Report of the 18th Session of the IOTC Working Party on Ecosystems and Bycatch

Microsoft Teams Online, 5 – 9 September 2022

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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 18th Session of the Indian Ocean Tuna Commission's (IOTC) Working Party on Ecosystems and Bycatch - WPEB was held Online on Zoom from 5-9 September 2022. A total of 103 participants (93 in 2021, 108 in 2020, 41 in 2019, 40 in 2018 and 39 in 2017) attended the Session. The list of participants is provided in Appendix I. The meeting was opened by the Chairperson, Dr Mariana Tolotti from IRD, France, who welcomed participants and formally opened the meeting.

The following are the complete recommendations from the WPEB18 to the Scientific Committee which are also provided in Appendix XVIII:

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

WPEB18.01 (para. 42) **NOTING** that sharks caught in association with tuna fisheries in the Indian Ocean include migratory and straddling stocks which require regional cooperation, joint scientific research programmes and mitigation measures for protection endangered, threatened and protected species, the WPEB **RECOMMENDED** that the SC support cooperation and coordination with the Nairobi Convention on the development of RPOAs and prioritise funding to support such research and management activities for improving the status of sharks and rays in the Indian Ocean.

Stock assessment and indicators for sharks: Recommendation and executive summaries

WPEB18.02 (para. 120) The WPEB **NOTED** the uncertainty in the catch series, high levels of misidentified catch and underreporting of catches for scalloped hammerhead sharks. The WPEB **RECOMMENDED** that the SC endorse an update of the list of sharks, rays and ETP species included in Appendix II of IOTC Resolution 15/01 for each fishing gear. In particular, to ensure that all species groups under the current broad categories (e.g., Hammerhead sharks (Sphyrna spp.) - SPN, Mako sharks (Isurus spp.) - MAK, Marine turtles - TTX, etc.) are reported separately by species (e.g. scalloped hammerhead (*Sphyrna lewini*; SPL), great hammerhead (*Sphyrna mokarran*; SPK), smooth hammerhead (*Sphyrna zygaena*; SPZ), shortfin mako (*Isurus oxyrinchus*).

WPEB18.03 (para. 127) **RECALLING** the request by the Commission to develop research plans for sharks, the WPEB **RECOMMENDED** that the SC endorse the creation of a working group to work intersessionally to develop a series of research plans/program for sharks with scalloped hammerhead as a priority species.

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

WPEB18.04 (para. 138) The WPEB **NOTED** that the use of artificial lights (a visual deterrent) in gillnet fisheries as a potential bycatch mitigation device was discussed at length and **NOTED** the strong support for the rolling out of future LED trials across the Indian Ocean by the workshop participants. However, the WPEB **NOTED** that the use of artificial lights is banned in the Indian Ocean due to IOTC Resolution 16/07. Therefore, the WPEB **RECOMMENDED** that the SC seek clarification from the Commission on whether Resolution 16/07 applies to gillnet fisheries and to scientific studies as the current wording is somewhat ambiguous.

WPEB18.05 (para. 149) The WPEB **RECOMMENDED** that the SC and other working groups review the ongoing ecoregion process, including their purpose and potential benefits in providing more integrated regional advice and provide feedback to the WPEB. The WPEB also **RECOMMENDED** that the SC endorses the proposed refined candidate ecoregions and the development of pilot projects to evaluate their utility and effectiveness as a tool to support regional ecosystem planning and prioritization, incentivized ecosystem research and the development of integrated advice products for informing fisheries management decisions.

All bycatch species

WPEB18.06 (para. 151) The WPEB **NOTED** the evidence indicating the increased operation of squid fisheries in the high seas of the Indian Ocean, and particularly in fishing grounds which overlap with areas where tuna purse seine fleets operate, **NOTING** that this overlap results in bycatch of tuna and tuna-like species in the squid fishery. However, as these fisheries are not managed by IOTC, data on these catches of tuna and tuna-like species are not provided to the IOTC. Therefore, the WPEB **RECOMMENDED** that the SC **RECOMMEND** that the Commission request that the CPCs report all catches of tuna to the IOTC regardless of the target species of the fishery. The WPEB further **REQUESTED** that the Compliance Committee seek more information on this fishery from the CPCs.

Seabirds: Review of mitigation measures in Resolution 12/06

WPEB18.07 (para. 176) **NOTING** the effectiveness of hook-shielding devices in reducing seabird bycatch mortality in pelagic longlines and the fact that the WCPFC included the hook-shielding devices in 2018 as an optional measure to mitigate longline seabird bycatch, while also **NOTING** that the actual utilisation of this device in commercial fishing has been limited partially due to operational difficulty and cost efficiencies, the WPEB **RECOMMENDED** that the SC consider whether to include hook-shielding devices as an additional option for seabird bycatch mitigation measures in Res. 12/06 and if so, to recommend to the Commission, accordingly.

Sea turtles

WPEB18.08 (para. 181) The WPEB **NOTED** that the IOSEA has been collaborating with the IOTC for many years and the Letter of Intent is intended to formalise this collaboration. The WPEB **ACKNOWLEDGED** the Letter of Intent and **RECOMMENDED** that the letter is discussed at the SC.

Revision of the WPEB Program of Work 2023-2027

WPEB18.09 (para. 183) The WPEB **RECOMMENDED** that the SC consider and endorse the WPEB Program of Work (2023–2027), as provided in Appendix XVII.

Review of the draft, and adoption of the Report of the 18th Session of the WPEB

WPEB18.10 (para. 185): The WPEB **RECOMMENDED** that the Scientific Committee consider the consolidated set of recommendations arising from WPEB18, provided at Appendix XVIII, as well as the management advice provided in the draft resource stock status

summary for each of the seven shark species, as well of those for marine turtles and seabirds:

Sharks

- Blue sharks (*Prionace glauca*) – Appendix VII
- Oceanic whitetip sharks (*Carcharhinus longimanus*) – Appendix VIII
- Scalloped hammerhead sharks (*Sphyrna lewini*) – Appendix IX
- Shortfin mako sharks (*Isurus oxyrinchus*) – Appendix X
- Silky sharks (*Carcharhinus falciformis*) – Appendix XI
- Bigeye thresher sharks (*Alopias superciliosus*) – Appendix XII
- Pelagic thresher sharks (*Alopias pelagicus*) – Appendix XIII

Other species/groups

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

A summary of the stock status for some of the most commonly caught shark species caught in association with IOTC fisheries for tuna and tuna-like species is provided in Table 1.

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

Stock	Indicators	2017	2018	2019	2020	2021	2022	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 2020: 29,545t Estimated catch 2019: 43,240 t Not elsewhere included (nei) sharks 2020: 20,441 t Average reported catch 2016–20: 26,839 t Average estimated catch 2015–19: 48,781 t Ave. (nei) sharks[2] 2016–20: 30,260 t MSY (1,000 t) (80% CI): 36.0 (33.5 - 38.6) F_{MSY} (80% CI): 0.31 (0.306- 0.31) SSB_{MSY} (1,000 t) (80% CI): 42.0 (38.9 - 45.1) F_{2015}/F_{MSY} (80% CI): 0.64 (0.53 - 0.75) SSB_{2019}/SSB_{MSY} (80% CI): 1.39 (1.27 - 1.49) SSB_{2019}/SSB_0 (80% CI): 0.46 (0.42 - 0.49)	**72.6%**	**72.6%**	**72.6%**	**72.6%**	**99.9%**	**99.9%**	Target and limit reference points have not yet been specified for pelagic sharks in the Indian Ocean. Even though the blue shark in 2021 is assessed to be not overfished nor subject to overfishing, current catches are likely to result in decreasing biomass and making the stock become overfished and subject to overfishing in the near future. If the catches are increased by over 20%, the probability of maintaining spawning biomass above MSY reference levels ($SB>SB_{MSY}$) over the next 10 years will be decreased. While mechanisms exist for encouraging CPCs to comply with their recording and reporting requirements (Resolution 16/06), these need to be further implemented by the Commission, so as to better inform scientific advice in the future. Click below for a full stock status summary: ● Blue sharks – Appendix VII
Oceanic whitetip shark *Carcharhinus longimanus*	Reported catch 2020: 30 t Not elsewhere included (nei) sharks: 20,441 t Average reported catch 2016–2020: 129 t Not elsewhere included (nei) sharks 2015-2019: 30,260 t							
Scalloped hammerhead shark	Reported catch 2020: 38 t Not elsewhere included (nei) sharks: 27,893 t Average reported catch 2016–2020: 66 t Not elsewhere included (nei) sharks 2015-2019: 35,739 t							

Sphyrna lewini								There is a paucity of information available for these species and this situation is not expected to improve in the short to medium term. There is no quantitative stock assessment and limited basic fishery indicators currently available. Therefore, the stock status is highly uncertain. The available evidence indicates considerable risk to the stock status at current effort levels. The primary source of data that drive the assessment (total catches) is highly uncertain and should be investigated further as a priority. Click below for a full stock status summary: ● Oceanic whitetip sharks – Appendix VIII ● Scalloped hammerhead sharks – Appendix XI ● Shortfin mako sharks – Appendix XII ● Silky sharks – Appendix XIII ● Bigeye thresher sharks – Appendix XIV ● Pelagic thresher sharks – Appendix XV
Shortfin mako *Isurus oxyrinchus*	Reported catch 2020: 869 t Not elsewhere included (nei) sharks: 22,757 t Average reported catch 2016–2020: 1,616 t Not elsewhere included (nei) sharks 2015-2019: 32,561 t							
Silky shark *Carcharhinus falciformis*	Reported catch 2020: 1,335 t Not elsewhere included (nei) sharks: 20,441 t Average reported catch 2016–2020: 1,861 t Not elsewhere included (nei) sharks 2015-2019: 30,260 t							
Bigeye thresher shark *Alopias superciliosus*	Reported catch 2020: <1 t Not elsewhere included (nei) sharks: 26,344 t Average reported catch 2016–2020: <1 t Not elsewhere included (nei) sharks 2015-2019: 34,766 t							
Pelagic thresher shark *Alopias pelagicus*	Reported catch 2020: 176 t Not elsewhere included (nei) sharks: 26,344 t Average reported catch 2016–2020: 310 t Not elsewhere included (nei) sharks 2015-2019: 34,766t							

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 18th Session of the Indian Ocean Tuna Commission's (IOTC) Working Party on Ecosystems and Bycatch - WPEB was held Online on Zoom from 5-9 September 2022. A total of 103 participants (93 in 2021, 108 in 2020, 41 in 2019, 40 in 2018 and 39 in 2017) attended the Session. The list of participants is provided in Appendix I. The meeting was opened by the Chairperson, Dr Mariana Tolotti from IRD, France, who welcomed participants and formally opened the meeting.

2. Adoption of the Agenda and arrangements for the Session

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

3. The IOTC process: outcomes, updates and progress

3.1 Outcomes of the 24th Session of the Scientific Committee

3. The WPEB **NOTED** paper IOTC–2022–WPEB18–04 which outlined the main outcomes of the 24th Session of the Scientific Committee, specifically related to the work of the WPEB.

> "*The SC NOTED that in 2021, a stock assessment was completed for blue sharks using an integrated age-structured model (SS3). The SC NOTED that 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 (SB2019/SBMSY = 1.39 (1.27 - 1.49) and F2019/FMSY =0.64 (0.53 - 0.75)), but with the trajectories showing consistent trends towards the overfished and subject to overfishing quadrant of the Kobe plot*.
>
> *The SC NOTED the ongoing work on developing a series of eco-regions including an expert workshop to be held in January 2022 which will report to the WPEB data preparatory meeting with ideas on how various relevant parameters could contribute to IOTC stock assessments.*
>
> *The SC ACKNOWLEDGED the proposed Letter of Intent between the IWC and IOTC and NOTED that this letter is based on the language used in the Letter of Intent between IOTC and ACAP which has been accepted by the Commission. The SC RECOMMENDED that the letter is presented at the Commission for further consideration.*
>
> *The SC NOTED the high priority of work establishing stock structure as well as genetics research for sharks including Close Kin Mark Recapture (CKMR) techniques. The SC AGREED that funds in the IOTC main budget that were previously allocated to studying tropical tunas should now be allocated to funding CKMR studies in sharks. The SC NOTED that a feasibility study for conducting CKMR has already been carried out which provided recommendations on how best to proceed with this work for shark species including how the work should be done and the best species to target, further NOTING that shortfin mako was recommended as a key species to target for research.*
>
> *The SC AGREED with the recommendation from the WPEB that a multi-taxa bycatch mitigation workshop focused on drift gillnet fisheries in the Indian Ocean should be held, NOTING that bycatch is thought to be significant with this gear. The SC NOTED paper IOTC-2021-SC24-INF09 which provides a draft terms of reference for this workshop and NOTED that the expected results of such a workshop would be to provide a mitigation toolbox which can help to reduce bycatch in gillnet fisheries ensuring that these are replicable for gillnet fleets across all CPCs and to develop recommendations for consideration by the WPEB.*
>
> *The SC NOTED the use of subsurface gillnetting in the Indian Ocean may be an effective mitigation measure to reduce bycatch of cetaceans, sharks and sea turtles and that Resolution 19/01 already requests the utilization of subsurface gillnets by 2023 to mitigate ecological impacts of this gear. The SC RECOMMENDED that it be kept informed by the Commission on the current status of implementation of the relevant clause of Resolution 19/01.*
>
> *The SC NOTED that the WPEB discussed recent developments mitigation of seabird bycatch in relation to the development of new mitigation measures such as hook pods and underwater bait setters. The SC further REQUESTED that such mitigation measures be further explored and*

evaluated by the WPEB, along with seabird experts, as the potential inclusion of additional effective mitigation options in IOTC resolutions in future might provide greater flexibility for CPCs in how they reduce or avoid seabird interactions."

3.2 Progress on the recommendations of WPEB17

4. The WPEB **NOTED** paper IOTC–2022–WPEB18–06 which provided an update on the progress made in implementing the recommendations from the previous WPEB meeting WPEB17 which were endorsed by the Scientific Committee (SC24) in 2021.

5. The WPEB **NOTED** that good progress had been made on these Recommendations. The WPEB participants were **ENCOURAGED** to review IOTC-2022-WPEB18-06 during the meeting and report back on any progress in relation to requests or actions by CPCs that have not been captured by the report, and to note any pending actions for attention before the next meeting (WPEB18).

3.3 Outcomes of the 26th Session of the Commission

6. The WPEB **NOTED** paper IOTC–2022–WPEB18–03 which outlined the main outcomes of the 26th Session of the Commission, specifically related to the work of the WPEB.

7. The WPEB **NOTED** that there was little discussion related to the WPEB at the Commission meeting and that the main items were the endorsement by the Commission of the SC information on stock status, the agreement in principle to a letter of intent to continue a collaborative arrangement with the IWC and the request to develop research plans for sharks.

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

8. The WPEB **NOTED** paper IOTC–2022–WPEB18–05 which aimed to encourage participants to review some of the existing Conservation and Management Measures (CMM) relevant to ecosystems and bycatch. The WPEB **NOTED** that two CMMs relevant to ecosystems and bycatch were adopted by the Commission in 2022, one relating to climate change (Resolution 22/01) and another on the Regional Observer Scheme (Resolution 22/04) which updates Resolution 11/04.

4. Review of data available on ecosystems and bycatch

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

9. The WPEB **NOTED** paper IOTC–2022–WPEB18–07_Rev1 which provided an overview of the data received by the IOTC Secretariat for bycatch species for the period 1950–2020. A summary for shark and ray species is provided in Appendix IV.

10. The WPEB **NOTED** that the currently available catch time series for IOTC and bycatch species does not yet include data for 2021 which is still in the process of being received and cross-verified by the IOTC Secretariat.

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

12. The WPEB **RECALLED** that the available information, and in particular the level of catches by fleet and species, is thought to be a severe underestimation of the total biomass of bycatch species affected by the fisheries, as several of these species are discarded at sea and not recorded nor reported to the Secretariat.

13. In this regard, the WPEB **NOTED** the recent efforts made by the FAO Coordinating Working Party on Fishery Statistics (CWP) that at its 27th session in June 2022 endorsed a revised diagram of *catch concepts* which introduces sensible changes to the nomenclature used to describe the various components characterising the total production of marine capture fisheries.

14. In particular, the WPEB **NOTED** that the revised CWP catch concepts diagram now indicates with "*nominal landings*" the same quantity that is currently referred to as "*nominal catches*" in the IOTC, while "*nominal catches*" is used instead to indicate the combination of *nominal landings* and *discarded catches* (that include individuals discarded dead *and* alive, with the latter estimated by applying post-release mortality coefficients specific to the fishery and species concerned).

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

16. The WPEB **NOTED** the limited differences in total annual bycatch levels for the years 1950-2019 compared to the same information available at the last WPEB in 2021, **ACKNOWLEDGING** that the majority of these changes is due to revised data received after September 2021, that include:

    a) late submissions of mandatory data for the statistical year 2019 (Mozambique),

    b) updates to existing submissions from IOTC CPCs (Sri Lanka, Seychelles), and

    c) updates to catch levels from non-CPCs or non-reporting CPCs, which have been recently incorporated in the FAO global catch statistics data and eventually reflected in the IOTC databases (United Arab Emirates, Qatar, Yemen).

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

18. More generally, the WPEB **NOTED** with concern that data for bycatch species (including raised landings and discards, time-area catches and size-frequency data) are often incomplete or not reported according to IOTC standards and **RECALLED** that this has an adverse impact on the ability of the group to undertake its work, in particular for those species whose assessments mostly rely on nominal catches.

19. In this regard, the WPEB **RECALLED** that for several non-reporting CPCs (e.g., Yemen, Somalia and others, depending on the year considered) the information on total catch levels is either repeated from the previous years, or recovered from other data sources that include, among others, FAO official catch statistics which are also known to be incomplete.

20. The WPEB **RECALLED** how Resolution 15/01 *On the recording of catch and effort data by fishing vessels in the IOTC area of competence* provides a list of species, on a gear-by-gear basis, for which information should be mandatorily collected, and **SUGGESTED** that these might be revised to ensure all relevant species are included under each gear in case they aren't already (e.g., silky shark in the case of fisheries using gillnets).

21. The WPEB **NOTED** that combined landings of sharks, rays and all *other*[1] bycatch species correspond to around 10% of total landings for all species reported to the IOTC Secretariat in recent years, and **ACKNOWLEDGED** that, due to the extremely low level of compliance regarding the submission of discards data through form 1-DI, the disseminated current levels of bycatches only reflect *retained* individuals, and therefore do not provide an accurate depiction of the overall bycatch rate at a regional level.

22. The WPEB **NOTED** that artisanal fisheries still contribute to the majority of reported nominal landings of shark and ray species during 1950-2020, reaching about 90% of the average annual totals in recent

[1] I.e., those whose provision is considered voluntary according to currently standing IOTC resolutions

years (2016-2020), and **RECALLED** with concern how the contribution of these fisheries to the reporting of geo-referenced catches of shark and ray species remains extremely low.

23. The WPEB **ACKNOWLEDGED** that while the fraction of shark landings reported at species level has increased in recent years, to the point of reaching around 45% of total annual landings for the species group, it is still subject to frequent oscillations that might reflect long-standing issues in data collection and reporting.

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

25. In this regard, the WPEB **ACKNOWLEDGED** that the Secretariat is currently liaising with Indonesia to assess a proposal for a new catch re-estimation procedure that is expected to affect the level of catches for sharks and rays species currently included in the IOTC best scientific estimates.

26. Also, the WPEB **ACKNOWLEDGED** the offer from the Secretariat of providing support to both Pakistan and India to help clarify the cause of the identified issues and propose corrective actions to ensure that more accurate time series could be provided to the IOTC scientific community soon.

27. **NOTING** the status of the information on bycatch species (including ETP species) as available in the IOTC ROS database, the WPEB **RECALLED** how this information only reflects data collected and reported by those fisheries whose vessels fall in the categories[2] accounted for by Res. 11/04 *On a Regional Observer Scheme* and participate in a national scientific observer programme, therefore **ACKNOWLEDGING** that no information is available in the ROS database for the major Indian Ocean gillnet fisheries (although it should, at least for some of these).

28. Also, the WPEB **NOTED** the apparent *hotspots* in interactions between Indian Ocean fisheries and ETP species as derived from current ROS data, and **ACKNOWLEDGED** that in most circumstances (e.g., areas around Réunion island) these are more an indication of data availability than an accurate assessment of the real extent of interactions with the species concerned.

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

30. The WPEB **RECALLED** that while additional ROS information is available to the IOTC Secretariat, this cannot be properly processed due to the original format of submission (e.g., aggregated trip reports provided as Word documents) and **REQUESTED** that the IOTC Secretariat continue working in close collaboration with all concerned CPCs to get access to finer resolution data (still within the context of Res. 11/04 and taking into account the provisions of Res. 12/02) to further improve the coverage of the information currently in the IOTC ROS database.

[2] I.e., vessels of over 24m in length overall, or less if the vessel operates outside the area under national jurisdiction by their flag state

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–2022–WPEB18–08 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** paper IOTC-2022-WPEB18-10 on South Africa's NPOA Sharks II, including the following abstract provided by the authors:

> *"South Africa's marine ecosystems, spanning from the subtropical waters of the Mozambique Channel to the polar waters of the Prince Edward Islands, harbour one of the most diverse shark, ray, skate and chimaera faunas in the world. South Africa is home to nearly 200 species of these cartilaginous fishes (also known as chondrichthyans), and additional species continue to be discovered. For the purpose of this document the term "sharks" is used to refer to all chondrichthyans. Sharks form an integral part of South Africa's marine biota and their importance for the ecosystems cannot be overemphasized. Sharks have also been part of South African traditional fisheries for more than a century and some species are targeted and caught as bycatch in appreciable quantities."* - see document for full abstract.

36. The WPEB **NOTED** that several research activities were developed in the framework of the new NPOA sharks including: (i) contribution to the assessment of 47 species of chondrichthyes on the IUCN red list; (ii) installation of EMS for vessels catching sharks; (iii) development and distribution of ID guides, development of 3D printed fins racking system and shark fin ID training; and (iv) comprehensive stock assessments on target species.

37. The WPEB **NOTED** that a slot limit of 70 to 130 cm total length (TL) has been adopted for the demersal longline and commercial line fishery.

38. The WPEB **NOTED** that some major changes in management for sharks since the NPOA sharks I included the amalgamation of the shark and large pelagics fishery, the prohibition of wire traces, the prohibition of finning and the designation of shark as bycatch. The WPEB also **NOTED** that the implementation of these measures resulted in 85% of shark catch reductions in 4 years.

39. The WPEB **NOTED** the importance of measuring the effectiveness of NPOAs as was considered while developing this NPOA Sharks II. The expert review panel that reviewed the first NPOA Sharks discussed the need to have a way to measure the effectiveness of the plan and so clear objectives were developed as part of the development process which will give a clear indication of what the plan aims to achieve.

40. The WPEB **NOTED** the work undertaken by the Nairobi Convention on the development of regional management plans within the Western Indian Ocean.

41. The WPEB **NOTED** the importance of the development and implementation of NPOAs for sharks and rays and the need for revising them, given the current status of sharks and rays in the Indian Ocean.

42. **NOTING** that sharks caught in association with tuna fisheries in the Indian Ocean include migratory and straddling stocks which require regional cooperation, joint scientific research programmes and mitigation measures for protection endangered, threatened and protected species, the WPEB **RECOMMENDED** that the SC support cooperation and coordination with the Nairobi Convention on the development of RPOAs and prioritise funding to support such research and management activities for improving the status of sharks and rays in the Indian Ocean.

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

6.1 Presentation of new information available on sharks

43. The WPEB **NOTED** paper IOTC-2022-WPEB18-11 on length-weight relationships for several large pelagic sharks from the Indian Ocean, including the following abstract provided by the authors:

> *"Fork length-dressed weight relationships on shark species (Prionace glauca, Isurus oxyrinchus, Carcharhinus longimanus and Carcharhinus falciformis) were obtained from 8,331 observations recorded at sea on longliners. Significance of the sex factor was specifically assessed using GLM procedures. Linear and non-linear fits of size-weight data by species were tested. The results obtained were compared with those values provided by other authors using equivalent type of data. Deviation of the predicted versus observer weights were also assessed. Both types of fits tested have provided similar results, their confidence intervals plotted are mostly overlapped and the equations obtained were generally within those confidence intervals. Predicted mean dressed weights at size by species were in most cases quite similar or just mimetic to those obtained using equations previously reported."*

44. The WPEB **ACKNOWLEDGED** the quality and the importance of these data collected by observers and the analyses performed. The WPEB **NOTED** that at the Secretariat level, observer data from the EU,Spain longline fishery have only been submitted for 2017, 2018 and 2020 despite the fact that the fishery has been operating since 1993 and submission of data from observers has been required since 2012. The WPEB **THANKED** the authors of the study for having shared the morphometric data available for sharks with the Secretariat, while **NOTING** that data have been submitted in formats that are not in line with IOTC data requirements. The WPEB **QUERIED** whether the formats of future submissions to the ROS database will be changed so that they are in line with IOTC data requirements and can therefore be incorporated into the ROS database.

