REVIEW OF THE STATISTICAL DATA AVAILABLE FOR BYCATCH SPECIES

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Purpose

To provide participants at the Data Preparatory meeting of the 17th Session of the IOTC Working Party on Ecosystems and Bycatch (WPEB17(DP)) 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 March 2021 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.

Background

Overview of data reporting requirements

The data reporting requirements for bycatch species vary according to species category and fishing gear and changed over time with the advent of new resolutions (**Fig. 1**).

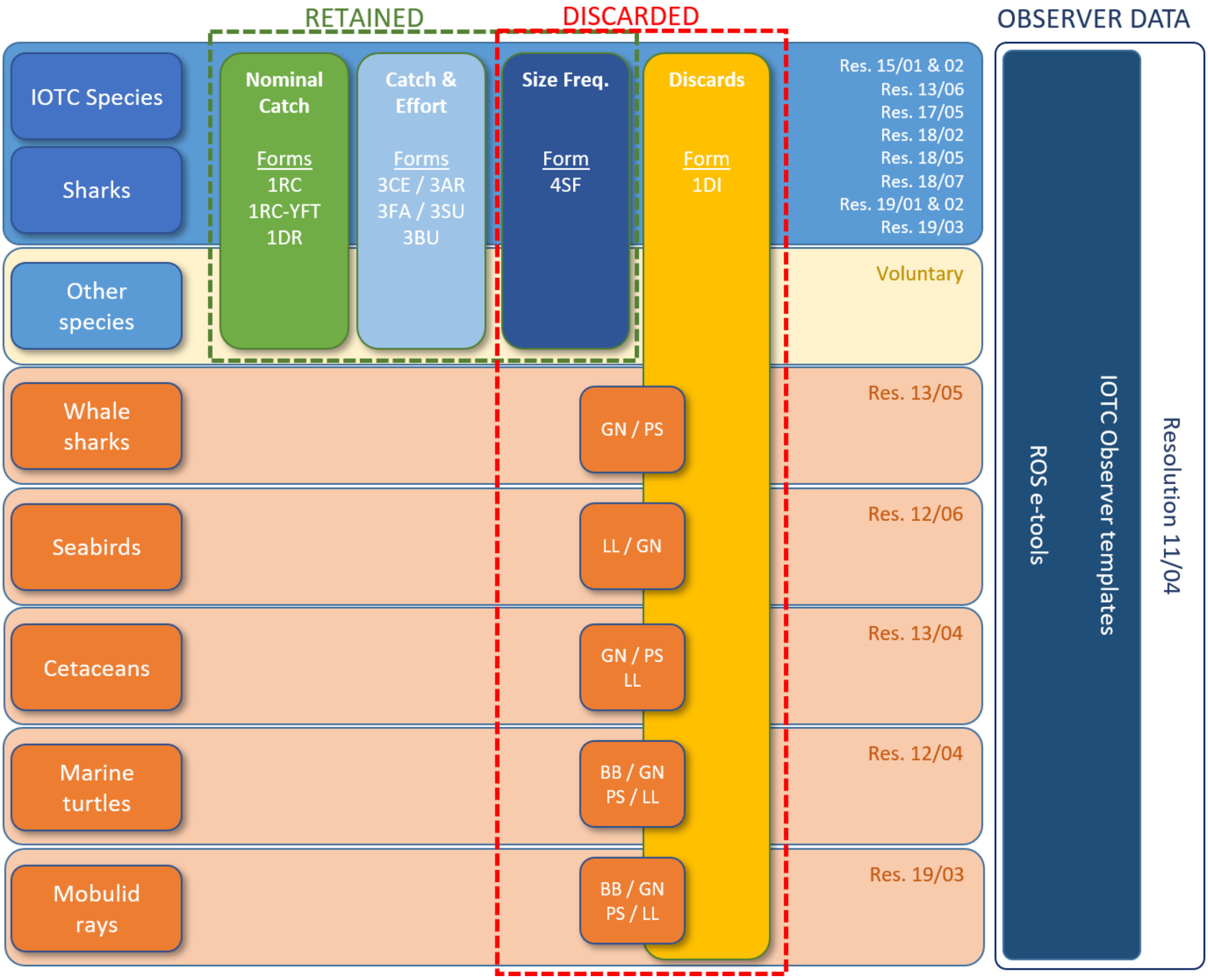

Fig. 1. Overview of the data reporting requirements, including IOTC reporting forms and tools, and resolutions for the 16 IOTC species and bycatch species caught or interacted with by fisheries for tuna and tuna-like species in the IOTC area of competence. BB = Baitboat; GN = Gillnet; LL = Longline; PS = Purse seine

The data requirements for each species category are described in each of the IOTC Resolutions listed in **Fig. 1** which are available from the IOTC website. The set of recommended IOTC forms developed by the IOTC Secretariat aim to ensure the comprehensiveness and completeness of the metadata and data sets to be submitted along with the consistency with the code lists used in the IOTC databases.

In addition, Resolution 11/04 on a *Regional Observer Scheme* (ROS) makes provision for the development and implementation of national observer schemes among the IOTC CPCs starting in 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 (species composition and quantities, live and processed weight and location). A first technical description of the ROS data requirements is available in the document IOTC–2018–WPDCS-35 Rev_2.

Sharks and rays

The same standards as those existing for IOTC species apply to the most commonly caught species of sharks and rays:

- Nominal catch data, which are highly aggregated statistics for each species estimated per fleet, gear and year for a large area (West / East Indian Ocean). If these data are not reported, the Secretariat attempts to estimate the total catch through alternative means, although this is not possible in many cases. A range of sources is used for this purpose, which includes: partial catch and effort data; data in the FAO FishStat database; catches estimated by the IOTC from data collected through port sampling as well as data published through web pages or other means.
- Catch-and-effort data, which refer to the fine-scale data, usually from logbooks, and reported per fleet, year, gear, type of school, month, grid and species. Information on the use of fish aggregating devices (FADs) and support vessels is also collected.
- Size frequency data, which refer to individual body lengths or weights of IOTC and bycatch species per fleet, year, gear, type of school, month and 5 degrees square areas.
- Observer data, which refer to fine-scale data as collected by scientific observers onboard vessels authorised to operate in the IOTC area, and reported at the end of each observer trip.

Seabirds, marine turtles, cetaceans, and other species

For seabirds, marine turtles, cetaceans, and all other species, similar standards apply and result in the reporting of:

- Total bycatch which are highly aggregated statistics for all species combined or, where available, by species, estimated per fleet, gear and year for the whole IOTC area.
- Catch-and-effort and observer data as for sharks.

Status of reporting

The most common bycatch species with mandatory reporting requirements and other species for which reporting is encouraged are listed in **Table 1**, which summarises those bycatch species identified by the Commission as relevant for the most common gears as indicated by IOTC Resolution 15/01 *On the recording of catch and effort data by fishing vessels in the IOTC area of competence by type of fishery*.

Table 1. 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 trolling (TR). e = encouraged; 08 = Res. 08/04; 13 = Res. 13/03; 15 = Res. 15/01; 19 = Res. 19/03

Common name	Scientific name	Species code	PS	LL	GN	BB	HL	TR
Blue shark	*Prionace glauca*	BSH		08	13			
Mako sharks	*Isurus spp.*	MAK; SMA; LMA		08	13			
Porbeagle	*Lamna nasus*	POR		08	13			
Hammerhead sharks	*Sphyrna spp.*	SPN; SPL; SPK; SPZ		13	13			
Whale shark	*Rhincodon typus*	RHN	13		13			
Thresher sharks	*Alopias spp.*	THR; PTH; ALV; BTH	13	13	13			
Oceanic whitetip shark	*Carcharhinus longimanus*	OCS	13	13	13			
Crocodile shark	*Pseudocarcharias kamoharai*	PSK		e	e			
Silky shark	*Carcharhinus falciformis*	FAL	15	15				

Common name	Scientific name	Species code	PS	LL	GN	BB	HL	TR
Tiger shark	*Galeocerdo cuvier*	TIG		e	e			
Great white Shark	*Carcharodon carcharias*	WSH		e				
Pelagic stingray	*Pteroplatytrygon violacea*	PSL		e	e			
Mobula NEI	*Mobula spp.*	RMV; RMB; RMM	19	19	19	19		
Other sharks		SKH	e	08	13	13	13	13
Rays, stingrays, mantas		SRX	e	e	e	13	13	13
Other marine fish NEI		MZZ	e	08	13	13	13	13
Marine turtles		TTX	13	13	13	13	13	13
Seabirds				13	13			
Cetaceans			13	13	13			

The data sets reported to the Secretariat as described in **Table 1** and used in the present report include:

- Nominal catch data for shark and ray species, including those reported as aggregates
- Catch and effort data for shark and ray species, including those reported as aggregates
- Size frequency data for shark and ray species
- Estimates of total incidental catches of marine turtles and cetaceans
- Estimates of total incidental catches of seabirds from longline and gillnet fisheries.

In addition, the document IOTC-2020-WPEB16-08 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.

Overall, the collection and reporting of catches of sharks and rays caught in association with species managed by the IOTC (tuna and tuna-like species) has been very inconsistent over time and so the information on the bycatch of sharks and rays gathered in the IOTC databases is thought to be highly incomplete. The list of shark and ray species reported in Indian Ocean fisheries directed at IOTC species or pelagic sharks is provided in **Appendix I**.

Overall reported levels of bycatch

Reported total nominal catches of all species caught by Indian Ocean fisheries have been increasing over time, with a particularly dramatic increase in the amount of tuna catches reported since the 1980s (**Fig. 2**).

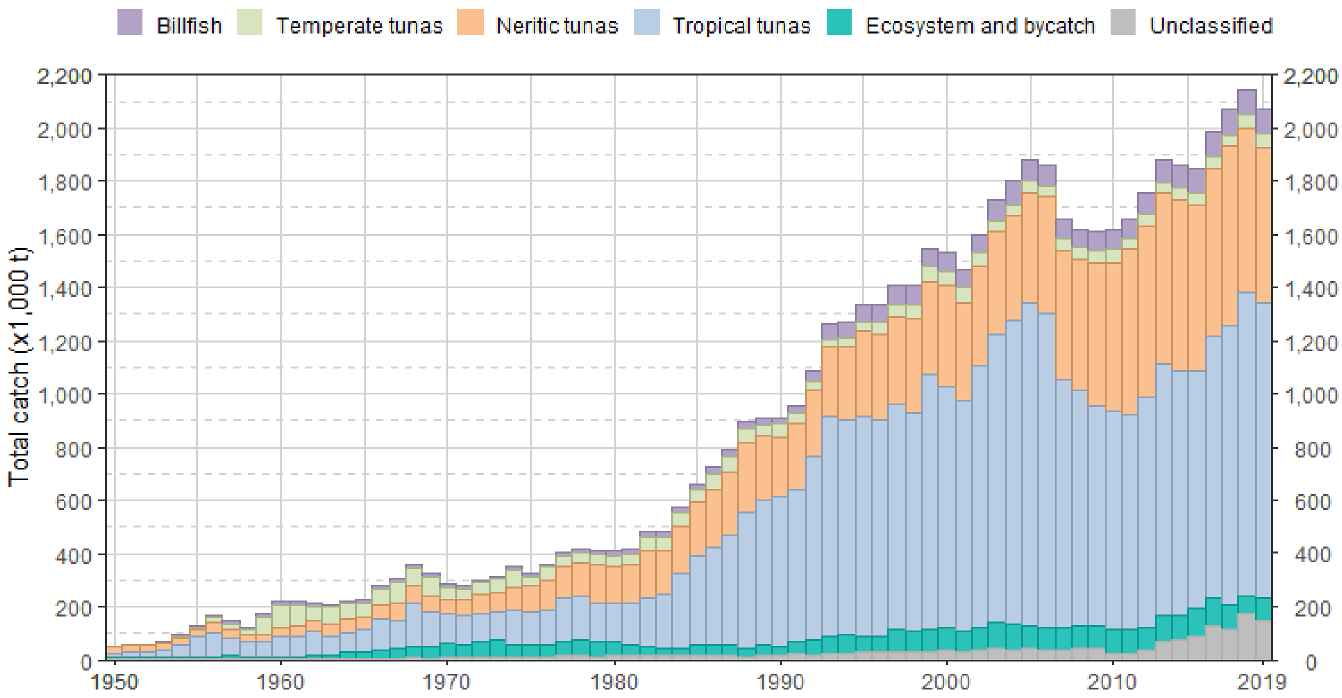

Fig. 2. Annual time series of nominal catches (t) of all species during 1950-2019. The colours reflect the Working Party of interest for a specific fraction of catches from reported species

Reported nominal catches of species of interest to the WPEB are largely predominated by sharks with some estimates from some artisanal fisheries dating back to the early 1950s (**Fig. 3**). Overall reported catches of shark and ray species have increased over time in relation to the development of the fisheries, the increased reporting requirements for some sensitive species such as thresher and oceanic whitetip sharks, and the implementation of retention bans in some fisheries. Rays represent a very small component of the reported bycatch as the seven species and groups of species of rays represented less than 1,000 t of annual nominal catch during the period 2010-2019, contributing to about 1% of the reported shark and ray catches (**Fig. 3**).

