REVIEW OF THE STATISTICAL DATA AVAILABLE FOR BYCATCH SPECIES

PREPARED BY: IOTC SECRETARIAT[1], AUGUST 2018

PURPOSE

To provide participants at the 14th Session of the IOTC Working Party on Ecosystems and Bycatch (WPEB13) with a review of the status of the information available on non-targeted, associated and dependent species of IOTC fisheries, termed 'Bycatch'. Bycatch has been 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*."

This paper covers data on sharks[2], seabirds, marine turtles, marine mammals and other bycatch in the IOTC Secretariat databases as of 30 August 2018.

This 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. 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

A summary of the type of datasets that need to be provided for sharks and other bycatch species including the time periods concerned, fleets and species and the level of requirement for reporting (mandatory or recommended) are provided in Table 1 and Table 2.

Sharks: The same standards as those existing for IOTC species apply to the most commonly caught species of sharks and rays, as defined by the Commission in 2015, including:

- **Nominal catches** which are highly aggregated statistics for each species estimated per fleet, gear and year for a large area. If these data are not reported the Secretariat attempts to estimate the total catch although this is not possible in many cases. A range of sources is used for this purpose (including: partial catch and effort data; data in the FAO FishStat database; catches estimated by the IOTC from data collected through port sampling; 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 supply vessels is also collected.
- **Length frequency data** which refer to individual body lengths of IOTC species and sharks 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, marine mammals, and other species**:** the following standards apply:

- **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.

A summary of the Resolutions relevant to each taxonomic group are provided in detail in Appendix 1.

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[2] Following standard international practice, the term shark is accepted to include both sharks and rays.

Table 1. Timeline of reporting requirements indicating the years for which each type of dataset should be reported[3]

Timeline of reporting requirements

		2006	2007	2008	2009	2010	2011	2012	2013	2014	----------->	Deadlines
	<--------------											
<--------------	Historic data on sharks according to IOTC reporting requirements											Jun (Dec) 30th 2006
Mandatory		Nominal catch data for main shark species										Jun (Dec) 30th of year following that for which data are due
Voluntary		Nominal catch data for other shark species										Jun (Dec) 30th of year following that for which data are due
Mandatory				Catch-and-effort data for main shark species								Jun (Dec) 30th of year following that for which data are due
Voluntary	all CPCs			Catch-and-effort data for other shark species								Jun (Dec) 30th of year following that for which data are due
Mandatory				Size frequency data for main shark species								Jun (Dec) 30th of year following that for which data are due
Voluntary				Size frequency data for other shark species								Jun (Dec) 30th of year following that for which data are due
Mandatory	all CPCs					Total incidental catches of marine turtles						Jun (Dec) 30th of year following that for which data are due
Mandatory	all CPCs with vessels >=24m in the IOTC Record of Authorised Vessels					Scientific observer data from vessels >=24m						No later than 150 days after the end of each observer trip
Mandatory	all CPCs with LL fleets in the IOTC area						Total incidental catches of seabirds from LL					Jun (Dec) 30th of year following that for which data are due
Mandatory	all CPCs with PS, LL and GN fleets in the IOTC area								Total incidental catches of marine mammals			as above; first report due 2014
Mandatory	all CPCs with vessels <24m in the IOTC Record of Authorised Vessels								Scientific observer data from vessels <24m			No later than 150 days after the end of each observer trip

[3] "Main" shark species mentioned here are those which the Commission identified as mandatory for reporting in Resolutions 08/04, 13/03 and 15/01

Table 2. List of bycatch species of concern to the IOTC and reporting requirements, by type of fishery. Fisheries: Purse seine (PS), Longline (LL), Gillnet (GN), Pole-and-line (BB), Hand line (HL), Trolling (TR).

Common name	Scientific name	Species Code	Reporting requirements by fishery					
			PS	LL	GN	BB	HL	TR
Blue shark	*Prionace glauca*	**BSH**		**08**	**13**			
Mako sharks	*Isurus spp.*	**MAK**		**08**	**13**			
Porbeagle	*Lamna nasus*	**POR**		**08**	**13**			
Hammerhead Sharks	*Sphyrnidae*	**SPN**		**13**	**13**			
Whale shark	*Rhincodon typus*	**RHN**	**13**		**13**			
Thresher sharks	*Alopias spp.*	**THR**	**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**				
Tiger shark	*Galeocerdo cuvier*	TIG		e	e			
Great White Shark	*Carcharodon carcharias*	WSH		e				
Pelagic stingray	*Pteroplatytrygon violacea*	PSL		e	e			
Mantas and devil rays	*Manta spp. (Mobulidae)*	MAN	e	e	e			
Other sharks nei		SKH	e	**08**	**13**	**13**	**13**	**13**
Other rays nei		SRX	e	e	e	**13**	**13**	**13**
Other marine fish nei		MZZ	e	**08**	**13**	**13**	**13**	**13**
Marine turtles nei		TTX	**13**	**13**	**13**	**13**	**13**	**13**
Seabirds nei				**13**	**13**			
Marine mammals nei			**13**	**13**	**13**			

Reporting requirements:
08: As from 2008 catch shall be recorded in logbooks and reported to the IOTC (08/04)
13: As from 2013 catch shall be recorded in logbooks and reported to the IOTC (13/03)
15: As from 2015 catch shall be recorded in logbooks and reported to the IOTC (15/01)
e: As from 2013 recording and reporting of catches to the IOTC is encouraged (13/03)

STATUS OF REPORTING

The most common bycatch species with mandatory reporting requirements (indicated by the date they came into force) and other species for which reporting is encouraged (shown as 'e') are listed in Table 2. Table 2 summarises those bycatch species identified by the Commission, through the adoption of 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. A list of shark species known to occur in Indian Ocean fisheries directed at IOTC species or pelagic sharks is provided in Appendix 2. Species of seabirds and marine turtles are presented in Table 4 and Table 5, respectively. Appendix 3 provides a summary of the datasets that have been provided by CPCs for industrial fleets according to the requirements in Table 1. This table includes all parties having reported some of the specified data, regardless of how complete the datasets provided might be. The data sets include:

- Historical data on sharks reported according to IOTC requirements
- Nominal catch data for 'main' shark species
- Nominal catch data for all other shark species (including those reported in aggregate)
- Catch and effort data for 'main' shark species
- Catch and effort data for all other shark species (including those reported in aggregate)
- Size frequency data for 'main' shark species
- Size frequency data for all other shark species
- Estimates of total incidental catches of seabirds from longline and gillnet fisheries
- Estimates of total incidental catches of marine turtles
- Estimates of total incidental catches of marine mammals

The availability of shark nominal catch data over the period 1950–2017 for those shark species identified by the Commission (Table 2), by species, gear type, and year, is presented in Appendix 4. The collection and reporting of catches of sharks 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 gathered in the IOTC database is thought to be highly incomplete.

BYCATCH AT THE ECOSYSTEM LEVEL

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. 1a). Reported catches of sharks have ranged from approximately 20% in the 1960s and 1970s to approximately 5% of total catch in recent years (Fig. 1b).

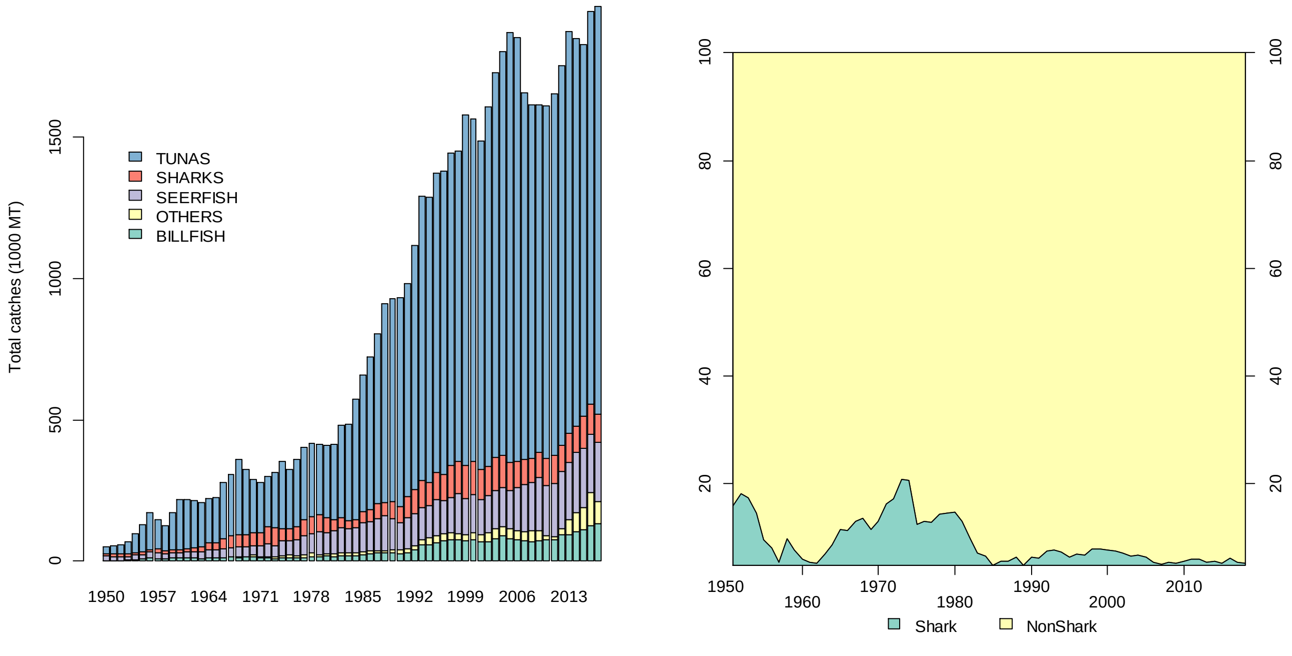


Fig. 1. a) Indian Ocean reported nominal catch trends of major species groups and b) proportion of reported shark to total Indian Ocean catch

SUMMARY OF FISHERIES DATA AVAILABLE FOR SHARKS

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

The nominal catch data for all shark species are presented in Fig. 2 by fleet. Very few fleets reported catches of sharks in the 1950s, but the number of fleets reporting has increased over time. Total reported shark catches have also increased over time with a particularly dramatic increase in reported catches in the 1990s, reaching a peak of approximately 120 000 mt in 1999. Since then, nominal catches have fluctuated and are currently around 100 000 mt.

The nominal catch data should be considered with caution given the historically low reporting rates. In addition to the low level of reporting, catches that have been reported are thought to represent only those species that are retained onboard without taking in to account 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 (Appendix 4) following the adoption of new measures by the Commission on sharks and other bycatch, which call for IOTC CPCs to collect and report more detailed statistics on bycatch species to the IOTC Secretariat.

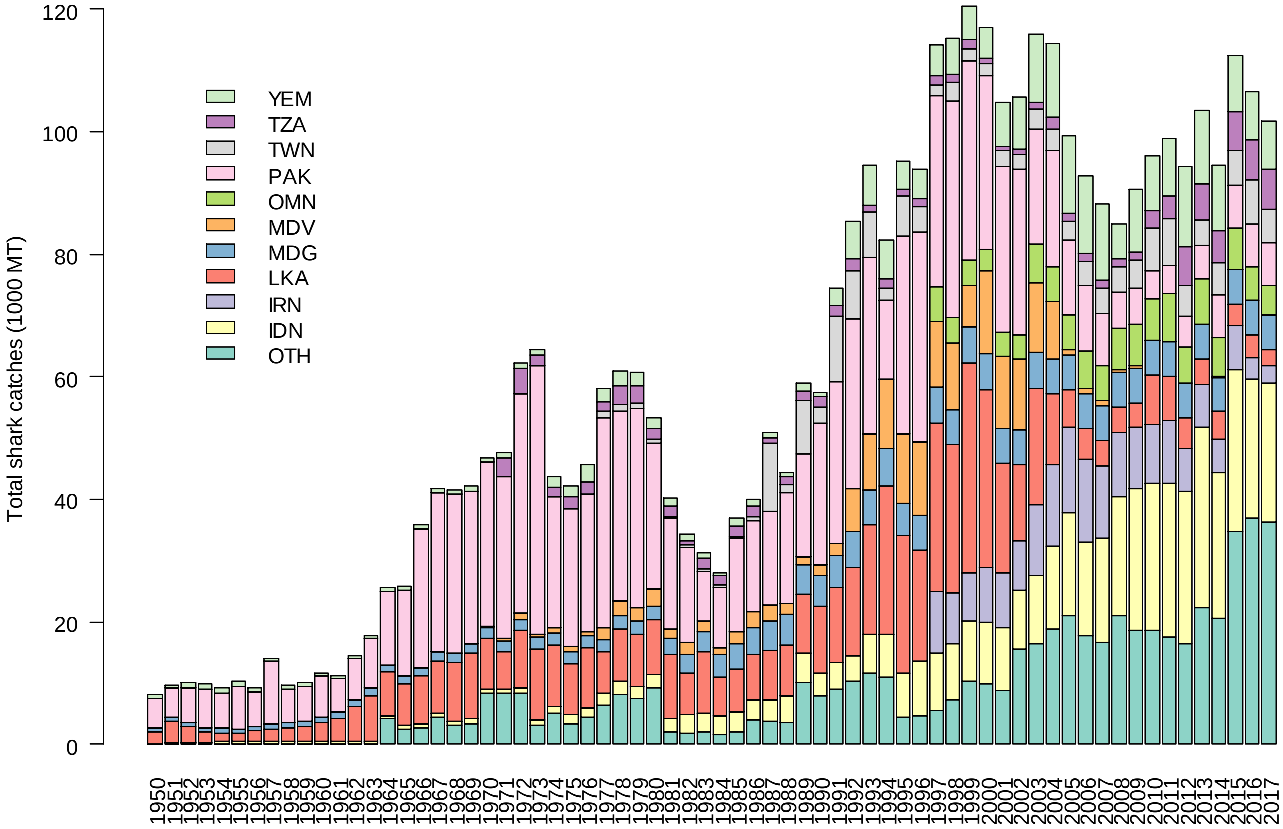


Fig. 2. Total reported nominal catches of sharks by fleet from 1950–2017 (YEM = Yemen, TZA = Tanzania, TWN = Taiwan,China, PAK = Pakistan, OMN = Oman, MDV = Maldives, MDG = Madagascar, LKA = Sri Lanka, IRN = I.R.Iran, IDN = Indonesia, OTH = all others).

Main reported gear types associated with shark bycatch for IOTC fisheries

Fig. 3 shows the distribution of catches across gear type. Gillnets are associated with the highest reported nominal catches of sharks, historically and are currently responsible for over 40% of reported catches. This is followed by the longline fleets which contributed substantially to shark catches from the 1990s, and handline and troll line fisheries which have increased in more recent years. Of the gillnet fisheries, the majority comprise standard, unclassified gillnets, followed by combinations of gillnets, handlines and troll lines and gillnet/longline combinations. Fig. 4 shows the main gear types used by fleets since 2000.