45. The WPEB **NOTED** that all data used in these analyses come from samples collected before 2013 when EU regulations were enforced.

46. The WPEB **REQUESTED** CPCs to provide observer data for their longline fisheries following the expected formats of the ROS (e.g., disaggregated ST09) so that they can be incorporated in the regional ROS database.

47. The WPEB **NOTED** that while both linear and non-linear methods were used to fit the length-weight data, the linear approach is preferred. In the case of non-linear models, incorrect specification of the model, poor initial starting values, insufficient data and/or insufficient interactions could affect the

convergence. But in this case, the samples are robust and truly representative of the range of sizes and sexes present in the stock, so the linear methods could provide a good approximation of size-weight relationship.

48. **ACKNOWLEDGING** that the Secretariat has already liaised with several CPCs for sharing length-weight data, the WPEB **NOTED** that a common database on biological data is being built by the IOTC and **ENCOURAGED** CPCs to share their data if collected and available.

49. The WPEB **NOTED** paper IOTC-2022-WPEB18-12 on species composition, commercial landings, distribution and some aspects of biology of shark (Class Pisces) of Pakistan: pelagic sharks including the following abstract provided by the authors:

> *"Sharks are important part of coastal and offshore pelagic ecosystems and being caught mainly as bycatch of tuna gillnet fishing operations. There are 12 species of pelagic sharks caught in Pakistan which belongs to 5 families and 7 genera. Silky shark (Carcharhinus falciformis) is the most dominating pelagic shark followed by shortfin mako (Isurus oxyrhinchus) and pelagic thresher shark (Alopias pelagicus). Blue shark (Prionace glauca) is the rarest pelagic shark that is seldom caught by tuna gillnet vessels. There is general concern regarding over-exploitation of pelagic sharks globally as well as in Pakistan, as some species including scalloped hammerhead (Sphyrna lewini) are disappearing very fast and it is feared that they may become extinct in near future. Although most pelagic sharks are included in the Appendix-II of CITES which restricts their global trade as well as there is a ban on their catching, landing, marketing and trade has been imposed through national fisheries legislations, however, there is no effective implementation mechanism in place for ensuring these restrictions in Pakistan. Exploitation of pelagic sharks, therefore, continue unabated in Pakistan as well as some other regional countries which may lead to their disappearance from commercial catches or may ends up in regional or global extinction."*

50. The WPEB **NOTED** that despite regulations on sharks, Endangered, Threatened and Protected (ETP) shark species are landed and marketed in different regions of Pakistan.

51. The WPEB **NOTED** paper IOTC-2022-WPEB18-13 on biological information for most commonly caught shark and ray species, including the following abstract provided by the authors:

> *"This paper presents the biological information for most commonly shark species collated by the EU Projects "Provision of scientific advice for the purpose of the implementation of the EUPOA sharks (MARE/2010/11, 2011-2013) (Murua et al., 2013)" and "Improving scientific advice for the conservation and management of oceanic sharks and rays (SC 01 EASME/EMFF/2016/008, 2016-2018) (Coelho et al., 2018) up to 2018. The biological information is not up to date but could be used as references for the work of the IOTC Working Party on Ecosystem and Bycatch."*

52. The WPEB **NOTED** that the authors were not able to present this paper and the Chair of the WPEB briefly recalled that the paper contains an update of biological information on sharks and rays.

53. The WPEB **NOTED** paper IOTC-2022-WPEB18-14 on the status of marine sharks and rays in Southeast Asia, including the following abstract provided by the authors:

> *"In Southeast Asia, elasmobranchs are particularly threatened. We synthesized knowledge from the peer-reviewed and gray literature on elasmobranchs in the region, including their fisheries, status, trade, biology, and management. We found that 59% of assessed species are threatened with extinction and 72.5% are in decline; rays were more threatened than sharks. Research and conservation is complicated by the socioeconomic contexts of the countries, geopolitical issues in*

the South China Sea, and the overcapacity and multispecies nature of fisheries that incidentally capture elasmobranchs. The general paucity of data, funds, personnel, and enforcement hinders management. Reduced capacity in the general fishery sector and marine protected areas of sufficient size (for elasmobranchs and local enforcement capabilities) are among recommendations to strengthen conservation."

54. The WPEB **NOTED** that it was surprising to see the increase in landings of coastal sharks such as bamboo sharks **NOTING** that bamboo sharks were not a desired species but were sold in the different markets of Southeast Asia.

55. The WPEB **NOTED** that in Pakistan, different markets are targeted depending on the size of shark fins. The WPEB **NOTED** that the shark trade from Pakistan was not included in these analyses because of data availability issues.

56. The WPEB **NOTED** that there are a number of actions that could be taken to mitigate the impact of shark and ray landings on their populations **NOTING** that some catch and release approaches have been proposed in Southeast Asia.

57. The WPEB **NOTED** that ray and shark bycatch have a commercial value so there may be limited willingness to release these species that are mostly dead by the time they are brought onboard vessels anyway. The WPEB **NOTED** that tailored management for the different countries may be a solution as well as a reduction in overall fishing capacity.

58. The WPEB **NOTED** a proposal for a Regional Plan of Action (RGPOA) for sharks and rays **NOTING** that currently no RGPOA has been developed but it would be interesting to develop one focused on the Southeast Asia region and those CPCs that trade with Southeast Asian countries.

59. The WPEB **NOTED** that skates have not been observed by the author in Singapore and that stingrays are more targeted than skates because they are more valuable.

60. The WPEB **NOTED** that the proportion of juvenile shark bycatch is increasing over time which could be a concern. The WPEB **NOTED** that there are different approaches for the conservation of sharks and rays proposed in the literature such as retention for juveniles and release for adults while the opposite proposal is put forward in other publications.

61. The WPEB **NOTED** paper IOTC-2022-WPEB18-15 on a semi-quantitative risk assessment of Chondrichthyan species from coastal Kenya using Productivity and Susceptibility Analysis (PSA), including the following abstract provided by the authors:

"Quantitative assessments of shark populations are difficult to undertake due to the scarcity of data, and the studies focusing on species identification and landings are limited in the Western Indian Ocean (WIO) region. Productivity and susceptibility analysis were used to examine the impact of the artisanal, prawn trawl and longline fishery on 45 shark species, 37 ray species, seven (7) guitarfish species, three (3) sawfish species, one (1) wedgefish and one (1) skate captured and landed off the Kenya coast. For all the fishing gears considered, the artisanal fishery reported five (5) species at high risk while the trawl fishery had 10 ray species, 15 shark species, two (2) sawfishes and two (2) guitarfishes. The industrial longline fisheries recorded two (2) sharks and three (3) rays in the high-risk category.

The IUCN Status and the regional and national regulatory measures currently applied to shark fisheries to assess their efficacy in mitigating the impact on fishing mortality were also examined. At least 12 species were listed as critically endangered, three (3) data deficient, 25 endangered,

10 least concern, 16 near threatened and 28 vulnerable. Thus, the management-risk is high for all species; prawn trawlers and artisanal fisheries have a significant impact particularly on coastal shark species, which can be very sensitive to overfishing as well as large species that use the coastal area during the early stages of their development. Research priorities should include studies assessing the elasticity and demographic aspects of all sharks and rays that require urgent attention due to the risk of extirpation. New regulations and improvements to existing legislation in Kenya may have a positive impact in shark populations, which can be examined in future assessments."

62. The WPEB **NOTED** that lots of species are in the red zone of the PSA and there is a debate on how to manage stock in this kind of situation, e.g. total ban. The WPEB **NOTED** that over time, hybrid approaches may be the best option with total ban in some areas/periods and sustainable measures in other time periods/areas. In total 20 species of sharks and rays are assessed to be in the red by the PSA and the author proposed that an increase in the number of closure months may be a solution.

63. The WPEB **QUERIED** whether the type/size/number of hooks can affect bycatch of the studied species and if any considerations could be given to that but **NOTED** that Kenyan fisheries do not use large gears. The WPEB **NOTED** that artisanal fisheries do not catch a wide variety of species compared to the trawler fishery for instance and that in industrial fisheries, half of the 16 species of sharks and rays caught were assessed as being in the red in the PSA analysis. The WPEB **NOTED** that similar analyses should be conducted in other countries and if similar results are found, concerns should be raised. The WPEB **NOTED** that this type of approach should be analysed together with stock assessment results and **NOTED** that this analysis calls for more scientific studies to be carried out to improve the scientific assessment of these highly sensitive species.

64. The WPEB **NOTED** the high proportion of female blue sharks in the samples with many of these individuals being gravid. The WPEB **NOTED** that samples were not collected only in the spawning season so it is not biased. The WPEB **NOTED** that trials for studying reproductive biology of some of the key species such as blue shark are being conducted at the moment. In this study, the GPS locations from sampling locations have been recorded and from this information it may be possible to investigate the origin of the gravid female sharks which may indicate the presence of a nursery area for the species. The WPEB **NOTED** that in the Kenyan EEZ, sampled females were at different levels of maturity.

65. The WPEB **NOTED** that Kenya would recommend a hybrid approach where total retention bans would apply to certain species while stock management measures such as time-area closures would be sufficient for other species.

66. **ACKNOWLEDGING** the regional assessment of the blue shark of 2021 that concluded that the species is not overfished or subject to overfishing, the WPEB **NOTED** the suggestion that blue shark may be vulnerable at a local scale (i.e., within Kenya's EEZ) according to their PSA and the WPEB **ENCOURAGED** similar assessments to be carried out in neighbouring countries.

67. The WPEB **NOTED** paper IOTC-2022-WPEB18-29 on silky shark bycatch in purse seine fisheries with dFADs exploring differences between fisheries and overall impact estimates, including the following abstract provided by the author:

"Carcharhinus falciformis is known to be the most significant bycatch species in purse sein tuna fisheries especially when setting on drifting FADs, the increasingly applied practice by large tuna fleets in the Indian Ocean. However, the magnitude of impact of this practice on the Indian Ocean stock of silky sharks continues to be considered as very low whilst longlining and gillnetting are quoted to be the main contributors to the overall annual catch of silky sharks at IOTC (Garcia and

Herrera, 2018). However, considering the poor compliance with reporting requirements for sharks in line with Resolution 17/05 huge doubts remain on both, the overall fishery related mortality of this IUCN listed vulnerable species and in particular the contribution of discards from purse seine fleets to this overall mortality. By combining data reported by CPCs to the IOTC Secretariat with fishery specific data disclosed by fisheries as part of their MSC certification the cumulative impact of purse seine fisheries on silky sharks in the Indian Ocean can be assessed more adequately. ."- see document for full abstract.

68. The WPEB **NOTED** that data used in the analyses all came from public sources (IOTC nominal catches, Marine Stewardship Council (MSC) reports, observer coverage and National Reports) and aimed at estimating the overall bycatch of silky sharks. The WPEB **NOTED** that other sources of data could be available for these analyses through a request to the Secretariat such as data from the ROS program. The WPEB also **NOTED** that there have been discrepancies between data reported by human onboard compared with electronic observers.

69. The WPEB **NOTED** that some fisheries are taking measures to fill the gaps and propose solutions for reducing silky shark bycatch (e.g., ramps onboard for alive specimens, non-untangling materials for dFADs, use of hanging sausage nets or ropes to reduce ghost fishing).

70. As already indicated by Garcia and Herrera in 2018 (IOTC-2018-WPDCS14-26_Rev1), the WPEB **NOTED** that it was difficult to correctly estimate the full extent of bycatch rates from purse seine fisheries in the Indian Ocean due to the inconsistent and incomplete reporting of bycatch / discards by CPCs. The WPEB **NOTED** that while some improvements in discard reporting have been made since then, confirming discard levels of silky sharks remains a challenge as some CPCs still do not provide these data as part of the national reports or in the 1DI forms for the purse seine fleets

71. The WPEB **NOTED** that the document used publicly available data and aimed at focusing on bycatch and discards issues for silky sharks especially considering the high proportion of juveniles. The WPEB **NOTED** that the retained catches and discards have not been systematically reported by large-scale purse seine fleets in the past despite IOTC Res. 15/02 and that discard data reported are difficult to combine as not all are raised. Most CPCs have been reporting discards since 2018 through the IOTC discard form (1DI) but not always for catch. The observer data can however be used to provide this information. The WPEB **NOTED** that ROS data aggregated on a fleet and monthly basis and by regular grid (1x1 or 5x5 depending on the fisheries concerned) can be made available on request. Overall, the observer coverage has increased over years and the more coverage there is, the more reliable the bycatch estimates will be.

72. The WPEB **QUERIED** whether the mortality was similar for the different ages and if the post-release mortality was estimated. The WPEB **NOTED** that this parameter was not included in the analyses and few studies are available on that topic but further **NOTED** that some studies on this topic are in progress and will be reported at the next WPEB.

73. The WPEB **NOTED** that a habitat model for silky sharks will be presented at the next WPEB. This type of approach would be useful to explore the dynamics of the spatio-temporal distribution of the silky shark, and hence design management measures.

74. The WPEB **NOTED** the high estimates of bycatch of juvenile silky sharks caught under drifting FADs. Given the high catch of silky sharks in the purse seine fisheries, the WPEB **ENCOURAGED** studies to be carried out to evaluate the impact of catches of juvenile silky sharks under dFADs on the stock of the species and the development of management and mitigation measures (such as time-area closures) to reduce its bycatch.

75. The WPEB **NOTED** paper IOTC-2022-WPEB18-30 on fishing, sizes and sex-ratios of blue shark and silky shark caught by Indonesian tuna longline in the eastern Indian Ocean, including the following abstract provided by the author:

> *"The production of shark captures in Indonesia is derived from multiple forms of fisheries, where these fisheries make shark resources the primary catch (target species) on artisanal fisheries and economically valuable by catch on fishing tuna industries. Silky sharks (Carcharhinus falciformis) and blue sharks (Prionace glauca) are the predominant shark species caught in artisanal and tuna fishing industries respectively. Datasets included information on catch location and CPUE, and specimen size and sex. a total of 3,181 shot-by-shot catch and effort data were acquired from the Indonesian scientific observer activity. The main fishing grounds cover the western and southern part of Indonesian waters, extending from 75o E to 35o S, with greatest CPUE tending to occur at latitudes 90o-100o E to 30o -35o S while silky shark very rare caught and more to occur near to neritic zone. A total of 1,756 blue shark and 99 silky shark records collected between 2006 and 2021 were compiled, with the sizes ranging from 50 to 312 cm FL and 29 to 200 cm FL (fork length) with differences in the sex ratios by quarter were also detected. "*

76. The WPEB **NOTED** recent training that has been conducted in Indonesia to train scientific observers and observer coordinators, **NOTING** that previously observers were only deployed onboard to monitor compliance issues. The WPEB **NOTED** that this training should lead to increased data quality and quantity from Indonesia as well as allowing trained observers to share their experience with other observers. At the moment, Indonesia has 85 people working for the observer program covering both the Indian and Pacific Oceans.

77. The WPEB **NOTED** that to date the training focus has mostly been on longliners with 15% observer coverage, and so the data will not be coming from purse seiners yet. The observers are deployed in territorial areas and the Pacific Ocean which requires a substantial amount of resources.

78. The WPEB **NOTED** IOTC-2022-WPEB18-INF22 which presents an update of the recent development of the IOTC Post-Release Mortality project for the bigeye thresher shark (BTH). This document included the following abstract 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, and 17th IOTC WPEB are presented."*

79. The WPEB **NOTED** that the program stalled in 2020-2021 because of the COVID pandemic and that deployments only resumed in 2022. The program will be extended until 2024 since a number of tags still need to be deployed.

80. The WPEB **NOTED** that the post-release survival from bigeye thresher sharks tagged so far has been estimated at 44% for sharks caught by longlines.

81. The WPEB **NOTED** that South Africa has had difficulties in deploying tags on bigeye threshers since they are very rarely encountered, and some fishers were reluctant to participate in the program. The WPEB **NOTED** that the results of the project showed that tags deployed in the high seas were popping up in the South African EEZ so this area would be particularly relevant for this study. The WPEB **NOTED** that South African scientists will try to engage with the industry to help the deployment of tags by the research project.

7. Stock assessment and indicators for sharks

7.1 Review of indicators

82. The WPEB **NOTED** paper IOTC-2022-WPEB18-16 on scalloped hammerhead (*Sphyrna lewini*): An important bycatch of in gillnet fisheries of Pakistan, including the following abstract provided by the author:

> *"Presently there is no aimed fisheries for scalloped hammerhead, however, it is mainly landed as bycatch of tuna gillnet fisheries that operates in coastal and offshore waters including Exclusive Economic Zone and Areas Beyond National Jurisdiction (ABNJ). In addition, small quantities of scalloped hammerhead are caught by coastal gillnet fisheries and coastal longline fisheries. Juveniles that are known to inhabit coastal waters, bays and lagoon are mainly caught by coastal gillnet fisheries, as well as from coastal waters by tuna gillnet vessels as bycatch. An aim shark fisheries was established in Pakistan in 1988 and hammerhead sharks used to a preferred species contributing about 25 % of the total shark catches. This fisheries started to dwindle by 1999 and by 2003 it collapsed. Since then no aimed shark fisheries is being practiced in Pakistan and sharks including scalloped hammerhead are landed as bycatch of other fisheries. At present it is contributing about 7 % of total landings of pelagic sharks of Pakistan. Along Pakistan coast maximum size recorded for this species was 270 cm TL, however, most of Sphyrna lewini recorded were 65 and 185 cm TL. Small specimens of scalloped hammerhead sharks are caught in coastal waters and continental shelf area by coastal gillnetters whereas larger specimens (150-400 cm) are mainly caught as bycatch by tuna gillnetters. In Pakistan, Sphyrna lewini feeds upon bony fishes small sharks, rays, crustaceans and cephalopods whereas juveniles were observed to feed on mantis shrimp, portunid crabs, shrimp, cephalopods and small fishes. Study on fecundity in Pakistan revealed that female may have 18-34 pups (44 to 47 cm TL) mainly during April and June. Although national legislations provide protection to scalloped hammerhead, however, there is no implementation of these laws. Considering that the stocks of scalloped hammerhead are dwindling in Pakistan, therefore, there is a need for implementation on the existing legislations as well as creating awareness among the coastal communities for protection of this iconic species."*

83. The WPEB **NOTED** that while adults are primarily caught in offshore regions, the majority of tuna fisheries catch juvenile sharks in coastal areas. Additionally, there is typically a significant lack of data regarding adult shark catches in the high seas.

84. The WPEB **NOTED** the occurrence in which eight tons of adult shark fins from one exporter ended up on the illicit Asian market despite the attempted intervention by the WWF-Pakistan. The WPEB further discussed the origin of adult shark fins and **NOTED** that juvenile shark fins have a separate route to the black Asian market, such as through Vietnam or Singapore.

85. The WPEB **NOTED** Hong Kong's strong traceability system, which may be used to identify the origin of the shark fin trade. The WPEB **NOTED** the group's interest in using Hong Kong trade statistics to better study shark fin trade and catches in the Indian Ocean. The WPEB also **NOTED** a study carried out by Clarke (2011) that provided estimates of blue shark captures in the Indian Ocean but further **NOTED** some issues that have been found with attempting to estimate catches in this way.

86. The WPEB **NOTED** that the targeted shark fishery in Pakistan ceased after 2003, and since then there have not been many shark catches reported, however, despite the significant catches, Pakistan's poor reporting of shark catches to the IOTC dates back to 1987. The WPEB **NOTED** that Pakistan is

currently working on a project financed by ABNJ to better reconcile and enhance the catch estimates by species for this period.

87. The WPEB **NOTED** paper IOTC-2022-WPEB18-17 on bycatch of hammerhead sharks caught by the French pelagic longline and purse seine fisheries in the Indian Ocean (2005-2021), including the following abstract provided by the author:

    "Hammerhead sharks (Sphyrnidae family) are sensitive species present in the Indian Ocean that are classified as globally "Critically Endangered" for the great hammerhead (Sphyrna mokarran – SPK) and scalloped hammerhead (Sphyrna lewini – SPL), and "Vulnerable" for the smooth hammerhead (Sphyrna zygaena – SPZ) by the IUCN. Hammerhead sharks are occasionally bycaught by the French tuna purse seine fishery and swordfish-targeting longline fishery operating in the western Indian Ocean." – see paper for the full abstract.

88. The WPEB **NOTED** there is only anecdotal evidence of bycatch of hammerhead sharks by the French purse seiners in the Indian Ocean, whereas there is a low but consistent occurrence of hammerhead shark catches by longliners.

89. The WPEB **NOTED** that there has been a downward trend in both the occurrence of hammerhead sharks and the positive catch rates in the Réunion-based longline fishery. It is unclear, however, whether this tendency is a result of the impact of climate change or a change in abundance.

90. The WPEB **NOTED** the exceptionally high hammerhead shark catch rate in the time series, which is attributable to a few sets near Madagascar. The WPEB further **NOTED** that there has been some spatial expansion of longline effort from coastal seas to more offshore locations, and that such spatial variables should be better handled in a standardisation framework. However, the WPEB **NOTED** that given the high percentage of zero captures, standardisation in these circumstances may not be feasible and is more likely to reflect variations in occurrence than abundance.

91. The WPEB **QUERIED** the accuracy of the information gathered by the crew or skipper who are not experts in identifying species and **NOTED** that there is an intention to train them to more accurately distinguish between the species caught. The WPEB further **NOTED** that this is not a straightforward problem, since hammerhead shark species are particularly difficult to differentiate and are frequently released soon before being hauled aboard, making accurate identification difficult or impossible.

92. The WPEB **NOTED** that longline vessels had an electronic monitoring program implemented in La Réunion, and that the equipment is still on board the vessels. The WPEB also **NOTED** that a study had been carried out to compare the information gathered by an electronic monitoring software with that gathered by observers. The report is available (see section WP3.2 of RECOLAPE project) but is yet to be presented to the WPEB.

93. The WPEB **THANKED** the production team for their excellent work on an updated species identification guide (IOTC-2022-WPEB18-INF17), which is currently being translated from French into English and Spanish.

94. The WPEB **NOTED** paper IOTC-2022-WPEB18-19 providing an update on the CPUE standardization of the blue shark caught by the Taiwanese large-scale tuna longline fishery in the Indian Ocean, including the following abstract provided by the author:

    "The catches and efforts of the blue shark in the Indian Ocean were estimated based on the observers' records (2005-2020) of Taiwanese tuna longline fisheries. To cope with the large

percentage of zero shark catch, the catch per unit effort (CPUE) of blue shark, as the number of fish caught per 1,000 hooks, was standardized using a two-step delta-lognormal model (DLN) that treats the proportion of positive sets and the CPUE of positive catches separately. The standardized CPUE showed a stable increasing trend for blue sharks from 2005 to 2014 (the second peak), although decreased in 2015, it increased again in 2016. Overall, the standardized CPUE series of the blue shark caught by Taiwanese longline fishery showed a stable trend. The stable trend suggested that blue shark stocks in the Indian Ocean seems at the level of optimum utilization."

95. The WPEB **NOTED** that blue shark was formally assessed in 2021 and this analysis provides an update of the CPUE index.

96. The WPEB **NOTED** the positive effect on the standardised index in the early 2000s may be attributed to lower observer coverage rather than changes in fishing operations.

97. The WPEB **NOTED** that the target variable used in the standardisation represents the target species from the observer records.

