Final summary report of the stock status of oceanic whitetip sharks and CITES-listed hammerhead sharks based on the results of the IOTC/CITES Shark Data Mining Workshop

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Executive Summary

In this report we present, for oceanic whitetip and CITES listed hammerhead shark species (smooth, great and scalloped hammerhead), information on the spatial distribution of catches; temporal trends in catch composition and catch rates; and key biological indicators of fishing pressure such as mean size and sex ratio. The analysis generally follows the framework first developed and described in the Pacific (Clarke and Harley, 2010, Rice et al 2015).

This analysis provides indicative trends for oceanic whitetip and hammerhead sharks however limited inferences are possible for the entire Indian Ocean (IO) region, due to two reasons. The first is a lack of data (both in terms of total catch estimates, and time-area catches) throughout the IO region and secondly a poor understanding of these species stock structure throughout the IO region. Hammerhead shark species considered in this analysis are not commonly caught in the primary fisheries in the Indian Ocean (pelagic gillnet, pelagic longline and industrial purse seine). Where they are frequently caught, i.e. coastal fisheries and fisheries operating within national waters, relatively little data collection occurs. Furthermore reported shark catches are often reported as aggregated shark species, and therefore species level inference on hammerhead sharks as a group should be made with caution.

Species occurrence indicators show that oceanic whitetip are caught throughout the majority of the Western Indian Ocean region and the western part of the Eastern Indian Ocean region (Figure EX 1). The same indicators show that hammerhead sharks are mainly caught in east African coastal waters as well as the equatorial high seas between India /Maldives and eastern Africa (Figure EX 2).

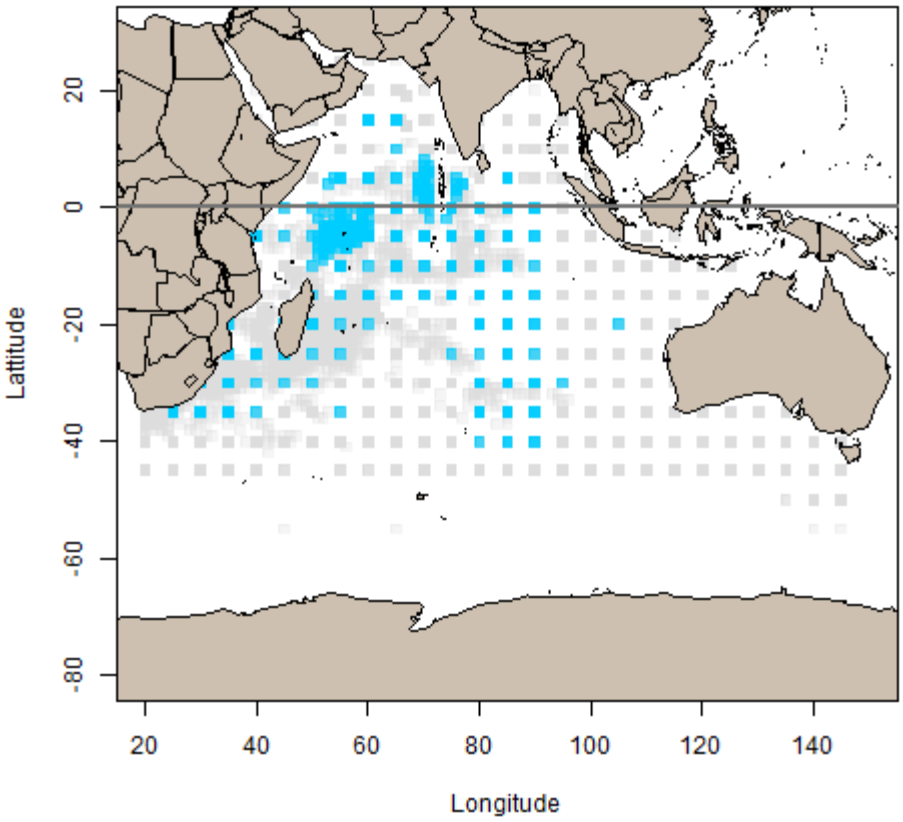

Figure EX 1. Reported catch of OCS in the longline fisheries of the Indian Ocean 1952-2015. Blue squares indicate reported OCS catch and grey squares indicate reported effort.

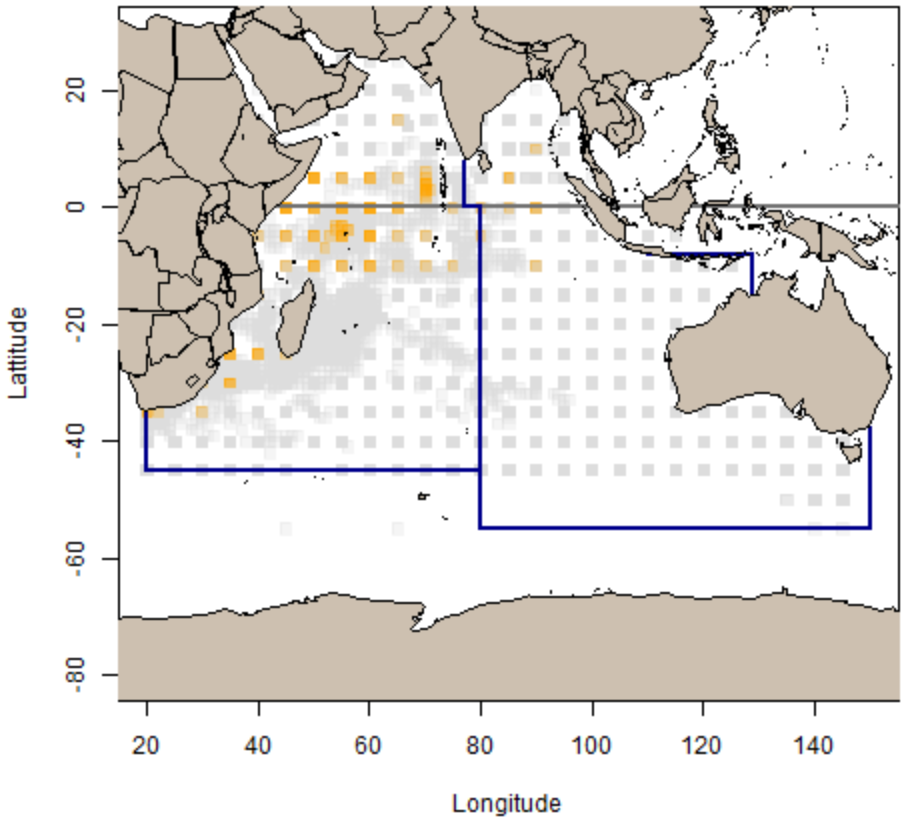

Figure EX 2. Reported catch of hammerhead in the longline fisheries of the Indian Ocean 1952-2015. Orange squares indicate reported hammerhead catch and grey squares indicate reported effort.

The proportion-presence indicators showed relatively high variability in the trends for oceanic whitetip and most hammerhead species in both regions. Species Composition indicators reveal that reports of oceanic whitetip bycatch increased in 2015, though blue sharks are the most prevalent longline caught shark, and unidentified sharks is the second most common species category. Information on shark catches by the purse seine fisheries is very limited. Catch per unit effort indicators for oceanic whitetip indicate a highly variable but slightly increasing trend in oceanic whitetip catch rates prior to 2013, since that time the catch per unit effort indicator has been flat.

Despite regular occurrence in the Indian Ocean tuna fisheries sharks are not considered to be 'IOTC species', and as such the data reporting requirements have changed over time and so the reporting of sharks to species level has been inconsistent. As per IOTC Resolution 15/02, all CPCs must provide total (nominal) catch data, catch and effort data and size frequency data. In addition to these IOTC datasets and as part of this project, the IOTC announced a data call (IOTC CIRCULAR 2016-076, Annex A) which requested all CPCs to provide their available national catch and trade data on hammerheads, oceanic whitetip and other sharks, and provide it for a data mining workshop, eight of the 35 CPCs responded to

the data call. What little information is available and compiled in this report indicates that both oceanic whitetip and hammerhead sharks are caught throughout much of the IOTC region, though significant gaps in the temporal –spatial nature of the data exist. Further complicating the analysis for hammerhead species is the lack of identification to species. The scalloped and smooth hammerhead sharks both inhabit deeper ocean waters, and are often observed over continental and insular shelves. While both species are vulnerable to artisanal and small-scale commercial fisheries smooth hammerhead sharks are more tolerant of temperate water and likely comprise the majority of the catch reported in the temperate water offshore pelagic longline and gillnet fisheries. However the species composition of both coastal and offshore fisheries is not well understood with regards to hammerhead sharks.

Capacity development is a necessary component to the long term management of these, and other shark species. Regional development needs are numerous, one of the foremost would be development and/or improvement of regional observer data collection and reporting programs for all fleets/nations. Observer programs require (in a broad sense) well trained observers (in species ID as well as observing fishing methods), an observer debriefing process, data transmission/reporting capabilities, data processing, data storage and extraction capabilities. Sufficient observer coverage, or data collection, in space and time to characterize each fishery should be the goal of any observer program. In practice this takes funding and management frameworks that stipulate the need for observers. Capacity building in the form of developing a framework for observer data collection would be an important step to accomplish early on because regional observer programs can serve as a platform to develop coordinated regional research projects on sharks such as catch composition, CPUE, and distribution. Capacity development for national (fisheries) scientists is a key step to leveraging any data collection efforts. Improved data collection and analysis would advance the ability of CITES parties to complete a Non Detriment Finding (NDF) and contribute to regional analyses. Especially for smaller nations with limited capacity to deal with CITES issues, the ability to produce NDFs is limited by availability of data, as well as incomplete monitoring and enforcement.

Recommendations to the WPEB This indicator analysis provides informative insights into the interactions between fisheries and oceanic whitetips but is somewhat limited in the amount of inference possible for hammerheads largely due to lack of species specific data. Hammerhead shark species are not commonly caught in the offshore pelagic fisheries in the IOTC and are historically not well reported in the inshore fisheries. Increased observer monitoring is vital to understanding the stock status of these shark species. Specific research recommendations include:

- Research to assess the stock structure for oceanic whitetip and hammerhead species in the Indian Ocean.
- Research linking reporting in logbooks and observer data so that data from one fleet can be used to support analysis from another.
- Research into the calculation of un-documented, and historical catch re-construction, by individual CPC and potentially by gear.
- Research into the initial depletion levels for shark stocks should be undertaken. This would include developing catch histories for these species.

- Assessing overall mortality rates is an important component of assessing the stocks. Currently there is no informative data on post-release mortality rates of oceanic whitetip and hammerhead sharks. Specifically because oceanic whitetips have non-retention management measures post-release survival rates are essential for monitoring the effectiveness of these measures. This information would help bridge data gaps for the provision of science-based advice for the management of oceanic whitetip shark.
- Comparative studies of logbook vs. observer data (reported catch rates may differ due e.g. due to discard at sea, use as bait for longlines, etc.) to identify and adjust for under reporting discarding or non-species specific recording.
- Examine the potential impact of shark related CMMs on data quality.
- Coastal fisheries catch of oceanic whitetip and hammerhead listed sharks are not well understood and it would be beneficial to do a short study to determine the levels of effort and catch before developing long term data collection.
- Efforts to improve the quality and amount of information regarding trade in shark products should be a focus. This should be done by both importing and exporting nations and could help inform research on catch rates and cross check information reported effort and landings.
- Capacity building to monitor and enforce trade regulations is needed in many regions.

1 Introduction

Shark catch in the pelagic fisheries of the Indian Ocean is considered as bycatch, though some directed and/or mixed species fisheries also exist. Coastal artisanal and semi industrial fisheries often target sharks for local consumption and trade. The Indian Ocean Tuna Commission (IOTC) has 16 designated key species, none of which are sharks. However due to the frequency of interaction with shark species and the mixed target nature of many fisheries IOTC Contracting Parties and Cooperating non-Contracting Parties are required to report information regarding sharks at various levels of detail depending on the fishery. The following are the main species caught in IOTC fisheries, although the list is not exhaustive. (Table 1).

The status of these species (blue (BSH, *Prioace glauca*), oceanic whitetip (OCS, *Carcharhinus longimanus*), mako (MAK, *Isurus spp*.), thresher (THR, *Alopias* spp.), silky (FAL, *Carcharhinus falciformis*), and scalloped hammerhead (SPL, *Sphyrna lewini,*) in the Indian Ocean is periodically reviewed by the IOTC to the extent possible. These summaries of stock status present the current state of knowledge for main IOTC sharks and where possible inform the Commission about the status of the stock of these shark species; currently the status of all sharks is "Not assessed/Uncertain". Given the lack of data availability for sharks compared to target species, indicators for stock status must be developed based on a variety of data sources including logbooks, observer records from industrial purse-seine and longline vessels, published reports and indirect estimates. This study updates key indicators for OCS, SPL, great hammerhead (*Sphyrna mokarran, SPK*) and smooth hammerhead (*Sphyrna zygaena, SPZ)* sharks in the region. This study covers the period 1980-2015. Note that given the incomplete or derived data certain inferences from these data should be made with caution.

In this report, we present information on the geographic range of catches for each of the species considered; temporal trends in catch composition and catch rates, and key biological indicators of fishing pressure such as mean size and sex ratio. The analyses are based on IOTC data holdings (see Section 2 below) and data submitted in conjunction with the IOTC/CITES data mining workshop. The IOTC/CITES data mining workshop had five main objectives:

(1) Improve and expand regional data on stock structures for OCS and CITES-listed hammerhead sharks namely SPL, SPK and SPZ;
(2) Support parties in the Indian Ocean region in the implementation of CITES shark listings;
(3) Increase capacity of CITES parties in the Indian Ocean region for the making of non-detriment findings for the above species, based upon better knowledge of the status of shared stocks;
(4) Encourage regional cooperation in the sharing of biological, and fisheries data for coherent fisheries management of shared stocks of CITES -listed sharks; and
(5) Support parties that have been identified as priority countries for capacity development for the implementation of CITES listings.

2 Description of Data

Despite regular occurrence in the Indian Ocean tuna fisheries sharks are not considered to be 'IOTC species', and as such reporting of sharks to species level has been inconsistent. As per IOTC Resolution 15/02, Reporting Requirements for IOTC Contracting Parties and Cooperating Non-Contracting Parties (CPCs), all CPCs must provide total (nominal) catch data, catch and effort data and size frequency data. These data sources and their relevance to this project are summarized below. Note that Resolution 15/02 supersedes the previous reporting requirement resolution (10/02) and was updated to contain

the following relevant language mandating reporting "for all species under the IOTC mandate as well as the most commonly caught elasmobranch species…as per resolution 15/01". Resolution 15/01 outlines the requirement for recording the catch and effort by vessel type. With respect to the species of interest for this study, longline vessels are required to report OCS and only general hammerhead species (SPN), for purse seine only OCS are required, for gillnet OCS and SPN are required, along with 'other sharks' (SKH), while for pole and line, handline and trolling vessels only SHK catch is required to be reported. In Resolution 15/01 it is noted that these are the minimum reporting guidelines and that other species should be added based on the area fished and operational type.

2.1 Nominal Catch Data

Supplied by both contracting and non-contracting parties fishing for tunas in the Indian Ocean, nominal catch of sharks is available for each IOTC statistical area (West and East, Figure 1), by species and fishing gear made by vessels flying the flag of the reporting country in live weight equivalent. These data are aggregated by calendar year for tuna and tuna-like species and non-target species (by-catch). The data set extends back to the 1950's when industrial longlining started in the Indian Ocean (Figure 2). In general the data are considered representative (though the completeness and accuracy of the data varies by year) of the nominal catch of the main IOTC target species (yellowfin tuna, bigeye tuna, skipjack tuna, albacore and swordfish) but are considered to be less complete for other species. Nominal catches are recorded by the Master of the fishing vessel, and submitted to the flag State, which in turn compiles and submits the data to the IOTC. Note that the data set is highly irregular for some species where there appears to be many incidences of 'missing' catch, particularly for bycatch. For example, two fleets fishing in the same vicinity for the same species, using the same gear, but only one reports any catch of sharks. This is likely a reporting issue.

2.2 Catch and Effort Data

The catch and effort data held by the IOTC represent a partial data set with respect to the nominal (total reported) catch. The resolution of the catch-and-effort database (which is spatially explicit to 1 by 1 degrees for surface fisheries, 5 by 5 for longline fisheries, and a mix of to 1 by 1 degrees and irregular areas for coastal fisheries) is considered to be fairly accurate, though incomplete. In addition to the longline fishery catch and effort data is available for purse seine (Figure 3) and coastal gear (gillnets, troll, line, beach seines and other fisheries operating in coastal waters) and handlines, some which is reported in sets, days, and trips (Figures 4-6). Reported annual effort in the longline fleet is larger in the western Indian Ocean than the eastern (Figure 7), correspondingly the reported catch of all sharks, in both numbers and MT is larger in the western region than the eastern (Figure 7).

2.3 Size Data

Size data is required to be provided for all gears and for all species with coverage set to at least one fish measured by MT caught, by species and type of fishery. The goal is to have the size samples reflect the time periods, gear and areas fished. The spatial and temporal aggregation are identical to those of the catch and effort data. The completeness of the size frequency data for in this study is limited with only 15 OCS and 2 SPL reported.

2.4 Transhipment data

Data on at-sea-transhipment data (2009-2016) and in-port transhipment data (2005-2016) exists however this data likely covers only part of the fishery. As noted in Martin et al. (2013) the IOTC Regional Observer Program monitors transshipments at sea between large-scale tuna longline fishing vessels (LSTLVs) and carrier vessels. The previously mentioned paper details the transshipments of shark and shark products by weight for the four years that data was available at the time. On an annual basis the majority of the records (54%-89%) are recorded as either Various Sharks or Pelagic Sharks. The observations between 2009 and 2016 that identified OCS are limited to two years, there were 3 observations of OCS being transshipped in in 2011, and 11 observations of OCS in transshipment in 2012. The observations of OCS transshipment amount to 0.4% of the total observed transshipped shark. The observations of SPN are limited to 2 in 2010, 6 in 2011, and 1 in 2016, these observations amount to 0.2% of the total observations of shark transshipment. The previous work on the transshipment data suggests that this data might provide a potentially useful source of information on the catch of sharks by the longline fleet. Before the data set can be fully utilized multiple issues need to be overcome. A partial list includes;

- The majority of sharks were not identified to species level.
- Converted weights from products to round weight are not very precise
- The transshipped data covers only those longlines which transship, and represents approximately 10% of the total pelagic shark catch.
- Misidentification of shark species is likely when identifying processed shark.

2.5 Data submitted to the IOTC/CITES workshop

In addition to the main IOTC datasets that are published online prior to each IOTC Working Party meeting, and as part of this project, the IOTC announced a data call (IOTC CIRCULAR 2016-076, Annex A) which requested all CPCs to provide their available national catch and trade data on hammerheads, oceanic whitetip and other sharks, and provide it for a data mining workshop. This data call covered all fisheries and extended from 1980-2015 and resulted in the following data summaries:

- **INDONESIA.** Marine waters in Indonesia total nearly 5.8 million km2 of (EEZ and territorial waters combined), approximately 1/3 of which is in the IOTC area of competence. In 2015 a total of 1,334 fishing vessels were registered with the Indonesian government consisting of longline (1,282), purse seine (40), gillnet (2) , and carrier vessels(10). These vessels range from <50 MT to over 800 MT, additionally there exist many unregistered smaller artisanal crafts. Fisheries Observer data from the Indonesian Research Institute for Tuna Fisheries (RITF) was presented dating from 2006 to 2015. This information comes from covered the Eastern Indian Ocean between latitudes 0° and 34°S and longitudes 75° and 135°E (the area between Western Australia and Indonesia). This data contains set by set information (mainly from longline vessels) and identifies most sharks to species, OCS were observed in this 8 times from 2006 to 2015 out of 13,939 sharks identified to species. Data on hammerhead sharks is limited to SPL and SPK only, with 546 and 66 observations, respectively out of the

same 13,939 sharks identified to species. Observed length data for both scalloped and great hammerheads indicates that the majority of the sampled fish are immature, while the OCS were evenly split between mature and immature. Summaries of additional data from the WWF Indonesia observer program were available, however this data was combined from areas both in (overlapping with the RITF data) and outside the IOTC area of competence (i.e the Celebes Sea and the Banda Sea). This data did not include observations of OCS and only identified hammerhead sharks in aggregate (SPN). The WWF dataset showed 6 observations of SPN (out of 1277 sharks observed) over 2006-2014. The dates of capture and fate of the sharks were not reported. Neither dataset is considered representative of the Indonesian fishery as a whole, which is large and contains a variety of gears.

- **IRAN (Islamic Republic of).** The fishing grounds for Iran are located in the Caspian Sea, Persian Gulf and Oman Sea. The Iranian fleet active in these areas is comprised of approximately 11,498 vessels of which about 6,762 fishing vessels are active in large pelagic fisheries (as of 2015). Gillnet and purse seine vessels dominate the fleet for both industrial and semi industrial fisheries. With respect to the species of interest in this report only SPN are reported for the gillnet fleet and comprise 1-2% of the total shark landings in the gillnet fishery. All data are collected by in-port fisheries monitors, the completeness of the data is unknown, at sea discards of sharks (and other bycatch) are not likely to be reported, the market for shark meat in Iran is small as many Iranians abstain from its consumption due to religious reasons. However there is a market in neighboring Pakistan and some (largely undocumented) trade is thought to exist. Reported landings of total sharks is available from 1997-2015. Landings records (from 1997-2015) of sharks indicate that the overall shark fishery lands approximately 11,000 MT/year and this amount comprises between 2% & 3% of the total (target + bycatch) landings. There exists data on shark landings by species from the tuna fleet in 2015 only. This data indicated that 118 MT of OCS were caught and 63 MT of SPN were landed, comprising 0.05% and 0.03%, respectively, of the total landed catch. Estimates of total shark landings prior to 1997 were estimated (for this workshop) using the average ratio (shark/total landings) from the 1997-2015 period, though this assumes a static species composition in the fishery.
- **SEYCHELLES.** The Seychelles fleet consists of 60 vessels (as of 2015), 11 of which are purse sein vessels and 36 of which are longline vessels, 9 semi-industrial vessels are also registered. The majority of the fishing effort for both purse seine and longline takes place in and around the Seychelles EEZ and the area between the East African coast and Madagascar. Longline vessels also fish in the area East of the South African EEZ, and have occasionally fished in the South East Indian Ocean. Catch records from the semi-industrial and industrial fisheries in the Seychelles indicate that 46 OCS were observed between 2009 and 2013 in the industrial fleet and 1.8 MT was landed in the semi –industrial fleet in 2013, during the same time period (2009-2013) 282 MT to 392 MT of shark was reported landed by the longline fleet and between 6 and 15 MT of shark were landed in the semi-industrial fleet. Additional data from 2014-2015 is currently being processed.

- **KENYA.** The shark fishery data in Kenya is based on the artisanal, recreational and longline fisheries. Currently there is one Kenyan flagged longliner which was subject to 100% observer coverage as of 2015. In addition to this industrial vessel numerous local semi-industrial boats are engaged in targeting tuna and associated species. These are broadly categorized as outrigger boats or dhows. It is estimated that 850 artisanal-commercial vessels are engaged in the fishing for tuna and tuna like species in 2014. These vessels use a variety of gear including artisanal long line hooks, gillnets, monofilament nets and artisanal trolling lines. Additionally a large number (3000- 4000) of artisanal vessels are engaged in coastal subsistence fisheries. These vessels are reported to catch some SPN and supply the local subsistence market. Catches of tuna from artisanal fisheries were 322 MT in 2015, with 343 MT of sharks and rays reported. The majority of the effort in assumed to be in the Kenyan EEZ. There is no data on OCS catch in any of these fisheries since 2010. Recreational fisheries have reported shark catch to species, however with variable frequency over the time period 2010-2015. Less than ten hammerhead sharks reported in the recreational fisheries annually since 2010, which reports catches ranging from 18 to 138mt.
- **TANZANIA.** Tanzania's fisheries are dominated by artisanal fleets which target multiple species using a variety of gears and multi-cultural fisheries. A small number of boats tuna, bill fish and sharks, using small-scale drift gillnets, trolling and longlines. Three longline vessels (foreign) are flagged to Tanzania and fish both inside and outside the EEZ, and in the high seas east of the South African EEZ. Data from Tanzania (mainland and Zanzibar) indicate that between approximately 3500 and 6500 MT of sharks and rays have been landed annually in the time period 2011-2015, compared with approximately 2100 to 7700 MT of tuna in the same period. The total catch for tuna (but within the EEZ) and high seas. There are 5,023 registered large pelagic fishing vessels of which 1607 are engaged in high seas fishing. The dominant type of gear was large mesh gillnet with 53% of the effort. The remainder of the fleet was ring-net (20%), gillnet-long line (17%) , longline (10%), handline and trolling account for the rest of the fishery.
- **SRI LANKA** Sri Lanka's fisheries consist of coastal (with in approximately 40 KM of land), offshore (but within the EEZ) and high seas. There are 5,023 registered large pelagic fishing vessels of which 1607 are engaged in high seas fishing. The dominant type of gear was large mesh gillnet with 53% of the effort. The remainder of the fleet was ring-net (20%), gillnet-long line (17%) , longline (10%), handline and trolling account for the rest of the fishery. The majority of the shark landings in Sri Lanka originate as by-catch from offshore tuna long-line fishery and gillnet fishery. Total tuna catch has ranged from approximately 80,000 MT to 90,000 MT over the years 2013-2015. Reported catch of OCS is 268, 149 and 42 MT in 2011,2012, and 2013 respectively. Reports of SPL 110, 79, 119 in 2011,2012, and 2013 respectively. Catch of SPZ (60 MT) and SPK(8 MT) were reported in 2013 only
- **PAKISTAN** Directed shark fisheries in Pakistan date to at least the mid 1800 with approximately 18,000 MT of sharks exported from Sindh province in 1845-1846.

Estimates of OCS and SPN species landings in Pakistan are based on extrapolation from total reported shark landings. Shark targeted fisheries historically used a variety of non-mechanized gear to including handline, longline and gillnets. In the mid 1980s the FAO and related programs introduced bottom set longline and gillnetting which quickly became popular numbering approximately 350 vessels, landing approximately 35,000 MT of shark at their peak in 2000, before the decline of the demersal fisheries in 2003. The post demersal shark fishery (2003- present) consists mainly of bycatch in the coastal and offshore tuna gillnet fisheries as well as some bycatch in the trawl/longline fisheries. Estimates of OCS and SPN catch are based on total reported shark landings (approximately 7000 MT 2012-2015) extrapolated to the species level. This extrapolation is based on the observed species composition from a program coordinated through WWF Pakistan (2013-2015). Observer records indicate that OCS and SPN are predominantly caught in the gillnet fisheries with some in the longline fishery. Estimates of SPN landings average approximately 29 MT per year (2013-2015), and 1.5 MT per year for OCS.

- **AUSTRALIA.** As of 2015 the Australian fishery in the IOTC Area of Competence consisted of seven long line vessels targeting tuna and billfish and six purse seine vessels targeting southern bluefin tuna. Combined catch of tuna, billfish and associated species was 321 MT in 2015 Australian logbook data reports a decrease in the number of oceanic whitetip sharks caught over the years 2000-2015, from over 1500 individuals in 2001 to just 11 in 2015. This decrease is in concert with a reduction of active fishing vessels from 61 in 2000, to only 7 in 2015. Reported and observed data on hammerhead sharks is not recorded to the species level and is even more limited than that for OCS.

2.6 Caveats about the data

Note that the catch estimates in this study differ from the 'best scientific estimates' of nominal catch which may be used for stock assessment purposes and published on the dedicated meeting pages for each IOTC Working Party. The best scientific estimate of catch may be the nominal data as reported by IOTC members, or a statistical estimate of catch, or disaggregated catches (originally recorded under species or gear aggregates), or some combination of these methods. When catch is reported in aggregate by gear or species (i.e. reported as sharks) a dissagregated estimate of species and gear specific catch can be produced for the IOTC database. This is done on a country by country basis by assigning a species or gear through a proxy-based substitution scheme, This is common practice for all IOTC mandate species, whereas for sharks and other non-mandate IOTC species the data is kept as originally provided by the data owners or inferred / estimated by the Secretariat from other sources of information. The disaggregation method is being explored for OCS and other more frequently caught sharks species. This report uses the raw nominal catch data except where noted. The reliability and completeness of the reported catches is considered higher than that of the reported effort.

3 Distribution Indicator Analyses

Distribution indicators consider patterns in the geographic distribution of catch. Spatial trends in fisheries data need to be interpreted carefully; targeting, reporting, distance to port, distribution of effort and other factors often result in a biased design (Walters, 2003). However if this data is carefully assessed it can provide useful insight into spatial and temporal trends in distribution as well as highlight areas of strong interactions between a species and fisheries. Spatial trends may reflect changes in stock abundance and distribution (MacCall, 1990), with increases and decreases in abundance resulting in range expansions and contractions, respectively. The indicators presented below are based on observer data and thus patterns in fishing effort and/or observer coverage may bias the results. These results should therefore be interpreted as potential indicative of the location and intensity of interactions between these species and Indian Ocean longline fisheries. These indicators can be updated over time to determine if the spatial patterns change or temporal trends change. More complex methodologies might also be applied to remove potential sampling biases.