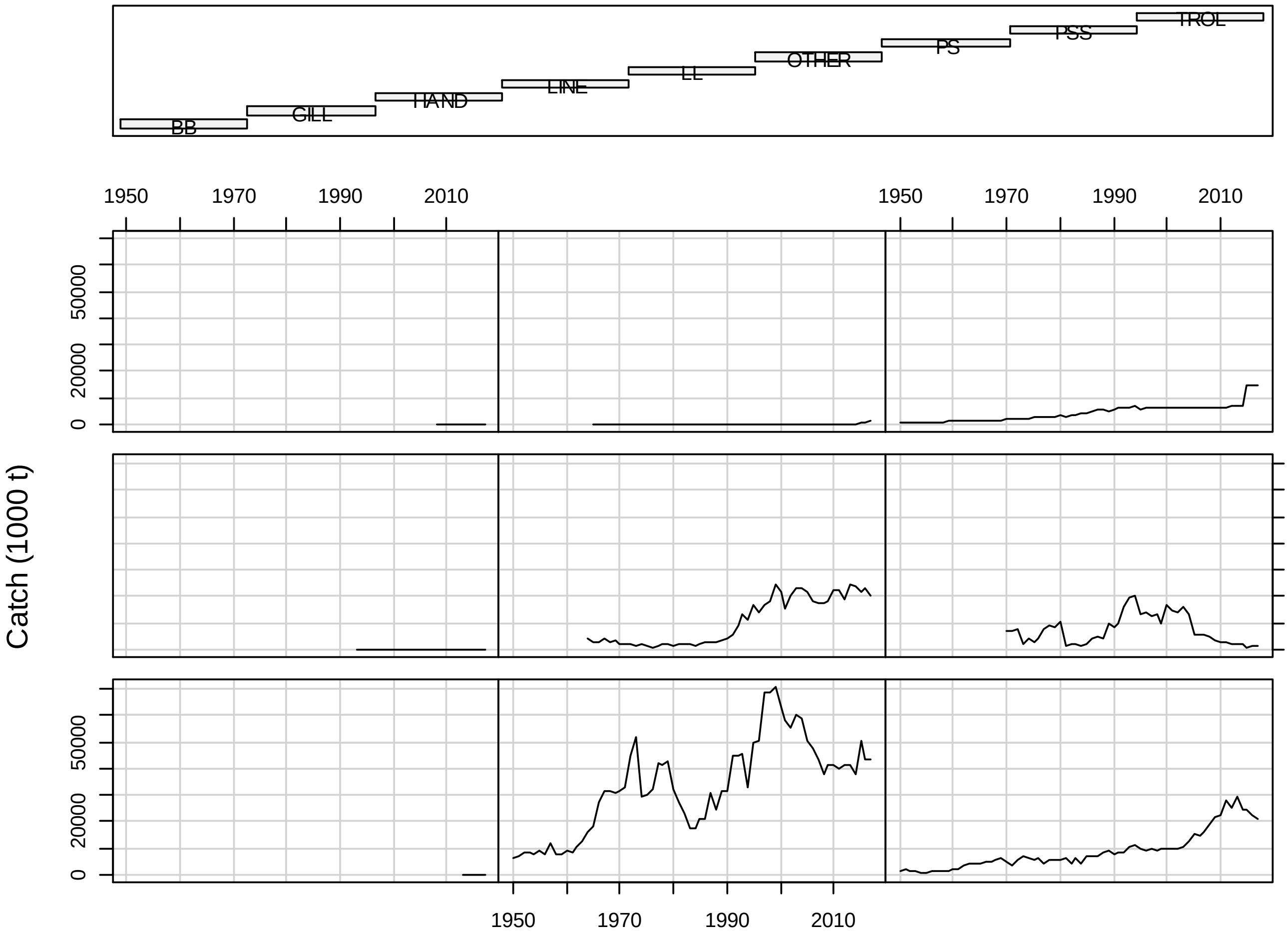


Figure 3. Nominal catches of sharks reported by gear type (1950–2017). Gears are listed in rows from bottom left to top right: Bait boat/pole and line (BB), gillnet (GILL), Handline (HAND), Line (LINE), Longline (LL), Purse seine (PS), Small purse seines/Ring nets (PSS), Troll lines (TROLL) and all other gear types (OTHER).

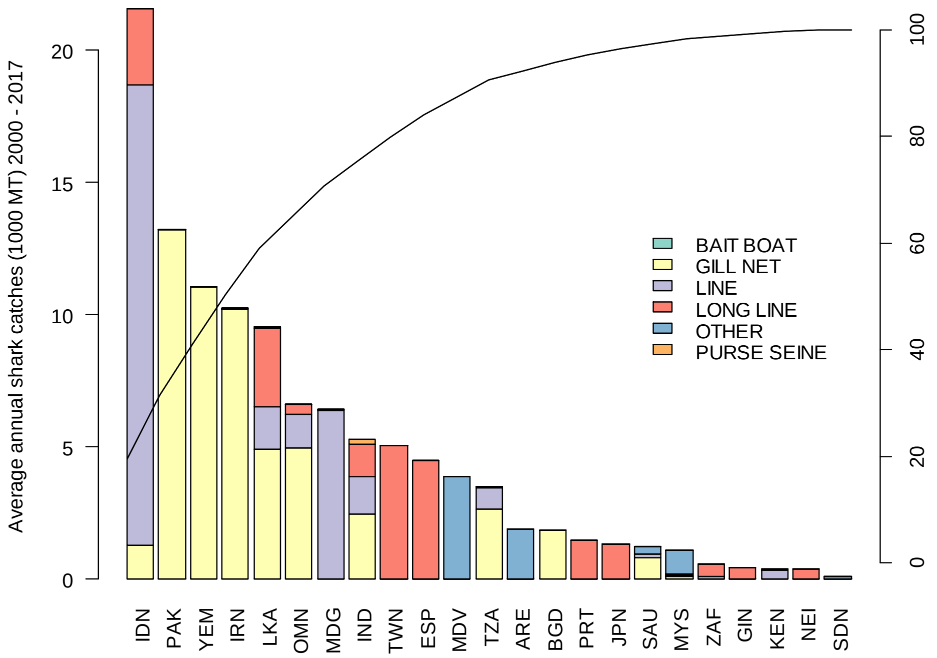


Fig. 4. Average annual shark catches by gear type and reporting country in recent years (2000-2017)

Main species of sharks caught in IOTC fisheries

A list of all species of sharks that are known to occur in Indian Ocean fisheries directed at IOTC species (IOTC fisheries) or pelagic sharks is provided in Appendix 2. In addition to an increase in reporting of shark catches over time, the resolution of the data provided has been improving with an increased proportion of reported shark catches provided identified to species/genus (Fig.5a). Of the shark catches reported by species, the blue shark forms the greatest proportion, comprising over 60% of total catches, with silky, milk, threshers, hammerheads, makos, oceanic whitetip sharks and manta rays forming a smaller percentage (Fig. 5b).

The increase in reporting by species is apparent in the species-specific catch series (Fig. 6a) with steadily increasing trends in reporting since the 1970s seen for blue sharks, thresher sharks, hammerhead sharks and mako sharks, all levelling off in recent years. The oceanic whitetip shark nominal catch series is dominated by the Sri Lankan longline-gillnet fisheries for which catches peaked just prior to 2000. The reported catches of silky shark show a similar trend with a peak just prior to 2000 followed by a steady decline, again based almost exclusively on data from the Sri Lankan longline-gillnet combination fisheries. Fig.6b highlights how the catch series of each species is dominated by very few fleets which are reporting by species and may therefore not be fully reflective of the ocean-wide trend.

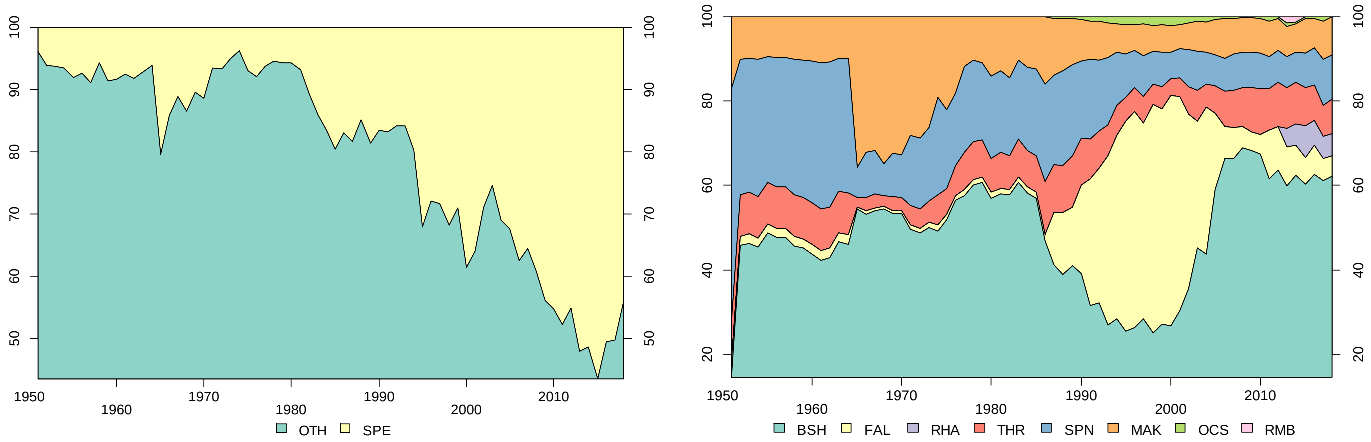


Fig. 5. a) Proportion of shark catches reported by species and as aggregate catch (OTH) and b) proportion of nominal shark catches by species

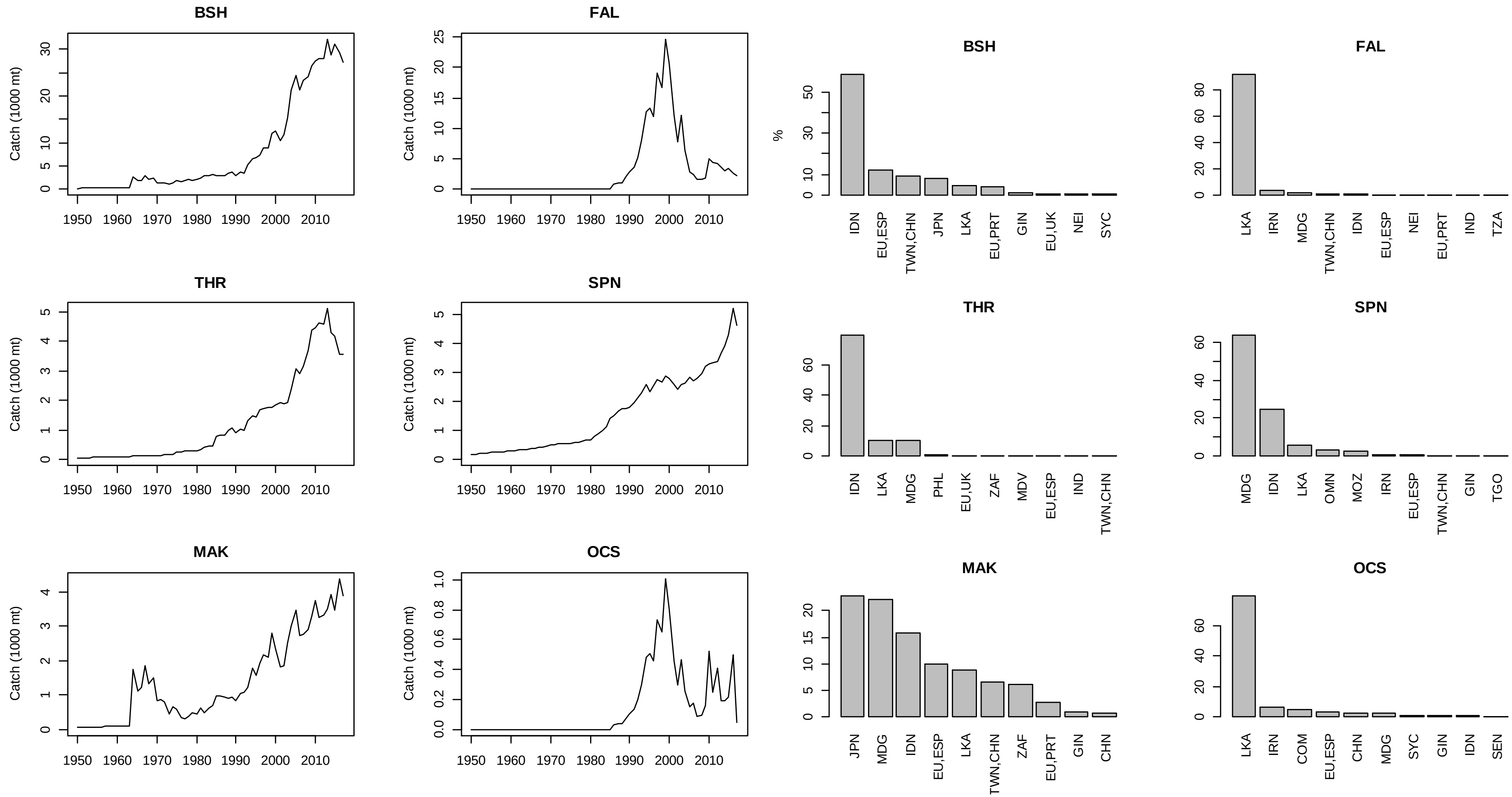


Fig. 6. a) Total nominal catches by species for all fleets (1950-2017) and b) contribution of each fleet to the total data series

Trends in species catches by gear types are summarised in Table 3. Longline fleets reported predominantly blue shark catches, followed by mako and silky sharks, while catches of handline gears are also 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 the majority of shark catches are reported as aggregates. Nevertheless, this is improving as shown in Fig. 7 by the level of species-specific reportin, particularly by the gillnet fleet of I.R. Iran. This figure highlights the relatively high catches of the Indonesia line fisheries (including troll lines, hook and line, hand line and coastal longlines[4]) and the gillnet fisheries of Pakistan, Yemen and I.R. Iran.

Table 3. Species-specific catches by gear type from 2005–2017 (pole and line (PL), gillnet (GILL), Handline (HAND), Line (LINE), logline (LL), Purse seine (PS), small purse seines/ring nets (PSS) and troll lines (TROL).

	BB	GILL	HAND	LINE	LL	PS	PSS	TROL
OTH	100	89	15	98	20	28	89	70
BSH	0	3	58	0	63	0	2	0
FAL	0	4	1	2	6	72	6	1
RHA	0	3	0	0	0	0	0	0
THR	0	0	16	0	0	0	0	3
SPN	0	1	7	0	0	0	3	20
MAK	0	0	3	0	10	0	0	6

[4] These are longlines which are operated by smaller vessels (<15m) and generally deployed within the EEZ.