98. The WPEB **NOTED** paper IOTC-2022-WPEB18-20 providing an update on the CPUE standardization of the shortfin mako shark caught by the Taiwanese large-scale tuna longline fishery in the Indian Ocean, including the following abstract provided by the author:

"In the present study, the shortfin mako shark catch and effort data from the logbook data of Taiwanese large longline fishing vessels operating in the Indian Ocean from 2005-2020 were analyzed. Based on the effort distribution, four areas, namely, (1) Northwest Indian Ocean (north of 10°S, east of 70°E); (2) Northeast Indian Ocean (north of 10°S, 70°E-120°E); (3) Southwest Indian Ocean (south of 10°S, 20°E-60°E); (4) Southeast Indian Ocean (south of 10°S, 60°E-120°E) were categorized. To cope with the large percentage of zero shark catch, the catch per unit effort (CPUE) of shortfin mako shark, as the number of fish caught per 1,000 hooks, was standardized using zero-inflated negative binomial model (ZINB) that allows for "extra" zeros. ZINB model includes the main variables Year, Quarter, Area, HPBF, CTNO, and Cluster. The standardized CPUE showed a stable and slightly increasing trend for shortfin mako sharks. The stable trend suggested that shortfin mako shark stocks in the Indian Ocean seems at the level of optimum utilization."

99. The WPEB **NOTED** that the analysis is based on the logbook data due to the very high proportions of zero catch of shortfin mako shark in the observer data.

100. The WPEB **NOTED** that due to the significant increase in standardised indices, it is not appropriate to describe the population trend as stable. The WPEB further **NOTED** that the significant increase may have been caused by the shortfin mako sharks displacing other shark species in the ecosystem, i.e., a top-down trophic effect but further evidence is required in order to confirm this.

7.2 Stock assessment model for scalloped hammerhead shark

101. The WPEB **NOTED** paper IOTC-2022-WPEB18-21 on a preliminary stock assessment of scalloped hammerhead shark in the Indian Ocean, including the following abstract provided by the author:

"The study conducted a demographic analysis and preliminary stock assessment to status by Leslie matrix and CMSY method for the Indian Ocean scalloped hammerhead shark (Sphyrna lewini). Monte Carlo simulation was used to integrate uncertainty of biological information and key parameters. The results indicated that scalloped hammerhead shark productivity was low,

with the intrinsic rate of increase r is from 0.12 to 0.23yr-1, and the most uncertainty is inconclusive fecundity where the litter size is from 13 - 41 pups per year. The results are sensitive to the final depletion level, and all scenarios reveal that the average of the last three-year catch is lower than MSY; however, the stock status is overfished. Given the high uncertainty in the catch series and high amounts of misidentified catch, future assessments need to consider more date-limited methods based on the different sources of data and improve the reconstruction of catch series."

102. The WPEB **THANKED** the author for their work in developing the first quantitative assessment of scalloped hammerhead sharks in the Indian Ocean, which provides a good foundation for understanding stock dynamics in connection with catch data and biological characteristics of the species.

103. The WPEB **NOTED** that the author used the nominal catch time series in the stock assessment (not shown in the working paper).

104. The WPEB **NOTED** the large uncertainty in the assumptions of depletion ratio and **NOTED** that the assumption of the depletion level in the last year may have a direct effect on the estimates of stock status in relation to the MSY reference point which is 50% of the B0 estimated by the production model. The WPEB **NOTED** that two depletion scenarios (1–40% and 20 – 60%) were assumed but the median values are lower than 50% of B0 in both scenarios. The WPEB further **NOTED** that a wider prior range may yield different stock status estimate results but is likely to produce implausible estimates of other population parameters like carrying capacity K.

105. The WPEB **NOTED** that data limited methods were used for conducting this preliminary stock assessment for scalloped hammerhead sharks. The WPEB **NOTED** that there was high uncertainty in the catch series but the results of fishing mortality based on biomass indicated that the stock is *overfished* but *overfishing is not occurring*. The WPEB further **NOTED** that these results were different to the results of the CMSY assessment where the assumption for the final depletion was causing the most uncertainty, and all scenarios showed that the average of the last three-year catch is lower than MSY. Further **NOTING** that the results indicated that scalloped hammerhead shark productivity was low, with an intrinsic rate of increase from 0.12 to 0.23 yr^{-1}, and the inconclusive fecundity where the litter size is from 13-41 pups per year creates a large level of uncertainty.

106. The WPEB **SUGGESTED** that the sex-specific demographic model be considered in future analyses to account for the sexual dimorphism of this species.

7.3 Review of the proposed stock assessment of scalloped hammerhead shark

107. The WPEB **AGREED** that the major issue of this stock assessment is the data poor situation as there are neither abundance indices nor information about the reliable biological parameters. The WPEB further **NOTED** that the CMSY are heavily dependent on accurate estimates of past catches, yet the reported nominal catches of hammerhead sharks are most likely to be inaccurate.

108. The WPEB **NOTED** that this is a preliminary assessment and so it may not be suitable for giving concrete management advice. The WPEB **AGREED** that it is critical to enhance data collecting for this data-poor species while managing it cautiously in the interim.

109. The WPEB **NOTED** that despite the absence of a robust stock assessment information, the Commission has been advised by the SC to consider taking a precautionary approach by implementing some management actions for scalloped hammerhead sharks, further **NOTING** the request of the Commission to the SC to develop research plans for shark species via its WPEB.

7.4 Recommendation and executive summaries (all)

110. The WPEB **REQUESTED** that the IOTC Secretariat update the draft executive summary for scalloped hammerhead with the latest 2020 catch data:

- Scalloped hammerhead shark (*Sphyrna lewini*) – Appendix IX

111. The WPEB **NOTED** paper IOTC-2022-WPEB18-18 on a preliminary recovery plan for scalloped hammerhead in the Indian Ocean, including the following abstract provided by the author:

> *"This document is a Preliminary Recovery Plan for the Scalloped Hammerhead in the Indian Ocean. It provides summary information on the Scalloped Hammerhead in the Indian Ocean, including biology and ecology, critical habitats, population and stock status, threats, current management measures, and information gaps. The main threat to Scalloped Hammerhead in the Indian Ocean is mortality resulting from fishing, in particular from the gillnet and artisanal fisheries. The Plan considers the conservation needs of the Scalloped Hammerhead in the Indian Ocean and identifies a preliminary set of recommended actions that can be implemented by the IOTC and its CPCs to begin to halt decline and promote recovery of the species. The overarching vision of the Plan is to see the Scalloped Hammerhead population in the Indian Ocean increasing and recovered and thriving in well-managed ecosystems. This Preliminary Recovery Plan describes a range of mechanisms that can be used to halt the decline of the Scalloped Hammerhead in the Indian Ocean and facilitate a recovery, for consideration by the IOTC and its Contracting Parties and Cooperating, Non- Contracting Parties (CPCs). It can form the basis for a full Recovery Plan derived through the normal IOTC processes and consultations with its CPCs. The Scalloped Hammerhead is in dire straits in the Indian Ocean and despite the lack of data, a precautionary approach is needed and management actions are needed without further delay."*

112. The WPEB **NOTED** the decline of scalloped hammerhead sharks in Southeast Asia and more widely in several locations of the Indian Ocean. The WPEB further **NOTED** that the large-scale catch of juvenile hammerhead sharks may result in growth overfishing considering that the data presented at the WPEB indicated low catches of adults.

113. Furthermore, the WPEB **NOTED** that the current IUCN threat status of 'Critically Endangered' applies to scalloped hammerhead sharks globally, but specifically for the western Indian Ocean the status is 'Endangered' (though this is incorrect and should be 'Critically Endangered' as it was based on the same western Indian Ocean data used in the recent global assessment but incorrectly only used one generation length (24 years) rather than three generation lengths (72 years) as required by the IUCN criteria to estimate the level of population reduction). Further, the IOTC nominal catch data for scalloped hammerhead presented at the WPEB has a level of population reduction that would also meet the criteria for a status of Critically Endangered.

114. The WPEB **NOTED** the marine protected area around the Indus River Canyons and/or coastal areas is an important nursery area of hammerhead sharks. The WPEB **NOTED** that the IUCN range map depicting the hammerhead sharks' coastal nursery area is based on data that has been observed and published over a long period of time, and that the resolution of the map can be enhanced or expanded to incorporate data from new research (such as those from habitat modelling).

115. The WPEB **NOTED** that the IUCN risk assessment is based on the CPUE from a localised coastal fishery (near the coast of South Africa) that catches mainly juveniles, and does not reflect the wider IOTC region. However, the WPEB **NOTED** the declining trend in catch time series of gillnet fishery in the Indian Ocean (which represents the best available data). The WPEB **NOTED** that these species

are considered to be in crisis globally, so a precautionary approach needs to be taken before a full assessment is possible.

116. The WPEB **NOTED** that the reasons for the decline in the French Longline fishery of scalloped hammerhead sharks in recent years (last three years) is unknown and may be due to either declines in the relative abundance of the species and/or climatic factors. The WPEB **NOTED** that the impact of IOTC fisheries on scalloped hammerhead sharks needs attention to ensure IOTC fisheries interactions are not hampering the Indian Ocean population and its reproductive capacity and **ENCOURAGED** further studies to understand their spatio-temporal distributions, critical habitats and interactions with IOTC fisheries (and resulting mortalities) to be undertaken along with studies exploring climatic variables that may be able to provide plausible explanations for the detected declines.

117. The WPEB **RECALLED** that the Ecological Risk Assessment (ERA) for sharks was conducted for the Indian Ocean by the WPEB and SC in 2018 and it estimated that scalloped hammerhead sharks are the one of the least productive species and were considered extremely vulnerable to gillnet fisheries, followed by longline and purse seine. The ERA also concluded that considering their life history characteristics, the scalloped hammerhead sharks are vulnerable to overfishing. The WPEB **SUGGESTED** that the results of the ERA can be useful in informing the susceptibility and productivity of these data poor species.

118. The WPEB **NOTED** that in IOTC, stock assessments are usually the basis for developing species management measures, whereas in ICCAT, ERAs have occasionally been used for managing shark species. The WPEB **SUGGESTED** that management measures should be put in place for species that are considered to be threatened with extinction based on the IUCN risk assessment. However, the WPEB **NOTED** the IUCN risk assessment assesses extinction risks, and while it is complementary to the stock assessment it can produce significantly different results.

119. The WPEB expressed **CONCERN** regarding data deficiencies for several shark species that are caught in association with IOTC fisheries and **NOTED** that this has resulted in providing skewed estimates of population trends. Furthermore, the WPEB **NOTED** that it has not been possible to derive indices of abundance from the poor nominal catch (retained or discarded) and catch and effort data, including very poor georeferenced fishery statistics that are available at the IOTC Secretariat. The WPEB also **NOTED** that the identification of hammerhead sharks at the species level and its reporting is low.

120. The WPEB **NOTED** the uncertainty in the catch series, high levels of misidentified catch and underreporting of catches for scalloped hammerhead sharks. The WPEB **RECOMMENDED** that the SC endorse an update of the list of sharks, rays and ETP species included in Appendix II of IOTC Resolution 15/01 for each fishing gear. In particular, to ensure that all species groups under the current broad categories (e.g., Hammerhead sharks (Sphyrna spp.) - SPN, Mako sharks (Isurus spp.) - MAK, Marine turtles - TTX, etc.) are reported separately by species (e.g. scalloped hammerhead (*Sphyrna lewini*; SPL), great hammerhead (*Sphyrna mokarran*; SPK), smooth hammerhead (*Sphyrna zygaena*; SPZ), shortfin mako (*Isurus oxyrinchus*).

121. The WPEB **ENCOURAGED** coastal CPCs to collect more information about adult and juvenile distribution of the species.

122. The WPEB **NOTED** that subsurface gillnet setting in Pakistan appears to be effective in reducing the bycatch of hammerhead sharks but there is lack of data to support this conclusion.

123. The WPEB **DISCUSSED** the effectiveness of a potential retention ban in the Indian Ocean for hammerhead sharks. The WPEB **NOTED** that this measure will not work entirely for scalloped hammerhead sharks because of the high at-vessel mortality and post-release mortality of the species. The WPEB also **NOTED** that there is a tendency to retain high value species such as hammerhead sharks.

124. The WPEB briefly **DISCUSSED** the potential use of close-kin-mark-recapture (CKMR) for data deficient shark species. The WPEB **NOTED** that CKMR has been applied to the white shark in Australia and is widely regarded as being appropriate for shark species whose biology and life cycle distribution are well-studied. CKMR can be used to set base-level population estimates for hammerhead sharks. However, for species listed on the CITES Appendix II (such as hammerhead sharks), sampling and transport of the samples required for CKMR analyses may be challenging.

125. The WPEB **NOTED** that although there is evidence (from the experience in the U.S.) that implies that the recovery of hammerhead shark population can be achieved within 10 years, the 10-year time frame set forth in the recovery plan is to move things forward rather than specifically to achieve recovery during this period. The WPEB **NOTED** that the time frame can be extended for long-lived species, such as hammerhead sharks, in a manner similar to an adaptive management strategy. The WPEB expressed **CONCERN** about the recovery plan because IOTC needs to manage a lot of fleets from more than 70 countries, which is a very different situation compared to the US where the recovery of the stock has been observed.

126. The WPEB **NOTED** that the information on scalloped hammerhead shark is very fragmented, the risk assessment relied on the data from a small area and the stock assessment presented today is preliminary. The WPEB **AGREED** that regional science and knowledge need to be utilised in order to improve the understanding of the status of the species. The WPEB **NOTED** the reluctance to adopt a global recovery plan for the hammerhead shark because its status is uncertain across the Indian Ocean. However, the WPEB **AGREED** that the recovery plan serves as a very good first step towards developing a research plan.

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

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

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

128. The WPEB **NOTED** paper IOTC-2022-WPEB18-23 providing an update on best practices onboard French and Italian tropical tuna purse seiners of the Atlantic and Indian Oceans: outcomes and ongoing projects, including the following abstract provided by the authors:

> *"The issue of mortality of sensitive species incidentally caught by fishing vessels has become a major concern for the sustainability of fisheries, in the last decades. In 2012, the collaboration with French scientists of the French Institute for Research and Development (IRD) and Ifremer resulted in the first manual of safe handling and releasing techniques for sharks, whale sharks, rays and sea turtles (Poisson et al. 2012, 2014b). Eight years after the publication of the manual on Best Practices, a comprehensive assessment of the application of best practices on board French and associated flag purse seiners has been carried out (Maufroy et al. 2020). This study highlighted several issues. Following this, changes were made to the observation programs and*

new projects were set up. This paper presents the various modifications made as well as the new programs launched by ORTHONGEL and its member shipowners."

129. The WPEB **NOTED** that the French and Italian purse seine fleets are not planning to use artificial intelligence (AI) to analyse videos recorded by their electronic monitoring programmes, however, this is considered to be a promising avenue to explore in the future by all fleets. The WPEB **NOTED** that instead, these fleets are planning to use AI to produce better estimates of the species which are retained onboard, and they also plan to use AI to develop a mobile application to help observers with species identification.

130. The WPEB **NOTED** that the French purse seine fleet has 13 vessels and that 7 of them do not have space onboard to accommodate a human observer, so instead they are monitored with EMS. The WPEB further **NOTED** that observer data collected by EMS are not yet submitted to IOTC (not required) since IOTC has not yet adopted a minimum standard for EMS, yet once adopted will be submitted for scientific purposes.

131. The WPEB **NOTED** that currently no specific actions are taken when vessels are in an area that has high bycatch of sharks. The WPEB further **NOTED** that the sharing of real-time information regarding such areas is a measure that is being considered by the fleet, but it has not been implemented yet.

132. The WPEB **NOTED** paper IOTC-2022-WPEB18-INF11 on a report of the multi-taxa gillnet bycatch mitigation workshop, including the following abstract provided by the authors:

"The World Wide Fund for Nature (WWF) held a technical workshop on multi-taxa bycatch mitigation focusing on drift/gillnets in collaboration with the Indian Ocean Tuna Commission. The objective of the workshop was to undertake an evaluation of existing mitigation measures for their sustainability to reduce bycatch of multiple taxa in drift/gillnet fisheries (gears) and to scope and assess the feasibility of novel or experimental measures being developed for this purpose in the Indian Ocean. The workshop successfully identified a suite of options, which may be ready to test/pilot and/or scale mitigation measures which benefit multi-taxa, with a focus on having improved monitoring and data collection systems in place so information from such trials is robust and scientific and put together a list of recommendations to the WPEB" – see document for full abstract

133. The WPEB **NOTED** the recommendations arising from the first multi-taxa bycatch mitigation workshop, and **ENCOURAGED** the organisers to continue with the work.

134. The WPEB **NOTED** that the workshop was successful in exploring a suite of options, a mitigation toolbox, for reducing the bycatch of sharks and rays, cetaceans, sea turtles among other species, and allowing for a robust exchange of information on the results of the trials being undertaken in other parts of the world for small-scale and large-scale gillnet fisheries. Among these, net illumination, the use of different gear settings (surface, subsurface), use of acoustic deterrents, magnetic or electric fields, and area-based measures among others were discussed.

135. The WPEB also **NOTED** that some mitigation methods may have limitations due to their experimental design, their nature and/or to an extent where they may be insufficient to halt population declines, further **NOTING** that the bycatch mitigation designs need to be economically viable, ecologically sustainable and socially acceptable.

136. The WPEB **NOTED** that in order to support bycatch mitigation work in gillnets, robust data collection mechanisms and reporting systems which are able to provide fine-scale resolution are required.

137. The WPEB **NOTED** that there is a real need to improve data from gillnet fisheries for both target and non-target species and the workshop largely agreed that the best way of collecting data from gillnet fisheries (whether small or large-scale) is to focus on scientific observers. However, the WPEB **ACKNOWLEDGED** that there is currently no requirement for onboard scientific observers for vessels which are less than 24 m and for those only operating within areas of national jurisdiction which could be something to be explored in the future to provide a potential solution to the lack of data in these fisheries.

138. The WPEB **NOTED** that the use of artificial lights (a visual deterrent) in gillnet fisheries as a potential bycatch mitigation device was discussed at length and **NOTED** the strong support for the rolling out of future LED trials across the Indian Ocean by the workshop participants. However, the WPEB **NOTED** that the use of artificial lights is banned in the Indian Ocean due to IOTC Resolution 16/07. Therefore, the WPEB **RECOMMENDED** that the SC seek clarification from the Commission on whether Resolution 16/07 applies to gillnet fisheries and to scientific studies as the current wording is somewhat ambiguous.

139. The WPEB **NOTED** that oxygen may be a major limiting factor for the habitat of several pelagic species and **ENCOURAGED** comparative analyses of the efficiency of some mitigation measures such as subsurface gillnetting between the coastal areas of Oman and Pakistan that may be characterised by different levels of oxygen concentration.

140. The WPEB **NOTED** a number of other recommendations from the workshop relating to: studying the validity of alternative data collection tools; providing support for trials of sub-surface setting across the wider Indian Ocean; continuing discussions around providing a way to report the setting depth of gillnets; strengthening of discards data collection mechanisms on board vessels; the study of at-vessel and post-release mortality for those species currently under retention bans; and continued support for the development of Ecological Risk Assessments, and the use of Important Marine Mammal Areas, Important Bird Areas, EBSAs and other tools that highlight important or sensitive habitat for ETP species.

141. The WPEB **NOTED** paper IOTC-2022-WPEB18-22 on the second IOTC Ecoregion Workshop: identification of regions in the IOTC convention area to inform the implementation of the ecosystem approach to fisheries management, including the following abstract provided by the authors:

> "*In 2019 the Working Party on Ecosystems and Bycatch (WPEB) recommended a second IOTC ecoregion workshop to advance the identification of ecologically meaningful regions (ecoregions) in the IOTC convention area to support the implementation of the ecosystem approach to fisheries management (EAFM). Ecoregions may provide a spatial framework to support regional ecosystem planning and prioritization, incentivized ecosystem research and the development of integrated advice products for informing fisheries management-decisions. This online workshop took place the 19-21 of January 2022 and gathered around 23 participants with a wide range of expertise in IOTC species, fisheries and oceanography of the Indian Ocean. Prior to the workshop, a consultant was hired to prepare a background report where Group discussions and feedback received during the first ecoregion workshop were addressed to be presented and discussed at the second workshop. During the workshop, the Group discussed the potential benefits and potential uses of ecoregions in the context of IOTC species and fisheries, and provided feedback on the technical aspects, the data and methodologies used in the derivation of a refined ecoregion proposal. The workshop resulted in a refined proposal of nine candidate ecoregions within the IOTC convention area. The Group requests that (i) the WPEB reviews and comments on the ecoregion delineation process and the refined proposal of candidate ecoregions within the IOTC convention area, (ii) the WPEB communicates with the rest of the WPs and the SC, and SC*

to the Commission, the ongoing ecoregion process to receive further feedback, (iii) the WPEB supports further refinements of the ecoregion process and establishes a mechanisms to progress this work, and (iv) the WPEB continues endorsing the candidate ecoregions to develop pilot projects to test their usefulness and utility as a tool to progress on EAFM implementation in IOTC."

142. The WPEB **ENDORSED** the proposed refined candidate ecoregions as a tool to develop pilot projects to test effectiveness and utility of the ecoregions as tools to provide more integrated advice products.

143. The WPEB also **AGREED** to communicate the ongoing ecoregion process, its purpose and potential benefits to provide more integrated regional advise, with the rest of the working parties and the SC, as well as to **REQUEST** that the SC communicate this process to the Commission, in order to receive further feedback and future direction.

144. The WPEB **SUPPORTED** the work being done to refine the ecoregion delineation process and develop ecoregion pilot projects and **SUPPORTED** the inclusion of the development of concrete pilot projects using the agreed proposed ecoregions to test their utility as a priority in its work plan to facilitate the acquisition of funding to support the work. In addition, the WPEB also **NOTED** that a project proposal to acquire funding is being developed, potentially to explore a range of other funding sources (EU funding), to support the pilot project. The WPEB **NOTED** the interest in this proposal and participation in the project by members of the WPEB and further **NOTED** that the project proposal with the description of the pilot project will be shared with the ecoregion group in due time to solicit feedback.

145. The WPEB **NOTED** that suggestions to refine specific areas of the draft ecoregion map based on expert knowledge can be easily addressed in future iterations of the ecoregion process and work. The WPEB **NOTED** that the ecoregion core team can gather all the WPEB (and SC) suggestions so they can be addressed in future group meetings. For example, there was a suggestion to revise the Chagos Archipelago and its fit within the Maldives ecoregion.

146. The WPEB **SUPPORTED** the idea of selecting two ecoregions, one coastal and one oceanic, to start developing the pilot regional and integrated advice products (regional ecosystem overviews - regional integrated bycatch assessments), starting with the integration and synthesis of existing knowledge within an ecoregion. The WPEB **ENCOURAGED** interactions between the ecoregion group and the multi-taxa bycatch mitigation group, so some of the work produced by the multi-taxa bycatch mitigation group can be used to inform the development of the coastal case study focusing on the Somali Current ecoregion. For example, the coastal case study could focus on fisheries bycatch impacts across taxa, with a focus on gillnets, using the Somali Current ecoregion.

147. The WPEB **DISCUSSED** the possibility of using the ecoregions as the spatial framework to develop ecosystem models (e.g., SEAPODYM, Ecopath/Ecosim EwE) in different regions (ecoregions) within IOTC. The WPEB **NOTED** that these ecosystem modelling approaches have been developed in the Pacific (WCPFC, IATTC) and they provide some insights into bottom-up and top-down control mechanisms in the food web in oceanic ecosystems. The WPEB **NOTED** that currently there is an ongoing activity funded by a H2020 EU project to undertake trophic analysis and develop an ecosystem model (EwE) for the ICCAT Tropical Ecoregion, and that this type of work could also be developed in the context of IOTC if project funds were acquired. The WPEB **NOTED** that in other regions (such as ICES) where there is more experience with using ecoregions as tools to support the development of advice products, at the early stages, the type of advice products being developed focused

on synthesising empirical evidence, then evolving into more quantitative integrated products to address regional trade-offs (e.g., ecosystem modelling, management strategy evaluation).

148. The WPEB **DISCUSSED** potential mechanisms to progress refining the ecoregion process and the validation of the refined ecoregion proposal derived from the second workshop including the possibility of continuing to work intersessional with the support of workshops. The WPEB **REQUESTED** future workshops/intersessional meetings to keep refining the ecoregion process, and to revise and contribute to the regional pilot studies to be developed for testing the utility of ecoregions.

149. The WPEB **RECOMMENDED** that the SC and other working groups review the ongoing ecoregion process, including their purpose and potential benefits in providing more integrated regional advice and provide feedback to the WPEB. The WPEB also **RECOMMENDED** that the SC endorses the proposed refined candidate ecoregions and the development of pilot projects to evaluate their utility and effectiveness as a tool to support regional ecosystem planning and prioritization, incentivized ecosystem research and the development of integrated advice products for informing fisheries management decisions.

