

# REVIEW OF THE STATISTICAL DATA AVAILABLE FOR IOTC BYCATCH SPECIES

Prepared by [IOTC Secretariat](#)<sup>1</sup>

## Purpose

To provide participants to the 20<sup>th</sup> Session of the IOTC Working Party on Ecosystems and Bycatch (WPEB20) with a review of the status of the information available on non-targeted, associated, and dependent species of IOTC fisheries (“bycatch”) defined by the IOTC Scientific Committee as:

*“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 species or species groups other than the 16 IOTC species listed in the IOTC Agreement, in accordance with relevant Resolutions adopted by the Commission. It provides an overview of the data available in the IOTC Secretariat databases as of September 2024 for sharks, rays, seabirds, marine turtles, cetaceans, and other bycatch species. The document describes the progress achieved in relation to the collection and verification of data, identifies problem areas and proposes actions that could be undertaken to improve them.

Additionally the document summarize the data available in the IOTC Secretariat databases for shortfin mako shark, under assessment this year, and for shortbill spearfish (SSP) as requested by the [WPEB19](#)

## Materials

Several fisheries data sets shall be reported to the IOTC Secretariat by the Contracting Parties and Cooperating Non-Contracting Parties (CPCs) as per the [IOTC Conservation and Management Measures](#) (CMMs) and following the standards and formats defined in the [IOTC Reporting guidelines](#). Although not mandatory, the use of the [IOTC forms](#) is recommended to report the data to the Secretariat as they facilitate data curation and management.

## Retained catch data

These correspond to the total retained catches (in live weight) per year, Indian Ocean major area, fleet, fishing gear, and species ([IOTC Res. 15/02](#)) and shall be reported through [IOTC form 1RC](#). In addition, in order to support the monitoring of the catch limits implemented by some industrial fisheries for the CPCs having objected to [IOTC Resolution 21/01](#) as part of the interim plan for rebuilding the yellowfin tuna stock, [IOTC Res. 19/01](#) requests CPCs still bound to this resolution to submit, from 2019 onwards, their retained catches of yellowfin tuna explicitly broken down by vessel length and area of operation (i.e., for vessel of 24 m overall length and over, and for those under 24 m if they fish outside the Exclusive Economic Zone (EEZ) of the flag state) ([IOTC Form 1RC-YFT](#)).

Two data sets of retained catches are made available by the Secretariat: (1) the [raw estimates](#) which include both the 16 IOTC species (prior to the breakdown of species and gear aggregates) and all other species considered as bycatch and (2) the [best scientific estimates](#) only available for the 16 IOTC species (e.g., [IOTC 2022](#)).

Changes in the IOTC consolidated data sets of retained catches (i.e., raw and best scientific estimates) may be required as a result of:

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- i. updates received by December 30<sup>th</sup> each year, of the preliminary data for longline fleets submitted by June 30<sup>th</sup> of the same year ([IOTC Res. 15/02](#));
- ii. revisions of historical data by CPCs following corrections of errors, addition of missing data, changes in data processing, etc.
- iii. changes in the estimation process performed by the Secretariat based on evidence of improved methods and/or assumptions (e.g., selection of proxy fleets, updated morphometric relationships) and upon endorsement by the Scientific Committee.

## Geo-referenced catch and effort data

Catch and effort data refer to finer-scale data, usually from logbooks, reported in aggregated format and stratified per year, month, [grid](#), fleet, gear, type of school, and species ([IOTC Res. 15/02](#)). The [IOTC forms](#) designed for reporting geo-referenced catch and effort data vary according to the nature of the fishing gear (e.g., surface, longline, and coastal gears). In addition, information on the use of fish aggregating devices (FADs) and activity of the support vessels that assist industrial purse seiners also has to be collected and reported to the Secretariat through [IOTC forms 3FA](#) and [3SU](#).

## Discard data

The IOTC follows the definition of discards adopted by FAO in previous reports ([Alverson et al. 1994](#); [Kelleher 2005](#)) which considers all non-retained catch, including individuals released alive or discarded dead. Estimates of total annual discard levels in live weight (or number) by Indian Ocean major area, species and type of fishery shall be reported to the Secretariat as per [IOTC Res. 15/02](#). The [IOTC form 1DI](#) has been designed for the reporting of discards and the data contained shall be extrapolated at the source to represent the total level of discards for the year, gear, fleet, Indian Ocean major area, and species concerned, including turtles, cetaceans, and seabirds.

Nevertheless, discard data reported to the Secretariat with [IOTC Form 1DI](#) are generally scarce, not raised, and not complying with all IOTC reporting standards. For these reasons, the most accurate information available on discards comes from the IOTC Regional Observer Scheme ([IOTC Res. 22/04](#)) that aims to collect detailed information (e.g., exact location in space and time of the sets and interactions, including the fate of observed individuals) on discards of IOTC and bycatch species for industrial fisheries (see below).

## Size-frequency data

The size composition of catches may be derived from the data set of individual body lengths or weights collected at sea and during the unloading of fishing vessels. The [IOTC Form 4SF](#) provides all fields requested for a complete reporting of size-frequency data to the stratification by fleet, year, gear, type of school, month, grid and species as required by [IOTC Res. 15/02](#). While the great majority of size data reported through IOTC Form 4SF are for retained catches, CPCs can also use the same form to report size data of discarded individuals. Furthermore, additional size data (including those for individuals discarded at sea) may be collected through onboard observer programs and reported to the Secretariat as part of the ROS (see below).

## Regional Observer Scheme

[Resolution 22/04](#) on a *Regional Observer Scheme* (ROS) makes provision for the development and implementation of national observer schemes among the IOTC CPCs starting from July 2010 with the overarching objective of collecting “*verified catch data and other scientific data related to the fisheries for tuna and tuna-like species in the IOTC area of competence*”. The ROS aims to cover “*at least 5% of the number of operations/sets for each gear type by the fleet of each CPC while fishing in the IOTC Area of competence of 24 meters overall length and over, and under 24 meters if they fish outside their EEZs shall be covered by this observer scheme*”. Observer data collected as part of the ROS include: (i) fishing activities and vessel positions, (ii) catch estimates with a view to identifying catch composition and monitoring discards, bycatch and size frequency, (iii) gear type, mesh size and attachments employed by the master, and (iv) information to enable the cross-checking of entries made to the logbooks (i.e., species composition and quantities, live and processed weight and location). A first technical description of the ROS data requirements is available in the reference document [IOTC Regional Observer Scheme \(ROS\) Data Collection Fields](#).

The document [IOTC-2022-WPDCS18-10](#) provides a comprehensive description of the current status, coverage and data collected as part of the ROS: although incomplete and characterized by a large variability in coverage between fisheries and over space and time, observer data include information on the fate of the catches (i.e. retained or discarded at sea) as well as on the condition of the discards. Observer data are also the main source of spatial information on interactions between IOTC fisheries and seabirds, marine turtles, cetaceans, as well as any other species encountered.

To date, the ROS regional database contains information for a total of 1,763 commercial fishing trips (1013 from purse seine vessels and 750 from longline vessels of various types) made during the period 2005-2022 from 7 fleets: Japan, EU, France and Sri Lanka for longline fisheries and EU, Spain, EU, France, Japan, Korea, Mauritius, and Seychelles for purse seine fisheries. In addition, some observer reports have been submitted to the Secretariat by some CPCs (e.g. Taiwan, China) but data sets were not provided in electronic format at the operational level following the [ROS standards](#), *de facto* preventing the entry of the data in the ROS regional database.

The ROS regional database includes a total of 101,970 interactions with bycatch species for the purse seine and longline fisheries having reported data to the Secretariat in electronic format (**Table 1**). Purse seine interactions (n = ) cover the time period 2005-2022 and correspond to % of all shark interactions in the ROS regional database against for longline. A total of 8,442 interactions with rays have been reported, while seabirds and cetaceans' interactions amount to 255 records, and are exclusively reported by longline fisheries.

Table 1: Number of bycatch interactions with longline and purse seine fisheries as reported in the ROS regional database

Fishery group	Species category	Initial year	Final year	Total interactions
Longline (n=40,562)	SHARKS	2009	2021	31,956
	RAYS	2009	2021	8,007
	TURTLES	2009	2021	344
	SEABIRDS	2012	2016	176
	CETACEANS	2009	2021	79
Purse seine (n=61,408)	SHARKS	2005	2022	60,747
	RAYS	2005	2022	435
	TURTLES	2006	2022	226

## Morphometric data

The current length-length and length-weight [IOTC reference relationships](#) for pelagic sharks mostly come from historical data collected in the Atlantic Ocean or Western-Central Pacific Ocean ([Skomal and Natanson 2003](#); [Francis and Duffy 2005](#)). However, several morphometric data sets have been collected for sharks through different research and monitoring programs conducted in the Indian Ocean over the last decades, including measurements taken at sea and on land ([Garcia-Cortés and Mejuto 2002](#); [Ariz et al. 2007](#); [Romanov and Romanova 2009](#); [Espino et al. 2010](#); [Filmlalter et al. 2012](#)). Hence, different statistical relationships have been established for several Indian Ocean pelagic sharks based on data that may cover different size ranges as well as different areas and time periods ([Appendix I](#)).

## Methods

### Data available for bycatch species

The data reporting requirements for bycatch species vary according to species categories and fishing gears, and changed over time with the adoption of new resolutions (Fig. 1).

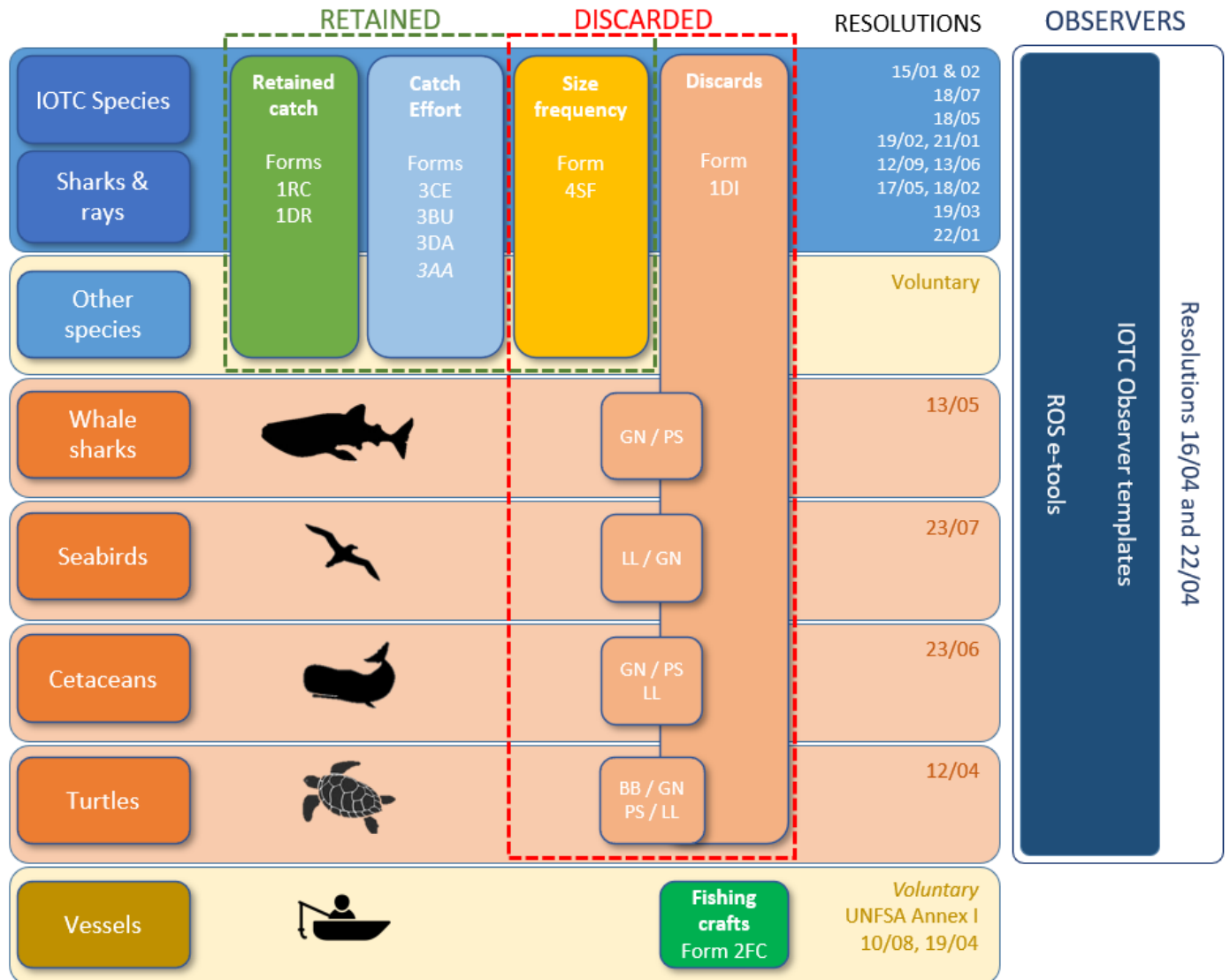


Figure 1: Overview of the data reporting requirements, including IOTC reporting forms and tools, and Resolutions for the 16 IOTC species and bycatch species caught or interacted with by fisheries for tuna and tuna-like species in the IOTC area of competence. BB = Baitboat; GN = Gillnet; LL = Longline; PS = Purse seine. \* applies to CPCs that have objected to Res. 21/01.

**Table 2** lists the most common bycatch species with mandatory reporting requirements, as well as any other species for which reporting is encouraged, and summarises those bycatch species identified by the Commission as relevant for the most common gears ([IOTC Res. 15/01](#)).

Table 2: List of bycatch species of concern to the IOTC and reporting requirements by type of fishery for purse seine (PS), longline (LL), gillnet (GN), baitboat (BB), hand line (HL) and troll line (TR). Red indicates the primary species of concern and orange the optional species for which reporting is encouraged. \* indicates that the Resolution only concerns fishing vessels on the IOTC Record of Authorised Vessels

Common name	Species code(s)	Resolution	PS	LL	GN	BB	HL	TR
Blue shark	BSH	18/02						
Mako sharks	MAK; SMA; LMA	15/01						
Porbeagle	POR	15/01						
Hammerhead sharks	SPN; SPL; SPK; SPZ	15/01						
Whale shark	RHN	13/05						
Thresher sharks	THR; PTH; ALV; BTH	12/09*						
Oceanic whitetip shark	OCS	13/06*						
Crocodile shark	PSK	15/01						
Silky shark	FAL	15/01						
Tiger shark	TIG	15/01						
Great white shark	WSH	15/01						
Pelagic stingray	PSL	15/01						
Mobula nei	RMV; RMB; RMM	19/03						
Other sharks	SKH	15/01						
Rays, stingrays, mantas	SRX	15/01						
Other marine fish nei	MZZ	15/01						
Marine turtles	Table 13	12/04						
Cetaceans	Table 14, 15	23/06						
Seabirds	Table 16	23/07						

The present report is based on the compilation of information derived from the data sets of bycatch species referenced in the Resolutions listed in **Table 2** that were reported to the Secretariat, i.e.:

- Retained catch data for shark and ray species, including those reported as species aggregates;
- Catch and effort data for shark and ray species, including those reported as species aggregates;
- Size-frequency data for shark and ray species;
- Information on discards for shark and ray species available from the ROS;

- Fishery interactions with marine turtles, cetaceans, and seabirds derived from the ROS.

Retained catch data for bycatch species should be considered with caution, due to several reasons (see Section [Uncertainties in shark and ray catch data](#)) that include the historically low reporting rates and a tendency to report catches for aggregated shark and ray species. Furthermore, catches of some shark and ray species that interact with coastal fisheries targeting other species than tuna and tuna-like ones may not be reported to the IOTC. In addition, catches that have been reported are thought to represent only those species that are retained onboard, without taking into account discarded individuals. Finally, in many cases, the reported catches refer to dressed weights while no information is provided on the type of processing undertaken, creating more uncertainty in the estimates of catches in live weight equivalents.

Information available on the estimates of total discards collated through IOTC form 1DI was not used in the present report as the data are currently very limited, often provided using heterogeneous formats (not fully compliant with IOTC standards) which do not include several metadata fields (e.g., reason for discard, fate) as well as the detailed information on sampling coverage and raising procedures adopted (if any).

## Data processing

The preparation of the curated [public-domain data sets](#) for bycatch species follows three main data processing steps which are briefly summarized below.

First, standard controls and checks are performed to ensure that the metadata and data submitted to the Secretariat are consistent and include all mandatory fields (e.g., dimensions of the strata, etc.). The controls depend on each data set and may require the submission of revised data from CPCs if the original ones are found to be incomplete.

Second, when retained catches are not reported by a CPC, catch data from the previous year may be repeated or derived from a range of sources, e.g., the [FAO FishStat database](#). In addition, for some specific fisheries characterized by well-known, outstanding issues in terms of data quality, a process of re-estimation of species and/or gear composition may be performed based on data available from other years or areas, or by using proxy fleets, i.e., fleets occurring in the same strata which are assumed to have a very similar catch composition (Moreno et al. (2012)).

Finally, filtering and conversions are applied to the size data reported for the most common shark and ray species in order to harmonize their format and structure, and remove data which are non-compliant with IOTC standards, e.g., provided with size bins exceeding the maximum width considered meaningful for the species (IOTC 2020). All samples collected using types of measurement other than fork length (FL; straight distance from the tip of the upper snout to the fork of the tail) are converted into FL by using the [IOTC equations](#) and binned by constant intervals of 5 cm in size. If no IOTC-endorsed equations exist to convert from a given length measurement for a species to the standard FL measurement, the original size-frequency data are not disseminated although they are kept within the IOTC databases for future reference.

## Results

### Overall bycatch levels & trends

Reported retained catches of species of interest to the WPEB are largely dominated by sharks with estimates from some artisanal fisheries dating back to the early 1950s (**Fig. 2**). Overall levels and quality of reported catches of shark and ray species have increased over time due to the development and expansion of tuna and tuna-like fisheries across the Indian Ocean, the increased reporting requirements for some sensitive species such as thresher and oceanic whitetip sharks. In 2022, the total retained catches of sharks reported to the Secretariat amounted to 80,263 t, with rays representing a very small component of the reported bycatch at 1,528 t, i.e., about 1.9% of total reported shark and ray catches for the same year (**Fig. 2**).

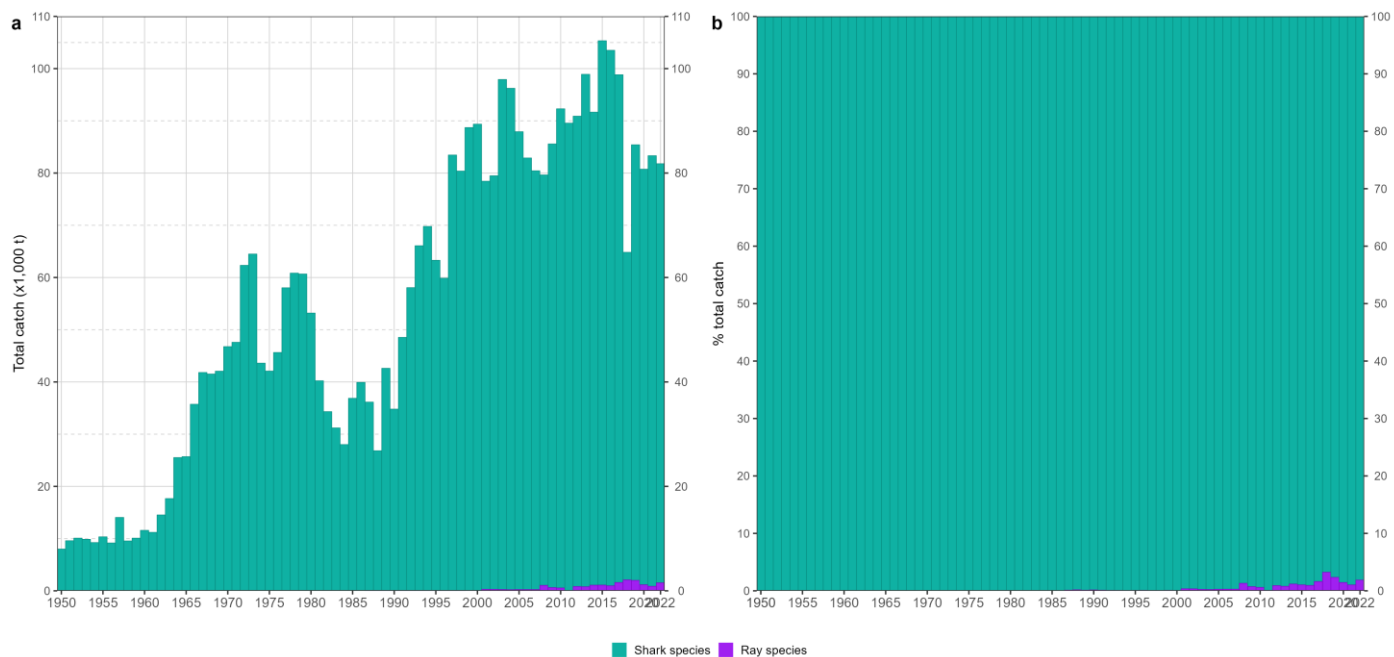


Figure 2: Annual cumulative absolute (a) and relative (b) time series of retained catches (metric tonnes; t) of shark and ray species by species category for the period 1950-2022

Very few fleets reported catches of sharks and rays in the 1950s, but the number of reporting fleets has increased over time (**Fig. 3**). Total reported catches of sharks and rays have also increased over time, reaching a recent peak of over 100,000 t in 2015-2016. Since then, retained catches have decreased to about 80,000 t in 2022.