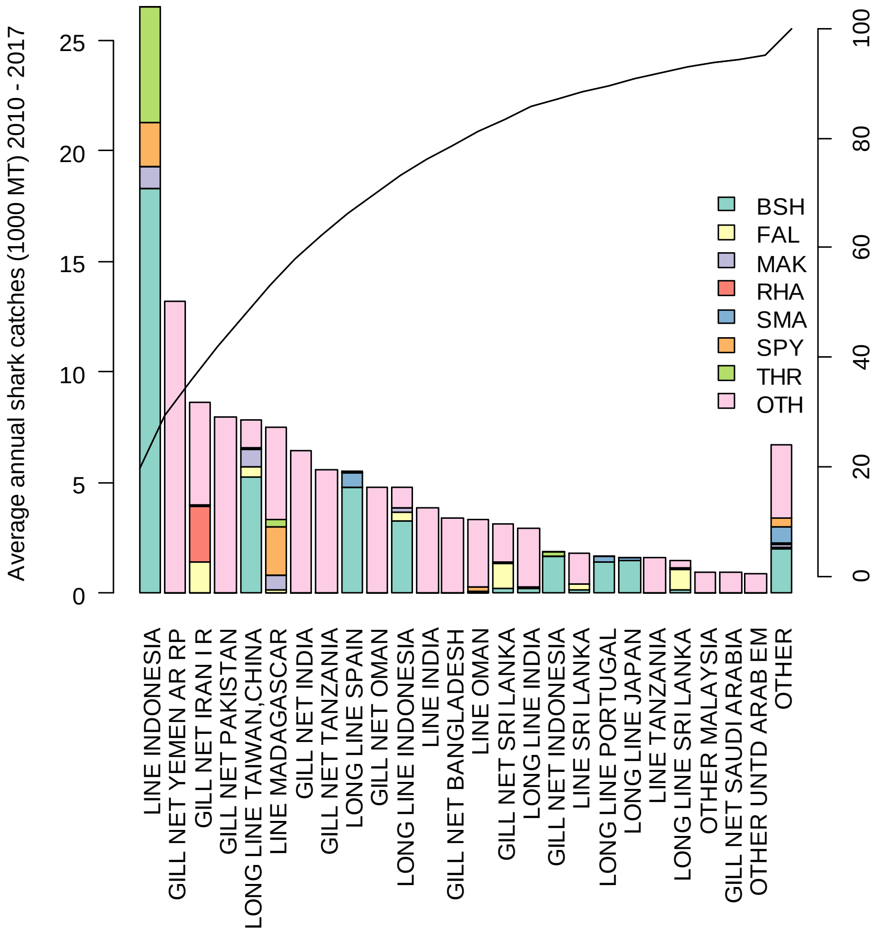


Fig. 7. Annual average shark catches reported by fleet and species from 2010–2017

Catch rates of IOTC fleets

While industrial longliners and drifting gillnets harvest important amounts of pelagic sharks, industrial purse seiners, pole-and-lines and most coastal fisheries are unlikely to harvest important quantities of pelagic sharks.

- **Pole and line fisheries:** The shark catches reported for the pole and line fisheries of Maldives are very low and none are reported for India. The extent of shark catches taken by these fisheries, if any, is not thought to be significant.

- **Gillnet fisheries:** The species of sharks caught are thought to vary significantly depending on the area of operation of the gillnets:
  - Gillnets operated in areas having low concentrations of pelagic sharks: The gillnet fisheries of most coastal countries operate these gears in coastal waters. The abundance of pelagic sharks in these areas is thought low.
  - Gillnets operated in areas having 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.
- **Gillnets operated on the high seas:** Vessels from Taiwan,China were using drifting gillnets (driftnets) from 1982 to 1992, when the use of this gear was banned worldwide. The catches of pelagic sharks 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. This was initially in waters of the Arabian Sea but covering a larger area in recent years as they expanded their range 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 (12 m average length) operating gillnets and longlines in combination have been harvesting important amounts of pelagic sharks since the mid-1980s. The longlines are believed to be responsible for most of the catches of sharks. Catches of sharks comprised ~45% of the total combined catch for all species in 1995 and declined 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 combination gear.

- **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 high historically, 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 20–40% of the total combined catch for all species. 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 catches 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 ports of landing of fresh-tuna longliners[5], 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 levels of discards of sharks, which are thought 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. The amount of sharks caught by longliners targeting swordfish in the IOTC area of competence has been increasing since the mid-1990s. The catches of sharks recorded for these fleets are thought more realistic than those recorded for other longline fisheries. The high catches are thought to be due to:
    - Gear configuration and time fished: The 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: The 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. High amounts of sharks are thought to occur in these areas.
    - Changes in the relative amounts of swordfish and sharks in the catches: Some of the 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. Limited nominal catch data have been reported for the purse seine fleets.
- **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 amount that other species of sharks make out of the catches of tuna and tuna-like species might change depending on the area fished and time of the day.

Fig. 8 shows the catch rates of sharks as a proportion of total catches as reported in the IOTC database. This suggests that some of the reported catch rates for the longline fleet are lower than expected and highlights the patchiness of the data leading to highly variable catch rates over time.

[5] The IOTC-OFCF (Overseas Fisheries Cooperation Foundation of Japan) Project implemented programmes in cooperation with local institutions in Thailand and Indonesia.

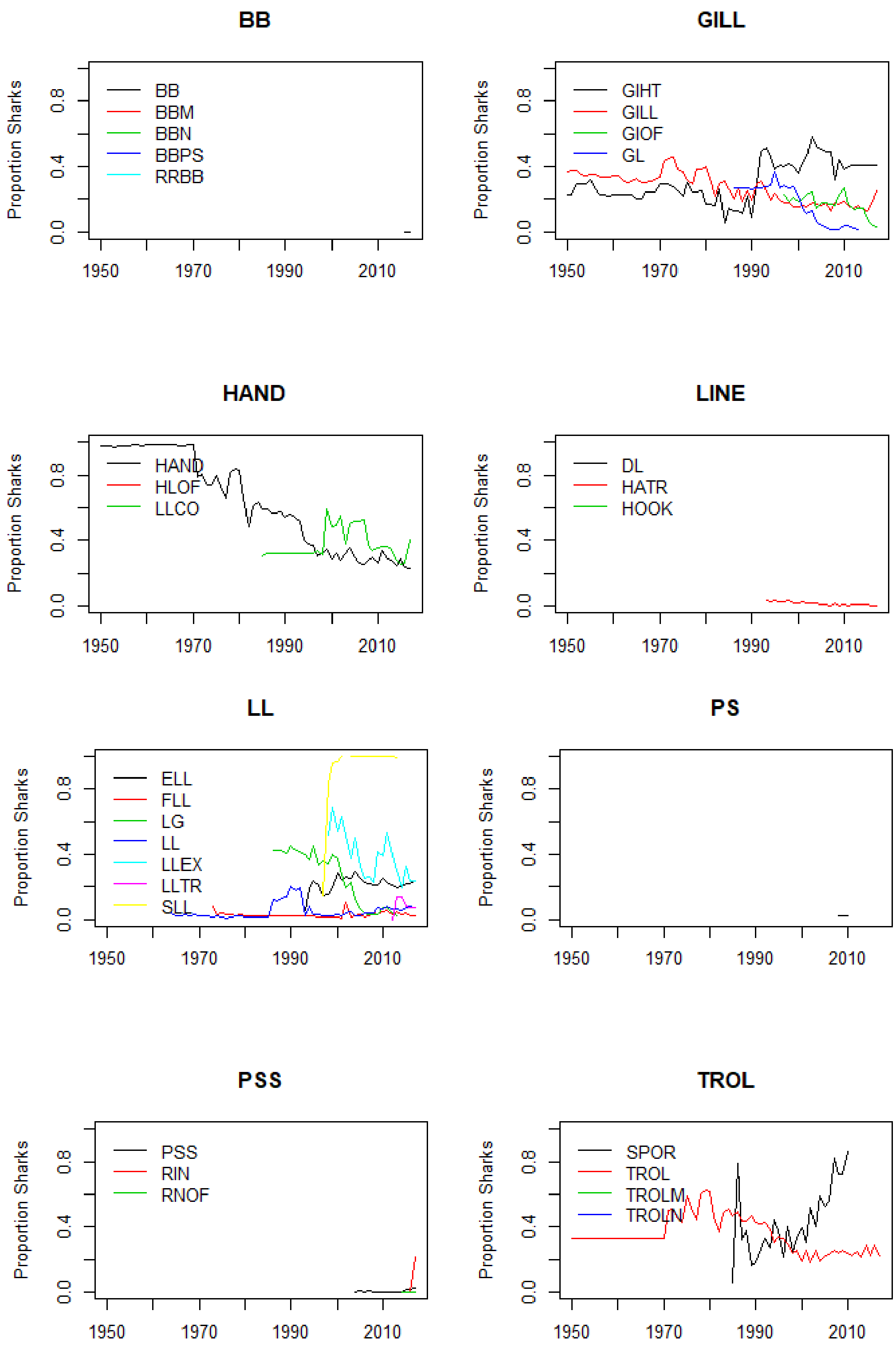
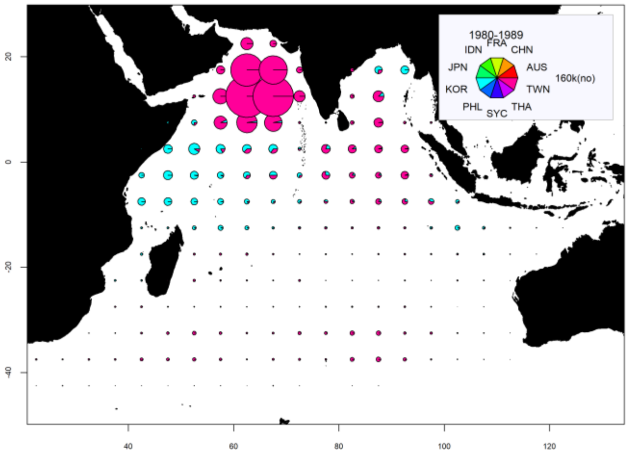


Fig. 8. Proportion of reported shark catch as a fraction of total reported catch by gear type over time

Spatial information on sharks catches

Fig. 9 presents the spatial catches of sharks by fleet reported over time. The main reporting fleets are Taiwan,China, Japan, Rep. of Korea, Seychelles, China, France and Australia. More limited time-area catches of sharks are also available from some other fleets, as recorded in Appendix 3. Fig. 10 shows the distribution of catches by gear over time. In the 1980s the Taiwanese gillnet fleet was the most important fleet for shark catches, operating predominantly in the northwestern Indian Ocean. In the 1980s and 1990s the deep-freezing longline catches increased, particularly in the southwestern region, while in more recent years the fresh longline component has also become important in central areas. Fig. 11 shows shark catches that have been reported by species. This highlights the increase in reporting by species over time. Records are dominated by blue shark catches, followed by silky sharks in the northwest and makos in the southwest Indian Ocean. Time-area catches of sharks by species are only available from 2009 for Japan, while these fleets have been operating in the Indian Ocean since the 1950s. Reported catches for Japan are also considered to be incomplete, as they only include species which have been listed as mandatory for reporting. Spatially disaggregated catches of sharks are available for Taiwan,China since 1977 aggregated by species, however, no species-specific information has been reported prior to 2007. Catches by the Seychelles fleets are available from 2001 and from the Republic of Korea from 2012.



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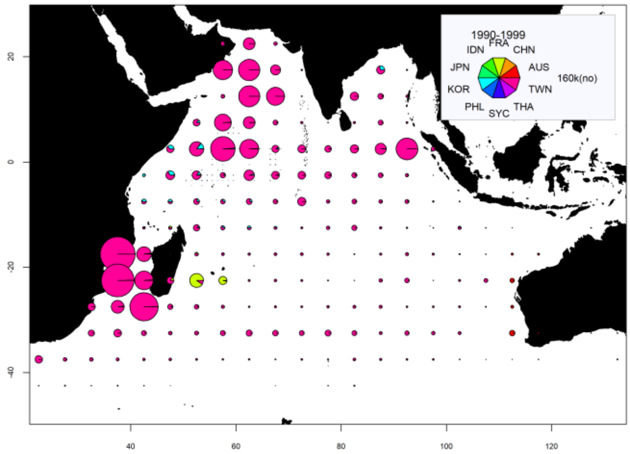

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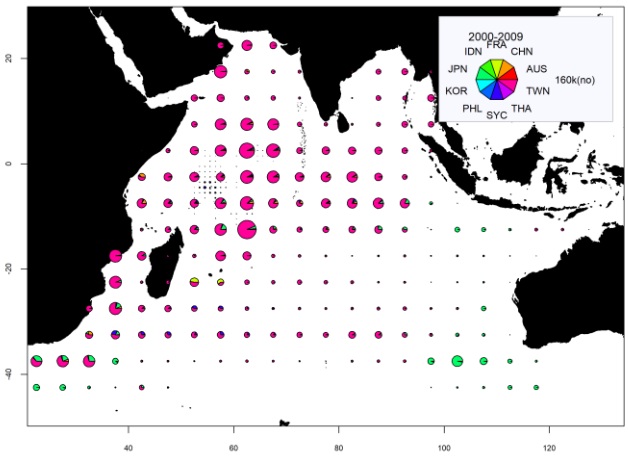

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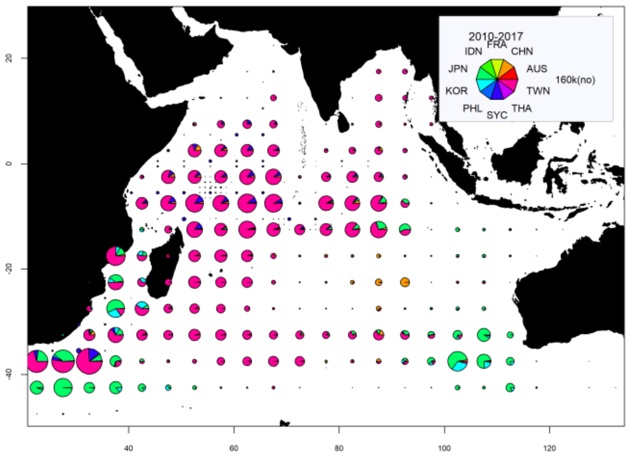

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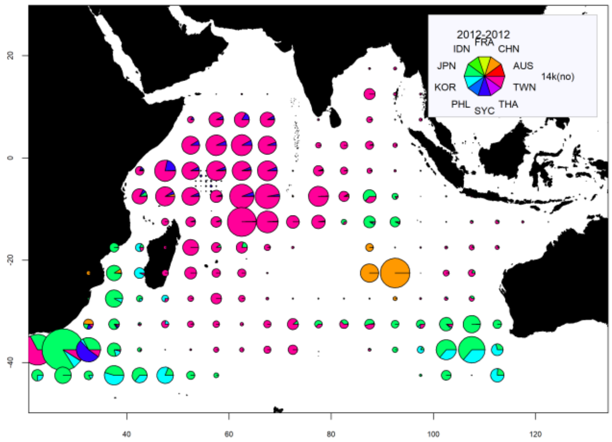

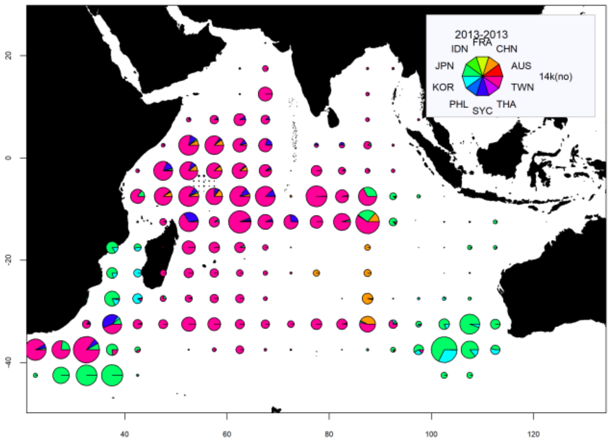

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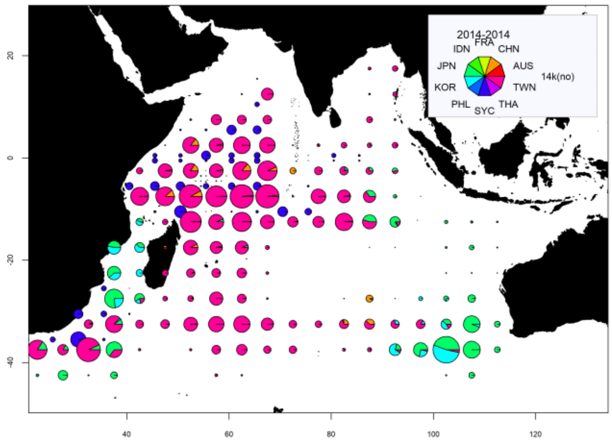

