Indian Ocean Tuna Commission
Commission des Thons de l'Océan Indien
iotc ctoi

IOTC–2016–WPEB12–07 Rev_1

REVIEW OF THE STATISTICAL DATA AVAILABLE FOR BYCATCH SPECIES

PREPARED BY: IOTC SECRETARIAT[1], 14 AUGUST 2016

PURPOSE

To provide participants at the 12th Session of the IOTC Working Party on Ecosystems and Bycatch (WPEB12) 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 9 August 2016.

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

Prior to each WPEB meeting the IOTC Secretariat develops a series of maps, figures and tables that highlight historic and emerging trends in the bycatch data held by the IOTC Secretariat. This information is used during each WPEB meeting to inform discussions around stock assessment and in developing advice for the Scientific Committee.

The report covers the following areas:

- Overview of data reporting requirements
- Status of reporting
- Summary of fisheries data available for sharks:
  - Total reported catches of sharks in the Indian Ocean
  - Main species of sharks caught in IOTC fisheries
  - Catch rates of sharks reported by fleets
  - Spatial information on shark catches
  - Length-frequency data on sharks
- Summary of fisheries data available for seabirds
  - Main species and fisheries concerned
  - Status of data on seabird bycatch
- Summary of fisheries data available for marine turtles
  - Main species and fisheries concerned
  - Status of data on marine turtle bycatch
- Summary of fisheries data available for marine mammals
- Main issues identified concerning the data on non-IOTC species available to the IOTC

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

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 2007 and extended in 2012, 2013 and 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 a 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 and 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.

IOTC CPCs are also encouraged to collect and report detailed data on other species, where possible.

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

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 with vessels in the IOTC Record of Authorised Vessels					Estimates of amounts of thresher sharks discarded dead + SF distribution						IOTC SC meeting Dec 2011
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

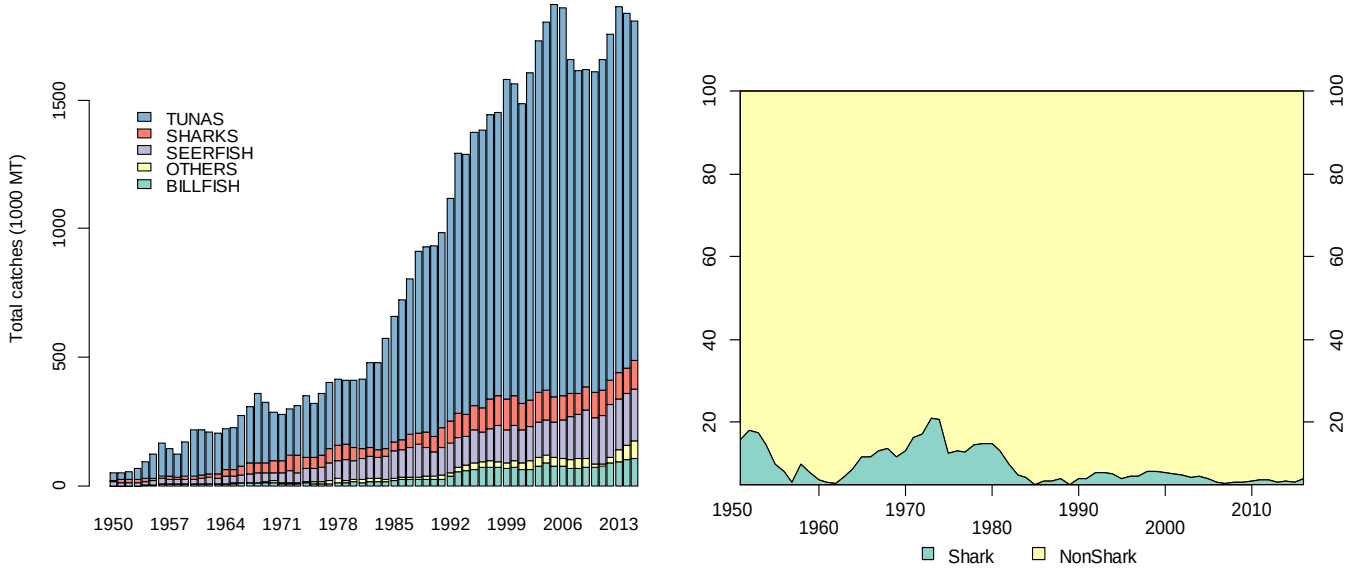
The most common bycatch species with mandatory reporting requirements (indicated by the date they came into force) and other species for which reporting is encouraged (shown as 'e') are listed in Table 2. Table 2 summarises those bycatch species identified by the Commission, through the adoption of IOTC 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' sharks 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 1950–2015 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 mid-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).



a) **b)**

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 000mt in 1999. Since then, nominal catches have fluctuated and are currently around 112 000 mt. Notably, India reported particularly high catches of unidentified shark species in 2015 (22 972mt).

The nominal catch data should be considered with caution given the historically low reporting rates. In addition to the underestimates from lack of reporting, when the catches are reported they are thought to represent only the catches of those species that are retained onboard without taking in to account discards (nominal catches). 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.

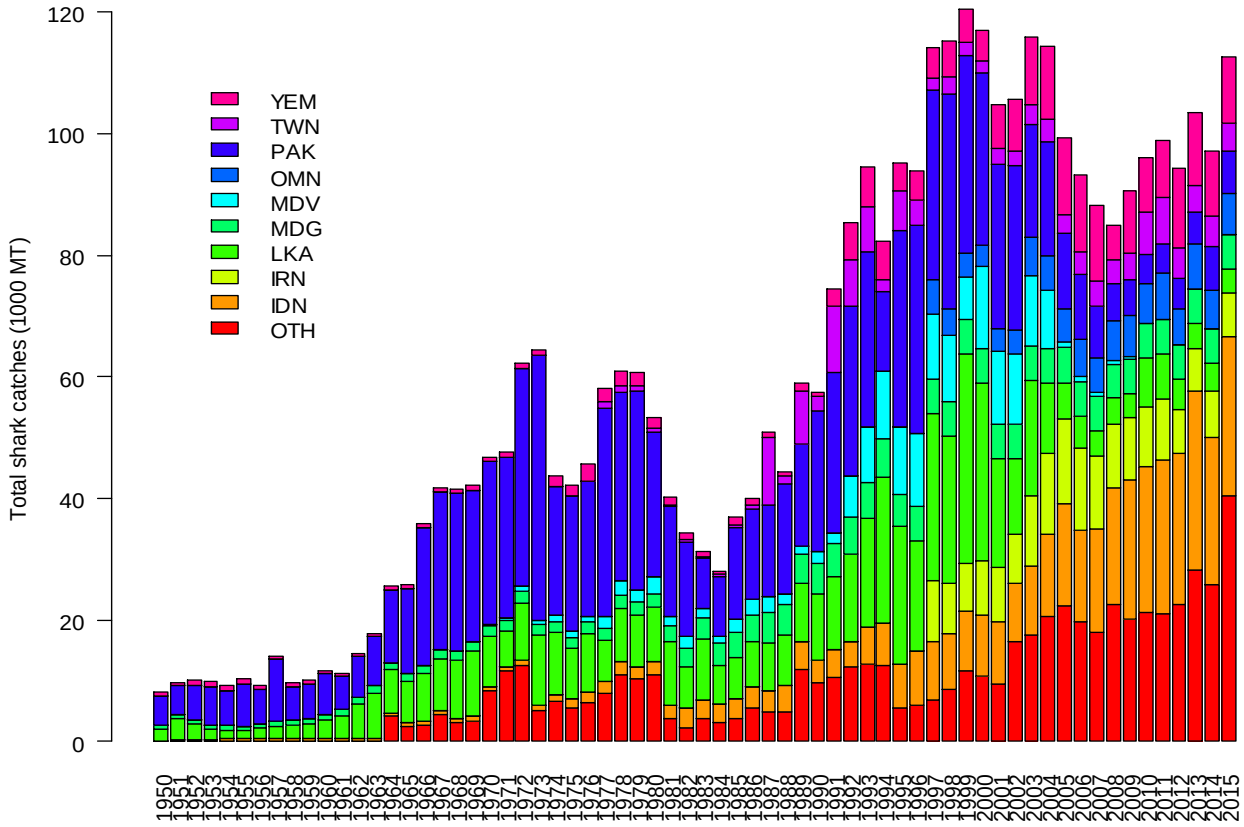


Fig. 2. Total reported nominal catches of sharks by fleet from 1950–2015 (YEM = Yemen, TWN = Taiwan,China, PAK = Pakistan, MDV = Maldives, MDG = Madagascar, LKA = Sri Lanka, IRN = I.R.Iran, IDN = Indonesia, OTH = all others).

Main reported gear types associated with shark bycatch for IOTC fisheries

Figure 3 shows the distribution of catches across gear type. Gillnets are associated with the highest reported nominal catches of sharks, historically and still contribute to over 40% of catches. This is followed by the longline fleets which contributed substantially to shark catches from the 1990s, and handline and troll line fisheries in more recent years. Of the gillnets fisheries, the majority comprise standard, unclassified gillnets, followed by combinations of gillnets, handlines and troll lines and gillnet/longline combinations. Figure 4 shows the main gear types used by fleets over the last 15 years.

