary effort unit when submitting time-area catches to the IOTC Secretariat (as part of the mandatory data submission cycle ending on June 30th each year) as this would be a more accurate measure of the actual effort exerted and could be used to better calculate the ROS coverage.

28. Furthermore, the WPEB **NOTED** recent improvements in the submission of ROS information in an electronic format suitable for automated data extraction, and that data from 1,492 of the 2,176 total trips available to the IOTC Secretariat are now incorporated within the ROS Regional Database and are publicly accessible in accordance with the provisions set forth by Resolution 12/02.

29. **RECALLING** that the target observer coverage is 5% of all fishing operations for affected vessels and fleets, the WPEB **NOTED** that only 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

30. The WPEB **NOTED** progress with the ROS pilot project and **RECALLED** that a workshop for representatives 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 were used to further streamline and rationalize the data collection and reporting requirements.

31. Also, the WPEB **NOTED** that clarification might be needed for the interpretation of the ROS data collection fields marked as *optional for reporting* (OR) in the ROS data fields specification document, and that *optional* in this case means that data corresponding to such fields should be collected if possible, and that when collected it is *mandatory* to report these data to the Secretariat.

32. 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 will be delivered to a number of CPCs soon after travel restrictions are lifted.

33. Also, the WPEB **NOTED** that the procurement of EMS equipment to be delivered to Sri Lanka has finally been completed, that a first round of test trips have been performed and helped identify several technical issues which are in the process of being resolved by the service provider (e.g. interference with radio communication equipment, excessive drain on the vessels' batteries) and that equipment for observers has also been sourced and delivered on site.

34. The WPEB **ACKNOWLEDGED** that the EMS Sri Lanka pilot project had to be put temporarily on hold due to causes of *force majeure* and is expected to resume as soon as circumstances allow.

35. The WPEB **NOTED** that the development of the observer training programme package awarded to *CapMarine* has advanced, and a first round of site visits was performed to Tanzania, Sri Lanka, Indonesia and Kenya during 2019.

36. Also, the WPEB **ACKNOWLEDGED** that a second site visit to Kenya in Q1 of 2020 was undertaken by the consortium, and that the complete on-site training was delivered to candidate observers as well as to national observer coordinators, **NOTING** that the Kenyan Observer Programme Coordination Team is in the process of informing the IOTC Secretariat of the results of the candidates' assessment and of their scheduled deployment onboard vessels.

37. **CONSIDERING** the insurgence of the CoVid-19 pandemic at the beginning of 2020, the WPEB **ACKNOWLEDGED** that the development of the observer training programme had to be halted temporarily due to *force majeure*, as was the deployment of scientific observers from IOTC CPCs, and **CONFIRMED** that the programme will resume as soon as circumstances allow.

38. The WPEB also **NOTED** that a LoA was signed in April 2020 between the International Seafood Sustainability Foundation (ISSF) and FAO / IOTC for the delivery of services for the development of Electronic Monitoring Systems (EMS) minimum standards, including specifications and procedures for the implementation of EMS for IOTC fisheries, as well as an evaluation of EMS capabilities to collect the IOTC ROS minimum standards data fields.

39. The WPEB **ACKNOWLEDGED** that the project focuses on species-agnostic EMS standards for purse seines and longliners, but will also include small-scale fisheries if possible, with a final report to be presented at the IOTC Working Party on Data Collection and Statistics and Scientific Committee in 2020.

40. While **ACKNOWLEDGING** the importance of port sampling to fulfil data collection requirements where all other approaches cannot be effectively implemented, the WPEB **NOTED** with concern that no funding source has yet been identified for this specific work stream, notwithstanding the continued interest shown for this activity by several CPCs for which this would be the only viable option to collect scientific data for several of their fisheries.

5. Review of national bycatch issues in IOTC managed fisheries and national plans of action (sharks; seabirds; marine turtles)

5.1 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 and IOTC Secretariat).

41. The WPEB **NOTED** paper IOTC–2020–WPEB16–09 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.

42. The WPEB **RECALLED** the request from WPEB15 for the Secretariat to provide links in the NPOA portal on the IOTC website (http://iotc.org/science/status-of-national-plans-of-action-and-fao-guidelines) to the actual plan documents. The WPEB **NOTED** that work is being done to collect these documents from CPCs and thanked those who had already submitted them.

43. The WPEB **REQUESTED** that CPCs submit their NPOA to Secretariat for upload onto the NPOA portal.

44. The WPEB **NOTED** small revisions to the previous update on NPOA including the revision of a NPOA sharks by Thailand for the period 2020-24, a revision to the South African NPOA seabirds and Sri Lankan NPOA sharks which are both scheduled to be finalised by the end of 2020.

45. The WPEB **NOTED** the lack of a NPOA type mechanism for marine mammals and **NOTED** the technical guidelines for mammals being developed by FAO but also that it is not clear when these will come into force.

6. New information on biology, ecology, fisheries and environmental data relating to ecosystems and bycatch species

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

Best practices onboard French purse seiner vessels

46. The **WPEB NOTED** presentation of paper IOTC-2020-WPEB16-11 which provided an overview of the 8 years of best practices onboard French and associated flags purse seiners in the Atlantic and Indian Oceans, including the following abstract provided by the authors:

> *"In 2012, the first manual for the safe handling of sensitive species onboard tropical tuna purse seiners was released. This Code of Best Practices, developed in collaboration between French associated flags tropical purse seiners and French scientists of IRD and Ifremer, provides a set of recommendations and techniques to improve the survival of sensitive species incidentally caught by tropical tuna purse seiners, while taking into consideration crew safety. Following the release of the Guide of Best Practices, purse seine crews have been trained to Best Practices, vessels have been equipped with adequate Best Practices handling gear, and the methodology for the monitoring of Best and Unsuitable Practices has gradually improved. This document presents the evolution of the methodology used for this monitoring since 2015, describes the data collected by onboard and electronic observers in the frame of the OCUP program and proposes further improvements in the monitoring methodology.``*

47. The WPEB **NOTED** that the level of implementation of good practices differed between vessels and that results might differ depending on the crew, since each vessel has two crews, one working on each deck.

48. The WPEB **NOTED** that there was a difference between the results obtained from onboard observers and Electronic Monitoring Systems (EMS), with a higher proportion of good practices observed with observers onboard the vessels. The WPEB **NOTED** that these differences might be explained by the

psychological effect of having an observer physically onboard which would encourage best practices, as well as by the strict classification applied for EMS.

49. The WPEB further **NOTED** that a pilot study to assess the efficiency of combining both on-board observer and EMS systems is underway. The authors believe these systems are complementary and a combination of both would be the ideal way to monitor purse seine fisheries. The WPEB **NOTED** that onboard observers could, for example, have access to the cameras during the fishing cruise to minimize the issue of not being able to cover the upper and lower decks at the same time.

50. The WPEB **NOTED** the possibility of using artificial intelligence to examine EMS data, in particular for species identification which still requires improvements in some programmes, however the authors explained that it is too early to apply this kind of tool, as technical issues such as camera positioning still need to be resolved and **NOTED** that further pilot studies are required.

51. The WPEB **NOTED** the challenges in maintaining good practices when handling dangerous, large and heavy animals, especially on the lower deck of vessels and that ideally vessels should avoid bycatch species from reaching the lower deck through prior sorting on the upper deck.

Bycatch trends in Indian tuna longline fishery

52. The WPEB **NOTED** presentation of paper IOTC-2020-WPEB16-12 which provided trends in bycatch in the tuna longline fishery in India with reference to the biology of pelagic sharks occurring in it, including the following abstract provided by the authors:

> *"The bycatch contribute substantially to the longline catch in India. The exploratory tuna longline surveys conducted by Fishery Survey of India in the exclusive economic zone (EEZ) of India has indicated the abundance of these species. The study of the bycatch trend is utmost important so as to manage the tuna fishery effectively. In the present study along with the targeted catch i.e. the tunas, 31 bycatch species i.e. the bill fishes, pelagic sharks, rays, barracudas, dolphin fish, lancet fish etc. were recorded. The sharks dominate the bycatch groups in the Indian EEZ. The fishes caught by the four longliners i.e. MFV Matsya Vrushti, MFV Matsya Drushti, MFV Yellow Fin and MFV Blue Marlin during 2010-19 were analysed for finding out the distribution and abundance pattern of the tunas and the bycatch species. An aggregate hooking rate of 0.28%(number/100 hooks) and a catch rate of 33.6(kg/1000hooks) was recorded from the Indian EEZ. The dominant species of pelagic sharks occurring as bycatch were taken for in depth biological studies such as sex ratio, length frequency, length-weight, dietary analysis etc. This study will be useful for framing necessary guidelines for managing the tuna long line fisheries and to know more on the biology of the large pelagics."*

53. The WPEB **QUERIED** the availability of pictures of common thresher shark (*Alopias vulpinus*), as there still exists no evidence of its occurrence in the tropical Indian Ocean. The authors confirmed the existence of such pictures and were willing to share these with the group.

54. The WPEB **NOTED** that the presented information came only from fishing surveys and that commercial fishery data is very limited.

55. The WPEB **SUGGESTED** the authors should provide coefficients of variation for hooking rates instead of aggregated averages in order to provide an indication of the reliability of these indices.

Feasibility of applying Close-kin abundance estimates to IOTC shark species

56. The WPEB **NOTED** the presentation of paper IOTC-2020-WPEB16-13 on the Feasibility of applying Close-Kin abundance estimates to IOTC shark species, including the following abstract provided by the authors:

"The Close-Kin mark recapture (CKMR) method is an innovative approach that allows estimating abundance and other important parameters by finding pairs of related individuals in a population based on their genetic make-up. The method that has been demonstrated suitable for application to fish and elasmobranch species and has been applied or is under consideration for application to about a dozen species. A revision of the studies performed or ongoing has revealed that the CKMR method can be applied to species spanning a large variety of life-histories, for which diverse levels of background biological knowledge is available, or with limited or extensive sample accessibility, as long as the model is adapted for each particularity. The compilation of the technical considerations associated with a CKMR study design, the evaluation of alternatives to overcome potential complications, and the review of available biological knowledge, catch data and tissue sampling programs has allowed to perform a preliminary assessment of the potential feasibility of CKMR for IOTC sharks." – see paper for full abstract

57. The WPEB **QUERIED** the interest of using CKMR to assess species such as blue shark (BSH, *Prionace glauca*), for which good CPUE data exist and full stock assessments have been completed. The WPEB **NOTED** that CKMR is a tool that can be used to complement standard stock assessment methods as the aim of the technique is to provide an estimate of absolute abundance and that when applied correctly CKMR can provide data on the spatial structure of populations. The WPEB **NOTED** that this technique can help to address uncertainties found in assessments of species such as BSH. The WPEB further **NOTED** that the technique is already being used to solve uncertainties regarding yellowfin tuna assessments, as well as providing an additional fishery-independent source of information for data rich species such as southern bluefin tuna. The WPEB **NOTED** that CKMR should be viewed as being similar to tagging in that it provides another source of data for stock assessment models.
58. The WPEB **NOTED** that if results of a CKMR assessment differ from standard stock assessments, the group shall evaluate the uncertainties of both approaches and understand the reasons behind differences between the obtained results before making any decisions or recommendations for management. The WPEB **CONCLUDED** that this is already the procedure adopted by the group as such evaluations are often conducted when different stock assessment models are tested.
59. The WPEB **NOTED** that using a good sampling protocol prior to conducting CKMR analyses will ensure that any unknown spatial structuring will emerge from the collected data. The WPEB further **NOTED** that a lot of uncertainty can be resolved through a well carried out CKMR analysis with a thorough scoping study.
60. The WPEB **ACKNOWLEDGED** the difficulty of obtaining samples from sensitive species listed on CITES Annex II, such as shortfin mako shark (SMA, *Isurus oxyrinchus*). The WPEB **NOTED** that IOTC is working with CITES to find solutions to ensure the feasibility of collecting biological samples of listed species without jeopardizing the monitoring and management of these listed species.

Estimating population structure of blue shark through genome scanning

61. The WPEB **NOTED** the presentation of paper IOTC-2020-WPEB16-14 proposing the discrimination of independent populations of BSH through genome scanning, including the following abstract provided by the authors:

"The blue shark Prionace glauca is a cosmopolitan species that inhabits all oceans worldwide except the poles. Several IUCN regional assessments have classified it as Near Threatened, mostly due to overfishing. Previous genetic studies that have used classical genetic markers failed to reject the hypothesis that the species is a single worldwide population (panmixia). As such, the blue shark was proposed to be an archetype of the 'grey zone of population differentiation', named to signify those cases common in the marine realm, where the split among population is too recent or too faint to be detected using classical genetic markers. Here, samples collected across the majority of the global range of blue shark were sequenced (using a specific genome scan method named DArTseq) and screened through genome scan using 37,655 single nucleotide polymorphisms. Significant differences distinguished locations from the northern (Mediterranean

and North Atlantic) vs. southern (southeastern Atlantic, Indian Ocean and southwestern Pacific) oceanic regions. Furthermore, F_{ST} values were significant, albeit low, between locations from distinct regions within the Atlantic Ocean (northern vs. northeastern vs. southeastern Atlantic). In addition, FST values were significant between these Atlantic locations and Mediterranean, Indian, and Pacific locations. These results illustrate the power of genome scans to delineate independent populations in marine species and to accurately identify distinct management units."

62. The WPEB **NOTED** that if there is one single global population which this, and other studies have suggested, managing this species will be challenging due to the required involvement of several RFMOs.
63. The WPEB **QUERIED** whether the sample size of the study needed to be increased before getting into any discussion concerning updates of population boundaries. The authors **CLARIFIED** that the appropriateness of the sample size was tested and considered good for most areas and that areas with low sample sizes, such as the northern Pacific, were excluded from the analysis.
64. The WPEB **NOTED** that to better understand the mixing of the South African population, more samples are required from the southwestern Atlantic. The WPEB **NOTED** that South Africa is willing to continue to collaborate and collect more samples and also offered to liaise with Brazilian colleagues to collect samples from the southwestern Atlantic.
65. The WPEB **NOTED** that the complete analysis of all collected samples was not completed within the initial timeframe and that it would be useful to continue this work in order to complete the analysis of the full set of samples. The WPEB **SUGGESTED** keeping the project in mind for continued inclusion in the program of work.
66. The WPEB **NOTED** that if there is a population overlap in South Africa, i.e. two separate the Atlantic and Indian Ocean populations are still thought to exist in South Africa, defining an accurate boundary would be very challenging. The authors **AGREED** and clarified that the proposition to move the boundary would be done to avoid the inclusion of the South African population in the Indian Ocean stock assessment.
67. The WPEB **NOTED** that genetics can help to show the evolutionary history of species populations, but it is still important to look at what is currently happening with tagging and other relevant studies. The WPEB further **NOTED** that many different methods including genetic, evolutionary history and tagging analyses should be looked at together to properly determine stock boundaries.

Sunfish in the Northern Arabian Sea

68. The WPEB **NOTED** the presentation of paper IOTC-2020-WPEB16-24 on the distribution and abundance of sunfish (Family *Molidae*) in the Northern Arabian Sea based on data collected by the WWF-Pakistan observer program, including the following abstract provided by the authors:

"Sunfish are among the important bycatch species of the tuna gillnet fisheries of Pakistan. Three species Mola alexandrini. Mola mola and Ranzania laevis are known from Pakistan, however, bumphead sunfish (M. alexandrini) seems to be the dominating species. High incidences of entanglements were reported during 2018 and 2019 in the tuna gillnet fisheries of Pakistan which is attributed to increase frequency of blooms of jellyfish and gelatinous material along the coast of Pakistan. Sunfish are known to feed on jellyfish, siphonophoes and salpids which are now frequently found along Pakistan coast. Major entanglements of sunfishes were reported from the continental margin along Sindh and Balochistan coast. No mortality of sunfish was reported and all entangled sunfishes were safely released by WWF-Pakistan's trained observers. A guideline for safe release of bycatch species including sunfish is being published."

69. The WPEB **THANKED** the authors for the presentation and highlighted the importance of bringing information and guidelines on teleost bycatch that have historically received less attention from the group than more charismatic species such as sharks, turtles and mammals. The WPEB **ENCOURAGED** CPCs to continue presenting information regarding this species group. The WPEB **NOTED** issues reported with other teleost species including a bycatch problem with dolphinfish in the south west Indian Ocean where catches have been decreasing, along with the size of the fish caught and highlighted that no other RFMO is managing this stock.

70. The WPEB **NOTED** that not all *Molidae* species have a FAO code assigned, which hinders catch reporting to IOTC. The Secretariat **SUGGESTED** that the generic code for the *Molidae* family, available in the FAO list of 2020, should be used while specific codes are not available and **NOTED** that the Secretariat can begin the process of requesting further FAO ASFIS codes but this will not be completed until 2021 when FAO conducts their next review.

71. The WPEB **NOTED** that information on the abundance of these species is still very limited and, therefore, it would be premature to discuss mitigation measures. The WPEB further **NOTED** that species identification also needs to be improved.

72. The WPEB **NOTED** that while there are a number of papers on bycatch of sunfish species, most of these are not specific to the Indian Ocean and the need for further information specific to the region was highlighted.

Post Release Mortality Study

73. An update was provided on the implementation of the IOTC bigeye thresher shark post-release mortality study project (IOTC BTH PRM Project) by the project coordinator.

74. The WPEB **NOTED** that the planned tagging operations have been impacted by the CoVid-19 crisis and that project deadlines will need to be extended.

75. The WPEB **THANKED** and congratulated the authors for the project coordination and preliminary results.

76. The WPEB **NOTED** that the preliminary post-release survival rate of bigeye thresher sharks is 41%. The WPEB **NOTED** that this high level of mortality may be due to the natural fragility of the species and the fact that tagged individuals are often caught by the tail (due to their hunting strategy) which reduces their mobility and leads to a deterioration of their physical condition.

77. The WPEB **NOTED** that the tags deployed this year were only done by crews onboard a Japanese longliner including a crew member who was once trained as a scientific observer by the Japanese Observer Program and that Japan would like to continue supporting this project.

78. The WPEB **NOTED** that a EU-funded project involving the French National Research Institute for Development (IRD) started in July 2020 for a 3-year period with two main objectives: (1) a follow up study on the post-release mortality of sharks for which 40 survival eTAGs have been purchased and (2) to develop and implement an autonomous device to be deployed on longlines to help to release animals by cutting leader lines close to the hook.

Joint tuna RFMO Bycatch working group meeting

79. The WPEB **NOTED** the presentation of information paper IOTC-2020-WPEB16-INF02 regarding the Report of the 2019 joint Tuna RFMO bycatch meeting held in Porto – Portugal.

80. The WPEB **THANKED** the Secretariat for sharing the highlights of the joint meeting with the group.

81. The WPEB **NOTED** that management procedures such as the inclusion of shark bycatch species in the IOTC mandate were not discussed during this meeting due to the different ways that the various RFMOs are run.

82. The WPEB **NOTED** that the paper details the key recommendations from this meeting including a separate set of recommendations for research and data collection initiatives and **ENCOURAGED** members of the WPEB to read the paper in detail. The WPEB **NOTED** that the recommendations for research could form part of the programme of work for the WPEB.

83. The WPEB **NOTED** key recommendations from this meeting including the promotion of alternative methodologies for stock assessments, such as CKMR, as well as the evaluation of the effectiveness of adopted management measures to date. The WPEB **NOTED** that any form of further information that can help to complement assessments of population status of bycatch species is helpful.