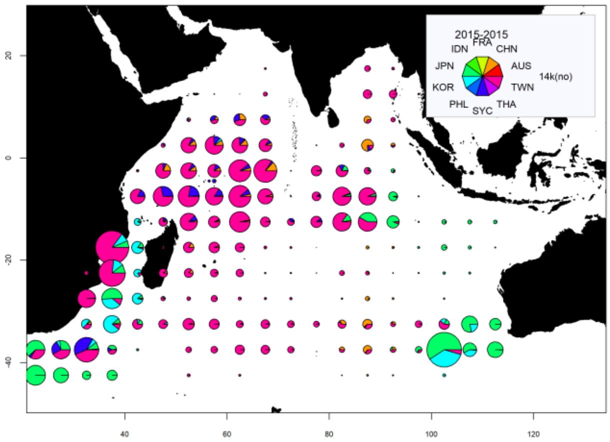

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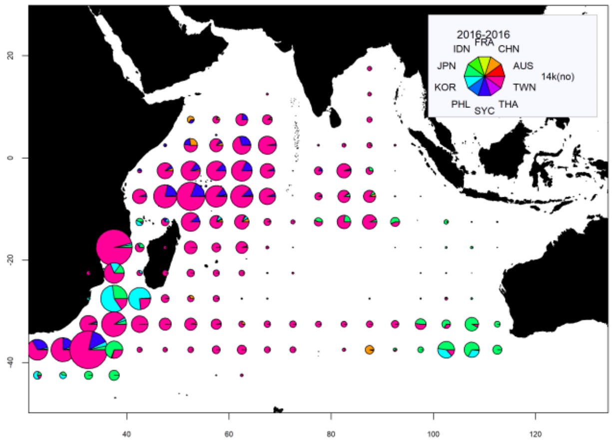
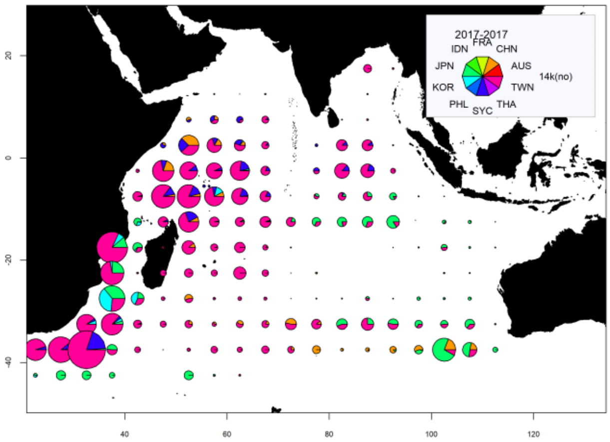
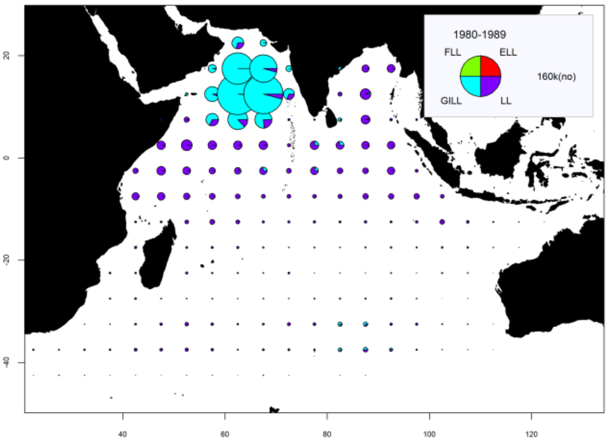




i)

j)

Fig. 9. Time-area catches (total numbers) of sharks caught by fleet by decade (a-d) and year 2012-2017 (e-j) for all reporting vessels.


1980-1989
FLL
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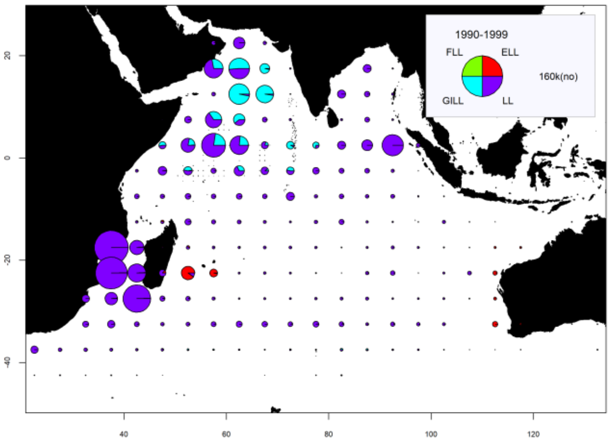
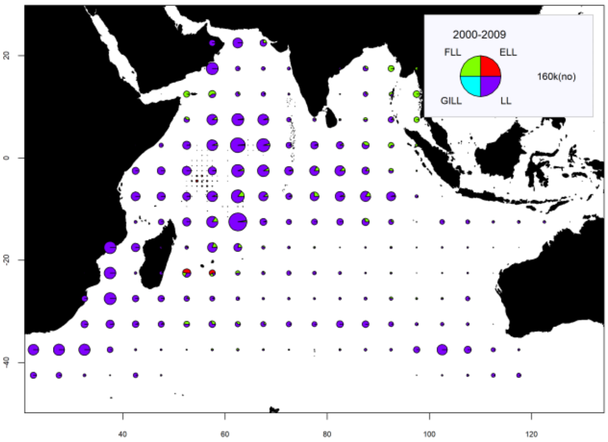
160k(no)

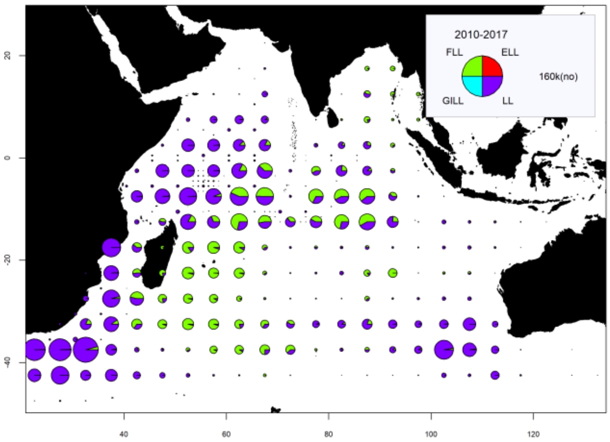
a)


1990-1999
FLL
ELL
GILL
LL
160k(no)

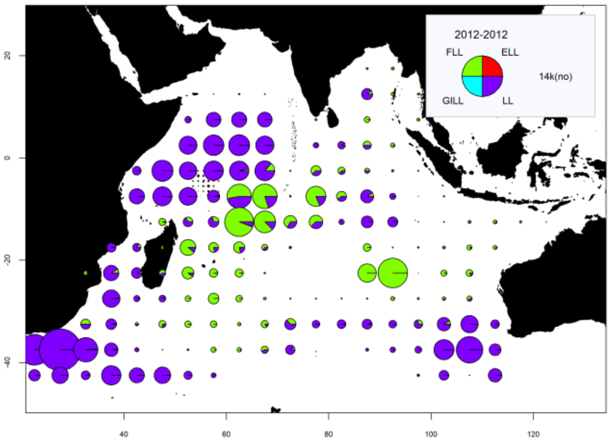
b)

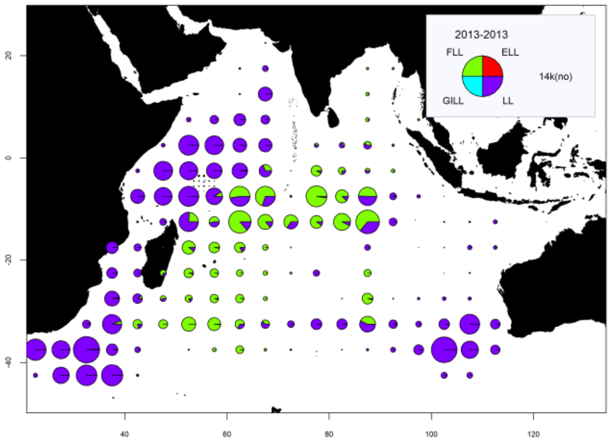

2000-2009
FLL
ELL
GILL
LL
160k(no)

c)

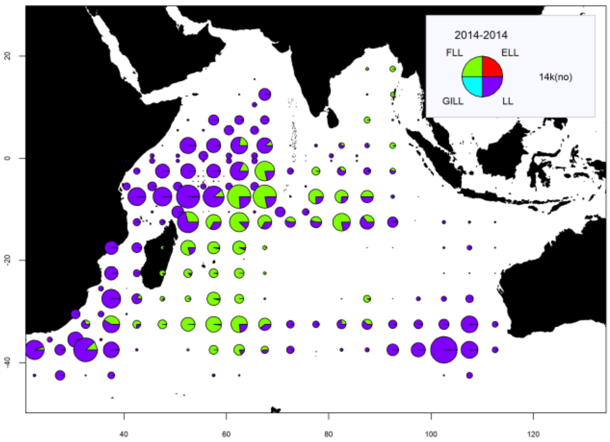

2010-2017
FLL
ELL
GILL
LL
160k(no)

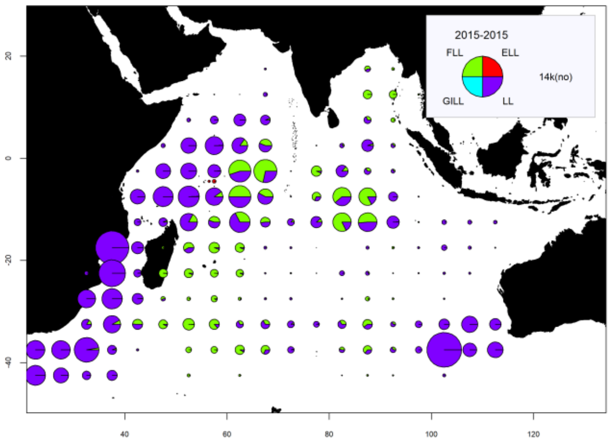
d)



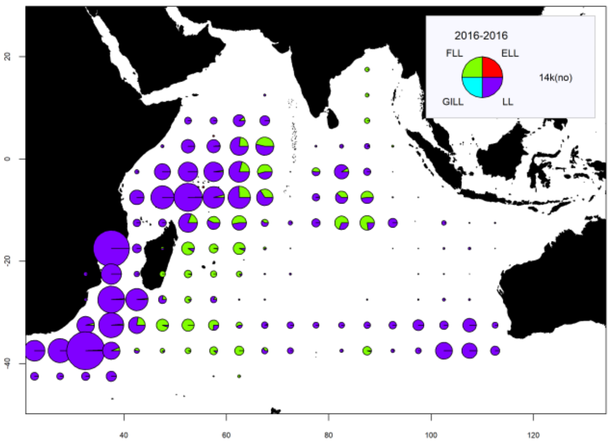


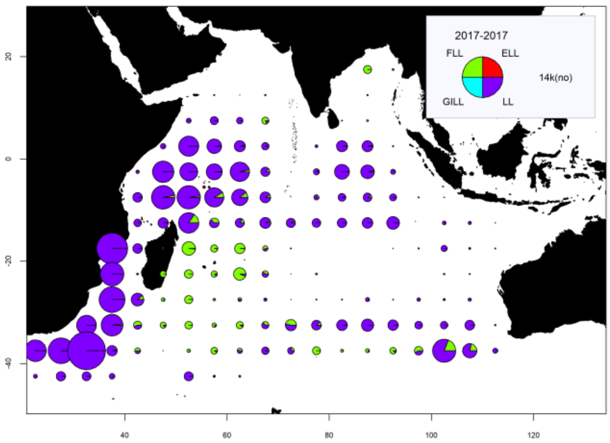
e) f)





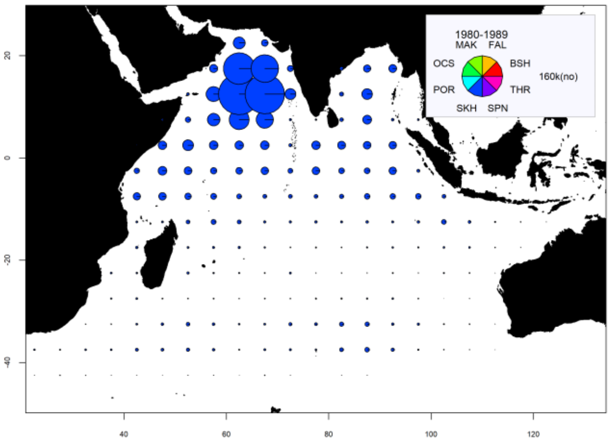
g) h)



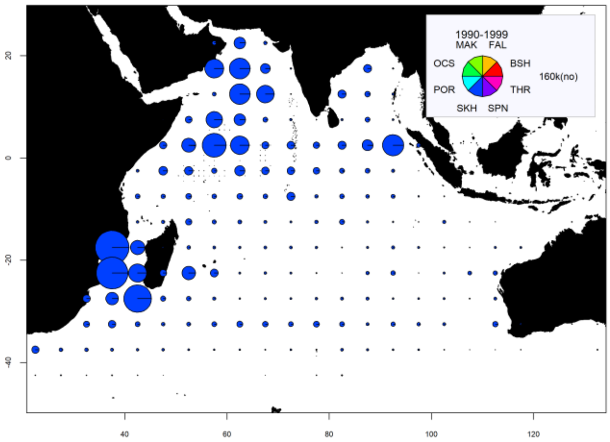


i) j)

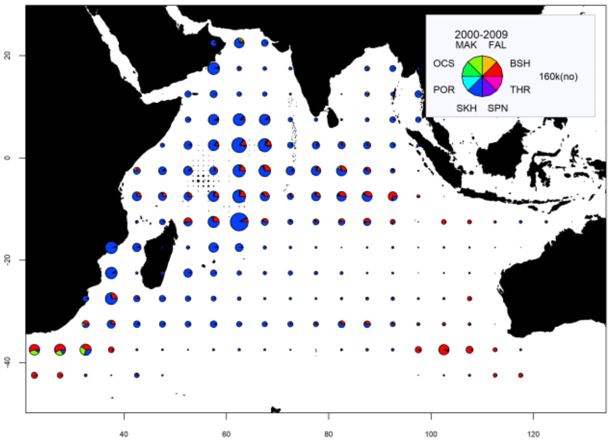
Fig. 10. Time-area catches (total numbers) of sharks by gear type by decade (a-d) and year 2012-2017 (e-j). FLL = fresh longline, ELL = longline targeting swordfish, LL = deep-freezing longline, GILL = drifting gillnet.


