Report of the 19th Session of the IOTC Working Party on Ecosystems and Bycatch

La Saline-les-Bains, La Réunion and Zoom, 11 – 15 September 2023

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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
CKMR	Close-Kin-Mark-Recapture
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
EMS	Electronic Monitoring System
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
RPOA	Regional Plan of Action
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**).

TABLE OF CONTENTS

Executive summary

The 19th Session of the Indian Ocean Tuna Commission's (IOTC) Working Party on Ecosystems and Bycatch - WPEB was held in La Réunion, France and online via Zoom from 11-15 September 2023. A total of 100 participants (103 in 2022, 93 in 2021, 108 in 2020, and 41 in 2019) attended the Session. The list of participants is provided in Appendix I. The meeting was opened by the Chairperson, Dr Mariana Tolotti from IRD, France, who welcomed participants and formally opened the meeting.

The following are the complete recommendations from the WPEB19 to the Scientific Committee which are also provided in Appendix XVIII:

Section 6. Review information on biology, ecology, fisheries and environmental data relating to sharks

WPEB19.01 (para. 66) The WPEB **RECOMMENDED** that the SC advise the Commission to consider extending measures to prevent finning of sharks such as fins naturally attached including partially attached and tethered for all fisheries or similar, alternative measures (for example, fins artificially attached), providing they had been assessed and endorsed by the SC and Compliance Committee as being equally or more likely to meet the conservation benefit (of a fins naturally attached measure) and are logistically feasible from a compliance monitoring perspective. The WPEB **NOTED** that while such other measures may be logistically more difficult to implement and monitor for governments, they may be logistically more practical for the fishing industry when conducting their fishing operations and storing shark catches on board.

WPEB19.02 (para. 68) **ACKNOWLEDGING** that the current ROS data requirements already enable the recording of shark fins attached / non-attached to carcasses. the WPEB **RECOMMENDED** that the SC identifies proper mechanisms to ensure this information is regularly collected and reported to the Secretariat through the ROS.

Section 10. WPEB Program of Work (Research and Priorities)

WPEB19.03 (para. 183) The WPEB **RECOMMENDED** that the SC consider and endorse the WPEB Program of Work (2024–2028), as provided in Appendix XVII.

Section 11. Review of the draft, and adoption of the Report of the 19th Session of the WPEB

WPEB19.04 (para 195) The WPEB **RECOMMENDED** that the Scientific Committee consider the consolidated set of recommendations arising from WPEB19, 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	2018	2019	2020	2021	2022	2023	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 2021: 24,487t Estimated catch 2019: 43,240 t Not elsewhere included (nei) sharks 2021: 35,603 t Average reported catch 2017–21: 26,616 t Average estimated catch 2015–19: 48,781 t Ave. (nei) sharks[2] 2017–21: 33,342 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%**	**99.9%**	**99.9%**	**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 was 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 2021: 32 t Not elsewhere included (nei) sharks 2021: 35,603 t Average reported catch 2017–2021: 36 t Not elsewhere included (nei) sharks 2017-2021: 33,342 t							
Scalloped hammerhead shark	Reported catch 2021: 206 t Not elsewhere included (nei) sharks 2021: 38,332 t Average reported catch 2017–2021: 87 t Not elsewhere included (nei) sharks 2017-2021: 36,418 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 IX • Shortfin mako sharks – Appendix X • Silky sharks – Appendix XI • Bigeye thresher sharks – Appendix XII • Pelagic thresher sharks – Appendix XIII
Shortfin mako *Isurus oxyrinchus*	Reported catch 2021: 782 t Not elsewhere included (nei) sharks 2021: 37,639 t Average reported catch 2017–2021: 1,317 t Not elsewhere included (nei) sharks 2017-2021: 35,518 t							
Silky shark *Carcharhinus falciformis*	Reported catch 2021: 1,466 t Not elsewhere included (nei) sharks 2021: 35,603 t Average reported catch 2017–2021: 1,898 t Not elsewhere included (nei) sharks 2017-2021: 33,342 t							
Bigeye thresher shark *Alopias superciliosus*	Reported catch 2021: <1 t Not elsewhere included (nei) sharks 2021: 41,076 t Thresher sharks nei 2021: 5,471 t Average reported catch 2017–2021: <1 t Not elsewhere included (nei) sharks 2017-2021: 38,254 t Av. Thresher sharks nei 2017-2021: 4,911 t							
Pelagic thresher shark *Alopias pelagicus*	Reported catch 2021: 156 t Not elsewhere included (nei) sharks 2021: 41,076 t Thresher sharks nei 2021: 5,471 t Average reported catch 2017–2021: 266 t Not elsewhere included (nei) sharks 2017-2021: 38,254 t Av. Thresher sharks nei 2017-2021: 4,911 t							

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

1. Opening of the meeting

1. The 19th Session of the Indian Ocean Tuna Commission's (IOTC) Working Party on Ecosystems and Bycatch - WPEB was held in La Réunion, France and online via Zoom from 11-15 September 2023. A total of 100 participants (103 in 2022, 93 in 2021, 108 in 2020, and 41 in 2019) attended the Session. The list of participants is provided in Appendix I. The meeting was opened by the Chairperson, Dr Mariana Tolotti from IRD, 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 25th Session of the Scientific Committee

3. The WPEB **NOTED** paper IOTC–2023–WPEB19–03 which outlined the main outcomes of the 25th Session of the Scientific Committee, specifically related to the work of the WPEB.

*"The SC **NOTED** the ongoing ecoregion process, including their purpose and potential benefits in providing more integrated regional advice. The SC **NOTED** that the next step in the process of the development of these ecoregions is to conduct a series of pilot projects to evaluate their utility and effectiveness as a tool to support regional ecosystem planning and prioritisation, incentivised ecosystem research and the development of integrated advice products for informing fisheries management decisions. The SC **NOTED** that there are two pilot projects currently planned – one which will focus on coastal regions and other focused on more oceanic regions which will provide an opportunity to compare the artisanal and industrial fisheries that tend to operate in each of these regions.*

*The SC **NOTED** that in the future these ecoregions might be considered for their potential to provide structured management advice focused on issues of particular importance to each of the regions and stock assessment advice would be incorporated into the overall advice alongside other information.*

*The SC **ENDORSED** the proposed refined candidate ecoregions and the development of the proposed pilot projects to evaluate their utility and effectiveness.*

*The SC **NOTED** a recommendation from the WPEB to revise the list of sharks, rays and Endangered, Threatened and Protected (ETP) species included in Appendix II of Resolution 15/01 to ensure that all species under broad categories such as hammerhead sharks (Sphyrna spp.) are reported separately by species. The SC **NOTED** that this could help to provide an incentive to improve catches of these species which may have historically been reported aggregated.*

*With a view to identifying mitigation measures to avoid or limit unwanted by-catches, the SC **NOTED** the need to improve the provision of data and information to describe the fishing gears and methods used by these artisanal fisheries.*

*The SC **NOTED** that a better technical understanding of fishing gears and methods, used in fisheries harvesting highly migratory stocks in the IOTC area, is needed to inform the WPEB recommendations. This knowledge will also assist the SC and Commission in their understanding of fishery interactions with bycatch species and to better facilitate consideration of management options to mitigate interactions for bycatch species for which that is needed. The SC suggested that particular consideration of this could be built into the work of the WPEB, through CPC contributions (fishing gears/methods descriptions for all areas and vessel types/sizes) and data summaries developed by the IOTC Secretariat.*

***RECALLING** the request by the Commission to develop research plans for sharks, the SC **ENDORSED** the creation of a working group to work intersessionally to develop a series of research plans/program for sharks with scalloped hammerhead as a priority species.*

*The SC **NOTED** the evidence indicating the increased operation of squid fisheries in the high seas of the Indian Ocean, and particularly in fishing grounds which overlap with areas where tuna purse seine fleets operate, **NOTING** that this overlap results in bycatch of tuna and tuna-like species in the squid fishery. However, as these fisheries are not managed by IOTC, data on these catches of tuna and tuna-like species are not provided to the IOTC. Therefore, the SC **RECOMMENDED** that the Commission request that the CPCs report all catches of tuna to the IOTC regardless of the target species of the fishery. The SC further **REQUESTED** that the Commission seek more information on this fishery from the CPCs.*

*The SC **NOTED** the potential for using artificial lights (a visual deterrent) in gillnet fisheries as a potential bycatch mitigation device and the need to test this further via LED trials, which could also determine if such lights might attract unwanted bycatch. However, the SC **NOTED** that Resolution 16/07 prohibits fishing vessels and other vessels including support, supply and auxiliary vessels to use, install or operate surface or submerged artificial lights for the purpose of aggregating tuna and tuna-like species. However, the SC **NOTED** that it is not clear if this also applies to gillnets. Therefore, the SC **RECOMMENDED** that the Commission provide clarification on whether Resolution 16/07 also applies to gillnet fisheries and/or to scientific studies as the current wording is somewhat ambiguous.*

*The SC **NOTED** the evidence provided to the WPEB on the effectiveness of hook-shielding devices in reducing seabird bycatch mortality in pelagic longlines and further **NOTED** that the WCPFC included the hook-shielding devices in 2018 as an option to mitigate longline seabird bycatch. The SC **ACKNOWLEDGED** the potential operational difficulties and costs of utilising these devices as well as the potential limited number of manufacturers. However, based on the scientific evidence (supported by the ACAP guidelines) the SC **RECOMMENDED** that the Commission consider including hook-shielding devices as an additional option for seabird bycatch mitigation measures in Resolution 12/06. The SC **NOTED** that this had previously been recommended as a stand-alone measure in 2016 for the proposed revision of 12/06 (IOTC-2016-SC19-R para. 69).*

*The SC **NOTED** paper IOTC-2022-SC25-INF01 on a draft Cooperation agreement between the IOTC and the Memorandum of Understanding on the Conservation and Management of Marine Turtles and their Habitats of the Indian Ocean and South-East Asia (IOSEA).*

*The SC **ACKNOWLEDGED** the proposed Cooperation Agreement between the IOSEA Marine Turtle MOU and IOTC and **NOTED** that this Agreement is based on the language used in the Agreement between IOTC and ACAP which has been accepted by the Commission. The SC **NOTED** this will facilitate better exchange of scientific information and data on sea turtles and their fishery interactions relevant to future commission discussions and decisions on this issue. The SC **RECOMMENDED** that the proposed Agreement is presented at the Commission for further consideration."*

3.2 Outcomes of the 27th Session of the Commission

4. The WPEB **NOTED** paper IOTC–2023–WPEB19–04 which outlined the main outcomes of the 27th Session of the Commission, specifically related to the work of the WPEB.

5. The WPEB **NOTED** that there was little discussion related to the WPEB at the Commission meeting and that the main items were the endorsement by the Commission of the SC information on stock status, the agreement in principle to a letter of intent to continue a collaborative arrangement with the IOSEA and the note that Resolution 16/07 *On the use of artificial lights to attract fish* (which prohibits using artificial lights for the purpose of aggregating tuna and tuna-like species) does not apply to scientific studies.

6. The WPEB **NOTED** that some scientists consider that more clarity is required from the Commission on how scientific studies may use artificial lights for trials, despite Resolution 16/07 as artificial lights are commonly used in longline Swordfish fisheries.

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

7. The WPEB **NOTED** paper IOTC–2023–WPEB19–05 which aimed to encourage participants to review some of the existing Conservation and Management Measures (CMM) relevant to ecosystems and bycatch.

8. The WPEB **NOTED** that three CMMs relevant to ecosystems and bycatch were adopted by the Commission in 2023, one relating to the conservation of cetaceans (Resolution 23/06), one relating to reducing the incidental bycatch of seabirds in longline fisheries (Resolution 23/07) and another on the Electronic Monitoring Standards for IOTC fisheries (Resolution 23/08).

9. The WPEB **ACKNOWLEDGED** that the WGEMS is currently working on the identification of all ROS data elements that could be reasonably collected through Electronic Monitoring Systems (EMS) and will report back any findings to the WPDCS.

3.4 Progress on the recommendations of WPEB18

10. The WPEB **NOTED** paper IOTC–2023–WPEB19–06 which provided an update on the progress made in implementing the recommendations from the previous WPEB meeting WPEB18 which were endorsed by the Scientific Committee (SC25) in 2022.

11. The WPEB **NOTED** that good progress had been made on these Recommendations and Requests. The WPEB participants were **ENCOURAGED** to review IOTC-2023-WPEB19-06 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 (WPEB20).

4. Review of data available on ecosystems and bycatch

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

12. The WPEB **NOTED** paper IOTC–2023–WPEB19–07_Rev2 which provided an overview of the data managed by the IOTC Secretariat for bycatch species for the period 1950–2021. A summary for shark and ray species is provided in Appendix IV.

13. The WPEB **RECALLED** that with the term *bycatch* the IOTC refers to all those species other than the 16 managed by the IOTC, regardless of their being targeted, incidentally caught, or elsewhere affected by IOTC fisheries.

14. The WPEB **NOTED** that the currently available catch time series for IOTC and bycatch species do not yet include data for 2022 which is still in the process of being received and cross-verified by the IOTC Secretariat.

15. The WPEB **NOTED** that the level of catches presented do not contain data on discards reported through form 1DI by some CPCs, **ACKNOWLEDGING** that these are not raised to annual levels and therefore do not represent the total catch discarded.

16. For this reason, the WPEB **ACKNOWLEDGED** the importance of CPCs regularly compiling (and submitting to the IOTC Secretariat) estimates of annual total discards of bycatch species (whose reporting is already prescribed by Res. 15/02).

17. 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 several of these species are discarded at sea and not recorded nor reported to the Secretariat.

18. The WPEB **NOTED** the differences in total annual levels of retained bycatch for the years 1950-2021 compared to the same information available at the last WPEB in 2022, **ACKNOWLEDGING** that most of these changes are due to:

    a) recent revisions of official catch data from I.R. Iran (2011-2020), Indonesia (2010-2019), Kenya (2016, 2020), Mozambique (2020), and Japan (2019)

    b) updated catch levels estimated by FAO for non-reporting CPCs or non-CPCs such as Eritrea, Qatar, Saudi Arabia, and United Arab Emirates.

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 and are not available by fishing gear/fishery.

20. More generally, the WPEB **NOTED** with concern that data for bycatch species (including raised landings and discards, time-area catches, and size-frequency data) are often incomplete or not reported according to IOTC standards and therefore **RECALLED** how 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 retained catch data.

21. Furthermore, the WPEB **RECALLED** that there are large uncertainties associated with the estimates of blue shark catches from artisanal Indonesian fisheries which accounted for about 64% of all catches of blue shark from the Indian Ocean in recent years.

22. The WPEB **ACKNOWLEDGED** the ongoing work conducted to review the estimation of catch by species for Indonesian fisheries and **ENCOURAGED** Indonesia to progress on the matter and report the results to the next WPEB.

23. The WPEB also **NOTED** how catches of several shark species recorded for Sri Lankan fisheries until 2013 are also the results of a re-estimation process performed by the Secretariat under advice from the Scientific Committee, and that these might require a thorough revision in collaboration with national scientists.

24. The WPEB **ACKNOWLEDGED** the outstanding issues affecting the quality and completeness of historical landings of shark and ray species as identified for important fisheries such as the gillnet fisheries of Pakistan (until 1987), the artisanal fisheries of India (2018), the artisanal fisheries of Indonesia (for 2010 and following years), and the artisanal fisheries of Sri Lanka (until 2013).

25. The WPEB **NOTED** the spatial and temporal extent of the interactions (including fate and condition at release, for discarded individuals) as recorded for the major ETP species within the ROS database and **ACKNOWLEDGED** that in some cases (e.g., interaction with cetaceans and seabirds) these are generally coming from those specific fisheries that provide data in a format suitable for extraction and processing.

26. **NOTING** that the IOTC databases include catches of oilfish (*Ruvettus pretiosus*) and escolar (*Lepidocybium flavobrunneum*) voluntarily reported by some tuna-targeting fleets, the WPEB **SUGGESTED** that the Secretariat liaises with SIOFA to exchange data on these species, and particularly those originated by fisheries targeting tuna and tuna-like species.

27. The WPEB **NOTED** that shortbill spearfish (*Tetrapturus angustirostris*; SSP) is *de facto* a bycatch species since it is not included in the list of the 16 IOTC species and **REQUESTED** the Secretariat to include SSP in future data review reports prepared for the WPEB.

28. The WPEB **QUERIED** whether scientific observer data could be used to check and validate logbook data, **ACKNOWLEDGED** that some cross-checking of the data on bycatch and discards can be

performed (e.g., species occurrences), but **RECALLED** that data received by the Secretariat are highly aggregated and that observer coverage (at least when considering information available in a format suitable for data analysis) is very low for most fisheries and fleets.

29. The WPEB **NOTED** the general lack of data from artisanal fisheries, which comprise subsistence fisheries and vessels less than 24 m in length exclusively fishing within the EEZ of their flag state, and **ACKNOWLEDGED** that EMS could be beneficial in these cases, while **NOTING** that CPCs with large artisanal fisheries like I.R. Iran and Pakistan face several geo-political and logistical issues which prevent the use of EMS.

30. The WPEB **NOTED** that data collection systems based on EMS have been initiated in some fisheries in recent years (e.g., Sri Lanka, Tanzania) but **ACKNOWLEDGED** that the overall quantity of data collected and made available through the ROS is insufficient for providing management advice on bycatch species, **NOTING** that the WPCFC has recently adopted a new CMM to double the minimum coverage of observation from 5% to 10%.

31. The WPEB **NOTED** that catches of blue shark (BSH) drive the trends of retained catches of all shark species reported to the Secretariat while **NOTING** that this species is the target of several fisheries, and so **SUGGESTED** excluding BSH when looking at trends in total shark catches.

32. The WPEB **NOTED** paper IOTC-2023-WPEB19-33 on Estimating trends and magnitudes of bycatch in the tuna fisheries of the Western and Central Pacific Ocean, including the following abstract provided by the authors:

    "Minimising the unintended capture of fish, marine mammals, reptiles, seabirds and other marine organisms is an important component of responsible fisheries management and for stabilising declines and rebuilding populations of threatened species. The analyses presented were designed to establish the first quantitative baseline of historical catches, catch rates and species composition for the dominant tuna fisheries operating in the western and central Pacific, the world's largest in terms of tuna catch. Using records from 612,148 fishing events collected by independent 'at sea' observers, estimates for finfish, billfish, elasmobranchs, marine mammals and sea turtles show that the composition and magnitude of catches varied considerably by fishery type and practice for the period 2003–2019. Simulations indicated that precision in longline estimates would be improved by monitoring a proportion of fishing sets from all fishing trips rather than full coverage from a proportion of all fishing trips. While attributing reasons for temporal trends in estimated bycatch was difficult due to the confounding impacts of changing abundances and fishing practices, the trends identified the nature of potential relationships for species that are not accurately quantified, or not covered, by fishing vessel logbooks. The trends in catch estimates, and the catch rate models, have utility in identifying species which may require targeted additional analyses and management interventions, including species of conservation interest (either due to their threatened status or vulnerability to fishing) such as elasmobranchs and sea turtles. Moreover, the estimates should support future evaluations of the impact of these industrial-scale fisheries on bycatch species."

33. The WPEB **THANKED** the authors for their contribution and **CONGRATULATED** them for the results which provides a good overview of the extent of bycatch levels in the main tuna fisheries of the Western and Central Pacific Ocean over almost two decades.