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

9.1 All bycatch species

150. The WPEB **NOTED** paper IOTC-2022-WPEB18-INF16 on squid fishing in the northwest Indian Ocean – clear as ink, including the following abstract provided by the authors:

> *"The vessels involved in the NWIO squid fishery continue to primarily operate on the high seas, adjacent to the Exclusive Economic Zone (EEZ) of Oman and Yemen, across an area equalling nearly 700,000km2. The fishery generally starts around October each year, peaks in terms of number of vessels present in November to January, and then decreases through to late May. Analysis of vessel identities and VIIRS 3 imagery indicates that squid continue to be a key target species. However, an increasing number of the fishing vessels operating in this area are multipurpose and it is possible that other species, such as tuna and small pelagic fish, are also targeted. The high seas fishing grounds fall outside the remit of any regional fisheries management organisation (RFMO) with a mandate to manage species other than tuna and tuna-like species. Like the larger and better-known squid fishery that takes place in the Southwest Atlantic, this means that regulation of the fishery is entirely reliant on participating flag States. Unlike the Southwest Atlantic fishery, evidence from AIS analysis indicates that the vast majority of vessels (if not all) that are targeting squid in the NWIO are flagged to only one country. This represents a challenge but potentially also an opportunity for strengthening the management and regulation of this fishery"*

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

9.2 Other sharks and rays

152. The WPEB **NOTED** paper IOTC-2022-WPEB18-INF21 on harnessing stakeholder knowledge for the collaborative development of mobulid bycatch mitigation strategies in tuna fisheries, including the following abstract provided by the authors:

> *"Manta and devil rays (Mobulids) face several immediate threats, including incidental capture in industrial tropical tuna fisheries. As a result, efforts have emerged to avoid or mitigate Mobulid bycatch in these fisheries. However, many mitigation efforts fail to incorporate fisher expertise from the outset, potentially leading to interventions that are not viable. Here, we combine survey and focus group data to synthesize knowledge of Mobulid bycatch and mitigation ideas in Eastern Pacific Ocean purse seine fisheries. Primary obstacles for mitigating Mobulid bycatch, according to respondents, are: (1) an inability to sight Mobulids before capture, (2) the lack of specific equipment on board, and (3) the difficulty of releasing large individuals; we suggest that the latter two can be addressed by simple operational modifications. We also find that Mobulids are most likely to be sighted by fishers after capture, suggesting that this is an important time in the fishing operation for bycatch mitigation interventions that ensure Mobulids survive capture. To address this, we share creative ideas brought by fishers for avoidance of Mobulids. This study provides a model of how to incorporate stakeholder input in the design of bycatch technology in large-scale fisheries and could inform similar efforts around the world."*

153. The WPEB **NOTED** the importance of obtaining post release survival data for mobulid species, but further **NOTED** that sample sizes are still small so **ENCOURAGED** further research on this issue.

154. The WPEB **NOTED** the ad hoc presentation IOTC-2022-WPEB18-INF24 providing an overview of the morphological data available on sharks at the IOTC Secretariat, including the following abstract provided by the authors:

> *"Morphometric data are instrumental to derive nominal landings (i.e., in live weight equivalent) from landings of dressed sharks, to estimate individual weights from length measurements, and to harmonise length measurement and derive size-frequency data sets for monitoring shark populations and assess their stock status. Firstly, we reviewed the published information on length-length and length-weight relationships for sharks occurring in the Indian Ocean. Secondly, we collated morphometric data from some CPCs (Sri Lanka, EU,Spain, EU,France and ex-USSR) to complement the data collected as part of the IOTC Regional Observer Scheme. We show the main bivariate relationships for the data available to illustrate their complementarity and the interest of managing a database of individual morphometric data at the Secretariat who would act as data custodian."*

155. The WPEB **NOTED** that the current IOTC reference relationships compiled in document IOTC-2022-WPEB18(AS)-DATA11 are mostly borrowed from other oceans and are largely incomplete and so should be updated with published information on Indian Ocean sharks.

156. The WPEB **NOTED** that the Secretariat is in the process of building a database of morphological data from around the Indian Ocean and **ENCOURAGED** CPCs to provide data to be included.

9.3 Marine Mammals

157. The WPEB **NOTED** paper IOTC-2022-WPEB18-24on bycatch of deep dwelling cetacean in gillnet fisheries of Pakistan, including the following abstract provided by the authors:

> *"Gillnet being deployed for catching tuna and tuna like species is known to be marred with high bycatch of non-target species including cetaceans. Studies have indicated that small cetaceans*

mainly dolphins frequently get entangled and die in gillnets that are placed on the surface of the sea. However, introduction of subsurface gillnetting (placing net 2 m below sea surface) led to major reduction in the entanglement of cetacean. This mode of gillnet operation was adopted by entire tuna gillnet fleet in Pakistan which eliminated mortality of cetaceans in Pakistan. Studies have, however, revealed that subsurface gillnetting is not effective against deep dwelling cetaceans. Species belonging to family Delphinidae (Risso's dolphin), Family Kogiidae (dwarf sperm whales and pygmy sperm whales) and Family Ziphiidae (Longman's beaked whale, Mesoplodon sp. And Cuvier's beaked whale) were reported to get entangled in gillnets placed on both surface and subsurface of sea. These deep dwelling species dive to deep sea (possibly deeper than 300 to 500 m) to feed mainly on meso- and bathypelagic cephalopods, fish and crustaceans. It seems that while surfacing, these cetaceans cannot avoid gillnet placed on surface or even subsurface. The study further revealed that entanglement of Risso's dolphin (Grampus griseus), dwarf sperm whales (Kogia sima) and pygmy sperm whale (Kogia breviceps) has an increasing trend since 2015 till 2019. Main entanglement of these species were observed during Pre-Southwest Monsoon Period (March and April) whereas limited entanglements were observed in other parts of the years. Study has further revealed that the entanglement of all deep dwelling cetaceans were more frequent between 1,000 and 2,000 m. The study also reports for the first-time entanglement and release of Longman's beaked whale Indopacetus pacificus, an unidentified species of Mesoplodon sp. And Cuvier's beaked whale (Ziphius cavirostris) in subsurface gillnets deployed along Pakistan coast. The study also suggests that Murray Ridge and continental slope along Indus Swatch seems to be hotspot of deep dwelling cetaceans."

158. The WPEB **NOTED** that while this study showed an increase in sightings of these cetaceans during the period of study, this is thought to be mainly as a result of an increase in the number of observers documenting the sightings.

159. The WPEB **NOTED** that this study did not provide any direct evidence of an increase in interactions between deep dwelling cetaceans and subsurface set gears.

160. The WPEB **NOTED** the need for a detailed cetacean survey to be conducted in the Arabian Sea for deep dwelling species inhabiting the area.

9.4 Seabirds

161. The WPEB **NOTED** paper IOTC-2022-WPEB18-25 on conservation Status of Albatrosses and Petrels and Advice on Reducing their Bycatch in IOTC 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. The need for international cooperation in addressing this concern was a major reason for establishing ACAP. 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. This paper provides a summary of the status and current trends of these 21 species as well as well as information on high priority populations that occur in the IOTC Area. We also provide an update on ACAP best practice bycatch mitigation advice for pelagic longline fisheries including a brief assessment of ACAP advice against the mitigation measures currently required by IOTC to identify options that would further reduce the bycatch of seabirds in IOTC longline fisheries. Finally, we highlight other resources relevant to seabird bycatch including new guidance on observer programme and electronic monitoring data collection."

162. The WPEB **NOTED** the updated conservation status and population trends of albatross and petrel species in the IOTC area, including priority populations of concern.

163. The WPEB **NOTED** that IOTC Resolution 12/06 varies from ACAP seabird bycatch mitigation advice in a number of ways. ACAP best practices advice has been updated to include additional seabird bycatch mitigation options including: the use of hook-shielding devices or an underwater bait setting device; the use of night setting, bird scaring line and branch line weighting simultaneously instead of the use of two of the three measures as stipulated in Resolution 12-06; and updates to the technical specifications in branch line weighting (current recommended minimum standards for branch line weighting configurations include 40 g or greater attached within 0.5 m of the hook; or 60 g or greater attached within 1 m of the hook; or 80 g or greater attached within 2 m of the hook).

164. The WPEB **NOTED** paper IOTC-2022-WPEB18-26 on a proposal to develop an IOTC seabird workplan, including the following abstract provided by the authors:

> *"The development and adoption of a seabird strategy and action plan is proposed. This strategy should be informed by relevant IOTC Resolutions and Recommendations to reduce levels of seabird bycatch across its fisheries, and the large volume of work presented at the Working Party on Ecosystems and Bycatch plus other relevant information. This will facilitate a strategic and coordinated approach to seabird bycatch management in IOTC convention area."*

165. The WPEB **NOTED** that the IOTC has recognised the need to consider seabird bycatch at a wider scale and has contributed to regional and global assessments in the past.

166. The WPEB **NOTED** the proposed multi-year seabird strategy and action plan to be developed to help guide and evaluate efforts to reduce seabird bycatch in IOTC fisheries which would establish a work plan (current and future), facilitate a link for ongoing and new research, monitor and evaluate the implementation of NPOAs for Seabirds by CPCs.

167. The WPEB **NOTED** that CCSBT is developing a multi-year seabird strategy that still needs to be approved by the CCSBT Commission and that the implementation of this strategy could be useful to guide and harmonise the efforts among tuna RFMOs to mitigate seabird bycatch, especially considering the strong overlap between CCSBT and IOTC areas.

168. The WPEB **NOTED** the need for the development of an IOTC-specific seabird strategy and **AGREED** to begin the discussion in the next two years, once the CCSBT multi-year seabird strategy is approved and started to be implemented.

Review of mitigation measures in Resolution 12/06

169. The WPEB **NOTED** paper IOTC-2022-WPEB18-INF18_rev1 on mitigation of seabird bycatch in longline pelagic fisheries: do current mitigation measures have an effect?, including the following abstract provided by the authors:

> *"Bycatch in industrial pelagic longline fleets has long been identified as a significant source of mortality and a conservation concern for many threatened seabird species. Despite recent efforts to develop and refine seabird bycatch mitigation measures in pelagic longline fisheries, the effect of these practices based on global observer information remains undescribed. Here we analyse about 15,800 longline sets and 36.4 million hooks observed during 583 trips aboard 132 pelagic longline vessels operating in the south Atlantic and southwestern Indian Oceans over a period of 15 years (2002-2016). Data were from the fleets of Brazil, Portugal, South Africa and Uruguay and include set-by-set information on two seabird bycatch mitigation measures,*

night setting and Tori line use, in addition to seabird bycatch data on species level. After exploring the importance of covariates related to fleet, area, time and environmental conditions with a random forest algorithm, we used general additive mixed modelling to interrogate the large-scale effect of the implementation of the two mitigation measures, over time, taking into account ancillary effects. There was a highly significant decrease in standardised BCPUE from period 1 (2002-2007) to period 2 (2008-2011) and a further reduction in period 3 (2012-2016), coinciding with the progressive implementation of the mitigation measures in the two relevant tuna Regional Fishery Management Organisations (RFMOs). Night-setting significantly reduced BCPUE, with a larger difference for albatross. Interestingly, BCPUE was higher when Tori lines were employed during the day. At night, Tori line further reduced bycatch but moon illumination significantly increases BCPUE, especially of petrels. The results indicate that if correctly applied, current mitigation practice is effective in reducing seabird bycatch under various conditions for a variety of fishing operations. As night setting proved to be effective under all conditions examined here, we recommend it to be mandatory within the combination of mitigation measures."

170. The WPEB **NOTED** that this research was an update of the paper IOTC–2019–WPEB15–INF13 and **ACKNOWLEDGED** that night-setting and bird scaring lines are effective in reducing seabird bycatch when they are correctly applied.

171. The WPEB **NOTED** the significant improvement in seabird bycatch between the periods selected in the study as a result of the increased use of mitigation measures.

172. The WPEB **NOTED** that large-scale studies under real fishing conditions may yield different or conflicting results from controlled experiments to determine the effectiveness of mitigation measures, as was observed for streamer lines in daylight longline sets. The WPEB **RECOGNISED** that this may be due to various reasons, including the incorrect application of mitigation measures on commercial fishing operations.

173. The WPEB **DISCUSSED** whether hook-shielding devices and the underwater bait setting device should be recommended for vessels fishing in areas overlapping with albatrosses and petrels as additional mitigation options to those listed in Resolution 12/06.

174. The WPEB **NOTED** that there could be practical issues related to implementing this mitigation measure in some vessels but **AGREED** that hook shielding devices and the underwater setting device could be included as different mitigation options to the simultaneous use of two of the three measures listed in Resolution 12/06.

175. The WPEB **NOTED** that wider-scale testing may be required for measures such as the hook-shielding devices to ensure that they are practical, cost-effective and effective for all fleets (using different equipment) **NOTING** that these might be feasible for some CPCs but not others. The WPEB **NOTED** that there is substantial evidence from other oceans that these mitigation measures are effective at reducing by-catch, however for some fleets these may be impractical/ too expensive and there may be operational reasons why they could not be used.

176. **NOTING** the effectiveness of hook-shielding devices in reducing seabird bycatch mortality in pelagic longlines and the fact that the WCPFC included the hook-shielding devices in 2018 as an optional measure to mitigate longline seabird bycatch, while also **NOTING** that the actual utilisation of this device in commercial fishing has been limited partially due to operational difficulty and cost efficiencies, the WPEB **RECOMMENDED** that the SC consider whether to include hook-shielding

devices as an additional option for seabird bycatch mitigation measures in Res. 12/06 and if so, to recommend to the Commission, accordingly.

9.5 Sea turtles

177. The WPEB **NOTED** paper IOTC-2022-WPEB18-28 on modelling the distribution of sea turtles in the Western Indian Ocean based on bycatch data from the French longline and purse seine fisheries, including the following abstract provided by the authors:

> *"Species Distribution Models (SDMs) are valuable predictive tools to anticipate bycatch risk in fisheries. Bycatch of sea turtles, which are of conservation concern worldwide, could negatively affect populations through direct mortality or decreased post-release fitness. With a better understanding of the environmental variables driving their distribution, one could provide successful bycatch mitigation strategies. However, this remains an important knowledge gap for sea turtles in the Western Indian Ocean. To address this, we used two modelling approaches, namely logistic regression and Random Forest, to identify and quantify the importance of 15 candidate environmental predictors for loggerhead (TTL), olive ridley (LKV), and green (TUG) turtles. Using on-board observer data from the French pelagic longline and purse seine fisheries, we show that sea surface height and the Dipole Mode Index could be important predictors of bycatch events for the three turtle species. Our results should prove useful to select appropriate environmental variables depending on the focal species to fit SDMs from bycatch data. Nevertheless, the modelling approaches used here have limitations that warrant consideration. We discuss those and provide recommendations for further improvement."*

178. The WPEB **NOTED** that presence and absence of sea turtles were analysed separately by longline and purse seine fisheries to consider the different life stages that are captured by each fishery.

179. The WPEB **NOTED** that only environmental predictors were used to model the distribution of sea turtles species and **ENCOURAGED** the use of other variables related to fishing operations.

180. The WPEB **NOTED** paper IOTC-2022-WPEB18-27: Draft Letter of Intent: Cooperation between the Indian Ocean Tuna Commission and the Memorandum of Understanding on the Conservation and Management of Marine Turtles and their Habitats of the Indian Ocean and South-East Asia.

181. The WPEB **NOTED** that the IOSEA has been collaborating with the IOTC for many years and the Letter of Intent is intended to formalise this collaboration. The WPEB **ACKNOWLEDGED** the Letter of Intent and **RECOMMENDED** that the letter is discussed at the SC.

10.WPEB Program of Work (Research and Priorities)

10.1 Revision of the WPEB Program of Work 2023-2027

182. The WPEB **NOTED** paper IOTC-2022-WPEB18-09: WPEB Program of Work 2023-2027 which provided the WPEB18 with the latest Program of Work (2023-2027) with an opportunity to consider and revise this by taking into account the specific requests of the Commission and Scientific Committee, given the current status of resources available to the IOTC Secretariat and CPCs.

183. The WPEB **RECOMMENDED** that the SC consider and endorse the WPEB Program of Work (2023–2027), as provided in Appendix XVII.

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

184. The WPEB **NOTED** that any invited experts for next year's meeting should have expertise in the priorities required for that meeting which include data poor stock assessments and indicators for

marine turtles. However, the WPEB **NOTED** that it is unlikely that a full stock assessment will be conducted in next year's meeting so a stock assessment expert may not be required.

11.Other Matters

11.1 Review of the draft, and adoption of the Report of the 18th Session of the WPEB

185. The WPEB **RECOMMENDED** that the Scientific Committee consider the consolidated set of recommendations arising from WPEB18, provided at Appendix XVIII, as well as the management advice provided in the draft resource stock status summary for each of the seven shark species, as well of those for marine turtles and seabirds:

Sharks

- Blue sharks (*Prionace glauca*) – Appendix VII
- Oceanic whitetip sharks (*Carcharhinus longimanus*) – Appendix VIII
- Scalloped hammerhead sharks (*Sphyrna lewini*) – Appendix IX
- Shortfin mako sharks (*Isurus oxyrinchus*) – Appendix X
- Silky sharks (*Carcharhinus falciformis*) – Appendix XI
- Bigeye thresher sharks (*Alopias superciliosus*) – Appendix XII
- Pelagic thresher sharks (*Alopias pelagicus*) – Appendix XIII

Other species/groups

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

186. The report of the 18th Session of the Working Party on Ecosystems and Bycatch (IOTC–2022–WPEB18–R) was **ADOPTED** by correspondence.

APPENDIX I
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APPENDIX II
AGENDA FOR THE 18TH WORKING PARTY ON ECOSYSTEMS AND BYCATCH ASSESSMENT MEETING

Date: 5 – 9 September 2022

Location: Microsoft Teams

Venue: Virtual

Time: 12:00 – 16:00 (Seychelles time)

Chair: Dr Mariana Tolotti (EU, France) **Vice-Chairs:** Dr 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**

   3.1. Outcomes of the 26th Sessions of the Commission (IOTC Secretariat)
   3.2. Outcomes of the 24th Session of the Scientific Committee (IOTC Secretariat)
   3.3. Review of the Conservation and Management Measures relevant to Ecosystems and Bycatch (IOTC Secretariat)
   3.4. Progress on the recommendations of WPEB17 (IOTC Secretariat)

4. **REVIEW OF THE DATA AVAILABLE AT THE SECRETARIAT FOR BYCATCH SPECIES** (IOTC Secretariat)

5. **REVIEW OF NATIONAL BYCATCH ISSUES IN IOTC MANAGED FISHERIES AND NATIONAL PLANS OF ACTION** (sharks; seabirds; marine turtles) (CPCs and IOTC Secretariat)

   5.1. Updated status of development and implementation of NPOA for seabirds and sharks, and the implementation of the FAO guidelines to reduce marine turtle mortality in fishing operations (CPCs)
   5.2. Species identification tools

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

   6.1. Presentation of new information available on sharks (all)
   6.2. Shark research plans (all)

7. **STOCK ASSESSMENT AND INDICATORS FOR SHARKS**

   7.1. Review of indicators(all)
      - Scalloped hammerhead
      - Oceanic whitetip
      - Pelagic thresher
      - Bigeye thresher
      - Other species
   7.2. Stock assessment model for scalloped hammerhead shark (all)

7.3. Review of the proposed stock assessment of scalloped hammerhead shark (IOTC Secretariat)
7.4. Recommendation and executive summaries (all)

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

8.1. Review new information on the environment and ecosystem interactions and modelling, including climate change issues affecting pelagic ecosystems in the IOTC area of responsibility (all)
- Ecosystems and climate
- Impact of gears
- Report on the gillnet bycatch mitigation workshop
- Report on the Second ecoregions workshop

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

9.1. All bycatch species (all)
9.2. Other sharks and rays (all)
9.3. Marine mammals (all)
- Review new information on marine mammal biology, ecology, fisheries interactions and bycatch mitigation measures (all);

9.4. Seabirds (all)
- Review new information on seabird biology, ecology, fisheries interactions and bycatch mitigation measures (all)
- Review of mitigation measures in Resolution 12/06

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

10. WPEB PROGRAM OF WORK (RESEARCH AND PRIORITIES)

10.1. Revision of the WPEB Program of Work 2023-2027 (Chairperson and IOTC Secretariat)
10.2. Development of priorities for an Invited Expert at the next WPEB meeting (Chairperson)

11. OTHER MATTERS (Chair)

11.1. Review of the draft, and adoption of the Report of the 18th Session of the Working Party on Ecosystems and Bycatch (Chairperson)

APPENDIX III
LIST OF DOCUMENTS

Document	Title
IOTC-2022-WPEB18-01a	Agenda of the 18th Working Party on Ecosystems and Bycatch
IOTC-2022-WPEB18-01b	Annotated agenda of the 18th Working Party on Ecosystems and Bycatch Assessment Meeting
IOTC-2022-WPEB18-02	List of documents of the 18th Working Party on Ecosystems and Bycatch Assessment Meeting
IOTC-2022-WPEB18-03	Outcomes of the 24th Session of the Scientific Committee (IOTC Secretariat)
IOTC-2022-WPEB18-04	Outcomes of the 26th Session of the Commission (IOTC Secretariat)
IOTC-2022-WPEB18-05	Review of Conservation and Management Measures relevant to ecosystems and bycatch (IOTC Secretariat)
IOTC-2022-WPEB18-06	Progress made on the recommendations and requests of WPEB17 and SC24 (IOTC Secretariat)
IOTC-2022-WPEB18-07	Review of the statistical data and fishery trends for ecosystems and bycatch species (IOTC Secretariat)
IOTC-2022-WPEB18-08	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-2022-WPEB18-09	Revision of the WPEB Program of Work (2023–2027) (IOTC Secretariat & Chairperson)
IOTC-2022-WPEB18-10	South Africa NPOA Sharks II 2022 (C. da Silva)
IOTC-2022-WPEB18-11	Length-Weight relationships for several large pelagic sharks from the Indian Ocean (A. Ramos-Cartelle, B. García-Cortés, J. Mejuto, I. González-González, A. Carroceda and J. Fernández-Costa)
IOTC-2022-WPEB18-12	Species composition, commercial landings, distribution and some aspects of biology of shark (Class Pisces) of Pakistan: pelagic sharks (M. Moazzam and H. B. Osmany)
IOTC-2022-WPEB18-13	Biological information for most commonly shark and ray species (Seret B., F. J. Abascal, J. Amande, J. Ariz, P. Bach, P. Chavance, R. Coelho, M. Korta, F. Poisson, M. N. Santos, and H. Murua)
IOTC-2022-WPEB18-14	Status of marine sharks and rays in Southeast Asia (N. Clark-Shen)
IOTC-2022-WPEB18-15	Semi-quantitative risk assessment of Chondrichthyan species from coastal Kenya using Productivity and Susceptibility Analysis (PSA) (B. K. Kiilu, B, Fulanda, E. Kimani, G. Okemwa, L. Menya, R. Oddenyo, E. Mueni, P. Musembi, G. Nduku, J. Musembei, M. Okeri)
IOTC-2022-WPEB18-16	Scalloped hammerhead (Sphyrna lewini): An important bycatch of in gillnet fisheries of Pakistan (M. Moazzam)
IOTC-2022-WPEB18-17	Bycatch of hammerhead sharks caught by the French pelagic longline and purse seine fisheries in the Indian Ocean (2005-2021) (P. Sabarros, E. Romanov, E. Mollier and P. Bach)
IOTC-2022-WPEB18-18	Preliminary recovery plan for scalloped hammerhead in the Indian Ocean (C. Rigby)
IOTC-2022-WPEB18-19	Update on the CPUE standardization of the blue shark caught by the Taiwanese large-scale tuna longline fishery in the Indian Ocean (X. H. Wu and W. P. Tsai)
IOTC-2022-WPEB18-20	Update on the CPUE standardization of the shortfin mako shark caught by the Taiwanese large-scale tuna longline fishery in the Indian Ocean (X. H. Wu and W. P. Tsai)
IOTC-2022-WPEB18-21	A preliminary stock assessment of Scalloped hammerhead shark in the Indian Ocean (Z. Geng)
IOTC-2022-WPEB18-22	Second IOTC Ecoregion Workshop: identification of regions in the IOTC convention area to inform the implementation of the ecosystem approach to fisheries management (M. J. Juan Jordá, A. E. Nieblas, H. Murua, E. Chassot, P. de Bruyn, D. Hayes, F. Marsac, U. Shahid, P. Thoya, S. Tsuji, E. Andonegi, M. Green, T. Kitakado, L. Nelson, M. Khan, L. Ramos Alonso, J. Moss, L. Lopetegui, Z. Hoque, L. Pierre, A. Sheikh)
IOTC-2022-WPEB18-23	An update on best practices onboard French and Italian tropical tuna purse seiners of the Atlantic and Indian Oceans: outcomes and ongoing projects (G. Wain, A. Maufroy and M. Goujon)
IOTC-2022-WPEB18-24	Bycatch of deep dwelling cetacean in gillnet fisheries of Pakistan (M. Moazzam)
IOTC-2022-WPEB18-25	Conservation Status of Albatrosses and Petrels and Advice on Reducing their Bycatch in IOTC Longline Fisheries (S. Jimenez)
IOTC-2022-WPEB18-26	Proposal to develop an IOTC seabird workplan (D. Gianuca)
IOTC-2022-WPEB18-27	Draft Letter of Intent: Cooperation between the Indian Ocean Tuna Commission and the Memorandum of Understanding on the Conservation and Management of Marine Turtles and their Habitats of the Indian Ocean and South-East Asia (IOSEA)