1980-1989
MAK FAL
OCS BSH
POR THR
SKH SPN
160k(no)

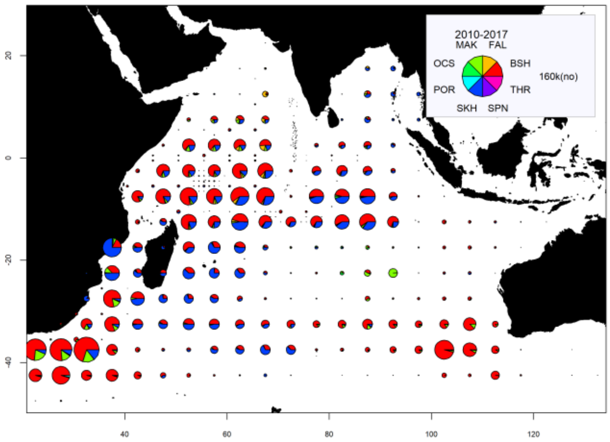
a)


1990-1999
MAK FAL
OCS BSH
POR THR
SKH SPN
160k(no)

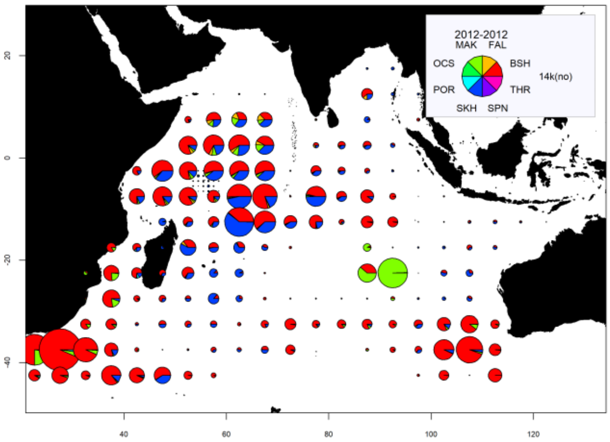
b)


2000-2009
MAK FAL
OCS BSH
POR THR
SKH SPN
160k(no)

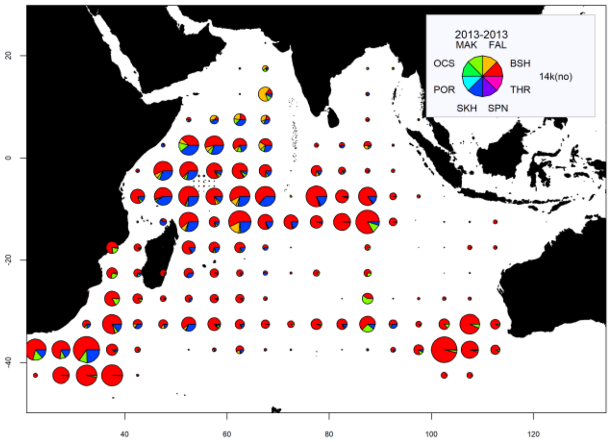
c)


2010-2017
MAK FAL
OCS BSH
POR THR
SKH SPN
160k(no)

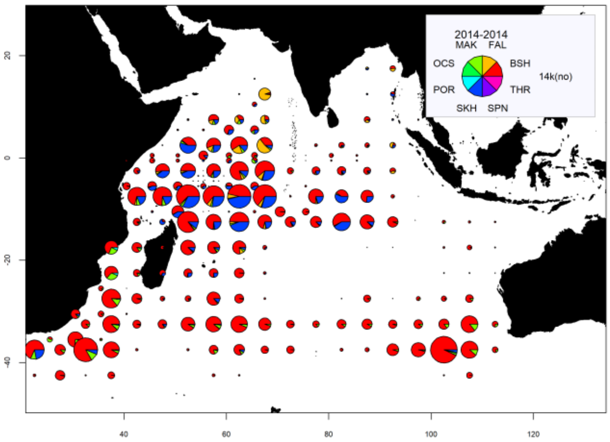
d)



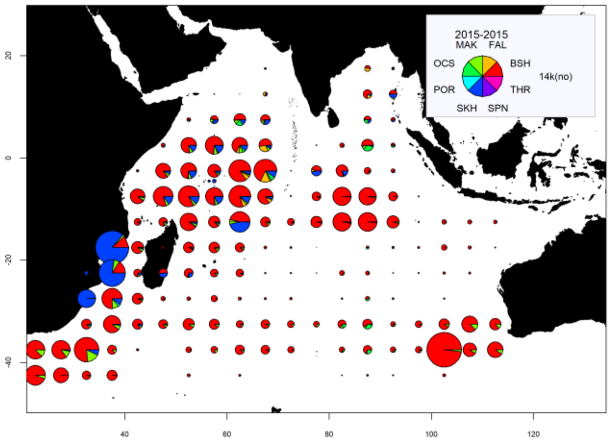
e)



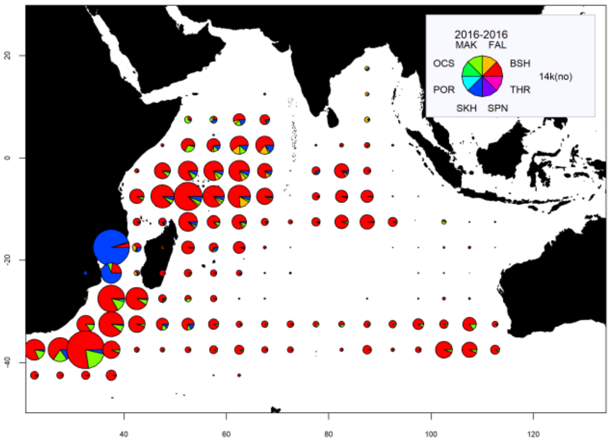
f)



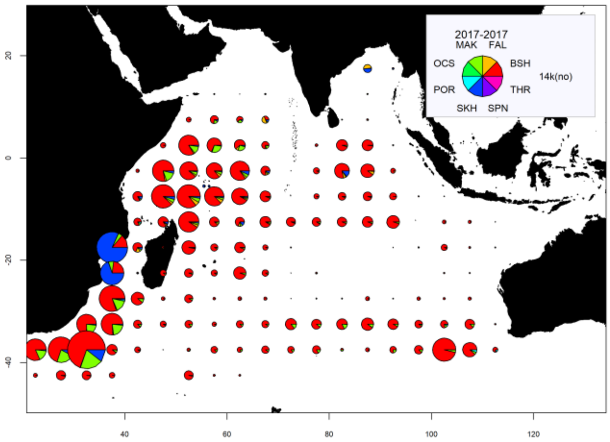
g)



h)



i)



j)

Fig. 11. Time-area catches (total numbers) of sharks by species by decade (a-d) and year 2012-2017 (e-j).

Length frequency data

Due to the different types of length measurement reported, a number of conversions were performed to standardise the length-frequency information. Given the increasing amount of data reported and the need for standardisation, a set of species-specific conversion factors and proxies that have been agreed by the Working Party on Ecosystems and Bycatch could help improve the estimates. Conversion factors currently used are provided in Appendix 4. Size frequency data are reported using different length classes ranging from 1cm to 10cm intervals. In addition to this, there appears to be rounding taking place when the smaller size intervals are used, creating abnormal peaks in the distributions. The graphs shown below have been aggregated to 5cm intervals in order to smooth this effect.

Fig. 12 shows the aggregated fork length frequency distribution for the longline fleets reporting size information on blue sharks for all areas between 2005 and 2017. The data reported for vessels flagged for China, Japan, Rep. of Korea and EU,Portugal include data reported for longline fleets with observers onboard. The results highlight the difference in size of the individuals caught by different fleets, with the EU fleets, on average, catching larger blue sharks than the other fleets. Fig. 13 shows the length distributions for the other shark species with reported size frequency data aggregated across all fleets and all years given the more limited amount of data available for these species.

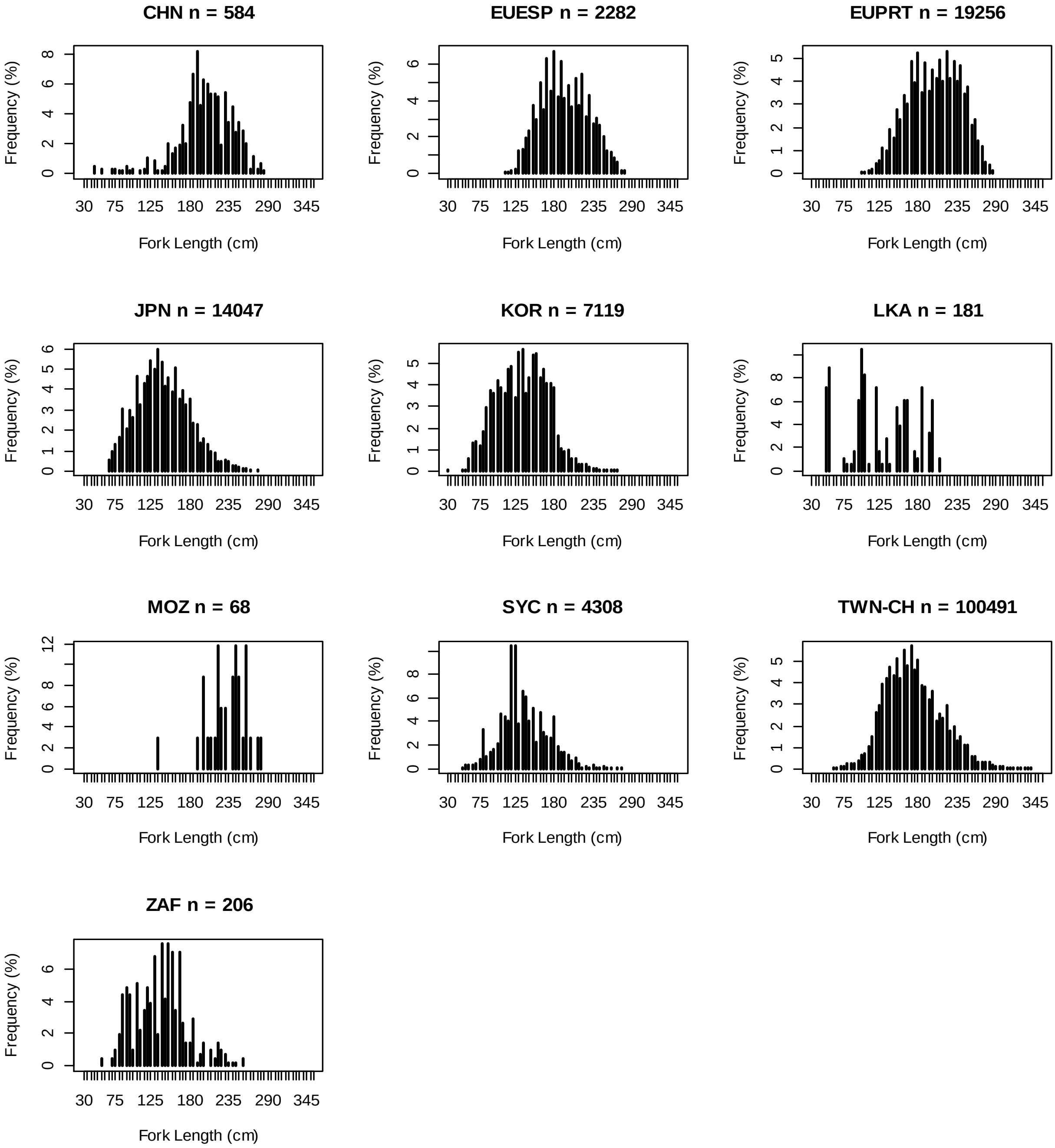


Fig. 12. Fork length frequency distributions (%) of blue shark derived from the samples reported for the longline and gillnet fleets of China (CHN LL), EU,Spain (EUESP ELL), EU,Portugal (EUPRT ELL), Japan (JPN LL), Korea (KOR LL), Sri Lanka LKA (FLL, G/L), Mozambique (MOZ HAND) Seychelles (SYC LL), Taiwan,China (TWN-CHN FLL,LL) and South Africa (ZAF ELL) between 2005 and 2017 in 5 cm length classes.

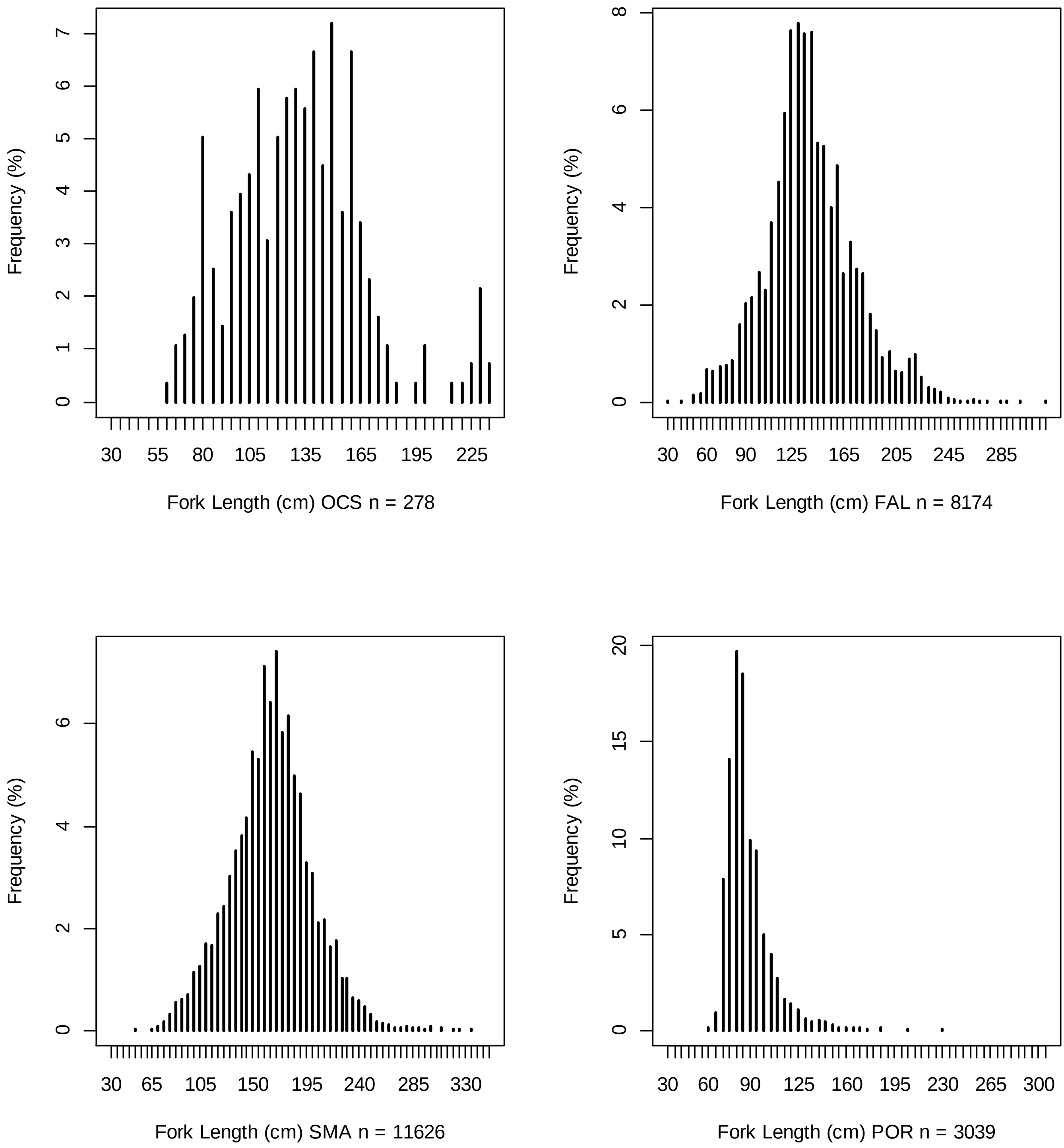


Fig. 13. Fork length frequency distributions (%) for oceanic whitetip shark (OCS), shortfin mako shark (SMA), porbeagle shark (POR) and silky shark (FAL) between 2005 and 2017.

SUMMARY OF FISHERIES DATA AVILABLE FOR SEABIRDS

Main species and fisheries concerned

The main species of seabirds likely to be caught as bycatch in IOTC fisheries are presented in Table 4[6].