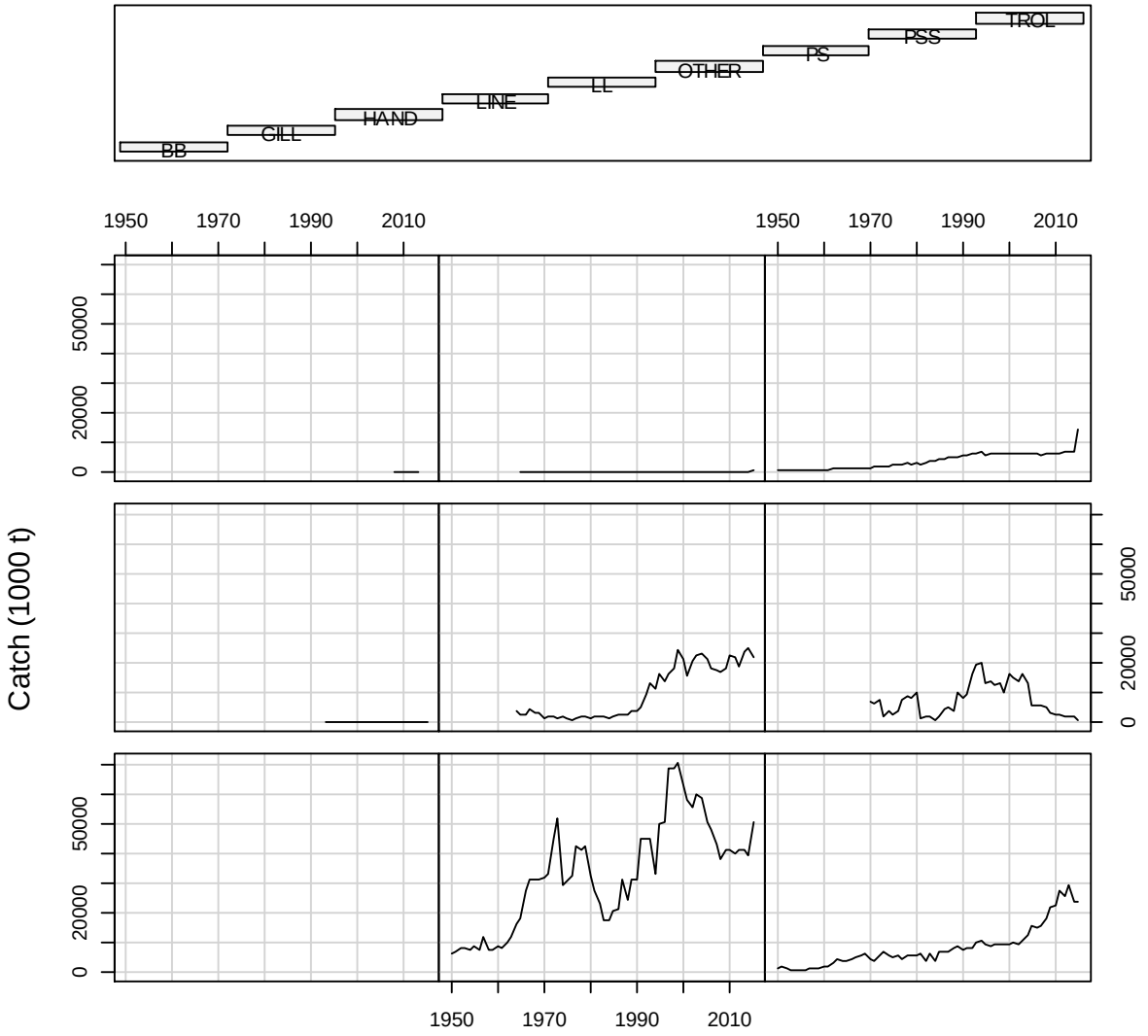


Figure 3. Nominal catches of sharks reported by gear type (1950–2015). Gears are listed bottom left to top right: Bait boat/pole and line (BB), gillnet (GILL), Handline (HAND), Line (LINE), logline (LL), Purse seine (PS), small purse seines/ring nets (PSS), troll lines (TROLL) and all other gear types (OTHER).

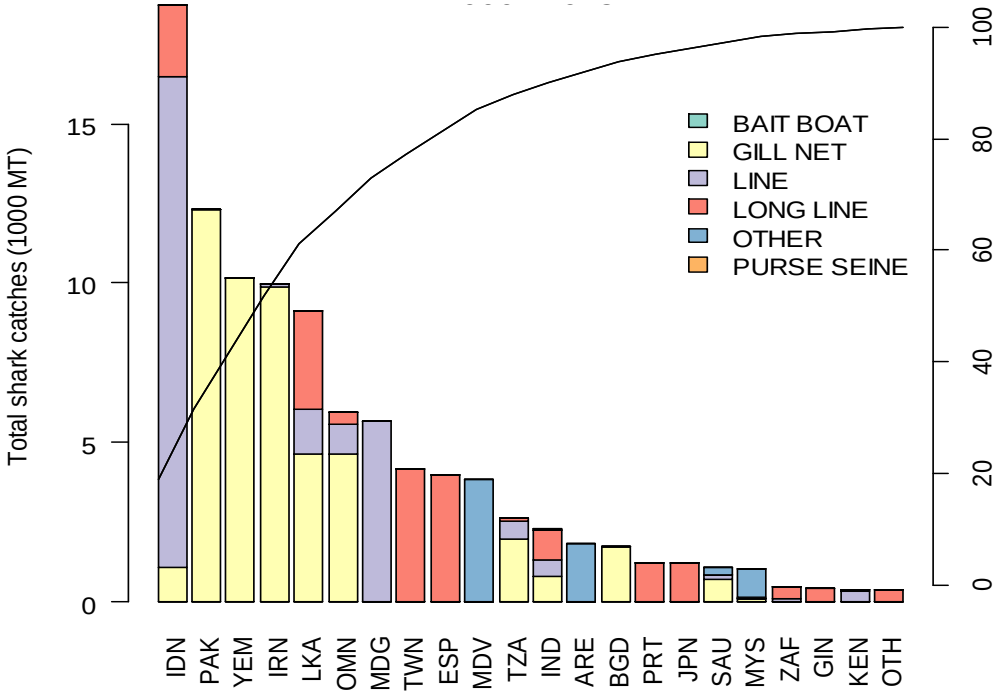


Figure 4. Average annual shark catches by gear type and reporting country in recent years (2000-2015)

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.4a). Of the shark catches reported by species, the blue shark forms the greatest proportion, comprising over 60% of total catches, with silky, threshers, hammerheads and mako sharks forming a smaller percentage (Fig. 4b).

The increase in reporting by species is apparent in the species-specific catch series (Fig. 6) with steadily increasing trends in reporting since the 1970s seen for blue sharks, thresher sharks, hammerhead sharks and mako sharks. The oceanic whitetip shark nominal catch series has changed in recent years due to a reallocation of catches reported by India and is now dominated by the Sri Lankan longline-gillnet fisheries which 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. The effect of single fleet reports in the nominal catch series by species is apparent when looking at Fig.5b which highlights how the catch series of each species is dominated by very few fleets which are reporting by species.

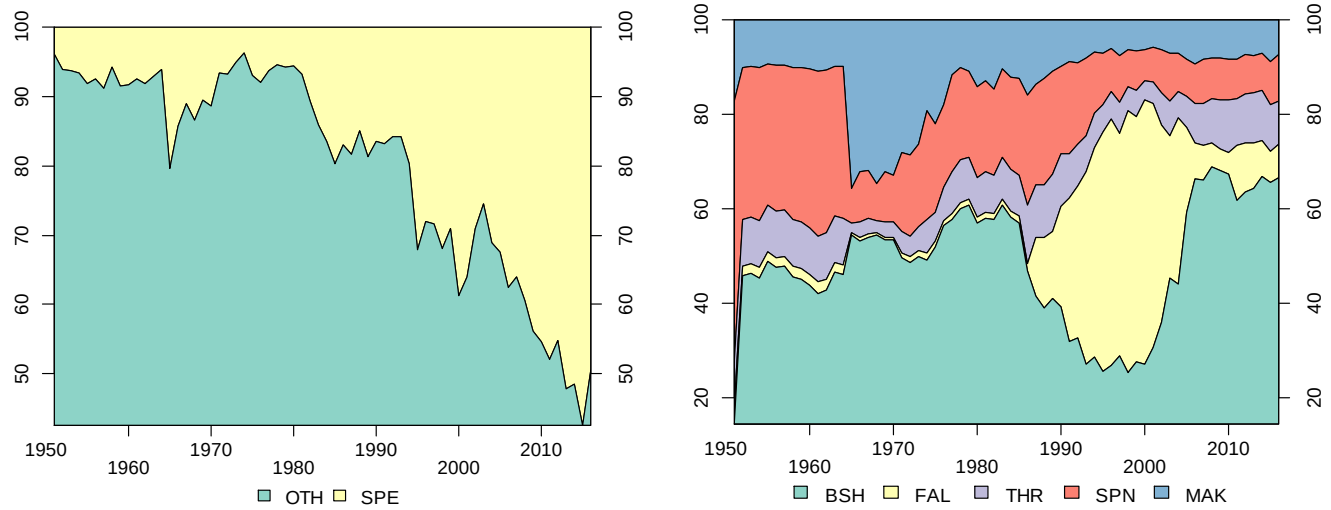


Fig. 5. a) Proportion of shark catches reported by species and as aggregate catch (OTH) and b) proportion of nominal shark catches by species

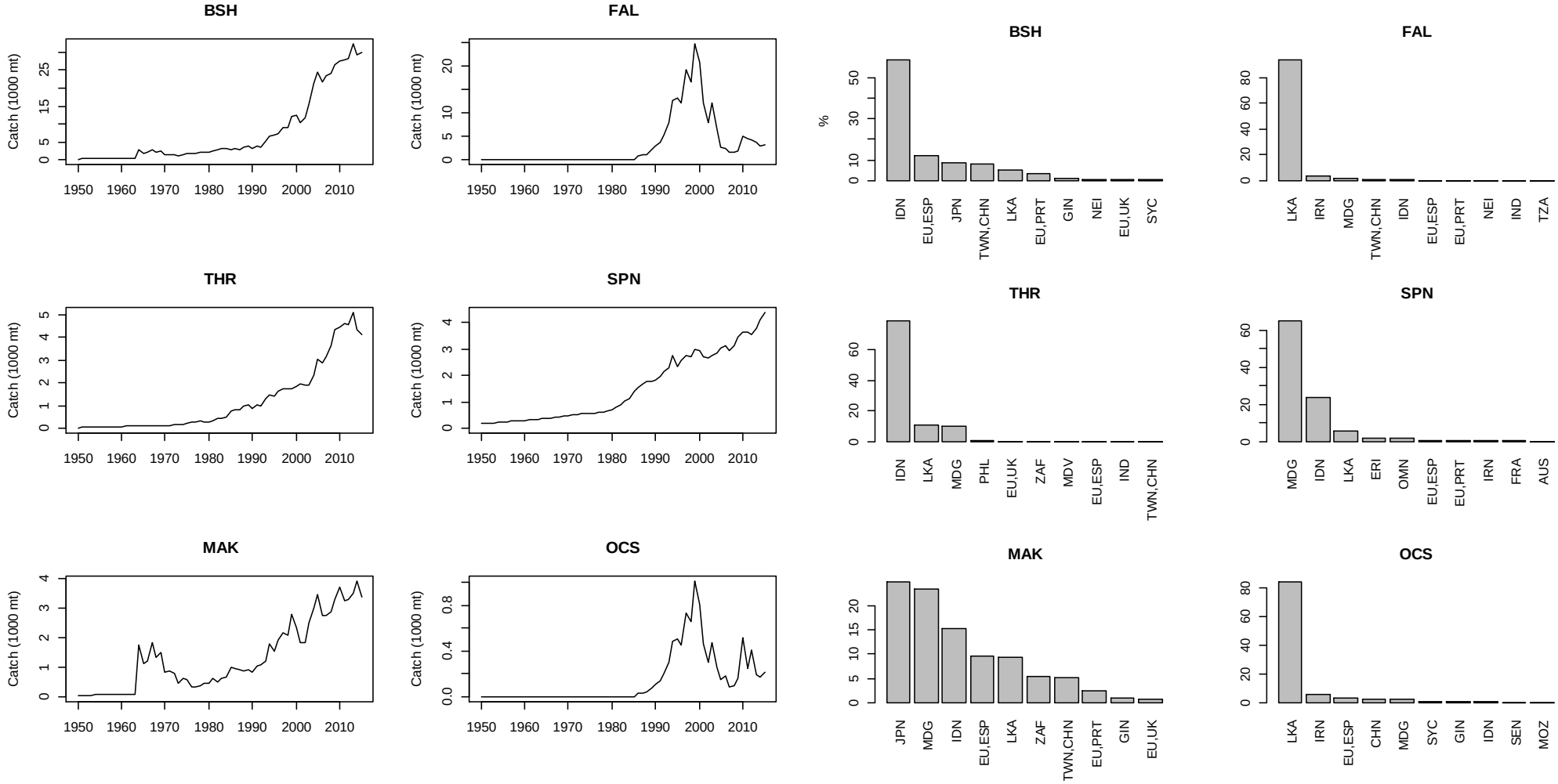


Fig. 6. a) Total nominal catches by species for all fleets (1950-2015) and b) contribution of each fleet to the total data series

