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Provision of scientific advice for the purpose of the implementation of the EUPOA sharks

FINAL REPORT

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For the Directorate-General for Maritime Affairs and Fisheries

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1 Executive Summary

The scope of the European Union Plan of Action for Sharks covers directed commercial, by-catch commercial, directed recreational, and by-catch recreational fishing of any chondrichthyans within European Union waters. It also includes any fisheries covered by current and potential agreements and partnerships between the European Union and third countries, as well as fisheries in the high seas and fisheries covered by RFMOs managing or issuing non-binding recommendations outside European Union waters.

Scientific advice for the purpose of the management of shark species in the high seas is carried out mainly via the Scientific Committees of the relevant Regional Fisheries Management Organisations (RFMO), as well as through specific projects by national institutes, and other research organisms. However, the level of knowledge concerning many shark populations in the high seas of the Atlantic, Indian and Pacific Oceans is far from satisfactory. It is therefore necessary to identify gaps in the current knowledge of fisheries, biology and ecology of sharks that should be filled in order to support advice on sustainable management of elasmobranches' fisheries and undertaking studies to fill those gaps.

Therefore, the objective of this project is to obtain scientific advice for the purpose of implementing the EUPOA on sharks as regards the facilitation of monitoring fisheries and shark stock assessment on a species-specific level in the high seas. The study is focused on major elasmobranch species caught by both artisanal and industrial large pelagic fisheries on the High Seas of the Atlantic, Indian and Pacific area, which are currently monitored and potentially managed by respective Tuna RFMOs. Specifically, firstly the study aims to collate and estimate historical fisheries data especially on species composition of catches, catches and effort, size frequencies in order to identify the gaps in the current availability of fishery statistics as well current knowledge biology and ecology of sharks that should be filled in order to support the scientific advice provided to RFMOs on sustainable management of elasmobranch fisheries. And secondly, the project aims to review and prioritise the gaps identified to develop a research program to fill those gaps in support for the formulation of scientific advice for management of sharks. The data and knowledge gaps identified through Phase I will allow focusing and prioritising the future research. From this summarisation of Phase I it will be clear as to what data is available for providing management advice for shark species, and where gaps in the data render this task difficult. In a second step, recommendations for data collection improvements as well as research necessities and activities will be described.

The data collected in Phase I of the project gives a complete picture of the current data availability of information about catch and effort, observer programs, size frequency information, biological information and fishery indicators that may support the assessment of major shark species in Tuna RFMOs. In spite of the importance of shark catches by industrial fleets, they have traditionally consisted of bycatch of commercial fisheries and sharks are most often discarded or finned. Therefore, most of the times, shark catches are not recorded, especially with the required level of resolution, and catches must be estimated by statistical procedures based on observer data, fishing effort and different covariates. Moreover, the information recorded is not usually available in the public domain in the Regional Fishery Management Organizations (RFMO) databases. The information on shark bycatch is scarce and their estimates found in the literature are not homogenous which made the raising and/or estimates of ratios (by-catch/target catch) uncertain due to various assumptions made (e.g. conversion of the estimates in number of individuals into weight without any information on the mean size per species).

In summary, the main difficulties and data gaps identified in the project can be described as follows: there is a lack of shark reporting in artisanal and coastal fisheries; there is a lack of shark reporting in industrial fisheries and when is reported usually is not broken down by species; there is a lack of any size frequency data; there is a lack of regional biological/ecological information for sharks; there are difficulties to access to the data both at RFMO level and at a country level; species misidentification which affect the collection of fishery statistics; low observer coverage for most of the fleets/areas; difficulties with the use of logbook data for shark assessment (misidentification, underreporting, change in targeting practice).

The work carried out in first phase of the project focuses on the collection of fishery information publicly available, mainly in the website public domain of the RFMOs in the Indian, Pacific and Atlantic Ocean as well as in the Mediterranean Sea (ICCAT-GFCM, IOTC, IATTC, and WCPFC) but also on information available in the literature, most of which comes from documents presented at the scientific meetings or workshops of RFMOs. The RFMO data administrators were also contacted in order to obtain any additional fishery statistics data. Similarly, information from flag states, and from EU-member states, was requested in order to improve the information available on discards levels, size frequencies and biological information.

Apart from RFMO official statistics, and in order to get more accurate and alternative catch data, shark catch estimations for the most recent period were appraised based on fleet specific ratios of shark catch over tuna (or target) catches. This was done in a two step process, first a general ratio between shark catches over tuna (target) catch was applied to estimate total shark catches for major fisheries and, then, the relative proportion by species in the catch was applied to estimate shark catches by species. Those ratios were obtained from the literature search and/or data from observer programs available in the RFMO or in the literature. This exercise allows identifying the fleets that could be mainly responsible for the catch of the main shark species included in the study based on the best assumption of the shark catch over target species catch ratios derived from the literature but also allows identifying the main impacted shark specis by fisheries in each areas as well as the main origin of underreporting.

In the Atlantic and Pacific (east and west), the Longline fleet targeting sharks, swordfish and/or tropical tunas is the most important métier catching sharks; which contributes with 59 %, 86 % and 95 % to the total shark catches respectively. On the contrary, the picture in the Indian Ocean is different where gillnet (GN - sensu lato) are contributing with 61 % of the total shark catch in comparison to 18 % for longliners.

In general, the species composition of the sharks in different métiers is similar in all Oceans as well as in the Mediterranan Sea. For example, Longline (LL - sensu lato) impacts mainly blueshark and shortfin mako and in a minor extend hammerhead, thresher, silky and oceanic whitetip sharks; whereas Gillnet (GN - sensu lato) are impacting mainly silky, thresher, Oceanic whitetip, and shortfin mako sharks. The catch of silky and oceanic whitetip shark for the longline fleet in the West Pacific is higher than other longline fleets of other Oceans because they are operating in more equatorial waters. Although, in all the Oceans, the contribution to the total catch of Purse seines is minor (maximum of 5 % of total catch in the West Pacific); the species composition of purse seines catch is clearly dominated by silky and oceanic whitetip sharks.

In all Oceans the main species impacted is blueshark with around 65-75 %, with the exception of the Indian Ocean and Mediterranean Sea, of the total shark catch. The contribution of the rest of the species can vary depending on the relative contribution of different fleets as well as the spatial distribution of the different fleets. However, in general the blueshark catch is then followed by shortfin mako, hammerhead, silky, thresher, Oceanic withetip shark. In the Indian Ocean, the blueshark contribution to total shark catch is around 35 % followed by silky shark (21 %), thresher (16 %), Oceanic whitetip (11 %), shortfin mako (10 %) and hammerheads (6 %). And in the Mediterrenean, blueshark contribution is around 50 % while other species make up the rest: thresher sharks (25 %), mako sharks (13.3 %), tope shark (6.1 %), rays (3.5 %), and porbeagle (1 %).

The comparison between the declared value and the estimated value can be considered as a figure for undereporting. For example, it is worth mentioning that the total average amount of the investigated species estimated is 1.5, 13 and 7 times higher than the average amount declared in the Atlantic Ocean, Mediterranean Sea and Indian Ocean, respectively. However, as the estimation carried out in this analysis was based on ratio of shark catch over total target catch there is high uncertainty on final estimations coming from different sources; such as métier classification, from target species quantities declared and from the shark/target catch ratio used to estimate the shark species investigated; which recommend to take these estimations with caution. It was not possible to apply this methodology to the Eastern and Western Pacific due to the lack of access to disaggretate tuna/target species catches from the IATTC/WCPFC public databases.

And the data above should be considered in the light of the different species productivity and susceptibility of a given species to a giving métier. This is important to take into account because in some cases a minor catch of one species from all fleets, or one fleet in particular, can have a great impact if the species in question is more vulnerable showing low productivity and high susceptibility to the fleet(s). So, it is important to consider the results above in the framework of Ecological Risk Assessment (ERA) which can help to identify priorities for observer programs/research efforts.

Finally, data gaps identified in relation to shark fishery statistics have been summarized with the aim to develop a research framework that would allow filling those gaps in order to assess and manage the shark population worldwide in a sustainable manner. The design of such programme is benefited and integrates all the information collected through phase I. For example, the data and knowledge gaps identified and listed/inventoried through Phase I allows focusing and prioritised the future research. From this summarisation of Phase I it is clear as to what data is available for providing management advice for shark species, and where gaps in the data render this task difficult. At this stage, recommendations for data collection improvements as well as research necessities and activities are described.

As such, the review of existing information; as well as the identification of information gaps, main shark species impacted and main métier responsible for major shark catch; presented above provides the basis for development of a research program and priorities for the assessment of the status of sharks in Tuna RFMOs. As it is not possible to develop a research program for all the Tuna RFMOs, a general framework to develop the research program in support of the scientific advice for shark management is proposed; which includes: (1) a research framework to identify the main species and fleets that needs to be prioritized for the collection of fishery data and information in order to assure the assessment of principal shark species regionally in the Tuna RFMOs; (2) a general recommendations for all Tuna RFMOs to improve the data collection to fill the gaps identified above; and (3) options for management and mitigation measures for sharks.

The research framework is proposed to be organized in three steps: (i) estimation of shark catches by species using the method proposed here which allows identifying the most impacted shark species and the métier most affecting those species; (ii) a preliminary Ecological Risk Assessment (or other preliminary assessment based on fishery indicators) by fleets which allows to identify the most vulnerable species to focus the efforts in conjunction with point (i); and (iii) specific recommendations of how to apply possible management measures, to improve data collection and assessment of those fleets/species identified as priorities based on points (ii) and (iii). The implementation of the three steps is highly related.

The project also recommends actions to fill the identified gaps structured in sections as data collection, data reporting, data resolution, data access, and assessment. As the data collected through phase I give a complete picture of what are the main fleets targeting the more important shark species caught in the Tuna RFMOs, both EU and other countries catching shark, as well as the extent of their volume; this exercise also helps to identify the different species for which more focus is needed and those that are supposed to be caught in a lesser extent. For example, this helps to focus the target or more important fleets to monitor and design specific representative observer schemes for those fleets as necessary. Having in mine the data gaps for major fisheries impacting pelagic sharks stocks in the different t-RFMOs Conventions areas as well as the most important metier catching sharks and most impacted shark species; the project proposes some possible solutions and recommendations for the implementation of observers programmes on those fisheries, aiming to improve shark data collection, namely regarding shark catch and discards: species composition; vessel mortality; size and sex data.

Management measures are essential when a given stock is seriously affected by the fishing activity and are aimed at limiting the impact of this activity. The election of a measure will depend on the stock status, on the behavior of the species, on the species being target or not, etc.; but the project summarizes several options of management and mitigation measures applicable to shark species.

2 Introduction

2.1 Background

The main objective of the Common Fisheries Policy is "*to ensure exploitation of living aquatic resources that provides sustainable economic, environmental and social conditions. For this purpose, the European Union shall apply the precautionary approach in taking measures designed to protect and conserve living aquatic resources, to provide for their sustainable exploitation and to minimise the impact of fishing activities on marine eco-systems. It shall aim at a progressive implementation of an ecosystem-based approach to fisheries management. It shall aim to contribute to efficient fishing activities within an economically viable and competitive fisheries and aquaculture industry, providing a fair standard of living for those who depend on fishing activities and taking into account the interests of consumers*" (EC Council Reg. 2371/2002). The principles inherent in this objective are particularly relevant to shark species[1], as they are top predators of the oceans and yet, due to their vulnerability, face significant decline and, for some species, even a real threat of extinction in the EU waters and worldwide.

Sharks are particularly vulnerable to overexploitation because of their biological characteristics of maturing late, low reproductive capacity and being long-lived. This results in these species having a limited capacity to recover from periods of over-fishing or other negative impacts. Action on sharks by the Food and Agriculture Organization of the United Nations (FAO), international treaties such as the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), Regional Fisheries Management Organizations (RFMOs) and shark catching countries and entities has been prompted by increasing international concern about shark stocks as a result of a growing body of evidence that many shark species are threatened and continuing to decline because of the fishing activity.

In this context, **an objective specified by the European Commission Directorate-General for Maritime Affairs and Fisheries (DG-MARE) is to obtain scientific advice for the purpose of implementing the European Union Plan of Action (EUPOA) on sharks as regards the facilitation of monitoring fisheries and shark stock assessment on a species-specific level in the high seas. The purpose of the EUPOA (which uses the FAO IPOA Sharks as a reference) is to contribute to the general objectives outlined in the FAO IPOA Sharks by ensuring the rebuilding of many depleted stocks fished by the European Union fleet within and outside European Union water**s. The Action Plan outlines what is already in place and what is still needed to do to ensure a comprehensive and coherent legislative policy and legislative framework for the conservation and management of sharks within and outside European Union waters.

The scope of the proposed Plan of Action covers directed commercial, by-catch commercial, directed recreational, and by-catch recreational fishing of any chondrichthyans within European Union waters. It also includes any fisheries covered

[1] For the purposes of this document, the term "shark" is taken to include all species of sharks, skates, rays and chimaeras (class Chondrichtyes).

by current and potential agreements and partnerships between the European Union and third countries, as well as fisheries in the high seas and fisheries covered by RFMOs managing or issuing non-binding recommendations outside European Union waters.

The Action Plan pursues the following three specific objectives[2]:

- To broaden the knowledge both on shark fisheries and on shark species and their role in the ecosystem;
- To ensure that directed fisheries for shark are sustainable and that by-catches of shark resulting from other fisheries are properly regulated;
- To encourage a coherent approach between the internal and external European Union policy for sharks.

2.2 *Objectives of the project*

The main objective of the European Union Action Plan is to contribute to the sustainability of shark populations fished by the European Union fleet within and outside European Union waters. The proposed Plan of Action covers any fishery activity in relation to sharks such as directed commercial, by-catch commercial, directed recreational, and by-catch recreational fishing of any shark within European Union waters but also of the European Union fleet fishing in high seas and managed by RFMOs.

Thus, from a scientific point of view th**e operational objective of the EUPOA on sharks aims to efficiently monitor and assess shark stocks on a species-specific level and develop harvesting strategies in accordance with the principles of biological sustainability and rational long term economic use**.

Scientific advice for the purpose of the management of shark species in the high seas is carried out mainly via the Scientific Committees of the relevant Regional Fisheries Management Organisations (RFMO), as well as through specific projects by national institutes, and other research organisms. However, the level of knowledge concerning many shark populations in the high seas of the Atlantic, Indian and Pacific Oceans is far from satisfactory. It is therefore necessary to identify gaps in the current knowledge of biology and ecology of sharks that should be filled in order to support advice on sustainable management of elasmobranches' fisheries and undertaking studies to fill any such gaps.

Therefore, the objective of this project is to obtain scientific advice for the purpose of implementing the EUPOA on sharks as regards the facilitation of monitoring fisheries and shark stock assessment on a species-specific level in the high seas. The study is focused on the large pelagic fisheries in the high seas of the Atlantic, Indian, Pacific Oceans and adjacent seas.

Specifically, the study will provide scientific information and advice regarding issues relating to the management of shark fisheries. It will collate and examine historical fisheries data especially on species composition of catches, realised catches and effort

[2] On a European Union Action Plan for the Conservation and Management of Sharks. COM(2009) 40 final. SEC(2009) 103.

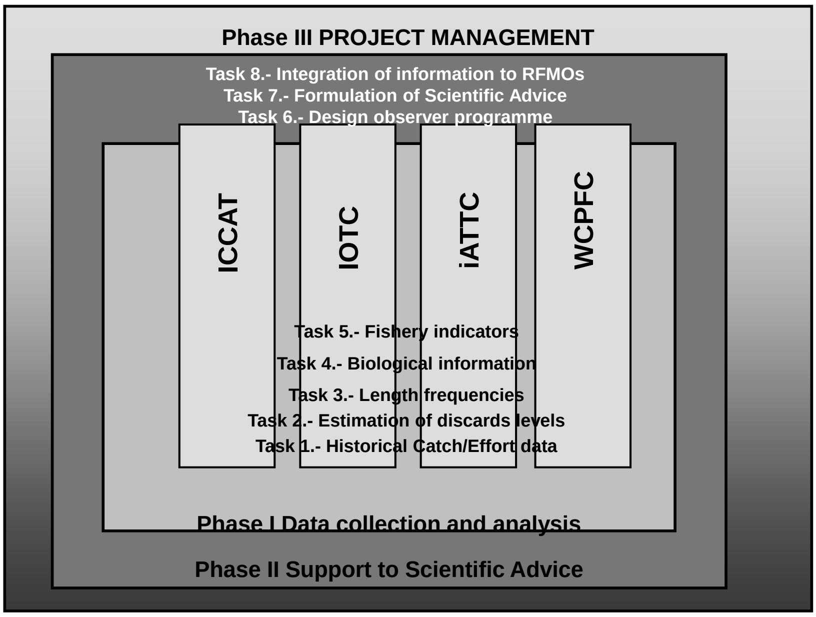
and will identify gaps in the current knowledge of the biology and ecology of sharks that should be filled in order to support advice provided to RFMOs on sustainable management of elasmobranch fisheries.

More specifically the project was focused on two main phases or stages each of them inclusing several tasks:

- Phase 1: Data collection, analysis and management;
  - ✓ Task 1.- Historical Catch/Effort data;
  - ✓ Task 2.- Estimation of discards levels;
  - ✓ Task 3.- Length frequencies from observers;
  - ✓ Task 4.- Biological information;
  - ✓ Task 5.- Fishery indicators (blue shark and shortfin mako).

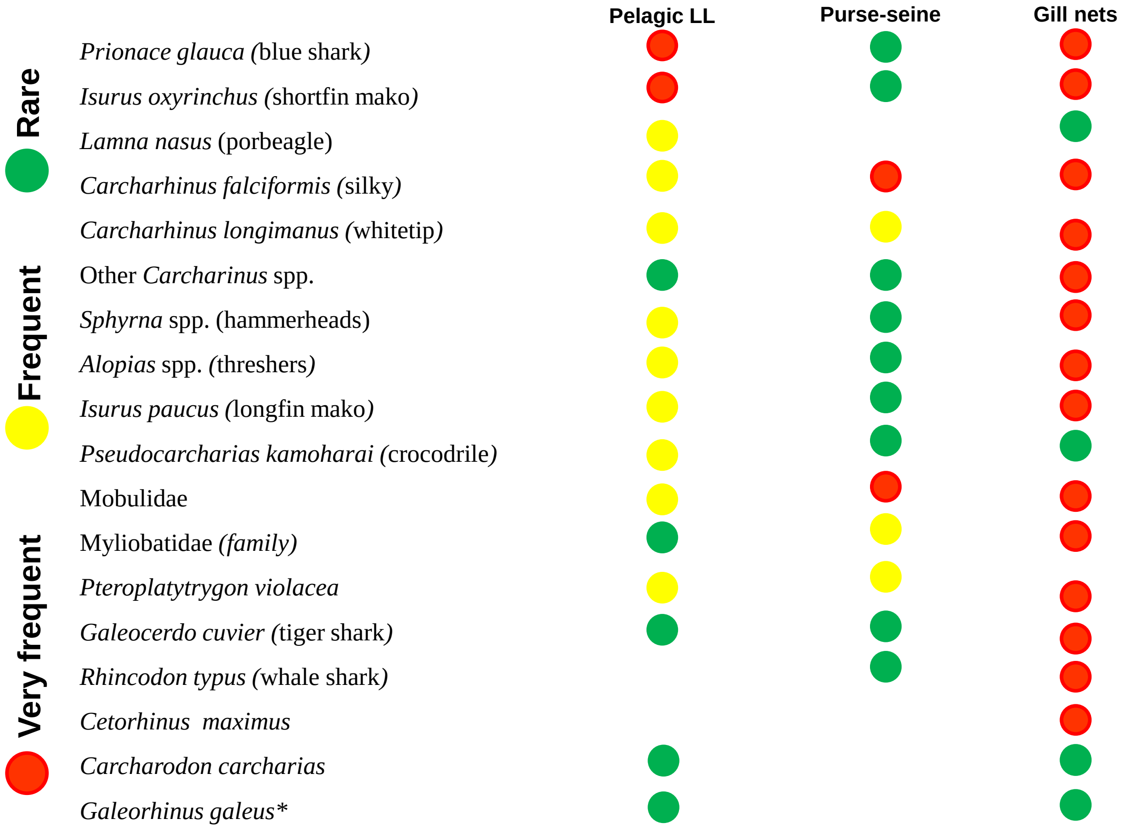
- Phase 2: Data analysis and support to scientific advice.
  - ✓ Task 6.- Design an observer program;
  - ✓ Task 7.- Formulation of scientific advice;
  - ✓ Task 8.- Integration of information to tuna RFMOs.

Where in the first phase a review of existing fishery, biological data, and assessments will be carried out and, in a second step, a program for the developing the scientific advice identifying the data and research gaps and the need of coordination will formulate.



The project is focused **<u>on major elasmobranch species caught by large pelagic fisheries (especially longline fishery, purse seine fishery, but also other major fisheries depending on the areas) on the High Seas of the Atlantic, Indian and Pacific area, which are currently monitored and potentially managed by respective Tuna RFMO (ICCAT, IOTC, IATTC, and WCPFC)</u>**.

Therefore, and based on previous definition, the following list of species was identified to be covered by the project ("studied shark species" through the report).



* Although is not taken in large pelagic fisheries, the project will also investigate this species in the Mediterranean Sea as it is very important catch of fisheries in the Mediterranean Sea.

2.3 Structure of the report

As said before, the project is focused on the large pelagic fisheries catching sharks as a target or bycatch (especially longline, purse seiner, but also other fisheries depending on the areas) of the Atlantic, Indian and Pacific area which are currently monitored and potentially managed by the respective Tuna RFMO (ICCAT, IOTC, IATTC, and WCPFC). For a more efficient data gathering and analyses of the fleets catching shark fisheries in the high seas of Atlantic, Indian and Pacific; the study in Phase I is divided into 4 areas which corresponds to the Tuna RFMOs managing the large pelagics fleets catching sharks (i.e. ICCAT in the Atlantic Ocean, IOTC in the Indian Ocean, and IATTC and WCPFC in the Pacific Ocean). In contrast, although the regional specifications are also important in the Phase II analysis, the Phase II tasks followed a more general approach to identify general pattern of data gaps and to recommend areas of future research to answer key questions for sustainable management and utilisation of shark resources within those areas and regions. As such, phase II report is not structured in 4 areas and, although includes some regional considerations, it is focused on common issues and problems and common solutions identified during phase I of the project.

2.4 *Methodology and data used*

This section is general to all Regions (or Tuna RFMOs).

Databases

Most of the information gathered so far was obtained from the Tuna RFMOs website, which allows visitors to download public fishery statistics databases, reports and scientific documents presented during the different Working Parties, Scientific Committee and Commission meetings. However, there is some delay on the incorporation of new information (namely statistics) on the Tuna RFMO website. Thus, the information provided in this report is mostly based on the last update of the databases. The RFMO data administrators were also contacted in order to obtain any additional fishery statistics data. Moreover, a large number of reports and scientific documents presented to the Tuna RFMO meetings were also analyzed to identify the availability of shark catch and bycatch data for various fleets and countries in the region.

The level of fishery statistics information available in the public domain of the Tuna RFMOs varies. While for WCPFC and IATTC the information is mainly given as nominal catches by species, gear and flag; the information available in IOTC and ICCAT public domain is more comprehensive including nominal catch as well as catch and effort and size frequency data disaggregated by areas, gear, flag and month. Therefore, the data available for the estimation of shark catches in IOTC/ICCAT was more comprehensive than the data available for IATTC/WCPFC.

In the case of IATTC/WCPFC, and although the persons responsible of IATTC and WCPFC databases were contacted to gather access to more disaggregated data for carrying the analysis and estimations planned in the project, the nominal catches of most of the fleets were mainly obtained from the public domain of the RFMOs' web sites, as well as from different sources within these organizations: annual reports, workshop reports, papers presented at scientific committees, resolutions, etc.

On the contrary, for ICCAT and IOTC, two different types of data were consulted to accomplish those objectives:

1. Databases available on the IOTC/ICCAT website (http://www.iotc.org; http://www.iccat.int)
    a. The Nominal Catch Information database (Task I): Nominal annual catch by species, region, gear and flag. Responsibility for reporting catch and landings data rests on flag states.
    b. Catch & Effort database (Task II): Catch and fishing effort statistics for each species by small area (1x1 degree squares for most gears, 5x5 degree squares for longlines), gear, flag and month.
    c. Size Frequency database (Task II): Actual size frequencies of samples measured for each species by small area (1x1 degree squares for most gears, 5x5 degree squares for longlines), gear, flag and month.
2. Reports available on the public website (SC documents, Working parties, Scientific documents, Resolutions, etc.).

In the particular case of GFCM, where the pelagic tuna fisheries data are reported to ICCAT while the rest of the fisheries report to GFCM, the major fisheries (country/fleet/gear) targeting tunas and sharks in the Mediterranean Sea have been identified using information available on the ICCAT (detailed data). For the time being, the GFCM Statistical Bulletin as overall statistical report/publication is the only way for the general public to access the GFCM Task 1 data. A web-based data access facility is going to be developed in the near future, in compliance with the resolution GFCM/35/2011/2 on data confidentiality policy and procedures.

Catch estimation

When possible, the data is presented in a 3 steps approach including 3 main general tables:

- Data gaps table: a table showing which countries reports data to the RFMO on shark catches. In summary, a table presenting if the data is available or not by country;
- RFMO official catch data for major fleets and countries catching sharks based on current data available in the RFMO. This table includes the catches of sharks but also the catches of target species, which may be a indicative of shark catch;
- Estimation of "possible" catch shark by major fleets and countries which are supposed to be catching shark based on the ratio of shark catch/bycatch over target species catch estimated through observers, literature or personnel communication.

For the estimation of 3rd table, dataset available in Tuna RFMOs (IATTC, ICCAT and IOTC) were analyzed in order to identify fleets susceptible to generate important catch of sharks. Based on the assumption that target species quantities declared by flag/fleet to RFMOs are correct estimation and that it is reliable to use these estimates to compute their potential shark catch knowing their métier (target species and their gear) and the corresponding ratio (shark bycatch/target species), we estimated the volume of sharks caught by fleets and ranked the main ones susceptible to impact sharks populations.

Based on the original database of RFMOs, which includes tuna and shark catch information by year, species, areas, gear, country, flag and fleet, we estimate the "potential" shark catches done by major fleets involved in shark fishery. Data used are reported as nominal catches by species for the period 2000-2010. The final table was the result of the following steps:

1. Step 1 - Ratio references table by métier: preparation of reference table of ratio shark bycatch/catch over target species catch by métier
    1.1. A list of métiers (combination of gear and target species group) is identified and for each of these métier are defined
        1.1.1. A ratio of shark (all species togehter) catch to target species group (in weight);
        1.1.2. shark species composition in proportion (sum = 1): the project focuses on 18 major sharks species.

The ratio's reference table is a summary including a list of métiers (see below) and the ratio of shark catch (all species together) to target species group (in weight) as well as the shark especies composition (in proportion) of the studied shark species.

So, this ratio reference table by métier incorporates the gear/target species information for each gear indicating the group of species targeted by the fishery. The ratio is the quantity (in tonnes) of sharks (all species included) caught for one ton of target species. For example, it is assumed in this study that baitboats (BB) generates zero (0) ton of sharks per ton of major tunas whereas gillnet combined (GN) generates 2 tons of shark per ton of target species (mostly tunas).

This information is based on literature available, expert knowledge and unpublished observer data.

Gear name	Metier Studied Sharks	Target species	Ratio catch / Target_sp	BSH	BSK	FAL	…	ALL
Baitboat	BB	Major tunas	0.000	*0.75*	*0*	*0.25*	*0*	*1*
Gillnet combined	GN	Major tunas	2.000					
Gillnet Inshore	GN-in	Small tunas	1.000					
Gillnet Offshore	GN-off	Major tunas	1.000					
Gillnet for sharks	GN-shark	Sharks	2.000					
Handline	HL	Major tunas	0.002					
Longline (others)	LL	Major tunas	0.150					
Longline for sharks	LL-shark	Sharks	1.200					
Longline for swordfish	LL-swo	Swordfish	0.700					
Longline for tunas	LL-tuna	Major tunas	0.150					
Others	OTH	Major tunas	0.300					
Purse seine	PS	Major tunas	0.002					
Purse seine - BFT	PS-bft	Major tunas	0.000					
PS: Small scale	PSST	Major tunas	0.002					
Recreational fisheries	SPOR	Major tunas	0.100					
Surface fisheries	SURF	Major tunas	0.500					
Trammel net	TN	Major tunas	0.002					
Trawl	TW	Major tunas	0.010					

In italic: an example to illustrate the species composition of shark catch.

2. Step 2: Preparation of data.

   2.1. Data task I (total nominal catches by flag and year) from RFMO are compiled by fishery i.e. a combination of flag, fleet and gear for the period 2000- 2010 (11 years)

   2.2. Mean nominal catches are calculated for target species groups (studied shark species, major tuna including billfishes but excluding swordfish, other sharks, other species, small tunas, swordfish). Two types of means have been calculated

2.2.1. Simple mean using all 11 years including 0. This means that if a country makes no declaration one year, this will be used as 0 catch. It is assumed here that each 0 or blank (no declaration) corresponds to a year without catch. This method give the **Low** estimate;

2.2.2. For positive years because we suspected most zero declaration were not zero catches. Then the mean is estimated by considering only years with positive shark catches. This method gives the **High** estimate;

2.2.3. Number of positive years has been compiled to see the effect of these two assumptions on the results.

2.3. For each fishery a métier is identified (combination of a gear and a target species group) according expert knowledge and species group profile declared.

3. Estimation of "potential" shark catches by métier

3.1. Based on ratio by métier (step 1) and target species average nominal catch declared (step 2) potential catch of studied sharks by species are estimated:

3.1.1. Studied Shark Species shark catch = Target species * Ratio $_{\text{studied shark species/target species}}$

3.2. The results are identified and ranked by

3.2.1. Studied shark species mostly impacted;

3.2.2. Métier most impacting studied sharks species altogether;

3.2.3. Métier most impacting studied sharks species by species.

The analysis is done by RFMO and the results are summarized in an Excel file by RFMO. Each file includes the following 12 tables:

1. **Readme**. General information on the file content and instructions for use;
2. **Ref_Table_Ratio**. Ratio references table by métier (step 1): the ratio of sharks to target species used by métiers as well as shark species composition;
3. **Results_Fisheries_H**. Main table compiling for each fisheries:
   a. Declared data by species group and studied species (mean tonnes for **positive years** and nb of positive years declared);
   b. Métier, target species (names and tonnage);
   c. Ratio to target species and estimated catch of studied shark species in tonnes;
   d. Rank of the fishery according to the studied shark species estimated catch;
   e. Various indicators compiled from previous columns.
4. **Results_Metier_H**. Internal table compiling crosstabulation of sheet Results_fisheries which is used to prepare the synthesis figures;
5. **Synthesis_dyn_H**. Serie of figures compiled dynamically from Results_fisheries and Results_métier to summarize the main results.
6. **Results_Fisheries_L**. Main table compiling for each fisheries:
   a. Declared data by species group and studied species (mean tonnes **for all years** and nb of positive years declared);

    b. Métier, target species (names and tonnage);
    c. Ratio to target species and estimated catch of studied shark species in tonnes;
    d. Rank of the fishery according to the studied shark species estimated catch;
    e. Various indicators compiled from previous columns.
7. **Results_Metier_L**. Internal table compiling crosstabulation of sheet Results_fisheries which is used to prepare the synthesis figures;
8. **Synthesis_dyn_L**. Serie of figures compiled dynamically from Results_fisheries and Results_métier to summarize the main results.
9. **Comparison**. Table comparing results for H (high) and L (los) estimation hypothesis;
10. **Data**. RFMO original data;
11. **Gears codes;**
12. **Species codes.**

<u>Assumptions and limitations</u>

Uncertainties in studied shark catches estimation may come from different sources: (i) from métier classification, (ii) from target species quantities declared and (iii) from the shark/target catch ratio used to estimate shark catches.

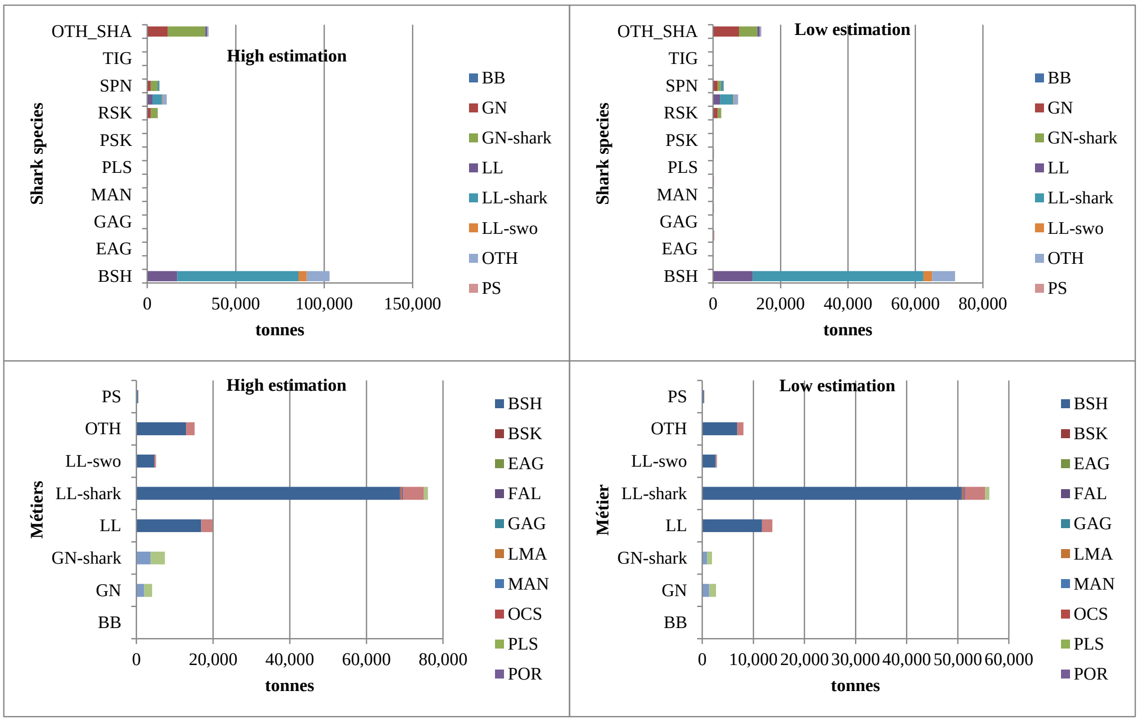
For example, for the Atlantic Ocean the total studied shark species catch is estimated to be 128,000 tonnes when a 0.15 ration is used for LL, whereas is estimated as 175,000 when the ratio used is 0.5. Therefore, it is very important to have observer data to estimate those ratios.

Ratios of studied sharks on target species have been considered homogeneous for the entire area exploited by the fishery. However, it is well known that ratios may vary according to fishing areas and this fact is sometime documented in litterature. Further analysis would gain in precision by aggregating data by large fishing areas.

A global sensitivity analysis of results should be conducted according to these different sources of uncertainties. Monte Carlo simulation may be used after assigning confident intervals to these different input parameters.

Another assumption which could produce different estimations is how to consider the undeclared catches (i.e. as 0 catches or just not reported). Average catch estimates based on positive year declaration avoid considering undeclared catch as 0 catch but it results considering an average positive catch for years without catch declaration. For the Indian Ocean this does not impact the global figure (+5%) but for the Atlantic Ocean this method generates important increase of estimated mean quantities declared, 50 % of difference globally by the two methods. This method may effectively correct undeclared catch (years undeclared) but may also consider non-active fisheries as active fisheries during the 11 years period studied. This assumption should be further explored. It is worth noting that the mean number of year declared is double is the IO than in the AO.

At this step we considered the estimate calculated with positive mean as the high level estimate and the one calculated with the simple mean including zero as the low level one.



High estimation
Shark species
OTH_SHA
TIG
SPN
RSK
PSK
PLS
MAN
GAG
EAG
BSH
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50,000
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GN-shark
LL
LL-shark
LL-swo
OTH
PS
Low estimation
Shark species
OTH_SHA
TIG
SPN
RSK
PSK
PLS
MAN
GAG
EAG
BSH
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3 Phase I

3.1 Indian Ocean Tuna Commission

3.1.1 Introduction

According to IOTC (2012) the Agreement for the Establishment of the Indian Ocean Tuna Commission was adopted by the FAO Council at its 105th Session in Rome on 25 November 1993, as the direct successor of the work conducted under Indo-Pacific Tuna Development and Management Programme (IPTP). The Agreement entered into force on the accession of the tenth Member on 27 March 1996.

The Indian Ocean Tuna Commission (IOTC) is an intergovernmental organization established under Article XIV of the FAO constitution. It is mandated to manage tuna and tuna-like species in the Indian Ocean and adjacent seas. The objective of the Commission is to promote cooperation among its Members with a view to ensuring, through appropriate management, the conservation and optimum utilization of stocks covered by this Agreement and encouraging sustainable development of fisheries based on such stocks. In order to achieve these objectives, the Commission has the following functions and responsibilities, in accordance with the principles expressed in the relevant provisions of the United Nations Convention on the Law of the Sea:

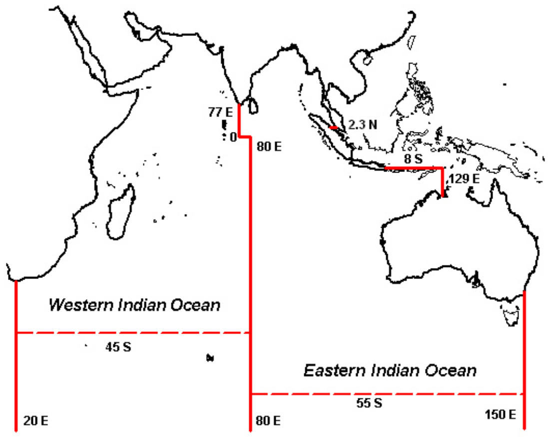
i) to keep under review the conditions and trends of the stocks and to gather, analyse and disseminate scientific information, catch and effort statistics and other data relevant to the conservation and management of the stocks and to fisheries based on the stocks covered by this Agreement;
ii) to encourage, recommend, and coordinate research and development activities in respect of the stocks and fisheries covered by this Agreement, and such other activities as the Commission may decide appropriate, including activities connected with transfer of technology, training and enhancement, having due regard to the need to ensure the equitable participation of Members of the Commission in the fisheries and the special interests and needs of Members in the region that are developing countries;
iii) to adopt, on the basis of scientific evidence, conservation and management measures to ensure the conservation of the stocks covered by this Agreement and to promote the objective of their optimum utilization throughout the Area;
iv) to keep under review the economic and social aspects of the fisheries based on the stocks covered by this Agreement bearing in mind, in particular, the interests of developing coastal states.

Conservation and management measures binding on Members of the Commission must be adopted by a two-thirds majority of Members present and voting. Individual members objecting to a decision are not bound by it. If objections to a measure are made by more than one-third of the Members of the Commission, the other Members are not bound by that measure; but this does not preclude any or all of them from giving effect. Recommendations concerning conservation and management of the stocks for furthering the objectives of this Agreement need only be adopted by a simple majority of its Members present and voting. It is under the responsibility of Members to ensure that action is taken under their national legislation to implement conservation and management measures which become binding on it. The Members of the Commission are also expected to cooperate in the exchange of information regarding any fishing for stocks covered by this Agreement by nationals of any State or entity which is not a Member of the Commission.

The Scientific Committee advises the Commission and sub-commissions on research and data collection, on the status of stocks and on management issues. As with other tuna RFMOs, separate sub groups composed of CPC country scientists conduct research on specific areas of interest to the Commission. Both Commission and Scientific Committee meetings take place on an annual basis. IOTC does not implicitly adhere to the precautionary approach to fisheries management, nor does it strictly include ecosystem considerations, although in practice, both are accounted for.

As regards shark issues, a specific working group dealing with ecosystem and bycatch issues was established to address ecosystem issues (WPEB - Working Party on Ecosystem and Bycatch). The WPEB first met in 2005, meeting regularly on annual basis since that. Outputs from these meetings are made available on a public access website and the Commission encourages the publication of relevant research in peer reviewed journals. Shark fisheries are currently the major issue during the WPEB meetings, which during the 2012 the WPEB "*recommended the IOTC Scientific Committee consider the following the possibility of a dedicated Working Party on Sharks (WPS), which could be held in alternate years to the WPEB, or to retaining the WPEB in its current form, but to ensure that each five to six day meeting alternatives its focus between sharks versus all other ecosystem and bycatch issues*".

The area of competence of the Commission is the Indian Ocean (defined for the purpose of this Agreement as being FAO statistical areas 51 and 57) 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.



IOTC area of competence

The species listed below are under the management mandate of IOTC. In addition, the Commission has instructed the Secretariat to collate data on non-target, associated and dependent species affected by tuna fishing operations, such as the pelagic sharks and rays.

Current list of species under the management of IOTC

FAO English name	**FAO French name**	**Scientific name**
Yellowfin tuna	Albacore	*Thunnus albacares*
Skipjack	Listao; Bonite à ventre rayé	*Katsuwonus pelamis*
Bigeye tuna	Patudo; Thon obèse	*Thunnus obesus*
Albacore tuna	Germon	*Thunnus alalunga*
Southern Bluefin tuna	Thon rouge du sud	*Thunnus maccoyii*
Longtail tuna	Thon mignon	*Thunnus tonggol*
Kawakawa	Thonine orientale	*Euthynnus affinis*
Frigate tuna	Auxide	*Auxis thazard*
Bullet tuna	Bonitou	*Auxis rochei*
Narrow barred Spanish Mackerel	Thazard rayé	*Scomberomorus commersoni*
Indo-Pacific king mackerel	Thazard ponctué	*Scomberomorus guttatus*
Indo-Pacific Blue Marlin	Makaire bleu de l'Indo Pacifique	*Makaira mazara*
Black Marlin	Makaire noir	*Makaira indica*
Striped Marlin	Marlin rayé	*Tetrapturus audax*
Indo-Pacific Sailfish	Voilier de l'Indo-Pacifique	*Istiophorus platypterus*
Swordfish	Espadon	*Xiphias gladius*

IOTC has currently 31 members (Australia, Belize, China, Comoros, Eritrea, European Union, France, Guinea, India, Indonesia, Iran-Islamic Republic of, Japan, Kenya, Republic of Korea, Madagascar, Malaysia, Maldives, Mauritius, Mozambique, Sultanate of Oman, Pakistan, Philippines, Seychelles, Sierra Leone, Sri Lanka, Sudan, Tanzania, Thailand, United Kingdom, Vanuatu and Yemen) and 2 cooperating non-contrating parties (Senegal, and South Africa).

In the following paragraphs there is a brief description of the fleets from the different IOTC members and cooperating non-contrating parties, with particular emphasis on those which may catch sharks. This resume is based on the most recent information presented at the 14th Session of the IOTC Scientific Committee, held in the Seychelles in December 2011.

Australia - Pelagic longline and purse seine are the two main fishing methods used by Australian vessels to target tuna and billfish in the Indian Ocean Tuna Commission (IOTC) Convention Area. In 2010, four Australian longliners (three from the Western Tuna and Billfish Fishery and one from the Eastern Tuna and Billfish Fishery) operated in the IOTC Convention Area. The number of active longliners and levels of fishing effort have declined substantially in recent years due to reduced profitability, primarily as a result of lower fish prices and higher operating costs.

Belize - Long line is the main fishing gear used by Belize flagged vessels to target tuna and tuna like species in the Indian Ocean Tuna Commission (IOTC) Convention area. The number of active long liners and levels of fishing effort have declined significantly in recent years due to reduced profitability, principally resulting from reduced fish prices and increased operating cost. The average size of the vessels from 2007 to 2010 have fluctuated over the years from 162 GT in 2007 to 241 GT in 2008, 88 GT in 2009 and 179 GT in 2010. There has also been a reduction in the number of vessels operating from 10 vessels in 2007, 9 in 2008, 6 in 2009 and 7 in 2010.

China - Longline is the only fishing method used by Chinese vessels to catch tuna and tuna-like species in the IOTC waters. The number of longliners operating in the Indian Ocean reduced from 32 in 2009 to 20 in 2010 due to piracy, with the main fishing area shifting to the central and eastern Indian Ocean (60 ºE ~ 85ºE , 5ºN ~20ºS).

Comoros – The Comoros fleet is exclusively artisanal, mostly comprising open-deck vessels, either equipped or not with engine, ranging in size from 3 to 9 m long. The most used fishing gears are trolling lines, small longlines and, at a lower level, gill nets.

Eritrea – not available.

European Union – The European Union fleet includes fleets from Spain, France, Portugal and United Kingdom:

- Two Spanish fleets are operating in the Indian Ocean: the purse seine fleet targeting tropical tuna and the longline fleet targeting swordfish. A total of 13 purse seiners and 12 longliners operated in the area during 2010. Purse seiners' carrying capacity for most of the vessels is higher than 1,200 t. Longline vessels range from 27 to 47 m in length.
- The French fleet is composed of three components: purse-seiners operating mostly from the Seychelles, longliners operating from La Réunion, and the artisanal fleet from Mauritius. In 2010 all 13 purse-seiners operating on the Convention area were over 800 GRT. The longline fleet based in La Réunion consisting of 43 vessels in 2009, 12 of which larger the 16 m long. The artisanal fleet from Mauritius as 192 vessels < 7 m long and 63 vessels ranging from 7 to 12 m, operating with trolling lines, longlines and nets.
- During 2010 the Portuguese fleet operating in the IOTC convention area consisted of four pelagic longliners targeting swordfish. The vessels ranged in size from 37 to 45 m (total length) and operated mostly in the SW (FAO area 51) and central (FAO area 57) areas of the Indian Ocean.

France (overseas territories) - The French fleet based in Mayotte is composed of purse-seiners and a large number of artisanal vessels (such as pirogues, open-deck boats and recently 3 longliners < 10 m) using mostly trolling lines, longlines and nets.

Guinea - not available.

India - India's tuna fishing fleet included in 2010 was composed of 295 vessels of which 80 (at least 53 longliners) are larger than 20 m. The coastal fleet is composed of small boats, namely gillnetters, mini-purseiners, and longliners. These coastal multipurpose boats operate a number of traditional gears, oceanic pole and line boats, small longliners and industrial longliners.

Indonesia – In 2010 the Indonesian fleet targeting tuna was compose by 1202 vessels, mostly longliners (1188) and at a much lower level purseiners (11) and gillnetters (3). Most of these vessels are in the range 51-200 GT. It is worth noting that there are fishing fleets targeting tunas less than Loa 24 m operating in the territorial waters above Indonesian EEZ that are not included in the above mentioned number.

Iran, Islamic Republic of - In 2010 a total of five industrial purse-seiners, 634 troll liners and 5920 gillnetters operated in the IOTC convention area. The purse seiners are >1000 GRT, while the gillnetters range from <3 (over 58%) to >100 GRT.

Japan - The Japanese fleet operating in the convention area is mostly composed of longliners, with 120-500GRT. Although some variation has been observed in terms of the annual active number of longliners, a maximum of 273 was reported in 1987, with a sharp decrease in recent years, with a minimum of 84 vessels operating in 2010. A few number of purse-seiners have been also operating in the convention area (1-12), with a single vessel fishing in 2010.

Kenya - In 2008 artisanal fishing activities are undertaken by 12,077 boats, of which about 2,687 boats are active. The most common fishing methods used are gillnets, traditional traps, seine nets, long line hooks, hook and line and others. In the EEZ 34 purse-seiners were licensed. The artisanal fleet is composed of different vessel types with two being the main target for tuna: outrigger (195) vessels and Dhows (629). The main gears targeting tuna are handlines (4132), longlines (9009), trolling lines (625), monofilament nets (1472) and gillnets (2150).

Korea, Republic of – Longline is the only fishing gear the Korean fleet uses to target for tuna species in the Indian Ocean. The fleet was decreased from 187 vessels in 1975 to 13 longliners in 2010, which was the lowest ever. All vessels are between 200-500 GRT.

Madagascar - The national fleet is composed by 41 vessels, most of which operating several fishing gears (e.g. longlines, trollinglines, gillnets and purse-seines). Most of the fleet (63%) is composed by vessels of 10-15 m long. However, the majority of the fleet consists of foreigner vessels from the UE and Asian countries.

Malaysia – The Malasysian fleet targeting tuna only consists of longliners, which increased from 15 in 2003 to 58 in 2010. Most of these vessels (72%) are larger than 24 m long, the fleet varying in LOA from 19 to 65 m and and from 38 to 882 GRT, respectively.

Maldives, Republic of - The Maldivian tuna fishing fleet underwent major changes since 1970. Prior to 1973 it was entirely a sailing fleet, sailing *masdhoni* (9-10 m LOA) for livebait pole-and-line and *vadhudhoni* (4-5 m LOA) for trolling, targeting mostly skipjack. By 1985 nearly all existing sailing vessels were mechanized. At the same time trolling vessels became less important and by 1990 the trolling fleet was no longer used for catching tuna. By 2010 an overall of 708 live bait pole-and-line and hand-line vessels were active, some of which over 30 m LOA.

Mauritius - Presently, only one local longliners with than 24 m is operating under Mauritian flag. The vessel has a GRT of 577 MT and LOA of 48 m, but two smaller longliners of GRT of 30-40 MT and LOA of 13-16 m were active in 2010. Moreover, licences are issued to foreign longliners (mostly Asian) and purse- seiners to operate in the Mauritian waters. A list of these is provided to IOTC.

Mozambique - Purse seine and long line are the two main fishing techniques used in Mozambique tuna fisheries. Those activities are undertaken by distant water fishing fleets, which operate in the EEZ as from 12 nautical miles off shore from January to December. In 2010, a total of 34 and 37 licenses were issued to foreigner purse-seiners (from France, Spain, Seychelles and Italy) and longliners from (Portugal, China, Spain, Korea, Japan, Namibia and UK), respectively. A sharp decrease on the number of licenses issued as been observed since 2008, probably due to security concerns in the western Indian Ocean region.

Oman, Sultanate of - In 2011 the fleet was composed of 18808 vessels (18731 artesanal, 49 coastal and 28 industrial). The artisanal fleet is responsible for most tuna (an tuna-like species) catches (>98%). The shark catches in 2011 amounted for 7055 MT, most caught by gillnets.

Senegal - Senegal has not conduct fishing activities in the IOTC area of competence since 2007.

Seychelles - In 2010 the purse seine fishery in the WIO is dominated by vessels from the European Union (France 9 and Spain 14 vessels), arising to a total of 35 vessels, only 8 being registered at the Seychelles. In 2010 a total of 42 licences were taken by longliners to fish inside the Seychelles EEZ, representing a decrease of 39% from the 69 licenses taken in 2009. 69% of the licences taken in 2010 were by Taiwanese longliners and 26% by Seychelles registered vessel. In 2010 there were 25 Seychelles registered vessels, all of Taiwanese origin.

South Africa – The country has three commercial fishing sectors which either target or catch tuna and tuna-like species as by-catch in the Indian Ocean. These sectors are swordfish/tuna longline, pole and line/rod and reel, and shark longline. In addition, there is a boat-based recreational/sport fishery. The swordfish/tuna longline fishery is restricted to 50 permits (one permit per vessel), in 2010 a total of 35 permits were issued. Seven shark exemption holders were permitted to fish in 2010, but only four vessels were active in the Indian Ocean. Six of the seven shark exemption holders were issued with tuna/swordfish rights in March 2011, five of which are actively fishing. The use of pole and line has been employed commercially since the 1970s to target tuna, in 2010 a total of 167 permits were issued. South Africa also has a commercial linefish fishery which opportunistically catches shark in the Indian Ocean, in 2010 a total of 454 were issued. It is worth noting that registered permits are not necessarily active in the Indian Ocean.

Pakistan - not available.

Philippines - not available.

Sierra Leone - not available.

Sri Lanka - Longlines and gillnets are the main fishing gears used for harvesting tuna and tuna-like species by Sri Lanka, although longlines have become more popular among fishermen. Around 3700 vessels were actively operating during the period 2009-2010, targeting large pelagic resources. About 1% of these vessels were <15 m in length.

Sudan - not available.

Tanzania - Presently the national fleet of Tanzania is all artisanal, with most fishing activities taking place within 6 nm from the shore, predominantly on reef areas. However a small number of boats are involved in the fisheries of tuna, bill fish and sharks, using manually handled drift gill nets and long lines.

Thailand – Thailand tuna fleet is comprised of purse-seiners, king mackerel gillneters and trawlers, while purse seine being the main fishing gear.

United Kingdom - On 1 April 2010 the BIOT Commissioner proclaimed a Marine Protected Area (MPA) in the British Indian Ocean Territory [UK (BIOT)]. No fishing licenses have been issued since that date and the last foreign fishing licenses expired on 31 October 2010. Diego Garcia and its territorial waters are excluded from the MPA and include a recreational fishery.

Vanuatu - There are only four longliners operating in the Indian Ocean since 2010. They are all less than 24 meters in size. They operated in the south-western region between 10°-40°S and 30°-75°E, mostly targeting oilfishes.

3.1.2 Bycatch issues at IOTC

IOTC has addressed for a number of years the issue of bycatch and has currently a devoted Working Party to specifically analyse and discuss bycatch issues – Working Party on Ecosystems and Bycatch (WPEB). The Table below (Table 3.1.1) resumes the current active resolutions by IOTC related with shark and shark data issues. The resolutions can be found in http://www.iotc.org/English/resolutions.php.

Table 3.1.1.-– Active IOTC resolutions related with shark issues.

Resolution #	Subject
05/05	Concerning the conservation of sharks caught in association with fisheries managed by IOTC
08/04	Concerning the recording of catch by longline fishing vessels in the IOTC area
10/03	Concerning the recording of catch by fishing vessels in the IOTC area
11/04	On a regional observer scheme
12/09	On the conservation of thresher sharks (family Alopiidae) caught in association with fisheries in the IOTC area of competence

What follows is a Resolution by Resolution brief resume of the major aspects covered by each of these:

Res. 2005/05 **- Concerning the conservation of sharks caught in association with fisheries managed by IOTC:**

- CPCs shall annually report data for catches of sharks, in accordance with IOTC data reporting procedures, including available historical data;
- In 2006 Scientific Committee (in collaboration with the WPEB) shall 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;
- CPCs shall require that fishermen fully utilise their entire catches of sharks. Full utilisation is defined as retention of all parts excepting head, guts and skins;
- 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/transhipment;
- Fishing vessels are prohibited from retaining on board, transhipping or landing any fins harvested in contravention of this Resolution;
- Ratio of fin-to-body weight of sharks shall be reviewed by the scientific committee;
- In fisheries that are not directed at sharks, CPCs shall encourage the release of live sharks that are caught incidentally and are not used for food and/or subsistence;

- CPCs shall, where possible, undertake research to identify ways to make fishing gears more selective (such as the implications of avoiding the use of wire traces);
- CPCs shall, where possible, conduct research to identify shark nursery areas;
- The Commission shall consider appropriate assistance to developing CPCs for the collection of data on their shark catches.

Res. 2008/04 **- Concerning the recording of catch by longline fishing vessels in the IOTC area:**

- CPCs shall ensure that all long line fishing vessels flying its flag and authorized to fish species managed by IOTC be subject to a data recording system. Within the IOTC Area of Competence, all long line vessels over 24 metres length and those under 24 metres if they fish outside the EEZs of their flag States shall keep a bound or electronic logbook to provide data for use by Working Parties and the Scientific Committee that includes, as a minimum requirement, the information and data in the logbook set forth in Annex I and II;
- Annex I include information on vessel, trip and gear configuration, and should be written once for each trip.
- Annex II, which contains information of longline operation and catch (in number and weight, should be filled for each set (blue shark, shortfin mako, porbeagle and other sharks, other species mentioned are not refereed herein) and discards.

Res. 2010/03 **- Concerning the recording of catch by fishing vessels in the IOTC area:**

- All purse-seine vessels flying its flag and authorized to fish species managed by IOTC be subject to a data recording system. Within the IOTC Area of Competence, all purse-seine vessels 24 metres length overall or greater and those under 24 metres if they fish outside the EEZs of their flag States shall keep a bound or electronic logbook to provide data for use by Working Parties and the Scientific Committee that includes minimum logbook requirements. As per this resolution, catch and discard of all shark species should be recorded.

Res. 2011/04 **- On a regional observer scheme** (This Resolution supersedes Resolution 10/04 on a Regional Observer Scheme)**:**

- The objective of the IOTC observer scheme shall be to collect verified catch data and other scientific data related to the fisheries for tuna and tuna–like species in the IOTC area;
- In order to improve the collection of scientific data, at least 5 % of the number of operations/sets for each gear type by the fleet of each CPC while fishing in the IOTC Area of 24 meters overall length and over, and under 24 meters if they fish outside their EEZs shall be covered by this observer scheme. For vessels under 24 meters if they fish outside their EEZ, the above mentioned coverage should be achieved progressively by January 2013;
- The indicative level of the coverage of the artisanal fishing vessels should progressively increase towards 5% of the total levels of vessel activity (i.e. total number of vessel trips or total number of vessels active);
- The confidentiality rules set out in the resolution 98/02 Data confidentiality policy and procedures for fine–scale data shall apply.

Res. 2012/09 **- On the conservation of thresher sharks (family Alopiidae) caught in association with fisheries in the IOTC area of competence:**

- Fishing Vessels flying the flag of an IOTC Member and Cooperating non-Contracting Parties (CPCs) are prohibited from retaining on board, transhipping, landing, storing, selling or offering for sale any part or whole carcass of thresher sharks of all the species of the family Alopiidae;
- CPCs shall require vessels to promptly release unharmed, to the extent practicable, thresher sharks when brought along side for taking on board the vessel;
- CPCs shall encourage fishermen to record incidental catches as well as live releases;
- CPCs and Co-operating non-Contracting Parties, especially those directing fishing activities for sharks, shall submit data for sharks, as required by IOTC data reporting procedures (including estimates of dead discard and size frequencies)

No specific IPOA has been developed in IOTC; however, as IOTC was established within the framework of the Food and Agriculture Organization of the United Nations (under article XIV of FAO Constitution), FAO IPOAs such as IPOA-IUU, IPOA-Seabirds, IPOA-Sharks, and IPOA-Capacity have been considered in IOTC resolutions.

At the 15th Session of the SC, the SC noted the current status of development and implementation of Nation Plans of Action for sharks and recommended that all CPCs without an NPOA-Sharks expedite the development and implementation of their NPOA-Sharks, and to report progress to the WPEB in 2013, recalling that NPOA-Sharks are a framework that should facilitate estimation of shark catches, and development and implementation of appropriate management measures, which should also enhance the collection of bycatch data and compliance with IOTC Resolutions.

The current status of development and implementation of National Plans of Action (NPOA's) for sharks, by each CPC, recalling that the IPOA-Sharks was adopted by the FAO in 1999 and 2000, respectively, and required the development of NPOAs is shown in table 3.1.2. Currently only nine of the 32 IOTC CPCs have NPOA-Sharks, with seven others in development.

Table 3.1.2.- Progress on the development and implementation of National Plan Of Actions (NPOA) for sharks according to the IOTC Secretariat, as by 30/08/2012. Color key: green - NPOA Completed; Yellow - Drafting being finalized; Orange - Drafting commenced; Red - Not begun.

CPC	Status	Date of implementation	Comments
Contracting Parties (IOTC Members)			
Australia	green	14/04/2004	2nd NPOA-Sharks (Shark-plan 2) was released in July 2012, along with an operational strategy for implementation: http://www.daff.gov.au/fisheries/environment/sharks/sharkplan2
Belize	red		No information available at IOTC Secretariat
China	red		Development as not begun
Taiwan,China	green	05/2006	No revision currently planned
Comoros	red		Development as not begun
Eritreia	red		No information available at IOTC Secretariat
European Union	green	05/02/2009	Currently being implemented
France (Terretories)	yellow		Approved on 05-Feb-2009 but not yet implemented.

Guinea			No information available at IOTC Secretariat
India			Currently being drafted with the assistance of BOBP-IGO
Indonesia			NPOA guidelines developed and released for public comment among stakeholders in 2010 (funded by ACIAR Australia -DGCF). Training to occur in 2011, including data collection for sharks based on forms of statistical data to national standards (by DGCF (supported by ACIAR Australia). Implementation expected late 2011/early 2012.
Iran, Islamic Republic of			Have communicated to all fishing cooperatives the IOTC resolutions on sharks. Have in place a ban on the retention of live sharks.
Japan		03/12/2009	NPOA - Shark assessment report submitted to COFI (Jan. 2011)
Kenya			Development has not begun. Scheduled for development in 2012. Sharks are considered a target species by Kenya.
Korea, Republic of			Approved on 18/08/2011 but not yet implemented
Madagascar			Development has not begun. *Note:* A fisheries monitoring system is in place in order to ensure compliance by vessels with the IOTC's shark and seabird conservation and management measures.
Malaysia		2006	No update received by the IOTC Secretariat
Maldives, Republic of			An earlier draft of the NOPA is available: Gaps/issues that arose following the total shark ban have been identified through support from the Bay of Bengal Large Marine Ecosystem (BOBLME) Project. Presently Maldives is seeking further support from BOBLME Project to finalize the plan and associated regulation to be published in Government Gazette.
Mauritius			Currently being drafted
Mozambique			Development as not begun
Oman, Sultinate of			No information received by the IOTC Secretariat
Pakistan			
Philippines		09/2009	Under periodic review. Shark catches for 2010 provided to the Secretariat.
Seychelles, Republic of		04/2007	NPOA-sharks to be reviewed in 2012
Sierra Leone			No information received by the IOTC Secretariat
Sri Lanka			An NPOA is planned for development in 2012provided at the next IOTC Scientific Committee meeting
Sudan			No information received by the IOTC Secretariat
Tanzania, United Republic of			Initial discussions have commenced
Thailand		25/11/2005	Second NPOA-sharks currently being drafted
United Kingdom	n/a	n/a	British Indian Ocean Territory (Chagos Archipelago) waters are a Marine Protected Area closed to fishing except recreational fishing around Diego Garcia.
Vanuatu			
Yemen			
Cooperating Non-Contracting Parties			
Senegal		25/09/2006	The Sub-Regional Fisheries Commission supported the development of a NPOA - sharks for Senegal in 2005. Other activities conducted include the organization of consultations with industry, the investigation of shark biology and social -economics of shark fisheries). The NPOA is currently being revised. Consideration is being made to the inclusion of minimum mesh size, minimum shark size, and a ban on shark finning.
South Africa, Republic of			The gazetting of the draft NPOA for public comment has been approved by the Minister of the Department of Agriculture, Forestry and Fisheries (06/07/2012).

3.1.3 Methodology and data used

Most of the information gathered so far was obtained from the IOTC website, which allows visitors to download public fishery statistics databases, reports and scientific documents presented during the different Working Parties, Scientific Committee and Commission meetings. However, there is some delay on the incorporation of new information (namely statistics) on the IOTC website. Thus, the information provided in this report is mostly based on the last update of the databases (NC_SHARKS and CEDATA), which occurred in 25/05/2011. The RFMO data administrators were also contacted in order to obtain any additional fishery statistics data. Moreover, a large number of reports and scientific documents presented to the IOTC meetings were also analyzed to identify the availability of shark catch and bycatch data for various fleets and countries in the region.

For more details see general section of Material and Methods.

3.1.4 Historical catch and effort data

The collection and reporting of catches of sharks caught in association with species managed by the IOTC (tuna and tuna-like species) has been very uneven over time. The information on the bycatch of sharks gathered in the IOTC database is thought, for this reason, to be very incomplete. The catches of sharks, when reported, are thought to represent simply the catches of these species that are retained on board. They refer, in many cases, to dressed weights and no indication is given on the type of processing that the different specimens underwent. The weights or numbers of sharks for which only the fins were kept on board are rarely recorded in the vessels‟ logbooks. This makes it really difficult any attempt to estimate the total catches of sharks in the Indian Ocean.

Table 3.1.3 resumes the information available for the IOTC convention area in terms of shark nominal catches and catch and effort by country (fleet), fishing gear and period. It was made based on the document present by the IOTC Secretariat (Herrera and Pierre, 2011) at the 7th WPEB meeting held in 2011.

According to this document:

- **Nominal catches** are highly aggregated statistics for each species estimated per fleet, gear and year for a large area. If these data are not reported the Secretariat attempts to estimate a total catch although this is not possible in many cases. A range of sources is used for this purpose (including: partial catch and effort data; data in the FAO FishStat database; catches estimated by the IOTC from data collected through port sampling and data published through web pages or other means).
- **Catch-and-effort** data refer to the fine-scale data (usually from logbooks, and reported per fleet, year, gear, type of school, month, grid and species). Information on the use of fish aggregating devices (FADs) and supply vessels is also collected.

Moreover, the information on sharks is assembled using the following criteria adopted by IOTC Secretariat for a document presented at the 7th WPEB meeting held in 2011 (Herrera and Pierre, 2011):

- **Historical SHARK data set** - general shark data that has been reported to the IOTC, corresponding to catches prior to 2006 and reported by June (December) 30th 2006. It is not clear which species of sharks are covered by this requirement.
- **Nominal catch data for MOST COMMON SHARK species** - general shark data that has been reported to the IOTC by June (December) 30th of year following that for which data are due, corresponding to catches from 2006 and thereafter. There is no definition for "most common species of sharks" and therefore it is not clear which species are covered.
- **Nominal catch data for OTHER SHARK species** - general shark data for most common species that has been reported to the IOTC by June (December) 30th of year following that for which data are due, corresponding to catches from 2006 and thereafter. As above, there is need to define for which shark species reporting of catch is obligatory so as the remaining species can be inferred.
- **Catch-and-effort data for MOST COMMON SHARK species** - general shark data that has been reported to the IOTC by June (December) 30th of year following that for which data are due, corresponding to catches from 2006 and thereafter. Same as above. Minima requirements for operational catch-and-effort data include provisions for the following species of sharks, by fishery:
  - ✓ <u>Longline and gillnet</u>: Blue Shark (*Prionace glauca*); Porbeagle Shark (*Lamna nasus*); Mako Sharks (*Isurus* spp.); Oceanic Whitetip Shark (*Carcharhinus longimanus*); Hammerhead Sharks (*Sphyrna* spp.); Other sharks (by species, where possible, in particular: Thresher Sharks (*Alopias* spp.); Tiger Shark (*Galeocerdo cuvier*); Crocodile Shark (*Pseudocarcharias kamoharai*); Other Requiem sharks (*Carcharhinus* spp.); Great White shark (*Carcharodon carcharias*); Pelagic stingray (*Pteroplatytrygon violacea*))
  - ✓ Purse seine: Not specified; where possible, data by species for: Whale Shark (*Rhincodon typus*); Oceanic Whitetip Shark (*Carcharhinus longimanus*); Silky shark (*Carcharhinus falciformis*)
  - ✓ <u>Pole-and-line</u>: Not specified; recorded as other species (sharks are seldom caught by baitboats)
  - ✓ <u>Other gears</u>: There are no requirements for operational catch-and-effort data for gears other than the above.
  - ✓ However, it is not clear if the above species are those for which reporting of catch-and-effort data is due.
- **Catch-and-effort data for OTHER SHARK species** - general shark data for most common species that has been reported to the IOTC by June (December) 30th of year following that for which data are due, corresponding to catches from 2006 and thereafter. As above, there is need to define for which shark species reporting of catch-and-effort data is obligatory so as the remaining species can be inferred.

The information compiled in Table 3.1.3 corresponds to the data available at the IOTC website (which was last updated by the Secretariat on 25/05/2011 and consulted in 20/04/2012) and that from the last Scientific Committee meeting report (2011). However, we are aware that new information has been and/or will be provided to IOTC in the near future, which will be incorporated in the other reports of this project.

Table 3.1.3.- Available information for the IOTC convention area in terms of shark nominal catches and catch and effort by country (fleet), fishing gear and period. *Historical* - general shark data that has been reported to the IOTC, corresponding to catches prior to 2006; *Common* - general shark data that has been reported to the IOTC, corresponding to catches for most common species from 2006 and thereafter; *Other* - general shark data that has been reported to the IOTC, corresponding to catches for other species from 2006 and thereafter.

			Nominal catches			**Catch and Effort**		
Country	**Flag**	**Gear Group**	**Common**	**Historical**	**Other**	**Common**	**Historical**	**Other**
CPC	Australia	LL	Post 2006	Prior to 2006	Post 2006			
CPC	Belize	LL	Post 2006	Prior to 2006	Post 2006			
CPC	China	LL	Post 2006	Prior to 2006	Post 2006			Post 2006
CPC	EU France	LL		Prior to 2006	Post 2006			Post 2006
CPC	EU France	PS	Post 2006	Prior to 2006	Post 2006			
CPC	EU Portugal	LL	Post 2006	Prior to 2006	Post 2006	Post 2006		Post 2006
CPC	EU Spain	LL	Post 2006	Prior to 2006	Post 2006			
CPC	EU Spain	PS	Post 2006	Prior to 2006	Post 2006			
CPC	EU UK	LL	Post 2006	Prior to 2006	Post 2006	Post 2006		Post 2006
CPC	France	LL		Prior to 2006	Post 2006			
CPC	Guinea	LL		Prior to 2006				
CPC	Indonesia	LL	Post 2006	Prior to 2006	Post 2006			
CPC	Korea, Republic of	LL		Prior to 2006	Post 2006			Post 2006
CPC	Japan	LL	Post 2006		Post 2006	Post 2006		Post 2006
CPC	Kenya	LL	Post 2006		Post 2006			
CPC	Malaysia	LL		Prior to 2006	Post 2006			Post 2006
CPC	Mauritius	LL		Prior to 2006	Post 2006			Post 2006
CPC	Oman, Sultanate of	LL		Prior to 2006	Post 2006			Post 2006
CPC	Pakistan	GN		Prior to 2006	Post 2006			
CPC	Philippines	LL	Post 2006		Post 2006	Post 2006		
CPC	Seychelles	LL		Prior to 2006	Post 2006	Post 2006		Post 2006
CPC	Sri Lanka	LL	Post 2006					Post 2006
CPC	Thailand	LL	Post 2006	Prior to 2006	Post 2006			Post 2006
CNCP	Senegal	LL		Prior to 2006				
CNCP	South Africa	LL	Post 2006	Prior to 2006	Post 2006	Post 2006		Post 2006
Other	Taiwan	LL	Post 2006	Prior to 2006	Post 2006	Post 2006		Post 2006
Other	Uruguay	LL			Post 2006			Post 2006

Table 3.1.4 as recently been presented at the WPEB08 regarding the availability of catch data for the main shark species expressed as the amount of fleets (%) for which catch data are available out of the total number of fleets for which data on IOTC species are available, by fishery, species of shark, and year, for the period 1950–2010.

Table 3.1.4.- Average levels of reporting for 1950–2010 and 2006–10 are shown column All and Last, respectively. Shark species in bold are those identified during the 2012 IOTC meeting, for which data shall be recorded in logbooks and reported to the IOTC Secretariat. Reporting of catch data for other species can be done in aggregated form (i.e. all species combined as sharks *nei* or mantas and rays *nei*). Hook and line refers to fisheries using handline and/or trolling and Other gears nei to other unidentified fisheries operated in coastal waters. Catch rates of sharks on pole-and-line fisheries are thought to be nil or negligible.

Table 3.1.5 presents the nominal catch of shark species available in the IOTC database. The information of catches until 1986 is given as total shark catch and since then the information is reported by species when possible. Although the information is broken down by species, in all year the % of unidentified sharks is around or greater than 75 %.

Table 3.1.5.- Nominal catch of shark species by species 1950-2009.

Year/Code	Lamnidae MSK	Short fin SMA	Makos MAK	Longfin mako LMA	Oceanic whitetip OCS	Silky FAL	Carcharhinidae RSK	Cocodrile PSK	Tope GAG	Bigeye Thresher BTH	Thresher ALV	Threshers THR	Blueshark BSH	Smooth hammerhead SPZ	Hammerheads SPN	Unidentified Shark SHK	Minor sharks	TOTAL
1950																2,600		**2,600**
1951																4,155		**4,155**
1952																3,714		**3,714**
1953																2,852		**2,852**
1954																2,784		**2,784**
1955																2,737		**2,737**
1956																2,725		**2,725**
1957																2,967		**2,967**
1958																3,144		**3,144**
1959																3,422		**3,422**
1960																3,956		**3,956**
1961																4,627		**4,627**
1962																6,613		**6,613**
1963																8,503		**8,503**
1964																12,306		**12,306**
1965																10,433		**10,433**
1966																11,615		**11,615**
1967																14,317		**14,317**
1968																14,047		**14,047**
1969																15,504		**15,504**
1970																18,293		**18,293**
1971																19,406		**19,406**
1972																24,710		**24,710**
1973																18,846		**18,846**
1974																20,447		**20,447**
1975																17,811		**17,811**
1976																21,326		**21,326**
1977																21,674		**21,674**
1978																27,815		**27,815**
1979																25,766		**25,766**

1980																27,123		**27,123**
1981																19,410		**19,410**
1982																15,730		**15,730**
1983																19,693		**19,693**
1984																14,401		**14,401**
1985																17,587		**17,587**
1986	48	4			98	449	74					67	171		61	19,730		**20,701**
1987	60	5			122	562	92					83	214		77	29,667		**30,883**
1988	63	6			127	584	96					87	222		80	20,067		**21,331**
1989	116	10			234	1,076	177					160	409		147	34,977		**37,307**
1990	166	16			335	1,540	253					229	585		210	25,861		**29,194**
1991	214	19			433	1,991	327					296	757		271	38,302		**42,610**
1992	312	28			632	2,904	477					431	1,104		396	63,467		**69,751**
1993	468	52		2	947	4,356	723					647	1,656		595	63,980		**73,425**
1994	754	148		3	1,525	7,010	1,317					1,041	2,844		968	59,943	1	**75,554**
1995	793	75			1,604	7,376	1,216					1,095	2,834		1,007	53,757	0	**69,758**
1996	716	71			1,447	6,654	1,114					988	2,565		909	49,060	0	**63,524**
1997	1,141	224		0	2,313	10,619	1,763		25			1,577	4,359	6	1,448	65,268	23	**88,765**
1998	997	469		1	2,026	9,231	1,538		6			1,434	4,480	16	1,258	64,546	10	**86,012**
1999	1,481	736		30	3,050	13,740	2,356		20			2,057	8,341	11	1,876	81,115	70	**114,884**
2000	439	388		5	2,647	10,886	3,679		16			265	9,020		1,201	81,588	56	**110,191**
2001	175	278		0	1,323	5,529	3,846		2			470	4,072	1	178	82,020	1	**97,894**
2002	267	524		0	1,022	2,947	1,039					1,121	6,766	2	880	85,802	4	**100,375**
2003	231	1,079		2	1,141	3,505	3,504	0	1	1		2,000	9,324	2	594	83,621	71	**105,075**
2004	171	1,565		5	648	2,949	1,707		8	0		1,005	10,493	1	449	85,631	154	**104,784**
2005	46	2,089		15	271	666	845		2	8		398	11,335	4	181	68,837	106	**84,803**
2006	40	1,401		50	289	748	939	1	1	10		341	8,599	3	133	69,657	58	**82,271**
2007	101	1,200	311	10	166	461	540	0		1		588	9,051	2	121	64,170	469	**77,190**
2008	25	1,048	586	5	175	447	501			1		226	7,613	3	121	66,165	693	**77,611**
2009	29	564	1,160	407	245	543	616	0		5	1	252	9,978	0	128	65,312	938	**80,180**

The study focused on estimating the "potential" shark catches by métier and the main fleets that could be mainly responsible for the catch of the shark species included in the study based on the best assumption of the shark catch over target species catch ratios (see Material and Methods) derived from the literature.

Estimated "potential" studied shark species catch (high estimation is only presented here) is around 160 000 t for 22 000 t. presently declared (7 time higher than declared) (Figure 3.1.1). Considering all sharks that are not reported at species level, the total amount of shark declared is around 100 000 tonnes and, thus, the underreporting level is much less (1.6 times higher). 19 fisheries among the 195 fisheries found in IOTC database generate 86 % of potential investigated shark catches. These fisheries are not those already declaring the bulk of studied shark catches and are those with the highest unreported catches of the species investigated in the project.

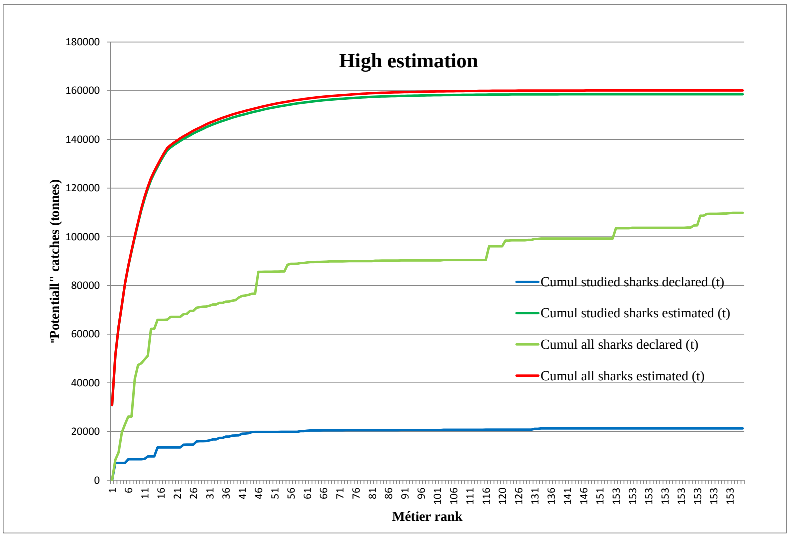


Figure 3.1.1.- Cumulative "potential" catch and declared catches of studied shark species as well as all shark together in tonnes by fisheries ranked according their descending estimated of studied shark species catches.

Among the different métier identified, Gillnet (GN) and a composition of Gillnet and Longline (GN-LL) are the most impacting one with 61 % of the total estimated studied shark species catches (97,000 t) (Figure 3.1.2). It is followed by longline (LL and LL-swo) with 18 % and other métiers (OTH) with 12, which precise gear composition is unknown.

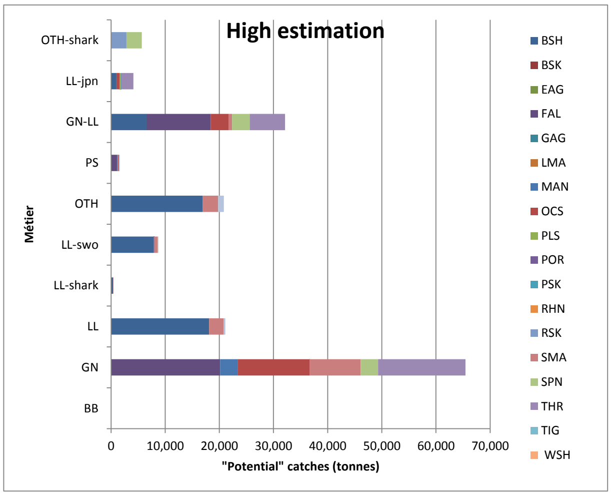


Figure 3.1.2.- Estimated Catch (tonnes) by Métiers and by studied shark species.

The fleets mainly responsible for the shark species studied were identified on the basis of tuna and tuna like catch reported to IOTC. IOTC data are based on reports from the national fisheries agencies but can be affected by the limitations in reporting efficiency and problems of species identification and species breakdown. The estimates depend on the level of under-reporting and non-reporting of tuna and tuna like catch by the countries.

The information on bycatch is scarce and the bycatch estimates found in the literature are not homogenous which made the raising and/or estimates of ratios uncertain due to various assumptions made (e.g. conversion of the estimates in number of individuals into weight without any information on the mean size per species).

As in the Atlantic Ocean, there are mainly two groups of métiers impacting the most important, in terms of total catch, two groups of shark species (Figure 3.1.3). Gillnet (GN - *sensu lato*) are impacting mainly silky (FAL), thresher (THR), Oceanic whitetip (OCS), and shortfin mako (SMA) sharks; whereas Longline (LL - *sensu lato*) impacts mainly blushark (BSH) and shortfin make (SMA) as well.

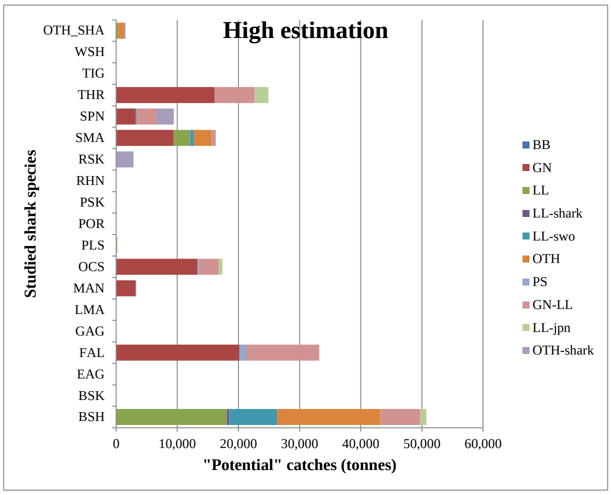


Figure 3.1.3.- Estimated Catch (tonnes) by studied shark pecies and by Métier.

Table 3.1.6 gives a picture of the "potential" catch estimated per year for 17 fleets identified as the major players in the Indian Ocean. The table also allows identifying the main origin of underreporting as well as the likely main species impacted by the fisheries in the area. In that sense, the comparison between the declared value and the estimated value can be considered as a figure for underreporting. The total average amount of sharks species studied estimated is 7 times higher than the average amount declared in the Indian Ocean based on our results.

Table 3.1.6.- Average yearly studied sharks species catch reported to the IOTC and the estimation carried out in the study (tons/year) by fleet; and the more accurate value considered (Retained value) between 2000 and 2010. Sharks estimated catch (tons) and % unreported by fleets. Na: data not available.

Fleet/Métier	Declared catch	Studied shark estimated catch	Cumulated Studied shark estimated	% Cumulated Studied shark estimated
IRN-GN	0	34,375	34,375	22.8
LKA-GN-LL	7076	32,141	66,516	44.1
IDN-GN	0	13,760	80,276	53.2
TWN-LL	547	9,075	89,352	59.2
YEM-OTH	0	6,074	95,426	63.2
IDN-OTH	0	6,039	101,464	67.2
PAK-GN	0	5,966	107,430	71.2
MDG-OTH-shark	0	5,690	113,120	75.0
IDN-LL	217	5,026	118,147	78.3
JPN-LL-jpn	466	4,116	122,263	81.0
OMN-GN	0	3,912	126,175	83.6
COM-OTH	0	2,952	129,127	85.6
IND-GN	0	2,870	131,997	87.5
ESP-LL-swo	3693	2,536	134,533	89.2
MDV-OTH	0	1,774	136,306	90.3
IND-LL	38	1,338	137,645	91.2
OMN-OTH	0	997	138,641	91.9

Table 3.1.7 compares the average yearly "potential" catch of studied shark species by species and métiers with the Ecological Risk Assessment (Murua *et al.*, 2012) carried out in the Indian Ocean in 2012.

Table 3.1.7.- Estimated (or range of estimated) annual catches of major species (MT) in the Indian Ocean tuna fisheries, for the period 2000-2011. Indication of ERA rank (top table, taking into consideration susceptibility for longline) and species productivity (bottom table) as provided by Murua et al. (2012).

	FAO code	Species name	Common name	LL Rank ERA	Productivity (Lambda)	Iran (GN off-shore)	Sri Lanka (G/L)	Sri Lanka (GN)	Indonesia (GN)	Indonesia (GHLI)	Taiwan (LL)	Yemen (HAND)	Pakistan (GN)	Madagascar (TROL)	Indonesia (TROL)	Indonesia (FLL)	Japan (LL)	Iran (GN)	Indonesia (GN)	UE-Spain (LL)	Other métiers
	SMA	*Isurus oxyrinchus*	Shortfin mako	1	1.061	4432	417	243	1283	694	898	895	857	0	792	600	0	508	412	178	3171 - 3512
	FAL	*Carcharhinus falciformis*	Silky shark	4	1.075	9497	7510	4370	2749	1488	0	0	1837	0	0	0	0	1088	884	8	2396 - 2544
	OCS	*Carcharhinus longimanus*	Oceanic whitetip shark	5	1.162	6268	2065	1202	1814	982	0	0	1213	0	0	0	573	718	583	8	1102 - 1138
	POR	*Lamna nasus*	Porbeagle	7	1.041	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8	13 - 19
	LMA	*Isurus paucus*	Longfin mako	8	1.029	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8	13 - 19
	BSH	*Prionace glauca*	Blue shark	10	1.483	0	4130	2403	0	0	6149	5179	0	0	4581	4109	1007	0	0	2288	17874 - 20907
	PLS	*Pteroplatytrygon violacea*	Pelagic stingray	13	1.242	0	0	0	0	0	0	0	0	0	0	0	232	0	0	0	0
RSK	DUS	*Carcharhinus obscurus*	Dusky shark	12	1.027	0	0	0	0	0	0	0	0	2845	0	0	0	0	0	1	41306
	CCP	*Carcharhinus plumbeus*	Sandbar shark	15	0.978																
SPN	SPZ	*Sphyrna zygaena*	Smooth hammerhead	6	1.281	1520	2065	1202	440	238	0	0	294	2845	0	0	0	174	141	33	
	SPM	*Sphyrna mokarran*	Great hammerhead	9	1.098																274 - 299
	SPL	*Sphyrna lewini*	Scalloped hammerhead	14	1.062																
THR	BTH	*Alopias superciliosus*	Bigeye thresher	2	1.033	7598	4130	2403	2199	1191	0	0	1470	0	0	0	2239	871	707	3	
	PTH	*Alopias pelagicus*	Pelagic thresher	3	1.098																1093 - 1101
	ALV	*Alopias vulpinus*	Common thresher	16	1.148																
SKH	TIG	*Galeocerdo cuvier*	Tiger shark	11	1.147	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	WSH	*Carcharodon carcharias*	Great white shark			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	BSK	*Cetorhinus maximus*	Basking shark			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	GAG	*Galeorhinus galeus*	Tope shark			0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	4 - 6
	EAG	Myliobatidae	Eagle rays nei			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	MAN	Mobulidae	Mantas, devil rays nei			1520	0	0	440	238	0	0	294	0	0	0	0	174	141	0	282 - 292
	PSK	*Psedocarcharias kamoharai*	Crocodile shark			0	0	0	0	0	0	0	0	0	0	0	65	0	0	0	0
	RHN	*Rhincodon typus*	Whale shark			6	0	0	2	1	0	0	1	0	0	0	0	1	1	0	1 - 1
	OTH_Sharks		Other sharks			0	0	0	0	0	112	320	0	0	283	75	0	0	0	0	710 - 765
		Estimated total shark catches (MT)				30841	20318	11823	8928	7159	6394	5966	5690	5655	4833	4785	4116	3534	2870	2536	26935 - 30606

In the Indian Ocean, impact on studied shark species is highly concentrated in 4 métiers, which generate more than 60 % of the estimated studied shark species (Figure 3.1.4). Gillnet from from Iran, Sri Lanka, Indonesia are leading followed by Taiwanese longliners.

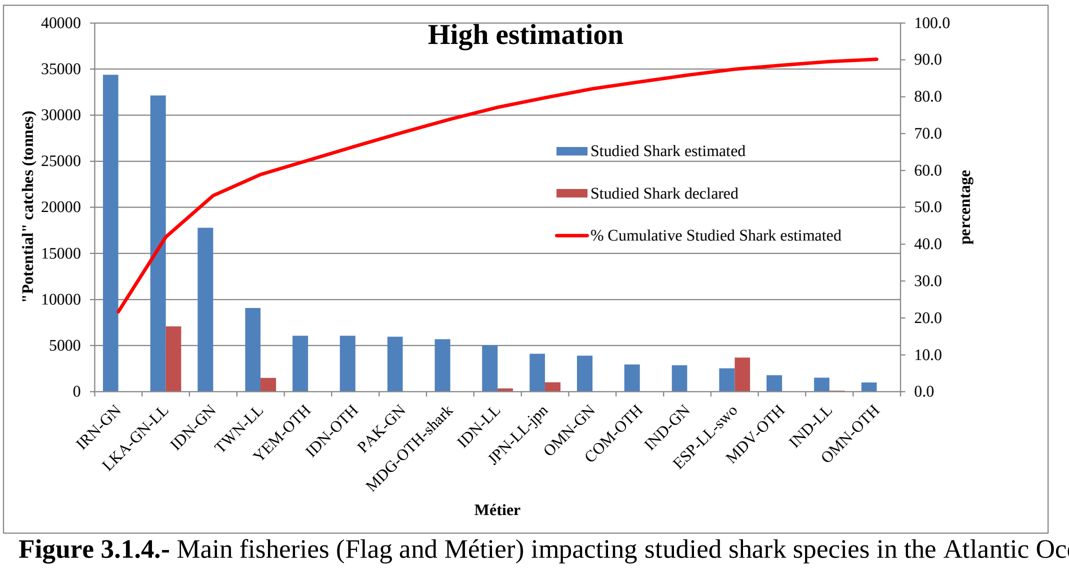


Figure 3.1.4.- Main fisheries (Flag and Métier) impacting studied shark species in the Atlantic Ocean.

Figure 3.1.5 shows the difference between the declared nominal catch of shark by species and our estimations by species. The underestimation is mainly related to the species with most catches such as BSH, FAL, OCS, THR, SMA for which our estimation are 3.9, 10.5, 19.4, 33.5, 10.6 higher, respcectively, than the declared estimation. Underestimation of studied shark species catches concerns all species at an extremely high level.

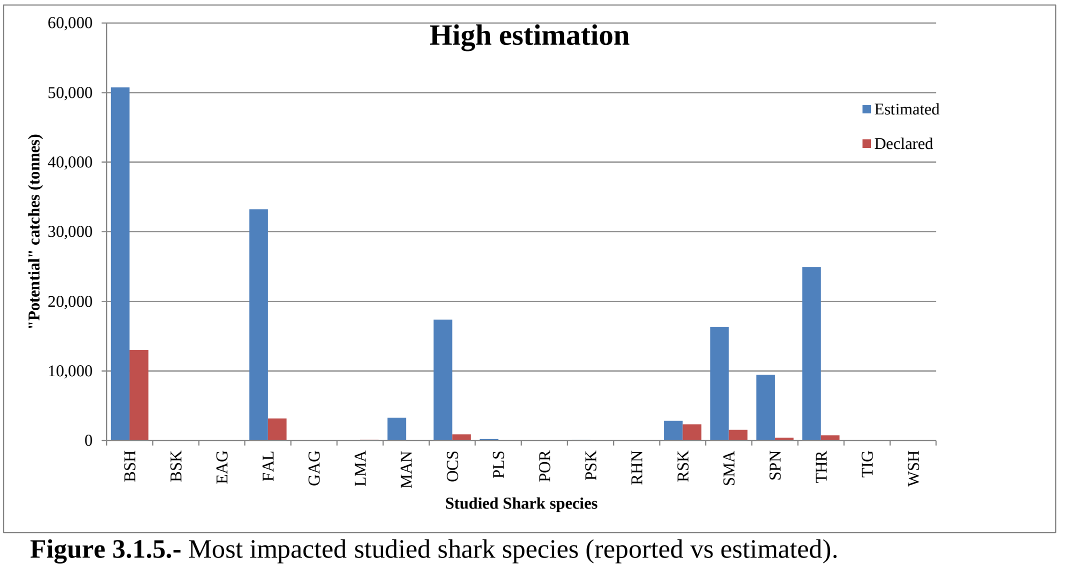


Figure 3.1.5.- Most impacted studied shark species (reported vs estimated).

The relative proportion of the species on the estimated catches of sharks in the Indian Ocean is shown in the figure Figure 3.1.6. The blue shark is estimated to be the major shark catch in the Indian Ocean followed by silky shark, threshers, oceanic whitetip, shortfin mako and hammerheads sharks. This is quite different from other Oceans but not unexpected due to the high catch of target species, and expected associated shark bycatch, done by gillnets in the Indian Ocean.

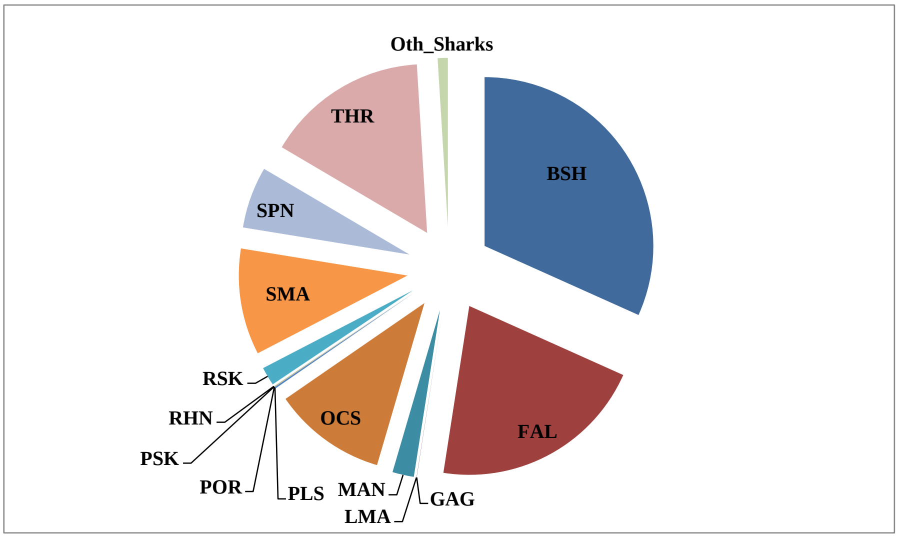


Figure 3.1.6.- Relative contribution of the total “potential” catch estimated for studied shark species in the Indian Ocean.

3.1.5 Estimation of discards levels

There is no public database available of observers programs and/or on the level of discards in the IOTC yet. Although as from November 2012, eleven CPCs (Australia, Comoros, EU (France and Portugal), France (OT), Japan, Korea (Rep. of), Madagascar, Mozambique, Seychelles, South Africa and Taiwan,China) have submitted a list of accredited observers. To date thirty eight (38) observer trip reports have been submitted to the Secretariat by seven CPCs, i.e. Australia, China, EU (France and Portugal), France (OT), Japan, Korea and South Africa: 11 reports for 2010, 23 reports for 2011, 4 reports for 2012. In addition, South Africa has also submitted 13 and 10 observer reports, respectively for 2011 and 2012, for foreign flag fishing vessels operating in South African waters (see details in Annex I). Tables A1.2 and A1.3 in Annex I provide an estimation of the level of effort covered by observer’s onboard longliners and purse seiners in 2010 and 2011, respectively.

According to Herrera and Pierre (2011) currently there are no estimates of discards levels of sharks in the IOTC convention area. Although being mandatory, namely for the thresher sharks (Res. 2010/12, Alopias spp.), the information will only be available during 2012. However, Australia has reported shark discard levels on its national reports (Anon, 2011) and other several countries also reported shark discards levels in various working documents presented to the IOTC WPEB.

3.1.6 Catch at size

There is not much public information on the catch at size of key shark species in the IOTC Statistical Area. Length frequencies for shark species bycaught in the IOTC convention area are scarce. According to the most recent information available on the IOTC database (by 10/07/2012) a limited a number of CPCs and Cooperative Non-CPCs (e.g. Japan, Republic of Korea, Seychelles and South Africa) have provided data for the major shark species caught on their fisheries [blue shark (BSH), bigeye thresher shark (BTH), silky shark (FAL), oceanic whitetip shark (OCS), porbeagle (POR), crocodile shark (PSK), and shortfin mako (SMA)]. However, it is worth noting that Portugal as recently provided size data for BSH and SMA for the most recent period. Moreover, Portugal is conducting an effort to provide further size data for these major shark species, based on the collection of historical skipper logbooks data and his onboard observer and self-sampling program.

3.1.7 Biological information

Biological information for all the species covered in the study is presented in **Annex II**.

3.1.8 Fishery indicators (blue shark and shortfin mako)

No quantitative stock assessment has been undertaken by the IOTC WPEB for none of the two major shark species caught in the convention area: blue shark and shortfin mako shark. The information summarized in the tables below derives from IUCN (International Union for Conservation of Nature) own assessment, as compiled in the most recently available report by the IOTC Scientific Committee (Anon, 2011). Therefore, the process of the threat assessment from IUCN is independent from the IOTC and is presented for information purpose only (Table 3.1.8).

Table 3.1.8.- IUCN threat status for the blue and shortfin mako sharks (source: Anon, 2011). WIO – West Indian Ocean; EIO - East Indian Ocean.

Common name	Scientific name	IUCN threat status		
		Global status	**WIO**	**EIO**
Blue shark	*Prionace glauca*	Near Threatened	-	-
Shortfin mako shark	*Isurus oxyrinchus*	Vulnerable	-	-
Oceanic whitetip shark	*Carcharhinus longimanus*	Vulnerable	-	-
Silky shark	*Carcharhinus falciformis*	Near Threatened	Near Threatened	Near Threatened

Blue shark (*Prionace glauca*) stock status - The current IUCN threat status of *Near Threatened* applies to blue sharks globally. There is a paucity of information available on this species and this situation is not expected to improve in the short to medium term. There is no quantitative stock assessment and limited basic fishery indicators currently available for blue shark in the Indian Ocean, therefore the stock status is highly uncertain. Blue sharks are commonly taken by a range of fisheries in the Indian Ocean and in some areas they are fished in their nursery grounds. Because of their life history characteristics – they are relatively long lived (16–20 years), mature relatively late (at 4–6 years), and have relativity few offspring (25–50 pups every year), the blue shark is vulnerable to overfishing. Blue shark assessments in the Atlantic and Pacific oceans seem to indicate that blue shark stocks can sustain relatively high fishing pressure.

Shortfin mako shark (*Isurus oxyrinchus*) stock status - The current IUCN threat status of *Vulnerable* applies to shortfin mako sharks globally. Trends in the Japanese CPUE series suggest that the longline vulnerable biomass has declined from 1994 to 2003, and has been increasing since then. There is a paucity of information available on this species and this situation is not expected to improve in the short to medium term. There is no quantitative stock assessment or basic fishery indicators currently available for shortfin mako shark in the Indian Ocean, therefore the stock status is highly uncertain. Shortfin mako sharks are commonly taken by a range of fisheries in the Indian Ocean. Because of their life history characteristics – they are relatively long lived (over 30 years), females mature at 18–21 years, and have relativity few offspring (<25 pups every two or three years), the shortfin mako shark is vulnerable to overfishing.

Oceanic whitetip shark (*Carcharhinus longimanus*) stock status - The current IUCN threat status of *Vulnerable* applies to oceanic whitetip sharks globally. There remains considerable uncertainty about the relationship between abundance and the standardised CPUE series from the Japanese longline fleet, and about the total catches over the past decade in the Indian Ocean. There is a paucity of information available on this species and this situation is not expected to improve in the short to medium term. There is no quantitative stock assessment or basic fishery indicators currently available for oceanic whitetip shark in the Indian Ocean, therefore the stock status is highly uncertain. Oceanic whitetip sharks are commonly taken by a range of fisheries in the Indian Ocean. Because of their life history characteristics they are relatively long lived, mature at 4–5 years, and have relativity few offspring (<20 pups every two years), the oceanic whitetip shark is vulnerable to overfishing. Despite the lack of data, it is apparent from the information that is available that oceanic whitetip shark abundance has declined significantly over recent decades.

Silky shark (*Carcharhinus falciformis*) stock status - The current IUCN threat status of *Near Threatened* applies to silky sharks in the western and eastern Indian Ocean and globally. There remains considerable uncertainty about the relationship between abundance and the nominal CPUE series from the main longline fleets, and about the total catches over the past decade in the Indian Ocean. There is a paucity of information available on this species and this situation is not expected to improve in the short to medium term. There is no quantitative stock assessment or basic fishery indicators currently available for silky shark in the Indian Ocean, therefore the stock status is highly uncertain. Silky sharks are commonly taken by a range of fisheries in the Indian Ocean. Because of their life history characteristics – they are relatively long lived (over 20 years), mature relatively late (at 6–12 years), and have relativity few offspring (<20 pups every two years), the silky shark is vulnerable to overfishing. Despite the lack of data, it is apparent from the information that is available that silky shark abundance has declined significantly over recent decades.

Fisheries

It appears that significant catches of sharks have gone unrecorded in several countries. Furthermore, many catch records probably under-represent the actual catches of sharks because they do not account for discards (i.e. do not record catches of sharks for which only the fins are kept or of sharks usually discarded because of their size or condition) or they reflect dressed weights instead of live weights. FAO also compiles landings data on elasmobranchs, but the statistics are limited by the lack of species-specific data and data from the major fleets.

Blue sharks are often targeted by some semi-industrial and artisanal fisheries and are a bycatch of industrial fisheries (pelagic longline tuna and swordfish fisheries, and anecdotally in the purse seine fishery). However, in recent years longliners are targeting this species opportunistically in particular areas and/or seasons, due to an increase in its commercial value worldwide. Typically, the fisheries take blue sharks between 180–240 cm FL or 30 to 52 kg. Sport fisheries for oceanic sharks are apparently not so common in the Indian Ocean. Table 3.1.9 summarizes the available information on the fisheries bycatching blue shark in the Indian Ocean.

Table 3.1.9.- Estimated blue shark frequency of occurrence and bycatch mortality by fishery in the Indian Ocean pelagic fisheries (source: Anon, 2011). PS – purse-seine; LL – longline; BB – bait boat; TROL – troll line; HAND – hand line; GILL – gill net; UNCL – unclassified.

		LL				
Fishing gear	**PS**	**SWO**	**Tuna**	**BB/TROL/HAND**	**GILL**	**UNCL**
Frequency	common	common		common	common	unknown
Fishing mortality	study in progress	58%		unknown	unknown	unknown
Post release mortality	study in progress			unknown	unknown	unknown

Shortfin mako sharks are often targeted by some semi-industrial, artisanal and recreational fisheries and are a bycatch of industrial fisheries (pelagic longline tuna and swordfish fisheries and anecdotally by the purse seine fishery). In other Oceans, due to its energetic displays and edibility, the shortfin mako shark is considered one of the great gamefish of the world. There is little information on the fisheries prior to the early 1970's, and some countries continue not to collect shark data while others do collect it but do not report it to IOTC. Table 3.1.10 resumes the available information on the fisheries bycatching shortfin mako shark in the Indian Ocean.

Table 3.1.10.- Estimated shortfin shark frequency of occurrence and bycatch mortality by fishery in the Indian Ocean pelagic fisheries (source: Anon, 2011). PS – purse-seine; LL – longline; BB – bait boat; TROL – troll line; HAND – hand line; GILL – gill net; UNCL – unclassified.

		LL				
Fishing gear	**PS**	**SWO**	**Tuna**	**BB/TROL/HAND**	**GILL**	**UNCL**
Frequency	rare	common		rare-common	unknown	unknown
Fishing mortality	unknown	13-51%	0-31%	unknown	unknown	unknown
Post release mortality	unknown	19%		unknown	unknown	unknown

Oceanic whitetip sharks are targeted by some semi-industrial and artisanal fisheries and are a bycatch of industrial fisheries (pelagic longline tuna and swordfish fisheries and purse seine fishery). There is little information on the fisheries prior to the early 1970's, and some countries continue not to collect shark data while others do collect it but do not report it to IOTC. The practice of shark finning is considered to be regularly occurring for this species (Clarke et al. 2006, Clarke 2008) and the bycatch/release injury rate is unknown but probably high. At-haulback mortality of oceanic whitetip sharks in the Atlantic ocean longline fishery targeting swordfish was estimated to be at 30.6% (Coelho et al. 2012). Table 3.1.11 resumes the available information on the fisheries bycatching oceanic whitetip shark in the Indian Ocean.

Table 3.1.11.- Estimated oceanic whitetip frequency of occurrence and bycatch mortality by fishery in the Indian Ocean pelagic fisheries (source: Anon, 2011). PS – purse-seine; LL – longline; BB – bait boat; TROL – troll line; HAND – hand line; GILL – gill net; UNCL – unclassified.

		LL				
Fishing gear	**PS**	**SWO**	**Tuna**	**BB/TROL/HAND**	**GILL**	**UNCL**
Frequency	common	common		common	common	unknown
Fishing mortality	Study in progress	58%		unknown	unknown	unknown
Post release mortality	Study in progress			unknown	unknown	unknown

Silky sharks are often targeted by some semi-industrial, artisanal and recreational fisheries and are a bycatch of industrial fisheries (pelagic longline tuna and swordfish fisheries and purse seine fishery). Sri Lanka has had a large fishery for silky shark for over 40 years. There is little information on the fisheries prior to the early 1970's, and some countries continue not to collect shark data while others do collect it but do not report it to IOTC. The practice of shark finning is considered to be regularly occurring for this species (Clarke et al. 2006, Clarke 2008) and the bycatch/release injury rate is unknown but probably high. Table 3.1.12 resumes the available information on the fisheries bycatching silky shark in the Indian Ocean.

Table 3.1.12.- Estimated oceanic whitetip frequency of occurrence and bycatch mortality by fishery in the Indian Ocean pelagic fisheries (source: Anon, 2011). PS – purse-seine; LL – longline; BB – bait boat; TROL – troll line; HAND – hand line; GILL – gill net; UNCL – unclassified.

		LL				
Fishing gear	**PS**	**SWO**	**Tuna**	**BB/TROL/HAND**	**GILL**	**UNCL**
Frequency	common	common		common	common	unknown
Fishing mortality	Study in progress	Study in progress	Study in progress	unknown	unknown	unknown
Post release mortality	Study in progress	unknown	unknown	unknown	unknown	unknown

Catch trends

Table 3.1.13 resumes the catch estimates for blue, shortfin mako and NEI (not elsewhere included) sharks in the IOTC convention area (source: IOTC Secretariat) for the most recent years and the average for the period 2006-2010.

Table 3.1.13.- Catch estimates (MT) for blue, shortfin mako and NEI (not elsewhere included) sharks in the IOTC convention area (source: Anon, 2011).

		Catch (MT)		
Common name	**Scientific name**	**2009**	**2010**	**Average 2006-2010**
Blue shark	*Prionace glauca*	9941	9416	8924
Shorfin mako	*Isurus oxyrinchus*	561	738	990
Oceanic whitetip shark	*Carcharhinus longimanus*	245	761	265
Silky shark	*Carcharhinus falciformis*	655	1836	670
NEI sharks		62229	61966	64838

Note that the catches recorded for sharks are thought incomplete. The catches of sharks are usually not reported and when they are they might not represent the total catches of this species but simply those retained on board. It is also likely that the amounts recorded refer to weights of processed specimens, not to live weights. In 2010, seven countries reported catches of blue and shortfin mako sharks in the IOTC region.

The blue shark catch estimates are highly uncertain as is their utility in terms of minimum catch estimates. Four CPCs have reported detailed data on sharks (i.e. Australia, EU (Spain, Portugal and United Kingdom), South Africa, and Sri Lanka) while nine CPCs have reported partial data or data aggregated for all species (i.e. Belize, China, Japan, Korea, Malaysia, Oman, Seychelles, Mauritius, UK-territories). For CPCs reporting longline data by species (i.e. Australia, Spain, Portugal, United Kingdom and South Africa), 74% of the catch of sharks by longliners, all targeting swordfish, were blue sharks.

The catch estimates for shortfin mako shark are highly uncertain as is their utility in terms of minimum catch estimates. Four CPCs have reported detailed data on sharks (i.e. Australia, EU (Spain, Portugal and United Kingdom), South Africa and Sri-Lanka, while nine CPCs have reported partial data or data aggregated for all species (i.e. Belize, China, Japan, Korea, Malaysia, Oman, Seychelles, Mauritius, UK-territories). For CPCs reporting longline data by species (i.e. Australia, Spain, Portugal, United Kingdom and South Africa), 12% of the catch of sharks by longliners, all targeting swordfish, were shortfin mako sharks.

The catch estimates for oceanic whitetip shark are highly uncertain as is their utility in terms of minimum catch estimates. Four CPCs have reported detailed data on sharks (i.e. Australia, EU (Spain, Portugal and United Kingdom), South Africa, and Sri-Lanka) while nine CPCs have reported partial data or data aggregated for all species (i.e. Belize, China, Japan, Korea, Malaysia, Oman, Seychelles, Mauritius, UK-territories). For CPCs reporting longline data by species (i.e. Australia, Spain, Portugal, United Kingdom and South Africa), 0.6% of the catch of sharks by longliners, all targeting swordfish, were oceanic whitetip sharks, and for CPCs reporting gillnet data by species (i.e. Sri Lanka), 7% of the catches of shark were oceanic whitetip sharks.

The catch estimates for silky shark are highly uncertain as is their utility in terms of minimum catch estimates. Four CPCs have reported detailed data on sharks (i.e. Australia, EU (Spain, Portugal and United Kingdom), South Africa, and Sri Lanka), while nine CPCs have reported partial data or data aggregated for all species (i.e. Belize, China, Japan, Korea, Malaysia, Oman, Seychelles, Mauritius, UK-territories). For CPCs reporting longline data by species (i.e. Australia, Spain, Portugal, United Kingdom and South Africa), 1.5% of the catch of sharks by longliners, all targeting swordfish, were silky sharks, and for CPCs reporting gillnet data by species (i.e. Sri Lanka), 22% of the catches of shark were silky sharks.

Nominal and standardized CPUE trends

Historical research data shows overall decline in blue shark CPUE, while mean weight of blue shark in this time series are relatively stable (Romanov *et al.*, 2008). Trends in the Japanese CPUE series (1994-2011) suggest that the longline vulnerable biomass was more or less stable during 1994-2003 and subsequently increased to 2011 (Hiraoka and Yokawa, 2012). The nominal CPUEs of blue shark catches by the Portuguese longline fleet in the Indian Ocean showed variability between 1999 and 2011 and a general decreasing trend.

However, the standardized series remained have remained relatively stable during the time period considered (1999-2011). This time series of standardized CPUEs is relatively short (13 years), and maybe further improved as it is part of an ongoing analysis (Coelho et al. 2012).

Historical research data shows overall decline in shortfin mako shark CPUE and mean weight of mako sharks (Romanov et al., 2008). CPUE in South African protection net is fluctuating without any trend (Holmes et al., 2009). The Japanese CPUE series suggest that the longline vulnerable biomass largely fluctuated during 1994-2010 and there are no apparent trends (Kimoto et al., 2011). The nominal CPUEs of shortfin mako catches by the Portuguese longline fleet in the Indian Ocean showed some significant variability a general decreasing trend was observed in the early years of the time series (1999-2002), followed by a sequence of years with relatively large oscillations (2002-2004), and finally followed by a period with a general increasing trend for the more recent years (2004-2011). The standardized CPUE series showed some variability, with a general decreasing trend in the initial years of the time series (1999-2004), and then followed by a general increasing trend until 2011. This time series of standardized CPUEs is relatively short (13 years), and maybe further improved as it is part of an ongoing analysis (Coelho et al. 2012).

Historical research data shows overall decline in CPUE and mean weight of oceanic whitetip shark (Romanov et al. 2008). Anecdotal reports suggest that oceanic white tips have become rare throughout much of the Indian Ocean during the past 20 years. Indian longline research surveys reported zero catches from the Arabia Sea during 2004–09 (John & Varghese 2009). Trends in the Japanese standardised CPUE series (2003–2011) suggest that the longline vulnerable biomass has decreased (Yokawa & Semba 2012). Trends in the EU,Spain standardised CPUE series (1998–2011) suggest that the longline vulnerable biomass declined until 2007 and has been variable since (Ramos-Cartelle et al. 2012).

There is no available standardized CPUE series for silky sharks. However, Maldivian shark fishermen report significant declines in silky shark abundance over past 20 years (Anderson 2009). In addition, Indian longline research surveys, in which silky sharks contributed 7% of catch, demonstrate declining catch rates over the period 1984–2006 (John & Varghese 2009).

Ecological Risk Assessment

In 2012 provide the results of a preliminary ecological risk assessment (ERA) of shark species caught in the Indian Ocean by longline and purse seine gears, which produced a ranked list of the most vulnerable shark species to longline and purse seine gears as detailed below (Murua et al., 2012). Although the gillnet fleet is responsible for around 68 % of the total shark catches in the Indian Ocean, there was no data available on gillnet effort distribution nor information from observers on shark size frequencies and post-capture mortality which would allow an ERA to be carried out for sharks caught by gillnet and, hence, to analyse the effect of gillnet fishing on shark.

For the longling fleet, according to Murua et al. (2012), the most vulnerable species are the shortfin mako, bigeye and pelagic thresher, followed by silky shark, oceanic whitetip shark, smooth hammerhead, porbeagle, longfin mako, great hammerhead and blueshark. The first four vulnerable species are characterized by low productivity and high susceptibility; while oceanich whitetip and smooth hammerhead are showing higher productivity but the same level of susceptibility. Porbeagle, longfin mako and great hammerhead are showing low productivity but also lower susceptibility. Blue sharks are the most productivity species but are characterized by the second highest susceptibility. The rest of the species show variable productivity (from lowest to intermediate levels) but lower susceptibility values for the fishery and, thus, they have a lower overall vulnerability corresponding to lower rank of vulnerability. Therefore, a priority should be given to those species with may request more attention from a biological point of view but also from a management point of view.

The list of the 10 most vulnerable shark species to longline gear (Table 3.1.14), as determined by the productivity susceptibility analysis, compared to the list of shark species/groups required to be recorded for longline (contained in Resolution 12/03 on the recording of catch and effort by fishing vessels in the IOTC area of competence), shows that there is currently no obligation of report for some of the most vulnerable species ranked.

Table 3.1.14.- List of the 10 most vulnerable shark species to longline gear compared to the list of shark species/groups required to be recorded in logbooks, as listed in Resolution 12/03 *on the recording of catch and effort by fishing vessels in the IOTC area of competence*.

PSA vulnerability ranking	Most susceptible shark species to longline gear	FAO Code	Shark species listed in IOTC Resolution 12/03 for longline gear	FAO Code
1	Shortfin mako (*Isurus oxyrinchus*)	SMA	Blue shark (*Prionace glauca*)	BSH
2	Bigeye thresher (*Alopias superciliosus*)	BTH	Mako sharks (*Isurus* spp.)	MAK
3	Pelagic thresher (*Alopias pelagicus*)	PTH	Porbeagle shark (*Lamna nasus*)	POR
4	Silky shark (*Carcharhinus falciformis*)	FAL	Hammerhead sharks (*Sphyrna* spp.)	SPN
5	Oceanic whitetip shark (*Carcharhinus longimanus*)	OCS		
6	Smooth hammerhead (*Sphyrna zygaena*)	SPZ		
7	Porbeagle (*Lamna nasus*)	POR		
8	Longfin mako (*Isurus paucus*)	LMA		
9	Great hammerhead (*Sphyrna mokarran*)	SPM		
10	Blue shark (*Prionace glauca*)	BSH		

For the purse seiner fleet, according to Murua et al. (2012), the most vulnerable species are the oceanic white-tip and silky shark. The rest of species are ranked in much lower levels of vulnerability. In the purse seiner fleet, the vulnerability is in a large extent defined by the susceptibility of the species to the gear rather than for the productivity of the species. As such, less productive species are not as susceptible as others and, hence, their vulnerability to the purse seine gear is low due to their low availability to the gear. The two most vulnerable species are characterized by medium productivity and high susceptibility. The rest of the species show variable productivity (from lowest to intermediate levels) but lower susceptibility values for the fishery and, thus, they have a lower overall vulnerability corresponding to lower rank of vulnerability. Therefore, a priority should be given to those species ranked high with may request more attention from a biological point of view but also from a management point of view.

The list of the 10 most vulnerable shark species to purse seine gear (Table 3.1.15), as determined by the productivity susceptibility analysis, compared to the list of shark species/groups required to be recorded for each gear (contained in Resolution 12/03 on the recording of catch and effort by fishing vessels in the IOTC area of competence), shows that there is currently no obligation of report for some of the most vulnerable species ranked.

Table 3.1.15.- List of the 10 most vulnerable shark species to purse seine gear compared to the list of shark species/groups required to be recorded in logbooks, as listed in Resolution 12/03 *on the recording of catch and effort by fishing vessels in the IOTC area of competence*.

PSA vulnerability ranking	Most susceptible shark species to purse seine gear	FAO Code	Shark species listed in IOTC Resolution 12/03 for purse seine gear	FAO Code
1	Oceanic whitetip shark (*Carcharhinus longimanus*)	OCS	Whale sharks (*Rhincodon typus*)	RHN
2	Silky shark (*Carcharhinus falciformis*)	FAL		
3	Shortfin mako (*Isurus oxyrinchus*)	SMA		
4	Great hammerhead (*Sphyrna mokarran*)	SPM		
5	Pelagic stingray (*Pteroplatytrygon violacea)*	PLS		
6	Scalloped hammerhead (*Sphyrna lewini*)	SPL		
7	Smooth hammerhead (*Sphyrna zygaena*)	SPZ		
8	Longfin mako (*Isurus paucus*)	LMA		
9	Dusky shark (*Carcharhinus obscurus*)	DUS		
10	Tiger shark (*Galeocerdo cuvier*)	GAC		

3.1.9 Major difficulties

No major difficulties have been suffered in the data gathering process and data identification gaps, however, the major difficulties of the project were related to a general scarcity of data and data availability for major fleets and countries as underlined in the previous section. Most of those data is coming from logbooks which may complicated the data gathering process due to species mis-identification, under-reporting and potential, unidentifiable in targeting strategies.

Specifically, the major problems regarding sharks statistics as identified by IOTC Secretariat are indicated below (Herrera and Pierre, 2011):

- **Some catch data are not available** - Several countries were not collecting fishery statistics, especially in years prior to the early 1970-s, and others have not reported catches of sharks to IOTC. It is thought that important catches of sharks might have gone unrecorded in several countries. The catches recorded in other cases might not represent the total catches of sharks but simply the amounts retained on board (e.g. dressed weights instead of live weights). The catches of sharks for which only the fins are kept on board or of sharks usually discarded, because of their size or condition, are seldom, if ever, recorded.
- **Poor resolution of catch data** - The catches of sharks are usually not recorded by species and/or gear. Be it sharks caught on the high seas or in coastal areas the amount of species that may occur in these areas is usually high. The estimation of catches by species is highly compromised in these cases due to the paucity of the data available. Miss-identification of shark species is also common. The identification of sharks in port is usually compromised by the way in which the different species of sharks are processed and landed. The identification of shark species unloaded as shark carcasses, shark fins or other shark products is difficult due to the scarcity of the information available (the majority of the information available on the identification of sharks refers to complete specimens). The main consequence of this is that, at the moment, the catches of sharks available cannot be used to estimate reliably total catches of sharks in the Indian Ocean, not even for the species for which the catches are partially available.

- **Catches by gear type** - The catches of sharks that are not recorded by gear do not represent a high proportion of the total catches recorded for these species, especially in recent years. Industrial longlines, gillnets, and, to a lesser extent, industrial purse seiners and other artisanal gears operated in the Indian Ocean are thought to be harvesting important amounts of pelagic sharks.
- **Deep-freezing tuna longlines and fresh-tuna longliness** - Catches of sharks are thought to represent between 20–40% of the total combined catch for all species. However, the catches of sharks recorded in the IOTC database only make for a small proportion of the total catches of all species over longline fleets. Catches of sharks are, therefore, thought to be very incomplete. The implementation of catch monitoring schemes in different ports of landing of fresh-tuna longlines in recent years has improved the estimates of catches of sharks for these fleets. The catches estimated, however, do not represent the total catches of sharks for this fishery due to the high amount of sharks that are believed to be discarded. In addition, the skippers of fresh-tuna longliners seldom allow that enumerators take samples of sharks during the unloading.
- **Freezing (fresh) swordfish longlines** - Catches of sharks are thought to represent between 40–60% of the total combined catch for all species. The amounts of sharks caught by longliners targeting swordfish in the Indian Ocean have been constantly increasing since the mid-90‟s. The catches of sharks recorded for these fleets are thought more realistic than those recorded for other longline fisheries.
- **Industrial tuna purse seines** - Catches of sharks are thought to represent less than 0.5% of the total combined catch for all species (10% of total discards). The EU reported preliminary estimates of catches of sharks for EU purse seiners during 2009, as derived from samples collected by observers during 2003–07. The EU plans to revise the catch series for its purse seine fleet to incorporate catches of sharks, as estimated from data collected from observers and other alternative sources. The Secretariat did not receive data from other purse seine fleets concerning bycatch levels of sharks (Iran, Seychelles or Thailand).
- **Pole and line fisheries** - There are no catches of sharks recorded for the pole and line fisheries of Maldives and India in the IOTC database. However, the amounts of sharks caught by these fisheries, if any, are not thought significant.
- **Gillnet fisheries** - The species of sharks caught are thought to vary significantly depending on the area of operation of gillnets. The major problems may arise from:
  - ✓ <u>Gillnets operated in areas having high concentrations of pelagic sharks</u> - Gillnets operated in Sri Lanka, Indonesia and Yemen (waters around Socotra), in spite of being set in coastal areas, are likely to catch significant amounts of pelagic sharks.
  - ✓ <u>Gillnets operated on the high seas</u> - Vessels from Taiwan,China were using drifting gillnets (driftnets) from 1982 to 1992, the year in which the use of this gear was banned worldwide. The catches of pelagic sharks were very high during that period, representing around 25% of the total catch of all species. Driftnet vessels from Iran and Pakistan have been fishing on the high seas since the early-1990's, initially in waters of the Arabian Sea but covering a larger area in recent years, as they moved to operate also in tropical waters of the western Indian Ocean and Mozambique Channel. The amounts of sharks that are caught by these fleets are thought high, representing between 25-50% of the total combined catches of sharks and other species.
  - ✓ <u>Gillnet/longline fishery of Sri Lanka</u> - Catches of sharks represent between 2% and 45% of the total combined catch for all species, depending on the year. Between 1,200 and 3,200 vessels (average size of 12 m) operating gillnets and longlines in

combination have been harvesting important amounts of pelagic sharks since the mid–1980's. The longlines are believed to be responsible for most of the catches of sharks. Since the mid–1990's the proportion of sharks, all species combined, in the catches of gillnet and longline vessels has been constantly decreasing, to represent less than 2% of the total catch in recent years (45% of the catch in 1995). Catches of sharks by vessel by year have also decreased markedly since the mid 1990's.

- **Hand line and troll line fisheries** - The majority of hand line and troll line fisheries in the Indian Ocean operate these gears in coastal waters. Thus, the amounts of pelagic sharks caught are thought to be low. The amount that other species of sharks make out of the catches of tuna and tuna-like species might change depending on the area fished and time of the day.

3.1.10 Summary

Table 3.1.16 summarizes the general shark data, compiled for the IOTC convention area, as by 30/04/2012, towards the objectives of the project. It was compiled from the database available at the IOTC website, namely file NC_SHARKS.ZIP (last updated on 25/05/2011) and the most recent National reports presented to the 14th Scientific Committee meeting (held in December 2011). It is organized by country, fleet and fishing gear, but also provides information on target species, other data sources and the period for which data is available.

Table 3.1.17 summarizes the available information for the IOTC convention area, as by 30/04/2012, in terms of shark nominal catches (NC), catch and effort (CF), catch-at-size (SF), discards (D) and biological (B) information. It is organized by country, fleet and fishing gear.

Table 3.1.16.- Summary information gather by 30/04/2012, based on records available at IOTC shark nominal catch database (last updated on 25/05/2011). This summary table compiles information by country, fleet and fishing gear, but also provides information (when available) on target species, other data sources and the period for which data is available.

Country	Flag	Gear Group	Sharks data	Target species	Other Sources of information	Remarks
CPC	Australia	LL	Available	Swordfish and tunas	IOTC-2011-SC14-NR01	1995-2011
		GN	Not available			
		OT	Available			1970-1994
		PS	Not available			
CPC	Belize	LL	Available		IOTC-2011-SC14-NR02	2002-2010
		OT	Not available			
		PS	Not available			
CPC	China	LL	Available		IOTC-2011-SC14-NR03	1999-2000, 2007-2010
CPC	Comoros	LL	Available			1992-1993, 2005-2009
		OT	Available			1992-1993
CPC	Eritrea	GN	Available			1995-2009
CPC	EU - France	PS	Not available	Tropical tunas	IOTC-2011-WPEB07-23 Rev_1	
		LL	Available	Swordfish and tunas	IOTC-2011-SC14-NR06	1993-2010
	EU - Germany	OT	Not available			1978-1979
	EU - Portugal	LL	Available		IOTC-2011-SC14-NR06	1998-2010
	EU - Spain	PS	Not available	Tropical tunas		
		LL	Available	Swordfish and tunas	IOTC-2011-SC14-NR06	1993-2010
		OT	Not available			
	EU - UK	LL	Available			2004-2009
CPC	France (overseas territories)	Line	Available			2007-2009
		LL	Available			1998-2005
		PS	Not available			
CPC	Guinea	LL	Available			2001-2009
CPC	India	GN	Not available			
		LL	Available		IOTC-2011-SC14-NR09	1986-2009
		OT	Not available			
CPC	Indonesia	GN	Available			1950-2009
		LL	Available			1950-2009
		OT	Not available			
		PS	Not available			
CPC	Iran, Islamic Republic of	GN	Available			1997-2009
		LL	Not available			
		PS	Not available			
CPC	Japan	LL	Available	Tuna and swordfish	IOTC-2011-SC14-NR12 Rev_1	1964-2009
		PS	Not available			
CPC	Kenya	GN	Not available			
		LL	Available		IOTC-2011-SC14-NR13	2005-2009
		OT	Available			1975-2009
CPC	Korea, Republic of	LL	Available		IOTC-2011-SC14-NR14	1971-2009
		OT	Not available			
CPC	Madagascar	LL	Available		IOTC-2011-WPEB07-26	2002-2009
		OT	Not available			
CPC	Malaysia	GN	Available			1999-2009
		LL	Available		IOTC-2011-SC14-NR16	1999-2009
		OT	Available			1999-2009
		PS	Available			2004-2009
CPC	Mauritius	LL	Available		IOTC-2011-SC14-NR18	2001-2007
		PS	Not available		IOTC-2011-WPEB07-20	
CPC	Oman, Sultanate of	GN	Available			1997-2009
		LL	Available			2000-2009
		OT	Not available			
		PS	Not available			
CPC	Pakistan	GN	Available			1992-2009
		LL	Not available		IOTC-2011-WPEB07-21	
CPC	Philippines	LL	Available			1998-2002
CPC	Seychelles	LL	Available		IOTC-2011-SC14-NR22	1997-2009
		OT	Not available			
		PS	Not available			
CPC	Sierra Leone		Not available			

Table 3.1.16.- Continued.

Country	Flag	Gear Group	Sharks data	Target species	Other Sources of information	Remarks
CPC	Sri Lanka	GN	Available		IOTC-2011-SC14-NR24	1950-2010
		LL	Available			1950-2010
		OT	Not available			
		PS	Not available			
CPC	Sudan	OT	Available			1998-2009
CPC	Tanzania	LL	Available		IOTC-2011-SC14-NR26 Rev_1	2005-2010
		OT	Available			1971-2009
CPC	Thailand	GN	Not available			
		LL	Available			2000-2001
		OT	Not available			
		PS	Not available			
CPC	United Kingdom	LL	Not available			
CPC	Vanuatu					
CNCP	Maldives, Republic of	GN	Not available			
		LL	Not available			
		OT	Available			1970-2009
CNCP	Mozambique	LL	Available		IOTC-2011-SC14-NR30	2006-2010
		PS	Not available			
CNCP	Senegal	LL	Available			2003-2006
CNCP	South Africa	LL	Available		IOTC-2011-SC14-NR32	1985-2010
		OT	Not available		IOTC-2011-WPEB07-32	
Other	Bahrain	GN	Not available			
		LL	Not available			
		OT	Not available			
Other	Bangladesh	GN	Available			2008-2009
Other	Bulgaria	OT	Not available			
Other	Dijibouti	GN	Not available			
Other	East Timor	GN	Not available			
		LL	Not available			
Other	Egypt	OT	Available			1977-2009
Other	Israel	OT	Not available			
Other	Jordan	OT	Not available			
Other	Kuwait	GN	Not available			
Other	Qatar	GN	Not available			
Other	Saudi Arabia	GN	Available			1997-2009
		LL	Available			1997-2009
		OT	Available			1982-2009
		PS	Available			2004-2009
Other	Soviet Union	LL	Not available			
		OT	Not available			
		PS	Not available			
Other	Taiwan, China	GN	Available			1986-1992
		LL	Available			1977-2009
Other	United Arab Emirates	GN	Not available			
		LL	Not available			
		OT	Available			1986-2009
Other	Uruguay	LL	Available			2001-2006
Other	Yemen	GN	Available			1950-2009
		LL	Not available			
Nei - Indonesia Fresh tuna		LL	Available			1986-1999
Nei - Ex-Soviet union		PS	Not available			
Nei - Fresh tuna		LL	Available			1989-2009
Nei - Deep Freezing		LL	Available			1993-2009
Nei - Other		LL	Not available			
		PS	Not available			

Nei Fresh tuna and Nei Indonesia Fresh tuna - refers to catches by small, fresh-tuna longliners operating under various flags, mainly from Taiwan,China. Catches estimated by the IOTC Secretariat from various sources (IOTC Sampling Programmes, historical information from plant operators, etc.).

Nei ex-Soviet Union - refers to catches of purse-seine vessels operating under various flags and monitored by scientists from the former USSR until 1991 and from Russia until 1995. Formerly reported as Liberia or Cayman Islands, currently under Belize or Panama flag.

Nei Other - refers to catches of purse-seine vessels flying various non-European flags and monitored and reported by European scientists. One Italian vessel is included in this category as it is the only purse seiner under this flag.

Nei Deep Freezing - refers to catches of non-reporting longline vessels, estimated by the IOTC Secretariat using, in most cases, the number of vessels operating per year. Most of them are recorded operating under Honduras, Belize, Panama or Equatorial Guinea flag.

Table 3.1.17.- Summary of the available information for the IOTC convention area, provided by country, fleet and fishing gear as by 30/04/2012, in terms of shark nominal catches (NC), catch and effort (CF), catch-at-size (SF), discards (D) and biological (B) information.