3.1 Methods

In this study three Distribution Indicators were calculated based on the reported data. This was done for the three data sets, longline, purse seine and coastal gears (gillnets, troll, line, beach seines and other fisheries operating in coastal waters), to the extent possible. The longline data set contained data on OCS, combined hammerhead species (SPN) along with other species of shark. The costal gear data set did not contain records for OCS or SPN only on the aggregate category 'shark'. The purse seine reported zero catch of OCS and data only minimal (11 records) on shark in general. The analysis focuses on the longline fleet.

Species-occurrence. This indicator summarizes the occurrence of a species in any longline set monitored by an observer. A positive value at any given location simply indicates that the species in question was observed at least once, without regard to annual frequency or fishing effort.

Proportion-presence. This indicator provides a rough indicator of the frequency of occurrence of each species in each region and trends in presence over time. Using the reported data, the indicator is computed by dividing the total number of sets with at least one occurrence by the total number of sets in each region/year combination. This is similar to the proportion positive sets sometimes calculated for stock assessment. Monotonically increasing or decreasing trends may indicate a change in relative abundance, a change in reporting or a combination of the two.

Catch-Hotspot. This indicator is an extension of the species-occurrence and proportion presence indicators, and is intended to illustrate the possible presence of variable species catch hotspots. All the reported data are aggregated within 5x5 degree cells over four separate time periods. The proportion of observed sets containing at least one species occurrence within that cell/time period cell is then computed and mapped. This provides better temporal resolution than the Species-occurrence indicator and better spatial resolution than the Proportion-presence indicator in helping to identify the distributional patterns of each shark species.

3.2 Results

The distribution indicators are presented as follows: species occurrence (Figures 8 & 9), proportion-presence (Figure 10), the hot spot analysis is presented in(Figures 11 -13).

Reports of OCS began in the late 1990s near the Seychelles and equatorial waters between 40° and 60° longitude. Over the years 2000-2015 reported catch of OCS occur throughout the Indian Ocean expanded through most of the western Indian Ocean and the western part of the Eastern Indian Ocean. The proportion of positive occurrence for OCS was variable and less than 0.1 for all years in the study. The analysis of catch hot spots over the last four years shows that the area east of Madagascar and the area 80° and 90 ° longitude was also held the highest percent occurrence of OCS being though there was high inter-annual variability with 2013 and 2014 not showing little reported catch at all.

Reports of SPN catch began in the late 1990s near the Seychelles and equatorial waters between the eastern African coast and the Maldives. The proportion of positive occurrence for SPN was variable and less than 0.05 for all years in the study (Figure 10). The analysis of catch hot spots over the last four years shows that northwest Indian Ocean (broadly the area between the eastern African coast north of Madagascar and the Maldives) as having the highest percent occurrence of SPY being reported.

4 Reported Species Composition

Changes in the species composition of the catch can be one of the most direct indicators of fishing induced changes to fish assemblages over time. Additional information on potential changes can be inferred by examining catch data on a finer basis, e.g., by separating longline sets by depth and purse seine sets by type of school association. We rely on reported catch by country for such analyses. Additionally, by examining time series of catch composition we can ascertain whether there has been a decline in the percentage of unidentified sharks; improvements in data reporting or changes in the reliability of the data. Understanding the reported and observed species composition data is important because a decline in the percentage of general sharks reported may indicate improvements in the resolution of data, or a change in fishing practice. This does not necessarily result in an increase in the reliability of the data as there are often errors in species identification. Examining the species composition can help resolve or identify potential regional and temporal trends in abundance. Data available for this analysis are mostly the reported catch and effort data.

4.1 Methods

Species composition data was compiled from reported data by region (east and west) for the top five fishing nations, as indicated by hooks fished, along with an ‘other’ group that contains the remainder of the reported effort (Figure 7). Annual catch of shark data for OCS, FAL, BSH, THR, SPN and SHK was divided by the total reported shark catch to obtain a proportion. This was done for both catch reported in MT and numbers, and for the data set with and without BSH to provide better resolution. The data to provide information on the relative proportion of key species in the reported catch data.

4.2 Results

The only reported data that include OCS and SPN to species are the longline data, results of the catch composition are shown in Figure 14. The early part of the time series (2000-2015) are dominated by

reported 'shark ', while since 2005 more than 50% of the reported catch has been blue shark. Without the reported BSH the catch composition shows that the contribution of OCS is less than 5% every year except 2015(Figure 15). Without additional data on the unreported historical catch data the species composition cannot be separated from changes that are likely due to improvements in species-specific reporting rather than actual trends in abundance of the species.

5 CPUE

Catch-per-unit-effort (CPUE) data are commonly used as indices of abundance for marine species. However, multiple factors including fishing technique, season, bait type, etc., can alter the relationship between CPUE and abundance. This is especially true in complex fisheries systems comprising of multiple fleets and spanning large spatial and temporal scales, or when data are aggregated in time or space. Nominal catch rates (annual catch divided by annual effort) may be indicative of relative abundance, however where possible these catch rates should be standardized to account for changes in these factors over time. This is typically done using General Linear Models (GLM), which can account for the relationship between CPUE and a set of explanatory variables. The nominal catch and effort data set contains many candidate variables, but, given the diversity of fleets represented, and the variability in reporting, the dataset is not reliable enough to use for CPUE standardization on a region wide basis. Additional available data comes from the Australian logbook and observer data sets, the nominal CPUE of which is comparable (Figure 16). The Australian observer data covers only part of the longline fleet operating in Western Australia and has low temporal-spatial coverage compared to the logbook data (Figure 17).

CPUE data for sharks often have a large proportion of observations (sets) with zero shark catch, while some sets have large catch. These instances of high catch can occur when areas of high shark densities are accidentally encountered or when fishers target sharks. The co-existence of both high proportions of zeros and high catch results in over-dispersed data, typical of bycatch species. These features are challenging to account for from a statistical point of view, and have been reviewed at length in the literature on bycatch analyses (Bigelow et al., 2002; Campbell, 2004; Ward and Myers, 2005; Minami et al., 2007). Here we use negative binomial generalized linear models to standardize the logbook data set for OCS. The Australian data was deemed insufficient to develop CPUE indicators for SPN, which were not recorded at the species level.

5.1 Methods

Nominal CPUE (catch per 1000 hooks where catch is reported in either numbers or MT) was calculated on an annual basis for OCS and SPN from the nominal catch and effort data (from the IOTC database). Standardized CPUE series for the Australian longline fishery were developed using generalized linear models using reported longline catch and effort data. CPUE is commonly used as an index of abundance for marine species. However, it is important that raw nominal catch rates be standardized to remove the effects of factors other than abundance. Catch data for non-target species (sharks in particular) often contain a large number of sets with zero catch as well as sets with substantial catch. These phenomenon need to be explicitly modelled (Bigelow et al. 2002, Campbell 2004, Ward and Myers 2005, Minami et al. 2007).

The number of hooks in a longline set was used as a measure of effort measure of effort. The model was fit to the data set in a stepwise manner and all variables (year, depth category, vessel and latitude) used in the models were included as categorical factors except the response variables for catch (OCS) and the effort offset variable (effort). These variables (effort and catch) were included in the model as continuous variables. Model selection was done with a forward step approach using Akaike information criterion (AIC) as a metric to score the results and determine the final models for each data set.

Multiple methods of calculating the indices of abundance and confidence intervals exist depending on the model type (Maunder and Punt 2004). In this study estimates were calculated by predicting results based on the fitted model and a training data set that included each year effect and the mean effect for each covariate (Zuur et al. 2009). Confidence intervals were calculated as ±1.96* SE, where SE is the standard error associated with the predicted year effect term.

5.2 Results

The nominal CPUE trend for SPN lacks data in many years (Figures 18 and 19) and is highly variable within, and across years. Then nominal CPUE trend for OCS similarly lacks data in multiple years and has low counts in others (Figure 20 & 21). Reports of OCS were most numerous in the years 2009-2013, during which the trend was mostly stable at low values. Few reports of OCS catch and effort occurred in 2014, the first year the retention ban was in force, however in 2015 numerous reports of OCS catch occurred.

The standardized oceanic whitetip shark trend (Figure 22) shows a fairly stable trend between 2000 and 2005 with large increases in 2008 and 2012, followed by very low estimates from 2013 to 2015. The standardized trend is somewhat different than the nominal (Figure 23), with the most noticeable departure from the nominal being the stable early years (2000-2005) and the lack of a peak in 2005. Model diagnostics (Figure 24), show no major lack of fit for the model. Models with first order interactions were attempted but did not converge.

Analyzing and interpreting CPUE trends for highly mobile species is difficult when the CPUE data is from a small subset of the population and the desired inference is on the population level. A number of potential biases also exist, such as, changes in the fisheries themselves (e.g. operational or gear changes) or from changes in observer coverage or reporting of these fisheries or from the species interactions with natural occurring forcing factors (e.g. climatic changes). Changes in regulations can also impact CPUE indices, e.g. the banning of finning or retention, mandatory reporting and gear restrictions can also cause changes in CPUE not related to the change in abundance. When interpreting the standardized CPUE from the Australian logbook data it is important to note that Australia banned finning in 2000 and implemented banning of wire leaders in Australian waters in 2005 and that IOTC CMM 13/6 banned retention of OCS in 2013. The nominal and standardized CPUE series both indicate a marked decline in catches of oceanic whitetip since 2013 when the retention ban in the IOTC was established, suggesting that this dataset only represents retained catches and that discarding is not reflected in this analysis. The drop in CPUE in 2013-2015 may just reflect lower reporting.

6 Feasibility of Stock Assessments

In general fisheries stock assessments are designed to provide stock status and management information via a population model that is scaled to the available data. Traditionally the data requirements include landings records or estimates of catch, abundance indices and biological information. For sharks, which are often considered bycatch and lack traditional management frameworks data often reflect a short time series and data gaps in space and time. For many bycatch species estimates of removals are often highly uncertain, based on target species catch or extrapolated from small sample sizes. Data poor methods or other alternatives may be more appropriate than full stock assessments. Here we consider the viability of a stock assessment or other population level study to provide stock status and management information for OCS and SPN sharks. The data call for this study resulted in only 7 of the IOTC CPCs responding, it is likely that additional data exists, for example previous studies using research or fishery dependent data but were not submitted to this study, perhaps due to the short timeframe between the data call and the workshop.

Oceanic whitetip shark (*Carcharhinus longimanus*) OCS in the Indian Ocean have never been assessed. Sub-regional data sets are available for limited time periods. Recent conservation and management measures in the IOTC region (CMM13/06) may have affected the availability and interpretation of reported catch and effort data for OCS. This is because catch is often associated with retention and discards are seldom reported (despite mandatory regulations on reporting discards). It is unclear as to what the effect of these CMMs have had on changes in data availability, and the interpretation on any stock assessment. Reported historical catch for OCS in the IOTC region is limited to only a few nations (e.g. Sri Lanka, Australia) and usually not available for the entire history of the fishery. Catch data for OCS is considered incomplete for the majority of the CPCs. Constructing a historical catch series for undocumented OCS bycatch in the large-scale fisheries would be difficult due to changing fisheries patterns, lack of reliable reported catch rates and a lack of information on effort by gear. Furthermore in some coastal regions where small scale fisheries catch sharks (including OCS) for local consumption, total catch and changes in catch rate are nearly impossible to quantify as these fisheries are not subject to the retention ban, and national reporting requirements are either not enforced or non-existent. Stock structure for OCS is assumed to be continuous throughout the equatorial waters of the Indian Ocean, however this distributional assumption warrants more study. Currently a stock assessment is not feasible due to the lack of available data. Additional data discovery is warranted and the construction of regional or sub regional CPUE series and catch estimates, should be the focus of further research. Data poor methods for evaluating the impact of fisheries on OCS do exist, and the completion of an ecological risk assessment (or a productivity/susceptibility analysis) is feasible for OCS, and has been completed in the past. An updated risk assessment is unlikely to shed new light on the relative vulnerability of OCS in the Indian Ocean. Other data poor methods such as depletion corrected average catch and index methods would only be appropriate if catch histories or indices of abundance were available. Given the data deficiencies and hurdles to traditional and data poor assessment methods the next steps should be the construction of catch trends, and indices of abundance.

Hammerhead Shark Species (*Sphyrna lewini, mokarran & zygaena*) Observations of SPN sharks to species are virtually non-existent in the reported catch and effort data. The majority of the reported catch in the nominal catch database were recorded as generic 'hammerhead' category. Globally SPL are commonly found in continental shelf waters, and to a lesser extent estuaries and the open ocean. Significant catches of SPL in the pelagic longline fishery off the southeastern United States indicate that SPL may be vulnerable to bycatch in other pelagic longline fisheries (e.g. in the Indian Ocean). Little data is available from the large scale fisheries on the catch of either SPL or SPZ. Misidentification of these

species is also a concern as their distributions overlap. The distribution of SPL is more tropical than SPZ, which are more commonly observed in the subtropical and temperate waters. Pelagic longline fisheries in temperate waters of the Indian Ocean catch more SPZ, and SPL likely interact to a greater extent with the tropical tuna fisheriesSimilar to SPL, SPK are distributed through tropical and the warm temperate waters, in the open ocean near the shelf continental shelf. Hammerhead shark populations in the Indian Ocean suffer from both small low-quality and limited data. . Additional data discovery for these species and the fleets with which they interact is warranted. A stock assessment for these species is not feasible given the current data. Hammerhead populations are not well defined throughout the region, and methods (even data poor methods) would need to develop additional data streams. Data poor methods have been used for hammerhead assessments in the past, and some methods would be appropriate if reliable estimates of catch and/or relative abundance were available. For example Jiao et al. (2010) used multilevel modelling to make inference on (the data poor species) SPK and SPZ based on good quality catch and abundance data from SPL. Difficulties in applying this or other data-limited methods for hammerhead sharks in the Indian Ocean stem from lack of a reliable catch history and an incomplete understanding of the stock structure.

6.1 Data Needs for stock assessment

The majority of global fish stocks lack adequate data to evaluate stock status using conventional stock assessment methods, this applies especially to sharks and is certainly the case for OCS and hammerhead sharks in the Indian Ocean. Data limited methods for assessment purposes have been adapted for many situations, typically these methods include a time series of historical catches, for both OCS and hammerhead sharks in the Indian Ocean this is the primary data need for an assessment. Additionally a better understanding of the stock structure and the degree of connectivity throughout the Indian Ocean would be important for defining the scope of any assessment. The construction of sub regional CPUE series and catch estimates by species should be the focus of further research along with stock structure information and catch histories. Other information such as an index of abundance, current stock size relative to unfished condition (or some reference year), biomass at maximum sustainable yield relative to unfished biomass, natural mortality rate, median age at maturity, current biomass, growth parameters, the mean length at first capture, and length composition are all components of various data limited approaches that would be helpful for future analyses.

7 Impact of CMM 13/06

See Appendix B for an analysis of the available data on OCS and an analysis of the data mining exercise to collect data on fisheries with OCS bycatch for the analysis of the effectiveness of the CMM 13/06. The summary of which reads “CPCs shall prohibit, as an interim pilot measure, all fishing vessels….. to retain onboard, tranship, land or store any part or whole carcass of oceanic whitetip sharks….”(para. 3). This is in effect, a retention ban on oceanic whitetip sharks. However, as also stated in (para 3) "the provisions of this measure do not apply to artisanal fisheries operating exclusively in their respective Exclusive Economic Zone (EEZ) for the purpose of local consumption.".

8 Conclusions

Species occurrence indicators show that oceanic whitetip are caught throughout the majority of the Western Indian Ocean region and the western part of the Eastern Indian Ocean region. The same indicators show that hammerhead sharks are mainly caught in coastal eastern African waters as well as the equatorial high seas between India /Maldives and eastern Africa.

The proportion-presence indicators showed relatively highly variable trends for OCS and SPN sharks in both regions. Species composition indicators reveal that reports of oceanic whitetip bycatch have increased in 2015, though blue sharks are the most prevalent longline caught shark, and general unidentified shark is the second most common. Information on the magnitude and species composition of shark catch in purse seine fisheries is nearly non-existent. The CPUE indicators from the Australian longline fishery for OCS indicate a highly variable but slightly increasing trend in OCS catch rates prior to the 2013 ban on retention, since which the CPUE has been flat.

What little information is available and compiled in this report indicates that both oceanic whitetip and hammerhead sharks are caught throughout much of the IOTC region, though significant gaps in the temporal –spatial nature of the data exist. Further complicating the analysis for SPN sharks is the lack of identification to species. The SPZ likely comprises the majority of the catch reported in the industrial high seas fisheries, however the species composition of coastal and offshore fisheries is not well understood with regards to hammerhead sharks, misidentification is thought to be common especially in the warm temperate waters where the distributions of SPL and SPZ overlap. Collecting species level information for SPN should be a priority in the next revision of Resolution 15/01.

No apparent trend is evident in the CPUE series based on data reported as numbers or MT for SPN (Figures 18 and 19). Both trends show high inter-annual variability and multiple years without any catch and effort data reported.

Reported catch and effort for OCS similarly lacks data in multiple years and has low counts in others (Figure 20 & 21). Reports of OCS were most numerous in the years 2009-2013, during which the trend was mostly stable at low values. Few reports of OCS catch and effort occurred in 2014, the first year the retention ban was in force, however in 2015 numerous reports of OCS catch occurred. While the nominal CPUE series for OCS and SPN do not show clear trends they do show that catch of OCS is still ongoing and that the reporting of SPN in the Catch and effort data set is inconsistent across years.

The total reported catch trend that is available for OCS (Figure 25) is highly influenced by the increase and then decrease in the Sri Lankan catch rates over time. Gillnet and longline fisheries remain the predominant source of reported catch for OCS in the Indian Ocean. Reported catch of SPZ (Figure 26) also follows the same increase until 1998 and decrease afterword that is influenced by the expansion and contraction of the Sri Lankan shark fishery. In contrast to OCS, reported SPZ catches have increased greatly in the recent years with gillnet fisheries remaining the dominant source of reported catch. Similar to SPZ and OCS the catch of SPL (Figure 27) follows the increase and decrease that follows the expansion of the Sri Lankan shark fishery, and the catch is dominated by gillnet and longline fisheries. Catch of SPK is reported for only the years 2013-2015 and is dominated by longline and gillnet

combinations (Figure 28). The longline and gillnet fleets are responsible for the majority of the OCS and SPN catches, and should be the subject of focused research efforts and data collection.

Discussions held in this workshop suggested that lack of awareness was an issue and indicated that a number of CPCs are currently addressing this by incorporating a ban on the retention of oceanic whitetip sharks into national legislation (Sri Lanka 2015, Seychelles 2015, Pakistan 2016). This suggests that adoption of the CMM is progressing, however, it may currently be too early to be able to evaluate impacts of the retention ban. Moreover, information presented at this workshop indicated that some commerce in OCS meat and fins is likely to occur as significant regional trade occurs without documentation. In practice oceanic whitetips will continue to be vulnerable to a variety of fishing gears. The number that have been reported as retained nominal catch is likely due to a delay in the adoption and of national bans on retention.

Discussions regarding the ongoing retention at the recent workshop indicated that fishermen were often reluctant to discard dead OCS, as this was perceived as wasteful. Another factor that leads to the retention of OCS included the lack enforcement regarding fisheries regulations in countries where compliance with fisheries regulations was a minor problem compared to other national concerns (i.e. security).

The retention ban on oceanic whitetip sharks was implemented in 2013, as detailed in IOTC Resolution 13/06. The notable exceptions to this measure are artisanal fisheries operating exclusively within their respective Exclusive Economic Zone (EEZ) for the purpose of local consumption and India, who objected to the Resolution. Nevertheless, catches of oceanic whitetip sharks continue to be reported in the nominal catches for a number of fleets, including China, I.R. Iran, Maldives, Seychelles, Sri Lanka, Tanzania (and India) which have all reported catches of the species since 2014. There are a number of potential reasons for this such as (i) the reported catches are from artisanal fisheries operating in the coastal EEZs; (ii) incorrect reporting as nominal catch rather than discards and (iii) a lack of awareness of the Resolution among fishers (iv) non-compliance and enforcement issues. Given that spatial information from the catch and effort database indicates that not all of these catches are taken on the high seas, it is likely that these are not all artisanal catches.

During the CITES workshop discussion of data collection at local level the lack of resources was cited as the primary obstacle to data collection. Discussion of the responsibility at the local level revealed that the national fisheries authority is not necessarily in charge of issuing NDFs and trade can happen under the auspices other national agencies (e.g. trade and tourism). It was noted that improved data collection at the local level is fundamental to any coordinated approach to assessing shared stocks, and completing a regional NDF. Participants also noted that the mechanism of an NDF is difficult implement because sub-regional -local trade continues (e.g. Iran-Pakistan, Kenya-Somalia) undocumented. This difficulty is further compounded by the fact that if there is a ban on sharks in the legal market, sharks products move to the black market. Additionally participants noted that blanket bans on retention at the local level are impossible to enforce because sharks are still an important part of many fisheries. Participants noted that trade in shark products is happening but the CITES authority is not integrated

into the larger governance, hence the CITES authority is often not aware of the practice, able to monitor the species traded, or control the trade. In general port state measures could help document and control flow of shark products but there is little information regarding specific shark species. This difficulty is further compounded by the fact that there has been a move towards non-specific reporting in shark exports in some regions, i.e. shark fin is exported as dried fish. Further confounding the analysis of trade is the fact that the separation between the international and national markets is often non-distinct. For example shark products for sale or export from Kenya are may in fact originate in Somalian waters. This is especially true in coastal fisheries where fins are often sold immediately then the carcass is sold later after it dries. Participants at the workshop noted that trade in shark products should be monitored and controlled at the point of origination, but also could benefit from control and tractability on the import side.

Capacity development is a necessary component to the long term management of these, and other shark species. Regional development needs are numerous, one of the foremost would be development and/or improvement of regional observer data collection and reporting programs for all fleets/nations. Observer programs require (in a broad sense) well trained observers (in species ID as well as observing fishing methods), an observer debriefing process, data transmission/reporting capabilities, data processing, data storage and extraction capabilities. Sufficient observer coverage, or data collection, in space and time to characterize each fishery should be the goal of any observer program. In practice this takes funding and management frameworks that stipulate the need for observers. Capacity building in the form of developing a framework for observer data collection would be an important step to accomplish early on because regional observer programs can serve as a platform to develop coordinated regional research projects on sharks such as catch composition, CPUE, and distribution. Capacity development for national (fisheries) scientists is a key step to leveraging any data collection efforts. Improved data collection and analysis would advance the ability of CITES parties to complete an NDF and contribute to regional analyses. Especially for smaller nations with limited capacity to deal with CITES issues, the ability to produce NDFs is limited by availability of data, as well as incomplete monitoring and enforcement.

In general there is limited data on the catch, retention and mortality of OCS and SPN in the Indian Ocean. Data on these sharks in the region are limited by the lack of full compliance with the IOTC data reporting measures on reporting sharks to species at the regional (Indian Ocean) level. Lack of observer programs and reporting mechanisms for sub-regional trade further compound the difficulty of assessing catch rates and trends. Artisanal fisheries (within the EEZ and for domestic consumption) are exempt from the CMM 13/06 (retention ban on OCS), yet likely interact with the same stock as the pelagic fisheries. Understanding the degree to which these fisheries interact with OCS and SPN is complicated by the same data deficiencies as the industrial fisheries, especially lack of identification of many retained sharks to species level.

9 Research Recommendations

Recommendations to the WPEB This indicator analysis provides informative insights into the interactions between fisheries and OCS but is somewhat limited in the amount of inference possible for SPN largely due to lack of species specific data. The scalloped and great hammerhead shark species are not commonly caught in the offshore pelagic fisheries in the IOTC and are historically not well reported in the inshore fisheries. Increased observer monitoring is vital to understanding the stock status of these shark species. Specific research recommendations include:

- Research to assess the stock structure for oceanic whitetip and hammerhead species in the Indian Ocean.
- Research linking reporting in logbooks and observer data so that data from one fleet can be used to support inference from another.
- Comparative studies of logbook vs. observer data (reported catch rates may differ due e.g. due to discard at sea, use as bait for longlines, etc.) to identify and adjust for under reporting discarding or non species specific recording within the same fleet.
- Research into the calculation of un-documented, and historical catch re-construction, by individual CPC and potentially by gear.
- Research into the initial depletion levels for shark stocks should be undertaken. This would include developing catch histories for these species.
- Assessing overall mortality rates is an important component of assessing the stocks. Currently there is no informative data on post-release mortality rates of oceanic whitetip and hammerhead sharks. Specifically because oceanic whitetips have non-retention management measures post-release survival rates are essential for monitoring the effectiveness of these measures. This information would help bridge data gaps for the provision of science-based advice for the management of oceanic whitetip shark.
- Examine the potential impact of shark related CMMs on data quality.
- Coastal fisheries catch of OCS and hammerhead listed sharks are not well understood and it would be beneficial to do a short study to determine the levels of effort and catch before developing long term data collection.
- Efforts to improve the quality and amount of information regarding trade in shark products should be a focus. This should be done by both importing and exporting nations and could help inform research on catch rates and cross check information reported effort and landings.
- Capacity building to monitor and enforce retention ban and trade regulations is needed in many regions.

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11 Tables

Table 1: Commonly caught shark species in the IOTC area. Species included in the analysis are in bold.

Name	Retention Ban	Code	Scientific name	CITES Appendix II
Blue shark		BSH	*Prionace glauca*	Not Listed
Oceanic whitetip shark	**Y**	**OCS**	***Carcharhinus longimanus***	14-Sep-14
Scalloped hammerhead shark		**SPL**	***Sphyrna lewini***	14-Sep-14
Shortfin mako shark		SMA	*Isurus oxyrinchus*	Not Listed
Silky shark		FAL	*Carcharhinus falciformis*	4-Oct-17
Bigeye thresher shark	Y	ALS	*Alopias superciliosus*	4-Oct-17
Pelagic thresher shark	Y	ALP	*Alopias pelagicus*	4-Oct-17
Smooth hammerhead shark		**SPZ**	***Sphyrna zygaena***	14-Sep-14
Great hammerhead shark		**SPK**	***Sphyrna mokarran***	14-Sep-14

12 Figures

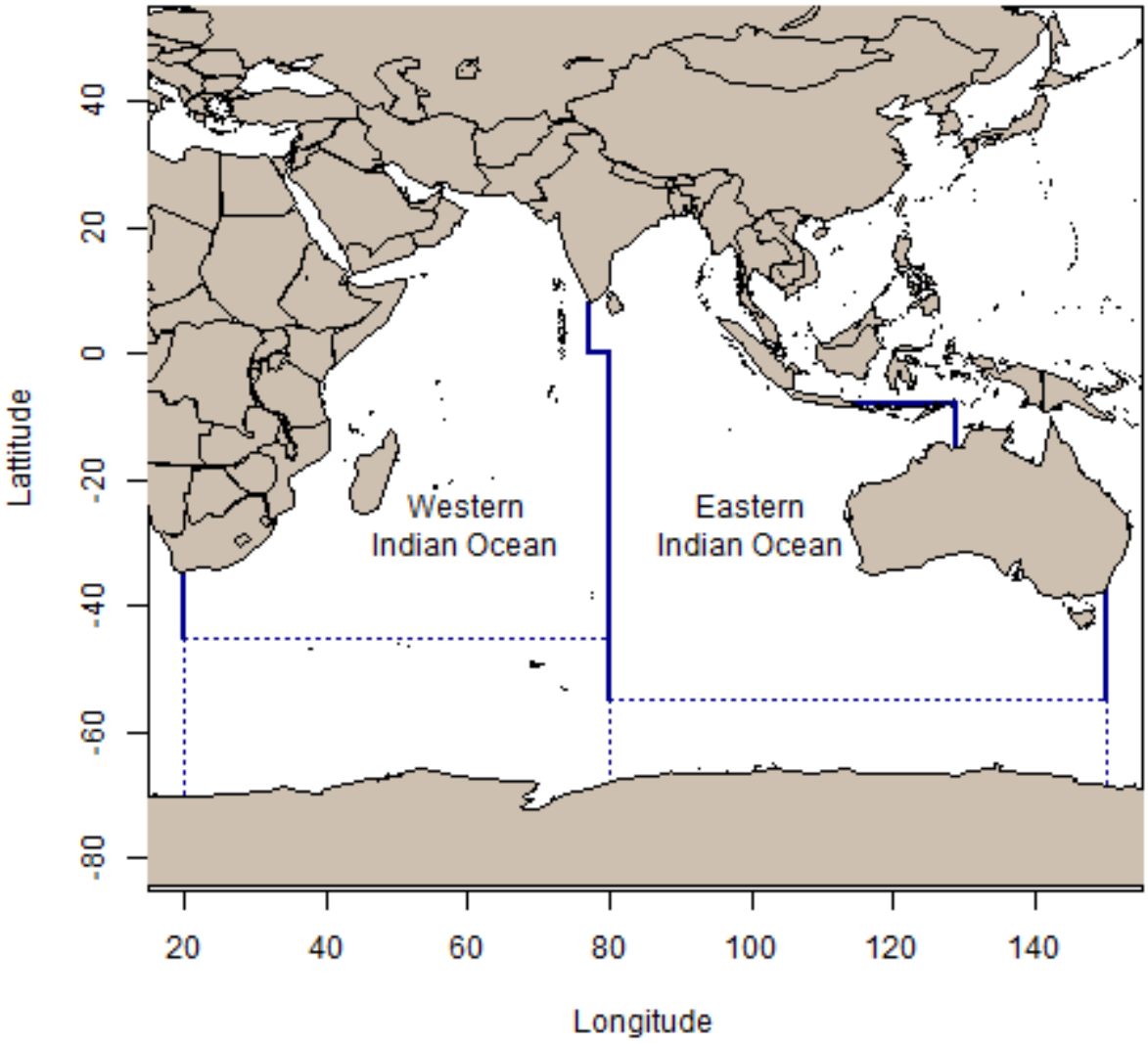

Figure 1. Map of the IOTC area and regions used for the analysis. The IOTC area of competence is outlined as "The area of competence of the Commission (hereinafter referred to as the "Area") shall be the Indian Ocean ….and adjacent seas, north of the Antarctic Convergence, insofar as it is necessary to cover such seas for the purpose of conserving and managing stocks that migrate into or out of the Indian Ocean."