Trends in species catches by gear types are summarised in Table 3. Nominal shark catches by longliners comprise predominantly blue shark followed by mako and silky sharks, while reported catches of handline gears are also dominated by blue shark, followed by thresher sharks. Purse seine catches are dominated by silky shark. 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 reporting 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 2005–2015 (Bait boat/pole and line (BB), 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%	92%	15%	100%	22%	28%	100%	66%
BSH	0%	3%	59%	0%	62%	0%	0%	0%
FAL	0%	4%	0%	0%	6%	72%	0%	2%
THR	0%	0%	17%	0%	0%	0%	0%	3%
SPN	0%	0%	6%	0%	0%	0%	0%	23%
MAK	0%	0%	3%	0%	9%	0%	0%	7%
OCS	0%	0%	0%	0%	1%	0%	0%	0%
RMB	0%	0%	0%	0%	0%	0%	0%	0%

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

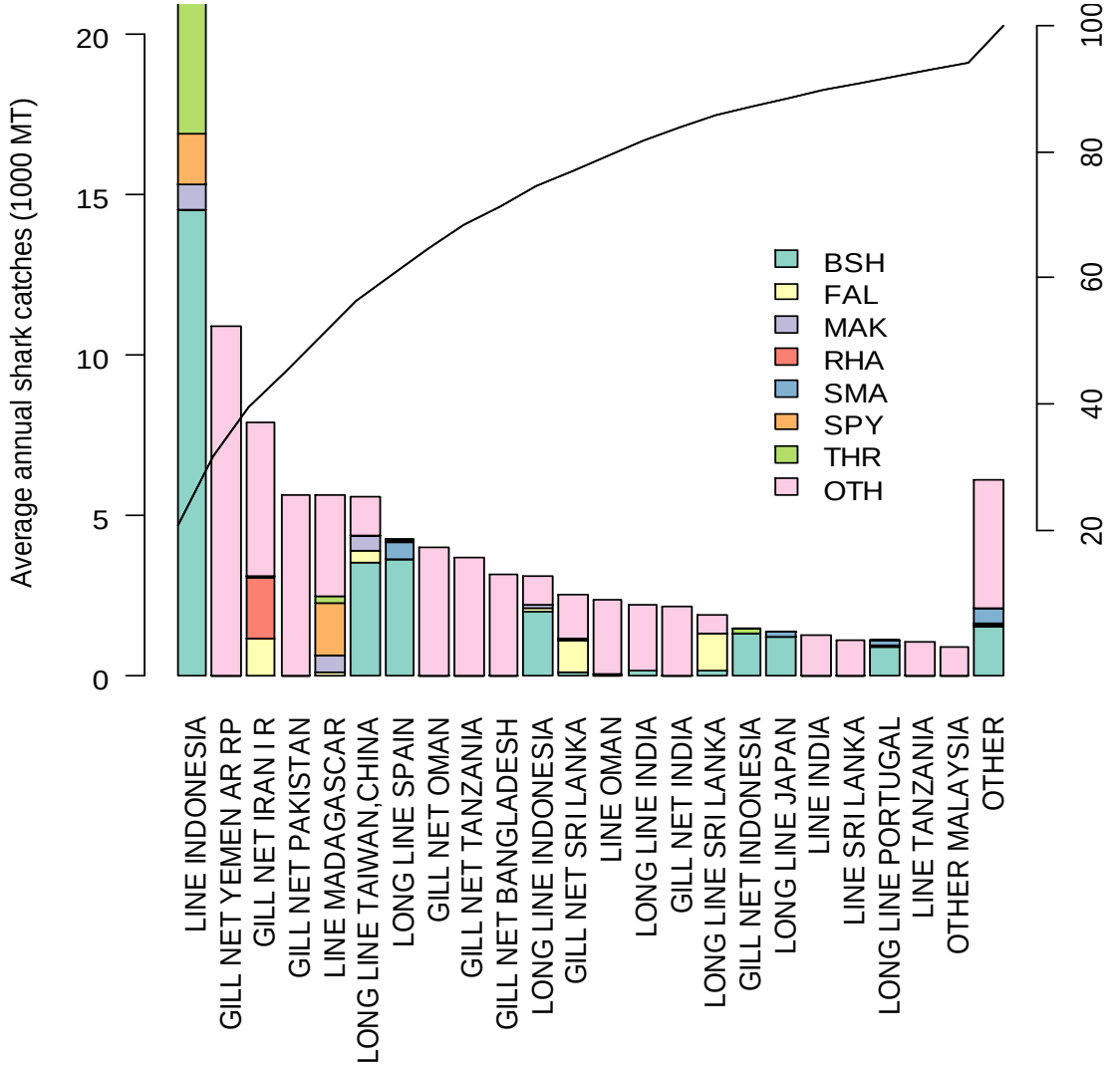


Fig. 7. Annual average shark catches reported by fleet and species from 2010–2015

Catch rates of the 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 amounts of sharks caught by these fisheries, if any, are not thought 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.

Figure 8 indicates 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.

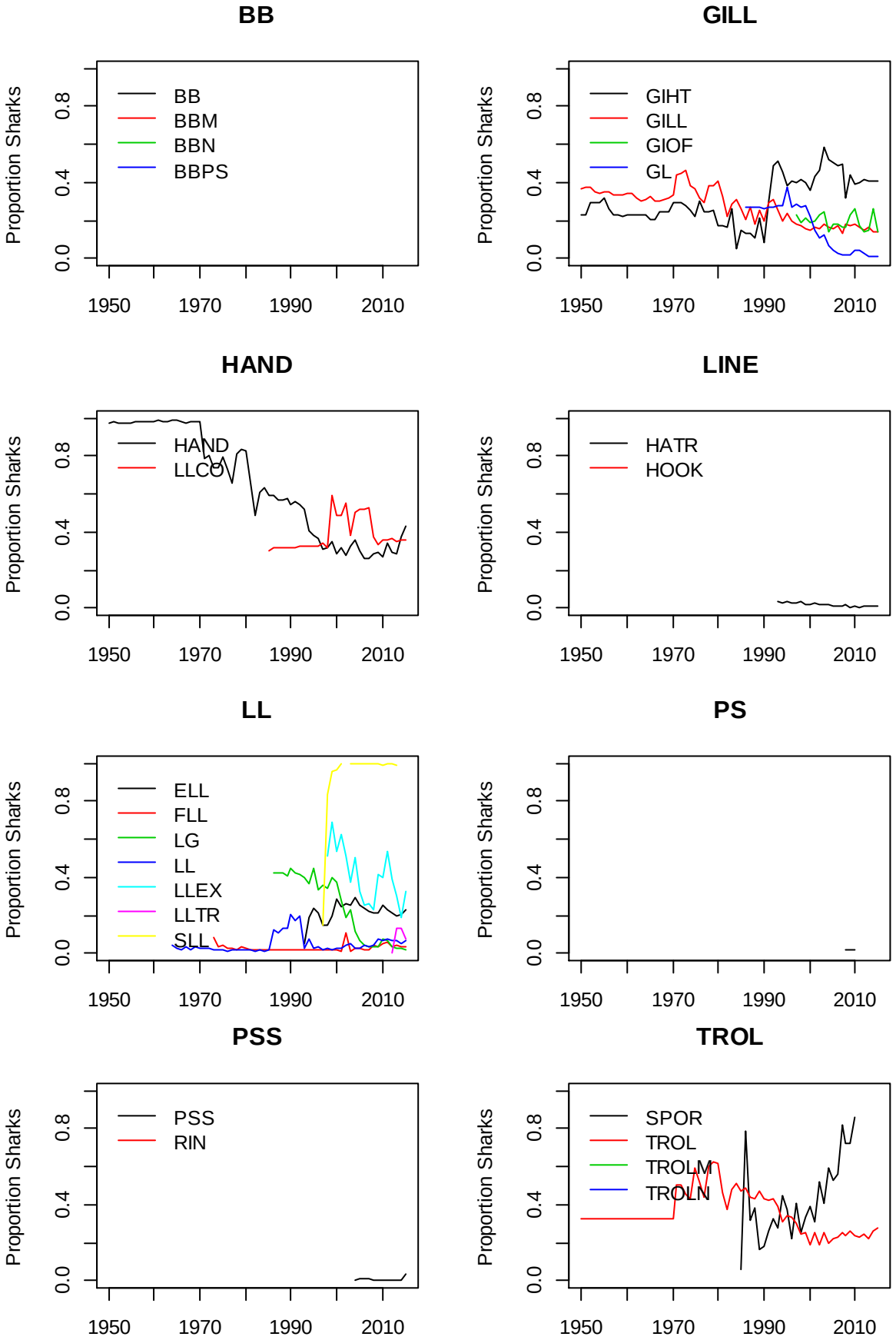


Figure 8. Proportion of reported shark catch as a fraction of total reported catch by gear type over time

Spatial information on sharks catches

Fig. 9 and Fig. 10 present the spatial catches of sharks reported in numbers for deep-freezing longliners flagged by Taiwan,China over time. The reporting by species has improved over time, indicating that the majority of the catches are blue shark with an increase in catches of silky shark in the northern Indian Ocean apparent in recent years, however, the presence of low numbers of dusky shark in the reported catches are somewhat surprising given its coastal distribution and may reflect species identification errors.

Fig. 11 shows the shark catches reported by the Japanese longline fleet from 2009–15. These show a clear dominance of blue sharks, followed by relatively minor catches of shortfin mako shark and porbeagle shark. However, it is important to note that time-area catches of sharks by species are only available from 2007 for Taiwan,China or 2009 for Japan, while these fleets have been operating in the Indian Ocean since the 1950s. Unlike Taiwan,China, for which spatially disaggregated catches of sharks are available aggregated by species from up to the late 1970s, Japan has not provided spatially disaggregated catches of sharks other than those reported for 2009 and following years. In addition, the catches available are considered to be incomplete, as they are likely to not include discards, only including those species which have been listed as mandatory for reporting. More limited time-area catches of sharks are also available from some other fleets, as recorded in Appendix 3.

Figure 12 shows catches by the Seychelles longline fleet from 2006 onwards showing a dominance in catches of blue shark, followed by makos in the southern regions.