7. Stock assessment for Shortfin mako shark

CPUE for Portuguese pelagic longline fishery for shortfin mako shark

84. The WPEB **NOTED** paper IOTC–2020–WPEB16–15 which provided updated fishery indicators and standardised CPUEs from the Portuguese Pelagic Longline Fishery for SMA, including the following abstract provided by the authors:

> *"This working document provides updated fishery indicators for the shortfin mako shark captured by the Portuguese pelagic longline fishery in the Indian Ocean, in terms of catches, effort and standardized CPUEs. The analysis was based on data collected from fishery observers, skipper's logbooks (self sampling) and official logbooks collected between 1998 and 2018. The CPUEs were analysed for the Indian Ocean and compared between years, and were modelled with tweedie GLM models for the CPUE standardization procedure. In general, there was a large variability in the CPUE trends, with the standardized CPUEs relatively similar to the nominal trend and showing a general increasing trend, especially in recent years."*

85. The WPEB **NOTED** that the nominal catch rates show almost identical trends as the proportion of positive sets and this suggests the two sources of data may have provided the same information.

86. The WPEB **NOTED** the suggestion that if there are generally a few fish caught for most sets, then a logistic model fitting to presence/absence data would suffice to provide the abundance index.

87. The WPEB **NOTED** that there is still room to improve the model fitting to data from the mis-fitting evident in the quantile-quantile plots.

CPUE for Spanish longline fishery for shortfin mako shark

88. The WPEB **NOTED** paper IOTC–2020–WPEB16–16 which provided updated standardised CPUEs from the Spanish Longline Fishery for SMA, including the following abstract provided by the authors:

> *"Standardized catches per unit of effort in number and weight were obtained for the shortfin mako (Isurus oxyrinchus) using General Linear Modelling procedures based on trip data from the Spanish surface longline fleet targeting swordfish in the Indian Ocean over the period 2001-2018. Factors such as area, quarter, gear and bait, as well as the fishing strategy were taken into account. The model explained 31% and 24% of CPUE variability in number and weight, respectively."*

89. The WPEB **NOTED** that the standardisation analysis is based on trip-level positive catches, and the proportion of zeros is relatively low, therefore a two-stage, delta model is not used in this case.

90. The WPEB **NOTED** that the swordfish (SWO) to BSH catch ratio (categorised from 1-10) is included as a variable to indicate targeting but the variable has little effect on the standardised index. The WPEB **SUGGESTED** that a plot showing the annual catch ratio category frequency would provide some insight into how the targeting may have changed over time.

91. The WPEB **QUERIED** how the species identification is done onboard commercial vessels, particularly with respect to the separation of SMA and longfin mako sharks (LMA). The WPEB **NOTED** that the

SMA have a much higher market value, and the separation of this species from other species is usually not an issue.

Stock assessment for shortfin mako shark

92. The WPEB **NOTED** paper IOTC–2020–WPEB16–17 which provided a stock assessment for SMA in the Indian Ocean using CMSY, BSM and JABBA methods, including the following abstract provided by the authors:

> *"The shortfin mako shark, Isurus oxyrinchus (SMA), is a highly migratory pelagic species found globally. It is particularly vulnerable as bycatch in longline fisheries, and has a vulnerable status according to the IUCN. SMA is considered a data-limited stock as there is incomplete catch information, limited information on the catch composition (size frequencies), and few abundance indices (e.g., standardised CPUE series). A preliminary stock assessment was performed by Brunel et al. in 2018 for the IOTC convention area using CMSY, a catch-only method, and a built-in Bayesian surplus production model (BSM), based on reconstructed catch data and standardised CPUEs from the EU longline fleet of Spain (2006-2016), and Portugal (2000-2016)."* – see paper for full abstract

93. The WPEB **THANKED** the author for providing the assessment for SMA using a range of methods, including the catch only method (CMSY), Bayesian surplus production model (BSM), and the just another Bayesian biomass assessment (JABBA) model. The WPEB **NOTED** the various sensitivity runs applied to quantify the influence of production function (Schaefer, Fox, and Pella Tomlinson) and various combinations of relative abundance (CPUE) indices had on the stock status. The WPEB further **NOTED** the key assessment results for JABBA as shown below (**Table 2; Figure 1**) for which estimates from the base case are reported.

94. The WPEB **NOTED** that the paper represents the work conducted by CPC scientists, with assistance from the Secretariat, not as a document prepared by the WPEB Chair and IOTC Secretariat.

95. The WPEB **NOTED** that the standardised CPUE indices available to the assessment model include JPN (1993-2018), CHN-TWN (2005-2018), EU,ESP (2001-2018), and EU,PRT (2000-2018). The WPEB **NOTED** that the JPN index shows an overall stable trend since 2005 whereas all the other indices show an increasing trend, therefore, the inclusion of the JPN index in the model leads to a more pessimistic result. However, the WPEB **NOTED** that the JPN index has a longer time period, the fleets operated in the main distributional area of SMA, and the target is mostly southern Bluefin tuna unlike the other indices. As such, the JPN index is deemed appropriate and should not be excluded simply because it is inconsistent with other indices.

96. The WPEB **NOTED** that the Japanese longline catches of SMA (mainly caught in temperate waters which is the main distributional area of SMA) has been declining due to decreases in the fishing effort, whereas the recent increase in catches (and higher fishing mortality compared to the MSY level) are mostly attributed to other fleets (e.g. Pakistan gillnet fishery operating offshore waters).

97. The WPEB **NOTED** that the nominal catch data utilized in the assessment included estimations of SMA catch from certain CPCs, based on limited information on shark catches and species composition data submitted to the IOTC Secretariat, which has included the species-specific shark catches from Japan including SMA from 1964 to 1993. The WPEB **NOTED** the request from Japan that these data should not be used in the stock assessment for key shark species in the Indian Ocean until Japan clarifies its credibility and agrees with its usage for stock assessment purposes.

98. The WPEB **ACKNOWLEDGED** that species-specific nominal catches of sharks for Japan for years prior to 1993 are derived from other sources (FAO capture database, in particular) due to a lack of official submissions from the CPC concerned and then adjusted - in terms of species composition - by the IOTC Secretariat. For this reason, the WPEB **AGREED** that for the next assessment of BSH, the fraction

of estimated Japanese nominal catches held in the IOTC databases for the species and years concerned would not be considered.

99. The WPEB **NOTED** that the prior value for the intrinsic growth rate parameter *r* derived from a demographic analysis based on the Leslie Matrix model was relatively low (mean = 0.03, and CV=0.2). The WPEB **RECALLED** that a more comprehensive modelling study based on a two-sex age-structured matrix population model (IOTC-2019-WPEB15-20) suggested a higher *r* value (median=0.11, range 0.06 – 0.13). The WPEB **NOTED** the higher-*r* was estimated using best available biological parameters including the growth curves estimated from samples taken from the Indian Ocean, and accepted in the data preparatory meeting of SMA in 2019 as one of the possible *r* values to be considered in the assessment. The WPEB **NOTED** that sensitivity analysis suggested that the model is sensitive to the choice of *r* prior (there is little information in the observations to inform estimates of *r*), and a higher *r* value leads to a more optimistic stock status.

100. The WPEB **NOTED** *r* estimates from working paper IOTC-2019-WPEB16-17 (now tabled as information paper IOTC-2020-WPEB16-INF07 to this meeting) were not used or referenced in the original assessment, although a sensitivity analysis using these values was conducted during the meeting. The WPEB further **NOTED** that extenuating circumstances and logistical constraints resulted in a late distribution of this information paper and as such there was limited time for the WPEB to review the *r* estimates.

101. The WPEB **NOTED** that the increasing CPUE trends since the 2000s coincide with the period of high catches, and that SMA has a low intrinsic population growth rate (*r*). The WPEB **ACKNOWLEDGED** that the observation process (CPUE data) is therefore in conflict with the process equation (high catches and low *r*) and that this probably implies a certain degree of model misspecification, as indicated by the 'anti-clockwise' stock trend (increasing B/BMSY with increasing F/FMSY).

102. The WPEB **NOTED** that the maturity age of female SMA is 18-21 years old and that the fishery predominantly caught juvenile SMA (mainly 3-10 years old) and very few adults. Therefore, there will be a significant time delay (approx. 8+ years) between fishing and its effect on the spawning population and hence future recruits. The WPEB further **NOTED** that this time lag cannot be easily dealt with using the aggregated biomass dynamic model (see papers IOTC-2020-WPEB16-INF08 and INF09) but can be better accommodated within an age-structured modelling framework (which explicitly accounts for the processes of recruitment, sex-specific growth and maturation, and selectivity of fishery). However, the WPEB **NOTED** that more reliable data (e.g. length or age composition data) are required to enable an integrated, age-structured model to be developed for SMA.

103. The WPEB **AGREED** not to provide the management recommendation based on these stock assessment results due to several fundamental issues: 1) model misspecification; 2) data credibility of nominal catch; 3) selection of information utilized (e.g. productivity-*r*); 4) inability of aggregated biomass dynamic model (JABBA) to reconcile significant time delay (approx. 8+ years) between fishing and its effect on the spawning population.

Table 2. Stock status summary table for the assessment of shortfin mako shark from JABBA model including all time series of catch per unit effort (CPUE) ('All CPUE') and excluding the Japanese time series ('Without JPN CPUE')

	All CPUE	Without JPN CPUE
MSY (t) (80% CI)	385 (19–750)	393 (20–767)
F_{MSY}	0.12 (0.02–0.20)	0.12 (0.02–0.20)
SB_0(t) (80% CI)	66,879 (33,711–181,988)	69,361 (37,145–140,777)

SB_{2018} (t)	13,264	23,150
SB_{MSY}	13,375 (669–26,081)	13,871 (693–27,049)
SB_{2018}/SB_0 (80% CI)	0.20	0.33
SB_{2018} / SSB_{MSY}	0.99 (0.41–1.88)	1.67 (0.72–2.81)
F_{2018} / F_{MSY}	2.27 (1.07–2.27)	1.32 (0.56–3.00)

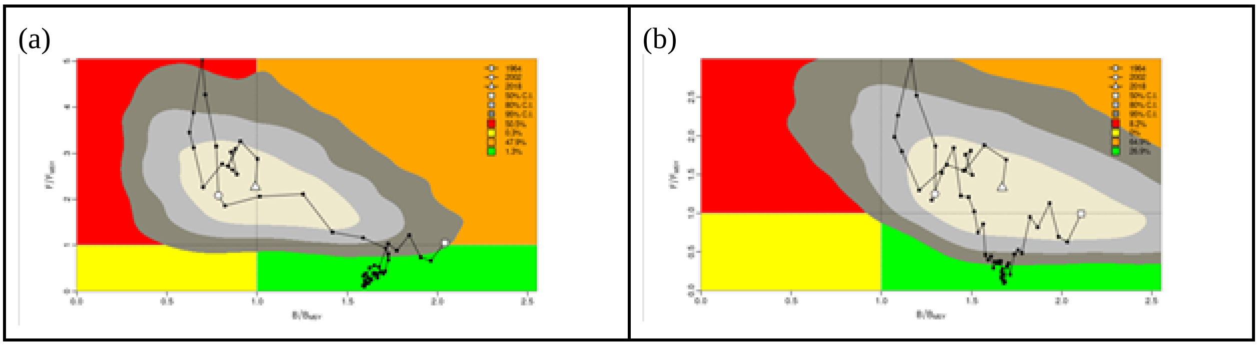

Figure 1. *Kobe stock status plot for the Indian Ocean shortfin mako shark from JABBA model: (a) All CPUE, and (b) Without JPN CPUE*

8. Indicators for oceanic whitetip shark and mobulid rays, data preparation for blue shark

8.1 Review of indicators for oceanic whitetip shark

104. The WPEB **NOTED** that no papers were submitted ahead of the meeting relating to indicators for oceanic whitetip shark.

8.2 Review of indicators for mobulid rays

105. The WPEB **NOTED** paper IOTC-2020-WPEB16-18 which describes the impact of the IOTC fisheries on mobulid rays: status and interactions, data availability, and recommendations for management, which included the following abstract provided by the authors:

"Manta and devil rays (collectively known as mobulids) are a family of migratory elasmobranchs. Their life history traits mean the largest Mobula species have maximum rates of intrinsic population increase among the lowest of all elasmobranchs. Mobulids are vulnerable to both targeted fisheries and bycatch and are caught in both small-scale and commercial (e.g. tuna) fisheries. Such fisheries are a major threat to mobulids, with some populations exhibiting declines of over 90%. In the Indian Ocean, all mobulid species are assessed as either Vulnerable or Endangered, with steep population declines due to exploitation in fisheries playing a major role in these assessments. In response to growing concern, in 2019 the IOTC adopted Resolution 19/03 on the conservation of mobulids caught in association with fisheries in the IOTC Area of Competence. Mobulids are mainly caught as bycatch, primarily in the industrial purse-seine fisheries, and to a lesser extent in longline fisheries. See WP for full abstract.

106. The WPEB **NOTED** that mobulid rays (7 species; 2 Vulnerable species and 5 Endangered species in IUCN) are caught in small-scale and industrial fisheries as bycatch mostly, however, mobulid rays have also been targeted and landed by Indonesia and Sri Lanka, both in coastal and open-ocean fisheries, mostly for gill plates. This practice is prohibited now that these species have been placed on CITES list and that they are subject to retention bans (Res. 19/03).

107. The WPEB **NOTED** the high post-release mortality for mobulids and therefore that effective conservation measures are required to mitigate their capture.

108. **ACKNOWLEDGING** that several post-release mortality studies for mobulids have been conducted, the WPEB **SUGGESTED** that a centralized post-release mortality study for mobulids within IOTC area of competence should be conducted.

109. The WPEB **NOTED** that the use of best practices already developed for the release of mobulids is essential to improve survival of released individuals. The WPEB **NOTED** that new tools for safe handling of these species, such as grids and modified brailers, are being trialled and developed in the Atlantic Ocean. The WPEB **ENCOURAGED** these trials to be extended to the Indian Ocean as well.

110. The WPEB **NOTED** the IOTC Commission had noted the importance and vulnerable status of these mobulid species, resulting in the adoption of Resolution 19/03 ON THE CONSERVATION OF MOBULID RAYS CAUGHT IN ASSOCIATION WITH FISHERIES IN THE IOTC AREA OF COMPETENCE. The WPEB further **NOTED** that this Resolution already encompasses many of the recommendations provided in the document.

111. The WPEB **NOTED** that the ID guide should be updated with new information on mobulids through collaboration with relevant experts and that other sources of uncertainty such as gaps in life history parameters, taxonomy, population trends and the impact of bycatch still need to be addressed.

112. The WPEB **NOTED** that LED lights could be used as a tool to reduce mobulid interactions with gillnets (this method is thought to be effective for sea turtles and cetaceans also) however these methods need further investigation.

113. The WPEB **NOTED** paper IOTC-2020-WPEB16-19, which presented a review of mobulid ray interactions with fisheries for tuna and tuna-like species in the Indian Ocean, which included the following abstract provided by the authors:

> *"Manta and devil rays (Mobula spp.) are threatened globally, primarily from fishing pressure, with all Indian Ocean species reported to be in decline. Mobulids are large, mobile marine animals that can cover vast areas of ocean. To be able to effectively mitigate the impacts of fishing, we need to understand their spatial and temporal ecology, including the factors governing their distribution, and how they interact with fisheries. While there has been a global increase in research and data on mobulid rays in recent years, our knowledge of their ecology and distribution in the Indian Ocean and interactions with pelagic tuna and tuna-like fisheries is still relatively limited and there remain key gaps in our understanding of their oceanic habitats and interactions with the physical environment. This study represents the first attempt to explore mobulid interactions across many of the major tuna fleets operating in the Indian Ocean based on a newly collated observer dataset managed by the IOTC. This study aims to review the available observer information to identify spatial and temporal hotspots and analyse trends in interactions with the different fisheries in operation across the Indian Ocean to support the conservation and management of these species."*

114. The WPEB **NOTED** several coastal hotspots for mobulids across the Indian Ocean as well as an increased abundance of these species around upwelling and convergent oceanic features, mostly highlighting the association of mobulids with areas of high productivity (as identified on Chl-a maps). However, concerns were raised about the fact that the hotspots of mobulids might only reflect the distribution of fishing effort although further investigation could be carried out to confirm this association.

115. The WPEB **NOTED** that most mobulids are discarded by the PS and LL fleets, although it was suggested that they may be retained by the gillnet fishery. The WPEB further **NOTED** that this practice may be diminishing with more gillnetters releasing captured mobulids.

116. The WPEB **NOTED** that due to a high level of overlap in the distribution of target species and mobulids, the implementation of mitigation measures may be difficult, therefore utilization of best-practices for safe handling and release is essential.

117. The WPEB **NOTED** that the ROS data from two important PS fisheries (SYC and EU,FRA which accounted for 25% of the records available for analysis) is currently lacking details on total catches of target species, due to the format through which the data was shared with the IOTC Secretariat, and that therefore these datasets had to be excluded from the analysis. **ACKNOWLEDGING** that the Secretariat is actively working towards incorporating observer data from these two fleets directly from the original source (ObServe database) and that the missing information will eventually become an integral part of the ROS regional database, the WPEB **SUGGESTED** that this analysis be updated once the complete data for the two PS fleets have become available and eventually presented at the next session of the working party.

118. The WPEB **NOTED** paper IOTC-2020-WPEB16-26 that presented by WWF Pakistan on safe handling and release guidelines for gillnet fisheries (Whale sharks, Manta & Devil Rays, Sea turtles, which included the following abstract provided by the authors:

> *"Pakistan is an important gillnet coastal state with the well known marine biodiversity. Around 709 tuna fishing vessels are operating in Pakistani waters. These boats have high of ETP/CITES-listed bycatch species such as whale shark, mobulids and sea turtles. these bycatch animals protected by several national and international instruments and encouraged their safe releases to ensure the survivability of these protected species. the data of the crew-based observer programme help into the development of guidebook for safe handling and release of these bycatch species in tuna gillnet fisheries. This guidebook focuses on three main possible levels of entanglement of animals in fishing operations. It follows and guides the target group to follow 'key' of different precautionary and handling and steps for every situation. The guidebook also encourages the user for the collection of the information and reporting of the entangled animal including the recording of the whole process of operation. This guidebook can be served and adopted by conservation institutes and organization as best practices of safe handling and release of bycatch animals in ghost nets/ gillnet fisheries."*

119. The WPEB **NOTED** and **THANKED** WWF Pakistan for providing guidelines for safe handling and release of ETP species caught by gillnetters.

120. The WPEB expressed concern that crew safety may be an issue for some of the proposed methods, particularly those requiring crew to enter the water to facilitate safe release. The WPEB **NOTED** that crew safety was considered in the proposed guidelines and multiple options for safe handling are provided to be used as and where applicable. The WPEB also **NOTED** that sea conditions may be different in various regions of the Indian Ocean and therefore some methods may not be universally applicable in all the IOTC regions.

121. The WPEB **NOTED** that it did not have the mandate to make the adoption of these guidelines mandatory for all IOTC fisheries as this can only be decided by the Commission and encapsulated in a Resolution, but that it could endorse them or recommend that the Commission consider these guidelines when considering the management of these species in the future. As such, the WPEB **SUGGESTED** that CPCs review these guidelines and apply them where suitable within their fisheries.