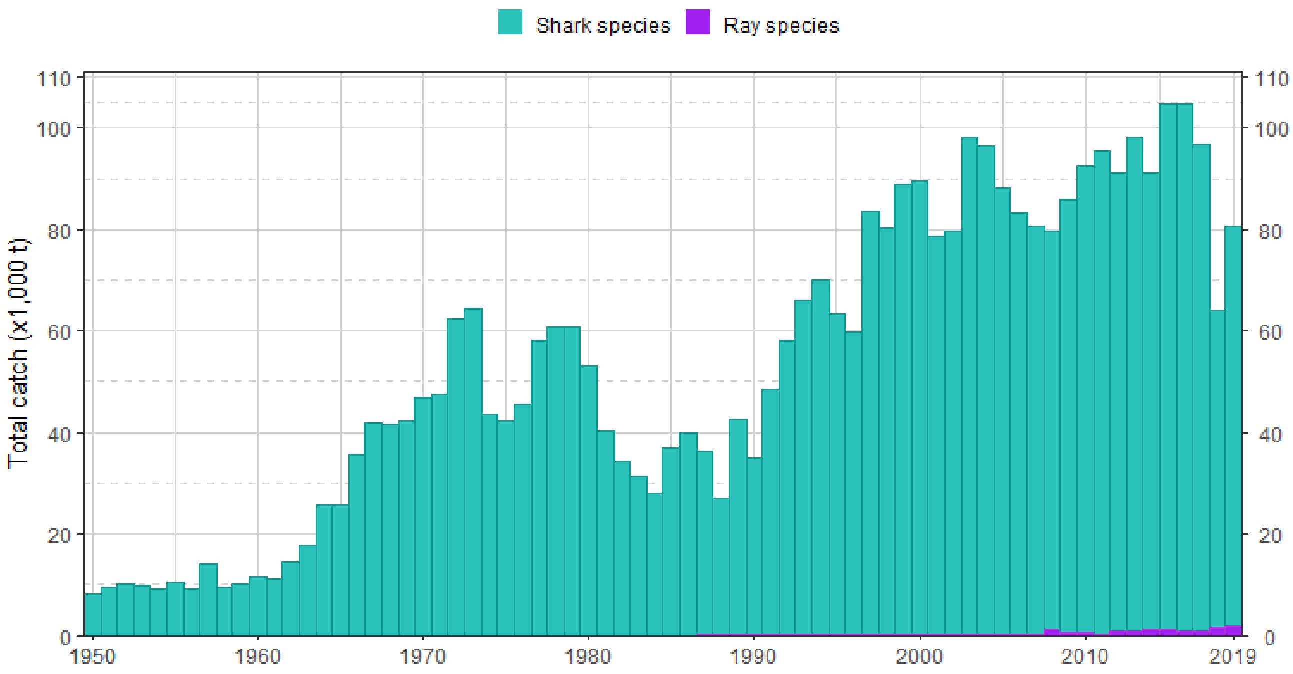

Fig. 3. Annual time series of nominal catches (t) of sharks and rays during 1950-2019

Summary of fisheries data available for sharks and rays

Data available on the total nominal catches of sharks and rays in the Indian Ocean

Very few fleets reported catches of sharks and rays in the 1950s, but the number of reporting fleets has increased over time (**Fig. 4**). Total reported shark and ray catches have also increased over time, reaching a peak of more than 100,000t in 2015-2016: since then, nominal catches have decreased to about 80,000 t in 2019. In 2018, shark and ray catches reduced significantly when compared with 2017 mostly due to a complete disappearance of reported catches of aggregated shark species by India (not replaced by detailed catches by species) as well as marked decreases in reported shark catches from other CPCs (Mozambique and Indonesia) which in some cases are thought to indicate reporting issues rather than real reduction in catch levels. Furthermore, the 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 during the relevant period when compared to previously available data.

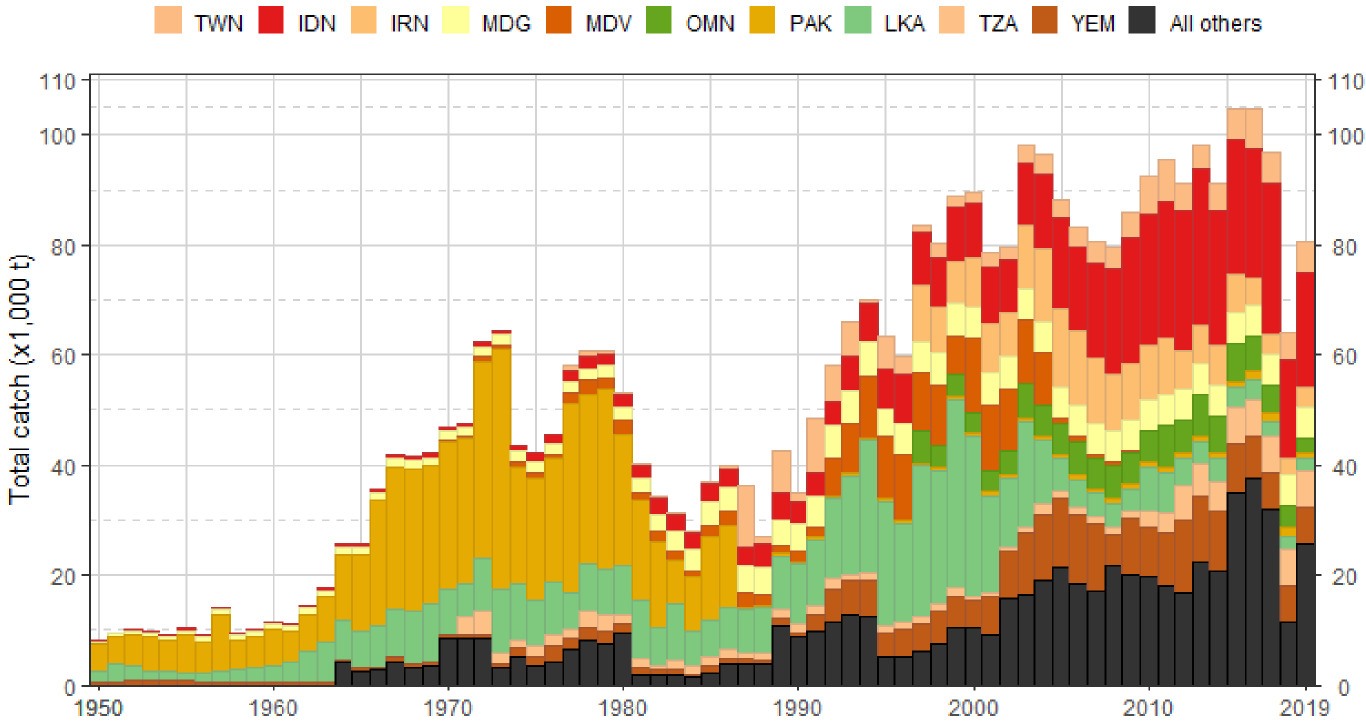

Fig. 4. Annual time series of nominal catches (t) of sharks and rays by CPC and fishing entity during 1950–2019

Given the historically low reporting rates and a tendency to report catches for aggregated shark species, nominal catch data should be considered with caution. In addition, catches that have been reported are thought to represent only those species that are retained onboard without considering discards. 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. Nevertheless, reporting rates in recent years have improved substantially following the adoption by the Commission of new measures on sharks and other bycatch, which call for IOTC CPCs to collect and report more detailed statistics on bycatch species to the IOTC Secretariat (**Table 1**).

Main reported gear types associated with shark and ray bycatch for IOTC fisheries

Levels of nominal catches reported strongly vary with fishing gear (**Fig. 5**). Gillnets are historically associated with the highest nominal catches of sharks and rays and are currently responsible for almost 50% of reported catches. They are followed by longline fisheries which contributed substantially to shark and ray catches in the 1990s, then by catches from handline and troll line fisheries which have increased in more recent years. 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. Other CPCs including Oman, Indonesia and Mozambique have also reported marked decreases in generalized shark catches. Of the gillnet fisheries, the majority comprise of standard, unclassified gillnets, followed by gillnets, handlines and troll lines and gillnet/longline combinations. Purse seine fisheries report low catches of sharks, mainly because most sharks caught are discarded at sea. Baitboat fisheries also report very low levels of shark catches retained onboard, which is mainly due to the high selectivity of this fishing gear (Miller et al. 2017).

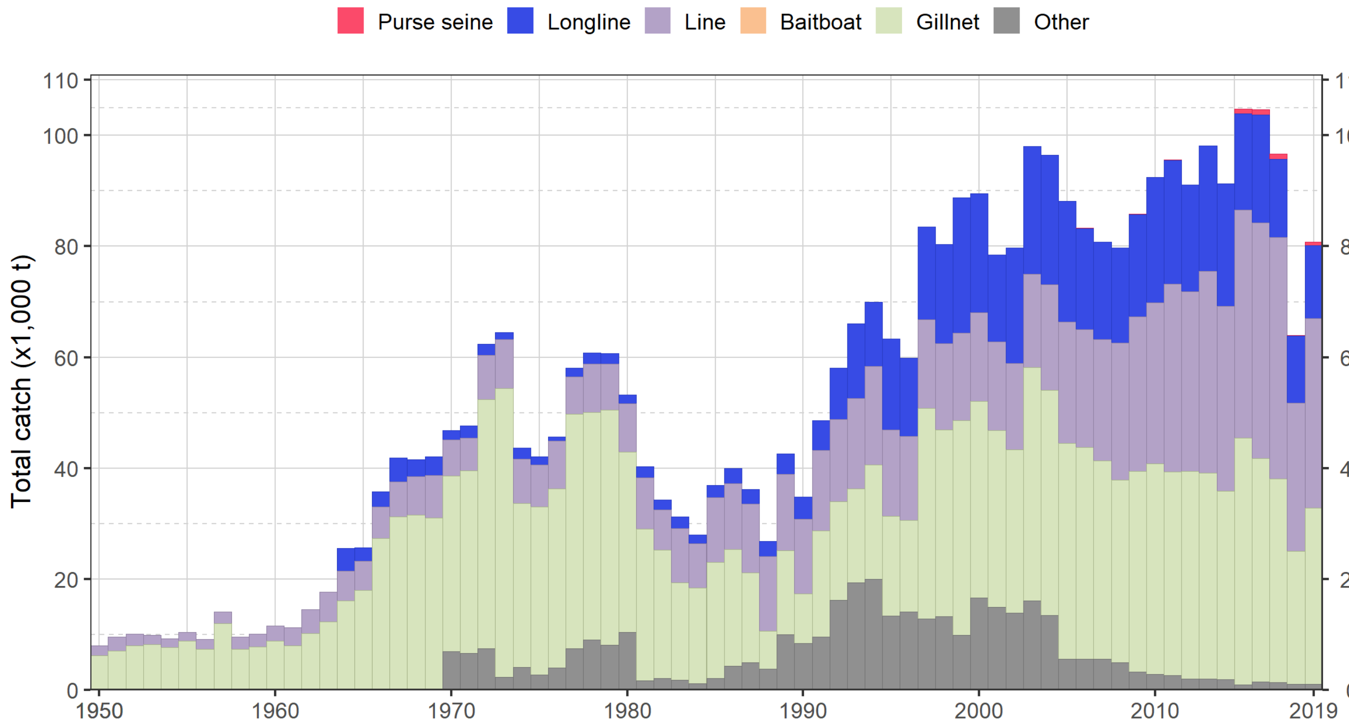

Fig. 5. Annual time series of nominal catches (t) of sharks and rays reported by fishery group during 1950–2019. Other = all other fisheries combined

During 2015-2019, Indonesia contributed an average of about 25% of the catches of sharks and rays retained and reported to the Secretariat, with a mean annual catch of about 23,000 t mainly caught by coastal longliners (**Fig. 6**). India also reported relatively high levels of catches of sharks (15,000-23,000 t / year excluding 2018) which were mainly caught with gillnets and trolling lines. Shark nominal catches from coastal fisheries of Yemen (gillnets, hand lines and trolling lines) are also thought to be important although they are widely uncertain.

