Report of the Indian Ocean Shark Research Plan workshop (IO-ShPl02)

Cape Town, South Africa, 28–30 July 2026

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ACRONYMS

ASPIC	A Stock Production Model Incorporating Covariates
ASPM	Age-Structured Production Model
AZTI	Aztapen Zientzia eta Teknologia Institutua (Spain)
B	Biomass (total)
BBNJ	Agreement on the Conservation and Sustainable Use of Marine Biological Diversity of Areas Beyond National Jurisdiction
B_{MSY}	Biomass which produces MSY
BLICC	Bayesian Length Interval Catch Curve
BSH	Blue shark (*Prionace glauca*)
BTH	Bigeye thresher sharks (*Alopias superciliosus*)
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora
CKMR	Close-Kin-Mark-Recapture
CMFRI	Central Marine Fisheries Research Institute (India)
CMM	Conservation and Management Measure (of the IOTC; Resolutions and Recommendations)
CMS	Convention on Migratory Species
CMSY	Catch-only resilience model
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.
EASI-Fish	Ecological Assessment of the Sustainable Impacts of Fisheries
EEZ	Exclusive Economic Zone
EMS	Electronic Monitoring Systems
ERA	Ecological Risk Assessment
F	Fishing mortality; F_{2024} is the fishing mortality estimated in the year 2024
FAD	Fish aggregating device
FAL	Silky shark (*Carcharhinus falciformis*)
F_{MSY}	Fishing mortality at MSY
GLM	Generalized linear model
GN	Gillnet
ICCAT	International Commission for the Conservation of Atlantic Tunas
ID	Identification
IDN	Indonesia
IO	Indian Ocean
IOShPl	Indian Ocean shark research plan
IOTC	Indian Ocean Tuna Commission
IRN	I. R. Iran
ISRA	Important Shark and Ray Areas
IUCN	International Union for Conservation of Nature
JABBA	Just Another Bayesian Biomass Assessment
LB-SPR	Length-Based Spawning Potential Ratio
LL	Longline
LMA	Longfin mako shark (*Isurus paucus)*
M	Natural mortality
MAK	Mako sharks (*Isurus* spp.)
MAN	Manta and devil rays (Mobulidae)
MOB	Mobulidae
MOZ	Mozambique
MSY	Maximum sustainable yield
n.a.	Not applicable
NDF	Non Detrimental Findings
NGO	Non Governmental Organisation
NMFDC	National Marine Fisheries Data Centre (India)
OCS	Oceanic whitetip shark (*Carcharhinus longimanus*)
PAK	Pakistan

PLS	Pelagic stingray
POR	Porbeagle (*Lamna nasus*)
PRM	Post Release Mortality
PRS	Post Release Survival
PS	Purse seine
PSA	Productivity Susceptibility Analysis
PSK	Crocodile shark (*Pseudocarcharias kamoharai*)
PTH	Pelagic thresher sharks (*Alopias pelagicus*)
RFMO	Regional Fisheries Management Organization
RHN	Whale shark (*Rhincodon typus*)
ROS	Regional Observer Scheme
SAFE	Sustainability Assessment for Fishing Effects
SC	Scientific Committee of the IOTC
SB	Spawning biomass (sometimes expressed as SSB)
SB_{MSY}	Spawning stock biomass which produces MSY
SKH	Other Sharks and rays
SMA	Shortfin mako sharks (*Isurus oxyrinchus*)
SPiCT	Stochastic Production in Continuous Time
SPK	Great hammerhead shark (*Sphyrna mokarran*)
SPL	Scalloped hammerhead sharks (*Sphyrna lewini*)
SPR	Spawning Per-Recruit
SPY	Hammerhead shark (Sphyrnidae)
SPZ	Smooth hammerhead shark (*Sphyrna zygaena*)
SRA	Stock-reduction analysis
SS3	Stock Synthesis III
THR	Thresher sharks (*Alopias* spp.)
TIG	Tiger shark (*Galeocerdo cuvier*)
VPA	Virtual Population Analysis
WCS	Wildlife Conservation Society
WIO	Western Indian Ocean
WPEB	Working Party on Ecosystems and Bycatch (of the IOTC)
XSA	Extended Survivors Analysis
YPR	Yield Per-Recruit

TABLE OF CONTENTS

1. Opening of the session and introductory discussions 12
2. Review of the current shark data available and identification of main data gaps 15
3. Review of the current available information in terms of biological and ecological knowledge of the seven major shark species (BSH, SMA, OCS, FAL, SPL, PTH AND BTH) 24
4. Review of the current available and implemented mitigation measures, including best practice codes/procedures, in terms of reducing shark bycatch and incidental mortality 30
5. Review of the most appropriate assessment methods that could be used on the main shark species, as well as the potential use of other indicators as alternatives to traditional stock assessment approaches 41
6. Identify major needs in terms of capacity building, aiming to bring the quality and quantity of data up to minimum IOTC standards 49
7. Priorities for data collection and research on shark species and a plan to move forwards ... 52
8. Identification of potential funding sources and application procedures 63
9. Review of the draft Indian Ocean shark year program (IO-ShYP) for submission to the WPEB in 2026 63

Appendix I List of participants 64
Appendix II Agenda for the Indian Ocean Shark Year Program (IO-ShPl02) workshop 65
Appendix III Agenda Item 2 Supporting Information: Review of the IOTC Resolutions relevant to sharks, current information available (fisheries, data collection) and identification of major gaps 67
Appendix IV Agenda Item 3 Supporting Information: Review of the current available information in terms of biological and ecological knowledge of the seven major shark species (bsh, sma, ocs, fal, spl, pth and bth) 94
Appendix V Agenda Item 4 Supporting Information: Review of the current available and implemented mitigation measures, including best practice codes/procedures, in terms of reducing shark bycatch and incidental mortality 110
Appendix VI Agenda Item 5: Supporting Information on assessment methodologies............ 150
Appendix VII Directory of available capacity building materials 153
Appendix VIII Directory of potential funding sources 160
Appendix VIV Consolidated Recommendations of the First Session of the Indian Ocean Shark Year Program Workshop (IO-ShPl02)............ 164

EXECUTIVE SUMMARY

Readers of this report are encouraged to interpret it as a document with the sole aim of improving the information at the IOTC for future use in developing stock assessment and/or status indicators for shark species caught by IOTC fisheries and not as compliance issues with IOTC Conservation and Management Measures on provision of data for shark species.

The following is a set of recommendations from the workshop:

2. Review of the current shark data available and identification of main data gaps

2.5 Information and datasets from coastal CPCs

(para. 63) The IOShPl **RECOMMENDED** that a high priority activity would be to secure a consultant with expertise in gillnet fisheries to work in various CPCs in order to improve the validity of data and information coming from these fisheries. The IOShPl **NOTED** that this could be combined with capacity building activities. The IOShPl **STRESSED** that improvements to data collection systems in CPCs should include all species **NOTING** that neritic tuna species are also subject to many data gaps. The IOShPl **NOTED** that these capacity building activities would need to be continued for a number of years until CPCs are able to manage it by themselves.

(para. 65) The IOShPl **NOTED** that Resolution 15/01 only requires species level reporting of 4 species for gillnets (blue, porbeagle, oceanic whitetip and whale sharks) and 3 species for purse seine fisheries (oceanic whitetip, silky and whale sharks) while other species are either optional species to be recorded or are only required at family level (mako, hammerhead and thresher sharks). The IOShPl further **NOTED** that elements of Resolution 15/01 actively promote poor data reporting practices such as aggregating data by saying that any species not listed as mandatory for collection under each gear may be reported as aggregates. Therefore, the IOShPl **RECOMMENDED** that the WPEB once again recommend that the Commission update Resolution 15/01 so species level reporting is required for more shark species for all gears as suggested by WPEB in 2025.

(para. 67) The IOShPl **NOTED** that many research organisations and scientists are holding data that have not been fully analysed or published and so **RECOMMENDED** that the WPEB organise a data call for these kinds of data for sharks.

2.8 Trade data

(para. 89) The IOShPl **NOTED** that there have been found to be large disparities between landings data and trade data for sharks with landings data being much lower generally. In some cases, trade data is available for sharks being exported from countries that report no catches of sharks. This has been investigated mostly for CITES listed species to date.

(para. 90) The IOShPI **NOTED** that at the 34th CITES Animals Committee some key country species combinations were selected to undergo a Review of Significant Trade.

(para. 91) The IOShPl **RECOMMENDED** that the WPEB explore these disparities further specifically for the Indian Ocean.

3. Review of current available information in terms of biological and ecological knowledge of the seven major shark species

3.2 Review of the current biological knowledge

(para. 150) The IOShPl **RECOMMENDED** the WPEB to facilitate the creation of an inventory of samples through putting out a call for information on sample availability around the Indian Ocean.

In addition to this, the workshop produced a detailed roadmap of activities that should be carried out in order to improve the management of sharks by IOTC. This can be seen in Section 7 - Priorities for data collection and research on shark species and a plan to move forwards.

An infographic setting out an overview of the road map of key activities to be undertaken under this shark research plan can be seen on the next page (Figure 1).

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, as adopted by the Scientific Committee in 2025 (IOTC–2025–SC28–R).

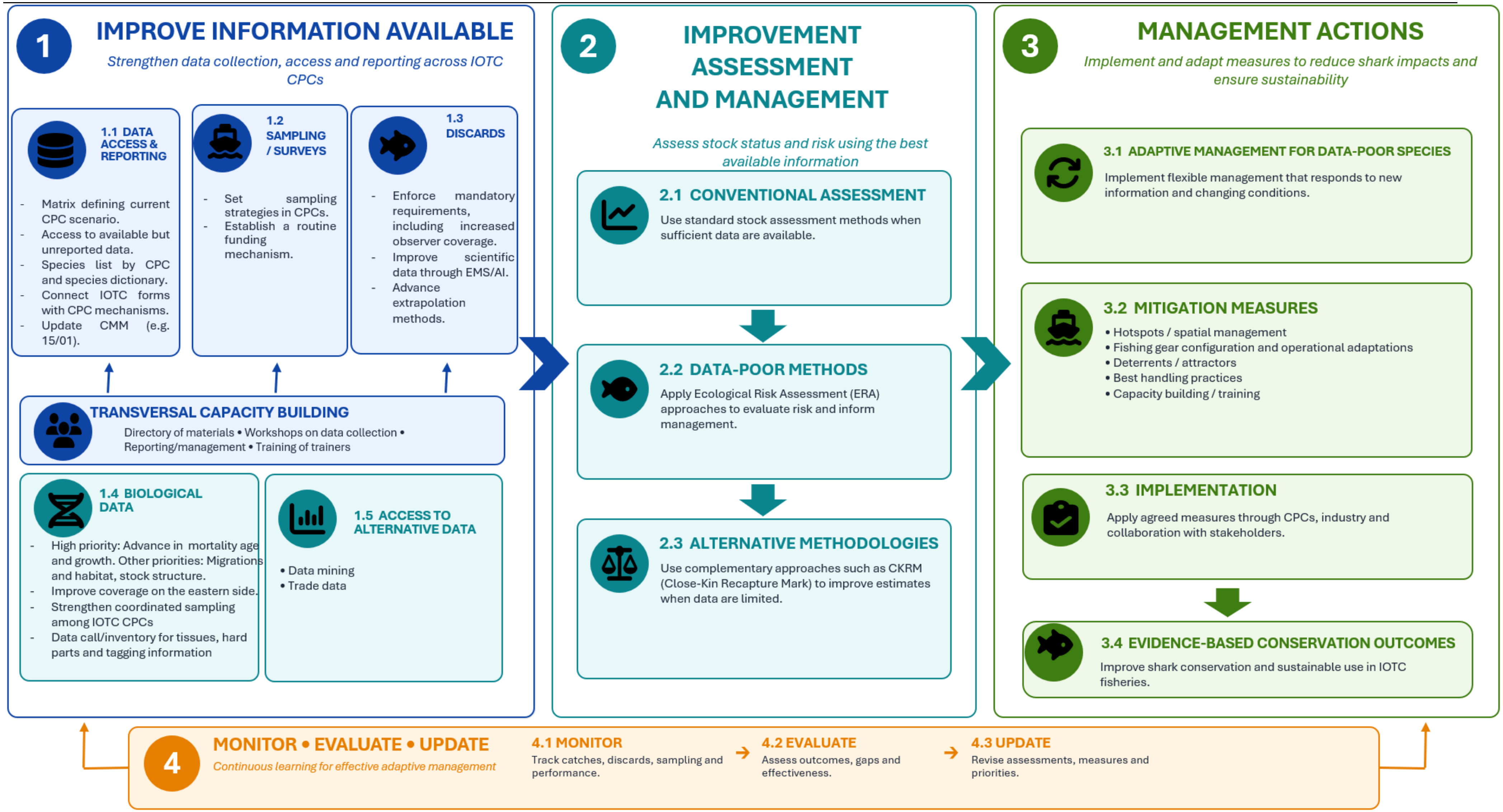

Figure 1: Infographic setting out an overview of the road map of key activities to be undertaken under this shark research plan

Table 1. Status summary for species of sharks impacted by IOTC fisheries (Source: IOTC–2025–SC28–R)

Stock	Indicators		2021	2022	2023	2024	2025	Advice to the Commission
Blue shark *Prionace glauca*	Reported catch 2024 (t) Not elsewhere included (nei) sharks1 2024 (t) Average reported catch 2020-2024 (t) Avg. not elsewhere included (nei) sharks 2020-2024 (t) MSY (1,000 t) (80% CI) F_{MSY} (80% CI) SB_{MSY} (1,000 t) (80% CI) F_{2022}/F_{MSY} (80% CI) SB_{2022}/SB_{MSY} (80% CI) SB_{2022}/SB_0 (80% CI)	9,562 15,742t 9,463 24,929 t 30.81 (21.79 - 39.84) 0.18 (0.18 - 0.18) 52.87 (37.38 - 68.37) 0.39 (0.21 - 0.57) 2.22 (1.76 - 2.68) 0.73 (0.34 - 1.13)					**100%**	Two stock assessments were carried out for blue shark (BSH) in 2025: one using a Bayesian state-space surplus production model (JABBA) and another using an integrated age-structured model (SS3). Both assessments used data (catch and indices of abundance) from 1950 to 2023, although the model structure was inherently different. The SS3 model included annual length composition data where available. Uncertainty in data inputs and model configuration were explored through sensitivity analyses. All models produced similar results. On the weight-of-evidence available in 2025, the stock status is determined to be **not overfished** and **not subject to overfishing**. The SS3 assessment indicates current catches are near MSY, and significant increases could result in decreasing biomass and the stock becoming subject to overfishing in the future. The stock should be closely monitored, especially with respect to overall catch and discard reporting. 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.
Shortfin mako *Isurus oxyrinchus*	Reported catch 2024 (t) Catches reported to MAK in 2024 (t) Average catches reported to MAK 2020-2024 (t) Catches in 2024 (MAK, SMA, LMA) (t) Average catches 2020-2024 (MAK, SMA, LMA) (t)	1,451 930 474 1,280 16,033 25,873 846 30,813				50%		In 2024 a stock assessment was carried out for the shortfin mako shark in the IOTC area of competence, using data until 2022. The model applied was a population biomass dynamics model using the platform JABBA. The stock status and projections were based on an ensemble grid of 9 models designed to capture the main uncertainties relating to biology (3 options) and the shape of the production curve used in biomass dynamics models (3 options). Considering the characterised uncertainty, and on the weight-of-evidence available in 2024, the shortfin mako shark stock is determined to be **overfished** and **subject to overfishing**.

	Not elsewhere included (nei) sharks 2024 (t) Average reported catch 2020-2024 (t) Av. Not elsewhere included (nei) sharks 2020-2024 (t) MSY (1,000 t) (80% CI) FMSY (80% CI) BMSY (1,000 t) (80% CI) F_{2022} /FMSY (80% CI) B_{2022} /BMSY (80% CI) B_{2022} /B0 (80% CI)	 1.93 (0.99 – 3.31) 0.03 (0.01 – 0.07) 60.0 (35.7 – 103.8) 1.53 (0.65 – 3.71) 0.96 (0.58 – 1.41) 0.45 (0.27- 0.69)						The Commission should take a cautious approach by implementing management actions that reduce fishing mortality on shortfin mako sharks, and the stock should be closely monitored. While mechanisms exist for encouraging CPCs to comply with their recording and reporting requirements (Resolution 18/07), these need to be further implemented by the Commission so as to better inform future scientific advice. In order to have a lower than 50% probability of exceeding MSY-reference points in 10 years, i.e., to recover the stock to the green quadrant of the Kobe plot with at least 50% probability in 10 years, future catches should not exceed 40% of the average catches between 2020-2022 (i.e., last 3 year of catches used in the model). This corresponds to an annual TAC of 1,217.2 t (representing all fishing mortality including retention, dead discards and post-release mortality), noting that this TAC level should include and account for the SMA, MAK and MSK species codes as reported to IOTC
Oceanic whitetip shark *Carcharhinus longimanus*	Reported catch 2024 (t) Not elsewhere included (nei) sharks 2024 (t) Average reported catch 2020–2024 (t) Ave. (nei) sharks 2020–2024 (t)	901 15,55 9 541 24,593						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.
Scalloped hammerhead shark *Sphyrna lewini*	Reported catch 2024 (t) Not elsewhere included (nei) sharks 2024 (t) Average reported catch 2020–2024 (t) Ave. (nei) sharks 2020–2024 (t)	1,537 15,694 766 24,976						
Silky shark *Carcharhinus falciformis*	Reported catch 2024 (t) Not elsewhere included (nei) sharks 2024 (t) Average reported catch 2020–2024 (t) Ave. (nei) sharks 2020–2024 (t)	1,591 15,559 2,062 24,593						
Bigeye thresher shark *Alopias superciliosus*	Reported catch 2024 (t) Not elsewhere included (nei) sharks2 2024 (t)	< 1 15,559 <1						

	Thresher sharks nei 2024 (t) Average reported catch 2020-2024 (t) Av. Not elsewhere included (nei) sharks 2020-2024 (t) Av. Thresher sharks nei 2020-2024 (t)	<1 24,976 383						
Pelagic thresher shark *Alopias pelagicus*	Reported catch 2024 (t) Not elsewhere included (nei) sharks 2024 (t) Thresher sharks nei 2024 (t) Average reported catch 2020-2024 (t) Av. Not elsewhere included (nei) sharks2 2020-2024 (t) Av. Thresher sharks nei 2020-2024 (t)	145 15,559 <1 149 24,976 383						
Porbeagle shark *Lamna nasus*	Reported catch 2024 (t) Not elsewhere included (nei) sharks1 2024 (t) Average reported catch 2020-24 (t) Avg. not elsewhere included (nei) sharks1 2020-24 (t)	<1 15,559 <1 24,593						

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		

1. OPENING OF THE SESSION AND INTRODUCTORY DISCUSSIONS

1. The Indian Ocean Shark Year Program workshop (IOShPl02) was held in Cape Town, South Africa from 28 to 30 July 2026. A total of 12 invited experts attended the workshop (Appendix I). The meeting was opened by the Coordinators Dr. Charlene da Silva (Chair of the WPEB) and Lauren Nelson (IOTC Secretariat).

2. The IOShPl **ADOPTED** the Agenda provided at Appendix II.

3. The IOShPl **RECALLED** that the Working Party on Ecosystems and Bycatch (WPEB) have been discussing the need to develop a multi-year shark research plan for many years and further **RECALLED** that the Commission adopted Resolution 25/08 which also called for the development of such a plan:

   (para. 38) "*The IOTC Scientific Committee shall, through the IOTC Working Party on Ecosystems and Bycatch, continue its work on identifying and monitoring the status of sharks until such time as comprehensive assessments are possible for all relevant sharks, including those listed in paragraph 3, silky sharks, hammerhead sharks and mako sharks. The IOTC Scientific Committee shall establish terms of reference for a long term-project on sharks in the IOTC area of competence to be considered by the Commission at its annual Session in 2026, with the aim to ensure the collection of data required for performing reliable stock assessments for key shark species, including those listed in paragraph 3, silky sharks, hammerhead sharks and mako sharks. The project will include:*

   a) the identification of data gaps for key shark species in IOTC;

   b) the collection of relevant data, including through direct contacts with CPC national administrations, research institutes and stakeholders;

   c) any other activity that could contribute to improving the collection of data required for performing stock assessments of key shark species in IOTC;

   d) the development and further improvement of shark identification guides for relevant shark species to provide a better overview on the compliance status of CPCs and thereby assist CPCs to comply with their reporting obligations. The IOTC Executive Secretary shall make these shark identification guides available on the IOTC website and distribute them among CPCs in regular intervals.

   CPCs are encouraged to contribute financially to the implementation of the project."

   Comparison with 2014 research plan

4. The IOShPl **NOTED** that the development of the 2026 research plan represents the first comprehensive review of shark research priorities since the 2014 exercise, which provided a strong foundation for subsequent work. While many of the priority research needs identified in 2014 remain relevant, the meeting recognised that the management and scientific landscape has evolved over the past decade.

5. The IOShPl **NOTED** that the introduction of non-retention measures for several shark species has changed the information available for monitoring and assessment, creating new challenges for estimating catch, mortality, and population trends.

6. The IOShPl **NOTED** that the reported catch and discards continue to be underestimated for shark species in longline, purse seine, and particularly in gillnet and small-scale fisheries

7. The IOShPl **NOTED** that significant advances have also been made in research methodologies and technologies since 2014. Emerging approaches, including Close-Kin Mark-Recapture (CKMR), offer new opportunities to improve estimates of population size and demographic parameters for shark species where conventional assessment methods remain data-limited.

8. The IOShPl **NOTED** concerns that, despite the development of a comprehensive shark research plan in 2014, relatively limited progress has been made in implementing many of its priorities. The meeting observed that key knowledge gaps in shark biology, ecology, and fisheries remain largely unchanged, highlighting the need to place greater emphasis on implementation rather than further identifying research needs.

   Other organisations and international obligations

9. The IOShPl **NOTED** that many of the research activities that the IOShPl will propose are complementary to the objectives of organisations and international agreements beyond the tuna RFMOs. The IOShPl **NOTED** that

greater collaboration with bodies such as the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), the Convention on Migratory Species (CMS), the Important Shark and Ray (ISRA) process, and initiatives established under the Agreement on the Conservation and Sustainable Use of Marine Biological Diversity of Areas Beyond National Jurisdiction (BBNJ) would be beneficial, **RECOGNISING** that CPCs may be able to undertake research that simultaneously supports multiple international obligations.

10. The IOShPl **NOTED** that CITES permit requirements present large challenges for research on listed shark species, particularly where the international transfer of biological samples is required. The IOShPl therefore **EMPHASISED** the importance of identifying practical mechanisms that facilitate legitimate scientific research while ensuring compliance with CITES provisions.

11. The IOShPl **NOTED** that closer collaboration between tuna RFMOs, CITES authorities, and the wider scientific community is needed to develop practical solutions for the collection and transfer of biological samples from CITES-listed species. This could include exploring streamlined permitting processes or other mechanisms to facilitate research while maintaining appropriate regulatory oversight.

12. The IOShPl **NOTED** that this issue extends beyond the IOTC and should be considered as a shared priority across all tuna RFMOs. The workshop therefore **REQUESTED** the Secretariat to engage with other tRFMOs to develop a coordinated proposal, in collaboration with other international scientific organisations, to engage with CITES on facilitating scientific research involving CITES-listed shark species.

Research community involvement

13. The IOShPl **NOTED** that the research priorities identified during the workshop should be communicated more broadly to the wider scientific community.

14. . The IOShPl **AGREED** that making research priorities more widely accessible could encourage greater scientific collaboration and attract expertise from outside the RFMO community which could help to address the issue of this not having been done often in the past due to academic shark researchers perceiving tRFMOs as being difficult to engage with, although IOTC's WPEB is open to all interested stakeholders.

15. The IOShPl **NOTED** that there is a need to better align the research priorities of the scientific community with the information needs of the tuna RFMOs. While many researchers focus on species-specific questions, the RFMOs often require broader information to support fisheries management, highlighting the importance of identifying research objectives that can address both scientific and management needs.

16. The IOShPl **AGREED** that the list of scientific priorities for IOTC and the Indian Ocean region resulting from the IOShPl workshop will be publicised to the wider research community in order to provide them with some direction on activities that would actively assist to providing improvements to the knowledge required to monitor and manage these species. The IOShPl **NOTED** that networks such as the IUCN shark specialist group and the FAO Regional Secretariats Network could both be useful for circulating this information.

17. The IOShPl **NOTED** that successful collaborative initiatives already exist within various tuna research programmes, particularly for the collection of biological information such as reproductive and growth indicators. The IOShPl **RECOGNISED** that these collaborative sampling and data collection frameworks provide useful models that could be adapted to address similar biological data gaps for shark species.

18. The IOShPl **NOTED** that a greater emphasis should be placed on social science research within the implementation of the shark research plan. The IOShPl **ACKNOWLEDGED** that many existing knowledge gaps could be addressed through improved engagement with industry and NGOs working with many IOTC countries, alongside strengthened monitoring, compliance, and enforcement. The IOShPl further **NOTED** that addressing data limitations will require not only biological research but also targeted capacity development and socio-economic research.

19. The IOShPl **NOTED** that upcoming international scientific forums provide valuable opportunities to communicate the research priorities and foster collaboration. In particular, the 2027 International Forum on Bycatch of Marine Megafauna (IFBMM) symposium was identified as a potential opportunity to disseminate the research plan and propose dedicated workshops on priority shark research topics.

20. The IOShPl **NOTED** that additional opportunities for outreach and collaboration are expected through the launch of EU funded projects, including the potential to organise thematic panels with participating organisations such as AZTI to raise awareness of the identified research priorities and encourage broader scientific engagement.

Need for alternative approaches

21. The IOShPl **NOTED** that, for many shark species, the quantity and quality of available data make conventional stock assessment approaches increasingly challenging. The IOShPl **EMPHASISED** the need to explore alternative assessment methods and research approaches that are better suited to data-limited species.

22. The IOShPl **NOTED** the importance of holding focused discussions to identify practical next steps for advancing shark assessments, including the consideration of alternative analytical approaches and collaborative research initiatives to address priority knowledge gaps.

23. **NOTING** the major issue with data reported to IOTC for sharks, the IOShPl discussed some potential approaches to overcome these issues.

24. The IOShPl **NOTED** that in the past eco-labels had provided strong incentives for behavioural change in fisheries due to market pressure. The IOShPl **NOTED** a suggestion for these eco-labels to better integrate data compliance related kind of requirements into existing eco-labelling schemes. The IOShPl **NOTED** that publicity would be needed for this kind of scheme to draw both market and industry attention.

25. The IOShPl **NOTED** the issues with the lack of data reporting for species under retention bans and **SUGGESTED** that fleets could be encouraged to incorporate new technologies such as EMS onboard their fleets which will help to improve data collection (particularly in cases where it is not possible for them to host a human observer) or increase observed coverage. The IOShPI **RECALLED** that CPCs should also collect information on discards (dead or alive) as per Resolution 15/01 and, hence, that logbooks should collect this information irrespective of whether the shark species is discarded or retained.

26. The IOShPl **NOTED** that while these could be practical approaches, ultimately the responsibility of providing accurate data lies with the CPCs so focus needs to be put on assisting coastal CPCs to help improve their data collection and reporting.

27. The IOShPl **NOTED** that a number of capacity building activities have been carried out by the Secretariat staff in recent years which helps them to identify the areas where CPCs require more support. The IOShPl **NOTED** that coastal fisheries are complex, often involving multi-species and multi-gear fleets and a large number of landing sites. The IOShPl **NOTED** that data collection at coastal CPCs may involve various institutions and collection systems. The Secretariat may make suggestions and seek to facilitate improvements at the CPCs, but these approaches will not be uniform across all CPCs, which makes large-scale implementation difficult.

28. The IOShPl **NOTED** that it is known that there are a large number of projects conducting surveys of small-scale fisheries at landing sites around the Indian Ocean as many of these were presented at the Sharks International Conference. This shows that there is a huge workforce actively monitoring these sites but these data rarely appear to be integrated with the data reporting of CPCs. The IOShPl **NOTED** that there is scope for a piece of work to get a better understanding of the work that is being done, the data being collected and how this could be brought together as a census to better understand the small-scale fisheries of the Indian Ocean and provide a complementary source of data and information.

2. REVIEW OF THE CURRENT SHARK DATA AVAILABLE AND IDENTIFICATION OF MAIN DATA GAPS

2.1 Shark catches trends, and species gear composition

29. The IOShPl **NOTED** that fishery statistics information necessary to carry out the assessment of shark species are required under a range of IOTC Conservation and Management Measures (CMMs). There are various requirements in IOTC for the collection of fishery data for sharks (Table 2).

Table 2: Summary of current Conservation and Management Measurements for sharks in the IOTC area of competence as of 2026

Management Requirement	Target species group	IOTC resolution
Reporting in logbooks	All bycatch including discards (dead/alive)	Res. 15/01, 26/06 & 25/08
Observers	All bycatch including discards (dead/alive)	Res. 25/06
Report catch including discards (dead/alive)	Sharks	Res. 15/01, 26/06 & 25/08
Mako sharks	Mako sharks	Res. 25/09
Mobulids	Mobulids	Res. 26/03
Full utilisation of sharks	Sharks	Res. 25/08
Fins naturally attached	Sharks	Res. 25/08
Mitigation research	Sharks	Res. 25/08
Prohibition of use of wire trace (North of 20 degrees South)	Sharks	Res. 25/08
Research Programme	Sharks	Res. 25/08
Mako sharks	Mako sharks	Res. 25/09
Mobulids	Mobulids	Res. 26/03
Prohibition of retention, transhipping, landing or storing any part of carcass		
Thresher sharks	Thresher shark	Res. 25/08
Oceanic whitetip shark	Oceanic whitetip shark	Res. 25/08
*Whale sharks**	Whale Shark	Res. 25/08
*Mako sharks***		
*Mobulids****	Mobulids	Res. 26/03
Prohibition of intentional setting on animal		
Whale shark	Whale shark	Res. 25/08
Mobulids	Mobulids	Res. 26/03
Safe handling and release guidelines	Sharks	Res. 25/08
Mako sharks	Mako sharks	Res 25/09
Mobulids	Mobulids	Res. 26/03
Move towards method to constrain total levels of mortality (including HCRs)		
Blue shark	Blue shark	Res. 25/08
Mako sharks	Mako sharks	Res 25/09
Development of NPOA Sharks	Sharks	Res. 25/08
Requirement for catch monitoring plans	Mobulids	Res. 26/03

* There is debate around whether the retention ban has actually come into force for whale sharks as the SC in 2025 did not specifically recommend this measure

** Retention is banned unless shark is dead at haulback and observer or EMS in place to verify this

*** There is an exemption for subsistence fisheries but those fisheries may not tranship, sell or offer for sale any part or whole carcass of mobulid rays

30. The IOShPl **NOTED** that to some extent, there are inconsistencies between the IOTC species-specific Resolutions adopted by the Commission and the core data reporting Resolutions (15/01 and 15/02), as well as in the Scientific Committee (SC) reports with regards to the species to be covered under different Resolutions and research priorities (i.e. most common species, other terminology) (Table 3).

Table 3. Species or species groups identified detailed by the Commission in Resolution 15/01 for data collection. (BTH: Bigeye thresher sharks *Alopias superciliosus*; BSH: Blue shark *Prionace glauca*; MAK: Mako sharks *Isurus* spp.; OCS: Oceanic whitetip shark *Carcharhinus longimanus*; FAL: Silky shark *Carcharhinus falciformis*; PTH: Pelagic thresher sharks *Alopias pelagicus*; SPL: Scalloped hammerhead sharks *Sphyrna lewini*; SPN: Hammerhead shark Sphyrnidae; SMA: Shortfin mako sharks *Isurus oxyrinchus*; THR: Thresher sharks *Alopias* spp.; RHN: Whale shark *Rhincodon typus*; MAN: Manta and devil rays Mobulidae; SKH: Other Sharks and rays; POR: porbeagle *Lamna nasus*).
The bottom portion underneath the solid line refer to species which are optional for recording.

Resolution 15/01			
Gillnet	**Longline**	**Purse seine**	**Pole and line**
BSH	BSH		
MAK	MAK		
OCS	OCS	OCS	
	FAL	FAL	
SPN	SPN		
THR	THR	THR	
THR	THR	THR	
RHN		RHN	
POR	POR		
SKH	SKH		SKH
Tiger shark	Tiger shark	FAL	
Crocodile shark	Crocodile shark	Manta/rays	
	Great white shark	SKH	
MAN	MAN	MAN	
Pelagic stingray	Pelagic stingray		

31. The IOShPl **NOTED** that reported shark catches increased substantially from approximately 8,000 t in 1950 to a peak of nearly 87,000 t around 2003–2004, followed by a gradual decline through the late 2010s and a partial increase in the most recent years. Throughout the time series, aggregated catches (categories “Various sharks nei” and “Unclassified”, hereafter aggregated as SKH/UNCL) have consistently dominated the reported composition, exceeding 90% of total catch for most of the period prior to the mid-1980s and remaining above 50% in relative terms even in recent decades.

32. The IOShPl **NOTED** that the first call to report shark data came in 2005 and some catches were reported retrospectively but these were mostly aggregated and were not linked to the current requirement for reporting data for sharks.

33. The IOShPl **NOTED** that gillnet fisheries account for the highest cumulative reported catch of sharks of all fishing groups, followed by longline and line fisheries.

34. Additional supporting information for this section is provided in Appendix III.

2.2 Data availability [Catch (landings and discards), effort, CPUEs series; gear selectivity; catch-at-size/age; Data mining/recovery of historical data sets for sharks]

35. The IOShPl **NOTED** the following main findings from the reported data:
    - a substantial proportion of total catches continues to be reported as aggregates,
    - the vast majority of size samples are concentrated in a small number of species, primarily the blue shark, and are almost exclusively derived from longline fisheries,

- for many species, no spatial overlap is observed between the georeferenced catches and size data samples distribution reported,
- discard records are not extrapolated to fleet-wide totals and cannot support quantitative discard-rate estimates, and
- observer coverage varies considerably and is not standardised in terms of fishing effort by fleet and year.

36. The IOShPl **NOTED** the species-level assessments of each of the five main datasets, where species-level data availability was classified into three tiers — High, Medium, or Low — using two complementary criteria: the number of distinct reporting fleets contributing data for that species, and a volume/detail metric specific to each dataset (cumulative catch in tonnes, number of 5°×5° grid cells, number of individual length measurements, or number of records) as seen in Figure 2. It can be seen that several species that are not mandatory for reporting under Resolution 15/01 have been reported.

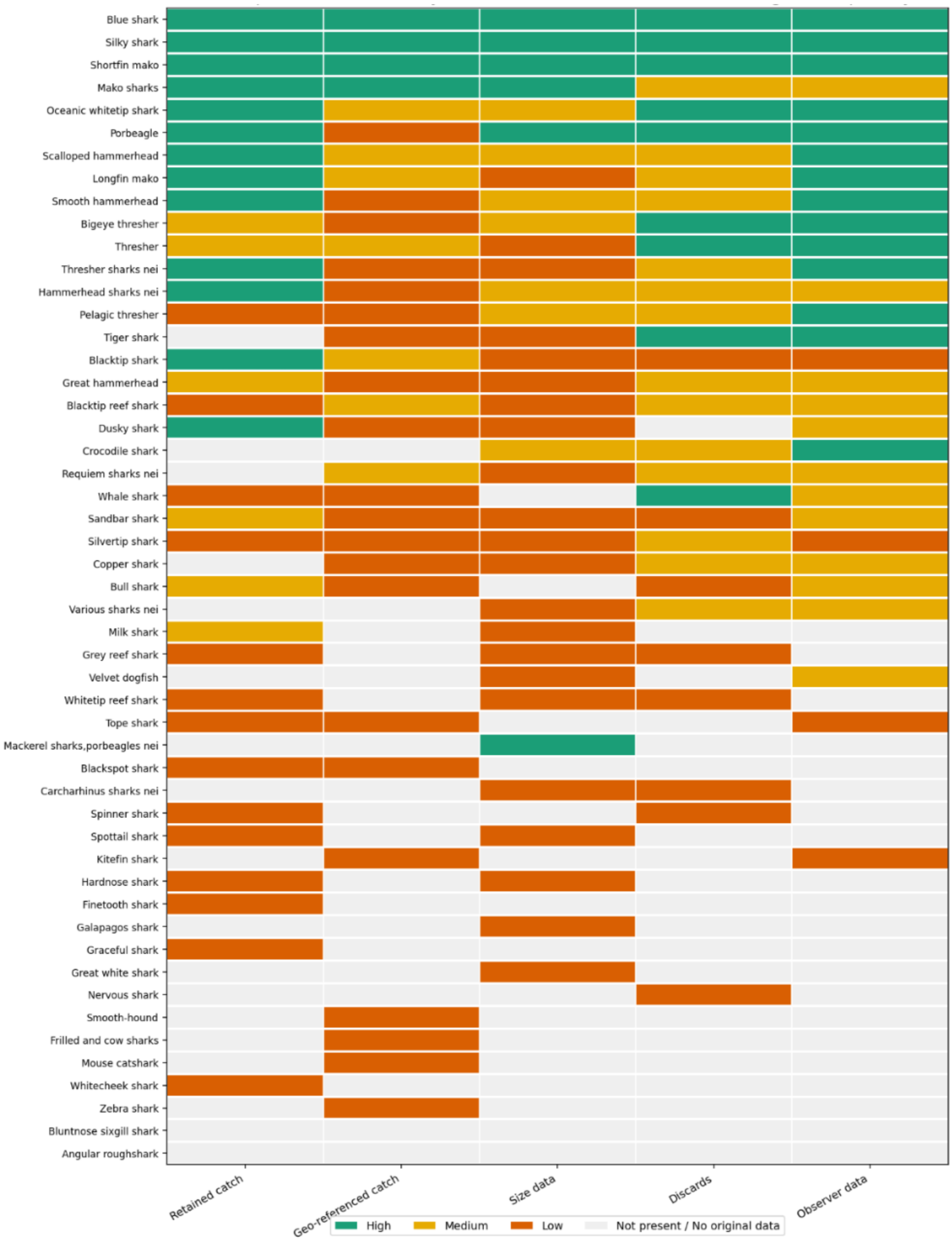

Figure 2. Summary of data availability (High / Medium / Low / not present) across five IOTC datasets (retained catch, geo-referenced catch, size data, discards, observer data), for all shark species/categories identified in this review, ranked from best-documented to least-documented by composite score.

37. The IOShPl **NOTED** Figure 2 and the information provided in Appendix III from which the following aspects can be noted:
    - Most of the shark species are taken as bycatch although there are fisheries targeting some shark species such as longline fleets targeting blue shark
    - Although there was an improvement in the reporting of shark catch data, a large volume of shark catches remains reported as aggregated (i.e. not to species level), representing between 40% and 70% of the catches and with high variability between years.
    - The main fisheries responsible for shark catches during the time series are gillnet fisheries, which includes a large proportion of catches of aggregated species being reported FAO Fishstat database, complements the dataset for some fleets, and although is useful for verifying the completeness of reports, however, it has its own limitations in terms of resolution since it is not disaggregated by gear.
    - Some coastal CPCs have improved their reporting at species level. Nevertheless, changes to the catch trends within the data series, have also been influenced by the re-estimation of catches by CPCs in recent years, particularly in the case of line fisheries (Indonesia and Mozambique).
    - The data availability analysis shows that only four species reach the maximum composite score across all five datasets, resulting in a small, well-documented number of species followed by a long list of poorly documented species.