8.3 Review of data for blue shark for assessment

122. The WPEB **NOTED** paper IOTC-2020-WPEB16-20 presented an updated CPUE of BSH (*Prionace glauca*) in the Indian Ocean estimated from Japanese observer data between 1992 and 2019, which included the following abstract provided by the authors:

> *"We updated the Japanese observer data until 2019 and standardized nominal catch-per-unit-effort (CPUE) of blue shark caught by Japanese tuna longline fisheries in the Indian Ocean from*

1992 to 2019. We used generalized linear model (GLM) with negative binomial error distribution to standardize the nominal CPUEs. The most parsimonious model was selected by Akaike Information Criterion (AIC) as the best model for the estimation of annual CPUEs. The goodness-of-fits were diagnosed by residual plots. The 95% confidence intervals were estimated from the bootstrapping method. The annual CPUEs had a similar trend to those shown in the previous analysis except in 2000. The annual CPUE increased in 1990s and reached to the peak in 2000, and then gradually decreased with a large fluctuation until 2013. Since 2014, the annual CPUE showed an increasing trend. We suggest that the estimated annual CPUE should be utilized as one of the candidates of primary abundance indices in the next stock assessment of blue shark in the Indian Ocean scheduled in 2021 because the Japanese observer data covers a wide range of the main distribution area (temperate water) of blue shark in the Indian Ocean and a longer time period compared to the other fleets' CPUE data."

123. The WPEB **NOTED** that the standardized CPUE presented by Japanese scientists based on longline observer data includes an update of the data (since 1992) and an update of the model used in comparison with the last standardized CPUE presented by Japan in 2016. The WPEB **NOTED** that the inclusion of the gear effect (hooks between floats) has had a large effect on the standardized CPUE after 2015. The WPEB **NOTED** that investigating the gear effect as well as how the gear configuration changes over time would be useful for understanding this influence.

124. The WPEB **NOTED** that the standardized CPUE from observer data demonstrates a similar trend to the previous analysis and may provide a robust basis for further stock assessment work in 2021.

125. The WPEB **RECOGNIZED** the importance of CPUE indices based on observer data (such as this Japanese series) due to the large extent of discarding of BSH by many fisheries. CPCs were **ENCOURAGED** to provide standardised CPUE series for the 2021 assessment.

126. The WPEB **AGREED** on the principle of having a pre-assessment or data preparatory meeting prior to the assessment meeting for BSH in 2021 to review and agree on the input data, stock assessment models to be used, model parameterizations and model specifications. Online meetings should be encouraged to facilitate participation and minimize costs.

127. **ACKNOWLEDGING** that for continuity purposes, the same stock assessment model as that used in 2017 should be run with updated data. The WPEB **ENCOURAGED** CPCs to present other stock assessment models in 2021 to allow the investigation of other model specifications.

128. The WPEB **NOTED** paper IOTC-2020-WPEB16-21 on the trends of catch and effort on the BSH as bycatch of Indonesian tuna longline fishery, which included the following abstract provided by the authors:

"The blue shark or BSH (Prionace glauca) is one of bycatch species caught by Indonesian tuna longline fishery in the Indian Ocean. Updated on the catch per unit effort (CPUE) are needed to reduce an uncertainty for assessing the stocks as an input for the species management and conservation. This study provides an update on the nominal CPUE changes and spatial distribution of BSH in the eastern Indian Ocean. Data were gathered by a scientific observer program placed in commercial tuna longline of Indonesia operated in the eastern Indian Ocean from August 2005 to December 2019. Overall, the abundance of BSH increased substantially during the period of observation. The abundance of BSH also showed a variation according to latitudinal gradient where CPUE increased in high latitude. However, the downward trend of CPUE observed in 2019 compared to 2018 suggests a precautionary approach is needed in BSH fisheries."

129. The WPEB **NOTED** the BSH nominal CPUE presented by Indonesia which shows an increase over the period 2005-2019 in the eastern Indian Ocean. Indonesian scientists are planning and are **ENCOURAGED** to produce a standardized CPUE, including longline configuration and potentially taking into account environmental data.

130. The WPEB further **ENCOURAGED** CPCs to produce at least a nominal CPUE series for BSH in view of the next stock assessment (to be carried out in 2021) as the catch of this species is increasing in fleets for which no catch and effort data are currently available. The WPEB **NOTED** that other long-term data sources may be available (such as data from India and Pakistan) and **ENCOURAGED** CPCs to provide these data for future stock assessments.

131. The WPEB **NOTED** that spatial changes in fishing effort were observed during the study period which may to some extent explain the CPUE variability.

132. The WPEB **AGREED** that a reconstruction of historical catch should be considered **NOTING** that past efforts of this type of work were presented at the WPEB14.

133. The WPEB **NOTED** that the paucity of data available for this species necessitates the utilisation of alternative sources of data collection (such as EMS or crew-based observer schemes). Preventative management such as that adopted for mobulid rays is another option to ensure these species are managed sustainably in the absence of information.

9. Ecosystem modelling and report cards

134. The WPEB **RECALLED** the suggestion by the group in WPEB14 for the development of a set of indicator report cards which could be used to inform management advice.

135. The WPEB **NOTED** delays with this work due to the CoVid-19 crisis and that those working on this will continue with the aim of presenting further information to the WPEB in 2021. The WPEB **ENCOURAGED** others to contribute to this work.

10. Bycatch, species interactions and ecosystem risk assessments for marine mammals, seabirds and sea turtles

10.1 Marine Mammals

136. The WPEB **NOTED** paper IOTC-2020-WPEB16-22 on Cetacean bycatch in Indian Ocean tuna gillnet fisheries, including the following abstract provided by the authors:

> *"Pelagic gillnet (driftnet) fisheries account for some 34% of Indian Ocean tuna catches. We combined published results from 10 bycatch sampling programmes (1981−2016) in Australia, Sri Lanka, India and Pakistan to estimate bycatch rates for cetaceans across all Indian Ocean tuna gillnet fisheries. Estimated cetacean bycatch peaked at almost 100 000 ind. yr−1 during 2004−2006, but has declined by over 15% since then, despite an increase in tuna gillnet fishing effort. These fisheries caught an estimated cumulative total of 4.1 million small cetaceans between 1950 and 2018. These bycatch estimates take little or no account of cetaceans caught by gillnet but not landed, of delayed mortality or sub-lethal impacts on cetaceans (especially whales) that escape from gillnets, of mortality associated with ghost nets, of harpoon catches made from gillnetters, or of mortality from other tuna fisheries. Total cetacean mortality from Indian Ocean tuna fisheries may therefore be substantially higher than estimated here. Declining cetacean bycatch rates suggest that such levels of mortality are not sustainable. Indeed, mean small cetacean abundance may currently be 13% of pre-fishery levels. None of these estimates are precise, but they do demonstrate the likely order of magnitude of the issue. Countries with the largest current gillnet catches of tuna, and thus the ones likely to have the largest cetacean bycatch are (in order): Iran, Indonesia, India, Sri Lanka, Pakistan, Oman, Yemen, UAE and Tanzania. These 9 countries together may account for roughly 96% of all cetacean bycatch from tuna gillnet fisheries across the Indian Ocean.*

137. The WPEB **NOTED** that the study made use of the very limited data available to provide an indicative estimate of cetacean bycatch in the Indian Ocean tuna gillnet fishery in the absence of meaningful effort data for the gillnet fishery.

138. The WPEB **NOTED** that the study concentrated on bycatch of small cetaceans, but **NOTED** that even relatively low rates of bycatch for large whales might have a significant impact on population status, particularly if the population size was already low, for example the Arabian Sea Humpback whale population listed as Endangered on the IUCN red list.

139. The WPEB **NOTED** that learning behaviour resulting in the avoidance of fishing gear has been observed in some fish such as tuna and could affect the estimates of abundance in the initial period of exploitation but that, although this process may exist for cetaceans, should not affect the results of the study that is based on bycatch data available since the 1980s while the fishery dates back prior to the 1950s.

140. The WPEB **NOTED** that bycatch ratios (i.e. numbers of cetaceans bycaught per 1000 Mt of tuna) have been widely used for other bycatch groups and data-poor target species although these have some limitations and require an idea of the dynamics of the target species used to compute the ratio to get an approximate scale of the extent. The methodology accounted for the dynamics of yellowfin tuna as derived from the stock assessment model, including the fact that the stock is currently overfished and described as having a low abundance.

141. The WPEB **NOTED** that one potential limitation of this approach is that it requires knowledge of the changing status of the target stocks against which bycatch rates are measured but that the status of tuna stocks under IOTC management was known well enough for the purposes of the study.

142. The WPEB **NOTED** that the study suggests that cetacean populations in the Indian Ocean may have been reduced to a low level, perhaps <20%, of their original levels but that the use of an aggregated approach was problematic, and that it is not possible to fully evaluate the change of population abundance without a species specific analysis. With this in mind, the WPEB **RECALLED** the importance of cetacean bycatch monitoring and the collection of species-specific bycatch data.

143. The WPEB **ACKNOWLEDGED** that the lack of cetacean bycatch data limited the possibilities of analysis and therefore **RECOGNISED** that fishery-independent cetacean surveys have the potential to provide information on abundance of cetacean populations, and (if earlier surveys were repeated) to provide information on abundance trends. Such surveys would also enable CPCs to fulfil their national and international monitoring obligations. In any such future studies, oceanographic and climate data should ideally be incorporated into habitat modelling.

144. The WPEB **NOTED** that the association between yellowfin tuna and dolphins within the Indian Ocean needed to be investigated. The association appears to be rather widespread, and is used by coastal country fishermen in Maldives, Sri Lanka, Oman and elsewhere to target yellowfin tuna.

145. The WPEB **NOTED** paper IOTC-WPEB16-25 on Guidelines for the safe and humane handling and release of bycaught small cetaceans from fishing gear, developed and published by the Convention on Conservation of Migratory Species of Wild Animals (CMS), IWC and World Wildlife Fund (WWF) that were prepared by authorities on cetacean bycatch, reviewed by international experts, and endorsed by the IWC SC. Best practice guidelines were outlined for the handling and release of small cetaceans from longline and dropline, purse seine, gillnet and trawl.

146. The WPEB **NOTED** that priorities for handling and release should include the safety of fishers and that guidelines for fishers should be presented in a form that is simple and in the appropriate local language. The WPEB **NOTED** that a draft of these guidelines had been presented at WPEB15 with a request for feedback from fishers, but this was not forthcoming in part because the draft guidelines were not available in local languages.

147. The WPEB **NOTED** that a priority for handling and release should maximize post-release survival and that the reduction of stress and minimising further injury were important factors in increasing post-

release survival. Furthermore, the WPEB **NOTED** that guidelines should ideally be coordinated across oceans and RFMOs, but nevertheless should take account of local fleet differences.

148. The WPEB **NOTED** that safe handling and release guidelines should be developed for all bycatch groups where appropriate.

149. The WPEB **NOTED** that the document requires more information on animal welfare and that there is currently a lack of data on the stress experienced by animals in the field as such experiments are not authorized, i.e. data come from experiments conducted on animals in captivity. The WPEB **NOTED** that the animal welfare is beyond the scope of the WPEB and that the main objective of guidelines for fishermen should be to maximize the post-release survival.

150. The WPEB **DISCUSSED** the specific guidelines for the safe release of small cetaceans hooked by longlines as an example, but was unable to reach consensus on whether or not to recommend these to the SC. The WPEB **SUGGESTED** the discussion of this issue to continue intersessionally, and these discussions could be incorporated into the intersessional meeting outlined in para 153 and 154 below.

151. The WPEB **NOTED** information paper IOTC-2020-WPEB16-INF03 on Whale distribution in the Northern Arabian Sea along the Coast of Pakistan in 2019 based on the information obtained through fisheries crew-based observer programme.

152. The WPEB **NOTED** a report on the IWC Bycatch Mitigation Initiative, which summarized three information papers: IOTC-2020-WPEB16-INF04: Summary prepared for the IOTC 15th Working Party on Ecosystems and Bycatch – Report of the IWC Workshop on Bycatch Mitigation opportunities in the Western Indian Ocean and Arabian Sea. IOTC-2020-WPEB16-INF05: Report of the IWC 68B Scientific Committee – abridged excerpt. IOTC-2020-WPEB16-INF06: Draft report: Meeting on collaborative activities for cetacean bycatch, IOTC-IWC.

153. Regarding the development of management advice on the status of marine mammal species, the WPEB **NOTED** that there was a need to conduct an Ecological Risk Assessment for cetaceans (as already detailed in the WPEB Plan of Work for 2021); to work towards filling cetacean bycatch data gaps; to review best practice guidelines for safe release of cetaceans; and to consider the update of Resolution 13/04 (On the Conservation of Cetaceans).

154. The WPEB **RECOMMENDED** that an intersessional meeting of a subgroup of cetacean bycatch specialists and other interested scientists continue work on these issues prior to the next WPEB meeting.

10.2 Seabirds.

155. The WPEB **ENDORSED** the extension of a LoU between IOTC and ACAP based on the productive past collaborations facilitated by this agreement.

10.3 Sea Turtles

156. The WPEB **NOTED** paper IOTC-2020-WPEB16-23 on species estimation of unidentified bycatch sea turtles in the Indian Ocean using Random Forest, including the following abstract provided by the authors:

> *"We attempted to classify unidentified sea turtles that were recorded as bycatch by scientific observers boarded on Japanese longline vessels in the IOTC area with using a random forest model. We constructed two models using only the IOTC area data, and combining the IOTC and the ICCAT data and compared the model performance. Both models showed high accuracy in species estimates."*

11. WPEB Program of Work (Research and Priorities)

11.1 Revision of the WPEB Program of Work 2021–2025

157. The WPEB **NOTED** paper IOTC–2020–WPEB16–10 which provided the WPEB16 with the latest Program of Work (2021-2025) 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.

158. The WPEB **RECOMMENDED** that the SC consider and endorse the WPEB Program of Work (2021–2025), as provided in Appendix XIX.

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

159. 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 2021, by the Invited Expert:
    - **Expertise:** Shark assessment expert (possibly with data poor experience). The Blue shark assessment would ideally be conducted by this expert.

12. Other Business

12.1 Date and place of the 17th and 18th Sessions of the Working Party on Ecosystems and Bycatch

160. The WPEB **NOTED** that China was due to host the 17th Session of the WPEB however the global CoVid-19 pandemic resulted in these plans being abandoned. The Secretariat will continue to liaise with CPCs to determine their interest in hosting these meetings in the future when this once again becomes feasible. 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 in September 2021. The meeting locations will be communicated by the IOTC Secretariat to the SC for its consideration at its next session in December 2020 (**Table 3**).

Table 3. Draft meeting schedule for the WPEB (2021 and 2022), proposed to continue to be held back-to-back with WPB.

	2021			2022		
Meeting	**No.**	**Date**	**Location**	**No.**	**Date**	**Location**
Working Party on **Billfish** (WPB)	19th	September (5d, TBC)	(TBC)	20th	(TBC)	(TBC)
Working Party on **Ecosystems and Bycatch** (WPEB)	17th	September (5d, TBC)	(TBC)	18th	(TBC)	(TBC)

12.2 Review of the draft, and adoption of the Report of the 16thSession of the Working Party on Ecosystems and Bycatch

161. The report of the 16th Session of the Working Party on Ecosystems and Bycatch (IOTC-2020-WPEB16-R) was **ADOPTED** intersessionally via correspondence.

162. The WPEB **RECOMMENDED** that the Scientific Committee consider the consolidated set of recommendations arising from WPEB16, 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

APPENDIX I
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APPENDIX II
AGENDA FOR THE 16TH WORKING PARTY ON ECOSYSTEMS AND BYCATCH

Date: 7- 10th September 2020
Location: Online
Venue: Microsoft Teams
Time: 12:00 – 16:00 (Seychelles time) daily
Chair: Dr Sylvain Bonhommeau (EU, France) **Vice-Chair:** Dr Mariana Tolotti (EU, France)/Mr Mohammed Koya (India)

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

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

3. **THE IOTC PROCESS: OUTCOMES, UPDATES AND PROGRESS**
   3.1. Outcomes of the 22nd Session of the Scientific Committee (IOTC Secretariat)
   3.2. Progress on the recommendations of WPEB15 (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. Updated status of development and implementation of NPOA for seabirds and sharks, and the implementation of the FAO guidelines to reduce marine turtle mortality in fishing operations (CPCs)
   5.2. Species identification tools

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

7. **STOCK ASSESSMENT FOR SHORTFIN MAKO SHARK**
   7.1. Review of indicators for shortfin mako shark (all)
   7.2. Stock assessment models (all)
   7.3. Review of the proposed stock assessment of shortfin mako shark (IOTC Secretariat)
   7.4. Recommendation and executive summary for shortfin mako shark (all)

8. **INDICATORS FOR OCEANIC WHITETIP SHARK AND MOBULID RAYS, DATA PREPARATION FOR BLUE SHARK**
   8.1. Review of indicators for oceanic whitetip shark
   8.2. Review of indicators for mobulid rays
   8.3. Review of data for blue shark for assessment

9. **ECOSYSTEM MODELLING AND REPORT CARDS**
   9.1. Update on development of indicators for a system of ecosystem report cards (all)

10. BYCATCH, SPECIES INTERACTIONS, AND ECOSYSTEM RISK ASSESSMENTS FOR MARINE MAMMALS, SEABIRDS, AND SEA TURTLES

10.1. 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

10.2. Seabirds (all)

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

10.3. Sea turtles

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

11. WPEB PROGRAM OF WORK (RESEARCH AND PRIORITES)

11.1. Revision of the WPEB Program of Work 2021–2025 (Chairperson and IOTC Secretariat)

11.2. Development of priorities for an Invited Expert at the next WPEB meeting (Chairperson)

12. OTHER BUSINESS

12.1. Review of the draft, and adoption of the Report of the 16th Working Party on Ecosystems and Bycatch (Chair)

APPENDIX III
LIST OF DOCUMENTS

Document	Title
IOTC-2020-WPEB16-01a	Agenda of the 16th Working Party on Ecosystems and Bycatch
IOTC-2020-WPEB16-01b	Annotated agenda of the 16th Working Party on Ecosystems and Bycatch
IOTC-2020-WPEB16-02	List of documents of the 16th Working Party on Ecosystems and Bycatch
IOTC-2020-WPEB16-03	Outcomes of the 22nd Session of the Scientific Committee (IOTC Secretariat)
IOTC-2020-WPEB16-04	Outcomes of the 23rd Session of the Commission (IOTC Secretariat)
IOTC-2020-WPEB16-05	Review of Conservation and Management Measures relevant to ecosystems and bycatch (IOTC Secretariat)
IOTC-2020-WPEB16-06	Progress made on the recommendations and requests of WPEB15 and SC22 (IOTC Secretariat)
IOTC-2020-WPEB16-07	Review of the statistical data and fishery trends for ecosystems and bycatch species (IOTC Secretariat)
IOTC-2020-WPEB16-08	Update on the implementation of the IOTC Regional Observer Scheme (IOTC Secretariat)
IOTC-2020-WPEB16-09	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-2020-WPEB16-10	Revision of the WPEB Program of Work (2020–2024) (IOTC Secretariat & Chairperson)
IOTC-2020-WPEB16-11	8 years of Best Practices onboard French and associated flags tropical tuna purse seiners: an overview in the Atlantic and Indian Oceans (Maufroy A., Gamon A., Vernet A.-L. and Goujon M)
IOTC-2020-WPEB16-12	Trend in bycatch in the tuna longline fishery in India with reference to the biology of dominant species of pelagic sharks occurring in it (Kar A B, Silambarasan K, Solomon S, Varghese S and Ramalingam L.)
IOTC-2020-WPEB16-13	Feasibility study on applying CK abundance estimates to an IOTC shark species (Rodríguez-Ezpeleta N, et al.)
IOTC-2020-WPEB16-14	Genome scan allows discriminating independent populations in blue shark (Nikolic N, Delvoo-Delva F, Bailleul D, Noskova E, Rougeux C, Liautard-Haag C, Hassan M, Marie A, Borsa P, Feutry P, Grewe P, Davies C, Farley J, Fernando D, Biton Porsmoguer S, Poisson F, Marsac F, Arnaud-Haond S)
IOTC-2020-WPEB16-15	Updated Fishery Indicators for Shortfin Mako Shark (Isurus Oxyrinchus) Caught by the Portuguese Pelagic Longline Fishery in the Indian Ocean: Catch, Effort and Standardized CPUEs (Coelho R, Santos C and Rosa D)
IOTC-2020-WPEB16-16	Standardized catch rates of shortfin mako (Isurus oxyrinchus) caught by the Spanish surface longline fishery targeting swordfish in the Indian Ocean during the period 2001-2018 (Ramos-Cartelle A, Fernández-Costa J, and Mejuto J.)
IOTC-2020-WPEB16-17	Preliminary Modelling for the Stock Assessment of Shortfin Mako Shark, Isurus oxyrinchus using CMSY and JABBA (Bonhommeau S, Chassot E, Barde J, de Bruyn P, Fiorellato F, Nelson L, and Fu D. and Nieblas A.E.)
IOTC-2020-WPEB16-18	The impact of the IOTC fisheries on mobulid rays: status and interactions, data availability, and recommendations for management (Flounders L)
IOTC-2020-WPEB16-19	A review of mobulid ray interactions with fisheries for tuna and tuna-like species in the Indian Ocean (Martin S)
IOTC-2020-WPEB16-20	Updated CPUE of blue shark (Prionace glauca) in the Indian Ocean estimated from Japanese observer data between 1992 and 2019 (Kai M and Semba Y)
IOTC-2020-WPEB16-21	Trend of catch and effort on the blue shark (Prionace glauca) as bycatch of Indonesian tuna longline fishery (Wujdi A)
IOTC-2020-WPEB16-22	Cetacean bycatch in Indian Ocean tuna gillnet fisheries (Anderson R.C., Herrera M., Ilangakoon A.D., Koya K.M., Moazzam M., Mustika P.L. and Sutaria D.N.)
IOTC-2020-WPEB16-23	Species Estimation of Unidentified Bycatch Sea Turtles in the Indian Ocean using RandomForest (Sato Y, Masubuchi T, Yamamoto A, Shibano A, Kanaiwa
IOTC-2020-WPEB16-24	Distribution and abundance of sunfish (Family Molidae) in the Northern Arabian Sea based on data collected through the Observer Programme of WWF-
IOTC-2020-WPEB16-25	Guidelines for the Safe and Humane Handling and Release of Bycaught Small Cetaceans from Fishing Gear (CMS, IWC, WWF)