Document	Title
IOTC-2022-WPEB18-28	Modelling the distribution of sea turtles in the Western Indian Ocean based on bycatch data from the French longline and purse seine fisheries (J. Monsinjon, P. Sabarros, P. Bach, J. Bourjea and S. Bonhommeau)
IOTC-2022-WPEB18-29	Silky shark bycatch in purse Seine fisheries with dFADs exploring differences between fisheries and overall impact estimates (I. Ziegler)
IOTC-2022-WPEB18-30	Fishing, sizes and sex-ratios of blue shark and silky shark caught by Indonesian tuna longline in the eastern Indian Ocean (D. Novianto, B. Setyadji, A. Wujdi, R. Yuneni and A. Mustofa)
Information papers	
IOTC-2022-WPEB18-INF01	Sharks caught in the protective gillnets off KZN South Africa. 10. The dusky shark *Carcharhinus obscurus* (Leseur 1818) (S. F. J. Dudley, G. Cliff, M. P. Zungu and M. J. Smale)
IOTC-2022-WPEB18-INF02	Sharks caught in the protective gillnets off KZN South Africa. 8. The great hammerhead shark *Sphyrna mokarran* (Rüppell) (G. Cliff)
IOTC-2022-WPEB18-INF03	Sharks caught in the protective gillnets off KZN South Africa. 11. The scalloped hammerhead shark *Sphyrna lewini* (Griffith and Smith) (P. de Bruyn, S. F. J. Dudley, G. Cliff and M. J. Smale)
IOTC-2022-WPEB18-INF04	Sharks caught in the protective gillnets off KZN South Africa. 9. The spinner shark *Carcharhinus brevipinna* (Müller and Henle) (B. R. Allen and G. Cliff)
IOTC-2022-WPEB18-INF05	Spatio-Temporal Distribution of Juvenile Oceanic Whitetip Shark Incidental Catch in the Western Indian Ocean (L. Lopetegui-Eguren, J. J. Poos, H. Arrizabalaga, G. L. Guirhem, H. Murua, N. Lezama-Ochoa, S. P. Griffiths, J. R. Gondra, P. S. Sabarros, J. C. Báez and M. J. Juan-Jordá)
IOTC-2022-WPEB18-INF06	M-Risk: A framework for assessing global fisheries management efficacy of sharks, rays, and chimaeras (C. S. Sherman, G. Sant, C. A. Simpfendorfer, E. D. Digel, P. Zubick, G. Johnson, M. Usher, N. K. Dulvy)
IOTC-2022-WPEB18-INF11	Report of the multi-taxa gillnet bycatch mitigation workshop
IOTC-2022-WPEB18-INF12	Unintended effects of single-species fisheries management (M. Tolotti, P. Guillotreau, F. Forget, M. Capello, L. Dagorn)
IOTC-2022-WPEB18-INF13	Predicting bycatch hotspots in tropical tuna purse seine fisheries at the basin scale (L. Mannocci, F. Forget, M. Tolotti, P. Bach, N. Bez, H. Demarcq, D. Kaplan, P. Sabarros, M. Simier, M. Capello, L. Dagorn)
IOTC-2022-WPEB18-INF14	Pre-workshop analysis in preparation for the 2022 IOTC Ecoregions Workshop: “Identification of regions in the IOTC convention area to inform the implementation of the ecosystem approach to fisheries management” (A. E. Nieblas, H. Murua, P. De Bruyn, E. Chassot, F. Fiorellato, M. J. Juan Jordá)
IOTC-2022-WPEB18-INF15	High bycatch rates of manta and devil rays in the ‘small-scale’ artisanal fisheries of Sri Lanka (D. Fernando and J. D. Stewart)
IOTC-2022-WPEB18-INF16	Squid fishing in the northwest Indian Ocean – clear as ink (M. T. Trygg)
IOTC-2022-WPEB18-INF17	Guide d’identification des espèces capturées dans les pêcheries tropicales (P. Sabarros, F. Moussy and E. Mollier)
IOTC-2022-WPEB18-INF18	Towards mitigation of seabird bycatch in longline pelagic fisheries: do current mitigation measures have an effect? (S. Jiménez, A. Domingo, H. Winker, D. Parker, D. Gianuca, T. Neves, R. Coelho, S. Kerwath)
IOTC-2022-WPEB18-INF19	A decision support tool for integrated fisheries bycatch management (E. Gilman, M. Hall, H. Booth, T. Gupta, M. Chaloupka, H. Fennell, M. J. Kaiser, D. Karnad, E. J. Milner-Gulland)
IOTC-2022-WPEB18-INF20	Sightings of whales in the Northern Arabian Sea along the coast of Pakistan in 2021 (M. Moazzam and R. Nawaz)
IOTC-2022-WPEB18-INF21	Harnessing stakeholder knowledge for the collaborative development of mobulid bycatch mitigation strategies in tuna fisheries (M. R. Cronin, D. A. Croll, M. A. Hall, N. Lezama-Ochoa, J. Lopez, H. Murua, J. Murua, V. Restrepo, S. Rojas-Perea, J. D. Stewart, J. L. Waldo and G. Moreno)
IOTC-2022-WPEB18-INF22	An update on the recent developments of the IOTC Post-Release Mortality project for the bigeye thresher shark (BTH) (E. Romanov)
IOTC-2022-WPEB18-INF23	Regional workshop on shark conservation and management in the North Indian Ocean (WWF Pakistan)

Document	Title
IOTC-2022-WPEB18-INF24	An overview of morphological data available on sharks at the IOTC Secretariat (Secretariat)

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

Extract from IOTC–2022–WPEB18–07.
(Appendix references in this Appendix, refer only to those contained in this appendix)

Overall bycatch levels & trends

Nominal catches of all species caught by Indian Ocean fisheries reported to the Secretariat have been increasing over time, with a particularly dramatic increase in the amount of tuna catches reported between the 1980s and the mid-2000s, followed by a sudden decrease due to piracy threats and by a new sharp increase in more recent years (**Figure A 1**). In 2020, the total nominal catches of all IOTC and non-IOTC (bycatch) species were 1,877,379 t and 213,482 t, respectively.

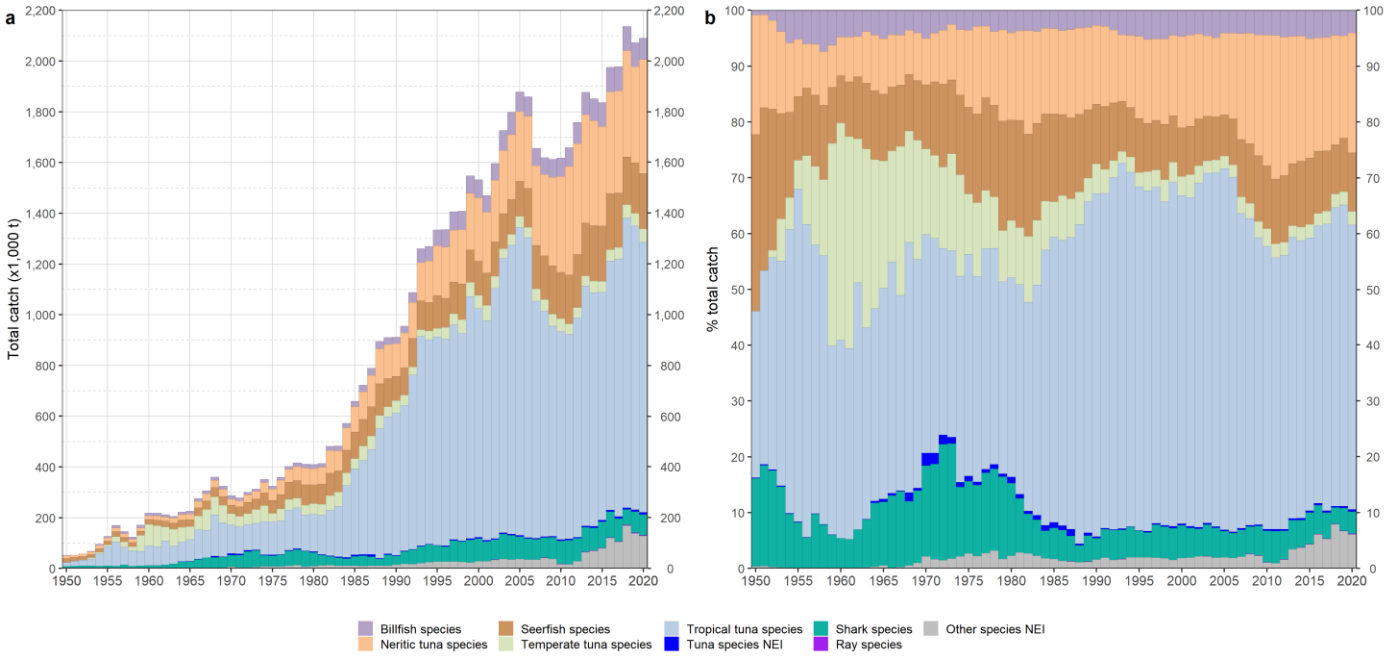

Figure A 1: Annual time series of cumulative nominal absolute (a) and relative (b) catches (metric tons; t) of all IOTC tuna and tuna-like species by species category for the period 1950-2020

Reported nominal catches of species of interest to the WPEB are largely dominated by sharks with estimates from some artisanal fisheries dating back to the early 1950s (**Figure A 2**). Overall levels and quality of reported catches of shark and ray species have increased over time due to the development and expansion of tuna and tuna-like fisheries across the Indian Ocean, the increased reporting requirements for some sensitive species such as thresher and oceanic whitetip sharks, and the implementation of retention bans in some fisheries. In 2020, the total nominal catches of sharks reported to the Secretariat amounted to 82,396 t, with rays representing a very small component of the reported bycatch at 1,860 t, i.e., about 2.2% of total reported shark and ray catches in 2020 (**Figure A 2**).

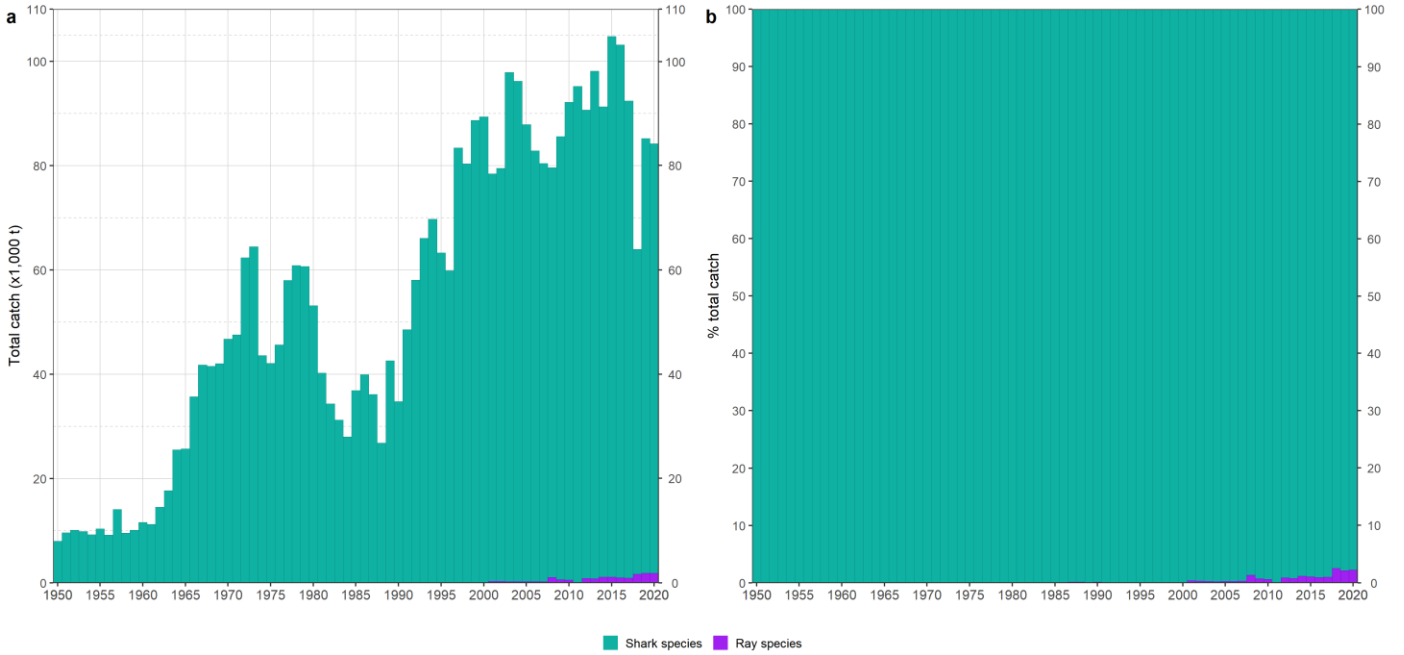

Figure A 2: Annual time series of cumulative nominal absolute (a) and relative (b) catches (metric tons; t) of shark and ray species by species category for the period 1950-2020

Very few fleets reported catches of sharks and rays in the 1950s, but the number of reporting fleets has increased over time (**Figure A 3**). Total reported catches of sharks and rays have also increased over time, reaching a peak of over 100,000 t in 2015-2016. Since then, nominal catches have decreased by 20% to about 80,000 t in 2020.

In 2018, reported catches of sharks and rays declined significantly when compared with 2017 and 2019 levels, mostly due to a complete disappearance of reported catches of aggregated shark species 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 real reduction in catch levels. Furthermore, revisions to Pakistani gillnet catches from 1987 onwards (endorsed by the SC in December 2019) introduced a mean annual decrease of around 17,000 t in total catches of shark species during the concerned period when compared to previously available official data reported by the country.

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

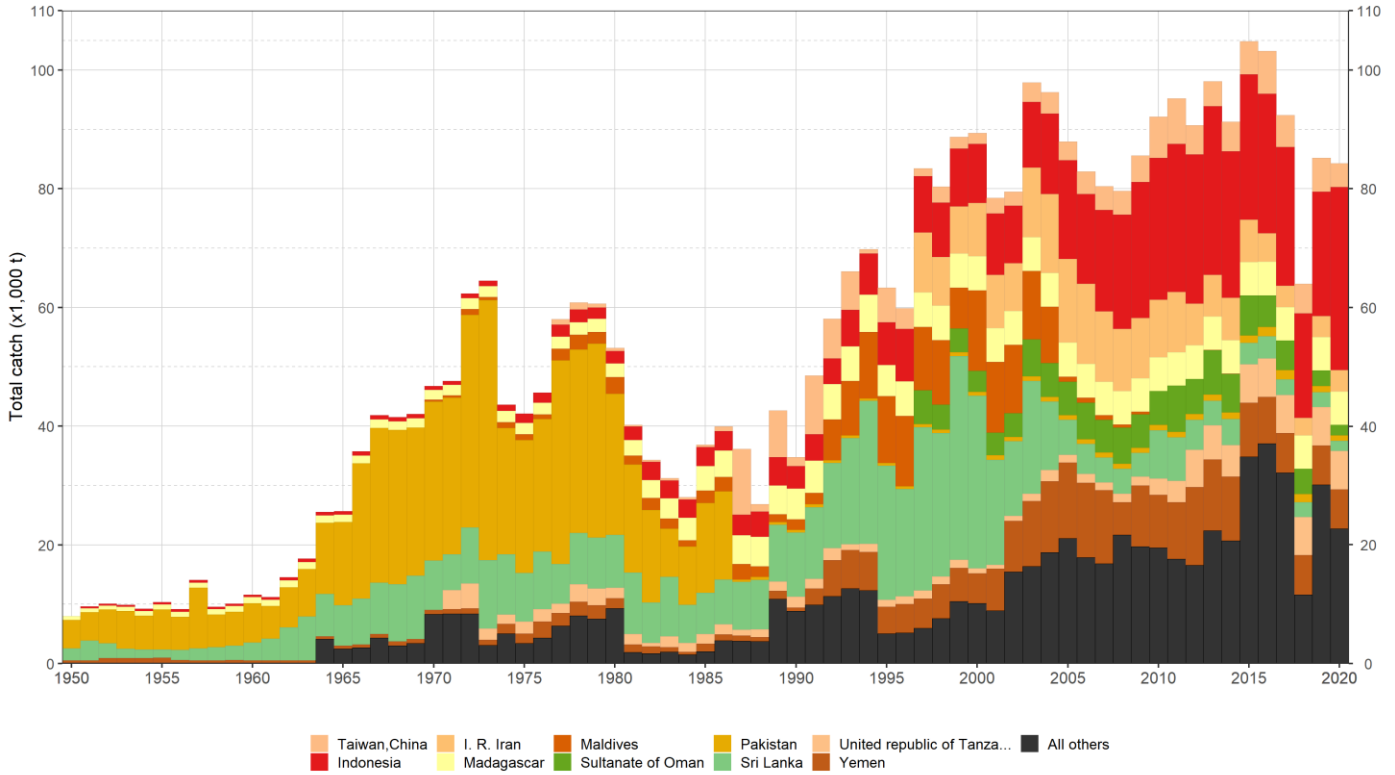

Figure A 3: Annual time series of nominal catches (metric tons; t) of sharks and rays by fleet during 1950-2020

Sharks and rays

Levels of reported nominal 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 nominal catches and are currently responsible for almost 40% of reported catches of the species, followed by lines (handlines, coastal longlines and troll lines), which doubled the catches in the last two decades and currently represent around 49.5% of the reported 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 catch levels reported for the species (**Figure A 4**).

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

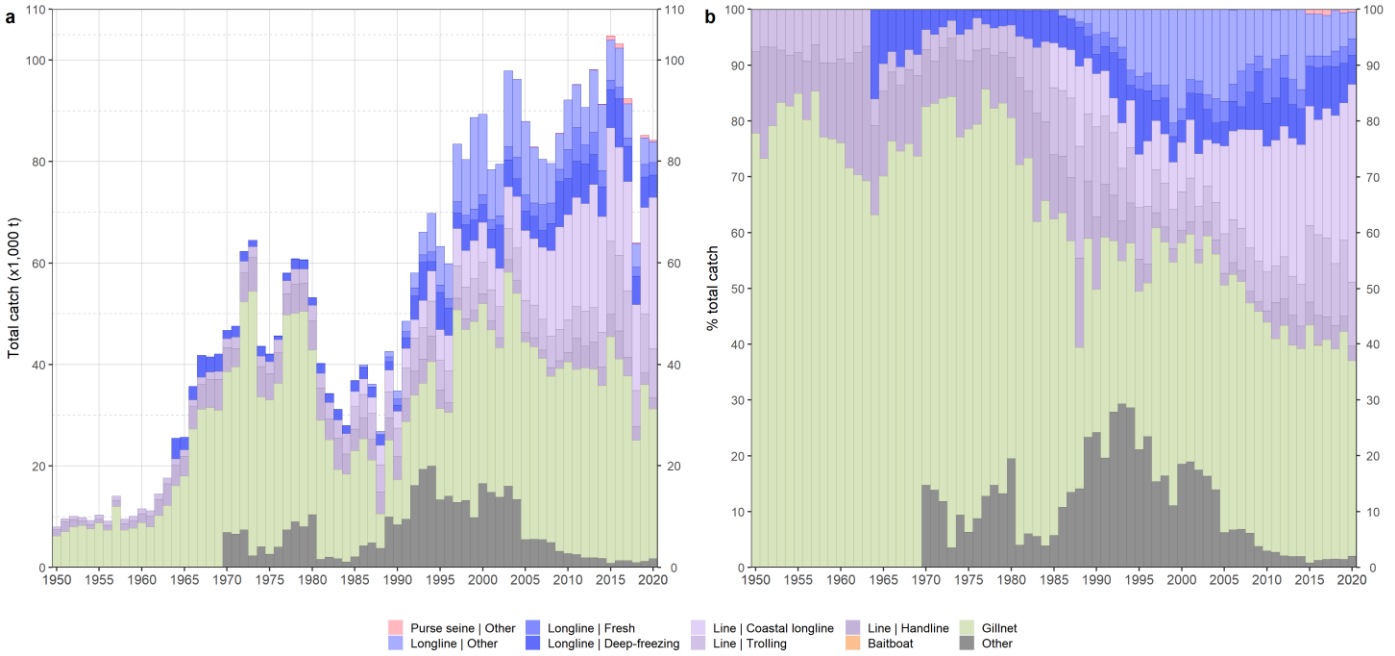

Figure A 4: Annual time series of nominal absolute (a) and relative (b) catches (metric tons; t) of sharks and rays by fishery for the period 1950-2020. 'Other' corresponds to all other fisheries combined

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

Other bycatch species categories

The reporting of non-IOTC species other than sharks is extremely poor and where it does occur, this is often in the form of patchy information which is not submitted according to IOTC data reporting procedures, is non-standardized and often lacking in clarity. Formal submissions of data in an electronic and standardized format using the available IOTC templates, in combination with observer data reported in the context of the ROS programme, will considerably improve the quality of data obtained and the type of regional analyses that these data can be used for.

