PACIFIC ISLANDS

REGIONAL PLAN OF ACTION FOR SHARKS:

Guidance for Pacific Island Countries and Territories on the Conservation and Management of Sharks

Prepared by Mary Lack and Frank Meere
Shellack Pty Ltd

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FOREWORD

The Regional Plan of Action for Sharks (RPOA Sharks) is a collaborative project between the Pacific Islands Forum Fisheries Agency (FFA), the Secretariat of the Pacific Community (SPC) and the Secretariat of the Pacific Regional Environment Programme (SPREP). The initiative was funded under Part VII of the United Nations Fish Stocks Agreement with the support of the Republic of Palau, the Republic of Kiribati and Papua New Guinea.

The development of the Pacific Islands RPOA Sharks was a response to both the International Plan of Action for the Conservation and Management of Sharks and to the Conservation and Management Measure (CMM) for Sharks adopted by the Western and Central Pacific Fisheries Commission (WCPFC) of which the Pacific Island Countries and Territories (PICTs) are members. The former encourages assessments and management of shark fisheries and the latter imposes obligations on the PICTs to implement measures compatible with those imposed on the high seas in the Pacific Ocean.

The RPOA Sharks is not intended to prescribe specific actions to be taken nationally or regionally by the PICTs. Rather, the intent of the RPOA Sharks is to provide guidance to the PICTs as to how to assess their shark fisheries, how to ensure that management arrangements for sharks within their waters meet the requirements of the WCPFC CMM and to identify what other initiatives, such as improved data collection and research, might be necessary in order to ensure the long-term sustainable management of sharks in their waters and the region more generally.

It is hoped that the PICTs will find the information and the analysis contained in the RPOA useful in determining what actions can be taken collaboratively and individually to maintain and improve the status of shark stocks in the Western and Central Pacific Ocean.

The FFA, SPC and SPREP are keen to work with the PICTs to consider and implement actions proposed in the RPOA.

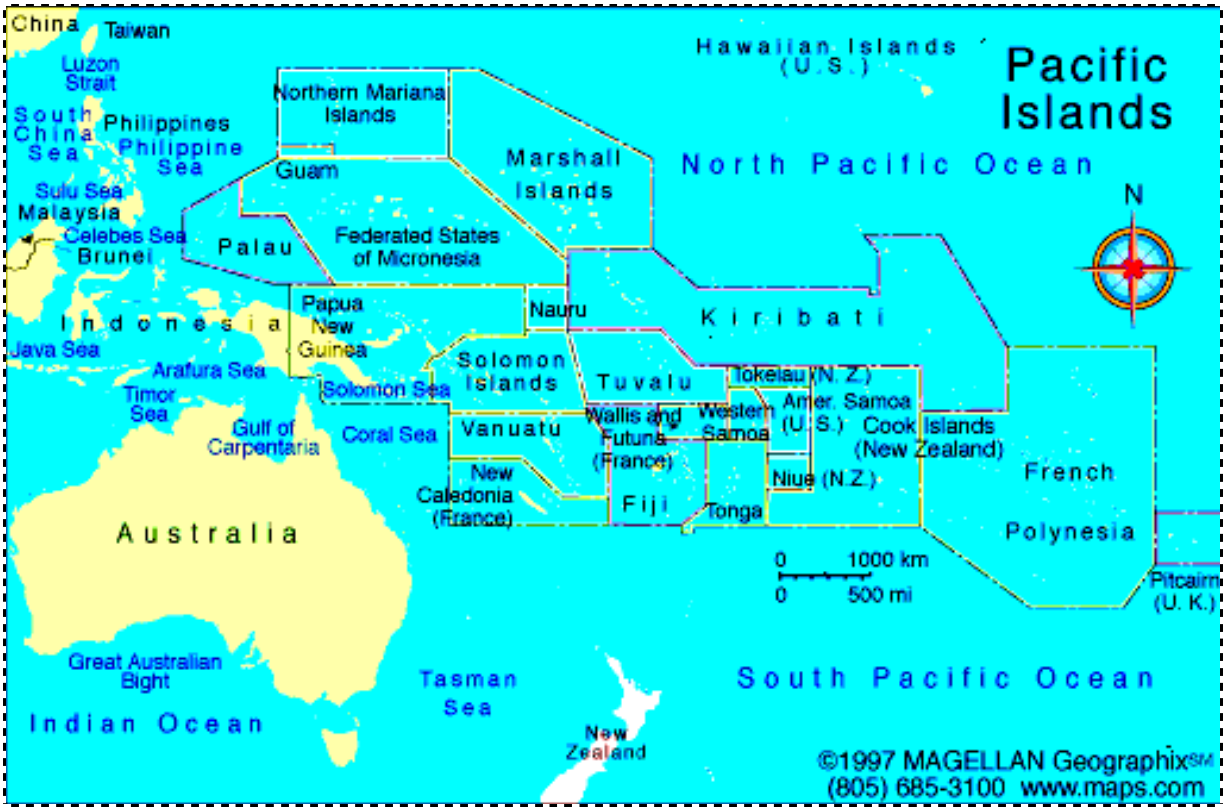

Figure 1: Location of the Pacific Island Countries and Territories (PICTs)

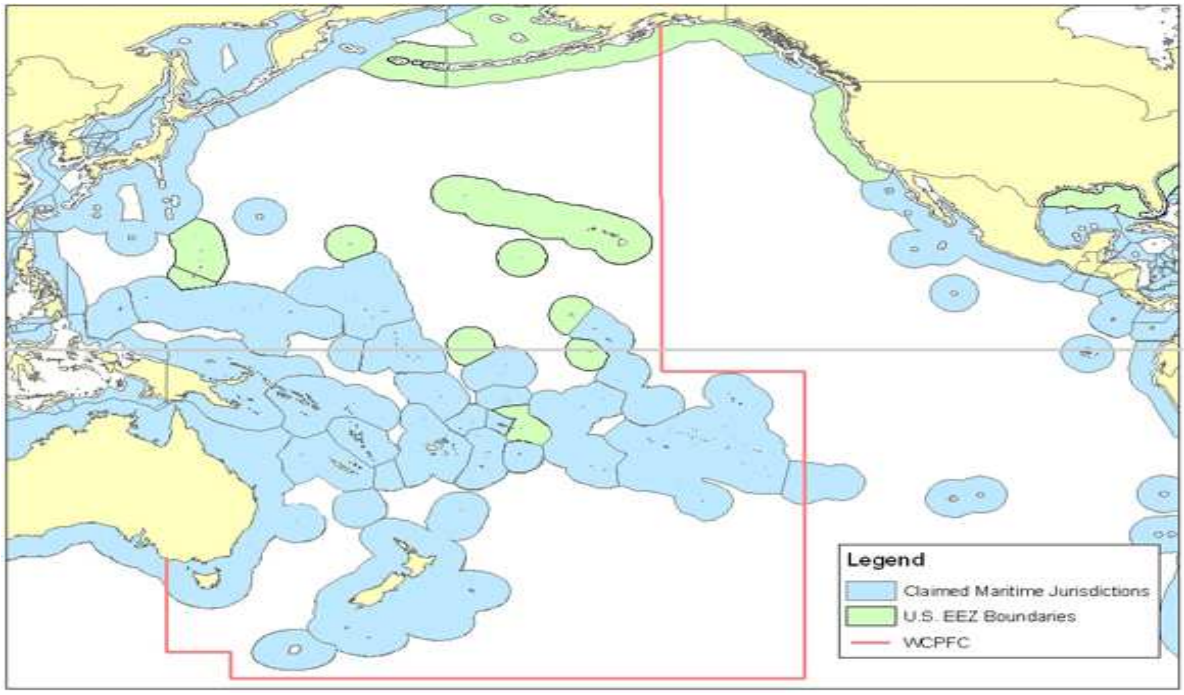

Figure 2: WCPFC Convention Area and claimed maritime boundaries of the PICTs

Source: NOAA National Marine Fisheries Service (2009). *WCPFC Boundary*. Available at: http://www.fpir.noaa.gov/IFD/ifd_wcpfc_map.html.

INTRODUCTION

The decision to develop a Regional Plan of Action on Sharks (PI-RPOA Sharks) for Pacific island countries and territories (PICTs)[1] was a response to:

- the requirement for management of sharks[2] in their national waters to be compatible with measures adopted by them as members/participating territories of the Western and Central Pacific Fisheries Commission (WCPFC);
- their broader commitment to ensuring the sustainable management of sharks in the Western and Central Pacific Ocean (WCPO) in line with the objectives of the International Plan of Action for the Conservation and Management of Sharks (IPOA Sharks) (FAO, 2000a) and their obligations under various international conventions and treaties; and
- the recent decision by the Secretariat of the Pacific Regional Environment Programme (SPREP) to include sharks in its marine species programme.

Regional cooperation and responses are common across the PICTs. SPREP already has in place regional action plans for marine turtles, dugongs, and whales and dolphins. In addition, the Forum Fisheries Agency (FFA), comprising 17 Pacific States, has a proven track record in cooperation on fisheries management issues including the longstanding Nauru Agreement and the current development of a regional monitoring, control and surveillance (MCS) strategy. The participation of the PICTs in other regional initiatives such as the Coral Triangle Initiative, in the WCPFC (see Figure 2) and in development of the Commission's regional observer programme and vessel monitoring system, reinforce the view that this group of countries is well placed to adopt a regional approach to conservation and management of sharks.

The objective of the WCPFC is to:

> *"…to ensure, through effective management, the long-term conservation and sustainable use of highly migratory fish stocks in the western and central Pacific Ocean…" (*WCPFC Convention[3])

The WCPFC's management mandate relates to highly migratory fish species, including shark species, listed in Annex 1 of the United Nations Convention on the Law of the Sea of 10 December 1982 (UNCLOS) and extends to the management of non-target species taken in fisheries for target stocks. In

[1] The PICTs (see Figure 1) comprise the 22 members of the Secretariat of the Pacific Community (American Samoa, Cook Islands, Federated States of Micronesia (FSM), Fiji, French Polynesia, Guam, Kiribati, Marshall Islands, Nauru, New Caledonia, Niue, Northern Mariana Islands (NMI), Palau, Papua New Guinea (PNG), Pitcairn Islands, Samoa, Solomon Islands, Tokelau, Tonga, Tuvalu, Vanuatu and Wallis and Futuna). However, Pitcairn Islands has been excluded from the direct analysis in the RPOA since it is not a party to, or a participating territory of, the Western and Central Pacific Fisheries Commission.

[2] In keeping with the definition adopted by the IPOA Sharks, the term 'sharks' refers to all species of sharks, skates, rays and chimaeras (Class *Chondrichthyes*).

[3] Available at: http://www.wcpfc.int/key-documents/convention-text

keeping with its objective and management mandate and recognizing the ecological significance of sharks in the WCPO and that the IPOA Sharks calls for regional fisheries management organizations (RFMOs) to cooperate to ensure the sustainability of shark stocks, the WCPFC adopted a Conservation and Management Measure (CMM) for sharks in 2006. This was revised and replaced in 2008 by CMM 2008-06, *Conservation and Management of Sharks* (See Annex 1).

In addition to their obligations to implement CMM 2008-06, many of the PICTs are participants in one or more international agreements/bodies including:

- the United Nations;
- UNCLOS;
- the United Nations Fish Stocks Agreement (UNFSA)[4];
- the Food and Agriculture Organization of the United Nations (FAO);
- the Convention on Migratory Species (CMS); and
- the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES).

These instruments/bodies impose obligations on, or provide strong guidance to, the PICTs on the conservation and management of shark stocks in their waters and reporting on catch and trade of such stocks. Over the last decade increasing attention has been paid to sharks by the United Nations, the FAO and Parties of the CMS and CITES. Each of these bodies has called for greater cooperation and action to monitor and reduce fishing impacts on sharks and, in the case of CITES and CMS, have listed several shark species on their Appendices, thereby requiring specific actions by the Parties. In addition, the 2009 joint meeting of Tuna RFMOs called for immediate action to establish precautionary science-based conservation and management measures for sharks.

This increased focus on sharks has been driven by the increasing recognition of the relatively low biological productivity of sharks and the deteriorating status of shark stocks worldwide. The 2008 IUCN Red List of Threatened Species[5] lists 22 chondrichthyan species as Critically Endangered, 29 as Endangered and 75 as Vulnerable. A further 205 species are assessed as Data Deficient and 107 as Near Threatened (IUCN, 2009). Of the pelagic sharks and rays, 6% are classed as Endangered, 26% as

[4] Agreement for the Implementation of the Provisions of the United Nations Convention on the Law of the Sea of 10 December 1982 relating to the Conservation and Management of Straddling Fish Stocks and Highly Migratory Fish Stocks

[5] The IUCN Red List of Threatened Species provides taxonomic, conservation status and distribution information on plants and animals that have been globally evaluated using the IUCN Red List Categories and Criteria. The main purpose of the IUCN Red List is to catalogue and highlight those plants and animals that are facing a higher risk of global extinction (i.e. those listed as **Critically Endangered**, **Endangered** and **Vulnerable**). The IUCN Red List also includes information on plants and animals that are categorized as **Extinct** or **Extinct in the Wild**; on taxa that cannot be evaluated because of insufficient information (i.e., are **Data Deficient**); and on plants and animals that are either close to meeting the threatened thresholds or that would be threatened were it not for an ongoing taxon-specific conservation program (i.e., are **Near Threatened**). (See: http://www.iucnredlist.org/static/categories_criteria)

Vulnerable, 24% as Near Threatened, 25% as Data Deficient and 19% as Least Concern (Camhi *et al.,* 2009).

IMPLEMENTATION OF THE IPOA SHARKS IN THE REGION

Globally the number of countries having implemented national plans of action for shark (NPOA Sharks) is limited. While two of the Pacific island countries, Marshall Islands and Cook Islands, have drafted NPOA Sharks, neither have finalized these and implemented agreed management responses. However, the USA's NPOA Sharks applies to the US territories of American Samoa, Guam, and Northern Mariana Islands (NMI). Other members and co-operating non-members of the WCPFC have also implemented NPOAs (Australia, Japan, Canada, Chinese Taipei, Mexico, the European Community (EC)) or are in the process of developing them (Korea, the Philippines, Senegal).

Globally, there are few examples of regional cooperation on sharks. Two RPOA Sharks have been identified: The Action Plan for the Conservation of Cartilaginous Fishes (*Chondrichthyans*) in the Mediterranean Sea; and the Sub-regional Plan of Action for Sharks developed by La Commission Sous Régionale des Pêches in West Africa (Cape Verde, Gambia, Guinea, Guinea Bissau, Mauritania, Senegal, Sierra Leone). In addition, the USA, through Asia-Pacific Economic Cooperation, has been working with a number of Central and South American countries to improve conservation and management of sharks.

The number of national and regional plans of action should not, in itself however, be seen as the primary indicator of trends in conservation and management of sharks. There is a risk that the development of a shark plan is seen as the end in itself rather than as a tool to achieve better management outcomes for sharks. To date, the quality of the plans in place is highly variable and there has been no assessment of the extent to which the plans have been implemented and no evaluation of their effectiveness. In considering the slow process in implementation of the IPOA Sharks, a 2008 FAO technical workshop agreed that many countries were unable to fully meet all of the requirements of the IPOA and that "a more pragmatic, step by step, approach toward the ultimate goal" might facilitate the achievement of the goals of the IPOA Sharks (FAO, 2009). The Workshop's recommendations included that:

- the first priority step towards an NPOA, especially for those countries which struggle with low monitoring and management capacity, is to improve information about catches and life history parameters on a limited number of their primary shark species;
- countries should make every effort to monitor and collect catch and trade information for their agreed list of primary species;
- gears and regulations to minimize bycatch of sharks, including time-area closures should be developed;
- as monitoring and management capacity improves countries should take further steps toward developing and implementing an NPOA in the full context of IPOA Sharks, including the

identification of main weaknesses in monitoring of shark fisheries and trade and the adoption of actions to overcome these limitations to realize the full monitoring of catch, bycatch, discards, and trade, both in terms of quantity and species composition; and

- countries should develop regional coordination mechanisms in regions where fishers can easily migrate and land their catches in neighbouring countries.