Document	Title
IOTC-2020-WPEB16-26	Safe Handling and Release Guide for Gillnet Fisheries: Whale sharks, Manta & Devil Rays, Sea turtles (WWF Pakistan)
Information papers	
IOTC-2020-WPEB16-INF01	The third progress report on the implementation of the IOTC bigeye thresher shark post-release mortality study project (IOTC BTH PRM Project) (IOTC BTH PRM Project Team)
IOTC-2020-WPEB16-INF02	Report of the 2019 joint Tuna RFMO bycatch meeting (Anon)
IOTC-2020-WPEB16-INF03	Whale distribution in the Northern Arabian Sea along Coast of Pakistan in 2019 based on the information obtained through fisheries crew-based observer programme (Moazzam M, Nawaz R, Khan B, Ahmed S)
IOTC-2020-WPEB16-INF04	Summary prepared for the IOTC 15th Working Party on Ecosystems and Bycatch – Report of the IWC Workshop on Bycatch Mitigation opportunities in the Western Indian Ocean and Arabian Sea
IOTC-2020-WPEB16-INF05	Report of the IWC 68B Scientific Committee – abridged excerpt
IOTC-2020-WPEB16-INF06	Draft report: Meeting on collaborative activities for cetacean bycatch, IOTC-IWC
IOTC-2020-WPEB16-INF07	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-2020-WPEB16-INF08	Age-Structured Biomass Dynamics of North Atlantic Shortfin Mako with Implications for the Interpretation of Surplus Production Models (Winker H, Carvalho F and Kerwath S)
IOTC-2020-WPEB16-INF09	Initial Results for North and South Atlantic Shortfin Mako (Isurus Oxyrinchus) Stock Assessments Using the Bayesian Surplus Production Model Jabba and the Catch-Resilience Method Cmsy (Winker H, Carvalho F, Sharma R, Parker D and Kerwath S)

APPENDIX IV

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

Extract from IOTC–2020–WPEB16–07.
(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 by fleet are presented in **Fig. A1.** Total reported nominal catches of sharks by CPC / fishing entity from 1950–2018 for Yemen (YEM), Tanzania (TZA), Taiwan,China (TWN,CHN), Pakistan (PAK), Oman (OMN), Maldives (MDV), Madagascar (MDG), Sri Lanka (LKA), I.R.Iran (IRN), Indonesia (IDN) and all others combined (OTH). Note: Data from Maldives is until 2010 as it does not have a fishery for sharks since 2010 and prohibits retention of live shark bycatch

Very few fleets reported catches of sharks in the '50s, 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 '90s, reaching a peak of approximately 90,000 Mt in 1999. Since then, nominal catches have fluctuated and are currently at around 60,000 Mt (in 2018). Shark catches reduced significantly when compared with 2017 mostly due to a complete disappearance of reported catches of aggregated shark species by India (not replaced by detailed catches by species) as well as marked decreases in reported shark catches from other CPCs (Mozambique and Indonesia) which in some cases are thought to represent reporting issues rather than real reduction in CPUE.

Furthermore, the revisions to Pakistani gillnet catches from 1987 onwards endorsed by the SC in December 2019, introduce an average yearly decrease of around 17,000 Mt in total catches during the concerned period when compared to previously available data.

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 into 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 IV) 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.

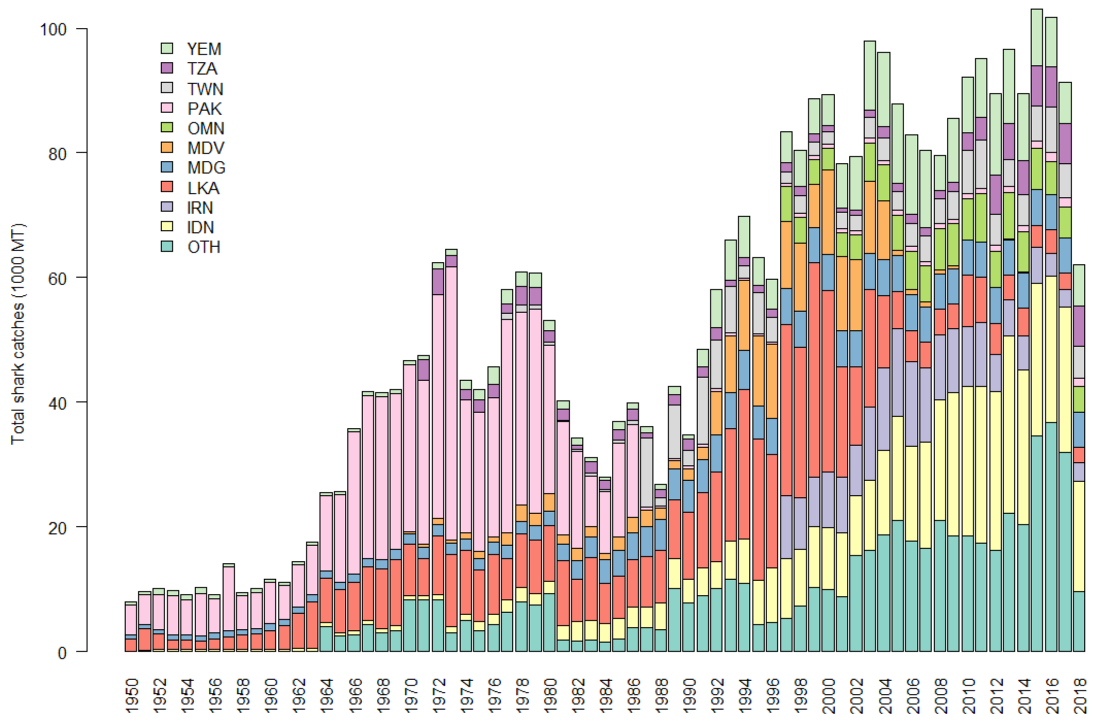


Fig. A1. Total reported nominal catches of sharks by CPC / fishing entity from 1950–2018 for Yemen (YEM), Tanzania (TZA), Taiwan,China (TWN,CHN), Pakistan (PAK), Oman (OMN), Maldives (MDV), Madagascar (MDG), Sri Lanka (LKA), I.R.Iran (IRN), Indonesia (IDN) and all others combined (OTH). Note: Data from Maldives is until 2010 as it does not have a fishery for sharks since 2010 and prohibits retention of live shark bycatch

Main reported gear types associated with shark bycatch for IOTC fisheries

Fig. A2. shows the distribution of catches across gear type: gillnets are historically associated with the highest nominal catches of sharks 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 '90s, and handline and troll line fisheries which have increased in more recent years. A revision of gillnet catches by Pakistan from 1987-2018 has impacted the average shark catches of the CPC to the point where these are close to negligible whereas they previously reported the second highest average yearly catches of all CPCs: other CPCs including Oman, Indonesia and Mozambique have also reported marked decreases in generalised shark catches, with these revised data still to be further verified with the CPCs to ensure their validity. Catches of shark have been forbidden in the Maldives since 2010, as is the retention of live bycatch of these species. Of the gillnet fisheries, the majority comprises standard, unclassified gillnets, followed by gillnets, handlines and troll lines and gillnet/longline combinations. **Fig. A3** shows the main gear types used by fleets since 2000.

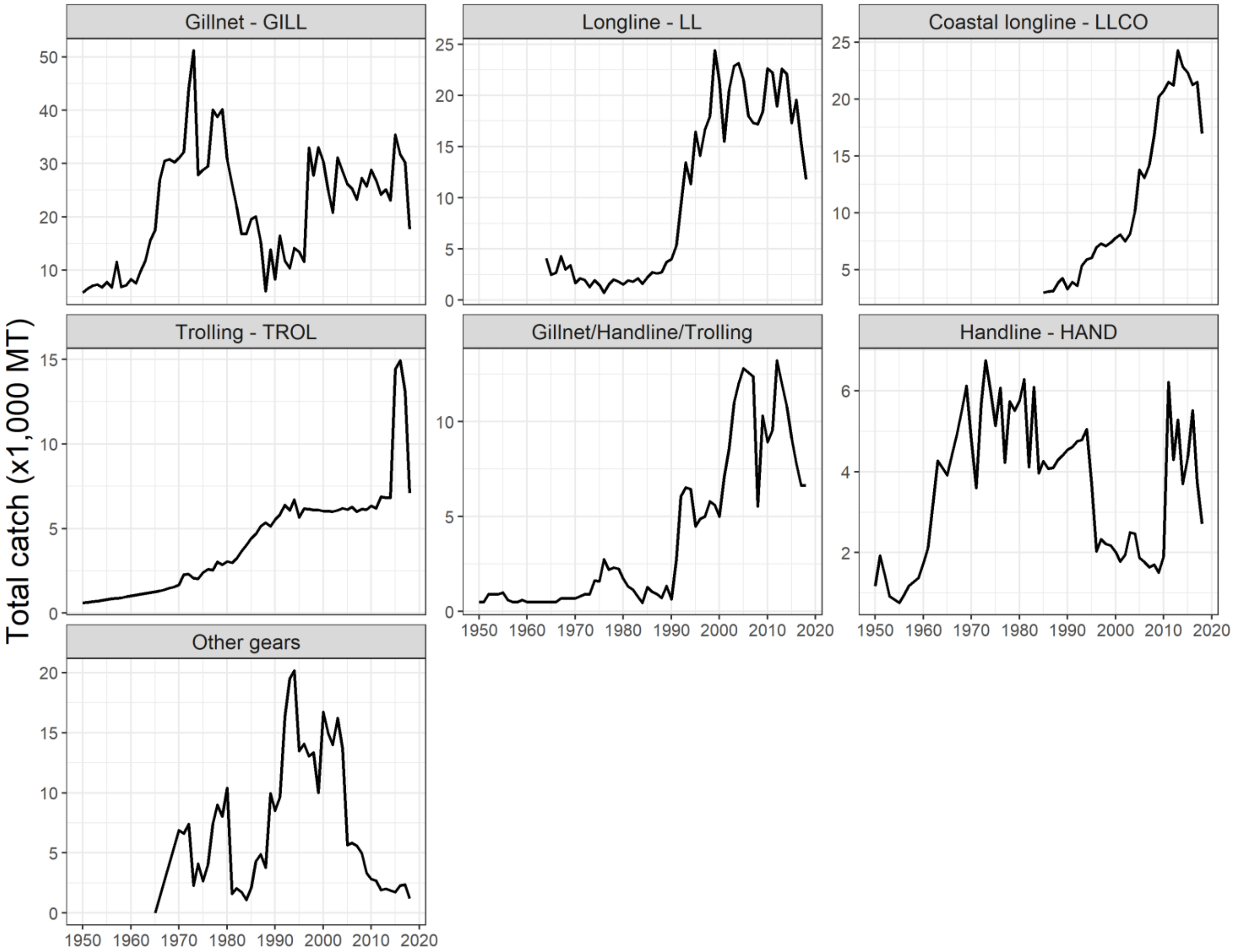


Fig. A2. Nominal catches of sharks reported by gear type (1950–2018) for gillnets (GILL), handlines (HAND), lines (LINE), longlines (LL), purse seine (PS), small purse seines / ring nets (PSS), troll lines (TROLL) and all other gear types combined (OTHER)

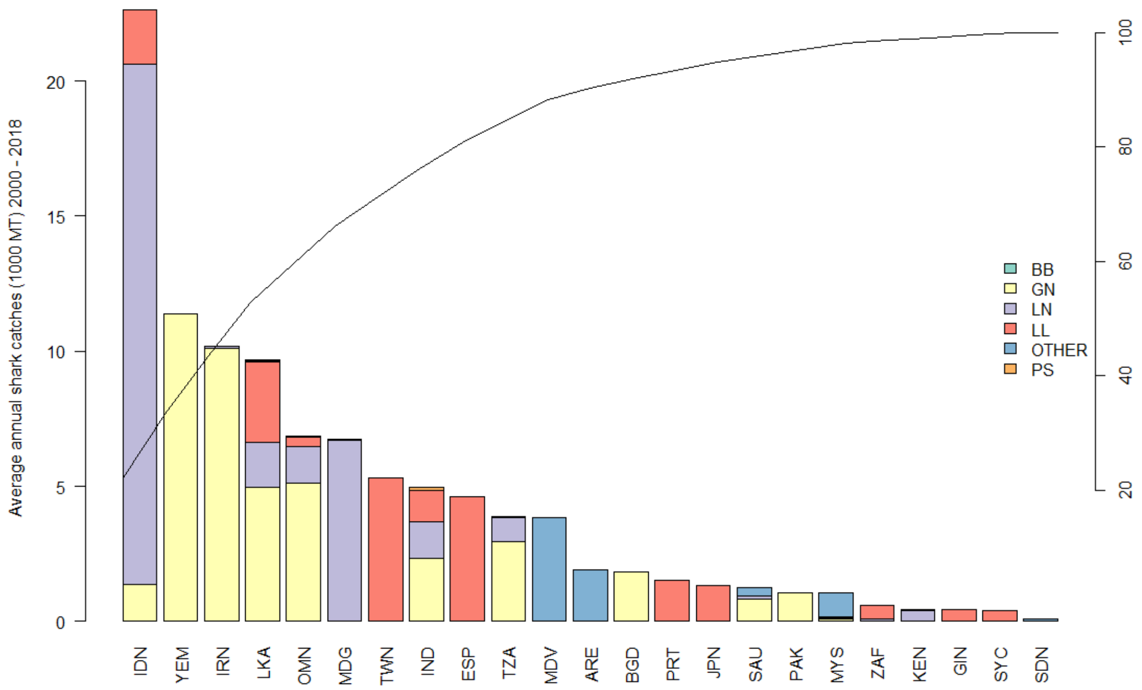


Fig. A3. Average annual level of sharks caught and retained by CPC and gear type groups in recent years (2000-2018). The black line represents the cumulative percentage of total catch in the same period. Note: Data from Maldives is until 2010 as it does not have a fishery for sharks since 2010 and prohibits retention of live shark bycatch

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 II. 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 identified to species/genus (**Fig. A4**).

In 2018 there was a large reduction in the percentage of shark catch data reported as aggregated compared with the previous year: this is predominantly accounted for by the reduction in shark catches reported by India which were previously reported largely as aggregated rather than by species. Oman reported stable levels of shark catches but improved their reporting by species which also contributes to the decrease in the proportion of aggregated shark catch data. Of the shark catches reported by species, blue shark forms the greatest proportion, comprising around 60% of total catches, with silky, milk, thresher, hammerhead, mako, oceanic whitetip sharks and manta rays forming a smaller percentage **(Fig. A5).**

The increase in reporting by species is apparent in the species-specific catch series (**Fig. A6**) with steadily increasing trends in reporting since the '70s seen for blue, thresher, hammerhead 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. A7** 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.

