Report of the 17th Session of the IOTC Working Party on Ecosystems and Bycatch

Microsoft Teams Online, 6 – 10 September 2021

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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	Memorandum of Understanding on the Conservation and Management of Marine Turtles and their Habitats of the Indian Ocean and South-East Asia
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 17th Session of the Indian Ocean Tuna Commission's (IOTC) Working Party on Ecosystems and Bycatch - Assessment Meeting (WPEB(AS)) was held Online on Microsoft Teams from 6-10 September 2021. A total of 93 participants (108 in 2020, 41 in 2019, 40 in 2018 and 39 in 2017) 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 meeting.

The following are the complete recommendations from the WPEB17(AS) to the Scientific Committee which are also provided in Appendix XVIII:

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

WPEB17(AS).01 (para 92): Therefore, the WPEB **RECOMMENDED** that the SC endorse the use of subsurface gillnetting in the Indian Ocean as an effective mitigation measure. The WPEB reminds the SC that Resolution 19/01 already requests the utilization of subsurface gillnets by 2023 to mitigate ecological impacts of this gear. The WPEB **RECOMMENDED** that the SC is kept informed about the current status of implementation of the relevant clause of Resolution 19/01.

All bycatch species

WPEB17(AS).02 (para 121): The WPEB **RECOMMENDED** that the SC endorse a workshop on multi-taxa bycatch mitigation measures dedicated to drift/gillnet fisheries in the Indian Ocean to be conducted in 2022, in order to develop recommendations for consideration by the WPEB. The WPEB further **AGREED** to review in 2022 the need to address multi-taxa mitigation measures for additional gear types in future years.

Marine Mammals

WPEB17(AS).03 (para 157): One of the key discussions during this meeting was for the WPEB to endorse the draft Letter of Intent intended to formalise the collaboration between IOTC and IWC (paper IOTC-2021-WPEB17(AS)-INF03). The WPEB **NOTED** that this letter is based on the language used in the Letter of Intent between IOTC and ACAP which has been accepted by the Commission. The WPEB **NOTED** that there was dissent during discussions of this proposal but finally the WPEB **ACKNOWLEDGED** the Letter of Intent and **RECOMMENDED** that the letter is discussed at the SC.

Review of the draft, and adoption of the Report of the 17th Session of the (Chairperson)

WPEB17(AS).04 (para 169): The WPEB **RECOMMENDED** that the Scientific Committee consider the consolidated set of recommendations arising from WPEB17, provided at Appendix XVIII, 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 VII
- Oceanic whitetip sharks (*Carcharhinus longimanus*) – Appendix VIII

- Scalloped hammerhead sharks (*Sphyrna lewini*) – Appendix IX
- Shortfin mako sharks (*Isurus oxyrinchus*) – Appendix X
- Silky sharks (*Carcharhinus falciformis*) – Appendix XI
- Bigeye thresher sharks (*Alopias superciliosus*) – Appendix XII
- Pelagic thresher sharks (*Alopias pelagicus*) – Appendix XIII

Other species/groups

- Marine turtles – Appendix XIV
- Seabirds – Appendix XV
- Marine mammals - Appendix XVI

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	2016	2017	2018	2019	2020	2021	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 2019: 25,001t Estimated catch 2019: 43,240 t Not elsewhere included (nei) sharks 2019: 36,551 t Average reported catch 2015–19: 26,691 t Average estimated catch 2015–19: 48,781 t Ave. (nei) sharks[2] 2015–19: 40,091 t MSY (1,000 t) (80% CI): 36.0 (33.5 - 38.6) F_{MSY} (80% CI): 0.31 (0.306- 0.31) SSB_{MSY} (1,000 t) (80% CI): 42.0 (38.9 - 45.1) F_{2015}/F_{MSY} (80% CI): 0.64 (0.53 - 0.75) SSB_{2019}/SSB_{MSY} (80% CI): 1.39 (1.27 - 1.49) SSB_{2019}/SSB_0 (80% CI): 0.46 (0.42 - 0.49)		**72.6%**	**72.6%**	**72.6%**	**72.6%**	**99.9%**	Target and limit reference points have not yet been specified for pelagic sharks in the Indian Ocean. Even though the blue shark in 2021 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 catches are increased by over 20%, the probability of maintaining spawning biomass above MSY reference levels ($SB>SB_{MSY}$) over the next 10 years will be decreased. 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. Click below for a full stock status summary: ● Blue sharks – Appendix VII
Oceanic whitetip shark *Carcharhinus longimanus*	Reported catch 2019: 32 t Not elsewhere included (nei) sharks: 35,964 t Average reported catch 2015–2019: 169 t Not elsewhere included (nei) sharks 2015-2019: 39,478 t							
Scalloped hammerhead shark	Reported catch 2019: 51 t Not elsewhere included (nei) sharks: 21,899 t Average reported catch 2015–2019: 67 t Not elsewhere included (nei) sharks 2015-2019: 38,190 t							

Sphyrna lewini								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 VIII • Scalloped hammerhead sharks – Appendix XI • Shortfin mako sharks – Appendix XII • Silky sharks – Appendix XIII • Bigeye thresher sharks – Appendix XIV • Pelagic thresher sharks – Appendix XV
Shortfin mako *Isurus oxyrinchus*	Reported catch 2019: 1,087 t Not elsewhere included (nei) sharks: 37,773 t Average reported catch 2015–2019: 1,789 t Not elsewhere included (nei) sharks 2015-2019: 41,367 t							
Silky shark *Carcharhinus falciformis*	Reported catch 2019: 2,094 t Not elsewhere included (nei) sharks: 20,717 t Average reported catch 2015–2019: 2,241 t Not elsewhere included (nei) sharks 2015-2019: 36,248 t							
Bigeye thresher shark *Alopias superciliosus*	Reported catch 2019: 0 t Not elsewhere included (nei) sharks: 24,043 t Average reported catch 2015–2019: <1 t Not elsewhere included (nei) sharks 2015-2019: 40,006 t							
Pelagic thresher shark *Alopias pelagicus*	Reported catch 2019: 209 t Not elsewhere included (nei) sharks: 24,043 t Average reported catch 2015–2019: 335 t Not elsewhere included (nei) sharks 2015-2019: 40,006t							

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 17th Session of the Indian Ocean Tuna Commission's (IOTC) Working Party on Ecosystems and Bycatch - Assessment Meeting (WPEB17(AS)) was held Online on Microsoft Teams from 6 - 10 September 2021. A total of 93 participants (108 in 2020, 41 in 2019, 40 in 2018 and 39 in 2017) 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 meeting.

2. Adoption of the Agenda and arrangements for the Session

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

3. The IOTC process: outcomes, updates and progress

3.1 Outcomes of the 23rd Session of the Scientific Committee

3. The WPEB **NOTED** paper IOTC–2021–WPEB17(AS)–04 which outlined the main outcomes of the 23rd Session of the Scientific Committee, specifically related to the work of the WPEB.

3.2 Progress on the recommendations of WPEB16

4. The WPEB **NOTED** paper IOTC–2021–WPEB17(AS)–06 which provided an update on the progress made in implementing the recommendations from the previous WPEB meeting WPEB16 which were endorsed by the Scientific Committee (SC23) in 2020.

5. The WPEB **NOTED** that good progress had been made on these Recommendations. The WPEB participants were **ENCOURAGED** to review IOTC-2021-WPEB17(AS)-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 (WPEB18).

3.3 Outcomes of the 25th Session of the Commission

6. The WPEB **NOTED** paper IOTC–2021–WPEB17(AS)–03 which outlined the main outcomes of the 25th Session of the Commission, specifically related to the work of the WPEB.

7. The WPEB **NOTED** that there was very little discussion related to the WPEB, due to the shortened format of the Commission meeting and that the main items were the endorsement by the Commission of the SC information on stock status as well as the agreement in principle to a letter of intent to continue a collaborative arrangement with the Agreement on the Conservation of Albatrosses and Petrels (ACAP). The WPEB further **NOTED** that the report from S25 has yet to be adopted and so no official guidance is available from that meeting at this stage.

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

8. The WPEB **NOTED** paper IOTC–2021–WPEB17(AS)–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 no CMM relevant to Ecosystems and Bycatch has been added since 2019.

4. Review of data available on ecosystems and bycatch

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

9. The WPEB **NOTED** paper IOTC–2021–WPEB17(AS)–07 which provided an overview of the data received by the IOTC Secretariat for bycatch species for the period 1950–2019. A summary for shark and ray species is provided in Appendix IV.

10. The WPEB **CONGRATULATED** the IOTC Secretariat on the improved structure and quality of the charts of the data review paper which improve the readability of the document.
11. The WPEB **RECALLED** that the currently available catch time series for IOTC and bycatch species does not yet include data for 2020 which is still in the process of being received and cross-verified by the IOTC Secretariat.
12. The WPEB **RECALLED** that with the term "bycatch species" the IOTC refers to all those species other than the 16 managed species, regardless of them being targeted or incidentally caught in the fisheries.
13. The WPEB **NOTED** that artisanal fisheries contributed to the majority of reported nominal catches of shark and ray species during 1950-2019, reaching more than 80% of the average total reported nominal catches in recent years (2015-2019).
14. At the same time, the WPEB **NOTED** that the contribution of artisanal fisheries to the reporting of geo-referenced catches of shark and ray species is very low, with about 5% of the nominal catches reported with spatial information between 2015 and 2019.
15. Also, the WPEB **ACKNOWLEDGED** that while the fraction of shark catches reported to the species level has increased in recent years, to the point of reaching around 50% of total annual catches for the species group, it is still subject to frequent oscillations that might reflect long-standing issues in reporting.
16. The WPEB **RECALLED** that the available information, and in particular the level of catches by fleet and species, is thought to be a severe underestimation of the total biomass of bycatch species affected by the fisheries, as most of these are discarded at sea and not recorded nor reported to the Secretariat.
17. In particular, the WPEB **NOTED** again with concern that a sudden drop (of around 30,000 t) appears in the level of total shark catches reported for 2018 compared to the data available for 2017 and 2019, and **ENCOURAGED** all concerned CPCs (India, Indonesia and Mozambique, among others) to liaise with the IOTC Secretariat to identify the causes of this issue and provide updated catch figures where required.
18. More generally, the WPEB **NOTED** with concern that data for all bycatch species (including raised catches and discards, time-area catches and size-frequency data) are often incomplete or not reported according to IOTC standards and **RECALLED** that this has an adverse impact on the ability of the group to undertake its work, in particular for those species whose assessments mostly rely on nominal catches.
19. In this regard, the WPEB **RECALLED** that for several non-reporting CPCs (e.g., Yemen, Somalia and others, depending on the year considered) the information on total catch levels is either repeated from the previous years, or recovered from other data sources that include, among others, FAO official catch statistics which are also known to be incomplete.
20. The WPEB **ACKNOWLEDGED** that the IOTC Secretariat is at a very advanced stage in engaging with some of the most relevant non-reporting CPCs, namely Yemen and Somalia, in order to clarify the status of tuna and tuna-like fisheries in the countries and provide support to improve national data collection and reporting processes when required.
21. The WPEB **NOTED** that the species-specific time series of nominal catches for sharks and rays presented in the paper (Fig. 9) mostly represent the statistics reported at species level, i.e., they did not account for any reallocation processes for aggregate shark catches except for a few fisheries for which the estimation of shark and ray catches was made by the Secretariat (i.e., Indonesia and Madagascar).

22. The WPEB **NOTED** that despite the recent improvements in data reporting for sharks and rays (e.g., increased number of reporting CPCs, better coverage, and improved species level resolution), the overall quality of the data remains low, and the time series of catches are considered to be highly incomplete.

23. The WPEB **NOTED** that some of the CPCs indicated by the last Compliance Committee as *partially-compliant* or *non-compliant* with respect to size data reporting requirements for shark species (at least one fish measured by ton caught, as per paragraph 5 of Resolution 15/02) are not in a position to fulfil this requirement when individuals are discarded, either because of safety concerns, or because of retention bans at national level requiring immediate release of all caught individuals for the species.

24. For this reason, the WPEB **REQUESTED** that the matter be further discussed at the next WPDCS, and that these constraints are properly taken into account when assessing the level of compliance of such CPCs with respect to size data reporting requirements.

25. The WPEB **NOTED** presentation of paper IOTC-2021-WPEB17(AS)-10 on Japanese annual catches of pelagic sharks in two subareas between 1964 and 1993, including the following abstract provided by the author:

"In response to a request from the 17th Session of the IOTC WPEB(DP), Japanese annual catches of three pelagic sharks (blue shark, shortfin mako, and porbeagle) and other sharks caught in the IOTC area between 1964 and 1993 were updated by splitting the annual catch data into Eastern and Western Indian Ocean."

26. The WPEB **NOTED** that the updated series of annual catches of shark species from the Japanese longline fleet (for the years between 1964 and 1993) is now available by shark species and major Indian Ocean areas (East vs. West), and **THANKED** Japan for the provision of this information which increases the level of completeness and accuracy of the time series in its earlier periods.

27. Also, the WPEB **ACKNOWLEDGED** that the updated time series has been incorporated in the IOTC databases and is now disseminated as part of the regular datasets prepared in support of the meeting.

5. Review of national bycatch issues in IOTC managed fisheries and National Plans of Action

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).

28. The WPEB **NOTED** paper IOTC–2021–WPEB17(AS)–08 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.

29. The WPEB **NOTED** that the Secretariat continues to collect information on NPOAs from CPCs and provides 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.

30. The WPEB thanked those CPCs who had already submitted these documents and **REQUESTED** CPCs who had not yet done so to submit their NPOAs to the Secretariat to be uploaded onto the NPOA portal. The WPEB encouraged participants to view these documents.

31. The WPEB **NOTED** small revisions to the previous update on NPOA including the revision of outdated plans and updates to the progress of developing new plans of action for CPCs that do not yet have NPOAs in place.

6. Stock Assessment for Blue Sharks

6.1 Review of indicators for blue shark

32. The WPEB **NOTED** paper IOTC–2021–WPEB17(AS)–11 providing a review of the reproductive biology of the Blue shark (*Prionace glauca*) in the western Indian Ocean, including the following abstract provided by the authors:

    "This paper describes preliminary work to assess the sex-ratio and the length at 50% maturity of blue shark in the southwest Indian Ocean as part of the 'GERUNDIO' project . A total of 266 samples were collected and for 206 individuals the macroscopic maturity staging was reported as part of the project. The maturity staging was observed from sharks ranging in size from 53 to 275 cm straight fork length (SFL) for males and between 105 and 254 cm SFL for females and all sharks were caught in the southwest Indian Ocean off the coast of South Africa. According to available data, male individuals were much more numerous, especially in large individuals. Estimated size at 50% maturity was 201.7 cm SFL for males, 142.0 cm SFL for females and 190.5 cm SFL for both sexes combined. The maturity ogive estimated in our study is similar to the size at 50 % maturity used for blue shark stock assessment in the Indian Ocean, which uses a knife edge logistic maturity schedule with the length-at-50% maturity for females equal to 145cm."

33. The WPEB **CONGRATULATED** the authors for the analysis and **RECALLED** the importance of reproduction studies that provide insight into the sensitivity of species to fishing and key inputs for assessment methods.

34. The WPEB **NOTED** that the samples used in the paper were collected through opportunistic sampling operations performed on commercial longliners that were complemented with samples collected in 2018 as part of the EU-funded PSTBS-IO project to address the major difficulties of field sampling inherent during the Covid-19 pandemic.

35. The WPEB **NOTED** that data on litter size and pup size are useful for the analysis of shark reproduction and mortality but that they were not consistently collected as part of the project.

36. The WPEB **NOTED** that a few individuals of large size (SFL>200 cm) were apparently misclassified as immature juveniles or adults and **ENCOURAGED** the authors to review the classification of these samples.

37. The WPEB **NOTED** the preliminary estimate of L50 for females (142 cm SFL) found to be lower than in other studies conducted in the Pacific and Atlantic Oceans, which may be due to the different spatial distribution by size for blue shark but may also result from the limited sample size of the study.

38. The WPEB **NOTED** the major differences observed in sex ratio and sex-specific size at maturity of blue sharks although the exact reasons for this (e.g., sample size, season or area effect) remain unknown.

39. The WPEB **NOTED** that additional observations of macroscopic and microscopic maturity stages are needed to complement the analysis and better cover the fishing grounds of blue sharks in the Indian Ocean.

40. However, the WPEB **NOTED** that the sample size target of the project has been reached for blue shark and that no more samples will be collected for this species as part of the project.

41. The WPEB **NOTED** that the Secretariat aims to develop a biological database to host individual morphometric, reproductive, and tagging data which could be used to store and archive some of the biological data collected as part of the project for future analyses.

42. The WPEB **NOTED** paper IOTC-2021-WPEB17(AS)-12 on preliminary age and growth of blue shark (*Prionace glauca*) in the southwest Indian Ocean, including the following abstract provided by the authors:

"This paper describes preliminary work to assess the age and growth of blue shark in the southwest Indian Ocean as part of the 'GERUNDIO' project. A total of 262 vertebrae samples were available for analysis and 98 were selected for ageing as part of this initial phase of the project. The vertebrae were collected from sharks ranging in size from 96 to 276 cm straight fork length and were caught in the southwest Indian Ocean (close to the coast of South Africa). The maximum age (paired band count) was 17 years for males and 12 years for females. The youngest fish was aged two years. Direct validation of the accuracy of the ageing methods used was not possible in the current project. However, our preliminary length at age data is consistent with the results of Andrade et al. (2019) for blue shark in the southern Indian Ocean. Limited age validation has been done using bomb radiocarbon dating (^{14}C) methods and we think further consideration should be given to this method to continue efforts to validate the annual periodicity of the bands being counted. Without direct age validation, it is impossible to determine if the age estimates are accurate. We also recommend that additional vertebrae are collected from blue shark in the western and other areas of the Indian Ocean to provide further age information. Given the difficulty of reading blue shark vertebrae, an exchange of vertebrae sections (or images) among reading laboratories and an ageing workshop may help to standardise the approaches used for counting growth increments."

43. The WPEB **THANKED** the authors for the work and **NOTED** the good fit of the curve to the data and the similarity between the growth curve estimated during this study and the reference growth curve developed by Andrade et al. (2019) for the common size range of the two studies.