These recommendations are directly relevant to the PICTs and have been used to guide the development of the PI-RPOA Sharks. The development of an RPOA is an efficient first step for the PICTs in moving towards improved management of sharks but it does not remove the necessity for the PICTs to undertake national assessments[6] of their shark fisheries as a basis for deciding whether further action is required or whether an NPOA should be developed.

OVERVIEW OF THE PI-RPOA SHARKS

Objectives

The specific objectives of the PI-RPOA Sharks are to:

- enable the PICTs to meet their obligations arising under CMM 2008-06;
- promote data collection, monitoring and analysis of fisheries impacts on sharks;
- promote consistency in approaches to conservation and management of sharks across the PICTs;
- promote efficiency and effectiveness in monitoring and enforcement programmes for shark conservation measures;
- facilitate, over time, the adoption by the PICTs of best practice in the conservation and management of sharks in their national waters; and
- to provide a platform from which the PICTs can respond to more exacting regional management measures for sharks as they emerge.

Focus and structure

The RPOA addresses three needs:

1. the need for a Regional Shark Assessment to identify issues that need to be addressed to improve the conservation and management of sharks in the national waters of the PICTs;
2. the need to provide immediate guidance to the PICTs on management measures which will ensure that they are compliant with the provisions of CMM 2008-06 either through direct

[6] The IPOA Sharks recommends that States should carry out a regular assessment of the status of shark stocks subject to fishing so as to determine if there is a need for development of an NPOA Sharks.

implementation of those provisions or through the application of 'alternative measures' as provided for under Paragraph 11 of the CMM; and

3. the need for a model NPOA Sharks as a framework for individual PICTs to undertake a national shark assessment and to respond to the issues identified in the regional and national assessments.

The PI-RPOA therefore comprises four distinct but inter-related Parts. Part 1 provides an overview of sharks, shark fisheries and management based on the Regional Shark Assessment, which is provided in Annex 2. This informs the development of management options and the model NPOA Sharks. Part 2 examines CMM 2008-06 as a basis for development of advice on management options available to the PICTs that would, at a minimum, ensure compliance with their obligations under the CMM and those that would potentially deliver better conservation and management outcomes for sharks. Part 2 also includes discussion of the data and scientific advice required to underpin improved conservation and management of sharks. Part 3 provides a model NPOA Sharks including an outline of the elements required in national assessments of shark resources and fisheries. Part 4 provides an indicative implementation framework for the actions proposed under the RPOA.

PART 1 FINDINGS OF THE REGIONAL SHARK ASSESSMENT

The Regional Shark Assessment is provided in Annex 2. The Assessment paints a picture of the shark species occurring in waters under the national jurisdiction of the PICTs, the nature and level of shark catch in those waters, the current understanding of the status of shark stocks and the arrangements in place for management of the fisheries in which sharks are taken. A summary of the key points arising from the assessment and of their implications for development of the PI-RPOA is provided in Table 1.

It is clear from the Assessment that there remains considerable uncertainty in relation to many aspects of the environment in which regional and national approaches to shark conservation and management must be developed. Nevertheless, the information presented in the Assessment reflects the best available advice on shark fisheries and stocks in the waters of the PICTs. The precautionary approach requires that the best available information is used to develop management measures and that those measures reflect the level of uncertainty. The PI-RPOA Sharks has been developed in that context.

Table 1: Summary of the findings of the Regional Shark Assessment

Characteristic	Implications for the RPOA Sharks
Species and stock status	
At least 80 shark species are likely to occur in the waters of the PICTs. Around half of these are highly migratory species (HMS) and nearly half live in or penetrate open ocean waters. Given the migratory nature of these species, stocks are affected by fishing in and across the PICTs and on the high seas.	There is a need for both national and regional management of these shark species.
An ecological risk assessment (ERA) has shown many shark species to be at substantially higher risk relative to most of the target species of tunas and billfishes with which they are associated.	Management needs to reflect the relative risks attached to tunas and billfishes and non-target shark species and to acknowledge that generic 'shark' management measures may not provide adequate protection to higher risk shark species. Effective management of sharks may require trade-offs with target tuna fisheries.
The stock status of even those shark species taken in large numbers (notably blue shark[7], silky shark and oceanic whitetip shark) is unknown. Some indicators of stock status suggest that some stocks may be unable to sustain current levels of catch. In addition, preliminary risk assessments suggest that the shark species most frequently encountered are not the species at highest risk from fishing and that the highest risk shark species comprise a relatively small proportion of the catch.	There is a need for formal stock status advice on those species of greatest management concern.
Research efforts are focused on the species that are frequently encountered rather than necessarily the highest risk species.	The differing levels of risk across shark species, together with the lack of information on stock status, point clearly to the need for scientific advice on the status of those species considered to be at highest risk from fishing.
The available observer data provide a reasonable guide to the species composition of shark catch. Observer data from PICT waters indicate that the most frequently observed species:	Blue shark comprises the highest proportion of shark catch in most longline fisheries in the region and silky shark comprises the highest proportion in all purse seine fisheries. Silky shark is represented highly in the shark

[7] A full list of common and scientific names of the shark species occurring in the waters of the PICTs is provided in Table A2.1 of the Regional Shark Assessment (Annex 2).

Characteristic	Implications for the RPOA Sharks
• in longline fisheries, overall, were silky shark (53%), blue shark (14%), oceanic whitetip shark (6%), pelagic stingray (4%) and bigeye thresher (3%) however, blue shark comprised the highest proportion of the observed longline catch in most PICTs. • in purse seine catch were silky shark (81%), unidentified sharks (8%), oceanic whitetip shark (6%) and manta rays (3%).	catch of both fleets.
Species listed on CITES and/or on CMS (basking shark, whale shark, great white shark, shortfin mako shark and longfin mako shark) are represented in the observer data from the PICTs at very low levels.	The PI-RPOA needs to recognize that some PICTs have a responsibilities in relation to shark species listed on CITES and/or the CMS.
Most sharks are alive when caught. There remains considerable uncertainty around the fate of sharks released alive.	There is scope to reduce shark mortality through measures designed to reduce the retention of sharks however, these measures need to be informed by better information on the post-release survival of sharks.
Fisheries	
Waters under national jurisdiction of the PICTs include internal waters, archipelagic waters, territorial seas and exclusive economic zones (EEZs). Sharks occur in each of these areas and are fished to varying degrees by artisanal, small-scale domestic vessels, industrial domestic vessels and foreign industrial vessels operating under access agreements. While data on the industrial fleets are limited, data on the artisanal and small-scale fleets are practically non-existent. However, there is likely to be a significant difference in the species composition of the sharks taken by the industrial and small scale fleets with the latter likely to take a far greater proportion of coastal rather than oceanic species.	Part 2 of the PI-RPOA will focus on the provision of advice on management of shark taken by industrial longline and purse seine fleets. The model NPOA (Part 3) will provide guidance to the PICTs on the conduct of national assessments of sharks, drawing on the regional assessment where possible. It will also provide a framework for the articulation of the actions required to implement regional management measures and to address issues associated with sharks taken by their artisanal and small fisheries.
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.	Mitigation measures are therefore likely to be opposed by some fishers and, as a result, their effective implementation is likely to require significant compliance resources. The cost-effectiveness and enforcement burden will vary across management measures. In addition, the available physical and human surveillance assets, the current and potential level of observer coverage and the operational practices of fishing vessels, particularly of foreign vessels, will vary across the PICTs, and influence the effectiveness of these measures.
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. One managed target shark fishery exists.	Management measures must address the impacts of both fishing methods and both incidental and targeted catch of shark. Given the uncertainty surrounding shark species and catch there is a need to minimize the potential for unmanaged, targeted shark fishing to occur.
Longline and purse seine fisheries affecting sharks in waters under the jurisdiction of the PICTs are comprised largely of fleets from distant water fishing nations but some PICTs have purse seine and/or longline fleets.	Effective regional management will involve management of both domestic and foreign fleets in national waters and on the high seas.
Some PICTs have domestic tuna fisheries and many rely heavily on access fees from foreign vessel activity in their waters.	Management of incidental shark catch will need to provide adequate protection to shark stocks while attempting to minimize the impact on target fishing operations for tunas and on revenue from access fees.
Fishing mortality	
Effective management of sharks relies on an	The PI-RPOA needs to encourage a precautionary

Characteristic	Implications for the RPOA Sharks
understanding of the mortality of shark species by fishing method. The data available do not provide a reasonable understanding of the level of fishing mortality on sharks, particularly on a species basis. There are no comprehensive data on even total retained catch and there is a lack of understanding about the post-release mortality of sharks released alive. Only piecemeal information on retained catch is available from logsheet data and reports to the WCPFC and FAO. Logsheet data appear to underestimate shark catch significantly and provide little indication of the species composition of the catch. Likewise, there is limited information available from port sampling and unloading records for sharks. Given the lack of spatial representativeness of existing observer data, it may not provide a sound basis for estimation of total catch. A trade-based analysis suggests that shark catch may be 2-3 times higher than the estimates derived from observer data. This could mean that shark catch in the WCPFC Convention Area (WCPFC-CA) may have averaged 160,000t to 240,000t per year over the period 2001-2006. Given that around 25% of longline catch and around 45% of purse seine catch in the WCPFC-CA is taken in the waters of the PICTs substantial quantities of sharks are likely to be being taken from PICT waters.	approach to management and to initiate means to improve the available data. Effective regional management of sharks in the long term will require improvements in the reporting of shark catch data at the species level from all fleets and by all methods. The PICTs have control over a significant proportion of total fishing effort in the region and therefore have the capacity to have a significant influence on the level and nature of the impact of tuna fishing on sharks. There is a need for research to confirm post-release mortality on a species basis in order to inform the development of effective management options.
Utilization	
The domestic market for shark meat in the PICTs is limited, but reportedly growing in some areas. Relatively small quantities of shark meat and fins are known to be exported by the PICTs. There are reports of dumping of shark carcasses in some PICTs. Global markets for shark meat may be increasing	The effectiveness of conservation and management measures against the objectives of maximizing utilization and minimizing waste must be assessed in the context of available markets for shark products and changing markets
Management	
There are no species-specific management measures for sharks in place in the PICTs or in the WCPFC. The WCPFC has in place a measure mandating the use of a 5% fin:carcass ratio for shark landings/transshipment. Most PICTs apply some generic measures for sharks including: a 5% fin:carcass ratio; prohibiting targeting sharks; prohibiting retention of sharks; and limits on the proportion of sharks in the catch.	Management measures within the waters of the PICTs must be compatible with those applied by the WCPFC for shark fishing on the high seas.
There has been no assessment of whether the management measures in place, regionally or nationally, are achieving their objectives in relation to conservation and management of sharks.	There is a need for a clear articulation of the objectives of shark conservation and management measures. Management measures must be assessed to determine their relative effectiveness in achieving these objectives both in theory and in practice. However, assessment of effectiveness may be constrained by the lack of data and this highlights the need for improved data collection.
Relevant initiatives	
Preliminary advice on the status of key shark stocks is to be provided to the WCPFC in 2010. A Shark Research Plan will be developed for WCPFC. The WCPFC's Regional Observer Programme (ROP) is being expanded. A Regional MCS strategy is being developed by FFA. Measures to reduce the catch of bigeye tuna have been	The PI-RPOA must be developed in the context of a changing scientific, management, operational and enforcement environment. Recently introduced measures to reduce the catch of bigeye tuna in particular may result in a reduction in associated incidental catch of sharks but may also provide an incentive to retain more incidental catch of shark or to target unmanaged sharks stocks.

Characteristic	Implications for the RPOA Sharks
introduced in the WCPFC.	

PART 2 ACTION TO ADDRESS SHARK CONSERVATION ISSUES

Introduction

In addition to providing a platform from which the PICTs can ensure that they comply with the mandatory components of CMM 2008-06 there is a need for the PI-RPOA to identify measures which the PICTs can take to fill some of the gaps not addressed by the CMM and to improve the likelihood of better management outcomes for sharks. The following approach has been adopted to ensure that the PI-RPOA fulfils these requirements.

- The objectives of the CMM are examined to provide a basis for determining whether 'alternative measures' will deliver equivalent outcomes and ensure that the measures adopted by the PICTs are compatible with those adopted by the WCPFC.
- The range of management measures available is identified.
- The management options are assessed against their capacity to address the objectives and their feasibility from cost, operational and enforcement perspectives.
- Data and scientific advice necessary to inform sustainable shark management are discussed.

Conservation and management

The provisions of CMM 2008-06

The WCPFC's CMM 2008-06 (Annex 1) recognizes the need to address many of the issues identified by the Regional Shark Assessment. However, even if each PICT and every other member of the WCPFC, was fully compliant with the CMM there would be no certainty of better conservation and management outcomes for sharks. Some of the factors that compromise the effectiveness of the provisions of the CMM are described in Table 2.

Table 2: Potential impact of CMM 2008-06

Provision	Factors affecting management outcomes
Implement the IPOA Sharks Report to WCPFC on assessment of the need for an NPOA Sharks, the status of their NPOA Sharks and the nature of any measures in their NPOA Sharks to minimize waste and discards and encourage the live release of incidental catches of sharks	Provision is voluntary Globally, the scope and implementation of NPOAs has proven to be variable Unless effective mandatory measures are applied on the high seas by the WCPFC with which coastal States' measures must be compatible, even a mandatory requirement for an NPOA will not necessarily deliver better shark management outcomes
Data collection Members, co-operating non-members and participating territories (CCMs) are asked	Provisions are voluntary Key shark species for reporting are based on ease of identification rather than relative risk identified by the ecological risk assessment

Provision	Factors affecting management outcomes
to provide catch and effort statistics by gear type and, retained catch and discards, on key shark species (blue shark, oceanic whitetip shark, mako sharks, thresher sharks)	(ERA) or stock status Logsheets not necessarily well configured to provide for species-specific reporting Retained and discarded catch data are to be provided in Part 2 of Annual Reports to WCPFC which are not made publicly available
Utilization Shark must be fully utilized: i.e. only the heads, guts and skin may be discarded prior to the first point of landing or transshipment The weight of fins on board a vessel (a catching vessel) must not total more than 5% of the weight (dressed or liveweight not specified) of shark on board up to first point of landing Where fins and carcasses are not required to be offloaded together at point of first landing measures must be taken to ensure compliance with the 5% ratio through certification, monitoring by an observer or other measures Alternatively, CCMs may require that fins are landed attached to the carcass or landed with the carcass CCMs shall prohibit their fishing vessels from retaining on board, transship, land or trade any fins harvested in contravention of the CMM Alternative compatible measures applied by coastal States	Provision is mandatory This is an explicit objective of the CMM Can be difficult to enforce depending on the way in which the measure is applied by coastal States Since the 5% fin:carcass ratio does not apply to carrier vessels shark carcasses can be dumped after transshipment at sea has occurred compromising the impact of the measure on utilization. Equally, carcasses landed in port in compliance with the ratio can be dumped without utilization Assumes that all shark species can withstand increased utilization Full utilization as defined by the CMM does not require that the shark carcass is, ultimately, utilized. Wastage of carcasses after landing or transshipment may/will still occur. There is little scope for the PICTs to absorb increased landings of shark carcasses from domestic and/or foreign fleets. The demand for shark fins remains strong and may negate the disincentive provided by finning controls to retain sharks. Unless viable international markets develop for shark products other than fins, it is likely that compliance with finning controls will result in dumping of shark carcasses after landing. Allows for fins to be removed from the carcass at sea and allows for fins and carcasses to be landed separately and relies on CCMs to ensure compliance with the 5% ratio Provides for stronger measures to be adopted by CCMs Requires CCMs to regulate the implementation of the measures Provides for coastal States to implement alternative measures in waters under their jurisdiction, but given the lack of specific outcomes sought by the CMM it will be difficult to assess whether alternative measures deliver equivalent outcomes
Conservation As for utilization above CCMs to take measures to encourage the release of live sharks that are caught incidentally and not used for food or other purposes	Provision is mandatory Comments as for utilization Sustainable use is an implied rather than an explicit objective of the CMM Does not preclude increased mortality of sharks since catch of sharks can continue to increase even with full compliance with the measure Provides no additional protection to higher risk shark species It is possible to 'encourage' the release of live sharks but this may have little effect
Research CCMs to support research and development of strategies to avoid unwanted shark catches	Provision is voluntary
In 2010 the Scientific Committee of the WCPFC to provide preliminary advice on	The Secretariat of the Pacific Community (SPC), the WCPFC's science service provider and data manager, will be required to provide this

Provision	Factors affecting management outcomes
stock status of key shark species and propose a research plan for the assessment of the status of those stocks	advice under its service level agreement with the WCPFC. The key shark stocks identified by the WCPFC do not fully reflect the scientific advice which indicated that assessment should be guided by the results of the ERA.
Reporting CCMs to report to the Commission in Part 2 of their Annual Report on the implementation of the CMM and any alternative measures adopted	Provision is mandatory but the information will not be publicly available
Evaluation CCMs shall review their implementation of the CMM and any alternative measures on the basis of advice from the Scientific Committee the Technical and Compliance Committee and the Commission will provide advice to CCMs on the implementation and effectiveness of the CMM and any alternative measures adopted and shall consider the application of additional measures as appropriate.	Provision is mandatory Assessment of the effectiveness of implementation and alternative measures will be difficult in the absence of a statement of clear outcomes sought by the Commission. It is unclear which body in the WCPFC has primary responsibility for assessing the effectiveness of the CMM and in particular the 'equivalency' of alternative measures.