Country	Flag	Gear Group	NC	CF	SF	D	B
CPC	Australia	LL	+			+	+
CPC	Belize	LL	+				
CPC	China	LL	+	+			
CPC	EU France	LL	+	+			
		PS	+				
	EU Portugal	LL	+	+	+		
	EU Spain	LL	+				
		PS	+				
	EU UK	LL	+	+			
CPC	France	LL	+				
CPC	Guinea	LL	+				
CPC	Indonesia	LL	+				
CPC	Korea, Republic of	LL	+	+	+		
CPC	Japan	LL	+	+	+		
CPC	Kenya	LL	+				
CPC	Malaysia	LL	+	+			
CPC	Mauritius	LL	+	+			
CPC	Oman, Sultanate of	LL	+	+			
CPC	Pakistan	GN	+				
CPC	Philippines	LL	+	+			
CPC	Seychelles	LL	+	+	+		
CPC	Sri Lanka	LL	+	+	+		
CPC	Thailand	LL	+	+			
CNCP	Senegal	LL	+				
CNCP	South Africa	LL	+	+	+		
Other	Taiwan	LL	+	+			
Other	Uruguay	LL	+	+			

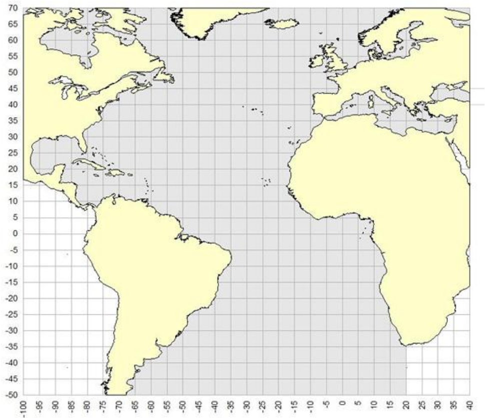
3.2 International Commission for the Conservation of Atlantic Tuna

3.2.1 Introduction

The International Commission for the Conservation of Atlantic Tunas is responsible for the conservation of tunas and tuna-like species in the Atlantic Ocean and adjacent seas (Figure 1). The organization was established at a Conference of Plenipotentiaries, which prepared and adopted the International Convention for the Conservation of Atlantic Tunas [see http://www.iccat.int/en/ for downloading the basic texts, including the Convention], signed in Rio de Janeiro, Brazil, in 1966. After a ratification process, the Convention entered formally into force in 1969.

About 30 species are of direct concern to ICCAT: Atlantic bluefin (*Thunnus thynnus thynnus*), skipjack (*Katsuwonus pelamis*), yellowfin (*Thunnus albacares*), albacore (*Thunnus alalunga*) and bigeye tuna (*Thunnus obesus*); swordfish (*Xiphias gladius*); billfishes such as white marlin (*Tetrapturus albidus*), blue marlin (*Makaira nigricans*), sailfish (*Istiophorus albicans*) and spearfish (*Tetrapturus pfluegeri*); mackerels such as spotted Spanish mackerel (*Scomberomorus maculatus*) and king mackerel (*Scomberomorus cavalla*); and, small tunas like black skipjack (*Euthynnus alletteratus*), frigate tuna (*Auxis thazard*), and Atlantic bonito (*Sarda sarda*).

Through the Convention, it is established that ICCAT is the only fisheries organization that can undertake the range of work required for the study and management of tunas and tuna-like fishes in the Atlantic. Such studies include research on biometry, ecology, and oceanography, with a principal focus on the effects of fishing on stock abundance. The Commission's work requires the collection and analysis of statistical information relative to current conditions and trends of the fishery resources in the Convention area. The Commission also undertakes work in the compilation of data for other fish species that are caught during tuna fishing ("bycatch", principally sharks) in the Convention area, and which are not investigated by another international fishery organization.



ICCAT area of competence (source: http://iccat.int/en/)

Composed of Contracting Party Delegations, the Commission carries out the objectives set forth in the 1966 International Convention for the Conservation of Atlantic Tunas. The Standing Committee on Finance and Administration (STACFAD) advises the Commission on matters relating to the Executive Secretary and his staff, on the budget of the Commission, on the time and place of meetings of the Commission, on publications of the Commission and on such other matters as may be referred to it by the Commission.

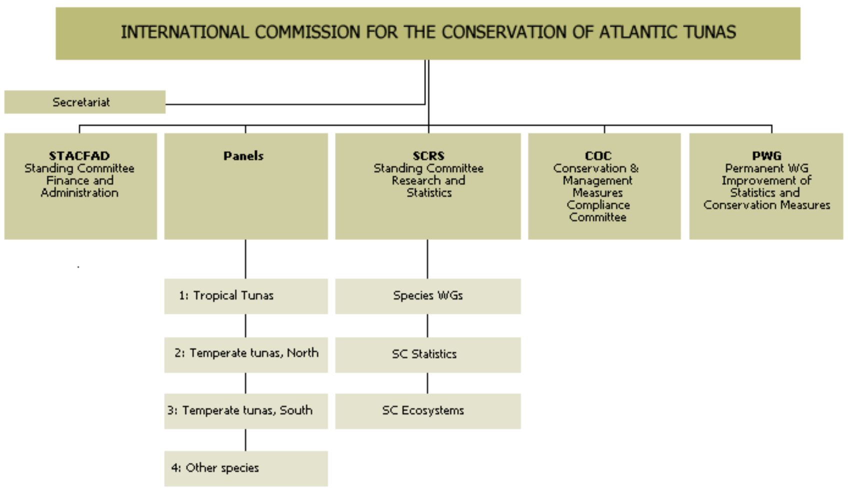
The Standing Committee on Research and Statistics (SCRS) develop and recommend to the Commission such policies and procedures in the collection, compilation, analysis and dissemination of fishery statistics as may be necessary to ensure that the Commission has available at all times complete, current and equivalent statistics on fishery activities in the Convention area.

The Panels are responsible for keeping under review the species, group of species, or geographic area under its purview, and for collecting scientific and other information relating thereto. Based on investigations from the SCRS, Panels may propose to the Commission recommendations for joint action by the Contracting Parties:

- Panel 1: Tropical tunas (yellowfin, bigeye and skipjack)
- Panel 2: Northern temperate tunas (albacore and Atlantic Bluefin)
- Panel 3: Southern temperate tunas (albacore and southern Bluefin)
- Panel 4: Other species (swordfish, billfishes, small tunas, sharks, marine turtles, seabrids)

The Conservation and Management Measures Compliance Committee reviews all aspects of compliance with ICCAT conservation and management measures in the ICCAT Convention Area, with particular reference to compliance with such measures by ICCAT Contracting Parties

The Permanent Working for the Improvement of ICCAT Statistics and Conservation Measures (PWG) obtains, compiles and reviews all available information on the fishing activities of non-Contracting Parties, for species under the purview of ICCAT, including details on the type, flag and name of vessels and reported or estimated catches by species and area.



Organigram of the ICCAT (source: http://iccat.int/en/)

ICCAT has currently 48 Contracting Parties: United States of America, Japan, South Africa, Ghana, Canada, France (St. Pierre et Miquelon), Brasil, Morocco, Republic of Korea, Cote de D'Ivoire, Angola, Russia, Gabon, Cap-Vert, Uruguay, Sao Tome e Principe, Venezuela, Guinea Ecuatorial, Republic of Guinea, United Kingdom, Libya, China, Croatia, European Union, Tunisie, Panama, Trinidad and Tobago, Namibia, Barbados, Honduras, Algeria, Mexico, Vanuatu, Iceland, Turkey, Philippines, Norway, Nicaragua, Guatemala, Senegal, Belize, Syria, St. Vincent and the Grenadines, Nigeria, Egypt, Albania, Sierra Leone, and Mauritania.

In the following paragraphs there is a brief description of the fleets from the ICCAT member, with particular emphasis on those which may catch sharks. This revision is based on the most recent Member States Annual Reports presented at the 2012 Session of the Standing Committee on Research and Statistics (SCRS), held in Madrid during 1-5 October 2012.

United States of America.- Pelagic longline targeting swordfish, shark bottom longline and the recreational fisheries are the main fishing gear interacting with sharks. The U.S. Federal Fisheries Management Plan (FMP) implemented in 1993 (NMFS 1993) identified three management groups: large coastal sharks, small coastal sharks, and pelagic sharks. The pelagic complex included ten species: shortfin mako, longfin mako, porbeagle, thresher, bigeye thresher, blue shark, oceanic whitetip shark, sevengill (*Heptranchias perlo*), sixgill (*Hexanchus griseus*), and bigeye sixgill (*Hexanchus vitulus*). The 1993 FMP classified the status of pelagic sharks as unknown because no stock assessment had been conducted for this complex. The Maximum Sustainable Yield (MSY) for pelagic sharks was set at 1,560 MT dressed weight (dw), which was the 1986-1991 commercial landings average for this group. In 1997, as a result of indications that the abundance of Atlantic sharks had declined, commercial quotas for large coastal, small coastal, and pelagic sharks were reduced. The quota for pelagic sharks was set at 580 MT. In 1999, the U.S. FMP for Atlantic Tunas, Swordfish, and Sharks (NMFS 1999) proposed the following measures affecting pelagic sharks: 1) a reduction in the recreational bag limit to one Atlantic shark per vessel per trip, with a minimum size of 137 cm fork length for all sharks, 2) an increase in the annual commercial quota for pelagic sharks to 853 MT dw, apportioned between porbeagle (92 MT), blue sharks (273 MT dw), and other pelagic sharks (488 MT dw), with the pelagic shark quota being reduced by any overharvest in the blue shark quota, and 3) making the bigeye sixgill, sixgill, sevengill, bigeye thresher, and longfin mako sharks prohibited species that cannot be retained. Regulations on prohibited species went into effect in 2000, whereas those on pelagic shark quotas were enacted in 2001. Presently, the commercial quotas for pelagic sharks are 273 MT dw (blue sharks), 1.7 MT dw (porbeagles), and 488 MT dw (pelagic sharks other than porbeagle or blue).

Landings and dead discards of sharks by U.S. pelagic longline fishermen are monitored and reported to ICCAT. In 2011, the species of shark with the largest amount of landings (in weight) was shortfin mako with a total of approximately 372 MT (of which 171 MT were landed by the U.S. recreational fishery), followed by thresher sharks, blue shark, and hammerhead sharks with approximately 89, 65, and 3.8 MT, respectively.

In 2011, estimates of dead discards for blue shark by the U.S. pelagic longline fleet amounted to almost 1,115MT, the largest amount of any shark species discarded by this fleet. The second largest amount of dead discards by this fleet corresponded to tiger shark with 357 MT followed by silky shark and shortfin mako with 83, and 28 MT, respectively.

Japan.- Longline is the only tuna-fishing gear deployed by Japan at present in the Atlantic Ocean. The number and fishing days of the Japanese longliners, which operated in the Atlantic in the 2011 calendar year, was estimated to be 103 and 19,700 days. Fishing effort showed a decreasing trend as to entire Atlantic; however, in the tropical Atlantic (20N-equatorial-20S) fishing effort demonstrated an upward trend from 2002 to 2007 and stability after 2008, and in the north area it showed a remarkable decreasing tendency since 2005. The hook number in the North Atlantic area (> 20N) decreased to 3500 (x 1000 hooks) in 2011, which was 10% of the hook number in 2005. The catch of tunas and tuna-like fishes (excluding sharks) is estimated to be about 24,000 t. The catch of sharks (including porbeagle, blue shark, shortfin mako, and other sharks) was 3,394 tonnes (preliminary estimates) which is the highest value of the time series since 1994 when shark were started to be reported. Although the total amount of fishing efforts in 2011 was 73% of the past average for the last ten years (2001-2010), the total catches excluding discards and sharks in 2011 were as about 81% of the average catch for the same years and the total catches of sharks in 2011 were as about 50 % higher than the average of last ten years (2,241 tonnes).

South Africa.- No report available.

Ghana.- The tuna industry in Ghana comprises both bait-boats and purse seiners exploiting mainly the Skipjack, Yellowfin and Bigeye tuna species. Twenty two baitboats and seventeen Purse-seiners operated during the year fishing mainly within the EEZ of Ghanaian territorial waters. A total catch of 70,578 mt of tunas was caught in 2011. Skipjack catches were the highest (72%) followed by Yellowfin (15%), Bigeye (6%) and other minor tunas (7%) respectively. Over 80% of catches were made around FADs and both fleets continued to collaborate sharing their catch. Although it would be expected to appear catches associated to FAD fishing, no catches of sharks are reported in the Ghanian annual report.

Canada.- Directed bluefin tuna fisheries take place in Canadian waters from July through December over the Scotian Shelf, in the Gulf of St. Lawrence, in the Bay of Fundy, and traditionally off Newfoundland. The adjusted Canadian quota for the 2011 calendar year was 488.9t. The Canadian nominal landings (directed and bycatch) of Atlantic bluefin tuna in 2011 were 474.1t made up of 398.0t in the directed fishery, 76.0t as an incidental bycatch by the pelagic longline fleet in the swordfish and other tunas fishery. Canadian catches of other tunas (albacore, bigeye and yellowfin) have traditionally been a minor portion of the overall Canadian catch of large pelagic species. In 2011, other tunas accounted for approximately 9% of commercial large pelagic species landed. Bigeye Tuna (136.9t) was the most important other tuna species landed, followed by Yellowfin Tuna (49.7t) and albacore (28.0t).

Swordfish occur in Canadian waters from April to December, primarily on the edge of Georges Bank, the Scotian Shelf and the Grand Banks of Newfoundland. Canada's adjusted quota for 2011 was 1606.0 t. Canadian nominal landings in 2011 were 1550.6, resulting in an underage of 55.4t. The 2011 dead discards were 7.8 t which will be deducted from the initial catch limit in 2013. The Canadian tonnage taken by longline was 1325.4 t (or 86% of the catch), while 207.7 t were taken by harpoon.

With regard to sharks, porbeagle (lamna nasus) is the only shark species for which there is a directed longline fishery though landings in recent years have been minimal. Historically, blue shark and shortfin mako have been a bycatch of the Canadian swordfish and groundfish longline fisheries although small amounts are also landed from other fisheries. The bycatch of blue shark is much larger than reported due to the live release of most incidental harvests and some unreported dead discards. A Management Plan for all shark species was first implemented in 1995. The current management plan for porbeagle sharks has resulted in a significant allowable catch reduction for porbeagle (to 185t) and the closure of the porbeagle mating grounds in order to facilitate stock rebuilding. Total reported landings of porbeagle sharks in the directed fishery and as a bycatch were down significantly over the previous year to a level of 30.0t in 2011. Blue shark and shortfin mako landings in 2011 were 0.8t and 37.4t respectively mainly as a bycatch in other directed pelagic fisheries. The swordfish fleet has adopted the practice of retaining only dead shortfin mako sharks, which has reduced landings in recent years.

France St. Pierre et Miquelon.- Only one longline of 28 meters operated under the flag of France St. Pierre et Miquelon. The total catches of tuna and tuna like species was of 1.03 tonnes during 2011; from which 0.6 corresponds to swordfish and 0.43 to Bluefin tuna. The total shark catch was 0.2 tonnes in 2001 without specifying the species composition.

Brazil.- In 2011, the Brazilian tuna fleet consisted of 583 vessels. Of these 583 boats, mainly baitboat and longline, 568 were national and 15 were foreign chartered vessels. The Brazilian catch of tunas and tuna-like fishes, including billfishes, sharks, and other species of minor importance (e.g., wahoo and dolphin fish), was 52,014.97 t (live weight) in 2011, representing an increase of almost 25% from 2010, when the production reached 41,684.51 t. Almost 93% of total catch was represented by skipjack tuna (30,563.34 t; 59% of total catch), dolfin fish (4,379.23 t; 8.4%), yellowfin tuna (3,498.83 t; 6.7%), swordfish (3,033.03 t; 5.8%), blue shark (1,979.53 t; 3.8%), bigeye tuna (1,799.22 t; 3.4%), unclassified tunas (1,718 t; 3.3%) and southern albacore (1,269.06 t; 2.4%). The total catch of the tuna longline fishery (11,673.72 t) was 5% lowest than 2010 (12,293.08 t), with swordfish (2,800.15 t), blue shark (1,912.6 t) and yellowfin tuna (1,793.82 t) representing almost 56% of longline catches.

Morocco.- Total catch of tuna and tuna like especies was 8,584 tonnes in 2011 in comparison to the total catch of 10,722 t. in 2011, which represents a reduciont of 20 % in volume. The Moroccan fleet is composed by longliners, gillnets, purse seiners and traps in the Atlantic and by longliners, gillnets, handlines and purse seiners in the Mediterranean Sea. Total shark catch was estimated to be 697 tonnes in the Atlantic and 60 tonnes in the Mediterranean Sea. For the Atlantic, 420 t. were made of Blue shark, followed by hammerheads (143 tonnes), great white shark (92), tope shark (*Galeorhinus galeus*) (19 t.) and other sharks. It is worth mentioning that the statistics of great white shark correspondes to other species as it is surely misidentified in the report. In the Mediterranean, most of the catch was of tope shark.

Republic of Korea.- There are three types (longline, bait boats and purse seine) of Korean gears fishing for tuna and tuna-like species in the Atlantic Ocean. Purse seine fleets operates since October 2010 as chartered with other flag. In 2011, 16 Korean longliners were engaged in fishing for tuna and tuna-like species in the Atlantic Ocean.

The total catches were 4,614 mt, which was an increase by 20.4% compared to the previous year. Of the catches, bigeye tuna, yellowfin tuna and albacore comprises 60%, 11% and 3%, respectively. Shark species were relatively abundant comprising around 10% of total catch. From the total declared shark catches of 729 tonnes, 663 t. corresponds to blue shark and 39 to short fin mako.

Cote d'Ivoire.- The fleet is composed by local and Korean industrial fleet as well as artisanal local vessels. The total catch of tuna and tuna-like species was 2,892 tonnes in 2011, from which the sharks represent around 1.75 % of total catch (50.5 tonnes). The most common shark was the hammerhead *Sphyrna lewini* (34.6t o 68.5%), followed by the blue shark (10.3 t and 20.4 %) and the shortfin mako (6 t. and 12%).

Angola.- No report available.

Russia.- During 2008-2012 Russia conducts two types of fishery in the ICCAT Convention area – trawl and purse-seine fishing, during which tunas occur in the catches. In the course of non-specialized trawl fishing (small coastal fishes) tunas are found as a by-catch. The purse-seine specialized fishing for tunas belonging to a tropical group was resumed in the late 2006 after a four-year interruption and is now at the stage of formation; the vessels were engaged in fishing at regular intervals and in experimental mode of operation. During 2010, 2011 and 2012 the specialized (purse seine) fleet did not operate. No shark information is provided.

Gabon.- No report available.

Cap Vert.- The total preliminary catch in 2011 was of 16,011 tonnes, made mainly by the industrial or semi-industrial and with hand line artisanal fishery. The Cap Vert fishery resources are harvested by an artisanal fleet (around 1293 vessels) and by a semi-industrial and industrial fleet (91 vessels). In the artisanal fishery, the shark catch represents around 0.3% of the total catch; which indicates clearly that these fishery target other species. With respect to the industrial fishery, the sharks are the main catches with around 442 tonnes in 2011 in comparison to 79 t. of swordfish and 11 t. of marlins.

Uruguay.- During 2011 the fishing effort of Uruguay fishing fleet decreased in comparison to 2010. Most of the vessels are longline vessels less than 27 m targeting swordfih. The preliminary catch landing was 1.067 t. in 2011; from which 179 was swordfish, 724 tonnes of blue shark, and 76 tonnes of shortfin mako. Since 2010, the fleet started to discard the hammerhead (Sphyrna spp) following ICCAT recommmendations and the porbeagle (Lamna nasus) following internal administrative rules

Sao Tome e Principe.- No report available.

Venezuela.- In 2011 the fleet was composed by 74 vessels (61 longlines, 6 purse seines and 7 baitboats) and 41 coastal gillnet vessels. The total catch in the Atlantic was 8,042 t. in 2011. Tuna species represent 93.5% of the total catch (yellowfin 55 % and skijpack 18 %). The bycatch was comprised by marlins and sharks. The landing of sharks represent 2 % of the total catch with around 130 tonnes (116 t. of blueshark and 18 t. of shortfin mako). Around 57.8 % of the landings correspond to purse seines, 22.1 % to longlines, 15.4 % to baitboats, and around 4.6 % to the artisanal fleet.

Guinea Ecuatorial.- The fleets by artisanal fleet. UE industrial purse seines are also fishing in the EEZ under a Fishery Partnership Agreement. No information on catches is presented.

Republic of Guinea.- The fleets is composed by 3 purse seines and the artisanal fleet. The total catch of those 3 purse seines was around 6,000 t. in 2011 but no information about species composition of catches nor shark is presented. UE industrial purse seines (28 vessels) and bait boats (12 vessels) are also fishing in the EEZ under a Fishery Partnership Agreement.

United Kingdom.- No report available.

Libya.- In the 2012 fishing season, bluefin tuna was targeted by the Libyan fishing fleet in the Mediterranean Sea using only one type of fishing gear, purse seine. The total number of vessels engaged in the operation was 13 purse seiners. In 2011, Libya had no bluefin tuna fishing.

China.- Longline is the only fishing gear used by the Chinese fishing fleet to fish tunas in the Atlantic Ocean. Thirty (30) Chinese tuna longliners operated in 2011, with a total catch of 4997.1 t including tuna, tuna-like species and sharks (in round weight), 1875.9 t lower than that of 2010 (6873 t). The target species were bigeye tuna and bluefin tuna, of which catches amounted to 3720.2 t and 35.9 t, in 2011, respectively. Bigeye tuna was still the major target species in Chinese catch, accounting for 74.4% of the total. Yellowfin tuna, swordfish and albacore were taken as bycatch. The catch of yellowfin tuna, swordfish, and albacore was 346.4 t, 322.2 t, and 181.0 t, in 2011, respectively. The total catch of blue shark in 2011 amounted to 239.6 t and increased greatly compared with 2010 (93.4 t). But the total catch of shortfin mako was 46.9 t, which was 23.3% lower than that of 2010 (61.1 t).

Croatia.- Total Croatian catch of BFT in 2011 was 375 metric tons. Out of that, total catch in commercial fisheries was 372 metric tons (t) and in sport/recreational fisheries was 3 tons. Out of total catch 4.45 t (1,20 %) was dead discard (mortality). BFT catches in commercial fisheries were mostly realized by purse seiners – 366 t (98,39 %), while the remaining (5,98 t; 1,61 %) was caught using hook and line gears. Total Croatian catch of Mediterranean (Adriatic) swordfish in 2011 amounted to 6 tonnes. No information on catches is provided.

European Union.- The European Union fleet included fleets from Spain, France, Portugal, Italy, Cyprus, Greece, Ireland, Malta, and United Kingdom:

- Cyprus: The large pelagic species targeted by the Cyprus fishing fleet are bluefin tuna, albacore, and swordfish. The fishing fleet categories involved in the large pelagic fishery are the polyvalent vessels using primarily drifting longlines, a small number of non-exclusive bottom trawlers and the small scale inshore fleet in a much lesser extent. The recreational fishery is also directed seasonally to the large pelagic fishery, basically albacore. The Cyprus fleet is not actively fishing sharks, the majority of which are caught incidentally. The polyvalent vessels catch some quantities of pelagic sharks on drifting long-lines, but their quantities are very small compared to the total catch. Landings are recorded as a general category "sharks", and basically include quantities of shortfin mako and blue shark (based on observations and information provided by fishermen). Effort is made to collect landings information per species. During 2011 only about 0.9 tons of pelagic sharks were recorded as bycatch.

- France: The French fleet is composed of three components: purse-seiners for tropical in the Atlantic and Bluefin in the Mediterranean, longliners both in the Atlantic and Mediterranean, baitboats operating from Dakar, and pelagic trawl in the Atlantic targeting albacore. The French fleet captures occasionally pelagic shark species, such as blue shark short fin mako, silky shark, etc. The fishery targeting porbeagle done by 5 longliners was closed in 2009 after the establishment of TAC zero by the UE based on the ICES and ICCAT expert advice. Currently, the estimated catches of the French fleet in the Atlantic in 2011 are 130 tonnes of Squalus acanthias, 82 t. of blue shark, and 40 tonnes of thresher sharks; whereas in the Mediterranean 2 tonnes of thresher sharks and 250 kg of blue shark are declared.
- Greece: The Greek fishery for large pelagic species, as mentioned in previous reports, is characterized by a variety of vessel types and fishing gears (multigear vessels), with landing sites in many locations depending on season and local abundance of different species. In addition to fishing license, special fishing permits are issued for each vessel employed in large pelagic fishery. For bluefin tuna (BFT) catches, a decrease of 51,45 tn was observed in relation to last year catches (2010), and underused by 7,08 tn the adjusted quota. The total landings of bluefin tuna for the year 2011 reached the amount of 172,29 tn. As for swordfish (SWO) catches, there is an decrease of 187,68 tn from the production of the previous year 2010. Swordfish catches were carried out using only long lines, and the total amount caught, reached 1306,0 tn, in round weight. No data on sharks is presented.
- Ireland: The Irish fishery for tunas and tuna like fishes is restricted to a commercial fishery for northern albacore tuna, north of latitude 5ºN. In 2011, 50 vessels were authorised to fish Albacore tuna, and 45 of these vessels participated in the fishery, reporting an annual catch of 3597t representing a 456% increase in landings compared to 2010. Some 99.94% of Albacore landings were caught with mid water paired trawls (MWTD). A total of 2.2t of broadbill swordfish and 4.4t of Bluefin Tuna were reported as bycatch in the northern Albacore fishery. No shark bycatch occurred in Albacore fisheries but some shark bycatch occurred in other non-tuna fisheries as reported in ICCAT Task data form ST02.
- Italy: The Italian BFT fleet, in 2011, was composed by 12 purse seiners, 30 long liners and 6 fixed tuna traps. During 2011, the most important amount of bluefin tuna was caught by purse seiners, while the catch by longliners are positioned in the second place; whereas catch of traps had lower incidence. Considering also the fisheries activity exercised with other gears, the total catch of swordfish is 5.356,9 tons. Referring to albacore the catch amounts to 2.503,9 tons. No information on bycathes or sharks is presented.
- Malta: In Malta bluefin tuna is targeted mainly by surface longlines. In 2011, 39 longline vessels were authorised to fish for bluefin tuna and only one purse seiner was allowed to operate. In 2010, the total landings of BFT were 135.588 metric tonnes (t), while in 2011 a total of 141.790 tonnes (t) were landed, leading to an increase in landings of 4.4%. The amount landed in 2011 resulted

from 91.770 and 50.020 metric tonnes (t) landed from surface longlines and purse seining operations respectively. Swordfish are targeted all year round except during the closed seasons. During the bluefin tuna season swordfish are mainly landed as a by-catch. In 2010, the total landings of swordfish were 312.82 metric tonnes (t), while in 2011 a total of 413.065 tonnes (t) were landed, leading to an increase in landings of 24.3%. The amount landed in 2011 resulted from 376.179 and 36.886 metric tonnes (t) from drifting surface longlines for vessels over 10m length overall and landings from set surface longlines for vessels over 10m length overall respectively. The amount landed in 2010 resulted from 312.81, and 0.01 metric tonnes (t) from drifting surface longlines for vessels over 10m length overall and landings from set surface longlines for vessels over 10m length overall respectively. No shark or bycatch catches are presented, only few data on numbers and length of sharks by observers are included in the National report.

- Portugal: The main fish species for the Portuguese fleet, composed mainly by artisanal fleet of Azores/Madeira and longliners, are the swordfish, yellowfin, bigeye, skipjack, albacore, and bluefin. In 2011, the total catch of tunas and tuna like species including sharks increased to 32,241.8 tonnes. The main species in the total catch is the blueshark, followed by the bigeye, skipjack, swordfish, and shortfin mako shark.
- Spain: The Spanish fleet is composed of four main components: purse-seiners for tropical tunas in the Atlantic and for bluefin in the Mediterranean, longliners both in the Atlantic and Mediterranean, baitboats operating in the Bay of Biscay for albacore and bluefin and from Dakar for tropical tunas, the almadrabas for Bluefin tuan in the Mediterranean. Spanish total catch of tuna and tuna like species in the ICCAT regulatory area in 2008 was around 100,000 tonnes; and this included 35,000 tonnes of skipjack, 25,000 t. of yellowfin, around 7,000 t. of bigeye, 13,000 t. of albacore, around 5,500 t. of bluefin, and around 10,000 t. of swordfish both in the Atlantic and Mediterranean.The Spanish purse seinter fleet caught pelagic sharks (mainly silky shark and oceanic white tip shark) as a bycatch and the surface longline fleet targeting swordfish captures pelagic shark species, mainly species such as blue shark and short fin mako. Currently, the estimated catches of the Spanish fleet in the Atlantic in 2011 were around 45,000 tonnes of blueshark and 3,200 tonnes of short fin mako, 80 t. of longfin mako, and around 120 t. of other Carcharhinidae; whereas in the Mediterranean 40 tonnes of blueshark and 2 t. of short fin mako.
- United Kingdom: The UK's total catch of tuna and tuna like species in the ICCAT regulatory area in 2011 was 2100 tonnes. This includes 57 tonnes of albacore and 21 tonnes of yellowfin with the remainder being non quota species such as frigate tuna, black marlin and various species of shark.

Tunisie.- The tuna fleet is composed by 23 vessels (19 longer than 24 meters) along the SouthEast coast fishing for Bluefin tuna and all coast targeting swordfish. The total catches of Bluefin and swordfish in 2011 were 1850 t. which accounted for 10 % less than in 2010. No shark or bycatch data is presented.

Panama.- The fleet is comprised by 2 purse seines and 35 longlines greater than 20 meters targeting yellowfin, skipjack and bigeye. No information on catches or discards of tuna and tuna-like species and sharks.

Trinidad and Tobago.- The Trinidad and Tobago catch of tuna and tuna-like species for 2011 was estimated at approximately 4300 t. Yellowfin tuna continued to be the most abundant species in the catch of the longliners (788 t.). The fleet size has not changed since 2011. Currently there are 31 operational longliners, two of which are greater than 24 m LOA. No information on catches specific composition nor shark catches is presented.

Namibia.- Namibia charters bait boats on a seasonal basis, mostly from South Africa, to catch ALB and BET during the short fishing season from October to April. Due to chartering constraints experienced in 2009 and 2010 only 25 bait boats operated in 2009, 21 in 2010 and then, back to normal at 55 in 2011. During 2011 these 55 vessels landed 3711 tons of ALB (4963 tons in 2009 and 1263 tons in 2010) and 263 tons of BET (60 tons in 2009 and 47.9 tons in 2010). Also in 2011, 47.5 tons of YFT were caught (0 in 2009 and 2.1 ton in 2010). The same chartering constraints for longline vessels occurred during 2009 and 2010 eg. only 11 vessels operated in 2009, 12 in 2010 and back to normal in 2011 with 25 vessels. The main species harvested during 2011 by these 25 vessels were 414.5 tons of SWO (25.4 tons in 2009 and 408 tons in 2010), 2956.8 tons of BSH (206.8 tons in 2009 and 2351 tons in 2010), 872.8 tons of SMA (163 tons in 2009 and 408 tons in 2010). For 2011 a range of bycatch species were caught namely 80 tons of ALB, 25.7 tons of BET, 42.1 tons of YFT, 1.7 tons of SKJ, 19.1 tons of THR and 10 tons of BUM.

Barbados.- In 2011, the estimated total Barbados catches of large pelagic species under the purview of ICCAT was around 260 t. As usual the longline fleet landed the majority (80%) of the island's catch of the large highly-migratory species group (tunas, billfishes and swordfish). On the other hand the majority (88%) of Wahoo (Acanthocybium solandri) were taken by the smaller vessels using single-hook lines, usually during fishing trips targeting flying fish (Hirundichthys affinis) and associated large pelagics (please refer to Barbados National Report 2010 for a detailed description of vessel types comprising the local fishing fleet). Longliners landed around 46% of the island's total shark catch. Sharks are not targeted by local fishermen as they are not a popular local market species. Of the 39 longline vessels registered in the local fishing fleet in 2011, only 25 were actively fishing during the year. There are no vessels larger than 24m LOA in the Barbados fishing fleet. However, there are two longline vessels greater than 20m LOA registered in the fleet but these were inactive throughout the reporting period as they were being refurbished. These vessels will be added to the ICCAT Record of Vessels over 20m when they are seaworthy and allowed to commence fishing. No foreign owned vessels are registered in the Barbados fishing fleet. All Barbadian fishing vessels are home-based and none use purse seine gear. No transhipments of large pelagics were made through Barbados in 2011. No total catch figures are presented.

Honduras.- No report available.

Algeria.- The total catch of Algerian tuna vessels was 1797 tonnes in 2011: 216 t. swordfish, 355 t. albacore, 98 t. bigeye, 9 t. palometa, and 1119 t. of bullet tuna. This catch was caught by artisanal longline vessels and purse seines between 9 and 15 meters. The Bluefin fleets composed by 20 purse seines and 2 longlines did not fish during 2011. No shark data is presented.

Mexico.- In the Gulf of Mexico the tuna fishery is carried out during the whole year by a longline fleet (less than 25 meters) targeting yellowfin but with a bycatch of other tuna and tuna-like species and sharks. Based on the observer program, in 2011 27 vessels actively fished in the ICCAT Convention Area; which made 326 fishing trips, 2,883 sets using 1'771,514 hooks. The total catch of yellowfin was 1,220 tonnes. And the bycatch was comprised by (i) 33 tonnes of tunas such as Bluefin, skipjack, bigeye; (ii) 171 t. of swordfish and marlins; (iii) 33 t. of sharks such as shortfin mako and threshers, ; (iv) and 52 t. of other fishes.

Vanuatu.- No report available.

Iceland.- The Ministry of Industries and Innovation in Iceland allocates its bluefin tuna quota for one year at a time. In 2011 there were no targetet bluefin tuna fisheries. One longline vessel was allocated quota, but did not fish. Incidental bycatches of bluefin tuna by Icelandic vessels in the Icelandic EEZ amounted to 2.4 t. In 2012 the allowed fishing method is longline in the area south of Iceland and the fishing season starting 1 August. In 2012 the Icelandic quota was in total 29.82 tonnes (t). One longline vessel was allocated 25 t of IQ and the remaining tonnes of the quota reserved for incidental bycatches of bluefin tuna by Icelandic vessels or recreational fisheries.

Turkey.- During the course of 2011, the total catch of tuna and tuna-like fishes amounted to 16,120.9 t. In 2011, Turkey's total catch of bluefin tuna, albacore, Atlantic bonito and swordfish were 527.5 t, 1,395.7 t, 10,018.9 t, and 189.6 t, respectively. The entire bluefin tuna catch was caught by purse seiners, the majority of which have an overall length 40-50 meters. The fishing operation was conducted intensively off Antalya Bay in the south of Turkey and in the Eastern Mediterranean region. The swordfish fishery in Turkey is carried out in Aegean Sea and eastern Mediterranean Sea. While swordfish fishing is carried out using harpoon in the northern Aegean Sea, it is carried out by longlines in the eastern Mediterranean Sea. The total catch amount in 2011 was 189.6 t. Despite a decrease compared with previous years the fishery trend has not changed since 2000. No shark information is provided.

Philippines.- In 2011, there were 23 fishing vessels that are authorized and registered to fish in the ICCAT Convention Area but only eleven (11) vessels are authorized to fish in the area in any given year. The catches of these vessels for 2011 was 1,500 tonnes broken down by species as follows: 1,266 t. of bigeye, 134 t. of Yellowfin and 52 t. of Swordfish. No information of sharks is provided.

Norway.- There have been no catches of Atlantic bluefin tuna, Atlantic swordfish and Atlantic bonito in Norway in 2011.

Nicaragua.- No report available.

Guatemala.- No report available. There are 2 authorized vessels for which only 1 is in the active list of vessels. The target species are yellowfin, skipjack and bigeye. The total catch of this vessel was around 5,950 tonnes comprised by yellowfin (2,802 t.), skipjack (2,828 t.), bigeye (282 t.) and other species (48 t.). No information of bycatch of sharks is provided.

Senegal.- there are 3 types of fisheries targeting tuna and tuna-like species: the industrial fishery composed of 6 baitboats targeting tropical tunas, one longline targeting swordfish and the artisanal and recreational fishery. In 2011, the total catches of baitboas were estimated to be 6,118 tonnes which are higher than the reported in 2010 (4,606 tonnes). The fishing effort in 2011 slighly increased from 1220 fishing days in 2010 to 1366 fishing days. For the longline fleet, the total catch was 533 tonnes in 2011 which were larger than the estimated catches in 2010 (312 tonnes). The longline catches mainly comprised swordfish (264tonnes) and sharks (216 tonnes). With regard to the artisanal fishery, the total catch of all species together accounted for 9,024 in 2011 which is higher than the estimated 8,719 tonnes in 2010). The recreational fishery catches were estimated in 81 tonnes in 2011 which decreased from the 288 tonnes estimated in 2010. No information of shark catch species composition is provided in the report.

Belize.- Belize's fishing fleet operating in the ICCAT area comprises mostly of longliners which are licensed to target tuna and tuna like species. We also have 5 purse seiners actively operating in the area. The total number of tuna long liners operating in the ICCAT Convention area has increased over the past several years, from 11 in 2006 to 12 in 2007, 14 in 2008, 20 in 2009, 22 in 2010, 26 in 2011 and 19 in 2012. Our purse seine fleet was 1 in 2010 and has increased to 5 in 2011 and 2012. Over the last five years our total catches of tuna and tuna-like species and sharks amounted to 1676.18 m/t in 2007, 1431m/t in 2008, 1664 m/t in 2009 to 6851.59 m/t in 2010 and 14,409 m/t in 2011. Yellowfin has been our dominant catch for the past several years amounting to 71% of the total catch in 2006, 69% in 2007, 81% in 2008 and 59% in 2009. However, in 2010 and 2011 our dominant catch has been skipjack, amounting to 39% and 51 % respectively of our overall catches. The average size of our vessels in 2006 and 2007 was 116 gt, 133 gt in 2008, 359 gt in 2009, 397 gt in 2010 and 583 in 2011. Blue shark and Mako shark continues to be the most common non-tuna species in our long line fishery followed by blue marlin. The catch of sharks increased since 2007 and it was the highest in 2011 with around 1310 t. from which 1280 t. was blueshark and 130 t. mako shark.

Syria.- No report available.

St. Vincent and the Grenadines.- No report available.

Nigeria.- No report available.

Egypt.- No report available.

Albania.- No report available.

Sierra Leone.- No report available.

Mauritania.- The tuna fishery is carried by the industrial foreign vessels (Spanish, Senegalese, and Japanese) and the artisanal fishery. No information on catches or bycatches is provided.

3.2.2 Methodology and data used

The major fisheries (country/fleet/gear) targeting tunas and sharks in the Atlantic have been identified using information available on the ICCAT website. In Addition, all the relevant documents, publications and working documents, which could provide complementary information on all the fisheries catching a large amount of tunas and sharks, have been collated.

For more details see general section on Methodology and data used.

3.2.3 Bycatch issues at ICCAT

ICCAT has addressed for a number of years the issue of bycatch and as mentioned previously has currently a devoted two Working Groups to specifically discuss and analyse and discuss bycatch issues – Working Group on Ecosystems and Working Group on Sharks. The Table below (Table 3.2.1) resumes the current active resolutions by ICCAT related with shark and shark data issues. The resolutions can be found in http://www.iccat.int/en/RecsRegs.asp.

It is worth mentioning that there is no common definition stating today by ICCAT. ICCAT have adopted presently a list of recommendation and resolution on bycatch and discards relevant for our study that are listed below.

Table 3.2.1.- List of the ICCAT active recommendations (binding) and resolution (non-binding) concerning the by-catches and discards of sharks as well as those recommendations on other species that may affect the shark mortality and management.

Recommendation/Resolutions	Number
Recommendation by ICCAT on compliance with existing measures on shark conservation and management	[2012-05]
Recommendation by ICCAT Amending the Recommendation by ICCAT to Establish a Multi-Annual Recovery Plan for Bluefin Tuna in the Eastern Atlantic and Mediterranean	[2012-03]
Recommendation by ICCAT on Information Collection and Harmonization of Data on By-catch and Discards in ICCAT Fisheries	[2011-10]
Recommendation by ICCAT on the Conservation of Silky Sharks Caught in Association with ICCAT Fisheries	[2011-08]
Recommendation by ICCAT on a Multi-Annual Conservation and Management Program for Bigeye and Yellowfin Tunas	[2011-01]
Recommendation by ICCAT on hammerhead sharks (family sphyrnidae) caught in association with fisheries managed by ICCAT	[2010-08]
Recommendation by ICCAT on the conservation of oceanic whitetip shark caught in association with fisheries in the ICCAT convention area	[2010-07]
Recommendation by ICCAT on atlantic shortfin mako sharks caught in association with ICCAT fisheries	[2010-06]
Recommendation by ICCAT on the conservation of thresher sharks caught in association with fisheries in the iccat convention area	[2009-07]
Supplemental Recommendation by ICCAT Concerning Sharks	[2007-06]
Supplementary Recommendation by ICCAT Concerning the Conservation of Sharks Caught in Association with Fisheries Managed by ICCAT	[2006-10]
Recommendation by ICCAT to Amend Recommendation 04-10 Concerning	[2005-05]

the Conservation of Sharks Caught in Association with Fisheries Managed by ICCAT	
Recommendation by ICCAT concerning the conservation of sharks caught in association with fisheries managed by ICCAT	[2004-10]
Resolution by ICCAT on the shark fishery	[2003-10]

What follows is a brief summary of the major aspects covered by each of these recommendations/resolutions:

Rec. 2012-05 - Recommendation by ICCAT on compliance with existing measures on shark conservation and management

- ICCAT has put in place recommendations that prohibit the retention of shark species identified as at risk due to the impact of fisheries within the ICCAT Convention area: bigeye thresher (09-07), oceanic whitetip (10-07), hammerhead (10-08), silky sharks (11- 08);
- Shark recommendations have now been in place for some years, and that contrary to other species explicitly covered by the Convention, there are no extensive records of compliance by Contracting Parties, non-Contracting Parties, Entities and Fishing Entities (CPCs) on shark recommendations;
- Recommendation by ICCAT Concerning the Conservation of sharks Caught in Association with Fisheries Managed by ICCAT [Rec. 04-10] highlights the need for action and co-operation for the proper conservation and management of sharks in the ICCAT convention area and that establishes the obligation to annually report;
- All CPCs submit to the ICCAT Secretariat, in advance of the 2013 annual meeting, details of their implementation of and compliance with shark conservation and management measures [Recs. 04-10, 07-06, 09-07, 10-08, 10-07, 11-08 and 11-15].

Rec. 2012-03 - Recommendation by ICCAT Amending the Recommendation by ICCAT to Establish a Multi-Annual Recovery Plan for Bluefin Tuna in the Eastern Atlantic and Mediterranean

- Each CPC shall ensure observer coverage on vessels and traps active in the bluefin tuna fishery on at least:
  - ✓ 20% of its active pelagic trawlers (over 15m),
  - ✓ 20% of its active longline vessels (over 15m),
  - ✓ 20% of its active baitboats (over 15m),
  - ✓ 100% of towing vessels,
  - ✓ 100% of harvesting operations from traps.

  Which shall record the amount of catch and by-catch, that also includes species disposition, such as retained on board or discarded dead or alive;
- An ICCAT Regional Observer Programme shall be implemented to ensure an observer coverage of 100%:
  - ✓ on all purse seiners authorised to fish bluefin tuna;
  - ✓ during all transfers of bluefin tuna from purse seiners
  - ✓ during all transfers of bluefin tuna from traps to transport cages;
  - ✓ during all cagings of bluefin tuna in farms;
  - ✓ during all harvesting of bluefin tuna from farms.

Rec. 2011-10 - Recommendation by ICCAT on Information Collection and Harmonization of Data on By-catch and Discards in ICCAT Fisheriea

- Contracting Parties and Cooperating non-Contracting Parties, Entities and Fishing Entities (CPCs) shall require the collection of bycatch and discard data in their existing domestic scientific observer programs and logbook programs;
- CPCs that wish to employ an alternative scientific monitoring approach for vessels <15 meters, as specified in paragraph 1b) of Recommendation 10-10, shall describe their alternative approach as part of the observer program report that is due to the SCRS on July 31, 2012 (as required by paragraph 5 of Recommendation 10-10).
- For artisanal fisheries that are not subject to ICCAT's minimum standards for scientific observer programs (Recommendation 10-10) or recording of catch requirements (Recommendation 03-13) CPCs shall implement measures to collect bycatch and discard data through alternative means and describe these efforts in their Annual Reports, beginning in 2012. The SCRS shall evaluate these measures in 2013 and provide advice to the Commission on this matter;
- CPCs shall report the bycatch and discard data collected under paragraphs 1a and b to the Secretariat in the format specified by SCRS, in accordance with existing deadlines for data reporting;
- CPCs shall report on steps taken to mitigate bycatch and reduce discards, and on any relevant research in this field, as part of their Annual Reports, beginning in 2012;
- CPCs shall provide these data in a manner consistent with their domestic confidentiality requirements.
- Where possible, CPCs shall provide existing identification guides for sharks, seabirds and turtles and marine mammals caught in the Convention Area to the ICCAT Secretariat, and the Secretariat shall request subregional RFMOs to provide the Commission with relevant identification guides. The Secretariat shall share these guides with the T-RFMO Technical Working Group on Bycatch, as appropriate.
- This recommendation applies to discards and bycatch of species caught in association with fisheries managed by ICCAT, as reflected in the FAO International Guidelines on Bycatch Management and the Reduction of Discards.

Rec. 2011-08 - Recommendation by ICCAT on the Conservation of Silky Sharks Caught in Association with ICCAT Fisheries

- Contracting Parties, and Cooperating non-Contracting Parties, Entities or Fishing Entities (hereafter referred to as CPCs) shall require fishing vessels flying their flag and operating in ICCAT managed fisheries to release all silky sharks whether dead or alive, and prohibit retaining on board, transshipping, or landing any part or whole carcass of silky shark.
- CPCs shall require vessels flying their flag to promptly release silky sharks unharmed, at the latest before putting the catch into the fish holds, giving due consideration to the safety of crew members. Purse seine vessels engaged in ICCAT fisheries shall endeavor to take additional measures to increase the survival rate of silky sharks incidentally caught.
- CPCs shall record through their observer programs the number of discards and releases of silky sharks with indication of status (dead or alive) and report it to ICCAT.

- Silky sharks that are caught by developing coastal CPCs for local consumption are exempted from the measures established in paragraphs 1 and 2, provided these CPCs submit Task I and, if possible, Task II data according to the reporting procedures established by the SCRS. CPCs that have not reported species-specific shark data shall provide a plan by July 1, 2012, for improving their data collection for sharks on a species specific level for review by the SCRS and Commission. Developing coastal CPCs exempted from the prohibition pursuant to this paragraph shall not increase their catches of silky sharks. Such CPCs shall take necessary measures to ensure that silky sharks will not enter international trade and shall notify the Commission of such measures.
- Any CPC that does not report Task I data for silky shark, in accordance with SCRS data reporting requirements, shall be subject to the provisions of paragraph 1 until such data have been reported.
- The prohibition on retention in paragraph 1 does not apply to CPCs whose domestic law requires that all dead fish be landed, that the fishermen cannot draw any commercial profit from such fish and that includes a prohibition against silky shark fisheries.

Rec. 2011-01 - Recommendation by ICCAT on a Multi-Annual Conservation and Management Program for Bigeye and Yellowfin Tunas

- Includes a area/time closure in relation with protection of juveniles of bigeye and yellowfin where fishing for for, or supported activities to fish for bigeye and yellowfin tunas in association with objects that could affect fish aggregation, including FADs, shall be prohibited between African coast and parallel 10 ºS in latitude and between 5º W and 5 º E in longitude from 1st January to 28 February starting in 2013;
- An ICCAT Regional Observer Program shall be established in 2013 to ensure observer
  coverage of 100% of all surface fishing vessels 20 meters LOA or greater fishing bigeye and/or yellowfin tunas in the area/time closure referred to in previous paragraph.

Rec. 2010-08 - Recommendation by ICCAT on hammerhead sharks (family sphyrnidae) caught in association with fisheries managed by ICCAT

- Contracting Parties, and Cooperating non-Contracting Parties, Entities or Fishing Entities (hereafter referred to as CPCs) shall prohibit retaining onboard, transshipping, landing, storing, selling, or offering for sale any part or whole carcass of hammerhead sharks of the family *Sphyrnidae* (except for the *Sphyrna tiburo*), taken in the Convention area in association with ICCAT fisheries.
- CPCs shall require vessels flying their flag, to promptly release unharmed, to the extent practicable, hammerhead sharks when brought alongside the vessel.
- Hammerhead sharks that are caught by developing coastal CPCs for local consumption are exempted from the measures established in paragraphs 1 and 2, provided these CPCs submit Task I and, if possible, Task II data according to the reporting procedures established by the SCRS. If it is not possible to provide catch data by species, they shall be provided at least by genus *Sphryna*. Developing coastal CPCs exempted from this prohibition pursuant to this paragraph should endeavor not to increase their catches of hammerhead sharks. Such CPCs shall take necessary measures to ensure that hammerhead sharks of

the family *Sphyrnidae* (except of *Sphyrna tiburo*) will not enter international trade and shall notify the Commission of such measures.

- CPCs shall require that the number of discards and releases of hammerhead sharks are recorded with indication of status (dead or alive) and reported to ICCAT in accordance with ICCAT data reporting requirements.
- CPCs shall, where possible, implement research on hammerhead sharks in the Convention area in order to identify potential nursery areas. Based on this research, CPCs shall consider time and area closures and other measures, as appropriate.
- As appropriate, the Commission and its CPCs should, individually and collectively, engage in capacity building efforts and other cooperative activities to support the effective implementation of this Recommendation, including entering into cooperative arrangements with other appropriate international bodies.

Rec. 2010-07 Recommendation by ICCAT on the conservation of oceanic whitetip shark caught in association with fisheries in the ICCAT convention area

- Contracting Parties, and Cooperating non-Contracting Parties, Entities or Fishing Entities (hereafter referred to as CPCs) shall prohibit retaining onboard, transshipping, landing, storing, selling, or offering for sale any part or whole carcass of oceanic whitetip sharks in any fishery.
- CPCs shall record through their observer programs the number of discards and releases of oceanic whitetip sharks with indication of status (dead or alive) and report it to ICCAT.

Rec. 2010-06 - Recommendation by ICCAT on atlantic shortfin mako sharks caught in association with ICCAT fisheries

- CPCs shall include information in their 2012 Annual Reports on actions taken to implement Recommendations 04-10, 05-05, and 07-06, in particular the steps taken to improve their Task I and Task II data collection for direct and incidental catches;
- Actions taken by CPCs, as described in paragraph 1, shall be reviewed annually by ICCAT's Compliance Committee, beginning in 2012;
- CPCs that do not report Task I data for Atlantic shortfin mako sharks, in accordance with SCRS data reporting requirements, shall be prohibited from retaining this species, beginning in 2013 until such data have been received by the ICCAT Secretariat;
- The SCRS shall conduct a stock assessment for shortfin mako sharks in 2012 and advise the Commission on:
    - the annual catch levels of shortfin mako that would support MSY;
    - other appropriate conservation measures for shortfin mako sharks, taking into account species identification difficulties;
- The SCRS shall complete its shark identification guide and circulate it to CPCs before the 2011 Commission meeting.

Rec. 2009-07 - Recommendation by ICCAT on the conservation of thresher sharks caught in association with fisheries in the iccat convention area

- Contracting Parties, and Cooperating non-Contracting Parties, Entities or Fishing Entities (hereafter referred to as CPCs) shall prohibit, retaining onboard, transshipping, landing, storing, selling, or offering for sale any part or whole carcass of bigeye thresher sharks (*Alopias superciliosus*) in any fishery with exception of a Mexican small-scale coastal fishery with a catch of less than 110 fish.

- CPCs shall require vessels flying their flag to promptly release unharmed, to the extent practicable, bigeye thresher sharks when brought along side for taking on board the vessel.
- CPCs should strongly endeavor to ensure that vessels flying their flag do not undertake a directed fishery for species of thresher sharks of the genus *Alopias spp.*
- CPCs shall require the collection and submission of Task I and Task II data for *Alopias spp* other than *A. superciliosus* in accordance with ICCAT data reporting requirements. The number of discards and releases of *A. superciliosus* must be recorded with indication of status (dead or alive) and reported to ICCAT in accordance with ICCAT data reporting requirements.
- CPCs shall, where possible, implement research on thresher sharks of the species *Alopias spp* in the Convention area in order to identify potential nursery areas. Based on this research, CPCs shall consider time and area closures and other measures, as appropriate.

Rec. 2007-06 Supplemental Recommendation by ICCAT Concerning Sharks

- Contracting Parties, Cooperating non-Contracting Parties, Entities and Fishing Entities (hereinafter referred to as CPCs), especially those directing fishing activities for sharks, shall submit Task I and II data for sharks, as required by ICCAT data reporting procedures (including estimates of dead discards and size frequencies) in advance of the next SCRS assessment;
- Until such time as sustainable levels of harvest can be determined through peer reviewed stock assessments by SCRS or other organizations, CPCs shall take appropriate measures to reduce fishing mortality in fisheries targeting porbeagle (*Lamna nasus*) and North Atlantic shortfin mako sharks (*Isurus oxyrinchus*).
- Notwithstanding paragraph 2, CPCs may conduct scientifically based research that is submitted to SCRS for these species in the Convention area.
- CPCs shall, where possible, implement research on pelagic shark species caught in the Convention area in order to identify potential nursery areas. Based on this research, CPCs shall consider time and area closures and other measures, as appropriate.
- The SCRS shall, as soon as possible but no later than 2009, conduct a stock assessment or a thorough review of available stock assessment information of, and recommend management advice for, porbeagle shark (*Lamna nasus*).

Rec. 2006-10 - Supplementary Recommendation by ICCAT Concerning the Conservation of Sharks Caught in Association with Fisheries Managed by ICCAT

- Paragraph 7 of the *Recommendation by ICCAT Concerning the Conservation of Sharks Caught in Association with Fisheries Managed by ICCAT* [Rec. 04-10], is amended to read:
- "SCRS shall conduct stock assessments of, and recommend management alternatives for, shortfin mako (*Isurus oxyrinchus*) and blue shark (*Prionace glauca*) in time for consideration at the 2008 annual meeting of the Commission. A data preparatory meeting will be held in 2007 to review all relevant data on biological parameters, catch, effort, discards, and trade, including historical data. Parties should submit all relevant data sufficiently in advance of the meeting to

allow the SCRS adequate time to review and incorporate the data into the assessment."

Rec. 2005-05 - Recommendation by ICCAT to Amend Recommendation 04-10 Concerning the Conservation of Sharks Caught in Association with Fisheries Managed by ICCAT

- In point 7 of the 2004 *Recommendation by ICCAT Concerning the Conservation of Sharks Caught in Association with Fisheries Managed by ICCAT* [Rec. 04-10], a new paragraph is added:
  "Contracting Parties, Cooperating non-Contracting Parties, Entities or Fishing Entities (CPCs) shall annually report on their implementation of this Recommendation. CPCs that have not yet implemented this recommendation to reduce North Atlantic shortfin mako shark (*Isurus oxyrinchus*) mortality, shall implement it and report to the Commission."

Rec. 2004-10 - Recommendation by ICCAT concerning the conservation of sharks caught in association with fisheries managed by ICCAT

- Contracting Parties, Cooperating non-Contracting Parties, Entities or Fishing Entities (CPCs) shall annually report Task I and Task II data for catches of sharks, in accordance with ICCAT data reporting procedures, including available historical data.
- CPCs shall take the necessary measures to require that their fishermen fully utilize their entire catches of sharks. Full utilization is defined as retention by the fishing vessel of all parts of the shark excepting head, guts and skins, to the point of first landing.
- 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. CPCs that currently do not require fins and carcasses to be offloaded together at the point of first landing shall take the necessary measures to ensure compliance with the 5% ratio through certification, monitoring by an observer, or other appropriate measures.
- The ratio of fin-to-body weight of sharks described in paragraph 3 shall be reviewed by the SCRS and reported back to the Commission in 2005 for revision, if necessary.
- Fishing vessels are prohibited from retaining on board, transshipping or landing any fins harvested in contravention of this Recommendation.
- In fisheries that are not directed at sharks, CPCs shall encourage the release of live sharks, especially juveniles, to the extent possible, that are caught incidentally and are not used for food and/or subsistence.
- In 2005, the SCRS shall review the assessment of shortfin mako sharks (*Isurus oxyrinchus*) and recommend management alternatives for consideration by the Commission, and reassess blue shark (*Prionaca glauca*) and shortfin mako no later than 2007.
- CPCs shall, where possible, undertake research to identify ways to make fishing gears more selective.
- CPCs shall, where possible, conduct research to identify shark nursery areas.
- The Commission shall consider appropriate assistance to developing CPCs for the collection of data on their shark catches.

- This recommendation applies only to sharks caught in association with fisheries managed by ICCAT.

Res. 2003-10 - Resolution by ICCAT on the shark fishery

- Each Contracting Party and Cooperating non-Contracting Party, Entity or Fishing Entity take the following actions:
  - o Provide the Working Group of the Sub-Committee on By-catch scheduled to meet in 2004 with the information on their shark catches, effort by gear type, landings and trade of shark products.
  - o Fully implement a NPOA in accordance with the FAO IPOA for the Conservation and Management of Sharks adopted by FAO.

Where RFMOs and/or countries have overlapping jurisdictions, or are involved in managing the same fisheries, there is a clear need to have clear lines of communication and effective and timely data sharing to ensure proper assessment and management controls are in place. This is the case for sharks species inhabiting the Mediterranean and Atlantic water and managed by GFCM, ICCAT and the Barcelona Convention; which is appropriate for both scientific and management issues.

For the scientific part: the communication between GFCM and ICCAT should be improved to account for the fishery statistics of pelagic sharks (or other sharks) that are caught by fleets managed in ICCAT and GFCM; which is currently the case. For the management part, it is recognized that the relationship between different bodies it is a legal task and, therefore, any recommendation and/or resolution adopted by one organization needs to be incorporated in other organization and viceversa) as well as in the UE legislation. For example, shortfin mako, porbeagle, scalloped hammerhead, great hammerhead and smooth hammerhead have been included in Annex II of Barcelona Convention. Then, those species retention has been forbidden in the fisheries managed by GFCM (Recommendation GFCM/36/2012/3) but for some of those species included in the Annex II of Barcelona there is no ICCAT recommendation to prohibit retaining on board (i.e. shortfin mako and porbeagle).

3.2.4 Historical catch and effort data

Earlier reviews of the shark database resulted in recommendations to improve data reporting on shark catches. Though global statistics on shark catches included in the database have improved, they are still insufficient to permit the Committee to provide quantitative advice on stock status with sufficient precision to guide fishery management toward optimal harvest levels.

The collection and reporting of catches of sharks caught in association with species managed by ICCAT (tuna and tuna-like species) has been very uneven over time. The information on the bycatch of sharks gathered in the ICCAT database is thought, for this reason, to be very incomplete. The catches of sharks, when reported, are thought to represent simply the catches of these species that are retained on board. They refer, in many cases, to dressed weights and no indication is given on the type of processing that the different specimens underwent. The weights or numbers of sharks for which only the fins were kept on board are rarely recorded in the vessels" logbooks. This makes it really difficult any attempt to estimate the total catches of sharks in the Atlantic Ocean. The major sharks (blueshark, shortfin mako shark, and porbeagle) shark reporting is considered to be better than other sharks, however, still there are inconsistencies in the reporting of the fishery statistics of those shark species.

According to this document:

- **Task I nominal** catch data (landings and discards by species, stock, gear, fleets and year) is the basic information used in all the stock assessments. The availability of timely data is essential for the SCRS work. The deadline for submission of Task I varied according to the species reviewed by the SCRS, and for major shark species the deadline is 26th of May (data until 2 previous years). For the 12 major ICCAT species (nine tuna and tuna-like species and three sharks species), 43 flag States reported Task I before the deadline(s), 2 flag States reported Task I after the deadline(s), and 22 flag States have not reported Task I as of September 14, 2012. Details by species (taking into account the respective deadlines of the inter-sessional meetings) and by flag State are presented in Table 3.2.2.
- **Task II catch and effort and size sampling** are more detailed in terms of time and geographic area information, and often they reflect partial coverage (or sampling) compared to Task I statistics. Task II information is the main source of data used by the Secretariat to estimate important datasets to be used in the assessment of the species. During the reporting period, the Secretariat received Task II catch and effort data from 42 flag States (40 on time and 2 after the deadline). Twenty-three (23) flag States did not report Task II catch and effort. Table 3.2.3 presents the detailed report card for Task II catch and effort statistics. There has been an increase in the number of species reported in the Task II data, particularly pelagic shark species as part of the catch composition in recent years. However, the Secretariat reiterates to the CPCs that Task II catch-effort statistics require submitting all species caught (target and non-target fish species), and effort units, with time (month) and area strata as detailed as possible (LL: 5°x5° squares; other gears: 1°x1° squares).

Moreover, information has also been collected regarding shark data improvement towards the implementation of Recs. [09-07], [10-07] and [10-08]. Morocco has implemented the necessary measures prohibiting respectively to retain onboard, tranship, land, store, sell or offer for sale any part of whole carcass of bigeye thresher sharks (*Alopias superciliosus*), oceanic whitetip sharks (*Carcharhinus longimanus*) and hammerhead sharks of the family Sphyrnidae (except for *Sphyrna tiburo*) in all fisheries. To this effect, the fishing of these species is prohibited in Moroccan waters for a period of 5 years. In order to develop monitoring, control and surveillance measures to facilitate the plan for improving data collection for sharks on a species-specific level, Brazil have implemented the National Program of Onboard Observers for the Fishing Fleet and the Logbooks System, both managed by the Ministry of Fisheries and Aquaculture. With the increasing data requirement for stock status research, China is enhancing its scientific data collection system for sharks. All the scientific data from the Chinese fleet are collected along with target and other bycatch species through three national programs (Logbook, Observer, and Monthly Reports) designed for the tuna fishery with the purpose of stock assessment- related research and monitoring. China Overseas Fisheries Association (COFA) and Shanghai Ocean University (SHOU), under the lead and supervision of Bureau of Fisheries, Ministry of Agriculture of China, are conducting these data collection programs in the

Atlantic Ocean. For Egypt, the GAFRD has issued a decree (No. 4441 12) prohibiting the fishing of all species of sharks in the Mediterranean and also prohibiting the trade of either whole sharks or parts in the markets. Landing statistics in Iceland are by species and all landings are recorded by the Directorate of Fisheries into an electronic decentralized database. Those shark species caught as bycatch in Iceland by Icelandic vessels, i.e., porbeagle, Greenland shark and spotted dogfish, have been reported to the SCRS even though they are not caught in ICCAT fisheries. There is an ongoing collaboration, where needed, between the Marine Research Institute and the Directorate of Fisheries on statistics and species identification on species caught by Icelandic vessels. The act of Korean distant-water fisheries was revised and came into effect in 1st July 2012, which takes in the recent data collection and reporting requirements for the conservation measures for shark species taken by the ICCAT and other tuna RFMOs. The act obligates the vessel to record sharks bycaught by species in the logsheet in electronic format and to report it monthly. Korea has also distributed bycatch species classification guides and has conducted periodical education for fishermen on sharks data collection and reporting.

Table 3.2.2.- Task I nominal catch (form ST02-T1NC) submission status for 2011 data (green = before deadline; yellow = after deadline; blank = Not Submitted or zero catch).

			Tuna (major sp.)										Tuna (small)	Sharks (major sp.)		
			ALB	BET	BFT	BUM	SAI	SKJ	SPF	SWO	WHM	YFT	(any of 13 sp)	BSH	POR	SMA
Status	**Party**	**Flag**	01/08/2012										01/08/2012	01/08/2012		
CP	ALBANIA	Albania			1											
	ALGÉRIE	Algerie								1			1			
	ANGOLA	Angola														
	BARBADOS	Barbados	1	1		1	1	1			1	1	1			
	BELIZE	Belize	1	1		1	1	1	1	1		1		1		1
	BRASIL	Brasil	1	1	1	1	1	1	1	1	1	1	1	1	1	1
	CANADA	Canada	1	1	1			1		1	1	1		1	1	1
	CAP-VERT	Cape Verde	1	1				1				1	1			
	CHINA REP	China P.R.	1	1	1	1	1			1	1	1		1		1
	CÔTE D'IVOIRE	Côte D'Ivoire		1		1	1	1		1	1	1	1			
	CROATIA	Croatia	1		1					1			1			
	EGYPT	Egypt														
	EUROPEAN UNION	EU.Bulgaria														
		EU.Cyprus	1		1					1						1
		EU.Denmark														
		EU.España	1	1	1			1		1		1	1			
		EU.France	1	1	1			1		1	1	1	1	1	1	1
		EU.Greece	1		1					1			1			
		EU.Ireland	1		1					1				1		
		EU.Italy	1		1					1			1			
		EU.Malta	1		1					1			1	1	1	
		EU.Netherlands	1					1		1		1	1		1	
		EU.Portugal	1	1	1	1	1	1	1	1	1	1	1	1	1	1
		EU.United Kingdom	1									1	1	1	1	1
	FRANCE (St-Pierre et Miquelon)	FR.St Pierre et Miquelon	1	1	1					1						1
	GABON	Gabon														
	GHANA	Ghana		1		1	1	1		1	1	1	1			
	GUATEMALA	Guatemala		1				1				1	1			
	GUINEA ECUATORIAL	Guinea Ecuatorial		1				1				1				
	GUINÉE REP.	Guinée Conakry														
	HONDURAS	Honduras														
	ICELAND	Iceland			1											
	JAPAN	Japan	1	1	1	1	1	1	1	1	1	1		1	1	1
	KOREA REP.	Korea Rep.	1	1		1	1			1		1		1	1	1
	LIBYA	**Libya**			1											
	MAROC	Maroc	1	1	1	1	1	1		1		1	1		1	1
	MAURITANIA	Mauritania														
	MEXICO	Mexico		1	1	1	1	1		1	1	1	1	1		1
	NAMIBIA	Namibia	0	0		0		0		0		0		0		0
	NICARAGUA	Nicaragua														
	NIGERIA	Nigeria														
	NORWAY	**Norway**													1	
	PANAMA	Panama	1	1				1				1	1			
	PHILIPPINES	Philippines	1	1						1		1				
	RUSSIA	Russian Federation						1					1			
	S. TOMÉ E PRINCIPE	S. Tomé e Príncipe														
	SENEGAL	Senegal	1	1		1	1	1		1		1	1	1		1
	SIERRA LEONE	Sierra Leone														
	SOUTH AFRICA	South Africa	0	0		0	0	0	0	0	0	0	0	0		0
	St VINCENT & GRENADINES	St. Vincent and Grenadines	1	1			1	1	1	1	1	1	1			
	SYRIA	Syria Rep.														
	TRINIDAD and TOBAGO	Trinidad and Tobago														
	TUNISIE	Tunisie			1											
	TURKEY	Turkey	1		1					1			1			
	UNITED KINGDOM (O.Territories)	UK.Bermuda	1	1	1	1		1		1	1	1	1	1		1
		UK.British Virgin Islands								1		1	1			
		UK.Sta Helena	1	1		1		1		1	1	1	1	1	1	1
		UK.Turks and Caicos				1										
	UNITED STATES	U.S.A.	1	1	1	1	1	1		1	1	1	1	1	1	1
	URUGUAY	Uruguay	1	1						1		1		1	1	1
	VANUATU	Vanuatu	1	1		1				1	1	1				
	VENEZUELA	Venezuela	1	1		1	1	1	1	1	1	1	1	1		1
NCC	Chinese Taipei	Chinese Taipei	1	1	1	1	1	1	1	1	1	1		1	1	1
	Colombia	Colombia														
	Curaçao	Curaçao	1	1				1				1	1			
	Guyana	Guyana														
	Suriname	Suriname														
NCO	non-contracting parties	Dominica				0	0	0		0		0	0			

NOTES: Norway, EU.Denmark, EU Bulgaria, Libya, UK Turks & Caicos and UK.Virgin Islands reported for 2011 "zero" catch of the major ICCAT species (no active fleets fishing for ICCAT species). Côte d'Ivoire, Guinea Rep. (PS), Panama (LL) and Ghana reported non-standard formats of ICCAT statistics, and therefore were not included in the present report.

Table 3.2.3.- Task II catch and effort (form ST03-T2CE) submission status for 2011 data (green = before deadline; yellow = after deadline; blank = Not Submitted or zero catch).

			Tuna (major sp.)										Tuna (small)	Sharks (major sp.)		
			ALB	BET	BFT	BUM	SAI	SKJ	SPF	SWO	WHM	YFT	(any of 13 sp)	BSH	POR	SMA
Status	**Party**	**Flag**	01/08/2012										01/08/2012	01/08/2012		
CP	ALBANIE	Albania			1											
	ALGÉRIE	Algerie								1			1			
	ANGOLA	Angola														
	BARBADOS	Barbados	1	1		1	1	1		1	1	1	1			
	BELIZE	Belize	1	1		1	1	1	1	1		1		1		1
	BRASIL	Brasil	1	1		1	1	1	1	1	1	1	1	1		1
	CANADA	Canada	1	1	1			1		1	1	1		1	1	1
	CAP-VERT	Cape Verde	1	1				1				1	1			
	CHINA	China P.R.	1	1	1	1	1			1	1	1		1		1
	CÔTE D'IVOIRE	Côte D'Ivoire		1		1	1	1		1	1	1				
	CROATIA	Croatia	1		1					1			1			
	EGYPT	Egypt														
	EUROPEAN UNION	EU.Bulgaria														
		EU.Cyprus	1		1					1						1
		EU.Denmark														
		EU.España	1	1	1			1		1		1	1			
		EU.France	1	1	1			1				1	1			
		EU.Greece			1					1						
		EU.Ireland	1		1					1						
		EU.Italy	1		1					1			1			
		EU.Malta	1		1					1			1	1	1	
		EU.Netherlands														
		EU.Portugal	1	1	1	1	1	1	1	1	1	1	1	1	1	1
		EU.United Kingdom														
	FRANCE (St-Pierre et Miquelon)	FR.St Pierre et Miquelon			1					1						1
	GABON	Gabon														
	GHANA	Ghana		1		1	1	1		1	1	1				
	GUATEMALA	Guatemala		1				1				1	1			
	GUINEA ECUATORIAL	Guinea Ecuatorial														
	GUINÉE REP.	Guinée Conakry						1				1				
	HONDURAS	Honduras														
	ICELAND	Iceland			1											
	JAPAN	Japan	1	1	1	1	1	1	1	1	1	1		1	1	1
	KOREA REP.	Korea Rep.	1	1						1		1				
	LIBYA	**Libya**														
	MAROC	Maroc			1					1		1				
	MAURITANIA	Mauritania														
	MEXICO	Mexico		1	1	1	1	1		1	1	1	1	1		1
	NAMIBIA	Namibia	0	0		0				0		0		0		0
	NICARAGUA	Nicaragua														
	NIGERIA	Nigeria														
	NORWAY	**Norway**														
	PANAMA	Panama		1				1				1	1			
	PHILIPPINES	Philippines	1	1		1				1	1	1		1		1
	RUSSIA	Russian Federation						1					1			
	S. TOMÉ E PRÍNCIPE	S. Tomé e Príncipe														
	SENEGAL	Senegal		1				1		1		1	1	1		1
	SIERRA LEONE	Sierra Leone														
	SOUTH AFRICA	South Africa	0	0		0		0		0		0		0		0
	St VINCENT & GRENADINES	St. Vincent and Grenadines	1	1			1		1	1		1				
	SYRIA	Syria Rep.														
	TRINIDAD and TOBAGO	Trinidad and Tobago														
	TUNISIE	Tunisie			1											
	TURKEY	Turkey			1											
	UNITED KINGDOM (O.Territories)	UK.Bermuda	1	1	1					1		1		1		1
		UK.British Virgin Islands														
		UK.Sta Helena	1	1		1		1				1	1			1
		UK.Turks and Caicos														
	UNITED STATES	U.S.A.	1	1	1	1	1	1		1	1	1		1	1	1
	URUGUAY	Uruguay	1	1						1		1		1	1	1
	VANUATU	Vanuatu	1	1		1				1		1				
	VENEZUELA	Venezuela	1	1		1	1	1	1	1	1	1	1	1		1
NCC	Chinese Taipei	Chinese Taipei	1	1		1	1	1	1	1	1	1		1		1
	Colombia	Colombia														
	Curaçao	Curaçao	1	1				1				1	1			
	Guyana	Guyana														
	Suriname	Suriname														
NCO	non-contracting parties	Dominica				0	0	0		0		0	0			

NOTES: Norway, EU.Denmark, EU Bulgaria, Libya, UK Turks & Caicos and UK.Virgin Islands reported for 2011 "zero" catch of the major ICCAT species (no active fleets fishing for ICCAT species). Côte d'Ivoire, Guinea Rep. (PS), Panama (LL) and Ghana reported non-standard formats of ICCAT statistics, and therefore were not included in the present report.

Moreover, the information on sharks was discussed by ICCAT Secretariat based on a document presented at the 2012 shark assessment working group. The Secretariat presented to the Working Group the most recent TaskI nominal catch statistics available for shortfin mako (SMA, *Isurus oxyrinchus*) and the other shark species included in the Ecological Risk Analyses (ERA). Despite some important Task I catch series recovered (EU-España: 1997-2010; EU-Portugal: 1990-2010; Uruguay: 1981-2010; South Africa: 1998-2010) in recent years, the Working Group considers that the shark overall catch reported as Task I continues to be underestimated, in particular before 2000.

During the 2011 Shark Data Preparatory Meeting (Anon, 2012), the Working Group recognized that, historically, sharks were reported in aggregated form (no species breakdown) by a considerable number of the above mentioned fleets. Those sharks "unclassified" catch series (CVX: Carcharhiniformes; CXX: Coastal Sharks nei; DGX: Squalidae; PXX: Pelagic Sharks nei; SHX: Squaliformes; SKH: Selachimorpha; SYX: Scyliorhinidae), which represents about 20% on average (ranging from 11% to 32% between 1994 and 2002) of the total shark catches, were kept in the Task I database. An explicit recommendation was therefore made to split these catches by shark species. Since then, no improvements have been made.

On the follow up of a Working Group request to compare ICCAT Task I data with EUROSTAT yearly statistics, the Secretariat prepared a consolidated dataset containing three data sources: (a) ICCAT Task I; (b) EUROSTAT statistics; (c) FAO statistics. This work is presented in document SCRS/2012/078. The Working Group recognized the importance of having all this information harmonized in a unique database, and considered that considerable data mining work is needed to explore and interpret the differences among datasets (SMA and nearly 90 other shark species). This should be a long-term task and count with the participation of the ICCAT CPC scientists.

Moreover ICCAT Secretariat presented in standard catalog, which compares Task I against the existence of Task II (both catch and effort and size frequencies) per fleet, gear and year. The poor Task II coverage, of both catch and effort data and size frequencies, is still an important drawback in the majority of shark species. The Working Group considers that efforts should continue aiming to recover Task II information on sharks. The corresponding most up to date datasets of Task II size frequencies were also made available to the assessment.

Based on information provided in Task I the major fisheries (country/fleet/gear) targeting tunas and sharks in the Atlantic Ocean have been identified. A preliminary exploration of the ICCAT databases have been made in order to identify main fisheries (defined as a combination of a Flag and a fishing gear) which catch significant quantities of tunas and/or of sharks. The period studied was 2000-2010.

According to the aggregated total catch available in the ICCAT database (Table 3.2.4), in the Atlantic during the last decade, the largest shark catches (all species included) have been declared by EU.España (344,909 tonnes), followed by EU.Portugal (113,331 tonnes), EU.France (65,851 tonnes), Argentina (54,735 tonnes), etc. These catches need to be investigated in greater depth, due to the possible misidentification of species.

Table 3.2.4.- Sharks (all species) catch by fleet between 2000 and 2010 (Sources: ICCAT).

Flag	Total	%
EU.España	344 909	41.23
EU.Portugal	113 331	13.55
EU.France	65 851	7.87
Argentina	54 735	6.54
Brasil	41 594	4.97
Namibia	35 173	4.20
Maroc	29 869	3.57
Japan	26 129	3.12
Chinese Taipei	17 322	2.07
Guyana	17 218	2.06
Senegal	16 338	1.95
Canada	9 952	1.19
EU.United Kingdom	9 571	1.14
Trinidad and Tobago	8 488	1.01
U.S.A.	7 922	0.95
Norway	6 919	0.83
Uruguay	6 547	0.78
China P.R.	4 239	0.51
Panama	4 057	0.48
St. Vincent and Grenadines	2 877	0.34
South Africa	2 529	0.30
Iceland	1 638	0.20
Belize	1 629	0.19
S. Tomé e Príncipe	1 601	0.19
EU.Ireland	1 479	0.18
Venezuela	1 049	0.13
EU.Germany	659	0.08
Gabon	658	0.08
Côte D'Ivoire	550	0.07
Togo	323	0.04
Korea Rep.	303	0.04
EU.Denmark	231	0.03
Vanuatu	189	0.02
Mexico	182	0.02
EU.Netherlands	162	0.02
Grenada	91	0.01
Barbados	79	0.01
Sta. Lucia	74	0.01
UK.Bermuda	37	0.00
UK.Sta Helena	29	0.00
FR.St Pierre et Miquelon	19	0.00
Russian Federation	18	0.00

Seychelles	4	0.00
EU.Estonia	4	0.00
EU.Sweden	2	0.00
Philippines	1	0.00
Falklands	1	0.00
Guinea Ecuatorial	0	0.00
UK.Turks and Caicos	0	0.00

Figures 3.2.1 and 3.2.2, respectively, show the total shark landings and catch by gear for the period studied 2000-2010.

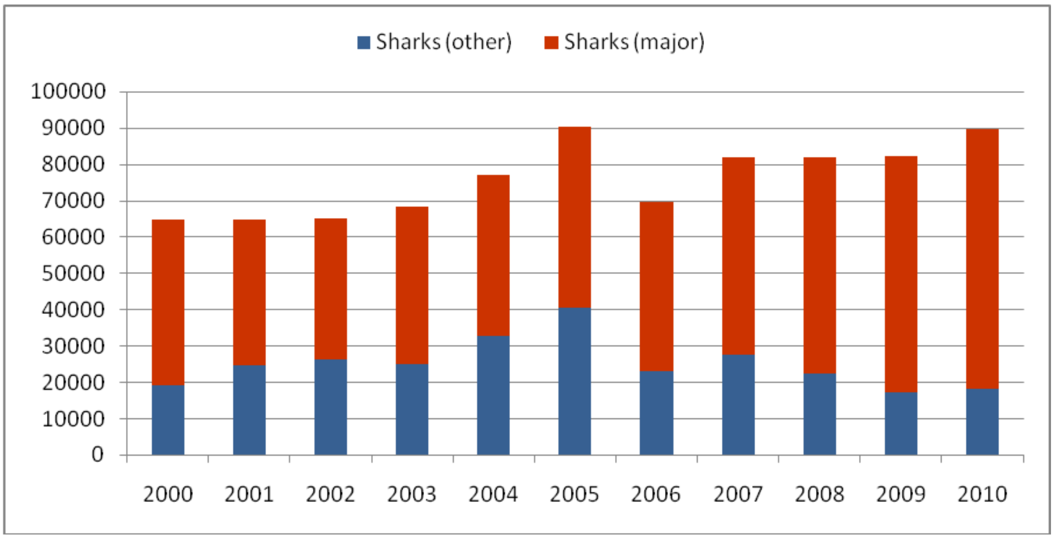


Figure 3.2.1.- Landings of sharks (tonnes) between 2000 and 2010 in the Atlantic Ocean for major shark spcies (blueshark, shortfin mako shark and porbeagle) and other sharks.

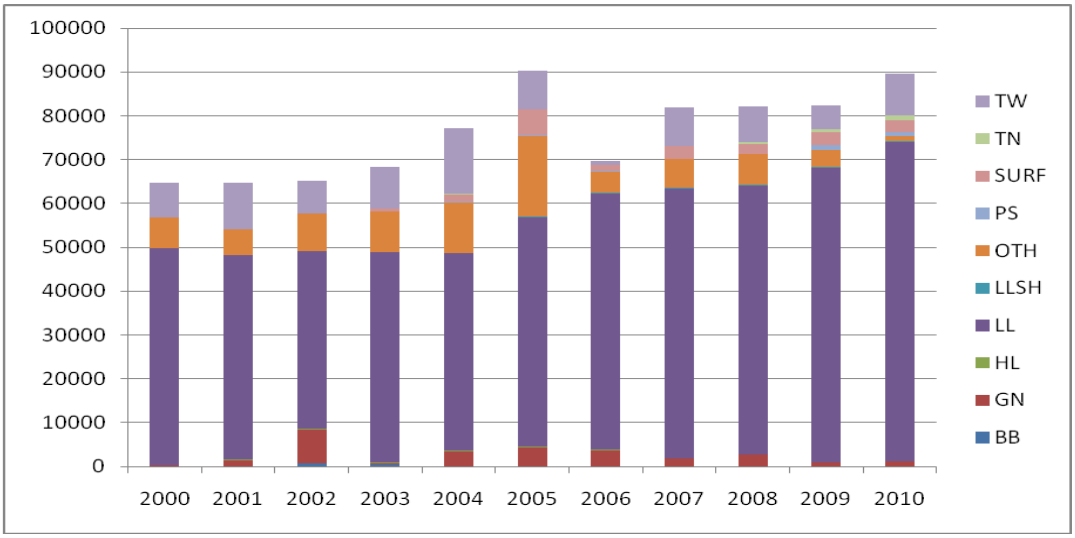


Figure 3.2.2.- Declared landings of sharks (all species in tonnes) per gear between 2000 and 2010: Purse seine (PS), Longline: Surface Shark (LLSH), Longline (LL), Gillnet: Drift net (GN), OTH (Unclassified: Gears not reported), Handline (HL) Surface fisheries unclassified (SURF), Baitboat (BB) Trammel net (TN), Trawl (TW) in the Atlantic Ocean (Source: ICCAT).

The study focused on estimating the "potential" shark catches by métier and the main fleets that could be mainly responsible for the catch of the shark species included in the study based on the best assumption of the shark catch over target species catch ratios (see Material and Methods) derived from the literature.

Estimated "potential" studied shark species catch (high estimation is only presented here) is above 120 000 t for 80 000 t presently declared (around 33 % underestimation) (Figure 3.2.3). 69 fisheries among the 500 fisheries found in ICCAT database generate 90 % of potential studied shark species catches. These fisheries are those already declaring the bulk of studied shark species catches and are those with the highest unreported catches of studied shark species catches. It is worth noting that some fisheries have negative unreported catches indicating that ratio defined for a métier underestimate their actual impact on studied shark species shark. Using their declared figures would (slightly) increase the total quantities of studied shark species.

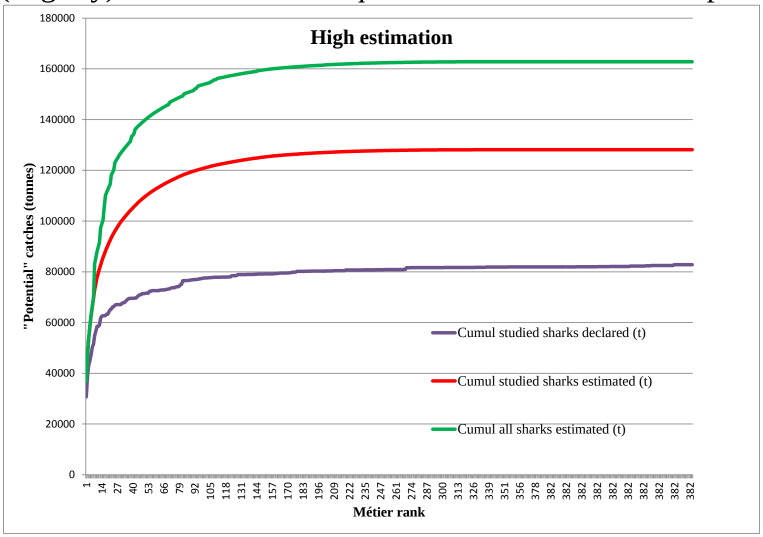


Figure 3.2.3.- Cumulative "potential" catch in tonnes and undreported studied shark species catches by fisheries ranked according their descending estimated studied shark species catches.

Among the different métier identified, Longline targeting sharks (LL-shark) is the most impacting one with 59 % of the total estimated studied shark species catches (Figure 3.2.4). It is followed by Longline (LL = 15%) and OTH (12%), which precise gear composition is unknown. LL-sharks and LL generate 75 % of studied shark species catches (95 900 t).

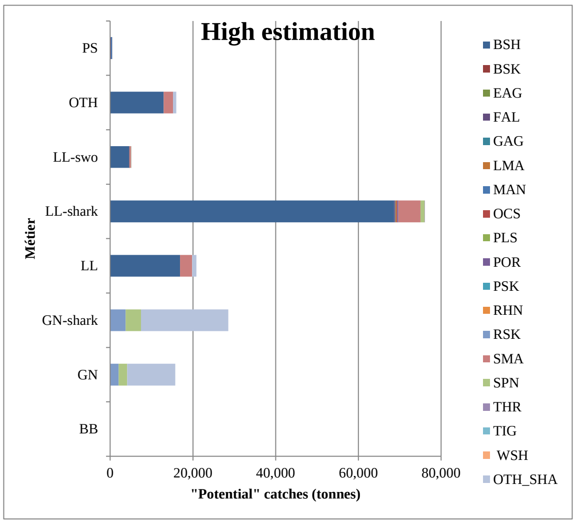


Figure 3.2.4.- Estimated Catch (tonnes) by Métiers and by Species studied shark speciesin the Atlantic Ocean.

The fleets mainly responsible for the shark species studied were identified on the basis of tuna and tuna like catch reported to ICCAT. ICCAT data are based on reports from the national fisheries agencies but can be affected by the limitations in reporting efficiency and problems of species identification and species breakdown. The estimates depend on the level of under-reporting and non-reporting of tuna and tuna like catch by the countries.

The information on bycatch is scarce and the bycatch estimates found in the literature are not homogenous which made the raising and/or estimates of ratios uncertain due to various assumptions made (e.g. conversion of the estimates in number of individuals into weight without any information on the mean size per species).

There are mainly two groups of métiers impacting the most important, in terms of total catch, two groups of shark species (Figure 3.2.5). Among studied sharks, main species impacted is blueshark (BSH) with 80 % of the total in weight followed by Shortfin mako (8%) (SMA), 10 time less. These two species are mainly impacted by LL (LL-sharks and LL). Hammerhead sharks (SPN) and Carcharhinidae sharks (RSK) represent 5 % in weight each and are mainly impacted by GN (GN-sharks and GN).

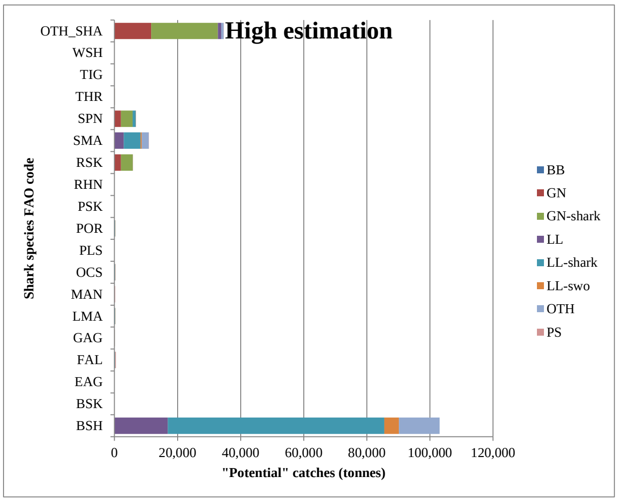


Figure 3.2.5.- Estimated Catch (tonnes) of studied shark species by Métier in the Atlantic Ocean.

In the Atlantic Ocean, impact on studied shark species is highly concentrated in 5 fisheries, which generate 60 % of the estimated studied shark species (Figure 3.2.6). European LL sharks is the first one impacting studied shark species mainly BSH and SMA.

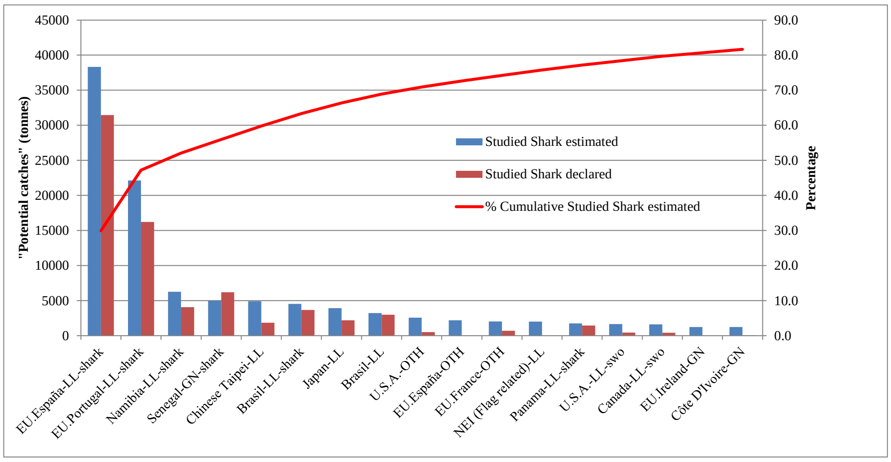


Figure 3.2.6.- Main fisheries (Flag and Métier) impacting studied shark species in the Atlantic Ocean.

Table 3.2.5 compares the average yearly “potential” catch of studied shark species by species and métiers with the Ecological Risk Assessment (Murua *et al.*, 2012) carried out in the Indian Ocean in 2012.

Table 3.2.5.- Estimated (or range of estimated) annual catches of major species (MT) in the Atlantic Ocean tuna fisheries, for the period 2000-2010. Indication of ERA rank (taking into consideration susceptability for longline, calculated with three methods: V1 - Euclidean distance), V2 - multiplicative and V3 - arithmetic mean) and species productivity as provided by Cortés et al. (2012).

FAO code		Species name	Common name	Rank ERA V1	V2	V3	Productivity (r)	EU-Spain (LL)	EU-Portugal (LL)	Taiwan (LLFB)	Ivory Coast (GN)	Japan (LLHB)	Namibia (LL)	Guyana (GN)	EU-Spain (TROL)	Ghana (LL)	Brazil (LL)	China P.R. (LL)	EU-France (MWTD)	USA (LL)	USA (RR)	Canada (LL)	Other métiers
	SMA	*Isurus oxyrinchus*	Shortfin mako	1	8	2	0.058	2634-2691	779-1485	724	0	577	266-439	0	269	0	95-230	170	131-160	63-116	114-209	50-58	1477-3622
	FAL North	*Carcharhinus falciformis*	Silky shark	8	11	8	0.078	113-115	33-64	0	0	0	0-19	0	0	0	0-10	0	0	0-5	0	0-2	158-240
	FAL South			12	5	6	0.042																
	OCS	*Carcharhinus longimanus*	Oceanic whitetip shark	4	13	8	0.121	113-115	33-64	0	0	0	0-19	0	0	0	4-10	0	0	0-5	0	0-2	18-40
	POR	*Lamna nasus*	Porbeagle	2	7	4	0.052	113-115	33-64	0	0	0	0-19	0	0	0	0-10	0	0	0-5	0	0-2	10-29
	LMA	*Isurus paucus*	Longfin mako	5	3	2	0.029	113-115	33-64	0	0	0	0-19	0	0	0	0-10	0	0	5	0	0-2	10-29
	BSH North	*Prionace glauca*	Blue shark	6	19	10	0.299	33864-34599	10009-19093	4187	0	3341	3317-5644	0	1556	0	1224-2952	983	755-923	813-1491	659-1208	645-745	10343-25761
	BSH South			7	20	14	0.314																
	PLS North	*Pteroplatytrygon violacea*	Pelagic stingray	20	18	20	0.23	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	PLS South			18	9	16	0.051																
RSK	DUS	*Carcharhinus obscurus*	Dusky shark	17	6	12	0.043	11-12	3-6	0	621	0	1-2	289-482	0	249	0-1	0	0	0	0	0	1142-3635
	CCS	*Carcharhinus signatus*	Night shark	11	4	5	0.041																
	CCP	*Carcharhinus plumbeus*	Sandbar shark	15	2	6	0.01																
SPN	SPZ	*Sphyrna zygaena*	Smooth hammerhead	13	17	18	0.225	489-500	145-276	0	621	0	49-82	289-482	0	249	18-43	0	0	12-22	0	9-11	1191-3762
	SPM	*Sphyrna mokarran*	Great hammerhead	14	10	13	0.07																
	SPL North	*Sphyrna lewini*	Scalloped hammerhead	16	12	16	0.096																
	SPL South			19	15	19	0.121																
THR	BTH	*Alopias superciliosus*	Bigeye thresher	3	1	1	0.314	38	11	0	0	0	4	0	0	0	1	0	0	1	0	1	4
	ALV	*Alopias vulpinus*	Common thresher	9	14	11	0.121																
SKH	TIG	*Galeocerdo cuvier*	Tiger shark	10	16	15	0.19	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	WSH	*Carcharodon carcharias*	Great white shark					0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	BSK	*Cetorhinus maximus*	Basking shark					0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	GAG	*Galeorhinus galeus*	Tope shark					38	11-21	0	0	0	4-6	0	0	0	1-3	0	0	1-2	0	0-1	4-10
	EAG	Myliobatidae	Eagle rays nei					0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	MAN	Mobulidae	Mantas, devil rays nei					0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	158-226
	PSK	*Psedocarcharias kamoharai*	Crocodile shark					0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	RHN	*Rhincodon typus*	Whale shark					0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	OTH_Sharks		Other sharks					0	0	258	3537	206	0	1643-2745	96	1418	0	61	47-57	0	41-75	0	6983-21796
				Estimated total shark catches (MT)				37525-38339	11090-21158	5169	4780	4124	3785-6254	2220-3710	1921	1916	1356-3271	1213	932-1139	901-1652	813-1491	714-825	21500-59159

Figure 3.2.7 shows the difference between the declared nominal catch of shark by species and our estimations by species. The underestimation is mainly related to the species with most catches (i.e. BSH) where our estimation is 1.8 higher than the declared estimation. For all species studied altogether, the total average amount of sharks catch estimated is 1.41 times higher than the average amount declared.

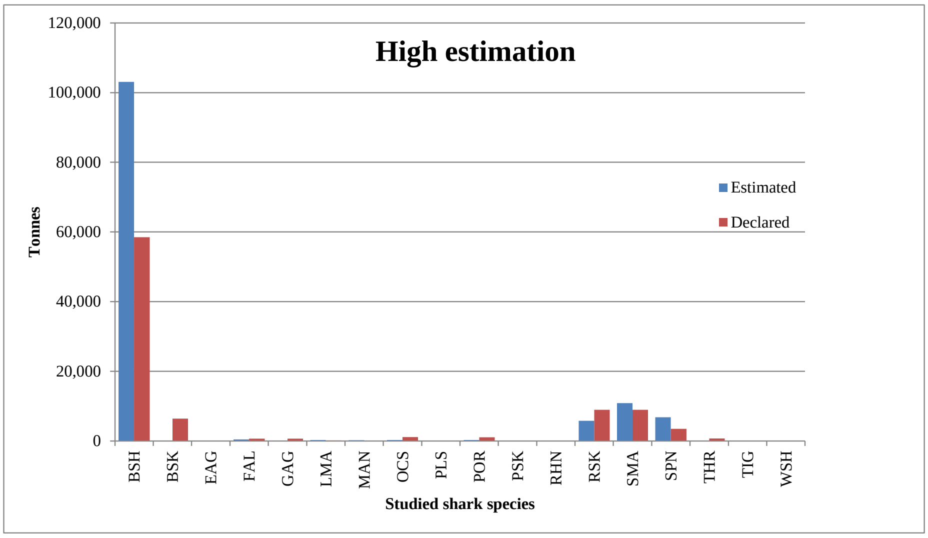
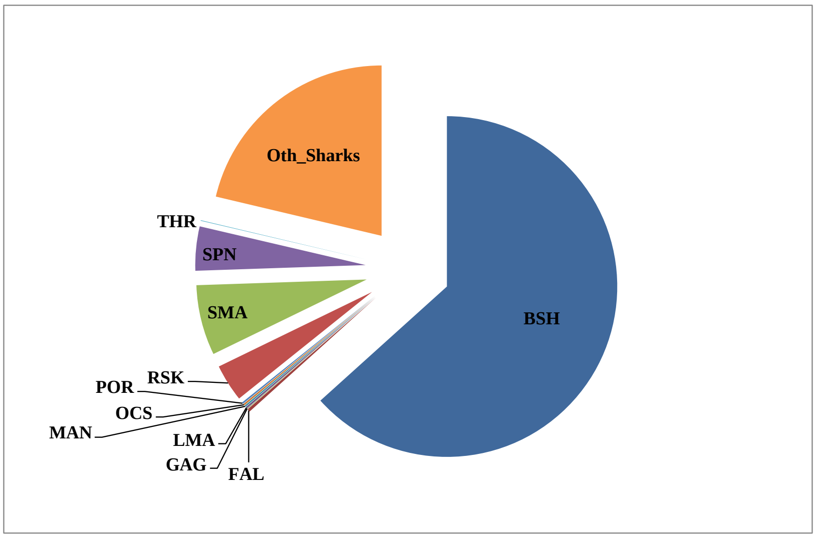


Figure 3.2.7.- Most impacted studied shark species (reported vs estimated) in the Atlantic Ocean.

The main species identified were blueshark, followed by shortfin mako, hammerhead and carcharinidae.



3.2.5 Estimation of discards levels

Information more specifically to shark was reported for the 2011 reporting period and the Secretariat received bycatch and discards information for 21 shark species/categories (Table 3.2.6). This information was obtained from two different sources. Information was obtained from the Task I or nominal catch information submitted by each CPC and was augmented by additional information provided in statistical data reports requested by the Commission. Task I data was generally provided in terms of weight while the statistical reports usually provided numbers. There is no much information available in the ICCAT public database about observers programs and/or the level of discards. Therefore, a request has been done to get access to these data. However, no positive responses have been obtained yet.

Table 3.2.6.- Information provided on bycatch and discards species by CPCs in 2011. Values are in tones, except when column labelled (N) that represent number of fish.

		Brazil		EU.Cyprus		Korea Rep.	Mexico		St Pierre et Miquelon	South Africa		Uruguay		U.S.A.		UK.Bermuda		China	
Species		DD (N)	DL (N)	DD	DL	DD	DD	DL	DD	DD	DL	DD (N)	DL (N)	DD	DL	DD	DL	DD	DL
Thresher	ALV	6	34								2								
Blue Shark	BSH									5	10			1117.6		0.1	1.7		
Bigeye thresher	BTH	10	41											12.1					
Sandbar shark	CCP													10.5					
Night shark	CCS													8.3					
Dusky shark	DUS													25.6					
Silky shark	FAL	2	4			2 N								83.6				3 N	2 N
Longfin mako	LMA	1	10											18.6					
Unidentified Mako	MAK																		
Oceanic whitetip shark	OCS	2	7			1.1								3.2					
Pelagic stingray	PLS	35	189																
Porbeagle	POR	6	3			0.1								0.8					
Crocodile shark	PSK	97	62																
Giant Manta	RMB		44																
Shortfin mako	SMA		5					0.437	0.18	1	2			28.5					
Great bhammerhead	SPK	1																	
Scalloped hammerhead	SPL	38	27																
Hammerhead sharks nei	SPN											2	3	4.2					
Smooth hammerhead	SPZ		2			3.6													
Thresher sharks nei	THR				0.1									16.9					
Tiger shark	TIG		10											357.5					

Information on national observer programmes in ICCAT is scarce. ICCAT observer data collection forms were developed in 2012. Some member countires submitted information of its national observer programmes in 2011 and in 2012; however, the information of 2011 is not directly compatible with the information submitted in 2012 due to different formats. In total, 12 CPCs submitted information in 2011 (Chinese Taipei, Ghana, Korea, Iceland, Japan, Tunisia, Mexico, Namibia, USA, Canada, Uruguay and EU.France). In addition, in 2012, Brazil, Algeria, Egypt, EU Italy, EU Greece, Ghana, Iceland, Japan, Korea, Mauritania, Namibia and South Africa submitted information regarding their national observer programme.

3.2.6 Catch at size

There is not much public information on the catch at size of key shark species in the ICCAT Statistical Area. Length frequencies for shark species bycaught in the ICCAT convention area are scarce (Table 3.2.7). However, a number of CPCs and Cooperative Non-CPCs have provided data for the major species caught (e.g. Japan, Republic of Korea, Seychelles, South Africa and EU-Portugal). In that sense, catch at size for the major ICCAT sharks are prepared based on the nomical catch available in order to carry out the stock assessment of blue sharks, shortfin mako, and porbeagle. For the rest of shark species, the size data available from task II and/or observer programs are very scarce.

Table 3.2.7.- Task II size information (forms: ST04-T2SZ - observed samples; ST05-CAS - catch-at-size) submission status for 2011 data (green = before deadline; yellow = after deadline; blank = Not Submitted or zero catch).

			Sharks (major sp.)		
			BSH	POR	SMA
StatusTypeID	PartyName	Flag	01/08/2012		
CP	ALBANIE	Albania			
	ALGÉRIE	Algerie			
	ANGOLA	Angola			
	BARBADOS	Barbados			
	BELIZE	Belize	1		1
	BRASIL	Brasil	1		1
	CANADA	Canada		1	1
	CAP-VERT	Cape Verde			
	CHINA	China P.R.			
	CÔTE D'IVOIRE	Côte D'Ivoire			
	CROATIA	Croatia			
	EGYPT	Egypt			
	EUROPEAN UNION	EU.Bulgaria			
		EU.Cyprus			
		EU.Denmark			
		EU.España			
		EU.France			
		EU.Greece			
		EU.Ireland			
		EU.Italy			
		EU.Malta	1	1	
		EU.Netherlands			
		EU.Portugal	1		1
		EU.United Kingdom			
	FRANCE (St-Pierre et Miquelon)	FR.St Pierre et Miquelon			
	GABON	Gabon			
	GHANA	Ghana			
	GUATEMALA	Guatemala			
	GUINEA ECUATORIAL	Guinea Ecuatorial			
	GUINÉE REP.	Guinée Conakry			
	HONDURAS	Honduras			
	ICELAND	Iceland			
	JAPAN	Japan	0	0	0
	KOREA REP.	Korea Rep.	1		1
	LIBYA	Libya			
	MAROC	Maroc			
	MAURITANIA	Mauritania			
	MEXICO	Mexico			
	NAMIBIA	Namibia	0		0
	NICARAGUA	Nicaragua			
	NIGERIA	Nigeria			
	NORWAY	Norway			
	PANAMA	Panama			
	PHILIPPINES	Philippines			
	RUSSIA	Russian Federation			
	S. TOMÉ E PRÍNCIPE	S. Tomé e Príncipe			
	SENEGAL	Senegal			
	SIERRA LEONE	Sierra Leone			
	SOUTH AFRICA	South Africa			
	St VINCENT & GRENADINES	St. Vincent and Grenadines			
	SYRIA	Syria Rep.			
	TRINIDAD and TOBAGO	Trinidad and Tobago			
	TUNISIE	Tunisie			
	TURKEY	Turkey			
	UNITED KINGDOM (O.Territories)	UK.Bermuda			
		UK.British Virgin Islands			
		UK.Sta Helena			1
		UK.Turks and Caicos			
	UNITED STATES	U.S.A.	1	1	1
	URUGUAY	Uruguay	1	1	1
	VANUATU	Vanuatu			
	VENEZUELA	Venezuela			
NCC	Chinese Taipei	Chinese Taipei	1		1
	Colombia	Colombia			
	Curaçao	Curaçao			
	Guyana	Guyana			
	Suriname	Suriname			

NOTE: Norway, EU.Denmark, EU Bulgaria, Libya, UK Turks & Caicos and UK.Virgin Islands reported for 2011 "zero" catch of the major ICCAT species (no active fleets fishing for ICCAT species). Côte d'Ivoire, Guinea Rep.

(PS), Panama (LL) and Ghana reported non-standard formats of ICCAT statistics, and therefore were not included in the present report.

3.2.7 Biological information

Biological information for all the species covered in the study is presented in **Annex II**.

3.2.8 Fishery indicators (blue shark and shortfin mako)

In response to the request from the Commission contained in the Recommendation by ICCAT Concerning the Conservation of Sharks Caught in Association with Three Fisheries Managed by ICCAT [Rec. 04-10], for the SCRS to carry out stock assessments of the Atlantic shortfin mako (*Isurus oxyrinchus*) and blue shark (Prionace glauca) a quantitative stock assessment was by ICCAT pelagic sharks group was carried out for blue shark and shortfin mako shark in 2008. The assessment was based on the most recent data on catch and effort, biological information for blueshark and shortfin mako shark. Moreover, a number of standardized CPUE data series for blue shark and shortfin mako were presented in 2008 as relative indices of abundance. The SCRS emphasised on using the series that pertained to fisheries that operate in oceanic waters over wide areas.

Moreover, in response to the request from the Commission contained in the 2007 Supplemental Recommendation by ICCAT Concerning Sharks [Rec. 07-06] which states that the SCRS shall, as soon as possible but no later than 2009, conduct a stock assessment or a thorough review of available stock assessment information of, and recommend management advice for, porbeagle shark (*Lamna nasus*) a joint assessment was carried out for porbeagle by ICCAT and ICES in 2009.

The status of the shark species is summarized in the ICCAT SCRS report (ICCAT, 2011) as most Atlantic pelagic sharks havig limited biological productivity and, as such, can be overfished even at very low levels of fishing mortality. Specifically, their concluded based on an ERA analysis (Cortes et al., 2008) that bigeye threshers, longfin makos, and shortfin makos have the highest vulnerability (and lowest biological productivity) of the shark species examined (with bigeye thresher being substantially less productive than the other species). All species considered in the ERA, particularly smooth hammerhead, longfin mako, bigeye thresher and crocodile sharks, are in need of improved biological data to evaluate their biological productivity more accurately (Cortes et al., 2008).

Moreover, in 2012 a new assessment of short fin make as well as an updated of the Ecological Risk Assessment was carried out following recommendation of ICCAT SCRS. Thus, in the following section the 2012 SCRS conclusions based on 2008 stock assessment of blueshark, 2009 stock assessment of porbeagle, and 2012 stock assessment for short fin mako and Ecological Risck Assessment are summarized:

Blue shark (*Prionace glauca*) fishery indicators and stock status

As said previously, though global statistics on shark catches included in the database have improved, they are still insufficient to permit the Committee to provide quantitative advice on stock status with sufficient precision to guide fishery management toward optimal harvest levels (Figure 3.2.8).

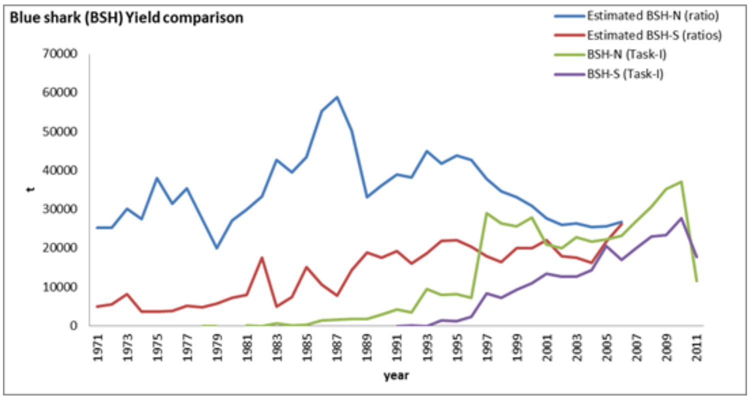


Figure 3.2.8.- Blue shark (BSH) catches reported to ICCAT (Task-I) and estimated by the SCRS to conduct the assessment.

A number of standardized CPUE data series for blue shark were presented in 2008. The Committee placed emphasis on using the series that pertained to fisheries that operate in oceanic waters over wide areas.

Indices of abundance developed for blue shark (from the Venezuelan Pelagic Longline Observer Program (VPLOP) for the period 1994-2007, which covers on average 12.7% of the fleet trips were available for the 2008 stock assessment (SCRS/2008/095). The results suggested that within vessels, the variability of catch rates was smaller compared to the size class grouping, and that smaller/medium size vessels showed the higher catch rates of blue shark in the Venezuelan pelagic longline fishery. However, the vessel size category model achieved better fit than the repeated measures models CS or AR1. The standardized CPUE series showed that the relative abundance of blue shark increased in the early part of the series (1994-98) followed by a decline from 1998 until 2006 with the lowest value in 2005, with a small recovery in the last year of the series.

Spanish longline standardized catch per unit of effort data obtained for the shortfin mako and blue shark using General Linear Modeling (GLM) procedures from 7,511 and 11,244 trip records for the blue shark and shortfin mako during the periods 1997-2007 and 1990-2007, respectively, was presented in document SCRS/2008/129. The main factors used for modeling were year, area, quarter, gear and ratio between swordfish and blue shark catches. The significant models explained around 80% and 40% of the CPUE variability for both species, respectively. As in the case of the Atlantic swordfish, an important fraction of the variability in the blue shark CPUE was attributed to the ratio between the two most prevalent species in the catch. The area was identified as the most relevant factor to explain the CPUE variability in the shortfin mako. The results obtained show CPUE trends that are quite stable for both species during the respective periods considered. A moderate decrease in the CPUE for the North Atlantic shortfin mako was observed during the initial period 1990-1995, when the highest longline activity on the North Atlantic swordfish fishery was achieved, and stability afterwards.

Document SCRS/2008/130 presents two series of nominal CPUE from the Irish recreational fishery for blue shark. The first was based on a survey of recreational catches (numbers of sharks) and represents an average of the number of anglers per day in a given year. This dataset included both targeted shark fishing and general fishing. In order to obtain a more adequate representation of the fishery, a subset of 10 vessels was chosen that had the same skippers, technical specifications and fishing patterns. The skippers of these vessels had been fishing continuously for the period 1989-2005. CPUE was expressed as numbers of blue shark per day of shark fihing for 10 fishing stations, on the Irish south, west and north coasts. These correspond to a spatial extent o f two 5-degree ICCAT squares. Both Irish series showed the same peaks in 1990, 1993, 1996 and 1997 with a decline since 1997 to levels much lower than the earlier period. A slight upturn i n 2005-2007 was observed, but overall CPUE is much lower in the recent period. Similar downward trends since the mid-1990s were also reported from Venezuelan fisheries (SCRS/2008/095), U.S. mid-east coast (SCRS/2008/136) and the US observer program data (SCRS/2008/137), though not from Canadian bluefin tuna and bigeye/swordfish fisheries (SCRS/2008/147). Data from the Japanese tuna longline fishery showed a similar peak to the Irish data from the mid-1990s (SCRS/2008/149), though a slight increase occurred earlier than in the Irish data.

Document SCRS/2008/136 represents an update to prior analyses (SCRS/2007/071), in which abundance indices for unclassified mako (Isurus spp.) and blue sharks off the coast of the United States from Virginia through Massachusetts were developed using data obtained during interviews of rod and reel anglers in 1986-2007. The standardized CPUE series for blue shark showed an increasing trend from the beginni ng of the ti me series peaking in 1996 and a general decreasing trend until 2006, which was reversed in 2007. For mako shark the estimated standardized CPUE series followed the same pattern with a maximum value observed in 1998.

Document SCRS/2008/137 updated indices of abundance developed for blue shark and mako sharks (Isurus spp.) from two commercial sources, the U.S. Pelagic Longline Logbook Program (1986-2007) and the U.S. Pelagic Longline Observer Program (1992-2007). For blue sharks, the logbook time series showed a marked decreasing trend with signs of a potential recent recovery, but the observer time series showed no clear trend. For makos, both the logbook and observer time series showed a concave shape, with essentially no decline since 1992 and an upward trend since the late 1990s.

Document SCRS/2008/141 presents updated standardized indices of the catch-per-unit-of-effort (CPUE) of blue shark caught by the Uruguaan longline fleet. The indices were obtained by Generalized Linear Model (GLM) with a delta lognormal approach. The data in number and weight of the fish caught are from the fishing logbooks of the Uruguayan longline fleet that operated in the South Atlantic Ocean between 1992 and 2007. The standardized CPUE shows similar trends in both cases (for the CPUE calculated in number and in weight) with a relatively stable trend in the last eight years, and an observed recovery in the catch rates in the last year of the series.

Document SCRS/2008/149 provides updated standardized CPUEs for blue shark and shortfin mako caught by the Japanese tuna longline fisher y in the Atlantic Ocean. Indices were estimated using filtered logbook data during 1971-2006 for blue shark, and 1994-2006 for shortfin mako, whose reporting rates were more than 80%. Blue shark CPUE shows some fluctuations and relatively stable trends during the past three decades for North, South and whole Atlantic stock hypotheses. Shortfin mako CPUE indicates a decreasing trend until 2001, but after that ti me recovery to the level at the beginni ng is observed.

Document SCRS/2008/154 provided blue and mako shark catch and effort data from Brazilian tuna longline fleet (national and chartered; 60.645 sets), which operated in the southwestern Atlantic Ocean, from 1978 to 2007 (30 years). Blue shark standardized indices showed a relatively stable trend from 1978 to 1995. From 1995 on, however, there was an increasing trend, with a sharp rise between 2000 and 2002, up to a maximum value in 2007. Like for the blue shark, the mako shark standardized CPUE was relatively stable up to the mid-1990s, increasing in more recent years.

In discussing which indices to use for the blue and shortfin mako assessments, participants generally agreed that it would be better to use indices from fisheries with oceanic distributions that matched the distribution of the species. On the other hand, it was also noted that some coastal indices from the fringe of a species' distribution could also be informative. The Worki ng Group agreed to weight the various indices by relative catch proportions as was done in the 2004 assessment, as well as by the area covered by each fishery.

The following series were used for the 4 base case assessments: (1) North Atlantic BSH: US Logbook (USLL-log), Japan Longline (JLL-N), Ireland recreational (Ire), US early time period (values for 1957-1985 from Aires da Silva, 2008; Usold), Venezuela Longline (VenLL), Spain Longline (SpLL-N); (2) South Atlantic BSH: Japan longline (JLL-S), Spain Longline (SpLL-S), Uruguay Longline (Ur LL), Brazil Longline (Br LL); (3) North Atlantic SMA: US Logbook (USLL-log), Japan Longline (JLL-N), Spain Longli ne (SpLL-N). (4) South Atlantic SMA: Ur uguay Longline (Ur LL), Japan Longline (JLL-S), Brazil Longline (Br LL), Spain Longline (SpLL-S).

There are major changes to the choice and availability of indices for this assessment compared to the 2004 assessment, including:

- A Spanish longline index became available for the 4 stocks assessed
- A historical (since 1957) index for blue shark in the North Atlantic became available
- An index for blue shark in the North Atlantic from the Irish recreational fisher y was now included
- The available Japanese longline index series became shorter
- The Chinese Taipei longline index was not used in this assessment because the group had concerns about the assumed historical species composition (see Section 4.1)
- Estimated trends in several of the series changed substantially, probably as a result of modeling targetting strategies

The Working Group decided to produce combined indices as overall indicators. The indices were combined though a GLM method. The combined indices are shown in Figure 3.2.9.

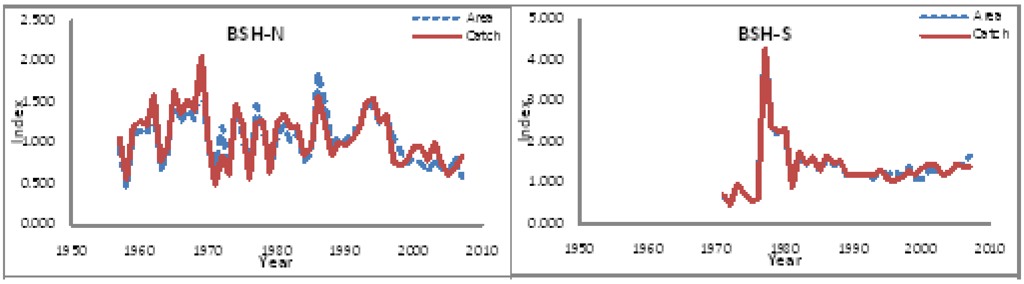


Figure 3.2.9.- Combined indices of abundance for blue shark.

Several assessment methos were used to assess both, North and South Atlantic, blueshark population (e.g. Age Structure Production Method, Bayesian Surplus Production Method, Catch free Age Structure Production Method, etc…). And although both the quantity and quality of the data available to conduct stock assessments improved with respect to the last assessment in in 2004, the results were still quite uninformative and do not provide a consistent signal to inform the models. Unless these and other issues can be resolved, the assessments of stock status for these and other species will continue to be very uncertain.

However, the results for both North and South Atlantic blue shark stocks estimated the biomass to be above the biomass that would support MSY and harvest levels of 2008 harvest below F_{MSY}. However, there is a high uncertainty in the results. Results from all models used in the 2008 assessment (SCRS, 2011) were conditional on the assumptions made (*e.g.*, estimates of historical catches and effort, the relationship between catch rates and abundance, the initial state of the stock in the 1950s, and various life-history parameters), and a full evaluation of the sensitivity of results to these assumptions was not possible during the assessment. Nonetheless, as for the 2004 stock assessment (Anon. 2005c), the weight of available evidence does not support hypotheses that fishing has yet resulted in depletion to levels below the Convention objective.

Shortfin mako shark (*Isurus oxyrinchus*) fishery indicators and stock status

As said previously, though global statistics on shark catches included in the database have improved, they are still insufficient to permit the Committee to provide quantitative advice on stock status with sufficient precision to guide fishery management toward optimal harvest levels.

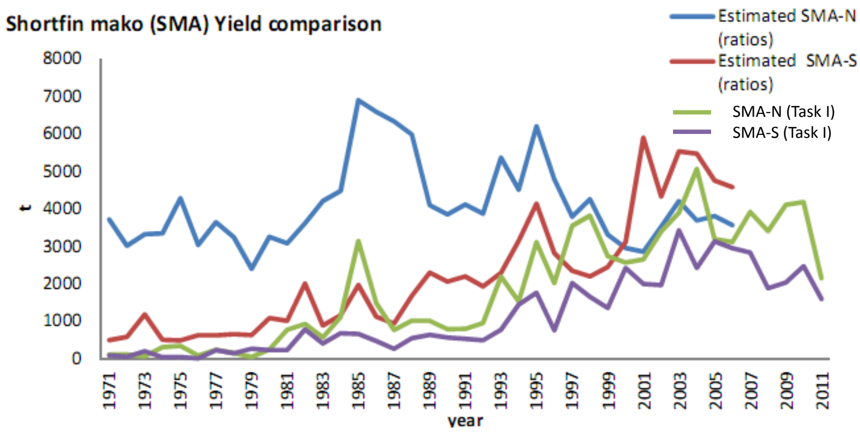


Figure 3.2.10.- Shortfin mako shark (SMA) catches reported to ICCAT (Task-I) and estimated by the SCRS to conduct the assessment.

A number of standardized CPUE data series for shortfin mako were presented in 2012. The Committee placed emphasis on using the series that pertained to fisheries that operate in oceanic waters over wide areas.

SCRS/2012/046 provided information on the standardized catches per unit of effort (in number and weight) obtained for the Atlantic shortfin mako using General Linear Modeling (GLM) procedures based on trip data from the Spanish surface longline fleet targeting swordfish in the North and South Atlantic Ocean over the period 1990-2010.

Updated indices of abundance were developed for mako sharks from two commercial sources, the U.S. pelagic longline logbook program (1986-2010) and the U.S. pelagic longline observer program (1992-2010) in document SCRS/2012/070. Indices were calculated using a two-step delta-lognormal approach that treats the proportion of positive sets and the CPUE of positive catches separately. The logbook and observer time series showed a concave shape, marked by an initial decline until the late 1990s, followed by an upward trend to 2010.

Document SCRS/2012/072 provided information on Portuguese longliners targeting swordfish and operating in the Atlantic Ocean. This fleet regularly captures elasmobranch fishes as bycatch. Of those, the blue shark and the shortfin mako constitute the two main shark species captured. This paper reports the CPUE trends and standardization of the shortfin mako captured by this fleet. The results presented are part of an ongoing study, and provide the first preliminary standardized trends of the shortfin mako catch rates from the Portuguese longline fishery operating in the Atlantic Ocean.

In document SCRS/2012/074, standardized CPUE for shortfin mako caught by the Japanese tuna longline fishery in the Atlantic Ocean was estimated using the logbook data from 1994 and 2010. It revised the method to extract accurate records of the shortfin mako catch from logbook data, based on the information on data collected during the observer program. For the North Atlantic, the standardized CPUE ranged from 0.07 to 0.1 between 1994 and 2005, and thereafter showed a continuous increasing trend. For the South Atlantic, the standardized CPUE was stable around 0.06 from 1994 to 2006, and then displayed a continuous increasing trend as observed in the North Atlantic.

SCRS/2012/076 presented an update of the standardized catch rate of the shortfin mako shark caught by the Uruguayan tuna longline fleet based on information from logbooks between 1982 and 2010. We analyzed a total of 19,272 sets. Of these, 11,395 (59%) records had reported catches of shortfin mako. A not clear trend was observed along the study period for the standard shortfin mako CPUE. Between 2001 and 2008 a decrease was observed; however, there was an increase in the last two years (2009-2010).

The standardized index of abundance for shortfin mako sharks from the National Marine Fisheries Service Marine Recreational Fishery Statistics Survey (MRFSS) was updated in document SCRS/2012/077 with data from 1981 through 2010. Both the fraction of trips with a positive observation, and the delta-lognormal abundance index were highly variable, and showed a high in the mid-1990s, followed by a decline, then a stable trend over the last 10 years.

In document SCRS/2012/080, catch and effort data from 88423 sets made by the Brazilian tuna longline fleet (national and chartered), in the equatorial and southwestern Atlantic Ocean, from 1978 to 2011 (34 years), were analyzed. The standardized CPUE series obtained for mako sharks by the zero inflated negative binomial was not much different from the one done in 2008. Abundance indices showed a moderate inter-annual oscillation, with a gradual increase in values of CPUE until 2003, with a decreasing trend from that year forward.

The 2012 assessment of the status of North and South Atlantic stocks of shortfin mako shark was conducted with updated time series of relative abundance indices and annual catches. Coverage of Task I catch data and number of CPUE series increased since the last stock assessment conducted in 2008, with Task I data now being available for most major longline fleets. The available CPUE series showed increasing or flat trends for the finals years of each series (since the 2008 stock assessment) for both North and South stocks, hence the indications of potential overfishing shown in the previous stock assessment have diminished and the current level of catches may be considered sustainable (Figure 3.2.11).

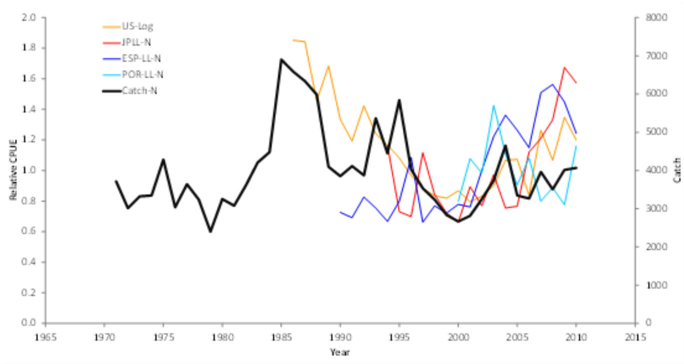
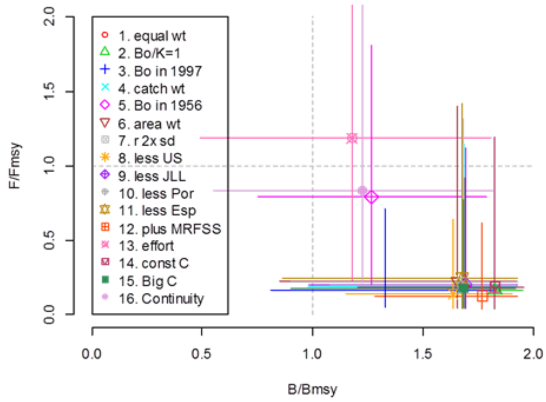


Figure 3.2.11.- CPUE indices of abundance for shortfin mako shark.

Several assessment methods were used to assess both, North and South Atlantic, blueshark population (e.g. Length based methods, Bayesian Surplus Production Method, Catch free Age Structure Production Method, etc…).

For the North Atlantic stock, results of the two stock assessment model runs used indicated almost unanimously that stock abundance in 2011 was above B_{MSY} and F was below F_{MSY} (Figure 3.2.12). For the South Atlantic stock, all model runs indicated that the stock was not overfished and overfishing was not occurring (Figure 3.2.13). Thus, these results indicated that both the North and South Atlantic stocks are healthy and the probability of overfishing is low. However, they also showed inconsistencies between estimated biomass trajectories and input CPUE trends, which resulted in wide confidence intervals in the estimated biomass and fishing mortality trajectories and other parameters. Particularly in the south Atlantic an increasing trend in the abundance indices since the 1970s was not consistent with the increasing catches.

Taking into consideration results from the modeling approaches used in the assessment, the associated uncertainty, and the relatively low productivity of shortfin mako sharks, the SCRS recommends, as a precautionary approach, that the fishing mortality of shortfin mako sharks should not be increased until more reliable stock assessment results are available for both the northern and southern stocks. The high uncertainty in past catch estimates and deficiency of some important biological parameters, particularly for the southern stock, are still obstacles for obtaining reliable estimates of current status of the stocks.



SHK-Figure 3.2.12.- For North Atlantic shortfin mako sharks, median biomass relative to B_{MSY} and median fishing mortality rate relative to F_{MSY}, with 80% credibility intervals, from BSP model.

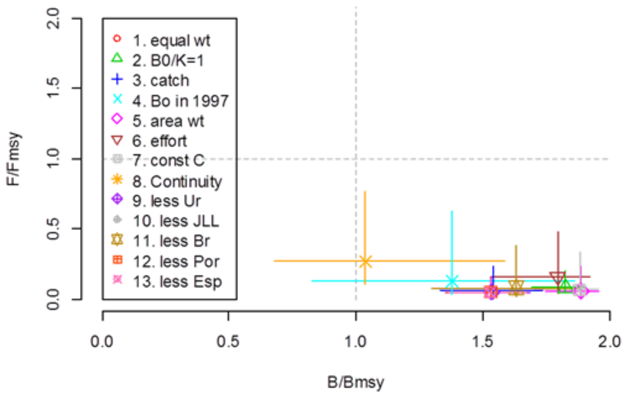


Figure 3.2.13.- For South Atlantic shortfin mako sharks, median biomass relative to B_{MS}y and fishing mortality rate relative to F_{MSY}, with 80% credibility intervals.

3.2.9 Major difficulties

No major difficulties have been suffered in the data gathering process and data identification gaps, however, the major difficulties of the project are the scarcity of data and data availability for major fleets and countries as underlined in the previous section. Most of those data is coming from logbooks which may complicated the data gathering process due to species mis-identification, under-reporting and potential, unidentifiable in targeting strategies.

Many Atlantic countries are not reporting any catches or, in the case of a few countries, only a small number of landings are declared. If these data are not reported, total catches are estimated from a range of sources (including: partial catch and effort data, data in the FAO FishStat database, scientific reports or publications, data published through web pages or other means). Nevertheless, the lack of relevant information needed to undertake extrapolations could prevent accurate shark catch estimates. If the data are reported, the discrepancies between the ratio nominal tuna catches and shark catches could help to detect any misreported information.

The main difficulties can be summarized as follows:

- Artisanal and coastal fisheries: lack of shark catch reporting;
- Industrial fisheries: lack of shark catch reporting and when it is done usually not broken down by species;
- Lack of any size frequency data;
- Lack of regional biological/ecological information for sharks;
- Data access;
- Species misidentification;
- Low observer coverage for most of the fleets;
- Difficulties with the use of logbook data for shark assessment (misidentification, underreporting, change in targeting practice).

3.2.10 Summary

Table 3.2.8 summarizes the level of tuna and sharks catches of all the fleets operating in the Atlantic Ocean. It is intended to highlight the data gaps and the discrepancies in the landings declared. More attention will be required to these fisheries in order to reconstruct a theoretical catch series based on the most relevant information available. This synthesis table Table 3.2.8 shows that very few fisheries declare significant sharks catches.

Table 3.2.8.- Summary information extracted from the Nominal Catch Information database (Task 1) available on the ICCAT website (http://www.iccat.int/en/): Major tuna catches (min, max, mean and total in tons) and sharks catches (min. max. mean and total in tons) by country, fleet and fishing gear between 2000 and 2010, and other sources of information available. NCP: Non-Contracting Parties.