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

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

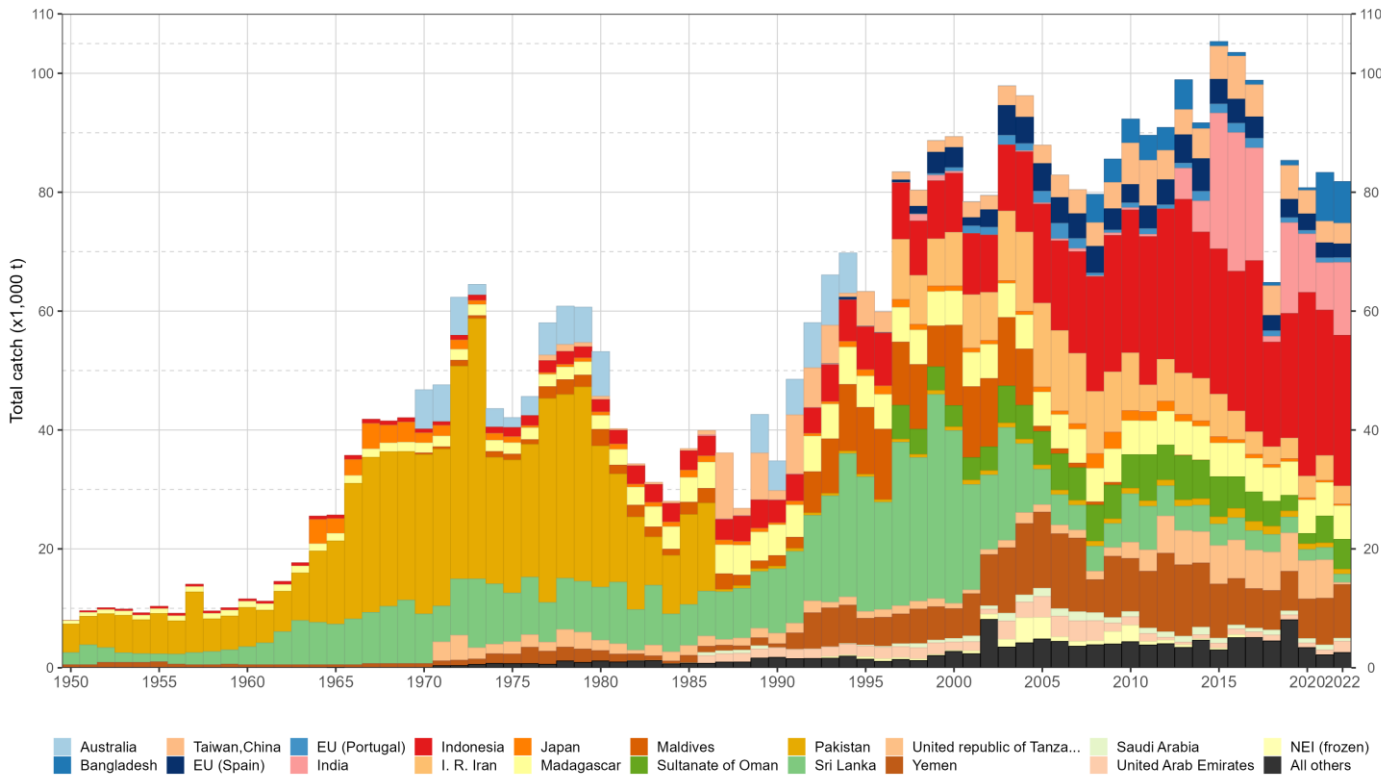


Figure 3: Annual time series of retained catches (metric tonnes; t) of sharks and rays by fleet during 1950-2022



## Sharks and rays

### Vulnerability to fisheries

Levels of reported retained catches for sharks and rays strongly vary with fishing gear and over time but are generally increasing. Gillnets (not further classified) have historically been associated with the highest catch levels and are currently responsible for around 34% of all retained catches reported for the species, while lines (handlines, coastal longlines and trolling lines), which doubled the catches in the last two decades, currently contribute for around 45.2% of the total retained catches (**Table 3**). Historically, longline fisheries contributed substantially to shark and ray catches from 1990 onwards and in recent years they rank as the third most relevant group of gears in terms of total retained catch levels reported for the species (**Fig. 4**).

Table 3: Retained catches (metric tonnes; t) of shark and ray species by decade and fishery for the period 1950-2022. The background intensity color of each cell is directly proportional to the catch level

FISHERY	1950s	1960s	1970s	1980s	1990s	2000s	2010s	2020s
Purse seine   Other	0	4	0	0	0	24	361	380
Longline   Other	0	0	0	680	7,341	11,552	8,331	4,544
Longline   Fresh	0	0	48	187	1,697	2,980	3,350	2,152
Longline   Deep-freezing	0	3,333	1,634	1,843	4,251	5,051	6,971	3,890
Line   Coastal longline	0	0	0	3,454	5,702	12,003	21,988	26,295
Line   Trolling	783	1,262	2,379	4,168	6,220	6,239	9,440	9,404
Line   Handline	1,184	4,033	5,348	4,735	3,605	1,910	3,993	2,203
Baitboat	0	0	0	0	0	0	20	2
Gillnet	8,036	19,439	37,966	19,803	22,798	36,084	35,745	27,928
Other	0	0	5,846	4,198	13,684	9,960	1,941	5,158
<b>Total</b>	<b>10,003</b>	<b>28,071</b>	<b>53,220</b>	<b>39,066</b>	<b>65,298</b>	<b>85,802</b>	<b>92,140</b>	<b>81,954</b>

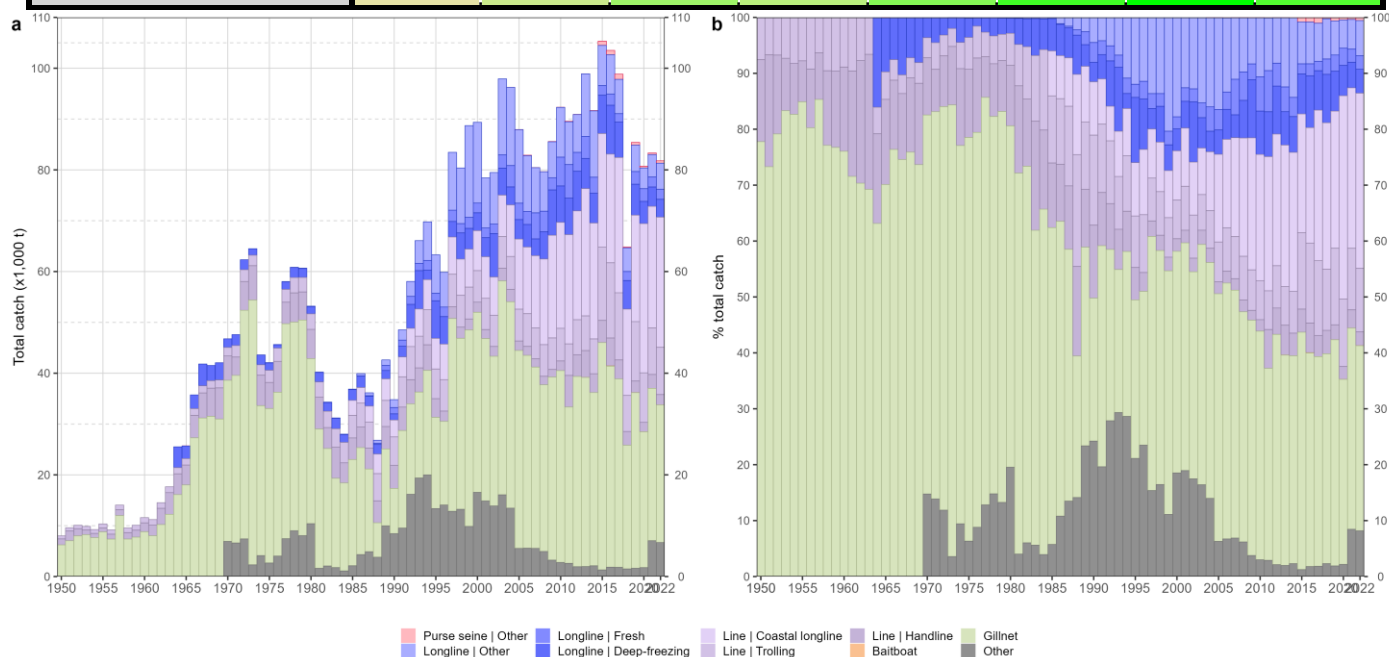


Figure 4: Annual absolute (a) and relative (b) time series of retained catches (metric tonnes; t) of sharks and rays by fishery for the period 1950-2022. 'Other' corresponds to all other fisheries combined

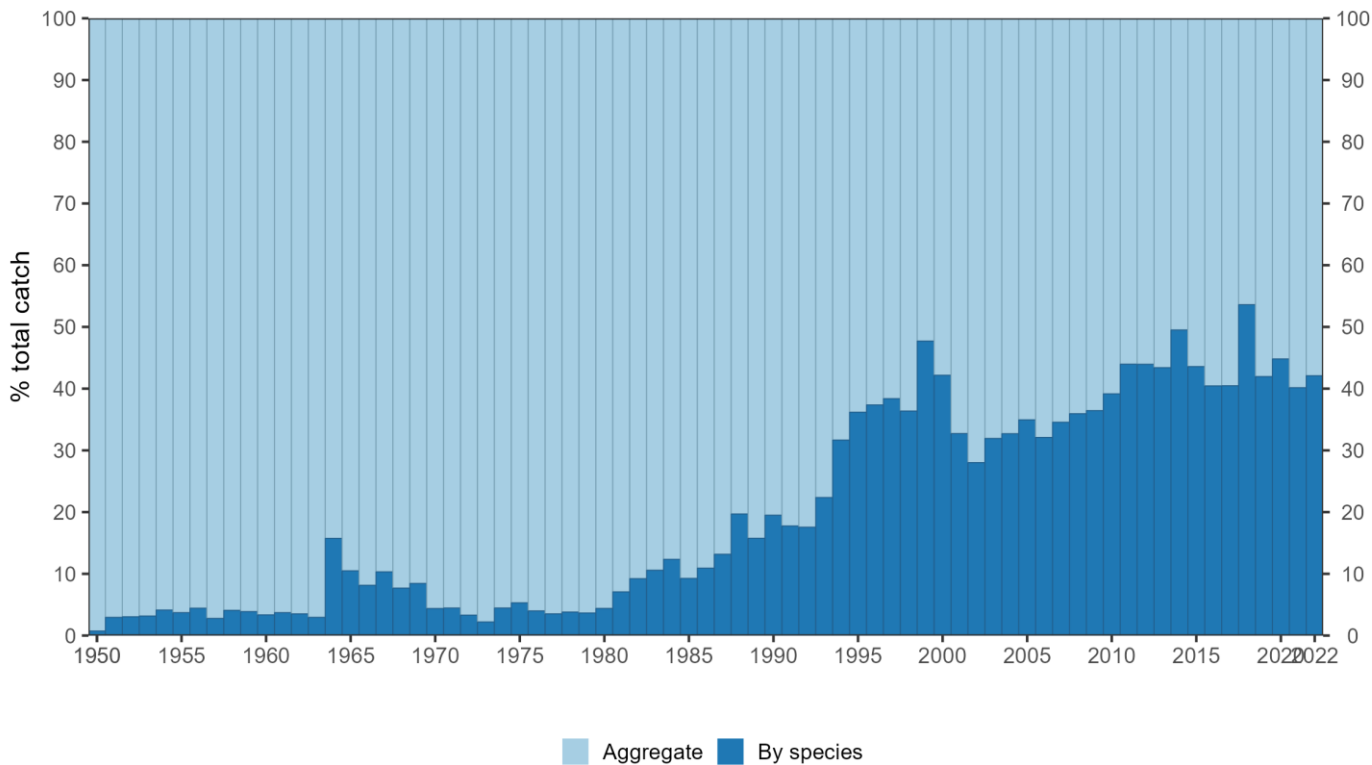


Figure 5: Annual breakdown (percentage; %) between shark and ray catches reported at species level and lower resolution (i.e., aggregate) level

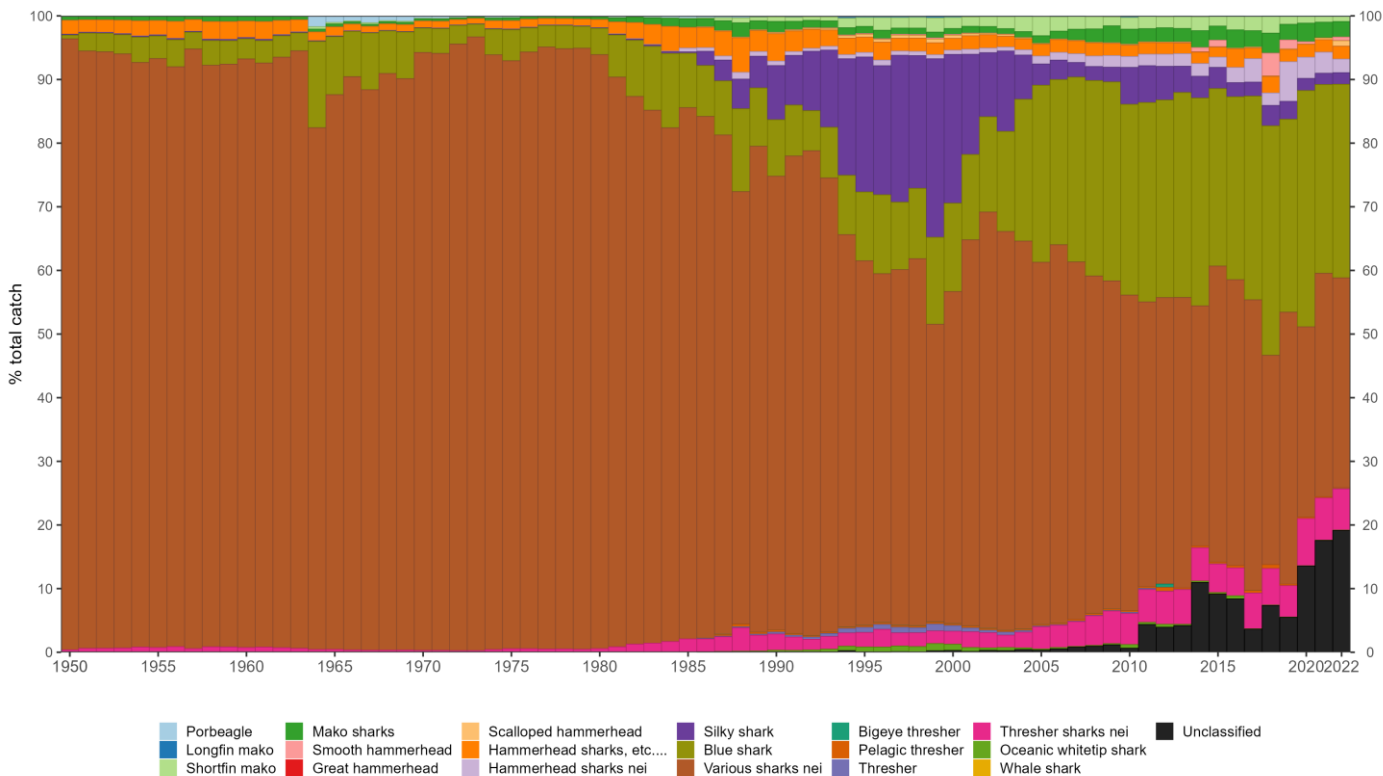


Figure 6: Annual percentage (%) of shark catches reported at species and lower resolution (i.e., aggregate) level. Unclassified = all other shark species not displayed in legend

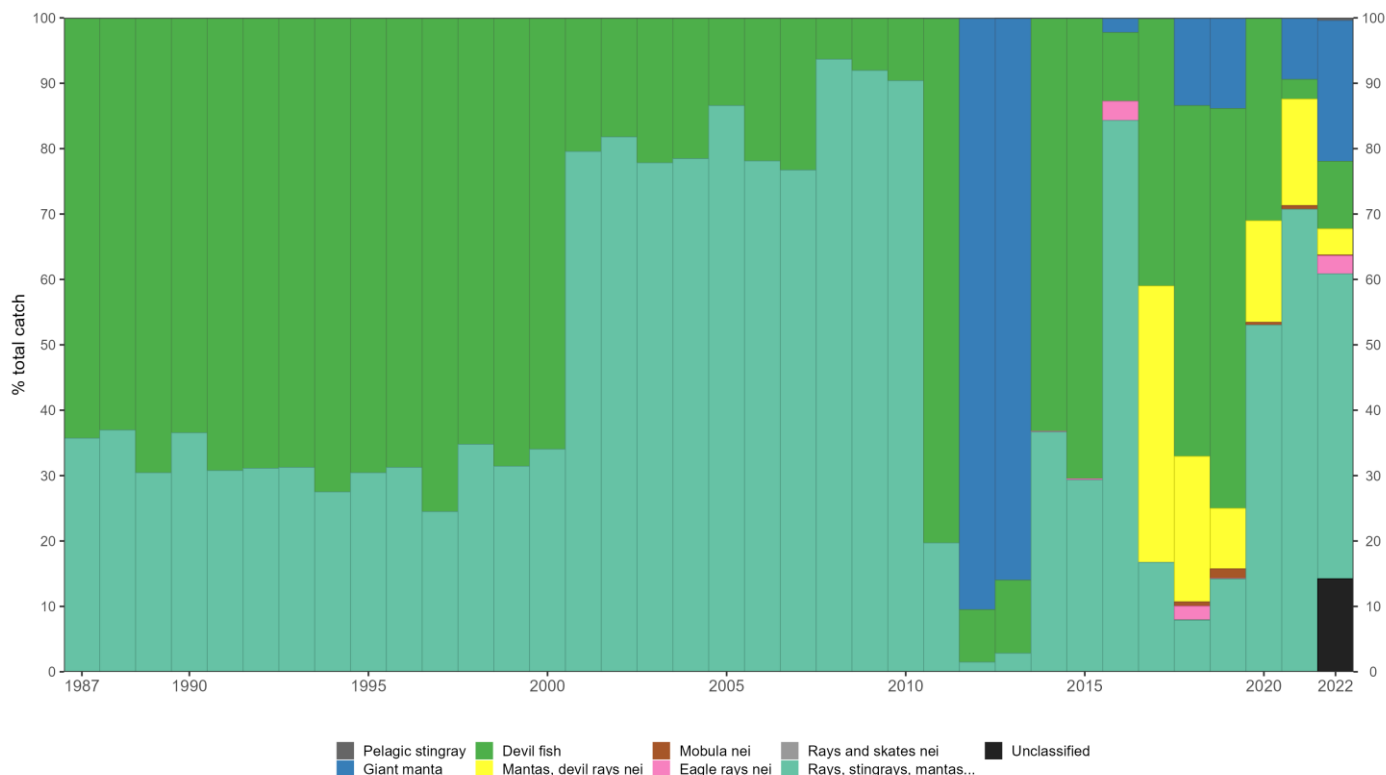


Figure 7: Annual percentage (%) of ray catches reported at species and lower resolution (i.e., aggregate) level

The significant reduction in the percentage of catches of aggregated shark species observed in 2018 (when they went down to represent 45% of total shark catches for the year) is mainly due to India not reporting the usual level of annual catches for this species component. However, from 2019 onwards Indian fisheries (and gillnet in particular) began reporting almost exclusively unclassified shark species, with a peak of 15,000 t recorded in 2019 for this species aggregate.

Of the 55 shark and ray species reported at the species level in either the retained catch or ROS data ([Appendix II](#)), blue shark (BSH) contributes to the large majority, comprising about 63% of catches during 1950-2022. Over the entire period covered by the time series, silky shark (FAL) and shortfin mako shark (SMA) represented 22% and 4% of total catches of sharks and rays reported at species level, with all remaining species combined representing a small percentage overall.

When catches for shark species reported at the genus level are considered, i.e. when including catches reported for the [ASFIS](#) codes SPN (hammerhead sharks - *Sphyrna* spp.), THR (thresher sharks - *Alopias* spp.), and MAK (mako sharks - *Isurus* spp), the overall contribution of blue shark decreases to 50% over the period considered. The genera *Sphyrna* (SPK, SPL, SPN, SPZ), *Alopias* (ALV, BTH, PTH, THR), and *Isurus* (MAK, SMA, LMA) contribute to about 5%, 10%, and 8% of the total shark and ray catches reported at species and genus level, respectively (**Fig. 8**).

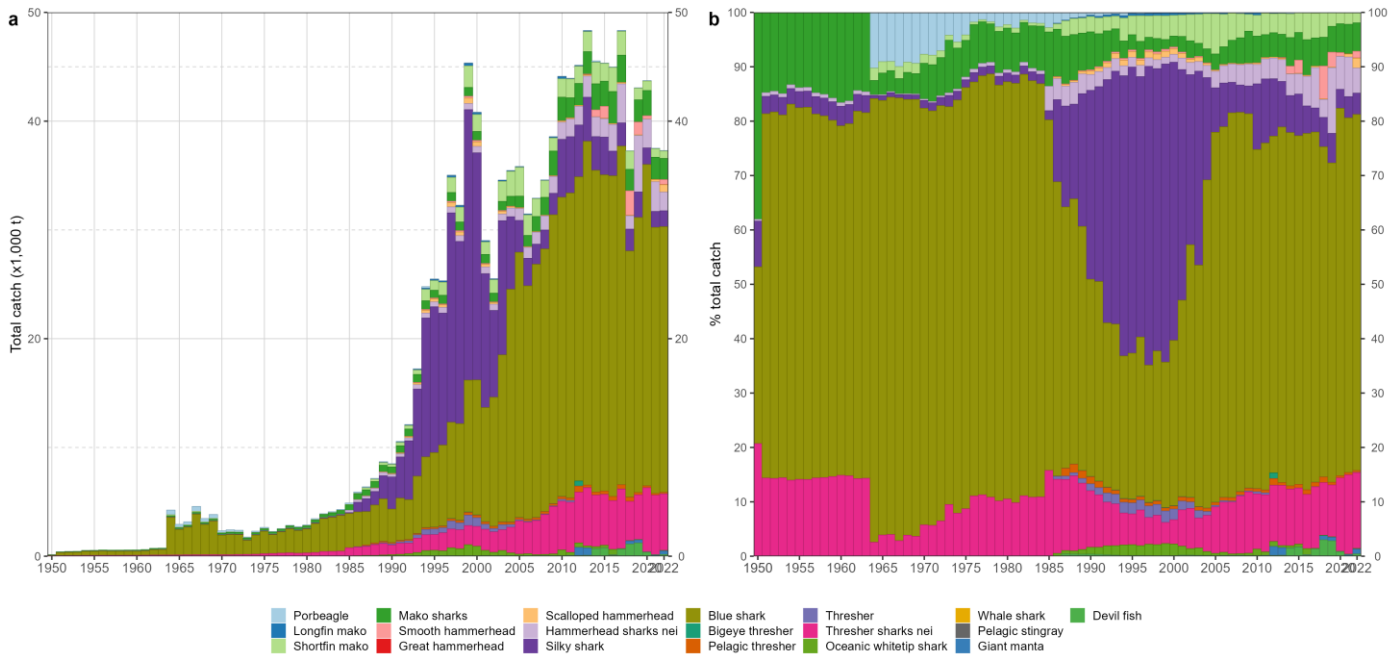


Figure 8: Annual absolute (a) and relative (b) time series of retained catches (metric tonnes; t) of sharks and rays by species, for the catch component of the main sharks and rays reported at species and genus level for the period 1950-2022

Longline fleets predominantly reported catches of blue shark, followed by mako and silky sharks, with catches of handline gears also being dominated by blue shark, followed by thresher sharks. Purse seine catches are dominated by silky shark while trolling lines reported relatively high catches of hammerhead sharks. Reporting by species is very uncommon for gillnet fleets, where the majority of shark catches are reported as aggregates.