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

Extract from IOTC–2022–WPEB18–07

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 (1950-2019)). 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 (2012-2020);
  - **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 (2014-2020) 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

2022: STATUS OF DEVELOPMENT AND IMPLEMENTATION OF NATIONAL PLANS OF ACTION FOR SEABIRDS AND SHARKS, AND IMPLEMENTATION OF THE FAO GUIDELINES TO REDUCE MARINE TURTLE MORTALITY IN FISHING OPERATIONS

(*updated September 2022*)

CPC	Sharks	Date of Implementation	Seabirds	Date of implementation	Marine turtles	Date of implementation	Comments
MEMBERS							
Australia		1st: April 2004 2nd: July 2012		1st: 1998 2nd: 2006 3rd: 2014 NPOA in 2018.		2003	**Sharks:** 2nd NPOA-Sharks (Shark-plan 2) was released in July 2012, along with an operational strategy for implementation: http://www.daff.gov.au/fisheries/environment/sharks/sharkplan2 **Seabirds:** Has implemented a Threat Abatement Plan [TAP] for the Incidental Catch (or Bycatch) of Seabirds During Oceanic Longline Fishing Operations since 1998. The present TAP took effect from 2014 and largely fulfilled the role of an NPOA in terms of longline fisheries. http://www.antarctica.gov.au/__data/assets/pdf_file/0017/21509/Threat-Abatement-Plan-2014.pdf. In 2018 Australia finalised, an NPOA to address the potential risk posed to seabirds by other fishing methods, including longline fishing in state and territory waters, which are not covered by the current threat abatement plan. **Marine turtles:** Australia's current marine turtle bycatch management and mitigation measures fulfil Australia's obligations under the FAO-Sea turtles Guidelines.
Bangladesh							**Sharks:** Bangladesh has drafted a NPOA for shark and rays which is now in the process of being finalised and approved by the relevant ministries. The Wildlife Conservation and Security Act introduced in 2012 lays out general rules on requirements for hunting wild animals but no specific mention of sharks. The Wildlife Conservation and Security Act was introduced in 2012 states: No person shall hunt any wild animal without license, or import or export any wild animal without a CITES certificate **Seabirds:** Bangladesh currently do not have a NPOA for seabirds. The Wildlife Conservation and Security Act introduced in 2012 lays out general rules on permits required to hunt wild animals but no specific mention of seabirds **Marine turtles:** Bangladesh currently have no information on their implementation of FAO guidelines on sea turtles. The Wildlife Conservation and Security Act introduced in 2012 lays out general rules on requirements for hunting wild animals but no specific mention of turtles

China		–		–			**Sharks:** China is currently considering developing an NPOA for sharks. Regulations relating to the conservation of sharks managed by RFMOs has been updated. **Seabirds:** China is currently considering developing an NPOA for seabirds. Regulations relating to the conservation of seabirds managed by RFMOs has been updated. **Marine turtles:** No information received by the Secretariat.
–Taiwan,China		1st: May 2006 2nd: May 2012		1st: May 2006 2nd: Jul 2014			**Sharks:** No revision currently planned. **Seabirds:** No revision currently planned. **Marine turtles:** Wildlife Protection Act introduced in 2013, Protected Wildlife shall not be disturbed, abused, hunted, killed, traded, exhibited, displayed, owned, imported, exported, raised or bred, unless under special circumstances recognized in this or related legislation. *Cheloniidae spp*., *Caretta*, *Chelonia mydas*, *Eretmochelys imbricata, Lepidochelys olivacea* and *Dermochelys coriacea* are listed into List of Protected Species. Domestic Fisheries Management Regulation on Far Sea Fisheries request all fishing vessels must carry line cutters, de-hookers and hauling nets in order to facilitate the appropriate handling and prompt release of marine turtles caught or entangled.
Comoros		–		–			**Sharks:** No NPOA has been developed. Shark fishing is prohibited but measures are difficult to enforce due to the artisanal nature of the fisheries. A campaign to raise awareness of measures is being implemented to improve compliance. Shark catches and size frequency data are submitted to IOTC **Seabirds:** No NPOA has been developed. There is no fleet in operation south of 25 degrees south and no long-line fleet. The main fishery is artisanal operating within 24 miles of the coast where there is low risk of interactions with seabirds. **Marine turtles:** According to the Comoros Fisheries Code Article 78, fishing, capture, possession and marketing of turtle and marine mammals or of protected aquatic organisms is strictly forbidden in accordance with national legislation in force and International Conventions applicable to the Comoros.
Eritrea							**Sharks:** No information received by the Secretariat. **Seabirds:** No information received by the Secretariat. **Marine turtles:** No information received by the Secretariat.
European Union		5 Feb 2009		16-Nov-2012		2007	**Sharks:** Approved on 05-Feb-2009 and it is currently being implemented. **Seabirds:** The EU adopted on Friday 16 November 2012 an Action Plan to address the problem of incidental catches of seabirds in fishing gears. **Marine turtles**: European Union Council Regulation (EC) No 520/2007 of 7 May 2007 lay down technical measures for the conservation of marine turtles including articles and provisions to reduce marine turtle bycatch. The regulation urges Member States to do their utmost to reduce the impact of fishing on sea turtles, in particular by applying the measures provided for in paragraphs 2, 3 and 4 of the resolution.

France (territories)		2009		2009, 2011		2015	**Sharks:** approved on 05-Feb-2009. **Seabirds:** Implemented in 2009 and 2011. 2009 for Barrau's petrel and 2019 for Amsterdam albatross which will be in force from 2018-2027. **Marine turtles:** Implemented in 2015 for the five species of marine turtles that are present in the southwest Indian Ocean for the period2015-2020. This is still being applied and currently is under evaluation in view of its renewal.
India							**Sharks:** In preparation. In June 2015, India published a document entitled "Guidance on National Plan of Action for Sharks in India" which is intended as a guidance to the NPOA-Sharks, and seeks to (1) present an overview of the currents status of India's shark fishery, (2) assess the current management measures and their effectiveness, (3) identify the knowledge gaps that need to be addressed in NPOA-Sharks and (4) suggest a theme-based action plan for NPOA-Sharks. **Seabirds:** India has determined that seabird interactions are not a problem for their fleets. However, a formal evaluation has not yet taken place which the WPEB and SC require. **Marine turtles:** No information received by the Secretariat.
Indonesia		–		–			**Sharks:** Indonesia first drafted a NPOA in 2010 then later developed a revised NPOA for sharks and rays for the period 2016-2020. Indonesia is in the process of revising the latest version of the shark NPOA. Indonesia has also established a national plan of action for whale sharks from 2021-2025 through Ministerial Decree No. 16 of 2021. **Seabirds:** An NPOA was finalized in 2016 **Marine turtles:** Indonesia has established an NPOA for Marine Turtles but this does not fully conform with FAO guidelines. Indonesia has also been implementing Ministerial Regulations 12/2012 and 30/2012 regarding capture fishing business on high seas to reduce turtle bycatch. Indonesia is also cooperating with Coral Triangle countries including Malaysia, the Philippines, the Solomon Islands, Papua New Guinea, and Timor Leste through Coral Triangle Initiatives on Coral Reefs, Fish, and Food Security (CTI CFF) platform to protect threatened migratory species, including marine turtles. The CTI CFF is now developing a regional plan of action (RPOA) 2020-2030 and areas of critical habitats, such as migratory corridors, nesting beaches, and Inter-nesting and feeding areas, have been identified.
Iran, Islamic Republic of		–		–		–	**Sharks:** Have communicated to all fishing cooperatives the IOTC resolutions on sharks. Have in place a ban on the retention of live sharks. **Seabirds:** I.R. Iran determined that seabird interactions are not a problem for their fleet as they consist of gillnet vessels only. i.e. no longline vessels. **Marine turtles:** No information received by the Secretariat.
Japan		03-Dec-2009, 2016		03-Dec-2009, 2016			**Sharks:** NPOA–Shark assessment implementation report submitted to COFI in July 2012 (Revised in 2016) **Seabirds:** NPOA–Seabird implementation report submitted to COFI in July 2012 (Revised in 2016). **Marine turtles:** All Japanese fleets fully implement Resolution 12/04.

Kenya			n.a.	–			**Sharks:** A National Plan of Action for sharks is being developed and shall put in place a framework to ensure the conservation and management of sharks and their long-term sustainable use in Kenya. A draft has been developed and preliminary meetings have been held. **Seabirds:** Kenya does not have any flagged longline vessels on its registry. There is no evidence of any gear seabird interaction with the current fishing fleet. Kenya plans to develop a NPOA for seabirds after the NPOA Sharks has been finalised. **Marine turtles:** The Kenyan fisheries law prohibits retention and landing of turtles caught incidentally in fishing operations. Public awareness efforts are conducted for artisanal gillnet and artisanal longline fishing fleets on the mitigations measures that enhance marine turtle conservation. Kenya plans to develop a NPOA for turtles after the NPOA Sharks has been finalised.
Korea, Republic of		08-Aug-11		2019		–	**Sharks:** Currently being implemented. **Seabirds:** NPOA seabirds was submitted to FAO in 2019. **Marine turtles:** All Rep. of Korea vessels fully implement Res 12/04.
Madagascar		–		–			**Sharks:** Madagascar has developed a NPOA for sharks which is awaiting final ministerial approval. **Seabirds:** Development has not begun. Note: A fisheries monitoring system is in place in order to ensure compliance by vessels with the IOTC's shark and seabird conservation and management measures. **Marine turtles:** There is zero capture of marine turtle recorded in logbooks. All longliners use circle hooks. This has been confirmed by onboard observers and port samplers.

Malaysia		2008 2014		–		2008	**Sharks:** A revised NPOA-sharks was published in 2014. **Seabirds:** To be developed **Marine turtles:** A NPOA For Conservation and Management of Sea Turtles had been published in 2008. A revision will be published in 2017.
Maldives, Republic of		Apr 2015	n.a.	–			**Sharks:** Maldives has developed the NPOA-Sharks with the assistance of Bay of Bengal Large Marine Ecosystem (BoBLME) Project. The final NPOA was published in 2015. The longline logbooks ensure the collection of shark bycatch data to genus level. Maldives would be reporting on shark bycatch to the appropriate technical Working Party meetings of IOTC. **Seabirds:** Maldives is in the final stages of developing an action plan on seabird nesting sites. Article 12 of IPOA states that if a 'problem exists' CPCs adopt an NPOA. IOTC Resolution 05/09 suggests CPCs to report on seabirds to the IOTC Scientific Committee if the issue is appropriate'. Maldives considers that seabirds are not an issue in the Maldives fisheries, both in the pole-and-line fishery and in the longline fishery. The new longline fishing regulations has provision on mitigation measures on seabird bycatch. **Marine turtles:** Standards of code and conduct for managing sea turtles have been developed by the Environmental Protection Agency in the drafted National sea turtle management plan under the protected species regulation. Longline regulation has provisions to reduce marine turtle bycatch. The regulation urges longline vessels to have dehookers for removal of hook and a line cutter on board, to release the caught marine turtles as prescribed in Resolution 12/04.
Mauritius		2016					**Sharks:** The NPOA-sharks has been finalised; it focuses on actions needed to exercise influence on foreign fishing through the IOTC process and licence conditions, as well as improving the national legislation and the skills and data handling systems available for managing sharks. **Seabirds:** Mauritius does not have national vessels operating beyond 25^0S. However, fishing companies have been requested to implement all mitigation measures as provided in the IOTC Resolutions. **Marine turtles:** Marine turtles are protected by the national law. Fishing companies have been **requested** to carry line cutters and de-hookers in order to facilitate the appropriate handling and prompt release of marine turtles caught or entangled.
Mozambique		–		–			**Sharks**: Drafting of the NPOA-Shark started in 2016. At this stage, a baseline assessment was performed and the relevant information of coastal, pelagic and demersal shark species along the Mozambican coast was gathered. The ongoing process is expected to be completed by the end of 2018. **Seabirds**: Mozambique is regularly briefing the Masters of their fishing vessels on the mandatory requirement to report any seabird interaction with longliner fleet. **Marine turtles**: see above.

Oman, Sultanate of							**Sharks:** The drafting of an NPOA-sharks started in 2017 but has not yet been finalised. **Seabirds:** Not yet initiated. **Marine turtles:** The law does not allow the catch of sea turtles, and the fishermen are requested to release any hooked or entangled turtle. The longline fleet are required to carry out the line cutters and de-hookers.
Pakistan							**Sharks:** A stakeholder consultation workshop was conducted in 2016 to review the actions of the draft NPOA – Sharks. The final version of the NPOA – Sharks has been submitted to the provincial fisheries departments for endorsement but has not yet been finalised. Meanwhile, the provincial fisheries departments have passed notification on catch, trade and/or retention of sharks including Thresher sharks, hammerheads, oceanic whitetip, whale sharks, guitarfishes, sawfishes, wedgefishes and mobulids. Sharks are landed with the fins attached and each and every part of the body of sharks are utilised. **Seabirds:** Pakistan considers that seabird interactions are not a problem for the Pakistani fishing fleet as the tuna fishing operations do not include longline vessels. **Marine turtles:** Pakistan has already framed Regulations regarding the prohibition of catching and retaining marine turtles. As regards to the reduction of marine turtle bycatch by gillnetters; presently Marine Fisheries Department (MFD) in collaboration with International Union for Conservation of Nature (IUCN) Pakistan, is undertaking an assessment. Stakeholder Coordination Committee Meeting was conducted on 10th September 2014. The "Turtle Assessment Report (TAR)" will be finalized by February 2015 and necessary guidelines / action plan will be finalized by June 2015. As per clause-5 I of Pakistan Fish Inspection & Quality Control Act, 1997, "Aquatic turtles, tortoises, snakes, mammals including dugongs, dolphins, porpoises and whales etc" are totally forbidden for export and domestic consumption. Pakistan is also in the process of drafting a NPOA for cetaceans.
Philippines		Sept. 2009		–			**Sharks:** A NPOA sharks was published in 2009 and this document is under periodic review. **Seabirds:** Development has not begun. **Marine turtles:** No information received by the Secretariat.
Seychelles, Republic of		Apr-2007 2016		–			**Sharks:** Seychelles has developed and is implementing a new NPOA for Sharks for years 2016-2020 **Seabirds:** SFA is collaborating with Birdlife South Africa to develop an NPOA for sea bird. A consultant will be recruited to start development in December 2017 **Marine turtles:** An NPOA for turtles is planned to start in 2018.

Somalia							**Sharks:** Somalia is currently revising its fisheries legislation (current one being from 1985) and has completed the necessary steps for required for the consultative process to begin in order to develop these NPOA. **Seabirds:** See above. **Marine turtles:** The Somali national fisheries law and legislation was reviewed and approved in 2014. This includes Articles on the protection of marine turtles. Further review of the National Law is underway to harmonize this with IOTC Resolutions and is expected to be presented to the new parliament for endorsement in 2017.
South Africa, Republic of		2013 2022		2008			**Sharks**: The NPOA-sharks was first approved and published in 2013. A revised version of the document was finalised in 2022 following extensive review including input from the research community and affected stakeholders. **Seabirds**: The NPOA seabirds was published in August 2008 and fully implemented. The NPOA is in the process being updated in 2022. **Marine turtles**: A report from 2019 on the implementation of FAO guidelines to reduce marine turtle mortality has been provided to the IOTC. Bycatch in South African fisheries is considered to be very low. The South African permit conditions for the large pelagic longline fishery prohibits landing of turtles. All interactions with turtles are recorded, by species, within logbooks and in observer reports, including data on release condition. Vessels are required to carry a de-hooker on board and instructions on turtle handling and release in line with the FAO guidelines are included in the South African Large Pelagic permit conditions. All turtle interactions in respective areas of competence are reported to the respective RFMOs. Recent South African led studies on impact of marine debris on turtles have been published in the scientific literature (Ryan et al. 2016). Marine turtle nesting sites in South Africa are protected by coastal MPAs since 1963.
Sri Lanka		2013 2018					**Sharks:** The first NPOA-sharks was finalized in 2013 then revised in 2018 and is currently being implemented. 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. Laws relating to conservation of marine turtles include: a prohibition on catching marine turtles; discarding of any marine turtles caught and recording details on catches; and a requirement to take care of injured marine turtles that have been caught.
United Kingdom	n.a.	–	n.a.	–		–	British Indian Ocean Territory (Chagos Archipelago) waters are a Marine Protected Area closed to fishing except recreational fishing in the 3nm territorial waters around Diego Garcia. Separate NPOAs have not been developed within this context. **Sharks/Seabirds:** For sharks, UK is the 24th signatory to the Convention on Migratory Species 'Memorandum of Understanding on the Conservation of Migratory Sharks' which extends the agreement to UK Overseas Territories including British Indian Ocean Territories; Section 7 (10) (e) of the *Fisheries (Conservation and Management) Ordinance* refers to recreational fishing and requires sharks to be released alive. No seabirds are caught in the recreational fishery. **Marine turtles:** No marine turtles are captured in the recreational fishery. A monitoring programme is taking place to assess the marine turtle population in UK (OT).
Yemen							**Sharks:** No information received by the Secretariat. **Seabirds:** No information received by the Secretariat. **Marine turtles:** No information received by the Secretariat.

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

Colour key	
Completed	
Drafting being finalised	
Drafting commenced	
Not begun	

APPENDIX VII
EXECUTIVE SUMMARY: BLUE SHARK (2022)

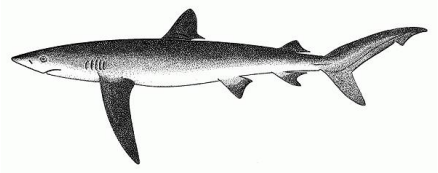

Table A 1. Status of blue shark (*Prionace glauca*) in the Indian Ocean

Area	Indicators		2021 stock status determination
Indian Ocean	Reported catch 2020 (t)	29,545	99.9%
	Estimated catch 2019 (t)	43,240	
	Not elsewhere included (nei) sharks[1] 2020 (t)	20,441	
	Average reported catch 2016-20 (t)	26,839	
	Average estimated catch 2015-19 (t)	48,781	
	Avg. not elsewhere included (nei) sharks[1] 2016-20 (t)	30,260	
	MSY (1,000 t) (80% CI)[2]	36.0 (33–5 - 38.6)	
	F_{MSY} (80% CI) [2]	0.31 (0.3–6 - 0.31)	
	SB_{MSY} (1,000 t) (80% CI) [2,3]	42.0 (38–9 - 45.1)	
	F_{2019}/F_{MSY} (80% CI) [2]	0.64 (0.–3 - 0.75)	
	SB_{2019}/SB_{MSY} (80% CI) [2]	1.39 (1.–7 - 1.49)	
	SB_{2019}/SB_0 (80% CI) [2]	0.46 (0.–2 - 0.49)	

Boundaries for the Indian Ocean are defined as the IOTC area of competence

[1]Includes data under the species codes BSH, SKH, RSK, AG38

[2]Includes all other shark catches reported to the IOTC Secretariat, which may contain this species (i.e., SHK: sharks various nei; RSK: requiem sharks nei)

[3]Estimates refer to the base case model using estimated catches

[4]Refers to fecund stock biomass

Colour key	Stock overfished ($SB_{2019}/SB_{MSY}< 1$)	Stock not overfished ($SB_{2019}/SB_{MSY}\geq 1$)
Stock subject to overfishing($F_{2019}/F_{MSY}> 1$)	0%	0.1%
Stock not subject to overfishing ($F_{2019}/F_{MSY}\leq 1$)	0%	99.9%
Not assessed/Uncertain		

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

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

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

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

Sources: IUCN Red List 2020, Stevens 2009

INDIAN OCEAN STOCK – MANAGEMENT ADVICE

Stock status. A new stock assessment for blue sharks was carried out in 2021 using an integrated age-structured model (SS3) (**Fig. A** 1). Uncertainty in data inputs and model configuration were explored through sensitivity analysis. All models produced similar results suggesting the stock is currently not overfished nor subject to overfishing, but with the trajectories showing consistent trends towards the overfished and subject to overfishing quadrant of the Kobe plot (**Fig. A** 1). A base case model was selected based on the best Indian Ocean biological data, consistency of CPUE standardized relative abundance series, model fits and spatial extent of the data (**Fig. A** 1, **Table A 1**). In particular, the base case model used the GAM-based catch history estimates and CPUE series from South Africa, EU-Portugal, EU-

France (Reunion), EU-Spain, Taiwan and Japan. The major sources of uncertainty identified in the current model are catches and CPUE indices of abundance. Model results were explored with respect to their sensitivity to the major axes of uncertainty identified, however the ratio-based and nominal catches were considered unrealistic. If the alternative CPUE groupings were used, then the stock status was somewhat less positive. The ecological risk assessment (ERA) conducted for the Indian Ocean by the WPEB and SC in 2018 consisted of a semi-quantitative risk assessment analysis to evaluate the resilience of shark species to the impact of a given fishery by combining the biological productivity of the species and its susceptibility to each fishing gear type. Blue sharks received a medium vulnerability ranking (No. 10) in the ERA rank for longline gear because it was estimated as the most productive shark species but was also characterised by the second highest susceptibility to longline gear. Blue shark was estimated as not being susceptible thus not vulnerable to purse seine gear. The current IUCN threat status of 'Near Threatened' applies to blue sharks globally (**Table A 2**). Information available on this species has been improving in recent years. Blue sharks are commonly taken by a range of fisheries in the Indian Ocean and in some areas they are fished in their nursery grounds. Because of their life history characteristics – they live until at least 25 years, mature at 4–6 years, and have 25–50 pups every year – they are considered to be the most productive of the pelagic sharks. On the weight-of-evidence available in 2021, the stock status is determined to be **not overfished** and **not subject to overfishing** (**Table A 1**).

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

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

The following key points should also be noted:

- **Maximum Sustainable Yield (MSY)**: estimate for the Indian Ocean stock is approximately 36,000 t.
- **Reference points**: The Commission has not adopted reference points or harvest control rules for any shark species.
- **Main fishing gear** (2014–18): Coastal longline; longline (deep-freezing); longline targeting swordfish.
- **Main fleets** (2015–19): Indonesia; Taiwan,China; EU,Spain; EU,Portugal; Japan, Sri Lanka, Seychelles.

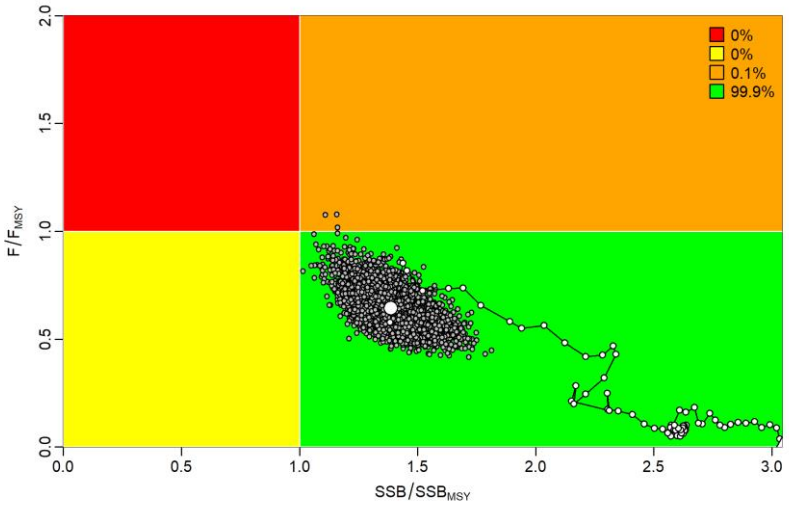

Fig. A 1. Blue shark: Aggregated Indian Ocean stock assessment Kobe plot for the 2021 assessment base case model. (base case model with trajectory and uncertainty in the terminal year.

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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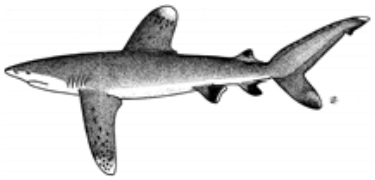
Stevens J (2009) *Prionace glauca*. In: IUCN 2012. IUCN Red List of Threatened Species. Version 2012.2. <www.iucnredlist.org>. Downloaded on 08 November 2012

APPENDIX VIII
EXECUTIVE SUMMARY: OCEANIC WHITETIP SHARK (2022)



CITES APPENDIX II species

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

Area[1]	Indicators		2018 stock status determination
Indian Ocean	Reported catch 2020	30 t	
	Not elsewhere included (nei) sharks[2] 2020	20,441 t	
	Average reported catch 2016-20	129 t	
	Av. not elsewhere included 2016-2020 (nei) sharks[2]	30,260 t	
	MSY (1,000 t) (80% CI)	unknown	
	F_{MSY} (80% CI)		
	SB_{MSY} (1,000 t) (80% CI)		
	$F_{current}/F_{MSY}$ (80% CI)		
	$SB_{current}/SB_{MSY}$ (80% CI)		
	$SB_{current}/SB_0$ (80% CI)		

[1]Boundaries for the Indian Ocean = IOTC area of competence

[2]Includes all other shark catches reported to the IOTC Secretariat, which may contain this species (i.e., SHK: sharks various nei; RSK: requiem sharks nei)

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

Table A 5. Oceanic whitetip shark: IUCN threat status of oceanic whitetip shark (*Carcharhinus longimanus*) in the Indian Ocean.

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

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

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

Sour ces: IUCN Red List 2020, Baum et al. 2006

CIT–S - In March 2013, CITES agreed to include oceanic whitetip shark to Appendix II to provide further protections prohibiting the international trade; which will become effective on September 14, 2014.