Country	Flag	Gear Group	Tuna (major sp.)	SHARKS	Period	Other sources of information	Sharks data
ANGOLA	Angola	BB	708.0		2000-2004		Not Available
		GN			2005-2005		Not Available
		HL	382.0		2005-2007		Not Available
		LL	189.0		2005-2005		Not Available
		OTH	322.0		2000-2010		Not Available
		SURF			2005-2005		Not Available
BARBADOS	Barbados	HL	310.9	39.6	2003-2010		Available
		LL	2539.4	39.6	2000-2010		Available
		OTH			2000-2003		Not Available
BELIZE	Belize	LL	5811.1	1628.9	2000-2010		Available
		PS	4735.5		2010-2010		Not Available
BRASIL	Brasil	BB	259426.5	684.2	2000-2010		Available
		HL	444.7	45.0	2003-2009		Available
		LL	106760.6	32737.8	2000-2010		Available
		OTH	14033.3	6945.6	2000-2010		Available
		PS	3282.1	12.9	2000-2009		Available
		SURF	3000.0	1168.2	2000-2005		Available
CANADA	Canada	GN	1.3	272.0	2000-2010		Available
		HL		6.8	2000-2010		Available

		LL	17125.7	3333.5	2000-2010	Available
		OTH	7990.3	6318.5	2000-2010	Available
		TW	0.8	21.4	2000-2010	Available
CAP-VERT	Cape Verde	BB	3922.5		2000-2010	Not Available
		HL	14914.0		2000-2010	Not Available
		LL	6.0		2003-2008	Not Available
		PS	75534.5		2000-2010	Not Available
CHINA REP	China P.R.	LL	89563.6	4239.3	2000-2010	Available
Chinese Taipei	Chinese Taipei	LL	389106.3	17321.8	2000-2010	Available
Colombia	Colombia	OTH	322.0		2000-2006	Not Available
CÔTE D'IVOIRE	Côte D'Ivoire	GN	23266.9	537.5	2000-2010	Available
		LL	2056.4	12.1	2009-2010	Available
Curaçao	Curaçao	OTH	215.0		2000-2002	Not Available
		PS	144452.8		2000-2010	Not Available
		TW			2010-2010	Not Available
EUROPEAN UNION	EU.Denmark	LL		0.0	2010-2010	Available
		OTH		216.6	2000-2010	Available
		PS		0.1	2010-2010	Available
		TN		0.1	2010-2010	Available
		TW		13.6	2010-2010	Available
	EU.España	BB	228634.9		2000-2010	Not Available
		HL	500.7		2000-2010	Not Available
		LL	130560.3	344909.1	2000-2010	Available
		OTH	82909.0		2000-2010	Not Available

	PS	591305.3		2000-2010	Not Available
	SURF			2000-2010	Not Available
EU.Estonia	TW		3.9	2003-2003	Available
EU.France	BB	33506.4		2000-2010	Not Available
	GN	3229.7	1291.1	2000-2010	Available
	HL	964.5	7.6	2000-2010	Available
	LL	1360.0	2834.7	2000-2010	Available
	OTH	5184.3	25180.4	2000-2010	Available
	PS	410409.3	48.4	2000-2010	Available
	SURF			2000-2002	Not Available
	TN	0.8	2316.3	2004-2010	Available
	TW	42753.7	34172.7	2000-2010	Available
EU.Germany	OTH		658.8	2000-2002	Available
	TW			2002-2002	Not Available
EU.Ireland	GN	4852.4	48.4	2000-2010	Available
	HL		0.0	2009-2009	Available
	LL	0.1	1.0	2004-2004	Available
	OTH	287.8	1072.3	2000-2010	Available
	PS		0.2	2004-2007	Available
	TN		0.1	2006-2010	Available
	TW	8412.1	356.6	2000-2010	Available
EU.Latvia	TW	1778.0		2000-2006	Not Available
EU.Lithuania	OTH			2002-2002	Not Available

	EU.Netherlands	OTH		0.3	2008-2009	Available
		TW	14.1	161.9	2007-2009	Available
	EU.Portugal	BB	104052.8	0.2	2000-2010	Available
		GN			2000-2010	Not Available
		HL	212.3		2008-2008	Not Available
		LL	24342.8	106022.7	2000-2010	Available
		OTH	386.5	0.5	2000-2010	Available
		PS	26.8	39.8	2000-2010	Available
		SURF	2915.4	7267.3	2000-2010	Available
	EU.Sweden	OTH		1.6	2000-2001	Available
	EU.United Kingdom	GN	20.3	1678.8	2000-2010	Available
		HL	196.6	10.5	2005-2010	Available
		LL	132.2	2588.9	2004-2010	Available
		OTH	0.1	130.6	2000-2010	Available
		PS	0.0	321.3	2006-2010	Available
		TN	0.0	62.3	2005-2010	Available
		TW	70.5	4778.8	2000-2010	Available
FRANCE (St-Pierre et Miquelon)	FR.St Pierre et Miquelon	LL	447.7	19.1	2002-2010	Available
GABON	Gabon	GN	245.2	122.1	2000-2003	Available
		OTH	3.0		2000-2000	Not Available
		SURF	288.0		2000-2002	Not Available
		TW	726.3	536.2	2001-2006	Available
GHANA	Ghana	BB	361312.5		2000-2010	Not Available

		GN	13210.7		2000-2010	Not Available
		PS	342545.9		2000-2010	Not Available
GUATEMALA	Guatemala	PS	57039.3		2005-2010	Not Available
GUINEA ECUATORIAL	Guinea Ecuatorial	HL	3391.0	0.5	2009-2010	Available
		LL	892.0		2010-2010	Not Available
GUINÉE REP.	Guinée Conakry	PS	730.0		2010-2010	Not Available
Guyana	Guyana	GN		12218.6	2001-2010	Available
ICELAND	Iceland	OTH		4999.7	2000-2003	Available
		GN		682.7	2000-2010	Available
		HL		3.6	2000-2007	Available
		LL	1.1	350.7	2000-2010	Available
		OTH		2.4	2007-2010	Available
		PS		70.5	2000-2010	Available
		TW		528.4	2000-2010	Available
JAPAN	Japan	LL	314459.8	26128.6	2000-2010	Available
KOREA REP.	Korea Rep.	LL	21023.6	303.2	2000-2010	Available
		OTH			2003-2003	Not Available
		PS	0.9		2010-2010	Not Available
LIBYA	Libya	LL	2024.3		2000-2006	Not Available
		PS	486.5		2000-2000	Not Available
MAROC	Maroc	GN	2898.0	10.0	2000-2010	Available
		HL	1884.0		2004-2010	Not Available
		LL	17582.2	2518.0	2000-2010	Available
		OTH	22149.0	25872.0	2000-2010	Available

		PS	8332.0	1469.0	2000-2010	Available
		SURF	1627.4		2000-2001	Not Available
MEXICO	Mexico	LL	14555.5	181.6	2000-2010	Available
		OTH			2000-2003	Not Available
NAMIBIA	Namibia	BB	28421.0	375.9	2000-2010	Available
		LL	13968.5	34797.5	2000-2010	Available
non-contracting parties	Argentina	GN		104.7	2000-2005	Available
		LL		24.7	2000-2004	Available
		OTH	0.1	3001.6	2000-2005	Available
		PS		59.7	2000-2005	Available
		TW	738.2	51543.9	2000-2005	Available
	Aruba	OTH	10.0		2000-2002	Not Available
	Benin	GN	42.9		2000-2007	Not Available
		OTH	3.4		2000-2002	Not Available
	Costa Rica	OTH	15.0		2000-2003	Not Available
	Cuba	BB	2868.8		2000-2006	Not Available
		LL	2296.2		2002-2006	Not Available
		OTH	661.1		2000-2007	Not Available
	Dominica	GN	0.8		2006-2009	Not Available
		HL	870.5		2001-2010	Not Available
		LL	4.2		2006-2009	Not Available
		OTH	1417.8		2000-2010	Not Available
	Dominican Republic	OTH	230.0		2001-2003	Not Available

	SURF	2785.1		2000-2007	Not Available
Falklands	LL		0.3	2002-2002	Available
	OTH		0.1	2001-2001	Available
	TW		0.1	2000-2002	Available
Faroe Islands	LL	131.0		2000-2000	Not Available
Grenada	LL	8045.5		2000-2010	Not Available
	OTH	1960.4	90.9	2000-2010	Available
Jamaica	OTH			2000-2002	Not Available
Liberia	GN	2164.8		2000-2007	Not Available
	OTH	228.0		2000-2003	Not Available
Mixed flags (FR+ES)	PS	67819.0		2000-2010	Not Available
	SURF			2000-2002	Not Available
NEI (BIL)	LL	2895.8		2000-2009	Not Available
	OTH	406.8		2001-2008	Not Available
	SURF	1271.2		2001-2004	Not Available
NEI (ETRO)	BB	16537.8		2000-2005	Not Available
	LL	1574.8		2000-2007	Not Available
	PS	79118.7		2000-2007	Not Available
NEI (Flag related)	LL	33317.2		2000-2003	Not Available
Saint Kitts and Nevis	OTH			2000-2005	Not Available
Seychelles	LL	290.1	4.4	2000-2002	Available
Sta. Lucia	HL	664.9		2000-2002	Not Available
	OTH	2752.3	73.7	2002-2010	Available

	Togo	GN	1617.0	323.0	2000-2007	Available
	Ukraine	TW			2000-2003	Not Available
NORWAY	Norway	GN		3693.7	2001-2006	Available
		HL		4.0	2006-2006	Available
		LL		961.0	2001-2006	Available
		OTH		1771.3	2000-2010	Available
		PS		102.0	2001-2006	Available
		TW	0.3	386.8	2001-2008	Available
PANAMA	Panama	BB	291.4		2000-2000	Not Available
		LL	6917.5	4057.1	2000-2010	Available
		PS	142409.0		2000-2010	Not Available
PHILIPPINES	Philippines	LL	18726.7	1.4	2000-2010	Available
RUSSIA	Russian Federation	LL	7.1	18.4	2005-2005	Available
		PS	3811.0		2000-2009	Not Available
		TW			2000-2010	Not Available
S. TOMÉ E PRINCIPE	S. Tomé e Príncipe	HL	133.6	1229.4	2000-2010	Available
		OTH	4423.8	215.7	2000-2010	Available
		PS	2319.0	155.5	2005-2010	Available
		SURF	1455.5		2000-2004	Not Available
SENEGAL	Senegal	BB	44994.2		2000-2010	Not Available
		GN	453.2	6596.0	2000-2010	Available
		HL	3162.3		2000-2010	Not Available
		LL	829.1	855.6	2007-2010	Available
		OTH	3475.5		2000-2010	Not Available

		PS	4.0		2000-2002	Not Available
		SURF		8886.0	2005-2007	Available
SIERRA LEONE	Sierra Leone	LL	314.8		2000-2001	Not Available
		OTH			2000-2002	Not Available
SOUTH AFRICA	South Africa	BB	45779.8	6.1	2000-2010	Available
		HL	329.6	101.4	2004-2010	Available
		LL	6886.2	988.5	2000-2010	Available
		LLSH	27.4	1433.1	2004-2010	Available
		OTH	6779.9	0.1	2000-2008	Available
St VINCENT & GRENADINES	St. Vincent and Grenadines	LL	38468.1	2842.3	2000-2010	Available
		OTH	1287.4	34.3	2000-2010	Available
TRINIDAD and TOBAGO	Trinidad and Tobago	LL	5478.3	324.6	2000-2010	Available
		OTH	12.2	5218.8	2000-2010	Available
		SURF	59.7	2944.1	2000-2010	Available
UNITED KINGDOM (O.Territories)	UK.Bermuda	LL	23.8	9.7	2000-2010	Available
		OTH	499.6	27.1	2000-2010	Available
	UK.British Virgin Islands	LL	22.0		2004-2008	Not Available
	UK.Sta Helena	BB	824.3		2000-2005	Not Available
		LL	27.3	28.8	2001-2002	Available
		OTH	1457.1		2000-2010	Not Available
	UK.Turks and Caicos	OTH	3.9	0.1	2004-2008	Available
UNITED STATES	U.S.A.	GN	93.4	2.5	2000-2010	Available
		HL	2966.7	6.8	2000-2010	Available
		LL	61244.7	5567.6	2000-2010	Available

		OTH	50547.5	2343.7	2000-2010	Available
		PS	1205.5		2000-2010	Not Available
		SURF			2000-2006	Not Available
		TW	75.9	0.9	2000-2010	Available
URUGUAY	Uruguay	LL	11141.2	6547.0	2000-2010	Available
VANUATU	Vanuatu	LL	11239.0	188.8	2004-2010	Available
VENEZUELA	Venezuela	BB	27236.0		2000-2010	Not Available
		GN	2595.9	108.1	2000-2010	Available
		LL	10847.2	929.4	2000-2010	Available
		OTH	1733.9		2000-2002	Not Available
		PS	79278.9		2000-2010	Not Available
		SURF		11.0	2000-2002	Available

3.3 General Fisheries Commission for the Mediterranean

3.3.1 Introduction

The Mediterranean and Black Seas region includes twenty-three countries, three continents, and 45,000 kilometers of coast (Table 3.3.1). The Mediterranean is a semi-enclosed marine area with generally narrow continental shelves.

Table 3.3.1.- Estimates of the main geographical characteristics of the countries with a Mediterranean coastline (source: Sacchi, 2011)

COUNTRY	Length of Mediterranean coastline (km) (*)	Surface area of Mediterranean continental Shelf from 0 to 200 m depth (km^2) (*)	Surface area of Mediterranean coastal regions (km^2) (***)	% of national surface area (***)
Albania	427	6,076	12,149	42%
Algeria	1,280	13,700	42,899	2%
Bosnia and Herzegovina	20	14	10	0.0%
Cyprus	796	2,960	9,251	100%
Croatia	6,168	44,850	17,297	35%
Egypt	1,050	(**) 30,475	260,912	28%
Spain	2,372	58,225	95,553	19%
France	1,703	16,240	34,379	6%
Gibraltar	12	-	7	100%
Greece	13,676	94,340	92,547	70%
Israel	205	3,207	7,398	36%
Italy	7,600	110,750	165,112	18%
Lebanon	294	1,169	6,074	60%
Libya	1,970	63,695	348,833	20%
Malta	197	1,800	316	100%
Morocco	512	5,460	17,757	4%
Monaco	4	-	2	100%
Montenegro	293	3,079	1,591	12%
Palestine – Gaza Strip	41	386	360	100%
Slovenia	46	194	1,044	5%
Syria	183	900	4,189	2%
Tunisia	1,298	65,347	45,410	29%
Turkey	5,191	18,614	119,288	15%
Total (rounded values)	45,500	525,600	1,283,000	17 %

Source: * FAO Country profile. Note: Length of coastline and continental shelf surface area are for Mediterranean areas only.
** Sea Around Us
*** World Bank and national statistics. Other source consulted: CIA The World Factbook [3]

The General Fisheries Commission for the Mediterranean (GFCM) was established under the provisions of Article XIV of the FAO constitution, and entered into force in 1952. In addition to European Union there are 23 Member countries, with Contracting Parties contributing to an autonomous budget for the functioning of the Commission. Membership is open to Mediterranean coastal states and regional economic organizations, and United Nations member states whose vessels engage in fishing in Mediterranean waters (e.g. Japan).

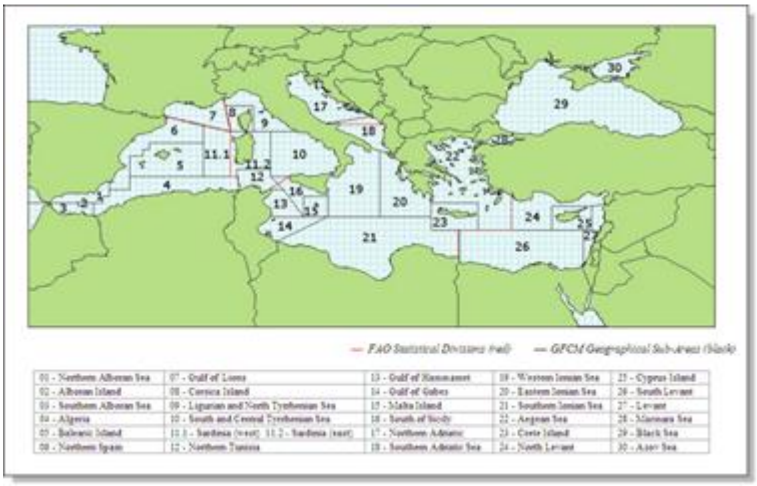
[3] https://www.cia.gov/library/publications/the-world-factbook/geos/

GFCM's objectives are to promote the development, conservation. rational management and best utilization of living marine resources, as well as the sustainable development of aquaculture in the Mediterranean, Black Sea and connecting waters. With other Regional Fisheries Management Organizations (RFMOs), GFCM coordinates government's efforts to manage fisheries at regional level, following the FAO Code of Conduct. The GFCM has the authority to adopt binding recommendations for fisheries conservation and management in its Convention Area. Precautionary principle is adopted within the Code of Conduct.

The Commission has the following responsibilities:

- to keep under review the state of the Mediterranean living resources, including their abundance and the level of their exploitation. as well as the state of the fisheries based thereon;
- to formulate and recommend. appropriate measures: (i) for the conservation and rational management of living marine resources; and (ii) for the implementation of these recommendations;
- to keep under review the economic and social aspects of the fishing industry and recommend any measures aimed at its development;
- to encourage. Recommend, coordinate and. as appropriate. undertake training and extension activities in all aspects of fisheries;
- to encourage, recommend, coordinate and as appropriate, undertake research and development activities; including cooperative projects in the areas of fisheries and the protection of living marine resources;
- to assemble, publish or disseminate information regarding exploitable living marine resources and fisheries based on these resources;
- to promote programmes for marine and brackish water aquaculture and coastal fisheries enhancement;
- to carry out such other activities as may be necessary for the Commission to achieve its purpose as defined above.

The area of competence including both the high seas and the coastal zones under national jurisdiction is divided into 30 sub-areas.



GFCM Geographical Sub-Areas (GSAs) map

Species and Stocks of EU interest

It is difficult to specify key stocks, given number of “commercial” species within Mediterranean catches. However, main ones are: hake (*Merluccius merluccius*), red mullet (*Mullus barbatus)*, deep-water rose shrimp (*Parapenaeus longirostris)*,giant red shrimp (*Aristaeomorpha foliacea)*, demersal octopus (*Octopus vulgaris*), anchovy (*Engraulisencrasicolus),* sardine (*Sardina pilchardus)* and pelagic round sardinella (*Sardinella aurita*). Large pelagic tuna and tuna-like species are covered by ICCAT.

Structure

Commission membership is open to Members of the United Nations, especially coastal StatesStates whose vessels engage in fishing in the Convention Area as well as to Regional Economic Integration Organizations.

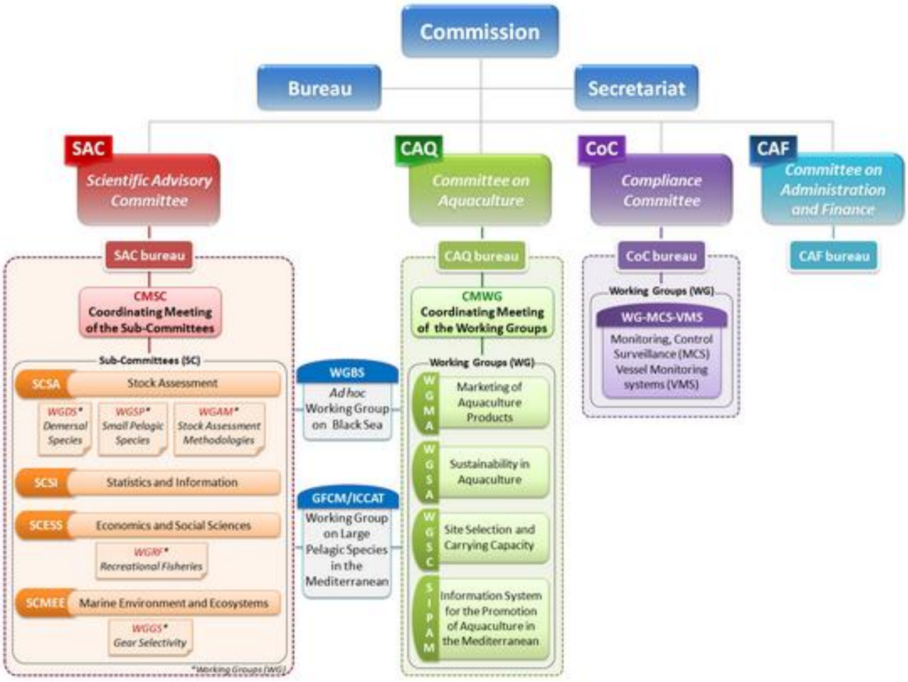
The Commission normally holds its Regular Session on an annual basis and convenes special sessions, as appropriate, at the request or with the approval of the majority of the Members. It seeks to promote the conservation and rational management of living marine resources through, inter alia, drawing up binding measures related to the regulation of fishing methods, fishing gear and minimum landing sizes, together with the establishment of open and closed fishing seasons and areas. It also strives to implement a fishing effort control regime by Operational Units through the regulation of catch and fishing effort and their allocation among Members.

GFCM holds regular annual sessions. It implements its policy and activities through the Secretariat (Rome), and operates during the inter-sessional period by means of its committees:

- Scientific Advisory Committee (SAC).
- The Committee on Aquaculture (CAQ).
- The Compliance Committee (CoC).

SAC operates through five subsidiary bodies:

- Coordination Meeting of the Sub-Committees (CMSC);
- Sub-Committee on Stock Assessment (SCSA);
- Sub-Committee on Marine Environment and Ecosystems (SCMEE);
- Sub-Committee on Statistics and Information (SCSI);
- Sub-Committee on Economic and Social Sciences (SCESS).



The Scientific Advisory Committee (SAC) provides independent advice on the technical and scientific bases for decisions concerning fisheries conservation and management including biological social and economic aspects. in particular:

- Assess information provided by Members and relevant fisheries organizations or programmes on catches, fishing efforts and other data relevant to the conservation and management of fisheries;
- Formulate advice to the Commission on the conservation and management of fisheries;
- Identify cooperative research programmes and coordinate their implementation;
- Undertake such other functions or responsibilities as may be conferred by the Commission.

<u>GFCM working groups dedicated to sharks issues</u>

Sharks issues have been addressed during the first meeting of the SCMEE/SCSA Transversal Working Group on bycatch/incidental catches which was held at the FAO HQs, Rome (Italy), in 2008. The meeting was attended by 29 Experts from 6 GFCM Members namely Bulgaria, Croatia, France, Italy, Spain and Tunisia, as well as by representatives from GFCM partners and NGOs (ACCOBAMS, WWF, CIRSPE, Black Sea Council for Marine Mammals etc.) and the GFCM Secretariat. The 2nd Transversal Working Group on By-catch was held in Antalya (Turkey) in 2011. It was attended by 29 participants from 9 countries as well as representatives of the GFCM and ACCOBAMS Secretariats.

In 2010, during its twelfth session, the Scientific Advisory Committee (SAC) of the General Fisheries Commission for the Mediterranean acknowledged the proposal to develop a three–year workplan on elasmobranches to improve knowledge, develop a standardized protocol to promote the collection of basic data on elasmobranches and assess the status of elasmobranches in the Mediterranean and the Black Sea. The programme proposed on elasmobranches species included an expert meeting and training course (see detailed proposal in Appendix I of the Report of the twelfth session of the SAC). The SAC stressed that the objectives should include also data gathering and information on anthropic activities other than fisheries that may have direct impact on deteriorating essential habitats for different life-stages of elasmobranches.

In 2010, the **First Expert meeting on the status of Elasmobranches** in the Mediterranean and Black Sea was held in Tunisia (20-22 Septembre 2010). The meeting was attended by 17 experts from seven GFCM members namely Algeria, France, Greece, Italy, Morocco, Tunisia and Turkey as well as by participants from IUCN and RAC/SPA.

In December 2011, the **first meeting of the Workshop on Stock Assessment of Selected Species of Elasmobranchs** in the GFCM area was held in Brussels, Belgium, in the premises of the Directorate General for Maritime Affairs and Fisheries (DG MARE) of the European Commission. It was attended by 25 experts from Algeria, Bulgaria, Croatia, France, Ireland, Italy, Morocco, Romania, Syria, Tunisia, Turkey as well as representatives of the European Union (EU), the Mediterranean Action Plan for the United Nations Environment Programme – Regional Activity Centre for Specially Protected Areas (UNEP-MAP RAC/SPA), and the GFCM Secretariat.

Finally, in October 2012, a **Workshop on age determination of elasmobranchs** in the GFCM area was held in Turkey. It was a hands-on workshop with an important training component. It was attended by 19 participants from 9 member countries and Ukraine as well as by the GFCM Secretariat. A manual of the techniques used is being published separately and made available on the GFCM web site. A manual of the techniques has been available on the GFCM website: Age determination of elasmobranchs, with special reference to Mediterranean species: A technical manual (Campana) http://151.1.154.86/GfcmWebSite/SAC/15/GFCM_SAC15_2013_Dma.3.pdf.

In 2012, the SAC decided that the stock assessment of sharks and rays could be regularly included in the annual work plan of the SAC Working Groups on Stock Assessment. According to REC. GFCM/36/2012/3, Countries had to submit information on shark catch under Task 1.

In February 2013, during the last Sub-Committee on Marine Environment and Ecosystems (SCMEE) – (13th Session), the participants stated that:

Given the interest of the GFCM in issues related to the by-catch of species of conservation concern, as reflected in Recommendations GFCM/35/2011/4, GFCM/35/2011/5, GFCM/36/2012/2, GFCM/36/2012/3, and given that most of large pelagic shark species and some rays species are in decline in the Mediterranean and Black Sea, it is recommended to the GFCM SAC/Commission **to extend the programme on elasmobranchs for another three years**. A proposal of topics to be addressed is presented in the SCMEE Workplan 2013.

The following activities, in elasmobranchs, are proposed for the SCMEE Workplan 2013:

- Develop a three-year extension of the GFCM medium-term elasmobranchs Programme.

The terms of reference of the programme should include:

- Preparation of a draft proposal on practical options for mitigating by-catch for the most impacting gears in the Mediterranean and Black Sea.
- Production and dissemination of guidelines on good practices to reduce the mortality of sharks and rays caught incidentally by artisanal fisheries.
- Carrying out studies on growth, reproduction, population genetic structure and post-released mortality and identification of critical areas (nurseries) at national or regional level. A list of priority species should be selected.
- Preparation of factsheets and executive summaries for some commercial species presenting identification problems.
- Assessment of the impact of anthropogenic activities other than fisheries on the observed decline of certain sharks and rays populations.
- Carrying out of a pilot tagging programme for pelagic sharks.

With the aim of facilitating prioritization of the proposed activities, a table containing all proposals along with the possible source of funding was introduced by the Secretariat during the fifteenth sesión the Scientific Advisory Committee (SAC) (Rome, Italy, 8–11 April 2013) and the Committee agreed on the second three-year research programme on elasmobranchs planned.

During the Thirty-seventh session of the Commission (Split, Croatia, 13-17 May 2013), The Chairperson reported the Scientific Advisory Committee (SAC) advice concerning the conservation of elasmobranchs and The Commission endorsed the programme of work proposed by SAC. The next meeting on the status of Elasmobranches will be held in France (Sète) before thte end of 2013.

<u>Fishing context in the Mediterranean Sea</u>

In the following paragraphs there is a brief description of the fishing activity in the Mediterranean and a presentation of the major fleets targeting tuna and tuna like species which may interact with shark populations. The accessible information varies considerably across the countries and, thus, the comprehensiveness for each country fleet activities varies.

The Mediterranean fisheries can be broken down into three main categories: small scale fisheries, trawling and seining fisheries (which operate on demersal species and small pelagics) and large pelagic resources (Papaconstantinou and Farrugio 2000). During the last 40-year period, Spanish, Italian, and Greek longline and driftnet fleets have operated throughout the Mediterranean, targeting mainly swordfish or albacore and bluefin tuna. Catches began to expand slowly after 1962, increased rapidly with the advent of monofilament driftnets, and peaked in the late 1980s. Among thosegears, the swordfish longline is the main gear used in the Mediterranean Sea. Although purse seining for Bluefin tuna existed since around the 50s, the industrial blue fin tuna purse seine fishery increased rapidly around the 90s associated to the development of Bluefin cage facilities developed in the Mediterranean.

In 1992 the European Union prohibited driftnet fishing in the Mediterranean with nets more than 2.5 km in length, as did the General Fisheries Commission for the Mediterranean (GFCM) in 1997 under a binding Resolution (97/1) (GFCM, 1997). A total ban on driftnet fishing on large pelagic species by the European Union (EU) fleet in the Mediterranean entered into force from 1st January 2002 (European Regulation No. 1239/98; Tudela, 2004). The same decision was adopted by ICCAT (International Commission for the Conservation of Atlantic Tuna) by means of a binding Recommendation (03-04) in November 2003. However, even some countries initiated a national conversion plan for vessels to shift from driftnet fishing to other gear types, providing fishermen with financial compensation for so doing, evidences indicate that the ban is not being enforced in some countries. All fishing activities outside this legal framework qualify for illegal, unregulated and unreported fishing according to FAO.

During the last decade, the Moroccan swordfish catches by driftnet have been important and have represented about 60% on average of the total catch of this species at the national level. But, since 2003, swordfish catches taken by this gear have steadily decreased because of the implementation of the ICCAT recommendation (Rec.03-04) to ban gradually the driftnet activity in the Mediterranean Sea (Abid and Idrissi, 2011). Since 2012, this fishing activity is definitively banned in Morroco.

It was observed in 2006 that Italian fishing boats illegally used driftnets in the Tyrrhenian and Ionian Seas (Greenpeace, 2006). In 2007, it was stated by Environmental Justice Foundation (EJF, 2007) that there were 600 vessels in the Mediterranean Sea that conducted illegal driftnet fishery and also reported than more than 100 vessels related with this fishery were based in Italy, 70-100 vessels in France, 150-300 vessels in Morocco and over 110 in Turkey (Oceana, 2008 a; b).

In Mediterranean Sea, data series have been collected on target species while on the contrary data on bycatch were neglected and rarely recorded. Megalofonou et al. (2005) conducted a study of incidental catches and discards of pelagic sharks from the swordfish and tuna fisheries in the Mediterranean Sea. Data were taken onboard and at fishing ports from 1998 to 2000. Until recent years sharks were the most abundant incidental catch (landed, but not specifically targeted, or discarded). Sharks comprise about 18% of the total catch of theItalian Mediterranean Sea large pelagic longline fishery. Blue shark (*Prionace glauca*) was the main bycatch species in all gears and areas examined. The next most abundant species were shortfin mako (*Isurus oxyrinchus*), thresher shark (*Alopias vulpinus*), and tope shark (*Galeorhinus galeus*) (Megalofonou et al., 2005a).

Following, a summary of National Report of GFCM countries fleets is provided in order to review major fleets and countries that may be involved with shark catch.

Algeria-Algerian fisheries are carried out within the GSA4. In 2009, the catches of tunas and tuna-like species amounted 2,400 tonneswere made by a national fishing fleet whose vessels measure between 6 and 24 m in length. The fleet is comprised of artisanal longliners and drift netters and 19 purse seiners (4 of which are specialized), and 12 chartered longliners measuring 45 m (Japanese longline).

Bulgaria -The Bulgarian marine fishery is taking place in the Black Sea and in GSA 29. The opportunities of marine fishing in the country are limited by the specific characteristics of the Black Sea. The exploitation of the fish recourses is limited in the shelf area. No Tuna and tuna like catches were reported.

Croatia- Croatian fisheries are carried out within the GSA 17 – Northern Adriatic and GSA 18 – Southern Adriatic. Majority of catches are realized within the GSA 17. Fisheries are divided in several main segments – small pelagic fishery (purse seine and pelagic trawls), bottom trawl and other towed fishery, fixed gear fishery, bluefin tuna fishery and coastal (artisanal) fishery. The total Croatian catch of bluefin tuna in 2009 was 618.6 metric tons (t). Bluefin tuna were predominantly transferred into farming cages (608.96 kg, 98.44%) and 9.65 t (1.56 %) were landed. Catches of bluefin tuna were mostly made by purse seiners (98.51%), while the remainder was caught using hook and line gears. The total Croatian catch of Mediterranean (Adriatic) swordfish amounted to 3,119 kg in 2009.

Cyprus- The Cyprus capture fisheries consist of the small-scale inshore fishery (artisanal fishery), the trawl fishery and the polyvalent fishery.The Polyvalent fishery fleet consists of vessels with length ranging between 12 – 26m (OAL), and an average length of 16 m. The fleet operates with passive polyvalent gears, both in the territorial waters of Cyprus and international waters of the Eastern Mediterranean, mainly in GSA 26-South Levant.Polyvalent vessels target highly migratory species, such as bluefin tuna (*Thunnus thynnus*), swordfish (*Xiphias gladius*) and albacore (*Thunnus alalunga*) with surface longlines. In 2009, 222 t of albacore tuna, 37 t of swordfish and 2.2 t of blue fin tuna were reported.

Egypt- Historical the main fishing ground used by Egyptian vessels is the continental shelf off the Nile delta; extend last ten years to the eastern side off Sinai and seasonally to the western side of Alexandria. The continental shelf is narrow in western area comparable to the wider central delta region and its eastern side. The seabed is flat, mostly muddy to sandy along the middle and eastern coast. Limited grounds for trawling are available on the western coast where the area is sandy and rocky. Inshore fisheries are widespread, with artisanal fishermen along the coast. The vessels operate mainly in GSA 26-South Levant. No Tuna and tuna like catches were reported.

France- French fisheries are carried out within the GSA7 and GSA8. In 2009, the catches of bluefin tuna amounted 3,087 tonnes were made mainly by the national purse seine fishing fleet of 28 vessels measuring an average of 36 m in length. France is one of the EU Mediterranean countries where drift net was still used after the EU prohibition came into effect in 2002. The French fleet's illegal fishing practices was "tolerated" by authorities until 2007 and continued illegally after (between 2007 and 2009 some illegal fishers were sanctioned). The length of the net used exceeds 2.5 km (Banaru et al., 2010). Driftnet fishing, also called "Thonaille" (French term), a pelagic traditional fishing technique has been conducted in the Northwestern Mediterranean sea to target Atlantic bluefin tuna (*Thunnus thynnus*). Skipjack and then frigate tuna constituted the majority of the tuna and tuna-like by-catches of the Atlantic bluefin tuna (Fromentin and Farrugio, 2005).

Greece -Greek fisheries are carried out fishing activities within the GSA22.Data for 2007, 2009 and 2010 have not been collected as the National Fisheries Data Collection Programme has yet to be conducted for those years.Regarding shark fisheries and the data collated:In Greece there is no section of the fishing fleet that targets pelagic sharks. Minimal catches (mainly blue sharks) have been observed as by-catches on longliners that target tuna species and swordfish. Shark landings range from 12 to 15 tonnes/year. (13 tonnes had been recorded in the National Fisheries Data Collection Programme for 2008) but they cannot be accurately classified as they are often landed without skin, headless and gutted. Shark discards appear to be negligible. In 2008 zero shark discards were reported.

Italy - In 2009, total production showed a small increase respect to 2008 with a total volume of 234,000 tonnes. The national fleet is characterized by a strong multi-specificity and multi-gear activity. The small-scale fishery (polyvalent passive gears under 6m and 6-12m) is the most important fishery in terms of vessels'number, employment and activity. Polyvalent passive gears under 12m represents 66% of the total active fleets. The small scale fishery accounts for about a quarter of the national value of landings. Italy has always been one of the largest harvesters of swordfish in the Mediterranean. Italy's fleet now fishes in most areas of the Mediterranean, including the Ligurian, Ionian and Adriatic Seas. Swordfish fishing commenced in those seas during the 1960s, initially using longliners.In the mid-1980s large-scale pelagic driftnets became popular. Since 1998, after the enforcement of the regulatory measures for the driftnets, the traditional nets were rejected and the Italian fishermen introduced a smaller driftnet, called ferrettara. This net has a length of 2.5 km, a depth from 18 to 25 m, and a mesh size of 180 mm. All gears targeting large pelagic fish, both longliners and nets, are deployed in the evening and their retrieval begins after midnight. Landings from the Adriatic Sea and the Sicily Channel account for almost two thirds of national production.

Lebanon -The continental shelf is narrow, especially in the South. Bottom grounds are mainly rough with intensive rocky patches, good for stationary demersal gear. The fisheries of Lebanon are classified as small-scale, artisanal, and are traditionally based on bottom stationary gear (trammel nets and longlines), purse seine nets, and beach seines. Fishing operations, with the exception of longlines, are mostly carried out at depths of up to 50 meters. The vessels operate mainly in GSA 27. No Tuna and tuna like catches were reported.

Libya- In 2009, the catches of blue fin tuna amounted 1,081 tonnes were made mainly by the national purse seine fishing fleet and by the longline fleet, respectively 1047.3 t (97%) and 34.4 t (3%).

Malta- In 2009, the Maltese fishing fleet was composed of 2,995 vessels of which 396 vessels (13.2%) and 701 (23.4%) vessels were commercial full-time and part-time vessels respectively.Landings from marine capture fisheries are dominated by bluefin tuna (262 t),swordfish(266 t),and dolphinfish (*Coryphaena hippurus*) (395 t) in decreasing order of importance.Between the months of April and July the market is dominated by landings of bluefin tuna withswordfish being the second most available species. Both these species are targeted by the samemethod that is pelagic drifting long-lines. Landings of dolphinfish occur mainly between the 15August and 31 December mostly by the Fish Aggregating Device (FAD) fishery. The major fishingarea is GSA 15, however the longline fleet and the trawling fleet also operates in neighboring GSAs.In Malta, albacore are not targeted directly but are usually caught as by-catch during the bluefin tuna season and with swordfish from July to September.

Montenegro-Montenegro is part of GSA 18 that shares with Albania on the east coast and with Italy on the west coast. In front of Montenegro is south Adriatic basin with the greatest depth of 1228m. The greatest part of Adriatic shelf is covered with muddy and sandy sediments. Sandy sediments are formed on the coastal area and in the shallow parts of Adriatic shelf, where on greater depths can be found muddy sediment, i.e. mud thatderives from the land. No Tuna and tuna like catches were reported.

Morocco- The fishing of tuna and tuna-like species reached a production of 13,956 tons in 2009, the same level of general catches as in 2008. The major species caught along the Moroccan coasts are bluefin tuna, swordfish, bigeye tuna, yellowfin tuna, albacore, small tunas, and some shark species.The Moroccan driftnet fishery quickly developed in Northern Morocco in the early 1990s involving the ports of Larache, Asilah, Tangiers, Al Hoceima and Nador. In 2005, large-scale driftnets targeting swordfish in the Alboran Sea were still used in Morocco. According to international official sources, Morocco harbors the bulk of this fleet in the Mediterranean. Parallel surveys were made in the main Mediterranean ports and in that of Tangiers, in the Gibraltar Straits, to estimate the total fishing effort. Results showed an active driftnet fleet conservatively estimated at 177 units. Estimated average net length ranges from 6.5 to 7.1 km, depending on the port, though actual figures are suspected to be much higher (12–14 km). Most boats perform driftnet fishing all year round, resulting in very high annual effort levels (Tudela, 2005).

Slovenia- The Slovenian fishing vessels are carrying out fishing activities in the area GSA 17. No Tuna and tuna like catches were reported.

Spain - In 2009, 1755 tons of Bluefin tuna were caught in the Mediterranean Sea, most of which (66%) were caught by Purse seine. The rest correspond to long-liners and other minor gears. The main fishing grounds were Balearic Islands, Alboran Sea and Central Mediterranean.

Albacore was caught in the Mediterranean during 2009 using only surface longlines and troll. 204 tons were landed in the Mediterranean (which represents a 15% decline from the catches taken in 2008) from which 198 t were caught using Longlines. Swordfish landings were 2000 t in the Spanish Mediterranean, from which 95% of the catches corresponds to long-line while minor catches were obtained by traps and trolls. The small tuna catches in Spain are mainly from the Mediterranean Sea. Small tunas are caught using surface gears and Traps.Valeiras et al. (2003) reported that the Alboran Sea is the area of the Western Mediterranean where Spanish fleets targeting swordfish using surface longlines achieve the higher by-catch rates of pelagic sharks (between 78% and 92% of the total by-catch in weight). According to this source the shark species involved in this bycatch are, in this order, *P. glauca*, *I. oxyrinchus* and *A. vulpinus* (Valeiras, de la Serna et al. 2003).

Turkey- During the course of 2009, the total catch of tuna and tuna-like fishes amounted to 8,633 t. In 2009, Turkey’s total catches of bluefin tuna, albacore, Atlantic bonito and swordfish were 665 t, 631 t, 7,036 t, and 301 t, respectively. All bluefin catch was caught by purse seiners, the majority of which have an overall length of 30-50 m and a GRT of 200-300. The fishing operation was conducted intensively off Antalya Bay and in the region between Antalya Gazi Paşa and Cyprus. In the Mediterranean, fisheries were conducted in the region between Cyprus-Turkey and in the Cyprus-Syria region. The highest bluefin tuna catch was obtained in June. There are two main fishing methods, drift-netting and longlining for swordfish in the Turkish Aegean Sea. Swordfish fishery in Turkey has only been carried out in the Aegean and the

Mediterranean seas since swordfish were disappeared about last two decades in the Sea of Marmara and the Black Sea. Currently, the small-scale driftnet fishery is especially carrying out in Sivrice Region, NE Aegean Sea, and some in Fethiye Region, SE Aegean Sea. When not fishing for swordfish most of fishermen are engaged in other coastal fisheries, tourism and farming. In Turkey, targeted albacore fishery started in 2004. In the beginning of this fishery, one boat caught albacore by gillnet as target species. No sharks bycatch are reported for this fishery (Ceyhan et al., 2011). Longline is now dominant fishing method, and there are now four types of longline for swordfish in Turkey. Between 2004 and 2009, high catches of tope shark (*Galeorhinus galeus*)- have been noticed. Averages of 450 t were caught by a directed shark longline fishery while 1,200 t were also caught under unclassified gears. No complementary information has been found on these two fisheries. Seemingly, the tope shark was directly targeted, this species was reported to be caught under longline but also under other unclassified gear but there is no information about the directed sharks' fisheries. In 2003, EU enforced a recommendation prohibiting the use of drift nets in the Mediterranean. Afterwards drifnetting in Turkey was also banned in 2006. Pelagic gillnetting has currently been decreasing due to this banning but many fishermen demonstrated against the prohibition. They have made some modifications in their nets and put some weights and buoys on both sides of the net in order to get out of the scope of the conventional drift net definition, and so, the Turkish fisheries authorities and ICCAT have given a limited permission for traditional pelagic fishery in Turkish seas until July 2011. The fisheries authorities stimulate the transition to other gears such as longline gear (Tokaç et al., 2012). Korean Tuna purse seiners were charted from Turkey operated in the Mediterranean Sea and targeted bluefin tuna in 2004 and 2005.
In spite of its rare consumption in internal market, sharks fishery contributes to Turkey's economy as an export product. They were exported to the other countries as fresh/chilled, frozen, topeshark fillets, dried, salted or in brine products (Dogan, 2006).

Tunisia-Tunisian fisheries are carried out fishing activities within the GSA12, GSA13, GSA14. The tuna and tuna-like species fisheries are among the most important species fished along the Tunisian coast. The fishing gears used to catch tuna are mainly purse seine and surface longline but gillnet are also used. The traps which were the major gear for catching Bluefin tuna and small tunas have been abandoned since 2003. The bluefin tuna purse seiners are active from March to October off the Tunisian coast, mainly in the Gulf of Gabes and close to the Tunisian Lybian border. No data are available on the other fleet concerned by the small tuna fishery.

3.3.2 Bycatch issues at GFCM

The term "bycatch" has several meanings in the different areas and, thus, its use creates considerable confusion depending on the area. Therefore, it seemed appropriate precise the definition of bycatch for the GFCM.

In 2009, the participants of the selectivity workshop of the GFCM reviewed the definition of "bycatch" in the context of the Mediterranean and the Black sea. They recognised that most fishing operations whether they employ towed or fixed gears, catch organisms that are not the primary target. Although there is no actually international standard definition of bycatch, GFCM finally agreed on the following definition:

"The bycatch" is the part of the catch taken together with the [authorised] target species. In a broad context, this includes all non-targeted catch including (by-product), discards, illegal and species of conservation concern.

The management actions agreed in GFCM take into account the outputs from GFCM SAC assessment activities, but also the recommendations and resolutions from GFCM account for other factors (e.g. social and economic). The management recommendations in relation to shark agreed by GFCM are summarized in Table 3.3.2. In this context, ICCAT recommendations are considered and adopted if they can fit to the Mediterranean context. Generally, management mechanisms focus on effort control, with technical measures such as mesh size limits and spatial/seasonal closures (e.g. closed periods for Mediterranean swordfish); which are considered to be appropriate for the Mediterranean multispecies/multigear context. In addition, TACs are used for large pelagics.

Table 3.3.2.- List of the GFCM Recommendations and Resolutions related to the catches , by catches and to the conservation of sharks. GFCM recommendations are binding on its members.

Description	
Recommendation GFCM/36/2012/3 on fisheries management measures for conservation of sharks and rays in the GFCM area PART II -Fisheries management measures • Finning' shall be prohibited; • Beheading and skinning of specimens on board and before landing shall be prohibited. Beheaded and skinned sharks cannot be marketed at the first sale markets after landing; • It shall be prohibited to purchase, offer for sale or sell shark fins which have been removed, retained on board, transhipped or landed in contravention of this Recommendation; • Contracting Parties and Cooperating non-contracting Parties of the GFCM (hereafter referred to as CPCs) shall ensure that sharks are kept on board, ranshipped, landed and marketed at first sale in a way that species are recognizable and identifiable and catches, incidental takings and, whenever appropriate, releases by species can be monitored and recorded. CPCs shall ensure a high protection from fishing activities to elasmobranches species listed in Annex II of the SPA/BD protocol of the Barcelona Convention that must be released unharmed and alive to the extent possible; • Specimens of sharks' species listed in Annex II of the SPA/BD Protocol cannot be retained on board, transhipped, landed, transferred, stored, sold or displayed or offered for sale; • CPCs shall ensure that catches of tope shark (Galeorhinus galeus) taken with bottom-set nets, longlines and in tuna traps shall be promptly released unharmed and alive to the extent possible. PART III - Monitoring, data collection and research CPCs shall ensure that: • information on fishing activities, catch data, incidental taking, release and/or discarding events for sharks species listed either in Annex II or III of the SPA/BD Protocol, must be recorded by the ship-owners in the logbook or equivalent document, in line with requirements of	**GFCM/36/2012/3**

Recommendation GFCM/35/2011/1 establishing the GFCM logbook; • this information must be reported to the national authorities for notification to GFCM Secretariat within the annual national reporting to SAC and through the Task 1; • Any other additional measures are taken to improve data gathering in view of scientific monitoring of the species. • As appropriate, the GFCM and its CPCs should, individually and collectively, engage in capacity building efforts and other research cooperative activities to improve knowledge on sharks and sharks fisheries and to support the effective implementation of this recommendation, including entering into cooperative arrangements with other appropriate international bodies.	
Recommendation GFCM/35/2011/1 Concerning the establishment of a GFCM Logbook, amending Recommendation GFCM/34/2010/1 • Contracting Parties shall require that the masters of fishing vessels more than 15 meters in overall length (LOA) authorized to fish in the GFCM area and registered on the GFCM Record of Vessels shall keep a bound logbook of their operations, indicating particularly quantities of each species caught and kept on board, above 50 kg in live weight, whether the catches are weighed or estimated, the date and geographical positions of such catches and the type of gear(s) used in accordance with the minimum specifications and information set out in Annex 1. • The minimum quantity referred to in paragraph 1 shall be without prejudice to stricter rules implemented by Contracting Parties who may define a lower threshold between 0 and 50 kg in the light of further work to be undertaken under the GFCM framework. • The provisions of the present Recommendation shall not affect more detailed or stricter obligations on the use of logbooks, including on the use of electronic means, adopted and implemented by Contracting Parties. • Contracting Parties are committed to implement this recommendation as from 1st January 2013.	**GFCM/35/2011/1**

ICCAT recommendation [10-06] on Atlantic Shortfin Mako sharks caught in association with fisheries managed by ICCAT:
• CPCs that do not report Task I data for Atlantic shortfin mako sharks, in accordance with SCRS data reporting requirements, shall be prohibited from retaining this species, beginning in 2013 until such data have been received by the ICCAT Secretariat;
• The SCRS shall conduct a stock assessment for shortfin mako sharks in 2012 and advise the Commission on:
    o the annual catch levels of shortfin mako that would support MSY;
    o other appropriate conservation measures for shortfin mako sharks, taking into account species
	GFCM/35/2011/7(b)

GFCM adopted ICCAT recommendation [10-08] on Hammerhead sharks (family Sphyrnidae) caught in association with fisheries managed by ICCAT • Retaining onboard, transshipping, landing, storing, selling, or offering for sale any part or whole carcass of hammerhead sharks of the family *Sphyrnidae* (except for the *Sphyrna tiburo*), shall be prohibited in the Convention area in association with ICCAT fisheries, they should be promptly release unharmed and the number of discards and releases of hammerhead sharks are recorded with indication of status (dead or alive) and reported to ICCAT in accordance with ICCAT data reporting requirements. • Hammerhead sharks that are caught by developing CPCs for local consumption are exempted from the measures, but catch data by species,	**GFCM/35/2011/7(c)**

or at least by genus *Sphryna* (Task I) and, if possible, Task II. CPCs shall take necessary measures to ensure that hammerhead sharks of the family *Sphyrnidae* (except of *Sphyrna tiburo*) will not enter international trade. • CPCs shall, where possible, implement research on hammerhead sharks in the Convention area in order to identify potential nursery areas. Based on this research, CPCs shall consider time and area closures and other measures, as appropriate.	
GFCM adopted ICCAT recommendation [09-07] on the conservation of thresher sharks caught in association with fisheries in the ICCAT convention area: • Retaining onboard, transshipping, landing, storing, selling, or offering for sale any part or whole carcass ofpart or whole carcass of bigeye thresher sharks (*Alopias superciliosus*) in any fishery shall be prohibited in the Convention area in association with ICCAT fisheries, they should be promptly release unharmed. No directed fishery for species of thresher sharks of the genus *Alopias spp*. are allowed. • CPCs shall require the collection and submission of Task I and Task II data for *Alopias spp* other than *A superciliosus* in accordance with ICCAT data reporting requirements. The number of discards and releases ofA. superciliosus must be recorded with indication of status (dead or alive) and reported to ICCAT inaccordance with ICCAT data reporting requirements. • CPCs shall, implement research on thresher sharks of the species *Alopias spp* in the Convention area in order to identify potential nursery areas. Based on this research, CPCs shall consider time and area closures and other measures, as appropriate.	**GFCM/34/2010/4c)**
On the implementation of the GFCM Task 1 statistical matrix.(repealing Resolution GFCM/31/2007/1): • The GFCM Task 1 statistical matrix (Annex 3) is an adequate tool to communicate in standardized format relevant information for fisheries management to the GFCM Secretary with aview to develop the GFCM database. • Members and Cooperating non-members shall submit to the GFCM Secretary the complete (Task 1.1 (capacity by Fleet Segment). Task 1.2 (fishing activity descriptors and resources exploited by Operational Units). Task 1.3 (economic data by Fleet Segment) and Task 1.4 (catch and effort by gear and species) for the first time byFebruary 2010 at the latest, and subsequently update the relevant data by transmissions to the GFCMSecretariat not later than May each calendar year, and in accordance with appropriate data submissionstandards and protocols to be set by the Secretariat.	**GFCM/33/2009/3**
Recommendation [05-05] to amend the Recommendation [04-10] concerning the conservation of Sharks caught in association with fisheries managed by ICCAT (GFCM/2006/8 (B)) • CPCs shall annually report Task I and Task II data for catches of sharks, in accordance with ICCAT data reporting procedures, including available historical data. • CPCs shall take the necessary measures to require that their fishermen fully utilize their entire catches of sharks. Vessels should not have onboard fins that total more than 5% of the weight of sharks onboard, up to the first point of landing. In fisheries that are not directed at sharks, CPCs shall encourage the release of live sharks, especially juveniles, to the extent possible, that are caught incidentally and are not used for food and/or subsistence. • CPCs shall, where possible, undertake research to identify ways to make fishing gears more selective and hall, conduct research to identify shark nursery areas.	**GFCM/2006/8**

Where RFMOs and/or countries have overlapping jurisdictions, or are involved in managing the same fisheries, there is a clear need to have clear lines of communication and effective and timely data sharing to ensure proper assessment and management controls are in place. This is the case for sharks species inhabiting the Mediterranean and Atlantic water and managed by GFCM, ICCAT and the Barcelona Convention; which is appropriate for both scientific and management issues.

For the scientific part: the communication between GFCM and ICCAT should be improved to account for the fishery statistics of pelagic sharks (or other sharks) that are caught by fleets managed in ICCAT and GFCM; which is currently the case. For the management part, it is recognized that the relationship between different bodies it is a legal task and, therefore, any recommendation and/or resolution adopted by one organization needs to be incorporated in other organization and viceversa) as well as in the UE legislation. For example, shortfin mako, porbeagle, scalloped hammerhead, great hammerhead and smooth hammerhead have been included in Annex II of Barcelona Convention. Then, those species retention has been forbidden in the fisheries managed by GFCM (Recommendation GFCM/36/2012/3) but for some of those species included in the Annex II of Barcelona there is no ICCAT recommendation to prohibit retaining on board (i.e. shortfin mako and porbeagle).

Data collection

Logbook: A standardised logbook structure has been developed. EU countries have Data Collection Format regulations, adopted by some other countries (e.g. Turkey). Other countries collect information through logbooks for sizes of vessel (e.g. >15m LOA), or for key species, while species caught by artisanal fleet may be sampled at port. Reporting for tuna is formalised through ICCAT. Surveys e.g. MEDITS and acoustic surveys (e.g. MEDIAS) being performed using standard protocols across the Mediterranean through the regional projects and workshops under GFCM.

IUU: At its 32nd session (Feb 2008), GFCM adopted a binding Recommendation on a Regional Scheme on Port States Measures to Combat Illegal, Unreported and Unregulated (IUU) Fishing, and established a Regional Record of Fishing Vessels. Port state controls in place and list of IUU vessels developed. A fleet register is to be developed and produced by end 2010.

VMS: VMS minimum standards recommendation developed for vessels on GFCM vessel register >15m in length to have in place VMS within 2010, while many nations already have this in place (see Compliance Committee 2009 report). These data are not yet routinely used within science.

Observer programmes: Observers may be present on tuna vessels through ICCAT programmes, but seldom on the smaller scale vessels or vessels directly managed by GFCM. Scientific monitoring through standardised surveys (e.g. MEDITS)are beginning to be used and underpin stock assessments.

GFCM recognizes various IPOAs; including the UNEP Mediterranean Action Plan on seabirds, and the bycatch and special protected areas. Moreover, the General Fisheries Commission for the Mediterranean (GFCM) includes the implementation of the FAO-IPOA-Sharks as a high priority on its agenda (UNEP MAP RAC/SPA 2003), in particular regarding the collection of information on the status of shark and ray stocks. There is a focus to improve data collection analysis and assessment skills within the Mediterranean, with training generally undertaken through FAO regional projects and the SCSA. In this sense, effort has been devoted to:

- Increase cooperation and collaboration in data collection and assessments due to the share nature of the populations.
- Effectiveness of technical measures for fisheries management to reduce catch of juveniles;
- Increase knowledge of the social and economic issues of fishing;
- Implement an ecosystem approach to management, noting the particular conditions within the Mediterranean.

All the European countries have adopted EU Plan of Action (EUPOA Sharks) by the European Commission in February 2009. The EUPOA Sharks describes EC shark fisheries, shark markets in the EU and the legislative framework applicable to sharks in the EU.

An Action Plan for the Conservation of Cartilaginous Fishes in the Mediterranean Sea, produced by UNEP, encourages the development of NPOAs throughout the region (UNEP MAP RAC/SPA 2003) (see Table 3.3.3).

Other global and/or regional initiatives for elasmobranch conservation in the Mediterranean are summarized below:

Convention on the Conservation of European Wildlife and Natural Habitats (Bern Convention, 1982) which aims to ensure conservation of wild flora and fauna species and their habitats. Special attention is given to endangered and vulnerable species, including endangered and vulnerable migratory species specified in appendices. The Bern Convention covers most of the natural heritage of the European continent and extends to some States of Africa.

The basking shark *Cetorhinus maximus* and the white shark *Carcharodon carcharias* were listed in Appendix II as strictly protected species.

The following Mediterranean species were listed in Appendices III as protected fauna species:

- **Lamnidae:** *Isurus oxyrinchus /Lamna nasus;*
- **Carcharhinidae:** *Prionace glauca;*
- **Squatinidae:** *Squatina squatina;*
- **Rajidae:** *Raja alba.*

Convention for the Protection of the Mediterranean Sea against Pollution (Barcelona Convention, 1976), Protocol on Specially Protected Areas and Biological Diversity (SPA &BD, 1995), which has come into force in December 1999, lists the basking shark and the great white shark along with the devil ray as Endangered or Threatened species (Appendix II). Parties signing the Protocol must ensure “the maximum protection possible and the recovery of these species”. This Protocol recommends that the exploitation of five other species be regulated (Appendix III): *Isurus oxyrinchus*, *Lamna nasus*, *Prionace glauca*, *Squatina squatina* and *Raja alba*.

IUCN Red List of Threatened Species is a widely recognised system for classifying species at risk of global extinction. It has no legal standing, but is frequently used by governments and environmental institutions to set priorities and conservation actions.

IUCN Shark Specialist Group (SSG) was established by IUCN, as part of its Species Survival Commission in 1991. The SSG was formed to assess and address the conservation needs of sharks. The SSG is currently part way through a programme to complete global assessments for all chondrichthyan species.

Mediterranean Large Elasmobranchs Monitoring (MEDLEM) is a monitoring programme on the captures and sightings of the large cartilaginous fishes occurring in the Mediterranean Sea. This programme directly links up with the FAO IPOA–SHARKS. A dedicated database is maintained and information on incidental catches of protected species and on bycatch of large migratory sharks in the commercial fisheries are continuously updated. Seventeen great cartilaginous fishes are actually concerned by the programme. The definition of "great cartilaginous fishes" is referred to sharks with total length bigger than 100 cm or batoid fishes (rays and skates) with disc width bigger than 150 cm. Another important aspect of this project is the collection of scientific papers related to elasmobranchs in the Mediterranean area. About 400 bibliographic references are currently listed in a specific set of the project database.

National species protection status, Table 3.3.3 summarises the answers provided to a short questionnaire circulated in March 2008, and further updated in April 2009, asking Parties to the Barcelona Protocol to provide a brief update on steps taken at national level to implement the Action Plan for the Conservation of Cartilaginous Fishes (Chondrichthyans) in the Mediterranean Sea (UNEP-MAP RAC/SPA, 2003).

Table 3.3.3- Progress on the development and implementation of NPOAs for sharks (Source: UNEP, 2009).

Country	**Species protection status (name of legal instrument and competent ministry)?**	**Progress on data deficient species**	**Regulation of shark finning?**	**Habitat protection/MPAs to support shark conservation?**	**Coverage of sharks in fisheries management programmes?**	**Monitoring of shark fisheries and bycatch?**	**Education and public awareness?**
European Union	Catch, retention on board, transhipment and landing prohibited since 2007 for *Cetorhinus maximus* and *Carchadon carcharias*.		Regulation EC n°1185/2003 bans removal of fins followed by discard of the carcass at sea. Finning with retention of carcasses on board is permitted in accordance with the provisions of Regulation.	None.	European Union Action Plan for Sharks published in February 2009. Some general provisions already contribute to reduction of bycatch (e.g. ban on driftnets, more selective fishing gear) and overfishing (eg closed seasons). The TAC for deep-sea sharks will be reduced to zero by 2010.	Covered by the European Union Action Plan.	
Egypt	-	-	-	-	-	-	-
France	-	-	-	-	-	-	-
Greece	Protected species are the ones that are mentioned in CITES Convention (competent ministry – Ministry of Rural Development and Food), Bern convention and		Regulation EC n°1185/2003 bans removal of fins followed by discard of the carcass at sea. According to the Ministry of Merchant Marine that controls the implementation	There are no MPAs for shark conservation.	Fisheries management programmes do not refer specifically to shark fishes because they are not commercial species. Driftnets are prohibited, contributing to reduction of bycatch .	Fisheries data Including bycatch have been collected for some years under responsibility of Ministry of Rural Development and Food. In the frame of the	No actions for the time being.

	SPA – Biodiversity protocol of Barcelona Convention (competent ministry – Min. For the Environment, Physical planning and Public Works)		of the Regulation, the national fishing fleet does not perform finning.			application of Council Regulation (EC) No 199/2008 a new project for the years 2009-2010 will be procured. Research and data collection is also carried out by individual scientists	
Israel	All Cartilaginous Fishes (Class Elasmobranchii, including Order Sellachii and Order Batoidae) are being protected from any type of harm or damage at the entire Israeli water region. This inclusive protection is given to sharks being Cartilaginous Fishes declared as a protected natural value (2005	No quantitativ e data and limited capacity for this taxonomic group	No (no fining activities).	Currently, all organisms are declared protected within the borders of Israeli marine nature reserves (6) and Marine Protected Areas (2 Mediterranean Sea Reserves"). Commercial fishing of any species or other harmful activities is forbidden at those areas. Critical areas for sharks were not determined yet, and there is no specific declaration of	Sharks should not be fished under any occasion, and therefore are not included in any management plan.	no	Not on a regular bases. The issue is being widely exposed and discussed by the Media upon targeted hunting of Cartilaginous fishes or massive by catch. Protective legislation is presented to the public on these occasions.

	declaration within the legislative framework of National Parks, Nature Reserves and National Monuments 1998 – The Ministry of Environmental Protection).			MPAs for the sake of sharks conservation.			
Italy	Applies to species listed for strict protection under Barcelona Protocol, Bern Convention and in CITES Appendices.	Data lacking for *Sphyrna* spp. and *Rhinobatos* spp. Stock assessment under way for *R.polystigma* based on data from trawl surveys	No finning permits have been granted pursuant to EC Regulation n°1185/2003	No legal protection for critical habitats though these have been identified for some species (mating, spawning and nursery grounds for *Raja asterias*, *Scyliorhinus canicula*, *Galeus melastomus*, *Etmopterus spinax*, etc.). The trilateral Pelagos Sanctuary could have benefits for pelagic sharks.	Pending. The final report for an Italian Action Plan was produced mid 2007 by ICRAM with the support of the Ministry of the Environment and Sea (MATTM).	Yes, through MEDITS, GRUND (assessment of demersal resources in N.Thyrrenian/ Ligurian Seas, and MEDLEM.	Some initiatives targeted at public, students and other stakeholders but no overall EPA plan.
Lebanon	no	no	-	-	-	-	-
Lybia	-	-	-	-	-	-	-
Malta	Strict protection for *Carcharodon*	All species in Maltese waters	The national fishing fleet does not perform	Critical habitats have not yet been identified.	No management programmes covering shark species. A Fleet	Yes, under the Malta Centre for Fisheries Science,	No but under consideration by VAFD. Will involve

	carcharias *Cetorhinus maximus* *Mobula mobular* (Sch.VI).14 species listed in Sch.VIII (species of national interest whose taking in the wild and exploitation may be subject to management measures) *Alopias vulpinus* *Carcharhinus brevipinna* *Carcharhinus limbatus* *Carcharhinus plumbeus* *Carcharias taurus* *Galeorhinus galeus* *Hexanchus griseus* *Isurus oxyrinchus* *Lamna nasus* *Leucoraja melitensis* *Prionace glauca* *Pristis pristis* *Rostroraja alba* *Squatina squatina*. Protection conferred	classified as DD. Nature Protection Unit (Environment & Planning Authority) commissioned study and associated database *Threatened Fish of the Maltese Islands* (ADI & EcoServ, 2006).	finning. No special permits have been issued pursuant to EC Regulation n° 1185/2003	Some mapping of nursery areas and spawning ground for some demersal sharks being carried out by the Veterinary Affairs &Fisheries Division (VAFD). Legislation provides for creation of Marine Conservation Areas which can support protection of nursery grounds and protection of juveniles.	Management programme will be set up to efficiently manage the national fishing fleet on the basis of the gear utilised. This will indirectly assist in proper management of bycatch e.g. through more selective use of gear in surface longlining and bottom trawling. Fisheries enforcement comes under the responsibility of the Armed Forces (limited capacity because of other responsibilities). Onboard fisheries inspections only carried on in waters under national jurisdiction.	conducted by VAFD. Two data collection programmes/ surveys (MEDITS and MEDLEM) plus collection programmes for Fisheries Landing Data	fishers, the Armed Forces of (Malta Maritime Squadron) due to their involvement in fisheries enforcement) and the general public.

	through Flora, Fauna and Natural Habitats Regulations (311/2006) issued under the Environment Protection Act (Malta Environment and Planning Authority).						
Monaco	Protection is mainly delivered through legislation for implementation of CITES (Ordonnance Souveraine n° 67 du 23 mai 2005, Journal de Monaco du 26 mai 2006 n° 7757).	no	no	Two MPAs: Larvotto (Ordonnance Souveraine du 25 avril 1978) and Spélugues (Ordonnance Souveraine du 29 août 1986) as well as the trilateral Pelagos Sanctuary. Not established with reference to sharks	Not applicable as there are no fisheries in Monaco.	There is no monitoring system as there are no fisheries.	no
Montenegro	Strict protection for *Carcharodon carcharias* and *Lamna nasus* under the Decision on Endangered or Threatened Species of	No available data or capacity for this taxonomic group		Ministry of Agriculture, Forestry and Water Management has jurisdiction over fisheries. The new Law on Marine Fisheries regulates commercial fishing	Nothing specific for sharks, though marine fisheries management plan is under preparation. National Strategy for Sustainable Development prepared in 2006: targets include protecting at least	none	Nothing specific but members of Institute for Marine Biology attend training courses, seminars and workshops

	Flora and Fauna (2006) and CITES implementation legislation (Decision on control list of import, export and transit: Official Gazette RME, no. 28/06).			and mariculture and provides for protection of marine biodiversity. EU support to Montenegro focused on strengthening administrative structures to ensure effective implementation of fisheries policy	10% of the coastal zone by 2009. National ICZM Strategy being finalised.		
Morocco							
Slovenia	Strict protection for *Carcharodon carcharias* and *Cetorhinus maximus* (covers harm, disturbance, poisoning, killing, hunting or keeping in captivity) under Decree on Protected Wild Fauna, Official Bulletin 46/2004 (Ministry of Environment and Physical Planning)	Some data now available on species found in Slovenian waters and their status is being evaluated.	Finning not specifically mentioned but falls under the general protection regulations	No legal protection of shark critical habitats or proper fishery management programmes	Fisheries management programmes do not refer specifically to shark fishes. Bycatch is the major problem. An Action Plan is to be drafted in 2009.	No mandatory monitoring but ongoing research and data collection carried out by the Marine Biological Station.	none
Spain	None		Permitted only		Integrated national		on Sharks Sustainable

			under special permit in accordance with EC Regulation n° 1185/2003		management plan for the conservation of the fisheries resources in the Mediterranean Sea (*Order APA 79/2006*, Ministry of Agriculture, Fisheries and Food). No specific provisions on sharks but general provisions for closed seasons for trawling and other fisheries; ban on bottom trawling below 1000m depth; protection of critical vulnerable habitats e.g. seagrasses, maerl beds, coral reefs.		Fisheries (Feb 2008) Jointly organised by Fisheries Department and the Spanish Fisheries Alliance with Stakeholder participation. Proposals include rapid production of species identification brochure.
Syria		Yes for *Rhinobathos rhinobathos*	no	There are critical habitats in the Gulf of Gabès but these are not legally protected.	Some. It is prohibited to fish rays and skates less than 40 cm and torpedos below 20 cm in length, measured from tip of snout to start of tail (Decree 28.9.1995, Minister of Agriculture)	Yes. Monitoring covers many species (research projects plus the MEDLEM framework.	Limited. Few actions with fishers
Turkey	Strict protection for *Carcharhinus plumbeus* and *Cetorhinus maximus* (covers harvesting and trade) under Circulars on	No specific research on population dynamics or migratory routes.	Not regulated, as finning does not take place in Turkish waters	Mating and breeding habitats of *Carcharhinus plumbeus* in the Bay of Boncuk are protected by the Environmental Protection Agency for Special Areas	No programmes specifically for sharks as there are no directed fisheries.	Determining the occurrence and distribution patterns of *C.plumbeus* within the survey area, using in situ observation techniques,	Several brochures have been prepared and distributed for public awareness, in addition to the book entitled “Conservation and Monitoring Project of Sandbar Sharks (*Carcharhinu*

	Fisheries, (related to Fisheries Law:1380) Ministry of Agriculture and Rural Affairs.					Annual survey (Two Months) in Bay of Boncuk for *Carcharhinus plumbeus.* Determining the possible threats on local sand- bar shark opulation, Processing all the observation and threat data using GIS (global nformation system) on 1/25000 scale maps,	*s plumbeus*) in Boncuk Bay, Gökova Special Environment al Protection area

3.3.3 Methodology and data used

The major fisheries (country/fleet/gear) targeting tunas and sharks in the Mediterranean Sea have been identified using information available on the ICCAT and GFCM websites. In Addition, all the relevant documents, publications and working documents, which could provide complementary information on all the fisheries catching a large amount of tunas and sharks, have been collated

Two different types of data were consulted: (1) the databases available on the ICCAT website (http://www.iccat.es) and (2) the Task 1 Statistical Bulletin available on the GFCM Website (http://www.gfcm.org). There is no web-based data access facility available at the moment to extract the data.

The Capture production statistics by country or areas, species item, and GFCM statistical división are available from the FAO Production Statistics (Fishery Statistical Collection) can be extrated online using FishStatJ - software for fishery statistical time series.

The ICCAT data were used to carry out the estimates, for more details see general section on Methodology and data used.

3.3.4 Historical catch and effort data

It seems essential to have a good understanding of the fishing effort and of the fleet composition in order to understand the scale of catch. Fleet structure, especially numbers of units, activity patterns and gear types used, are fundamental elements that will allow proper stratification of fleet for sampling/extrapolation. Reliable effort statistics are also necessary.

The GFCM Task 1 bulletin contains information derived from data submitted to the GFCM Secretariat within the framework of Recommendation GFCM/33/2009/3 and in accordance with the established data transmission protocols and standards. It provides a synopsis of both qualitative and quantitative information by Fleet Segment and Operational Unit for each GFCM Geographical Sub-Area (GSA). Information (where available) on the activity of Operational Units, particularly in relation to fishing periods, specific gear used, target species and catches is also included. In general, reporting countries have, so far, submitted data for Task 1.1 (capacity by Fleet Segment), Task 1.2 (fishing activity descriptors and resources exploited by Operational Units), Task 1.3 (economic data by Fleet Segment) and Task 1.4 (catch and effort by gear and species); albeit at different levels of resolution and completeness. For the time being, the GFCM Statistical Bulletin as overall statistical report/publication is the only way for the general public to access the GFCM Task 1 data. A web-based data access facility is going to be developed in the near future, in compliance with the resolution GFCM/35/2011/2 on data confidentiality policy and procedures. For these reasons, the ICCAT databses were used to carry out the first estimates.

Earlier reviews of the shark database resulted in recommendations to improve data reporting on shark catches. Though global statistics on shark catches included in the database have improved, they are still insufficient to permit the Committee to provide quantitative advice on stock status with sufficient precision to guide fishery management toward optimal harvest levels.

The collection and reporting of catches of sharks caught in association with species managed by ICCAT (tuna and tuna-like species) has been very uneven over time. The information on the bycatch of sharks gathered in the ICCAT database is thought, for this reason, to be very incomplete. The catches of sharks, when reported, are thought to represent simply the catches of these species that are retained on board. They refer, in many cases, to dressed weights and no indication is given on the type of processing that the different specimens underwent. The weights or numbers of sharks for which only the fins were kept on board are rarely recorded in the vessels‟ logbooks. This makes it really difficult any attempt to estimate the total catches of sharks in the Atlantic Ocean. The major sharks (blueshark, shortfin mako shark, and porbeagle) shark reporting is considered to be better than other sharks, however, still there are inconsistencies in the reporting of the fishery statistics of those shark species.

According to this document:

- **Task I nominal** catch data (landings and discards by species, stock, gear, fleets and year) is the basic information used in all the stock assessments. The availability of timely data is essential for the SCRS work. The deadline for submission of Task I varied according to the species reviewed by the SCRS, and for major shark species the deadline is 26th of May (data until 2 previous years). For the 12 major ICCAT species (nine tuna and tuna-like species and three sharks species), 43 flag States reported Task I before the deadline(s), 2 flag States reported Task I after the deadline(s), and 22 flag States have not reported Task I as of September 14, 2012. Details by species (taking into account the respective deadlines of the inter-sessional meetings) and by flag State are presented in Table 3.2.2.
- **Task II catch and effort and size sampling** are more detailed in terms of time and geographic area information, and often they reflect partial coverage (or sampling) compared to Task I statistics. Task II information is the main source of data used by the Secretariat to estimate important datasets to be used in the assessment of the species. During the reporting period, the Secretariat received Task II catch and effort data from 42 flag States (40 on time and 2 after the deadline). Twenty-three (23) flag States did not report Task II catch and effort. Table 3.2.3 presents the detailed report card for Task II catch and effort statistics. There has been an increase in the number of species reported in the Task II data, particularly pelagic shark species as part of the catch composition in recent years. However, the Secretariat reiterates to the CPCs that Task II catch-effort statistics require submitting all species caught (target and non-target fish species), and effort units, with time (month) and area strata as detailed as possible (LL: 5°x5° squares; other gears: 1°x1° squares).

The first investigation of the Catch & Effort Data Base (Task II) showed that effort data were partially reported by few fleets. Globally, the effort statistics are thought poor quality for most of the fleets for which long catches series are available. ICCAT also points out that:

- The Task II database is comprised of data from many sources that are compiled using different sampling and statistical procedures.
- The Task II catch and effort samples rarely coincide with total catches or total nominal fishing effort.

Fishery data availability by countries

The preliminary investigations allow gathering the total tuna and sharks landings by fisheries, and any fisheries actually targeting sharks. Table 3.3.4 gives the available information on tuna fishing in the Mediterranean and shows that in the entire region, all fisheries combined have produced around an annual average of 41,000 tonnes during 2000-2010. Table 3.3.12 summarizes the data availability for target and sharks catches by Country based on ICCAT database.

Table 3.3.4.- Major tuna landings by gear combined between 2000 and 2010 in the Mediterranean and Black Seas. (Sources: ICCAT).

Gear group	Gear Code	Total tonnes (2000-2010)	%
Purse seine	PS	187,032	42.4%
Longline	LL	168,953	38.3%
Unclassified: Gears not reported	OTH	43,480	9.9%
Gillnet: Drift net	GN	34,422	7.8%
Handline	HL	6,388	1.4%
Baitboat	BB	225	0.1%
Surface fisheries unclassified	SURF	512	0.1%
Trammel net	TN	66	0.0%
Trawl	TW	10	0.0%
TOTAL		441,091	

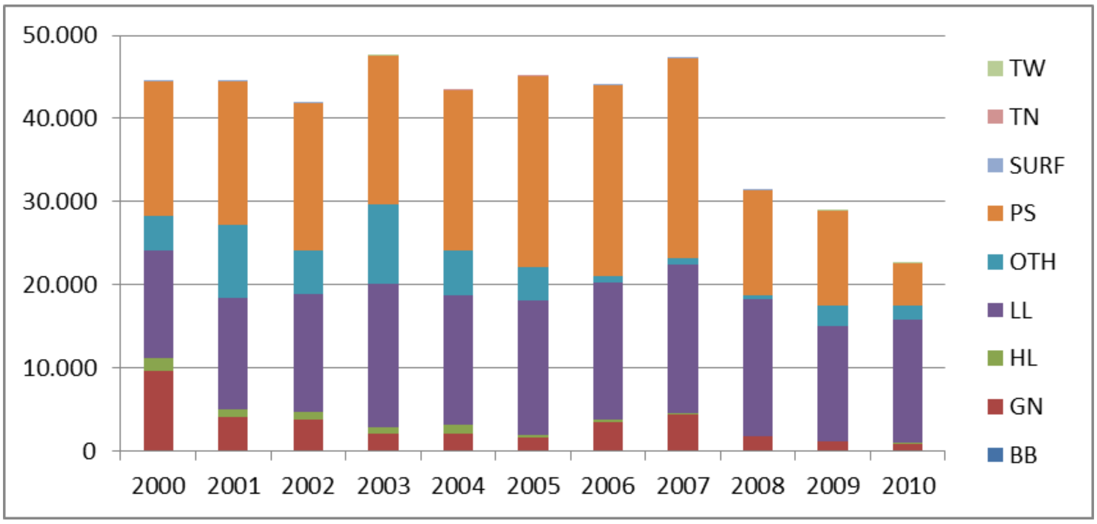


Figure 3.3.1.- Landings of major tuna species (tonnes) per gear between 2000 and 2010: Purse seine (PS), Longline (LL) , Gillnet: Drift net (GN), OTH (Unclassified: Gears not reported), Handline (HL) Surface fisheries unclassified (SURF), Baitboat (BB) Trammel net (TN), Trawl (TW) in the Mediterranean and Black Seas. (Source: ICCAT).

Major tuna species (Table 3.3.3, Figure 3.3.1) are caught mainly under purse seiner (42.4%) and longlines (38.3%) with remaining catches recorded under other gears (9.9%) and gillnets (7.8%). The catches of major tuna species steadily decreased since

2007, the year in which a peak of 47,400 tonnes for these species was recorded. This drop in catches id explained by the drop in fishing effort and catch of the purse seine fishery targeting Bluefin tuna.

Sharks catches

All fisheries combined targeting tuna species declared an annual average around 100 tonnes of major sharks and 460 tonnes of other sharks during the period 2000-2010. On the basis of the available information, the landings of sharks have dramatically increased since 2003 (Figure 3.3.2). The landings averaged around 825 tonnes between 2004 and 2010 and had peaked at around 1,000 tonnes in 2007 and 2009. It seems also there is one longline fishery directly targeting *Galeorhinus galeus* in Turkey which landed around yearly around 550 tonnes between 2006 and 2009. In addition, 458 t in 2004 and 734 t in 2005 (around 1,200 tonnes) of this species had been also landed in this country but the type of gear was not identified.

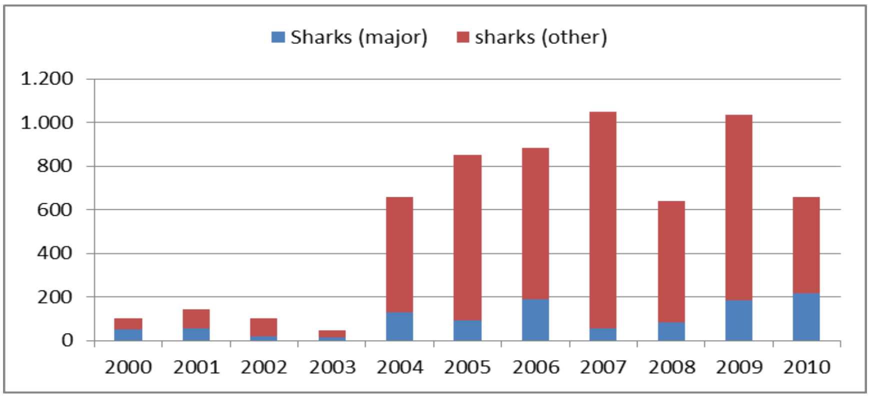


Figure 3.3.2.- Landings of major sharks (blueshark, shortfin mako shark, and porbeagle) as well as other sharks during 2000-2010 in the Mediterranean and Black Seas. (Sources: ICCAT).

Table 3.3.5 below shows the sharks species or group of species landed in the Mediterranean and Black Seas from ICCAT database. The accumulated catches for 2000–2010 of the species of concern to the study makes up 77% out of the total catches of sharks recorded with an amount of 4,776 tonnes. Most of the catches of sharks are available by species, only 34 tonnes are declared under group of species (*Alopias* spp , Carcharhinidae, *Sphyrna* spp, Pelagic Sharks nei).

Table 3.3.5.- Landings of sharks per species or groups of species in the Mediterranean and Black Seas over the period 2000-2010 (Sources: ICCAT).

Species	**Name**	**Total (in tonnes)**	**Total of species or groups of Concern to the study (in tonnes)**
GAG	*Galeorhinus galeus*	3,392.8	3,392.8
BSH	*Prionace glauca*	1,026.7	1,026.7
SYC	*Scyliorhinus canicula*	460.2	
SHX	*Squaliformes*	277.6	
DGS	*Squalus acanthias*	223.8	
WSH	*Carcharodon carcharias*	177.3	177.3
DGX	*Squalidae*	147.2	
DGZ	*Squalus spp*	140.6	
ALV	*Alopias vulpinus*	69.7	69.7
SBL	*Hexanchus griseus*	49.6	

SMA	*Isurus oxyrinchus*	48.8	48.8
SMD	*Mustelus mustelus*	34.7	
THR	*Alopias spp*	31.0	31.0
SHO	*Galeus melastomus*	16.2	
DGH	*Squalidae, Scyliorhinidae*	13.2	
POR	*Lamna nasus*	10.5	10.5
GUP	*Centrophorus granulosus*	10.1	
OCS	*Carcharhinus longimanus*	8.1	8.1
GAU	*Galeus spp*	6.7	
BTH	*Alopias superciliosus*	4.6	4.6
SDV	*Mustelus spp*	3.6	
SCL	*Scyliorhinus spp*	2.8	
SYT	*Scyliorhinus stellaris*	2.3	
RSK	*Carcharhinidae*	2.3	2.3
SYX	*Scyliorhinidae*	2.3	
BRO	*Carcharhinus brachyurus*	1.6	1.6
SPZ	*Sphyrna zygaena*	1.4	1.4
SDS	*Mustelus asterias*	1.2	
SCK	*Dalatias licha*	0.9	
SPN	*Sphyrna spp*	0.4	0.4
PXX	*Pelagic Sharks nei*	0.4	0.4
CCP	*Carcharhinus plumbeus*	0.3	0.3
ASK	*Squatinidae*	0.2	
CPL	*Centrophorus lusitanicus*	0.2	
SYR	*Scymnodon ringens*	0.2	
AGN	*Squatina squatina*	0.1	
CYO	*Centroscymnus coelolepis*	0.1	
SOR	*Somniosus rostratus*	0.1	
GUQ	*Centrophorus squamosus*	0.1	
DCA	*Deania calcea*	0	
MSK	*Lamnidae*	0	
SDP	*Mustelus schmitti*	0	
ETR	*Etmopterus princeps*	0	
Total		**6,170**	**4,775.9**

Major countries involved

Among the 143 fisheries identified reporting tuna and tuna-like species to ICCAT, 36 have been declaring sharks and only 2 fleets have declared every year during the whole period (the Spanish shark longline fleet and the Maltese longline fleet). Sixteen countries (92 fleets) need to ensure that they meet the shark reporting requirements of the ICCAT. According to the total catch available in the ICCAT database (table 3.3.5), in the Mediterranean and the Black Seas in the last decade,6,170 tonnes of sharks were landed, the largest shark catches have been declared by Turkey (3,387 tonnes), followed by EC-Italia (1,418 tonnes), EC-Malta (305 tonnes), EC-Spain (286), EC-France (224 tonnes), Morocco (207 tonnes) and EC-Portugal (171 tonnes). Although the catches are disaggregated by speices, these need to be investigated in greater depth due to the possible misidentification of species, particularly in the Southern Mediterranean countries.

Table 3.3.6.- Sharks landings per species or groups of species (total and 18 investigated sharks species) by country between 2000 and 2010 in the Mediterranean and Black Seas. (Sources: ICCAT).

Country	Total sharks	Studied sharks species
TURKEY	3,387	3,387
ITALY	1,418	886
MALTA	305	13
SPAIN	286	247
FRANCE	224	38
MOROCCO	207	0
PORTUGAL	171	171
BULGARIA	77	0
CYPRUS	73	27
LIBYA	12	0
JAPAN	8	7
PSE-PSE-GAZA.ST	2	0
Total	**6,170**	**4,776**

The catch of the investigated sharks species declared in the Mediterranean Sea (4,776 t) account for 1.1 % of the Major tuna (441,091 t) reported to ICCAT for the Mediterranean Sea.

Information on the major gears used to target tuna like species in the Mediterranean Sea

- ✓ *Longlines*

Several types of longlines are used in the Mediterranean. Depending on the species targeted, either demersal or pelagic, there are respectively bottom longline and surface longline. The surface longlines targets, according to the hook size and immersion depth, mainly swordfish (*Xiphias gladius*), albacore (*Thunnus alalunga*) and Bluefin tuna (*Thunnus thynnus*). These lines generate significant bycatch of sharks.

Home-based longline (LLHB): The length of traditional surface longlines targeting swordfish is variable, ranging from 37 to 65 km. The main line hangs from floats and information recorded by depth sensors indicates that the average depth of surface hooks is 30 m (maximum depth 50 m). The hooks used are J-shaped Mustad number 2 (approximately 7.5 × 2.5 cm), usually baited with mackerel (*Scomber sp*.) and squid (Illex sp.). This gear is used throughout the year.

American longline (LLAM). Hydraulically-operated monofilament: Llongline reel (commonly known as the "American roller") is a type of gear imported from the Italian and American long-liners in the early 2000s (Báez et al. 2006). Unlike the traditional longline, it employs a hydraulic reel to pick up the mainline, which is often placed at the stern of the boat. Monofilament longlines reach 90 to 100 km in length with fewer hooks than LLHB, implying a greater distance between each hook. Fishing depth is greater, with the deepest hooks working at 70 m below the surface. This gear is used throughout the year.

Japanese longline (LLJAP): This is a monofilament longline used exclusively during the months of May, June and the first half of July, which is the period when bluefin tuna enter the Mediterranean to breed. The differences between this gear and the swordfish monofilament longline are that the fishing depth is greater, the bait is almost always squid (Illex sp.) larger than 500 g, and the gear remains in use for periods of 24 hours. LLJAP typically uses a C-shaped hook.

Longline targeting albacore (LLALB): This is the shallowest longline gear. Both the size of the hook and the thickness and length of the fishing lines are less than other longlines.

Semipelagic longline (LLSP, not included in ICCAT codes): This is a hydraulically-operated monofilament longline reel (commonly known as the “American roller”). Unlike the LLAM, it includes weights and buoys so that

Very deep longline targeting swordfish (LLVDSWO, not included in ICCAT codes): a significant change in fishing practices over the survey years, as the longline fishery switched from surface (10–100 m) to mid-water (100–500 m) depth and from 11 h to 25–30 h soak time. These modifications in fishing operations, which result in an increase and redistribution of the effort, were motivated by a drastic decrease in the swordfish catches made with the traditional surface longline. They have modified the fleet structure, catch species composition and size of the target species (Cambiè et al., 2013).

At least 12 species of sharks (*Prionace glauca*, *Isurus oxyrinchus*, *Alopias vulpinus*, *Galeorhinus galeus*, *Lamna nasus*, *Alopias superciliosus*, *Sphyrna zygaena*, *Hexanchus griseus*, *Carcharinus plumbeus*, *Squalus blainvillei*, *Mustelus mustelus and Cetorhinus maximus*) are affected by surface longline (Megalofonou et al., 2005a, Megalofonou et al., 2005b, Di Natale, 1998). In addition, bycatch of young white shark (*Carcharodon carcharias*), *Dasyatis violacea* and *Mobula mobular* are also reported in longline fisheries in the Mediterranean (Peristeraki et al., 2005, Garibaldi, 2006, Bradai et al., 2012).

Throughout the whole Mediterranean, shark by-catches are generally low if compared with those obtained in the adjacent Atlantic waters. Swordfish longline present the highest number of by-catches, but, except in the Alboran Sea, percentage of sharks caught in relation to the target species is very low.

Everywhere CPUE values show a great variability, depending on species, year, gear and fishing areas, but there is not a definite and clear trend (Buencuerpo et al., 1998, Garibaldi, 2006, Megalofonou et al., 2005a).

- ✓ *Driftnes*

A driftnet is a net held near the sea surface by floats and drifting with the current. It is most often attached only to the fishing vessel.

The characteristics of Italian driftnets vary considerably depending on the target species. In general, there are two main types of driftnets, differentiated by current Italian legislation:

- ✓ Spadara and alalungara: used to catch large pelagic species, mainly swordfish (Xiphias gladius) and tunas (Thunnus spp.), with a mesh size larger than 18 cm.
- ✓ Ferrettara: with a mesh size smaller than 18 cm and used to catch a wide range of commercial species depending on the mesh size.

In Morocco, Estimated average net length ranges from 6.5 to 7.1 km, depending on the port, though actual figures are suspected to be much higher (12-14 km) (Tudela et al., 2005).

Incidental catches of large sharks (Prionace glauca, Carcharhinus carcharias, Alopias vulpinus, Isurus oxyrinchus and Cethorhinus maximus), the pelagic stingray Pteroplatytrygon violacea and the giant devil ray Mobula mobular have been cited in various driftnet fisheries. For the basking shark C. maximus, driftnets contribute to about 1 percent of total catch (Mancusi et al., 2005).

- ✓ *Trammel nets and gillnets*

Trammel nets and gillnets are the nets most commonly used by small Mediterranean fisheries. These nets are often used at night. The length of set nets depends on the size of the fishing boat.

In the Mediterranean, there is a little use of gillnet targeting sharks. Trammel nets monitored in the Balearic islands shows the capture of 12 species of elasmobranchs (ten sharks and two rays) representing 10 percent in abundance and 28 percent in biomass of the total catch. The most common species are *Dasyatis pastinaca*, *Raja radula* and *Torpedo marmorata* representing respectively 48 percent, 24 percent and 15 percent of catches of elasmobranchs (Bradai et al., 2012). Trammel nets contribute by 30 percent of the total catch of basking shark in the Mediterranean (Mancusi et al., 2005).

- ✓ *Trawler*

Mediterranean trawling uses various techniques suitable for the production of benthic, demersal and pelagic species. It is practiced by a little more than 10 percent of the Mediterranean fleet. Trawlers contribute approximately to a little more than half of the landed catch, which underlines the importance of this activity. This technique generates occasional catch of pelagic sharks as *Alopias vulpinus*, *Prionace glauca*, *C. carcharias*, *I oxyrinchus* and rarely the basking shark *Cetorhinus maximus*. In the Mediterranean, 5 percent of the basking shark catches are reported in trawl fisheries (Mancusi et al., 2005). Furthermore, this gear generates capture of juvenile white sharks mainly in the central Mediterranean and especially in the Gulf of Gabès (Bradai et al., 2012). The bycatch of shark species covered in the study varies greatly, not only in term of weight but also in the number of species according to the area.

- ✓ *Purse seiner*

The Bluefin purse seine is constituted by a long net made of a series of layers of different mesh sizes with floats on the headline and weights attached to the bottom rope. The codend or "pocket" is located at one end. Although there is little information available in the literature on the bycatch of this gear occasionally catch pelagic sharks and stingrays in fisheries of the bluefin tuna and small pelagic (Fromentin and Powers, 2005). Other species are also reported in the catch mainly in Central Mediterranean Sea, *C. carcharias*, *Isurus oxyrinchus*, *Cetorhinus maximus* and *Alopias vulpinus*. (Fergusson, 1996; Mancusi, et al., 2005). Shark by-catches are very low if compared with those obtained in the tropical tuna purse seiners fisheries (Amandè et al., 2012).

- ✓ *Harpoon*

The traditional harpoon fishery show a really low shark by-catch, generally reduced to a few large specimens.

- ✓ *Trap net*

These fixed fisheries are placed along the coast, on the passage of migratory species, especially Bluefin tuna as they approach the shore. These structures were distributed along the Mediterranean coast, mainly from Italy, but today and after the fall of their productions, many have been abandoned. Some, however, currently remain on the main islands of Italy and Tunisia.

Historical and new observations on tuna trap catch show that several elasmobranch, mainly large pelagic sharks are affected. Among the ten total elasmobranch species recognized in the tuna traps, several (white shark *Carcharodon carcharias*; bronze whaler *Carcharhinus brachyurus*, dusky shark *Carcharhinus obscurus* and devil ray *Mobula mobular* are regarded as rare in the Mediterranean basin, while others (shortfin mako shark and smooth hammerhead shark are more common ((Hattour et al., 2005, Bradai et al., 2012)). The tuna traps bycatch events are rare but information related to the bycatch of this species is important because elasmobranchs bycaught are considered rare and vulnerable to fisheries or have reportedly been depleted in the region.

Studied shark species catch estimates

The study has focused on identifying the fleets that could be mainly responsible for the catch of the 18 shark species studied based on the best assumption of the shark catch over target species catch ratios (see Material and Methods) derived from the literature.

For the estimation of the studied sharks species catch in the Mediterranean Sea, the “High estimation method” has been used (see Material and Methods). The tentative catches estimates give an amount of 6,143 tonnes *vs* 434 tonnes declared (Figure 3.3.3). 17 among the 199 fisheries found in ICCAT database generate 95 % of studied shark species catches estimates (Table 3.3.7).

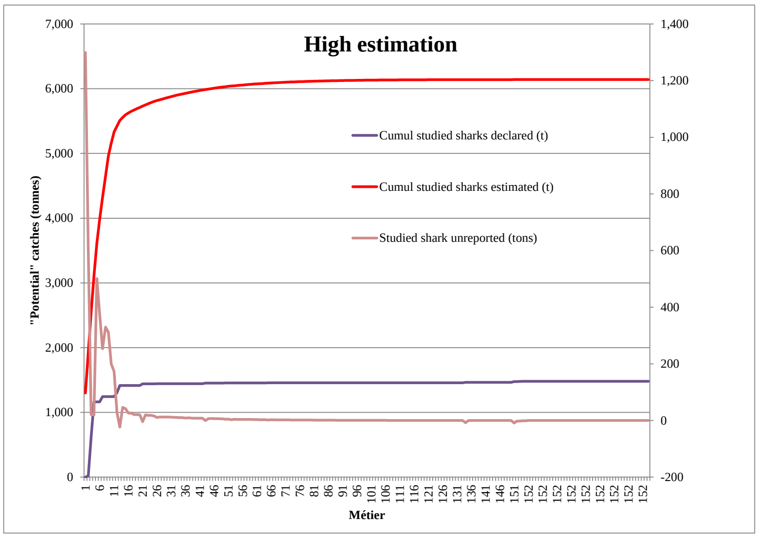


Figure 3.3.3.- Cumulated "potential" catch estimates in tonnes and undreported studied shark species catches by fisheries ranked according their descending estimated studied shark species catches.

Table 3.3.7.- Average yearly studied sharks species catch reported to the ICCAT and the estimation carried out in the study (tons/year) by fishery.

Fleet	Studied shark declared	Studied shark estimated	Cumulated Studied shark estimated	% Cumulated Studied shark estimated
Maroc-GN-swo-tul	0	1299	1299	21.2
Turkey-LL-shark	1145	1185	2484	40.4
EU.España-LL-swo-sp	18	670	3154	51.4
EU.Italy-GN-swo-it	193	633	3787	61.7
Maroc-LL-swo-albo	0	501	4288	69.8
Algerie-GN-swo-tul	0	375	4663	75.9
Tunisie-LL-swo-albo	0	330	4993	81.3
EU.Italy-LL-swo-ad	0	312	5304	86.3
Algerie-LL-swo-albo	0	199	5503	89.6
EU.Italy-LL-swo-li	60	105	5609	91.3
EU.Italy-LL-swo-ic	0	68	5677	92.4
EU.Italy-LL-swo-ty	0	51	5728	93.3
EU.Greece-LL-swo-gr	0	41	5770	93.9
Turkey-GN-alb-tur	0	24	5794	94.3
EU.Cyprus-LL-tuna-malt	3	24	5818	94.7
EU.Italy-LL-tuna-tur	0	24	5841	95.1
EU.Malta-LL-tuna-malt	1	22	5863	95.4

Among the 30 metiers identified, 99% of the total amount are caught respectively by longlines (LL, 54%) and gillnets (GN, 45%). The remaining amount is caught by purse seiners, trawlers, handlines, recreational and traps fisheries (Figure 3.3.4).

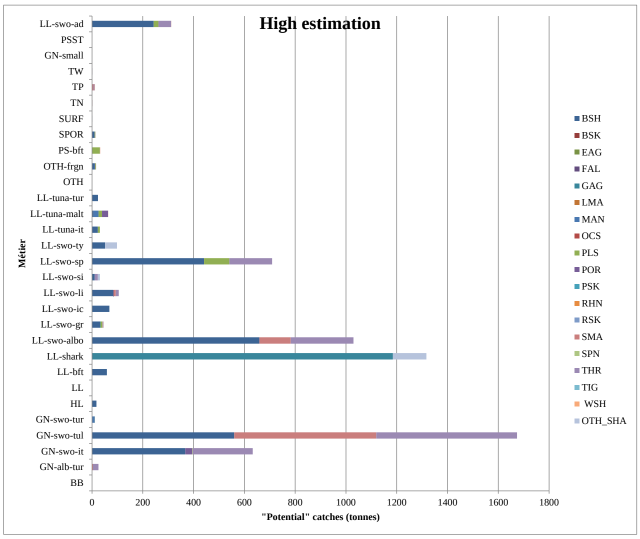


Figure 3.3.4.- Estimated Catch (tonnes) by Métiers and by the studied shark species.

The main fisheries responsible for the highest catches of investigated shark species were identified on the basis of tuna and tuna like catch reported to ICCAT. The amount of investigated shark species estimated is 3.8 times higher than the average amount declared. The average amount estimated of 6,143 t over the period corresponds to 37% of the amount of swordfish or 13% of all tuna-like species (bluefin, albacore tuna, and swordfish combined).

The major swordfish fisheries which are reporting on a regular basis, swordfish catches to ICCAT and do not report shark catches can be clearly identified in the following chart namely the swordfish gillnet fisheries (GN) of Morocco, Italia and Algeria and the swordfish longline fisheries (LL-swo) of Spain, Morocco, Turkey and Italy (Figure 3.3.5).

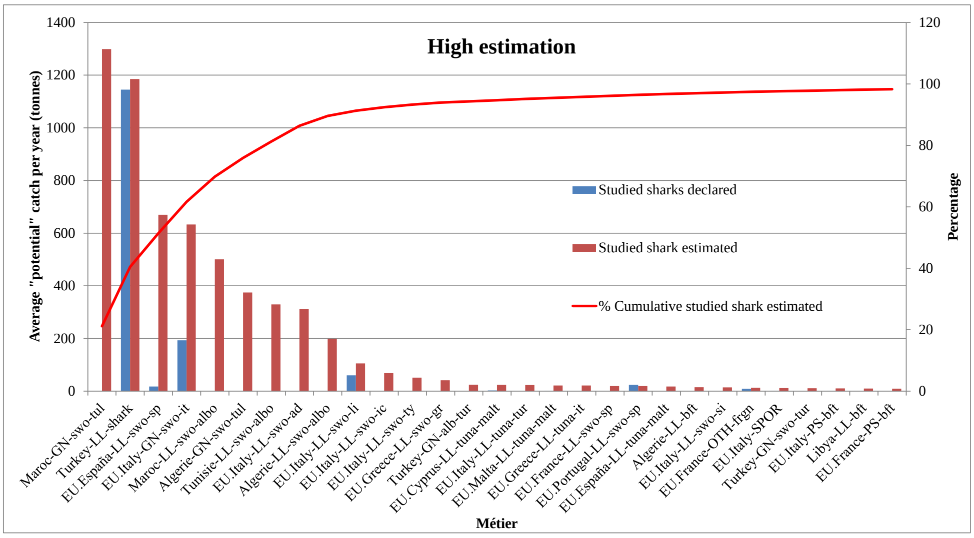


Figure 3.3.5.- Main Métiers impacting studied shark species in the Mediterranean Sea.

According to the estimates, mainly 6 species are impacted in the Mediteranean; and the amount estimated is as follows 2,665 tonnes of are blue shark (BSH) (43.4%); 1,313 tonnes of thresher sharks (THR) (21.4%), 1,187 tonnes of tope shark (GAG) (19.3%), 704 tonnes of shortfin mako (SMA) (11.5%), 183 tonnes pelagic rays (PLS) (3.0%), and 51 tonnes of porbeagle (POR) (0.8%). Silky, hammerhead and basking sharks make up the remaining percentage. These three last species are very rarely caught. The presence of some species in the region may be questionable unless these species became too rare to be detected in the course of a conventional monitoring survey (Fig. 3.3.6. and 3.3.7).

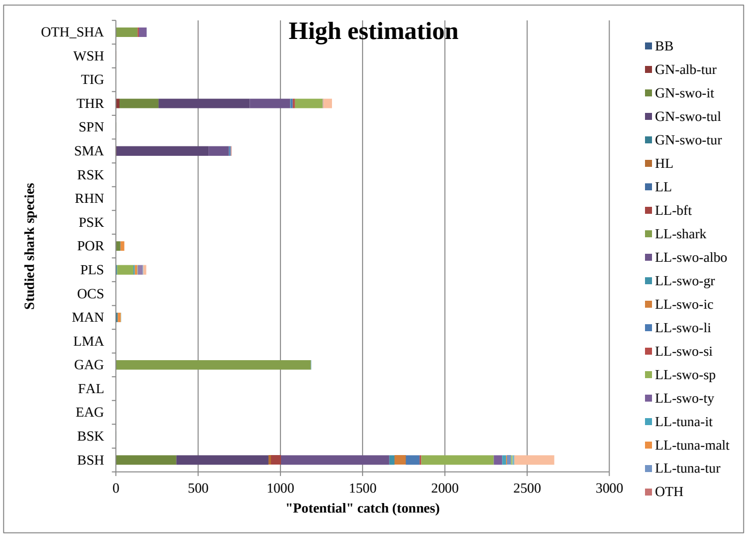


Figure 3.3.6.- Estimated Catch (tonnes) by Métiers and by studied shark species.

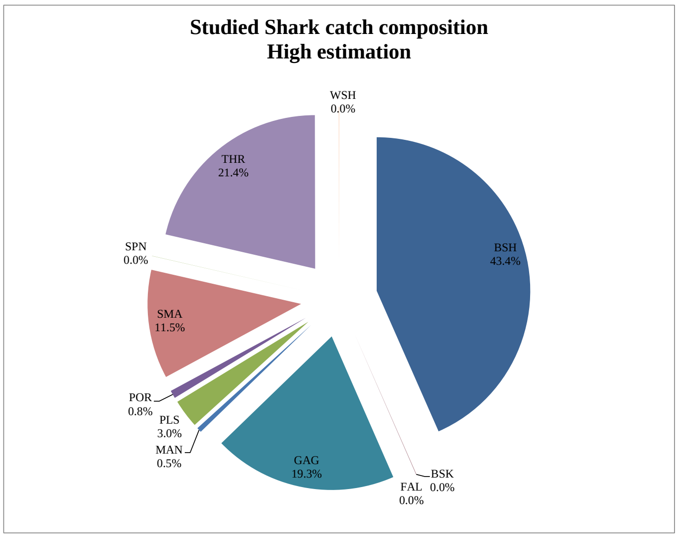


Figure 3.3.7.- Composition of the studied shark species.

It has been noticed during the review of these numerous documents that the proportions of shark catches were significantly different among fishing gears and catch composition also differed significantly by area. In addition, ratios were also estimated at different period, and may not reflect the current situation any more.

Megalofonou et al. (2005) highlighted that statistically highly significant differences were detected in catch composition among types of sampling (observers at sea and sampling at landing site). Sharks can represent 15.3% of the total catch in biomass at landings and only 5.3% onboard vessels. The discrepancies in observed at-sea and at-landing data, especially in the western Mediterranean Sea catch composition, could be mainly due to the discarding of "other species" or undersize target species, such as swordfish and tunas. So the studies based on at landing sampling sites can be biaised.

The information on bycatch is scarce and the bycatch estimates found in the literature are not homogenous which made the raising and/or estimates of ratios uncertain due to various assumptions made (e.g. conversion of the estimates in number of individuals into weight without any information on the mean size per species).

ICCAT data are based on reports from the national fisheries agencies but can be affected by the limitations in reporting efficiency and problems of species identification and species breakdown. The estimates depends on the level of under-reporting and non-reporting of tuna and tuna like catch by the countries (i.e. French banned driftnet carried out their activity between 2003 and 2007 and the catches of blue fin tuna were estimated at 120 tonnes per year during this period, but the catches were not reported to ICCAT).

3.3.5 Estimation of discards levels

The 6 following species or group of species, as pointed out by *Prionace glauca, Alopias spp, Isurus oxyrinchus, Galeorhinus galeus, Pteroplatytrigon violacea, Lamna nasus,* consist of the major sharks catches and bycatches. All but pelagic stingrays have a commercial value. In all areas examined throughout the Mediterranean Sea, Megalofonou et al. (2005) noticed that sharks were rarely discarded from vessels. Fishermen usually do not discard their shark catch because there is a market demand for sharks in the Mediterranean countries. Furthermore, finning, the cutting of the shark fin and the discarding of the rest of the animal, is probably practiced in the Mediterranean high seas by longline fleets making long trips (Tudela, 2004). Based on the same author, the thresher shark and the porbeagle are easily sold; the blue shark and the hammerheads in some cases are discarded because of the strong smell. Fishermen discard not marketable sharks, usually by cutting the branch line which may increase the survival rate of the bycatch.

Although, in Mediterranean, generally, the discards are considered low, because fisheries are not considered “targeting” on a single species but rather they are of a multispecies nature; no observers’ programs data has been analyzed up to now. The data of observers program is not available to the public in ICCAT/CFCM and, thus, a request has been done to get access to these data. However, no responses have been received so far to get access to observers’ data.

3.3.6 Catch at size

Size frequency data are very scarce or even lacking. Only few fleets have reported individual body size per year, gear, month and 1x1 degree square areas in the area BIL95 and mainly for blue shark, porbeagle and mako sharks are available. Size frequency data are very scarce, Malta provided some length data for four species sampled in the vicinity of the Island (GSA 15).

Table 3.3.8.- Mean size and sample size for four species caught by Maltese longliners in the GSA 15 between 2008 and 2011.

Species (FAO code)	Mean length (TL cm)	Sample size
Blue shark	227	240
Tope shark	164	4
Porbeagle	190	59
Thresher sharks	357	14

3.3.7 Biological information

Biological information for all the species covered in the study is presented in **Annex II**.

3.3.8 Fishery indicators (blue shark and shortfin mako)

No data is available for the Mediterranean (see ICCAT section). Some information in the case of several Italian swordfish longline fisheries are available in the literature Catch per unit of effort (CPUE) in number (number of individuals for 1000 hooks for longlines, and for 1000 m of net for driftnets) and mean weight are valuable tools trying to analyze trends in sharks abundance.

Table 3.3.9.- Blue shark CPUE (n) and mean weight (kg) values in the Gulf of Taranto - Swordfish longline (Ionian Sea) (Garibaldi, 2006).

Year	**1978**	**1979**	**1980**	**1981**	**1982**	**1983**	**1984**	**1985**
CPUEn	1.53	1.13	0.94	2.25	1.40	3.07	1.12	1.17
Mean weight	9.4	47.4	30.3	20.2	13.8	12.3	21	9.5

Table 3.3.10.- Blue shark CPUE (n) and mean weight (kg) values in the Southern Adriatic Sea - Swordfish longline (Garibaldi, 2006).

Year	**1984**	**1985**	**1986**	**1987**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**
CPUEn	0.71	0.76	1.71	0.97	0.89	2.38	1.51	0.55	1.12	0.69	1.13	1.87
Mean weight	16.3	17	15.9	11.6	14.2	8.4	10.1	9.8	11.8	11.7	10.7	10.8

Table 3.3.11.- Blue shark CPUE (n) and mean weight (kg) values in the Ligurian Sea - Swordfish longline (Garibaldi, 2006).

Year	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**
CPUEn	0.28	0.52	1.09	0.08	0.18	0.65	0.4	0.2	0.12
Mean weight	12	16.6	12.5	13.3	9.3	8.5	9.6	10.4	9.3

In all these areas, CPUE values showed a great variability, depending on species, year, gear and fishing areas, but there is not a definite and clear trend, in many cases data sets derive from restricted geographical subareas, covering a limited time period.

3.3.9 Major difficulties

Many Mediterranean and Black Sea countries are not reporting any catches or, in the case of a few countries, only a small number of landings are declared. If these data are not reported, total catches are estimated from a range of sources (including: partial catch and effort data, data in the FAO FishStat database, scientific reports or publications, data published through web pages or other means). Nevertheless, the lack of relevant information needed to undertake extrapolations could prevent accurate shark catch estimates. If the data are reported, the discrepancies between the ratio nominal tuna catches and shark catches could help to detect any misreported information.

<u>Prevalence of artisanal fisheries</u>

The first investigation of the Catch & Effort Data Base a number of problem areas in the data situation for sharks data in the Mediterranean and Black Seas. The fishing activity in Mediterranean resulted in the present variety of fishing practices and fishing gears. Most of which can be described as “artisanal” or “small scale” rather than “industrial” fishing. Over 80% of the boats registered in the EU and other Mediterranean countries are smaller than 12 m which correspond to “small scale” vessels according to the EU (Swan 2005). As small scale fisheries are difficult to monitor, the information on the catch (and eventually bycatch) of sharks provided by the countries are thought, for this reason, to be very incomplete. The catches of sharks, when reported, are thought to represent simply the catches of these species that are retained on board and sold through monitored market places. It is thought that important catches of sharks might have gone unrecorded in several countries. Landings data collected in most countries revealed to be unreliable. Furthermore, no indication is given on the type of processing that the different specimens underwent and we assume they refer, in many cases, to dressed weights. Even if the collection and reporting of catches of sharks caught in association with species tuna and tuna-like species has shown some improvements since few years, it has been very uneven over the period considered. Several countries are thought not collecting efficiently fishery statistics. This makes it really difficult any attempt to estimate the total catches of sharks in the Mediterranean and Black Seas.

Data access

The data available in the public domain of GFCM is scarce and difficult to acces.

Species identification

In 2010, the participants of the selectivity workshop expert meeting on the status of elasmobranches in the Mediterranean and Black Sea of the GFCM noted that “After critical analysis of the literature and taking into account new published data on the systematic of elasmobranches, 86 species of elasmobranchs were considered to occur in the Mediterranean Sea (49 sharks and 37 batoids). However, much confusion persists for some species and some others are doubtful. These species need more systematic revision. It is surprising to found that 177 tonnes of white sharks have been reported over the period while this species is protected and surely the declaration is due to misidentification of the species.

Issues identified for the different fisheries

The main problem areas identified for the longline fisheries are indicated below:

(1) The Lack of catch and bycatch data for the 12 longline fleets for the whole period: 2 distance offshore fisheries, 1 Non contracting party and 18 regional fleets;
(2) The Lack of accurate catch and bycatch data for the 2 regional gillnet fleets;
(3) The lack of information for the catch reported under unclassified gears;
(4) The need cross checking the validity/discrepancies of the data reported;
(5) An application developed by ICCAT allows you to access catch-effort records from the ICCAT database but difficult to extract data for different fleets.
(6) The GFCM Task 1 bulletin contains interesting information about the number of boats involved in the fleets but unfortunately but there is no possibility so far to extract this information.

(7) Poor knowledge of the size-frequency data from most of the fleets. An application developed by ICCAT allows you to access size frequency records from the ICCAT database (Task II) but difficult to extract data for different fleets.

The main problem areas identified for the gillnet fisheries are indicated below:

Catch Effort and Catch at size data:

(1) The Lack of catch, and bycatch, size frequency data for the illegal driftnets which continue to be used by Italian, French, Moroccan, Turkish and Algerian fleets;

The main problem areas identified for the other fisheries (Unclassified: Gears not reported are indicated below):

(1) Poor knowledge of the catches and lack of effort and size-frequency data for these fleets. In 2008 , the GFCM Working Group on bycatch expressed serious concern about the ongoing evidence that large pelagic driftnets are still deployed and still cause large numbers of bycatch events;

Globally, the main difficulties can be summarized as follows:

- Artisanal and coastal fisheries: lack of shark catch reporting;
- Industrial fisheries: lack of shark catch reporting and when it is done usually not broken down by species;
- Lack of any size frequency data;
- Lack of regional biological/ecological information for sharks;
- Data access;
- Species misidentification;
- Low observer coverage for most of the fleets;
- Difficulties with the use of logbook data for shark assessment (misidentification, underreporting, change in targeting practice).

3.3.10 Summary

Table 3.3.12 summarizes the level of tuna and sharks catches of all the fleets operating in the Mediterranean Sea. It is intended to highlight the data gaps and the discrepancies in the landings declared. More attention will be required to these fisheries in order to reconstruct a theoretical catch series based on the most relevant information available.

After further analysis it would be possible to go into details and get information on the quality of data available in order to identify; any regional fishing patterns to emerge and the major components of the sharks catch.

Many Mediterranean and Black Sea countries are not reporting any catches or, in the case of afew countries, only a small number of landings are declared. Nevertheless,the landings of sharks have dramatically increased since 2003 and the fishery productiondata related to shark species show a total official reported landing of 6,170 tonnes over the period 2000-2010 (against 441,091 tonnes of major tuna species). The under-reporting is believed to be significant because landing sites are scatteredall along the coastline and the islands where many thousands of small- and mediumsized vessels operate and the catches are often directly marketed. Under such circumstances, an extensive bibliographic search in the scientific literature and public archives for quantitative scientific and fisheries information will be needed in order to fill the critical gaps and a lot of assumptions made to reconstruct the catch time series.

In Mediterranean, tuna fishing and the associated bycatch have received relatively little attention, and only few studies have been carried out to obtain a national and global overview.The analysis of catch composition by gear and areasindicated that the various gears used in the swordfishand tuna fisheries affect the shark populations differently and that the proportion of shark catches is related both to the type of fishing gear and the sampling area. This finding is consistent with previous findings for the Mediterranean Sea where incidental shark catch in the swordfish fisheries varied from insignificant to dominant, depending on the area studied (Buencuerpo et al., 1998; Di Natale, 1998; Mejuto et al., 2002a).

The highest shark incidental catches were found in the Alboran Sea and were probably related to their location (Alboran Sea), adjacent to the Atlantic Ocean. The shark ratios found in the literature were lower than those reported in the other Oceans probably because of the fishing pressure throughout the years.

Shark discarding is not a common practice in the large pelagic fisheries in the Mediterranean Sea.In all areas examined throughout the Mediterranean Sea, Megalofonou et al (2005) noticed that sharks represented Sharks were rarely discarded from vessels. The fishermen usually retain their incidental catches because there is a market demand for sharks in Europe. However, wholesale shark flesh prices are quite variable, ranging from 2 to 8 euros. Moreover, the jaws and tails of some shark species are often soldin local markets.

Driftnet fleets continue their activities despite successive international initiatives banning or limiting this low selective fishing practice. There are serious concerns about the ongoing evidence that large pelagic driftnets are still deployed and still cause large numbers of bycatch events for species of conservation matter.

In their study , Megalofonou et al (2005) noticed that twelve shark species were identified—blue shark (*Prionace glauca*), being the most common in all areas and gears studied. Shortfin mako (*Isurus oxyrinchus*), common threshershark (*Alopias vulpinus*), and tope shark (*Galeorhinus galeus*) were the next most abundant shark species andwere found in more than half of the areas sampled.The rest of the shark species identified were the porbeagle(*Lamna nasus*), bigeyed thresher shark (*Alopias superciliosus*), smooth hammerhead (*Sphyrna zygaena*),bluntnose sixgill shark (*Hexanchus griseus*), sandbarshark (*Carcharinus plumbeus*), longnose spurdog (*Squalus blainvillei*), smoothhound (*Mustelus mustelus*), andbasking shark (*Cetorhinus maximus*). Only few reference concerning these species appeared in the literature found so far, which could demonstrate the decrease of the sharks populations in the Mediterranean and the Black sea.

Conclusions

Paucity of lage sharks in the Mediterranean Sea

A recent study, analysing large pelagic fisheries data between 1998 and 2005 from the open waters of the southeastern Mediterranean Sea, showed a significant decline in large sharks species richness, with the probability of shark occurrence reducing to its lowest level in the most recent years (Damalas and Megalofonou, 2012); no more than 10 species were identified, although most updated literature cites more than twice this number in the region. The authors concluded that some species may have become too rare to be detected in the course of a conventional monitoring survey.

These results aere confirmed by another study based on interviews of a representative sample of 106 retired fishers in several contries (Italy, Spain and Greece). It shows that fishers' perceptions are in agreement with the declining populationtrends detected by scientists. Shark catches were also perceived to have diminished since the early 1940s for all species (Maynou et al., 2011). The rarity of the occurrence of some species poses serious concerns about their population: the catch of hammerhead sharks Sphyrna spp. have been reported in 2005 in the North Ionian Italian fisheries (Megalofonou et al., 2005a, Damalas and Megalofonou, 2012). Great white and basking shark are also rare in the literature during the past three decades (Soldo and Jardas, 2002, Soldo et al., 2008, Soldo and Dulcic, 2005, Mancusi et al., 2005). Finaly, the shark catch ratios throughout the Mediterranean were lower than those reported in other Oceans.

Table 3.3.12.- Summary information extracted from the Nominal Catch Information database (Task 1) available on the ICCAT website (http://www.iccat.es): Tuna and tuna-like species catches and sharks catches and number of years of declaration of sharks by country, fleet and fishing gear between 2000 and 2010 and rank . CE: Catches report expected

Flag	Fleet	Metier	Target species	Major tunas	Swordfish	Small tunas	Studied Sharks	No. year declared
Algeria	DZA-TUR	PS-bft	Major tunas	84	0	0	CE	0
	DZA-JPN	LL	Major tunas	532.33	492	0	CE	0
	DZA	LL	Major tunas	208.29	345.88	293.71	CE	0
	DZA	OTH	Major tunas	375	311.6	833.93	CE	0
	DZA	PS-bft	Major tunas	784.71	37.16	680.39	CE	0
	DZA	GN-swo	swordfish	276.5	349.57	172.44	CE	0
	DZA	HL	Major tunas	79.71	89.9	22.25	0	0
Chinese Taipei	TAI	LL	Major tunas	253.43	0	0	CE	0
Croatia	HRV	HL	Major tunas	10.47	0.59	1.89	0	0
	HRV	OTH	Major tunas	2.06	0	5.26	0	0
	HRV	GN-mituna	minor tunas	0	0	15.08	0	0
	HRV	LL	Major tunas	2.81	2.34	0.52	CE	0
	HRV	PS-bft	Major tunas	855.92	2.16	51.46	CE	0
Egypt	EGY	OTH	Major tunas	0	0	1128	0	0
	EGY	PS-bft	Major tunas	0	0	1442	CE	0
EU.Bulgaria	EU.BGR	OTH	Major tunas	0	0	26.64	0	0
	EU.BGR	HL	Major tunas	0	0	0.11	0	0
	EU.BGR	PS-bft	Major tunas	0	0	0.06	CE	0
	EU.BGR	TW	Major tunas	0	0	0.89	0	0
	EU.BGR	GN-mituna	minor tunas	0	0	13.7	0	0
	EU.BGR	LL	Major tunas	0	0	0	CE	0
EU.Cyprus	EU.CYP	OTH	Major tunas	16.59	0	13.08	0	0

Flag	Fleet	Metier	Target species	Major tunas	Swordfish	Small tunas	Studied Sharks	No. year declared
	EU.CYP	LL-swo	Swordfish	2.87	31.06	0	0.5	1
	EU.CYP	PS-bft	Major tunas	73.73	0	0	CE	0
	EU.CYP	GN-mituna	minor tunas	0.41	0	11.37	0	0
	EU.CYP	TW	Major tunas	0	0	0	0	0
	EU.CYP	HL	Major tunas	3.48	0	0	0	0
	EU.CYP	LL	Major tunas	276.96	68.5	0	3.36	8
	EU.CYP	TN	Major tunas	32.46	0	4.43	CE	0
	EU.CYP	LL-tuna	Major tunas	205.76	0	0	CE	0
EU.España	EU.ESP	HL	Major tunas	30.47	0	0	0	0
	EU.ESP	OTH	Major tunas	90.81	40.1	253.43	CE	0
	EU.ESP-ES-MEDI_SPOR	SURF	Major tunas	32.9	0	0	CE	0
	EU.ESP-ES-CANT_ALB	OTH	Major tunas	117.1	0	0	CE	0
	EU.ESP	SURF	Major tunas	17.63	13.34	1828.69	CE	0
	EU.ESP-ES-MEDI_SPOR	OTH	Major tunas	10.79	0	0	CE	0
	EU.ESP	BB	Major tunas	32.23	0	0	0	0
	EU.ESP-ES-SWO	LL-shark	Sharks	2.66	1303.26	4.51	18.07	11
	EU.ESP-ES-MEDI_PS	PS-bft	Major tunas	1637.83	0	0	CE	0
	EU.ESP-ES-MEDI_SWO	LL	Major tunas	17.94	0	0	CE	0
	EU.ESP	LL-tuna	Major tunas	364.33	50.66	13.6	CE	0
	EU.ESP	LL	Major tunas	354.64	106.91	12.3	7.98	6
EU.France	EU.FRA-MED	TN	Major tunas	0.1	0.49	0.53	0.12	2
	EU.FRA-MED	TW	Major tunas	1.46	3.46	4.74	9.77	2
	EU.FRA-MED	LL	Major tunas	1.06	41.36	0.81	0.49	2
	EU.FRA-MED	GN-Mtuna	Major tunas	0.11	0.36	3.62	0.06	2
	EU.FRA	PS-bft	Major tunas	6493.8	0	0	CE	0
	EU.FRA-MED	PS-bft	Major tunas	2234.96	0.14	3.3	0.01	1
	EU.FRA	TW	Major tunas	0	0	0	0.45	1
	EU.FRA	OTH	Major tunas	204.8	17.22	25.15	7.73	2
	EU.FRA-MED	HL	Major tunas	0.48	0.06	0.48	0	0
	EU.FRA-MED	OTH	Major tunas	188.54	1.08	8.81	0.75	2
EU.Greece	EU.GRC	LL-swo	Swordfish	278.1	1458.96	0	CE	0
	EU.GRC	LL-tuna	Major tunas	51.59	0	0	CE	0
	EU.GRC	PS-bft	Major tunas	288.84	0	1490.39	CE	0
	EU.GRC	OTH	Major tunas	1608.33	0	0	CE	0
	EU.GRC	HL	Major tunas	195.28	0	0	0	0
EU.Italy	EU.ITA-IT-IONIAN	LL-swo	Swordfish	0	213.13	0	CE	0
	EU.ITA-IT-ADRIAT	LL-swo	Swordfish	0	2395.84	0	CE	0
	EU.ITA-IT-TYRREN	OTH	Major tunas	630.11	1412.57	43.82	CE	0
	EU.ITA	OTH	Major tunas	821.51	803.61	2598.22	111.76	3
	EU.ITA-IT-IONI.N	OTH	Major tunas	78.67	31	0	CE	0
	EU.ITA	LL-tuna	Major tunas	918.53	0	0	CE	0
	EU.ITA-IT-ADRI.S	LL-swo	Swordfish	235.81	599.67	0	CE	0
	EU.ITA-IT-ADRIAT	OTH	Major tunas	81.44	0	0	CE	0
	EU.ITA-IT-TYRREN	LL-swo	Swordfish	209.59	1189.83	0	CE	0
	EU.ITA	GN-swo	swordfish	894.48	3050.95	847.98	82.18	3
	EU.ITA-IT-LIGURY	LL-swo	Swordfish	0	467.83	0	CE	0
	EU.ITA-IT-SARDHA	OTH	Major tunas	117.22	35.67	0	CE	0
	EU.ITA-IT-SIC.ST	LL-tuna	Major tunas	161.18	0	0	CE	0
	EU.ITA-IT-IONI.N	LL	Major tunas	141	162.33	0	CE	0
	EU.ITA	TW	Major tunas	0	0	1.43	1.97	2

Flag	Fleet	Metier	Target species	Major tunas	Swordfish	Small tunas	Studied Sharks	No. year declared
	EU.ITA-IT-TYRREN	LL-tuna	Major tunas	328.12	0	0	CE	0
	EU.ITA-IT-IONIAN	LL-tuna	Major tunas	567.81	0	0	CE	0
	EU.ITA-IT-ADRIAT	LL-tuna	Major tunas	554.23	0	0	CE	0
	EU.ITA-IT-SIC.ST	LL-swo	Swordfish	0	361.11	0	CE	0
	EU.ITA-IT-IONI.S	LL	Major tunas	412.84	843.67	0	CE	0
	EU.ITA-IT-IONI.S	OTH	Major tunas	231.43	234.76	0	CE	0
	EU.ITA-IT-IONI.S	PS-bft	Major tunas	73.49	0	0	CE	0
	EU.ITA-IT-LIGURY	LL	Major tunas	6	152.33	3.77	CE	0
	EU.ITA	HL	Major tunas	6.4	0	321.12	0	0
	EU.ITA	BB	Major tunas	0.25	0	0	0	0
	EU.ITA-IT-SARDHA	LL	Major tunas	29.08	312	0	CE	0
	EU.ITA-IT-LIGURY	LL-tuna	Major tunas	17.87	0	0	CE	0
	EU.ITA-IT-ADRI.S	OTH	Major tunas	16	8.67	0	CE	0
	EU.ITA	PS-bft	Major tunas	3285.71	9.66	547.49	0.7	1
	EU.ITA-IT-LIGURY	OTH	Major tunas	17.02	24.33	1.57	CE	0
	EU.ITA-IT-SIC.ST	OTH	Major tunas	2.31	0	0	CE	0
	EU.ITA-IT-ADRIAT	PS-bft	Major tunas	757.27	0	0	CE	0
	EU.ITA-IT-IONI.N	PS-bft	Major tunas	12.9	0	0	CE	0
	EU.ITA	LL-swo	Swordfish	2204.12	3329.01	672.03	59.79	5
	EU.ITA-IT-TYRREN	PS-bft	Major tunas	254.08	0	201.98	CE	0
	EU.ITA-IT-LIGURY	PS-bft	Major tunas	17.68	0	0	CE	0
	EU.ITA-IT-ADRIAT	LL	Major tunas	24.04	0	0	CE	0
	EU.ITA-IT-IONIAN	LL	Major tunas	26.8	0	156.05	CE	0
	EU.ITA-IT-IONIAN	OTH	Major tunas	29.06	0	556.34	0	0
EU.Malta	EU.MLT	LL-swo	Swordfish	10.1	286.02	0	CE	0
	EU.MLT	LL-tuna	Major tunas	248.79	73.38	0	CE	0
	EU.MLT	LL	Major tunas	192.85	191.97	0	1.19	11
	EU.MLT	PS-bft	Major tunas	115.32	0	0	CE	0
	EU.MLT	TW	Major tunas	0	0	0	0	0
	EU.MLT	OTH	Major tunas	69.74	0	15.25	CE	0
EU.Portugal	EU.PRT-PT-MAINLND	LL	Major tunas	7.98	40.89	0.7	24.43	7
	EU.PRT-PT-MADEIRA	LL	Major tunas	62.4	0	0	CE	0
Iceland	ISL	PS-bft	Major tunas	50	0	0	CE	0
Israel	ISR	OTH	Major tunas	0	0	119	0	0
Japan	JPN	LL	Major tunas	313.04	1.61	0	1.33	5
Korea Rep.	KOR	PS-bft	Major tunas	922.5	0	0	CE	0
	KOR-MLT	PS-bft	Major tunas	237.67	0	0	CE	0
	KOR	LL	Major tunas	22.5	1	0	CE	0
Libya	LBY	LL	Major tunas	446.5	7.84	0	CE	0
	LBY	PS-bft	Major tunas	762.92	0	0	CE	0
	LBY	OTH	Major tunas	62.01	0	4.26	0	0
Maroc	MAR	PS-bft	Major tunas	155.1	4	110.89	CE	0
	MAR	HL	Major tunas	248.18	0	51	0	0
	MAR	LL-swo	Swordfish	151.27	1252.27	219.29	CE	0
	MAR	OTH	Major tunas	93	1.5	185.5	0	0
	MAR	GN-swo	swordfish	7.43	1212.82	165	CE	0
NEI (combined)	NEI.COMB	OTH	Major tunas	501.4	0	0	0	0
NEI (Flag related)	NEI.081	LL	Major tunas	17	0	0	CE	0
Palestina	PSE-PSE-GAZA.ST	OTH	Major tunas	100	0	83	CE	0
Serbia	SCG	PS-bft	Major tunas	0	0	41	CE	0

Flag	Fleet	Metier	Target species	Major tunas	Swordfish	Small tunas	Studied Sharks	No. year declared
& Montenegro	SCG	OTH	Major tunas	4.35	0	0	0	0
Syria Rep.	SYR	LL	Major tunas	49.45	19.63	0	CE	0
	SYR	OTH	Major tunas	0	0	292.7	0	0
	SYR	PS-bft	Major tunas	44.1	13.17	0	CE	0
Tunisie	TUN-TUN-KELIBIA	PS-bft	Major tunas	39.05	0	0	CE	0
	TUN-TUN-SOUSSE	PS-bft	Major tunas	16	0	0	CE	0
	TUN	OTH	Major tunas	621.92	0.32	3332.18	CE	0
	TUN	PS-bft	Major tunas	2122.46	2	0	CE	0
	TUN-TUN-MAHDIA	PS-bft	Major tunas	220.84	0	0	CE	0
	TUN-TUN-MONAST	PS-bft	Major tunas	5.07	0	0	CE	0
	TUN-TUN-SFAX	PS-bft	Major tunas	1436.75	0	0	CE	0
	TUN	LL	Major tunas	0	824.27	0	CE	0
	TUN	HL	Major tunas	34.54	0	0	0	0
	TUN	TW	Major tunas	0	0.31	0	0	0
Turkey	TUR	PS-bft	Major tunas	1408.64	0	17293.05	CE	0
	TUR	GN	Major tunas	402.12	343.33	0	CE	0
	TUR	LL-swo	Swordfish	0	272.75	0	CE	0
	TUR	GN-alb	albacore tuna	419.5	0	0	CE	0
	TUR	OTH	Major tunas	0	0	750	596	2
	TUR	LL-shark	Sharks	0	0	0	548.75	4
	TUR	GN-swo	swordfish	0	398.8	0	CE	0

3.4 Inter-American Tropical Tuna Commission

3.4.1 Introduction

The Inter American Tropical Tuna Commission (ATTC-CIAT) was founded in 1949 (the oldest tuna commission) with the signing of the IATTC convention (http://www.iattc.org/PDFFiles/IATTC_convention_1949.pdf). The IATTC was established as a bilateral agreement between USA and Costa Rica and since then several countries with fisheries interests in the Eastern Pacific Ocean (EPO) joined. With the development of the purse seiner fisheries in the 1960s, the activity of this Commission increased, focusing its work mainly on the purse seine and yellowfin tuna fishery. The problem of fishing with dolphins lead to the Agreement of La Jolla (1992), precursor of the current Agreement on the International Dolphin Conservation Program (AIDCP), legal instrument that was born in 1998 and which enshrines a number of activities (such as the of 100% of observers) intimately related with the IATTC.