44. The WPEB **NOTED** the need to increase the sample size as most samples come from the coasts of South Africa while the stock of blue shark is considered to extend across the whole of the Indian Ocean.

45. The WPEB **NOTED** the current absence of validation procedure for the deposit of annual growth increment in blue sharks' vertebrae and the potential interest of bomb radiocarbon dating which has been shown to perform well as a tool for age validation in other fish species (e.g., yellowfin tuna).

46. Regarding the difficulties in reading blue sharks' vertebrae, the WPEB **NOTED** the interest of sharing methods and experience in reading as well as conducting cross-reading exercises to assess and possibly improve and standardise reading methods across ageing laboratories.

47. The WPEB **THANKED** the authors for making the images of the vertebrae with the annual marks identified by the readers available but **NOTED** that reading of growth increments solely from images is not an easy task, **ACKNOWLEDGING** that working with the vertebrae through in-person technical workshops would be strongly beneficial to the success of the inter-calibration exercise.

48. In the longer term, the WPEB **RECALLED** the interest of a sample tissue bank as done in the Western-Central Pacific Ocean (https://www.spc.int/ofp/PacificSpecimenBank) to support the collection and management of samples at the scale of the Indian Ocean for scientific analyses but **NOTED** that the IOTC Secretariat does not have the facilities and human resources to develop such a project.

49. However, the WPEB **NOTED** that the IOTC Secretariat could manage the metadata (e.g., species, origin, sample type etc.) relating to the samples collected during some research projects while these samples could be possibly stored and archived for future study in the national research institutions of some CPCs interested in sharing their facilities and services.

50. The WPEB **NOTED** paper IOTC-2021-WPEB17(AS)-13 on habitat modelling for the blue shark (*Prionace glauca*) by sex and size classes in the Indian Ocean, including the following abstract provided by the authors:

"This paper is a regional focus in the Indian Ocean (IO) of a global analysis of blue shark (Prionace glauca) habitat by size and sex classes (small juveniles, large juvenile males and females, adult males and females, Druon et al., in prep.). The habitat modelling, calibrated using fishing interaction data (i.e., fishery observer data) and electronic tracking data, uses two feeding proxies, i.e., the satellite-derived productivity fronts in mesotrophic areas and the mesopelagic micronekton in oligotrophic areas, and two abiotic variables, i.e., temperature and sea surface height anomaly. The temperature niche includes sea surface temperature (SST) and temperature 100 m below the mixed layer depth ($T_{mld+100}$) to ensure that both the horizontal and vertical extent of this thermoregulated species' habitat are covered. Here we show that the overall feeding niche displays highly diverse biotic and abiotic conditions although the blue shark population tends to progress from mesotrophic and relatively cold surface waters for the juvenile stages (North and South of IO) to more oligotrophic and warm surface waters for the adults (central IO). However, warm temperatures or low productivity limit the habitat of mostly the juveniles in the Central and/or North IO mainly in Apr-Jun and Jul-Sep. Large females tend to have more habitat overlap with small juveniles than large males, notably driven by temperature preferences. Large females also display an intermediate range of SST avoidance resulting in an important lack of habitat overlap with large males mostly in Jan-Mar and Apr-Jun in the South IO around 30°S. In Oct-Dec however, fisheries observer data show a higher habitat overlap between large males and females in this intermediate SST range, which may correspond to mating. These results on blue shark habitat provide key elements useful to stock assessment models and potential leads for conservation and management measures of this near threatened species."

51. The WPEB **THANKED** the authors for the work and **NOTED** the utility of habitat modelling to better understand the determinants of the distribution of juvenile and sex-specific adult stages of blue sharks in the Indian Ocean.

52. The WPEB **NOTED** that the feeding habitat model for blue sharks is based on two distinct feeding proxies: (1) mesopelagic micronekton in oligotrophic areas and (2) productivity fronts in mesotrophic areas while the abiotic variables (i.e., water temperature and sea surface height) were used to exclude unsuitable environments.

53. The WPEB **NOTED** that seasonal and spatial patterns of the blue shark population by sex and size classes in the Indian Ocean highlight major differences in feeding habitat between classes.

54. The WPEB **NOTED** that the two distinct global data sets of blue shark occurrences (i.e., fisheries observer data and electronic tag data) described by different resolutions were merged together by filtering the observations with geographical precision below 50 km, to account for the uncertainty in the positions derived from electronic tags as well as stemming from the length of drifting longlines.

55. The WPEB **NOTED** that the feeding habitat model developed for blue shark is deterministic (and not stochastic) for identifying the global environmental niche, and used data covering almost two decades (2003-2018) of contrasted environmental conditions in the Indian Ocean, making the results

robust for assessing the potential effects of climate change on the distribution of the Indian Ocean population of blue sharks.

56. The WPEB **NOTED** paper IOTC-2021-WPEB17(AS)-14 on catch estimates of blue shark in the IOTC area of competence for the 2021 stock assessment, including the following abstract provided by the author:

"Catch histories form an important component of stock assessments and so having a reliable and believable catch series is a key part in gauging the level of stock depletion. In data-limited situations, reported nominal catches are often not considered reliable and so reconstruction of catch histories plays an important role. The first Indian Ocean stock assessment of blue shark took place in 2015, however, due to the amount of uncertainty in the assessments, the conclusion regarding stock status remained uncertain. The historic catch series was considered to be one of the key sources of uncertainty and so the Working Party requested that participants develop new approaches to reconstructing historic catches to be used as alternate series for assessment. This paper uses the available nominal catch data currently held in the IOTC database and a generalized additive model (GAM) approach to reconstructing historic blue shark catches in the Indian Ocean. Additionally, a ratio-based method was used to estimate the unreported blue shark catches.

The methods described in this paper attempt to account for not reporting of blue shark catches. Based on the methodology used in 2017 GAM using target catches were used to predict the expected catches where there are zero reported catches. The resulting estimated catch series were very similar to the catches estimated in 2017 (same trend and scale) with catches increasing over the time period of the fishery, reaching approximately 50-66,000 t in recent years. With a drop in catches in recent years that mimics the drop in reported catch. Similar to the work done in 2017 these estimates are prepared for use in the assessment model that has 8 fleets."

57. The WPEB **RECALLED** that a number of catch reconstruction methods have been studied in the past to address uncertainties associated with blue shark catch estimates, including the modelling approach, ratio-based method, and trade-based estimates. The WPEB **NOTED** that the study provides an update to the first two methods and there was not sufficient data to estimate catch in recent years from the shark fin trade. The WPEB **AGREED** that the catch estimates contributed to one of the major sources of uncertainty in the blue shark assessment.

58. The WPEB **NOTED** that baitboat, purse seine, and a number of miscellaneous gears did not report any blue shark catches, and were therefore excluded from catch estimation, assuming that blue sharks are not generally vulnerable to these gear types.

59. The WPEB **NOTED** that both the GAM model and the ratio-based method attempt to correct for non-reporting of blue shark catches and these methods are not designed to account for under-reporting of positive catches. The WPEB discussed the possible utility of using observer data for catch reconstruction and **NOTED** that there are well-developed methods based on observer data in other oceans, however, in the Indian Ocean, a significant part of catch is produced by fishing gear/fisheries that are not covered by observers. The WPEB also **NOTED** that with the recent development of the IOTC regional observer database, there is scope to explore the use of observer data to assess under-reporting of blue shark catches, particularly for the longline fishery.

60. The WPEB **NOTED** that estimated catches have dropped significantly in the last few years. The reason is not clear, but it may be due to the characteristics of the original data. The WPEB **NOTED** that the decline is likely to have an impact on both population status estimates and forecasts. The WPEB

SUGGESTED that possible scenarios to reduce fishing mortality (e.g., due to the Covid-19 pandemic) be considered in the stock assessment forecast.

61. WPEB **NOTED** that when compared to ratio-based estimates, GAM's estimated catch explicitly takes into account the factors that affect blue shark catch reports. The estimate is consistent with the previous estimate and the annual change is small. The WPEB **AGREED** to use the GAM estimated catches in the blue shark stock assessment. The WPEB further **REQUESTED** standard errors of the catch estimates to be reported.

62. The WPEB **NOTED** paper IOTC-2021-WPEB17(AS)-16 which provides Age and Sex Specific Natural Mortality of the Blue Shark in the Indian Ocean, including the following abstract provided by the author

"Biological parameters such as growth and natural mortality form the basis for the inputs for stock assessment models (Siegfried and Sanso 2013) and can be used to assess the vulnerability of the stock to fishing (Hilborn and Walters 1992). Some attempts have been made to combine gross estimates of biological change such as length or age over time, with catch data to get a rough estimate of trends in stock status (e.g., Clarke 2011). In the absence of good biological data, estimates derived from closely related populations or species can be used. However, these estimates may differ from reality and in order to encapsulate the uncertainty appropriately for use in a stock assessment, additional work is required (Cortes 2002).

This work was motivated by a desire for age and sex specific natural mortality estimates for a length based integrated stock assessment model. The IOTC Working Party on Ecosystems and Bycatch requested that age and sex-specific natural mortality estimates be developed for blue shark (Prionace glauca) in Indian Ocean based on published literature. This paper documents the methods and results of calculating sex specific natural mortality-at-age for Indian Ocean blue shark, which are estimated based on length-at-age from Andrade et al 2019."

63. The WPEB **NOTED** that the age-specific natural mortality has biological realism and is well supported by extensive research, although in many cases, it may not have an appreciable impact on stock assessment estimates compared to a mean, constant M. However, the WPEB pointed out the average M may be more dependent on the empirical methods being used.

64. The WPEB **NOTED** the suggestion that a U-shaped mortality schedule that assigns higher mortality rates to older fish may be more biologically realistic and could be explored in the future.

6.2 Review of indicators for blue shark

65. The WPEB **NOTED** paper IOTC-2021-WPEB17(AS)-15 on stock assessment of blue shark in the Indian Ocean, including the following abstract provided by the author:

"This paper presents a stock assessment of blue shark in the Indian Ocean using Stock Synthesis (version 3.30.16.02 http://nft.nefsc.noaa.gov/Download.html). The blue shark assessment model is an age structured (25 years), spatially aggregated (1 region) and two sex model. The catch, effort, and size composition of catch, are grouped into 8 fisheries covering the time period from 1950 through 2019. Six indices of abundance, all from longline fisheries were considered for this analysis. This assessment considered two alternative time series of total catch. The diagnostic case model is parameterized using indices of abundance from the Portugal (2000-2019), Reunion (2007-2019) and the Japanese late (1992-2019) series, along with estimates of catch generated via a generalized additive model. The estimated abundance trend is decreasing throughout the time frame of the

model, and spawning stock abundance has decreased to approximately 1.21 times SSB_{MSY}, (80% CI is 1.08-1.36). The fishing mortality has increased over the model time frame with F2019/FMSY= 0.81 (80% CI =0.66 to 0.96)." (See document for full abstract)

66. The WPEB **AGREED** that the model methodology and parameterization were appropriate and that all models converged. Furthermore, the biology (i.e., growth and mortality) of blue sharks in the Indian Ocean is relatively well studied. As such, the WPEB **AGREED** that there was no need to include exhaustive biological sensitivity runs or to deviate from the proposal to include all CPUE time series in the final model. The CPUE indices were discussed in detail (spatial coverage, diagnostics etc.) in the DP meeting and it was proposed that all indices were included in the blue shark assessment, with the exception of that provided by Indonesia.

67. The WPEB **NOTED** the need for further research into the Japanese CPUE, particularly the pre-2000 period which exhibited high inter-annual variability which resulted in residual fit deviations at the beginning of the time series in both the SS3 and JABBA models.

68. The WPEB **NOTED** that there was a continual increase in catches derived from the miscellaneous states in coastal waters, however the majority of CPUE indices are derived from distant water fleets fishing the open ocean – the exception being South Africa and EU,France (La Réunion).

69. The WPEB **NOTED** that the current biological studies on blue shark are encouraging, however there are still gaps in important information sources for this species (i.e., fleet-specific size composition data).

70. The WPEB **NOTED** that the growth estimates provided in IOTC-2021-WPEB17(AS)-12 were consistent with previous estimates (Andrade, 2019) but the former are yet to be validated. The WPEB further **NOTED** that there is a potential to underestimate longevity when using vertebrae to age blue sharks.

71. The WPEB **NOTED** that despite recent catches remaining above MSY estimates, the decline in catches observed in 2019-2020 could potentially underestimate current fishing mortality and may have a disproportionate effect on model projections. This can be overcome by averaging catches over a longer timeframe.

Table 2. **Blue shark: Key management quantities from the SS3 assessment, assuming the base case model using GAM estimated catches for the Indian Ocean**

Management quantity	Indian Ocean
2019 catch estimate (t)	43,240
Mean catch from 2015–2019 (t)	48,781
MSY (t) (80% CI)	33,600 (31,161 – 36,037)
Data period used in assessment	1950-2019
F_{MSY} (80% CI)	0.308 (0.306 – 0.31)
SB_{MSY} (t) (80% CI)	41,988 (38,867 – 44,109)
F_{2019}/F_{MSY} (80% CI)	0.643 (0.533 – 0.753)
B_{2019}/B_{MSY} (80% CI)	1.387 (1.246 – 1.529)
SB_{2019}/SB_{MSY}	1.387 (1.272 – 1.486)

B_{2019}/B_{1950} (80% CI)	0.456 (0.41 – 0.501)
SB_{2019}/SB_{1950}	0.456 (0.419 – 0.488)
B_{2019}/B_{1950}, F=0	0.398
SB_{2019}/SB_{1950}, F=0	0.456

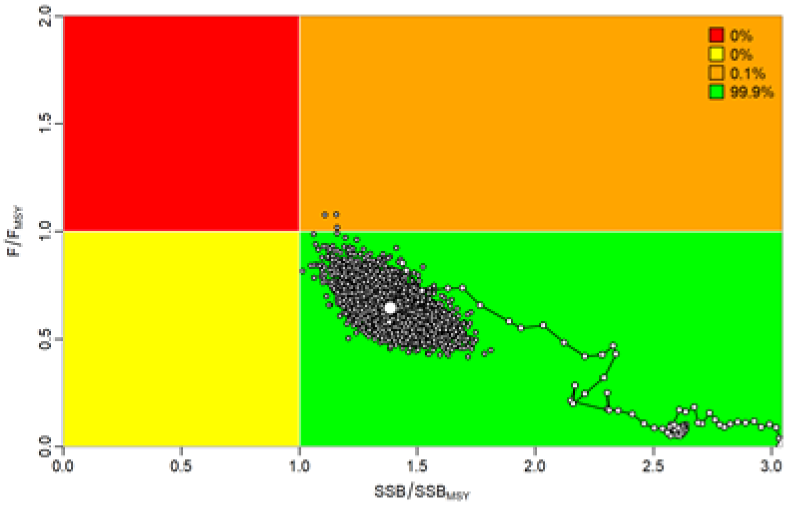

Figure 1. **Blue shark: SS3 Indian Ocean assessment Kobe plot. The results are from the final base case SS3 model**

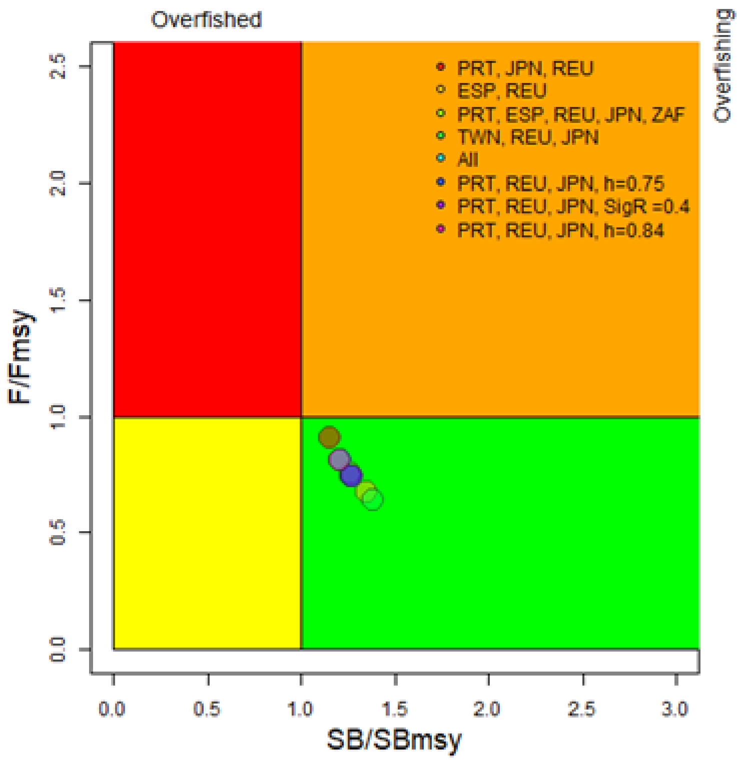

Figure 2. **Blue shark: SS3 Indian Ocean assessment Kobe plot. The results are from the grid of sensitivities using alternative groupings of CPUE series, steepness and sigmaR**

Blue shark: Summary of stock assessment models in 2020

72. The WPEB **AGREED** that the final advice for the executive summary should be provided for a base case model using the GAM-based catch history estimates and CPUE series from South Africa,

EU,Portugal, EU,France (La Réunion), EU,Spain, Taiwan,China and Japan (Table 2, Figure 1). The major sources of uncertainty identified in the current model are catches and CPUE indices of abundance. The WPEB **NOTED** that recent studies of age and growth have corroborated the biological information previously used, although additional work (i.e., age validation, expansion of sampling programs) should be considered. Model results were explored with respect to their sensitivity to the major axes of uncertainty identified, however the ratio-based and nominal catches were considered unrealistic. If the alternative CPUE groupings were used, then the stock status was somewhat less positive (Figure 2).

73. The WPEB **AGREED** to prepare the Kobe II Strategy Matrix based on a deterministic projection with probabilities estimated from the Hessian Matrix of the base case model for the final advice.

74. The WPEB **NOTED** that the additional analysis using the JABBA model also suggested a relatively healthy population (B_{2019}/B_{MSY} estimates range 1.4–1.6 and F_{2019}/F_{MSY} estimates range 0.38–0.51 from a range of CPUE grouping scenarios).