### Recent fishery features (2018-2022)

Overall, catches from longline fisheries showed a decrease between 2018 and 2022 (**Fig. 9c**). In the case of line fisheries, Indonesia's catches have increased in recent years. India and Oman also increased their catches slightly in 2022 (**Fig. 9a**). Catches of sharks and rays retained in gillnets increased last year for Yemen and Indonesia. For Tanzania, in the absence of data officially reported to the Secretariat, they were estimated to have remained constant (**Fig. 9b**).

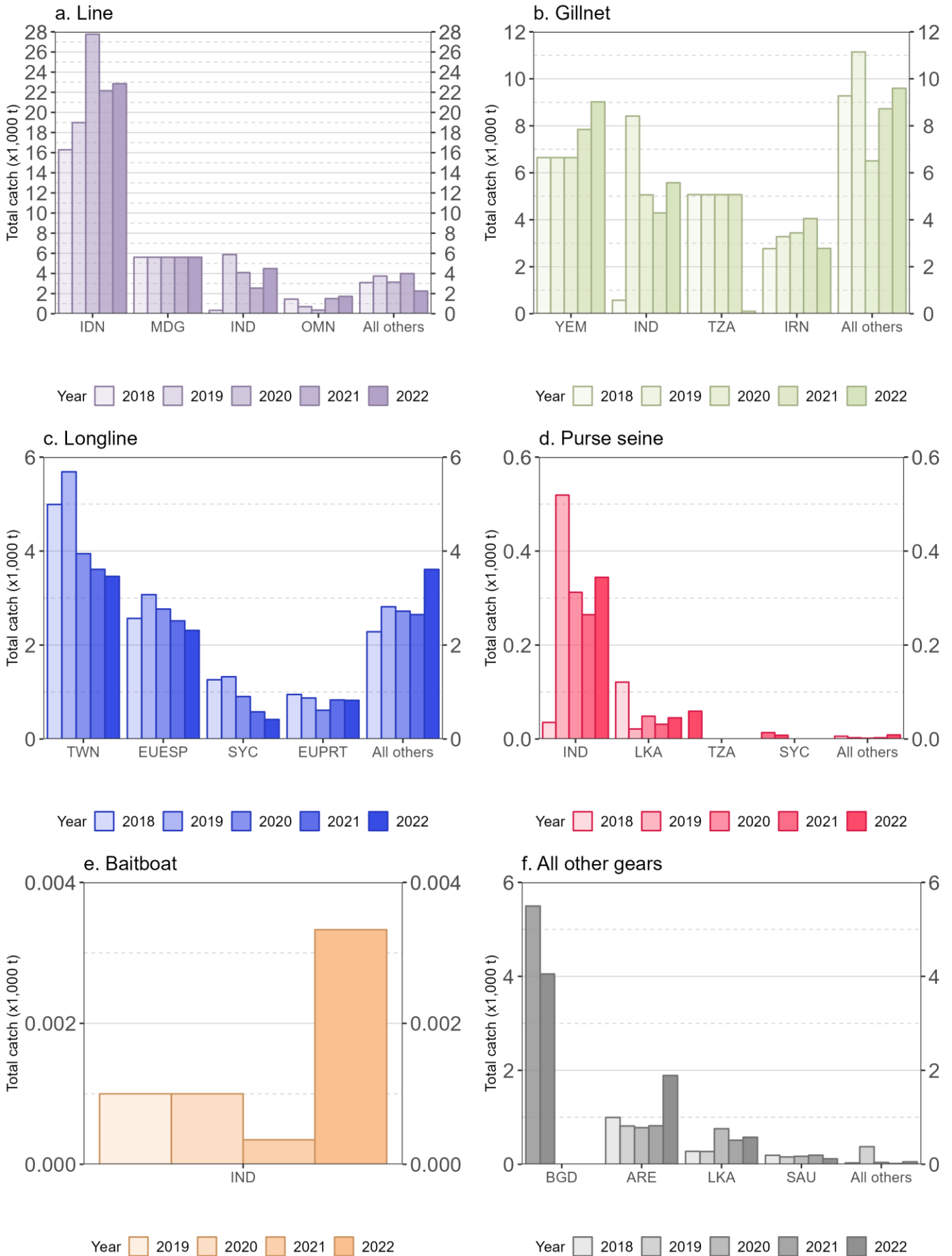


Figure 9: Annual catch trends (metric tonnes; t) of shark and ray species by fishery group between for the period 2018-2022

During 2018-2022, Indonesian fisheries contributed an average of about 30% of total retained catches of sharks and rays, with a mean annual catch estimated at about 24,000 t and mainly accounted for by coastal longliners (**Fig. 10**). India also accounts for relatively high levels of catches of sharks (8,000-15,000 t per year, excluding 2018) which were mainly caught by gillnets and trolling lines. Both fleets combined account for 42% of the total catch in recent years, with retained catches of sharks from the coastal fisheries of Yemen and Tanzania (i.e., gillnets, hand lines and trolling lines) also thought to be important yet highly uncertain.

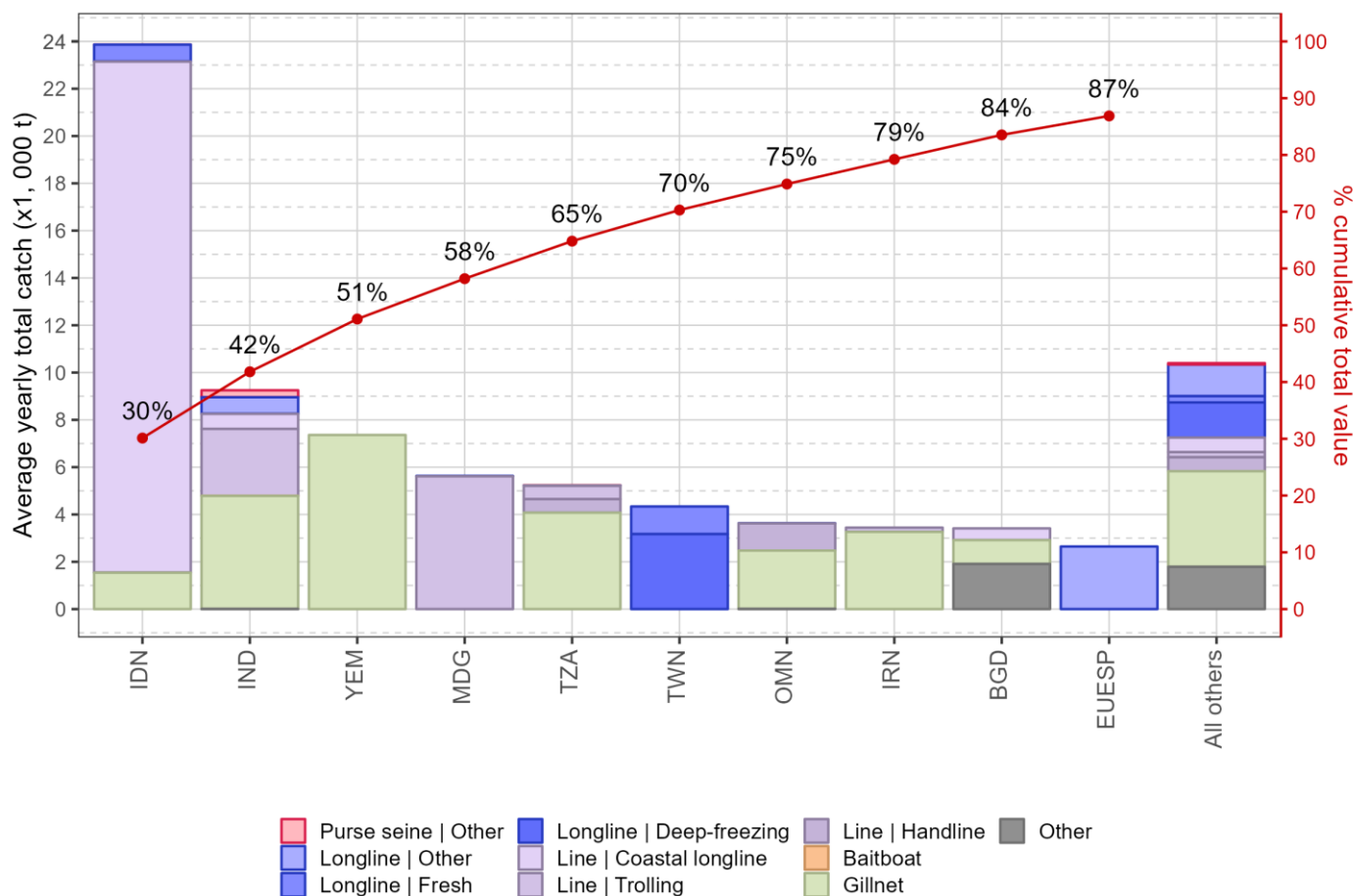


Figure 10: Mean annual retained catches (metric tonnes; t) of sharks and rays over the period 2018-2022 by fishery and fleet ordered according to the importance of catches. The solid line indicates the cumulative percentage of the total combined catches of the species for the fleets concerned

## Discarding practices

### Longline fisheries

In the absence of data on total discard for most fisheries (see section [Uncertainties in catch data](#)), information on discarding practices can only be inferred from observer data collected through the ROS programme. However, the distribution of shark interactions with pelagic longline fisheries available through the ROS data for the period 2009-2021 only covers a small part of the longline fishing grounds (**Fig. 11**). This is mainly due to the unavailability (in a format suitable for analysis) of observer data from major longline fisheries such as Taiwan, China, China, EU, Spain, EU, Portugal, Seychelles, and Korea as well as to an almost complete lack of observer data from minor longline fisheries. 4% of the interactions in this data set refers to species reported in aggregate form (e.g., “various sharks NEI”). Furthermore, information on fate and condition at release is lacking for more than 2% and 15% of the recorded interactions, respectively.

It is also important to highlight how restrictions following the onset of the CoViD pandemic have had a huge impact on the number of observers deployed onboard during 2020 and 2021, therefore reducing the coverage of the information available in the ROS database.

Nevertheless, and on the basis of the data currently available to the ROS, the species composition of longline catches appears to vary between the western and eastern parts of the Indian Ocean, although blue shark dominates the catches in both areas (**Fig. 11a**). Most sharks are discarded at sea and the fate of the species seems to depend on the fishery and fishing grounds, with the majority of individuals being discarded when caught around Reunion Island and Madagascar (as well as in the eastern Indian Ocean, to a lesser extent) and retained when caught in the waters off South Africa (**Fig. 11c**). Information collected by the observers on the condition at release indicates that about 44% of all sharks discarded at sea were alive: little information is known about post-release survival rates in Indian Ocean longline fisheries but experiments conducted in other oceans with satellite tags have shown that the mortality of the most common sharks discarded at sea varies around 15-20% ([Musyl and Gilman 2018](#); [Schaefer et al. 2021](#)).

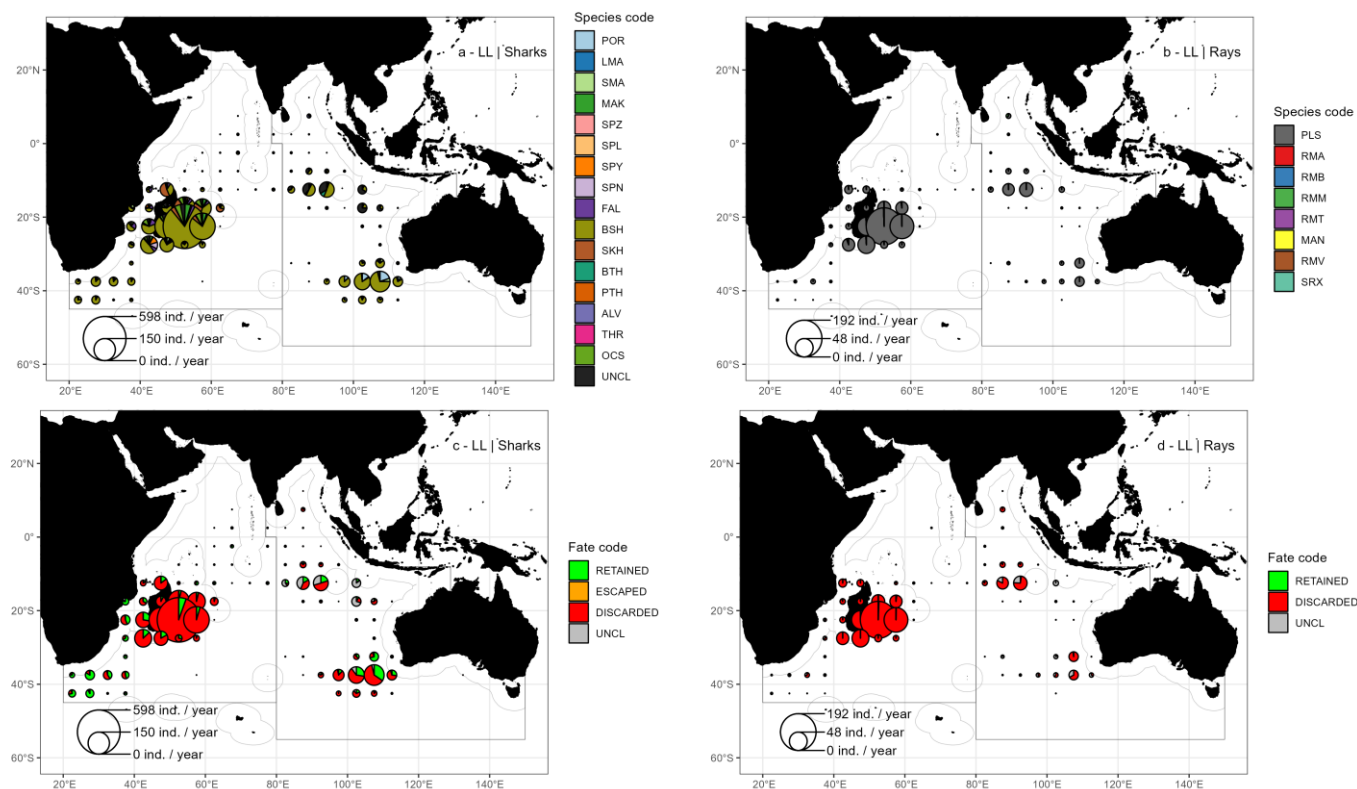


Figure 11: Mean annual number of shark and ray interactions (numbers of individuals per year) with deep-freezing longline fisheries by species (a & b) and fate (c & d) as reported to the Secretariat during the period 2005-2022

Pelagic stingray largely dominates the longline catches of rays by contributing to 99% of all rays' interactions reported as observed at sea (**Fig. 11b**). A large majority of these individuals is reported as being discarded at sea, with less than 50% of the individuals being released alive (**Fig. 11d**).

Observer data collected onboard purse seiners show the large dominance of silky shark interactions, which represent 97% of all shark interactions recorded by the fishery in the data available to the Secretariat for the period 2005-2022 (**Fig. 12a**). Oceanic whitetip shark comes second with about 1.5% of all shark interactions for the fishery, while most reports of bycatch of bull sharks might be due to errors in species identification. In this fishery, most sharks are discarded at sea (**Fig. 12c**) following the guidelines and best practices developed over the last decade by the fishing companies ([Poisson et al. 2014b](#); [Grande et al. 2019](#)) and the overall mortality rate of silky sharks caught with purse seine in the Indian Ocean has been estimated to be at around 80%, including a mortality rate of about 50% for the sharks released alive ([Poisson et al. 2014a](#)).

Overall, few interactions with rays are observed in the purse seine fishery (**Fig. 12b**) and almost all rays are discarded at sea (**Fig. 12d**). As for longline, pelagic stingray is the dominant species with a total of 162 interactions reported. Among the pelagic stingrays for which the condition at release was known and recorded, the percentage of dead individuals was more than 60%, an apparent mortality rate (i.e. excluding the additional mortality after release) consistent with that reported for this species from a larger observer data set collected onboard the EU and associated purse seine fishery ([Clavareau et al. 2020](#)).



Purse seine interactions with mobulid rays, i.e., reef manta (RMA), giant manta (RMB), spinetail mobula (RMJ), devil fish (RMM), and Chilean devil ray (RMT) also occur in the Indian Ocean ([Martin 2020](#)), with an apparent mortality of about 35% among the 188 mobulid rays reported with a known condition at release.

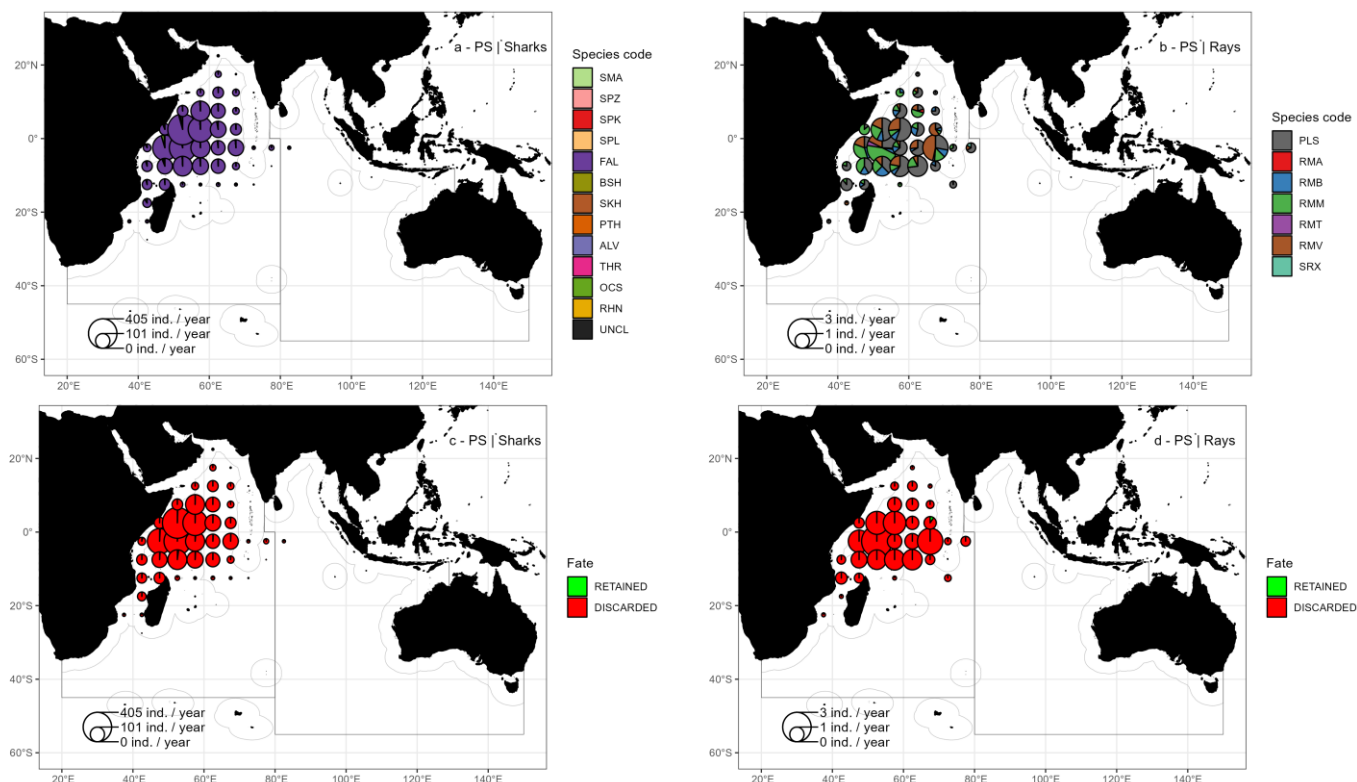


Figure 12: Mean annual number of shark and ray interactions (numbers of individuals per year) with large-scale purse seine fisheries by species (a & b) and fate (c & d) as reported to the Secretariat during the period 2005-2022

### Size composition of the catch

There are two major reporting sources of size data for sharks and rays:

- 1) length/weight data by species, stratified by year, fleet, type of fishery, month, and 5x5 degrees grid, as per IOTC [Res. 15/02](#) and to be reported according to the IOTC guidelines and through the recommended [form 4SF](#), and
- 2) length/weight data collected through the Regional Observer Scheme programme ([Res. 11/04](#)).

Size data can be collected at sea by fishers or observers and at landing sites by staff from research institutions or the industry, and no size data derived from the analysis of pictures or videos collected through Electronic Monitoring systems has been yet reported as such to the IOTC Secretariat.

[Res. 15/02](#) states that “size data for longline fleets may be provided as part of the Regional Observer Scheme where such fleets have at least 5% observer coverage of all fishing operations”. Size data collected by observers could then have been reported twice to the Secretariat, although at different levels of spatio-temporal resolution, i.e., once per year, through regular submissions of fishery statistics stratified by fleet, gear, grid and month, and (when available) through the more detailed ROS data sets, which include information recorded by day / hour and exact location of capture.

The number of size samples for sharks and rays reported according to [Res. 15/02](#) varies greatly between species, fisheries, and fleets, with 17% of all available samples collected by observers at sea. Blue sharks, which are mainly caught with longlines, represent 80% of all size samples (n = 294,629). About 15,000 size samples are available for shortfin mako and silky shark, while the number of samples decreases dramatically for the other shark species and almost no size sample is available for rays (**Table 4**).



Also, a total of 24,786 samples have been reported for species groups (SKH, MSK, MAK, THR), which is of limited use when the species composition of the aggregates is unknown.