Objectives of CMM 2008-06

It is important that a common understanding of the objectives of the CMM is reached since if the PICTs choose to adopt 'alternative measures' in waters under national jurisdiction these will be required to deliver at least equivalent outcomes to those of the CMM if they are to be considered 'compatible' under Article 8 of the WCPFC Convention.

The WCPFC's consideration of the proposal to adopt the first shark CMM (CMM 2006-05) indicates that the objectives of the measure were to:

- implement the IPOA Sharks by encouraging CCMs to adopt NPOAs; and
- apply measures for the full utilization of sharks, including measures relating to:
    - collection of data on sharks,
    - the retention, landing, transshipment and trade in shark fins, and
    - the release of live sharks caught by tuna and tuna-like fisheries (WCPFC, 2006).

In 2008 the WCPFC replaced CMM 2006-05 with CMM 2008-06 however the report of the meeting provides no further guidance as to the objectives of the CMM. Given that the preamble to the CMM specifies it is in accordance with the WCPFC Convention and recalls that the IPOA Sharks calls for cooperation to ensure sustainability of sharks stocks, it can be inferred that the objectives of both the WCPFC Convention and the IPOA Sharks constitute the underlying objectives of the CMM. The relevant objectives of these two instruments are to:

- ensure the long-term conservation and sustainable use of highly migratory fish stocks in the WCPO (Article 2 of the WCPFC Convention); and
- ensure the conservation and management of sharks and their long-term sustainable use (paragraph 16, IPOA Sharks).

Each of these instruments provides guidance on how these objectives are to be pursued. Of particular importance is the emphasis that both instruments give to:

- the application of the precautionary approach (Article 5(c) of the WCPFC Convention and Paragraph 14 of the IPOA Sharks);
- the adoption of conservation and management measures for both target and non-target catches (Article 5(e) of the WCPFC Convention and Paragraph 12 of the IPOA Sharks);
- assessing the impacts of fishing on target and non-target species (Article 5(d) of the WCPFC Convention and Paragraph 22 of the IPOA Sharks);
- minimizing waste, discards and catch of non-target species (Article 5 (e) of the WCPFC Convention and Paragraph 22 of the IPOA Sharks); and
- collecting data (Article 5 (i) of the WCPFC Convention and Paragraph 22 of the IPOA Sharks).

For the purposes of the PI-RPOA, and based on the discussion above, the objectives of both the CMM and of the PICTs, in relation to their broader management of shark stocks in waters under their jurisdiction, are considered to be:

1. to ensure the long-term conservation of sharks through adoption of precautionary management measures;
2. to collect data on shark catches and fishing activity at appropriate levels of resolution and provide scientific advice on the status and/or risk profile of shark stocks; and
3. to minimize wastage and promote the utilization of sharks within the constraints of long-term sustainability of shark stocks.

The objective of 'promoting utilization' is considered secondary to that of long-term conservation of sharks, i.e. utilization should be seen as a means to an end rather than an end in itself. This is clearly the intent of the WCPFC Convention and the IPOA Sharks, both of which refer to "sustainable use" rather than to maximizing utilization per se. The WCPFC Convention emphasizes the secondary nature of the 'utilization' objective in Article 5 (a) which refers to adopting measures to "***ensure*** long-term sustainability" of highly migratory fish stocks but requires only that that those measures "***promote*** the objective of their optimum utilization". While it is possible to pursue both objectives there will necessarily be trade-offs involved in attempting to maximize both. These trade-offs are demonstrated in Table 3 which depicts broad management options along the management objective continuum from conservation to utilization.

Table 3: Management trade-offs between conservation and utilization objectives for sharks

Focus on conservation → Emphasis on conservation → Emphasis on utilization →Focus on utilization			
Minimize impact of fishing **No extractive utilization (not necessarily zero mortality)**	**Manage impact of fishing at minimal unavoidable level** **Waste minimization**	**Manage impact at sustainable level** **Promoting utilization**	**Do not manage fisheries impacts on sharks** **No restriction on utilization**
No targeted shark fishing permitted	No targeted shark fishing permitted	Targeted shark fishing permitted	Targeted shark fishing permitted
Bycatch mitigation measures required	Bycatch mitigation measures required	Bycatch mitigation measures not required	Bycatch mitigation measures not required
Incidental catch not to be retained	Incidental catch of live sharks must be returned to the sea	Incidental catch of sharks may be retained and marketed	Incidental catch of sharks may be retained and marketed
Catch is effectively set to zero	Incidental catch of dead sharks may be retained and marketed	Fins and carcasses must be retained	Finning and discard of carcasses acceptable if no market for carcasses
	Fins and carcasses must be retained	Catch limits set at sustainable or precautionary levels	No catch limits
	Catch limits based on sustainability established for incidental catch		

Assessment of management measures for sharks

In order to meet the utilization and conservation requirements of CMM 2008-06 PICTs can:

1. chose to apply the "full utilization" and fin:carcass ratio provisions of the CMM to their domestic industrial fleets and to foreign fleets operating in their waters (noting that the CMM provides a range of options for implementing the fin:carcass ratio); or
2. adopt alternative measures that provide equivalent or better conservation and utilization outcomes than the CMM.

The literature contains an extensive range of potential management measures for sharks. These can be broadly categorized as measures that:

- impose direct limits on the level of catch or fishing effort;
- control the time or area in which fishing can occur;
- control the nature of fishing gear or fishing practices;
- control the size of sharks that can be retained; or
- provide market/economic incentives to constrain catch.

A summary of the measures available and a discussion of their potential impacts, based where possible on experience with their application to sharks, are provided in Annex 3.

A clear message from the Regional Shark Assessment is the need for a precautionary approach to management of shark stocks and the need to prioritize conservation over utilization. In priority order, management measures adopted by the PICTs should be directed to:

1. minimizing incidental interactions with sharks;
2. discouraging targeting;
3. maximizing the number of sharks returned to the sea alive; and
4. minimizing waste and maximizing the utilization of those sharks that are dead when captured.

In addition, management measures aimed at pursuing these objectives must be cost-effective and feasible in the current operating, management and MCS environment of the PICTs. Consideration of the potential management measures against the four identified priorities is contained in Table 4 along with consideration of the feasibility of their implementation and an assessment of whether they represent viable management options. Some important features of the analysis are outlined in Box 1.

Box 1: Interpreting the analysis in Table 4

- The analysis reflects consideration of each measure in isolation from each other and any other measures currently in place.
- Measures are listed in decreasing order of their rating against the four objectives.
- The analysis is qualitative and attempts to indicate the most likely direction of the impact of each measure on the basis of the information available. The actual impact may vary depending on the particular circumstances of a fishery and with more information/research.
- The analysis uses the following ratings:
  - a 'Positive' impact denotes that this measure has the potential to reduce interactions, to discourage targeting, to increase survival of incidental catch or to reduce wastage or improve utilization;
  - a 'Negative 'impact' denotes that the measure has the potential to increase interactions, to encourage targeting, to reduce survival of incidental catch, or to increase wastage or reduce utilization; and
  - a 'Neutral' impact denotes that the measure is considered unlikely to affect current levels of incidental catch, targeting, survival of incidental catch, waste or utilization.
- Feasibility was assessed on the basis of factors including the strength of the evidence that a measure is, or is likely to be, effective, whether it has been demonstrated as operational in other fisheries and its likely associated enforcement burden and costs.
- Ultimately, the impact of a measure will depend on the specific fishery, governance and administrative circumstances in which it is implemented, and the extent to which fishers can circumvent its affect by compensating with increased effort or some other change to fishing operations.
- Five categories of measures are identified:
  - those that could be implemented immediately;
  - those that could be implemented immediately as interim measures pending further research;
  - those which are currently the subject of research, the results of which should be considered when available;
  - those that are likely to be effective for species-specific management; and
  - those that are not likely to be feasible or effective currently or in the foreseeable future.

In the longer term, the relevance and feasibility of many of the options identified may improve as research identifies the need for species-specific management and as the cost-effectiveness of emerging technologies for monitoring catch, fishing operations and compliance are proven. For example, the use of on-board cameras to record the extent of interactions with bycatch species and the methods used for their handling and release is being investigated in some fisheries as a cost-effective alternative to observer coverage. Similarly, electronic reporting of catch to enable near real-time monitoring of catches may, ultimately, expand the range of measures that are considered feasible. In addition, new methods, such as the use of DNA barcoding for species identification may facilitate the monitoring of compliance with species-specific measures and data collection in general.

Table 4: Assessment of potential impact of management measures for incidental shark catch

	Conservation			Utilization	Feasibility	Assessment
	Reduce incidental catch	**Discourage targeting**	**Increase survival of incidental catch**	**Minimize wastage / promote utilization**		
A COULD BE IMPLEMENTED IMMEDIATELY						
Prohibit wire traces	Positive	Positive	Positive	Positive (less wastage)	Already in place in a number of fisheries. Some research suggests it is cost-effective for fishers Questions remain about mortality of sharks that bite free. Cost-effective to enforce	Potentially high conservation and wastage outcomes Could be implemented immediately
Prohibit purse seine sets on schools associated with whale sharks	Positive	Neutral	Neutral	Positive	Would be cost effective to monitor under 100% observer coverage of purse seine fleet Whale sharks are listed on both CITES and CMS	Could be implemented immediately
Reduce effort for target tuna stocks	Positive	Neutral to negative	Neutral-negative	Positive	CMM 2008-01 for Bigeye and Yellowfin tuna seeks to reduce bigeye fishing tuna mortality by 30% over 2009-2011 and to maintain the level of mortality of yellowfin tuna Cost-effective in that any protection of shark stocks comes at no extra cost Impact on shark stocks will depend on the effectiveness of the measure in reducing effort for target tuna stocks and the level to which parties comply with the measure	Implemented May reduce incidental catch but may provide an incentive to retain more incidental shark catch or to target sharks
Prohibit the dumping of carcasses after landing	Neutral	Positive	Positive	Positive	Cost-effective to enforce	Potentially high conservation and utilisation outcomes Could be implemented immediately
Requirement to land carcasses (except for heads guts and skins) of retained sharks together with the application of a fin/carcass ratio applied to retained shark	Neutral	Positive	Positive	Neutral-positive	Can be implemented under CMM 2008-06 Cost-effective to enforce In place in many fisheries Facilitates collection of data Still some scope for high grading of carcasses with fins attached and still no guarantee that shark carcasses will be utilized after landing The requirement to land sharks with fins attached to carcasses may provide additional incentive to	Could be implemented immediately for domestic fleets and when new access agreements negotiated for foreign fleets

	Conservation			Utilization	Feasibility	Assessment
	Reduce incidental catch	**Discourage targeting**	**Increase survival of incidental catch**	**Minimize wastage / promote utilization**		
catch Fins must be landed attached to the carcass					release live sharks producing more positive conservation outcomes than other finning control options Avoids need for 5% ratio	
Require discard of all live shark	Neutral	Positive	Positive	Neutral	In place in some fisheries, for example in New Zealand, some shark species are required to be released alive and as soon as practicable after capture. ICCAT also requires this for bigeye thresher shark. May be difficult/costly to enforce	CMM 2008-06 actively encourages the release of live sharks in both national and high seas fisheries A precautionary measure pending availability of more information on individual species
Prohibit retention of sharks or any part of shark (no take)	Neutral	Positive	Positive	Negative	Relatively cost-effective to enforce	Could be implemented now Will involve a considerable degree of wastage.
Prohibit targeting of sharks	Neutral	Positive	Neutral	Neutral	Cost-effectiveness of enforcement will depend on how targeting is defined	Could be implemented now
B CONSIDER RESULTS OF RESEARCH WHEN AVAILABLE						
Require use of circle hook and prohibit use of J hook	Positive	Positive	Possibly positive	Positive (less wastage)	Requires further research to determine: • relative impact of circle hooks and J hooks on shark catch rates on a species basis • relative impact of circle hook and J hooks on target species catch rate • relative impact of different sized circle hooks on catch rates of sharks and target species • relative impact of different sized circle hooks on post-release mortality • relative impact of barbed and barbless circle hooks on catch rates of shark and target species • the impact of hook type/size alone in isolation from impact of change in bait from squid to fish • the impact of corrodible hooks on post release survival	Potentially high conservation and wastage outcomes Research required to confirm effectiveness and most effective configuration Research priority

	Conservation			Utilization	Feasibility	Assessment
	Reduce incidental catch	**Discourage targeting**	**Increase survival of incidental catch**	**Minimize wastage / promote utilization**		
					Some relevant research underway in US Currently an option in bycatch mitigation measures for turtles in the WCPFC swordfish fishery Likely to be cost-effective to administer and enforce	
Require use of fish bait rather than squid	Positive	Positive	Neutral	Positive (less wastage)	Research suggests that the change of bait is more likely to result in a reduction in catch-per-unit-effort (CPUE) of shark than the change in hook type. Currently an option for mitigation of sea turtle bycatch in the WCPFC swordfish fishery Could be costly/difficult to enforce	Potentially positive conservation and wastage outcomes Research required to confirm effectiveness Research priority Open to high level of non-compliance
Shark deterrents	Positive	Positive	Neutral	Positive	Research underway to assess effectiveness of some deterrents in reducing catch of shark Cost and operational implications for fishers would need to be determined Impacts on catch of target species needs to be analyzed	Research underway Consider results when available
Require use of bait stations	Positive	Neutral	Neutral	Neutral	Research underway to assess effectiveness in reducing catch of shark One of a limited range of measures applicable to the purse seine fishery Cost implications for fishers would need to be determined	Research underway Consider results when available
Require use of dehooker	Neutral	Neutral	Positive	Positive	Requires further research to confirm operational ease and effectiveness Similar requirements in place for turtles in the WCPFC	Research conducted Requires follow up
Require use of corrodible hook	Neutral	Neutral	Positive	Neutral	Relatively easy to enforce Requires further research to determine: • impact of the corrodible hook on catch rates of target species • the impact of the corrodible hook on catch rates of sharks • The impact of corrodible hooks on post-release survival of sharks • Impact on operating costs	Research required. Not a priority, but should be included in a comprehensive study of the impact of hook type and size on shark catch

	Conservation			Utilization	Feasibility	Assessment
	Reduce incidental catch	**Discourage targeting**	**Increase survival of incidental catch**	**Minimize wastage / promote utilization**		
C LIKELY TO BE EFFECTIVE FOR SPECIES-SPECIFIC MANAGEMENT						
Require deep sets	Positive	Positive	Neutral	Neutral-Positive	Requires further research to determine: • the impact on shark catch rates (conflicting findings to date) • the differential impact on shark species that live in different depths in the water column • the impact on catch rates of target species Will be difficult to enforce	Potentially high conservation outcomes but further research required Results may inform species-specific management Research priority.
Allocated quotas for sharks (generic)	Neutral	Positive	Neutral-positive	Negative	Likely to be difficult and costly to enforce and administer	Generic shark quotas are likely to pose an unacceptable impost on target fishing operations if they result in the cessations of such operations when the quota is reached May be justified operationally and in terms of cost-effectiveness to address a species-specific shark issue
Maximum size limits for specific species	Neutral	Neutral-Positive	Positive	Negative	May be difficult to enforce Effective only on a species-specific basis	Consider in context of species-specific management as required
Minimum size limits for specific species	Neutral	Neutral	Positive	Negative	May be difficult to enforce Effective only on a species-specific basis	Consider in context of species-specific management as required
Global total allowable catch (TAC) of sharks	Neutral	Negative	Negative	Negative	Likely to be difficult and costly to enforce and administer Discarding and highgrading likely	Generic shark quotas are likely to pose an unacceptable impost on target fishing operations if they result in the cessations of such operations when the TAC is reached May be justified operationally and in terms of cost-effectiveness to address a species-specific shark issue
D UNLIKELY TO BE EFFECTIVE AND/OR FEASIBLE						
Move-on provisions	Positive	Positive	Positive	Neutral	Difficult to administer and enforce since it relies on real-time knowledge of the catch rate and a high level of observer coverage to enforce.	Potentially high conservation outcomes but these may be reduced by poor compliance
Require day	Positive	Positive	Neutral	Positive	Requires further research to determine:	Research required but given potential