Selection of Stock Status indicators for blue shark

75. The WPEB **NOTED** that while the CPUE indices are not perfect, they provide more information which is useful to incorporate, and the SS model also allows for the incorporation of more detailed biological information, including the available size data. The WPEB **AGREED** to use the SS model for management advice.

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

76. The WPEB **ADOPTED** the management advice developed for blue shark, as provided in the draft status summary and **REQUESTED** that the IOTC Secretariat update the draft stock status summary with the latest 2019 interaction data and the results from the projections in the Kobe II Strategy Matrix, and for the summary to be provided to the SC as part of the draft Executive Summary, for its consideration:

    - Blue Shark (Appendix VII).

7. Review information on biology, ecology, fisheries and environmental data relating to Silky Sharks

7.1 Review of data available on silky sharks

77. The WPEB **NOTED** that paper IOTC-2021-WPEB17(AS)-17 was withdrawn.

78. The WPEB **NOTED** paper IOTC-2021-WPEB17(AS)-18 on an investigation into the effects of catch time series estimations on stock assessment of Silky shark (*Carcharhinus falciformis*) in the Indian Ocean, including the following abstract provided by the authors:

"Reported catches of sharks to the IOTC are likely highly inaccurate due to insufficient species-specific reporting. This creates difficulties in conducting quantitative stock assessments in the region. Silky sharks are one of the most abundant shark species caught in the Indian Ocean and are ranked as one of the most vulnerable species in the region, putting their populations at high risk of being overfished. Following the preliminary stock assessment of Indian Ocean silky sharks in 2018 (uncertain status), this study proposes novel estimated catch time series for silky sharks and investigates their effects on stock assessment results using the data-limited CMSY model. It was found that estimated values of resilience (r) and F-based statistics were considerably different when using different r categories. The

two reconstructions varied most in k, MSY and B_{MSY}, while F_{MSY}, B/k, B/B_{MSY} and F remained relatively constant across all reconstructions within the same r categories. F/F_{MSY}, however, remained consistent across all scenarios. Overall, the input resilience category has a larger influence on the output of the model than the estimated catch time series. All 4 assessments showed that overfishing (F/F_{MSY} > 1) is occurring and that the stock is more likely to be overfished when a low resilience category is used, compared to very low. Therefore, adopting a precautionary approach and introducing specific management measures for silky sharks in the Indian Ocean is highly encouraged."

79. The WPEB **NOTED** that the shark catch reconstruction was not based on observer data but available IOTC nominal catch data for the gillnet, longline, purse seine, hand line, and bait boat fisheries.

80. The WPEB **NOTED** that this analysis relied heavily on reported silky shark data for Sri Lanka. The Secretariat **HIGHLIGHTED** that a consultant was hired in 2012 to estimate catch data for Sri Lanka for the period 1996-2011. Such estimation was based on a ratio of sharks to total target catch (provided by NARA) and the relative proportion of shark species. The WPEB also **NOTED** that for this work, catch estimates for sharks rely on strong assumptions such as a constant ratio between shark and target species throughout the period as well as a constant relative proportion between shark species.

81. The WPEB **NOTED** that it was assumed in this study that silky sharks belonged to a certain size class. However, size frequency data were not available and should be collected and ultimately analysed. As a consequence, the proposed management plan for the conservation of the silky shark seems premature.

82. The WPEB **NOTED** that default categories for the productivity value (r) were taken from previous studies, notably the stock assessment carried out in 2017 where r was estimated using Leslie matrices. However, the WPEB **SUGGESTED** that r could be estimated using available biological information. At this stage, and **ACKNOWLEDGING** the large uncertainties in the results, notably regarding the productivity value, the proposed management plan would be premature even though the precautionary approach should be adopted.

83. Overall, the WPEB **ENCOURAGED** such kind of work.

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

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

84. The WPEB **NOTED** paper IOTC-2021-WPEB17(AS)-19 on the contribution of tuna gillnet fisheries of Pakistan towards abandoned, lost or otherwise discarded fishing gears (ALDFG), including the following abstract provided by the authors:

"Increased consumption of plastic in daily life has resulted in increased plastic pollution globally including manifold increase in the pollution resulting from disposal of plastic in the marine environment. Of the many sources, plastic pollution results from fishing and fishing related activities. Deliberate, inadvertent and accidental loss of fishing nets in the sea represents a significant threat to marine ecosystems. Abandoned, discarded and lost fishing gear (ALDFG), is estimated to account for 10 % of global marine plastic pollution and the quantities are ever increasing. Although tuna fishing vessels operates in the deep oceanic waters where chances of their entanglements in bottom rocks, reefs and shipwrecks are negligible but still tuna gillnetting is important source of ALDFG mainly because largest quantity of fishing gear carried by a single vessel i.e., on average 3,303 kg

per tuna gillnetter whereas small gillnet vessels operating in coastal waters carry on average 96 kg only. Out of a total of 42.340 events of ALDFGs reported from Pakistan only 874 related to tuna gillnet operation was reported. Of the total amount of gears lost at sea i.e., 2,608,058 kg only 221,551 kg was contributed by tuna gillnetters. Major causes of loss or damage to fishing gears of tuna gillnet are accidental entanglement and loss due to environmental factors such currents and waves action as well as cyclone and high winds. Now with the marking of tuna gillnets with AIS (Automatic Identification System) beacon events of ALDFGs are practically diminished."

85. The WPEB **THANKED** the authors for the presentation and highlighted the importance of monitoring and conducting baseline national assessments of ALDFG.

86. The WPEB **ACKNOWLEDGED** the efforts of WWF-Pakistan for taking the lead in collecting information about the contribution of tuna fisheries in the Indian Ocean to plastic pollution and **ENCOURAGED** other CPCs to develop such national baseline assessments to understand the scale and extent of ALDFG derived from IOTC fisheries in the Indian Ocean.

87. The WPEB **NOTED** that the IOTC Ecosystem Report Card being developed by the WPEB has a component covering marine debris and suggested that CPCs interested in this topic work together to raise this issue through the ecosystem report card.

88. The WPEB **NOTED** that there is currently an ongoing project funded by FAO / NFIFO that focuses on estimating the impact of ALDFG in the Indian Ocean, which is targeting Pakistani gillnetters alongside other fisheries, and therefore **ACKNOWLEDGED** the benefits of merging the results from these two studies to reach a more complete understanding of the phenomenon.

89. The WPEB **NOTED** paper IOTC-2021-WPEB17(AS)-20 on subsurface gillnetting: what motivated fishermen to change, including the following abstract provided by the authors:

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

90. The WPEB **THANKED** the author for sharing this successful gear modification as a bycatch mitigation measure. The WPEB **NOTED** WWF-Pakistan's efforts in reducing mortality of ETP species in gillnet fisheries which are known to be marred with high levels of bycatch and mortality of non-target species.

91. The WPEB **NOTED** that WWF-Pakistan has been implementing a fleet conversion programme since 2014 and has been engaged in trialling several mitigation methods to reduce bycatch, including the introduction and use of subsurface gillnets. This work has been presented several times to the WPEB. This conversion program implemented in Pakistan gillnet fisheries has shown to be successful in mitigating the bycatch of ETP species including cetaceans, sea turtles and pelagic sharks.

92. Therefore, the WPEB **RECOMMENDED** that the SC endorse the use of subsurface gillnetting in the Indian Ocean as an effective mitigation measure. The WPEB reminds the SC that Resolution 19/01 already requests the utilization of subsurface gillnets by 2023 to mitigate ecological impacts of this

gear. The WPEB **RECOMMENDED** that the SC is kept informed about the current status of implementation of the relevant clause of Resolution 19/01.

93. In light of the above, and **ACKNOWLEDGING** that subsurface setting is becoming a common practice across Indian Ocean gillnet fisheries, the WPEB **AGREED** on the importance of updating the process for the provision of catch statistics (as per IOTC Resolution 15/02) so as to clearly distinguish catches from the two gear configurations, and **REQUESTED** the WPDCS to take the lead on this activity and eventually support CPCs in the revision of their historical gillnet catches in that sense.

94. The WPEB **NOTED** paper IOTC-2021-WPEB17(AS)-21 on Jelly-FADs: a paradigm shift in bio-FAD design, including the following abstract provided by the authors:

"Fishers and scientists in the three tropical oceans are investigating different designs of biodegradable FADs (bio-FAD) efficient for fishing. The tactic followed by most fishers is to maintain the same traditional drifting FAD (dFAD) design (submerged netting panels hanging from the raft) but made of organic ropes and canvas. Results of those experiences show that the lifetime of bio-FADs that maintain the traditional dFAD design but made of organic materials, is shorter than that required by fishers. The short lifespan of those bio-FADs is due to the structural stress suffered by dFAD designs traditionally used. Thus, in order to use organic materials instead of the strong plastic and increase the lifespan of those bio-FADs, a paradigm shift is needed. Bio-FAD structures should be re-designed to suffer the least structural stress in the water. The present document aims at (i) summarizing what we learned across the different experiences testing bio-FADs in the three oceans, (ii) proposing a new concept in dFAD design, the Jelly-FAD design, and (iii) providing recommendations to reduce the impact of dFAD structures on the ecosystem and for bio-FADs construction and use."

95. The WPEB queried the acceptance of the Jelly-FAD by fishers. The WPEB **NOTED** that the Jelly-FAD design reduces the structural stress of the FAD so that when plastic is replaced by organic materials, it does not break and so the design increases the FAD's lifetime. Initially some fleets made the Jelly-FAD using plastic to test if they would also aggregate tuna and to test its drift. The WPEB **NOTED** that the overall experience has been successful so far since initial results indicate that both the Jelly-FAD attraction potential and resistance appear to meet fishers expectations. In addition, Jelly-FADs are less costly than the traditional dFADs because of their simpler design which also facilitates the logistics for their recovery. The WPEB **NOTED** that Jelly-FADs are now made of biodegradable, organic materials and are being tested in fishing conditions by several fleets in the Atlantic and Pacific Ocean regions.

96. The WPEB inquired about the materials currently tested to build Jelly-FADs, **NOTING** that some of the materials were the same as those used in the frame of the EU BIOFAD project in 2018-2019, which did not meet fishers expectations in terms of resistance. The WPEB **NOTED** that since the Jelly-FAD is designed to reduce the structural stress, materials that were not appropriate for the BIOFAD designs used in the EU BIOFAD project, tend to last longer when used to build Jelly-FADs.

97. The WPEB **REQUESTED** that this work is presented in the coming FAD WG meeting.

98. The WPEB **NOTED** the fate of dFADs with deactivated tracking buoys is often unknown as tracking buoys are often deactivated once they drift out of the fishing grounds. This is done to reduce communication costs and avoid overshooting operational buoy limits, and thereby contributes to lost and abandoned dFADs that can contribute to pollution and damaging habitats. The impact of ghost fishing is eliminated if netting is not used to build the FADs and the IOTC Res. 19/02 does not allow the use of netting in FAD construction.

99. Furthermore, the WPEB **QUERIED** whether and how those remotely deactivated tracking buoys and the dFADs they are attached to, could be better monitored throughout their lifetime to better estimate the number of lost / abandoned dFADs and their potential impacts on ecosystems. The WPEB **NOTED** that several options are being explored to monitor the fate of dFADs once they leave the fishing grounds and for recovery purposes. One option includes a permanent marking of dFADs, independent from their tracking buoys, which provides information via satellite, attached to the FAD structure. This independent system would also facilitate FAD tracking when fishers exchange echo-sounder buoys. Another option would be to maintain active fisher´s buoys until the end of FADs´ lifetime, even when they drift out of the fishing ground and consider "the FADs/ fisher´s buoys to be recovered" apart from operational buoys.

100. The WPEB **NOTED** paper IOTC-2021-WPEB17(AS)-22 on a concept note for the second IOTC workshop on identification of regions in the IOTC convention area to inform the implementation of the ecosystem approach to fisheries management, including the following abstract provided by the authors:

"The Indian Ocean Tuna Commission (IOTC) has committed in principle to operationalize an Ecosystem Approach to Fisheries Management (EAFM) in accordance with internationally agreed standards. Accordingly, the IOTC Working Party on Ecosystems and Bycatch (WPEB) has been working to assess the feasibility of and developing several ecosystem products to inform EAFM implementation in the region. However, in the context of managing highly migratory species such as tunas, billfishes and sharks in the Regional Fisheries Management Organization (RFMOs), the spatial scale at which these ecosystem products should be developed remains largely unexplored. Regionalization of the IOTC convention area into areas or ecoregions that make ecological sense and are large enough to be practical can provide a foundation for developing a wide range of ecosystem products to assist in the production of more integrated ecosystem-based advice to the Commission. The WPEB14 recommended convening a workshop to provide advice on the identification of draft ecoregions to foster discussions on the operationalization of the EAFM in the IOTC convention area. The first IOTC ecoregion workshop took place in September 2019 with the participation of CPC national scientists and external experts. This process resulted in a draft proposal of seven ecoregions within the IOTC convention area which were presented to the WPEB15. The WPEB15 recommended a second IOTC ecoregion workshop to refine the process of ecoregion delineation while considering the expert advice and feedback received in the first workshop and the draft proposal of ecoregions. The second IOTC ecoregion workshop is planned to take place early 2022. This report summarizes the main preparatory work that will be carried out prior to the second IOTC Ecoregion workshop, and it presents the main tasks and expected outputs of this second workshop."

101. The WPEB **THANKED** the author for sharing the preparatory work and main tasks planned for the second workshop. The WPEB **QUERIED** how the depth dimension of the different species and fishing gears were accounted for in the spatial analysis to derive the ecoregions. The WPEB **NOTED** that the data being analysed, which consist mainly of the IOTC catch and effort datasets, does not contain any depth information, so the depth dimension is not being accounted for in the analysis.

102. The WPEB **QUERIED** whether it would be possible to include additional environmental and biological information such as the plankton mesopelagic fish components, which could be derived from the Copernicus program, to inform the delineation of ecoregions.

103. The WPEB **NOTED** that the derivation of ecoregions has taken rather a simpler approach since it is already using the existing biogeographic classifications available in the Indian Ocean (Longhurst biogeographic classification, and Spalding pelagic provinces of the world) to inform the derivation of

the ecoregions. Therefore, with the current methodology there is no need to gather environmental variables characterizing the biological and physical characteristics of the water columns to derive new biogeographic provinces in the Indian Ocean and examine how they could be further used to inform the boundaries of ecoregions for the purpose of structuring ecosystem advice to inform fisheries management in IOTC.

104. The WPEB **DISCUSSED** whether the second ecoregion workshop planned for Spring 2022 would be too premature, considering the benefits of ecosystem reporting products (e.g., ecosystem fisheries overviews) using the current draft ecoregions, prior to conducting further refinements of the ecoregion. The WPEB **NOTED** that the (1) development of ecoregions as a tool for ecosystem planning and (2) the development of an ecosystem report card as a tool for providing an overview of the impacts of climate and fisheries on the ecosystem and communicating main priorities and issues to the commission, are two different but related processes running in, and being developed in, parallel that may complement each other in the future.

105. The WPEB **NOTED** that there are a small number of opportunities for in-depth discussions on these two parallel processes due to the annual frequency of the WPEB meeting, and that the Spring 2022 workshop will provide an opportunity to refine the process and methods of ecoregion delineation in IOTC and their potential uses in the context of IOTC. In addition, some funds have been secured that are being used to do all the preparatory work and supporting work for the workshop.

106. The WPEB **NOTED** the importance of understanding the role of the ecoregions in the context of providing the ecosystem reporting products (e.g., ecosystem and fishery overview reports, ecosystem risk assessments, etc.) and that the concrete example of ecosystem reporting products utilizing ecoregions would facilitate the discussion at the second ecoregion workshop as well as providing a clear picture of their benefits and potential uses.

107. Therefore, the WPEB **REQUESTED** a modification to the Terms of Reference of the second IOTC eco-region workshop to add a task of providing an example of an ecosystem reporting product tailored to the ecoregions derived from the first workshop prior to the meeting and to be presented at the workshop.

9. Bycatch, species interactions and ecosystem risk assessments for other shark species, marine mammals, seabirds and sea turtles

9.1 All bycatch species

108. The WPEB **NOTED** paper IOTC-2021-WPEB17(AS)-23 on guidelines on the safe handling and release of ETP species in gillnet fisheries. No abstract was provided by the authors.

109. THE WPEB **NOTED** that this is an important initiative providing a very useful practical tool for gillnet fisheries and **NOTED** that interested parties would like to develop best practices for multiple gears.

110. The WPEB **NOTED** that interactions with seabirds in gillnet fisheries of Pakistan are thought to occur very infrequently so the WWF guidelines on seabirds are based on very limited experience of handling seabirds and with few species such as boobies and shearwaters. The WPEB **ENCOURAGED** the authors to review the best practice guidelines on the safe handling and release of seabirds produced by ACAP.

111. The WPEB **NOTED** that the guides intentionally include many graphics and limited text to increase usability. The WPEB **SUGGESTED** that these guidelines are shared with other CPCs with comparable fisheries and supported the plans for translation in national languages in order to improve handling of ETP species in these CPCs and to provide more opportunities for the evaluation of the guidelines.

112. The WPEB **ENCOURAGED** the implementation of satellite tagging determine the rates of post-release mortality to evaluate the success of the handling and release methods, acknowledging that fishers would need to be trained in tagging protocols due to the small size of vessels and limited space for scientists or observers onboard.

113. The WPEB **NOTED** paper IOTC-2021-WPEB17(AS)-24 on bycatch management in IOTC fisheries, including the following abstract provided by the authors:

"Over the past decade, the IOTC has adopted a number of Conservation and Management Measures (CMMs), supporting the conservation of vulnerable species interacting with IOTC fisheries as bycatch. The adoption of a CMM represents the first step in management, however, it is vital to subsequently evaluate the effectiveness of these following implementation. The main overall aim of the bycatch CMMs is to minimise the fishery impacts on the species of concern, while the specific objectives are typically three-fold, involving; (i) a direct reduction in mortality (often in the form of a retention ban or modification of gear/practices to reduce harmful interactions), (ii) improvements to data quality and (iii) research-related objectives."