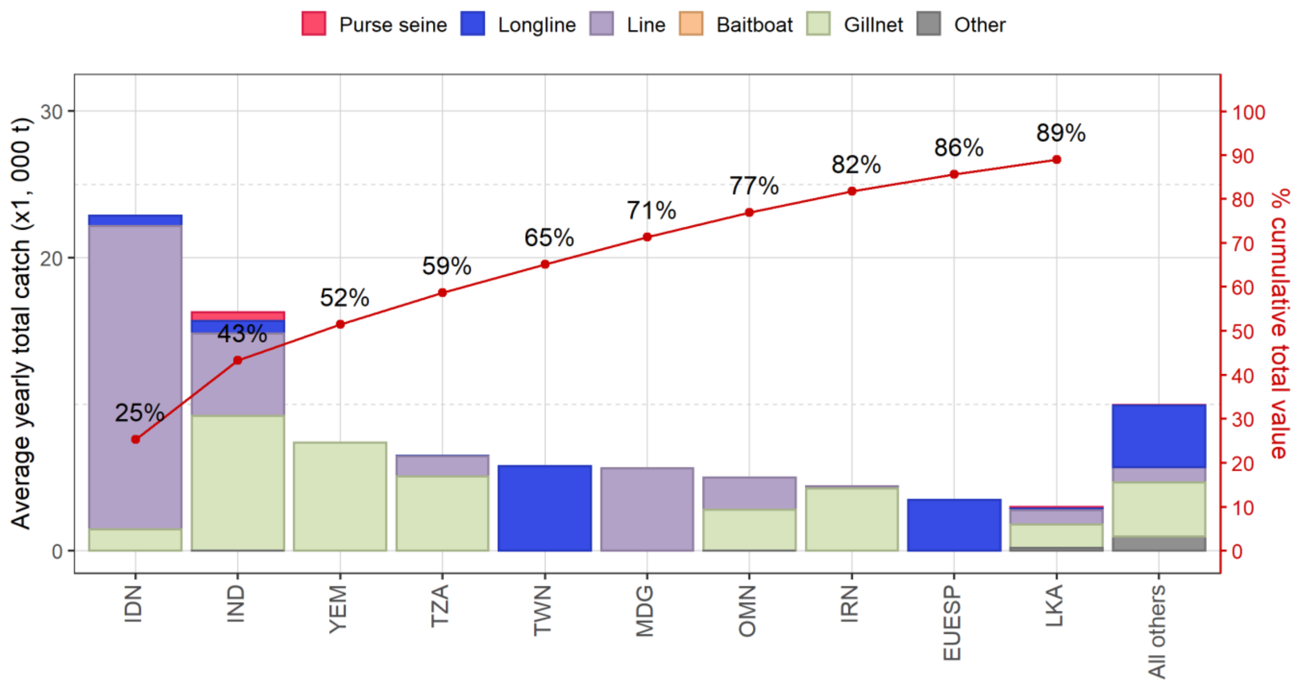

Fig. 6. Mean nominal catches (t) of sharks and rays over the period 2015–2019, by type of fishery and CPC ordered according to the importance of catches. The solid line indicates the cumulative percentage of the total combined catches of the species for the CPCs concerned

Species of sharks and rays caught in IOTC fisheries

In addition to an increase in reported catch levels of shark and rays over time (**Fig. 3**), the resolution of the data has improved, with an increased proportion of reported shark and ray catches identified to species/genus level (**Fig. 7**). In 2018 there was a large reduction in the percentage of shark catch data reported as aggregated compared with the previous years (2016-2017) during which India had reported more than 20,000 t of aggregated sharks annually. In 2019, more than 15,000 t of unclassified shark species were again reported to have been caught in the gillnet and line fisheries of India.

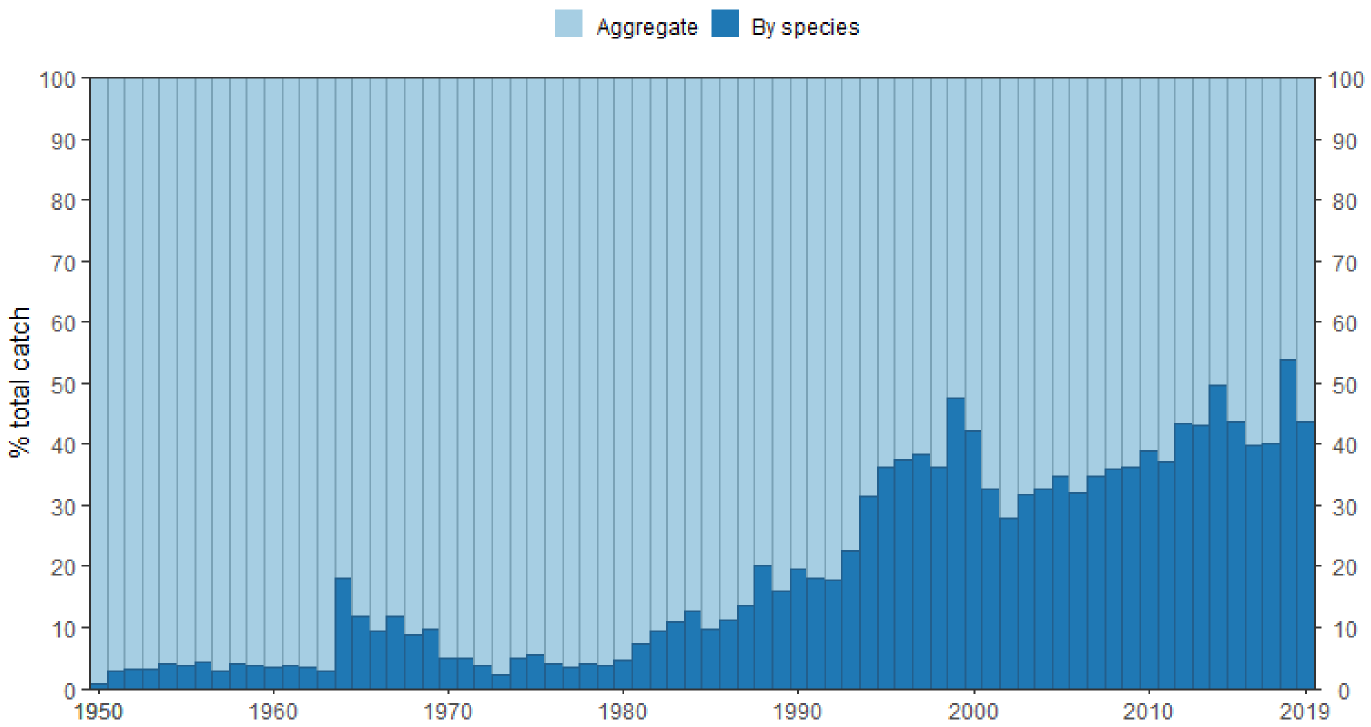

Fig. 7. Annual percentage of shark and ray catches reported as aggregated or by species

Of the 52 shark species reported at the species level, blue shark (BSH) forms the greatest proportion, comprising about 61% of total catches during 1950-2019. Over the whole period, silky shark (FAL) and shortfin mako shark (SMA) represented 23% and 6% respectively of the total shark catches reported at species level, with all remaining species combined contributing a very small percentage overall (**Fig. 8**). When shark species reported at the genus level are considered, the overall contribution of blue shark decreases to 50% over the period and the genera *sphyrna* (SPK, SPL, SPN, SPZ), *alopias* (ALV, BTH, PTH, THR), and *isurus* (MAK, SMA, LMA) represent 10%, 9%, and 9% of the total shark catches, respectively.

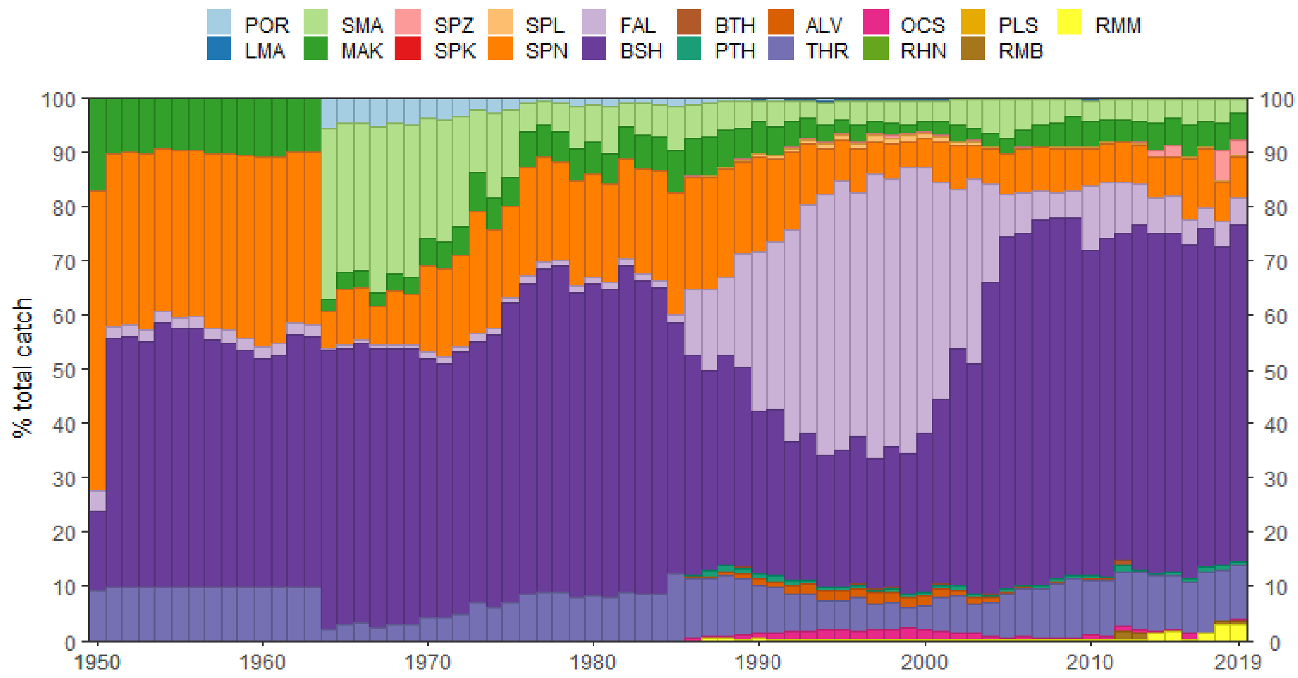

Fig. 8. Annual percentage of nominal catches by species for the catch component of the main sharks and rays reported at species and genus level

The temporal trends in annual nominal catches of sharks and rays reported to the Secretariat strongly differ between species (**Fig. 9**). Blue shark shows a steady increase in reported catches from the early 1950s and exceeded 30,000 t in 2013, before dropping to about 25,000 t in 2019. It is noteworthy that the catches of BSH are predominantly reported by coastal longliners of Indonesia which are estimated by the Secretariat from the total reported catches of sharks by applying an average species composition derived from historical literature and catch samples (White 2007, Moreno et al. 2012). The similar temporal trend observed in the nominal catch series of silky shark (FAL), oceanic whitetip shark (OCS), common thresher (ALV), scalloped hammerhead (SPL), and longfin mako (LMA) is driven by the Sri Lankan longline-gillnet fisheries. For these species, the catches show an increasing trend from the early 1990s that reached a peak in 1999, before showing a steady decline as a consequence of the adoption of management measures requiring the landing of shark carcasses along with the fins (Herath 2012).

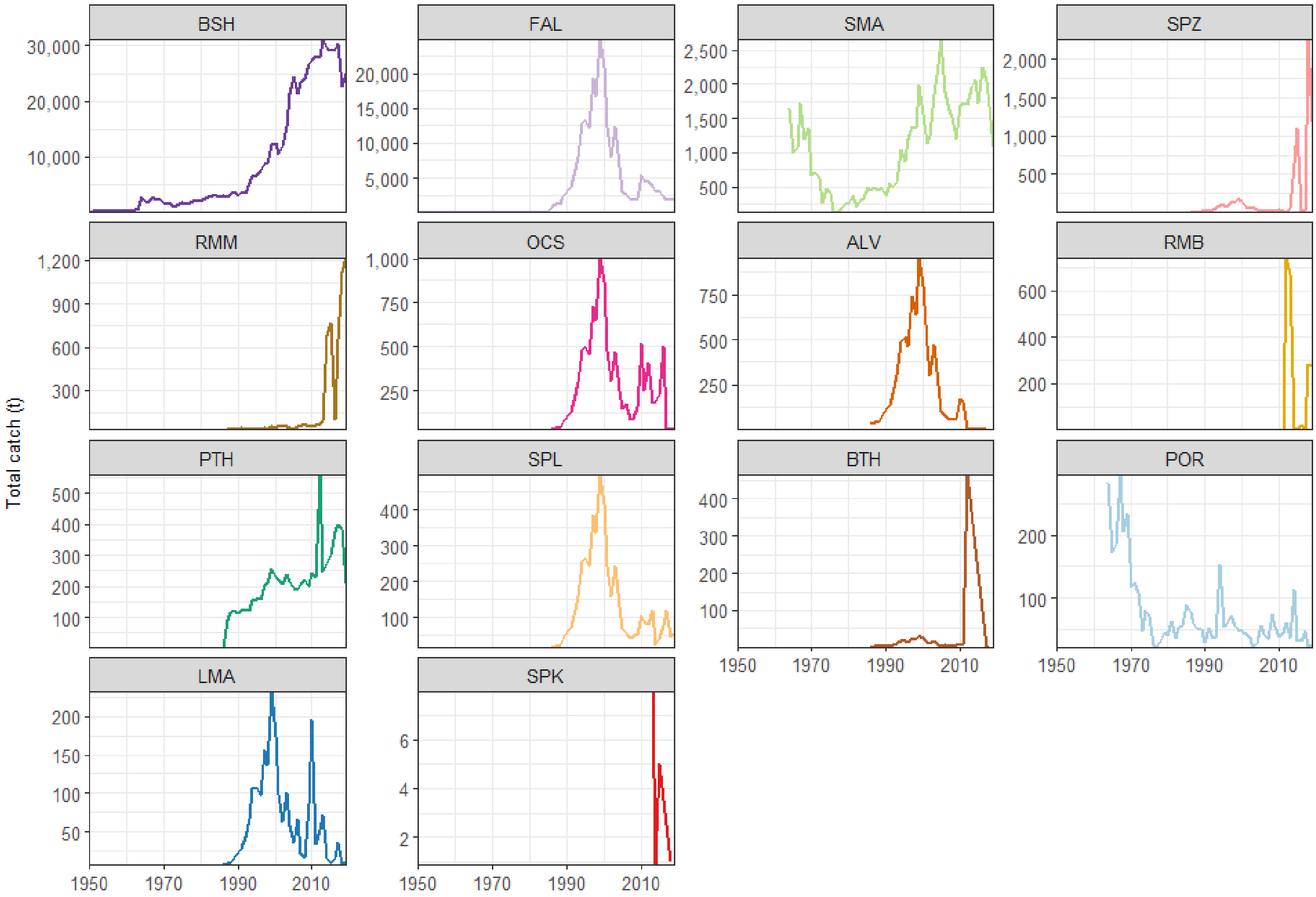

Fig. 9. Total nominal catches (t) of the main sharks and rays reported at species level for all fleets (1950-2019)

Longline fleets reported predominantly blue shark catches, 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 troll lines reported relatively high catches of hammerhead sharks. Reporting by species is very uncommon for gillnet fleets, where most shark catches are reported as aggregates.