Table 4: Total number of fish size samples collected as per Res. 15/02 and reported at species level for shark and ray species covering the period 2005-2022 through IOTC forms 4SF or equivalent. Only species with more than 20 samples are shown.

Species		Year		Number of samples			
Code	Name	From	To	Logbooks	Observers	Total	% Logbooks
BSH	Blue shark	2005	2022	243,447	51,182	294,629	82.63
FAL	Silky shark	2005	2022	23,808	1,868	25,676	92.72
SMA	Shortfin mako	2005	2022	11,645	4,189	15,834	73.54
POR	Porbeagle	2007	2022	623	2,157	2,780	22.41
CCL	Blacktip shark	2007	2022	2,092	0	2,092	100.00
ALV	Thresher	2017	2022	1,651	0	1,651	100.00
OCS	Oceanic whitetip shark	2007	2022	280	243	523	53.54
PLS	Pelagic stingray	2013	2022	451	56	507	88.95
BLR	Blacktip reef shark	2007	2021	351	0	351	100.00
SPL	Scalloped hammerhead	2007	2022	290	4	294	98.64
BTH	Bigeye thresher	2005	2022	98	97	195	50.26
PTH	Pelagic thresher	2013	2022	157	9	166	94.58
PSK	Crocodile shark	2007	2022	29	127	156	18.59
SPZ	Smooth hammerhead	2016	2021	65	2	67	97.01
DUS	Dusky shark	2015	2015	56	0	56	100.00
LMA	Longfin mako	2007	2022	3	36	39	7.69
ALS	Silvertip shark	2016	2022	23	2	25	92.00
WSH	Great white shark	2019	2022	22	0	22	100.00

For the shark species with a substantial sample size, fork length distributions show strong variability and spikes for some fisheries, particularly in the data collected for blue sharks by longline fisheries other than “deep-freezing” and “fresh”, i.e., those targeting swordfish and sharks (**Fig 13**). Size data from deep-freezing longliners are consistent between observer and non-observer data for both blue shark (BSH) and porbeagle (POR), indicating a median fork length of about 170 cm (i.e., ~30.7 kg) and 90 cm (i.e., ~9.2 kg), respectively (**Fig 13a-b**). Blue sharks caught by coastal longliners of Sri Lanka and Indonesia are dominated by small sharks, described by a median fork length of about 120 cm (~10 kg) (**Fig 13a**).

Size data collected for shortfin mako (SMA) by observers onboard deep-freezing longliners show a distribution described by a median fork length of 177.5 cm, which is larger than the median of the sizes collected by other enumerators (162 cm) (**Fig 13c**). Spatial information shows that observer samples for this species mostly come from southern latitudes (south of 20°S) while other size data mainly come from the central and southwestern Indian Ocean,

which might explain the differences in distributions beside suggesting some size-dependent variability in the spatio-temporal distribution of shortfin mako that needs further investigation.

Finally, size data collected for silky shark caught with deep-freezing and fresh longline show quite similar distributions described by a median fork length of about 145 cm (~31.9 kg) (**Fig 13d**). Recent information available for silky shark caught by Sri Lankan coastal longliners and gillnetters shows these sharks are smaller than those caught with longline, having a median fork length of about 130 cm (~23.2 kg) and 115 cm (~16.2 kg), respectively.

Few data are available at the IOTC Secretariat for silky sharks caught and discarded at sea by purse seiners: those available indicate that measured individuals are all juveniles with a median fork length of about 90 cm (~7.9 kg). This pattern is confirmed by a larger data set (>20,000 fish) collected onboard EU purse seiners during 2005-2017 which indicates that most silky sharks are caught with purse seine when in association with drifting floating objects and FADs in particular ([Clavareau et al. 2020](#)).

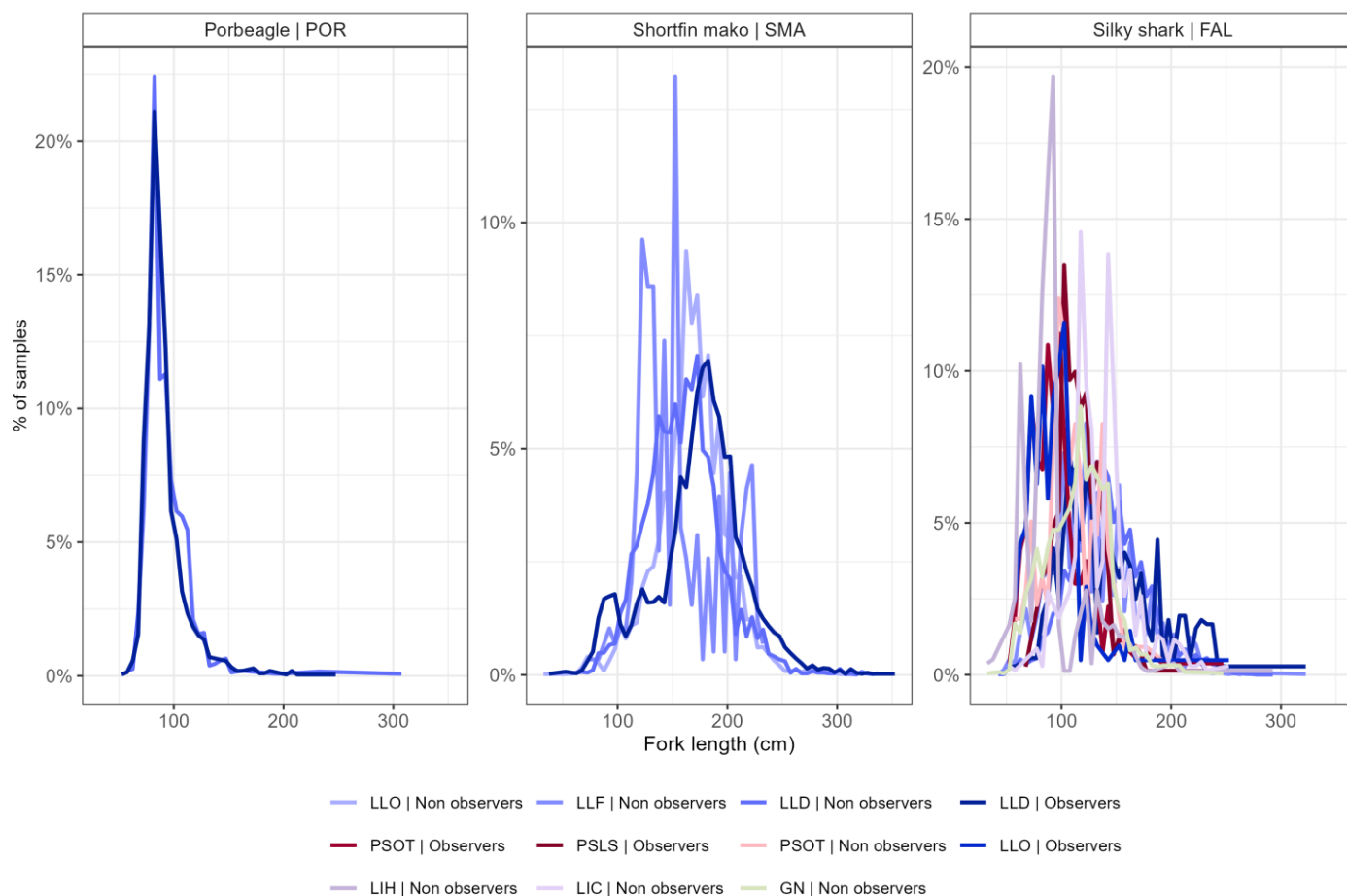


Figure 13: Relative distribution of fork lengths (cm) by 5 cm classes by fishery and source of information (i.e., observers vs. fishers or enumerators) for the four shark species with more than 200 fish samples by fishery available after conversion of raw size data into fork length when required.

There are some major outstanding issues in the reporting of size data:

- **Gillnet fisheries of I.R. Iran and Pakistan:** to date, I.R. Iran and Pakistan have not reported size-frequency data of sharks species caught by their gillnet fisheries;
- **Longline fisheries of India, Malaysia, and Oman:** to date, these countries have seldom or not at all reported size-frequency data of shark species caught by their longline fisheries. In 2018 and 2019 Madagascar reported size-frequency data for blue shark and smooth hammerhead shark, while Indonesia has reported size-frequency data for shark species for their fresh-tuna longline fleet collected by scientific observers (2018) and through logbooks (2019-2021);

- **Coastal fisheries of India, Indonesia, Madagascar, and Yemen:** to date, these countries have seldom or not at all reported size-frequency data for their coastal fisheries. Madagascar reported size-frequency data for blue shark, silky shark, and smooth hammerhead shark for 2018-2020, and Indonesia for blue shark and silky shark for 2019-2020.

Furthermore, the IOTC Secretariat must use length-age keys, length-weight keys, ratios of fin-to-body weight, and processed weight-to-live weight keys for sharks from other oceans due to the limited amount of biological data available: this situation could be potentially addressed in the medium to long term by guaranteeing a consistent increase in scientific observer data submissions according to ROS standards and requirements.

### Spatial information on sharks and rays' catches

Geo-referenced catches of sharks and rays are reported both in number of fish and total weight, and generally represent only a subset of the annual retained catches reported by fleet and gear for each species. Due to the general lack of information on the size composition of the catch, these cannot be converted into a common unit and therefore spatial distribution maps of catches are provided both in numbers and in weight. Overall, the distribution of the catches of sharks and rays shows the increasing improvements of data reporting over time, with data becoming available for more shark and ray species from an increasing number of CPCs and fisheries over the last four decades.

During the 1980s and 1990s, most spatial information available on retained catches of sharks and rays came from longliners of Taiwan, China and Korea, and from gillnetters of Pakistan (Figs. 14-15a-b). All nominal catches reported during the 1980s were aggregated sharks (SKH) while catches started to be reported at species and genus levels throughout the 1990s for blue shark (BSH), oceanic whitetip shark (OCS), silky shark (FAL), shortfin mako (SMA), thresher sharks (THR), and hammerhead sharks (SPN).

During the 2000s, important levels of geo-referenced sharks and rays' catches were reported for the handline fishery of Yemen in addition to the catches taken by longline and gillnet fisheries from several other CPCs (Figs. 15c). The number of CPCs reporting information on geo-referenced retained catches of sharks and rays increased throughout the 2000s and 2010s as well as the proportion of geo-referenced catches reported at species level (Figs. 16-17). In 2022, aggregated species represented around 13% of the total geo-referenced catches reported in number and around 28% of those reported in weight.

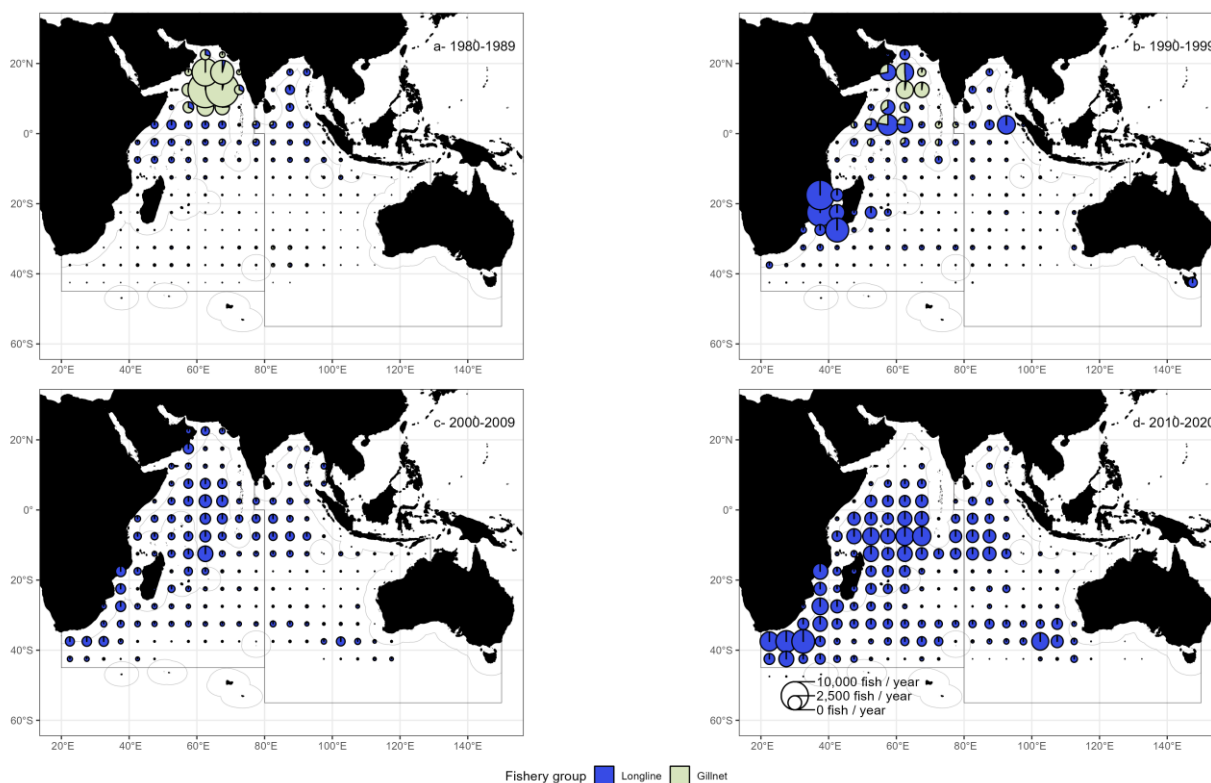


Figure 14: Mean annual retained catches by number of sharks and rays by fishery group and decade reported to the Secretariat covering the period 1980-2020

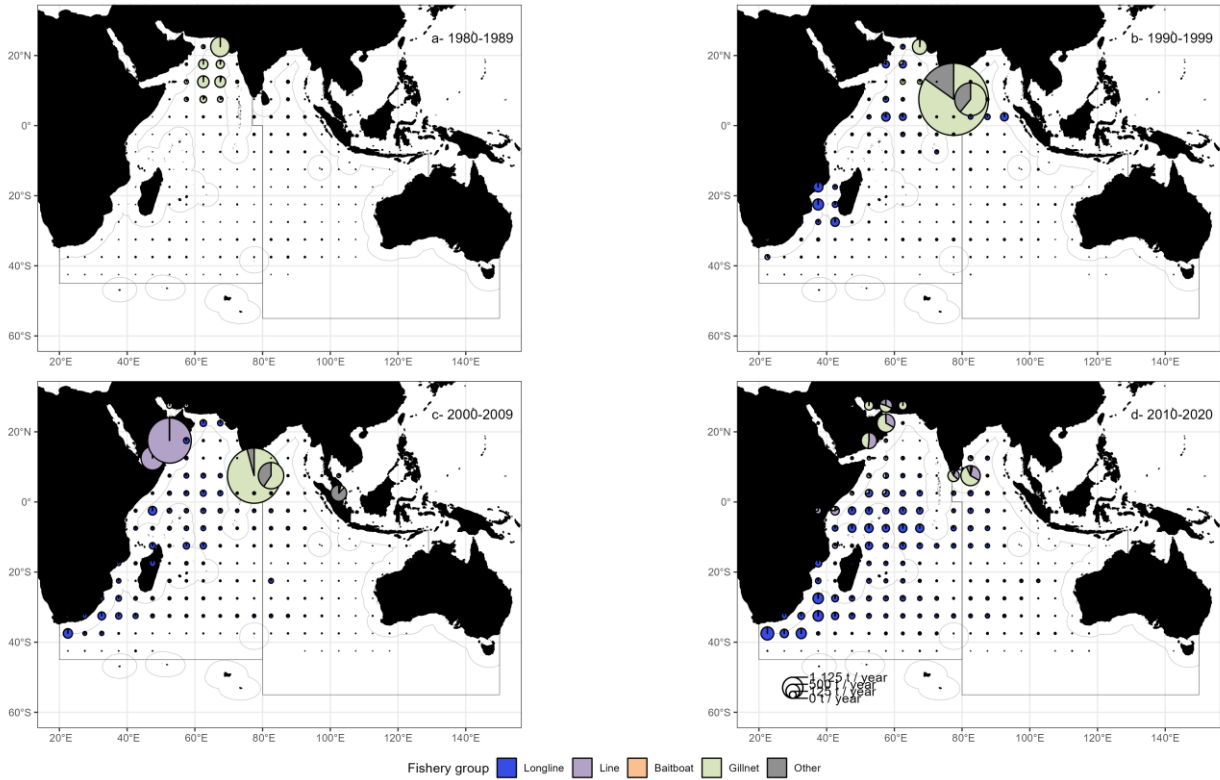


Figure 15: Mean annual retained catches by weight (metric tonnes; t) of sharks and rays by fishery group and decade reported to the Secretariat covering the period 1980-2020

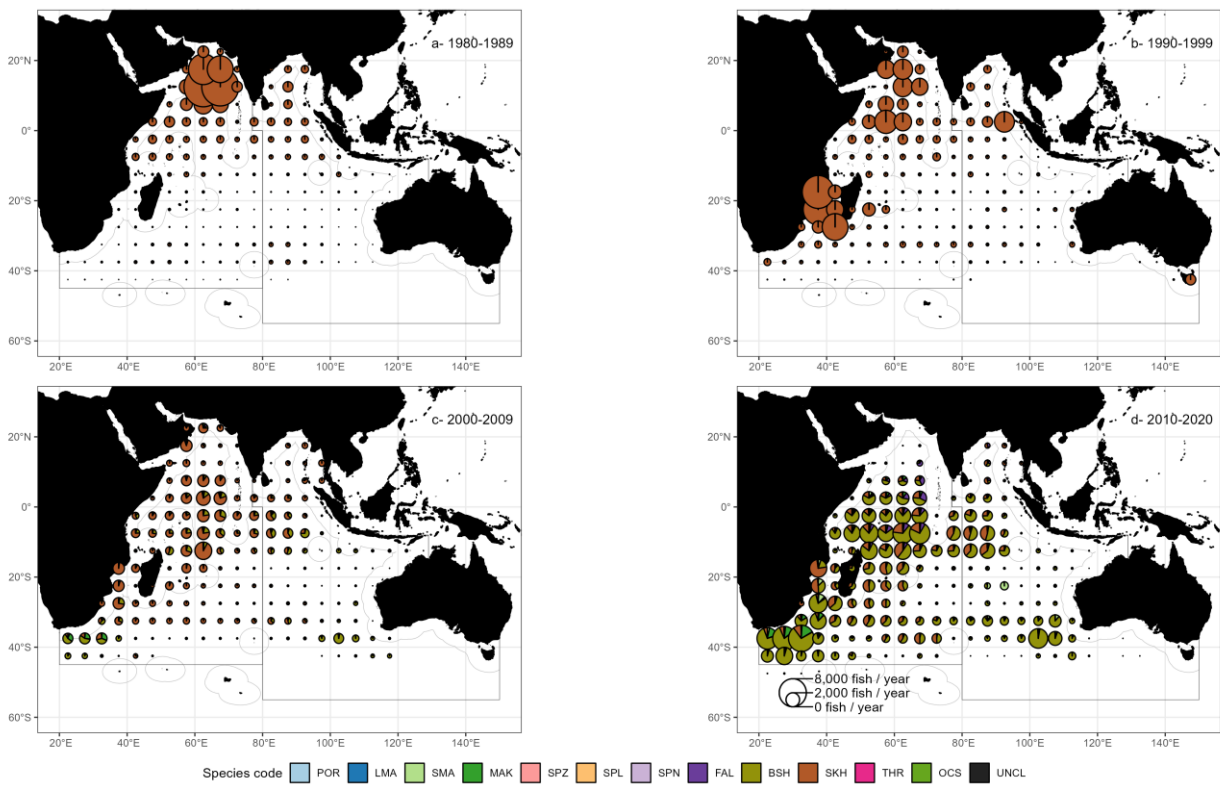


Figure 16: Mean annual retained catches by number of sharks and rays by species and decade reported to the Secretariat covering the period 1980-2020

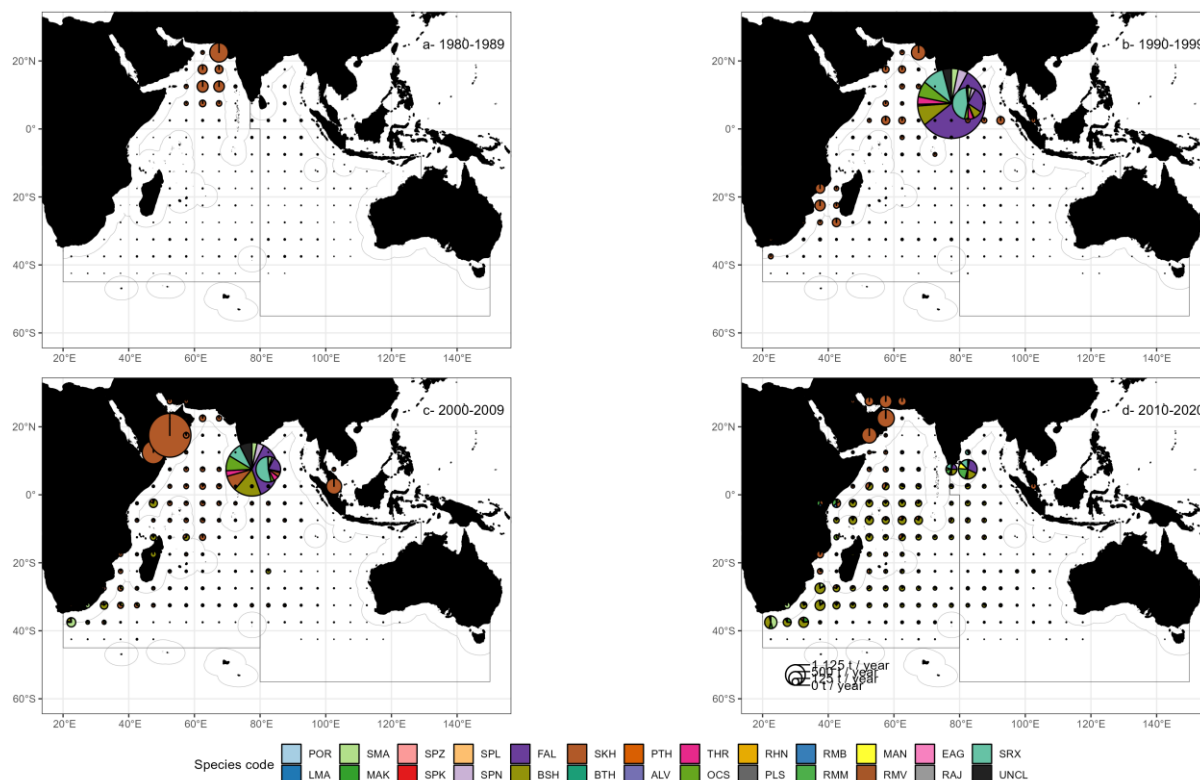


Figure 17: Mean annual retained catches by weight (metric tonnes; t) of sharks and rays by species and decade reported to the Secretariat covering the period 1980-2020. Sri Lanka reported high levels of shark catches during the 1990s

### Uncertainties in catch and effort data

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

#### *Unreported catches*

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

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

#### *Errors in reported catches*

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

Errors are also introduced by the processing of retained catches undertaken at national level: these create further problems in the estimation of total weight or numbers, as sometimes dressed weight might be recorded instead of live

weights. For high levels of processing such as finning, where the carcasses are not retained, the estimation of total live weight is extremely difficult and prone to errors.