114. The WPEB **NOTED** the summary of many key issues regarding the bycatch CMMs and the management of bycatch species

115. The WPEB **SUGGESTED** the development of a project to synthesise these results into a summary format tool outlining the main issues and highlighting these in a clear and usable format. The WPEB **NOTED** that the tool could highlight, by gear, the gaps in existing CMMs (such as fleet exemptions) which can be updated as CMMs are amended to help to monitor the progress made with improving the effectiveness of CMMs. The WPEB **NOTED** that this tool could help to highlight the trade-offs currently being made between some fisheries and fleets within certain CMMs. The WPEB **NOTED** that it would be useful to include such a tool in the bycatch component of the ecosystem report cards and **NOTED** that the tool could be tailored for different regions.

116. The WPEB **AGREED** that there is a need to prioritise the trial and implementation of effective mitigation measures for bycatch species to support non-retention measures.

117. The WPEB **NOTED** the high level of bycatch found in gillnets in particular, further **NOTING** that much of the bycatch found in these fisheries is often of high value but ETP species require particular attention to reduce the impact on these species.

118. The WPEB **NOTED** measures such as subsurface setting of gillnets that have been trialled in Pakistan and **SUGGESTED** that these and other gear modifications should be trialled in other areas.

119. The WPEB **NOTED** that many of the issues and recommendations highlighted in this paper were raised during the workshop of the Joint tuna RFMO bycatch group and encouraged WPEB participants to read the report from this workshop as it could help to develop clear recommendations for the SC.

120. The WPEB **NOTED** the potential benefits in separating the group into two to focus on (i) shark assessments and (ii) other bycatch and ecosystem issues, **NOTING** that this approach has proved successful for ICCAT, but further **NOTING** that limited resources and capacity are issues.

121. The WPEB **RECOMMENDED** that the SC endorse a workshop on multi-taxa bycatch mitigation measures dedicated to drift/gillnet fisheries in the Indian Ocean to be conducted in 2022, in order to develop recommendations for consideration by the WPEB. The WPEB further **AGREED** to review in 2022 the need to address multi-taxa mitigation measures for additional gear types in future years.

122. The WPEB **NOTED** the need for development of terms of references for the proposed multi-taxa bycatch mitigation workshops, identifying roles and responsibilities and lead agencies, and **AGREED** that a proposal should be shared with the SC in 2021 for approval.

123. The WPEB **NOTED** the request for joint collaboration on organizing multi-taxa bycatch mitigation workshops with relevant organisations including but not limited to IWC, ACAP, IOSEA Marine Turtle MOU and CMS Sharks MOU.

124. The WPEB **NOTED** the need for detailed discussions around mitigation measures such as the use of artificial lights which have been trialled in certain fisheries but for which research efforts are being hampered by the IOTC Resolution 16/07 banning the use of artificial lights on fishing gears

125. The WPEB **NOTED** the need to adopt a precautionary approach to the management of bycatch considering the range of issues faced by many bycatch species, in particular in artisanal fleets which have been overlooked to date.

126. The WPEB **NOTED** paper IOTC-2021-WPEB17(AS)-32 on the bycatch status in tuna fisheries in India, including the following abstract provided by the authors:

"In the tuna fishery apart from the targeted catch i.e., the tunas, the allied catches like the swordfish, sailfish, marlins and pelagic sharks, dolphinfish, turtles etc. contribute to the bycatch. The landing pattern of these resources clearly indicates this. Also, the exploratory tuna longline surveys in the exclusive economic zone (EEZ) of India has indicated the abundance of these species. For managing the tuna fishery, it is utmost important to know the status of the bycatch occurring in it. In the present study along with the targeted catch i.e., the tunas, 39 bycatch species i.e., the billfishes, seerfishes, pelagic sharks, rays, barracudas, sickle pomfret, oilfish, sunfish, escolar, dolphinfish, lancetfish etc. were recorded. The fishes recorded during the tuna longline survey in the Indian waters by the four longliners i.e., MFV Matsya Vrushti, MFV Matsya Drushti, MFV Yellow Fin and MFV Blue Marlin during 2009-19 were studied and the distribution and abundance pattern of the tunas and the bycatch species were recorded. An aggregate hooking rate of 0.28% (number/100 hooks) and a catch rate of 33.3 (kg/1000 hooks) was recorded from the Indian EEZ. This study will definitely help the researchers and entrepreneurs as well as the fishery managers of India for devising the desired policy for the management of bycatch in Indian waters."

127. The WPEB **NOTED** the discrepancies between the data presented and the data submitted to the IOTC Secretariat, much of which has been aggregated, and **REQUESTED** the authors to review the differences and submit data to the required level of detail with the support of the Secretariat.

128. The WPEB **NOTED** the drop in reported catches of sharks in 2018 in the data submitted to IOTC by India and the lack of information on the reasons for this (i.e., whether these are data reporting issues or reflect an actual decline in catches) and **REQUESTED** the authors to investigate this with the IOTC Secretariat and report back to WPEB.

129. The WPEB **NOTED** the importance of prioritising areas which are thought to be important for neritic species when working towards an ecosystem-based approach, given their diversity and complexity, and ensuring these are incorporated in future discussions on ecosystem-based approaches to management. The WPEB further **NOTED** that the proposed ecoregion which encompasses parts of the Indian coast could be one of the first target areas for applying the ecosystem-based approach due to the prevalence of neritic species in this region.

130. The WPEB **NOTED** the seasonal patterns in the elasmobranch and tuna catches, which suggest an apparent inverse correlation, and **ENCOURAGED** the authors to investigate this trend further.

131. The WPEB **NOTED** paper IOTC-2021-WPEB17(AS)-INF04 on the position of WWF on the impacts on oceanic sharks and rays, including the following abstract provided by the authors:

"According to a recent reassessment by the IUCN – SSG global shark and rays are in a critical state. Around 37% of the world's shark and ray species are now threatened with extinction, overfishing being a driver of the decline, where possibly three species of sharks are considered to be extinct. The current management measures are not sufficient as there is low observer coverage." – see paper for full abstract."

132. The WPEB **NOTED** the WWF position on oceanic shark and ray conservation, given the urgent need to focus on mitigation methods and recovery plans for species in decline, WWF has initiated a study on developing a recovery plan for hammerhead sharks in the Indian Ocean, and the WPEB **ENCOURAGED** WWF to share the results of the study.

9.2 Other sharks and rays

133. The WPEB **NOTED** paper IOTC-2021-WPEB17(AS)-25 on a preliminary habitat suitability model for oceanic whitetip shark in the western Indian Ocean, including the following abstract provided by the authors:

"Understanding the temporal, spatial and environmental factors influencing species distributions is essential to minimize the interactions of vulnerable species with fisheries and can be used to identify areas of high bycatch rates and their environmental conditions. Classified as critically endangered by the International Union for the Conservation of Nature, the oceanic whitetip shark (Carcharhinus longimanus) is the second main shark species incidentally caught by the tropical tuna purse seine fishery in the western Indian Ocean. In this study, we used the European Union purse seine fishery observer data (2010-2020) and generalized additive models to develop a habitat suitability model for juvenile oceanic whitetip shark in the western Indian Ocean. Sea surface temperature was the main environmental driver suggesting a higher probability of occurrence of this shark with decreasing temperatures. The type of fishing operation also was an important predictor explaining its occurrence, suggesting a higher probability of incidentally catching this species when using fish aggregating devices as set type. Moreover, predictive maps of habitat suitability suggested the area offshore of Kenya and Somalia are an important hotspot with higher probabilities of incidentally catching this species during the summer monsoon (June to September) when upwelling takes place. The habitat suitability models developed here could be used to inform the design and testing of potential time-area closures in the Kenya-Somalia basin with the objective of minimizing the bycatch of this critically endangered species with the least possible impact on fishing operations and fishery yields of target tunas."

134. The WPEB **NOTED** that the observed oceanic whitetip shark (OCS) hotspots correspond to areas with high levels of PS fishing effort and so are apparently biased by data that represent only a single gear.

135. The WPEB **NOTED** that such a study represents an interesting approach to evaluating the habitat of OCS, however such studies should include data from various gear types to avoid biases related to a single gear approach.

136. The WPEB **NOTED** that FADs may affect spatial distribution of OCSs and therefore, potential FAD attractive and aggregative effects should be considered in future studies.

137. The WPEB **NOTED** paper IOTC-2021-WPEB17(AS)-26 providing an update on tag deployments to investigate the post-release mortality of oceanic whitetip sharks discarded by EU purse seine and pelagic longline fisheries in the south west Indian Ocean (POREMO project), including the following abstract provided by the authors:

"In this third progress report, we again briefly present the context of the POREMO project funded by EU France (FEAMP Mesure 77, Data Collection Framework) for the development of appropriate IOTC conservation measures for both targeted and non-targeted large pelagic resources exploited by open ocean fisheries. The POREMO project specifically aims at quantifying the post release mortality of the oceanic whitetip shark Carcharhinus longimanus (OCS) caught as bycatch in the EU tuna purse seine and pelagic longline fisheries to assess the effectiveness of the OCS retention ban measure adopted in the IOTC Resolution 13/06. In this working paper we present activities done since the 14th WPEB (2018) regarding, in particular, the deployment of satellite tags (both miniPATs and sPATs) on OCS. Based on the tags reported data so far, the post release survival of the OCS is 100% for the pelagic longline, and 93% for the purse seine EU fisheries."

138. The WPEB **NOTED** that observed OCS post-release mortality in purse seine and longline fisheries is very low (7% for purse seine, and 0% for longline), which is a positive signal that the IOTC retention ban (Resolution 13/06) is likely to be a relevant conservation measure contributing to the recovery of the OCS population In the Indian Ocean. The WPEB **NOTED** that the results suggest that implementation by fishermen of best practices for handling and release of sharks in PS and LL gears should be encouraged to mitigate post-release mortalities.

139. The WPEB **NOTED** that fork length (FL) of tagged OCS ranged from 87 cm to 200 cm (measured on board or estimated) and that the majority of tagged sharks were females.

140. The WPEB **NOTED** that according to experimental design observers do not specifically select individuals which are in good condition and for the longline gear OCSs are mostly tagged in the water. The WPEB **NOTED** that these handling protocols are similar to those practiced during routine fishing operations. Therefore, the WPEB **NOTED** that results of OCS survivorship estimated might be robust enough to be extrapolated at the scale of the two fisheries.

141. The WPEB **NOTED** paper IOTC-2021-WPEB17(AS)-27 on a preliminary habitat suitability model for devil rays in the western Indian Ocean, including the following abstract provided by the authors:

"The European tropical tuna purse seine fishery incidentally captures three highly migratory and endangered species of devil rays, spinetail devil ray Mobula mobular, sicklefin devil ray M. tarapacana, and bentfin devil ray M. thurstoni in the Indian Ocean. Due to their global decreasing populations, understanding the factors of their spatial and temporal distributions and the associated environmental conditions are fundamental for their management and conservation. Yet, the spatial and temporal distribution of devil rays in the Indian Ocean is poorly understood. Here we developed a habitat suitability model for devil rays in the Western Indian Ocean depicting the seasonal and interannual changes in their spatial distributions and underlying environmental conditions. We used bycatch data collected between the period 2010-2020 by the EU tropical tuna purse seine observer

program to determine which environmental variables influence the occurrence of devil rays using generalized additive models. A separate modelling was done for the spinetail devil ray and for the three species of devil rays combined, since many individuals are only recorded at the genus level. The environmental variables associated with the presence of devil rays were chlorophyll, sea surface height and sea surface temperature fronts. When modelling the habitat suitability for spinetail devil ray, the most influential environmental variables were net primary production of phytoplankton and sea surface temperature fronts. Both the interannual and seasonal variability in habitat suitability of devil rays were explained by these environmental variables. We also revealed that devil rays are associated to permanent hotspots in the Mascarene Plateau and Central Indian Ridge, and to seasonal hotspots in the Western Arabian Sea and Equatorial regions where there is a high occurrence of devil rays during winter monsoon. We found that setting in big schools of tuna decreases the chances of devil ray bycatch. Both models predicted a higher probability of incidental catch of devil rays in fishing sets on free swimming schools of tunas than in sets on fish aggregating devices. The identified hotspots and associated environmental characteristics provide information about the habitat use and ecology of the devil rays in the Western Indian Ocean. Furthermore, the habitat suitability models, and biological hotspots identified in this study could also to be used to inform the development of future spatial management measures, including time-area closures, to minimize the interaction of pelagic fisheries with these vulnerable species."

142. The WPEB **NOTED** that devil rays are rarely attracted by FADs and mostly tend to be found to occur in PS sets on free schools.

143. The WPEB **NOTED** that results of the habitat suitability model might be biased by fishery dependent data coming only from the purse seine fishery.

144. The WPEB **ENCOURAGED** the further development of such habitat suitability models considering several different data sources.

145. The WPEB **NOTED** paper IOTC-2021-WPEB17(AS)-28 on 3D printing of pelagic shark fins for use as a training and compliance tool, including the following abstract provided by the authors:

"Identical 3D replica fins of CITES Appendix II-listed sharks, and one non-CITES listed species, covering a total of 10 species and two families have been developed through a collaboration between TRAFFIC and the South African Department of Forestry, Fisheries and the Environment. The entire process from scanning, printing and painting has been documented and is available online at https://www.traffic.org/3d-replica-shark-fins/. The scan files and images providing painting guidance are all open access documents, available at no cost. The development of the 3D printed fins accompanied by QR codes, which link to dedicated webpages providing additional guidance on identification, will facilitate the identification of dried shark fins in trade and allow for rapid and confident decision-making by relevant law enforcement officials. It also has the potential for improving the collection of trade and catch data which in a CITES context should assist in strengthening the scientific basis for the development of Non-Detriment Findings by CITES Scientific Authorities."

146. The WPEB **NOTED** that the current cost to produce a set of 22 fins (from 10 species) (including printing and painting) is currently around $US 1,500 in South Africa. The WPEB **NOTED** that reducing these costs is essential for wider distribution of this practice and further **NOTED** that TRAFFIC is attempting to reduce costs by producing smaller fins. The WPEB **NOTED** that the authors are also working to expand the species included in the current set.

147. The WPEB **ENCOURAGED** the authors to share their experience and guidelines with other countries involved in the shark trading chains.

148. The WPEB **NOTED** paper IOTC-2021-WPEB17(AS)-INF01 which describe quantifying the accuracy of shark bycatch estimations in tuna purse seine fisheries and which included the following abstract provided by the authors:

"Estimating bycatch is essential for monitoring the ecological impacts of a fishery in order to set management and mitigation priorities. Purse seine vessels targeting tropical tunas incidentally catch pelagic sharks (mainly silky and oceanic whitetip sharks), which are brought onboard and can be observed on the upper and lower decks. Currently, single onboard observers can only be efficiently stationed on one of the two decks, and thus often rely on information provided by the crew to complement their bycatch estimations. In this study, we used dedicated scientists strategically positioned during fishing sets in order to establish a reference count of captured sharks during conventional commercial fishing trips. We then assessed the accuracy of the counts made by (i) single observers onboard during the same fishing trips in the Pacific Ocean (where observers' main duty is to estimate catch of target species and bycatch estimation is of a lower priority) and the Atlantic Ocean (where observers' focus is on bycatch) and (ii) Electronic Monitoring System (EMS) in the Indian Ocean. A total of 74 fishing sets conducted during four purse seine fishing trips revealed that shark counts were underestimated for 50%–100% of the sets, with the mean shark count underestimation, at the fishing trip level, ranging from 9% to 40% (onboard observers) and 65% for EMS. Given the importance of monitoring populations of vulnerable species, we strongly encourage specific studies during which the complementary counts of two onboard observers are used simultaneously to assess the accuracy of various EMS configurations, bearing in mind that single onboard observers appear to underestimate the number of captured sharks."

149. The WPEB **NOTED** the rather high underestimation by onboard observers of the number of sharks caught as bycatch by purse seiners engaged in this study, particularly when compared with the deployed electronic monitoring system which suggested the possibility of a boat effect whereby the inability of one observer to monitor both the upper and lower decks simultaneously led to undercounting of shark bycatch on these vessels.

150. The WPEB **NOTED** that EMS is a good complementary tool to support observer coverage. However, the WPEB **NOTED** the general difficulties with the ability of EMS to identify sharks, turtles and some billfishes at a species level and because of these challenges with identification the WPEB **ENCOURAGED** stakeholders involved in the development of EMS to deploy cameras with the highest resolution possible.

151. The WPEB **NOTED** that purse seiners are not equipped with infrared cameras for night vision but further **NOTED** that mostly hauling operations take place when there is sufficient light for the cameras to be able to capture the operations.

152. The WPEB **NOTED** paper IOTC-2021-WPEB17(AS)-INF02 which presents an update on the recent development of IOTC BTH PRM Project, and which included the following abstract provided by the authors:

153. *This note provides recent updates on IOTC bigeye thresher shark (Alopias superciliosus, BTH) post-release mortality study project (IOTC BTH PRM Project). The objective of the study is to evaluate the efficiency of the IOTC Conservation and Management Measure on non-retention of thresher sharks of the genus Alopias (Resolution 12/09). The summary of collective efforts since the 13th, 14th, 15th, and 16th IOTC WPEB are presented.*

154. The WPEB **NOTED** that there have been some challenges with this project which have caused delays including technical issues with the tags and difficulties in deploying tags due to restrictions resulting from the Covid-19 pandemic. The WPEB **NOTED** that the project will therefore need to be extended.

9.3 Marine Mammals

155. The WPEB **NOTED** paper IOTC-2021-WPEB17(AS)-29 on the 2021 meeting on collaborative activities for cetacean bycatch between IOTC and IWC, including the following abstract provided by the authors:

"The IWC and IOTC held a meeting to identify collaborative work areas between the two organisations relating to bycatch of cetaceans in Indian Ocean tuna fisheries. During the meeting, presentations were given by researchers working on: quantifying cetacean bycatch, conducting abundance estimates and ecological risk assessments; testing mitigation measures; and guidelines on releasing cetaceans safely if they are caught incidentally. Discussions were held around the IWC proposal submitted to the Common Oceans ABNJ programme which will include activities such as data collation and analysis, spatial bycatch risk assessments and outreach, training and knowledge transfer activities. The current IOTC Resolutions relating to cetaceans were discussed and loopholes such as limited gear coverage and exemptions for data reporting were considered. Finally, recommendations to take to the WPEB were developed and included: the endorsement of the Letter of Intent between IOTC and IWC to formalise the collaboration between the two organisations; the consideration of splitting the WPEB into one group focused on shark assessments and another group to discuss all other issues relating to ecosystems and bycatch; and the continuation of collaboration and activities between IOTC and IWC."