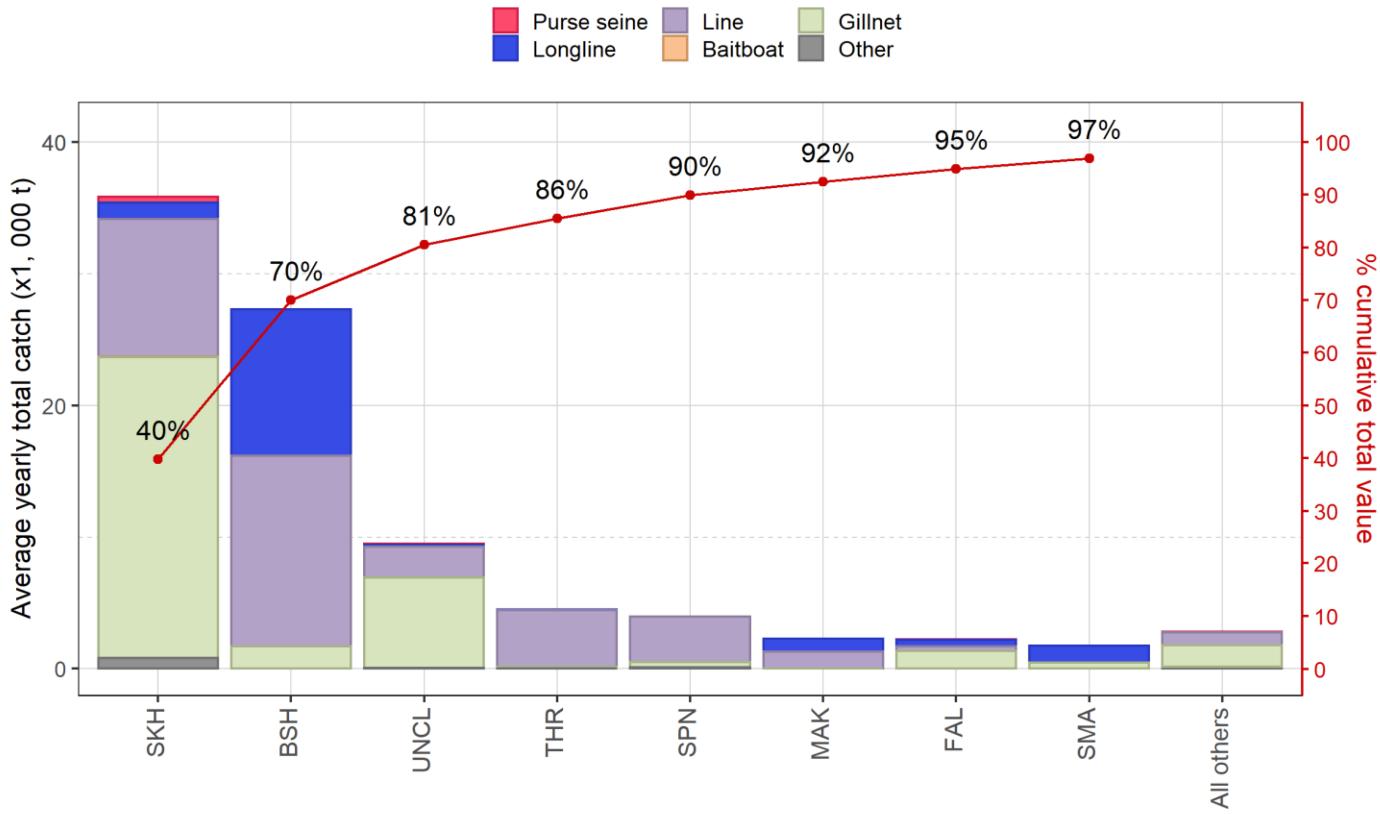

Fig. 10. Mean nominal catches (t) of sharks and rays over the period 2015–2019, by type of fishery and species ordered according to the importance of catches. The solid line indicates the cumulative percentage of the total combined catches of the species for the species concerned

Catch levels of sharks and ray by IOTC fleets

Overall, while industrial longliners and drifting gillnetters are known for harvesting important amounts of pelagic sharks, the same cannot be said of industrial purse seiners, pole and liners or most coastal fisheries.

- **Baitboat fisheries**: shark catches reported for the pole and line fisheries of Maldives and India are very low: the extent of shark catches taken by these fisheries has been shown to be not significant (Miller et al. 2017).
- **Gillnet fisheries**: the species of sharks and rays caught are thought to vary significantly depending on the area of operation of the gillnets (Moazzam 2012):
  - **Gillnets operating in areas with low concentrations of pelagic sharks**: the gillnet fisheries of most coastal countries operate these gears in coastal waters, where the abundance of pelagic sharks is thought to be low.
  - **Gillnets operating in areas with high concentrations of pelagic sharks**: gillnets operated in Sri Lanka, Indonesia and Yemen (waters around Socotra), in spite of being set in coastal areas, are likely to catch significant amounts of pelagic sharks (Fahmi & Dharmadi 2015).
  - **Gillnets operating on the high seas**: vessels from Taiwan,China were using drifting gillnets (driftnets) from 1982 to 1992, before the use of this gear was banned worldwide, and catches of pelagic sharks from the fishery were very high during this period. Driftnet vessels from I.R. Iran and Pakistan have been fishing on the high seas since but with lower catch rates: while initially setting in waters of the Arabian Sea, in recent years they expanded their range of operation to include the tropical waters of the western Indian Ocean and Mozambique Channel. The quantity of sharks caught by these fleets is thought to be relatively high, representing between 25–50% of the total combined catches of sharks and other species.

- **Gillnet/longline fishery of Sri Lanka**: between 1,200 and 3,200 vessels (with an average length of 12 m) operating a combination of gillnets and longlines have been harvesting important levels of pelagic sharks since the mid-1980s. The longlines are believed to be responsible for most of the catches of sharks, which comprised ~45% of the total combined catch for all species in 1995 declining to <2% in the late 2000s. The fleet has been shifting towards predominantly longline gear in recent years, but most catches are still reported as aggregates of the combined gears.

- **Fisheries using handlines**: the majority of fisheries using hand lines and trolling in the Indian Ocean operate these gears in coastal waters, so although the total proportion of sharks caught has been historically high, the amount of pelagic sharks caught are thought to be low. The proportion of other species of sharks might change depending on the area fished and time of the day.

- **Deep-freezing tuna longliners and fresh-tuna longliners**: catches of sharks are thought to represent between 10–40% of the total combined catch for all species (Huang & Liu 2010, Oliver et al. 2015). However, the catches of sharks recorded in the IOTC database only make up a small proportion of the total catches of all species by longline fleets. These catch series' for sharks are, therefore, thought to be very incomplete. Nevertheless, levels of reporting have improved in recent years, following the implementation of catch monitoring schemes in different landing ports of fresh-tuna longliners, and the recording of catches of main species of sharks in logbooks and observer programmes. The catches estimated, however, are unlikely to represent the total catches of sharks for these fisheries due to the paucity of information on the level of discards of sharks, which are thought to be high in some areas and for some species.

- **Freezing (fresh) swordfish longliners**: catches of sharks are thought to represent between 40–60% of the total combined catch for all species (Ariz et al. 2006, Petersen et al. 2009). The amount of sharks caught by longliners targeting swordfish in the IOTC area of competence has been increasing since the mid-1990s, with catches of sharks recorded for these fleets thought to be more realistic than those recorded for other longline fisheries. The high catch levels are thought to be due to:

  - **Gear configuration and time fished:** vessels targeting swordfish use surface longlines and set the lines at dusk or during the night. Many pelagic sharks are thought to be abundant at these depths and most active during dusk or night hours.

  - **Area fished:** fleets targeting swordfish have been deploying most of the fishing effort in the Southwest Indian Ocean, in the vicinity of South Africa, southern Madagascar, Reunion and Mauritius. Large amounts of sharks are thought to occur in these areas.

  - **Changes in the relative amounts of swordfish and sharks in the catches:** some vessels are known to alternate between targeting swordfish and sharks (particularly blue sharks) depending on the season, or when catch rates of swordfish are poor.

- **Industrial tuna purse seiners**: catches of sharks are thought to represent less than 0.5% of the total combined catch for all species and vary according the type of school association (Amandè et al. 2012, Fonteneau et al. 2013, Clavareau et al. 2020). Limited nominal catch data have been reported for the purse seine fleets but a large amount of information is available from observations at sea (Ruiz et al. 2018, Grande et al. 2019).

- **Trolling fisheries**: the majority of fisheries trolling in the Indian Ocean operate in coastal waters so the amounts of pelagic sharks caught are thought to be low. The proportion of the total catch of tuna and tuna-like species that other species of shark make up might change depending on the area fished and the time of day.

Spatial information on sharks and rays' catches

Geo-referenced catches of sharks and rays are reported in both numbers and weight of fish and generally represent only a subset of the nominal catches reported by fleet and gear for each species. Due to the general lack of information on the size composition of the catch, the catches cannot be converted into a common unit and maps of spatial distribution of the catches are provided for both numbers and weights. Overall, the distribution of the catches of sharks and rays shows the 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. 11-12a-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 shark and ray 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. 12c**). The number of CPCs reporting information on retained catches of sharks and rays increased throughout the 2000s and 2010s as well as the proportion of catch reported at species level (**Figs. 13-14**). In 2019, aggregated species represented less than 10% of the total geo-referenced catches reported in number and less than 20% of the catches reported in weight.

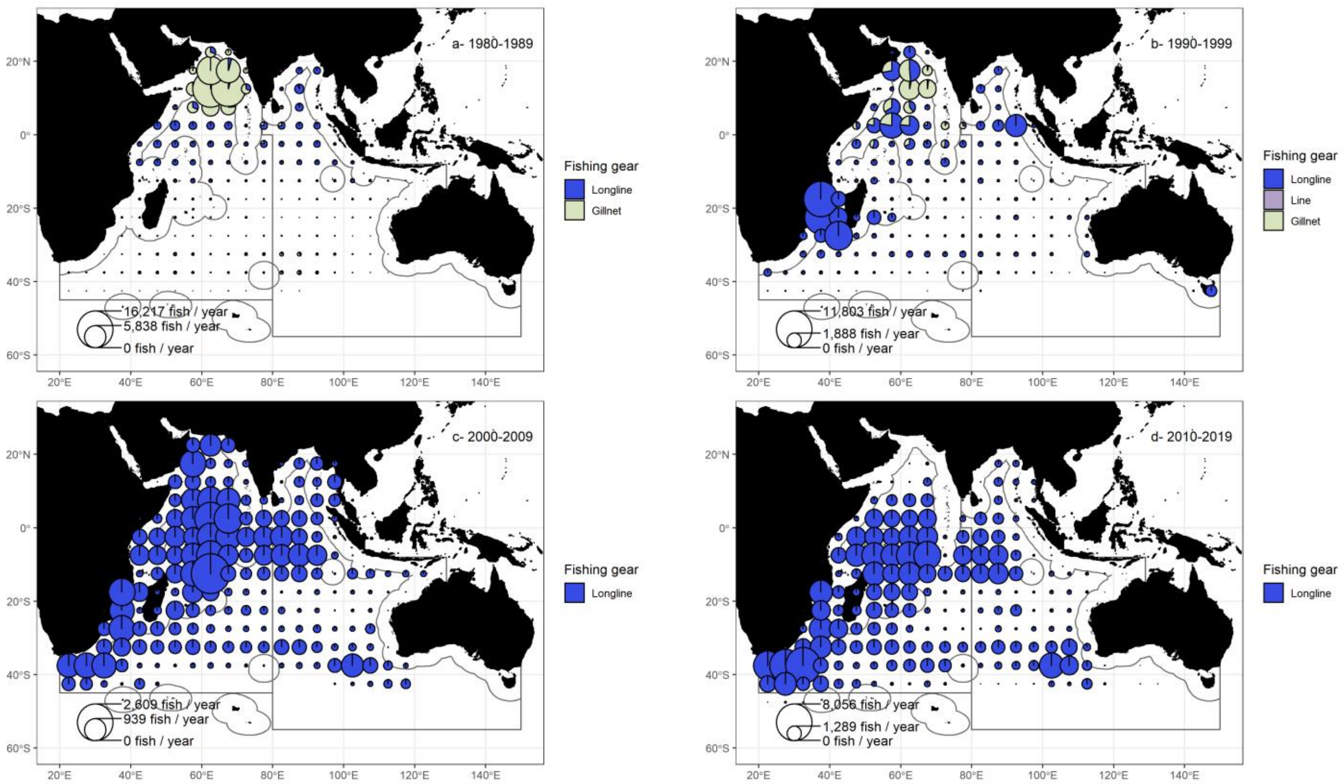

Fig. 11. Mean annual retained catches by number of sharks and rays by fishing gear and decade reported to the Secretariat covering the period 1980-2019