38. The IOShPl **AGREED** that generally, it is therefore possible to conclude that:
    - Catch, catch and effort, and size frequency data for shark species from fisheries other than longline are lacking;
    - Catch, catch and effort, and size frequency data are lacking for several species included in the current reporting requirements.
    - Discards data for sharks and reports from observer programs are missing or have very low coverage and are not directly comparable across fleets; therefore, should only be used as an indication of the species recorded rather than to verify reported catch.

2.3 Data gaps and actions taken

Species aggregation

39. The IOShPl **NOTED** that the Secretariat communicates with CPCs regarding issues with data including when data have been submitted as aggregates. The IOShPl **NOTED** that several CPCs have reported that they have issues with species identification. The IOShPl **NOTED** that two species identification workshops have been held in recent years and a range of identification tools have been, or are in the process of being developed. The IOShPl **NOTED** that no obvious improvements to the data have been seen to date but this could be due to: insufficient time since the workshops to see this reflected in the datasets; a high level of turnover of staff in some CPCs meaning that this knowledge may have been lost from national institutions; and fundamental issues with the data collection and reporting systems in many CPCs.

40. The IOShPl **AGREEED** that species aggregated data is a key issue so there should be continued focus to improve the situation with regular capacity building activities. The IOShPl **NOTED** examples from the Caribbean where a capacity building activity was only conducted in one year which resulted in data being reported only for that year then the situation returned to previous state **HIGHLIGHTING** the need for sustained focus.

41. The IOShPl **NOTED** that an approach taken in the Mediterranean was to focus on specific species where there was a lack of understanding of their status by industry which found that when there was a greater awareness of

their legal status, there was an increased willingness to report their catches and release them. This required a compromise to focus on specific species rather than trying to address all species/issues simultaneously.

42. The IOShPl **AGREED** that a useful activity would be to ask CPCs to provide a list of species caught in their fisheries with an estimate of the species composition and any changes through time involving several stakeholders from each CPC in the process. The IOShPl **NOTED** that a starting point would be to use IUCN species distribution information for each EEZ so a list of species that are likely to be encountered within each CPCs' EEZ can be provided for them to check against. The IOShPl **NOTED** that this could also be used to develop a directory of species including local names and a feel from local stakeholders regarding how catches may have changed through time. The IOShPl **NOTED** that this approach could be used to provide a rough estimate of abundance of each species as has been done in Australia for a while.

Discards and length-frequency reporting

43. The IOShPl **NOTED** that the poor data quality situation has not been helped by the introduction of retention bans for several species which may have incentivised underreporting of catches and discards of these species. This has been seen in particular for mobulid rays which have very low levels of reporting. The IOShPl **NOTED** that these bans are necessary for the recovery of many species but there needs to be a way to encourage the continued reporting of released animals as required by Resolutions 25/08 and 25/09.

44. The IOShPl **NOTED** that several bycatch resolutions refer to a requirement to report 'interactions' with species but interactions is not well defined as it differs from regular catch and discards reporting.

45. The IOShPl **NOTED** that reporting discards can be problematic for some fleets due to national control systems – for example French fish inspection controls compare catches reported in electronic or paper logbooks against what is found onboard, which does not account for any discarded animals. Consequently, fishermen refrain from recording discards in their logbooks, despite this being a mandatory requirement. Bycatch is reporting through observer reports extrapolated to the total fishing effort of the French purse seine fleet. The IOShPl **NOTED** that for longline fleets, shark bycatch is reported both by the vessels (though self-reporting programs) and by observers but the longline bycatch estimations provided to IOTC are not extrapolated to the total fishing effort. The IOShPl **NOTED** that this highlights the conflicts between legislation and management needs which is difficult to solve given the current legislation and control systems. The IOShPl further **NOTED** that this highlights the need for better regulation.

46. The IOShPl **NOTED** that in some management frameworks, if discards information are not provided, assumptions are made that catch levels remain consistent after the introduction of a retention ban if there have been no changes to fleet behaviour and so the historical catches are used alongside a post-release mortality conversion factor to get an estimate of total mortality. The IOShPl **NOTED** however, that this can make monitoring of these species and any population recovery after a retention ban difficult to monitor which further highlights the need for discards information to be provided.

47. The IOShPl **NOTED** that there is known to be a potentially very large-scale underreporting of bycatch and discards as highlighted by Mucientes et al., 2022 who found that onboard a Spanish longline vessel operating in the Atlantic Ocean, the total discards of three threatened shark species (bigeye thresher, oceanic whitetip and smooth hammerhead sharks) made by a single observed vessel (from April-June) well exceeded the discards officially reported for the whole of that year for all CPCs. While this study only covered a single vessel operating in the Atlantic Ocean, the results are very likely to be similar for other vessels and those operating in other oceans and so highlights the potentially huge scale of underreporting by many fleets and so the scale of the underestimation of mortality of many species.

48. The IOShPl **NOTED** that, in purse seine fisheries, sharks are generally not reported as either retained catch or discards. Retention bans and the implementation of best handling and release practices could be contributing to the release of sharks that interact with the fishery. These interactions are recorded by observers and reported through the Regional Observer Scheme (ROS).

49. The IOShPl **NOTED** that for many fleets, ROS data do not align with the current retained catch and discard reporting frameworks due to their low coverage rates which results in a large underestimation of the reported catch and discards, which may result in an incomplete representation of shark interactions in official catch statistics.

50. The IOShPl **NOTED** that currently discards can be reported in either weight or number of animals and discard records are not extrapolated to fleet-wide totals and so these data cannot support quantitative discard-rate estimates. The IOShPl **NOTED** that there are very few discards data reported from gillnet fisheries and in many coastal fisheries there are thought to be very few discards as everything caught is thought to be retained in those fisheries.

51. The IOShPl **NOTED** that for some but not all discards records, the fate of the animal has been recorded.

52. The IOShPl **NOTED** that there is a much wider range of species recorded as discarded in observer data compared with the logbook data.

53. The IOShPl **NOTED** that reporting of size frequency data is very poor for many species and the majority of measurements originate from longline fisheries. The IOShPl further **NOTED** that very few samples include information on sex, in part due to the fact that the old form for submitting these data did not include a space to include this information but this has been updated with the new form adopted in 2024.

54. The IOShPl **NOTED** that a number of different length types have been submitted but there are limited conversion equations available for these species, particularly in the Indian Ocean. The IOShPl **NOTED** that there are several papers providing morphometric relationships for sharks in the Indian Ocean which are not thought to be being used currently. The IOShPl **NOTED** that for the Carcharhinus family, the morphometric relationships are thought to be exactly the same for several species. The IOShPl **SUGGESTED** approaching the Kwazulu-Natal Shark Board for length-weight data that could be examined to develop morphometric relationships as they have a large dataset.

55. The IOShPl **NOTED** that in many cases there is no spatial overlap observed between the georeferenced catches and size data samples distribution reported to the IOTC which highlights a large gap in both the size and georeferenced catch data.

CPC data collection systems

56. The IOShPl **NOTED** that many coastal fisheries are multi-gear and multi-species making data collection complex and often clear data collection procedures are not in place and, thus, data are often collected at an aggregated level or become aggregated when processed. The IOShPl **NOTED** that in some cases it is known that data are collected at species level but are not reported as such which may be related to the raising methodologies applied and, therefore, the IOShPl **REQUESTED** the Secretariat to work with such CPCs to improve their methodologies and systems to avoid this issue.

57. The IOShPl **NOTED** that there is a known issue with data from Madagascar where there is lots of instability in the data collection systems with changes to data collection sites. The IOShPl **NOTED** that the Secretariat are focusing on this CPC for missions to try to improve the situation.

2.4 Observer programs (design and implementation)

58. The IOShPl **NOTED** that the Regional Observer Scheme (ROS) started in 2010 but there have been issues since then to streamline the whole process including the stabilisation of the database and improving data reporting formats.

59. The IOShPl **NOTED** that two workshops were held in 2026 to try to improve the situation with observer programmes for purse seine and longline fleets. The IOShPl **NOTED** that the workshop including the purse seine industry found that these fleets are mostly reporting bycatch but not retained catch so it is not possible to estimate the catch composition (and this is therefore not meeting the requirements of the Resolution for the ROS). The longline workshop participants were presented with new forms which were revised by the relevant working parties in recent years and CPCs/are working with the Secretariat to re-compile data retrospectively using these forms.

60. The IOShPl **NOTED** that the observer data coverage are low for all major fleets and may not be representative of all areas where sharks are caught. There are also currently no implemented observer programs in gillnet fisheries in the IOTC area.

61. The IOShPl **NOTED** that many CPCs implementing or piloting EMS are not currently reporting these data. The IOShPI **REQUESTED** those CPCs to submit EMS collected data as part of their ROS data submissions.

2.5 Information and datasets from coastal CPCs

62. The IOShPl **NOTED** that a search was conducted for published and unpublished bycatch datasets from Indian Ocean coastal countries that may not already be incorporated into the IOTC database with a particular focus on certain priority CPCs (Iran, Pakistan, Indonesia, Yemen, Oman, India, Sri Lanka, Somalia, Kenya and Tanzania) and on gillnet fisheries in particular.

63. The IOShPl **NOTED** that CMFRI and NMFDC in India were highlighted as key data holders for the Indian fisheries and so suggested that they are contacted to collate any available bycatch datasets. The IOShPl **NOTED** that some other key data holders were identified such as NGOs like Wildlife Conservation Society (WCS) who could be approached to access these data.

64. The IOShPl **NOTED** that dealing with any new datasets will need to be handled with caution – there needs to be a clear distinction between data reported by CPCs to IOTC officially and other sources of data and **NOTED** that this will require the Secretariat to communicate with CPCs to avoid confusion.

65. The IOShPl **NOTED** that there are several data reporting streams from each CPC for various processes including CMS, CITES and BBNJ and highlighted that these could be harnessed by each CPC to flow into the IOTC process. The IOShPl **NOTED** however, that these international obligations are often handled by different organisations or government departments within CPCs meaning that internal communication may require improvements to facilitate this.

66. The IOShPl **NOTED** that in some cases the issue in CPCs may not be the lack of data but instead a weak monitoring and management system so some capacity building activities could focus on this aspect and should involve managers as well as scientists and enumerators.

67. The IOShPl **NOTED** that often in economies that are very fishing dependent, it is particularly challenging to collect data due to the large number of vessels and landing sites.

68. The IOShPl **SUGGESTED** that a high priority activity would be to secure a consultant with expertise in gillnet fisheries to work in various CPCs in order to improve the validity of data and information coming from these fisheries. The IOShPl **NOTED** that this could be combined with capacity building activities. The IOShPl **STRESSED** that improvements to data collection systems in CPCs should include all species **NOTING** that neritic tuna species are also subject to many data gaps. The IOShPl **NOTED** that these capacity building activities would need to be continued for a number of years until CPCs are able to manage it by themselves.

69. The IOShPl **NOTED** that enumerators tend to prioritise catches of the high value commercial species before other species such as sharks which often leads to issues such as species aggregation during data collection.

70. The IOShPl **NOTED** that Resolution 15/01 only requires species level reporting of 4 species for gillnets (blue, porbeagle, oceanic whitetip and whale sharks) and 3 species for purse seine fisheries (oceanic whitetip, silky and whale sharks) while other species are either optional species to be recorded or are only required at family level (mako, hammerhead and thresher sharks). The IOShPl further **NOTED** that elements of Resolution 15/01 actively promote poor data reporting practices such as aggregating data by saying that any species not listed as mandatory for collection under each gear may be reported as aggregates. Therefore, the IOShPl **RECOMMENDED** that the WPEB once again recommend that the Commission update Resolution 15/01 so species level reporting is required for more shark species for all gears as recommended by WPEB in 2025.

71. The IOShPl **NOTED** that South Africa have initiated citizen science projects which allow the general public to report the presence of illegal gillnets and FADs which provide data which have been used in assessments for hammerheads within the country. The IOShPl **NOTED** that something similar could potentially be rolled out in other countries where gillnets are illegal.

72. The IOShPl **NOTED** that many research organisations and scientists are holding data that have not been fully analysed or published and so **RECOMMENDED** that the WPEB organise a data call for these kinds of data for sharks.

73. The IOShPl **NOTED** that the Shark Trust have developed a data directory which helps to collate the metadata for datasets regarding certain species which allows data holders to publish the metadata for the data that they hold and provides a platform for others to access a wide range of data or contact the data holders directly.

74. The IOShPl **NOTED** that in the past Madagascar was known to have a strong coastal gillnet fleet which was thought to be focused on shark finning but that not much information is known about this fishery so the IOShPl **REQUESTED** the Secretariat to approach Madagascar to find out more.

75. The IOShPl **NOTED** that Sri Lanka intends to stop granting licences to newly registered gillnet vessels with the aim of encouraging the adoption of more sustainable fishing practices such as using longlines. The IOShPl **NOTED** that they are planning programmes to work with fishers to better understand bycatch and discards trends and reasoning behind retention of bycatch.

76. The IOShPl **REQUESTED** the Secretariat to take the following next steps regarding improving datasets from coastal CPCs:

- To look at the datasets that have already been identified
- Start building a platform with key contacts of data holders and follow up with them (e.g. CMFRI)
- Draw together maps of where data are in the region and their timelines
- From this identify any additional gaps to address can be identified and this should help to develop a plan required for the next steps.

2.6 Availability of nominal CPUE series which may not have been presented

77. The IOShPl **NOTED** that it is thought that all available robust CPUE series for sharks have been incorporated into relevant stock assessments to date. A summary of the available CPUE series can be seen in Appendix III.

78. The IOShPl **NOTED** that to date, historically the CPUEs derived from the longline fleets have been accepted as they were passive gears with less selectivity variability, they had broad coverage in time and area, and they provided a good historical time series with relatively consistent operations through time. However, due to the contraction of fleet operations in recent years, along with potential impacts from non-retention requirements for many species, the CPUE series from longline fleets are becoming less representative of the Indian Ocean as a whole so new abundance indices need to be explored.

79. The IOShPl **NOTED** that desirable characteristics of CPUE indices to be used as abundance indicators include:

- Adequate coverage of the extent of temporal and spatial distribution of target animals;
- Informative relationship with the density of animals in the fisheries operating time/area;
- An adequate time-series with relatively consistent gear efficiency and selectivity ; and

- A series that represents the Spawning Stock Biomass reasonably well, or at least, certain segment(s) of the target stock.

80. The IOShPl **NOTED** that the catch occurrence was compared with the availability of CPUE series for fisheries across the Indian Ocean.

81. After conducting this exercise, the IOShPl **NOTED** that the majority of catches of key species are taken in coastal fisheries where no abundance indices are available. The IOShPl **NOTED** that the amount of retained catch reported from longline fisheries has been decreasing in the last 15 years, and some of this reduction may be a result of the introduction of retention bans for various species. The IOShPl further **NOTED** that most CPCs with adequate tempo-spatial coverage have already been providing CPUEs derived using a variety of methodologies.

82. The IOShPl **NOTED** that there is little prospect of stopping the deterioration of longline monitoring capacity under non-retention requirements (due to lower acceptability of EMS, in particular for long distance fishing fleets and the lower probability of improving a detection of discarding events without pulling animals out of water). The IOShPl **NOTED** that in La Réunion some vessels are trialling cameras underwater to record discards and depredation events which could potentially be rolled out to other fleets if this proves to be successful.

83. The IOShPl **NOTED** that there is a potential to improve monitoring of shark bycatch and discards in purse seine fisheries according to the technological improvement and increased implementation of EMS in these fleets.

84. The IOShPl **NOTED** that there is also a possibility to improve monitoring in coastal small-scale fisheries, particularly if mobile phone-based EMS can be developed with additional functionalities beneficial to fishers. There is a potential to develop indicators using information from such applications.

85. The IOShPl **CONCLUDED** that developing abundance indices or indicators for coastal fisheries, in particular gillnet fisheries should be a high priority. The IOShPl **NOTED** that many coastal CPCs still require assistance to meet their data collection and reporting obligations. The IOShPl **SUGGESTED** that a joint abundance index in coastal CPCs could be explored based on the data available at the moment and **SUGGESTED** putting out a data call to understand what may be available ahead of specific assessments being conducted.

2.7 Collection of genetic data

86. The IOShPl **NOTED** that no information was provided by research institutions working on genetics projects for this section.

87. The IOShPl **NOTED** that it is known that a shortfin mako shark CKMR feasibility study concluded that 2,000 samples would be required annually for 5 years to conduct a full CKMR study for this species. However, the IOShPl **NOTED** that this sample collection will be complicated by the new retention ban for this species.

88. The IOShPl **NOTED** that there is also known to be an ongoing project for CKMR on whale sharks and a preliminary feasibility study for scalloped hammerhead sharks in the Indian Ocean.

2.8 Trade data

89. The IOShPl **NOTED** that there have been found to be large disparities between landings data and trade data for sharks with landings data being much lower generally. In some cases, trade data is available for sharks being exported from countries that report no catches of sharks. This has been investigated mostly for CITES listed species to date.

90. The IOShPI **NOTED** that at the 34th CITES Animals Committee some key country species combinations were selected to undergo a Review of Significant Trade.

91. The IOShPl **RECOMMENDED** that the WPEB explore these disparities further specifically for the Indian Ocean.

3. Review of the current available information in terms of biological and ecological knowledge of the seven major shark species (BSH, SMA, OCS, FAL, SPL, PTH and BTH)

3.1 Life history traits (age and growth; reproduction; mortality)

92. In this section, the IOShPl **NOTED** any updates on the life history parameters that have been published since the 2014 Shark Year Plan.

93. The IOShPl **NOTED** that the available literature on the prioritized IOTC sharks biology and ecology was compiled and revised to the best extent possible. The IOShPl **NOTED** that the updates were made only based on peer review papers so papers presented to the WPEB were not included at this stage, however they have been included in a separate section in Appendix IV as there has been a substantial body of relevant literature and new research findings presented through WPEB working documents.

94. The IOShPl **NOTED** that the life history information, required to assess the status of the shark stocks, was compiled for the seven main species prioritized by IOTC. The Indian Ocean area was divided into the two major regions, specifically the eastern and western Indian Ocean, and the species-specific information compiled was grouped into major biological aspects, namely reproduction, age and growth, feeding, population genetics, tracking, habitat/environmental preferences, and other aspects.

95. The IOShPl **NOTED** that information was collected on mortality (at vessel, post-release and natural mortality) for the key species which had not been assessed in 2014.

Age and growth

96. The IOShPl **NOTED** that knowledge on age structure and growth dynamics of a population is essential for age-structured stock assessment models. These parameters are often used to estimate natural or total mortality that are important for the calculation of important population and demographic parameters, such as population growth rates and generation times. Inaccurate age estimates can lead to serious errors in stock assessments and possibly to overexploitation. Because sharks lack otoliths and pelagic species are lacking fin spines: information on age and growth is usually derived from counts of opaque and translucent bands on vertebral centre or spines. Goldman (2004) provides a revision on the more common techniques that have been used for age and growth studies on elasmobranchs. In terms of growth models, the von Bertalanffy growth function has been the model more commonly applied to elasmobranchs, even though alternative growth models have also been applied with success to some sharks in recent years. However, many of these models still lack age verification and/or validation, and often times suffer from small sample sizes for some age groups. To resolve these issues, collaborations among scientists is encouraged to collect samples and develop more complete models.

97. The IOTC–2014–IO-ShYP01 stated: '...knowledge on age structure and growth dynamics of a population is essential for age-structured stock assessment models... ...many of ... models still lack age verification and/or validation, and often times suffer from small sample sizes for some age groups. To resolve these issues, collaborations among scientists is encouraged to collect samples and develop more complete models'. The summary table stated that age and growth data available for BSH in the WIO and OCS in the EIO only.

98. The IOShPl **NOTED** that several papers were published on ageing of elasmobranch globally or regionally since 2014. These are listed in Appendix IV.

99. The IOShPl **NOTED** that new available Indian Ocean papers provide new information on age and growth of BSH and SMA. However both papers are lacking validation of the assumptions of ring deposition periodicity. The IOShPl **NOTED** that bomb radiocarbon validation techniques for Indian Ocean blue shark (Romanov and Campana, 2011) have shown quite different growth rates for specimens collected in temperate waters compared to equatorial waters. As such, robust information on age and growth are still lacking for all major Indian Ocean shark species and so require further efforts.

100. The IOShPl **NOTED** that globally, ageing techniques for shark studies are still mostly based on carrying out a direct reading of vertebrae/spines, while some other techniques (neural arches, caudal thorns, and eye lenses) have been explored and applied (see Cailliet, 2015; Nielsen et al., 2016). However most studies globally also lack validation (such as release-recapture, OTC tagging, radiometric dating (Cotton et al., 2014) or bomb radiocarbon). Bomb radiocarbon validations are problematic for specimens born after 1968 (i.e. start of descent

of 14C concentrations). Bomb radiocarbon validation based on post-peak bomb radiocarbon dating (descending 14C concentration curves) have been developed for several species (e.g. Andrews et al., 2024; Shervette et al., 2025) but not for sharks. Therefore developing of such techniques need further research and substantial investments as bomb radiocarbon dating is very expensive. However this approach is potentially promising as could be applied to recent samples and not depends on specimens born before or during nuclear test in the atmosphere. Genetic ageing (Piferrer and Anastasiadi, 2023) has not yet been applied to elasmobranchs.

101. The IOShPl **NOTED** that age and growth parameters are very important for traditional stock assessment methods but further **NOTED** studies are very difficult to conduct due to these issues of validation and so the practicalities need to be considered.

102. **NOTING** that resources for conducting studies on sharks can be limited and that a priority is to achieve population recoveries, the IOShPl **SUGGESTED** that it may be more prudent to focus more on reducing mortality for these species instead of putting funds and time into trying to estimate parameters that are difficult to develop.

103. The IOShPl **NOTED** that there is known mortality of oceanic whitetip sharks in certain fisheries and so there are opportunities for observers to collect vertebrae and tissues from dead animals to be studied.

104. The IOShPl **NOTED** that countries like Japan have collected a large number of biological samples over the years that have not yet been analysed and **NOTED** that other countries are likely to be in a similar situation. The IOShPl therefore **RECOMMEDED** that the WPEB put out a call to scientists to provide information on any stored samples or genetic information that could be used in future studies.

105. The IOShPl **NOTED** that the most recent age-growth curve developed by Andrade et al., 2019 was used in the recent stock assessments for blue shark.

Reproduction

106. The IOShPl **NOTED** that knowledge on the reproductive biology is essential for stock assessment models that attempt to accurately capture the biology of a species, such as age- and sex-structured models. Size-at-maturity is usually set after consideration of the size at which 50% of individuals become sexually mature. This is particularly important for sharks, as females tend to mature at a later age and larger size, and reach a larger size and older age than their male counterparts. Other important reproductive parameters include fecundity, seasonality and periodicity, which are all needed to calculate fertility, an important parameter in demographic analysis type assessments.

107. The IOTC–2014–IO-ShYP01 stated: that knowledge on the reproductive biology is essential for stock assessment. The summary table stated that information on reproductive biology was available for all principal shark species of both parts of the Indian Ocean (except PTH, EIO only).

108. The IOShPl **NOTED** that not much information was published on reproduction either regionally and globally since 2014. There was only one paper published on blue shark in the Indian Ocean and none for any other species in the Indian Ocean. Two further papers were published in other oceans. The IOShPl **NOTED** that the new information is coherent with the results of previous studies.

109. The IOShPl **NOTED** that reproduction patterns are thought to be similar across regions for each species so it is feasible to use information from other oceans. The IOShPl **CONCLUDED** that no significant knowledge gaps exist on the reproductive biology of main species of pelagic sharks in the Indian Ocean (except pelagic thresher shark in the Western Indian Ocean).

Mortality

110. The IOShPl **NOTED** that the majority of population modelling studies for elasmobranchs rely on indirect estimates of mortality obtained through empirical methods based on predictive equations of life history traits. However, it is possible to estimate instantaneous natural mortality rates (M) or instantaneous total mortality rates (Z) for sharks based on mark-recapture techniques or catch curves. Simpfendorfer et al. (2004) provides a revision on some of those direct and indirect techniques to calculate mortalities.

111. The IOTC–2014–IO-ShYP01 stated: '…that majority of population modelling studies for elasmobranchs relies on … estimates of mortality…'. However the question of mortality is diverse (just F includes various components including at-haulback and post-realise mortalities for protected species) and includes several aspects related

both to population status modelling and conservation approaches. However, the state of knowledge of mortality was not fully evaluated during the 2014 meeting.

112. The IOShPl **NOTED** that currently numerous studies examining shark mortality estimates have been initiated and are either completed or ongoing. However besides Poisson et al., 2014, most of published studies are either global reviews or studies performed in other oceans. For the Indian Ocean, preliminary results from POREMO, ASUR, and IOTC Bigeye thresher or silky shark Post Release Mortality (PRM) projects have either been presented as IOTC papers or have not yet been completed. While several IOTC Working Parties have provided estimates of at-haulback mortality, the knowledge across fleets, gears, and fishing strategies is still poor.

113. The IOShPl **NOTED** that it is probably not possible to base our knowledge of mortality of shark species on other oceans as this can vary considerably across gears, fleets and ecological zones so it is important to develop specific estimates for this for the Indian Ocean.

114. The IOShPl **NOTED** that AZTI are currently analysing data on mortality rates of sharks caught by purse seines across different oceans and have found that the ocean or environmental factors were not found to be a significant co-variate explaining post-release survival rates and that other factors such as operational factors (i.e. size of the catch or time in the sack which may also be vessel-specific) and the size of the sharks were found to be more important. These findings suggest that post-release survival estimates may be broadly applicable across ocean basins with comparable fishing operations.

115. However, the IOShPl **NOTED** that longline fleets are more diverse with a wide range and differing operations depending on where they are operating so estimates could not be easily applied across all oceans.

116. The IOShPl **NOTED** that there is very little information on mortality rates from gillnet fisheries.

117. The IOShPl **NOTED** that this lack of information across most fleets highlights the need to continue to obtain data on haulback mortality.

Stock structure and delimitation

118. The IOShPl **NOTED** that to better understand the impact of fisheries on shark populations, it is important to determine the stock boundaries, existence of mixing areas and migration between geographic areas within and between Oceans. Different approaches can be used for identifying, delimiting and classifying the stocks, and one of the most used is to carry out population genetic studies using several types of molecular markers, such as allozymes, mitochondrial DNA and microsatellites. Other techniques are available and have been used mainly to complement population genetics studies. Those include biometric analysis including meristic and morphometric characters, comparison of population parameters, tagging, and parasites. However, the application of those techniques to pelagic sharks is still limited, and most studies were carried out on coastal sharks and bony fishes.

119. The IOTC–2014–IO-ShYP01 stated: '... to better understand the impact of fisheries on shark populations, it is important to determine the stock boundaries, existence of mixing areas and migration between geographic areas within and between Oceans...'

120. The IOShPl **NOTED** that since 2014, a number of papers focused on stock structure were published but these mostly focused global populations and their connectivity.

121. The IOShPl **NOTED** that most of the studies showed little segregation of principal pelagic shark stocks globally. As such, the current approach to ocean-wide management of various shark species as single stock seems to be the most reasonable approach based on available knowledge to date.

122. The IOShPl **NOTED** that a newer technique that can be applied to estimate stock structure is Close-Kin-Mark-Recapture. This has not been done on an Indian Ocean shark species to date but a feasibility study has been carried out for shortfin mako shark and a full CKMR study is due to be completed for whale shark soon.

Habitat use and migrations

123. The IOShPl **NOTED** that knowledge on the movement patterns and on how the animals use the space for their activities is essential for understanding the behaviour and defining essential habitats for that species. Conventional tagging (based on mark-recapture) can provide patterns of movement, growth and mortality rates and assist in inferring the degree of mixing among stocks. On the other hand, the use of satellite tagging technology can provide insights on migration patterns, habitat use (both spatial and in terms of depth) and post-

release mortality. The collection of oceanographic information (e.g., sea surface temperature, chlorophyll concentration, current velocity, depth of the thermocline, oceanic fronts, and upwelling) is then necessary, and this information can either be collected *in situ* or through remote sensing techniques.

124. The IOTC–2014–IO-ShYP01 stated: '…that knowledge on the movement patterns and on how the animals use the space for their activities is essential for understanding the behaviour and defining essential habitats for that species...'

125. The IOShPl **NOTED** that there have been some improvements in knowledge since 2014 but large gaps still remain.

126. The IOShPl **NOTED** that these data are also essential for the understanding of ocean-wide connectivity and interactions with various fleet segments. Several projects focused on studies of shark migratory behaviour and habitat use were developed for the Indian Ocean and were funded either nationally or internationally: MADE, POREMO, ASUR, IOTC BTH PRM, Bertarelli Programme at BIOT (Chagos Archipelago) or other initiatives with private funding. However few results have been published to date for completed projects, and the IOTC Bigeye thresher shark PRM project is still ongoing.

127. The IOShPl **NOTED** that studies on habitat use and migration require the same techniques as post-release mortality studies – i.e. the use of satellite tags.

128. The IOShPl **NOTED** that there are large knowledge gaps regarding migration patterns for all species except silky shark. The IOShPl **NOTED** that most of the information about silky shark distribution is derived from purse seine fleets. The IOShPl **NOTED** that the functional habitat of the species and their distribution across their population and size is not well understood but it is thought to mostly be associated with EEZs while smaller animals are found around FADs and in the open ocean.

129. The IOShPl **NOTED** interesting results from a 2025 paper (Zhu et al., 2025) which found that exploiting younger animals would result in the highest risk for the population. However, the reality is showing an opposite trends – smaller animals have been caught under FADs for 20 years since they first started being deployed but there does not appear to be a decreasing trend in catches.

130. The IOShPl **NOTED** that the migratory patterns and level of population connectivity in the eastern Indian Ocean region are generally not well known.

131. The IOShPl **NOTED** that it appears that habitat utilisation and vertical movement behaviours are similar across similar species and ecosystems, therefore these can be projected from to one ocean to another in the absence of regional data. However, the IOShPl **NOTED** that this is not the case for horizontal migratory behaviour so cross-regional generalisation may be extremely misleading. Further efforts on migratory patterns and intra-oceanic connectivity are necessary.

3.2. Review of the current biological knowledge

132. The IOShPl **NOTED** that Table 4 presents a summary with life history and other parameters sorted into five data categories (reproduction, age and growth, feeding, stock ID, and movements/migratory patterns), that are most relevant for stock assessments, and the two major Indian Ocean geographical areas. The following specific aspects are noted:
    - More studies have been carried out in the west than in the east Indian Ocean;
    - In the west region there is some information available in terms of feeding and movements for all species except the thresher sharks;
    - In the west region the research areas with larger information gaps are age and growth, and mortality;
    - In the eastern area there is still a lot less information available for all species compared with the western area. There are some reproductive parameters for several species; age and growth for the silky shark, scalloped hammerhead and pelagic thresher; stock ID for most species and some knowledge of movement and migrations for blue shark, shortfin mako and silky sharks. However, there is no information on age and growth and mortality for most species;
    - The most data-poor shark species in the IO are the thresher sharks, and in particularly the pelagic thresher; common misidentification is likely to be one of the major reasons for this situation.

133. The IOShPl **AGREED** that generally, it is therefore possible to conclude that:

- The most data-poor biological parameters are age and growth and mortality and movements and stock ID in the west IO, and age and growth, feeding, movements and mortality in the east IO;
- The most data-poor species are the two thresher sharks.

Table 4. Summary of the level of information available by research topic in the two main Indian Ocean geographical areas for the seven shark species in 2026. Colour code: red = no studies available; yellow = 1 or 2 studies; green = 3+ studies. The numbers in the table relate to the number of peer reviewed studies. BSH = blue shark, SMA = shortfin mako, OCS = oceanic whitetip, FAL = silky shark, SPL = scalloped hammerhead, BTH = bigeye thresher and PTH = pelagic thresher.

Species	West Indian Ocean						East Indian Ocean					
	Reproduction	Age & growth	Feeding	Stock ID	Movements & migrations	Mortality	Reproduction	Age & growth	Feeding	Stock ID	Movements & migrations	Mortality
BSH	5	2	3	4	3	0	1	0	0	4	1	0
SMA	3	1	3	3	1	0	0	0	2	3	3	0
OCS	2	0	2	3	1	2	0	0	0	3	0	0
FAL	3	1	4	2	2	3	2	1	0	2	1	0
SPL	3	0	3	5	1	0	4	1	0	2	0	0
BTH	3	0	2	1	0	0	3	0	0	1	0	0
PTH	2	0	2	0	0	0	1	1	0	0	0	0

Exploring alternative sources of information

134. The IOShPl **NOTED** that unpublished and non-peer-reviewed information could provide a valuable source of evidence where peer-reviewed literature is limited, particularly given the need to incorporate the most recent research findings into the research planning process. However, the meeting recognised that studies may use different methodologies or not follow the same quality-control procedures as peer-reviewed research, and therefore their results should be evaluated carefully before being incorporated into assessments or management advice.

135. **NOTING** that more information is thought to be available on the species of interest in other oceans, the IOShPl **NOTED** that cross-boundary studies undertaken in the Atlantic Ocean could provide useful information for the IOTC, although broader geographic coverage would be required to determine their applicability.

136. The IOShPl **SUGGESTED** exploring the availability of satellite tracking data and publicly accessible shark tagging datasets, which could provide useful information on habitat use and movements, although these data are unlikely to be suitable for estimating post-release mortality where fishing gears differ substantially among fleets and regions. A study led by researcher Andrés Domingo and the ICCAT Shark Research and Data Collection Program found a post-release mortality rate of roughly 28% to 29.4% for shortfin mako sharks discarded alive from pelagic longlines. This study included shortfin mako sharks tagged near the IOTC boundary from South Africa (Domingo et al., 2025).

137. The IOShPl **NOTED** that declining numbers of thresher sharks being encountered in fisheries may reflect changes in population abundance, although further investigation is required to distinguish potential population declines from changes in fishing practices, distribution, or reporting.

138. The IOShPl **NOTED** that some post-release mortality studies have been conducted in the Atlantic Ocean with a few animals tagged in the Indian Ocean included shortfin mako sharks target at the IOTC/ICCAT boundary off South Africa (Domingo et al., 2025). While the mortality rates from such studies could be indicative of likely mortality rates in the Indian Ocean, however, in this study, the majority of the short-fin mako shark tagged were from vessels with Observers on board or from Researchers/ Research Vessels, where handling would have been better than in real world fishing vessels. Hence PRM is likely to be higher in real world fishing situations.

Priorities for research

139. The IOShPl **NOTED** that parameters that are needed for population dynamics studies include: age, growth and reproduction. These parameters can then be used to estimate mortalities and intrinsic population growth rates. The IOShPl **NOTED** that substantial gaps remain in the information available to be used in stock assessments, particularly with respect to validated age and growth parameters for many species making full assessments difficult to conduct.

140. The IOShPl **AGREED** that age and growth and mortality estimates should be prioritised as key research areas for improving shark assessments.

141. The IOShPl **NOTED** that information on mortality is also limited, including estimates of mortality at haulback, post-release mortality, and natural mortality. Although relevant research has been presented to the WPEB, relatively few peer-reviewed studies are currently available, with several ongoing projects expected to generate additional information in the coming years.

142. The IOShPl **NOTED** that research on mortality of oceanic whitetip sharks and bigeye threshers is currently ongoing, and that some information is also available for other species, although sample sizes remain limited.

Priority species

143. There were a number of different species proposed for being included in the highest priority for research for various reasons.

144. The IOShPl **NOTED** that research in the IOTC region has historically focused heavily on blue shark and shortfin mako shark, while comparatively less attention has been directed towards other species, including hammerhead and thresher sharks. The meeting suggested that future research priorities should consider these comparatively understudied species, particularly where there are significant knowledge gaps.

145. The IOShPl **NOTED** that silky shark is currently the only priority shark species in the IOTC area for which no retention ban is in place. Given its importance as a bycatch species in purse seine fisheries and the potential low post-release survival, the IOShPl suggested that silky shark could be considered a priority species for future research. The IOShPl further **NOTED** that previous mortality estimates may have been substantially influenced by entanglement interactions with drifting fish aggregating devices (FADs), and that mortality associated with these entanglements may have declined following the introduction of fully non-entangling FADs. Silky shark also occurs in coastal fisheries, where additional information is required.

146. The IOShPl **NOTED** that research efforts could initially focus on shortfin mako shark during the first two years of the research plan, before shifting greater attention towards silky shark over the subsequent three to five years as additional data from coastal fisheries become available.

Sampling

147. The IOShPl **NOTED** the potential for the IOTC observer scheme to incorporate targeted biological sampling; however, long-term preservation of samples presents logistical challenges, particularly due to limited storage capacity. The IOShPl **NOTED** that establishing a centralised sample bank could provide a practical solution to these constraints. The IOShPl **HIGHLIGHTED** the Pacific Community (SPC) sample bank as a potential model, which maintains biological samples alongside associated metadata and provides access to the metadata through its website.

148. The IOShPl **NOTED** that the development of an IOTC sample bank where samples can be maintained could be considered as part of the planned sampling programme, with samples centrally stored and subsequently made available to research institutions for targeted analyses as required, however, this will take some time to develop.

149. The IOShPl **NOTED** that some research techniques such as age and growth verification with bomb radiocarbon dating analyses are destructive, requiring sufficient sample material to allow these analyses to be undertaken while retaining adequate material for other current or future research needs.

150. The IOShPl **RECOMMENDED** the WPEB to facilitate the creation of an inventory of samples through putting out a call for information on sample availability around the Indian Ocean.

4. Review of the current available and implemented mitigation measures, including best practice codes/procedures, in terms of reducing shark bycatch and incidental mortality

4.1 Operational and technological aspects (Gillnet; Longline; Purse seine)

151. The IOShPl compared the list of mitigation measures examined in 2014 with the latest research on this topic based on a 2024 ISSF report on a Bycatch Management Strategy Evaluation Framework in tuna fisheries proposed by Gilman et al., 2024 which compared the pros and cons of known mitigation measures. The IOShPl **NOTED** that the appendices of that report review the different bycatch mitigation measures in detail.

152. The IOShPl **NOTED** that there has not been substantial research conducted on bycatch mitigation and best practices to reduce bycatch and mortality (research differs across gears) since 2014. However, the IOShPl **NOTED** that some mitigation measures have been adopted by the Commission since then such as retention and finning bans.

153. The IOShPl **NOTED** that measures for mitigation of shark bycatch in IOTC managed pelagic fisheries have both major 'pros and cons'. The IOShPl further **NOTED** that multi-species tradeoffs exist for some bycatch interventions and some, but not all of these have been examined. These pros and cons were highlighted for each method, based on best scientific knowledge currently available. Additionally, the level of research needs and financial implications were also considered (Table 5). Additional information providing more detail on each of the mitigation measures is provided in Appendix V.

154. The IOShPl **NOTED** that the key takeaway from this review is that multiple mitigation measures exist for all gears but no single mitigation measure eliminates all bycatch for a certain group or all groups. The IOShPl further **NOTED** that the most effective strategy follows the sequential mitigation hierarchy proposed by Gilman et al., 2024 which combines:

- The avoidance of encounters with sharks
- Reducing shark captures
- Reducing fishing mortality and improving post-release survival
- Offsets
- Monitoring implementation

155. The IOShPl **NOTED** that pelagic longline fisheries currently have the largest number of available shark, marine turtle and seabird mitigation options, including both capture avoidance and mortality reduction, but implementation remains low and is challenging, particularly in coastal pelagic longline fisheries.

156. The IOShPl **NOTED** that on the contrary, gillnet fisheries currently have the lowest number of available megafauna mitigation measures, which could be primarily due to less research being carried out with gillnets.