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Stock status. There remains considerable uncertainty about the relationship between abundance, standardised CPUE series and total catches over the past decade (**Table A 4**). The ecological risk assessment (ERA) conducted for the Indian Ocean by the WPEB and SC in 2018 consisted of a semi-quantitative risk assessment analysis to evaluate the resilience of shark species to the impact of a given fishery, by combining the biological productivity of the species and its susceptibility to each fishing gear type (Murua *et al.* 2018). Oceanic whitetip shark received a medium vulnerability ranking (No. 9) in the ERA rank for longline gear because it was estimated as one of the least productive shark species but was only characterised by a medium susceptibility to longline gear. Oceanic whitetip shark was estimated as being the 11th most vulnerable shark species to purse seine gear, as it was characterised as having a relatively low productive rate, and medium susceptibility to the gear. The current IUCN threat status of 'Critically Endangered' applies to oceanic

whitetip sharks globally (**Table A 5**). There is a paucity of information available on this species in the Indian Ocean and this situation is not expected to improve in the short to medium term. Oceanic whitetip sharks are commonly taken by a range of fisheries in the Indian Ocean. Because of their life history characteristics – they are relatively long lived, mature at 4–5 years, and have relatively few offspring (<20 pups every two years), the oceanic whitetip shark is likely vulnerable to overfishing. Despite the limited amount of data, recent studies (Tolotti et al., 2016) suggest that oceanic whitetip shark abundance has declined in recent years (2000-2015) compared with historic years (1986-1999). Available pelagic longline standardised CPUE indices from Japan and EU,Spain indicate conflicting trends as discussed in the IOTC Supporting Information for oceanic whitetip sharks. There is no quantitative stock assessment and limited basic fishery indicators currently available for oceanic whitetip sharks in the Indian Ocean therefore the stock status is **unknown** (**Table A 4**).

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

Management advice. A cautious approach to the management of oceanic whitetip shark should be considered by the Commission, noting that recent studies suggest that longline mortality at haulback is high (50%) in the Indian Ocean (IOTC-2016-WPEB12-26), while mortality rates for interactions with other gear types such as purse seines and gillnets may be higher. While mechanisms exist for encouraging CPCs to comply with their recording and reporting requirements (Resolution 18/07), these need to be further implemented by the Commission, so as to better inform scientific advice. IOTC Resolution 13/06 *on a scientific and management framework on the conservation of shark species caught in association with IOTC managed fisheries*, prohibits retention onboard, transhipping, landing or storing any part or whole carcass of oceanic whitetip sharks. Given that some CPCs are still reporting oceanic whitetip shark as landed catch, there is a need to strengthen mechanisms to ensure CPCs comply with Resolution 13/06.

The following key points should be also noted:

- **Maximum Sustainable Yield (MSY)**: Not applicable. Retention prohibited.
- **Reference points**: Not applicable.
- **Main fishing gear** (2014-18): Troll line; Gillnet; offshore gillnet.
- **Main fleets** (2014-2018): Comoros; I.R. Iran; Sri Lanka; Indonesia; and India; (Reported as discarded/released alive by China, Korea, France, Australia, South Africa, Sri Lanka, Japan).

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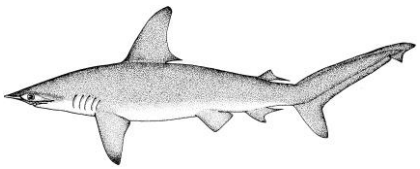
APPENDIX IX
EXECUTIVE SUMMARY: SCALLOPED HAMMERHEAD SHARK (2022)



CITES APPENDIX II species

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

Area[1]	Indicators		2018 stock status determination
Indian Ocean	Reported catch 2020	38 t	
	Not elsewhere included (nei) sharks[2] 2020	27,893 t	
	Average reported catch 2016-20	66 t	
	Av. not elsewhere included 2016-2020 (nei) sharks[2]	35,739 t	
	MSY (1,000 t) (80% CI) F_{MSY} (80% CI) SB_{MSY} (1,000 t) (80% CI) $F_{current}/F_{MSY}$ (80% CI) $SB_{current}/SB_{MSY}$ (80% CI) $SB_{current}/SB_0$ (80% CI)	unknown	

[1]Boundaries for the Indian Ocean = IOTC area of competence

[2]Includes all other shark catches reported to the IOTC Secretariat, which may contain this species (i.e., SHK: sharks various nei; RSK: requiem sharks nei).

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

Table A 7. IUCN threat status of scalloped hammerhead shark (*Sphyrna lewini*) in the Indian Ocean.

Common name	Scientific name	IUCN threat status[3]		
		Global status	WIO	EIO
Scalloped hammerhead shark	*Sphyrna lewini*	Critically Endangered	Endangered	–

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

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

Sources: IUCN Red List 2020, Baum 2007

INDIAN OCEAN STOCK – MANAGEMENT ADVICE

Stock status. The current IUCN threat status of 'Critically Endangered' applies to scalloped hammerhead sharks globally but specifically for the western Indian Ocean the status is 'Endangered' (**Table A 7**). The ecological risk assessment (ERA) conducted for the Indian Ocean by the WPEB and SC in 2018 consisted of a semi-quantitative risk assessment analysis to evaluate the resilience of shark species to the impact of a given fishery, by combining the biological productivity of the species and its susceptibility to each fishing gear type (Murua *et al.* 2018). Scalloped hammerhead shark received a low vulnerability ranking (No. 17) in the ERA rank for longline gear because it was estimated to be one of the least productive shark species but was also characterised by a lower susceptibility to longline gear. Scalloped hammerhead shark was estimated as the twelfth most vulnerable shark species in the ERA ranking for purse seine gear, but with lower levels of vulnerability compared to longline gear, because the susceptibility

was lower for purse seine gear. There is a paucity of information available on this species and this situation is not expected to improve in the short to medium term. Scalloped hammerhead sharks are commonly taken by a range of fisheries in the Indian Ocean. They are extremely vulnerable to gillnet fisheries. Furthermore, pups occupy shallow coastal nursery grounds, often heavily exploited by inshore fisheries. Because of their life history characteristics – they are relatively long lived (over 30 years) and have relativity few offspring (<31 pups each year), the scalloped hammerhead shark is vulnerable to overfishing. There is no quantitative stock assessment or basic fishery indicators currently available for scalloped hammerhead shark in the Indian Ocean therefore the stock status is unknown (**Table A 6**).

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

Management advice. Despite the absence of stock assessment information, the Commission should consider taking a cautious approach by implementing some management actions for scalloped hammerhead sharks. While mechanisms exist for encouraging CPCs to comply with their recording and reporting requirements (Resolution 18/07), these need to be further implemented by the Commission so as to better inform scientific advice.

The following key points should be noted:

- **Maximum Sustainable Yield (MSY)**: Unknown.
- **Reference points**: Not applicable.
- **Main fishing gear** (2014-2018): Ringnet; Gillnet; longline-coastal; longline (fresh) and offshore gillnet.
- **Main fleets** (2014-18): Sri Lanka; Kenya; Seychelles; NEI-Fresh (report as released alive/discarded by EU-France, South Africa, Indonesia, Japan).

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APPENDIX X
EXECUTIVE SUMMARY: SHORTFIN MAKO SHARK (2022)

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

Area[1]	Indicators		2020 stock status determination
Indian Ocean	Reported catch 2020	869 t	
	Not elsewhere included (nei) sharks[2] 2020	22,757 t	
	Average reported catch 2016-20	1,616 t	
	Av. not elsewhere included (nei) sharks[2] 2016-20	32,561 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 ($SB_{year}/SB_{MSY}\geq 1$)
Stock subject to overfishing ($F_{year}/F_{MSY}> 1$)		
Stock not subject to overfishing ($F_{year}/F_{MSY}\leq 1$)		
Not assessed/Uncertain		

Table A 9. Shortfin mako shark: IUCN threat status of shortfin mako shark (*Isurus oxyrinchus*) in the Indian Ocean.

Common name	**Scientific name**	**IUCN threat status[3]**		
		Global status	**WIO**	**EIO**
Shortfin mako shark	*Isurus oxyrinchus*	Endangered	–	–

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

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

Sources: IUCN Red List 2020, Cailliet 2009

INDIAN OCEAN STOCK – MANAGEMENT ADVICE

Stock status. There remains considerable uncertainty about the relationship between abundance, the standardised CPUE series, and total catches over the past decade (**Table A 8**). The ecological risk assessment (ERA) conducted for the Indian Ocean by the WPEB and SC in 2018 consisted of a semi-quantitative risk assessment analysis to evaluate the resilience of shark species to the impact of a given fishery, by combining the biological productivity of the species and its susceptibility to each fishing gear type (Murua *et al.* 2018). Shortfin mako sharks received the highest vulnerability ranking (No. 1) in the ERA rank for longline gear because it was characterised as one of the least productive shark species and has a high susceptibility to longline gear. Shortfin mako sharks were estimated to be the fourth most vulnerable shark species in the ERA ranking for purse seine gear but had lower levels of vulnerability than to longline gear, because of the lower susceptibility of the species to purse seine gear. The current IUCN threat status of ‘‘Endangered’ applies to shortfin mako sharks globally (**Table A 9**). Trends in the Japanese standardised CPUE series from its longline fleet has declined from 1999 to 2004 but has remained relatively stable since 2005. Conversely, trends in EU,Portugal longline standardised CPUE series have been increasing since 2008 as has the trends in the EU,Spain and Taiwanese longline series (see IOTC Supporting Information). There is a paucity of information available on this

species, but this situation has been improving in recent years. Shortfin mako sharks are commonly taken by a range of fisheries in the Indian Ocean. Because of their life history characteristics – they are relatively long lived (over 30 years), females mature at 18–21 years, and have relativity few offspring (<25 pups every two or three year–) - the shortfin mako shark is vulnerable to overfishing. Although an attempt was made to assess the shortfin mako stock in 2020, there is no quantitative stock assessment currently available for shortfin mako shark in the Indian Ocean. Therefore, the stock status is **unknown**. This highlights the need for further work on data improvement and provision of abundance indices as well as utilizing complimentary approaches (e.g., genetic tools) to inform the trends in abundance of the stock.

Outlook. Maintaining or increasing effort can result in declines in biomass, productivity and CPUE. Piracy in the western Indian Ocean has resulted in the displacement and subsequent concentration of a substantial portion of longline fishing effort into certain areas in the southern and eastern Indian Ocean. Some longline vessels have returned to their traditional fishing areas in the northwest Indian Ocean, due to the increased security onboard vessels, with the exception of the Japanese fleet which has still not returned to the levels seen before the start of the piracy threat. It is therefore unlikely that global catch and effort on shortfin mako shark has declined in the southern and eastern areas and may have resulted in localised depletion there. It should be noted that subsequent to the past assessment, shortfin mako has been placed on CITES Appendix II and therefore this may influence the landings in the future.

Management advice. In the absence of a stock assessment and noting conflicting information, the Commission should take a cautious approach by implementing management actions that reduce fishing mortality on shortfin mako sharks. While mechanisms exist for encouraging CPCs to comply with their recording and reporting requirements (Resolution 18/07), these need to be further implemented by the Commission so as to better inform scientific advice.

The following key points should also be noted:

- **Maximum Sustainable Yield (MSY)**: Unknown.
- **Reference points**: Not applicable.
- **Main fishing gear** (2015-19): Longline targeting swordfish; longline (fresh); longline (targeting sharks); gillnet.
- **Main fleets** (2015-19): EU,Spain; South Africa; EU,Portugal; Japan, I.R. Iran, China, Sri Lanka, (Reported as discarded/released alive: Australia, EU,France, Indonesia, Japan, Korea, South Africa).

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APPENDIX XI
EXECUTIVE SUMMARY: SILKY SHARK (2022)

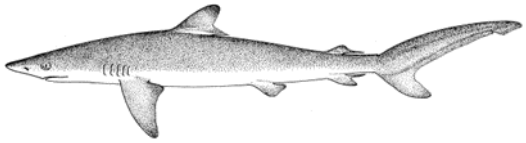

Table A 10. Status of silky shark (*Carcharhinus falciformis*) in the Indian Ocean.

Area[1]	Indicators		2018 stock status determination
Indian Ocean	Reported catch 2020 Not elsewhere included (nei) sharks[2] 2020 Average reported catch 2016-20 Av. not elsewhere included (nei) sharks[2] 2016-20	1,335 t 20,441 t 1,861 t 30,260 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 ($SB_{year}/SB_{MSY} \geq 1$)
Stock subject to overfishing ($F_{year}/F_{MSY} > 1$)		
Stock not subject to overfishing ($F_{year}/F_{MSY} \leq 1$)		
Not assessed/Uncertain		

Table A 11. Silky shark: IUCN threat status of silky shark (*Carcharhinus falciformis*) in the Indian Ocean.

Common name	Scientific name	IUCN threat status[3]		
		Global status	WIO	EIO
Silky shark	*Carcharhinus falciformis*	Vulnerable	Near Threatened	Near Threatened

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

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

Sources IUCN Red List 2020

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Stock status. There remains considerable uncertainty about the relationship between abundance and the nominal CPUE series from the main longline fleets, and about the total catches over the past decade (**Table A 10**). The ecological risk assessment (ERA) conducted for the Indian Ocean by the WPEB and SC in 2018 consisted of a semi-quantitative risk assessment analysis to evaluate the resilience of shark species to the impact of a given fishery, by combining the biological productivity of the species and its susceptibility to each fishing gear type (Murua *et al.* 2018). Silky shark received a high vulnerability ranking (No. 2) in the ERA rank for longline gear because it was estimated to be one of the least productive shark species, and with a high susceptibility to longline gear. Silky shark was estimated to be the fifth most vulnerable shark species in the ERA ranking for purse seine gear, due to its low productivity and high susceptibility to purse seine gear. The current IUCN threat status of 'Near Threatened' applies to silky shark in the western and eastern Indian Ocean but globally the status is 'Vulnerable' (**Table A 11**). There is a paucity of information available on this species, but several studies have been carried out for this species in the recent years. CPUE derived

from longline fishery observations indicated a decrease from 2009 to 2011 with a stable pattern onward. A preliminary stock assessment was run in 2018 but could not be updated in 2019. This assessment is extremely uncertain, however, and so the population status of silky sharks in the Indian Ocean is considered uncertain. Silky sharks are commonly taken by a range of fisheries in the Indian Ocean. Because of their life history characteristics – they are relatively long lived (over 20 years), mature relatively late (at 6–12 years), and have relativity few offspring (<20 pups every two years), the silky shark can be vulnerable to overfishing. Despite the lack of data, there is some anecdotal information suggesting that silky shark abundance has declined over recent decades, including from Indian longline research surveys, which are described in the IOTC Supporting Information for silky shark sharks. There is no quantitative stock assessment or basic fishery indicators currently available for silky shark in the Indian Ocean therefore the stock status is unknown.

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

Management advice. Despite the absence of stock assessment information, the Commission should consider taking a cautious approach by implementing some management actions for silky sharks. While mechanisms exist for encouraging CPCs to comply with their recording and reporting requirements (Resolution 18/07), these need to be further implemented by the Commission so as to better inform scientific advice.

The following key points should also be noted:

- **Maximum Sustainable Yield (MSY)**: Unknown.
- **Reference points**: Not applicable.
- **Main fishing gear** (2014-18): Gillnet; offshore gillnet; longline-coastal; longline (fresh), , longline
- **Main fleets** (2014-18): I.R. Iran; Sri Lanka; Taiwan,China; Pakistan; .

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APPENDIX XII
EXECUTIVE SUMMARY: BIGEYE THRESHER SHARK (2022)

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

Area[1]	Indicators		2018 stock status determination
Indian Ocean	Reported catch 2020	< 1 t	
	Not elsewhere included (nei) sharks[2] 2020	26,344 t	
	Average reported catch 2016-20	< 1 t	
	Av. not elsewhere included (nei) sharks[2] 2016-20	34,766 t	
	MSY (1,000 t) (80% CI)	unknown	
	F_{MSY} (80% CI)		
	SB_{MSY} (1,000 t) (80% CI)		
	$F_{current}/F_{MSY}$ (80% CI)		
	$SB_{current}/SB_{MSY}$ (80% CI)		
	$SB_{current}/SB_0$ (80% CI)		

[1]Boundaries for the Indian Ocean = IOTC area of competence

[2]Includes all other shark catches reported to the IOTC Secretariat, which may contain this species (i.e., SHK: sharks various nei; RSK: requiem sharks nei).

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

Table A 13. Bigeye thresher shark: IUCN threat status of bigeye thresher shark (*Alopias superciliosus*) in the Indian Ocean.

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

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

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

Sources: IUCN Red List 2020, Amorim et al. 2009

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Stock status. There remains considerable uncertainty in the stock status due to lack of information necessary for assessment or for the development of other indicators of the stock (**Table A 12**). The ecological risk assessment (ERA) conducted for the Indian Ocean by the WPEB and SC in 2018 consisted of a semi-quantitative risk assessment analysis to evaluate the resilience of shark species to the impact of a given fishery, by combining the biological productivity of the species and its susceptibility to each fishing gear type (Murua *et al.* 2018). Bigeye thresher shark received a high vulnerability ranking (No. 4) in the ERA rank for longline gear because it was characterised as one of the least productive shark species, and highly susceptible to longline gear. Despite its low productivity, bigeye thresher shark has a low vulnerability ranking to purse seine gear due to its low susceptibility to this particular gear. The current IUCN threat status of 'Vulnerable' applies to bigeye thresher shark globally (**Table A 13**). There is a paucity of information available on this species and this situation is not expected to improve in the short to medium term. Bigeye thresher sharks are commonly taken by a range of fisheries in the Indian Ocean. Because of their life history characteristics – they are relatively long lived (+20 years), mature at 3–9 years, and have few offspring (2–4 pups every year), the bigeye thresher shark is vulnerable to overfishing. There has been no quantitative stock assessment and limited basic fishery indicators are available for bigeye thresher shark in the Indian Ocean. Therefore, the stock status is unknown.

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

Management advice. The prohibition on retention of bigeye thresher shark should be maintained. While mechanisms exist for encouraging CPCs to comply with their recording and reporting requirements (Resolution 18/07), these need to be further implemented by the Commission, so as to better inform scientific advice. IOTC Resolution 12/09 *On the conservation of thresher sharks (family Alopiidae) caught in association with fisheries in the IOTC area of competence*, prohibits retention onboard, transhipping, landing, storing, selling or offering for sale any part or whole carcass of thresher sharks of all the species of the family *Alopiidae*[3].

The following key points should also be noted:

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

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[3] Scientific observers shall be allowed to collect biological samples from thresher sharks that are dead at haulback, provided that the samples are part of the research project approved by the Scientific Committee (or the Working Party on Ecosystems and Bycatch).

APPENDIX XIII
EXECUTIVE SUMMARY: PELAGIC THRESHER SHARK (2022)

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

Area[1]	Indicators		2018 stock status determination
Indian Ocean	Reported catch 2020	176 t	
	Not elsewhere included (nei) sharks[2] 2020	26,344 t	
	Average reported catch 2016-20	310 t	
	Av. not elsewhere included (nei) sharks[2] 2016-20	34,766 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 ($SB_{year}/SB_{MSY}\geq 1$)
Stock subject to overfishing ($F_{year}/F_{MSY}> 1$)		
Stock not subject to overfishing ($F_{year}/F_{MSY}\leq 1$)		
Not assessed/Uncertain		

Table A 15. Pelagic thresher shark: IUCN threat status of pelagic thresher shark (*Alopias pelagicus*) in the Indian Ocean.

Common name	**Scientific name**	**IUCN threat status[3]**		
		Global status	**WIO**	**EIO**
Pelagic thresher shark	*Alopias pelagicus*	Endangered	–	–

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

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

Sources: IUCN Red List 2020, Reardon et al. 2009

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Stock status. There remains considerable uncertainty in the stock status due to lack of information necessary for assessment or for the development of other indicators (**Table A 14**). The ecological risk assessment (ERA) conducted for the Indian Ocean by the WPEB and SC in 2018 consisted of a semi-quantitative analysis to evaluate the resilience of shark species to the impact of a given fishery, by combining the biological productivity of the species and susceptibility to each fishing gear type (Murua *et al.* 2018). Pelagic thresher shark received a medium vulnerability ranking (No. 12) in the ERA for longline gear because it was characterised as one of the least productive shark species, and with a medium susceptibility to longline gear. Due to its low productivity, pelagic thresher shark has a high vulnerability ranking (No. 2) to purse seine gear due to its high availability for this particular gear. The current IUCN threat status of 'Endangered' applies to pelagic thresher shark globally (**Table A 15**). There is a paucity of information available on this species and this situation is not expected to improve in the short to medium term. Pelagic thresher sharks are commonly taken by a range of fisheries in the Indian Ocean. Because of their life history characteristics – they are relatively long lived (+ 20 years), mature at 8–9 years, and have few offspring (2 pups every yea–) - the pelagic thresher shark is vulnerable to overfishing. There is no quantitative stock assessment and limited basic fishery indicators are currently available for pelagic thresher shark in the Indian Ocean. Therefore, the stock status is unknown**.**

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

Management advice. The prohibition on the retention of pelagic thresher shark should be maintained. While mechanisms exist for encouraging CPCs to comply with their recording and reporting requirements (Resolution 18/07), these need to be further implemented by the Commission, so as to better inform scientific advice. IOTC Resolution 12/09 *On the conservation of thresher sharks (family Alopiidae) caught in association with fisheries in the IOTC area of competence*, prohibits retention onboard, transhipping, landing, storing, selling or offering for sale any part or whole carcass of thresher sharks of all the species of the family *Alopiidae*[4].

The following key points should also be noted:

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

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[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 XIV
EXECUTIVE SUMMARY: MARINE TURTLES (2022)

Table A 16. Marine turtles: IUCN threat status for all marine turtle species reported as caught in fisheries within the IOTC area of competence.

Common name	Scientific name	IUCN threat status[5]
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

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Stock status. No assessment has been undertaken by the IOTC WPEB for marine turtles due to the lack of data being submitted by CPCs. However, the current International Union for Conservation of Nature (IUCN) threat status for each of the marine turtle species reported as caught in IOTC fisheries to date is provided in **Table A 16**. It is important to note that a number of international global environmental accords (e.g., Convention on Migratory Species (CMS), Convention on Biological Diversity (CBD), as well as numerous fisheries agreements obligate States to provide protection for these species. In particular, there are now 35 Signatories to the Memorandum of Understanding on the Conservation and Management of Marine Turtles and their Habitats of the Indian Ocean and South-East Asia (IOSEA MoU). Of the 35 Signatories to the IOSEA MoU, 23 are also members of the IOTC. While the status of marine turtles is affected by a range of factors such as degradation of marine turtle natural habitats and targeted harvesting of eggs and turtles, the level of mortality of marine turtles due to capture by gillnets is likely to be substantial as shown by the Ecological Risk Assessment (ERA) presented in 2018 (Williams et al., 2018). Stock assessments of all species of marine turtles in the Indian Ocean are limited due to data insufficiencies as well as limited data quality (Wallace et al., 2011). Bycatch and mortality from gillnet fisheries have greater population-level impacts on marine turtles relative to other gear types, such as longline, purse seine and trawl fisheries in the Indian Ocean (Wallace et al., 2013). Population levels of impacts of leatherback turtles caught in longline gear in the Southwest Indian Ocean were also identified as a conservation priority.

Outlook. Resolution 12/04 *On the conservation of marine turtles* includes an annual evaluation requirement (para. 17) by the Scientific Committee (SC). However, given the lack of reporting of marine turtle interactions by CPCs to date, such an evaluation cannot be undertaken. Unless IOTC CPCs become compliant with the data collection and reporting requirements for marine turtles, the WPEB and the SC will continue to be unable to address this issue. So far, reporting of sea turtle interactions are not described at the species level. It is recommended that CPCs now declare interactions indicating the sea turtle species. Guides for species identification are available at http://iotc.org/science/species-identification-cards. Notwithstanding this, it is acknowledged that the impact on marine turtle populations from fishing for tuna and tuna-like species will increase as fishing pressure increases, and that the status of the marine turtle

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

populations will continue to worsen due to other factors such as an increase in fishing pressure from other fisheries or anthropological or climatic impacts.

The following should also be noted:

1. The available evidence indicates considerable risk to marine turtles in the Indian Ocean.
2. Given the high mortality rates associated with marine turtle interactions with gillnet fisheries and the increasing use of gillnets in the Indian Ocean (Aranda, 2017) there is a need to both assess and mitigate impacts on threatened and endangered marine turtle populations.
3. The primary sources of data that drive the ability of the WPEB to determine a status for the Indian Ocean, total interactions by fishing vessels or in net fisheries, are highly uncertain and should be addressed as a matter of priority.
4. Current reported interactions are known to be a severe underestimate.
5. The Ecological Risk Assessment (Nel et al., 2013) estimated that ~3,500 and ~250 marine turtles are caught by longline and purse seine vessels, respectively, per annum, with an estimated 75% of turtles released alive[7]. The ERA set out two separate approaches to estimate gillnet impacts on marine turtles, based on very limited data. The first calculated that 52,425 marine turtles p.a. and the second that 11,400–47,500 turtles p.a. are caught in gillnets (with a mean of the two methods being 29,488 marine turtles p.a.). Anecdotal/published studies reported values of >5000–16,000 marine turtles p.a. for each of India, Sri Lanka and Madagascar. Of these reports, green turtles are under the greatest pressure from gillnet fishing, constituting 50–88% of catches for Madagascar. Loggerhead, hawksbill, leatherback and olive Ridley turtles are caught in varying proportions depending on the region, season and type of fishing gear.
6. Maintaining or increasing fishing effort in the Indian Ocean without appropriate mitigation measures in place, will likely result in further declines in marine turtle populations.
7. Efforts should be undertaken to encourage CPCs to investigate means to reduce marine turtle bycatch and mortality in IOTC fisheries.
8. That appropriate mechanisms are developed by the Compliance Committee to ensure CPCs comply with their data collection and reporting requirements for marine turtles.