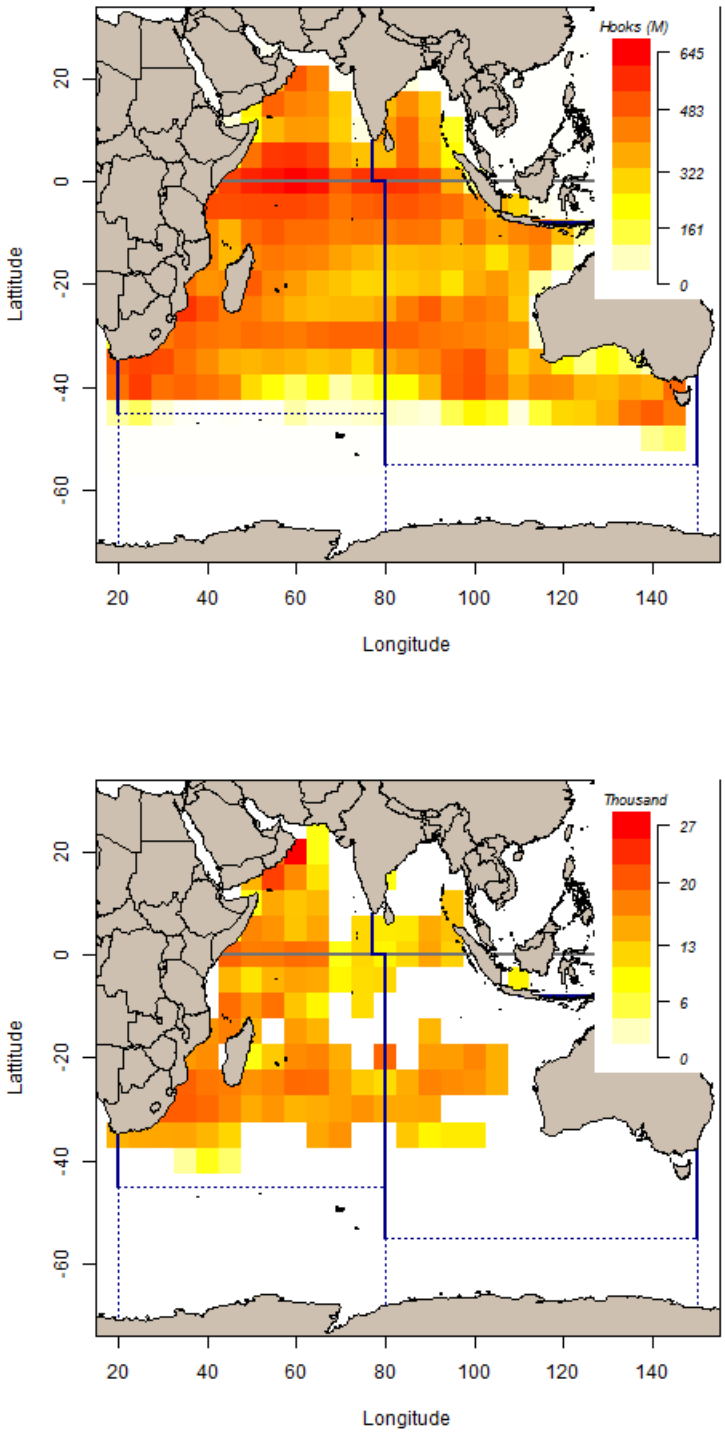

Figure 2. Total reported effort in the longline fisheries of the Indian Ocean, from 1990 - 2015. The top panel is data reported in millions of hooks, the bottom shows data reported in days (thousands).

These plots are mutually exclusive in terms of total effort however some fleets reported days in early time periods and later reported effort in number of hooks.

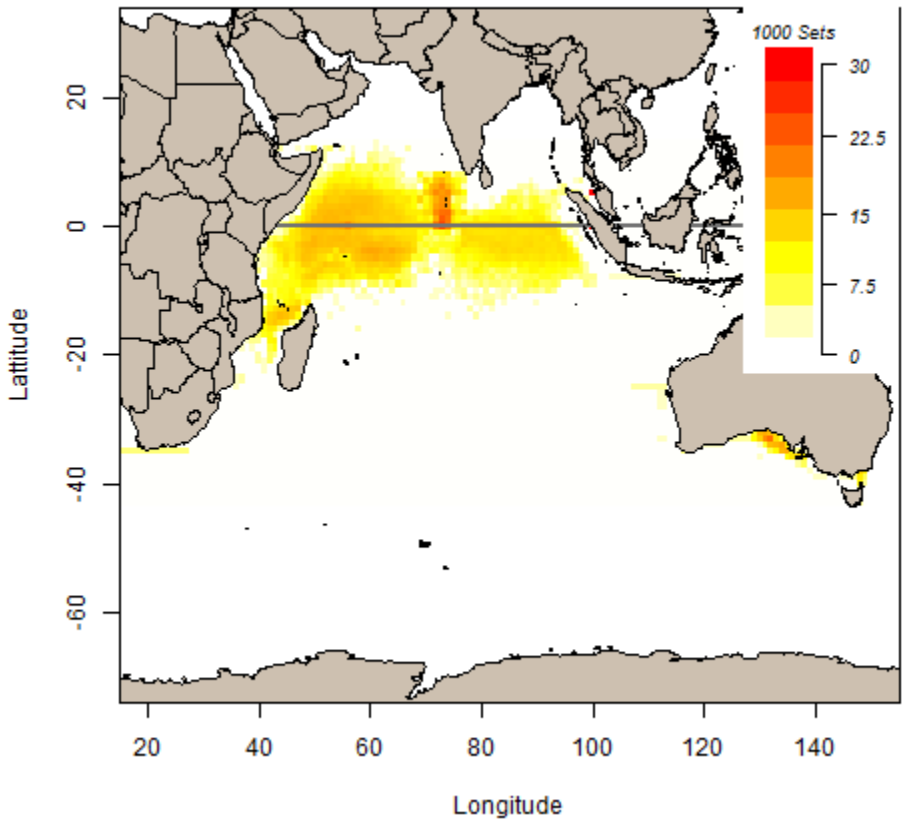

Figure 3. Reported sets by the Purse Seine fisheries of the Indian Ocean. All fleets, 1981-2015 Darker colours indicate more sets.

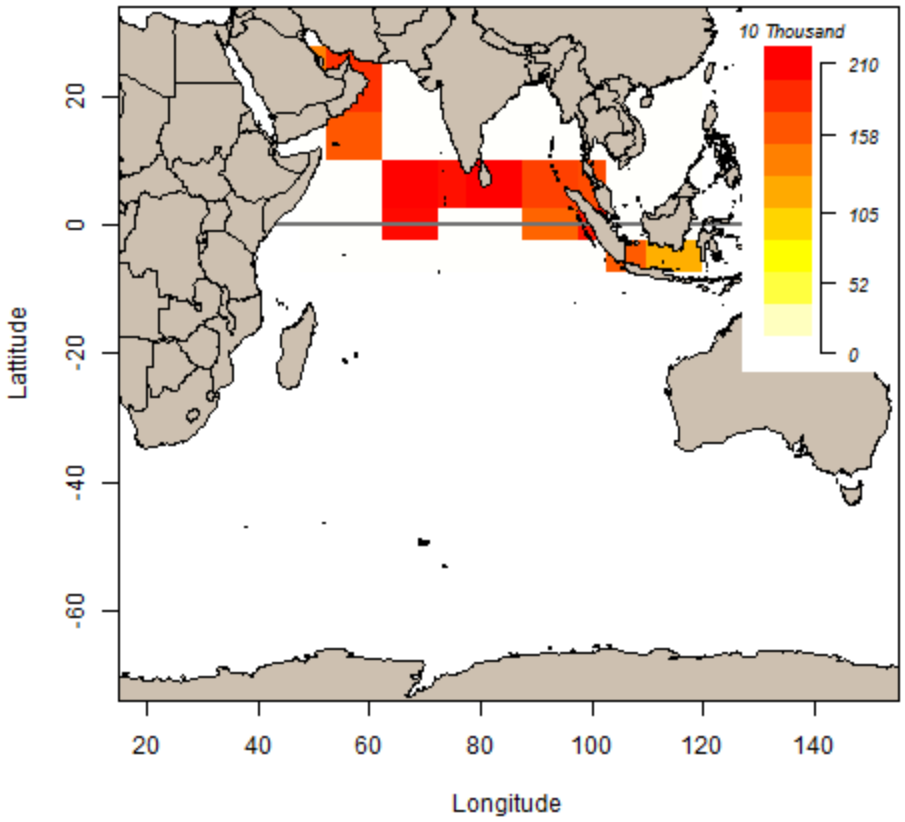

Figure 4. Reported effort as trips from coastal fisheries. (red, yellow, and orange squares), and reported by all nations, from 1990 - 2015.

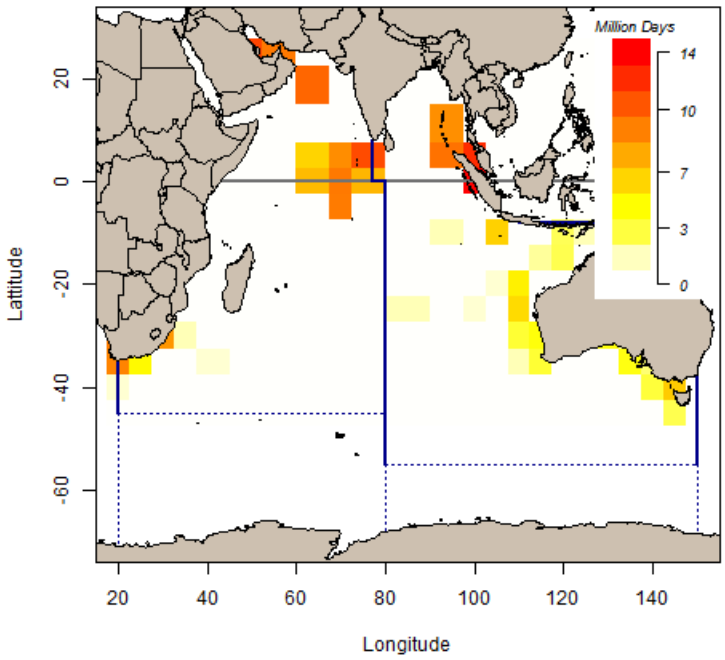

Figure 5. Reported days in the coastal fishery. All fleets, 1979-2015.

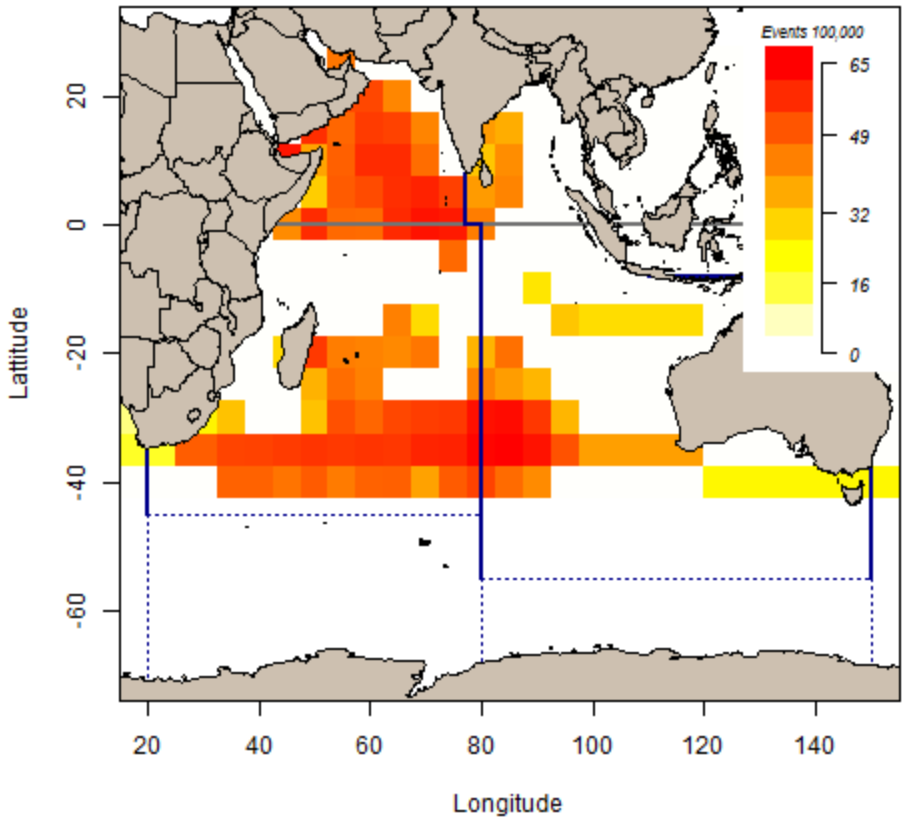

Figure 6. Reported fishing events (not reported as days or trips, commonly reported as boats), all fleets 1988-2015.

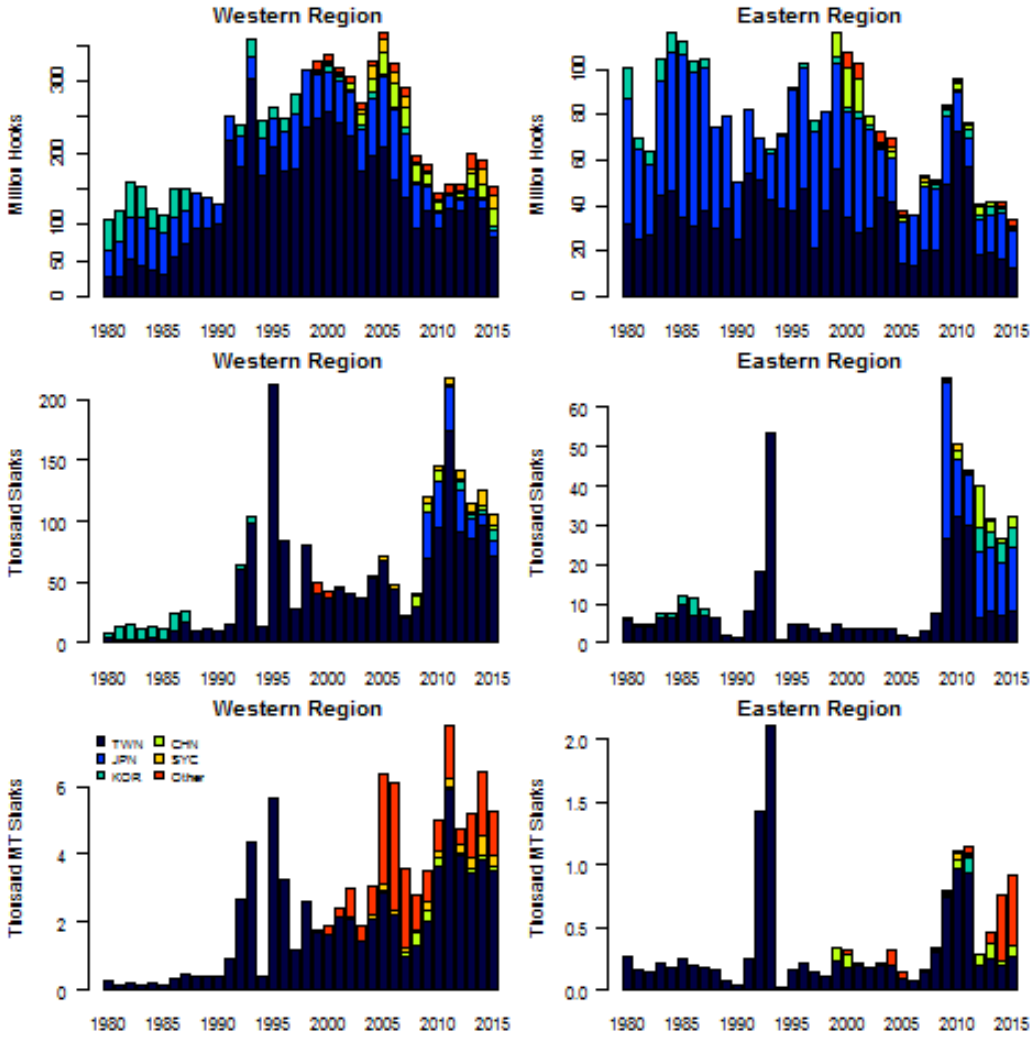

Figure 7. Reported annual effort in millions of hooks (top panels) and reported total shark catch in numbers (middle panels), and reported total shark catch in MT (bottom panels), for the longline fleet.

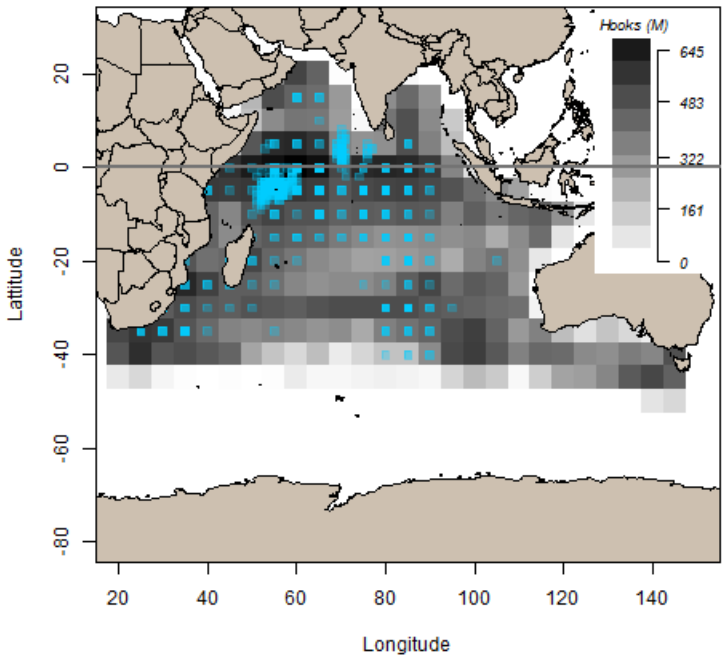

Figure 8. Reported occurrence of OCS in the longline fishery. Grey squares indicate reported effort and blue squares indicate reported OCS catch. Data is from all fleets covering the years 1952-2015

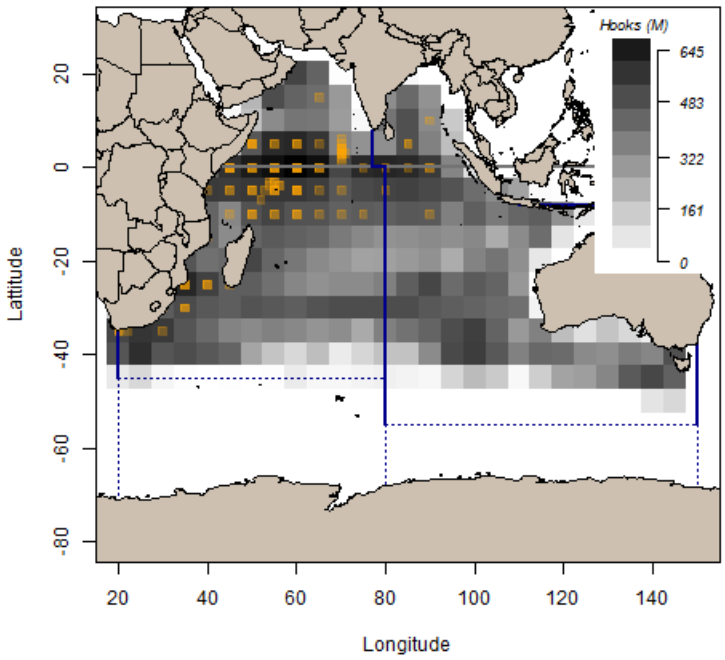

Figure 9. Reported occurrence for hammerhead sharks in the longline fishery. Grey squares indicate reported effort and orange squares indicate reported SPN catch. Data is from all fleets covering the years 1952-2015.

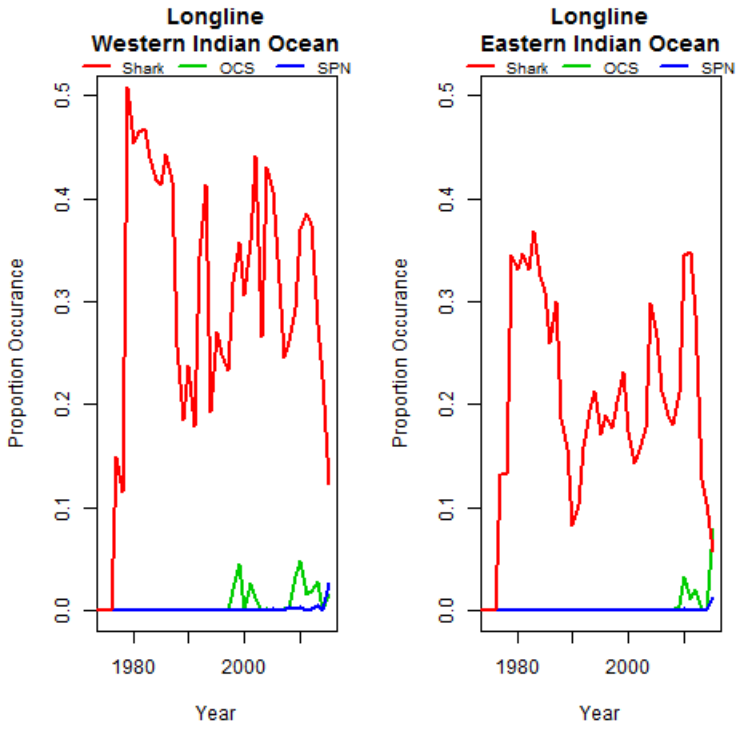

Figure 10. Reported proportion present. This indicator provides a rough indicator of the frequency of occurrence of each species in each region and trends in presence over time. Red lines indicate reports of unidentified shark while green and blue indicate OCS and SPN respectively.

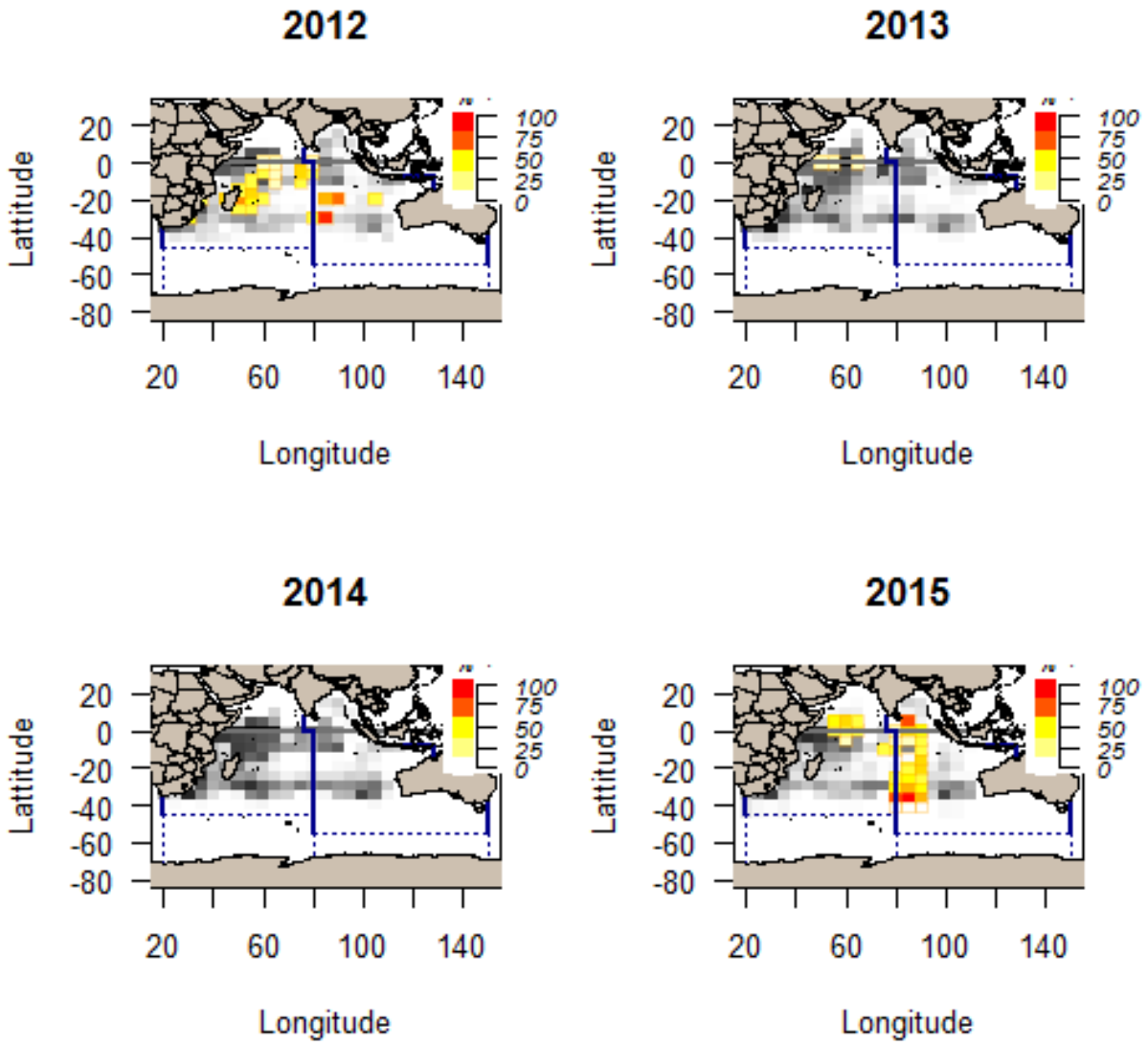

Figure 11. Catch hot spot for OCS reported caught in the longline fishery the years 2012-2015. This indicator is an extension of the species-occurrence and proportion presence indicators, and is intended to illustrate the possible presence of variable species catch hotspots. All reported data are totaled within 1x1degre cells over four separate years. The proportion of observed sets containing at least one species occurrence within that cell/year cell is then computed and mapped. Grey shading indicates effort with darker shading indicating a higher level of effort.