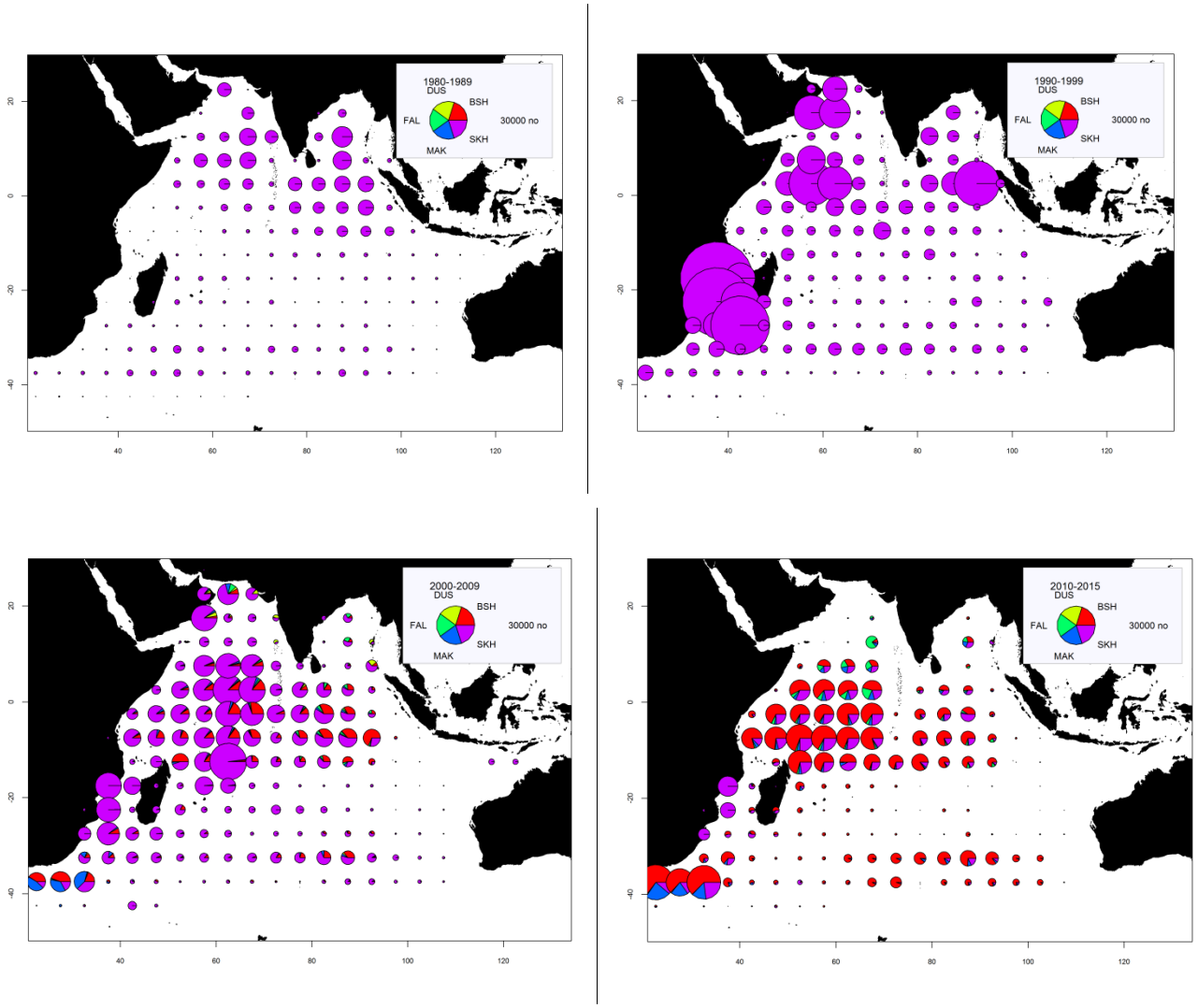
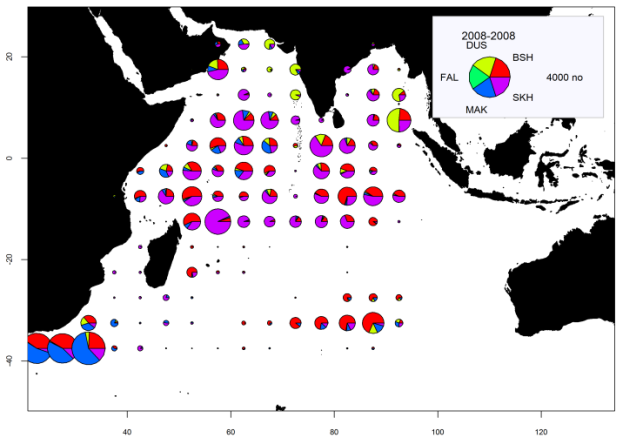
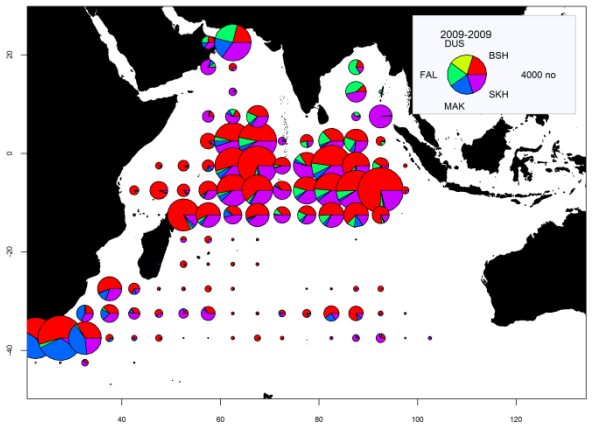
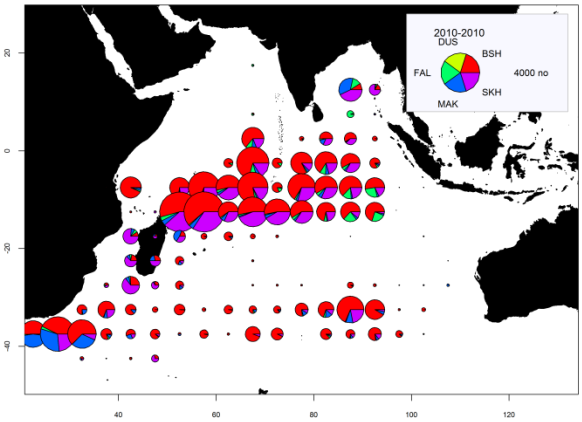
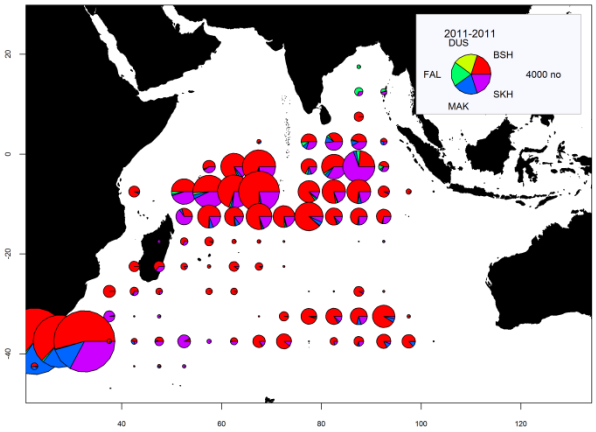


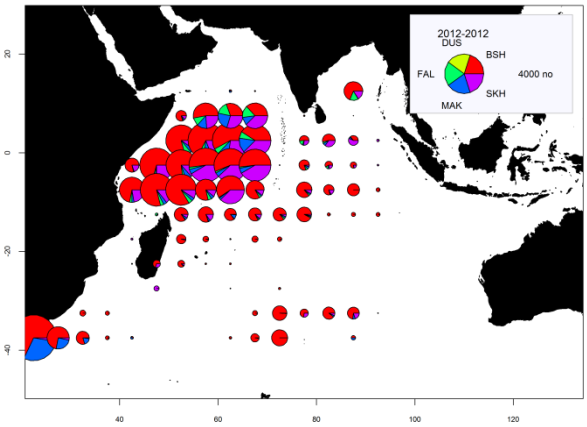
Fig. 9. Time-area catches (total numbers) of sharks for deep-freezing longliners flagged in Taiwan,China, by decade (also including 2010–15) and species. Unidentified shark catches are shown in purple.

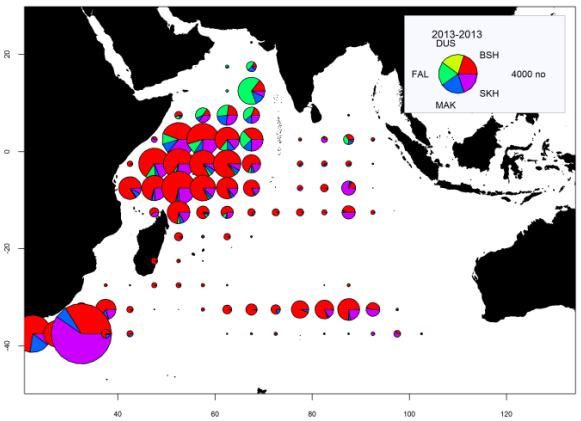

2008-2008
DUS
BSH
FAL
4000 no
SKH
MAK


2009-2009
DUS
BSH
FAL
4000 no
SKH
MAK


2010-2010
DUS
BSH
FAL
4000 no
SKH
MAK


2011-2011
DUS
BSH
FAL
4000 no
SKH
MAK


2012-2012
DUS
BSH
FAL
4000 no
SKH
MAK


2013-2013
DUS
BSH
FAL
4000 no
SKH
MAK

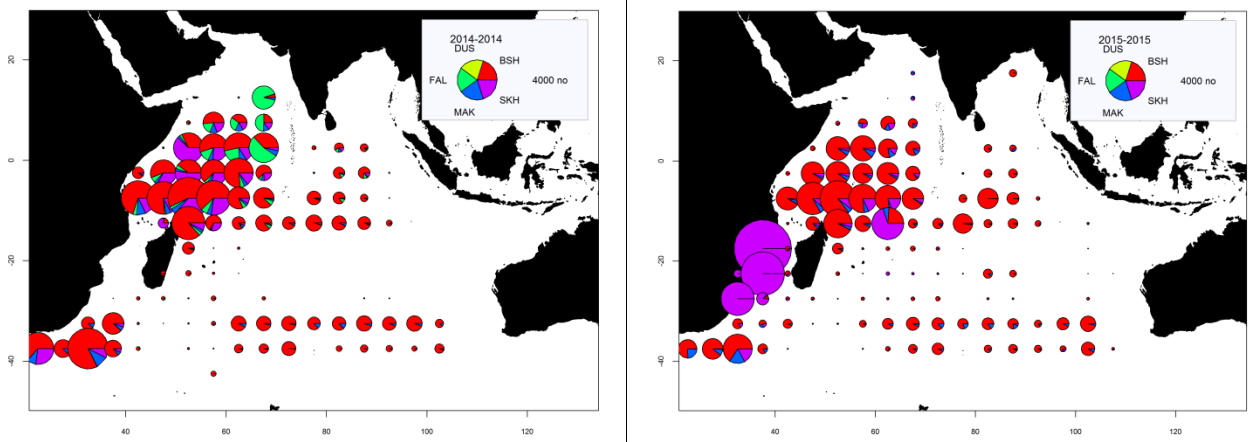
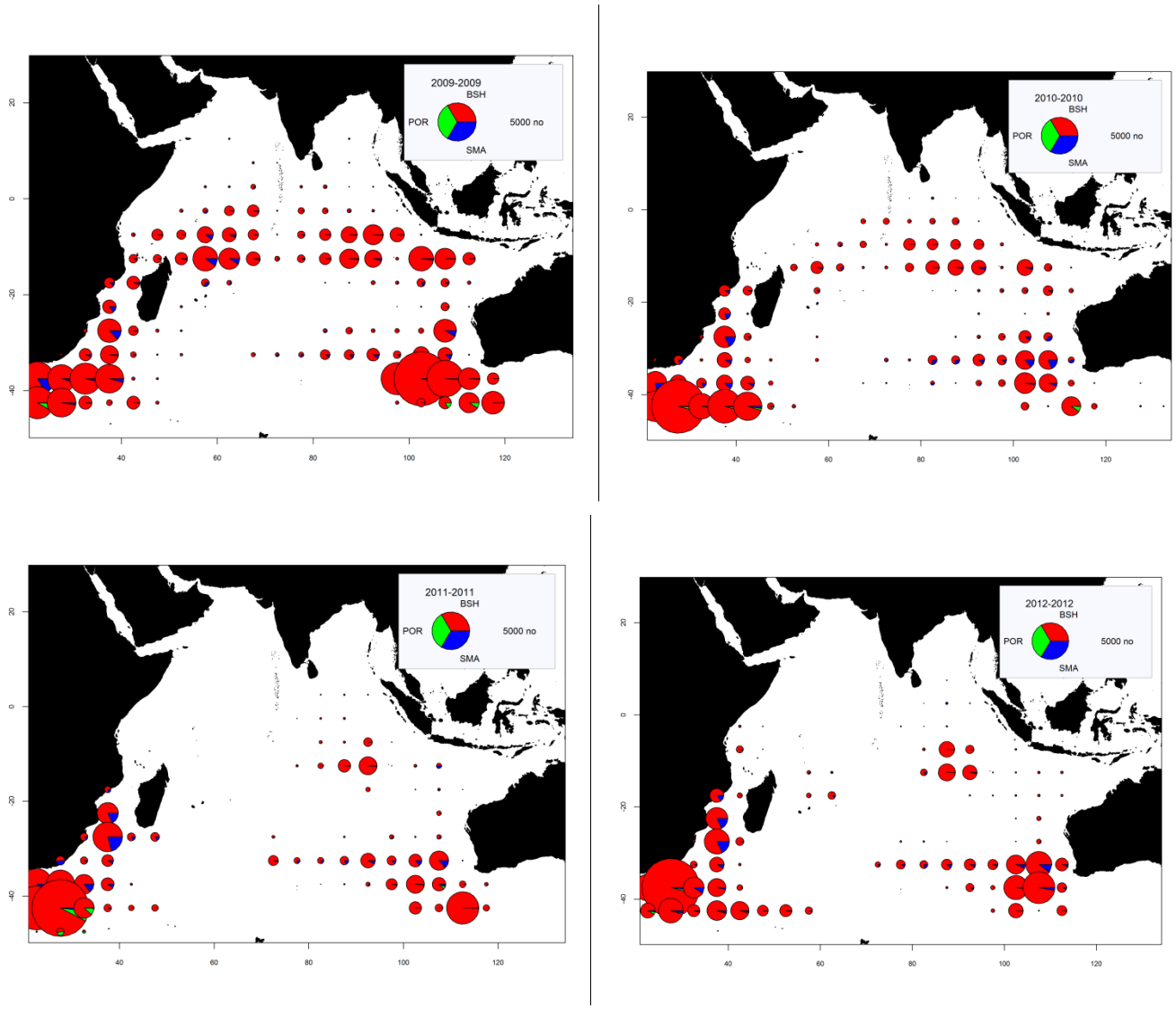