34. The WPEB **NOTED** that it is difficult to disentangle the causes of the estimated trends as there are confounding impacts of changing abundances and fishing practices through time.

35. The WPEB **NOTED** the strong increasing temporal trend for purse seine catches of tropical tuna (i.e., skipjack, yellowfin and bigeye tuna) from 2003 to 2019, which is not reflected in temporal trends in estimated catches for the other species types, particularly 'other finfish', i.e., finfish excluding

skipjack, yellowfin and bigeye, and elasmobranchs. The trends in estimated catches for 'other finfish' and elasmobranchs reflect a combination of temporal changes in effort levels by set-type, as well the year effects of the presence-absence models.

36. The WPEB **NOTED** that the declining trend in estimated purse seine catches of 'other finfish' was driven by the decline in sets on schools associated with logs and anchored FADs, as well as declining year effects in the presence/absence models for some species, including rainbow runner, oceanic triggerfish, and mahi mahi. The increasing trend in estimated elasmobranch catches by purse seines from 2015 onwards reflected increasing year effects in the silky shark model, with the initial declining trend reflecting a decrease in sets on schools associated with logs in combination with declining trends in year effects for the silky shark model.

37. The WPEB **NOTED** that the models did not include any spatial effect but bycatch rates may be very different according to fishing grounds and configurations of the fishing gears, e.g., in the case of longline. The WPEB **NOTED** that the modelling approach for longlines included flag, hooks-between-floats and catch composition from reported catches as covariates to account for potential differences in gear configuration between fleets but did not include explicit effects for the distribution of fishing effort. The WPEB **NOTED** that the study was initiated some time ago when few observer data were available for key longline fleets operating in the region and **ENCOURAGED** the authors to extend the model and include spatial dynamics of the fisheries in future work.

38. The WPEB **NOTED** that reported catches were used for catches of tropical tuna for both purse seine and longline fisheries, with reported longline catches also used for albacore tuna and billfish, and assumed to be reported without error. The WPEB further **NOTED** that the confidence intervals were larger in the first part of the time series for billfish, elasmobranchs, turtles, and marine mammals. For longline fisheries, this was due to lower coverage rates from both observer data and hooks-between-floats specific effort data early in the time series. For purse seine fisheries, catches were only estimated for unobserved effort and observer coverage was lower pre-2010.

39. The WPEB **NOTED** that sea surface temperature (SST) was included in the model to represent the spatial variability in environmental conditions and that it was kept as it was found to have similar or better predictive capability than the other candidate environmental variables that were tested.

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).

40. The WPEB **NOTED** paper IOTC–2023–WPEB19–08_rev1 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.

41. 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.

42. 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.

43. 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.

44. The WPEB **NOTED** paper IOTC–2023–WPEB19–10 on Research prioritisation to manage sharks and rays in South African Fisheries, including the following abstract provided by the authors:

"The National Plan of Action for Sharks South Africa II was finalised in 2022 and serves as a pivotal strategy for addressing the conservation concerns of the ~100 species of chondrichthyans caught as by-catch and target in South African fisheries. Globally chondrichthyes are experiencing severe population declines attributable to a combination of conservative life-history traits, unmonitored fishing practices, poor data collection, and insufficient management. Despite their ecological significance and contributions to economies through fisheries, trade, and tourism, existing management interventions often fall short in ensuring their sustainability. The NPOA-Sharks South Africa II, aligned with the FAO Code of Conduct for Responsible Fisheries, outlines a framework to improve conservation and management efforts in South Africa. Implicit in the NPOA Sharks South Africa II is a list of actions, timeframes, and responsibilities to be completed by the end of the 5-year plan. This prioritization exercise represents an action as required by the NPOA Sharks II, to determine which chondrichthyans in South Africa warrant urgent research. By prioritizing species for research, the plan aims to gather crucial information on the risks associated with shark exploitation and guide effective management within fisheries. The prioritization is done separately for three marine ecosystems roughly separating three fishery systems, namely coastal, demersal, and pelagic. The prioritization emphasises research gaps, while acknowledging challenges in data collection, identification, and observer coverage. Recommendations include resolving species composition issues, updating catch lists, immediate sample collection, and fostering international collaboration for pelagic species. The NPOA-Sharks underscores the complexity of managing chondrichthyan species affected by fisheries and highlights the importance of bridging the gap between scientific research, policy implementation, and international cooperation to secure their future."

45. The WPEB **NOTED** that this paper provided information on the research prioritisation exercise that was completed under South Africa's NPOA-Sharks II.
46. The WPEB **NOTED** that this analysis included both South African vessels and foreign vessels operating under joint-venture agreements.
47. The WPEB **NOTED** that the fishing regulations and requirements regarding sharks apply to both South African flagged vessels and foreign vessels operating in the EEZ of South Africa. Vessels operating under the joint-venture agreement are required to work under South African laws and also require 100% observer coverage meaning that these vessels provide useful supplementary bycatch data.

5.2 Updated status of national fisheries and bycatch (CPCs)

48. The WPEB **NOTED** paper IOTC–2023–WPEB19–11 on Gillnet tuna fisheries in the Coastal waters of India: Intensity and spatial spread of the fisheries with implications of non-target and sensitive species interactions, including the following abstract provided by the authors:

"Artisanal large mesh pelagic drift gillnet fisheries accounts for nearly 34% of the Indian Ocean tuna catches. India is one of the major coastal countries employing gillnets for harvesting tuna and tuna like fishes. Cooccurrence of non-tuna species including endangered threatened and protected species is universal in this fishery although the rates of incidence varies with the fishing area, time and intensity of fishing. The study aimed at updating the dynamics of large mesh pelagic gillnet fisheries of northwest coast of India through skipper supplied data for the period of 2011 to 2022 together with analysis of the landing data of large mesh pelagic gillnets of India obtained by the ICAR-CMFRI through the multistage, stratified random sampling survey protocols for the corresponding period. The study reveals the patterns of landing by the gear across the four regions of India's coast over the seasons and the pattern of catches in the observed gillnetters during the period. Tunas are the major group caught in this gear followed by other large pelagics like seer fishes, leather jackets, billfishes etc. Sensitive bycatches like sharks, turtles and cetaceans are lesser compared to other gillnet fisheries in the region."

49. The author was not available to present this paper.

50. The WPEB **NOTED** paper IOTC–2023–WPEB19–12 on An overview on large pelagic species and Estimation of By-catch by Iranian fishing vessels (Gillnets) In IOTC competence of area in 2021, including the following abstract provided by the authors:

"Iran fishing grounds in southern waters of country are of the oldest and most important resources of large pelagic species. There are 4 coastal provinces in those areas and more than 11 thousand vessels consist of fishing boat, dhows and vessels which are engaged in fishing in the coastal and offshore waters. There are three fishing methods targeting tuna and tuna-like species in the IOTC area which include gillnet and purse seine and also some of small boats use trolling in coastal fisheries. In order to assess the level of Iranian tuna fishing vessels By-catch in the IOTC area of competence in 2021 tuna fisheries data which are collected through the Iran Fishery Organization Data Collection system are used. Base on the information, around 30 different species of Tuna, Tuna-like and some others are caught by Iranian fishermen through the Tuna fishing activities. Base on the information in total, 308231 tons of different species including, 248806 tons Tuna and Tuna-like species, 26077 tons Billfish, 4085 tons of Sharks and 29263 tons the other species, are caught by Iranian fishing vessels in the IOTC area of competence. According to IOTC target species list (16 species covered by IOTC agreement) 89% of Iran catch belong to target species and 11% of catch belong to non-target species, in the 2021." – see paper for full abstract

51. The author was not available to present this paper.

52. The WPEB **NOTED** paper IOTC–2023–WPEB19–13 on Ecosystem and bycatch in Somalia 2023, including the following abstract provided by the authors:

"Somalia is a country with diverse ecosystems, ranging from arid plains to lush savannas, that support a variety of wildlife and plant species. However, these ecosystems are also vulnerable to the impacts of climate change, overfishing, and other human activities. Bycatch, the incidental capture of non-target species in fishing gear, is one of the major threats to the marine biodiversity and ecosystem health in Somalia. Bycatch can affect endangered, threatened and protected species, such as sea turtles, sharks, rays, and dolphins, as well as species that are important for the food security and livelihoods of local communities. The International Commission for the Conservation of Atlantic Tunas (ICCAT) has established a subcommittee on ecosystems and bycatch to monitor and assess the status of these species and to develop indicators and reference levels for the ecosystem report card. The subcommittee also provides recommendations for the implementation of the ecosystem based approach to fisheries management and the adoption of best practices to reduce bycatch and its impacts. This abstract aims to provide an overview of the current state of knowledge on the ecosystem and bycatch in Somalia and to highlight the challenges and opportunities for conservation and management."

53. The author was not available to present this paper.

54. The WPEB **NOTED** paper IOTC–2023–WPEB19–14 on Vulnerability assessment of elasmobranch species to fisheries in coastal Kenya: implications for conservation and management policies, including the following abstract provided by the authors:

"Ecological risk assessment (ERA) of species to fisheries is useful for making informed management decisions especially in data-scarce situations based on species relative vulnerabilities to fisheries. Understanding the vulnerability of species to fishing gears is important for targeted management measures especially for species known to have delicate life-history strategies such as the elasmobranchs. As part of a National Plan of Action for Sharks (NPOA-sharks) initiative, a three-day workshop was organized (in April 2022) involving various experts and stakeholders to analyze relative

vulnerability risks of shark and ray species to fishing gears in Kenya's Exclusive Economic Zone (EEZ). The workshop applied a Productivity and Susceptibility Analysis (PSA) approach to estimate relative vulnerability of species to the fishing gears. A total of 30-shark and 29-ray species were used for analysis of relative vulnerability to artisanal fishing gears, prawn trawlers, and industrial pelagic longline fishery within Kenya's EEZ. Overall, results showed high species vulnerability to the prawn trawl fishery (35% for rays and, 65% for sharks and shark-like rays) and to the industrial longlines (100% for rays and, 46% for sharks and shark-like rays). There were variable but lower vulnerability ranges for species in the artisanal fishery gears. Thirty species, grouped as a High Vulnerability Species Assemblage (HVSA), were assessed to have High Relative Vulnerabilities to the gears calling for their targeted management strategies. Of the HVSA group, five species; Sphryna lewini, Pseudoginglymostoma brevicaudatum, Rhina ancyclostoma, Rhynchobatus djid-densis, Rhynchobatus laevi are classified as Critically Endangered (CR), while another five; Car-charhinus plumbeus, Mobula birostris, Mobula eregoodoo, Stegostoma tigrinum, Rhinoptera jaya-kari are Endangered (EN) according to the IUCN Red List assessment (www.iucnredlist.org, release 2022-1). The results suggest that a lower fishing-pressure threshold is required to predispose the prawn trawl bycatch species to High Vulnerabilities. Lastly, over 50% of the species evaluated as being of High Vulnerability also fell under the IUCN Threatened Category. A validation approach has been used to reduce uncertainty around PSA, however, the tool will require continuous updat-ing to include more species and improve on its sensitivity. A precautionary Shark and Ray Manage-ment Plan (SRMP) that takes into account the outputs of the PSA is recommended for the manage-ment and conservation of the elasmobranch stocks within the framework of a NPOA-Sharks for Kenya."

55. The WPEB **NOTED** that during this study, the productivity was estimated by considering the biological attributes of the species including intrinsic growth rate, fecundity and number of live young while the susceptibility was estimated by considering the probability of species' overlapping with various gears based on the depth profile of the species' and the gears.

56. The WPEB **NOTED** some uncertainty with the analyses shown in the paper, particularly relating to the ranking of productivity for each of the species as species which are known to have low productivity were shown as having high productivity. The WPEB **NOTED** that it is possible that the axes of the PSA plots had been accidentally presented in reverse, resulting in species at lower risk appearing to be at higher risk and vice versa.

57. The WPEB **NOTED** that this study highlights the fact that some species (such as blue shark) are at particular risk of high fishing mortality as they are directly targeted in some fisheries.

58. The WPEB **NOTED** that while the author did not have any specific recommendations on the best methods for managing the shark species assessed during the study, the WPEB **CONSIDERED** that targeted management of certain species is likely to have a positive impact on the fishing mortality of other species due to the fact that many species are vulnerable to similar gears.

59. The WPEB **NOTED** paper IOTC-2023-WPEB19-35 on Catch composition and some biological aspects of silky sharks *(Carcharhinus falciformis*) landed by surrounding net fishery in Sri Lanka, including the following abstract provided by the authors:

"The surrounding net (ring net) fishery in Sri Lanka is responsible for more than 36% of total large pelagic fish landings, while the highest landings are recorded from coastal fisheries (37%). This study was carried out on a monthly basis from January 2019 to December 2021 to investigate the catch composition and reproductive aspects of silky sharks (Carcharhinus falciformis) landed as by-catch in the ring net fishery in major fish landing sites in Sri Lanka. Skipjack tuna (Katsuwonus pelamis), yellowfin tuna (Thunnus albacores), frigate tuna (Auxis thazard), and rainbow runner (Elagatis bipinnulata) contributed to the by-catch, while sharks contributed quite a small

quantity, less than 1% in weight. 82% of the shark by-catch is composed of silky sharks, followed by blue sharks (14%) and Isurus sp (2%) A total of 1197 silky sharks were recorded during the study period, and the fork length range was 69–204 cm. The overall sex ratio for males and females was determined at 1:6. The results showed that more than 80% of the silky sharks landed by the purse seine ring net were juveniles. Recorded fishing locations were scattered, but most were confined to the Exclusive Economic Zone. The silky shark can be considered as a highly vulnerable shark species to the ring net fishery in Sri Lanka, and this study provides important information on their reproductive aspects, which will be crucial to the implementation of management and conservation measures."

60. The WPEB **THANKED** the authors for providing information on the catch composition of silky sharks in Sri Lanka.

61. The WPEB **NOTED** that catch reductions for the species could be implemented by using measures such as mesh size permit conditions for gillnets and the mandatory release of pregnant and undersized sharks in high sea fisheries.

6. Review information on biology, ecology, fisheries and environmental data relating to sharks

6.1 Presentation of new information available on sharks

62. The WPEB **NOTED** paper IOTC-2023-WPEB19-16_rev1 on Fins Naturally Attached the globally acknowledged best practice to prevent Finning, including the following abstract provided by the authors:

"After the amphibians, chondrichthyans are the most threatened vertebrate Class assessed to date. (IPBES 2019). The lucrative shark fin trade remains a main driver for overexploitation of sharks (Clarke et al. 2006). Oceanic shark species have been particularly affected due to the high value of their fins and their low reproduction rates, so that 52% of oceanic shark species are now classified as endangered or critically endangered by the IUCN (Pacoureau et al. 2021). In light of these threats numerous jurisdictions have banned finning, but the implemented methods vary substantially in their effectiveness. A report published in 2021 "Analysis of the Marine Stewardship Council's policy on shark finning and the opportunity for adoption of a 'Fins Naturally Attached' policy in the MSC Fisheries Standard Review" analyses the effectiveness of various fisheries management measures in enacting shark finning bans - including FNA, fin-to-carcass ratios, and fins artificially attached - finding that approaches other than FNA all contain substantial inadequacies and loopholes that complicate monitoring and enforcement. It is also noted that FNA without exception has now been adopted by multiple organizations and states including the European Union, the United States, Canada, NAFO, and GFCM, and is no longer just a feasible 'best practice' but increasingly a minimum requirement for sustainable fisheries management. Subsequently the Marine Stewardship Council (MSC) itself introduced an FNA policy in the latest version 3.0 of its Standard. The report concludes that Fins Naturally Attached (FNA) policy accompanied by adequate monitoring is well-established as the only effective method to enforce a shark finning ban and demonstrates that none of the common counter arguments represent impediments to implementation of such a policy. Alongside catch limits, retention bans, and bycatch reduction measures, eliminating finning by enacting FNA policy is essential to prevent the extinction of many shark species and the destabilising impact this will have on marine ecosystems.

From 2018 to 2022 to Marine Stewardship Council, one of the leading ecolabels for seafood, had been reviewing its Fisheries Standard and its new Version 3.0 of the Standard came into effect on

May 1st, 2023, including substantially revised requirements for fisheries to demonstrate that no shark finning happens on board certified vessels. After many years of consultations with stake-holders throughout academia, civil society, and the industry, the new MSC Standard now requires all fisheries to demonstrate having a Fins Naturally Attached policy in place – without exceptions - as a prerequisite for certification. Based on scientific evidence and global acknowledgment the MSC is now also applying the global best practice as a minimum requirement for certification, a step IOTC should also consider embarking on to step-up shark conservation in the Indian Ocean by aiding identification and reporting, and enabling enforcement of the existing ban on Finning."

63. **NOTING** that there have been cases where vessels were caught with illegal shark fins (not attached) but that no adequate sanctions were taken, the authors argued that a "Fins Naturally Attached" policy would both improve the data collection and surveillance of finning activities and allow prosecution when finning has been found to be occurring.

64. The WPEB **NOTED** concerns on the feasibility for fishermen to implement a "Fins Naturally Attached" only policy, considering that this would impact the processing and storage of fins and carcasses for some fleets, and possibly have economic consequences. However, the authors argued that a strong finning policy will benefit fisheries via the obtention of certification (such as MSC), being transparent vis-à-vis consumers, and being in line with the market and import requirements of certain countries.

65. The WPEB **ACKNOWLEDGED** that some measures in place for controlling the implementation of finning bans, such as the use of fin/carcass ratios, raise concerns in terms of their efficacy given that there is considerable species-specific variability in such ratios, as well as variability depending on the type of cut and processing of the fins.

66. The WPEB **RECOMMENDED** that the SC advise the Commission to consider extending measures to prevent finning of sharks such as fins naturally attached including partially attached and tethered for all fisheries, or similar, alternative measures (for example, fins artificially attached), providing they had been assessed and endorsed by the SC and Compliance Committee as being equally or more likely to meet the conservation benefit (of a fins naturally attached measure) and are logistically feasible from a compliance monitoring perspective. The WPEB **NOTED** that while such other measures may be logistically more difficult to implement and monitor for governments, they may be logistically more practical for the fishing industry when conducting their fishing operations and storing shark catches on board.

67. The WPEB **REQUESTED** CPCs to collect and provide all information necessary to evaluate the effectiveness of all relevant measures. The WPEB **AGREED** to review this information on a regular basis.

68. **ACKNOWLEDGING** that the current ROS data requirements already enable the recording of shark fins attached / non-attached to carcasses. the WPEB **RECOMMENDED** that the SC identifies proper mechanisms to ensure this information is regularly collected and reported to the Secretariat through the ROS.

69. The WPEB **NOTED** paper IOTC-2023-WPEB19-23 on A review of the effectiveness of gear modifications to reduce shark bycatch mortality in longlining, including the following abstract provided by the authors:

"IOTC has so far adopted only few shark conservation measures and existing measures focus on banning retention of Carcharhinus longimanus, Rincodon typus, and all three species of Alopias. No measures to reduce at-vessel mortality (AVM) and post-release mortality (PRM) have been adopted for longlining fleets at IOTC. While targeted catches will be disincentivized by such bans, an effective overall mortality reduction needs to address bycatch mortality, especially when the sharks that are to be released make up a substantial part of the bycatch of a fishery. While silky sharks are targeted by several artisanal fleets in the Indian Ocean and artisanal fisheries are

exempted from the retention ban for Oceanic whitetip sharks, both species get discarded as a regular bycatch by industrial tuna and swordfish fleets, specially by those fleets targeting blue sharks. Scientific studies in the Pacific have recently shown that fishing mortality of both species can be reduced by more than 40% and 30% respectively, when steel leaders are replaced by monofilament leaders and shark lines removed (Bigelow et al. 2021). Therefore, the WCPFC will ban both gear modifications between 20°N and 20°S from 2024 onwards. However, IOTC has failed to agree on a similar conservation measure at its 26th IOTC Commission Meeting.