#### *Poor data resolution*

Historically, shark catches have not been reported by species but simply as an aggregated total. However, the proportion of catches reported by species has increased substantially in recent years (see section [Historical trends in catches \(1950-2021\)](#)). Misidentification of shark species is also common, and additional data processing might introduce further problems related to proper species identification requiring a high level of expertise and experience to be able to accurately identify specimens. The level of reporting by gear type is much higher, and catches reported as allocated to gear aggregates are now a smaller proportion of the total.

#### *Catch and effort data*

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

The main issues with shark data affecting the information sets available to the IOTC Secretariat vary with gear and fleet:

- **Gillnet fisheries**
  - **Driftnet fishery of Taiwan,China (1982–92):** data not reported to IOTC standards (no species-specific catches);
  - **Gillnet fisheries of Pakistan:** revised nominal catches with species-specific shark data have been provided from 1987 onward (although reports of catches for “various sharks NEI” are still present). Catch levels of shark species decrease dramatically with the revised time series (to levels which are practically negligible compared to years prior to 1987). Furthermore, spatially disaggregated catch-and-effort data have never been provided, if not for a very limited number of years (1987-1991);
  - **Gillnet fisheries of I.R. Iran:** spatially disaggregated catch-and-effort data are now available from 2007 onwards, although not fully reported to IOTC standards as they do not include data for distinct shark species for the years in which these are instead available as nominal catches (2012-2022);
  - **Gillnet fisheries of Oman:** data not reported to IOTC standards, as nominal catches of distinct shark species are only available for a limited period of the recent time-series (2014-2022) for which no spatially disaggregated catch-and-effort data have been provided.
- **Longline fisheries**
  - **Historical catches of sharks from major longline fisheries (Taiwan,China, Indonesia, and Rep. of Korea):** for years before 2006 data are either unavailable or not reported according to IOTC standards;
  - **Fresh-tuna longline fisheries (Malaysia, Indonesia):** data not provided or not reported to IOTC standards. Indonesia started reporting catch and effort data since 2018 but the level of coverage is very low, with minor reported blue shark catches;
  - **Deep-freezing longline fisheries (EU,Spain, India, Indonesia, and Oman):** data not provided or not reported according to IOTC standards for the periods during which these fisheries were known to be active.
- **Coastal fisheries**
  - **Coastal fisheries of Yemen:** data not provided;
  - **Coastal fisheries of India and Oman:** data not reported to IOTC standards;



- **Coastal fisheries of Madagascar:** data provided since 2018 but with a very low coverage and not reported to IOTC standards;
- **Coastal fisheries of Indonesia:** data provided since 2018 but coverage is very low, with minor reported catches of some shark and ray species.

### *Catch estimation process*

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

## **Marine turtles**

### **Main species and fisheries concerned**

The interaction between marine turtles and IOTC fisheries is likely to be significant only in tropical areas, involving both industrial and artisanal fisheries, notably for:

- Industrial purse seine fisheries, in particular on sets using fish aggregating devices (EU, Seychelles, Mauritius, Korea, Japan, I.R. Iran) ([Bourjea et al. 2014](#); [Ruiz et al. 2018](#));
- Gillnet fisheries operating in coastal waters or on the high seas (Sri Lanka, I.R. Iran, Pakistan, Indonesia) ([Gilman et al. 2010](#); [Shahid et al. 2015](#));
- Industrial longline fisheries operating in tropical areas (China, Taiwan, China, Japan, Indonesia, Seychelles, India, Oman, Malaysia and the Philippines) ([Huang 2016](#)).

### **Status of data on marine turtles' bycatch**

Six distinct species of marine turtles (plus '*TTX - marine turtles nei*') have been involved in reported interactions with pelagic fisheries (**Table 5**). The overall abundance and IUCN status varies by species, ranging from data deficient (flatback turtle) to critically endangered (hawksbill turtle).

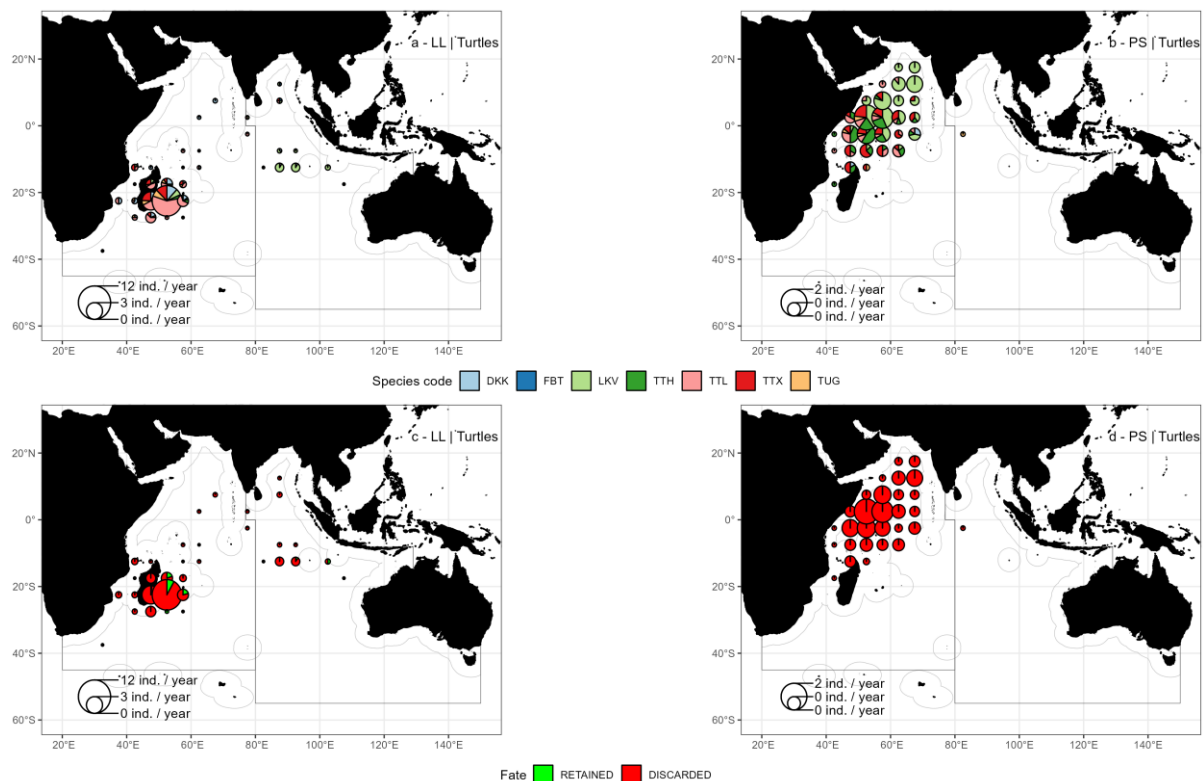
Overall, the reported data available on marine turtles caught in the IOTC area of competence are considered to be of low to poor quality, sparse and not standardised. All information related to marine turtles' interactions was extracted from the data currently incorporated in the ROS regional database. Although some CPCs tend to report (limited) information on incidental catches of marine turtles through their national reports, these are not integrated in the present study due to their incompleteness and lack of standardization. It is important to recall that the current version of the ROS database includes only a fraction of the data expected from longline fisheries.

A total of 570 turtle interactions with tuna fisheries were reported through the ROS, with loggerhead (n = ) and Olive ridley turtles (n = ) being the most frequent incidentally caught species in longline and purse seine fisheries, respectively (**Table 5**). Only 2 flatback turtles were reported to have interacted with tuna fisheries, notably by the longline fishery of Sri Lanka.

Table 5: Number of turtle interactions by species with as reported in the ROS regional database during the period 2005-2022

Fishery group	Species code	Name	Scientific name	IUCN status	Interactions
Longline (n=344)	TTL	Loggerhead turtle	<i>Caretta caretta</i>	Vulnerable	155
	LKV	Olive ridley turtle	<i>Lepidochelys olivacea</i>	Vulnerable	55
	DKK	Leatherback turtle	<i>Dermochelys coriacea</i>	Vulnerable	53
	TUG	Green turtle	<i>Chelonia mydas</i>	Endangered	43
	TTX	Marine turtles nei	<i>Testudinata</i>	N/A	21
	TTH	Hawksbill turtle	<i>Eretmochelys imbricata</i>	Critically endangered	15
	FBT	Flatback turtle	<i>Natator depressus</i>	Data deficient	2
Purse seine (n=226)	LKV	Olive ridley turtle	<i>Lepidochelys olivacea</i>	Vulnerable	94
	TUG	Green turtle	<i>Chelonia mydas</i>	Endangered	47
	TTH	Hawksbill turtle	<i>Eretmochelys imbricata</i>	Critically endangered	46
	TTL	Loggerhead turtle	<i>Caretta caretta</i>	Vulnerable	29
	TTX	Marine turtles nei	<i>Testudinata</i>	N/A	7
	DKK	Leatherback turtle	<i>Dermochelys coriacea</i>	Vulnerable	3

The spatial distribution of turtle interactions with longline fisheries is limited to very few areas due to the small size of the longline observer data set while the purse seiner observer data cover the purse seine fishing grounds well (Fig. 18). Most turtles were released (as expected) except for a few injured individuals caught by Reunion-based longliners that were brought back to the Kelonia turtles observatory and care center. The survival rate appeared to be lower in longline fisheries (~70%) than in purse seine fisheries (>95%) although data from other longline fisheries are required to confirm this pattern.





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Figure 18: Mean annual number of marine turtle interactions (numbers of individuals per year) with pelagic fisheries by species (a & b) and fate (c & d) as reported to the Secretariat during the period 2005-2022

### **Incidental catches of marine turtles**

- Gillnet fisheries of Pakistan and Indonesia: to date, there have been no reported incidental catches of marine turtles for these gillnet fisheries;
- Longline fisheries of Malaysia, Oman, India, Philippines and Seychelles: to date, these countries have not reported incidental catches of marine turtles for their longline fisheries;
- Purse seine fisheries of Japan, I.R. Iran and Thailand: to date these countries have not reported incidental catches of marine turtles for their purse seine fisheries, including incidental catches of marine turtles on Fish Aggregating Devices. Seychelles provided data on discards of marine turtles from their purse seine fleet for 2018.

While a number of CPCs have been mentioned specifically here, as they have important fisheries or have not provided any information, there are still many CPCs that are providing data that are not consistent with the IOTC minimum reporting standards.

## Cetaceans

### Main species and fisheries concerned

Reporting of interactions between IOTC fisheries and cetaceans has been extremely limited to date, and interactions are expected to vary greatly by fishing gear, gear configuration, time-area strata, and environmental conditions. The full lists of whale and dolphin species susceptible to interactions with tuna and tuna-like species fisheries are given in [Appendix II](#).

The overall expected levels of interactions are as follows:

- Few interactions occur between purse seine and cetaceans although tuna schools associated with whales could have been targeted prior to the entry in force of [IOTC Resolution 23/06](#) as was the case for schools associated with whale sharks. Those sets represented a small component of all sets and the animals were released alive in most cases ([Escalle et al. 2015](#)). Very few cases of dolphin-associated schools have been reported in the Indian Ocean while they are more common in the Pacific Ocean;
- Most interactions between longline and cetaceans stem from the animals being attracted mainly to longlines as a source of food, possibly resulting in incidental entanglement, injury, and mortality ([Gilman et al. 2006](#); [Hamer et al. 2012](#)). The extent of these interactions and associated levels of mortality are poorly known although several studies have focused on depredation in the Indian Ocean ([Romanov et al. 2013](#); [Munoz-Lechuga et al. 2016](#));
- Gillnet (or driftnet) is considered to be the main fishing gear responsible for direct mortality of cetaceans through entanglement ([Anderson et al. 2020](#))
- Artisanal fisheries may be responsible for some bycatch of small cetaceans, with different fishing gears involved, including gillnet ([Temple et al. 2018](#))

### Status of data on cetaceans' bycatch

A total of 79 cetacean interactions with tuna fisheries has been reported through the ROS (**Table 6**). Most interactions were reported for the fresh pelagic longline fishery of Reunion Island (85% of all observations) and are limited to the south-western Indian Ocean, east of Madagascar (**Fig. 19**). The interactions observed for this fishery were dominated by Risso's dolphins that were all released alive. Overall, 97% of the cetaceans having interacted with the fishery were assessed to be alive at release. Remaining interactions were reported from Japanese longliners operating in the eastern part of the Indian Ocean (9 toothed whales with about 90% of them released alive) while only 2 observations of common dolphins were reported for Sri Lankan longliners without information on their condition at release (**Fig. 19b**).

Table 6: Number of cetacean interactions by species as reported in the ROS regional database during the period 2005-2022

Fishery group	Species code	Name	Scientific name	IUCN status	Interactions
Longline (n=79)	DRR	Risso's dolphin	<i>Grampus griseus</i>	Least concern	53
	ODN	Toothed whales nei	<i>Odontoceti</i>	Unclassified	12
	DCO	Common dolphin	<i>Delphinus delphis</i>	Least concern	4
	FAW	False killer whale	<i>Pseudorca crassidens</i>	Near threatened	3
	HUW	Humpback whale	<i>Megaptera novaeangliae</i>	Least concern	3
	SHW	Short-finned pilot whale	<i>Globicephala macrorhynchus</i>	Least concern	2
	MIW	Minke whale	<i>Balaenoptera acutorostrata</i>	Least concern	1
	DBO	Bottlenose dolphin	<i>Tursiops truncatus</i>	Least concern	1

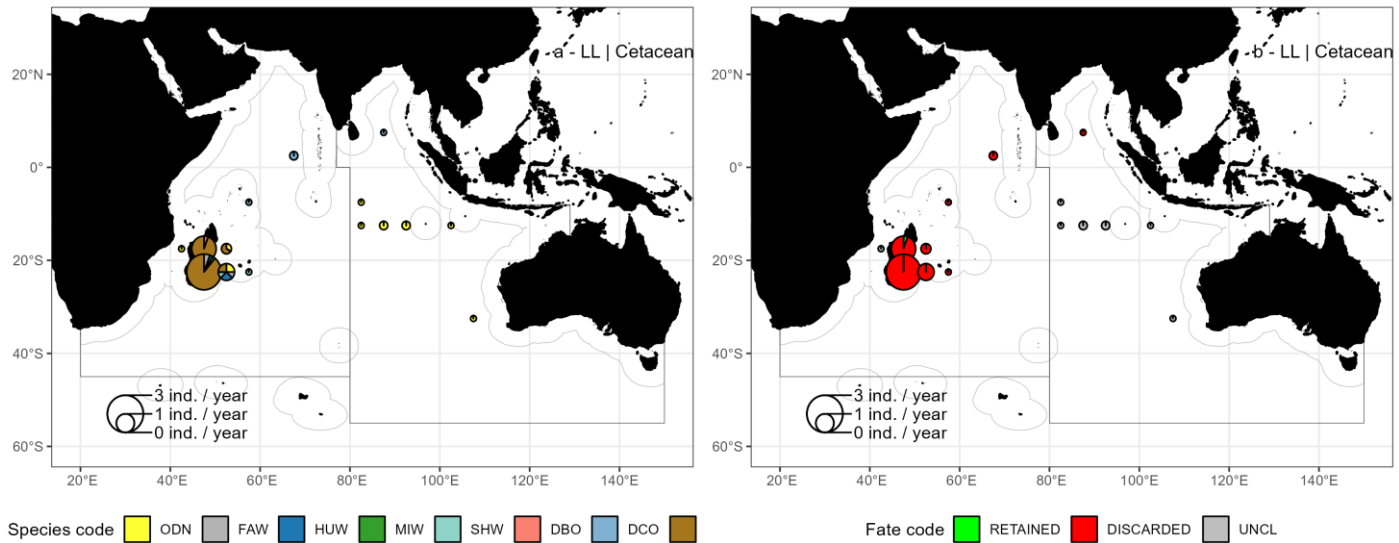


Figure 19: Cetacean interactions (numbers of individuals) with pelagic longline fisheries by species and fate as reported to the Secretariat during the period 2005-2022

## Seabirds

### Longline vessels fishing in southern waters

The interaction between seabirds and IOTC fisheries is likely to be significant only in southern waters (south of 25°S), an area where most of the effort is exerted by longliners ([ACAP 2007](#)).

Spatial information available on longline fishing effort shows the dominance of vessels from Japan and Taiwan,China in this area since the mid-1950s, with a progressive decline in the effort exerted by the Japanese fleet since the mid-2000s and an increased effort of the Taiwan,China fleet starting from the 2010s (**Fig. 20**). In recent years (2017-2020), Taiwan,China represented about 70% (~80 million hooks) of the total reported longline effort of about 115 million hooks deployed annually in southern waters.

With more than 11 million hooks deployed annually, Japanese longliners contribute to about 10% of the total effort while the fleets of China, Seychelles, EU,Spain, and Malaysia deploy between 2.8 and 7.3 million hooks annually. The fishing effort might actually be incomplete for some reporting fleets while a number of other longline fleets may also operate in this area as suggested by the presence of temperate species in their catch data (e.g., Indonesia).

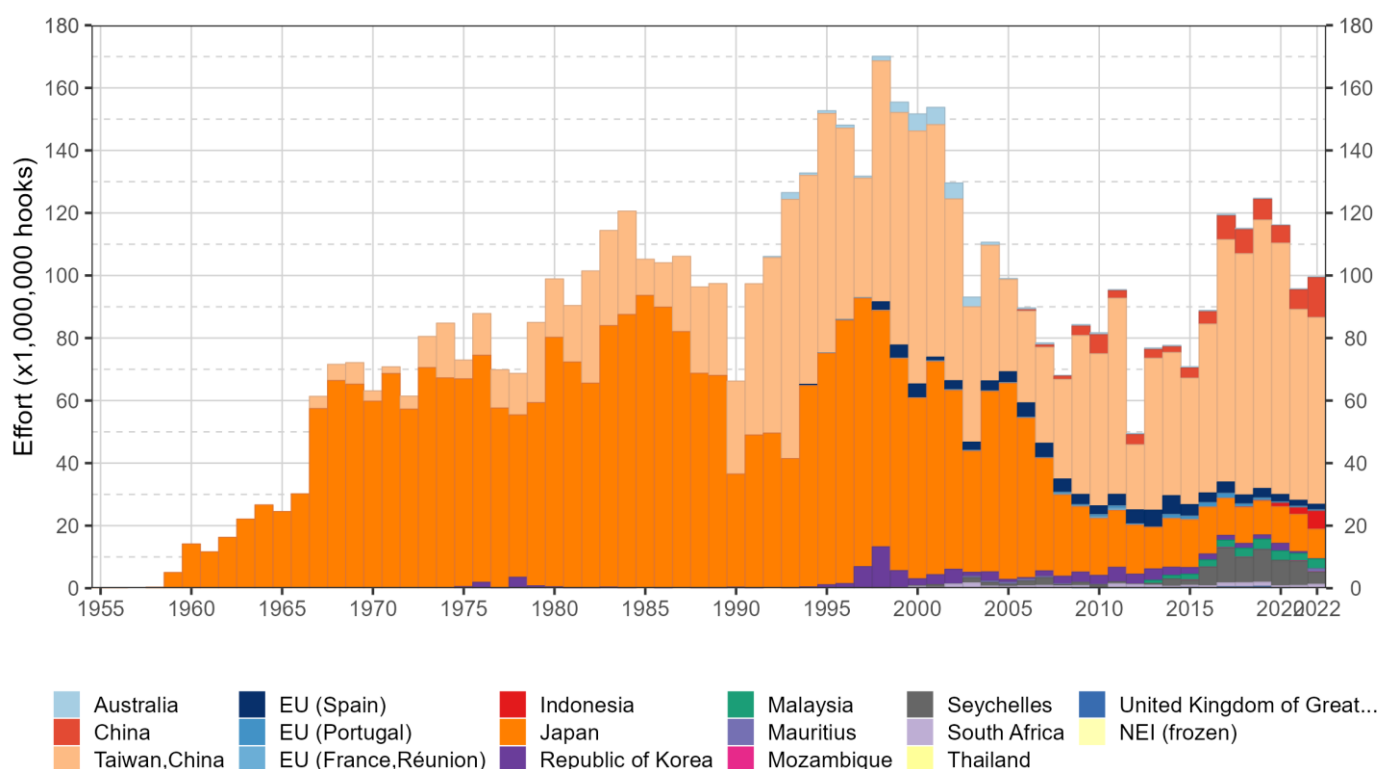


Figure 20: Reported longline effort (hooks) for fleets operating south of 25°S between 1955 and 2020

### Main species and fisheries concerned

Among the 30 species of petrels and albatrosses known to occur in the IOTC area of competence ([ACAP 2007](#)), 13 species have been reported to interact with longline fisheries according to the ROS regional database (**Table 7**). It is important to note that the ROS data set only includes data from Japan over the time period 2012-2016 and no other data of interactions with seabirds have been reported to date using reporting formats suitable for automated data extraction according to the ROS data standards.

In 2016, six CPCs (Australia, EU-Portugal, EU-Spain, EU-France, Japan, Rep. of Korea, Taiwan,China and South Africa) submitted data in response to a call for data submission on seabirds following the dissemination of the IOTC Circular 2016-043 ([IOTC 2016](#)). Although some of the interactions with seabirds were reported in aggregate form, 16 species were recorded to have interacted with longline fisheries in the compiled data set covering the period 2009-2015, including six in addition to those available from the ROS (**Table 7**).