Fig. 10. Time-area catches (total numbers) of sharks for deep-freezing longliners flagged in Taiwan,China, by year (2008–15) and species. Unidentified shark catches are shown in purple.



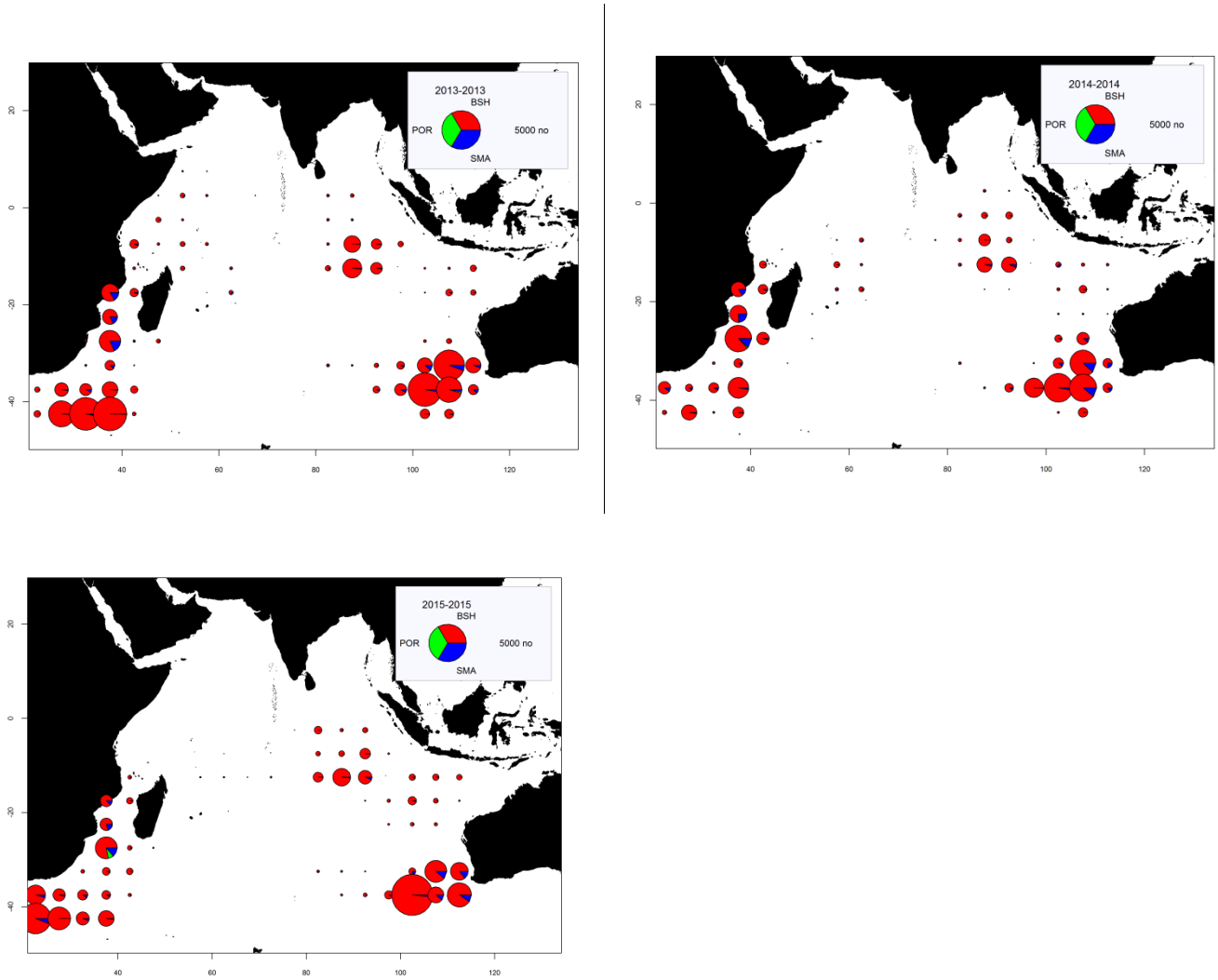
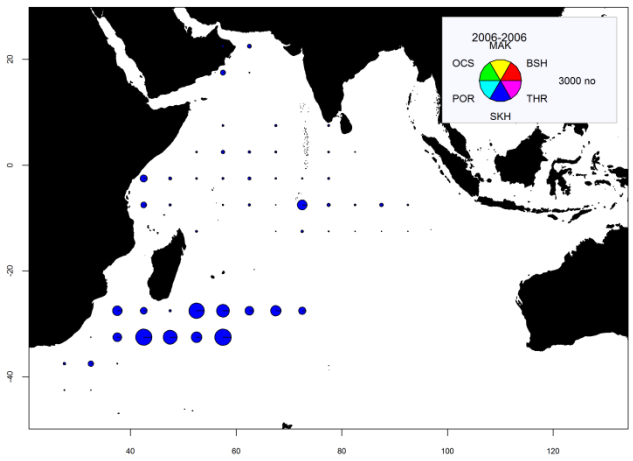
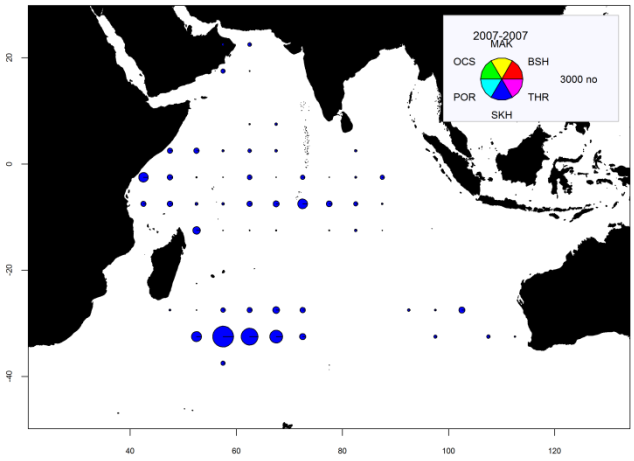
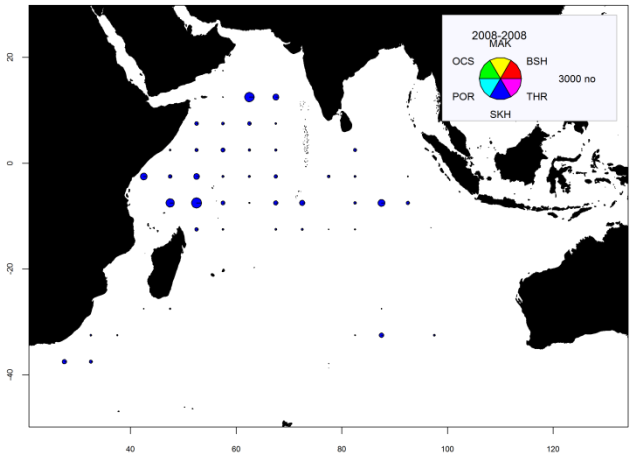
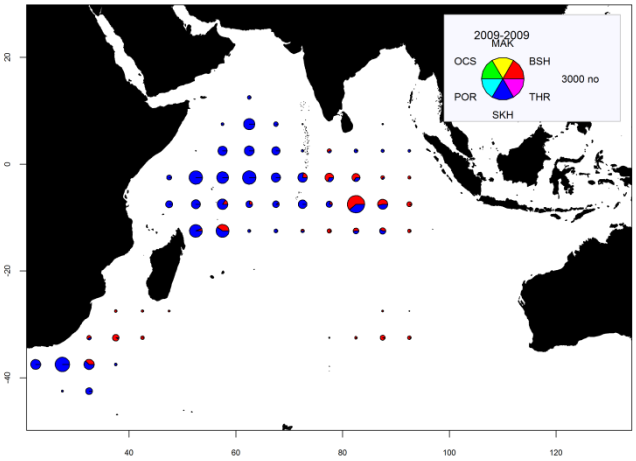


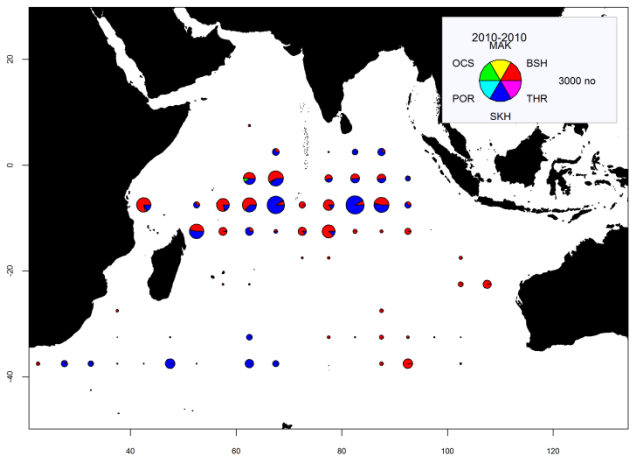
Fig. 11. Time-area catches (total numbers) of sharks for deep-freezing longliners flagged in Japan by year (2009–15) and species.