The original 1949 IATTC convention was replaced by the new “Antigua” convention in 27th August 2010. The new convention specifically covers aspects of the biology of the managed species, ecosystems in the area of jurisdiction, socio-economic aspects of fishing within the member countries, the environment and fisheries management (http://www.iattc.org/PDFFiles2/Antigua_Convention_Jun_2003.pdf). For example, the new convention gives legal authority to work deeply in bycatch as stated in Article 7 paragraph (f): “The Commission shall adopt, as necessary, conservation and management measures and recommendations for species belonging to the same ecosystem and that are affected by fishing for, or dependent on or associated with, the fish stocks covered by this Convention, with a view to maintaining or restoring populations of such species above levels at which their reproduction may become seriously threatened.”

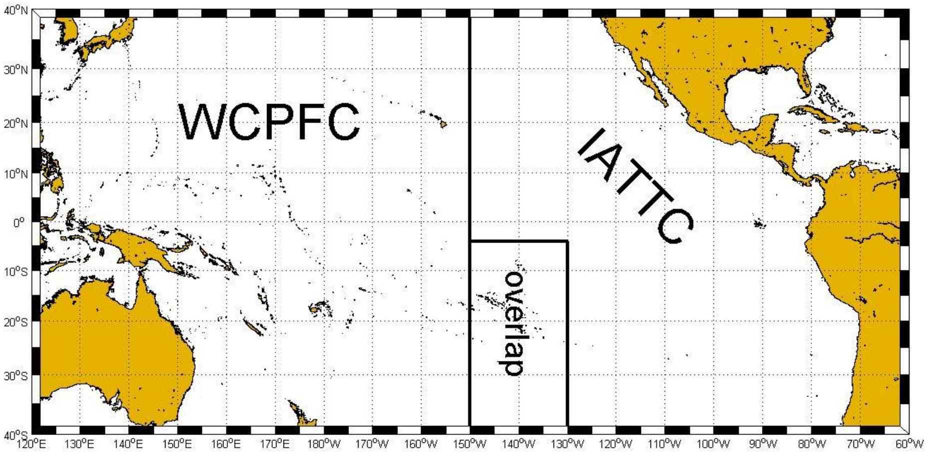
The IATTC RFMO is relatively small, comprising only 21 members (Belize, Canada, China, Colombia, Costa Rica, Ecuador, El Salvador, European Union, France, Guatemala, Japan, Kiribati, Korea, Mexico, Nicaragua, Panama, Peru, Chinese Taipei, United States, Vanuatu and Venezuela) and 1 cooperative non-member. The Secretariat, however, is relatively large, with 62 permanent staff employed. The different working groups usually meet on an annual or biannual basis (e.g. Stock assessment review meeting and the Scientific Committee is annual while the IATTC Commission meets bi- or tri-annually) although smaller groups meet on an ad hoc basis as required. The Secretariat is also somewhat unique, as all research, planning, execution, analysis and delivery is carried out by staff of the Secretariat. The IATTC has several transboundary issues that need co-ordination. Transboundary stocks of temperate tuna require careful coordination with the International Scientific Committee of Tuna and Tuna like species in the Northern Pacific Ocean (ISC) while tropical tuna are co-ordinated with the WCPFC.

IATTC also follows several International Plans of Action (IPOAs). The Commission also applies the precautionary principle to fisheries management. The Commission interprets MSY as a limit reference point and, thus, if catches for target species reach MSY limit, management measures are sought.

Mandatory fisheries data submitted to the Commission include catch and effort data and length frequency data. In addition, the Commission holds information on gear, flag, and fish-carrying capacity for several fisheries. The IATTC has an extremely comprehensive observer programme covering 100% of large PS vessels although coverage on longline and small purse seine vessels is not carried out by the Secretariat. The level of confidentiality of the data varies. Very detailed data are submitted to the Secretariat under the agreement that this data are kept confidential but allowed to be used for research. The Secretariat has expressed its wish that these countries would give permission for this data to be made freely available to increase transparency.

In terms of biological data, statistical data and fishery management, the Commission runs four separate scientific programmes: the Stock Assessment Program, the Biology and Ecosystem Program, the Bycatch and International Dolphin conservation Program and the Data Collection and Database Program. The latter is the driving force behind the extensive observer programme as well as extensive gear technology research and bycatch mitigation methods development. The Commission also maintains seven field offices: Las Playas and Manta in Ecuador, Manzanillo and Mazatlán in México, Achotines and Panamá City in Panamá and Cumaná in Venezuela.

The area of application of the Convention (Eastern Pacific Ocean-EPO) comprises the area of the Pacific Ocean bounded by the coastline of North, Central, and South America and by the following lines (i) the 50°N parallel from the coast of North America to its intersection with the 150°W meridian; (ii) the 150°W meridian to its intersection with the 50°S parallel; and (iii) the 50°S parallel to its intersection with the coast of South America.



IATTC and WCPFC area of competence

There is an area of overlap with the WCPFC: latitude south of the 4 °S and between 130° W and 150° W meridian. Both RFMOs (WCPFC and IATTC) have jurisdiction in this area.

The AIDCP only applies to the tuna purse seiners fleet, since it is the one fishing on dolphins in the EPO. Among the provisions laying down the AIDCP is that of the establishment of an international programme of observers on board. This means that for the purse seiners fleet, the IATTC has important and detailed information on catches (in number or weight and length), species identification, etc.. of all sharks caught by this fleet since 1993. Only the IATTC has the complete database of the various observers programmes of the AIDCP. Each national programme (such as the EU-SPAIN, called PNOT: Programa Nacional de Observadores de Túnidos) has data by their own observers and the CIAT observers on board their flagged vessels.

The information gathered by the observers of the AIDCP is very "sensitive", so its dissemination is subject to strict rules of confidentiality. As mentioned, the complete database of all observers is only held at the IATTC and within each observer programme, each country has its corresponding database.

Currently there are seven national programmes of observers in tuna purse seiners, integrated in the AIPCD (Colombia, Ecuador, UE-Spain, Mexico, Nicaragua, Panama and Venezuela).

The Spanish fleet of tuna purse seiners and longliners is the same in the IATTC and WCPFC areas, and it is the only European fleet in the Pacific Ocean, with the exception of a Portuguese longliners that sporadically fishes in the area.

The LL and the PS are the main fishing gear to catch sharks in the EPO. In addition to these fishing gears, there are others gears types such as: trollers, harpooners, gillnetters, and recreational vessels. The LL fleet has two components: industrial LL and LL artisanal and the PS fleet is dominated by large boats.

Concerning specific activities related to sharks, the IATTC has carried out so far four workshops in order to analyse existing information and data (catches, biological, etc.) in the EPO area and focus the work on a future assessment on silky shark, Carcharhinus falciformis. In this aspect, although there is enough information, it is extremely incomplete. Taking into account that the silky shark is the species in which the scientific work (technical meetings or workshops) has focused, there is less knowledge, and no data or numerous gaps, both statistical and biological, for the rest of shark species.

The first workshop was held in August 2010: http://www.iattc.org/Meetings2010/PDF/Aug/Shark-workshop-Aug-2010-Agenda-ENG.pdf, the second in May 2011 http://www.iattc.org/Meetings2011/May-SAC-Shark/PDFfiles/Shark-meeting-May-2011-report-ENG.pdf , the third in December 2011 http://www.iattc.org/Meetings2011/Dec/PDFs/Shark-workshop-Meeting-report-Dec-2011ENG.pdf and the four in February 2013 http://www.iattc.org/Meetings/Meetings2013/FebShark/PDFs/Shark-meeting-Feb-2013-AgendaENG.pdf.

For this work, the following responsibles have been identified: for IATTC databases Nick Vogel nvogel@iattc.org; and for sharks management Alexandre Aires-Da-Siva alexdasilva@iattc.org.

Unlike other RFMOs in the IATTC-CIAT countries do not present a national report with a description of their fisheries. The closest thing to a report of this kind and that it has begun to occur lately, is a report on the implementation of the measures established by the Commission. Therefore, it is not possible to identify fishery/fleet by country that may be involved in shark fishery based on National Reports.

Anyway, below the various fisheries and fleets operating in the IATTC area are described.

For the Purse seine fishery, the following table shows the number of active vessels by flag operating in the EPO in 2013.

Table 3.4.1.- Number of active purse seiners by flag and category in the IATTC register in 2013.

Nº of active Purse seine vessels	**IATTC**		
	<401 m3	**>401 m3**	**TOTAL**
Bolivia	1		1
Colombia	2	10	12
Ecuador	31	70	101
El Salvador		4	4
EU-Spain		4	4
Guatemala		3	3
Mexico	18	39	57
Nicaragua		8	8
Panama		14	14
Peru	1		1
USA	6		6
Vanuatu		1	1
Venezuela		19	19
TOTAL	59	172	231

For the longline fishery, the following table lists the countries that have longline fisheries in the EPO and their corresponding catches of sharks (all species together) found in the public database of the IATTC.

Table 3.4.2.- Long Line (LL) sharks catches (t) by flag in the IATTC public data base.

LL fleetc/ Shark catches (t)	**Year**										
Country	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
Belize		1326	1684	2448	3158	2825	2582	2970	3062	2217	2021
China							9		510		218
Costa Rica		10	3653	4530	2026	2192	1698	2422	2480	1405	
UE-Spain	1889	2864	2909	3003	3226	4283					4311
Guatemala	3715			286	248	194	109	140	267	551	602
Korea								198	15	188	728
Mexico	1728	1888	2370	2442	341	786	2098	2000	2254	2011	2235
Nicaragua					158	236	8	16	66	13	75
Other									37	44	35

Panama	415	2020	1152		1485	803	194	244	52	262	57
UE-Portugal											78
French Polynesia	252	150	7	245	272	156	116	14	8	12	15
Taiwan	66	363				1189	984	610	494	352	1159
USA	6	2	7	4	3	12	6	14	24	19	26
Vanuatu	1	1		1	7						

The number of active vessels by country is unknown in the longline case because, unlike the purse seine fleet, the IATTC only maintains a list of vessels authorized to fish in the area but not a list of active vessles operating in the area. The fleets of Asian countries (Japan, Korea, China and Taiwan) catch sharks in fisheries targeting tropical tunas LL; while EU-Spain and EU-Portugal LL catch sharks in fisheries targeting swordfish; and other longline fleets (industrial fisheries, artisanal and semi-industrial) take sharks in fisheries targeting tunas.

3.4.2 Bycatch issues at IATTC

Decisions, resolutions and recommendations are approved by consensus. There is no objection or opting out procedure. All Resolutions are binding (recommendations are non-binding). All management measures apply equally inside EEZ and on high seas. CPs is the responsible to enforce management measures within EEZ.

There are different resolutions of the IATTC and the AIDCP affecting the conservation of sharks, the provision of information and data (by countries to the Commission) and on confidentiality of the databases submitted to the Commission. Identified resolutions related to the above aspects are presented in the following table. The links to access these resolutions: http://www.iattc.org/ResolutionsActiveENG.htm

The table 3.4.3 below summarizes those active resolutions affecting sharks, bycatch and statistical data.

Table 3.4.3.- List of the IATTC active resolutions concerning data submission and confidentiality in relation to shark fishery data and bycatch and conservation of sharks.

Code	Title	Date	Summary
C-51-01	Resolution on confidentiality	1951	Catch statistics of individual boats, records of individual company operations, and all other records obtained by the staff of the Commission regarding individual persons, companies or enterprises shall be kept completely confidential and shall be available only to those members of the staff requiring access to them in the course of the scientific investigations.
C-99-07	Resolution on fish aggregating devices	1999	Prohibit the transshipment of tuna by purse-seine vessels fishing for tuna in the EPO, unless such transshipment takes place in port. Prohibit the use of tender vessels operating in support of vessels fishing on FADs in the EPO and establish a scientific working group to carry out comprehensive research, in conjunction with the IATTC staff.
C-03-05	Resolution on data provision.	2003	Through the appropriate government authorities and in collaboration with those authorities, they take the necessary steps to ensure that all pertinent catch information is provided to the Director on an annual basis, for all of their vessels fishing for species under the purview of the Commission. The data be provided, by species and fishing gear, where practical, via vessel logbooks and unloading records, and otherwise in aggregated form as in the table described in the Resolution, with Level 3 catch and effort data as a minimum requirement, and, whenever possible, Levels 2 and 1 catch and effort data and length frequency data. The aggregated data for each year shall be provided by 30 June of the following year.
C-04-07	Resolution on a three year program to mitigate the impact of tuna fishing	2004	Main objectives: a) collection and analysis of all available information on interactions with sea turtles (for the purpose of collection of statistically reliable scientific data regarding bycatch of sea turtles from fisheries, high priority of

	on sea turtles.		research in coastal habitat areas of sea turtles and review of information and data on sea turtles), b) Mitigation measures for reducing sea turtle bycatch, c)Industry education, d) Capacity building in coastal developing countries and e)Reporting: CPCs should report to the IATTC, information relevant to this program.
C-04-05 (REV 2)	Consolidated resolution on bycatch	2004 Rev in 2006	Include: Actions by governments. Reduction of the incidental mortality of juvenile tunas, release of non-target species (sharks, turtles, etc…), develop techniques and/or equipment to facilitate non-target species release of life individuals, general issues and specific actions for sea turtles and actions by IATTC Staff (large pelagic fish of interest to the artisanal fisheries, billfish, sharks , rays and sea turtles).
C-05-03	Resolution on the conservation of sharks caught in association with fisheries in the eastern Pacific Ocean.	2005	CPCs should establish and implement a national plan of action for conservation and management of shark stocks, in accordance with the *FAO International Plan of Action for the Conservation and Management of Sharks.* In 2006, the IATTC, in cooperation with scientists of CPCs and, if possible, the Western and Central Pacific Fisheries Commission, shall provide preliminary advice on the stock status of key shark species and propose a research plan for a comprehensive assessment of these stocks. CPCs shall take the measures necessary to require that their fishers fully utilize any retained catches of sharks. CPCs shall require their vessels to have onboard fins that total no more than 5% of the weight of sharks onboard, up to the first point of landing. CPCs that currently do not require fins and carcasses to be offloaded together at the point of first landing shall take the necessary measures to ensure compliance with the 5% ratio through certification, monitoring by an observer, or other appropriate measures. Fishing vessels are prohibited from retaining on board, transshipping, landing or trading in any fins harvested in contravention of this Resolution. In fisheries for tunas and tuna-like species that are not directed at sharks, CPCs shall encourage the release of live sharks, especially juveniles, to the extent practicable, that are caught incidentally and are not used for food and/or subsistence. CPCs shall, where possible, undertake research to identify ways to make fishing gears more selective. CPCs are encouraged, where possible, to conduct research to identify shark nursery areas. The Commission shall consider appropriate assistance to developing CPCs for the collection of data on shark catches. Each CPC shall annually report data for catches, effort by gear type, landing and trade of sharks by species, where possible, in accordance with IATTC reporting procedures, including available historical data. CPCs shall send to the IATTC Secretariat, by May 1, at the latest, a comprehensive annual report of the implementation of this Resolution during the previous year.
C-07-03	Resolution to mitigate the impact of tuna fishing vessels on sea turtles	2007	Actions to be done by Member States cover (i) the implementation the FAO Guidelines to reduce the bycatch, injury, and mortality of sea turtles in fishing operations and to ensure the safe handling of all captured sea turtles, in order to improve their survival; (ii) report to the IATTC annually by 30 June on the progress of implementation of the FAO Guidelines; (iii) implement observer programs for fisheries; (iv) require fishermen on vessels targeting species covered by the Convention to bring aboard, any comatose or inactive hard-shell sea turtle including resuscitation, before returning it to the water; (v) for PS avoid encirclement of sea turtles to the extent practicable, take actions necessary to monitor FADs for the entanglement of sea turtles, require fishermen to release all sea turtles observed entangled in FADs, conduct research and development of modified FAD designs to reduce sea turtle entanglement; and (vi) for LL vessels require fishermen to carry and, when sea turtle interactions occur, employ the necessary equipment (e.g. de-hookers, line cutters, and scoop nets) for the prompt release of incidentally caught sea turtles, continue to improve techniques to further reduce sea turtle bycatch and expeditiously undertake fishing trials to determine the feasibility and effectiveness of appropriate combinations of circle hooks and bait, depth, gear specifications, fishing practices, and other measures in reducing the bycatch, injury, and mortality of sea turtles, assess their effects on the catch of target and other bycatch species, and provide results to the IATTC. Actions by IATTC Staff: review the information submitted; the results of research and fishing trials provided by CPCs (including the development of modified FADs and effectiveness of circle hook/bait combinations); and any new information available regarding proven techniques to reduce sea turtle bycatch, injury and mortality in fisheries targeting tuna and tuna-like species.
C-11-11	Resolution on capacity building in developing countries	2011	Taking into account the provisions of the Antigua Convention that the Commission shall seek to adopt measures relating to technical assistance, technology transfer, training and other forms of cooperation, to assist developing countries that are members of the Commission to fulfill their obligations under the Convention, as well as to enhance their ability to develop fisheries under their respective national jurisdictions and to participate in high seas fisheries on a sustainable basis.
C-11-10	Resolution on the conservation of oceanic whitetip sharks caught in association with fisheries in the Antigua Convention area.	2011	(CPCs) shall prohibit retaining onboard, transhipping, landing, storing, selling, or offering for sale any part or whole carcass of oceanic whitetip sharks in the fisheries covered by the Antigua Convention. CPCs shall require vessels flying their flag to promptly release unharmed, to the extent practicable, whitetip sharks when brought alongside the vessel and CPCs shall record *inter alia*, through the observer programs, the number of discards and releases of oceanic whitetip sharks with indication of status (dead or alive) and report it to IATTC.

C-11-08	Resolution on scientific observers for longline vessels	2011	Due to the need to collect scientific information on target species as well as comprehensive data on interactions with non-target species, in particular, sea turtles, sharks and seabird, CPCs shall ensure that at least 5% of the fishing effort made by its longline fishing vessels greater than 20 meters length overall carry a scientific observer. The Secretariat, after consulting the Scientific Advisory Committee, will recommend to the Commission on the efficiency level needed to accomplish the objectives of this Resolution, and particularly on the potential increase of the required coverage rate.
C-11-02	Resolution to mitigate the impact on seabirds of fishing for species covered by the IATTC.	2011	CPCs shall report to the IATTC on their implementation of the IPOA-Seabirds, including, as appropriate, the status of their National Plans of Action for reducing incidental catches of seabirds in longline fisheries. And CPCs are encouraged to voluntarily employ mitigation measures and to work, jointly and individually, to undertake research, especially on specifications for weighted branch lines, to further develop and refine methods for mitigating seabird bycatch, including measures for use during the process of hauling in longlines, and shall submit to the IATTC any information derived from such efforts.
C-12-10	Recommendation Best available Science	2012	Recognizing the importance of sound scientific advice as the centrepiece for the conservation and management of tuna and tuna-like species in the IATTC Convention Area, in accordance with international law and in line with the information needs of the IATTC, take measures to ensure a more interactive relationship between CPCs, the IATTC scientific staff, and the Scientific Advisory Committee in relation to the-provision of scientific advice, to improve the collection and submission of data to the IATTC, including on bycatches; and to support research programs and projects relevant to the information needs of the IATTC .

The current status of development and implementation of National Plans of Action (NPOA's) for sharks, by each CPC, recalling that the IPOA-Sharks was adopted by the FAO in 2000, is shown in the table below. Currently only 14 of the 21 IATTC CPCs have a NPOA-Sharks.

MEMBERS	NPOA
Belize	
Canadá	Yes
China	
Colombia	Yes
Costa Rica	Yes
Ecuador	Yes
El Salvador	
European Union	Yes
France	Yes
Guatemala	Yes
Japan	Yes
Kiribati	
Korea	Yes
Mexico	Yes
Nicaragua	
Panama	Yes
Peru	
Chinese Taipei	Yes
United States of America	Yes
Vanuatu	
Venezuela	Yes

3.4.3 Methodology and data used

For the present report, as explained above, data were mainly obtained from the public domain of the RFMOs' web sites, as well as from different sources within these organizations: annual reports, workshop reports, papers presented at scientific committees, resolutions, etc. The persons responsible of IATTC and WCPFC databases have been contacted to progress in the analysis work on the quality and quantity of the data.

For more details see general section of Material and Methods.

3.4.4 Historical catch and effort data

Catches

The catches in IATTC database (public) summarize the fisheries for species covered by the IATTC Convention (tunas and other fishes caught by tuna-fishing vessels) in the eastern Pacific Ocean (EPO). The most important of these are the scombrids (Family Scombridae), which include tunas, bonitos, seerfishes, and mackerels. The principal species of tunas caught are yellowfin, skipjack, bigeye, and albacore, with lesser catches of Pacific bluefin, black skipjack, and frigate and bullet tunas. Other scombrids, such as bonitos and wahoo, are also caught.

These database also covers other species caught by tuna-fishing vessels in the EPO: billfishes (swordfish, marlins, shortbill spearfish, and sailfish), carangids (yellowtail, rainbow runner, and jack mackerel), dorado, elasmobranchs (sharks, rays, and skates), and other fishes.

In the fishery for tunas, billfishes and associated species in the Eastern Pacific Ocean (EPO), most of the catches are made by the purse-seine and longline fleets; the pole-and-line fleet and various artisanal and recreational fisheries account for a small percentage of the total catches. In general, detailed data are available for the purse-seine and pole-and-line fisheries; the data for the longline, artisanal, and recreational fisheries are incomplete. The IATTC Regional Vessel Register contains details of vessels authorized to fish for tunas in the EPO.
(http://www.iattc.org/VesselRegister/VesselList.aspx?List=RegVessels&Lang=ENG).

The IATTC has detailed records of most of the purse-seine and pole-and-line vessels that fish for yellowfin, skipjack, bigeye, and/or Pacific bluefin tuna in the EPO. The Register is incomplete for small vessels. It contains records for most large (overall length >24 m) longline vessels that fish in the EPO and in other areas.

Estimating the total catch of a species of fish is difficult, for various reasons. Some fish are discarded at sea, and the data for some gear types are incomplete. Data for fish discarded at sea by purse-seine vessels with carrying capacities greater than 363 metric tons (t) have been collected by observers since 1993, which allows for better estimation of the total amounts of fish caught by the purse-seine fleet. Estimates of the total amount of the catch that is landed (hereafter referred to as the retained catch) are based principally on data from unloading. Data on the retained catches of most of the larger longline vessels are obtained from the governments of the nations that fish for tunas in the EPO. Longline vessels, particularly the larger ones, direct their effort primarily at bigeye, yellowfin, albacore, or swordfish. Data from smaller longliners, artisanal vessels, and other vessels that fish for tunas, billfishes, dorado, and sharks in the EPO were gathered either directly from the governments, from logbooks, or from reports published by the governments. The data from all of the above sources are compiled in a database by the IATTC staff. In recent years, the IATTC staff has increased its effort toward compiling data on the catches of tunas, billfishes, and other species caught by other gear types, such as trollers, harpooners, gillnetters, and recreational vessels.

Figure 3.4.1 presents the evolution of total catches (all gears), in tonnes, of the main species of tuna in the EPO from 1982 until 2011. YFT= yellowfin, SKJ= skipjack, BET = bigeye, PBF = Pacific bluefin and ALB = albacore.

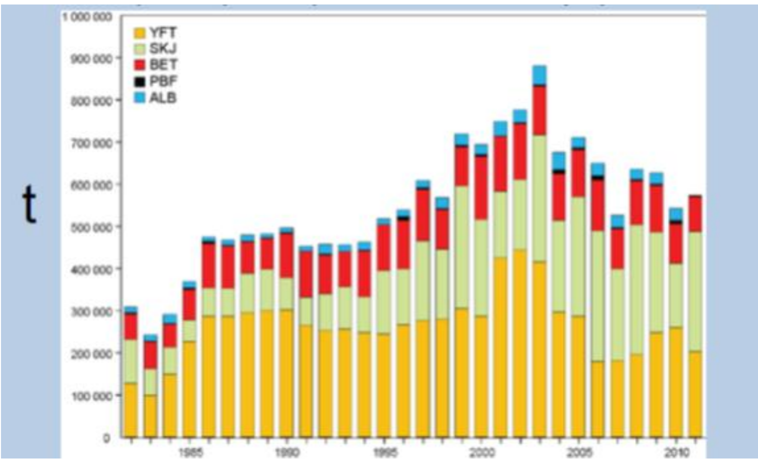


Figure 3.4.1.- Total catches (all gears), in tonnes, of the main species of tuna in the Eastern Pacific Ocean from 1982 until 2011 (YFT= yellowfin tuna, SKJ=skipjack, BET= bigeye tuna, PBF= Pacific bluefin tuna and ALB = albacore).

The following figure shows the catches of tuna and sharks by the various types of fishing gear available in the public database of the IATTC.

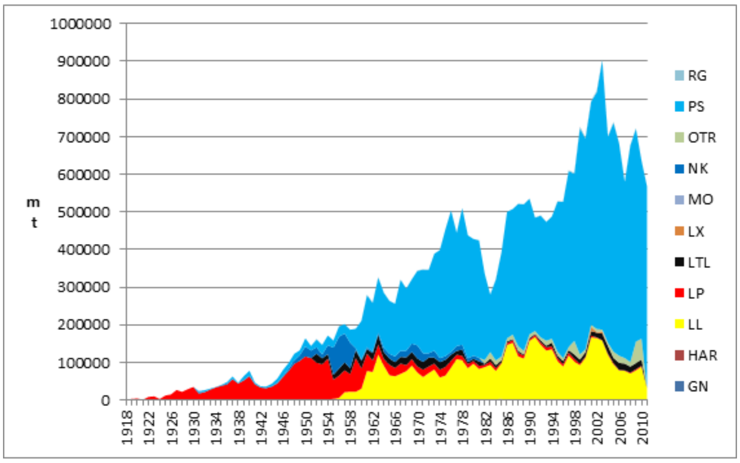


Figure 3.4.2.- Tuna and sharks catches by types of fishing gear from the IATCC public database. RG: recreational; PS: Purse seine; OTR: Other; NK: Unknown; MO: ; LX: Hooks and lines; LTL: Troll; LP: Pole and line; LL: longline ; HAR: Harpoon; GN: gillnet.

Data on the catches and discards of elasmobranchs (sharks, rays, and skates) caught in the EPO, by year and gear, are shown in the next figure and table:

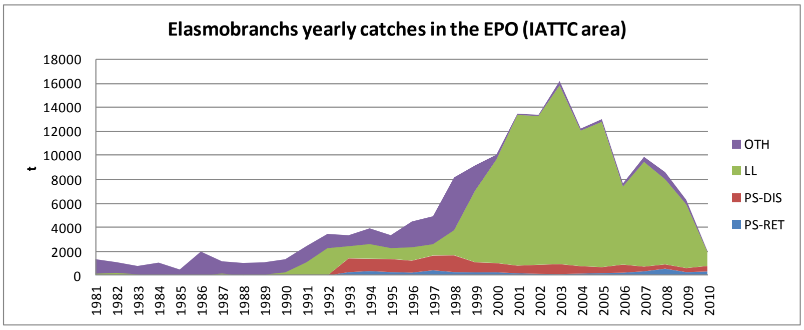


Figure 3.4.3.- Catches and discards (t) of elasmobranchs (sharks, rays, and skates) caught in the EPO by year and gear.

Preliminary estimates of the catches (including purse-seine discards), in metric tons, of sharks and other large fishes by large purse-seine vessels in the EPO during 2011 are shown in Table 3.4.4. Complete data are not available for small purse-seine, longline, and other types of vessels (OBJ: Objects set; NOA: unassociated sets and DEL: Dolfin sets). (Estimations bases on our methodology are presented in Annex III).

Table 3.4.4.- Estimates of the catches (including purse-seine discards), in metric tons, of sharks and other large fishes by large purse seiners in the EPO during 2011.

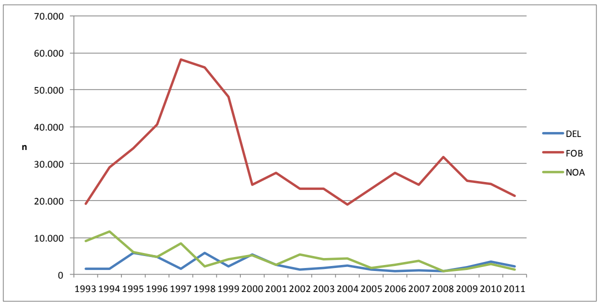
	Set type			Total
	OBJ	NOA	DEL	
Silky shark (*Carcharhinus falciformis)*	358	62	69	489
Oceanic whitetip shark (*C. longimanus)*	2	0	<1	2
Hammerhead sharks (*Sphyrna* spp.)	49	3	4	56
Thresher sharks (*Alopias* spp.)	1	2	6	10
Other sharks	32	17	25	74
Manta rays (Mobulidae)	7	97	56	160
Pelagic sting rays (Dasyatidae)	<1	<1	3	3

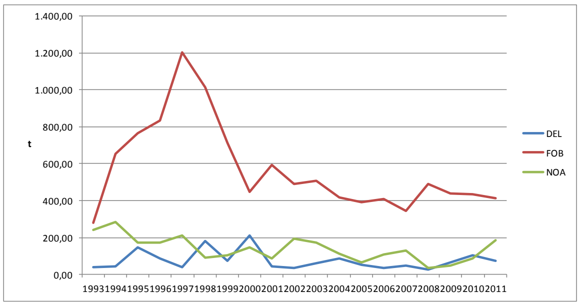
With a few exceptions, the bycatch rates are greatest in sets on floating objects, followed by unassociated sets and, at a much lower level, dolphin sets. Dolphin bycatch rates are greatest for dolphin sets, followed by unassociated sets and, at a much lower level, floating-object sets. The bycatch rates of manta rays (Mobulidae), and stingrays (Dasyatidae) are greatest in unassociated sets, followed by dolphin sets, and lowest in floating-object sets. Because of these differences, it is necessary to follow the changes in frequency of the different types of sets to interpret the changes in bycatch (DOL-Dolphin set, FRS-Free school set and FAD set).

Table 3.4.5.- Catch rates of major shark species (or species groups) by type of association-set in the purse seine fishery in the EPO (DOL= Dolphins.FRS= Free school and FAD= Fishing aggregated devices).

SHARKS		DOL	FRS	FAD
Silky shark	*Carcharhinus falciformis*	3%	4%	93%
Oceanic whitetip shark	*Carcharhinus longimanus*	8%	--	91%
Bigeye thresher shark	*Alopias superciliosus*	35%	51%	14%
Pelagic thresher shark	*Alopias pelagicus*	34%	43%	23%
Scalloped hammerhead shark	*Sphyrna lewini*	--	18%	77%
Great hammerhead	*Sphyrna mokarran*	--	--	93%
Smooth hammerhead shark	*Sphyrna zygaena*	--	--	88%

The following figures show yearly shark bycatches in number (left) and tonnes (right) by the purse seine fleet (greather than 363 t capacity) in the EPO.





Figures 3.4.4.- Yearly shark bycatches in number (left) and tonnes (right) by the purse seine fleet (greather than 363 t capacity) in the EPO by type of association (DOL = dolphins,,FOB = FADs and UNA= not associated).

The next table presents the annual PS catches of sharks by species in tonnes from 2000 to 2012 (Set type: Dol=Dolphins; Fob=Floating objects and Noa=Non associated).

Table 3.4.6.- Shark catches in tonnes by species and type of association, made by the purse seine fleet in the EPO from 2000 to 2010 (observer data).

IATTC PS (observer data)

	Shark catches (tonnes) by No Associated Schools (UNA)										
Shark species	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
Alopias pelagicus	0,7	1,0	0,5	8,6	4,0	2,8	30,8	3,3	3,5	1,0	0,9
Alopias spp.	0,9	6,3	10,9	6,5	5,4	0,8	3,6	1,3	1,9	0,3	0,6
Alopias superciliosus	8,5	5,8	13,8	13,6	22,5	5,5	27,9	2,6	3,8	1,0	0,6
Alopias vulpinus	0,9	1,3	2,9	0,9	2,5	1,0	8,7	1,0	1,8	1,2	0,7
Carcharhinus brachyurus	0,9	0,0	0,0	0,0	0,2	0,0	0,0	0,0	0,0	0,0	0,0
Carcharhinus falciformis	69,8	83,5	212,1	140,3	67,7	36,0	54,1	124,1	21,6	47,4	86,2
Carcharhinus falciformis, C. limbatus	37,1	37,4	35,5	30,2	11,7	17,0	0,0	0,2	0,0	0,0	0,0
Carcharhinus galapagensis	0,0	0,0	0,0	0,0	0,1	0,0	0,0	0,0	0,0	0,0	0,0
Carcharhinus leucas	0,0	1,2	0,4	7,3	1,0	0,2	0,0	0,4	0,0	0,0	0,0
Carcharhinus limbatus	0,0	0,0	0,0	0,0	0,0	0,3	1,6	0,0	0,0	3,8	0,3
Carcharhinus longimanus	12,2	1,0	10,4	0,8	0,2	0,0	0,1	0,0	0,0	0,0	0,0
Carcharhinus obscurus	0,4	0,1	0,3	0,2	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Carcharhinus plumbeus	0,0	0,1	0,1	0,1	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Carcharhinus spp.	0,0	0,0	30,3	2,5	3,0	1,9	1,1	24,8	0,5	2,2	12,4
Carcharodon carcharias	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Cetorhinus maximus	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Elasmobranchii	47,1	6,0	11,8	13,3	10,4	5,2	0,6	3,2	0,8	4,6	2,8
Galeocerdo cuvier	0,0	0,0	0,0	0,0	0,3	0,0	0,0	0,0	0,0	0,0	0,0
Isurus oxyrinchus	0,3	0,1	0,7	1,1	1,0	1,6	3,1	1,3	1,4	0,4	0,9
Isurus spp.	0,0	0,1	0,0	0,0	0,0	0,2	0,7	0,2	0,3	0,7	0,3
Nasolamia velox	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Negaprion brevirostris	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Prionace glauca	0,5	0,2	0,6	0,1	0,4	0,4	0,9	0,9	1,0	1,2	1,4
Rhincodon typus	20,0	0,0	4,8	49,2	3,8	0,0	0,0	0,0	0,0	0,0	2,3
Rhizoprionodon longurio	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Sphyrna corona	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Sphyrna lewini	18,9	1,3	1,2	5,5	3,5	14,2	3,7	2,8	8,5	2,6	1,5
Sphyrna media	0,1	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Sphyrna mokarran	0,3	0,0	0,0	0,4	0,5	0,0	0,1	0,1	0,0	0,0	0,0
Sphyrna spp.	2,3	1,3	7,6	4,6	3,2	1,3	0,5	1,3	0,8	2,2	0,0
Sphyrna tiburo	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Sphyrna zygaena	3,1	1,6	4,4	10,3	16,0	2,1	7,2	3,6	0,9	1,1	1,6
TOTAL	**224,09**	**148,15**	**348,21**	**295,39**	**157,30**	**90,69**	**144,74**	**171,10**	**46,73**	**69,69**	**112,63**

	Shark catches (tonnes) in FADs										
Shark species	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
Alopias pelagicus	0,1	0,5	0,3	1,2	6,1	1,1	1,7	3,2	1,3	0,6	0,8
Alopias spp.	0,4	0,4	0,3	0,2	0,5	0,3	0,2	0,3	0,3	0,5	0,2
Alopias superciliosus	0,6	0,6	2,2	0,9	1,0	1,0	0,8	2,1	0,5	0,8	0,2
Alopias vulpinus	0,1	0,1	0,5	0,2	0,2	0,2	0,2	0,2	0,2	0,1	1,2
Carcharhinus altimus	1,0	0,3	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Carcharhinus brachyurus	0,1	0,7	0,1	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Carcharhinus falciformis	176,2	350,4	282,3	307,7	215,7	314,1	345,5	308,2	478,7	379,7	393,8
Carcharhinus falciformis, C. limbatus	127,1	61,9	21,9	23,7	21,4	4,1	5,1	9,1	1,1	0,2	0,0
Carcharhinus galapagensis	0,3	0,0	0,1	0,7	0,1	0,0	0,0	0,0	0,0	0,0	0,2
Carcharhinus leucas	0,0	0,0	0,0	1,5	0,0	0,1	0,0	0,0	0,0	0,0	0,0
Carcharhinus limbatus	0,0	0,0	0,0	0,0	0,0	0,0	4,4	0,2	2,7	4,9	1,0
Carcharhinus longimanus	100,6	100,7	32,0	20,0	8,6	2,6	5,0	2,7	2,2	4,0	2,5
Carcharhinus obscurus	0,0	0,0	0,3	0,5	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Carcharhinus plumbeus	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	2,3	0,0
Carcharhinus porosus	0,0	0,0	1,0	4,3	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Carcharhinus spp.	3,2	8,9	2,7	0,6	5,1	3,8	8,9	9,5	9,6	24,5	17,8
Elasmobranchii	17,9	27,7	28,8	9,8	10,7	2,0	6,6	5,8	11,5	21,4	11,1
Galeocerdo cuvier	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Isurus oxyrinchus	1,7	2,3	3,6	2,0	0,9	1,4	1,7	1,8	0,7	1,3	2,2
Isurus spp.	0,0	0,1	0,1	0,0	0,2	0,1	0,4	0,5	0,2	0,4	1,2
Prionace glauca	0,6	4,1	1,2	0,2	0,3	0,3	0,3	0,1	0,3	0,3	0,1
Rhincodon typus	2,7	0,0	11,1	2,8	22,3	2,8	1,9	0,0	1,0	0,0	8,4
Sphyrna corona	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Sphyrna lewini	6,8	12,8	47,5	40,5	26,1	26,4	20,2	13,9	17,7	14,2	14,3
Sphyrna media	0,2	0,0	0,8	0,9	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Sphyrna mokarran	7,1	5,3	7,0	13,6	3,5	2,0	1,4	0,0	0,9	0,2	0,6
Sphyrna spp.	6,4	23,5	46,8	54,0	63,1	20,6	3,4	1,5	7,0	6,3	4,0
Sphyrna tiburo	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Sphyrna zygaena	11,0	25,3	24,8	51,8	52,9	36,5	36,2	28,7	18,0	24,6	32,8
Total	**464,0**	**625,8**	**515,7**	**537,1**	**438,9**	**419,3**	**443,8**	**387,8**	**554,0**	**486,4**	**492,4**

	Shark catches (tonnes) in Dolphin Sets										
Shark species	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
Alopias pelagicus	0,3	0,5	0,8	3,1	1,7	1,6	0,7	3,0	1,0	0,8	2,3
Alopias spp.	2,7	1,2	6,4	3,4	1,6	0,6	0,2	0,7	0,8	0,8	1,0
Alopias superciliosus	0,5	1,1	1,8	4,9	0,9	2,2	0,7	1,3	1,2	1,4	1,7
Alopias vulpinus	0,4	0,4	0,5	0,7	0,7	1,1	0,3	0,3	0,2	0,5	0,6
Carcharhinus altimus	0,1	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Carcharhinus brachyurus	0,1	0,0	0,1	0,0	0,2	0,0	0,0	0,0	0,0	0,0	0,0
Carcharhinus falciformis	5,5	18,8	29,8	34,7	63,4	27,1	7,2	12,3	8,2	24,7	64,7
Carcharhinus falciformis, C. limbatus	7,1	16,7	3,7	9,6	2,7	4,3	0,0	0,3	0,0	0,1	0,0
Carcharhinus leucas	0,0	0,0	0,0	0,5	0,0	0,0	0,0	2,0	0,0	0,0	0,0
Carcharhinus limbatus	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,1	0,1	4,2	0,0
Carcharhinus longimanus	0,7	0,5	1,1	0,3	0,2	0,2	0,0	0,0	0,1	0,7	0,1
Carcharhinus obscurus	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Carcharhinus plumbeus	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	4,4	0,0
Carcharhinus porosus	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Carcharhinus spp.	0,0	0,0	0,4	0,0	0,6	2,6	1,4	3,3	0,5	6,1	19,9
Elasmobranchii	104,2	1,1	4,8	3,2	3,4	1,2	0,1	0,6	0,6	1,0	1,5
Isurus oxyrinchus	0,0	0,0	0,3	0,0	0,1	0,0	0,0	0,0	0,0	0,1	0,2
Isurus spp.	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Nasolamia velox	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Negaprion brevirostris	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Prionace glauca	0,1	0,1	0,2	0,2	0,0	0,0	0,0	0,0	0,1	0,3	0,9
Rhizoprionodon longurio	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Sphyrna corona	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Sphyrna lewini	0,6	0,8	1,5	2,0	1,1	2,1	0,3	0,5	0,3	1,0	1,2
Sphyrna media	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Sphyrna mokarran	0,0	0,1	0,2	0,1	0,1	0,1	0,0	0,1	0,1	0,0	0,1
Sphyrna spp.	3,9	1,3	2,8	2,1	0,7	0,4	0,0	0,1	0,5	0,6	0,3
Sphyrna zygaena	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Total	**126,0**	**42,5**	**54,3**	**64,9**	**77,4**	**43,4**	**11,1**	**24,8**	**13,8**	**46,7**	**94,6**

Although the IATTC has an observer program with a 100 % of coverage, similar to other regions we have estimated the likely catch of shark based on the ratios published in the literature of shark catch over target catch as has been done for other regions. The following table presents our estimation of shark catches by species for all purse seines operating in the Easten Pacific Ocean for all sets types combined (note that depending on the set type the shark catch varies – see table above). The following table 3.4.7 gives a tentative picture of the first estimates of the average tonnages per year for the purse seine fleet in the Eastern Atlantic Ocean.

Table 3.4.7.- Average yearly studied sharks species catch estimated during the study (tons/year) by PS fleet.

NOA+OBJ+DOL	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Alopias pelagicus	1	2	2	13	12	6	33	10	6	2	4	5
Alopias spp.	4	8	18	10	8	2	4	2	3	2	2	2
Alopias superciliosus	10	8	18	19	24	9	29	6	5	3	3	5
Alopias vulpinus	1	2	4	2	3	2	9	2	2	2	2	1
Carcharhinus altimus	1	0	0	0	0	0	0	0	0	0	0	0
Carcharhinus brachyurus	1	1	0	0	0	0	0	0	0	0	0	0
Carcharhinus falciformis	251	453	524	483	347	377	407	445	509	452	545	379
Carcharhinus falciformis, C. limbatus	171	116	61	64	36	25	5	10	1	0	0	0
Carcharhinus galapagensis	0	0	0	1	0	0	0	0	0	0	0	0
Carcharhinus leucas	0	1	0	9	1	0	0	2	0	0	0	0
Carcharhinus limbatus	0	0	0	0	0	0	6	0	3	13	1	6
Carcharhinus longimanus	113	102	44	21	9	3	5	3	2	5	3	2
Carcharhinus obscurus	0	0	1	1	0	0	0	0	0	0	0	0
Carcharhinus plumbeus	0	0	0	0	0	0	0	0	0	7	0	0
Carcharhinus porosus	0	0	1	4	0	0	0	0	0	0	0	0
Carcharhinus spp.	3	9	33	3	9	8	11	38	11	33	50	27
Carcharodon carcharias	0	0	0	0	0	0	0	0	0	0	0	0
Cetorhinus maximus	0	0	0	0	0	0	0	0	0	0	0	0
Elasmobranchii	169	35	45	26	25	8	7	10	13	27	15	206
Galeocerdo cuvier	0	0	0	0	0	0	0	0	0	0	0	0
Isurus oxyrinchus	2	3	5	3	2	3	5	3	2	2	3	5
Isurus spp.	0	0	0	0	0	0	1	1	0	1	2	2
Nasolamia velox	0	0	0	0	0	0	0	0	0	0	0	0
Negaprion brevirostris	0	0	0	0	0	0	0	0	0	0	0	0
Prionace glauca	1	4	2	0	1	1	1	1	1	2	2	2
Rhincodon typus	23	0	16	52	26	3	2	0	1	0	11	11
Rhizoprionodon longurio	0	0	0	0	0	0	0	0	0	0	0	0
Sphyrna corona	0	0	0	0	0	0	0	0	0	0	0	0
Sphyrna lewini	26	15	50	48	31	43	24	17	27	18	17	24
Sphyrna media	0	0	1	1	0	0	0	0	0	0	0	0
Sphyrna mokarran	7	5	7	14	4	2	1	0	1	0	1	5
Sphyrna spp.	13	26	57	61	67	22	4	3	8	9	4	15
Sphyrna tiburo	0	0	0	0	0	0	0	0	0	0	0	0
Sphyrna zygaena	14	27	29	62	69	39	43	32	19	26	34	62
Total SHARKS (t)	**814**	**816**	**918**	**897**	**674**	**553**	**600**	**584**	**615**	**603**	**700**	**758**

Total TUNA (1000 t)	**554**	**588**	**623**	**710**	**536**	**599**	**547**	**442**	**557**	**544**	**456**	**538**

The following figure below shows the relative contribution of each shark species to the overall shark catch for the purse seine fleet in the Eastern Pacific Ocean.

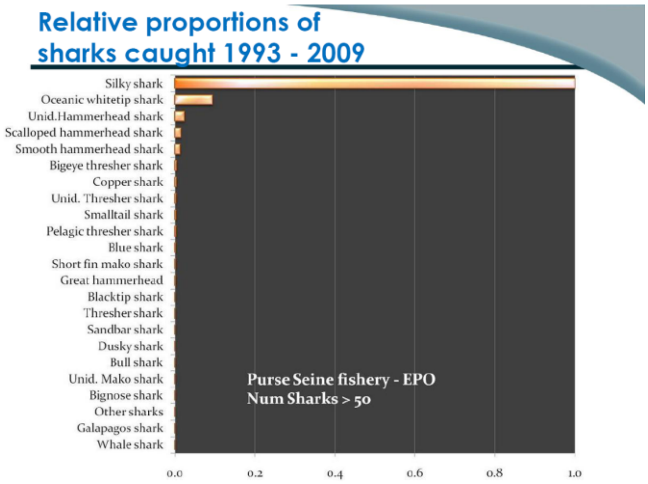


Figure 3.4.5.- Relative contribution of each shark species to the overall shark catch for the purse seine fleet in the Eastern Pacific Ocean.

Effort

The purse-seine and pole-and-line fleets

The IATTC staff maintains detailed records of gear, flag, and fish-carrying capacity for most of the vessels that fish with purse-seine or pole-and-line gear for yellowfin, skipjack, bigeye, and/or Pacific bluefin tuna in the EPO. The fleet described here includes purse-seine and pole-and-line vessels that have fished all or part of the year in the EPO for any of these four species. Historically, the owner's or builder's estimates of carrying capacities of individual vessels, in tonnes of fish, were used until landing records indicated that revision of these estimates was required. Since 2000, the IATTC has used well volume, in cubic meters (m3), instead of weight, in metric tons (t), to measure the carrying capacities of the vessels (Figure 3.4.6). Since a well can be loaded with different densities of fish, measuring carrying capacity in weight is subjective, as a load of fish packed into a well at a higher density weighs more than a load of fish packed at a lower density. Using volume as a measure of capacity eliminates this problem. The IATTC staff began collecting capacity data by volume in 1999, but has not yet obtained this information for all vessels. For vessels for which reliable information on well volume is not available, the estimated capacity in metric tons was converted to cubic meters. Until about 1960, fishing for tunas in the EPO was dominated by pole-and-line vessels operating in coastal regions and in the vicinity of offshore islands and banks. During the late 1950s and early 1960s most of the larger pole-and-line vessels were converted to purse seiners, and by 1961 the EPO fishery was dominated by these vessels. From 1961 to 2010 the number of pole-and-line vessels decreased from 93 to 3, and their total well volume from about 11 thousand to about 255 m3. During the same period the number of purse-seine vessels increased from 125 to 200, and their total well volume from about 32 thousand to about 210 thousand m3, an average of about 1,050 m3 per vessel. An earlier peak in numbers and total well volume of purse seiners occurred from the mid-1970s to the early 1980s, when the number of vessels reached 282 and the total well volume about 195 thousand m3, an average of about 700 m3 per vessel.

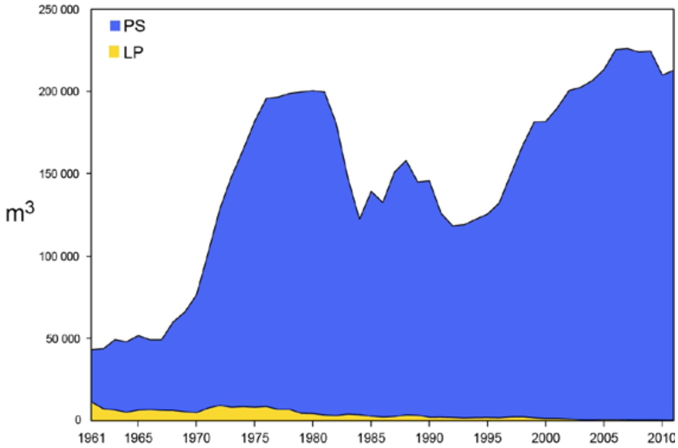


Figure 3.4.6.- The evolution on carrying capacity, in cubic meters of well volume, of the purse-seine-PS (blue) and pole-and-line PL (yellow) fleets in the EPO, 1961-2011.

The next figure show the evolution of the fishing effort (millions of hooks) for the longline fleet in the EPO, 1981-2011.

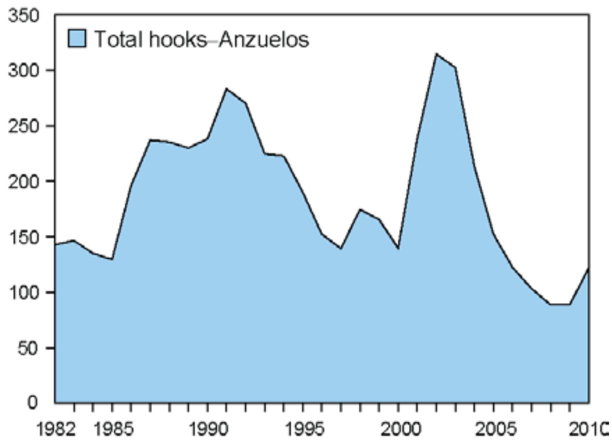


Figure 3.4.7.- fishing effort (millions of hooks) for the longline fleet in the EPO, 1981-2010.

Table 3.4.8 presents the estimates of the numbers and well volumes (cubic meters) of purse-seine (PS) and pole-and-line (LP) vessels that fished in the EPO in 2011 by flag (BOL-Bolivia, COL-Colombia, ECU-Ecuador, ESP-Spain, GTM-Guatemala, HND-Honduras, MEX-Mexico, NIC-Nicaragua, Pan-Panama, PER-Peru, SLV-El Salvador, VEN-Venezuela and VUT-Vanuatu) and gear PS and PL). Each vessel is included in the total for each flag under which it fished during the year, but is included only once in the "Grand total"; therefore the grand total may not equal the sums of the individual flags.

Table 3.4.8.- Number of boats and well volumes (cubic meters) of purse-seine (PS) and pole-and-line (LP) vessels that fished in the EPO in 2011 by flag

Flag Bandera	Gear Arte	Well volume —Volumen de bodega (m^3)					Total	
		<401	401-800	801-1300	1301-1800	>1800	No.	Vol. (m^3)
		Number—Número						
BOL	PS	1	-	-	-	-	1	222
COL	PS	2	2	7	3	-	14	14,860
ECU	PS	36	28	17	6	9	96	70,014
ESP	PS	-	-	-	-	4	4	10,116
GTM	PS	-	-	1	1	1	3	4,819
MEX	PS	3	3	20	15	-	41	47,274
	LP	2	-	-	-	-	2	143
NIC	PS	-	-	4	3	-	7	9,685
PAN	PS	-	3	7	6	3	19	25,443
SLV	PS	-	-	-	1	3	4	7,892
USA	PS	-	-	2	1	-	3	4,046
VEN	PS	-	-	10	8	-	18	24,007
VUT	PS	-	-	1	2	-	3	3,609
Grand total— Total general	PS	42	36	65	43	20	206	
	LP	2	-	-	-	-	2	
	PS + LP	44	36	65	43	20	208	
		Well volume—Volumen de bodega (m^3)						
Grand total— Total general	PS	11,031	21,562	73,042	64,137	43,236		213,008
	LP	143	-	-	-	-		143
	PS + LP	11,174	21,562	73,042	64,137	43,236		213,151

- : none—ninguno

Table 3.4.9 presents the numbers and well volumes, in cubic meters, of purse-seine and pole-and line vessels of the EPO tuna fleet. The data for 2011 are preliminary.

Table 3.4.9.- Number of boats and well volumes, in cubic meters, of purse-seine and pole-and line vessels of the EPO tuna fleet

	PS		LP		Total	
	No.	Vol. (m^3)	No.	Vol. (m^3)	No.	Vol. (m^3)
1982	222	177,643	40	3,016	262	180,659
1983	211	143,859	59	3,829	270	147,688
1984	164	118,964	49	3,499	213	122,463
1985	176	136,845	26	2,595	202	139,440
1986	165	130,530	17	2,066	182	132,596
1987	173	148,713	29	2,383	202	151,096
1988	185	154,845	39	3,352	224	158,197
1989	176	141,956	32	3,181	208	145,137
1990	172	143,877	23	1,975	195	145,852
1991	152	124,062	22	1,997	174	126,059
1992	158	116,619	20	1,807	178	118,426
1993	151	117,593	15	1,550	166	119,143
1994	166	120,726	20	1,726	186	122,452
1995	175	123,798	20	1,784	195	125,582
1996	180	130,774	17	1,646	197	132,420
1997	194	147,926	23	2,127	217	150,053
1998	202	164,956	22	2,216	224	167,172
1999	209	179,999	14	1,642	223	181,641
2000	205	180,679	12	1,220	217	181,899
2001	204	189,088	10	1,259	214	190,347
2002	218	199,870	6	921	224	200,791
2003	214	202,381	3	338	217	202,719
2004	218	206,473	3	338	221	206,811
2005	221	213,144	4	498	225	213,642
2006	225	225,166	4	498	229	225,664
2007	228	225,901	4	380	232	226,281
2008	219	223,804	4	380	223	224,184
2009	217	224,296	4	380	221	224,676
2010	201	209,870	3	255	204	210,125
2011	206	213,008	2	143	208	213,151

Table 3.4.10 shows the historical available information (for years and flag) of sharks in the IATTC database obtained by observers in various purse seiners fleets.

Table: 3.4.10.- Historical available information (for years and flag) of sharks in the IATTC database obtained by observers in various purse seiners fleets (from 1993 to 2011).

Flag/Year	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Belize	x	x	x	x	x	x	x	x	x	x									
Bolivia								x	x	x	x	x							
UE-Cyprus	x	x	x	x	x	x													
Colombia	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Costa Rica			x	x															
Unknown					x	x			x		x								
Ecuador	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
El Salvador						x	x		x	x	x	x	x	x	x	x	x	x	x
UE-Spain	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
USA	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Guatemala							x	x	x	x	x	x	x	x	x	x	x	x	x
Honduras				x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Liberia				x															
Mexico	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Nicaragua							x	x	x	x		x	x	x	x	x	x	x	x
Panama	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Peru										x	x				x	x	x		
San Vicente		x																	
Vanuatu	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Venezuela	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x

The Longliners and other fleets in the EPO.

Information on other types of vessels that fish for tunas in the EPO is available on the IATTC's Regional Vessel Register, on the IATTC web site. The Register is incomplete for small vessels. In some cases, particularly for large longline vessels, the Register contains information for vessels authorized to fish not only in the EPO, but also in other oceans, and which may not have fished in the EPO during 2011, or ever.

Table 3.4.11 presents reported nominal longline fishing effort (E; 1000 hooks), and catch (C; metric tons) of yellowfin, skipjack, bigeye, Pacific bluefin, and albacore tunas only (not include sharks), by flag (CHN-China, JPN-Japan, KOR-South Korea, PYF- French Polynesia, TWN-Taiwan, USA-United States of America and OTR(only catch): Belize, Chile, Costa Rica, Ecuador, El Salvador, Guatemala, Honduras, Mexico, Nicaragua, Panamá and Vanuatu) in the EPO.

Table 3.4.11.- Nominal longline fishing effort (E; 1000 hooks) and catch (C; metric tons) of yellowfin, skipjack, bigeye, Pacific bluefin, and albacore tunas only (not including sharks) by flag.

LL	CHN		JPN		KOR		PYF		TWN		USA		OTR[1]
	E	C	E	C	E	C	E	C	E	C	E	C	C
1982	-	-	116,210	61,369	18,608	7,489	-	-	8,117	3,910	-	-	-
1983	-	-	127,177	69,563	14,680	6,478	-	-	4,850	2,311	-	-	49
1984	-	-	119,628	57,262	11,770	4,490	-	-	3,730	1,734	-	-	-
1985	-	-	106,761	74,347	19,799	10,508	-	-	3,126	1,979	-	-	2
1986	-	-	160,572	111,673	30,778	17,432	-	-	4,874	2,569	-	-	68
1987	-	-	188,386	104,053	36,436	19,405	-	-	12,267	5,335	-	-	273
1988	-	-	182,709	82,384	43,056	10,172	-	-	9,567	4,590	-	-	234
1989	-	-	170,370	84,961	43,365	4,879	-	-	16,360	4,962	-	-	9
1990	-	-	178,414	117,923	47,167	17,415	-	-	12,543	4,755	-	-	-
1991	-	-	200,374	112,337	65,024	24,644	-	-	17,969	5,862	42	12	173
1992	-	-	191,300	93,011	45,634	13,104	199	88	33,025	14,142	325	106	128
1993	-	-	159,956	87,976	46,375	12,843	153	80	18,064	6,566	415	81	227
1994	-	-	163,999	92,606	44,788	13,249	1,373	574	12,588	4,883	303	26	523
1995	-	-	129,599	69,435	54,979	12,778	1,776	559	2,910	1,639	828	179	562
1996	-	-	103,649	52,298	40,290	14,120	2,087	931	5,830	3,554	510	181	184
1997	-	-	96,385	59,325	30,493	16,663	3,464	1,941	8,720	5,673	464	216	752
1998	-	-	106,568	50,167	51,817	15,089	4,724	2,858	10,586	5,039	1,008	405	1,176
1999	-	-	80,950	32,886	54,269	13,295	5,512	4,446	23,247	7,865	1,756	470	1,156
2000	-	-	79,327	45,216	33,585	18,758	8,090	4,382	18,152	7,809	736	204	4,868
2001	13,054	5,162	102,220	54,775	72,261	18,200	7,445	5,086	41,926	20,060	1,438	238	15,614
2002	34,894	10,398	103,912	45,401	96,273	14,370	943	3,238	78,024	31,773	611	138	10,258
2003	43,290	14,548	101,236	36,187	71,006	15,551	11,098	4,101	74,456	28,328	1,313	262	11,595
2004	15,886	4,033	76,828	30,937	55,861	14,540	13,757	3,030	49,981	19,535	1,047	166	9,194
2005	16,895	3,681	65,085	25,712	15,798	12,284	13,356	2,514	38,542	12,229	2,397	557	5,442
2006	*	969	56,525	21,432	*	8,752	11,786	3,220	38,139	12,375	234	121	6,792
2007	12,229	2,624	45,970	20,515	10,548	6,037	9,672	3,753	22,243	9,498	2,686	436	3,731
2008	11,519	2,984	44,555	21,375	4,394	4,302	10,255	3,017	12,547	4,198	6,322	1,369	3,207
2009	*	2,481	41,798	21,698	22,316	8,920	10,686	4,032	13,033	6,366	5,145	852	3,178
2010	11,900	3,590	47,094	20,788	29,356	10,377	8,976	3,139	19,579	10,396	8,823	1,478	2,247

The following table shows the historical available information (for years and flag) of sharks in the IATTC database in different longliners fleets.

Table 3.4.12.- Historical information available in the database of the IATTC for shark catches by longline fleets by flag (data is not publicy available).

Flag/Year	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
China																X		X	
Taiwan	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Korea										X	X	X	X		X	X	X	X	X
USA	X	X	X	X	X	X	X	X	X			X	X	X	X	X	X	X	X
Mexico																			
Frenh Polynesia	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X

Table 3.4.13.- Catch sharks registers (in number) in IATTC long line database.

Catch Shark registers in IATTC LL database		
SpeciesAbv	**ScientificName**	**NumRecords**
BSH	*Prionace glauca*	2357
CCL	*Carcharhinus limbatus*	50
FAL	*Carcharhinus falciformis*	188
MAK	*Isurus spp.*	2393
OCS	*Carcharhinus longimanus*	1185
SKX	*Elasmobranchii*	12861
SMA	*Isurus oxyrinchus*	386
SPN	*Sphyrna spp.*	134
THR	*Alopias spp.*	1595
TIG	*Galeocerdo cuvier*	28

In the case of longling fleet, there is neither official catch of shark nor observer records for sharks of the longline fleet operating in the Easter Pacific Ocean. Thus, we have estimated the possible shark catches for the longling fleet operating in the Eastern Pacific Ocean based on the ratios published in the literature of shark catch over target tuna catch for the Eastern Pacific longline fleet (Mejuto et al., 2007). The following table 3.4.14 gives a tentative picture of the first estimates of the average tonnages per year for the longling fleet in the Eastern Atlantic Ocean.

Table 3.4.14.- Average yearly studied sharks species catch estimated during the study (tons/year) by species and by country for the longling fleet in the Eastern Pacific Ocean.

Shark spp.	**Anual average (t.)**	**Country**	**Anual average (t.)**
Alopias sp	26	Belize	1268
Alopias supercillosus	52	Chile	1424
Alopias vulpinus	5	China	3217
Carcharhinus sp	149	Costa Rica	1932
Carcharhinus altimus	0	Ecuador	237
Carcharhinus brachyurus	38	Spain	3212
Carcharhinus falciformis	91	Guatemala	177
Carcharhinus galapagensis	3	Japan	20260
Carcharhinus longimanus	205	Korea	7236
Carcharhinus obscurus	1	Mexico	225
Carcharhinus plumbeus	12	Nicaragua	29
Galeocerdo cuvier	12	OTR	13
Isurus oxyrhinchus	17246	Panama	1000
Isurus paucus	129	Portugal	172
Lamna ditropis	966	French Polynesia	2125
Lamna nasus	154	Taiwan	9723
Prionace glauca	35207	USA	592
Sphyrna lewini	4	Vanuatu	1485
Sphyrna spp.	10		
Sphyrna zygaena	16		

TOTAL	**54327**	**54327**

The following two figures below show the relative contribution of each shark species to the overall shark catch for the longline and artisanal fleet in the Eastern Pacific Ocean.

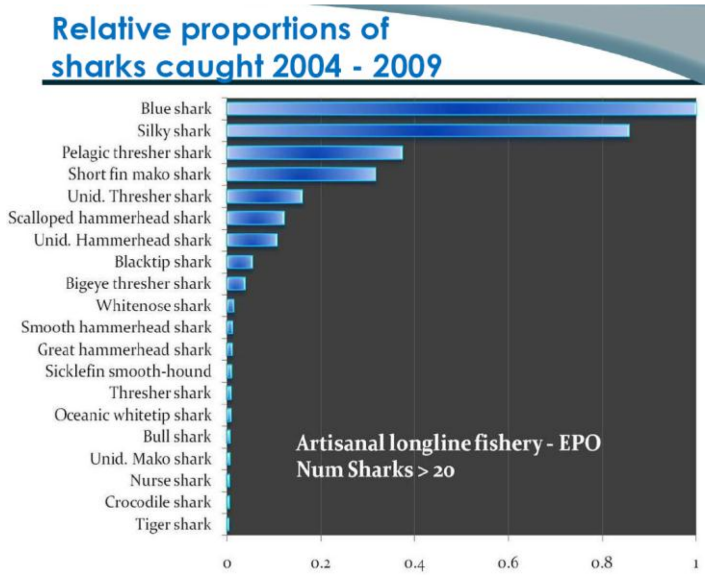


Figure 3.4.8.- Relative contribution of each shark species to the overall shark catch for the artisanal longline fleet in the Eastern Pacific Ocean.

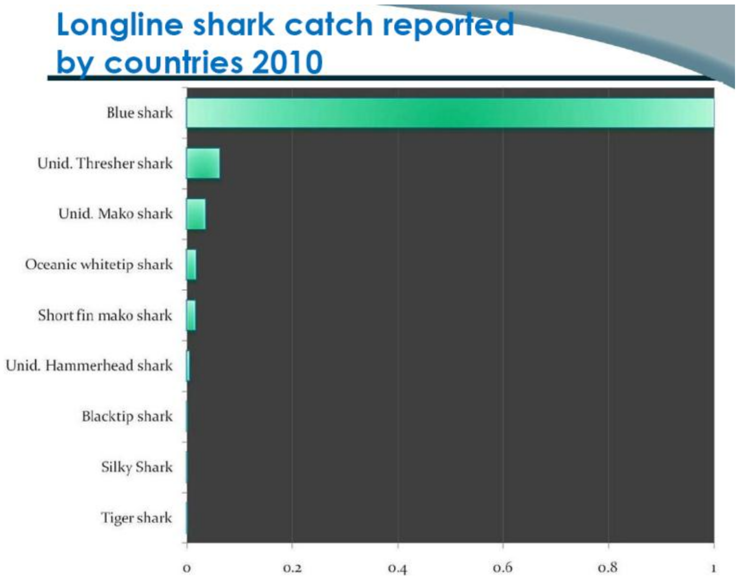


Figure 3.4.9.- Relative contribution of each shark species to the overall shark catch for the longline fleet in the Eastern Pacific Ocean.

3.4.5 Estimation of discards levels

Discards of sharks in the purse seine fleet are perfectly recorded by observers since 1993 (100%) for large boats; however, they are not publicly available by country. For the other gears, fundamentally LL, there is no information available, by species, in the IATTC public database (usually all species are grouped under a common label: SKX).

3.4.6 Catch at size

Although 100% coverage is available for large purse seiners, the information is not totally publicly available, and for other fleets little information about the catch size of key shark species in the IATTC is available.

The biological information has only been revised for silky sharks in the area. It is very fragmented and is held by different countries or organizations.

The tables below summarize the catch and effort and catch at size data available for shark species in the IATTC area.

Table 3.4.15.- Table summary of available data on sharks in the IATTC (source: IATTC Teechnical meeting on sharks, December 2011) for North and South Pacific.

NORTH PACIFIC		
CATCH/EFFORT		
Fleet/area	**Source**	**Data description**
Purse seine	IATTC observer and logbook database	Effort (numbers of sets) 1993-2010. Total bycatch (numbers of sharks), 1993-2010. For large vessels (class 6), from bycatch-per-set x total sets. For small vessels (class 1-5), from bycatch-per-set (large vessels) x total sets by small vessels.
Longline	IATTC longline database; various publications; Chinese and Korean observer program data; U.S. total catches	Effort 1993-2010. From: 1) sum of 5x5 effort data; or 2) totals prorated with 5x5 effort ; or 3) (total effort not available) raised using the total target species catch and hooks per ton. Catch = Effort*CPUE, plus reported total catches (where available). CPUE series from: 1) Clarke (2011) (nominal trend for central Pacific); and 2) purse-seine floating-object standardized trend (north and south). CPUE series scaled with observer data from Chinese and Korean observer programs (provided by Jiangfeng Zhu, Shanghai Ocean University, and Sung Il Lee, National Fisheries Research and Development Institute, respectively).
Mexico	Fernando Márquez-Farias	Annual landing statistics are available by Mexican state for total sharks (>150 cm) and cazón (<150 cm) since 1976 (CONAPESCA-SAGARPA). Silky shark species composition proportions are available from various sources, but cover mostly recent years.

Central America	Manuel Pérez (OSPESCA) José Carvajal (INCOPESCA, Costa Rica)	Annual landings statistics are available by country (various sources) for total sharks, but the temporal coverage varies by country and does not fully cover the historic period of the assessment. Assumptions/interpolations need to be made, in particular for the 1990s. Silky shark species composition proportions are available from the "*Plan Piloto de Monitoreo de Desembarques Artesanales de Tiburones y Rayas en Centroamérica*", but for recent years only (2009-2010). For Costa Rica, annual landings statistics are available for total sharks (*Tiburón*) since 1969 (INCOPESCA). Species composition data are available since 2006, but silky sharks are contained in a pooled species group (grey sharks), with unknown proportions. Fleet composition data also exist for Costa Rica (Costa Rican and foreign vessels landing in Costa Rica), but for recent years only (2009-2010).
LENGTH COMPOSITION		
Fleet/area	**Source**	**Data description**
Purse seine	IATTC observer database (large vessels only)	Size composition data: 1) size categories (< 90 cm TL; 90-150 cm TL; > 150 cm TL) for 1993-2010; 2) length frequencies (cm TL) for 2005-2010, by sex.
Longline	Chinese and Korean observer programs	Size- and sex-composition data available from Chinese and Korean observer programs for 2003-2010, provided by Jiangfeng Zhu and Sung Il Lee, respectively.
Mexico	Fernando Márquez-Farias	Length-frequency data from Mazatlán, 2006-2011, by sex, combined gears. Length-frequency data also exist for the artisanal fishery in Chiapas, 1996-2011, by sex (Sandra Soriano, INAPESCA-Mexico); these data may be available in the future.
Central America	Manuel Pérez (OSPECA); Salvador Siu, CENDEPESCA, El Salvador	Length-frequency data from *Plan Piloto de Monitoreo de Desembarques Artesanales de Tiburones y Rayas en Centroamérica* (2009-2010), and early years from El Salvador (2003, 2006, 2007, 2008), by sex.
INDEX OF ABUNDANCE		
Fleet/area	**Source**	**Data description**
Purse seine	IATTC observer database (large vessels only)	Standardized bycatch trends 1994-2010. From ZINB GAM for floating-object sets for small/medium/large/total sharks. For dolphin and unassociated sets, trends are for presence/absence of large sharks and total sharks.

SOUTH PACIFIC		
CATCH/EFFORT		
Fleet/area	**Source**	**Data description**
Purse seine	IATTC observer and log-book databases	Effort (numbers of sets) 1993-2010. Total bycatch (numbers of sharks), 1993-2010. For large vessels (class 6), from bycatch-per-set x total sets. For small vessels (class 1-5), from bycatch-per-set (large vessels) x total sets by small vessels.
Longline	IATTC longline database; various publications; Chinese and Korean observer program data; U.S. total catches.	Effort 1993-2010. From: 1) sum of 5x5 effort data; or 2) totals prorated with 5x5 effort; or 3) (total effort not available) raised using the total target species catch and hooks per ton. Catch = Effort*CPUE, plus reported total catches (where available). CPUE series from: 1) Clarke (2011) (nominal trend for central Pacific); and 2) purse-seine floating-object standardized trend (north and south). CPUE series scaled with observer data from Chinese and Korean observer programs (provided by Jiangfeng Zhu and Sung Il Lee, respectively).
Ecuador	Subsecretaría de Recursos Pesqueros (SRP)	Silky shark monthly landing statistics available from September 2007 to July 2011 (SRP), for longlines and gillnets. Annual shark landings available for total sharks (1991, 1994-1996, and 2002-2010) from various Ecuadorian sources, including the Instituto Nacional de Pesca. Assumptions/interpolations need
Other		Information on silky sharks catches from Colombia, Peru and Chile is not available, but catches are thought to be low.
LENGTH COMPOSITION		
Fleet/area	**Source**	**Data description**
Purse seine	IATTC observer database (large vessels only)	Size composition data: 1) size categories (< 90cm TL; 90-150cm TL; > 150cm TL) for 1993-2010; 2) length-frequencies (cm TL) for 2005-2010, by sex.
Longline	Chinese and Korean observer programs	Size and sex composition data available from Chinese and Korean observer programs for 2003-2010, provided by Jiangfeng Zhu and Sung Il Lee, respectively.
Ecuador	SRP	Length-frequency data are available for 2004-2010, by sex and gear type (longlines and gillnets).
INDEX OF ABUNDANCE		
Fleet/area	**Source**	**Data description**
Purse seine	IATTC observer database (large vessels only)	Standardized bycatch trends 1994-2010. From ZINB GAM for floating-object sets for medium/large/total sharks. For dolphin and unassociated sets, trends are for presence/absence of large sharks and total sharks.

3.4.7 Biological information

Biological information for all the species covered in the study is presented in **Annex II**.

3.4.8 Fishery indicators (blue shark and shortfin mako)

A stock assessment for blue sharks (*Prionace glauca*) in the North Pacific Ocean as conducted by scientists of the NMFS and the NRIFSF. Preliminary results provided a range of plausible values for MSY of 1.8 to nearly 4 times the 2001 catch of blue sharks per year. A more recent assessment that used catch and effort data for 1971-2002 showed a decline in abundance in the 1980s, followed by a recovery to above the level of 1971. It was assumed that the blue shark population in 2009 was close to MSY level, and fishing mortality may be approaching the MSY level in the future.

Apart from blue sharks, there are no stock assessments available for these species in the EPO, and hence the impacts of the bycatches on the stocks are unknown. A preliminary stock assessment for the silky shark in the EPO was attempted in 2011, and plans exist to do the same for the oceanic whitetip shark in the near future.

Sharks and other large fishes are taken by both purse-seine and longline vessels. Silky sharks (*Carcharhinus falciformis*) are the most commonly-caught species of shark in the purse-seine fishery, followed by oceanic whitetip sharks (*C. longimanus*). The longline fisheries also take silky sharks. A Pacific-wide analysis of longline and purse-seine fishing is necessary to estimate the impact of fishing on the stock(s). Indices of relative abundance of silky sharks, based on data for purse-seine sets on floating objects, showed a decreasing trend during 1994-2004; the trends in unstandardized bycatch per set were similar for the other two types of purse-seine sets (standardized trends are not yet available). The unstandardized average bycatches per set of oceanic whitetip sharks also showed decreasing trends for all three set types during the same period. It is not known whether these decreasing trends were due to incidental capture by the fisheries, changes in the environment (perhaps associated with the 1997-1998 El Niño event), or other factors. The decreasing trends do not appear to be due to changes in the density of floating objects.

3.4.9 Major difficulties

No major difficulties have been suffered in the data gathering process and data identification gaps, however, the major difficulties of the project are the scarcity of data and data availability for major fleets and countries as underlined in the previous section. Most of those data is coming from logbooks which may complicated the data gathering process due to species mis-identification, under-reporting and potential, unidentifiable in targeting strategies.

As advanced above, the major difficulties are related to the lack of data. In many instances, shark catches are not recorded or not disaggregated at the required level. Besides, most of the data recorded are not publicly available and under very strict rules of confidentiality. This problem worsens in the case of developing states and, especially, for historical data. For example, one of the greatest difficulties is to obtain database of catch of artisanal and industrial LL fisheries, which probably do not exist. In many instances, shark catches are not recorded or not disaggregated at the required level.

Another problem, in the specific case of Eatern Pacific Ocean, is the difficulty to access to disaggregated and aggregated data for some of the fleets such as the longline and coastal fleets and in a lesser extend the purse seine fleet.

3.4.10 Summary

Although the IATTC is the oldest Regional Fisheries Management Organization (founded in 1949), its initial work was focused on YFT and SKJ fisheries by the pole-and-line and purse seine fisheries. Research and data gathering on bycatch species, as well as artisanal or longline fisheries data, remained a role of flag states. After La Jolla Agreement (1992) and the AIDCP (1998), a scientific observer programme for large purse seiners (the vast majority of purse seiners in the area) came into effort. This programme provides detailed information on shark catches. However, it is not until 2003 when a resolution on data provision comes into effect. The Antigua Convention, which entered into force in 2010, establishes the need for studying and assessing these species, as well as for obtaining basic data (catch by species, size, etc) from the different fisheries (apart from the purse seine).

The work carried out so far has been focused on the collection of information publicly available, mainly in the public domain of IATTC but also on information available in the literature, most of which comes from documents presented at the scientific meetings or workshops of both RFMOs. As in other Tuna RFMOs, the data gaps, which are quite considerably, have been identified.

There is currently excellent information on sharks from the purse seine fishery, while information from artisanal and industrial longline, gillnet and sport fisheries remains extremely poor. It must be outlined that, with regards to sharks, LL fisheries are much more important than PS. Consequently, there is a lack of essential data for most of the shark species in IATTC databases. However, additional sources of information, from flag states with fisheries in the EPO and supranational organisms, have been unidentified.

3.5 *Western and Central Pacific Fishery Commission*

3.5.1 Introduction

The Convention for the Conservation and Management of Highly Migratory Fish Stocks in the Western and Central Pacific Ocean (WCPF Convention), entered into force on 19 June 2004. The Convention establishes a governing body known as the Commission which is comprised of representatives from members, cooperating non-members and participating territories (collectively, CCMs). The Commission holds annual meetings and is presided over by a Chairman and a Vice-Chairman, who are elected from amongst the membership.

Four subsidiary bodies support the work of the Commission and meet in the months prior to the annual meeting, which is always held in December. The Scientific Committee (SC) meets in August and ensures that the Commission has the best available scientific information on which to consider appropriate conservation and management measures. The Scientific Committee utilizes the services of expert fisheries scientists and its meetings usually comprise scientific and other related technical representatives. The SC also coordinates with the Technical and Compliance Committee on certain matters to ensure consistent advice is provided to the Commission. From the first session of the Scientific Committee, back in 2005, there is a specific Eco-systems and By-catch Specialist Working Group. In 2010, the SC is structured around four different Themes, one of them termed Ecosystem and Bycatch Mitigation Theme.

The Technical and Compliance Committee (TCC) meets in October and is the "enforcement" committee of the Commission. The TCC reviews members' adherence to Commission decisions and monitors individual countries' implementation of those measures. The TCC also makes recommendations to the Commission with respect to encouraging, improving and enforcing compliance by members with the decisions of the Commission.

The Northern Committee (NC) meets in September and makes recommendations to the Commission on species that are mostly found in the Convention Area north of 20 degrees north. Unlike the SC and the TCC, not all members of the Commission are represented on the NC. Although participation in the NC is limited to those members that are located in the area north of 20 degrees north, or are fishing in this area, any member of the Commission may participate in NC meetings as an observer. Any decisions the Commission takes on species under the purview of the NC must be based on recommendations from the NC.

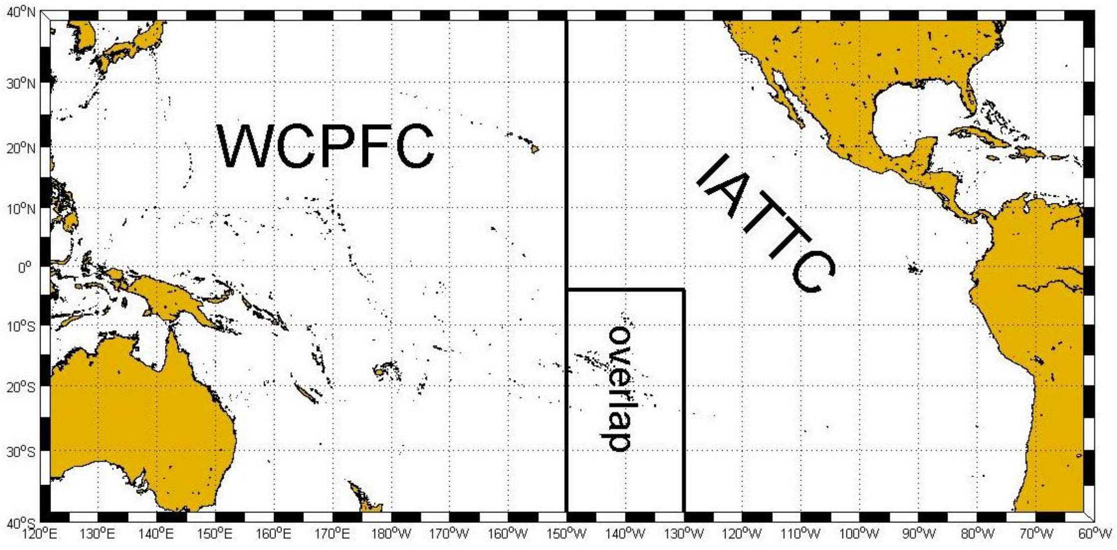
The Finance and Administration Committee meets annually along with the Commission meeting and deliberates over the Commission's budget. All Commission members are represented on the Finance and Administration Committee and recommendations are forwarded to the Commission for adoption.

Decisions taken by the Commission are generally done by consensus. In cases where decisions have to be taken by vote, usually on substantive matters, a "two-chamber system" applies. The FFA members of the Commission comprise one chamber, while the non-FFA members form the other chamber. Decisions are taken by a three-fourths majority of those present and voting in each chamber and no proposal can be defeated by two or fewer votes in either chamber.

As of now, the WCPFC has 25 members, 7 participating territories and 9 cooperating non-members:

- ✓ *Members:* Australia, China, Canada, Cook Islands, European Union, Federated States of Micronesia, Fiji, France, Japan, Kiribati, Korea, Republic of Marshall Islands, Nauru, New Zealand, Niue, Palau, Papua New Guinea, Philippines, Samoa, Solomon Islands, Chinese Taipei, Tonga, Tuvalu, United States of America, Vanuatu.
- ✓ *Participating Territories:* American Samoa, Commonwealth of the Northern Mariana Islands, French Polynesia, Guam, New Caledonia, Tokelau, Wallis and Futuna.
- ✓ *Cooperating Non-member(s)*: Belize, Ecuador, El Salvador, Indonesia, Mexico, Senegal, Vietnam, Panama, Thailand.

The area covered by the Convention covers almost 20 per cent of the Earth's surface. Although the western boundary notionally extends to the east Asian seaboard, it is understood that the Convention Area does not include the South China Sea. In the east, the Convention Area adjoins, or overlaps, the area of competence of the Inter-American Tropical Tuna Commission. The southern boundary extends to 60 degrees south and the northern boundary extends to Alaska and the Bering Sea. The eastern boundary extends to 150ºW and, south of 4ºS, to 130ºW.



In the following paragraphs there is a brief description of the different fleets fishing in the WCPFC Convention Area. This summary is based upon the most recent information presented at the 8th Regular Session of the Scientific Committee of the WCPFC, held in August 2012.

Australia: Australian commercial fisheries for highly migratory species in the Western and Central Pacific Fisheries Commission (WCPFC) Convention Area are managed as part of the Eastern Tuna and Billfish Fishery (ETBF) (a mainly longline fishery with a small minor line component) and Eastern Skipjack Fishery (a purse seine fishery). The majority of fishing occurs in the longline sector of the ETBF. Total catches reported in logbooks for the ETBF increased from 4349 t in 2010 (4346 t longline, 3 t minor line) to 4508 t in 2011 (4470 t longline, 38 t minor line). Forty-nine vessels reported longlining in the WCPFC Convention Area during 2011. Total retained shark catch in 2011 was estimated to be c. 117 t in the WCPFC. A total of c. 5600 sharks were discarded in 2011.

Canada: The Canadian tuna fishery is a troll fishery that uses jigs and targets albacore exclusively. Minimal catch (1 t) and effort (3 vessel-days) were recorded in the WCPFC convention area north of the equator in 2011. Canadian flagged vessels did not operate in the south Pacific Ocean in 2011.

China: There are two types of tuna fisheries in the WCPFC Convention Areas: longline and purse seine fishery. In 2011, totally 275 longliners and 12 purse seiners operated in the WCPFC Convention Areas, the tuna catch from longline fishery and purse seine fishery were estimated 33 363 t and 77 551 t, respectively. Catch estimates for the main shark species were 726 t blueshark, and 408 t shortfin mako in 2011.

Cook Islands: Catch within the WCPF-CA was 8 489 t, with 7.8 t caught beyond national jurisdiction. Albacore accounts for 56.4% of total catches within the Convention Area. Yellowfin tuna catches totalled 2 052 t and bigeye catch totalled 960 t. Total shark catch was 1.9 t however no species specific shark data was recorded. The latest regional (SPC/FFA) logsheets were adopted and implemented at the beginning of the year. This latest revision requires fishing vessels to record shark catch by species. Noting this development, it is expected that better species catch information will be available next year.

European Union: There are two EU-Spain fishing fleets operating in the Pacific Ocean: a purse seine fleet targeting tropical tuna, and a surface longline fishery targeting swordfish. In 2011, four EC-Spain purse seiners and 5 longline vessels targeting swordfish were fishing in the WCPFC Convention Area. In 2011, landed catches totaled 39451 t (7367 t BET, 27907 t SKJ and 4177 t YFT) for the purse seine fleet, and 1431 t swordfish for the longline fleet. Additionally, an EC-Portugal longliner fished in the WCPFC-CA during four months in 2011. Preliminary data indicate a total catch of 461 t, being black marlin and blue shark the main target species. Silky shark is the main shark bycatch species in the purse seine fishery. In 2011, estimated shark catches totaled 41 t silky shark and between 0.1 and 0.3 t thresher, oceanic whitetip and hammerhead sharks. Around 42% of the silky shark, as well as 50% of the hammerhead and thresher sharks was released alive. Shark catch estimates were not available for the longline fleet. However, previous reports indicate that blue and shortfin mako shark catches are around 75% and 30% of the total swordfish catch, respectively.

Federated States of Micronesia: The current estimate of the total catch by the 33 FSM purse seine and longline vessels (national fleet) within the WCPFC Convention Area for the year 2011 is 28 663 t. Skipjack, yellowfin and bigeye the key target species accounted for 97% of the catches with the remaining 3% of non-target species catch. The total number of purse seine vessels employed by FSM is 7 purse seiners and 26 longline vessels in 2011. In 2011, a total of 128 t silky shark catch by purse seine was recorded. Species catch estimates for sharks for the longline fleet were not available for the report, but species composition and discard rates from observers were provided. The species composition of the longline shark catch is: 83% blue shark, 11% silky shark, 4% oceanic whitetip shark and 2% thresher shark. The discard rate of the longline shark catch is 90% blue shark, 28% silky shark, 12% oceanic white tip and 95% thresher shark.

Fiji: The Fiji Domestic tuna longline fleet predominantly targets albacore. Provisional estimates for 2011 indicate a total catch of 10 171 t (7085 t albacore tuna). Total catches of the main shark species for 2011 were 374 t blue shark, 250 t silky shark, 92 t oceanic whitetip shark and 172 t shortfin mako shark.

French Polynesia: French Polynesia professional tuna fleet in 2011 comprised 59 longliners (ranging from 13 m to 24 m) operating only within French Polynesia Economic Zone and 413 small boats (5m to 11 m) using artisanal gears (pole and line, handlines, trolling…) and operating inside the territorial waters. The overall nominal catches for the professional tuna fisheries in 2011 is estimated around 8 433 t, albacore accounting for 41 %, yellowfin tuna for 12 %, skipjack for 11 % and bigeye tuna for 7 %. Since 2006, all sharks except mako are fully protected inside the entire French Polynesia Economic Zone. It is planned to include mako.

Japan: In 2011, a total of 406 commercial longline vessels (larger than 10 GRT), 90 pole-and-line vessels (larger than 20 GRT) and 37 purse seine vessels (over 200 GRT) fished in the WCPFC-CA in 2011. In 2011, the total tuna catch by the purse seine fishery was 199 084 t (53% of the total), with 113 682 t (30%) by the pole-and-line fishery, 48 774 t (13%) by the longline, and the remaining (4%) by the other gears. Provisional data for 2011 indicate a total catch of 4 101 t blueshark and 551 t mako shark by distant water and offshore longliners.

Kiribati: There were 10 industrial Kiribati-flagged vessels (6 purse-seiners and 4 lonliners), with a total estimated catch of 4 521 t, in 2011. Estimates for 2011, only avaible for the purse seine fleet, indicate a total shark catch of 15.4 t silky shark , 0.6 t oceanic whitetip and 8.5 t unidentified.

Korea: Korea has two types of fishing gears, distant water purse seine and distant water longlines, that engage in fishing tuna and tuna-like species in the WCPFC Convention Area. Purse seine catch was 207 702 t reported from 28 vessels active in 2011. Longline catch was 30 736 t from 124 vessels active in 2011, No reliable estimate of shark bycatch was reported in 2011.

Marshall Islands: The tuna fishery in the Republic of the Marshall Islands (RMI) is comprised of foreign flagged purse seine, pole-and-line and longline vessels and RMI-flagged purse seine and longline vessels. During 2010, estimated total catch of the RMI's purse seine fleet (10 vessels) operating throughout the Western and Central Pacific Ocean (WCPO) was just over 56 800 t (48 106 t skipjack, 7 173 t yellowfin and 1556 t bigeye). Provisional estimates from the national longline fleet (4 vessels) which fished primarily in the RMI EEZ indicate just under 450 t of catch (257 t bigeye, 117 t yellowfin, 52 t blue marlin). Estimated shark catches in 2010 totaled 11.1 tand 11.7 t of mako and and silky sharks, respectively.

Nauru: There are no commercial scale domestic fisheries of any category operating under the Nauru flag or through charter arrangements. The artisanal fishery is comprised mainly of local fishermen operating on small motorized skiff (average length 2 m) and outrigger canoes, targeting tuna and other coastal pelagic fishes, that are both free schooling and congregating around coastal FAD's. Annual estimated catch of tuna for 2011 by the domestic fleet was 9 575 t.

New Caledonia: In 2011, there were 19 domestic longliners licensed in New Caledonia, and they all fished in the EEZ. Annual catch for 2011 was of 2 736 t (1 736 t albacore, 585 t yellowfin, 76 t marlins and 10 t swordfish). Catches of sharks have been decreasing since 2006, due to an increasing use of monofilament branchlines. Makos, which are the only sharks species kept onboard to be sold on the local market (trunks), totaled 10 t in 2011. The incidental catch of shark and ray species, which are all discarded, except makos, was reported by the New Caledonia observer programme at 514 individuals in 2011. The corresponding tonnage estimated for the species of interest (blue shark, silky shark, oceanic white tip shark, and thresher sharks) was 22 t.

New Zealand: Since 2002, skipjack (25 833 t in 2011), which is nearly all taken by purse seine, has comprised the greatest part of the New Zealand catch of all tuna species, both within and beyond New Zealand fisheries waters. The second most important component of New Zealand's domestic fisheries is albacore (3 213 t) which are taken mostly by troll gear, but are also landed as target and bycatch in the longline fishery. The domestic longline fleet targets both bigeye and southern bluefin tuna and more recently swordfish, but the greatest part of the catch consists of albacore. New Zealand has four Class-6 purse seiners and up to seven smaller capacity domestic-based purse seiners. The New Zealand longline tuna fleet consists of domestically owned and operated vessels (mostly between 15 and 25 m in length) and a limited number of foreign owned vessels that operate under charter. The number of longline vessels operating in New Zealand was 42 in 2011. Total shark catch (in number of fish) in the longline fishery, estimated from observer data, in 2011 was 53 432 blue sharks, 9 929 porbeagle shark, 9 770 mako shark, 349 thresher shark, and 49 school shark.

Palau: Under the current regulation, foreign fishing vessesls are not allowed to intentionally fish sharks, or to intentionally mutilate or injure any shark. According to their reports, Palau is a shark sanctuary. Palau has no industrial domestic fleet. Most of the fish in its EEZ is done by Japan and Chinese.

Papua New Guinea: The Papua New Guinea (PNG) tuna fishery is made up of both the purse-seine and longline sectors with a small, but important handline sector. The longline and handline sector is a citizen- only activity and all vessels fish exclusively in the waters under PNG national jurisdiction. The purse-seine sector is a mix of both domestic and foreign access vessels. Total catch in 2010 within PNG waters was 702 969 t. No estimates were available for 2011, but the overall catch estimate for 2010 by the 9 PNG flagged domestic purse seine vessels was 27 972.30 t. There is also an important locally-based purse seine foreign fleet fishing under chartering arrangements, which comprised 39 vessels and caught around 178 000 t in 2010. In 2010, there were 19 PNG domestic longline vessels targeting tuna, with a total catch of 3 472 t (mainly yellowfin tuna and albacore). Shark catch for this fleet was estimated in 134 t (no species composition available). There is also a shark longline fleet, comprised of 8 vessels, which caught 64 924 sharks in 2010 (71% silky shark, 11% blue shark, <3% for other shark species like black-tipped reef shark, black-tip shark, galapagos shark, grey reef shark, hammerhead shark, oceanic white tip, silver tip and tiger shark). No estimates were available for the fleets operating under charter arrangements.

Philippines: There is a considerable uncertainty in the catch estimates by The Philippines. Latest provisional estimates indicate a total catch of 197 383 t skipjack , 123 014 t yellowfin and 9 612 t bigeye. The fishing sector consists of municipal and commercial components, with the former involving vessels less than 3 GT in size, and is not well documented. A total of 127 commercial purse seiners and 24 longliners are currently registered in the WCPFC. There is no estimate of the shark catches by the Philippines fleet.

Samoa: The fishery is comprised of the a tuna longline fishery and the smaller scale troll fishery. Both fisheries operate within Samoa's Exclusive Economic Zone. The longline fleet is currently composed of 46 fishing vessels, with a total estimated catch of 2 047 t in 2011. This fleet targets albacore (70% of the catch), although large yellowfin and bigeye are also an important component of the catch. The total estimated catch of the troll fishery was 334 t skipjack. Annual estimated catches of non-target species for the longline fleet indicate minor catches of oceanic whitetip, blue and mako sharks.

Solomon Islands: The tuna fishery in Solomon Islands is comprised of an industrial and an artisanal sector. The provisional 2011 total annual catch estimates within the Solomon Islands EEZ for all gear type was more than 150 000 t. In 2011, the domestic fleet was composed of a total of 5 purse seiners and 3 pole and line vessels. Total catch for this domestic fleet was of over 27 000 t (63% skipjack and 35.0% yellowfin) for the purse seine and 870 t for the pole and line (721 t skipjack and 149 t yellowfin). Additionally, 9 purse seiners (total catch over 4 000 t) and 148 longliners (total catch above 2 400 t) were registered under charter arrangements to fish in the EEZ of Solomon Islands. Licenses for vessels targeting sharks were not renewed in Solomon Islands in 2011.

Chinese Taipei: There are 3 Chinese Taipei's tuna fishing fleets operating in the WCPFC Convention Area: a large scale tuna longline fleet (95 vessels), a distant-water purse seine fleet (34 vessels) and small scale tuna longline fleet (1376 vessels). In 2011, the total catches of main tuna and tuna-like species for these 3 fleets were 22 402 t, 175 935 t and 42 410 t, respectively. Estimates for 2011 for the longline fleets indicate a total shark catch of around 19 000 t blue shark, 1 000 t silky shark, 1 200 t shorfin mako, 330 t pelagic thresher, 474 t bigeye thresher, 136 t smooth hammerhead and 291 t scalloped hammerhead sharks. Silky shark (c. 108 t) accounts for the majority of the purse seine shark catch.

Tokelau: The domestic fleet is composed of artisanal boats that catch a low amount of tuna and tuna-like species (estimates for 2011 around 12 t). There are around 60 purse seiners and 9 foreign lonliners licensed to fish in the EEZ of Tokelau. There are no available estimates of shark catch for 2011.

Tonga: In 2011, only 3 local longliners and 1 foreign longline vessel had valid licenses to fish in the Tonga EEZ. Total catch estimates for 2011 are of 227 t (around 171 t yellowfin, 34 t albacore, 18 t bigeye, 22 t swordfish and 31 t marlin). Total shark catch for 2011 was estimated in 14.2 t, with no information at the species level.

United States of America: Large-scale fisheries of the United States and its Participating Territories in the Pacific Ocean include purse seine fisheries (37 vessels) for skipjack tuna and yellowfin tuna; longline fisheries (152 vessels) for bigeye tuna, swordfish, albacore and associated pelagic fish species; and a troll fishery for albacore. Small-scale fisheries include troll fisheries for a wide variety of tropical tunas and associated pelagic species, handline fisheries for yellowfin and bigeye tuna, a pole-and-line fishery for skipjack tuna, and miscellaneous-gear fisheries. Preliminary 2011 purse seine estimates total 176 654 t of skipjack, 23 212 t of yellowfin, and 3 373 t of bigeye tuna. Longline estimates total around 4 700 t bigeye, 3 100 t albacore and 856 t swordfish. Total preliminary shark landings in 2011 were 14 t blue shark, 50 t mako shark 18 t thresher shaks and 3 t of other species, the practical totality caught by longline. No estimate of the discarded catch is available for the longline (the main fleet catching sharks).

El Salvador: There are 2 purse seiners fishing in the WCPFC Convention Area, with a total estimated catch of 7182 t for 2011. No estimated shark bycatch was available in the annual report.

Indonesia: Nominal catches in the EEZs (not territorial waters, which accounts for more than 50% of the marine fisheries area of Indonesia) of Sulawesi Sea and the Pacific Ocean indicate a total preliminary catch of around 15 200 t by longline (92% yellowfin, 8% bigeye), 33 000 t by purse seine (87% skipjack, 10% yellowfin and 3% bigeye), 1 685 t by handline (98% yellowfin, 2% bigeye), and around 22 000 t by other artisanal gears (81.5% skipjack, 18% yellowfin and 0.5% bigeye). The fleet in these areas was composed of 125 longline, 18 pole and line and 156 purse seine vessels (other gears unknown). No estimates of non-target species are available for these fleets.

Vietnam: There are three vietnamese fisheries targeting tuna species. In 2011, Vietnam fleet was composed of 714 longline, 495 purse seine and 1312 gillnet vessels. Catch estimates are highly uncertain, although have improved significantly in the latest years. Estimates for 2011 total arund15 000 t by longline, 23 000 t by purse seine and 12 600 t by gillnet in Vietnam's EEZ. There is no information on bycatch composition for these fleets.

3.5.2 Bycatch issues at WCPFC

To clarify the legal implications of the range of decisions that the WCPFC may take, the Second Meeting of the WCPFC (see WCPFC/Comm2/29 14 December 2005) adopted the following nomenclature for its decisions.

- ✓ Resolutions describe non-binding statements and recommendations addressed to members of the Commssion and Cooperating non-members. Such Resolutions are sequentially numbered and include the year of adoption.
- ✓ Conservation and Management Measures describe binding decisions relating to conservation and management measures. Such decisions are sequentially numbered and include the year of adoption.
- ✓ Other Decisions of the Commission describe all other decisions made by the Commission.

All these decisions can be found at: http://www.wcpfc.int/conservation-and-management-measures

The table below summarizes those active decisions affecting shark species:

Code	Title	Date of adoption
Resolution 2005-03	Resolution on non-target species	16 December 2005
CMM2007-01	Conservation and Management Measure for the Regional Observer Programme	15 December 2006
CMM2008-01	Conservation and Management Measure for Bigeye and Yellowfin Tuna in the Western and Central Pacific Ocean	12 December 2008
CMM2008-04	Conservation and Management Measure to Prohibit the use of Large Scale Driftnets on the High Seas in the Convention Area	12 December 2008
CMM2010-07	Conservation and Management Measure for Sharks	10 December 2010
CMM2011-04	Conservation and Management Measure for Oceanic Whitetip Sharks	30 March 2012
CMM2012-01	Conservation and Management Measure for Bigeye and Yellowfin Tuna in the Western and Central Pacific Ocean	6 December 2012
CMM2012-04	Conservation and Management Measure for protection of Whale Sharks from Purse Seiner Fishing Operations	6 December 2012
Data-01	Scientific Data to be provided to the Commission	11 February 2013

Resolution 2005-03 encourages the avoidance and release, to the extent possible, of non-target species in general.

CMM2007-01 establishes the Commission Regional Observer Programme. No later than June 2012, the members should achieve a 5% coverage of the effort in each fishery under the jurisdiction of the Commission (with some exemptions). There are several guidelines regulating the data fields to be covered by each programme, including the activity related to FADs in the purse seine fishery, and a thorough record of the activity aboard longline vessels.

CMM2008-04 prohibits the use of gillnets or other nets that are more than 2.5 km in length whose purpose is to enmesh, entrap, or entangle fish by drifting on the surface of, or in, the water column, but only in the high seas.

CMM2008-1 is a measure for bigeye and yellowfin tunas, but which limits the fishing effort of purse seine (to the levels of 2001-2004), the longline catch of bigeye, establishes a 3 months ban on FAD-fishing, the closure of the western high-seas pockets (high-seas areas in the western Pacific enclosed by coastal states EEZs) and a 100% percent observer coverage aboard purse seiners fishing in the high seas or in more than one coastal state. This measure has been extended, through **CMM2012-01** with some modifications (new effort limits, re-opening of the high seas pockets, extension of FAD closure, limitation of FAD sets, etc.).

Until very recently the only Conservation and Management Measure specifically implemented for sharks in the WCPFC Convention Area was **CMM2010-07**. This measure was first adopted in 2006 and has been subsequently amended. It establishes, among others, that:

- ✓ Commission Members, Cooperating non-Members, and participating Territories (CCMs) shall implement FAO International Plan of Action for the Conservation and Management of Sharks (IPOA Sharks), and report on its implementation. This plan should include measures to minimize waste and discards from shark catches and encourage the live release of incidental catches of sharks.
- ✓ CCMs shall report on annual catches of key shark species by gear type, as well as on discards.
- ✓ CCMs shall take measures necessary to require that their fishers fully utilize any retained catches of sharks (excepting head, guts, and skins) to the point of first landing or transhipment.
- ✓ CCMs shall require their vessels to have on board fins that no more than 5% of the weight of sharks on board (of ensure compliance with the 5% ration through certification).

During the 8th Annual Meeting of the Commission, a new CMM for Oceanic Whitetip Sharks (**CMM-2011-04**) was adopted. This CMM prohibits the retention, transhipment or storing of oceanic whitetip sharks on fishing vessels. It also requires all vessels to record interactions with this species and the prompt release of this fish caught as soon as possible, and in a manner that results in as little harm to the shark as possible.

During the 9th Annual Meeting of the Commission, a new CMM for Whale Shark (**CMM-2012-04**) was adopted which will be in force from 1st of January 2014. This CMM prohibits purse seine sets on a school of tuna associated with a whale shark if the animal is sighted prior to the commencement of the set. It also requires all vessels, in the case of a whale shark is not deliberately encircled, to ensure that all reasonable actions are carried out to ensure its safe release and to record interactions with this species in the logbooks and the authority of the flag State.

Additionally, the "**Scientific Data to be Provided to the Commission**" regulation was amended during the 7th Session of the Commission and the following shark species where included in the data provision requirements: blue shark, silky shark, oceanic whitetip shark, mako sharks, thresher sharks, porbeagle shark (south of 20°S, until biological data shows this or another geographic limit to be appropriate), hammerhead sharks (winghead, scalloped, great, and smooth). Data provision includes:

- ✓ Estimates of annual catches: Estimates of catches during each calendar year must be provided for each gear type
- ✓ Operational level catch and effort data: Information on individual sets by longliners and purse seiners, and individual days fished by pole-and-line vessels and trollers shall be provided in accordance with the standards adopted by the Commission at its Second Regular Session. This information includes, among

others, the number of key shark fish caught per set and the total or averaged weight.

- ✓ Catch and effort data aggregated by time period and geographic area: If the coverage rate of the operational catch and effort data that are provided to the Commission is less than 100%, then catch and effort data aggregated by time period and geographic area that have been raised to represent the total catch and effort shall be provided. Longline catch and effort data shall be aggregated by periods of month and areas of 5° longitude and 5° latitude. Purse-seine and ringnet catch and effort data shall be aggregated by periods of month, areas of 1° longitude and 1° latitude, and type of school association. Catch and effort data for other surface fisheries targeting tuna shall be aggregated by periods of month and areas of 1° longitude and 1° latitude.
- ✓ Size composition data: Length and/or weight composition data that are representative of catches by the fisheries shall be provided to the Commission at the finest possible resolution of time period and geographic area and at least as fine as periods of quarter and areas of 20° longitude and 10° latitude.

WCPFC Members and Cooperating non-members who adopted a National Plan of Action on Sharks include: Australia, Canada, European Union, France, Japan, Republic of Korea, New Zealand, Chinese Taipei, United States of America, Ecuador, Indonesia, Mexico, Panama and Senegal (FAO Fisheries and Aquaculture Circular No. 1076). Additionally, the Pacific Island Countries and Territories have developed a Regional Plan of Action for Sharks (available at http://www.ffa.int/sharks). The PICTs comprise the following members: American Samoa, Cook Islands, Federated States of Micronesia, Fiji, French Polynesia, Guam, Kiribati, Marshall Islands, Nauru, New Caledonia, Niue, Northern Mariana Islands, Palau, Papua New Guinea, Pitcairn Islands, Samoa, Solomon Islands, Tokelau, Tonga, Tuvalu, Vanuatu and Wallis and Futuna.

3.5.3 Methodology and data used

For the present report, as explained above, data were mainly obtained from the public domain of the RFMOs' web sites, as well as from different sources within these organizations: annual reports, workshop reports, papers presented at scientific committees, resolutions, etc. The persons responsible of IATTC and WCPFC databases have been contacted to progress in the analysis work on the quality and quantity of the data.

For more details see general section of Material and Methods.

3.5.4 Historical catch and effort data

The Pacific Ocean is home to some of the world's most abundant populations of tuna species such as albacore, skipjack and yellowfin, and to billfish species such as marlin and swordfish. In the Western and Central Pacific Ocean (WCPO) several countries fish commercially for these species, representing an annual multi-billion dollar industry. The WCPFC focuses on the effective management and conservation of these highly migratory stocks for sustainable use.

There are many different methods used for capturing highly migratory stocks, but the WCPFC is primarily concerned with the management of fishing vessels that use longlines (fishing line with hooks set at regular intervals) and purse seine gear (large nets that surround schools of fish and cinch at the bottom, much like a drawstring of a "purse"), as well as troll lines, pole and line gear and other small scale fishing methods, including some artisanal methods. The Commission develops conservation and management measures that are often specific to fishing gear types, primarily because different gear types target different species. Longline gear, for example, is most often used to catch adult bigeye tuna, yellowfin tuna and swordfish, while purse seine gear targets skipjack tuna.

The provisional total WCPFC Convention Area tuna catch for 2010 was estimated at 2,414,994 mt, the second highest annual catch recorded and 80,000 mt lower the previous record in 2009 (2,494,112 mt). During 2010, the purse seine fishery accounted for an estimated 1,820,844 mt (75% of the total catch), with pole and-line taking an estimated 171,604 mt (7%), the longline fishery an estimated 239,853 mt (10%), and the remainder (7%) taken by troll gear and a variety of artisanal gears, mostly in eastern Indonesia and the Philippines. The WCP–CA tuna catch for 2010 represented 84% of the total Pacific Ocean catch of 2,875,909 mt, and 60% of the global tuna catch (the provisional estimate for 2010 is 4,017,660 mt, which is the lowest for 8 years).

The 2010 catch of skipjack (1,706,166 mt – 71% of the total catch) was the second highest recorded and 115,000 mt less than the previous record catch of 2009 (1,821,770 mt). The yellowfin catch for 2010 (470,161 mt – 19%) was more than 50,000 mt higher than the 2009 catch level, but still 70,000 mt lower than the record catch taken in 2008 (541,262 mt). The WCP–CA bigeye catch for 2010 (108,997 mt – 5%) was the lowest since 1996, mainly due to a drop in 2010 provisional estimates for the longline fishery. The 2010 WCP–CA albacore catch (129,670 mt - 5%) was the second highest on record, with very good catches from the longline fishery.

The 2010 WCP–CA albacore catch (129,670 mt - 5%) was the second highest on record, with very good catches from the longline fishery.

The only information on effort available so far is in the public domain of the WCPFC web site, for the industrial purse seine and longline fleets and up to 2006 and 2007 respectively. It shows a steep increase in the longline effort since 1950 (figure 3.5.1), and a dramatic increase of the purse seine effort since *c.* 1980 (figure 3.5.2).

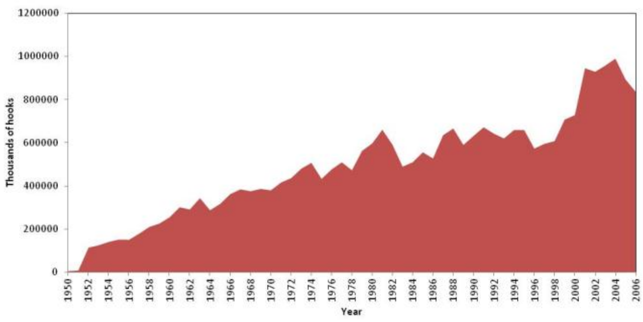


Fig. 3.5.1.- Longline effort (in thousand of hooks) in the WCPFC-Convention Area (source:public domain data).

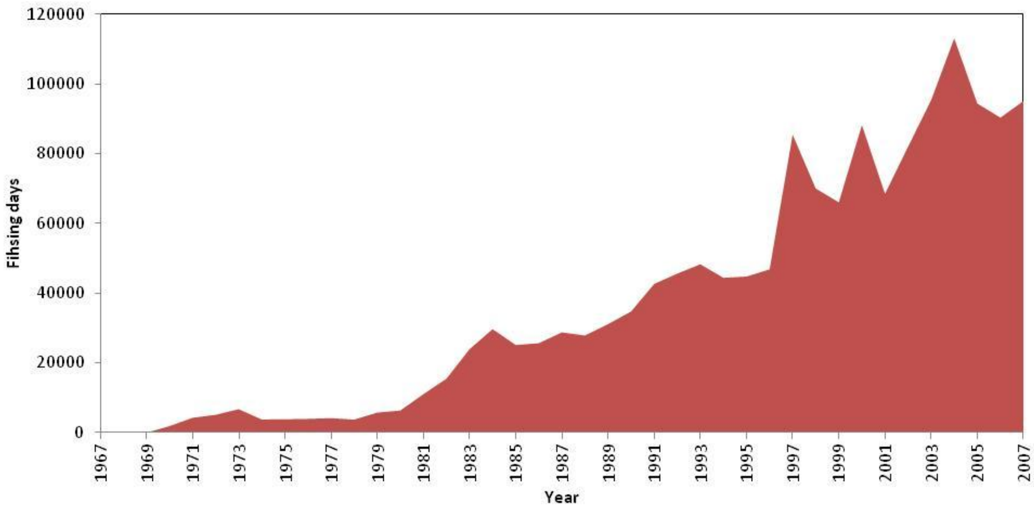


Fig. 3.5.2.- Purse seine effort (in fishing days) in the WCPFC-Convention Area (source:public domain data).

Regarding the catches, data from the WCPFC Tuna Fishery Yearbook, which covers the catch estimates by flag and gear for the main commercial tuna and billfish species caught in the region, for the longline and purse seine fleet are presented in tables 3.5.1 and 3.5.2, respectively. These fleets account for around 90% of the total catch of highly migratory stocks managed by the WCPFC.

Table 3.5.1.- Estimates of total purse seine catches in the WCPFC Statistical Area by flag and year (source: WCPFC Tuna Fishery Yearbook).

Flag/Year	2006	2007	2008	2009	2010
Korea	251922	258292	248893	283344	277398
US	68470	88761	209359	281729	245565
Japan	250929	266664	254308	231734	241608
Indonesia	204939	207079	206994	206970	207212
Papua New Guinea	229125	226895	202829	209351	205357
Taiwan	210255	232606	204073	192148	198935
Philippines	182445	205309	244197	209245	167350
Marshal Islands	42374	59424	32550	43479	56882
China	52765	54968	55576	76273	53751
Spain	11034	22961	36212	26573	29494
Kiribati	4664	5452	5758	20882	25757
New Zealand	24683	36636	30001	28169	24516
Vanuatu	61935	71299	38742	37855	23731
FSM	10349	13506	18129	19143	22455
Solomon Islands	22512	17317	16044	17891	12972
Tuvalu	-	-	-	4429	10556
Ecuador	9523	9187	25415	4432	8452
El Salvador	0	6025	10962	8826	6827
US EPO fleet	709	709	708	709	709

Korea, US, Japan, Indonesia, Papua New Guinea and Taiwan accounted for *c.* 75% of the total purse seine catch in 2010.

Table 3.5.2.- Estimates of total longline catches in the WCPFC Statistical Area by flag and year (source: WCPFC Tuna Fishery Yearbook).

flag/year	**2006**	**2007**	**2008**	**2009**	**2010**
Japan	74646	77678	61931	63692	65148
Taiwan	57798	54638	52528	58718	60608
China	24996	18894	32247	41884	27700
Korea	27291	22463	29983	31083	25709
Indonesia	14831	14679	18700	24599	17640
Vanuatu	11626	11963	7270	10123	15728
Vietnam	-	-	-	-	13187
Solomon Islands	-	-	-	-	12157
US	12863	14754	12167	11019	11405
Fiji	15578	9849	11514	10800	10264
French Polynesia	4605	5526	4469	5286	4826
Australia	6634	6097	5912	5357	3783
Papua New Guinea	4397	3489	3124	3983	3360
Cook Islands	2868	3324	2890	2098	3222
Samoa	2597	3619	2840	3456	3134
New Caledonia	1904	1898	2159	2307	2613
FSM	493	2167	1516	2313	1566
New Zealand	1262	989	874	1097	1129
EU-Spain	3984	5094	3627	1909	1018
Philippines	641	641	641	641	641
Marshall Islands	-	5	552	567	448
Belize	655	684	279	212	166
Tonga	829	941	649	312	166
Niue	299	212	18	182	112
Kiribati	-	-	53	-	73
Senegal	146	116	-	-	-

In the case of the lonfline, Japan, Taiwan, China, Korea, Indonesia and Vanuatu accounted for c. 75% of the total longline catch in 2010.

There are no estimates of effort by flag in the public domain.

Sharks in the WCPFC Convention Area are fished by artisanal, small-scale domestic vessels and industrial vessels. Data on shark catches by these fleets are limited in the case of the industrial fleets and practically non-existent for the artisanal and small scale fisheries. However, the vast majority of highly migratory species managed by the WCPFC are caught by the industrial fleets (mainly longline and purse seine).

The bulk of shark catch in offshore fisheries is taken as incidental catch to tuna fishing operations. However, unlike many bycatch species (e.g. seabirds and turtles), sharks have an economic value and there is an economic incentive to retain incidental catches of sharks or at least their fins. While most catch of tunas in the region is taken by purse seine fishing, sharks form a much higher proportion of total catch in the longline fisheries and it is in the longline fisheries where the potential for shark targeting exists (Lack and Meere, 2009).

Tables 3.5.3 to 3.5.8 summarize the data holdings or the WCPFC by flag and level of aggregation for the longline fishery for blueshark, oceanic whitetip, shortfin mako, silky, threshers and porbeagle sharks. It also includes information on the annual average catch.

Regarding observer coverage, there is no synthetic information available on the historical level of coverage by flag. During the Seventh Regular Session of the Scientific Committee, Lawson (2011) presented an estimation of catch rates and catches of key shark species in the WCPFC Convention Area, based on models from observer and total effort data. The observer coverage in the SPC data holdings for the longline and purse seine, by fleet group, is shown in tables 3.5.9 and 3.5.10, respectively. The catch estimations, show that the longline accounts for the majority of the shark catches (Table 3.5.11).

Table 3.5.3.- Blueshark data holdings for the longline fleet by flag and level of aggregation in the WCPFC-CA (Source: WCPFC Data Catalogue).

State	Fishery		Annual Cath Estimates			Aggregate Data			Operational Data			Size Data		
	From	To	From	To	Average Catch	From	To	Catch recs.	From	To	Catch Recs.	From	To	Samples
Australia	1985	2011	1991	2011	46	1991	2011	2030	1991	2011	31662	2002	2010	584
Belize	1995	2011	2011	2011	11	2010	2011	7						
Cook Islands	1994	2011			0	2002	2011	31	2002	2011	87	1995	2008	5
China	1988	2011	2010	2011	616	2008	2011	638				1993	2008	2783
Spain	2004	2011	2006	2011	1216	2011	2011	78	2004	2011	12486			
Fiji	1989	2011	2011	2011	374	2006	2010	31	2006	2010	80	1994	2010	2606
FSM	1991	2011			0							1994	2008	862
Indonesia	1978	2011			0									
Japan	1960	2011	2006	2011	7809	1994	2009	6762				1979	2008	45341
Kiribati	1995	2011			0							2008	2008	7
Korea	1960	2011	2011	2011	9	2011	2011	77				1992	2007	569
Marshall Is.	1992	2011			0							2008	2008	41
New Caledonia	1983	2011	2011	2011	20	1996	2011	17	1996	2011	110	1996	2011	673
Nauru	2000	2004			0									
Niue	2005	2010			0									
New Zealand	1987	2011	2000	2011	781	1989	2011	1367	1989	2011	39044	1994	2011	19125
French Polynesia	1990	2011			0							1997	2011	497
PNG	1993	2011			0	1998	2003	74	1998	2003	848	2001	2008	388
Philippines	1970	2010			0									
Portugal	2011	2011	2011	2011	188									
Palau	1992	2004			0							2000	2000	1
Solomon Islands	1973	2011			0							1996	2004	271
Senegal	2005	2007			0	2006	2007	65						
Tonga	1982	2011			0	2007	2007	1	2002	2007	17	1995	2010	644
Tuvalu	2011	2011			0									
Chinese Taipei	1960	2011	2009	2011	14956	1997	2011	1695				1993	2011	1730
US- Am. Samoa	1988	2011	2006	2011	2	2005	2011	418				2002	2002	2
US- Hawaii	1960	2011	2005	2011	11	2005	2011	1224	2007	2010	44127	1994	2004	301
US-Pacific based	1991	2000			0							2004	2004	2
Vietnam	2000	2011			0							2011	2011	10
Vanuatu	1995	2011			0	2009	2009	1	2009	2009	1	2009	2010	60
Wallis and Futuna	2011	2011			0									
WS	1993	2011			0	2007	2011	5	2007	2011	7	2001	2010	10

Table 3.5.4.- Oceanic whitetip data holdings for the longline fleet by flag and level of aggregation in the WCPFC-CA (Source: WCPFC Data Catalogue).

State	Fishery		Annual Cath Estimates			Aggregate Data			Operational Data			Size Data		
	From	To	From	To	Average Catch	From	To	Catch recs.	From	To	Catch Recs.	From	To	Samples
Australia	1985	2011	1998	2011	10	1997	2011	1138	1997	2011	5485	2002	2010	73
Belize	1995	2011			0									
Cook Islands	1994	2011			0	2011	2011	1	2011	2011	1			
China	1988	2011	2010	2010	532	2009	2010	257				1993	2009	687
Spain	2004	2011	2010	2011	2				2007	2008	17			
Fiji	1989	2011	2011	2011	92							1995	2010	943
FSM	1991	2011			0							2001	2008	126
Indonesia	1978	2011			0									
Japan	1960	2011			0							1987	2005	304
Kiribati	1995	2011			0							2008	2008	3
Korea	1960	2011			0							1992	2006	230
Marshall Is.	1992	2011			0							2008	2008	7
New Caledonia	1983	2011	2011	2011	1	2010	2010	2	2010	2010	7	1996	2011	80
Nauru	2000	2004			0									
Niue	2005	2010			0									
New Zealand	1987	2011			0	2001	2008	2	2001	2008	2	1998	2008	7
French Polynesia	1990	2011			0							1997	2010	255
PNG	1993	2011			0							1999	2008	1061
Philippines	1970	2010			0									
Portugal	2011	2011			0									
Palau	1992	2004			0									
Solomon Islands	1973	2011			0							1996	2004	208
Senegal	2005	2007			0									
Tonga	1982	2011			0	2007	2007	1	2007	2007	2	1995	2009	424
Tuvalu	2011	2011			0									
Chinese Taipei	1960	2011	2009	2011	101	2008	2011	1197				1993	2011	887
US- Am. Samoa	1988	2011			0	2005	2011	332				2002	2002	5
US- Hawaii	1960	2011			0	2005	2011	656	2007	2010	2056	1995	2001	6
US-Pacific based	1991	2000			0							2004	2004	4
Vietnam	2000	2011			0									
Vanuatu	1995	2011			0							2009	2010	39
Wallis and Futuna	2011	2011			0									
WS	1993	2011			0	2007	2010	2	2007	2010	4	2001	2010	9

Table 3.5.5.- Shortfin mako data holdings for the longline fleet by flag and level of aggregation in the WCPFC-CA (Source: WCPFC Data Catalogue).

State	Fishery		Annual Cath Estimates			Aggregate Data			Operational Data			Size Data		
	From	To	From	To	Average Catch	From	To	Catch recs.	From	To	Catch Recs.	From	To	Samples
Australia	1985	2011	1996	2011	76	1986	2011	2138	1986	2011	26941			
Belize	1995	2011			0	2004	2006	21						
Cook Islands	1994	2011			0	2002	2011	321	2002	2011	1246			
China	1988	2011	2010	2011	271	2002	2011	907						
Spain	2004	2011	2006	2011	448	2011	2011	65	2004	2011	4775			
Fiji	1989	2011	2011	2011	180	1997	2010	1042	1997	2011	8519			
FSM	1991	2011			0	2003	2010	141	2003	2011	666			
Indonesia	1978	2011			0									
Japan	1960	2011	2006	2011	618	1994	2010	6696						
Kiribati	1995	2011			0									
Korea	1960	2011			0									
Marshall Is.	1992	2011			0	2004	2009	41	2004	2009	128			
New Caledonia	1983	2011	2001	2011	20	1998	2011	313	1998	2011	1959			
Nauru	2000	2004			0									
Niue	2005	2010			0	2005	2007	13	2005	2007	29			
New Zealand	1987	2011	2000	2011	128	1991	2011	1126	1991	2011	18299			
French Polynesia	1990	2011	2009	2011	16	1993	2011	1000	1993	2011	4134			
PNG	1993	2011			0	1997	2004	8	1997	2004	16			
Philippines	1970	2010			0									
Portugal	2011	2011	2011	2011	44									
Palau	1992	2004			0									
Solomon Islands	1973	2011			0									
Senegal	2005	2007			0	2006	2007	68						
Tonga	1982	2011			0	2002	2011	144	2002	2011	480			
Tuvalu	2011	2011			0									
Chinese Taipei	1960	2011	2009	2011	1084	1995	2011	1630						
US- Am. Samoa	1988	2011	2006	2011	2	2005	2011	309						
US- Hawaii	1960	2011	2005	2011	90	2005	2011	1082	2007	2010	8282			
US-Pacific based	1991	2000			0	2008	2008	9						
Vietnam	2000	2011			0									
Vanuatu	1995	2011			0	2002	2011	607	2002	2011	2587			
Wallis and Futuna	2011	2011			0									
WS	1993	2011			0	1998	2007	4	1998	2007	5			

Table 3.5.6.- Silky shark data holdings for the longline fleet by flag and level of aggregation in the WCPFC-CA (Source: WCPFC Data Catalogue).

State	Fishery		Annual Cath Estimates			Aggregate Data			Operational Data			Size Data		
	From	To	From	To	Average Catch	From	To	Catch recs.	From	To	Catch Recs.	From	To	Samples
Australia	1985	2011	2006	2007	2	2001	2011	125	2001	2011	252	2002	2010	58
Belize	1995	2011			0									
Cook Islands	1994	2011			0									
China	1988	2011			0							1995	2009	2712
Spain	2004	2011	2006	2006	1	2011	2011	3	2005	2011	189			
Fiji	1989	2011	2011	2011	250							1995	2010	963
FSM	1991	2011			0							1995	2008	464
Indonesia	1978	2011			0									
Japan	1960	2011			0							1979	2009	219
Kiribati	1995	2011			0									
Korea	1960	2011			0							1998	2007	256
Marshall Is.	1992	2011			0							2008	2008	38
New Caledonia	1983	2011	2011	2011	1	2010	2011	3	2010	2011	4	1996	2011	135
Nauru	2000	2004			0									
Niue	2005	2010			0									
New Zealand	1987	2011			0							2007	2007	1
French Polynesia	1990	2011			0							1997	2010	105
PNG	1993	2011			0							1996	2008	30101
Philippines	1970	2010			0									
Portugal	2011	2011			0									
Palau	1992	2004			0									
Solomon Islands	1973	2011			0							1996	2004	362
Senegal	2005	2007			0									
Tonga	1982	2011			0							1998	2009	179
Tuvalu	2011	2011			0									
Chinese Taipei	1960	2011	2009	2011	788	2008	2011	1591				1995	2011	6941
US- Am. Samoa	1988	2011			0	2006	2011	108				2002	2002	5
US- Hawaii	1960	2011			0	2005	2011	123	2007	2010	190	1994	2000	3
US-Pacific based	1991	2000			0									
Vietnam	2000	2011			0									
Vanuatu	1995	2011			0							2009	2010	171
Wallis and Futuna	2011	2011			0									
WS	1993	2011			0	1998	2010	26	1998	2010	59	2000	2010	2

Table 3.5.7.- Thresher sharks data holdings for the longline fleet by flag and level of aggregation in the WCPFC-CA (Source: WCPFC Data Catalogue).

State	Fishery		Annual Cath Estimates			Aggregate Data			Operational Data			Size Data		
	From	To	From	To	Average Catch	From	To	Catch recs.	From	To	Catch Recs.	From	To	Samples
Australia	1985	2011	2005	2005	1	2007	2011	164	1996	2011	1533			
Belize	1995	2011			0									
Cook Islands	1994	2011			0									
China	1988	2011			0									
Spain	2004	2011			0				2006	2009	76			
Fiji	1989	2011	2011	2011	3	2002	2011	3	2002	2011	3			
FSM	1991	2011			0									
Indonesia	1978	2011			0									
Japan	1960	2011			0									
Kiribati	1995	2011			0									
Korea	1960	2011	2011	2011	1	2011	2011	16						
Marshall Is.	1992	2011			0									
New Caledonia	1983	2011	2011	2011	1	2010	2011	4	2010	2011	4			
Nauru	2000	2004			0									
Niue	2005	2010			0									
New Zealand	1987	2011	2000	2011	37	2007	2011	95	1991	2011	2182			
French Polynesia	1990	2011			0									
PNG	1993	2011			0	1997	1997	1	1997	1997	1			
Philippines	1970	2010			0									
Portugal	2011	2011			0									
Palau	1992	2004			0									
Solomon Islands	1973	2011			0									
Senegal	2005	2007			0									
Tonga	1982	2011			0									
Tuvalu	2011	2011			0									
Chinese Taipei	1960	2011	2009	2011	676	2008	2011	904						
US- Am. Samoa	1988	2011	2011	2011	3	2005	2011	310						
US- Hawaii	1960	2011	2005	2011	30	2005	2011	1019	2007	2010	8912			
US-Pacific based	1991	2000			0									
Vietnam	2000	2011			0									
Vanuatu	1995	2011			0									
Wallis and Futuna	2011	2011			0									
WS	1993	2011			0	1998	2000	68	1998	2000	507			

Table 3.5.8.- Porbeagle shark data holdings for the longline fleet by flag and level of aggregation in the WCPFC-CA (Source: WCPFC Data Catalogue).

State	Fishery		Annual Cath Estimates			Aggregate Data			Operational Data			Size Data		
	From	To	From	To	Average Catch	From	To	Catch recs.	From	To	Catch Recs.	From	To	Samples
Australia	1985	2011			0				1991	2011	4233			
Belize	1995	2011			0									
Cook Islands	1994	2011			0									
China	1988	2011			0									
Spain	2004	2011	2006	2008	11				2004	2011	7622			
Fiji	1989	2011			0									
FSM	1991	2011			0									
Indonesia	1978	2011			0									
Japan	1960	2011	2006	2011	278									
Kiribati	1995	2011			0									
Korea	1960	2011	2011	2011	17									
Marshall Is.	1992	2011			0									
New Caledonia	1983	2011			0									
Nauru	2000	2004			0									
Niue	2005	2010			0									
New Zealand	1987	2011	2000	2011	87				1993	2011	7046			
French Polynesia	1990	2011			0									
PNG	1993	2011			0									
Philippines	1970	2010			0									
Portugal	2011	2011			0									
Palau	1992	2004			0									
Solomon Islands	1973	2011			0									
Senegal	2005	2007			0									
Tonga	1982	2011			0									
Tuvalu	2011	2011			0									
Chinese Taipei	1960	2011			0									
US- Am. Samoa	1988	2011			0									
US- Hawaii	1960	2011			0									
US-Pacific based	1991	2000			0									
Vietnam	2000	2011			0									
Vanuatu	1995	2011			0									
Wallis and Futuna	2011	2011			0									
WS	1993	2011			0									

Table 3.5.9.- Coverage of longline fishing effort by observer (%) data held by the SPC Oceanic Fisheries Programme, by sector (source: Lawson, 2011).

Year	Australia: Japanese fleet	Distant-water albacore	Distant water yellowfin & bigeye	Hawaii	New Zealand: domestic fleet	New Zealand: Japanese fleet	Offshore albacore	Offshore tropical	Total
1992	17.124	0.000	0.000	0.000	0.530	6.225	0.000	0.083	0.574
1993	16.013	0.000	0.000	0.000	0.000	31.440	0.000	0.276	0.872
1994	10.149	0.000	0.000	4.330	0.555	46.101	0.000	0.309	0.681
1995	6.434	0.000	0.028	4.140	2.611	88.792	0.685	0.256	0.593
1996	8.793	0.264	0.000	5.043	4.846	0.000	1.126	0.269	0.644
1997	5.491	0.000	0.000	3.531	5.258	81.322	0.597	0.971	0.867
1998	0.732	0.165	0.061	3.991	3.534	46.710	0.392	0.675	0.658
1999	0.000	0.070	0.000	3.166	0.412	84.144	0.416	0.466	0.516
2000	0.000	0.000	0.018	8.695	0.206	76.290	0.166	0.660	0.664
2001	0.000	0.000	0.000	15.152	3.106	65.801	0.084	0.107	0.866
2002	0.000	0.000	0.185	23.897	1.441	100.000	0.529	1.371	1.630
2003	0.000	0.000	0.027	21.505	6.343	47.162	0.826	1.209	1.671
2004	0.000	0.000	0.000	16.522	13.133	0.000	1.067	1.049	1.361
2005	0.000	0.000	0.261	0.000	2.768	51.348	1.512	1.081	0.650
2006	0.000	0.000	0.296	0.000	2.258	100.000	1.943	1.287	0.872
2007	0.000	0.000	0.170	0.000	4.226	63.908	1.584	1.031	0.751
2008	0.000	0.000	0.000	0.000	4.073	16.017	1.348	0.849	0.597
2009	0.000	0.000	0.000	0.000	0.000	0.000	1.165	0.331	0.443
Total	5.083	0.027	0.061	6.456	3.569	35.510	1.034	0.763	0.868

Table 3.5.10.- Coverage of purse seine fishing effort (%) by observer data held by the SPC Oceanic Fisheries Programme, by sector (source: Lawson, 2011).