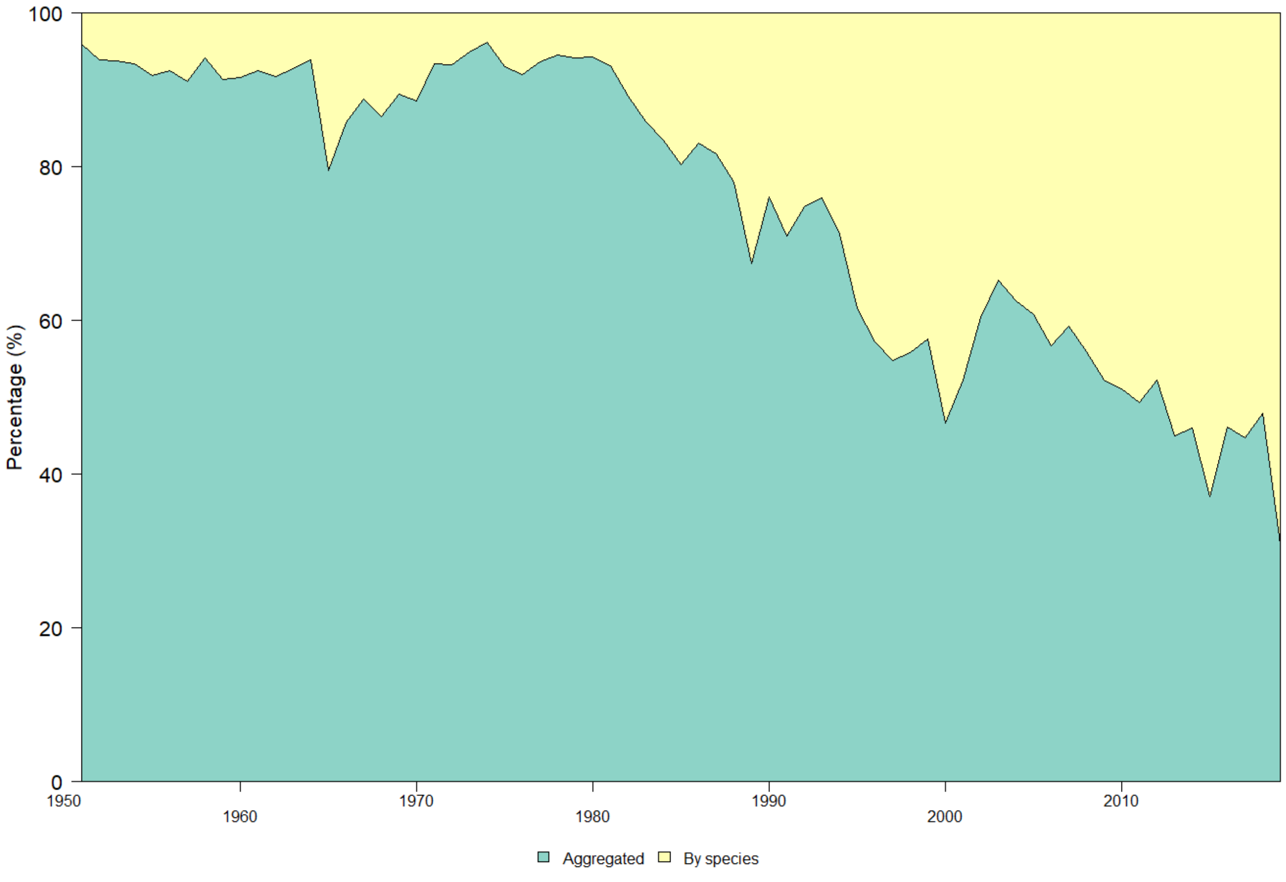


Fig. A4. Yearly percentage of shark catches reported as aggregated or by species

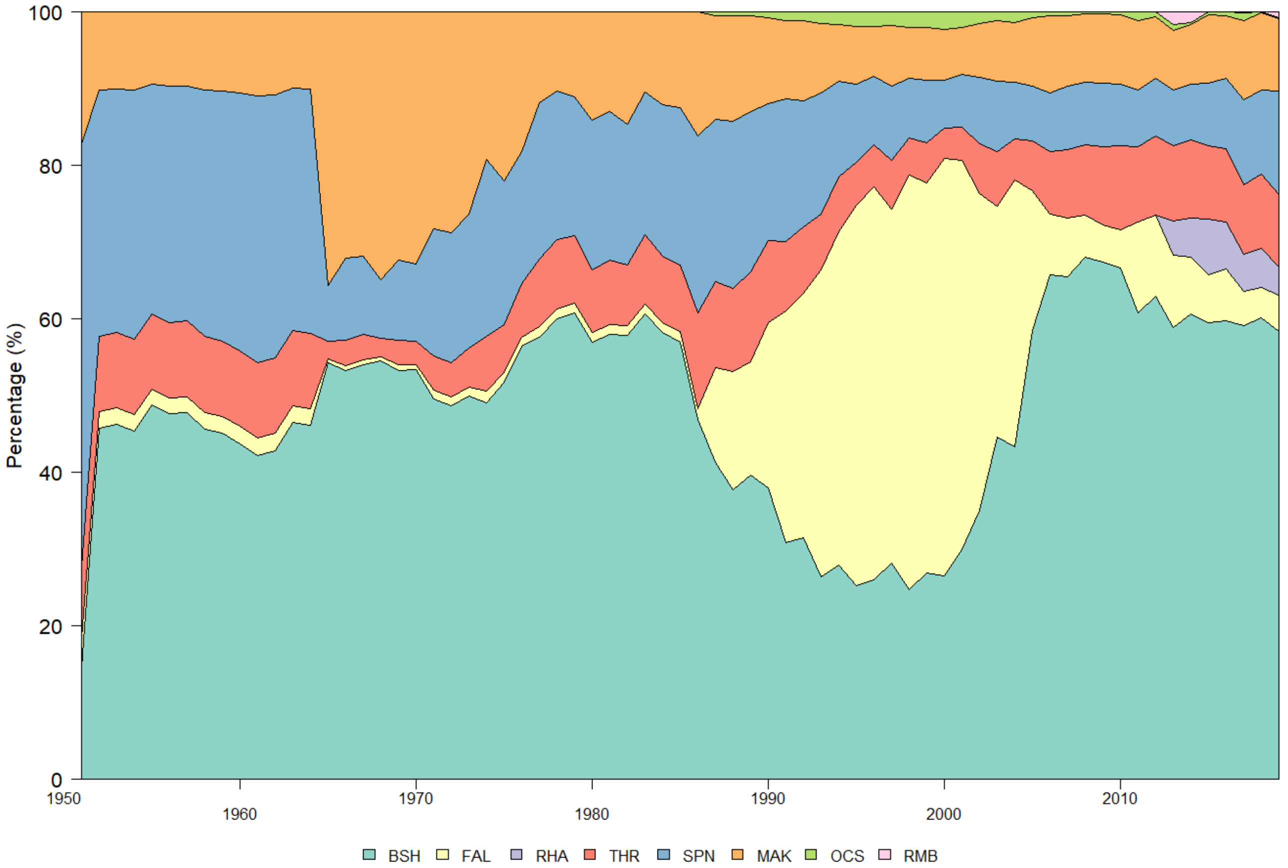


Fig. A5. Yearly percentage of nominal shark catches by species

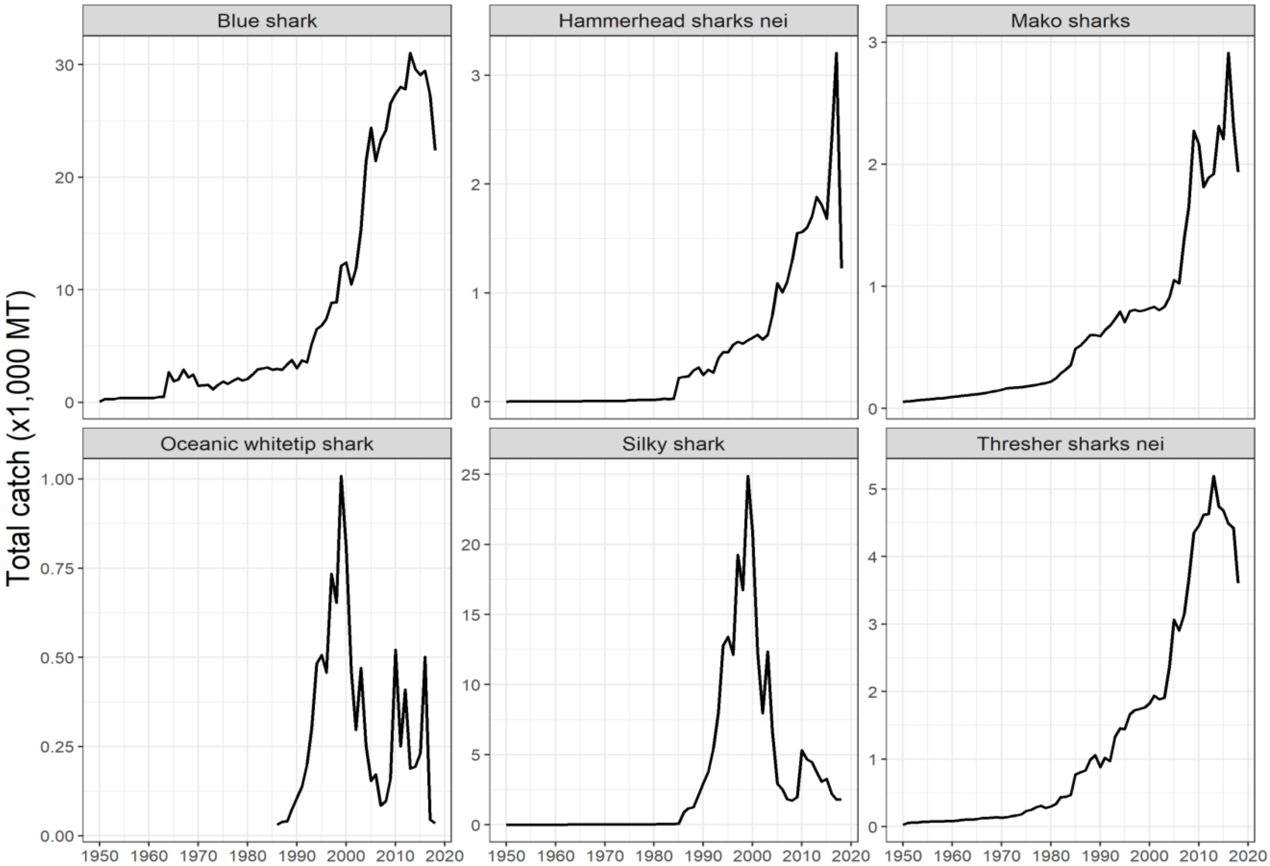


Fig. A6. Total nominal catches by species for all fleets (1950-2018)

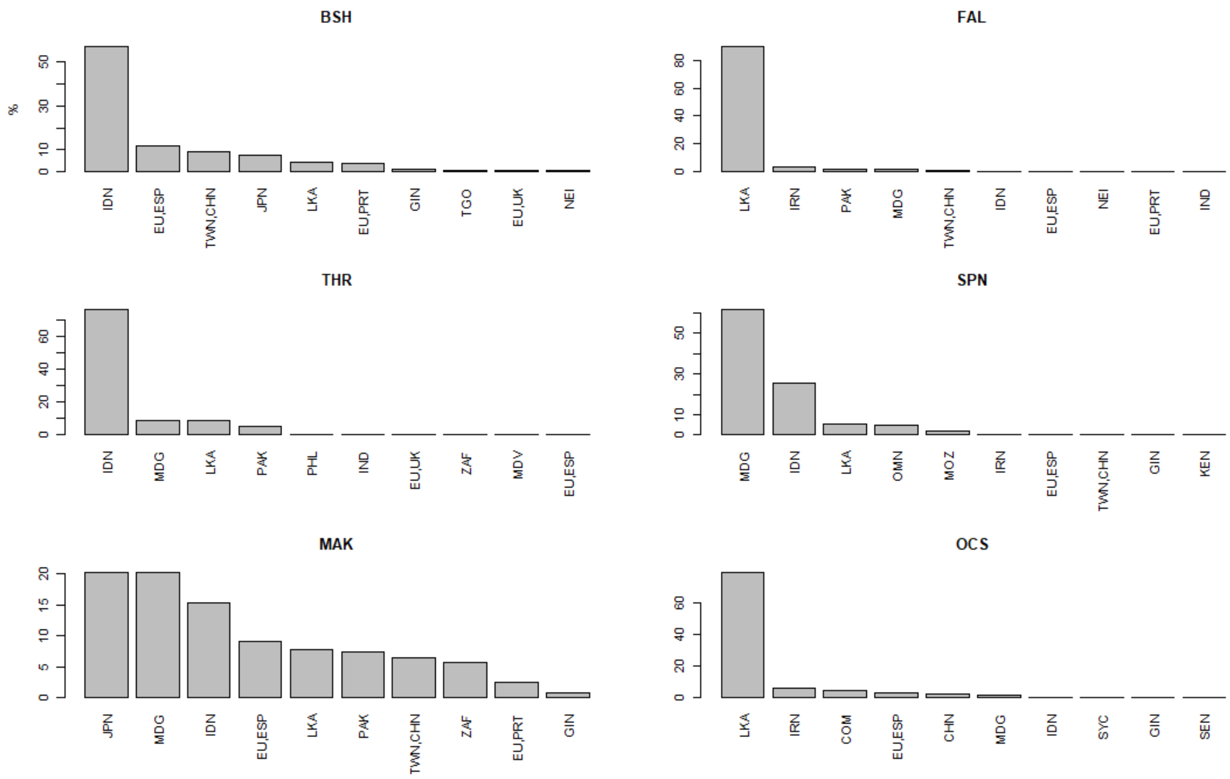


Fig. A7. CPCs' contribution (%) by major shark species for blue (BSH), silky (FAL), thresher (THR), hammerhead (SPN), mako (MAK) and oceanic-whitetip (OCS) sharks.

Trends in species catches by gear types are summarised in

Table A1. 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, the level of species-specific reporting is improving, particularly by the gillnet fleet of I.R. Iran (**Fig. A8**). 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 Yemen and I.R. Iran.

Table A1. Proportion of species-specific shark catches by gear type from 2005–2018 for baitboats / pole-and-line (BB), gillnets (GILL), handlines (HAND), lines (LINE), longlines (LL), purse seines (PS), small purse-seines and ringnets (PSS) and troll lines (TROL)

	BB	GILL	HAND	LINE	LL	PS	PSS	TROL
OTH	100%	85%	14%	97%	20%	26%	87%	69%
BSH	0%	4%	58%	0%	63%	0%	2%	0%
FAL	0%	4%	0%	2%	5%	74%	7%	1%
RHA	0%	3%	0%	0%	0%	0%	0%	0%
THR	0%	0%	17%	0%	0%	0%	0%	3%
SPN	0%	1%	7%	1%	0%	0%	3%	20%
MAK	0%	1%	3%	0%	11%	0%	0%	6%

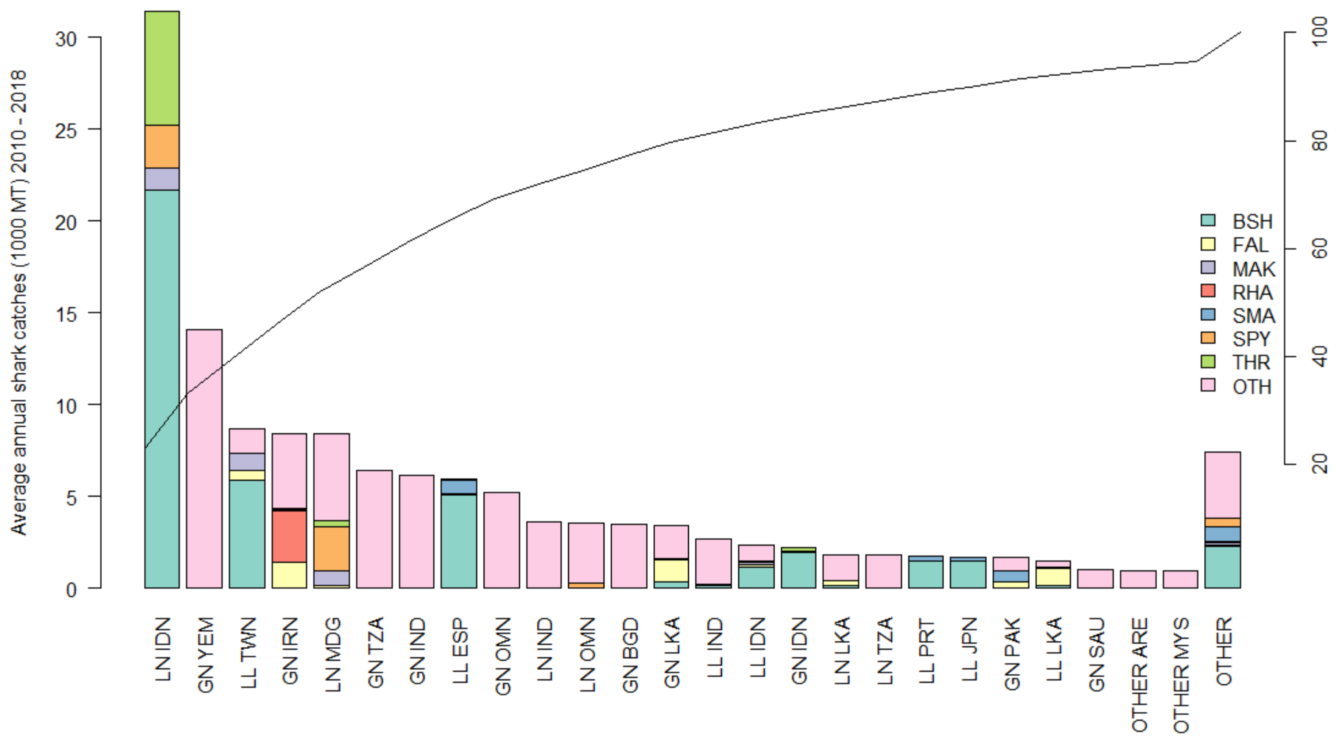


Fig. A8. Annual average level of sharks caught and retained reported by CPC and species for 2010–2018 and CPC's cumulative contribution (%) of total shark catch in the same period

[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 gillnetters harvest important amounts of pelagic sharks, industrial purse seiners, pole-and-liners and most coastal fisheries are unlikely to harvest important quantities of pelagic sharks.

- **Pole and line fisheries:** shark catches reported for the pole and line fisheries of Maldives and India are very low: 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 with low concentrations of pelagic sharks**: the gillnet fisheries of most coastal countries operate these gears in coastal waters, where the abundance of pelagic sharks is thought to be low.
  - **Gillnets operated in areas with 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 levels of pelagic sharks since the mid-'80s. 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 '00s. 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 catch 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 '90s. The catches of sharks recorded for these fleets are thought to be more realistic than those recorded for other longline fisheries. The high catches are thought to be due to:
  - **Gear configuration and time fished**: 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.

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

   - **Area fished**: 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 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[3]. 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 proportion of the total catch of tuna and tuna-like species that other species of shark make up might change depending on the area fished and the time of day.
- **Fig. A9** 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.

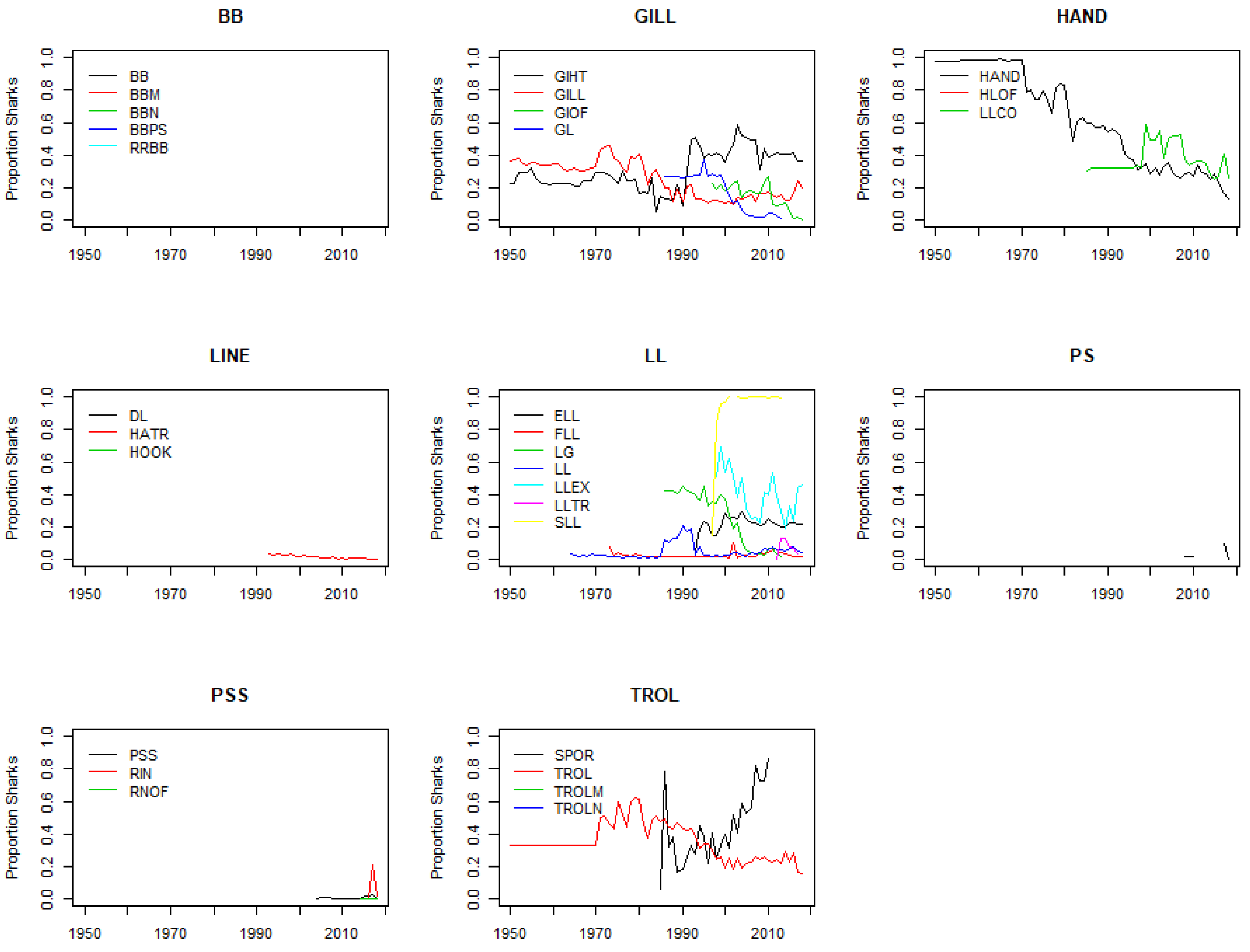


Fig. A9. Proportion of reported shark catch as a fraction of total reported catch by gear type over time

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

3 Ruiz, J. et al. (2018) 'Bycatch of the European and associated flag purse-seine tuna fishery in the Indian ocean for the period 2008-2017', IOTC-2018-WPEB14-15, p. 15)

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 IV. 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. A10 shows the aggregated fork length frequency distribution for the fleets reporting size information on shortfin mako sharks for all areas between 2005 and 2018. The data reported for vessels flagged for: China, Taiwan,China EU,Spain, EU,Great Britain, EU,Portugal, EU,Reunion, India, Japan, Korea, Sri Lanka, Mozambique, Mauritius and South Africa include data reported for fleets with observers onboard. The results highlight the difference in size of the individuals caught by different fleets with China on average catching larger shortfin mako sharks than the other fleets.