Reducing bycatch mortality at IOTC is also important for all sharks that get discarded by longline fisheries that do not retain sharks, including but not limited to oceanic whitetip sharks and thresher sharks, but also including silky sharks, mako sharks, and hammerhead sharks. All of them scored high in the ecological risk assessment (Murua et al. 2018), being highly vulnerable to longline interaction combined with high post release mortality when injured during the catch operation. Although little research has been done at IOTC on leader types and other gear modifications suitable to reduce bycatch mortality of sharks in the IOTC, a substantial number of studies have been performed in the Pacific and Atlantic over the last 15 years demonstrating the potential of gear modification to reduce mortality of these and other vulnerable bycatch species, especially when combined with other bycatch avoidance and mitigation measures. Therefore, a substantial number of nations has already banned or are in the process of banning the use of these gear modifications in their fleets."

70. **RECOGNIZING** the need for a comprehensive analysis of the effectiveness of gear modifications (wire traces replaced by monofilament, hook type, bait type, etc.) to mitigate bycatch, the WPEB **AGREED** to hold an intersessional online workshop gathering experts to review the already-conducted meta analyses in order to clarify the beneficial and negative effects of gear modifications on the different species (including target species) and reach a consensus between experts.

71. The WPEB **ACKNOWLEDGED** the support for crafting a Regional Plan of Action (RPOA) for shark species, contingent upon the presence of tangible commitments and specific objectives. Nevertheless, the WPEB **NOTED** that a decade ago, a workshop was convened to establish a Shark Year Program aimed at mitigating mortality and formulating conservation measures. The WPEB **NOTED** concerns about a proposed RPOA overlapping with the work completed during the Shark Year Program so **NOTED** that it would be useful to build on and update this earlier work as part of the development process for the RPOA.

72. **RECOGNIZING** that the stock assessment of shark species is hindered by data limitations and that more work is needed, the WPEB **AGREED** that the precautionary approach would be one way to move forward to mitigate mortality on shark species.

73. The WPEB **NOTED** paper IOTC-2023-WPEB19-17_rev1 on Undetected silky sharks (Carcharhinus falciformis) in the wells of the tropical tuna Spanish purses–seine fleet from the Indian Ocean, including the following abstract provided by the authors:

"In this document the authors have studied the presence of silky sharks (Carcharhinus falciformis) undetected in the fishing deck in the landings of the Spanish tuna purse-seiners fishing in the Indian Ocean. They have compared this data with the observations of the Scientific Observers on board of the Spanish Vessels and they found significative differences. This study demonstrates that there is a component of the catch that is not sampled or not estimated during the capture and that accidentally ends in the wells, increasing the rate of specimens that die during the fishing manoeuvre. There is an undetected impact on silky shark populations from purse seine vessels."

74. The WPEB **ENCOURAGED** the authors to estimate the yearly number of silky sharks found in the wells by extrapolation, and/or estimate the relative proportion of silky sharks observed in the wells versus those observed on board.

75. **ACKNOWLEDGING** that many but not all EU purse seiners have EMS, the WPEB **NOTED** that EMS would not necessarily capture the sharks unseen by observers as it is not always configured to look directly at all wells (too far away, dead angles etc.). Moreover, considering the current configuration of Spanish vessels, some of which do not include discard belts, cameras are unlikely to detect small silky sharks on a conveyor belt crowded with tunas. The WPEB further **NOTED** that having a hopper on the upper deck will help sorting operations at this level, hence reducing the chances that small silky sharks fall on the lower deck and potentially end up in the wells undetected.

76. The WPEB also **NOTED** that according to Forget et al. (2021)[1], observers and EMS generally underestimate silky shark numbers by 9-40% and 65% respectively, hence **RECOGNIZING** the potential usefulness of dedicated port sampling for bycatch species to accurately estimate fishing mortality providing that the amount of undetected silky sharks by observers found in the wells is not anecdotal.

77. The WPEB **NOTED** paper IOTC-2023-WPEB19-18 on Post-release mortality of oceanic whitetip sharks caught by purse seiners in the Indian Ocean: POREMO project, including the following abstract provided by the authors:

"Oceanic whitetip shark (Carcharhinus longimanus – OCS) is a sensitive species present in the Indian Ocean that is classified as globally "Critically Endangered". OCS are occasionally bycaught by tuna purse seine fleets operating in the Indian Ocean. The retention of OCS is prohibited and despite the efforts made to handle and release those sharks, post-release mortality (PRM) of OCS needs to be assessed. In the frame of the POREMO project that is dedicated to this particular task, onboard observers deployed electronic tags (16 sPATs and 3 miniPATs) on OCS released by French, Spanish and Mauritian purse seiners in the western Indian Ocean between 2018 and 2023. Based on the 16 tags that reported data, we determined the overall PRM rate and explored the effect of fish condition upon release, individuals' size, sex, and time spent on deck before release on the PRM. We found that the overall PRM for OCS bycaught by purse seiners was 18.75 %. Our results show that PRM is dependent on fish condition upon release, with full survival for lively individuals (100 %) and poorer survival chances for the injured and moribund ones (20 and 0 %). The time that individuals spend on deck directly affects their condition at the time of release, subsequently influencing their likelihood of survival. Furthermore, the size of individuals size appears to enhance the survival prospects of injured and moribund individuals. Those results suggest that handling carefully and releasing promptly bycaught OCS would likely improve their PRM."

78. The WPEB **NOTED** that this study provides the first post-release mortality results for oceanic whitetip sharks released by purse seiners despite some similar experiments having been conducted in the Pacific which remain unpublished to date.

79. The WPEB **NOTED** that in this particular case where oceanic whitetip sharks have high survival rates after release (81%), the current IOTC retention ban measure (Res. 13/06) is an efficient conservation measure to reduce mortality for this species. However, this might not be sufficient for species with higher post-release mortality such as the silky shark. The WPEB also **NOTED** that the high survival

[1] Forget et al., 2021. Quantifying the accuracy of shark bycatch estimations in tuna purse seine fisheries. *Ocean & Coastal Management*, *210*, p.105637.

rate may also be explained by the fact that EU purse seiners follow good practices for handling and releasing sharks.

80. **ACKNOWLEDGING** that oceanic whitetip sharks were tagged by observers during regular commercial fishing operations, the WPEB **NOTED** that their post-release mortality was much lower than that of silky sharks released by purse seiners. It is thought that oceanic whitetip sharks are generally more robust than silky sharks and tend to swim their way up on top of the seine when forming the sack; this way they are within the first ones to be brailed on board. The WPEB also **NOTED** that oceanic whitetip sharks are more conspicuous than silky sharks and are generally handled with better care by the crew. The WPEB **ENCOURAGED** scientists, for future tagging experiments, to record additional information such as the brail number (first to last brail), how sharks were handled (manipulation, passing through the lower deck or not), and more details on injuries to individuals.

81. **ACKNOWLEDGING** that the amount of time spent on deck has an influence on the post-release mortality of oceanic whitetip sharks, the WPEB **NOTED** that the study suggests that the use of sorting hoppers and discard ramps to quickly release sharks will likely increase the survival rates of oceanic whitetip sharks as well as other shark species.

82. The WPEB **NOTED** that tagging experiments on longliners planned as part of the POREMO project have not yet been carried out, and that an update of results will be presented at the next WPEB. The WPEB **NOTED** however, that the preliminary results on the longliners show a higher survival rate for oceanic whitetip sharks, suggesting that individuals caught and released by smaller scale fisheries generally have better survival rates.

83. The WPEB **NOTED** paper IOTC-2023-WPEB19-19 on An update on the recent development of IOTC BTH PRM Project and considerations for further actions, including the following abstract provided by the authors:

    "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, 16th, 17th, and 18th IOTC WPEB are presented."

84. **ACKNOWLEDGING** that the authors were asked to provide a comprehensive analysis of tagging experiments, the WPEB **NOTED** that the results of the study will be presented when tagging operations come to an end, rather than presenting preliminary analyses.

85. The WPEB also **NOTED** that given the remaining number of tags to be deployed (31), the WPEB requires additional funds from IOTC to cover ARGOS fees. Therefore, the WPEB **REQUESTED** that the Secretariat seek funds to cover these fees.

86. The WPEB **NOTED** the need for having data from different longline fleets and thus **ENCOURAGED** CPCs that have an observer program to join the project if they are willing to deploy tags.

87. The WPEB **NOTED** that some bigeye thresher sharks tagged on Taiwanese vessels were not handled as they would have been in the normal conditions of commercial fishing operations, which is likely to create a bias for their survival rates after release. The WPEB **EMPHASIZED** that tagged individuals should be handled how they usually are during commercial fishing operations.

6.2 Development of shark research work plan for scalloped hammerhead

88. The draft Terms of Reference for this consultancy can be found in Annex XVIV.

7. Stock assessment and indicators for sharks

7.1 Review of indicators

- Silky shark
- Porbeagle shark
- Other species

89. The WPEB **NOTED** paper IOTC-2023-WPEB19-20 on Historical standardized CPUEs of seven shark species in the Indian Ocean with preliminary catch estimation, including the following abstract provided by the author:

"We used an historical longline survey from 1966 to 1989 in the Indian Ocean basin to calculate standardized CPUEs for the blue shark (Prionace glauca), silky shark (Carcharhinus falciformis), tiger shark (Galeocerdo cuvier), silvertip shark (C. albimarginatus), sandbar shark (C. plumbeus), oceanic whitetip (C. longimanus), and shortfin mako (Isurus oxyrinchus), as well as the genera Sphyrna, Alopias, Isurus, and Carcharhinus. Twelve other shark species were recorded in the survey, but were not caught frequently enough to create standardized CPUEs. We use the standardized CPUEs of the blue shark to estimate catches by the Taiwanese longline fleet from 1977 - 1989. These CPUEs represent an important basin-wide baseline for shark abundance at the start of industrialization of Indian Ocean fisheries. We also demonstrate how they can be used in combination with effort data to generate catches for use in stock assessment models. Additionally, we present standardized CPUEs for the porbeagle (Lamna nasus) derived from the IOTC's publicly available catch and effort data."

90. The WPEB **ACKNOWLEDGED** the methodology followed by the authors whereby they reviewed historical catch rates of longline research cruises and then used these catch rates to estimate fleet-specific catches for the same period of the research cruise up to 1989.

91. The WPEB **NOTED** that the methodology could be useful for reconstructing missing shark catches for similar longline fleets (areas, gear configuration, etc.) assuming that catches are available for the start of industrialized longline fishery. Moreover, the WPEB **NOTED** that the methodology could also be used to estimate catches of shark species for fleets without data using similar fleet catch rates.

92. The WPEB **NOTED** that the Soviet Indian Ocean Tuna Longline Research Programme (SIOTLLRP) was a fishery exploratory cruise targeting tunas with day setting but no night setting targeting swordfish, which may explain the low shark catch rate observed during the research cruises. Therefore, the WPEB **NOTED** that the catch rates of the SIOTLLRP might not be fully representative of the longline fishery of that time.

93. The WPEB **NOTED** that while there is good spatial and temporal information in the datasets in the historic surveys conducted by the former USSR, unfortunately there is interannual variability of these aspects.

94. The WPEB **NOTED** that life history traits relating to species biology were used as predictors and further **NOTED** that it would be interesting to include habitat predictors. However, the WPEB **ACKNOWLEDGED** the difficulty of exploring CPUE indices in relation to different habitat areas due to the migratory nature of the shark species studied.

95. The WPEB **NOTED** paper IOTC-2023-WPEB19-34_rev1 on Silky shark abundance index based on CPUE standardisation of French Indian Ocean tropical tuna purse seine observer bycatch data, including the following abstract provided by the authors:

"Here we present an annual abundance index for silky shark for the period 2012 to 2021 based on standardized silky shark catch per FOB fishing set for the French tropical tuna purse seine fishery in the Indian Ocean. The methodology used general additive models with mixed effects (GAMMs) in a novel approach using three submodels, including one model for tropical tuna catch per set, and two others that form the components of a Δ log-normal model (i.e., a presence-absence model and an abundance when present model) for silky shark catch per set with total tuna catch used as predictors in those models. Results indicate an overall increasing trend in silky shark abundance over the study time period, though when interannual variability in catch of target tunas is removed model CPUE predictions are found to be more or less stable over time. Though there is evidence to support a potential increasing trend in abundance, there are a number of reasons to believe that these predictions may be overly optimistic, including low data coverage and a biased spatial distribution of fishing effort and observer coverage of bycatch in the original two years of the data (2012-2013) and poorly understood impacts of the implementation of a quota on yellowfin tuna catch in 2017."

96. The WPEB **THANKED** the authors for the interesting analysis which provides a useful fishery indicator for the main bycatch shark species of the purse seine fishery and a data poor species such as silky shark.

97. The WPEB **NOTED** that the purse seiner silky shark catch per unit effort standardization shows an overall increasing trend from 2012 to 2021, which could be explained by different reasons such as increased in abundance or catchability, changes in the yellowfin tuna quota management or this might be an artefact of observer coverage and spatial distribution.

98. The WPEB also **NOTED** that when tuna catch interannual variability is included in the model the silky CPUE is stable over time.

99. The WPEB **QUESTIONED** whether the increase in the number of FADs and changes in the characteristics of the FADs will have an effect on the observer silky shark CPUE trend. The use of echosounder buoys (FADs) has increased in recent periods and, therefore, the fishery has increased efficiency with an increase in catch per set. The WPEB **NOTED** that the increased number of FADs could explain the increase in tuna catch per set and, therefore, the increase in the silky shark catch rates given the functional relationship between tunas and silky shark around FADs. The WPEB further **NOTED** that the presence/absence of echosounders on FADs should be accounted for when modelling catch.

100. The WPEB **NOTED** that the changes in FAD design, moving from entangling to non-entangling FADs, will not affect the results of the study since the study is focused on the silky shark catch encircled by the purse seiners. The WPEB **NOTED** that non-entangling FADs may have reduced ghost fishing and, therefore, may have a positive effect on the population.

101. The WPEB **ENCOURAGED** the authors to continue with the analysis to disentangle possible reasons for the observed increasing trend and provided suggestions for further analyses, including additional fleets, different model structure such as random forest and inclusion of different co-variates and interactions such as the type of FADs.

102. The WPEB **NOTED** paper IOTC-2023-WPEB19-21 on Developing an Abundance Index of Blue Shark from a Handline Fishery in Southern Java Waters Part of Eastern Indian Ocean, including the following abstract provided by the author:

"The Handline tuna fishing operations based in the Ocean Fishing Port location in Cilacap, Central Java, have expanded significantly. Several species of pelagic sharks, including the Blue shark, were

reportedly captured and landed through handline operations. This working document provides information on an abundance index for blue sharks captured by handline tuna fishery from 2019 to 2022 based on fishery-dependent data. Generalized linear models (GLMs) were utilized to standardize the catch-per-unit-of-effort (CPUE) with year, quarter, number of the crew, and capacity (gross tonnage) serving as the prediction variables. Model selection and model goodness-of-fit were determined using the Akaike Information Criterion (AIC), the pseudo coefficient of determination (R^2), and model diagnostics with residual analysis. The final estimation of the abundance index was determined using least square means or marginal means. The results showed that the index was heavily influenced by the year and followed by quarter, but it did not relate to the vessel's capacity and number of crew. The trends of the standardized CPUEs were relatively similar to the nominal series, in general there were downward noticeable trends, even with high fishing effort, there is a clear decreased trend, with the maximum index value occurring in the second year of observation and continuing to down until it is lower than it was at the beginning of the year observation."

103. The WPEB **THANKED** the author for this analysis and **ENCOURAGED** them to continue and expand the work and collection of shark fishery data to other species/fisheries of Indonesia as well as to compile historical data.

104. However, the WPEB **NOTED** that the time series is very short (from 2019) and, therefore, **ENCOURAGED** the authors to also focus on recovering and compiling historical data so as to enlarge the time series.

105. The WPEB **NOTED** that the handline fishery does not have a specific target species and utilises multiple gears.

106. The WPEB **NOTED** that life history traits used to explain differences in abundance trends were maximum length, rebound potential, and trophic level. The WPEB further **NOTED** that habitat characteristics were not included as this information is very coarse.

107. The WPEB **NOTED** that the effort unit is number of days of the trip and **REQUESTED** the authors to collect more detailed information regarding the fishing operations, including the number of hooks used which may improve the model.

108. The WPEB **NOTED** the substantial increase in effort seen over the four-year period of the study and the author confirmed that this is in line with a real increase in effort that has been observed in these fisheries rather than being a reflection of improvements in data collection.

109. The WPEB **NOTED** suggestions for improvements in the model structure through the inclusion of a random effect for vessels or the inclusion of some characteristics of the vessels that could provide information about their shark catchability (e.g., vessel LoA, etc.) to reduce the number of categorical variables included in the model.

7.2 Stock assessment models

110. The WPEB **NOTED** paper IOTC-2023-WPEB19-32 on Assessment of the shark stock complex in the Bering Sea/Aleutian Islands and Gulf of Alaska, including the following abstract provided by the author:

"This document presents the assessment for the shark stock complex (Pacific spiny dogfish, Pacific sleeper shark, salmon shark and other/unidentified sharks) in both the Gulf of Alaska (GOA) and Bering Sea/Aleutian Islands (BSAI) Fishery Management Plan (FMP) areas. While

advice remains separate by FMP, recent tagging and genetic studies suggest that the stocks are shared between these areas. We combined the assessments here to streamline the presentation of data that are in common (e.g., life history, data summaries, etc.) and to harmonize advice and management recommendations between regions.

For the BSAI, the SSC has placed this complex within Tier 6 of the FMP. This means the OFL is based on the maximum historical catch between the years 2003-2015, and the ABC is 75% of OFL. For the GOA, the complex is managed as a combination of Tier 5 (for spiny dogfish) and Tier 6 species (for all other sharks). The OFL and ABC for the GOA complex sums over these tiers. The GOA spiny dogfish assessment uses the random effects while the remaining components (Tier 6) are based on species specific average catches from 1997-2007."

111. The WPEB **THANKED** the authors for their interesting contribution and the established process of stock assessment and management for shark stock-complex (comprising more than one shark species) by the Alaskan management regulatory system for shark species depending on fishery data availability, including how to establish the biological limit and target reference points for shark species.

112. The WPEB **NOTED** that although Alaskan governance and research classifies shark data availability in 6 tiers, from data poor to rich data, the amount of fishery data is much larger than the data availability for IOTC shark species which to some extent precludes the application of the same process for IOTC species. However, the WPEB **NOTED** that the process described could be of great help and a valuable methodology to apply to IOTC shark species.

113. The WPEB **NOTED** that the limit reference point (OFL) is established at the maximum historical catch level of the shark complex and then the target reference point is established at 75% of this OFL, which establishes the total allowable catch of the shark complex.

114. The WPEB **NOTED** that changes in the relative contribution of species-specific catches are monitored along the time series to determine if the OFL, target reference point and, thus, total allowable catch should be changed. Moreover, the WPEB NOTED that depending on the group of species assessed, the methodology to estimate OFL is different.