	Conservation			Utilization	Feasibility	Assessment
	Reduce incidental catch	**Discourage targeting**	**Increase survival of incidental catch**	**Minimize wastage / promote utilization**		
setting				(less wastage)	• the impact on shark catch rates (conflicting findings to date) • the potential impact on other species of interest, namely seabird May not be cost-effective to enforce	for impact on other species this may not be a research priority
Time/area closures	Positive	Neutral-Positive	Neutral	Positive	Data required to set effective closures unlikely to be available VMS would contribute to cost-effectiveness	Data collection required to support implementation
Reduce soak time	Positive	Neutral	Positive	Positive	Requires further research to determine the relationship between soak time and capture rates May be difficult to enforce	Research required Not a priority.
Prohibit associated FAD sets	Positive	Neutral	Neutral	Positive (less wastage)	Would have significant consequences for catch rates of target species. Seasonal FAD closures have been implemented in the WCPFC purse seine fishery from August 2009.	General FAD prohibitions would not be feasible because of unacceptably high level of impact on target fishing operations
Controls on use of light sticks	Possibly positive	Neutral	Neutral	Positive (less wastage)	Requires further research to determine strength of relationship between use of light sticks and shark catch rates Applies to swordfish fishery Operation of the swordfish fishery appears to be limited in most PICTs	Requires research Not a high priority for PICTs
Requirement to land carcasses (except for heads guts and skins) of retained sharks together with the application of a fin/carcass ratio applied to retained shark catch Fins and carcasses must be landed together but fins may be	Neutral	Positive	Positive	Neutral-Positive	Can be implemented under CMM 2008-06 Difficult and costly to enforce compliance with the 5% fin:carcass ratio In place in many fisheries Subject to the loopholes provided by the generic 5% ratio The high potential for highgrading and for landed carcasses to be discarded, compromise the potential positive conservation and utilization outcomes	Costs/logistics associated with compliance outweigh any potential conservation/utilization benefits

	Conservation			Utilization	Feasibility	Assessment
	Reduce incidental catch	**Discourage targeting**	**Increase survival of incidental catch**	**Minimize wastage / promote utilization**		
separated from the carcass						
Requirement to land carcasses (except for heads guts and skins) of retained sharks together with the application of a fin/carcass ratio applied to retained shark catch Fins and carcasses can be offloaded separately	Neutral	Positive	Positive	Neutral-	Can be implemented under CMM 2008-06 In place in some fisheries Very difficult and costly to enforce compliance with the 5% fin:carcass ratio Subject to the loopholes provided by the generic 5% ratio The high potential for highgrading and for landed carcasses to be discarded, compromise the potential positive conservation and utilization outcomes	Costs/logistics associated with compliance outweigh any potential conservation/utilization benefits
Prohibit landing, trade and/or export of shark	Neutral	Positive	Positive	Negative	Relatively cost-effective to enforce	Could be implemented now but could be relatively easily circumvented and will involve a considerable degree of wastage
Tax landings/trade of sharks	Neutral	Positive	Positive	Negative	Could be relatively easily avoided by foreign fleets May have negative financial implications for PICTs Imposes an administrative burden and requires broader government support	Unlikely to be effective
Trip limits No. of sharks or proportion of shark in catch/per trip	Neutral	Positive	Neutral - Positive	Negative	Likely to be cost-effective and feasible for domestic fleets Would be generic and set arbitrarily Discarding and highgrading likely Unlikely to be feasible for foreign fleets	Some conservation outcomes but these could be compromised by highgrading and utilization outcomes compromised by need to discard even dead sharks after limit reached

PI-RPOA management actions

From the assessment in Table 4 it is possible to identify a relatively small number of additional measures that could be implemented immediately with a high likelihood, in aggregate, of delivering improved conservation outcomes for sharks. Those measures are:

1. prohibit the use of wire traces;
2. prohibit the use of purse seine sets on schools associated with whale sharks;
3. require the release of all live sharks;
4. require sharks to be landed with fins naturally attached, allowing for fins to be partially severed and folded back against the carcass for storage; and
5. prohibit the dumping of carcasses after landing.

Prohibiting retention of shark or any part of sharks and prohibiting the targeting of sharks are also identified in Table 4 as effective measures that could be introduced immediately. However the five measures identified above would, if introduced as a package, effectively preclude shark targeting and a separate prohibition on targeting may provide little additional value. Further, the prohibition on retention of all sharks or any part of the shark may involve an unacceptable degree of wastage of sharks that are dead at the time of capture (around 35% in the longline fleet) while doing nothing to address the level of incidental catch.

The package acknowledges the reality that many shark carcasses will continue to be landed and discarded simply because the value of the fins provides sufficient incentive to land the carcass in compliance with the finning controls, but the market for meat is limited and the price is generally low. In addition, it recognizes that growing markets for shark meat may negate the contribution of shark finning controls to conservation of sharks. As a result, the package focuses on measures which, taken together, reduce incidental catch and increase survival of sharks captured alive and hence minimize waste, and remove the incentive to target sharks, thus promoting their long-term conservation.

The package could be adopted across the PICTs and be applied, as appropriate, to industrial longline or purse seine vessels flagged to the PICTs regardless of whether they are fishing in the waters of their flag State, the waters of another coastal State or on the high seas, and to foreign longline or purse seine fishing vessels authorized to fish in the waters of the PICTs. The Harmonised Minimum Terms and Conditions applied by FFA members to foreign fishing vessels operating in their waters may provide a vehicle to apply the package to foreign vessels. National measures would be required to be implemented for domestic fleets and for the implementation of a prohibition on the dumping of carcasses after landing.

On its own, introduction of the finning control based on a ‘fins attached’ policy, together with national legislation to make it illegal to carry on board, tranship, land or trade shark taken in contravention of that

measure (Paragraph 9 of the CMM) would deliver at least equivalent management outcomes for sharks than those likely under the default requirements of CMM 2008-06 and would ensure that the PICTs were compliant with the management requirements of the CMM. The implementation of the four additional measures across the PICTs would demonstrate a strong regional position on the need for immediate action which has a higher probability of reducing the impact of fishing on sharks than that provided by finning controls in isolation. However, it is very difficult to determine whether the other four measures, individually or in combination, will deliver equivalent effects to those of the CMM. It is considered, therefore, that adoption of the package will maximize the chances of reducing the impact of fishing on sharks and waste of shark products while also providing the PICTs with the confidence that they are compliant with the requirements of the CMM.

The package, must however be seen as the first step in conservation and management of sharks. The following discussion on data collection and research will provide a platform to inform the development of more effective longer-term management of sharks in the region.

It is noted that some PICTs already have in place measures including:

- 5% fin:carcass ratio;
- prohibition on targeting of sharks and/or wire traces not permitted; or
- prohibition on retention of sharks.

Under the package of measures proposed above, the 5% fin:carcass ratio could be replaced with the fins attached policy and the prohibition on targeting and/or on the use wire traces would be consistent with the regional measure to prohibit wire traces. PICTs that currently prohibit the retention of sharks could chose to retain this measure but since it does not address the level of incidental catch and involves significant wastage, those PICTs could supplement it with the regional measures related to use of wire traces and whale shark associated purse seine sets. Alternatively, the current measures could be replaced by the proposed regional package of measures.

Data collection and analysis

Fisheries in the WCPO are essentially data-poor with respect to their impact on sharks. The Regional Shark Assessment has highlighted deficiencies in:

- the capacity of current logsheets to record shark catch on a species basis;
- the extent of recording of even generic ‘shark’ catch on logsheets;
- the level of completion and submission of logsheets;
- the capacity of crew to identify all but the most commonly encountered shark species (blue, oceanic whitetip shark, silky shark, mako sharks and thresher sharks);

- the level and spatial representativeness of observer data;
- the capacity of some observers to correctly identify shark species; and
- the lack of information on distribution and biology of many shark species.

As a result of those deficiencies, neither the extent of total shark catch nor catch of individual species is known and many biological characteristics that inform assessments of risk and stock status are not well understood.

On the positive side:

- the observer data available provides a sound indication of the species composition of shark catch by longline and purse seine fisheries and of the life status of sharks upon capture and release;
- SPC's work on ecological risk assessment provides a guide to those shark species which may be most at risk from fishing;
- the level of observer coverage in both the longline and purse seine fisheries is set to increase substantially over the next 3 years; and
- there are a number of shark identification guides available to improve the capacity of observers and crew to correctly identify shark species (for example, SPC, 2005; McAuliffe, Itano and Arceneauz, 2007; and Fukofuka and Itano, 2007).

The WCPFC has attempted to improve the provision of shark catch data to the Commission under its CMMs for sharks. Currently, Paragraph 4 of CMM 2008-06 states that:

- Each CCM shall include key shark species, as identified by the Scientific Committee in their annual reporting to the Commission of annual catch and fishing effort statistics by gear type, including available historical data, in accordance with the WCPF Convention and agreed reporting procedures
    - This requires CCMs to report in Part 1 of their Annual Report which is provided to the Scientific Committee each year and is publicly available on the WCPFC website
- CCMs shall also report annual retained and discarded catches in Part 2 of their Annual Report to the WCPFC.
    - Part 2 of Annual Reports are provided to the WCPFC and are not publicly available

However, these provisions may do little to improve the submission of data on sharks since:

1. they are voluntary;
2. they apply only to the 'key shark species' which includes two species (blue shark and oceanic whitetip shark) and two groups of sharks (mako sharks and thresher sharks);

- SPC has since advised that silky shark should be added to the list of 'key' species included in CMM 2008-06 (Manning *et al*., 2009)

3. the key shark species for reporting purposes were proposed by the Scientific Committee on the basis of their ease of identification rather than reflecting the level of risk or uncertainty in respect of shark species;
4. the standard SPC/FFA Regional Longline and Regional Purse Seine Logsheets do not currently provide for the reporting of the key species identified.

Improved data on shark taken in WCPO fisheries is required to:

- improve ecological risk assessments;
- provide a basis for assessment of stock status; and
- inform the selection of appropriate and effective management options.

Improved data collection, whether it be by more rigorous reporting in logbooks, increased observer coverage, increased port sampling and unloading observations, implementation of tagging programs or the introduction of species/product form-specific shark trade codes, will come at a cost. The high levels of uncertainty surrounding sharks and shark fisheries and the recognized vulnerability of many shark species to overfishing dictates the need for a precautionary approach. In those circumstances there should be a relationship between the level of uncertainty/risk, the extent of shark catch permitted by management and the level of investment in data collection and research. Essentially, there is a trade-off between uncertainty and the level of permitted catch that can, potentially, be reduced by investment in data collection and research. The absence of good information on sharks may also, ultimately, have an impact on access to target stocks. Improved data and research that reduces uncertainty about stock status and risk levels may allow higher catch levels or, at a minimum, justify the precautionary management adopted. Currently however, fishers in the WCPO have unconstrained access to sharks. They have no incentive to improve data collection or to support research on sharks. The introduction of precautionary management that seeks to constrain catch and reflect the level of uncertainty may provide an incentive for fishers and governments to invest in data collection and research.

Manning *et al.* (2009) have identified the data required for stock assessments. Historically, there are few species-specific catch records on sharks. This means that for stock assessment purposes or even for analysis of trends it is not possible to extract, standardize and collate data from various independent collections. In the main, the time series of species-specific shark catches will rely on data collected from here on in. It is critical therefore that the data collections are as comprehensive as possible in terms of their species coverage, information on catch and discards, effort and biological data. In the short term these data will be useful as a basis for indicators and their usefulness to identify trends, and for stock assessment purposes will improve as the time series expands.

It must be acknowledged that any changes to management arrangements to address incidental catches of sharks, including those in the PI-RPOA, are likely to have at least a short-term affect on the continuity of data sets, for both target and non-target species. However, given the dearth of data collected on sharks to date the impact on shark data sets is more likely to be positive. In addition, and as noted earlier there is some potential for some measures to facilitate data collection. In particular, the fins attached policy of the PI-RPOA will improve the capacity to collect data from landed sharks since:

- monitoring the sex composition of the catch is possible if the pelvic fins of male and female sharks and claspers of males are attached;
- the certainty of length-frequency measurements (and enforcing size limits if adopted in the longer term) is improved if the fins and the tail are intact; and
- species, sex and partial length of a shark can be determined ashore if sharks are beheaded and eviscerated at sea and landed as carcasses with fins, skins, claspers and where applicable dorsal spines attached (Musick and Bonfil, 2004).

However, the data collection value of the fins attached policy will only be realized if the resources are available to collect the data.

It is planned to increase observer coverage in the purse seine fisheries of the WCPFC to 100% by 2010 and in the longline fisheries to 5% of each longline fleet by 2012. While 5% appears comparatively low it represents a significant increase from the current average level of coverage of less than 1% in the longline fisheries. While considerably higher coverage may be required to adequately monitor interactions with those shark species that are not frequently encountered in the catch, analysis has shown that the reliability of estimates of CPUE improves less rapidly with increasing coverage, once coverage rates of 20% percent are achieved CPUE (Lawson, 2006). These findings are significant in the context of relatively scarce human and financial resources to implement observer-based programmes.

Under the ROP, the minimum data fields that will be completed by observers will provide information on catch, sex, condition upon catch and release and fate of shark species caught, In addition, information relevant to shark assessment and management will be collected, including whether wire traces are used, the hook type and hook size, mainline and branchline material, estimated shark fin weight by species and estimated shark carcass weight by species. Observers will also play a role in monitoring compliance with WCPFC CMMs and will be required to indicate whether the vessel failed to comply with any CMMs during the course of a trip. Increased observer coverage will improve the capacity of the observer database to be used to validate logsheet data and will also provide an opportunity to monitor the effectiveness of any bycatch mitigation measures implemented under this RPOA.

While the increase in observer coverage is positive for shark data collection the benefits will only be maximized if observers are well trained and well-equipped to identify shark species. It is likely, given the rapid increase in observer coverage required in the purse seine sector that observers may not, initially at

least, be sufficiently trained or experienced to deliver significant improvements in shark data. Realistically, the competing demands for the services of observers, particularly in relation to collection of tuna data in the purse seine fishery, may mean that prioritising the use of observers to collect shark data is some way off.

PI-RPOA data actions

Improve data collection in logsheets

- SPC/FFA should amend the logsheets to:
    - Provide for species listing of the oceanic or semi-pelagic shark species likely to be at highest risk from longline and purse seine fishing in the waters of the PICTs and key shark species identified by the WCPFC. These species are bigeye thresher shark, blacktip shark, salmon shark, thresher shark, pelagic stingray, silky shark, oceanic whitetip shark, silvertip shark, sandbar shark, shortfin mako, longfin mako, Galapagos shark, blue shark and pelagic thresher shark.
    - For each species listed above provide for the numbers and weight of shark retained and numbers of sharks discarded, by life status, by species to be recorded
    - Retain the current provision for numbers and weights of 'other' retained sharks and numbers of discards to be recorded
        - The Data Collection Committee of SPC/FFA is scheduled to meet in November/December 2009 and should consider how best to implement the required amendments to the logsheets.
- Available shark identification guides should be used as the basis for the publication of identification guides in appropriate languages and formats for use by crew and observers on-board all vessels operating in the waters of the PICTs and in port sampling programmes
    - There would be value in extending these guides to facilitate identification of sharks (particularly those specified on logsheets) in various forms (whole, carcass or even from fins)
- SPC to ensure that programmes are in place to validate logsheet data against observer data.
- PICTs should require as a condition of authorization to fish the use of the standard regional logsheet forms and the submission of logsheet data on shark catch and ensure effective sanctions are in place for failure to comply.