Fig. A11 shows the aggregated length frequency distributions of shortfin mako sharks from the purse seine fleets of Seychelles and EU,Spain and the longline fleets of Japan and EU,France as collected by scientific observers and reported as part of the ROS data submissions: the limited data available still permits to highlight the difference in size of individuals caught by the two longline fleets.

Fig. A12 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.

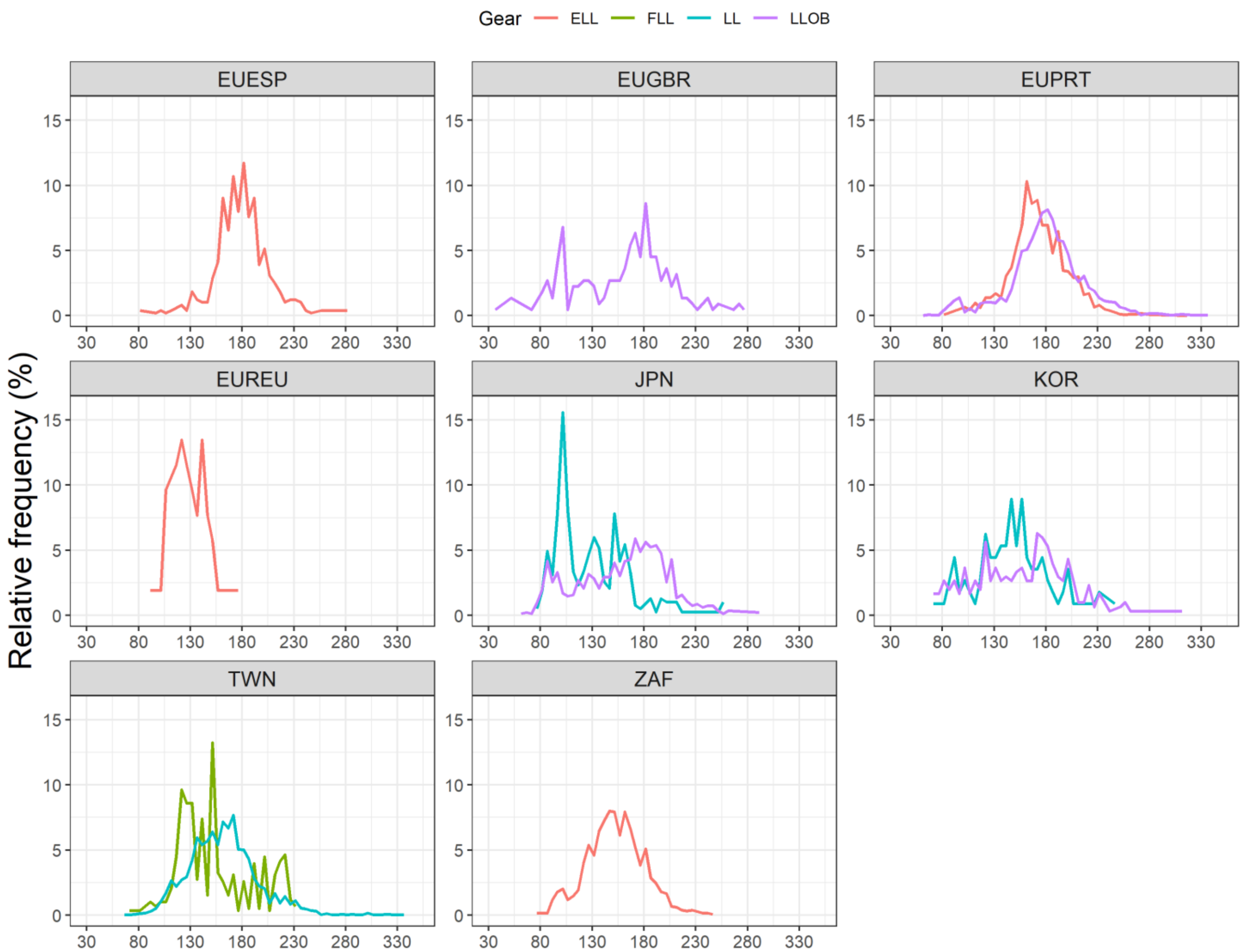


Fig. A10. Fork length frequency distributions (%) of shortfin mako shark derived from the samples reported for the fleets of China (CHN LL, LLOB), EU,Spain (EUESP ELL), EU,Portugal (EUPRT ELL, LLOB), EU,Great Britain (EUGBR LL), EU,France (Reunion) (EUREU ELL, ELLOB, HAND), Japan (JPN LL, LLOB), Korea (KOR LL, LLOB), Mozambique (MOZ ELL, HAND), Mauritius (MUS ELL), Taiwan,China (TWN,CHN FLL, LL)) and South Africa (ZAF ELL) between 2005 and 2018 in 5 cm length classes. Note: there were very few data provided by Sri Lanka and India so these were not included

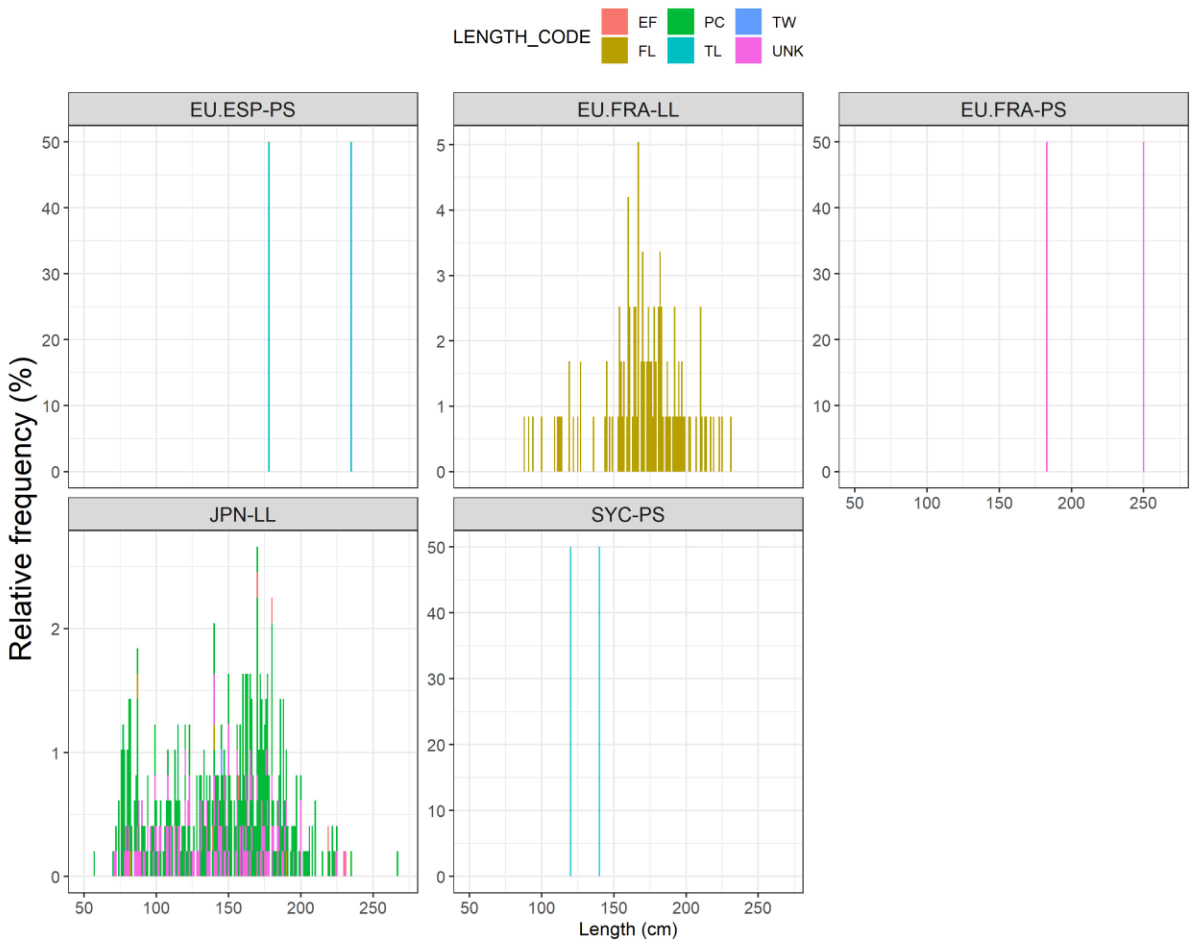


Fig. A11. Length frequency distributions (%) of shortfin mako sharks derived from the samples reported by onboard scientific observers (ROS data) for the purse seine fleets of EU,Spain (EU.ESP) and Seychelles (SYC) and the longline fleets of Japan (JPN) and EU,France (EU.FRA) between 2005 and 2019 in 5 cm length classes.

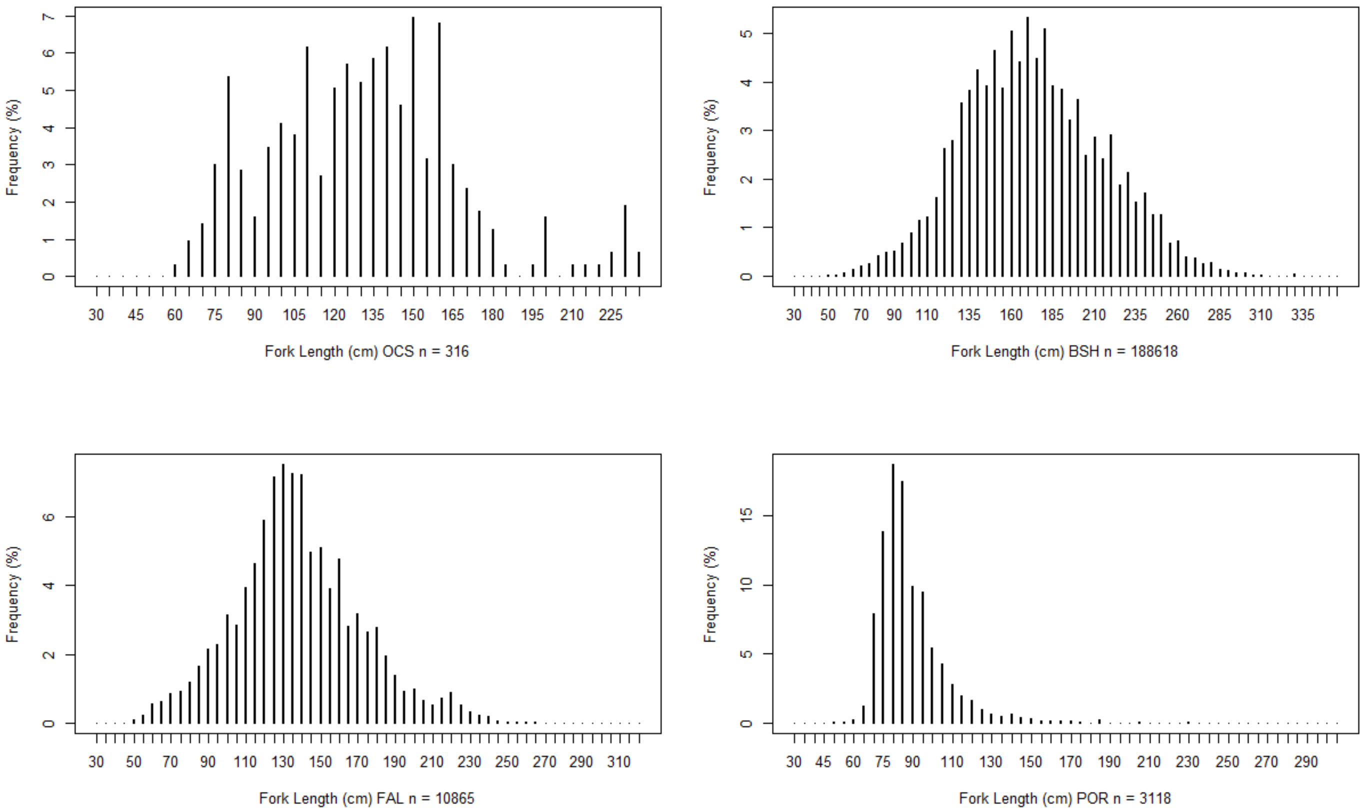


Fig. A12. Fork length frequency distributions (%) for oceanic whitetip shark (OCS), blue shark (BSH), shortfin mako shark (SMA) and porbeagle shark (POR) between 2005 and 2018

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 A2.**[4].

Table A2. Main species of seabirds likely to be incidentally caught on longline operations

Common Name	Status*	Scientific Name
Amsterdam Albatross	Endangered	*Diomedea amsterdamensis*
Antipodean Albatross	Vulnerable	*Diomedea antipodensis*
Black-browed Albatross	Least Concern	*Thalassarche melanophrys*
Buller's Albatross	Near Threatened	*Thalassarche bulleri*
Campbell Albatross	Vulnerable	*Thalassarche impavida*
Chatham Albatross	Vulnerable	*Thalassarche eremite*
Grey-headed Albatross	Endangered	*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*
Cape/Pintado Petrel	Least Concern	*Daption capense*
Great-winged Petrel	Least Concern	*Pterodroma macroptera*
Grey Petrel	Near Threatened	*Procellaria cinerea*
Short-tailed Shearwater	Least Concern	*Puffinus tenuirostris*
Sooty Shearwater	Endangered	*Puffinus griseus*
Cape Gannet	Endangered	*Morus capensis*
Flesh-footed Shearwater	Near Threatened	*Puffinus carneipes*

***Source** IUCN 2020, BirdLife International 2004b.

[4] As in IOTC–2007–WPEB–22, Appendix 2, page 24. Paper submitted on behalf of the 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 (**Fig. A13**). 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).

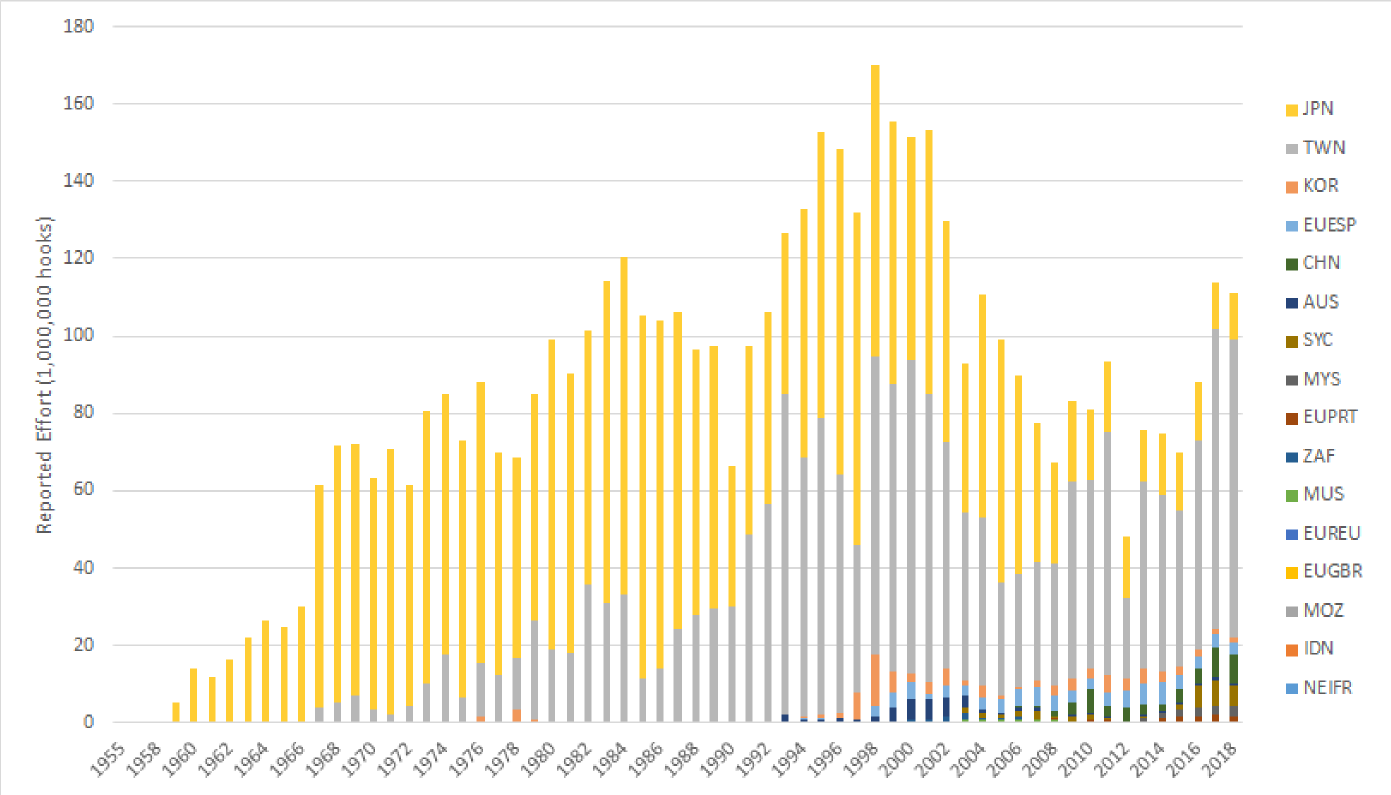


Fig. A13. Reported longline effort for fleets operating south of 25° south between 1955 and 2018 for Thailand (THA), EU,UK (EUGBR), Malaysia (MYS), EU,Portugal (EU,PRT), EU,France / Réunion (EUREU), Mauritius (MUS), South Africa (ZAF), Seychelles (SYC), China (CHN), Australia (AUS), EU,Spain (EUESP), Rep. of Korea (KOR), Taiwan,China (TWN,CHN) and Japan (JPN))

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.[5]

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 A3.**

Table A3. Main species of Indian Ocean marine turtles[6].

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).