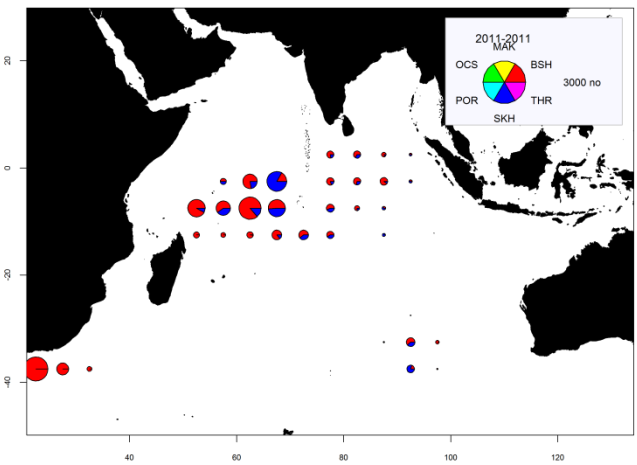

2006-2006
MAK
OCS
BSH
3000 no
POR
THR
SKH


2007-2007
MAK
OCS
BSH
3000 no
POR
THR
SKH


2008-2008
MAK
OCS
BSH
3000 no
POR
THR
SKH


2009-2009
MAK
OCS
BSH
3000 no
POR
THR
SKH


2010-2010
MAK
OCS
BSH
3000 no
POR
THR
SKH


2011-2011
MAK
OCS
BSH
3000 no
POR
THR
SKH

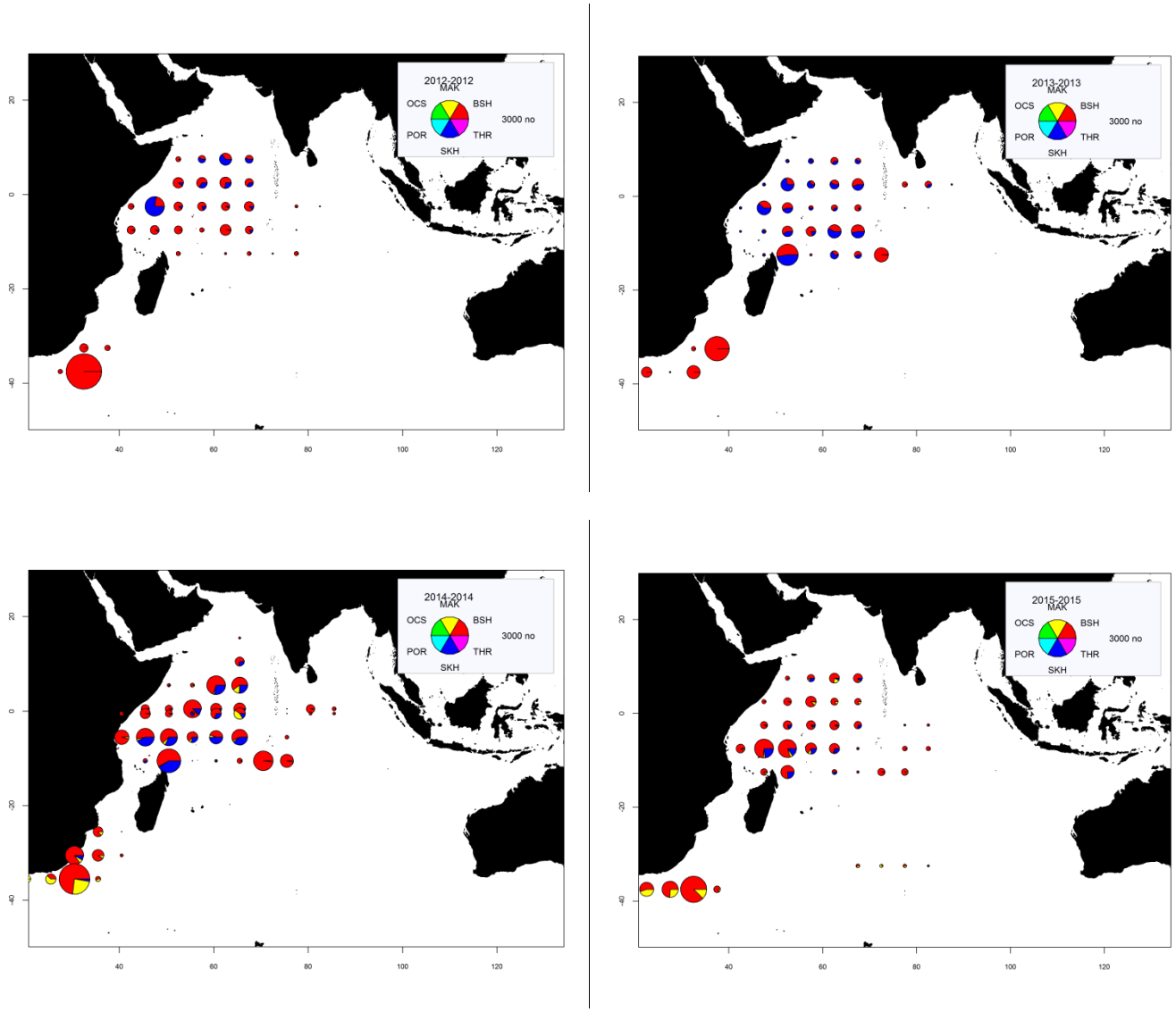


Figure 12. Time-area catches (total numbers) of sharks for Seychelles flagged longliners by year (2006–15) and species.

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. 13 shows the aggregated fork length frequency distribution for the longline fleets reporting size information on blue sharks for all areas between 2005 and 2015. 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. 14 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.

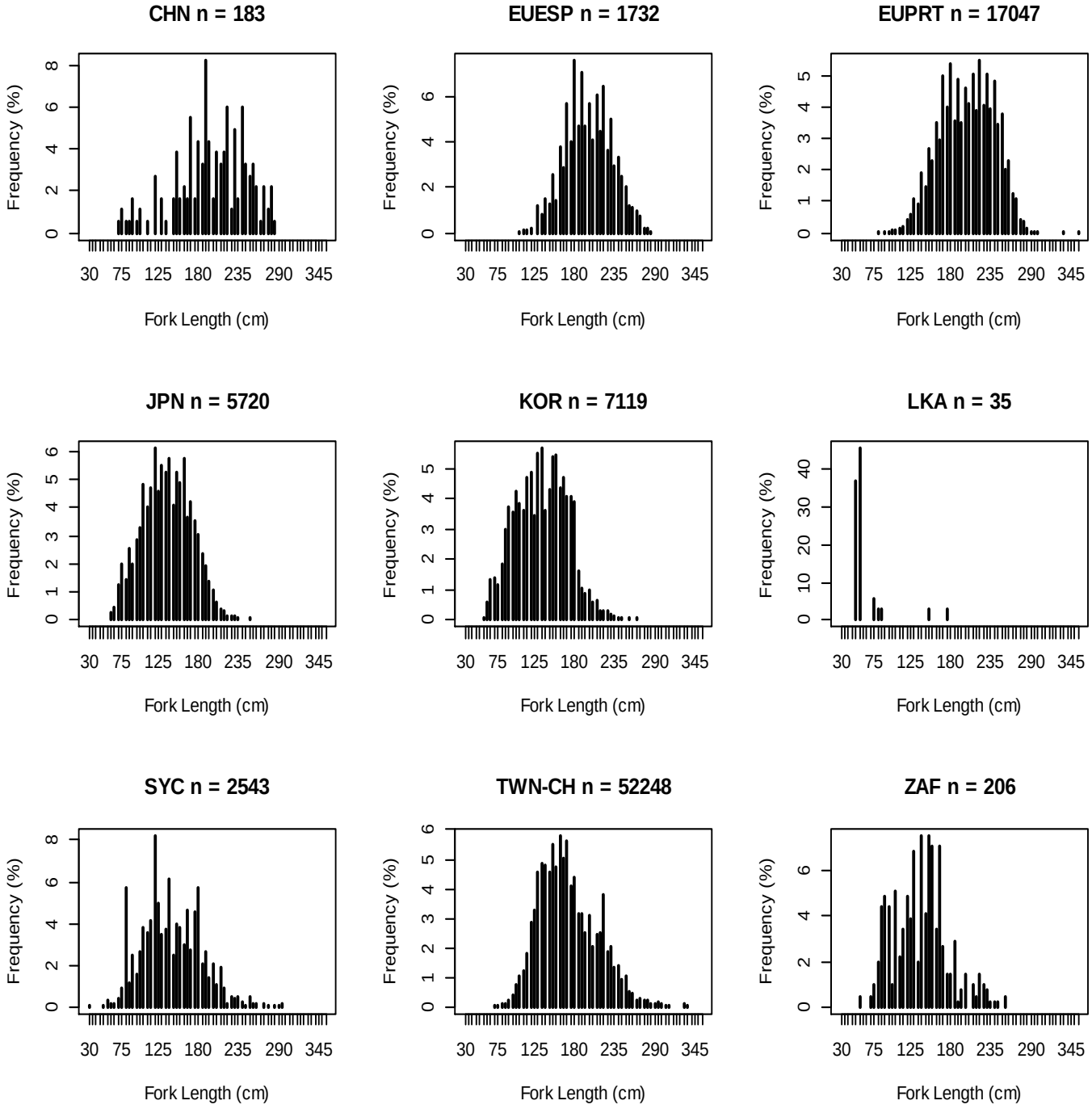


Fig. 13. Fork length frequency distributions (%) of blue shark derived from the samples reported for the longline fleets of China (CHN LL), EU,Spain (EUESP ELL), EU,Portugal (EUPRT ELL), Japan (JPN LL), Korea (KOR LL), Sri Lanka LKA (G/L), Seychelles (SYC LL), Taiwan,China (TWN FLL/LL) and South Africa (ZAF ELL) between 2005 and 2015 in 5 cm length classes.