Improve reporting on shark catch to the WCPFC

- PICTs should regard the data reporting provisions of CMM 2008-06 as mandatory.

- PICTs should provide all available shark catch arising from the proposed changes to logsheets to the WCPFC.
- PICTs should seek, within the WCPFC, to amend 2008-06:
    - to mandate submission of catch and effort data on high risk shark species by all CCMs; and
    - to include all high risk shark species in the reporting requirements.

Improve observer data

- PICTs need to ensure that WCPFC's target observer coverage rates for longline and purse seine fleets are met and, in relation to coverage rates in the longline sector, aim to increase coverage to 10% by 2015 and to 20% as soon as possible thereafter.
- PICTs/SPC to ensure that observers are specifically equipped to accurately identify shark species and competent in sampling procedures and measurement techniques.
    - The use of digital cameras to facilitate the identification of unknown species could be implemented.
- SPC, in consultation with the PICTs/WCPFC, should take into account the need to address the current lack of spatial representation in the observer data on sharks in determining observer placement, particularly in the longline fisheries.
- Observers operating in the waters of the PICTs should be charged with monitoring the effectiveness of measures such as the use of monofilament traces, release of live shark etc.

Improve port sampling of sharks

- PICTs should aim to increase their sampling of sharks over time with a view to sampling 10% of the landed catch by 2015 to take advantage of the easier identification of shark species resulting from the adoption of the fins attached policy.

Tagging programme for sharks

- The feasibility of initiating electronic or conventional tagging programmes to provide important information for stock assessment including information on movement, growth, natural mortality habitat use, post release survival and discard mortality should be investigated.
    - Information on post-release survival and discard mortality are critical to determining the effectiveness of a range of management options including requirements to discard all live sharks, the use of trip limits, catch quotas and controls on finning.

Improve trade data for sharks

- PICTs that export shark products should introduce trade codes for the main species traded and for the main forms of the trade (meat, fillets, fins etc) in order to provide an additional mechanism to validate estimates of catch.
- PICTs should seek, within the WCPFC, for the Commission to mandate the implementation of appropriate trade codes for sharks and the provision of annual import and export data on sharks by source and destination respectively to the Commission.

Research

Status of stocks

CMM 2008-06 requires that, in 2010, the Scientific Committee, if possible in conjunction with the Inter-American Tropical Tuna Commission (IATTC), provide preliminary advice on the stock status of key shark species and propose a research plan for the assessment of the status of these stocks.

The SPC advised the August 2009 meeting of the WCPFC's Scientific Committee (Manning *et al.,* 2009) that:

- sufficient basic biological and fishery data, drawn mainly from observer data collected by the SPC's members, exist to provide preliminary stock status advice on the key shark species (blue shark, oceanic whitetip shark, shortfin and longfin mako sharks, silky shark and bigeye, common and pelagic thresher sharks) over the next 12 months;
- three steps are proposed in developing this advice
    i. revise the productivity-susceptibility analysis (PSA) and resilience analysis available for these species
        - following reviews of stock boundaries and biological characteristics
        - incorporate the more sophisticated indicators for productivity and susceptibility
            - new indicators may include trends in catch, changes in unstandardized and standardized CPUE, changes in the size or other composition of the catch
        - compare the results of the revised PSA with the results of ranking each key shark species in terms of their 'resilience' to fishery harvesting using demographic models and comparison with IUCN rankings
    ii. evaluate stock-status indicators outside a population model fit

        - detailed analysis of trends in nominal and standardized CPUE and in time series of functions of catch-composition distribution (e.g. catch-at-length)

    iii. evaluate stock status indicators calculated from the results of a series of simple population fits

        - analysis of trends in stock status indicators that are derived from the results of a series of simple population model fits

            - this step may only be feasible for blue shark, oceanic whitetip shark and shortfin mako shark and, for the remaining three species of thresher sharks and longfin mako shark, data gaps and other information needs will be identified;

- the process will require:

    i. collaboration with IATTC and national scientists from WCPFC CCMs;

    ii. Updating of biological information;

    iii. Identifying and accessing other relevant data sets not currently available to SPC or the WCPFC;

    iv. developing alternative catch histories for the key species reflecting different sets of assumptions about the data;

    v. analysis of standardized CPUE and size data; and

    vi. application of different stock assessment modelling methodologies.

The SPC has also advised that in the longer term, the provision of stock status advice (biomass and yield) with statistical confidence will require considerable investment in shark fishery data collection and reporting systems. Dedicated funding for shark research will also need to be provided, through the WCPFC, in order to allow SPC to provide the necessary advice to underpin sound conservation and management of sharks.

On the basis of the lessons learned in undertaking the preliminary assessments, a Shark Research Plan will be developed for consideration of the Scientific Committee in 2010. A summary of the likely status of advice on the highest risk shark species by end 2010 is provided in Table 5.

Table 5: Stock status advice for highest risk oceanic/semi-pelagic identified in the ERA and key shark species

Species	Likely advice by end 2010
Bigeye thresher shark	Preliminary advice and data gaps and other information needs identified (Steps 1-2 of SPC's 3 step process)
Blacktip shark	No additional advice
Salmon shark	No additional advice
Thresher	Preliminary advice and data gaps and other information needs identified (Steps 1-2)
Pelagic stingray	No additional advice
Silky shark	The Scientific Committee recommended in August 2009 that silky shark be added to the list of key species. If the WCPFC accepts this recommendation in December 2009 preliminary advice and data gaps and other information needs may be identified (Steps 1-2 of SPC's 3 step process) by end 2010
Oceanic whitetip shark	Preliminary advice and data gaps and other information needs identified (Steps 1-2 of SPC's 3 step process)
Silvertip shark	No additional advice
Sandbar shark	No additional advice
Shortfin mako	Preliminary advice and data gaps and other information needs identified (Steps 1-2 of SPC's 3 step process)
Longfin mako	Preliminary advice and data gaps and other information needs identified (Steps 1-2 of SPCs 3 step process)
Galapagos shark	No additional advice
Blue shark	Preliminary advice and data gaps and other information needs identified (Steps 1-2 of SPC's 3 step process)
Pelagic thresher	Preliminary advice and data gaps and other information needs identified (Steps 1-2 of SPCs 3 step process)

Of those shark species considered, on the basis of the best available scientific advice, to be at the highest risk from fishing, six are unlikely to be subject to further consideration or specific shark management measures in the near future. Table 6 provides a summary of information on these species extracted from the Regional Shark Assessment and available observer data. With the exception of pelagic stingray, each of these species is a highly migratory species under UNCLOS and signatories to the UNFSA have a duty to cooperate to manage such species. None of these species are identified separately in the limited logsheet data that is recorded by species. The implementation of the generic management measures and data collection initiatives identified in earlier sections of this RPOA should provide some immediate protection to these species and deliver improved information on the impact of fishing and enhanced knowledge of biological characteristics of these species in the medium to longer-term. However, the species-specific impacts of the management measures are largely unknown. In addition, it is unlikely that there is sufficient data available to use indicators such as trends in catches, nominal CPUE or average weight to provide a preliminary indication of the impact of fishing on these

species. Further, the scientific resources available and competing priorities mean that additional scientific advice on these species is unlikely to be available for a minimum of two years.

Table 6: High risk species not subject to stock status consideration at this time

Species	Other assessments/UNCLOS HMS	WCPO Fisheries	Presence in observed catch in PICT waters[1]	Utilization
Blacktip shark	IUCN global: Near Threatened UNCLOS: HMS	Longline and purse seine	LL: 13% in Tonga and 10.5% in Tuvalu; between 0.04% and 3% in another seven PICTs PS: 2% in Kiribati and Tuvalu; between 0.02 and 0.2% in FSM, Nauru, PNG and Solomon Islands	Fins
Salmon shark[2]	IUCN Global: Least Concern UNCLOS: HMS	Longline and purse seine	LL: 0.01% in PNG PS: 0.12% in PNG	Meat, fins and liver oil
Pelagic stingray	IUCN Global: Least Concern (requires monitoring) Relatively low catch rates and stable median size may mean that catches are sustainable (Molony, 2008)	Longline and purse seine	Comprises between 10% and 26% of observed longline shark catch in Fiji, New Caledonia, Solomon Islands, FSM, French Polynesia, Samoa and Palau	May not be marketed (Ribeiro-Prado and Amorium, 2007)
Silvertip shark	IUCN Global: Near Threatened IUCN SWP: Least Concern UNCLOS: HMS	Longline and purse seine	LL: 3.5% in French Polynesia 2.5% in PNG; between 0.02% and 0.5 % in Cook Islands, Kiribati, New Caledonia, French Polynesia and Solomon Islands PS: 100% in Samoa; 15% in Tokelau; between 0.01 and 1.6% in Kiribati, PNG, Solomon Islands and Tuvalu	Not known
Sandbar shark	IUCN Global: Vulnerable IUCN SWP: Near Threatened (draft) UNCLOS: HMS	Longline and purse seine	LL: between 0.01% and 0.5% in Fiji, Marshall Islands, New Caledonia and PNG PS: <0.01% in PNG	Fins, skin
Galapagos shark	IUCN Global: Near Threatened IUCN SWP: Data Deficient UNCLOS: HMS	Longline and purse seine	LL: between 0.04 and 1.5% across 11 PICTs PS: 0.13% in Nauru and 0.04% in PNG	Not known

1. In some cases these percentages reflect very small sample sizes.
2. Salmon shark is mostly taken in the North Pacific.

Mitigation measures

Table 4 and Annex 3 identify the need for further research to confirm the impact of various mitigation measures including:

- circle hooks and size of circle hook;
- bait type;
- corrodible hooks;

- deeper sets; and
- reduced soak time.

The results of some research conducted or underway also warrants further investigation:

- the development of an effective shark de-hooker in the USA; and
- the results of IATTC research into the effectiveness/feasibility of bait stations in purse seine fisheries.

In addition, results to date suggest that further research and development of shark deterrents may be worthwhile.

While there have been a number of studies that have directly or indirectly assessed the impact of various mitigation measures, the results have been contradictory and often confounded by the number of factors influencing the results. This uncertainty has delayed the introduction of mitigation measures for sharks. There is an urgent need to address this uncertainty through a well-designed and comprehensive program of shark mitigation research.

A key determinant of the effectiveness of many management measures that seek to reduce mortality by improving the likelihood that live captured sharks will be returned to the sea alive is post-release mortality. These data are also important for the estimation of total mortality for stock assessment purposes. The work of Walsh *et al.* (2009) suggests that there is a substantial difference between species in their capacity to survive the stress of capture. Campana *et al.* (in press) found that all healthy blue sharks from a random sample of captured sharks, survived release while 33% of those that were badly injured or gut hooked subsequently died. Overall blue shark mortality in the Canadian Atlantic pelagic longline fishery was estimated at 35%, while the estimated discard mortality for blue sharks that were released alive was 19%. Further information on species-specific post-release survival is required before the impact of measures on reducing mortality of species can be predicted confidently.

Given the commonality of the need for improved shark mitigation measures across the tuna RFMOs, and the limited human and financial resources available to undertake the necessary research, the proposed joint tuna RFMO workshop to be held in the United States in 2010 would provide a forum to:

- review all the available information on shark mitigation measures;
- identify the extent of support for the introduction of measures based on the available evidence ;
- identify those measure for which further research is required; and
- develop a collaborative research program to ensure that well-designed research programs are implemented to provide the required advice in a timely manner.

The outcomes of that workshop could also be used to further inform the development of WCPFC's Shark Research Plan.

PI-RPOA research actions

- SPC should be provided with sufficient resources to initiate the three-step approach to provision of preliminary stock status advice in 2010 and to enable completion of steps 1 and 2 for the key shark species and silky shark in 2010.
- Research to identify available information relating to factors that influence the impact of management for blacktip shark, sandbar shark, salmon shark, pelagic stingray, silvertip shark and Galapagos shark should be initiated as a priority, to identify information on:
    - the extent to which these species are retained or discarded;
    - the post release mortality of these species; and
    - the demand for products derived from these species.
- SPC consider the feasibility of applying Steps 1 and 2 of the SPC's proposed three step approach to providing preliminary advice on the stock status of these six species as the next priority following completion of the work scheduled for 2010.
- Utilize the joint Tuna RFMO 2010 Workshop on Bycatch to identify effective shark mitigation measures, areas for further research and cost-effective and collaborative mechanisms to complete this research in a timely manner.

PART 3 MODEL NPOA SHARKS

Introduction

The Model NPOA is comprised of four elements:

- Section 1: A stepwise approach to shark conservation and management at the national level
- Section 2: The framework for undertaking a National Shark Assessment
- Section 3: Guidance on the elements of an NPOA Sharks
- Section 4: A template for summary presentation of the NPOA Sharks

Section 1 A stepwise approach

Part 2 of the PI-RPOA focused on development of management arrangements that could be applied across the PICTs to domestic and foreign industrial tuna fleets operating in their zones to ensure immediate compliance with the WCPFC's CMM 2008-06 and to provide a platform for improved management outcomes for oceanic/semi-pelagic shark species. Implementation of the PI-RPOA will require action at the national level to implement, administer and enforce the regionally agreed measures.

The Regional Shark Assessment of the PI-RPOA identified that artisanal and small scale fisheries in the PICTs may also have an impact on shark stocks. This impact will be mainly on coastal species but it is likely that some semi-pelagic and oceanic shark species are also taken by these fisheries. The extent to which artisanal fishers take pelagic sharks will depend, for example, on the topography. Where there are extensive archipelagic or shallow waters artisinal fishers are likely to take predominantly coastal shark species. However, where the land rises quickly from very deep depths artisanal fishers are more likely to encounter pelagic shark species. The development of the PI-RPOA did not provide scope for a detailed analysis of the nature and extent of the impact of artisanal and small scale fisheries on shark stocks. Further, the nature of these fisheries and the species of sharks taken will vary across the PICTs.

In order to ensure that all impacts on sharks are addressed, it is critical that each PICT conduct a National Shark Assessment (see guidance in Section 2), focusing on their own artisanal and small scale fisheries and drawing where possible on the information contained in the Regional Shark Assessment. According to the IPOA Sharks the next step is to consider whether an NPOA Sharks is required. The benefit of developing an NPOA is that it provides a mechanism for articulating, prioritising and implementing actions required under the PI-RPOA and for responding to the issues identified in the National Shark Assessment. However, an NPOA is not an end in itself. The priority must be on implementation of actions to address identified issues. If the resources required to develop a formal NPOA (see Section 3 below) are limited, a stepwise approach to addressing the issues identified in the National and Regional Shark Assessment (see Table 7) could be adopted as a more feasible alternative.

Table 7: Suggested stepwise approach to shark conservation and management at the national level in the PICTs

Steps	PICTS with only artisanal/small-scale fisheries		PICTs with Industrial domestic and/or foreign fisheries	
		Model NPOA Section Reference		PI-RPOA Implementation Framework Reference
1. Implement Regional measures under the RPOA	Not required		Yes. ***Priority 1***	
• Management measures				Actions 1-5
• Data collection				Actions 6-11
2. Conduct a National Shark Assessment (NSA)	Yes. ***Priority 1***	Section 2	Yes ***Priority 2***	
3. Assess and respond to the outcomes of the NSA with respect to fishery impacts on sharks	**Yes. *Priority 2***		**Yes. *Priority 3*** ***Proceed as for*** Steps 3, 4 and 5 to address impacts of artisanal and small scale fisheries	
i. Does the NSA identify the shark species taken?				
a) No	Collect data then proceed to i(b)			
b) Yes	Use ERA and other available information to identify high risk species (primary species)	Section 2(b)		
	Defer action on other shark species until Step 4			
ii. Do you have adequate catch, trade and life history information for primary species?		Section 2(c)		
a) No	Identify the gaps and impediments to collection of data			
	Identify and implement appropriate data collection mechanisms	Section 3(e)		
	Implement interim precautionary management where the need is indicated	Section 3(e) and Annex 3 RPOA		
	Proceed to 3(ii)b when sufficient data is available to develop longer-term management measures.			