In addition, some CPCs have also reported seabird interactions through their national reports. For instance, Taiwan,China reported a total of 40 interactions with their longline fishery operating south of 25°S for 8 species of seabirds in 2018: black-browed albatross (1), wandering albatross (2), Salvin’s albatross (1), light-mantled sooty albatross (1), sooty albatross (7), white-chinned petrel (17), white-capped albatross (5), and yellow-nosed albatross (6). In the same year, Korea reported the incidental catch of three grey-headed albatrosses and one sooty albatross.

Table 7: List of seabird species reported to have interacted with longline fisheries in the Indian Ocean with the most recent status of the IUCN Red List. ROS = Regional Observer Scheme; 2016-043 = IOTC Circular 2016-043

Species code	Name	Scientific name	IUCN status	Source
DCR	Atlantic yellow-nosed albatross	<i>Thalassarche chlororhynchos</i>	Endangered	2016-043
DCU	Shy albatross	<i>Thalassarche cauta</i>	Near threatened	2016-043
DIC	Grey-headed albatross	<i>Thalassarche chrysostoma</i>	Endangered	ROS
DIM	Black-browed albatross	<i>Thalassarche melanophris</i>	Least concern	ROS
DIP	Southern royal albatross	<i>Diomedea epomophora</i>	Vulnerable	ROS
DIQ	Northern royal albatross	<i>Diomedea sanfordi</i>	Endangered	2016-043
DIX	Wandering albatross	<i>Diomedea exulans</i>	Vulnerable	ROS
MAH	Hall's giant petrel	<i>Macronectes halli</i>	Least concern	ROS
MAI	Antarctic giant petrel	<i>Macronectes giganteus</i>	Least concern	ROS
MWE	Cape gannet	<i>Morus capensis</i>	Endangered	2016-043
PFC	Flesh-footed shearwater	<i>Ardenna carneipes</i>	Near threatened	ROS
PFG	Sooty shearwater	<i>Ardenna grisea</i>	Near threatened	ROS
PFT	Short tailed shearwater	<i>Ardenna tenuirostris</i>	Least concern	2016-043
PHE	Light-mantled sooty albatross	<i>Phoebastria palpebrata</i>	Near threatened	ROS
PHU	Sooty albatross	<i>Phoebastria fusca</i>	Endangered	ROS
PRO	White-chinned petrel	<i>Procellaria aequinoctialis</i>	Vulnerable	ROS
TQH	Indian yellow-nosed albatross	<i>Thalassarche carteri</i>	Endangered	ROS
TQW	Campbell albatross	<i>Thalassarche impavida</i>	Vulnerable	ROS
TWD	White-capped albatross	<i>Thalassarche steadi</i>	Near threatened	2016-043

### Status of data on seabirds' bycatch

The data available on seabirds caught in the IOTC area of competence are generally fairly limited: the information collected through circular 2016-043 highlighted some general trends in seabird bycatch rates across the Indian Ocean, with higher catch rates at higher latitudes – even within the area south of 25°S – and higher catch rates in the coastal areas in the eastern and western parts of the southern Indian Ocean ([IOTC 2016](#)). Data also showed that the mortality rates were generally high for most species, and the mean mortality rate across all years and fleets was higher than 70%.

To date, properly structured data on seabird interactions collected as part of the ROS are only available for the Japanese longline fishery: a total of 176 interactions was reported during 2012-2016, with an average of 35.2 interactions per year and all birds reported as dead, when the information on condition at capture was available. Regarding the overall low observer coverage and very few data currently available on seabird interactions, no estimation of the total bycatch of seabirds from the longline fishery south of 25°S was undertaken.

Table 8: Number of seabird interactions by species as reported in the ROS regional database during the period 2005-2022

Fishery group	Species code	Name	Scientific name	IUCN status	Interactions
Longline (n=176)	TQH	Indian yellow-nosed albatross	<i>Thalassarche carteri</i>	Endangered	72
	PFC	Flesh-footed shearwater	<i>Puffinus carneipes</i>	Unclassified	17
	DIC	Grey-headed albatross	<i>Thalassarche chrysostoma</i>	Endangered	15
	PHE	Light-mantled sooty albatross	<i>Phoebastria palpebrata</i>	Near threatened	15
	PHU	Sooty albatross	<i>Phoebastria fusca</i>	Endangered	15
	PRO	White-chinned petrel	<i>Procellaria aequinoctialis</i>	Vulnerable	10
	DIX	Wandering albatross	<i>Diomedea exulans</i>	Vulnerable	9
	DIM	Black-browed albatross	<i>Thalassarche melanophrys</i>	Unclassified	7
	MAH	Hall's giant petrel	<i>Macronectes halli</i>	Least concern	6
	TQW	Campbell albatross	<i>Thalassarche impavida</i>	Vulnerable	4
	MAI	Antarctic giant petrel	<i>Macronectes giganteus</i>	Least concern	3
	DIP	Southern royal albatross	<i>Diomedea epomophora</i>	Vulnerable	2
	PFG	Sooty shearwater	<i>Puffinus griseus</i>	Unclassified	1

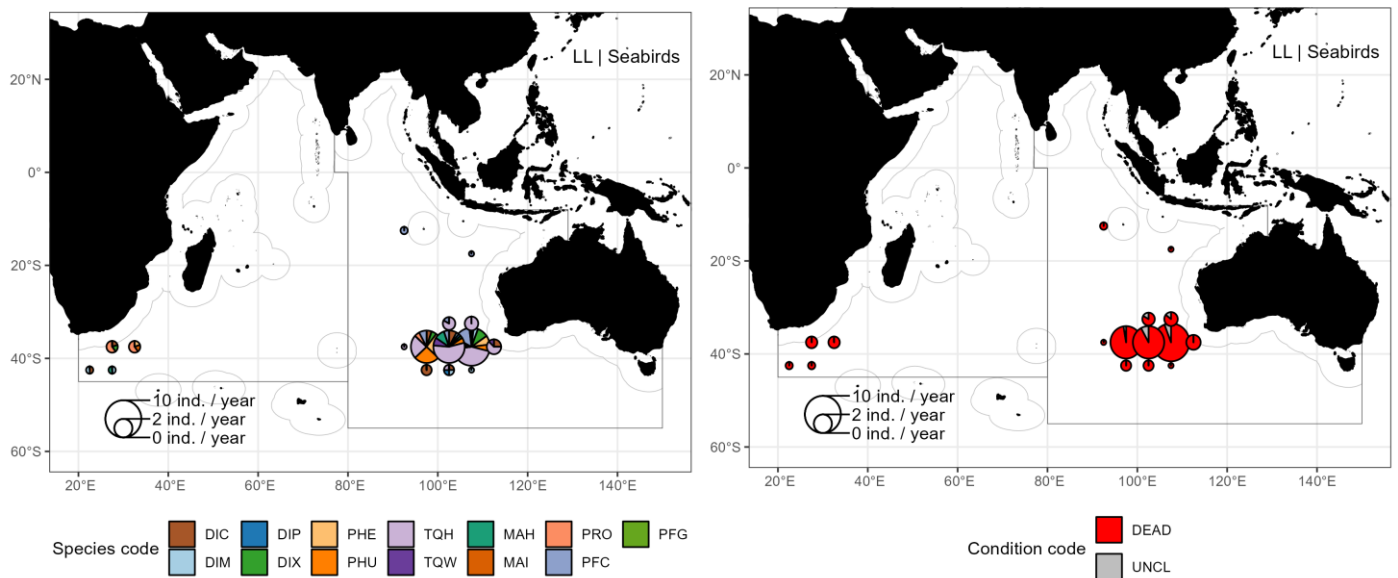


Figure 21: Mean annual number of seabird interactions (number of individuals per year) with deep-freezing longline fisheries by species and fate as reported to the Secretariat during 2012-2016

The longline fisheries of Seychelles, Malaysia, and Mauritius that operate or have operated in areas with high densities of seabirds have not reported incidental catches of seabirds for longliners under their flag.

**Other bycatch species categories**

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

## Mako shark species

### Overall bycatch levels & trends

Before 1995 the catches of mako shark species were dominated by artisanal fisheries. Since then, with the expansion of industrial fisheries, was a continued increase reaching a peak of about 5000 t in 2016 comprised around a 60 % of the catches for the industrial fisheries. After that a substantial decrease in the total catches was experienced after which the trend reversed, with catches falling by around 50% in the last year (Fig. 22).

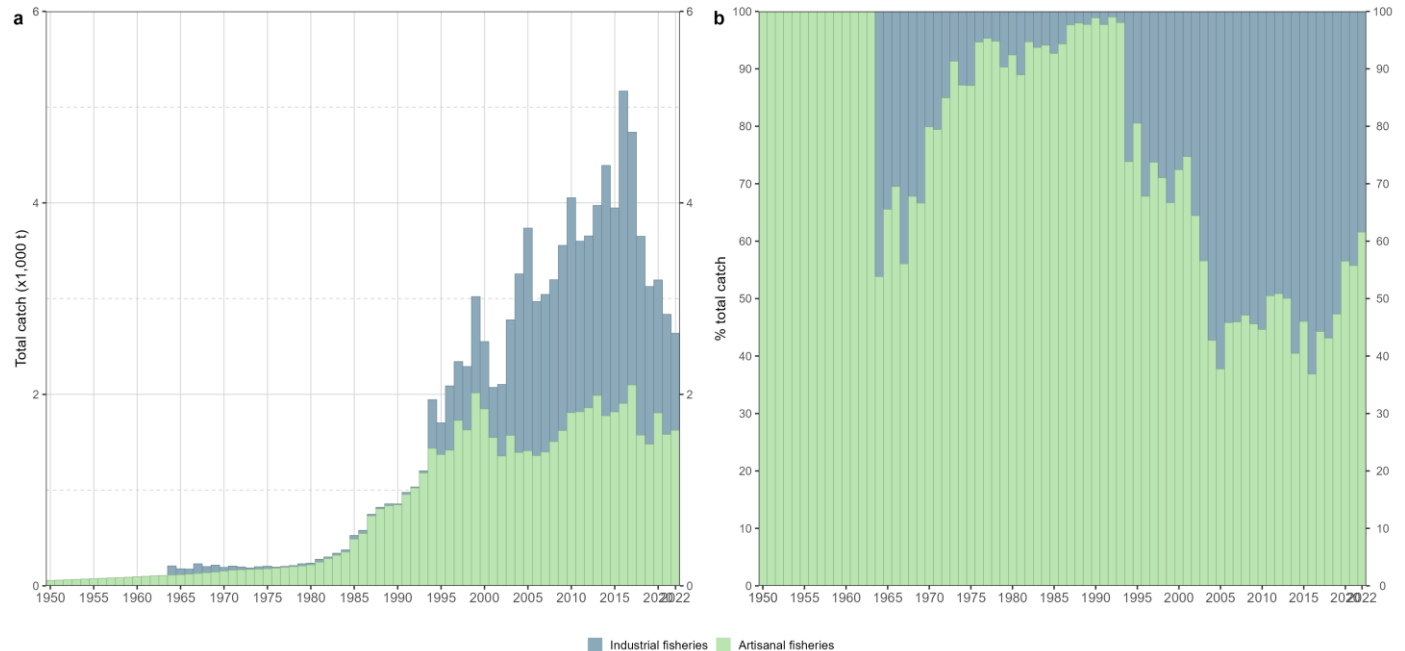


Figure 22: Annual cumulative absolute (a) and relative (b) time series of retained catches (metric tonnes; t) of mako shark species by species category for the period 1950-2022

### Vulnerability to fisheries

Shortfin mako shark received the highest vulnerability ranking (No. 1) for longline gear in the ecological risk assessment (ERA) conducted for the Indian Ocean by the WPEB and SC in 2018 because it was characterized as one of the least productive shark species and with a high susceptibility to longline gear (Murua et al., 2018). Catches of mako shark species have increased sharply from early 1990s to mid-2010s (Table 9), period in which longline and line fisheries accounted for more than 70% of total catches of these species. After a peak of 5,168 tonnes of mako shark species caught in 2016, total annual catches fell to 2,638 tonnes last year (Fig. 24).

Table 9: Retained catches (metric tonnes; t) of mako sharks by decade and fishery for the period 1950-2022. The background intensity color of each cell is directly proportional to the catch level



FISHERY	1950s	1960s	1970s	1980s	1990s	2000s	2010s	2020s
Purse seine   Other	0	0	0	0	0	0	2	1
Longline   Other	0	0	0	21	332	1,135	1,144	484
Longline   Fresh	0	0	0	0	0	4	157	183
Longline   Deep-freezing	0	75	23	23	262	410	904	535
Line   Coastal longline	0	0	0	133	220	462	832	942
Line   Trolling	70	114	173	345	514	513	505	505
Line   Handline	0	0	0	0	0	0	5	0
Gillnet	2	3	7	63	418	406	486	240
<b>Total</b>	<b>72</b>	<b>192</b>	<b>203</b>	<b>586</b>	<b>1,746</b>	<b>2,929</b>	<b>4,036</b>	<b>2,890</b>

Longfin makos are poorly recorded in the Indian Ocean and catches reported to the Secretariat in recent years represent less than 1% of mako species (**Fig. 23**). However, the percentage of reported catches of mako species aggregated remains considerable. Between the two species, shortfin mako dominates the catches reported by industrial fisheries, although it varies from year to year, accounting for between 50% and 70% of catches of these species. For artisanal fisheries around 80% of catches reported for mako species are aggregated.

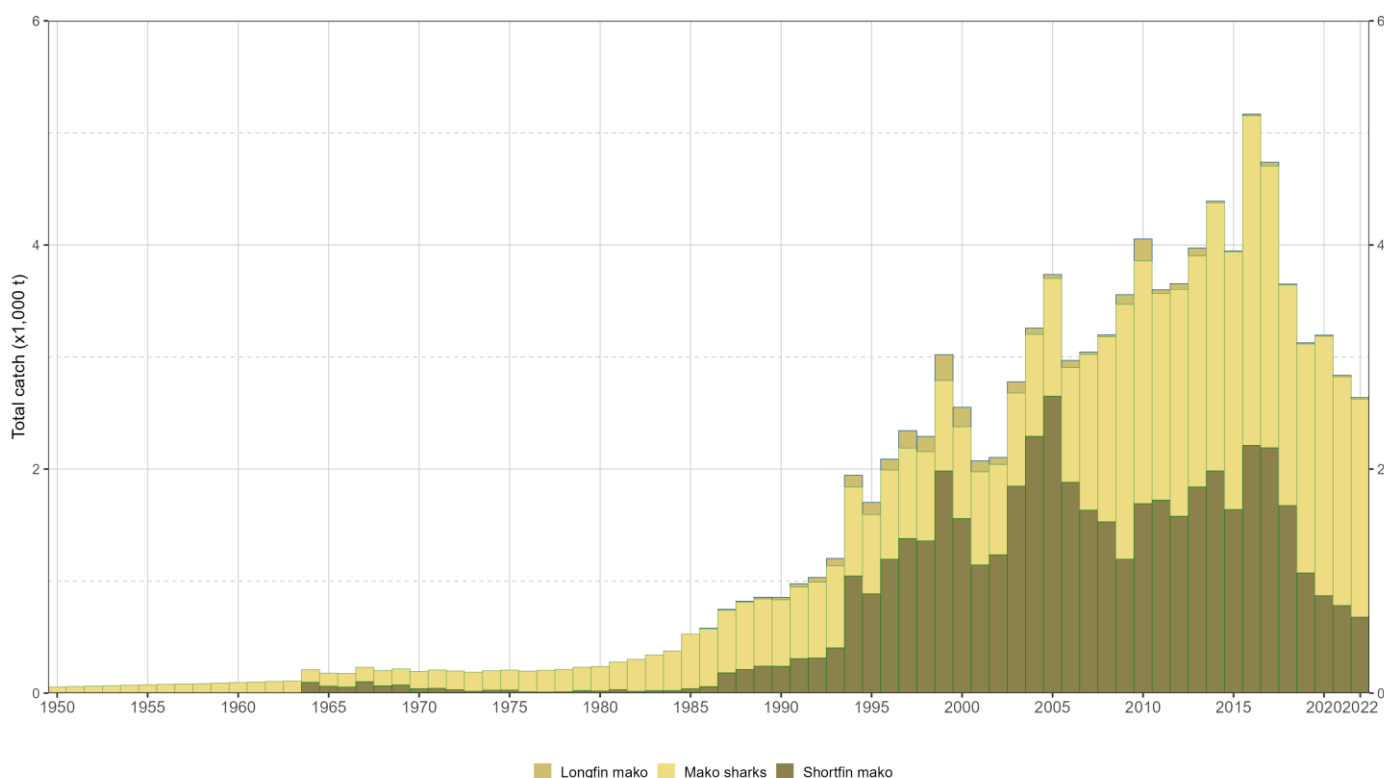


Figure 23: Annual time series of retained catches (metric tonnes; t) of mako sharks by species, for the period 1950-2022

### Recent fishery features (2018-2022)

Mako shark species shows a decline in catches in recent years in all fleets and fisheries (**Fig. 24**), with the exception of the IDN line fishery, where a peak in 2020 and a subsequent decline in catches is followed by a very smooth increase in the last year. The main fleets accounting with 74% of total catches of mako shark species are Indonesia, Taiwan, province of China, Madagascar and Eu, Spain (**Fig. 25**). Nevertheless, is important to note that data for Madagascar are repeated for the coastal fisheries in recent years. Furthermore, revisions to Pakistani gillnet catches from 1987 onwards, endorsed by the SC in December 2019, introduced a mean annual decrease of around 17,000 t in total catches

of shark species during the concerned period when compared to previously available official data reported by the country (Fig. 26).

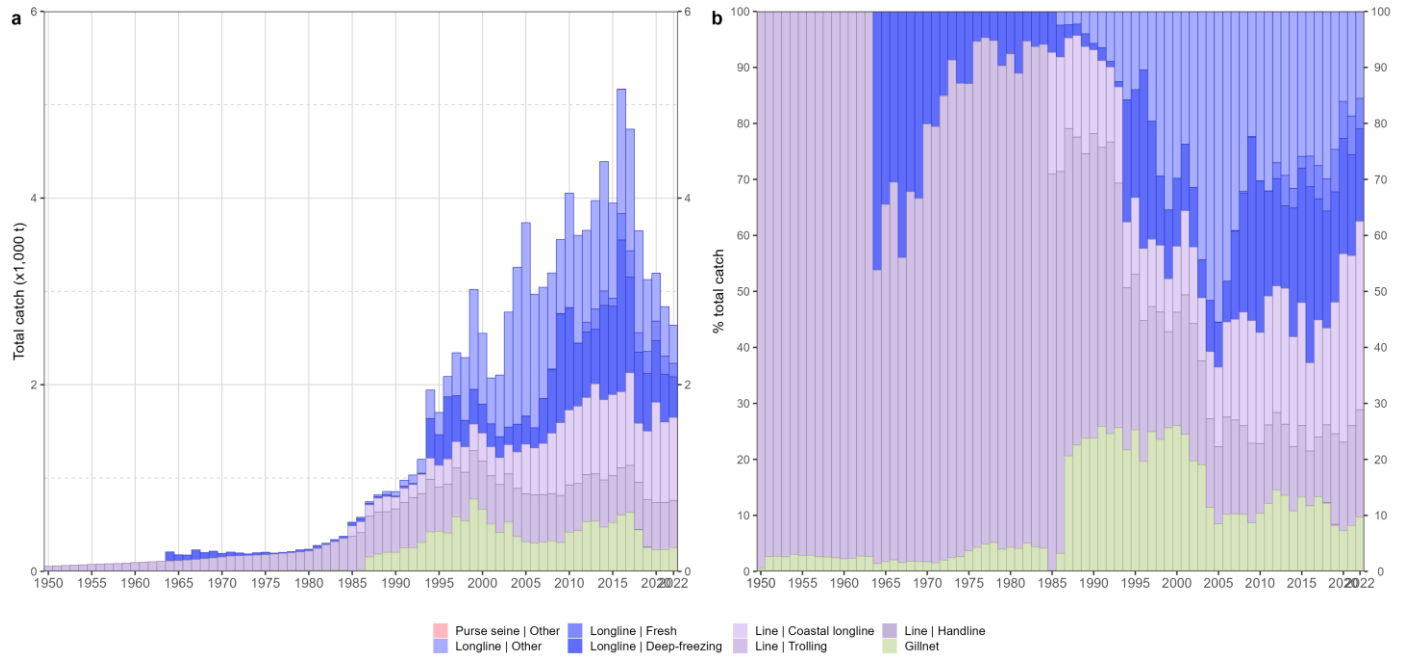


Figure 24: Annual absolute (a) and relative (b) time series of retained catches (metric tonnes; t) of mako sharks by fishery for the period 1950-2022. 'Other' corresponds to all other fisheries combined