Year	Unassociated schools	Associated schools	Total
1995	4.16	2.83	3.56
1996	6.21	5.16	5.64
1997	5.65	6.45	6.13
1998	6.54	7.92	7.22
1999	2.46	4.27	3.62
2000	2.44	7.30	4.95
2001	5.07	7.40	6.13
2002	7.51	13.03	10.25
2003	7.92	13.72	10.83
2004	11.10	16.01	14.34
2005	12.03	18.86	15.51
2006	12.04	18.21	15.65
2007	10.79	15.37	13.07
2008	13.19	14.09	13.64
2009	17.71	11.60	14.51
2010	20.23	24.39	21.61
Total	10.03	12.01	11.05

Table 3.5.11.- Estimates of longline shark catches (thousands of sharks) in the WCPFC Statistical Area east of 130°E (source: Lawson, 2011).

Year	Oceanic whitetip	Silky Shark	Blue shark	Thresher sharks	Mako sharks	Total
1992	39	0	1351	58	86	1534
1993	85	0	1333	64	71	1552
1994	184	16	1662	70	75	2007
1995	236	161	235	75	73	2896
1996	196	140	305	68	72	3527
1997	186	135	3587	57	76	404
1998	249	165	4049	62	90	4615
1999	223	167	3683	74	100	4247
2000	186	163	2124	70	91	2635
2001	122	149	1033	71	84	1459
2002	110	142	627	80	79	1038
2003	88	97	574	76	74	909
2004	100	103	639	75	65	983
2005	74	114	671	71	55	985
2006	46	133	642	64	47	932
2007	51	167	672	72	44	1006
2008	55	185	588	71	47	946
2009	53	189	358	61	53	715
Average	127	124	1611	69	71	2011
%	6.3	6.2	80.5	3.4	3.6	100.0

Blue shark is the main shark species caught by longline, accounting for more than 50% of the shark catch in recent years. Blue shark catches peaked during the late 1990s and decreased in the following years, remaining stable at around half a million fish since 2002 (figure 3.5.3).

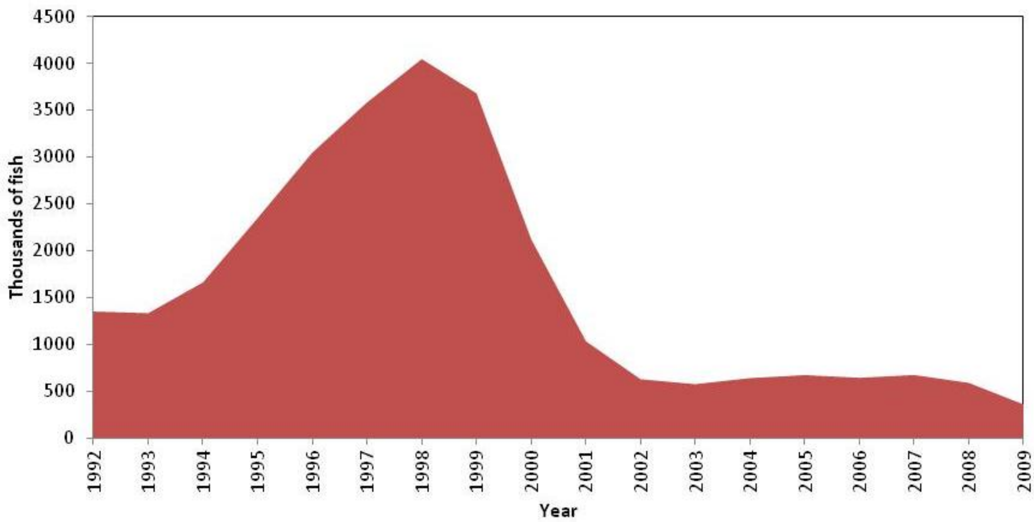


Fig. 3.5.3.- Estimated longline blue shark catches in the WCPFC statistical area east of 130ºE (source: Lawson, 2011).

Silky shark catches have remained more or less stable in the last decade at around 150 thousand fish. Current catches of mako, threshser and oceanic whitetip sharks are slightly over 50 thounsand fish per year. Worth of note is the decrease in whitetip shark catches since the late 1990s (figure 3.5.4).

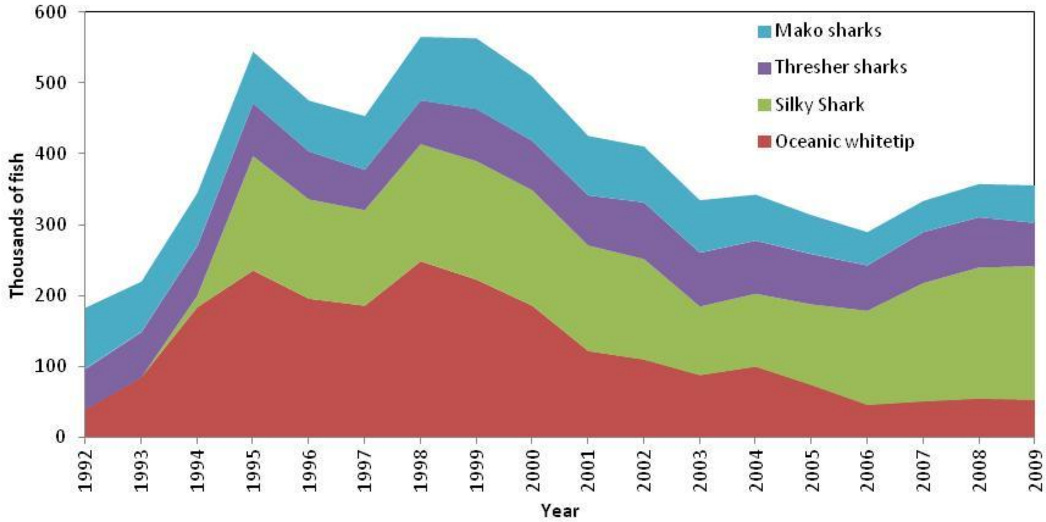


Fig. 3.5.4.- Estimated longline catches of mako, threshser, silky and oceanic whitetip sharks in the WCPFC statistical area east of 130ºE (source: Lawson, 2011).

In the case of the purse seine, estimates were provided for silky and oceanic whitetip sharks (table 3.5.12). Silky shark catches (figure 3.5.5) increased from 2000 to 2004, and account for more than 95% of the estimated purse seine shark catch since then. Oceanic whitetip catchs by purse seine also show a steep decline since the late 1990s (figure 3.5.6).

Table 3.5.12.- Estimates of purse seiner shark catches (number of sharks) in the WCPFC Statistical Area east of 130°E (source: Lawson, 2011).

Year	Oceanic whitetip	Silky Shark	Total
1995	997	23800	24797
1996	2492	24561	27053
1997	3677	28102	31779
1998	4065	27422	31486
1999	4302	35172	39474
2000	3556	31358	34914
2001	3003	35069	38072
2002	2740	43042	45782
2003	2076	56544	58620
2004	1938	84679	86617
2005	1747	78976	80723
2006	1585	81454	83039
2007	1392	78999	80391
2008	1128	78904	80033

2009	711	69790	70501
2010	864	47861	48726
Average	**2267**	**51608**	**53875**
%	**4.2**	**95.8**	**100.0**

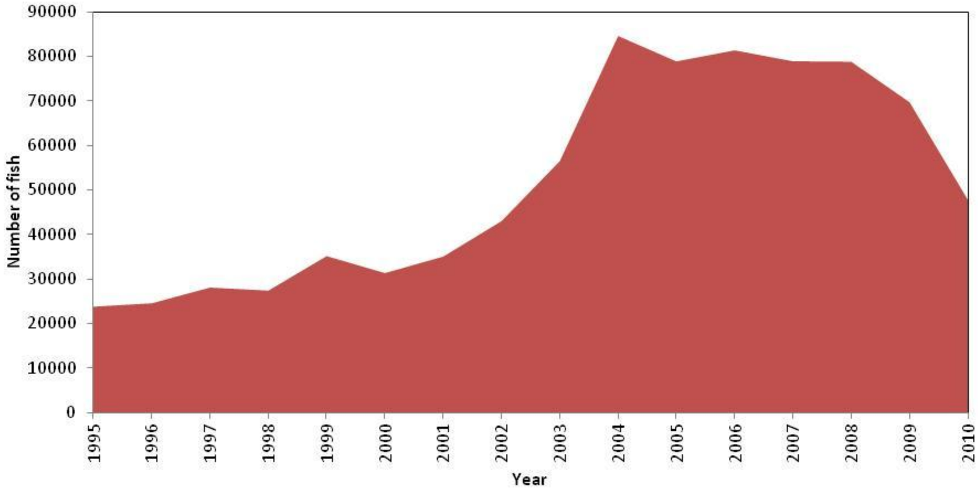


Fig. 3.5.5.- Estimated purse seine catches of silky shark in the WCPFC statistical area east of 130ºE (source: Lawson, 2011).

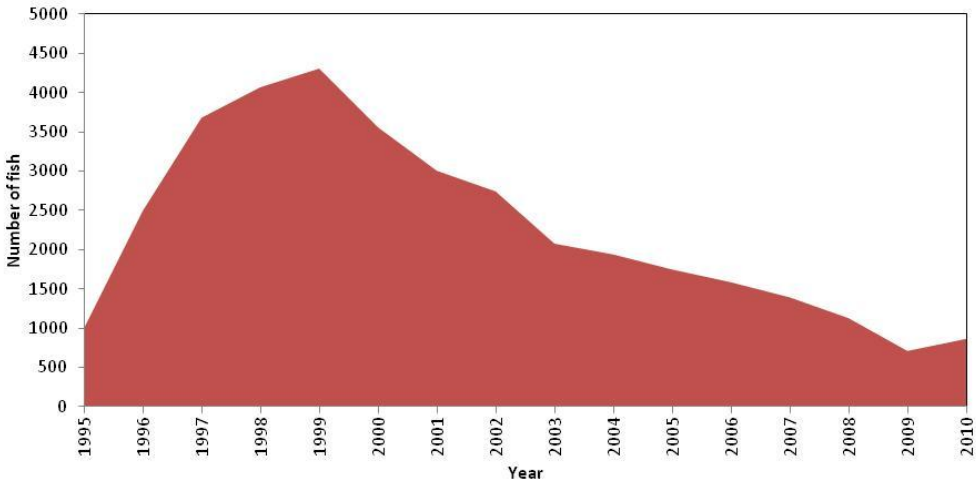


Fig. 3.5.6.- Estimated purse seine catches of oceanic whitetip shark in the WCPFC statistical area east of 130ºE (source: Lawson, 2011).

In August 2012, alternate catch estimates, developed for the estimation of uncertainty through sensitivity runs in the stock assessment, were presented for silky and oceanic whitetip shark (Rice, 2012). It was also based in the parameterization of CPUE data and the availability of effort data. The main difference with the study by Lawson, was the way the CPUE grid (as a function of latitude and longitude) was estimated. Alternate catches are shown in table 3.5.13 and figure 3.5.7.

Table 3.5.13.- Alternate catch estimates (in thousands of sharks) in the WCPFC Statistical Area by gear and year for silky and oceanic whitetip sharks (source: Rice, 2012).

	Silky Shark				Oceanic Whitetip Shark			
	Longline		Purse Seine		Longline		Purse Seine	
Year	Bycatch	Target	Associated	Unassociated	Bycatch	Target	Associated	Unassociated
1995	255.37	16.60	29.40	5.08	71.05	5.61	1.40	0.98
1996	92.26	277.08	37.22	4.74	57.30	5.23	1.69	0.86
1997	96.46	22.05	69.35	3.81	52.23	4.60	2.74	0.65
1998	79.68	24.84	48.66	5.81	59.67	4.76	1.82	0.74
1999	214.95	22.21	56.16	3.36	76.59	6.34	2.23	0.64
2000	174.19	17.66	60.78	6.51	74.28	5.69	2.39	1.09
2001	219.92	22.00	44.36	6.51	83.42	7.66	1.67	0.89
2002	160.74	39.84	57.46	5.29	92.02	10.60	2.17	0.75
2003	138.00	45.57	90.11	5.99	83.34	8.66	3.67	1.78
2004	150.51	31.37	131.04	4.63	78.99	6.91	5.33	0.75
2005	105.04	29.34	76.49	7.35	73.36	7.80	3.08	1.10
2006	175.80	33.77	83.26	6.49	74.67	7.08	3.25	0.85
2007	291.57	46.83	80.52	8.47	101.86	8.22	3.23	1.05
2008	304.31	22.00	86.63	10.22	102.23	7.03	3.40	1.06
2009	189.21	200.31	90.11	8.98	89.34	9.00	3.41	1.17

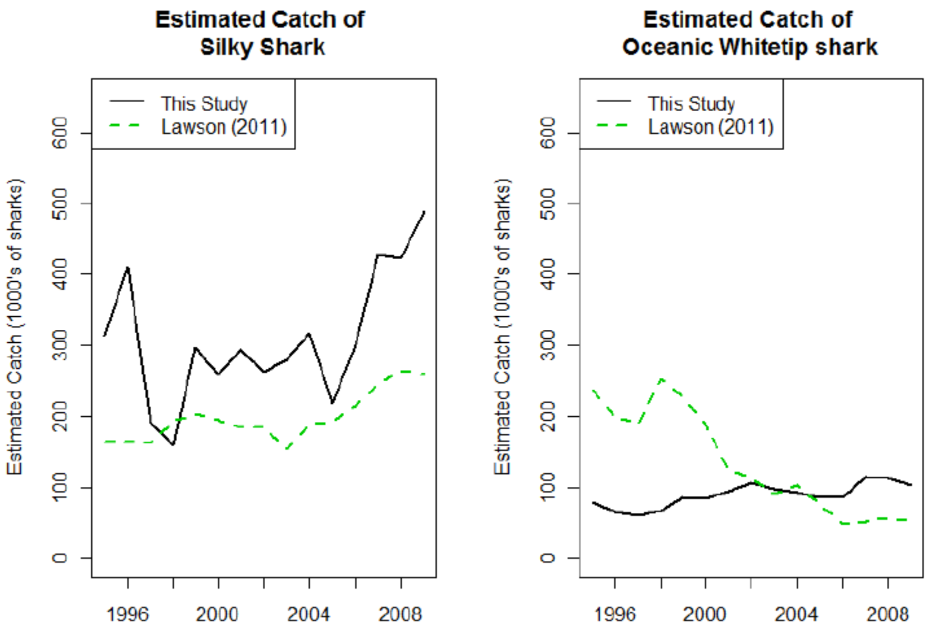


Fig. 3.5.7.- Alternate total catch trends for silky and oceanic whitetip sharks (source: Rice, 2012).

3.5.5 Estimation of discards levels

There is no public database available on the level of discards in the WCPFC. However, Clarke (2011), based in trips covered by observers and provided to the SPC-OFP database, presented data on the fate of sharks caught aboard longine and purse seine vessels.

The number of sharks finned on longline trips with observers onboard decreased slightly in 2008, the first full year after the WCPFC shark CMM was implemented, compared to the two previous years (Figure 3.5.8, left panel). However, the number of sharks in the observer database for 2008 also decreased such that the proportion of sharks finned in 2008 (48%) was lower than 2007 (53%) but higher than 2006 (42%), the year before the measure was implemented. Data for 2009 are still incomplete. The absence of the US observer data post-20044 reduces the number of discarded sharks in the database in recent years.

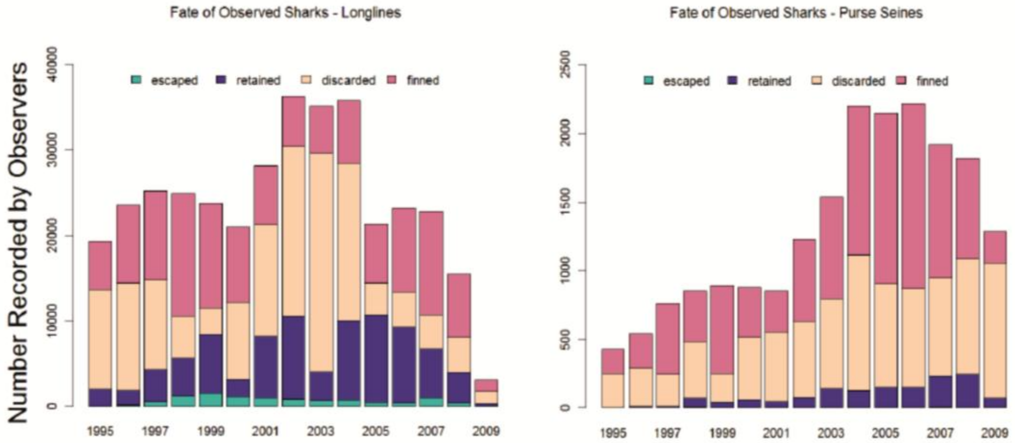


Fig. 3.5.8.- Fate of observed shark in longline and purse seine in the WCPFC vs. year (source: Clarke, 2011).

Unlike longline observer data, purse seine observer data for 2009 is largely complete, therefore both 2008 and 2009 data (as well as 2007 data as a transition period) can be used to assess the number of sharks finned since implementation of the WCPFC shark CMM in February 2007. For the purse seine fishery, the proportion of sharks finned has decreased each year since 2006 (0.61, 0.51, 0.40, 0.18), and the proportion of sharks discarded has increased (Figure 3.5.8, right panel; 0.32, 0.37, 0.46, 0.76). It is possible that the adoption of CMM 2008-01, which was designed as a CMM for bigeye and yellowfin tuna and which included a two-month closure of fishing on fish aggregating devices (FAD), may have influenced the number of sharks caught in purse seine fisheries since most shark catch occurs in sets on FADs.

Shark fate by species over the period 1995-2009 indicates different disposition patterns by species within a fishery (e.g. blue versus silky sharks in the longline fishery) and between fisheries for a given species. In the longline fishery silky sharks are usually retained, but in the purse seine fishery this species is usually finned and rarely retained (Figure 3.5.9). It must be noted that there is still place for finning under the CMM, mainly for coastal states. In addition, figure 3.5.9 includes data from years prior to the enter into force of the first shark CMM.

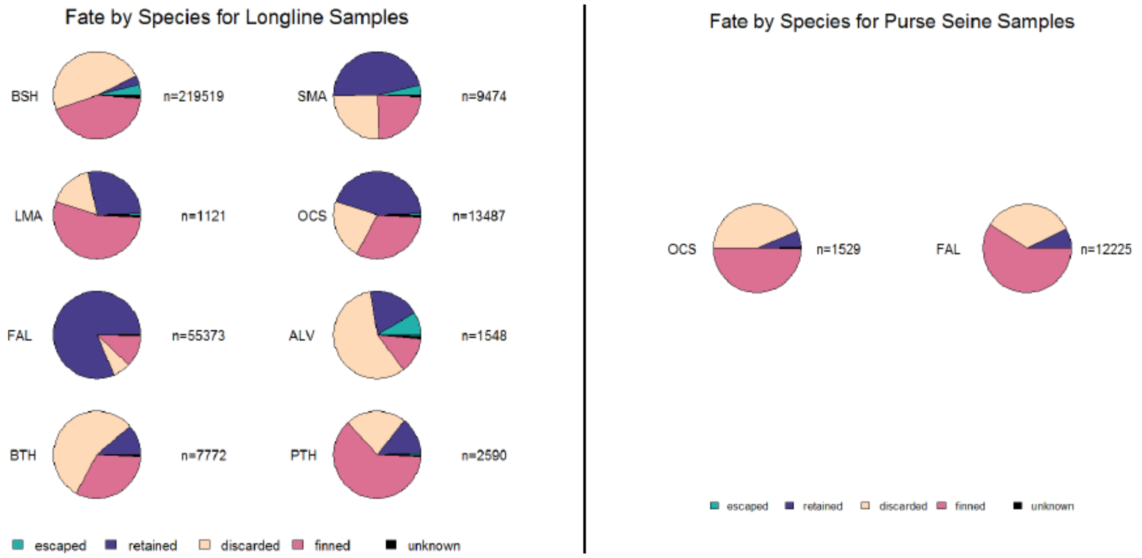


Fig. 3.5.9.- Fate of observed shark in longline and purse seine in the WCPFC by species as recorded by observers during 1995-2009 (source: Clarke, 2011). BSH=blue, SMA=shortfin mako, LMA=longfin mako, OCS=oceanic whitetip, FAL=silky, ALV=common thresher, BTH=bigeye thresher, PTH=pelagic thresher.

Oceanic whitetip sharks show a similar but less pronounced pattern. Another species that is commonly retained in the longline fishery is the shortfin mako. Species which are most commonly discarded (or cut free) are the blue shark, and the common and bigeye threshers. Pelagic thresher and longfin makos are most commonly finned. Due to expectations that only a small amount of the observer data reflects implementation of current finning prohibitions, it should be noted that these characterizations may show more finning, and less retention and discarding, than is currently occurring. On the other hand, if the presence of the observer discourages finning in favour of discarding or cutting free, the rates of finning recorded by observers would be underestimates (*sic)*.

3.5.6 Catch at size

There is not much public information on the catch at size of key shark species in the WCPFC Statistical Area. However, some results based on observer datasets held at SPC-OFP have been recently published (Clarke et al., 2011).

Data from the purse seine fishery are mainly restricted to oceanic whitetip and silky shark in the equatorial areas (figure 3.5.10). Oceanic whitetip median lengths in the purse seine were smaller than in the longline (figure 3.5.13), and few of the sharks sampled were mature. Decreasing size trends were observed in both the western and eastern equatorial regions for this species. Silky sharks sampled from purse seine fishery were also usually immature and there was a statistically significant decline in the nominal median lengths in the westernmost region.

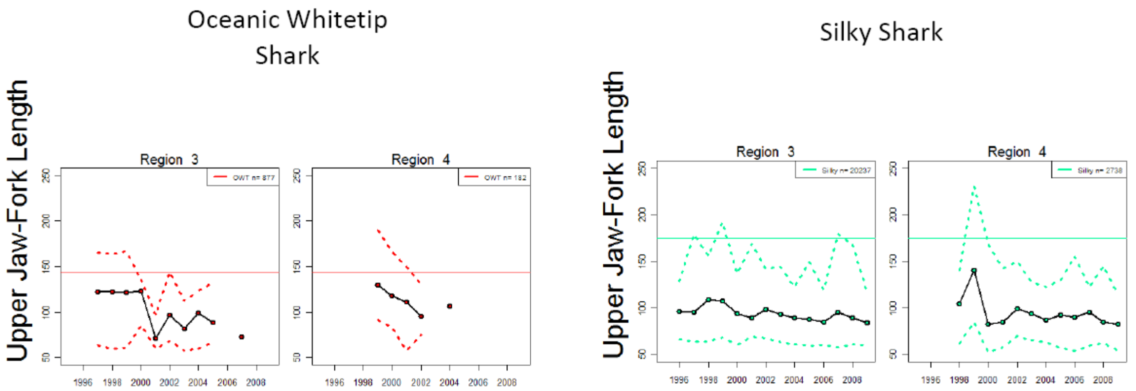


Fig. 3.5.10.- Median length (in fork length) for both sexes (combined) of oceanic whitetip and silky sharks in Regions 3 and 4 based on samples taken from the purse seine fishery, 1996-2009. The 5th and 95th percentiles of the data are shown with dashed lines. Size at maturity is represented by the solid horizontal line. The sample size is shown in the inset to each plot (Source: Clake et al., 2011).

Information on the median length by region for the main shark species caught by longline is also provided in Clarke et al. (2001), and is showed in figures 3.5.11-15. Due to small longline fishery sample sizes for longfin makos, and for bigeye, common and pelagic threshers, results for makos (two species plus unidentified) and threshers (three species plus unidentified) were grouped. Length at maturity data for shortfin mako and bigeye thresher were chosen to represent each group, respectively, as both observer data and literature sources were greatest for these species.

Blue sharks show varying trends in median size depending on region and sex with most trends toward decreasing size. There have been declines in median lengths for blue sharks in the longline fishery for both sexes in Regions 3 and 5, and males in Region 6, with the trends of males in Regions 3 and 6 being statistically significant. Increases were estimated for some regions and sexes, but only females in region 4 had a statistically significant increase. Nominal median lengths in the longline fishery usually fell just above or below the length at maturity depending on the year, except for Region 5 where both male and female median lengths were usually below and Region 2 where both male and female median lengths were consistently above (figure 3.5.11).

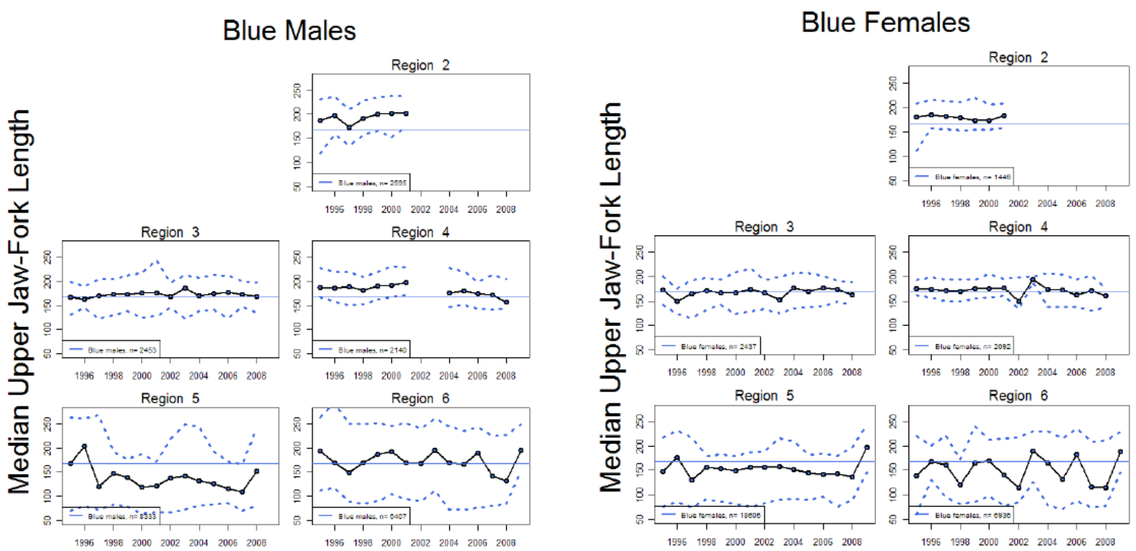


Fig. 3.5.11.- Median length (in fork length) for male (left panel) and female (right panel) blue sharks by region from longline observer data, 1995-2009. The 5th and 95th percentiles of the data are shown with

dashed lines. The sample size is shown in the inset to each plot. Size at maturity is represented by the solid horizontal line (source: Clarke et al., 2011).

Summarized mako size trends were similar to those observed for blue shark with most but not all trends toward decreasing size (figure 3.5.12). Sample sizes for mako shark lengths from the longline fishery were limited in all but Regions 5 and 6. Although median size trends were mostly decreasing, no significant trends were apparent in either the nominal or the standardized results for longline fisheries in these regions. While male mako shark median lengths appear to be at or near the length at maturity, the entire 90% confidence interval for female mako sharks lies below the length at maturity.

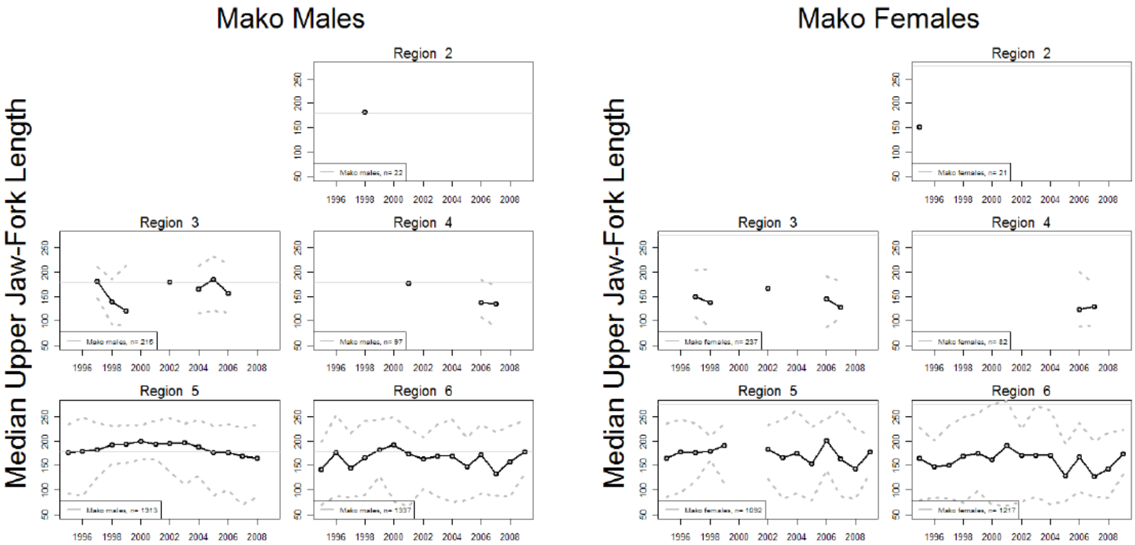


Fig. 3.5.12.- Median length (in fork length) for male (left panel) and female (right panel) mako sharks by region from longline observer data, 1995-2009. The 5th and 95th percentiles of the data are shown with dashed lines. The sample size is shown in the inset to each plot. Size at maturity is represented by the solid horizontal line (source: Clarke et al., 2011).

No positive trends in median size were observed for oceanic whitetip sharks (figure 3.5.13). The estimated trends in median length were declining for both sexes for all regions, with statistically significant trends for females in Regions 3 and 4. Regional medians were near the length at maturity (138 cm for males and 144 cm for females. Both Regions 3 and 4 show decreasing sizes in the nominal data since 2000 with the trend being statistically significant for Region 3 (Figure 3.5.13).

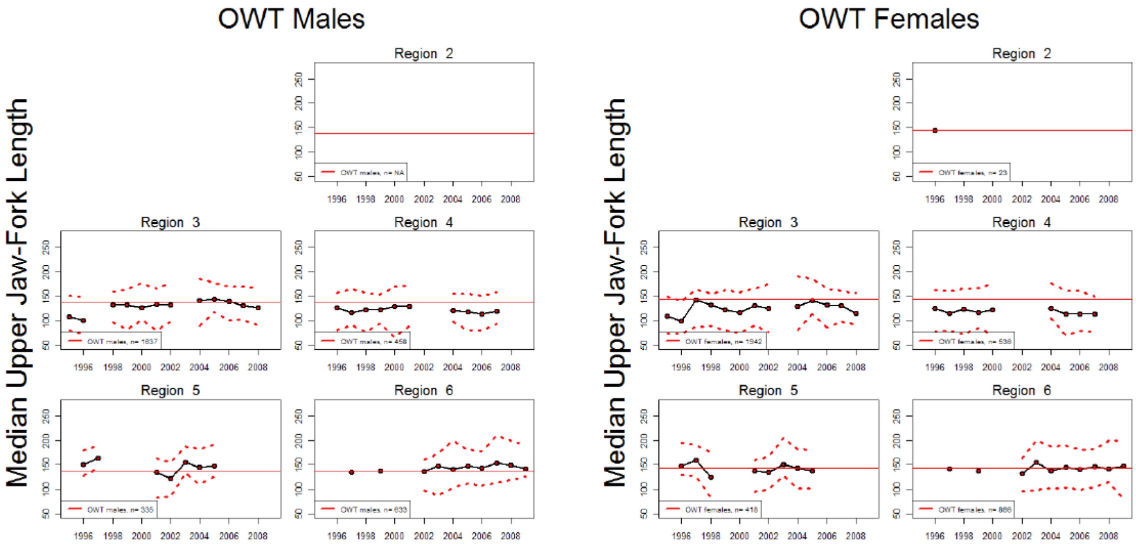


Fig. 3.5.13.- Median length (in fork length) for male (left panel) and female (right panel) oceanic whitetip sharks by region from longline observer data, 1995-2009. The 5th and 95th percentiles of the data are shown with dashed lines. The sample size is shown in the inset to each plot. Size at maturity is represented by the solid horizontal line (source: Clarke et al., 2011).

Similar to oceanic whitetip sharks, no positive trends in median size were observed for silky sharks (Figure 3.5.14). In the longline fishery standardized trends were declining for both sexes in all regions, with statistically significant trends for both sexes in Regions 3 and 5, i.e. the western WCPO. Most longline silky shark samples from the core habitat area (Region 3) were immature, as were many of the individuals sampled from longline catches in Regions 4-6.

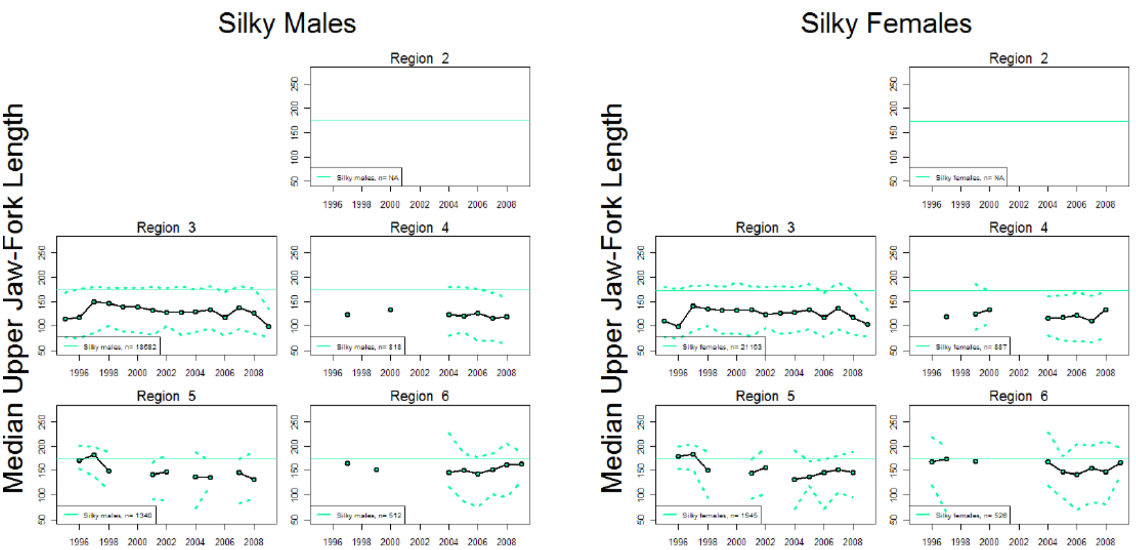


Fig. 3.5.14.- Median length (in fork length) for male (left panel) and female (right panel) silky sharks by region from longline observer data, 1995-2009. The 5th and 95th percentiles of the data are shown with dashed lines. The sample size is shown in the inset to each plot. Size at maturity is represented by the solid horizontal line (source: Clarke et al., 2011).

Like blue and mako sharks, threshers showed mostly negative trends in median sizes (figure 3.5.15). Most thresher median lengths were slightly below the length at maturity but application of a single length at maturity for the most commonly recorded thresher species (bigeye threshers) to the two other rarer species is an approximation that caveats this interpretation. Although samples were limited, standardized results show decreasing median size trends, particularly for females in Region 3 and for males and females in Region 4, both of which showed significant declines.

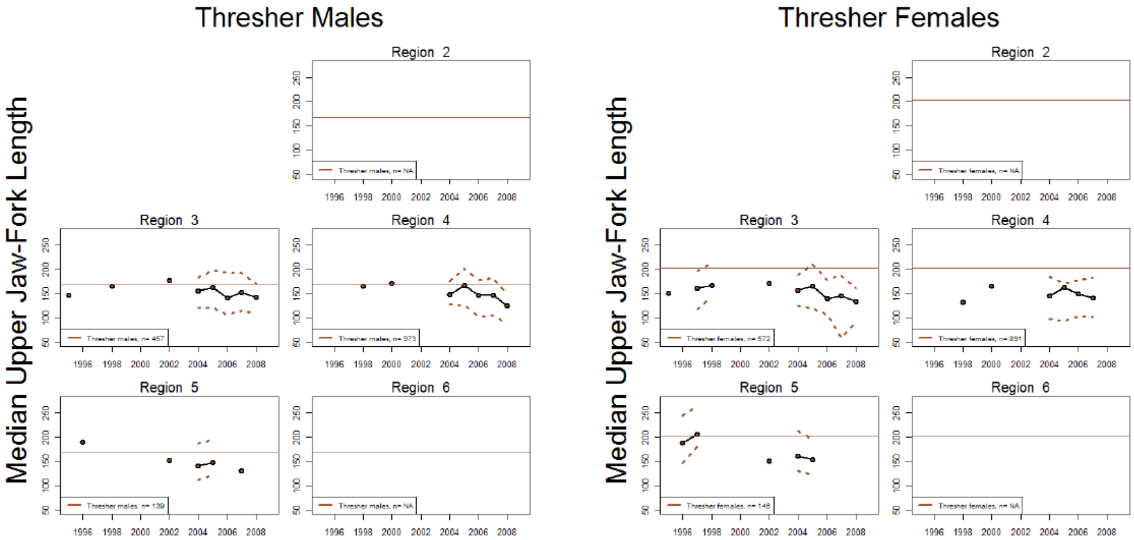


Fig. 3.5.15.- Median length (in fork length) for male (left panel) and female (right panel) thresher sharks by region from longline observer data, 1995-2009. The 5th and 95th percentiles of the data are shown with dashed lines. The sample size is shown in the inset to each plot. Size at maturity is represented by the solid horizontal line (source: Clarke et al., 2011).

3.5.7 Biological information

Biological information for all the species covered in the study is presented in **Annex II**.

Moreover, in addition to the data recorded by the observers of the Regional Observer Programme, the Oceanic Fisheries Programme of the Secretariat of the Pacific Community (SPC-OFP), scientific service provider of the WCPFC, carries out several activities aimed at improving the information available for the assessment of the stocks managed by the Commission. This work ranges from tagging to age-determination or reproductive biology studies. In the particular case of sharks, effort has been mainly devoted to the compilation of data available in the literature and data mining of several observer programmes so far. Members and cooperating non-members also provide information on the biology of the species during the pre-stock assessment or Scientific Committee meetings.

Apart from the information on size provided above, the most useful biological parameter available in the SPC-OFP database is shark sex. Fish sex is not usually available for purse seine samples. In the case of longline observer data, the extent of this information varies depending on the region and species. Longline data on sex-ratio by species and region (figure 3.5.16) generally shows that the percentage of females varies from 40-60% in most years and regions. Exceptions to this include a high percentage of male blue sharks in Region 2 (probably adult), a high percentage of female blue sharks in Region 5 (probably juvenile) and a high percentage of male mako sharks in Region 5. There are no strong trends observed over time for any species, sex or region.

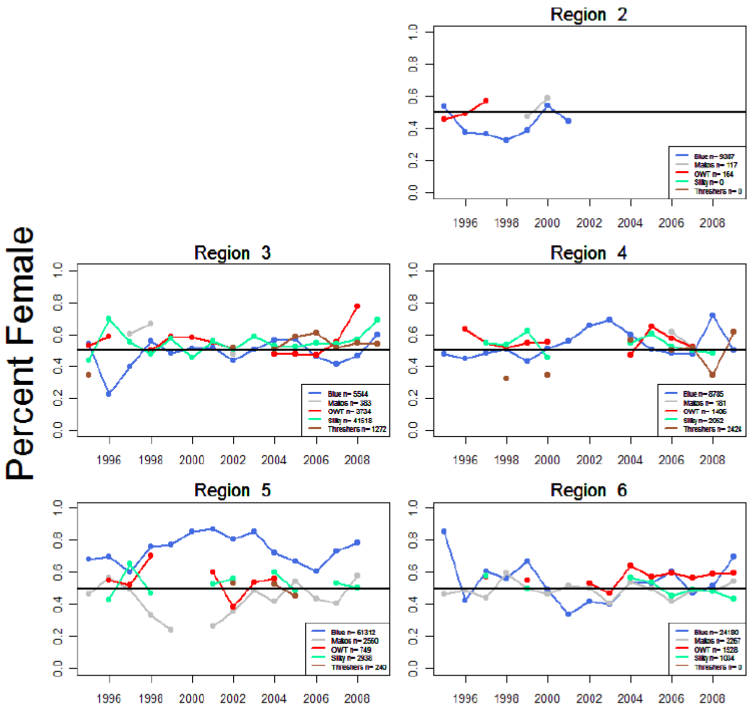


Fig. 3.5.16.- Percentage of sharks sampled by longline observers which were female for five shark groups in Regions 2-6 of the WCPO Statistical Area, 1995-2009. (Source: Clarke et al., 2011).

There is also important information in the literature regarding the biology of different shark species in the WCPFC area:

Francis, M.P. and Duffy, C. 2005. Length at maturity in three pelagic sharks (*Lamna nasus*, *Isurus oxyrinchus*, and *Prionace glauca*) from New Zealand. Fishery Bulletin 103:489–500

Joung, S.J., Chen, C.T.; Lee H.H. and Liu, K.M. 2008. Age, growth, and reproduction of silky sharks, *Carcharhinus falciformis* in northeastern Taiwan waters. Fisheries Research 90 (1–3): 78–85.

Nakano, H. 1994. Age, reproduction and migration of blue shark in the North Pacific Ocean. National Research Institute of Far Seas Fisheries Bulletin 31: 141-256.

Nakano, H. and Stevens, J.D. 2008. The biology and ecology of the blue shark, *Prionace glauca*. pp. 140-151 IN: Sharks of the Open Ocean: Biology, Fisheries and Conservation. M.D. Camhi, E.K. Pikitch and E.A. Babcock (eds). Blackwell Publishing, Oxford, United Kingdom. 502 pp.

Seki, T., Taniuchi, T., Nakano, H. and Shimizu, M. 1998. Age, growth and reproduction of the oceanic whitetip shark from the Pacific Ocean. Fisheries Science 64(1): 14-20.

3.5.8 Fishery indicators (blue shark and shortfin mako)

Until very recently, information on the status of most of the shark species managed by the WCPFC Commission was scarce. However, during the last Regular Session of the Scientific Committee, in August 2012, stock assessments were presented for first for oceanic whitetip and silky sharks.

In the previous Scientific Committee, a status snapshot of the considered key shark species (Clarke, 2011) and an indicator-based analysis of several shark species (Clarke et al., 2011) were published. This work was based on a review of previous studies available in the literature and on working papers presented to the Scientific Committee.

The main conclusions of the stock assessments and the fishery indicators study, by species, are:

<u>Blueshark</u>:

The blue shark is probably the most common, but not the most vulnerable, of pelagic sharks. The blue shark was categorized as being at “medium” ecological risk for deep longline sets and “medium-low” ecological risk for shallow longline sets (Kirby and Hobday, 2007).

A stock assessments, based on data through 2002, in the North Pacific (Kleiber et al., 2009) concluded that the population appeared close to the B_{MSY} reference point and fishing effort might be approaching F_{MSY} (figure 3.5.17). However, in the recent WCPO analyses, substantial recent catch rate declines (*e.g.* figure 3.5.18) found in four different datasets for the North Pacific, in combination with demonstrated targeting of blue shark by a large commercial fleet operating in this area, are scientific grounds for concern and suggest further declines in abundance since 2002. Therefore, the conclusion of Kleiber et al. (2009) that this stock was above B_{MSY} may no longer hold.

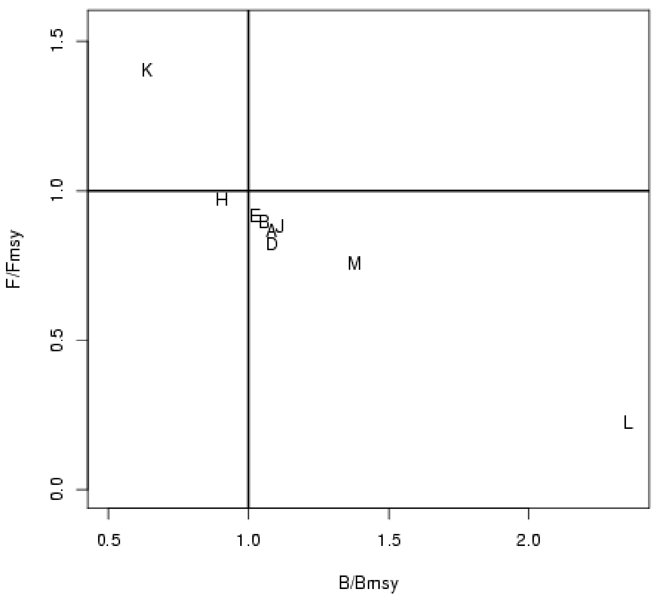


Fig. 3.5.17.- Average (1998–2002) F/F_{MSY} vs. B/B_{MSY} for a range of alternate model fits conducted under a variety of constraints and conditions. “A” is the basecase (source: Kleiber et al., 2005).

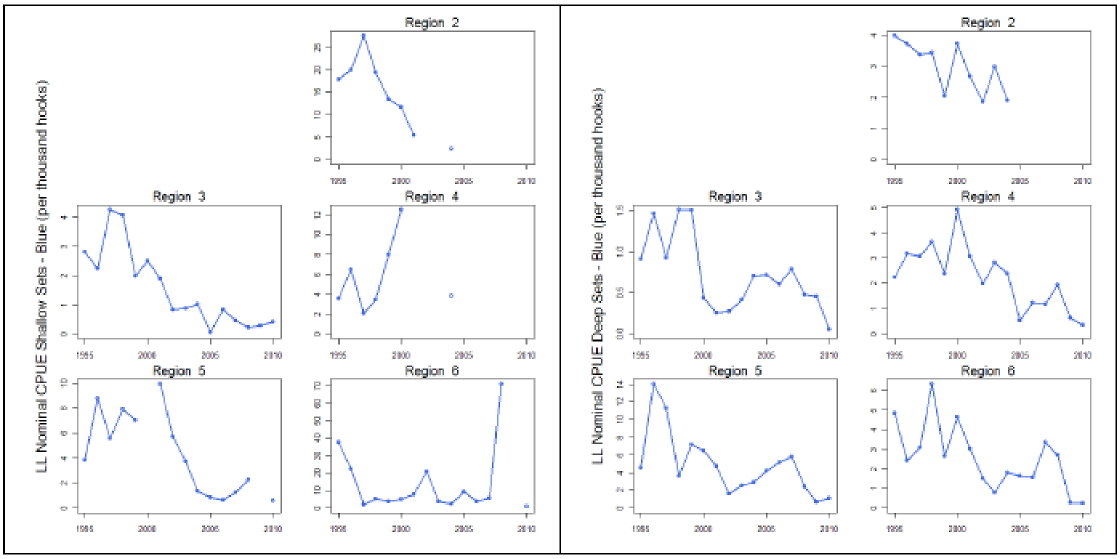


Fig. 3.5.18.- Nominal catch rates by region and year for blue sharks by shallow (<10 hooks per basket) and deep (≥10 hooks per basket) sets (source Clarke et al., 2011).

No significant trends in median size have been observed throughout the different areas (figure 3.5.11).

Mako sharks:

Recent abundance indices (figure 3.5.19) and median size analyses (figure 3.5.12) for shortfin mako in the WCPO have shown no clear trends; therefore there is no apparent evidence of the impact of fishing on this species in the WCPO. Ongoing issues of concern for the WCPO are: 1) a previously published study suggesting stock reduction in the Northwest Pacific using virtual population analysis (Chang and Liu, 2009); 2) the high vulnerability of shortfin makos to longline fishing (Cortés et al., 2010; Arrizabalaga et al., 2011); and 3) the potential for collateral targeting in directed fishing for blue sharks in the North Pacific. The status of longfin mako stocks is unknown for the WCPO. The shortfin and longfin makos were categorized as being at “medium” ecological risk for both deep and shallow longline sets (Kirby and Hobday 2007).

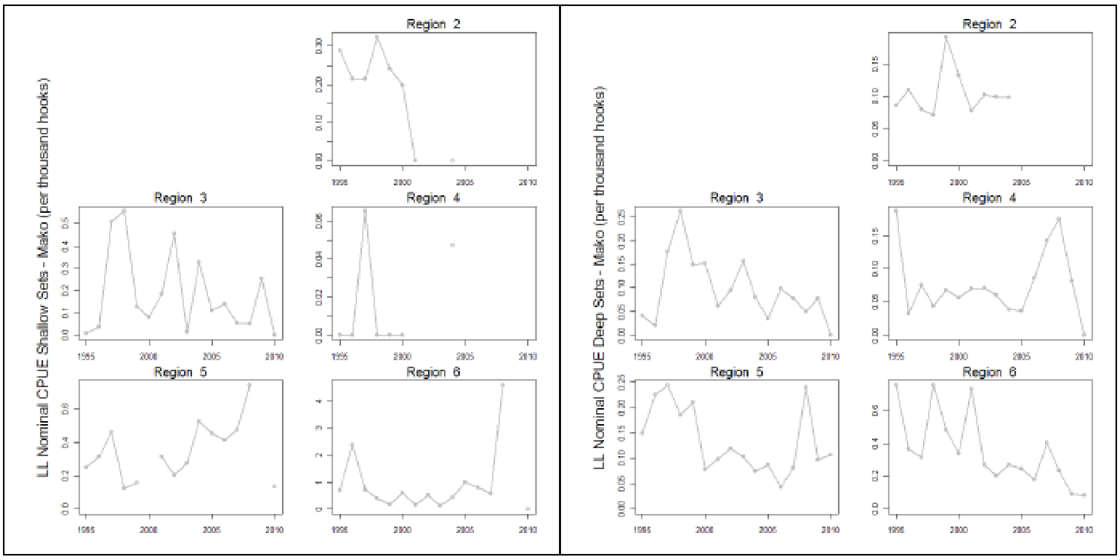


Fig. 3.5.19.- Nominal catch rates by region and year for mako sharks by shallow (<10 hooks per basket) and deep (≥10 hooks per basket) sets (source Clarke et al., 2011).

Oceanic whitetip:

Recent analysis of four different datasets for the WCPO show clear, steep and declining trends in abundance indices for this species (see Clarke, 2011 for review). An example of the longline CPUE trends is shown in figure 3.5.20. Analysis of two of these datasets for median lengths also confirmed that oceanic whitetip sizes decreased significantly until samples became too scarce for analysis. Additionally, catch estimates in number based on observer data indicate removals have dropped by ~70% in the past decade (Lawson 2011).

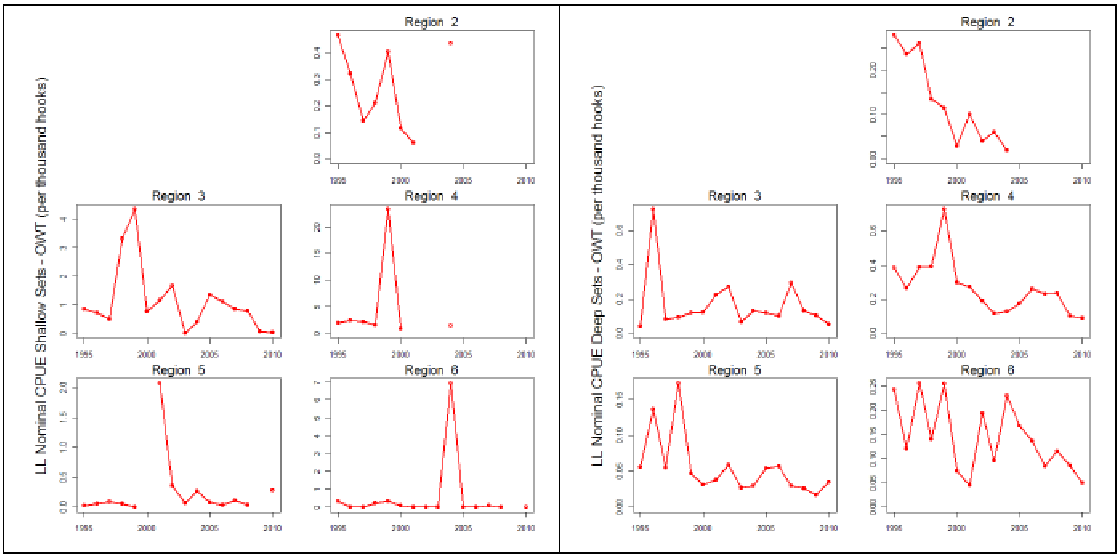


Fig. 3.5.20.- Nominal catch rates by region and year for oceanic whitetip sharks by shallow (<10 hooks per basket) and deep (≥10 hooks per basket) sets (source Clarke et al., 2011).

The first stock assessment for this species in the Western and Central Pacific was presented in August 2012 at the 8th Session of the Scientific Committee (Rice and Harley, 2012a). The assessment used the stock assessment model Stock Synthesis.

Oceanic whitetip sharks are most often caught as bycatch in the Pacific tuna fisheries, though some directed and mixed species (sharks and tunas/billfish) fisheries do exist. Commercial reporting of landings has been minimal, as has information regarding the targeting, and fate of sharks encountered in the fisheries. Useful data on catch and effort is mostly limited to observer data held by the SPC, but the observer data also suffers from poor coverage, especially in the longline fishery. Therefore multiple data gaps had to be overcome through the use of integrated stock assessment techniques and the inclusion of alternate data that reflected different states of nature. Multiple models with different combinations of the input datasets and structural model hypotheses were run to assess the plausible range of stock status for oceanic whitetips. Each model was given a weight based on the plausibility of the assumptions and data used in each model.

The key conclusions of the first stock assessment for oceanic whitetip sharks in the WCPO are as follows:

a. Notwithstanding the uncertainties inherent in the input data, the catch, CPUE, and size composition data all show consistent declines over the period of the model (1995-2009).
b. This is a low fecundity species and this is reflected in the low estimated value for F_{MSY} (0.07) and high estimated value for SB_{MSY}/SB_0 (0.424). These directly impact the conclusions about overfishing and the overfished status of the stock.
c. Estimated spawning biomass, total biomass and recruitment all decline consistently throughout the period of the model. The biomass declines are driven by the CPUE series, and the recruitment decline is driven through the tight assumed relationship between spawning biomass and recruitment.
d. Estimated fishing mortality has increased to levels far in excess of F_{MSY} ($F_{CURRENT}$ / F_{MSY} = 6.5) and across all model runs undertaken estimated F values were much higher than F_{MSY} (the 5th and 95th quantiles of the grid are 3 and 20). <u>Based on these results we conclude that overfishing is occurring</u>.
e. Estimated spawning biomass has declined to levels far below SB_{MSY} ($SB_{CURRENT}/SB_{MSY}$ = 0.153) and across all model runs undertaken $SB_{CURRENT}$ is much lower than SB_{MSY} (the 5th and 95th quantiles of the grid are 0.082 and 0.409). <u>Based on these results we conclude that the stock is overfished</u>.
f. Noting that estimates of SB_0 and SB_{MSY} are particularly uncertain as the model domain begins in 1995, it is also useful to compare current stock size to that at the start of the model. Estimated spawning biomass has declined over the model period by 86% and across all model runs undertaken $SB_{CURRENT}$ is much lower than SB_{1995} (the 5th and 95th quantiles indicate a decline to 8.7% and 45.8% of SB_{1995}).
g. Current catches are lower than the MSY (2,001 versus 2,700), but this is not surprising given the estimated stock status and fishing mortality. Current (2005-2008 average) and latest (2009) catches are significantly greater than the forecast catch in 2010 under F_{MSY} conditions (230 mt).
h. The greatest impact on the stock is attributed to bycatch from the longline fishery, with lesser impacts from target longline activities and purse seining.

i. Given the bycatch nature of fishery impacts, mitigation measures provide the best opportunity to improve the status of the oceanic whitetip population. Existing observer data may provide some information on which measures would be the most effective.

j. Given recent decisions to improve logsheet catch reporting and observer coverage in the longline fishery it is recommended that an updated assessment be undertaken in 2014.

In spite of the uncertainties affecting this assessment, the sensitivity analysis showed that the results are quite robust in terms of stock status, since all the plausible model runs indicated overfishing is occurring and the stock is overfished (figure 3.5.21).

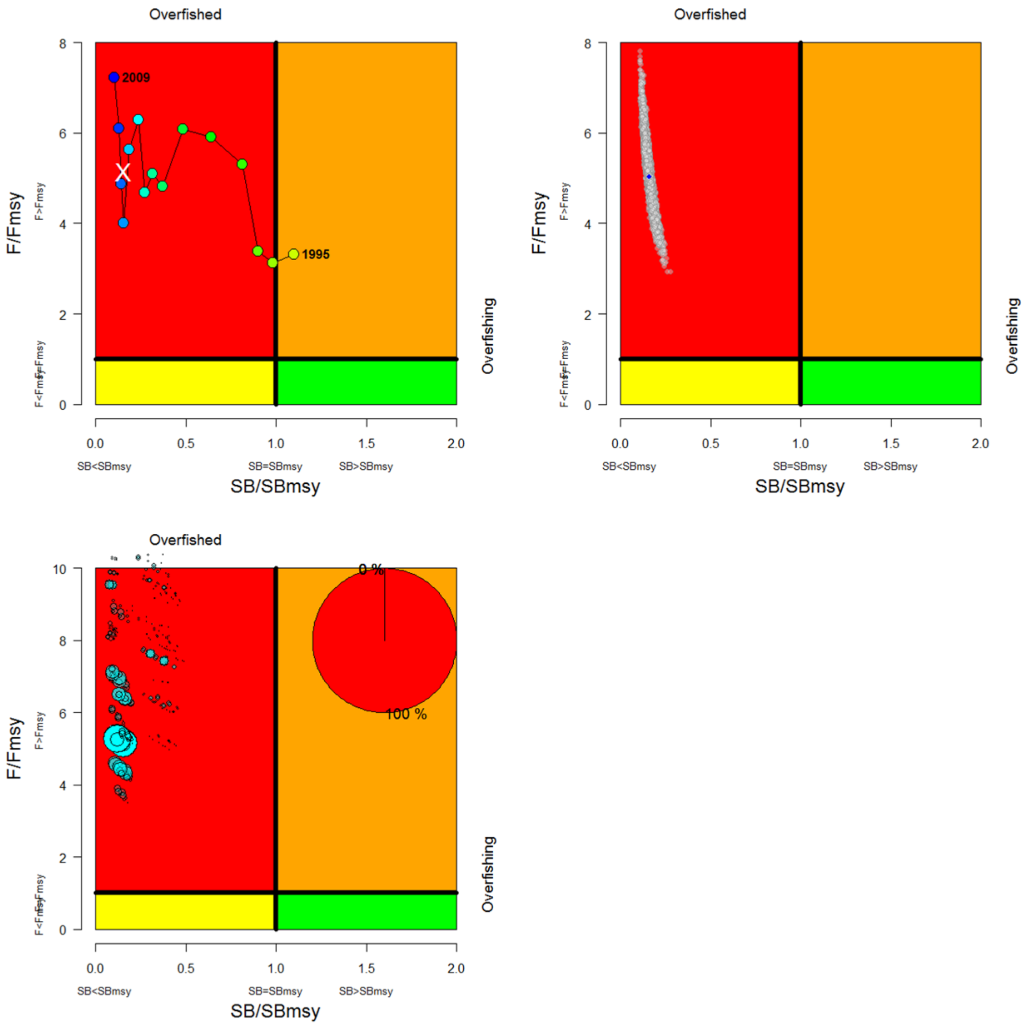


Fig. 3.5.21.- Kobe plots indicating annual stock status, relative to SB_{MSY} (x-axis) and F_{MSY} (y-axis) reference points. These present the reference model for the period 1995–2009 (top left panel), the statistical uncertainty based on the MCMC analysis for the current (average of 2005-2008) status (top right panel, blue dot indicates current estimates), and based on the current (average of 2005-2008) estimates for all 648 models in the grid (bottom panel). In the bottom panel the size of the circle is proportional to the weight (plausibility) of the model run. Note that the y-axes range differ in the bottom plot.

Silky shark

Silky sharks have a restricted habitat range compared to the other WCPFC key species but within this range they dominate both longline and purse seine catches. Although silky sharks have been shown to have declining catch rate trends in past studies in the Pacific, no strong trends were found in recent (2011) WCPO analyses (figure 3.5.22).

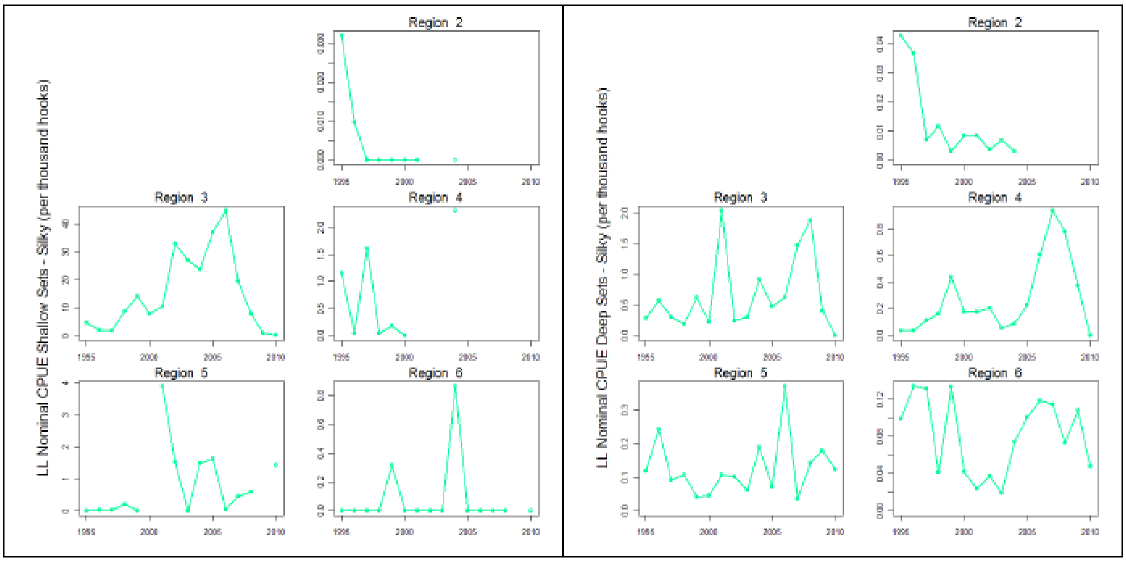


Fig. 3.5.22.- Nominal catch rates by region and year for silky sharks by shallow (<10 hooks per basket) and deep (≥10 hooks per basket) sets (source Clarke et al., 2011).

Lawson (2011) identified increasing catch rate trends in standardized purse seine catch rates through 2008 (figure 3.5.5). Despite the lack of clear trends in catch rates, median lengths were always decreasing and trends were often significant for both sexes in SPC-held purse seine and longline observer data from the core habitat areas (figure 3.5.10; figure 3.5.14).

The first stock assessment for this species was also presented during the last Regular Session of the Scientific Committee of the WCPFC, in August 2012 (Rice and Harley, 2012b). The assessment uses the stock assessment model Stock Synthesis.

Silky sharks are most often caught as bycatch in the Pacific tuna fisheries, though some shark target and mixed species (sharks and tunas/billfish) fisheries do exist. Commercial reporting of landings has been minimal, as has information regarding the targeting, and fate of sharks encountered in the fisheries. Useful data on catch and effort is mostly limited to observer data held by the SPC, but the observer data also suffers from poor coverage. Therefore multiple data gaps had to be overcome through the use of integrated stock assessment techniques and the inclusion of alternate data that reflected different states of nature.

Multiple models with different combinations of the input datasets and structural model hypotheses were run to assess the plausible range of inputs and the resulting estimates of stock status. These models were each given a 'weight' based on the a priori plausibility of the assumptions and data used in each model.

The key conclusions of the WCPO silky shark stock assessment are:

a. Notwithstanding the difficulties inherent in the input data, the size composition data shows consistent declines over the period of the model (1995-2009) which is coupled with increasing fishing mortality, and a recently declining CPUE trend.
b. The results of the model can be split into two categories which are mutually exclusive with respect to the estimates of stock status. These two categories are characterized by the CPUE input. All runs that included the target longline and purse seine CPUE trends estimated a current total biomass in excess of 150,000,000 t which is more than 18 times greater than the combined 2010 estimate of bigeye, south Pacific albacore, skipjack and yellowfin tuna total biomass combined. Therefore these runs are not considered plausible and dropped from the summary. The following results are based on the reference case and the minimum and maximum values of the runs selected by the committee to depict the uncertainty in the model.
c. This is a low productivity species and this is reflected in the low estimated value for F_{MSY} (0.078) and high estimated value for SB_{MSY} /SB_0 (0.38). These directly impact on conclusions about overfishing and the overfished status of the stock.
d. Based on the highest probability model (the reference case), estimated spawning biomass, total biomass and recruitment all decline consistently throughout the period of the model. The biomass declines are driven by the CPUE series, and the recruitment decline is driven through the tight assumed relationship between spawning biomass and recruitment.
e. Estimated fishing mortality has increased to levels far in excess of F_{MSY}. The reference case estimate of $F_{CURRENT}/F_{MSY}$ = 6.4 (with a range of 4.2 to 10.2 based on the runs selected by the committee to represent the uncertainty in the model). Based on these results it is concluded that overfishing is occurring.
f. Estimated spawning biomass has declined to levels far below SB_{MSY}. The reference case estimate of $SB_{current}$ / SB_{MSY}= 0.66 (with a range of 0.48 to 0.81 based on the runs selected by the SC to represent the uncertainty in the model). Based on these results it is concluded that the stock is overfished.
g. Noting that estimates of SB_0 and SB_{MSY} are particularly uncertain since the model domain begins in 1995, it is also useful to compare current stock size to that at the start of the model. Estimated spawning biomass has declined over the model period to 62% of the 1995 value in the reference case (with a range of 0.51 to 0.95 based on the runs selected by the committee to represent the uncertainty in the model).
h. Current catch based on the reference case is higher than the MSY (5,950 t versus 1,885 t), further catch at current levels of fishing mortality would continue to deplete the stock below MSY. Current (2005 to 2008 average) and latest (2009) catches are significantly greater than the forecast catch in 2010 under F_{MSY} conditions (510 t).
i. The greatest impact on the stock is attributed to bycatch from the longline fishery, but there are also significant impacts from the associated purse seine fishery which catches predominantly juvenile individuals, the fishing mortality from the associated purse seine fishery alone is above F_{MSY}.
j. Given the bycatch nature of fishery impacts, mitigation measures provides the best opportunity to improve the status of the silky shark population.

Existing observer data may provide some information on which measures would be the most effective.

k. Given recent decisions to improve logsheet catch reporting and observer coverage in the longline fishery it is recommended that an updated assessment be undertaken in 2014.

In spite of the conclusions of this assessment, there is large structural which needs to be addressed in future assessments. There is a conflicting trends in the standardized bycatch longline (declines after 2004) and both the target longline and the purse seine (increases in most of the time series) CPUE series (figure 3.5.23). Additionally, the model fit to the highly influential bycatch longline series was poor.

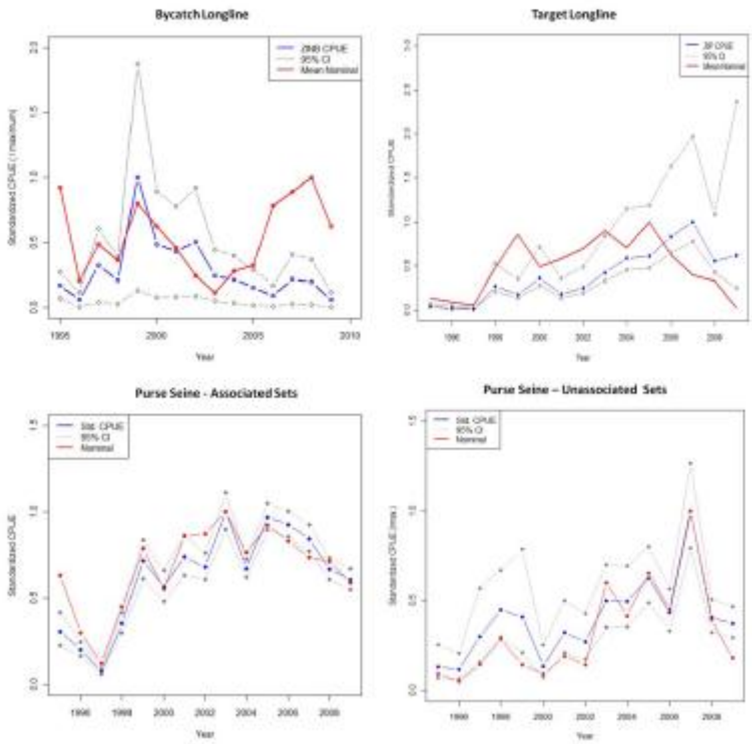


Fig. 3.5.23.- Standardized and nominal CPUE series for each of the four fisheries used in the stock assessment (source: Rice and Harley, 2012b).

Therefore, the SC considered this assessment could not be used for management advice, but recommended no increase in fishing mortality due to some basic fishery indicators (e.g. mean lengths and some CPUE series). This stock assessment will likely be updated in 2013, once all the important data series are incorporated in the stock assessment.

Thresher sharks:

Threshers are poorly studied as a group, and even more poorly known on a species-by-species basis. The relative vulnerability of thresher sharks to longline fisheries, and the appropriateness of assessing some or all thresher species as a group, are still under debate. Regardless, data limitations including problems with species identification led to grouping these species in recent (2011) WCPO thresher analyses. Declines in median sizes were identified (figure 3.5.15) but no strong catch rate trends were found in any data set (figure 3.5.24). On the other hand, two recent studies in the northwestern

Pacific (Liu et al., 2006; Tsai et al., 2010) concluded the stock was over-exploited in this area.

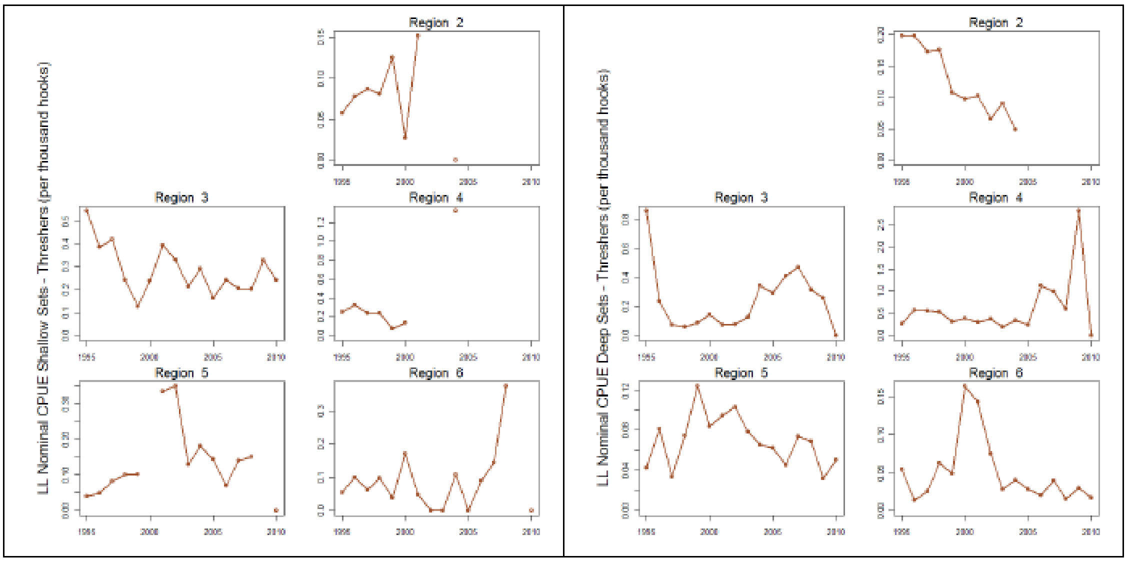


Fig. 3.5.24.- Nominal catch rates by region and year for thresher sharks by shallow (<10 hooks per basket) and deep (≥10 hooks per basket) sets (source Clarke et al., 2011).

Further research into better analytical methods, in parallel with species-specific data improvement, is required for all three thresher species.

3.5.9 Major difficulties

No major difficulties have been suffered in the data gathering process and data identification gaps, however, the major difficulties of the project are the scarcity of data and data availability for major fleets and countries as underlined in the previous section. Most of those data is coming from logbooks which may complicated the data gathering process due to species mis-identification, under-reporting and potential, unidentifiable in targeting strategies.

As advanced above, the major difficulties are related to the lack of data. In many instances, shark catches are not recorded or not disaggregated at the required level. Besides, most of the data recorded are not publicly available and under very strict rules of confidentiality. This problem worsens in the case of developing states and, especially, for historical data. For example, one of the greatest difficulties is to obtain database of catch of artisanal and industrial LL fisheries, which probably do not exist. In many instances, shark catches are not recorded or not disaggregated at the required level.

Another problem, in the specific case of Western Pacific Ocean, is the difficulty to access to disaggregated and aggregated data for some of the fleets such as the longline and coastal fleets and in a lesser extend the purse seine fleet.

3.5.10 Summary

Highly migratory fish stocks, including sharks, in the Western Pacific Ocean are managed by the Western and Central Pacific Fisheries Commission (WCPFC). The WCPFC Convention Area covers almost 20% of the Earth's surface and around 60% of the current world tuna catch takes place in this area.

In spite of the importance of shark catches by industrial fleets, they have traditionally consisted of bycatch of commercial fisheries and sharks are most often discarded or finned. Therefore, most of the times, shark catches are not recorded, especially with the required level of disaggregation, and catches must be estimated by statistical procedures based on observer data, fishing effort and different covariates. Moreover, the information recorded is not usually available in the public domain.

The work carried out so far has been focused on the collection of information publicly available, mainly in the public domain of the two Pacific Ocean RFMOs but also on information available in the literature, most of which comes from documents presented at the scientific meetings or workshops of both RFMOs. After data gaps have been identified, the next step is determining whether this information has been recorded and is available elsewhere or if it simply does not exist. With that aim, requests on the availability and structure of their databases have been submitted to the Secretariat of the RFMOs, main flag states and EU-member states but no positive responses have been received so far.

Although the lack of data in relation to sharks in the WCPFC is also evident from the analysis carried out here, it is worth mentioning that attemps have been done to assess the silky shark and oceanic white tip shark in 2012. In both cases, although the results can be considered preliminary and in the case of silky shark contradictory, the main conclusions were that it is likely that both stocks are overfished and thus it is recommended to decrease the fishing mortality.

3.6 Conclusions

3.6.1 Methodology and data used

Most of the information gathered so far was obtained from the public RFMOs websites (IOTC, IATTC, WCPFC, GFCM, and ICCAT) and in the case of Mediterranean also from the FAO FishStat database, which allows visitors to download public fishery statistics databases, reports and scientific documents presented during the different Working Parties, Scientific Committee and Commission meetings. However, there is some delay on the incorporation of new information (namely statistics) on the RFMOs websites. Thus, the information provided in this report is mostly based on the last update of the databases, which occurred around mid- and/or end- 2011, up to 2010 in most of the cases. The RFMO data administrators were also contacted in order to obtain any additional fishery statistics data. Similarly, information from flag states, and from EU-member states, has been requested in order to improve the information available on discards levels, size frequencies and biological information. Moreover, a large number of reports and scientific documents presented by Member Countries to the Tuna RFMO meetings were also analyzed to identify the availability of shark catch and bycatch data for various fleets and countries in the region.

Apart from RFMO official statistics, and in order to get more accurate and alternative catch data, shark catch estimations for the most recent period were appraised based on fleet specific ratios of shark catch over tuna (or target) catches. This was done in a two step process, first a general ratio between shark catches over tuna (target) catch was applied to estimate total shark catches for major fisheries and, then, the relative proportion of shark species in the catch was applied to estimate shark catchs by species. Those ratios were obtained from the literature search and/or data from observer programs available in the RFMO or in the literature. This exercise allows identifying the fleets that could be mainly responsible for the catch of the shark species included in the study based on the best assumption of the shark catch over target species catch ratios (see Material and Methods) derived from the literature but also allows identifying the main origin of underreporting as well as the likely main species impacted by the fisheries in each area. In that sense, the comparison between the declared value and the estimated value can be considered as a figure for undereporting. For example, it is worth mentioning that the total average amount of investigated sharks species estimated is 1.25, 2.2 and 13 times higher than the average amount declared in the Atlantic Ocean, Mediterranean Sea and Indian Ocean, respectively. It was not possible to apply this methodology to the Eastern and Western Pacific due to the lack of access to disaggretated tuna/target species catches from the IATTC/WCPFC public databases.

3.6.2 Major difficulties

No major difficulties have been suffered in the data gathering process and data identification gaps, however, as anticipated the major difficulties of the project in phase I are associated to the data scarcity and data availability for major fleets and countries as underlined in the previous section. The regional specific issues have been identified in the respective sections (see above). In general, the major difficulties in relation to data availability and data gaps can be divided in various general items:

- **Some catch/effort data are not available** - several countries were not collecting fishery statistics, especially in years prior to the early 1970‟s, and others have not reported catches of sharks to RFMOs. It is thought that important catches of sharks might have gone unrecorded in several countries. This problem worsens in the case of developing states and, especially, for historical data.
- **Fishery statistics disaggregation level** – when recorded, in many instances, shark catches are not disaggregated at the required level; for example, by area or fleet.
- **Under-reporting** - The catches recorded in other cases might not represent the total catches of sharks but simply the amounts retained on board (e.g. dressed weights instead of live weights). The catches of sharks for which only the fins are kept on board or of sharks usually discarded, because of their size or condition, are seldom, if ever, recorded.
- **Species mis-identification** - The catches of sharks are usually not recorded by species. Miss-identification of shark species is also common. The identification of sharks in port is usually compromised by the way in which the different species of sharks are processed and landed. The identification of shark species unloaded as shark carcasses, shark fins or other shark products is difficult due to the scarcity of the information available (the majority of the information available on the identification of sharks refers to complete specimens).
- **Data accessibility –** due to confidentiality issues is difficult to get the basic fishery information regarding the fleet activity catching sharks in various RFMOs. It will be also difficult to get access to Country specific information when this data is hold by the Country itself.
- **Observer data coverage** - Observer data coverage, especially for longline fleets, is low and may not be representative of all areas where sharks are caught. And the data of observer programs is not available or accessible in most of the cases.

3.6.3 Significant results

A number of activities related to the project have occurred during the current period. Following are presented the most important ones:

- The consortium conducted an extensive investigation as to what information is available regarding task 1 to 5 in relation to pelagic sharks caught as target or as bycatch species in the main pelagic fisheries in Atlantic, Mediterranean, Indian and Pacific Oceans (i.e. ICCAT-GFCM, IOTC, IATTC, WCPFC); using RFMO databases as well as literature (working documents, scientific committee documents and reports, Commission reports, etc…).
- National Institutions within the EU, who are responsible for warehousing their national catch data, have been contacted to request information. However, the positive responses and data sharing have been less than satisfactory (see the table belos) as the data has been received in different formats by, in some cases including only total catch data without specifying species specific catches/discards or data from observer programs, which made the analysis of the information very difficult.

Country	Gear/Fleet	IATTC	WCPFC	IOTC	ICCAT	GFCM
Spain	**LL**	Only metadatabase	Only metadatabase	Only metadatabase	Only metadatabase	Only metadatabase
Spain	**PS**	data available	data available	data available	data available	No active
France	**LL**	No active	No active	data available	No active	data available
France	**PS**	No active	No active	data available	data available	No data receivedl
France	**GN**	No active	No active	No active	data available	data available
Portugal	**LL**	No active	No active	data available	data available	No active
Malta	**LL**	No active	No active	No active	No active	data available
Malta	**Other**	No active	No active	No active	No active	data available
Cyprus	**LL**	No active	No active	No active	No active	data available
Greece		No active	No active	No active	No active	data available
Croatia		No active	No active	No active	No active	No data received
Italy	**LL**	No active	No active	No active	No active	No data received
Italy	GN	No active	No active	No active	No active	No data received
Slovenia		No active	No active	No active	No active	No data received

- Major shark fishing nations from outside the EU have been contacted to get information. However, the only positive response and data has been received from Japan and Taiwan and the rest of nations have been not responded so far. Japanese observer data received was very valuable in order to estimation the rations of shark catch over the total catch of the Japanese Longling fleet. However, the Taiwanese information received was very scarce and not usefult for the incorporation in the calculation.

Based on that work, the main nations, which are known to land shark species (either through targeting or indirectly through bycatch), were identified based on the various RFMOs databases. As such, a review of existing fishery and biological information is presented in the report and data gaps are summarized (see each RFMO section). And then, using the shark catch over the total tuna target catch; a more accurate shark figure was obtained for each specific area. This allows identifying major shark catch countries as well as the level of possible misreporting of shark catches. Moreover, information about catch and size, observer programs, and stock indicators for specific shark species has been summarized for each region. An introduction to various shark species is presented, including a brief review of the history of their designation and species profiles containing information on habitat, life history and ecological risk, conservation status (Annex II).

3.6.1 Shark official statistics summary tables

The following tables summarized the shark official statistics by EU Countries in the Indian Ocean (IOTC) and Atlantic Ocean and Mediterranean Sea (ICCAT/GFCM) for the last years (IOTC: 2006-2009; ICCAT: 2007-2011).

Table 3.6.1.- Sharks by species caught by EU Member States in the Atlantic and Mediterranean area between 2007 and 2011 (Sources: ICCAT).

Flag	Area	Blueshark BSH	Porbeagle POR	Shortfin SMA	Other Sharks	TOTAL Sharks
EU.Bulgaria	AT + MED				77	**77**
EU.Cyprus	MED			4		**4**
EU.Denmark	ATN	0	0		17	**17**
EU.España	ATN	116,374	126	9,685		**126,185**
	ATS	62,587	22	4,948		**67,558**
	MED	98		4		**102**
	AT + MED				1,791	**1,791**
EU.France	ATN	607	894	17		**1,518**
	MED	2		0		**2**
	AT + MED				48,571	**48,571**
EU.Ireland	ATN	2	17		741	**761**
EU.Italy	MED	462	2		741	**1,205**
EU.Malta	MED	7	2		111	**120**
EU.Netherlands	ATN	1	0		240	**242**
EU.Portugal	ATN	32,472	27	6,219		**38,718**
	ATS	28,698		1,943		**30,642**
	MED	2		0		**2**
	AT + MED				8,225	**8,225**
EU.United Kingdom	ATN	127	53	17	7,781	**7,977**
	ATS	14		11		**25**

Table 3.6.2.- Sharks by species caught by EU Member States in the Indian Ocean between 2006 and 2009 (Sources: ICCAT).

Flag	Short fin SMA	Mako MAK	Longfin mako LMA	Oceanic whitetip OCS	Silky FAL	Carcha rhinida e RSK	Coco drile PSK	Bigeye Thresher BTH	Blue shark BSH	Smooth hammer head SPZ	Hammer head SPN	Other Shark	TOTAL
France-Reunion						63						200	**263**
France-Territori												43	**43**
Portugal	503				44	71			4,641	2	1	39	**5301**
Spain	1,429		359	155	215		1	7	14,105	5	133	124	**16533**
United Kingdom	28	169	31		3				1,790			343	**2364**

4 Phase II

4.1 Design of Observer Programs

4.1.1 Introduction

For a responsible and sustainable management of fisheries fishing countries need to assure the timely, complete and reliable collection of fishery statistics on catch and fishing effort (FAO, 1995). Such data needs to be updated regularly and submitted to the relevant Fishery Organization to be used in the fishery assessment and for the provision of the scientific advice. Moreover, for an Ecosystem Approach to Fisheries Management it is necessary to estimate the incidental mortality of non-target species coming from bycatch and discards. The FAO code of conduct for responsible fisheries also states that fishing countries should implement effective fisheries monitoring, control, surveillance and law enforcement measures including, where appropriate, observer programmes, inspection schemes and vessel monitoring systems in order to collect basic fishery statistics.

Bycatch is a critical source of mortality for marine species, including endangered species, heavily fished commercial and many species of so-called “trash fish” whose importance in marine food webs is now being recognized (Babcock et al., 2003). Sharks are an important component of the bycatch in most tuna fisheries and, therefore, whether fisheries management objectives include conservation issues, adequate measurement of at-sea shark mortality is essential for any management framework, and observer programmes are the most reliable source of information.

In tuna RFMOs, mostly data is reported as the nominal catch data (landings and discards by species, stock, gear, fleets and year) which is the basic information used in all the stock assessments but also data on catch/effort and size data are provided which are more detailed in terms of time and geographic area information. In that sense, the objective of any Observer Program can be two-fold. On one hand, the aim could be to monitor compliance of management regulations (which may be related to collection of catch/effort data or not) and, on the other hand, to collect basic fishery statistics such as catch and effort data as well as to conduct biological sampling. The second objective is aligned to the objective of getting information about the total removal from the system. So, it is necessary to carry out such observer schemes when there are discards/processing/transhipment or not good fishery statistics collection based on port sampling/video monitoring. As such, the Observer Program provides research organisations, regional fishery management bodies, environmental agencies, the fishing industry and the wider community with independent, reliable, verified and accurate information on the fishing catch, effort, practice and biological information.

In the case of Tuna RFMO most of observer programs are directed to (i) compliance issues of different management regulation (i.e. temporal/spatial closures, avoiding dolphin catch, etc…), (ii) estimation of total catches of target species (i.e. tuna species), and (iii) estimation of the bycatch/discards for the best specific resolution possible. Those various objectives of the observer programs in place will have an effect on the estimation of shark catches, bycatches, and discards in the Tuna RFMOs.

In the case of sharks, although the role of observer programmes can vary widely, their major goal is the collection of scientific data, monitoring of fishing effort and bycatch numbers and rates. Observers also offer one of the few methods appropriate to obtain accurate location, catch and effort information for sharks caught in tuna fisheries. Sampling at sea can be conducted either by a biologist, by a trained technician aboard, or occasionally by well instructed fishermen. This may be particularly relevant for longliners and purse-seiners operating far from base ports, since trips for these vessels may last for several weeks or months. Daily catches may be few for most species, and consequently when the vessel returns to port for unloading the retained catches, most of the sharks will have lost their identity in terms of time, date and place where they were caught.

4.1.2 Coverage of Observer Programs

When designing an observer sampling program the level of coverage required depends on the objectives of the observer program as described above, which might vary from compliance purposes to improving target and non-target species catch data for population assessments, to estimating bycatch and discards of protected and endangered species, and to collecting biological data. Moreover, the level of coverage of the observer program is a key element to provide bycatch and discard rates with appropriate level of precision for the success of any cost effective observer program. Although the objectives of the observer programmes can be diverse, observer programs will generally require high or moderate levels of precision if the purpose of the observer program is to provide adequate information to improve fisheries stock assessments, endangered species protections, and ecosystem management.

In Tuna RFMOs depending on the observer program objective, the coverage agreed is usually different. While in all cases reviewed the observer programs established for compliance purposes covers 100 % of the vessels, when the goal is to monitor the total tuna catch and/or bycatch/discards the range of maximum coverage is between 5 % and 20 % (Table 4.1.1). As such, in relation to the estimation of shark catches, the different goals of the observer programs and the different coverage have a clear effect on the ability to obtain accurate data of both shark catch estimates and status (alive or dead) of sharks discarded

Table 4.1.1.- The table below identified the various resolutions in the Tuna RFMOs regarding the observer programs (in bold observer programs with compliance objectives). GFCM adopts ICCAT resolutions in relation to sharks in the Mediterranea, although this adoption by GFCM is usually carried out with a time lag.

	IATTC	ICCAT	IOTC	WCPFC
Resolution	1. Agreement on the Dolphin Conservation Program Annex II 2. C-11-08	1. Rec. 2011-10 2. Rec. 2011-01 3. Rec. 2012-03	1. Res. 11/04	1. CMM 2007-01 2. CMM 2012-01
Name	1. Agreement on the Dolphin Conservation	1. Recommendation by ICCAT on Information Collection and	1. On a regional observer scheme	1. Conservation and Management Measure for the

	Program Annex II 2. Resolution on scientific observers for longline vessels	Harmonization of Data on By-catch and Discards in ICCAT Fisheries 2. On a Multi-annual conservation and management program for bigeye and yellowfin tunas. 3. Recommendation amending the Rec. to establish a multi-annual recovery plan for Bluefin tuna.		Regional Observer Programme 2. Conservation and Management Measure for Bigeye and Yellowfin Tuna in the Western and Central Pacific Ocean
Objectives	1. 2. to collect scientific information on target species as well as comprehensive data on interactions with non-target species, in particular, sea turtles, sharks and seabird	1. Bycatch and discard data 2. The ICCAT Regional Observer Program in shall be established in 2013 to ensure observer coverage of 100% of all surface fishing vessels 20 meters LOA or greater fishing bigeye and/or yellowfin tunas in the area/time closure. 3. Bluefin catch and bycatch data.	1. to collect verified catch data and other scientific data related to the fisheries for tuna and tuna–like species	1. to collect verified catch data, other scientific data, and additional information related to the fishery from the Convention Area and to monitor the implementation of the conservation and management measures adopted by the Commission. 2. Compliance of the management measures under CMM 2012-01 (FAD closures, effort limitation, …)
% Coverage	1. 100 % of PS > 363 tonnes capacity 2. at least 5% of the fishing effort made by its longline fishing vessels greater than 20 meters length overall carry a scientific observer.	1. Not defined. 2. 100 % of PS. 3. 100 % PS, 100 % tranfers from PS, 100 % tranfers from traps to cages, 100 % farms, traps and towing vessels, 20 % active BB, LL and pelagic trawlers.	1. at least 5 % of the number of operations/sets for each gear type by the fleet of each CPC while fishing in the IOTC Area of 24 meters overall length and over, and under 24 meters if they fish outside their EEZs	1. No later than 30 June 2012, CCMs shall achieve 5% coverage of the effort in each fishery under the jurisdiction of the Commission 2. 100 % for all PS and 5 % for LL/BB and other fleets.
Shark collection	1. As bycatch/discard 2. As bycatch /discards	1. As bycatch/discard 2. As bycatch/discard 3. As bycatch/discard	1. As bycatch/discard	1. As bycatch /discards 2. As bycatch /discards

Observer programmes are widely recognized as the best way to obtain reliable information of bycatch and discarding practices at sea. Ideally, all fishing activity shall be monitored by observer programs, however, the coverage of observer programs is constrained by the funding resources available.

A key area has been the examination of observer coverage levels to assess threatened and endangered species, where low levels of mortality may jeopardize their recovery. In this case, an exact count of the total incidental mortality may be required, and 100% observer coverage becomes necessary. This is the case in the eastern tropical Pacific tuna purse-seine fisheries, in which the IATTC requires 100% coverage. However, often the level of observer coverage is limited by budget and the 100% coverage that may be required for some species, may therefore not be possible. In fact, the level of precision obtained from a given level of coverage depends upon a number of factors (i.e. time, area and gear categories to be covered; level of set-to-set and vessel-to-vessel variability; etc.). These facts may require observer coverage to be planned and spread among all (or at least major) nations/vessel types/gears/fishing strategies/areas to cover the range of potential situations, as samples taken in only one part of the year or from only one area covered by a single fishery or fleet will most probably not be representative of the annual impacts of fishing in the shark stocks.

As described above, usually a 100 % of coverage is set when the observer program is designed for compliance purposes because as such the fully compliance of all the fleet is assured to a given management regulation (i.e. spatial and temporal closures). In the case of sharks, when the objective is to estimate the total removals from the system of the various species, sufficient data must be collected to ensure acceptable levels of precision in the estimation of discards. Generally, bycatch of a species that is commonly encountered produces estimations with low variance or can be measured with a lower level of coverage than bycatch of a rare species or a species with highly variable catch rates (Hall 1999; Rochet et al., 1988). For example, if the observer samples are an unbiased sample of the fishery, literature review and simulation studies suggest that coverage levels of at least 20 % for common species, and 50 % for rare species, would give reasonably good estimates of total bycatch (Babcock et al., 2003). Other studies showed that a coverage between 20 and 33 % is needed to estimate the total bycatch of purse seiners in the Pacific (Lennert-Cody, 2001) and that around 25 % coverage is needed for shark catch estimation for purse seiner in the Indian Ocean (Sanchez et al., 2007). Moreover, the characterization of the bycatch/discards of a given fishery with a different level of precision will require different observer coverage depending on various factors such as taxa, fishing area, season, nº of total trips per fishery, fishery, etc.

Other studies, however, suggested that is more appropriately to specify a precision target of around 20 to 30%, rather than setting the level of coverage, because precision can be improved from actions other than increasing observer coverage (NMFS, 2004). In this sense, in addition to high observer coverage other factors such as the size of the fishery, encounter probability of the species and the variability of the catch in the positive sets might improve the precision of estimates (Hanke et al., 2011). The observer coverage percentage should, however, be calculated on a fleet/species case by case basis in order to account for specific error, biases and fleet/fisheries dynamics as well as the objective of the observer program for the specific species. The observer coverage needs to be representative of the spatial/temporal coverage of the fleet segment (i.e unbiased sample of the fishery) in order to get accurate and precise estimates of the bycatch and discards.

Although the level of observer coverage for the estimation of shark mortality depends on species and fleets specific cases, it is important that the observer programme has the following characteristics:

- Sufficient coverage to provide statistically accurate estimates of catch, bycatch and discards. A preliminary aim is to have observer coverage of 20% or above.
- Sufficient spatial/temporal coverage of the main fleets.
- Sufficiently trained observers: to develop an observer training programme in order for observers to be sufficiently competent to record the data required by the RFMOs for management purposes.
- Species identification guides: species identification is a major problem with regard to shark bycatch data collection and, thus, species identification guides such as those developed by IATTC/IOTC are necessary.

- Data forms: harmonized data forms to collect the shark bycatch and discard information (sex, size and life status: life or dead upon retrieval of the gear /at time of discarding).
- Collation of data after each fishing trip: data should be collected from observers and recorded promptly after each trip, facilitating almost real time availability of observer data for research (Observer website facilities to transfer and validate data collected).
- Database: database for recording of all observer data as well as well designed protocols for accessing the data, taking into account data confidentiality and ownership.

As mentioned by Anon (2009), to include all those characteristics the observer program requires a reasonable level of coverage within nation/vessel/gear/etc. category. These conflicting factors require substantial amounts of observer data to calculate. Once homogenous spatial/temporal/gear strata have been identified, vessels can be selected randomly. However, practicalities, safety and feasibility must all be taken into account.
The ICCAT Manual (Anon., 2009) also make note that adaptive sampling approaches can also be used, where coverage is modified based upon observations made during the observer programme. For example, identified areas of high abundance may be sampled more intensively using more observers on other vessels. The reader should be aware of a number of potential biases in observer data, and attempt to mitigate against them. They include:

- Bias caused by observer effects (e.g. vessel behaviour is changed due to the presence of an observer)
- Bias due to non-random allocation of sampling effort
- Bias caused by logistical constraints (e.g. components of the fishery which are logistically difficult to sample)
- Bias caused by inaccurate recording of data by observers
- Bias caused by small sample size
- Bias caused by inappropriate stratification

There are already data collection methods and protocols established by existing observer schemes in Tuna RFMOs where appropriate protocols such as those used by observers existing National observer programmes (such as the European Tuna vessel observer programme under DCF and run by IEO/IRD/AZTI) or IATTC observer programmes. These protocols are developed to ensure accurate recording of data, training for observers, onboard protocols as well as to describe data storage and data transmission level and format. In section 3, an example is provided which can be used in any of the Tuna RFMOs. In that sense, it is recommended that the protocols of the various observer programs used by IATTC, ICCAT-GFCM, IOTC, and WCPFC are harmonized to assure a standardized collection of information. Those, observer program protocols should, at least, include information on:

Fishing practices

The observers should ideally examine the characteristics of the vessel on which they are stationed, and its practices of setting and hauling (longlines), searching and setting (purse seines), etc. For this purpose all t-RFMOs have available specific forms on their web sites. Although fishing effort (which are essential for CPUE calculations should be available from vessel logbook records, information such as 'days fishing', 'number of sets', 'number of hooks' etc., should be recorded as observers can identify finer scale factors including those relevant to searching success (Gaertner et al., 1999; e.g. number and power of binoculars, radar power, vessel power and speed of vessels). Catch may be more difficult to monitor (namely in the purse-seiners), particularly if biological sampling is being carried out as the fish are brought on board. However, observer can collect data which will allow checking on the levels of information entered into the vessel logbook. Due to discarding practices, which may affect many shark species due to current fishing management regulation or lack of commercial value of some species, the information collected by the scientific observers are essential to monitor these bycatches and discards (particularly in terms of their number and status, dead or alive, which are key to identifying the impact of fishing operations on the wider ecosystem (Gaertner et al., 2002).

Biological information

The collection of biological information is pretty standardized and has been detailed in manuals available in all t-RFMOs. As mentioned in the ICCAT Manual (Anon., 2009), the advantage of observers collecting such information at sea is that they can directly link it with the location from which the samples were taken (as in the geographic location of the catch).

4.1.3 Tuna RFMOs: current observer progrms

The data collected through task 1 to 5 gave a complete picture of the current observer programs in the Tuna RFMOs as well as their objectives, requirements and current coverage of those programs. Although some of them are not specifically focused on obtaining shark catch and discards estimations, they can also provide information on fisheries-shark interaction. Table 4.1.2 below summarized the current observer programs in different Tuna RFMOs and the current observer coverage (when available) of those observer programs.

Table 4.1.2.- Summary of the observer program carried out in Tuna RFMOs as well as the current observer coverage.

	IATTC	ICCAT	IOTC	WCPFC
Resolution	1. Agreement on the Dolphin Conservation Program Annex II 2. C-11-08	1. Rec. 2011-10 2. Rec. 2011-01 3. Rec. 2012-03 4. Voluntary PS observer implementatio n.	1. Res. 11/04	1. CMM 2007-01 2. CMM 2012-01
Objectives	1. Compliance dolphins + bycatch estimation 2. Bycatch	1. Bycatch 2. FAD time/area closure compliance 3. Bluefin tuna compliance 4. Bycatch	1. Fishery data collection + bycatch	1. Fishery data collection + bycatch 2. Monitoring and control.
Required % Coverage	1. 100 % of PS > 363 tonnes capacity 2. at least 5% of the fishing effort made by its longline	1. Not defined. 2. 100 % of PS in 2 months in moratoria area (compliance)	2. At least 5 % of the number of operations/sets for each gear type by the fleet of each CPC while fishing in the IOTC Area of 24 meters overall	1. No later than 30 June 2012, CCMs shall achieve 5% coverage of the effort in each

	fishing vessels greater than 20 meters length overall carry a scientific observer.	3. 100 % on PS, Traps, towing vessels, caging. 20 % of LL, BB, pelagic trawlers. 4. 100 % PS starting in 2013.	length and over, and under 24 meters if they fish outside their EEZs	fishery under the jurisdiction of the Commission 2. 100 % for all PS and 5 % for LL/BB and other fleets.
Current level % coverage	1. 100 % of PS > 363 tonnes capacity. 2. 5 % Longline (starting in 2013)	1. Info N/A 2. Info N/A 3. Almost 100 % 4. Not evaluated	1. As from November 2012, for the IOTC convention area eleven CPCs (Australia, Comoros, EU(France and Portugal), France(OT), Japan, Korea (Rep. of), Madagascar, Mozambique, Seychelles, South Africa and Taiwan,China) have submitted a list of accredited observers. To date thirty eight (38) observer trip reports have been submitted to the Secretariat by seven CPCs, i.e. Australia, China, EU(France and Portugal), France(OT), Japan, Korea and South Africa: 11 reports for 2010, 23 reports for 2011, 4 report for 2012. In addition, South Africa has also submitted 13 and 10 observer reports, respectively for 2011 and 2012, for foreign flag fishing vessels operating in South African waters.	1. LL 0.87 % from 92-2009. 2. PS 11 % from 95-2010.

Although the data on current observer coverage is scarce and, in most cases, not available, it is clear from the table above that the both the objectives of current observer programs and the current coverage requirements of the observer programs are not sufficient focused on shark to get an accurate shark catch/discards estimation. Moreover, not only the focus and the current level of coverage are important but the availability of the data is also a key issue because in most of the cases the data of various national observer programs are not available for the Tuna RFMO Scientific Committes or the data collected under RFMO observer program are not available.

4.1.4 Identify the problem by region

Similarly, the data collected through task 1 to 5 gave a complete picture of what are the main fleets targeting the more important shark species caught in the Tuna RFMOs, both EU and other countries catching shark, as well as the extent of their volume (Table 4.1.3). The exercise done through task 1 to 5 also helps to identify the different species for which more focus is needed and those that are supposed to be caught in a lesser extent. This will help to focus the target or more important fleets to monitor and design specific representative observer schemes for those fleets as requested in the call.

Table 4.1.3.- Summary of the main métiers impacting global catches of shark species in Tuna RFMOs and summary of most impacted shark species in Tuna RFMOs (based on our estimation). * No information of other fleets than Purse Seine and Longline.

	IATTC*	**ICCAT**	**GFCM**	**IOTC**	**WCPFC***
Fisheries most impacting Studied Sharks (% of total catch)	1. LL (49 %) 2. LL targeting swordfish (36 %) 3. Other fleet (10 %) 4. PS (5 %)	1. Longline targeting sharks (59 %) 2. LL (15 %) 3. Other fleets (12 %) 4. Gillnet (9 %) 5. LL Swordfish (4 %) 6. PS (< 1%)	1. LL (54 %) 2. GN (45%)	3. Gillnet (61%) 4. LL (18 %) 5. Other fleets (12 %) 6. PS (1 %)	1. LL (95 %) 2. PS (5 %) 3. No information no other fleets
Studied shark most impacted (the gear most impacting this species)	1. Blueshark (75 %) 2. Shortfin mako (19 %) 3. Silky shark (3 %) 4. Hammerheads (1 %)	1. Blueshark (63 %) 2. Other shark no identified (21 %) 3. Shortfin mako (7 %) 4. Hammerhead shark (4 %) 5. Carcharhinidae (4 %) 6. Silky (< 1 %) 7. Oceanic whitetip (< 1 %).	8. Blueshark (50.5 %) 9. Thresher sharks (25 %) 10. Mako sharks (13.3 %) 11. Tope shark (6.1 %) 12. Pelagic rays (3.5%) 13. porbeagle (1 %)	1. Blueshark (32 %) 2. Silky shark (21 %) 3. Thresher (16 %) 4. Oceanic whitetip (11 %) 5. Shortfin mako (10 %) 6. Hammerheads (6 %)	1. Blueshark (75 %) 2. Silky shark (9 %) 3. Oceanic whitetip (7%) 4. Mako sharks (4 %) 5. Thresher sharks (4 %)

In the Atlantic and Pacific (east and west), the Longline fleet targeting sharks, swordfish and/or tropical tunas is the most important métier cathching sharks; which contributes with 59 %, 86 % and 95 % to the total shark catches respectively. On the contrary, the picture in the Indian Ocean is different where gillnet (GN - *sensu lato*) are contributing with 61 % of the total shark catch in comparison of the 18 % of longliners.

In general, the species composition of the sharks in different métiers is similar in all Oceans as well as in the Mediterranan Sea. For example, Longline (LL - *sensu lato*) impacts mainly blushark (BSH) and shortfin make (SMA) and in a minor extend hammerhead, threshers, silky and oceanic whitetip sharks; whereas Gillnet (GN - *sensu lato*) are impacting mainly silky (FAL), thresher (THR), Oceanic whitetip (OCS), and shortfin mako (SMA) sharks. The LL fleet in the West Pacific catch of silky and oceanic whitetip sharks is higher than other LL fleets of other Oceans because they are operating in more equatorial waters. Although, in all the Oceans, the contribution to the total catch of Purse seiner is minor (maximum of 5 % of total catch in the West Pacific); the species composition of PS catch is clearly dominated by silky and oceanic whitetip sharks.

In all Oceans the main species impacted is blueshark (BSH) with around 65-75 %, with the exception of the Indian Ocean and Mediterranean Sea, of the total shark catch. The contribution of the rest of the species can vary depending on the relative contribution of different fleets as well as the spatial operations of the different fleets. However, in general the blueshark catch is then followed by Shortfin mako, hammerhead, silky, thresher, Oceanic withetip shark. In the Indian Ocean, the blueshark contribution to total shark catch is around 35 % followed by Silky shark (21 %), Thresher (16 %), Oceanic whitetip (11 %), shortfin mako (10 %) and hammerheads (6 %). And in the Mediterrenean, blueshark contribution is around 50 % while other species make up the rest: thresher sharks (25 %), mako sharks (13.3 %), tope shark (6.1 %), rays (3.5 %), and porbeagle (1 %).

And the data above should be considered in the light of the different species productivity and susceptibility of a given species to a giving métier. This is important to take into account because in some cases a minor catch of one species of all fleets, or one fleet in particular, can have a great impact on a more vulnerable species with low productivity and high susceptibility. So, it is important to consider the results above in the framework of Ecological Risk Assessment which can help to identify priorities for observer programs/research efforts.

4.1.5 Solutions and Recommendations

Having in mine the data gaps for major fisheries impacting pelagic sharks stocks in the different t-RFMOs Conventions areas as well as the most important metier catching sharks and most impacted shark species; the following is a brief overview of some possible solutions and recommendations for the implementation of observers programmes on those fisheries, aiming to improve shark data collection, namely regarding shark catch and discards: species composition; vessel mortality; size and sex data. However, the problems raised above regarding coverage were not taken into consideration, as the objective is just to highlight ways to improve our knowledge and fulfil data gaps.

As mentioned above, gillnets, pelagic longlines and purse-seines fisheries are amongst those that most impact pelagic shark stocks. Moreover, due to the different levels of observer coverage for each of these fisheries, there is an urgent need to improve such observer programs, particularly having in mind the collection of shark data, as some of these bycatch species might not be properly covered by current schemes (see table above). In fact, in the case of the gillnets fisheries the shark data collection trough the implementation of observer programmes is very low or absent in most cases, while for longlines the situation is better for some major players although the level of reporting is low. In contrast, on purse-seines fisheries, which in some Tuna-RFMOs have 100% observer coverage, the protocols implemented need to be further improved as these schemes were mostly designed taking into consideration target species and not necessarily the bycatch. Apart from the improvement on the current observer schemes, althernative methods such as self-sampling and/or electronic monitoring might play a key role on future data collection programmes, aiming to improve current practices and levels of coverage of shark catches in t-RFMOs.

One of the major problems of any observer program (or data collection through logbooks) is the shark species identification which in some cases can be jeopardized the accuracy of observers reporting. The catches of sharks are usually not recorded by species because miss-identification of shark species is also common. Thus, shark species identification guides, as the ones produced by IOTC/WCPFC, are necessary for the correct identification of shark species by observers/fishermen. Thus, it is recommended that each of Tuna RFMOs produces shark identification guides to facilitate the species identification during data collection through observer programs and logbooks.

Observer Programmes

Industrial fleets

Industrial fleets are amongst those that mostly impact shark stocks within the scope of tuna fisheries. Therefore, the implementation of scientific observer programmes designed to improve shark data collection is essential to enhance the current knowledge on shark catches, discards and at vessel mortality. Therefore, the two major fleets that should have specific observer programmes are the pelagic longliners, namely those targeting swordfish or tropical tunas, and purse-seiners targeting tropical tunas.

Longline

The pelagic longline fleet has two major components: one targeting swordfish (and sharks opportunistically), making shallow sets, which is the one that most impacts sharks; and another, targeting tuna and setting the gear at deeper depths, but that opportunistically can shift the target species to swordfish. In order to increase the data collection of shark catches, discards and vessel mortality, it would be necessary to increase the observer coverage of theses fleets (i.e. EU – Spain and Portugal; Taiwan, Indonesia, Japan, Namibia, Brazil, etc.). Moreover, the observer programmes for these fisheries, should be further developed in order to include the collection of more data on sharks, as it is currently being made by EU-Portugal operating in the Atlantic and Indian Oceans. Annex IV presents the example of the observer programme implemented on the Portuguese pelagic longline fisheries.

However, as previously mentioned, these observer programmes should take into consideration the diversity of these fisheries, in terms of target species, gear specifications, fishing regimes and spatial-temporal activity (ocean-wide), among other issues. Thus, good observer coverage will be very difficult to be achieved and very cost demanding and expensive. Therefore, as an alternative self-sampling could be implemented, relying on strait collaboration between scientists and fishers and be based on clear aims, aiming to generate high quality data. As mentioned above, it is essential that the fishers have some incentives, in order to keep them motivated. A possible way to achieve motivation is the production of user-friendly software/applications that can help them correctly identifying the different species and provide accurate estimation of live and dressed weight for the different species retained. This is particular important in the case of EU fleets that currently face a reduction on the tolerance of error of the catches (from 20% to 10%), while filling the electronic logbooks that are currently mandatory. Within the scope data collection program on the Portuguese pelagic longline fishery it is been increasingly implemented such a scheme. Basically, the fishers measure the different species and introduce the data on a simple spreadsheet, which calculate for them the different types of weight (i.e. live and dressed weight), as well as, the total fin weight. It also calculates the cumulative weight by species (see figure 4.1.1). Once on port, the file is provided to the scientists (or sent by e-mail), following a confidentiality agreement. Such application can easily be improved and provide to the skippers other packages that might be of their interest, such as bait management; tables of load by species weight classes, which would allow them to calculate yields based on market prices; maps with gear setting positioning; etc.

Figure 4.1.1.- Outlook of a spreadsheet currently provided to Portuguese longliners, which allow fishers to estimate weight of the catch and fishing products by species and set, and the accumulated catch, based on fish size conducted by fishers (self-sampling).

Dados do lance	Data	Nº lance	Posição	Latitude (º ' S/N)	Longitude (º ' S/N)	Rumo	Profundidade pesca aparelho	Nº anzóis	Nº bóias	Tipo estralho	Vento	Lua	Temperatura (ºC)	Nº Tartarugas libertadas vivas	Nº Tartarugas mortas	Nº Aves capturadas	Cetáceos
	04-04-12	19	Posição inicial	35º 05' S	40º 23' E	VARIOS	20-50	1380	17	AÇO	S	CRECI	21,3-21,2	1	0	0	0
			Posição final	35º 14' S	39º 56' E												

Espécie	Espadarte (SWO)	Tintureira (BSH)	Anequim (SMA)	Atum-patudo (BET)	Atum-albacora (YFT)	Atum-voador (ALB)	Espadim-negro (BLM)	Espadim-raiado (MLS)	Veleiro (SAI)	Escolar (LEC)	Doirado (DOL)	T.luzidio (FAL)	T.pt.branca (OCS)	T.martelo (SPN)	Barracuda (BAZ)	Lírio (AMB)
Capturas lance	Quilos	Quilos	Quilos	Quilos	Quilos	Quilos	Quilos	Quilos	Quilos	Quilos	Quilos	Quilos	Quilos	Quilos	Quilos	Quilos
peso-vivo	1486	902	96	0	0	0	0	0	38	0	66	0	0	0	29	0
Barbatanas		58	5									0	0	0		

Comprimentos dos peixes capturados (incluindo os de pequena dimensão)

Espadarte (SWO)	Espadarte (SWO)	Tintureira (BSH)	Anequim (SMA)	Veleiro (SAI)	Doirado (DOL)	Barracuda (BAZ)
120	200	160	160	200	110	150
130	215	185	170		110	
135	215	210			110	
140		215			120	
150		220			120	
150		235				
160		260				
160		260				
160		255				
165		260				
170						
170						
175						
175						
180						
180						
180						
190						
190						

Nº peixes não medidos

	SWO	BSH	SMA	BET	YFT	ALB	BLM	MLS	SAI	LEC	DOL	FAL	OCS	SPN	BAZ	AMB
	Quilos	Quilos	Quilos	Quilos	Quilos	Quilos	Quilos	Quilos	Quilos	Quilos	Quilos	Quilos	Quilos	Quilos	Quilos	Quilos
Lances prévios (peso-vivo)	19386	18069	1732	460	0	0	42	138	0	639	512	912	0	0	75	0
Total peso barbatanas		1216	91									42	0	0		
Total peso vivo	20872	18971	1828	460	0	0	42	138	38	639	579	912	0	0	105	0
Total peso limpo	16071	7968	1298	368	0	0	32	106	31	512	486	484	0	0	89	0

Purse seine

Observer coverage in the purse seine fleet has been typically much higher than for other gears. As an example, in the case of the Pacific Ocean RFMOs, coverage rates were set at 100% in the IATTC convention area for purse seiners with carrying capacity over 363 MT back in 1993, and 100 % observer coverage has also been recently adopted by the WCPFC. However, in the case of the ICCAT convention area, as of now, 100% observer coverage is only mandatory during the two months FAD closure established in Recommendation 2011-01, and the overall minimum observer coverage required for the purse seine, as for the rest of the gears, is not defined. Similarly, piracy activities have affected immensely the level of observer coverage in the Indian Ocean, although there was low observer coverage before this problem arose and the mandatory requirements for all fleets is 10 % coverage. As an example, observer coverage for the European tropical tuna purse-seine fishery was 4.6 % of the fishing trips in the period 2003-2009 improving to almost 10 % in 2008-2009 (Amande et al., 2012).

Several studies (see review by Anon., 2012) have shown that biases and precision are minimised when observer coverage exceeds 20% (under several assumptions, like that there are no flag effects, that the coverage is representative of all the strata, etc.). In this regard, an increase in the observer coverage of the purse seine fleet for the Atlantic and Indian Oceans would be the best possible improvement for the collection of shark data, although it may not be feasible due to economic or security reasons. Alternative approaches could include self-sampling programs, as explained in previous sections, or Eletronic monitoring as a complement.

Regarding data collection, most of the observer programs require species identification and estimation of total and retained catches. Although additional information, like length, weight or gender is also included, there are in general no clear indications on the level of coverage for these biological data. Therefore, the current observer programmes should include such level of details for shark species too. An example of the minimum data requirements in the WCPFC regional observer program for species of special interest is shown in table 4.1.4. Moreover, annex V present the minimum data requirement harmonizatioin process carried out under joint Tuna RFMOs Kobe process.

Table 4.1.4.- Minimum standard data fields for species of special interest under the WCPFC Regional Observer Programme.

GENERAL INFORMATION	
Type of interaction	Indicate what type of interaction, i.e. caught on line - tangled in net, swimming around outside of net, etc.
Date and time of interaction	Record ships date and time of interaction
Latitude and longitude of interaction	Record position of the interaction.
Species code of marine reptile, marine mammal, or seabird.	Use FAO codes for Species.
LANDED ON DECK	
Length	Measure length in Centimetres.
Length measurement code	Measure using the measure method determined for that species.
Gender	Sex the animal if possible.

Estimated shark fin weight by species	Weigh each species shark fins separately if shark has been fined by crew, if no scales estimate the weight.
Estimated shark carcass weight by species	Weigh each carcass of a finned shark, if no scales available or body is discarded, or if it is too large to handle; estimate the weight.
Condition when landed on deck	What is the condition when caught use codes
Condition when released	What is the condition when discarded use codes
Tag recovery information	Record as much as information as possible on any Tags recovered
Tag release information	Record as much as information as possible on any Tags placed on the species before being released.
INTERACTION WITH VESSEL OR GEAR ONLY	
Vessel's activity during interaction	What was the vessel doing when the interaction took place i.e. setting, hauling, etc.
Condition observed at start of interaction	Condition of species at the start of the interaction
Condition observed at end of interaction	Condition of species at the end of the interaction
Description of interaction	Indicate interaction, with the vessel gear only - caught on line - tangled in net, etc
Number of animals sighted	How many animals sighted during interaction

The Second Joint Meeting of the Tuna RFMOs (known as the "Kobe Process") established a Joint Technical Working Group on Bycatch. This group met in March 2012 with the aim of harmonising the purse-seine data collected by tuna-RFMO observer programs. Harmonisation of data across tuna RFMOs is desired to allow for more comprehensive reporting on the status of bycatch species, to assist with the identification of factors that cause or increment bycatch, to evaluate the performance of mitigation methods and, in general, improve the quality of the data collected. A summary on the level of harmonisation between RFMO's, as evaluated by this Working Group, is shown in table 4.1.5 (Anon., 2012).

Table 4.1.5.- Data harmonisation among tuna RFMOs as evaluated by the Joint Technical Working Group on Bycatch in Sukarrieta II.

DATA CATEGORY	RANK
Harmonisation of Effort Data	
Vessel Identification (Information to uniquely identify vessels)	HIGH
Vessel Trip Information (Information to calculate trip duration, location and time)	HIGH
Observer Information (Information to uniquely identify captain/fishing master)	HIGH
Crew Information (Information to calculate crew number)	HIGH
Vessel and Gear Attributes (Information to detail vessel specification and equipment)	HIGH
Daily Activities (Information characterize vessel fishing and non-fishing activities during a trip allowing effort to be examined in finer resolution)	INTERMEDIATE

School and Set Information (Information to characterize school type and detection method)	HIGH
Harmonization of catch data	
Catch Information (weight and or numbers of target and bycatch species)	INTERMEDIATE
Length Information (weight and or numbers of target and bycatch species)	LOW
Species of Special Interest (weight, length, fate and description of interaction)	INTERMEDIATE

During the joint Tuna RFMOs Kobe process the harmonization of data collection and observer programs was considered a key issue which will allow to compare and progress on different analysis for the estimation of the bycatch and in the application of the ecosystem approach to fishery management. The exercise described above and carried out for the harmonization of the Purse seine observer programs should be expanded to other gears.

Artisanal fisheries

Artisanal fleets, namely those small scale fisheries (SSFs) making use of gill nets are amongst those that mostly impact shark stocks within the scope of tuna fisheries. SSFs provide an important source of food and income to coastal communities worldwide and nearly 23 million people around the world earn their living from marine capture fisheries. Moreover, SSFs are complex and correspond to dynamic social-ecological systems with many interactions between scales of operation (small- and large-scale, artisanal and industrial) and among different interest groups (Garcia et al., 2008).

SSF is the component of global fisheries for which reliable information is least available. For many countries, vessels smaller than a certain size are not subject to national registration or are only subject to local registries that might not be reflected in national statistics. However, compared to industrial fisheries which could discard 8–20 millions MT of bycatch each year, in general SSFs have low levels of discards (Jacquet & Pauly, 2008).

Compared to industrialized fisheries SSF are characterized by many features: variety of gear types, multiple landing areas and distribution routes, with sometimes a self-consumption of catches (King and Lambeth, 2000; Gillet, 2011). Moreover, the size of boats is reduced and in some countries fishermen have a low education level. These attributes make SSF difficult to monitor in order to collect reliable and comprehensive statistics at a reasonable sampling cost. Regarding shark populations which are hugely impacted by SSF, mostly gillnet fisheries, there is an urgent needed to improve monitoring to address this problem of data deficiency. In fact, the quantity of shark catches and effort data in RFMOs database is extremely poor, as shown by the discrepancy between data reported and estimated catches in this report. Therefore, all nations should implement a Plan of Action (POA) for sharks in compliance with resolutions of RFMOs. We provide below some suggestions to improve the monitoring protocols to improve this situation.

<u>Data collection from landing sites</u>

Rapid Capture Assessment

Rapid Capture Assessments (RCA) is a method usually used for data-poor fisheries. It aims to display an overview of landing places, type of boats and gears involved in the fishery, fishing areas, species or group of species usually caught by gears/métier with sometimes information on the amount of catches. RCA are generally based on interview of actors having different forms (informant interviews, focus group interviews, community interviews and informal surveys). RCA present the advantage to be a low-cost method. It must be conducted or coordinated by social scientists or fishery biologist having professional training and experiences. This method is well adapted for developing countries where fishery statistics are still data-poor. Even if RCA can be perceived as a self-reporting monitoring at low resolution, it can produce both accurate qualitative and quantitative data which meet criteria for acceptable research and stock assessment (Johannes et al., 2000; Lunn & Dearden, 2006). This monitoring method is time-limited but it is a valuable approach to set up a well-structured sampling program after the identification of the spatio-temporal heterogeneity of capture, gear used, fishing effort deployed, etc.

Self-reporting at landings

Self-reporting can be considered as an extension of the RCA. As mentioned above there is ongoing efforts worldwide to develop programmes to imply fishermen to self-sample their catches. There are also strong requests to fishing industry for being involved in assessment processes. As RCA, self-reporting can be considered for developing countries, where fishermen have a low education level. It should be conducted at least at the beginning of the project by collaborative people having a professional training. Incentives will be one of the major key of the success of this monitoring to maintain the motivation of the industry to participate and of the fishermen to be educated for being able to fill accurately the sampling templates.

Sampling at landing sites (Port, market places)

The sampling at landing sites is one of the best “value for money” monitoring method for artisanal fisheries, as they keep most of the catches on board either being target or bycatch (except species that cannot be retained). This monitoring strategy can be applied after a RCA for data-poor fishery. RCA would have permit to implement a sampling strategy adapted to the objectives of the shark catch and effort monitoring. For well documented artisanal fisheries, sampling at land sites will allow to collect detailed information on species caught, species abundance in catches, length and sex data. If possible, fishermen interviews could allow the provision of information about fishing areas, fishing gear used and fishing effort.

Electronic logbooks

Difficult to implement for SSF as declaration depends on a personal identification code which needs an exhaustive registration of fishermen.

Interactive Voice Response

To our best knowledge, interactive voice response (IVR) technology is still not used in the frame of fisheries. IVR allow users to interact with a company’s host system via a telephone keypad or by speech recognition. As many people around the world including fishermen are able to use a cell phone, self-reporting using IVR is likely a technology to develop to monitor small scale fisheries as well as industrial fisheries.

Data collection at sea

Self-reporting
For many artisanal fisheries worldwide, self-reporting at sea cannot be implemented due to low experienced people. The implementation of such a programme should be considered after a self-reporting at landings program or a training period. Incentives should be proposed to maintain motivation of participants.

Vessel monitoring system (VMS)
Difficult to implement on artisanal boats and not really useful for fishing boats with reduced spatial displacements.

At-sea observers
At-sea observers is not a priority for artisanal fisheries where level of discards are particularly low.

Below it is presented an example of a possible 3 year program to improve shark statistics on artisanal fisheries.

Year 1 – Implement Rapid Catch Assessment (RCA)
When any accurate data on shark capture are available, RFMOs could enforce management regulations aiming CPCs to implement a RCA dedicated for sharks. The goal of this RCA would be to highlight characteristics and complexity (landing sites, markets, gear/metier, species in concern) of the fishery in order to consider the spatial and temporal scales and characteristics of the exploitation (gear/métier involved, number of fishing boats, ..) before developing a monitoring program. A period of one year could be granted for CPC fishery agencies to present results of the RCA and prepare a proposal for a monitoring program.

Year 2 – Monitoring landings at ports/markets
As artisanal fisheries generate low level of bycatch, the monitoring of landings at ports is a low-cost protocol to collect relevant fishery statistics. The sampling strategy (sampling effort by selected landing sites) should be defined in accordance with the results of the RCA. Moreover, this sampling program should reach a coverage of at least 25% of total shark capture with associated fishing effort data and length distribution by species and sex.

Year 3 – Implement a monitoring program aims to collect a representative sample of 20% of catches per major shark species
During the year 1 and year 2 of the implementation of the shark monitoring program, CPCs should organize training to involve the fishing industry in the project. This training will allow them to be able to implement adapted monitoring (self-reporting at landings or at sea, sampling at landings, etc.) in order to produce representative statistics (capture, effort, length distributions by sex) by species. At this stage, incentives would be necessary to motivate the fishing industry to be involved in the project and the choice of these incentives should be prepared during the first two years.

This period of three years would allow CPCs to implement an adapted monitoring program in routine to report accurate extrapolated shark and effort statistics at RFMOs mandatory resolutions.

Self-Sampling

Using fisheries scientists and/or technicians to collect information on commercial catches is usually not cost effective. Therefore, currently there is ongoing effort worldwide to develop programmes to use fishers to self-sample their catches. Such programmes have generally two major objectives: i) reduce costs and increase efficiency on the collection of commercial fishery data; and, ii) to involve fishing industry in the assessment process by having them work closely with the scientists. Thus, the overall purpose of the programmes is to improve data collection and consequently reduce stock assessments uncertainty.

One of the major recognized problems with self-sampling is that some scientists do not see the data as fully scientific or valid. In order to shift this attitude is it necessary to properly verify the usability and high quality of data, for which is essential to have the industry willing to participate in such self-sampling schemes. Therefore, they should rely on the development of guidelines of best practice and general recommendations to assist in the initiation and execution of self-sampling and self-reporting programmes. Moreover, such schemes should rely on strait collaboration between scientists and fishers, aiming to define clear aims and generate high quality data.

A key issue for the success of these programmes is the need for incentives for the industry to participate. If there are no incentives, motivation will be lost and fishermen will stop cooperating (Catchpole 2007). There are two forms of incentive and both are present in the most successful projects. The first is the knowledge that the data will be used to improve stock assessments or to their own use; the second is direct remuneration.

Confidentiality is another important issue that should be assured on these programmes, namely by ensuring that when used the data is presented in an anonymous and aggregated way. This is particularly important as some data sets might be used for enforcement purposes, and therefore might endanger trust between scientists and fishers.

Prior to the implementation of such self-sampling schemes and depending on the objectives of a self-sampling programme, the training should be adapted to each particular situation. Some general remarks includes (as mentioned by Catchpole, 2007):

i. Training/Instruction of a group of participants can be achieved through a plenary meeting. The timing of this meeting is important: make sure that fishermen are available;
ii. An individual approach is important to increase understanding and commitment, which can be achieved by onboard training;
iii. The goal should be to instruct fishermen how to sample, not to educate them to be fisheries scientists;

iv. It should be clear what kind of data are required (and why) and what kind of format is required in order to make data processing more efficient;
v. Short feedback loops from researchers to fishers are required;
vi. It should be easy for fishermen to contact the relevant researcher;
vii. It is important that all participants are properly trained, not only the skippers/ship owners (as it is the men on deck that take the samples);
viii. Scientists (or fisheries technicians) should go to sea with fishers to quality control data collection techniques.

Electronic monitoring

Electronic monitoring (EM) systems are being used in some fisheries as an alternative, or a complement to human observers. The EM systems consist of a centralized computer combined with several sensors and cameras, which can be deployed on fishing vessels to monitor a range of fisheries issues, including: fishing location, catch, catch handling, fishing methods, protected species interactions, and mitigation measures. The efficacy of EM for monitoring issues varies according to fishing methods and other factors (Mc Elderry, 2008). Over the past decade, pilot studies have been carried out in more than 25 fisheries to test the efficacy of this technology, being involved different countries, gears and target species. Furthermore, EM systems have been fully integrated as a fishery monitoring tool on the west coast of Canada and the USA (McElderry, 2008).

During 2012, the first trial with EM on a tropical tuna purse seine was performed in the Atlantic Ocean (Ruiz et al., 2012). This study suggested that EM is a viable tool for monitoring effort, set-type and tuna catch within the tropical tuna purse seine fishery. However, some limitations exist for the monitoring of the bycatch. The use of EM was able to reliably estimate and identify billfish catch, but underestimated the bycatch for some shark species and small bony fishes. This result is influenced to a large degree by the methods used to handle catch on an industrial tuna purse-seiner, which allow for easy identification of large bycatch *taxa*, but make it very difficult to track and identify small specimens mixed in with tuna. Furthermore, observers constantly identified sharks to a higher taxonomic level, as 100 % of the shark species were identified by the observer, EM system provided limited identification (e.g. often to family level). The EM-based bycatch assessment was also limited by the quality of imagery itself. The current EM system uses analog CCTV cameras because they are economical, reliable, and quite durable for fishing deck conditions. The lower resolution (about 0.33 megapixels per image) has generally been addressed by setting the field of view of each camera to the desired objective. When there are many activities occurring, more cameras are needed to cover the resolution needs properly. Digital cameras are rapidly overtaking the analog camera market with models that are comparable in cost and durability. Digital cameras have much higher image resolution and frame rates and will dramatically improve the ability to make catch assessments. Digital cameras come at a high data storage cost and the challenge of balancing resolution needs with data storage duration becomes more difficult, especially on vessels making 6-8 week fishing trips. However, as mentioned above, this was just the first trial with EM systems on the tuna purse seine fleet, and with some adjustments on the system, the development of digital cameras, and with some modification on the crew catch handling behaviour, a more accurate bycatch monitoring will be achievable in a near future.

The success of an EM program would require that the vessel owners and crew understand the importance of standardized catch handling points. EM systems are designed to be flexible enough to accommodate a variety of catch handling methods, but handling must be consistent and standardized in order to collect reliable data. For example, if a camera is installed above the discard handling area, and discarding handling is moved to another area of the vessel, the camera will no longer capture discarding events. This example illustrates the importance of having strong support from the vessel owners, officers and crew to achieve monitoring objectives.

It is also possible to apply such EM systems to gill nets and long-line fleets. McElderry (2005) conducted a study on a gillnet fishery, showing that EM offers opportunities for monitoring shark gillnet fishing activity. Overall, the high quality of imagery, the ability to identify most catch items, and no missing imagery in the data set, indicated that EM equipment was reliable and suitable for shark gillnet vessels. In the case of gill net tuna fisheries, due to size of the fleet and the artisanal nature of the fisheries, it could be quite difficult the implementation of an EM sampling program. However, it can be considered a suitable approach taking into account the complete lack of data and observers programs that are currently being implemented in gillnets tuna fisheries. In the case of longliners, it might be worthy and easier to implement such system.

4.1.6 Summary recommendations for improving coverage by region

The table below describes some general recommendations and way forward to improve the observer coverage in order to get more accurate level of shark bycatch estimations (this should be considered in conjunction with actions to improve general shark catch statistics – see next section).

Country	Gear	Gear	Observer coverage	Self sampling	EM	Others
UE vessels	**Industrial**	**PS**	Yes 100 %			
		LL	Yes minimum 20 %)	Selfsampling	EM	
All vessels	**Industrial**	**PS**	Yes 100 %			
		LL	Yes minimum 20 %)	Selfsampling	EM	
	Artisanal	**LL-GN**	Yes: minimum 10 %	yes	EM	Pilot obserever vessels with 100 %
GENERAL CONSIDERATIONS						
ALL VESSLES	Species identification guides					
	Needs to change the focus: change the focus on collection of "bycatch" to shark species					
	Minimum data requirements: they are available in the Tuna RFMO observer program guides (see Annex V).					
	Developing of sampling protocols: they are available in the Tuna RFMO observer program guides examples (see Annex V).					