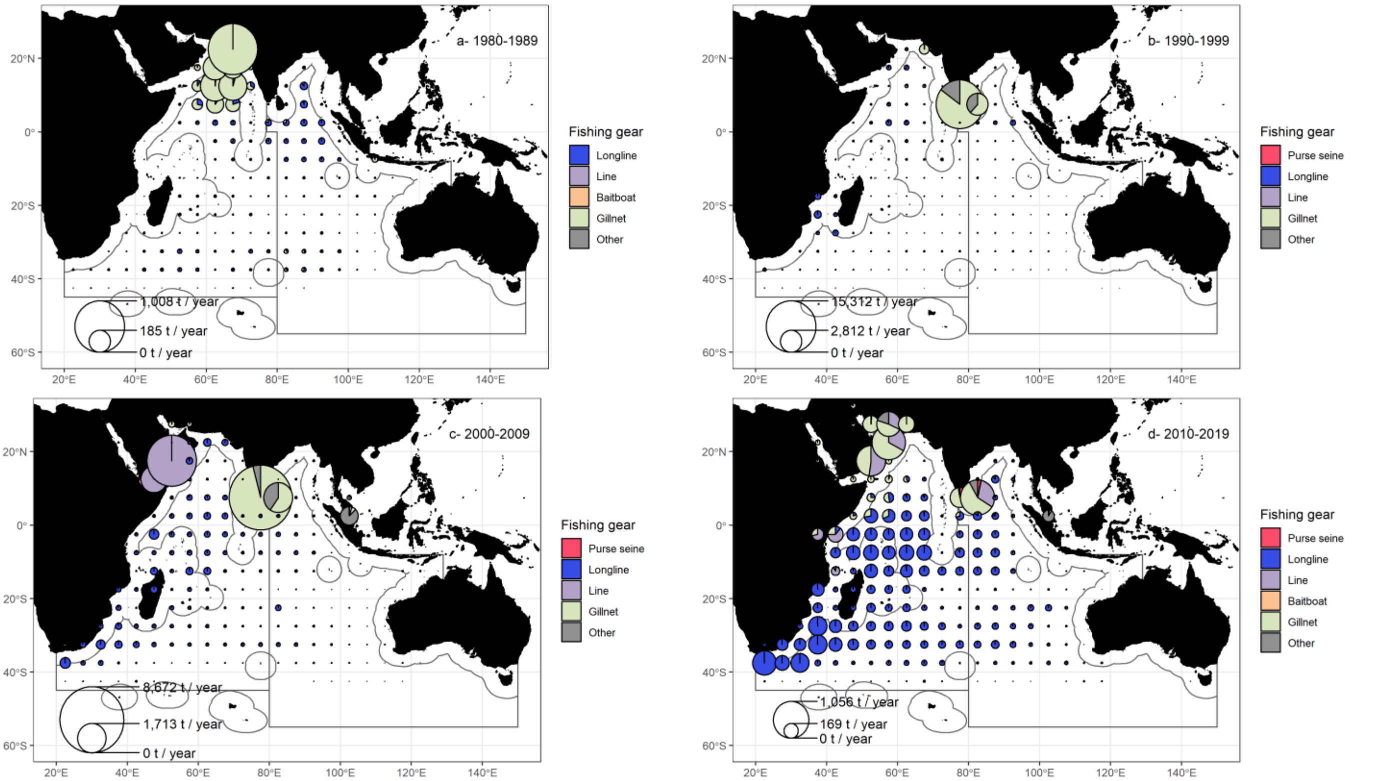

Fig. 12. Mean annual retained catches by weight (t) of sharks and rays by fishing gear and decade reported to the Secretariat covering the period 1980-2019

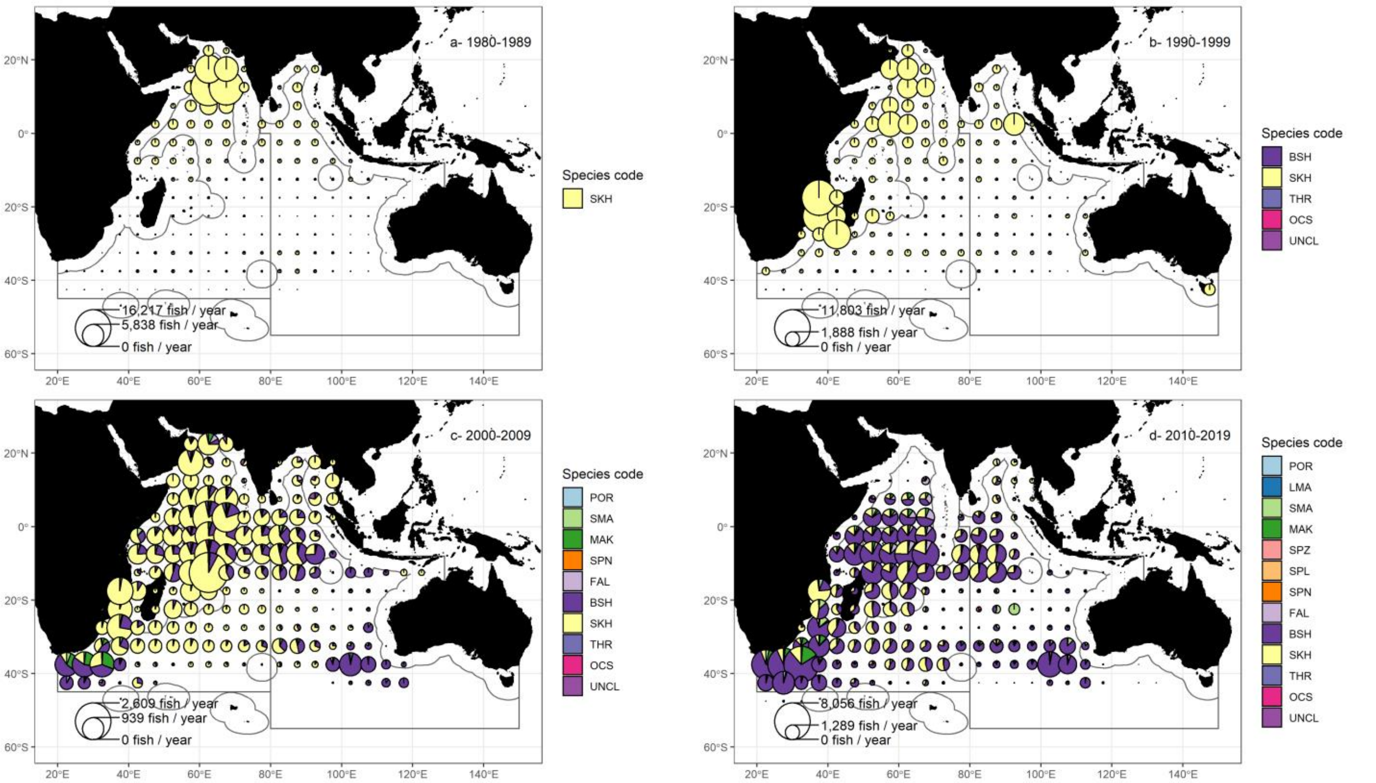

Fig. 13. Mean annual retained catches by number of sharks and rays by species and decade reported to the Secretariat covering the period 1980-2019

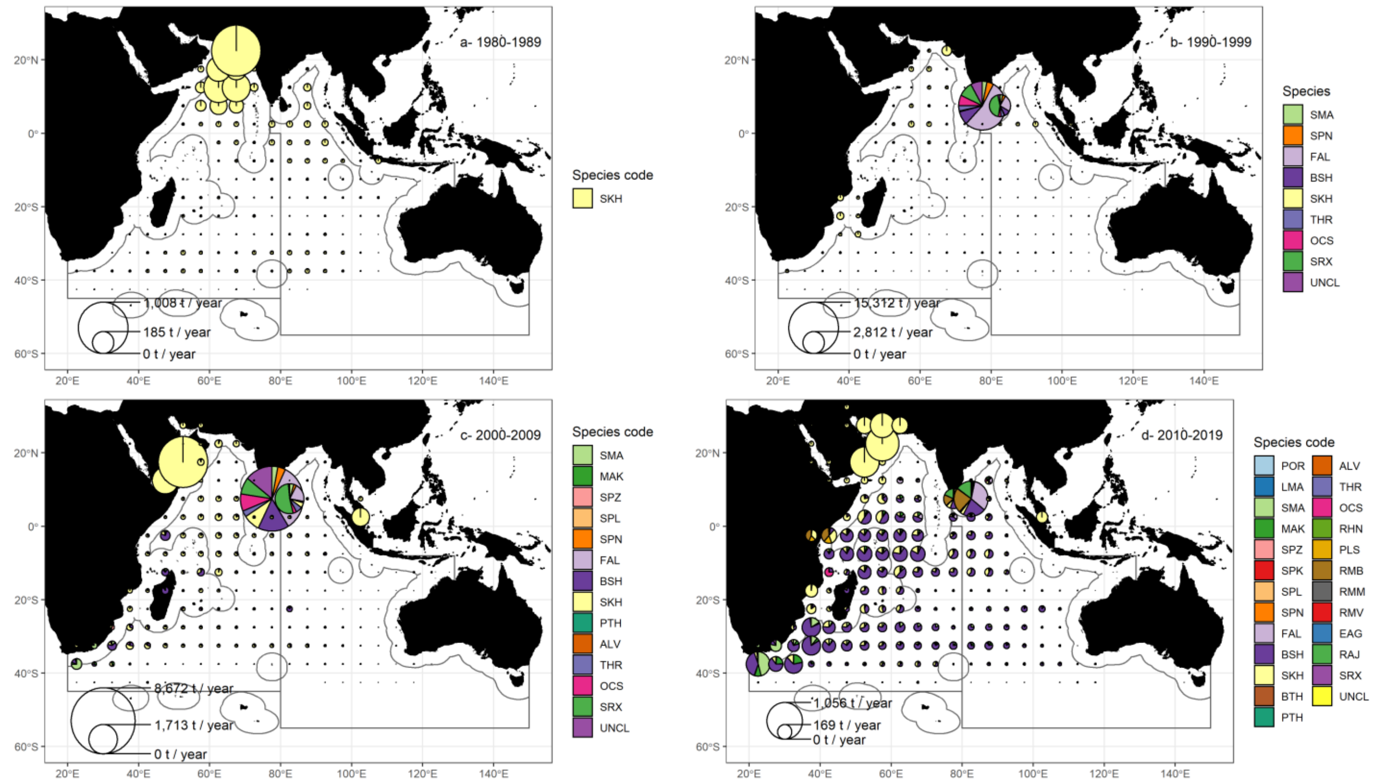

Fig. 14. Mean annual retained catches by weight (t) of sharks and rays by species and decade reported to the Secretariat covering the period 1980-2019. Sri Lanka reported high levels of shark catches during the 1990s

Size frequency data

There are two major reporting sources of size data for sharks and rays: (1) length/weight data by species, type of fishery and 5 degree grid area and month strata as per IOTC Res. 15/02 to be reported according to the IOTC guidelines and recommended form 4SF and (2) length/weight data collected as per the Regional Observer Scheme (Res. 11/04). Size data can be collected at sea by fishermen or observers and at landing sites by staff from research institutions or industry and there are currently no size data available derived from the analysis of pictures or videos collected with Electronic Monitoring Systems. It is worth recalling that 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 may then be reported twice to the Secretariat, although at different levels of spatio-temporal resolution, i.e. according to the standard annual submissions and through the ROS data sets.

The number of size samples for sharks and rays reported according to Res. 15/02 greatly varies between species, fisheries, and fleets, with 19% of available size data collected by observers at sea. Blue shark, which are mainly caught with longline, represent 81% of all size samples (n = 226,615 samples). 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 2**). Also, a total of 18,930 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 2. 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 2005-2019 through IOTC forms 4SF or equivalent. Only species with more than 20 samples are shown. N_STD = number of samples collected by fishermen or enumerators at landing; N_OBS = number of samples collected by observers)

Species code	Species name	Initial year	Final year	N_STD	N_OBS	N_TOT	%
BSH	Blue shark	2005	2019	181,290	45,325	226,615	80.6
SMA	Shortfin mako	2005	2019	11,221	4,189	15,410	5.5
FAL	Silky shark	2005	2019	14,596	600	15,196	5.4
POR	Porbeagle	2007	2019	623	1,874	2,497	0.9
CCL	Blacktip shark	2007	2019	473	0	473	0.2
OCS	Oceanic whitetip shark	2007	2019	232	233	465	0.2
PLS	Pelagic stingray	2013	2018	326	112	438	0.2
BLR	Blacktip reef shark	2007	2017	335	0	335	0.1
BTH	Bigeye thresher	2005	2019	81	97	178	0.1
PTH	Pelagic thresher	2013	2018	144	9	153	0.1
PSK	Crocodile shark	2007	2017	8	127	135	0.0
SPL	Scalloped hammerhead	2007	2019	88	4	92	0.0
SPZ	Smooth hammerhead	2016	2018	64	2	66	0.0
DUS	Dusky shark	2015	2015	56	0	56	0.0
LMA	Longfin mako	2007	2019	2	36	38	0.0

Due to the different types of length measurement reported (e.g. pectoral-caudal length, eye-fork length, etc.) several conversions had to be performed to standardise the size-frequency information. All size measurements were first converted into fork length using the standard IOTC morphometric relationships; eventually, as size frequency data were reported using different length classes ranging from 1 cm to 10 cm intervals, all fork lengths were categorized into 5 cm length classes in a second step.