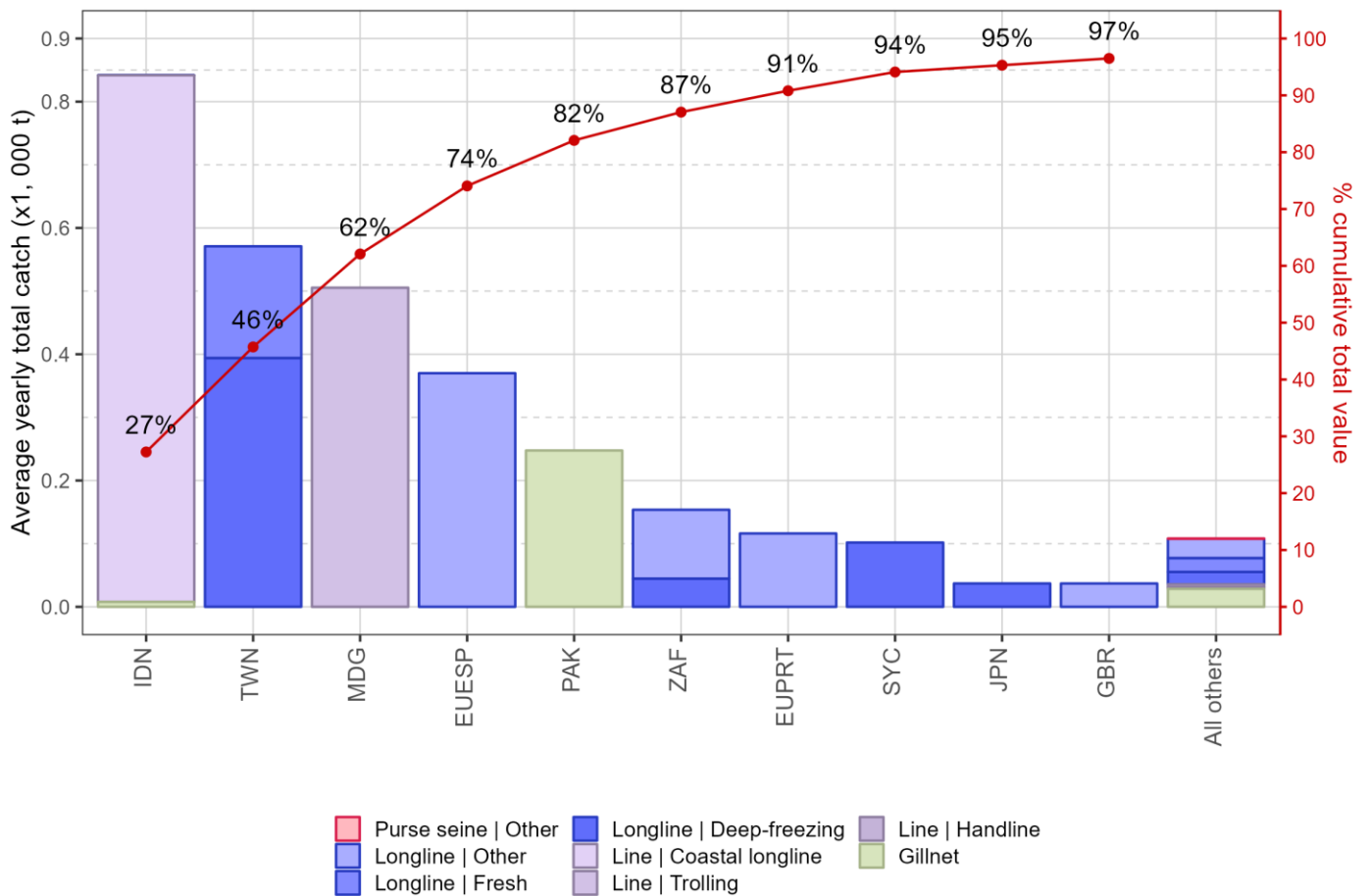


Figure 25: Annual absolute (a) and relative (b) time series of retained catches (metric tonnes; t) of mako sharks by fishery for the period 1950-2022. 'Other' corresponds to all other fisheries combined

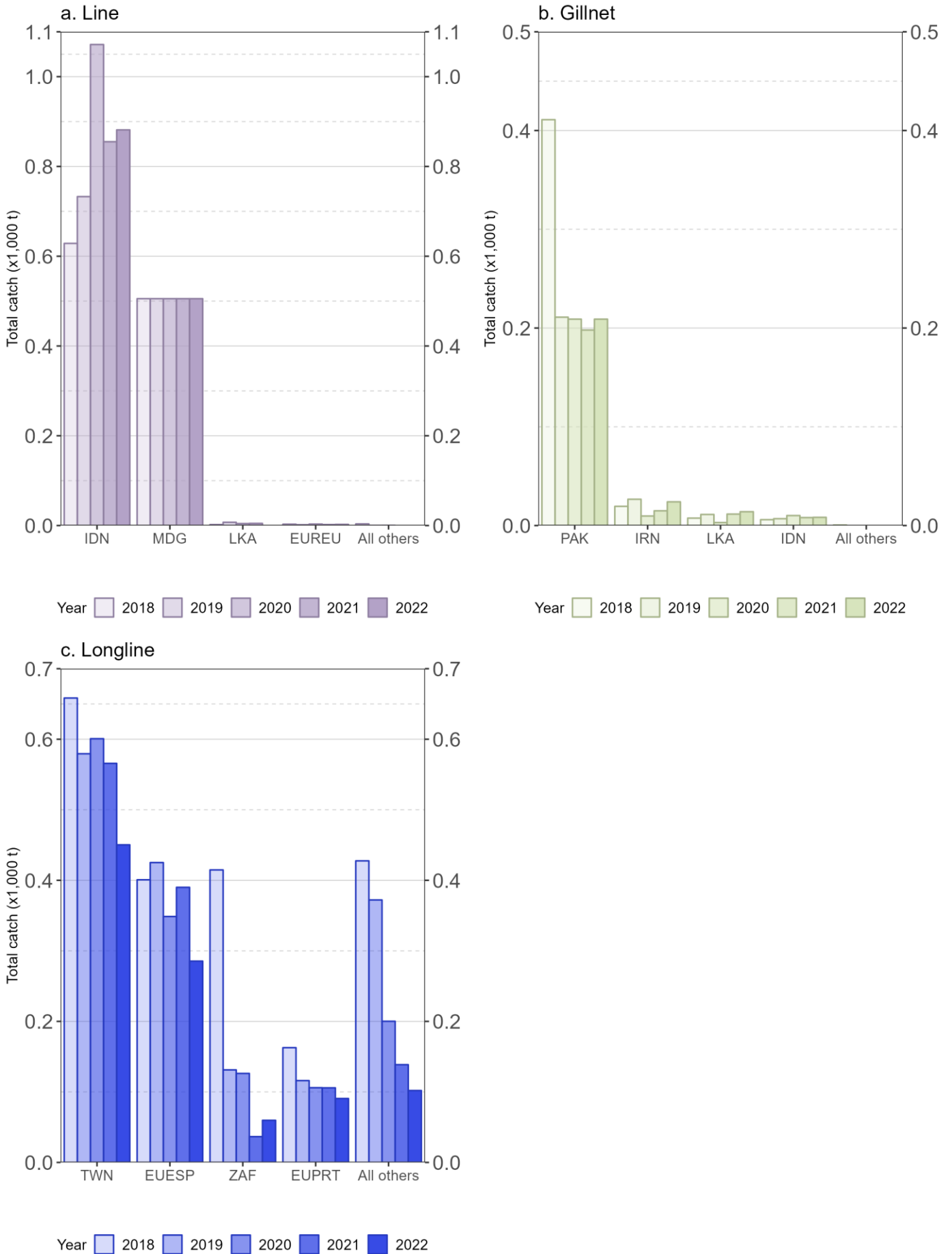


Figure 26: Annual catch trends (metric tonnes; t) of mako shark species by fishery group between for the period 2018-2022

## Discarding practices

Information on discarding practices can only be inferred from observer data collected through the ROS programme. Mako shark species interactions are mainly recorded in the Western Indian Ocean and at aggregated level (**Fig. 27**).

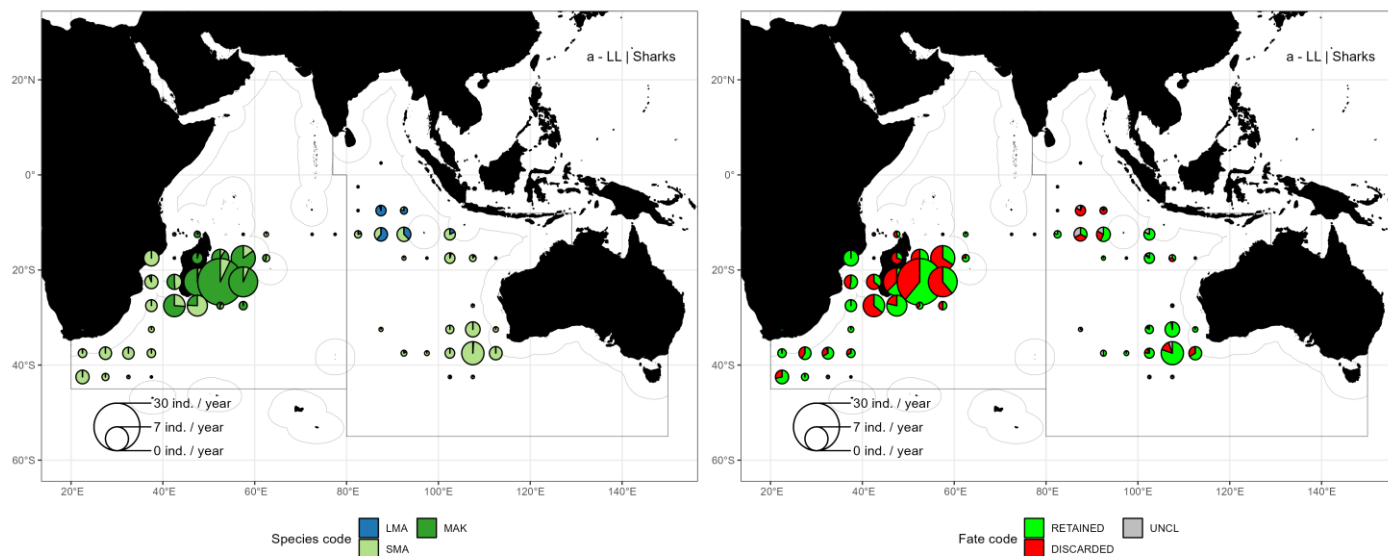


Figure 27: Mean annual number of mako shark species interactions (numbers of individuals per year) with deep-freezing longline fisheries by species (a) and fate (b) as reported to the Secretariat during the period 2009-2021

## Size composition of the catch

Size data collected for shortfin mako (SMA) by observers onboard deep-freezing longliners show a distribution described by a median fork length of 177.5 cm, which is larger than the median of the sizes collected by other enumerators (162 cm) (**Fig 13**). Spatial information shows that observer samples for this species mostly come from southern latitudes (south of 20°S) while other size data mainly come from the central and southwestern Indian Ocean, which might explain the differences in distributions beside suggesting some size-dependent variability in the spatio-temporal distribution of shortfin mako that needs further investigation.

## Shortbill spearfish

The shortbill spearfish (*Tetrapturus angustirostris*) is caught primarily as by-catch in industrial fisheries in the Indian and Pacific Oceans. Little is known about its biology, ecology and population structure, and it has never been the subject of a stock assessment in any part of its range (Marin-Enriquez et al., 2018, Arostegui et al., 2019). The species is listed as data deficient by the IUCN (Collette et al., 2023).

In response to the request made by the [WPEB19](#) this section summarize the available information of shortbill spearfish in the IOTC databases.

### Overall bycatch levels & trends

Retained catches of Shortbill spearfish were exclusively reported by Japanese longline fleets until 90's. Although reported catches show great fluctuations throughout the time series, the highest catches were recorded between 1955 and 1970, with a peak of 376 tonnes in 1968, followed by a drastic decline to 11 tonnes in 1977 (**Fig. ??**). In the early 1990s, catches started to increase again with the reporting of new fleets, but highly fluctuating between fleets and between years. (**Fig. 29**).

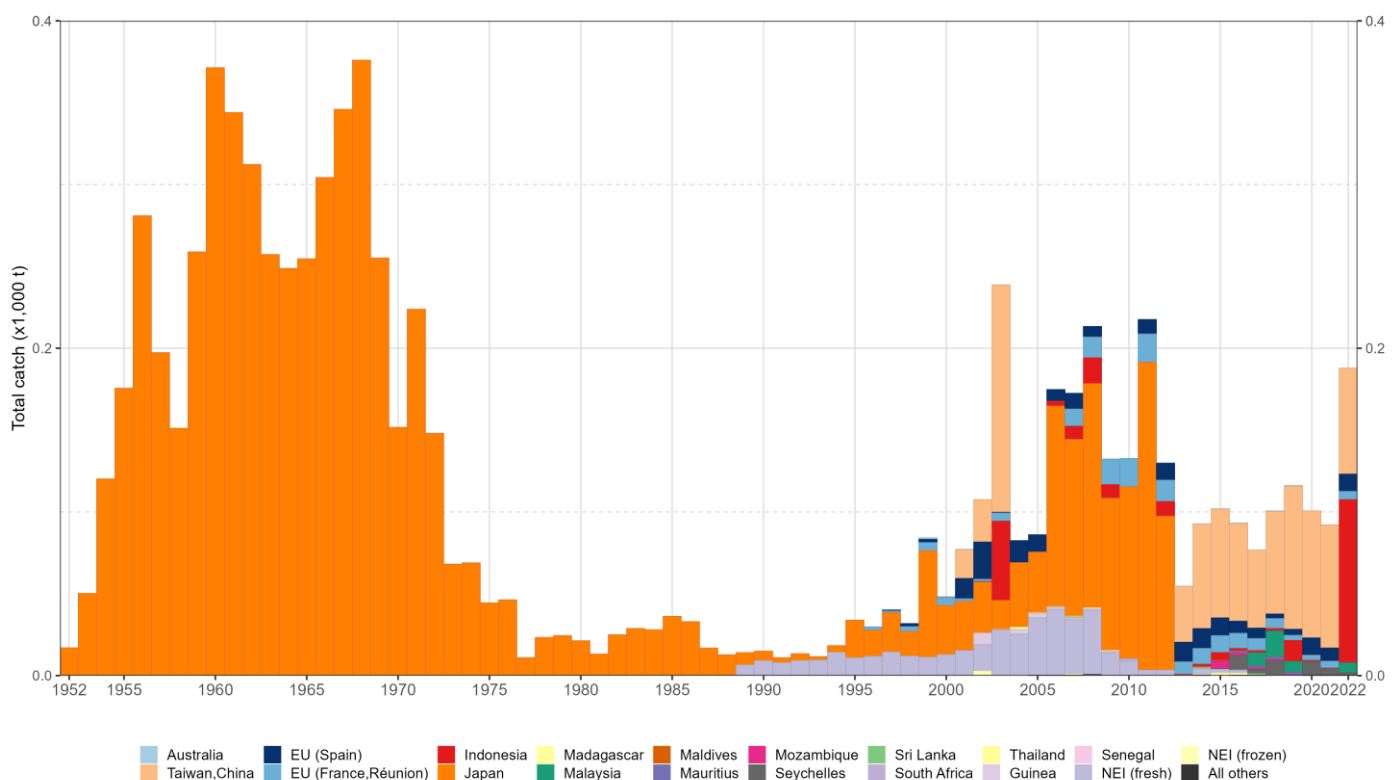


Figure 28: Annual time series of retained catches (metric tonnes; t) of Shortbill spearfish by fleet during 1950-2022

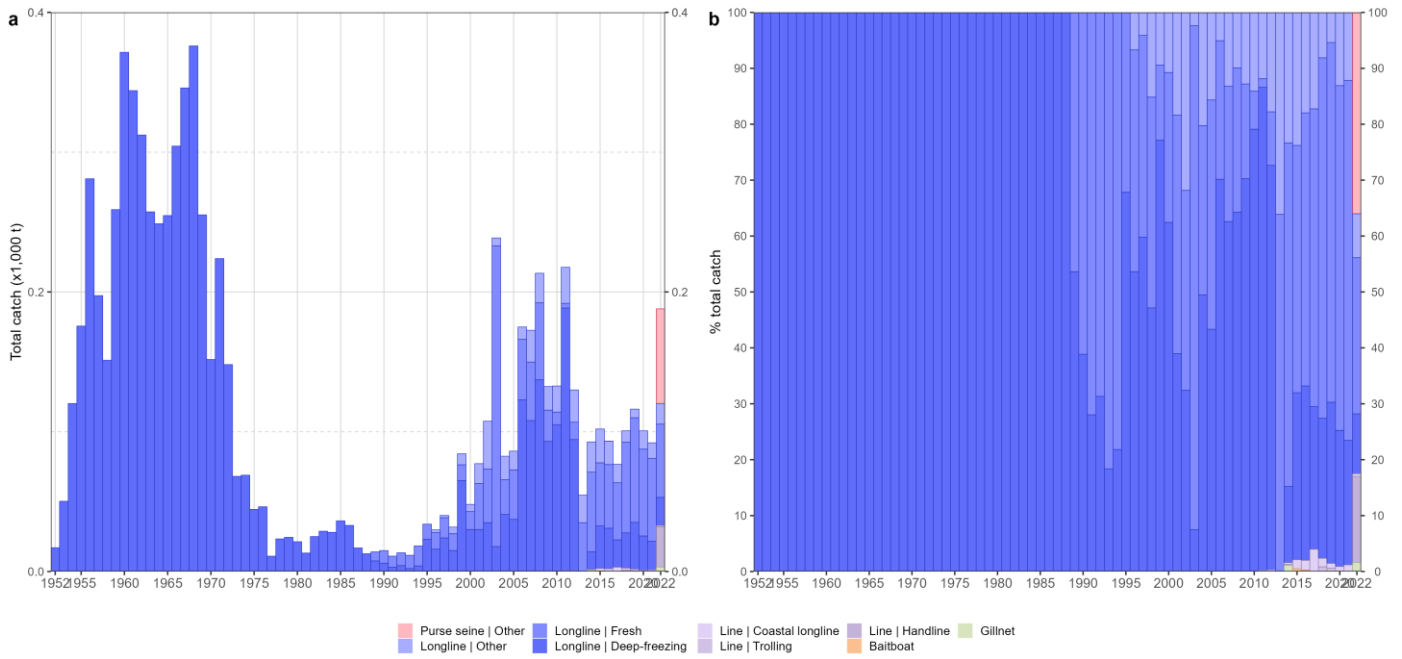


Figure 29: Annual time series of retained catches (metric tonnes; t) of Shortbill spearfish by fishery during 1950-2022

### Recent fishery features (2018-2022)

Shortbill spearfish catches have remained at around 100 tonnes in recent years, but have doubled in the last year, mainly due to exceptional catches reported by the Indonesian line and purse seine fisheries. (Fig. 29). Longline fisheries of Taiwan, province of China accounted for the 62% of the Shortbill spearfish catches, followed by Indonesia (mostly due the last year contribution). Other fleets as EU, Spain, Malaysia, Seychelles and reunion contributed with less than 10 tonnes by year (Fig. 30).

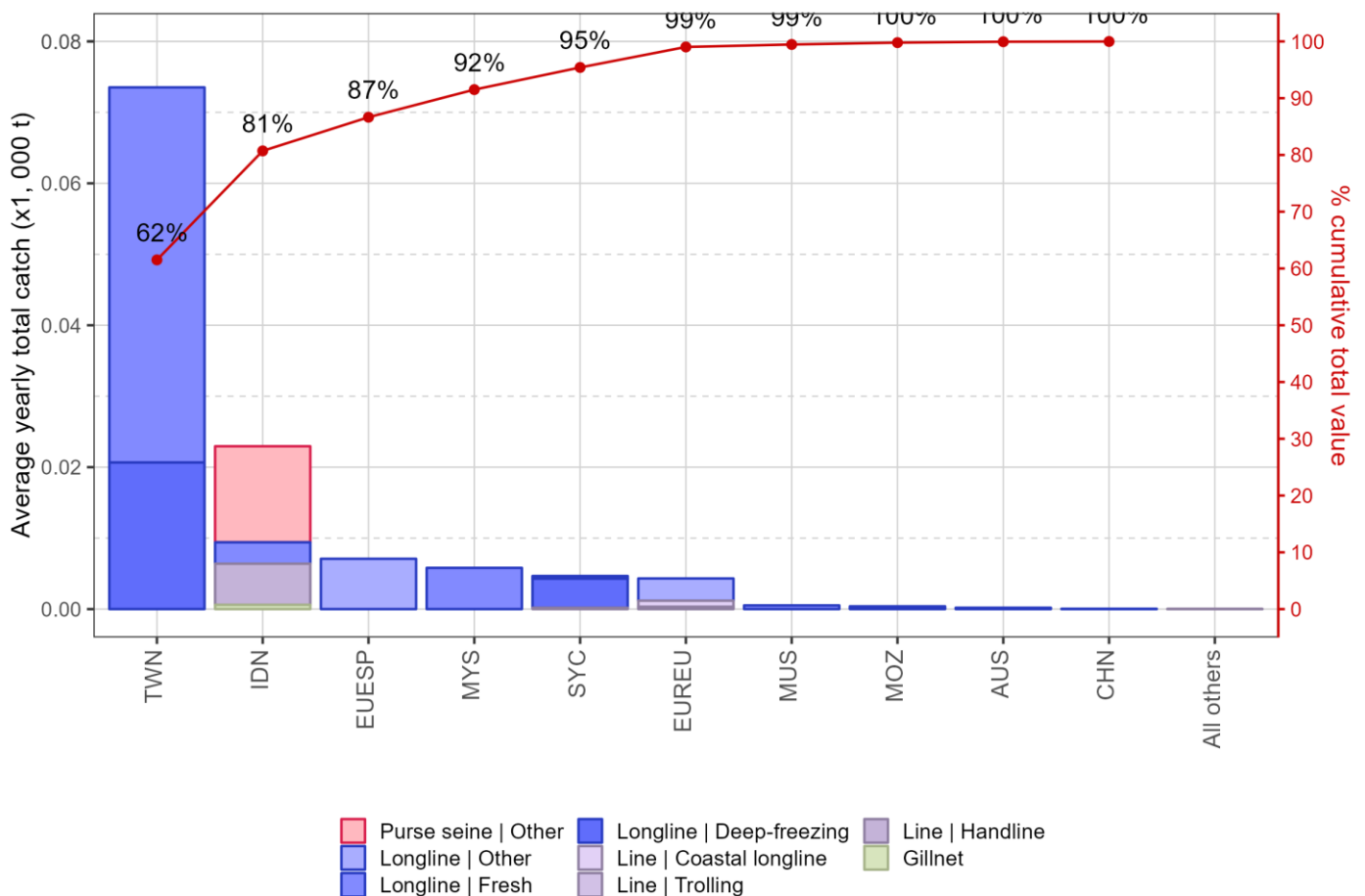


Figure 30: Mean annual catches of Shortbill spearfish by fleet and fishery (metric tonnes; t) between 2018 and 2022 with indication of cumulative catches by fleet

Shortbill spearfish is included in the Annex II of the Res. 15/01 as one of the species, other than the IOTC species, required for reporting by longline fleets as well in the Zero catches matrix (1DR IOTC form) for reporting the presence of species on the catch. Some CPCs (e.g. LKA, PAK) indicated the occurrence of shortbill spearfish although the contribution to the total catches was considered insignificant [WPB22](#) and [WPB22](#).