4.2 Design a formulation of scientific advice

4.2.1 Introduction

Within the framework of the Code of Conduct for Responsible Fisheries, the FAO adopted in 1999 the International Plan of action for the conservation and management of sharks (IPOA-Sharks). While the FAO plan of action is not binding, it aims to provide all concerned States with a reference point and guidelines for designing their own plans for the conservation, management and long-term sustainable exploitation of sharks. The FAO IPOA-Sharks applies to States in the waters of which sharks are caught by their own or foreign vessels and to States the vessels of which catch sharks on the high seas. States should adopt a national plan of action for conservation and management of shark stocks (Shark-plan) if their vessels conduct directed fisheries for sharks or if their vessels regularly catch sharks in non-directed fisheries. Each State is responsible for developing, implementing and monitoring its Shark-plan which mainly is focused, along with other provisions, to ensure that sharks populations are sustainable (FAO, 1999).

The 2005 FAO Expert Consultation (FAO, 2006), that evaluated progress in the implementation of the FAO IPOA–Sharks, concluded that few countries had had a successful record of conservation and management of elasmobranch resources and that the problem of depleted and threatened stocks and species continued to increase.

The scope of the European Union Plan of Action of Sharks covers directed commercial, by-catch commercial, directed recreational, and by-catch recreational fishing of any chondrichthyans within European Union waters. It also includes any fisheries covered by current and potential agreements and partnerships between the European Union and third countries, as well as fisheries in the high seas and fisheries covered by RFMOs managing or issuing non-binding recommendations outside European Union waters. In response to regional and global concerns about the status of shark populations, Tuna RFMOs has already taken some steps towards the collection of fishery data of shark which will allow assessing the major shark species caught under the areas of their mandate. Preliminary assessment and provision of management advice on the status of stock of major shark species is currently provided in Tuna RFMOs; however, there are a lot of sources of uncertainty; such as fishery statistics, size frequency, biological data, which precludes the provsision of sound management advice for most of shark species. Therefore, in order to reduce the sources of uncertainty is necessary to develop a research program to fill the information gaps which will allow assessing and developing the formulation of management advice.

The design of such programme will be benefited and integrated all the information collected through tasks 1-6 above. For example, the data and knowledge gaps identified through Phase I tasks 1-5 listed/inventoried will allow focusing and prioritised the future research. From this summarisation of Phase 1 it will be clear as to what data is available for providing management advice for shark species, and where gaps in the data render this task difficult. At this stage, recommendations for data collection improvements as well as research necessities and activities will be described.

4.2.2 GAPs identified in Phase I

The data collected through task 1 to 5 gave a complete picture of the current data availability of information about catch and effort, observer programs, size frequency information, biological information and fishery indicators that may support the assessment of major shark species in Tuna RFMOs (see table 4.2.1). Moreover, this revision has allowed also gathering information of other various issues currently addressing in Tuna RFMO with regard to shark assessment and management, such as current management measures. The table below synthetizes the information collected in task 1 to 5 about major important issues in relation to shark assessment and management in Tuna RFMOs.

Catch and Effort

Data availability

In general, there is a scarcity of data and limited data availability for major fleets and countries in Tuna RFMOs. Attending to historical data, several countries were not collecting fishery statistics, especially in years prior to the development of tuna and tuna-like fisheries in early 1970s. At the moment, industrial fisheries provide limited data while artisanal and small scale fisheries data is almost non-existent due to monitoring difficulties. Many Tuna RFMO countries are not reporting any catches or, in the case of few countries, only a small number of landings are declared. The information on the catch of sharks provided by the countries is thought, for this reason, to be incomplete in several countries. The catches recorded in other cases might not represent the total catches of sharks but simply the amounts retained on board (e.g. dressed weights instead of live weights). The catches of sharks for which only the fins are kept on board are rarely recorded.

Therefore catches of sharks might have gone unrecorded. The main consequence of this is that, at the moment, the catches of sharks available cannot be used to estimate reliably total catches of sharks. At this point, estimations of catch are made based on ratios published by literature. Then, the consistency of these estimations is conditioned to the levels of underreporting and non-reporting of tuna and tuna like species catches.

Effort data submission is mandatory in IATTC region while it is partially reported by few fleet or even not reported in other regions: in some cases vessels fishing outside EEZ are not recorded and in other cases registered permits not necessarily involve active vessels as in few countries of IOTC. Generally, the main gear responsible of shark catches is identify in each region but should be considered with caution due to unclassified gears.

The lack of catch data for the illegal driftnets in the areas that are still being used as well as opportunistic catches in a particular area and season due to economic reasons are also a major impediment when gathering data for shark catches.

Table 4.2.1.- Synthetic information on gaps by Convention area obtained through Phase I. NOTE: in some cases a blank refers to data that was not available to review rather than inexistent.

	IATTC	ICCAT	GFCM	IOTC	WCPFC
Historical Catch/effort					
Directing fishing	▪	▪ Improved due to implementation Recs. but insufficient for stock assessment>advice	▪ 1 LL targeting GAG in turkey	▪	▪
Caught in association	▪ Scarcity of data and data availability for major fleets and countries. ▪ Most of those data is coming from logbooks: > Species mis-identification > Under-reporting > Potential, unidentifiable in targeting strategies	▪ 143 fisheries >36 declaring SH>2 fleet annual reporting LL-(EU_SP, EU_MAL) ▪ Very uneven overtime ▪ Incomplete by-catch data ▪ If reported >Only those retained on board >No data on dw >No data on type of processing >Rarely recorded weight/number of indv. which fins are retained on board ▪ Major sharks (BSH, SMA, PB) better reported than other spp. but still inconsistencies	▪ SH landings increased since 2003 ▪ Many countries not reporting> underecording ▪ Few countries only small n of landings declared>unreliable ▪ Several countries not collecting fishery statistics efficiently> difficult to estimate Tcatch ▪ Difficult to data access ▪ Variety of fishing practice: most artisanal or small scale rather than industrial >Difficult to monitor >then , information on catch and by-catch incomplete ▪ If reported >Only those retained on board >No data on type of processing >No data on dw	▪ Very uneven overtime ▪ Incomplete by-catch data ▪ If reported >Only those retained on board >No data on dw >No data on type of processing >Rarely recorded weight/number of indv. which fins are retained on board ▪ Highly aggregated statistics for each species per fleet/gear/year are available ▪ Catches before 2006 (historical) and thereafter >Not clear which species are covered by this requirement >Not defined most common shark species and other shark species ▪ Catch and effort thereafter 2006 for general sharks >Not clear which species are covered by this requirement >Not defined most common shark species and other shark species	▪
Catch	▪ In many instances, shark catches are not recorded or not disaggregated at the required level. ▪ Most of the data recorded are not publicly available and under very strict rules of confidentiality. ▪ Difficulty to access to disaggregated and aggregated data for some of the fleets such as LL and coastal fleets and in a			▪ Several countries not collecting data ▪ Several countries not reporting data ▪ Several countries underecording catches(only retained on board and dw) ▪ No recorded by species and/or gear ▪ Then paucity of data available == estimation highly compromised ▪ Miss-identification of species compromised by the way different species are processed >actual data available cannot be used	▪ Data non-existent: artisanal, small scale. ▪ Data limited: industrial ▪ Estimation on catch rates on key species based on models from LL-obser. ▪ LL-FAL; SMA; retained ▪ PS-FAL; usually finned rarely retained

	lesser extend the PS ▪ Estimating the total catch of a species of fish is difficult: > some discarded at sea > some gear types are incomplete. ▪ In the case of longline fleet, there is neither official catch of shark nor observer records for sharks of the longline fleet operating in EPO >estimations base on ratios published by literature			to estimate reliably Tcatches, even in species where catches are partially available	
Major responsible fleet	▪ No possible to identify fishery/fleet by country involved in shark catch based on national reports	▪ Identified based on data available (EU_Spain and EU_Portugal) >22 flag states no reported >Limitation reporting efficiency/Countries >Not for all fisheries/Countries >Not for all areas/Countries >Chartered vessels issue	▪ TUR, EU_IT; on the basis of tuna and tuna like spp. catches ▪ Estimates affected by: >Limitations in reporting efficiency >Problems of species identification >Problems of species breakdown >Level of underreporting of tuna and tuna like spp. catches >Non-reporting of tuna and tuna like spp. catches >Lot of assumptions made to reconstruct the catch time series	▪ Based on data available: SRI LANKA; IRAN ▪ Main gear: GN; GN-off ▪ Main origin of underreporting: low level declaration ▪ Limitation reporting efficiency ▪ Estimates depends on under-reporting and non-reporting of tuna like-ssp.	▪ LL ▪ PS ▪ Troll, pole-line ▪ Small scale methods
Major Studied shark species	▪	▪ Identified based on data available (BSH, POR, SMA) > Possible misidentification of some species/countries	▪	▪ Identified based on data available on NP: ▪ FAL; THR, BSH; OCN, SPN, SMA	▪ LL-BSH; FAL, SMA, THR, OCS ▪ PS-FAL; OCS
Studied Shark Species Catch Composition	▪	▪ Not for all Countries >No species breakdown >Problems local consumption CPCs species-specific reporting	▪ Data disaggregated by species ▪ Possible misidentification, particularly in Scountries	▪ Not for all Countries >When reported simply those retained on board >No species breakdown >Partial data or data aggregated for all species >For CPCs reporting LL (SWO)by species ==74% and 12% shark catches are BSH and SMA	
Effort	▪ Submission is mandatory ▪ Records of gear, flag, and fish-carrying capacity for most of the vessels that fish with PS or pole-and-line		Partially reported by few fleets		▪ No data by flag public domain ▪ Data PS 2006: LL 2007
Gears	▪ Main gears: LL (industrial, artisanal), PS (large boats) to catch sharks	▪ Not all gears/fisheries identified >artisanal and recreational	▪ Varity of fishing gears ▪ Main responsible: PS and LL; OTH unclassified	▪ Catch record by gear high proportion ▪ Main: ILL-GN-iPS-artisanal gears >DFTUN and FTUN–LL==20-40%	

	▪ OTH: Troll, harpooners, GN, recreational	▪ Not all gears/Countries monitored		total catches species combined > high discards believed >FSWOLL==40-60% total catches species combined >PSTUN==less than 0.5% total catches species combined (10% total discard) >P-L==no record, if any, but not significant >GN==catches varying significantly depending on areas >HL-TRL==coastal waters==Low catches	
No. Vessels	▪	▪ Not all flag states reported	▪	▪ Most countries recorded ▪ Some cases not included vessels fishing outside EZZ ▪ Some cases registered permits are not necessarily active	▪
Size vessels	▪	▪ Not all flag States reported	▪ Over 80% registered boats <12m	▪ Most countries recorded	▪
No. Fishing days	▪	▪ Not all flag States reported	▪ No data available	▪ No da available	▪
No. Fishing trips	▪	▪ Not all flag States reported	▪ No data available	▪ No data available	▪
No. Hooks	▪	▪ Not all flag States reported	▪ No data available	▪ No data available	▪
CPUE series	▪	▪ Not all flag States reported >Data confidentiality	▪ No data available	▪ Overall decline in BSH but relatively stable mean weight >LL-Japan (1994-2010) and LL-Portuguese (1999-2011) ▪ Overall decline in SMA and mean weight >South Africa PN; LL-Japan (1994-2010) and LL-Portuguese (1999-2011)	
Limitations	▪	▪ TACs: Not all species/Countries	▪	▪	▪
By-catch and Discards	▪	▪ Fisheries-specific restrictions (recreational) >Few countries applied Recs. and Res.: ▪ Prohibition retaining on board for some species ▪ Support MSY for some species ▪ Time and area closures for some species ▪ Trade constrains for some species	▪ 9 species as bycatch by LL(SWO, TUNA): BSH; SMA, THR, GAG, POR, BTH,SPN, RSK ▪ DN>BSH,SMA, , THR ▪ Artisanal (TMMN, GN)> Coastal species ▪ Trap>seveal rare species in the Med. Sea and SMA, SPN. ▪ P-DTW>THR; BSH, WSH, SMA, etc. ▪ % of catches differ among gears/areas ▪ SH catch ratios lower than other oceans. Highest Alboran Sea		▪ Incidental catch in off-fisheries ▪ Retained on board if economic incentive

			▪ Discards are considered low> targeting multispecies> retained because market demand ▪ DN activity continue although prohibited or limited		
Database	▪ Data for fish discarded at sea by purse-seine vessels with carrying capacities greater than 363 metric tons (t) have been collected by observers since 1993 ▪ With a few exceptions, the bycatch rates are greatest in sets on floating objects, followed by unassociated sets and, at a much lower level, dolphin sets. ▪ purse seine fleet are perfectly recorded by observers since 1993 (100%) for large boats ▪ not publicly available by country ▪ For the other gears, fundamentally LL, there is no information available, by species		▪ Scarce data ▪ Not homogenous data: in terms of weight and in numbers >Difficult to merge data >Assumptions made on raising and/or ratios estimates	▪ Scarce data ▪ Not homogenous data: in terms of weight and in numbers >Difficult to merge data >Assumptions made on raising and/or ratios estimates	▪ No public discards database available ▪ LL but incomplete (BSH, BTH) ▪ PS largely complete> assess nº SH finned ▪ Discards mostly on FADs
Observer programs	▪ Extremely comprehensive program covering 100%of PS ▪ Coverage of LL and sPS not carried out ▪ Very detailed ▪ Level of confidentiality of data varies: agreement to use it to research ▪ Few countries (7) national programs: own observers	▪ Information on 21 sharks ▪ Not for all species /gears/vessels/Countries ▪ No status indication (dead/alive) ▪ Scarce data ▪ Not homogenous data: in terms of weight and in numbers >Difficult to merge data >Assumptions made on raising and/or ratios estimates ▪ Reporting limitation: CPCs confidentiality	▪ Discrepancies in observed at-sea and at-landing catch data ▪ Due to discarding OTH spp. or undersize SWO or TUNA ▪ Data of observer program is not available to public> no analysis done at all. ▪ Low observer coverage for most fleet	▪ No much public available information ▪ No estimates; few on national reports (Australia) other working documents	▪ Only small amount of obsev.data due to implem. >less retention and discarding than occurring >underestimation
Catch at size	▪ Submission is mandatory ▪ Although 100% coverage is available for large purse seiners, the information is not totally publicly available, and for other fleets little information about the	▪ Not all countries ▪ Not all gears monitored ▪ Not all areas/Fisheries/Country ▪ No much public available information	▪ Scarce or ever lacking ▪ Only few fleet reported body size/year/gear/month/1x1 degree square areaBIL95 >Mainly for BSH, POR, SMA ▪ LL-Malta provided some data for 4	▪ No much public information available ▪ Few CPs and CNCPCs provided on major shark species ▪ Portugal collecting historical data from skipper logbooks	▪ No much public info. On key spp. ▪ PS (OCS, FAL) ▪ LL(mainly FAL)

	catch size of key sharks species in the IATTC is available. ▪ For FAL in the area. It is very fragmented and is held by different countries or organizations.		species in GSA15		
Biological information	▪ Annex I	▪ No much public information available ▪ Few CPs and CNCPCs provided on key shark species ▪ Based on nominal catch available ▪ Length freq. on by-catch/observ. programs scarce for other ssp.			
Fisheries indicators	▪ Commission applies Precautionary approach ▪ Commission interprets MSY as a limit reference point		▪ No data available ▪ Difficult with the use of logbook data for SH assessment	▪ Limited basic fisheries indicator ▪ Stock status highly uncertain	▪
Quantitative Stock Assessment	▪ FAL; rest of spps. Less knowledge	▪ Abundance indices data from few countries ▪ Not all species updated series ▪ ERA analysis updated for few species (BSH, SMA, POR)	▪	▪ No quantitative stock assessment undertaken for BSH and SMA ▪ An independent IUCN own threat assessment	▪
Assessment method	▪	▪ Depend on species (combined indices, etc.)	▪	▪	▪ OCS: model stock synthesis and sensitivity analysis quite robust ▪ FAL: model stock synthesis.
Species	▪	▪ Not all species (BSH, POR, SMA)	▪	▪ Major shark caught: BSH, SMA	▪
Model Output	▪	▪ Overfishing probability low (sa.2012)	▪	▪ BSH: Near threatened ▪ SMA: Vulnerable	▪ BSH: close to BMSY and approaching FMSY>but situation no longer hold ▪ SMA: unknown ▪ OCS: overfished ▪ FAL: overfished ▪ THR: overexploited
Quantitative advice	▪	▪ Data insufficient to provide it ▪ Prec. appr.: not increase F until more reliable stock assess. (SMA)	▪	▪	▪ FAl: current assess. no use for management
Recommendation	▪	▪ Using indices from oceanic	▪	▪	▪ FAL: not to increase F

		distribution fisheries			
Limitation	▪	▪	▪	▪ Underecorded catches in several countries ▪ Many records under-represent actual catches >no account for discards >no record catches of sharks o which only fins are kept >Reflect dw instead of live weight ▪ No species-specific data from major fleets ▪ Opportunistic catches by LL in particular area/season due to market price of BSH ▪ Most fishing gears F and post release M on BSH unknown; Only fisheries LL-SWO>F=58% ▪ Little information on fisheries prior to 1970 SMA ▪ Most fishing gears F and post release M on SMA unknown; Only fisheries LL-SWO>F=13-51% M=19%; LL-tuna>F=0.31%	▪ OCS: Uncertainties ▪ FAL: Gaps to overcome. Assumptions. ▪ THR: poorly studied. Identification problem
Mandatory fisheries requirements					
Management	▪	▪	▪	▪ No specific IPOA developed. Considered FAO IPOAs.	▪
Directing Fishing	▪	▪ Fully implementation of NPA in accordance with FAO IPOA [03-10] ▪ Measures to reduce F targeting POR, SMA, until sustainable levels of harvest can be determined [CPCs, 07-06] ▪ Consideration time and area closures and other measures based on research [CPCs, 07-06] ▪ Stock assessment through review available information and recommend management advice on POR [SCRS, 07-06]	▪	▪	▪

Caught in association	▪ Ensure that at least 5% of the fishing effort made by its longline fishing vessels greater than 20 meters length overall carry a scientific observer [CPCs, 11-08] ▪ Potential increase of the required coverage rate. [CPCs, 11-08] ▪ Recommendation of best available practice: [CPCs, 11-08] >Recognizing the importance of sound scientific advice as the centerpiece for the conservation and management of tuna and tuna-like species > take measures to ensure a more interactive relationship between CPCs, the IATTC scientific staff, > improve the collection and submission of data to the IATTC, including on bycatches > support research programs and projects relevant to the information needs of the IATTC ▪ Develop techniques and/or equipment to facilitate non-target species release of life individuals [CPCs, 04-05] ▪ Data confidentiality and availability only to those members of the staff requiring access to them in the course of the scientific investigations [CPCs, 51-01]	▪ Stock assessment and recommend management alternatives for SMA and BSH by 2008 [SCRS, 06-10] ▪ Describe and implement alternative monitoring approach for reporting by-catch and discard data for vessels<15 m by 2012 [SCRS, 06-10] ▪ Alternative monitoring measures to collect by-catch and discard data for artisanal fisheries no subject to standard SOP [SCRS, 06-10] ▪ Report on steps taken to mitigate by-catch and reduce discard [CPCs, 11-10] ▪ Provide relevant identification guides [CPCs, 11-10]	▪ Measures to require that their fishermen fully utilize their entire catches of sharks [CPCs, 2006/08] ▪ No on board fins at total more than 5% of the weight of sharks onboard, up to the first point of landing [CPCs, 2006/08] ▪ In fisheries not directed at SH, release of live sharks, especially juveniles, to the extent possible, caught incidentally and are not used for food and/or subsistence. [CPCs, 2006/08]	▪ Report on catches according to IOTC data reporting procedure [CPCs, 05-05] ▪ Report on available historical data [CPCs, 05-05] ▪ Provide advice on stock status of key sharks [SCRS, 05-05] ▪ Fully utilization entire SH catches by fishermen [CPCs, 05-05] ▪ No more fins on board than 5% of total SH weight on board to first point landing/transshippment [CPCs, 05-05] ▪ Ratio fin-to-body weight revision [SCRS, 05-05] ▪ Release shark catch incidentally and not use for food or subsistence [CPCs, 05-05]	▪ CMM2011-01: ▪ CCMs shall report on annual catches of key shark species by gear type, as well as on discards. ▪ CCMs shall take measures necessary to require that their fishers fully utilize any retained catches of sharks (excepting head, guts, and skins) to the point of first landing or transshipment. ▪ CCMs shall require their vessels to have on board fins that no more than 5% of the weight of sharks on board (of ensure compliance with the 5% ration through certification).
Hammerhead shark	▪	▪ Prohibition retaining on board [CP, CNCPs, CPCs, 10-08] ▪ Prohibition transhipping, landing, storing, selling or offering for sale any part or whole indv. [CP, CNCPs, CPCs, 10-08] ▪ Unharmed release [CPCs, 10-08]	▪ Prohibited retaining onboard, transshipping, landing, storing, selling, or offering for sale any part or whole carcass of hammerhead sharks of the family *Sphyrnidae* [CPCs, 35/11/07c] [ICCAT 10-08] ▪ Promptly release unharmed and the number of discards [CPCs, 35/11/07c] [ICCAT 10-08]	▪	▪

		▪ Not increase of catch Coastal CPCs exempted for prohibition [CPCs, 10-08] ▪ Measures to ensure FAL will not enter international trade, Coastal CPCs exempted for prohibition [CPCs, 10-08] ▪ Measures engaging in capacity building efforts and cooperative actives to support the implementation of Rec. [CPCs, 10-07]	▪ Necessary measures to ensure SH of the family *Sphyrnidae* (except of *Sphyrna tiburo*) will not enter international trade [CPCs, 35/11/07c] [ICCAT 10-08] ▪ Consider time and area closures and other measures [CPCs, 35/11/07c] [ICCAT 10-08]		
<u>*Shortfin mako shark*</u>	▪	▪ Report actions on implement Recs. [CPCs, 10-06] ▪ Report on steps taken to improve data collection [CPCs, 10-06] ▪ Annual review of actions taken [CPCs, 10-06] ▪ Prohibition retaining on board from 2013 on until reception of data, if data on SMA no in accordance with ICCAT data reporting procedures [CPCs, 10-06] ▪ Stock assess. and advice on TAC supporting MSY and other conservation measure [SCRS, 10-06] ▪ Complete identification guide [SCRS, 10-06]	▪ Not reporting in accordance with SCRS data reporting requirements, shall prohibited from retaining this species, beginning in 2013 until such data have been received [CPCs, 35/11/07b]. ▪ Stock assessment in 2012 and advise: a) the annual catch levels o that would support MSY; b) other appropriate conservation measures [SRCS, 35/11/07b]	▪	▪
<u>*Threser shark*</u>	▪	▪	▪ Prohibited retaining onboard, transshipping, landing, storing, selling, or offering for sale any part or whole carcass of part or whole carcass in any fishery [CPCs, 34/10/0uc] [ICCAT 09-07] ▪ promptly release unharmed [CPCs, 34/10/0uc] [ICCAT 09-07] ▪ consider time and area closures and other measures, [CPCs, 34/10/0uc] [ICCAT 09-07]	▪	▪

<u>Bigeye Threser shark</u>	▪	▪	▪	▪ Prohibition transhipping, landing, storing, selling or offering for sale any part or whole individual [CPCs, CNCPs, 10-12] ▪ Unharmed release [CPCs, 10-12] ▪ Report data as required IOTC data reporting procedures, especially those directing fishing for sharks [CPCs, CNCPs, 10-12]	▪
Whitetip shark	▪	▪	▪	▪	▪ CMM2011-04: >Prohibits the retention, transshipment or storing of oceanic whitetip sharks on fishing vessels. >Requires all vessels to record interactions with this species and the prompt release of this fish caught as soon as possible, and in a manner that results in as little harm to the shark as possible
Observer program	▪	▪	▪	▪ Verify catch data and other scientific data on tuna/tuna-like spp. [11-04] ▪ In respect of coverage: [11-04] >At least 5% of n.operations/sets by gear by fleet CPCs >24m/ <24m fishing outside EZZ >Achieving it by Jan. 2013 the vessels<24m fishing outside EZZ >Progressively increase towards 5% of the total activities of artisanal fishery	▪
Conservation	▪	▪	▪ Ensure sharks are kept on board, transhipped, landed and marketed at first sale in a way that species are recognizable and identifiable [CPCs, CNCP; 36/12/3] ▪ Species in Annex II SPA/BD protocol Barcelona Convention that must be released unharmed and alive to the extent possible [CPCs, CNCP; 36/12/3] ▪ Specimens of sharks' species in Annex II SPA/BD Protocol cannot be retained on board, transhipped, landed, transferred, stored, sold or displayed or	▪	▪

			offered for sale [CPCs, CNCP; 36/12/3] ▪ Ensure catches of TSH taken with BN, LL, tuna traps shall be promptly released unharmed and alive to the extent possible.		
Caught in association	▪ Establish and implement a national plan of action for conservation and management of shark stocks, in accordance with the FAO International [CPCs, c-05-03] ▪ Plan of Action for the Conservation and Management of Sharks. [CPCs, c-05-03] ▪ Provide preliminary advice on the stock status of key shark species and propose a research plan for a comprehensive assessment of these stocks[CPCs, c-05-03] ▪ Measures necessary to require that their fishers fully utilize any retained catches of sharks [CPCs, c-05-03] ▪ Require their vessels to have onboard fins that total no more than 5% of the weight of sharks onboard, up to the first point of landing [CPCs, c-05-03] ▪ Not require fins and carcasses to be offloaded together at the point of first landing ▪ Measures to ensure compliance with the 5% ratio through certification, monitoring by an observer, or other appropriate measures [CPCs, c-05-03] ▪ Fishing vessels are prohibited from retaining on board, transshipping, landing or trading in any fins harvested in contravention of this Resolution [CPCs, c-05-03] ▪ In fisheries for tunas and tuna-	▪ Stock assess. and recommend management alternatives for SMA and BSH by 2008 [SCRS ,06-10] ▪ Annually report on catches [CP, CNCP, E, FE, 04-10] ▪ Data reported in accordance with ICCAT reporting procedures [04-10] ▪ Fully utilization entire SH catches by fishermen [CPCs, 04-10] ▪ No more fins on board than 5% of total SH weight on board to first point landing [CPCs, 04-10] ▪ Ensure compliance with 5% ratio through monitoring by observ. or other measure [CPCs, 04-10] ▪ Ratio fin-to-body weight revision [SCRS, 04-10] ▪ Prohibition retaining on board, transhipping or landing any fins in contravention [04-10] Revision of SMA assessment in 2005, reassess BSH and SMA no later than 2007 [SCRS, 04-10]	▪	▪ Assistance to developing CPCs [COMM., 05-05] ▪ All LL vessels subject to data recording system [CPCs, 05-05] ▪ E-logbook in LL vessels>24m and LL vessels<24m fishing outside EZZ their flag States [CPCs, 08-04] ▪ LL E-logbook minimum required data:vessel7trip/gear/operation/catch for BSH, SMA, POR, OTH)/discards [CPCs, 08-04] ▪ All PS vessels subject to data recording system [CPCs, 10-03] ▪ E-logbook in PS vessels>24m and LL vessels<24m fishing outside EZZ their flag States [CPCs, 10-03] ▪ PS E-logbook minimum required data: catch/ vessel/ discard/ species [CPCs, 10-03]	▪

	like species that are not directed at sharks, encourage the release of live sharks, especially juveniles, to the extent practicable, that are caught incidentally and are not used for food and/or subsistence [CPCs, c-05-03] ▪ Annually report data for catches, effort by gear type, landing and trade of sharks by species, where possible, in accordance with IATTC reporting procedures, including available historical data [CPCs, c-05-03]				
<u>*Silky shark*</u>	▪	▪ Release whether dead or alive [CP, CNCPs, CPCs, 11-08] ▪ Prohibition retaining on board, transshipping or landing any part or whole individual [CPCs, 11-08] ▪ Unless obliged all dead fish be landed, fishermen cannot commercial profit from it [CPCs, 11-08] ▪ Unharmed release individual at latest before putting the catch in the fish holds [CPCs, 11-08] ▪ Additional measure to increase survival rate of incidentally caught individual in PS [CPCs, 11-08] ▪ Plan to Improve reporting by species-specific, Coastal CPCs exempted for prohibition [CPCs, 11-08] ▪ Not increase of catch Coastal CPCs exempted for prohibition [CPCs, 11-08] ▪ Taken measure to ensure specim. not enter international trade, Coastal	▪	▪	▪

		CPCs exempted for prohibition and report them[CPCs, 11-08] ▪ Prohibition against these fisheries Coastal CPCs exempted for prohibition [CPCs, 11-08]			
Whitetip shark	▪ Prohibit retaining onboard, transhipping, landing, storing, selling, or offering for sale any part or whole [CPCs, c-11-10] ▪ Promptly release unharmed, to the extent practicable [CPCs, c-11-10] ▪	▪ Prohibition transhipping, landing, storing, selling or offering for sale any part or whole indv. [CP, CNCPs, CPCs, 10-07]	▪	▪	▪
Bigeye Thresher shark	▪	▪ Prohibition transhipping, landing, storing, selling or offering for sale any part or whole indv. [CP, CNCPs, CPCs, 09-07] ▪ Mexican small scale coastal fishery catch less than 100 fish [CPCs, 09-07] ▪ Unharmed release [CPCs, 09-07] ▪ Ensurance not undertake a direct fishery on genus *Alopias* [CPCs, 09-07]	▪	▪	▪
Data collection	▪	▪	▪	▪	▪ Amen. Shark species where included in the data provision requirements: BSH, FAL, OCS; SMA, THR, POR, SPN
Directing fishing	▪	▪	▪	▪	▪
Caught in association	▪ collection of data on shark catches [CPCs, c-05-03]	▪ Assistance to developing CPCs [COMM., 04-10] ▪ By-catch and discard data in existing observer programs and logbooks [CPCs, 11-10] ▪ By-catch and discard data submission in accordance with specified format and data Reporting deadlines[CPCs, 11-10]	▪ Incidental catches and, whenever appropriate, releases by species can be monitored and recorded [CPCs, CNCP; 36/12/3] ▪ Annually report Task I and Task II data for catches of sharks, in accordance with ICCAT data reporting procedures, including available historical data [CPCs, 2006/08]	▪	▪
Silky shark	▪	▪ Task I and if possible task II according to data reporting	▪	▪	▪

		procedures Coastal CPCs exempted for prohibition [CPCs, 10-08] ▪ Discards and release recorded with indication status (dead or alive) [CPCs, 11-08]			
Hammerhead shark	▪	▪ Task I and if possible task II according to data reporting procedures Coastal CPCs exempted for prohibition [CPCs, 10-08] ▪ Task I-II at least by *genus* Coastal CPCs exempted for prohibition [CPCs, 10-08] ▪ Discards and release recorded with indication status (dead or alive) [CPCs, 10-08]	▪ Releases are recorded with indication of status (dead or alive) and reported to ICCAT in accordance with ICCAT data reporting requirements [CPCs, 35/11/07c] [ICCAT 10-08] ▪ CPCs for local consumption are exempted from the measures, but catch data by species, or at least by genus *Sphryna* (Task I) and, if possible, Task II [CPCs, 35/11/07c] [ICCAT 10-08]	▪	▪
Whitetip shark	▪ Record *inter alia*, through the observer programs, the number of discards and releases of oceanic whitetip sharks with indication of status (dead or alive) and report it to IATTC [CPCs, c-11-10]	▪ Discards and release recorded with indication status (dead or alive) [CPCs, 10-07]	▪	▪	▪
Shortfin mako	▪	▪ Task I-II data for *S*MA in accordance with data reporting procedures [CPCs, 10-06]	▪	▪	▪
Threser shark	▪	▪	▪ Collection and submission of Task I and Task II data for *Alopias* spp other than *A. superciliosus* in accordance with ICCAT data reporting requirements [CPCs, 34/10/0uc] [ICCAT 09-07]	▪	▪
Bigeye thresher shark	▪	▪ Task I-II data for *Alopias* in accordance with data reporting procedures [CPCs, 09-07] ▪ Discards and release recorded with indication status (dead or alive) [CPCs, 09-07]	▪ Discards and releases must be recorded with indication of status (dead or alive) and reported to ICCAT in accordance with ICCAT data reporting requirements[CPCs, 34/10/0uc] [ICCAT 09-07]	▪ Record on incidental catches by fishermen [CPCs, 10-12] ▪ Record live releases by fishermen [CPCs, 10-12]	▪

Research					
Directing fishing	▪	▪ CPCs implement research to identify potential nursery areas PB and NASMA ▪ Identification ways to make fishing gears more selective [CPCs, 04-10] ▪ Identification of nursery areas [CPCs, 04-10; 07-06]	▪	▪	▪
Caught in association	▪ Undertake research to identify ways to make fishing gears more selective [CPCs, c-05-03] ▪ Identify shark nursery areas [CPCs, c-05-03]	▪	▪ Identify potential nursery areas [CPCs, 2006/08]	▪ Propose research plan and timeline for stock assessment [SCRS, 05-05] ▪ Identification ways to make fishing gears more selective [CPCs, 05-05] ▪ Identification of nursery areas [CPCs, 05-05]	▪
Hammerhead shark	▪	▪ Identify potential nursery areas [CPCs, 10-08]	▪ Identify potential nursery areas [CPCs, 35/11/07c] [ICCAT 10-08]	▪	▪
Threser shark	▪	▪	▪ Identify potential nursery areas[CPCs, 34/10/0uc] [ICCAT 09-07]	▪	▪
Bigeye thresher shark	▪	▪ Identify potential nursery areas [CPCs, 09-07]	▪	▪	▪

Data resolution

The catches of sharks are not recorded by gear and/or species. The catches of sharks are not disaggregated at the required level for each species by area or fleet. Generally major sharks are better reported that other species but still are inconsistencies. Mis-identification of shark species is also common. The identification of sharks in port is usually compromised by the way in which the different species of sharks are processed before landed. Generally, no indication is given on the type of processing that the different specimens underwent. Then, the identification of sharks unloaded as shark carcasses, shark fins or other shark products is difficult.

Data access

The data available by flag in the public domain is scarce in RFMO countries. In some cases due to confidentiality issues is difficult to get the basic fishery information regarding the fleet activity catching sharks, especially for historical data. It is difficult to extract disaggregated and aggregated data for some data different fleets, especially for longline and coastal fishery.

Discards

Data availability

There is scarce discards data, incomplete and no homogenous: some countries report discards weight while others provide discard numbers. Moreover, discards differ depending on the aggregations behavior (FADS, free schooling).This makes difficult to merge the data. Data from observer programs is not available or partially available, and vary significantly by gear: observer data coverage is 100% for purse seine from IATTC but it is low for longline fleets and artisanal and coastal fisheries which may not be representative of all areas where sharks are caught (see previous section 4.1). When countries implement recommendations and resolutions, only small amount of observe data is improve.

Although prohibited or limited illegal driftnets activity continues and they do not provide discard information.

Data resolution

Although there are fishery restrictions enshrined in RFMOs recommendations and resolutions related with shark discards there is poor quality discarding data. When discards occurs very often there is no information on shark species by gear and if shark are release dead or alive. In addition to the limited historical observer coverage by gear in terms of sample size, the distribution of the samples over the spatial range of the fisheries is also limited.

Frequently there are discrepancies in observed at –sea and at-landing catch data due to discarding other species (or undersize tuna and tuna like species catches). Discards also may be masked if there is an economic incentive for retaining them on board.

Data access

Data is not accessible for most of the countries. In IATTC and WCPFC data is no publically available while in IOTC/ICCAT data being available is quite scarce.

<u>Size frequency data</u>

<u>Data availability</u>

Submission is mandatory in all Tuna RFMOs (through management recommendation on shark fishery statistics and/or observer programs); however, little information about the catch-size for sharks species bycaught is available. In general, there is poor knowledge of the size-frequency data from most of the fleets in RFMOs although a number of countries have provided data for major species caught. Data is therefore scarce or ever lacking.

<u>Data resolution</u>

Data is provided mainly for major shark species.

<u>Data access</u>

No much public information available.

<u>Biology</u>

<u>Data availability</u>

There is a lack of regional biological/ecological information for sharks. Fishery-specific biological data (length, weight, sex, fate and condition) drawn from observer programs appear to be ample for few key shark species but are limited for other species, and all samples will reflect any biases in the observer data. Port sampling could in theory provide additional fishery-specific biological data but this is hampered by the fact that most sharks are landed as processed carcasses resulting in half of the samples collected so far not being identified to species.

Shark biology data is available from other sources such as literature, research, peer-review publications; however, the data available is not enough in most of the cases (see table 4.2.2).

<u>Data resolution</u>

Few countries provided data on key shark species but it is very fragmented and is held by different countries or organizations.

<u>Data access</u>

No much public information available.

Table 4.2.2.- State of knowledge on the biological parameters and ecological data for the selected pelagic shark and rays species. (In blue : data available – In green: data without regional origin- In red : data not available).

		SHARKS											
Species		*Alopias pelagicus*	*Alopias superciliosus*	*Alopias vulpinus*	*Carcharhinus falciformis*	*Carcharhinus longimanus*	*Carcharodon carcharias*	*Cetorhinus maximus*	*Galeocerdo cuvier*	*Galeorhius galeus*	*Isurus oxyrinchus*	*Isurus paucus*	*Lamna nasus*
FAO code		PTH	BTH	ALV	FAL	OCS	WSH	BSK	TIG	GAG	SMA	LMA	POR
Maximum size		IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP
Maximum weight		IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP
Conversion factors	Length – Weight relationships	IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP
	LT- LF relationships	IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP
	Fin weight – Body weight ratio	IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP
Reproduction	Maturity length for females	IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP
	Maturity age for females	IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP
	Maturity length for males	IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP
	Maturity age for males	IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP
Reproduction	Birth size	IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP
	Sex ratio	IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP

	Mode of development	IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP
	Gestation period	IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP
	Fecundity (uterine)	IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP
Age & growth	$L\infty$ for females	IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP
	K for females	IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP
	t_o for females	IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP
	$L\infty$ for males	IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP
	K for males	IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP
	t_o for males	IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP
	Longevity	IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP
Diet	Nature of prey	IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP
	%F (prey frequency)	IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP
	%N (prey in numbers)	IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP
	%W (prey in weight	IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP
	%IRI (index of relative importance)	IO WP	ATL MED IO WP	ATL MED IO WP	ATL MED IO WP	ATL MED IO WP	ATL MED IO WP	ATL MED IO WP	ATL MED IO WP	ATL MED IO WP	ATL MED IO WP	ATL MED IO WP	ATL MED IO WP

		EP	EP	EP	EP	EP	EP	EP	EP	EP	EP	EP	EP
	Isotopes N^{15} / C^{13}	IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP
	Trophic level	IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP
Habitat		IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP
Contaminants		IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP

Table 4.2.2.- (continuation).

		SHARKS						RAYS					
Species		*Prionace glauca*	*Pseudocarcharias kamoharai*	*Rhincodon typus*	*Sphyrna lewini*	*Sphyrna mokarran*	*Sphyrna zygaena*	*Aetobatus narinari*	*Manta alfredi*	*Manta birostris*	*Pteroplatytrygon violacea*	*Rhinoptera javanica*	*Rhinoptera marginata*
FAO code		BSH	PSK	RHN	SPL	SPK	SPZ	MAE	RMA	RMB	PLS	MRJ	MRM
Maximum size		ATL MED IO WP EP	ATL IO WP EP	ATL IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL IO WP EP	ATL IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	IO WP	ATL MED
Maximum weight		ATL MED IO WP EP	ATL IO WP EP	ATL IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL IO WP EP	ATL IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	IO WP	ATL MED
Conversion factors	Length – Weight relationships	ATL MED IO WP EP	ATL IO WP EP	ATL IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL IO WP EP	ATL IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	IO WP	ATL MED
	LT- LF relationships	ATL MED IO WP EP	ATL IO WP EP	ATL IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL IO WP EP	ATL IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	IO WP	ATL MED
	Fin weight – Body weight ratio	ATL MED IO WP EP	ATL IO WP EP	ATL IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP						
Reproduction	Maturity length for females	ATL MED IO WP EP	ATL IO WP EP	ATL IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL IO WP EP	ATL IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	IO WP	ATL MED
	Maturity age for females	ATL MED IO WP EP	ATL IO WP EP	ATL IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL IO WP EP	ATL IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	IO WP	ATL MED
	Maturity length for males	ATL MED IO WP EP	ATL IO WP EP	ATL IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL IO WP EP	ATL IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	IO WP	ATL MED
	Maturity age for males	ATL MED IO WP EP	ATL IO WP EP	ATL IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL IO WP EP	ATL IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	IO WP	ATL MED
Reproduction	Birth size	ATL MED IO WP EP	ATL IO WP EP	ATL IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL IO WP EP	ATL IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	IO WP	ATL MED
	Sex ratio	ATL MED IO WP EP	ATL IO WP EP	ATL IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL IO WP EP	ATL IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	IO WP	ATL MED
	Mode of development	ATL MED IO WP	ATL IO WP	ATL IO WP	ATL MED IO WP	ATL MED IO WP	ATL MED IO WP	ATL IO WP	ATL IO WP	ATL MED IO WP	ATL MED IO WP	IO WP	ATL MED

		EP	EP	EP	EP	EP	EP	EP	EP	EP	EP		
	Gestation period	ATL MED IO WP EP	ATL IO WP EP	ATL IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL IO WP EP	ATL IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	IO WP	ATL MED
	Fecundity (uterine)	ATL MED IO WP EP	ATL IO WP EP	ATL IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL IO WP EP	ATL IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	IO WP	ATL MED
Age & growth	$L\infty$ for females	ATL MED IO WP EP	ATL IO WP EP	ATL IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL IO WP EP	ATL IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	IO WP	ATL MED
	K for females	ATL MED IO WP EP	ATL IO WP EP	ATL IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL IO WP EP	ATL IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	IO WP	ATL MED
	t_o for females	ATL MED IO WP EP	ATL IO WP EP	ATL IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL IO WP EP	ATL IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	IO WP	ATL MED
	$L\infty$ for males	ATL MED IO WP EP	ATL IO WP EP	ATL IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL IO WP EP	ATL IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	IO WP	ATL MED
	K for males	ATL MED IO WP EP	ATL IO WP EP	ATL IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	IO WP	ATL MED
	t_o for males	ATL MED IO WP EP	ATL IO WP EP	ATL IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL IO WP EP	ATL IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	IO WP	ATL MED
	Longevity	ATL MED IO WP EP	ATL IO WP EP	ATL IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL IO WP EP	ATL IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	IO WP	ATL MED
Diet	Nature of prey	ATL MED IO WP EP	ATL IO WP EP	ATL IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL IO WP EP	ATL IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	IO WP	ATL MED
	%F (prey frequency)	ATL MED IO WP EP	ATL IO WP EP	ATL IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL IO WP EP	ATL IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	IO WP	ATL MED
	%N (prey in numbers)	ATL MED IO WP EP	ATL IO WP EP	ATL IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL IO WP EP	ATL IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	IO WP	ATL MED
	%W (prey in weight	ATL MED IO WP EP	ATL IO WP EP	ATL IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL IO WP EP	ATL IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	IO WP	ATL MED
	%IRI (index of relative importance)	ATL MED IO WP EP	ATL IO WP EP	ATL IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL IO WP EP	ATL IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	IO WP	ATL MED
	Isotopes N^{15} /C^{13}	ATL MED IO	ATL IO	ATL IO	ATL MED IO	ATL MED IO	ATL MED IO	ATL IO	ATL IO	ATL MED IO	ATL MED IO	IO	ATL MED

		WP EP	WP EP	WP EP	WP EP	WP EP	WP EP	WP EP	WP EP	WP EP	WP EP	WP	
	Trophic level	ATL MED IO WP EP	ATL IO WP EP	ATL IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL IO WP EP	ATL IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	IO WP	ATL MED
Habitat		ATL MED IO WP EP	ATL IO WP EP	ATL IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL IO WP EP	ATL IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	IO WP	ATL MED
Contaminants		ATL MED IO WP EP	ATL IO WP EP	ATL IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	ATL IO WP EP	ATL IO WP EP	ATL MED IO WP EP	ATL MED IO WP EP	IO WP	ATL MED

Fishery indicators – Stock Assessment

Data availability

Most of the data is coming from logbooks which may complicate the data gathering process for shark assessment by issues of mis-identification, under-reporting, and potential, unidentifiable changes in the targeting practice. The lack of relevant information needed to undertake extrapolations could prevent accurate shark estimates. Many reports lack species-specific data and reports from some of the world's leading shark fishing nations lack even aggregated annual catch data. Assumptions are made to reconstruct the catch time series and stock status is highly uncertain and insufficient to give quantitative advice based on it.

Observer data provide the best source of catch and effort data for shark assessment but coverage is low and may not be representative of all areas where sharks are caught.

Data on shark catches from recreational fisheries, can be useful indices of abundance, particularly when commercial data are lacking. The availability and usefulness of these and other recreational data sets has not as yet been investigated in detail.

Market data for shark fin have been used to estimate total shark catches by species for the Western Central Pacific Ocean but are unlikely to provide additional useful information for shark assessments. Shark landings data appear very limited and are likely to be uninformative due to unknown rates of discarding at sea.

Data resolution

There are several series of abundance indices from few countries for few major species such as blueshark, shortfin mako, silky and oceanic whitetip sharks (see Phase I report). There is less knowledge for the rest of species.

Data access

See data access sections a-c above.

Research

Data known to exist are not currently available for use in the assessments. There is no coordinated source of information on fishery statistcis, CPUE analysis, tagging data for key shark species and results have often not been published.

Mandatory data requirements

Actions and measures for the conservation, management, data collection and research of shark fishery were adopted and applied by RFMOs and countries/entities (see table 4.2.1 and Phase I report).

Conservation and Management

Plan of action for sharks: The full development and implementation of National Plans of Action for sharks is carried out in few countries of RFMOs. In some countries a draft is developed but not yet approved. In other countries there is no information available on the status of development of NPOA (Table 4.2.3).

Table 4.2.3.- National shark action plans and shark fin bans in major shark fishing countries (production data from FAO Figis).

Countries	RFMOs	Average production (t/year) 2000-2010	Production trend	NPOA	Remarks	Shark fin ban
UE (27 countries)	ICCAT – IOTC - GFCM – IATTC - WCPFC	125 291	decline	Yes (2009)	UEPOA	2003 rev. 2013
Indonesia	IOTC	106 288	decline	Yes (2010)		No
India	IOTC	74 008	variable	In prep		No
Spain	ICCAT – IOTC - GFCM – IATTC - WCPFC	61 760	increase	Yes (2009)	UEPOA	2003 rev. 2013
Taiwan	IATTC - WCPFC	48 853	decline	Yes (2006)		Yes
Argentina		35 975	increase	Yes (2009)		Yes
Mexico	ICCAT - IATTC	34 018	increase	Yes (2004)		Yes
USA	ICCAT – IATTC - WCPFC	31 860	increase	Yes (2001)		Yes
Pakistan	IOTC	28 629	decline	No		No
Malaysia	IOTC	23 133	decline	Yes (2006)		No
Japan	ICCAT – IOTC - GFCM – IATTC - WCPFC	22 973	decline	Yes (2001)	Revised 2009	No
France	ICCAT – IOTC - GFCM – IATTC - WCPFC	21 270	decline	Yes (2009)	UEPOA	2003 rev. 2013
Brazil	ICCAT	20 540	stable	In prep.		No
Thailand	IOTC	19 683	decline	In prep.		No
New Zealand	WCPFC	17 879	stable	Yes (2008)		Yes
Sri Lanka	IOTC	17 479	decline	In prep.		No
Portugal	ICCAT	16 365	increase	Yes (2009)	UEPOA	2003 rev. 2013
Nigeria	ICCAT	15 309	increase	No		Yes
Iran	IOTC	13 906	decline	No		No
Korea	ICCAT – IOTC – IATTC - WCPFC	12 242	stable	Yes (2011)		No
UK	ICCAT – IOTC	11 828	decline	Yes (2009 /2011)	UEPOA	2003 rev. 2013
Canada	ICCAT - WCPFC	10 322	decline	Yes (2007)		Yes
Peru	IATTC	9 944	variable	Yes (2009)		No
Yemen	IOTC	9 577	decline	No		Yes
Australia	IOTC - WCPFC	9 225	decline	Yes (2004)		Yes (3 miles)
Senegal	ICCAT	8 692	variable	Yes (2005)	PSRA of CSRP	No
Venezuela	ICCAT - IATTC	8 536	increase	Yes (2006)		Yes
Costa Rica	IATTC	7 104	decline	No		Yes
Chile		4 824	decline	Yes (2006)		Yes

Panama	ICCAT - IATTC	4 751	decline	Yes (2006)		Yes
Uruguay	ICCAT	4 193	decline	Yes (2008)		
Ghana	ICCAT	3 256	increase	No		
Ecuador	IATTC	3 076	increase	Yes (2005)		Yes
South Africa	IOTC	2 725	increase	Yes (2012)		
Sierra-Leone	ICCAT	1 768	variable	Yes (2005)	PSRA of CSRP	No
Mauritania	ICCAT	1 564	increase	Yes (2005)	PSRA of CSRP	No
Gambia	ICCAT	1 483	decline	Yes (2005)	PSRA of CSRP	No
Guinea Conakry	ICCAT	1 137	decline	Yes (2005)	PSRA of CSRP	No
Belize	ICCAT – IOTC - IATTC	717	increase	No		Yes
Columbia	IATTC	424	decline	No		Yes
Nicaragua	IATTC	285	stable	No		Yes
Seychelles	IOTC	230	stable	Yes (2007)		Yes (foreigners)
Guatemala	IATTC	186	stable	No		Yes
Sweden		171	decline	Yes (2004)		Yes
Guinea Bissau	ICCAT	5	stable	Yes (2005)	PSRA of CSRP	No
Cape Verde	ICCAT			Yes (2005)	PSRA of CSRP	No
UNEP – RAC / SPA				Yes (2003)	Mediterranean	
68 countries **3 entities**		742 260 t 91% total production	22 decline 11 increase 7 stable 3 variable	29 NPOA 4 in prep. 10 No NPOA		21 bans

Cooperative actions: Countries are encouraged to cooperate regionally and sub-regionally in capacity building efforts through RFMOs to support the implementation of recommendations and resolutions.

Reporting requirements: Countries are required to report all catches of sharks, including available historical data according to data reporting procedures of specific RMFOs (see Table 4.2.4). Particular reporting requirements apply to shark species in each region. Countries are also urged to report in steps taken to improve data collection and revision on actions taken.

Table 4.2.4.- Summary of management measurement in relation to shark in Tuna RFMOs (GFCM adopts ICCAT resolutions).

Management Requirement	IATTC	ICCAT	IOTC	WCPFC
Report catch	C 05-03	Res 04-10	Res. 05-05	CMM 10-07
Full utilisation of shark	C 05-03	Res 04-10	Res. 05-05	CMM 10-07
No more fins than 5 % ratio	C 05-03	Res 04-10	Res. 05-05	CMM 10-07
Mitigation research	C 05-03	Res 04-10	Res. 05-05	Rec. 05-03
Reporting in logbooks	C 03-05	Rec 07-06	Res. 08-04 & Res. 10-03	Rec. 05-03
Observers	C 11-08	Rec 11-10	Res. 11-04	CMM 07-01 CMM 12-01
Prohibition of retention				
Thresher sharks		Rec. 09-07	Res. 12-09	
Oceanic whitetip shark	C 11-10	Rec. 10-07		CMM 11-04
Hammerhead sharks		Rec. 11-08		
Silky sharks		Rec. 11-08		
Prohibition of setting on whale sharks				CMM 12-04

Shark fin: Countries are required to fully utilize retained catches of sharks and a 5% fin-to-body weight ratio for shark onboard vessels up to the first point of landing or transshipment.

Discard: In fisheries for tunas and tuna-like species that are not directed at sharks, the live release of incidentally caught sharks is encouraged, especially juveniles, that are not used for food and/or subsistence is encouraged. Unharmed release and report is required for silky shark, ocean whitetip shark and bigeye thresher shark.

Survival rate: Countries are encouraged to adopt additional measures to increase survival rate of incidental caught shark individual by gear.

Prohibited species: Fishing, landing and trade of hammerhead shark, shortfin mako shark, thresher shark, Bigeye thresher shark and ocean whitetip shark is prohibited depending on the region (see Table 4.2.4). Coastal countries exempted for prohibition are encouraged to adopt necessary measures to ensure individuals will not enter international trade. In some cases, not reporting in accordance shall prohibit from retention species until data is received.

Identification guides: Countries are encouraged to develop complete identification guide for species to be used whether by observers and fishermen.

Observer program: Countries within IOTC are encourage to coverage at least 5% of the number of operations/sets by gear and fleet for vessels above 24m and vessels below 24m fishing outside EZZ of their flag states. Artisanal fishery is urged to progressively increase the coverage towards 5% of the total activities. In IATTC, 100 % for PS and 5 % for LL is mandatory while it is mandatory for 100 % PS and 20 % in WCPFC. Similarly, in ICCAT member states should implement observer programs (see previous section).

Data collection and research

Recording system: Countries within Tuna RFMOs are subject to data recording system. Logbook minimum data is required by gear and in various Tuna RFMOs the inclusion of varios shark species in the logbooks is mandatory. Tuna RFMOs Member Countries are encouraged to alternative monitoring measures to collect bycatch and discard data for artisanal fishery.

Stock assessment: Countries are requested to report on their shark catches, effort by gear type, landings and trade of shark products available for further evaluation and advice on the stock status of key shark species. Countries are encouraged also to propose a research plan to improve the knowledge for a comprehensive assessment of these stocks and to recommend management alternatives for shark species.

Assistance: Countries are encouraged to assist developing countries on data collection issues.

Gears: Countries shall, where possible, undertake research to identify ways to make fishing gears more selective and to develop strategies for the avoidance of unwanted shark captures.

Nursery areas: Countries are encouraged to undertake research to identify shark nursery areas for hammerhead shark, threser shark and bigeye thresher shark.

4.2.3 Summary of data gaps

Catch and Effort

- There is a scarcity of data and limited data availability for major fleets and countries in Tuna RFMOs specially for historic time period.
- In many cases, recorded catches represent retained catches rather than life catches.
- Most of the shark catches are not recorded by gear and/or species. The catches of sharks are not disaggregated at the required level for each species by area or fleet.
- Mis-identification of shark species is also common onboard which make difficult the inclusion of accurate data in the logbooks. The identification of sharks in port is usually compromised by the way in which the different species of sharks are processed before landed.
- Most of the data is coming from logbooks which may complicate the data gathering process for shark assessment by issues of mis-identification, under-reporting, and potential, unidentifiable changes in the targeting practice.

Discards

- There is scarce discards data, incomplete and no homogenous: some countries report discards weight while others provide discard numbers.
- Low coverage of observer programs

Length frequencies

- Little information about the catch-size for sharks species bycaught is available.

Biology

- Among the sharks, the species whose biology is best known are the following: the tope shark *Galeorhinus galeus*, the silky shark *Carcharhinus falciformis*, the shortfin mako *Isurus oxyrinchus* and the blue shark *Prionace glauca*. These are common shark species caught in the pelagic fisheries, and are commercial species.
- Shark species whose biology is poorly known are the following: the crocodile shark *Pseudocarcharias kamoharai*, the longfin mako *Isurus paucus*, and the pelagic thresher shark *Alopias pelagicus*. Those species are thought to have low productivity and high susceptivility to fishing gears based on Ecological Risk Assessment done in various Oceans (Cortes et al., 2012; Murua et al., 2012). Even the biology of the popular great white shark *Carcharodon carcharias*, needs to be better studied with regard to its reproduction and diet.
- For the biological parameters, the main need is getting accurate diet analysis for most of the selected species. The parameters related to "age and growth" are best known for the shark populations of the western Pacific, then for those of the Atlantic. In general, the reproduction parameters are better known; however, available data often concern the species as a whole, thus data for regional populations are lacking.

- In general, the biology of rays is much less known than that of sharks, even for the basic parameters such as the maximum weight and the most common conversion factors. For example, the biology of the charismatic species like the manta rays is still largely unknown.
- This compilation shown that biological data are more numerous than thought, however they are heterogeneous and concern mainly the most valuable species for the markets. Also, this compilation pinpoints the gaps in scientific knowledge to be filled up to take or improve management measures for these species.

Conservation status

- Table 4.2.5 shows a summary of conservation status of all the species investigated using different conservation organization criteria.

Table 4.2.5.- Conservation status and measures for the selected pelagic shark and ray species.

FAO code	Scientific name & English name	IUCN Red List GlobaL	IUCN Red List Regional	CITES	CMS	Barcelona Convention	UE regulations	ICCAT	IOTC	IATTC	WCPFC	GFCM
PTH	*Alopias pelagicus* Pelagic thresher	VU (2009)	NT : ECP VU : NWA&WCA VU : MED NT : NEA				P	P	P			P
BTH	*Alopias superciliosus* Bigeye thresher	VU (2009)	EN : NWA & WCA DD: MED VU : NEA NT : SWA VU : ECP VU : IWP				P	P	P			P
ALV	*Alopias vulpinus* Thresher shark	VU (2009)	NT : NEA VU : MED				P	P	P			P
FAL	*Carcharhinus falciformis* Silky shark	NT (2009)	VU : ECP & SEP VU : NWA & WCA NT : NEA NT : SWA NT : IO & WCP				P	P				
OCS	*Carcharhinus longimanus* Oceanic whitetip shark	VU (2006)	CR : NWA & WCA VU : NEA	App. II (2013)			P	P		P	P	
TIG	*Galeocerdo cuvier* Tiger shark	NT (2009)	NT : NEA									
BSH	*Prionace glauca* Blue shark	NT (2009)	VU : MED									
WSH	*Carcharodon carcharias* Great white shark	VU (2009)	VU : NEA EN : MED	App. II (2005)	App. I & II + MoU	App.II	P					
BSK	*Cetorhinus maximus* Basking shark	VU (2005)	EN : NEA (2009) EN : NP (2009)	App. II (2003)	App. I & II + MoU	App.II	P					
SMA	*Isurus oxyrinchus* Shortfin mako	VU (2009)	VU : NEA CR : MED NT : ENP VU : IWP		App. II + MoU	App. II (2012)						
LMA	*Isurus paucus* Longfin mako	VU (2006)	VU : NEA		App. II + MoU							
POR	*Lamna nasus* Porbeagle	VU (2006)	CR : MED CR : NEA EN : NWA	App. III UE (2012) Proposed App. II Cop16 (2013)	App. II + MoU	App. II (2012)	P					
PSK	*Pseudocarcharias kamoharai* Crocodile shark	NT (2005)										
RHN	*Rhincodon typus* Whale shark	VU (2005)		App. II (2004)	App. II + MoU		P					
SPL	*Sphyrna lewini* Scalloped hammerhead	EN (2007)	EN : ECP & SEP VU : ECA EN : NWA & WCA VU : SWA EN : WIO	App. II (2013)		App. II (2012)	P	P				P
SPK	*Sphyrna mokarran* Great hammerhead	EN (2007)		App. II (2013)		App. II (2012)	P	P				P
SPZ	*Sphyrna zyganea* Smooth hammerhead	VU (2005)	NT : NEA VU : MED	App. II (2013)		App. II (2012)	P	P				P
GAG	*Galeorhinus galeus* Tope shark	VU (2006)	DD : NEA VU : MED CR : SWA LC : ENP			App. II (2012)	LL P					
	RAYS											
PLS	*Pteroplatytrygon violacea* Pelagic stingray	LC (2009)	NT : MED									
RMA	*Manta alfredi* Alfred manta	VU (2011)		App. II (2013)								
RMB	*Manta birostris* Giant manta	VU (2011)		App. II (2013)	App. II & II + MoU							
MAE	*Aetobatus narinari* Spotted eagle ray	NT (2006)										
MRJ	*Rhinoptera javanica* Javanese cownose ray	VU (2006)										
MRM	*Rhinoptera marginata* Lusitanian cownose ray	NT (2009)	NT : NEA									

IUCN categories		Geographical regions			
LC	Least concern	ECP	Eastern central Pacific	NEA	North eastern Atlantic
NT	Near threatened	ENP	Eastern north Pacific	NWA	North western Atlantic
VU	Vulnerable	IO	Indian Ocean	SEP	South eastern Pacific
EN	Endangered	IWP	Indo-West Pacific	SWA	South western Atlantic
CR	Critically endangered	MED	Mediterranean Sea	WCA	Western central Atlantic

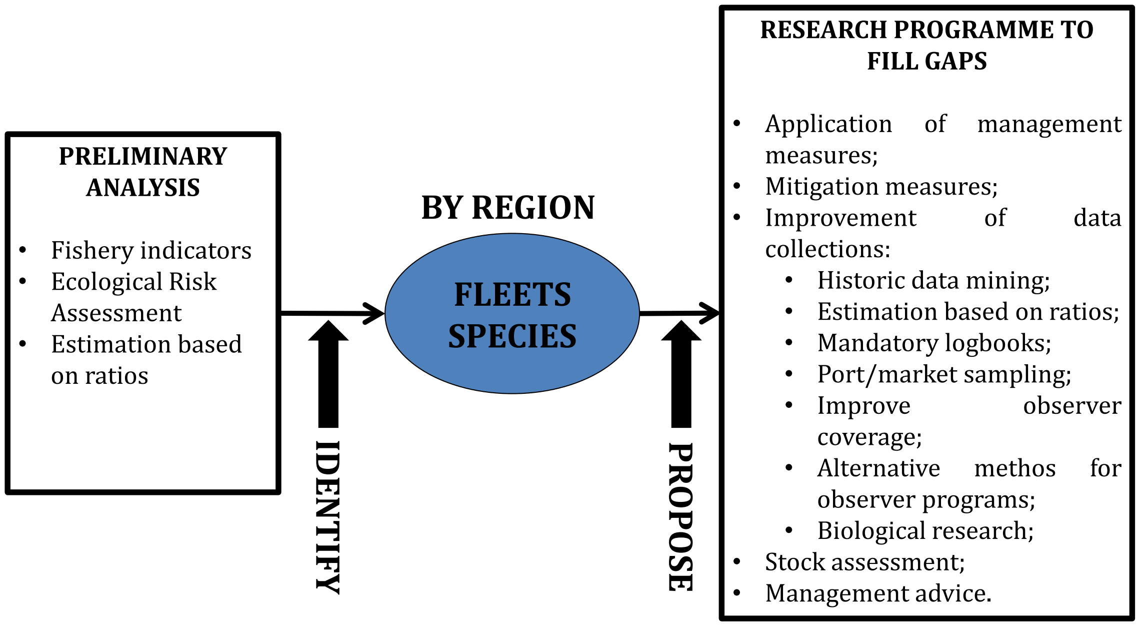
4.2.4 Solutions and recommendations: Desing of research program and priorities

Although there are gaps of data stock assessment for sharks have been and are being attempted in all Tuna RFMOs in response to growing concerns over the conservation status of pelagic shark species. Those assessments can be based from simple fishery indicators, to more complex semi-quantitative Ecological Risk Assessment, to full stock assessments. However, as mentioned above, several gaps in data and information make difficult to obtain reliable and accurate stock status assessment to formulate sound scientific advice.

The review of existing information as well as the identification of information gaps, main shark species impated and main métier responsible for major shark catch presented above provides the basis for development of a research program and priorities for the assessment of the status of sharks in Tuna RFMOs. As it is not possible to develop a research program for all the Tuna RFMOs here, the following sections are structured (i) to offer a framework to identify the main species and fleets that needs to be prioritized for the collection of fishery data and information in order to assure the assessment of principal shark species regionally in the Tuna RFMOs, (ii) to provide general recommendations for all Tuna RFMOs to improve the data collection to fill the gaps identified above, and (iii) options for management and mitigation measures for sharks.

Research Program Framework

The framework is proposed to organized in three steps: (i) estimation of shark catches by species using the method proposed here which will allow identifying the most impacted shark species and the métier most affecting those species; (ii) to carry out a preliminary Ecological Risk Assessment (or other preliminary assessment based on fishery indicators) by fleets which will allow to identify the most vulnerable species to focus the on in conjunction with point (i); and (iii) to propose specific recommendations of how to apply possible management measures, to improve data collection and assessment of those species/fleets identify as priorities in point (ii) and (iii). The implementation of the three steps is highly related and can be summarized in the figure below.



As indicated above data gaps are the main constraints to assess shark species population and the improvement of data for shark species (point iii) collected should be the ultimate goal of the research program aiming to provide a sound formulation of scientific advice. Following the work conducted in the WCPFC (Clarke and Harley 2010, Clarke 2011a), we propose hereafter a framework in order to improve data collection for main shark species/fleets. This process may be qualified as:

- **Species oriented** because at the end it is expected to have data with required level of precision on a particular shark species which will allow assessing fishing impact on its population;
- **Fishery/métier** based because the impact is different by métier, data collection has specific operational constraints and are set in place on a fishery/métier basis;
- **RFMO** based because situations are different regionally.

The 3 step framework or process can described as follows (see figure above):

1. **Define the priority level for shark species/fleets.**

   ✓ Estimation of shark catch by species and fleets based on ratios: this will allow identifying highly impacted species and the fisheries impacting most the priority species by region.

2. **Identify most vulnerable species/métier impacting:**

   ✓ Status of the stock:
      i. Fishery indicators;
      ii. Ecological Risk Assessment rank with high vulnerability to a given gear;
      iii. Identified as at risk by other managing systems (CITES, etc.).

At the end of 2 first steps, a list of priorities for species and fleets is established.

- ✓ For species listed and for which data required for assessment are available, assessment should be conducted;
- ✓ For species suffering data gaps in specific and/or major fleets identified in step 1 the third step is proposed specifically to improve data collection.

3. The final step is **defining a research program for species by métier** to improve the data quality for the assessment. This research strategy would guarantee that data collection is adequate for the most priority sharks species impacted by the major fisheries/métier. The research program should be a combination of improvement of data collection through logbooks, observer programmes including alternative method such as autosampling and/or videomonitoring, biological research, mitigation research, etc. This step does not preclude taking management actions based on the results of step 1 and 2. The research program should answer, for example, the questions below and try to take actions to improve the data collection:

- ✓ Is the information of the priority species included in the mandatory requirement for collection fishery data in the logbooks for the main fleets?
- ✓ Are logbook data presently collected appropriate? Which potential improvements and operationally feasible? How is the misidentification problem for the species in question? Are identification guides available in the regions?
- ✓ Are observer data appropriate in terms of precision at the coverage which is presently mandatory? Which coverage level would be required?
- ✓ How to insure adequate biological information availability (Size, sex, weight)?

The species and fleets identified in step 1 and 2 should be the focus of the following actions:

- ✓ Application of some management measures (e.g. prohibition of retention);
- ✓ Identification of mitigation measures;
- ✓ Improvement of data collections:
    - o Historic data mining;
    - o Estimation based on ratios from observer programs;
    - o Inclusion of the species in the mandatory requirements for the logbooks;
    - o Improve observer coverage including alternative methos for observer programs (e.g. selfsampling, electronic monitoring);
    - o Biological research;
- ✓ Stock assessment and management.

General Recommendations

Data collection

1. Define key shark species based on empirical evidence of interaction between species and fisheries, e.g., observer records and other scientific records, ERAs, estimates of total catch, evidence of targeting, listing on international instrument of conservation/management).
2. Enlarge observer coverage to be representative of all areas where sharks are caught and all gear that catch sharks.
3. Research and training cruise data to avoid many of the biases of logbooks data
4. Data from recreational fisheries and market may provide important supplementary data.
5. Encourage CMMs to identify opportunities for rescue of historical shark data.
6. Request CCMs to investigate their own data holdings for sharks and report to the Commission regarding the existence and availability of useful data.
7. Implement new procedures to collect more meaningful shark data.

Data report:

8. Agreement on a data collection and reporting logsheet format
9. Review logsheet formats to confirm they allow and facilitate the recoding of all key sharks
10. Review procedures for hadling non-species specific shark logsheet data

Data resolution:

11. Systematic revision for those species that is doubtful.
12. Cross checking the validity/discrepancies of the data reported.
13. Complete identification guides distributed among different agents dealing with shark issue, e.g., fishermen, scientist, managers, etc.
14. Encourage further research into key shark species whose presence in fisheries and whose biology are less well understood
15. Coordinate information characterize tagging data for sharks.

Data access:

16. Continuing access to datasets pursued if possible.

Assessment

17. Annual fishery indicators for species which do not currently appear to have sufficient data calculated as group.

Management Measures

Management measures are essential when a given stock is seriously affected by the fishing activity and are aimed at limiting the impact of this activity. The election of a measure will depend on the stock status, on the behavior of the species, on the species being target or not, etc.

The main problem for pelagic shark's management is that there are few targeted fisheries. Sharks are mainly caught as bycatch of longline fisheries targeting tropical tuna, swordfish, or other species. As for the purse seine, shark catches have no commercial value and fish are usually discarded. Therefore, management measures have not been focused on shark species so far, but to the target species of those fisheries in which they are caught.

In the following section some of the potential management measures for sharks may include:

1. Spatial/temporal closures

Time and/or area closures have been widely used as management measures to prevent overfishing and to protect certain marine habitats. Although there are very few examples on the use of this kind of measures to reduce shark bycatch, the development of protected areas or time closures, focused on shark "hot spots" or in critical habitats (e.g. nursery grounds) have great conservation potential. A measure of this kind must take into account the effect of effort reallocation to adjacent areas, as well as the possible reduction in target species catch.

As an example, in the eastern Pacific, Watson et al. (2008) examined the spatial distribution of silky shark and modeled the effect of area closures over target and bycatch species. These authors found bycatch of juveniles was consistently higher north of the equator, and found potential areas whose closure would reduce silky shark bycatch by 33%, while compromising only 12% of the total tuna catch.

The control of this kind of regulations can be easily enforced in industrial fisheries (thanks to VMS systems), but not in artisanal fleets (smaller vessels without VMS systems implemented).

2. TACs

Total allowable catches (TACs) are catch limits that are set for most significant commercial fish stocks, and is widely used as the main management measure for several exploited stocks. Although sharks are mainly caught as bycatch, there are fisheries directly targeting sharks, and others which actually catch more sharks than their targeted species. In the case where the productivity of the stocks and the impact of the fisheries can be adequately assessed, the establishment of TACs can ensure these populations are kept at levels that do not significantly affect their productivity.

The main inconvenient of TACs is the difficulty in the estimation of total catches, especially in those fisheries where sharks are processed on board. Other problem with

TACs is the control of the catch levels in non-directed fisheries, where sharks are often discarded, unless there is significant observer coverage.

3. No retention polices

One of the conservation and management measures for sharks adopted by IATTC and WCPFC (for oceanic whitetip sharks), by ICCAT (for bigeye thresher sharks, oceanic whitetip sharks and hammerhead sharks) and by IOTC (for all thresher sharks) is a prohibition on retaining any part or whole carcass of these species. Some of these conservation and management measures also specify that these sharks should promptly be released unharmed when caught.

Using observer data on shark condition and fate to compute expected mortality by species under various mitigation scenarios, an SPC- OFP analysis estimated that “no retention” policies would reduce mortality to 30-60% of current levels (depending on species) and that requirements for prompt release unharmed may secure an additional 10-20% reduction in mortality for certain species including oceanic whitetips (Clarke 2011b).

This measure is probably the most efficient for the most threatened species (increase in survival rates) and can be easily controlled, although identification can be problematic when the catches are processed on board.

4. Finning

Finning is the practice of slicing off fins and dumping carcasses at sea. This practice is due to a combination of factors, mainly the limited on-board storage space and the much higher value of shark fins (for shark fin soup), in comparison to the carcass. It is therefore economically advantageous to discard the bulky shark bodies while retaining the fins, which can be sun dried and easily stored. It implies there is practically no storage constraint and greatly increases the threat to sharks.

Although shark finning has been banned in the four main tuna RFMOs, discussion is now focused on the enforcement of this regulation. Due to the problems of storage, most of the current measures allow for a 5% shark fin to carcass ratio on board, but this ratio highly depends on the fin usage, on the species and on the way the carcass weight is computed (whole, dressed…), and can lead to finning going undetected.

On 22 November 2012, the European Parliament voted for the prohibition on the removal of fins on board vessels. This means all sharks caught by EU vessels anywhere in the world shall be landed with their fins naturally attached to the body. Endorsement of this vote by the EU fisheries ministers is still pending.

Fate

For effective management measures to be implemented (e.g. no retention polices), it is beneficial to have accurate estimates of both at-vessel and post-release mortality rates. These data are necessary for estimating total fishery-induced mortality and for improving stock assessments. In addition, mitigation strategies could then be given special consideration for species with high rates of postrelease mortality (Carruthers et al., 2009).

For the main fishing gears: tuna and swordfish longline, bottom longline, tropical tuna purse seine and recreational fisheries, these two indicators have been estimated and assessed using different methodologies; retention in cages, acoustic tracking; pop up archival tags in some cases combined with hematological profiling, models using results of conventional tag recapture or risk-based approach. It is important to highlight the fact that the postrelease mortality rates inferred from two types of studies; the first ones were clearly devoted to estimate this parameter with dedicated experimental protocols while in the other cases, the main purposes were to provide information on horizontal movements and habitat preferences; the data recorded by pop up satellite tags were secondarily used for this estimation.

In the case of longline fishing gear, at-vessel mortality also called hooking mortality, at hauling or at gear retrieval, as well as the post-release mortality of sharks are closely related to fishing practices. These include a number of different aspect, such as: hook type, time spent hooked on the line, fight time, leader material, fish size, and handling and discard practices can influence the at-vessel and post-release mortality of pelagic shark species. It appeared also that the fraction of sharks found dead during gear re-trieval was species-specific and size classes-specific within species. The at vessel mortality for blue sharks in the swordfish fisheries range from 13.2% to 51% (13.2%, (Beerkircher et al., 2009) and was 14.3%; (Coelho et al., 2012); 16% (Campana et al., 2009) and 51% (Poisson et al., 2010) in different studies. In the tuna fisheries or mixed swordfish/tuna fisheries, the mortality at hauling for blue sharks are lower and range from 0% to 13% (Boggs, 1992; Francis et al., 2001; Morgan and Burgess, 2007). The post released mortality for blue shark is about 19% in the commercial swordfish fishery, while it range from 0 (Moyes et al., 2006) to 12.5% (Stevens et al., 2010) in experimental fishing conditions. The high values for the mortality rates (mortality at vessel: 67% and post-release mortality: 82%) in the tropical tuna purse seine fishery reflect the harsh conditions encountered by sharks during the fishing process. Like in the longline fisheries, gillnets capture restricts mobility and causes exhaustive anaerobic exercise. The typical duration of commercial fishing can exceed 20 h. The mortality rates are high in the case of pelagic sharks (Braccini et al., 2012).

In the particular case of thresher sharks caught by the California recreational fishery that commonly typically captures individuals by hooking them in the caudal fin, the overall post-release mortality is estimated of 26% . This technique reduces the ability for forward locomotion and the capacity for ram ventilation and the fight duration can exceed 85 min.

The review focused on studies dealing with estimate of elasmobranchs mortality of discarded sharks in fisheries targeting tuna and tuna-like species. For each study, the following information was recorded: (1) study location and origin of the data; (2) objective of the study; (3) gear type ; results on at-vessel mortality per species; (4) the main results of the study; (5) mitigation measure proposed if any.

The main results of the review of studies dealing with these issues are presented in the table titles "*Review of the information on at-vessel and postrelease mortality estimated onboard longliners, purse seiners and gillnets in various Oceans*".

Review of the information on at-vessel and post-release survival (PRS) estimated onboard longliners, purse seiners and gillnets in various fisheries.

Fishery /data	Objectives of the study	Gear type (hook, light attractor)	At-vessel mortality	Post-release survival (PRS)	Management implication	Other results	References
Canadian pelagic longline swordfish fishery in the northwest Atlantic Ocean	(1) To estimate at-vessel mortality of blue sharks; (2) to test the value of archival satellite pop-up tags as indicators of postrelease mortality in discarded blue sharks; (3) to estimate post-release mortality rate (4) to infer the implications of discard mortality rates on overall fishing mortality of blue sharks in the North Atlantic.	Circle hooks (size 16/0) are the most common hook type used in this fishery followed by J-hooks and offset J-hooks, either 8/0 or 9/0 . Offset J-hook	Blue shark: 12-13%	40 pop up tags deployed: 95% of the blue shark post-release mortality occurred within 11 days after fish release, indicative of death by trauma rather than starvation Estimated PRS for Blue shark: 81%	Propose to incorporate Dead discard estimates into ICCAT shark assessments. this would substantially increase estimates of fishing mortality, and could potentially change the perspective of population health.	Overall blue shark bycatch mortality in the pelagic longline fishery was estimated at 35%, the blue shark had decreasing odds of hooking mortality with increasing specimen size Recovery behaviour for a period of 2 to 7 d after release. Blue shark noted that the survivorship of sharks landed in an apparently healthy condition was likely to be high	(Campana et al., 2009)
Portuguese pelagic longline swordfish fishery in the Atlantic Ocean	(1) To predict at-vessel mortality of blue sharks (2) to identify and interpret variables that significantly influence this mortality rates.	Fishing depth 20-50m Stainless steel J-hooks baited either with squid (Illex spp.) or mackerel (*Scomber spp.*), Gear setting at 17:00 Hauling time at 06:00	Blue shark: 13.3%	None	The prediction model for this fishery could be taken into account by the fisheries management organizations for assessing the efficacy of management and conservation initiatives for sharks species	At-vessel defined for 15 species and 2 groups of species blue shark sizes are important predictors for estimating at-haulback mortality rates, with the probabilities of dying at-haulback decreasing with increasing specimen sizes.	(Coelho et al., 2013)
Commercial longliners targeting swordfish in the Atlantic Ocean: observer data	(1)To present species-specific proportions of at-vessel mortality (2) to explore relationships between the at-vessel mortality and some possible explanatory variables	Steel J-style hooks, squid (Illex spp.) or mackerel (Scomber spp.) for bait	Blue shark : 14.3% Crocodile shark : 13.3% Shortfin mako: 35.6% Bigeye thresher: 50.6% Pelagic stingray : 1% Smooth hammerhead :71% Silky shark : 55.8% Oceanic whitetip : 34.2% Longfin mako:30.7% Mantas & devil rays : 1.4% Tiger shark : 2.9% Tope shark : 0% Scalloped hammerhead : 57.1% Eagle rays:0% Bignose shark: 60% Porbeagle: 30% Common Thresher: 66.7% Great hammerhead: 0%	None	New information on the impacts of this longline fishery on pelagic elasmobranches can now be incorporated into further stock assessment models, including ecological risk assessment analysis. Discarding practices must be assessed at a species-specific level. This measure seem to be largely inefficient for some of the species (e.g., smooth hammerhead), but seem to be more efficient, for example, for the oceanic whitetip, where a higher proportion of the specimens captured are discarded alive.	At-vessel defined for 15 species and 2 groups of species. mortality the blue shark and shortfin mako had decreasing odds of hooking mortality with increasing specimen size. The soaking time, significant variable not been considered in this study.	(Coelho et al., 2012)

Review of the information on at-vessel and post-release survival (PRS) estimated onboard longliners, purse seiners and gillnets in various.

Fishery /data	Objectives of the study	Gear type (hook, light attractor)	At-vessel mortality	Post-release survival (PRS)	Management implication	Other results	References
Reunion-Island based commercial longliners targeting Swordfish in the Indian Ocean	(1) To investigate the performance of the domestic longline fishery at Réunion Island with regard to several variables (2) to investigate the at vessel mortality rates of large pelagic fish	Steel J-style hooks, squid (Illex spp.) spp.) for bait	Blue shark: 51% oceanic whitetip:59%	None	Reducing the soaking period would increase the number of sharks released alive. catch-and-release in longline fisheries can be a viable management tool to biomass in shark populations Reconsider the use of Chemical Lightsticks as suspected to attract sea turtles in the vicinity of longlines And constitute a potential toxicant to marine flora and fauna.		(Poisson et al., 2010)
Commercial swordfish, and tuna, pelagic longline fleet off the Southeastern United States	To quantify and describe the patterns of shark bycatch in a major U.S. pelagic fishery Magnitude of shark bycatch, and the distribution, relative abundance, and characteristics of shark populations	(size 7/0–11/0) hook depths varying from 35 to 60 m Vessels targeting swordfish generally set gear around sunset and haulback around dawn, use chemical light sticks attached near the hooks, and use mackerel or squid for bait	Silky shark : 66.3% Dusky shark: 48.7% Night shark: 80.8% Blue shark: 12.2% Tiger shark : 3% Scalloped hammerhead : 61% Oceanic white tip: 27.5% Rays:0% Sandbar shark: 26.8% Bigeye thresher: 53.7% shortfin mako:35%	None	For several of the observed species, examination of catch status suggests that bycatch mortality is not prevented by retention prohibitions. The sharks population may have benefit of the areas closures proposed to protect undersized swordfish	The characteristics of sharks using the pelagic habitat off the southeastern United States vary greatly depending on the species, year, and season.	(Beerkircher et al., 2002)
Commercial longliners targeting either Swordfish or Swordfish and tuna in the Atlantic Ocean: observer data	To explore relationships between the at-vessel mortality and some possible explanatory variables	Not specified	Blue shark: 31%	None	Shortening longline set duration would be difficult to implement because of the negative economic impacts unacceptable to the industry Use a hook domed-shape selectivity function for the assessment to incorporate the size-based survival information obtained in the study	Set duration has a moderate impact on the largest size classes, the proportion of live sharks <185 FL(immature) is considerably reduced even at relatively short set durations. the blue shark had decreasing odds of hooking mortality with increasing specimen size.	(Diaz and Serafy, 2005)

Review of the information on at-vessel and post-release survival (PRS) estimated onboard longliners, purse seiners and gillnets in various.

Fishery /data	Objectives of the study	Gear type (hook, light attractor)	At-vessel mortality	Post-release survival (PRS)	Management implication	Other results	References
Research cruise targeting swordfish in the Pacific Ocean	(1) Estimate at vessel mortality for major shark species and Post –release mortality for 5 shark species (2)To investigate vertical movement pattern	16/0 and 18/0 ; circle hooks ; no offset ; pacific saury for bait soaking time: 10-24h	Blue shark: 5.9% Crocodile shark: 66.7% Ocanic whitetip: 5.3% Shortfin mako: 0% Silky shark :11% Bigeye thresher:25% Pelagic thresher shark:35.7%	Estimated with 16 pop-up tags only for one species : Blue shark : 6.3% One individual died after 7 days	Catch-and-release in longline fisheries can be a viable management tool to protect parental biomass in shark populations Furthermore, information on the temporal and spatial vertical distribution patterns and community structure of pelagic species can assist in the formulation of management strategies to modify fishing gear, and thus reduce bycatch.	Pelagic species can be separated into three broad groups based on daytime temperature preferences: 1) epipelagic species (silky and oceanic whitetip sharks), which spent >95% of their time at temperatures within 2°C of sea surface temperature; 2) mesopelagic-I species (blue sharks and shortfin makos, which spent 95% of their time at temperatures from 9.7° to 26.9°C and from 9.4° to 25.0°C, respectively; 3) mesopelagic-II species (bigeye threshers), which spent 95% of their time at temperatures from 6.7° to 21.2°C	(Musyl et al., 2011)
Experimental drift longline in the Pacific Ocean	The present paper reports a study of the effects of rod-and-reel and longline fishing on plasma catecholamine levels and other variables in mako, thresher and blue sharks.	2/0 size and 12/0 size 'J' hooks baited with mackerel or squid longline was deployed for a short period (around 3 h) before recovery	Blue shark: 6%. Mako shark: 10% Common thresher shark: 5%	Mako shark conservative estimate of 80% viability on the sharks released	None	Result based on the Plasma catecholamine levels of the longline-captured and released population	(Hight et al., 2007)
Experimental longline fishing strategy approximated the typical Hawaiian ''swordfish'' style of fishing employed by commercial longliners in the Pacific Ocean.	Development of a model to predict the long-term survival of released animals based on tagging combined with biochemical analysis	15/0 circle hooks baited with squid (*Illex spp.*).		Blue shark: 95% survival based on biochemical analyses; Null when estimated with 11 pop-up tags that reported data programmed to detach either 6 or 13 months after deployment (12 tags failed at reporting data): 100% PSATs data showed that the sharks roamed at sea for at least 3 weeks post-release	Reducing the soaking period would increase the number of sharks released alive. The approach can yield important predictive information about postrelease survival, which should help guide fisheries management.	These analyses suggest that blue sharks landed in an apparently healthy condition are likely to survive long term if released it is likely that the lower water temperature would reduce locomotor activities and perhaps increase the likelihood of survival	(Moyes et al., 2006)

Review of the information on at-vessel and post-release survival (PRS) estimated onboard longliners, purse seiners and gillnets in various.

Fishery /data	Objectives of the study	Gear type (hook, light attractor)	At-vessel mortality	Post-release survival (PRS)	Management implication	Other results	References
Commercial longliners targeting billfish and tuna operating offshore from southern Queensland or northern New South Wales	Movements pattern and habitat preferences of the blue sharks	Not specified		Only sharks in good condition were tagged	None	This study has provided new information on the vertical movements of several species of pelagic sharks in the southwestern PaciWc These data will assist in assessing the vulnerability of pelagic sharks to gear Wshed at different depths over the diel period	(Stevens et al., 2010)
Commercial longliners targeting swordfish in the southeastern Pacific Ocean	Movements pattern and habitat preferences of the shortfin mako sharks	Not specified		Only shaks in good condition were tagged	None	Post-release mortality could be attributed to handling process. More accurate fishery data and further research, from basic biological data to stock structure information, are still needed to evaluate the state of the stocks and to assess the effect of the fisheries in the area.	(Abascal et al., 2011)
Commercial longliners targeting Swordfish or Swordfish and tuna in the Pacific Ocean: observers data	To provide quantitative information needed for management of sharks in the fishery	Not specified	Blue shark: Deep set: 4% shallow set: 6%			Reduction of the mortality of blue sharks by the combination of reduced catch rates, the finning ban, and the apparent capacity of this species to resist the stress of capture on longline gear. contributed to these low	(Walsh et al., 2009)
Commercial longliners targeting tuna in the Pacific Ocean	To provide quantitative information needed for management of sharks in the fishery	Not specified	Blue shark: 13%			Most males and females were immature, and most sharks were alive when recovered	(Francis et al., 2001)
Commercial longliners targeting bigeye tuna in the Pacific Ocean	To describe the depth distributions and capture times of tunas, billfishes, sharks, and other pelagic fishes	J hooks (size 8/0 or 9/0) baited with saury *Cololabis saira* soaking time: 12 h	Blue shark: 0% Whitetip shark : 15% Thresher shark : 40%		Identifying the habitats of pelagic fishes should make it easier to estimate real changes in fish abundance by accounting for changes in fishing methods and the environment.	Most confirmed capture depths were <100m for, whitetip and blue sharks	(Boggs, 1992)

Review of the information on at-vessel and post-release survival (PRS) estimated onboard longliners, purse seiners and gillnets in various.

Fishery /data	Objectives of the study	Gear type (hook, light attractor)	At-vessel mortality	Post-release survival (PRS)	Management implication	Other results	References
Commercial bottom longline vessels targeting sharks in the western north Atlantic Ocean and Gulf of Mexico	To estimate the at vessel mortality for six species of sharks	From 3/0 to 20/0 circle hooks, some "J" hooks were employed. set at sunset and hauled back the following morning near dawn	Tiger shark : 8.5% 9.1% young, 7.6% juvenile, 37.5% adult the sandbar :36.1% 89.1% young, 41.8% juvenile, 22.4% adult dusky shark: 81.1% 87.7% young, 82.4% juvenile, 44.4% adult blacktip shark :88% 86.4% young, 90.5% juvenile 87.3% adult scalloped hammerhead 91.4%, 70% young, 95.2% juvenile, 90.9% adult great hammerhead :93.8% 86.4% young, 90.5% juvenile 87.3% adult.			Multiple stepwise linear regressions indicate that age group, soak time and bottom water temperature can be used as predictors of at-vessel mortality and that size restrictions, size selective gear, restricting the soak time and time/area closures may be benefi cial to fisheries targeting large coastal sharks.	(Morgan and Burgess, 2007)
Commercial fishing trips and one chartered research cruise in the Indian Ocean	Estimate the at-vessel mortality , survival rate and overall mortality of the silky shark	Purse seine set around FADs	Silky shark : 67%	Silky shark : 59%	No retention to encourage the discards of sharks Promote good handling practices to avoid injuries to the crew when handling sharks and rays and to minimize physical trauma and stress of animals in order to improve their post-release survival. New information on the impacts of this longline fishery on pelagic elasmobranches can now be incorporated into further stock assessment models, including ecological risk assessment analysis.	Overall mortality for Silky shark in the French ps fishery operating in the IO : 82-91%	(Filmalter et al., 2012; Poisson et al., 2011)

Review of the information on at-vessel and post-release survival (PRS) estimated onboard longliners, purse seiners and gillnets in various.

Fishery /data	Objectives of the study	Gear type (hook, light attractor)	At-vessel mortality	Post-release survival (PRS)	Management implication	Other results	References
Commercial shark gillnet fishery in the Pacific Ocean : observers data	Apply a riskbased method to semi quantitatively determine delayed and total post capture survival	Net was 500 m long and 2.4 m high, and had a standard hanging coefficient (0.6) and colour (green).	Post capture survival immediate bronze whaler :0.638 tope shark: 0.273 shortfin mako:0.625 smooth hammerhead:0.107 thresher shark: 0.333	Post capture survival delayed bronze whaler: 0.645 tope shark: 0.506 shortfin mako: 0.387 smooth hammerhead: 0.568 thresher shark: 0.465		The risk-based method proposed aims to provide fisheries scientists and on-board observers with a simple tool for a first-level assessment of the post capture survival	(Braccini et al., 2012)
California recreational fishery that typically captures individuals by hooking them in the caudal fin	The objectives of this work were to: (1) use pop-off satellite archival tags (PSATs) to assess post-release survivorship of common thresher sharks captured using the caudal-based techniques, and (2) quantify the changes in blood stress indicators that manifest from the use of current angling methods.	Lead-headed lures [(0.5 kg); Leadmasters, Hesperia, CA, USA] were rigged with tandem 8/0 Mustad 7691 J-hooks, baited with chub mackerel Houttuyn) and slow trolled behind the tagging vessel		Survival of the acute effects of capture was determined from the depth and temperature records of 10-day PSAT deployments (19 tags): common thresher shark: 26%	These results suggest that for larger individuals the current caudal-based capture methods used in the California recreational fishery may not be suitable for an effective catch-and-release based conservation strategy		(Heberer et al., 2010)
Recreational hook and line fishery in the Gulf of Mexico	To estimate short-term survival and movements of the sharpnose sharks after hook-and-line capture.	Hook and line 13.6 Kg test monofilament line 68 kg barrel swivel, steel leader and 9/0 bronze hook			High survival (90%) and quick recovery indicate that the practice of catch-and-release would be a viable method to reduce capture mortality for this species	Ultrasonic telemetry tracking period between 0.75- 5.90 h mortalities may take longer than tracking periods of the study especially for the hooked fish	(Gurshin and Szedlmayer, 2004)

Review of the information on at-vessel and post-release survival (PRS) estimated onboard longliners, purse seiners and gillnets in various.

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Mitigation measures

Mitigation measures (MMs) development in fisheries is a part of the responsible fisheries conduct undertaken firstly under the 1982 Law of the Sea Convention (United Nations, 1982). This was addressed in the 1995 FAO document stated the Code of Conduct for Responsible Fisheries (FAO, 1995). MMs aim at minimizing the negative impact of the fisheries over non-target species principally, but also on target species to increase the gear selectivity on juveniles for example. As well as being efficient in minimizing this impact, mitigation measures must be enforceable, easy to implement technically and by fishermen and easy to control. The effect over target species must also be carefully taken into account, as well as the human dimension.

There is no single solution to mitigate the impact of the fishing activity in shark mortality and specific measures must be considered according to the specificities of each fishery and shark species.

Some countries and international management bodies have adopted by-catch reduction measures to protect particular species or taxa of conservation concern or to regulate a particular fishery. However, species- or fishery-specific management approaches may be inefficient and only partially effective and may lead to unintended consequences for other species or fisheries. We focused much of our analysis on the evaluation of strategies to reduce by-catch or to improve the fate of sharks that are captured and discarded with multi-taxa approach. To do so, we performed a review of the peer reviewed and relevant grey literature dealing with by-catch mitigation methods.

Fisheries by-catch reduction is a very active area of research with many ongoing studies and the frequent development of novel initiatives. Table titled "*Technical mitigation options for sharks and rays, sea turtles, seabirds, marine mammals by fishing gears using criteria proposed by Patterson et al, 2009*" lists the technical measure options by gear which are or could be used, and a reference to studies evaluating their efficacy for several by-catch taxa: shark, sea turtles, sea birds, marine mammals, Swordfish, tunas and bony fishes.

34 methods are presently proposed for potential development and application. 18 for Longline gears, 7 for purse seiner, 7 for gillnet, 4 for trawlers, and 4 recreational fisheries.

These technical options can be classified into three major types which are: fishing gears modification; fishing practices and strategy, and practices to increase survival rates. While some options could be implemented immediately others required more research. All gears combined, 15 technical measure options related to fishing gears modification has been identified; 12 related to the fishing practices and strategy and three for the practices to increase survival rates (almost identical for all the gears).

By far, most of the measures take an approach of reducing the interactions with fishing gear (23 cases; 67%), as opposed to facilitating escape or release once an animal has come into contact with it (8 cases;23%). Sixteen (47%) measures have the ability to minimize the level of discarding and 12 (35%) the ability to improve the survivorship.

A wide variety of by-catch (seabirds, turtles, marine mammals and sharks and rays) are likely to be incidentally captured in various fisheries. It appears that some mitigation measures developed for these taxa could result in an increase in shark catches (e.g. negative impacts of circle hook on sharks CPUE and mortality). In this context, before the implementing phase of a measure, it is important to identify and contact organizations and working groups that will address a multi taxon approach in order to optimize the results of the measure. Collaboration between experts working groups within RFMOs should be enhanced to avoid these potential problems.

Some of the measures considered, for each fishing gear and/or metier are described below.

1. Longline

<u>Fishing gear modification</u>

There are several longline gear characteristics that can affect its selectivity (both size of fish and species): hook size, shape/style/offset, material of the gangions, the presence of swivels to attach the gangion to the main line and light attractors type/color.

a. Restrictions on Light Attractors

Light attractors, including chemical lightsticks and battery-powered light-emitting diodes (LEDs), are mainly used by longliners targeting swordfish. These devices are attached near baited hooks on branchlines to attract prey of fish and fish itself towards the bait. Studies have shown that using light attractors' increases shark and the sea turtles catch rates. The negative potential impact on shark catches indicates the need for further research. Chemical lightsticks have a limited lifespan, and are not reusable. In addition they are plastic made and contain a harmful chemical products. Light-emitting diodes (LEDs) are powered with batteries. Thus, in both cases there are environmental concerns.

b. No wire traces

The use of wire leaders has already been banned in some pelagic longline fisheries to reduce shark mortality. Experiments showed that catch rates of several species, including sharks, were lower on nylon than on wire leaders, probably because those animals often escape by biting through the nylon leaders. High bite-off rates indicate that as many animals escape from nylon leaders as are caught on nylon leaders. Twisted monofilament is also used in some fisheries to reduce the rate of fish escapement.

c. Circle hooks

Circle hooks, J-hooks and tuna hooks are three hooks style in use in pelagic longline fisheries. Catch-and-release studies have revealed that one of the strongest correlations of mortality for fishes is deep hooking in body organs such as the esophagus, gills, or stomach, which is largely influenced by gear choice and angler behavior. Circle hook's shape is rounded with the point oriented perpendicular to the shank, while a J-hook is shaped as its name implies, with its point oriented parallel to the hook shaft. In shape, a tuna hook is in between a circle and a J hook, but the point of the tuna hook is not guarded by the shaft, as is the case for J hooks. The point on a circle hook is turned in, towards the hook shank. Circle hooks come in a variety of shapes, offset and sizes. Different shapes can change the performance of individual hooks. However, there is no uniform system of hook measurements. This is problematic when reporting research results and comparing results between experiments and may be compounded by the fact that the different manufacturers of hooks use different terminology. Using wide circle hooks has been shown to significantly reduce sea turtle interactions in longline fisheries. However, conflicting results have been reported from different studies, suggesting a reduction of target species catch rates but also increases of some by-catch species rates. In addition, there is a need to understanding the role of every longline component in gear performance analysis.

d. Smart hook

The Smart Hook system has been developed over the past few years. The premise of the Smart Hook system is that it prevents hooking of seabirds and turtles during line setting by protecting a baited hook with a metal shield, which is held in place with a biodegradable pin. The pin dissolves once the hook is below the feeding depth of seabirds (25 m) and turtles (100 m). Once the pin dissolves, the shield is released and the baited hook is ready for fishing. The shield and the pin are both made of a metal alloy which dissolves, leaving no contaminants. Results have been promising, but more investigation on the impact of this device on sharks catches rates and large-scale trials are required.

e. Corrodible hooks

Corrodible hooks are fishing hooks composed of material other than stainless steel. They may be made from different alloys, with different coatings, which all affect how long they last. The hook may dissolve quickly, within a couple of days, or more slowly over weeks or months. The premise behind the use of corrodible hooks is that they should improve the mortality rate of by-catch released with a hook attached. However, this needs to be tested through tagging studies. The economic impact of adopting corrodible hooks requires a thorough assessment, as these hooks would need to be replaced more often than the low-grade stainless steel hooks currently used in fishing operations. However, they cost less than stainless hooks. No extra skill is required to secure a corrodible hook, compared with a stainless steel hook.

g. Magnetic, E+ metals

Elasmobranch fishes (sharks, skates and rays) are able to detect the Earth's geomagnetic field using their ampullae of Lorenzini. Electropositive metals or magnets appear to generate an aversion response in some species of sharks through an overstimulation of their ampullae, which are sensitive electroreceptors. Research has shown that different shark species respond differently to magnets and metals. Tuna and swordfish do not have electroreceptors and are not repelled by magnets or EPREM. Recent studies have evaluated the effects of incorporating magnets and rare earth metals into longline and rod and reel fishing gear. In some instances, magnets and/or metals have been incorporated directly into fishing hooks, while at other times they have been added to the line (e.g. as metal discs) at varying distances from the hook. Magnets and EPREM have been trailed individually and in tandem. Trials at large scale (in the Canadian longline) showed that rare-earth metal deterrent do not present a practical by-catch mitigation measure for this fishery.

h. Management of offal discharge

The offal and spent bait typically discarded during hauling operations represent an additional food source for birds but also sharks and marine mammals. Removing this source of food can greatly and mainly reduce the number of birds associating with fishing vessels. However, little is known of the impact upon shark catch rates of these practices. Thus the main offal management actions are (1) to avoid offal discharge during setting or hauling, (2) if offal cannot be retained on board during setting/hauling, it should be discharged from the opposite side of the boat to setting/hauling, to actively encourage birds away from baited hooks and (3) all hooks should be removed and retained onboard before discards are discharged from the vessel.

i. Artificial bait

The use of artificial, or manufactured, baits can reduce by-catch through avoiding hooking unwanted species. In the context of by-catch management, artificial baits are successful if they are attractive to target species but repellent or deterrent for by-catch species (species-selective baits). Synthetic baits (lures) that use visual stimulus as an attractant are also known as artificial baits but are not considered here.

j. Acoustic attractant

Sharks are known to be attracted by sounds. Some studies on attractive sounds were significantly developed in the 1970's. It was shown that low frequency sounds have strong attractive effect on sharks such as distress sounds (emitted from fish struggling after being struck by a spear gun or being caught on a hook), sounds produced during natural feeding, or when fish exhibiting other frenzy behaviours (accelerating, jumping). Results have been promising, but more investigation and large-scale trials are required.

k. Olfative repellent/attractant

The sensitivity of elasmobranchs to olfactory sense was studied as well as their well-known electrical stimuli. Potential means to attract or repulse sharks away from the fishing gear using Chemical stimuli (blood, amino acids, and pheromones). It was recognized that the method will require a great deal of experimentation and evaluation and run the risk of also attracting or repulsing tuna.

Fishing practices/strategy

a. Fleet communication program

Fishers avoid reputed infested areas and change fishing area when high predators' interactions occur. Fleet communication programs can report real-time observations of temporally and spatially unpredictable by-catch hotspots to be avoided by vessels in a fleet. Fleet communication may be successful when there are strong economic incentives to reduce depredation, by-catch, by-catch rates of sensitive species.

b. Switching from squid to fish bait

The use of fish bait, in preference to squid bait, has been shown to reduce the incidence of turtle by-catch in longline fisheries, with conflicting results as regards shark catch rates. The effectiveness of this method seems species-, fisheries- and geographically-specific. More research is required.

c. Soaking time

Results of these experiments suggest that soaking longlines no more than some optimal duration may increase the survival of by-catch species, while maintaining the catch of target species. Optimal soaking duration likely varies by fishery. The surest method for reducing by-catch mortality in any fishery, however, is to avoid hooking unwanted by-catch in the first place. The advantages of shortening the soaking time during the fishing operation have been investigated. This measure should be beneficial as it could reduce at the same time: (1) the catches of minor commercial species, (2) the depredation rates, (3) the fish losses at sea, (4) the hooking and post-release mortality, and (5) improve the quality of the flesh of the target species. Swordfish catch did not increase with soak time as showed by fisheries observer data collected from swordfish-targeted sets. While minimum soak time limits would likely decrease by-catch mortality rates in swordfish longline fisheries, impacts on other aspects of the fishing process would need to be considered, such as negative impacts on fisher safety. A reduced soak time would be difficult to monitor and ensure compliance.

d. Setting gear deeper

Deep setting is a longline fishing technique where hooks are set below a critical depth, out of range of most by-catch species, but within the range that target species are usually captured. In trials at sea, deep setting has been shown to decrease by-catch. It may also increase or decrease target catch. More research is required before applying this method as such shift of fishing effort into deeper water could impact demersal shark species. This is difficult to monitor and ensure compliance.

e. Management of offal discharge

The offal and spent bait typically discarded during hauling operations represent a potential food source for birds but also sharks and marine mammals. Removing this source of food can greatly and mainly reduce the number of birds associating with fishing vessels. However, little is known of the impact upon shark catch rates of these practices. Thus the main offal management actions are: (1) to avoid offal discharge during setting or hauling, (2) if offal cannot be retained on board during setting/hauling, it should be discharged from the opposite side of the boat to setting/hauling, to actively encourage birds away from baited hooks, and (3) all hooks should be removed and retained onboard before discards are discharged from the vessel.

<u>Practices to increase survival rates</u>

a. Safe handling and release

No progress has been made to identify best practices to handle and release sharks and rays captured in longline fisheries. Booklet giving general techniques for handling while onboard, techniques to remove as much gear as safely possible before release, and use of line cutters should be developed. The enforcement of protocols or good practices could greatly reduce post release mortality rates. Industry would be generally supportive of these measures as they would be easy to implement with relatively little expense. Such measures could also have positive effects on other species and could thus improve handling of other sensitive species.

b. Workshop/training information dissemination on good handling practices/fishing practices

Transferring the mitigation methods to the entire fleet by training the crew on the good practices identified, and finally monitoring the implementation of these practices onboard, are the main axes of the future actions to be taken. Workshops/trainings gathering fishers, observers and scientists, should be organized to review all the mitigation methods and fishing practices aiming at reducing shark mortality and to present the good handling/release guidelines identified, hence to ensure the safety of the crews and optimize the survival of released animals. In addition, Educating fishers on species identification would be relatively simple. Fishers would be generally supportive of these measures if they receive some subsidies in return.

c. Mandatory Turtle/shark safe handling equipment

The instruments used to handle entangled or hooked turtles/sharks and rays during fishing operation (dehooker, mouth opener, bold cutter, line cutter with long handle, dipnet) should be mandatory onboard longline fishing vessels.

2. Purse seine

<u>Fishing gear modification</u>

a. Non entangling FADs

The entanglement of marine organisms (sharks and turtles) was identified as an issue. The entanglement rate of turtles was fairly well established from observations made by onboard observers and it was known that the majority were released alive. However, the frequency with which sharks became entangled, and hence the extent of the problem, had not been investigated until recently. A study revealed that this was indeed an extremely significant issue, with entanglement attributing much more to overall silky shark mortality, than that caused by incidental capture during purse seine operations. The solution to this problem is simple. Only FADs designed to have a zero probability of entangling animals should be deployed. That is, the use of netting should be completely discontinued. Different designs of ecoFADs have been proposed, including the use of nets wrapped up into “sausages” to avoid having large panels of nets underneath the FADs. Even if such designs of FADs would considerably decrease the probability of sharks getting entangled, it would be more efficient if the use of netting became banned. Materials like ropes could be promoted. In this context it has been recommended the use of non-entangling and biodegradable material on FADs to reduce ghost fishing to the lowest level.

b. Release panels for shark

Silky sharks were observed to collect in a pocket of purse seine net during the latter stages of net retrieval. An experimental release panel was installed at this location that extended down from the corkline for about 10 m. The panel could be opened and closed with minimal loss in time to the fishing operation and with low risk of losing target catch. The release panel was tested during seven sets but only two silky sharks exited the panel. Although the panel failed to release significant quantities of non-target catch in these experimental trials, this approach seemed promising. Further refinements of this concept with additional testing and experimentation must be undertaken.

Fishing practices/strategies

a. Setting on bigger aggregations

A study has shown that the ratio of target catch to by-catch is non-linear. That is, the amount of by-catch (tons) is fairly constant regardless of the size of the tuna aggregation at a FAD. Consequently, the ratio of target catch to by-catch is significantly lower when individual sets are bigger. By simply avoiding setting on aggregations of less than 10 tons, between 23 – 43% of the by-catch could be avoided, depending on the Ocean. Although sets of this size class (0-10 t) are the most common in the fishery, representing between 25 – 41% of all sets made, they have a negligible impact on the overall harvest and are responsible for only 3 – 10 % of the total target catch. The same analysis was conducted regarding the number of silky sharks caught, and a very similar result was found. Most silky sharks were taken in sets of less than 10 tons (21 - 41%) and the portion decreased rapidly with increasing haul size. The study also demonstrated that vessel skippers were able to determine the size of the aggregation prior setting the net, with sufficient accuracy to successfully discriminate between aggregations less than or greater than 10t on a regular basis. As such, the avoidance of small aggregations appears to be both a useful and practical solution to provide significant reductions in the fisheries total by-catch. While the authors do not advocate for management authorities to implement a restriction on minimum set size, they do suggest that this method could be used in conjuction with other incentive based systems. Fishers could then voluntarily adopt this technique when they, for example, approach a predetermined seasonal by-catch quota, but wished to continue catching tuna.

b. Prohibition of setting on whale sharks

Due to the propensity of tunas to aggregate around large animals, whale sharks (*Rhincodon typus*) and mantas (*Manta spp.*) can be encircled intentionally or by accident if not visible at the time of the setting. More than one animal can be caught during a set, and the same individual, can be caught several times during the fishing season (the rope attached around the tail to release the animal can be recognised easily by the crew). In the Pacific Ocean, 12% of interactions with whale sharks resulted in mortality and though approximately 60 individuals died in 2009 (Anonymous, 2010b). A study using data derived from logbooks systematically filled by captains of the French and Spanish tuna purse seine fleets operating in the Indian and Atlantic Oceans showed that the impact of fishing on the mortality of whale sharks was seemingly lower (1%) than in the Pacific Ocean. Some Regional Fisheries Management Organisations

(RFMOs) have discussed adopting measures to prevent their use as FADs and to release accidental by-catch unharmed. During the Seventh Regular session of the Western and central Pacific Fisheries Commission in December 2010, Australia has proposed at the technical and compliance committee to prohibit the setting of purse seine nets around whale shark and to mitigate the impact of the inadvertent encirclement in developing the best practice guidelines to release whale sharks without injury (Anonymous, 2010a). Some captains also admitted that they were reluctant to set on whale sharks considering all the problem encountered to release the animals afterwards, they prefer minimizing the nets damages and the time spent to sort out the trapped megafauna.

c. Multiple FADs

Another possible way is being investigated to reduce small tuna by-catch is using stacking or double FADs, whereby two FADs are placed in close proximity, thereby increasing the potential for segregation by certain species. Research in the equatorial eastern Pacific Ocean is currently being conducted to determine whether such species-specific aggregations occur.

Fishing practices/strategies

a. Safe handling and releasese

A manual is dedicated to the skippers and crew of tropical tuna purse Seiners has been developed following observations by scientists during commercial fishing trips and discussions with fishermen. These handling/release guidelines, are intended to promote good handling practices to avoid injuries to the crew when handling sharks and rays and to minimize physical trauma and stress of animals in order to improve their post-release survival. A study shows that if sharks are released as rapidly as possible and handled in a good manner, by-catch mortality of silky sharks can be reduced by 15% in the fishery.

b. Workshop/training information dissemination on good handling practices/fishing practices

(See above).

3. Gillnets

Fishing gear modification

a. Gear configuration

Gillnets are very size selective: a specific mesh size tends to catch fish of a limited size range. The mesh size may therefore be considered the most important characteristic of this gear. A net may be rigged with varying degrees of slack, which is primarily regulated by the hanging ratio. The hanging ratio measures how tightly the net is stretched along the head and foot rope. Modification on a case by case basis could hinder their ability to retain sharks. A maximum size limit may be useful as it will protect the breeding stock and larger sharks likely have a better chance of surviving after being hooked.

b. Turtle/shark lights for gillnest

Gillnet fisheries have been associated with significant sea turtle and shark by-catch rates.The Turtle Lights for Gillnets and their ability to reduce the by-catch of turtles has the potential to be an effective device for turtle conservation all over the world. When tested in commercial gillnet fisheries, the illuminated nets did not have an effect on the overall target catch rates nor the overall catch value. In addition, analysis of the catch composition found that the experimental nets showed a 45% increase in California halibut or lenguado (*Paralichthys californicus*), the primary target species, and a 30% decrease in overall elasmobranch by-catch, with a 57% decrease in scalloped hammerhead by-catch (*Sphyrna lewini*). These results suggest that UV illuminated nets may not only be useful in reducing sea turtle interactions with gillnets, but may also be a method of reducing scalloped hammerhead by-catch in gillnets.

Fishing practices/strategy

a. Soaking time

Shorter soak times would likely increase the survivorship of the individuals caught. The measure could lead to an increased number of sets. As fishers would be moving their gear around more, this would potentially increase the number of interactions. A reduced soak time would be difficult to monitor and ensure compliance.

b. Setting time

Case by case assessment based on research is needed to identify appropriate fishing time ensuring a reduction of shark (and protected species) catches. Optimal setting time duration likely varies by fishery.

c. Fleet communication program

(See above).

Practices to increase survival

a. Safe handling and release

No progress has been made to identify best practices to handle and release sharks and rays captured in the gillnet fisheries. Booklet giving general techniques for handling while onboard, techniques to remove as much gear as safely possible before release, should be developed if the direct mortality (at hauling) is not negligible and sharks non marketable.

b. Workshop/training information dissemination on good handling practices/fishing practices

(See above).

4. Trawlers

Fishing gear modification

a. **Bycatch Reduction Devices (BRD)**

These devices are components added to the trawl net to avoid the catch of unwanted species ore facilitate their escapement once these are inside the net. Usually a strong metal grid is placed at the beginning of the codend to avoid catches of turtle: TEDs (Turtle Exclusion Devices). Turtles are avoided to enter the sack and an auxiliary door beside the grid helps them to escape from the gear. With the same principle, other sorting grids or modifications of gear netting are placed in other strategic sectors of the net. These prevent fishes and other marine animals from penetrating the final portion of the gear with its fine meshes, and help them to escape through large windows.

Fishing practices/strategy

a. **Fleet communication program**

(See above)

Practices to increase survival rates

a. **Safe handling and release**

No progress has been made to identify best practices to handle and release sharks and rays captured in the trawler fisheries. Booklet giving general techniques for handling while onboard, techniques to remove as much gear as safely possible before release, should be developed if the direct mortality (at hauling) is not negligible and sharks non marketable.

b. **Workshop/training information dissemination on good handling practices/fishing practices**

(See above).

5. **Recreational fishing**

Fishing gear modification

a. **Circle hooks**

(See above).

Fishing practices/strategy

a. **Fleet communication program**

(See above).

Practices to increase survival

b. Catch and release

Catch and release fishing is increasingly important, both mandatory release of protected fish and the voluntary catch-and-release of non-protected fish. Catch-and-release angling strategy is based on the assumption that fish experience low mortality and minimal sub-lethal effects. Given the emphasis on tag-and-release strategy, it is important to gain some understanding of post-release behaviour and mortality.

c. Safe handling and release

As recreational angling continues to grow in popularity, expanding to many developing countries, and targeting alternative species, it is important that reasonable data appropriate for specific fish and fisheries are available. The sustainable use and conservation of recreational fishery resources will depend upon the development and dissemination of effective catch-and-release angling strategies based upon sound science to stakeholders around the world .Species--specific guidelines for catch-and-release are needed. These guidelines would take into account the inter-specific diversity of fishes and variation in fishing techniques based upon results of scientific studies.

6. Common measures applicable

a. Finning prohibitioin and other legal constrains in the fishery

Shark mortality from fishing could be reduced considerably if finning prohibitions were adopted. Others legal constraints have been proposed to reduce shark mortality by pelagic longline fisheries (Table 4.2.6). The enforcement of the federal Shark Finning Prohibition Act, in the Hawaii based longline fishery has been critically important from the perspective of shark conservation.

The percentage of sharks that were caught and released dead was very low for blue sharks in 2004–2006 (4.0–5.7%), whereas those for all other common species exceeded 20% in each sector or period. Besides, it is also argued that finning prohibitions divert attention from assessing whether catch levels are sustainable and that the need for management of sharks should not be addressed by measures that are simple to implement but complex to enforce and evaluate. The industry targeting sharks (e.g. pelagic longliners) argue that the obligation of landing the shark carcass with the fins attached will increase labour costs, reduce onboard storage and deteriorate shark products as they need to be defrost prior to fin removal (shark carcass and fins have distinct markets and are commonly shipped frozen).

Table 4.2.6.- Example of legal framework that influence practices and attitudes towards shark bycatch (from Gilman et al., 2008).

	Legal constraints [a]			
Pelagic LL fisheries by flag state	Retention of fins requires retention of corresponding carcass [b]	Shark retention limit [c]	Prohibit retention of specified shark species	Size Limit
Australia tuna and billfish	X	X	X	

Italy Mediterranean industrial swordfish	X			
Peru artisanal mahi mahi and shark				X
South Africa tuna and swordfish	X	X		
USA-Hawaii tuna	X			
USA-Hawaii swordfish	X			

(a) Japan and Fiji distant water longline tuna vessels may comply with voluntary measures adopted by Regional Fishery Management Organizations, and vessels operating in EEZs of other nations through foreign license access agreements may be required to comply with restrictions on shark catch, retention and use under these access agreements.
(b) USA, Italy (European Union), and South Africa require the total weight of retained shark fins to be p5% of the total dressed ‘‘live’’ weight of shark carcasses. Australia requires fins to be attached to the shark carcass when landed.
(c) Australia has a 20 shark carcass per trip retention limit for longline tuna and billfish fisheries. South Africa has a shark landing limit of 10% of the total swordfish and tuna catch.

b. Compensatory mitigation

Individual vessels or a fisheries association could meet by-catch mitigation requirements through compensation used to mitigate non-fishery threats. Alternatively, management authorities could create a fee and exemption structure, similar to a ‘‘polluter pays’’ system. For instance, governments could reduce or withhold subsidies, charge a higher permit or license fee, or use a higher tax rate if by-catch thresholds are exceeded. Or, the fee structure can provide a positive incentive, where a higher subsidy, lower permit or license fee, or lower tax applies when by-catch standards are met. Compensatory mitigation programmes likely require 100% observer coverage, which is a substantial limitation.

c. Industry self-policing

Self-policing uses peer pressure from within the industry to criticize bad actors and acknowledge good actors. A fishing industry can create a programme where information for individual vessel by-catch levels, compliance with relevant regulations, and other relevant information, is made available to the entire industry. This is especially effective where regulations contain industry-wide penalties if by-catch rates or caps are exceeded (Gilman et al., 2010).

d. Spatial/temporal closure

Regulations involving closure of fishing zones in combination with regulated fishing times are common practices used to reduce by-catch levels (Alverson et al., 1994). Understanding patterns of habitat use, by sex and by sizes, both horizontal and vertical of pelagic sharks with regards to is valuable for management purposes, especially in species that are at risk from expanding fisheries.

e. Reduction of fishing effort

Restrictions on the number of hooks deployed: Managers could restrict the number of hooks per set for longliner in an effort to reduce the by-catch, including that of sharks.

Restrictions on sets on FADs: Managers could prohibit the setting of purse seines around FADs or other floating objects in an effort to reduce the by-catch, including that of sharks. Such prohibition of setting on FADs have been initiated during time and area closures in the Atlantic Ocean (ICCAT 1999) and on floating objects in the western and central Pacific Ocean (Parties to the Naura Agreement [PNA] 2010).

Limitation of the tow duration for trawlers: Managers could promote short duration tow in an effort to reduce the by-catch, including that of sharks and to improve their survival rates.

f. Bycatch management

Several management approaches have been developed to reduce wastage, by-catch, and discarding in fisheries. A number of these approaches, including comprehensive by-catch and discard policies and economic incentives for sustainable fishing have been proposed (Davis and Worm, 2013); among them (1) the national by-catch policy; (2) by-catch quotas or caps;(3) individual habitat quotas (IHQs); (4) by catch tax system.

Technical mitigation options for sharks and rays, sea turtles, seabirds, marine mammals by fishing gears using criteria proposed by Patterson *et al*, 2009

	Mitigation method Measure	Ability to reduce interactions	Ability to minimize the level of discarding	Ability to facilitate the escape	Ability to improve survivorship	Technical feasibility to detect a response	Level of industry support	Impact on currently collected data	Groups affected by the measure	Remarks	Main References
LONGLINE GEAR											
Fishing Gear modifications	Restriction of Light attractors	++ "for all species groups"	++	0	0	++	--	0	ST: ++ SHK: ++ SB: 0 MM:? TUN-BIL: -- SWO:-/? BF:?	Chemical lightsticks have a limited lifespan, and are not reusable. light-emitting diodes (LEDs) are powered with batteries. In both cases thus are an environmental concern.	(Wang et al., 2007, Poisson et al., 2010, Alessandro and Antonello, 2010, Bigelow et al., 1999, Gless et al., 2008, Bromhead et al., 2012)
	No wire trace/twisted monofilament	++/--	++	++	+	++	Na for most, but – for those targeting sharks	0	SHK: ++	Need for more studies for better understanding of the impacts on the other groups	(Stone and Dixon, 2001, Ward et al., 2008, Branstetter and Musick, 1993, Bromhead et al., 2012)
	Circle hooks	++/--	++	++/--	+	++	Na/-- Impact on target species to consider (e.g. could decrease the swordfish catche)	na	ST: ++ SHK: ++ SB: 0 MM:? BILL na/ -- TUN:++/-- SWO:0/-- BF:?	Circles hooks are not a panacea for species conservation.Many conflicting results - The only obvious positive impact is detected on sea turtles. results are fisheries ,species, specific and fishing area dependant	(Domingo et al., 2012, Coelho et al., 2012, Wilson and Diaz, 2012, Serafy et al., 2012b, Sauls and Ayala, 2012, Rudershausen et al., 2012, Pacheco et al., 2011, Sales et al., 2010, Graves and Horodysky, 2008, Prince et al., 2007, Kaplan et al., 2007, Yokota et al., 2006, Carruthers et al., 2009, Piovano et al., 2010, Curran and Beverly, 2012, Curran and Bigelow, 2011, Anonymous, 2012, Epperly et al., 2012, Godin et al., 2012, Graves et al., 2012, Rice et al., 2012, Richards et al., 2012, Serafy et al., 2012a, Yokota et al., 2012, Cass-Calay et al., 2012, Galeana-Villasenor et al., 2009, Afonso et al., 2 011)

++: very positive; +: positive; 0: no effect; - -: very negative; - : negative; NA: not applicable or impossible to reply. SHK: Sharks/rays; SB: Seabird; ST: Sea turtles; UNS: Unwanted sized target species; MM: Marine mammals.

Technical mitigation options for sharks and rays, sea turtles, seabirds, marine mammals by fishing gears using criteria proposed by Patterson *et al*, 2009

	Mitigation method Measure	Ability to reduce interactions	Ability to minimize the level of discarding	Ability to facilitate the escape	Ability to improve survivorship	Technical feasibility to detect a response	Level of industry support	Impact on currently collected data	Groups affected by the measure	Remarks	Main References
Fishing Gear modifications	Corrodible hook	0	0	0	Na/+	++	Na/-	0	More research needed	The use of corrodible hooks is that it should decrease the post-release mortality rate of by-catch.	(Patterson and Tudman, 2009. , McGrath et al., 2011)
	Smart Hook	?	?	0	0	++	?	na	More research needed	Effect on sharks must be investigated Further research is needed to assess the efficiency of this technology	(Jusseit, 2010)
	Artificial bait	++/?	na	0	0	++	na	na	ST: ? SHK:++/ ? SB: ? MM:? BILL? TUN:? SWO-BIL:? BF:?	More research and development needed	(Tryggvadottir et al., 2002., Erickson and Berkeley, 2008, Gilman et al., 2007)
	Acoustic attractant	++/?	0	0	0	++	na	0	ST: ? SHK:++/ ? SB: ? MM:? BILL? TUN:? SWO-BIL:? BF:?	Low frequency sounds have strong attractive effect on sharks. Potentially attract Sharks away from the fishing gear Additional research is needed	(Nelson and Gruber, 1963, Nelson, 1976, Myrberg Arthur A, 2001, Myrberg et al., 1969, Myrberg, 2001, Southwood et al., 2008)
	Olfative repellent/ attractant	++	0	0	0	++	na	0	SHK	Testing in Progress on several species. The existence of a putative chemical shark repellent like shark necromone has been confirmed.	(Sisneros and Nelson, 2001, Dagorn et al., 2010, Southwood et al., 2008, Stroud et al., 2013, Jordan et al., 2013)

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Fishing practices/strategy	Fleet communication programme	++	++	0	0	0	na	++	ALL	avoiding hotspots collection of information on the hotspots.	(Gilman et al., 2008, Gilman et al., 2006)
	switching from squid to fish bait	--/++	++	0	0	++	na	na	SHK	Conflicting results: there is a species-specific response that needs to be evaluated.	(Coelho et al., 2012, Gilman et al., 2008, Foster et al., 2012)
	soaking time	++	++	0	++	++	na	0	ALL	Can reduce by-catch mortalities would not cause decreased swordfish catch nor result in economic losses for fishers. by-catchBeside there is a negative impacts on fisher safety. Optimal soaking duration likely varies by fishery	(Ward and Myers, 2007, Carruthers et al., 2011, Poisson et al., 2010, Erickson and Berkeley, 2008)
	Setting gear deeper	++ Pelagic sharks	++ Pelagic sharks	0	0	++	na	0	ALL	Deeper setting reduces catches of pelagic sharks, but likely increases catches of deeper-dwelling shark species in some areas	(Cambiè et al., 2013, Beverly, 2004, SPC, 2005)
	Management of offal discharge	++	0	0	0	na	na	0	SB SHK MM	refraining from discarding offal and spent bait during the haul would affect shark interactions.	(Gilman et al., 2008)

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Practices to increase survival rates	Safe handling & release	0	++	0	++	++	++	na	ALL	The objectives provide fishers with the skills to reduce the mortality of protected species and sharks. Species identification could be taught in an effort to improve reporting. fishers would be generally supportive of these measures as they would be easy to implement with relatively little expense. Such measures could also have positive effects on other species and could thus improve handling of other sensitive species. To be developed for Longliner.	(Carruthers and Neis, 2011)
	Workshop/ training information dissemination on good handling practices/fishing practices	++	++	0	++	0	na	++	ALL	Fishers would be generally supportive of these measures if they receive some subsidies in return To be developed for Longliner	
	Mandatory sea Turtles/sharks safe handling equipment	0	0	++	++	++	na	0	SHK ST	To be implemented	

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TROPICAL TUNA PURSE SEINE											
Fishing Gear modifications	Non-entangling FADs (ghost fishing)	++	++	0	0	++	++	0	SHK ST		(Filmalter et al., in press)
	release panel for sharks	0	++	++	++	++	na	0	SHK		(Itano et al., 2012)
Fishing practices/strategy	Setting on bigger aggregations	++	0	0	0	na	na	0	SHK		(Dagorn et al., 2012)
	Restriction of setting on whale sharks/manta rays and marine mammals	++	0	0	0	0	na	0	SHK MM	refraining from setting on large individual	(Anonymous, 2010b, Anonymous, 2010a)
	Multiple FADs	?	0	0	0	++	na	0	SHK?	more investigation on the impact of this device on sharks catches rates and large-scale trials are required.	(Schaefer and Fuller, 2011)
Practices to increase survival rates	Safe handling & release	0	++	0	++	++	++	na	SHK	Appropriate documents available	(Poisson et al., 2012b)
	Workshop/ training information dissemination on good handling practices/fishing practices	++	++	0	++	0	++	++	ALL	Already Implemented in some countries	(Poisson et al., 2012a)

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GILLNET											
Fishing Gear modifications	Selective mesh size	++	++	++	++	++	na	0	SHK, ST	Gillnet are size selective Modification on a case by case basis	(Patterson and Tudman, 2009. , Hovgård and Lassen, 2000)
	Turtle/shark lights for Gillnets	++	0	0	0	++	na	0	ST SHK	Illuminated nets may not only be useful in reducing sea turtle interactions with gillnets, but may also be a method of reducing scalloped hammerhead by-catch in gillnets.	(Wang et al., 2007, Southwood et al., 2008)
	Soaking time	0	++	0	++	++	na	0	SHK ST	Shorter soak times would likely increase the survivorship but could increase the number of interactions if the effort is not limited. Optimal soaking duration likely varies by fishery	(Patterson and Tudman, 2009. , Frick et al., 2012)
Fishing practices / strategy	Setting time	++	0	0	0	++	na	0	SHK ST	Optimal setting time duration likely varies by fishery. More research and development needed	(Patterson and Tudman, 2009.)
	Fleet communication programme	++	++	0	0	0	na	++	ALL	avoiding hotspots collection of information on the hotspots.	(Gilman et al., 2008, Gilman et al., 2006)

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Practices to increase survival rates	Safe handling & release	0	++	0	++	++	na	++	ALL	To be developed if the direct mortality (at hauling) is not negligible and sharks by caught non marketable	(Carruthers and Neis, 2011, Frick et al., 2012)
	Workshop/ training information dissemination on good handling practices/fishing practices	++	++	0	++	0	na	++	SHK	To be developed	
TRAWL											
Fishing Gear modifications	By-catch Reduction Devices (BRD)	++	0	++	0	na	na	0	ST SHK		(Ferretti and Myers, 2006., Sala et al., 2011, Fennessy and Isaksen, 2007)
Fishing practices /strategy	Fleet communication programme	++	++	0	0	0	na	++	ALL	avoiding hotspots collection of information on the hotspots.	(Gilman et al., 2008, Gilman et al., 2006)
Practices to increase survival rates	Safe handling & release	0	++	0	++	++	++	na	ALL	To be developed	
	Workshop/ training information dissemination on good handling practices/fishing practices	++	++	0	++	0	++	++	SHK	To be developed	

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SPORT FISHING											
Fishing Gear modifications	Circle hooks	++	++	++	++	++	na	na	SHK	using circle hooks to increase post-release survival of non-target species	Wilson and Diaz, 2012(Serafy et al., 2012a))
ing practices / strategy	Fleet communication programme	++	++	0	0	0	na	++	ALL	avoiding hotspots collection of additional information on the hotspots.	(Gilman et al., 2008, Gilman et al., 2006)
Practices to increase survival rates	Catch-and-release	0	0	++	++	++	++	0	SHK	Given the emphasis on tag-and-release strategy, it is important to gain some understanding of post-release behaviour and mortality.	(Pepperell and Davis, 1999, Graves et al., 2002, Cooke and Suski, 2005)
	Safe handling & release	0	++	0	++	++	++	na	SHK	Appropriate document available	(Fowler and Partridge, 2012, NOAA., 2009)
	Workshop/ training information dissemination on good handling practices/fishing practices	++	++	0	++	0	++	++	SHK	To be developed	

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Common measures applicable for the by-catch against criteria for sharks and rays, sea turtles, seabirds, marine mammals, bony fishes, Tunas, swordfish, Billfishes and by fishing gears using criteria proposed by Patterson *et al*, 2009

Mitigation method Measure	Ability to reduce interactions	Ability to minimize the level of discarding	Ability to facilitate the escape	Ability to improve survivorship	Technical feasibility to detect a response	Level of industry support	Impact on currently collected data	Groups affected by the measure	Remarks	Main References
Legal constraints in fishery for fin cutting and removal	0	0	0	++	++	--/++	--/0	SHK	Fishers argue with increasing labor costs, decrease storing capacity and deterioration of shark meat as defrost is required for removing the fins	(Walsh et al., 2009, Clarke et al., 2013)
Compensation mitigation	++	++	0	++	++	++	0	SHK Potentially ALL		(Gilman et al., 2010)
Industry self-policing	++	++	0	++	++	++	++	SHK Potentially ALL		(Gilman et al., 2010)
Spatial/temporal closure	++	0	0	0	++	na	0	ALL		(Dunn et al., 2011)
By-catch management	++	0	0	0	++	na	++	SHK		(Davis and Worm, 2013)
Fishing effort reduction	++	0	0	0	++	--	-	ALL:++		
TAC	++	0	0	0	++	--	-	ALL:++		

++: very positive; +: positive; 0: no effect; - -: very negative; - : negative; NA: not applicable or impossible to reply.
SHK: Sharks/rays; SB: Seabird; ST: Sea turtles; MM: Marine mammals; BF: bony fishes; TUN: Tunas; SWO: swordfish; BIL: Billfishes

Technical mitigation options for sharks and rays, sea turtles, seabirds, marine mammals by fishing gears using criteria proposed by Patterson *et al*, 2009

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4.3 Integration of compiled information to RFMOs

The information gathered during the project could be presented as working documents for the use of the Scientific Committees of the Tuna RFMOs. Below the main examples of information that can be presented in the Tuna RFMOs.