Steps	PICTS with only artisanal/small-scale fisheries		PICTs with Industrial domestic and/or foreign fisheries	
		Model NPOA Section Reference		PI-RPOA Implementation Framework Reference
b) Yes	Implement long-term precautionary management	Section 3(e) and Annex 3 RPOA		
iii. Do you have the MCS capability to effectively implement management measures?		Section 3(g)		
a) No	Reassess feasibility and cost of management arrangements and/or address gaps in capacity (human and financial)			
b) Yes	Proceed to implement management measures			
4. Develop data collection, research, MCS and management arrangements for the remaining species	Yes. ***Priority 3*** Repeat Step 3 for the remaining (i.e other than primary) shark species	Section 3	Yes. ***Priority 4*** Repeat Step 3 for the remaining (i.e other than primary) shark species	
5. Develop mechanisms to address non-fishery impacts on sharks	Yes. **Priority 4**		Yes**. *Priority 5***	

Section 2 National Shark Assessment

The development of a National Shark Assessment is an essential element in assessing what is known about fishery impacts on sharks, the species affected and how these interactions are being managed. It will provide important information on what is known and what needs to done to fill gaps in knowledge and management arrangements to conserve and manage shark stocks within each PICT.

a) Shark species

- In this section a review of the available information on shark species within the EEZ should be undertaken and the information collated and presented.
- Table A2.1 from the PI-RPOA can be used as a starting point as it provides valuable information on shark species likely to be found in the region but also suggests which species might be found in individual PICTs.
- PICTs should use any other information available to them to present as comprehensive a listing as possible of the species found in their waters.

b) Understanding of the status of shark stocks

Stock status

- Any available information on the stock status of the shark species identified above should be compiled. It is likely that in most cases the SPC will be the major source of this information.

Ecological Risk Assessment (ERA)

- The SPC undertakes ERA for the region and at the national level and PICTs should review this work to determine the risk rating of shark species occurring in their waters.
- As part of the FFA Ecosystem Approach to Fisheries Management (EAFM) process being implemented across FFA members, SPC has been providing ERA advice at a national level, attempting to take into account the fisheries operating in the EEZ, the interaction levels with different shark s species (where data available) and place these in the context of different species' susceptibility and productivity. With SPCs assistance, PICTS may wish to compare the regional and national level ERA research, identify differences and consider the reasons for any differences (differing fishery selectivities, stock overlaps etc).

IUCN assessments and convention listings

- PICTs should review the IUCN assessment of shark species the listing of sharks under a range of international conventions. Table A2.4 of the Regional Shark Assessment provides useful guidance on IUCN and Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) and the Convention on Migratory Species (CMS) listing information. PICTs

should reflect any obligations arising from their membership of these Conventions in the National Shark Assessment.

Proposed stock assessments for key shark species

- Preliminary stock advice on key shark species (blue shark, oceanic whitetip shark, shortfin and longfin mako sharks, pelagic thresher, bigeye thresher shark and thresher shark) is being prepared by the SPC for the WCPFC. If PICTs have any other stock advice/assessments underway these should be highlighted
    - Stock assessments of the key shark species require an understanding of their biological characteristics, their stock boundaries, and the impact of fishing on those stocks. More information on these requirements is available in Annex 2 Regional Shark Assessment.

  PICTs should consider whether the proposed schedule of shark stock status advice under the WCPFC addresses the high risk species occurring in their waters in an adequate timeframe.

c) Impacts on sharks

- An overview of the various impacts on shark stocks within national waters should be provided covering what is known about industrial fishing, artisanal and small scale fishing, recreational and charter fishing, cultural uses of sharks and tourism operations.
    - Much of the information on industrial fishing is likely to be contained in the Regional Shark Assessment
    - Relevant information may also be contained in the National Tuna Fishery Status Reports prepared by SPC for its member countries, with these reports typically having a chapter on bycatch impacts or risks at a national level.
- Other factors which may affect coastal shark stocks should also be outlined here, such as tourism, coastal zone development and pollution. These factors are likely to be relatively more important for small scale and artisanal fisheries.

Industrial, small scale and artisanal fisheries affecting sharks

Sources of data

- For industrial fisheries logsheets, some observer data, some port sampling and other information may be available, either collected locally or through programs administered by SPC/WCPFC. Some of this information is already collated and provided to SPC and the WCPFC in Annual Reports. This information should be set out in as much detail as possible in this section.
    - There will potentially be very limited data available on small scale and artisanal fisheries. PICTs should collate and list whatever information they have on the target and incidental catch of sharks in these fisheries. Where quantitative data are not available, the inclusion of

best available information on the nature and scale and operation of these fisheries will be useful.

Nature of the fisheries

- A profile of the nature of the fishing fleets taking sharks in the PICT and a summary of the size and nature (method, domestic/foreign) of the fleet should be provided in this section. It is anticipated that reasonable information will be available on industrial fisheries (see for example Table A2.16). As much information as possible should be provided noting that limited information may be available on small scale and artisanal fisheries.

(d) Shark utilization

- Sharks can be utilized for their fins, meat, liver oil, cartilage and skin. In this section information on the known uses of sharks within the PICT should be provided. This should include product used domestically as well as exported product. Table A2.17 provides background information on the known uses of sharks by species on a regional basis.
- PICTs should provide as much information as possible on the use of sharks, both from industrial fisheries and small scale and artisanal fisheries in their waters. This information may influence subsequence management options.

(e) Shark management

- The section should outline is as much detail as possible national management arrangements implemented by the PICTs for both industrial fisheries and small scale and artisanal fisheries. It should provide information on the arrangements in place for each sector. If there are no arrangements in place for a sector this should be stated.
- The national measures taken, or required to be taken, to implement the regional management arrangements under the PI-RPOA should be specified in this section.
- Consider the impact of any broader government policies on shark fishing (e.g. tax incentives, subsidies)

(f) Monitoring, control and surveillance (MCS)

- PICTs should collate and list the MCS arrangements in place in support of the management arrangements implemented for each sector/fishery impacting on sharks. The industrial fishery will have a number of regional initiatives including harmonized terms and conditions for access of foreign vessels, VMS and be part of the regional observer program.
- It is likely that arrangements for the small scale and artisanal fisheries will be far less developed. Any arrangements in place should be outlined along with known gaps which might need to be addressed.

Section 3 Development of an NPOA Sharks

It is proposed that the PICTs might adopt the following structure in developing an NPOA. Further guidance on the contents and development of an NPOA can be found in the IPOA-sharks (FAO, 2000a) and the FAO's Technical Guidelines on Conservation and Management of Sharks (FAO, 2000b).

(a) Consultation

- The development of responses to address the issues identified in the National Shark Assessment should involve input from fishers directly involved in the fisheries concerned and from other stakeholders. This will ensure that all stakeholders are aware of the need for the new measures and will maximize the likelihood that the measures will be feasible and effective.

(b) Objectives

- Provide a clear outline of the objectives of the NPOA Sharks in relation to the issues affecting shark stocks. The objectives will need to reflect not only fisheries management objectives but broader national policies and regional and international obligations:
  - Domestic policies in relation to food security, income generation, employment and natural resource management, export earnings
  - Domestic legislation
  - Regional policies such as the Apia Policy[8]
  - Regional initiatives such as the Ecosystem Approach to Coastal Fisheries and Aquaculture in Pacific Island Countries and Territories
  - Regional obligations and agreements such as those agreed to through membership of FFA and through measures such as the Nauru Agreement
  - Obligations as members of the WCPFC, especially those agreed under CMM 2008-06.
  - Responsibilities as parties to the UNFSA, CITES or the CMS

(c) Scope

- The coverage of the NPOA should be specified. For example, the plan might apply to all or some of the following:
  - domestic industrial fleets operating in national waters, on the high seas or in the EEZs of other countries
  - foreign industrial fishing fleets operating in the waters of the PICTs
  - artisanal and small scale domestic fleets

[8] Pacific Islands Regional Coastal Fisheries Management Policy and Strategic Actions (Apia Policy): 2008-2013

- sharks taken as incidental catch to target fishing operations for other species
- sharks taken in target shark fisheries
- non-fishing related impacts on sharks
  - tourism
  - coastal development
  - pollution

(d) Issues arising from the Assessment

- The National Shark Assessment and the Regional Shark Assessment will together provide a comprehensive review of the knowledge about the nature and extent of the impacts on sharks in national waters. The Assessments provide a basis to **identify issues** that need to be addressed. For example the Assessments might:
  - identify gaps in the understanding of the species, the fisheries or other impacts affecting them and/or the extent of those impacts; and
  - highlight areas where actions are required to reduce the impact.
- The next step is to **prioritize the issues**. Some principles that might guide prioritization include:
  - the objectives and obligations identified in Section 1;
  - the level of knowledge of the stocks, with higher levels of uncertainty indicating the need for higher priority; and/or
  - the importance of the resource for subsistence and local economies

(e) Actions to respond to the Issues

- PICTs who are in the process of adopting EAFM should attempt to integrate their actions under the NPOA Sharks into that approach since the principles of EAFM will provide a sound basis for improving conservation and management of sharks.
- Utilising existing mechanism to address common issues is likely to provide a cost-effective way of identifying effective mechanisms to address shark management issues in artisanal and small scale fisheries across the PICTs
  - For example, consideration might be given to increasing the focus of the SPC's Coastal Fisheries Programme on shark management issues for the period of its next Strategic Plan (commencing 2010).
  - SPC is currently undertaking a survey of artisanal tuna fisheries in the PICTs as a means of identifying appropriate data collection mechanisms for these fisheries. This survey may

provide useful information on the nature and scale of some of the coastal fisheries in which sharks may be taken as well as advice on the mechanisms likely to be relevant to collection of shark catch data.

- It is likely that the issues relating to sharks taken in artisanal and small scale fisheries will be similar, in broad terms to those identified at the regional level for industrial fleets. For example, there is likely to be:
  - uncertainty about the species composition of the catch;
  - uncertainty about the total level of catch and catch of each species;
  - lack of understanding of stock status; and
  - lack of basic distributional and biological data for shark species.
- Part 2 of the PI-RPOA includes actions to address the issues in relation to sharks taken by industrial fleets. PICTs should consider:
  - whether additional actions are required in respect of those fleets; and
  - whether the same actions should be applied to sharks taken by artisinal and small scale fleet.
- A review of management measures available has been provided in Annex 3 of the PI-RPOA. However, these measures may not be relevant or feasible in relation to artisanal and small scale fleets. In reviewing the relevance of these measures to their artisanal and small-scale fleets PICTs may wish to consider:
  - whether shark discards are as significant an issue as they are in industrial fleets;
  - whether they can be applied to the fishing gears in those fleets (e.g. troll and handline gears);
  - the extent and sophistication of the framework for management, data collection and coordination of research;
  - the potential for using or building on existing customary marine tenure rather than attempting to overlay them with modern fisheries management and enforcement measures;
  - the diversity of objectives, fishing operators and operations and the geographical dispersion of fishers and landings sites; and
  - the practicality of some options for data collection and validation, such as observer coverage, in the context of artisanal and small-scale fisheries.
- In considering alternative approaches for these fisheries PICTs may wish to consider:

- whether logsheets can be applied in some sectors of these fisheries, for example, the Data Collection Committee is developing a Regional Artisanal FAD Fishing Logsheet that could be completed by artisanal fishermen or used by fisheries officers as a survey form;
- whether surveys may be more feasible than ongoing formal data collection systems
  - an annual or bi-annual census of active fishing vessels to determine number of boats by type and gear used,
  - regular (monthly or six-monthly) sample surveys to gather information about effort e.g. how many days fished over a specified period),
  - regular sampling of landings of catch by boat type to determine the species composition and weight of the fish and also the length of the fishing trip;

- the cost-effectiveness of using market, processor and/or export data as an alternative or complementary indicator of the species composition and level of catch of shark; and
- the long-term cost effectiveness of using fishery independent surveys of shark resources to provide invaluable baseline data and regular snapshots of the resource.
- The need for appropriate shark identification guides
  - The PI-RPOA has identified a number of shark identification guides that have been developed for species taken in the offshore fisheries, however it may be necessary to develop or collate from existing sources, guides focused more closely on the species likely to be encountered in the smaller-scale fisheries. For example, a recent SPC fish identification guide (Chapman *et al.,* 2008) for snapper fishermen includes seven shark species of coastal/ semi-pelagic sharks.

(f) MCS

- The feasibility of the actions identified in the previous section need to be assessed against the capability to effectively enforce them.
- The development of Regional MCS Strategy by FFA members may provide avenues for both regional and national cooperation to address shark enforcement issues in industrial fleets.
- Compliance with national measures by artisanal and small scale fishers may require innovative approaches relevant to the diversity and geographic spread of the fisheries.

(g) Capacity to undertake those actions

- Review the human and financial resources available to determine:
  - the timeframe in which a response can be initiated, or

- if there is no capacity to respond
    - identify possible sources of assistance, and/or
    - initiate training or development of systems to develop that capacity, or
    - acknowledge that no action is possible.

Capacity building can take many forms including formal tertiary training, fellowship programmes, regional or national workshops and training courses, exposure to relevant meetings and negotiations, development of manuals, software etc (Cartwright and Preston, 2006). The long-term benefits of these options need to be weighed up against the costs. In assessing the benefits, capacity building is likely to benefit a broader spectrum of fisheries management and governance rather than merely shark conservation and management.

(h) Review of the NPOA

The IPOA recommends that the Plan be reviewed at least every four years. PICTs should include in the NPOA a specified time for implementing a review of the Plan and an evaluation of the Plan against its objectives. Best practice would suggest that the Plan also include some performance indicators against which the effectiveness of the Plan can be evaluated.

Section 4 Template for presentation of an NPOA Sharks

A suggested template for use in presenting an NPOA Sharks is provided in Table 8. The template is based around the actions being undertaken in the four areas of:

1. fisheries management and species conservation;
2. data and research;
3. monitoring, control and surveillance; and
4. human resources and capacity building requirements.

The template also provides for the allocation of priorities to actions along with identification of responsibility for implementation and timeframes in which the actions should be implemented. Some examples of how the template might be completed are provided.

Table 8: Template for presentation of NPOA Sharks

Issue/Action	Priority	Capacity available		Capacity not available
		Responsibility	**Deadline**	**Options**
Fisheries management and species conservation				
Action 1 *E.g. Develop a management plan for sharks*	*1*	*Fisheries Agency*	*End 2010*	
Action 2 *E.g. Develop regulations to support the Management Plan*	*1*	*Fisheries Agency* *Central Legal Agency*		*Seek assistance from WCPFC Assistance fund to fund provision of legal advice*
Data and research				
Action 1				
Action 2				
Monitoring, control and surveillance				
Action 1				
Action 2				
Human resources and capacity building requirements				
Action 1 *E.g. Building scientific research capacity*				*Seek assistance from SPREP, SPC*
Action 2				

PART 4 INDICATIVE IMPLEMENTATION FRAMEWORK FOR THE PI-RPOA SHARKS

The RPOA approach reflects the staged approach to addressing shark conservation and management issues recommended by the 2008 FAO workshop (FAO, 2009). Importantly, the measures identified are well-aligned with the actions proposed by the 2009 joint meeting of Tuna RFMOs, which highlighted the need for:

- precautionary, science-based (see Actions 12-16) conservation and management measures for sharks taken in fisheries within the convention areas of each tuna RFMO, including as appropriate:
    - measures to improve the enforcement of existing finning bans (Actions 4 and 5);
    - concrete management measures in line with best available scientific advice with priority given to overfished populations (Action 2);
    - precautionary fishing controls on a provisional basis for shark species for which there is no scientific advice (Actions 1, 2 and 3); and
    - measures to improve the provision of data on sharks in all fisheries and by all gears (Actions 6-11).

An indicative implementation framework for the actions proposed by the PI-RPOA Sharks is provided below. The framework relates to both the regional actions specified by the Plan and the actions required at a national level to implement those regional actions and to address broader shark conservation and management issues in national waters. Possible mechanisms that could be used to implement the actions are identified and earliest implementation dates are proposed.

Implementation will also require the allocation of responsibilities for actions. In broad terms this responsibility might be shared between:

- national governments and fisheries, conservation and other relevant agencies (e.g. customs, trade, legal agencies) in the PICTs; and
- regional bodies such as FFA, SPC, SPREP and WCPFC.