115. However, the WPEB **NOTED** that the species biology and productivity (less vs higher productive species) is not considered when estimating the OFL, which could allow less resilient species of the shark complex to be caught at unsustainable levels if their catchability increases or new vessels start targeting this species, even in cases where the total catch of the shark complex is within the catch limits established based on the target and limit reference points for this. The WPEB **ENCOURAGED** the authors to revisit this issue so as to include the productivity of the different species comprising the group of species.

116. The WPEB **NOTED** that the model has not accounted for the changes in fleet behaviour and changes in species catch and **SUGGESTED** that these should be accounted for in the assessment process.

117. The authors indicated that the recent declining trend in survey indices for all species might be an artefact, caused by changes in catchability and measurement error. The WPEB **NOTED** that the species are unevenly distributed and segregated by size as surveys are not directed towards sharks and fisheries data are not representative.

118. The WPEB **NOTED** that the author is currently not using genetic tools such as CKMR in their assessments but **NOTED** that a large collection of tissues that could be used for genetic studies are available for these species as these were collected for population structure studies in the past.

119. The WPEB **NOTED** that the author is seeking to collaborate to expand the stocks included in the non-targeted ORCS model simulations and considers the IOTC shark species to be interesting stocks to include. The WPEB **ENCOURAGED** such collaborations and urged those interested to get in touch with the author.

7.3 Recommendation and executive summaries (all)

120. The WPEB **NOTED** that the supplementary information which goes alongside the Executive summaries is quite out of date for most species. The WPEB **NOTED** that the Secretariat is working to update these and **ENCOURAGED** the group to contact the Secretariat to provide assistance with this.

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

- Ecosystems and climate
- Impact of gears
- Mitigation devices/techniques

121. The WPEB **NOTED** paper IOTC-2023-WPEB19-22 on SMARTSNAP: A new device to aid in the reduction of bycatch in longline fisheries, including the following abstract provided by the authors:

"SMARTSNAPs are a new device to aid in reducing mortality of bycatch species caught on longlines. The device is equipped with several sensors to assist in characterizing species-specific line behavior of fish caught on longlines, with the goal to detect species in real-time and release bycatch species automatically and immediately after capture, thereby reducing the risk of negative physiological and behavioral impacts and depredation, and thus lowering mortality. The SMARTSNAP1 project has recently completed with the development of a first prototype to test the proof of concept. The prototype developed was successfully deployed in both the Gulf of Lions and the waters around La Reunion, capturing 27 individuals from 10 different species on smartsnaps. Metadata about the capture, state of the fish, fishing effort, bait, and line setup were recorded with a custom-developed metadata elogger. Sensor data for each smartsnap is stored in a specially-developed InfluxDB database, and is read from a SMARTSNAP data visualisation dashboard, to assist in comparing and analysing sensor signals. Algorithms are beginning to be developed to determine important fishing events (capture, line fighting, death), and will continue to progress towards species-specific detection. Improvements to the device are planned in future projects."

122. The WPEB **NOTED** that misidentification of catch species may confound the species-specific line behavioural profiles. The WPEB **NOTED** that this was a concern of the authors that was being mitigated using quality assurance checks and identification of species via photos taken at the time of capture or metadata logging. In particular, the local fish name "snoek" was used in the data collected while it refers to different species from the Gempylidae family.

123. The WPEB **NOTED** that the device is currently placed on the line itself, which when the hook is released, would leave a long line attached to the individual that may cause onward mortality or impacts to behaviour and physiology. The WPEB further **NOTED** that if the device was placed next to the hook, this would change the line patterns that are currently observed. The WPEB **NOTED** that the current placement of the SMARTSNAP is due to current limitations in the device, and that

algorithm development will be adjusted should the placement of the device at deployment be altered.

124. The WPEB **NOTED** that caution should be taken when employing wireless charging and data transfer on the next prototype as these features can significantly impact battery life. The WPEB **NOTED** that given the large number of devices that would be needed for the effective detection and release of bycatch and the time required to undertake wired charging and data transfer, these features may be essential in terms of feasibility of use and uptake by fishers, but that the optimisation of the battery life would be a key objective of the improved prototype.

125. The WPEB **NOTED** that currently, including the off-the-rack sensors that are currently used, the price is relatively high at 100 euros per device. The WPEB **NOTED** that one of the major objectives of the follow-up SMARTSNAP-pei project is to industrialise the device, including developing custom electronics to lower the cost of each device to around 5 euros per sensor.

126. The WPEB **ASKED** how the analyses towards developing the species-specific behaviours would be undertaken. The authors indicated that the analyses are only in the beginning stages and they could not elaborate further at this time.

127. The WPEB **NOTED** that the fishers involved in the study have been positive about the device, **NOTING** that the conception of the devices was made with the practicality of use and low-cost of the device in mind. Future projects will also focus on assisting with automated effort logging to function as a win-win for fishers and scientists. The WPEB further **NOTED** that fishers had communicated their interest in the device as a way to minimize depredation of their catch and thus improve the quality of their product. Overall, the WPEB **NOTED** that the fishers involved in the study have science positive attitudes and see the potential of the devices not only to mitigate bycatch, but also to enhance the value of their improved product.

128. The WPEB **NOTED** paper IOTC-2023-WPEB19-31 on Turtles, TEDs, tunas, dolphins, and diffusion of innovations: key drivers of adoption of bycatch reduction devices, including the following abstract provided by the authors:

> *"Fisheries extension programmes frequently fail to secure mandatory or voluntary adoption of bycatch reduction devices and techniques. Approaches for improving the outcomes of extension programmes are often based on ad hoc assessments and do not consider human behaviour or change theories. This paper offers an in-depth analysis of extension activities that led to various adoption outcomes in two prominent bycatch case studies in the United States: turtle excluder devices in shrimp trawl fisheries and dolphin bycatch in the tuna purse seine fishery. Using a grounded theory approach to text analysis of interviews and documents, I examine five periods of voluntary or mandatory adoption efforts. I explain the outcomes through the lens of diffusion of innovation theory. The most effective extension programme involved informative and persuasive efforts, enforced regulations, and commercially practical bycatch reduction devices. Voluntary adoption occurred under exceptional circumstances of public and political pressure and a device that offered substantial benefits to the adopter. The two periods of successful adoption applied the most core principles of diffusion theory. This paper concludes with recommendations for how change agents can apply diffusion theory to future fisheries extension programmes to improve the adoption of bycatch reduction devices."*

129. The WPEB **NOTED** that cost is incorporated into the practicality aspect of the adoption process so is taken into account.

130. The WPEB **NOTED** that in the case studies mentioned in the paper, the fisheries involved both centralised (including an IATTC fishery) and less centralised aspects meaning that this approach can be taken across a wide range of fishery types.

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

9.1 Mobulids

131. The WPEB **NOTED** that Resolution 19/03 *On the conservation of mobulid rays caught in association with fisheries in the IOTC area of competence* includes the following clause:

> *"The IOTC Scientific Committee shall review the status of Mobula spp. in the IOTC Area of Competence and provide management advice to the Commission in 2023 also to identify possible hot-spots for conservation and management of mobulids within and beyond EEZs. Moreover, the IOTC Scientific Committee is requested to provide, whenever considered adequate on the basis of evolving knowledge and scientific advice, further improvements to the handling procedures detailed in Annex 1."*

132. The WPEB **NOTED** that as no papers were provided and no specific mobulid experts were participating in the meeting, it was not possible to provide such advice to the Commission this year.

133. The WPEB **NOTED** the intent of the Chair and Secretariat to reach out to the Manta Trust and other organisations and individuals with expertise on mobulids so that more information is available to the WPEB in the future so advice can be provided to the Commission.

9.2 Marine Mammals

- Review new information on marine mammal biology, ecology, fisheries interactions and bycatch mitigation measures (all);
- Best practice guidelines for safe release and handling of cetaceans (all);
- Development of management advice on the status of marine mammal species (all)

134. The WPEB **NOTED** that the new Resolution 23/06 *On the conservation of cetaceans* includes calls for the SC to provide advice on appropriate measure for mitigating the effects of interactions with cetaceans by IOTC fisheries and to develop best practice guidelines for the safe release and handling of encircled cetaceans by 2025.

135. **ACKNOWLEDGING** the recently signed Cooperation Agreement between IOTC (FAO) and IWC, the WPEB **NOTED** that the IWC will provide their advice on what they consider to be the best practices on the issue of release and handling guidelines at the next meeting of the WPEB for review by the group.

136. The WPEB **NOTED** paper IOTC-2023-WPEB19-24 on Ecological risk assessment of cetaceans to Indian Ocean tuna fisheries, including the following abstract provided by the authors:

> *"Bycatch, or the incidental capture in fishing gears, is the most significant threat to marine megafauna in the world's oceans. It is currently the main driver of the decline and extirpation of cetaceans (whales, dolphins and porpoises) in many regions around the globe, both in coastal and open-ocean ecosystems. However, the magnitude of bycatch remains poorly quantified in many regions and fisheries. Over the past decade, there has been increasing concerns on the extent of cetacean bycatch in the Indian Ocean, particularly in expanding drift gillnets fisheries. Here, an ecological risk assessment including a productivity-susceptibility analysis (PSA) designed for data-poor situations was adapted to investigate the vulnerability of cetaceans to bycatch in*

tuna fisheries, particularly in drift gillnets, pelagic longlines, and purse seines within the IOTC (Indian Ocean Tuna Commission) area of competence. The PSA revealed that risk varies greatly between gears and species. Overall, risk is higher and for more species in drift gillnets than in pelagic longlines and purse seines. Species at higher risk include oceanic small delphinids, medium-sized delphinids, and, to a lesser extent, baleen whales. For pelagic longline fisheries, risk was also relatively high for several large oceanic delphinids. Risk for purse seine fisheries was lower than for other gears, but was relatively high for some baleen whales (particularly B. edeni). Most species with high susceptibility also had high vulnerability scores. Vulnerability scores were also the highest for gillnets and for all species, but particularly small oceanic dolphins. An assessment of the spatial overlap between cetacean occurrence generated by AquaMaps (https://www.aquamaps.org) and tuna fishing effort also allowed to assess vulnerability of species groups for each gear. The spatial overlap between gillnets fisheries and baleen whales is limited to the northern portion of the Indian Ocean. Small and large oceanic dolphins exhibit similar patterns of overlap for all three gears, with high overlap in the northern Indian Ocean with gillnets, and with pelagic longlines and purse seines in the western tropical Indian Ocean. Large toothed whale distribution overlaps extensively with the three gears, including gillnets in the northern Indian Ocean and pelagic longlines in the southern and southwestern parts of the IOTC area. Overall, this study highlights the need to better quantify cetacean bycatch in Indian Ocean tuna fisheries, particularly in gillnet fisheries..”

137. The WPEB **NOTED** that bycatch remains the primary threat to cetaceans globally, and that bycatch generates economic losses of 12.1 billion USD annually. The Indian Ocean is a significant fishing region, contributing to 20 percent of the world’s catch across three main gears (purse seines, longlines, and gillnets).

138. The WPEB **NOTED** that given the high estimated bycatch but limited information, an ecological risk assessment (ERA) is an approach to screen species habitats and communities in data-poor scenarios – particularly via a productivity and susceptibility analysis – with the goal to assess cetacean species’ vulnerability to tuna fisheries.

139. The WPEB **NOTED** that this study considered spatial overlap with IOTC fisheries across three gear types and four life histories. The WPEB **NOTED** that cetacean density and occurrence from AquaMaps were used during the analysis alongside fishing catch and effort data reported to the IOTC (nominal catch data in tons) for 2017 to 2019. Overlap maps were developed for each gear type for five taxonomic groups of ecologically similar species: inshore small cetaceans, baleen whales, small oceanic dolphins, large oceanic dolphins, and deep-diving whales.

140. The WPEB **NOTED** that results showed that 48 species are known to occur in the IOTC area, with 26 identified as interacting with gillnets, 27 in pelagic longlines, and 24 in purse seines. The WPEB **NOTED** that gillnet fisheries were considered to pose the highest risk overall, with small oceanic delphinids having the highest risk (eight species had a higher susceptibility score over 3), while purse seine interactions exist but are likely limited and there is limited information on pelagic longline bycatch and depredation.

141. The WPEB **NOTED** that while this approach includes a wide range of limitations (overestimation of risk, limited data on life history traits), the ERA framework is repeatable, transparent, and not data demanding.

142. The WPEB **NOTED** the author’s suggestion that developing international networks are needed as the next step to better understand fisheries and bycatch, with a particular need to better understand spatiotemporal dynamics of fishing effort and cetacean distribution.

143. The WPEB **NOTED** that some solutions already exist and need to be implemented (e.g. sub-surface gillnetting, as described in Kiszka et al., 2021).

144. **ACKNOWLEDGING** that it is forbidden to set on sperm whales (as per Resolution 23/06) and the fact that there are limited known interactions with this species, the WPEB **NOTED** that sperm whale life history traits and their widespread distribution in the Indian Ocean have inflated the risk vulnerability scores for this species.

145. The WPEB **NOTED** the limited fishing spatial and effort data available for many regions of the Indian Ocean for inclusion in this study, particularly in relation to gillnet fisheries.

146. The WPEB **NOTED** that this study design and existing information did not allow for investigating seasonality of interactions or post-capture mortality in detail, and that looking to post-release mortality in other fisheries would be useful.

147. The WPEB **NOTED** that the analysis shows high risk for various species in the southern Indian Ocean due to the high overlap between species occurrences and effort distribution in this area.

148. The WPEB **SUGGESTED** that future revisions to this work should consider false positive interactions in the analyses.

149. The WPEB **NOTED** paper IOTC-2023-WPEB19-25 on International Whaling Commission activities relevant to the assessment of cetacean bycatch in the Indian Ocean, including the following abstract provided by the authors:

> *"The International Whaling Commission (IWC) continues to address several themes relevant to the assessment of cetacean bycatch in tuna fisheries of the Indian Ocean (IO) through its Scientific and Conservation Committees. The IWC Bycatch Mitigation Initiative (BMI) and the Sub-committee on Non-deliberate Human Induced Mortality of cetaceans (HIM) in particular concentrate on improving the monitoring and mitigation of cetacean bycatch in fisheries around the world, adopting numerous recommendations that include the IO. The BMI, the IWC's Global Whale Entanglement Response Network and Stranding Initiative share expertise and assist countries by providing capacity building programmes to monitor and assess cetacean bycatch, prevent entanglement of large cetaceans and develop entanglement/stranding response capability. The IWC engages with local, regional and international organisations, such as the Indian Ocean Tuna Commission (IOTC) and the Food and Agriculture Organization (FAO). In early 2023, the IWC agreed on a 4-year capsule project within the GEF/FAO Common Oceans ABNJ Tuna project Phase 2. This capsule aims to collaboratively advance efforts to assess and address cetacean bycatch in tuna fisheries across two ocean basins, notably the western central Pacific and the Indian Oceans. The capsule's activities fall within the following themes: assessing cetacean bycatch and data gaps to inform Regional Fisheries Management Organisations (RFMOs); building regional capacity and awareness on cetacean bycatch and available solutions; and collaboratively developing recommendations to address cetacean bycatch for consideration by multi-lateral environmental and fisheries agreements. This paper describes the activities planned for the IO as part of this capsule. The IOTC is a named partner in this capsule, and a Cooperation Agreement was signed by the two organisations. IWC seeks advice from the IOTC on how to continue to strengthen collaboration and ensure the workplans of IOTC and IWC are complementary while also meeting the objectives of the capsule project."*

150. The WPEB **NOTED** the work being done by the IWC's Bycatch Mitigation Initiative (BMI) since 2016 which has included sharing information, expertise and engaging in capacity building activities. The WPEB **NOTED** that in the Indian Ocean, the BMI has supported capacity building workshops on Bycatch Risk Assessments in India, Malaysia and Thailand while workshops on entanglement response were delivered in several countries and an entanglement apprenticeship to representatives from Kenya.

151. The WPEB **NOTED** that IWC has formed an ad-hoc working group on sanctuaries, there will be an IWC portal to gather relevant information to review the Indian Ocean whale sanctuary, and that they are planning for an Intersessional Correspondence Group for this sanctuary. The WPEB further **NOTED** the next State of the Cetacean Environment report will be focused on Indian Ocean cetaceans.

152. The WPEB **NOTED** collaborations that IWC is holding with other organisations including FAO, CPPS and RFMOs including IOTC. The WPEB further **NOTED** the work being done to develop the FAO Guidelines to prevent and reduce bycatch of marine mammals in capture fisheries, and FAO marine mammal bycatch mitigation factsheets.

153. The WPEB **NOTED** the IWC's Tuna Project II which is in collaboration with FAO and seeks to address data gaps, build regional capacity, and develop recommendations for future work.

154. The WPEB **NOTED** that IWC welcomes advice on specific work to include in this project for the Indian Ocean.

155. The WPEB **NOTED** that trials conducted by WWF Pakistan on sub-surface setting of gillnets has led to an increased implementation of this measure in both Pakistan and Iran.

156. The WPEB **NOTED** an offer from IEO to share cetacean sightings data from their observer programs onboard purse seine and longline vessels and welcomed this information which can contribute to better understand distribution of cetaceans in this region. The WPEB **ENCOURAGED** other CPCs and organisations to make data like this available to the IOTC.

157. The WPEB **NOTED** that to date, the IWC has not yet defined the countries where training workshops will be held but that they would be defined according to the needs in the region and so will likely focus on member countries with gillnet fisheries.

158. The WPEB **NOTED** paper IOTC-2023-WPEB19-27 on Unilateral and multilateral approaches to cetacean bycatch management: risk and potential under the U.S. Marine Mammal Import Provisions Rule for IOTC Members, including the following abstract provided by the authors:

"The U.S. Marine Mammal Protection Act Import Provisions Rule is the first unilateral attempt to address cetacean bycatch at a global level by leveraging the U.S. market. The Rule requires that all nations exporting fish and fish products to the U.S. apply for a "Comparability Finding" that demonstrates marine mammal bycatch policies are comparable to certain pillars in the U.S. legal scheme for marine mammal bycatch. It holds significant potential to both advance marine mammal conservation but also to disrupt trade of seafood – one of the world's most highly traded commodities – as well as pose capacity burdens on many nations. The majority of IOTC Members have fisheries listed under the Import Rule, and initiatives undertaken to comply with the Rule may offer opportunities for improving bycatch management at the IOTC. For some IOTC members, however, the Rule may pose significant financial, scientific, and political issues and be challenging to comply. This paper reviews the scope of the MMPA Import Rule for IOTC Members, with an emphasis on the top gillnet fishing members, and discusses potential synergies between the Rule and IOTC bycatch reporting and monitoring. This preliminary, working analysis is one portion of an ongoing, broader analysis reviewing unilateral and multilateral approaches the bycatch management in the Indian Ocean across multiple scales."

159. The WPEB **NOTED** that the U.S. Marine Mammal Protection Act Import Provisions Rule is the first unilateral attempt to address cetacean bycatch at a global level by leveraging the U.S. market. The Rule requires that nations exporting certain fish and fish products to the U.S. apply for a "Comparability Finding" that demonstrates marine mammal bycatch policies are comparable to certain pillars in the U.S. legal scheme for marine mammal bycatch.