Table 4. Main species of seabirds likely to be incidentally caught on longline operations

Common Name	Status*	Scientific Name
Amsterdam Albatross	Critically Endangered	*Diomedea amsterdamensis*
Antipodean Albatross	Vulnerable	*Diomedea antipodensis*
Black-browed Albatross	Endangered	*Thalassarche melanophrys*
Buller's Albatross	Near Threaten	*Thalassarche bulleri*
Campbell Albatross	Vulnerable	*Thalassarche impavida*
Chatham Albatross	Vulnerable	*Thalassarche eremite*
Grey-headed Albatross	Vulnerable	*Thalassarche chrysostoma*
Light-mantled Albatross	Near Threatened	*Phoebetria palpebrata*
Northern Royal Albatross	Endangered	*Diomedea sanfordi*
Southern Royal Albatross	Vulnerable	*Diomedea epomophora*
Salvin's Albatross	Vulnerable	*Thalassarche salvini*
Shy Albatross	Near Threatened	*Thalassarche cauta*
White-capped Albatross	Near Threatened	*Thalassarche steadi*
Sooty Albatross	Endangered	*Phoebetria fusca*
Tristan Albatross	Critically Endangered	*Diomedea dabbenena*
Wandering Albatross	Vulnerable	*Diomedea exulans*
Atlantic Yellow-nosed Albatross	Endangered	*Thalassarche chlororhynchos*
Indian Yellow-nosed Albatross	Endangered	*Thalassarche carteri*
Northern Giant Petrel	Least Concern	*Macronectes halli*
Southern Giant Petrel	Least Concern	*Macronectes giganteus*
White-chinned Petrel	Vulnerable	*Procellaria aequinoctialis*
Westland Petrel	Vulnerable	*Procellaria westlandica*
Short-tailed Shearwater	Least Concern	*Puffinus tenuirostris*
Sooty Shearwater	Near Threatened	*Puffinus griseus*

*****Source IUCN 2006, BirdLife International 2004b.

[6] As in IOTC–2007–WPEB–22, Appendix 2, page 24. Paper submitted on behalf of the Agreement for the Conservation of Albatrosses and Petrels (ACAP)

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° degrees South), an area where most of the effort is exerted by longliners. Incidental catches are, for this reason, likely to be of importance only for longline fleets having vessels operating in these areas. The main fleets reporting longline fishing effort since 1955 in this area are those of Japan and Taiwan,China, accounting for 13% and 62% of total effort in the area in 2017 (Figure 14). This summarises total reported effort, however, this is incomplete for some reporting fleets, i.e. for Malaysia, South Africa, Seychelles, Rep. of Korea and Taiwan,China the effort is likely to be higher. It is also important to note that these are only the countries that are reporting some information on effort, while it is expected that a number of other longline fleets also fish in this area based on the presence of temperate species in their catch data. These include Indonesia, Madagascar, Tanzania, Philippines, Mozambique and Belize. The effort from some of these CPCs is also likely to be substantial, given the catch quantities of temperate species (e.g. Indonesia National Report Fig; 3b IOTC-2016-SC19-NR01).

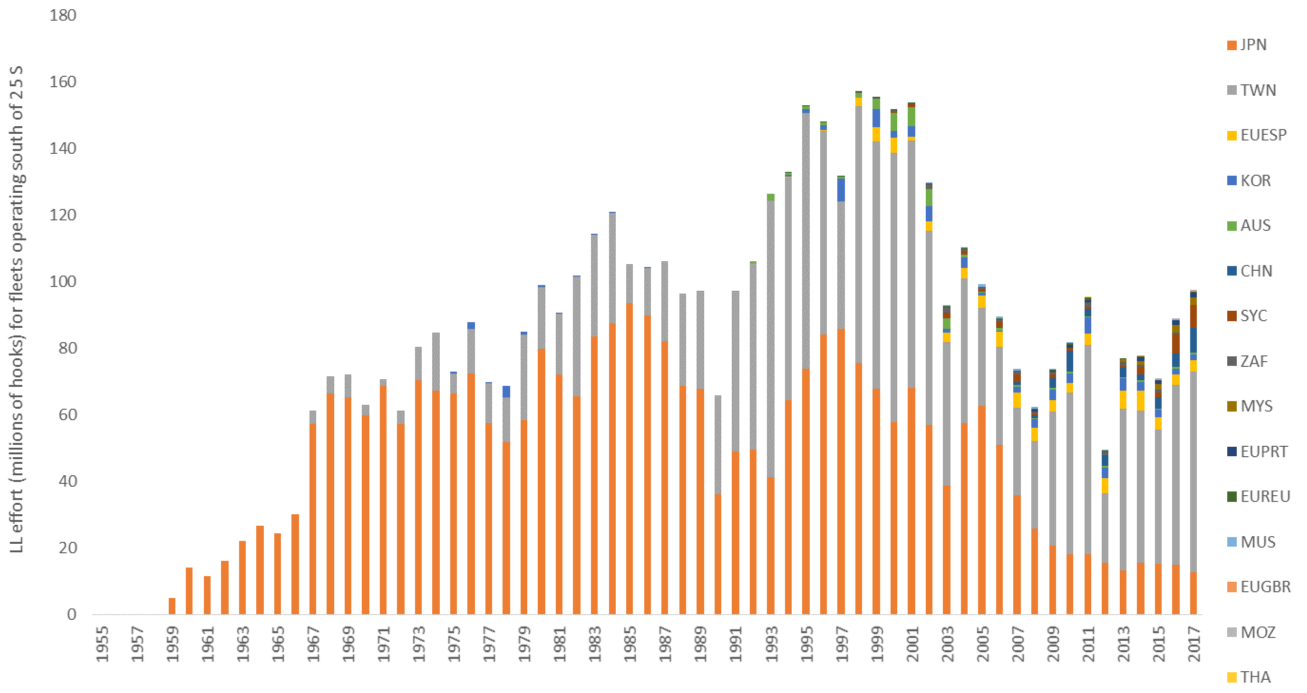


Figure 14. Reported longline effort for fleets operating south of 25° south between 1955 and 2017. (THA = Thailand, EUGBR = EU,UK, MYS = Malaysia, EUPRT = EU,Portugal, EU,REU = EU,France, MUS = Mauritius, ZAF, = South Africa, SYC = Seychelles, CHN = China, AUS = Australia, EUESP = EU,Spain, KOR = Rep. of Kora, TWN = Taiwan,China, JPN = Japan).

Status of data on seabird bycatch

The reported data available on seabirds caught in the IOTC area of competence are generally fairly limited. In 2016 six CPCs (Australia, EU-Portugal, EU-Spain, EU-France, Japan, Rep. of Korea, Taiwan,China and South Africa) of the 15 CPCs which report effort or are likely to exert longline fishing effort south of 25°S to IOTC submitted data in response to a call for data submission on seabirds which was reported to the SC.[7] In addition, three CPCs submitted substantive papers on seabird bycatch to the WPEB12: China[8], EU-Spain[9]), and Japan[10].

The information provided 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. Because the reporting of effort has been low (some CPCs fishing south of 25°S in the Indian Ocean did not report any effort while for others it was incomplete), and the observer coverage is relatively low (though improving) for many fleets, data submitted through the data-call is unlikely to be able to provide reliable estimates of total bycatch of seabirds from the longline fishery south of 25°S latitude in the Indian Ocean and so extrapolations of the information to total Indian Ocean captures were not undertaken. Bycatch mortality, where reported, was high but there is a lack of information on post release mortality/survival as well as total effort which means that the total fishery induced mortality on the seabird populations cannot be estimated.

SUMMARY OF FISHERIES DATA AVILABLE FOR MARINE TURTLES

Main species and fisheries concerned

The main species of marine turtles likely to be caught as bycatch by IOTC fisheries are listed in Table 5**.**

Table 5. Main species of Indian Ocean marine turtles[11].

Common Name	Scientific Name
Loggerhead turtle	*Caretta caretta*
Olive ridley turtle	*Lepidochelys olivacea*
Green turtle	*Chelonia mydas*
Hawksbill turtle	*Eretmochelys imbricata*
Leatherback turtle	*Dermochelys coriacea*
Flatback turtle	*Natator depressus*

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, I.R. Iran, Thailand, Japan)
- Gillnet fisheries operating in coastal waters or on the high seas (Sri Lanka, I.R. Iran, Pakistan, Indonesia)
- Industrial longline fisheries operating in tropical areas (China, Taiwan,China, Japan, Indonesia, Seychelles, India, Oman, Malaysia and the Philippines)

[7] IOTC-2016-SC19-INF02

[8] Gai, C.; Dai, X. (2016). Estimating the composition and capture status of bycatch using Chinese longline observer data in the Indian Ocean. IOTC–2016–WPEB12–16.

[9] Fernández-Costa J.; Ramos-Cartelle, A.; Carroceda, A.; Mejuto, J. (2016). Interaction between seabirds and Spanish surface longline targeting swordfish in the Indian Ocean (⩾ 25º South) during the period 2011-2015. IOTC–2016–WPEB12–29.

[10] Inoue, Y.; Kanaiwa, M.; Yokawa, K.; Oshima, K. (2016a). Examination of factors affecting seabird bycatch occurrence rate in southern hemisphere in Japanese longline fishery with using random forest. IOTC–2016–WPEB12–INF07.

Inoue, Y.; Kanaiwa, M.; Yokawa, K.; Oshima, K. (2016b). MODELING OF BYCATCH OCCURRENCE RATE OF SEABIRDS FOR JAPANESE LONGLINE FISHERY OPERATED IN SOUTHERN HEMISPHERE. IOTC–2016–WPEB12–INF08.

Yokawa, K.; Oshima, K.; Inoue, Y.; Katsumata, N. (2016). Operational pattern of Japanese longliners in the south of 25S in the Atlantic and the Indian Ocean for the consideration of seabird bycatches. IOTC–2016–WPEB12–INF09.

Katsumata, N.; Yokawa, K.; Oshima, K. (2016). Information of seabirds bycatch in area south of 25 S latitude in 2010 from 2015. IOTC–2016–WPEB12–INF10.

[11] Memorandum of Understanding on the Conservation and Management of Marine Turtles and their Habitats of the Indian Ocean and South-East Asia

Status of data on marine turtle bycatch

The reported data available on marine turtles caught in the IOTC area of competence are poor quality, sparse and not standardised, as highlighted in paper IOTC-2015-WPEB11-07. Nevertheless, as importing of the ROS data is finalised, data summaries will soon be made available.

SUMMARY OF FISHERIES DATA AVILABLE FOR MARINE MAMMALS

The reporting of the interactions of IOTC fisheries with marine mammals has been extremely limited to date, as highlighted in paper IOTC-2015-WPEB11-07. The current low level, lack of standardisation and ad hoc nature of data reporting are not conducive to supporting regional level analyses. Nevertheless, with the current development of the cetacean identification guides and publication in multiple languages, this is expected to improve considerably. Observer data summaries will be made available as soon as the data importing is complete.

MAIN ISSUES IDENTIFIED CONCERNING DATA ON BYCATCH (NON-IOTC) SPECIES AVAILABLE TO THE IOTC

General issues

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

Sharks

- 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.

Some fleets have also been noted to report catches by species only for those that have been specifically identified by the Commission and do not report catches of other species even in aggregate form. This creates problems for the estimation of total catches of all sharks and for attempts to apportion aggregate catches into species groups at a later date. The changing requirements for species-specific reporting also complicates the interpretation of these data.

- Errors in reported catches

For the fleets that do report interactions, there are a number of issues with these estimates. The estimates are often based on retained catches rather than total catches, and so if discarding is high then this is a major source of error where discards are not reported. Errors are also introduced due to the processing of the retained catches that is undertaken. This creates problems for calculating 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.

- 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. Processing creates further problems for species identification, requiring a high level of expertise and experience in order to be able to accurately identify specimens, if at all. The level of reporting by gear type is much higher and catches reported with no gear type allocated 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 of the data available.

1. **Catch-and-Effort data from gillnet fisheries:**
   - Driftnet fishery of Taiwan,China (1982–92): Catch-and-effort data does not include catches of sharks by species.
   - Drifting gillnet fisheries of I.R. Iran and Pakistan: To date, I.R.Iran and Pakistan have not reported time-area catches of sharks, by species, for the gillnet fisheries, although both CPCs are now providing nominal catches of sharks by species.
2. **Catch-and-Effort data from Longline Fisheries:**
   - Historical catches of sharks from major longline fisheries: To date, Japan, Taiwan,China, Indonesia and Rep. of Korea, have not provided estimates of catches of sharks, by species, for years before 2006.
   - Fresh-tuna longline fisheries of Indonesia and Malaysia: Indonesia and Malaysia have not reported catches of sharks by IOTC standards for longliners under their flag.
   - Freezing longline fisheries of EU,Spain, India, Indonesia, Malaysia, and Oman: These countries have not reported catch-and-effort data of sharks by species for longliners under their flag.
3. **Catch-and-Effort data from coastal fisheries:**
   - Coastal fisheries of India, Indonesia and Yemen: to date, these countries have not provided detailed catches of sharks to the IOTC.
4. **Discard levels from surface and longline fisheries:**

- Discard levels of sharks from major longline fisheries: to date the EU (Spain, UK), Japan, Taiwan,China and Indonesia, 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: to date, the EU,Spain, I.R. Iran, Japan, Seychelles, and Thailand have not provided estimates of total quantities of discards of sharks, by species, for industrial purse seiners under their flag, although EU, Spain and Seychelles are now reporting discards in their observer data.

5. 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 and Philippines: to date, these countries have not reported size frequency data for 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.

6. Biological data:

- Surface and longline fisheries, in particular China, Taiwan,China, Indonesia and Japan: 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.

Other bycatch species groups

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 unstandardized and often lacking in clarity. Formal submissions of data in an electronic and standardized format using the available IOTC templates will considerably improve the quality of data obtained and the type of regional analyses that these data can be used for.

1. 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.

2. Incidental catches of MARINE TURTLES:

- Gillnet fisheries of Pakistan and Indonesia: to date, there have been no reported incidental catches of marine turtles for the 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, Seychelles, 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.

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 Resolution 12/06) and not providing an estimation of the total mortality of marine turtles incidentally caught in their fisheries (as required by Resolution 12/04).