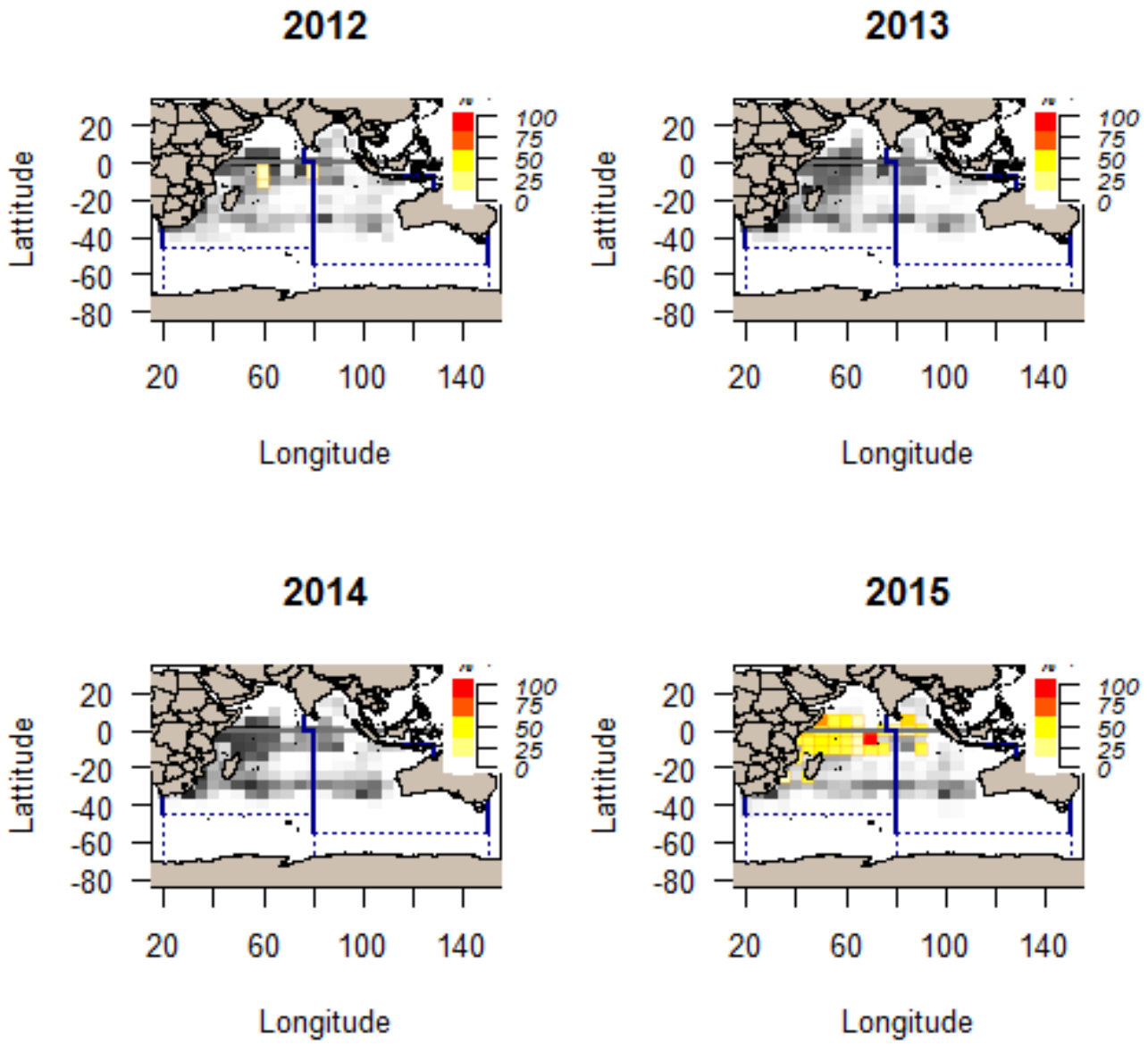

Figure 12. Catch hot spot for SPN reported caught in the longline fishery (all fleets) for the years 2012-2015. This indicator is an extension of the species-occurrence and proportion presence indicators, and is intended to illustrate the possible presence of variable species catch hotspots. All reported data are totaled within 1x1degre cells over four separate years. The proportion of observed sets containing at least one species occurrence within that cell/year cell is then computed and mapped.

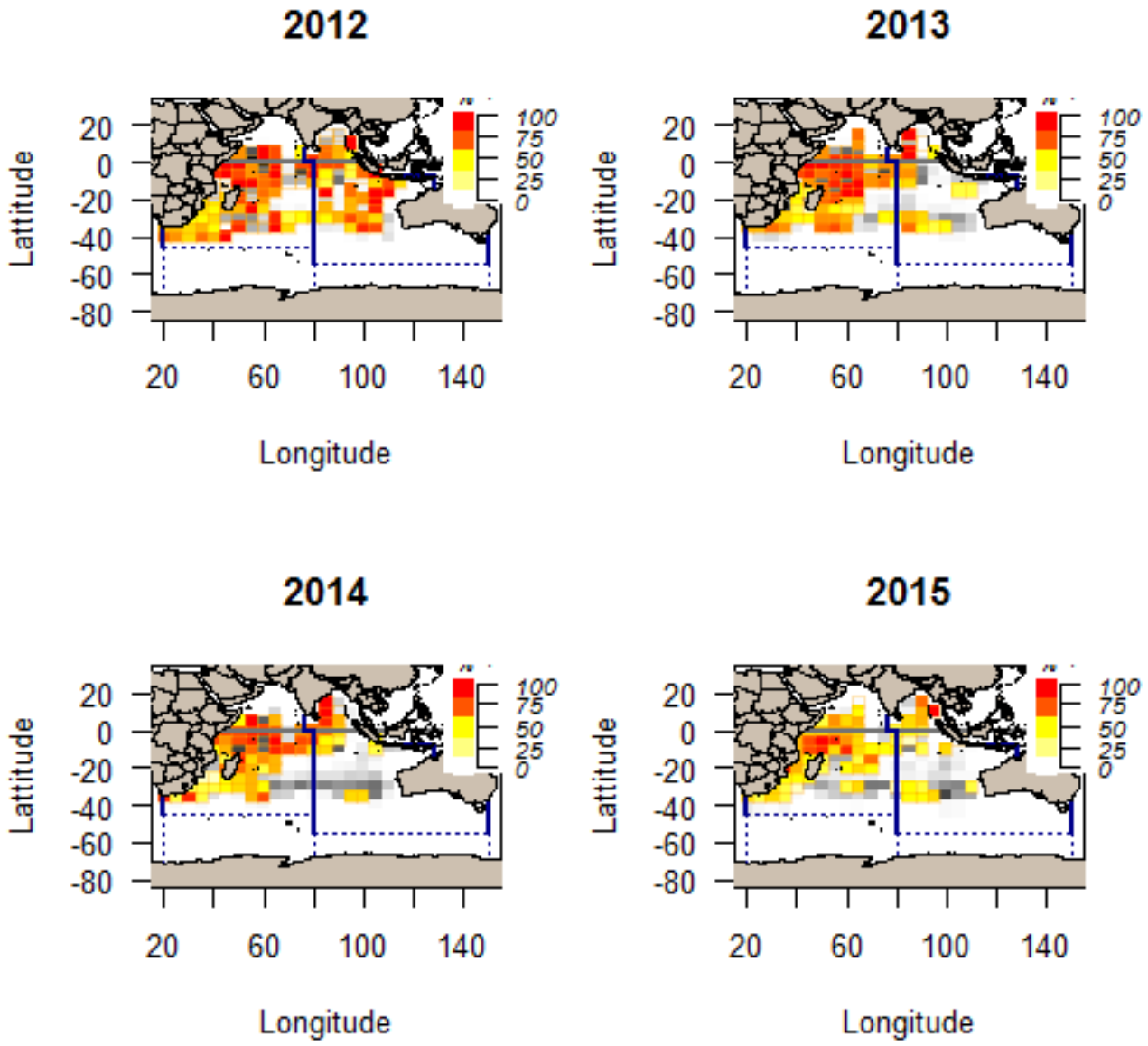

Figure 13. Catch hot spot for sharks (general) reported caught in the longline fishery (all fleets) for the years 2012-2015. This indicator is an extension of the species-occurrence and proportion presence indicators, and is intended to illustrate the possible presence of variable species catch hotspots. All reported data are totaled within 1x1degre cells over four separate years. The proportion of observed sets containing at least one species occurrence within that cell/year cell is then computed and mapped

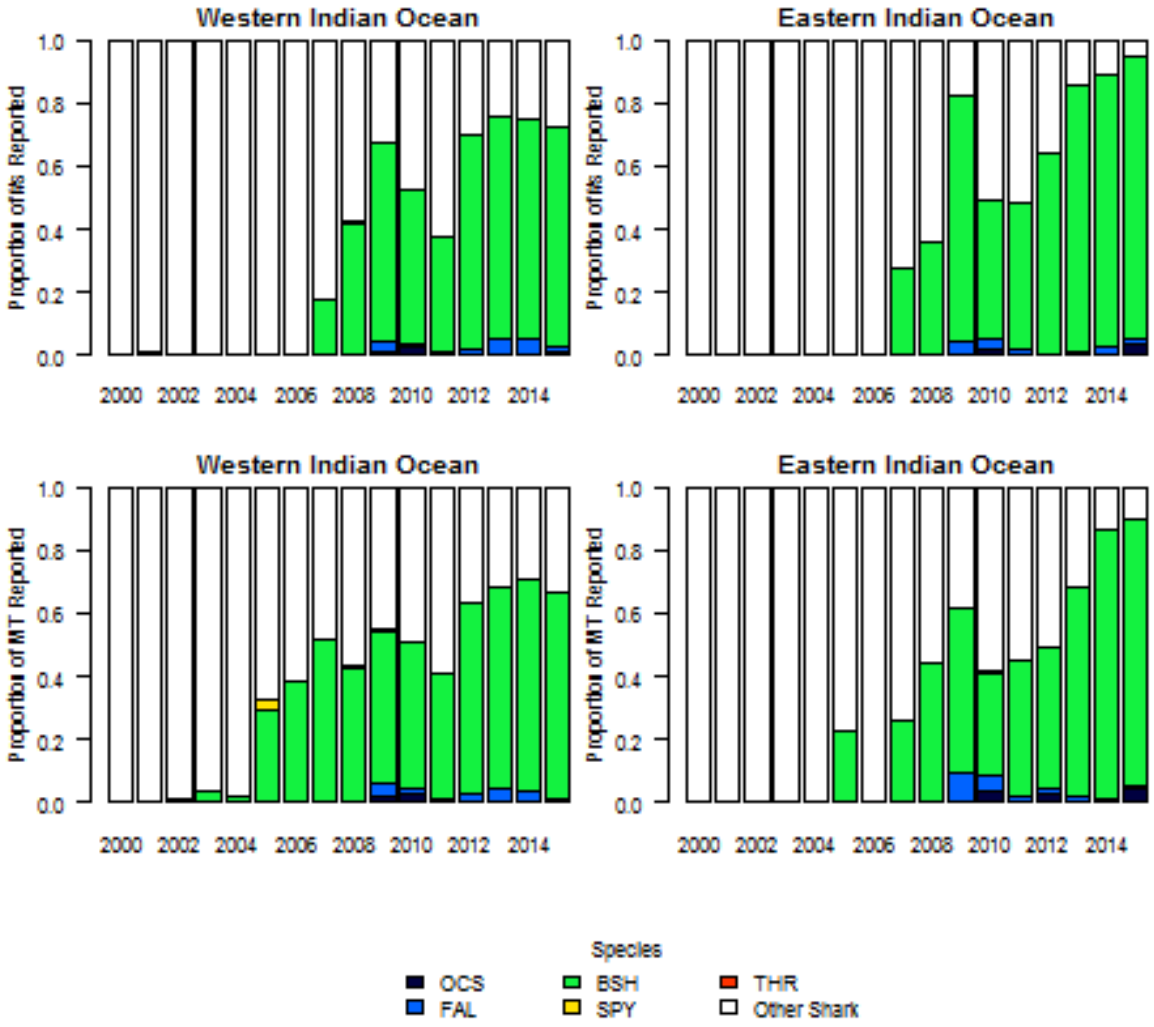

Figure 14. Reported catch composition for the longline fleet from 2000-2015. The top row shows the catch composition of reported sharks in numbers, the bottom row shows catch composition reported in MT. Reports of weights and numbers do not necessarily correspond to the same catch events, i.e. the top and bottom rows are not mutually exclusive and not overlapping either.

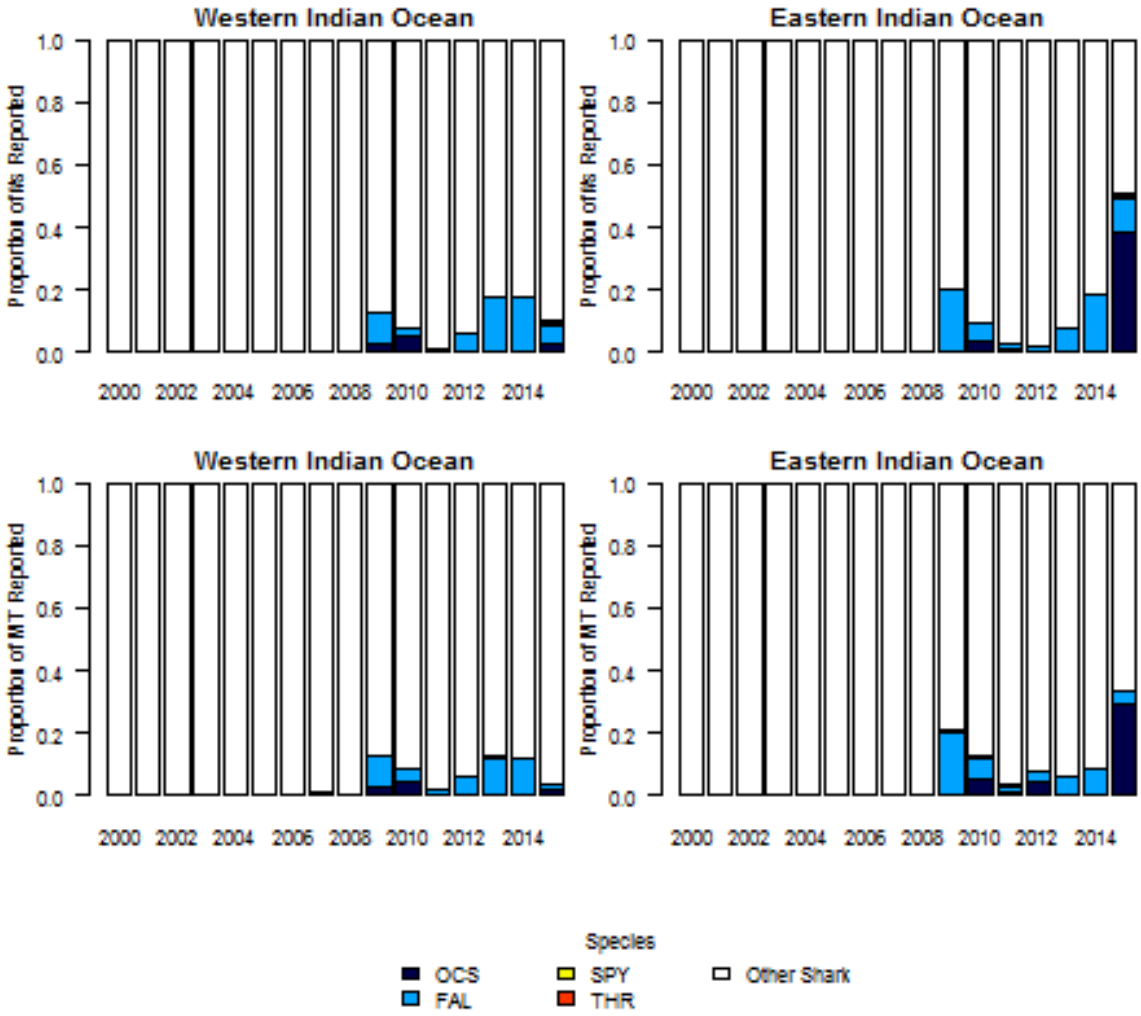

Figure 15. Reported Catch Composition for the longline fleet from 2000-2015, without blue shark. The top row shows the catch composition of reported sharks in numbers, the bottom row shows catch composition reported in MT.

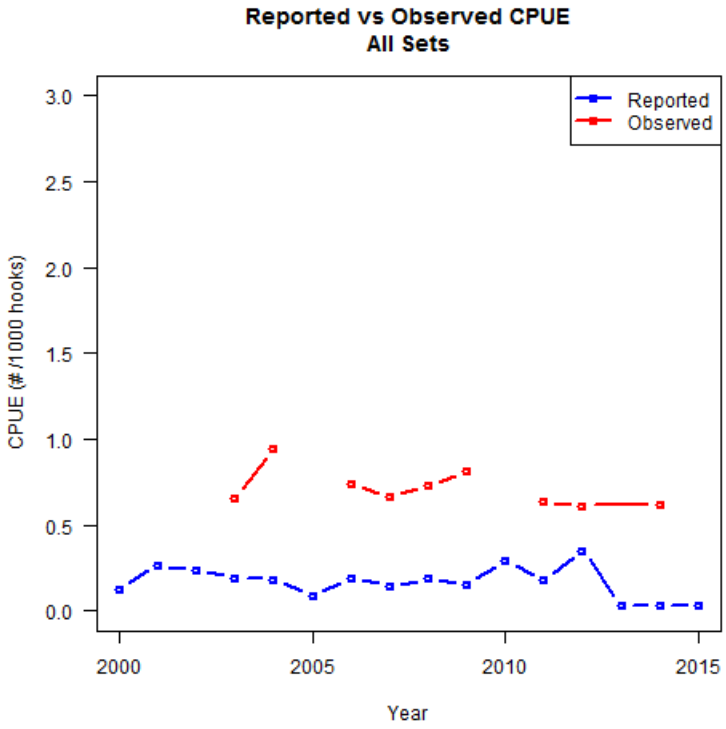

Figure 16. Nominal OCS CPUE based on Australian logbook (blue lines), and observer data (red lines).

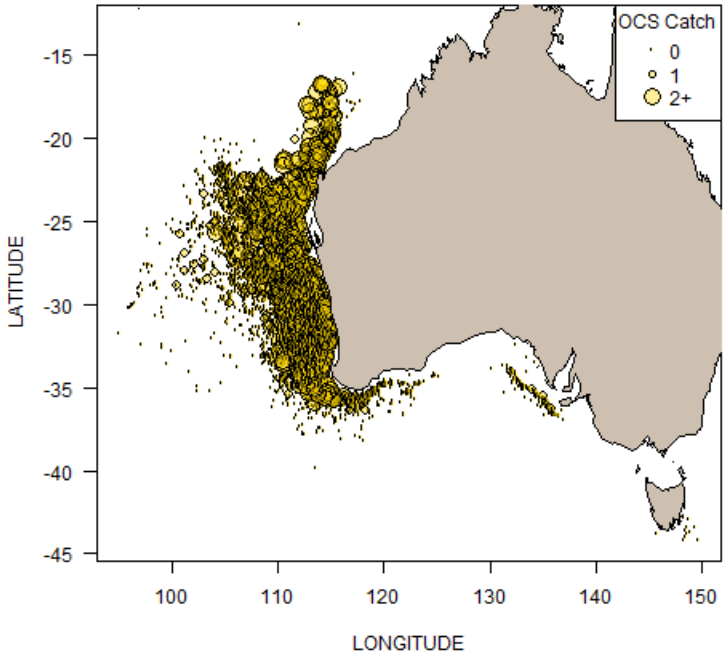

Figure 17. Catch of oceanic whitetip CPUE from Australian logbook data.

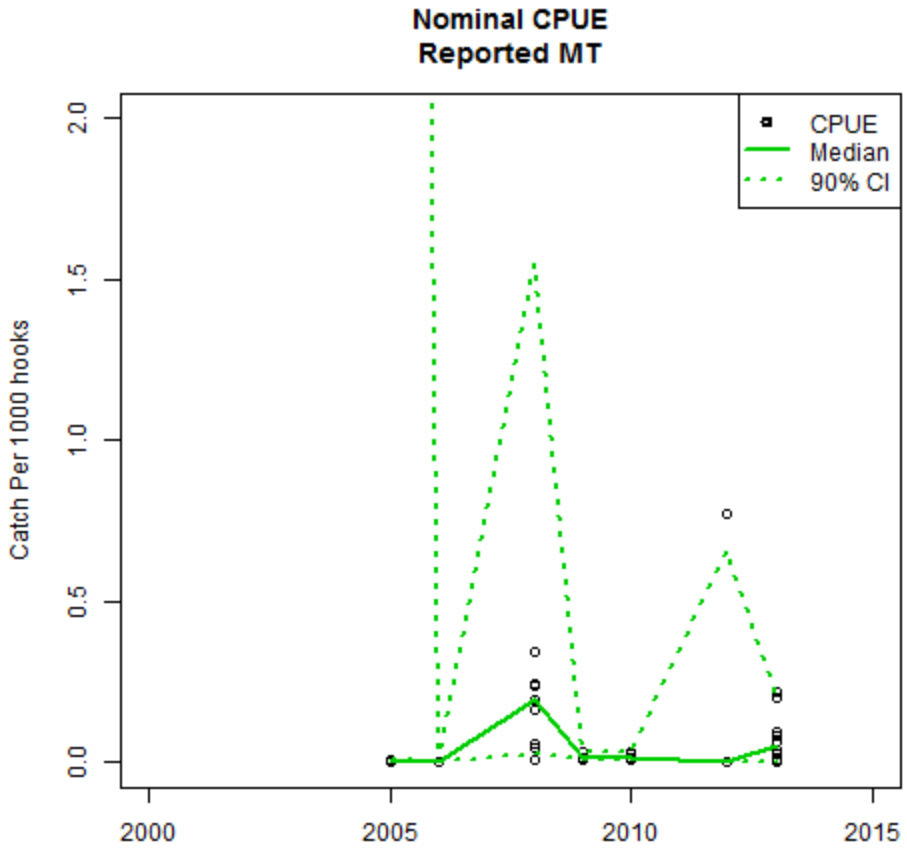

Figure 18. Reported CPUE, in MT for SPN from the nominal catch and effort data (from the IOTC database) for the longline fishery. Black circles indicate reported annual CPUE, solid line indicates the median of the annual values and the dashed lines represent the area between the 5th and 95th quantiles.

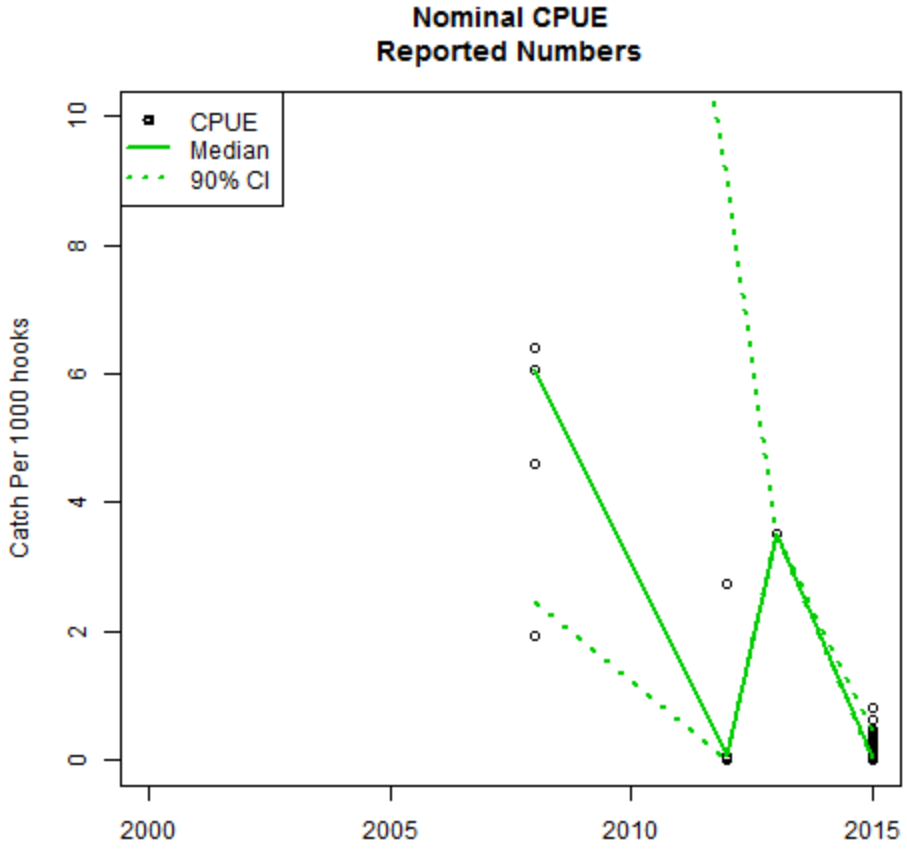

Figure 19 Reported CPUE, in numbers for SPN from the nominal catch and effort data (from the IOTC database) for the longline fishery. Black circles indicate reported annual CPUE, solid line indicates the median of the annual values and the dashed lines represent the area between the 5th and 95th quantiles.

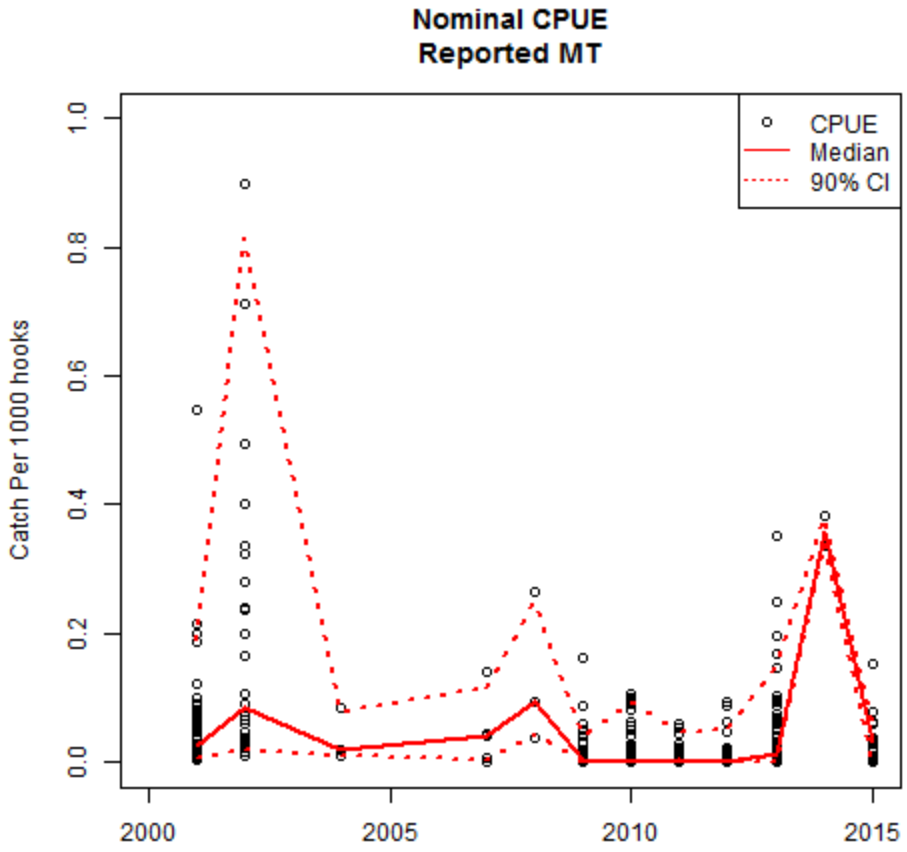

Figure 20. Reported CPUE, in MT for OCS from the nominal catch and effort data (from the IOTC database) for the longline fishery.. Black circles indicate reported annual CPUE, solid line indicates the median of the annual values and the dashed lines represent the area between the 5th and 95th quantiles.

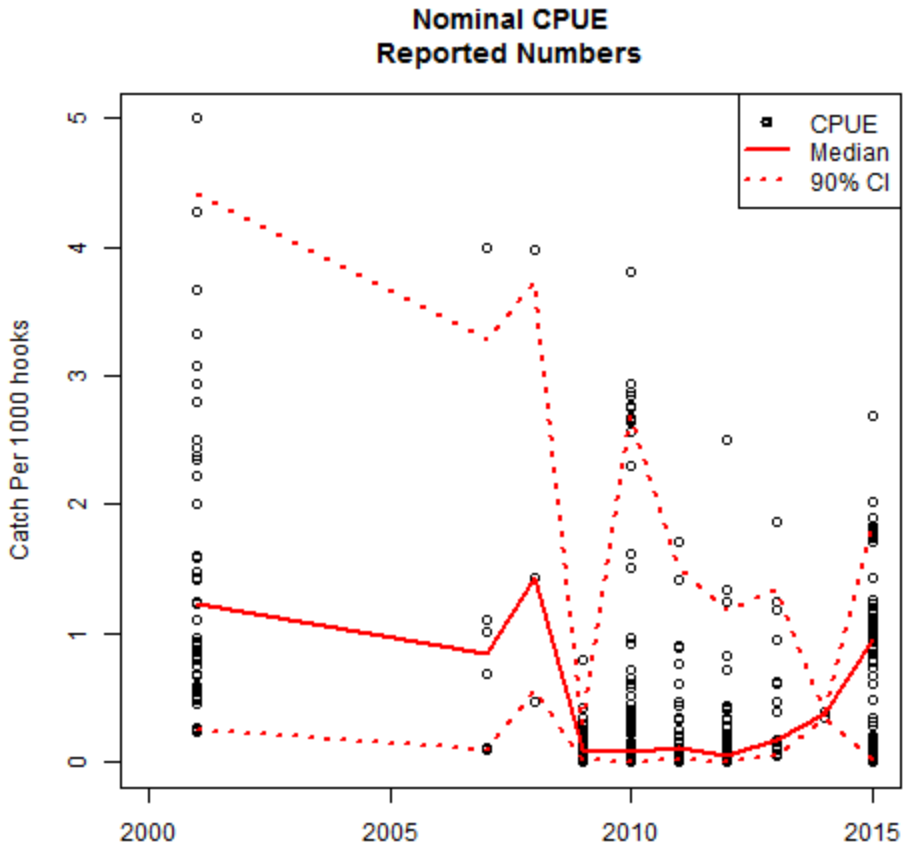

Figure 21. Reported CPUE, in numbers for OCS from the nominal catch and effort data (from the IOTC database) for the longline fishery. Black circles indicate reported annual CPUE, solid line indicates the median of the annual values and the dashed lines represent the area between the 5th and 95th quantiles.