157. The IOShPl **NOTED** that new measures since 2014 include some new measures such as shark release ramps, mobulid sorting grids. Other new measures still require further research including the meka-ring/loop gear and technical measures such as repellents and smart devices that can attach to hooks and automatically release bycatch. The IOShPl **NOTED** that IOTC prohibited the use of wire tracers and shark lines through Resolution 25/08. The IOShPl **NOTED** that while the ban on shark lines applies throughout the convention area, the ban on wire tracers doesn't impact the southern Indian Ocean EU blue shark targeted fishery due to the geographic scope of the measure in the Resolutionas it only applies to the area North of 20°S. The IOShPl **NOTED** that handling and release best practices have been adopted by the Commission but there is insufficient observer coverage to monitor the implementation of this.

158. The IOShPl **NOTED** that some non-tuna longline fleets are actively targeting sharks which are not directly managed by IOTC as their focus is on tuna targeting fleets so it is the responsibility of the CPCs to manage these fleets. The IOShPl further **NOTED** that not much information has been collected on the operations of these fleets for this reason so the amount of shark mortality from non-tuna targeting fleets is not known. The IOShPl further **NOTED** that there is likely to be a lot of diversity in the coastal longline fleets meaning that it is difficult to monitor implementation of mitigation measures and these fisheries may also be targeting sharks.

159. The IOShPl **NOTED** that there are fleets targeting blue sharks also catching shortfin mako shark, which have been assessed to be overfished and overfishing is occurring and, hence, a retention ban was adopted (Resolution 25/09). The IOShPl also **NOTED** that in those cases common shark mitigation measures might not work since both, the target and the bycatch, are shark species and, thus, in those cases, the IOShPl further **NOTED** that spatial/technical avoidance measures are likely the only effective measure for avoiding shortfin mako while continuing to catch blue shark, however, the level of implementation of this kind of measure is unknown.

160. The IOShPl **NOTED** that purse seine fisheries have made the greatest advances in the implementation of avoidance measures, particularly through non-entangling FADs and improved handling and release techniques to increase post-release survival (PRS). The IOShPl **NOTED** that a number of tools and techniques for the quick release of elasmobranchs (e.g. hoppers with release ramps, mobulid sorting grids) have been trialled and implemented in recent years. The IOShPl **NOTED** that improvements since 2014 include the fact that fully non-entangling FADs without netting and a transition to biodegradable FADs have been adopted, intentional setting on whale sharks has been prohibited and safe release tools have been increasingly adopted by vessels in recent years.

161. The IOShPl **NOTED** that measures such as avoiding sets with high shark aggregations are not currently possible to implement as tools to determine how many sharks are present under a FAD and/or to discriminate between sharks and tunas do not yet exist. Preliminary experiments with cameras set up under FADs have been promising but have not been rolled out while acoustic selectivity is not currently developed enough for identifying sharks. The IOShPl **NOTED** that a predictive tool with real-time information providing predictions for shark hotspots could be useful but has not yet been developed. The IOShPl **NOTED** that real-time shark hotspot identification, through for example fleet communication regarding locations of high shark catches/aggregations, could allow vessels to avoid areas with a high number of sharks.

162. The IOShPl **NOTED** that there is a large fleet of small purse seine vessels in the Indian Ocean (e.g., Indonesia) which may have more limitations on the options available to them in terms of implementation of mitigation and handling measures which needs to be considered further.

163. The IOShPl **NOTED** that drift gillnet fisheries have comparatively few shark-specific mitigation measures and implementation of measures is limited, making this gear type a priority for further research and innovation. The IOShPl also **NOTED** that the implementation of bycatch mitigation measures is very limited. The IOShPl further **NOTED** that more mitigation options were identified in 2014 for gillnets, however, some have since been discarded based on more recent research and advice.

164. The IOShPl **NOTED** that implementation of measures in gillnet fisheries have included retention bans, deployment of sub-surface gillnets, and some handling and release practices but many of these are experimental with limited commercial updates.

165. The IOShPl **NOTED** that ambiguity remains regarding the application of Resolution 16/07 to the use of lights on fishing gear. While the Resolution is understood to have been adopted with the intent to apply to drifting FADs, its wording is unclear as to whether the prohibition on attaching lights also applies to gillnets This is of particular concern given that the use of lights is considered one of the most effective mitigation strategies for bycatch of all taxa in gillnets.

166. The IOShPl **NOTED** that across all three gears: avoidance measures are very limited, and crew training, implementation of best handling practices, and effective monitoring for some fleets remain among the most practical and impactful measures for reducing shark fishing mortality, and hence the IOShPl **ENCOURAGED** further research across all IOTC fisheries.

167. The IOShPl **NOTED** that the 2024 ISSF Technical Report gave more consideration to elements such as compliance likelihood, commercial availability and viability of mitigation measures/tools, and multi-species conflicts.

168. The IOShPl **NOTED** that consideration also needs to be given to the commercial viability of measures including: the economic viability, practicality, crew safety and commercial availability. The IOShPl **NOTED** that trade-offs between species need to be accounted for and considered when implementing mitigation measures. The IOShPl **NOTED** that all of these factors will influence the level of implementation and compliance with measures by fleets. The IOShPl further **HIGHLIGHTED** the need for robust Monitoring, Control and Surveillance (MCS) frameworks to ensure compliance with measures.

169. The IOShPl **NOTED** that offsets have been applied for sea turtle conservation such as funding habitat/nesting conservation projects to offset the impact of tuna longline fisheries (e.g., ISSF sea turtle research and conservation through funds collected from participating companies) and there is a potential to do this for sharks.

170. The IOShPl **AGREED** that the list of mitigation measures summarised in Table 5 is **not** a ranking of potential measures, as the objective of this review was just **to highlight research needs** before any advice can be provided on their potential efficiency and application if introduced to manage IOTC pelagic fisheries. Additionally, the research needs to take into consideration their potential as shark mitigation measures, but also the implications that its implementation might have on fisheries data collection and, consequently, on the shark stock assessment process. For example, the IOShPI **NOTED** that retention bans might have unintended consequences reducing the monitoring and collection of key information for stock assessment and, thus, it also **NOTED** that retention bans should be implemented along with strengthen monitoring systems.

171. The IOShPl **NOTED** that the listed management mitigation measures for major IOTC fisheries impacting sharks were split into two different categories: i) Operational and technological aspects, and ii) Best practices. Further details on these measures can be found in Appendix V.

Table 5. Summary of mitigation measures reviewed by the working group. The funding level refers to the amount of funding that would be required to conduct the necessary research, the priority of research refers to how high a priority the IOShPl considered the research to be and consideration for implementation refers to how likely/challenging it would be for fleets to implement these measures.

Measure / Method	Approach	Knowledge available	Funding level	Priority for research	Priority level and considerations for implementation	Implemented at IOTC	Implemented elsewhere
				LONGLINE			
Avoiding hotspots	Fleet communication program	Well understood	No	Low	Medium	Ad-hoc implementation	Ad-hoc implementation
Avoiding hotpots: Spatial and/or temporal closure	Spatial and/or temporal closure/MPAs	High research needs	Medium	High	Difficult		
Fishing time	Soaking time	Moderate research needs	Medium	Medium	Difficult		
Fishing depth	Deep setting - traditional	Well understood	No	Low	Difficult		
Fishing depth	Deep setting and elimination of shallow hooks	Well understood	No	Low	Difficult		
Gear configuration	Technical mitigation measures (such as repellents)	High research needs	Medium	High	Expensive to implement		

Measure / Method	Approach	Knowledge available	Funding level	Priority for research	Priority level and consideration s for implementati on	Implemented at IOTC	Implemented elsewhere
			LONGLINE				
Decrease fishing mortality	Reduction of fishing effort	Well understood	No	Management decision	Management decision		
Decrease fishing mortality	Prohibition of retention	High research needs	Medium	Management decision	Management decision	Implemented	Implemented
Finning prohibition and other legal constrains in the fishery	Prohibition of shark finning	Well understood	No	Already implemented	Already implemented	Implemented	Implemented
Bait modification	Bait type (squid vs. fish)	Well understood	Medium	Low	Medium		
Bait modification	Blue/Green-dyed bait	Well understood	No	Low	Low		
Bait modification	Artificial bait	Moderate research needs	High	Low	Low		
Catchability /Selectivity	Modification of terminal gears (including hook type)	Moderate research needs	High	Low	Medium		

Measure / Method	Approach	Knowledge available	Funding level	Priority for research	Priority level and considerations for implementation	Implemented at IOTC	Implemented elsewhere
LONGLINE							
Leader material	Ban on wire leaders	Moderate research needs	High	Medium	Medium	Partially implemented	WCPFC and IATTC
Shark lines	Ban on shark lines	Moderate research needs	High	Medium	Medium	Partially implemented	WCPFC and IATTC
Terminal gears	Meka-ring/loop gear/ trap line	High research needs	High	High	Medium		
Safe handling and release	Safe handling and release, promoting post-release survivorship (faster gear retrieval, line cutters, release alongside vessel, avoid bringing large sharks onboard)	High research needs	High	Medium	High	Implemented	All RFMOs
Safe handling and release – handling equipment	Mandatory shark safe handling equipment	Well understood	No	Medium	High	Implemented	All RFMOs

Measure / Method	Approach	Knowledge available	Funding level	Priority for research	Priority level and considerations for implementation	Implemented at IOTC	Implemented elsewhere
Awareness	Workshop/ training information dissemination on good handling practices/fishing practices	Well understood	Medium	High	High	Partially implemented	Partially implemented
				GILLNET			
Fishing time	Soaking time	Moderate research needs	Medium	High	Medium		
Decrease fishing mortality	Reduction of fishing effort	Well understood	No	Management decision	Management decision		
Decrease fishing mortality	Prohibition of retention	High research needs	Medium	Management decision	Management decision	Implemented	Implemented
Gear configuration	Selectivity (mesh size, gear rigging/construction, net panel material)	Well understood	High	High	Medium		

Measure / Method	Approach	Knowledge available	Funding level	Priority for research	Priority level and considerations for implementation	Implemented at IOTC	Implemented elsewhere
			GILLNET				
Turtle/shark lights for gillnets	LED lights, UV lights, nets constructed of photoluminescent materials.	Well understood	No	Medium	Medium		
Gear modifications	Sub surface setting	Moderate research needs	Medium	Medium	High	Implemented	
Attractant / Deterrent use	Repellent/ attractant	Well understood	No	Low	Low		
Safe handling and release	Safe handling and release, facilitation post-release survivorship (including quick release)	High research needs	High	High	High	Implemented but not well understood	Implemented but not well understood
Safe handling and release – handling equipment	Mandatory turtle/shark safe handling equipment	Well understood	Moderate	Medium	High	Implemented but not well understood	Implemented but not well understood

Measure / Method	Approach	Knowledge available	Funding level	Priority for research	Priority level and considerations for implementation	Implemented at IOTC	Implemented elsewhere
Awareness	Workshop/ training information dissemination on good handling practices/fishing practices	Well understood	Medium	High	High		
			PURSE SEINE				
Decrease ratio bycatch/target catch	Setting on bigger aggregations	Well understood	No	Low	Low		
Avoiding ETP species	Prohibition of setting on whale sharks & mantas	Moderate research needs	Medium	Low	High (implemented)	Implemented	Implemented
Avoiding hotspots	Fleet communication program	Well understood	No	Low	Medium	Ad-hoc implementation	Ad-hoc implementation
Avoiding hotspots	Remote detection, fleet communication	Moderate research needs	Medium	Medium	Low		
Avoiding hotpots: Spatial and/or temporal closure	Spatial and/or temporal closure/MPAs	High research needs	Medium	High	Difficult		

Measure / Method	Approach	Knowledge available	Funding level	Priority for research	Priority level and considerations for implementation	Implemented at IOTC	Implemented elsewhere
			PURSE SEINE				
Decrease fishing mortality	Prohibition of retention	High research needs	Medium	Management decision	Management decision	Implemented	Implemented
Decrease fishing mortality	Reduction of fishing effort for certain types of schools	Well understood	No	Low	Low		
Decrease fishing mortality	Release sharks from net (release panel, fishing from the net, attractors/repellents)	High research needs	High	Low	Low		
Non entangling FADs	Non entangling FADs	Well understood	No	Low	Implemented		
Improved FAD management	Reduce FAD density	Moderate research needs	Medium	Low	Low	Partially implemented – reduction in number of FADs allowed	

Measure / Method	Approach	Knowledge available	Funding level	Priority for research	Priority level and considerations for implementation	Implemented at IOTC	Implemented elsewhere
			PURSE SEINE				
Safe handling and release	Safe handling and release practice (handling tools)	Good knowledge level	Medium	High	High	Implemented	Implemented
Workshop/training information dissemination on good handling practices/fishing practices	Fishermen training / awareness	Well understood	Medium	High	High	Partially implemented	Partially implemented

5. Review of the most appropriate assessment methods that could be used on the main shark species, as well as the potential use of other indicators as alternatives to traditional stock assessment approaches

172. The IOShPl **NOTED** the list of assessment methods that could be used to apply to shark stocks including a range from data limited to data intensive methods. The IOShPl **NOTED** that a number of new methods have been developed since 2014 including: EASI-Fish, LB-SPR, Bayesian length-catch curves, JABBA and SS3.
173. The IOShPl **NOTED** that these methods will be discussed in more detail during WPEB22 in 2026 as some risk assessment methodologies have been applied to several Indian Ocean shark stocks which will be presented to the WPEB meeting.
174. A summary of the methods is provided in Table 6. The data needed for each method was also explained and is summarised in Table 7 and supporting information is available in Appendix VI.

Table 6. Stock assessment models, data requirements, Reference points, Management advice and Pros/Cons

Category	Data tier	Method	Biology data needs	Fishery data needs	Reference points produced	Management advice produced	Pros	Cons	Software	References
Risk-based	**Data-limited**	**ERA / PSA - Ecological Risk Assessment / Productivity-Susceptibility Analysis**	Qualitative/semi-quantitative life-history attributes (growth, maturity, fecundity, M, max age) used to score productivity.	Qualitative/semi-quantitative susceptibility scores: availability, encounterability, selectivity, post-capture mortality.	No - provides vulnerability and productivity-susceptibility score/ranks	Qualitative ranking of species-fleet combinations by vulnerability; useful for prioritising management focus and research	Works with limited data; widely adopted as a first approach; better when done across multiple species/taxa; highlights species most vulnerable	Cannot estimate current stock status or fishing mortality; sensitive to LH attributes, weights and scoring of the categories	Custom spreadsheets / R.	Stobutzki et al. 2001; Hobday et al. 2011; Murua et al. 2012; 2018; Cortés et al. 2015
	Data-limited	**SAFE - Sustainability Assessment for Fishing Effects**	Life-history-derived F reference points (r and M)	Spatial overlap of fishing effort with species distribution; gear-specific catchability; post-release mortality.	Yes - quantitative F reference points (Fcrash, Flim) and estimated F	Probability of stock being above/below each F reference point; supports quantitative bycatch risk advice.	Quantitative alternative to PSA; uses spatial fishing-effort data; produces F estimates without catch series; supports gear-/area-specific advice.	Needs reliable species distribution and spatial effort layers; sensitive to catchability assumptions; biomass status not estimated.	Custom implementations	Zhou & Griffiths 2008; Zhou et al. 2016.
	Data-limited	**EASI-Fish - Ecological Assessment for the Sustainable Impacts of Fisheries**	Life-history vulnerability traits; preferably sex/age-specific if available.	Spatial-temporal overlap with multiple fisheries; gear selectivity; bycatch rates.	Yes - F vs Flim; multi-fleet vulnerability scores.	Cumulative F across fleets; supports management strategy comparison (gear, area, season closures).	Cumulative effects across fleets; flexible to gear/area scenarios.	Data-intensive on spatial effort and selectivity by fleet; assumptions on independence of fleets.	Custom implementations	Griffiths et al. 2019; Duffy et al. 2019.
Life-history-based	**Data-limited**	**Demographic Analysis**	Age & growth, fecundity, age-specific maturity, natural mortality (M), sex ratio at birth.	Selectivity at age (and optional F at age) when fishery component included.	No - Produces population growth rate (λ or r), generation time	Whether current F is compatible with population replacement; identifies life stages most influential for	Easy to apply if LH parameters available; identifies sensitive life stages relevant to gear/area measures;	Equilibrium and density-independence assumptions; results sensitive to LH inputs; no current biomass estimate.	R packages: popbio	Cortés 2002, 2007; Caswell 2001; Simpfendorfer 2005.

						recovery (elasticity).	supports conservation prioritisation; can be used to estimate PSA inputs and priors for models like JABBA			
	Data-limited	**YPR / SPR - Yield-Per-Recruit and Spawning-Per-Recruit analyses**	Growth (length- and weight-at-age), natural mortality M, age at maturity, fecundity-at-age (for SPR).	Selectivity-at-age (or length); no catch or CPUE series required.	Yes - F0.1, Fmax (from YPR); F20–F40 (from SPR); F0.1 and F40 commonly used as FMSY proxies.	Target and limit F reference points; relative yield and spawning potential vs the unfished state. Does not provide current stock status (no B estimate).	Classical and easy to compute; minimal data needs (LH + assumed selectivity); produces reference points widely used in advice (e.g. F0.1 or F40 as FMSY proxies); useful to establish F reference points together with other methods.	Per-recruit only methods; no current status or absolute biomass. Equilibrium and constant-recruitment assumptions. Selectivity must be assumed. Best used as a reference-point estimator paired with a status indicator (e.g. CPUE trend, LBSPR).	R packages: fishmethods	Beverton & Holt 1957; Goodyear 1993; Clark 2002.
Catch-only	**Data-limited**	**CMSY / CMSY++ - Catch-only resilience models**	LH-derived r prior, or assume a categorical resilience (low/medium/high)	Catch time series; depletion priors at start and end of series (sometimes intermediate).	Yes - MSY, FMSY, BMSY.	Status (B/BMSY, F/FMSY), Kobe plot.	Catch-only method that estimates MSY-based reference points; CMSY++ adds biomass priors; widely tested and accepted; useful as a simple approach for many data-limited stocks.	Very strongly dependent on catch series quality and depletion priors assumed; no process error.	Implemented in R: cmsyPlusPlus; R package datalimited2 has multiple catch-only methods	Froese et al. 2017; Froese et al. 2023
	Data-limited	**SRA / DB-SRA - Stock Reduction Analysis**	Priors on r and K (usually LH-derived).	Catch series; assumed depletion at terminal year	Yes - MSY, FMSY, BMSY.	MSY, current depletion.	Catch only method that estimates MSY and depletion	Very sensitive to catch series and assumed depletion; now	R packages: fishmethods, datalimited, datalimited2	Walters et al. 2006; Dick & MacCall 2011

				(sometimes initial or intermediate).			levels; can incorporate Bayesian priors.	largely superseded by the CMSY++ within the catch-only models.		
Length-based	**Data-limited**	**LB-SPR - Length-Based Spawning Potential Ratio**	M/K ratio, Linf, length at maturity (L50).	Length-frequency of the catch (representative).	Yes - SPR-based reference points; F/M proxy	Current SPR vs reference SPR (commonly 20% as limit and 40% as target); relative F.	Only needs length samples and LH ratios; no catch time series or CPUEs required; well-tested length-based method for data-limited stocks	Needs representative size sampling across the fishery; equilibrium assumption; biased if selectivity changes over time or if growth varies.	Implemented in R: LBSPR	Hordyk et al. 2015, 2016.
	Data-limited	**BLICC - Bayesian Length Interval Catch Curve**	Linf (prior); natural mortality M prior.	Length-frequency of the catch, ideally split by gear/fleet. Can be a snapshot of data in time, no time series required.	Yes - SPR-based reference points; F-at-length by gear.	Stock status (SPR) and fishing mortality by gear; supports per-gear management evaluation.	Handles multiple gears with different selectivities; flexible selectivity functions (incl. logistic, dome-shaped, multimodal); Bayesian with full uncertainty; useful for relatively short-duration length sampling.	Stationary equilibrium assumption (same as LB-SPR); informative priors on Linf and M influence results; no trend information if used on single snapshot data	Implemented in R: fishblicc (uses Stan via rstan)	Medley 2025
CPUE-based	**Data-moderate**	**Catch-free CPUE-based age-structured production models**	M, growth, age at maturity, recruitment.	Selectivity at age, standardised CPUE series.	Yes - MSY, FMSY, BMSY.	Status and reference points without catch data.	Useful when catches are unreliable but CPUE is informative; uses biological LH and fisheries selectivity.	LH assumptions; CPUE must be correctly standardized as a true and representative index of abundance.	Custom ADMB/TMB code	Porch et al. 2006

Production model	Data-moderate	**ASPIC - A Stock-Production Model Incorporating Covariates**	Implicit LH needs for r and shape parameter in the production function	Catch series; standardised CPUE series.	Yes - MSY, FMSY, BMSY.	Status, MSY, projections (deterministic).	Simple method, well-understood, widely tested over the years	Frequentist approach; limited uncertainty quantification; no process error. Largely superseded by JABBA / SPiCT in recent years	ASPIC software	Prager 1994.
	Data-moderate	**SPiCT - Stochastic Production in Continuous Time**	Priors on r and shape parameter for production function (often LH derived).	Catch series and one or more CPUE series; sub-annual data supported.	Yes - MSY, FMSY, BMSY.	Stock status with uncertainty; widely used in ICES (standardised advice templates).	State-space (process and observation error); continuous time; rich diagnostics; ICES-accepted for many data-moderate stocks.	Aggregates biomass (no internal age/size structure); needs informative CPUE and catch series; can be sensitive to priors used (r, shape parameters, etc.); less applied to pelagic sharks	Implemented in R: spict	Pedersen & Berg 2017.
	Data-moderate	**JABBA - Just Another Bayesian Biomass Assessment**	Priors on r (often LH derived), shape parameter for production function; optional B/K priors.	Catch series and one or multiple standardised CPUE series (with CVs)	Yes - MSY, FMSY, BMSY.	Stock status with uncertainty; constant-catch and constant-F projections; widely used in tRFMOs	Widely used for pelagic shark assessments in t-RFMOs; Bayesian state-space; handles multiple CPUE series with weighting; widely tested with well-documented diagnostics (retrospectives, hindcasts).	Aggregates biomass (no internal age/size structure); needs informative CPUE and catch series; can be sensitive to priors used (r, shape parameters, etc.).	Implemented in R: JABBA	Winker et al. 2018
Age-structured Production model	Data-moderate	**JABBA-Select - Production model with size selectivity**	LH parameters: growth, maturity, M-at-age, fecundity at age.	Catch and CPUE by fleet; selectivity-at-length per fleet.	Yes - MSY, FMSY, SBMSY.	Status and projections as JABBA, but accounting for selectivity differences between fleets.	Builds a bridge from biomass-dynamic to age-structured models; explicitly production	More data-demanding than JABBA; less widely tested for pelagic species; relies on selectivity assumptions.	Implemented in R: JABBA-Select	Winker et al. 2020

							model with fleet selectivity; lighter than full integrated models.			
	Data-moderate	**ASPM - Age-Structured Production Model**	Growth, maturity-at-age, M, fecundity.	Catch, CPUE, selectivity-at-age.	Yes - MSY, FMSY, SBMSY.	Status and projections accounting for selectivity differences between fleets.	Adds age structure to production models.	Selectivity-at-age must be assumed or estimated; Data needs are similar to full SS3 models, so less used in recent years.	Custom ADMB/TMB code	Punt 2003
Fully age-structured	Data-rich	**VPA / XSA - Virtual Population Analysis / Extended Survivors Analysis**	Natural mortality M (assumed, by age); growth (for age-length conversion).	Catch-at-age across multiple years. XSA additionally requires one or more tuning indices (CPUE or survey).	Yes - F-at-age, F0.1; SSB time series; BMSY-style reference points	Status (F and SSB trajectories); projections.	Classical model with cohort reconstruction, long track record of many assessments in multiple RFMO in the past.	Needs high quality and consistent catch-at-age; difficult ageing for many pelagic species, no systematic age sampling in most pelagic species in tRFMOs; very sensitive to terminal-year assumptions. Those methods are now largely superseded by integrated models like SS3.	VPA-2BOX software	Pope 1971; Shepherd 1999
Integrated model	Data-rich	**SS3 - Stock Synthesis**	Growth (sex-specific), maturity, fecundity, M-at-age, recruitment dynamics.	Catch by fleet, CPUE indices, length and/or age compositions, optional tagging and conditional age-at-length data.	Yes - MSY, FMSY, BMSY, SBMSY, SPR-based reference points, etc.	Comprehensive Kobe-style advice, projections, can be used as the basis for MSE operational models development	Extremely flexible framework; now standard for many t-RFMO stock assessments; handle uncertainty and mixed data coherently; produces many	Heavy data demands (but can be scaled from simpler to more complex); long development time; steep learning curve; convergence and parameterisation sensitivities; risk of over-	Stock Synthesis Software; R package for diagnostics: r4ss	Methot & Wetzel 2013; Taylor et al 2021 (r4ss)

							diagnostics via accessory packages.	parameterisation for data-limited sharks.		

Note: The full list of references for this section can be found in Appendix VI.

Table 7: Summary of the data requirements for the various assessment methods

Category	Method	Life history	Catch series	CPUE indices	Length comps	Age comps (catch-at-age)	Spatial structure
Risk-based	PSA / ERA	R					S
	SAFE	R					R
	EASI-Fish	R	O	O	O		R
Life-history-based	Demographic Analysis	R					
	YPR / SPR (per-recruit analyses)	R			O		
Catch-only	CMSY / CMSY++	S	R	O			
	SRA / DB-SRA	S	R	O			
Length-based	LB-SPR	R			R		
	BLICC	R			R		
CPUE-based	Catch-free CPUE-based	R		R	O	O	
Production model	ASPIC	O	R	R			
	SPiCT	S	R	R			
	JABBA	S	R	R	O		
Age-structured Production model	JABBA-Select	S	R	R	R		
	ASPM	R	R	R	S	S	O
Fully age-structured	VPA / XSA	R	R	R	O	R	
Integrated model	SS3	R	R	R	R	S	S

Legend:

R = required

S = strongly informs

O = optional and can inform

blank = not needed

6. IDENTIFY MAJOR NEEDS IN TERMS OF CAPACITY BUILDING, AIMING TO BRING THE QUALITY AND QUANTITY OF DATA UP TO MINIMUM IOTC STANDARDS

175. The IOShPl **NOTED** that ahead of the meeting, major capacity building needs were identified with the aim of bringing the quality and quantity of data up to the minimum IOTC standards. Both the gaps in data being submitted by CPCs and capacity building activities that CPCs feel would be beneficial were identified.

6.1 Data collection

176. The IOShPl **RECALLED** the range of IOTC Resolutions relevant to the collection and reporting of data on sharks:

- Resolution 25/08 *On the conservation of sharks caught in association with fisheries managed by IOTC* sets out a wide range of conservation measures relating to sharks including the following reporting requirements: All interactions with sharks in relation to prohibited species being caught, retained sharks, release of sharks and encircling of whale sharks must be recorded through logbooks and observer reports in accordance with Resolutions 15/01 (data collection) and 25/06 (ROS). CPCs shall report annual data for catches of all sharks in accordance with Resolution 15/02.
- Resolution 15/01 *On the recording of catch and effort data by fishing vessels in the IOTC area of competence* sets out the data that should be collected by CPCs for their fisheries. It includes a list of species for which catch (including discards and their fate) and effort data must be collected on a gear by gear basis.
- Resolution 15/02 *Mandatory statistical reporting requirements for IOTC Contracting Parties and Cooperating Non-Contracting Parties (CPC's)* sets out the data that must be reported to the IOTC Secretariat. [To be superseded by Resolution 26/06]
- Resolution 25/06 *On a regional observer scheme*. This resolution puts in place a programme comprising national observer schemes to collect verified catch data and other scientific data related to the fisheries for tuna and tuna-like species in the IOTC area. CPCs are required to cover a minimum of 5% of their operations/sets per year on vessels over 24m in length or vessels of all lengths operating outside of their EEZ. The Resolution provides provisions for the use of Electronic Monitoring Systems (EMS) to complement or substitute for human onboard observers provided that ROS minimum data requirements are collected and applying adopted EMS standards.

177. The IOShPl **NOTED** that although there have been improvements in recent years, data reported to IOTC on shark catches continue to have limitations and gaps.

178. The IOShPl **NOTED** that, in addition to the further implementation of the ROS which is likely to take time, the collection of scientific data by all other means available including pilot observer schemes, self-sampling (collection of data by trained crew) and electronic monitoring should be encouraged and developed.

179. The IOShPl **NOTED** that in many cases where data is being collected, it is being incorrectly reported, or is being reported aggregated rather than to species level. A concerted effort to enhance data gathering abilities, database development and ongoing maintenance and verification would be needed to develop stock status indicators for shark species.

180. The IOShPl **RECOGNISED** that while expertise exists in many CPCs, monitoring and management systems remain weak, especially for artisanal fisheries, in particular for gillnet fisheries. The IOShPl **AGREED** that coastal states require targeted support to build the technical, human, and institutional capacity necessary to meet IOTC's minimum data standards. The IOShPl further **NOTED** that implementing these activities will not only improve the timeliness and accuracy of data submissions but also strengthen the scientific basis for management decisions across the Commission. Thus, the IOShPI **REQUESTED** the Secretariat to develop targeted training capacity starting with priority countries identified in this report (Section 2).

181. The IOShPl **NOTED** the following gaps in CPC data submissions:

- Incomplete species-level reporting, with reported catches lacking disaggregation by species, gear, or fleet segment.

- Delays and inconsistencies in annual sharks and rays data submissions, and sometimes discrepancies between logbook and landing data.

182. Limited observer coverage.

- Weak data collection, collation and validation systems for artisanal and small-scale gillnet fisheries.
- Low uptake of electronic reporting tools.
- Lack of trained staff to process and validate data for IOTC scientific assessments

183. The IOShPl **NOTED** a number of suggested approaches that could be taken to address some of these issues and **REQUESTED** the Secretariat to action these, including:

- Securing a consultant with expertise in gillnet fisheries to work specifically in CPCs with significant gillnet fisheries
- Including fisheries managers in workshops to bridge the gap between science and management, especially in gillnet-dependent countries.
- Encourage collaboration with existing landing site monitoring programmes to expand data gathering exercise.
- Deploy observers and enumerators to artisanal landing sites to collect species-level data directly from fishers.
- Pilot electronic reporting systems to improve timeliness and accuracy of CPC submissions.
- Conduct a critical review of nominal catch data at IOTC, then integrate or synthesize catch data into a structure such as a dashboard which allows for the identification of gaps and anomalies.
- Conduct a regional data validation workshop to reconcile discrepancies and align reporting formats across CPCs.
- Harmonise reporting templates: organise a consultancy to support the design of standardised templates for CPCs.

184. The IOShPl **NOTED** that these types of interventions should help to: improve the timeliness and completeness of CPC data submissions; increase observer coverage and reliable shark catch/bycatch data; enhance monitoring of artisanal fisheries; lead to the wider adoption of electronic reporting tools; and lead to a stronger scientific basis for IOTC stock assessments and management decisions.

185. The IOShPl **NOTED** the shark implementation check sheet process in place at ICCAT **NOTING** that it is a good way to ensure that a consistent set of data are provided by CPCs but that it is ambitious to get IOTC's CPCs to complete a similar process.

186. The IOShPl **NOTED** suggestions to harmonise data collection forms used by CPCs but further **NOTED** that each CPC has a different monitoring system in place making it difficult to produce one set of forms that will work across all systems in all CPCs. The IOShPl **NOTED** that some CPCs such as Kenya are developing or using tools such as Calipseo which can assist with data management and reporting processes.

187. The IOShPl **NOTED** that training on data management would be beneficial in many CPCs to help to streamline the process from data collection to processing and reporting.

188. The IOShPl **NOTED** that there is already a lot of capacity building work being undertaken and further **NOTED** that there is a large role for the NGO community to assist with capacity building activities as they often have more flexibility on how to deliver these kinds of activities than other organisations may have. The IOShPl **NOTED** that a 'training of trainers' approach oftens works well with NGOs in individual CPCs.

189. The IOShPl **NOTED** that capacity building activities such as teaching the use of R software, CPUE standardisation and stock assessment training could also be beneficial for developing capacity in coastal CPCs. The IOShPl **NOTED** that a training package that helps to walk users through the processes needed to make data better and more fit for purposes could be developed to assist CPCs with these processes.

190. The IOShPl **NOTED** that data workshops focusing on facilitating the preparation of data to be submitted to IOTC have been conducted but could be rolled out further. The IOShPl **NOTED** that it is important to track the progress made after such activities to ensure that implementation has improved and to assess if further interventions are required. The IOShPl **NOTED** that workshops that allow different CPCs with similar fisheries to learn together and learn from the experiences of other CPCs would be beneficial.

6.2 Capacity building tools and materials

191. The IOShPl **NOTED** that a range of capacity building tools and materials already exist such as species identification and safe handling and release guides developed by IOTC and other organisations. See a list of these in Appendix VII.

192. The IOShPl **NOTED** that a directory of materials like these has already been created for the Atlantic and Mediterranean by the Shark Trust and **SUGGESTED** that this is also done for the Indian Ocean. The IOShPl further **NOTED** that the Shark Trust have created a range of advisory products for the Atlantic Ocean which bring together identification guides with regulations and CPC obligations which have been well received by industry.

193. The IOShPl **NOTED** that a google form has been developed by the Shark Trust to be circulated to CPCs by the Secretariat with the objective of determining the capacity building needs of all CPCs along with NGOs and other stakeholders in the region in order to develop a baseline understanding of the needs across the whole region.

7. Priorities for data collection and research on shark species and a plan to move forwards

7.1 Overall plan to move forward (practical road map)

194. The IOShPl **NOTED** that successful implementation of the research plan will require continued support from the Commission and a strong commitment from CPCs to address the identified research priorities through coordinated data collection, research, and capacity development activities.

195. The IOShPl further **NOTED** that successful implementation will also require stronger collaboration among CPCs, research institutions, and other partners, together with the identification of sustainable funding mechanisms. The workshop encouraged further discussion with the wider IOTC scientific community on practical approaches to coordinate research activities and maximise opportunities for collaborative projects.

196. The IOShPl **NOTED** that the IOTC WPEB develops a five-year programme of work; however, implementation of research priorities largely depends on the initiatives of individual CPCs unless dedicated project funding is available. Consequently, revisions to the workplan alone are unlikely to result in substantial progress without clear implementation mechanisms.

197. The IOShPl **NOTED** that the stock assessment schedule has been one of the most effective drivers of research and data collection, as it provides a clear timetable and incentivises CPCs to generate the information required for assessments.

198. The IOShPl **AGREED** on a list of priority activities to be carried out - an overview table of the priority activities can be seen in **Error! Reference source not found.**. The priority activities are split into general themes: data improvements; mitigation implementation; and biological information and parameters.

7.2 Fisheries and data collection

199. The IOShPl **AGREED** that in general, there is a scarcity of data and limited data availability for major fleets and countries in IOTC for all shark species (although species such as blue shark can be considered a better documented species). However, this is particularly evident for gillnet and/or coastal fisheries. Although some countries using gillnets are providing the shark statistics to IOTC in aggregated level, the Resolution and stratification of the data is poor. This paucity of information of gillnet/coastal fisheries is due to the difficulties for coastal countries to cover all unloading sites, identification of species and implementation of observer programs.

200. The IOShPl **AGREED** that the shark fishery data collection for gillnet/coastal fisheries is a high priority area, particularly for I.R. Iran, Sri Lanka, Pakistan, Yemen, India, Oman, Somalia and Indonesia. Any work in this area should include all the components of data collection program including information on the type of vessels, fleet characteristics and observer programs along with the implementation of a capacity building program.

201. The IOShPl **NOTED** that for a few species catch and effort, and spatial distribution of catches statistics is available for major longline and purse seiner fleets, but data gaps remain for several species and gear combinations. Thus, the IOShPl considers the collection of information about catch and effort and spatial distribution of those fleets with important shark catches as high priority.

202. The IOShPl **NOTED** that size frequency data from observer programs are available for major longline and purse seiner fleets. Thus, the workshop considered the collection of information about size frequency of catches and bycatches of those fleets with important shark catches as high priority.

203. The IOShPl **AGREED** that the increased implementation of the Regional Observer Scheme is necessary for the collection of basic information such as shark bycatch rates, shark species composition of the catch, correct species identification of shark, size frequency data, spatial/temporal shark catches, etc. The IOShPl **NOTED** that the low progress in the implementation of observer programs is hindering the ability of IOTC WPEB to infer the status of shark populations.

204. The IOShPl **AGREED** that the implementation of Regional Observer Schemes in major IOTC fleets is a high priority, , and/or the collection of scientific data by all other means available including, pilot observer programmes, self-sampling (collection of data by trained crew) and electronic monitoring (sensors and video cameras).

205. The IOShPl **NOTED** that Resolution 15/01 only requires species level reporting of 4 species for gillnets (blue, porbeagle and whale sharks) and 3 species for purse seine fisheries (oceanic whitetip, silky and whale sharks) while other species are either optional species to be recorded or are only required at family level (mako, hammerhead and thresher sharks). The IOShPl further **NOTED** that elements of Resolution 15/01 actively promote poor data reporting practices such as aggregating data by saying that any species not listed as mandatory for collection under each gear may be reported as aggregates. Therefore, the IOShPl **RECOMMENDED** that the WPEB once again recommend that the Commission update Resolution 15/01 so species level reporting is required for more shark species for all gears as recommended by WPEB in 2025.

206. The IOShPl **NOTED** that several steps are required to improve reporting and the quality of data submitted to IOTC:

- improve species identification to enable disaggregated reporting;
- improve and/or implement sampling protocols and data management for coastal fisheries at the CPC level; and
- improve reporting to IOTC. The actions required to achieve these goals are listed below. Key capacity-building actions are designed as long-term, periodic activities.

7.3 Shark biology and ecology

207. The IOShPl **AGREED** to the following list of research priorities in terms of biology and ecology which are also included in Table 8.

- **Age and growth**: ***HIGH priority in the long term*** - Age and growth studies have been conducted and published in the Indian Ocean only for the blue, shortfin mako and silky shark, but not for the other species. Those parameters are used as inputs in several stock assessment methods, and as such should be prioritised in future scientific research.
- **All biological parameters, particularly for oceanic whitetip shark:** ***High priority in the long term.*** There is known to be mortality of oceanic whitetip shark so it should be prioritised.
- **All biological parameters, all species:** ***High priority in the short/medium term.*** Key biological parameters are missing for many species. There is thought to be a range of samples and data that have not yet been analysed that could be used in a broader study.
- **Migrations and habitat use**: ***HIGH priority in the medium term*** – Tagging studies have been done for several species but some have limited data included in the studies so it is suggested that further work is done to better understand migration patterns. Priority species are bigeye and pelagic thresher sharks as no studies have been completed on these to date.
- **All biological parameters, all species, focus on the Eastern Indian Ocean:** ***High priority in the medium/long term.*** There are few studies that have been conducted to estimate key biological parameters for the main shark species in the Eastern Indian Ocean.

