Report of the 20th Session of the IOTC Working Party on Ecosystems and Bycatch

Eden Bleu Hotel, Seychelles and Zoom, 9 – 13 September 2024

DISTRIBUTION:

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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**).

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Executive summary

The 20th Session of the Indian Ocean Tuna Commission's (IOTC) Working Party on Ecosystems and Bycatch - WPEB was held in Seychelles and online via Zoom from 9-13 September 2024. A total of 92 participants (100 in 2023, 103 in 2022, 93 in 2021 and 108 in 2020) 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 WPEB20 to the Scientific Committee which are also provided in Appendix XVIII:

Section 6. Outcomes of bycatch mitigation workshop

WPEB20(AS).01 (para. 40) **ACKNOWLEDGING** that the bycatch mitigation workshop was held as a part of the data preparatory meeting, the WPEB **NOTED** that the role and status of a "workshop" as well as a Working Party's data preparatory meeting is unclear as it is not explicitly defined in the IOTC rules of procedure. The WPEB **NOTED** that this caused a lot of confusion between participants, in particular regarding whether recommendations from a data preparatory meeting can be taken directly to the SC rather than being approved by the main Working Party meeting. The WPEB **NOTED** that while the recommendations from the April 2024 WPEB (data preparatory) meeting will be presented to the Scientific Committee (See Appendix XVVI) for its consideration, the WPEB **RECOMMENDED** that the SC provide clarification on the nature of data "workshops" and working party data preparatory meetings and their capacity to submit their recommendations independently and directly to the SC, to guide future WP recommendation processes.

WPEB20(AS).02 (para. 42) The WPEB **NOTED** the **recommendations** arising from the WPEB Data Prep meeting (DP) which included a shark mitigation workshop and reviewed these again. The WPEB assessment meeting **NOTED** that there was consensus on the following:

- The WPEB **RECOMMENDED** that the SC request that CPCs carry out training with fishers to ensure that they are aware of the best practices for handling and release of sharks including the minimisation of trailing gears. The WPEB **REQUESTED** that CPCs provide information on how they are monitoring the implementation of these best practices in the form of training materials, number of training/handling workshops etc.
- The WPEB **RECOMMENDED** that the collection of information on leader material type should be made mandatory under the Regional Observer Scheme Minimum Data Requirements and reported to the Secretariat. The WPEB also **RECOMMENDED** that these data collected under the ROS are strictly used for scientific purposes in research.
- The WPEB **RECOMMENDED** that mitigation surveys should be developed by CPCs in the IOTC areas and with different gear types and configurations to assess mitigation measures such as the type of leaders and other factors to be tested and implemented. The WPEB **NOTED** that the increase of bite offs by the prohibition of wire leaders could lead to the decrease in the basic information necessary for stock assessment or monitoring abundance of shark species. **ACKNOWLEDGING** the importance of these data, the WPEB **SUGGESTED** that bite offs are recorded by observers to further inform bycatch estimates.
- The WPEB **NOTED** that some studies using large circle hook have reduced injury to sharks by increasing rates of mouth hooking. The WPEB further **NOTED** that decreasing injury rates associated with large circle hooks results in a reduction in at-vessel mortality for some species. Circle hooks use also reduces observed retention of some vulnerable taxa, such as sea turtles and marlins. The WPEB also **NOTED** that some experimental sea-trials from other Oceans have reported increases in observed retention of some shark species when using large circle hooks, especially blue shark and crocodile shark, and that the results from a global meta-analysis and multiple experimental sea-trials have found that the use of large circle hooks reduces retention of target species like swordfish. The WPEB further **NOTED** that there are still many information gaps regarding their effectiveness for sharks, and the number of case studies on deep-setting operations and effect of hook size is still too few and there is also concern that

circle hooks may increase shark catches, the WPEB **RECOMMENDED** continued accumulation of information on circle hook effectiveness including in deep-setting operations.

Section 10 Bycatch, species interactions and ecosystem risk assessments for other shark species, marine mammals, seabirds and sea turtles

10.3 Mobulids

WPEB20(AS).03 (para. 238) However, based on handling and release guidelines for mobulids presented to the WPEB, the WPEB **RECOMMENDED** that the SC consider endorsing a revision to the live release handling procedures provided in Annex 1 of Resolution 19/03 for consideration by the Commission. The WPEB **NOTED** that work is required to further develop the guidelines for gillnets and this will be done intersessionally with the aim of reporting to the WPEB21. The details of the suggested revisions to the handling procedures can be found in Appendix XVV.

Section 11. WPEB Program of Work (Research and Priorities)

WPEB20(AS).04 (para. 254) The WPEB **RECOMMENDED** that the SC consider and endorse the WPEB Program of Work (2025–2029), as provided in Appendix XVIV.

Section 12. Other matters

12.2 Review of the draft, and adoption of the Report of the 20th Session of the WPEB

WPEB20(AS).05 (para. 258) The WPEB **RECOMMENDED** that the Scientific Committee consider the consolidated set of recommendations arising from WPEB20, provided at Appendix XVVII, as well as the management advice provided in the draft resource stock status summary for each of the eight 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
- Porbeagle sharks (*Lamna nasus*) - Appendix XIV

Other species/groups

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

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.

The following are the **requests** from the WPEB20 to other working parties for their attention:

Section 3. The IOTC process: outcomes, updates and progress

3.1 Outcomes of the 28th Session of the Commission

(para. 7) The WPEB **NOTED** the request from the Commission for the SC to initiate the Management Strategy Evaluation process for blue shark in order to develop a Management Procedure for this species. Therefore, the

WPEB **REQUESTED** the WPM to start discussions around the MSE process for this species, further **NOTING** that blue shark is scheduled to be assessed in 2025 and so this assessment can feed into the MSE process.

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

(para. 12) The WPEB **REITERATED** the importance of the recommendation made by the group in 2023: "***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.*" The WPEB **REQUESTED** that this is discussed by the WPDCS at its meeting later this year as this may be a more appropriate forum for this discussion.

Section 7. Review information on biology, ecology, fisheries and environmental data relating to sharks

7.1 Presentation of new information available on sharks

(para. 51) The WPEB **REQUESTED** that the WPDCS and WGEMS note the study presented by the authors (IOTC-2024-WPEB20(AS)-14), and **REQUESTED** assistance from the WGEMS for collecting information related to the current status of AI-based species identification.

(para. 54) **ACKNOWLEDGING** that this initiative would encompass a broader scope than that addressed by the WPEB, the WPEB **REQUESTED** the WPDCS to explore ways to establish collaboration across t-RFMOs and with other interested organizations. The goal is to compile images for developing these tools, including the formulation of Terms of Reference and a work plan for initial activities.

Section 9. New information on biology, ecology, fisheries and environmental data relating to ecosystems and bycatch species

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

(para 152) The WPEB **NOTED** that mainline material is consistently being submitted by CPCs in their ROS data. The WPEB **NOTED** that the ROS minimum data requirements are currently under revision by the WGEMS/WPDCS and that the current working draft review for longline vessels suggested that collecting detailed branchline configuration information should be "mandatory" at the trip level, however, branchline materials and leader materials for catches of sensitive species should be "mandatory" but this should include the possibility to record this information as "unknown" due to the practical difficulties of collecting this information both by onboard human observers and by EMS. The WPEB further **NOTED** that collecting data on leader material for each fishing set as part of the ROS remains "optional" and includes the possibility of recording this information as "unknown" due to the practical difficulties of collecting this information both by onboard human observers and by EMS. The WPEB **NOTED** that these points will be further discussed at the WPDCS and the WPEB **REQUESTED** that the WPDCS consider these recommendations in their discussions.

(para 162) The WPEB **REQUESTED** the WPDCS to examine the online digital atlas project to receive additional feedback to what has been expressed by the WPEB, in order to design a consolidated project to be presented at SC27.

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

Stock	Indicators		2019	2020	2021	2022	2023	2024	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 2022: Estimated catch 2019: Not elsewhere included (nei) sharks 2022: Average reported catch 2018–22: Average estimated catch 2015–19: Ave. (nei) sharks[2] 2018–22:	24,421t 43,240 t 26,473 t 25,270 t 48,781 t 27,098 t	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
	MSY (1,000 t) (80% CI): F_{MSY} (80% CI): SSB_{MSY} (1,000 t) (80% CI): F_{2015}/F_{MSY} (80% CI): SSB_{2019}/SSB_{MSY} (80% CI): SSB_{2019}/SSB_0 (80% CI):	36.0 (33.5 - 38.6) 0.31 (0.306- 0.31) 42.0 (38.9 - 45.1) 0.64 (0.53 - 0.75) 1.39 (1.27 - 1.49) 0.46 (0.42 - 0.49)							
Shortfin mako *Isurus oxyrinchus*	Reported catch 2022: Not elsewhere included (nei) sharks 2022: Average reported catch 2018–2022: Not elsewhere included (nei) sharks 2018-2022:	678 t 28,419 t 1,015 t 29,161 t						49.7%	Current catches are higher than MSY, and the shortfin mako is currently overfished (B/Bmsy < 1) and undergoing overfishing (F/Fmsy > 1). Under those levels of catches, the biomass will continue to decline, and fishing mortality will continue to increase over time. In order to have a lower than 50% probability of exceeding MSY-reference points in 10 years, i.e., to recover the stock to the green quadrant of the Kobe plot with at least 50% probability in 10 years, future
	MSY (1,000 t) (80% CI) F_{MSY} (80% CI) B_{MSY} (1,000 t) (80% CI) F_{2022}/F_{MSY} (80% CI) B_{2022}/B_{MSY} (80% CI)	1,930 (0.985 – 3.313) 0.03 (0.01 – 0.07) 60.0 (35.7 – 103.8) 1.53 (0.65 – 3.71)							

	B_{2022}/B_0 (80% CI)	0.96 (0.58 – 1.41) 0.45 (0.27-0.69)							catches should not exceed 40% of current catches. This corresponds to an annual TAC of 1,217.2 t (representing all fishing mortality including retention, dead discards and post-release mortality), noting that this TAC level should include and account for the SMA, MAK and MSK species codes as reported to IOTC. The Commission should take a cautious approach by implementing management actions that reduce fishing mortality on shortfin mako sharks, and the stock should be closely monitored. 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 future scientific advice. Click below for a full stock status summary: ● Shortfin mako sharks – Appendix X
Oceanic whitetip shark *Carcharhinus longimanus*	Reported catch 2022: Not elsewhere included (nei) sharks 2022: Average reported catch 2018–2022: Not elsewhere included (nei) sharks 2018-2022:	41 t 26,473 t 35 t 27,098 t							There is a paucity of information available for these species and this situation is not expected to improve in the short to medium term. There is no quantitative stock assessment and limited basic fishery indicators currently available. Therefore, the stock status is highly uncertain. The available evidence indicates considerable risk to the stock status at current effort levels. The primary source of data that drive the assessment (total catches) is highly uncertain and should be investigated further as a priority. Click below for a full stock status summary: ● Oceanic whitetip sharks – Appendix VIII
Scalloped hammerhead shark *Sphyrna lewini*	Reported catch 2022: Not elsewhere included (nei) sharks 2022: Average reported catch 2018–2022: Not elsewhere included (nei) sharks 2012-2022:	681 t 28,192 t 200 t 29,801 t							
Silky shark *Carcharhinus falciformis*	Reported catch 2022: Not elsewhere included (nei) sharks 2022: Average reported catch 2018–2022: Not elsewhere included (nei) sharks 2012-2022:	1,461 t 26,473 t 1,762 t 27,098 t							

Bigeye thresher shark *Alopias superciliosus*	Reported catch 2022: <1 t Not elsewhere included (nei) sharks 2022: 31,668 t Thresher sharks nei 2022: 5,196 t Average reported catch 2018–2022: <1 t Not elsewhere included (nei) sharks 2018-2022: 31,955 t Av. Thresher sharks nei 2018-2022: 4,857 t							• Scalloped hammerhead sharks – Appendix IX • Silky sharks – Appendix XI • Bigeye thresher sharks – Appendix XII • Pelagic thresher sharks – Appendix XIII • Porbeagle sharks – Appendix XIV
Pelagic thresher shark *Alopias pelagicus*	Reported catch 2022: 132 t Not elsewhere included (nei) sharks 2022: 31,668 t Thresher sharks nei 2022: 5,196 t Average reported catch 2018–2022: 212 t Not elsewhere included (nei) sharks 2018-2022: 31,955 t Av. Thresher sharks nei 2018-2022: 4,857 t							
Porbeagle shark *Lamna nasus*	Reported catch 2022: 28t Not elsewhere included (nei) sharks 2022: 26,779t Average reported catch 2018–2022: 28 t Not elsewhere included (nei) sharks 2018-2022: 27,572t							

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 20th Session of the Indian Ocean Tuna Commission's (IOTC) Working Party on Ecosystems and Bycatch - WPEB was held in Seychelles and online via Zoom from 9-13 September 2024. A total of 92 participants (100 in 2023, 103 in 2022, 93 in 2021 and 108 in 2020) 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. At the beginning of the meeting, the clarification of the formal name and nature of this meeting was sought, since the meeting was called under the different name, i.e. WPEB20(AS), indicating that the decision was taken to split the existing WPEB into two. The Chairperson and Secretariat confirmed that there was no modification in the name and status of the meeting as the sole meeting of the Working Party of Ecosystem and Bycatch under the Scientific Committee.

2. Adoption of the Agenda and arrangements for the Session

3. 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 26th Session of the Scientific Committee

4. The WPEB **NOTED** paper IOTC–2024–WPEB20(AS)–03 which outlined the main outcomes of the 26th Session of the Scientific Committee, specifically related to the work of the WPEB.

*"The SC **NOTED** that papers on the fins-naturally-attached approach were discussed extensively during the WPEB meeting and this is thought to be the best practice to prevent shark finning from occurring. The SC **NOTED** that different approaches to fins-partially attached (which is thought to also be suitable) can be taken such as using wires to attach fins to the main body of the shark or using a bag to put both the body and fins into. The SC **NOTED** that fins-naturally-attached also allows for the partial cutting of fins which can then be folded over to aid with storage and to help to avoid injuries to crew while moving the sharks.*

*The SC **RECOMMENDED** that the Commission 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 SC **NOTED** that while such other measures may be logistically more difficult to implement and monitor for governments, they may be more practical (and beneficial to crew safety) for the fishing industry when conducting their fishing operations and storing shark catches on board.*

*The SC **NOTED** that while the WPEB had held discussion on the scientific need to improve measures to prevent shark finning, the WPEB has not provided a summary of this evidence to the SC. Subsequently, the SC **REQUESTED** the WPEB to provide this information to support the SC and Commission's further consideration of this issue.*

*The SC **NOTED** the intention of the WPEB to use the assigned Data Preparatory meeting both for data and stock assessment model preparation issues for shortfin mako which is due to be assessed in 2024, and also to hold a bycatch mitigation measure workshop with a range of experts on this topic. The SC further **NOTED** that there is unlikely to be a lot of new information and data for shortfin mako so there should be plenty of time during that meeting to look at mitigation measures. The SC **NOTED** the intention of the WPEB Chair and the Secretariat to reach out to experts both on mitigation measures and CPUE and stock assessments for this data preparatory meeting to make it as effective as possible.*

*The SC **NOTED** the poor status of discards data in terms of quality and availability which should be submitted by CPCs through form 1DI. The SC **NOTED** that the data on taxa such as cetaceans, turtles and seabirds reported through these forms are mostly data on occurrences rather than fully raised data. They **ENCOURAGED** CPCs to increase their reporting levels through this form. The SC **NOTED** that as a result of this issue, data on cetaceans, marine turtles and seabirds are available only through the Regional Observer Scheme and are therefore very limited. The SC **SUGGESTED** that increasing the minimum required level of observer coverage may help to improve data for these species.*

*The SC **NOTED** the ongoing work by the WPEB on ecoregions, further **NOTING** that no progress was made on this work in 2023 as the expert on this topic was not able to attend the WPEB meeting. The SC **NOTED** that the intention is for the ecoregions to be incorporated into future Ecological Risk Assessment (ERA) and stock assessment work for all species including tropical tunas. The SC **NOTED** that draft ecoregions have been mapped and the idea now is to conduct a pilot study to assess the suitability of these draft regions.*

*The SC **NOTED** that several longline fleets targeting swordfish in the IOTC area of competence are using submerged artificial lights (chemical light sticks or electrically powered lights) attached to the terminal gear for the purpose of attracting the target species and further **NOTED** that Resolution 16/07 prohibits all vessels from using artificial lights to attract fish, without specifying the type of fleet or gear subjected to the Resolution. The SC therefore **RECOMMENDED** that the Commission provides clarity on whether Resolution 16/07 applies to longline fisheries as the current wording is somewhat ambiguous. The SC also **SUGGESTED** that Resolution 16/07 could be amended to clearly state which fleets and/or gears are bound by the Resolution to avoid future doubts.*

*The SC **NOTED** that although an assessment was scheduled for porbeagle shark in 2023, an Executive Summary has not yet been developed for this species. The SC therefore **REQUESTED** the WPEB to develop an Executive Summary for this species.*

*The SC **NOTED** that a local assessment had been conducted for Indian Ocean humpback dolphins in India which assessed the population to be 'Vulnerable' (as opposed to the 'Endangered' assessment for the global population). The SC **SUGGESTED** that this be discussed during the next WPEB to determine whether a sub-population of this species should be added to the Executive Summary for cetaceans."*

3.2 Outcomes of the 28th Session of the Commission

5. The WPEB **NOTED** paper IOTC–2024–WPEB20(AS)–04 which outlined the main outcomes of the 28th Session of the Commission, specifically related to the work of the WPEB.

6. 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. However, the WPEB **NOTED** that proposals for Resolutions relating to implementing more management measures for sharks were discussed but none were adopted by the Commission. Measures that were proposed included provisions for fins naturally attached.

*"(para. 28) The Commission **NOTED** the stock status summaries for species of tuna and tuna-like species under the IOTC mandate, as well as other species impacted by IOTC fisheries and considered the recommendations made by the Scientific Committee to the Commission. The Commission **ENDORSED** the Scientific Committee's 2023 list of recommendations as its own.*

*(para. 29) The Commission **ENDORSED** those officials elected for the SC and its subsidiary (scientific) bodies for the coming years, as listed in Appendix 7 of the 2023 Scientific Committee Report.*

*(para. 31) The Commission **NOTED** 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) requires further clarifications as to which fishery/gear this measure should apply. The Commission **REQUESTED** the CPCs to provide proposals to revise the Resolution next year.*

*(para. 32) The Commission **NOTED** that some of, the IOTC CMMs apply to vessels targeting tuna and tuna like species that exceed 24 meters in length or operate outside the EEZ when shorter than 24 meters. The Commission further **NOTED** that nominal catch data submitted to the IOTC Secretariat are provided without distinction*

by vessel class or size; consequently, it is not possible, for example, to estimate accurately catches specifically by vessels less than 12 meters.

*(para. 33) The Commission **NOTED** that in 2023, the SC endorsed new data reporting forms to enhance clarity and to facilitate the reporting of mandatory fishery statistics as per Resolutions 15/01 and 15/02. The Commission **NOTED** two regional workshops have been organized in 2024 to train CPCs in using the new forms. The Commission **NOTED** that adaptation to the new reporting forms may require time and **AGREED** that implementation should start in 2025.*

*(para. 34) The Commission **NOTED** that the SC suggested a consultancy to evaluate the feasibility of developing gillnet CPUE across the Indian Ocean. The Commission **NOTED** that the gillnet fishery accounted for a significant proportion of catches for key IOTC species, but they lack geo-referenced catch effort data. The Commission tasked the SC with drafting a plan to engage a consultant to develop indices from the gillnet fishery.*

*(para. 35) The Commission **NOTED** that WWF has pledged funds to participate and assist in the proposed yellowfin CKMR project. The Commission **THANKED** WWF for its support.*

*(para. 54) The Commission **REQUESTED** the Scientific Committee to initiate management strategy evaluation (MSE) simulations for blue shark with the aim of developing an MP for the species."*

7. The WPEB **NOTED** the request from the Commission for the SC to initiate the Management Strategy Evaluation process for blue shark in order to develop a Management Procedure for this species. Therefore, the WPEB **REQUESTED** the WPM to start discussions around the MSE process for this species, further **NOTING** that blue shark is scheduled to be assessed in 2025 and so this assessment can feed into the MSE process.

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

8. The WPEB **NOTED** paper IOTC–2024–WPEB20(AS)–05 which aimed to encourage participants to review some of the existing Conservation and Management Measures (CMM) relevant to ecosystems and bycatch.

9. The WPEB **NOTED** that two CMMs relevant to ecosystems and bycatch were adopted by the Commission in 2024, one relating to the climate change as it relates to the IOTC (Resolution 24/01, superseding Res 22/01) and another on the Regional Observer Scheme (Resolution 24/04, superseding Res 22/04).

3.4 Progress on the recommendations of WPEB19

10. The WPEB **NOTED** paper IOTC–2024–WPEB20(AS)–06 which provided an update on the progress made in implementing the recommendations from the previous WPEB meeting WPEB19 which were endorsed by the Scientific Committee (SC26) in 2023.

11. The WPEB **NOTED** that good progress had been made on these Recommendations and Requests. The WPEB participants were **ENCOURAGED** to review IOTC-2024-WPEB20(AS)-06 during the meeting and report back on any progress in relation to requests or actions by CPCs that have not been captured by the report, and to note any pending actions for attention before the next meeting (WPEB21).

12. The WPEB **REITERATED** the importance of the recommendation made by the group in 2023: "***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.*" The WPEB **REQUESTED** that this is discussed by the WPDCS at its meeting later this year as this may be a more appropriate forum for this discussion.

4. Review of data available on ecosystems and bycatch

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

13. The WPEB **NOTED** paper IOTC–2024–WPEB20(AS)–07 which provided an overview of the data managed by the IOTC Secretariat for bycatch species for the period 1950–2022. A summary for shark and ray species is provided in Appendix IV.

14. 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.

15. The WPEB **NOTED** that the currently available catch time series for IOTC and bycatch species do not yet include data for 2023 as the Secretariat is still in the process of receiving and cross-verifying these data.

16. The WPEB **NOTED** that the retained catches of sharks and rays reported to the Secretariat have decreased in recent years amounting to 80,263 t in 2022, with rays representing about 1.9% of total reported shark and ray catches.

17. The WPEB **NOTED** that line fisheries (handlines, coastal longlines and trolling lines), for which (total shark and ray) catches have doubled in the last two decades, currently account for around 45.2% of the total retained catches of sharks and rays.

18. The WPEB **NOTED** that for both sharks and rays, only about 40% of catches are reported at species level.

19. The WPEB **RECALLED** that the catches presented do not contain data on discards reported through form 1DI, **ACKNOWLEDGING** that these data on discards are not raised to annual levels and therefore do not represent the total catch discarded on an annual basis. For this reason, the WPEB **EMPHASISED** 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).

20. The WPEB **RECALLED** that the information on total catch for those CPCs who do not report their catch (e.g., Yemen) 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. The WPEB **REQUESTED** the Secretariat to consult with the relevant CPCs whenever utilising alternative sources of data for fulfilling the non-reported components or modifying the reported catch.

21. The WPEB **NOTED** that the ROS database includes data up to 2022 for longline fisheries and **REQUESTED** the Secretariat to update the database with all recent submissions. **ACKNOWLEDGING** that some CPCs are providing data in a format unsuitable for extraction and processing, the WPEB also **REQUESTED** the Secretariat to present a summary with the status of submissions by CPC identifying the reporting coverage as well issues related to the formats being provided.

22. The WPEB **NOTED** that the Secretariat plans to hire a consultant to work on the ROS database, **NOTING** that CPCs are being encouraged to use the latest electronic format to submit ROS data instead of submitting summary reports.

23. The WPEB **NOTED** that EU,France (Reunion) have been collecting ROS data, either through self-reporting or observers on-board since 2007, and that the Secretariat should liaise with EU,France (Reunion) to retrieve the missing data. Furthermore, the WPEB **NOTED** that CPCs with incomplete ROS data series should work with the Secretariat to provide the missing data.

24. The WPEB **NOTED** that resolutions that provide exemptions from reporting of some species in cases where CPCs have national legislation in place hinder the overall collection of information on interactions and so considered the possibility of removing exemptions from the relevant to enhance data reporting of these species to IOTC but no agreement was made.

25. The WPEB **NOTED** the decreasing trend in the reported catches of mako shark species in recent years which started at a peak of 5,168 t caught in 2016 to a total annual catch that fell to 2,638 t in 2022.

26. The WPEB **NOTED** that although longfin makos are poorly recorded in the Indian Ocean and catches of this species reported to the Secretariat in recent years represent less than 1% of the overall mako catches, the percentage of reported catches of aggregated mako species remains considerable.

27. The WPEB **THANKED** the Secretariat for addressing the request made by this working party in the previous year in relation to the available information on shortbill spearfish (*Tetrapturus angustirostris*; SSP) as summarized in the document presented.

28. The WPEB **NOTED** that shortbill spearfish is caught primarily as bycatch in industrial fisheries with retained catches showing great fluctuations throughout the period 1952-2022. The WPEB also **NOTED** that high catches were recorded between 1955 and 1970, with a peak of 376 t in 1968, which were followed by a drastic decline to 11 t in 1977. The WPEB further **NOTED** that catches have remained stable at around 100 t in recent years.

29. The WPEB **NOTED** that longline fisheries of Taiwan, province of China, accounted for 62% of the shortbill spearfish catches, followed by Indonesia (mostly due the contributions of 2022) while other fleets as EU,Spain, Malaysia, Seychelles and Reunion contributed less than 10 t annually in recent years.

30. The WPEB **NOTED** that the available spatial information, as well as interactions recorded by the ROS is negligible for shortbill spearfish, and the historical high reported catches of the species from longline fisheries may have been subject to occasional misidentification or recorded in logbooks as aggregate billfish and this issue needs to be further clarified. The WPEB further **NOTED** that the available fishery data for shortbill spearfish in the Indian Ocean appears to be scarce.

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).

31. The WPEB **NOTED** paper IOTC–2024–WPEB20(AS)–08 which provided the status of development and implementation of National Plans of Action for seabirds and sharks, and implementation of the FAO guidelines to reduce marine turtle mortality in fishing operations.

32. 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.

33. 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.

34. 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.

35. The WPEB **NOTED** that Australia had recently published a third revision of their NPOA for sharks in 2024.

36. The WPEB **NOTED** that Bangladesh finalised their NPOA for sharks which will apply to 2023-2027.

37. The WPEB **NOTED** that Kenya finalised their NPOA for sharks and they are also preparing a NPOA for seabirds that will be reviewed by stakeholders soon.

38. The WPEB **NOTED** that Seychelles have extended their NPOA for sharks to include 2024 and are working on an update which should be completed in 2025.

39. The WPEB **NOTED** that South Africa have developed an updated NPOA for seabirds which is now awaiting approval.

6. Outcomes of bycatch mitigation workshop

40. **ACKNOWLEDGING** that the bycatch mitigation workshop was held as a part of the data preparatory meeting, the WPEB **NOTED** that the role and status of a "workshop" as well as a Working Party's data preparatory meeting is unclear as it is not explicitly defined in the IOTC rules of procedure. The WPEB **NOTED** that this caused a lot of confusion between participants, in particular regarding whether recommendations from a data preparatory meeting can be taken directly to the SC rather than being approved by the main Working Party meeting.The WPEB **NOTED** that while the recommendations from the April 2024 WPEB (data preparatory) meeting will be presented to the Scientific Committee (See Appendix XVVI) as such for its consideration, the WPEB also **RECOMMENDED** that the SC provide clarification on the nature of data "workshops" and working party data preparatory meetings and their capacity to submit their recommendations independently and directly to the SC, to guide future WP recommendation processes.