160. The WPEB **NOTED** that the Import Rule holds significant potential to both advance marine mammal conservation but further **NOTED** that it could disrupt trade of seafood, one of the world's most highly traded commodities, as well as pose capacity burdens on certain nations.

161. The WPEB **NOTED** that the majority of IOTC Members have fisheries listed under the Import Rule, which may offer opportunities for improving bycatch management at the IOTC.

162. The WPEB **NOTED** a question regarding the capacity for compliance, both within the U.S. government to process Comparability Findings and countries' abilities to work with this Rule. The WPEB **NOTED** that many of IOTC's CPCs are likely to have difficulties in meeting the standards due to their lower capacity to carry out this extra work and further **NOTED** that this point has been a major criticism of the Rule so far.

163. The WPEB **NOTED** that this preliminary review is one portion of an ongoing, broader analysis of unilateral and multilateral approaches the bycatch management in the Indian Ocean across multiple scales.

164. The WPEB **NOTED** paper IOTC-2023-WPEB19-28 on Drift gillnet vessels from space: leveraging low-cost methodologies for enhanced understanding of a data-poor fishery, including the following abstract provided by the authors:

> *"The Indian Ocean produces the second-highest tuna catch across the world's oceans. Here, the prevalence of drift gillnets – used to catch about one-third of tuna and tuna-like harvest – is unique compared to other global tuna fisheries, more commonly dominated by longlines and purse seines. Most drift gillnet fleets in the Indian Ocean are comprised of relatively small vessels under 24 meters in length overall. These vessels are poorly documented, fishing effort is opaque, and catch/bycatch is underreported. This is in contrast with purse seine and pelagic longline fleets operating in this region, for which fishing effort and catch are better understood and typically subject to more reporting requirements under the Indian Ocean Tuna Commission (IOTC), the regional body for managing tuna and tuna-like fisheries. Given existing data gaps, this study set out to trial different approaches to better document, monitor, and understand drift gillnet fleets and ultimately bycatch, with Pakistan's drift gillnet fleet as a case study. Using image annotation, deep learning on satellite images, and port-based interviews in Pakistan, we tested different methods to quantify and describe the Pakistani tuna drift gillnet fleet and bycatch. We found several low-cost image annotation methods and deep learning are powerful tools to illuminate information on a fleet where other monitoring and surveillance is missing, but additional supporting information from local expertise, ground-truthing, and other considerations are necessary for robust estimates of fleet size. This paper describes the 1) existing information on catch and bycatch in the Pakistani drift gillnet fleet, 2) the potential of satellite imagery analysis and deep learning towards fisheries management, and 3) the different methods, challenges, and lessons learned. This paper serves as a baseline for future similar analyses in the Indian Ocean and other regions towards better understanding data-poor fisheries."*

165. The WPEB **NOTED** that given existing data gaps and the lack of mandatory reporting for gillnet vessels under 24 meters length overall on the IOTC Record of Authorized Vessels, this study set out to trial different approaches to better document, monitor, and understand drift gillnet fleets and, ultimately, bycatch, through satellite imagery focusing on Pakistan's drift gillnet fleet as a case study.

166. The WPEB **NOTED** that the study is using image annotation, deep learning on satellite images, and port-based interviews to quantify and describe the Pakistani tuna drift gillnet fleet and bycatch further **NOTING** that low-cost image annotation methods and deep learning are powerful tools to collect information on a fleet where other monitoring and surveillance is lacking.

167. The WPEB **NOTED** that authors estimate that there are roughly 600 vessels in the gillnet fleet based on this analysis, which is likely an underestimate, with most vessels between 15 to 24 m LOA.

168. The WPEB **NOTED** that while work is ongoing, this paper serves as a baseline for future similar analyses in the Indian Ocean and other regions toward a better understanding of data-poor fisheries.

169. The WPEB **NOTED** that the spatial and temporal availability of images varies by satellite sensor and location, so it was not an option for daily monitoring of fishing activity.

170. The WPEB **NOTED** that while it may be possible to expand this approach to vessels landing on shore instead of into ports as very small vessels can be identified in this way, the Pakistani tuna gillnet fleet does not land on shore and so this has not been considered in much detail.

171. The WPEB **NOTED** that a pilot survey has been done and WWF Pakistan expects to complete 75 to 90 surveys before the end of 2023.

9.3 Seabirds

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

172. The WPEB **NOTED** paper IOTC-2023-WPEB19-29 on Updated ACAP Advice on Reducing the Bycatch of Albatrosses and Petrels in IOTC Pelagic Longline Fisheries, including the following abstract provided by the authors:

> *"The incidental mortality (bycatch) of seabirds in longline and trawl fisheries continues to be a serious global concern, especially for threatened albatrosses and petrels, resulting in a Conservation Crisis being declared by the Agreement on the Conservation of Albatrosses and Petrels (ACAP) in 2019. There are currently 31 species listed in Annex 1 of the Agreement. Of the 22 species of albatrosses, 17 breed or forage in the IOTC Area, as do four of the nine listed petrel species. ACAP routinely reviews and updates the best practice bycatch mitigation advice for industrial fishing gear types, including pelagic longline. The most recent review took place in May 2023, at the 11th meeting of the Seabird Bycatch Working Group (SBWG11), with updates endorsed by the 13th meeting of ACAP's Advisory Committee (AC13). This paper provides an update on this review and on other resources and information relevant to seabird bycatch in IOTC pelagic longline fisheries. AC13 reiterated and further endorsed current Best Practice Advice. 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: (1) branch line weighting, (2) night setting and (3) bird scaring lines. In addition, three hookshielding devices and one underwater bait setting device are options incorporated into ACAP's Best Practice Advice as stand-alone mitigation measures. Based on new Research reviewed at SBWG11, the use of high-energy laser technologies for seabird bycatch mitigation is strongly discouraged by ACAP, since there is currently no evidence of effectiveness, and serious concerns remain regarding the potential impacts on the health of individual birds. "*

173. The WPEB **NOTED** that IOTC Resolution 23/07 varies from ACAP seabird bycatch mitigation advice in a number of ways. ACAP recommends the use of night setting, bird scaring line and branch line weighting simultaneously instead of the use of two of the three measures. The WPEB further **NOTED** that Resolution 23-07 does not include the option for the use of underwater bait setting devices as a stand-alone measure and specifies branch line weighting options different to those currently recommended by ACAP.

9.4 Sea turtles

- Review new information on marine turtle biology, ecology, fisheries interactions and bycatch mitigation measures (all)
- Review of indicators for sea turtles (all);

174. The WPEB **NOTED** that sea turtle indicators were scheduled to be discussed during this meeting but due to a lack of presented information and limited presence of sea turtle experts in the meeting this was postponed until next year. The WPEB **NOTED** that the Chair and Secretariat will reach out to experts to assist with this next year.

175. The WPEB **NOTED** paper IOTC-2023-WPEB19-30_rev1 on Methods for mitigating sea turtle bycatch in longline fisheries: a meta-analysis, including the following abstract provided by the authors:

"Among the various species affected by bycatch, sea turtles are particularly vulnerable due to their low population numbers. Although many methods have been developed to mitigate sea turtle bycatch in longline fisheries, the extent to which these methods reduce the probability of sea turtle bycatch remains unclear. We performed a meta-analysis of 21 publications which included control experiments in longline fisheries comparing the use of mitigation methods to no mitigation methods for the same target species. The results indicate that the use of circle hooks, circle hooks with a wire appendage, fish bait, blue-white lights, and stingray-like bait can mitigate sea turtle bycatch (only circle hooks and fish bait were used in fishing operations). The remaining two types (blue-white lights and stingray-like bait) affected the catch of the target species and did not have the prospect of practical application. We also found that most mitigation measures did not significantly affect the catch of the target species, and some studies did not assess the catch of target species. Setting Hookpod-mini on branch lines and dyeing bait with colors are alternative mitigation methods. However, most of these methods are ineffective or inefficient in mitigating sea turtle bycatch or even unsuitable for applying to actual operations. Our study also identified two ways to mitigate turtle bycatch by affecting their senses (i.e., effective chemical deterrents and auditory systems), which may be promising research directions for the future."

176. The WPEB **NOTED** that 21 publications that used mitigation measures to reduce sea turtle by-catch in longline fisheries were reviewed by the authors and that the literature reviewed focused on sea turtle bycatch of four species: leatherback, loggerhead, green, and olive ridley.

177. The WPEB **NOTED** that multiple methods exist for sea turtle bycatch, including use of circle hooks, circle hooks with a wire appendage, fish bait, blue-white lights, and stingray-like bait (only circle hooks and fish bait were used in fishing operations). The WPEB **NOTED** that while most of the other mitigation measures were found to not significantly affect the catch of the target species, some studies did not assess the catch of target species.

178. The WPEB **NOTED** that setting hook shielding devices on branch lines and dyeing bait with col-ours are alternative mitigation methods but are often ineffective or inefficient in mitigating sea turtle bycatch or even unsuitable for applying to actual operations.

179. The WPEB **NOTED** that considering species-level efficacy when considering sea turtle mitigation measures is important.

180. The WPEB **NOTED** that loggerheads and green turtles can detect chemicals in bait, and thus rec-ommend looking at olfactory interventions as a primary means of bycatch reduction and further **NOTED** that while these measures look promising, multi-taxa considerations must be taken to by-catch mitigation.

181. The WPEB **THANKED** the authors for an extensive and thorough literature review.

10.WPEB Program of Work (Research and Priorities)

10.1 Revision of the WPEB Program of Work 2024-2028

182. The WPEB **NOTED** paper IOTC-2023-WPEB19-09: WPEB Program of Work 2023-2027 which provided the WPEB19 with the latest Program of Work (2023-2027) with an opportunity to consider and revise this for 2024-2028 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.

183. The WPEB **RECOMMENDED** that the SC consider and endorse the WPEB Program of Work (2024–2028), as provided in Appendix XVII.

10.2 Development of priorities for an Invited Expert at the next WPEB meeting

184. The WPEB **NOTED** that the invited expert for this year had expertise in data poor stock assessments which provided the group with a number of useful ideas for applying these methods to stocks assessed by the WPEB as well as opportunities to collaborate.

185. The WPEB **AGREED** to the following core areas of expertise and priority areas for contribution that need to be enhanced for the next meeting of the WPEB in 2024, by the Invited Expert:

- Gear modifications as mitigation measures;
- Mobulids;
- Data poor methods for assessments;
- Stock assessment expert for shortfin mako.

11.Other Matters

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

Chairperson

186. The WPEB **NOTED** that the first term of the current Chairperson, Dr Mariana Tolotti (EU, France) expired at the close of the WPEB19 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.

187. **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 Tolotti was nominated, seconded and re-elected as Chairperson of the WPEB for the next biennium.

Vice-Chairpersons

188. The WPEB **NOTED** that the first term of the current first Vice-Chairperson, Dr Mohammed Koya (India) expired at the close of the WPEB19 meeting and, as per the IOTC Rules of Procedure (2014), participants are required to elect a new Vice-Chairperson of the WPEB for the next biennium.

189. **NOTING** the Rules of Procedure (2014), the WPEB **CALLED** for nominations for the position of first Vice-Chairperson of the IOTC WPEB for the next biennium. Dr Koya was nominated, seconded and re-elected as first Vice-Chairperson of the WPEB for the next biennium.

190. The WPEB **NOTED** that the first term of the current second Vice-Chairperson, Dr Charlene da Silva (South Africa) expired at the close of the WPEB19 meeting and, as per the IOTC Rules of Procedure (2014), participants are required to elect a new Vice-Chairperson of the WPEB for the next biennium.

191. **NOTING** the Rules of Procedure (2014), the WPEB **CALLED** for nominations for the position of second Vice-Chairperson of the IOTC WPEB for the next biennium. Dr da Silva was nominated, seconded and re-elected as second Vice-Chairperson of the WPEB for the next biennium.

11.2 Date and place of the 20th and 21st Working Party on Ecosystems and Bycatch

192. The WPEB **NOTED** the intention to continue to hold the WPEB back to back with the WPB in early to mid-September. The WPEB **NOTED** the intention of the WPB to hold a workshop prior to the full WPB meeting so **REQUESTED** that the WPEB again be held after the WPB meeting.

193. The WPEB **REQUESTED** CPCs that may be interested in hosting the 20th and 21st Working Party on Ecosystems and Bycatch to contact the Secretariat.

194. The WPEB **NOTED** the customary data preparatory meeting which is usually held in the first half of the year. The WPEB **NOTED** that as there is likely to be little new to discuss with relation to data preparation for a stock assessment for shortfin mako shark, the group instead **AGREED** to use this scheduled meeting to cover aspects of the agenda that required more time and/or expertise including: reviewing mitigation measures for sharks and other taxa and various gear types; reviewing indicators for mobulids; and developing management advice for cetaceans.

11.3 Review of the draft, and adoption of the Report of the 19th Session of the WPEB

195. The WPEB **RECOMMENDED** that the Scientific Committee consider the consolidated set of recommendations arising from WPEB19, 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

196. The report of the 19th Session of the Working Party on Ecosystems and Bycatch (IOTC–2023–WPEB19–R) was **ADOPTED** by correspondence.

Appendix I
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APPENDIX II
AGENDA FOR THE 19TH WORKING PARTY ON ECOSYSTEMS AND BYCATCH ASSESSMENT MEETING

Date: 11-15 September 2023

Location: La Réunion, France

Venue: Hotel le Récif, La Saline-les-Bains

Time: 09:00 – 17:00 (Réunion time, GMT+4)

Chair: Dr Mariana Tolotti (EU, France)

Vice-Chairs: Mr Mohammed Koya (India) and Dr Charlene da Silva (South Africa)

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** (IOTC Secretariat)

   3.1. Outcomes of the 25th Session of the Scientific Committee (IOTC Secretariat)
   3.2. Outcomes of the 27th Session of the Commission (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 WPEB18 (IOTC Secretariat)

4. **REVIEW OF THE DATA AVAILABLE AT THE SECRETARIAT FOR BYCATCH SPECIES AND BYCATCH DATA ESTIMATION APPROACHES** (All)

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. Updated status of national fisheries and bycatch (CPCs)

6. **REVIEW INFORMATION ON BIOLOGY, ECOLOGY, FISHERIES AND ENVIRONMENTAL DATA RELATING TO SHARKS** (all)

   6.1. Presentation of new information available on sharks (all)
   6.2. Development of shark research work plan for scalloped hammerhead shark (all)

7. **STOCK ASSESSMENT AND INDICATORS FOR SHARKS** (all)

   7.1. Review of indicators(all) for:
      - Silky shark
      - Porbeagle shark
      - Other species

   7.2. Stock assessment models (all)
   7.3. Recommendations and executive summaries (all)

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

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)

- Ecosystems and climate
- Impact of gears
- Mitigation devices/techniques

8.2. Development of climate change work plan (all)

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

9.1. All bycatch species (all)
9.2. Other sharks and rays (all)
9.3. Mobulids (all)
9.4. Marine mammals (all)

- Review new information on marine mammal biology, ecology, fisheries interactions and bycatch mitigation measures (all);
- Best practice guidelines for safe release and handling of cetaceans (all);
- Development of management advice on the status of marine mammal species (all)

9.5. Seabirds (all)

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

9.6. Sea turtles

- Review new information on marine turtle biology, ecology, fisheries interactions and bycatch mitigation measures (all)
- Review of indicators for sea turtles (all);

10. WPEB PROGRAM OF WORK (RESEARCH AND PRIORITIES) (all)

10.1. Revision of the WPEB Program of Work 2024-2028 (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 (all)
11.2. Date and place of the 20th and 21st Working Party on Ecosystems and Bycatch (Chair)
11.3. Review of the draft, and adoption of the Report of the 19th Session of the Working Party on Ecosystems and Bycatch (Chairperson)

APPENDIX III
LIST OF DOCUMENTS

Document	Title
IOTC-2023-WPEB19-01a	Agenda of the 19th Working Party on Ecosystems and Bycatch
IOTC-2023-WPEB19-01b	Annotated agenda of the 19th Working Party on Ecosystems and Bycatch Assessment Meeting
IOTC-2023-WPEB19-02	List of documents of the 19th Working Party on Ecosystems and Bycatch Assessment Meeting
IOTC-2023-WPEB19-03	Outcomes of the 25th Session of the Scientific Committee (IOTC Secretariat)
IOTC-2023-WPEB19-04	Outcomes of the 27th Session of the Commission (IOTC Secretariat)
IOTC-2023-WPEB19-05	Review of Conservation and Management Measures relevant to ecosystems and bycatch (IOTC Secretariat)
IOTC-2023-WPEB19-06	Progress made on the recommendations and requests of WPEB18 and SC25 (IOTC Secretariat)
IOTC-2023-WPEB19-07_rev2	Review of the statistical data and fishery trends for ecosystems and bycatch species (IOTC Secretariat)
IOTC-2023-WPEB19-08_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-2023-WPEB19-09	Revision of the WPEB Program of Work (2024–2028) (IOTC Secretariat & Chairperson)
IOTC-2023-WPEB19-10	Research prioritisation to manage sharks and rays in South African Fisheries (C. da Silva, S. Lamberth and S. Kerwath)
IOTC-2023-WPEB19-11	Gillnet tuna fisheries in the Coastal waters of India: Intensity and spatial spread of the fisheries with implications of non-target and sensitive species interactions (M. Koya, A. Azeez, E.M. Abdussamad, P. Rohit and K. Shoba Joe)
IOTC-2023-WPEB19-12	An overview on large pelagic species and Estimation of By-catch by Iranian fishing vessels (Gillnets) In IOTC competence of area in 2021 (M. D. Siyahaki)
IOTC-2023-WPEB19-13	Ecosystem and bycatch in Somalia 2023 (M. M. Adawe, S. Abdulahi Nor)
IOTC-2023-WPEB19-14	Vulnerability assessment of elasmobranch species to fisheries in coastal Kenya: implications for conservation and management policies (B. Kiilu, B. Kaunda-Arara, G. Okemwa, R. Oddenyo, E. Mueni, P. Musembi, B. Fulanda, M. Okeri, L. Menya, G. Nduku, J. Musembei, M. Omar, E. Kimani)