156. The WPEB **NOTED** that IWC recently held a meeting with the IOTC and other interested stakeholders to discuss issues relating to cetacean bycatch and produce some recommendations to bring to the WPEB.

157. One of the key discussions during this meeting was for the WPEB to endorse the draft Letter of Intent intended to formalise the collaboration between IOTC and IWC (paper IOTC-2021-WPEB17(AS)-INF03). The WPEB **NOTED** that this letter is based on the language used in the Letter of Intent between IOTC and ACAP which has been accepted by the Commission. The WPEB **NOTED** that there was dissent during discussions of this proposal but finally the WPEB **ACKNOWLEDGED** the Letter of Intent and **RECOMMENDED** that the letter is discussed at the SC.

9.4 Seabirds

158. The WPEB **NOTED** paper IOTC-2021-WPEB17(AS)-30 on ACAP advice for reducing the impact of pelagic longline fishing operations on seabirds, including the following abstract provided by the authors:

"The incidental mortality of seabirds in pelagic longline and other fisheries continues to be a serious global concern, especially for threatened albatrosses and petrels. The Agreement on the Conservation of Albatrosses and Petrels (ACAP) was established to address this concern. ACAP routinely reviews and updates its advice, most recently in August-September 2021, at the Twelfth Meeting of ACAP's Advisory Committee (AC12) and preceding Tenth meeting of the Seabird Bycatch Working Group (SBWG10). This paper summarizes the latest advice and recent recommended changes. ACAP recommends that the most effective way to reduce seabird bycatch in pelagic longline fisheries is to use the following three best practice measures simultaneously: branch line weighting, night-setting and Bird Scaring Lines. Alternatively, the use of one of two assessed hook-shielding devices is recommended. During SBWG10, two additional mitigation measures for pelagic longline

fisheries were assessed against the six best practice seabird bycatch mitigation criteria adopted by the ACAP Advisory Committee (AC). These were underwater bait setting devices, specifically the Underwater Bait Setter (Skadia Technologies) and the Hookpod-mini. The Advisory Committee is due to consider endorsement of these as ACAP best practice seabird bycatch mitigation. ACAP is working towards communicating more effectively the conservation crisis facing albatrosses and petrels, and its advice regarding how best to address the threats that these seabirds face."

159. The WPEB **NOTED** the need for strong evaluation of these measures due to the cost of installing such gear modifications to fleets. The WPEB **NOTED** that some evaluation has been conducted on the new technology but that it would be beneficial to evaluate the use of the measures further and in other fisheries from where they have already been studied.

9.5 Sea turtles

160. The WPEB **NOTED** paper IOTC-2021-WPEB17(AS)-31 on the proposed Letter of Understanding on the Conservation and Management of Marine Turtles and their Habitats of the Indian Ocean and South-East Asia (IOSEA).

161. The WPEB **NOTED** that this letter is also heavily based on the language used in the Letter of Intent between IOTC and ACAP which has been accepted by the Commission. The WPEB **NOTED** that the IOSEA has been collaborating with the IOTC for many years and the Letter of Intent is intended to formalise this collaboration.

162. The WPEB **REQUESTED** that IOSEA provide more information about its structure and functioning and the rationale for the need for collaboration. The WPEB **NOTED** that there were differing opinions during discussions of this proposal and therefore there was no agreement to pass the letter on to the SC at this stage.

10.WPEB Program of Work (Research and Priorities)

163. The WPEB **NOTED** paper IOTC–2020–WPEB17(AS)–09 which provided the WPEB17 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.

164. The WPEB **RECOMMENDED** that the SC consider and endorse the WPEB Program of Work (2022–2026), as provided in Appendix XVII.

11.Other Matters

11.1 Election of new Chairs for the Working Party on Ecosystems and Bycatch

Chairperson

165. The WPEB **NOTED** that the second term of the current Chairperson, Dr Sylvain Bonhommeau (EU) expired at the close of the WPEB17 meeting and, as per the IOTC Rules of Procedure (2014), participants are required to elect a new Chairperson of the WPEB for the next biennium.

166. **NOTING** the Rules of Procedure (2014), the WPEB **CALLED** for nominations for the position of Chairperson of the IOTC WPEB for the next biennium. Dr Mariana Tolotti (EU) was nominated, seconded and elected as Chairperson of the WPEB for the next biennium.

Vice-Chairperson

167. The WPEB **NOTED** that the first term of the current 1st Vice-Chairperson, Dr Mariana Tolotti (EU) expired at the close of the WPEB17 meeting and that the first term for the current 2nd Vice-Chairperson Dr Mohammed Koya (India) also expired. As per the IOTC Rules of Procedure (2014), participants are required to elect a new 1st and 2nd Vice-Chairperson of the WPEB for the next biennium.

168. **NOTING** the Rules of Procedure (2014), the WPEB **CALLED** for nominations for the positions of 1st and 2nd Vice-Chairpersons of the IOTC WPEB for the next biennium. Dr Mohammed Koya (India) was nominated, seconded and elected as 1st Vice-Chairperson of the WPEB, and Dr Charlene da Silva (South Africa) was nominated, seconded and elected as 2nd Vice-Chairperson of the WPEB for the next biennium.

11.2 Review of the draft, and adoption of the Report of the 17th Session of the (Chairperson)

169. The WPEB **RECOMMENDED** that the Scientific Committee consider the consolidated set of recommendations arising from WPEB17, provided at Appendix XVIII, 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 VII
- Oceanic whitetip sharks (*Carcharhinus longimanus*) – Appendix VIII
- Scalloped hammerhead sharks (*Sphyrna lewini*) – Appendix IX
- Shortfin mako sharks (*Isurus oxyrinchus*) – Appendix X
- Silky sharks (*Carcharhinus falciformis*) – Appendix XI
- Bigeye thresher sharks (*Alopias superciliosus*) – Appendix XII
- Pelagic thresher sharks (*Alopias pelagicus*) – Appendix XIII

Other species/groups

- Marine turtles – Appendix XIV
- Seabirds – Appendix XV
- Marine mammals - Appendix XVI

170. The report of the 17th Session of the Working Party on Ecosystems and Bycatch (IOTC–2021–WPEB17–R) was **ADOPTED** by correspondence.

APPENDIX I
LIST OF PARTICIPANTS

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APPENDIX II
AGENDA FOR THE 17TH WORKING PARTY ON ECOSYSTEMS AND BYCATCH ASSESSMENT MEETING

Date: 6 – 10 September 2021

Location: Microsoft Teams

Venue: Virtual

Time: 12:00 – 16:00 (Seychelles time)

Chair: Dr Mariana Tolotti (EU, France) **Vice-Chair:** 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 25th Session of the Commission (IOTC Secretariat)
   3.2. Outcomes of the 23rd Session of the Scientific Committee (IOTC Secretariat)
   3.3. Review of the Conservation and Management Measures relevant to Ecosystems and Bycatch (IOTC Secretariat)
   3.4. Progress on the recommendations of WPEB16 (IOTC Secretariat)

4. **REVIEW OF THE DATA AVAILABLE AT THE SECRETARIAT FOR 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. **STOCK ASSESSMENT FOR BLUE SHARKS**

   6.1. Review of indicators for blue shark (all)
   6.2. Stock assessment models (all)
   6.3. Review of the proposed stock assessment of blue shark (IOTC Secretariat)
   6.4. Recommendation and executive summary for blue shark (all)

7. **REVIEW INFORMATION ON BIOLOGY, ECOLOGY, FISHERIES AND ENVIRONMENTAL DATA RELATING TO SILKY SHARKS** (Chair)

   7.1. Presentation of new information available on silky sharks
   7.2. Review of all data available on silky sharks

8. **NEW INFORMATION ON BIOLOGY, ECOLOGY, FISHERIES AND ENVIRONMENTAL DATA RELATING TO ECOSYSTEMS AND BYCATCH SPECIES** (Chair)

8.1. 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)
- Impact of gears
- Ecosystems and climate

9. BYCATCH, SPECIES INTERACTIONS, AND ECOSYSTEM RISK ASSESSMENTS FOR OTHER SHARK SPECIES, MARINE MAMMALS, SEABIRDS, AND SEA TURTLES

9.1. All bycatch species (all)

9.2. Other sharks and rays (all)

9.3. 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
- Collaboration with the IWC

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

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

10. WPEB PROGRAM OF WORK (RESEARCH AND PRIORITIES)

10.1. Revision of the WPEB Program of Work 2021-2025 (Chairperson and IOTC Secretariat)

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

11. OTHER MATTERS (Chair)

11.1. Election of new Chairs for the Working Party on Ecosystems and Bycatch

11.2. Review of the draft, and adoption of the Report of the 17th Session of the Working Party on Ecosystems and Bycatch (Chairperson)

APPENDIX III
LIST OF DOCUMENTS

Document	Title
IOTC-2021-WPEB17(AS)-01a	Agenda of the 17th Working Party on Ecosystems and Bycatch Assessment Meeting
IOTC-2021-WPEB17(AS)-01b_rev4	Annotated agenda of the 17th Working Party on Ecosystems and Bycatch Assessment Meeting
IOTC-2021-WPEB17(AS)-02	List of documents of the 17th Working Party on Ecosystems and Bycatch Assessment Meeting
IOTC-2021-WPEB17(AS)-03	Outcomes of the 23rd Session of the Scientific Committee (IOTC Secretariat)
IOTC-2021-WPEB17(AS)-04	Outcomes of the 25th Session of the Commission (IOTC Secretariat)
IOTC-2021-WPEB17(AS)-05	Review of Conservation and Management Measures relevant to ecosystems and bycatch (IOTC Secretariat)
IOTC-2021-WPEB17(AS)-06	Progress made on the recommendations and requests of WPEB16 and SC23 (IOTC Secretariat)
IOTC-2021-WPEB17(AS)-07	Review of the statistical data and fishery trends for ecosystems and bycatch species (IOTC Secretariat)
IOTC-2021-WPEB17(AS)-08_rev1	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-2021-WPEB17(AS)-09	Revision of the WPEB Program of Work (2021–2025) (IOTC Secretariat & Chairperson)
IOTC-2021-WPEB17(AS)-10	Japanese annual catches of pelagic sharks in two subareas between 1964 and 1993 (Kai M)
IOTC-2021-WPEB17(AS)-11	A review of the reproductive biology of the Blue shark (*Prionace glauca*) in the Western Indian Ocean (Murua H et al)
IOTC-2021-WPEB17(AS)-12	Preliminary age and growth of blue shark (*Prionace glauca*) in the southwest Indian Ocean (Farley et al)
IOTC-2021-WPEB17(AS)-13	Habitat modelling for the blue shark (*Prionace glauca*) by sex and size classes in the Indian Ocean (Druon J-N, Sabarros P, Bach P, Romanov E and Coelho R)
IOTC-2021-WPEB17(AS)-14	Catch estimates of blue shark in the IOTC area of competence for the 2021 stock assessment (Rice J)
IOTC-2021-WPEB17(AS)-15_rev1	Stock assessment of Blue Shark in the Indian Ocean (Rice J)
IOTC-2021-WPEB17(AS)-16	Estimates of natural mortality for blue shark in the Indian Ocean (Rice J)
IOTC-2021-WPEB17(AS)-17	An update on the CPUE standardization of the silky shark (*Carcharhinus falciformis*) caught by the Indonesian longline fishery in the eastern Indian Ocean (Wujdi A)
IOTC-2021-WPEB17(AS)-18	Investigation into the effects of catch time series estimations on stock assessment of Silky shark (*Carcharhinus falciformis*) in the Indian Ocean (Cramp J, Moss J and Tanna A)
IOTC-2021-WPEB17(AS)-19	Contribution of tuna gillnet fisheries of Pakistan towards abandoned, lost or otherwise discarded fishing gears (ALDFG) (Moazzam M, Gallagher A, Aisha H, Nawaz R and Rasheed T)
IOTC-2021-WPEB17(AS)-20	Subsurface gillnetting: What motivated fishermen to Change (Moazzam M)

Document	**Title**
IOTC-2021-WPEB17(AS)-21	The Jelly-FAD: a paradigm shift in bio-FAD design (Moreno G, Salvador J, Murua H, Uranga J, Zudaire I, Murua J, Grande M, Cabezas O and Restrepo V)
IOTC-2021-WPEB17(AS)-22	Concept note for the second IOTC workshop on identification of regions in the IOTC convention area to inform the implementation of the ecosystem approach to fisheries management (Juan-Jordá M-J, Nieblas AE and Murua H)
IOTC-2021-WPEB17(AS)-23	Guidelines on the safe handling and release of ETP species in gillnet fisheries (Razzaque S A)
IOTC-2021-WPEB17(AS)-24	Bycatch management in IOTC fisheries (Martin S and Shahid U)
IOTC-2021-WPEB17(AS)-25	A preliminary habitat suitability model for oceanic whitetip shark in the Western Indian Ocean (Lopetegui L, Poos JJ, Arrizabalaga H, Guirhem G, Murua H, Lezama Ochoa N, Griffiths S, Ruiz Gondra J, Sabarros P, Baez J-C and Juan-Jordá M-J)
IOTC-2021-WPEB17(AS)-26_rev1	Third progress report on tag deployments to investigate the post-release mortality of oceanic whitetip sharks discarded by EU purse seine and pelagic longline fisheries in the South West Indian Ocean (POREMO project) (Bach P, Sabarros P, Romanov E, Coelho R, Guillon N, Massey Y and Murua H)
IOTC-2021-WPEB17(AS)-27	A preliminary habitat suitability model for devil rays in the western Indian Ocean (Guirhem G, Arrizabalaga H, Lopetegui L, Murua H, Lezama Ochoa N, Griffiths S, Ruiz Gondra J, Sabarros P, Baez J-C and Juan-Jordá M-J)
IOTC-2021-WPEB17(AS)-28	3D printing of pelagic shark fins for use as a training and compliance tool (Bürgener M, Louw S and da Silva C)
IOTC-2021-WPEB17(AS)-29	Report of 2021 Meeting on collaborative activities for cetacean bycatch, IOTC-IWC (IWC/IOTC)
IOTC-2021-WPEB17(AS)-30	ACAP advice for reducing the impact of pelagic longline fishing operations on seabirds (ACAP)
IOTC-2021-WPEB17(AS)-31	Proposed Letter of Understanding between the Indian Ocean Tuna Commission and the Secretariat of the Memorandum of Understanding on the Conservation and Management of Marine Turtles and their Habitats of the Indian Ocean and South-East Asia (IOSEA)
IOTC-2021-WPEB17(AS)-32_rev1	An Overview of the bycatch status in tuna fishery in India (Kar AB, Prasad GVA, Das P, Silambarasan K, Bhami Reddy D, Ayoob AE, Unnikrishnan N, Pawar RU and Jeyabaskaran R)
Information papers	
IOTC-2021-WPEB17(AS)-INF01	Quantifying the accuracy of shark bycatch estimations in tuna purse seine fisheries (Forget F, Muir J, Hutchinson M, Itano D, Sancristobal I, Leroy B, Filmalter J, Martinez U, Holland K, Restrepo V and Dagorn L)
IOTC-2021-WPEB17(AS)-INF02	An update on the recent development of IOTC BTH PRM Project (Romanov E)
IOTC-2021-WPEB17(AS)-INF03	Proposed Letter of Intent between IOTC and IWC (IWC)
IOTC-2021-WPEB17(AS)-INF04	WWF position on the impact of fisheries on oceanic sharks and rays (WWF)
IOTC-2021-WPEB17(AS)-INF05	Shark mortality overlap cannot be assessed by fishery overlap alone (Murua H, Griffiths S, Hobday A, Clarke S, Cortés R, Gilman E, Santiago J, Arrizabalaga H, de Bruyn P, Lopez J, Aires-da-Silva A and Restrepo V)
IOTC-2021-WPEB17(AS)-INF06	Caution over the use of ecological big data for conservation (Harry A and Braccini J)
IOTC-2021-WPEB17(AS)-INF07	Biological observations of shortfin mako shark (*Isurus oxyrinchus*) on Spanish surface longline fishery targeting swordfish (García-Cortés B, Ramos-Cartelle A, Mejuto J, Carroceda A and Fernández-Costa J)

Document	Title
IOTC-2021-WPEB17(AS)-INF08	Spatially-explicit risk assessment of interactions between marine megafauna and Indian Ocean tuna fisheries (Robertson L, Boussarie G, Dugan E, Wilcox C, Garilao C, Gonzalez K, Green M, Kark S, Kaschner K, Klein C, Rousseau T, Vallentyne F, Watson J and Kiszka J)
IOTC-2021-WPEB17(AS)-INF09	Using eDNA to reconstruct logbook information and improve estimates of by-catch (Green M E, Craw P, Hardesty B D, Deagle B and Wilcox C)
IOTC-2021-WPEB17(DP)-06	Updated on the CPUE standardization of the blue shark caught by the Indonesian longline fishery in the eastern Indian Ocean (Wujdi A, Setyadji B, Fahmi Z)
IOTC-2021-WPEB17(DP)-07	Updated standardized catch rates for blue shark caught by the Taiwanese large-scale tuna longline fishery in the Indian Ocean (Wu XH and Tsai WP)
IOTC-2021-WPEB17(DP)-08	Updated standardized CPUE of blue shark bycaught by the French Reunion-based pelagic longline fishery (2007-2020) (Sabarros P, Coelho R, Romanov E, Guillon N, Bach P)
IOTC-2021-WPEB17(DP)-09	Updated Standardized Catch Rates in Biomass for the Blue Shark (Prionace glauca) Caught by the Spanish Surface Longline Fleet in the Indian Ocean During the 2001-2019 Period (Fernández Costa J, Ramos-Cartelle A and Mejuto J)
IOTC-2021-WPEB17(DP)-10	Updated Blue shark catches and standardized CPUE for the Portuguese pelagic longline fleet in the Indian Ocean from 1998 to 2019 (Coelho R, Santos C, Rosa D, Lino P)
IOTC-2021-WPEB17(DP)-INF01	Demographic and harvest analysis for blue shark (Prionace glauca) in the Indian Ocean (Geng Z, Wang Y, Kindong R, Zhu J, Dai X
IOTC-2021-WPEB17(DP)-INF02	On the dangers of including demographic analysis in Bayesian surplus production models: A case study for Indian Ocean blue shark (Geng Z, Punt A, Wang Y, Zhu J, Dai X)
IOTC-2021-WPEB17(DP)-INF06	Age and growth of the blue shark (Prionace glauca) in the Indian Ocean (Andrade I, Rosa D, Muñoz Lechuga R, Coelho R)
IOTC-2021-WPEB17(DP)-INF07	Update of Age and sex specific Natural mortality of the blue shark (Prionace glauca) in the North Pacific Ocean (Semba Y and Yokoi H)
IOTC-2021-WPEB17(DP)-INF08	Reproductive biology of the blue shark (Prionace glauca) in the western North Pacific Ocean (Fujinami Y, Semba Y, Okamoto H, Ohshimo S and Tanaka S)

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

Extract from IOTC–2021–WPEB17(AS)–07.
(Appendix references in this Appendix, refer only to those contained in this appendix)

Overall bycatch levels & trends

Nominal catches of all species caught by Indian Ocean fisheries reported to the Secretariat have been increasing over time, with a particularly dramatic increase in the amount of tuna catches reported since the 1980s (**Fig. A 1**). In 2019, the total nominal catches of all IOTC and non-IOTC species were 1,848,828 t and 223,362 t, respectively.