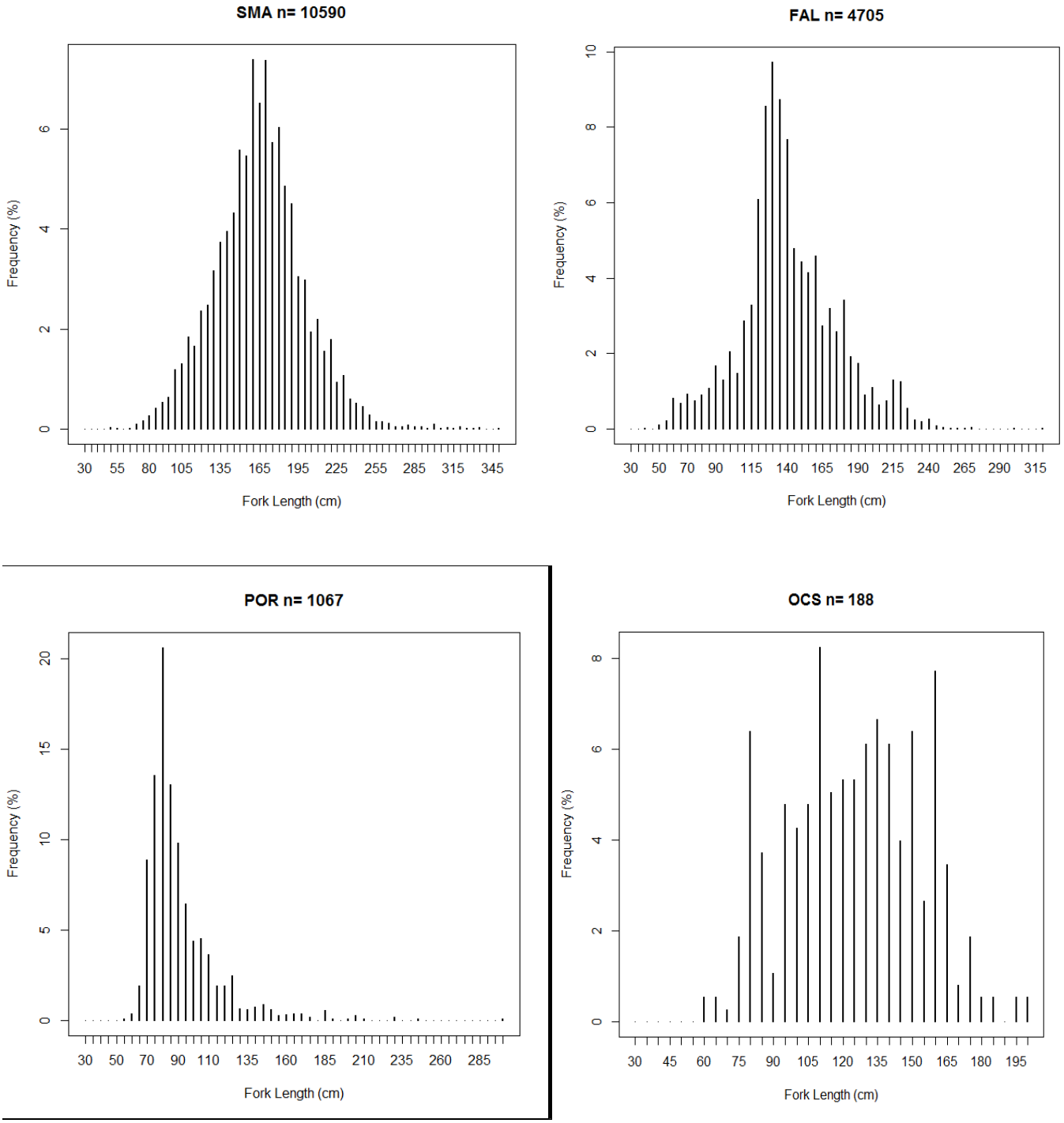


Fig. 14. Fork length frequency distributions (%) for shortfin mako shark (SMA), silky shark (FAL), porbeagle shark (POR) and oceanic whitetip shark (OCS) between 2005 and 2015.

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 (accounting for 61%) and Taiwan,China (accounting for 35%) (Figure 15). Figure 16 shows the spatial distribution of reported effort exerted by longliners for fleets fishing south of 25° south.

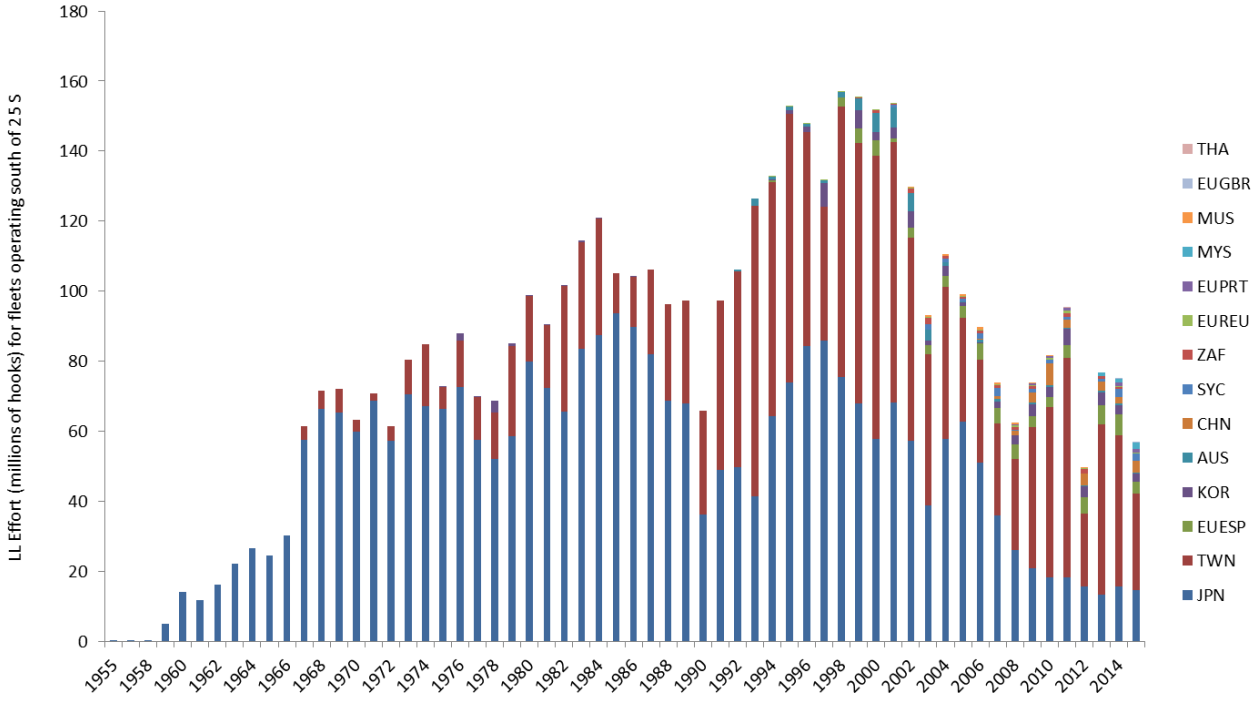


Figure 15. Reported longline effort for fleets operating south of 25° south between 1955 and 2015. (THA = Thailand, EUGBR = EU,UK, MYS = Malaysia, EUPRT = EU,Portugal, EU,REU = EU,France, MUS = Mauritius, ZAF, = South Africa, SYC = Seychelles, CHN = China, AUS = Australia, EUESP = EU,Spain, KOR = Rep. of Kora, TWN = Taiwan,China, JPN = Japan).

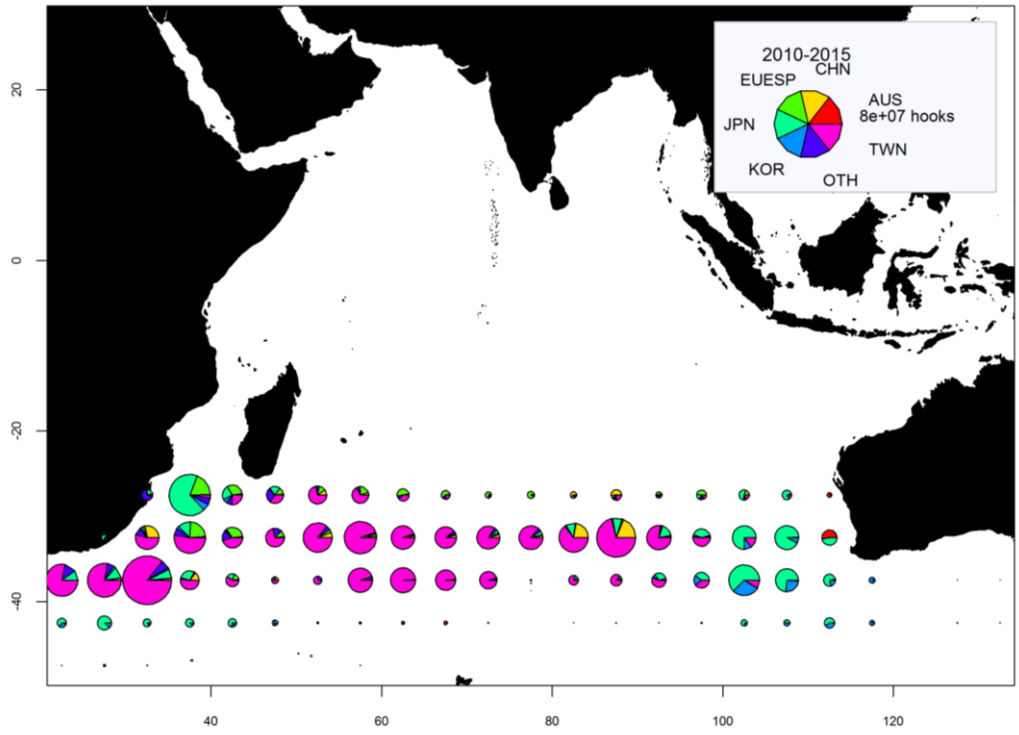


Figure 16. Reported longline effort for fleets operating south of 25° south between 2010 and 2015.

Status of data on seabird bycatch

The reported data available on seabirds caught in the IOTC area of competence are poor quality, sparse and not standardised, as highlighted in paper IOTC-2015-WPEB11-07. As the IOTC database for non-retained catches and the observer database are currently under development, these data will be available for summary by the end of the year.

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[7].

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)

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. As the IOTC database for non-retained catches and the observer database are currently under development, these data will be available for summary by the end of the year.

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.

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

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 sometimes based on retained catches rather than total catches, and so if discarding is high then this is a major source of error. 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.

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. While ad hoc pieces of information from a number of sources have been collated here as far as possible, it is noted that data presented in various documents such as Working Party papers and National Reports are not considered to be formal data submissions to the IOTC. 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.

The following list is provided by the IOTC Secretariat for the consideration of the WPEB. The list covers the main issues which the IOTC Secretariat considers to affect the quality of the statistics available at the IOTC Secretariat, by type of dataset and type of fishery.

SHARKS

1. **Catch-and-Effort data from gillnet fisheries:**
   - Drifting gillnet fisheries of I.R. Iran and Pakistan: To date, I.R. Iran and Pakistan have not reported catches of sharks, by species, for the gillnet fisheries.
   - Driftnet fishery of Taiwan,China (1982–92): Catch-and-effort data does not include 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, Madagascar, Sri Lanka 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, in particular thresher sharks and oceanic whitetip sharks, although Japan, Taiwan,China and Indonesia 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. Sri Lanka has recently reported some size frequency data by species for 2014, however, these data are very limited.
   - 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

1. **Incidental catches of SEABIRDS:**
   - Longline fisheries operating in areas with high densities of seabirds. Seychelles, Malaysia, Mauritius, EU(UK) 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 05/05: *Concerning the conservation of* ***SHARKS*** *caught in association with fisheries managed by IOTC*
    - *Paragraph 1: Contracting Parties, Cooperating non-Contracting Parties (CPCs) shall annually report data for catches of sharks, in accordance with IOTC data reporting procedures, including available historical data.*
- 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*