4.3.1 Species Executive Summary Sheets

Blueshark and shortfin mako shark species executive summary sheets; which includes information on fishery statistics, stock assessment used, stock status, current management advice as well as future recommendations; are presented in Annex VI.

4.3.2 Estimation method

The bibliographic revision of the ratio of shark catches over total target catch used to estimate the potential shark catches as well as the catch estimation method/tables used can be presented for discussion in the Scientific Committees of Tuna RFMOS.

4.3.3 Summary report of management/mitigation measures and revision of shark fate on different fisheries

Tables “Technical mitigation options for sharks and rays, sea turtles, seabirds, marine mammals by fishing gears using criteria proposed by Patterson et al, 2009” and “Review of the information on at-vessel and postrelease mortality estimated onboard longliners, purse seiners and gillnets in various Oceans” can be valuable for Tuna RFMOs Scientific Committees..

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Annex I

IOTC –Implementation of Observer Programs

Table A1.1.- Update on the implementation of the IOTC regional observer scheme, as by December 2012 (Anon., 2012).

CPCs	Active Vessels LOA≥24m or High Seas vessels[1]				Progress	List of accredited observers submitted	Observer Trip Reports[2]		
	LL	PS	GN	BB			2010	2011	2012
MEMBERS									
Australia	6	5			Australia has implemented an observer programme that complies with the IOTC Regional Observer Scheme.	YES: 21	2	1	2
Belize	7				No information received by the Secretariat.	No	No	No	No
China	15				China has an observer programme.	No	1	No	No
–Taiwan,China	447				No information received by the Secretariat.	- YES: 54	- No	- No	- No
Comoros					Comoros does not have vessel more than 24m on which observer should be placed. 2 observers were trained under the IOC Regional Monitoring Project, and 5 by SWIOFP.	YES: 6	N/A	N/A	N/A
Eritrea	No information received				No information received by the Secretariat.	No	No	No	No
European Union	23	15			EU has an observer programme on-board its purse seine fleets, however the programme is limited due to the piracy activity in the western Indian Ocean. EU has or is developing observer programmes on-board its longline fleets, i.e. La Réunion, Spanish and Portuguese fleets.	Fra: 24 Prt: 4 Spn: no UK: no	No	Fra: 12 Prt: 1 Spn: no UK: no	Fra: 1 Prt: 1 Spn: no UK: no
France (OT)		5			France has an observer programme on board it purse seine fleet.	YES: 19	No	9	No
Guinea	No information received				No information received by the Secretariat.	No	No	No	No
India	51				India has not developed any observer programme so far.	No	No	No	No
Indonesia	1183	13	2		Indonesia has an observer programme based in Benoa, Bali with 5 trained observers. The number of observers should double in 2012.	No	No	No	No
Iran, Isl. Rep. of		5	1244		No information received by the Secretariat.	No	No	No	No
Japan	69	1			Japan has started its observer programme on the 1st of July 2010, and 14 observers are currently being deployed in the Indian Ocean.	YES: 14	6	No	No
Kenya	4				Kenya is developing an observer programme and 5 observers have been trained under the SWIOFP training.	No	No	No	No
Korea, Rep. of	7				Korea has an observer programme since 2002 with 3 observers being deployed in the Indian Ocean giving a14.5% coverage of	YES: 11	2	No	No
Madagascar	3				Madagascar is developing an observer programme. Five and three observers have been trained respectively under the SWIOFP and the IOC projects.	YES: 7	No	No	No
Malaysia	8				No information received by the Secretariat.	No	No	No	No
Maldives	No information received				Maldives vessels are monitored by field samplers at landing sites. Have in excess of 250 vessels larger than 24m.	No	No	No	No
Mauritius	4				Mauritius is developing an observer programme, and, 5 and 3 observers have been trained respectively under the SWIOFP and the IOC projects.	No	No	No	No
Mozambique	1				No information received by the Secretariat.	YES: 11	No	No	No
Oman	No information received				No information received by the Secretariat.	No	No	No	No
Pakistan			10		No information received by the Secretariat.	No	No	No	No
Philippines	3				No information received by the Secretariat.	No	No	No	No
Seychelles	23	8			Seychelles is developing an observer programme. Four and three observers have been trained respectively under the SWIOFP and the IOC projects.	YES: 7	No	No	No
Sierra Leone	0	0	0	0				No	No
Sri Lanka	749				Sri Lanka has not started the implementation of an observer programme.	No	No	No	No
Sudan	No information received				No information received by the Secretariat.	No	No	No	No
Tanzania, United Rep.of	1				No information received by the Secretariat.	No	No	No	No
Thailand	2				Thailand has not developed an observer programme so far.	No	No	No	No
United Kingdom	0	0	0	0	UK does not have any active vessels in the Indian Ocean.	N/A	N/A	N/A	N/A
Vanuatu					No information received by the Secretariat.	No	No	No	No
Yemen	No information received				No information received by the Secretariat.	No	No	No	No
COOPERATING NON-CONTRACTING PARTIES									
Senegal	0	0	0	0	Senegal does not have any active vessels in the Indian Ocean.	No	No	No	No
South Africa	15				South Africa has only an observer programme for foreign vessels operating in the EEZ of South Africa at the moment.	YES: 16	No	13[3]	10[3]

Table A1.2.- Estimated observer coverage for longline vessels, as by December 2012 (Anon., 2012).

CPCs	F		Observed		Coverage	
	2010	2011	2010	2011	2010	2011
Australia	622,461	359,832	15,330	6,232	2.46%	1.73%
Belize						
China - Taiwan,China	16,993,970 - 167,582,569	4,136,710 - 140,704,176	145,800		0.86%	-
Comoros						
Eritrea						
European Union						
France	2,856,404			113,269		-
Portugal	949,134	903,600		140,317		15.53%
Spain	3,174,705					
United Kingdom	61,400	92,300				
France(OT)						
Guinea						
India	143,652	134,845				
Indonesia						
Iran, Islamic Rep. of						
Japan	37,032,932	26,300,526	1,150,505		3.11%	-
Kenya						
Korea, Rep. of	3,843,901	5,361,769	389,042		10.12%	-
Madagascar						
Malaysia						
Maldives						
Mauritius	267,063	252,480				
Mozambique						
Oman						
Pakistan						
Philippines						
Seychelles	3,640,668	2,885,431				
Sierra Leone						
Sri Lanka						
Sudan						
Tanzania, United Rep. of						
Thailand						
United Kingdom						
Vanuatu						
Yemen						
COOPERATING NON CONTRACTING PARTIES						
Senegal						
South Africa		1,219,015				

Table A1.3.- Estimated observer coverage for Purse seine vessels, as by December 2012 (Anon., 2012).

CPCs	F		Observed		Coverage	
	2010	2011	2010	2011	2010	2011
Australia						
Belize						
China - Taiwan,China						
Comoros						
Eritrea						
European Union						
France	1066	1054		85		8.06%
Portugal						
Spain						
United Kingdom						
France(OT)	451	632		167		26.42%
Guinea						
India						
Indonesia						
Iran, Islamic Rep. of						
Japan						
Kenya						
Korea, Rep. of						
Madagascar						
Malaysia						
Maldives						
Mauritius						
Mozambique						
Oman						
Pakistan						
Philippines						
Seychelles						
Sierra Leone						
Sri Lanka						
Sudan						
Tanzania, United Rep. of						
Thailand						
United Kingdom						
Vanuatu						
Yemen						
Senegal						
South Africa						

Annex II

ACRONYMS

TL/TL	Total Length
LF	Fork Length
W	Weight
TW	Total Weight
PCL/PRC	Pre-Caudal Length
L∞	Asymptotic Length or Maximum population length (Von Bertalanffy growth parameters)
k	Growth rate (Von Bertalanffy growth parameters)
t0	Time when the fish has Length = 0 (Von Bertalanffy growth parameters)
% F	Frequency of Occurrence
% N	Percentage in Number
% W	Percentage in Weight
IRI	diet Index of Relative Importance
N^{15}	Stable Isotope of Nitrogen 15
C^{13}	Stable Isotope of Carbon 13

The biological parameters were compiled for the following sharks and ray species:

SHARKS									
FAO code	**Family**	**Scientific name**	**English name**	**French name**	**Spanish name**	**Distribution**			**TL cm**
PTH	Alopiidae	*Alopias pelagicus*	Pelagic thresher	Renard pélagique	Zorro pelagico		Ind.	Pac.	330
BTH	Alopiidae	*Alopias superciliosus*	Bigeye thresher	Renard à gros yeux	Zorro ojon	Atl.	Ind.	Pac.	460
ALV	Alopiidae	*Alopias vulpinus*	Thresher shark	Renard de mer	Zorro	Atl.	Ind.	Pac.	550
FAL	Carcharhinidae	*Carcharhinus falciformis*	Silky shark	Requin soyeux	Tiburón jaquetón	Atl.	Ind.	Pac.	330
OCS	Carcharhinidae	*Carcharhinus longimanus*	Oceanic whitetip shark	Requin océanique	Tiburón oceánico	Atl.	Ind.	Pac.	395
TIG	Carcharhinidae	*Galeocerdo cuvier*	Tiger shark	Requin-tigre commun	Tintorera tigre	Atl.	Ind.	Pac.	#600
BSH	Carcharhinidae	*Prionace glauca*	Blue shark	Peau bleue	Tiburón azul	Atl.	Ind.	Pac.	380
WSH	Lamnidae	*Carcharodon carcharias*	Great white shark	Grand requin blanc	Jaquetón blanco	Atl.	Ind.	Pac.	640
BSK	Lamnidae	*Cetorhinus maximus*	Basking shark	Pélerin	Peregrino	Atl.	Ind.	Pac.	1000
SMA	Lamnidae	*Isurus oxyrinchus*	Shortfin mako	Taupe bleue	Marrajo dientuso	Atl.	Ind.	Pac.	400
LMA	Lamnidae	*Isurus paucus*	Longfin mako	Petite taupe	Marrajo carite	Atl.	Ind.	Pac.	420
POR	Lamnidae	*Lamna nasus*	Porbeagle	Requin-taupe commun	Marrajo sardinero	Atl.	Ind.	Pac.	300
PSK	Pseudocarchariidae	*Pseudocarcharias kamoharai*	Crocodile shark	Requin-crocodile	Tiburon crocodrilo	Atl.	Ind.	Pac.	110
RHN	Rhincodontidae	*Rhincodon typus*	Whale shark	Requin-baleine	Tiburón ballena	Atl.	Ind.	Pac.	1500
SPL	Sphyrnidae	*Sphyrna lewini*	Scalloped hammerhead	Requins-marteau halicorne	Cornuda comùn	Atl.	Ind.	Pac.	420
SPK	Sphyrnidae	*Sphyrna mokarran*	Great hammerhad	Grand requin-marteau	Cornuda gigante	Atl.	Ind.	Pac.	610
SPZ	Sphyrnidae	*Sphyrna zyganea*	Smooth hammerhead	Requin-marteau commun	Cornuda cruz	Atl.	Ind.	Pac.	400
GAG	Triakidae	*Galeorhinus galeus*	Tope shark	Requin-hâ	Cazón	Atl.	Ind.	Pac.	200
RAYS									
FAO code	**Family**	**Scientific name**	**English name**	**French name**	**Spanish name**	**Distribution**			DW cm
PLS	Dasyatidae	*Pteroplatytrygon violacea*	Pelagic stingray	Pastenague violette	Chucho	Atl.	Ind	Pac.	160
RMA	Mobulidae	*Manta alfredi*	Alfred manta	Mante d'Alfred		?	Ind	Pac.	500
RMB	Mobulidae	*Manta birostris*	Giant manta	Mante géante	Manta gigante	Atl.	Ind	Pac.	910
MAE	Myliobatidae	*Aetobatus narinari*	Spotted eagle ray	Aigle de mer léopard	Chucho pintado	Atl.	Ind	Pac.	330
MRJ	Rhinopteridae	*Rhinoptera javanica*	Javanese cownose ray	Mourine javanaise	Gavilan machado		Ind	Pac.	150
MRM	Rhinopteridae	*Rhinoptera marginata*	Lusitanian cownose ray	Mourine échancrée	Gavilan lusitanico	Atl.			200

The data were compiled from the scientific and grey literatures as well as from some web sites. The data-bases from the regional fisheries organizations (e.g. ICCAT, IOTC, IATTC) were also searched. Every piece of information is indexed with number giving the reference. "Other references" mean additional useful references on the biology of the species and the few references that could not be obtained.

Many parameters are lacking; this compilation shows that the biology of the most important pelagic sharks and rays species is largely unknown.

Alopias pelagicus (Nakamura, 1935)

	Atlantic ocean	Mediterranean Sea	Indian ocean	Pacific ocean (West)	Pacific ocean (East)
BIOLOGY					
Maximum size (TL) (cm)	/		365① 383 ③⑤	383 ③⑤ 383 ④	383 ③⑤
Common size in fisheries (range LF) (cm)	/				
Maximum weight (kg)	/				
CONVERSION FACTORS					
Length / weight relationship	/		$TW=0,001*10^{-4}*FL^{2,15243}$ For males & females ①	Females: $W(kg) = 4.61 \times 10^{-5}$ $TL(cm)^{2.494}$ (n = 230) Males: $W(kg) = 3.98 \times 10^{-5}$ $TL(cm)^{2.52}$ (n = 230) ④ $W=2.56*10^{-4} * PCL^{2.511}$ (n=1300) (K.-M. Liu, unpubl. data) ⑥	value& n by sex
Wet Weight / dressed weight ratio	/				
TL / LF	/		TL = 2*LF⑤	TL = 2*LF⑤	TL = 2*LF⑤
LT / PRC	/		value& n by sex	value& n by sex	value& n by sex
Fins / carcass ratios	/				
REPRODUCTION					
Female maturity size (cm)	/		282-292 ③	282-292 TL ④	282-292 ③
Female maturity age (yr)	/		8-9 ①	8-9 ④	
Male maturity size (cm)	/		267-276 ③	267-276 TL④	267-276 ③
Male maturity age (yr)	/		7-8 ①	7-8 ④	
Birth size (cm)	/		130 - 160 up to 190 ③	130 - 160 up to 190 ③ 158 - 190 TL ④	130 - 160 up to 190 ③
Sex ratio	/		1:1 (for embryos) ③	1:1 (for embryos) ④	1:1 (for embryos) ③
Mode of development	/		aplacentally viviparous①②③	aplacentally viviparous ②③	aplacentally viviparous ②③
Gestation period (month)	/				
Mating period	/				
Spawning period	/				
Fecundity (embryos per litter)	/		Very low (2-4) ① 2 ③	2 ④	2 ③
Nursery ground	/				
AGE & GROWTH					
Von Bertalanffy growth curves parameters L∞, k, t_0 for females	/		value, method &range and type of size	L∞= 197 k= 0.09 t_0= -7.67 ④	value, method &range and type of size

Von Bertalanffy growth curves parameters L∞, k, t_0 for males	/		value, method &range and type of size	L∞= 182 k= 0.12 t_0= -5.48 ④	value, method & range and type of size
Longevity (yr)	/		estimated : 25-30ans observed: male : 20ans female : 28ans ①	Estimated : male : 20ans female : 29ans ③	Estimated : male : 20ans female : 29ans ③
DIET					
Nature of prey	/		Presumed: small fishes and cephalopod ③⑤	Presumed: small fishes and cephalopod ③⑤	Presumed: small fishes and cephalopod ③⑤
%F	/		Value, n and size range	Value, n and size range	Value, n and size range
%N	/		Value, n and size range	Value, n and size range	Value, n and size range
%W	/		Value, n and size range	Value, n and size range	Value, n and size range
IRI	/		Value, n and size range	Value, n and size range	Value, n and size range
Stables isotopes N^{15}& C^{13}	/		Value, n and size range	Value, n and size range	Value, n and size range
Trophic level	/		4.5 ⑤	4.5 ⑤	4.5 ⑤
HABITAT					
Depth range (m)	/		0 - 150 (neritic to oceanic) ⑦	0 - 150 (neritic to oceanic) ⑦ Abundant in 40 - 100 ④	0 - 150 (neritic to oceanic) ⑦
Temperature range (°C)	/				
CONTAMINANTS					
Heavy metals	/				
Organic pollutants	/				
PARASITES	/				

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Alopias superciliosus Lowe, 1840

	Atlantic ocean	Mediterranean Sea	Indian ocean	Pacific ocean (West)	Pacific ocean (East)
BIOLOGY					
Maximum size (TL) (cm)	488②③ 461⑧ [12] 460.7 [15] [16]	488②③ 461⑧ [12] 460.7 [15] [16]	461①⑧ 488②③ [12] 460.7 [15] [16]	488②③ 461⑧ [12] 460.7 [15] [16]	488②③ 461⑧[12] 460.7 [15] [16]
Common size in fisheries (range LF) (cm)					
Maximum weight (kg)	363.8 ②③	363.8 ②③	363.8 ②③	363.8 ②③	363.8 ②③
CONVERSION FACTORS					
Length / weight relationship	W (kg) = 9.1069 x 10^{-6} x FL $(cm)^{3.0802}$ (n = 55; both sexes) ⑦⑧ Females : W (kg) = 1.02 x 10^{-5} $TL(cm)^{2.78}$ (n = 175) Males : W (kg) = 3.73 x 10^{-5} $TL(cm)^{2.57}$ (n = 65) ⑧ W = 0.1825* 10^{-5} * $L^{3.448534}$ [20] [19]	Females : W (kg) = 1.02 x 10^{-5} $TL(cm)^{2.78}$ (n = 175) Males : W (kg) = 3.73 x 10^{-5} $TL(cm)^{2.57}$ (n = 65) ⑧	Both sexes : PT=0.155*10^{-4}*$FL^{2.97883}$ ① Females : W (kg) = 1.02 x 10^{-5} $TL(cm)^{2.78}$ (n = 175) Males : W (kg) = 3.73 x 10^{-5} $TL(cm)^{2.57}$ (n = 65) ⑧	Females : W (kg) = 1.02 x 10^{-5} $TL(cm)^{2.78}$ (n = 175) Males : W (kg) = 3.73 x 10^{-5} $TL(cm)^{2.57}$ (n = 65) ⑨	Females : W (kg) = 1.02 x 10^{-5} $TL(cm)^{2.78}$ (n = 175) Males : W (kg) = 3.73 x 10^{-5} $TL(cm)^{2.57}$ (n = 65) ⑧
Wet Weight / dressed weight ratio					
LT / LF	Both sexes : LF=0.5598LT+17.666 (n=56) ⑦⑧ TL=1.775FL-13.007 (n=77) [11]	Both sexes : LF=0.5598LT+ 17.666 (n=56) ⑧	Both sexes : LF=0.5598LT+ 17.666 (n=56) ⑧	Females: TL=13.3+1.69FL (n=177) Males: TL=26.3+1.56FL (n=68) ⑨ Both sexes : LF=0.5598LT+ 17.666 (n=56) ⑧	Both sexes : LF=0.5598LT+ 17.666 (n=56) ⑧
LT / PRC				Females: TL=15.3+1.81PCL (n=177) Males: TL=15.1+1.76PCL (n=68) ⑨	
Fins / carcass ratios					
REPRODUCTION					
Female maturity size (cm)	294-355⑧ 350 [13] 206.09 FL [14]	294-355⑧	332-355 ① 294-355⑧	294-355⑧ 332 341.1 ⑩	294-355⑧
Female maturity age (yr)	12-13⑧	12-13⑧	12-13 ①⑧	12-13 ⑧	12-13 ⑧
Male maturity size (cm)	279-300⑧ 290 - 300 [13] 159.74 FL [14] north-eastern Atlantic Ocean & western Mediterranean	279-300⑧ north-eastern Atlantic Ocean & western Mediterranean Sea : 276 [15]	270-300① 279-300⑧	279-300⑧ 270.1 -287.6 TL⑩	279-300⑧

	Sea : 276 [15]				
Male maturity age (yr)	9-10 ⑧	9-10 ⑧	9-10 ①⑧	9-10 ⑧	9-10 ⑧
Birth size (cm)	64-106cm⑥ 100-140⑧ 100 - 130 [12] Between 64 [17] - 105 [18] [15] north-eastern Atlantic Ocean & western Mediterranean Sea : at least 100 [15]	64-106cm⑥ 100-140⑧ 100 - 130 [12] Between 64 [17] - 105 [18] [15] north-eastern Atlantic Ocean & western Mediterranean Sea : at least 100 [15]]	64 – 140cm ① 64-106cm⑥ 100-140⑧ 100 - 130 [12] Between 64 [17] - 105 [18] [15]	64-106cm⑥ 100-140⑧ 135-140cm⑩ 100 - 130 [12] Between 64 [17] - 105 [18] [15]	64-106cm⑥ 100-140⑧ 100 - 130 [12] Between 64 [17] - 105 [18] [15]
Sex ratio	1:1⑧ 1.52:1 (Females (n=459) : males (n=301), n total =760 recorded) [14]	1:1⑧	1:1⑧	1:1⑧⑩	1:1⑧
Mode of development	Ovoviviparous aplacentary ⑧ Ovoviviparous [18]	Ovoviviparous aplacentary ⑧ Ovoviviparous [18]	Ovoviviparous aplacentary ①⑧ Ovoviviparous [18]	Ovoviviparous aplacentary ⑧ Ovoviviparous [18]	Ovoviviparous aplacentary ⑧ Ovoviviparous [18]
Gestation period (month)	12⑧ Probably 12	12⑧	12 ①⑧	12⑧ not etermined⑩	12⑧
Mating period					
Spawning period					
Fecundity (embryos per litter)	2 up to 4⑥ Commonly 2 [15] [19] 2 - 4 [15]	2 up to 4⑥ 2 - 4 [15]	Very low (2) ① 2up to 4⑥	2 up to 4⑥ 2⑩	2 up to 4⑥
Nursery ground	Nursery area: Straits of Gibraltar ⑧				
AGE & GROWTH					
Von Bertalanffy growth curves parameters L∞, k, t_0 for females				L∞= 224.6 k=0.092/yr t_0= -4.21 yr (n=214 VBGE) ⑨	
Von Bertalanffy growth curves parameters L∞, k, t_0 for males				L∞= 218.8 k=0.088/yr t_0= -4.24 yr (n=107 VBGE) ⑨	
Longevity (yr)	Observed: 20ans ②	Observed: 20ans ②	Observed: 20ans ②	Observed: Male: 19ans Femelle 20ans ①⑨	Observed: 20ans ②
DIET					
Nature of prey	Fish, Squid ④ Squid, scombrid remain [13]				
%F					
%N					
%W	Fish: 83.5% - Squid: 15.1%④				
IRI					
Stables isotopes N^{15}& C^{13}					
Trophic level	4.5②④	4.2②⑤	4.2②⑤	4.2②⑤	4.2②⑤

	4.2②⑤				
HABITAT					
Depth range (m)					
Temperature range (°C)					
CONTAMINANTS					
Heavy metals					
Organic pollutants					
PARASITES					

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Alopias vulpinus (Bonnaterre, 1788)

	Atlantic ocean	Mediterranean Sea	Indian ocean	Pacific ocean (West)	Pacific ocean (East)
BIOLOGY					
Maximum size (TL) (cm)	(unconfirmed: 760 ①③⑦) 573 ⑦ 610 ③	(unconfirmed: 760 ①③⑦) 573 ⑦ 610 ③	(unconfirmed: 760 ①③⑦) 573 ⑦ 610 ③	(unconfirmed: 760 ①③⑦) 573 ⑦ 610 ③	(unconfirmed: 760 ①③⑦) 573 ③⑦ 610③
Common size in fisheries (range LF) (cm)					
Maximum weight (kg)	348①②	348①②	348①②	348①②	348①②
CONVERSION FACTORS					
Length / weight relationship	Combined: $W= 1.8821*10^{-4}*FL^{2.5188}$ (n=88) ⑤⑦	Combined: $W= 1.8821*10^{-4}*FL^{2.5188}$ (n=88) ⑦	Combined: $W= 1.8821*10^{-4}*FL^{2.5188}$ (n=88) ⑦	Combined: $W= 1.8821*10^{-4}*FL^{2.5188}$ (n=88) ⑦	Combined: $W= 1.8821*10^{-4}*FL^{2.5188}$ (n=88) ⑦
Wet Weight / dressed weight ratio	value& n by sex	value& n by sex	value& n by sex	value& n by sex	value& n by sex
LT / LF	Combined : FL=0.5474TL+ 7.0262 (n=13) ⑤⑦	Combined : FL=0.5474TL+ 7.0262 (n=13) ⑦	Combined : FL=0.5474TL+ 7.0262 (n=13) ⑦	Combined : FL=0.5474TL+ 7.0262 (n=13) ⑦	Combined : FL=0.5474TL+ 7.0262 (n=13) ⑦
LT / PRC	value& n by sex	value& n by sex	value& n by sex	value& n by sex	value& n by sex
Fins / carcass ratios					
REPRODUCTION					
Female maturity size (cm)	FL=226 ⑤ (315 - 400 ⑦) (260 – 426.7 ⑨)	(315 - 400 ⑦) (260 – 426.7 ⑨)	(315 - 400 ⑦) (260 – 426.7 ⑨) 260 - 330 ⑩ [11] [12]	(315 - 400 ⑦) (260 – 426.7 ⑨)	(315 - 400 ⑦) (260 – 426.7 ⑨) 260 - 315 ③
Female maturity age (yr)	3 - 8 ⑦ 3 - 9 ⑨	3 - 8 ⑦ 3 - 9 ⑨	3 - 8 ⑦ 3 - 9 ⑨	3 - 8 ⑦ 3 - 9 ⑨	3 - 7 ③ 3 - 8 ⑦ 3 - 9 ⑨
Male maturity size (cm)	(FL=184 ⑤) (min: 252 ⑦) (260 - 426.7 ⑨)	(min: 252 ⑦) (260 - 426.7 ⑨)	(min: 252 ⑦) (260 - 426.7 ⑨)	(min: 252 ⑦) (260 - 426.7 ⑨)	(333 ③) (min: 252 ⑦) (260 - 426.7 ⑨)
Male maturity age (yr)	3 - 8 ⑦ 3 - 7 ⑨	3 - 8 ⑦ 3 - 7 ⑨	3 - 8 ⑦ 3 - 7 ⑨	3 - 8 ⑦ 3 - 7 ⑨	3 - 8 ⑦(③?) 3 - 7 ⑨
Birth size (cm)	117 - 150 ③ 114 - 160 ⑦ 100 - 158 ⑨	117 - 150 ③ 114 - 160 ⑦ 100 - 158 ⑨	117 - 150 ③ 114 - 160 ⑦ 100 - 158 ⑨ 149 ⑩ [11] [12]	117 - 150 ③ 114 - 160 ⑦ 100 - 158 ⑨	Estimed: 158 ③ 117 - 150 ③ 114 - 160 ⑦ 100 - 158 ⑨
Sex ratio					
Mode of development	Ovoviviparous ⑥	Ovoviviparous ⑥	Ovoviviparous ⑥	Ovoviviparous ⑥	Ovoviviparous ⑥
Gestation period (month)	9 ⑨	9 ⑨	9 ⑨	9 ⑨	9 ⑦⑨
Mating period	Summer ⑨				Summer ⑦⑨
Spawning period	Spring ⑨		Spring/Summer ⑩ [11] [12]		Spring ⑦⑨
Fecundity (embryos per litter)	3 - 7 ⑦	2 - 4 ⑥⑦	2 - 4 ⑥⑦	2 - 4 ⑥⑦	2 - 4 ⑥⑦ up to 6 ⑦
Nursery ground	Apparently uses inshore nursery areas in temperate waters ⑦	Apparently uses inshore nursery areas in temperate waters ⑦	Apparently uses inshore nursery areas in temperate waters ⑦	Apparently uses inshore nursery areas in temperate waters ⑦	Apparently uses inshore nursery areas in temperate waters ⑦
AGE & GROWTH					

Von Bertalanffy growth curves parameters L∞, k, t_0 for females	value, method & range and type of size	value, method & range and type of size	value, method &range and type of size	value, method & range and type of size	L∞ =636 k=0.158 t_0=1.021 (n =23 VBGE) ③
Von Bertalanffy growth curves parameters L∞, k, t_0 for males	value, method &range and type of size	value, method & range and type of size	value, method &range and type of size	value, method &range and type of size	L∞ =492.7 k=0.215 t0=1.416 (n=16 VBGE) ③
Longevity (yr)	Estimated : 45 - 50 ⑦ Observed : 25 ①④	Estimated : 45 - 50 ⑦ Observed : 25 ①④	Estimated : 45 - 50 ⑦ Observed : 25 ①④	Estimated : 45 - 50 ⑦ Observed : 25 ①④	Estimated : 45 - 50 ⑦③ Observed : 25 ①④
DIET					
Nature of prey	Fishes, squid, octopus, pelagic crustaceans,… ⑥	Fishes, squid, octopus, pelagic crustaceans,… ⑥	Fishes, squid, octopus, pelagic crustaceans,… ⑥	Fishes, squid, octopus, pelagic crustaceans,… ⑥	Fishes, squid, octopus, pelagic crustaceans,… ⑥
%F	Value, n and size range	Value, n and size range	Value, n and size range	Value, n and size range	Value, n and size range
%N	Value, n and size range	Value, n and size range	Value, n and size range	Value, n and size range	Value, n and size range
%W	Value, n and size range	Value, n and size range	Value, n and size range	Value, n and size range	Value, n and size range
IRI	Value, n and size range	Value, n and size range	Value, n and size range	Value, n and size range	Value, n and size range
Stables isotopes N^{15}& C^{13}	Value, n and size range	Value, n and size range	Value, n and size range	Value, n and size range	Value, n and size range
Trophic level	4.2⑧	4.2⑧	4.2⑧	4.2⑧	4.2⑧
HABITAT					
Depth range (m)					
Temperature range (°C)					
CONTAMINANTS					
Heavy metals					
Organic pollutants					
PARASITES					

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Carcharhinus falciformis (Müller & Henle, 1839)

	Atlantic ocean	Mediterranean Sea	Indian ocean	Pacific ocean (West)	Pacific ocean (East)
BIOLOGY					
Maximum size (TL) (cm)	350①② Observé: 305⑤[15]	350①②	350①②	350①② observé: 256⑥	350①②
Common size in fisheries (range LF) (cm)	2.5 LT②	2.5 LT②	2.5 LT②	2.5 LT②	2.5 LT②
Maximum weight (kg)	346①③	346①③	346①③	346①③	346①③
CONVERSION FACTORS					
Length / weight relationship	$W=2.01*10^{-6}TL^{3.23}$ ⑤ $W=1.5406*10^{-5} FL^{2.9221}$ (n=85)⑦ Cuba: $WT = 0.8782 * 10^{-5} TL^{3.091}$ ⑨ [16]	value& n by sex	$TW=0.160*10^{-4}*FL^{2.91497}$ ⑩	$W=2.92*10^{-6}TL^{3.15}$ (n=469)⑥	value& n by sex
Wet Weight / dressed weight ratio	value& n by sex	value& n by sex	value& n by sex	value& n by sex	value& n by sex
LT / LF	TL=1.20FL - 1.16 (n=108) ⑤ FL=0.8388TL - 2.6510 (n=15)⑦	value& n by sex	value& n by sex	TL=1.21FL + 3.64 (n=469)⑥	value& n by sex
LT / PRC	value& n by sex	value& n by sex	value& n by sex	TL=1.31PCL+3.64 (n=469)⑥ TL=2.08 + 1.32 PCL (n=82) [11]	TL=2.08 + 1.32 PCL (n=82) [11]
Fins / carcass ratios	Fine Weight (FW) / Carcass Weight (DW) = 2.5% (n=19) [14]	Fine Weight (FW) / Carcass Weight (DW) = 2.5% (n=19) [14]	Fine Weight (FW) / Carcass Weight (DW) = 2.5% (n=19) [14]	Fine Weight (FW) / Carcass Weight (DW) = 2.5% (n=19) [14]	Fine Weight (FW) / Carcass Weight (DW) = 2.5% (n=19) [14]
REPRODUCTION					
Female maturity size (cm)	>225 LT⑤ 233 [11] 232 - 245 [11] [12]		215.6 [13]	210 - 220⑥ 186 [11] 214 [11]	186 [11]
Female maturity age (yr)	7 - 9⑤ 12 [11] [12]		15 [13]	9.2 - 10.2⑥ 6 - 7 [11]	6 - 7 [11]
Male maturity size (cm)	210 - 220 LT⑤ 221 [11] 225 [11] [12]		207.6 [13]	212.5⑥ 200 - 206 [11] 238 - 250 [11]	200 - 206 [11]
Male maturity age (yr)	6 - 7⑤ 10 [11] [12]		13 [13]	9.3⑥ 5 - 6 [11]	5 - 6 [11]
Birth size (cm)	57 - 87② 72⑤ 68 - 84 [11] 75-80 ⑥ [12]	57 - 87②	57 - 87② 81.1 [13]	57 - 87② 63.5 - 75.5⑥ 65 - 81⑥ [11]	57 - 87② 65 - 81 ⑥[11]
Sex ratio			Female:1 male:1.14 (n=145 embryos) Female 1 Male 1.05 (n=1264 adult) [13]	1:1⑥	
Mode of development	viviparous②	viviparous②	viviparous②	viviparous②	viviparous②
Gestation period	12 month⑤ [11] [12]				
Mating period					
Spawning period	May - June⑤		No period [11]	No period⑥ [11]	No period [11]
Fecundity (embryos per litter)	2 - 14② 2 - 12 [11] [12]	2 - 14②	2 - 14② 2 - 14 [13]	2 - 14② 8 -10⑥ 1 - 16 [11]	2 - 14② 1 - 16 [11]
Nursery ground					

AGE & GROWTH					
Von Bertalanffy growth curves parameters L∞, k, t_0 for females	L∞=291cm k=0.153yr^{-1} t_0 =-2.2yr (n=135 VBGF)⑤		k= 0.057 L∞ = 320.4cm (n=90) [13]	L∞=332cm k=0.0838yr^{-1} t_0 =-2.761yr (n=250 VBGF)⑥	
Von Bertalanffy growth curves parameters L∞, k, t_0 for males	L∞=291cm k=0.153yr^{-1} t_0 =-2.2yr (n=135 VBGF)⑤		k = 0.079 L∞ = 277.3cm (n=78) [13]	L∞=332cm k=0.0838yr^{-1} t_0 =-2.761yr (n=250 VBGF)⑥	
Longevity (yr)	25④	25④	25④	25④ estimated: female: 35.8 male:28.6 (VBGF)⑥	25④
DIET					
Nature of prey	Fish, octopus②	Fish, octopus②	Fish, octopus②	Fish, octopus②	Fish, octopus②
%F	Value, n and size range	Value, n and size range	Value, n and size range	Value, n and size range	Value, n and size range
%N	Value, n and size range	Value, n and size range	Value, n and size range	Value, n and size range	Value, n and size range
%W	Value, n and size range	Value, n and size range	Value, n and size range	Value, n and size range	Value, n and size range
IRI	Value, n and size range	Value, n and size range	Value, n and size range	Value, n and size range	Value, n and size range
Stables isotopes N^{15}& C^{13}	Value, n and size range	Value, n and size range	Value, n and size range	Value, n and size range	Value, n and size range
Trophic level	4.2⑧	4.2⑧	4.2⑧	4.2⑧	4.2⑧
HABITAT					
Depth range	0 -500 m⑨	0 -500 m⑨	0 -500 m⑨	0 -500 m⑨	0 -500 m⑨
Temperature range	23 -24 °C⑨	23 -24 °C⑨	23 -24 °C⑨	23 -24 °C⑨	23 -24 °C⑨
CONTAMINANTS					
Heavy metals					
Organic pollutants					
PARASITES					

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IOTC-2011-SC14-27. Etat de la ressource du requin soyeux (*Carcharhinus falciformis*)

Carcharhinus longimanus (Poey, 1861)

	Atlantic ocean	Mediterranean Sea	Indian ocean	Pacific ocean (West)	Pacific ocean (East)
BIOLOGY					
Maximum size (TL) (cm)	396① 260⑨ max reported: 350 ⑧[14] estimated: 395 ⑧[14]	396①	396① 300⑨	396①②	396①
Common size in fisheries (range LF) (cm)	100 - 220 [13]		270TL⑨		
Maximum weight (kg)	167.4①③	167.4①③	167.4①③	167.4①③	167.4①③
CONVERSION FACTORS					
Length / weight relationship	$TW=0.7272*10^{-4} TL^{2.678}$ ⑩	value& n by sex	all sex: $TW=0.386*10^{-4} *FL^{2.75586}$ [11] [12] Females: $WT=0.508*10^{-4} *FL^{2.70428}$ [12] males: $WT=0.120*10^{-4} *FL^{2.98524}$ [12]	Males : $W=3.077 * 10^{-5} * PCL^{2.860}$ (n=133) Females: $W=5.076 * 10^{-5} * PCL^{2.761}$ (n=128) ⑧	Males : $W=3.077 * 10^{-5} * PCL^{2.860}$ (n=133) Females: $W=5.076 * 10^{-5} * PCL^{2.761}$ (n=128) ⑧
Wet Weight / dressed weight ratio	value& n by sex	value& n by sex	value& n by sex	value& n by sex	value& n by sex
LT / LF	TL=1.224*FL①	TL=1.224*FL①	TL=1.224*FL①	TL=1.224*FL①	TL=1.224*FL①
LT / PRC	TL=1.397xPCL [13]	TL=1.397xPCL [13]	TL=1.397xPCL [13]	TL=1.397 *PCL⑧	TL=1.397 *PCL⑧
Fins / carcass ratios					
REPRODUCTION					
Female maturity size (cm)	180 - 190⑦ 180 - 200⑩ 181 - 203 [13]	180 - 200⑩	180-190⑨ 180 - 200⑩	180 - 200⑩ 170 180 [11] 125 - 135 PCL (= 175 - 189 TL) ⑧ 170 - 180 ⑧ [15]	180 - 200⑩ 125 - 135 PCL (= 175 - 189 TL) ⑧
Female maturity age (yr)	6 - 7⑦			4 - 5 [11] 4 - 5 ⑧	4 - 5 ⑧
Male maturity size (cm)	180 - 190⑦ 175 - 198⑩ 160 196 [13]	175 - 198⑩	185 - 198⑨ 175 - 198⑩	175 - 198⑩ 170 180 [11] 125 - 135 PCL (= 175 - 189 TL) ⑧	175 - 198⑩ 125 - 135 PCL (= 175 - 189 TL) ⑧
Male maturity age (yr)	6 - 7⑦			4 - 5 [11] 4 - 5 ⑧	4 - 5 ⑧
Birth size (cm)	60-65①⑩ 65-70⑦	60-65①⑩	60-65①⑨⑩	60-65①⑤⑩ 45 - 55 PCL ⑧	60-65①⑩ 45 - 55 PCL ⑧
Sex ratio	(male:female) 1.2:1 [13]				
Mode of development	Placental viviparous⑦	Placental viviparous⑩	Placental viviparous⑩	Placental viviparous⑩	Placental viviparous⑩
Gestation period (months)	12⑩		12⑩	9 - 12 ⑧	9 - 12 ⑧
Mating period	Early summer⑩ Possibly around		Early summer⑩	June - July [13]⑧	June - July [13]⑧

	March [13]				
Spawning period	Early summer⑩ Possibly around January [13]		Early summer⑩	February - July [13]⑧	February - July [13]⑧
Fecundity (embryos per litter)	1 - 15①⑩ 1 - 14 [13]	1 - 15①⑩	1 - 15①⑩ 6 - 8 [13]⑨	1 - 15①⑤⑩ 1 - 14 (mean=6) ⑧	1 - 15①⑩ 1 - 14 (mean=6) ⑧
Nursery ground					
AGE & GROWTH					
Von Bertalanffy growth curves parameters L∞, k, t_0 for females	Combined sex L∞=325.4cm k=0.075yr^{-1} t_0= -3.342 yr^{-1} (n=258 VBGE) ⑦	value, method & range and type of size	value, method &range and type of size	Combined sex L∞=244.6cm k=0.1yr^{-1} t_0= -2.7yr^{-1} ⑧	Combined sex L∞=244.6cm k=0.1yr^{-1} t_0= -2.7yr^{-1} ⑧
Von Bertalanffy growth curves parameters L∞, k, t_0 for males	Combined sex L∞=284.9cm k=0.996yr^{-1} t_0= -3.391 yr^{-1} (n=258) ⑦	value, method & range and type of size	value, method &range and type of size	Combined sex L∞=244.6cm k=0.1yr^{-1} t_0= -2.7yr^{-1} ⑧	Combined sex L∞=244.6cm k=0.1yr^{-1} t_0= -2.7yr^{-1} ⑧
Longevity (yr)	22①④	22①④	22①④ observé: 17 [11]	22①④	22①④
DIET					
Nature of prey	Fish, Cephalopoda ⑥	Fish, Cephalopoda ⑥	Fish, Cephalopoda ⑥	Fish, Cephalopoda ⑥	Fish, Cephalopoda ⑥
%F	Value, n and size range	Value, n and size range	Value, n and size range	Value, n and size range	Value, n and size range
%N	Value, n and size range	Value, n and size range	Value, n and size range	Value, n and size range	Value, n and size range
%W	Value, n and size range	Value, n and size range	Value, n and size range	Value, n and size range	Value, n and size range
IRI	Value, n and size range	Value, n and size range	Value, n and size range	Value, n and size range	Value, n and size range
Stables isotopes N^{15}& C^{13}	Value, n and size range	Value, n and size range	Value, n and size range	Value, n and size range	Value, n and size range
Trophic level	4.2⑥	4.2⑥	4.2⑥	4.2⑥	4.2⑥
HABITAT					
Depth range	0 to -152m⑩	0 to -152m⑩	0 to -152m⑩	0 to -152m⑩	0 to -152m⑩
Temperature range	18 - 28°C⑩	18 - 28°C⑩	18 - 28°C⑩	18 - 28°C⑩	18 - 28°C⑩
CONTAMINANTS					
Heavy metals					
Organic pollutants					
PARASITES					

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Carcharodon carcharias (Linnaeus, 1758)

	Atlantic ocean	Mediterranean Sea	Indian ocean	Pacific ocean (West)	Pacific ocean (East)
BIOLOGY					
Maximum size (TL) (cm)	Estimated : 760 ①② About 600 ① Possibly 6.4 to 7.2 ⑧ 792 ⑨ Max measured : 6.4 (Cuba) [18]	Estimated : 760 ①② About 600 ① Possibly 6.4 to 7.2 ⑧ 792 ⑨	Estimated : 760 ①② About 600 ① Possibly 6.4 to 7.2 ⑧ 792 ⑨	Estimated : 760 ①② About 600 ① Possibly 6.4 to 7.2 ⑧ 792 ⑨	Estimated : 760 ①② About 600 ① Possibly 6.4 to 7.2 ⑧ 792 ⑨
Common size in fisheries (range LF) (cm)					
Maximum weight (kg)	3400 ⑨	3400 ⑨	3400 ⑨	3400 ⑨	3400 ⑨
CONVERSION FACTORS					
Length / weight relationship	$W=4.34*10^{-6}*TL^{3.14}$ (n=98 TL =127 to 554) ①③ $W=3.026*10^{-6}*TL^{3.188}$ ① (update③) $W=4.804*10^{-6}TL^{3.095}$ (n=200) ①⑤ $W=7.5763*10^{-6}*FL^{3.0848}$ (n=125) ①⑦	$W=4.34*10^{-6}*TL^{3.14}$ (n=98 TL =127 to 554) ①③ $W=3.026*10^{-6}*TL^{3.188}$ ① (update③)	$W=4.34*10^{-6}*TL^{3.14}$ (n=98 TL =127 to 554) ①③ $W=3.026*10^{-6}*TL^{3.188}$ ① (update③) $W=3.8*10^{-6}L^{3.15}$ (n=127 South Australia) ①④ $W=2.14*10^{-5}PCL^{2.944}$ (n=383 from South Africa) ①⑥	$W=4.34*10^{-6}*TL^{3.14}$ (n=98 TL =127 to 554) ①③ $W=3.026*10^{-6}*TL^{3.188}$ ① (update③) $W= 3.8*10^{-6}*L^{3.15}$ (n=127 South Australia) ①④ $W= 1.5710*10^{-5}*TL^{2.932}$ (n=21) [20]	$W=4.34*10^{-6}*TL^{3.14}$ (n=98 TL =127 to 554) ①③ $W=3.026*10^{-6}*TL^{3.188}$ ① (update③)
Wet Weight / dressed weight ratio	value& n by sex	value& n by sex	value& n by sex	value& n by sex	value& n by sex
LT / LF	FL = 0.9442*TL - 5.7441 (n=112) ①⑦ FL= -0.068359 + 0.9517TL (n=79) [12] ⑤	value& n by sex	value& n by sex	TL = 1.089 FL -1.01 (n=21) [20]	value& n by sex
LT / PRC	PCL = 0.8550 TL - 0.0955 (n=58) [11] [12]	PCL = 0.8550 TL - 0.0955 (n=58) [11] [12]	TL=1.251PCL + 5.207 (n=36) [11] ⑥ [15] PCL = 0.8550 TL - 0.0955 (n=58) [11] [12]	PCL = 0.8550 TL - 0.0955 (n=58) [11] [12] TL = 1.159 PCL + 15.76 (n=21) [20]	PCL = 0.8550 TL - 0.0955 (n=58) [11] [12]
Fins / carcass ratios					
REPRODUCTION					
Female maturity size (cm)	400 -500 ① 450 500 [15] [17]	400 -500 ① 450 500 [15] [17]	400 -500 ① 450 500 [15] [17]	400 -500 ① 450 500 [15] [17] 450 [20]	400 -500 ① 450 500 [15] [17]
Female maturity age (yr)	12 - 14 ① 12 - 17 [15]	12 - 14 ① 12 - 17 [15]	12 - 14 ① at least 12 - 13 [11] 12 - 17 [15]	12 - 14 ① 12 - 17 [15] 7 [20]	12 - 14 ① 12 - 17 [15] 9 - 10 ⑩ ②

Male maturity size (cm)	350 - 410 ① 366 - 427 [11] ② 360 - 380 [15]	350 - 410 ① 366 - 427 [11] ② 360 - 380 [15]	350 - 410 ① 366 - 427 [11] ② 360 - 380 [15]	350 - 410 ① 366 - 427 [11] ② 360 - 380 [15] 310 [20]	350 - 410 ① 366 - 427 [11] ② 360 - 380 [15]
Male maturity age (yr)	9 - 10 ① 9 - 10 [11] ② 7 - 9 [15]	9 - 10 ① 9 - 10 [11] ② 7 - 9 [15]	9 - 10 ① 8 - 10 [11] 9 - 10 [11] ② 7 - 9 [15]	9 - 10 ① 9 - 10 [11] ② 7 - 9 [15] 4 [20]	9 - 10 ① 9 - 10 [11] ② 7 - 9 [15]
Birth size (cm)	109 - 165 ① 120 - 150 [15] [17]	109 - 165 ① 120 - 150 [15] [17]	109 - 165 ① estimated: 100 - 135 [11] 120 - 150 [15] [17]	109 - 165 ① 120 - 150 [15] [17]	109 - 165 ① 120 - 150 [15] [17]
Sex ratio	1:1 (embryos) [15]	1:1 (embryos) [15]	1:1 (embryos) [15]	1:1 (embryos) [15]	1:1 (embryos) [15]
Mode of development	Ovoviviparous ①	Ovoviviparous ①	Ovoviviparous ①	Ovoviviparous ①	Ovoviviparous ①
Gestation period (month)	Not known but could be a year or more ① up to 18 [15]	Not known but could be a year or more ① up to 18 [15]	Not known but could be a year or more ① up to 18 [15]	Not known but could be a year or more ① up to 18 [15]	Not known but could be a year or more ① up to 18 [15]
Mating period					
Spawning period	Summer [14] ⑤ Spring/summer [14] ②	Spring/summer [14] ②	Spring/summer [14] ②	Spring/summer [14] ②	Spring/summer [14] ②
Fecundity (embryos per litter)	2 - 14 ① up to 10 ⑧ 7 - 14 ⑨ 2 - 17 [15]	2 - 14 ① up to 10 ⑧ 7 - 14 ⑨ 2 - 17 [15]	2 - 14 ① up to 10 ⑧ 7 - 14 ⑨ 2 - 17 [15]	2 - 14 ① up to 10 ⑧ 7 - 14 ⑨ 2 - 17 [15]	2 - 14 ① up to 10 ⑧ 7 - 14 ⑨ 7 ⑩ 2 - 17 [15]
Nursery ground					Point Conception California coast? [14]
AGE & GROWTH					
Von Bertalanffy growth curves parameters L∞, k, t_0 for females	L∞=764 TL k= 0.058/yr t_0= -3.5 yr (VBGF for both sex, n=21 size range: 129 - 507.9 TL) [11] ② [15]	L∞=764 TL k= 0.058/yr t_0= -3.5 yr (VBGF for both sex, n=21 size range: 129 - 507.9 TL) [11] ② [15]	L∞=764 TL k= 0.058/yr t_0= -3.5 yr (VBGF for both sex, n=21 size range: 129 - 507.9 TL) [11] ② [15] L∞=544 PCL k= 0.065/yr t_0= -4.4 yr (for both sex size range: 128 - 373 PCL) [11] [15] L∞=659.8 TL k= 0.071/yr t_0= -2.33 yr (for both sex size range: 140 - 520 TL) [14] [15]	L∞=764 TL k= 0.058/yr t_0= -3.5 yr (VBGF for both sex, n=21 size range: 129 - 507.9 TL) [11] ② [15] L∞=659.8 TL k= 0.071/yr t_0= -2.33 yr (for both sex size range: 140 - 520 TL) [14] [15] L∞= 607 TL k= 0.159 t_0= -1.80 yr [20]	L∞=764 TL k= 0.058/yr t_0= -3.5 yr (VBGF for both sex, n=21 size range: 129 - 507.9 TL) [11] ② [15]
Von Bertalanffy growth curves parameters L∞, k, t_0 for males	L∞=764 TL k= 0.058/yr t_0= -3.5 yr (VBGF for both sex, n=21 size	L∞=764 TL k= 0.058/yr t_0= -3.5 yr (VBGF for both sex, n=21 size	L∞=764 TL k= 0.058/yr t_0= -3.5 yr (VBGF for both sex, n=21 size	L∞=764 TL k= 0.058/yr t_0= -3.5 yr (VBGF for both sex, n=21 size	L∞ L∞=764 TL k= 0.058/yr t_0= -3.5 yr (VBGF for both sex, n=21 size

	range: 129 - 507.9 TL) [11] ② [15]	range: 129 - 507.9 TL) [11] ② [15]	range: 129 - 507.9 TL) [11] ② [15] L∞=544 PCL k= 0.065/yr t_0= -4.4 yr (for both sex size range: 128 - 373 PCL) [11] [15]	range: 129 - 507.9 TL) [11] ② [15] L∞= 455 TL k= 0.196 t_0= -1.92 yr [20]	range: 129 - 507.9 TL) [11] ② [15]
Longevity (yr)	Female: at least 23 ① Estimated: 27 ①② 40 - 50 [15] 30 [19] ②	emale: at least 23 ① Estimated: 27 ①② 40 - 50 [15]	emale: at least 23 ① Estimated: 27 ①② 40 - 50 [15]	emale: at least 23 ① Estimated: 27 ①② 40 - 50 [15]	emale: at least 23 ① Estimated: 27 ①② Max: 36 ⑩ 40 - 50 [15]
DIET					
Nature of prey	Bony fishes, marine mammals, marine birds, cephalopods & crustaceans, other shark,… ①	Bony fishes, marine mammals, marine birds, cephalopods & crustaceans, other shark,… ①	Bony fishes, marine mammals, marine birds, cephalopods & crustaceans, other shark,… ①	Bony fishes, marine mammals, marine birds, cephalopods & crustaceans, other shark,… ①	Bony fishes, marine mammals, marine birds, cephalopods & crustaceans, other shark,… ①
%F	Value, n and size range	Value, n and size range	Value, n and size range	Value, n and size range	Value, n and size range
%N	Value, n and size range	Value, n and size range	Value, n and size range	Value, n and size range	Value, n and size range
%W	Value, n and size range	Value, n and size range	Value, n and size range	Value, n and size range	Value, n and size range
IRI	Value, n and size range	Value, n and size range	Value, n and size range	Value, n and size range	Value, n and size range
Stables isotopes N^{15}& C^{13}	Value, n and size range	Value, n and size range	Value, n and size range	Value, n and size range	Value, n and size range
Trophic level	4.5 [13]	4.5 [13]	4.5 [13]	4.5 [13]	4.5 [13]
HABITAT					
Depth range (m)	0 to -1280 ⑧	0 to -1280 ⑧	0 to -1280 ⑧	0 to -1280 ⑧	0 to -1280 ⑧
Temperature range (°C)					
CONTAMINANTS					
Heavy metals					
Organic pollutants					
PARASITES					

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Cetorhinus maximus (Gunnerus, 1765)

	Atlantic ocean	Mediterranean Sea	Indian ocean	Pacific ocean (West)	Pacific ocean (East)
BIOLOGY					
Maximum size (TL) (cm)	maybe 1220 to 1520 but usually not exceed 980 ①	maybe 1220 to 1520 but usually not exceed 980 ①	maybe 1220 to 1520 but usually not exceed 980 ①	maybe 1220 to 1520 but usually not exceed 980 ①	maybe 1220 to 1520 but usually not exceed 980 ①
Common size in fisheries (range LF) (cm)					
Maximum weight (kg)	maybe up to7500 ① max published: 4000 ④	maybe up to7500 ① max published: 4000 ④	maybe up to7500 ① max published: 4000 ④	maybe up to7500 ① max published: 4000 ④	maybe up to7500 ① max published: 4000 ④
CONVERSION FACTORS					
Length / weight relationship	$Wt=0.0075*TL^3$ ① $W= 0.00494*L^3$ ④	$Wt=0.0075*TL^3$ ① $W= 0.00494*L^3$ ④	$Wt=0.0075*TL^3$ ① $W= 0.00494*L^3$ ④	$Wt=0.0075*TL^3$ ① $W= 0.00494*L^3$ ④	$Wt=0.0075*TL^3$ ① $W= 0.00494*L^3$ ④
Wet Weight / dressed weight ratio	value& n by sex	value& n by sex	value& n by sex	value& n by sex	value& n by sex
LT / LF	value& n by sex	value& n by sex	value& n by sex	value& n by sex	value& n by sex
LT / PRC	value& n by sex	value& n by sex	value& n by sex	value& n by sex	value& n by sex
Fins / carcass ratios					
REPRODUCTION					
Female maturity size (cm)	800 - 980 ①	800 - 980 ①	800 - 980 ①	800 - 980 ①	800 - 980 ①
Female maturity age (yr)	up to 20 ①	up to 20 ①	up to 20 ①	up to 20 ①	up to 20 ①
Male maturity size (cm)	400- 700①	400- 700①	400- 700①	400- 700①	400- 700①
Male maturity age (yr)	6 - 8 ①② 12 to 16 ①	6 - 8 ①② 12 to 16 ①	6 - 8 ①② 12 to 16 ①	6 - 8 ①② 12 to 16 ①	6 - 8 ①② 12 to 16 ①
Birth size (cm)	150 - 170 ① 150 - 200 ④ 153 ②	150 - 170 ① 150 - 200 ④ 153 ②	150 - 170 ① 150 - 200 ④ 153 ②	150 - 170 ① 150 - 200 ④ 153 ②	150 - 170 ① 150 - 200 ④ 153 ②
Sex ratio					
Mode of development	ovoviviparous ⑤	ovoviviparous ⑤	ovoviviparous ⑤	ovoviviparous ⑤	ovoviviparous ⑤
Gestation period (year)	3.5 ①② 2.6 ① ③? 1 - 3.5 ④	3.5 ①② 2.6 ① ③? 1 - 3.5 ④	3.5 ①② 2.6 ① ③? 1 - 3.5 ④	3.5 ①② 2.6 ① ③? 1 - 3.5 ④	3.5 ①② 2.6 ① ③? 1 - 3.5 ④
Mating period	early summer ④	early summer ④	early summer ④	early summer ④	early summer ④
Spawning period					
Fecundity (embryos per litter)					
Nursery ground					
AGE & GROWTH					
Von Bertalanffy growth curves parameters $L\infty$, k, t_0 for females	Female : $L\infty$= 1314cm k=0.0357 t_0= -3.4 yr whole population: $L\infty$= 1226cm k=0.045 t_0= -2.9 yr	Female : $L\infty$= 1314cm k=0.0357 t_0= -3.4 yr whole population: $L\infty$= 1226cm k=0.045 t_0= -2.9 yr	Female : $L\infty$= 1314cm k=0.0357 t_0= -3.4 yr whole population: $L\infty$= 1226cm k=0.045 t_0= -2.9 yr	Female : $L\infty$= 1314cm k=0.0357 t_0= -3.4 yr whole population: $L\infty$= 1226cm k=0.045 t_0= -2.9 yr	Female : $L\infty$= 1314cm k=0.0357 t_0= -3.4 yr whole population: $L\infty$= 1226cm k=0.045 t_0= -2.9 yr

	③ both sex: L∞= 10m k=0.062 t_0= -2.26 yr ⑦	③ both sex: L∞= 10m k=0.062 t_0= -2.26 yr ⑦	③ both sex: L∞= 10m k=0.062 t_0= -2.26 yr ⑦	③ both sex: L∞= 10m k=0.062 t_0= -2.26 yr ⑦	③ both sex: L∞= 10m k=0.062 t_0= -2.26 yr ⑦
Von Bertalanffy growth curves parameters L∞, k, t_0 for males	whole population: L∞= 1226cm k=0.045 t_0= -2.9 yr ③ both sex: L∞= 10m k=0.062 t_0= -2.26 yr ⑦	whole population: L∞= 1226cm k=0.045 t_0= -2.9 yr ③ both sex: L∞= 10m k=0.062 t_0= -2.26 yr ⑦	whole population: L∞= 1226cm k=0.045 t_0= -2.9 yr ③ both sex: L∞= 10m k=0.062 t_0= -2.26 yr ⑦	whole population: L∞= 1226cm k=0.045 t_0= -2.9 yr ③ both sex: L∞= 10m k=0.062 t_0= -2.26 yr ⑦	whole population: L∞= 1226cm k=0.045 t_0= -2.9 yr ③ both sex: L∞= 10m k=0.062 t_0= -2.26 yr ⑦
Longevity (yr)	50 ①②	50 ①②	50 ①②	50 ①②	50 ①②
DIET					
Nature of prey	small planktonic organisms, small copepods, barnacle, decapod stomatopod & fish eggs ①	small planktonic organisms, small copepods, barnacle, decapod stomatopod & fish eggs ①	small planktonic organisms, small copepods, barnacle, decapod stomatopod & fish eggs ①	small planktonic organisms, small copepods, barnacle, decapod stomatopod & fish eggs ①	small planktonic organisms, small copepods, barnacle, decapod stomatopod & fish eggs ①
%F	Value, n and size range	Value, n and size range	Value, n and size range	Value, n and size range	Value, n and size range
%N	Value, n and size range	Value, n and size range	Value, n and size range	Value, n and size range	Value, n and size range
%W	Value, n and size range	Value, n and size range	Value, n and size range	Value, n and size range	Value, n and size range
IRI	Value, n and size range	Value, n and size range	Value, n and size range	Value, n and size range	Value, n and size range
Stables isotopes N^{15}& C^{13}	Value, n and size range	Value, n and size range	Value, n and size range	Value, n and size range	Value, n and size range
Trophic level	3.2 ⑥	3.2 ⑥	3.2 ⑥	3.2 ⑥	3.2 ⑥
HABITAT					
Depth range (m)	0 - 2000 maybe to 4000 ① Recorded at 1264 ⑨	0 - 2000 maybe to 4000 ①	0 - 2000 maybe to 4000 ①	0 - 2000 maybe to 4000 ①	0 - 2000 maybe to 4000 ①
Temperature range (°C)	8 - 24 ①	8 - 24 ①	8 - 24 ①	8 - 24 ①	8 - 24 ①
CONTAMINANTS					
Heavy metals					
Organic pollutants					
PARASITES					

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Galeocerdo cuvier (Péron & Lesueur, 1822)

	Atlantic ocean	Mediterranean Sea	Indian ocean	Pacific ocean (West)	Pacific ocean (East)
BIOLOGY					
Maximum size (TL) (cm)	750① examined: 419④ reported: 550⑨	750①	750① recorded: 410⑨ seen: 740⑨	750① examined: 447⑦	750① examined: 447⑦
Common size in fisheries (range LF) (cm)	400②	400②	400②	400② 251 - 375⑦	400② 251 - 375⑦
Maximum weight (kg)	807.4①③	807.4①③	807.4①③	807.4①③	807.4①③
CONVERSION FACTORS					
Length / weight relationship	(Atlantic + Gulf of Mexico) $Wt=1.41*10^{-6}TL^{3.24}$ (n=120) ④ $WT=2.5281*10^{-6}*FL^{3.2603}$ (n=187) ⑥	value& n by sex	value& n by sex	value& n by sex	value& n by sex
Wet Weight / dressed weight ratio	value& n by sex	value& n by sex	value& n by sex	value& n by sex	value& n by sex
LT / LF	(Atlantic) FL=0.853TL-10.1 (n=66) ④ FL=0.8761TL - 13.3535 (n=44) ⑤⑥	value& n by sex	value& n by sex	value& n by sex	value& n by sex
LT / PRC	(Atlantic) PCL=0.797TL - 14.2 (n=68) ④	value& n by sex	(East coast of South Africa) TL= 1.215PCL + 16.483 (*n* = 478) ⑨	both sex: TL=1.2191PCL+ 20.181 (n=187) ⑦	both sex: TL=1.2191PCL+ 20.181 (n=187) ⑦
Fins / carcass ratios					
REPRODUCTION					
Female maturity size (cm)	315 - 320④ 297 mini ⑧ 250 - 350 [15]	250 - 350 [15]	340⑨ 250 - 350 [15] L_{50}= 274 PCL [19]	330 - 345⑦ 250 - 350 [15] 287 [17]	330 - 345⑦ 250 - 350 [15]
Female maturity age (yr)	10④ 7⑤ 4 - 6 [15] 8 - 11 [11]	4 - 6 [15]	4 - 6 [15] 11 [19]	4 - 6 [15]	4 - 6 [15]
Male maturity size (cm)	310④ 290mini ⑧ 226 - 290⑦⑩ [15]	226 - 290⑦⑩ [15]	290mini⑨ 226 - 290⑦⑩ [15] approximately 300 cm TL [13] L_{50}= 250 PCL [19]	292⑦ 226 - 290⑦⑩ [15]	292⑦ 226 - 290⑦⑩ [15]
Male maturity age (yr)	10④ 7⑤		8 [19]		
Birth size (cm)	73FL ⑤④ 61FL⑤ 51 - 76 [15]	51 - 76 [15]	51 - 76 [15]	Hawaii: usually: 80 - 90⑦ 51 - 76 [15] 60 - 104 [16] Australia: 80 - 90 [17]	Hawaii: usually: 80 - 90⑦ 51 - 76 [15]
Sex ratio			1:1 [13]	1:1(n=16 litters)⑦	1:1(n=16 litters)⑦
Mode of development	aplacental viviparous ⑦ Ovoviviparous [15]	aplacental viviparous ⑦ Ovoviviparous [15]	aplacental viviparous ⑦ Ovoviviparous [15]	aplacental viviparous ⑦ Ovoviviparous [15]	aplacental viviparous ⑦ Ovoviviparous [15]
Gestation period (month)	slightly over 1 year [15]	slightly over 1 year [15]	slightly over 1 year [15]	15 - 16 (give birth only once every 3 years)⑦ slightly over 1	15 - 16 (give birth only once every 3 years)⑦ slightly over 1

				year [15]	year [15]
Mating period	Northern Hemisphere: spring ⑩	in the Northern Hemisphere: spring ⑩	in the Northern Hemisphere: spring ⑩	January - February (ovulation in May-July) (n=3)⑦ in the Northern Hemisphere: spring ⑩ Summer [17]	Januay - February (ovulation in May-July) (n=3)⑦ in the Northern Hemisphere: spring ⑩
Spawning period	Northern Hemisphere: spring and summer ⑩	Northern Hemisphere: spring and summer ⑩	Northern Hemisphere: spring and summer ⑩	September-October⑦ Northern Hemisphere: spring and summer ⑩ Australia: summer [17] [18]	September-October⑦ Northern Hemisphere: spring and summer ⑩
Fecundity (embryos per litter)	10 - 82 [15]	10 - 82 [15]	10 - 82 [15]	3 - 57⑦ 10 - 82 [15] 10 - 82 [16] 6 - 56 [17]	3 - 57⑦ 10 - 82 [15]
Nursery ground					
AGE & GROWTH					
Von Bertalanffy growth curves parameters L∞, k, t_0 for females	both sex (Atlantic + Gulf of Mexico): L∞=294 PCL cm k=0.158 t_0= -1.73yr (VBGE)④ both sex: L∞=337cmFL k=0.178 t_0= -1.12yr (VBGE)⑤	value, method & range and type of size	both sex (East coast of South Africa): L∞=301 PCL cm k=0.202 t_0= -1.11yr (VBGE) [19]	both sex (Hawaii): L∞=335 PCL cm k=0.155 t_0= -0.619yr (VBGE) [19] [20]	both sex (Hawaii): L∞=335 PCL cm k=0.155 t_0= -0.619yr (VBGE) [19] [20]
Von Bertalanffy growth curves parameters L∞, k, t_0 for males	both sex (Atlantic + Gulf of Mexico): L∞=294 PCL cm k=0.158 t_0= -1.73yr (VBGE)④ both sex: L∞=337cmFL k=0.178 t_0= -1.12yr (VBGE)⑤	value, method & range and type of size	both sex (East coast of South Africa): L∞=301 PCL cm k=0.202 t_0= -1.11yr (VBGE) [19]	both sex (Hawaii): L∞=335 PCL cm k=0.155 t_0= -0.619yr (VBGE) [19] [20]	both sex (Hawaii): L∞=335 PCL cm k=0.155 t_0= -0.619yr (VBGE) [19] [20]
Longevity (yr)	Estimated: 20 -37 ④ 27⑤			28 [11]	28 [11]
DIET					
Nature of prey	Bony fishes, sharks (including its own species when hooked), rays, sea turtles, sea birds, seals, dolphins, cephalopods, spiny lobsters, crabs, horseshoe crabs, gastropods,	Bony fishes, sharks (including its own species when hooked), rays, sea turtles, sea birds, seals, dolphins, cephalopods, spiny lobsters, crabs, horseshoe crabs, gastropods,	Reptiles (turtle & sea snake), Teleost fishes, mammals (dugong,…) molluscs,… [12] Dugong, sea snack, sea turtle [13] Bony fishes,	Bony fishes, sharks (including its own species when hooked), rays, sea turtles, sea birds, seals, dolphins, cephalopods, spiny lobsters, crabs, horseshoe crabs, gastropods,	Bony fishes, sharks (including its own species when hooked), rays, sea turtles, sea birds, seals, dolphins, cephalopods, spiny lobsters, crabs, horseshoe crabs, gastropods,

	and jellyfishes. Terrestrial animals and incredible variety of refuse and garbage, including indigestible plastic, metal, and other items of human origin. ⑩	and jellyfishes. Terrestrial animals and incredible variety of refuse and garbage, including indigestible plastic, metal, and other items of human origin. ⑩	sharks (including its own species when hooked), rays, sea turtles, sea birds, seals, dolphins, cephalopods, spiny lobsters, crabs, horseshoe crabs, gastropods, and jellyfishes. Terrestrial animals and incredible variety of refuse and garbage, including indigestible plastic, metal, and other items of human origin. ⑩	and jellyfishes. Terrestrial animals and incredible variety of refuse and garbage, including indigestible plastic, metal, and other items of human origin. ⑩	and jellyfishes. Terrestrial animals and incredible variety of refuse and garbage, including indigestible plastic, metal, and other items of human origin. ⑩
%F	Value, n and size range	Value, n and size range	Value, n and size range	Occurrence of food item in the Townsville (n=558): Teleost 63.3% Sea snake 50% Crab 13.6% Bird 10.4% Turtle 10.4% Ray 2.2% Squid 2.0% Shark 1.6% Dugong 1.4% Dolphin 1.3% Lobster 0.6% Other molluscs 0.4 Prawn 0.4 Flying fox 0.4 Unidentified 0.7 [17]	Value, n and size range
%N	Value, n and size range	Value, n and size range	Value, n and size range	Value, n and size range	Value, n and size range
%W	Value, n and size range	Value, n and size range	Value, n and size range	Value, n and size range	Value, n and size range
IRI	Value, n and size range	Value, n and size range	Value, n and size range	Value, n and size range	Value, n and size range
Stables isotopes N^{15}& C^{13}	Value, n and size range	Value, n and size range	Value, n and size range	Value, n and size range	Value, n and size range
Trophic level	4.1 (n=13 study) [14]	4.1 (n=13 study) [14]	4.1 (n=13 study) [14]	4.1 (n=13 study) [14]	4.1 (n=13 study) [14]
HABITAT					
Depth range (m)	0 - 140 [15]	0 - 140 [15]	0 - 140 [15]	0 - 140 [15]	0 - 140 [15]
Temperature range (°C)					
CONTAMINANTS					
Heavy metals					
Organic pollutants					
PARASITES ?					

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Galeorhinus galeus (Linnaeus, 1758)

	Atlantic ocean	Mediterranean Sea	Indian ocean	Pacific ocean (West)	Pacific ocean (East)
BIOLOGY					
Maximum size (TL) (cm)	154.5 [13]	200 [12] [16]	In south Australia: 174.5 [21]	170 ② In south Australia: 174.5 [21]	195 ① 195 [15]
Common size in fisheries (range LF) (cm)					
Maximum weight (kg)	44.7 ③④	44.7 ③④	44.7 ③④	44.7 ③④	44.7 ③④
CONVERSION FACTORS					
Length / weight relationship	value& n by sex	value& n by sex	value& n by sex	Females: Wt = 4.86 x 10^{-6} $TL^{3.18}$ Males: Wt = 4.80 x 10^{-6} $TL^{3.17}$ ②	value& n by sex
Wet Weight / dressed weight ratio	value& n by sex	value& n by sex	value& n by sex	value& n by sex	value& n by sex
LT / LF	value& n by sex	value& n by sex	value& n by sex	value& n by sex	value& n by sex
LT / PRC	TL = 1.119 PCL + 13.738 [20]	value& n by sex	value& n by sex	value& n by sex	value& n by sex
Fins / carcass ratios					
REPRODUCTION					
Female maturity size (cm)	maturing between 130 - 185 ① >128 ⑧⑨ 118 - 128 TL (L_{50}= 123) [13] South-western Cape: females maturing at 137cm [14] L_{50}=125 [20]	maturing between 130 - 185 ① >140 [12] [16] 140 [19]	maturing between 130 - 185 ① (Australia) 140 ③⑦	maturing between 130 - 185 ① > 135 ② (Australia) 140 ③⑦	maturing between 130 - 185 ① First maturity at 170 [15]
Female maturity age (yr)	10 [14]			11 - 12 ① > 10 ②	
Male maturity size (cm)	maturing between 120 - 170 ① >113 ⑧⑨ 107 - 117 TL (L_{50}= 111) [13] South-western Cape: males maturing at 128cm [14] 108 - 119 [20]	maturing between 120 - 170 ① >125 [12] [16] 122.5 126 [19]	maturing between 120 - 170 ①	maturing between 120 - 170 ① > 120 ②	maturing between 120 - 170 ① First maturity at 135 [15]
Male maturity age (yr)	8.5 [14]			over 8 years ②	
Birth size (cm)	30 - 40 ① Average: 30.3 [13] 31 [19]	30 - 40 ① 37 [12] [16] 24 - 32 [19]	30 - 40 ①	30 - 40 ① 28 - 35 ②	30 - 40 ① 35 - 37 [15]

Sex ratio				Embryos: (males : females) 54:46 ② 12 months after parturition (males:females): 46:54 ②	
Mode of development	Ovoviviparous ①	Ovoviviparous ①	Ovoviviparous ①	Ovoviviparous ①	Ovoviviparous ①
Gestation period (month)	12 ③⑦ 12 [20]	12 ③⑦ 12 [19]	12 ③⑦	12 ③⑦	12 ③⑦ 12 [15]
Mating period		Tunisia : April to June [12] [16]			In California ovulation and fertilisation of the eggs occurred in spring [15]
Spawning period	South Africa: late December and January [12] [14]	Tunisia : April to June [12] [16]		Australia: Novembre - January ②	California: May to July [15]
Fecundity (embryos per litter)	6 - 52 ① mean : < 20 ① 4 - 41 (mean 23) [13] max 20 [14]	6 - 52 ① 10 - 41 (mean 30) [12] [16] 8 - 41 [19]	6 - 52 ①	6 - 52 ① mean : 28 ① 17 - 41 (mean: 28) ②	6 - 52 ① mean : 35 ① 6 - 52 [15]
Nursery ground	Off the Portugese coast, around the Canary Islands [12] [17] off northern Argentina [20]			Australia: Waters of Victoria, Tasmania ②	California: San Francisco Bay, Tomales bay [15]
AGE & GROWTH					
Von Bertalanffy growth curves parameters L∞, k, t_0 for females	L∞ =163 TL cm k = 0.075 t_0 = - 3 ⑧	Mixed: L∞ =184.9 TLcm k = 0.33 t_0 = - 1.35 ③ [11]	In South Australia for both sex: L∞ =182.9 TL k = 0.124 t_0 = - 1.29 (n=655) [21]	L∞ =162 TL cm k = 0.16 t_0 = - 1.28 (n=50) ⑩ In South Australia for both sex: L∞ =182.9 TL k = 0.124 t_0 = - 1.29 (n=655) [21]	value, method &range and type of size
Von Bertalanffy growth curves parameters L∞, k, t_0 for males	L∞ =152 TL cm k = 0.092 t_0 = - 2.69 ⑧	Mixed: L∞ =184.9 TLcm k = 0.33 t_0 = - 1.35 ③ [11]	In South Australia for both sex: L∞ =182.9 TL k = 0.124 t_0 = - 1.29 (n=655) [21]	L∞ =158 TL cm k = 0.17 t_0 = - 1.25 (n=53) ⑩ In South Australia for both sex: L∞ =182.9 TL k = 0.124 t_0 = - 1.29 (n=655) [21]	value, method & range and type of size
Longevity (yr)	22 ① 25 [12] [14] 40 up to 60 [12]	22 ① 40 up to 60 [12]	22 ① 40 up to 60 [12]	22 ① 22 ② 40 up to 60 [12]	22 ① 40 up to 60 [12]
DIET					
Nature of prey	Preys heavily on bony fishes, taking a wide	Preys heavily on bony fishes, taking a wide	Preys heavily on bony fishes, taking a wide	Preys heavily on bony fishes, taking a wide	Preys heavily on bony fishes, taking a wide

	variety of bottom and schooling midwater fishes, cephalopods, marine snail, crabs, other chondrichthyians, worms ① Fish [22]	variety of bottom and schooling midwater fishes, cephalopods, marine snail, crabs, other chondrichthyians, worms ①	variety of bottom and schooling midwater fishes, cephalopods, marine snail, crabs, other chondrichthyians, worms ①	variety of bottom and schooling midwater fishes, cephalopods, marine snail, crabs, other chondrichthyians, worms ①	variety of bottom and schooling midwater fishes, cephalopods, marine snail, crabs, other chondrichthyians, worms ①
%F	boarfish (C. aper): 38.6% [22]	Value, n and size range	Value, n and size range	Value, n and size range	Value, n and size range
%N	boarfish (C. aper): 65.0% snipefish (M. scolopax): 11.2% [22]	Value, n and size range	Value, n and size range	Value, n and size range	Value, n and size range
%W	boarfish (C. aper): 25.6% snipefish (M. scolopax): 2.7% [22]	Value, n and size range	Value, n and size range	Value, n and size range	Value, n and size range
IRI	Fish: %IRI= 99.95 Crustaceans: %IRI=0.03 cephalopods: %IRI=0.02 <u>In fishes:</u> boarfish (C. aper): %IRI= 93.2 snipefish (M. scolopax) %IRI= 3 [22]	Value, n and size range	Value, n and size range	Value, n and size range	Value, n and size range
Stables isotopes N^{15}& C^{13}	Value, n and size range	Value, n and size range	Value, n and size range	Value, n and size range	Value, n and size range
Trophic level	4.2 ⑥	4.2 ⑥	4.2 ⑥	4.2 ⑥	4.2 ⑥
HABITAT					
Depth range (m)	2 - 471 ①	2 - 471 ①	2 - 471 ①	2 - 471 ① up to 1100 ③⑤	2 - 471 ①
Temperature range (°C)					
CONTAMINANTS					
Heavy metals				mercury concentrations in the axial muscle ranging from 0.01 to 4.9µg g^{-1} wet weight [12] [18]	
Organic pollutants					
PARASITES					

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Isurus oxyrinchus Rafinesque, 1810

	Atlantic ocean	Mediterranean Sea	Indian ocean	Pacific ocean (West)	Pacific ocean (East)
BIOLOGY					
Maximum size (TL) (cm)	396 estimated: 408 ① 396.2 ② [25]	396 estimated: 408 ①	396 estimated: 408 ①	396 estimated: 408 ①	396 estimated: 408 ① 350.7 ② [26]
Common size in fisheries (range LF) (cm)	commonly to 207 ⑧	commonly to 207 ⑧	commonly to 207 ⑧	commonly to 207 ⑧	commonly to 207 ⑧
Maximum weight (kg)	505.8 ⑨	505.8 ⑨	505.8 ⑨	505.8 ⑨	505.8 ⑨
CONVERSION FACTORS					
Length / weight relationship	$W=1.193*10^{-6} *TL^{3.46}$ (n=23, TL=160 to 260) ①④ $W= 1.47*10^{-5} *PCL^{2.95}$ (n=143, PCL=84 to 260 South Africa) ①⑤ $W=5.2432*10^{-6} *FL^{3.1407}$ (n=2081) ⑥ $W=7.2999 * TL(m)^{3.224}$ (n=63) ⑦		$W= 1.47*10^{-5} *PCL^{2.95}$ (n=143, PCL=84 to 260 South Africa) ①⑤	$W=4.832*10^{-6} *TL^{3.10}$ (n=80 TL=58 to 343) ①③	
Wet Weight / dressed weight ratio	value& n by sex	value& n by sex	value& n by sex	value& n by sex	value& n by sex
LT / LF	FL= 0.9286*TL -1.7101 (n=199) ⑥ FL=0.972TL - 9.36 TL= 1.02FL + 11.75 [20]	value& n by sex	value& n by sex	FL=0.918TL - 2.078 [15] FL=0.952 + 0.890TL (n=1236 TL: 80 - 375) [20]	value& n by sex
LT / PRC	value& n by sex	value& n by sex	value& n by sex	PCL= 0.784+0.816TL (n=1240 TL: 80 - 375) [20] PCL=0.84TL - 2.13 (n=131) [24]	value& n by sex
Fins / carcass ratios					
REPRODUCTION					
Female maturity size (cm)	maturing: 275 - 293 ① 298 (West North Atlantic) ⑦ 273 (Southern Hemisphere) ⑦ 275 FL ⑩ 270 - 300 [22]	275 - 293 ① 270 - 300 [22]	275 - 293 ① 273 ⑦ 270 - 300 [22]	275 - 293 ① 280 ③ 273 ⑦ 275 - 285 FL [18] 278 [20] 270 - 300 [22]	275 - 293 ① 273 ⑦ [13] 270 - 300 [22]
Female maturity age (yr)	18 [10] 7 ⑩ [11]			19.1 - 21 [15] 18 - 19 [10]	7 - 8 [12] 15 [13]

				[17] 16 [24]	
Male maturity size (cm)	maturing : 203 - 215 ① 185 FL ⑩ 180 FL [21] 200 - 220 [22]	maturing : 203 - 215 ① 200 - 220 [22]	maturing : 203 - 215 ① 200 - 220 [22]	maturing : 203 - 215 ① 195 ③ 180 - 185 FL [18] 210 [20] 200 - 220 [22]	maturing : 203 - 215 ① 180 [13] [14] 180 - 195 [20] [3] 200 - 220 [22]
Male maturity age (yr)	8 ⑩ 3 ⑩ [11]			6.9 - 9 [15] 13 - 14 [10] [17] 6 [24]	7 - 8 [12] 7 [13]
Birth size (cm)	60 - 70 ① 70 - 90 ② 70 ⑦ 60 - 110 [23]	60 - 70 ① 70 - 90 ② 70 ⑦ 60 - 110 [23]	60 - 70 ① 70 - 90 ② 70 ⑦ 60 - 110 [23]	60 - 70 ① 70 - 90 ② 70 ⑦ 74 [20] 60 - 110 [23]	60 - 70 ① 70 - 90 ② 70 ⑦ 60.5 [12] 60 - 110 [23]
Sex ratio	1:1 (young of the year) [21]	1:1 [21] [3]	1:1 [21] [3]	1:1 [21] [3]	1:1 [21] [3]
Mode of development	ovoviviparous ①	ovoviviparous ①	ovoviviparous ①	ovoviviparous ①	ovoviviparous ①
Gestation period (month)	15 - 18 ① 15 - 18 ⑦	15 - 18 ① 15 - 18 ⑦	15 - 18 ① 15 - 18 ⑦	15 - 18 ① 15 - 18 ⑦ 23 - 25 months [20]	15 - 18 ① 15 - 18 ⑦
Mating period				January to June [20]	
Spawning period	late winter to midsummer ①	late winter to midsummer ①	late winter to midsummer ①	late winter to midsummer ① Decembre to July [20]	late winter to midsummer ①
Fecundity (embryos per litter)	4 - 30 (mostly 10 to 18) ① 4 - 25 ⑦ In south Africa: 9 - 14 ⑦⑤	4 - 30 (mostly 10 to 18) ① 4 - 25 ⑦ 25 - 30 ⑦[27]	4 - 30 (mostly 10 to 18) ① 4 - 25 ⑦ In Australia: 4 - 16 ⑦③ In south Africa: 9 - 14 ⑦⑤	4 - 30 (mostly 10 to 18) ① 4 - 25 ⑦ 4 - 15 [20] In Australia: 4 - 16 ⑦③	4 - 30 (mostly 10 to 18) ① 4 - 25 ⑦ 2 - 16 [12]
Nursery ground					
AGE & GROWTH					
Von Bertalanffy growth curves parameters $L\infty$, k, t_0 for females	$L\infty$=366cm FL k=0.087yr^{-1} (n=140; VBGF) ⑩ $L\infty$=345cm FL k=0.203yr^{-1} t_0= -1yr (n=54; VBGF) ⑩[11]	value, method & range and type of size	value, method &range and type of size	$L\infty$=732.41cm FL k=0.0154yr^{-1} t_0= -10.79yr (n=111; VBGF) [15] $L\infty$=403.62cm FL k=0.040yr^{-1} t_0= -5.27yr (n= 174; FL: 72.6 - 314.9; VBGF) [10] [16] $L\infty$=349cm FL k=0.155yr^{-1} t_0= -1.97yr (n=52; FL: 74 - 314; VBGF) [10] [17] $L\infty$=308.3cm FL	sexes combined $L\infty$=321cm TL k=0.072yr^{-1} t_0= -3.75yr (n=44; VBGF) ② [12] sexes combined $L\infty$=411cm TL k=0.05yr^{-1} t_0= -4.7yr (n=109; VBGF) [13]

				$k=0.09yr^{-1}$ (n = 147) [24]	
Von Bertalanffy growth curves parameters L∞, k, t_0 for males	L∞=253cm FL $k=0.125yr^{-1}$ (n= 118; VBGF) ⑩ L∞=302cm FL $k=0.266yr^{-1}$ t_0= -1yr (n=49; VBGF) ⑩ [11]	value, method & range and type of size	value, method &range and type of size	L∞=302.16cm FL $k=0.0524yr^{-1}$ t_0= -9.04yr (n=145; VBGF) [15] L∞=321.8cm FL $k=0.049yr^{-1}$ t_0= -6.07yr (n= 133; FL: 72.6 - 314.9; VBGF) [10] [16] L∞=267cm FL $k=0.312yr^{-1}$ t_0= -0.95yr (n=24; FL: 66 - 274; VBGF) [10] [17] L∞=231cm FL $k=0.16yr^{-1}$ (n=128) [24]	sexes combined L∞=321cm TL $k=0.072yr^{-1}$ t_0= -3.75yr (n=44; VBGF) ②[12] sexes combined L∞=411cm TL $k=0.05yr^{-1}$ t_0= -4.7yr (n=109; VBGF) [13]
Longevity (yr)	estimated: 45 ①② Reported: female: 32; male: 29 ⑩	estimated: 45 ①②	estimated: 45 ①②	estimated: 45 ①② estimated: male: 29 female: 28 [15]	estimated: 45 ①② 38 [12]
DIET					
Nature of prey	bony fishes, other elasmobranchs, cephalopods [1]	bony fishes, other elasmobranchs, cephalopods [1]	bony fishes, other elasmobranchs, cephalopods [1]	bony fishes, other elasmobranchs, cephalopods [1]	bony fishes, other elasmobranchs, cephalopods [1]
%F	Value, n and size range	Value, n and size range	Value, n and size range	Value, n and size range	Value, n and size range
%N	Value, n and size range	Value, n and size range	Value, n and size range	Value, n and size range	Value, n and size range
%W	Value, n and size range	Value, n and size range	Value, n and size range	Value, n and size range	Value, n and size range
IRI	Value, n and size range	Value, n and size range	Value, n and size range	Value, n and size range	Value, n and size range
Stables isotopes N^{15}& C^{13}	Value, n and size range	Value, n and size range	Value, n and size range	Value, n and size range	Value, n and size range
Trophic level	4.3 [19]	4.3 [19]	4.3 [19]	4.3 [19]	4.3 [19]
HABITAT					
Depth range (m)	0 - 500 ① usually 0 -150 ⑨	0 - 500 ① usually 0 -150 ⑨	0 - 500 ① usually 0 -150 ⑨	0 - 500 ① usually 0 -150 ⑨	0 - 500 ① usually 0 -150 ⑨
Temperature range (°C)	16° to tropical & warm temperature ①	16° to Tropical & warm temperature ①	16° to tropical & warm temperature ①	16° to tropical & warm temperature ①	16° to tropical & warm temperature ①
CONTAMINANTS					
Heavy metals					
Organic pollutants					
PARASITES					

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Isurus paucus Guitart, 1966

	Atlantic ocean	Mediterranean Sea	Indian ocean	Pacific ocean (West)	Pacific ocean (East)
BIOLOGY					
Maximum size (TL) (cm)	417 ① 426.7 ⑦	417 ① 426.7 ⑦	417 ① 426.7 ⑦	417 ① 426.7 ⑦	417 ① 426.7 ⑦
Common size in fisheries (range LF) (cm)					
Maximum weight (kg)					
CONVERSION FACTORS					
Length / weight relationship	value& n by sex	value& n by sex	$W=2.54*10^{-4}*FL^{2.32}$ (n=17 FL: 150 - 250) ⑨	value& n by sex	value& n by sex
Wet Weight / dressed weight ratio	value& n by sex	value& n by sex	value& n by	value& n by sex	value& n by sex
LT / LF	FL=0.888TL (based on photo measurement) ③	FL=0.888TL (based on photo measurement) ③	FL=0.888TL (based on photo measurement) ③	FL=0.888TL (based on photo measurement) ③	FL=0.888TL (based on photo measurement) ③
LT / PRC	value& n by sex	value& n by sex	value& n by sex	value& n by sex	value& n by sex
Fins / carcass ratios					
REPRODUCTION					
Female maturity size (cm)	245 ①	245 ①	245 ①	245 ①	245 ①
Female maturity age (yr)	14 ⑧	14 ⑧	14 ⑧	14 ⑧	14 ⑧
Male maturity size (cm)	245 ① 229 ⑦	245 ① 229 ⑦	245 ① 229 ⑦	245 ① 229 ⑦	245 ① 229 ⑦
Male maturity age (yr)					
Birth size (cm)	97 - 120 ①⑦ 122 ⑤ 97 ⑥	97 - 120 ①⑦ 122 ⑤	97 - 120 ①⑦ 122 ⑤	97 - 120 ①⑦ 122 ⑤	97 - 120 ①⑦ 122 ⑤
Sex ratio					
Mode of development	ovoviviparous ①	ovoviviparous ①	ovoviviparous ①	ovoviviparous ①	ovoviviparous ①
Gestation period (month)					
Mating period					
Spawning period					
Fecundity (embryos per litter)	2 ② 2 - 8 ③⑦ 2 - 4 ⑧ 2 (but only one was present in uterus) ⑥	2 ② 2 - 8 ③⑦ 2 - 4 ⑧	2 ② 2 - 8 ③⑦ 2 - 4 ⑧	2 ② 2 - 8 ③⑦ 2 - 4 ⑧	2 ② 2 - 8 ③⑦ 2 - 4 ⑧
Nursery ground					
AGE & GROWTH					
Von Bertalanffy growth curves parameters L∞, k, t_0 for females	value, method & range and type of size	value, method & range and type of size	value, method &range and type of size	value, method & range and type of size	value, method &range and type of size
Von Bertalanffy growth curves parameters L∞, k, t_0	value, method &range and type of size	value, method & range and type of size	value, method &range and type of size	value, method &range and type of size	value, method & range and type of size

for males					
Longevity (yr)					
DIET					
Nature of prey	bony fish, cephalopods ③ ④	bony fish, cephalopods ③	bony fish, cephalopods ③	bony fish, cephalopods ③	bony fish, cephalopods ③
%F	Value, n and size range	Value, n and size range	Value, n and size range	Value, n and size range	Value, n and size range
%N	Value, n and size range	Value, n and size range	Value, n and size range	Value, n and size range	Value, n and size range
%W	Value, n and size range	Value, n and size range	Value, n and size range	Value, n and size range	Value, n and size range
IRI	Value, n and size range	Value, n and size range	Value, n and size range	Value, n and size range	Value, n and size range
Stables isotopes N^{15}& C^{13}	Value, n and size range	Value, n and size range	Value, n and size range	Value, n and size range	Value, n and size range
Trophic level	4.5 ③	4.5 ③	4.5 ③	4.5 ③	4.5 ③
HABITAT					
Depth range (m)	0 - 200 ③	0 - 200 ③	0 - 200 ③	0 - 200 ③	0 - 200 ③
Temperature range (°C)					
CONTAMINANTS					
Heavy metals					
Organic pollutants					
PARASITES					

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Lamna nasus (Bonnaterre, 1788)

	Atlantic ocean	Mediterranean Sea	Indian ocean	Pacific ocean (West)	Pacific ocean (East)
BIOLOGY					
Maximum size (TL) (cm)	300 (possibly to 370) ① max reported size: 355 TL [14]	300 (possibly to 370) ① max reported size: 355 TL [14]	300 (possibly to 370) ① max reported size: 355 TL [14]	300 (possibly to 370) ① max reported size: 355 TL [14]	300 (possibly to 370) ① max reported size: 355 TL [14]
Common size in fisheries (range LF) (cm)					
Maximum weight (kg)	230 ⑩⑤	230 ⑩⑤	230 ⑩⑤	230 ⑩⑤	230 ⑩⑤
CONVERSION FACTORS					
Length / weight relationship	$W=1.4823*10^{-6} * FL^{2.9641}$ (n=15) ② $W=0.5*10^{-4} * FL^{2.713}$ (n=286) ③ male: $TW=0.001922* L^{2.008}$ Female: $TW=0.000315* L^{2.327}$ [12] [13]	value& n by sex	value& n by sex	mixed: $TW=0.0000286* FL^{2.924}$ ⑩ Log_{10} (weight) = -5.050 + 3.128 Log_{10} (FL) (n=641) ④	value& n by sex
Wet Weight / dressed weight ratio	value& n by sex	value& n by sex	value& n by sex	value& n by sex	value& n by sex
LT / LF	FL=1.7939 + 0.8971TL (n=13) ② FL=0.99+ 0.885TL TL=1.12FL (n=361) ③	value& n by sex	value& n by sex	TL = 4.165 + 1.098FL (n=173; FL: 63 - 180) ④	value& n by sex
LT / PRC		value& n by sex	value& n by sex	For New Zealand : PL = -1.366 + 0.907 FL FL - 1.990 + 1.098 PL (n=866) For Australia: PL = 4.165 + 1.098 FL FL = -0.567 + 0.881 TL (n=173) ④	value& n by sex
Fins / carcass ratios					
REPRODUCTION					
Female maturity size (cm)	237 TL ① 212 FL ③ 210 - 230 FL (L_{50}=218 FL) ⑦			185 - 202 south pacific ① 170 - 180 FL ⑥ 195 TL (South Pacific) [14] 165 - 180 FL ④	185 - 202 south pacific ① 195 TL (South Pacific) [14]
Female maturity age	14 ① ③				

(yr)	13.1 ⑦				
Male maturity size (cm)	196 TL ① 150 -200 TL ① 175 FL ③ 162 - 185 FL (L_{50}=174 FL) ⑦	150 -200 TL ①	150 -200 TL ①	150 -200 TL ① 140 - 150 FL ⑥ 165 TL (south Pacific) [14]	150 -200 TL ① 165 TL (south Pacific) [14]
Male maturity age (yr)	7 ① ③ 8.1 ⑦				
Birth size (cm)	60 - 75 ① 65 - 75 ③ 61 - 76 [15]	60 - 75 ① 65 - 75 ③ 61 - 76 [15]	60 - 75 ① 65 - 75 ③ 61 - 76 [15]	60 - 75 ① 69 - 80 in South Pacific ① 65 - 75 ③ 61 - 76 [15] 58 - 67 FL ④	60 - 75 ① 69 - 80 in South Pacific ① 65 - 75 ③ 61 - 76 [15]
Sex ratio					
Mode of development	ovoviviparous ①	ovoviviparous ①	ovoviviparous ①	ovoviviparous ①	ovoviviparous ①
Gestation period (month)	8 - 9 ①			8 - 9 (south Pacific pop) ① 8 -9 ④	8 - 9 (south Pacific pop) ①
Mating period	late summer ① Septembre - Novembre ⑦				
Spawning period	spring ① In North Atlantic: Spring - Summer ④ April - June (spring) ⑦		winter [14]	winter [14] In South West Pacific probably June July (winter) ④	winter [14]
Fecundity (embryos per litter)	1 - 5 (majority of 4 young) ① 4 ③ average of 4 ⑦	1 - 5 (majority of 4 young) ① 4 ③	1 - 5 (majority of 4 young) ① 4 ③	1 - 5 (majority of 4 young) ① 4 ③ usually 4 ④	1 - 5 (majority of 4 young) ① 4 ③
Nursery ground	may be in contineental water ① In northeast Atlantic: off the coast of Europe & the British Isles ⑩	may be in contineental water ①	may be in contineental water ①	may be in contineental water ①	may be in contineental water ①
AGE & GROWTH					
Von Bertalanffy growth curves parameters L∞, k, t_0 for females	both sex: L∞=253 FL k=0.097 t_0=-4.89 (n=308) ③ L∞=309.8 FL k=0.061 t_0= -5.90 (n=291 Vertebral method) [10]	value, method & range and type of size	value, method &range and type of size	value, method & range and type of size	value, method &range and type of size
Von Bertalanffy growth curves parameters L∞, k, t_0 for males	both sex: L∞=253 FL k=0.097 t_0=-4.89 (n=308) ③ L∞=257.7 FL k=0.08 t_0= -5.78 (n=283	value, method & range and type of size	value, method &range and type of size	value, method &range and type of size	value, method & range and type of size

	vertebral Method) [10]				
Longevity (yr)	30 - 45 ① Observed: males: 25 Females: 24 Calculated: 45 - 46 [11] reported : 26 [14]	reported : 26 [14]	reported : 26 [14]	reported : 26 [14]	reported : 26 [14]
DIET					
Nature of prey	moderate-sized pelagic schooling fishes, demersal fishes, cephalopods ①	moderate-sized pelagic schooling fishes, demersal fishes, cephalopods ①	moderate-sized pelagic schooling fishes, demersal fishes, cephalopods ①	moderate-sized pelagic schooling fishes, demersal fishes, cephalopods ①	moderate-sized pelagic schooling fishes, demersal fishes, cephalopods ①
%F	Value, n and size range	Value, n and size range	Value, n and size range	Value, n and size range	Value, n and size range
%N	Value, n and size range	Value, n and size range	Value, n and size range	Value, n and size range	Value, n and size range
%W	Value, n and size range	Value, n and size range	Value, n and size range	Value, n and size range	Value, n and size range
IRI	Value, n and size range	Value, n and size range	Value, n and size range	Value, n and size range	Value, n and size range
Stables isotopes N^{15}& C^{13}	Value, n and size range	Value, n and size range	Value, n and size range	Value, n and size range	Value, n and size range
Trophic level	4.2 ⑨	4.2 ⑨	4.2 ⑨	4.2 ⑨	4.2 ⑨
HABITAT					
Depth range (m)	0 - 700 ①	0 - 700 ①	0 - 700 ①	0 - 700 ①	0 - 700 ①
Temperature range (°C)	usually : 1 -18 but up to 23 ① 2 - 18 but mainly 5 -10 ⑧	usually : 1 -18 but up to 23 ①	usually : 1 -18 but up to 23 ①	usually : 1 -18 but up to 23 ①	usually : 1 -18 but up to 23 ①
CONTAMINANTS					
Heavy metals					
Organic pollutants					
PARASITES					

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Prionace glauca (Linnaeus, 1758)

	Atlantic ocean	Mediterranean Sea	Indian ocean	Pacific ocean (West)	Pacific ocean (East)
BIOLOGY					
Maximum size (TL) (cm)	383①② (unconfirmed): 4.8-6.5①② 396.2 [30]	383①② (unconfirmed): 4.8-6.5①② 396.2 [30]	383①② (unconfirmed): 4.8-6.5①② 396.2 [30]	383①② (unconfirmed): 4.8-6.5①② 396.2 [30]	383①② (unconfirmed): 4.8-6.5①② 396.2 [30]
Common size in fisheries (range LF) (cm)	common length: 335③ 93 - 387 TL [20] Usually: 180 - 240FL [22] male: 156 - 250 female: 156 - 250 [25]	common length: 335③ Usually: 180 - 240FL [22]	common length: 335③ male: 170 - 330 female 130 - 330 [22] [23] Usually: 180 - 240FL [22]	common length: 335③ Usually: 180 - 240FL [22]	common length: 335③ Usually: 180 - 240FL [22]
Maximum weight (kg)	205.9③④	205.9③④	205.9③④	205.9③④	205.9③④
CONVERSION FACTORS					
Length / weight relationship	LogW=-5.396 + 3.134logTL ① $WT=0.0110LT^{2.828}$ (n=74) ⑨ $WT=3.1841*10^{-6}FL^{3.1313}$ (n=4529) ⑩	LogW=-5.396 + 3.134logTL ①	LogW=-5.396 + 3.134logTL ① $WT=0.159*10^{-4}LF^{2.84554}$ [26]	LogW=-5.396 + 3.134logTL ①	LogW=-5.396 + 3.134logTL ①
Wet Weight / dressed weight ratio	value& n by sex	value& n by sex	value& n by sex	value& n by sex	value& n by sex
LT / LF	FL=0.8313TL+ 1.3908 (n=572) ⑩ FL = 1.73872 + 0.82995TL [19] TL = 1.175*FL + 4.103 [22] FL=11.27 + 0.78TL [25] FL=-1.2+0.842TL TL=3.8+1.17FL [27] In Gulf of Guinea: FL = -1.061 + 0.8203TL TL = 1.716 + 1.2158FL (n=62) [35]	value& n by sex	value& n by sex	$FL=-1.615+0.838TL_{nat}$ (n=273) ⑥	value& n by sex
LT / PRC	value& n by sex	value& n by sex	value& n by sex	value& n by sex	value& n by sex
Fins / carcass ratios	(*) [24] FW=65.84BW/ 0.0888 [27]				
REPRODUCTION					
Female maturity size (cm)	221① >185 [19] 228 LT [28] [25] 50% of females have embryos : 180 FL (=220 TL)	221①	221①	221① 170 - 190⑥ 170 - 195⑦ 186 - 212 [17][16]	221① 186 - 212 [17][16]

	[35]				
Female maturity age (yr)	5 - 6 ① 6 [19] 5 - 7 [28] [29] 5 [28] [25]			7 - 9 ⑦ 5 - 6 [17] [16]	5 - 6 [17] [16]
Male maturity size (cm)	182 - 281? ①③ 193 - 210 (at 50% maturity of 201) FL [17] [18] 183 FL [19] 225 FL [28] [25] L_{95} = 205 FL [36]	182 - 281? ①③	182 - 281? ①③	182 - 281? ①③ 190 - 195⑥⑦ 203 [17] [16]	182 - 281? ①③ 203 [17] [16]
Male maturity age (yr)	4 - 5 ① 4 - 6 [28] [29]			8 ⑦ 4-5 [17] [16]	4-5 [17] [16]
Birth size (cm)	35 - 44 ① 40 - 50 [17]	35 - 44 ①	35 - 44 ①	35 - 44 ① 40 - 50 [17]	35 - 44 ① 40 - 50 [17] 43.5 [14] [30]
Sex ratio	1:1 (embryos) [17] 1:1 (embryos) [35]		1:1 (embryos)①	1:1 (embryos) [17]	1:1 (embryos) [17]
Mode of development	viviparous with a yolk-sac placenta ① Placentally viviparous [19]	viviparous with a yolk-sac placenta ①	viviparous with a yolk-sac placenta ①	viviparous with a yolk-sac placenta ①	viviparous with a yolk-sac placenta ①
Gestation period (month)	9 - 12 ① 9 -12 [19]	9 - 12 ①	9 - 12 ①	9 - 12 ①	9 - 12 ①
Mating period	ovulation and fertilization occurred mainly from December to July [36]				
Spawning period	spring to early summer ①⑦ April to July [19]	spring to early summer ①	spring to early summer ①	spring to early summer ①⑦	spring to early summer ①⑦
Fecundity (embryos per litter)	4 - 135 ① 4 - 63② 80③ up to 82 [19]	4 - 135 ① 4 - 63② 80③	4 - 135 ① 4 - 63② 80③	4 - 135 ① 4 - 63② 80③ 1 - 62 (n=600) [17] [16]	4 - 135 ① 4 - 63② 80③ 1 - 62 (n=600) [17] [16]
Nursery ground					
AGE & GROWTH					
Von Bertalanffy growth curves parameters L_∞, k, t_0 for females	L_∞=310FL k=0.16 t_0= -1.56 (n=118) [13] Both sex: L_∞=394 k=0.13 t_0= -0.80 (n=268) [21] [33] Both sex: L_∞=423 k=0.11 t_0= - 1.04 (n=82) [21] [34]	value, method & range and type of size	value, method &range and type of size	L_∞= 235.5 k= 0.2297 ⑦ L_∞=304 k=0.16 t_0= -1.01 (n=43) [21]	L_∞=237.5 TL k=0.15 t_0= -2.15 (n=62) [12] L_∞=241.9 k=0.25 t_0= -0.79 (n=88) [12] [14] [30]
Von Bertalanffy growth curves parameters L_∞, k, t_0 for males	L_∞=282FL k=0.18 t_0= -1.35 (n=287) [13] Both sex: L_∞=394	value, method & range and type of size	value, method &range and type of size	L_∞= 297.18 k= 0.1650 ⑦ L_∞=369 k=0.1 t_0= -1.38 (n=152) [21]	L_∞=299.85 TL k=0.10 t_0= -2.44 (n=122) [12] L_∞=295.3 TL k=0.18

	k=0.13 t_0= -0.80 (n=268) [21] [33] Both sex: L∞=423 k=0.11 t_0= - 1.04 (n=82) [21] [34]				t_0= -1.11 (n=38) [12] [14] [30]
Longevity (yr)	at least 20 ①③ estimated: 16 - 20 [13]	at least 20 ①③	at least 20 ①③ males: 25, female: 21 [26]	at least 20 ①③ estimated: male: 22.76 female: 19.73 ⑦	at least 20 ①③
DIET					
Nature of prey	bony fishes & squid ① Pelagic teleosts, groundfish [11]	bony fishes & squid ①	bony fishes & squid ①	bony fishes & squid ①	bony fishes & squid ①
%F	Value, n and size range	Value, n and size range	Value, n and size range	Value, n and size range	Value, n and size range
%N	Value, n and size range	Value, n and size range	Value, n and size range	Value, n and size range	Value, n and size range
%W	Value, n and size range	Value, n and size range	Value, n and size range	Value, n and size range	Value, n and size range
IRI	Value, n and size range	Value, n and size range	Value, n and size range	Value, n and size range	Value, n and size range
Stables isotopes N^{15}& C^{13}	Value, n and size range	Value, n and size range	Value, n and size range	Value, n and size range	Value, n and size range
Trophic level	4.1 [32]	4.1 [32]	4.1 [32]	4.1 [32]	4.1 [32]
HABITAT					
Depth range (m)	0 - 152 ① 0 - 350 ⑧ 0 - 600	0 - 152 ①	0 - 152 ① 80 - 220 ①	0 - 152 ①	0 - 152 ①
Temperature range (°C)	7 - 16 up to 21 ①	7 - 16 up to 21 ①	7 - 16 up to 21 ①	7 - 16 up to 21 ① female caught: 8 -21° male caught : 12 - 21° [15]	7 - 16 up to 21① female caught: 8 -21° male caught : 12 - 21° [15]
CONTAMINANTS					
Heavy metals	[31]				
Organic pollutants					
PARASITES					

(*) : tableau p4 [24]

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Pseudocarcharias kamoharai (Matsubara, 1936)

	Atlantic ocean	Mediterranean Sea	Indian ocean	Pacific ocean (West)	Pacific ocean (East)
BIOLOGY					
Maximum size (TL) (cm)	110 ① 131 ⑤	110 ① 131 ⑤	110 ① 131 ⑤	110 ① 131 ⑤	110 ① 131 ⑤
Common size in fisheries (range LF) (cm)	males: 65.5 - 109 Females: 75 - 122 ⑥				
Maximum weight (kg)					
CONVERSION FACTORS					
Length / weight relationship	value& n by sex	value& n by sex	value& n by sex	value& n by sex	value& n by sex
Wet Weight / dressed weight ratio	value& n by sex	value& n by sex	value& n by sex	value& n by sex	value& n by sex
LT / LF	FL=0.7516TL + 11.33 (n=238) ⑤	FL=0.7516TL + 11.33 (n=238) ⑤	FL=0.7516TL + 11.33 (n=238) ⑤	FL=0.7516TL + 11.33 (n=238) ⑤	FL=0.7516TL + 11.33 (n=238) ⑤
LT / PRC	value& n by sex	value& n by sex	value& n by sex	value& n by sex	value& n by sex
Fins / carcass ratios					
REPRODUCTION					
Female maturity size (cm)	89 ① 87 - 103 ⑤ 87 - 98 (L_{T50}=91.6) ⑥	89 - 110 ① 87 - 103 ⑤	89 - 110 ① 87 - 103 ⑤	89 - 110 ① 87 - 103 ⑤	89 - 110 ① 87 - 103 ⑤
Female maturity age (yr)					
Male maturity size (cm)	74 ① 73 - 74 ⑤ 76 - 81 (L_{T50}=80) ⑥	74 - 110 ① 73 - 74 ⑤	74 - 110 ① 73 - 74 ⑤	74 - 110 ① 73 - 74 ⑤	74 - 110 ① 73 - 74 ⑤
Male maturity age (yr)					
Birth size (cm)	41 ① 40 - 43 ③ 36 - 45 ⑤ 41.5 ⑥	41 ① 40 - 43 ③ 36 - 45 ⑤	41 ① 40 - 43 ③ 36 - 45 ⑤	41 ① 40 - 43 ③ 36 - 45 ⑤	41 ① 40 - 43 ③ 36 - 45 ⑤
Sex ratio	embryos: 1:1 by catch: 1:1.8 (male:female) ⑥				
Mode of development	ovoviviparous ①	ovoviviparous ①	ovoviviparous ①	ovoviviparous ①	ovoviviparous ①
Gestation period (month)					
Mating period	no reproduvtive seasonality ⑥				
Spawning period	no reproduvtive seasonality ⑥				
Fecundity (embryos per litter)	4 ①	4 ①	4 ①	4 ① ④	4 ① ④
Nursery ground					
AGE & GROWTH					
Von Bertalanffy growth curves parameters L∞, k, t_0 for females	value, method & range and type of size	value, method & range and type of size	value, method &range and type of size	value, method & range and type of size	value, method &range and type of size

Von Bertalanffy growth curves parameters $L\infty$, k, t_0 for males	value, method &range and type of size	value, method & range and type of size	value, method &range and type of size	value, method &range and type of size	value, method & range and type of size
Longevity (yr)					
DIET					
Nature of prey	small fishes, small shrimp, squid beaks,… ①	small fishes, small shrimp, squid beaks,… ①	small fishes, small shrimp, squid beaks,… ①	small fishes, small shrimp, squid beaks,… ①	small fishes, small shrimp, squid beaks,… ①
%F	Value, n and size range	Value, n and size range	Value, n and size range	Value, n and size range	Value, n and size range
%N	Value, n and size range	Value, n and size range	Value, n and size range	Value, n and size range	Value, n and size range
%W	Value, n and size range	Value, n and size range	Value, n and size range	Value, n and size range	Value, n and size range
IRI	Value, n and size range	Value, n and size range	Value, n and size range	Value, n and size range	Value, n and size range
Stables isotopes N^{15}& C^{13}	Value, n and size range	Value, n and size range	Value, n and size range	Value, n and size range	Value, n and size range
Trophic level	4.21 (estimated) ②	4.21 (estimated) ②	4.21 (estimated) ②	4.21 (estimated) ②	4.21 (estimated) ②
HABITAT					
Depth range (m)	0 - 590 ①	0 - 590 ①	0 - 590 ①	0 - 590 ①	0 - 590 ①
Temperature range (°C)					
CONTAMINANTS					
Heavy metals					
Organic pollutants					
PARASITES					

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Rhincodon typus Smith, 1828

	Atlantic ocean	Mediterranean Sea	Indian ocean	Pacific ocean (West)	Pacific ocean (East)
BIOLOGY					
Maximum size (TL) (cm)	1700 - 1800 or even 2140 max measured: 1370 ①	1700 - 1800 or even 2140 max measured: 1370 ①	1700 - 1800 or even 2140 max measured: 1370 ① 1880 ⑥ ⑦	1700 - 1800 or even 2140 max measured: 1370 ①	1700 - 1800 or even 2140 max measured: 1370 ①
Common size in fisheries (range LF) (cm)	300 - 1200 ①	300 - 1200 ①	300 - 1200 ①	300 - 1200 ①	300 - 1200 ①
Maximum weight (kg)	2000 up to 3600 ①	2000 up to 3600 ①	2000 ①	2000 ①	2000 ①
CONVERSION FACTORS					
Length / weight relationship	$W(t)= 0.0075TL^3$ ①	$W(t)= 0.0075TL^3$ ①	$W(t)= 0.0075TL^3$ ①	$W(t)= 0.0075TL^3$ ①	$W(t)= 0.0075TL^3$ ①
Wet Weight / dressed weight ratio					
LT / LF			TL= 1.063 FL + 26.491 (n=8; FL: 473 - 850) ⑤		
LT / PRC			TL= 1.252 PCL + 20.308 (n=21; PCL: 254 - 780) ⑤		
Fins / carcass ratios					
REPRODUCTION					
Female maturity size (cm)	760? ①	760? ①	760? ① > 900 ⑥	760? ①	760? ①
Female maturity age (yr)					
Male maturity size (cm)	705 ①	705 ①	705 ① 810 (L_{50}) ⑧ > 900 ⑥ ⑨	705 ①	705 ①
Male maturity age (yr)			30 ⑧		
Birth size (cm)	55 - 64 ① 41 - 48 PCL ⑤ 50 - 60 ⑧ smallest free swimming: 55 [11] [13]	55 - 64 ① 41 - 48 PCL ⑤ 50 - 60 ⑧ smallest free swimming: 55 [11] [13]	55 - 64 ① 41 - 48 PCL ⑤ 50 - 60 ⑧ smallest free swimming: 55 [11] [13]	55 - 64 ① 41 - 48 PCL ⑤ 50 - 60 ⑧ > 46 [11] 58 - 64 [12] ④ smallest free swimming: 55 [11] [13]	55 - 64 ① 41 - 48 PCL ⑤ 50 - 60 ⑧ smallest free swimming: 55 [11] [13]
Sex ratio	1:1 at birth ⑥	1:1 at birth ⑥	1:1 at birth ⑥	1.0:1.1 (male:female, young) ① 1:1 at birth ④⑥	1:1 at birth ⑥
Mode of development	ovoviviparous ③	ovoviviparous ③	ovoviviparous ③	ovoviviparous ③ Ovoviviparous ④	ovoviviparous ③
Gestation period (month)	not known ①	not known ①	not known ①	not known ①	not known ①
Mating period					
Spawning period					
Fecundity (embryos per litter)				up to 300 ④	
Nursery ground					

AGE & GROWTH					
Von Bertalanffy growth curves parameters L∞, k, t_0 for females	both sex: L∞=14m k= 0.05yr^{-1} ? ②	both sex: L∞=14m k= 0.05yr^{-1} ? ②	both sex: L∞=14m k= 0.05yr^{-1} ? ② Both sex : L∞=14.96m k= 0.032yr^{-1} t0=-0.85yr ⑤	both sex: L∞=14m k= 0.05yr^{-1} ? ②	both sex: L∞=14m k= 0.05yr^{-1} ? ②
Von Bertalanffy growth curves parameters L∞, k, t_0 for males	both sex: L∞=14m k= 0.05yr^{-1} ? ②	both sex: L∞=14m k= 0.05yr^{-1} ? ②	both sex: L∞=14m k= 0.05yr^{-1} ? ② Both sex : L∞=14.96m k= 0.032yr^{-1} t0=-0.85yr ⑤	both sex: L∞=14m k= 0.05yr^{-1} ? ②	both sex: L∞=14m k= 0.05yr^{-1} ? ②
Longevity (yr)					
DIET					
Nature of prey	planktonic & nektonic organisms, small crustaceans, fish ① copepod, jellyfish, eggs of fish, small fish, plankton, shrimp,… ⑥	planktonic & nektonic organisms, small crustaceans, fish ① copepod, jellyfish, eggs of fish, small fish, plankton, shrimp,… ⑥	planktonic & nektonic organisms, small crustaceans, fish ① copepod, jellyfish, eggs of fish, small fish, plankton, shrimp,… ⑥	planktonic & nektonic organisms, small crustaceans, fish ① copepod, jellyfish, eggs of fish, small fish, plankton, shrimp,… ⑥	planktonic & nektonic organisms, small crustaceans, fish ① copepod, jellyfish, eggs of fish, small fish, plankton, shrimp,… ⑥
%F	Value, n and size range	Value, n and size range	Value, n and size range	Value, n and size range	Value, n and size range
%N	Value, n and size range	Value, n and size range	Value, n and size range	Value, n and size range	Value, n and size range
%W	Value, n and size range	Value, n and size range	Value, n and size range	Value, n and size range	Value, n and size range
IRI	Value, n and size range	Value, n and size range	Value, n and size range	Value, n and size range	Value, n and size range
Stables isotopes N^{15}& C^{13}	A revoir p14 ⑥	A revoir p14 ⑥	A revoir p14 ⑥	A revoir p14 ⑥	A revoir p14 ⑥
Trophic level	3.5 ⑩		3.5 ⑩	3.5 ⑩	3.5 ⑩
HABITAT					
Depth range (m)	700 ① 0 up to 1000 with majority of time <100 ⑥	0 up to 1000 with majority of time <250 ⑥	0 up to 1000 with majority of time <250 ⑥	0 up to 1000 with majority of time <250 ⑥	0 up to 1000 with majority of time <250 ⑥
Temperature range (°C)	Predominantly in warm temperature (20 - 35) with limited periods at 6 - 10 ⑥	Predominantly in warm temperature (20 - 35) with limited periods at 6 - 10 ⑥	Predominantly in warm temperature (20 - 35) with limited periods at 6 - 10 ⑥	Surface: 21 - 25 with upwelling ① Predominantly in warm temperature (20 - 35) with limited periods at 6 - 10 ⑥	prefer 26 - 34 but down to 10 ① Predominantly in warm temperature (20 - 35) with limited periods at 6 - 10 ⑥
CONTAMINANTS					
Heavy metals					
Organic pollutants					
PARASITES					

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Sphyrna lewini (Griffith & Smith, 1834)

	Atlantic ocean	Mediterranean Sea	Indian ocean	Pacific ocean (West)	Pacific ocean (East)
BIOLOGY					
Maximum size (TL) (cm)	370 - 420 ①	370 - 420 ①	370 - 420 ①	370 - 420 ① 309 [18]	370 - 420 ① 309 [18]
Common size in fisheries (range LF) (cm)					
Maximum weight (kg)	152.4 ③ 166 ⑨	152.4 ③	152.4 ③	152.4 ③	152.4 ③
CONVERSION FACTORS					
Length / weight relationship	$Wt= 1.26*10^{-5}* TL^{2.81}$ ⑤ $WT= 7.7745 * 10^{-6} * FL^{3.0669}$ (n=390) ⑨	value& n by sex	$W=3.99*10^{-6}* TL^{3.03}$ ⑩	Female: $W=2.82*10^{-6} * TL^{3.129}$ male: $W=1.35*10^{-6} * TL^{3.252}$ ⑥ $W=3.99*10^{-6}* TL^{3.03}$ ⑩	Female: $WT=2* 10^{-5}* LT^{2.8}$ (n=42) Male $WT= 1.05*10^{-5}* LT^{2.87}$ (n=39) [13] Female: $W=4.03*10^{-6}* TL^{3}$ (n=163) male: $W=4.3*10^{-6}* TL^{3}$ (n=162) [17]
Wet Weight / dressed weight ratio	value& n by sex	value& n by sex	value& n by sex	value& n by sex	value& n by sex
LT / LF	TL= 1.31FL - 0.64 (n=55) ⑤ FL= 0.7756TL - 0.3132 (n=111) ⑨ TL=1.296FL + 0.516 (n=1488) [12]	value& n by sex	TL= 1.28 + 1.3FL ⑩	TL= 1.28 + 1.3FL ⑩	value& n by sex
LT / PRC	value& n by sex	value& n by sex	value& n by sex	value& n by sex	value& n by sex
Fins / carcass ratios					
REPRODUCTION					
Female maturity size (cm)	Maturing : 212 ① 250 ⑤ 210 - 250 [11] 240 [15]	Maturing : 212 ① 210 - 250 [11]	Maturing : 212 ① 200 ⑩ 210 - 250 [11] 228.5 Lt_{50} (indonesia) [13]	Maturing : 212 ① 210 ⑥ 200 ⑩ 210 - 250 [11] 228.5 Lt_{50} (indonesia) [13]	Maturing : 212 ① 210 - 250 [11]
Female maturity age (yr)	15 ⑤			4.1 ⑥	
Male maturity size (cm)	Maturing: 140 -165 ① 180 ⑤ 140 - 198 [11] 180 [15]	Maturing: 140 -165 ① 140 - 198 [11]	Maturing: 140 -165 ① [19] 150 ⑩ 140 - 198 [11] 175.6 Lt_{50} (indonesia) [13]	Maturing: 140 -165 ① 198 ⑥ 150 ⑩ 140 - 198 [11] 175.6 Lt_{50} (indonesia) [13]	Maturing: 140 -165 ① 140 - 198 [11]
Male maturity age (yr)	10 ⑤			3.8 ⑥	

Birth size (cm)	42 - 55 ① 45 - 50 ② 49 ⑤ 31 - 57 [11]	42 - 55 ① 45 - 50 ② 31 - 57 [11]	42 - 55 ① 45 - 50 ② 45 - 50 ⑩ 31 - 57 [11] 40 (indonesia) [13]	42 - 55 ① 45 - 50 ② 31.3 - 48.9 ⑥ 45 - 50 ⑩ 31 - 57 [11] 40 (indonesia) [13]	42 - 55 ① 45 - 50 ② 31 - 57 [11]
Sex ratio			In north Australia for embryos: not significantly different 1:1 ⑩	In Hawaii For embryos: 1:1 [18] In north Australia for embryos: not significantly different 1:1 ⑩ In taiwan for embryos 1:1 [20] [21]	In Hawaii For embryos: 1:1 [18]
Mode of development	Viviparous ①	Viviparous ①	Viviparous ①	Viviparous ①	Viviparous ①
Gestation period (month)	9 - 10 ③	9 - 10 ③	9 - 10 ③ 9 - 10 ⑩	9 - 10 ③ 9 - 10 ⑩	9 - 10 ③
Mating period			Septembre - decembre ⑩	Septembre - decembre ⑩	
Spawning period	Novembre - February in southern Brazil [11] Spring - Summer [11]	Spring - Summer [11]	October - January (North Australia) ⑩ Spring - Summer [11] Octobre - Novembre (Indonesia) [13]	October - January (North Australia) ⑩ Spring - Summer [11] Octobre - Novembre (Indonesia) [13]	May & July [11] Spring - Summer [11]
Fecundity (embryos per litter)	15 - 31 ① 12 - 41 [11] 2 - 21 [15] 15 - 31 ⑩ ([18]+[19])	15 - 31 ① 12 - 41 [11] 15 - 31 ⑩ ([18]+[19])	15 - 31 ① 12 - 41 [11] 14 - 41 (Indonesia) [13] mean: 17 ⑩ 15 - 31 ⑩ ([18]+[19])	15 - 31 ① 12 - 41 [11] 14 - 41 (Indonesia) [13] mean: 17 ⑩ 15 - 31 ⑩ ([18]+[19]) 12 - 38 (mean 25.8) [20] [21]	15 - 31 ① 12 - 41 [11] 15 - 31 ⑩ ([18]+[19])
Nursery ground	Bulls Bay, South Carolina in Southeastern coast of US [22]			The large numbers of S. *lewini* pups found in Kaneohe Bay, Oahu, suggest that the bay is one of the principal pupping grounds for this species. [18]	Northern Gulf of California & Bahia Almejas [11] The large numbers of S. *lewini* pups found in Kaneohe Bay, Oahu, suggest that the bay is one of the principal pupping grounds for this species. [18]
AGE & GROWTH					

Von Bertalanffy growth curves parameters L∞, k, t_0 for females	Combined sexes: L∞= 329 TL k= 0.073 t_0= -2.2yr ⑤ L∞= 233.1 FL k= 0.09 t_0= -2.22yr (n= 116) [12] L∞= 300 TL k= 0.05 (n=116) [16]	value, method & range and type of size	value, method &range and type of size	L∞= 319.72 TL k= 0.249 t_0= -0.413yr (n=276) ⑥	L∞= 353.3 TL k= 0.156 t_0= -0.63yr (n=51) [13] L∞= 376 TL k= 0.1 t_0= -1.16yr (n=44) [17]
Von Bertalanffy growth curves parameters L∞, k, t_0 for males	Combined sexes: L∞= 329 TL k= 0.073 t_0= -2.2yr ⑤ L∞= 214.8 FL k= 0.13 t_0= -1.62yr (n=191) [12] L∞= 266 TL k= 0.05 (n=115) [16]	value, method & range and type of size	value, method &range and type of size	L∞=320.59 TL k= 0.222 t_0= -0.746yr (n=49) ⑥	L∞= 336.4 TL k= 0.131 t_0= -1.09yr (n=50) [13] L∞= 364 TL k= 0.123 t_0= -1.18yr (n=65) [17]
Longevity (yr)	35 ④ estimated: 30.5 [12] estimated: 55 [16]	35 ④	35 ④	35 ④	35 ④
DIET					
Nature of prey	Fish, invertebrates (especially cephalopods) ① Pelagic & demersal fishes, squid ⑤	Fish, invertebrates (especially cephalopods) ①	Fish, invertebrates (especially cephalopods) ①	Fish, invertebrates (especially cephalopods) ①	Fish, invertebrates (especially cephalopods) ①
%F	Value, n and size range	Value, n and size range	In north Australia: Fish were found in 87.3% of stomachs containing food, cephalopods in 31.1% and crustaceans in 5.2% ⑩	In north Australia: Fish were found in 87.3% of stomachs containing food, cephalopods in 31.1% and crustaceans in 5.2% ⑩	Value, n and size range
%N	Value, n and size range	Value, n and size range	Value, n and size range	Value, n and size range	Value, n and size range
%W	Value, n and size range	Value, n and size range	Value, n and size range	Value, n and size range	Value, n and size range
IRI	Value, n and size range	Value, n and size range	Value, n and size range	Value, n and size range	Value, n and size range
Stables isotopes N^{15}& C^{13}	Value, n and size range	Value, n and size range	Value, n and size range	Value, n and size range	Value, n and size range
Trophic level	4.1 ⑦ 4.5 ⑧	4.1 ⑦	4.1 ⑦	4.1 ⑦	4.1 ⑦

HABITAT					
Depth range (m)	0 at least 275 ① down to 512 ③	0 at least 275 ① down to 512 ③	0 at least 275 ① down to 512 ③	0 at least 275 ① down to 512 ③	0 at least 275 ① down to 512 ③
Temperature range (°C)					
CONTAMINANTS					
Heavy metals					
Organic pollutants					
PARASITES					

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Remarque:

"Current published age estimates of *S. lewini* from the Mexican Pacific and Taiwanese Pacific are based on growth estimates that assume the deposition of two centrum annuli per year (Chen *et al.* 1990, Ansilado-Tolentino and Robinson-Mendoza 2001), whereas studies in the Gulf of Mexico assume the deposition of one growth band per year (Branstetter 1987, Piercy *et al.* 2007). The Pacific estimates have not been validated and the deposition of two centrum annuli has not been confirmed in any other shark species to date (W. Smith pers. comm.), therefore these estimates should be viewed with caution." [11]

Sphyrna mokarran (Rüppell, 1837)

	Atlantic ocean	Mediterranean Sea	Indian ocean	Pacific ocean (West)	Pacific ocean (East)
BIOLOGY					
Maximum size (TL) (cm)	550 - 610 ①	550 - 610 ①	550 - 610 ①	550 - 610 ①	550 - 610 ①
Common size in fisheries (range LF) (cm)	< 366 ① 240 - 370 ②	< 366 ① 240 - 370 ②	< 366 ① 240 - 370 ②	< 366 ① 240 - 370 ②	< 366 ① 240 - 370 ②
Maximum weight (kg)	449.5 ③	449.5 ③	449.5 ③	449.5 ③	449.5 ③
CONVERSION FACTORS					
Length / weight relationship	$1.19*10^{-6}*TL^{3.16}$ ⑤	value& n by sex	$1.23*10^{-6}*TL^{3.24}$ (North Australia) ⑥	$1.23*10^{-6}*TL^{3.24}$ (North Australia) ⑥	value& n by sex
Wet Weight / dressed weight ratio					
LT / LF	TL = 1.2533FL + 3.472 ⑨		TL= 3.58 + 1.29FL ⑥	TL= 3.58 + 1.29FL ⑥	
LT / PRC					
Fins / carcass ratios					
REPRODUCTION					
Female maturity size (cm)	maturing 250 - 300 ①	maturing 250 - 300 ①	maturing 250 - 300 ① North Australia 210 ⑥ 250 - 300 ⑥⑩	maturing 250 - 300 ① 210 ⑥ 227.9 ⑧	maturing 250 - 300 ①
Female maturity age (yr)	5 - 6 ⑨			8.3 ⑧	
Male maturity size (cm)	maturing 234 - 269 ①	maturing 234 - 269 ①	maturing 234 - 269 ① North Australia 225 ⑥ 234 - 269 ⑥⑩	maturing 234 - 269 ① 225 ⑥ 227.9 ⑧	maturing 234 - 269 ①
Male maturity age (yr)	5 - 6 ⑨			8.3 ⑧	
Birth size (cm)	50 - 70 ① ⑥(⑩+[11]+[13]) 60 - 70 ②	50 - 70 ① ⑥(⑩+[11]+[13]) 60 - 70 ②	50 - 70 ① ⑥(⑩+[11]+[13]) 60 - 70 ② 65 ⑥	50 - 70 ① ⑥(⑩+[11]+[13]) 60 - 70 ② 65 ⑥ 70 ⑧	50 - 70 ① ⑥(⑩+[11]+[13]) 60 - 70 ②
Sex ratio	embryos : 1:1 ①	embryos : 1:1 ①	embryos : 1:1 ① embryos from North Australia: 1:1 ⑥ post embryos: Females: 45.7% Males: 54.3% (n=1334) ⑥	embryos : 1:1 ① embryos from North Australia: 1:1 ⑥	embryos : 1:1 ①
Mode of development	Viviparous ①	Viviparous ①	Viviparous ①	Viviparous ①	Viviparous ①
Gestation period (month)	at least 7 ① 11 ③⑦	at least 7 ① 11 ③⑦	at least 7 ① 11 ③⑦ 10 - 11 ⑥	at least 7 ① 11 ③⑦ 10 - 11 ⑥	at least 7 ① 11 ③⑦

Mating period	in West African waters: end of July to September ⑥ [11]		In Australia October - November ⑥	In Australia October - November ⑥	
Spawning period	Spring - Summer ① in Florida waters: late spring to early summer ⑥ [12]	Spring - Summer ①	Spring - Summer ① Decembre - January ⑥	Spring - Summer ① Decembre - January ⑥	Spring - Summer ①
Fecundity (embryos per litter)	13 - 42 ① ⑥(⑩+[11]+[13]) 18 - 38 ② 6 - 42 ⑦	13 - 42 ① ⑥(⑩+[11]+[13]) 18 - 38 ② 6 - 42 ⑦	13 - 42 ① ⑥(⑩+[11]+[13]) 18 - 38 ② 6 - 42 ⑦	13 - 42 ① ⑥(⑩+[11]+[13]) 18 - 38 ② 6 - 42 ⑦	13 - 42 ① ⑥(⑩+[11]+[13]) 18 - 38 ② 6 - 42 ⑦
Nursery ground					
AGE & GROWTH					
Von Bertalanffy growth curves parameters L∞, k, t_0 for females	L∞= 307.8 FL k= 0.11 t_0= -2.86 ⑨			both sexes L∞= 402.7 L_{st} k= 0.079 ⑧	
Von Bertalanffy growth curves parameters L∞, k, t_0 for males	L∞= 264.2 FL k= 0.16 t_0= -1.99 ⑨			both sexes L∞= 402.7 L_{st} k= 0.079 ⑧	
Longevity (yr)	Observed: 44 ⑨			39.1 ⑧	
DIET					
Nature of prey	Fishes, other shark, crabs & squid ①	Fishes, other shark, crabs & squid ①	Fishes, other shark, crabs & squid ①	Fishes, other shark, crabs & squid ①	Fishes, other shark, crabs & squid ①
%F	Value, n and size range	Value, n and size range	Value, n and size range	Value, n and size range	Value, n and size range
%N	Value, n and size range	Value, n and size range	Value, n and size range	Value, n and size range	Value, n and size range
%W	Value, n and size range	Value, n and size range	Value, n and size range	Value, n and size range	Value, n and size range
IRI	Value, n and size range	Value, n and size range	Value, n and size range	Value, n and size range	Value, n and size range
Stables isotopes N^{15}& C^{13}	Value, n and size range	Value, n and size range	Value, n and size range	Value, n and size range	Value, n and size range
Trophic level	4.3 ④	4.3 ④	4.3 ④	4.3 ④	4.3 ④
HABITAT					
Depth range (m)	0 - 80 ① 0 - 300 ③	0 - 80 ① 0 - 300 ③	0 - 80 ① 0 - 300 ③	0 - 80 ① 0 - 300 ③	0 - 80 ① 0 - 300 ③
Temperature range (°C)					
CONTAMINANTS					
Heavy metals					
Organic pollutants					
PARASITES					

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Sphyrna zygaena (Linnaeus, 1758)

	Atlantic ocean	Mediterranean Sea	Indian ocean	Pacific ocean (West)	Pacific ocean (East)
BIOLOGY					
Maximum size (TL) (cm)	370 - 400 ① 500 ③④	370 - 400 ① 500 ③④	370 - 400 ① 500 ③④	370 - 400 ① 500 ③④	370 - 400 ① 500 ③④
Common size in fisheries (range LF) (cm)	275 - 335 ②	275 - 335 ②	275 - 335 ②	275 - 335 ②	275 - 335 ②
Maximum weight (kg)	400 ③⑤	400 ③⑤	400 ③⑤	400 ③⑤	400 ③⑤
CONVERSION FACTORS					
Length / weight relationship	(South Africa) $W=1.42*10^{-6}*L^{3.3}$ ⑦ $W= 2.61*10^{-5}*FL^{2.709}$ (n=10 FL: 125 - 225) [14]		(South Africa) $W=1.42*10^{-6}*L^{3.3}$ ⑦	$W= 3,0091*10^{-5}* FL^{2,64805}$ (n=8, FL: 100 - 155) [14] New South Wales : $W= 5.270 * 10^{-7} TL^{3.42}$ ⑨	$W= 3,0091*10^{-5}* FL^{2,64805}$ (n=8, FL: 100 - 155) [14]
Wet Weight / dressed weight ratio	value& n by sex	value& n by sex	value& n by sex	value& n by sex	value& n by sex
LT / LF	FL= 0.8 TL Based on photo measurement ③	FL= 0.8 TL Based on photo measurement ③	FL= 0.8 TL Based on photo measurement ③	FL= 0.8 TL Based on photo measurement ③	FL= 0.8 TL Based on photo measurement ③
LT / PRC	value& n by sex	value& n by sex	value& n by sex	value& n by sex	value& n by sex
Fins / carcass ratios					
REPRODUCTION					
Female maturity size (cm)	304 ①	304 ①	304 ①	304 ① 265 ⑨	304 ①
Female maturity age (yr)					
Male maturity size (cm)	256 ①	256 ①	256 ①	256 ① > 250 - 260 ⑨	256 ①
Male maturity age (yr)					
Birth size (cm)	50 - 61 ① around 60 ⑨ [17]	50 - 61 ① around 60 ⑨ [17]	50 - 61 ① around 60 ⑨ [17]	50 - 61 ① around 60 ⑨ [17]	50 - 61 ① around 60 ⑨ [17]
Sex ratio	1:1 ⑩			Around 1:1 (52% were female) ⑨	
Mode of development	Viviparous ①	Viviparous ①	Viviparous ①	Viviparous ①	Viviparous ①
Gestation period (month)				10 - 11 ⑨	
Mating period					
Spawning period				January - March ⑨	
Fecundity (embryos per litter)	29 - 37 ①	29 - 37 ①	29 - 37 ①	29 - 37 ① 20 - 49 (mean 32) ⑨	29 - 37 ①
Nursery ground	shallow coastal waters off southern Brazil and Uruguay ⑧ [11] [12]				the northern Gulf of California ⑧
AGE & GROWTH					
Von Bertalanffy growth curves parameters $L\infty$, k, t_0 for females	value, method & range and type of size	value, method & range and type of size	value, method &range and type of size	value, method & range and type of size	Combined sex $L\infty = 301.6$ k,= 0.14 t_0= -2.45

					[15] [16]
Von Bertalanffy growth curves parameters L∞, k, t_0 for males	value, method &range and type of size	value, method & range and type of size	value, method &range and type of size	value, method &range and type of size	Combined sex L∞ = 301.6 k,= 0.14 t_0= -2.45 [15] [16]
Longevity (yr)	20 [13]	20 [13]	20 [13]	20 [13]	20 [13]
DIET					
Nature of prey	Bony fishes, small sharks, rays, crustaceans, cephalopods ①	Bony fishes, small sharks, rays, crustaceans, cephalopods ①	Bony fishes, small sharks, rays, crustaceans, cephalopods ①	Bony fishes, small sharks, rays, crustaceans, cephalopods ①	Bony fishes, small sharks, rays, crustaceans, cephalopods ①
%F	Value, n and size range	Value, n and size range	Value, n and size range	Occurrence of prey category: Cephalopod: 76.2% Fish: 54.8% Crustacea: 2.4% Miscellaneous : 2.4% ⑨	Value, n and size range
%N	Value, n and size range	Value, n and size range	Value, n and size range	Value, n and size range	Value, n and size range
%W	Value, n and size range	Value, n and size range	Value, n and size range	Value, n and size range	Value, n and size range
IRI	Value, n and size range	Value, n and size range	Value, n and size range	Value, n and size range	Value, n and size range
Stables isotopes N^{15}& C^{13}	Value, n and size range	Value, n and size range	Value, n and size range	Value, n and size range	Value, n and size range
Trophic level	4.2 ⑥	4.2 ⑥	4.2 ⑥	4.2 ⑥	4.2 ⑥
HABITAT					
Depth range (m)	Usually 0 - 20 ① Reported 0 - 200 [13]	Usually 0 - 20 ① Reported 0 - 200 [13]	Usually 0 - 20 ① Reported 0 - 200 [13]	Usually 0 - 20 ① Reported 0 - 200 [13]	Usually 0 - 20 ① Reported 0 - 200 [13]
Temperature range (°C)					
CONTAMINANTS					
Heavy metals					
Organic pollutants					
PARASITES					

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Annex III

IATTC "potential" shark catch estimate

The fleets mainly responsible for the studied shark species were identified on the basis of tuna and tuna like catch reported to IATTC. IATTC data are based on reports from the national fisheries agencies but can be affected by the limitations in reporting efficiency and problems of species identification and species breakdown. The estimates depend on the level of under-reporting and non-reporting of tuna and tuna like catch by the countries.