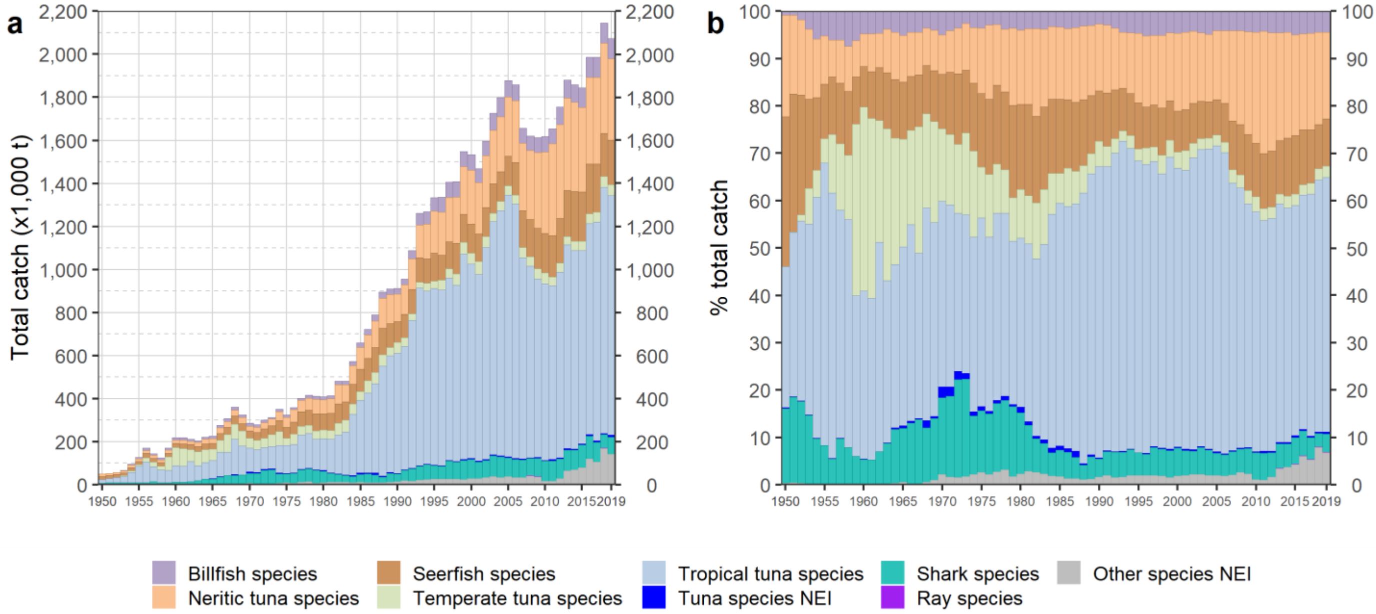

Fig. A 1: Annual time series of cumulative nominal absolute (a) and relative (b) catches of all IOTC tuna and tuna-like species in metric tons (t) by species category for the period 1950-2019

Reported nominal catches of species of interest to the WPEB are largely predominated by sharks with estimates from some artisanal fisheries dating back to the early 1950s (**Fig. A 2**). Overall reported catches of shark and ray species have increased over time in relation to the development and expansion of tuna and tuna-like fisheries across the Indian Ocean, the increased reporting requirements for some sensitive species such as thresher and oceanic whitetip sharks, and the implementation of retention bans in some fisheries. In 2019, the total nominal catches of sharks reported to the Secretariat were 79,543 t, with rays representing a very small component of the reported bycatch and amounting to 1,813 t, i.e., about 2.2% of total reported shark and ray catches in 2019 (**Fig. A 2**).

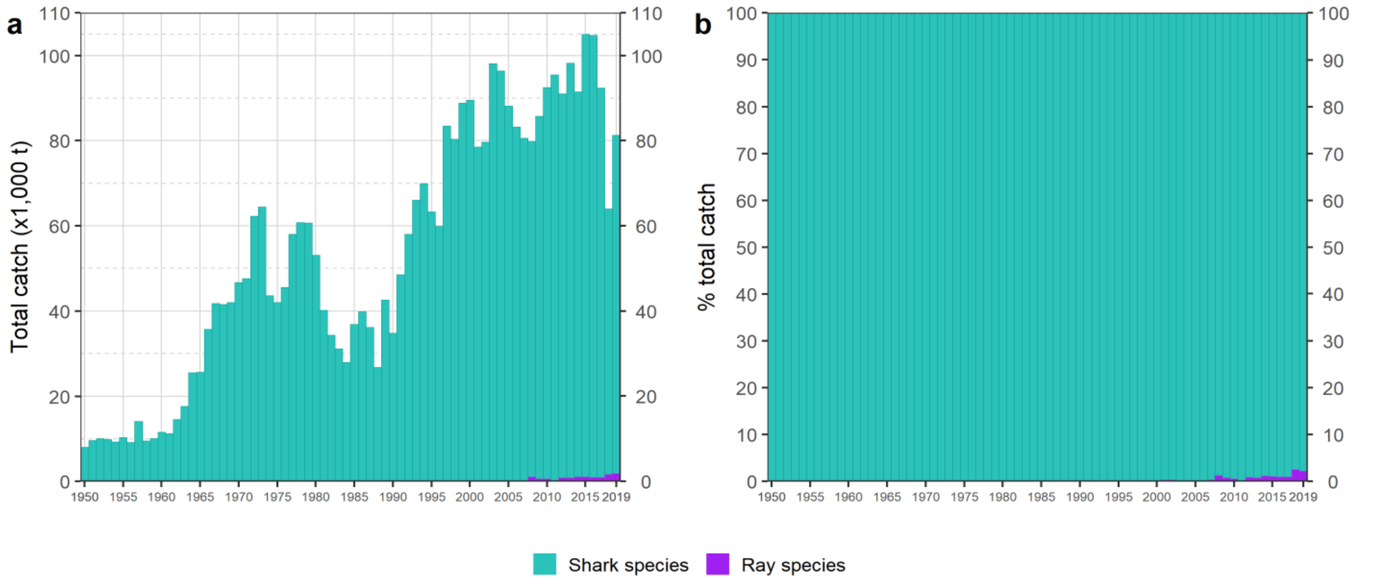

Fig. A 2: Annual time series of cumulative nominal absolute (a) and relative (b) catches of shark and ray species in metric tons (t) by species category for the period 1950-2019

Very few fleets reported catches of sharks and rays in the 1950s, but the number of reporting fleets has increased over time (**Fig. A 3**). Total reported shark and ray catches of sharks and rays have also increased over time, reaching a peak of more than 100,000 t in 2015-2016: since then, nominal catches have decreased to about 80,000 t in 2019.

In 2018, reported catches of sharks and rays reduced declined significantly when compared with 2017 and 2019, mostly due to a complete disappearance of reported catches of aggregated shark species by India, (there that were not replaced by detailed catches by species), as well as to marked decreases in reported shark catches from other CPCs (Mozambique and Indonesia) which in some cases are thought to indicate reporting issues rather than a real reduction in catch levels. Furthermore, the revisions to Pakistani gillnet catches from 1987 onwards (endorsed by the SC in December 2019) introduced a mean annual decrease of around 17,000 t in total catches during the concerned period when compared to previously available data.

Recently, Japan provided a detailed species breakdown of retained shark catches from their deep-freezing longline fisheries for the years 1964-1993, which replaces the original re-estimates made by the IOTC Secretariat for the period concerned (Kai 2021). The revised Japanese catch series is now an integral part of the IOTC databases and is disseminated through the nominal catch data set prepared for the meeting.

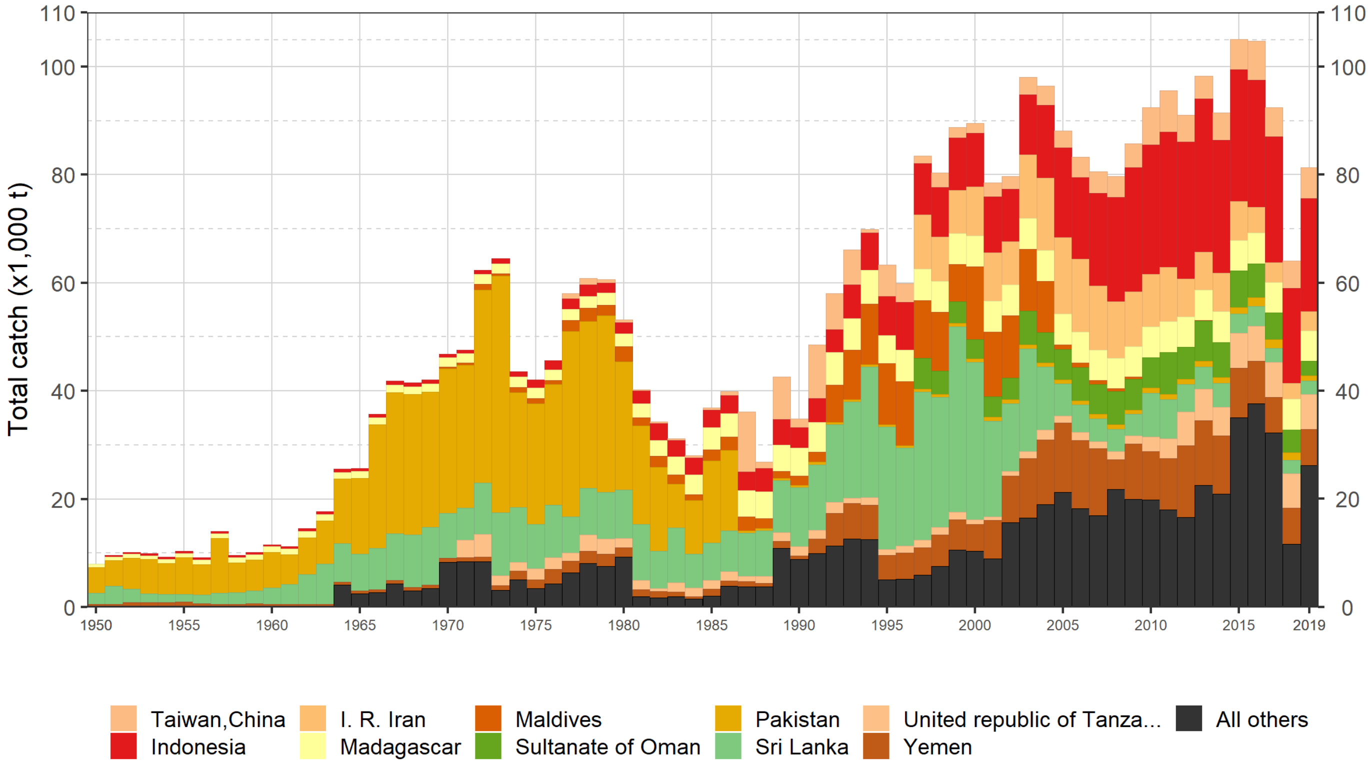

Fig. A 3: Annual time series of nominal catches (t) of sharks and rays by fleet during 1950–2019

Sharks and rays

Levels of reported nominal catches for sharks and rays strongly vary with fishing gear and over time, with gillnets that have historically been associated with the highest nominal catches and are currently responsible for almost 40% of reported catches of the species. Of all gillnet fisheries, the majority comprise of standard, unclassified gillnets, followed by gillnets, handlines and troll lines and gillnet/longline combinations.

In terms of catch magnitude, gillnet fisheries are followed by longline fisheries (which contributed substantially to shark and ray catches in the 1990s) and by catches from handline and troll line fisheries, which have increased markedly in more recent years (**Fig. A 4**).

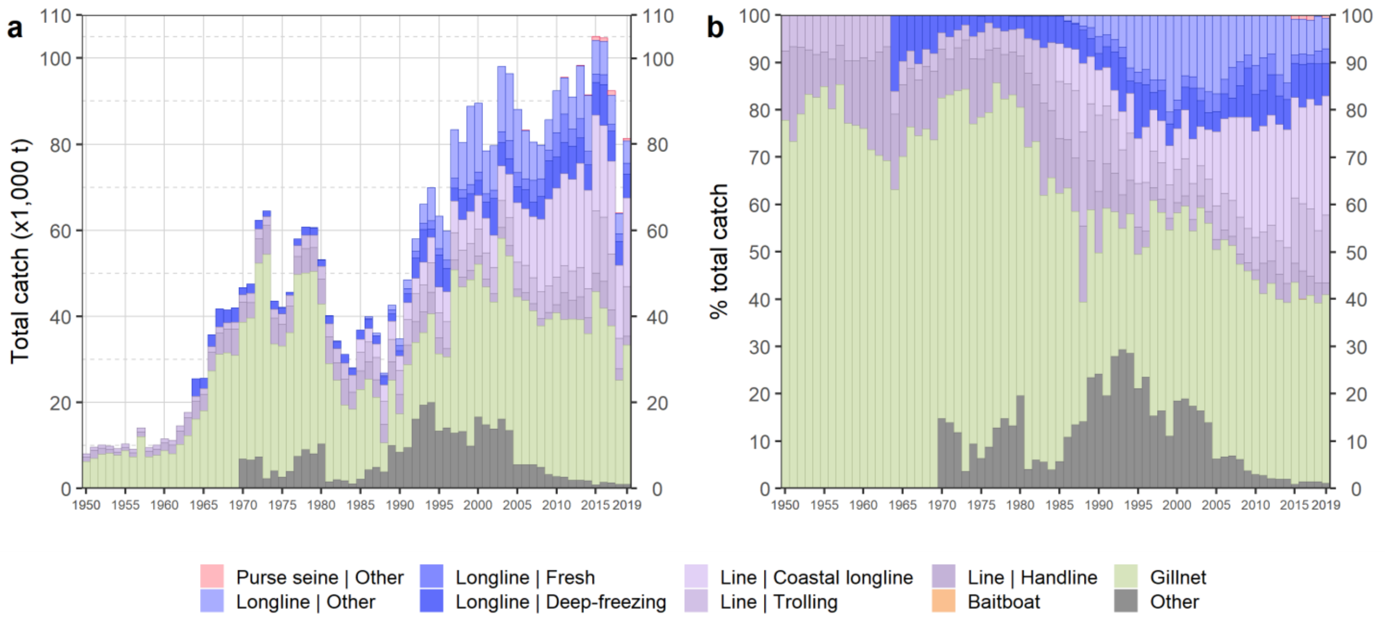

Fig. A 4: Annual time series of nominal absolute (a) and relative (b) catches of sharks and rays in metric tons (t) by fishery for the period 1950–2019. Other = all other fisheries combined

Overall, while industrial longliners and drifting gillnetters are known for harvesting important amounts of pelagic sharks, the same cannot be said of industrial purse seiners, pole-and-liners and most coastal fisheries.

Other bycatch species categories

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.

APPENDIX V

MAIN ISSUES IDENTIFIED CONCERNING DATA ON NON-IOTC SPECIES

Extract from IOTC–2021–WPEB17(AS)–07

Uncertainties in catch and effort data

The estimation of catch and effort for sharks and rays in the Indian Ocean is compromised by the paucity and inaccuracy of the data originally reported by some CPCs.

Unreported catches

Although some fleets have been operating since the early 1950s, there are many cases where historical catches have gone unreported as many countries were not collecting fishery statistics in years prior to the 1970s. It is therefore thought that important catches of sharks and rays might have gone unrecorded in several countries. Also, there still are several fleets not reporting on their interactions with bycatch species, despite data showing that other fleets using similar gears report high catch rates of bycatch species.

Some fleets have also been noted to report distinct catches only for those species that have been specifically identified by the Commission and do not report catches of other species – not even in aggregate form: this creates problems for the estimation of total catches of all sharks and rays and hinders the possibility of further disaggregating catches originally provided as species groups.

Errors in reported catches

For the fleets that do report interactions, there still are several issues with estimates of total volumes of biomass caught. In fact, reported data tend to refer only to retained catches rather than total catches, with discard levels that are often severely under-reported or not available at all. While IOTC Res. 15/02 explicitly calls for the provision of discard data for the most commonly caught elasmobranch species, very little information has been received so far by the Secretariat. To date the EU (Spain, UK), Japan and Taiwan,China, have not provided estimates of total discards of sharks by species for their longline fisheries, although all are now reporting discards in their observer data. As for industrial purse seine fisheries, I.R. Iran, Japan, and Thailand have not provided estimates of total quantities of discards of sharks and rays by species for industrial purse seiners under their flag. EU,Spain and Seychelles are now reporting discards in their observer data and EU,Spain reported total discards for its PS fleet in 2018.