41. The WPEB **NOTED** that the advice and recommendations that were agreed at the WPEB data preparatory meeting were based on careful review of a wide range of robust scientific research, using appropriate statistical methodologies to demonstrate which mitigation options are most likely to present effective measures for strengthening the conservation of sharks (and are likely to result in a reduction in both the observed catch and the fishing mortality for shortfin mako, oceanic whitetip and silky shark). The WPEB **NOTED** the WPEB(DP)'s report which indicated that this research was presented and reviewed by numerous IOTC and global scientific experts and stressed the need for the WPEB to continue to develop advice based on this standard of statistically robust research.

42. The WPEB **NOTED** the **recommendations** arising from the WPEB Data Prep meeting (DP) which included a shark mitigation workshop and reviewed these again. The WPEB assessment meeting **NOTED** that there was consensus on the following:

    - The WPEB **RECOMMENDED** that the SC request that CPCs carry out training with fishers to ensure that they are aware of the best practices for handling and release of sharks including the minimisation of trailing gears. The WPEB **REQUESTED** that CPCs provide information on how they are monitoring the implementation of these best practices in the form of training materials, number of training/handling workshops etc.
    - The WPEB **RECOMMENDED** that the collection of information on leader material type should be made mandatory under the Regional Observer Scheme Minimum Data Requirements and reported to the Secretariat. The WPEB also **RECOMMENDED** that these data collected under the ROS are strictly used for scientific purposes in research.
    - The WPEB **RECOMMENDED** that mitigation surveys should be developed by CPCs in the IOTC areas and with different gear types and configurations to assess mitigation measures such as the type of leaders and other factors to be tested and implemented. The WPEB **NOTED** that the

increase of bite offs by the prohibition of wire leaders could lead to the decrease in the basic information necessary for stock assessment or monitoring abundance of shark species. **ACKNOWLEDGING** the importance of these data, the WPEB **SUGGESTED** that bite offs are recorded by observers to further inform bycatch estimates.

- The WPEB **NOTED** that some studies using large circle hook have reduced injury to sharks by increasing rates of mouth hooking. The WPEB further **NOTED** that decreasing injury rates associated with large circle hooks results in a reduction in at-vessel mortality for some species. Circle hooks use also reduces observed retention of some vulnerable taxa, such as sea turtles and marlins. The WPEB also **NOTED** that some experimental sea-trials from other Oceans have reported increases in observed retention of some shark species when using large circle hooks, especially blue shark and crocodile shark, and that the results from a global meta-analysis and multiple experimental sea-trials have found that the use of large circle hooks reduces retention of target species like swordfish. The WPEB further **NOTED** that there are still many information gaps regarding their effectiveness for sharks, and the number of case studies on deep-setting operations and effect of hook size is still too few and there is also concern that circle hooks may increase shark catches, the WPEB **RECOMMENDED** continued accumulation of information on circle hook effectiveness including in deep-setting operations.

43. The WPEB also **NOTED** the following recommendation from the data preparatory workshop, however, there were diverging views on this recommendation:

    - The WPEB **NOTED** on the basis of its review of global research that a prohibition on the use of wire leaders and shark lines by longline and other fisheries operating in the IOTC would likely result in a reduction in both the observed catch and the fishing mortality of shark species. The WPEB **NOTED** supporting evidence from a range of research studies as seen in Table 2 (in Appendix VI). The WPEB **NOTED** that these results are likely to be similar in the Indian Ocean. Based on these studies and on the basis of taking the precautionary approach, and consistent with existing SC advice on the need to reduce fishing mortality for shortfin mako, oceanic whitetip and silky shark, the WPEB **RECOMMENDED** that additional mitigation measures such as, but not limited to, the non-use of wire leaders and shark lines should be implemented. The WPEB **AGREED** to further discuss this issue at the WPEB Assessment meeting in September.

44. Following the recommendation of the WPEB20(DP), the Secretariat collected information from CPCs on the utilisation of wire leaders and shark lines. The WPEB **NOTED** that several CPCs are currently using wire leaders with various levels of deployment. The WPEB **AGREED** with the recommendation from the WPEB20(DP) that further information on gear types and configurations should be collected in order to further assess mitigation measures such as leader types and other mitigation approaches to be tested and implemented.

45. Regarding the WPEB20(DP)'s suggestion relating to the recording of bite-offs by observers, the WPEB **NOTED** the concerns of some participants regarding the already high workload of onboard observers and questioned their ability to monitor all hooks in addition to their existing duties.

46. The WPEB **NOTED** the importance of understanding all the details of longline operations and the bycatch situation, including the actual numbers deployed, hook type used, and status and condition of bycatch occurrence with detailed information on the configuration of hauled gear. However the WPEB **NOTED** that testing the impact of different gears in real situations may not be possible in many operations.

47. The WPEB **NOTED** that the impact on some bycatch in longline fisheries may be relatively small compared with other gears such as gillnets and so **SUGGESTED** that similar workshops are held for

other gear types. The WPEB **NOTED** that a focus on gillnets would be particularly important given the limited data available from these fisheries and the large amount of bycatch that these gears are thought to have.

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

7.1 Presentation of new information available on sharks

48. The WPEB **NOTED** paper IOTC-2024-WPEB20(AS)-14 on Embracing modern methods in fisheries: an encouraging first attempt at using machine learning to monitor catches in the demersal shark long-line fishery, including the following abstract provided by the authors:

"Accurate fisheries catch data are essential if fisheries are to be sustainably managed. In South Africa, many fisheries have compulsory observer programmes paid for by industry, but the percentage of fishery activities observed is generally low (<5%) with poor spatial coverage. Smaller fisheries, such as the demersal shark longline fishery, have no observer coverage except for a few months in 2008/2009. This gap in observer data could, however, be filled by an electronic monitoring system (EMS). The demersal shark longline fishery has been controversial since its inception and has been the focus of negative press around allegations of high mortality rates of Endangered, Threatened and Protected (ETP) species. To improve observer coverage and to monitor ETP species, the DFFE in collaboration with WildTrust and the fishery, initiated a collaborative project to install an EMS on an active vessel. To date, 13,665 videos have been collected since December 2023 with 3,538 videos processed for still images. An initial run analysed 113 still images of sharks, batoids, and teleosts from the processed videos were uploaded to BIIGLE and annotated. A total of 337 annotations were then analysed in YOLOv 5, an object recognition algorithm. The initial model was trained using 75% of the images and tested with the remaining 25%. Unannotated images were also used to evaluate the model's performance and feasibility. Species-level identification was not feasible due to the limited number of images. The model, however, successfully differentiated batoids, sharks, and teleosts from each other with a precision of between 72 and 73%. and recorded a higher species diversity than from logbook data. The precision and rate of recall will improve with additional training images. The next stage of the project will use additional deep learning methods to automatically extract video segments of catch events, which would substantially reduce storage space and review time by analysts."

49. The WPEB **NOTED** that machine learning algorithms in general easily reach 70% of precision, but that further improvements are more difficult to achieve and that this could also apply to the development of species identification algorithms for all species including sharks. The WPEB **AGREED** that species identification can be ultimately achieved but that it should be done step by step, starting with discriminating between species groups and building up from there.

50. **RECOGNISING** that machine learning is a data hungry process, the WPEB **AGREED** on the benefits of sharing the images obtained via EMS in a common repository to be shared between CPCs and RFMOS, and of developing a standard methodology with machine learning for the identification of a catch event and a rough classification of species caught in a concerted way. The WPEB further **NOTED** that machine learning requires 'good' but also 'bad' images (e.g. water splash on the camera) as well as a range of different backgrounds.

51. The WPEB **REQUESTED** that the WPDCS and WGEMS note the study presented by the authors, and **REQUESTED** assistance from the WGEMS for collecting information related to the current status of AI-based species identification.

52. The WPEB **NOTED** the strong need to make a reliable tool for identifying catch events and caught species to assist with the processing of information collected through EM programmes and so supported the initial effort made by South Africa on this aspect.

53. The WPEB **NOTED** the pressing need for a reliable tool to identify catch events and species to enhance the processing of data collected through EM programmes and so expressed support for South Africa's initial efforts in this area. Recognizing the nature of the machine learning process, the WPEB **EMPHASISED** the importance of global collaboration in developing such a tool, particularly in gathering a large volume of images needed to train the machine learning models.

54. **ACKNOWLEDGING** that this initiative would encompass a broader scope than that addressed by the WPEB, the WPEB **REQUESTED** the WPDCS to explore ways to establish collaboration across t-RFMOs and with other interested organizations. The goal is to compile images for developing these tools, including the formulation of Terms of Reference and a work plan for initial activities.

55. The WPEB **NOTED** paper IOTC-2024-WPEB20(AS)-15 on Elasmobranchs bycatch in purse seine fishery in the Andaman Sea of Thailand, including the following abstract provided by the authors:

    "The concern of ETP bycatch in Thai fisheries has significantly increased in past decades. The data of elasmobranch bycatch from purse seine in the Andaman Sea of Thailand were collected through landing statistics and landing sampling between 2021 and 2023. About 71,157 purse seine landing declaration and 2,412 purse seine fishing trips were observed. It was found that purse seine fishery in the area had very few elasmobranch bycatch, accounted for 0.000004% of the total catch, which was dominant by sharks. There are 5 records of elasmobranch found during landing sampling, consisted of 3 records of shark and 2 records of ray. All elasmobranchs were found from purse seine operating with fish aggregating devices while free schooled purse seine had no elasmobranch bycatch. By plotting location of found elasmobranchs, it shows that sharks likely distribute in deeper areas than rays. This study concludes that purse seine fishery in the Andaman Sea of Thailand has low impact on elasmobranchs."

56. The WPEB **NOTED** that all elasmobranchs caught as bycatch in the Thai purse seine fishery are landed and are generally processed for fish meal so there are no discards from these fisheries.

57. The WPEB **NOTED** that Thai purse seiners cannot have observers on board (vessels are too small) and that sampling was therefore exclusively conducted during landing. Even though observers would be useful to monitor discards, the authors provided assurance that there are no elasmobranchs nor fish discarded by Thai purse seiners and that the sampling at landing sites is the best method to collect data on this fishery.

58. **ACKNOWLEDGING** the very low catch rates of elasmobranchs observed in the Thai purse seine fishery, the WPEB **RECOGNIZED** the low impact of this fishery on elasmobranchs. The WPEB further **NOTED** that Thai purse seine elasmobranch bycatch only include non-IOTC species. The WPEB **ENCOURAGED** Thailand to keep submitting such information.

59. The WPEB **NOTED** that FAD sets in this fishery tended to have more bycatch of elasmobranchs.

60. The WPEB **NOTED** paper IOTC-2024-WPEB20(AS)-16 on Estimation Iran's sharks total catch historical data 1950-2023, including the following abstract provided by the authors:

    "Historical data is one of the scientific addresses which are given a briefed overview about data condition of any fish stocks in the past. It usually used as a base for prediction of future data or trends. On the other hands, historical data are applicable for evaluation of catch in the past and

future. While Sharks are valuable species with significance importance for marine biologist and ecologist in any ecosystems, but historically their data have not registered in many countries."...[see paper for full abstract]

61. **ACKNOWLEDGING** that the ratio of sharks to total production varied throughout the period and depended on the source of data used, the WPEB **NOTED** that the number of sharks caught as bycatch decreased in the later period. The WPEB **NOTED** that there is no profitable market for sharks in Iran and so the landings have dropped since 2000. The WPEB further **NOTED** that an explanation for this decrease in shark bycatch is that the number of studies increased which is giving better and more representative information regarding the current situation of shark catches. However, the WPEB **NOTED** that another plausible explanation is that shark biomass may have actually decreased in the region.

62. The WPEB **NOTED** that the total catch time series shown by the authors shows some discrepancies with the data submitted to IOTC and that elasmobranch bycatch from Iran comes from their gillnet fishery and is mostly aggregated to species level (90% of reported catches in recent years).

63. The WPEB **NOTED** that there are no official catches reported before 1992 and the authors used other sources of information to obtain estimates for shark catches between 1970 and 1992.

64. The WPEB **NOTED** that Iran had a whale shark harpoon fishery (mostly for oil) prior to the 1970's, which was similar to those operating in India and Pakistan. The WPEB **NOTED** this fishery is not active and so is not catching whale sharks anymore.

65. The WPEB **NOTED** paper IOTC-2024-WPEB20(AS)-17 on Estimation of Iranian fishing vessels By-catch in IOTC competence of area in 2023, including the following abstract provided by the authors:

    "In the western Indian Ocean, Iran is one of the countries benefiting from marine resources. More than 15,000 fishing vessels, including fishing boats, floats, and ships, operate in the coastal, marine, and offshore waters of southern Iran. There are three main fishing methods targeting tuna and tuna-like species in the IOTC area: gillnetting, purse seining, and trolling, with the latter primarily used by small boats in coastal fisheries. The production of large pelagic fishes amounted to approximately 332 thousand tonnes, representing about 43% of the country's total catch in 2023. The estimated total quantity of tuna and tuna-like species caught is approximately 274 thousand tonnes."... [see paper for full abstract]

66. The WPEB **NOTED** that Iran has made some efforts to decrease the impact of fisheries on sharks, including banning shark finning, awareness training with fishers, creation of a shark awareness day, best release practices training, etc.

67. The WPEB **NOTED** that the observations presented here are from a recurrent program which will hopefully continue in the future.

68. Despite Iran presenting information on sharks at the species level in this paper, the WPEB **NOTED** that data related to sharks provided to IOTC by Iran are aggregated to the group level.

69. **ACKNOWLEDGING** that most sharks retrieved to vessels are cut into pieces, the WPEB **NOTED** that the identification of such individuals is quite difficult which might lead to some mis-identification of different species. The WPEB also **NOTED** that some thresher sharks may have been misidentified at the species level or aggregated.

70. The WPEB **NOTED** that the monitoring of ray bycatch was initiated 3 years ago.

71. The WPEB **NOTED** that some photos show landings of very small sharks which appear to be juvenile, however the authors explained that the sharks shown in the photographs were Milk sharks (*Rhizoprionondon acutus*), medium size sharks with a usual size of 100 cm, which constitute the most abundant sharks in the catches.

72. The WPEB **NOTED** that the Secretariat is planning a species identification workshop in December to train participants from 10 CPCs in the western Indian Ocean in species identification methods for all IOTC species and commonly caught sharks and rays. The WPEB further **NOTED** the intention to also organize an equivalent workshop for CPCs from the eastern side of the Indian Ocean in 2025.

73. The WPEB **NOTED** paper IOTC-2024-WPEB20(AS)-18 on Necessity to review and updating fish taxonomic guidelines in the Northern Indian Ocean, including the following abstract provided by the authors:

"Sri Lanka has the privilege of having the FAO fishery resources book published in 1994, one of the most used species identification books in the field. However, as almost three decades passed, a necessity for a new field guide with updated information has emerged. According to the literature review, 12 new marine fish species have been identified in Sri Lankan waters. Apart from that, new fishery resources have been introduced to the Sri Lankan fishery industry. Our study reveals that some of the vital commercially viable fish family groups contained conspicuous changes in the taxonomical details of the species. It shows that 70.6% of the species of the family Leiognathidae included in the FAO guidebook have been changed. Also, the changes in the scientific names occur in the family Gerridae (42.9%), family Ephippidae (33.3%), family Haemulidae (31.3%) and, followed by several elasmobranchs including Dasyatidae (54.5%) and Rhinobatidae (50.0%). If so, it is a timely requisite for the arrival of a new FAO fishery resources guidebook for Sri Lanka."

74. **ACKNOWLEDGING** that the knowledge of the taxonomy of fish is in perpetual change, especially since the introduction of molecular approaches, the WPEB **NOTED** the need expressed by the authors from Sri Lanka for an updated species identification guide for their region given that most guides were published around 1990-2000.

75. The WPEB **NOTED** that Sri Lankan researchers requested FAO to update the regional FAO guide. In the meantime, the WPEB **SUGGESTED** that Sri Lankan scientists track taxonomic evolutions and conduct such updates locally.

76. The WPEB **NOTED** that Sri Lanka conducted independent surveys in 2018 from which they identified 593 species.

77. The WPEB **NOTED** paper IOTC-2024-WPEB20(AS)-37 on Spatio-temporal Distribution of Catch and Population Structure of Blue shark, Prionace glauca and Silky shark, Carcharhinus falciformis, caught by longlines in Kenya's Exclusive Economic Zone, including the following abstract provided by the authors:

"The Kenya exclusive economic zone (EEZ) and the entire Western Indian Ocean (WIO) forms a region that is characterized with a high degree of fishing pressure, which has resulted to increased bycatches especially of sharks (Kiilu et al., 2019). The Blue shark Prionace glauca (Linnaeus, 1758) and Silky shark Carcharhinus falciformis are considered as the most salient pelagic shark species in the Kenyan EEZ with high incidental catches across various fishery types (Kiilu et al., 2023). The risk of increased bycatch continues to raise alarm on inevitable extinction of several shark species and various ecosystem structure and functions through elimination of these apex predators (Zhang et al., 2024). This study aimed to assess their distribution and

abundance by employing approach to combine longline industrial fishing catch logbooks and fishery-independent data from the national observer scheme. The output shows unique spatial and temporal patterns of distribution for both species. It was discovered that cool and high productive waters were suitable for the Blue shark coupled with considerable seasonal migrations noted towards equatorial regions during the cooler South Easterly Monsoon winds and warmer North Easterly Monsoon winds seasons. On the other hand, warmer waters revealed high suitability of Silky sharks that had a seamless distribution across the Kenyan EEZ all year round, however areas of high production and specific depths had recognizable aggregations. The abundance of both species was determined as significant hotspots that tend to overlap with regions of high fishing and exploitation. Therefore, such overlaps highlights a vital opportunity for targeted conservation measure to control risks of over-exploitation. This research emphasizes that in the development of effective conservation and management measures it is paramount to deliberate on the distinguishable ecological needs and migration patterns of each species."

78. **ACKNOWLEDGING** that the chlorophyll-a data are highly left-skewed, the WPEB **ENCOURAGED** the authors to log-transform these data in order to obtain a more normally distributed explanatory variable. The WPEB also **ENCOURAGED** the authors to investigate non-linear relationships using GAMs prior to using GLMs.

79. The WPEB **ENCOURAGED** the authors to apply consistent spatio-temporal scales between the environmental and response data in the analyses.

80. **ACKNOWLEDGING** that the presented analysis considers catches in weight as the response variable, the WPEB **ENCOURAGED** the authors to investigate the CPUE (effort in number of hooks) which would better reflect the spatial density of the species.

81. The WPEB **NOTED** the outliers that appear in the correlation between the shark catches shown in weight and numbers, and therefore **ENCOURAGED** the authors to further verify and clean their dataset. The WPEB further **SUGGESTED** scaling down the data to an absence/presence dataset and investigating the relationships.

82. The WPEB **ENCOURAGED** the authors to investigate the spatio-temporal patterns of the distribution in relation to shark sizes. The WPEB **NOTED** that size measurements were recorded by observers because this information is not available from logbooks.

83. The WPEB **SUGGESTED** investigating the potential link between the presence of sharks with the monsoon season which can have a substantial impact on the seasonality patterns.

84. The WPEB **NOTED** paper IOTC-2024-WPEB20(AS)-INF01 on the inputs for comprehensive bycatch management strategy evaluation in tuna fisheries, including the following abstract provided by the authors:

“*There has been growing concern over the sustainability of marine megafauna exposed to bycatch fishing mortality. This study assembled databases of mitigation methods for at-risk species exposed to pelagic longline, tuna purse seine and drift gillnet fisheries. The databases enable the discovery of bycatch mitigation methods and enable accounting for multispecies effects of alternative bycatch mitigation strategies across exposed populations and stocks of at-risk species. The study defines key inputs for comprehensive, multispecies bycatch management strategy evaluation of: the size of the effect of an intervention on catch and fishing mortality rates; multispecies conflicts and mutual benefits; strength of evidence, including in practice; commercial viability costs; compliance likelihood; and rates of components of fishing mortality. The robust evaluation of alternative bycatch management strategies against this suite of criteria enables simulating the outcomes of alternative strategies to determine which best meets* *objectives. The report includes a draft Decision or Resolution on holistic bycatch MSE to aid regional fisheries management organizations in identifying candidate elements for potential inclusion in measures.*"

85. **RECOGNIZING** that bycatch mitigation measures may have different effects on each species, the WPEB **AGREED** that once in place, the efficiency of such measures should be assessed, taking into account their impact on target species, socio-economic aspects, practicability, crew safety, etc. The WPEB further **AGREED** that such an assessment should be quantitative rather than qualitative as much as possible.

86. The WPEB **NOTED** that the tables presented provide a useful representation of the pros and cons of the various potential measures for various bycatch species. **ACKNOWLEDGING** that this provides a good baseline, the WPEB **NOTED** that it would be useful to update these tables regularly.

87. The WPEB **NOTED** that this is currently a qualitative approach as indicators relating to population trends are generally not available and these would be required to take a quantitative approach. The WPEB further **NOTED** that it would be complicated to incorporate so many factors from different species into one single model.

88. The WPEB **NOTED** the potential benefits of identifying key indicators to assess ecosystem health, along with methods for estimating these indicators.

89. The WPEB **NOTED** the potential interest in understanding the socio-economic impacts behind each of the indicators or measures being evaluated. The WPEB **NOTED** that elements such as the willingness to pay for the costs of changing fishing practices may be very difficult to measure but would be a key consideration for managers when taking a decision on whether to adopt a measure. The WPEB **SUGGESTED** that this kind of mitigation trade-off is discussed at the Working Party on Socio-economics.

90. The WPEB **NOTED** that there will be trade-offs with each of the mitigation measures and that those should be presented comprehensively so that managers can make informed decisions. The WPEB **AGREED** that mitigation measures with only benefits should be prioritized.

7.2 Development of shark research work plan for scalloped hammerhead

91. The WPEB **NOTED** that scalloped hammerhead was originally chosen as the priority species for these shark research work plans as it was the species being assessed in the year that the work plans were being discussed and a preliminary recovery plan for the species had recently been published (IOTC-2022-WPEB18-18).

92. The WPEB **NOTED** an update on the work being done on this which included a compilation of biological parameters. The WPEB **NOTED** that this species is considered to be relatively well studied in South Africa but **NOTED** that there may be regional differences in life history characteristics.

93. The WPEB **NOTED** that there is limited information on catches of this species in IOTC, perhaps due to the overlap in species distribution with gillnet fleets and the limited interactions with longline fisheries.

94. The WPEB **NOTED** that there are some unpublished datasets on scalloped hammerhead shark from coastal fisheries in the Western Indian Ocean that have been developed by WCS for Kenya, Tanzania, Mozambique and Madagascar and that landed sharks in these countries appear to be dominated by very small immature individuals. The WPEB **NOTED** that this information for Kenya has shown that it is the most abundant species landed in artisanal fisheries and 100% of landings during surveys

were of immature individuals. The WPEB further **NOTED** that it is also one of the common elasmobranch species caught in Madagascar and pregnant females have been documented in landings from the north of the country indicating that this may be a nursery area.

95. The WPEB **NOTED** that improving data on this species should be a priority and could be used to help to identify habitats of importance for different life stages and **SUGGESTED** that data mining could be used to reconstruct historical catch and effort data. The WPEB **NOTED** that quantifying fishing mortality and monitoring the total fishing effort on this species is important.

96. The WPEB **NOTED** that there is some knowledge of nursery grounds and that work could be done to monitor these habitats, create habitat maps and look at alternative management measures for this species such as nursery closures.

97. Despite the lack of studies on hammerhead sharks, the WPEB **AGREED** that it is necessary to take steps forward to reduce at-vessel mortality.

98. Based on the experience of Australian scientists, the WPEB **NOTED** that it is difficult to obtain samples for hammerhead sharks. The WPEB **AGREED** on the importance of beginning data collection efforts, including genetic sampling when feasible. This process should be coordinated across IOTC CPCs for maximum effectiveness.

99. The WPEB **NOTED** that ICCAT has developed a research plan which covers several shark species, and this was **AGREED** by the WPEB to be a better strategy than focusing on one particular species at a time considering that broadening the scope will likely attract more CPCs and may be beneficial for raising funds. The WPEB **AGREED** to contact scientists involved in ICCAT's research plan to learn from their work and to make progress.

100. **ACKNOWLEDGING** that the last Ecological Risk Assessment for IOTC sharks was conducted in 2018, it was **NOTED** that it could be beneficial to update this analysis, particularly as it may help to identify the species' of priority for inclusion in the work plan.

101. **NOTING** the shark year plan that was developed by IOTC a few years ago, the WPEB **AGREED** that a workshop to update this document should be held with a small group of experts, including the original authors. The WPEB **NOTED** that it would be helpful to include an indication of the funding that would be required for items in the workplan.

8. Stock assessment for shortfin mako shark

8.1 Review of indicators for shortfin mako shark

102. The WPEB **NOTED** paper IOTC-2024-WPEB20(AS)-11 on Regional observer scheme data on shortfin mako shark CPUE, including the following abstract provided by the author:

> *"The paper is to update the 20th Working Group on Ecosystem and Bycatch (WPEB20) about catch effort data related to shortfin mako shark (SMA) from the Regional Observer Scheme (ROS). We aim to check if this data can help develop a suitable catch per unit effort (CPUE) index for the SMA stock assessment. The data examined in the paper are based on data already submitted and included in the IOTC ROS database."*

103. The WPEB **NOTED** that following the request from the Data Preparatory meeting in April 2024, the Secretariat investigated the possibility of providing an abundance index for shortfin mako (SMA) using the available ROS data from the different CPCs. The investigation concluded that the ROS data are currently not adequate to derive an abundance index for SMA. The only data concerning SMA

included in the ROS database are from EU,France (Reunion LL fleets) and Japan. The WPEB **NOTED** that the Secretariat receives observer data from other CPCs, but the formats (older excel IOTC form, pdf, etc., which differ between CPCs) are not appropriate for inclusion in the ROS database.

104. The WPEB **NOTED** that quite a few CPCs submitted electronic (excel) data but these were not in the format requested by the IOTC, and that liaison between the Secretariat and CPCs should take place to improve the situation and ensure that data are submitted in the appropriate format so they can be included in the ROS database. The WPEB also **NOTED t**hat the ROS database and data forms have been changing substantially over time, which limits the stability of the data that can be used for analysis.

105. The WPEB **NOTED** paper IOTC-2024-WPEB20(AS)-12 on Standardized CPUE of Shortfin Mako Shark (*Isurus oxyrinchus*) from Indonesian tuna longline fleets in the north-eastern Indian Ocean, including the following abstract provided by the authors:

"The main objective of this study was to assess the abundance index of shortfin mako sharks (Isurus oxyrinchus) in the northeastern Indian Ocean using fishery-independent data collected by scientific observers. The study aimed to address this region's information gaps associated with low coverage. A total of 3,296 observer data points were obtained from the Indonesian scientific observer program, covering the years 2005 to 2021. The nominal annual CPUE was calculated as the number (N)/1000 hooks. Standardized CPUE was estimated with Generalized Linear Models (GLM) using year, quarter, Lat/Lon, and gear operational characteristics. Model fit and model comparison were conducted with Akaike Information Criteria (AIC), apparent coefficient of determination (R2), and model validation with residual analysis. The final estimate of the abundance index was calculated using the least square means method. The results showed that the factor contributing most to the deviation was Year, followed by Latitude, Quarter, Longitude, and other effects and interactions. The trend of standardized CPUE remained relatively stable (with very low abundance). These fluctuations were thought to be due to natural population variations and inter-annual environmental factors rather than operational changes."

106. The WPEB **NOTED** that CPUE, defined as the number of fish per 1,000 hooks, from the Indonesian scientific observer program for the years 2005 to 2021, were standardized with a GLM using year, quarter, Lat/Lon, and gear operational characteristics. The results showed that the factor contributing most to the deviation was Year, followed by Latitude, Quarter, Longitude, and other effects and interactions. The trend of standardized CPUE was relatively stable.

107. The WPEB **NOTED** the unusually low proportion of zeros in year 2017 (when compared with the rest of the time series) and the impact this may have on the diagnostics and results. On the other extreme, an exact 0 value (without any confidence interval) is estimated for the standardized CPUE in 2011, which the WPEB **NOTED** does not seem to be fully representative of true population abundance.