### Discarding practices

Discards reports are negligible and on the basis of the data currently available on the ROS, the Shortbill spearfish caught by the longline fisheries is mostly retained and the occurrence of the specie is concentrate on the western of the Indian Ocean (**Fig. 31**).

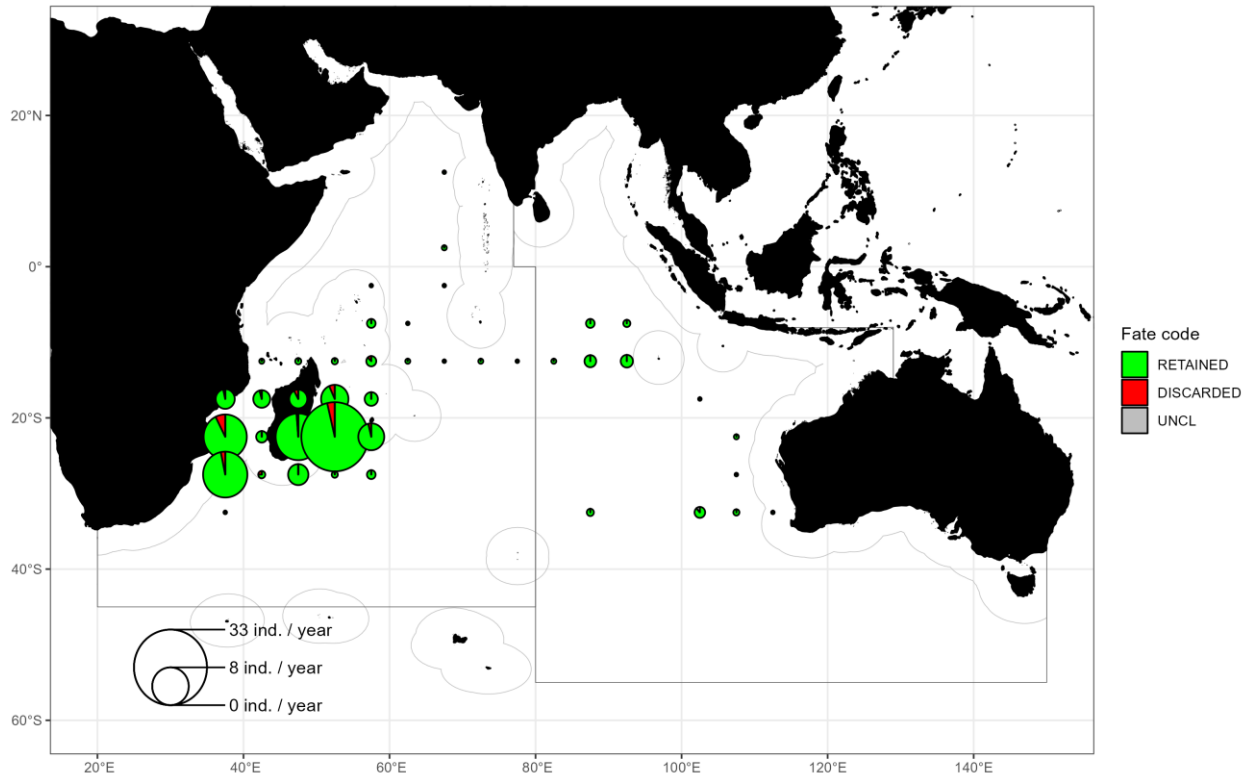


Figure 31: Mean annual number of Shortbill spearfish interactions (numbers of individuals per year) with longline fisheries by fate during 1950-2022

### Spatial information on Shortbill spearfish

Only Japan and Seychelles reported spatial information for Shortbill spearfish catches to the Secretariat in different periods, and although very limited, seems to be in line with the information provided by the ROS indicating the main occurrence of the specie on the Western Indian Ocean (**Figs.32**).

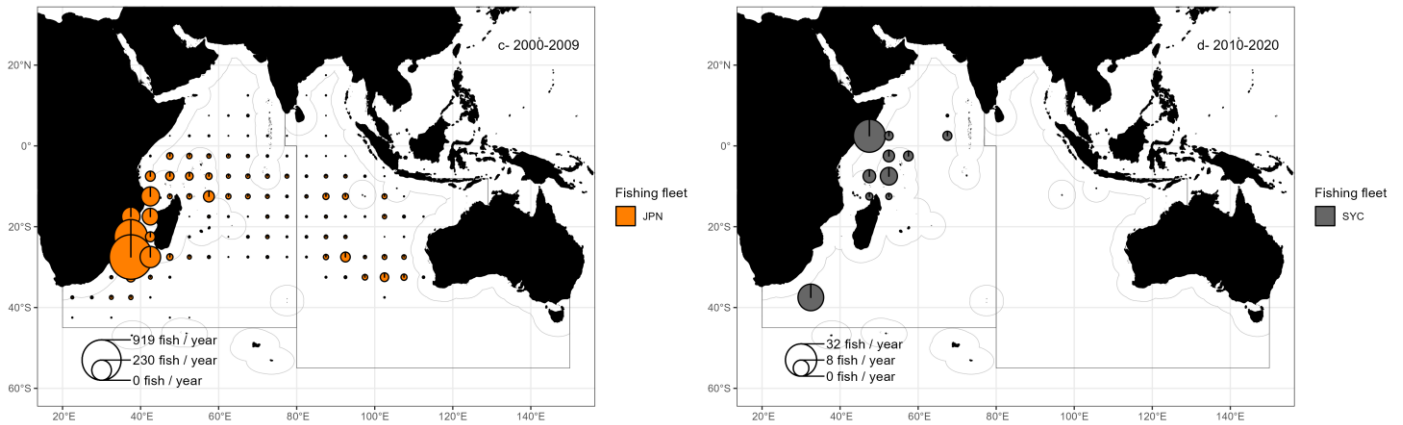


Figure 32: Mean annual retained catches by number of Shortbill spearfish by fishing longline fleet and decade reported to the Secretariat

Some information obtained through observer programmes indicates that Shortbill spearfish occurs in catches throughout the year in Reunion Island, accounting for 31% of billfish catches monitored by SRP, OBS and SCI programs between 2007 and 2014 [WPB13](#) and also in the Eastern Indian Ocean (range from 1°03' to 33°14' S and from 76°00' to 118°39' E) [WPB13](#). Although the information on their reproductive biology is limited, the presence of spawning areas in the Western Indian Ocean was also considered (Nakamura, 1985).

Considering that Shortbill spearfish may be under-reported, subject to occasional misidentification (Walsh et al., 2005) and reported in logbooks as aggregate billfish (Pepperell et al., 2011), available surveys and reports suggest that the occurrence of shortbill spearfish in the Indian Ocean is low.



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## Appendices

### Appendix I: Morphometrics for pelagic sharks of the Indian Ocean

Table 10: Summary of length-length relationships available for some pelagic sharks of the Indian Ocean. PCL = Precaudal length (cm); FL = fork length (cm); TL = total length (cm)

Species	Equation	a	b	N	MinFL	MaxFL	Reference
Blue shark	$TL=a+b*FL$	-2.133820	1.2165450	10			Anderson et al. 2011
	$PCL=a+b*FL$	-0.831809	0.9145784				Coelho et al. 2017
	$TL=a+b*FL$	-4.417651	1.2172855				
	$TL=a+b*FL$	5.319706	1.1680878	6,485	68	352	Ariz et al. 2007
Silky shark	$TL=a+b*FL$	2.900000	1.2000000	265			Filmalter et al. 2012
	$PCL=a+b*FL$	0.400000	0.9090909	214			
	$TL=a+b*FL$	4.404965	1.2168411	192			Anderson et al. 2011
	$TL=a+b*FL$	10.136700	1.1436000	520	66	247	Ariz et al. 2007

Table 11: Summary of length-weight relationships available for some pelagic sharks of the Indian Ocean. FL = fork length (cm); RD = round weight (kg); HG = dressed weight (kg)

Species	Equation	a	b	N	MinFL	MaxFL	Reference
Blue shark	$RD=a*FL^b$	0.00001590000	2.84554	2,842	57	311	Romanov and Romanova 2009
	$RD=a*FL^b$	0.00000279680	3.16970	2,279	81	298	Ariz et al. 2007
	$HG=a*FL^b$	0.00000040189	3.36200	2,129	82	352	
	$HG=a*FL^b$	0.00000160945	3.09904	289	150	260	Garcia-Cortés and Mejuto 2002
	$HG=a*FL^b$	0.00000190163	3.07615	164	93	253	Espino et al. 2010
Silky shark	$RD=a*FL^b$	0.00001600000	2.91497	687	66	281	Romanov and Romanova 2009
	$RD=a*FL^b$	0.00000472550	3.17710	369	66	244	Ariz et al. 2007
	$HG=a*FL^b$	0.00001297700	2.83230	94	97	269	
	$HG=a*FL^b$	0.00001132940	2.91484	411	50	220	Garcia-Cortés and Mejuto 2002
Oceanic whitetip shark	$RD=a*FL^b$	0.00001842800	2.92450	93	57	219	Ariz et al. 2007
	$HG=a*FL^b$	0.00008043100	2.44780	131	94	243	
	$HG=a*FL^b$	0.00000298446	3.15417	567	65	215	Garcia-Cortés and Mejuto 2002
Shortfin mako	$RD=a*FL^b$	0.00003490000	2.76544	906	70	342	Romanov and Romanova 2009
Bigeye tresher	$RD=a*FL^b$	0.00001413000	2.99565	185	110	256	Romanov and Romanova 2012
Tiger shark	$RD=a*FL^b$	0.00002614000	2.82374	676	50	351	
Great hammerhead	$RD=a*FL^b$	0.00000293000	3.23475	143	107	335	
Scalloped hammerhead	$RD=a*FL^b$	0.00002101000	2.88029	197	94	257	

**Appendix II: List of bycatch species interacting with Indian Ocean tuna fisheries****Elasmobranchs***Sharks*

Table 12: List of shark species reported at species level in the nominal catch or ROS data for the period 1950-2022

Species code	Name	Scientific name	IUCN status
ALS	Silvertip shark	<i>Carcharhinus albimarginatus</i>	Vulnerable
ALV	Thresher	<i>Alopias vulpinus</i>	Vulnerable
AML	Grey reef shark	<i>Carcharhinus amblyrhynchos</i>	Endangered
BLR	Blacktip reef shark	<i>Carcharhinus melanopterus</i>	Vulnerable
BRO	Copper shark	<i>Carcharhinus brachyurus</i>	Vulnerable
BSH	Blue shark	<i>Prionace glauca</i>	Near threatened
BTH	Bigeye thresher	<i>Alopias superciliosus</i>	Vulnerable
CCE	Bull shark	<i>Carcharhinus leucas</i>	Near threatened
CCL	Blacktip shark	<i>Carcharhinus limbatus</i>	Near threatened
CCP	Sandbar shark	<i>Carcharhinus plumbeus</i>	Vulnerable
CCQ	Spottail shark	<i>Carcharhinus sorrah</i>	Near threatened
FAL	Silky shark	<i>Carcharhinus falciformis</i>	Vulnerable
LMA	Longfin mako	<i>Isurus paucus</i>	Endangered
OCS	Oceanic whitetip shark	<i>Carcharhinus longimanus</i>	Critically endangered
OSF	Zebra shark	<i>Stegostoma fasciatum</i>	Endangered
POR	Porbeagle	<i>Lamna nasus</i>	Vulnerable
PSK	Crocodile shark	<i>Pseudocarcharias kamoharai</i>	Least concern
PTH	Pelagic thresher	<i>Alopias pelagicus</i>	Endangered
RHN	Whale shark	<i>Rhincodon typus</i>	Endangered
SMA	Shortfin mako	<i>Isurus oxyrinchus</i>	Endangered
SPK	Great hammerhead	<i>Sphyrna mokarran</i>	Critically endangered
SPL	Scalloped hammerhead	<i>Sphyrna lewini</i>	Critically endangered
SPZ	Smooth hammerhead	<i>Sphyrna zygaena</i>	Vulnerable
SSQ	Velvet dogfish	<i>Scymnodon squamulosus</i>	Least concern
TIG	Tiger shark	<i>Galeocerdo cuvier</i>	Near threatened
AGN	Angelshark	<i>Squatina squatina</i>	Critically endangered
CCB	Spinner shark	<i>Carcharhinus brevipinna</i>	Vulnerable
CCD	Whitecheek shark	<i>Carcharhinus dussumieri</i>	Endangered
CCG	Galapagos shark	<i>Carcharhinus galapagensis</i>	Least concern
CCM	Hardnose shark	<i>Carcharhinus macloti</i>	Near threatened
CCO	Finetooth shark	<i>Carcharhinus isodon</i>	Least concern
CCY	Graceful shark	<i>Carcharhinus amblyrhynchoides</i>	Near threatened
CLD	Sliteye shark	<i>Loxodon macrorhinus</i>	Least concern
CTU	Gummy shark	<i>Mustelus antarcticus</i>	Least concern

Species code	Name	Scientific name	IUCN status
DUS	Dusky shark	<i>Carcharhinus obscurus</i>	Endangered
GAG	Tope shark	<i>Galeorhinus galeus</i>	Critically endangered
GAM	Mouse catshark	<i>Galeus murinus</i>	Least concern
HAY	Lined catshark	<i>Halaelurus lineatus</i>	Least concern
HCM	Hooktooth shark	<i>Chaenogaleus macrostoma</i>	Vulnerable
HEE	Snaggletooth shark	<i>Hemipristis elongata</i>	Vulnerable
NTC	Broadnose sevendill shark	<i>Notorynchus cepedianus</i>	Vulnerable
OXY	Angular roughshark	<i>Oxynotus centrina</i>	Vulnerable
RHA	Milk shark	<i>Rhizoprionodon acutus</i>	Vulnerable
SBL	Bluntnose sixgill shark	<i>Hexanchus griseus</i>	Near threatened
SCK	Kitefin shark	<i>Dalatias licha</i>	Vulnerable
SHM	Shark mackerel	<i>Grammatocyclus bicarinatus</i>	Least concern
SMD	Smooth-hound	<i>Mustelus mustelus</i>	Vulnerable
TFM	Whiskery shark	<i>Furgaleus macki</i>	Least concern
TRB	Whitetip reef shark	<i>Triaenodon obesus</i>	Vulnerable
WSH	Great white shark	<i>Carcharodon carcharias</i>	Vulnerable

## Rays

Table 13: List of ray species reported at species level in the nominal catch or ROS data for the period 1950-2022

Species code	Name	Scientific name	IUCN status
PLS	Pelagic stingray	<i>Pteroplatytrygon violacea</i>	Least concern
RMA	Alfred manta (reef manta ray)	<i>Mobula alfredi</i>	Vulnerable
RMB	Giant manta	<i>Mobula birostris</i>	Endangered
RMM	Devil fish	<i>Mobula mobular</i>	Endangered
RMT	Chilean devil ray	<i>Mobula tarapacana</i>	Endangered



## Marine turtles

Table 14: List of marine turtles species susceptible to interactions with tuna and tuna-like species fisheries in the IOTC area of competence

Species code	Name	Scientific name	IUCN status
DKK	Leatherback turtle	<i>Dermochelys coriacea</i>	Vulnerable
FBT	Flatback turtle	<i>Natator depressus</i>	Data deficient
LKV	Olive ridley turtle	<i>Lepidochelys olivacea</i>	Vulnerable
TTH	Hawksbill turtle	<i>Eretmochelys imbricata</i>	Critically endangered
TTL	Loggerhead turtle	<i>Caretta caretta</i>	Vulnerable
TUG	Green turtle	<i>Chelonia mydas</i>	Endangered

## Cetaceans

## Whales

Table 15: List of whale species susceptible to interactions with tuna and tuna-like species fisheries in the IOTC area of competence

Species code	Name	Scientific name	IUCN status
BAW	Arnoux's beaked whale	<i>Berardius arnuxii</i>	Least concern
BBW	Blainville's beaked whale	<i>Mesoplodon densirostris</i>	Least concern
BCW	Cuvier's beaked whale	<i>Ziphius cavirostris</i>	Least concern
BDW	Andrews' beaked whale	<i>Mesoplodon bowdoini</i>	Data deficient
BHW	Hector's beaked whale	<i>Mesoplodon hectori</i>	Data deficient
BLW	Blue whale	<i>Balaenoptera musculus</i>	Endangered
BNW	Longman's beaked whale	<i>Indopacetus pacificus</i>	Least concern
BRW	Bryde's whale	<i>Balaenoptera edeni</i>	Least concern
BSW	Sherpherd's beaked whale	<i>Tasmacetus shepherdi</i>	Data deficient
BYW	Gray's beaked whale	<i>Mesoplodon grayi</i>	Least concern
CPM	Pygmy right whale	<i>Caperea marginata</i>	Least concern
DWW	Dwarf sperm whale	<i>Kogia sima</i>	Least concern
EUA	Southern right whale	<i>Eubalaena australis</i>	Least concern
FAW	False killer whale	<i>Pseudorca crassidens</i>	Near threatened
FIW	Fin whale	<i>Balaenoptera physalus</i>	Vulnerable
HUW	Humpback whale	<i>Megaptera novaeangliae</i>	Least concern
KIW	Killer whale	<i>Orcinus orca</i>	Data deficient
KPW	Pygmy killer whale	<i>Feresa attenuata</i>	Least concern
MIW	Minke whale	<i>Balaenoptera acutorostrata</i>	Least concern
ODN	Toothed whales nei	<i>Odontoceti</i>	N/A
PIW	Long-finned pilot whale	<i>Globicephala melas</i>	Least concern
PYW	Pygmy sperm whale	<i>Kogia breviceps</i>	Least concern
SHW	Short-finned pilot whale	<i>Globicephala macrorhynchus</i>	Least concern
SPW	Sperm whale	<i>Physeter macrocephalus</i>	Vulnerable
SRW	Southern bottlenose whale	<i>Hyperoodon planifrons</i>	Least concern
TGW	Ginkgo-toothed beaked whale	<i>Mesoplodon ginkgodens</i>	Data deficient
TSW	Strap-toothed whale	<i>Mesoplodon layardii</i>	Least concern

**Dolphins**

Table 16: List of dolphin species susceptible to interactions with tuna and tuna-like species fisheries in the IOTC area of competence

Species code	Name	Scientific name	IUCN status
CMD	Commerson's dolphin	<i>Cephalorhynchus commersonii</i>	Least concern
DBO	Bottlenose dolphin	<i>Tursiops truncatus</i>	Least concern
DCO	Common dolphin	<i>Delphinus delphis</i>	Least concern
DDU	Dusky dolphin	<i>Lagenorhynchus obscurus</i>	Least concern
DHI	Indo-Pac. hump-backed dolphin	<i>Sousa chinensis</i>	Vulnerable
DPN	Pantropical spotted dolphin	<i>Stenella attenuata</i>	Least concern
DRR	Risso's dolphin	<i>Grampus griseus</i>	Least concern
DSI	Spinner dolphin	<i>Stenella longirostris</i>	Least concern
DSP	Spotted dolphins nei	<i>Stenella spp</i>	N/A
DST	Striped dolphin	<i>Stenella coeruleoalba</i>	Least concern
FRD	Fraser's dolphin	<i>Lagenodelphis hosei</i>	Least concern
HRD	Hourglass dolphin	<i>Lagenorhynchus cruciger</i>	Least concern
IRD	Irrawaddy dolphin	<i>Orcaella brevirostris</i>	Endangered
RSW	Southern right whale dolphin	<i>Lissodelphis peronii</i>	Least concern
RTD	Rough-toothed dolphin	<i>Steno bredanensis</i>	Least concern

## Seabirds

Table 17: List of seabird species susceptible to interactions with tuna and tuna-like species fisheries in the IOTC area of competence

Species code	Name	Scientific name	IUCN status
ALZ	Albatrosses nei	<i>Diomedeidae</i>	N/A
DAC	Cape petrel	<i>Daption capense</i>	Least concern
DAM	Amsterdam Island albatross	<i>Diomedea amsterdamensis</i>	Endangered
DBN	Tristan albatross	<i>Diomedea dabbenena</i>	Critically endangered
DCR	Atlant. yellow-nosed albatross	<i>Thalassarche chlororhynchus</i>	Endangered
DCU	Shy albatross	<i>Thalassarche cauta</i>	Near threatened
DER	Chatham Islands albatross	<i>Thalassarche eremita</i>	Vulnerable
DIB	Buller's albatross	<i>Thalassarche bulleri</i>	Near threatened
DIC	Grey-headed albatross	<i>Thalassarche chrysostoma</i>	Endangered
DIM	Black-browed albatross	<i>Thalassarche melanophris</i>	Least concern
DIP	Southern royal albatross	<i>Diomedea epomophora</i>	Vulnerable
DIQ	Northern royal albatross	<i>Diomedea sanfordi</i>	Endangered
DIX	Wandering albatross	<i>Diomedea exulans</i>	Vulnerable
DKS	Salvin's albatross	<i>Thalassarche salvini</i>	Vulnerable
DQS	Antipodean albatross	<i>Diomedea antipodensis</i>	Endangered
MAH	Hall's giant petrel	<i>Macronectes halli</i>	Least concern
MAI	Antarctic giant petrel	<i>Macronectes giganteus</i>	Least concern
MWE	Cape gannet	<i>Morus capensis</i>	Endangered
PCI	Grey petrel	<i>Procellaria cinerea</i>	Near threatened
PCW	Westland petrel	<i>Procellaria westlandica</i>	Endangered
PDM	Great-winged petrel	<i>Pterodroma macroptera</i>	Least concern
PFC	Flesh-footed shearwater	<i>Ardenna carneipes</i>	Near threatened
PFG	Sooty shearwater	<i>Ardenna grisea</i>	Near threatened
PFT	Short-tailed Shearwater	<i>Puffinus tenuirostris</i>	N/A
PHE	Light-mantled sooty albatross	<i>Phoebetria palpebrata</i>	Near threatened
PHU	Sooty albatross	<i>Phoebetria fusca</i>	Endangered
PRO	White-chinned petrel	<i>Procellaria aequinoctialis</i>	Vulnerable
TQH	Indian yellow-nosed albatross	<i>Thalassarche carteri</i>	Endangered
TQW	Campbell albatross	<i>Thalassarche impavida</i>	Vulnerable
TWD	White-capped albatross	<i>Thalassarche steadi</i>	Near threatened