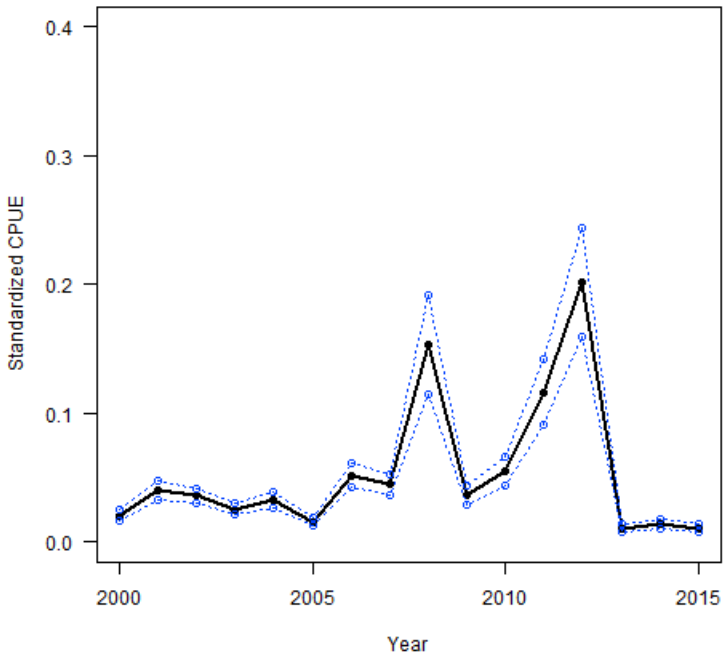

Figure 22. Standardized oceanic whitetip CPUE from Australian logbook data, blue lines indicate a 95% confidence interval, black line is the estimate.

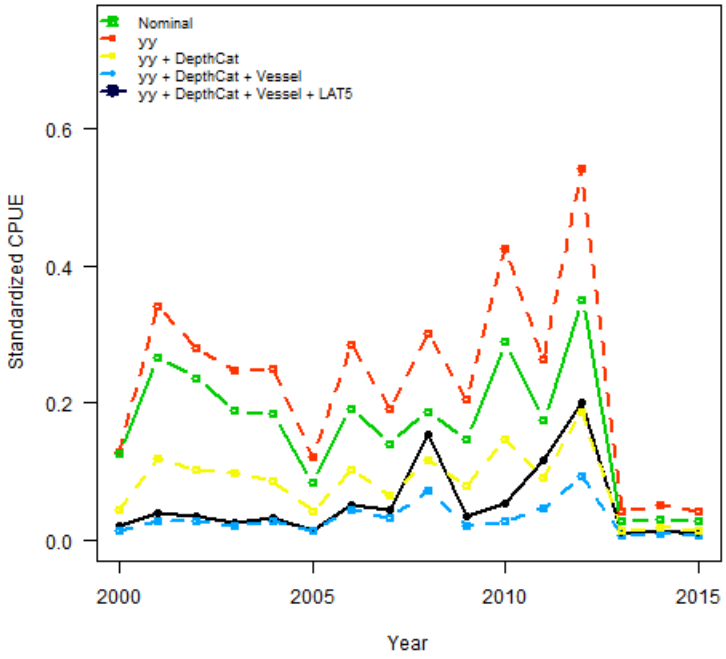

Figure 23. Step plot showing the nominal CPUE (green line) and each candidate model for the OCS standardization based on the Australian longline logbook data the final model is the black line.

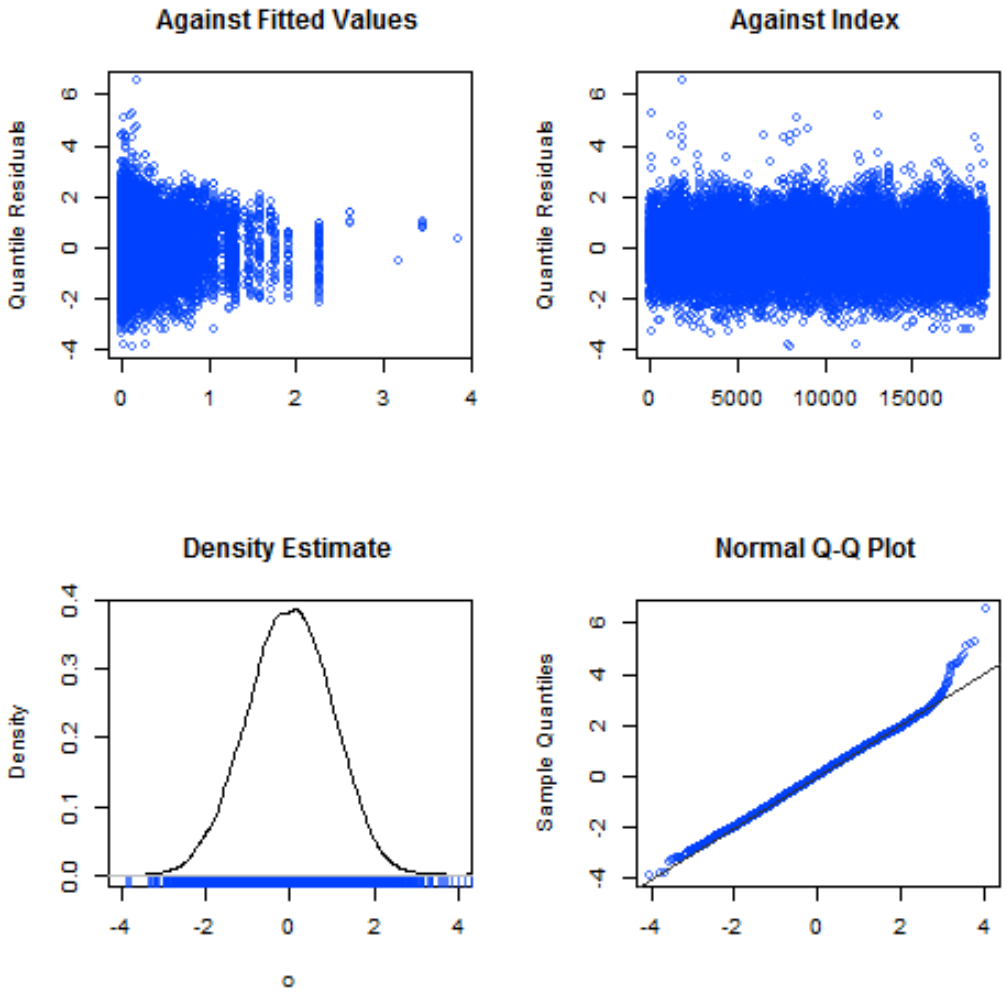

Figure 24. Model diagnostics for the final oceanic whitetip CPUE standardization via the negative binomial models.

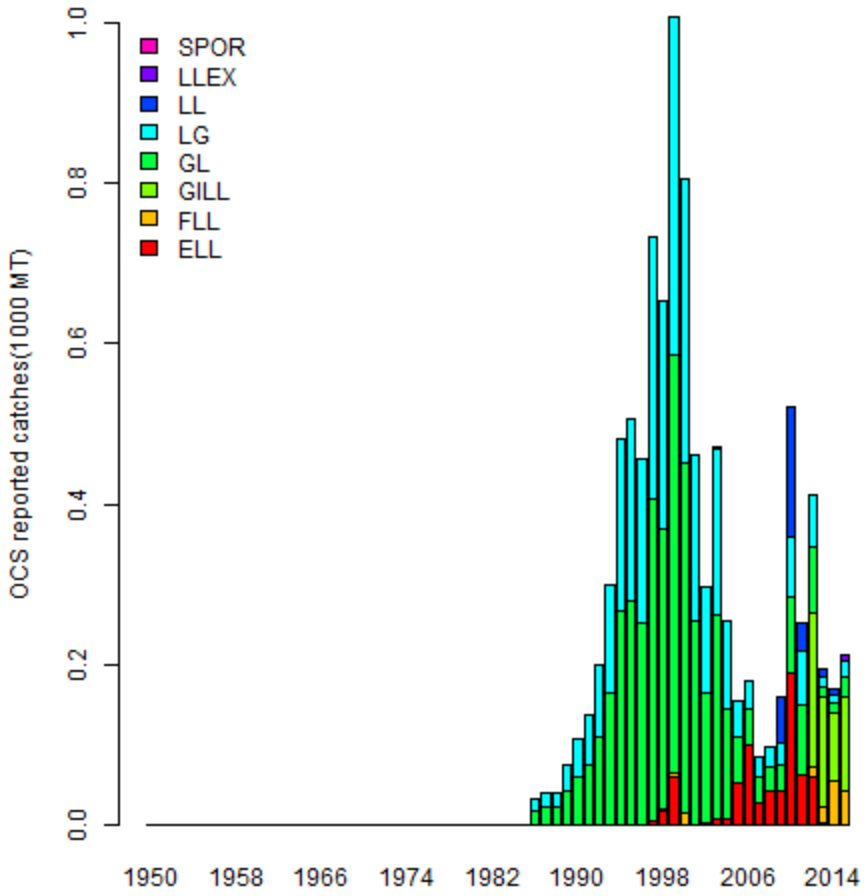

Figure 25. Reported OCS catch by gear. Abbreviations in the legend refer to different gear types; SPOR is sport fish trolling, LLEX is Exploratory longline; LL is longline, LG is longline(predominant) with gillnet attached, GL is gillnet (predominant gear) with a longline attached, GILL is gillnet, FLL is longline Fresh, ELL is longline targeting swordfish.

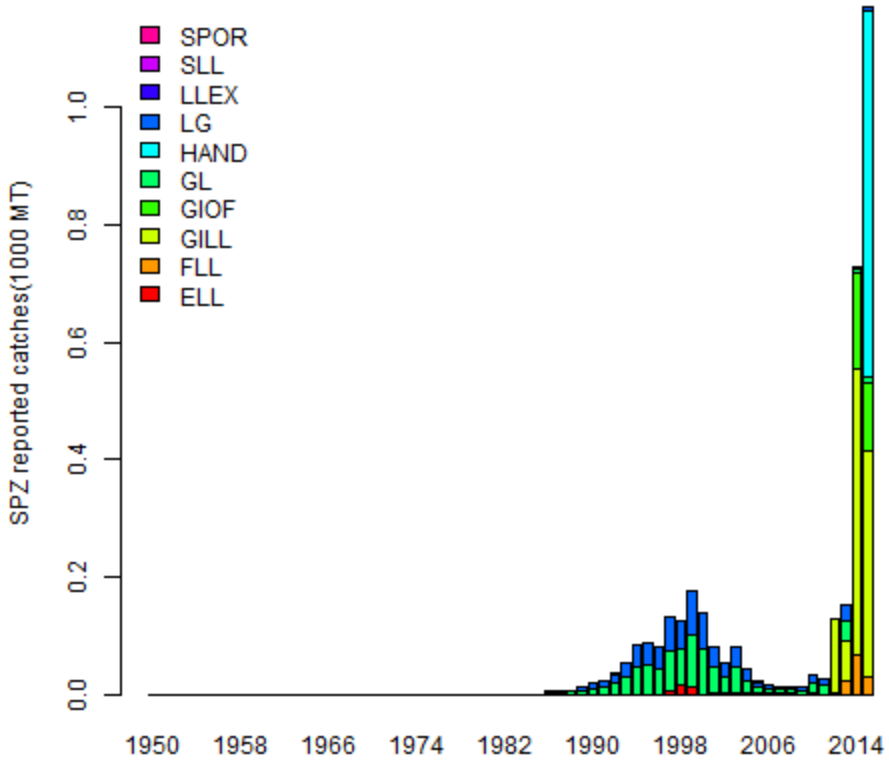

Figure 26. Reported SPZ catch by gear. Abbreviations in the legend refer to different gear types; SPOR is sport fish trolling, SLL is shark longline, HAND is handline, GIOF is offshore gillnet, LLEX is Exploratory longline; LL is longline, LG is longline(predominant) with gillnet attached, GL is gillnet (predominant gear) with a longline attached, GILL is gillnet, FLL is longline Fresh, ELL is longline targeting swordfish.

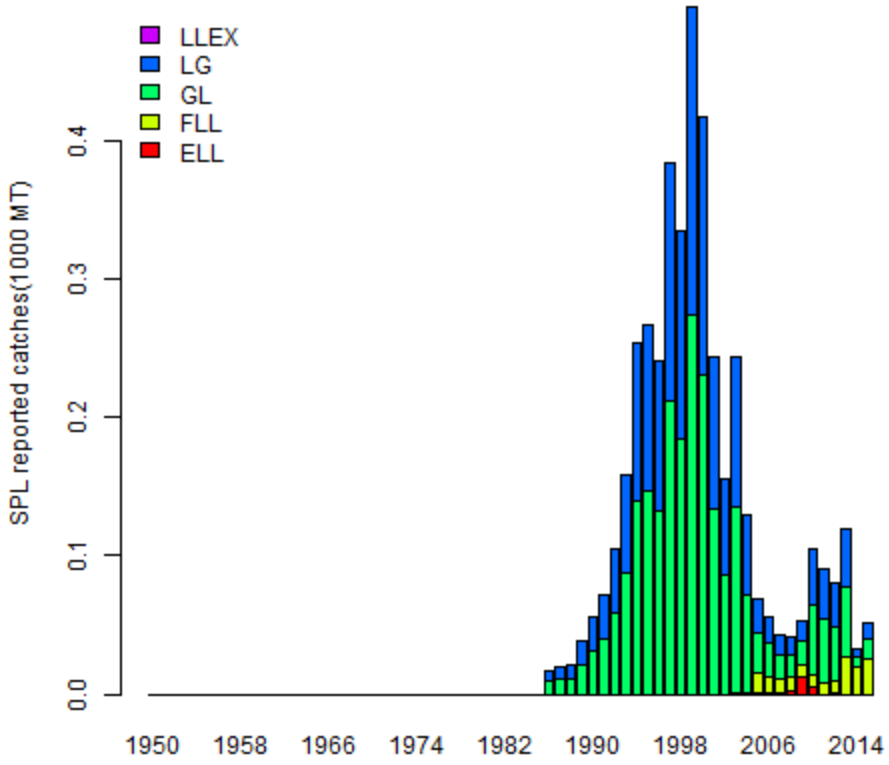

FIGURE 27. Reported SPL catch by gear. Abbreviations in the legend refer to different gear types, LLEX is Exploratory longline; LG is longline(predominant) with gillnet attached, GL is gillnet (predominant gear) with a longline attached, FLL is longline Fresh, ELL is longline targeting swordfish.

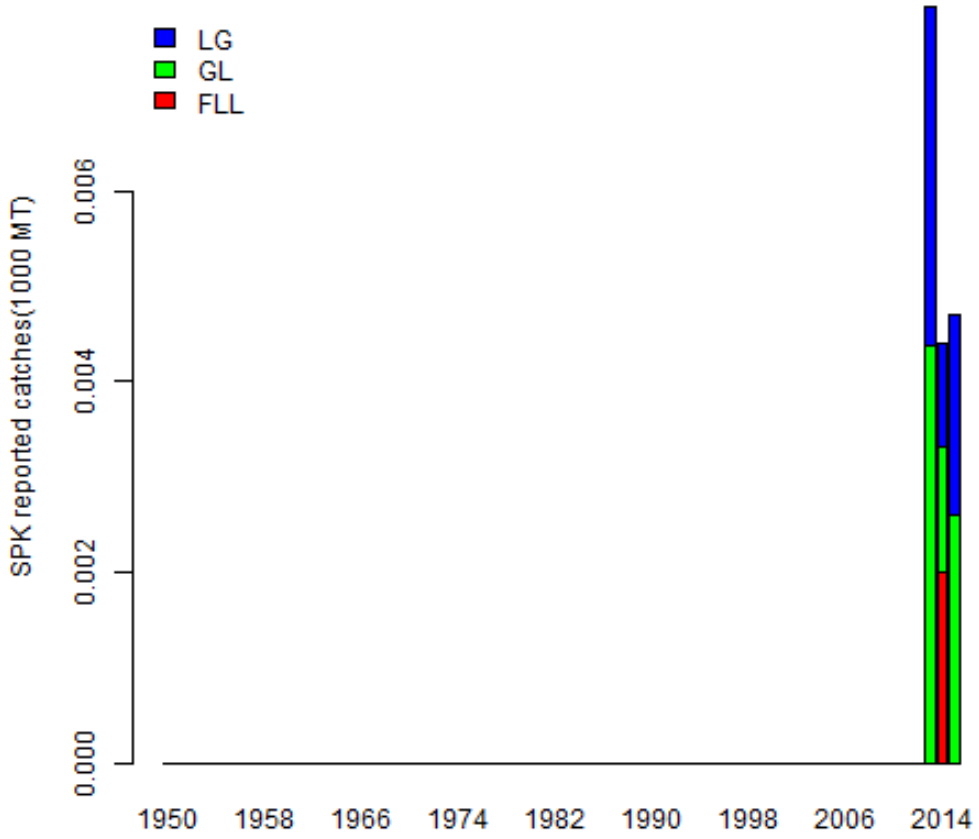

FIGURE 28 Reported SPK catch by gear, Abbreviations in the legend refer to different gear types, LG is longline(predominant) with gillnet attached, GL is gillnet (predominant gear) with a longline attached, FLL is longline Fresh.

13 Annex A IOTC CIRCULAR 2016-076

IOTC CIRCULAR 2016-076 / CIRCULAIRE CTOI 2016-076

Dear Sir/Madam,

SUBJECT: DATA MINING AND REVIEW WORKSHOP FOR CITES LISTED SPECIES IN THE IOTC AREA OF COMPETENCE

On behalf of the Chairperson of the IOTC Working Party on Ecosystems and Bycatch (Dr Rui Coelho) and Vice-Chairpersons (Dr Reza Shahifar and Dr Ross Wanless), please find attached a '*Call for data submissions on CITES listed species*' relevant to an upcoming workshop on CITES listed species in the IOTC area of competence.

Please communicate this request to your data managers, scientists and other relevant parties at your earliest convenience.

Madame/Monsieur,

OBJET: ATELIER D'EXPLORATION ET D'EXAMEN DES DONNÉES SUR LES ESPÈCES INSCRITES À LA CITES DANS LA ZONE DE COMPETENCE DE LA CTOI

Au nom du président du Groupe de travail sur les écosystèmes et les prises accessoires (Dr Rui Coelho) et de ses vice-présidents (Dr Reza Shahifar et Dr Ross Wanless), veuillez trouver ci-joint un «*Appel à soumission de données sur les espèces inscrites à la CITES*» concernant le prochain atelier sur les espèces inscrites à la CITES dans la zone de compétence de la CTOI.

Merci de communiquer cette demande à vos gestionnaires des données, à vos scientifiques et autres parties concernées dès que possible.

Yours sincerely / Cordialement

Mr Alejandro Anganuzzi
Executive Secretary (a. i.)/ Secrétaire exécutif (a. i.)

Attachments / Pièces jointes:

- Call for data submission on CITES listed species / Appel à soumission de données sur les espèces inscrites à la CITES

DATA MINING AND REVIEW WORKSHOP: CITES LISTED SPECIES IN THE IOTC AREA OF COMPETENCE

Call for data submission on CITES listed species:

The purpose of the IOTC's Working Party on Ecosystems and Bycatch (WPEB) is to review and analyse matters relevant to bycatch, byproduct and non-target species which are affected by IOTC fisheries for tuna and tuna-like species (i.e. sharks, marine turtles, seabirds, marine mammals and other fishes), as well as the ecosystems in which they operate; and to develop mechanisms which can be used to better integrate ecosystem considerations into the scientific advice provided by the Scientific Committee to the Commission. Its focus species include the CITES-listed species oceanic whitetip shark (*Carcharhinus longimanus*) and Scalloped Hammerhead Shark (*Sphyrna lewini*).

A project has been developed, in collaboration with CITES, to improve the status of information for populations of oceanic whitetip shark and CITES-listed hammerhead sharks, namely *Sphyrna lewini, S. mokarran and S. zygaena* in the IOTC area. Historical data will be compiled and a workshop will be held to provide a forum for reviewing fisheries data and biological information on these species and relevant descriptive indicators of stock status. These indicators will be dependent on data availability but might include indicators such as the geographic range of catches; temporal trends in catch composition and catch rates; and key biological indicators of fishing pressure such as mean size and sex ratio. Analysis of the data gaps and obstacles to data collection are a complementary focus of this project.

All IOTC CPCs and other interested parties which may have relevant data are encouraged to submit this for consideration in advance of the workshop and are invited to participate directly in the workshop which also aims to provide support and training to national scientists. This project seeks to encourage regional cooperation in the sharing of biological, and fisheries data for coherent fisheries management of shared stocks, and to develop the capacity of CITES parties in the Indian Ocean region in making non-detriment findings for the above species, based upon better knowledge of the status of shared stocks. Interested parties are invited to contact the IOTC Secretariat (secretariat@iotc.org). The meeting venue is Victoria, Seychelles and the workshop will take place from 2nd- 4th November 2016.

Data submitted to the IOTC under this data call are subject to Resolution 12/02 *Data confidentiality policy and procedures*.

CPCs are ENCOURAGED to submit data to the IOTC Secretariat 14 days before the workshop (19/10/2016). However, if data submission by the deadline is not possible, then the participating CPCs are REQUESTED to bring the data to the workshop for analysis.

CPC datasets should be submitted in English and should cover the period 1980 to 2015. CPC datasets should include the catch and effort from data from logbooks and/or observer programs at the finest scale possible, where appropriate. To assist with standardisation of data submissions, CPCs are requested to use the following tables for data submission, including data for time/area strata where zero shark bycatch was recorded. Data submission cover the period 1980 to 2015 or where available. If the data were extrapolated or raised to reflect the fishery as a whole this should be noted in the table and explained in text accompanying the data submission. Data for oceanic whitetip, great hammerhead, scalloped hammerhead and smooth hammerhead sharks are requested along with total unidentified shark catch.

Table 1. Information on catch and effort by fishery.

CPC: **Data Source: (eg. Observer, Logbook, Research, etc.)**

YEAR	GEAR	AREA[1] (Lat.)	AREA[1] (Long.)	TARGET SPECIES	EFFORT	EFFORT UNITS	TARGET SPECIES CATCH	OCS CATCH	SPK CATCH	SPL CATCH	SPZ CATCH	OTHER SKH CATCH	CATCH UNITS	WAS DATA RAISED?

[1]Spatial stratification at the finest scale possible.

CPCs are REQUESTED to submit a second table of shark species associated with this data call (i.e. OCS, SPK, SPL, SPZ) caught during the period covered by the data being submitted. The separate table should provide more detailed information including, where possible:

1. the state of each shark when brought aboard (dead or alive);
2. the fate of each individual (dead, released alive, released alive but moribund/severely injured = in poor state).
3. the sex of each individual
4. the length of each individual, with information on the units and measurement type (i.e. fork length (FL), total length (TL), etc.).

Table 2. Information on condition, fate and biological characteristics of the focus shark species.

CPC:	**Data Source: (eg. Observer, Logbook, Research, etc.)**									
Species	**Year**	**Gear**	**Area (lat.)**	**Area (long.)**	**Condition at capture**	**Fate**	**Sex**	**Length**	**Length Units**	**Length Type**

14 Annex B Impacts of CMM 13/06

Preliminary results of data mining for oceanic whitetip sharks and the effectiveness of resolution 13/06

IOTC–2016–SC19–INF01

Joel Rice[2]

Scientific Committee Meeting, Victoria- Seychelles

[2] Joel Rice Consulting (joelrice@uw.edu)

1 Introduction

This paper outlines the data mining exercise currently being done to collect data on fisheries with oceanic whitetip shark (*Carcharhinus longimanus*, OCS) bycatch for the analysis of the effectiveness of the CMM 13/06 a summary of which reads "*CPCs shall prohibit, as an interim pilot measure, all fishing vessels….. to retain onboard, tranship, land or store any part or whole carcass of oceanic whitetip sharks….”(para. 3).* This is in effect, a retention ban on oceanic whitetip sharks. However, as also stated in (para 3) *"the provisions of this measure do not apply to artisanal fisheries operating exclusively in their respective Exclusive Economic Zone (EEZ) for the purpose of local consumption*.".

2 Data availability

Available catch data for sharks at species level that has been submitted to the IOTC databases is limited in a historical context, and recent data may not reflect the combined catch from all fisheries. Data on oceanic whitetip shark include the following:

- **Nominal Catch Data**: This data set is total catch data submitted by IOTC members stratified by East and West Indian Ocean. Nominal catches are requested to be reported on a species-specific level, but sharks are often aggregated in the sharks-nei (*not elsewhere reported*) category. Reported species-specific OCS nominal catch is dominated by gillnet fisheries, sometimes operated jointly with longlines (Figure 1). Peak reported catch occurred in the late 1990’s, since that time there has been a decline, corresponding with the decline in Sri Lanka’s shark fisheries (Figure 2). The countries reporting nominal catch (retained) of OCS since 2014 include; India, Iran, Maldives, Seychelles, Sri Lanka, Tanzania.

- **Nominal Catch and Effort data:** This data set is stratified by gear type (surface, coastal, longline), and area (5° by 5° for longline and 1° by 1° for surface fisheries) and is submitted by IOTC members where the data is available. This data set indicates that the first reported catches of OCS are in 1998. In fact few fleets are actually reporting nominal catch and effort data. There is no catch and effort data on OCS in the surface fishery or coastal fishery catch and effort databases, however OCS catch is reported in the longline catch and effort data base. Only five countries have ever reported catch of OCS in the nominal catch and effort database, and of those, only 2 have reported catch more than once. The NCE –LL database indicates 2 and 81 records of OCS catch in 2014 and 2015 respectively (Figure 3). This data totals 2 and nearly 68MT in 2014 an2015 respectively (Figure 4). It should be noted, however, the retention ban in effect since 2013 in waters outside coastal EEZs

- **Discard Data**
  Discard data was historically submitted through national reports and by skippers (via logbooks), more recently from observer programs, this data is quite limited showing a low level of observed discards (Table 1). Discard data collected by observers is considered the most reliable (left hand side Table 1), discard levels monitored by the vessel skipper indicate an increase in two orders of magnitude since the CMM went into effect (right hand side Table 1). It should be

noted that this information in not considered complete, but rather a picture into the specific fisheries reporting discards.

Table 1: Discard Information on OCS based on observer data and skipper reported/WP papers.

Observer Data					Skipper Reported/WP Papers				
Year	Number of Reports	OCS #	MT	KG	Year	Number of Reports	OCS #	MT	KG
2000	-	-	-	-	2000	1	23	-	-
2001	-	-	-	-	2001	-	-	-	-
2002	-	-	-	-	2002	2	4	-	-
2003	-	-	-	-	2003	-	-	-	-
2004	-	-	-	-	2004	-	-	-	-
2005	-	-	-	-	2005	1	0	-	-
2006	-	-	-	-	2006	1	2	-	-
2007	1	85	-	-	2007	1	14	-	-
2008	1	19	-	-	2008	1	4	-	-
2009	1	66	-	-	2009	1	10	-	-
2010	-	-	-	-	2010	4	30	-	-
2011	1	51	-	-	2011	2	8	-	-
2012	2	135	-	-	2012	3	4	-	979
2013	1	388	-	-	2013	3	3	-	-
2014	1	14	-	205	2014	98	1655	-	-
2015	1	14	2	-	2015	8	2391	-	-

- **Transhipment data**: This data set has two components the at sea transhipment data which 100% observer coverage, and the port based data. Often shark products have been processed making the identification and enumeration of sharks to species difficult or impossible. In this data set OCS occurs only in 2011 & 2012, therefore no information regarding the effectiveness or compliance with CMM 13-06 is available from this dataset.

- **Data submitted in response to IOTC data call 2016/076 and as part of the data mining workshop. All CPCs were requested to provide data to improve the status of information for populations of oceanic whitetip shark and CITES-listed hammerhead sharks, namely *Sphyrna lewini*, *S. mokarran* and *S. zygaena* in the IOTC area. This data call covered all fisheries and extended from 1980-2015 (Annex 1).**

    - **INDONESIA.** Observer data from the Indonesian Research Institute for Tuna Fisheries (RITF) was submitted dating from 2006 to 2015. This information contains set by set information and identifies most sharks to species, however OCS were unobserved in this fishery during this time period. Summaries of additional data from the WWF Indonesia observer program indicated that only 8 out of nearly 14,000 sharks identified to species were OCS, this data set is from 2006-2014, though the dates of capture and fate of the sharks were not reported. This dataset is limited to only four landing sites and is likely not representative of the Indonesian fishery as a whole, which is large and contains a variety of gears.
    - **I.R. of IRAN**. Ratio based estimates of total shark catch from Iran are available prior to 1997, while reported catch of all sharks is available from 1997-2015. Catch records (from 1997-2015) of sharks indicate that the overall shark fishery lands approximately

11,000 MT/year and this amount comprises between 2% & 3% of the total (target +shark) landings. There exists data on shark catch by species from the tuna fleet in 2015 only. This data indicated that 118 MT of OCS were caught, comprising 0.005% of the total catch.

- **SEYCHELLES.** Catch records from the semi-industrial and industrial fisheries in the Seychelles indicate that 46 OCS were observed between 2009 and 2013 in the industrial fleet and 1.8 MT was landed in the semi –industrial fleet in 2013. Additional data from 2014-2015 is currently being processed.
- **KENYA.** The shark fishery data in Kenya is based on the artisanal, recreational and longline fisheries. Currently there is one Kenyan flagged longliner which is subject to 100% observer coverage as of 2015. There is no data on OCS catch in any of these fisheries since 2010
- **TANZANIA.** Data from Tanzania (mainland and Zanzibar) indicate that between approximately 2800 and 4000 MT of sharks are landed annually. No species level data exists for sharks.
- **PAKISTAN.** Estimates of OCS landings in Pakistan are based on extrapolation from total reported shark landings. This extrapolation is based on observer data from WWF Pakistan (2013-2016) which indicates that the catch is predominantly in the gillnet fisheries with some in the longline fishery.
- **SRI LANKA.** The majority of the shark landings in Sri Lanka originate as by-catch from offshore tuna long-line fishery and gillnet fishery. Estimates of OCS catch in the Sri Lankan longline fishery range from 41 to 453 MT over the time frame 2005-2014. These estimates are based on the observed catch composition of sharks in the 2012/2013 fishing season (which showed OCS as 2% of the overall shark landings), and the annual ratio of sharks to total landings.