108. The WPEB further **NOTED** that this CPUE is not currently included in the stock assessment, as it was not presented at the Data Preparatory meeting and only became available for this meeting. However, it was agreed that it could be included in a sensitivity run (see later in this report).

109. The WPEB **NOTED** paper IOTC-2024-WPEB20(AS)-13 on Exploring the spatial-temporal dynamics of standardized CPUE for shortfin mako shark (*Isurus oxyrinchus*) caught by the Taiwanese large-scale tuna longline fishery in the Indian Ocean, including the following abstract provided by the author:

"Understanding spatiotemporal variability is essential in stock assessment and fishery conservation to accurately track changes in the distribution and abundance of fish stocks over time. This study investigates recent trends in the relative abundance of shortfin mako sharks (Isurus oxyrinchus) in the Indian Ocean, utilizing catch rate data from the Taiwanese large-scale longline fishery. We standardized the catch per unit effort (CPUE), defined as the number of fish caught per 1,000 hooks, using a vector autoregressive spatiotemporal (VAST) model. The results indicate that the standardized CPUE of shortfin mako sharks has remained stable, with a slight upward trend. While nominal CPUE exhibited significant fluctuations, particularly in 2005 and 2015, the standardized CPUE showed a more consistent increase, especially during 2015 and 2023. This suggests that shortfin mako shark stocks were optimally utilized between 2005 and 2023. The application of a spatiotemporal model, combined with comprehensive data from the Indian Ocean, provided valuable insights into the abundance trends of shortfin mako sharks. Future research should consider integrating environmental factors and extending the observation period to further enhance the analysis."

110. The WPEB **NOTED** that the CPUE data, defined as the number of fish per 1,000 hooks, for the years 2005 to 2023, were standardized using a vector autoregressive spatiotemporal (VAST) model. The WPEB **NOTED** that the resulting standardized CPUE showed a slight upward trend.

111. The WPEB **NOTED** that the 2020 year had a very high standardized CPUE value, which does not seem fully representative of population abundance (as this is not likely to change so strongly between consecutive years, especially for a species with low productivity such as shortfin mako).

112. The WPEB **NOTED** that this CPUE series was not available at the Data Preparatory meeting but was provided later to the scientist conducting the stock assessment. This series has been included in a sensitivity run (see later in this report).

113. The WPEB **NOTED** the presentation that provided an update of the progress of the Close-Kin Mark Recapture (CKMR) project for Indian Ocean SMA, currently being implemented by CSIRO. In CKMR, genetic data are used to identify closely related individuals which provides a way to estimate absolute spawning abundance. The method can also provide information on stock structure, etc. It has been applied in Australia already for several shark species and for southern bluefin tuna.

114. The WPEB **NOTED** that before starting a full CKMR study, it is very useful to conduct a design study to assess the feasibility of the method for a certain species and to investigate the suitability of alternative sampling schemes. Such a study has now begun for SMA and will make use of any new updated stock assessment results that the WPEB may provide.

115. The WPEB **NOTED** that such study can allow for the possibility of determining stock structure of the species within the Indian Ocean (and even possibly connections with other oceans). The aim is to be able to present some results at the next meeting.

8.2 Stock assessment models

116. The WPEB **NOTED** paper IOTC-2024-WPEB20(AS)-10 on Stock assessment of the shortfin mako shark in the Indian Ocean (IOTC), using Bayesian surplus production models (JABBA): catch reconstruction, demographic analysis, stock assessment models and projections, including the following abstract provided by the author:

"Bayesian Surplus Production Models were fitted to the Indian Ocean shortfin mako shark, using the JABBA framework (Just Another Bayesian Biomass Assessment). The catch history of the fishery used either the data reported to IOTC or, alternatively, a time series using estimated

catches. Priors for the intrinsic growth rate of the population (r) were calculated using stochastic Leslie matrices, using a set of plausible life history parameters. An ensemble grid approach was used for the stock assessment, to incorporate uncertainties associated with the life history parameters and the form of the production function. The combination of the various scenarios used as the base case model grid ensemble showed that the stock is currently overfished (B<Bmsy) and subject to overfishing (F>Fmsy). Stochastic projections were carried out for this base case grid model ensemble. Given the current high levels of fishing mortality and stock status, there is a need to reduce future catches to a maximum value (TAC) of 40% of current catches, to prevent future declines in biomass and allow the population to start recovery."

117. The WPEB **NOTED** that previous preliminary attempts at stock assessments for shortfin mako were conducted in 2018 and 2020 (using CMSY and JABBA), but due to the uncertainties in the model and data the stock status remained "Unknown". After the WPEB Data Preparatory Meeting held in April 2024, a new stock assessment was developed based on JABBA (a biomass dynamics model including process error and fitted by Bayesian methods) and using the data agreed at the Data Preparatory Meeting.

118. The WPEB **NOTED** that the main catch series used in this year's assessment is the IOTC reported catches of SMA, MAK (short and long fin mako combined), MSK (Lamnidae: Mackerel sharks, porbeagles nei), AG17 (equivalent to MAK) and AG20 (equivalent to MSK) combined. SMA and MAK are the categories with the largest amounts of catch, while the amount of catch in the other categories is very small. The WPEB **NOTED** that the catch series shows a drop in recent years, which is likely related to recent non-retention policies.

119. The WPEB further **NOTED** that another catch series, where SMA catches are estimated based on ratios relative to main catch species, is used only as a sensitivity. This estimated catch series does not show a drop in recent years and may not be applicable for recent years because it does not account for likely changes due to non-retention policies for this species.

120. The WPEB **NOTED** that the biological parameters agreed at the Data Preparatory meeting were applied in a Leslie matrix model to derive values for the intrinsic growth rate, r, used in JABBA. Applying a Leslie matrix model approach with these parameters and including uncertainty in natural mortality and fecundity at age, three distinct prior distributions for r were proposed, centred at values of 0.031, 0.055 and 0.085, which are in line with a low productivity species. A prior with a CV of 15% was used for the assessment models.

121. The WPEB **NOTED** that three different specifications were considered for the shape parameter of the JABBA production function: Schaefer (shape parameter m=2, which corresponds to Bmsy/K=0.5) and two Pella-Tomlinson models with Bmsy/K = 0.4 and 0.55, which correspond to values of the shape parameter m below 2 and above 2, respectively, corresponding to different levels of density-dependence in the population. For the two Pella-Tomlinson models, prior uncertainty was incorporated around the value of m assuming a CV of 20%.

122. The WPEB **NOTED** that the base-case assessment consisted of a grid of 9 equally-weighted models, corresponding to all combinations of the 3 settings for the intrinsic growth rate (r) and the 3 settings for the shape parameter (m).

123. The WPEB **NOTED** that the CPUE series' used for the model fit in the base-case assessment were those corresponding to USSR (1967-1989), Japan (1993-2018) and Spain (2001-2022). In general terms, these series show a relatively flat trend (USSR), a big drop around 2000 and then mostly flat (Japan) and a slowly increasing trend (Spain). The Portuguese CPUE series (2000-2022) was not used

in the base-case assessment, only in sensitivity runs, but had a similar trend to the Spanish CPUE series but with higher variability. The Taiwanese series (available in the Data Preparatory Meeting for 2005-2018 and later extended to 2022) was also used only in sensitivity runs.

124. The WPEB **AGREED** to use the CPUE series from the USSR (1967-1989) as sensitivity runs during the Data Prep meeting and **NOTED** that this index provides information from the early period and it was not influential in the outcome of current stock status.

125. The WPEB **NOTED** that other settings used in the JABBA base-case assessment were: a CV of 20% assumed for the catch series, a Beta prior distribution on B(1967)/K, with mean=0.9 and CV=10%, process error (i.e. annual deviations from the biomass dynamics model) where the CV of this process error is estimated using a non-informative prior, and an additional observation error component estimated separately for each of the CPUE series.

126. The WPEB **NOTED** that the diagnostics of the 9-model grid base-case assessment (fits to CPUEs, RMSE, runs test for the residuals, retrospective analysis, hindcast cross-validation) were deemed to be acceptable.

127. The WPEB **NOTED** that a range of sensitivities were run, specifically: a) a catch-only model (i.e. dropping all CPUE series), b) leaving out one CPUE series at a time, c) fixing the CV of the process error to either 5% or 10%, d) not estimating an additional component of the observation error for each CPUE series, and e) using the estimated catch series (based on ratios to main catch species) instead of the reported catch series.

128. The WPEB **NOTED** that the sensitivity analyses showed that the Japanese CPUE series is the most influential for the estimates of stock status, which may be explained by the fact that it is the only CPUE series available during the 1990s, a time when the catches increased substantially. This is the case, not only for the base-case assessment (which includes the USSR, Japanese and Spanish CPUE series), but also for an assessment including all CPUE series (i.e. also including the Portuguese and Taiwanese series). In the base-case, the Spanish series was influential for the results of the most recent years, although this was not the case for an assessment including all CPUE series. The catch-only sensitivity run, excluding all CPUE series, estimated a more pessimistic stock status in recent years. The WPEB **NOTED** that the catch-only method has to make assumptions about the current depletion level. JABBA model settings concerning process error and observation error also had an impact on model goodness of fit and the estimated stock status. The sensitivity run using estimated catch (based on ratios) indicated a very different overall scale for the stock biomass, although stock status in relative terms (i.e. relative to Bmsy or K) is similar.

129. The WPEB **NOTED** that the results from the 9-model grid base-case assessment were combined, with equal weights, to determine current stock status (B/Bmsy and F/Fmsy) and to conduct projections of future stock status under various levels of catch in future years. The combined model results are in **Table 2**.

130. The WPEB **DISCUSSED** various potential difficulties with the CPUE series (particularly, the Japanese one, which has the largest impact on the stock assessment results given that it is the only series available for the 1990s, a period when stock catches increased substantially) and also the limitations of using a biomass dynamics model (i.e. JABBA) for a late-maturing species, as is the case for SMA.

131. The WPEB **NOTED** that the CPUE series were based only on retained catch and the retention practices could have changed in recent years, which would create difficulties for their interpretation

as indices of stock abundance. The WPEB **REITERATED** the requests of the WPEB(DP) to explore whether it is possible to use observer data to examine if discard ratios have changed over time. Furthermore, the WPEB **NOTED** that the assessment team had not had time to undertake a comparison of CPUE trends (suggested by WPEB(DP)) between fleets in the core area of the southwest Indian Ocean to which fishing effort by a number of fleets had contracted to over time. Such an analysis would assess if the fleets in the same core area show similar or different CPUE trends (as a test of the use of these data as abundance indices). Undertaking such an analysis would be useful prior to future assessments.

132. Concerning the growth parameters, the WPEB **NOTED** that a view was expressed that it might be more appropriate to use the Liu et al. 2018 growth parameters (which are based on data from the Indian Ocean but assume the formation of 1 band pair per year) only in sensitivity runs and to base the assessment only on the Takahashi et al. 2017 growth parameters (as the latter is based on a meta-analysis, considering studies that assume either 1 or 2 band pair per year, although the data are not from the Indian Ocean). However, the WPEB **AGREED** that the use of both models provided a more realistic characterization of the current state of knowledge and existing uncertainty about growth and productivity of the stock.

133. The WPEB **REQUESTED** that the developer run an extra sensitivity run using the Indonesian CPUE series, which became available for this meeting and for a run with the Japanese CPUE starting in 2000 to 2021. To further understand the impact of process error in the assessment results, a sensitivity run without process error was also requested, with and without extra observation error for the CPUE series (so actually, two sensitivity runs). Those additional runs were presented at the meeting, with the following observations:

- The Indonesian CPUE is relatively short and highly variable and resulted in much worse model fits. The end results in terms of stock status are a little more pessimistic than the base case, but are still relatively similar.
- The sensitivity run without process error (or with a very low process error fixed at 1%) did not achieve convergence, even after running multiple MCMC chains with many iterations and a long burn-in period. It is noted that it would be highly unusual to do a formal stock assessment without process error, although it was also agreed that levels of process error that are too high could result in data overfitting and would decrease the quality of an assessment.
- An additional sensitivity run starting the Japanese CPUE series in year 2001 (instead of 1993) was also conducted and showed results very similar to the sensitivity run which excluded the whole Japanese CPUE series. This again highlighted the fact that this CPUE series (which covers the years 1993-2018) is very influential on the stock assessment results and that this is because it is the only CPUE series available during the 1990s and running into the 2000s.
- The strong impact of the Japanese CPUE series increases the uncertainty of the assessment, as there is no other CPUE series against which the drop observed in the CPUE values of the Japanese series around year 2000 can be contrasted.
- The catch-only model provided similar results of current stock status, providing additional confidence. However, it was also noted that those models need to make some assumptions concerning a range of plausible biomass depletion levels in some relatively recent years.
- The flat or increasing trend seen in all of the available CPUE series' since the early 2000s does not seem to be totally consistent with the increasing catches observed from the mid-1980s until about 2016, bearing in mind the decrease observed in the Japanese series around year 2000.

Table 2. Shortfin-mako shark: Key management quantities from the JABBA assessment:

Management quantity	Indian Ocean
2022 catch estimate (t)[1]	2,697 t
Mean catch from 2018–2022 (t)	1,317 t
MSY (t) (80% CI)	1930 (985 – 3313)
Data period used in assessment	1950-2022
F_{MSY} (80% CI)	0.03 (0.01 – 0.07)
B_{MSY} (t) (80% CI)	60,000 (35,700 – 103,800)
F_{2022}/F_{MSY} (80% CI)	1.53 (0.65 – 3.71)
B_{2022}/B_{MSY} (80% CI)	0.96 (0.58 – 1.41)
B_{2022}/B_{1950} (80% CI)	0.45 (0.27 – 0.69)

8.3 Review of proposed stock assessment of shortfin mako

134. The WPEB **AGREED** that this is a data-limited assessment and that it is not possible to assess the stock with a high degree of certainty at present. The WPEB **AGREED** that the key uncertainties must be highlighted. The current stock assessment has taken the key biological uncertainties into account and reflected those in the model (via a grid of 9 models) and in the results of the stock assessment, and the available CPUE data have been used appropriately. The sensitivities explored were found to be valuable. In conclusion, despite the difficulties and issues raised, the WPEB **AGREED** that this is an appropriate stock assessment, suitable to provide management advice on stock status and projections for future catches.

135. Considering the characterized uncertainty, and on the weight-of-evidence available in 2024, the shortfin mako shark stock is determined to be **overfished** and subject to **overfishing** (**Figure 1**).

136. The WPEB **NOTED** that current catches (2020-2022) are higher than MSY. Under those levels of catches, the biomass will continue to decline, and fishing mortality will continue to increase over time. In order to have a lower than 50% probability of exceeding MSY-reference points in 10 years, i.e., to recover the stock to the green quadrant of the Kobe plot with at least 50% probability in 10 years, future catches should not exceed 40% of current catches. This corresponds to an annual TAC of 1,217.2 t (representing all fishing mortality including retention, dead discards and post-release mortality).

[1] This (and the average for 2018-2022) includes catches with the following species codes: SMA, MAK (short and long fin mako combined), MSK (Lamnidae: Mackerel sharks, porbeagles nei), AG17 (equivalent to MAK) and AG20 (equivalent to MSK) combined

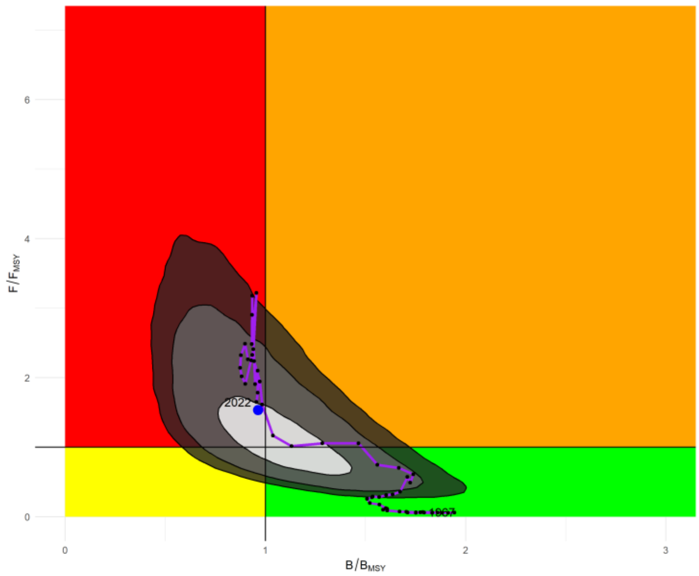

Figure 1. Shortfin mako: 2024 stock status, relative to B_{MSY} (x-axis) and F_{MSY} (y-axis) for the final model. The point represents the median of the 9 final models used in the ensemble grid and the shaded areas are the 50%, 80% and 90% contours of the uncertainties in the terminal year. The line represents the time series of the median stock trajectory from the ensemble grid of models.

8.4 Recommendation and executive summaries (all)

137. The WPEB **ADOPTED** the management advice developed for shortfin mako shark, as provided in the draft status summary in <u>Appendix X</u> and **REQUESTED** that the IOTC Secretariat update the draft stock status summary with the latest 2022 catch data and the results from the projections in the Kobe II Strategy Matrix, and for the summary to be provided to the SC as part of the draft Executive Summary, for its consideration.

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

9.1 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

138. The WPEB **NOTED** paper IOTC-2024-WPEB20(AS)-19 on Preliminary summary report on the leader type used by Japanese longline fleet in the Indian Ocean, including the following abstract provided by the authors:

"In this document, we provide the additional information on the situation at the actual Japanese commercial longline operation in the Indian Ocean on the leader materials in use together with relevant shark catches, based on the Japanese scientific observer database, deployed in the Indian Ocean between 2015 and 2019. As a result of analysis on vessel-base, the actual utilization of wire leader was quite limited in the case of Japanese fleet operating in the Indian Ocean. Around 80% of vessels exclusively utilized monofilament leaders and even remaining vessels tended to replace with wire leaders for few branch-lines per basket. The species composition of shark in the observed catch indicates majority of sharks caught was blue shark, followed by shortfin mako generally, irrespective of leader type. Comparison of CPUE for blue shark and shortfin mako between leader type suggested higher or almost similar level of CPUE by monofilament operation, compared to the wire leader operation. Comparison of at-vessel mortality between leader type showed higher mortality in the

operations with monofilament leaders for two majority shark species caught, blue shark and shortfin mako with inconclusive result for silky shark and bigeye thresher. As a conclusion, the quick analysis of Japanese observer data indicated no or insignificant impacts of introducing the non-use of wire leaders on the conservation of sharks, mainly due to the low proportion of branch lines with wire leaders at current stage, together with the results indicating lack or insignificance of its mitigation effects on sharks."

139. The WPEB **THANKED** the authors for preparing this analysis in response to the request made during the WPEB Data Preparatory Meeting and **ENCOURAGED** other CPCs to undertake similar analysis for review in future meetings.

140. The WPEB **NOTED** that in this study using human observer data, nearly 80% of Japanese longline vessels observed exclusively used monofilament leaders, and some others use wire leaders on less than half of branch lines deployed, while only one vessel observed exclusively used wire leaders. The WPEB further **NOTED** that the study summarized data on leader materials at a trips/cruises level since the observer data indicated that generally there were no modifications to the leader materials when operating in the same area and targeting the same species (i.e. trips/cruises). The WPEB **NOTED** that the use of wire leaders likely varies depending on factors such as the operational area, target species, and fleet practices although no clear pattern was identified during this preliminary analysis and further **NOTED** that more detailed information (e.g. on why some vessels use only monofilament and some only use wire) would be provided to the group once it becomes available. The WPEB **NOTED** that the observer data used in the study confirmed that shark lines were not used in the Japanese longline fleet.

141. The WPEB **NOTED** that the WPEB(DP) meeting in April focused on reviewing statistically robust research on leader effect, including experimental trials (with controlled design), and statistical model based analyses of observer data, both of which represent more robust approaches to assessing the impact of using wire leader materials on shark catch and mortality. The WPEB **NOTED** that in both types of research, appropriate statistical methods are used to account for the effects of various factors upon catch/retention rates and mortality and to then estimate the effects of leader types specifically.

142. In relation to the paper presented, the WPEB **NOTED** the limitations of the document in drawing robust conclusions about leader effects due to the lack of thorough statistical analysis resulting from data limitations. However, some pointed to the importance of direct observation obtained from the fleet operating in the Indian Ocean which should not be ignored.

143. Finally, the WPEB **NOTED** two key issues with respect to the papers conclusion regarding the potential for a lower conservation benefit from prohibiting wire trace, due to the relatively low observed use of wire trace at least in the Japanese fleet. Firstly, the WPEB **NOTED** the need and importance of understanding the current situation of wire trace use across other fleets in the Indian Ocean. Secondly, some considered that even if wire trace use (in any fleet) was low currently, a prohibition on its use can act to prevent increases in use (and shark mortality) in the future. However, others emphasised the importance of considering the seriousness of impacts to the operations of a certain fleet regardless of the actual amounts of use.

144. The WPEB **NOTED** that the investigation of hook type and spatial distribution of gear configurations would be useful as future work.

145. The WPEB **NOTED** paper IOTC-2024-WPEB20(AS)-20 on Effect of bait and hook types on pelagic shark by-catch and discards of tuna longline fishery in Sri Lanka, including the following abstract provided by the authors:

"Sharks can be identified as the dominant by-catch of the tuna targeting longline fishery in Sri Lanka. Understanding of the effect of bait type, hook type on catch rate of retained and discarded sharks is a significant factor to be considered to management of the shark by-catch. This study aims to investigate the status of shark by-catch retained and discarded by tuna longline fishing activities of multiday boats in Sri Lanka from January 2020- December 2023, based on the logbook data. Further field surveys were conducted randomly to verify the shark by-catch landings at the fishing harbours. Catch rate (Number/1000hooks) were estimated relevant to the hook type and the bait type. Four types of hook were identified during the survey (J 36, J26, 0 83 and 0 17) and highest CPUE was recorded by J shape hoop type 26 size (0.0889ind/1000hooks) while no records of retaining shark landing by circle shape 17 size hooks. Highest percentage of live released of sharks were recorded by the O shaped 83 size hooks. highest catch rate (0.0836 ind/1000hooks) was recorded by the squid bait followed by the flying fish (Family Exocoetidae) (0.0640ind/1000hooks). Generalized Linear Model resulted the positive effect of J 26 hook type and flying fish bait type on the catch rate while logistic regression model. Flying fish and J 26 hook type combination resulted the highest likelihood of catching sharks (Odd Ratio=4.5, p<0.00). Use of circle shape hooks can be recommended to reduce the by-catch but, further investigations should be conducted on the effect of other fishing operations and environmental variables to make proper conclusion. Further studies are recommended to introduce gear modifications to reduce the shark by-catch."

146. The WPEB **NOTED** that the analysis was specifically focused on bait types used for shark catches, and therefore, no data are available regarding the effectiveness of different bait types for targeting tuna or billfish species.

147. The WPEB **NOTED** paper IOTC-2024-WPEB20(AS)-21 on IOTC ROS mitigation measure and shark catches summary, including the following abstract provided by the authors:

"This paper was developed at the request of the bycatch mitigation workshop held during the data preparatory meeting. The summary presented is related to the reporting of the use of mitigation measures for sharks in longline fisheries, including data contained within the IOTC ROS database and a review of observer trips carried out between 2018-2022 as well the responses of some CPCs to the WPEB request for information. It was found that mainline material was reported on 99.1% of observer trips with a wide range of materials except for wire. The reporting of leader material is not mandatory and was only notified in 59% of the reports reviewed, of which wire only accounted for 3%. The use of shark lines was only reported in 6.2% of the observer trips (and in all of them it was reported that no shark lines were used). The document includes the observed catches of sharks and tunas only for those CPCs that responded to the consultation carried out by the WPEB."

148. The WPEB **NOTED** that the use of shark lines is poorly reported in the ROS submissions although it is a mandatory requirement, therefore the WPEB **ENCOURAGED** CPCs to provide this information according to the ROS standard.

149. The WPEB **NOTED** that the Secretariat is liaising with those countries that reported data in Observer trips reports (e.g. in word or pdf formats) to reconstruct the historical submissions according to the ROS standard and **ENCOURAGED** CPCs to use the latest IOTC ROS forms developed by the Secretariat to facilitate their validation and inclusion in the ROS database.

150. The WPEB **NOTED** and confirmed the definition of the number of shark lines and the use of wire leaders as reported by Indonesia, as well as the target species associated with these operations. The WPEB **NOTED** that the primary target species for operations utilizing wire leaders in Indonesian longline fisheries was bigeye tuna. The WPEB **SUGGESTED** conducting a comparative analysis of shark catch ratios between different leader types.

151. The WPEB **DISCUSSED** the potential for collecting detailed information on leader materials through Electronic Monitoring System (EMS) data collection programs.

152. The WPEB **NOTED** that mainline material is consistently being submitted by CPCs in their ROS data. The WPEB **NOTED** that the ROS minimum data requirements are currently under revision by the WGEMS/WPDCS and that the current working draft review for longline vessels suggested that collecting detailed branchline configuration information should be "mandatory" at the trip level, however, branchline materials and leader materials for catches of sensitive species should be "mandatory" but this should include the possibility to record this information as "unknown" due to the practical difficulties of collecting this information both by onboard human observers and by EMS. The WPEB further **NOTED** that collecting data on leader material for each fishing set as part of the ROS remains "optional" and includes the possibility of recording this information as "unknown" due to the practical difficulties of collecting this information both by onboard human observers and by EMS. The WPEB **NOTED** that these points will be further discussed at the WPDCS and the WPEB **REQUESTED** that the WPDCS consider these recommendations in their discussions.

153. The WPEB **NOTED** paper IOTC-2024-WPEB20(AS)-22 on Proposal of an online digital ocean atlas for the Indian Ocean and a dedicated IOTC webpage on climate change and its impacts on tuna fisheries, including the following abstract provided by the authors:

"Resolution 24/01 of the IOTC, adopted at the 28th session of the Commission, calls for a better integration of ocean and climate change information in the development of conservation and management measures. In this context, a design for a digital ocean atlas for the area of competence of the IOTC (IODA) is proposed. The atlas would produce interactively monthly maps, time series, transects, space-time plots (hovmoller) and vertical profiles, from a set of 18 physical and biogeochemical oceanic variables, from surface to 763 m depth. Different options are discussed on the required datasets to optimize the disk space. The Fisheries and Aquatic Resource Department of Sri Lanka is candidate to support hosting the server and deploying IT team, to perform the maintenance of the system and to have IODA running routinely. In this paper, we also suggest guidelines for the development of an ocean-climate web page on the IOTC web site, to present indicators and trends on the ocean and climate, and provide educational materials in relation to climate change in the Indian Ocean. Those suggestions for the atlas and the web page must be discussed by the WPEB to define a roadmap in accordance with Res 24/01"

154. The WPEB **AGREED** in the interest in developing tools which will make ocean and climate information more readily available to the IOTC scientific community as requested in Resolution 24/01. In this respect, the WPEB **ACKNOWLEDGED** that the proposed Indian Ocean Digital Atlas (IODA) would contribute greatly to this objective.

155. The WPEB **NOTED** the possibility of having additional layers of information (fisheries, biological data) overlaid on the maps of physical or biogeochemical parameters produced by the atlas. The WPEB **NOTED** that the atlas maps can be exported to SIG-compatible formats, where this overlay could be done. Otherwise, a more elaborated version could be designed at a later stage, but the WPEB **NOTED** this would come with an additional cost.

156. The WPEB **NOTED** that the selected datasets would come from the European Copernicus Marine Service which is an operational service supported by an active community, with products of excellent quality delivered freely at various time scales and high spatial resolution (8 and 25 km) matching the resolution of tuna data.

157. The WPEB **NOTED** that the monthly basis proposed for the IODA might not be appropriate for all fisheries, and that a shorter time scale, such as a week, could be considered and **NOTED** that this could be an option, but at the cost of a significant higher disk space to accommodate the datasets.