For the shark species with a substantial sample size, the fork length distributions show some strong variability and spikes for some fisheries, particularly for the data collected for blue shark caught by longline fisheries other than deep-freezing and "fresh," i.e., those targeting swordfish and sharks (**Fig 15**). 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 15a-b**). Blue shark caught by coastal longliners of Sri Lanka and Indonesia are dominated by small sharks, mostly less than 150 cm in fork length and described by a median fork length of about 120 cm (~10 kg) (**Fig 15a**).

Size data collected for shortfin mako (SMA) by observers onboard deep-freezing longliners show a distribution described by a median fork length (177.5 cm) larger than the sizes collected by other enumerators (median = 162 cm) (**Fig 15c**). Spatial information shows that most observer samples for this species come from southern latitudes (south of 20°S) while the other size data mainly come from the central and south western Indian Ocean, likely explaining the differences in distributions, and suggesting some size-dependent variability in the spatio-temporal distribution of shorfin mako that needs further investigation.

Finally, size data collected for silky shark (FAL) 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 15d**). Recent information available for silky sharks (FAL) caught by Sri Lankan coastal longliners and gillnetters shows the sharks are smaller than those caught with longline, with median fork lengths of about 130 cm (23.2 kg) and 115 cm (16.2 kg), respectively.

Few data are available at the Secretariat for silky sharks caught and discarded at sea by purse seiners: those available that have been measured indicate that 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 dominated by FADs (Clavareau et al. 2020).

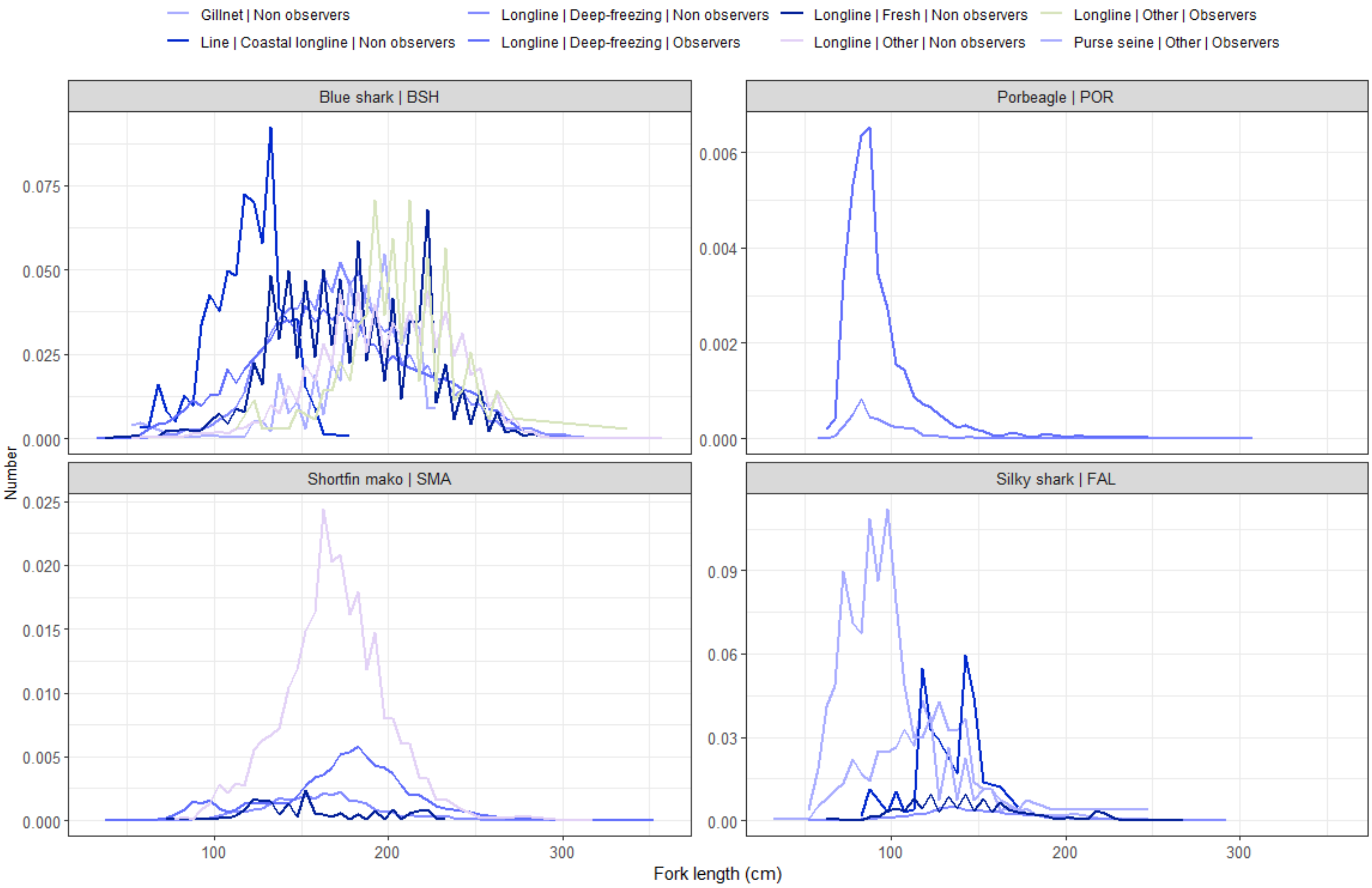

Fig. 15. Relative distribution of fork lengths (cm) by 5 cm classes by fishery and source of information (i.e. observers vs. fishermen or enumerators) for the four shark species with more than 200 fish samples by fishery available after conversion of raw size data into fork length when required

Data from the Regional Observer Scheme

To date, the ROS regional database contains information for a total of 1,492 commercial fishing trips (845 from purse seine vessels and 647 from longline vessels of various types) made during the period 2005-2019 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 an electronic format at the operational level following the [ROS standards](), *de facto* preventing the entry of the data in the ROS regional database.

Overview of fishery interactions

The ROS regional database includes a total of 87,195 interactions for the purse seine and longline fisheries having reported data to the Secretariat in a suitable electronic format (**Table 3**). Purse seine interactions (n = 50,259) cover the time period 2005-2019 and correspond to 63% of all shark interactions in the ROS regional database against 29,843 for longline. More than 6,000 interactions with rays have been reported while few have been reported for seabirds and cetaceans.

Table 3. 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	CETACEANS	2009	2018	77
Longline	RAYS	2009	2019	5,962
Longline	SEABIRDS	2012	2016	180
Longline	SHARKS	2009	2019	29,843
Longline	TURTLES	2009	2019	302
Purse seine	RAYS	2005	2019	384
Purse seine	SHARKS	2005	2019	50,259
Purse seine	TURTLES	2006	2019	188

Sharks and rays

Interactions, fate and condition at release

The distribution of shark interactions with pelagic longline fisheries, as available from the ROS during the time period 2009-2019, covers a small part of the longline fishing grounds (**Fig. 16**). This is mainly due to the non-availability of observer data (in a format suitable for analysis) from major longline fisheries such as Taiwan,China, China, EU,Spain, EU,Portugal, Seychelles, and Korea. The data set includes about 8% of species reported in aggregate form (e.g., “various sharks NEI”). Furthermore, information on fate and condition at release is lacking for more than 8% and 3% of the records, respectively.

The species composition of the longline catch appears to vary between the western and eastern parts of the Indian Ocean with blue shark dominating the catches in all areas (**Fig. 16a**). Most sharks are discarded at sea and the fate of the species seems to depend on the fishery and fishing grounds, with most sharks discarded around Reunion Island and Madagascar and in the eastern Indian Ocean to a lesser extent, while most sharks were retained when fishing occurred off South Africa (**Fig. 16c**). Information collected by the observers on the condition at release indicates that about 75% 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 between around 15-20% (Musyl & Gilman 2018, Schaefer et al. 2021).

Pelagic stingray largely dominates the longline catches of rays by contributing to 99% of all rays observed at sea (**Fig. 16b**). The very large majority of these are reported to have been discarded at sea with less than 50% alive (**Fig. 16d**).

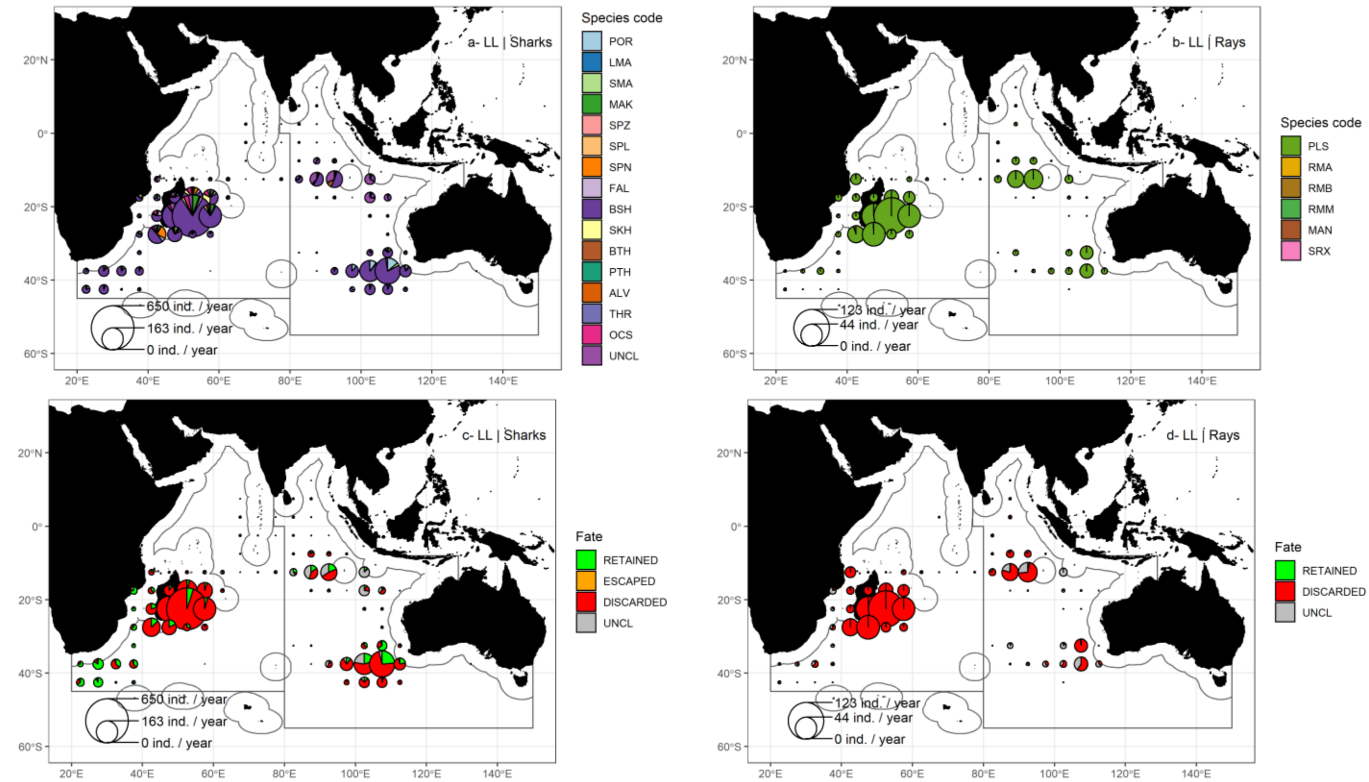

Fig. 16. Mean annual number of shark and ray interactions (numbers of individuals per year) with deep-freezing longline fisheries by species (a & b) and fate (c & d) as reported to the Secretariat during the period 2009-2019

Observer data collected onboard purse seiners show the large dominance of silky shark in the shark catches, representing 97% of all interactions recorded in the data available to the Secretariat for the period 2005-2019 (**Fig. 17a**). Oceanic whitetip shark comes second with 771 observations of occurrence in the purse seine catches, i.e. about 1.5% of all shark interactions, while most reports of bycatch of bull shark are due to errors of species identification. Most sharks are discarded at sea (**Fig. 17c**) following the guidelines of best practices developed over the last decade by the fishing companies (Poisson et al. 2014b, Grande et al. 2019). The overall mortality rate of silky sharks caught with purse seine in the Indian Ocean has been estimated at around 80%, including a mortality rate of about 50% for the sharks released alive at sea (Poisson et al. 2014a).

Overall, few interactions with rays are observed in the purse seine fishery (**Fig. 17b**) and almost all rays are discarded at sea (**Fig. 17d**). As for longline, pelagic stingray dominates the catches 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 animals 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 (Clavareau et al. 2020). Purse seine interactions with mobulid rays, i.e. devil fish (RMM), giant manta (RMB), Alfredi manta (RMA), 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 known condition at release.