Information on the efficiency of the no-retention measure

Studies of the at-vessel mortality (Coelho, 2016) indicate that the overall at-haulback mortality for oceanic whitetip sharks was estimated at 50.0% in the Portuguese longline fishery. This fishery targets swordfish in the southwest and more recently the southeast region of the Indian Ocean, pelagic sharks are an important component of the fishery. Previously reported estimates of at-haulback are from the Atlantic and smaller (34%). This study also found that specimen size is significant for the odds of at-haulback mortality, with mortality decreasing as specimen size increases. This study provides important information about on aspect of the no-retention measures currently in place for oceanic whitetip sharks in the Indian Ocean. The author of the study cautioned that there was no information on the post-release mortality of the sharks released and that this study was concentrated on only one fishery and fleet.

3 Discussion

In general there is limited data on the catch, retention and mortality of OCS in the Indian Ocean. Data on OCS in the region are limited by the lack of full compliance with the IOTC data reporting measures on reporting sharks to species at the regional (Indian Ocean) level. Lack of observer programs and reporting mechanisms for sub-regional trade further compound the difficulty of assessing catch rates and trends. Artisanal fisheries (within the EEZ and for domestic consumption) are exempt from the CMM, yet likely interact with the same stock as the pelagic fisheries. Understanding the degree to which these fisheries interact with OCS is complicated by the same data deficiencies as the industrial fisheries, especially lack of identification of many retained sharks to species level.

The retention ban on oceanic whitetip sharks was implemented in 2013, as detailed in IOTC Resolution 13/06. The notable exceptions to this measure are artisanal fisheries operating exclusively within their respective Exclusive Economic Zone (EEZ) for the purpose of local consumption and India, who objected to the Resolution. Nevertheless, catches of oceanic whitetip sharks continue to be reported in the nominal catches for a number of fleets, including China, I.R. Iran, Maldives, Seychelles, Sri Lanka, Tanzania (and India) which have all reported catches of the species since 2014. There are a number of potential reasons for this such as (i) the reported catches are from artisanal fisheries operating in the coastal EEZs; (ii) incorrect reporting as nominal catch rather than discards and (iii) a lack of awareness of the Resolution among fishers (iv) non-compliance and enforcement issues. Given that spatial information from the catch and effort database indicates that not all of these catches are taken on the high seas, it is likely that these are not all artisanal catches.

Recently the IOTC held a workshop focused on data mining for CITES listed species in the Indian Ocean (November 2-4). Discussions suggested that lack of awareness was an issue and indicated that a number of CPCs are currently addressing this by incorporating a ban on the retention of oceanic whitetip sharks into national legislation (Sri Lanka 2015, Seychelles 2015, Pakistan 2016). This suggests that progress in adoption of the CMM is progressing, however, it may currently be too early to be able to evaluate impacts of the retention ban. Moreover, information presented at this workshop indicated that some commerce in OCS meat and fins is likely to occur as significant regional trade occurs without documentation. In practice oceanic whitetips will continue to be vulnerable to a variety of fishing gears. The number that have been reported as retained nominal catch is likely due to a delay in the adoption and of national bans on retention.

Discussions regarding the ongoing retention at the recent workshop indicated that fishermen were often reluctant to discard dead OCS, as this was perceived as wasteful. Another factor that leads to the retention of OCS included the lack enforcement regarding fisheries regulations in countries where compliance with fisheries regulations was a minor problem compared to other national concerns (i.e. security). The result of the data mining project and overall project report are due at the end of this year.

4 References

Coelho, R. 2016. IOTC–2016–WPEB12–26: Hooking mortality of oceanic whitetip sharks caught in a pelagic longline fishery targeting swordfish in the SW Indian Ocean: comments on the efficiency of no-retention measures (http://www.iotc.org/sites/default/files/documents/2016/08/IOTC-2016-WPEB12-26.pdf)

RESOLUTION 13/06 ON A SCIENTIFIC AND MANAGEMENT FRAMEWORK ON THE CONSERVATION OF SHARKS SPECIES CAUGHT IN ASSOCIATION WITH IOTC MANAGED FISHERIES (http://www.iotc.org/cmm/resolution-1306-scientific-and-management-framework-conservation-sharks-species-caught)

5 Figures

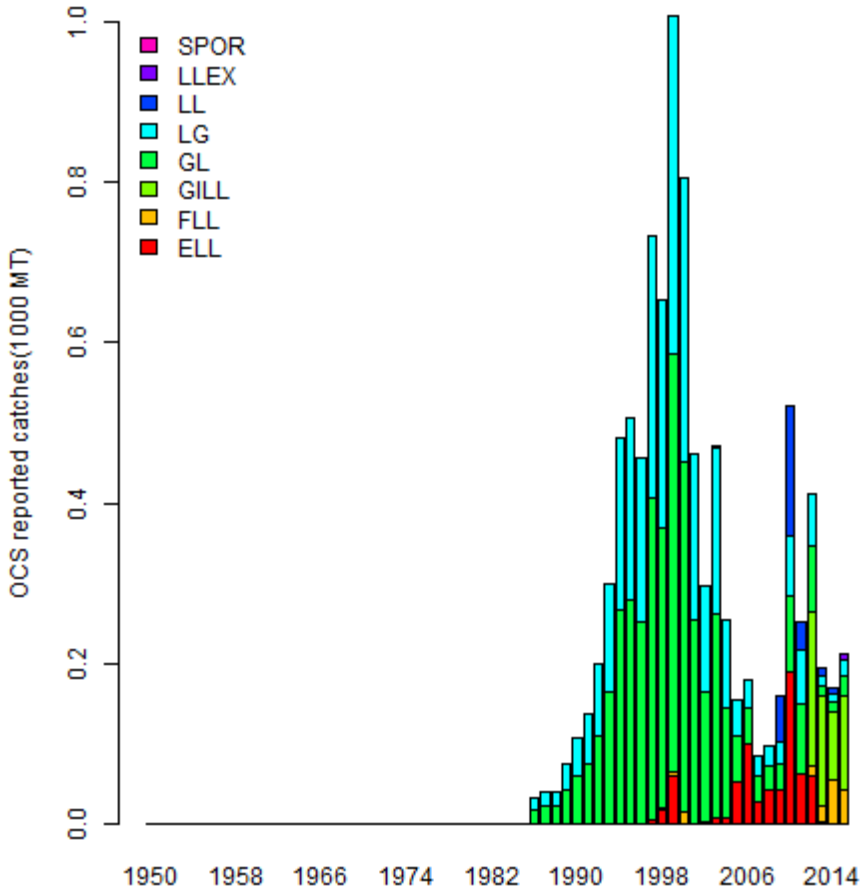

Figure 1. Nominal reported catch of OCS in MT by gear type. Note that a ban on retention of OCS has been in place since 2013, with the exception of coastal countries fishing inside their EEZs. Legend entries refer to sport fishing (SPOR), exploratory longline (LLEX), longline (LL), predominately longline combined with some gillnet (LG), predominately gillnet combined with longline (GL), gillnet (GILL), fresh longline (FLL) and longline targeting swordfish (ELL).

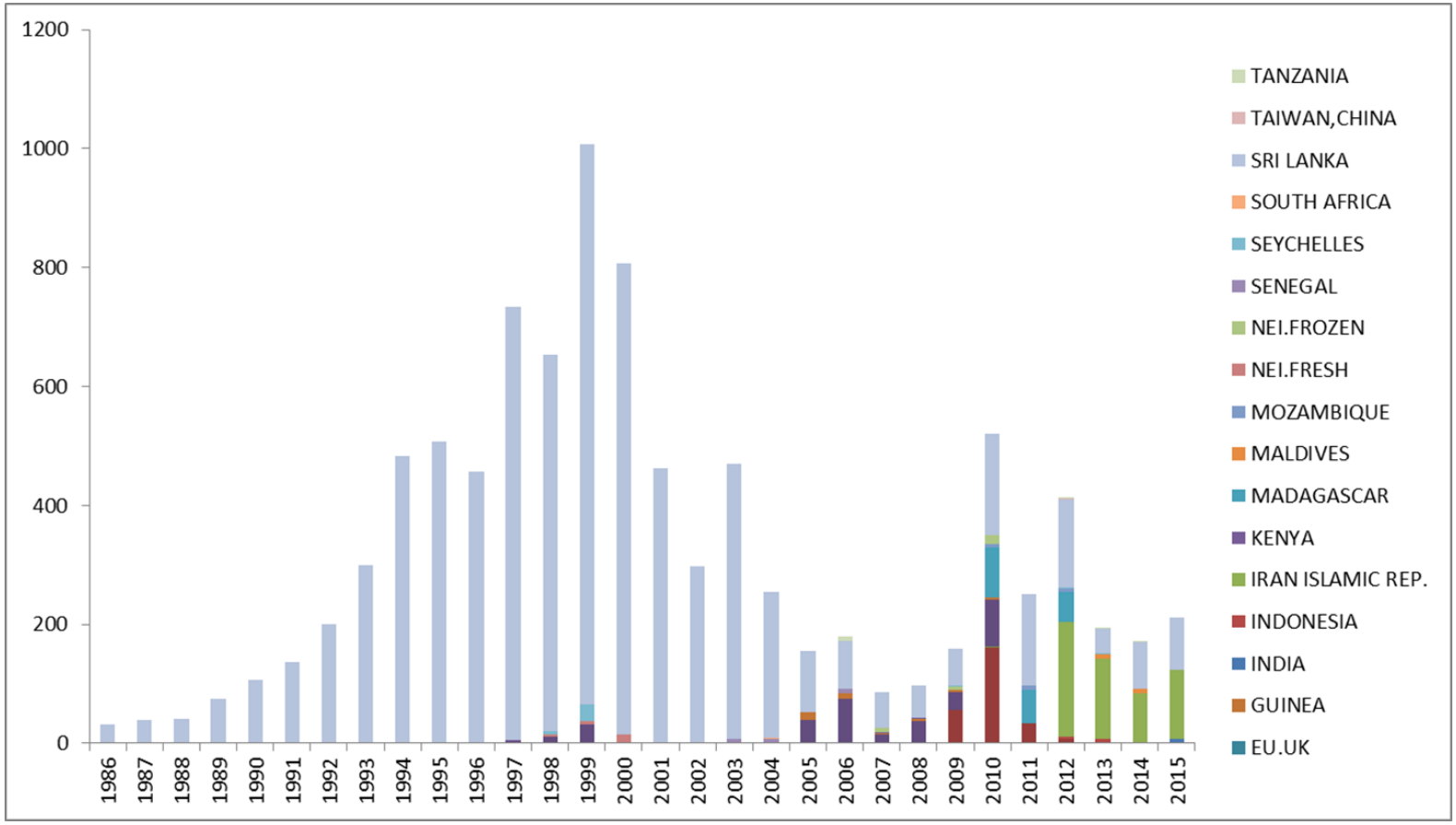

Figure 2. Reported nominal catch by year and country.

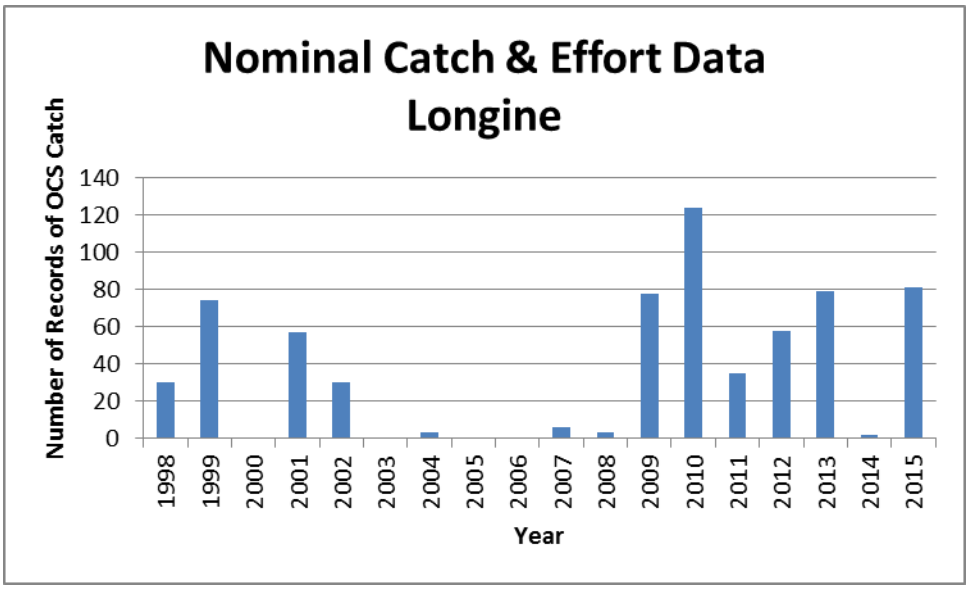

Figure 3. Number of records of OCS in the NCE-LL database.

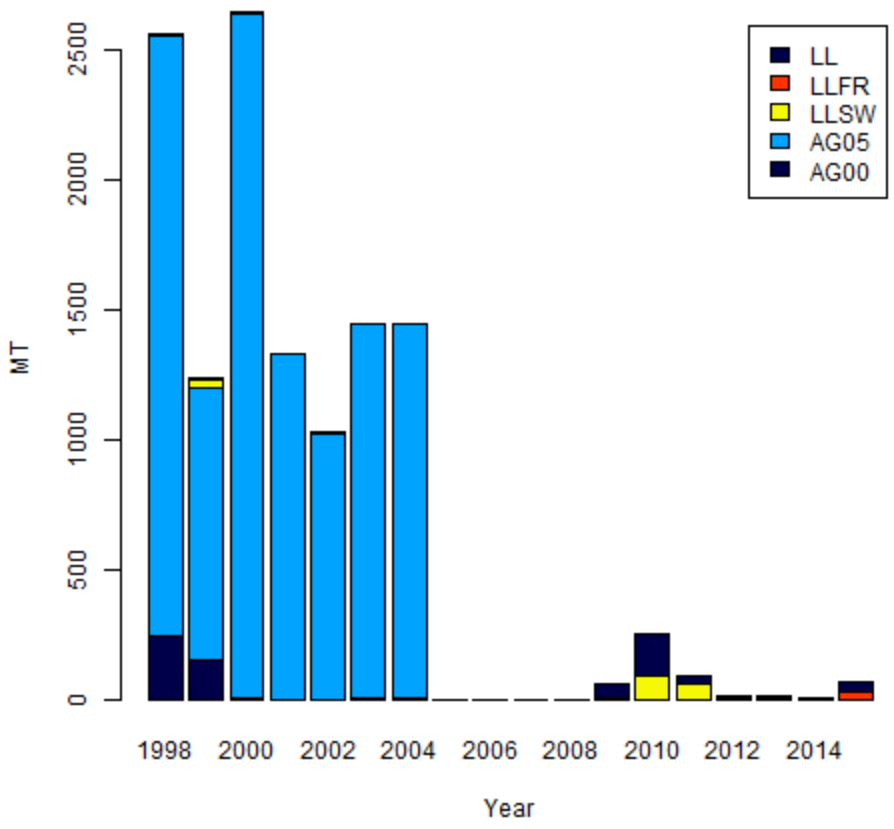

Figure 4. Reported catch f OCS for all gears. Legend entries indicate longline (LL), drifting longline (LLFR), swordfish longline (LLSW), unidentified (AG00), and gillnet-longline combinations (AG05).

15 Annex C. Report of the IOTC /CITES Data mining workshop.

REPORT OF THE IOTC/CITES SHARK DATA MINING WORKSHOP

2-4 November 2016, Victoria, Seychelles

Joel Rice[3]

DISTRIBUTION:
Participants in the Session

BIBLIOGRAPHIC ENTRY
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Executive Summary
The IOTC held a workshop focused on data mining for CITES listed species in the Indian Ocean (November 2-4, 2016). This project was developed, in collaboration with CITES, to improve the status of information for populations of oceanic whitetip shark (*Carcharhinus longimanus*) and CITES-listed hammerhead sharks, namely *Sphyrna lewini*, *S. mokarran* and *S. zygaena* in the IOTC area. Part of the aim of this study was to compile historical data and provide a forum for reviewing fisheries data and biological information on these species and relevant descriptive indicators of stock status. This project was also oriented at developing the capacity of CITES parties in the Indian Ocean region in making non-detriment findings for the above species, based upon better knowledge of the status of shared stocks. Additional aims were to encourage regional cooperation in the sharing of biological, and fisheries data for coherent fisheries management of these stocks. Participants from 7 nations (Pakistan, Iran, Sri Lanka, Kenya, Tanzania, Seychelles, Indonesia) as well as one NGO (WWF Pakistan) were able to attend the meeting.

In general there is limited data on the catch, retention and mortality of oceanic whitetip and hammerhead sharks in the Indian Ocean. Data on these sharks in the region are limited by the lack of full compliance with the IOTC data reporting measures on reporting sharks to species at the regional (Indian Ocean) level. Furthermore lack of observer programs and reporting mechanisms for sub-regional trade further compound the difficulty of assessing catch rates and trends. Artisanal fisheries (within the EEZ and for domestic consumption) are exempt from the CMM 13-06 (no retention of oceanic white tip sharks), yet likely interact with the same stock as the pelagic fisheries. Artisanal fisheries also tend to have low observer /reporting compared to commercial fisheries and interact more broadly with the hammerhead species. Understanding the degree to which these artisanal fisheries interact with oceanic whitetip and hammerhead sharks is complicated by the same data deficiencies as the industrial fisheries, especially lack of identification to the species level.

A range of key points and recommendations are identified.

Key points

- The hammerhead shark and oceanic whitetip shark populations in the Indian Ocean are most likely shared among many countries. Participants recognized they will need to cooperate to understand sustainability of the stocks to produce individual country NDFs.
- Lack of data, and regional understanding of stock structure would likely preclude a completion of an NDF in many cases.
- Participants agreed on the format and content of a Regional NDF Template and that the pre-populated Template will be very beneficial in starting the shark NDF process in the Indian Ocean.
- Because the Indian Ocean Tuna Commission currently has a no-retention CMM for oceanic whitetip sharks the production of NDFs for this species is not necessary
- The Regional NDF Template directs the type of data that needs to be collected and should be the focus of ongoing regional data collection efforts for the shark NDFs.
- Capacity development in coastal fisheries data is likely to be of greater importance than pelagic fisheries data for most countries since the latter is relatively well developed through the IOTC.

- There is need for expanded communication among national agencies, including the scientific authority, the management authority, Customs, and the IOTC representatives in many countries.
- Discussions suggested that lack of awareness of CMMs was an issue however a number of CPCs are currently addressing this by incorporating a ban on the retention of oceanic whitetip sharks into national legislation (Sri Lanka 2015, Seychelles 2015, Pakistan 2016).
- Moreover, information presented at this workshop indicated that some commerce in OCS meat and fins is likely to occur as significant regional trade occurs without documentation.
- In practice oceanic whitetips will continue to be vulnerable to a variety of fishing gears.
- While oceanic whitetips have still been reported as retained nominal catch since 2013 for a number of countries, this is likely due to a delay in the adoption and of national bans on retention.
- Discussions regarding the ongoing retention at the recent workshop indicated that fishermen were often reluctant to discard dead OCS and SPN, as this was perceived as wasteful and in the case of a live shark, dangerous.
- Retention of OCS is influenced by lack enforcement where compliance with fisheries regulations was a minor problem compared to other national concerns (i.e. security).

Recommendations.

- Further examination of the regional stock structure of the listed shark species.
- An indicative guide, with graphics, on the best practices for handling/live release of (large) sharks should be produced for the main fisheries including artisanal and semi-industrial fisheries.
- Further data mining & research of historical information, this could be done in conjunction with capacity building workshops or regional data exchanges.
- Research to develop observer program/data from artisanal/subsistence fisheries.
- Further support NPOA-Sharks & RPOA-Sharks.
- Local Knowledge to assess fishing pressure.
- Assisting the Action of the NPOA for members of the IOTC.
- Research into the effectiveness of the CMM 13-06.
- Implementation of locally based observer programs.
- Research projects to quantify the coastal catch of the CITES listed species.

1 Introduction

The purpose of the IOTC's Working Party on Ecosystems and Bycatch (WPEB) is to review and analyse matters relevant to bycatch, byproduct and non-target species which are affected by IOTC fisheries for tuna and tuna-like species (i.e. sharks, marine turtles, seabirds, marine mammals and other fishes), as well as the ecosystems in which they operate; and to develop mechanisms which can be used to better integrate ecosystem considerations into the scientific advice provided by the Scientific Committee to the Commission. Its focus species include the CITES-listed species oceanic whitetip shark (*Carcharhinus longimanus*) and scalloped hammerhead shark (*Sphyrna lewini*).

Sharks comprise a significant source of bycatch in the tuna and billfish fisheries of the Indian Ocean. Artisanal and semi-industrial fisheries often interact with the same stocks as the commercial vessels. Given the potential for overlap, in the species habitat between neighbouring national waters and the IOTC area of competence this project has been developed, in collaboration with CITES, to improve the status of information for populations of oceanic whitetip shark and CITES-listed hammerhead sharks, namely *Sphyrna lewini*, *S. mokarran* and *S. zygaena* in the IOTC area. This paper is a report of the workshop held to provide a forum for reviewing fisheries data and relevant descriptive indicators on these species. Specific goals of the workshop were:

- Introduce and explain CITES, their role in the region and the concept of a Non-Determent Finding (NDF).Historical data mining, including the collection of information about catch, effort and spatial distribution of those species and fleets catching them.
- Calculate species specific indicators including catch rate, size, sex, maturity, distribution, species composition and targeting.
- Summarize the results from the workshop in a report, including an assessment of the feasibility to conduct a full stock assessment for the above species in the IOTC area, data gaps, lessons learned and next steps, and make that report available to WPEB meeting.
- Enhance the participation of CPCS that have the need for capacity development.
- To encourage the CPC's to submit relevant data for consideration at the workshop.
- To provide advice on if the available information can support a stock assessment.
- To advise on the selection of Stock Status indicators for those sharks.
- To introduce the format of regional NDF template for use by CITES Parties in the Indian ocean to develop national NDFs, and agree to use this format as
- Discuss a regionally coordinated approach to sustainable management of shark species that occur across multiple countries (shared stocks), including gaps.
- Discuss the framework for ongoing regional data collection and monitoring of CITES listed shark species.

1.1 Workshop Topics and General Discussions

During the workshop there was considerable round-table discussions on all aspects of the regional fisheries and their interaction with sharks in general and the CITES listed hammerhead and oceanic whitetip sharks in specific. A range of comments and suggestions were noted and include the following, organized by topic discussed.

1.1.1 Background and Overview of Non-detriment Findings (NDFs) for Sharks

An introduction to the workshop outlining the main goals as well as the role of CITES in the area and a brief overview of the NDF was given by Joel Rice and Sarah Martin. The difference between CITES, the IOTC and other regional NGOs (e.g. WWF, TRAFFIC) was discussed as well as the need for regional cooperation in order to understand the status of shared stocks of hammerhead and oceanic whitetip sharks.

Non-Detriment Findings for Sharks in the Indian Ocean.

Joel Rice provided an in-depth presentation of what constitutes an NDF, who the responsible party is for completing the NDF, development of the CITES NDF Guidance for Shark Species (Mundy-Taylor et al. 2014), and the steps in the NDF Process. Participants understood the overall NDF Process and noted that the NDF Guidance for Shark species was useful. During the discussion of the need for non-detriment findings for sharks some CPCs noted that:

Significant amounts of trade happen without documentation

Many shark fisheries are strictly for local consumption, and partially to wholly undocumented

The national CITES authority often does not work closely with the national fisheries agency and is un-aware, or unable to issue NDFs. There may be competing purposes between in country agencies (e.g. trade vs. conservation).

Discussion on draft regional NDF template format.

Joel Rice presented a draft format for a Regional NDF Template (based on the workshop in the Pacific) that is essentially the Worksheets from the six step process in the CITES NDF Guidance for Shark Species (Mundy-Taylor et al. 2014). As had been done in the Pacific each of the worksheets (one for each of the hammerhead species) had been pre-populated with some information that is common, for e.g. global reported catches, biological parameters and common regional conservation measures. This provided an example of how this Regional NDF Template would work.

Participants agreed that having pre-populated worksheets was helpful in developing an NDF and that the Regional NDF Template format and content as described were appropriate. The workshop noted that many of the CPCs lack the data to fill this out at a species level.

Shark Catch and trade data

Sarah Martin (IOTC) presented the public domain IOTC data on catch of hammerhead and oceanic whitetip sharks and all sharks. These presentations were based on reported catch and very little of the overall shark catch was reported to species.

CITES countries. All CPCs were requested to describe their available national catch and trade data on hammerheads and oceanic whitetip sharks, as well as other sharks and to provide any available data and

to describe their fisheries with the goal of improving the status of information for CITES listed sharks. This data call covered all fisheries and extended from 1980-2015**.**

- **INDONESIA.** Observer data from the Indonesian Research Institute for Tuna Fisheries (RITF) was presented dating from 2006 to 2015. This information contains set by set information and identifies most sharks to species, however OCS were unobserved in this fishery during this time period. Summaries of additional data from the WWF Indonesia observer program indicated that only 8 out of nearly 14,000 sharks identified to species were OCS, this data set is from 2006-2014, though the dates of capture and fate of the sharks were not reported. Data on hammerhead sharks is limited to scalloped and great hammerheads only, and much of what was reported was reported as grouped. Available data on the length of both scalloped and great hammerheads indicates that the majority of the sampled This dataset is limited to only four landing sites and is likely not representative of the Indonesian fishery as a whole, which is large and contains a variety of gears.
- **I.R. of IRAN**. Ratio based estimates of total shark catch from Iran are available prior to 1997, while reported catch of all sharks is available from 1997-2015. Catch records (from 1997-2015) of sharks indicate that the overall shark fishery lands approximately 11,000 MT/year and this amount comprises between 2% & 3% of the total (target +shark) landings. There exists data on shark catch by species from the tuna fleet in 2015 only. This data indicated that 118 MT of OCS were caught and 63 MT of hammerhead sharks were caught, comprising 0.05% and 0.03%, respectively, of the total catch.
- **SEYCHELLES.** Catch records from the semi-industrial and industrial fisheries in the Seychelles indicate that 46 OCS were observed between 2009 and 2013 in the industrial fleet and 1.8 MT was landed in the semi –industrial fleet in 2013. Additional data from 2014-2015 is currently being processed.
- **KENYA.** The shark fishery data in Kenya is based on the artisanal, recreational and longline fisheries. Currently there is one Kenyan flagged longliner which is subject to 100% observer coverage as of 2015. There is no data on OCS catch in any of these fisheries since 2010, with less than ten hammerhead sharks reported in the recreational fisheries annually since 2010.
- **TANZANIA.** Data from Tanzania (mainland and Zanzibar) indicate that between approximately 2800 and 4000 MT of sharks are landed annually. No species level data exists for sharks.
- **PAKISTAN.** Estimates of OCS landings in Pakistan are based on extrapolation from total reported shark landings. This extrapolation is based on observer data from WWF Pakistan (2013-2015) which indicates that the catch is predominantly in the gillnet fisheries with some in the longline fishery. Estimates of hammerhead landings average approximately 29 MT per year (2013-2015).
- **SRI LANKA.** The majority of the shark landings in Sri Lanka originate as by-catch from offshore tuna long-line fishery and gillnet fishery. Estimates of OCS and hammerhead catch in the Sri Lankan longline fishery range from 41 to 453 and 55 to 273 MT, respectively, over

the time frame 2005-2014. These estimates are based on the observed catch composition of sharks in the 2012/2013 fishing season (which showed OCS as 2% of the overall shark landings), and the annual ratio of sharks to total landings.

Analysis of the data gaps and obstacles to data collection

Joel Rice led a discussion of data collection at local level, including obstacles and what worked well. Over all of the issues identified, lack of resources was cited as the primary obstacle to data collection. Discussion of the responsibility at the local level revealed that the national fisheries authority is not necessarily in charge of issuing NDFs and trade can happen under the auspices other national agencies (e.g. trade and tourism). Participants noted that this workshop, in addition to the usual WPEB meetings, was one way to improve data sharing and communication. Specific comments included:

- Improved data collection at the local level is fundamental to any coordinated approach to addressing shared stocks in the NDFs.
- The mechanism of an NDF is difficult implement because sub-regional -local trade continues (e.g. Iran-Pakistan, Kenya-Somalia) undocumented
- if there is a ban on sharks in the market, sharks move to the black market
- Blanket bans on retention at the local level are impossible to enforce because sharks are still an important part of fisheries.
- Participants noted that there is a dilemma because the trade is happening but the CITES authority is not aware, or able to control it.
- Occasionally the CITES concerned authority has been asked to delegate authority to exports to trade companies.
- In general port state measures could help document and control flow of shark products but there is little information regarding specific shark species.
- There has been a move towards non-specific reporting in shark exports in some regions since i.e. shark fin is exported as dried fish.
- Often the separation between the formal and informal market was non-distinct. For example shark products for sale or export from Kenya are may in fact originate in Somalian waters.
- Often fins are sold immediately then the carcass is sold later after it dries.
- Participants had the impression that illegal high dollar value trade is more appealing than legal trade, particularly due to the lack of enforcement.
- Particularity port sampling is lacking.
- There is further a traceability issue with the fresh and dried markets, while fresh shark goes to market, and is often accounted for, many sharks are skinned and are sold dried, which is unidentifiable and often mixed with teleost species.
- Trade in shark products should be monitored and controlled at the point of origination, but also could benefit from control and tractability on the import side.
- Need for a protocol for the live release of protected shark species.