Table 8: List of priority actions to address the identified gaps in knowledge

Action	Start	Duration	Description	Notes	Responsible
			DATA IMPROVEMENTS		
Define priority CPC	2027	1 year	Create a matrix with indicators such as fleet size, NDFs, data reporting, engagement, and interest in capacity building. Incorporate trade-data research.	Start with two CPCs and increase the number as the work begins to flow.	IOShPl Working group and WPEB
Consultant to work with key GN fleets to assess their data-collection systems and help fill gaps	2027	2 years	Consultant to visit priority CPCs to: Inspect entire process of data collection, processing and management Cover fishing ports, markets and any other landing sites Make recommendations for how to improve the data collection and reporting process		Secretariat to recruit consultant
Define a sampling strategy for priority countries	2027	1 year	Ask CPCs to provide lists of sharks caught in their fisheries, species composition percentages, landing sites, gear types, etc. To reconstruct historical data, ask CPCs to engage stakeholders (fishers, sellers, industry, etc.) and include their perceptions of changes over time. Use IUCN species distributions within EEZs as checklists of species likely to be encountered and ask CPCs to validate them. Generate regional lists and create a species dictionary that includes local names. This is an achievable project.		IOShPl Working group and WPEB

Action	Start	Duration	Description	Notes	Responsible
Implement routine sampling for priority countries	2028	every year	Sampling should be conducted by hired experts according to the predefined strategy and followed by CPC-appointed personnel. The sampling operation should be preceded by separate capacity-building workshops targeting the three pillars of data collection: identification, sampling protocols, and reporting. This is to be done first in the priority countries.	Bear in mind that routine sampling should ideally incorporate all IOTC species, as the data issue is widespread across working parties.	Secretariat
Implement routine detailed sampling focusing on catch composition and size	2029	every 2–3 years	Sampling initiatives to focus on collecting morphometric data	Ask CPCs to provide information on how sharks are processed, measured, and weighed. Ask CPCs for historical and current L-W data and length types. Use this information to revise the relationships.	Secretariat
Updating morphometric relationships	2029	1 year	Finding alternative sources of data to revise morphometric relationships	Approach the KZN Shark Board (in South Africa) who probably have a good dataset for L-W data.	Secretariat
Linking management systems with IOTC's data submission process	2030	1 year	Consultant to work to connect CPC data management systems with IOTC's data reporting requirement automatically		Secretariat

Action	Start	Duration	Description	Notes	Responsible
Create capacity building materials	2027	1–2 years	(1) Collate baseline materials into a directory—a living document that can be updated and eventually added to the IOTC website in greater detail; (2) create a Google Form to seek additional materials and improve understanding of CPC needs; (3) create Indian Ocean specific fisheries advisory products; and (4) create training materials to guide people through the process of cleaning data and making it more fit for purpose.	Create a training package that guides through the processes needed to improve data quality and fitness for purpose. An analyst could develop a simple resource tailored by need. Use a training-of-trainers approach: bring together a group to provide training and share experiences and problems. The IATTC provides a good example, working closely with CPCs through webinars and in-person training. Data mentors could hold clinics ahead of the main reporting dates.	IOShPl Working group, WPEB & Secretariat
Carry out capacity building workshops	2027	Every 1-2 years	To address the lack of capacity for data collection and management, carry out capacity building workshops on: 1) species ID 2) improving sampling protocols and data management	Review each government's sampling protocols for its fisheries and how it manages the data collected.	Secretariat

Action	Start	Duration	Description	Notes	Responsible
Data mining	2026	1–2 years	Involve the broader research community in research useful to RFMOs. Create a research priorities directory and reach out through groups such as RSN and IUCN. Call for data and information from CPC scientists. Speak directly with NGOs and other identified data holders to obtain data from SSF and Sharks International projects.	Approach the RSN network. Engage IUCN SSG groups. Consider Common Oceans Project III. Issue a call for data. Invite collaboration. Create data directories, as is done for seabirds.	IOShPl Working group and WPEB
Data mining	2027	1–2 years	Assess the feasibility and relevance of using the information sources identified through the data/information call.		IOShPl Working Group / assessment expert
Data mining	2030	4 years	Use alternative information for data-poor species in future assessments.		WPEB
Trade data	2027	Every 2 years	Explore discrepancies between trade data and catch reporting, and investigate the possibility of using these data to improve current catch estimates.	Repeat every two years to align with the CITES Animals Committee.	IOShPl Working group and WPEB
Discards estimation & extrapolation methods	2026	2 years	Improve discards reporting to species level by enforcing mandatory reporting	Estimate SMA discards for Resolution 25/09 in 2028. Use training-of-trainers capacity-building activities to address this.	Commission (compliance), working group (scientific work)
Improve levels of observer coverage	Ongoing		Improve levels of observer coverage by enforcing mandatory reporting		Commission

Action	Start	Duration	Description	Notes	Responsible
MITIGATION MEASURES IMPLEMENTATION					
Capacity building for mitigation measures	2028	1-2 years	Capacity building activities can be used to improve understanding how to implement mitigation measures in certain gears,		Secretariat and WPEB
Monitoring effectiveness of mitigation measures after implementation	2028	2-3 years	Implementation of mitigation measures is not well monitored currently.		WPEB
BIOLOGICAL INFORMATION AND PARAMETERS					
Collaborate with RFMOs and other groups to address CITES permit issues and seek research exemptions through RFMOs	2027	2-5 years	Joint collaboration among RFMO Secretariats. Speak with CITES. Facilitate communication among RFMO scientists. Agree on a common position to present to CITES. CPCs nominate a scientist to complete and document the application process. Create a Google Sheet describing the process and listing contacts in each CPC who can identify the relevant people (CITES authorities). The Secretariat coordinates CPC responses. Coordinate through the SRG.		Secretariat to coordinate with other RFMOs

Action	Start	Duration	Description	Notes	Responsible
Create an inventory of available biological samples and tagging data	2026	1 year	Call for samples and tagging data to create an inventory (particularly of any data that have not yet been analysed but could be used in a broader study). Establish a reporting form. Use the IUCN network and others. Include the tagging network at GlobalSharkMovement.org.	ICCAT has a template to review. Investigate whether it is in place for all species and, if so, expand it to include sharks.	IOShPl Working group, WPEB, SC IOTC circular
Investigate age and growth parameters	2027	1–2 years	Encourage CPCs (and their observers) to collect information, samples and data that can be used to estimate age and growth. This could be linked to retrieved samples. Conduct age and growth studies.	ICCAT have a template to look at. Investigate if this is in place for all species and if so expand to include sharks The CITES permit issue will need to be resolved first for many CPCs. OCS data collection is needed because mortality is known to occur. Observers can be asked to collect vertebrae and tissues from dead OCS. Observers should be able to transport these samples under their mandate with a letter from IOTC authorising them to bring the samples home. It is feasible to begin collecting these samples.	IOShPl Working Group to develop form, Secretariat to circulate
Investigate Age and Growth parameters	2028	5 years	Continue to finalise current projects. Identify priority species for future projects	Define priority species with WPEB – OCS as a possibility.	CPC's Scientists
Mortality estimates (PRM and AV)	Ongoing	Regular updates	Continue to finalise current projects. Identify priority species for future projects	SMA as one priority spp. Others to be identified	CPC's Scientists

Action	Start	Duration	Description	Notes	Responsible
		(long-term)			
Movement and migration information	2030	6-10 years	Carry out studies to better understand movements and migrations of sharks		CPC's Scientists
All biological parameters	Ongoing	Long-term		There is a lack of all biological parameters for all species in the Eastern Indian Ocean	CPC's scientists
Additional proposed actions					
Discards estimation			Improve AI technology for species ID, size measurement and discard estimates in EMS		CPC's Scientists

7.4 Indicators and assessment methods

208. The IOShPl **NOTED** that traditional stock assessment methods have only been applied to blue shark and shortfin mako shark to date.

209. The IOShPl **NOTED** that to improve the capacity of the WPEB to provide management advice and assess the population status of shark species, new methodologies need to be incorporated including data poor methods set out in Section 5. These can be revisited as the data situation improves.

210. The plan for moving forward with stock assessments is provided in Table 9.

Table 9: Actions to be taken to improve assessments of sharks

Action	Start	Duration	Description
Continue with conventional assessment methods	Follow WPEB's schedule	every 4 years	SS3, JABBA, etc. Blue sharks and shortfin mako are currently assessed using these conventional methods. Based on the review of available information for silky sharks, such methods might become possible in the near future (in approximately three years).
Data poor methods	2026	4 years	Evaluate new data-poor methods in the year before each data-poor assessment, including ERAs and other risk assessments.
Apply CKMR to feasible species	2027	10 years	(1) Start with a workshop to define priority species (e.g., scalloped hammerhead: 500 samples per year for three years) and the sampling protocol. Build on the feasibility studies already conducted. (2) Address CITES permits (lines 2 and 3 of the Overview table). (3) Implement sampling with volunteer CPCs and monitor progress annually.
Implement adaptive management for data-poor species with stakeholder engagement, as done in Australia.	2029	Forever (review progress and modify as needed every 4 years)	Start with a pilot study including stakeholder consultations to develop a shared view on way(s) to monitor stock condition and way(s) to react when stock in at-risk situation(s), e.g. focusing on most sensitive but least data available species. This will be a slow process but may offer substantial benefits. It should continue even when data reach 'ideal' levels and can complement traditional methods. It includes a socioeconomic dimension and promotes greater acceptance of management measures.

7.5 Mitigation measures

211. The IOShPl **RECALLED** that under Agenda item 4 the working group reviewed a summary of available peer-reviewed publications on potential mitigation measures for mitigation of shark bycatch in IOTC managed pelagic fisheries. Major 'pros and cons' of each method were highlighted, based on best scientific knowledge currently available. Additionally, the level of research needs and financial implications were also considered. For many, the mitigation measures are well understood, so, while they are included in the summary table in Appendix V, they are not included in the following list of priorities for research. However, other mitigation measures still require substantial research.

212. The IOShPl **AGREED** that the list of mitigation measures summarised in Appendix V is **not** a ranking of potential measures, as the objective of this review was just **to highlight research needs** before any advice can be provided on their potential efficiency and application if introduced to manage IOTC pelagic fisheries. Additionally, the research needs to take into consideration their potential as shark mitigation measures, but also the implications its implementation might have on fisheries data collection and, consequently, on the shark stock assessment process. For example, the IOShPI **NOTED** that retention bans might have unintended consequences reducing the monitoring and collection of key information for stock assessment and, thus, it also **NOTED** that retention bans should be implemented along with strengthen monitoring systems.

8. IDENTIFICATION OF POTENTIAL FUNDING SOURCES AND APPLICATION PROCEDURES

213. The IOShPl **RECOMMENDED** that the Chair of the SC and the Chair of the WPEB to liaise with the IOTC Secretariat for coordinate efforts on how funding can be achieved, and on how to use research funding in the most efficient, collaborative and transparent way, within the objectives of this research plan.

214. The IOShPl **NOTED** a range of potential funding opportunities for projects identified as being high priority for closing data and knowledge gaps. The IOShPl **NOTED** that applying for these funds would be the responsibility of the project leaders in most cases.

8.1 IOTC Membership

215. The IOShPl **NOTED** the following avenues for seeking funding with the IOTC membership:

Table 10: Summary of information regarding seeking funding through IOTC and its members

Source	Typical timeframe / call frequency	Typical funding amount/project timeframes	Application process	Topic focus
IOTC annual budget	The IOTC budget is now estimated and approved on a two-yearly basis. Thus, the next budget cycle will cover 2027 and 2028. In exceptional circumstances, the Commission may approve additional budget items for 2027.	Varied. There is no set maximum, however projects in excess of $30K are unlikely to be successful given the nature of the budget.	Proposals should come via the WPEB to the SC to the Commission.	Any approved by the WPEB and SC
CPCs	No specific timeframe, though most Members work at least one full year in advance.	Varied	CPC specific. Suggest that once a workplan is developed and approved by the WPEB, that TORs are developed for each element and submitted to the Membership.	CPC specific

216. The IOShPl **AGREED** that interested participants should contact other relevant parties and develop short concept notes for each of the core topics requiring action from the workplan, and to circulate these among the IOShPl participants for comment. These should then be presented to the WPEB and the SC for general approval.

8.2 Other sources

217. The IOShPl **NOTED** a range of other potential avenues for seeking external funding which is summarised in Appendix VIII.

9. REVIEW OF THE DRAFT INDIAN OCEAN SHARK RESEARCH PLAN (IOSHPL) FOR SUBMISSION TO THE WPEB IN 2026

218. The IOShPl **RECOMMENDED** that the working group continue its work intersessionally via email to refine the workplan for the consideration and potential endorsement by the WPEB at its next session to be held in September, 2026, including the consolidated set of recommendations arising from the IOShPl, provided at Appendix VII.

219. The report of the Indian Ocean Shark Research Plan (IOShPl02) (IOTC–2026–IOShPl02–R) was **ADOPTED** by correspondence.

APPENDIX I
LIST OF PARTICIPANTS

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APPENDIX II
AGENDA FOR THE INDIAN OCEAN SHARK YEAR PROGRAM (IO-SHPL02) WORKSHOP

Date: 28–30 July 2026

Location: Cape Town, South Africa

Time: 09:00 – 17:00 daily

Coordinators: Dr Charlene da Silva, Dr Mariana Tolotti, Lauren Nelson

1. **OPENING OF THE SESSION** (Coordinators)
2. **REVIEW OF THE CURRENT INFORMATION AVAILABLE (FISHERIES, DATA COLLECTION) AND IDENTIFY MAJOR GAPS**
   - 2.1 Fleet and gear characterisation and fleet dynamics
   - 2.2 Data needs [Catch (landings and discards), effort, CPUEs series; gear selectivity; catch-at-size/age; Data mining/recover of historical data sets for sharks]
   - 2.3 Observer programs (design and implementation)
   - 2.4 Trade data
   - 2.5 Availability of Nominal CPUE series for key shark species (particularly from Asian LL fleets) (Sachiko)
   - 2.6 Information and datasets from coastal CPCs which exist but have not yet been presented to the WPEB
   - 2.7 Collection of genetic data
3. **REVIEW OF THE CURRENT AVAILABLE INFORMATION IN TERMS OF BIOLOGICAL AND ECOLOGICAL KNOWLEDGE OF THE SEVEN MAJOR SHARK SPECIES (BSH, SMA, OCS, FAL, SPL, PTH AND BTH)**
   - 3.1 Life history traits (age and growth; reproduction; mortality)
   - 3.2 Review of current biological knowledge
   - 3.3 Stock structure, range and distribution (tagging and genetics)
   - 3.4 Habitat use and migrations
   - 3.5 Morphometrics and conversion factors for shark products
4. **REVIEW OF THE CURRENT AVAILABLE AND IMPLEMENTED MITIGATION MEASURES, INCLUDING BEST PRACTICE CODES/PROCEDURES, IN TERMS OF REDUCING SHARK BYCATCH AND INCIDENTAL MORTALITY**
   - 4.1 Operational and technological aspects (Gillnet; Longline; Purse seine)
   - 4.2 Best practices
5. **REVIEW OF THE MOST APPROPRIATE ASSESSMENT METHODS THAT COULD BE USED ON THE MAIN SHARK SPECIES, AS WELL AS THE POTENTIAL USE OF OTHER INDICATORS AS ALTERNATIVES TO TRADITIONAL STOCK ASSESSMENT APPROACHES**
   - 5.1 Stock status indicators
     - 5.1.1 CPUE standardisation
     - 5.1.2 Demographic analysis
   - 5.2 Stock assessment approaches
     - 5.2.1 Assessment approaches
       - Risk-based Assessments (including Productivity Susceptibility Analysis) (data limited)
       - List-history based assessments (data limited)
       - Catch only methods (data limited)
       - Length based methods (data limited)
       - CPUE based methods (data moderate)
       - Production models (data moderate)
       - Age-structured production models (data moderate)

- Fully age-structured models (data rich)
- Integrated model (data rich)

5.2.2 Weight-of-Evidence approach to stock status determination

6. IDENTIFY MAJOR NEEDS IN TERMS OF CAPACITY BUILDING, AIMING TO BRING THE QUALITY AND QUANTITY OF DATA UP TO MINIMUM IOTC STANDARDS & MATERIALS

6.1 Data collection

6.2 Verification / Regional Observer Scheme

6.3 Reporting

6.4 Other capacity building activities

6.5 Capacity building tools and materials

7. PRIORITISE DATA COLLECTION AND RESEARCH ON SHARK SPECIES, BEARING IN MIND THE SC SCHEDULE OF ASSESSMENT (OCS, SPN, FAL – INDICATORS IN 2026; BTH, PTH, POR – INDICATORS IN 2027; FAL – INDICATORS IN 2028; SMA – ASSESSMENT IN 2029; BSH – ASSESSMENT IN 2030, OCS INDICATORS IN 2030)

7.1 Fisheries and data collection

7.2 Shark biology and ecology

7.3 Indicators and assessment methods

7.4 Mitigation measures

7.5 Capacity building

8. IDENTIFICATION OF POTENTIAL FUNDING SOURCES AND APPLICATION PROCEDURES

9. REVIEW OF THE DRAFT INDIAN OCEAN SHARK RESEARCH PLAN WORKSHOP REPORT (IOShPl02) FOR SUBMISSION TO THE WPEB IN 2026

APPENDIX III

AGENDA ITEM 2 SUPPORTING INFORMATION: REVIEW OF THE IOTC RESOLUTIONS RELEVANT TO SHARKS, CURRENT INFORMATION AVAILABLE (FISHERIES, DATA COLLECTION) AND IDENTIFICATION OF MAJOR GAPS

Review of the Resolutions relevant to sharks managed by IOTC

Bycatch are subject to a range of different management measures under various IOTC Resolutions which are outlined in the following section. A summary of main requirements of those Resolutions are described as follows:

IOTC Resolution 25/08: *On the conservation of sharks caught in association with fisheries managed by IOTC*

- Para 3: CPCs shall ensure that their flag vessels **do not retain** on board, transship, land and store any part or whole carcass of the following sharks: a) **oceanic whitetip sharks; b) thresher sharks; and c) whale sharks.**
- Para 5: CPCs shall take the measures necessary to require that all sharks retained on board their vessels are **fully utilised**. CPCs shall ensure that the **practice of shark finning is prohibited**
- Para 6: In order to implement the obligation in paragraph 5 for sharks landed fresh, CPCs shall require their vessels to land sharks with **fins naturally attached** to the carcass.
- Para 14: From 1 January 2026, CPCs shall ensure that their flag long-line vessels do not use branch lines running directly off the longline floats or drop lines, known as shark lines
- Para 26: The Commission shall consider at its 2026 Session specific conservation and management measures for **blue sharks**, including a total allowable catch, catch limits for each CPC to be decided
- Para 27: Scientific Committee shall continue the development of a **management strategy evaluation** framework for Indian Ocean **blue shark**
- Para 28: CPCs shall ensure that their flag vessels **do not intentionally set a purse seine net around a whale shark** if it is sighted prior to the commencement of the set.
- Para 29: CPCs shall ensure that, if a whale shark is unintentionally encircled in a purse seine net, the master of the vessel takes all reasonable steps to ensure its **safe release**
- Para 30: CPCs shall ensure that, if a flag purse seine vessel unintentionally encircles a whale shark in a purse seine net or fishing vessels using other gear types have an interaction with a whale shark in association with their fishing activity, the master of the vessel **reports the incident** to the relevant authority of the flag State
- Para 31: CPCs shall ensure that all interactions with sharks related are duly **recorded** through logbooks and, when an observer is on board, through observer reports in accordance with Resolutions 15/01, 25/06 and 15/02
- Para 32: CPCs shall **report annual data for catches of all sharks** in accordance with IOTC data reporting requirements and procedures in Resolution 15/02
- Para 34: The Commission shall consider **appropriate assistance to developing CPCs** for the identification of sharks and the collection of data on their shark catches and assist in reporting of those
- Para 36: CPCs should implement the FAO **International Plan of Action for the Conservation and Management of Sharks**
- Para 38: The IOTC Scientific Committee shall **establish terms of reference for a long term-project on sharks** in the IOTC area of competence to be considered by the Commission… with the aim to ensure the collection of data required for performing reliable stock assessments for key shark species
- Para 39: The IOTC Scientific Committee shall **advise the Commission on the population status** of **relevant sharks**, on their vulnerability to overfishing, and on whether precautionary management of these species
- Para 40: CPCs with reported catches and landings of sharks shall endeavour to **undertake**

research to: identify ways to make **fishing gears more selective** and **reduce the mortality** of incidentally caught sharks; **improve knowledge on key biological/ecological parameters**, life-history, behavioural traits, migration patterns, and post-release survival of key shark species; **facilitate capacity building** of CPCs in shark species identification to improve data reporting at species level; **identify key shark mating, pupping and nursery areas**; and **improve handling practices** for live sharks to maximise post-release survival
- Para 41: The SC shall **review annually the information** reported by CPCs pursuant to this Resolution and the results of the research project pursuant to paragraph 38, on a gear-by-gear-basis. On this basis, the IOTC Scientific Committee shall, as appropriate and on an annual basis, **provide recommendations to the Commission on ways to strengthen the conservation and management of sharks** within IOTC
- Para 43: The IOTC Scientific Committee shall, at its annual Session in 2025, **review existing data and information relating to the life history and conservation status of whale sharks, and confirm whether they meet the definition of being a taxon of the greatest biological vulnerability and conservation concern for which there are very few data**. Should this be the case, the IOTC Scientific Committee shall advise the Commission on the appropriateness of applying precautionary management measures in IOTC fisheries, including a retention ban. The IOTC Scientific Committee may also identify options for future research and data collection, as well as advise on other mitigation measures for relevant IOTC fisheries.

IOTC Resolution 25/09: *On the conservation of* ***shortfin and longline mako sharks*** *caught in association with IOTC fisheries*

- Para 2: CPCs shall require vessels flying their flag to **promptly release unharmed** … shortfin mako sharks (Isurus oxyrinchus) and longfin mako sharks (Isurus paucus) when brought along side for taking on board the vessel.
- Para 3: Any retention permissible shall be allowed only when the fish is dead at haulback, and the vessel has an observer or a functioning electronic monitoring system on board to verify the condition of the sharks.
- Para 4: CPCs whose fishing vessels retain shortfin or longfin mako sharks shall **prohibit transhipping**, whole or in part, shortfin or longfin mako sharks
- Para 5: CPC shall ensure that their fishers **record and report all catches including dead discards** and **live releases** of mako sharks in accordance with Resolution 15/01
- Para 8: CPCs are **encouraged** to continue **undertaking scientific research** that provides information on key biological/ecological parameters, life-history, migrations and post-release survival of shortfin and longfin mako sharks and to report any such information to the SC
- Para 11: No later than its 32nd Session in 2028, the Commission will develop a mechanism to constrain the total levels of mortality, including dead discards and post-release mortality, with the objective for the stock to be in the green zone of the Kobe matrix by 2038.

IOTC Resolution 26/03: *On the conservation of* ***mobulid rays*** *caught in association with fisheries managed by IOTC*

- Para 4: CPCs shall **prohibit** their flag vessels, other than those carrying out subsistence fisheries, from **retaining onboard, transhipping, landing or storing any part or whole carcass of mobulid rays**. CPCs shall ensure that their flag vessels carrying out subsistence fisheries do not tranship, sell or offer for sale any part or whole carcass of mobulid rays.
- Para 5: CPCs shall require all their flag fishing vessels, other than those carrying out subsistence fisheries, to **promptly release alive and unharmed** … mobulid rays incidentally caught in IOTC fisheries as soon as they are seen … and do it in a manner that will result in the least possible harm to the individuals captured
- Para 7: CPCs shall report the information and data collected on interactions (i.e. number of discards and releases) with mobulid rays by vessels through logbooks and/or through observer programmes.
- Para 8: Except for CPCs that have clearly demonstrated that intentional and/or incidental catches

of mobulid rays do not occur in their IOTC fisheries, CPCs shall ensure that fishers on their flag fishing vessels are aware of and **use proper mitigation, identification, handling and releasing techniques** and keep on board all necessary equipment for the release of mobulid rays in accordance with the Minimum Standards for Safe Handling and Live Release Procedures
- Para 12: Except for those CPCs that have clearly demonstrated that intentional and/or incidental catches of mobulid rays do not occur in their IOTC fisheries, CPCs shall **develop**, with the assistance from the IOTC Secretariat where required, **catch monitoring plans** for mobulid ray catches and interactions by their flag fishing vessels carrying out subsistence and artisanal fisheries
- Para 15: CPCs are encouraged to **investigate at-vessel and post-release mortality** in mobulid rays including the application of satellite tagging programmes

IOTC Resolution 15/01: *On the **recording of catch and effort data** by fishing vessels in the IOTC area of competence*
- Para 1: Each flag CPC shall ensure that all purse seine, longline, gillnet, pole and line, handline and trolling fishing vessels flying its flag and authorised to fish species managed by IOTC be subject to a **data recording system**
- Annex I: Record once per trip – trip information and gear configuration
- Annex II: Record once per set – set information including **catch weight** or number by species per set and form of processing. Species include most commonly caught elasmobranch species

IOTC Resolution 26/06: ***Mandatory statistical reporting requirements** for IOTC Members and Cooperating Non-Contracting Parties (CPC's)*
- Para 2: CPCs shall **submit annual estimates of the total catch** by species and gear, by **retained catches** in live weight and by **discards** in live weight or numbers) for all species under the IOTC mandate as well as the **most commonly caught elasmobranch species**
- Para 3: CPCs should provide **data concerning non-target species** as required under the relevant Resolutions
- Para 4: CPCs shall submit catch and effort data for their IOTC fisheries as follows:
  - **Surface Fisheries:** catch weight by species and fishing effort shall be provided by 1° grid area and month strata
  - **Longline Fisheries:** catch by species, in numbers or weight, and effort as the number of hooks deployed shall be provided by 5° grid area and month strata
  - **Coastal Fisheries:** catches by species, fishing effort and fishing gear shall be submitted annually
- **Para 5: Size data shall be provided** for all gears and for all species mentioned in paragraph 4 and following the procedures described in the Guidelines for the reporting of fisheries statistics to the IOTC**.**

IOTC Resolution 25/06: *On a **regional observer scheme***
- Para 2: The objective of the IOTC Regional Observer Scheme (ROS) shall be to **collect verified catch data** and other scientific data related to the fisheries for tuna and tuna-like species in the IOTC area of competence.
- Para 3: In order to improve the collection of scientific data, each CPC shall ensure that all fishing vessels of 24 meters length overall and above and under 24 meters if they operate outside the exclusive economic zone (EEZ) of the flag CPC and in the IOTC area of competence comply with the **minimum observer coverage of 5%,** as defined by the number of operations/sets
- Para 4: Providing CPCs meet the minimum mandatory ROS data reporting standards, the minimum human observer coverage provided for in paragraph 3 may be **complemented or substituted by means of an EMS**
- Para 9: Landings from artisanal fishing vessels shall also be monitored at the landing place by field samplers. The indicative level of the coverage of the artisanal fishing vessels shall be **5% of the total levels of vessel activity**
- Para 14: Observers shall:

- a. **record and report fishing activities**, verify positions of the vessel;
- b. observe and **estimate catches** as far as possible with a view to identifying catch composition and bycatch and to **monitoring discards** including their fate (e.g. released alive) and size frequency;
- c. **record the gear type**, mesh size and attachments employed by the master;
- d. collect information to enable the cross-checking of entries made to the logbooks (species composition and quantities, live and processed weight and location, where available); and
- e. carry out such scientific work (e.g. collecting samples), as requested by the IOTC Scientific Committee.

- Paragraph 4: The number of the **artisanal** fishing vessels landings shall also be monitored at the landing place by field samplers. The indicative level of the coverage of the artisanal fishing vessels should progressively increase towards 5% of the total levels of vessel activity (i.e. total number of vessel trips or total number of vessels active).

Review of the current sharks data available and identification of main data gaps

Prepared by IOTC Secretariat[1]

Purpose

To provide participants to the Indian Ocean Shark Research Plan workshop (IOShPl) with a review of the status of the information available on shark species associated, and dependent of IOTC fisheries. According the IOTC Scientific Committee:

"*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. A bycatch species includes those non-IOTC species which are (a) retained (byproduct), (b) incidentally taken in a fishery and returned to the sea (discarded); or (c) incidentally affected by interacting with fishing equipment in the fishery but not taken*."

The document summarises the current information received for shark species, in accordance with relevant Resolutions adopted by the Commission. It provides an overview of the data available in the IOTC Secretariat databases as of July 2026 for sharks and rays.

Shark catches levels & trends

When considered alongside the total catches reported to the IOTC across all species categories, sharks represent a comparatively small, though non-negligible, proportion of this total (Figure A 1).

[1] IOTC-Statistics@fao.org

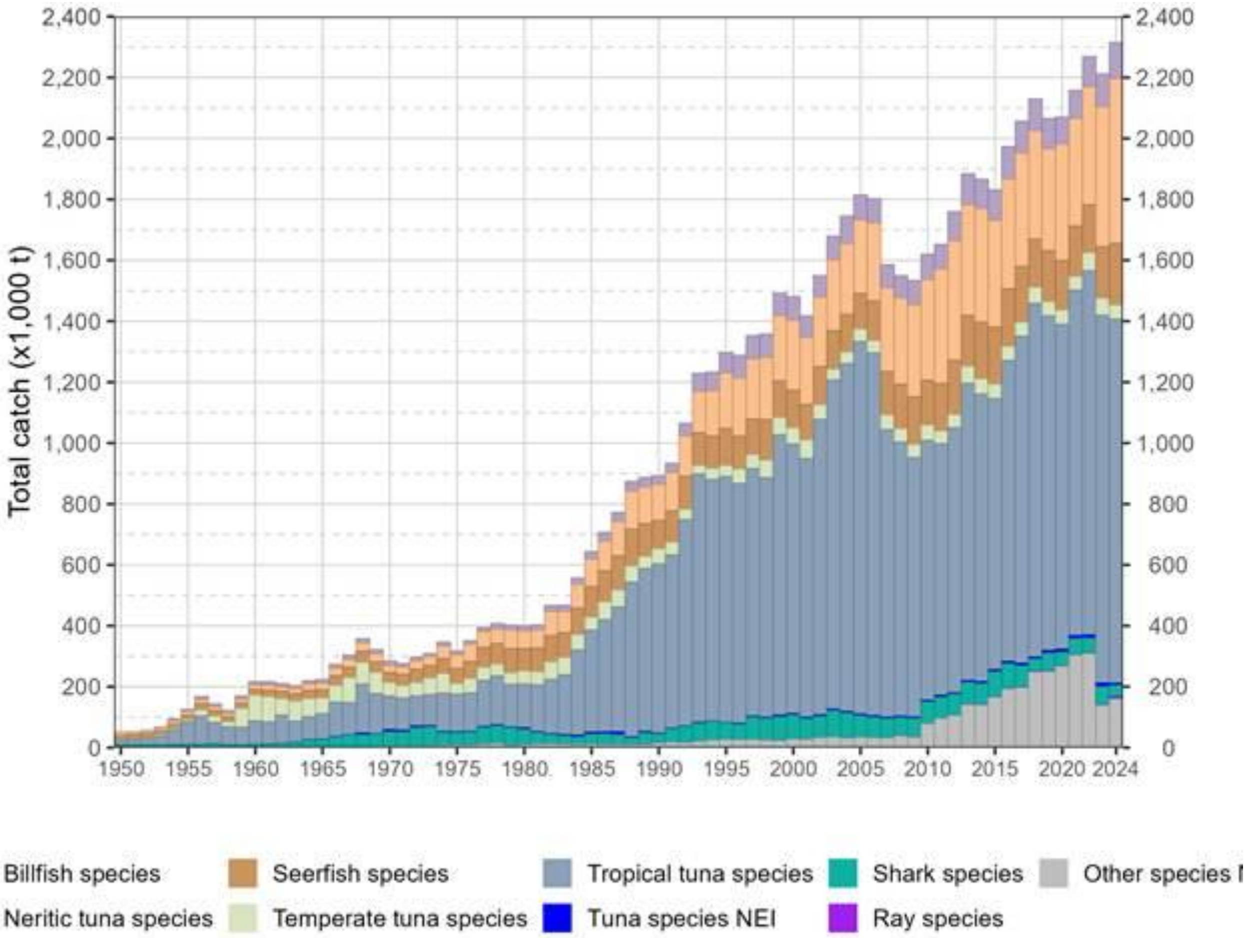


Figure A 1: Annual cumulative absolute time series of retained catches (metric tonnes; t) of IOTC catches by species groups for the period 1950-2024

Reported shark catches increased substantially from approximately 8,000 t in 1950 to a peak of nearly 87,000 t around 2003–2004, followed by a gradual decline through the late 2010s and a partial recovery in the most recent years (Figure A 2). Throughout the time series, catches classified only to the family or order level ("Various sharks nei" and "Unclassified", hereafter aggregated as SKH/UNCL) have consistently dominated the reported composition, exceeding 90% of total catch for most of the period prior to the mid-1980s and remaining above 50% in relative terms even in recent decades. Species-specific reporting became more prominent from the 1990s onward, with silky shark (*Carcharhinus falciformis*) and blue shark (*Prionace glauca*) emerging as the most consistently identified taxa, while mako (*Isurus* spp.) and hammerhead (*Sphyrna* spp.) shark groups show a more marginal but steady presence in the catch composition from the same period (Figure A 2).

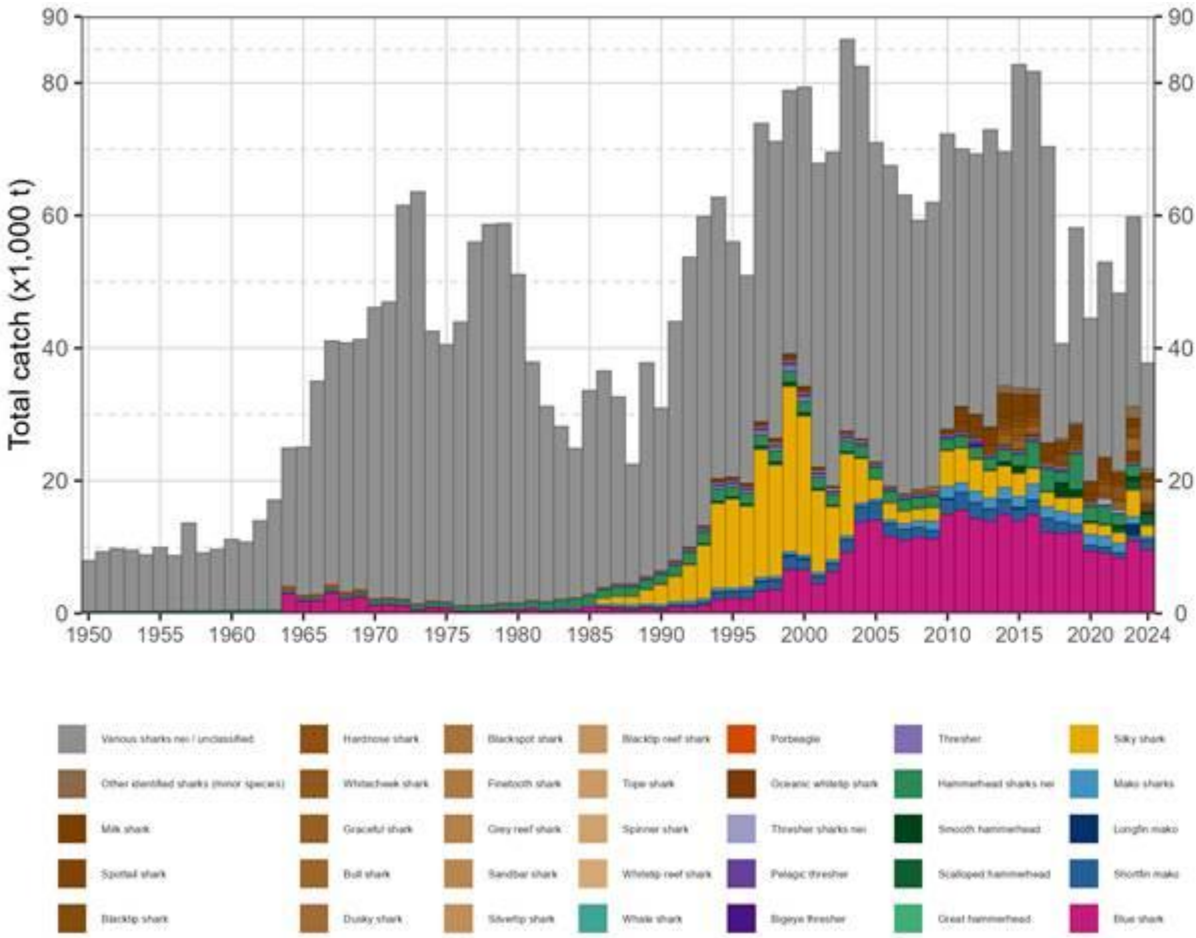


Figure A 2: **Annual cumulative absolute time series of retained catches (metric tonnes; t) of sharks for the period 1950-2024**

Species Composition by Fishery and Gear

Disaggregating catch composition by fishery group reveals substantial differences in species composition among gear types. Gillnet fisheries account for the largest cumulative shark catch of any fishery group in the dataset (approximately 1.79 million t) (Figure A 3), exceeding longline (approximately 584,000 t) for the complete data series. Longline and line fisheries show broadly similar species composition, dominated by blue shark, with smaller but consistent contributions from silky shark, mako sharks, and hammerhead species (Figure A 4 and Figure A 5).