158. The WPEB **NOTED** the possibility of extending the northern boundary to 30°N in order to include the Gulf region and to set a southern limit at 45°S, as well as extending the depth covered by the atlas down to 1,000 m to cover the vertical movements of species such as swordfish.

159. The WPEB **ACKNOWLEDGED** that the atlas would supply essential information to the Ecosystem Fisheries Overview which is being initiated at the IOTC and presented in paper IOTC-2024-WPEB20(AS)-24.

160. The WPEB expressed **CONCERN** regarding the necessary long-term commitment of the CPC/institutions which would host and maintain the atlas, stressing the need to ensure continuity in the maintenance and access to the atlas. With that in mind, the WPEB **NOTED** that it could be worth comparing two scenarios, one with a CPC hosting the atlas, the other with IOTC being in charge, in terms of resources and budget.

161. The WPEB **NOTED** that no exact budget has been developed to date, but the WPEB **AGREED** to include this project in its program of work, to make further progress on the technical aspects and further **NOTED** that a tentative budget will be prepared to be presented at the upcoming SC27.

162. The WPEB **REQUESTED** the WPDCS to examine the online digital atlas project to receive additional feedback to what has been expressed by the WPEB, in order to design a consolidated project to be presented at SC27.

163. The WPEB **ACKNOWLEDGED** that discussions are required between the authors and the interested scientists of the WPEB in order to prepare a consolidated proposal to be examined by the WPDCS and later by the SC during their 2024 sessions.

164. The WPEB **NOTED** paper IOTC-2024-WPEB20(AS)-23 on Preliminary steps towards assessing the ecosystem impacts of fishing in the tropical Indian Ocean through a trophic modelling approach, including the following abstract provided by the authors:

"An Ecopath model of the Tropical Indian Ocean (TIO) pelagic ecosystem has been developed to improve understanding of its structure and functioning, and to assess the impacts of fishing on the ecosystem. The model represents the pelagic oceanic ecosystem during the early 2000s, covering an area of over 21 million km², from the surface to a depth of 500 meters. It includes 35 functional groups, ranging from primary producers to top predators. For both ecological and fisheries management purposes, tropical tuna species (bigeye, yellowfin, and skipjack) are divided into two life stages (juveniles and adults). The model also incorporates 13 fishing fleets, distinguishing between operations targeting free schools and those focused on fish aggregating device (FAD)-associated tuna schools, particularly for the purse seine fleets. Input data such as biomass, catches, diets, and production and consumption rates were sourced from visual surveys, stock assessments, the IOTC fishery statistics databases, empirical equations, and both published and unpublished literature. The results highlighted the significant impact of fisheries on tuna, tuna-

like species, and vulnerable species caught in tuna fisheries, such as pelagic sharks, with notable differences between the fleets. This preliminary Ecopath model lays the groundwork for further analysis, enabling the assessment of the historical dynamics of the ecosystem and the cumulative effects of fishing and climate change through the temporal module, Ecosim. Ultimately, this modeling tool aims to complement single-species fisheries management advice, offering managers a broader ecological perspective for the management of tropical tuna species and the associated ecosystems."

165. The WPEB **ACKNOWLEDGED** the value of developing the ecosystem model to understand the structure and function of the pelagic tropical ecosystem and model its responses to fishing and climate change to inform management advice on tropical tuna fisheries.

166. **ACKNOWLEDGING** that the area within EEZs is relevant for tuna and tuna-like fisheries, the WPEB **NOTED** that the EEZs have been excluded from the model area and clarified that the model pretends to represent the oceanic ecosystem only including functional groups relevant to oceanic ecosystems, excluding functional groups more representative of continental shelf areas.

167. The WPEB **NOTED** that there are plans to use the model to generate ecosystem indicators to help fisheries managers evaluate the impacts of tuna fisheries not only on tropical tuna target species but also on the broader marine ecosystem.

168. **NOTING** that the Ecopath model represents the oceanic tropical pelagic ecosystem from the year 2000 onwards, the WPEB **NOTED** that there are currently no plans to hindcast to earlier periods, largely due to the lack of sufficient historical data to support such an analysis. The WPEB **NOTED** that instead, the focus will be on using the Ecosim model to generate future projections, to assess the potential impacts of climate change and different fishing scenarios on the ecosystem.

169. The WPEB **NOTED** that the analysis distinguished between the EU, Seychelles, and other purse seine fisheries, while grouping other gear types, such as longliners and pole-and-line fisheries, into broader categories because the project funders have a particular interest in examining the distinct effects of each gear group on tropical tunas and associated ecosystems. This differentiation aims to provide a better understanding of gear-specific interactions and trade-offs, which are critical for assessing the cumulative impact of different fishing methods and informing management strategies.

170. The WPEB **NOTED** paper IOTC-2024-WPEB20(AS)-24 on Ecosystem Fisheries Overviews - A Pilot Product to Assess the General Applicability of IOTC Candidate Ecoregions as a Spatial Framework for developing Ecosystem-Based Advisory Products, including the following abstract provided by the authors:

"The Indian Ocean Tuna Commission (IOTC) is advancing the development of tools and products to support the implementation of the Ecosystem Approach to Fisheries Management (EAFM). A spatial framework has been created, comprising nine candidate ecoregions within the IOTC convention area, to facilitate ecosystem-based planning and research. This framework also aims to assist in the development of ecosystem-based advice products that complement traditional single-species fisheries management advice. However, before these candidate ecoregions can be applied in resource planning, research, and management, they need to be validated. This study seeks to contribute to the development of a pilot advice product—regional Ecosystem-Fishery Overviews (EFOs)—to assess the feasibility and general applicability of the candidate ecoregions as a spatial framework for creating integrated, ecosystem-based advice products for IOTC. A preliminary EFO was successfully developed as a proof of concept, focusing on two key thematic sections: (i) who is fishing and (ii) what are they catching, within three selected candidate

ecoregions (the Somali Current Ecoregion, the Indian Ocean Monsoon Gyre Ecoregion, and the Maldives Ecoregion). A strengths, weaknesses, opportunities, and threats (SWOT) analysis was also conducted to evaluate the potential usefulness of regional EFOs as advisory products to complement existing processes within IOTC. While the initial development of regional EFOs appears promising, significant challenges remain, particularly in terms of the quality and spatial resolution of IOTC fishery statistics. These limitations hinder the accurate characterization of fleet dynamics and catch composition within ecoregions, highlighting the need for improved data collection and reporting. Nevertheless, the study emphasizes the strengths of EFOs, including their ability to provide cumulative assessments of fisheries and ecosystems, enhance regional ecosystem planning, and integrate ecosystem considerations into management advice. However, further interdisciplinary research, collaboration, and consultative processes are essential to refine and fully embed regional EFOs into the IOTC advisory framework."

171. The WPEB **NOTED** the progress made in developing a pilot product using ecoregions as spatial units. Among the various potential components for inclusion in an Ecosystem Fisheries Overview product, the WPEB **NOTED** that the two sections that have been developed to date (1. the characterization of major fishing fleets and 2. the characterization of their historical catches) are relatively straightforward to complete compared with other potential sections. The WPEB **SUGGESTED** that the decision on which other sections to prioritize going forwards should be informed by the specific needs and priorities of each ecoregion and the WPEB **AGREED** that expert groups involved in the case studies should explore available options. For example, ongoing work utilizing the Ecopath with Ecosim model in tropical pelagic ecosystems is expected to generate ecosystem and climate indicators, which could serve as inputs for future sections of the Ecosystem Fishery Overview product.

172. The WPEB expressed **CONCERN** regarding the potential long-term commitment required to develop and sustain a regional Ecosystem Fisheries Overview for specific ecoregions in the future and the WPEB **NOTED** that as the product is still in the pilot phase and under development, it is difficult to accurately estimate the level of effort needed for its ongoing maintenance. Based on experience from other regions (e.g., ICES), maintaining and updating such products typically involves a combination of voluntary contributions from regional scientists, with additional support from the Secretariat and the relevant working groups responsible for overseeing the process. The WPEB **NOTED** that caution should be exercised when drawing comparisons between the IOTC and ICES, due to significant differences in regional characteristics and operational scales.

173. The WPEB **NOTED** the importance of presenting the pilot case studies of the Ecosystem Fisheries Overview to the Commission early in the process to assess their interest in such a product and its potential application in informing decisions around ecosystem planning, research and fisheries advice. However, the WPEB **NOTED** that the pilot product is not yet sufficiently developed for submission to the Commission, as additional sections are planned for inclusion in the Ecosystem Fisheries Overviews to enhance its comprehensiveness and utility.

174. The WPEB **NOTED** the interest expressed by several members in collaborating intersessionally to develop the environmental and climate sections of the Ecosystem Fisheries Overview for the pilot case studies (Somali Current Ecoregion and Indian Ocean Monsoon Gyre Ecoregion), taking advantage of the ongoing work on the development of the Indian Ocean Digital Atlas. Progress made on these sections will be presented at the next WPEB meeting.

175. The WPEB **ACKNOWLEDGED** that the IOTC is actively working towards implementing an Ecosystem Approach to Fisheries Management (EAFM) and that, to date, the work guiding its

implementation (e.g. Ecoregion delineation, Ecosystem Report Card, Ecosystem Fishery Overviews, Online Digital Ocean Atlas) has been primarily led by the Scientific Committee. The WPEB **NOTED** that at some stage, this bottom-up process would benefit from strategic guidance from the Commission to ensure that the tools and products developed are aligned with and responsive to the Commission's priorities. The WPEB **ENCOURAGED** the continuation of this work and an exploration of opportunities to initiate a dialogue with managers on tools and products that would be most beneficial to them.

176. The WPEB **NOTED** that certain ecoregion names may benefit from revision to enhance clarity and appropriateness. For example, the WPEB **NOTED** that the Maldives Ecoregion also includes the Laccadive Islands to the North which is part of India and suggested a better alternative would be to name the region as "Maldives - Laccadive Ridge" which will better convey the geophysical features of the area. The WPEB also **NOTED** that future plans, include refining the boundaries of the ecoregions, could also involve renaming some ecoregions to improve their descriptive accuracy and alignment with regional characteristics.

177. The WPEB **NOTED** paper IOTC-2024-WPEB20(AS)-25 on Validating IOTC candidate ecoregions through a comparative analysis of main tuna and tuna-like species and fishing fleets, including the following abstract provided by the authors:

"Implementing an Ecosystem Approach to Fisheries Management (EAFM) requires the identification of a spatial framework where ecosystems can be characterized, monitored, and reported. In the IOTC convention area, a spatial framework of nine candidate ecoregions has been developed to facilitate ecosystem-based planning and research, as well as the creation of ecosystem-based advice products that complement traditional single-species fisheries management. Building on earlier efforts to delineate ecoregions, this study aims to validate the nine candidate ecoregions by evaluating their capacity to demarcate areas with distinct communities of tuna and tuna-like species, as well as unique fisheries and fleets. Using fishery statistics from the IOTC and the Commission for the Conservation of Southern Bluefin Tuna (CCSBT), we characterized the core fleets, fishing gears, and catch compositions within each ecoregion, and analyzed the differences among ecoregions to assess their ecological and fisheries uniqueness. These distinctions are crucial for supporting ecosystem-based planning, research, and advice products. The findings reveal that each ecoregion hosts unique fleet compositions, with regional fleets dominating most areas. However, in the Agulhas Current ecoregion, long-distance fleets prevail. Catch composition also varies significantly across ecoregions: coastal tropical ecoregions feature more neritic tunas and Spanish mackerels, tropical oceanic ecoregions are dominated by species such as skipjack and yellowfin tunas, and higher-latitude ecoregions are home to temperate oceanic species like southern bluefin tuna and swordfish. While the study highlights the unique ecological and fishery characteristics of each ecoregion, it also suggests several refinements and boundary adjustments. These include treating coastal areas adjacent to continental landmasses as distinct ecoregions, extending ecoregion boundaries to align with Exclusive Economic Zones (EEZs), and reclassifying areas like the northern region of the Agulhas Current ecoregion and the Indonesian Throughflow to improve ecological and fleet representation within each ecoregion."

178. The WPEB **NOTED** that the quality of IOTC fishery statistics datasets has improved significantly in recent decades, compared to the early periods, and **SUGGESTED** considering this when interpreting historical catch data for each ecoregion. The WPEB **NOTED** the discontinuous reporting of catches in certain ecoregions and **NOTED** that, for the Southern Ocean Ecoregion, the discontinuity in catch data is due to a combination of Australian coastal fisheries operating nearshore and fleets targeting southern bluefin tuna in more oceanic waters, resulting in a fragmented time

series. For the Leewing Current Ecoregion, the cause of discontinuity in the catches remains unknown.

179. The WPEB **ACKNOWLEDGED** that the current ecoregions are considered working hypotheses, which need to remain flexible and adaptable as new knowledge emerges. The analysis presented provided several recommendations for refining these ecoregions. The WPEB **ENCOURAGED** future refinements as additional knowledge becomes available to enhance their delineation.

180. The WPEB **QUERIED** the methodology used to merge the IOTC raised catch dataset with the CCSBT datasets, specifically relating to how the integration ensures that catches of southern bluefin tuna are not double counted in the analysis. The WPEB **NOTED** that this issue will be reviewed in future versions of the Ecosystem Fisheries Overview report to ensure that double counting of catches is avoided.

181. The WPEB **ACKNOWLEDGED** the existence of a parallel project led by CSIRO focusing on the regionalization of the Indian Ocean pelagic ecosystem. The WPEB **NOTED** that one of the lead scientists from CSIRO was invited to participate in the second IOTC ecoregion workshop, during which the CSIRO project was presented. The WPEB **NOTED** that the two regionalization efforts have distinct objectives and intended applications but nonetheless, a high degree of alignment between the outcomes of both regionalization initiatives was observed.

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

10.1 All bycatch species (all)

182. The WPEB **NOTED** paper IOTC-2024-WPEB20(AS)-26 on Crustacean as bycatch of tuna gillnet fishery of Pakistan, including the following abstract provided by the authors:

"Crustaceans are not commonly found as bycatch of commercial fishing operations in offshore waters. Studies carried out under the WWF-Pakistan's Crew Based Observer Programme conducted between 2012 and 2019 revealed that mud crab (Scylla spp.) and slipper lobster (Thenus spp.) are frequently caught in the tuna gillnets. Female mud crabs are known for their offshore migration for spawning and during their migration, these females are occasionally seen in the catches of tuna gillnets. Although slipper lobsters of genus Thenus inhabit comparatively shallow waters to a maximum of 100 m and are not known to be for spawning migration. Still, the present paper reports frequent occurrences of berried females in offshore waters and are caught in the tuna gillnets. The present provides information about the spatial distribution of the mud crab and slipper lobster in the coastal and offshore areas of Pakistan."

183. The WPEB **NOTED** that some species of crustaceans are caught as bycatch by the Pakistan gillnet fleet targeting tuna species and some coastal trawlers. The WPEB further **NOTED** that they are a small part of the bycatch and most of them lack commercial value, but the collection of these data could help to understand the migration behaviour of these species.

184. The WPEB **NOTED** that the paper analyses a pool of data collected by observer programs in the 2012-2019 period. The WPEB further **NOTED** that most of the species were registered far away from their usual distribution area and some of them had fully developed eggs (genus Scilla f.e.) or encrusted epibionts indicating a process of migration.

185. The WPEB **NOTED** that the average mesh size is 15-20 cm, the height around 20 m and the gillnets are set in areas around 40-50m deep. The WPEB **NOTED** that this information helps to better understand the catchability of crustacean species in gillnets.

10.2 Other sharks and rays (all)

186. The WPEB **NOTED** paper IOTC-2024-WPEB20(AS)-27 on An update for 2024 on the development of IOTC BTH PRM Project, 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, 18th, and 19th IOTC WPEB are presented."*

187. The WPEB **NOTED** that currently the IOTC BTH PRM Project active collaborators are limited to just two fleets, EU,France (Reunion) and South Africa.

188. The WPEB **NOTED** that the project was delayed by the pandemic, but it will be restarted in 2024 to end in 2028 and **NOTED** that the main sharks and rays were the highest priority.

189. The WPEB **NOTED** that observers from China, Japan, South Africa, Portugal, Taiwan,China and France have been trained in deploying tags.

190. The WPEB **NOTED** that Taiwan,China stopped participating in this project in 2020 and China and Japan have not yet restarted but Japan has shown interest in getting involved in the project since its observer programme was reestablished after having stopped during the pandemic period. The WPEB **NOTED** that while Portugal and Spain have expressed their interest in participating, the Portuguese longline fleet has drastically reduced the number of vessels operating in the Indian Ocean to two and in order to participate it needs incentives to involve the fleet in the tagging activity. For Spain there are some administrative issues to be solved before getting involved in the project.

191. The WPEB **NOTED** that observers placed 20 miniPAT tags on bigeye thresher sharks and only 10 survived and so the post-release mortality is preliminarily estimated as 50%, though it is an approximated value that will be updated after the comprehensive analysis considering various factors affecting the mortality has been conducted and when more tags have been deployed and most of the fleets have been covered.

192. The WPEB **NOTED** that there have been issues with the batteries of the miniPATs and further **NOTED** that even after replacing the batteries, there seems to be a 2-3 day delay in the receipt of information and sometimes the information is not received at all but that the issue may be solved by changing the batteries.

193. The WPEB **NOTED** that a tag reporting sheet has been developed to collect detailed information on the sharks tagged (e.g. state of the shark, estimated fork length and sex) as well as associated data such as position, date, type of gear where possible.

194. The WPEB **NOTED** that the area covered by the tagged sharks show not only a huge distribution range but also some kind of spatial aggregation. The WPEB **NOTED** that the coverage is very low, so the preliminary analysis has some limitations and therefore the WPEB **ENCOURAGED** the participation of other fleets in the project.

195. The WPEB **NOTED** paper IOTC-2024-WPEB20(AS)-28 on Demographic analysis for silky shark (*Carcharhinus falciformis*) in the Indian Ocean, including the following abstract provided by the authors:

"This study investigated the key parameters for population dynamic of the silky shark (Carcharhinus falciformis) in the Indian Ocean through demographic analysis. To assess the impact of survival rate uncertainties on the estimates of demographic parameters, we developed six scenarios using growth parameters and age-at-maturity data specific to the Indian Ocean, considering reproductive cycles of 1-2 years and 1-3 years, respectively. Through 10000 Monte Carlo simulations, we estimated the intrinsic rate of population increase (γ), net reproductive rate (R0), generation time (G), population doubling time (tx2), and steepness (h). The results showed that the mean intrinsic growth rate ranged from 0.069 to 0.135 across different scenarios, the mean R0 ranged from 2.61 to 5.62, the mean generation time ranged from 12.7 to 15.9 years, the mean tx2 ranged from 5.17 to 11.2 years, and the mean h ranged from 0.245 to 0.507. Scenarios with a lower age at maturity and shorter reproductive cycles indicated higher growth rates and shorter doubling times, suggesting more favorable population dynamics. The uncertainties in life history information and model estimator influenced these statistical results, highlighting the necessity of considering multiple scenarios and uncertainties in the development of population management and conservation strategies."

196. The WPEB **NOTED** that there are numerous gaps in the understanding of the life-history traits of silky sharks and so recognised the potential of the proposed methods for future stock assessments.

197. The WPEB **REQUESTED** that the R code for the demographic analysis be shared with the group so this work could be replicated and potentially be applied to other species.

198. **ACKNOWLEDGING** the uncertainty and poor knowledge of growth and reproductive studies for silky shark, the WPEB **NOTED** that there are currently no known life-history studies being conducted in the Indian Ocean on the species. The WPEB **NOTED** that there was a recent assessment conducted for silky sharks in the WCPFC and so **SUGGESTED** that the different life history information and studies used in the assessment should be reviewed.

199. The WPEB **NOTED** paper IOTC-2024-WPEB20(AS)-29 titled Why is IOTC lagging behind on shark conservation? An analysis of the status quo and comparison with other tuna RFMOs, including the following abstract provided by the authors:

"This paper analyzes the existing management measures for shark species across the four major tuna Regional Fisheries Management Organizations (RFMOs), comparing the Indian Ocean Tuna Commission (IOTC) in the Indian Ocean with the International Commission for the Conservation of Atlantic Tunas (ICCAT) in the Atlantic, and the two Pacific RFMOs, the Inter-American Tropical Tuna Commission (IATTC) and the Western and Central Pacific Fisheries Commission (WCPFC). In addition to addressing the absence of much-needed active management for sharks targeted for commercial purposes in all but one RFMO, it also highlights the lack of consistent conservation and management measures for threatened shark species across the four RFMOs. The paper compares the historical development of existing measures and evaluates their effectiveness in reducing shark mortality. The case of blue sharks is examined in detail as an example of delayed or absent stock management and inadequate management procedures. The reasons behind the ineffectiveness and reluctance to manage sharks in a manner similar to other commercial stocks are assessed, and a path forward is suggested for the IOTC, including 12 specific improvements that are urgently needed, which are outlined in the Conclusions and 12 Recommendations to improve shark conservation at the IOTC. In summary, the paper finds that all RFMOs are failing to

adequately protect sharks and rays within their respective jurisdictions, and have thus far clearly failed to manage these stocks at sustainable levels. However, the IOTC lags furthest behind the other RFMOs in terms of shark conservation and reducing shark mortality, whether due to the lack of management for targeted species or the ineffectiveness of the few existing bycatch measures. These measures are further undermined by excessive exemptions, poor compliance with reporting requirements, and the lack of strong advice from the IOTC's Scientific Committee. As a result, no significant improvements have been implemented at the IOTC over the past decade, while other RFMOs have made at least some progress in certain areas. Attempts by some Contracting Parties (CPCs) to strengthen shark conservation measures have failed, largely due to either a lack of clear scientific advice or the unwillingness of certain fisheries to accept measures that might impact their catches, including shark bycatch or fishing practices. An analysis of existing measures and their weaknesses is provided, with a focus on stock status, stock management attempts, and specific conservation and management measures such as retention bans, alongside discussions of existing exemptions. Details are presented in tables at the end of the paper. The paper concludes that shark conservation must overcome these challenges across all RFMOs, with the IOTC in particular needing to make urgent and substantial improvements."

200. The WPEB **NOTED** that the authors referred to the Worm et al., 2024 paper which finds the Indian Ocean to be one of the primary areas of shark bycatch concern based on the responses of two thirds of 22 experts interviewed.

201. The WPEB **NOTED** a number of recommendations from the author, but these were not discussed in greater detail during the meeting due to a lack of time. From a procedural perspective, the WPEB **NOTED** the need to prioritise and review only recommendations arising from the science discussions taking place during the course of the WPEB meeting. However, the WPEB **NOTED** that many of the recommendations from the author are already under discussion in different scientific processes within IOTC.

202. The WPEB **NOTED** that the comparison of active conservation measures across different tRFMOs referred to in the paper might be misleading due to regional differences in each tuna RFMO in terms of designated shark species, species with stock assessments conducted and related fisheries. However, the authors maintained that the adopted shark conservation measures and the extent of stock assessments conducted by RFMOs can be compared across them and suggests that IOTC lags behind other RFMOs, since the species of concern are the same in each ocean, and the fisheries and their interactions with endangered sharks remain consistent across regions.

203. **NOTING** that several studies suggest that there are high levels of bycatch of many species in gillnet fisheries, the WPEB **SUGGESTED** that studies are carried out to validate the findings of studies (Senko et al., 2022; Allman et al., 2020 and many others) that suggest that there are benefits to installing green LED lights on gillnets to mitigate bycatch in these fisheries in the IOTC. This activity was added to the Program of Work for WPEB.

204. The WPEB **NOTED** paper IOTC-2024-WPEB20(AS)-30 on Ecological interactions between 19 shark species in the Indian Ocean, including the following abstract provided by the authors:

"Apex predators such as sharks are a critical component of ocean ecosystems, playing a vital role in maintaining the balance of marine life by controlling prey populations and influencing the behavior of other species. Yet the ecosystem consequences of shark declines remain poorly understood, primarily because of a lack of population and community baselines. The Indian Ocean, in particular, is especially lacking in ecological data, and even more so in historical data. To address this gap, we utilized a longline survey dataset from 1966 through 1989 that spanned the majority

of the Indian Ocean and recorded 19 shark species. This time period corresponds to the start of large-scale industrial fishing in the region, which likely had a profound impact on shark populations. Trends across the species were highly variable; life history traits and fishing pressure metrics were not able to explain differences in responses between species, suggesting that changes in ecological interactions such as competition and predation had a significant role historically. To further explore these ecological interactions between species, we conducted a literature review of the study species' diets with a focus on intra-guild predation (predation within the same trophic level). We constructed an interaction web to identify potential keystone species—those that have a disproportionately large effect on their environment relative to their abundance. Several species were found to be neither predator nor prey of other sharks, suggesting that competition may be the more dominant relationship among these species. Overall, species with broader habitat preferences and smaller individuals now make up a larger part of the pelagic shark community, whereas open-ocean species have declined significantly. These results suggest that industrial fishing has restructured shark communities and diminished the top-down control that sharks once exerted in pelagic ecosystems. This shift has likely led to broader ecological consequences, impacting the structure and function of the entire marine food web."

205. The WPEB **NOTED** that the study's outcomes indicate that shark abundance fluctuated in response to industrial fishing activities. Species such as the shortfin mako, tiger shark, and bull shark are key predators of other sharks and serve as critical connectors between different habitats. Sharks affected by longline bycatch are part of intricate ecological interactions, and their relationships with one another can result in unexpected outcomes. However, increased exploitation may have disrupted these interactions, potentially altering ecosystem dynamics. The longfin mako, in particular, remains enigmatic, with further research needed to better understand its ecological role.

206. The WPEB **NOTED** that the study explored the level of predation among shark species, incorporating weighted averages of prey species, which included all sharks identified in their diets, not just those considered in the study. This approach allows for a broader understanding of predation dynamics. Additionally, the WPEB **NOTED** that the overlap in diets between shark species offers further opportunities for exploration.

207. The WPEB **NOTED** the analysis linked abundance trends to several life-history parameters and ecological knowledge. The WPEB **SUGGESTED** that the link between speed-related traits such as growth rate, age at maturity, and longevity and species population trends should be further examined, instead of length-based life-history traits (e.g. maximum size, length at maturity), as speed-related traits are better predictors of species' responses to exploitation.

208. **NOTING** that longevity is commonly underestimated in shark species due to the difficulties of estimating it, the WPEB cautioned against using this parameter as a predictor of species responses.

10.3 Mobulids

- Review new information on mobulid biology, ecology, fisheries interactions and bycatch mitigation measures (all);
- Review of indicators for Mobulids (all)
- Development of management advice on the status of mobulid species (all)

209. The WPEB **NOTED** paper IOTC-2024-WPEB20(AS)-31 on Mobulids caught by French purse seiners in the western Indian Ocean between 2005 and 2023, including the following abstract provided by the authors:

"Mobulids (manta and devil rays) are large, generally pelagic rays, that are occasionally caught by various fishing gears, including purse seine. Most mobulids are listed as "Endangered" by IUCN. Here we present an overview of bycatch of mobulids accidentally caught by French purse seiners operating in the western Indian Ocean between 2005 and 2023 based on observer data. We observed 4 distinct species: spinetail devil ray (Mobula mobular), giant manta (M. birostris), Chilean devil ray (M. tarapacana), and smoothtail devil ray (M. thurstoni). Bycatch rates were low, with an overall probability of occurrence below 0.12% across the study period. Estimated total catches varied by species and year, ranging from 0 to 90 tons. No clear temporal or spatial trends in mobulids distribution were detected, though M. thurstoni was found exclusively in the Mozambique Channel. Species exhibited different associations with tuna school types, with M. birostris preferring floating object-associated sets and other species showing more balanced preferences. The study highlights the significant improvement in mobulids release with 89% of individuals being released alive by 2023, following the adoption of best practices for handling and release. The analysis of mobulids size and sex ratio revealed no apparent trends over time. The results underscore the rarity of bycatch of mobulids in the French purse seine fishery and the ongoing need for improved data collection and species identification to support conservation efforts."