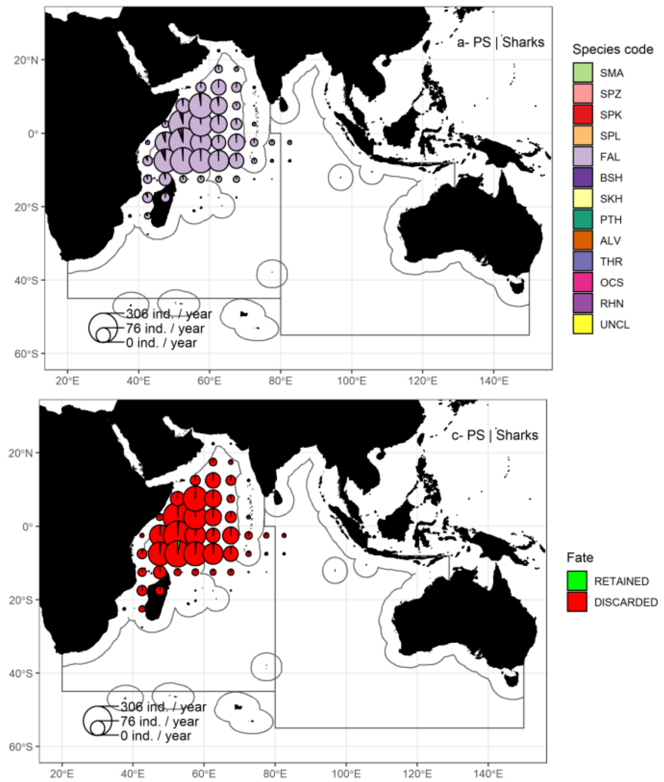

Fig. 17. Mean annual number of shark and ray interactions (numbers of individuals per year) with large-scale purse seine fisheries by species (a & b) and fate (c & d) as reported to the Secretariat during the period 2005-2019

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 Japanese and Taiwanese vessels 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 Taiwanese fleet starting from the 2010s (**Fig. 18**). In recent years (2017-2019), 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 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).

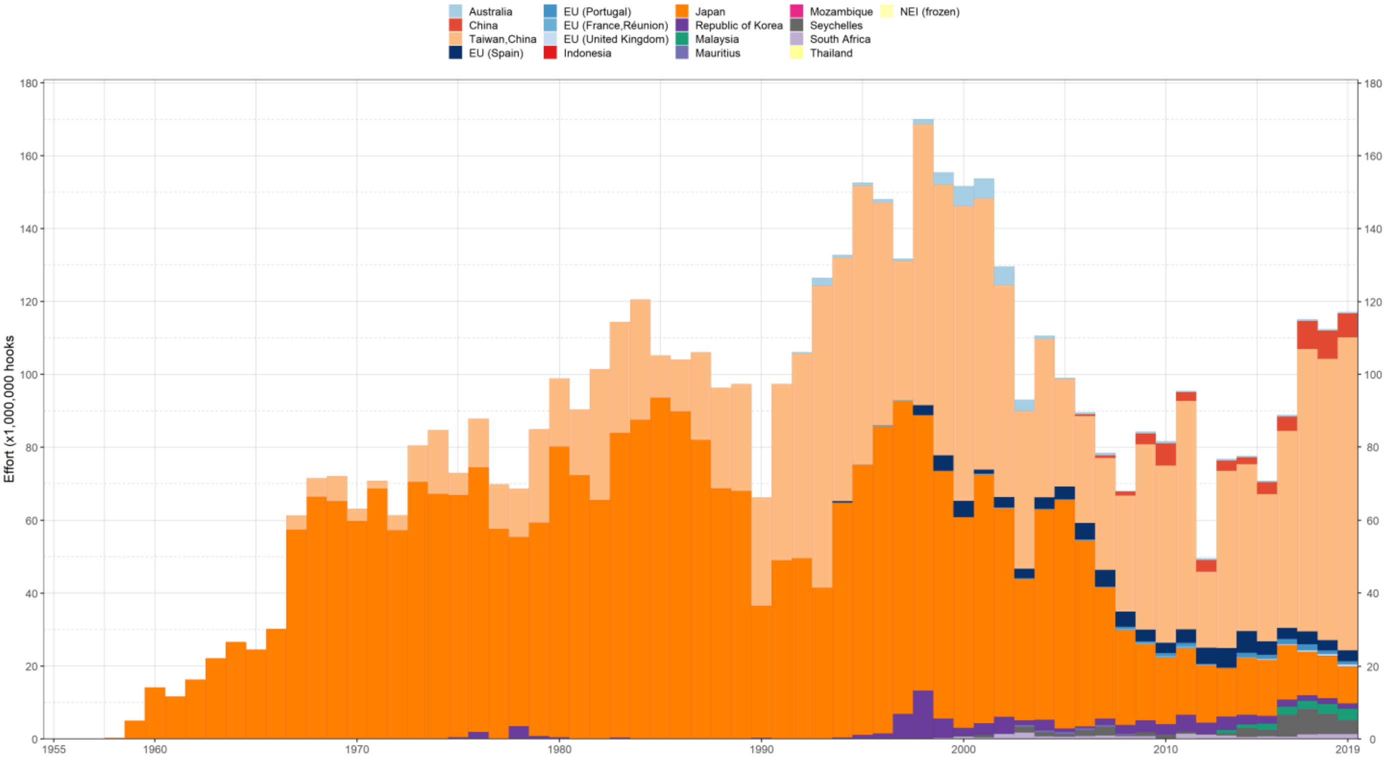

Fig. 18. Reported longline effort (hooks) for fleets operating south of 25°S between 1955 and 2019

Main species concerned

Among the 24 species of petrels and albatrosses known to occur in the IOTC area of competence (ACAP 2007), 19 species have been reported to interact with longline fisheries according to the ROS regional database (**Table 4)**. 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 as having interacted with longline fisheries in the compiled data set covering the period 2009-2015, including six in additional to those available from the ROS (**Table 4)**.

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 4. List of seabirds reported to have interacted with longline fisheries in the Indian Ocean with the most recent status of the IUCN Red List

Species code	Species name	Scientific name	IUCN status	Source
DCR	Atlantic yellow-nosed albatross	*Thalassarche chlororhynchos*	Endangered	2016-043
DCU	Shy albatross	*Thalassarche cauta*	Near threatened	2016-043
DIC	Grey-headed albatross	*Thalassarche chrysostoma*	Endangered	ROS
DIM	Black-browed albatross	*Thalassarche melanophris*	Least concern	ROS

Species code	Species name	Scientific name	IUCN status	Source
DIP	Southern royal albatross	*Diomedea epomophora*	Vulnerable	ROS
DIQ	Northern royal albatross	*Diomedea sanfordi*	Endangered	2016-043
DIX	Wandering albatross	*Diomedea exulans*	Vulnerable	ROS
MAH	Hall's giant petrel	*Macronectes halli*	Least concern	ROS
MAI	Antarctic giant petrel	*Macronectes giganteus*	Least concern	ROS
MWE	Cape gannet	*Morus capensis*	Endangered	2016-043
PFC	Flesh-footed shearwater	*Ardenna carneipes*	Near threatened	ROS
PFG	Sooty shearwater	*Ardenna grisea*	Near threatened	ROS
PFT	Short tailed shearwater	*Ardenna tenuirostris*	Least concern	2016-043
PHE	Light-mantled sooty albatross	*Phoebetria palpebrata*	Near threatened	ROS
PHU	Sooty albatross	*Phoebetria fusca*	Endangered	ROS
PRO	White-chinned petrel	*Procellaria aequinoctialis*	Vulnerable	ROS
TQH	Indian yellow-nosed albatross	*Thalassarche carteri*	Endangered	ROS
TQW	Campbell albatross	*Thalassarche impavida*	Vulnerable	ROS
TWD	White-capped albatross	*Thalassarche steadi*	Near threatened	2016-043

Status of data on seabirds' bycatch

The data available on seabirds caught in the IOTC area of competence are generally 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 larger 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 180 interactions was reported during 2012-2016, with an average of 22.5 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.

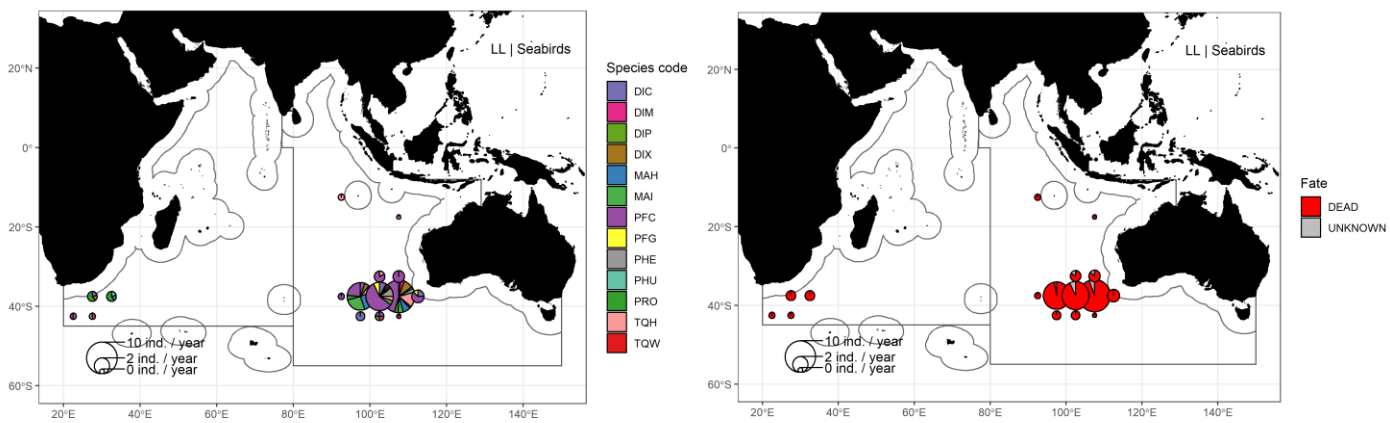

Fig. 19. Mean annual number of seabird interactions (number of individuals per year) with deep-freezing longline fisheries by species and fate as reported to the Secretariat during 2012-2016

Marine turtles

Main species and fisheries concerned

Six species of marine turtles have been recorded as interacting 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).

Table 5. Marine turtles reported to occur in the Indian Ocean with the most recent status of the IUCN Red List

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

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

Overall, the reported data available on marine turtles caught in the IOTC area of competence are 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: as for seabirds, some CPCs did report some information on incidental catches of marine turtles through their national reports, but these data were not integrated in the present study. 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 490 turtle interactions with tuna fisheries were reported through the ROS, with loggerhead (n = 155) and Olive ridley turtles (n = 138) being the most frequent incidentally caught species in longline and purse seine fisheries, respectively (**Table 6**). Only two flatback turtles were reported to have interacted with tuna fisheries, notably by the longline fishery of Sri Lanka.

Table 6. Number of turtle interactions by species with longline and purse seine fisheries as reported in the ROS regional database

Fishery group	Species code	Species name	Interactions
Longline	TTL	Loggerhead turtle	127
Longline	LKV	Olive ridley turtle	58
Longline	TUG	Green turtle	42
Longline	DKK	Leatherback turtle	41
Longline	TTX	Marine turtles NEI	19
Longline	TTH	Hawksbill turtle	13
Longline	FBT	Flatback turtle	2
Purse seine	LKV	Olive ridley turtle	80
Purse seine	TTH	Hawksbill turtle	40
Purse seine	TUG	Green turtle	32
Purse seine	TTL	Loggerhead turtle	28
Purse seine	TTX	Marine turtles NEI	6
Purse seine	DKK	Leatherback turtle	2

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. 20**). Most turtles were discarded, as expected, except for a few from Reunion-based longliners when the turtle was injured and brought back to the Kelonia turtles observatory and care centre. 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.

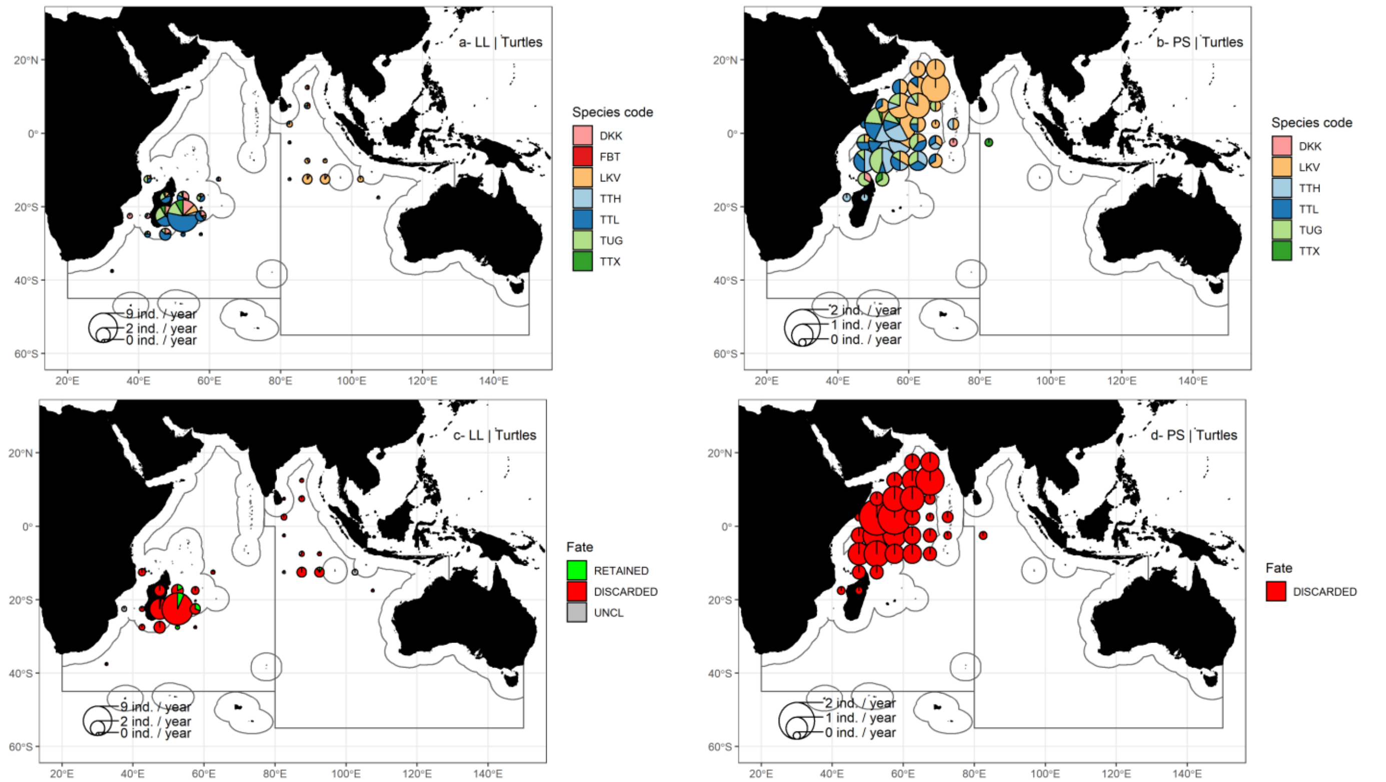

Fig. 20. Mean annual number of marine turtle interactions (numbers of individuals per year) with pelagic fisheries by species (a & b) and fate (c & d) as reported to the Secretariat during the period 2005-2019

Cetaceans

Data availability and fisheries concerned

Reporting of interactions between IOTC fisheries and cetaceans has been extremely limited to date and interactions are expected to greatly vary with fishing gear, gear configuration, time-area strata, and environmental conditions. 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 13/04 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 76 cetacean interactions with tuna fisheries has been reported through the ROS (**Table 7**). Most interactions were reported for the fresh pelagic longline fishery of Reunion Island (85% of all observations) and are limited to the Southwest Indian Ocean, East of Madagascar (**Fig. 21**). 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. 21b**).