Errors are also introduced by the processing of retained catches undertaken at national level: these create further problems in the estimation of 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 and prone to errors.

Poor data resolution

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 (see section Historical trends in catches (1950-2019)). Mis-identification of shark species is also common and additional data processing might introduce further problems related to proper species identification, requiring a high level of expertise and experience to be able to accurately identify specimens. The level of reporting by gear type is much higher, and catches reported as allocated to gear aggregates are only a small proportion of the total.

Catch and effort data

For all the aforementioned reasons, the geo-referenced catch and effort data sets available at the Secretariat for shark and ray species are of overall poor quality, with very little information available to derive time series of abundance indices that are essential for conducting stock assessments. The main issues vary with gear and fleet:

- **Gillnet fisheries**
  - Driftnet fishery of Taiwan,China (1982–92): data not reported to 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 for any years;
  - Gillnet fisheries of I.R. Iran: spatially disaggregated catch and effort data are now available from 2007 onwards, although not fully reported to IOTC standards (do not include catches by shark species, which are instead available as nominal catches during the same period);

  - Gillnet fisheries of Oman: data not reported to IOTC standards.

- **Longline fisheries**
  - Historical catches of sharks from major longline fisheries (Japan, Taiwan,China, Indonesia, and Rep. of Korea): data not reported to IOTC standards for years before 2006 (no species-specific catches);
  - Fresh-tuna longline fisheries (Malaysia): data not provided or not reported to 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 to IOTC standards (for the periods during which these fisheries were known to be active).

- **Coastal fisheries**
  - Coastal fisheries of India and Yemen: data not provided;
  - Coastal fisheries of Oman: data not reported to IOTC standards;
  - Coastal fisheries of Madagascar: data provided since 2018 but with a very low coverage and not reported to 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 and ray species.

Catch estimation process

For some fisheries characterized by outstanding issues in terms of data collection and management, the composition of the catch may be derived from a data processing procedure that relies on constant proportions of the catch assigned to shark species over time (e.g., Moreno et al. 2012). Also, revisions of historical data aimed at estimating species-specific time series of catch may rely on assumptions of constant species composition (e.g., Kai 2021), although more complex approaches exist (Martin et al. 2017). The use of constant catch proportions conceals the variability in catches inherent to changes in abundance and catchability and strongly depends on the original samples used for the processing. Recently, a revision of gillnet catches by Pakistan from 1987-2018 has impacted the mean shark catches of the CPC to the point where these are close to negligible, whereas they previously accounted for the second highest mean annual catch from all CPCs (IOTC 2019).

APPENDIX VI

2021: 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 2021*)

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, but a working group has been formed to update the draft NPOA sharks which was developed in 2014 during the BOBLME Phase 1 programme. 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 2019 for Amsterdam albatross which will be in force from 2018-2027. **Marine turtles:** Implemented in 2015 for the five species of marine turtles that are present in the southwest Indian Ocean.
India							**Sharks:** In preparation. In June 2015, India published a document entitled "Guidance on National Plan of Action for Sharks in India" which is intended as a guidance to the NPOA-Sharks and seeks to (1) present an overview of the currents status of India's shark fishery, (2) assess the current management measures and their effectiveness, (3) identify the knowledge gaps that need to be addressed in NPOA-Sharks and (4) suggest a theme-based action plan for NPOA-Sharks. **Seabirds:** India has determined that seabird interactions are not a problem for their fleets. However, a formal evaluation has not yet taken place which the WPEB and SC require. **Marine turtles:** No information received by the Secretariat.
Indonesia		–		–			**Sharks:** Indonesia has established an NPOA for sharks and rays in 2015-2019 **Seabirds:** An NPOA was finalized in 2016 **Marine turtles:** Indonesia has established an NPOA for Marine Turtles, but this does not fully conform with FAO guidelines. Indonesia has also been implementing Ministerial Regulation 12/2012 regarding captured fishing business on high seas to reduce turtle bycatch.
Iran, Islamic Republic of		–		–		–	**Sharks:** Have communicated to all fishing cooperatives the IOTC resolutions on sharks. Have in place a ban on the retention of live sharks. **Seabirds:** I.R. Iran determined that seabird interactions are not a problem for their fleet as they consist of gillnet vessels only. i.e., no longline vessels. **Marine turtles:** No information received by the Secretariat.
Japan		03-Dec-2009, 2016		03-Dec-2009, 2016			**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 2022. **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		2019		–	**Sharks:** Currently being implemented. **Seabirds:** NPOA seabirds was submitted to FAO in 2019. **Marine turtles:** All Rep. of Korea vessels fully implement Res 12/04.
Madagascar		–		–			**Sharks:** Development has not begun. **Seabirds:** Development has not begun. Note: A fisheries monitoring system is in place in order to ensure compliance by vessels with the IOTC's shark and seabird conservation and management measures. **Marine turtles:** There is zero capture of marine turtle recorded in logbooks. All longliners use circle hooks. This has been confirmed by onboard observers and port samplers.
Malaysia		2008 2014		–		2008	**Sharks:** A revised NPOA-sharks was published in 2014. **Seabirds:** To be developed **Marine turtles:** A NPOA For Conservation and Management of Sea Turtles had been published in 2008. A revision will be published in 2017.
Maldives, Republic of		Apr 2015	n.a.	–			**Sharks:** Maldives has developed the NPOA-Sharks with the assistance of Bay of Bengal Large Marine Ecosystem (BoBLME) Project. A stakeholder consultation for the NPOA-Sharks was held in April of 2014. The NPOA-Sharks is in the finalization process and is expected to be published in November of 2014. The longline logbooks ensure the collection of shark bycatch data to genus level. Maldives would be reporting on shark bycatch to the appropriate technical Working Party meetings of IOTC. **Seabirds:** Maldives is in the final stages of developing an action plan on seabird nesting sites. Article 12 of IPOA states that if a 'problem exists' CPCs adopt an NPOA. IOTC Resolution 05/09 suggests CPCs to report on seabirds to the IOTC Scientific Committee if the issue is appropriate'. Maldives considers that seabirds are not an issue in the Maldives fisheries, both in the pole-and-line fishery and in the longline fishery. The new longline fishing regulations has provision on mitigation measures on seabird bycatch. **Marine turtles:** Standards of code and conduct for managing sea turtles have been developed by the Environmental Protection Agency in the drafted National sea turtle management plan under the protected species regulation. Longline regulation has provisions to reduce marine turtle bycatch. The regulation urges longline vessels to have dehookers for removal of hook and a line cutter on board, to release the caught marine turtles as prescribed in Resolution 12/04.

Mauritius		2016					**Sharks:** The NPOA-sharks has been finalised; it focuses on actions needed to exercise influence on foreign fishing through the IOTC process and licence conditions, as well as improving the national legislation and the skills and data handling systems available for managing sharks. **Seabirds:** Mauritius does not have national vessels operating beyond 25^{0}S. However, fishing companies have been requested to implement all mitigation measures as provided in the IOTC Resolutions. **Marine turtles:** Marine turtles are protected by the national law. Fishing companies have been **requested** to carry line cutters and de-hookers in order to facilitate the appropriate handling and prompt release of marine turtles caught or entangled.
Mozambique		–		–			**Sharks**: Drafting of the NPOA-Shark started in 2016. At this stage, a baseline assessment was performed and the relevant information of coastal, pelagic and demersal shark species along the Mozambican coast was gathered. The ongoing process is expected to be completed by the end of 2018. **Seabirds**: Mozambique is regularly briefing the Masters of their fishing vessels on the mandatory requirement to report any seabird interaction with longliner fleet. **Marine turtles**: see above.
Oman, Sultanate of							**Sharks:** An NPOA-sharks is currently being drafted and is due to be finalized in 2017 **Seabirds:** Not yet initiated. **Marine turtles:** The law does not allow the catch of sea turtles, and the fishermen are requested to release any hooked or entangled turtle. The longline fleet are required to carry out the line cutters and de-hookers.

Pakistan							**Sharks:** 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. Sharks are landed with the fins attached and each and every part of the body of sharks are utilised. **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. Pakistan is also in the process of drafting a NPOA for cetaceans.
Philippines		Sept. 2009		–			**Sharks:** Under periodic review. **Seabirds:** Development has not begun. **Marine turtles:** No information received by the Secretariat.
Seychelles, Republic of		Apr-2007		–			**Sharks:** Seychelles has developed and is implementing a new NPOA for Sharks for years 2016-2020 **Seabirds:** SFA is collaborating with Birdlife South Africa to develop an NPOA for sea bird. A consultant will be recruited to start development in December 2017 **Marine turtles:** An NPOA for turtles is planned to start in 2018.
Somalia							**Sharks:** Somalia is currently revising its fisheries legislation (current one being from 1985) and has completed the necessary steps for required for the consultative process to begin in order to develop these NPOA. **Seabirds:** See above. **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.

South Africa, Republic of		–		2008			**Sharks**: The NPOA-sharks was first approved and published in 2013. A review is now being undertaken with cooperation from several International and National experts in order to update the NPOA. **Seabirds**: Published in August 2008 and fully implemented. The NPOA-seabirds has been earmarked for review. **Marine turtles**: The South African permit conditions for the large pelagic longline fishery prohibits landing of turtles. All interactions with turtles are recorded, by species, within logbooks and in observer reports, including data on release condition. Vessels are required to carry a de-hooker on board and instructions on turtle handling and release in line with the FAO guidelines are included in the South African Large Pelagic permit conditions. All turtle interactions in respective areas of competence are reported to the respective RFMOs. Recent South African led studies on impact of marine debris on turtles have been published in the scientific literature (Ryan et al. 2016). Marine turtle nesting sites in South Africa are protected by coastal MPAs since 1963.
Sri Lanka							**Sharks:** An NPOA-sharks has been finalized and is currently being implemented. **Seabirds:** Sri Lanka has determined that seabird interactions are not a problem for their fleets. However, a formal review has not yet been provided to the WPEB and SC for approval. **Marine turtles:** Implementation of the FAO Guideline to Reduce Sea Turtle Mortality in Fishing Operation in 2015 was submitted to IOTC in January 2016. Marine turtles are legally protected in Sri Lanka. Longliner vessels are required to have dehookers for removal of hooks and a line cutter on board, to release the caught marine turtles. Gillnets longer than 2.5 km are now prohibited in domestic legislation. Reporting of bycatch has made legally mandatory and facilitated via logbooks.
Sudan							**Sharks:** No information received by the Secretariat. **Seabirds:** No information received by the Secretariat. **Marine turtles:** No information received by the Secretariat.
Tanzania, United Republic of		–		–			**Sharks:** Initial discussions have commenced. **Seabirds:** Initial discussions have commenced. Note: Terms and conditions related to protected sharks and seabirds contained within fishing licenses. **Marine turtles:** Sea turtles are protected by law. However as there is a national turtle and Dugong conservation committee that oversee all issues related to sea turtles and dugongs. There is no information so far with regards to interaction between sea turtles and long line fishery.

Thailand		2020		–			**Sharks:** An updated NPOA Sharks has been developed for the years 2020-2024 and has been submitted to the Secretariat and FAO. **Seabirds:** Development of NPOA seabirds has not begun. Thailand does not have longliners operating in the southern region of the Indian Ocean far from Thailand or large purse seine vessels operating in the Indian Ocean as a whole and has no record of incidental catches of seabirds in Thailand's tuna fisheries. The Notification of the Department of fishing vessels operating in Indian Ocean Tuna Commission Competence Area B.E.2561 has been in force since 2018 and includes requirements for line-cutters and dehookers to be carried for releasing marine animals and for any fishing vessel operating south of 25°S to follow the measures for mitigating capture of seabirds **Marine turtles:** Thailand reports on progress of the implementation of FAO guidelines on turtles in their National Report to IOTC. Laws relating to conservation of marine turtles include: a prohibition on catching marine turtles; discarding of any marine turtles caught and recording details on catches; and a requirement to take care of injured marine turtles that have been caught.
United Kingdom	n.a.	–	n.a.	–		–	British Indian Ocean Territory (Chagos Archipelago) waters are a Marine Protected Area closed to fishing except recreational fishing in the 3nm territorial waters around Diego Garcia. Separate NPOAs have not been developed within this context. **Sharks/Seabirds:** For sharks, UK is the 24th signatory to the Convention on Migratory Species 'Memorandum of Understanding on the Conservation of Migratory Sharks' which extends the agreement to UK Overseas Territories including British Indian Ocean Territories; Section 7 (10) (e) of the *Fisheries (Conservation and Management) Ordinance* refers to recreational fishing and requires sharks to be released alive. No seabirds are caught in the recreational fishery. **Marine turtles:** No marine turtles are captured in the recreational fishery. A monitoring programme is taking place to assess the marine turtle population in UK (OT).
Yemen							**Sharks:** No information received by the Secretariat. **Seabirds:** No information received by the Secretariat. **Marine turtles:** No information received by the Secretariat.

COOPERATING NON-CONTRACTING PARTIES							
Liberia							**Sharks:** No information received by the Secretariat. **Seabirds:** No information received by the Secretariat. **Marine turtles:** No information received by the Secretariat.
Senegal		25-Sept-2006		–			**Sharks:** The Sub-Regional Fisheries Commission supported the development of a NPOA-sharks for Senegal in 2005. Other activities conducted include the organization of consultations with industry, the investigation of shark biology and social -economics of shark fisheries). The NPOA is currently being revised. Consideration is being made to the inclusion of minimum mesh size, minimum shark size, and a ban on shark finning. **Seabirds:** The need for a NPOA-seabirds has not yet been assessed. **Marine turtles:** No information received by the Secretariat.

Colour key	
Completed	
Drafting being finalised	
Drafting commenced	
Not begun	

APPENDIX VII
EXECUTIVE SUMMARY: BLUE SHARK (2021)

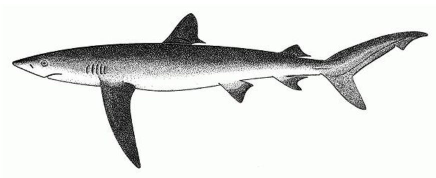

Table A 1. Status of blue shark (Prionace glauca) in the Indian Ocean

Area	Indicators		2021 stock status determination
Indian Ocean	Reported catch 2019[1] (MT)	25,001	99.9%
	Estimated catch 2019 (MT)	43,240	
	Not elsewhere included (nei) sharks[2] 2019 (MT)	36,551 t	
	Average reported catch 2015-19 (MT)	26,691	
	Average estimated catch 2015-19 (MT)	48,781	
	Avg. not elsewhere included (nei) sharks[2] 2015-19 (MT)	40,091 t	
	MSY (1,000 MT) (80% CI)[3]	36.0 (33.5 - 38.6)	
	F_{MSY} (80% CI)[3]	0.31 (0.306 - 0.31)	
	SB_{MSY} (1,000 MT) (80% CI)[3,4]	42.0 (38.9 - 45.1)	
	F_{2019}/F_{MSY} (80% CI)[3]	0.64 (0.53 - 0.75)	
	SB_{2019}/SB_{MSY} (80% CI)[3]	1.39 (1.27 - 1.49)	
	SB_{2019}/SB_0 (80% CI)[3]	0.46 (0.42 - 0.49)	

Boundaries for the Indian Ocean are defined as the IOTC area of competence
[1]Includes data under the species codes BSH, SKH, RSK, AG38
[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_{2019}/SB_{MSY}< 1)	Stock not overfished ($SB_{2019}/SB_{MSY}\geq$ 1)
Stock subject to overfishing(F_{2019}/F_{MSY}> 1)	0%	0.1%
Stock not subject to overfishing ($F_{2019}/F_{MSY}\leq$ 1)	0%	99.9%
Not assessed/Uncertain		

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

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

IUCN = International Union for Conservation of Nature; WIO = Western Indian Ocean; EIO = Eastern Indian Ocean

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

Sources: IUCN Red List 2020, Stevens 2009

INDIAN OCEAN STOCK – MANAGEMENT ADVICE

Stock status. A new stock assessment for blue sharks was carried out in 2021 using an integrated age-structured model (SS3) (**Fig. A 5**). Uncertainty in data inputs and model configuration were explored through sensitivity analysis. 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. A 5**). 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. A 5, Table A 1**). In particular, the base case model used the GAM-based catch history estimates and CPUE series from South Africa, EU-Portugal, EU-France (Reunion), EU-Spain, Taiwan and Japan. The major sources of uncertainty 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, however the ratio-based and nominal catches were considered unrealistic. If the alternative CPUE groupings were used, then the stock status was somewhat less positive. 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 A 2**). Information available on this species has been improving in recent years. Blue sharks are commonly taken by a range of fisheries in the Indian Ocean and in some areas they are fished in their nursery grounds. Because of their life history characteristics – they live until at least 25 years, mature at 4–6 years, and have 25–50 pups every year – they are considered to be the most productive of the pelagic sharks. On the weight-of-evidence available in 2021, the stock status is determined to be **not overfished** and **not subject to overfishing** (**Table A 1**).

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

Management advice. Target and limit reference points have not yet been specified for pelagic sharks in the Indian Ocean. Even though the 2021 assessment indicates that Indian Ocean blue shark are not overfished nor subject to overfishing, increasing current catches is likely to result in decreasing biomass and the stock becoming overfished and subject to overfishing in the near future (**Table A 3**). If the catches are increased by over 20%, the probability of maintaining spawning biomass above MSY reference levels ($SB>SB_{MSY}$) over the next 10 years will be decreased (**Table A 3).** The stock should be closely monitored. While mechanisms exist for encouraging CPCs to comply with their recording and reporting requirements (Resolution 16/06), these need to be further implemented by the Commission, so as to better inform scientific advice in the future.

The following key points should also be noted:

- **Maximum Sustainable Yield (MSY)**: estimate for the Indian Ocean stock is approximately 36,000 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** (2015–19): Indonesia; Taiwan,China; EU,Spain; EU,Portugal; Japan, Sri Lanka, Seychelles.