210. The WPEB **NOTED** that the catch of mobulids presented in the study has been raised and expressed in biomass to comply with the IOTC requirements for statistical data submission.

211. The WPEB **NOTED** that the data are collected onboard and are not coming from EMS data. The WPEB **NOTED** that the rise in the number of sets with reported mobulids in 2015 corresponded with the start of a new program with higher numbers of observers.

212. The WPEB **NOTED** that the raising method used a linear model (a ratios approach that assumes that mobulid catches are proportional to targeted species) but the relationship might not be linear, and estimates may be inaccurate in particular for rare species. The WPEB **NOTED** that further analyses can be conducted to explore improvements to the raising estimation methodology.

213. The WPEB **NOTED** that size at maturity would be interesting additional information to include in the size distribution figures and **SUGGESTED** that a literature review is carried out in order to add this information.

214. The WPEB **NOTED** that spinetail mobula was the most common mobulid species observed in the bycatch of French purse seiners between 2005 and 2023. The WPEB further **NOTED** that a significant number of mobulids were not identified at species level prior to 2020, but this was improved thanks to the development of an identification guide by IRD.

215. The WPEB **NOTED** that the smoothtail mobula was found in the southernmost French purse seine fishing grounds in the Mozambique Channel, while the rest of the observed species did not show seasonally related patterns in their distribution.

216. The WPEB **NOTED** an increase in the number of individuals released alive thanks to the application of best practices for safe handling and release of elasmobranchs, reaching 89% of mobulids released alive by 2023. The WPEB **NOTED** that a tagging study would provide insights into the post-release survival rates. The WPEB further **NOTED** that some work is ongoing to investigate different release methods (e.g. using a sorting grid or other specific device lifted with the onboard crane). The WPEB **NOTED** that guidelines to release rays and mobulids have been available since 2012.

217. The WPEB **NOTED** paper IOTC-2024-WPEB20(AS)-32 on High bycatch rates of manta and devil rays in the “small-scale” artisanal fisheries of Sri Lanka, including the following abstract provided by the authors:

“Expanding fisheries in developing nations like Sri Lanka have a significant impact on threatened marine species, including elasmobranchs. Manta and devil (mobulid) rays, in particular, have some of the most conservative life history strategies among elasmobranchs, and even low to moderate levels of bycatch from gillnet fisheries can result in significant population declines. A lack of data on life history, demographics, population trends, and fisheries impacts hampers effective management measures for these species. This study reports on mobulid fishery landings over a nine-year period, from 2011 to 2020, across 38 landing sites in Sri Lanka. Data were collected on catch numbers, body sizes, sex, and maturity status for five mobulid species. A Bayesian state-space model was employed to estimate monthly country-wide catch rates and total annual landings of mobulid rays. Additionally, catch curve analyses were conducted to estimate total mortality for Mobula mobular, and trends in recorded body sizes were evaluated over the study period for M. mobular, M. birostris, M. tarapacana, and M. thurstoni. The findings indicate that catch rates have declined by an order of magnitude for all species throughout the study period. Total annual captures of mobulid rays by the Sri Lankan artisanal fishing fleet surpass the estimated annual captures of mobulids by all global industrial purse seine fisheries combined. Catch curve analyses suggest that M. mobular is being fished at rates far exceeding its intrinsic population growth rate. Furthermore, the average body sizes of all mobulids in the fishery, with the exception of M. birostris, are declining. Collectively, these results indicate that mobulid ray populations in the northern Indian Ocean are being overfished by Sri Lankan artisanal fisheries. The study recommends strengthening the management of mobulid rays through better implementation of international agreements such as CITES and CMS, as well as regional fisheries management actions. Additionally, this research reports on the demographic characteristics of mobulids landed in Sri Lanka and provides the first record of M. eregoodoo in the country.”

218. The WPEB **NOTED** that the raised catches estimated in this document are not used for IOTC statistical data declarations as these data are from independent field surveys but they are aggregated in the submitted data. The WPEB further **NOTED** that there is an exemption on reporting mobulid catches when they are from subsistence fisheries (Res 19/03) but this is not the case for these species caught by gillnetters.

219. The WPEB **NOTED** that the catch curve analyses estimated a total mortality (Z) of 0.6 and an intrinsic growth rate (*r*) of 0.108. The WPEB further **NOTED** that *Z* includes natural mortality and fishing mortality with *M* often considered as 0.14 or 0.2, which is already higher than *r*. The rationale that *Z* is substantially higher than *r* is a source of concern, with explanations requested.

220. The WPEB **NOTED** that size at first maturity information is presented in the paper for most species, while age at maturity is currently far less certain (due to lack of calcification in many of the species) and was only available for *M. mobular*.

221. The WPEB **NOTED** that there was evidence presented regarding a significant level of exports of gill plates to south-east Asian markets, with the gill plates *marketed* as a Chinese traditional medicine product despite the well-recognised fact that gill plates are not traditional Chinese medicine as this market only started in the last few decades. The WPEB **NOTED** that it is a false remedy known to actually be harmful to consume due to high content of heavy metals.

222. The WPEB **NOTED** that mitigation measures such as sub-surface setting of gillnets may be efficient to limit bycatch as shown by WWF Pakistan. The WPEB **NOTED** that Sri Lanka plans to

conduct research into the use of lights on subsurface gillnets as an approach to mitigate the capture of mobulids by that gear. The WPEB **NOTED** that the levels of mobulid catch in Sri Lanka is uncertain but considered by some local experts to be high, that there is limited local consumption of fresh meat by a few, mainly poorer coastal families to provide protein, and that Sri Lanka was looking to strengthen protections for these species.

223. The WPEB **NOTED** the guidelines on best handling practice and the current CMM that are in place to limit bycatch.

224. The WPEB **NOTED** that better data collection is further needed to improve the information on the level of catch of these species. Information on post-release survival would also provide critical information on their mortality levels.

225. The WPEB **QUESTIONED** the possibility that landings of manta and devil rays decreased due to the international regulation of trade rather than population decline, however landings regulations are not in place for these species in Sri Lanka and international regulation of trade does not affect the behaviour of fishermen suggesting that this is not driving the decline in catches and the author suggested that overfishing was the cause based on the presented data.

226. The WPEB **NOTED** paper IOTC-2024-WPEB20(AS)-33 on Mobulid ray fisheries and conservation management in the Chagos Archipelago, including the following abstract provided by the authors:

"Mobulids (manta and devil rays) are filter-feeding elasmobranchs facing unsustainable depletion from targeted fisheries for their gill plates and bycatch, particularly in the Indian Ocean. The Chagos Archipelago, in the central Indian Ocean, is one of the world's largest no-take marine protected areas (MPA; 640, 000 km2), which could be a potential refuge for mobulid species. Nonetheless, illegal fishing, mainly by Sri Lankan and Indian vessels, is prevalent in the region and poses a significant threat to marine life. Illegal fishing vessels historically have targeted shark species; however, research in both Sri Lanka and India shows a substantial amount of mobulid landings. As of 2023, the local enforcement authority, the Marine Resources Assessment Group (MRAG), had documented only one record of mobulids in an illegal fishing vessel catch. However, concern was raised that this could be an underrepresentation as, currently, no policies specifically mandate that a governing country must report mobulid catches found on illegal fishing vessels from other countries. Furthermore, the identification of mobulid species can be challenging due to a lack of taxonomic knowledge among data recorders. Here, an examination of available illegal catch photographs from MRAG revealed approximately 79 individual mobulids from just seven vessels, equating to an estimated 20 tonnes. This is likely a vast underestimation due to the lack of species-specific reporting. If catches of this magnitude are commonplace within the MPA, they are likely detrimental to local mobulid populations. Accurate and consistent catch data recording and reporting are crucial to fulfil mobulid protection responsibilities, as is comprehensive research on the movement ecology and habitat use dynamics of all mobulid species in the region, which currently relies on accurate mobulid catch data. Therefore, the University of Plymouth and the Manta Trust's Chagos Manta Ray Project are working with MRAG to improve catch recording through extensive mobulid species and mobulid body parts (e.g., gill plates) identification training, helping implement efficient data collection protocols and provide ongoing support for governing bodies."

227. The WPEB **CONGRATULATED** the authors on their work to quantify the issue of illegal fishing catches.

228. The WPEB **NOTED** that the map used in the presentation corresponds to the one from document IOTC-2024-WPEB20(AS)-34 which was compiled using expert knowledge.

229. The WPEB **NOTED** that genetics could help to identify the mobulid species and their region of capture (market origin) but may be expensive for routine application.

230. The WPEB **NOTED** paper IOTC-2024-WPEB20(AS)-34 on Overview of Mobulid fisheries and trade in the Indian Ocean, including the following abstract provided by the authors:

"Manta and devil rays, collectively known as mobulids, are a monogeneric family of planktivorous rays characterized by their unique filter-feeding adaptations and large size. These species are found in tropical and subtropical waters worldwide, with seven of the nine recognized Mobula species inhabiting the Indian Ocean (Stevens et al., 2018). Mobulids are particularly vulnerable to overexploitation due to their conservative life history traits, which include slow growth, late maturation, and extremely low fecundity. These traits result in some of the lowest maximum rates of intrinsic population increase among all elasmobranchs, making them especially susceptible to population declines, particularly for the largest manta ray species (Dulvy et al., 2014)."...[see paper for full abstract]

231. The WPEB **NOTED** that the declining weights of mobulids reported in the paper are calculated from catch/landings and trade data. The WPEB **NOTED** that the sources of data were from online and land surveys as well as interviews.

232. The WPEB **NOTED** that catches were reported in IR Iran, but Iranian scientists explained that no catch or landing of these species occur in IR Iran further **NOTING** that fishermen release/discard any rays caught.

233. The WPEB **NOTED** paper IOTC-2024-WPEB20(AS)-35 on Progress in addressing key research to inform Mobulid ray conservation, including the following abstract provided by the authors:

"Manta and devil rays (mobulids) are globally threatened species. Their preference for productive tropical and subtropical habitats where tropical tunas also aggregate increases their vulnerability to tuna purse seine fishing. However, interaction rates between the tropical tuna purse seine fishery and different mobulid species have not been quantified in detail. One of the challenges to quantifying the impact of the fishery on mobulids is unreliable species identification by crew and observers onboard the vessels, potentially due to poor training and/or lack of time for identification. Additionally, to evaluate the impact on mobulids and test possible interventions, it is necessary to assess mobulid post-release mortality using proper handling and release methods. This project aims to address key research to inform mobulid conservation. Bycatch reduction devices in the form of modified sorting grids were constructed and deployed to perform rapid release for the mobulids captured by 12 purse seine vessels from the U.S. fleet operating in the Pacific Ocean. Since June 2022, 29 mobulid captures were documented, and seven mobulids were released using these devices. Preliminary evidence suggests that sorting grids did not increase the duration of captures, even though the grids are used for larger individuals that would otherwise take longer to release. Satellite tags were deployed on three mobulids to estimate survival after release, but further research is necessary to examine the impact of the devices on mortality. In addition to testing the grids, eleven mobulid tissue samples were collected to contribute to knowledge of population genetic structure for mobulids. Lessons learned from applying current protocols and practices will allow developing improved best practices to be implemented by the U.S. tropical tuna purse seine fleet, which can be scaled up to other purse seine fisheries in the Indian and Atlantic Oceans."

234. The WPEB **NOTED** that the bycatch reduction study was conducted on US vessels in the Pacific that are using grids for the handling of mobulids but it is uncertain if Spanish vessels in the Indian Ocean are using the grids (at least one Spanish vessel is using the grid system in the Pacific). The WPEB **NOTED** that it is believed that there is a plan to implement the use of the grids in the Spanish purse seine fleet in the Indian Ocean.

235. The WPEB **NOTED** that the tags deployed during the project described were deployed mostly by observers and one tag was deployed by a crew member trained in the correct tagging method.

236. The WPEB **NOTED** that there has been a very significant drop in the observed catches (in the Pacific) from levels of around 2000/yr over two decades ago to around 500/yr in the past 10 years.

237. **ACKNOWLEDGING** the request from the Commission to review the status of *Mobula spp.* in the IOTC Area of Competence and provide management advice to the Commission, the WPEB **NOTED** a number of papers on this topic. The WPEB **NOTED** information collected by a range of studies that suggest that there is a high mortality rate of these species, much of which is underreported. However, due to the lack of robust data on catches of these species, the WPEB was unable to provide management advice on status of these species.

238. However, based on handling and release guidelines for mobulids presented to the WPEB, the WPEB **RECOMMENDED** that the SC consider endorsing a revision to the live release handling procedures provided in Annex 1 of Resolution 19/03 for consideration by the Commission. The WPEB **NOTED** that work is required to further develop the guidelines for gillnets and this will be done intersessionally. The details of the suggested revisions to the handling procedures can be found in Appendix XVV.

239. The WPEB **SUGGESTED** that it would be helpful to develop an executive summary document for mobulids and the Manta Trust offered their assistance with this work. The WPEB **NOTED** that a document will be drafted for approval by the WPEB at its next meeting.

10.4 Marine Mammals

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

240. The WPEB **NOTED** paper IOTC-2024-WPEB20(AS)-38 on IWC advice on best practice guidelines for safe release and handling of cetaceans, including the following abstract provided by the authors:

"The IOTC's Resolution 23/06 on cetacean conservation includes a call for the IOTC Scientific Committee (IOTC-SC) to provide advice on appropriate measures to mitigate the effects of interactions between cetaceans and IOTC fisheries. Additionally, the resolution mandates the development of best practice guidelines for the safe release and handling of bycaught cetaceans by 2025. In response, the International Whaling Commission (IWC) presents its advice in this document, outlining the best practices available for the safe and humane handling and release of cetaceans caught in various types of fishing gear, including longlines, purse seines, gillnets, and trawls. This guidance is intended to inform the IOTC-SC's considerations on this issue."

241. The WPEB **NOTED** that handling and releasing cetaceans can be very dangerous in particular cases and that while the guidelines are useful in general, they should be adapted to the specific circumstances of each IOTC fishery.

242. **NOTING** the request from the Commission to provide advice on best practice handling and release guidelines for cetaceans, the WPEB **NOTED** the guidelines from IWC on this topic. The WPEB **NOTED** that while the guidelines provide generic advice applicable to handling and live release of bycaught cetaceans in different fishing gears, they have not yet been adapted to the specific characteristics of the IOTC fisheries. Therefore, the WPEB **SUGGESTED** that the guidelines presented by the IWC are adapted to the specific needs of all IOTC fleets in the future. The WPEB also **AGREED** to work to provide a short summary of the measures that could apply to each individual fleet which could then be considered for the inclusion in a Resolution on cetaceans. The WPEB **NOTED** the offer of IWC to lead the development of these summaries for presentation at the WPDCS.

243. The WPEB **NOTED** paper IOTC-2024-WPEB20(AS)-39 on Spatial and temporal dynamics of dolphin bycatch in gillnet fisheries of the Northern Arabian Sea and Indian Ocean: implications for conservation and management, including the following abstract provided by the authors:

> *"Bycatch, or the incidental capture of non-target species, poses a significant threat to marine biodiversity, particularly in areas where gillnet fisheries intersect with sensitive habitats. This study provides an integrated spatial-temporal analysis of dolphin bycatch in the gillnet fisheries of Pakistan's coastal waters, covering the Northern Arabian Sea and the Indian Ocean from 2013 to 2017. Using a comprehensive dataset of 4,111 entries recorded by crew-based observers, we examined Dolphin Total Number (DTN) and Dolphin Total Weight (DTW) to identify patterns, hotspots, and key drivers of bycatch. The results indicated a weak linear relationship between DTN and DTW (Pearson's r = 0.21), while stronger non-linear associations (Spearman's ρ = 0.39) suggest that bycatch is influenced by complex interactions involving fishing methods, seasonal dynamics, and environmental conditions."...[see paper for full abstract]*

244. The WPEB **ACKNOWLEDGED** the value of the *Crew-based Observer Program*, highlighting it as a low-cost and valuable tool for monitoring bycatch and collecting critical data to inform management decisions.

10.5 Seabirds

- Review new information on seabird biology, ecology, fisheries interactions and bycatch mitigation measures (all)
- Developing advice on best practices for branch weighting (all)

245. The WPEB **NOTED** paper IOTC-2024-WPEB20(AS)-36 on Updated ACAP Advice on Branch line Weighting as a Mitigation Measure to 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. The IOTC has recently reviewed the mitigation measures to reduce seabird bycatch and adopted the Resolution 23/07 On Reducing the Incidental Bycatch of Seabirds in Longline Fisheries. This resolution recommended to its Scientific Committee (SC) to develop advice on best practice branch line weighting by 2024 as a mitigation measure the reduce seabird bycatch. 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 August 2024, at the 12th meeting of the Seabird Bycatch Working Group (SBWG12), with updates endorsed by the 14th meeting of ACAP's Advisory Committee (AC14). This paper provides the updates on the review of the minimum standards for the ACAP advice on branch line weighting for pelagic longline fisheries. SBWG12 updated the pelagic longline advice, in particular: (i) to indicate that best practice branch line weighting should achieve a minimum sink rate under experimentally controlled conditions of 0.5 m/s to 5 m depth; (ii) to indicate that when weighting is attached to, or integrated into the hook a minimum of total weight of 50 g will be needed to achieve this sink rate criterion; and (iii) to avoid the use of lead when the lead may be ingested (e.g. attached to or integrated into the hook). The following configurations have been demonstrated, under controlled conditions and with metal materials, to meet this standard: (a) 40 g or greater attached within 0.5 m of the hook; or (b) 60 g or greater attached within 1 m of the hook; or (c) 80 g or greater attached within 2 m of the hook. The use of lighting devices or other fishing accessories as weights is not recommended unless they achieve the sink rate criterion. It is advisable that the WPEB consider ACAP's updated recommendations on best practices for branch line weighting when providing the requested advice to the IOTC Commission."

246. The WPEB **NOTED** that the mitigation methods detailed in IOTC Resolution 23/07 are partially aligned with ACAP's Best Practice Advice. The WPEB **NOTED** that the use of two out of the three measures (branch line weighting, night setting, and bird scaring lines) is required under the Resolution, rather than the simultaneous use of all three as recommended by ACAP and further **NOTED** that underwater Bait Setters are not mentioned in Resolution 23/07. The WPEB **NOTED** that the stipulation to allow the use of two out of the three measures gives flexibility and that in some cases the configuration of two mitigation measures might reduce seabird bycatch to very low levels.

247. The WPEB **NOTED** that among the seabird bycatch mitigation methods stipulated in the IOTC Resolution 23/07, the branch line weighting specifications are those that show the greatest divergence in actual implementation. The WPEB **NOTED** the presentation of the recently revised ACAP best practices and **ACKNOWLEDGED** that the inclusion of sink rates in the minimum standards for branch line weighting was a positive addition for those fisheries that might experience difficulties in implementing certain branch line configurations. The WPEB **NOTED** the need for guidelines to measure sink rates of baited hooks in pelagic longline fisheries and **NOTED** that ACAP has formed an intersessional group to review available information on protocols for measuring sink rates in pelagic longline branch lines and will develop standard protocols and guidelines for measuring sink rates of baited hooks in pelagic longline fisheries.

248. The WPEB **NOTED** that in tropical areas seabird interaction is not a priority due to minimal interactions between seabirds and the fisheries operating in this area. Therefore, the WPEB **NOTED** that there is no evidence to suggest that the area specified for Res 23/07 (which only applies to the area south of 25 degrees South latitude) should be modified.

249. The WPEB expressed **CONCERN** about the risk to fishers posed by weighted branch lines, including crew hazards from flybacks. The WPEB **NOTED** that in 2021 ACAP produced Advice on Improving Safety when Hauling Branch lines during Pelagic Longline Fishing Operations and this document may be updated for ACAP's upcoming meetings. The WPEB further **NOTED** that in the specific situation where the weight is integrated into the hook, the safety benefit is the absence of recoil when a bite-off occurs.

250. **NOTING** the request from the Commission to provide advice on best practice branch line weighting, the WPEB **NOTED** the updated recommendations provided by ACAP on this topic. The WPEB **NOTED** that the branchline weighting regimes outlined in the ACAP best practice guidelines

have been demonstrated by research to provide faster sinking rates and reduce risk to seabirds. However, **NOTING** that ACAP best practice guidelines for branchline weighting were extended to include sink rates as a criterion and that some fleets may have difficulty in implementing the weighted branchline configurations as indicated in the Resolution, the WPEB **NOTED** the plan for ACAP to develop guidelines for measuring sink rates of baited hooks in pelagic line fisheries. The WPEB therefore **AGREED** that it would continue working to provide advice to the Commission on this issue once these guidelines have been developed and studies have been conducted by longline fleets in the Indian Ocean. The WPEB **NOTED** that it is unlikely to be able to provide specific advice on this topic until at least 2027 to allow time for the guidelines to have been developed and applied in studies.

251. The WPEB **NOTED** a brief presentation providing an update on the work of the CCSBT Ecologically Related Species Working Group, based on document CCSBT-ERSWG/2024. This document outlines a collaborative risk assessment, specifically focusing on seabird bycatch. Key points from the summary included:

- *Relating to the SEFRA (Spatially Explicit Fisheries Risk Assessment). There were concerns related to the accuracy of seabird distribution solely based on tracking data and some model behaviours. There is a need to refine the predictions related to seabird distribution and model to improve risk assessments.*
- *Wandering and royal albatrosses were identified as the groups at the highest risk of bycatch. These species were therefore designated as top priorities for mitigation efforts.*
- *Further Model Review: The meeting agreed to continue reviewing and refining the risk assessment model and seabird distribution data.*
- *Consultation with ACAP and BLI: A decision was made to consult with ACAP and BirdLife International to incorporate more precise seabird distribution and biological parameter inputs.*
- *Data Commitment: All CCSBT member states, except Indonesia, committed to providing seabird bycatch data to support the ongoing risk assessment and model refinement.*
- *Technical Meeting: A technical meeting will be held in mid-2025 to finalize the risk assessment model.*
- *Future Management Measures: Additional management measures will be discussed during the 2026 ERSWG (Ecologically Related Species Working Group) meeting.*
- *Global Risk Assessment including non-CCSBT country in the Southern hemisphere will be held at the end of 2025, under ABNJ II as the second round of global risk assessments of seabird bycatch, with informal communication between parties to begin as soon as possible.*

10.6 Sea turtles

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

252. There were no papers submitted on sea turtles.

11. WPEB Program of Work (Research and Priorities)

11.1 Revision of the WPEB Program of Work 2025-2029

253. The WPEB **NOTED** paper IOTC-2024-WPEB20(AS)-09 on WPEB Program of Work 2024-2028 which provided the WPEB20 with the latest Program of Work (2024-2028) with an opportunity to consider and revise this for 2025-2029 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.

254. The WPEB **RECOMMENDED** that the SC consider and endorse the WPEB Program of Work (2025–2029), as provided in Appendix XVIV.

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

255. 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 2025, by the Invited Expert:

- Data poor methods for assessments;
- Stock assessment expert for blue shark.

12.Other Matters

12.1 Date and place of the 21st and 22nd Working Party on Ecosystems and Bycatch

256. The WPEB **NOTED** the intention to continue to hold the WPEB back-to-back with the WPB in early to mid-September and further **NOTED** that the WPEB will be held first in 2025.

257. The WPEB **REQUESTED** CPCs that may be interested in hosting the 21st and 22nd Working Party on Ecosystems and Bycatch to contact the Secretariat.

12.2 Review of the draft, and adoption of the Report of the 20th Session of the WPEB

258. The WPEB **RECOMMENDED** that the Scientific Committee consider the consolidated set of recommendations arising from WPEB20, provided at Appendix XVVII, as well as the management advice provided in the draft resource stock status summary for each of the eight 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
- Porbeagle sharks (*Lamna nasus*) - Appendix XIV

Other species/groups

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

259. The report of the 20th Session of the Working Party on Ecosystems and Bycatch (IOTC–2024–WPEB20(AS)–R) was **ADOPTED** by correspondence.