Document	Title
IOTC-2023-WPEB19-16_rev1	Fins Naturally Attached the globally acknowledged best practice to prevent finning (I. Ziegler)
IOTC-2023-WPEB19-17_rev1	Undetected silky sharks (*Carcharhinus falciformis*) in the wells of the tropical tuna Spanish purses–seine fleet from the Indian Ocean (A. Perez San Juan, M. L. Ramos Alonso, J. C. Baez and V. Sierra)
IOTC-2023-WPEB19-18	Post-release mortality of oceanic whitetip sharks caught by purse seiners in the Indian Ocean: POREMO project (P. S. Sabarros, E. V. Romanov, E. Mollier, M. Tolotti, P. Bach)
IOTC-2023-WPEB19-19	An update on the recent development of IOTC BTH PRM Project and considerations for further actions (E. Romanov)
IOTC-2023-WPEB19-20	Historical standardized CPUEs of seven shark species in the Indian Ocean with preliminary catch estimation (E. Gee, E. V. Romanov, D. Curnick, B. Block and F. Ferretti)
IOTC-2023-WPEB19-21	Developing an Abundance Index of Blue Shark From a Handline Fishery in Southern Java Waters Part of Eastern Indian Ocean (D. Novianto, B. Setyadji, L. Sadiyah, F.Satriya, U.Chodrijah, Agustinus A. Widodo, Wudianto, A. F. Nugroho)
IOTC-2023-WPEB19-22	SMARTSNAP: A new device to aid in the reduction of bycatch in longline fisheries (A.E. Nieblas, T. Rouyer, S. Bonhommeau, S. Benard, J. Chanut, A. Boyer, O. Derridj, B. Brisset, H. Evano, V. Kerzerho)
IOTC-2023-WPEB19-23_rev1	A review of the effectiveness of gear modifications to reduce shark bycatch mortality in longlining (I. Ziegler)
IOTC-2023-WPEB19-24	Ecological risk assessment of cetaceans to Indian Ocean tuna fisheries (J. Kiszka)
IOTC-2023-WPEB19-25	International Whaling Commission activities relevant to the assessment of cetacean bycatch in the Indian Ocean (C. Passadore)
IOTC-2023-WPEB19-27	Unilateral and multilateral approaches to cetacean bycatch management: risk and potential under the U.S. Marine Mammal Import Provisions Rule for IOTC Members (B. Elliott)
IOTC-2023-WPEB19-28	Drift gillnet vessels from space: leveraging low-cost methodologies for enhanced understanding of a data-poor fishery (B. Elliott)
IOTC-2023-WPEB19-29	Updated ACAP Advice on Reducing the Bycatch of Albatrosses and Petrels in IOTC Pelagic Longline Fisheries (S. Jiménez)
IOTC-2023-WPEB19-30_rev1	Methods for mitigating sea turtle bycatch in longline fisheries: a meta-analysis (H. Yan)
IOTC-2023-WPEB19-31	Turtles, TEDs, tunas, dolphins, and diffusion of innovations: key drivers of adoption of bycatch reduction devices (L. D. Jenkins)

Document	Title
IOTC-2023-WPEB19-32	Assessment of the shark stock complex in the Bering Sea/Aleutian Islands and Gulf of Alaska (C. A. Tribuzio, M. A. Matta, K. B. Enchave, C. Rodgveller, G. Dunne and K. Fuller)
IOTC-2023-WPEB19-33	Estimating trends and magnitudes of bycatch in the tuna fisheries of the Western and Central Pacific Ocean (T. Peatman, V. Allain, L. Bell, B. Muller, A. Panizza, N. B. Phillip, G. Pilling and S. Nicol)
IOTC-2023-WPEB19-34_rev1	Silky shark abundance index based on CPUE standardisation of French Indian Ocean tropical tuna purse seine observer bycatch data (D. Kaplan and M. Tolotti)
IOTC-2023-WPEB19-35	Catch composition and some biological aspects of silky sharks (*Carcharhinus falciformis*) landed by surrounding net fishery in Sri Lanka (D. G. Balawardhana, H. L. Herath and S. S. Haputhantri)
Information papers	
IOTC-2023-WPEB19-INF01	
IOTC-2023-WPEB19-INF02	Note on incidents of oceanic manta ray (*Mobula birostris*) fishing gear entanglements from the Maldives (S. Hilbourne and G. Stevens)
IOTC-2023-WPEB19-INF03	Bycatch in Drift Gillnet Fisheries: a sink for Indian Ocean cetaceans (B. Elliott)
IOTC-2023-WPEB19-INF04	Diet composition of silky shark in the Arabian Sea, offshore waters of Pakistan (H. B. Osmany, H. Imran and K. Zohra)
IOTC-2023-WPEB19-INF05	Spatio-temporal distribution of juvenile oceanic whitetip shark incidental catch in the western Indian Ocean (L. Lopetegui-Eguren, J. J. Poos, H. Arrizabalaga, G. L. Guirhem, H. Murua, N. Lezama-Ochoa, S. P. Griffiths, J. R. Gondra, P. S. Sabarros, J. C. Baez and M. J. Juan-Jorda)
IOTC-2023-WPEB19-INF06	Identifying the drivers of silky shark distribution and an evaluation of protective measures (S. Murray, J. J. Meeuwig, C. D. H. Thompson and D. Mouillot)
IOTC-2023-WPEB19-INF07	Biological aspects, exploitation rates, and spawning potential ratio of scalloped hammerhead shark (Sphyrna lewini Griffith & Smith, 1834) in Lampung Bay waters, Indonesia (B. Nugraga, A. S. Samusamu, R. Puspasari, D. Oktaviani, R. Rachmawati, P. F. Rachmawati, P. S. Sulaeman, S. T. Hartati and N. N. Wiadnyana)
IOTC-2023-WPEB19-INF08	Global hotspots of shark interactions with industrial longline fisheries (E. S. Burns, D. Bradley and L. R. Thomas)
IOTC-2023-WPEB19-INF09	Phylogeny explains capture mortality of sharks and rays in pelagic longline fisheries: a global meta-analytic synthesis (E. Gilman, M. Chaloupka, L. R. Benaka, H. Bowley, M. Fitchett, M. Kaiser and M. Musyl)

Document	Title
IOTC-2023-WPEB19-INF10	Beyond Post-release Mortality: Inferences on Recovery Periods and Natural Mortality From Electronic Tagging Data for Discarded Lamnid Sharks (H. D. Bowlby, H. P. Benoit, W. Joyce, J. Sulikowski, R. Coelho, A. Domingo, E. Cortes, F. Hazin, D. Macias, G. Biais, C. Santos and B. Anderson)
IOTC-2023-WPEB19-INF11	Preliminary recovery plan for scalloped hammerhead in the Indian Ocean (C. Rigby)
IOTC-2023-WPEB19-INF12	Implementing Ecosystem Approach to Fisheries Management in the Western and Central Pacific Fisheries Commission: Challenges and Prospects (H. Shen and L. Song)
IOTC-2023-WPEB19-INF13	Technical mitigation techniques to reduce bycatch of sharks: there is no silver bullet (D. Drynan and G. B. Baker)
IOTC-2023-WPEB19-INF14	Efficacy of a novel shark bycatch mitigation device in a tuna longline fishery (P. D. Doherty, R. Enever, L. C. M. Omeyer, L. Tivenan, G. Course, G. Pasco, D. Thomas, B. Sullivan, B. Kibel, P. Kibel, B. J. Godley)
IOTC-2023-WPEB19-INF15	New technologies to improve bycatch mitigation in industrial tuna fisheries (F. Poisson, P. Budan, S. Coudray, E. Gilman, T. Kojima, M. Musyl and T. Takagi)
IOTC-2023-WPEB19-INF16	A comparison of catch efficiency and bycatch reduction of tuna pole-and-line fisheries using Japan tuna hook (JT-hook) and circle-shaped hook (C-hook) (K. Q. Nguyen, B. V. Nguyen, H. T. Phan, L. T. Nguyen, P. V. To and H. V. Tran)
IOTC-2023-WPEB19-INF17	A systematic review of sensory deterrents for bycatch mitigation of marine megafauna (S. Lucas and P. Berggren)
IOTC-2023-WPEB19-INF18	Bycatch mitigation of protected and threatened species in tuna purse seine and longline fisheries (Y. Swimmer, E. A. Zollett, A. Gutierrez)
IOTC-2023-WPEB19-INF19	Multifaceted effects of bycatch mitigation measures on target/non-target species for pelagic longline fisheries and consideration for bycatch management (D. Ochi, K. Okamoto and S. Ueno)
IOTC-2023-WPEB19-INF20	A decision support tool for integrated fisheries bycatch management (E. Gilman, M. Hall, H. Booth, T. Gupta, M. Chaloupka, H. Fennell, M. J. Kaiser, D. Karnad, E. J. Milner-Gulland)
IOTC-2023-WPEB19-INF21	Bycatch-neutral fisheries through a sequential mitigation hierarchy (E. Gilman, M. Chaloupka, H. Booth, M. Hall, H. Murua and J. Wilson)
IOTC-2023-WPEB19-INF22	Spatially explicit risk assessment of marine megafauna vulnerability to Indian Ocean tuna fisheries (L. Roberson, C. Wilcox, G. Boussarie, E. Dugan, C. Garilao, K. Gonzalez, M. Green, S. Kark, K. Kaschner, C. J. Klein, Y. Rousseau, D. Vallentyne, J. E. M. Watson and J. J. Kiszka)
IOTC-2023-WPEB19-INF23	Regional variation in anthropogenic threats to Indian Ocean whale sharks (S. D. Reynolds, B. M. Norman, C. E. Franklin, S. S. Bach, F. G. Comezzi, S. Diamant, M. Y. Jaidah, S. J. Pierce, A. J. Richardson, D. P. Robinson, C. A. Rohner and R. G. Dwyer)

Document	Title
IOTC-2023-WPEB19-INF24	Policy and transparency gaps for oceanic shark and rays in high seas tuna fisheries (M. R. Cronin, J. E. Amaral, A. M. Jackson, J. Jacquet, K. L. Seto and D. A. Croll)
IOTC-2023-WPEB19-INF25	High bycatch rates of manta and devil rays in the "small-scale" artisanal fisheries of Sri Lanka (D. Fernando and J. D. Stewart)
IOTC-2023-WPEB19-INF26	Comparative population genomics of manta rays has global implications for management (E. Humble, J. Hosegood, G. Carvalho, M. de Bruyn, S. Creer, G. M. W. Stevens, A. Armstrong, R. Bonfil, M. Deakos, D. Fernando, N. Froman, L. R. Peel, S. Pollett, A. Ponzo, J. D. Stewart, S. Wintner and R. Ogden)
IOTC-2023-WPEB19-INF27	Assessing the effectiveness of LED lights for the reduction of sea turtle bycatch in an artisanal gillnet fishery – a case study from the north coast of Kenya (T. Kakai)
IOTC-2023-WPEB19-INF28	Reducing sea turtle bycatch with net illumination in an Indonesian small-scale coastal gillnet fishery (D. A. Gautama, H. Susanto, M. Riyanto, R. I. Wahju, M. Osmond and J. H. Wang)
IOTC-2023-WPEB19-INF29	Loggerhead turtle oceanic-neritic habitat shift reveals key foraging areas in the Western Indian Ocean (J. R. Monsinjon, A. Laforge, P. Gaspar, A. Barat, O. Bousquet, S. Ciccione, C. Jean, K. Ballorain, M. Dalleau, R. Coelho, S. Bonhommeau and J. Bourjea)
IOTC-2023-WPEB19-INF30	Calculating acceptable biological catch for stocks that have reliable catch data only (J. Berkson, L. Barbieri, S. Cadrin, S. Cass-Calay, P. Crone, M. Dorn, C. Friess, D. Kobayashi, T. J. Miller, W. S. Patrick, S. Pautzke, S. Ralston and M. Trianni)
IOTC-2023-WPEB19-INF31	The refined ORCS approach: A catch-based method for estimating stock status and catch limits for data-poor fish stocks (C. M. Free, O. P. Jensen, J. Wiedenmann and J. J. Deroba)
IOTC-2023-WPEB19-INF32	Scientific and Statistical committee draft report to the North Pacific fishery management council (S. Dressel, F. Mueter, A. Whitman, C. Anderson, A. Bishop, C. Cunningham, M. Downs, R. Foy, J. Gasper, D. Hanselman, B. Harris, G. Hunt, K. Kroetz, K. Meyer, A. Munro, C. Siddon, I. Stewart and P. Sullivan)
IOTC-2023-WPEB19-INF33	Meeting of the Gulf of Alaska Groundfish plan team (J. Ianelli, C. Lunsford, S. Cleaver, O. Davis, C. Faunce, L. Hillier, P. Hulson, S. Lowe, N. Nichols, C. O'Leary, A. Olson, J. Rumble, P. Spencer, M. Szymkowiak, B. Williams and K. Williams)
IOTC-2023-WPEB19-INF34	Meeting of the Bering Sea and Aleutian Islands Groundfish plan team (S. Barbeaux, K. Shotwell, C. Tribuzio, D. Stram, C. A. Akselrud, M. Furuness, A. Hicks, L. Hillier, K. Holsman, P. Joy, A. Kingham, B. Matta, A. Seitz, M. Smith and J. Sullivan)
IOTC-2023-WPEB19-INF35	Joint Groundfish plan teams minutes (S. Barbeaux, K. Shotwell, C. Tribuzio, D. Stram, C. A. Akselrud, M. Furuness, A. Hicks, L. Hillier, K. Holsman, P. Joy, A. Kingham, B. Matta, A. Seitz, M. Smith, J. Sullivan, J. Ianelli, C. Lunsford, S. Cleaver, K. Blackhart, O. Davis, C. Faunce, P. Hulson, S. Lowe, N. Nichols, A. Olson, J. Rumble, P. Spencer, M. Szymkowiak)

Document	Title
IOTC-2023-WPEB19-INF36	Analysis of the Marine Stewardship Council's policy on shark finning and the opportunity for adoption of a 'Fins naturally attached' policy in the MSC fisheries standards review (I. Ziegler, A. Hammond, S. Millward, K. Woodroffe, C. Vail, L. Guida, A. Hofford, R. Arauz)
IOTC-2023-WPEB19-INF37	Global prevalence of setting longlines at dawn highlights bycatch risk for threatened albatross (D. Kroodsma, J. Turner, C. Luck, T. Hochberg, N. Miller, P. Augustyn, S. Prince)
IOTC-2023-WPEB19-INF38	Global governance guard rails for sharks: Progress towards implementing the United Nations international plan of action (E. Gilman, M. Chaloupka, N. Taylor, L. Nelson, K. Friedman and H. Murua)
IOTC-2023-WPEB19-INF39	CCSBT Multi-year seabird strategy and its action plan - towards establishment of global risk assessment framework of seabird bycatch by tuna longliners
IOTC-2023-WPEB19-INF40	A review of mobulid ray interactions with fisheries for tuna and tuna-like species in the Indian Ocean
IOTC-2023-WPEB19-INF41	Is the demand for fins driving the high capture of sharks, or are there more significantly valuable commodities? (G. Moreno)

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

Extract from IOTC–2023–WPEB19–07.
(Appendix references in this Appendix, refer only to those contained in this appendix)

Overall bycatch levels & trends

Retained 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 between the 1980s and the mid-2000s, followed by a sudden decrease due to piracy threats and by a new sharp increase in more recent years (**Figure A 1**). In 2021, the total retained catches of all IOTC and non-IOTC species (bycatch, including also species other than sharks and rays) were around 1,903,000 t and 299,000 t, respectively.

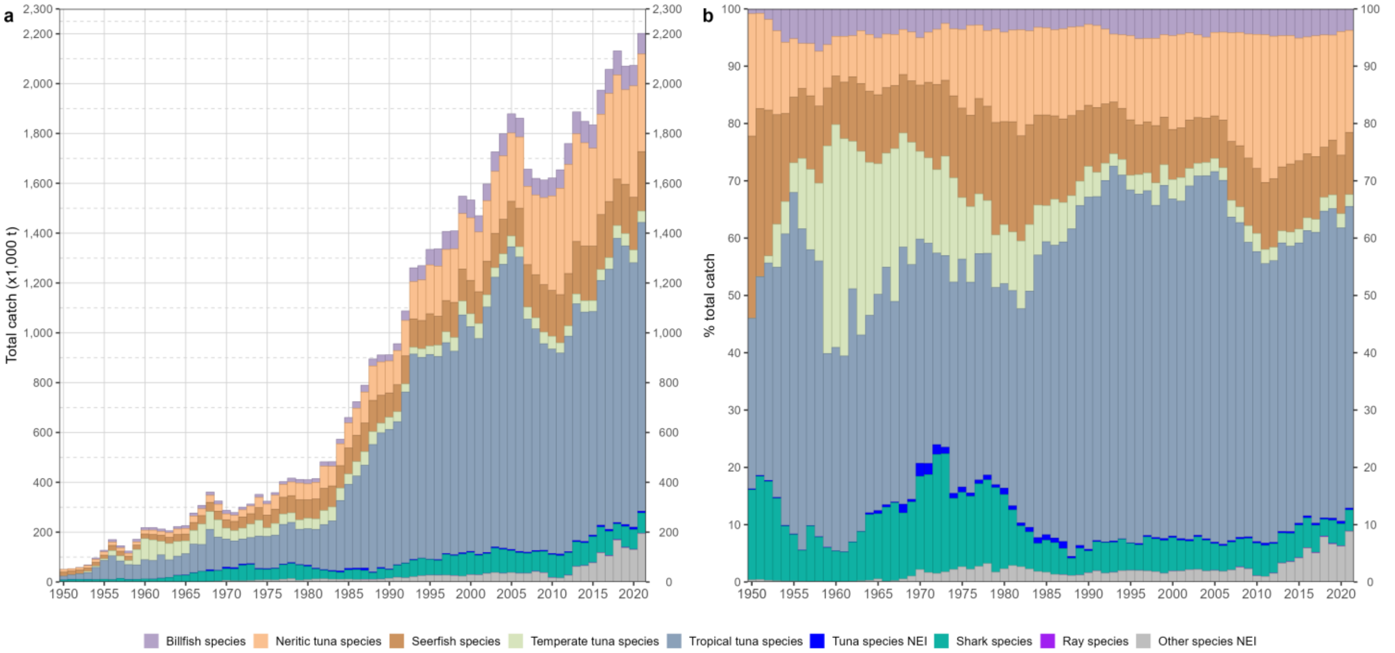

Figure A 1: Annual time series of cumulative nominal absolute (a) and relative (b) catches (metric tons; t) of all IOTC tuna and tuna-like species by species category for the period 1950-2021

Reported nominal catches of species of interest to the WPEB are largely dominated by sharks with estimates from some artisanal fisheries dating back to the early 1950s (**Figure A 2**). Overall levels and quality of reported catches of shark and ray species have increased over time due 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 2021, the total retained catches of sharks reported to the Secretariat amounted to 81,286 t, with rays representing a very small component of the reported bycatch at 860 t, i.e., about 1% of total reported shark and ray catches for the same year (**Figure A 2**).

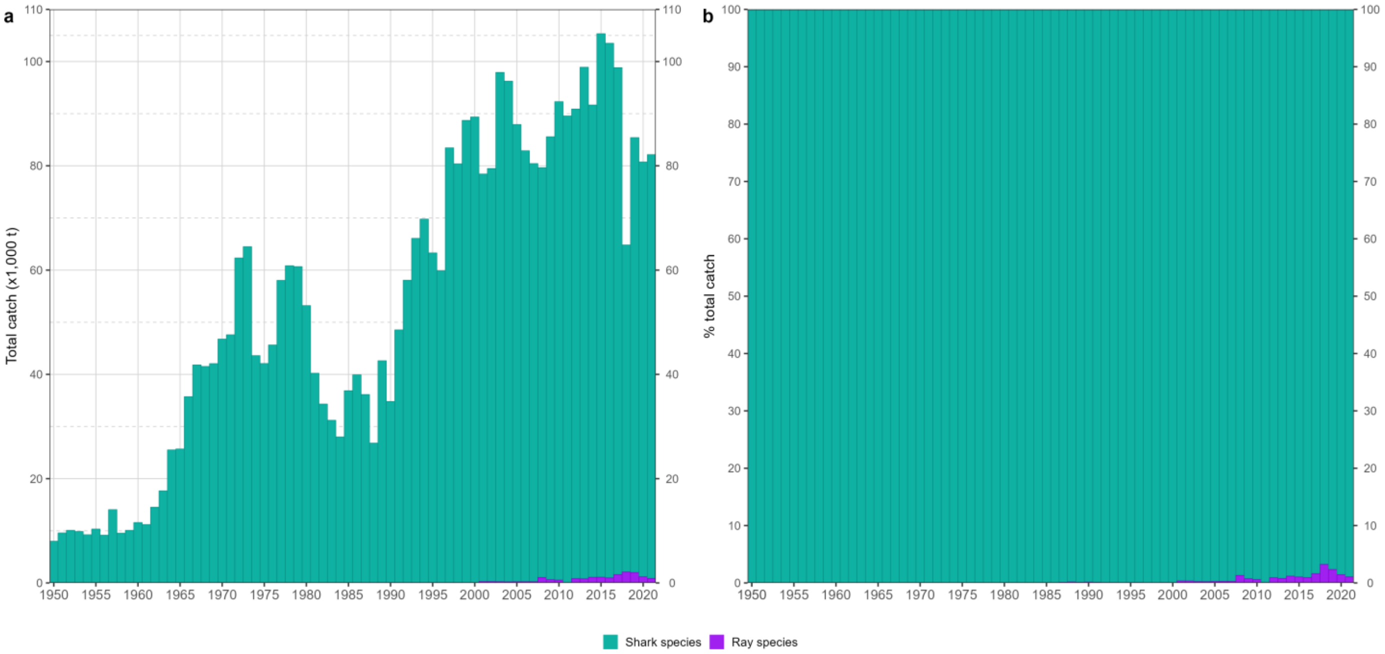

Figure A 2: Annual time series of cumulative nominal absolute (a) and relative (b) catches (metric tons; t) of shark and ray species by species category for the period 1950-2021

Very few fleets reported catches of sharks and rays in the 1950s, but the number of reporting fleets has increased over time (**Figure A 3**). Total reported catches of sharks and rays have also increased over time, reaching a peak of over 100,000 t in 2015-2016. Since then, nominal catches have decreased by 20% to about 80,000 t in 2021.