INDICATIVE PI-RPOA SHARKS IMPLEMENTATION FRAMEWORK

Action	Possible mechanisms	Earliest implementation date
MANAGEMENT MEASURES		
1. Prohibit use of wire traces	MTCs National regulations	2010
2. Prohibit the use of purse seine sets on schools associated with whale sharks	MTCs National regulations	2010
3. Require the release of all live shark	MTCs	2010

Action	Possible mechanisms	Earliest implementation date
as soon as practicable after capture and without further harm	National regulations	
4. Require sharks to be landed with fins naturally attached and allow fins to be partially severed and folded back against the carcass for storage	MTCs National regulations	2010
5. Prohibit the dumping of shark carcasses after landing	National regulations	2010
DATA COLLECTION		
6. Improve data collection in logsheets	Amend logsheets to provide for recording of all high risk shark species	2009/10
	Compile and distribute shark identification guides	2010
	Sanctions established for non compliance with logsheet reporting	2011
	Logsheet validation against observer data	From 2011
7. Improve reporting to WCPFC	Treat the reporting provisions of CMM 2008-06 as mandatory and provide catch and effort data on other high risk shark species	From 2010
	Seek to amend CMM 2008-06 to make the reporting requirements mandatory for all CCMs and to include all high risk shark species in the reporting requirements	2009
8. Improve observer data	Longline observer coverage in PICT waters to be increased to 10% with a view to moving to 20% as soon as possible thereafter	2015
	Ensure observers trained/equipped to identify sharks	From 2011
	Utilize ROP to address lack of spatial representativeness in shark observer data with a focus on the longline fleet	From 2011
	Utilize ROP to monitor effectiveness of shark bycatch mitigation measures with a focus on the longline fleet	From 2011
9. Improve port sampling	A minimum of 10% of shark landings to be sampled in port	By 2015
10. Initiate shark tagging programme	Investigate feasibility of initiating a tagging programme for sharks	By 2011

Action	Possible mechanisms	Earliest implementation date
11. Improve shark trade data	Implement species and product form-specific export codes for the main species exported Get agreement from WCPFC (7) for CCMs to be required to implement appropriate trade codes for sharks and provide shark trade data	By 2012 2010
RESEARCH		
12. Provide preliminary stock status advice on key shark species	Adopt the three-step process proposed by SPC	2010
13. Consider the feasibility of providing preliminary stock status advice on the remaining high risk shark stocks	Consider the feasibility of applying the three-step process to these species	2011
14. Provide preliminary advice on interim management measures for the remaining high risk species	Review available information on remaining high risk shark species to inform appropriate management measures	2011
15. Initiate further consideration of and research on the effectiveness of shark bycatch mitigation measures	Utilize the joint Tuna RFMO Bycatch workshop to initiate joint work to confirm the effectiveness of promising bycatch mitigation measures Identify effective and feasible bycatch mitigation measures	2010 2011
16. Develop a Shark Research Plan reflecting the research and data collection needs identified in this Plan	Develop research programme to address outstanding issues Research outcomes Implement through the Scientific Committee of WCPFC	2011 2012 2010
17. Undertake a National Shark Assessment	Model NPOA	2010
18. Implement: o step-wise approach or o develop an NPOA	Model NPOA	 Initiate 2011 2011
19. Development of legislation as required	National processes	2011
20. Undertake education and awareness raising	Expand existing mechanisms e.g SPREP's shark listserver	Ongoing

ACRONYMS

CCMs	Members, cooperating non-members and participating territories (of the WCPFC)
CEP	Central-eastern Pacific
CITES	Convention for International Trade in Endangered Species of Wild Fauna and Flora
CMM	Conservation and management measure (of the WCPFC)
CMS	Convention on Migratory Species
CPUE	Catch-per-unit-effort
CWP	Central-western Pacific
EAFM	Ecosystem approach to fisheries management
EC	European Community
ECPO	Eastern Central Pacific Ocean
EEZ	Exclusive Economic Zone
ERA	Ecological risk assessment
FAD	Fish aggregating device
FAO	Food and Agriculture Organization of the United Nations
FFA	Forum Fisheries Agency
FSM	Federated States of Micronesia
HMS	Highly migratory species
IATTC	Inter-American Tropical Tuna Commission
ICCAT	International Commission for the Conservation of Atlantic Tunas
IPOA Sharks	International Plan of Action for the Conservation and Management of Sharks
IUCN	The World Conservation Union
IUU	Illegal, unreported and unregulated (fishing)
LL	Longline
MCS	Monitoring, control and surveillance
MOU	Memorandum of Understanding
MSY	Maximum sustainable yield
MTCs	Harmonised Minimum Terms and Conditions for Foreign Fishing Vessels Access (FFA members)
NMI	Northern Mariana Islands (US Territory)
NPOA Sharks	National Plan of Action for the Conservation and Management of Sharks
NSA	National Shark Assessment
PICTs	Pacific island countries and territories
PNG	Papua New Guinea
PSA	Productivity-susceptibility analysis
PS	Purse seine
RFMO	Regional fisheries management organization
ROP	Regional observer programme
PI-RPOA Sharks	Pacific Islands Regional Plan of Action for the Conservation and Management of Sharks
SPC	Secretariat of the Pacific Community
SPC-OFP	Oceanic Fisheries Programme of the SPC
SPREP	Secretariat of the Pacific Regional Environment Programme
SWP	South-western Pacific

TAC	Total allowable catch
TAL	Tropical albacore longline fishery
TDL	Tropical deep longline fishery
TSL	Tropical shallow longline fishery
UNCLOS	United Nations Convention on the Law of the Sea of 10 December 1982
UNFSA	The Agreement for the Implementation of the of the Provision of the United Nations Convention on the Law of the Sea of 10 December 1982 relating to the Conservation and Management of Straddling Fish Stocks and Highly Migratory Fish Stocks
VDS	Vessel day scheme
VMS	Vessel monitoring system
WCPFC	Western and Central Pacific Fisheries Commission
WCPFC-CA	WCPFC Convention Area
WCPO	Western and Central Pacific Ocean

REFERENCES

Anon. (2009a). *Draft Report of the Second Joint Meeting of the Tuna Regional Fisheries Management Organizations (San Sebastian, Spain, June 29 – July 3, 2009*). Available at: http://www.tuna-org.org/Documents/TRFMO2/01%20Draft%20Report_ENG.pdf

Anon (2009b). *Fisheries to be Monitored*, Paper to Third Intersessional Working Group meeting on the Regional Observer Programme, Guam, 17-21 March, 2009. WCPFC/ROP-IWG3/2009-08

Amos, M. (2007). Vanuatu Fishery Resource Profiles. *WP-Pacific Technical Report (International Waters Project) No. 49*. SPREP, Samoa

Beverly, S., D. Curran, M. Musyl, and B. Molony. (2009). Effects of Eliminating Shallow Hooks from Tuna Longline Sets on Target and Non-Target Species in the Hawaii-based Pelagic Tuna Fishery. *Fisheries Research* 96: 281-288.

Bolten, A. And Bjorndal, K (2002). *Experiment to Evaluate Gear Modification on Rates of Sea Turtle Bycatch in the Swordfish Longline Fishery in the Azores*. Archie Carr Center for Sea Turtle Research, University of Florida.

Bolten, A. And Bjorndal, K (2003). *Experiment to Evaluate Gear Modification on Rates of Sea Turtle Bycatch in the Swordfish Longline Fishery in the Azores* – Phase 2. . Archie Carr Center for Sea Turtle Research, University of Florida.

Brouwer, S. and Griggs, L. (2009). *Description of New Zealand's shallow-set longline fisheries, WCPFC-SC5-2009/EB-IP-01*, Fifth Regular Session of the WCPFC Scientific Committee, 10-21 August, 2009, Port Villa, Vanuatu.

Camhi, M. D., Valenti, S.V., Fordham, S.V., Fowler, S.L. and Gibson, C. (2009). *The Conservation Status of Pelagic Sharks and Rays. Report of the IUCN Shark Specialist Group Pelagic Shark Red List Workshop*. IUCN Species Survival Commission Shark Specialist Group, Newbury, UK.

Campana, S.E., Joyce, W. and Manning M.J. (in press). Bycatch and discard mortality in commercially caught blue sharks *Prionace glauca* assessed using archival satellite pop-up tags (Abstract only). *Marine Ecology Progress Series*. .

Cartwright I.C. and Preston G.L. (2006). *A Capacity-building Strategy for the Commission for the Conservation and Management of Highly Migratory Fish Stocks in the Western and Central Pacific Ocean*. Pacific Islands Forum Fisheries Agency, Honiara, Solomon Islands.

Cavanagh,R.D, Kyne,P.M., Fowler, S. L., Musick, J.A. and Bennett,M. B. (Eds) (2003). *The Conservation Status of Australasian Chondrichthyans: Report of the IUCN Shark Specialist Group, Australia and Oceania Regional Red List Workshop Queensland, Australia, 7-9 March 2003*.

Chapman, L., Desurmont, A, Choi, Y., Boblin, P., Skimi, W and Beverly, S. (2008). *Fish Species Identification Manual for Deep-bottom Snapper Fishermen*. SPC.

Clarke, S. McAllister, M.K, Milner-Gulland, E.J., Kirkwood, G.P. Michielsens, C.G.J., Agnew, D.J., Pikitch, E.K., Nakano, H. and Shivji, M.S. (2006). Global estimates of shark catches using trade records from commercial markets. *Ecology Letters*, 9, 1115-1126.

Clarke, S. (2009). An Alternative Estimate of Catches of Five Species of Sharks in the Western and Central Pacific Ocean based on Shark Fin Trade Data. WCPFC – SC5/EB-WP-02. Available at: http://www.wcpfc.int/meetings/2009/5th-regular-session-0 .

European Commission (2009). *External Trade*. Available at: http://epp.eurostat.ec.europa.eu/portal/page/portal/external_trade/introduction.

FAO (2000a). *International Plan of Action for the Conservation and Management of Sharks*. FAO, Rome. Available at: ftp://ftp.fao.org/docrep/fao/006/x3170e/X3170E00.pdf

FAO (2000b). Fisheries Management. 1 Conservation and management of sharks. *FAO Technical Guidelines for Responsible Fisheries. No. 4, Suppl. 1*. Rome. Available at: http://www.fao.org/docrep/003/x8692e/x8692e00.htm

FAO (2009). Report of the technical workshop on the status, limitations and opportunities for improving the monitoring of shark fisheries and trade, 3-6 November 2008, Rome. *FAO Fisheries and Aquaculture Report No. 897. FIMF/R897 (Advance Copy).* Presented to the Twenty-fourth Meeting of the Animals Committee, CITES, Geneva, 20-24 April 2009.

FAO Fisheries and Aquaculture Information and Statistics Service. 2009. *Capture Production 1950-2007.* FISHSTAT Plus - Universal software for fishery statistical time series [online or CD-ROM]. Food and Agriculture Organization of the United Nations. Available at: http://www.fao.org/fi/statist/FISOFT/FISHPLUS.asp

FAO Fisheries and Aquaculture Information and Statistics Service 2008. *Fisheries Commodities Production and Trade 1976-2006.* FISHSTAT Plus - Universal software for fishery statistical time series [online or CD-ROM]. Food and Agriculture Organization of the United Nations. Available at: http://www.fao.org/fi/statist/FISOFT/FISHPLUS.asp

Francis, M. P., Griggs, L. H. and Baird, S. J. (2001). Pelagic shark bycatch in the New Zealand tuna longline fishery. *Marine and Freshwater Research*. 52: 165–178.

Froese, R. and D. Pauly. (Eds) (2009). *FishBase. World Wide Web electronic publication.www.fishbase.org*, version (04/2009).

Fukofuka, S. and Itano, D.G. (2007). *Photographic Identification Guide for Non-target Fish Species taken in WCPO Purse Seine Fisheries* WCPFC-SC3-FT SWG/IP-7, Scientific Committee, Third regular session, 13-24 August 2007, Honolulu, United States of America

Gaffney, R. (2000). *Tourism and Jaws*. Shark Conference 2000 Online Documents Honolulu, Hawaii February 21-24, 2000. Available at: http://www.pacfish.org/sharkcon/documents/gaffneyr.html

Gilman, E. (2007). *Shark Capture and Disposition in the Hawaii Pelagic Longline Swordfish and Tuna Fisheries*. WCPFC-SC3-EB SWG/IP-15. WCPFC Scientific Committee Third Regular Session 13-24 August 2007, Honolulu, USA.

Gilman, E., Clarke, S., Brothers, N., Alfaro-Shigueto, J., Mandelman, J., Mangel, J., Petersen, S., Piovano, S., Thomson, N., Dalzell, P., Donoso, M., Goren, M. and Werner, T. (2007a). *Shark Depredation and Unwanted Bycatch in Pelagic Longline Fisheries: Industry practices and attitudes and shark avoidance strategies*. Western Pacific Regional Fishery Management Council, Honolulu, USA.

Gilman, E., Kobayashi, D., Swenarton, T., Brothers, N., Dalzell, P. and Kinan-Kelly, I. (2007b). Reducing sea turtle interactions in the Hawaii-based longline swordfish fishery. *Biological Conservation*, 139 (1-2): 19-28.

Gilman, E., Clarke, S., Brothers, N., Alfaro-Shigueto, J., Mandelman, J., Mangel, J., Petersen, S., Piovano, S., Thomson, N., Dalzell, P. Donoso, M., Goren, M. and Werner, T (2008). Shark interaction in pelagic longline fisheries. *Marine Policy*. 32 (1). 1-18.

Hareide, N.R., Carlson, J., Clarke, M., Clarke, S., Ellis, J., Fordham, S., Fowler, S., Pinho, M., Raymakers, C., Seret, B. and Polti, S. (2007). *Strengthening European Fisheries Management: Options for enforcing the shark finning ban*, Lenfest Ocean Program.

Harley, S. J. (2006). Preliminary characterization of sea turtle catches in New Zealand fisheries waters. EB-WP3, Second Regular Session of the WCPFC Scientific Committee, 7-18 August, 2006, Manila, Philippines.

Hay, R. (2009). *Regional Reports: Oceania.* Doc. 5.6, Twenty-fourth meeting of the CITES Animals Committee, 20-24 April, 2009, Geneva Switzerland.

Hemida, F., Seridiji, R., Ennajar, S., Bradai, M. N., Collier, E., Guelorget, O. and Capape, C. (2003). New observations on the reproductive biology of the pelagic stingray, *Dasyatis violacea* Bonaparte, 1832 (Chondrichthyes: Dasyatidae) from the Mediterranean Sea. *Acta adriatica.* ***44:*** 193–204. (Abstract only).

IOTC (2008). *Report of the Fourth Session of the IOTC Working Party on Ecosystems and Bycatch, Bangkok, Thailand 20-22 October 2008*. Available at: http://www.iotc.org/English/index.php

IUCN (2008). *Global Policy against Shark Finning*. Available at: http://portal.worldconservationcongress.org/motions/Motions%20Publication%20Library/035-EN-Global%20policy%20against%20shark%20finning.pdf

IUCN (2009). *The IUCN Red List of threatened Species. Summary statistics, Status Summary by major taxonomic group (animals): Chondrichthyes*. Available at: http://www.iucnredlist.org/documents/2008RL_stats_table_3a_v1223294385.pdf

IUCN Species Survival Commission Shark Specialist Group (2007). *Review of Migratory Chondrichthyan Fishes*. IUCN/CMS. Available at: http://www.cms.int/publications/pdf/Technical%20Series/CMS_Technical%20_Series15_Migratory_sharks.pdf

Jaynes, (2008). Longliners caught in FSM Law Enforcement Net, *Kaselehlie Press*. February 19, 2008.

Juncker, M. (2006). *Coastal Shark Fisheries in the Pacific – a brief overview of current knowledge*. Coral Reef Initiative for the South Pacific (CRISP) Programme.

Kerstetter, D.W. and Graves, J.E. (2006). Effects of circle versus J-style hooks on target and non-target species in a pelagic longline fishery. *Fisheries Research* 80 (2-3):239-250.

Kerstetter, D.W., Pacheco, J.C., Hazin, F.H., Travassos, P.E. and Graves, J.E. (2007). Preliminary results of circle and J-style hook comparisons in the Brazilian pelagic longline fishery. *Collective Volume of Science Papers ICCAT*, 60(6): 2140-2147.

Kim, S-S, Moon, D-Y, An, D-H and Koh, J-R (2006*). Comparison of Circle Hooks and J Hooks in the Catch Rate of Target and Bycatch Species taken in the Korean Tuna Longline Fishery*. WCPFC-SC2-2006/EB WP-12. Second Regular Session of the WCPFC Scientific Committee, 7-18 August, 2006, Manila, Philippines.