APPENDIX I
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APPENDIX II
AGENDA FOR THE 20TH WORKING PARTY ON ECOSYSTEMS AND BYCATCH ASSESSMENT MEETING

Date: 9-13 September 2024
Location: Seychelles
Venue: Eden Bleu Hotel
Time: 09:00 – 17:00 (Seychelles 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 26th Session of the Scientific Committee (IOTC Secretariat)
    - 3.2. Outcomes of the 28th 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 WPEB19 (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. **OUTCOMES OF BYCATCH MITIGATION WORKSHOP** (all)
    - 6.1. Presentation of summary of the bycatch mitigation workshop (all)
    - 6.2. Discussion of recommendations arising from workshop for adoption (all)

7. **REVIEW INFORMATION ON BIOLOGY, ECOLOGY, FISHERIES AND ENVIRONMENTAL DATA RELATING TO SHARKS** (all)
    - 7.1. Presentation of new information available on sharks (all)
    - 7.2. Development of shark research work plan for scalloped hammerhead shark (all)

8. **STOCK ASSESSMENT FOR SHORTFIN MAKO SHARK** (all)
    - 8.1. Review of indicators for shortfin mako shark (all)
    - 8.2. Stock assessment models (all)
    - 8.3. Review of the proposed stock assessment of shortfin mako shark (all)
    - 8.4. Recommendations and executive summaries (all)

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

9.1. 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

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

10.1. All bycatch species (all)
10.2. Other sharks and rays (all)
10.3. Mobulids (all)

- Review new information on mobulid biology, ecology, fisheries interactions and bycatch mitigation measures (all);
- Review of indicators for mobulids (all)
- Development of management advice on the status of mobulid species (all)

10.4. Marine mammals (all)

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

10.5. Seabirds (all)

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

10.6. Sea turtles

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

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

11.1. Revision of the WPEB Program of Work 2025-2029 (Chairperson and IOTC Secretariat)
11.2. Development of priorities for an Invited Expert at the next WPEB meeting (Chairperson)

12. OTHER MATTERS (Chair)

12.1. Date and place of the 21st and 22nd Working Party on Ecosystems and Bycatch (Chair)
12.2. Review of the draft, and adoption of the Report of the 20th Session of the Working Party on Ecosystems and Bycatch (Chairperson)

APPENDIX III
LIST OF DOCUMENTS

Document	Title
IOTC-2024-WPEB20(AS)-01a	Agenda of the 20th Working Party on Ecosystems and Bycatch
IOTC-2024-WPEB20(AS)-01b_rev3	Annotated agenda of the 20th Working Party on Ecosystems and Bycatch Assessment Meeting
IOTC-2024-WPEB20(AS)-02_rev2	List of documents of the 20th Working Party on Ecosystems and Bycatch Assessment Meeting
IOTC-2024-WPEB20(AS)-03	Outcomes of the 26th Session of the Scientific Committee (IOTC Secretariat)
IOTC-2024-WPEB20(AS)-04	Outcomes of the 28th Session of the Commission (IOTC Secretariat)
IOTC-2024-WPEB20(AS)-05	Review of Conservation and Management Measures relevant to ecosystems and bycatch (IOTC Secretariat)
IOTC-2024-WPEB20(AS)-06_rev1	Progress made on the recommendations and requests of WPEB19 and SC26 (IOTC Secretariat)
IOTC-2024-WPEB20(AS)-07_rev2	Review of the statistical data and fishery trends for ecosystems and bycatch species (IOTC Secretariat)
IOTC-2024-WPEB20(AS)-08_rev1	Status of development and implementation of National Plans of Action for seabirds and sharks, and implementation of the FAO guidelines to reduce marine turtle mortality in fishing operations (IOTC Secretariat)
IOTC-2024-WPEB20(AS)-09	Revision of the WPEB Program of Work (2025–2029) (IOTC Secretariat & Chairperson)
IOTC-2024-WPEB20(AS)-10	Stock assessment of the shortfin mako shark in the Indian Ocean (IOTC), using Bayesian surplus production models (JABBA): catch reconstruction, demographic analysis, stock assessment models and projections (R Coelho, D Rosa, B Mourato)
IOTC-2024-WPEB20(AS)-11	Regional observer scheme data on shortfin mako shark CPUE
IOTC-2024-WPEB20(AS)-12_rev1	Standardized CPUE of Shortfin Mako Shark (Isurus oxyrinchus) from Indonesian tuna longline fleets in the north-eastern Indian Ocean (D Novianto, B Setyadji, A Widodo, U Chodrijah)
IOTC-2024-WPEB20(AS)-13	Exploring the spatial-temporal dynamics of standardized CPUE for shortfin mako shark (Isurus oxyrinchus) caught by the Taiwanese large-scale tuna longline fishery in the Indian Ocean (H Huynh, W Tsai)

Document	Title
IOTC-2024-WPEB20(AS)-14	Embracing modern methods in fisheries: an encouraging first attempt at using machine learning to monitor catches in the demersal shark longline fishery (C da Silva, N Chapman, M Rio, W West, A Booth, S Lamberth, S Kerwath)
IOTC-2024-WPEB20(AS)-15	Elasmobranchs bycatch in purse seine fishery in the Andaman Sea of Thailand (W Thitipongtrakul, S Hoimuk)
IOTC-2024-WPEB20(AS)-16	Estimation Iran's sharks total catch historical data 1950-2022 (R Shahifar)
IOTC-2024-WPEB20(AS)-17	Estimation of Iranian fishing vessels By-catch in IOTC competence of area in 2023 (H Bargahi)
IOTC-2024-WPEB20(AS)-18_rev1	Necessity to review and updating fish taxonomic guidelines in the Northern Indian Ocean (H Ayeshya, D Balawardhana, R Jayasinghe)
IOTC-2024-WPEB20(AS)-19	Preliminary summary report on the leader type used by Japanese longline fleet in the Indian Ocean (Y Semba)
IOTC-2024-WPEB20(AS)-20	Effect of bait and hook types on pelagic shark by-catch and discards of tuna longline fishery in Sri Lanka (D Balawardhana, R Jayasinghe, S Haputhantri, M Ariyarathna)
IOTC-2024-WPEB20(AS)-21	IOTC ROS mitigation measure and shark catches summary (IOTC Secretariat)
IOTC-2024-WPEB20(AS)-22_rev1	Proposal of an online digital ocean atlas for the Indian Ocean and a dedicated IOTC webpage on climate change and its impacts on tuna fisheries (F Marsac, N Gunawardane)
IOTC-2024-WPEB20(AS)-23_rev1	Preliminary steps towards assessing the ecosystem impacts of fishing in the tropical Indian Ocean through a trophic modelling approach (R Amate, M Juan-Jordá, X Corrales, I Zudaire, E Andonegi)
IOTC-2024-WPEB20(AS)-24_rev1	Ecosystem Fisheries Overviews - A Pilot Product to Assess the General Applicability of IOTC Candidate Ecoregions as a Spatial Framework for developing Ecosystem-Based Advisory Products (M Juan-Jordá, H Murua; V dárraga-Garcés, E Andonegi)
IOTC-2024-WPEB20(AS)-25_rev1	Validating IOTC candidate ecoregions through a comparative analysis of main tuna and tuna-like species and fishing fleets (V Idárraga-Garcés, E Andonegi, H Murua, M Juan-Jordá)
IOTC-2024-WPEB20(AS)-26	Crustacean as bycatch of tuna gillnet fishery of Pakistan (M Moazzam)
IOTC-2024-WPEB20(AS)-27_rev1	An update for 2024 on the development of IOTC BTH PRM Project (E Romanov)
IOTC-2024-WPEB20(AS)-28_rev1	Demographic analysis for silky shark (Carcharhinus falciformis) in the Indian Ocean (J Zhu, Z Geng, Y Li, X Wang)

Document	**Title**
IOTC-2024-WPEB20(AS)-29_rev2	Why is IOTC lagging behind on shark conservation? An analysis of the status quo and comparison with other tuna RFMOs (I. Ziegler)
IOTC-2024-WPEB20(AS)-30	Ecological interactions between 19 shark species in the Indian Ocean (E Gee)
IOTC-2024-WPEB20(AS)-31	Mobulids caught by French purse seiners in the western Indian Ocean between 2005 and 2023 (P Sabarros, E Mollier, C Tellier)
IOTC-2024-WPEB20(AS)-32	High bycatch rates of manta and devil rays in the “small-scale” artisanal fisheries of Sri Lanka (D Fernando, J Stewart)
IOTC-2024-WPEB20(AS)-33	Mobulid ray fisheries and conservation management in the Chagos Archipelago (N Barros)
IOTC-2024-WPEB20(AS)-34	Overview of mobulid fisheries and trade in the Indian Ocean (N. D’Costa, N Barros, B. Carter and G. M. W. Stevens)
IOTC-2024-WPEB20(AS)-35	Progress in addressing key research to inform Mobulid ray conservation (M Cronin, G Moreno, J Murua, H Murua, V Restrepo)
IOTC-2024-WPEB20(AS)-36	Updated ACAP Advice on Branch line Weighting as a Mitigation Measure to Reducing the Bycatch of Albatrosses and Petrels in IOTC Pelagic Longline Fisheries (S Jiménez)
IOTC-2024-WPEB20(AS)-37_rev1	Spatio-temporal Distribution of Catch and Population Structure of Blue shark, Prionace glauca and Silky shark, Carcharhinus falciformis, caught by longlines in Kenya’s Exclusive Economic Zone (K Wachira, S Ndegwa, E Mueni, B Kiilu, A Lukhwendah, G Okemwa)
IOTC-2024-WPEB20(AS)-38	IWC advice on best practice guidelines for safe release and handling of cetaceans
IOTC-2024-WPEB20(AS)-39	Spatial and temporal dynamics of dolphin bycatch in gillnet fisheries of the Northern Arabian Sea and Indian Ocean: implications for conservation and management (S. A. Razzaque, U. Shahid, C. Johnson, R. Nawaz, G. Salahuddin, N. Afsar)
Information papers	
IOTC-2024-WPEB20(AS)-INF01	Inputs for comprehensive bycatch management strategy evaluation in tuna fisheries (E Gilman, H Murua, M Chaloupka)
IOTC-2024-WPEB20(AS)-INF02	Undetected silky sharks (*Carcharhinus falciformis*) in the wells of the tropical tuna purse seine fleet in the Indian Ocean (A Juan, M Alonso, V Sierra, J Baez)
IOTC-2024-WPEB20(AS)-INF03	Best handling and release practice guidelines for sharks in IATTC fisheries
IOTC-2024-WPEB20(AS)-INF04	Safe handling and release guidelines for mobulids - updated version (Manta trust)

Document	Title
IOTC-2024-WPEB20(AS)-INF05	Best Practices for the disentanglement of free-swimming small cetaceans (IWC)

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

Extract from IOTC–2024–WPEB20(AS)–07.
(Appendix references in this Appendix, refer only to those contained in this appendix)

Overall bycatch levels & trends

Reported retained 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 1)**. 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. In 2022, the total retained catches of sharks reported to the Secretariat amounted to 80,263 t, with rays representing a very small component of the reported bycatch at 1,528 t, i.e., about 1.9% of total reported shark and ray catches for the same year (**Figure A 1**).

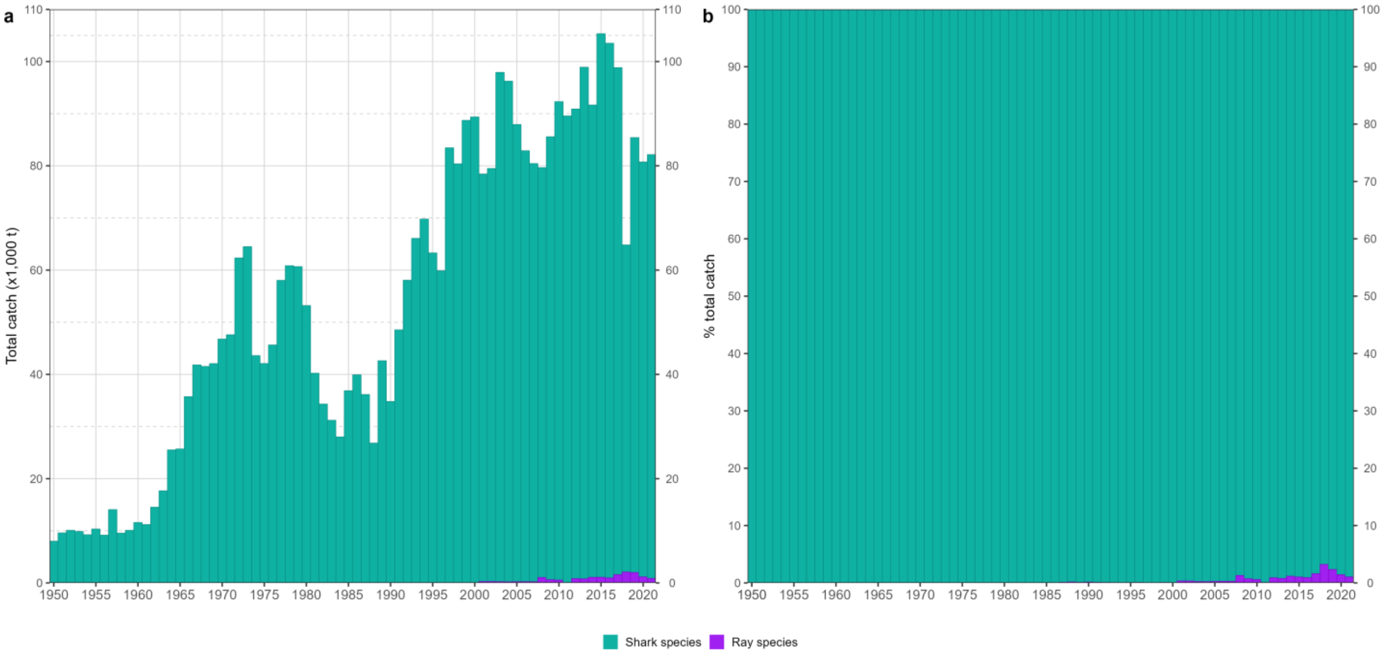

Figure A 1: Annual time series of cumulative nominal absolute (a) and relative (b) catches (metric tons; t) of shark and ray species by species category for the period 1950-2022

Very few fleets reported catches of sharks and rays in the 1950s, but the number of reporting fleets has increased over time (**Fig. A 2**). Total reported catches of sharks and rays have also increased over time, reaching a recent peak of over 100,000 t in 2015-2016. Since then, retained catches have decreased to about 80,000 t in 2022.

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 retained catch data set prepared for the meeting.

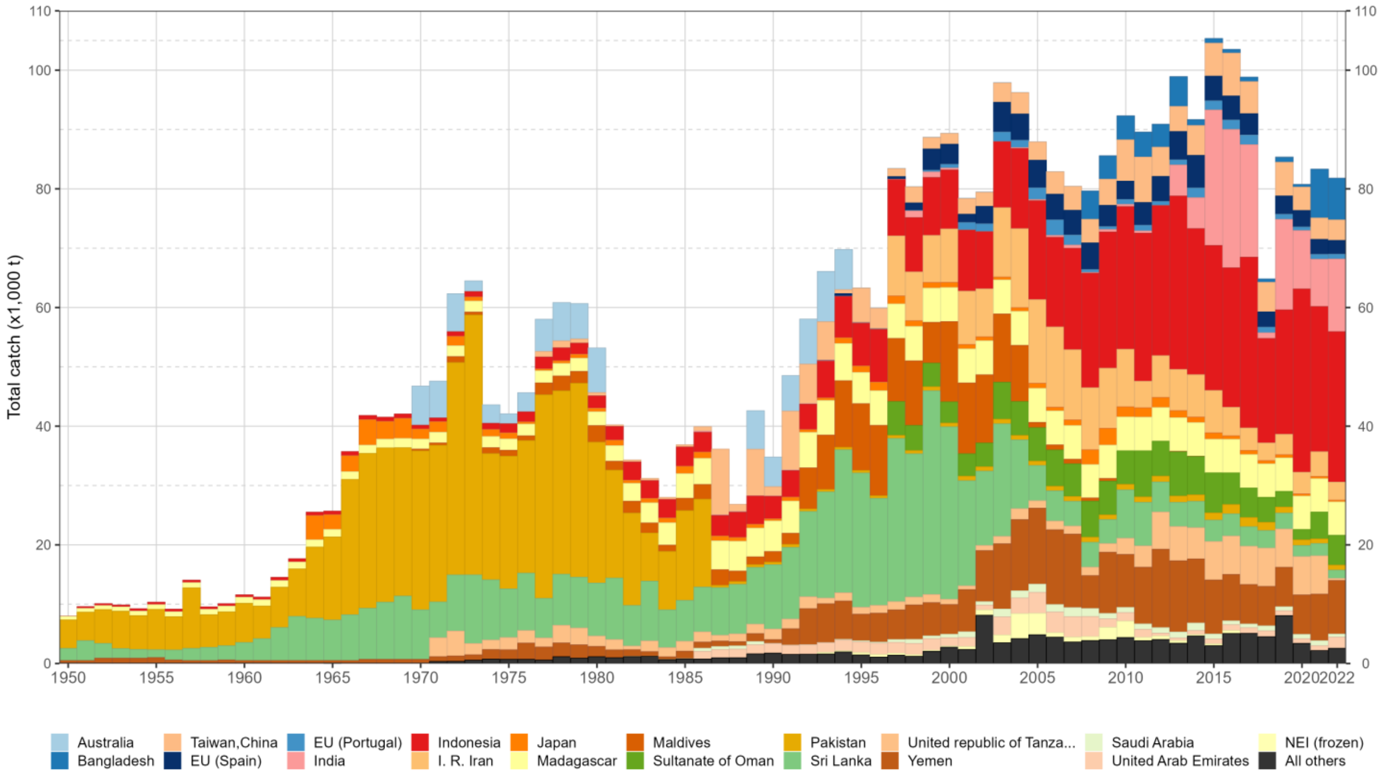

Figure A 2: Annual time series of nominal catches (metric tons; t) of sharks and rays by fleet during 1950-2022

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 34% 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 45.2% 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 (**Fig. A3**).

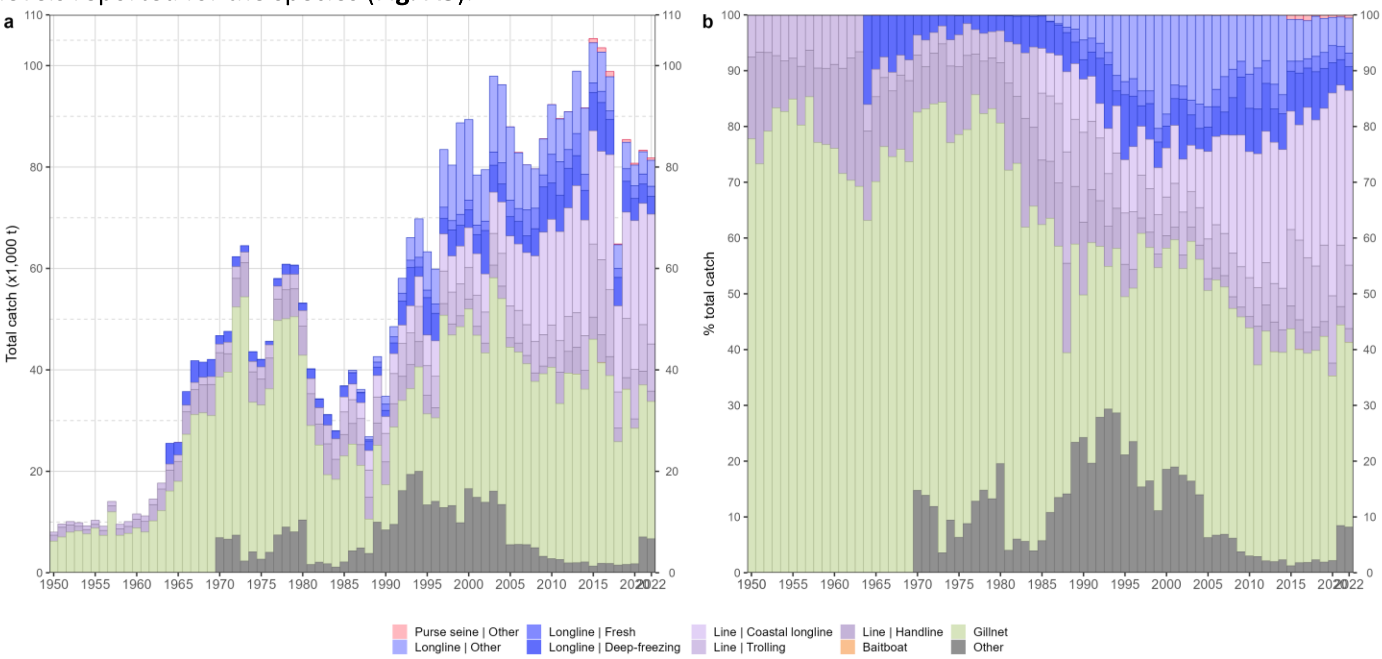

Figure A 3: Annual time series of nominal absolute (a) and relative (b) catches (metric tons; t) of sharks and rays by fishery for the period 1950-2022. 'Other' corresponds to all other fisheries combined

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–2024-WPEB20(AS)–07

Uncertainties in catch and effort data

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

Unreported catches

Although some fleets have been operating since the early 1950s, there are many cases where historical catches have gone unreported as many countries were not collecting fishery statistics in years prior to the 1970s. It is therefore thought that important catches of sharks and rays might have gone unrecorded in several countries. Also, there still are several fleets not reporting on their interactions with bycatch species, despite data showing that other fleets using similar gears 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 (2012-2022);
  - **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 (2014-2022) 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

2024: 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 2024*)

CPC	Sharks	Date of Implementation	Seabirds	Date of implementation	Marine turtles	Date of implementation	Comments
MEMBERS							
Australia		1st: April 2004 2nd: July 2012 3rd: 2021 4th: August 2024		1st: 1998 2nd: 2006 3rd: 2014 NPOA in 2018.		2003	**Sharks:** 3rd NPOA-Sharks (Shark-plan 3) was released in 2021 replacing the previous Shark-plan 2.. Australia produced a revised NPOA for the conservation and management of sharks (Revised Shark-plan 2) in 2024. **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			n.a.				**Sharks:** Bangladesh has finalised a NPOA for shark and rays which will be in place for 2023-2027. The Wildlife Conservation and Security Act introduced in 2012 lays out rules on requirements for hunting wild animals. It includes provisions for the protection of sharks and rays including the species for which there are active IOTC CMMs (hammerhead, blue, mako, silky, oceanic whitetip, thresher and whale sharks, and mobulid rays).**Seabirds:** Bangladesh currently do not have a NPOA for seabirds. The Wildlife Conservation and Security Act introduced in 2012 lays out 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 rules on requirements for hunting wild animals and includes provisions for the protection of marine 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 have been updated. Targeted distant water fisheries for sharks and rays are prohibited and vessels must avoid or reduce catching of sharks. Sharks (species not under a retention ban) caught as bycatch shall be fully utilised and finning is prohibited. Longliners are prohibited from using shark lines and wire tracers. **Seabirds:** China is currently considering developing an NPOA for seabirds. Regulations relating to the conservation of seabirds managed by RFMOs have been updated. Vessels operating in the area south of 25ºS shall use two mitigation measures from: tori lines, night setting and weighted branch lines. They may also use hook-shielding devices to replace the above three measures. **Marine turtles:** Regulations relating to the conservation of turtles managed by RFMOs has been updated. All longlines shall use circle hooks whenever possible. Longline vessels are encouraged to use finfish as bait, not squid.

–Taiwan,China		1st: May 2006 2nd: May 2012		1st: May 2006 2nd: Jul 2014			**Sharks:** No revision currently planned. **Seabirds:** No revision currently planned. **Marine turtles:** Wildlife Protection Act introduced in 2013, Protected Wildlife shall not be disturbed, abused, hunted, killed, traded, exhibited, displayed, owned, imported, exported, raised or bred, unless under special circumstances recognized in this or related legislation. *Cheloniidae spp*., *Caretta Caretta*, *Chelonia mydas*, *Eretmochelys imbricata, Lepidochelys olivacea* and *Dermochelys coriacea* are listed into List of Protected Species. Domestic Fisheries Management Regulation on Far Sea Fisheries request all fishing vessels must carry line cutters, de-hookers and hauling nets in order to facilitate the appropriate handling and prompt release of marine turtles caught or entangled.
Comoros		–		–			**Sharks:** No NPOA has been developed. Shark fishing is prohibited but measures are difficult to enforce due to the artisanal nature of the fisheries. A campaign to raise awareness of measures is being implemented to improve compliance. Shark catches and size frequency data are submitted to IOTC **Seabirds:** No NPOA has been developed. There is no fleet in operation south of 25 degrees south and no long-line fleet. The main fishery is artisanal operating within 24 miles of the coast where there is low risk of interactions with seabirds. **Marine turtles:** According to the Comoros Fisheries Code Article 78, fishing, capture, possession and marketing of turtle and marine mammals or of protected aquatic organisms is strictly forbidden in accordance with national legislation in force and International Conventions applicable to the Comoros.
European Union		5 Feb 2009		16-Nov-2012		2007	Regulation n°2021-47 of 9th of July 2021 legislating tuna and tuna-like species fisheries includes marine species protection measures, especially in its Annex 2, aiming to reduce the impact on marine turtles, sea birds and sharks. **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. A specific national plan of action has been published for Albatrosses which runs from 2018-2027. **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 period 2015-2020. This is still being applied and currently being revised and will be published in 2025.
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 has also established a national plan of action for whale sharks from 2021-2025 through Ministerial Decree No. 16 of 2021. Indonesia plans to review the NPOA for sharks in 2025 **Seabirds:** An NPOA was finalized in 2016 **Marine turtles:** Indonesia has established an NPOA for Marine Turtles in 2022 and this will be reviewed in 2025. 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, 2023		03-Dec-2009, 2016			**Sharks:** NPOA–Shark assessment implementation report submitted to COFI in July 2012 has since been revised in 2016 and again in 2023. **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 prepared a NPOA for seabirds which is in the process of being reviewed by relevant stakeholders. **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 prepared a NPOA for marine turtles which is in the process of being reviewed by relevant stakeholders.
Korea, Republic of		08-Aug-11		2019		–	**Sharks:** A NPOA for sharks was finalised in 2011 and is 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:** NPOA Sharks was finalised in 2015 with the assistance of Bay of Bengal Large Marine Ecosystem (BoBLME) Project. On 14th July 2019 the Government of Maldives officially announced the cessation of the Maldives long line fishery in Maldives EEZ and High Seas so consider the NPOA for sharks to now be unnecessary. **Seabirds** 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 seabird entanglement and bycatch is not an issue in Maldives fisheries especially with the cessation of the Maldives long line fishery in 2019. **Marine turtles:** Standards of code and conduct for managing sea turtles have been developed by the Environmental Protection Agency in the drafted national sea turtle management plan under the protected species regulation. Longline regulation has provisions to reduce marine turtle bycatch. The regulation urges longline vessels to have dehookers for removal of hook and a line cutter on board, to release the caught marine turtles as prescribed in Resolution 12/04.
Mauritius		2016					**Sharks:** The NPOA-sharks has been finalised; it focuses on actions needed to exercise influence on foreign fishing through the IOTC process and licence conditions, as well as improving the national legislation and the skills and data handling systems available for managing sharks. **Seabirds:** Mauritius does not have national vessels operating beyond 25^{0}S. However, fishing companies have been requested to implement all mitigation measures as provided in the IOTC Resolutions. There are currently no plans to develop a NPOA for seabirds. **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. There are currently no plans to develop a NPOA for marine turtles.

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 (c) of Pakistan Fish Inspection & Quality Control Act, 1997, "Aquatic turtles, tortoises, snakes, mammals including dugongs, dolphins, porpoises and whales etc" are totally forbidden for export and domestic consumption. Pakistan is also in the process of drafting a NPOA for cetaceans.
Philippines		Sept. 2009		–			**Sharks:** 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 developed and is implementing a NPOA for Sharks for years 2016-2020 which has been extended for 2024. Seychelles are working to develop a new NPOA for sharks which should be complete by mid-2025. **Seabirds:** SFA is collaborating with Birdlife South Africa to develop an NPOA for seabirds. **Marine turtles:** The development of a NPOA for turtles is planned to start in 2025.
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. An updated NPOA has been drafted and is now awaiting approval. **Marine turtles**: All FAO guidelines to reduce marine turtle mortality have been inserted into permit conditions. 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 with assistance from CEFAS. 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:** Currently the draft NPOA – Seabirds for Thailand is being reviewed. 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. Regulations on Fishing Vessels operating outside Thai waters in the IOTC area of competence contains clauses relating to the conservation of marine turtles including: Clause 14 prohibiting purse seines from setting around cetaceans, marine turtles or whale sharks; Clause 18 requiring the release and recording of incidental bycatch of sensitive species including marine turtles; Clause 19 requiring that any bycaught marine turtles that are not healthy should be cared for until it is ready to be released.

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 the British Indian Ocean Territory; 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). In August 2022 the UK Government published the Bycatch Mitigation Initiative which applies to metropolitan UK waters but includes commitments to work with the international community to contribute to the understanding, reduction and elimination of bycatch globally, including by advocating for effective measures through RFMOs.
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 (2024)

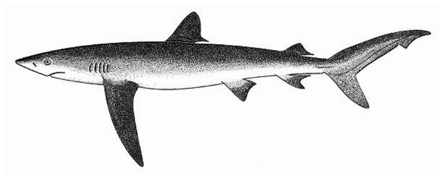

Table A 1. Status of blue shark (*Prionace glauca*) in the Indian Ocean

Area	Indicators		2021 stock status determination
Indian Ocean	Reported catch 2022 (t)	24,421	99.9%
	Estimated catch 2019 (t)[4]	43,240	
	Not elsewhere included (nei) sharks[1] 2022 (t)	26,473	
	Average reported catch 2018-22 (t)	25,270	
	Average estimated catch 2015-19 (t)[4]	48,781	
	Avg. not elsewhere included (nei) sharks[1] 2018-22 (t)	27,098	
	MSY (1,000 t) (80% CI)[2]	36.0 (33.5 - 38.6)	
	F_{MSY} (80% CI)[2]	0.31 (0.306 - 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 (0.53 - 0.75)	
	SB_{2019}/SB_{MSY} (80% CI)[2,3]	1.39 (1.27 - 1.49)	
	SB_{2019}/SB_0 (80% CI)[2,3]	0.46 (0.42 - 0.49)	

Boundaries for the Indian Ocean are defined as the IOTC area of competence
[1]Includes all other shark catches reported to the IOTC Secretariat, which may contain this species (i.e., SKH: Various sharks nei; RSK: Requiem sharks nei; AG38: Blue shark, shortfin mako, oceanic whitetip shark)
[2]Estimates refer to the base case model using estimated catches
[3]Refers to fecund stock biomass
[4]Catch estimated for stock assessment purposes only (doc IOTC-2021-WPEB17(AS)-14_Rev1). Proportion of 2022 catch estimated or partially estimated by IOTC Secretariat: 70.8%
[5]2019 is the final year that data were available for this assessment

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, Rigby et al 2019

INDIAN OCEAN STOCK – MANAGEMENT ADVICE

Stock status. No new stock assessment was carried out for blue sharks in 2024 and so the results are based on the assessment carried out in 2021 using an integrated age-structured model (SS3) (**Fig. A 3**) (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 3**). 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**). 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. A3**, **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): coastal longline; longline (deep-freezing); longline targeting swordfish; gillnet (**Fig. A1**).
- **Main fleets** (2018–22): Indonesia[2]; Taiwan,China; EU-Spain; EU-Portugal Seychelles (**Fig. A2**)

[2] 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.