Table 7. Number of cetacean interactions by species with longline fisheries as reported in the ROS regional database

Species code	Species name	Scientific name	Interactions
DRR	Risso's dolphin	*Grampus griseus*	53
ODN	Toothed whales nei	*Odontoceti*	11
FAW	False killer whale	*Pseudorca crassidens*	3
HUW	Humpback whale	*Megaptera novaeangliae*	3
SHW	Short-finned pilot whale	*Globicephala macrorhynchus*	2
DCO	Common dolphin	*Delphinus delphis*	2
MIW	Minke whale	*Balaenoptera acutorostrata*	1
DBO	Bottlenose dolphin	*Tursiops truncatus*	1

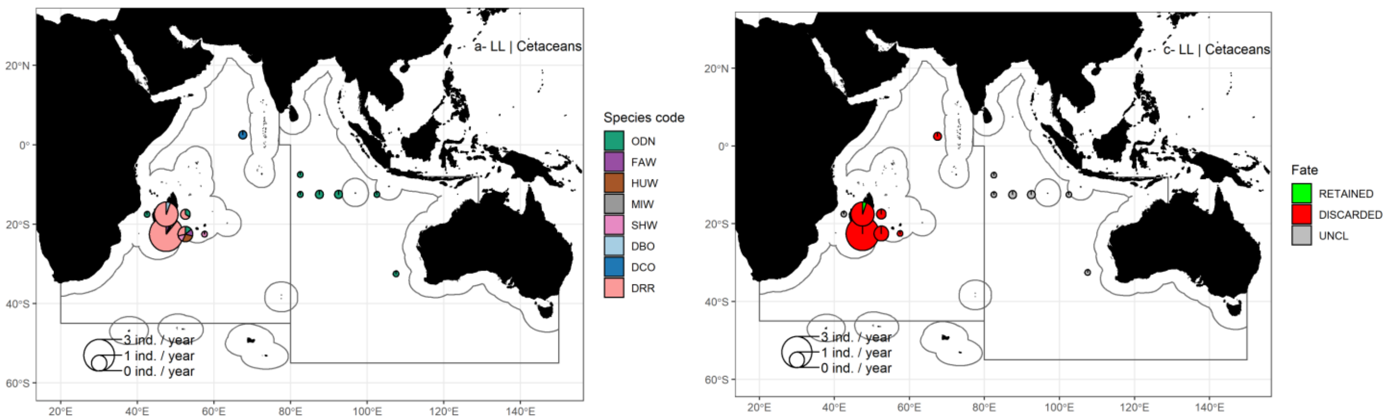

Fig. 21. Mean annual number of cetacean interactions (numbers of individuals) with pelagic longline fisheries by species and fate as reported to the Secretariat during the period 2005-2019

Main issues identified concerning data on bycatch (non-IOTC) species available to the IOTC

There are a number of key issues with the data that are apparent from this summary and discussed below.

Sharks and rays

Unreported catches

Although some fleets have been operating since 1950, there are many cases where historical catches have gone unreported as many countries were not collecting fishery statistics in years prior to 1970. It is therefore thought that important catches of sharks might have gone unrecorded in several countries. There are also a number of fleets which are still not reporting on their interactions with bycatch species, despite fleets using similar gears reporting high catch rates of bycatch species.

Some fleets have also been noted to report distinct 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 reduces the attempts at disaggregating catches originally provided as species groups. The changing requirements in species-specific reporting standards also complicates the interpretation of these data.

Errors in reported catches

For the fleets that do report interactions, there are several issues with estimates. In fact, these are often based on retained catches rather than total catches, with discard levels that are often severely underreported when not unavailable at all. 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 resolution of data

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. Misidentification of shark species is also common and 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 form a small proportion of the total.

The main consequence of this is that the estimation of total catches of sharks in the Indian Ocean is compromised by the paucity and inaccuracy of the data originally available from several national sources.

Catch-and-Effort data from 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 catch data have been provided from 1987 onward, with species-specific shark data available from 2018 only. However catch and effort data have not been provided;
- Gillnet fisheries of I.R. Iran: spatially disaggregated CE data is now available from 2007 onwards, although not fully reported to IOTC standards (does not include catches by shark species, which are instead available as nominal catches during the same period);
- Gillnet fisheries of Oman: data not reported to IOTC standards.

Catch-and-Effort data from longline fisheries

- Historical catches of sharks from major longline fisheries (Japan, Taiwan,China, Indonesia and Rep. of Korea): data not reported to IOTC standards for years before 2006 (no species-specific catches);
- Fresh-tuna longline fisheries (Malaysia): data not provided or not reported to IOTC standards. Indonesia has reported catch and effort data since 2018 but the level of coverage is very low with only minor reported catches of blue shark;
- Deep-freezing longline fisheries (EU,Spain, India, Indonesia and Oman): data not provided or not reported to IOTC standards (for the periods during which these fisheries were known to be active).

Catch-and-Effort data from coastal fisheries

- Coastal fisheries of India, Madagascar and Yemen: data not provided;
- Coastal fisheries of Oman: data not reported to IOTC standards;
- Coastal fisheries of Indonesia: catch and effort data has been reported since 2018 for coastal fisheries but coverage is very low with minor reported catches of some shark species.

Discard levels from surface and longline fisheries

- Discard levels of sharks from major longline fisheries: to date the EU (Spain, UK), Japan and Taiwan,China, have not provided estimates of total discards of sharks, by species, although all are now reporting discards in their observer data;

- Discard levels of sharks for industrial purse seine fisheries: I.R. Iran, Japan, and Thailand have not provided estimates of total quantities of discards of sharks, 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 PS fleet in 2018.

Size frequency data

- Gillnet fisheries of I.R. Iran and Pakistan: to date, I.R. Iran and Pakistan have not reported size frequency data for their driftnet fisheries;

- Longline fisheries of India, Malaysia, Oman: to date, these countries have not reported size frequency data for their longline fisheries. Madagascar reported size frequency data for blue shark and smooth hammerhead shark for 2018 in their longline fisheries;

- Coastal fisheries of India, Indonesia, Madagascar and Yemen: to date, these countries have not reported size frequency data for their coastal fisheries. Madagascar reported size frequency data for blue shark and smooth hammerhead shark for 2018 in their coastal fisheries. Fresh tuna longline fishery: Indonesia have provided size frequency data for sharks for the fresh longline fleet for 2018 based on observer data.

Biological data

- The IOTC Secretariat has to use length-age keys, length-weight keys, ratios of fin-to-body weight, and processed weight-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 term to long term with the steady increase in scientific observer data submissions according to ROS standards and requirements.

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.

Incidental catches of seabirds

- Longline fisheries operating in areas with high densities of seabirds. Seychelles, Malaysia and Mauritius have not reported incidental catches of seabirds for longliners under their flag.

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 driftnet 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: this includes not reporting bird bycatch data by species (as required by Res. 12/06) and not providing an estimation of the total mortality of marine turtles incidentally caught in their fisheries (as required by Res. 12/04).

Appendix

Table A1. List of shark and ray species reported at species level in the IOTC databases during 1950-2019

Category	Species code	Species name	Scientific name	IUCN status
RAYS	PLS	Pelagic stingray	*Pteroplatytrygon violacea*	Least concern
RAYS	RMB	Giant manta	*Mobula birostris*	Endangered
RAYS	RMM	Devil fish	*Mobula mobular*	Endangered
SHARKS	AGN	Angelshark	*Squatina squatina*	Critically endangered
SHARKS	ALS	Silvertip shark	*Carcharhinus albimarginatus*	Vulnerable
SHARKS	ALV	Thresher	*Alopias vulpinus*	Vulnerable
SHARKS	BLR	Blacktip reef shark	*Carcharhinus melanopterus*	Vulnerable
SHARKS	BRO	Copper shark	*Carcharhinus brachyurus*	Vulnerable
SHARKS	BSH	Blue shark	*Prionace glauca*	Near threatened
SHARKS	BTH	Bigeye thresher	*Alopias superciliosus*	Vulnerable
SHARKS	CCB	Spinner shark	*Carcharhinus brevipinna*	Vulnerable
SHARKS	CCC	Nervous shark	*Carcharhinus cautus*	Least concern
SHARKS	CCD	Whitecheek shark	*Carcharhinus dussumieri*	Endangered
SHARKS	CCE	Bull shark	*Carcharhinus leucas*	Near threatened
SHARKS	CCG	Galapagos shark	*Carcharhinus galapagensis*	Least concern
SHARKS	CCL	Blacktip shark	*Carcharhinus limbatus*	Near threatened
SHARKS	CCM	Hardnose shark	*Carcharhinus macloti*	Near threatened
SHARKS	CCO	Finetooth shark	*Carcharhinus isodon*	Least concern
SHARKS	CCP	Sandbar shark	*Carcharhinus plumbeus*	Vulnerable
SHARKS	CCQ	Spottail shark	*Carcharhinus sorrah*	Near threatened
SHARKS	CCW	Grey reef Shark	*Carcharhinus amblyrhynchos*	Endangered
SHARKS	CCY	Graceful shark	*Carcharhinus amblyrhynchoides*	Near threatened
SHARKS	CLD	Sliteye shark	*Loxodon macrorhinus*	Least concern
SHARKS	CTU	Gummy shark	*Mustelus antarcticus*	Least concern
SHARKS	DUS	Dusky shark	*Carcharhinus obscurus*	Endangered
SHARKS	FAL	Silky shark	*Carcharhinus falciformis*	Vulnerable
SHARKS	GAG	Tope shark	*Galeorhinus galeus*	Critically endangered
SHARKS	GAM	Mouse catshark	*Galeus murinus*	Least concern
SHARKS	HAY	Lined catshark	*Halaelurus lineatus*	Least concern
SHARKS	HCM	Hooktooth shark	*Chaenogaleus macrostoma*	Vulnerable

Category	Species code	Species name	Scientific name	IUCN status
SHARKS	HEE	Snaggletooth shark	*Hemipristis elongata*	Vulnerable
SHARKS	LMA	Longfin mako	*Isurus paucus*	Endangered
SHARKS	NTC	Broadnose sevengill shark	*Notorynchus cepedianus*	Vulnerable
SHARKS	OCS	Oceanic whitetip shark	*Carcharhinus longimanus*	Critically endangered
SHARKS	OSF	Zebra shark	*Stegostoma fasciatum*	Endangered
SHARKS	OXY	Angular roughshark	*Oxynotus centrina*	Vulnerable
SHARKS	POR	Porbeagle	*Lamna nasus*	Vulnerable
SHARKS	PSK	Crocodile shark	*Pseudocarcharias kamoharai*	Least concern
SHARKS	PTH	Pelagic thresher	*Alopias pelagicus*	Endangered
SHARKS	RHA	Milk shark	*Rhizoprionodon acutus*	Vulnerable
SHARKS	RHN	Whale shark	*Rhincodon typus*	Endangered
SHARKS	SBL	Bluntnose sixgill shark	*Hexanchus griseus*	Near threatened
SHARKS	SCK	Kitefin shark	*Dalatias licha*	Vulnerable
SHARKS	SHM	Shark mackerel	*Grammatorcynus bicarinatus*	Least concern
SHARKS	SMA	Shortfin mako	*Isurus oxyrinchus*	Endangered
SHARKS	SMD	Smooth-hound	*Mustelus mustelus*	Vulnerable
SHARKS	SPK	Great hammerhead	*Sphyrna mokarran*	Critically endangered
SHARKS	SPL	Scalloped hammerhead	*Sphyrna lewini*	Critically endangered
SHARKS	SPZ	Smooth hammerhead	*Sphyrna zygaena*	Vulnerable
SHARKS	TFM	Whiskery shark	*Furgaleus macki*	Least concern
SHARKS	TIG	Tiger shark	*Galeocerdo cuvier*	Near threatened
SHARKS	TRB	Whitetip reef shark	*Triaenodon obesus*	Vulnerable
SHARKS	WSH	Great white shark	*Carcharodon carcharias*	Vulnerable

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