[5] IOTC-2016-SC19-INF02

[6] 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–2020–WPEB16–07

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**: Revised nominal catch data have been provided from 1987 onward, with species-specific shark data available from 2018 only. However catch and effort data have not been 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** (Malaysia): data not provided or not reported by IOTC standards. Indonesia has reported catch and effort data since 2018 but the level of coverage is very low with only minor reported catches of blue shark
- **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, Madagascar and Yemen**: data not provided;
- **Coastal fisheries of Oman**: data not reported by IOTC standards.
- **Coastal fisheries of Indonesia**: catch and effort data has been reported since 2018 for coastal fisheries but coverage is very low with minor reported catches of some shark species

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, and Thailand have not provided estimates of total quantities of discards of sharks, by species, for industrial purse seiners under their flag. 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. Madagascar reported size frequency data for blue shark and smooth hammerhead shark for 2018 in 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. Madagascar reported size frequency data for blue shark and smooth hammerhead shark for 2018 in their coastal fisheries. **Fresh tuna longline fishery**: Indonesia have provided size frequency data for sharks for the fresh longline fleet for 2018 based on observer data

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 non-standardized 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 these 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, 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. Seychelles provided data on discards of marine turtles from their purse seine fleet for 2018.

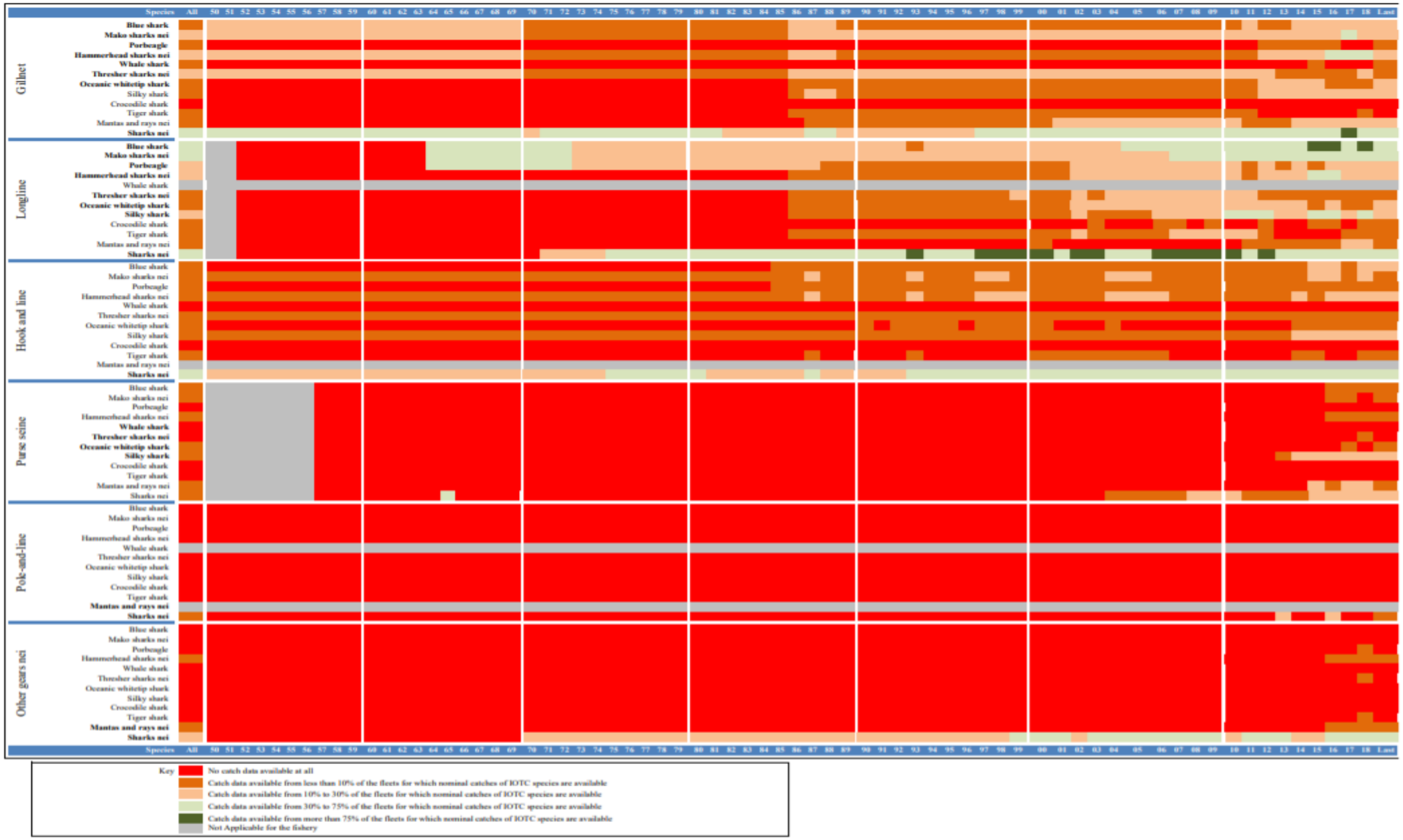
While a number of CPCs have been mentioned specifically here, as they have important fisheries or have not provided any information, there are still many CPCs that are providing data that are not consistent with the IOTC minimum reporting standards: this includes not reporting bird bycatch data by species (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–2020–WPEB16–07

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[7] for which data on IOTC species are available, by fishery, species of shark, and year, for the period 1950–2018.



[7] 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.

- 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 1950–2018 and 2010–2018 are shown in columns ***All*** and ***Last***, respectively.

Appendix VII
Implementation of the Regional Observer Scheme

Extract from IOTC–2020–WPEB16–08

(Updated September 2020)

CPCs		Vessels on active list (2019)					Accredited observers		Number of observer reports provided																				
		LL	PS	GN	BB	Tot	Number	Last update	2010		2011		2012		2013		2014		2015		2016		2017		2018		2019		Totals
									O	E	O	E	O	E	O	E	O	E	O	E	O	E	O	E	O	E	O	E	
MEMBERS																													
Australia		3	7		1	11	21		2		1		3				2	4		11		28							51
China	CHN	88				88	4	2020-06	1				1		1		2		1		4		4		5		4		23
	TWN, CHN	260				260	54						1		19		18		26		18		20		21		24		147
Comoros						0	7		N/A		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		10	45	16	92	10	92	23	116	24	135		111		121		110		105	1016
	ITA		1			1			N/A		N/A		N/A		N/A		N/A		6		4				10				20
	PRT	3				3	6	2019-10			1		1		1		1		1		1			1		1		1	9
	ESP	11	15			26	9								1		2			24		15	17		3	37		42	141
	GBR	2				2	3	2019-09																2		2			4
France (OT)						0	N/A	N/A			9		7		7		N/A		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		N/A
India						0																					N/A		0
Indonesia		242	73			315	9											5				7		4		5			21
Iran, Isl. Rep. of			5	1207		1212																					N/A		0
Japan		45	1			46	24	2020-01		8		11		10		6		14		12		9		9		11			90
Kenya						0	5				N/A		N/A		N/A		N/A		N/A			1			6		4		11
Korea, Rep. of		10	2			12	40		2				2		3		3		4		11		4		3				32
Madagascar		5				5	7						5		7		7		5										24
Malaysia		17				17																							0

CPCs	Vessels on active list (2019)					Accredited observers		Number of observer reports provided																				
	LL	PS	GN	BB	Tot	Number	Last update	2010		2011		2012		2013		2014		2015		2016		2017		2018		2019		Totals
								O	E	O	E	O	E	O	E	O	E	O	E	O	E	O	E	O	E	O	E	
MEMBERS																												
Maldives	28			365	393	4																	1		2		53	56
Mauritius	12	3			15	5	2019-04											5		8		4		9		9		35
Mozambique	4				4	11						1		N/A					7		3		2					13
Oman					0																			N/A		N/A		0
Pakistan					0																							0
Philippines					0													N/A		N/A		N/A		N/A		N/A		0
Seychelles	79	15			94	78											7		66		63		91		83		44	354
Sierra Leone	No information received																											0
Somalia	No information received																											0
South Africa	16			1	17	33	2019-08			12		10		13		10		16		5		8				18		92
Sri Lanka	633		549		1182	23										2		2		2					4		3	13
Sudan	No information received																											0
Tanzania, United Rep.of	1				1															1		N/A		N/A		N/A		1
Thailand					0	12	2019-10																	N/A		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		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		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		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		N/A
																												2176

- **Year** = year in which considered observed trip began with the vessel sailing from its origin port
- **Number of observer reports provided: E**: number of trips reported in a structured electronic format, **O**: number of trips reported in other formats, including non-structured electronic ones)
- ❖ Reports from Madagascar include observers onboard foreign vessels
- ❖ Reporting status for Japan and South Africa is in the process of being updated following the provisions of Resolution 19/07 (superseding Resolution 18/10) and regarding vessels chartering in the IOTC area

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

APPENDIX VIII

2020: 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 2020*)

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 fulfilled 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. In 2018 Australia finalised, 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 fulfil Australia's obligations under the FAO-Sea turtles Guidelines.

Bangladesh							**Sharks:** Bangladesh currently do not have a NPOA for sharks. The Wildlife Conservation and Security Act introduced in 2012 lays out general rules on requirements for hunting wild animals but no specific mention of sharks. The Wildlife Conservation and Security Act was introduced in 2012 states: No person shall hunt any wild animal without license, or import or export any wild animal without a CITES certificate **Seabirds:** Bangladesh currently do not have a NPOA for seabirds. The Wildlife Conservation and Security Act introduced in 2012 lays out general rules on permits required to hunt wild animals but no specific mention of seabirds **Marine turtles:** Bangladesh currently have no information on their implementation of FAO guidelines on sea turtles. The Wildlife Conservation and Security Act introduced in 2012 lays out general rules on requirements for hunting wild animals but no specific mention of turtles
China		–		–			**Sharks:** China is currently considering developing an NPOA for sharks. **Seabirds:** China is currently considering developing an NPOA for seabirds **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 imbricata, Lepidochelys olivacea* and *Dermochelys coriacea* are listed into List of Protected Species. Domestic Fisheries Management Regulation on Far Sea Fisheries request all fishing vessels must carry line cutters, de-hookers and hauling nets in order to facilitate the appropriate handling and prompt release of marine turtles caught or entangled.

Comoros		–		–			**Sharks:** No NPOA has been developed. Shark fishing is prohibited but measures are difficult to enforce due to the artisanal nature of the fisheries. A campaign to raise awareness of measures is being implemented to improve compliance. Shark catches and size frequency data are submitted to IOTC **Seabirds:** No NPOA has been developed. There is no fleet in operation south of 25 degrees south and no long-line fleet. The main fishery is artisanal operating within 24 miles of the coast where there is low risk of interactions with seabirds. **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 2012 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 for 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 2021. **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 plans to develop a NPOA for seabirds after the NPOA Sharks has been finalised. **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. Kenya plans to develop a NPOA for turtles after the NPOA Sharks has been finalised.
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 NPOA on Sharks was finalised in 2015 with the assistance of Bay of Bengal Large Marine Ecosystem (BoBLME) Project. 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. On 14th July 2019 the Government of Maldives officially announced the cessation of the Maldives Long line fishery in Maldives EEZ and High Seas so consider the NPOA for sharks to now be unnecessary **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 seabird entanglement and bycatch is not an issue in Maldives fisheries especially with the recent cessation of the Maldives Long line fishery. **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. Maldives considers that sea turtle entanglement and bycatch is not an issue in Maldives fisheries especially with the recent cessation of the Maldives Long line fishery.
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 25⁰S. 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 longline 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 the whole sharks is 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. The NPOA will be revised with input from relevant stakeholders when the current document expires at the end of 2020. **Seabirds:** SFA is developing a TOR to hire a consultant to develop a NPOA for seabirds in the Seychelles with a planned completion date of December 2020. **Marine turtles:** IOTC mandatory requirements for marine turtles are being addressed through the ATF (Certificate of Authorisation to Fish). Data reporting requirements are addressed via logbook and observer programmes.
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. A consultation process has begun in order to develop the NPOA for Sharks. **Seabirds:** There are no purse seine or long line vessels operating under the Somalia flag, the only fleet is a small-scale artisanal fishery. Seabird bycatch does not occur in this fishery. However, a consultation process has begun in order to develop the NPOA for Seabirds. **Marine turtles:** The Somali national fisheries law and legislation was reviewed and approved in 2014. This includes 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. A consultation process has begun in order to implement FAO guidelines on reducing sea turtle mortality.

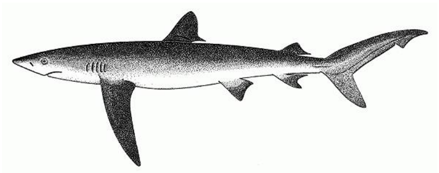
South Africa, Republic of		–		2008			**Sharks**: The NPOA-sharks was first approved and published in 2013. An update of the NPOA was provided in 2018. **Seabirds**: Published in August 2008 and fully implemented. The NPOA-seabirds is being reviewed and is due to be finalised in 2020. **Marine turtles**: 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 was finalized in 2013 and is currently being implemented. There is a revision planned to be completed before the end of 2020. **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:** An update on the progress of the implementation of the FAO Guideline to Reduce Sea Turtle Mortality in Fishing Operation in 2019 was submitted to IOTC in March 2020. Marine turtles are legally protected in Sri Lanka and it is prohibited to catch them. Longline 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 and Sri Lanka are in the process of phasing out the use of gill nets within its EEZ with a view to enforcing complete prohibition of gill nets by 2022. 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:** The second NPOA-sharks has been finalised for the period 2020-2024. **Seabirds:** Development of the NPOA has not begun. The Department of Fishing Vessels Operating in the IOTC Competence Area includes the following regulations: fishing vessels using longlines shall arrange line cutter and de-hookers for releasing aquatic animals; and for longline vessels operating in the area south of 25ºS it is mandatory to use bird-scaring lines and to fix line weights at the bird scaring lines before shooting. **Marine turtles:** Thailand report progress of the implementation of FAO guidelines to reduce sea turtle mortality to the IOTC. Purse seiners are prohibited to catch marine turtles and care must be taken to look after any turtles that are caught injured before re-releasing them. Longliners must carry de-hookers and line cutters to facilitate the handling and release of turtles caught or entangled
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. Encounters of illegal fishing are fully documented and reported through the Compliance committee, but these would not be covered by NPOAs as they concern foreign flagged fishing vessels. **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 and unharmed. 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) including maintaining records of turtle nests encountered during island patrols.

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 A4. Blue shark: Status of blue shark (*Prionace glauca*) in the Indian Ocean.

Area	Indicators		2018 stock status determination
Indian Ocean	Reported catch 2018	22,385 t	72.6%
	Estimated catch 2015	54,735 t	
	Not elsewhere included (nei) sharks[2] 2018	19,768 t	
	Average reported catch 2014-18	27,566 t	
	Average estimated catch 2011–15	54,993 t	
	Ave. not elsewhere included (nei) sharks[2] 2014-18	38,511 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)	

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}≥ 1)
Stock subject to overfishing(F_{2015}/F_{MSY}> 1)	0%	27.4%
Stock not subject to overfishing (F_{2015}/F_{MSY}≤ 1)	0%	72.6%
Not assessed/Uncertain		

Table A5. 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 Red List 2020, 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. A14.** 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

). 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. A14.** 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

). 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. A14, Table A4**). 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 A5**). 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 A4**).

Outlook. Increasing effort could result in declines in biomass. The Kobe II Strategy Matrix (**Table A6**) 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 A6**). 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 A6**). 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** (2014–18): Coastal longline; longline (deep-freezing); longline targeting swordfish.
- **Main fleets** (2014–18): Indonesia; Taiwan,China; EU,Spain; EU,Portugal; Japan, Sri Lanka, Seychelles.

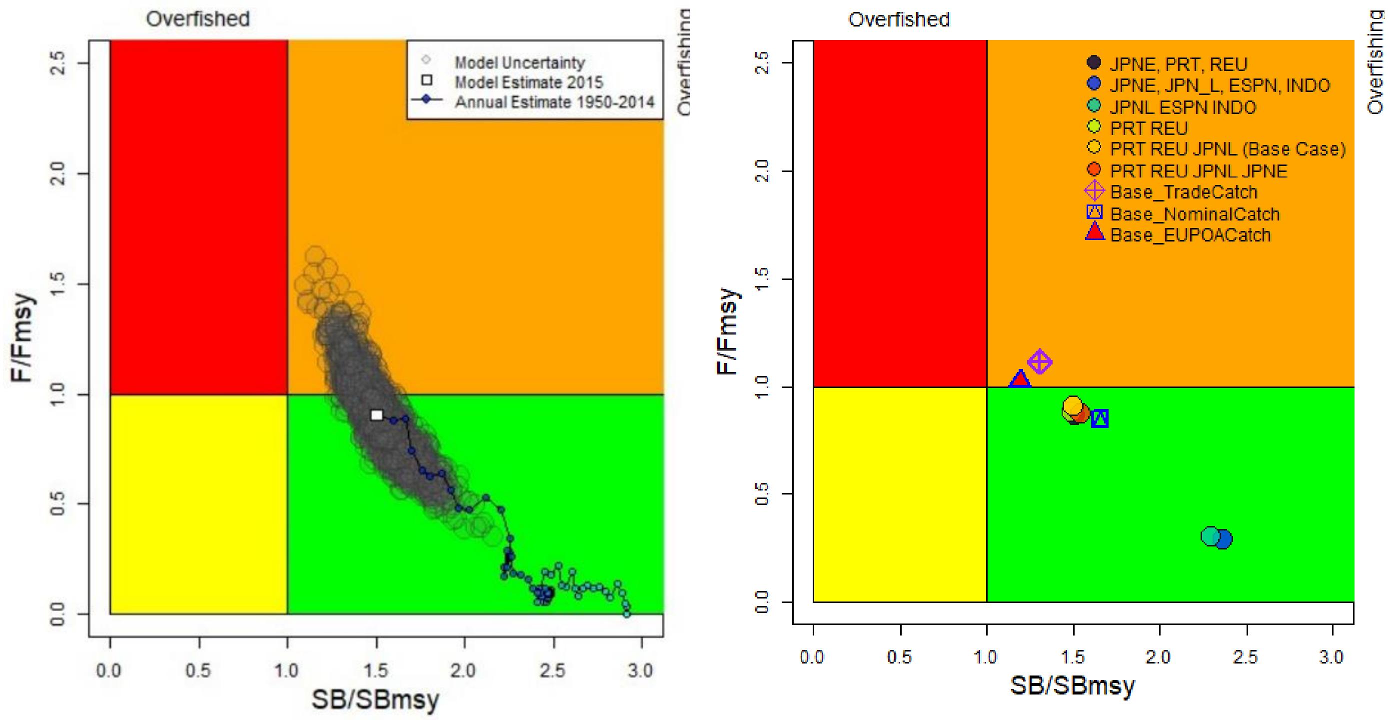


Fig. A14. Blue shark: Aggregated Indian Ocean stock assessment Kobe plot for the 2017 estimate based on the base case model and a range of sensitivity models explored with several catch reconstructions and fits to CPUE series. (Left panel: base case model with trajectory and MCMC uncertainties in the terminal year; Right panel: terminal year estimates of the sensitivity model runs). All models shown are run using SS3 - Stock Synthesis III

Table A6. 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)

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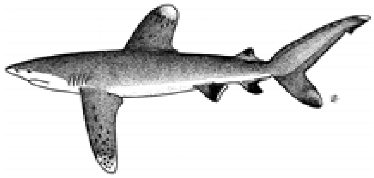
APPENDIX X
EXECUTIVE SUMMARY: OCEANIC WHITETIP SHARK

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 A7. 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 2018	35 t	
	Not elsewhere included (nei) sharks[2] 2018	19,768 t	
	Average reported catch 2014-18	201 t	
	Av. not elsewhere included 2014-2018 (nei) sharks[2]	38,511 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 A8. 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*	Critically 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 Red List 2020, 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 A7**). 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 'Critically Endangered' applies to oceanic whitetip sharks globally (**Table A8**). 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 A7**).