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APPENDIX XV
EXECUTIVE SUMMARY: SEABIRDS (2022)

Table A 17. IUCN threat status for all seabird species reported as caught in fisheries within the IOTC area of competence.

Common name	Scientific name	IUCN threat status[6]
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

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Stock status. Following a data call in 2016, the IOTC Secretariat received seabird bycatch data from 6 CPCs, out of the 15 with reported or expected longline effort South of 25ºS (IOTC-2016-SC19-INF02). Due to the lack of data submissions from other CPCs, and the limited information provided on the use of seabird bycatch mitigations, it has not yet been possible to undertake an assessment for seabirds. The current International Union for Conservation of Nature (IUCN) threat status for each of the seabird species reported as caught in IOTC fisheries to date is provided in **Table A 17**. It is important to note that the IUCN threat status for all birds is currently being re-assessed; this process is expected to be completed by the end of 2016. A number of international global environmental accords (e.g., Convention on Migratory Species (CMS), the Agreement on the Conservation of Albatrosses and Petrels (ACAP), Convention on Biological Diversity (CBD)), as well as numerous fisheries agreements obligate States to provide protection for these species. While the status of seabirds is affected by a range of factors such as degradation of nesting habitats and targeted harvesting of eggs, for albatrosses and large petrels, fisheries bycatch is generally considered to be the primary threat. The level of mortality of seabirds due to fishing gear in the Indian Ocean is poorly known, although where there has been rigorous assessment of impacts in areas south of 25 degrees (e.g., in South Africa), very high seabird incidental catches rates have been recorded in the absence of a suite of proven incidental catches mitigation measures.

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

Outlook. Resolution 12/06 *On Reducing the Incidental Bycatch of Seabirds in Longline Fisheries* includes an evaluation requirement (para. 8) by the Scientific Committee in time for the 2016 meeting of the Commission. The level of compliance with Resolution 12/06 and the frequency of use of each of the 3 measures (because vessels can choose two out of three possible options) are still poorly known. Observer reports and logbook data should be analysed to support assessments of the effectiveness of mitigation measures used and relative impacts on seabird mortality rates. Information regarding seabird interactions reported in National Reports should be stratified by season, broad area, and in the form of catch per unit effort. Following the data call in 2016 it was possible to carry out a preliminary and qualitative analysis. The information provided suggests higher sea bird catch rates at higher latitudes, even within the area south of 25°S, and higher catch rates in the coastal areas in the eastern and western parts of the southern Indian Ocean. In terms of mitigation measures, the preliminary information available suggests that those currently in use (Resolution 12/06) may be proving effective in some cases, but there are also some conflicting aspects that need to be explored further. Unless IOTC CPCs become compliant with the data collection, Regional Observer Scheme and reporting requirements for seabirds, the WPEB will continue to be unable to fully address this issue.

The following should also be noted:

- The available evidence indicates considerable risk from longline fishing to the status of seabirds in the Indian Ocean, where the best practice seabird incidental catches mitigation measures outlined in Resolution 12/06 are not implemented.
- CPCs that have not fully implemented the provisions of the IOTC Regional Observer Scheme outlined in paragraph 2 of Resolution 11/04 shall report seabird incidental catches through logbooks, including details of species, if possible.
- Appropriate mechanisms should be developed by the Compliance Committee to assess levels of compliance by CPCs with the Regional Observer Scheme requirements and the mandatory measures described in Res 12/06.

APPENDIX XVI
EXECUTIVE SUMMARY: CETACEANS

Table A 18. Cetaceans: IUCN Red List status and records of interaction (including entanglements and, for purse seines, encirclements) with tuna fishery gear types for all cetacean species that occur within the IOTC area of competence.

Family	Common name	Species	IUCN Red List status*	Interactions by Gear Type**
Balaenidae	Southern right whale	*Eubalaena australis*	LC	GN
Neobalaenidae	Pygmy right whale	*Caperea marginata*	LC	-
Balaenopteridae	Common minke whale	*Balaenoptera acutorostrata*	LC	-
	Antarctic minke whale	*Balaenoptera bonaerensis*	NT	-
	Sei whale	*Balaenoptera borealis*	EN	PS
	Br'de's whale	*Balaenoptera edeni/brydei*	LC	-
	Blue whale	*Balaenoptera musculus*	EN	-
	Fin whale	*Balaenoptera physalus*	VU	-
	Om'ra's whale	*Balaenoptera omurai*	DD	-
	Humpback whale	*Megaptera novaeangliae*	LC***	GN
Physeteridae	Sperm whale	*Physeter macrocephalus*	VU	GN
Kogiidae	Pygmy sperm whale	*Kogia breviceps*	LC	GN
	Dwarf sperm whale	*Kogia sima*	LC	GN
Ziphiidae	Arn'ux's beaked whale	*Berardius arnuxii*	LC	-
	Southern bottlenose whale	*Hyperoodon planifrons*	LC	-
	Long'an's beaked whale	*Indopacetus pacificus*	LC	GN
	And'ew's beaked whale	*Mesoplodon bowdoini*	DD	-
	Blainvi'le's beaked whale	*Mesoplodon densirostris*	LC	-
	G'ay's beaked whale	*Mesoplodon grayi*	LC	-
	Hec'or's beaked whale	*Mesoplodon hectori*	DD	-
	Deraniyag'la's beaked whale	*Mesoplodon hotaula*	DD	-
	Strap-toothed whale	*Mesoplodon layardii*	LC	-
	T'ue's beaked whale	*Mesoplodon mirus*	LC	-
	Spade-toothed whale	*Mesoplodon traversii*	DD	-
	Sheph'rd's beaked Whale	*Tasmacetus shepherdi*	DD	-
	Cuv'er's beaked whale	*Ziphius cavirostris*	LC	GN
Delphinidae	Long-beaked common dolphin	*Delphinus capensis*	DD	GN
	Short-beaked common dolphin	*Delphinus delphis*	LC	GN
	Pygmy killer whale	*Feresa attenuata*	LC	GN
	Short-finned pilot whale	*Globicephala macrorhynchus*	LC	LL, GN
	Long-finned pilot whale	*Globicephala melas*	LC	-
	Ri'so's dolphin	*Grampus griseus*	LC	LL, GN

Delphinidae	Fra'er'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
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Stock status. The current[7] International Union for Conservation of Nature (IUCN) Red List status for each of the cetacean species reported in the IOTC Area of Competence is provided in Table A 18. Information on their interactions with IOTC fisheries is also provided. It is important to note that a number of international global environmental accords (e.g., Convention on Migratory Species (CMS), Convention on Biological Diversity (CBD), International Whaling Commission (IWC)), as well as numerous fisheries agreements obligate States to provide protection for these species. The status of cetaceans is affected by a range of factors such as direct harvesting and habitat degradation, but the level of cetacean mortality due to capture in tuna drift gillnets is likely to be substantial and is also a major cause for concern (Anderson, 2014). Many reports (e.g., Sabarros et al., 2013) also suggest some level of cetacean mortality for species involved in depredation of pelagic longlines, and these interactions need to be further documented throughout the IOTC Area of Competence. Recently published information suggests that the incidental capture of cetaceans in purse seines is low (e.g., Escalle et al., 2015), but should be further monitored.

Outlook. Resolution 13/04 *On the conservation of cetaceans* highlights the concerns of the IOTC regarding the lack of accurate and complete data collection and reporting to the IOTC Secretariat of interactions and mortalities of cetaceans in association with tuna fisheries in the IOTC Area of Competence. In this resolution, the IOTC have agreed that CPCs shall prohibit their flagged vessels from intentionally setting a purse seine net around a cetacean if the animal is sighted prior to the commencement of the set. The IOTC also agreed that CPCs using other gear types targeting tuna and tuna-like species found in association with cetaceans shall report all interactions with cetaceans to the relevant authority of the flag State and that these will be reported to the IOTC Secretariat by 30 June of the following year. It is acknowledged that the impact on cetacean populations from fishing for tuna and tuna-like species may increase if fishing pressure increases (which is already clear for tuna gillnet fisheries from IOTC data) or if the status of cetacean populations worsens due to other factors such as an increase in external fishing pressure or other anthropogenic or climatic impacts.

[7] September 2020

The following should be noted:

- The number of fisheries interactions involving cetaceans is highly uncertain and should be addressed as a matter of priority as it is a prerequisite for the WPEB to determine a status for any Indian Ocean cetacean species.
- Available evidence indicates considerable risk to cetaceans in the Indian Ocean, particularly from tuna drift gillnets (Anderson, 2014).
- Current reported interactions and mortalities are scattered but are most likely severely underestimated.
- Maintaining or increasing fishing effort in the Indian Ocean without appropriate mitigation measures in place will likely result in further declines in a number of cetacean species. An increasing effort by tuna drift gillnet fisheries has been reported to the IOTC, which is a major cause of concern for a number of species, particularly in the northern Indian Ocean.
- Appropriate mechanisms should be developed by the Compliance Committee to ensure CPCs comply with their data collection and reporting requirements for cetaceans.

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APPENDIX XVII
WORKING PARTY ON ECOSYSTEMS AND BYCATCH PROGRAM OF WORK (2023–2027)

The Program of Work consists of the following, noting that a timeline for implementation would be developed by the SC once it has agreed to the priority projects across all of its Working Parties:

Table A19: Priority topics for obtaining the information necessary to develop stock status indicators for bycatch in the Indian Ocean; and
Table A20: Stock assessment schedule.

Table A19. Priority topics for obtaining the information necessary to develop stock status indicators for bycatch species in the Indian Ocean

Topic in order of priority	**Sub-topic and project**	Timing				
		2023	2024	2025	2026	2027
Connectivity, movements, habitat use and post release mortality*	Electronic tags (PSATs, SPOT, Splash MiniPAT) to assess the efficiency of management resolutions on non-retention species (BSH in LL, marine turtles and rays in GIL and PS, whale sharks) and to determine connectivity, movement rates and mortality estimates.					
1. Fisheries data collection	1.1 Historical data mining for the key species and IOTC fleets (e.g., as artisanal gillnet and longline coastal fisheries) including workshops:					
	1.1.2 Historical data mining for the key species, including the collection of information about catch, effort and spatial distribution of those species and fleets catching them					
	1.1.3 Catch composition reconstruction (initial focus Pakistan and Indonesia)					
	1.2 Implementation of the Pilot Project (Resolution 16/04) for the Regional Observer Scheme					
	1.2.1 Development of a Regional Observer database and population with historic observer data					
	1.2.2 Development, piloting and implementation of an electronic reporting tool to facilitate data reporting					
	1.2.3 Development and trial of Electronic Monitoring Systems for gillnet fleets					

	1.2.4 Port sampling protocols for artisanal fisheries					
2. Shark research plans	Consultancy to develop shark research plans Priority species: scalloped hammerhead sharks					
3. Ecoregions development	Support for the development and refinement of ecoregions in the Indian Ocean: • Development of a pilot study (focused on two ecoregions: one coastal, the Somali Current ecoregion and one oceanic, the Indian Ocean Gyre ecoregion)					

* The WPEB is not requesting funds for this activity at this time

Other Future Research Requirements (not in order of priority)						
Topic	Sub-topic and project	2022	2023	2024	2025	2026
1. Fisheries data collection	1.1 Historical data mining for the key species and IOTC fleets (e.g., as artisanal gillnet and longline coastal fisheries) including (Workshops – leader?):					
	1.1.1 Capacity building of fisheries observers (including the provision of ID guides, training, etc. Fishing gear guides from SPC)					
	1.1.2 Historical data mining for the key species, including the collection of information about catch, effort and spatial distribution of those species and fleets catching them					
	1.2 Implementation of the Pilot Project (Resolution 16/04) for the Regional Observer Scheme					
	1.2.1 Definition of minimum standards and development of a training package for the ROS to be reviewed and rolled out in voluntary CPCs (Sri Lanka, I.R. Iran, Tanzania)					

	1.2.2 Development of a Regional Observer database and population with historic observer data					
	1.2.3 Development, piloting and implementation of an electronic reporting tool to facilitate data reporting					
	1.2.4 Development and trial of Electronic Monitoring Systems for gillnet fleets					
	1.2.5 Port sampling protocols for artisanal fisheries					
	1.3 Review the status of manta and mobula rays and their interaction with IOTC fisheries. Evaluation of data availability and data gaps. Include ID guide revision and translation. ID guides to be updated with help of CPC scientists					
2. Bycatch mitigation measures	Undertake a series of gear specific workshops focusing on multi-taxa bycatch issues					
	Develop studies on bycatch mitigation measures (operational, technological aspects and best practices)					
	2.1 Sharks a) Harmonise and finalise guidelines and protocols for safe handling and release of sharks and rays caught in IOTC fisheries					
	2.2 Sea turtles 2.2.1 Res. 12/04 (para. 11) Part I. The IOTC Scientific Committee shall request the IOTC Working Party on Ecosystems and Bycatch to:					
	a) Develop recommendations on appropriate mitigation measures for gillnet, longline and purse seine fisheries in the IOTC area; [mostly completed for LL and PS]					
	b) Develop regional standards covering data collection, data exchange and training					
	2.2.2 Res. 12/04 (para. 17) The IOTC Scientific Committee shall annually review the information reported by CPCs pursuant to this measure and, as necessary, provide recommendations to the					

	Commission on ways to strengthen efforts to reduce marine turtle interactions with IOTC fisheries.					
	2.2.3 Regional workshop to review the effectiveness of marine turtle mitigation measures					
	2.2.4 Harmonise and finalise guidelines and protocols for safe handling and release of sea turtles caught in IOTC fisheries					
	2.3 Seabirds 2.3.1 Res. 12/06 (para. 8) The IOTC Scientific Committee, based notably on the work of the WPEB and information from CPCs, will analyse the impact of this Resolution on seabird bycatch no later than for the 2016 meeting of the Commission. It shall advise the Commission on any modifications that are required, based on experience to date of the operation of the Resolution and/or further international studies, research or advice on best practice on the issue, in order to make the Resolution more effective.					
	2.3.2 Bycatch assessment for seabirds taking into account the information from the various ongoing initiatives in the IO and adjacent oceans					
	2.3.3 Study on cryptic mortality of seabirds in tuna LL fisheries.					
	2.3.4 Study post release survival rates for seabirds and harmonise and finalise guidelines and protocols for safe handling and release of seabirds caught in IOTC fisheries					

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

	3.1.5 Silky shark: Priority fleets: Purse seine fleets					
	3.2 Joint CPUE standardization across the main LL fleets for silky shark, using detailed operational data					
	3.3 Stock assessment and other indicators					
4. Bycatch and discards	4.1 Review proposal on retention of non-targeted species					
	4.1.1 The Commission requested that the Scientific Committee review proposal IOTC–2014– S18–PropL Rev_1, and to make recommendations on the benefits of retaining non-targeted species catches, other than those prohibited via IOTC Resolutions, for consideration at the 19th Session of the Commission. (S18 Report, para. 143). Noting the lack of expertise and resources at the WPEB and the short timeframe to fulfil this task, the SC RECOMMENDED that a consultant be hired to conduct this work and present the results at the next WPEB meeting. The following tasks, necessary to address this issue, should be considered for the terms of reference, taking into account all species that are usually discarded on all major gears (i.e., purse-seines, longlines and gillnets), and fisheries that take place on the high seas and in coastal countries EEZs:					
	i) Estimate species-specific quantities of discards to assess the importance and potential of this new product supply, integrating data available at the Secretariat from the regional observer programs,					

	ii) Assess the species-specific percentage of discards that is captured dead versus alive, as well as the post-release mortality of species that are discarded alive, in order to estimate what will be the added fishing mortality to the populations, based on the best current information, iii) Assess the feasibility of full retention, taking into account the specificities of the fleets that operate with different gears and their fishing practices (e.g., transhipment, onboard storage capacity).					
	iv) Assess the capacity of the landing port facilities to handle and process this catch.					
	v) Assess the socio-economic impacts of retaining non-target species, including the feasibility to market those species that are usually not retained by those gears,					
	vi) Assess the benefits in terms of improving the catch statistics through port-sampling programmes,					
	vii) Evaluate the impacts of full retention on the conditions of work and data quality collected by onboard scientific observers, making sure that there is a strict distinction between scientific observer tasks and compliance issues.					
5. Ecosystems	5.1 Develop a plan for Ecosystem Approach to Fisheries (EAF) approaches in the IOTC, in conjunction with the Common Oceans Tuna Project.					
	5.1.2 Workshop for CPCs on continuing efforts to the development of an EAF including delineation of candidate eco regions within IOTC.					
	5.1.3 Practical Implementation of EBFM with the development and testing of ecosystem report cards.					

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

Table A20. Draft: Assessment schedule for the IOTC Working Party on Ecosystems and Bycatch 2023–2027 (adapted from IOTC–2021–SC24–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	**2023**	**2024**	**2025**	**2026**	
Blue shark	–	–	Data preparatory meeting Full assessment	-	–
Oceanic whitetip shark	–	Data preparation	Indicator analysis	-	Data preparation
Scalloped hammerhead shark	–	–	–	-	–
Shortfin mako shark		Data preparation Full assessment	–	-	Data preparatory meeting
Silky shark	Assessment*	-	–	Assessment*	-
Bigeye thresher shark	-	–	–	Assessment*	–
Pelagic thresher shark	-	–	–	Assessment*	–
Porbeagle shark	Assessment*	–	–	-	–
Mobulid Rays	-	Interactions/ Indicators	–	-	Interactions/ Indicators
Marine turtles	Indicators	–	–	-	–
Seabirds	–	Development of draft workplan	–	Review of mitigation measures in Res. 12/06	–
Marine Mammals	–	–	Review of mitigation measures	-	–
Ecosystem Based Fisheries Management (EBFM) approaches		Ecoregions pilot study			
Series of multi-taxa bycatch mitigation workshops	Focus: gillnets	Focus: gillnets	Focus: tbd	Focus: tbd	Focus: tbd

APPENDIX XVIII
CONSOLIDATED RECOMMENDATIONS OF THE 18TH SESSION OF THE WORKING PARTY ON ECOSYSTEMS AND BYCATCH

Note: Appendix references refer to the Report of the 18th Session of the Working Party on Ecosystems and Bycatch (IOTC–2022–WPEB18–R)

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

WPEB18.01 (para. 42) **NOTING** that sharks caught in association with tuna fisheries in the Indian Ocean include migratory and straddling stocks which require regional cooperation, joint scientific research programmes and mitigation measures for protection endangered, threatened and protected species, the WPEB **RECOMMENDED** that the SC support cooperation and coordination with the Nairobi Convention on the development of RPOAs and prioritise funding to support such research and management activities for improving the status of sharks and rays in the Indian Ocean.

Stock assessment and indicators for sharks: Recommendation and executive summaries

WPEB18.02 (para. 120) The WPEB **NOTED** the uncertainty in the catch series, high levels of misidentified catch and underreporting of catches for scalloped hammerhead sharks. The WPEB **RECOMMENDED** that the SC endorse an update of the list of sharks, rays and ETP species included in Appendix II of IOTC Resolution 15/01 for each fishing gear. In particular, to ensure that all species groups under the current broad categories (e.g., Hammerhead sharks (Sphyrna spp–) - SPN, Mako sharks (Isurus spp–) - MAK, Marine turtl–s - TTX, etc.) are reported separately by species (e.g. scalloped hammerhead (*Sphyrna lewini*; SPL), great hammerhead (*Sphyrna mokarran*; SPK), smooth hammerhead (*Sphyrna zygaena*; SPZ), shortfin mako (*Isurus oxyrinchus*).

WPEB18.03 (para. 128) **RECALLING** the request by the Commission to develop research plans for sharks, the WPEB **RECOMMENDED** that the SC endorse the creation of a working group to work intersessionally to develop a series of research plans/program for sharks with scalloped hammerhead as a priority species.

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

WPEB18.04 (para. 138) The WPEB **NOTED** that the use of artificial lights (a visual deterrent) in gillnet fisheries as a potential bycatch mitigation device was discussed at length and **NOTED** the strong support for the rolling out of future LED trials across the Indian Ocean by the workshop participants. However, the WPEB **NOTED** that the use of artificial lights is banned in the Indian Ocean due to IOTC Resolution 16/07. Therefore, the WPEB **RECOMMENDED** that the SC seek clarification from the Commission on whether Resolution 16/07 applies to gillnet fisheries and to scientific studies as the current wording is somewhat ambiguous.

WPEB18.05 (para. 149) The WPEB **RECOMMENDED** that the SC and other working groups review the ongoing ecoregion process, including their purpose and potential benefits in providing more integrated regional advice and provide feedback to the WPEB. The WPEB also **RECOMMENDED** that the SC endorses the proposed refined candidate ecoregions and the development of pilot projects to evaluate their utility and effectiveness as a tool to support regional ecosystem planning and prioritization, incentivized ecosystem research and the development of integrated advice products for informing fisheries management decisions. .

All bycatch species

WPEB18.06 (para. 151) The WPEB **NOTED** the evidence indicating the increased operation of squid fisheries in the high seas of the Indian Ocean, and particularly in fishing grounds which overlap with areas where tuna purse seine fleets operate, **NOTING** that this overlap results in bycatch of tuna and tuna-like species in the squid fishery. However, as these fisheries are not managed by IOTC, data on these catches of tuna and tuna-like species are not provided to the IOTC. Therefore, the WPEB **RECOMMENDED** that the SC **RECOMMEND** that the Commission request that CPCs report all catches of tuna to the IOTC regardless of the target species of the fishery. The WPEB further **REQUESTED** that the Compliance Committee seek more information on this fishery from the CPCs.

Seabirds: Review of mitigation measures in Resolution 12/06

WPEB18.07 (para. 176) **NOTING** the effectiveness of hook-shielding devices in reducing seabird bycatch mortality in pelagic longlines and the fact that the WCPFC included the hook-shielding devices in 2018 as an optional measure to mitigate longline seabird bycatch, while also **NOTING** that the actual utilisation of this device in commercial fishing has been limited partially due to operational difficulty and cost efficiencies, the WPEB **RECOMMENDED** that the SC consider whether to include hook-shielding devices as an additional option for seabird bycatch mitigation measures in Res. 12/06 and if so, to recommend to the Commission, accordingly.

Sea turtles

WPEB18.08 (para. 181) The WPEB **NOTED** that the IOSEA has been collaborating with the IOTC for many years and the Letter of Intent is intended to formalise this collaboration. The WPEB **ACKNOWLEDGED** the Letter of Intent and **RECOMMENDED** that the letter is discussed at the SC.

Revision of the WPEB Program of Work 2023-2027

WPEB18.09 (para. 183) The WPEB **RECOMMENDED** that the SC consider and endorse the WPEB Program of Work (2023–2027), as provided in Appendix XVII.

Review of the draft, and adoption of the Report of the 18th Session of the WPEB

WPEB18.10 (para. 185): The WPEB **RECOMMENDED** that the Scientific Committee consider the consolidated set of recommendations arising from WPEB18, provided at Appendix XVIII, as well as the management advice provided in the draft resource stock status summary for each of the seven shark species, as well of those for marine turtles and seabirds:

Sharks

- Blue sharks (*Prionace glauca*) – Appendix VII
- Oceanic whitetip sharks (*Carcharhinus longimanus*) – Appendix VIII
- Scalloped hammerhead sharks (*Sphyrna lewini*) – Appendix IX
- Shortfin mako sharks (*Isurus oxyrinchus*) – Appendix X
- Silky sharks (*Carcharhinus falciformis*) – Appendix XI
- Bigeye thresher sharks (*Alopias superciliosus*) – Appendix XII
- Pelagic thresher sharks (*Alopias pelagicus*) – Appendix XIII

Other species/groups

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