APPENDIX 1

OVERVIEW OF MINIMUM DATA REPORTING REQUIREMENTS

All bycatch

- IOTC Resolution 15/02: ***Mandatory statistical reporting requirements*** *for IOTC Contracting Parties and Cooperating Non-Contracting Parties (CPCs) (came into force on 10 September2015)*
  - Paragraph 2: *Estimates of the total catch by species and gear, if possible quarterly, that shall be submitted annually as referred in paragraph 7 (separated, whenever possible, by retained catches in live weight and by discards in live weight or numbers) for all species under the IOTC mandate as well as the most commonly caught elasmobranch species according to records of catches and incidents as established in Resolution 15/01 on the recording of catch and effort data by fishing vessels in the IOTC area of competence (or any subsequent superseding Resolution).*
  - Paragraph 3: *Concerning cetaceans, seabirds and marine turtles data should be provided as stated in Resolutions 13/04 on Conservation of Cetaceans, Resolution 12/06 on reduction the incidental bycatch of seabirds in longline fisheries and Resolution 12/04 on the conservation of marine turtles (or any subsequent superseding resolutions).*
- IOTC Resolution 15/01: *On the* ***recording of catch and effort by fishing vessels*** *in the IOTC area of competence (came into force on 10 September2015)*
  - *Paragraph 1: Each flag CPC shall ensure that all purse seine, longline, gillnet, pole and line, handline and trolling fishing vessels flying its flag and authorised to fish species managed by IOTC be subject to a data recording system.*
  - *Paragraph 10: The Flag State shall provide all the data for any given year to the IOTC Secretariat by June 30th of the following year on an aggregated basis. The confidentiality rules set out in Resolution 12/02 Data Confidentiality Policy and Procedures for fine–scale data shall apply.*
  - *Paragraph 11: Noting the difficulty in implementing a data recording system on fishing vessels from developing CPCs, the data recording systems for vessels less than 24 metres of developing CPCs operating inside the EEZ shall be implemented progressively from 1 July 2016.*
- IOTC Resolution 11/04: *On a* ***regional observer scheme***
  - *Paragraph 2: In order to improve the collection of scientific data, 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. For vessels under 24 meters if they fish outside their EEZ, the above mentioned coverage should be achieved progressively by January 2013.*
  - *Paragraph 4: The number of the artisanal fishing vessels landings shall also be monitored at the landing place by field samplers. The indicative level of the coverage of the artisanal fishing vessels should progressively increase towards 5% of the total levels of vessel activity (i.e. total number of vessel trips or total number of vessels active).*
  - *Paragraph 11: The observer shall, within 30 days of completion of each trip, provide a report to the CPCs of the vessel. The CPCs shall send within 150 days at the latest each report, as far as continuous flow of report from observer placed on the longline fleet is ensured, which is recommended to be provided with 1°x1° format to the Executive Secretary, who shall make the report available to the Scientific Committee upon request. In a case where the vessel is fishing in the EEZ of a coastal State, the report shall equally be submitted to that coastal State.*

Sharks

- IOTC Resolution 17/05: *On the conservation of* ***SHARKS*** *caught in association with fisheries managed by IOTC*
  - *Paragraph 6:CPCs shall report data for catches of sharks no later than 30 June of the following year, in accordance with IOTC data reporting requirements and procedures in Resolution 15/02 mandatory statistical requirements for IOTC Members and Cooperating Non-Contracting Parties (CPC's) (or any subsequent superseding resolution), including all available historical data, estimates and life status of discards (dead or alive) and size frequencies.*

- IOTC Resolution 12/09: *On the conservation of **THRESHER SHARKS** (family Alopiidae) caught in association with fisheries in the IOTC Area of Competence*
  - *Paragraph 1: This measure shall apply to all fishing vessels on the IOTC Record of authorised Vessels.*
  - *Paragraph 4: CPCs shall encourage their fishers to record and report incidental catches as well as live releases. These data will be then kept at the IOTC Secretariat.*
  - *Paragraph 8: The Contracting Parties, Co-operating non-Contracting Parties, especially those directing fishing activities for sharks, shall submit data for sharks, as required by IOTC data reporting procedures.*
- IOTC Resolution 13/05: *On the conservation of **WHALE SHARKS** (Rhincodon typus)*
  - *Paragraph 1: This measure shall apply to all fishing vessels flying the flag of a CPC and on the IOTC Record of Fishing Vessels or authorised to fish for tuna and tuna-like species managed by the IOTC on the high seas. The provisions of this measure do not apply to artisanal fisheries operating exclusively in their respective EEZ.*
  - *Paragraph 3: CPCs shall require that, in the event that a whale shark is unintentionally encircled in the purse seine net, the master of the vessel shall:*

    b) report the incident to the relevant authority of the flag State, with the following information:

    i. the number of individuals;
    ii. a short description of the interaction, including details of how and why the interaction occurred, if possible;
    iii. the location of the encirclement;
    iv. the steps taken to ensure safe release;
    v. an assessment of the life status of the animal on release, including whether the whale shark was released alive but subsequently died.
  - *Paragraph 4: CPCs using other gear types fishing for tuna and tuna-like species associated with a whale shark shall report all interactions with whale sharks to the relevant authority of the flag State and include all the information outlined in paragraph 3b(i–v).*
  - *Paragraph 7: CPCs shall report the information and data collected under paragraph 3(b) and paragraph 4 through logbooks, or when an observer is onboard through observer programs, and provide to the IOTC Secretariat by 30 June of the following year and according to the timelines specified in Resolution 10/02 (or any subsequent revision).*
  - *Paragraph 8: CPCs shall report, in accordance with Article X of the IOTC Agreement, any instances in which whale sharks have been encircled by the purse seine nets of their flagged vessels.*
  - *Paragraph 9: For CPCs having national and state legislation for protecting the species shall be exempt from reporting to IOTC, but are encouraged to provide data for the IOTC Scientific Committee consideration.*
- IOTC Resolution 13/06: *On a scientific and management framework on the conservation of **SHARK** species caught in association with IOTC managed fisheries*
  - *Paragraph 5: CPCs shall encourage their fishers to record incidental catches as well as live releases of **OCEANIC WHITETIP SHARKS**. These data shall be kept at the IOTC Secretariat.*
  - *Paragraph 8: The CPCs, especially those targeting sharks, shall submit data for sharks, as required by IOTC data reporting procedures.*

Seabirds

- IOTC Resolution 12/06 *On reducing the incidental bycatch of **SEABIRDS** in longline fisheries*
  - *Paragraph 1 (start): CPCs shall record data on seabird incidental bycatch by species, notably through scientific observers in accordance with Resolution 11/04 and report these annually.*
  - *Paragraph 2: CPCs that have not fully implemented the provisions of the IOTC Regional Observer Scheme outlined in paragraph 2 of Resolution 11/04 shall report seabird incidental bycatch through logbooks, including details of species, if possible.*

Marine turtles

- IOTC Resolution 12/04 *On the conservation of **MARINE TURTLES***
  - *Paragraph 3: CPCs shall collect (including through logbooks and observer programs) and provide to the IOTC Secretariat no later than 30 June of the following year in accordance with Resolution 10/02 (or any subsequent revision), all data on their vessels' interactions with marine turtles. The data shall include the level of logbook or observer coverage and an estimation of total mortality of marine turtles incidentally caught in their fisheries.*

Marine mammals

- IOTC Resolution 13/04 *On the conservation of **CETACEANS***
  - *Paragraph 1: This measure shall apply to all fishing vessels flying the flag of a CPC and on the IOTC Record of Fishing Vessels or authorised to fish tuna and tuna-like species managed by the IOTC on the high seas. The provisions of this measure do not apply to artisanal fisheries operating exclusively in their respective EEZ.*
  - *Paragraph 3: CPCs shall require that, in the event that a cetacean is unintentionally encircled in a purse seine net, the master of the vessels shall:*

    b) report the incident to the relevant authority of the flag State, with the following information:

    i. the species (if known);
    ii. the number of individuals;
    iii. a short description of the interaction, including details of how and why the interaction occurred, if possible;
    iv. the location of the encirclement;
    v. the steps taken to ensure safe release;
    vi. an assessment of the life status of the animal on release, including whether the cetacean was released alive but subsequently died.
  - *Paragraph 4: CPCs using other gear types fishing for tuna and tuna-like species associated with cetaceans shall report all interactions with cetaceans to the relevant authority of the flag State and include all the information outlined in paragraph 3b(i–vi).*
  - *Paragraph 7: CPCs shall report the information and data collected under paragraph 3(b) and paragraph 4, through logbooks, or when an observer is onboard through observer programs, and provide to the IOTC Secretariat by 30 June of the following year and according to the timelines specified in Resolution 10/02 (or any subsequent revision).*
  - *Paragraph 8: CPCs shall report, in accordance with Article X of the IOTC Agreement, any instances in which cetaceans have been encircled by the purse seine nets of their flagged vessels.*
  - *Paragraph 9 (part): For CPCs having national and state legislation for protecting these species shall be exempt from reporting to IOTC, but are encouraged to provide data for the IOTC Scientific Committee consideration.*

APPENDIX 2

SHARK SPECIES THAT ARE KNOWN TO OCCUR IN FISHERIES DIRECTED AT IOTC SPECIES OR SHARKS

Code	English Name	Source	French Name	Scientific Name
AML	Grey Reef Shark	IOTC	Requin dagsit	*Carcharhinus amblyrhynchos*
BLR	Blacktip reef shark	IOTC	Requin pointes noires	*Carcharhinus melanopterus*
BRO	Copper shark	IOTC	Requin cuivre	*Carcharhinus brachyurus*
CCB	Spinner Shark	IOTC	Requin tisserand	*Carcharhinus brevipinna*
CCG	Galapagos shark	IOTC[3]	Requin des Galapagos	*Carcharhinus galapagensis*
DOP	Shortnose spurdog	IOTC	Aiguillat nez court	*Squalus megalops*
DUS	Dusky shark	IOTC	Requin de sable	*Carcharhinus obscurus*
GAG	Tope shark	IOTC	Requin-hâ	*Galeorhinus galeus*
GAM	Mouse Catshark	IOTC	Chien islandais	*Galeus murinus*
NTC	Broadnose sevengill shark	IOTC	Platnez	*Notorhynchus cepedianus*
OXY	Angular rough shark	IOTC	Centrine commune	*Oxynotus centrina*
SBL	Bluntnose sixgill shark	IOTC	Requin griset	*Hexanchus griseus*
SCK	Kitefin shark	IOTC	Squale liche	*Dalatias licha*
SHBC	Banded catshark	IOTC	Holbiche des plages	*Halaelurus lineatus*
SHCW	Cow sharks	IOTC	Requins griset	*Hexanchidae spp.*
SMD	Smooth-hound	IOTC	Emissole lisse	*Mustelus mustelus*
SPZ	Smooth hammerhead	IOTC	Requin marteau commun	*Sphyrna zygaena*
SSQ	Velvet dogfish	IOTC	Squale grogneur velouté	*Scymnodon squamulosus*
SSU	Australian angelshark	IOTC	Ange de mer australien	*Squatina australis*
AGN	Angelsharks, sand devils nei	FAO	Ange de mer commun	*Squatina squatina*
CCD	Whitecheek shark	IOTC[1]	Requin joues blanches	*Carcharhinus dussumieri*
CCM	Hardnose shark	IOTC[1]	Requin nez rude	*Carcharhinus macloti*
CCQ	Spot-tail shark	IOTC[1]	Requin queue tachet	*Carcharhinus sorrah*
CEM	Smallfin gulper shark	FAO[2]	Squale-chagrin cagaou	*Centrophorus moluccensis*
CLD	Sliteye shark	IOTC[3]	Requin sagrin	*Loxodon macrorhinus*
CPU	Little gulper shark	FAO[2]	Petit squale-chagrin	*Centrophorus uyato*
CYT	Ornate dogfish	FAO[2]	Aiguillat élégant	*Centroscyllium ornatum*
MTM	Arabian smooth-hound	IOTC[3]	Emissole d'Arabie	*Mustelus mosis*
ODH	Bigeye sand tiger shark	FAO[2]	Requin noronhai	*Odontaspis noronhai*
ORI	Slender bambooshark	FAO[2]	Requin-chabot élégant	*Chiloscyllium indicum*
ORR	Grey bambooshark	FAO[2]	Requin-chabot gris	*Chiloscyllium griseum*
ORZ	Tawny nurse shark	FAO[2]	Requin nourrice fauve	*Nebrius ferrugineus*
OSF	Zebra shark	FAO[2]	Requin zèbre	*Stegostoma fasciatum*
PWS	Sawsharks nei	FAO	Requins scies nca	*Pristiophorus spp*
RHA	Milk shark	IOTC[3]	Requin museau pointu	*Rhizoprionodon acutus*
SHL	Lanternsharks nei	FAO	Sagres nca	*Etmopterus spp*
SLA	Spadenose shark	IOTC[1]	Requin épée	*Scoliodon laticaudus*
RHN	Whale shark	IOTC[1]	Requin baleine	*Rhincodon typus*
PTH	Pelagic thresher	IOTC[1]	Renard pelagique	*Alopias pelagicus*
BTH	Bigeye thresher	IOTC[1]	Renard a gros yeux	*Alopias superciliosus*
ALV	Thresher	IOTC[1]	Renard	*Alopias vulpinus*
SMA	Shortfin mako	IOTC[1]	Taupe bleue	*Isurus oxyrinchus*
LMA	Longfin mako	IOTC[1]	Petite taupe	*Isurus paucus*
PSK	Crocodile shark	IOTC[1]	Crocodile shark	*Pseudocarcharias kamoharai*
ALS	Silvertip shark	IOTC[1]	Requin pointe blanche	*Carcharhinus albimarginatus*
FAL	Silky shark	IOTC[1]	Requin soyeux	*Carcharhinus falciformis*
OCS	Oceanic whitetip	IOTC[1]	Requin océanique	*Carcharhinus longimanus*
CCP	Sandbar shark	IOTC[1]	Requin gris	*Carcharhinus plumbeus*
TIG	Tiger shark	IOTC[1]	Requin tigre commun	*Galeocerdo cuvier*
BSH	Blue shark	IOTC[1]	Peau bleue	*Prionace glauca*
SPL	Scalloped hammerhead	IOTC[1]	Requin marteau halicorne	*Sphyrna lewini*

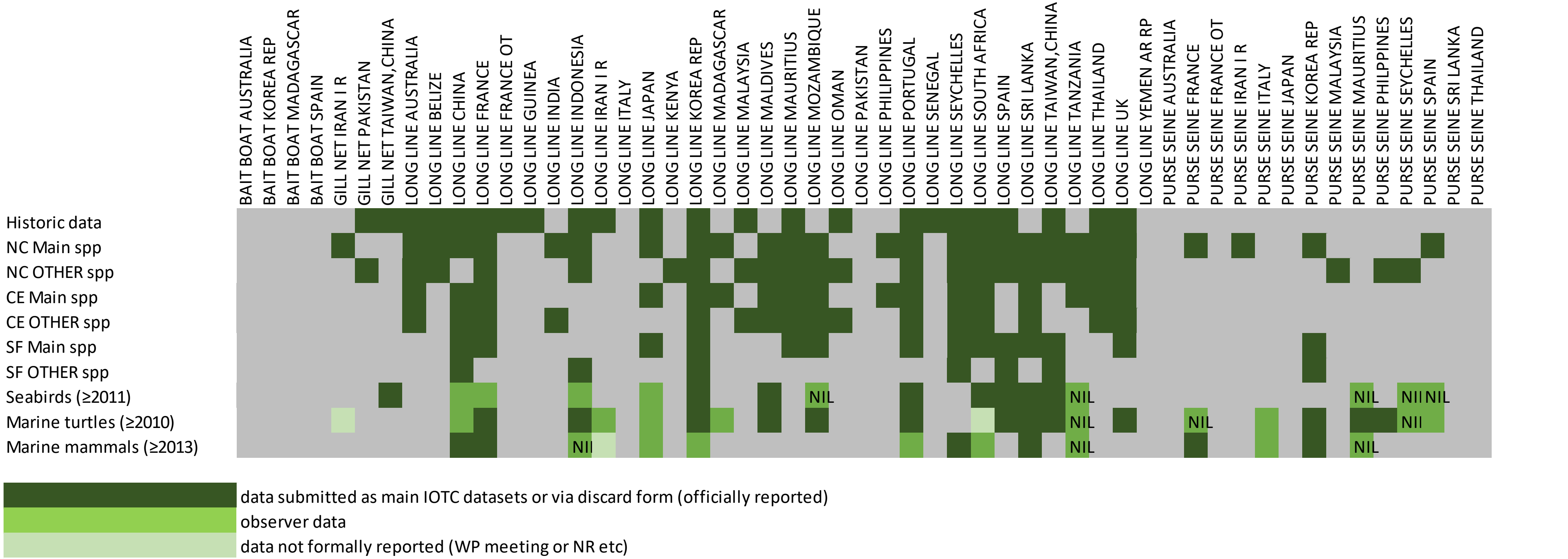
Code	English Name	Source	French Name	Scientific Name
POR	Porbeagle	IOTC[1]	Requin-taupe commun	*Lamna nasus*
WSH	Great White Shark	IOTC[1]	Grand requin blanc	*Carcharodon carcharias*
CWZ	Other Requiem Sharks	IOTC[1]	Requins Carcharhinus nca	*Carcharhinus spp*
SPN	Hammerhead Sharks	IOTC[1]	Requins marteau nca	*Sphyrna spp*

Note that most of the catches of sharks are not available by species and when available by species they are not considered to be an unbiased sample of the catch in the Indian Ocean

1. IOTC–2007–WPEB–13 (Sharks of India)
2. FAO: Case studies of the management of elasmobranch fisheries
3. IOTC: Information collected in Yemen by the IOTC/OFCF Project

APPENDIX 3
DATASETS AVAILABLE FOR BYCATCH BY FLEET

Datasets provided by industrial fleets according to IOTC reporting requirements[12]. Grey cells indicate which fleets have reported data for IOTC species, whereas green cells indicate which fleets have provided the bycatch data specified. Results are based on the nominal catch, catch–and-effort and size frequency data held within the databases at the IOTC Secretariat in August 2018 and other information on seabirds, marine turtles and marine mammals is taken from formally submitted discard reports (dark green), reported observer data (medium green) or information that has been summarised in documents such as national reports to the Scientific Committee or working party papers (pale green).