In 2018, reported catches of sharks and rays declined significantly when compared with 2017 and 2019 levels, mostly due to a complete disappearance of catches of aggregated shark species previously reported by India (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 true reduction in catch levels. Furthermore, 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 of shark species during the concerned period when compared to previously available official data reported by the country.

In 2021, 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.

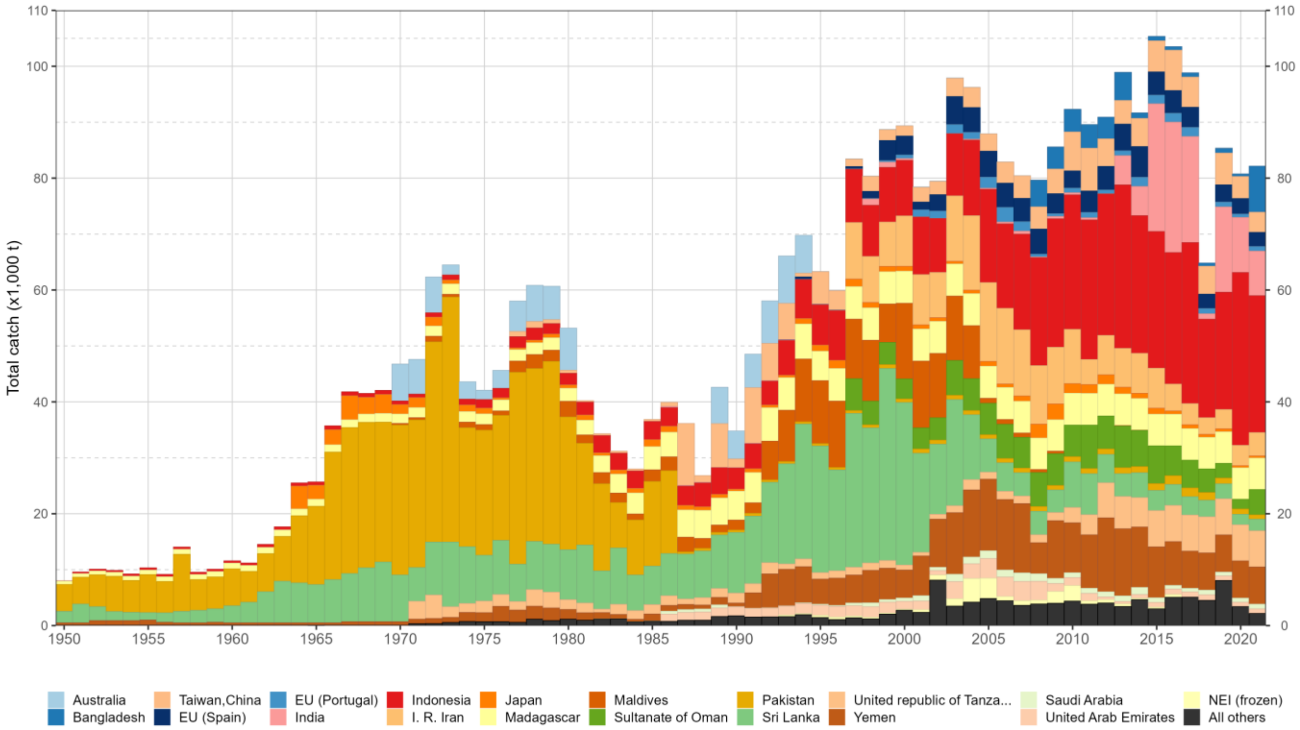

Figure A 3: Annual time series of nominal catches (metric tons; t) of sharks and rays by fleet during 1950-2021

Sharks and rays

Levels of reported retained catches for sharks and rays strongly vary with fishing gear and over time but are generally increasing. Gillnets (not further classified) have historically been associated with the highest catch levels and are currently responsible for around 40% of all retained catches reported for the species, while lines (handlines, coastal longlines and trolling lines), which doubled the catches in the last two decades, currently contribute for around 43.6% of the total retained catches. Historically, longline fisheries contributed substantially to shark and ray catches from 1990 onwards and in recent years they rank as the third most relevant group of gears in terms of total retained catch levels reported for the species (**Figure A 4**).

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 (**Figure A 4**).

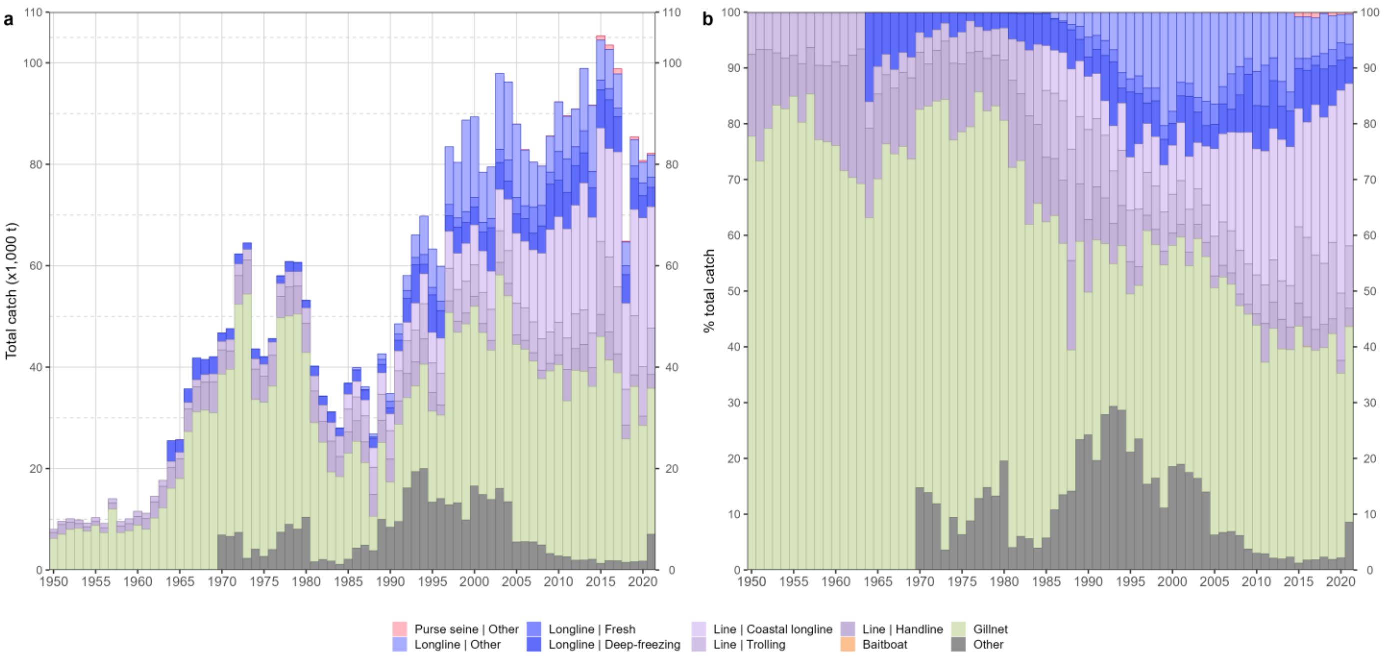

Figure A 4: Annual time series of nominal absolute (a) and relative (b) catches (metric tons; t) of sharks and rays by fishery for the period 1950-2021. 'Other' corresponds to all other fisheries combined

Overall, while industrial longliners and drifting gillnetters are known for harvesting important amounts of pelagic sharks, the industrial purse seiners, pole-and-liners and vessels operating in coastal waters contribute less to the total retained catches reported for shark and rays species.

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–2023-WPEB1–07

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 and with comparable fishing patterns report high catch rates of bycatch species.

Some fleets have also been noted to report 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 and UK prior to BREXIT), 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 purse seine 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 (1950-2021)). Misidentification 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 now a smaller proportion of the total.

Catch and effort data

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

The main issues with shark data affecting the information sets available to the IOTC Secretariat 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 catches with species-specific shark data have been provided from 1987 onward (although reports of catches for "various sharks NEI" are still present). Catch levels of shark species decrease dramatically with the revised time series (to levels which are practically negligible compared to years prior to 1987). Furthermore, spatially disaggregated catch-and-effort data have never been provided, if not for a very limited number of years (1987-1991);
  - **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 as they do not include data for distinct shark species for the years in which these are instead available as nominal catches (2012-2021);
  - **Gillnet fisheries of Oman**: data not reported to IOTC standards, as nominal catches of distinct shark species are only available for a limited period of the recent time-series (2014-2021) for which no spatially disaggregated catch-and-effort data have been provided.
- **Longline fisheries**
  - **Historical catches of sharks from major longline fisheries (Taiwan,China, Indonesia, and Rep. of Korea)**: for years before 2006 data are either unavailable or not reported according to IOTC standards;
  - **Fresh-tuna longline fisheries (Malaysia, Indonesia)**: data not provided or not reported to IOTC standards. Indonesia started reporting catch and effort data since 2018 but the level of coverage is very low, with minor reported blue shark catches;
  - **Deep-freezing longline fisheries (EU,Spain, India, Indonesia, and Oman)**: data not provided or not reported according to IOTC standards for the periods during which these fisheries were known to be active.
- **Coastal fisheries**
  - **Coastal fisheries of Yemen**: data not provided;
  - **Coastal fisheries of India and 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**: data provided since 2018 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

2023: 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 2022*)

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 has drafted a NPOA for shark and rays which is now in the process of being finalised and approved by the relevant ministries. 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 and includes provisions for the protection of seabirds. Bangladesh does not have any flagged purse seine or longline vessels so do not consider there to be any problems with seabird interactions in their fisheries. **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. A Marine Fisheries Rules act was finalised in 2023 which requires the use of turtle excluder devices onboard shrimp trawlers. The act also requires live release of marine turtles for all gear and the mandatory use of circle hooks for hook and line fishing.
China		–		–			**Sharks:** China is currently considering developing an NPOA for sharks. Regulations relating to the conservation of sharks managed by RFMOs has been updated. **Seabirds:** China is currently considering developing an NPOA for seabirds. Regulations relating to the conservation of seabirds managed by RFMOs has been updated. **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*, *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)		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 for the period2015-2020. This is still being applied and currently is under evaluation in view of its renewal.
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 first drafted a NPOA in 2010 then later developed a revised NPOA for sharks and rays for the period 2016-2020. Indonesia is in the process of revising the latest version of the shark NPOA. Indonesia has also established a national plan of action for whale sharks from 2021-2025 through Ministerial Decree No. 16 of 2021. **Seabirds:** An NPOA was finalized in 2016 **Marine turtles:** Indonesia established an NPOA for Marine Turtles in 2022. Indonesia has also been implementing Ministerial Regulations 12/2012 and 30/2012 regarding capture fishing business on high seas to reduce turtle bycatch. Indonesia is also cooperating with Coral Triangle countries including Malaysia, the Philippines, the Solomon Islands, Papua New Guinea, and Timor Leste through Coral Triangle Initiatives on Coral Reefs, Fish, and Food Security (CTI CFF) platform to protect threatened migratory species, including marine turtles. The CTI CFF is now developing a regional plan of action (RPOA) 2020-2030 and areas of critical habitats, such as migratory corridors, nesting beaches, and Inter-nesting and feeding areas, have been identified.
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 has been finalised and is awaiting cabinet approval. This document shall put in place a framework to ensure the conservation and management of sharks and their long-term sustainable use in Kenya. **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 has started to prepare a NPOA for seabirds in 2023. **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 has started to prepare a NPOA for turtles in 2023.
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:** Madagascar has developed a NPOA for sharks which is awaiting final ministerial approval. **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. The final NPOA was published in 2015. 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 25^0S. However, fishing companies have been requested to implement all mitigation measures as provided in the IOTC Resolutions. **Marine turtles:** Marine turtles are protected by the national law. Fishing companies have been **requested** to carry line cutters and de-hookers in order to facilitate the appropriate handling and prompt release of marine turtles caught or entangled.
Mozambique		–		–			**Sharks**: Drafting of the NPOA-Shark started in 2016. At this stage, a baseline assessment was performed and the relevant information of coastal, pelagic and demersal shark species along the Mozambican coast was gathered. **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:** The drafting of an NPOA-sharks started in 2017 but has not yet been finalised. **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 in 2016 to review the actions of the draft NPOA – Sharks. The final version of the NPOA – Sharks has been submitted to the provincial fisheries departments for endorsement but has not yet been finalised. 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 I 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:** A NPOA sharks was published in 2009 and this document is under periodic review. **Seabirds:** Development has not begun. **Marine turtles:** No information received by the Secretariat.
Seychelles, Republic of		Apr-2007 2016		–			**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		2013 2022		2008			**Sharks**: The NPOA-sharks was first approved and published in 2013. A revised version of the document was finalised in 2022 following extensive review including input from the research community and affected stakeholders. **Seabirds**: The NPOA seabirds was published in August 2008 and fully implemented. The NPOA is in the process being updated in 2022. **Marine turtles**: A report from 2019 on the implementation of FAO guidelines to reduce marine turtle mortality has been provided to the IOTC. Bycatch in South African fisheries is considered to be very low. 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		2013 2018					**Sharks:** The first NPOA-sharks was finalized in 2013 then revised in 2018 which was valid until 2022. This version is in the process of being reviewed. Shark data collection is done through logbooks and a large pelagic data collection programme. NARA has started to collect fisheries and biological data on blue, silky and scalloped hammerhead sharks. **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:** A NPOA has been drafted but not finalised. **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:** The NPOA – Seabirds for Thailand has been completed and is now awaiting approval from relevant Committees. Thailand has the Notification of the Department of Fisheries on Requirement and Regulations of Fishing Vessels Operating Outside Thai Water in IOTC Area of Competence (IOTC) B.E. 2565 (2022), Clause 18 and 21 include requirements for line-cutters and dehookers to be carried for releasing marine animals and for any fishing vessel operating south of 25ºS 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.

Colour key	
Completed	
Drafting being finalised	
Drafting commenced	
Not begun	

APPENDIX VII
EXECUTIVE SUMMARY: BLUE SHARK (2023)

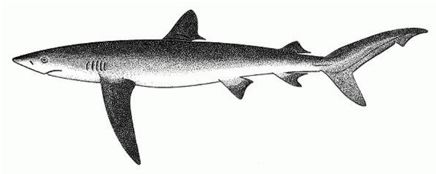

Table A 1. Status of blue shark (*Prionace glauca*) in the Indian Ocean

Area	Indicators		2021 stock status determination
Indian Ocean	Reported catch 2021 (t)	24,487	99.9%
	Estimated catch 2019 (t)[4]	43,240	
	Not elsewhere included (nei) sharks[1] 2021 (t)	35,603	
	Average reported catch 2017-21 (t)	26,616	
	Average estimated catch 2015-19 (t)[4]	48,781	
	Avg. not elsewhere included (nei) sharks[1] 2017-21 (t)	33,342	
	MSY (1,000 t) (80% CI)[2]	36.0 (33–5 - 38.6)	
	F_{MSY} (80% CI)[2]	0.31 (0.3–6 - 0.31)	
	SB_{MSY} (1,000 t) (80% CI)[2,3]	42.0 (38–9 - 45.1)	
	F_{2019}/F_{MSY} (80% CI)[2]	0.64 (0.–3 - 0.75)	
	SB_{2019}/SB_{MSY} (80% CI)[2]	1.39 (1.–7 - 1.49)	
	SB_{2019}/SB_0 (80% CI)[2]	0.46 (0.–2 - 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}≥ 1)
Stock subject to overfishing(F_{2019}/F_{MSY}> 1)	0%	0.1%
Stock not subject to overfishing (F_{2019}/F_{MSY}≤ 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. No new stock assessment was carried out for blue sharks in 2022 and so the results are based on the assessment carried out in 2021 using an integrated age-structured model (SS3) (**Fig. A** 1) (using data up to 2019). 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** 1). A base case model was selected based on the best Indian Ocean biological data, consistency of CPUE standardized relative abundance series, model fits and spatial extent of the data (**Fig. A** 1, **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. 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. The 2021 assessment indicates that Indian Ocean blue shark are not overfished nor subject to overfishing (**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** (2018–22): longline (deep-freezing); longline targeting swordfish; longline (fresh).
- **Main fleets** (2018–22): Taiwan,China; EU-Portugal; Seychelles; Sri Lanka.

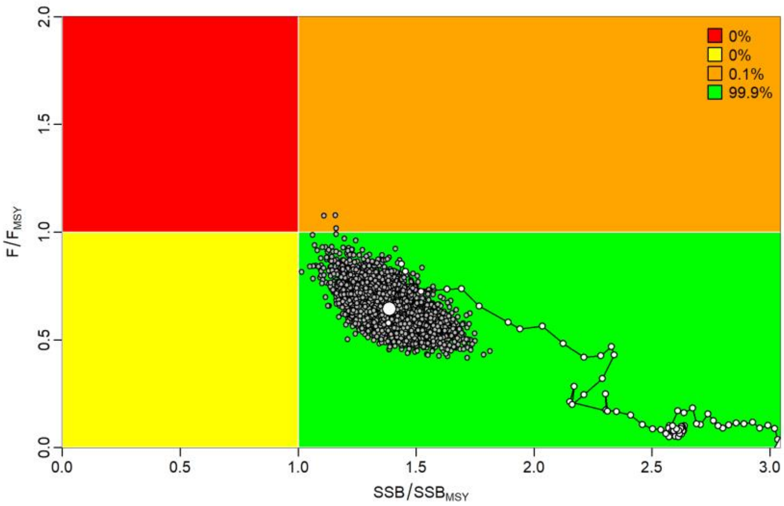

Fig. A 1. Blue shark: Aggregated Indian Ocean stock assessment Kobe plot for the 2021 assessment base case model. (base case model with trajectory and uncertainty in the terminal year.