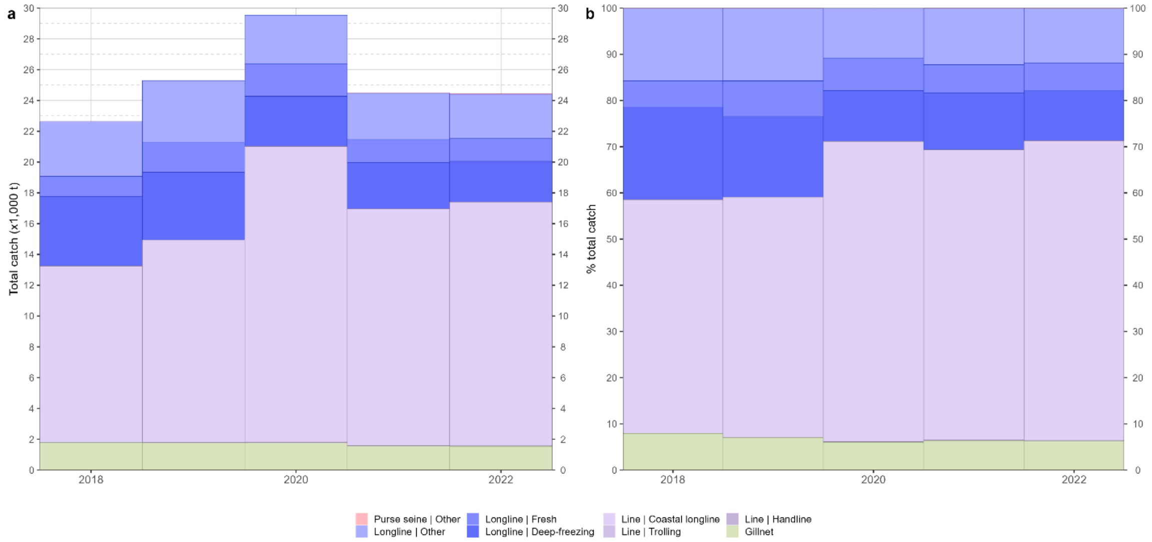

Figure A1 : Annual absolute (a) and relative (b) time series of retained catches (metric tonnes ; t) of blue shark and rays by fishery for the period 2018-2022.

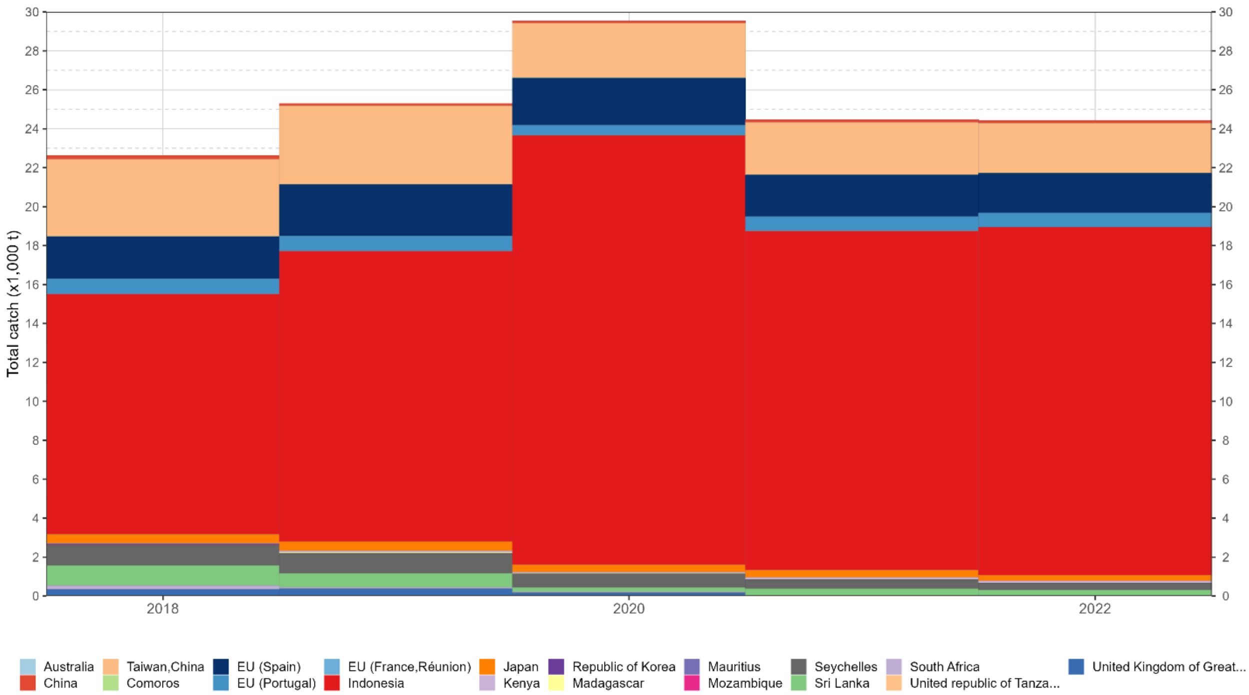

Figure 2: Annual time series of retained catches (metric tonnes; t) of blue shark by fleet during 2018 -2022. There are large uncertainties associated with the estimates of blue shark catches from artisanal Indonesian fisheries. The revision of the catch composition of Indonesian fisheries is ongoing.

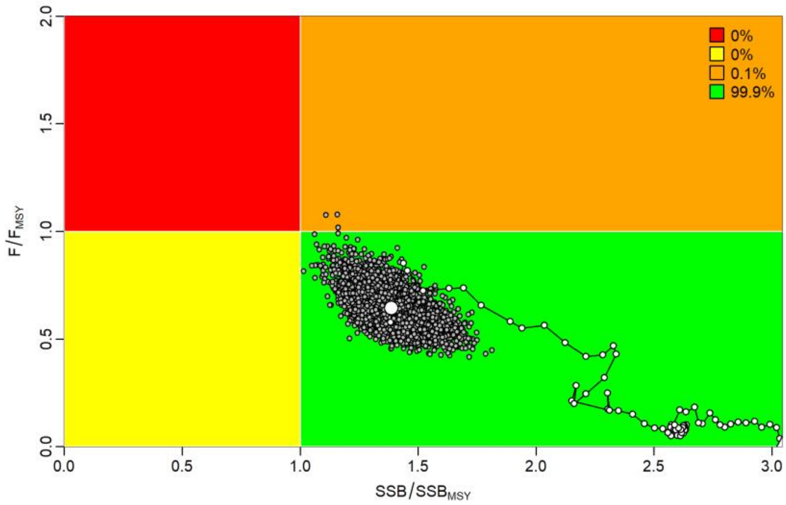

Fig. A 1. Blue shark: Aggregated Indian Ocean stock assessment Kobe plot for the 2021 assessment base case model. (base case model with trajectory and uncertainty in the terminal year.

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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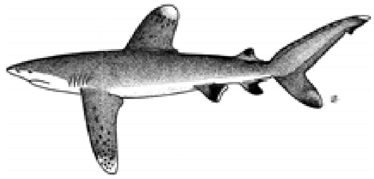
APPENDIX VIII
EXECUTIVE SUMMARY: OCEANIC WHITETIP SHARK (2024)



CITES APPENDIX II species

Table A 1. Status of oceanic whitetip shark (*Carcharhinus longimanus*) in the Indian Ocean.

Area[1]	Indicators		2018 stock status determination
Indian Ocean	Reported catch 2022 (t)[3] Not elsewhere included (nei) sharks[2] 2022 Average reported catch 2018-22 Av. not elsewhere included 2018-2022 (nei) sharks[2]	41 t 26,473 t 35 t 27,098 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 2. Oceanic whitetip shark: IUCN threat status of oceanic whitetip shark (*Carcharhinus longimanus*) in the Indian Ocean.

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

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

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

Sources: IUCN Red List 2020, Rigby et al 2019
CITES - In March 2013, CITES agreed to include oceanic whitetip shark to Appendix II to provide further protections prohibiting the international trade; which will become effective on September 14, 2014.

INDIAN OCEAN STOCK – MANAGEMENT ADVICE

Stock status. There remains considerable uncertainty about the relationship between abundance, standardised CPUE series and total catches over the past decade (**Table A**). 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**). 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**).

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.

Mitigation measures should be taken to reduce at-vessel and post release mortality, including consideration of potential gear modifications in longline fleets targeting tuna and swordfish. Noting that a recent study (Bigelow et al. 2021) concluded in WCPFC that banning both shark lines and wire leaders has the potential to reduce fishing mortality by 40.5% for oceanic whitetip shark.

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** (2018-2022): gillnet, line; Longline, purse seine (other).
- **Main fleets** (2018-22): I.R. Iran; Comoros; China, Indonesia, Seychelles, (Reported as discarded/released alive by China, EU-France, Mauritius, Tanzania, Sri Lanka, EU-Spain).
-

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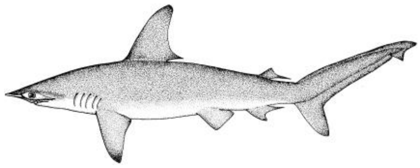
APPENDIX IX
EXECUTIVE SUMMARY: SCALLOPED HAMMERHEAD SHARK (2024)



CITES APPENDIX II species

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

Area[1]	Indicators		2018 stock status determination
Indian Ocean	Reported catch 2022 (t)[3]	681	
	Not elsewhere included (nei) sharks[2] 2022 (t)	28,192	
	Average reported catch 2018-22 (t)	200	
	Av. not elsewhere included 2018-2022 (nei) sharks[2] (t)	29,801	
	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., SKH: Various sharks nei; SPN: Hammerhead sharks nei).
[3]Proportion of catch fully or partially estimated for 2022: 0% All catches within the database were reported by CPCs.

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 4. 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	Critically Endangered	–

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

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

Sources: IUCN Red List 2020, Rigby et al 2019

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 'Critically Endangered' (**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). 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 and prawn trawl fisheries, especially when these occur in and around nursery areas. Scalloped hammerheads are commonly landed in coastal fisheries in the Western Indian Ocean, and have often been recorded among the species with the highest catches numerically. While species-level catch data are limited for the region, there are several sources of published and unpublished data on catches of this species. 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. The stock status is **unknown** due to a lack of data available for quantitative stock assessment or basic fishery indicators (**Table A**).

Outlook. The marked increase in catches over the previous year (200 t) is due to the breakdown by species reporting this year by Kenya and Tanzania, which previously reported sharks aggregated. 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 from longline fleets on scalloped hammerhead shark declined in the southern and eastern areas during this time period and may have resulted in localised depletion there. Mortality from coastal fisheries remain high and unmonitored.

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): Gillnet; Handline, longline-coastal; Ringnet; and offshore gillnet, Prawn trawl fisheries
- **Main fleets** (2018-22): Mozambique, Madagascar, Kenya; Tanzania; Sri Lanka; Malaysia; (report as released alive/discarded by United Kingdom, EU-France, South Africa,) (artisanal fisheries)

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APPENDIX X
EXECUTIVE SUMMARY: SHORTFIN MAKO SHARK (2024)

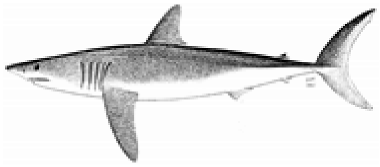

Table A 1. Status of shortfin mako shark (*Isurus oxyrinchus*) in the Indian Ocean.

Area[1]	Indicators		2024 stock status determination
Indian Ocean	Reported catch 2022 (t)[3]	678	49.7%
	Catches reported to MAK in 2022 (t)[4]	1,947	
	Average catches reported to MAK 2018-2022 (t)	2,057	
	Catches in 2022 (MAK, SMA, LMA) (t)	2,639	
	Average catches 2018-2022 (MAK, SMA, LMA) (t)	880	
	Not elsewhere included (nei) sharks[2] 2022 (t)	28,419	
	Average reported catch 2018-22 (t)	1,015	
	Av. Not elsewhere included (nei) sharks[2] 2018-22 (t)	29,161	
	MSY (1,000 t) (80% CI)	1.930 (0.985 – 3.313)	
	F_{MSY} (80% CI)	0.03 (0.01 – 0.07)	
	B_{MSY} (1,000 t) (80% CI)	60.0 (35.7 – 103.8)	
	F_{2022}/F_{MSY} (80% CI)	1.53 (0.65 – 3.71)	
	B_{2022}/B_{MSY} (80% CI)	0.96 (0.58 – 1.41)	
	B_{2022}/B_0 (80% CI)	0.45 (0.27- 0.69)	

[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., SKH: Various sharks nei; MSK: Mackerel sharks,porbeagles nei; MAK: Mako sharks; AG38: Blue shark, shortfin mako, oceanic whitetip shark).

[3] Proportion of 2022 catch estimated or partially estimated by IOTC Secretariat: 32.2%

[4] Catches of MAK include for all Isurus spp, reported as aggregated MAK.

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)	49.7	24.0
Stock not subject to overfishing (F_{year}/F_{MSY}≤ 1)	4.1	22.2
Not assessed/Uncertain		

Table A 5. 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, Rigby et al 2019

INDIAN OCEAN STOCK – MANAGEMENT ADVICE

Stock status. In 2024 a stock assessment was carried out for the shortfin mako shark in the IOTC area of competence. The WPEB carried out a data-preparatory meeting earlier in the year followed by the stock assessment meeting. The model applied was a population biomass dynamics model using the platform JABBA. The stock status and projections were based on an ensemble grid of 9 models designed to capture the main uncertainties relating to biology (3 options) and the shape of the production curve used in biomass dynamics models (3 options). A number of additional options and model configurations were explored as sensitivity runs. Median biomass in 2022 was estimated to be at 45% (80%

CI: 27-69%) of the unfished levels and below the levels that support MSY (B/BMSY in 2022 = 0.96, 80% CI: 0.58-1.41) (**Table 1**). Median fishing mortality in 2022 was estimated to be higher than the level that supports MSY (F/FMSY in 2022 = 1.53, 80% CI: 0.65-3.71), with the catch in 2022 (2,625 t, combining SMA and MAK codes) above the estimated MSY levels of 1,930 t (80% CI: 985 – 3,313 t (**Table 1**). While in recent years there were a number of CPUE indices to compare, the assessment relied on the Japanese CPUE index which showed a large depletion through the late 1990s and there is no alternative abundance index to compare the extent of this decline during that period. Additionally, although the reported catches of shortfin mako are generally considered to be reliable because this species used to be retained by several fleets, there is still significant uncertainty about the accuracy of reports from earlier years. This uncertainty also applies to more recent years (post-2018) due to discarding or non-retention.

A semi-quantitative ecological risk assessment (ERA) was conducted for the Indian Ocean by the WPEB and SC in 2018 to evaluate the resilience of shark species to the impact of pelagic fisheries (Murua *et al.* 2018). Shortfin mako sharks received the highest vulnerability ranking in the ERA for longline gear (No. 1) because of their low productivity and high susceptibility to longline gear, and were ranked the fourth most vulnerable shark species for purse seine gear. Considering the characterized uncertainty, and on the weight-of-evidence available in 2024, the shortfin mako shark stock is determined to be **overfished** and subject to **overfishing** (**Table 1, Fig 3**).

Outlook. Catches increased mostly from the mid-1980s up to 2016 followed by a decrease until 2022 as it has been under domestic landing restrictions by a number of fleets, and as a result of it having been listed in CITES Appendix II. The CPUE series for several key fleets which have been available since the early 2000s are generally stable or are increasing.

Management advice The Commission should take a cautious approach by implementing management actions that reduce fishing mortality on shortfin mako sharks, and the stock should be closely monitored. 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 future scientific advice. The Kobe II Strategy Matrix (**Table A** 3) provides the probability of exceeding reference levels over 3-, 10-, 20- and 30-year periods, over a range of TAC options established as a percentage of current catches. Current catches are higher than MSY, and the shortfin mako is currently overfished (B/Bmsy < 1) and undergoing overfishing (F/Fmsy > 1). Under those levels of catches, the biomass will continue to decline, and fishing mortality will continue to increase over time. In order to have a lower than 50% probability of exceeding MSY-reference points in 10 years, i.e., to recover the stock to the green quadrant of the Kobe plot with at least 50% probability in 10 years, future catches should not exceed 40% of current catches. This corresponds to an annual TAC of 1,217.2 t (representing all fishing mortality including retention, dead discards and post-release mortality), noting that this TAC level should include and account for the SMA, MAK and MSK species codes as reported to IOTC.

The following key points should also be noted:

- **Maximum Sustainable Yield (MSY)**: estimate for the Indian Ocean is approximately 1,930 t
- **Reference points**: The Commission has not adopted reference points or harvest control rules for any shark species.
- **Main fishing gear** (2018-22): Longline targeting swordfish; gillnet, longline (deep-freezing); longline (fresh); gillnet offshore (**Fig 1).**
- **Main fleets** (2018-22): Indonesia(26%); Taiwan,China (18%); Madagascar[3] (15%); EU,Spain (12%); Pakistan (8%); South Africa (5%); EU,Portugal (4%); Sultanate of Oman (3%); Japan (1%); United Kingdom (1%); (Reported as discarded/released alive: EU-Spain, Australia, EU,France, Indonesia, Korea, South Africa) **(Fig 2)**.

[3] In the absence of data officially reported to the Secretariat, the catches of Madagascar were estimated to have remained constant

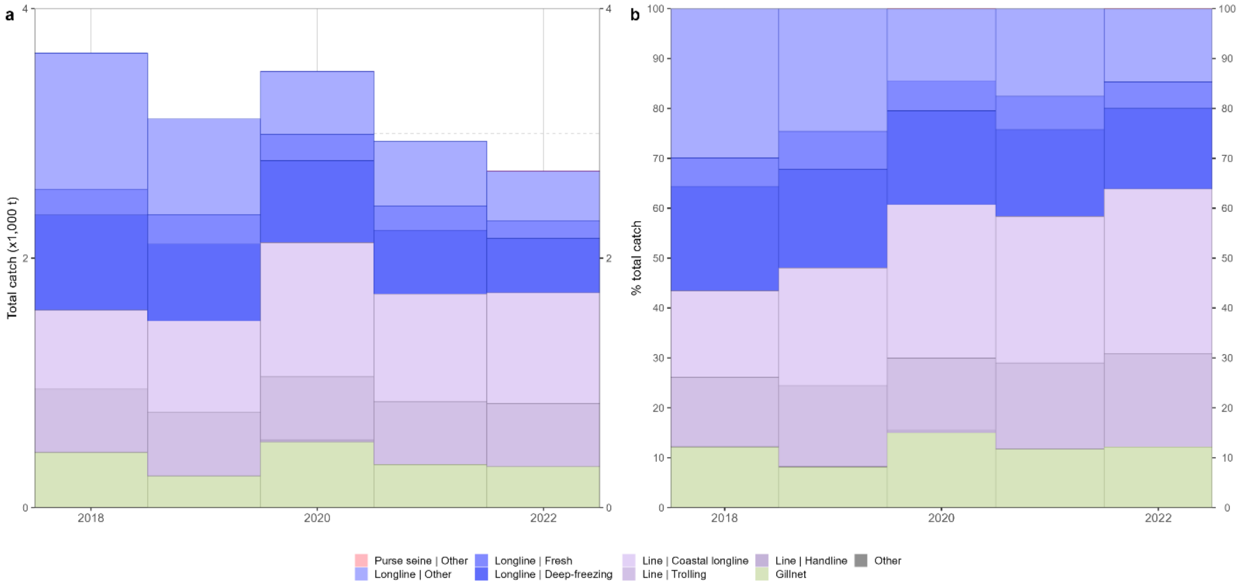

Fig 1: Annual absolute (a) and relative (b) time series of retained catches (metric tonnes; t) of shortfin mako reported at species level or aggregated (SMA, MAK and MSK) by fishery for the period 1918-2022

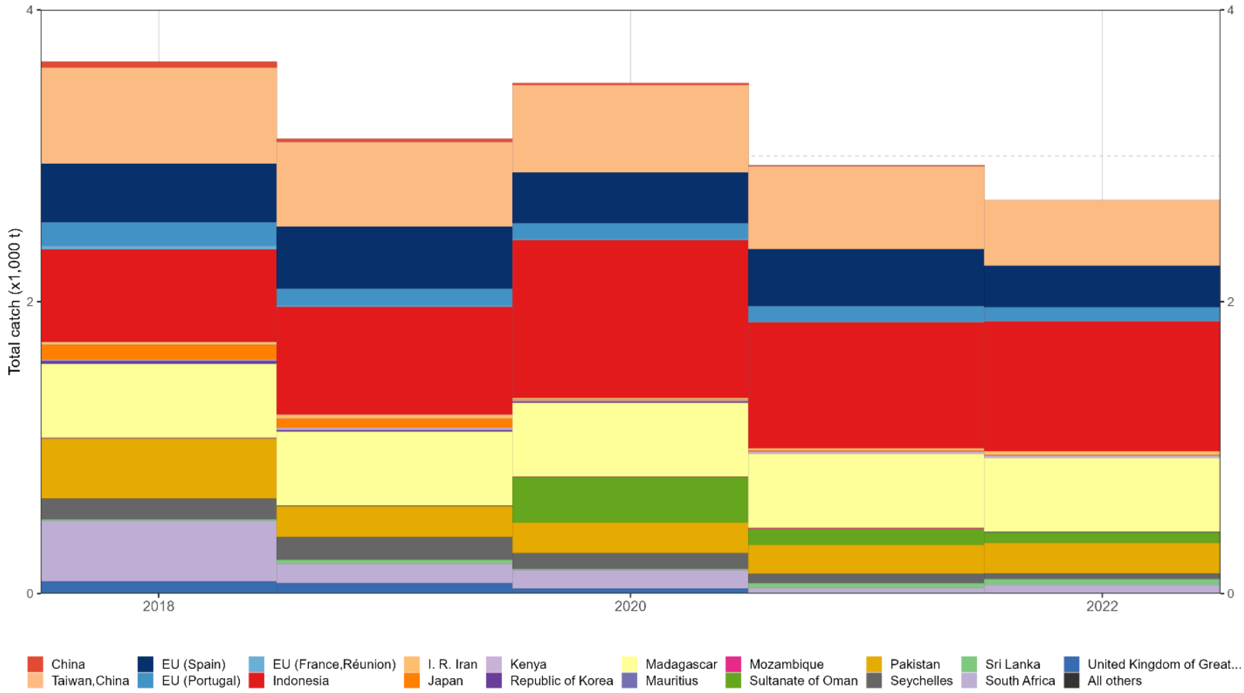

Fig 2: Annual time series of retained catches (metric tonnes; t) of shortfin mako reported at species level or aggregated (SMA, MAK and MSK) by fleet during 1918-2022

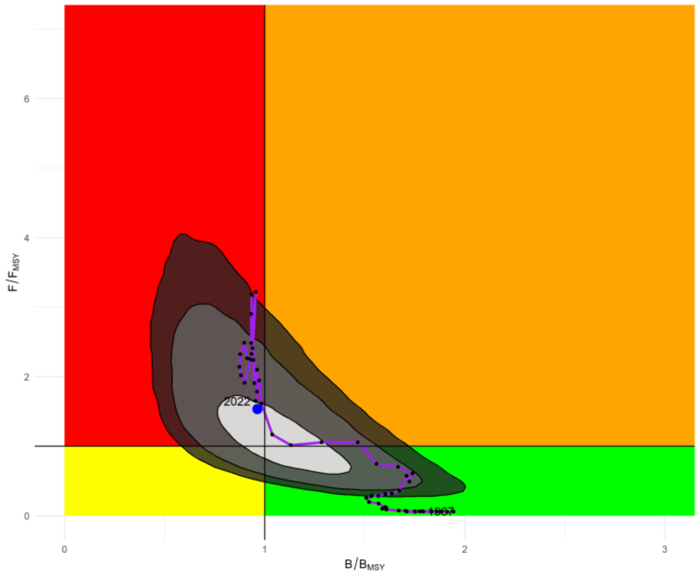

Fig 3: **Shortfin mako**: 2024 stock status, relative to BMSY (x-axis) and FMSY (y-axis) for the final model. The point represents the median of the 9 final models used in the ensemble grid and the shaded areas are the 50%, 80% and 90% contours of the uncertainties in the terminal year. The line represents the time series of the median stock trajectory from the ensemble grid of models.

Table 3. **Shortfin mako**: Final model ensemble aggregated Indian Ocean Kobe II Strategy Matrix. The values represent the probabilities (percentage) of exceeding the MSY-based target reference points, for constant catch projections between 0%-100% (10% intervals) relative to last year catches (average of last 3 years, 2020-2022), and projected for periods of 3, 10, 20 and 30 years.

Reference point and projection time	Catch projections (relative to the 2020-2022 catches) and probability (%) of exceeding MSY-based reference points										
Catch relative to 2020-2022 (%)	**0%**	**10%**	**20%**	**30%**	**40%**	**50%**	**60%**	**70%**	**80%**	**90%**	**100%**
TAC (t)	**0.0**	**304.3**	**608.6**	**912.9**	**1217.2**	**1521.5**	**1825.7**	**2130.0**	**2434.3**	**2738.6**	**3042.9**
3 year projection											
B2025 < BMSY	57.7	57.7	57.7	57.7	57.7	57.7	57.7	57.7	57.7	57.7	57.7
F2025 > FMSY	0.0	1.5	9.6	21.7	34.1	45.3	55.1	63.2	70.0	75.7	80.2
10 year projection											
B2032 < BMSY	39.2	41.8	44.5	47.1	49.8	52.5	55.2	57.9	60.6	63.2	65.8
F2032 > FMSY	0.0	2.0	10.0	21.2	32.8	43.8	53.6	62.2	69.5	75.6	80.6
20 year projection											
B2042 < BMSY	26.1	30.0	34.4	39.1	44.0	49.0	54.1	59.1	64.0	68.6	72.9
F2042 > FMSY	0.0	2.4	10.2	20.6	31.9	42.8	52.9	62.0	69.9	76.5	81.8
30 year projection											
B2052 < BMSY	19.3	23.9	29.0	34.9	41.2	47.7	54.3	60.7	66.7	72.3	77.3
F2052 > FMSY	0.0	2.6	10.2	20.4	31.6	42.6	53.1	62.4	70.6	77.5	83.0

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APPENDIX XI
EXECUTIVE SUMMARY: SILKY SHARK (2024)

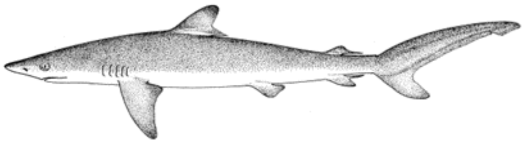

Table A 1. Status of silky shark (*Carcharhinus falciformis*) in the Indian Ocean.

Area[1]	Indicators		2018 stock status determination
Indian Ocean	Reported catch 2022 (t)[3] Not elsewhere included (nei) sharks[2] 2022 (t) Average reported catch 2018-22 (t) Av. Not elsewhere included (nei) sharks[2] 2018-22 (t)	1,461 26,473 1,762 27,098	
	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., SKH: Various sharks nei; RSK: requiem sharks nei).
[3]Proportion of 2022 catch estimated or partially estimated by IOTC Secretariat: 26.4%

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

Common name	**Scientific name**	**IUCN threat status[3]**		
		Global status	**WIO**	**EIO**
Silky shark	*Carcharhinus falciformis*	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, Rigby 2021

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 **A1**). 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 this species globally is 'Vulnerable' (**Table** A **A2**). 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. 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.

Mitigation measures should be taken to reduce at-vessel and post release mortality, including consideration of potential gear modifications in longline fleets targeting tuna and swordfish. Noting that a recent study (Bigelow et al. 2021) concluded in WCPFC that banning both shark lines and wire leaders has the potential to reduce fishing mortality by 30.8% for silky shark.

The following key points should also be noted:

- **Maximum Sustainable Yield (MSY)**: Unknown.
- **Reference points**: Not applicable.
- **Main fishing gear** (2018-22): Gillnet; offshore gillnet; longline; longline (fresh), trolling (reported as discard by PS)
- **Main fleets** (2018-22): I.R. Iran; Pakistan, Sri Lanka; Taiwan,China; Kenya (reported as discarded/released alive by: EU-France, Mauritius, EU-Spain, Korea, Seychelles and Tanzania).