Estimated "potential" studied sharks catch (high estimation is only presented here) is above 16 000 t for 3 600 t presently declared (around 80 % underestimation) (Figure A2.1). Eigth fisheries among the 52 fisheries found in IATTC database generate 80 % of potential studied shark catches. These fisheries are those already declaring the bulk of the studied shark catches and are those with the highest unreported catches of the studied shark catches.

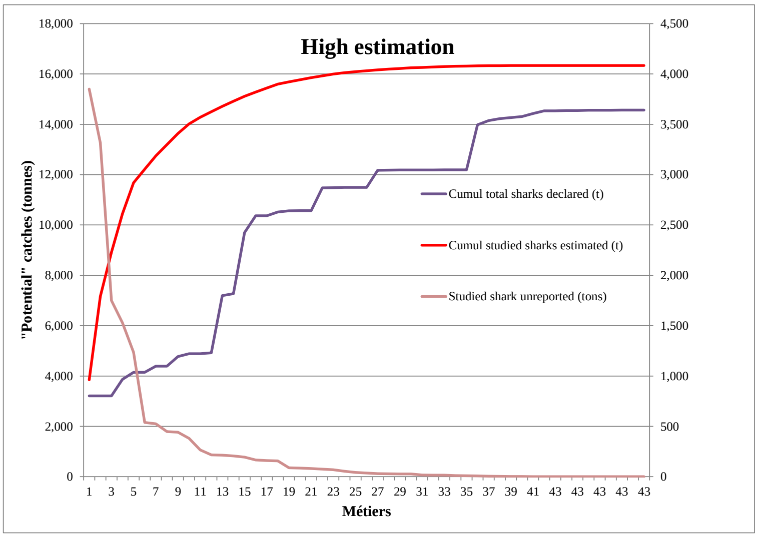


Figure A2.1.- Cumulated "potential" catch in tonnes and undreported estudied shark species catches by fisheries ranked according their descending estimated estudied shark species catches.

In the EPO fisheries with the highest incidence in sharks is the LL gear.The longline that contributes 86% of the shark catch: 54% LL targeting tropical tunas and 32 % LL targeting swordfish. It is followed by OTH and, finally, the PS fleets (Figure A2.2).

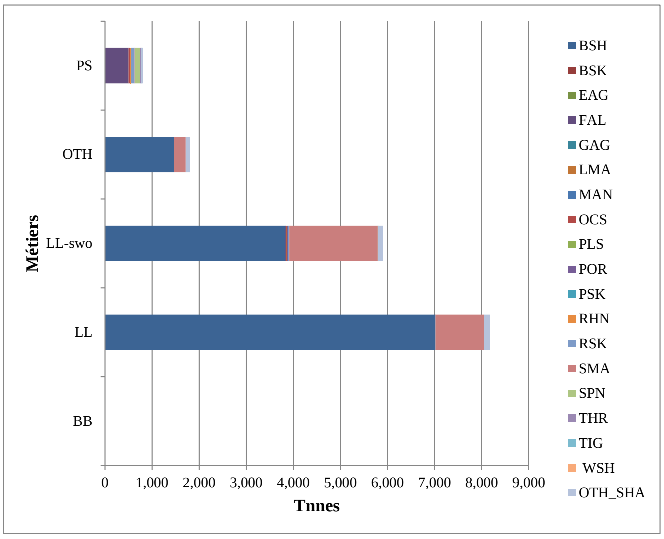


Figure A2.2.- Estimated Catch (tonnes) by Métiers and by studied shark species.

There are mainly two groups of métiers impacting the most important, in terms of total catch, two groups of shark species (Figure A2.3). Among estudied shark species, main species impacted is blueshark (BSH) with 76 % of the total in weight followed by Shortfin mako (19%) (SMA).

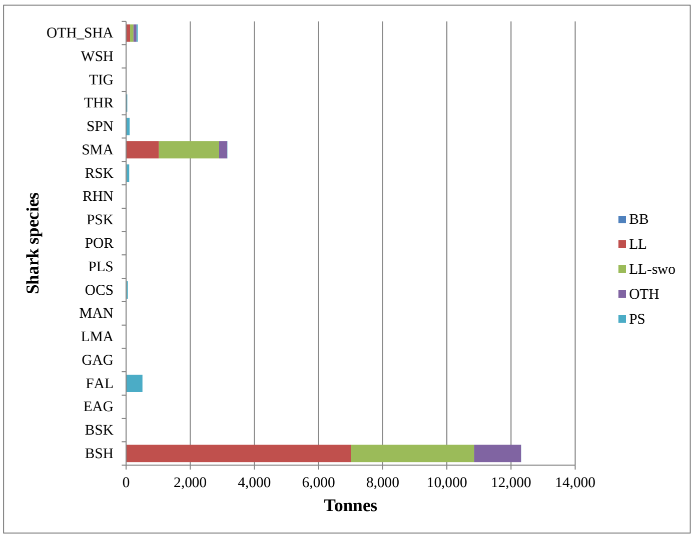


Figure A2.3.- Estimated Catch (tonnes) by studied shark species and by Métier.

In the Eastern Pacific Ocean, impact on the estudied shark species is highly concentrated in 5 fisheries, which generate 75 % of the estimated estudied shark species (Figure A2.4). European LL (targeting swordfish) is the first one impacting estudied shark species mainly BSH and SMA. The estimated shark catches for the PS are small. In the case of the IATTC, estimates of shark catches, obtained for observer in the purse seine fleet, are very close to those obtained in this estimation of “potential” shark catch for the "metier" purse seine (PS).

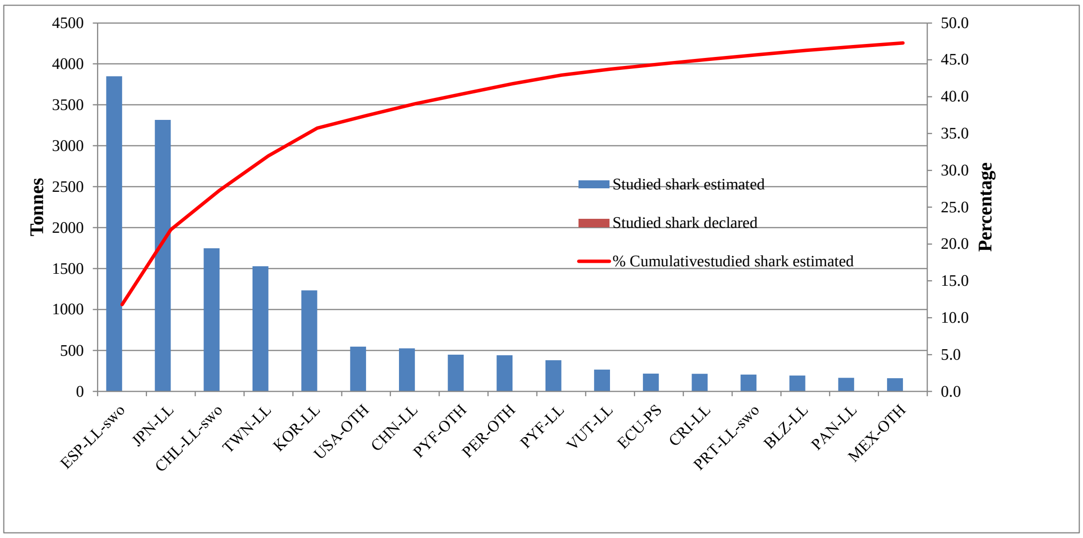


Figure A2.4.- Main fisheries (Flag and Métier) impacting studied shark species in the Eastern Pacific Ocean.

Figure A2.5 shows the difference between the declared nominal catch of shark by species and our estimations by species. In the public database of the IATTC, records of sharks out there are under a common label, making it impossible to identify the species. This is the reason that sharks are not reported by species, only estimates.

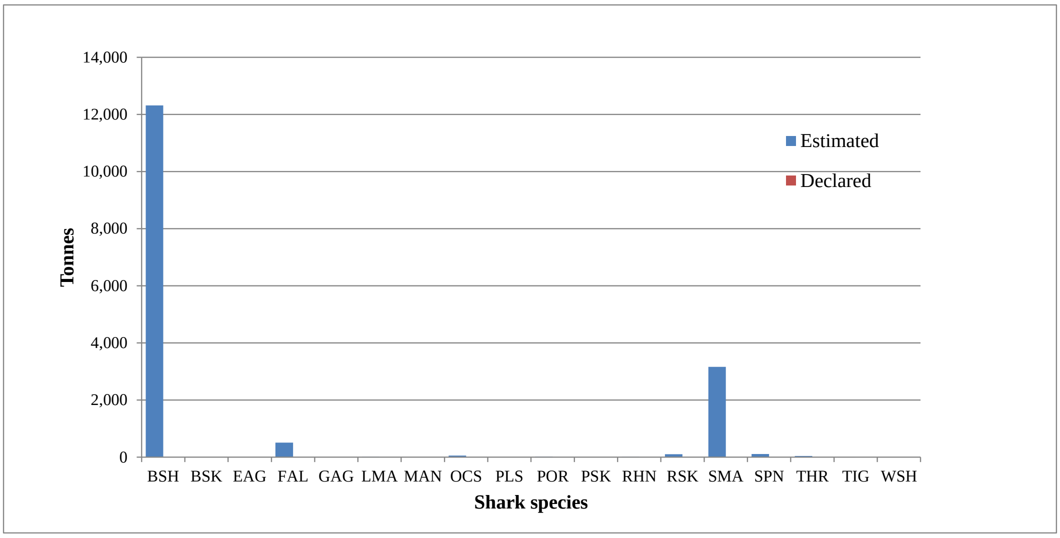


Figure A2.5.- Most impacted studied shark species (reported vs estimated).

The main species identified were blueshark, followed by shortfin mako, silky shark and hammerhead sharks nei.

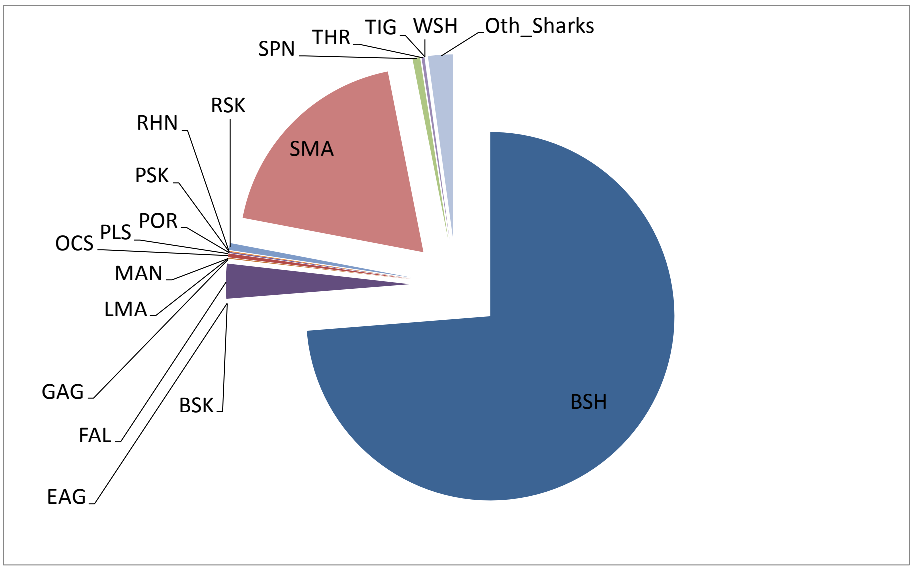


Figure A2.6.- IATTC most impacted studied shark species estimated.

Annex IV

Summary of data collection on the Portuguese observer program for the pelagic longline fishery

Level data recorded: by set (or fishing operation)

Frequency record: all set operations including zero catch

Target species: swordfish; **Bycatch species:** tunas, other billfishes, blue and shortfin mako sharks;

FISHING PRACTICES

Parameters	Yes	Start operation	End operation
Vessel ID, name and home port	x		
LOA, GRT and HP	x		
Electronics (GPS, Scanners, Sonars)	x		
Gear type	x		
Gear configuration	x		
Geo-position (Lat. and Long.)		x	x
Date/time operation		x	x
Hook type	x		
Branch line material	x		
Bait type	x		
Effort (no. hooks/set and sets/day)	x		

BIOLOGICAL INFORMATION

Data recorded	Target species	Bycatch species	Other species
Species identification	all	all	all
Catch (kg and/or No.)	all	all	all
Releases alive	all	all	all
Dead discards	all	all	all
At-haulback mortality	all	all	all

Main *taxa* groups monitored by:	Observers
Fish target species	all
Other fish species (sharks/rays)	all
Sea Turtles	all
Seabirds	all
Mammals	all

Biological sampling and samples collection	Target species	Bycatch species	Discarded species
Species identification photo	x	x	x
Size & weight[1] measurement	x	x	
Sex[2] and/or maturity status	x	x	
Hard parts[3] (otoliths, spines, vertebra)	x	x	x
Tissues[3] (muscles, gonads, blood)	x	x	x
Tagging[4]	x	x	

1) Weight measurements depending on oceanographic conditions
2) Sex and fecundity status only when species are gutted
3) Species specific or under special request
4) Undersized swordfish and some shark species under special request (e.g. scientific project)

OPTIONAL INFORMATION

Environmental information	Yes
Sea surface temperature	x
Depth of gear operation	x
Waving	x

Annex V

Minimum data requirement for PS (from KOBE III Bycatch Joint Technical Working Group Harmonisation of Purse-seine Data Collected by Tuna-RFMOs Observer Programmes)

OBSERVER PURSE-SEINE DATA HARMONISATION

Harmonisation of Effort Data

Part 1. Vessel Identification

The current "Minimum Data-field Standards" specified by each of the t-RFMOs are outlined in the Table below. However, if each t-RFMO fully participates in the TUVI database then the TUVI number is all that is required to uniquely identify vessels for inter-operability.

IATT	IOTC & ICCAT (IRD IEO AZTI)	WCPF
Full Name of Vessel **Vessel Code (provided by IATTC) Vessel Flag (provided by IATTC)**	**Name of Vessel** (before embarkation) **Vessel Code** (number given to observer before embarkment by IRD) **Vessel Owner/Company**	**Full Name of vessel** (including any numbers). **Flag State Registration Number** (sourced from the vessel papers). **International Radio Call Sign** (ICRS; issued to the vessel by the flag State in accordance with IMO regulations). **Vessel Owner/Company** **Hull markings consistent with CMM 2004-03**. **WCPFC identification number (WIN) markings consistent with CMM 2004-03**. **WIN format for markings consistent with CMM 2004-03.**

Part 2. Vessel Trip Information

The current "Minimum Data-field Standards" specified by each of the t-RFMOs are outlined in the Table below. Currently IAATC define a purse-seine vessel trip differently to the other t-RFMOs with a trip concluding at 20 days and/or when at least 50% of the catch is unloaded. The clear reporting of when a trip commences and concludes is required to reduce the potential for inappropriate representation of trip data when inter-t-RFMO comparisons are undertaken.

IATTC	IOTC & ICCAT (IRD IEO AZTI)	WCPFC
Trip Number (unique 4-digit number assigned by IATTC) Date (YYMMDD) of departure from port. **Name of the port of departure** **Date (YYMMDD) of return to port Name of the port of return**	**Date and time of departure from port with observer** **Name of the port of departure with observer** **Date and time of return to port with observer** **Name of the port of return with observer**	**Date and time of departure from port.** **Name of the port and country of departure Date and time of return to port** **Name of the port and country of return**

Part 3. Observer Information

The current "Minimum Data-field Standards" specified by each of the t-RFMOs are outlined in the Table below. The most important data are those that identify the duration of the observers trip and information that can be used to uniquely identify the observer for the purpose of interoperability. The creation of a joint t-RFMO observer register may be an efficient way to achieve the "unique observer identity" (ie similar principal to TUVI).

IATTC	IOTC & ICCAT (IRD IEO AZTI)	WCPFC
Observer name (First and Last name) **Observer code** (provided by IATTC)	**Observer Name** (First and Last Name)	**Observer name** (First name(s) First and Last name Last – no abbreviations or initials) **Nationality of observer** (Passport Country) **Name of Observer Programme** -country and or organization **Date, time and location of embarkation** **Date, time and location of disembarkation**

Part 4. Crew Information

The current "Minimum Data-field Standards" specified by each of the t-RFMOs are outlined in the Table below. The most important data are those that identify the total crew number and uniquely identify the captain/fishing master. The creation of a joint t-RFMO captain/fishing master register may be an efficient way to achieve the "unique observer identity" (ie similar principal to TUVI).

IATTC	IOTC & ICCAT (IRD IEO AZTI)	WCPFC
Name of fishing captain 1 (Last name(s) and First name) **Name of fishing captain 2** (Last name(s) and First name) **Date (YYMMDD) for change of captain (if occurred) Captain 1 code (provided by IATTC) Captain 1 code (provided by IATTC)**		**Name of captain** (First name(s) First and Last name Last – no abbreviations or initials) **Nationality of captain and type of Identification document** (e.g. Passport nationality of the captain). **Name of fishing master** (First name(s) First and Last name Last – no abbreviations or initials). **Nationality of fishing master and type of Identification document** **Total number of other crew and nationalities** (eg. 8 Philippines 6 Samoans 4 Taiwanese) **Total number of Crew** (total number of persons on the vessel excluding the observer).

Part 4. Vessel and Gear Attributes

The current "Minimum Data-field Standards" specified by each of the t-RFMOs are outlined in the Table below. The characteristics of the vessel and gear assist with standardizing effort and the over-riding principal for data collection should be to maximize the detail to the better the standardization. If the t-RFMOs fully participate in TUVI then much of the required information could be collected during registration and stored in the TUVI database.

IATT	IOTC & ICCAT (IRD IEO AZTI)	WCPF
Vessel Attributes		
Capacity (provided by IATTC) **Number of Speedboats** (the number that are functional) **Bow Thruster** (yes/no, equipped & operable) **Helicopter** (yes/no, equipped) **Ring stripper** (yes/no, equipped & used) **Number of screws** (number of propellers powering the vessel) **Power Block Diameter** (inches) **Inflatatble Raft** (yes/no, equipped & operable for dolphin rescue) **High Intensity Floodlights** (yes/no, equipped & operable and capable of producing 140,000 lumens) **Diver**	**Date of construction** **Overall** **Length Hull** **Length Width** **Draft** **Number of wells** **Well capacity (tons)** **Fuel tank capacity (cubic meters) Main engine power (HP) Maximum speed (knt)** **Searching speed** **Number of skiffs** **Number of nets** **Number of speedboats** **Number of fixed binoculars** **Number of binoculars** **Number of Radio buoys onboard (beginning of the trip) Radio direction finder Ryokuseisha Radio direction finder 400 for Argos buoys Trigger and location system for GPS buoys Location system for SERPE (Ariane 2) buoys**	**Vessel cruising speed** (defined as the speed the vessel travel, which allows it to optimize its fuel usage but also gets the vessel along at a good speed). **Vessel fish hold capacity** (The total maximum amounts in metric Tons (mT.) that the vessel freezers, wells and other fish storage areas on a vessel can hold). **Length** (taken from the vessel plans or from other paper work that indicates the LOA). **Tonnage** (specify unit. The vessel may be registered using Gross Tonnage (GT) or in (GRT) this will be indicated on the vessel registration papers). **Engine power** (Specify unit. Usually be found in the vessel plans or from the engineer). **Number of onboard support vessels** (How many vessels on board other than the net skiff, i.e. speedboats light boats, tow boats). **Aircraft Make/Model,/Colour/Call- sign/Registration**

Gear Attributes		
Maximum depth of net (observer estimated in fathoms) **Maximum depth of net** (observer estimated by reporting no. of panels) **Maximum length of net** (observer estimated in fathoms) **Net mesh size** (inches, measured by observer) **Dolphin Safety Panel Depth** (observer estimated in fathoms) **Dolphin Safety Panel Depth** (observer estimated by reporting no. of panels) **Dolphin Safety Panel length** (observer estimated in fathoms) **Dolphin Safety Panel mesh size** (inches, measured by observer)	**Depth of net** **Length of net** **Weight of bottom chain**	**Maximum depth of net** (obtained from engineer) **Maximum length of net** (obtained from engineer) **Net mesh size** (measured by observer) **Brailer(s) capacity sizes** (recorded in MT)
Vessel electronics (preference for make(s) and model(s) to be specified for each piece of equipment		
Sonar (yes/no, used to locate schools during cruise) **Bird Radar** (yes/no, equipped & operable)	**Compass/autopilot** **Distance** **recorder** **Navigation** **Radar Bird** **Radar** **Ecohsounder** **Sonar** **VHF & BLU Radio** **Satellite** **GPS** **Sea Temperature Meter** **VMS** **Othe**r (specify)	**Radars** **Depth Sounder** **Global Positioning System** **(GPS) Track Plotter** **Weather Facsimile** **Sea Surface Temperature (SST) gauge** **Sonar** **Radio/ Satellite Buoys** **Doppler Current Meter** **Expendable Bathythermograph** **(XBT) Fishery information services** **Satellite Communications Services** (Phone/Fax/Email numbers, and record Satellite numbers) **Vessel Monitoring System** (Indicate the type of systems used on a vessel).

Part 5. Daily Activities

The t-RFMOs require that a log/journal of daily activities is completed by the observer. This information is required to characterise effort data at resolutions finer than the trip (eg. set level). For inter-operability date, time, duration and location of activities is required. Activities can be classified into those that describe: the set; searching; transiting; FAD maintenance, deployment and retrieval; drifting; seamount; transshipment; and other non- fishing activities (such as breakdowns, sheltering from bad weather). There is considerable variation in the detail currently collected under these headings by each of the t-RFMOs but fishing activities can be clearly determined which is the critical requirement.

When floating objects are encountered the details for collection specified by each t-RFMO also vary, however information is collected on the type and detection method, and if the object is a FAD information is collected on its origin, construction and attachment materials, disposal, associated electronics/markers and size. The information collected by each t-RFMO appears sufficient to differentiate floating objects into FAD and non FAD and catergorize differences in FADs providing an intermediate level interoperability between t-RFMOs.

The current "Minimum Data-field Standards" specified by each of the t-RFMOs are outlined in the Table below.

IATTC	IOTC & ICCAT (IRD IEO AZTI)	WCPFC
Time of Sunrise and Sunset **On effort** (Yes/No whether on or near bridge to observe vessel operations) **Date of a particular event/activity** (ships time) **Time of event/activity** (ships time) **Latitude and longitude of activity** (record position of each activity) **Searching method** **Sighting method** **Bearing from Ship to sighting** (in degrees) **Distance from ship to sighting** (nearest 10th nautical mile) **Vessel speed** (search and run events) **Water temperature** (every set) **Weather** (cloud cover, beaufort No, visibility for every search or run)	**Date of the day** (day/month/year) **Daily Activity data form number** (one data sheet per day and number sequentially) **Morning distance** (from distance counter (eg GPS) at beginning of day) **Evening distance** (from distance counter (eg GPS) at end of day) **Ocean** **Time of activity** (GMT) **Latitude** (to minute), **longitude** (to minute) and **Quadrant** **Boat activity code** **Activity around the boat code** **Boat speed** (knots -2 digits) **Sea surface temperature** (1/10 degree – max 3 digit) **Wind speed** (table 4)	**Date and time of start of daily activities** (both ships time and UTC recorded) **Time of activity** (Record ships time for each activity) **Latitude and longitude of activity** (record position of each activity) **Numbers of school sighted per day** (How many free or associated schools of fish were sighted during the day)

Aerial Assistance (yes or no if helicopter or plane used) **Catch per set** (metric tons) for YFT, SKJ, Others (with codes) **Wells used** (well number catch was loaded in)	**Reason why no fishing undertaken** **Distance from vessel to sighting**	
Activities codes provided are	**Activities codes provided are**	**Activities codes provided are**
To describe the set	*To describe the set*	*To describe the set*
End set Mammal set Unassociated tuna set Floating object set	Start of set (skiff on water) (End of set (retrieve skiff)	Set Setting on FAD Net cleaning set
To describe searching	*To describe searching*	*To describe searching*
The vessel is searching Log sighted	Searching (general) Searching exclusively for floating objects End of searching	Searching Investigate free school Investigate floating object Helicopter takes off to search Helicopter returned from search
To describe transiting	*To describe transiting*	*To describe transiting*
Departed from a port Arrived at a port Depart at sea Arrive at sea Running to another area or to a port (no crew member is looking for signs of fish for 5 mins or more)	Transit (steaming) Transit to favourable oceanographic area Boat arriving on favourable oceanographic area) Steaming at night towards an object Continued steaming towards favourable area and write what the observed system is	Transit
To describe other non fishing activities	*To describe other non fishing activities*	*To describe other non fishing activities*
	Breakdown at sea Bad weather (sheltering with engine on) In Port	No fishing - Breakdown No fishing - Bad weather In port No fishing - Other reason
To describe FAD activities	*To describe FAD activities*	*To describe FAD activities*

	Deploy or modify floating object Retrieve a floating object belonging to the boat Retrieve a floating object not belonging to the boat Retrieve the object	Deploy - raft, FAD or payao Deploy locating buoy Servicing FAD or floating object Retrieve - raft, FAD or payao Retrieve locating buoy Investigate floating object using sonar/sounder Vessel drifting beside FAD attracting fish away from FAD before carrying out a Set Vessel setting close to FAD (specify estimated distance) Vessel using lights of boat or light boat to attract fish from FAD during night
To describe drifting activities	*To describe drifting activities*	*To describe drifting activities*
The vessel is drifting	Drifting at night with engine shutdown Drifting close to school or floating object	No fishing - Drifting at day's end No fishing - Drifting with floating object Drifting -With fish aggregating lights
To describe seamount activities	*To describe seamount activities*	*To describe seamount activities*
	At anchor on seamount	
To describe transshipping activities	*To describe transshipping activities*	*To describe transshipping activities*
	Transshippment at sea	Transshipping or bunkering
To describe other activities	*To describe other activities*	*To describe other activities*
	Other	
	To describe activities around the boat	
	Alone in the area In a group of boats with other purse seiner visible on radar and: 1. Same fishing gear and flag 2. Different fishing gear but same flag 3. Same fishing gear but different flag 4. Different fishing gear and flag	

When the activity is associated with a floating object or the sighting of a floating object the following information is also collected		
Type of Floating Object	**Type of Floating Object*****means I am not sure if this is a non FAD category	**Type of Floating Object**
To describe Non-FAD floating Objects	*To describe Non-FAD floating Objects*	*To describe Non-FAD floating Objects*
Non FAD Tree Dead animal	Tree (or branch) Palm of coconut/palm tree Dead animal Box, drum or large board Rope, cable Net or piece of net Plastic Object Metal object Artificial object (without locating beacon)*** Experimental object*** Drifting Raft or buoy***	Tree or log (natural, free floating) Dead Animal Manmade object (Non FAD)
To described FADs	*To described FADs*	*To described FADs*
FAD Artificial light for attracting fish Construction material Chain / cable / rings Cane / bamboo Bait container / bait Cord / rope Floats / corks Net material Sacks / bags Planks / pallets / plywood Metal drum / plastic drum PVC or other plastic tubes	Drifting raft (line and net) with beacon/buoy DCP anchored (purpose of attracting fish) Tuna boat (or skiff) Support boat (supply) Bundled straw Dead animal with beacon/buoy Manmade object (box, drum, board, rope, cable, net (or piece), plastic) with a beacon/buoy	Manmade object (Drifting FAD) Anchored Raft Fad or Payao Anchored Tree or Logs Tree or logs (converted into FAD) Debris (flotsam bunched together) Construction material Logs, trees, debris tied together Timber/planks/pallets/spool PVC or plastic tubing Plastic drums Plastic sheeting Metal drums Philippines design drum FAD

Plastic sheeting		Bamboo/cane Floats/cork Other Attachments Chain, cable rings, weights Chord/rope Netting hanging underneath FAD Bait containers Sacking/Bagging Coconut fronds/tree branches Other
Other Unknown		Other
How Floating Object is detected	**How Floating Object is detected**	**How Floating Object is detected**
By Visual Observation	*By Visual Observation*	*By Visual Observation*
Visual - the object itself Visual – Flag, Buoy, cork, etc Lights Visual - birds		Seen from vessel by crew Helicopter report Lights Flock of Birds sighted from vessel Discovered in pursed net
By Electronic/Remote Observation	*By Electronic/Remote Observation*	*By Electronic/Remote Observation*

Radio transmitter / beeper Radar reflector Radar Satellite	Radio direction finder (Radiogoniomètre) Satellite with various additions Radiogoniomètre + GPS GPS Serpe Satellite + échosondeur indéterminé Satellite sans échosondeur Satellite + sonar Satellite + échosondeur Zunibal Satellite + échosondeur Satlink Satellite + échosondeur Nautical Satellite + échosondeur autre (à préciser dans les notes)	Found using vessel radio buoy Bird radar Sonar / depth sounder Information from other vessel Navigation Radar Anchored (GPS) Marked with GPS buoy
Other Method	*Other Method*	*Other Method*
		Being deployed (so not detected)
Other	Autre type (à préciser dans les notes)	Other (please specify in comments)
Unknown		Unknown
IF a FAD then the following is also collected		
Origin of the FAD	**Origin of the FAD**	**Origin of the FAD** (** PIRFO addition)
Your vessel – this trip Your vessel – previous trip	Belonging to this boat or the company	Your Vessel
Other vessel– owner consent Other vessel– no owner consent	Belonging to another boat or another company	Other vessel's- with permission Other vessel's- without permission Other vessel's- consent unknown**
	Drifting Object found	Drifting and found by your vessel
	Seeded	Deployed by FAD auxiliary vessel
	Other	Other (describe)
Unknown	Unknown	Unknown (describe)
Disposal of the FAD	**Disposal of the FAD**	**Disposal of the FAD**

	Attach a beacon/buoy	Deploy - raft, FAD or payao Deploy radio buoy
Left in water with description of FAD component (as above)	Left in water Remain in water with the same beacon/buoy Replace the beacon/buoy	Manmade object (Drifting FAD)- changed Servicing FAD or floating object Retrieve radio buoy
Removed	Retrieve on vessel Destroyed Sink	Retrieve - raft, FAD or payao
	Other	
Electronics associated with FAD	**Electronics associated with FAD**	**Electronics associated with FAD**
Direction to the object		Radio buoy (with identification)
		Radio buoy -unidentified
Geographic position of the object		GPS buoy (with identification)
		GPS buoy - unidentified
Tuna quantity		Sounder buoy (with identification)
Tuna species		Sounder buoy - unidentified
		Light buoy
Water Temperature		Other (describe)
		Unknown (describe in comments)
Estimated size of FAD	**Estimated size of FAD**	**Estimated size of FAD**
Simple Diagram of FAD to be drawn indicating dimensions.		Simple Diagram of FAD to be drawn indicating dimensions.
Dimensions (in m)		
Netting hanging from the object (yes/no/unknown), estimated area of hanging netting (m^2), predominant mesh size (inches)		Record depth of Netting and or other materials hanging from FAD
Tag number		FAD Markings or numbers
Maximum depth of object (m)		

		Describe condition of the FAD when first and any attachments.
		Describe any changes or additions to the FAD by the vessel.
Other Data	**Other Data**	**Other Data**
Bait container refilled (yes/no/unknown)		
Fauna entrapped		
Water clarity (clear/turbid/very turbid)		
% epibiota		
	Describe fate/staus of species associated with FAD Caught and alive Caught and dead free	

Part 6 School and Set Information

Each of the t-RFMOs currently collects information on how the school was detected (with categories under the sub-headings of by observation and by the use of electronics), the type of school, and reasons why a set did not occur or was only partially completed. The level of detail varies between t- RFMOs, however the essential information to define school type which is required for inter-operability is collected by all t-RFMOs. WCPFC may wish to include a data category for breakdowns that occur during a set to allow differentiation of these malfunctions. Preferred definitions of school type are outlined in the preceding sections of this document. The current "Minimum Data-field Standards" specified by each of the t-RFMOs are outlined in the Table below.

IATTC	**IOTC & ICCAT (IRD IEO AZTI)**	**WCPFC**
Method of detection of school (How the vessel first detected the fish) Codes are:	**Method of detection of school** (How the vessel first detected the fish) Codes are:	**Method of detection of school** (How the vessel first detected the fish) Codes are:
By Observation	*By Observation*	*By Observation*
Birds sighted Mammal sighted Other cue sighted Splashes sighted Breezer sighted Log sighted Chase	School (no precision on type of school) Naked Eye Binoculars Breezer (Balbaya), Finner/Jumper/Splasher (Sardara ou Saut), Boiler/Meatball/Foamer/Smoker (Brisant ou rouge) Birds Object no beacon Dead animal Small cetacean (dolphin, pilot whale) Big cetacean (sperm whale) Whale (eg Baleine) Whale shark Shark School that have escaped from previous set Boat school Fishing on seamount	Seen from vessel Seen from helicopter

	Fishing on drop off of continental shelf	
Using Electronics	*Using Electronics*	*Using Electronics*
	Bird Radar Normal Radar Echosounder Object with beacon GPS buoy GPS buoy with echosounder Dead animal with a beacon)	Marked with beacon Bird radar Sonar / depth sounder Anchored FAD / payao (recorded)
Other Method	*Other Method*	*Other Method*
	No system Other tuna boat Supply vessel Other (specify)	Info. from other vessel
Type of school association	**Type of school association**	**Type of school association** (Noting that fish feeding on bait fish with no floating objects around is considered unassociated). Codes are:
Unassociated tuna set	Free school	Unassociated Feeding on Baitfish
Floating object set Live Whale set Dolphin set	School object Whale set Whale shark set	Drifting log, debris or dead animal Drifting raft, FAD or payao Anchored raft, FAD or payao Live whale Live whale shark Other floating object (please specify)
Accidental set		No tuna associated

Malfunction	Malfunction	
Roll-up Main engine failure Main vessel hydraulic failure Skiff failure (mechanical or hydraulic) Speed boat failure Winch failure (mechanical) Power block failure Bow thruster failure Ripped net (not caused by roll-up) Broken purse cable Fouled or broken bunchline Fouled or broken corkline Broken leadline Broken skiff towline Broken vang guy line Broken topping winch cable Webbing in the rings Webbing caught on the stern Other	Unknown Fish escape by diving Fish escape as travelling to quick Current to strong Too many fish Net damage Winch failure Bad weather Whale escape and school follow Other (specify)	
Reason no set	**Reason no set**	
Tuna separated from the dolphin school Dolphin running to a rain squall Other reason Voluntary aborted set	Nothing to report Captains decision 1. School to small 2. Fish to small 3. Company decision School behaviour 1. Moving to quick 2. Fish dive before making set 3. Too deep	

	Other 1. Sighting without fish 2. Strong current 3. Mechanical failure 4. Another boat is setting on the school	

Harmonisation of catch data

Part 7 Catch Information

Each of the t-RFMO require that the observer estimate the weight of the catch and/or numbers of bycatch species. The weight categories differ between the t-RFMOs and this places restriction on the inter-operability of the data collected. Information on whether the catch is retained or discarded is collected by each t-RFMO and although there are differences in the levels of detail the information is reasonably coherent allowing for inter-t-RFMOs comparison. The current "Minimum Data-field Standards" specified by each of the t-RFMOs are outlined in the Table below.

IATTC	IOTC & ICCAT (IRD IEO AZTI)	WCPFC
Trip number, Set number, Date **Let go time** (time when the skiff, with the net attached, hits the water) **Ringsup time** (the time when all the purse rings break the surface of the water) **Endset time** (the time when the skiff is secured on deck after completing the set) **Tunaset or logset** **Evidence of strong currents during set & how determined** **Malfunctions during the set** (rime occurred, time repair completed, delay in the set)	**Set number** **Date** **Daily Activity data form number and activity number** **Captains estimate of school size before commencement of set (if possible per species and mean weight of each species)** **Time of set start – skiff launched** **Rings up time** **End of set (skiff on board) Thickness of the school Mean depth of school** **Depth at shallowest part of school** **Sonar used during setting** **Supply vessel part of setting – supply name Speed & direction of current at 10m depth Maximum depth of net when in**	**Observer's record of date and time of start of set** (usually recorded when the pelican hook is released and net skiff slides in to the water taking the net with it) **Observers record of date and time of end of set** (Record when the net skiff is hauled on board after the set) **Vessel's record of date and time of start of set** (Record what time and date the vessel has entered in the Log sheet for the same set) **Retained catch and Discards, by species** (Record all species that are retained using the FAO codes.

IATTC collects catch in metric tons with fileds for YFT, SKJ, Other (spp code) and well numbers specified where	IRD form request an estimate from the Captain/Fishing master for total catch of YFT, SKJ, BET and all school	

loaded	average weight for each species	
	IRD request Species code, weight category, total weight and well number of retained tuna For discard tuna IRD requests species code, weight category, discard code (see below) total weight, weather landed on deck For bycatch, IRD request species code, fate code, discard code, total weight, total number and for sharks and billfish average weight and/or average size	PIRFO forms request an estimated breakdown down of total tuna catch (MT) by % in the following categories SKJ, YFT<9kgs, YFT>9Kgs, BET<9kgs, BET>9Kgs and number for YFT>9Kgs and BET>9Kgs).
	IRD weight categories as follows for YFT, BET, ALB (<3Kg, 3- 10Kg, 11-30Kg, 3-30Kg, 31-50Kg, 11-50Kg, >50Kg, >10Kg) IRD weight categories as follows for SKJ, BLT, FRI, FRZ, LTA, KAW (<1.8Kg, >1.8Kg, 1.8-4Kg, 1.8-6Kg, 4-6Kg, 4-8Kg, 6-8Kg,	An estimate of the catch by fate code is also requested for target tuna and bycatch according to the following codes:
For retained catch	*For retained catch*	*For retained catch*
Human consumption Mixed (some catch consumed, some discarded)	retained (in well) Partially kept (shark fin, dry fish etc) Crew consumption	Retained – whole weight Retained – headed and gutted (billfish only) Retained – gilled and gutted (kept for sale) Retained – partial (eg. fillet, loin) Retained trunk – fins retained(shark only) Discarded trunk – fins retained (shark only) Retained – crew consumption Retained – other reason (specify)
For discarded catch	*For discarded catch*	*For discarded catch*

Discarded Species/size undesirable for market Catch lost due to ripped sack Vessel full Well limitation (wells not ready to receive fish) Condition undesirable for market Other	Discard in sea alive Discard in sea dead Wrong size Wrong species Wells full Damage fish Other (specify)	Discarded – too small (tuna only) Discarded – unwanted species Discarded – gear damage (tuna only) Discarded – vessel fully loaded Discarded – shark damage Discarded – whale damage Discarded – poor quality Discarded species of special interest – alive Discarded species of special interest - dead Discarded species of special interest – unknown condition Discarded - other reason (specify)
		Tag recovery information

Part 8 Length Information

IATTC currently do not require length measurements to be undertaken on the vessel and have implemented port sampling for these data. The diversity of unloading locations for the IATTC is believed to be low and the traceability of tuna catch high. Consequently length based information collected in port can be related back to the set. The traceability of catch in the WCPFC is more complex due to the occurrence of well sorting and high diversity of unloading locations and observers are required to undertake length measurements on the vessel. This includes measurement of discarded species and those of special interest which provides the opportunity to raise the catch data into finer resolution size increments. This is not possible for discarded species in the IATTC and inter-operability with the IATTC is poor for this data field. The current "Minimum Data-field Standards" specified by each of the t-RFMOs are outlined in the Table below.

IATTC	IOTC & ICCAT (IRD IEO AZTI)	WCPFC
		Species code (FAO).
	One column per species – check form for details	**Length measurement code** (as per the measurement methods given in the codes) Upper jaw to fork in tail Upper jaw to second dorsal fin Lower jaw to fork in tail Pectoral fin to fork in tail Pectoral fin to second dorsal fin Total length (for sharks)
Tuna **Metric Tons captured by species code & size category** (small <2.5kg; medium 2.5-15 kg; large >25kg; Total) **Billfish by species and number** Post-orbital Length (cm, up to 12 individuals) Collective number of individuals by category small <90cm; medium 90-150cm; large >150cm; Total)	**Discarded tuna** Estimate species composition from 100 to 150 randomly selected individuals then measure 10-20 (nearest cm) for each species For other discards species All species length, sex, weight (if precision scales available), picture (if first time seen) to be reported but a priority for sharks, billfish and atlantic bonito.	**Length (cm)**

Part 9 Species of Special Interest

The information collected by the t-RFMOs provides for some inter-operability between the datasets. General information describing the type of interaction and set details along with information on the species and fate when landed on the deck and when released is collected (with level of detail varying between t-RFMO). The IATTC, IOTC and ICCAT also collect specific information on turtle interaction. The current "Minimum Data-field Standards" specified by each of the t-RFMOs are outlined in the Table below.

IATTC	IOTC & ICCAT (IRD IEO AZTI)	WCPFC
General Information	*General Information*	*General Information*
Trip Number	**Set number**	**Type of interaction** (eg. caught on line - tangled in net, swimming around outside of net, etc).
Set Number		**Date and time of interaction** (ship date & time)
		Latitude and longitude of interaction
Species (using code table or specified)		**Species FAO code of marine reptile, marine mammal, or seabird**.
Landed on deck	*Landed on deck*	*Landed on deck*
Rays and Manta Rays **Estimated number of individuals by species code & size category** (small <90cm; medium 90-150cm; large >150cm; Total) and **Density** (Small, Medium, Large, Total) **Other Big and Medium Fish** **Code & Estimated number of individuals by species code** **& size category** (small <30cm; medium 30-60cm; large >60cm; Total) and **Density** (Small, Medium, Large, Total) **Seabird species code & number** **Other Fish, invertebrates, other fauna species code, number & density** **Sharks by species and number** Length (cm, up to 12 individuals) Collective number of individuals by category small <90cm; medium 90-150cm; large >150cm; Total)	All species length, sex, weight (if precision scales available), picture (if first time seen) to be reported but a priority for sharks, billfish and atlantic bonito.	**Length** (cm)

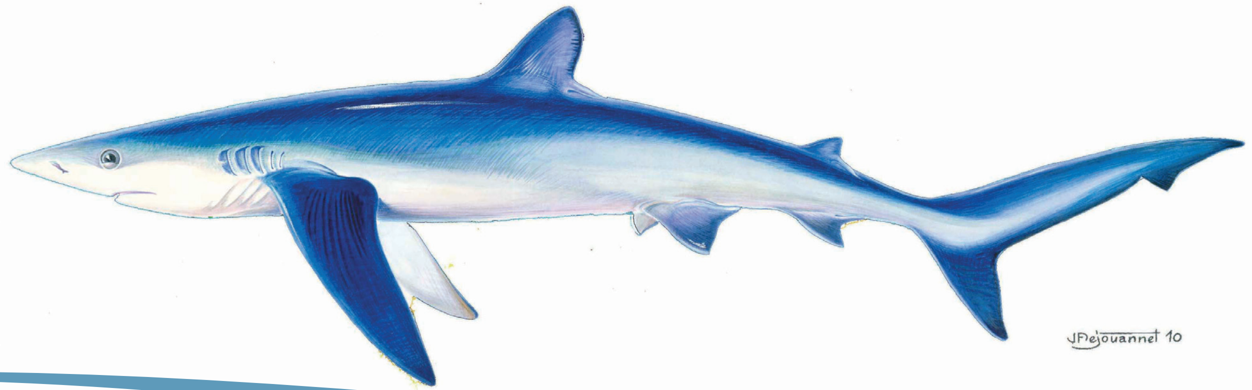
Length (cm) and girth (cm) Fetus length (cm)		
		Length measurement code (as above for codes)
Sharks Sex (Male/Female/Unknown) **Cetaceans** Sex (Male/Female)		**Gender** (Male/Female/Indeterminate/Unknown)
		Estimated shark fin weight by species
		Estimated shark carcass weight by species
		Condition when landed on deck (Codes are:)
Cetaceans Lactating (yes/no) Fetus & its sex		Alive but unable to describe condition Alive and healthy. Alive, but injured or distressed. Alive, but unlikely to live. Entangled, okay. Entangled, injured. Hooked, externally, injured. Hooked, externally, injured. Hooked, unknown, injured. Dead Entangled, dead Hooked, externally, dead. Hooked, internally, dead. Hooked, internally, dead. Condition unknown. Entangled, unknown condition. Hooked, externally, condition unknown Hooked, internally, condition unknown. Hooked, unknown, condition unknown.
Tuna **Code & Metric Tons discard to sea by category** (small <2.5kg; medium 2.5-15 kg; large >25kg; Total) plus reason (as above for codes) **Sharks**	**Condition when released** (same codes as above)	**Condition when released** (same codes as above)

Fate (human consumption, discarded, released alive, other , unknown) **Billfish** Fate (human consumption, discarded, released alive, other , unknown		
	Whaleshark and cetaceans Escape from net Released from net alive Released but dead Other (specify)	
		Tag recovery information
		Tag release information
		Interactions with Vessel or Gear only
		Vessel's activity during interaction (PIRFO options are: setting, hauling, searching, transiting, other)
		Condition of species observed at start of interaction (as above)
		Condition of species observed at end of interaction (as above)
		Description of interaction
		Number of animals sighted
Turtles	**Turtles**	
Species Olive Ridley Leatherback Hawksbill Loggerhead Unidentified		
Activity Alive & immobile Swimming		

Feeding Dead Other/Unkown		
Number of turtles Various sighting One group of multiple turtles Found trapped/entangled in floating object Passed alive through the power block		
Association Marine mammals Tuna (breezer) Unassociated Other Floating object Distance of the association (m)		
Condition upon leaving the Turtle Entangled alive in flotsam Previously dead Released unharmed Light injuries Grave injuries Killed Escaped/evaded net Consumed Not involved in set Other/Unknown	Tangled but alive Tangled but dead Free	

Annex VI

Prionace glauca (Linnaeus, 1758) Blue shark – FAO code: BSH



FAO code	Scientific name & English name	IUCN. Red List. Global assessment	IUCN. Red List. Regional assessments
BSH	*Prionace glauca.* Blue shark	NT (2009)	VU : MED

Biology

	Atlantic ocean	Mediterranean Sea	Indian ocean	Pacific ocean (West)	Pacific ocean (East)
Maximum size (TL) (cm)	383 [1] [2] 396.2 [30]	383 [1] [2] 396.2 [30]	383 [1] [2] 396.2 [30]	383 [1] [2] 396.2 [30]	383 [1] [2] 396.2 [30]
Common size in fisheries (range LF) (cm)	common length: 335[3] 93 - 387 TL [20] Usually: 180 - 240FL [22] male: 156 - 250 female: 156 - 250 [25]	common length: 335[3] Usually: 180 - 240FL [22]	common length: 335[3] male: 170 - 330 female 130 - 330 [22] [23] Usually: 180 - 240FL [22]	common length: 335[3] Usually: 180 - 240FL [22]	common length: 335[3] Usually: 180 - 240FL [22]
Maximum weight (kg)	205.9[3] [4]	205.9[3] [4]	205.9[3] [4]	205.9[3] [4]	205.9[3] [4]

Prionace glauca (Linnaeus, 1758). Blue shark – FAO code: BSH

Conversion factors

	Atlantic ocean	Mediterranean Sea	Indian ocean	Pacific ocean (West)	Pacific ocean (East)
Length / weight relationship	LogW=-5.396 + 3.134logTL [1] $WT=0.0110LT^{2.828}$ (n=74) [9] $WT=3.1841 * 10^{-6} FL^{3.1313}$ (n=4529) [10] Males $WT= 0.392 * 10^{-6} TL^{3.41}$ (n=17) Females $WT= 0.131 * 10^{-5} TL^{3.20}$ (n=450) [37] [34]	LogW=-5.396 + 3.134logTL [1]	LogW=-5.396 + 3.134logTL [1] $WT=0.159*10^{-4} LF^{2.84554}$ [26]	LogW=-5.396 + 3.134logTL [1] In north Central Pacific: Male: $WT= 3.8838 * 10^{-6} * TL^{3.174}$ (n=285) Female: $WT= 2.328 * 10^{-6} * PL^{3.294}$ (n=148) [37] [38] In New South Wales (Australia): $W= 3.113 * 10^{-6} * L^{3.04}$ (n=134) [46]	LogW=-5.396 + 3.134logTL [1] In north Central Pacific: Male: $WT= 3.8838 * 10^{-6} * TL^{3.174}$ (n=285) Female: $WT= 2.328 * 10^{-6} * PL^{3.294}$ (n=148) [37] [38] In California: (Mixed) $WT= 2.57 * 10^{-5} * TL^{3.05}$ (n=150) [37] [40]
Wet Weight / dressed weight ratio					
LT / LF	FL=0.8313TL+ 1.3908 (n=572) [10] FL = 1.73872 + 0.82995TL [19] TL = 1.175*FL + 4.103 [22] Male: FL=11.27 + 0.78TL Female: FL=23.52 + 0.73TL [37] [39] FL=-1.2+0.842TL TL=3.8+1.17FL [27] In Gulf of Guinea: FL = -1.061 + 0.8203TL TL = 1.716 + 1.2158FL (n=62) [35]	na	na	$FL= -1.615+0.838TL_{nat}$ (n=273) [6]	na
LT / PRC	Male: PCL= 3.92 + 0.74TL female: PCL= 28.95 + 0.63TL [27] [39]	na	na	North Central Pacific: PCL = 0.762TL - 2.505 (n=267) [37] [38]	North Central Pacific: PCL = 0.762TL - 2.505 (n=267) [37] [38]
Fins / carcass ratios	(*) [24] FW=65.84BW/ 0.0888 [27]	na	na	na	na

Prionace glauca (Linnaeus, 1758). Blue shark – FAO code: BSH

Reproduction

	Atlantic ocean	Mediterranean Sea	Indian ocean	Pacific ocean (West)	Pacific ocean (East)
Female maturity size (cm)	221 [1] >185 [19] 228 LT [28] [25] 50% of females have embryos : 180 FL (=220 TL) [35]	221 [1]	221 [1]	221 [1] 170 - 190 FL [6] 170 - 195 FL [7] 186 - 212 [17][16]	221 [1] 186 - 212 [17][16]
Female maturity age (yr)	5 - 6 [1] 6 [19] 5 - 7 [28] [29] 5 [28] [25]	5 - 7 [28] [29]	5 - 7 [28] [29]	7 - 9 [7] 5 - 6 [17] [16] 5 - 7 [28] [29]	5 - 6 [17] [16] 5 - 7 [28] [29]
Male maturity size (cm)	182 - 281? [1] [3] 193 - 210 (at 50% maturity of 201) FL [17] [18] 183 FL [19] 225 FL [28] [25] L_{95} = 205 FL [36]	182 - 281? [1] [3]	182 - 281? [1] [3]	182 - 281? [1] [3] 190 - 195 FL [6] [7] 203 [17] [16]	182 - 281? [1] [3] 203 [17] [16]
Male maturity age (yr)	4 - 5 [1] 4 - 6 [28] [29]	4 - 6 [28] [29]	4 - 6 [28] [29]	8 [7] 4 - 5 [17] [16] 4 - 6 [28] [29]	4 - 5 [17] [16] 4 - 6 [28] [29]
Birth size (cm)	35 - 44 [1] [19] 35 - 50 [29] 40 - 50 [46] [47]	35 - 44 [1] [19] 35 - 50 [29] 40 - 50 [46] [47]	35 - 44 [1] [19] 35 - 50 [29] 40 - 50 [46] [47]	35 - 44 [1] [19] 35 - 50 [29] 40 - 50 [46] [47]	35 - 44 [1] [19] 35 - 50 [29] 40 - 50 [46] [47] 43.5 [14] [30]
Sex ratio	1:1 (embryos) [17] 1:1 (embryos) [35]	na	1:1 (embryos)[1]	1:1 (embryos) [17] In New South Wales: (Females:males) 4:5 [46]	1:1 (embryos) [17]
Mode of development	viviparous with a yolk-sac placenta [1] Placentally viviparous [19]	viviparous with a yolk-sac placenta [1]	viviparous with a yolk-sac placenta [1]	viviparous with a yolk-sac placenta [1]	viviparous with a yolk-sac placenta [1]
Gestation period (month)	9 - 12 [1] [29] 9 -12 [19]	9 - 12 [1] [29]	9 - 12 [1] [29]	9 - 12 [1] [29]	9 - 12 [1] [29]
Mating period	ovulation and fertilization occurred mainly from December to July [36]	na	na	na	na
Spawning period	spring to early summer [1] [7] April to July [19]	spring to early summer [1]	spring to early summer [1]	spring to early summer [1] [7]	spring to early summer [1] [7]
Fecundity (embryos per litter)	4 - 135 [1] 4 - 63 [2] 80 [3] up to 82 [19] Average : 30 [29]	4 - 135 [1] 4 - 63 [2] 80 [3] Average : 30 [29]	4 - 135 [1] 4 - 63 [2] 80 [3] Average : 30 [29]	4 - 135 [1] 4 - 63 [2] 80 [3] Average : 30 [29] 1 - 62 (n=600) [17] [16] In New South Wales: 4 - 57 (mean 32) [46]	4 - 135 [1] 4 - 63 [2] 80 [3] 1 - 62 (n=600) [17] [16] Average : 30 [29]
Nursery ground	na	na	na	na	na

Prionace glauca (Linnaeus, 1758). Blue shark – FAO code: BSH

Age & growth

	Atlantic ocean	Mediterranean Sea	Indian ocean	Pacific ocean (West)	Pacific ocean (East)
L∞, k, t_0 for females	L∞=310FL k=0.16 t_0= -1.56 (n=118) [13] Both sex: L∞=394 k=0.13 t_0= -0.80 (n=268) [21] [33] Both sex: L∞=423 k=0.11 t_0= - 1.04 (n=82) [21] [34]	na	na	L∞= 235.5 k= 0.2297 [7] L∞=304 k=0.16 t_0= -1.01 (n=43) [21] North Pacific Ocean: L∞=243.3 k=0.144 t_0= -0.849 (n= 123) [29][16]	L∞=237.5 TL k=0.15 t_0= -2.15 (n=62) [12] L∞=241.9 k=0.25 t_0= -0.79 (n=88) [12] [14] [30] North Pacific Ocean: L∞=243.3 k=0.144 t_0= -0.849 (n= 123) [29][16]
L∞, k, t_0 for males	L∞=282FL k=0.18 t_0= -1.35 (n=287) [13] Both sex: L∞=394 k=0.13 t_0= -0.80 (n=268) [21] [33] Both sex: L∞=423 k=0.11 t_0= - 1.04 (n=82) [21] [34]	na	na	L∞= 297.18 k= 0.1650 [7] L∞=369 k=0.1 t_0= -1.38 (n=152) [21] North Pacific Ocean: L∞=289.7 k=0.129 t_0= -0.756 (n= 148) [29][16]	L∞=299.85 TL k=0.10 t_0= -2.44 (n=122) [12] L∞=295.3 TL k=0.18 t_0= -1.11 (n=38) [12] [14] [30] North Pacific Ocean: L∞=289.7 k=0.129 t_0= -0.756 (n= 148) [29][16]
Longevity (yr)	at least 20 [1] [3]estimated: 16 - 20 [13]	at least 20 [1] [3]	at least 20 [1] [3] males: 25, female: 21 [26]	at least 20 [1] [3] estimated: male: 22.76 female: 19.73 [7]	at least 20 [1] [3]

Prionace glauca (Linnaeus, 1758). Blue shark – FAO code: BSH

Habitat

	Atlantic ocean	Mediterranean Sea	Indian ocean	Pacific ocean (West)	Pacific ocean (East)
Depth range (m)	0 - 152 [1] 0 - 350 [8] 0 - 600	0 - 152 [1]	0 - 152 [1] 80 - 220 [1]	0 - 152 [1]	0 - 152 [1]
Temperature range (°C)	7 - 16 up to 21 [1]	7 - 16 up to 21 [1]	7 - 16 up to 21 [1]	7 - 16 up to 21 [1] female caught: 8 -21° male caught : 12 - 21° [15]	7 - 16 up to 21 [1] female caught: 8 -21° male caught : 12 - 21° [15]

Diet

	Atlantic ocean	Mediterranean Sea	Indian ocean	Pacific ocean (West)	Pacific ocean (East)
Nature of prey	bony fishes & squid [1] Pelagic teleosts, groundfish [11] Mainly small pelagic fish and cephalopods (particulary squid), with crustaceans, small sharks, cetaceans and seabirds [29] Diet composition (%volume) cephalopoda = 33.8 chondrichthyes = 2.1 Osteichthyes = 51.8 Sea and land birds = 0.4 Mammalia = 8 Animal remains and misc. = 3.9 (n=1199) [45]	bony fishes & squid [1] Mainly small pelagic fish and cephalopods (particulary squid), with crustaceans, small sharks, cetaceans and seabirds [29]	bony fishes & squid [1] Mainly small pelagic fish and cephalopods (particulary squid), with crustaceans, small sharks, cetaceans and seabirds [29]	bony fishes & squid [1] Mainly small pelagic fish and cephalopods (particulary squid), with crustaceans, small sharks, cetaceans and seabirds [29] In New South Wales: (occurrence of prey category %) Cephalopod : 61.3% Fish: 41.9% Bird: 3.2% Mammal: 3.2% Miscellaneous: 3.2% [46]	bony fishes & squid [1] Mainly small pelagic fish and cephalopods (particulary squid), with crustaceans, small sharks, cetaceans and seabirds [29]
%F	na	na	na	na	na
%N	na	na	na	na	na
%W	na	na	na	na	na
IRI	na	na	na	na	na
Stables isotopes N^{15}& C^{13}	na	na	na	na	na
Trophic level	4.1 [32]	4.1 [32]	4.1 [32]	4.1 [32]	4.1 [32]

Contaminants

	Atlantic ocean	Mediterranean Sea	Indian ocean	Pacific ocean (West)	Pacific ocean (East)
Heavy metals	In Northeastern Atlantic: In liver: Cu = 5.7 µg/g of dry weight Zn = 39 µg/g of dry weight. In Muscle: Cu = 4.4 µg/g of dry weight Zn = 35 µg/g of dry weight. [31] In Canary Is: Ranges of total mercury (HgT) concentrations: 0.16 - 1.84 µg/g of wet weight [42]	In Adriatic sea: mean mercury (HgT) concentrations: 0.38 µg/g of wet weight [42] [44]	na	Mercury concentrations in axial muscle tissues (mean) : 0.41µg/g [41] In Tasmania Ranges of total mercury (HgT) concentrations: 0.27 - 1.20 µg/g of wet weight [42] [43]	na
Organic pollutants	na	na	na	na	na

Prionace glauca **(Linnaeus, 1758). Blue shark – FAO code: BSH**

Stock Status Executive Summary

Stock structure

Atlantic Ocean and Mediterrenean Sea (ICCAT)

ICCAT separates North and South Atlantic blue shark stocks at 5ºN latitude based on tagging and catch data.

Indian Ocean (IOTC)

IOTC assumes a single stock of Blue shark in the Indian Ocean.

Pacific ocean – West Pacific Ocean (WCPFC) / East Pacific Ocean (IATTC)

The stock delineation for the North Pacific blue shark assessment was defined with a Northern limit on 60º N, eastern limit at 130º W and western limit at 140º. This stock delineation covered part of the WPCFC and IATTC.

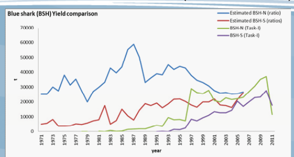
Fishery and Catches

Atlantic Ocean and Mediterrenean Sea (ICCAT)

Although global statistics on blue shark catches included in the ICCAT database have improved recently (specially from around mid-90s), they are still insufficient to permit the Committee to provide quantitative advice on stock status with sufficient precision to guide fishery management toward optimal harvest levels.

The first officials catch records for blueshark in ICCAT is from 1978 and 1991 for Northern and Southern stocks, respectively. For Northern stock, the official catch statistics increased up to around 3,000 t in 1990, to around 8,000 in 1996, reaching around 30,000 t. in 1997. Since then, the catches fluctuated between 20,000 t. and 30,000 t to increase up to 35,000 t. in 2009 and further to 39,500 t. in 2011. In the Southern stock a similar trend is observed, reaching 1,500 t. in 1994, 8,000 t. in 1997, 20,000 in 2005, 28,000 in 2010 and 35,000 t. in 2011. The catches for both stocks in 2011 are the highest records in the historic time series.

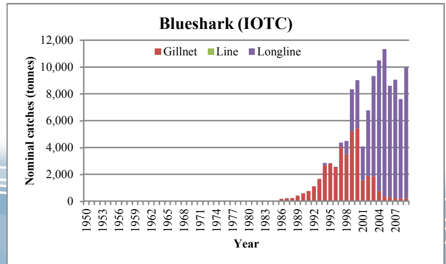
However, the ICCAT official catches are considered to represent only a portion of total removals and, thus, ICCAT have estimated a timeseries of blue shark catch based on the ratio of shark catches to tunas catch from fisheries where reliable information was available. Although the catch estimation is thought to be conservative because not all gear were included (ICCAT, 2008), the catch estimation is at a similar level and followed a similar pattern to ICCAT task I official catches from mid-90s. The catch estimation for northern stock showed an increasing trend to reach the highest catch level of around 60,000 t. in 1987 to decreased afterwards to the levels of 2005. In contrast, the estimated catch trend for the southern stock showed an increasing trend until 2005 where the latest estimation was available (ICCAT, 2008).



Indian Ocean (IOTC)

It appears that significant catches of sharks have gone unrecorded in several countries. Furthermore, many catch records probably under-represent the actual catches of blue shark because they do not account for species identification, discards (i.e. do not record catches of sharks for which only the fins are kept or of sharks usually discarded because of their size or condition) or they reflect dressed weights instead of live weights. FAO also compiles landings data on elasmobranchs, but the statistics are limited by the lack of species-specific data and data from the major fleets.

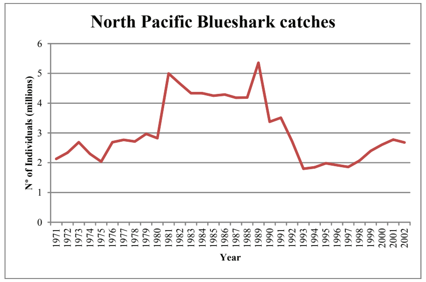
There is little information on the fisheries prior to the early 1970's, and some countries continue not to collect shark data while others do collect it but do not report it to IOTC.The catch estimates for blue shark are highly uncertain and few Members countries have reported detailed data on blue shark catches. As such, IOTC official catches are considered to represent only a portion of total removals. The first officials catch records for blueshark in IOTC dated back to 1986, it increased up to the highest records in the series of around 11,000 tonnes in 2005, and since then it slightly decreased to be at around 10,000 during last years.



Pacific ocean – West Pacific Ocean (WCPFC) / East Pacific Ocean (IATTC)

Catch data to carry out this assessment were gathered from the national commercial fleet statistics of Japan, the U.S., Taiwan, the Republic of Korea and the Secretariat of the Pacific Community, and research and training vessel data from Japan; however, data from other several countries were not available and, thus, the data reviewed here does not represent the total catches of the area.

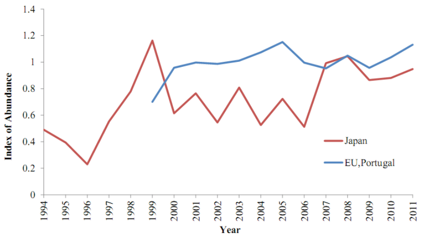
There is little information on the fisheries prior to the early 1970's. The catch estimates blue shark for those countries are estimated to increase constantly from 2 million individuals in 1971 up to 5 million individuals in 1981. Since then the catches continuously diminished up to 4.2 million in 1988; however, they increased suddenly to around 5.4 million in 1989. Afterwards, catches decreased again to reach the initial levels of 2 million in 1998 and since then catches increased to reach the 2.7 million level in 2001 and 2002.

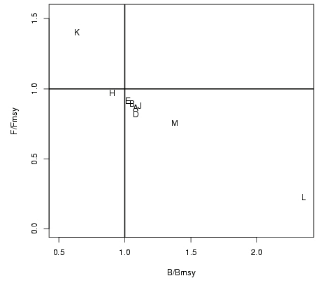


Prionace glauca (Linnaeus, 1758). Blue shark – FAO code: BSH

Stock Status Executive Summary

	Atlantic Ocean and Mediterrenean Sea (ICCAT)	Indian Ocean (IOTC)	Pacific ocean: West Pacific Ocean (WCPFC) / East Pacific Ocean (IATTC)
State of the Stock	The last full stock assessment for northern and southern stock of blue shark were conducted in 2008, applying Bayesian surplus production model and various age-structured production models to the available catch data through 2006. Various series of CPUE were available (6 for Northern stock and 4 for Southern stock). Although the quality of data, both quantitatively and qualitatively, improved from previous assessments, the results were still quite uninformative. Unless the catch data and CPUE standardization is improved, the assessments of stock status for blue shark will continue to be very unreliable.	The standardized Japanese CPUE trend suggest that the longline catch rate was kept at the same level during 2000–2006 and subsequently increased to higher levels for the period 2007–11 (Hiraoka and Yokawa 2012). The standardized Portuguese CPUE index shows little variability for the period studied 1999-2011 (Coelho et al., 2012). No quantitative stock assessment for blue shark has been carried out by IOTC. However, shark Ecological Risk Assessment for longline and purse seiner was undertaken in 2012 (Murua et al., 2012). Based on that work, blue shark was ranked as having highest productivity among the shark species considered but also showed high susceptibility (rank 2) to the longline gear while the susceptibility was low for purse seiner. Thus, the blueshark vulnerability to the longline gear was intermediate (rank 10 out of 16 especies) because although being the most productive it is also characterized by high susceptibility. For the purse seiner it was the less vulnerable ranking the last shark species in the ERA.	The last full stock assessment for northern Pacific blue shark was conducted in 2009, applying Bayesian surplus production and an integrated assessment model (Multifan-CL) to the available catch data through 2002. Various series of CPUE were available (6 for Northern stock and 4 for Southern stock). A variety of structural assumptions were tested with both assessment methods, a surplus production model and an integrated assessment model, and the results showed the production model was in general agreement with the alternative scenarios analysed in Multifan-CL.
Biomass	For both Northern and Southern stocks, the biomass at the beginning of 2008 was estimated to be above the biomass at MSY and, thus, most models suggested that stocks are not overfished and that biomass is estimated to be above ICCAT Convention Objective.		The trends in abundance in both models showed the same declining pattern in the 1980s followed by recovery to above the level at the start of the time series. The assessment results concluded that the population was close and approaching to the population BMSY reference point.
Fishing mortality	Fishing mortality rate in 2007 was estimated to be below the fishing mortality rate at MSY and, thus, most models concluded that overfishing was not occurring.		Fishing mortality rate in 2001 was also close and approaching to the fishing mortality at MSY levels.





Prionace glauca (Linnaeus, 1758). Blue shark – FAO code: BSH

Stock Status Executive Summary

Recommendation

Atlantic Ocean and Mediterrenean Sea (ICCAT)

In general for sharks, ICCAT recommends that precautionary management measures are needed for stocks where there is the greatest biological vulnerability and conservation concern, and for which there are very few data.

In order to improve the stock assessments of pelagic shark species harvested in ICCAT fisheries, ICCAT also recommended that the Member submit the corresponding statistics of all ICCAT and non-ICCAT fisheries capturing shark species, including recreational and artisanal fisheries. It is considered that for a correct assessment of the status of the stocks and management of those species a solid basis to estimate total catches is necessary.

Blue Shark	Northern Stock	Southern Stock
Assessment Year	2008	
Data available	2007	
Yield 2011[1]	11,548	17,812
Yield 2010	37,178	27,814
Yield 2007	61,845	37,075
MSY		
B_{2007}/B_{MSY}	1.87 - 2.74	1.95 - 2.80
F_{2007}/F_{MSY}	0.13 - 0.17	0.04 - 0.09

1 Provisional

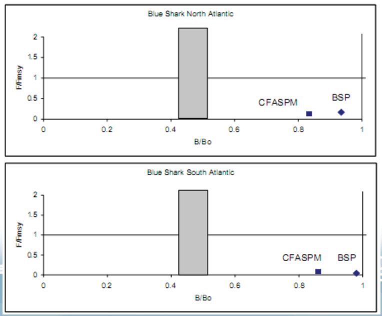


Figure 1.- Phase plot summarizing Blue shark stock status. The box represent the B/BMSY point and the line the F/FMSY threshold.

Indian Ocean (IOTC)

Maintaining or increasing effort will probably result in further declines in biomass, productivity and CPUE. The impact of piracy in the western Indian Ocean has resulted in the displacement and subsequent concentration of a substantial portion of longline fishing effort into certain areas in the southern and eastern Indian Ocean. It is therefore unlikely that catch and effort on blue shark will decline in these areas in the near future, and may result in localised depletion.

The following should also be noted:

- The available evidence indicates risk to the stock status at current effort levels.
- The two primary sources of data that drive the assessment, total catches and CPUE are highly uncertain and should be investigated further as a priority.
- Mechanisms need to be developed by the Commission to encourage CPCs to comply with their reporting requirement on sharks.

Blue Shark	Northern Stock
Assessment Year	2012
Data available	2011
Yield 2011	9,540
Yield 2010	9,829
Yield 2009	9,687
Stock status	Uncertain
MSY	-
B_{2002}/B_{MSY}	-
F_{2002}/F_{MSY}	-

Pacific ocean

West Pacific Ocean (WCPFC)

East Pacific Ocean (IATTC)

Blue Shark	Northern Stock
Assessment Year	2009
Data available	2002
MSY	-
B_{2002}/B_{MSY}	1.11
F_{2002}/F_{MSY}	0.86

* MSY reference points from Multifan CL integrated assessemnt model.

However, in the recent WCPO analyses, substantial recent catch rate declines found in four different datasets for the North Pacific, in combination with demonstrated targeting of blue shark by a large commercial fleet operating in this area, are scientific grounds for concern and suggest further declines in abundance since 2002. Therefore, the conclusion of Kleiber et al. (2009) that this stock was above BMSY may no longer hold.

Stock Status Executive Summary

	Atlantic Ocean and Mediterrenean Sea (ICCAT)	Indian Ocean (IOTC)	Pacific ocean	
			West Pacific Ocean (WCPFC)	East Pacific Ocean (IATTC)
Sources of Information	ICCAT. 2009. Report of the 2008 Shark Stock Assessment Meeting. Collect. Vol. Sci. Pap. ICCAT, 64(5): 1343-1491. ICCAT. 2012. Report of the Standing Committee on Research and Statistics (SCRS). SCRS Report 2012. ICCAT. 2012. 2012 Shortfin Mako Stock Assessment and Ecological Risk Assessment. ICCAT Shark Working Group meeting report 2012.	Coelho R., M.N. Santos and P.G. Lino. 2012. Update of the standardized CPUE series for major shark species caught by the Portuguese pelagic longline fishery in the Indian Ocean. IOTC–2012–WPEB08–29. Hiraoka Y. and K. Yokawa. 2012. Update of CPUE of blue shark caught by Japanese longliner and estimation of annual catch series in the Indian Ocean. IOTC–2012–WPEB08–28. IOTC–SC15 2012. Report of the Fifteenth Session of the IOTC Scientific Committee. Mahé, Seychelles, 10–15 December 2012. IOTC–2012–SC15–R[E]: 288 pp. Murua H., R. Cohelo, M.N. Neves, H. Arrizabalaga, K. Yokawa, E. Romanov, J.F. Zhu, Z.G. Kim, P. Bach, P. Chavance, A. Delgado de Molina and J. Ruiz. 2012. Preliminary Ecological Risk Assessment (ERA) for shark species caught in fisheries managed by the Indian Ocean Tuna Commission (IOTC). IOTC–2012–WPEB08–31.	Kleiber, P., S. Clarke, K. Bigelow, H. Nakano, M. McAllister, and Y. Takeuchi. 2009. North Pacific blue shark stock assessment. U.S. Dep. Commer., NOAA Tech. Memo., NOAA-TM-NMFS-PIFSC-17, 74 p.	

General Recommendations

Data collection

In general, there is a scarcity of data and limited data availability for major fleets and countries in Tuna RFMOs. Attending to historical data, several countries were not collecting fishery statistics, especially in years prior to the development of tuna and tuna-like fisheries in early 1970s. It is thought that important catches of sharks might have gone unrecorded in several countries. This problem worsens in the case of developing states and, especially, for historical data. Furthermore, many catch records probably under-represent the actual catches of blueshark because they do not account for discards (i.e. do not record catches of sharks for which only the fins are kept or of sharks usually discarded because of their size or condition) or they reflect dressed weights instead of live weights.

Although global statistics on blue shark catches included in Tuna RFMOs database have improved recently (specially from around mid-90s), they are still insufficient to permit the Committee to provide quantitative advice on stock status with sufficient precision to guide fishery management toward optimal harvest levels.

The catches of sharks are not recorded by gear and/or species. The catches of sharks are not disaggregated at the required level for each species by area or fleet. Generally major sharks such as blueshark and shortfin mako shark are better reported that other species but still are inconsistencies. Mis-identification of shark species is also common. The identification of sharks in port is usually compromised by the way in which the different species of sharks are processed before landed. Generally, no indication is given on the type of processing that the different specimens underwent. Then, the identification of sharks unloaded as shark carcasses, shark fins or other shark products is difficult.

In order to improve the stock assessments of blueshark harvested in Tuna RFMO fisheries, Tuna RFMOs also recommended that the Member submit the corresponding statistics of all fisheries capturing blueshark species, including recreational and artisanal fisheries. Countries are required to report all catches of blueshark, including available historical data according to data reporting procedures of specific RMFOs. Particular reporting requirements apply to shark species in each region. Countries are also urged to report in steps taken to improve data collection and revision on actions taken. It is considered that for a correct assessment of the status of the stocks and management of those species a solid basis to estimate total catches is necessary.

The data available by flag in the public domain is scarce in RFMO countries. In some cases due to confidentiality issues is difficult to get the basic fishery information regarding the fleet activity catching blueshark, especially for historical data. It is difficult to extract disaggregated and aggregated data for some data different fleets, especially for longline and coastal fishery. Attempts should be made to allow scientific committee of Tuna RFMOs access the available data for improving the stock assessments.

Observer programmes

In tuna RFMOs, data is mostly reported as the nominal catch data (landings and discards by species, stock, gear, fleets and year) which is the basic information used in all the stock assessments but also data on catch/effort and size data are provided which are more detailed in terms of time and geographic area information. Although the objectives of Observer Programs can vary widely, in general in the case of sharks their objective is to collect basic fishery statistics such as catch and effort data as well as to conduct biological sampling. Observers also offer one of the few methods appropriate to obtain accurate location, catch and effort information for sharks caught in tuna fisheries.

Although the objectives of the observer programmes can be diverse, observer programs will generally require high or moderate levels of precision if the purpose of the observer program is to provide adequate information to improve fisheries stock assessments, endangered species protections, and ecosystem management. In Tuna RFMOs, when the goal is to monitor the total tuna catch and/or bycatch/discards, the coverage agreed range between 5 % and 20 %. As such, in relation to the estimation of shark catches, the different coverage agreed have a clear effect on the ability to obtain accurate data of both shark catch estimates and status (alive or dead) of sharks discarded.

Although the level of observer coverage for the estimation of shark mortality depends on species and fleets specific cases, it is important that the observer programme has the following characteristics:

- Sufficient coverage to provide statistically accurate estimates of catch, bycatch and discards. A preliminary aim is to have observer coverage of 20% or above.
- Sufficient spatial/temporal coverage of the main fleets.
- Sufficiently trained observers: to develop an observer training programme in order for observers to be sufficiently competent to record the data required by the RFMOs for management purposes.
- Species identification guides: species identification is a major problem with regard to shark bycatch data collection and, thus, species identification guides.
- Data forms: harmonized data forms to collect the shark bycatch and discard information (sex, size and life status: life or dead upon retrieval of the gear /at time of discarding).
- Database: database for recording of all observer data as well as well-designed protocols for accessing the data, taking into account data confidentiality and ownership.

Alternative ways to improve the collection of fishery statistics could be the use of “self-sampling” and Electronic Monitoring (EM).

Self-sampling methodology uses fisheries scientists and/or technicians to collect information on commercial catches which is a cost effective method. Therefore, currently there is ongoing effort worldwide to develop programmes to use fishers to self-sample their catches. Such programmes have generally two major objectives: i) reduce costs and increase efficiency on the collection of commercial fishery data; and, ii) to involve fishing industry in the assessment process by having them work closely with the scientists. Thus, the overall purpose of the programmes is to improve data collection and consequently reduce stock assessments uncertainty.

One of the major recognized problems with self-sampling is that some scientists do not see the data as fully scientific or valid. In order

General Recommendations

to shift this attitude it is necessary to properly verify the usability, high quality of data and cross-validated the data collected by self-sampling with data compiled by traditional observer programs. Moreover, for a successful program of self-sampling the willingness and collaboration from industry is necessary. Therefore, they should rely on the development of guidelines of best practice and general recommendations to assist in the initiation and execution of self-sampling and self-reporting programmes. Moreover, such schemes should rely on good collaboration between scientists and fishers, aiming to define clear aims and generate high quality data.

Confidentiality is another important issue that should be assured on these programmes, namely by ensuring that when used the data is presented in an anonymous and aggregated way. This is particularly important as some data sets might be used for enforcement purposes, and therefore might endanger trust between scientists and fishers.

Electronic monitoring (EM) systems are being used in some fisheries as an alternative, or a complement to human observers. The EM systems consist of a centralized computer combined with several sensors and cameras, which can be deployed on fishing vessels to monitor a range of fisheries issues, including: fishing location, catch, catch handling, fishing methods, protected species interactions, and mitigation measures. The efficacy of EM for monitoring issues varies according to fishing methods and other factors. Over the past decade, pilot studies have been carried out in more than 25 fisheries to test the efficacy of this technology, being involved different countries, gears and target species.

During 2012, the first trial with EM on a tropical tuna purse seine was performed in the Atlantic Ocean and this study suggested that EM is a viable tool for monitoring effort, set-type and tuna catch within the tropical tuna purse seine fishery. However, some limitations exist for the monitoring of the bycatch and especially for reliably estimation and identification of some shark species. Furthermore, observers constantly identified sharks to a higher taxonomic level, as 100 % of the shark species were identified by the observer, EM system provided limited identification (e.g. often to family level). However, the problems observed with this first trial on the tuna purse seine fleet can be easily solved with some adjustments on the system such as the use of digital cameras and some modification on the crew catch handling behaviour.

Similar to the self-sampling programmes, the success of an EM program would depend on the good collaboration between fishers and scientist as it requires that the vessel owners and crew understand the importance of standardized catch handling protocols. EM systems are designed to be flexible enough to accommodate a variety of catch handling methods, but handling must be consistent and standardized in order to collect reliable data. For example, if a camera is installed above the discard handling area, and discarding handling is moved to another area of the vessel, the camera will no longer capture discarding events. This example illustrates the importance of having strong support from the vessel owners, officers and crew to achieve monitoring objectives.

It is also possible to apply such EM systems to gillnets and long-line fleets. For example, a study on a gillnet fishery shows that EM offers opportunities for monitoring shark gillnet fishing activity. Overall, the high quality of imagery, the ability to identify most catch items, and no missing imagery in the data set, indicated that EM equipment was reliable and suitable for shark gillnet vessels. In the particular case of gill net tuna fisheries, due to size of the fleet and the artisanal nature of the fisheries, it could be quite difficult a full-implementation of the EM sampling program. However, taking into account the complete lack of data and observers programs that are currently being implemented in gillnets tuna fisheries, the application of EM in a pilot observer vessels (100 % EM coverage of few vessels of the gillnet fishery) can be considered a suitable approach for collecting shark bycatch statistics on artisanal and coastal gillnet fisheries. In the case of longliners, it might be worthy and easier to implement such system.

Management measures

Management measures are essential when a given stock is seriously affected by the fishing activity and are aimed at limiting the impact of this activity. The election of a measure will depend on the stock status, on the behavior of the species, on the species being target or not, etc.

The main problem for pelagic shark's management is that there are few targeted fisheries. In the case of blueshark it can be considered that some of the longline fisheries catching them are targeting specifically blueshark.

In general for sharks, all Tuna RFMOs recommend that precautionary management measures are needed for stocks where there is the greatest biological vulnerability and conservation concern, and for which there are very few data. Taking into consideration the results of the modeling approaches used in the assessment, the associated uncertainty, and that maintaining or increasing effort will probably result in further declines in biomass and productivity, it can be recommended that the fishing mortality of bluesharks should not be increased.

And for the application of these recommendations several management measures can be recommended, such as:

TACs

Total allowable catches (TACs) are catch limits that are set for most significant commercial fish stocks, and is widely used as the main management measure for several exploited stocks. Although blueshark are also caught as bycatch, there are fisheries directly targeting blueshark. In the case where the productivity of the stocks and the impact of the fisheries can be adequately assessed, the establishment of TACs can ensure these populations are kept at levels that do not significantly affect their productivity. This could be the case of blueshark stocks for which an assessment and management advice is provided (e. g. ICCAT case).

Spatial/temporal closures

Time and/or area closures have been widely used as management measures to prevent overfishing and to protect certain marine habitats. Although there are very few examples on the use of this kind of measures to reduce shark bycatch, the development of protected areas or time closures, focused on shark "hot spots" or in critical habitats (e.g. nursery grounds) have great conservation potential. A measure of this kind must take into account the effect of effort

General Recommendations

reallocation to adjacent areas, as well as the possible reduction in target species catch.

However, for applying those measures it is first necessary to investigate possible spawning/nursery areas of great conservation potential. Until those studies are available the application of these types of management measures will be inappropriate. Moreover, the monitoring, surveillance and control of this kind of regulations can be easily enforced in industrial fisheries (thanks to VMS systems), but not in artisanal fleets (smaller vessels without VMS systems implemented).

No retention polices

Taking into account that the blueshark can be considered one of the few species of sharks for which a directed fishery exists, the "no retention policies" are not considered appropriate management measures. In the case of fisheries by-catching blueshark the "no retention policies" can be applied (see mitigation measures and post-release mortality tables).

Finning

Finning is the practice of slicing off fins and dumping carcasses at sea. Although shark finning has been banned in the four main tuna RFMOs, discussion is now focused on the enforcement of this regulation. Most of the current measures allow for a 5% shark fin to body weight ratio, but this ratio is highly dependent on the fin usage (primary fin sets vs all fins), on the species and on the way the body weight is computed (whole, dressed...), and can lead to finning going undetected. Having in mind the forthcoming EU legislation for the prohibition on the removal of fins on board vessels which assures that fins attached to carcass are unloaded, it would be advisable to promote this measure within all the TunaRFMOs.

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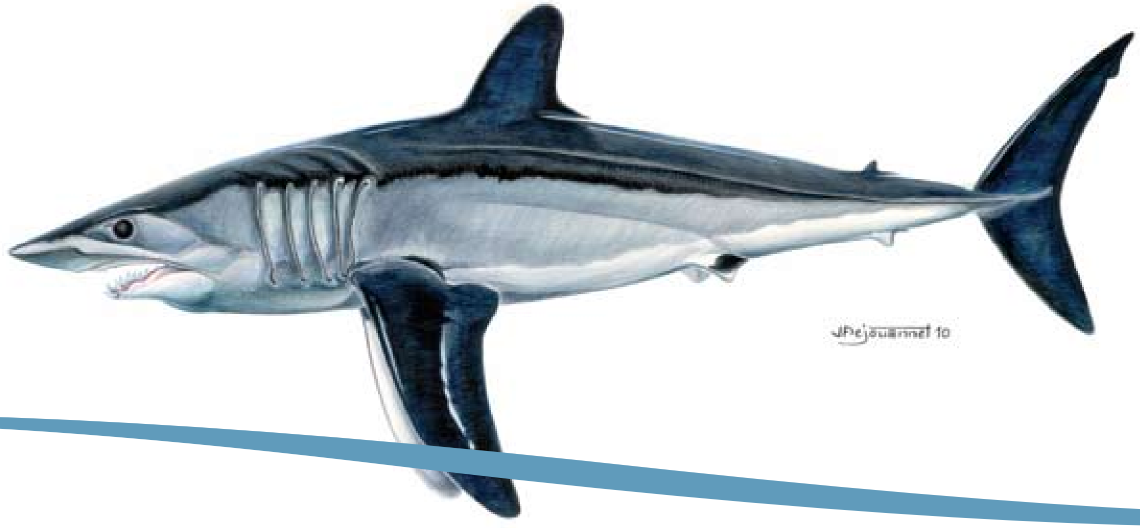
Isurus oxyrinchus (Rafinesque, 1810) Shortfin mako – FAO code: SMA



FAO code	Scientific name. English name	IUCN. Red List. Global assessment	IUCN. Red List. Regional assessments	CMS	Barcelona Convention	GFCM
SMA	*Isurus oxyrinchus.* Shortfin mako	VU (2009)	VU : NEA CR : MED NT : ENP VU : IWP	App. II + MoU	App. II (2012)	35/2012/7B 36/2012/3

Biology

	Atlantic ocean	Mediterranean Sea	Indian ocean	Pacific ocean (West)	Pacific ocean (East)
Maximum size (TL) (cm)	396 estimated: 408 [1] 396.2 [2] [25]	396 estimated: 408 [1]	396 estimated: 408 [1]	396 estimated: 408 [1]	396 estimated: 408 [1] 350.7 [2] [26]
Common size in fisheries (range LF) (cm)	commonly to 207 [8]	commonly to 207 [8]	commonly to 207 [8]	commonly to 207 [8]	commonly to 207 [8]
Maximum weight (kg)	505.8 [9]	505.8 [9]	505.8 [9]	505.8 [9]	505.8 [9]

Isurus oxyrinchus (Rafinesque, 1810) Shortfin mako – FAO code: SMA

Conversion factors

	Atlantic ocean	Mediterranean Sea	Indian ocean	Pacific ocean (West)	Pacific ocean (East)
Length / weight relationship	$W=1.193*10^{-6}*TL^{3.46}$ (n=23, TL=160 to 260) [1] $W= 1.47*10^{-5}*PCL^{2.95}$ (n=143, PCL=84 to 260 South Africa) [1][5] $W=5.2432*10^{-6}*FL^{3.1407}$ (n=2081) [6] $W=7.2999 * TL(m)^{3.224}$ (n=63) [7]		$W= 1.47*10^{-5}*PCL^{2.95}$ (n=143, PCL=84 to 260 South Africa) [1][5]	$W=4.832*10^{-6}*TL^{3.10}$ (n=80 TL=58 to 343) [1][3] In New South Wales: $W= 5.755 * 10^{-6} * L^{3.06}$ (n=110) [3] [31]	
Wet Weight / dressed weight ratio					
LT / LF	FL= 0.9286*TL -1.7101 (n=199) [6] FL=0.972TL - 9.36 TL= 1.02FL + 11.75 [20]			FL=0.918TL - 2.078 [15] FL=0.952 + 0.890TL (n=1236 TL: 80 - 375) [20]	
LT / PRC				PCL= 0.784+0.816TL (n=1240 TL: 80 - 375) [20] PCL=0.84TL - 2.13 (n=131) [24]	
Fins / carcass ratios					

LT / PRC

Fins / carcass ra

Isurus oxyrinchus (Rafinesque, 1810) Shortfin mako – FAO code: SMA

Reproduction

	Atlantic ocean	Mediterranean Sea	Indian ocean	Pacific ocean (West)	Pacific ocean (East)
Female maturity size (cm)	maturing: 275 - 293 [1] 298 (West North Atlantic) [7] 273 (Southern Hemisphere) [7] 275 FL [10] 270 - 300 [22]	275 - 293 [1] 270 - 300 [22]	275 - 293 [1] 273 [7] 270 - 300 [22]	275 - 293 [1] 280 [3] 273 [7] 275 - 285 FL [18] 278 [20] 270 - 300 [22]	275 - 293 [1] 273 [7] [13] 270 - 300 [22]
Female maturity age (yr)	18 [10] 7 [10] [11]			19.1 - 21 [15] 18 - 19 [10] [17] 16 [24]	7 - 8 [12] 15 [13]
Male maturity size (cm)	maturing : 203 - 215 [1] 185 FL [10] 180 FL [21] 200 - 220 [22]	maturing : 203 - 215 [1] 200 - 220 [22]	maturing : 203 - 215 [1] 200 - 220 [22]	maturing : 203 - 215 [1] 195 [3] 180 - 185 FL [18] 210 [20] 200 - 220 [22]	maturing : 203 - 215 [1] 180 [13] [14] 180 - 195 [20] [3] 200 - 220 [22]
Male maturity age (yr)	8 [10] 3 [10] [11]			6.9 - 9 [15] 13 - 14 [10] [17] 6 [24]	7 - 8 [12] 7 [13]
Birth size (cm)	60 - 70 [1] 70 - 90 [2] 70 [7] 60 - 110 [23] In South Africa: 60 - 70 [32]	60 - 70 [1] 70 - 90 [2] 70 [7] 60 - 110 [23]	60 - 70 [1] 70 - 90 [2] 70 [7] 60 - 110 [23] In South Africa: 60 - 70 [32]	60 - 70 [1] 70 - 90 [2] 70 [7] 60 - 110 [23] 74 [20] In new South Wales: about 70 [3]	60 - 70 [1] 70 - 90 [2] 70 [7] 60.5 [12] 60 - 110 [23]
Sex ratio	1:1 (young of the year) [21]	1:1 [21] [3]	1:1 [21] [3]	1:1 [21] [3]	1:1 [21] [3]
Mode of development	ovoviviparous [1]	ovoviviparous [1]	ovoviviparous [1]	ovoviviparous [1]	ovoviviparous [1]
Gestation period (month)	15 - 18 [1] 15 - 18 [7]	15 - 18 [1] 15 - 18 [7]	15 - 18 [1] 15 - 18 [7]	15 - 18 [1] 15 - 18 [7] 23 - 25 months [20]	15 - 18 [1] 15 - 18 [7]
Mating period				January to June [20]	
Spawning period	late winter to midsummer [1]	late winter to midsummer [1]	late winter to midsummer [1]	late winter to midsummer [1] Decembre to July [20] In New South Wales, probably in November	late winter to midsummer [1]
Fecundity (embryos per litter)	4 - 30 (mostly 10 to 18) [1] 4 - 25 [7] In south Africa: 9 - 14 [7][5]	4 - 30 (mostly 10 to 18) [1] 4 - 25 [7] 25 - 30 [7][27]	4 - 30 (mostly 10 to 18) [1] 4 - 25 [7] In south Africa: 9 - 14 [7][5]	4 - 30 (mostly 10 to 18) [1] 4 - 25 [7] 4 - 15 [20] In New South Wales: 4 - 16 [3]	4 - 30 (mostly 10 to 18) [1] 4 - 25 [7] 2 - 16 [12]
Nursery ground					

Isurus oxyrinchus (Rafinesque, 1810) Shortfin mako – FAO code: SMA

Age & growth

	Atlantic ocean	Mediterranean Sea	Indian ocean	Pacific ocean (West)	Pacific ocean (East)
L∞, k, t_0 for females	L∞=366cm FL k=0.087yr^{-1} (n=140; VBGF) [10] L∞=345cm FL k=0.203yr^{-1} t_0= -1yr (n=54; VBGF) [10][11]			L∞=732.41cm FL k=0.0154yr^{-1} t_0= -10.79yr (n=111; VBGF) [15] L∞=403.62cm FL k=0.040yr^{-1} t_0= -5.27yr (n= 174; FL: 72.6 - 314.9; VBGF) [10] [16] L∞=349cm FL k=0.155yr^{-1} t_0= -1.97yr (n=52; FL: 74 - 314; VBGF) [10] [17] L∞=308.3cm FL k=0.09yr^{-1} (n = 147) [24]	sexes combined L∞=321cm TL k=0.072yr^{-1} t_0= -3.75yr (n=44; VBGF) [2] [12] sexes combined L∞=411cm TL k=0.05yr^{-1} t_0= -4.7yr (n=109; VBGF) [13]
L∞, k, t_0 for males	L∞=253cm FL k=0.125yr^{-1} (n= 118; VBGF) [10] L∞=302cm FL k=0.266yr^{-1} t_0= -1yr (n=49; VBGF) [10] [11]			L∞=302.16cm FL k=0.0524yr^{-1} t_0= -9.04yr (n=145; VBGF) [15] L∞=321.8cm FL k=0.049yr^{-1} t_0= -6.07yr (n= 133; FL: 72.6 - 314.9; VBGF) [10] [16] L∞=267cm FL k=0.312yr^{-1} t_0= -0.95yr (n=24; FL: 66 - 274; VBGF) [10] [17] L∞=231cm FL k=0.16yr^{-1} (n=128) [24]	sexes combined L∞=321cm TL k=0.072yr^{-1} t_0= -3.75yr (n=44; VBGF) [2][12] sexes combined L∞=411cm TL k=0.05yr^{-1} t_0= -4.7yr (n=109; VBGF) [13]
Longevity (yr)	estimated: 45 [1][2] Reported: female: 32; male: 29 [10]	estimated: 45 [1][2]	estimated: 45 [1][2]	estimated: 45 [1][2] estimated: male: 29 female: 28 [15]	estimated: 45 [1][2] 38 [12]

Isurus oxyrinchus (Rafinesque, 1810) Shortfin mako – FAO code: SMA

Habitat

	Atlantic ocean	Mediterranean Sea	Indian ocean	Pacific ocean (West)	Pacific ocean (East)
Depth range (m)	0 - 500 [1] usually 0 -150 [9]	0 - 500 [1] usually 0 -150 [9]	0 - 500 [1] usually 0 -150 [9]	0 - 500 [1] usually 0 -150 [9]	0 - 500 [1] usually 0 -150 [9]
Temperature range (°C)	16° to tropical & warm temperature [1]	16° to Tropical & warm temperature [1]	16° to tropical & warm temperature [1]	16° to tropical & warm temperature [1]	16° to tropical & warm temperature [1]

Diet

	Atlantic ocean	Mediterranean Sea	Indian ocean	Pacific ocean (West)	Pacific ocean (East)
Nature of prey	bony fishes, other elasmobranchs, cephalopods [1] Diet composition (%volume) cephalopoda = 1.4 chondrichthyes = 0.3 Osteichthyes = 97.9 Mammalia = 0.3 Animal remains and misc. = 0.1 (n=399) [30]	bony fishes, other elasmobranchs, cephalopods [1]	bony fishes, other elasmobranchs, cephalopods [1]	bony fishes, other elasmobranchs, cephalopods [1]	bony fishes, other elasmobranchs, cephalopods [1]
%F					
%N					
%W					
IRI					
Stables isotopes N^{15}& C^{13}					
Trophic level	4.3 [19]	4.3 [19]	4.3 [19]	4.3 [19]	4.3 [19]

Isurus oxyrinchus (Rafinesque, 1810) Shortfin mako – FAO code: SMA

Contaminants

	Atlantic ocean	Mediterranean Sea	Indian ocean	Pacific ocean (West)	Pacific ocean (East)
Heavy metals				Mercury concentrations in axial muscle tissues (mean) : 3.2µg/g [29]	Hg level in the white muscle: (Mean) 1.13µg/g wet weight [28]
Organic pollutants					

Isurus oxyrinchus (Rafinesque, 1810) Shortfin mako – FAO code: SMA

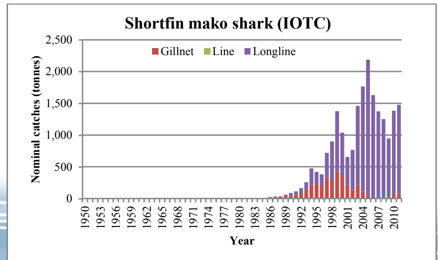
Stock Status Executive Summary

<table>
<tr><th rowspan="2"></th><th rowspan="2">Atlantic Ocean and Mediterrenean Sea (ICCAT)</th><th rowspan="2">Indian Ocean (IOTC)</th><th colspan="2">Pacific ocean</th></tr>
<tr><th>West Pacific Ocean (WCPFC)</th><th>East Pacific Ocean (IATTC)</th></tr>
<tr><td>Stock structure</td>
<td>ICCAT assumed that there are three different shortfin mako stocks in the Atlantic: North Atlantic and South Atlantic, which are separated at 5ºN latitude, and the Mediterranean stocks.</td>
<td>IOTC assumes a single stock of shortfin mako shark in the Indian Ocean.</td>
<td>WCPFC is planning to assess shortfin mako shark separately as northern and southern hemisphere units.</td>
<td>No information available</td></tr>
<tr><td>Fishery and Catches</td>
<td>Although global statistics on shortfin mako shark catches included in the ICCAT database have improved recently (specially from around mid-90s), they are still insufficient to permit the Committee to provide quantitative advice on stock status with sufficient precision to guide fishery management toward optimal harvest levels.

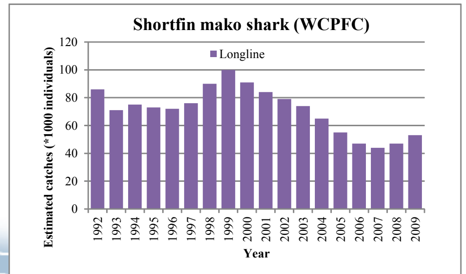
The first officials catch records for shortfin mako shark in ICCAT dates back to 1971 for Northern and Southern stocks and 1997 for Mediterranean stock. For Northern stock, the official catch statistics increased up to around 3,000 t in 1985, then decreased to around 1,000 t in the period 1986-1992, and since then increased until the highest observed record of around 5,000 in 2004. Since then, official catches fluctuated between 3,500 t. and 4,000 t. In the Southern stock a slightly different trend is observed, showing a continuous increasing trend since the beginning of the time series to reach the highest observed record of around 3,500 in 2003. Since then, official catches fluctuated between 2,000 t. and 3,000 t. The official recorded catches for the Mediterranean have been lower than 10 t with the exception of 17 and 10 tonnes in 2005 and 2006, respectively.

However, the ICCAT official catches are considered to represent only a portion of total removals and, thus, ICCAT have estimated a time series of shortfin mako shark catch based on the ratio of shark catches to tunas catch from fisheries where reliable information was available. Although the catch estimation is thought to be conservative because not all gear were included (ICCAT, 2008), the catch estimation is at a similar level and followed a similar pattern to ICCAT task I official catches from mid-90s.</td>
<td>It appears that significant catches of sharks have gone unrecorded in several countries. Furthermore, many catch records probably under-represent the actual catches of shortfin shark because they do not account for species identification, discards (i.e. do not record catches of sharks for which only the fins are kept or of sharks usually discarded because of their size or condition) or they reflect dressed weights instead of live weights. FAO also compiles landings data on elasmobranchs, but the statistics are limited by the lack of species-specific data and data from the major fleets.

There is little information on the fisheries prior to the early 1970's, and some countries continue not to collect shark data while others do collect it but do not report it to IOTC. The catch estimates for shortfin mako shark are highly uncertain and few Members countries have reported detailed data on shortfin mako shark catches. As such, IOTC official catches are considered to represent only a portion of total removals. The first officials catch records for shortfin mako shark in IOTC dated back to 1986, it increased up to the highest records in the series of around 2,200 tonnes in 2005, and since then it slightly decreased to be at between 1,000 and 1,500 during last years.


</td>
<td>It appears that significant catches of sharks have gone unrecorded in several countries. Furthermore, many catch records probably under-represent the actual catches of shortfin mako because they do not account for species identification, discards (i.e. do not record catches of sharks for which only the fins are kept or of sharks usually discarded because of their size or condition) or they reflect dressed weights instead of live weights. FAO also compiles landings data on elasmobranchs, but the statistics are limited by the lack of species-specific data and data from the major fleets.

There is little information on the fisheries prior to the early 1990's, and some countries continue not to collect shark data while others do collect it but do not report it to WCPFC. The catch estimates for shortfin mako shark are highly uncertain and few Members countries have reported detailed data on shortfin mako shark catches. The estimated shortfin mako shark catches in the WCPFC for longline fleet showed that catches were around 75 and 100 thousand of individual between 1992 and 2000 and then continuously decreased to be at around of 50 thousand of individuals during 2005-2009.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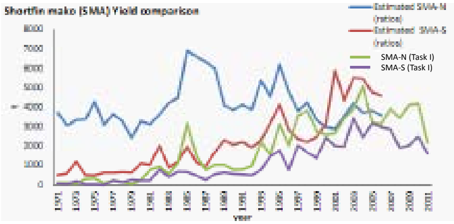
Isurus oxyrinchus (Rafinesque, 1810) Shortfin mako – FAO code: SMA

Stock Status Executive Summary

	Atlantic Ocean and Mediterrenean Sea (ICCAT)	Indian Ocean (IOTC)	Pacific ocean	
			West Pacific Ocean (WCPFC)	East Pacific Ocean (IATTC)
Fishery and Catches	The catch estimation for northern stock showed an increasing trend to reach the highest catch level of around 7,000 t. in 1985 to decrease afterwards to levels of 4,000 t. In contrast, the estimated catch trend for the southern stock showed an increasing trend until 2001 to higher level, of around 6,000 t, to that of reported catch (ICCAT, 2012).  			
State of the Stock	The last full stock assessment for northern and southern stock of shortfin mako shark were conducted in 2012, applying Bayesian surplus production model, catch-free age-structured production model and length based methods to the available catch data through 2010. Various series of CPUE were available (4 for Northern stock and 5 for Southern stock). Although the quality of data, both quantitatively and qualitatively, improved from previous assessments, the results were still quite uninformative. Unless the catch data and CPUE standardization is improved, the assessments of stock status for shortfin mako shark will continue to be uncertain.	There remains considerable uncertainty about the relationship between abundance and the standardised CPUE series from the Japanese longline fleet, and about the total catches over the past decade. The standardized Japanese CPUE trend suggest that the longline vulnerable biomass has declined from 1994 to 2003, and has been increasing since then (Kimoto et al., 2011). The standardized Portuguese CPUE index shows some variability for the period studied 1999-2011 with not clear trend (Coelho et al., 2012). No quantitative stock assessment for shortfin mako shark has been carried out by IOTC. However, shark Ecological Risk Assessment for longline and purse seiner was undertaken in 2012 (Murua et al., 2012). Based on that work, shortfin mako shark was ranked as having low productivity among the shark species considered but also showed high susceptibility (rank 3) to the longline gear while the susceptibility was very low for purse seiner. Thus, the shortfin mako shark vulnerability to the longline gear was highest (rank 1 out of 16 especies) because it is characterized by a combination of low productivity and high susceptibility. Although the shortfin mako shark for the purse seiner was rank as 3rd in the ERA, the vulnerability (due to availability) was very low.	No quantitative stock assessment for short fin mako shark has been carried out by WCPFC. Recent abundance indices and median size analyses for shortfin mako in the WCPO have shown no clear trends; therefore there is no apparent evidence of the impact of fishing on this species in the WCPO. Ongoing issues of concern for the WCPO are: 1) a previously published study suggesting stock reduction in the Northwest Pacific using virtual population analysis (Chang and Liu, 2009); 2) the high vulnerability of shortfin makos to longline fishing (Cortés et al., 2010; Arrizabalaga et al., 2011; Murua et al., 2012); and 3) the potential for collateral targeting in directed fishing for blue sharks in the North Pacific. The shortfin mako were categorized as being at “medium” ecological risk for both deep and shallow longline sets (Kirby and Hobday 2007). An assessment of shortfin mako sharks for Northern and Southern stocks are scheduled for 2014.	No information available

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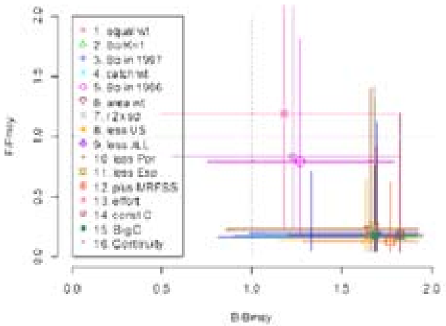
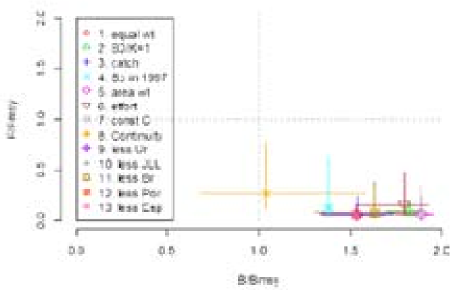
Stock Status Executive Summary

	Atlantic Ocean and Mediterrenean Sea (ICCAT)	Indian Ocean (IOTC)	Pacific ocean	
			West Pacific Ocean (WCPFC)	East Pacific Ocean (IATTC)
Biomass	For both Northern and Southern stocks, the biomass at the beginning of 2010 was estimated to be above the biomass at MSY and, thus, most models suggested that stocks are not overfished and that biomass is estimated to be above ICCAT Convention Objective.			
Fishing mortality	Fishing mortality rate in 2010 was estimated to be below the fishing mortality rate at MSY and, thus, most models concluded that overfishing was not occurring.   Figure 1.- For North Atlantic (above) and South Atlantic (below) shortfin mako sharks, median biomass relative to B_{MSY} and median fishing mortality rate relative to F_{MSY}, with 80% credibility intervals, from Bayesian Surplus Production model. However, they also showed inconsistencies between estimated biomass trajectories and input CPUE trends, which resulted in wide confidence intervals in the estimated biomass and fishing mortality trajectories and other parameters.			

Isurus oxyrinchus (Rafinesque, 1810) Shortfin mako – FAO code: SMA

Stock Status Executive Summary

	Atlantic Ocean and Mediterrenean Sea (ICCAT)	Indian Ocean (IOTC)	Pacific ocean: West Pacific Ocean (WCPFC)	Pacific ocean: East Pacific Ocean (IATTC)
Recommendation	See below	See below		

Recommendation — Atlantic Ocean and Mediterrenean Sea (ICCAT)

Taking into consideration the high vulnerability ranking in the Ecological Risk Assessment, results from the modeling approaches used in the assessment, the associated uncertainty, and the relatively low productivity of shortfin mako sharks, the SCRS recommends, as a precautionary approach, that the fishing mortality of shortfin mako sharks should not be increased until more reliable stock assessment results are available for both the northern and southern stocks. The high uncertainty in past catch estimates and deficiency of some important biological parameters, particularly for the southern stock, are still obstacles for obtaining reliable estimates of current status of the stocks.

In general for sharks, ICCAT recommends that precautionary management measures are needed for stocks where there is the greatest biological vulnerability and conservation concern, and for which there are very few data.

In order to improve the stock assessments of pelagic shark species harvested in ICCAT fisheries, ICCAT also recommended that the Member submit the corresponding statistics of all ICCAT and non-ICCAT fisheries capturing shark species, including recreational and artisanal fisheries. It is considered that for a correct assessment of the status of the stocks and management of those species a solid basis to estimate total catches is necessary.

Shortfin Mako Shark	Northern Stock	Southern Stock
Assessment Year	2012	
Data available	2010	
Yield 2011	3,821	3,235
Yield 2010	4,181	2,470
Yield 2009	4,109	2,034
MSY		
B_{2010}/B_{MSY}	1.15 - 2.04	1.36 - 2.16
F_{2010}/F_{MSY}	0.16 - 0.92	0.07 - 0.40

Recommendation — Indian Ocean (IOTC)

Maintaining or increasing effort will probably result in further declines in biomass, productivity and CPUE. The impact of piracy in the western Indian Ocean has resulted in the displacement and subsequent concentration of a substantial portion of longline fishing effort into certain areas in the southern and eastern Indian Ocean. It is therefore unlikely that catch and effort on shortfin mako shark will decline in these areas in the near future, and may result in localised depletion.

The following should also be noted:

- The available evidence indicates risk to the stock status at current effort levels.
- The two primary sources of data that drive the assessment, total catches and CPUE are highly uncertain and should be investigated further as a priority.
- Mechanisms need to be developed by the Commission to encourage CPCs to comply with their reporting requirement on sharks.

Shortfin Mako Shark	Indian Ocean
Assessment Year	2012
Data available	2011
Yield 2011	1,474
Yield 2010	1,386
Yield 2009	946
Stock status	Uncertain
MSY	-
B/B_{MSY}	-
F/F_{MSY}	-

Stock Status Executive Summary

	Atlantic Ocean and Mediterrenean Sea (ICCAT)	Indian Ocean (IOTC)	Pacific ocean: West Pacific Ocean (WCPFC)	Pacific ocean: East Pacific Ocean (IATTC)
Sources of Information	ICCAT. 2012. Report of the Standing Committee on Research and Statistics (SCRS). SCRS Report 2012. ICCAT. 2012. 2012 Shortfin Mako Stock Assessment and Ecological Risk Assessment. ICCAT Shark Working Group meeting report 2012.	Coelho R., M.N. Santos and P.G. Lino. 2012. Update of the standardized CPUE series for major shark species caught by the Portuguese pelagic longline fishery in the Indian Ocean. IOTC–2012–WPEB08–29. IOTC–SC15 2012. Report of the Fifteenth Session of the IOTC Scientific Committee. Mahé, Seychelles, 10–15 December 2012. IOTC–2012–SC15–R[E]: 288 pp. Kimoto A., Y. Hiraoka, T. Ando and K. Yokawa. 2011. Standardized CPUE of shortfin mako shark (Isurus oxyrinchus) caught by Japanese longliners in the Indian Ocean in the period between 1994 and 2010. IOTC-2011-WPEB07-34. Murua H., R. Cohelo, M.N. Neves, H. Arrizabalaga, K. Yokawa, E. Romanov, J.F. Zhu, Z.G. Kim, P. Bach, P. Chavance, A. Delgado de Molina and J. Ruiz. 2012. Preliminary Ecological Risk Assessment (ERA) for shark species caught in fisheries managed by the Indian Ocean Tuna Commission (IOTC). IOTC–2012–WPEB08–31.	Arrizabalaga, H., de Bruyn, P., Diaz, G.A., Murua, P., Chavance, P., Delgado de Molina, A., Gaertner, D., Ariz, J. and Ruiz, J. 2011. Productivity and susceptibility analysis for species caught in Atlantic tuna fisheries. Aquatic Living Resources 24: 1-12. Cortés, E., Arocha, F., Beerkircher, L., Carvalho, F., Domingo, A., Heupel, M., Holtzhausen, H., Neves, M., Ribera, M. and Simpfendorfer, C. 2010. Ecological risk assessment of pelagic sharks caught in Atlantic pelagic longline fisheries. Aquatic Living Resources 23: 25-34. Kirby, D.S. and Hobday, A. 2007. Ecological Risk Assessment for the Effects of Fishing in the Western and Central Pacific Ocean: Productivity-Susceptibility Analysis. Third Regular Session of the Scientific Committee. WCPFC-SC3-EB SWG/WP-1. Murua H., R. Cohelo, M.N. Neves, H. Arrizabalaga, K. Yokawa, E. Romanov, J.F. Zhu, Z.G. Kim, P. Bach, P. Chavance, A. Delgado de Molina and J. Ruiz. 2012. Preliminary Ecological Risk Assessment (ERA) for shark species caught in fisheries managed by the Indian Ocean Tuna Commission (IOTC). IOTC–2012–WPEB08–31.	

General Recommendations

Data collection

In general, there is a scarcity of data and limited data availability for major fleets and countries in Tuna RFMOs. Attending to historical data, several countries were not collecting fishery statistics, especially in years prior to the development of tuna and tuna-like fisheries in early 1970s. It is thought that important catches of sharks might have gone unrecorded in several countries. This problem worsens in the case of developing states and, especially, for historical data. Furthermore, many catch records probably under-represent the actual catches of shortfin mako shark because they do not account for discards (i.e. do not record catches of sharks for which only the fins are kept or of sharks usually discarded because of their size or condition) or they reflect dressed weights instead of live weights.

Although global statistics on shortfin mako shark catches included in Tuna RFMOs database have improved recently (specially from around mid-90s), they are still insufficient to permit the Committee to provide quantitative advice on stock status with sufficient precision to guide fishery management toward optimal harvest levels.

The catches of sharks are not recorded by gear and/or species. The catches of sharks are not disaggregated at the required level for each species by area or fleet. Generally major sharks such as blueshark and shortfin mako shark are better reported that other species but still are inconsistencies. Mis-identification of shark species is also common. The identification of sharks in port is usually compromised by the way in which the different species of sharks are processed before landed. Generally, no indication is given on the type of processing that the different specimens underwent. Then, the identification of sharks unloaded as shark carcasses, shark fins or other shark products is difficult.

In order to improve the stock assessments of shortfin mako shark harvested in Tuna RFMO fisheries, Tuna RFMOs also recommended that the Member submit the corresponding statistics of all fisheries capturing shortfin mako shark species, including recreational and artisanal fisheries. Countries are required to report all catches of shortfin mako shark, including available historical data according to data reporting procedures of specific RMFOs. Particular reporting requirements apply to shark species in each region. Countries are also urged to report in steps taken to improve data collection and revision on actions taken. It is considered that for a correct assessment of the status of the stocks and management of those species a solid basis to estimate total catches is necessary.

The data available by flag in the public domain is scarce in RFMO countries. In some cases due to confidentiality issues is difficult to get the basic fishery information regarding the fleet activity catching shortfin mako shark, especially for historical data. It is difficult to extract disaggregated and aggregated data for some data different fleets, especially for longline and coastal fishery. Attempts should be made to allow scientific committee of Tuna RFMOs access the available data for improving the stock assessments.

Observer programmes

In tuna RFMOs, data is mostly reported as the nominal catch data (landings and discards by species, stock, gear, fleets and year) which is the basic information used in all the stock assessments but also data on catch/effort and size data are provided which are more detailed in terms of time and geographic area information. Although the objectives of Observer Programs can vary widely, in general in the case of sharks their objective is to collect basic fishery statistics such as catch and effort data as well as to conduct biological sampling. Observers also offer one of the few methods appropriate to obtain accurate location, catch and effort information for sharks caught in tuna fisheries.

Although the objectives of the observer programmes can be diverse, observer programs will generally require high or moderate levels of precision if the purpose of the observer program is to provide adequate information to improve fisheries stock assessments, endangered species protections, and ecosystem management. In Tuna RFMOs, when the goal is to monitor the total tuna catch and/or bycatch/discards, the coverage agreed range between 5 % and 20 %. As such, in relation to the estimation of shark catches, the different coverage agreed have a clear effect on the ability to obtain accurate data of both shark catch estimates and status (alive or dead) of sharks discarded.

Although the level of observer coverage for the estimation of shark mortality depends on species and fleets specific cases, it is important that the observer programme has the following characteristics:

- Sufficient coverage to provide statistically accurate estimates of catch, bycatch and discards. A preliminary aim is to have observer coverage of 20% or above.
- Sufficient spatial/temporal coverage of the main fleets.
- Sufficiently trained observers: to develop an observer training programme in order for observers to be sufficiently competent to record the data required by the RFMOs for management purposes.
- Species identification guides: species identification is a major problem with regard to shark bycatch data collection and, thus, species identification guides.
- Data forms: harmonized data forms to collect the shark bycatch and discard information (sex, size and life status: life or dead upon retrieval of the gear /at time of discarding).
- Database: database for recording of all observer data as well as well-designed protocols for accessing the data, taking into account data confidentiality and ownership.

Alternative ways to improve the collection of fishery statistics could be the use of “self-sampling” and Electronic Monitoring (EM).

Self-sampling methodology uses fisheries scientists and/or technicians to collect information on commercial catches which is a cost effective method. Therefore, currently there is ongoing effort worldwide to develop programmes to use fishers to self-sample their catches. Such programmes have generally two major objectives: i) reduce costs and increase efficiency on the collection of commercial fishery data; and, ii) to involve fishing industry in the assessment process by having them work closely with the scientists. Thus, the overall purpose of the programmes is to improve data collection and consequently reduce stock assessments uncertainty.

One of the major recognized problems with self-sampling is that some scientists do not see the data as fully scientific or valid. In order to shift this attitude it is necessary to properly verify the usability,

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high quality of data and cross-validated the data collected by self-sampling with data compiled by traditional observer programs. Moreover, for a successful program of self-sampling the willingness and collaboration from industry is necessary. Therefore, they should rely on the development of guidelines of best practice and general recommendations to assist in the initiation and execution of self-sampling and self-reporting programmes. Moreover, such schemes should rely on good collaboration between scientists and fishers, aiming to define clear aims and generate high quality data.

Confidentiality is another important issue that should be assured on these programmes, namely by ensuring that when used the data is presented in an anonymous and aggregated way. This is particularly important as some data sets might be used for enforcement purposes, and therefore might endanger trust between scientists and fishers.

Electronic monitoring (EM) systems are being used in some fisheries as an alternative, or a complement to human observers. The EM systems consist of a centralized computer combined with several sensors and cameras, which can be deployed on fishing vessels to monitor a range of fisheries issues, including: fishing location, catch, catch handling, fishing methods, protected species interactions, and mitigation measures. The efficacy of EM for monitoring issues varies according to fishing methods and other factors. Over the past decade, pilot studies have been carried out in more than 25 fisheries to test the efficacy of this technology, being involved different countries, gears and target species.

During 2012, the first trial with EM on a tropical tuna purse seine was performed in the Atlantic Ocean and this study suggested that EM is a viable tool for monitoring effort, set-type and tuna catch within the tropical tuna purse seine fishery. However, some limitations exist for the monitoring of the bycatch and especially for reliably estimation and identification of some shark species. Furthermore, observers constantly identified sharks to a higher taxonomic level, as 100 % of the shark species were identified by the observer, EM system provided limited identification (e.g. often to family level). However, the problems observed with this first trial on the tuna purse seine fleet can be easily solved with some adjustments on the system such as the use of digital cameras and some modification on the crew catch handling behaviour.

Similar to the self-sampling programmes, the success of an EM program would depend on the good collaboration between fishers and scientist as it requires that the vessel owners and crew understand the importance of standardized catch handling protocols. EM systems are designed to be flexible enough to accommodate a variety of catch handling methods, but handling must be consistent and standardized in order to collect reliable data. For example, if a camera is installed above the discard handling area, and discarding handling is moved to another area of the vessel, the camera will no longer capture discarding events. This example illustrates the importance of having strong support from the vessel owners, officers and crew to achieve monitoring objectives.

It is also possible to apply such EM systems to gillnets and long-line fleets. For example, a study on a gillnet fishery shows that EM offers opportunities for monitoring shark gillnet fishing activity. Overall, the high quality of imagery, the ability to identify most catch items, and no missing imagery in the data set, indicated that EM equipment was reliable and suitable for shark gillnet vessels. In the particular case of gill net tuna fisheries, due to size of the fleet and the artisanal nature of the fisheries, it could be quite difficult a full-implementation of the EM sampling program. However, taking into account the complete lack of data and observers programs that are currently being implemented in gillnets tuna fisheries, the application of EM in a pilot observer vessels (100 % EM coverage of few vessels of the gillnet fishery) can be considered a suitable approach for collecting shark bycatch statistics on artisanal and coastal gillnet fisheries. In the case of longliners, it might be worthy and easier to implement such system.

Management measures

Management measures are essential when a given stock is seriously affected by the fishing activity and are aimed at limiting the impact of this activity. The election of a measure will depend on the stock status, on the behavior of the species, on the species being target or not, etc.

The main problem for pelagic shark's management is that there are few targeted fisheries. Shortfin mako shark it is mainly taken as bycatch in the longline fishery targeting blueshark and in other fisheries.

In general for sharks, all Tuna RFMOs recommend that precautionary management measures are needed for stocks where there is the greatest biological vulnerability and conservation concern, and for which there are very few data. Taking into consideration the high vulnerability ranking in the Ecological Risk Assessment, results from the modeling approaches used in the assessment, the associated uncertainty, and the relatively low productivity of shortfin mako sharks, Tuna RFMOs in general recommend, as a precautionary approach, that the fishing mortality of shortfin mako sharks should not be increased until more reliable stock assessment results are available for those populations. The high uncertainty in past catch estimates and deficiency of some important biological parameters, are still obstacles for obtaining reliable estimates of current status of the stocks.

And for the application of these recommendations several management measures can be recommended, such as:

TACs

Total allowable catches (TACs) are catch limits that are set for most significant commercial fish stocks, and is widely used as the main management measure for several exploited stocks. Although shortfin mako sharks are also caught as bycatch, there are fisheries directly targeting shortfin mako sharks. In the case where the productivity of the stocks and the impact of the fisheries can be adequately assessed, the establishment of TACs can ensure these populations are kept at levels that do not significantly affect their productivity. This could be the case of shortfin mako stocks for which an assessment and management advice is provided (e. g. ICCAT case).

Spatial/temporal closures

Time and/or area closures have been widely used as management measures to prevent overfishing and to protect certain marine habitats. Although there are very few examples on the use of this

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kind of measures to reduce shark bycatch, the development of protected areas or time closures, focused on shark “hot spots” or in critical habitats (e.g. nursery grounds) might have great conservation potential. A measure of this kind must take into account the effect of effort reallocation to adjacent areas, as well as the possible reduction in target species catch.

However, for applying those measures it is first necessary to investigate possible spawning/nursery areas of great conservation potential. Until those studies are available the application of these types of management measures will be inappropriate. Moreover, the monitoring, surveillance and control of this kind of regulations can be easily enforced in industrial fisheries (thanks to VMS systems), but not in artisanal fleets (smaller vessels without VMS systems implemented).

No retention polices

In those fisheries where the shortfin mako accounts as a wanted commercial component of the catch, other management measures rather than “no retention policies” should be considered. In the fisheries where shortfin mako shark is taken as a bycatch, or in areas where fishing for it is forbidden, the “no retention policies” described in the mitigation measures and post-release tables of the report would be applicable.

Finning

Finning is the practice of slicing off fins and dumping carcasses at sea. Although shark finning has been banned in the four main tuna RFMOs, discussion is now focused on the enforcement of this regulation. Most of the current measures allow for a 5% shark fin to body weight ratio, but this ratio is highly dependent on the fin usage (primary fin sets vs all fins), on the species and on the way the body weight is computed (whole, dressed...), and can lead to finning going undetected. Having in mind the forthcoming EU legislation for the prohibition on the removal of fins on board vessels which assures that fins attached to carcass are unloaded, it would be advisable to promote this measure within all the TunaRFMOs.

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