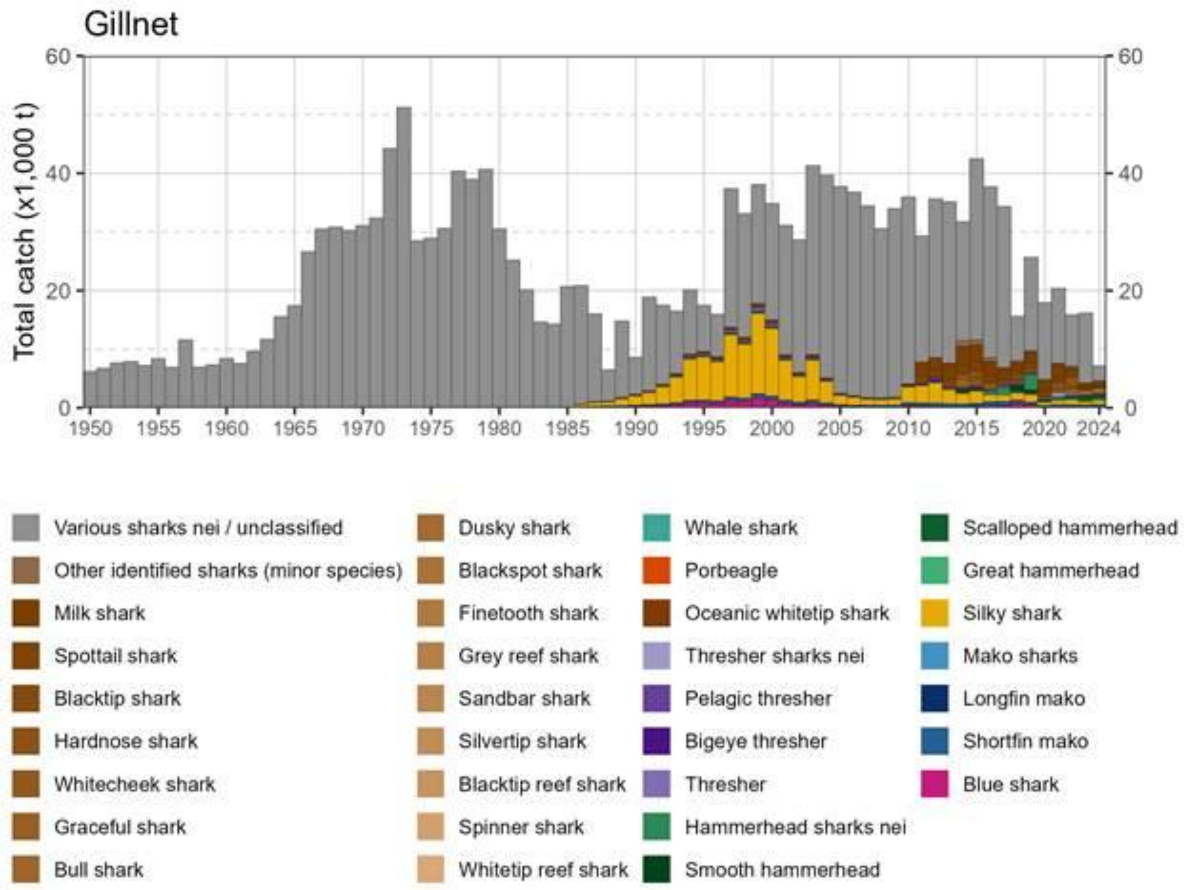


Figure A 3. **Catch composition by species within the gillnet fisheries, 1950–2024.**

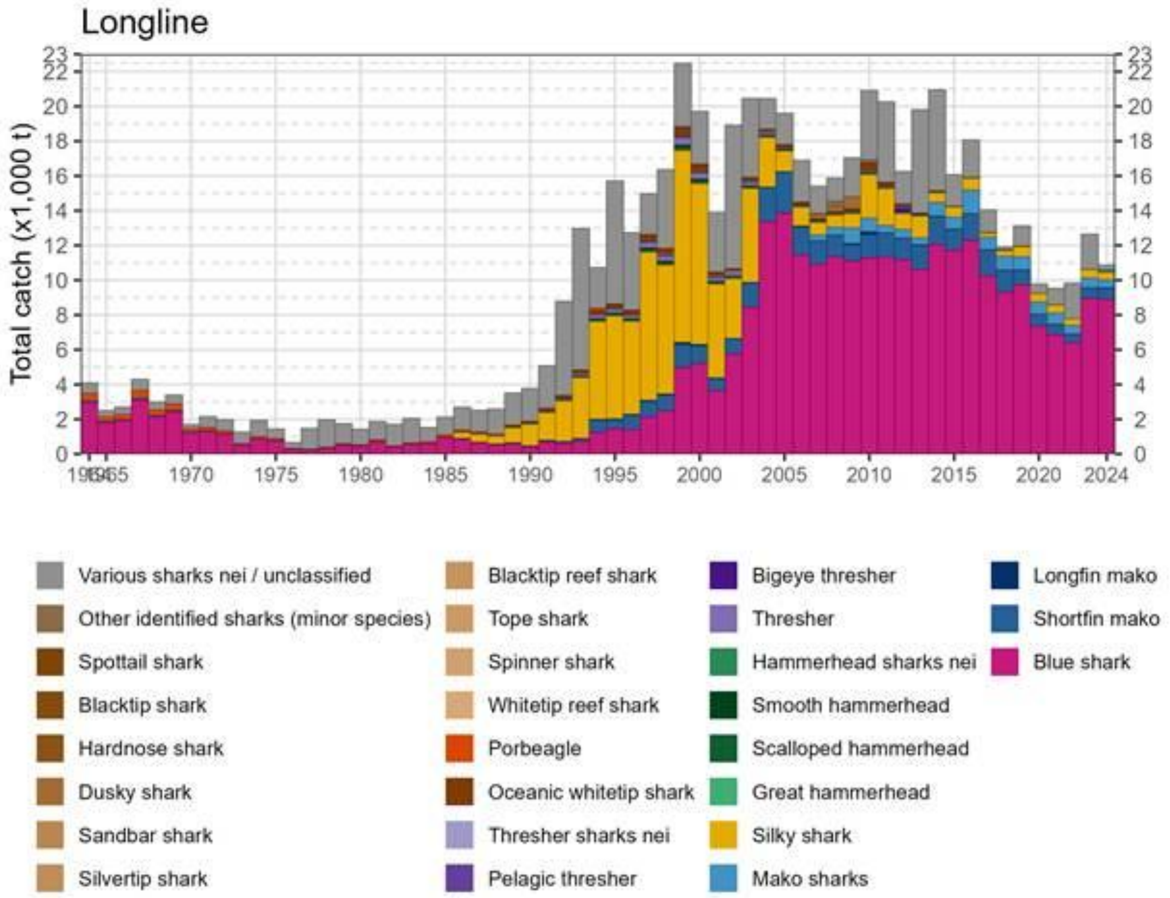


Figure A 4. **Catch composition by species within the longline fisheries 1950–2024.**

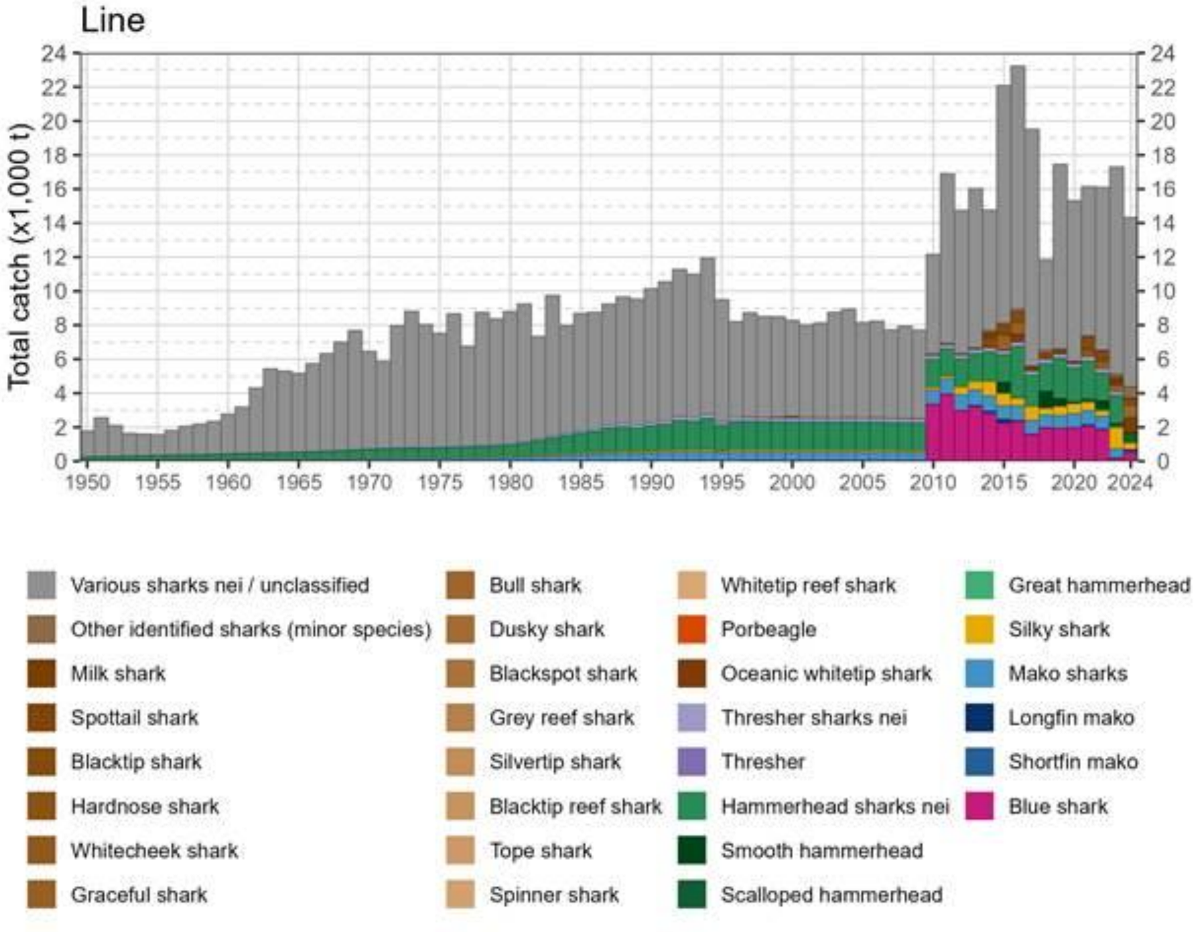


Figure A 5. **Catch composition by species within the line fisheries 1950–2024.**

Within each of the three highest-volume fishery groups (gillnet, longline, and line), catch is further concentrated within a small number of specific gear types. For longline, catches are dominated by deep-freezing longline, longline targeting swordfish, and longline operating in combination with gillnet, which together account for the large majority of total longline shark catch. For line fisheries, troll line and handline account for the bulk of the catch. For gillnet, catch is dominated by gillnet operated in combination with longline.

Heatmaps of cumulative catch by species and specific gear type within each of these three fishery groups (Figure A 6Figure A 7 and Figure A 8) show that this granularity is important for interpreting reported composition: different gear–fleet combinations within the same broad fishery group can show markedly different species profiles, reflecting differences in target species, fishing area, and fleet-specific practices, rather than a single homogeneous “gillnet” or “longline” fishery.

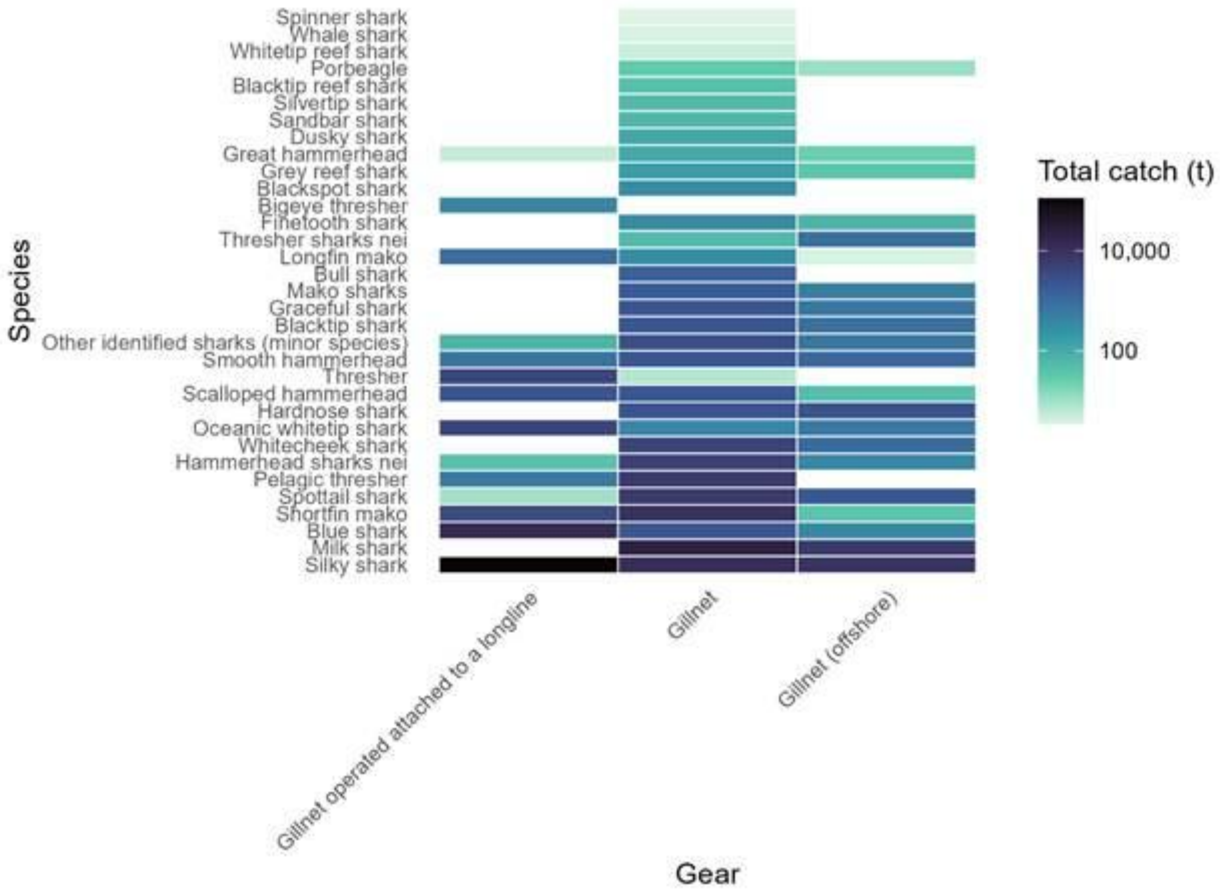


Figure A 6. **Cumulative reported catch (t) by species and specific gear type within the Gillnet fisheries**

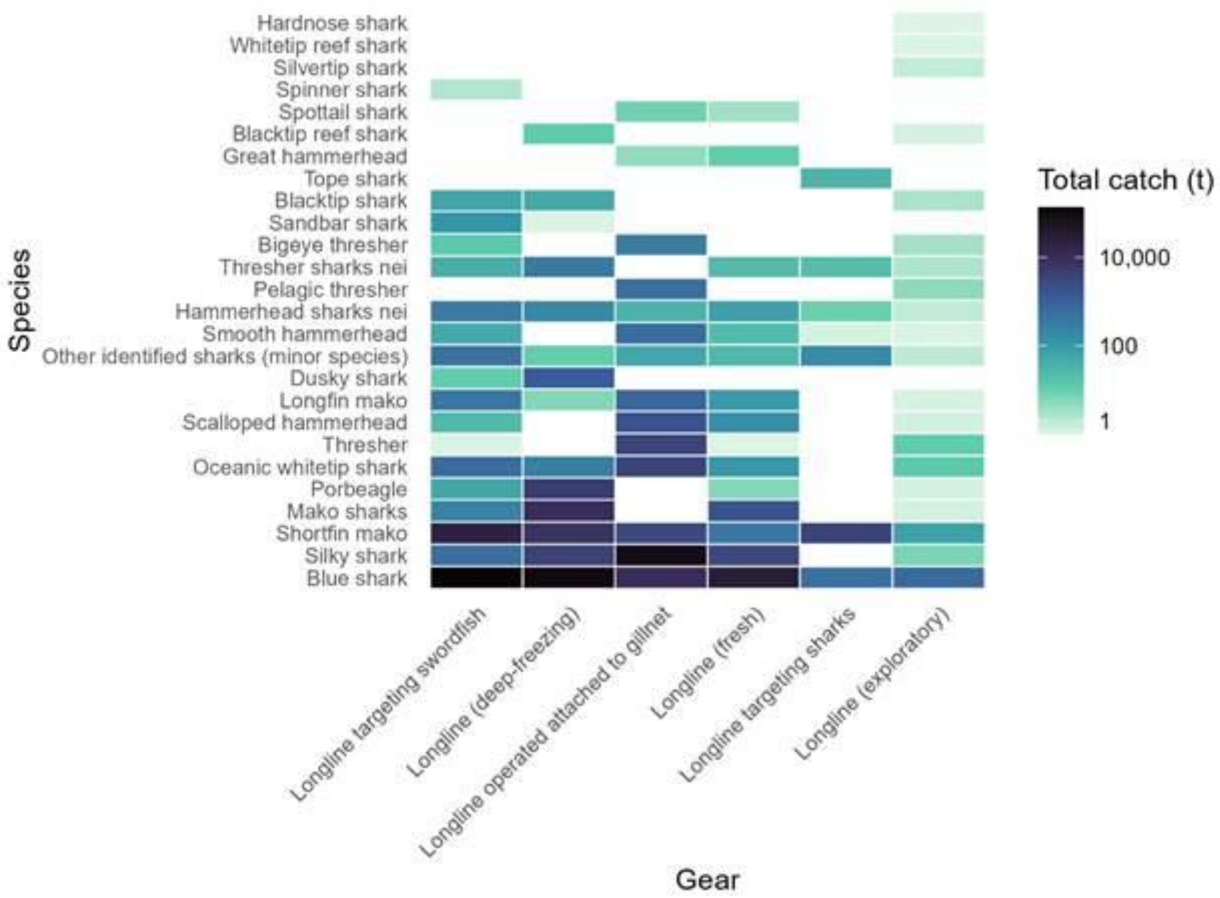


Figure A 7. **Cumulative reported catch (t) by species and specific gear type within the Longline fisheries**

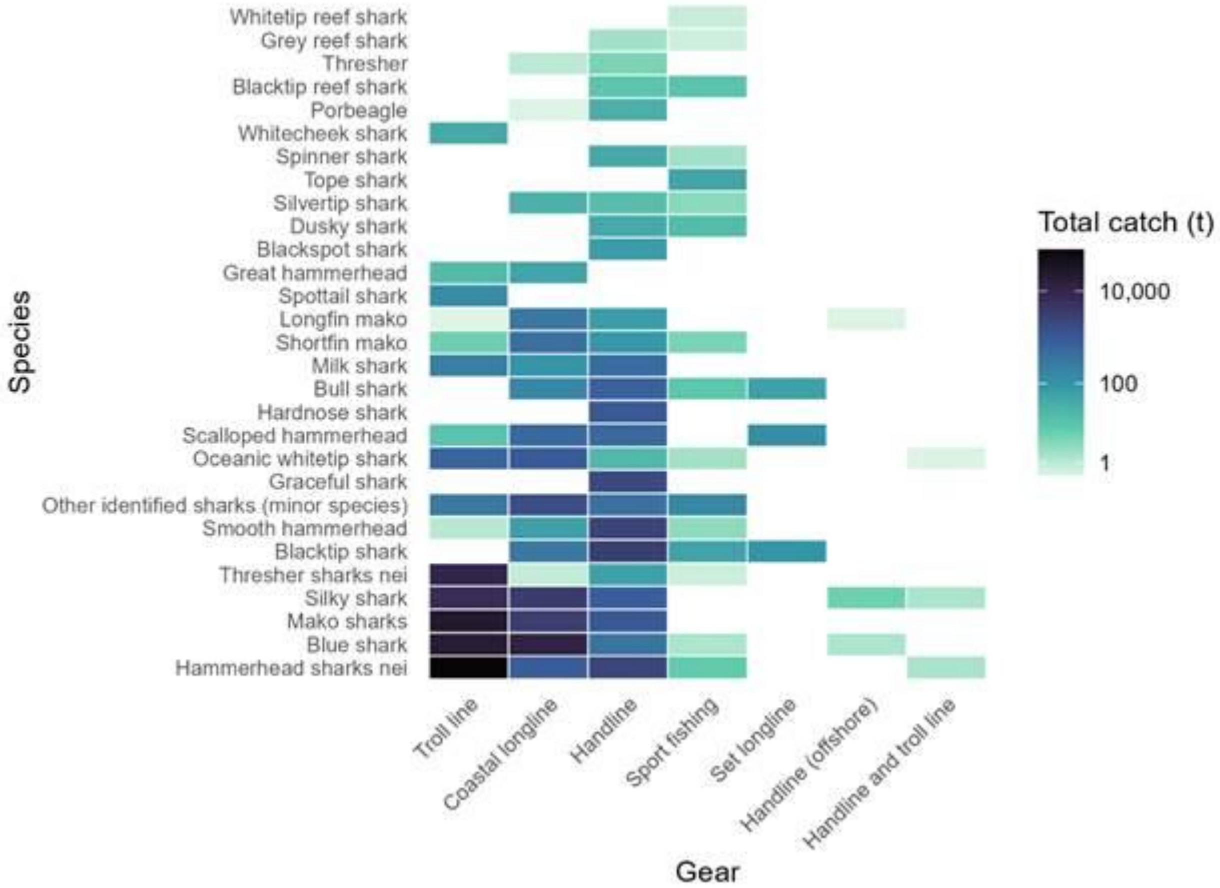


Figure A 8. Cumulative reported catch (t) by species and specific gear type within the Line fisheries

Reporting by fleet

The catch series is mostly comprised of data provided by the CPC fleets and complemented with FAO FishStat data to fill gaps in direct national reporting to IOTC. The reporting record for CPC fleets has grown steadily and, over the last decade, the vast majority of the approximately 30 CPC fleets listed in the report have reported their catches for a given year, reflecting both the expansion of fisheries in the region over time and improvements in reporting shark catches (Figure A 9).

Shark data from non-CPC (NCPC) fleets have also been incorporated into the IOTC database since the early 2000s, although their overall contribution to total catches remains relatively small, remaining within a range of approximately 1,500–3,000 tonnes per year over the last decade.

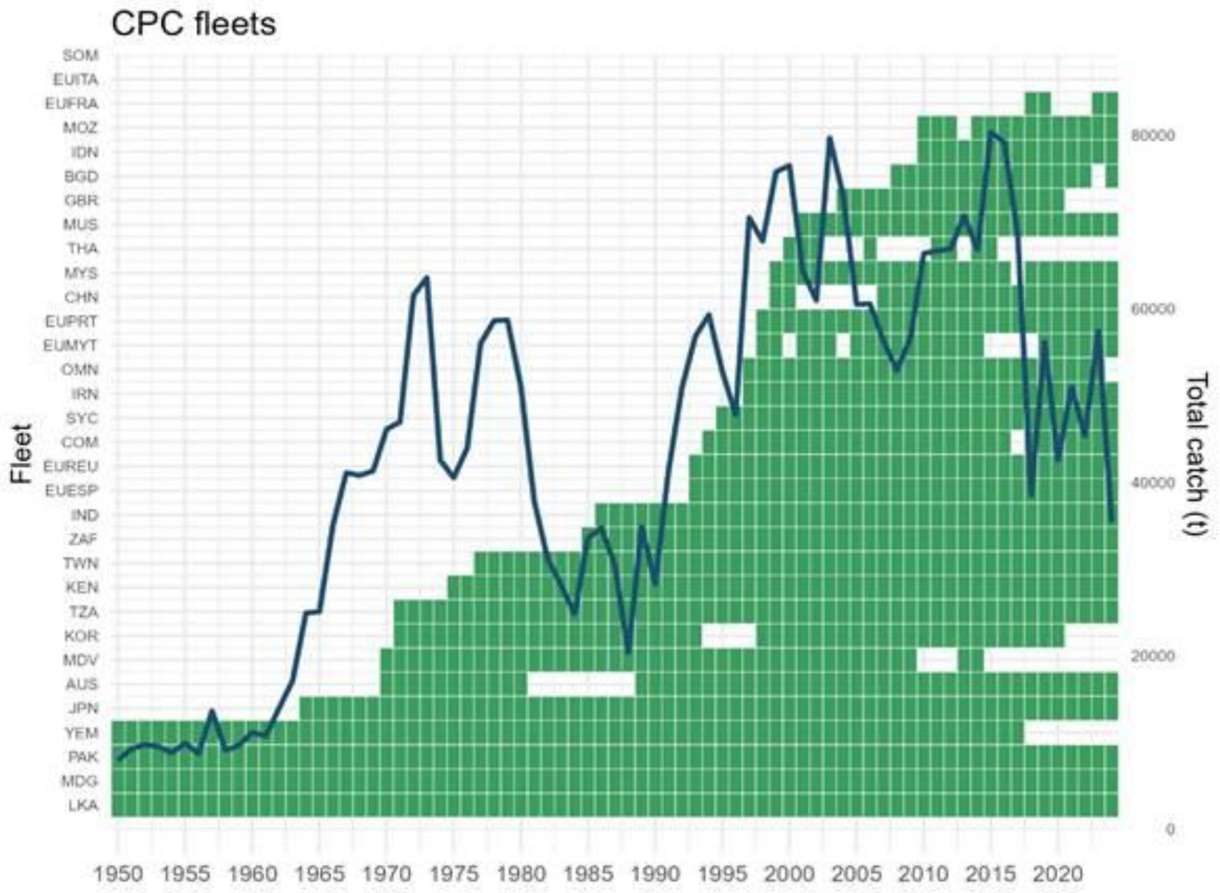


Figure A 9. Reporting availability by fleet and year (green = reported), overlaid with total catch trend for IOTC CPC fleets.

When gaps in national submissions to IOTC are supplemented, or in some years fully replaced, with catch statistics compiled by FAO's global capture fisheries production database (e.g. for Yemen), the are some associated limitations: FAO's database relies primarily on official statistics submitted by member countries, and the quality of national data varies considerably across countries and years; in some cases, official submissions are supplemented or replaced with estimates from other sources. Catch records in FAO's database (FishStat) are also not directly linked to fleets, gear types, or fishing effort. Consistent with this, catch data compiled through this route for Madagascar, Pakistan and Yemen in several years report identical catch levels across consecutive years, or catch aggregated at a coarse level by gear and, in some cases, by species — further higlighting the resolution limitations associated with these supplementary sources.

Retained catch data availability by species and fishery

Table A 1 classifies data availability for all 34 identified shark species/categories with any recorded catch (excluding the fully generic SKH/UNCL aggregate), using a status scheme defined as: High (≥ 5 reporting fleets and ≥ 1,000 t cumulative catch), Medium (an intermediate case, with either limited fleet participation or limited catch volume), and Low (≤ 2 reporting fleets or < 50 t cumulative catch — essentially anecdotal, regardless of any apparent catch volume). For each species, the table shows its best-covered fishery (the fishery-species combination driving its overall status) together with the total number of distinct fisheries (of four: Longline, Gillnet, Line, and Other) in which the species is reported at all.

Table A 1. **Data availability by shark species classified as High / Medium / Low, based on cumulative catch volume and number of reporting fleets in the species' best-covered fishery, full 1950–2024 time series. The fully generic "Various sharks nei / unclassified" aggregate is excluded.**

Species	Best-covered fishery	Status	N fleets	Total catch (t)	N fisheries
Blue shark	Longline	High	26	287,128.8	4
Silky shark	Gillnet	High	7	131,071.4	4
Hammerhead sharks nei	Line	High	8	81,922.6	4
Shortfin mako	Longline	High	21	35,773.3	4
Mako sharks	Line	High	6	28,683.5	4
Thresher sharks nei	Line	High	5	10,902.1	4
Porbeagle	Longline	High	13	5,042.4	3
Oceanic whitetip shark	Longline	High	20	4,499.3	4
Scalloped hammerhead	Gillnet	High	7	4,482.7	4
Other identified sharks (minor species)	Gillnet	High	5	3,662.3	4
Blacktip shark	Line	High	6	3,583.4	4
Smooth hammerhead	Line	High	5	2,591.2	4
Longfin mako	Longline	High	11	1,276.5	4
Dusky shark	Longline	High	10	1,227.4	4
Thresher	Longline	Medium	4	3,469.7	3
Bull shark	Line	Medium	4	960.7	3
Milk shark	Line	Medium	3	810.9	3
Bigeye thresher	Longline	Medium	7	340.7	2
Great hammerhead	Gillnet	Medium	4	136.7	4
Sandbar shark	Longline	Medium	7	112.0	3
Spottail shark	Gillnet	Low	2	8,700.2	3
Pelagic thresher	Gillnet	Low	2	7,524.8	2
Whitecheek shark	Gillnet	Low	2	5,557.9	2
Hardnose shark	Gillnet	Low	1	4,895.6	4
Graceful shark	Gillnet	Low	1	2,961.0	3
Finetooth shark	Gillnet	Low	1	407.0	1
Blackspot shark	Gillnet	Low	2	313.8	3
Grey reef shark	Gillnet	Low	2	208.3	3
Silvertip shark	Gillnet	Low	2	57.1	4
Tope shark	Line	Low	1	51.4	2
Spinner shark	Line	Low	2	44.1	3
Blacktip reef shark	Gillnet	Low	1	43.6	4
Whitetip reef shark	Other (PS/Baitboat/Other)	Low	1	5.4	4
Whale shark	Gillnet	Low	1	3.0	1

Length (Size) Data Availability by Species and Fishery

Length-frequency data extracted from the IOTC size-frequency database (fork length, the dominant measurement type, representing 282,516 of approximately 358,000 individual shark measurements available across all measurement types) show highly uneven sampling coverage across species (Table A 1). Blue shark alone accounts for approximately 82% of all length measurements, followed by silky shark, shortfin mako, mako sharks (undifferentiated Isurus spp.), and porbeagle. The remaining twelve species categories each have fewer than 500 recorded length measurements, and several — including great hammerhead, thresher, and "Hammerhead sharks, etc. nei" — are represented by fewer than 20 individuals across the entire 2005–2024 period (Table A 2).

Table A 2. Number of individual shark length measurements (fork length) available by species, IOTC size-frequency database, 2005–2024

Species	N fish measured	N unique length classes	Length min (cm)	Length max (cm)	Years
Blue shark	232,451	730	10	399	2005–2024
Silky shark	19,941	396	23	325	2005–2024
Shortfin mako	13,251	458	35	351	2005–2024
Mako sharks (Isurus spp.)	7,709	137	50	352	2013–2023
Porbeagle	1,262	131	52	306	2007–2024
Oceanic whitetip shark	406	144	60	241	2007–2024
Smooth hammerhead	290	41	20	230	2016–2023
Hammerhead sharks nei	173	74	33	294	2014–2023
Pelagic thresher	151	32	79	295	2015–2022
Scalloped hammerhead	137	53	40	308	2014–2024
Bigeye thresher	114	76	14	326	2005–2024
Various sharks nei	60	29	45	401	2017–2023
Longfin mako	26	26	50	255	2012–2024
Great hammerhead	19	8	122	257	2021–2022
Thresher	7	6	150	295	2017–2022
Thresher sharks nei	3	2	122	214	2015–2022
Hammerhead sharks, etc. nei	1	1	250	251	2024

Gear composition of the length samples mirrors the pattern observed in the catch data: longline gear accounts for most size measurements across four of the five species with sufficient coverage (Porbeagle: 100%; mako sharks: 100%; shortfin mako: 99.9%; blue shark: 98.7%). Silky shark is the only species with a greater mixed gear composition (longline: 81.2%; gillnet: 10.4%; line: 4.6%; purse seine: 3.9%) (Table A 3).

Table A 3. Number of individual shark length measurements (fork length) by species and fishery group. "Unclassified" specimens (n = 6,515) excluded.

Species	Purse seine	Longline	Line	Gillnet	Other	Total
Blue shark	0	229,275	1,076	1,928	0	232,279
Silky shark	779	16,185	909	2,066	2	19,941
Shortfin mako	0	13,233	18	0	0	13,251
Mako sharks	0	7,709	0	0	0	7,709
Porbeagle	0	1,262	0	0	0	1,262
Oceanic whitetip shark	9	364	33	0	0	406
Smooth hammerhead	0	68	50	172	0	290

Hammerhead sharks nei	0	88	26	59	0	173
Pelagic thresher	0	151	0	0	0	151
Scalloped hammerhead	0	11	11	115	0	137
Bigeye thresher	0	77	0	36	1	114
Various sharks nei	0	52	8	0	0	60
Longfin mako	0	26	0	0	0	26
Great hammerhead	0	0	19	0	0	19
Thresher	0	7	0	0	0	7
Thresher sharks nei	0	2	1	0	0	3
Hammerhead sharks, etc. nei	0	1	0	0	0	1
TOTAL	**788**	**268,510**	**2,101**	**4,236**	**3**	**275,638**

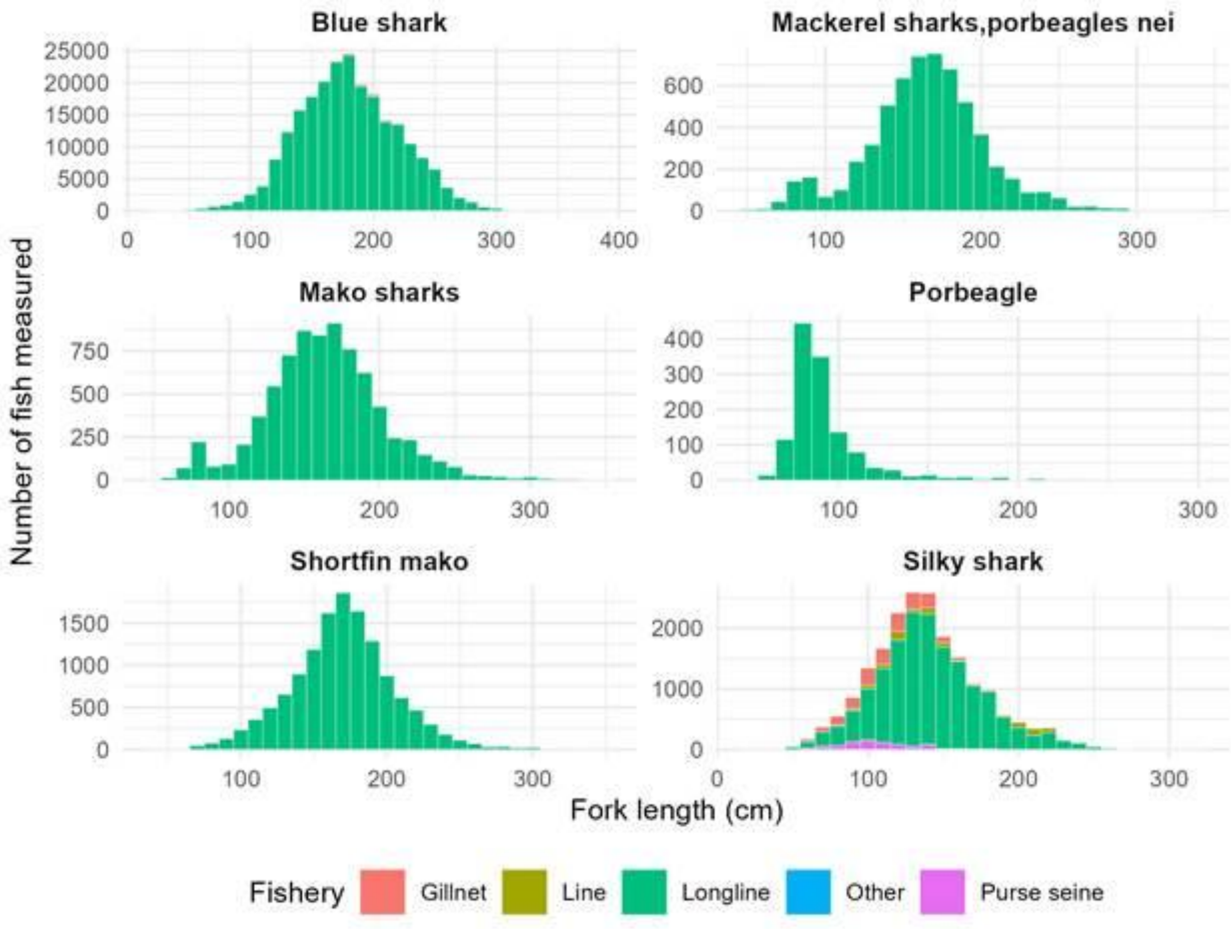


Figure A 10. Fork length distributions (cm) for the species/categories with sufficient sampling coverage, coloured by fishery.

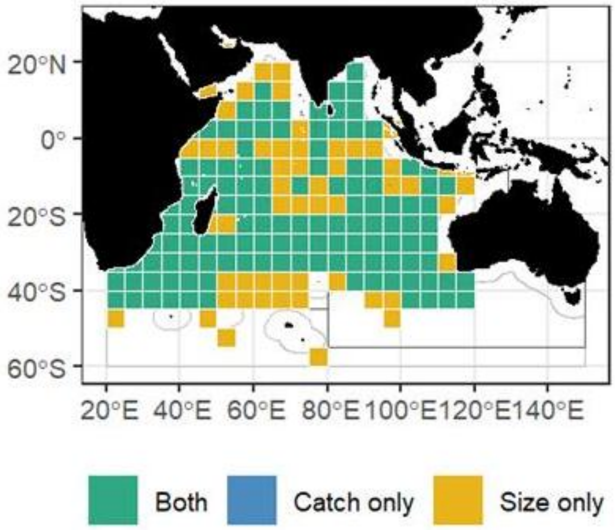
There are two further aspects of the dataset on size and frequency worth highlighting: the recording of sex and the existence of measurements taken using types of length other than fork length (FL), which are not currently reflected in Table A 1, Table A 2 or in Figure A 6. Sex is recorded for only 3.3% of all fork-length measurements (9,235 of 282,516); the remaining 96.7% are coded as unclassified/unknown sex. This is true even for the species with otherwise sufficient sampling coverage: blue shark (96.8% unsexed), silky shark (99.4%), mako sharks (100%), and “Mackerel sharks, porbeagles nei” (99.5%) are all measured almost exclusively without sex determination.

Separately, the size-frequency database contains a substantial number of measurements recorded using length types other than fork length — principally total length (TL), unconverted tape-measure fork length (FLUT), pectoral-caudal length (PCL), and others — that are not reflected in the FL-based totals presented in Tables 2–3. For several species with otherwise limited or anecdotal FL coverage, these alternative measurements are large enough to change their data-availability classification substantially if converted to a common FL basis. Validated conversion equations do exist for several of the species already well covered in FL (blue shark, silky shark, shortfin mako, porbeagle.

Shark spatial information

Mapping the geographic distribution of available length measurements by species highlights substantial spatial gaps in size data collection, particularly for species of elevated conservation concern. Sampling coverage for blue shark, silky shark, and shortfin mako spans a broad area of the western and central equatorial Indian Ocean, concentrated along the main longline fishing grounds. In contrast, coverage for hammerhead species is markedly restricted. Great hammerhead (*Sphyrna mokarran*) is particularly poorly represented: all 19 recorded length measurements for this species originate from a single 5°×5° grid cell across the entire time series.

Cross-referencing the resulting spatial footprint of reported catch (2005–2024, matching the period covered by the size-frequency database) against the footprint of length sampling shows that the best-sampled pelagic species reach reasonably high, though still incomplete, spatial overlap. Blue shark the most heavily reported species in the database, show correspondingly extensive geographic overlap between catch and length-sampling footprints and Shortfin mako (SMA) also shows relatively good overlap (Figure A 11). Longfin mako (LMA), by contrast, has limited catch and almost no spatial overlap with sampling; this is broadly consistent with the species' recognized rarity in fisheries and research records globally — reflected in its species epithet paucus ("scarce") — and its status as a genuinely uncommon, frequently misidentified lamnid shark (Mas & Domingo, 2022).



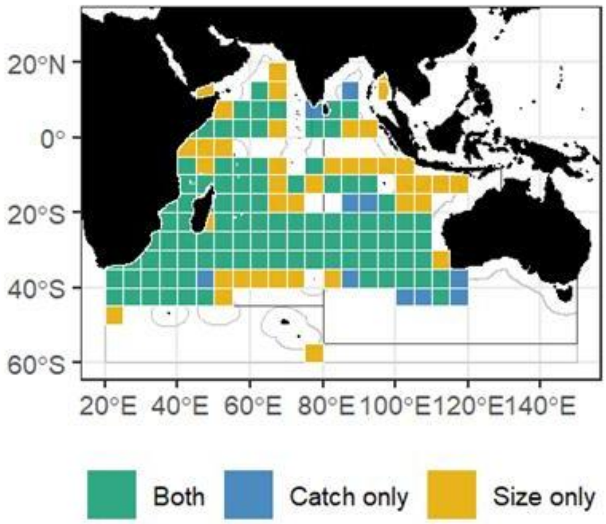


Figure A 11. Grid cells with reported catch only or length sampling only, 2005–2024, for blue shark (left) and shortfin mako (right).

For hammerhead species, there is an spatial mismatch identified and, in several cases, shown to be a matter of adjacency rather than simple absence: length-sampling cells for scalloped hammerhead (SPL) frequently sit immediately next to, but not overlapping, cells where catch of the same taxon is reported and Smooth hammerhead (SPZ) shows the most pronounced version of this pattern, with catch and sampling cells positioned in immediately adjacent but never coincident grid cells along the southwest Indian Ocean coast (Figure A 12).

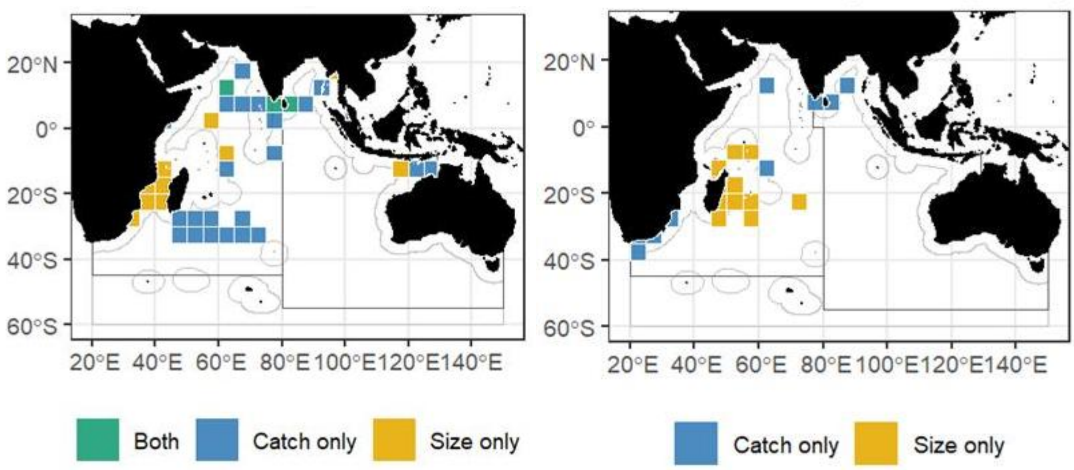


Figure A 12. Grid cells with reported catch only, length sampling only, or both, 2005–2024, for scalloped hammerhead (left) and smooth hammerhead (right).