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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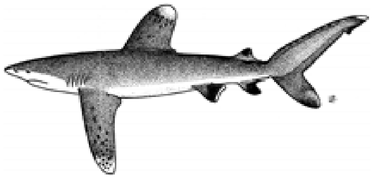
APPENDIX VIII
EXECUTIVE SUMMARY: OCEANIC WHITETIP SHARK (2023)



CITES APPENDIX II species

Table A 4. Status of oceanic whitetip shark (*Carcharhinus longimanus*) in the Indian Ocean.

Area[1]	Indicators		2018 stock status determination
Indian Ocean	Reported catch 2021	32 t	
	Not elsewhere included (nei) sharks[2] 2021	35,603 t	
	Average reported catch 2017-21	36 t	
	Av. not elsewhere included 2017-2021 (nei) sharks[2]	33,342 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 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

Sour ces: IUCN Red List 2020, Baum et al. 2006
CIT–S - 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** (2018-22): Offshore gillnet Troll line; Longline-fresh; Purse seine.
- **Main fleets** (2018-22): I.R. Iran; Comoros; China, Seychelles, (Reported as discarded/released alive by China, EU-France, Sri Lanka, EU-Spain).
-

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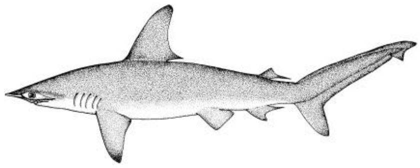
APPENDIX IX
EXECUTIVE SUMMARY: SCALLOPED HAMMERHEAD SHARK (2023)



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 2021 (t)	206	
	Not elsewhere included (nei) sharks[2] 2021 (t)	38,332	
	Average reported catch 2017-21 (t)	87	
	Av. not elsewhere included 2017-2021 (nei) sharks[2] (t)	36,418	
	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 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' (**Table A 7**). 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). Scalloped hammerhead shark received a low vulnerability ranking (No. 17) in the ERA rank for longline gear because it was estimated to be one of the least productive shark species but was also characterised by a lower susceptibility to longline gear. Scalloped hammerhead shark was estimated as the twelfth most vulnerable shark species in the ERA ranking for purse seine gear, but with lower levels of vulnerability compared to longline gear, because the susceptibility was lower for purse seine gear. There is a paucity of information available on this species and this situation is not expected to improve in the short to medium term. Scalloped hammerhead sharks are commonly taken by a range of fisheries in the Indian Ocean. They are extremely vulnerable to gillnet fisheries. Furthermore, pups occupy shallow coastal nursery grounds, often heavily exploited by inshore fisheries. Because of their life history characteristics – they are relatively long lived (over 30 years) and have relativity few offspring (<31 pups each year), the scalloped hammerhead shark is vulnerable to overfishing. There is no quantitative stock assessment or basic fishery indicators currently available for scalloped hammerhead shark in the Indian Ocean therefore the stock status is unknown (**Table A 6**).

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** (2018-2022): Handline, Gillnet; longline-coastal; and offshore gillnet.
- **Main fleets** (2018-22): Sri Lanka; Kenya; Malaysia (report as released alive/discarded by United Kingdom, EU-France, South Africa,).

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APPENDIX X
EXECUTIVE SUMMARY: SHORTFIN MAKO SHARK (2023)

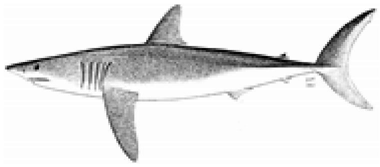

Table A 8. Status of shortfin mako shark (*Isurus oxyrinchus*) in the Indian Ocean.

Area[1]	Indicators		2020 stock status determination
Indian Ocean	Reported catch 2021 (t) Not elsewhere included (nei) sharks[2] 2021 (t) Average reported catch 2017-21 (t) Av. Not elsewhere included (nei) sharks[2] 2017-21 (t)	782 37,639 1,317 35,518	
	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 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 year–) - 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** (2018-22): Longline targeting swordfish; gillnet, longline (deep-freezing); longline (fresh); gillnet offshore.
- **Main fleets** (2018-22): EU,Spain; Kenya; EU,Portugal; United Kingdom; China; Sri Lanka, (Reported as discarded/released alive: EU-Spain, Australia, EU,France, Indonesia, Korea, South Africa).

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Appendix XI
Executive Summary: Silky Shark (2023)

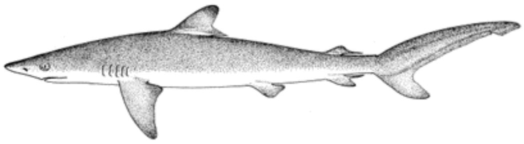

Table A 10. Status of silky shark (*Carcharhinus falciformis*) in the Indian Ocean.

Area[1]	Indicators		2018 stock status determination
Indian Ocean	Reported catch 2021 (t) Not elsewhere included (nei) sharks[2] 2021 (t) Average reported catch 2017-21 (t) Av. Not elsewhere included (nei) sharks[2] 2017-21 (t)	1,466 35,603 1,898 33,342	
	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** (2018-22): Gillnet; longline; longline (deep-freezing); longline (fresh), trolling; handline
- **Main fleets** (2018-22): Sri Lanka; Comoros; Seychelles; Taiwan,China; (reported as discarded/released alive by: China, EU-France, Mauritius, EU-Spain, Korea).

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APPENDIX XII
EXECUTIVE SUMMARY: BIGEYE THRESHER SHARK (2023)

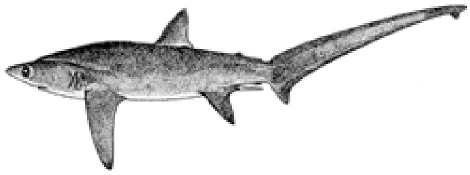

Table A 12. Status bigeye thresher shark (*Alopias superciliosus*) in the Indian Ocean.

Area[1]	Indicators		2018 stock status determination
Indian Ocean	Reported catch 2021 (t) Not elsewhere included (nei) sharks[2] 2021 (t) Thresher sharks nei 2021 (t) Average reported catch 2017-21 (t) Av. Not elsewhere included (nei) sharks[2] 2017-21 (t) Av. Thresher sharks nei 2017-21 (t)	< 1 41,076 5,471 < 1 38,254 4,911	
	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*[2].

The following key points should also be noted:

- **Maximum Sustainable Yield (MSY)**: Not applicable. Retention prohibited.
- **Reference points**: Not applicable.
- **Main fishing gear** (2018–22): Coastal longline. Only reported by Indonesia in 2021, otherwise no report after 2012. (reported previously as discard from gillnet and longline).
- **Main reporting fleets** (2018–22): Indonesia; (reported as discarded/released alive by United Kingdom, South Africa, Indonesia, Korea, EU,France,).

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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 XIII
EXECUTIVE SUMMARY: PELAGIC THRESHER SHARK (2023)

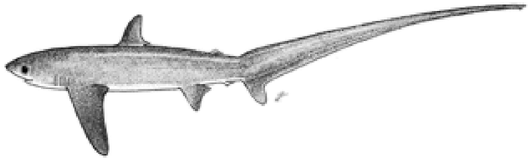

Table A 14. Status pelagic thresher shark (*Alopias pelagicus*) in the Indian Ocean.

Area[1]	Indicators		2018 stock status determination
Indian Ocean	Reported catch 2021 (t) Not elsewhere included (nei) sharks[2] 2021 (t) Thresher sharks nei 2021 (t) Average reported catch 2017-21 (t) Av. Not elsewhere included (nei) sharks[2] 2017-21 (t) Av. Thresher sharks nei 2017-21 (t)	156 41,076 5,471 266 38,254 4,911	
	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 yea–) - 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*[3].

The following key points should also be noted:

- **Maximum Sustainable Yield (MSY)**: Not applicable. Retention prohibited.
- **Reference points**: Not applicable.
- **Main fishing gear** (2018-22): Gillnet, coastal longline, exploratory longline (reported as discard/ released from gillnet and longline).
- **Main fleets** (2018-22): Pakistan; Indonesia reported as discarded/released alive by Korea, South Africa, Indonesia.

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[3]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 (2023)

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[4]
Flatback turtle	*Natator depressus*	Data deficient
Green turtle	*Chelonia mydas*	Endangered
Hawksbill turtle	*Eretmochelys imbricata*	Critically Endangered
Leatherback turtle	*Dermochelys coriacea*	Vulnerable (Globally)
	(N. East Indian Ocean subpopulation)	Data deficient
	(S. West Indian Ocean subpopulation)	Critically Endangered
Loggerhead turtle	*Caretta caretta*	Vulnerable (Globally)
	(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-

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

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

The following should also be noted:

1. The available evidence indicates considerable risk to marine turtles in the Indian Ocean.
2. Given the high mortality rates associated with marine turtle interactions with gillnet fisheries and the increasing use of gillnets in the Indian Ocean (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 (2023)

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[5]
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**. 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.

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

Outlook. The level of compliance with Resolution 23/07 (*On Reducing the Incidental Bycatch of Seabirds in Longline Fisheries)* and the frequency of use of each of the 4 measures (because vessels can choose two out of three possible options: night setting, bird scaring lines and line weighting, or, alternatively, use hook-shielding devices as a stand-alone measure) 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 23/07 are not implemented.
- CPCs that have not fully implemented the provisions of the IOTC Regional Observer Scheme outlined in paragraph 3 of Resolution 22/04 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 23/07.

APPENDIX XVI
EXECUTIVE SUMMARY: CETACEANS (2023)

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*	LC	-
	Blue whale	*Balaenoptera musculus*	EN	-
	Fin whale	*Balaenoptera physalus*	VU	-
	Omura's whale	*Balaenoptera omurai*	DD	-
	Humpback whale	*Megaptera novaeangliae*	LC***	GN, LL
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*	LC	-
	Southern bottlenose whale	*Hyperoodon planifrons*	LC	-
	Longman's beaked whale	*Indopacetus pacificus*	LC	GN
	Andrew's beaked whale	*Mesoplodon bowdoini*	DD	-
	Blainville's beaked whale	*Mesoplodon densirostris*	LC	-
	Ramari’s beaked whale	*Mesoplodon eueu*	DD	-
	Gray's beaked whale	*Mesoplodon grayi*	LC	-
	Hector's beaked whale	*Mesoplodon hectori*	DD	-
	Deraniyagala's beaked whale	*Mesoplodon hotaula*	DD	-
	Strap-toothed whale	*Mesoplodon layardii*	LC	-
	Spade-toothed whale	*Mesoplodon traversii*	DD	-

	Shepherd's beaked Whale	*Tasmacetus shepherdi*	DD	-
	Cuvier's beaked whale	*Ziphius cavirostris*	LC	GN
Delphinidae	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
	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
Delphinidae	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[6] 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

[6] September 2020

(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 et al., 2020, Kiszka et al 2021). Several 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 23/06 *On the conservation of cetaceans* highlights the concerns of the IOTC regarding the lack of accurate and complete data collection and reporting to the IOTC Secretariat of interactions and mortalities of cetaceans in association with tuna fisheries in the IOTC Area of Competence. In this resolution, the IOTC have agreed that CPCs shall prohibit their flagged vessels from intentionally setting a purse seine net around a cetacean if the animal is sighted prior to the commencement of the set. The IOTC also agreed that CPCs using other gear types targeting tuna and tuna-like species found in association with cetaceans shall report all interactions with cetaceans to the relevant authority of the flag State and that these will be reported to the IOTC Secretariat by 30 June of the following year. It is acknowledged that the impact on cetacean populations from fishing for tuna and tuna-like species may increase if fishing pressure increases (which is already clear for tuna gillnet fisheries from IOTC data) or if the status of cetacean populations worsens due to other factors such as an increase in external fishing pressure or other anthropogenic or climatic impacts.

The following should be noted:

- The number of fisheries interactions involving cetaceans is highly uncertain and should be addressed as a matter of priority as it is a prerequisite for the WPEB to determine a status for any Indian Ocean cetacean species.
- Available evidence indicates considerable risk to cetaceans in the Indian Ocean, particularly from tuna drift gillnets
- Current reported interactions and mortalities are scattered but are most likely severely underestimated (Anderson *et al*., 2020, Kiszka *et al*., 2021).
- 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 (2024–2028)

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

Table 1. 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				
		2024	2025	2026	2027	2028
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.					
1. Fisheries data collection	1.1 Catch composition reconstruction (initial focus Sri Lanka, Pakistan and Indonesia)					
	1.1.2 Historical data mining for the key species and IOTC fleets (e.g., as artisanal gillnet and longline coastal fisheries) including workshops:					
	1.1.3 Historical data mining for the key species, including the collection of information about catch, effort and spatial distribution of those species and fleets catching them					
	1.1.4 CPUE standardisation and review of additional abundance indicators series for each key shark species and fishery in the Indian Ocean					

2. Shark research and management strategy	2.1 Implementation of work suggested by shark work plan consultancy					
	2.2 Prioritising shark research based on previous work and including analysing gaps in knowledge					
3. Ecoregions development	Support for the development and refinement of ecoregions in the Indian Ocean: • Development of a pilot study (focused on two ecoregions: one coastal, the Somali Current ecoregion and one oceanic, the Indian Ocean Gyre ecoregion)					

Other Future Research Requirements (not in order of priority)

Topic	Sub-topic and project	2024	2025	2026	2027	2028
1. Review and improve data collection for mobulid rays	1.1 Mobulid ID guide revision and translation. ID guides to be updated with help of CPC scientists					
2. Bycatch mitigation measures	2.1 Gears 2.1.1 Undertake a series of gear specific workshops focusing on multi-taxa bycatch issues					
	2.1.2 Develop studies on bycatch mitigation measures for the main gears using in the IOTC area (operational, technological aspects and best practices)					
	2.2 Sharks a) Harmonise and finalise guidelines and protocols for safe handling and release of sharks and rays caught in IOTC fisheries					

	2.3 Sea turtles 2.3.1 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					
	2.3.2 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.					
	2.3.3 Regional workshop to review the effectiveness of marine turtle mitigation measures					
	2.3.4 Harmonise and finalise guidelines and protocols for safe handling and release of sea turtles caught in IOTC fisheries					
	2.3 Seabirds 2.3.1 Bycatch assessment for seabirds taking into account the information from the various ongoing initiatives in the IO and adjacent oceans					
	2.3.2 Study on cryptic mortality of seabirds in tuna LL fisheries.					
	2.3.3 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 Testing mitigation methods for cetacean bycatch in tuna drift gillnet fisheries					
	2.4.2 Harmonise and finalise guidelines and protocols for safe handling and release of cetaceans caught in IOTC fisheries					
	2.4.3. 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. Ecosystems	4.1 Develop a plan for Ecosystem Approach to Fisheries (EAF) approaches in the IOTC, in conjunction with the Common Oceans Tuna Project.					
	4.1.2 Workshop for CPCs on continuing efforts to the development of an EAF including delineation of candidate eco regions within IOTC.					
	4.1.3 Practical Implementation of EBFM with the development and testing of ecosystem report cards.					
	4.1.4 Evaluation of EBFM plan in IOTC area of competence by the WPEB to review its elements components and make any corrective measures.					
	4.2 Assessing the impacts of climate change and socio- economic factors on IOTC fisheries					
	4.3 Evaluate alternative approaches to ERAs to assess ecological risk					
	4.4 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 2024–2028 (adapted from IOTC–2022–SC25–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	**2024**	**2025**	**2026**	**2027**	**2028**
Blue shark	–	Data preparatory meeting Full assessment	-	–	–
Oceanic whitetip shark	Data preparation	Indicator analysis	-	Data preparation	–
Scalloped hammerhead shark	–	–	Data preparatory meeting Full assessment	–	–
Shortfin mako shark	Data preparatory meeting Full assessment	–	-	Data preparatory meeting Full assessment	
Silky shark	-	–	Assessment*	-	Assessment*
Bigeye thresher shark	–	–	Assessment*	–	-
Pelagic thresher shark	–	–	Assessment*	–	-
Porbeagle shark	–	–	-	–	Assessment*
Mobulid Rays	Interactions/ Indicators	–	-	Interactions/ Indicators	-
Marine turtles	–	Indicators	-	–	Indicators
Seabirds	Development of draft workplan	–	Review of mitigation measures in Res. 23/06	–	–
Marine Mammals	• Review of mitigation measures • Review of handling guidelines		-	–	–

Data preparatory meeting	• Methods for using available data for assessments • Considering the shark research plan • Consider effectiveness of mitigation measures for a range of taxa				
Ecosystem Based Fisheries Management (EBFM) approaches	Ecoregions pilot study	ongoing			

APPENDIX XVIII
CONSOLIDATED RECOMMENDATIONS OF THE 19TH SESSION OF THE WORKING PARTY ON ECOSYSTEMS AND BYCATCH

Note: Appendix references refer to the Report of the 19th Session of the Working Party on Ecosystems and Bycatch (IOTC–2023–WPEB19–R)

Section 6. Review information on biology, ecology, fisheries and environmental data relating to sharks

WPEB19.01 (para. 66) The WPEB **RECOMMENDED** that the SC advise the Commission to consider extending measures to prevent finning of sharks such as fins naturally attached including partially attached and tethered for all fisheries or similar, alternative measures (for example, fins artificially attached), providing they had been assessed and endorsed by the SC and Compliance Committee as being equally or more likely to meet the conservation benefit (of a fins naturally attached measure) and are logistically feasible from a compliance monitoring perspective. The WPEB **NOTED** that while such other measures may be logistically more difficult to implement and monitor for governments, they may be logistically more practical for the fishing industry when conducting their fishing operations and storing shark catches on board.

WPEB19.02 (para. 68) **ACKNOWLEDGING** that the current ROS data requirements already enable the recording of shark fins attached / non-attached to carcasses. the WPEB **RECOMMENDED** that the SC identifies proper mechanisms to ensure this information is regularly collected and reported to the Secretariat through the ROS.

Revision of the WPEB Program of Work 2024-2028

WPEB19.03 (para. 183) The WPEB **RECOMMENDED** that the SC consider and endorse the WPEB Program of Work (2024–2028), as provided in Appendix XVII.

Review of the draft, and adoption of the Report of the 19th Session of the WPEB

WPEB19.04 (para. 195): The WPEB **RECOMMENDED** that the Scientific Committee consider the consolidated set of recommendations arising from WPEB19, 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

APPENDIX XVIV

DRAFT TERMS OF REFERENCE FOR A CONSULTANCY TO DEVELOP A RESEARCH PRIORITISATION PLAN FOR SCALLOPED HAMMERHEAD SHARK...

Develop research prioritisation plan for Scalloped Hammerhead which can serve as a template to improve specific science-based advice to fill data gaps and to reduce fishing mortality.

1. Identify gaps in catch and abundance data
   a) Together with the Secretariat review available catch data and certainty thereof;
   b) Determine research/ analyses required to improve catch data collection and extrapolation for use in stock assessments.
2. Develop research towards gear/area specific measures
   a) Collate all available research findings for gear and area specific measures to reduce fishing mortality;
   b) Provide a gap analysis for research towards the effectiveness of gear/area specific measures;
   c) Create a concise summary of findings in form of an overview table/matrix of most effective gear/area measures that reduce fishing mortality of sharks for the example scalloped hammerhead, including references to available research.
3. Present findings at intersessional meeting of the WPEB and, together with the delegates, develop final report, including summary table to be used as a template for improved, concise advice to be endorsed by the SC and taken forward to the Commission