[12] NB: seabird discard reports for the Japan longline fleet and turtle discard reports for the Japan and Taiwan,China longline fleets were all submitted by South Africa

APPENDIX 4
AVAILABILITY OF CATCH DATA FOR SHARKS BY GEAR

Availability of catch data for the main shark species expressed as the proportion of fleets for which catch data on sharks are available out of the total number of fleets[13] for which data on IOTC species are available, by fishery, species of shark, and year, for the period 1950–2017.

- Shark species in bold are those identified as mandatory for reporting by each fleet, for which data shall be recorded in logbooks and reported to the IOTC Secretariat; reporting of catch data for other species can be done in aggregated form (i.e. all species combined as ***sharks nei*** or ***mantas and rays nei***).
- ***Hook and line*** refers to fisheries using handline and/or trolling and ***Other gears nei*** to other unidentified fisheries operated in coastal waters.
- Catch rates of sharks on pole-and-line fisheries are thought to be nil or negligible.
- Average levels of reporting for 1950–2015 and 2010–2015 are shown in columns ***All*** and ***Last***, respectively.

[13] The definition of fleets has changed since the previous report. Previously a fleet fishing in two areas were considered as two separate fleets, whereas here they are considered as one.

APPENDIX 5

ESTIMATION OF CATCHES AT SIZE FOR IOTC SHARK SPECIES

Equations used to convert from various length measurements to fork length and from fork length to round weight.

Species	*From type measurement – To type measurement*	*Equation*	*Parameters*	*n*	*FL range*	*IOTC reported data*
Blue shark (BSH) *Prionace glauca*	Fork length – Round Weight(kg)[A]	$RND=a.L^b$	a= 0.0000031841 b= 3.1313	4529	52-288	No. of samples: 46 440 Min: 13 cm Max: 357 cm
	Precaudal length – Fork Length[B]	$FL=\frac{PCL+b}{a}$	a= 0.9075 b= 0.3956	n/a	n/a	
	Total length – Fork length[C]	FL=a.TL+b	a= 0.8561 b= -4.5542	6485	n/a	
	Fork length (unconverted tape measure) – Fork Length[D]	FL = a.FLUT+b	a= 0.98 b= -0.8	782	n/a	
Shortfin Mako (SMA) *Isurus oxyrinchus*	Fork length – Round Weight[A]	$RND=a.L^b$	a= 0.0000052432 b= 3.1407	2081	65-338	No. of samples: 7186 Min: 52 cm Max: 323 cm
	Precaudal length – Fork Length[B]	FL=a.PCL+b	a= 1.100 b= 0.766	n/a	n/a	
	Total length – Fork length[C]	FL=a.TL+b	a= 0.9047 b= 0.5963	1114	n/a	
	Fork length (unconverted tape measure) – Fork Length	FL=a.TL+b	a= 0.968 b= -0.973	n/a	n/a	
Oceanic whitetip (OCS) *Carcharhinus longimanus*	Fork length – Round Weight[C]	$RND= a.L^b$	a= 0.000018428 b= 2.9245	n/a	n/a	No. of samples: 82 Min: 62 cm Max: 197 cm
	Total length – Fork length[C]	FL=a.TL+b	a= 0.8602 b= -7.2885	n/a	n/a	
Porbeagle (POR) *Lamna nasus*	Fork length – Round Weight[A]	$RND=a.L^b$	a= 0.000014823 b= 2.9641	15	106-227	No. of samples: 901 Min: 50 cm Max: 233 cm
	Precaudal length – Fork Length[B]	FL=a.PCL+b	a= 1.098 b= 1.99	n/a	n/a	
Silky Shark (FAL) *Carcharhinus falciformis*	Fork length – Round Weight[A]	$RND=a.L^b$	a= 0.000015406 b= 2.9221	n/a	n/a	No. of samples: 2075 Min: 42 cm Max: 257 cm
	Total length – Fork length[C]	FL=a.TL+b	a= 0.8113 b=1.0883	520	n/a	
Bigeye Thresher (BTH) *Alopias superciliosus*	Fork length – Round Weight[E]	$RND=a.L^b$	a= 0.00001413 b= 2.99565	185	110-256	No. of samples: 42 Min: 14 cm Max: 169cm
Thresher (ALV) *Alopias vulpinus*	Fork length – Round Weight[A]	$RND=a.L^b$	a= 0.00018821 b= 2.5188	88	154-262	No. of samples: 1
Crocodile Shark (PSK) *Pseudocarcharias kamoharai*	Fork length – Round Weight[D]	$RND= a.L^b$	a= 0.00033532 b= 2.1156	n/a	n/a	No. of samples: 118 Min: 70 cm Max: 140 cm
	Total length – Fork length[C]	FL=a.TL+b	a=0.8083 b=7.1478	407	62-103	
Scalloped hammerhead (SPL) *Sphyrna lewini*	Fork length – Round Weight[A]	$RND=a.L^b$	a=0.000000777 b=3.0669	390	79-423	No. samples
	Total length – Fork length[C]	FL=a.TL+b	a=0.7994 b=-1.0546	20	115-230	
Smooth hammerhead (SPZ) *Sphyrna zygaena*	Total length – Fork length[C]	FL=a.TL+b	a=0.8039 b=-4.3490	70	114-262	No. of samples: 3

A: Data from Western North Atlantic: Kohler, N.E., Casey, J.G and Truner, P.A. (1996). Length-length and length-weight relationships for 13 shark species from the Western North Atlantic. NOAA Technical Memorandum NMFS-NE-110, p83.

B: Inverse equation from north Pacific: Clarke, S., Yokawa, K., Matsunaga, H and Nakano, H (2011). Analysis of North Pacific Shark Data from Japanese Commercial Longline and Research/Training Vessel Records. WCPFC-SC7-2011/EB-WP-02.

C: Data from Indian Ocean: Ariz J, A Delgado de Molina, M.L Ramos, J.C Santana (2007). Length-weight relationships, conversion factors and analyses of sex-ratio, by length-range, Observers onboard Spanish Longliners in South Western Indian Ocean during 2005. IOTC-2007-WPEB-04.

D: Data from the Canadian Atlantic: Campana, S.E., Marks, L., Joyce, W. and Kohler, N. (2005). Catch, bycatch and indices of population status of Blue shark (Prionace glauca) in the Canadian Atlantic. Collect. Vol. Sci. Pap. ICCAT, 58(3): 891-934.

E: Data from the Soviet Indian Ocean Taun Longline Research Programme: Romanov, E.V., Romanova, N.V. (2012). Size distribution and length-weight relationships for some large pelagic sharks in the Indian Ocean. Communication 2. Bigeye thresher shark, tiger shark, silvertip shark, sandbar shark, great hammerhead shark and scalloped hammeread shark. IOTC-2012-WPEB08-22.

Alternative equations

Blue shark:

- *Campana et al., 2005.*
- *Romanov, E., 2012, conversion factors from standard length to fork length for Blue shark, email correspondence to IOTC Secretariat, July 2013.*

Shortfin Mako shark:

- *Kohler, et al., 1996.*
- *Romanov, E., 2012, conversion factors from standard length to fork length for Shortfin Mako shark, email correspondence to IOTC Secretariat, July 2013.*

Portbeagle shark:

- *Kohler, et al., 1996.*

Silky shark:

- *Kohler, et al., 1996.*

Bigeye Thresher shark:

- *Kohler, et al., 1996.*

Scalloped hammerhead shark:

- *Kohler, et al., 1996.*
- *Romanov & Romanova, 2012.*

Number and proportion of samples reported to the IOTC Secretariat by measurement type and shark species.

	Eye-Fork Length (unconverted tape measure lengths)	Fork length	Fork length (unconverted tape measure lengths)	Precaudal length	Total length	Total no. of samples
Blue shark		42102	1	1554	2783	46440
Bigeye thresher		37	5			42
Silky shark		2067	8			2075
Longfin mako	1	12			16	29
Oceanic whitetip shark		74			8	82
Porbeagle		680		203	18	901
Crocodile shark		94			24	118
Pelagic Thresher Shark					1	1
Requiem sharks nei					333	333
Sharks various nei		1			6	7
Shortfin mako	1	6992	5	66	122	7186
Scalloped hammerhead			3			3

	Eye-Fork Length (unconverted tape measure lengths)	Fork length	Fork length (unconverted tape measure lengths)	Precaudal length	Total length	Total
Blue shark		91%	0%	3%	6%	100%
Bigeye thresher		88%	12%			100%
Silky shark		100%	0%			100%
Longfin mako	3%	41%			55%	100%
Oceanic whitetip shark		90%			10%	100%
Porbeagle		75%		23%	2%	100%
Crocodile shark		80%			20%	100%
Pelagic Thresher Shark					100%	100%
Requiem sharks nei					100%	100%
Sharks various nei		14%			86%	100%
Shortfin mako	0%	97%	0%	1%	2%	100%
Scalloped hammerhead			100%			100%
Total	2	52060	22	1823	3324	57231

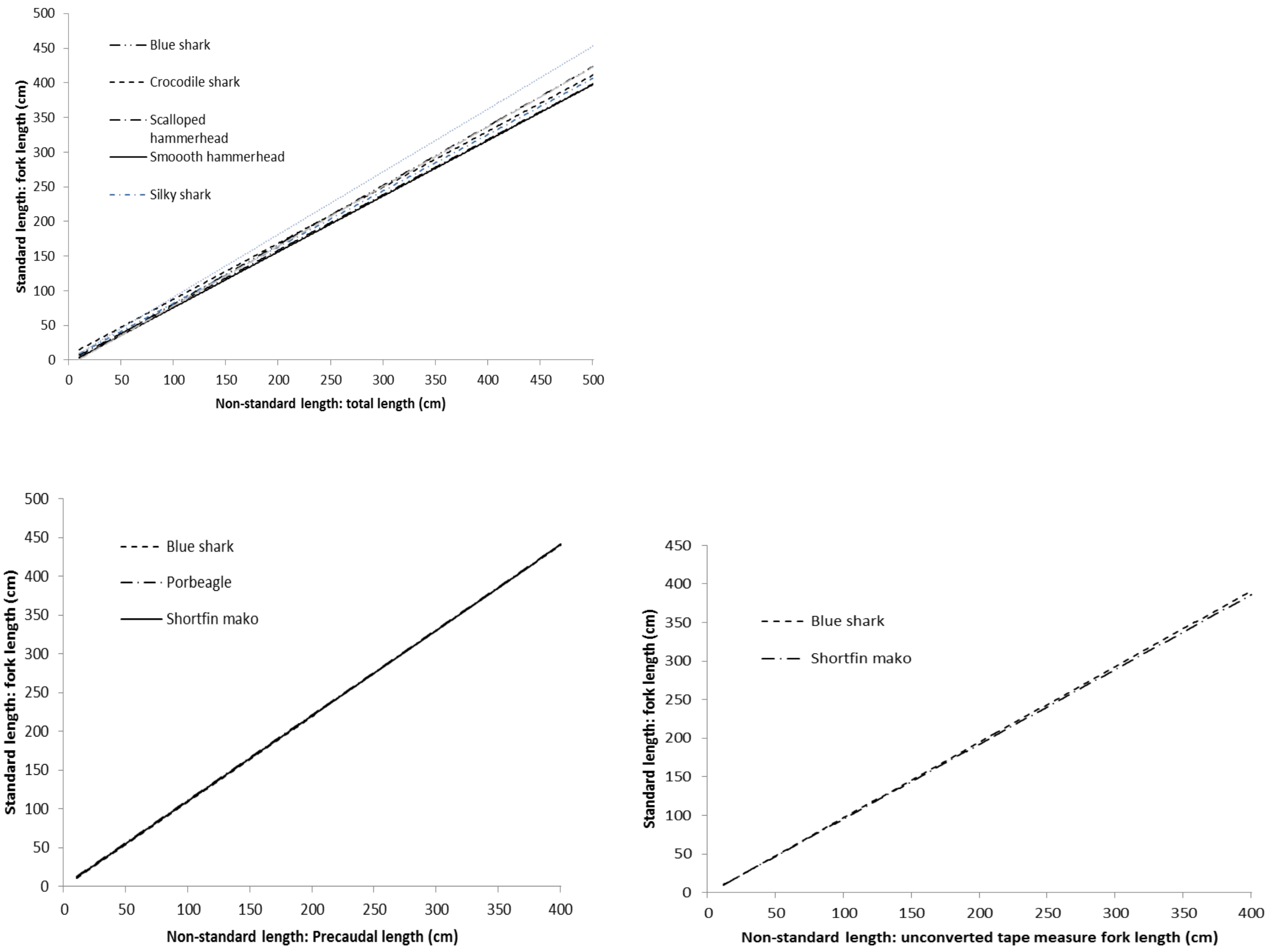


Fig. 1. Conversion equations from non-standard to standard length by shark species

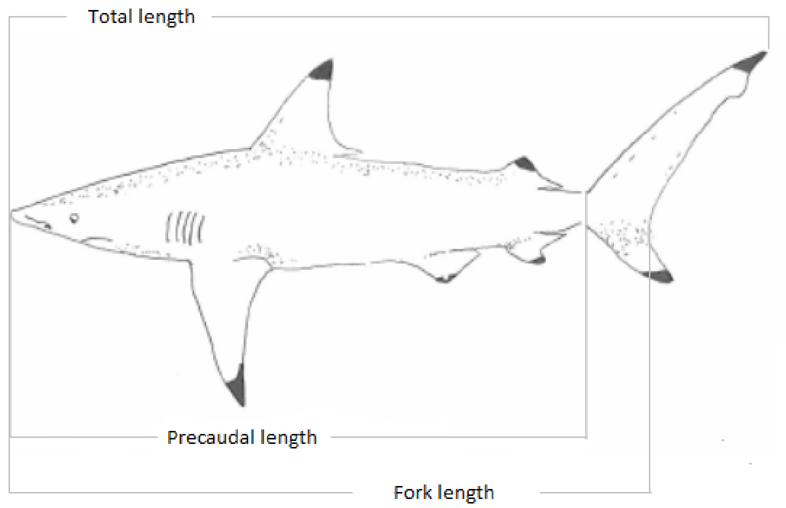


Fig. 2. Measurement types used for sharks