Porbeagle (POR) presents a distinct spatial signature: catch and sampling cells are both concentrated in the southern, higher-latitude portion of the IOTC area of competence, well south of the core tropical fishing grounds for the other species considered here. This is consistent with the species' cold-water affinity and its documented occurrence as bycatch in longline fisheries targeting southern bluefin tuna in southern hemisphere waters, including the southeastern and southwestern Indian Ocean (Semba et al., 2013), rather than in the tropical tuna and swordfish longline fisheries that drive most reported shark catch elsewhere in the IOTC area.

Oceanic whitetip shark (OCS) shows some concentrate overlap. The species is currently assessed as Critically Endangered globally by the IUCN, following major population declines attributed largely to fishing mortality in tuna longline and other pelagic fisheries (Rigby et al., 2019). Its retention has been prohibited under IOTC Resolution 13/06 since 2013; from that point onward, live oceanic whitetip sharks caught by IOTC vessels must be released, and biological sampling is only possible from animals already dead at haulback (Figure A 13).

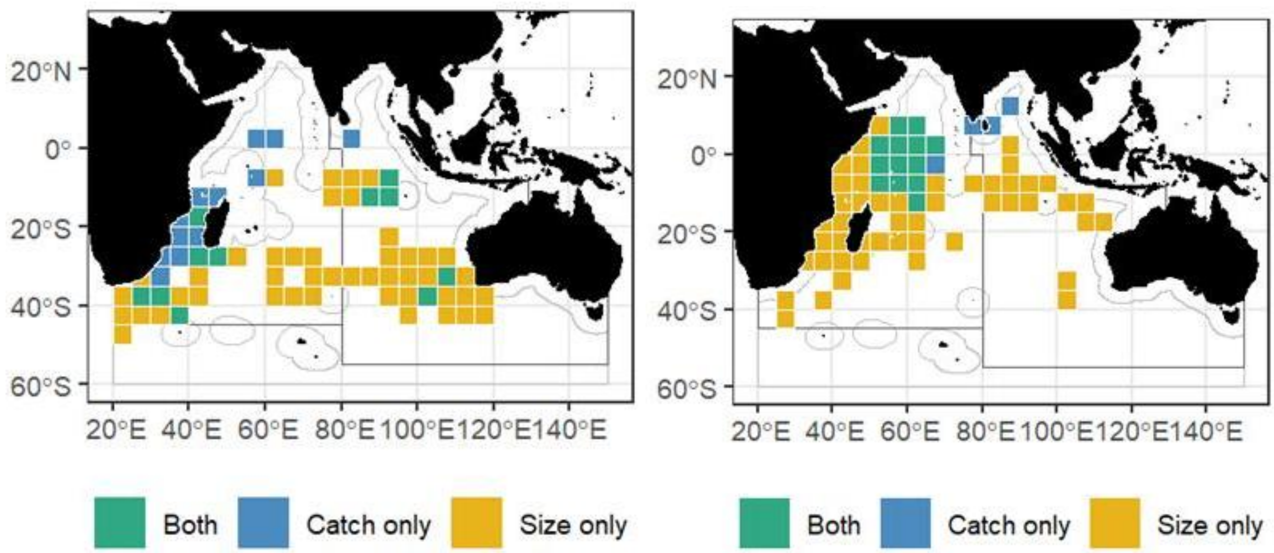


Figure A 13. Grid cells with reported catch only, length sampling only, or both, 2005–2024, for porbeagle (left) and oceanic whitetip (right)

Discard Data Availability by Species and Gear

Discard reporting to IOTC is a mandatory obligation for all CPCs, reported through the form 1DI. The resulting compilation reflects sampling or logbook data collection systems in place. Discard records in this compilation are not extrapolated (raised) to fleet-wide totals: each record represents what was actually collected and submitted, not an estimate of total fleet discards. As a result, differences in reported discard volume between fleets reflect a mix of genuine differences in discarding practice, differences in the scale of each fleet's data collection effort, and differences in reporting completeness.

Reporting density by species and gear mirrors the taxonomic and gear-level patterns already established for retained catch: blue shark dominates with its highest concentration of records under the generic "LL" (longline) gear code, alongside consistently high reporting for silky shark, oceanic whitetip shark, shortfin mako, and the aggregated mako/thresher/hammerhead "nei" categories. Reporting is concentrated in a small number of gear codes — principally the generic longline code and its named variants (targeting swordfish, deep-freezing, combined with gillnet, exploratory) together with purse seine and its sub-types — while gillnet-specific codes show only sparse reporting, limited mainly to whale shark and thresher, and entirely absent for blue shark, silky shark, and most other frequently retained species (Figure A 14).

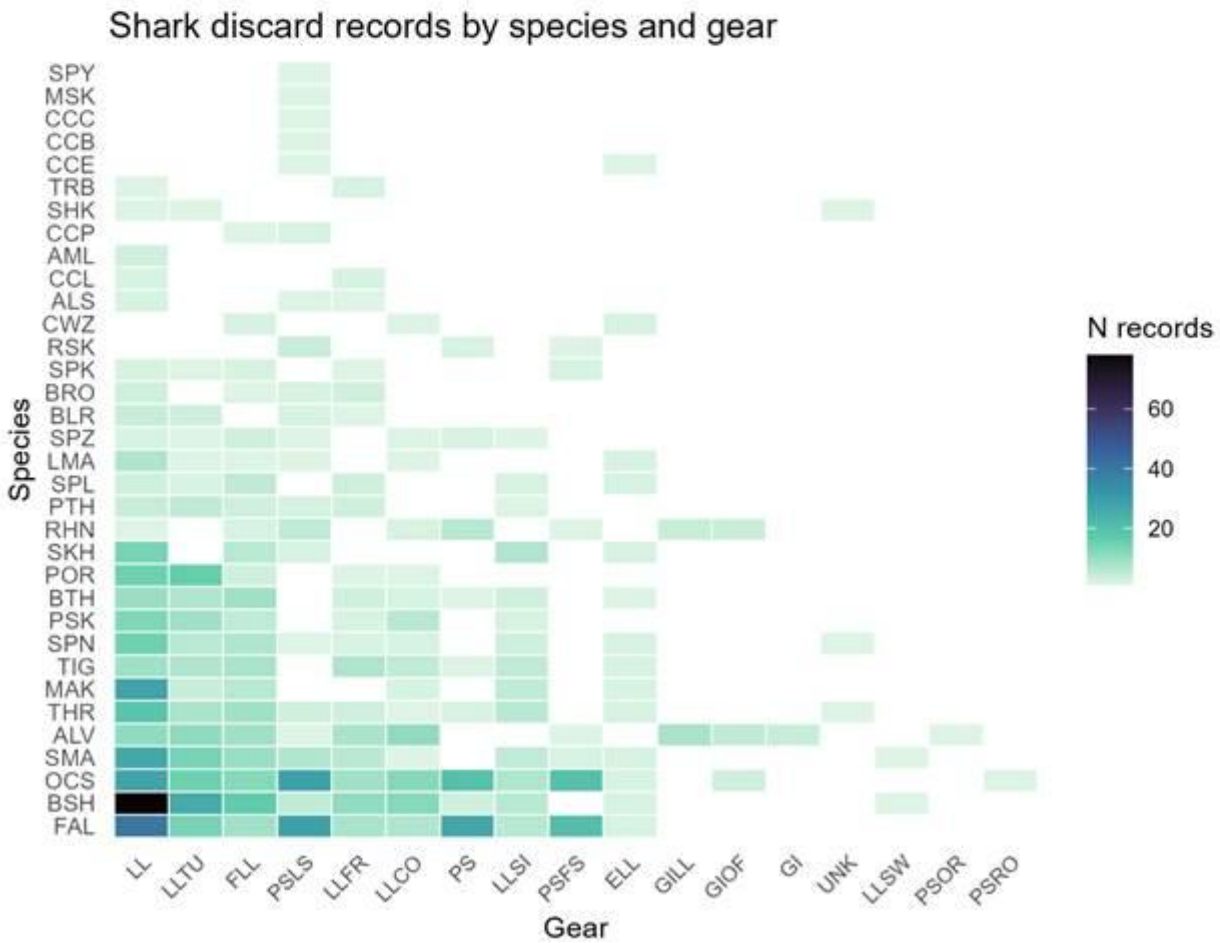


Figure A 14. Number of discard records by shark species and specific gear code, IOTC 1DI summary, 2015–2024

Discard fate composition (Figure A 15) is particularly informative for oceanic whitetip shark, which has been subject to a mandatory release requirement since 2013 under the superseded Resolution 13/06. Only 49.4% of oceanic whitetip shark discard records are classified as alive at the time of discard, with 34.8% recorded as dead and 15.8% of unknown fate — indicating that, even where discarding itself is correctly reported, a substantial share of released individuals are not confirmed to survive the interaction, a pattern directly relevant to ongoing efforts to quantify post-release mortality for species of special interest. Whale shark shows the most favourable fate profile (92.0% alive), though from only 25 records and 8 fleets. Crocodile shark (59.5% dead) and blacktip reef shark (70.0% dead) show the least favourable profiles among species with more than five records. For most other species, fate composition is fairly evenly split between alive, dead, and unknown, underscoring that fate recording itself — not only the decision to discard — remains an area requiring more consistent reporting.

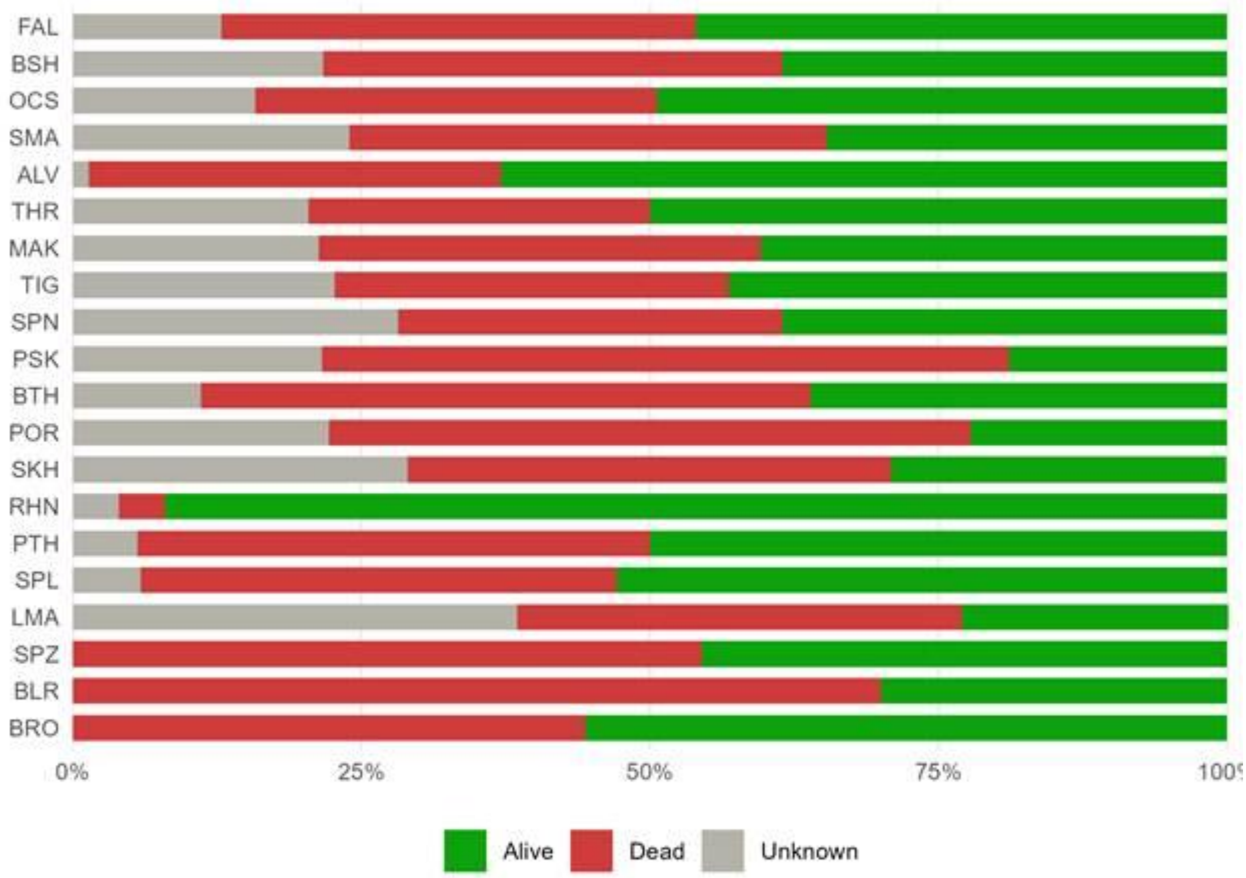


Figure A 15. Percentage of discard records recorded as alive, dead, or unknown fate at the time of discard, by species, sorted by total number of records, 2015–2024.

Observer Program (ROS) Data

In addition to the mandatory discard reporting reviewed before, IOTC compiles interaction data collected directly by scientific observers under the Regional Observer Scheme (ROS). For longline, ROS data available for this review were provided in a separate, less detailed compilation reflecting a different original reporting system than the standard IOTC observer database. For purse seine, ROS data were extracted directly from the IOTC observer database (IN_ros), which additionally records the fate type (retained/discarded) and the condition of discarded animals (alive/dead) for each interaction. Both sources were restricted to shark species/categories and harmonized (whitespace-trimmed species and fleet codes) prior to analysis.

Longline ROS data cover 2009–2024, 8 reporting fleets, and 38 shark species/categories, totalling 707,858 recorded interactions. Purse seine ROS data cover a comparatively narrow set of 3 reporting fleets and 15 shark species/categories, totalling 84,059 recorded interactions.

Retention and discard patterns differ sharply between the two gears (Figure A 16). In longline, retention is high for the main commercially valuable species — blue shark (92.2% retained), shortfin mako (99.0%), silky shark (83.4%), porbeagle (86.1%), tiger shark (88.7%), sandbar shark (99.0%), and Galapagos shark (99.7%)

— while the large majority of aggregated "nei" categories (various sharks nei, thresher sharks nei, hammerhead sharks nei, hammerhead sharks etc. nei, Carcharhinus sharks nei, dogfishes nei, mackerel sharks/porbeagles nei, sharks/rays/skates etc. nei) are reported as essentially 100% discarded.

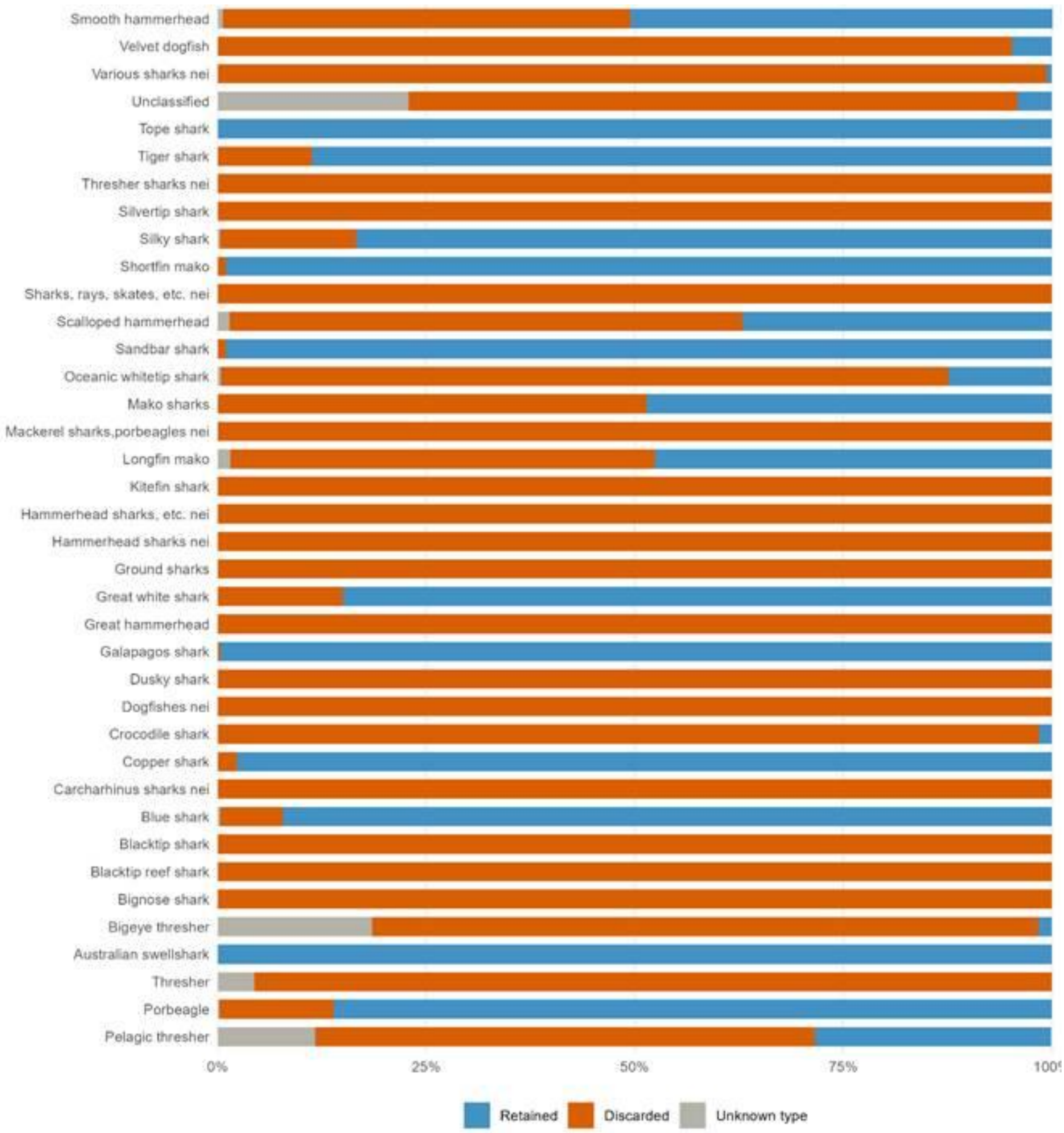


Figure A 16. Percentage of shark interactions retained versus discarded, by species, from observer (ROS) data longline, all 38 species with recorded interactions.

In purse seine, by contrast, nearly every species shown in Figure A 17Figure A 16 is close to 100% discarded, with shortfin mako (20.0% retained) as the only partial exception; silky shark, by far the most frequently recorded species in this gear (81,536 interactions, 99.4% of total purse seine shark interactions), is 98.8% discarded.

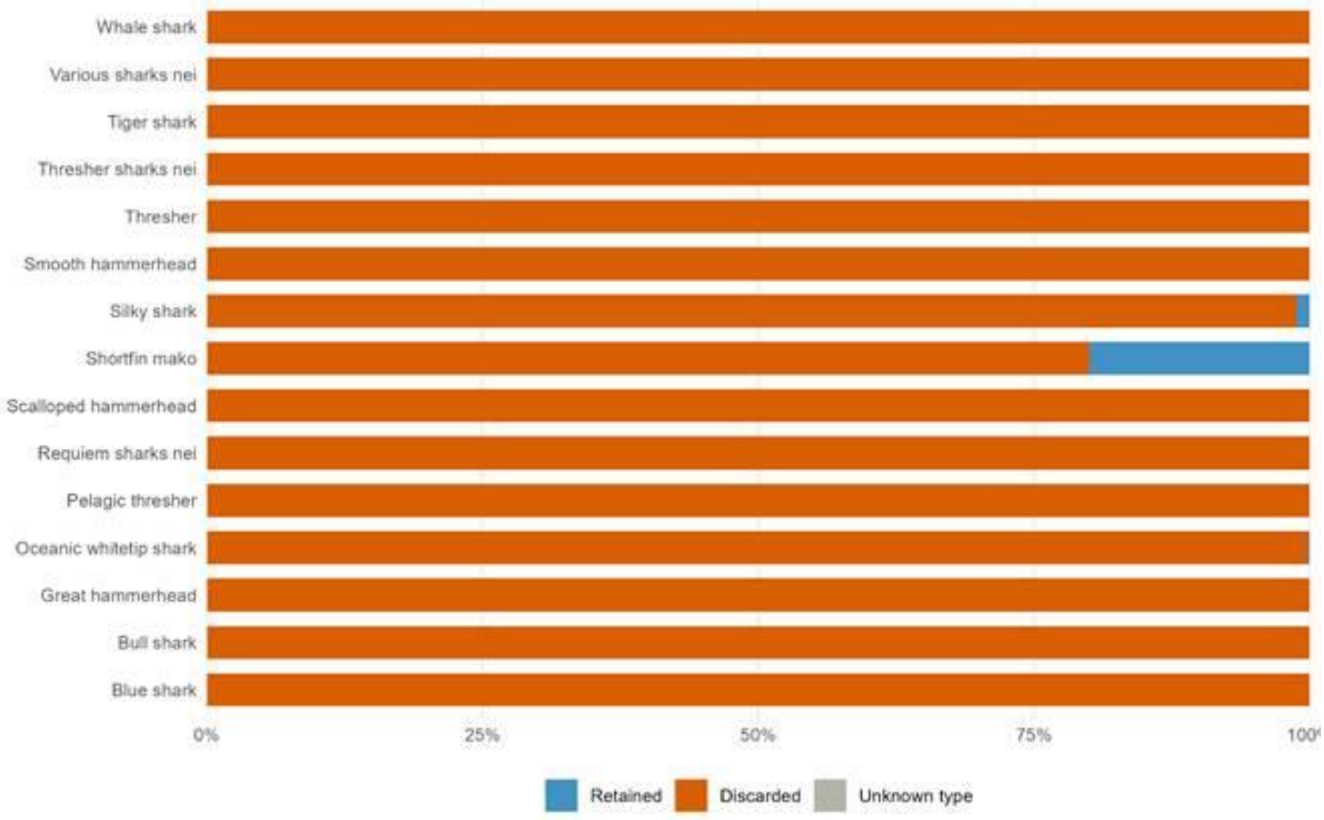


Figure A 17. Percentage of shark interactions retained versus discarded, by species, from observer (ROS) purse seine, all 15 species with recorded interactions.

Data Availability Summary Across Datasets

The sections above assessed data availability separately for each of five datasets relevant to shark stock status and bycatch monitoring: retained catch, geo-referenced catch, length/size data, discard reporting, and observer data. This section brings these five assessments together into a single, species-level summary intended to support prioritization within a shark research plan.

For each of the five datasets, species-level data availability was classified into three tiers — High, Medium, or Low — using two complementary criteria: the number of distinct reporting fleets contributing data for that species, and a volume/detail metric specific to each dataset (cumulative catch in tonnes, number of 5°×5° grid cells, number of individual length measurements, or number of records). Both criteria are necessary: a high volume of data contributed by only one or two fleets reflects the reporting practice of a single national fleet rather than a validated, multi-fleet body of data, and was therefore capped at Low regardless of apparent volume (for example, spottail shark and whitecheek shark, each with several thousand tonnes of cumulative gillnet catch but data from only one or two fleets). Threshold values for each dataset were calibrated against the empirical distribution of fleet counts and volume within that dataset (using the 50th, 75th, and 90th percentiles as a guide) so that the High tier represents approximately the best-documented quarter of species-dataset combinations, rather than an arbitrary fixed cutoff applied uniformly across datasets with very different underlying scales. The specific criteria applied are summarized in Table A 4.

Table A 4. Criteria used to classify species-level data availability (High / Medium / Low) within each of the five datasets summarized in this section.

Dataset	High criterion	Low criterion	Based on
Retained catch	≥5 fleets and ≥1,000 t	≤2 fleets or <50 t	Best-covered fishery per species
Geo-referenced catch	≥4 fleets and ≥24 grid cells (5°×5°)	≤1 fleet or <9 grid cells	Best-covered fishery per species, standardized grid
Size data	≥1,000 fork-length measurements	<100 measurements	Total fork-length (FL) measurements
Discards	≥8 reporting fleets	≤2 reporting fleets	IOTC form 1DI, number of reporting fleets
Observer (ROS)	≥5 fleets (longline + purse seine combined)	≤1 fleet	Number of fleets with recorded interactions

For each species, a composite score was calculated by summing points across the five datasets (High = 3, Medium = 2, Low = 1, not present in that dataset = 0; maximum possible score = 15). This composite score is unweighted: no dataset is treated as inherently more important than another for the purpose of measuring data availability. The composite score measures data availability and maturity, not conservation priority or biological importance — species of high conservation concern (e.g., great hammerhead, oceanic whitetip shark) may score low or moderate on this scale while remaining a priority for the research plan on independent grounds, and this distinction should be kept in mind wherever the summary below is used.

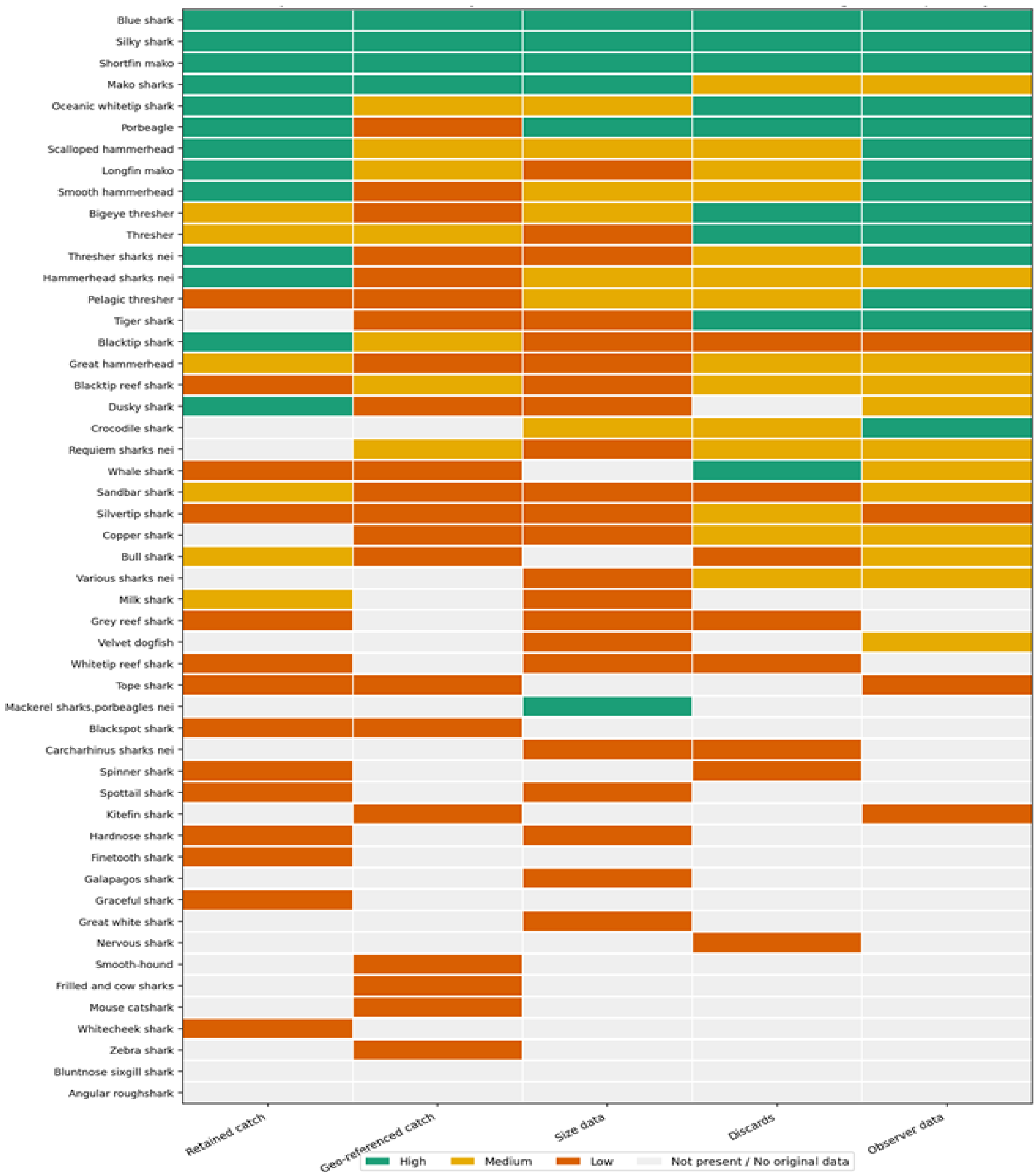


Figure A 18. **Data availability (High / Medium / Low / not present) across five IOTC datasets (retained catch, geo-referenced catch, size data, discards, observer data), for all shark species/categories identified in this review, ranked from best-documented to least-documented by composite score.**

Only four species/categories — blue shark, silky shark, porbeagle, and shortfin mako — reach the maximum composite score of 15, indicating High-tier data availability across all five datasets simultaneously. A further nine species (oceanic whitetip shark, mako sharks, longfin mako, scalloped and smooth hammerhead, thresher sharks nei, tiger shark, thresher, and bigeye thresher) score between 11 and 14. Data availability then drops sharply: no species scores between 10 and 12 except those already listed, and roughly half of the 66 species/categories identified across this review score 4 or below, indicating an essentially anecdotal presence in at most one or two of the five datasets. This step-change pattern — a small, well-documented core surrounded by a long tail of poorly documented species — recurs across every dataset examined individually in this document and is the central, cross-cutting finding of this review.

Conclusion

Taken together, the results presented above indicate a persistent and multi-dimensional gap between the formal reporting requirements established for sharks under IOTC conservation and management measures—including Resolution 15/01 and subsequent species-specific measures pertaining to species such as oceanic whitetip shark and thresher sharks — and the data that are, in practice, available to support scientific assessment and management of these species. This gap manifests across several distinct but related dimensions.

The taxonomic resolution of reported catches remains limited: the number of species categories recorded over the entire time series has increased, but a substantial proportion of total catches continues to be recorded only in aggregate form as 'various sharks' or 'unclassified', with year-on-year volatility in this proportion suggesting inconsistencies in reporting practices rather than actual changes in the composition of catches.

The coverage and consistency of the data varies between fleets over the years. While the use of complementary data sources, such as the FAO's FishStat database, is useful for verifying the completeness of reports, it has its own limitations in terms of resolution. This is particularly the case with regard to attributing catches to specific fleets, fishing gear and areas. Historical and current shark fisheries in some CPCs, such as Pakistan, Madagascar and Yemen, further complicate fleet-level time series, making them not directly comparable with reports based on tuna by-catch in other IOTC areas.

The availability of individual length measurements is even more limited and biased towards certain species than catch data. The vast majority of records are concentrated in a small number of species, primarily the blue shark, and are almost exclusively derived from longline fisheries. There is virtually no georeferenced size data for species that are the specific subject of IOTC conservation measures, such as the great hammerhead and other hammerhead species. This undermines the ability to characterise their size structure, growth or spatial population dynamics. Additionally, for many species, no spatial overlap is observed between the catch footprint and size data distribution.

Discard records are not extrapolated to fleet-wide totals and cannot support quantitative discard-rate estimates without further harmonization; reporting is patchy across fleets and years, with several fleets contributing data in only isolated years; gillnet, the largest contributor to retained shark catch of any gear, is almost entirely absent from discard reporting.

Data from the observer programme: observer coverage varies considerably and is not standardised in terms of fishing effort by fleet and year; consequently, raw species counts are not directly comparable across fleets and should only be used as an indication of the species recorded.

CPUE availability

As discussed in Section 2.6, the range of CPUE series that have been made available to the IOTC for shark species is summarised in Table A 5.

Table A 5: Summary of the CPUE series that have been presented to the WPEB to date including the years of the data series, the fleet, model type and references to the papers describing the CPUE methodology. The references in bold were used in the recent stock assessments.

	Blue Shark			**Shortfin Mako shark**			**Oceanic whitetip shark**			**Silky Shark**		
Japan	1994-2023	spatiotemporal model	**IOTC-2025-WPEB21(DP)-08_rev1**	1993-2018	GLM	**IOTC-2019-WPEB15-21**	2000-2011	GLM	IOTC-2012-WPEB08-26	na		
Indonesia	2006-2024	GLM & GLMM	IOTC-2025-WPEB21(AS)-27	2005-2021	GLM	IOTC-2024-WPEB20(AS)-12	na			2006-2017	GLM	IOTC-2018-WPEB14-31
Taiwan	2005-2023	spatiotemporal model	**IOTC-2025-WPEB21(AS)-10**	2005-2023	spatiotemporal model	**IOTC-2024-WPEB20(AS)-13**	na			2005-2018	GLM	IOTC-2019-WPEB15-24
Tanzania	2013-2022	nominal	IOTC-2025-WPEB21(AS)-16	na								
Reunion	2007-2024	GLMM	IOTC-2025-WPEB21(DP)-05	na			2007-2024	GAMM	IOTC-2025-WPEB21(AS)-18			
South Africa	2000-2024	spatiotemporal model	IOTC-2025-WPEB21(DP)-04	2000-2024	spatiotemporal model	IOTC-2025-WPEB21(DP)-04						
Portugal	2000-2023	GLMM	IOTC-2025-WPEB21(DP)-07	1999-2022	tweedie GLM	**IOTC-2024-WPEB20(DP)-20**						
USSR	1966-1989	ZINB-GAM	IOTC-2025-WPEB21(DP)-09	1966-1989	ZINB-GAM	**IOTC-2023-WPEB19-20**	1966-1989			1966-1989	ZINB-GAM	IOTC-2023-WPEB19-20
France	2007-2016(LL)	GLMM	IOTC–2017–WPEB13–27	na						2012-2021 (PS)	GAMMs	IOTC-2023-WPEB19-34

Spain	2001-2023	GLM	**IOTC-2025-WPEB21(DP)-06**	2001-2022	GLM	**IOTC-2024-WPEB20(DP)-21**	1998-2011	GLMM	IOTC-2012-WPEB08-27			
Sri Lanka	2020-2024	nominal	IOTC-2025-WPEB21(AS)-12	na								
EU(Spain, France)										2006-2018 (PS)		IOTC-2019-WPEB15-23

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Jatmiko, I., Setyadji, B., Fahmi, Z., and Rochman, F. 2018. Standardised CPUE of silky shark (Carcharhunis falciformis) caught by Indonesian longline fleet in the eastern Indian Ocean. IOTC-2018-WPEB14-31

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Sabarros, P. S., Tellier, C., Bach, P., Coelho, R., and Romanov, E. V. 2025. Updated standardized CPUE of blue shark bycaught by the French Reunion-based pelagic longline fishery (2007-2024) IOTC-2025-WPEB21(DP)-05

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Tsai, W. P., Wu, X. H., and Liu, K. M. 2019. Preliminary standardized catch rate of silky sharks caught by Taiwanese large-scale longline fishery in the Indian Ocean. IOTC-2019-WPEB15-24

Unknown 2025. CPUE and catch distribution of blue shark blue shark in the Tanzania EEZ 2013-2022. IOTC-2025-WPEB21(AS)-16

Yemane, D., da Silva, C. and Kerwath, S. 2025. Standardised CPUE indices of abundance for pelagic sharks, mako shark (Isurus oxyrinchus) and blue shark (Prionace glauca), off South AfricaIOTC-2025-WPEB21(DP)-04

Yokawa, K. and Semba, Y. 2012. Update of the standardized CPUE of oceanic whitetip shark (Carcharhinus longimanus) caught by Japanese longline fishery in the Indian Ocean IOTC-2012-WPEB08-26

APPENDIX IV

AGENDA ITEM 3 SUPPORTING INFORMATION: REVIEW OF THE CURRENT AVAILABLE INFORMATION IN TERMS OF BIOLOGICAL AND ECOLOGICAL KNOWLEDGE OF THE SEVEN MAJOR SHARK SPECIES (BSH, SMA, OCS, FAL, SPL, PTH AND BTH)

Age and growth

Since 2014 several papers were published on ageing of elasmobranch globally or regionally.

Indian Ocean
BSH: Varghese et al., 2017; Andrade et al., 2019;
SMA: Liu et al., 2018;

Globally / Other oceans
Reviews: Campana, 2014; Cailliet, 2015;

ALV: Natanson et al., 2015; Spear et al., 2023.pdf
OCS: Passerotti et al., 2020 (bomb radiocarbon)

Reproduction

Since 2014 not much information was published both regionally and globally.
Indian Ocean
BSH: Zhu et al., 2023;

Globally / Other oceans
BSH: Mas et al., 2023
PTH: Fernandez-Carvalho et al., 2015

Mortality

The following papers published since 2014 provide information on mortality of sharks

Indian Ocean

FAL: Poisson et al., 2014;

Globally / Other oceans

BSH: Gilman et al., 2022; Musyl et al., 2011;

SMA: Francis et al., 2023; Gilman et al., 2022; Musyl et al., 2011

OCS: Gilman et al., 2022; Musyl et al., 2011; Scott et al., 2023; Tolotti et al., 2015

FAL: Francis et al., 2023; Gilman et al., 2022; Musyl et al., 2011

SPL: Gilman et al., 2022

BTH: Musyl et al., 2011

PTH:

General methodology: Gilman et al., 2013; Gilman et al., 2016;

Stock structure and delimitation

The IOShPl **NOTED** that since 2014, a number of papers focused on stock structure were published but these mostly focused global populations and their connectivity.

Indian Ocean

OCS: Sreelekshmi et al., 2020

Species ID: Kottillil et al., 2025

Globally / Other oceans

BSH: Bailleul et al., 2018;

SMA: Taguchi et al., 2011;

OCS: Camargo et al., 2016; Ruck et al., 2024;

FAL: Kraft et al., 2025

SPL: Spaet et al., 2015.pdf

BTH:

PTH:

PSK: da Silva Ferrette et al., 2015.pdf

Segregation species:

Bigal et al., 2024; de Oliveira et al., 2026; Junge et al., 2019.pdf

Habitat use and migrations

The following papers published since 2014 provide information on habitat use and migrations of sharks

Indian Ocean

BSH: Heard et al., 2018

FAL: Curnick et al., 2020; Filmalter et al., 2021

PTH: Shidq et al., 2024

ALV: Heard et al., 2018

Globally / Other oceans

BSH: Andrzejaczek et al., 2022

SMA: Andrzejaczek et al., 2022; Santos et al., 2021;

OCS: Howey et al., 2016; Tolotti et al., 2017; Papastamatiou et al., 2018; Andrzejaczek et al., 2022; Burkhardt et al., 2025

FAL: Andrzejaczek et al., 2022

SPL:

BTH: Coelho et al., 2015;

PTH:

SPZ: Santos, Coelho, 2018; Santos, Coelho, 2019;

Table 1. Summary of the studies focusing on blue shark (BSH, *Prionace glauca*) life history parameters in the Indian Ocean. Each value refers to a particular study with the references provided as a footnote to the table.