Regional Data Collection

Moazzam Kahn (WWF Pakistan) presented on the crew based observer program that has been implemented through WWF Pakistan in recent years. Although there has been mandatory reporting for foreign vessels in the EEZ of Pakistan since 1982, reporting on local fisheries have been incomplete. In July 2012 the WWF started an observer program, with some initial support from the Indian Ocean Cetacean project. Currently funded through the Areas Beyond National Jurisdiction project (aka Common Oceans), this program has been quite successful because they are using the crew as observers and therefore, no additional gear or extensive training is necessary. Initial training was necessary due to the low education levels that limited the quality of data collected. Other limitations of the crew based observer program were noted dealt with the relative independence of the data, and the practical implementations of collecting data while working.

Discussion of the use of this type of observer program as a template for the region noted that while this is successful, requires significant funding, particularly to ensure the longevity of the scheme. The group noted that while subsidies to participate in similar programs could be effective, there is a risk that fishers would take the subsidy but not fully participate in the program.

Review of relevant descriptive indicators of stock status

Joel Rice presented on the approaches used in the Pacific to derive indicators of shark stock status. Important stock status indicators include geographic range of catches; temporal trends in catch composition and catch rates; and key biological indicators of fishing pressure include mean size and sex ratios. The discussion of alternative stock status indicators centred around the lack of data.

Review of the information on the effectiveness of mitigation measures for OCS

Joel Rice presented a review of mitigation measures contained in IOTC Resolution 13/06 for oceanic whitetip shark. Participants noted that as a direct consequence of the CMM national bans on the retention of OCS have been implemented in many cases. It was also noted that the enforcement of these bans requires more resources than currently available.

Shared stocks discussions and coordinated decision making processes to deal with shared stocks in the NDF

Joel Rice and Sarah Martin led an in depth discussion on how to manage shared stocks of hammerheads and oceanic whitetip sharks. Part of the discussion was focused on the difference between monitoring targeted /subsistence fisheries and commercial fisheries. It was noted that shared coastal stocks would benefit from increased monitoring in the subsistence fisheries which are wide spread and difficult to monitor. The CMM 13/06, a retention ban on oceanic whitetips, was considered to be a good mechanism for coordinated action with respect to the pelagic fisheries, and that species. Participants noted that oceanic whitetip sharks are also caught in local subsistence fisheries which are not covered by the CMM. The group also made the following comments:

- Local knowledge on fishing pressure could be used to assess the relative vulnerability.
- Research is needed to address large scale stock structure.
- Managing listed shark populations is a low priority issue for some CPCs relative to national security, economic and other issues.
- Managing shared stocks needs regional collaboration and could potentially be done through the IOTC based on individual NPOA sharks and a RPOA on sharks.
- Managing shared stocks requires more data than currently available
- Major barriers to coordinated decision making include funding and capacity.
- Data development and monitoring should start at the sub national level (province) then at a State level, and finally be synthesized at a regional level.

Capacity building needs to strengthen the development of regional capacity

During the discussion on the capacity needs and gaps for the provision of science-based advice for the management of sharks in the region the following topics were suggested:

- Regional Stock Structure Project.
- Regional Collaboration.
- Best Practice of handling/release for protected sharks.
- Data mining & Research of historical reports.
- Observer training and Species ID.
- Crew based observer program (Similar to WWFs program in Pakistan).
- Improved data collection and reporting from artisanal/subsistence fisheries.
- Use of traditional fisher knowledge/data mining with fishermen
- Joint Research Projects(regional).
- Support of development of NPOA-Sharks & RPOA-Sharks.
- Local knowledge to assess fishing pressure.
- Monitoring and traceability.
- Assisting the Action of the NPOA for members of the IOTC.
- Research into the effectiveness of the CMM 13/06.
- Implementation of observer programs.

Informal discussions between IOTC members on data analysis, and data submission

Joel Rice and Sarah Martin held informal discussions with participants to examine the data that was submitted, to allow them to raise questions about the NDF template, the completion process, and any other concerns or questions.

One re-occurring theme was that currently there is such a scarcity of data that the completion of NDFs is all but impossible. Some participants expressed that at a national level there is not sufficient cooperation between the relevant fisheries authority, the trade authority and the responsible CITES authority which contributes to the difficulties in managing fishery resources.

1.2 General Comments and Workshop Summary

In general participants agreed there is a need for regional assessments of shared stocks and a collaborative approach to NDFs. To this end participants noted that the Regional NDF Template is very beneficial in getting the NDF process started in the Indian Ocean. However a reoccurring theme was that the primary need was to focus on developing data reporting, compliance and enforcement mechanisms. The Regional NDF Template also provides some guidance as to what data should be collected, which can help inform local research priorities. The is a need to be clear about the roles of MA and SA in the CITES NDF process as well an agreement on the necessity of the NDF for trade.

The lack of data on CITES listed sharks will have an impact on participating CPCs' ability to complete any NDF. In fact the lack of data precludes full assessments for any of the hammerhead or oceanic whitetip sharks at this time. The FAO International Plan of Action and National Plan of Action Process (IPOA/NPOA) may be able to help drive research in the region that would benefit the NDF process and many Shark-NPOAs have now been developed (see IOTC-2016-SC19-06 for the most recent update on progress). Many of the data requirements for the Shark Assessment Reports (SAR) and the NDF are similar.

The status of the NPOAs for the participating CPCs ranged from 'not begun' to 'completed with FAO Guidelines implemented'. Regional capacity development oriented at the completion of the NPOAs in conjunction with work on producing NDFs for CITES listed species would facilitate management of these species in the Indian Ocean. New SARs and NPOAs should include specific language on addressing the common problems in understanding and assessing the status of shark populations such as the lack of region specific biological data and the lack of fishery data on bycatch and shark target fisheries.

2 Reference

Mundy-Taylor, V., Crook, V., Foster, S., Fowler, S., Sant, G. and Rice, J. (2014). CITES Non-detriment Findings Guidance for Shark Species (*2nd, Revised Version*). A Framework to assist Authorities in making Non-detriment Findings (NDFs) for species listed in CITES Appendix II. Report prepared for the Germany Federal Agency for Nature Conservation (Bundesamt für Naturschutz, BfN). Available at: https://cites.org/sites/default/files/eng/prog/shark/docs/SharkNDFguidanceinclAnnexes.pdf

3 ANNEX 1. Agenda for the data mining workshop

AGENDA FOR THE IOTC/CITES SHARK DATA MINING WORKSHOP

Date: 2-4 November 2016
Location: Victoria, Seychelles
Venue: IOTC Headquarters, 2nd level Chantier Mall
Time: 09:00 – 17:00 daily
Chair: Joel Rice (IOTC Consultant)
Vice-Chair: Dr Sarah Martin (IOTC)

Day 1: November 2nd 2016

Time	Topic	Lead
9:00 - 9:15	**OPENING OF THE MEETING**	
9:15 - 9:30	Introductions Self-introductions by participants	J. Rice/IOTC All
9:30-9:45	**Background and Overview**	J. Rice/IOTC
9:45-10:30	Non-detriment Findings (NDFs) for Sharks Content: What are NDFs, who does the NDFs, development of the Non-Detriment Findings Guidance for Sharks species, and the steps in the NDF Process. Outcome: Participants understand the NDF Guidance for Shark species and NDF Process.	Materials: CITES Non-detriment Findings Guidance for Shark Species https://cites.org/eng/prog/shark/index.php (Information Resources)
10:30-11:00	Morning Tea	
11:00 – 12:30	**Regional NDF Template** Content: Presentation of a draft regional NDF template that could be used by each CITES Party, and briefly outlines the common data (e.g. life history). Discussion on draft regional NDF template format. Outcome: Agreement on the format of a regional NDF template for use by CITES Parties to develop national NDFs.	 J. Rice/IOTC All country participants Materials: Draft regional NDF template
12:30 – 14:00	Lunch	
14:00 - 15:30	**Shark Catch and trade data** Content: Presentations of public domain IOTC data on catch of hammerhead and oceanic whitetip sharks CITES countries describe their available national catch and trade data on hammerheads and oceanic whitetip sharks	 J. Rice/IOTC All
15:30-16:00	Afternoon Tea	
16:00 - 17:00	**Shark Catch and trade data** Content (cont'd): CITES countries describe their available national catch and trade data of hammerheads and oceanic whitetip sharks. If time allows, begin discussion on how to prepare NDFs for shared stocks (i.e. species that occur within the waters of more than one country). Outcome: Catch and trade data presented, described and reviewed. Discussion begun on developing a coordinated approach to addressing shared stocks in the NDFs.	J. Rice/IOTC All

Day 2: November 3rd 2016

Time	Topic	Lead
9:00 - 9:30	**Review of Previous Day** Questions?	J. Rice/IOTC
9:30-11:00	**Analysis of the data gaps and obstacles to data collection** Discussion of data collection at local level, including obstacles and what worked well Outcome Identification of issues, responsibilities and discussion of ways to improve data sharing and communication.	J. Rice/IOTC All
10:30-11:00	Morning Tea	
11:00 – 12:30	**Regional Data Collection** Content: Discussion of regional data collection of CITES Appendix II shark species (pelagic and coastal). Outcome: Identification of issues, responsibilities and discussion of ways to improve data sharing and communication	J. Rice/IOTC All Content: https://www.wcpfc.int/system/files/EB-IP-06%20ABNJ%20Update%202.pdf and https://www.wcpfc.int/doc/bycatch-troublesome-deal-it
12:30 – 14:00	Lunch	
14:00 - 15:30	**Review of relevant descriptive indicators of stock status** Content: Presentation of the approaches used in the Pacific to derive indicators. Review and discuss which indicators are important such as geographic range of catches; temporal trends in catch composition and catch rates; and key biological indicators of fishing pressure such as mean size and sex ratio. Discussion of alternative stock status indicators	J. Rice/IOTC All
15:30-16:00	Afternoon Tea	
16:00 - 17:00	**Review of the information on the effectiveness of mitigation measures for OCS** A review of mitigation measures contained in IOTC Resolution 13/062 for oceanic whitetip shark Review of available data for assessing the effectiveness of Resolution 13/062 Discussion of awareness, acceptance and ability regarding the Resolution 13/062.	J. Rice/IOTC All

Day 3: November 4th 2016

Time	Topic	Lead
9:00 - 9:30	**Review of Previous Day** Questions?	J. Rice/IOTC
9:30-11:00	**Shared stocks discussions** Content: In-depth discussion on catch and trade data and shared stocks of hammerheads and oceanic whitetip Discussion on possible coordinated decision making processes to deal with shared stocks in the NDFs. Outcome: Agreement reached on a coordinated regional approach/process to address shared stocks in the NDFs.	J. Rice/IOTC All
10:30-11:00	Morning Tea	
11:00 – 12:30	**Capacity building needs to strengthen the development of regional capacity** Content: Discussion on the capacity needs and gaps for the provision of science-based advice for the management of sharks in the region.	J. Rice/IOTC All
12:30 – 14:00	Lunch	
14:00 - 15:30	**Informal discussions between IOTC members on data analysis** Content: One-on-one discussions between J. Rice/IOTC staff and IOTC members Outcome: Provide a one-on-one forum for each member to raise questions on any aspect of the NDF process, data analysis or other items.	J. Rice/IOTC All
	Review and close of meeting	J. Rice/IOTC
15:30-16:00	Afternoon Tea	

4 Draft Non-Detriment Finding Template

The following template is a draft document only and is a suggested format of a NDF template based on the worksheets in the document "*CITES Non-detriment Findings Guidance for Shark Species*" (Mundy-Taylor et al. 2014). Which is available at: https://cites.org/eng/prog/shark/Information_resources_from_Parties_and_other_stakeholders#NDFs%20and%20NDF%20guidance Select 'Shark NDF Guidance'

This template could potentially be used as a draft regional template. It is intentionally similar to the proposed draft regional NDF template from the Pacific to facilitate completion, and communication of shark status. This form was the basis for discussion on regional NDF template acceptable by all CITES Parties in the Indian Ocean.

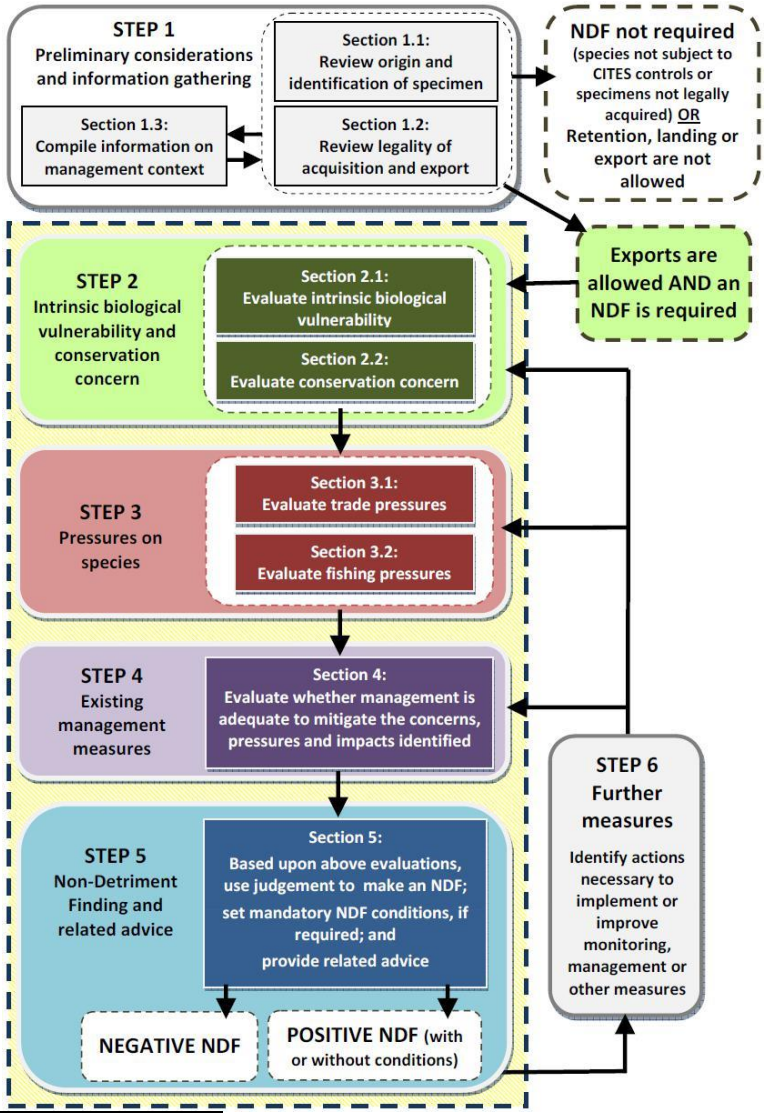
- The draft regional template is to be ultimately used by each country for an NDF
- The draft template has been populated with some of the information on Scalloped Hammerhead that is common across countries, and some of the common conservation measures
- This is to provide an example of how the NDF template may function.
- The template is not complete
- We have highlighted areas where information is required to be entered by each country when they produce an NDF.

……

Non-detriment finding (NDF) for Scalloped Hammerhead *Sphyrna lewini*

The Scalloped Hammerhead is listed on CITES Appendix II and trade in this species requires that the CITES Management Authority of the exporting country (or a designated competent authority in countries that are not Parties to CITES) must verify that the species was legally obtained. The CITES Scientific Authority of the exporting country must advise that export will not be detrimental to the survival of the species (a non-detriment finding).

The following Worksheets follow a six step process for the NDF that is illustrated in this Flow Chart from the Shark NDF Guidance[4]. The Worksheets are supported at each step by information in the Shark NDF Guidance.



[4] Mundy-Taylor, V., Crook, V., Foster, S., Fowler, S., Sant, G., and Rice, J. 2014. CITES Non-detriment findings guidance for shark species. 2nd, revised version. A framework to assist Authorities in making Non-detriment Findings (NDFs) for species listed in CITES Appendix II. Report prepared for the Germany Federal Agency for Nature Conservation (Bundesamt fur Naturschutz, BfN). Available at https://cites.org/eng/prog/shark/Information_resources_from_Parties_and_other_stakeholders.

<table>
<tr><th colspan="4">Worksheet for Step 1</th></tr>
<tr><th colspan="4">Question 1.1 (a)
Is the specimen subject to CITES controls?
(How did you identify the species?)</th></tr>
<tr><td colspan="4">See pages 64–65 of Annex 1 for additional Guidance Notes on completing this Worksheet.</td></tr>
<tr><td>Species Name</td><td>Product Form</td><td>CITES Appendix</td><td>Source of Identification</td></tr>
<tr><td>Sphyrna lewini</td><td>Country adds this</td><td>II</td><td>Country adds this</td></tr>
<tr><td colspan="4"><u>NEXT STEPS</u></td></tr>
<tr><td rowspan="3">In view of the above, is the specimen subject to CITES controls?
Consult ‘Decision and Next Steps’ guidance in Annex 1</td><td>YES</td><td colspan="2">GO TO Question 1.1 (b)</td></tr>
<tr><td>NOT CERTAIN</td><td colspan="2">Describe concerns in more detail below, and GO TO Question 1.1 (b)</td></tr>
<tr><td>NO</td><td colspan="2">NDF is not required</td></tr>
<tr><td>Concerns and uncertainties:</td><td colspan="3"></td></tr>
</table>

Worksheet for Step 1 (continued)		
Question 1.1 (b) **From which stock will the specimen be taken/was the specimen taken? (Can origin and stock be confidently identified)**		
See pages 66–67 of **Annex 1** for additional Guidance Notes on completing this Worksheet**.**		
	Description/comments	**Sources of information**
Ocean basin	Indian (requires verification from each country)	
Stock location/ distribution/ boundaries (attach a map)	There appear to be two distinct stocks: Atlantic and Indo-Pacific. Map of conceptual population model of Scalloped Hammerhead in the Indo-Pacific is included in the Published Information (Section 2.1).	Simpfendorfer 2014
Is this a shared stock (i.e. occurring in more than one EEZ[5] and/or the high seas)?	Yes	
If the stock occurs in more than one EEZ, which other Parties share this stock?	Australia, Belize, China, Comoros, Eritrea, European Union France, Guinea, India, Indonesia, Islamic Republic of Iran, Kenya , Madagascar, Malaysia, Maldives, Mauritius, Mozambique, Sultanate of Oman, Pakistan, Philippines, Seychelles Sierra Leone, Somalia, Sri Lanka, South Africa, Sudan, Tanzania, Thailand, United Kingdom, Yemen	Supporting Documentation?
If high seas stock, which other Parties shark this stock?	Country adds this	
Which, if any, RFB[6](s) cover(s) the range of this stock?	IOTC	
Are all Parties listed above (which fish or share the stock concerned) members of the relevant RFBs?	Yes- All CITES Parties and Competent Authorities are members of IOTC.	http://www.IOTC.org
Are there geographical management gaps?	The High Seas	
How reliable is the information on origin?	Country adds this	
NEXT STEPS		
Is information on origin sufficiently detailed for Question 1.2 to be answered?		**YES**

[5] Exclusive Economic Zone

[6] Regional Fisheries Body

Consult “Decision and Next Steps” guidance in **Annex 1**. **(Apply this answer at end of Question 1.2)**	**NO**

Worksheet for Step 1 (continued)		
Question 1.2 **Was (will) the specimen (be) legally obtained and is export allowed?**		
See pages 67–68 of **Annex 1** for additional Guidance Notes on completing this Worksheet**.**		
Is the species:	**Description/comments**	**Sources of information**
Protected under wildlife legislation, a regional biodiversity Agreement, or (for a CMS[7] Party) listed in CMS Appendix 1?	CITES Appendix II, CMS Appendix II	CITES website (https://cites.org/eng/prog/shark) CMS website (http://www.cms.int/en/page/appendix-i-ii-cms)
Sourced from illegal fishing activities (e.g. in contravention of finning regulations, or where a TAC[8] is zero or exceeded)?	Country adds this	
Taken from a no-take marine protected area or during a closed season?	Country adds this	
Taken in contravention of RFB recommendations, if any?	Country adds this	
Listed as a species whose export is prohibited?	Country adds this	
Of concern for any other reason?	Country adds this	
NEXT STEPS		
In view of the above and the final section of the Worksheet for Question 1.1(b), was the specimen legally acquired and can exports be permitted? Consult "Decision and Next Steps" guidance in **Annex 1.**	**YES**	**GO TO Question 1.3**
	SOME DOUBT	Describe concerns in more detail below, and **GO TO Question 1.3**
	NO	Export cannot be permitted, **NDF is not required**
Concerns and uncertainties:		

[7] Convention on Migratory Species

[8] Total Allowable Catch

Worksheet for Step 1 (continued)

Question 1.3
What does the available management information tell us?

See pages 69 and Table A of **Annex 1** for additional Guidance Notes on completing this Worksheet**.**

Part 1. Global-level information

	Description/comments	**Sources of information**
Reported global catch	222 tonnes (average global annual catch 2010-2014). This is considered a significant underestimate.	FAO 2016
Species distribution	Tropical and warm temperate oceans worldwide. Need more accurate information on occurrence of species within each of the Indian Ocean countries	Last and Stevens 2009
Known stocks/populations	Global stock structure is different between males and females. For females there are at least four genetically distinct subpopulations: Northwest Atlantic, Southwest Atlantic, Eastern Atlantic, and Indo-West Pacific. For males there appear to be no genetically distinct populations across and between ocean basins.	Duncan et al. 2006, Baum et al. 2007, Daley-Engel et al. 2012, NOAA 2013, Heupel et al. 2015
Main catching countries	Mauritania, Brazil and Ecuador. Hammerhead Shark (general): Indonesia, Senegal, Congo, Mexico, Ghana and Benin.	Mundy-Taylor and Crook 2013, FAO 2016
Main gear types by which the species is taken	Trawls, purse seines, gillnets, fixed bottom longlines, pelagic longlines and inshore artisanal fisheries.	Baum et al. 2007
Global conservation status	IUCN Status: Globally: Endangered (2007) Eastern Central and Southeast Pacific: Endangered (2007) Eastern Central Atlantic: Vulnerable (2007) Northwest and Western Central Atlantic: Endangered (2007) Southwest Atlantic: Vulnerable (2007) Western Indian Ocean: Endangered (2007)	Baum et al. 2007
Multilateral Environmental Agreements	CITES Appendix II, reservation by Japan (WCPFC CITES Party/ IOTC PARTY) CMS Appendix II, reservation by Australia Sharks MoU Annex 1	CITES https://cites.org/eng/prog/shark/index.php CMS http://www.cms.int/en/species Sharks MoU http://www.cms.int/sharks/en/mos2
Part 2. Stock/context-specific information		
Stock assessments	No stock assessments for the Indo-West Pacific Stock have been done. Due to the lack of data, a stock assessment is currently not feasible.	Lack et al. 2014, Rice et al. 2015

Main management bodies	IOTC	IOTC.org
Cooperative management arrangements	Scalloped Hammerhead is a Highly migratory species and the relevant RFMOS are: WCPFC, IATTC, ICCAT, IOTC and NAFO. Within the Pacific Ocean, SPC and FFA are also involved in data management and monitoring and surveillance. An advisory body (Council of Regional Organisations in the Pacific) facilitates cooperation between RFMOs. The ABNJ project is also aiming to improve cooperation between tuna RFMOs.	UNCLOS Annex 1 www.un.org/unlcos/annex1; http://www.commonoceans.org/home/en/ Lack et al. 2014, Clarke and Nichols 2015
Non-membership of RFBs	The main catching country of Hammerhead (general) is Indonesia which is a member of WCPFC & IOTC. There is no specific information on main catching country of Scalloped Hammerheads.	FAO 2016
Nature of harvest	Taken as target, byproduct and bycatch. Fishing effort is not evenly spread across Indian Ocean stock. Catch by Indian Ocean countries is poorly known (see Part 3).	Baum et al. 2007, FOA 2016
Fishery types	Country adds this.	See published information for summary of fisheries, target species, main gear types, and scale of fisheries.
Management units	In the Indian Ocean region, the main body responsible is IOTC. Gaps in regional management are in the Areas Beyond National Jurisdiction (ABNJs). National level: Country adds this	http://www.IOTC.org
Products in trade	Fins are the main product. In some cases, meat, skin, liver oil and jaws are also traded. Each country needs to verify their products in trade.	CITES 2013a, Lack and Meere 2009.
Part 3. Data and data sharing		
Reported national catch(es)	Country adds this	See Published Information (Section 2.3)
Are catch and/or trade data available from other States fishing this stock?	Yes, some. Tuna (and tuna like species) bycatch data are requested by IOTC with coastal data also managed by countries. Access to the data requires permission from each member country for both the pelagic and coastal catch data. Trade data reported by some Indian Ocean countries to FAO.	See Published Information (Section 2.3)
Reported catches by other States	Yes, there are reported catches by many other Flag States. Average annual catch in tonnes of all hammerheads in the Indian Ocean is for the previous five years:	
Catch trends and values	The limited catch data precludes any analyses of catch trends with confidence.	

Have RFBs and/or other States fishing this stock been consulted during or contributed data during this process?	Yes, member countries were requested to provide data.	See Published Information (Section 2.3)

Sources of information

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Lack, M., Sant, G., Burgener, M., and Okes, N. (2014) Development of a rapid management-risk assessment method for fish species through its application to sharks: framework and results. Report to the Department of Environment, Food and Rural Affairs. Defra Contract No. MB0123.

Last, P.R., and Stevens, J.D. (2009) 'Sharks and rays of Australia.' 2nd edn. (CSIRO Publishing: Melbourne)

Mundy-Taylor, V., and Crook, V. (2013) Into the deep: implementing CITES measures for commercially - valuable sharks and manta rays. TRAFFIC.

NOAA. 2013. https://www.federalregister.gov/a/2013-07781. Downloaded on 15 December 2015.

NEXT STEPS

The information collated in the above worksheets can now be passed to the Scientific Authority, so that the NDF process can begin with Step 2

Worksheet for Step 2

Question 2.1
What is the level of intrinsic biological vulnerability of the species?

- See pages 73–75 of **Annex 1** for additional Guidance Notes on completing this Worksheet**.**
- In the Worksheet below, circle **the level of vulnerability** associated with each **Intrinsic Biological Factor**. Default indicator/metric figures for listed shark and ray species are provided in **Annex 4** (pages 111-131). These may be inserted here, but they are derived from international standardised data and may not reflect local stock characteristics. Wherever possible, verified local data on stocks should be utilised.

Intrinsic biological factors *(see page 73 of the Guidance Notes)*	**Level of vulnerability** *(circle or highlight as appropriate)*	**Indicator/metric** *(see page 73 of the Guidance Notes)*
a) Median age at maturity	Low	3.8 years (male), 4.1 years (female) (2 band pairs per year) Chen et al. 1990; Taiwan)
	Medium	8.9 years (male), 13.2 years (female) (1 band pair per year) Drew et al. 2015; Indonesia) 5.7 years (male), (no female estimate) (1 band pair per year) (Harry et al. 2011; tropical east coast Australia) INDIAN OCEAN specific values are lacking.
	High	
	Unknown	
b) Median size at maturity	Low	
	Medium	1471 mm L_{ST} (male) (Harry et al. 2011; tropical east coast Australia) 1500 mm L_{ST} (male) (Stephens and Lyle 1989; northern Australia) 1756 mm L_{ST} (male) (White et al. 2008; Indonesia)
	High	2285 mm L_{ST} (female) (White et al. 2008; Indonesia)
	Unknown	
c) Maximum age/longevity in an unfished population	Low	
	Medium	10.6-11 years (male) and 14.0-18.6 years (female) (based on 2 band pairs per year) (Chen et al. 1990, Anislado-Telentino and Robinson-Mendoza 2001, Anislado-Telentino et al. 2008). 21 years (male) (1 band pair per year) (Harry *et al.* 2011)

	High	35 years (female) (1 band pair per year) (Drew et al. 2015)
	Unknown	
d) Maximum size	Low	
	Medium	
	High	3010 mm TL (male), 3460 mm TL (female) (Stephens and Lyle 1989) (observed)
	Unknown	
e) Natural Mortality rate (M)	Low	
	Medium	
	High	0.123 year-1 (Harry et al. 2011); 0.107 $year^{-1}$ (Chen and Yuan 2006).
	Unknown	
f) Maximum annual pup production (per mature female)	Low	12-41 (mean 25-26) (Chen et al. 1988, White *et al.* 2008) (annual cycle)
	Medium	6-21 (mean 12.5-13) biennial cycle (Liu and Chen 1999)
	High	
	Unknown	
g) Intrinsic rate of population increase (r)	Low	
	Medium	0.205 $year^{-1}$ (2 band pairs per year) (Liu and Chen 1999)
	High	0.086 $year^{-1}$ (1 band pair per year) (Chen and Yuan 2006)
	Unknown	
h) Geographic distribution of stock	Low	Global male population (Daly-Engel et al. 2012)
	Medium	Indo-West Pacific female population (Duncan et al. 2006; Baum et al. 2007, NOAA 2013)
	High	
	Unknown	
i) Current stock size relative to historic abundance	Low	
	Medium	
	High	Reported large declines in hammerhead complex abundance of 60-99% over

		recent decades in Atlantic and Indo-Pacific (CITES 2013a)
	Unknown	
j) Behavioural factors	Low	
	Medium	
	High	Inshore pupping and high natural predation on juveniles (Baum et al. 2007), aggregating behaviour, and very high at-vessel fishing mortality rates (Morgan and Burgess 2007)
	Unknown	
h) Trophic level	Low	
	Medium	
	High	4.1 (Froese and Pauly 2015)
	Unknown	

SUMMARY for Question 2.1
Intrinsic biological vulnerability of species

Provide an assessment of the overall intrinsic biological vulnerability of the species (tick appropriate box below). Explain how these conclusions were reached and the main information sources used.