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** (2014-18): Troll line; Gillnet; offshore gillnet.
- **Main fleets** (2014-2018): Comoros; I.R. Iran; Sri Lanka; Indonesia; India; and Maldives; (Reported as discarded/released alive by China, Maldives, Korea, France, Mauritius, Australia, South Africa, Sri Lanka, Japan).

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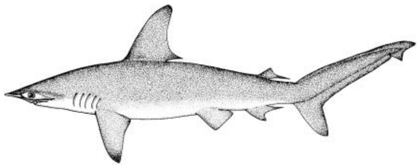
APPENDIX XI

EXECUTIVE SUMMARY: SCALLOPED HAMMERHEAD SHARK

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



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

CITES APPENDIX II species

Table A9. Status of scalloped hammerhead shark (*Sphyrna lewini*) in the Indian Ocean.

Area[1]	Indicators		2018 stock status determination
Indian Ocean	Reported catch 2018	45 t	
	Not elsewhere included (nei) sharks[2] 2018	19,768 t	
	Average reported catch 2014-18	62 t	
	Av. not elsewhere included 2014-2018 (nei) sharks[2]	38,511 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 A10. 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 shark	*Sphyrna lewini*	Critically 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 Red List 2020, Baum 2007

INDIAN OCEAN STOCK – MANAGEMENT ADVICE

Stock status. The current IUCN threat status of 'Critically Endangered' applies to scalloped hammerhead sharks globally but specifically for the western Indian Ocean the status is 'Endangered' (**Table A10**). 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 A9**).

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** (2014-2018): Ringnet; Gillnet; longline-coastal; longline (fresh) and offshore gillnet.
- **Main fleets** (2014-18): Sri Lanka; Kenya; 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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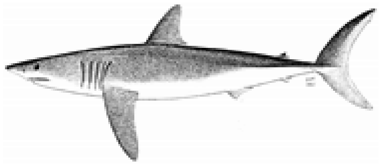

Status of the Indian Ocean shortfin mako shark (SMA: *Isurus oxyrinchus*)

Table A11. 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 2018	1,499 t	
	Not elsewhere included (nei) sharks[2] 2018	19,768t	
	Average reported catch 2014-18	1,582 t	
	Av. not elsewhere included (nei) sharks[2] 2014-18	38,511 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 A12. 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 Red List 2020, 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 A11**). 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 ''Endangered' applies to shortfin mako sharks globally (**Table A12**). Trends in the Japanese standardised CPUE series from its longline fleet has declined from 1999 to 2004, but has remained relatively stable since 2005. Conversely, trends in EU,Portugal longline standardised CPUE series have been increasing since 2008 as has the trends in the EU,Spain and Taiwanese longline series (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 is vulnerable to overfishing. Although an attempt was made to assess the shortfin mako stock in 2020, there is no quantitative stock assessment currently available for shortfin mako shark in the Indian Ocean. Therefore, the stock status is **unknown**. This highlights the need for further work on data improvement and provision of abundance indices as well as utilizing complimentary approaches (e.g. genetic tools) to inform the trends in abundance of the stock.

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 global catch and effort on shortfin mako shark has declined in the southern and eastern areas, and may have resulted in localised depletion there. It should be noted that subsequent to the past assessment, shortfin mako has been placed on CITES Appendix II and therefore this may influence the landings in the future.

Management advice. In the absence of a stock assessment and noting conflicting information, the Commission should take a cautious approach by implementing some management actions that reduces fishing mortality on 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** (2014-18): Longline targeting swordfish; longline (fresh); longline (targeting sharks); gillnet.
- **Main fleets** (2014-18): EU,Spain; South Africa; EU,Portugal; Japan, I.R. 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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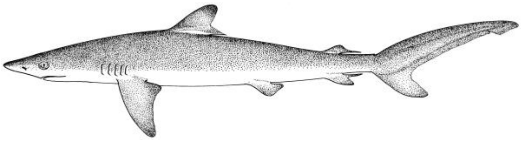

Status of the Indian Ocean silky shark (FAL: *Carcharhinus falciformis*)

Table A13. Silky shark: Status of silky shark (*Carcharhinus falciformis*) in the Indian Ocean.

Area[1]	Indicators		2018 stock status determination
Indian Ocean	Reported catch 2018 Not elsewhere included (nei) sharks[2] 2018 Average reported catch 2014-18 Av. not elsewhere included (nei) sharks[2] 2014-18	1,815 t 19,768 t 2,442 t 38,511 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 A14. 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*	Vulnerable	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 Red List 2020

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 A13**). 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 but globally the status is 'Vulnerable' (**Table A14**). 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** (2014-18): Gillnet; offshore gillnet; longline-coastal; longline (fresh), , longline
- **Main fleets** (2014-18): I.R. Iran; Sri Lanka; Taiwan,China; Pakistan; .

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APPENDIX XIV
EXECUTIVE SUMMARY: BIGEYE THRESHER SHARK

Indian Ocean Tuna Commission
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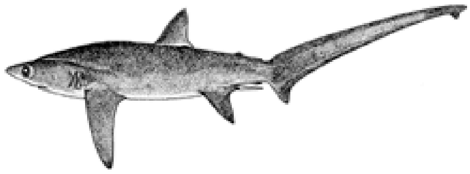

Status of the Indian Ocean bigeye thresher shark (BTH: *Alopias superciliosus*)

Table A15. Bigeye thresher shark: Status bigeye thresher shark (*Alopias superciliosus*) in the Indian Ocean.

Area[1]	**Indicators**		**2018 stock status determination**
Indian Ocean	Reported catch 2018	2 t	
	Not elsewhere included (nei) sharks[2] 2018	19,768 t	
	Average reported catch 2014-18	1 t	
	Av. not elsewhere included (nei) sharks[2] 2014-18	38,511 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 A16. 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 Red List 2020, 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 A15**). 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 A16**). 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 live 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*[8].

The following key points should also be noted:

- **Maximum Sustainable Yield (MSY)**: Not applicable. Retention prohibited.
- **Reference points**: Not applicable.
- **Main fishing gear** (2014–18): ~~Gillnet-longline; longline-gillnet~~. No report after 2012. (reported as discard from gillnet and longline).
- **Main reporting fleets** (2014–18): ~~Sri Lanka~~ (reported as discarded/released alive: South Africa, Sri Lanka, Japan, Korea, EU,France, Indonesia); India

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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 XV
EXECUTIVE SUMMARY: PELAGIC THRESHER SHARK

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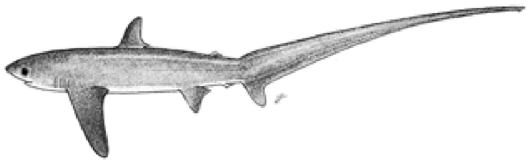

Status of the Indian Ocean pelagic thresher shark (PTH: *Alopias pelagicus*)

Table A17. Pelagic thresher shark: Status pelagic thresher shark (*Alopias pelagicus*) in the Indian Ocean.

Area[1]	Indicators		2018 stock status determination
Indian Ocean	Reported catch 2018	401 t	
	Not elsewhere included (nei) sharks[2] 2018	19,768 t	
	Average reported catch 2014-18	348 t	
	Av. not elsewhere included (nei) sharks[2] 2014-18	38,511 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 A18. 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*	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 Red List 2020, 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 A17**). 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 'Endangered' applies to pelagic thresher shark globally (**Table A18**). 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*[9].

The following key points should also be noted:

- **Maximum Sustainable Yield (MSY)**: Not applicable. Retention prohibited.
- **Reference points**: Not applicable.
- **Main fishing gear** (2014-18): Gillnet. ~~Gillnet-longline; longline-gillnet~~.(reported as discard/ released from gillnet and longline).
- **Main fleets** (2014-18): Pakistan (reported as discarded/released alive: Japan, Korea, Sri Lanka, South Africa, Indonesia).

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[9] 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 A19. 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[10]
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 2020, The IUCN Red List of Threatened species. <www.iucnredlist.org>. Downloaded on 16 September 2020

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 A19**. 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) presented in 2018 (Williams et al., 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 (Wallace et al., 2011). Bycatch and mortality from gillnet fisheries have greater population-level impacts on marine turtles relative to other gear types, such as longline, purse seine and trawl fisheries in the Indian Ocean (Wallace et al., 2013). Population levels of impacts of leatherback turtles caught in longline gear in the Southwest Indian Ocean were also identified as a conservation priority.

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

[10] IUCN, 2020. The process of the threat assessment from IUCN is independent from the IOTC and is presented for information purpose only

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 (Aranda, 2017) 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 (Nel et al., 2013) estimated that ~3,500 and ~250 marine turtles are caught by longline and purse seine vessels, respectively, per annum, with an estimated 75% of turtles released alive[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.

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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 A20. 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[11]**
Albatross		
Atlantic Yellow-nosed Albatross	*Thalassarche chlororhynchos*	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	*Diomedea 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 A20**. 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

[11] 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 A21. 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*	LC	-
Balaenopteridae	Common minke whale	*Balaenoptera acutorostrata*	LC	-
	Antarctic minke whale	*Balaenoptera bonaerensis*	NT	-
	Sei whale	*Balaenoptera borealis*	EN	PS
	Bryde's whale	*Balaenoptera edeni/brydei*	LC	-
	Blue whale	*Balaenoptera musculus*	EN	-
	Fin whale	*Balaenoptera physalus*	VU	-
	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*	LC	GN
	Dwarf sperm whale	*Kogia sima*	LC	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 bowdoini*	DD	-
	Blainville's beaked whale	*Mesoplodon densirostris*	DD	-
	Gray's beaked whale	*Mesoplodon grayi*	DD	-
	Hector's beaked whale	*Mesoplodon hectori*	DD	-
	Deraniyagala's beaked whale	*Mesoplodon hotaula*	DD	-
	Strap-toothed whale	*Mesoplodon layardii*	DD	-
	True's beaked whale	*Mesoplodon mirus*	DD	-
	Spade-toothed whale	*Mesoplodon traversii*	DD	-
	Shepherd's beaked Whale	*Tasmacetus 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

Delphinidae	Pygmy killer whale	*Feresa attenuata*	LC	GN
	Short-finned pilot whale	*Globicephala macrorhynchus*	LC	LL, GN
	Long-finned pilot whale	*Globicephala melas*	LC	-
	Risso's dolphin	*Grampus griseus*	LC	LL, GN
	Fraser's dolphin	*Lagenodelphis hosei*	LC	-
	Irrawaddy dolphin	*Orcaella brevirostris*	EN	GN
	Australian snubfin dolphin	*Orcaella heinsohni*	VU	GN
	Killer whale	*Orcinus orca*	DD	LL, GN
	Melon-headed whale	*Peponocephala electra*	LC	LL, GN
	False killer whale	*Pseudorca crassidens*	NT	LL, GN
	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*	LC	-
	Spinner dolphin	*Stenella longirostris*	LC	GN
	Rough-toothed dolphin	*Steno bredanensis*	LC	GN
	Indo-Pacific bottlenose dolphin	*Tursiops aduncus*	NT	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
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INDIAN OCEAN STOCK – MANAGEMENT ADVICE

Stock status. The current[12] 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 A21**. 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 (Anderson, 2014). Many reports (e.g. Sabarros et al., 2013) also suggest some level of cetacean mortality for species involved in depredation of pelagic longlines, and these interactions need to be further documented throughout the IOTC Area of Competence. Recently published information suggests that the incidental capture of cetaceans in purse seines is low (e.g. Escalle et al., 2015), but should be further monitored.

Outlook. Resolution 13/04 *On the conservation of cetaceans* highlights the concerns of the IOTC regarding the lack of accurate and complete data collection and reporting to the IOTC Secretariat of interactions and mortalities of cetaceans 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

[12] September 2020

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 (Anderson, 2014).
- Current reported interactions and mortalities are scattered, but are most likely severely underestimated.
- Maintaining or increasing fishing effort in the Indian Ocean without appropriate mitigation measures in place will likely result in further declines in a number of cetacean species. An increasing effort by tuna drift gillnet fisheries has been reported to the IOTC, which is a major cause of concern for a number of species, particularly in the northern Indian Ocean.
- Appropriate mechanisms should be developed by the Compliance Committee to ensure CPCs comply with their data collection and reporting requirements for cetaceans.

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APPENDIX XIX
WORKING PARTY ON ECOSYSTEMS AND BYCATCH PROGRAM OF WORK (2021–2025)

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 A22: Priority topics for obtaining the information necessary to develop stock status indicators for bycatch in the Indian Ocean; and
Table A23: Stock assessment schedule.

Table A22. Priority topics for obtaining the information necessary to develop stock status indicators for bycatch species in the Indian Ocean

Topic in order of priority	Sub-topic and project	Timing				
		2021	2022	2023	2024	2025
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. This may include Next Generation Sequencing (NGS), Nuclear markers (i.e. microsatellite) as well as other components of close-kin mark recapture studies (CKMR).					
2. Connectivity, movements, habitat use and post release mortality	Electronic tags (PSATs, SPOT, Splash MiniPAT) to assess the efficiency of management resolutions on non-retention species (BSH in LL, marine turtles and rays in GIL and PS, whale sharks) and to determine connectivity, movement rates and mortality estimates.					
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))					

	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					
	3.3 Reproduction research Priority species: blue shark (BSH), shortfin mako shark (SMA) and oceanic whitetip shark (OCS), and silky shark (FAL)					
	3.4 Ecological Risk Assessment (cetaceans)					

Other Future Research Requirements (not in order of priority)

Topic	Sub-topic and project	2021	2022	2023	2024	2025
1. Fisheries data collection	1.1 Historical data mining for the key species and IOTC fleets (e.g. as artisanal gillnet and longline coastal fisheries) including (Workshops – leader?):					
	1.1.1 Capacity building of fisheries observers (including the provision of ID guides, training, etc. Fishing gear guides from SPC)					
	1.1.2 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					
	1.2 Implementation of the Pilot Project (Resolution 16/04) for the Regional Observer Scheme					

	1.2.1 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)					
	1.2.2 Development of a Regional Observer database and population with historic observer data					
	1.2.3 Development, piloting and implementation of an electronic reporting tool to facilitate data reporting					
	1.2.4 Development and trial of Electronic Monitoring Systems for gillnet fleets					
	1.2.5 Port sampling protocols for artisanal fisheries					
	1.3 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 of CPC scientists					
4. Bycatch mitigation measures	Develop studies on bycatch mitigation measures (operational, technological aspects and best practices)					
	4.1 Sharks a) Harmonise and finalise guidelines and protocols for safe handling and release of sharks and rays caught on longlines and gillnets fisheries					
	4.2 Sea turtles 4.2.1 Res. 12/04 (para. 11) Part I. The IOTC Scientific Committee shall request the IOTC Working Party on Ecosystems and Bycatch to:					
	a) Develop recommendations on appropriate mitigation measures for gillnet, longline and purse seine fisheries in the IOTC area; [mostly completed for LL and PS]					
	b) Develop regional standards covering data collection, data exchange and training					
	4.2.2 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.					
	4.2.3 Regional workshop to review the effectiveness of marine turtle mitigation measures					
	4.3 Seabirds 4.3.1 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.					
	4.3.2 Bycatch assessment for seabirds taking into account the information from the various ongoing initiatives in the IO and adjacent oceans					
	4.3.3 Study on cryptic mortality of seabirds in tuna LL fisheries.					
	4.3.4 Post release survival rates for seabirds and review of safe release techniques.					
	4.4 Cetaceans 4.4.1 Collate all data available on bycatch of key species interacting with all tuna fisheries in the IOTC area (tuna drift gillnets, longlines, purse seines)					

	4.4.2 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					
	4.4.3 Testing mitigation methods for cetacean bycatch in tuna drift gillnet fisheries					
	4.4.4. Intersessional meeting to discuss cetacean guidelines, ERA, Data gaps.					
5. CPUE standardisation / Stock Assessment / Other indicators	5.1 Develop standardised CPUE series for each key shark species and fishery in the Indian Ocean					
	5.1.1 Development of CPUE guidelines for standardisation of CPC data.					
	5.1.2 Blue shark: Priority fleets: TWN,CHN LL, EU,Spain LL, Japan LL; Indonesia LL; EU,Portugal LL					
	5.1.3 Shortfin mako shark: Priority fleets: Longline and Gillnet fleets					
	5.1.4 Oceanic whitetip shark: Priority fleets: Longline fleets; purse seine fleets					
	5.1.5 Silky shark: Priority fleets: Purse seine fleets					
	5.2 Joint CPUE standardization across the main LL fleets for silky shark, using detailed operational data					
	5.3 Stock assessment and other indicators					
6. Bycatch and discards	6.1 Review proposal on retention of non-targeted species					

	6.1.1 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.					
7. Ecosystems	10.1 Develop a plan for Ecosystem Approach to Fisheries (EAF) approaches in the IOTC, in conjunction with the Common Oceans Tuna Project.					
	7.1.2 Workshop for CPCs on continuing efforts to the development of an EAF including delineation of candidate eco regions within IOTC.					
	7.1.3 Practical Implementation of EBFM with the development and testing of ecosystem report cards.					
	7.1.4 Evaluation of EBFM plan in IOTC area of competence by the WPEB to review its elements components and make any corrective measures.					
	7.2 Assessing the impacts of climate change and socio-economic factors on IOTC fisheries					
	7.3 Evaluate alternative approaches to ERAs to assess ecological risk					

7.4 Progress on Climate webpage on IOTC website and liaise with WPDCS for technical implementation					

Table A23. Draft: Assessment schedule for the IOTC Working Party on Ecosystems and Bycatch 2021–2025 (adapted from IOTC–2019–SC22–R).

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

Working Party on Ecosystems and Bycatch					
Species	**2021**	**2022**	**2023**	**2024**	**2025**
Blue shark	Data preparatory meeting Full assessment	-	–	–	Data preparatory meeting Full assessment
Oceanic whitetip shark	–	Indicator analysis	–	Data preparation	Indicator analysis
Scalloped hammerhead shark	–	Assessment*	–	–	–
Shortfin mako shark	–	–		Data preparation Full assessment	–
Silky shark	Data preparatory meeting Assessment*;	-	–	Assessment*;	–
Bigeye thresher shark	–	Assessment*		–	–
Pelagic thresher shark	–	Assessment*		–	–
Porbeagle shark	–	–	Assessment*	–	–
Mobulid Rays				Interactions/ Indicators	–
Marine turtles	–	–	Indicators	–	–
Seabirds	–	Review of mitigation measures in Res. 12/06	–	–	–
Marine Mammals	Review of mitigation measures in Res. 12/13/04	–	–	–	Review of mitigation measures
Ecosystem Based Fisheries Management (EBFM) approaches	ongoing	ongoing	ongoing	ongoing	ongoing

APPENDIX XX
CONSOLIDATED RECOMMENDATIONS OF THE 16TH SESSION OF THE WORKING PARTY ON ECOSYSTEMS AND BYCATCH

Note: Appendix references refer to the Report of the 16thSession of the Working Party on Ecosystems and Bycatch (IOTC–2020–WPEB16–R)

Marine Mammals

WPEB16.01 (para 154): The WPEB **RECOMMENDED** that an intersessional meeting of a subgroup of cetacean bycatch specialists and other interested scientists continue work on these issues prior to the next WPEB meeting.

Revision of the WPEB Program of Work 2021–2025

WPEB16.02 (para 1588): The WPEB **RECOMMENDED** that the SC consider and endorse the WPEB Program of Work (2021–2025), as provided in Appendix XIX

Review of the draft, and adoption of the Report of the 16th Session of the Working Party on Ecosystems and Bycatch

WPEB 16.03 (para 1622): The WPEB **RECOMMENDED** that the Scientific Committee consider the consolidated set of recommendations arising from WPEB16 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