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APPENDIX XII
EXECUTIVE SUMMARY: BIGEYE THRESHER SHARK (2024)

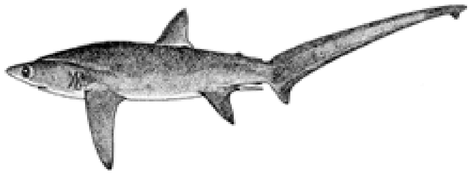

Table A 1. Status bigeye thresher shark (*Alopias superciliosus*) in the Indian Ocean.

Area[1]	Indicators		2018 stock status determination
Indian Ocean	Reported catch 2022 (t) Not elsewhere included (nei) sharks[2] 2022 (t) Thresher sharks nei 2022 (t) Average reported catch 2018-22 (t) Av. Not elsewhere included (nei) sharks[2] 2018-22 (t) Av. Thresher sharks nei 2018-22 (t)	< 1 31,668 5,196 < 1 31,955 4,857	
	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., SKH: Various sharks nei;THR: Thresher sharks nei; MSK: Mackerel sharks,porbeagles 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 2. Bigeye thresher shark: IUCN threat status of bigeye thresher shark (*Alopias superciliosus*) in the Indian Ocean.

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

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

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

Sources: IUCN Red List 2020, Rigby et al 2019

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 **1**). The ecological risk assessment (ERA) conducted for the Indian Ocean by the WPEB and SC in 2018 consisted of a semi-quantitative risk assessment analysis to evaluate the resilience of shark species to the impact of a given fishery, by combining the biological productivity of the species and its susceptibility to each fishing gear type (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 **2**). There is a paucity of information available on this species and this situation is not expected to improve in the short to medium term. Bigeye thresher sharks are commonly taken by a range of fisheries in the Indian Ocean. Because of their life history characteristics – they are relatively long lived (+20 years), mature at 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*[4].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): No report after 2012. (reported as discard from longline - records from submissions by CHN, IDN, ZAF, Eu FRA, KEN and KOR).
- **Main reporting fleets** (2018–22): India; (reported as discarded/released alive by United Kingdom, South Africa, Indonesia, Korea, EU,France).

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Rigby CL, Barreto R, Carlson J, Fernando D, Fordham S, Francis MP, Herman K, Jabado RW, Liu KM, Marshall, A., Pacoureau, N., Romanov, E., Sherley, R.B. & Winker, H. 2019. Alopias superciliosus. The IUCN Red List of Threatened Species 2019: e.T161696A894216. https://dx.doi.org/10.2305/IUCN.UK.2019-3.RLTS.T161696A894216.en. Accessed on 06 December 2023.

[4] 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 (2024)

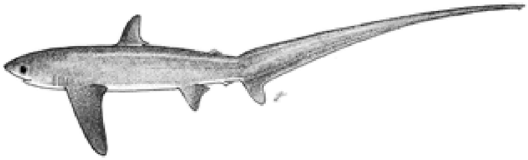

Table A 1. Status pelagic thresher shark (*Alopias pelagicus*) in the Indian Ocean.

Area[1]	Indicators		2018 stock status determination
Indian Ocean	Reported catch 2022 (t)[3]	132	
	Not elsewhere included (nei) sharks[2] 2022 (t)	31,668	
	Thresher sharks nei 2022 (t)	5,196	
	Average reported catch 2018-22 (t)	212	
	Av. Not elsewhere included (nei) sharks[2] 2018-22 (t)	31,955	
	Av. Thresher sharks nei 2018-22 (t)	4,857	
	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., SKH: Various sharks nei;THR: Thresher sharks nei; MSK: Mackerel sharks,porbeagles nei).
[3]Proportion of 2022 catch estimated or partially estimated by IOTC Secretariat: 100%

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

Common name	**Scientific name**	**IUCN threat status[3]**		
		Global status	**WIO**	**EIO**
Pelagic thresher shark	*Alopias pelagicus*	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, Rigby et al 2019

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 1**1**). The ecological risk assessment (ERA) conducted for the Indian Ocean by the WPEB and SC in 2018 consisted of a semi-quantitative analysis to evaluate the resilience of shark species to the impact of a given fishery, by combining the biological productivity of the species and susceptibility to each fishing gear type (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 **2**). There is a paucity of information available on this species and this situation is not expected to improve in the short to medium term. Pelagic thresher sharks are commonly taken by a range of fisheries in the Indian Ocean. Because of their life history characteristics – they are relatively long lived (+ 20 years), mature at 8–9 years, and have few offspring (2 pups every year–) - the pelagic thresher shark is vulnerable to overfishing. There is no quantitative stock assessment and limited basic fishery indicators are currently available for pelagic thresher shark in the Indian Ocean. Therefore, the stock status is **unknown.**

Outlook. Current longline fishing effort is directed at other species, however, pelagic thresher sharks are commonly taken as bycatch in these fisheries. Hooking mortality is apparently very high, therefore IOTC Resolution 12/09 prohibiting retaining of any part of thresher sharks onboard and promoting life release of thresher shark may be largely ineffective for species conservation. Maintaining or increasing effort can result in declines in biomass, productivity and CPUE. However, there are few data to estimate CPUE trends, and a reluctance of fishing fleets to report information on discards/non-retained catch. Piracy in the western Indian Ocean resulted in the displacement and subsequent concentration of a substantial portion of longline fishing effort into other areas in the southern and eastern Indian Ocean. Some longline vessels have returned to their traditional fishing areas in the northwest Indian Ocean, due to the increased security onboard vessels, with the exception of the Japanese fleet which has still not returned to the levels seen before the start of the piracy threat. It is therefore unlikely that catch and effort on pelagic thresher shark declined in the southern and eastern areas over that time period, potentially resulting in localised depletion there.

Management advice. The prohibition on the retention of pelagic thresher shark should be maintained. While mechanisms exist for encouraging CPCs to comply with their recording and reporting requirements (Resolution 18/07), these need to be further implemented by the Commission, so as to better inform scientific advice. IOTC Resolution 12/09 *On the conservation of thresher sharks (family Alopiidae) caught in association with fisheries in the IOTC area of competence*, prohibits retention onboard, transhipping, landing, storing, selling or offering for sale any part or whole carcass of thresher sharks of all the species of the family *Alopiidae*[5].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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[5]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: PORBEAGLE SHARK (2024)

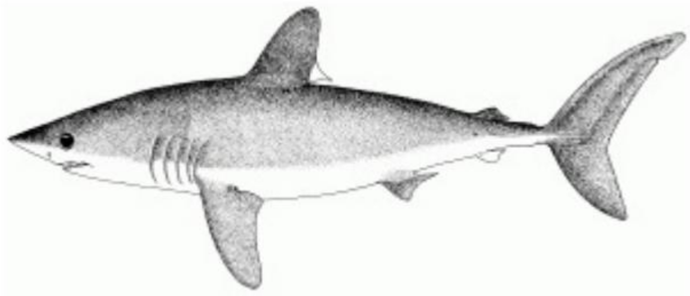

Table 6. Status of porbeagle shark (*Lamna nasus*) in the Indian Ocean

Area	Indicators		2024 stock status determination
Indian Ocean	Reported catch 2022 (t)[4]	28t	**Unknown**
	Not elsewhere included (nei) sharks[1] 2022 (t)	26,779t	
	Average reported catch 2018-22 (t)	28t	
	Avg. not elsewhere included (nei) sharks[1] 2018-22 (t)	27,572t	
	MSY (1,000 t) (80% CI)[2]		
	F_{MSY} (80% CI)[2]		
	SB_{MSY} (1,000 t) (80% CI)[2,3]		
	F_{2019}/F_{MSY} (80% CI)[2]		
	SB_{2019}/SB_{MSY} (80% CI)[2,3]		
	SB_{2019}/SB_0 (80% CI)[2,3]		

Boundaries for the Indian Ocean are defined as the IOTC area of competence
[1]Includes all other shark catches reported to the IOTC Secretariat, which may contain this species (i.e., SKH: Various sharks nei; MSK: Mackerel sharks, porbeagles nei, AG21: Sharks nei other than oceanic whitetip shark and blue shark)

Colour key	Stock overfished (SB_{2019}/SB_{MSY}< 1)	Stock not overfished (SB_{2019}/SB_{MSY}≥ 1)
Stock subject to overfishing(F/F_{MSY}> 1)		
Stock not subject to overfishing (F/F_{MSY}≤ 1)		
Not assessed/Uncertain		

Table 7. Porbeagle shark: IUCN threat status of porbeagle shark (*Lamna nasus*) in the Indian Ocean.

Common name	**Scientific name**	**IUCN threat status[3]**
		Global status
Porbeagle shark	*Lamna nasus*	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 2024

INDIAN OCEAN STOCK – MANAGEMENT ADVICE

Stock status. No stock assessment was carried out for porbeagle sharks in 2024. 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 **1**). The ecological risk assessment (ERA) conducted for the Indian Ocean by the WPEB and SC in 2018 consisted of a semi-quantitative risk assessment analysis to evaluate the resilience of shark species to the impact of a given fishery, by combining the biological productivity of the species and its susceptibility to each fishing gear type (Murua *et al.* 2018). Porbeagle shark received a high vulnerability ranking (No. 3) in the ERA rank for longline gear because it was characterised as one of the least productive shark species, and highly susceptible to longline gear. Despite its low productivity, porbeagle 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 porbeagle shark globally (**Table** A **2**). There is a paucity of information available on this species and this situation is not expected to improve in the short to medium term. Porbeagle sharks are commonly taken by a range of fisheries in the Indian Ocean. Because of their life history characteristics – they are relatively long lived (+30 years), mature at around 15 years, and have few offspring (around 4 pups every one or two years), the porbeagle shark is vulnerable to overfishing. There has been no quantitative stock assessment and limited basic fishery indicators are available for porbeagle shark in the Indian Ocean. Therefore, the stock status is **unknown**.

Outlook. Current longline fishing effort is directed at other species, however, porbeagle sharks are taken as bycatch in these fisheries but it may be released by some fleets. 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. Preliminary analysis of IOTC catch and effort data from the Japanese and Korean fleets found catchability to have declined from 2009 through 2018 (IOTC-2023-WPEB19-20). The Japanese fleet releases porbeagle sharks caught by longline vessels which may be a reason for the decline in catches of this species.

Management advice.

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. This is considered to be a vulnerable species

The following key points should also be noted:

- **Maximum Sustainable Yield (MSY)**: Unknown
- **Reference points**: The Commission has not adopted reference points or harvest control rules for any shark species.
- **Main fishing gear** (2018–22): coastal longline; Longline (deep-freezing),
- **Main fleets** (2018–22): IDN (96%), JPN, KOR, SYC, and TWN. Catches by JPN are discarded.

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APPENDIX XIVI
EXECUTIVE SUMMARY: MARINE TURTLES (2024)

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

Common name	Scientific name	IUCN threat status[6]
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 **1**. It is important to note that a number of international global environmental accords (e.g., Convention on Migratory Species (CMS), Convention on Biological Diversity (CBD), as well as numerous fisheries agreements obligate States to provide protection for these species. In particular, there are now 35 Signatories to the Memorandum of Understanding on the Conservation and Management of Marine Turtles and their Habitats of the Indian Ocean and South-East Asia (IOSEA MoU). Of the 35 Signatories to the IOSEA MoU, 25 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-

[6] 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 at-vessel and post-release mortality in IOTC fisheries and improve data collection and reporting for marine turtles. This may include alternative data collection mechanisms such as skipper-based reporting, port sampling and cost-effective electronic monitoring systems.

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APPENDIX XVII
EXECUTIVE SUMMARY: SEABIRDS (2024)

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

Common name	**Scientific name**	**IUCN threat status[7]**
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 **1**. 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

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

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.

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) 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 23/07) 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 XVIII
EXECUTIVE SUMMARY: CETACEANS (2024)

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

Family	Common name	Species	IUCN Red List status*	Interactions by Gear Type**
Balaenidae	Southern right whale	*Eubalaena australis*	LC	GN
Neobalaenidae	Pygmy right whale	*Caperea marginata*	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

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

* 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>.
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Indian Ocean stock – Management Advice

Stock status. . The current[8] 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** 1. Information on their interactions with IOTC fisheries is also provided. It is important to note that a number of international global environmental accords (e.g., Convention on Migratory Species (CMS), Convention on Biological Diversity (CBD), International Whaling Commission (IWC)), as well as numerous fisheries agreements obligate States to provide protection for these species. The status of cetaceans is affected by a range of factors such as direct harvesting and habitat degradation, but the level of cetacean mortality due to capture in tuna drift gillnets is likely to be substantial and is also a major cause for concern (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

[8] September 2023

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.
- Efforts should be undertaken to encourage CPCs to investigate means to reduce cetacean bycatch and at-vessel and post-release mortality in IOTC fisheries and improve data collection and reporting for cetaceans. This may include alternative data collection mechanisms such as skipper-based reporting, port sampling and cost-effective electronic monitoring systems.

RELEVANT LITERATURE

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APPENDIX XVIV
WORKING PARTY ON ECOSYSTEMS AND BYCATCH PROGRAM OF WORK (2025–2029)

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:

Error! Reference source not found.: Priority topics for obtaining the information necessary to develop stock status indicators for bycatch in the Indian Ocean; and
Table A8: Stock assessment schedule.

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

Topic in order of priority	**Sub-topic and project**	Timing				
		2025	2026	2027	2028	2029
Connectivity, movements, habitat use and post release mortality[9]	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, mortality estimates and genetic studies					
1. Fisheries data collection and development of alternative abundance indices	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					

[9] This item is a top priority for the WPEB; however, completing it will require substantial funding, which the WPEB recognizes is unlikely to be provided through the IOTC Scientific budget.

	1.1.4 CPUE standardisation and review of additional abundance indicators series for each key shark species and fishery in the Indian Ocean 1.2 Exploring different indices of abundance for sharks such as CKMR					
2. Shark research and management strategy	2.1 Prioritising shark research based on previous work and including analysing gaps in knowledge					
	2.2 Workshop to update and revise shark research plan with a small working group					
3. Studies and training focused on gillnet bycatch mitigation	3.1 Focused GN bycatch mitigation workshop – training and monitoring 3.2 Studies trialling gillnet mitigation measures such as: LED lights, sub-surface setting etc.					

Other Future Research Requirements (not in order of priority)

Topic	Sub-topic and project	2025	2026	2027	2028	2029
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					
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)					

Development of Indian Ocean Digital Atlas	Facilitate the discussions with WPDCS to consolidate the Indian Ocean Digital Atlas project with stakeholders					

Table A8. Draft: Assessment schedule for the IOTC Working Party on Ecosystems and Bycatch 2025–2029 (adapted from IOTC–2023–SC26–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	**2025**	**2026**	**2027**	**2028**	**2029**
Blue shark	Data preparatory meeting Full assessment	-	–	Data preparatory meeting Full assessment	–
Oceanic whitetip shark	Indicator analysis	-	Data preparation	–	Data preparation
Scalloped hammerhead shark	–	Data preparatory meeting Assessment*	–	–	–
Shortfin mako shark	–	-	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. 23/07	–	–	Development of draft workplan
Marine Mammals		-	–	–	

Ecosystem Approach to Fisheries Management (EAFM) approaches	Ecoregions pilot study ongoing				
Series of multi-taxa bycatch mitigation workshops	Focus: tbd	Focus: tbd	Focus: tbd	Focus: tbd	Focus: tbd
Shark research plan update		Shark research plan update workshop			

APPENDIX XVV

SUGGESTED REVISION TO THE LIVE RELEASE HANDLING PROCEDURES FOR MOBULIDS

Mobulid Ray safe-handling and live release procedures

General principles applying to all gears

- Mobulid rays should be released as soon as possible. Reducing the release time is the principal factor in determining survival of the released individual.
- Prohibit the use of gaff, hooks, or ropes to lift the mobulid rays.
- Prohibit lifting, dragging, carrying or holding mobulid rays by the "cephalic lobes", tail, gill slits, mouth, wing or spiracle even by hand. Prohibit dragging by the wings but lifting by the wings is allowed when no other option is available.
- Prohibit the punching of holes through the bodies of mobulid rays (e.g. to pass a cable through for lifting the mobulid ray).

Best Practices for live release from Purse seiners

- If brought onboard, do not allow the ray to go through the loading chute to the lower deck.
- Small and medium size rays shall be released using stretchers to facilitate release.
- In cases when stretchers are not available, they could also be released by hand. In those cases, it is recommended that the animal is:
    - handled by 2 or 3 people and carried by the ventral side of the wings. The ray should be held far away from the tail to avoid lashes or contact with the barbs.
    - Not held by its tail
    - Not dragged, carried or held by its "cephalic lobes" or in its gill slits.
    - Not expose the ray for long to air or sun.
    - Do not insert your hands in its mouth or gill slits to carry

- Rays that are too large to be lifted safely by hand shall be, to the extent possible, directly released from the net using the brailer or directly from the brailer (see methods recommended in document IOTC-2012-WPEB08-INF07).
- If a release from the brailer or the net is not possible, it is recommended to either:
    - release them using a cargo net, a canvas sling, or a similar device lifted with the crane. The crew must have this release equipment at hand on the deck at all times, or
    - use a ray sorting grid with a solid frame and wide spaces to allow fish to pass through when being unloaded from the brailer while the ray stays on top, it can be placed on the unloading hatch or the hopper and lifted for release with the crane, accelerating the process and preventing direct handling by fishers for increased safety.
- Large rays that cannot be released safely before being landed on deck, shall be returned to the water as soon as possible, using the methods described above

Best Practices for live-release for Gillnetters

- Mobulids should not intentionally be hauled aboard. So they should be maintained by the side of the vessel in the water and released by disentangling the ray from the net or by cutting the net, before the net is hauled onboard, while the animal is still in the sea (e.g. back down procedure, submerging corks, cutting net).

- For entangled animals, secure excess tangled area in the net with the long-handled gaff while other crew members remove the ray from the entangled areas of the net. The net cutter should be used to remove the animal from the tangled area of the net. Do not use the gaff on the animal.
- While the ray is in the water, use the body of the net to manoeuvre the ray alongside the vessel; care should be taken to minimise stress and/or injury to the ray. Try to disentangle the ray using tools e.g. a long-handled line cutter.
- If it is not possible to disentangle the ray while keeping it in the water, carefully bring the ray on board, making every attempt to support the ray's weight by at least two points (i.e., one point of contact being the midsection, the other being the bottom end of the body near the tail), or preferably have 2 or 3 people carry the ray by the sides of each wing; if feasible, use crane/cargo net/grid if it's as large ray).
- Disentangle the ray from the net—if the ray is 'badly' entangled, you may have to section some parts of the net (care should be taken to prevent injury to the animal while doing so). Try to minimise handling time and release it as soon as possible. If possible, get someone to pour water over the animal while you are handling it, remove as much of the netting as possible.
- Record biological information about the released fish, such as name of species, date, size, position of catch and the fate of the released fish.

<u>Best Practices for live-release from Longlines/ Hook and line</u>

- If possible stop the vessel to safely remove gear and release large rays.
- Bring the ray alongside the vessel, if possible. Always leave the animal in the water so that its chance of post-release survival is much higher.
- If the animal is not entangled and can be brought close to the boat, consider attaching a flyback prevention device to the branch line to reduce the risk of a lead (or hook) flyback accident.
- For animals that are hooked or have swallowed the hook, use a long-handled line cutter to cut the line as close to the hook as possible leaving as little trailing line as possible.
- For entangled animals, secure excess tangled line with the long-handled gaff while another crew member uses a long-handled line cutter to remove as much tangled line as possible. Do not use the gaff on the animal.

APPENDIX XVVI
RECOMMENDATIONS FROM THE WPEB20 (DATA PREPARATORY MEETING, INCLUDINGMITIGATION WORKSHOP MEETING) HELD APRIL 2024

Note: Appendix references refer to the Report of the 20th Session of the Working Party on Ecosystems and Bycatch Data Preparatory meeting report (IOTC–2024–WPEB20(DP)–R)

The following are the complete recommendations from the WPEB20(DP) to the Scientific Committee which are also provided in Appendix V:

Section 3. Longline bycatch mitigation workshop

Section 3.1.1 All taxa

WPEB20(DP).01 (para. 26) The WPEB **RECOMMENDED** that the SC request that CPCs carry out training with fishers to ensure that they are aware of the best practices for handling and release of sharks including the minimisation of trailing gears. The WPEB **REQUESTED** that CPCs provide information on how they are monitoring the implementation of these best practices in the form of training materials, number of training/handling workshops etc.

Section 3.2 Leader type/shark lines

WPEB20(DP).02 (para. 46) The WPEB **RECOMMENDED** that the collection of information on leader material type should be made mandatory under the Regional Observer Scheme Minimum Data Requirements and reported to the Secretariat. The WPEB also **RECOMMENDED** that these data collected under the ROS are strictly used for scientific purposes in research.

WPEB20(DP).03 (para. 47) The WPEB **RECOMMENDED** that mitigation surveys should be developed by CPCs in the IOTC areas and with different gear types and configurations to assess mitigation measures such as the type of leaders and other factors to be tested and implemented. The WPEB **NOTED** that the increase of bite offs by the prohibition of wire leaders could lead to the decrease in the basic information necessary for stock assessment or monitoring abundance of shark species. **ACKNOWLEDGING** the importance of these data, the WPEB **SUGGESTED** that bite offs are recorded by observers to further inform bycatch estimates.

Section 3.3 Hook type

WPEB20(DP).04 (para. 57) The WPEB **NOTED** that some studies using large circle hook have reduced injury to sharks by increasing rates of mouth hooking. The WPEB further **NOTED** that decreasing injury rates associated with large circle hooks results in a reduction in at-vessel mortality for some species. Circle hooks use also reduces observed retention of some vulnerable taxa, such as sea turtles and marlins. The WPEB also **NOTED** that some experimental sea-trials from other Oceans have reported increases in observed retention of some shark species when using large circle hooks, especially blue shark and crocodile shark, and that the results from a global meta-analysis and multiple experimental sea-trials have found that the use of large circle hooks reduces retention of target species like swordfish. The WPEB further **NOTED** that there are still many information gaps regarding their effectiveness for sharks, and the number of case studies on deep-setting operations and effect of hook size is still too few and there is also concern that circle hooks may increase shark catches, the WPEB **RECOMMENDED** continued accumulation of information on circle hook effectiveness including in deep-setting operations.

Section 3.5 Workshop summary

WPEB20(DP).05 (para. 74) The WPEB **NOTED** on the basis of its review of global research that a prohibition on the use of wire leaders and shark lines by longline and other fisheries operating in the IOTC would likely result in a reduction in both the observed catch and the fishing mortality of shark species. The WPEB NOTED supporting evidence from a range of research studies as seen in Table 2 (in Appendix VI). The WPEB **NOTED** that these results are likely to be similar in the Indian Ocean. Based on these studies and on the basis of taking the precautionary approach, and consistent with existing SC advice on the need to reduce fishing mortality for shortfin mako, oceanic whitetip and silky shark, the WPEB **RECOMMENDED** that additional mitigation measures such as, but not limited to, the non-use of wire leaders and shark lines should be implemented. The WPEB **AGREED** to further discuss this issue at the WPEB Assessment meeting in September.

Section 7. Review of the draft, and adoption of the Report of the 20th Session of the WPEB (Data Preparatory)

WPEB20(DP).06 (para. 133) The WPEB **RECOMMENDED** that the WPEB20(AS) consider the consolidated set of recommendations arising from WPEB20(DP), provided at Appendix V.

APPENDIX XVVII
CONSOLIDATED RECOMMENDATIONS OF THE 20TH SESSION OF THE WORKING PARTY ON ECOSYSTEMS AND BYCATCH

Note: Appendix references refer to the Report of the 20th Session of the Working Party on Ecosystems and Bycatch (IOTC–2024–WPEB20(AS)–R)

Section 6 Outcomes of bycatch mitigation workshop

WPEB20(AS).01 (para. 40) **ACKNOWLEDGING** that the bycatch mitigation workshop was held as a part of data preparatory meeting, the WPEB **NOTED** that the role and status of a "workshop" as well as a Working Party's data preparatory meeting is unclear as it is not explicitly defined in the IOTC rules of procedure. The WPEB **NOTED** that this caused a lot of confusion between participants, in particular regarding whether recommendations from a data preparatory meeting can be taken directly to the SC rather than being approved by the main Working Party meeting. The WPEB **NOTED** that while the recommendations from the April 2024 WPEB (data preparatory) meeting will be presented to the Scientific Committee (See Appendix XVVI) for its consideration, the WPEB **RECOMMENDED** that the SC provide clarification on the nature of data "workshops" and working party data preparatory meetings and their capacity to submit their recommendations independently and directly to the SC, to guide future WP recommendation processes.

WPEB20(AS).02 (para. 42) The WPEB **NOTED** the **recommendations** arising from the WPEB Data Prep meeting (DP) which included a shark mitigation workshop and reviewed these again. The WPEB assessment meeting **NOTED** that there was consensus on the following:

- The WPEB **RECOMMENDED** that the SC request that CPCs carry out training with fishers to ensure that they are aware of the best practices for handling and release of sharks including the minimisation of trailing gears. The WPEB **REQUESTED** that CPCs provide information on how they are monitoring the implementation of these best practices in the form of training materials, number of training/handling workshops etc.
- The WPEB **RECOMMENDED** that the collection of information on leader material type should be made mandatory under the Regional Observer Scheme Minimum Data Requirements and reported to the Secretariat. The WPEB also **RECOMMENDED** that these data collected under the ROS are strictly used for scientific purposes in research.
- The WPEB **RECOMMENDED** that mitigation surveys should be developed by CPCs in the IOTC areas and with different gear types and configurations to assess mitigation measures such as the type of leaders and other factors to be tested and implemented. The WPEB **NOTED** that the increase of bite offs by the prohibition of wire leaders could lead to the decrease in the basic information necessary for stock assessment or monitoring abundance of shark species. **ACKNOWLEDGING** the importance of these data, the WPEB **SUGGESTED** that bite offs are recorded by observers to further inform bycatch estimates.
- The WPEB **NOTED** that some studies using large circle hook have reduced injury to sharks by increasing rates of mouth hooking. The WPEB further **NOTED** that decreasing injury rates associated with large circle hooks results in a reduction in at-vessel mortality for some species. Circle hooks use also reduces observed retention of some vulnerable taxa, such as sea turtles and marlins. The WPEB also **NOTED** that some experimental sea-trials from other Oceans have reported increases in observed retention of some shark species when using large circle hooks, especially blue shark and crocodile shark, and that the results from a global meta-analysis and multiple experimental sea-trials have found that the use of large circle hooks reduces retention of target species like swordfish. The WPEB further **NOTED** that there are still many information gaps regarding their effectiveness for sharks, and the number of case studies on deep-setting operations and effect of hook size is still too few and there is also concern that circle hooks may increase shark catches, the WPEB **RECOMMENDED** continued accumulation of information on circle hook effectiveness including in deep-setting operations.

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

10.3 Mobulids

WPEB20(AS).03 (para. 238) However, based on handling and release guidelines for mobulids presented to the WPEB, the WPEB **RECOMMENDED** that the SC consider endorsing a revision to the live release handling procedures provided in Annex 1 of

Resolution 19/03 for consideration by the Commission. The WPEB **NOTED** that work is required to further develop the guidelines for gillnets and this will be done intersessionally. The details of the suggested revisions to the handling procedures can be found in Appendix XVV.

Section 11. WPEB Program of Work (Research and Priorities)

11.1 Revision of the WPEB Program of Work 2025-2029

WPEB20(AS).04 (para. 254) The WPEB **RECOMMENDED** that the SC consider and endorse the WPEB Program of Work (2025–2029), as provided in Appendix XVIV.

Section 12. Other matters

12.2 Review of the draft, and adoption of the Report of the 20th Session of the WPEB

WPEB20(AS).05 (para. 258) The WPEB **RECOMMENDED** that the Scientific Committee consider the consolidated set of recommendations arising from WPEB20, provided at Appendix XVVII, as well as the management advice provided in the draft resource stock status summary for each of the eight 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
- Porbeagle sharks (*Lamna nasus*) - Appendix XIV

Other species/groups

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