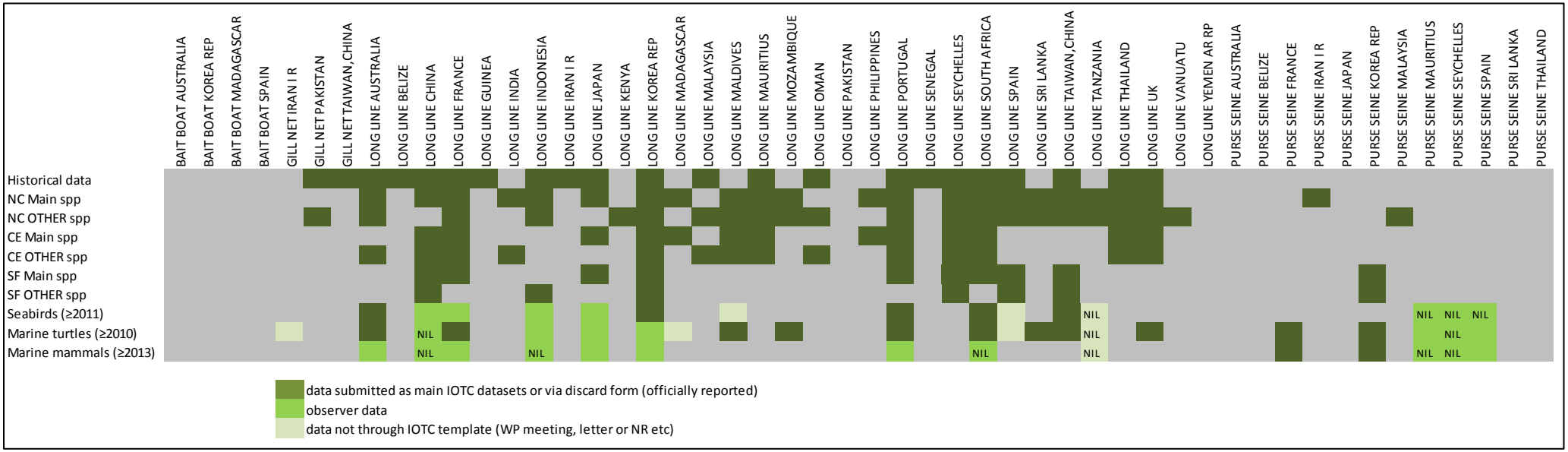
Code	English Name	Source	French Name	Scientific Name
POR	Porbeagle	IOTC[1]	Requin-taupe commun	*Lamna nasus*
WSH	Great White Shark	IOTC[1]	Grand requin blanc	*Carcharodon carcharias*
CWZ	Other Requiem Sharks	IOTC[1]	Requins Carcharhinus nca	*Carcharhinus spp*
SPN	Hammerhead Sharks	IOTC[1]	Requins marteau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

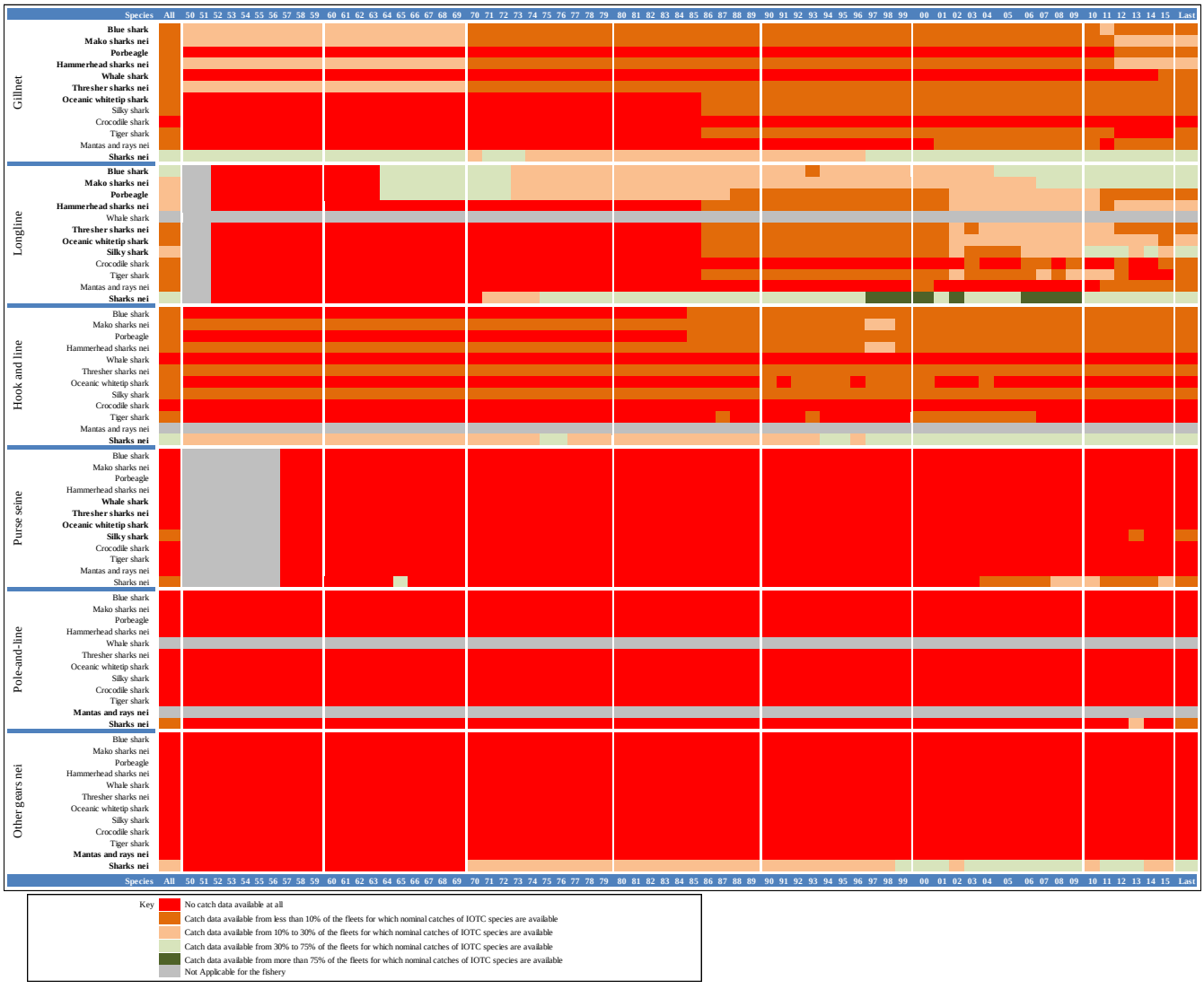
Table 6. Datasets provided by industrial fleets according to IOTC reporting requirements[8]. Grey cells indicate which fleets have reported data for IOTC species, whereas green cells indicate which fleets have provided the bycatch data specified. Results are based on the nominal catch, catch–and-effort and size frequency data held within the databases at the IOTC Secretariat on 25 August 2016 and other information on seabirds, marine turtles, mammals, thresher shark and oceanic whitetip shark 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).



[8] 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[9] for which data on IOTC species are available, by fishery, species of shark, and year, for the period 1950–2015.



- 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.

[9] 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

Table 1: 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.*

Table 2: 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

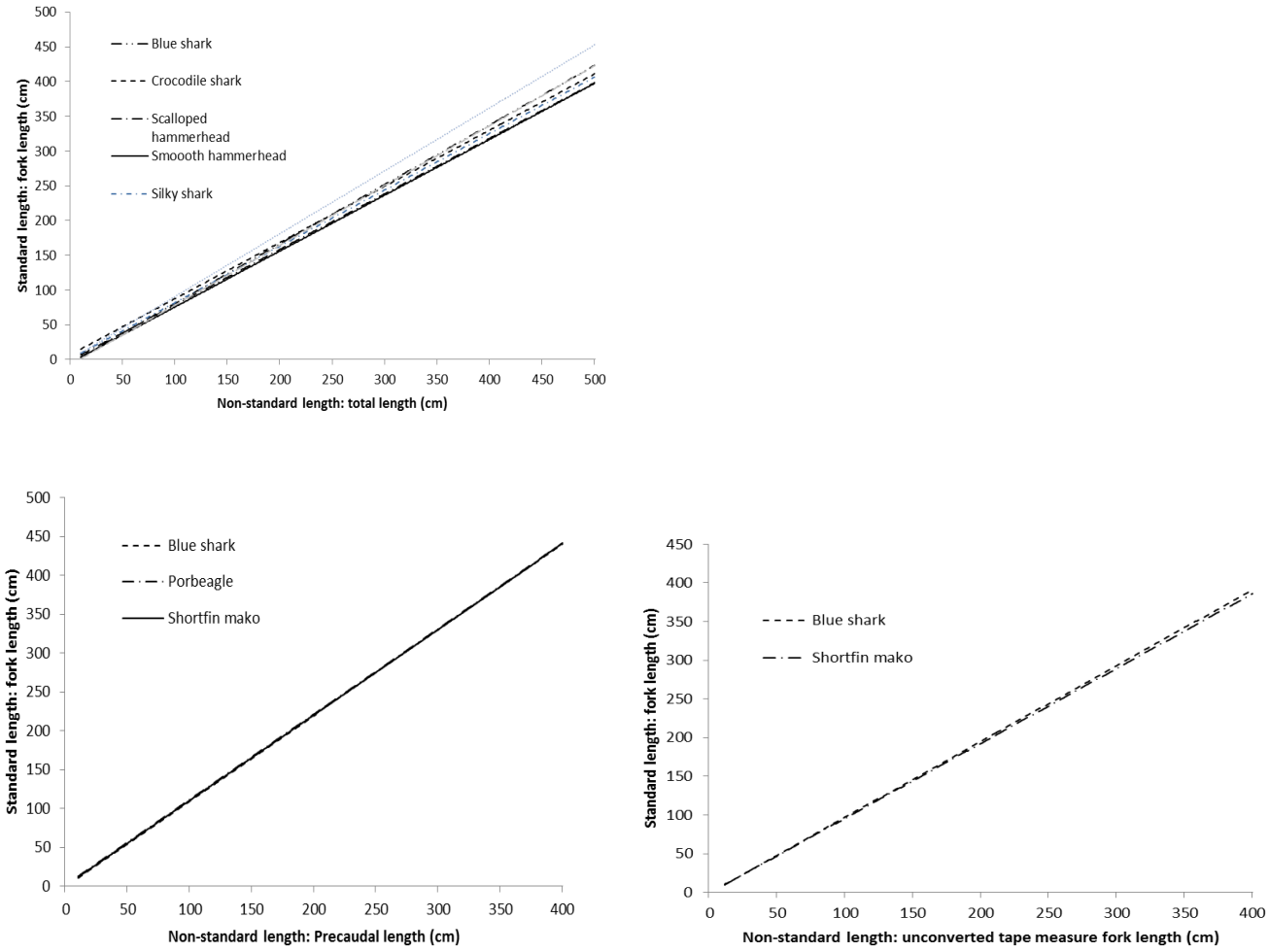


Fig. 1. Conversion equations from non-standard to standard length by shark species

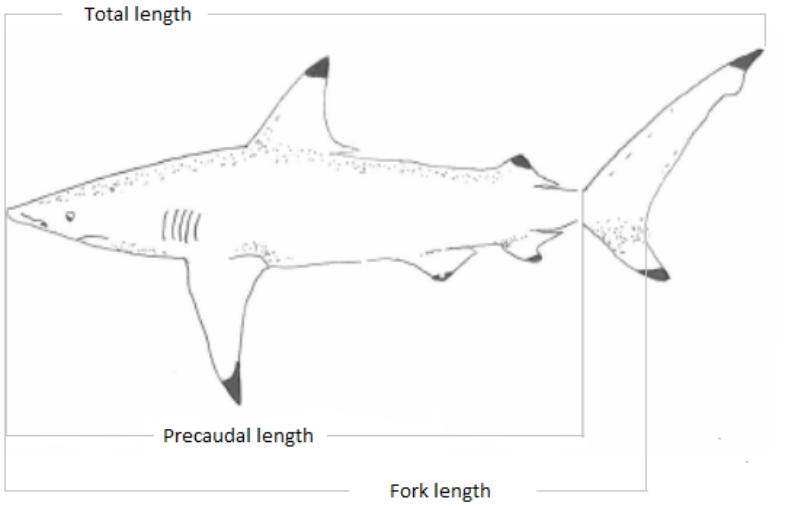


Fig. 2. Measurement types used for sharks