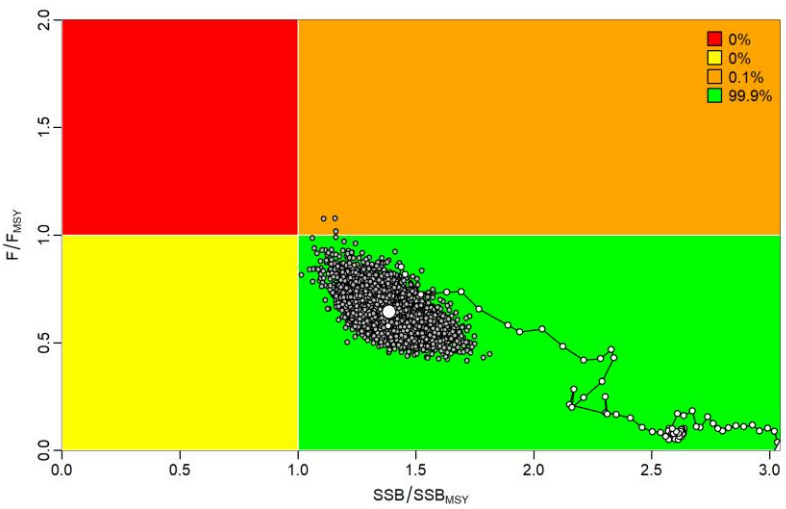

Fig. A 5. Blue shark: Aggregated Indian Ocean stock assessment Kobe plot for the 2021 assessment base case model. (base case model with trajectory and uncertainty in the terminal year.

Table A 3. **Blue shark: Aggregated Indian Ocean assessment Kobe II Strategy Matrix. Probability (percentage) of violating the MSY-based reference points for nine constant catch projections using the base case model (catch level from 2019* (43,240 MT), ± 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 2019) and probability (%) of exceeding MSY-based reference points**								
Catch Relative to 2019	60%	70%	80%	90%	100%	110%	120%	130%	140%
Catch (t)	(25,944)	(30,267)	(34,592)	(38,916)	(43,240)	(47,564)	(51,888)	(56,212)	(60,535)
$SB_{2022} < SB_{MSY}$	0%	0%	0%	0%	0%	0%	0%	0%	0%
$F_{2022} > F_{MSY}$	0%	0%	0%	0%	0%	1%	5%	16%	36%
$SB_{2029} < SB_{MSY}$	0%	0%	0%	0%	0%	2%	9%	25%	48%
$F_{2022} > F_{MSY}$	0%	0%	0%	0%	1%	13%	44%	75%	90%

*: average catch level and respective % changes refer to the estimated catch series used in the final base case model (IOTC-2021-WPEB17(AS)-15)

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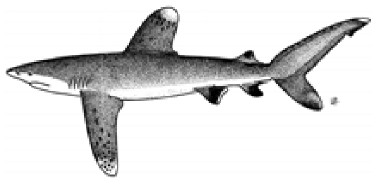
APPENDIX VIII
EXECUTIVE SUMMARY: OCEANIC WHITETIP SHARK (2020)



CITES APPENDIX II species

Table A 4. 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 2019	32 t	
	Not elsewhere included (nei) sharks[2] 2019	35,964 t	
	Average reported catch 2015-19	169 t	
	Av. not elsewhere included 2015-2019 (nei) sharks[2]	39,478 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 A 5. 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 A 4**). 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 (Murua *et al.* 2018). 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 A 5**). 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 A 4**).

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; and India; (Reported as discarded/released alive by China, Korea, France, Australia, South Africa, Sri Lanka, Japan).

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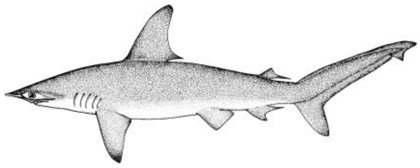
APPENDIX IX
EXECUTIVE SUMMARY: SCALLOPED HAMMERHEAD SHARK (2020)



CITES APPENDIX II species

Table A 6. Status of scalloped hammerhead shark (*Sphyrna lewini*) in the Indian Ocean.

Area[1]	Indicators		2018 stock status determination
Indian Ocean	Reported catch 2019 Not elsewhere included (nei) sharks[2] 2019 Average reported catch 2015-19 Av. not elsewhere included 2015-2019 (nei) sharks[2]	51 t 21,899 t 67 t 38,190 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 A 7. 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' (**Error! Reference source not found.**). T he 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 (Murua *et al.* 2018). 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 (Error! Reference source not found.).

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 X
EXECUTIVE SUMMARY: SHORTFIN MAKO SHARK (2020)

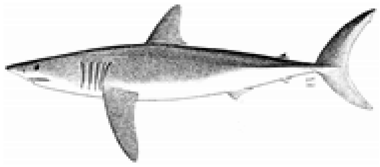

Table A 8. Shortfin mako shark: Status of shortfin mako shark (*Isurus oxyrinchus*) in the Indian Ocean.

Area[1]	Indicators		2020 stock status determination
Indian Ocean	Reported catch 2019	1,087 t	
	Not elsewhere included (nei) sharks[2] 2019	37,773 t	
	Average reported catch 2015-19	1,789 t	
	Av. not elsewhere included (nei) sharks[2] 2015-19	41,367 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 A 9. 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 A 8**). 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 (Murua *et al.* 2018). 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 A 9**). 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 management actions that reduce 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** (2015-19): Longline targeting swordfish; longline (fresh); longline (targeting sharks); gillnet.
- **Main fleets** (2015-19): 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 XI
EXECUTIVE SUMMARY: SILKY SHARK (2020)

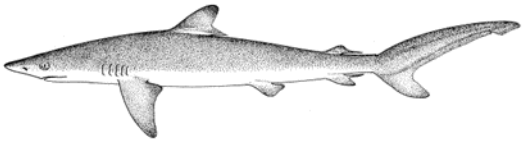

Table A 10. Silky shark: Status of silky shark (*Carcharhinus falciformis*) in the Indian Ocean.

Area[1]	Indicators		2018 stock status determination
Indian Ocean	Reported catch 2019 Not elsewhere included (nei) sharks[2] 2019 Average reported catch 2015-19 Av. not elsewhere included (nei) sharks[2] 2015-19	2,094 t 20,717 t 2,241 t 36,248 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 A 11. 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 A 10**). 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 (Murua *et al.* 2018). 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 A 11**). 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 XII
EXECUTIVE SUMMARY: BIGEYE THRESHER SHARK (2020)

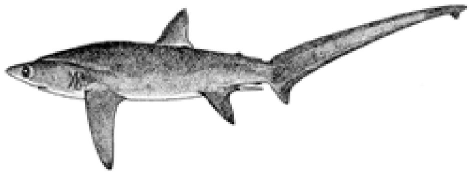

Table A 12. Bigeye thresher shark: Status bigeye thresher shark (*Alopias superciliosus*) in the Indian Ocean.

Area[1]	Indicators		2018 stock status determination
Indian Ocean	Reported catch 2019 Not elsewhere included (nei) sharks[2] 2019 Average reported catch 2015-19 Av. not elsewhere included (nei) sharks[2] 2015-19	0 t 24,043 t <1 t 40,006 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 A 13. 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 A 12**). 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 (Murua *et al.* 2018). 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 A 13**). 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 3–9 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*[1].

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): No report after 2012. (reported previously as discard from gillnet and longline).
- **Main reporting fleets** (2014–18): India; (reported as discarded/released alive by South Africa, Sri Lanka, Japan, Korea, EU,France, Indonesia).

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[1] 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 XIII
EXECUTIVE SUMMARY: PELAGIC THRESHER SHARK (2020)

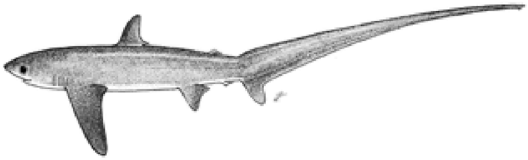

Table A 14. Pelagic thresher shark: Status pelagic thresher shark (*Alopias pelagicus*) in the Indian Ocean.

Area[1]	Indicators		2018 stock status determination
Indian Ocean	Reported catch 2019	209 t	
	Not elsewhere included (nei) sharks[2] 2019	24,043 t	
	Average reported catch 2015-19	335 t	
	Av. not elsewhere included (nei) sharks[2] 2015-19	40,006 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 A 15. 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 A 14**). 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 (Murua *et al.* 2018). 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 A 15**). 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*[2].

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 (reported as discard/ released from gillnet and longline).
- **Main fleets** (2014-18): Pakistan; (reported as discarded/released alive by Japan, Korea, Sri Lanka, South Africa, Indonesia).

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[2]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 XIV
EXECUTIVE SUMMARY: MARINE TURTLES (2020)

Table A 16. 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[3]
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 A 16**. 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

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

fishing for tuna and tuna-like species will increase as fishing pressure increases, and that the status of the marine turtle populations will continue to worsen due to other factors such as an increase in fishing pressure from other fisheries or anthropological or climatic impacts.

The following should also be noted:

1. The available evidence indicates considerable risk to marine turtles in the Indian Ocean.
2. Given the high mortality rates associated with marine turtle interactions with gillnet fisheries and the increasing use of gillnets in the Indian Ocean (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 XV
EXECUTIVE SUMMARY: SEABIRDS (2020)

Table A 17. **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[4]
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 A 17**. It is important to note that the IUCN threat status for all birds is currently being re-assessed; this process is expected to be completed by the end of 2016. A number of international global environmental accords (e.g., Convention on Migratory Species (CMS), the Agreement on the Conservation of Albatrosses and Petrels (ACAP), Convention on Biological Diversity (CBD)), as well as numerous fisheries agreements obligate States to provide protection for these species. While the status of seabirds is affected by a range of factors such as degradation of nesting habitats and targeted harvesting of eggs, for albatrosses and large petrels, fisheries bycatch is generally considered to be the primary threat. The level of mortality of seabirds due to fishing gear in the Indian Ocean is poorly known, although where there has been rigorous assessment of impacts in areas south of 25 degrees (e.g., in South Africa), very high seabird incidental catches rates have been recorded in the absence of a suite of proven incidental catches mitigation measures.

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

Outlook. Resolution 12/06 *On Reducing the Incidental Bycatch of Seabirds in Longline Fisheries* includes an evaluation requirement (para. 8) by the Scientific Committee in time for the 2016 meeting of the Commission. The level of compliance with Resolution 12/06 and the frequency of use of each of the 3 measures (because vessels can 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 XVI
EXECUTIVE SUMMARY: CETACEANS

Table A 18. 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
	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

Delphinidae	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

* The assessment of the status level in IUCN is independent of IOTC processes
** Published bycatch records only (reference at the end of the document)
*** Arabian Sea population: EN
The IUCN Red List of Threatened species. <www.iucnredlist.org>.
Downloaded on 16 September 2020.

Indian Ocean stock – Management Advice

Stock status. The current[5] 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 A 18. 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 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.

[5] September 2020

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 XVII
WORKING PARTY ON ECOSYSTEMS AND BYCATCH PROGRAM OF WORK (2022–2026)

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 A19: Priority topics for obtaining the information necessary to develop stock status indicators for bycatch in the Indian Ocean; and

Table A20: Stock assessment schedule.

Table A19. 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				
		2022	2023	2024	2025	2026
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. Biological and ecological information (incl. parameters for stock assessment)	2.1 Age and growth research (Priority species: blue shark (BSH), shortfin mako shark (SMA) and oceanic whitetip shark (OCS); silky shark (FAL))					
	2.1.1 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					
	2.3 Reproduction research Priority species: blue shark (BSH), shortfin mako shark (SMA) and oceanic whitetip shark (OCS), and silky shark (FAL)					

	2.4 Ecological Risk Assessment (cetaceans)					
3. 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.					

Other Future Research Requirements (not in order of priority)						
Topic	Sub-topic and project	2022	2023	2024	2025	2026
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					
2. Bycatch mitigation measures	Undertake a series of gear specific workshops focusing on multi-taxa bycatch issues					
	Develop studies on bycatch mitigation measures (operational, technological aspects and best practices)					
	2.1 Sharks a) Harmonise and finalise guidelines and protocols for safe handling and release of sharks and rays caught in IOTC fisheries					
	2.2 Sea turtles 2.2.1 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					
	2.2.2 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.					

	2.2.3 Regional workshop to review the effectiveness of marine turtle mitigation measures					
	2.2.4 Harmonise and finalise guidelines and protocols for safe handling and release of sea turtles caught in IOTC fisheries					
	2.3 Seabirds 2.3.1 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.					
	2.3.2 Bycatch assessment for seabirds taking into account the information from the various ongoing initiatives in the IO and adjacent oceans					
	2.3.3 Study on cryptic mortality of seabirds in tuna LL fisheries.					
	2.3.4 Study post release survival rates for seabirds and harmonise and finalise guidelines and protocols for safe handling and release of seabirds caught in IOTC fisheries					

	2.4 Cetaceans 2.4.1 Collate all data available on bycatch of key species interacting with all tuna fisheries in the IOTC area (tuna drift gillnets, longlines, purse seines)					
	2.4.2 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					
	2.4.3 Testing mitigation methods for cetacean bycatch in tuna drift gillnet fisheries					
	2.4.4 Harmonise and finalise guidelines and protocols for safe handling and release of cetaceans caught in IOTC fisheries					
	2.4.5. Intersessional meeting to discuss cetacean guidelines, ERA, Data gaps.					
3. CPUE standardisation / Stock Assessment / Other indicators	3.1 Develop standardised CPUE series for each key shark species and fishery in the Indian Ocean					
	3.1.1 Development of CPUE guidelines for standardisation of CPC data.					
	3.1.2 Blue shark: Priority fleets: TWN,CHN LL, EU,Spain LL, Japan LL; Indonesia LL; EU,Portugal LL					
	3.1.3 Shortfin mako shark: Priority fleets: Longline and Gillnet fleets					
	3.1.4 Oceanic whitetip shark: Priority fleets: Longline fleets; purse seine fleets					

	3.1.5 Silky shark: Priority fleets: Purse seine fleets					
	3.2 Joint CPUE standardization across the main LL fleets for silky shark, using detailed operational data					
	3.3 Stock assessment and other indicators					
4. Bycatch and discards	4.1 Review proposal on retention of non-targeted species					
	4.1.1 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.					
5. Ecosystems	5.1 Develop a plan for Ecosystem Approach to Fisheries (EAF) approaches in the IOTC, in conjunction with the Common Oceans Tuna Project.					
	5.1.2 Workshop for CPCs on continuing efforts to the development of an EAF including delineation of candidate eco regions within IOTC.					
	5.1.3 Practical Implementation of EBFM with the development and testing of ecosystem report cards.					

	5.1.4 Evaluation of EBFM plan in IOTC area of competence by the WPEB to review its elements components and make any corrective measures.					
	5.2 Assessing the impacts of climate change and socio-economic factors on IOTC fisheries					
	5.3 Evaluate alternative approaches to ERAs to assess ecological risk					
	5.4 Progress on Climate webpage on IOTC website and liaise with WPDCS for technical implementation					

Table A20. 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	**2022**	**2023**	**2024**	**2025**	**2026**
Blue shark	-	–	–	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	-	Assessment*	-	–	Assessment*
Bigeye thresher shark	Assessment*	-	–	–	Assessment*
Pelagic thresher shark	Assessment*	-	–	–	Assessment*
Porbeagle shark	–	Assessment*	–	–	-
Mobulid Rays	-	-	Interactions/ Indicators	–	-
Marine turtles	–	Indicators	–	–	-
Seabirds	Review of mitigation measures in Res. 12/06	–	–	–	Review of mitigation measures in Res. 12/06
Marine Mammals	–	–	–	Review of mitigation measures	-
Ecosystem Based Fisheries Management (EBFM) approaches	ongoing	ongoing	ongoing	ongoing	-

APPENDIX XVIII
CONSOLIDATED RECOMMENDATIONS OF THE 17TH SESSION OF THE WORKING PARTY ON ECOSYSTEMS AND BYCATCH

Note: Appendix references refer to the Report of the 17thSession of the Working Party on Ecosystems and Bycatch (IOTC–2021–WPEB17(AS)–R)

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

WPEB17(AS).01 (para 92): Therefore, the WPEB **RECOMMENDED** that the SC endorse the use of subsurface gillnetting in the Indian Ocean as an effective mitigation measure. The WPEB reminds the SC that Resolution 19/01 already requests the utilization of subsurface gillnets by 2023 to mitigate ecological impacts of this gear. The WPEB **RECOMMENDED** that the SC is kept informed about the current status of implementation of the relevant clause of Resolution 19/01.

All bycatch species

WPEB17(AS).02 (para 121): The WPEB **RECOMMENDED** that the SC endorse a workshop on multi-taxa bycatch mitigation measures dedicated to drift/gillnet fisheries in the Indian Ocean to be conducted in 2022, in order to develop recommendations for consideration by the WPEB. The WPEB further **AGREED** to review in 2022 the need to address multi-taxa mitigation measures for additional gear types in future years.

Marine Mammals

WPEB17(AS).03 (para 157): One of the key discussions during this meeting was for the WPEB to endorse the draft Letter of Intent intended to formalise the collaboration between IOTC and IWC (paper IOTC-2021-WPEB17(AS)-INF03). The WPEB **NOTED** that this letter is based on the language used in the Letter of Intent between IOTC and ACAP which has been accepted by the Commission. The WPEB **NOTED** that there was dissent during discussions of this proposal but finally the WPEB **ACKNOWLEDGED** the Letter of Intent and **RECOMMENDED** that the letter is discussed at the SC.

Review of the draft, and adoption of the Report of the 17th Session of the (Chairperson)

WPEB17(AS).04 (para 169): The WPEB **RECOMMENDED** that the Scientific Committee consider the consolidated set of recommendations arising from WPEB17, provided at Appendix XVIII, 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 VII
- Oceanic whitetip sharks (*Carcharhinus longimanus*) – Appendix VIII
- Scalloped hammerhead sharks (*Sphyrna lewini*) – Appendix IX
- Shortfin mako sharks (*Isurus oxyrinchus*) – Appendix X
- Silky sharks (*Carcharhinus falciformis*) – Appendix XI
- Bigeye thresher sharks (*Alopias superciliosus*) – Appendix XII
- Pelagic thresher sharks (*Alopias pelagicus*) – Appendix XIII

Other species/groups

- Marine turtles – Appendix XIV
- Seabirds – Appendix XV
- Marine mammals - Appendix XVI