BSH - *Prionace glauca*				
Parameters	**West IO**	**East IO**	**IO**	**Total**
Reproduction				
Size-at-maturity (male)	22	16, 18		2
Age-at-maturity (male)				0
Size-at-maturity (female)	22	16	5	2
Age-at-maturity (female)				0
Reproductive frequency				0
Gestation period				0
Size-at-birth	15	16		2
Fecundity (litter size)	6, 15, 22		5	3
Spawning period				0
Mating period				0
Total	2	2	1	
Age and growth				
L_{inf} (combined)	1, 21			1
k (combined)	1, 21			1
T_o/L_o (combined)	1, 21			1
Maximum obs. age (combined)	2, 21			1
Longevity estimate (combined)	2, 21			1
L_{inf} (male)	1, 21			1
k (male)	1, 21			1
T_o/L_o (male)	1, 21			1
Maximum obs. age (male)	2, 21			1
Longevity estimate (male)	2, 21			1
L_{inf} (female)	1, 21			1
k (female)	1, 21			1
T_o/L_o (female)	1, 21			1
Maximum obs. age (female)	2, 21			1
Longevity estimate (female)	1, 21			1
Total	2	0	0	
Feeding				
Traditional	5, 17			2
Isotopes	12			1
Total	3	0	0	
Genetics				
mtDNA				0
nDNA				0
Total	0	0	0	
Tracking				
Traditional tagging	7, 8, 14			3
Satellite telemetry	9			1
Acoustic telemetry	9			1
Total	4	0	0	
Habitat/Environmental preferences				
Temperature			5	1
Depth	9		5	2
Total	1	0	1	
Other aspects				
Haulback mortality	10, 13, 20			3
Post-release mortality				0
Size-size relationships	4, 19			2
Size-weight relationships	3, 19			2
Contaminants (e.g. heavy metals)				0
Total	6	0	0	

Table references: 1: Rabehagasoa et al (2009); 2: Romanov & Campana S (2011); 3: Romanov & Romanova (2009); 4: Romanov (2012, pers. Comm); 5: Gubanov & Gigor'ev (1975); 6: Mejuto & Garcia-Cortes (2005); Anonymous (2010); 8: Mejuto et al. (2005); 9: Filmalter et al. (2012a); 10: Coelho et al. (2011); 11: Petersen et al. (2008); 12: Rabehagasoa et al. (2012); 13:Petersen et al. (2009). 14: Dunlop et al. (2013); 15: Bass et al. (1975a); 16: White et al. (2006); 17: Romanov et al. (2009); 18: White (2007a); 19: Ariz et al. (2007); 20: Poisson (2009); 21: Andrade et al., (2019); 22: Zhu et al. (2023).

Table 2. Summary of the studies focusing on shortfin mako (SMA, *Isurus oxyrinchus*) life history parameters in the Indian Ocean. Each value refers to a particular study with the references provided as a footnote to the table.

SMA - *Isurus oxyrinchus*				
Parameters	**West IO**	**East IO**	**IO**	**Total**
Reproduction				
Size-at-maturity (male)	1, 5	4, 11		4
Age-at-maturity (male)				0
Size-at-maturity (female)	1, 5	4, 11		4
Age-at-maturity (female)				0
Reproductive frequency				0
Gestation period				0
Size-at-birth	1			1
Fecundity (litter size)				0
Spawning period				0
Mating period				0
Total	2	2	0	
Age and growth				
L_{inf} (combined)				0
k (combined)				0
T_o / L_o (combined)				0
Maximum obs. age (combined)				0
Longevity estimate (combined)				0
L_{inf} (male)				0
k (male)				0
T_o / L_o (male)				0
Maximum obs. age (male)				0
Longevity estimate (male)				0
L_{inf} (female)				0
k (female)				0
T_o / L_o (female)				0
Maximum obs. age (female)	14			1
Longevity estimate (female)				0
Total	1	0	0	
Feeding				
Traditional	1, 10			2
Isotopes				0
Total	2	0	0	
Genetics				
mtDNA				0
nDNA				0
Total	0	0	0	
Tracking				
Traditional tagging	6, 9			2
Satellite telemetry				0
Acoustic telemetry				0
Total	2	0	0	
Habitat/Environ. preferences				
Temperature				0
Depth				0
Total	0	0	0	
Other aspects				
Haulback mortality	8			1
Post-release mortality				0
Size-size relationships	3, 13			2
Size-weight relationships	2, 5, 13			3
Contaminants (e.g. heavy metals)				0
Total	5	0	0	

1: Bass et al. (1975b); 2: Romanov & Romanova (2009); 3: Romanov (2012, pers. comm.); 4: White (2007b); 5: Cliff et al. (1990); 6: Mejuto et al. (2005); 7: Fourmanoir (1961); 8: Coelho et al. (2011); 9: Dunlop et al.

(2013); 10: Romanov et al. (2009); 11: Stevens (1983); 12: Stevens (2008); 13: Ariz et al. (2007); 14: Romanov & Campana (2014, pers comm.).

Table 3. Summary of the studies focusing on oceanic whitetip shark (OCS, *Carcharhinus longimanus*) life history parameters in the Indian Ocean. Each value refers to a particular study with the references provided as a footnote to the table.

OCS - *Carcharhinus longimanus*				
Parameters	**West IO**	**East IO**	**IO**	**Total**
Reproduction				
Size-at-maturity (male)	1	3		2
Age-at-maturity (male)				0
Size-at-maturity (female)	1	6		2
Age-at-maturity (female)				0
Reproductive frequency				0
Gestation period				0
Size-at-birth	1	6		2
Fecundity (litter size)	1			1
Spawning period		3		1
Mating period				0
Total	1	2	0	
Age and growth				
L_{inf} (combined)				0
k (combined)				0
T_o / L_o (combined)				0
Maximum obs. age (combined)				0
Longevity estimate (combined)				0
L_{inf} (male)				0
k (male)				0
T_o / L_o (male)				0
Maximum obs. age (male)				0
Longevity estimate (male)				0
L_{inf} (female)				0
k (female)				0
T_o / L_o (female)				0
Maximum obs. age (female)				0
Longevity estimate (female)				0
Total	0	0	0	
Feeding				
Traditional	1, 8			2
Isotopes				0
Total	2	0	0	
Genetics				
mtDNA				0
nDNA				0
Total	0	0	0	
Tracking				
Traditional tagging	4, 7			2
Satellite telemetry	5			1
Acoustic telemetry	5			1
Total	3	0	0	
Habitat/Environ. preferences				
Temperature				0
Depth	5			1
Total	1	0	0	
Other aspects				
Haulback mortality	9, 11			2
Post-release mortality				0
Size-size relationships	10			1
Size-weight relationships	2, 10			2
Contaminants (e.g. heavy metals)				0
Total	4	0	0	

1: Bass et al. (1973); Romanov & Romanova (2009); 3:White (2007a); 4: Mejuto et al. (2005); 5: Filmalter et al. (2012a); 6: White et al. (2006); 7: Dunlop et al. (2013); 8: Romanov et al. (2009); 9: Poisson (2007); 10: Ariz et al. (2007); 11: Poisson (2009).

Table 4. Summary of the studies focusing on silky shark (FAL, *Carcharhinus falciformis*) life history parameters in the Indian Ocean. Each value refers to a particular study with the references provided as a footnote to the table.

FAL - *Carcharhinus flaciformis*				
Parameters	**West IO**	**East IO**	**IO**	**Total**
Reproduction				
Size-at-maturity (male)		3		1
Age-at-maturity (male)		3		1
Size-at-maturity (female)		3		1
Age-at-maturity (female)		3		1
Reproductive frequency				0
Gestation period		3(-)		1
Size-at-birth	1	3		2
Fecundity (litter size)	1	3		2
Spawning period		3		1
Mating period				0
Total	1	1	0	
Age and growth				
L_{inf} (combined)		3		1
k (combined)		3		1
T_o / L_o (combined)		3		1
Maximum obs. age (combined)		3		1
Longevity estimate (combined)		3		1
L_{inf} (male)		3		1
k (male)		3		1
T_o / L_o (male)		3		1
Maximum obs. age (male)		3		1
Longevity estimate (male)		3		1
L_{inf} (female)		3		1
k (female)		3		1
T_o / L_o (female)		3		1
Maximum obs. age (female)		3		1
Longevity estimate (female)		3		1
Total	0	1	0	
Feeding				
Traditional	10			1
Isotopes	8			1
Total	2	0	0	
Genetics				
mtDNA				0
nDNA				0
Total	0	0	0	
Tracking				
Traditional tagging	4, 9			2
Satellite telemetry	5			1
Acoustic telemetry	5, 11, 12			3
Total	5	0	0	
Habitat/Environ. preferences				
Temperature	11			1
Depth	5, 11, 12			3
Total	3	0	0	
Other aspects				
Haulback mortality	6, 15 (PS) 7 (LL)			3
Post-release mortality	6, 15 (PS)			2
Size-size relationships	13			1
Size-weight relationships	2, 13, 14	3		4
Contaminants (e.g. heavy metals)				0
Total	6	1	0	

1: Bass et al. (1973); 2: Romanov & Romanova (2009); 3: Hall et al. (2012); 4: Mejuto et al. (2005); 5: Filmalter et al. (2012a); 6: Poisson et al. (2014); 7: Coelho et al. (2011); 8: Rabehagasoa et al. (2012); 9: Dunlop et al. (2013); 10: Romanov et al. (2009); 11: Filmalter et al. (2011); 12: Filmalter et al. (2010); 13: Ariz et al. (2007); 14: Filmalter et al. (2012c); 15: Filmalter et al. (2012b).

Table 5. Summary of the studies focusing on the scalloped hammerhead (SPL, *Sphyrna lewini*) life history parameters in the Indian Ocean. Each value refers to a particular study with the references provided as a footnote to the table.

SPL - *Sphyrna lewini*				
Parameters	**West IO**	**East IO**	**IO**	**Total**
Reproduction				
Size-at-maturity (male)	1, 4	6, 10		4
Age-at-maturity (male)				0
Size-at-maturity (female)	4	6		2
Age-at-maturity (female)				0
Reproductive frequency				0
Gestation period				0
Size-at-birth	1	6		2
Fecundity (litter size)		6		1
Spawning period		6		1
Mating period				0
Total	2	2	0	
Age and growth				
L_{inf} (combined)				0
k (combined)				0
T_o / L_o (combined)				0
Maximum obs. age (combined)				0
Longevity estimate (combined)				0
L_{inf} (male)				0
k (male)				0
T_o / L_o (male)				0
Maximum obs. age (male)				0
Longevity estimate (male)				0
L_{inf} (female)				0
k (female)				0
T_o / L_o (female)				0
Maximum obs. age (female)				0
Longevity estimate (female)				0
Total	0	0	0	
Feeding				
Traditional	1, 4			2
Isotopes				0
Total	2	0	0	
Genetics				
mtDNA			3	1
nDNA				0
Total	0	0	1	
Tracking				
Traditional tagging	5, 7			2
Satellite telemetry				0
Acoustic telemetry				0
Total	2	0	0	
Habitat/Environ. preferences				
Temperature				0
Depth				0
Total	0	0	0	
Other aspects				
Haulback mortality				0
Post-release mortality				0
Size-size relationships	9			1
Size-weight relationships	2, 4, 9			3
Contaminants (e.g. heavy metals)				0
Total	3	0	0	

1: Bass et al. (1975a); 2: Romanov & Romanova (2012); 3: Duncan et al. (2006); 4:De Bruyn et al. (2005); 5: Diemer et al. (2011); 6: White et al. (2008); 7: Dunlop et al. (2013); 8: Stevens & Lyle (1989); 9: Ariz et al. (2007); 10: Kembaren et al. (2013).

Table 6. Summary of the studies focusing on the bigeye thresher (BTH, *Alopias superciliosus*) life history parameters in the Indian Ocean. Each value refers to a particular study with the references provided as a footnote to the table.

BTH - *Alopias superciliosus*				
Parameters	**West IO**	**East IO**	**IO**	**Total**
Reproduction				
Size-at-maturity (male)		5	3	2
Age-at-maturity (male)				0
Size-at-maturity (female)			3	1
Age-at-maturity (female)				0
Reproductive frequency				0
Gestation period				0
Size-at-birth	1			1
Fecundity (litter size)	1			1
Spawning period				0
Mating period				0
Total	1	1	1	
Age and growth				
L_{inf} (combined)				0
k (combined)				0
T_o / L_o (combined)				0
Maximum obs. age (combined)				0
Longevity estimate (combined)				0
L_{inf} (male)				0
k (male)				0
T_o / L_o (male)				0
Maximum obs. age (male)				0
Longevity estimate (male)				0
L_{inf} (female)				0
k (female)				0
T_o / L_o (female)				0
Maximum obs. age (female)				0
Longevity estimate (female)				0
Total	0	0	0	
Feeding				
Traditional				0
Isotopes				0
Total	0	0	0	
Genetics				
mtDNA				0
nDNA				0
Total	0	0	0	
Tracking				
Traditional tagging				0
Satellite telemetry				0
Acoustic telemetry				0
Total	0	0	0	
Habitat/Environ. preferences				
Temperature				0
Depth				0
Total	0	0	0	
Other aspects				
Haulback mortality	2			1
Post-release mortality				0
Size-size relationships				0
Size-weight relationships				0
Contaminants (e.g. heavy metals)				0
Total	1	0	0	

1: Bass et al. (1975b); 2: Coelho et al. (2011); 3: Gubanov (1978); 4: Romanov & Romanova (2012); 5: White (T. 2007).

Table 7. Summary of the studies focusing on the pelagic thresher (PTH, *Alopias pelagicus*) life history parameters in the Indian Ocean. Each value refers to a particular study with the references provided as a footnote to the table.

PTH - *Alopias pelagicus*				
Parameters	**West IO**	**East IO**	**IO**	**Total**
Reproduction				
Size-at-maturity (male)		1		1
Age-at-maturity (male)				0
Size-at-maturity (female)		1		1
Age-at-maturity (female)				0
Reproductive frequency				0
Gestation period				0
Size-at-birth		1		1
Fecundity (litter size)				0
Spawning period				0
Mating period				0
Total	0	1	0	
Age and growth				
L_{inf} (combined)				0
k (combined)				0
T_o / L_o (combined)				0
Maximum obs. age (combined)				0
Longevity estimate (combined)				0
L_{inf} (male)				0
k (male)				0
T_o / L_o (male)				0
Maximum obs. age (male)				0
Longevity estimate (male)				0
L_{inf} (female)				0
k (female)				0
T_o / L_o (female)				0
Maximum obs. age (female)				0
Longevity estimate (female)				0
Total	0	0	0	
Feeding				
Traditional				0
Isotopes				0
Total	0	0	0	
Genetics				
mtDNA				0
nDNA				0
Total	0	0	0	
Tracking				
Traditional tagging				0
Satellite telemetry				0
Acoustic telemetry				0
Total	0	0	0	
Habitat/Environ. preferences				
Temperature				0
Depth				0
Total	0	0	0	
Other aspects				
Haulback mortality				0
Post-release mortality				0
Size-size relationships				0
Size-weight relationships				0
Contaminants (e.g. heavy metals)				0
Total	0	0	0	

1: White (2007).

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APPENDIX V
AGENDA ITEM 4 SUPPORTING INFORMATION: REVIEW OF THE CURRENT AVAILABLE AND IMPLEMENTED MITIGATION MEASURES, INCLUDING BEST PRACTICE CODES/PROCEDURES, IN TERMS OF REDUCING SHARK BYCATCH AND INCIDENTAL MORTALITY

Under Agenda item 4 the working group used a report reviewing the current status of mitigation measures for bycatch in tunas fisheries (Gilman et al., 2024) to update the table provided in the 2014 review. Some measures were removed while others were added. Major 'pros and cons' were highlighted of each method, based on best scientific knowledge currently available. Additionally, the level of research needs and financial implications were also considered.

The list of mitigation measures summarised in Table 5 and the more substantial Table A 6 is **not** a ranking of potential measures, as the objective of this review was just **to highlight research needs** before any advice can be provided on their potential efficacy and application if introduced to manage IOTC pelagic fisheries. Additionally, the research needs take into consideration their potential as shark mitigation measures, but also the implications its implementation might have on fisheries data collection and, consequently, on the shark stock assessment process. For example, the IOShPI **NOTED** that retention bans might have unintended consequences of reducing the monitoring and collection of key information for stock assessment and, thus, it also **NOTED** that retention bans should be implemented along with strengthen monitoring systems.

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The listed management mitigation measures for major fisheries impacting sharks (LL, PS, GILL) were split into two different categories: i) Operational and technological aspects, and ii) Best practices.

4.1 Operational and technological aspects

Prohibition of retention – prohibition from retaining on board, transhipping, landing, storing, selling or offering for sale any part or whole carcass of sharks. Regulation was already set in place by IOTC for thresher sharks, oceanic whitetip shark, whale shark, mako sharks and mobulid rays (Resolutions 25/08, 25/09, 26/03).

Major scientific work (see references section): 157, 167, 168

Major results achieved (pros and cons) – Widely applied approach for protection of endangered species. Fishing mortality expected to decrease, but still can stay at a high level. Reduces the quality of reported data.

Research needs – High. Assess efficiency for currently prohibited species. Moderate for major shark species.

4.1.1. Longlines

Modification of terminal gears (including hook type)

Circle hooks – corresponds to a hook style distinguished for having a rounded shape with the point oriented perpendicular to the shank, as a means to reduce bycatch mortality. Most of the research involving circle hooks aimed at reducing interactions of longlines with marine turtles (see reviews by Read 2007; and Wallace et al., 2010).

Major scientific work (see references section): 18, 20, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 35, 36, 37, 38, 39, 40, 41, 42, 43, 76,78, 177, 178

Major results achieved (pros and cons) - Decrease deep-hooking of sharks and probably post-release mortality. Conflicting results in terms of catch rates, although most recent work suggesting an increase for sharks, namely when baited with fish. Other results are fisheries, species, specific and fishing area dependent.

Research needs – Moderate. Additional work is required to assess efficiency of the combination of circle hooks and bait types in terms of catch rates of both targeted species and bycatch, at-haulback and post-release mortality, particularly for major shark fishing areas in the IO.

<u>*Corrodible hooks*</u> – Corrodible hooks are fishing hooks composed of material other than stainless steel. They may be made from different alloys, with different coatings, which all affect how long they last. The hook may dissolve quickly, within a couple of days, or more slowly over weeks or months. The premise behind the use of corrodible hooks is that they should improve the mortality rate of by-catch released with a hook attached.

Major scientific work (see references section): 50.

Major results achieved (pros and cons) – Can reduce the post-escape mortality of sharks. Need to be replaced more often than low-grade stainless hooks.

Research needs – Moderate. Efficiency and economics impacts should be assessed.

<u>*Weak hooks*</u> – A weak hook is a hook that is constructed of round stock wire that is thinner-gauge than the traditional hooks currently used in a given fishery. The difference between the traditional hook and the weak hook is barely detectable to the naked eye; however, the weak hook is more likely to bend when a large fish or marine mammal is hooked.

Major scientific work (see references section): 34, 49, and 53.

Major results achieved (pros and cons) – Can reduce the incidental catch of large fish. The ability of weak hooks to release large fish alive and in good condition is questionable. Need to be replaced more often than low-grade stainless hooks.

Research priorities – Moderate. Efficiency and economics impacts should be assessed.

<u>***Bait type (squid vs. fish)***</u> – Squid and fish are the most common baits used in pelagic longline fisheries. Traditionally squid is used on targeted swordfish and tuna fisheries.

Major scientific work (see references section): 43, 2, 40, 19, 78, 107

Major results achieved (pros and cons) - The use of squid bait, in preference to fish bait, has been shown to reduce the catch rates of sea turtles in longline fisheries, however, results for shark catch rates are contradictory. The effectiveness of this method may vary between species and also within species. Several studies demonstrate significant increase of shark catches with fish bait.

Research needs – No needs for dedicated research. Only in combination with hook types/leaders.

<u>***Dyed bait***</u> – In the 1970s, fishermen experimented with dyed bait as a means of improving their target fish catch. More recently, experiments have been directed towards using blue-dyed bait to reduce seabird bycatch in pelagic longline fisheries. In theory, dyeing bait blue reduces the contrast between the bait and

the surrounding seawater making it more difficult for foraging seabirds to detect. Alternative theories suggest that seabirds are simply less interested in blue-dyed bait compared with undyed controls.

Major scientific work (see references section): 19, 44, 45, 46, 47 and 48.

Major results achieved (pros and cons) - In the 1970s, fishermen experimented with dyed bait as a means of improving their target fish catch. More recently, experiments have been directed towards using blue-dyed bait to reduce seabird by-catch in pelagic longline fisheries, however, more recent studies do not show any significant effect on seabird bycatch reduction. Not a promising measure as regards to mitigating shark catches.

Research needs – No needs for research.

<u>Artificial bait</u> – Artificial baits are an experimental technology in pelagic longline fisheries. Prototype artificial baits have relied upon olfactory attractants alone or in combination with a visual attractant (bait shape), each with different physical properties. Natural and/or synthetic ingredients have been used to fabricate the baits.

Major scientific work (see references section): 1, 54, 55, 56, 57, 58 and 59.

Major results achieved (pros and cons) - Research in the field has been very limited, with mixed success. However, artificial baits may reduce some types of shark bycatch under certain conditions. Although they have the potential to reduce shark bycatch, much work remains to be done before artificial baits are a viable alternative to natural baits.

Research needs – Moderate. Although they have the potential to reduce shark bycatch, much work remains to be done before artificial baits could be used as a viable alternative to natural baits.

<u>Soaking time</u> – The pelagic longlines are often soaking for long periods, in some cases for more than 24 hours, depending on the vessels characteristics and sea conditions. Longer soaking time usually results in higher proportion of shark caught in relation to target species catch. The proportion of fish alive at-haulback is inversely related to time on the line, hence the mortality of fish caught increased as soak time increased. Of the pelagic species shown, sharks were most resistant to hooking mortality.

Major scientific work (see references section): 3, 4, 5, 6 and 7, 162, 163, 164

Major results achieved (pros and cons) - Can reduce by-catch mortalities rates. Would not necessarily decrease swordfish catches but a reduction of total catch may occur. Optimal soaking duration varies by fishery.

Research needs – Moderate. Optimal soaking duration to be assessed for target species.

<u>Deep setting</u> – Deep setting is a longline fishing technique where hooks are set below a critical depth, out of range of most bycatch species, but within the range that target species are usually captured (i.e. tuna).

Major scientific work (see references section): 8, 9 and 10, 84.

Major results achieved (pros and cons) - Deeper setting reduces catch rates of pelagic sharks, but likely increases catches of deeper-dwelling shark species in some areas. Impossible to apply in swordfish targeting fisheries. Additional equipment (line-shooter) is required. More labour-costly, considerably increase duration of fishing operation.

Research needs – No needs for research (well understood).

Deep setting and elimination of shallow hooks -

Major scientific work (see references section):

Major results achieved (pros and cons) - Deeper setting reduces catch rates of pelagic sharks, but likely increases catches of deeper-dwelling shark species in some areas. Impossible to apply in swordfish targeting fisheries. Additional equipment (line-shooter) is required. More labour-costly, considerably increase duration of fishing operation.

Research needs – No needs for research (well understood).

Technical mitigation measures (such as repellents) – The use of permanent magnets, electropositive rare earth metals (EPREM) and other electrical measures has been tested as a means of deterring sharks from approaching baited hooks. Permanent magnets are made from magnetized material and create their own persistent magnetic field. EPREM react with seawater to create such fields. Sharks are able to detect the Earth's geomagnetic field using their ampullae of Lorenzini. Electropositive metals or magnets appear to generate an aversion response in some species of sharks through an overstimulation of their ampullae, which are sensitive electroreceptors.

Additionally, devices such as the 'SMARTSNAP' are being trialled. The SMARTSNAP is fitted onto the hook and is equipped with sensors to assist in characterizing species-specific line behaviour with the goal of detecting in real-time and releasing bycatch species automatically and immediately after capture. The prototype is being tested to collect data on species-specific behaviour after catch and preliminary results show difference in these behaviours suggested that this may be a viable tool.

Major scientific work (see references section): 66, 68, 69, 70, 74, 75 and 126, 128, 129, 130, 131, 132, 133, 134, 135.

Major results achieved (pros and cons) - Conflicting results concerning the efficiency of magnetic deterrents. Impact on the target species unknown. Little information on the effect that magnet and metal could have as repellent on pelagic sharks commonly caught by commercial longliners. Trials at large scale (in the Canadian longline) showed that rare-earth metal deterrent do not present a practical by-catch mitigation measure for this fishery. These devices are fragile, costly and the method can be difficult to implement.

Research needs – Moderate. Need to assess efficiency to mitigate shark by-catch.

Prohibition of wire leaders and shark lines

Major scientific work (see references section): 2, 16, 42, 83, 136, 137, 138, 139, 140, 141

Major results achieved (pros and cons) - Using monofilament instead of wire leaders has been found to result in significantly lower at-vessel catch rates of pelagic sharks. Target bony fish species at-vessel catch rates remained the same or higher with monofilament leaders. Prohibiting the use of shark lines can significantly reduce the mortality of some shark species, in situations where the use of shark lines is common. Prohibiting shark lines would also prevent increases in future mortality as a result of an increase in the use of shark lines which may occur if they were not prohibited. At vessel mortality rates have also been found to be significantly higher on wire leaders compared to monofilament leaders

Predictive modelling research conducted in the Western and Central Pacific determined that banning both shark lines and wire traces in the WCPFC Area had the potential to reduce fishing mortality by 30.8% and 40.5% for silky sharks and oceanic whitetip sharks respectively in that region

The degree to which a reduction in shark mortality would occur depends on the current level of use of these gears in IOTC, which is uncertain and requires further investigation. Some gear configurations may take over a year to break down (i.e. stainless hooks with monofilament leaders). Thus, recommendations to reduce trailing gear will improve post release survival probabilities

Research needs – Moderate.

Meka-ring/loop gear/trap line

Major scientific work (see references section): None to date – only plans for research: 142, 143.

Major results achieved (pros and cons) - There is a lot still unknown about this gear. It is effective at catching swordfish and other billfish and appears to result in limited catches of other species including sharks (some blue shark are known to be caught). There appears to be a high potential for this gear to reduce bycatch of other ETP species including turtles.

Research needs – High.

Spatial and/or temporal closure/MPAs – Time and area closures is a common management tool in coastal fisheries, as a tool to reduce fishing effort and mortality, protect sensitive areas and/or specific species life stages. However, as regards highly migratory species, the implementation of such spatial-temporal areas closures has been limited to tropical tuna fisheries.

Major scientific work (see references section): 108, 109, 110, 111 and 112, 157, 158, 159, 160, 161.

Major results achieved (pros and cons) - Time and area closures are effective at reducing by-catch only when target and non-target species segregate spatially, which is generally not the case for the pelagic sharks caught in longline fisheries targeting tunas.

Research needs – High. Identify major pelagic shark hotspots and investigate associated environmental conditions affecting shark distribution in the Indian Ocean.

Reduction of fishing effort – Limitation of fishing effort at certain (lower) level.

Major scientific work (see references section): 4, 5, 6, 7 and 79.

Major results achieved (pros and cons) – Reduction of shark catches and improvement of the overall at-haulback survival rates for by-catch species. May result in decrease catch rates of target and by-catch commercial species. Difficult to monitor and can result in an increase of non-reported fishing effort.

Research needs – No needs for research.

Prohibition of shark finning – prohibition of practice to keep fins discarding shark carcasses. Regulation of IOTC based on shark carcass/fins body ratio.

Major scientific work (see references section): 76, 169, 170.

Major results achieved (pros and cons) – Keeping shark with fins naturally attached to the body until first port of unloading simplifies enforcement as detached fins are not permitted, thus disincentivising the practice of shark finning

Research needs – No needs for research.

Reduction of fishing effort – Limitation of fishing effort at certain (lower) level for certain types of schools.

Major scientific work (see references section): Not available.

Major results achieved (pros and cons) – Reduction of shark bycatch especially FAL/OCS will result in decreased catch rates of target commercial species. Difficult to monitor and can result in an increase of non-reported fishing effort.

Research needs – No needs for research.

4.1.2. Purse-seines

Release panel – corresponds to part of purse seine wall, which could opened to provide a 'window' for free escape of sharks form the gear.

Major scientific work (see references section): 119.

Major results achieved (pros and cons) - An experimental release panel was installed in a portion of the net that forms a "pocket" toward the end of net retrieval to determine their ability to release both silky sharks and non-target finfish. Dive surveys previously reported that silky sharks tend to segregate and collect in this section of the net. The release panel was tested during seven purse seine sets, but only two silky sharks (out of 105) exited through this panel. In net observations indicated that sharks and other non-target finfish did not appear to recognize the opening as an escape route out of the net. Despite this initial failure of the release panel, the authors feel refinement of the panel and additional testing is still warranted.

Research needs – High. Efficiency of shark release procedure through the panel should be considerably improved.

Non entangling FADs – corresponds to fish aggregation devices both drifting and anchored that made from the material that prevent entanglement of associated species. Required through IOTC Resolution 24/02.

Major scientific work (see references section): 118, 124, 190, 191, 192, 193, 194

Major results achieved (pros and cons) - To reduce entanglement of turtles on the FAD itself, the surface structure should not be covered or only covered with non-meshed material. If a sub-surface component is used, to reduce entanglement of turtles and sharks it should not be made from netting but from non-meshed materials such as ropes or canvas sheets. To reduce the amount of synthetic marine debris, and to promote environmentally friendly FADs, the use of natural or biodegradable materials should be promoted.

Research needs – No needs for research.

Reduce FAD density – Reduction of the number of FADs on the water at a certain lower level could reduce the total catch of sharks. This is required through Resolution 24/02.

Major scientific work (see references section): 144, 145.

Major results achieved (pros and cons) - There are few studies investigating the impact of FAD density on shark catch rates and with inconclusive results as some are suggesting a decrease while others estimated an increase on shark bycatch.

Research needs – High

Remote detection (for example cameras on FADs and acoustic selectivity –

Major scientific work (see references section): 113, 146, 147, 153, 180, 185

Major results achieved (pros and cons) - Acoustic selectivity does not work for sharks. Autonomous buoy system prototypes which have the ability to detect and enumerate pelagic sharks at FADs automatically using cameras was tested but generally estimated around 50% of the actual number of sharks at the FAD (verified by divers).

Machine learning has also been applied to data obtained from echosounders which was compared with data from onboard observers to determine the possibility of detecting high and low bycatch occurrence. The algorithms developed showed some promise for discriminating between high and low levels of teleost bycatch but sharks were excluded from the analyses due to their lack of swim bladder and the fact that they do not usually form dense schools so it is unclear how well this would detect non-teleost bycatch species.

Research needs – Moderate.

Reduction of fishing effort – Limitation of fishing effort at certain (lower) level for certain types of schools.

Major scientific work (see references section): 157, 158, 166, 186, 187, 188, 189.

Major results achieved (pros and cons) – Reduction of shark bycatch especially FAL/OCS will result in decreased catch rates of target commercial species. Difficult to monitor and can result in an increase of non-reported fishing effort.

Research needs – No needs for research.

Setting on bigger aggregations (PS) – corresponds to the purse seine fishing tactics of avoiding setting on small schools given preferences to big schools of tuna.

Major scientific work (see references section): 113.

Major results achieved (pros and cons) – Such fishing tactics will reduce the number of fishing sets (a part of the total effort) while maintaining the same total yield. Such tactics will improve bycatch/target catch ratio. Ratios were always highest when catches were small, with the smallest class of catches responsible for the highest total portion of bycatch (23%–43%) while only contributing negligibly to the total target catch (3%–10%).

Research needs – No needs for research.

Prohibition of setting on ETP species (PS) – corresponds to prohibition from intentionally setting a purse seine net around a whale shark in the IOTC area of competence, if it is sighted prior to the commencement of the set. Regulation was already set in place by IOTC for whale shark and mantas (Resolutions 25/08 and 26/03).

Major scientific work (see references section): 115, 116, 117, 183, 184.

Major results achieved (pros and cons) – Decrease encircling/entanglement and potentially fishing mortality. Decrease data quality: non-reporting of whale-shark sets occurs.

Research needs – High. Post release mortality of whale sharks released from purse seine is unknown. Efficiency of the best practice currently set in place should be assessed.

4.1.3. Gill nets

Selectivity (Mesh size, hanging ratio, net panel material, etc…) – corresponds to length of the mesh. There are three approaches to measure mesh size: is length of mesh side (bar length), length of mesh, and opening of mesh (ICES, 2004). The latter is most commonly used measurement, accepted by EU Regulation (Anon., 1997). A net may be rigged with varying degrees of slack, which is primarily regulated by the ***hanging ratio***. The hanging ratio measures how tightly the net is stretched along the head and foot rope. The hanging ratio may theoretically vary between the value 0 and a value of 1.0. In commercial fisheries hanging ratios are normally between 0.25 and 0.65 (Hovgård, Lassen, 2000). ***Net panel material*** – corresponds to characteristic of twine (braided line or monofilament, twine diameter) and method of netting (knotted or knotless).

Major scientific work (see references section): 85, 86, 87, 88, 104, 105, 106.

Major results achieved (pros and cons) – Selectivity curves are species-specific. Therefore selection of particular mesh sizes may reduce catchability of certain shark species. However shark species demonstrate relatively wide selectivity curves that can overlap with selectivity curves of target species. It was found also that increased tension in a gillnet (using larger floats on the head-rope and increasing the lead-core lead-line weigh) may reduce shark entanglement in the net.

Research needs – Well understood. All types of technical aspects of the gear affecting selectivity needs research by fleet, depends on target species.

Subsurface net setting –

Major scientific work (see references section): 148, 149, 150.

Major results achieved (pros and cons) - Sub surface setting of gillnets (1.4-2m below the sea surface) has been trialled in Pakistan and appears to reduce the bycatch of sharks by 15%. This trial compared 2013 with 2018 catches (before and after the introduction of the subsetting). The full impact on other taxa is not yet well known but it appears that bycatch of cetaceans and turtles also reduced.

The trials showed a reduction of catch of some important commercial species including billfish, Spanish mackerel and dolphinfish but there continued to be high catches of target species.

Research needs – Moderate.

Illuminated nets/net lights – corresponds to lights (mostly battery-powered light-emitting diodes (LEDs)) attached to the net or nets constructed of photoluminescent materials in order to make net visible for bycatch species. May emit light in various spectral areas: visible lights, UV lights.

Major scientific work (see references section): 89, 90, 91, 92, 93.

Major results achieved (pros and cons) – visible spectrum LED lights and UV lights demonstrate decrease of sea turtle bycatch in gillnets without any effect on CPUE of target species. Apparently light might decrease bycatch of marine mammals also. No published information on efficiency of such measure on sharks: only theoretical conclusions (93).

Research needs – No needs for research (well understood). Apparently not as appropriate mitigation measure for sharks.

Repellents/attractors:

Major scientific work: 66, 67, 74, 91, 93, 94, 97, 98, 99, 100, 101, 102, 103, 125, 128, 129, 130, 131, 134, 195, 196

Acoustic pingers – corresponds to devices that produce high intensity acoustic signals on constant or variable frequencies in order to scare unwanted species.

Major scientific work (see references section): 93, 94.

Major results achieved (pros and cons) – Proved to be effective to decrease bycatch of marine mammals. No any evidence of potential efficiency to mitigate shark bycatch.

Research needs – No needs for research.

Olfactory repellent/attractant – corresponds to chemical compound that provide repulsive/attractive stimuli for shark species.

Major scientific work (see references section): 91, 93, 97, 98.

Major results achieved (pros and cons) – Research has not passed beyond experimental stage. The existence of a putative chemical shark repellent like shark necromone has been confirmed.

Research needs – No needs for research.

Powered electric field 'barrier' Magnetic field 'barrier' – corresponds to devices that produce magnetic or electric filed to repulse shark species.

Major scientific work (see references section): 93, 99, 100, 101, 102, 103, 125.

Major results achieved (pros and cons) – Some prototypes tested on experimental beach nets. It was demonstrated that bull sharks and great white sharks can be deterred by permanent magnets. Magnet efficacy can vary based on situational context. Study shows the potential for permanent magnets as devices that may reduce sharks encounters with nets. However research on magnet exclusion properties should be conducted prior to applying this concept to future shark exclusion technologies. There are also some ongoing studies of electrically-powered magnetic shark repulsion devices. 'Sharkshield'.

Research needs – No needs for research.

Pre-net fence (tactile) – corresponds to mechanical barrier from vertically positioned ropes (twines) with spaces that allow free passage of target species, positioned at some distance from the main net. Tactile contact should repulse shark species.

Major scientific work (see references section): 93.

Major results achieved (pros and cons) – A theoretical idea provided in the reference 93. Have been never tested in the field.

Research needs – No needs for research.

Soaking time – The pelagic driftnets are often soaking for long periods, in some cases for more than 24 hours, depending on the vessels characteristics and sea conditions. The proportion of fish that still alive at-haulback is inversely related to time in the net, hence the mortality of fish caught increased as soak time increased. Of the pelagic species shown, sharks were most resistant to hooking mortality.

Major scientific work (see references section): 165. Mostly unknown for pelagic gillnet fisheries.

Major results achieved (pros and cons) – Can reduce by-catch mortalities rates. No information if decreased soaking time will decrease catch of target species. Optimal soaking duration may vary by fishery.

Research needs – Moderate. Optimal soaking duration to be assessed by target species. Impact on the target catch levels should be assessed for major fleets.

Reduction of fishing effort – Limitation of fishing effort at certain (lower) level.

Major scientific work (see references section): not available.

Major results achieved (pros and cons) – Reduction of shark bycatch. Will result in decrease catch rates of target commercial species. Difficult to monitor and can result in an increase of non-reported fishing effort.

Research needs – No needs for research.

4.2. Best practices

Communication program – direct communication between fishing vessels aimed to avoid areas with high level of bycatch.

Major scientific work (see references section): 1, 2, 14, 154, 156.

Major results achieved (pros and cons) – Mostly depends on fishermen incentive to mitigate bycatch. Efficiency depends on distribution patterns of target/bycatch species. Bycatch limitation regulation apparently might facilitate mitigation based on fleet communication.

Research needs – No needs for research.

Safe handling and release – guidelines to handle and release sharks and other protected species in order to reduce the mortality without detrimental effect on safety of fishermen. For some gears kits of specific equipment (e.g. de-hooking or leader cutting devices for LL are necessary).

Major scientific work (see references section): LL: 71, 72, 73, 181; PS: 120, 121, 179, 180, 182; GILL: not available

Major results achieved (pros and cons) – A preliminary study indicated that, depending from gear and release practice used, from 20 to 50% of sharks died after release. It is therefore important to inform fishermen what practices can cause a delayed mortality and which ones minimize physical trauma and stress to the animals.

Research needs – Developing guidelines and protocols for safe handling and release: High priority for longline and gillnet.

Workshop/training information dissemination on good handling practices/ fishing practices - Fishers would be generally supportive of these measures if they receive some subsidies in return.

Major scientific work (see references section): 151, 152, 153

Major results achieved (pros and cons) - Training workshops have been carried out for some major purse seine and longline fleets with good engagement from fishers. Fishers have helped to develop and test tools for releasing animals and have also been involved in promoting gear innovations such as non-entangling FADs.

Research needs – No needs for research.