High	*Medium*	*Low*	*Unknown*

Explanation of conclusion and sources of information used:

Most of the intrinsic biological factors are ranked as a high vulnerability with females generally more vulnerable than males. The exceptions are pup production which is low to medium vulnerability and male geographic distribution which is also a low vulnerability but medium vulnerability for females. There is a circumglobal distribution but genetic structuring is evident between ocean basins. The Indo-West pacific population is considered as warranted for Endangered listing (NOAA US listing process).

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NEXT STEPS

- Go to **Section 2.2**

Worksheet for Step 2 (continued)

Question 2.2
What is the severity and geographic extent of the conservation concern?

- See pages 76–80 of **Annex 1** for additional Guidance Notes on completing this Worksheet**.**
- Based on existing stock assessments or conservation status assessments, evaluate the severity and geographic extent/scope of conservation concern, including reasons for the conclusions drawn and information on sources used.
- In the Worksheet below, circle the **level of severity/scope of concern** associated with each **Factor** using the descriptions in the indicator column in **Table B** in the Guidance Notes (**Annex 1**). In the column entitled Indicator in the Worksheet below, note briefly the reason for this assessment of level of severity/scope of concern. Further explanation (including information on sources used) can be provided in the boxes entitled '*Comments*'.

Conservation concern factors *(see page 78 of the Guidance Notes)*	**Level of severity/scope of concern** *(circle as appropriate)*	**Indicator/metric** *(see page 78 of the Guidance Notes)*
Conservation or stock assessment status	Low	
	Medium	
	High	IUCN – Global Endangered and Eastern Central and Southeast Pacific stock Endangered (Baum et al. 2007) NAFO only stock assessment-stock is overfished and overfishing occurring (Lack et al. 2014)
	Unknown	
	Comments:	
Population trend	Low	
	Medium	
	High	Population trend decreasing and global stock of hammerhead complex is estimated at 15-20% of historic baseline (CITES 2013a)
	Unknown	
	Comments:	
Geographic extent/scope of conservation concern	Low	
	Medium	
	High	Identified threats affect the entire global population of the species and the Indo-West Pacific Population (Baum et al. 2007)

	Unknown	
	Comments:	

SUMMARY for Question 2.2
Severity and geographic extent of the conservation concern

Provide an assessment of the overall severity and geographic extent of the conservation concern for this species or stock (tick appropriate box below). Explain how these conclusions were reached and the main information sources used.

High	*Medium*	*Low*	*Unknown*

Explanation of conclusion and sources of information used:

The Scalloped Hammerhead is Endangered, populations of the hammerhead complex have decreased dramatically from baseline levels and the threats are high to both the global and Indo-West Pacific population.

Baum, J., Clarke, S., Domingo, A., Durocq, M., Lamonaca, A.F., Gaboir, N., Graham, R., Jorgensen, S., Kotas, J.E., Medina, E., Martinez-Ortiz, J., Monzini, J., Morales, M.R., Navarro, S.S., Perez-Jimenez, J.C., Ruiz, C., Smith, W.D., Valenti, S.V., and Vooren, C.M. 2007. www.iucnredlist.org. Downloaded on 15 December 2015.

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NEXT STEPS

- Go to **Step 3**

Worksheet for Step 3

Question 3.1
What is the severity of trade pressure on the stock of species concerned?

- See pages 81–84 of **Annex 1** for additional Guidance Notes on completing this Worksheet**.**
- In the Worksheet below, circle the **level of severity** associated with each trade pressure **Factor** using the descriptions in the Indicator column in **Table C** in the Guidance Notes (**Annex 1**). In the column entitled **Indicator/metric** in the Worksheet below, note briefly the reason for this assessment of level of trade pressure severity. Consider **all products in both domestic and international trade.**
- For each Factor, circle the **level of confidence** associated with each assessment of trade pressure severity. This involves an assessment of the **quality of the information** used to evaluate the severity of trade pressure on the stock of the species concerned.
- In the box entitled '*Reasoning*', provide reasons to justify the evaluation of severity of trade pressure and assessment of confidence level (i.e. quality of information used). Here, comments/information should also be provided on:
  - the sources of information used to evaluate severity of trade pressure;
  - whether a precautionary approach was taken to the evaluation of trade pressure severity (e.g. due to a lack of robust trade information to inform the evaluation);
  - whether the evaluation of trade pressure was adjusted (i.e. severity increased to a higher level) to take into account high intrinsic biological vulnerability/conservation concern assessed in **Step 2**;
  - whether information is particularly lacking and, if so, how this data availability may be improved (see also **Section 6.1** of the Guidance Notes in **Annex 1** for further advice).

Factor *(see page 84 of the Guidance Notes)*	**Level of severity of trade pressure** **Country needs to fill this in** *(highlight or circle as appropriate)*	**Indicator/metric** *(see page 84 of the Guidance Notes)*
a) Magnitude of legal trade	Low	
	Medium	
	High	
	Unknown	
	Level of confidence *(circle as appropriate): (see page 83 of Guidance Notes)* Low Medium High	
Reasoning (e.g. has this assessment involved the exercise of precaution, and/or has severity of trade pressure been increased in light of the assessment in Step 2?)		
b) Magnitude of illegal trade	Low	
	Medium	
	High	
	Unknown	
	Level of confidence *(circle as appropriate): (see page 83 of Guidance Notes)* Low Medium High	

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NDF

Reasoning (e.g. has this assessment involved the exercise of precaution, and/or has severity of trade pressure been increased in light of the assessment in Step 2?)

NEXT STEPS

- Add notes in the Worksheet for **Section 6.1** on improvements in trade data availability/monitoring required to evaluate trade pressure under **Section 3.1**.
- GO TO **Section 3.2** to evaluate fishing pressures.

Worksheet for Step 3

Question 3.2
What is the severity of fishing pressure on the stock of species concerned?

- See pages 85–90 of **Annex 1** for additional Guidance Notes on completing this Worksheet**.**
- In the Worksheet below, circle the **level of severity** associated with each fishing pressure **Factor** using the descriptions in the Indicator column in **Table D** in the Guidance Notes (**Annex 1**). In the column entitled **Indicator/metric** in the Worksheet below, note briefly the reason for this assessment of level of fishing pressure severity. Consider **all fishing methods and gears that** interact with the shark stock concerned.
- For each Factor, circle the **level of confidence** associated with each assessment of fishing pressure severity. This involves an assessment of the **quality of the information** used to evaluate the severity of fishing pressure on the stock of the species concerned.
- In the box entitled '*Reasoning*', provide reasons to justify the evaluation of severity of fishing pressure and assessment of confidence level (i.e. quality of information used). Here, comments/information should also be provided on:
  - the sources of information used to evaluate severity of fishing pressure;
  - whether a precautionary approach was taken to the evaluation of fishing pressure severity (e.g. due to a lack of robust information to inform the evaluation);
  - whether the evaluation of fishing pressure was adjusted (i.e. severity increased to a higher level) to take into account high intrinsic biological vulnerability/conservation concern assessed in **Step 2**;
  - whether information is particularly lacking and, if so, how this data availability may be improved (see also **Section 6.1** of the Guidance Notes in **Annex 1** for further advice).

Factor *(see page 89 of the Guidance Notes)*	**Level of severity of fishing pressure** **Country needs to fill this in** *(highlight or circle as appropriate)*	**Indicator/metric** *(see page 89 of the Guidance Notes)*
a) Fishing mortality (retained catch)	Low	

	Medium	
	High	
	Unknown	
	Level of confidence *(circle as appropriate): (see page 88 of Guidance Notes)* Low Medium High	
Reasoning (e.g. has this assessment involved the exercise of precaution, and/or has severity of fishing pressure been increased in light of the assessment in Step 2?)		
b) Discard mortality	Low	
	Medium	
	High	
	Unknown	
	Level of confidence *(circle as appropriate): (see page 88 of Guidance Notes)* Low Medium High	
Reasoning (e.g. has this assessment involved the exercise of precaution, and/or has severity of fishing pressure been increased in light of the assessment in Step 2?)		
c) Size/age/sex selectivity	Low	
	Medium	
	High	
	Unknown	
	Level of confidence *(circle as appropriate): (see page 88 of Guidance Notes)* Low Medium High	
Reasoning (e.g. has this assessment involved the exercise of precaution, and/or has severity of fishing pressure been increased in light of the assessment in Step 2?)		

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d) Magnitude of illegal, unreported and unregulated (IUU) fishing	Low	
	Medium	
	High	
	Unknown	
	Level of confidence *(circle as appropriate): (see page 88 of Guidance Notes)* Low Medium High	
Reasoning (e.g. has this assessment involved the exercise of precaution, and/or has severity of fishing pressure been increased in light of the assessment in Step 2?)		

NEXT STEPS

- Add notes in the Worksheet for **Section 6.1** on improvements in fisheries data availability/monitoring required to evaluate fishing pressure under **Section 3.2**.
- GO TO **Section 4** to evaluate the extent to which existing management measures are effective in mitigating the risks/pressures/concerns identified in **Steps 2 and 3**.

Worksheet for Step 4

Preliminary stage
Compile information on existing management measures

In the table below, provide a list of existing generic and species-specific management measures in place for the stock or population of the species concerned. Consider measures implemented at the **(sub-) national, regional and international level** (i.e. including any measures implemented by relevant RFBs). Include a brief description of each measure, the sources of information used and any other comments if appropriate.

A table of commonly used generic and species-specific fisheries management measures is provided in **Annex 5** (page 132). It is **advisable to consult Annex 5 prior to completing the Worksheets in this section, in conjunction with context-specific fisheries management advice.**

Existing management measures *(see Annex 5 for examples)*	**Is the measure generic or species-specific?**	**Descriptions/comments/sources of information**
(SUB-)NATIONAL Country needs to fill this in		
REGIONAL/INTERNATIONAL		
IOTC 05/05-1	Generic to sharks	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 (http://iotc.org/sites/default/files/documents/compliance/cmm/iotc_cmm_05-05_en.pdf)
IOTC 05/05-2	Generic	IOTC Working Party on Ecosystems and Bycatch) provide preliminary advice on the stock status of key shark species and propose a research plan and timeline for a comprehensive assessment of these stocks.
IOTC 05/05-3	Generic	CPCs shall take the necessary measures to require that their fishermen fully utilise their entire catches of sharks.
IOTC 05/05-3,4,5,6	Generic	CPCs shall require their vessels to not have onboard fins that total more than 5 % of the weight of sharks onboard, up to the first point of landing.
IOTC 05/05-7	Generic	CPCs shall require their vessels to release sharks caught incidentally and are not used for food and/or subsistence.
IOTC 05/05-8-12	Generic	
IOTC 13/06-1,2	Generic to sharks	Regarding the assessment and management, provision of data.
IOTC 13/06-3	Oceanic Whitetip sharks	Prohibits the retention onboard, transhipment, landanding or storage of any part or whole carcass of oceanic whitetip sharks. (http://iotc.org/cmm/resolution-1306-scientific-and-management-framework-conservation-sharks-species-caught)
IOTC 13/06-4-6	Generic	Governs the reporting of catch, research, data collection and data submission

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NEXT STEPS

- GO TO **Question 4.1(a).**

Worksheet for Step 4 (continued)

Question 4.1(a)
Are existing management measures appropriately designed and implemented to mitigate the pressures affecting the stock/population of the species concerned?

- See pages 91–92 of **Annex 1** for additional Guidance Notes on completing this Worksheet**.**
- Firstly assess whether **appropriately designed** management measures are in place to mitigate the pressures affecting the stock/population of the species concerned:
  - From the '**Preliminary stage**' Worksheet above, transfer information on existing management measures into the Worksheet below, alongside the relevant fishing and trade pressure Factor(s) the measures(s) can help to mitigate (as evaluated in **Step 3**).
  - Use the information in the table of commonly used generic and species-specific fisheries management measures in **Annex 5** to determine which pressures the existing management measures in place can help to address/mitigate.
- Next, assess whether the existing management measures in place are being **implemented**:
  - In the column entitled "Relevant Monitoring, Control and Surveillance (MCS) measure(s)", include information on existing MCS measures that are relevant to the implementation of the existing management measures identified. **Annex 5** provides information on MCS measures that can help to secure compliance with commonly used fisheries management measures.
  - Second, based on the explanations provided in the column in the Worksheet below entitled "Overall assessment of compliance regime", make a judgement as to whether the existing management measure(s) identified is/are being implemented (i.e. adequately enforced/complied with).
  -

NOTE: in some circumstances where the fishing/trade pressure severity was assessed as "Low" for any of the Factors in **Step 3**, mitigation may not be required (see also the Guidance Notes for Question 4(a) in **Annex 1**). In such cases, "Not applicable" can be noted under the "Existing management measure(s)" and "Relevant MCS measure(s)" columns in the Worksheet (for that trade/fishing pressure Factor).

- Provide reasons to justify the assessments made in this Worksheet in the box entitled "Reasoning/comments", including any sources used.
- Where certain management measures are being implemented but others are not, this information can also be included under "Reasoning/comments". Also note down any considerations, issues or shortcomings relating to any of the management measures identified that will need to be kept in mind when completing the Worksheet for **Question 4.1(b)** below

Factor	**Existing management measure(s)**	**Relevant monitoring, control and surveillance (MSC) measure(s)**	**Overall assessment of compliance regime** *(tick as appropriate)*	
TRADE PRESSSURE **Country needs to fill this in**				
a) Magnitude of legal trade			Unknown (no information on compliance)	
			Poor (limited relevant compliance measures in place)	

			Moderate (some relevant compliance measures in place)	
			Good (comprehensive relevant compliance measures in place)	
	Reasoning/comments (e.g. Are management measures being implemented to varying degrees? Which compliance measures are lacking?)			
b) Magnitude of illegal trade			Unknown (no information on compliance)	
			Poor (limited relevant compliance measures in place)	
			Moderate (some relevant compliance measures in place)	
			Good (comprehensive relevant compliance measures in place)	
	Reasoning/comments (e.g. Are management measures being implemented to varying degrees? Which compliance measures are lacking?)			
FISHING PRESSSURE **Country needs to fill this in**				
a) Fishing mortality (retained catch)			Unknown (no information on compliance)	
			Poor (limited relevant compliance measures in place)	
			Moderate (some relevant compliance measures in place)	
			Good (comprehensive relevant compliance measures in place)	
	Reasoning/comments (e.g. Are management measures being implemented to varying degrees? Which compliance measures are lacking?)			

b) Discard mortality			Unknown (no information on compliance)	
			Poor (limited relevant compliance measures in place)	
			Moderate (some relevant compliance measures in place)	
			Good (comprehensive relevant compliance measures in place)	
	Reasoning/comments (e.g. Are management measures being implemented to varying degrees? Which compliance measures are lacking?)			
c) Size/age/sex selectivity			Unknown (no information on compliance)	
			Poor (limited relevant compliance measures in place)	
			Moderate (some relevant compliance measures in place)	
			Good (comprehensive relevant compliance measures in place)	
	Reasoning/comments (e.g. Are management measures being implemented to varying degrees? Which compliance measures are lacking?)			
d) Magnitude of IUU fishing			Unknown (no information on compliance)	
			Poor (limited relevant compliance measures in place)	
			Moderate (some relevant compliance measures in place)	
			Good (comprehensive relevant compliance measures in place)	
	Reasoning/comments (e.g. Are management measures being implemented to varying degrees? Which compliance measures are lacking?)			

NEXT STEPS	
• **Go to Question 4.1(b)**	

Worksheet for Step 4 (continued)

Question 4.1(b)
Are existing management measures effective (or likely to be effective) in mitigating the pressures affecting the stock/population of the species concerned?

- See pages 93–94 of **Annex 1** for additional Guidance Notes on completing this Worksheet**.**
- From the **Worksheet for Question 4.1(a)** above, transfer information on existing management measures currently in place into the column in the table below entitled "Existing management measure(s)", alongside the relevant fishing/trade pressure Factor.

NOTE as above for **Question 4.1(a)**: in some circumstances where the fishing/trade pressure severity was assessed as "Low" for any of the Factors in **Step 3**, mitigation may not be required (see also the Guidance Notes for **Question 4(b)** in **Annex 1**). In such cases, "Not applicable" can be noted under the "Existing management measure(s)" and "Relevant MCS measure(s)" columns in the Worksheet (for that trade/fishing pressure Factor).

- In the relevant columns in the table below, for each management measure indicate with a tick in the appropriate box whether:
    1. Data are collected and analysed to inform management decisions?
    2. Management is consistent with expert advice?

- Based on the responses to these questions, make a judgement as to whether the management measures(s) identified is/are effective/likely to be effective. Provide reasons to justify this assessment. For example, is effectiveness being compromised by poor design of the management measures or by their inadequate implementation (see responses in the Worksheet for **Question 4.1(a)** above)? Include information on any sources used in the box entitled "Reasoning/comments".

- Note that for each fishing/trade pressure identified, there may be more than one management measure currently in place aimed at mitigating the pressure. When assessing whether the management of a particular fishing/trade pressure is effective/likely to be effective, the aim should be to consider the combined effect of all relevant measures in mitigating the pressure identified.

Factor	**Existing management measure(s)**	**Are relevant data collected and analysed to inform management decisions? (e.g. landings, effort, fisheries independent data)** *Tick as appropriate*		**Is management consistent with expert advice?** *(tick as appropriate)*	
TRADE PRESSSURE **Country needs to fill this in**					
a) Magnitude of legal trade		No data OR data are of poor quality OR data are not analysed (adequately) to inform management		No expert advice on management identified	

		Limited relevant data are collected AND analysed to inform management		Not consistent	
		Some relevant data are collected AND analysed to inform management		Expert advice partially implemented	
		Comprehensive data collected AND analysed to inform management		Consistent	
	Management measure(s) effective/likely to be effective? (circle as appropriate) Yes Partially No Insufficient information				
	Reasoning/comments (e.g. Is effectiveness compromised by poor design and/or implementation, or is a greater diversity or amount of management required? What data are required to better inform and evaluate management decisions? How is management inconsistent with expert advice?)				
TRADE PRESSSURE **Country needs to fill this in**					
b) Magnitude of illegal trade		No data OR data are of poor quality OR data are not analysed (adequately) to inform management		No expert advice on management identified	
		Limited relevant data are collected AND analysed to inform management		Not consistent	
		Some relevant data are collected AND analysed to inform management		Expert advice partially implemented	
		Comprehensive data collected AND analysed to inform management		Consistent	
	Management measure(s) effective/likely to be effective? (circle as appropriate) Yes Partially No Insufficient information				
	Reasoning/comments (e.g. Is effectiveness compromised by poor design and/or implementation, or is a greater diversity or amount of management required? What data are required to better inform and evaluate management decisions? How is management inconsistent with expert advice?)				

FISHING PRESSSURE **Country needs to fill this in**					
a) Fishing mortality (retained catch)		No data OR data are of poor quality OR data are not analysed (adequately) to inform management		No expert advice on management identified	
		Limited relevant data are collected AND analysed to inform management		Not consistent	
		Some relevant data are collected AND analysed to inform management		Expert advice partially implemented	
		Comprehensive data collected AND analysed to inform management		Consistent	
	Management measure(s) effective/likely to be effective? (circle as appropriate) Yes Partially No Insufficient information				
	Reasoning/comments (e.g. Is effectiveness compromised by poor design and/or implementation, or is a greater diversity or amount of management required? What data are required to better inform and evaluate management decisions? How is management inconsistent with expert advice?)				
FISHING PRESSSURE **Country needs to fill this in**					
b) Discard mortality		No data OR data are of poor quality OR data are not analysed (adequately) to inform management		No expert advice on management identified	
		Limited relevant data are collected AND analysed to inform management		Not consistent	

		Some relevant data are collected AND analysed to inform management		Expert advice partially implemented	
		Comprehensive data collected AND analysed to inform management		Consistent	
	Management measure(s) effective/likely to be effective? (circle as appropriate) Yes Partially No Insufficient information				
	Reasoning/comments (e.g. Is effectiveness compromised by poor design and/or implementation, or is a greater diversity or amount of management required? What data are required to better inform and evaluate management decisions? How is management inconsistent with expert advice?)				
FISHING PRESSSURE					
c) Size/age/sex selectivity		No data OR data are of poor quality OR data are not analysed (adequately) to inform management		No expert advice on management identified	
		Limited relevant data are collected AND analysed to inform management		Not consistent	
		Some relevant data are collected AND analysed to inform management		Expert advice partially implemented	
		Comprehensive data collected AND analysed to inform management		Consistent	
	Management measure(s) effective/likely to be effective? (circle as appropriate) Yes Partially No Insufficient information				
	Reasoning/comments (e.g. Is effectiveness compromised by poor design and/or implementation, or is a greater diversity or amount of management required? What data are required to better inform and evaluate management decisions? How is management inconsistent with expert advice?)				

d) Magnitude of IUU fishing		No data OR data are of poor quality OR data are not analysed (adequately) to inform management		No expert advice on management identified	
		Limited relevant data are collected AND analysed to inform management		Not consistent	
		Some relevant data are collected AND analysed to inform management		Expert advice partially implemented	
		Comprehensive data collected AND analysed to inform management		Consistent	
	Management measure(s) effective/likely to be effective? (circle as appropriate) Yes Partially No Insufficient information				
	Reasoning/comments (e.g. Is effectiveness compromised by poor design and/or implementation, or is a greater diversity or amount of management required? What data are required to better inform and evaluate management decisions? How is management inconsistent with expert advice?)				

NEXT STEPS

- Add notes in the Worksheet for **Section 6.1** on improvements in data availability/monitoring required to evaluate the effectiveness/likely effectiveness of management under **Question 4.1(b)**.
- Add notes in the Worksheet for **Section 6.2** on improvements in management (including compliance systems) required to more fully mitigate the pressures impacting the stock/population of the shark species concerned.
- Go to **Step 5**

Worksheet for Step 5

Question 5.1
Based on the outcomes of the previous steps, is it possible to make a positive NDF (with or without associated conditions) or is a negative NDF required?

- See pages 95–97 of **Annex 1** for additional Guidance Notes on completing this Worksheet**.**
- Transfer all results from **Steps 2–4** to the Table below by circling the appropriate descriptors.
    - From the **Worksheets for Questions 2.1 and 2.2** above, transfer the **level of vulnerability** and **level of severity/scope of conservation concern** into the Worksheet below.
    - From the **Worksheets for Questions 3.1 and 3.2** above, transfer the **level of severity** for each trade and fishing pressure Factor into the second column in the Worksheet below and the **level of confidence** associated with each evaluation of severity into the third column in the Worksheet below.
    - Based on the information contained in the **Worksheets for Questions 4.1(a) and 4.1(b),** state in the Worksheet below whether the **existing management measures are effective/likely to be effective** at mitigating each of the pressures identified (taking into account whether they are **appropriately designed** and **being implemented**), or whether there is insufficient information to make such an assessment.
- Based on the information generated and evaluations made in the previous **Steps**, the Scientific Authority now has to decide whether to make a positive NDF for the export (with or without mandatory conditions), or a negative NDF. A decision tree to assist in this decision-making process is provided in the Guidance Notes in **Annex 1**.
- The final decision regarding the NDF should be indicated in the relevant box at the end of this Worksheet. Under "Reasoning/comments" include justification for the decision made and describe any **mandatory conditions** (for a positive NDF) and/or **recommendations as to further measures** (e.g. improvements in monitoring and/or management required – relevant for both positive and negative NDFs).

Step 2: Intrinsic biological vulnerability and conservation concern Country needs to fill this in				
Intrinsic biological vulnerability (Question 2.1)	High	Medium	Low	Unknown
Conservation concern (Question 2.2)	High	Medium	Low	Unknown

Step 3: Pressures on species Country needs to fill this in			**Step 4: Existing management measures** Country needs to fill this in
Pressure	**Level of severity (Questions 3.1 and 3.2)**	**Level of confidence (Questions 3.1 and 3.2)**	**Are the management measures effective* at addressing the concerns/pressures/impacts identified? (Question 4.1b)** **Taking into account the evaluation of management appropriateness and implementation under Question 4.1a*
Trade pressures Country needs to fill this in			
a) Magnitude of legal trade	High Medium Low Unknown	High Medium Low	Yes Partially No Insufficient Information **Not applicable

a) Magnitude of illegal trade	High Medium Low Unknown	High Medium Low	Yes Partially No Insufficient Information **Not applicable
** Only to be used where the trade pressure severity was assessed as "Low" for any of the Factors in **Step 3** and a judgement is made that the impacts on the shark stock/population concerned are so low that mitigation is not required.			
Fishing pressures Country needs to fill this in			
a) Fishing mortality (retained catch)	High Medium Low Unknown	High Medium Low	Yes Partially No Insufficient Information **Not applicable
b) Discard mortality	High Medium Low Unknown	High Medium Low	Yes Partially No Insufficient Information **Not applicable
c) Size/age/sex selectivity of fishing	High Medium Low Unknown	High Medium Low	Yes Partially No Insufficient Information **Not applicable
d) Magnitude of IUU fishing	High Medium Low Unknown	High Medium Low	Yes Partially No Insufficient Information **Not applicable
** Only to be used where the fishing pressure severity was assessed as "Low" for any of the Factors in **Step 3** and a judgement is made that the impacts on the shark stock/population concerned are so low that mitigation is not required.			

A) Can a positive NDF be made?	**YES** – *go to B*	**NO** – *go to **Step 6** and list recommendations for measures to improve monitoring/management under Reasoning/comments below*
B) Are there any mandatory conditions to the positive NDF?	**YES** - *list under Reasoning/comments below and go to C*	**NO** – *go to C*
C) Are there any other further recommendations? *(e.g. for improvements to monitoring/management)*	**YES** - *go to **Step 6** and list recommendations for measures to improve monitoring/management under Reasoning/comments below*	**NO**

Reasoning/comments (include justification for decision made and information on mandatory conditions and/or further recommendations)

NEXT STEPS

- OPTION 1: If improvements in monitoring or management are required (whether in the case of a **positive or negative NDF**) go to **Step 6**
- OPTION 2: If no improvements in monitoring or management are required, make a **positive NDF** and stipulate any **mandatory conditions**, if appropriate, to the Management Authority and any other relevant bodies.

Worksheet for Step 6
Further measures

Section 6.1
Improvement in monitoring or information required

In the space below, authorities are encouraged to list the improvements in monitoring or information that are required to address cases where:

(i) The severity of trade/fishing pressures has been assessed as unknown.
(ii) The level of confidence in the evaluation of trade/fishing pressures is low.
(iii) There is insufficient information on the effectiveness of management.
(iv)

Recommendations should be made in **consultation with the national fisheries management agency** and should be as **specific as possible** to address any gaps/shortcomings identified with **clearly defined objectives**. Time-frames for implementation should be specified where possible, including with regard to the review of progress on implementation.

See pages 98-99 of **Annex 1** for additional Guidance Notes on completing this Worksheet.

Country needs to fill this in

Section 6.2
Improvement in management is required

In the space below, authorities are encouraged to list the improvements in management that are required to address cases where management has been assessed as partially effective or ineffective at addressing any of the concerns/pressures/impacts identified, particularly where a fishing or trade pressure is assessed as medium or high (confidence levels: low, medium or high).

As noted above for **Section 6.1**, recommendations should be made in **consultation with the national fisheries management agency** and should be as **specific as possible** to address any gaps/shortcomings identified with **clearly defined objectives**. Time-frames for implementation should be specified where possible, including with regard to the review of progress on implementation.

See page 100 of **Annex 1** for additional Guidance Notes on completing this Worksheet.

Country needs to fill this in

5 Participant List

Participants in the CITES/IOTC workshop(left to right): Andhika Prima Prasetyo, Moazzam Khan, Lucia Pierre, Sarah Martin, Joel Rice, Farhan Khan, Johnson Grayson, Reza Shahifar, Rodney Govinden, Sisira Haputhantri., Stephen Ndegwa.