Table A 6. Mitigation measures reviewed by the working group

Direction	Measure / Method	Approach	Comment	References	Research needs	Regulation in place at IOTC	Available on the market?
LONGLINE							
Fishing technique/practices/strategy modification	Avoiding hotspots	Fleet communication program	Including 'move-on rules'	1, 2, 14, 154, 156	Not a priority.	No	n/a
	Spatial and/or temporal closure	Spatial and/or temporal closure/MPAs	Time and area closures are effective at reducing by-catch only when target and non-target species segregate spatially, which is generally not the case for the pelagic sharks caught in longline fisheries targeting tunas.	108, 109, 110, 111, 112, 157, 158, 159, 160, 161	High. Identify major pelagic shark hotspots and investigate associated environmental conditions affecting shark distribution in the Indian Ocean.	No	n/a
	Fishing time	Soaking time	Can reduce by-catch mortalities rates. Would not necessarily decrease swordfish catches but a reduction of total catch may occur. Optimal soaking duration varies by fishery.	3, 4, 5, 6, 7, 162, 163, 164, 165	Moderate. Optimal soaking duration to be assessed for target species.	No	n/a

	Fishing depth	Deep setting - traditional	Deeper setting reduces catch rates of pelagic sharks, but likely increases catches of deeper-dwelling shark species in some areas. Impossible to apply in swordfish targeting fisheries. Additional equipment (line-shooter) is required. More labour-costly, considerably increase duration of fishing operation.	10	Not a priority (well understood)	No	Yes
	Fishing depth	Deep setting and elimination of shallow hooks	Deeper setting reduces catch rates of pelagic sharks, but likely increases catches of deeper-dwelling shark species in some areas. Impossible to apply in swordfish targeting fisheries. Additional equipment (line-shooter) is required. More labour-costly, considerably increase duration of fishing operation.	8, 9	Not a priority (well understood)	No	Yes
	Decrease fishing mortality	Reduction of fishing effort	Reduction of shark catches and improvement of the overall at-haulback survival rates for by-catch species. May result in decrease catch rates of target and by-catch commercial species. Difficult to monitor and can result in an increase of non-reported fishing effort.	4, 5, 6, 7, 79, 157, 158, 166	Management decision	No	n/a

	Decrease fishing mortality	Prohibition of retention	Widely applied approach for protection of endangered species. Fishing mortality expected to decrease, but still can stay at a high level. Reduces the quality of reported data – so this should trigger the need to focus on improved reporting activities	157, 167, 168	Management decision	Species: OCS, BTH, PTH, ALV, RHN Resolution 25/08 SMA, LMA, MAK Resolution 25/09 MAN Resolution 26/03	n/a
	Finning prohibition and other legal constrains in the fishery	Prohibition of shark finning	Some fishers argue with increasing labour costs, decreased storing capacity and deterioration of shark meat as defrosting is required to remove the fins. However, this is well accepted practice in large sectors of the fleet.	76, 169, 170	Already implemented	Yes. FNA Resolution 25/08	n/a
Gear and bait modification	Bait modification	Bait type (squid vs. fish)	The use of squid bait, in preference to fish bait, has been shown to reduce the shark catch rates in longline fisheries. However, the effectiveness of this method may vary between species. Earlier studies demonstrate opposite	43, 2, 40, 19,	No needs for dedicated research. Only in combination with hook types/leaders.	No	Yes

			results showing preference of sharks to squid bait.				
	Bait modification	Blue/Green-dyed bait	In the 1970s, fishermen experimented with dyed bait as a means of improving their target fish catch. More recently, experiments have been directed towards using blue-dyed bait to reduce seabird by-catch in pelagic longline fisheries. Not a promising measure as regards mitigating shark catches.	19, 44, 45, 46, 47, 48	No needs for research.	No	Yes
	Bait modification	Artificial bait	Research in the field has been very limited, with mixed success. However, artificial baits may reduce some types of bycatch under certain conditions. Although they have the potential to reduce shark bycatch, much work remains to be done before artificial baits are a viable alternative to natural baits.	1, 54, 55, 56, 57, 58, 59, 171, 172, 173, 174, 175	Moderate. Although they have the potential to reduce shark bycatch, much work remains to be done before artificial baits could be used as a viable alternative to natural baits.	No	Yes
	Gear configuration	Technical mitigation measures (such as repellents)	There are a range of technical mitigation measures that have been tested including: repellents (Rare earth electropositive metals; olfactory chemicals such as necromones produced by decomposing shark tissue; and electrical, magnetic, light	66, 68, 69, 70, 74, 75 and 126, 128, 129, 130, 131, 132, 133, 134, 135	High research needs.	No	No

			repellents); and remote release of the hook (Remote release from the branchline when catch is determined, through a sensor that detects line movement (accelerometer, pressure, magnetometer, temperature) from behaviour of the catch while hooked on the line to be an at-risk bycatch species				
	Leader materials	Ban on wire leaders	Monofilament leaders only. Research suggests that the prohibition of these leaders would likely result in a reduction in observed catch and fishing mortality of shark species.	2, 16, 42, 83, 136, 137, 138, 139, 140, 141	Moderate research needs	Prohibited, Resolution 25/08	n/a
	Prohibition of shark lines	Ban on shark lines	Branchlines that fish near the surface, through attachment to floats or floatlines, designed to target epipelagic species, including sharks. Research suggests that the prohibition of shark lines would likely result in a reduction in observed catch and fishing mortality of shark species.	2, 16, 139	Moderate research needs	Prohibited, Resolution 25/08	n/a

	Gear configuration	Meka-ring/loop gear/ trap line	These are ring-shaped branch lines which are used to catch swordfish and appear to have very limited bycatch of sharks	142, 143	High research needs	No	Yes
	Catchability /Selectivity	Modification of terminal gears (including hook type)	Decrease deep-hooking of sharks and probably post-release mortality. Conflicting results in terms of catch rates, although most recent work suggesting an increase for sharks, namely when baited with fish. Other results are fisheries, species, specific and fishing area dependent. Corrodible hooks are fishing hooks composed of material other than stainless steel. The hook may dissolve quickly, within a couple of days, or more slowly over weeks or months. The premise behind the use of corrodible hooks is that they should improve the mortality rate of by-catch released with a hook attached. Weak hooks can reduce the incidental catch of large fish. The ability of weak hooks to release large fish alive and in good condition is questionable. Need to be replaced more often than low-grade stainless hooks.	18, 20, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 49, 50, 53, 177, 178	Moderate research needs. Additional work is required to assess efficiency of the combination of circle hooks and bait types in terms of catch rates of both targeted species and bycatch, at-haulback and post-release mortality, particularly for major shark fishing areas in the IO. Efficiency and economics impacts should be assessed.	No	Yes

	Decrease fishing mortality	Reduction of fishing effort	Reduction of shark catches and improvement of the overall at-haulback survival rates for by-catch species. May result in decrease catch rates of target and by-catch commercial species. Difficult to monitor and can result in an increase of non-reported fishing effort.	4, 5, 6, 7 and 79, 157, 158, 166	Management decision	No	n/a
Practices to increase survival rates	Safe handling and release	Safe handling and release, facilitation post-release survivorship (faster gear retrieval, line cutters, release alongside vessel, avoid bringing large sharks onboard)	The objectives provide fishers with the skills to reduce the mortality of protected species and sharks. Species identification could be taught in an effort to improve reporting. Fishers would be generally supportive of these measures as they would be easy to implement with relatively little expense. Such measures could also have positive effects on other species and could thus improve handling of other sensitive species.	71, 72, 73, 179, 180, 181, 182, 197	High research needs - high priority to develop best practice guidelines and effect of such practice on post-release survival.	Yes Resolution 25/08	n/a

	Safe handling and release	Mandatory Turtle/shark safe handling equipment	Fishers would be generally supportive of these measures.		No need for research (well understood). Like cutter from turtle release kits could be used to cut monofilament leaders during shark release.	Yes Resolution 25/08 for sharks	Yes
	Awareness	Workshop/training information dissemination on good handling practices/fishing practices	Fishers would be generally supportive of these measures.	151, 152, 153	No needs for research.	No	n/a
PURSE SEINE							
Fishing technique/practices/strategy modification	Decrease ratio bycatch/target catch	Setting on bigger aggregations	Avoiding setting on small schools will improve catch/bycatch ratio	1	No needs for research.	No	n/a
	Avoiding ETP species	Prohibition of setting on whale sharks & mantas	Decrease encircling/entanglement and potentially fishing mortality. Decrease data quality: non-reporting of whale-shark sets occurs.	115, 116, 117, 183, 184	Moderate research needs. Post release mortality of whale sharks released from purse seine is	Yes. Species: whale shark, mantas, cetaceans, Resolutions	n/a

					unknown. Efficiency of the best practice currently set in place should be assessed.	25/08, 23/06. 26/03	
	Avoiding hotspots	Fleet communication program	Including 'move-on rules'	1, 2, 14, 154, 155, 156	Not a priority.	No	n/a
	Remote detection	For example cameras on FADs and acoustic selectivity	Use estimates derived from automated real-time machine learning analyses of data from satellite-linked echosounder buoys or of video from satellite-linked cameras attached below a buoy located at a FAD to inform decisions on which drifting FADs sets are to be made, including when the: (1) School biomass exceeds a minimum threshold (e.g., 10 tons), (2) Ratio of the weight of at-risk bycatch species to the weight of target species is below a threshold, and (3) Number or biomass of at-risk bycatch species is below a threshold	113, 146, 147, 153, 180, 185	Moderate research needs	No	No

	Decrease fishing mortality	Reduction of fishing effort for certain types of schools	Free school sets compared to drifting fish aggregating device (FAD) sets	157, 158, 166, 186, 187, 188, 189	No needs for research	No	n/a
	Decrease fishing mortality	Prohibition of retention	Widely applied approach for protection of endangered species. Fishing mortality expected to decrease, but still can stay at a high level. Reduces the quality of reported data.	157, 167, 168	High. Assess efficiency for currently prohibited species. Moderate for major shark species.	Species: OCS, BTH, PTH, ALV, RHN Resolution 25/08 SMA, LMA, MAK Resolution	n/a
Fishing gear modification	Non entangling FADs	Non entangling FADs	Reduction of shark interactions. Considerably decrease ghost fishing by FADs.	118, 124, 190, 191, 192, 193, 194	No needs for research.	Resolution 24/02	Yes
	Improved FAD management	Reduce FAD density	Few research and results not conclusive	144, 145.	Moderate research needs.	Resolution 24/02	n/a
	Decrease fishing mortality	Release sharks from net (release panel, fishing from the net, attractors/repellents)	Results are highly uncertain due to shark behaviour issues.	119	High research needs. Efficiency of shark release procedure through the panel should be considerably improved. Experiments are being carried out by ISSF in other oceans.	No	No

	Remote detection	For example cameras on FADs and acoustic selectivity	Mostly considered as a theoretical concept. Never tested in real or experimental environment in relation with fishing gear protection.	60, 61, 62, 63, 64	Moderate research needs	No	No
Practices to increase survival rates	Safe handling and releases	Safe handling and release practice (including handling tools)	The objectives provide fishers with the skills to reduce the mortality of protected species and sharks. Species identification could be taught in an effort to improve reporting. Fishers would be generally supportive of these measures as they would be easy to implement with relatively little expense. Such measures could also have positive effects on other species and could thus improve handling of other sensitive species.	73, 120, 121, 151, 152, 153, 180, 181, 182, 197	Good knowledge level. Probably will further studies will be warranted after whale shark post-release survival studies.	Resolution 25/08	n/a
	Workshop/training information dissemination on good handling practices/fishing practices	Fishers training / awareness	Fishers would be generally supportive of these measures.	122, 151, 152, 153	No needs for research.	No	n/a
GILLNETS							
Fishing technique/practices/ strategy modification	Fishing time	Controlling soaking time	Shorter soak times would likely increase the survivorship but could increase the number of interactions if the effort is not limited. Optimal soaking duration likely varies by fishery.	162, 163, 165	Moderate research needs. Optimal soaking duration to be assessed for target species.	No	n/a

	Decrease fishing mortality	Prohibition of retention	Widely applied approach for protection of endangered species. Fishing mortality expected to decrease, but still can stay at a high level. Reduces the quality of reported data.	157, 167, 168	High research needs. Assess efficiency for currently prohibited species. Moderate for major shark species.	Species: OCS, BTH, PTH, ALV, RHN Resolution 25/08 SMA, LMA, MAK Resolution 25/09 MAN Resolution 26/03	n/a
		Reduction of fishing effort	Reduction of shark bycatch. Will result in decrease catch rates of target commercial species. Difficult to monitor and can result in an increase of non-reported fishing effort.	157, 158, 166	No needs for research. Management decision	No	n/a
Fishing gear modification	Gear configuration	Selective mesh size, gear rigging/construction	Selectivity curves are species-specific. Therefore selection of particular mesh sizes may reduce catchability of certain shark species. However shark species demonstrate relatively wide selectivity curves that can overlap with selectivity curves of target species. It was found also that increased tension in a gillnet (using larger floats on the head-rope and increasing the lead-core lead-line	1, 85, 86, 87, 88	Well understood. All types of technical aspects of the gear affecting selectivity needs research by fleet, depends on target species.	No	n/a

			weigh) may reduce shark entanglement in the net.				
	Gear configuration	Sub surface setting	Sub surface setting of gillnets (1.4-2m below the sea surface) has been trialled in Pakistan and appears to reduce the bycatch of sharks by 15%. This trial compared 2013 with 2018 catches (before and after the introduction of the subsetting). There was also seen to be a reduction of catches of some important commercial species including billfish, Spanish mackerel and dolphinfish but there continued to be high catches of target species.	148, 149, 150	Moderate research needs	Yes in Resolution 21/01	n/a
	Turtle/shark lights for gillnets	LED lights, UV lights, nets constructed of photoluminescent materials.	Visible spectrum LED lights and UV lights demonstrate decrease of marine turtle bycatch in gillnets without any effect on CPUE of target species. Apparently light might decrease bycatch of marine mammals also. No published information on efficiency of such measure on sharks: only theoretical conclusions.	89, 90, 91, 92, 93	No needs for research. Apparently not as appropriate mitigation measure for sharks.	No	Yes

	Attractant / Deterrent use	Repellent/attractors	Pingers proved to be effective to decrease bycatch of marine mammals. No any evidence of potential efficiency to mitigate shark bycatch. Olfactory repellent/attractant - research has not passed beyond experimental stage. The existence of a putative chemical shark repellent like shark necromone has been confirmed. Some prototypes tested on experimental beach nets. It was demonstrated that bull sharks and great white sharks can be deterred by permanent magnets. Magnet efficacy can vary based on situational context. Study shows a the potential for permanent magnets as devices that may reduce sharks encounters with nets. Further research should be conducted prior to applying this concept to technologies. There are also some ongoing studies of electrically-powered magnetic shark repulsion devices. 'Sharkshield'.	66, 67, 74, 91, 93, 94, 97, 98, 99, 100, 101, 102, 103, 125, 128, 129, 130, 131, 134, 195, 196	No needs for research.	No	Yes
Practices to increase survival rates	Safe handling and release	Safe handling and release, facilitation post-release survivorship	The objectives provide fishers with the skills to reduce the mortality of protected species and sharks. Species identification could be taught in an effort to improve	73, 120, 121, 151, 152, 153, 180, 181, 182	High research needs. No any guidelines	No	n/a

		(including quick release)	reporting. Fishers would be generally supportive of these measures as they would be easy to implement with relatively little expense. Such measures could also have positive effects on other species and could thus improve handling of other sensitive species.		available at present.		
	Safe handling and release	Mandatory Turtle/shark safe handling equipment	Fishers would be generally supportive of these measures.	73, 120, 121, 151, 152, 153, 180, 181, 182	No needs for research.	No for sharks. Yes for turtles Resolution 12/04 but for LL only	n/a
	Awareness	Workshop/training information dissemination on good handling practices/fishing practices	Fishers would be generally supportive of these measures if they receive some subsidies in return.	122	No needs for research.	No	n/a

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APPENDIX VI
AGENDA ITEM 5: SUPPORTING INFORMATION ON ASSESSMENT METHODOLOGIES

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APPENDIX VII
DIRECTORY OF AVAILABLE CAPACITY BUILDING MATERIALS

Table A 7 Summary of capacity building materials that are relevant for improving data collection for sharks in Indian Ocean tuna fisheries * Note that this list is not comprehensive and that the plan is to reach out to Parties through the Google form referenced in Section 6.2

Title	Author	Geographic scope	Fishery / gear	Taxa covered	Language(s)	Direct URL / access
Shark and ray identification in Indian Ocean fisheries	IOTC / FAO	Indian Ocean / IOTC Area	Gillnet, longline, pole-and-line, purse seine / general tuna fisheries	Sharks and rays interacting with tuna fisheries	English Portuguese Bahasa	EN https://openknowledge.fao.org/handle/20.500.14283/ca3440en PT http://www.fao.org/3/ca3440pt/CA3440PT.pdf ID http://www.fao.org/3/ca3440id/CA3440ID.pdf
On board guide for the identification of pelagic sharks and rays of the Western Indian Ocean	FAO / David A. Ebert	Western Indian Ocean; FAO Fishing Area 51 offshore/high seas	Offshore / high seas fisheries	34 shark species and 7 ray species	English	https://www.bmis-bycatch.org/system/files/zotero_attachments/library_1/AUP6CFTR%20-%20FAO_Onboard_Identification_Pelagic_Guide_Part_1-1.pdf
A practical guide to identifying CITES-listed sharks and rays in the Western Indian Ocean / Carcass ID guide	WCS / Cefas / Dr Rima Jabado	Western Indian Ocean	Landing sites, markets, enforcement, fisheries inspection	76 WIO species: 42 sharks and 34 rays	French, English	FR: https://drive.google.com/file/d/1APnxei5gOKA1qmKS1u4U8rpDLg4G39T1/view?usp=sharing EN: ONLINE_Jabado_2024_Sharks_Guide_CITES.pdf
Field identification guide to the sharks and rays of the Red Sea and Gulf of Aden	FAO / IUCN SSG hosted copy	Red Sea and Gulf of Aden	Fisheries / field identification	Sharks and rays	English	https://www.iucnssg.org/uploads/5/4/1/2/54120303/2004_-_field_identification_guide_to_the_sharks_and_rays_of_the_red_sea_and_gulf_of_aden.pdf see also : FIELD IDENTIFICATION GUIDE TO THE SHARKS AND RAYS OF THE RED SEAAND GULF OF ADEN

Field identification guide to the living marine resources of Kenya	FAO / Anam & Mostarda	Kenya	General marine fisheries	Living marine resources, including sharks and rays	English	https://www.fao.org/4/i2741e/i2741e.pdf pages 51-78 specifically
Field guide to the commercial marine and brackish-water species of Tanzania	FAO / Bianchi	Tanzania	Commercial marine and brackish-water fisheries	Commercial marine species, including elasmobranchs	English	https://www.fao.org/4/r6722e/r6722e00.htm
Field identification guide to Western Australian sharks and shark-like rays	Western Australia fisheries / BMIS-hosted copy	Western Australia	Commercial/recreational fisheries, observers, researchers	Sharks and shark-like rays	English	https://www.bmis-bycatch.org/system/files/zotero_attachments/library_1/2MDP9FA2%20-%20WA%20sharks%20ID%20guide_.pdf
Sri Lanka NPOA-Sharks 2025–2030: planned brochures, posters, species ID guides and fact sheets	Sri Lanka DFAR / OCPP / Cefas / partners	Sri Lanka	Fisheries offices, harbours, fishers, traders	Chondrichthyans	Sinhala, Tamil, English planned	https://iotc.org/sites/default/files/NPOA_portal/Sri_Lanka/LKA_-_NPOA_Sharks_2025-30.pdf
Shark Action Plan 2015 for the Maldives	Maldives government / IOTC NPOA portal	Maldives	National shark management	Sharks	English	https://iotc.org/sites/default/files/NPOA_portal/Maldives/IOTC-2015-WPEB11-INF12_-_Maldives_NPOA_Sharks.pdf
Collaborative research: Development of a manual on elasmobranch handling and release best practices in tropical tuna purse-seine fisheries	Poisson, Séret, Vernet, Goujon & Dagorn / Marine Policy; IOTC-hosted copy	Atlantic and Indian Oceans; WIO purse seine observations	Tropical tuna purse seine	Sharks and rays	English	https://iotc.org/sites/default/files/documents/2014/10/IOTC-2014-WPEB10-INF15_-_Elasmobranch_handling.pdf
Best bycatch release practices in longliners	ISSF Skippers Workshop Guidebook	Global tuna longliners; applicable to Indian Ocean fleets	Tuna longliners	Small/medium sharks, manta rays, whale sharks, turtles, seabirds	English plus Chinese, French, Indonesian, Japanese, Korean,	https://issfguidebooks.squarespace.com/downloadable-guides?tag=Longline%20Skipper

					Spanish, Tagalog, Vietnamese	
Best bycatch release practices in tuna purse seiners	ISSF Skippers Workshop / based on Poisson et al. good practices Some may now be out dated	Global tuna purse seine; applicable to Indian Ocean fleets	Tropical tuna purse seine	Small/medium sharks, manta rays, whale sharks, turtles	English plus Chinese, French, Indonesian, Japanese, Korean, Spanish, Tagalog, Vietnamese	https://www.iss-foundation.org/downloads/16456/?tmstv=1781616899
Sorting Grid Construction Guide	ISSF: Cronin, Murua & Moreno	Global tuna purse seiner; explicitly fisher guidebook linked	Tuna purse seine	Mobulids	English plus Chinese, French, Indonesian, Japanese, Korean, Spanish, Tagalog, Vietnamese	https://www.iss-foundation.org/about-issf/what-we-publish/issf-documents/manta-ray-sorting-grid-construction-instructions-for-purse-seine-vessels-spanish/
Shark Release Ramp Guide for Purse-Seine Vessels	ISSF / AZTI: Moreno, Murua & Murua	Global tuna purse seine; explicitly fisher guidebook-linked	Tuna purse seine	Sharks	English plus Chinese, French, Indonesian, Japanese, Korean, Spanish, Tagalog, Vietnamese	https://www.iss-foundation.org/about-issf/what-we-publish/issf-documents/shark-release-ramp-guide-for-purse-seine-vessels/
New best handling and release practice guide for vulnerable species interactions in purse-seine fisheries	IOTC WPEB21 paper	IOTC / purse seine context	Purse seine	Vulnerable species incl. elasmobranchs	English	https://iotc.org/sites/default/files/documents/2025/08/IOTC_2025_WPEB21_AS_35_-_PS_best_practices.pdf
ETP Management Strategy for the Indian Ocean tuna and large pelagics longline fishery	FisheryProgress / Afritex Ventures / Pescamoz	Indian Ocean high seas and EEZs; Mozambique/	Longline tuna and large pelagics	ETP species including sharks/rays	English	https://fisheryprogress.org/sites/default/files/documents_actions/0062_ETP%20species%20Management%20Strategy_signed_Jan2023.pdf

		Mauritius flags				
Shark and Ray Handling Practices: a guide for commercial fishers in southern Australia	Australian Fisheries Management Authority	Southern Australia	Commercial fisheries	Sharks and rays	English	https://www.afma.gov.au/sites/default/files/2023-02/shark_and_ray_handling_practices_-_a_guide_for_commercial_fishers_in_southern_australia.pdf
Best handling and release practice guidelines for sharks	IATTC Scientific Advisory Committee	Eastern Pacific RFMO; global evidence incl. IO studies Not Indian Ocean specific but likely to be overlap	Longline and purse seine	Sharks	English	https://www.iattc.org/GetAttachment/e94b362b-ed75-43d6-b506-64e1f1a5e253/SAC-15-11_Best-handling-and-release-practice-guidelines-for-sharks.pdf
Saving the Mobula Rays Poster: Western & Central Pacific Ocean & Indian Ocean	ISSF	WCPFC and Indian Ocean	Tuna fisheries	Mobula rays	Taiwanese/Chinese page located; likely more language variants	https://www.iss-foundation.org/about-issf/what-we-publish/issf-documents/saving-the-mobula-rays-poster-western-central-pacific-ocean-indian-ocean-taiwanese/
IOTC Compendium of Active Conservation and Management Measures	IOTC	IOTC Area of Competence	IOTC managed fisheries	Includes sharks, mobulids, whale sharks and other NTADs	English	https://iotc.org/sites/default/files/documents/compliance/IOTC_-_Compendium_of_ACTIVE_CMMs_22_June_2026.pdf
Sri Lanka fisher-facing shark/ray ID posters or guides from OCPP/Cefas/DFAR/BRT	Cefas / DFAR / Blue Resources Trust	Sri Lanka	Fisheries staff and harbours	Sharks, rays and chimaeras	Sinhala, Tamil, English likely	Sourcing digital copy
Tanzania CITES-listed shark and ray identification guide, three-volume guide used in training	WCS / TRAFFIC / Tanzania agencies / IWT Challenge Fund	Tanzania / WIO	Enforcement and trade controls	CITES-listed sharks/rays and fins	Unknown	Sourcing digital copy

Kenya shark and ray catch-data / identification materials from WildlifeDirect/KMFRI projects	WildlifeDirect / KMFRI / partners	Kenya	Artisanal fisheries	Sharks and rays	Unknown	Sourcing digital copy
Madagascar shark/ray fisher or enforcement guides beyond WCS CITES carcass ID guide	WCS Madagascar / Blue Ventures / national agencies	Madagascar	Small-scale fisheries, trade and enforcement	Sharks and rays	French/ Malagasy possible	Sourcing digital copy
Introduction to the Sharks, Rays and Marine Turtles of Bangladesh	WCS	Bangladesh		Sharks and rays	English	Sourcing digital copy
Amazing Aquatic Animals	WCS	Bangladesh		ETP species	Bangla	Sourcing digital copy
Amazing Aquatic Animals	WCS	Bangladesh		ETP	English	Amazing Aquatic Animals _WCS BD_2016_English.pdf
Protected Sharks and rays of Bangladesh	WCS	Bangladesh		Sharks and Rays	English/ Bangla	Brochure_sharks and rays_v12_Web_april_22_outlined.pdf
Protected Sharks and rays - poster	WCS	Bangladesh		Sharks and Rays	Bangla	Protected sharks and rays of Bangladesh poster_v11_outlined.pdf
CITES Sharks and Rays	WCS	Bangladesh		Sharks and Rays	English	CITES sharks and rays_May_22_English_outlined.pdf
Sharks and Rays of Bangladesh - A guide to identifying protected species and their	WCS	Bangladesh		Sharks and Rays	English	https://bangladesh.wcs.org/DesktopModules/Bring2mind/DMX/API/Entries/Download?EntryId=49759&PortalId=179&DownloadMethod=attachment

commonly traded parts (English version)					
Poster on Protected Sharks and Rays of Bangladesh (English Version)	WCS	Bangladesh	Sharks and Rays	English/Bangla	https://bangladesh.wcs.org/DesktopModules/Bring2mind/DMX/API/Entries/Download?EntryId=44605&PortalId=179&DownloadMethod=attachment
Brochure on Protected Sharks and Rays of Bangladesh (Bangla Version)	WCS	Bangladesh	Sharks and Rays	Bangla	https://bangladesh.wcs.org/DesktopModules/Bring2mind/DMX/API/Entries/Download?EntryId=44603&PortalId=179&DownloadMethod=attachment
A Species Identification Guide to Commonly Traded Wildlife, their Body Parts and Products in Bangladesh (Bangla version)	WCS	Bangladesh	Includes Sharks and Rays	Bangla	https://bangladesh.wcs.org/DesktopModules/Bring2mind/DMX/API/Entries/Download?EntryId=49767&PortalId=179&DownloadMethod=attachment
Sharks of the Arabian Seas Identification Guide	CMS	Arabian Seas	Sharks	English	https://sharks.cms.int/sites/default/files/publication/Sharks%20of%20the%20Arabian%20Seas%20Identification%20Guide.pdf
Deep Sea Cartilaginous Fishes of the Indian Ocean. Volume 1 - Sharks	FAO Fish Finder	Indian Ocean	Sharks	English	https://openknowledge.fao.org/server/api/core/bitstreams/88f2e118-cd0a-4533-9eba-e24d2a4e46ce/content
Deep Sea Cartilaginous Fishes of the Indian Ocean. Volume 2 – Batoids and Chimaeras	FAO Fish Finder	Indian Ocean	Batoids and Chimaeras	English	https://books.googleusercontent.com/books/content?req=AKW5QafgWuP8AowAx-5qTDDmBj4dUpp5uoLBuCXZ1xmLwkA8DRy8RMU83p8HRmUym10kFF3Eick2DMhTdsbbQFfghQJPSLuEXlF4POv1VzRiFRD3jAZlfcCV0cK95uNjTvNvePLnCWCpZkQJWANwdu69GZ5fGKqf2BwJeL8r0RqO6dL13LYh5dCEncgc4tKYWDjf4iXyzgX3LJNrd2s37aqmMucQ19KymWubGCkiZZnNNw6AteObUCHdluF_S2jE2qHJ0AXNHs5efmOlnzbLS2r7fF1ice8-rQQG4xE-PiwW0sTSLHscpEw

Table A 8: Gaps identified in the available capacity building materials and suggested follow up actions

Priority	Gap / lead	Why it matters	Suggested action
High	IOTC species identification cards page	Likely central host for current English/French IOTC cards and possible updated versions.	Download all current language versions and compare against FAO Open Knowledge/IOTC 2013 files.
High	Sri Lanka OCPP/Cefas/DFAR materials	Training and NPOA work are recent and may have produced practical ID/handling materials in Sinhala, Tamil and English.	Email Cefas OCPP contact, DFAR and Blue Resources Trust.
High	WCS/Cefas WIO CITES carcass guide language versions	Confirmed excellent WIO ID guide, but only French Google Drive link found in public search.	Ask WCS/Cefas/Dr Rima Jabado for English, Malagasy, Portuguese, Swahili or Arabic versions.
Medium	Tanzania CITES three-volume guide	Likely highly relevant for enforcement and trade identification; public article says it was developed for Tanzania training.	Contact WCS/TRAFFIC/IWT Challenge Fund project team.
Medium	Kenya and Madagascar fisher training materials	Research and projects indicate training/photographic ID materials exist, but public PDFs were not located.	Contact KMFRI/WildlifeDirect/WCS/Blue Ventures.
Medium	ISSF guidebook resource library	Multiple bycatch/handling posters and guidebooks exist in language variants relevant to Indian Ocean fleets.	Download English, French, Indonesian, Chinese, Korean, Vietnamese and Tagalog where relevant.
Medium	National fisheries authorities across WIO	Materials may be hosted on ministry sites in French, Arabic, Portuguese, Malagasy, Sinhala or local languages.	Search country-by-country in English and local-language terms.

APPENDIX VIII
DIRECTORY OF POTENTIAL FUNDING SOURCES

Below is a list of potential funding sources for projects relating to sharks and their management

Source	Typical timeframe / call frequency	Typical funding amount/project timeframes	Application process	Topic focus
WWF	Ad hoc concept notes	<$50K		
ISSF		$30–50K	Once specific projects are agreed upon, a short concept note to be submitted for consideration. Additional information may be required.	Capacity building/ training workshops. Mitigation measures research and practical application.
Shark Conservation Fund	Ad hoc concept notes. Funding variable. Organisations can only apply for funding once per year	Variable. 18 months duration max	Concept notes	It seeks projects that will result in conservation measures linked to reductions in shark and ray mortality in the near term. Activities should be clearly linked to an agency that will use the data to improve shark regulation or management
Pew Charitable Trusts – Ocean Conservation	No regular open calls.	Variable; often $100,000–1 million+.	Normally through invited partnerships.	RFMO policy, shark conservation, international fisheries governance, science-policy interface.
World Bank (Global wildlife programme)	Ad hoc concept notes.	Variable.		
Global Environment Facility (GEF)	Projects developed over 6–18 months before approval. GEF replenishment cycles run every four years; countries submit projects throughout the cycle. (GEF)	Medium-sized projects: up to $5 million GEF financing; Full-sized projects: >$5 million. (GEF)	Requires endorsement by participating countries and a GEF Agency (e.g. FAO, UNDP, UNEP, World Bank). Lengthy concept note, project preparation grant, full proposal and Council approval.	Regional shark conservation; bycatch reduction; biodiversity conservation; implementation of the Global Biodiversity Framework; electronic monitoring; capacity development; fisheries governance.

European Union (DG INTPA / Horizon Europe / Sustainable Oceans programmes)	Most calls open annually; preparation usually 2–4 months.	Generally $500,000–10+ million depending on programme.	Competitive consortium proposals involving EU institutions and international partners.	Fisheries management, biodiversity, electronic monitoring, innovation, climate resilience, capacity building, CITES implementation.
European Maritime, Fisheries and Aquaculture Fund (EMFAF)	Annual or thematic calls.	Typically $250,000–5 million.	Competitive EU call; usually requires European partners.	Electronic monitoring, selective fishing gears, bycatch mitigation technology, fisheries data systems.
Shark Conservation Fund	Small grants accepted periodically; larger strategic investments by invitation. (Research and innovation)	Approximately $25,000–250,000 for small grants (larger strategic grants can exceed this).	Short concept note followed by full proposal for invited applicants. Partnership with national programmes is encouraged. (Research and innovation)	Shark conservation policy, RFMO implementation, CITES, Important Shark and Ray Areas (ISRAs), management measures, trade-related conservation.
Blue Action Fund	Calls every 1–2 years; proposal development typically 3–6 months. No standing applications—only open Calls for Proposals. (Blue Action Fund)	Generally €2–5 million. (Blue Action Fund)	Two-stage competitive process for NGOs (usually with government partners).	Marine protected areas, coastal fisheries, biodiversity, community livelihoods, shark nursery protection, Western Indian Ocean conservation.
Bloomberg Ocean Initiative	Irregular strategic calls.	Approximately $500,000–5 million.	Usually by invitation or through strategic partnerships.	Fisheries transparency, bycatch reduction, electronic monitoring, policy implementation.
Schmidt Marine Technology Partners		Most grants are between $100,000 and $400,000	Short applications then invited to full proposal	Technology innovation focused sustaining fisheries, habitat health, ocean observing, and network support
Oak Foundation – Marine Conservation	Rolling strategic funding.	Approximately $100,000–2 million.	Initial concept followed by invited proposal.	Sustainable fisheries, biodiversity conservation, governance, bycatch reduction.

International Climate Initiative (IKI) – Germany	Usually annual calls.	Typically $500,000–10 million.	Concept note followed by full proposal if shortlisted.	Climate-resilient fisheries, ecosystem-based management, marine biodiversity, blue economy.
PROBLUE (World Bank)	Rolling opportunities linked to World Bank projects.	Often $500,000–5 million.	Normally accessed through World Bank country programmes.	Fisheries governance, sustainable fisheries, monitoring systems, blue economy, regional fisheries management.
French Facility for Global Environment (FFEM)	Calls every 1–2 years.	Approximately $500,000–3 million.	Concept note then full proposal.	Marine biodiversity, Western Indian Ocean conservation, innovative fisheries management.
Agence Française de Développement (AFD)	Rolling programmes.	Highly variable ($500,000–20+ million).	Usually government-led or institutional partnerships.	Fisheries governance, regional cooperation, observer programmes, monitoring and surveillance.
Norad (Norwegian Agency for Development Cooperation)	Annual thematic calls.	Approximately $250,000–5 million.	Competitive applications.	Sustainable fisheries, marine biodiversity, capacity development, data systems.
UK Blue Planet Fund	Periodic calls.	Typically $500,000–10 million.	Competitive government/institutional partnerships.	Sustainable fisheries, illegal fishing, bycatch mitigation, biodiversity, electronic monitoring.
FAO Technical Cooperation Programme (TCP)	Rolling. Approval generally 3–6 months.	Up to approximately $500,000.	Government request through FAO country office.	Pilot projects, technical assistance, training, observer programmes, national implementation of RFMO measures.
Save Our Seas Foundation	Biennual calls	Up to approx. $25,000 (Keystone grants)	Online through their grants portal. Stage I concept note via online portal, reviewed by SOSF scientific committee with final Board approval	Work that delivers clear, direct and measureable conservation outcomes for sharks and rays
Fishing Watch – Open Ocean Research Grants	2026 cycle uses a new letter-of-intent stage	Small grants (typical range low	Only LOI-selected applicants invited to submit full proposal	Research using public vessel-tracking/AIS data for

	before full proposal; cohort commences November	tens of thousands USD)		governance, incl. bycatch-risk hotspot mapping
Darwin Plus (UK biodiversity challenge funds)	Annual call, typically opens autumn/winter (UK Overseas Territories only)	Main Darwin Plus grants roughly £250k–£400k; Darwin Plus Local smaller (~£50k)	Competitive UK government application via Darwin Plus portal	Biodiversity/marine conservation in UK Overseas Territories — has funded shark/bycatch monitoring (e.g., BRUVS surveys
MSC Ocean Stewardship Fund	Annual call, typically opens early in the year	Project grants generally $20,000–$200,000+	Application via MSC's online portal; open to fisheries (incl. those in Fishery Improvement Projects) and partners	Improving bycatch estimation methodology and onboard monitoring in tuna fisheries, incl. shark bycatch in Indian/Atlantic Ocean purse seine fleets
NOAA Bycatch reduction engineering program	Annual, typically opens early in the fiscal year	Grants vary; NOAA has awarded more than $7 million total since 2018 across shark-focused research grant programs	Competitive federal grant application (grants.gov)	Development and testing of fishing gear/technology to minimize bycatch and habitat impacts
Rufford Foundation	Folling basis throughout the year	Up to £7,000 for first-time applicants, rising to £18,000 by fourth grant	Online application portal, geared to early-career conservationists in developing countries	Field-based conservation research, broadly applicable to shark bycatch fieldwork
Bycatch solutions hub			Online project proposals. The Bycatch Solutions Hub team reviews all submissions for scientific rigor, feasibility, and alignment with bycatch-reduction goals before listing.	Projects focused on bycatch reduction through gear modifications, best practices, monitoring, or training programs in any fishery worldwide.

APPENDIX VIV
CONSOLIDATED RECOMMENDATIONS OF THE FIRST SESSION OF THE INDIAN OCEAN SHARK YEAR PROGRAM WORKSHOP (IO-SHPL02)

Note: Appendix references refer to the Report of the First Session of the Indian Ocean Shark Year Program Workshops (IOTC–2026–IOShPl02–R)

2. Review of the current shark data available and identification of main data gaps
2.5 Information and datasets from coastal CPCs

(para. 63) The IOShPl **RECOMMENDED** that a high priority activity would be to secure a consultant with expertise in gillnet fisheries to work in various CPCs in order to improve the validity of data and information coming from these fisheries. The IOShPl **NOTED** that this could be combined with capacity building activities. The IOShPl **STRESSED** that improvements to data collection systems in CPCs should include all species **NOTING** that neritic tuna species are also subject to many data gaps. The IOShPl **NOTED** that these capacity building activities would need to be continued for a number of years until CPCs are able to manage it by themselves.

(para. 65) The IOShPl **NOTED** that Resolution 15/01 only requires species level reporting of 4 species for gillnets (blue, porbeagle, oceanic whitetip and whale sharks) and 3 species for purse seine fisheries (oceanic whitetip, silky and whale sharks) while other species are either optional species to be recorded or are only required at family level (mako, hammerhead and thresher sharks). The IOShPl further **NOTED** that elements of Resolution 15/01 actively promote poor data reporting practices such as aggregating data by saying that any species not listed as mandatory for collection under each gear may be reported as aggregates. Therefore, the IOShPl **RECOMMENDED** that the WPEB once again recommend that the Commission update Resolution 15/01 so species level reporting is required for more shark species for all gears as suggested by WPEB in 2025.

(para. 67) The IOShPl **NOTED** that many research organisations and scientists are holding data that have not been fully analysed or published and so **RECOMMENDED** that the WPEB organise a data call for these kinds of data for sharks.

2.8 Trade data

(para. 89) The IOShPl **NOTED** that there have been found to be large disparities between landings data and trade data for sharks with landings data being much lower generally. In some cases, trade data is available for sharks being exported from countries that report no catches of sharks. This has been investigated mostly for CITES listed species to date.

(para. 90) The IOShPl **NOTED** that at the 34th CITES Animals Committee some key country species combinations were selected to undergo a Review of Significant Trade.

(para. 91) The IOShPl **RECOMMENDED** that the WPEB explore these disparities further specifically for the Indian Ocean.

3. Review of current available information in terms of biological and ecological knowledge of the seven major shark species

3.2 Review of the current biological knowledge

(para. 150) The IOShPl **RECOMMENDED** the WPEB to facilitate the creation of an inventory of samples through putting out a call for information on sample availability around the Indian Ocean.

In addition to this, the workshop produced a detailed roadmap of activities that should be carried out in order to improve the management of sharks by IOTC. This can be seen in Section 7 - Priorities for data collection and research on shark species and a plan to move forwards.