Kirby, D.S. and Molony, B. (2006). *Ecological Risk Assessment for Species Caught in WCPO Longline and Purse Seine Fisheries: Inherent risk as determined by productivity-susceptibility analysis*, WCPFC-SC2-2006/EB WP-1. Second Regular Session of the WCPFC Scientific Committee, 7-18 August, 2006, Manila, Philippines. Available at: http://www.wcpfc.int/sc2/pdf/SC2_EB_WP1.pdf

Kirby, D.S. (2009). *Ecological Risk Assessment Implementation Report*. WCPFC-SC5-2009/EB-WP-05. Scientific Committee Fifth Regular Session 10-21 August 2009 Port Vila, Vanuatu. Available at: http://www.wcpfc.int/meetings/2009/5th-regular-session-0

Kleiber, P., Clarke, S., Bigelow, K. Nakano, H., McAllister, M., and Takeuchi, Y (2009). *North Pacific Blue Shark Stock Assessment* . WCPFC-SC5-2005/EB-WP-01. Scientific Committee Fifth Regular Session 10-21 August 2009 Port Vila, Vanuatu

Lack, M. and Sant, G. (2008). *Illegal, Unreported and Unregulated Shark Catch: A review of current knowledge and action.* TRAFFIC/Australian Department of the Environment, Water, Heritage and the Arts. Canberra

Last, P. and Stevens, J. (2009). *Sharks and Rays of Australia* (2nd Edition). CSIRO, Hobart.

Manning, M.J., Bromhead, D. B., Harley, S.J., Hoyle, S. and Kirby, D.S. (2009). *The Feasibility of Conducting Quantitative Stock Assessments for Key Shark Species and Recommendations for Providing Preliminary Advice on Stock Status in 2010*. WCPFC-SC5-2009/EB-WP-08. Scientific Committee Fifth Regular Session 10-21 August 2009 Port Vila, Vanuatu. Available at: http://www.wcpfc.int/meetings/2009/5th-regular-session-0

McAuliffe, J.A., Itano, D.G. and Arceneaux, S. (2007). *Photographic Identification Guide for Billfish, Sharks, Rays, Tuna-Like And Non-Tuna Finfish Taken in WCPO Pelagic Longline Fisheries* (v1). WCPFC-SC3-FT SWG/IP-6. Scientific Committee, Third regular session, 13-24 August 2007, Honolulu,

McCoy, M. (2006). *Addressing Shark Finning in FFA Member Countries: Issues and considerations.* Gillett, Preston and Associates Inc**.** Available at: http://www.spc.int/coastfish/sections/reef/PROCFish_Web/Modules/Library/DigitalLibraryRetrieve.aspx?att=false&hit=1&id=2111fa64-27b1-41ae-bc95-c39c9466f81d

McCoy, M. (2007). *An Assessment of Opportunities for Increasing Utilization and Value Adding from Shark Bycatch in Tuna Longline Fisheries of FFA Member Countries*. FFA Report 2007/22. Available at: http://www.spc.int/coastfish/sections/reef/PROCFish_Web/Modules/Library/DigitalLibraryRetrieve.aspx?att=false&hit=2&id=0fd1892b-5717-4680-b76b-203e9b34ce02

Mejuto, J., Garcia-Cortés, B., Ramos-Cartelle, A. and Ariz, J. 2007. *Preliminary Overall Estimations of Bycatch Landed by the Spanish Surface Longline Fleet Targeting Swordfish (*Xiphias Gladius*) in the Pacific Ocean and Interaction With Marine Turtles And Sea Birds: Years 1990–2005*. Inter-American Tropical Tuna Commission, IATTC Working Group on Bycatch, February 2007, BYC-6-INF

Molony, B. (2007*). Commonly Captured Sharks and Rays for Consideration by the Ecosystem and Bycatch SWG at SC3*. WCPFC-SC3-EB SWG/IP-19. Third Regular Session of the Scientific Committee, 13-24 August 2007, Honolulu, USA.

Molony, B. W. (2005). *Estimates of the Mortality of Non-target Species with an Initial Focus on Seabirds, Turtles and Sharks*. Working Paper EB WP-1. 1st meeting of the Scientific Committee of the Western and Central Pacific Fisheries Commission, Noumea, New Caledonia 8–19th August, 2005.

Molony, B. (2008). *Fisheries Biology and Ecology of Highly Migratory Species that Commonly Interact with Industrialized Longline and Purse Seine Fisheries in the Western and Central Pacific Ocean*. WCPFC-SC4-2008/EB-IP-6. Fourth Regular Session of the WCPFC Scientific Committee, 11-22 August 2008, Port Moresby, Papua New Guinea. Available at: http://www.wcpfc.int/meetings/2008/4th-regular-session#eco_and_bycatch_swg

Musick, J.A and Bonfil, R. (2004 (Eds). *Elasmobranch Fisheries Management Techniques*. APEC.

Nicol, S., Lawson, T., Briand, K, Kirby, D., Molony, B., Bromhead, D. Williams, P., Schneiter,E., Kumoru, L. and Hampton, J. (2009). Characterisation of the tuna purse seine fishery in Papua New Guinea. *ACIAR Technical Report No. 70*.

Oceana (2007). *Fishy Business: How EU shark fleets escape regulation and undermine shark conservation around the world*.

Oceana (2008). *From Head to Tail: How European nations commercialize shark products*. Available at: http://europe.oceana.org/index.php?id=2847&L=0

Patterson, H. M. and Tudman, M.J. (in prep.). *Chondrichthyan guide for fisheries managers: A practical guide for mitigating chondrichthyan bycatch*. AFMA/BRS. Canberra

Paul, L. (2009). *International trade in shark fins and illegal unreported and unregulated shark fishing* . Hawaii Audobon Society. Available at: http://www.pacfish.org/pub09/sharktrade.pdf

Piovano, S. Clò, S., Basciano, G and Giacoma, C. (2008). *Reducing Pelagic Stingray* (Pteroplatytrygon violacea*) Bycatch in Central Mediterranean Longline Fisheries*. Presented at the annual meeting of the International Congress for Conservation Biology, Convention Centre, Chattanooga, TN, July 10 2008 (Abstract only)

Ribeiro-Prado, C.C. and Amorim, A.F. (2007). Fishery Biology on Pelagic Stingray *Pteroplatytrygon Violacea c*aught off Southern Brazil by Longliners settled In Sao Paulo State (2006-2007. SCRS/2007/173 *Collect. Vol. Sci. Pap. ICCAT, 62(6): 1883-1891 (2008).* Available at: http://www.iccat.int/Documents/CVSP/CV062_2008/no_6/CV062061883.pdf

Scott, M.D. (2007). *IATTC Research on Reducing Shark Bycatch in the Tuna Purse Seine Fishery in the Eastern Tropical Pacific Ocean*. WCPFC-SC3-EB SWG/IP-3. Third Regular Session of the Scientific Committee, 13-24 August 2007, Honolulu, USA.

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: 14-20.

SPC (2007). *Report of the Seventh Meeting of the Tuna Fishery Data Collection Committee, 12–16 November 2007: Brisbane, Queensland, Australia*. SPC/FFA

SPC (2008). *Estimates of Annual Catches in the WCPFC Statistical Area*. WCPFC–sc4–2008/st–ip–1; Fourth Regular Session, 11-22 August 2008, Port Moresby, Papua New Guinea. Available at: www.wcpfc.int/sc4/pdf/SC4-ST-IP1%20Annual%20Catch%20Estimates.pdf

SPC-OFP (2009a). *Estimates of Annual Catches in the WCPFC Statistical Area.* WCPFC-SC5-2009/ST IP-1, WCPFC Scientific Committee Fifth Regular Session, 10-21 August, 2009 Port Vila Vanuatu.

SPC-OFP (2009b). Scientific Data Available to the Western and Central Pacific Fisheries Commission. WCPFC- SC5-2009/ST WP-1. WCPFC Scientific Committee Fifth Regular Session, 10-21 August, 2009 Port Vila Vanuatu. Available at: http://www.wcpfc.int/meetings/2009/5th-regular-session-0

SPC (2005). *Shark Identification in Pacific Tropical Offshore Fisheries*. Available at: http://www.spc.int/coastfish/Fishing/SharkID/SharksID.pdf

Vega, R. And Licandeo, R. (2009). The effect of American and Spanish longline systems on target and non-target species in the eastern South Pacific swordfish fishery. *Fisheries Research*. Vol. 98, Issues 1-3. June 2009, pp. 22-32.

WCPFC ROP Working Group (2009). *Summary Report Third Intersessional Working Group*, 17-20 March 2009, Guam, USA

WCPFC Scientific Committee (2007). Summary Report of the Third Regular Meeting of the Scientific Committee, 13-24 August 2007. Honolulu, USA. Available at: http://www.wcpfc.int/meetings/2.

WCPFC Scientific Committee (2008). Summary Report, Fourth Regular Session of the Scientific Committee, 11–22 August 2008, Port Moresby, Papua New Guinea. Available at: http://www.wcpfc.int/sc4/pdf/0_SC4%20Summary%20Report%20[Edited%20Version].pdf.

Walsh, W., Bigelow, K. and Sender, K. (2009) *Decreases in Shark Catches and Mortality in the Hawaii-based Longline Fishery as Documented by Fishery Observers* WCPFC-SC5-2009/EB- IP-8.

Scientific Committee Fifth Regular Session 10-21 August 2009 Port Vila, Vanuatu. Available at: http://www.wcpfc.int/meetings/2009/5th-regular-session-0

Ward, P., Myers, R. A and Blanchard, W. (2004). Fish lost at sea: the effect of soak time on pelagic longline catches. *Fishery Bulletin* 101(1): 179-195.

Ward, P. and Myers, R. A. (2005). Shifts in open-ocean fish communities coinciding with the commencement of commercial fishing. *Ecology*. **85:** 835–847.

Ward, P. Lawrence, E., Derbyshire, R. and Hindmarch, S. (2008). Large-scale experiments shows that nylon leaders reduce shark bycatch and benefit pelagic longline fishers. *Fisheries Research*, 90 (1-3): 100-108.

Ward, P. Epe, S, Kruetze, D., Lawrence, E. Robins, C. and Sands, A. (2008b). *Implementation of Bycatch Mitigation Measures in Australia's Pelagic Longline Fisheries: The effects of circle hooks on target and non-target catches*. Final report to the Natural Heritage Trust. Bureau of Rural Sciences, Canberra.

Watson, J., Foster, D., Epperly, S. and Shah, A. (2005). Fishing methods to reduce sea turtle mortality associated with pelagic longlines. *Canadian Journal of Fisheries and Aquatic Sciences*. 62: 965-981.

Williams, P. and Terawasi, P. (2009). *Overview of Tuna Fisheries in the Western and Central Pacific Ocean including Economic Conditions – 2008*. WCPFC-SC5-2009/GN WP-1/ WCPFC Scientific Committee Fifth Regular Session 10-21 August 2009 Port Vila, Vanuatu. Available at: http://www.wcpfc.int/meetings/2009/5th-regular-session-0.

Yokota, K., Kiyota, M. and Minami, H. (2006). Shark catch in a pelagic longline fishery: Comparison of circle and tuna hooks. *Fisheries Research*, 81 (2-3): 337-341.

ANNEX 1 CMM 2008-06

CONSERVATION AND MANAGEMENT OF SHARKS

Conservation and Management Measure 2008-061[9]

The Commission for the Conservation and Management of Highly Migratory Fish Stocks in the Western and Central Pacific Ocean;

In accordance with the Convention on the Conservation and Management of Highly Migratory Fish Stocks in the Western and Central Pacific Ocean;

Recognizing the ecological and cultural significance of sharks in the western and central Pacific Ocean (WCPO);

Recalling that the United Nations Food and Agriculture Organization (FAO) International Plan of action for the Conservation and Management of Sharks calls on FAO members, within the framework of their respective competencies and consistent with international law, to cooperate through regional fisheries organizations with a view to ensuring the sustainability of shark stocks as well as to adopt National Plans of Action for the conservation and management of sharks;

Recognizing the need to collect data on catch, effort, discards, and trade, as well as information on the biological parameters of many species, to enable effective shark conservation and management;

Recognizing further that certain species of pelagic sharks, such as basking shark and great white shark, have been listed on Appendix II of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES).

Resolves as follows:

1. Commission Members, Cooperating non-Members, and participating Territories (CCMs) shall implement, as appropriate, the FAO International Plan of Action for the Conservation and Management of Sharks (IPOA Sharks).

2. CCMs shall advise the Commission (in Part 2 of the annual report) on their implementation of the IPOA Sharks, including, results of their assessment of the need for a National Plan of Action and/or the status of their National Plans of Action for the Conservation and Management of Sharks.

3. National Plans of Action or other relevant policies for sharks should include measures to minimize waste and discards from shark catches and encourage the live release of incidental catches of sharks.

4. Each CCM shall include key shark species[10], as identified by the Scientific Committee, in their annual reporting to the Commission of annual catch and fishing effort statistics by gear type, including available historical data, in accordance with the WCPF Convention and agreed reporting procedures. CCMs shall also report annual retained and discarded catches in Part 2 of their annual report. CCMs shall as appropriate, support research and development of strategies for the avoidance of unwanted shark captures (e.g. chemical, magnetic and rare earth metal shark deterrents).

5. The Commission shall consider appropriate assistance to developing State Members and participating Territories for the implementation of the IPOA and collection of data on retained and discarded shark catches.

And adopts, in accordance with Articles 5 and 10 of the Convention, that:

6. CCMs shall take measures necessary to require that their fishers fully utilize any retained 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 or transshipment.

[9] Replaces CMM 2006-05
[10] The key shark species are blue shark, oceanic whitetip shark, mako sharks and thresher sharks.

7. CCMs shall require their vessels to have on board fins that total no more than 5% of the weight of sharks on board up to the first point of landing. CCMs 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. CCMs may alternatively require that their vessels land sharks with fins attached to the carcass or that fins not be landed without the corresponding carcass.

8. As finer resolution data become available, the specification of the ratio of fin weight to shark weight described in paragraph 7 shall be periodically reviewed by the Scientific Committee (SC) and the SC will recommend any appropriate revisions to the Commission for its consideration. The SC and the Technical and Compliance Committee (TCC) are directed to consider if additional appropriate measures that give effect to paragraph 7 are required.

9. CCMs shall take measures necessary to prohibit their fishing vessels from retaining on board, transshipping, landing, or trading any fins harvested in contravention of this Conservation and Management Measure (CMM).

10. In fisheries for tunas and tuna-like species that are not directed at sharks, CCMs shall take measures to encourage the release of live sharks that are caught incidentally and are not used for food or other purposes.

11. Nothing in this measure shall prejudice the sovereignty and sovereign rights of coastal States, including for traditional fishing activities and the rights of traditional artisanal fishers, to apply alternative measures for the purpose of exploring, exploiting, conserving and managing sharks, including any national plans of action for the conservation and management of sharks, within areas under their national jurisdiction.

12. CCMs shall advise the Commission in Part 2 of the annual report on the implementation of this CMM and any alternative measures adopted under paragraph 11.

13. On the basis of advice from the SC, the TCC and the Commission, CCMs shall review the implementation and effectiveness of this measure, and any alternative measures applied under paragraph 11 above, and shall consider the application of additional measures for the management of shark stocks in the Convention Area, as appropriate.

14. In 2010, the SC, and if possible in conjunction with the Inter-American Tropical Tuna Commission, provide preliminary advice on the stock status of key shark species and propose a research plan for the assessment of the status of these stocks.

15. This CMM shall apply to sharks caught in association with fisheries managed under the WCPF Convention, and to sharks listed in Annex 1 of the 1982 Convention.

16. The Commission shall consider appropriate assistance to developing State Members and participating Territories for the implementation of this measure, including, in accordance with Article 7 of the Convention, in areas under national jurisdiction.

17. This CMM shall replace 2006-05.

ANNEX 2 REGIONAL SHARK ASSESSMENT

INTRODUCTION

The International Plan of Action for the Conservation and Management of Sharks (IPOA Sharks) (FAO, 2000a) highlights the need for an assessment of the status of shark stocks as a basis for the development of national or regional plans of actions. In keeping with that approach, a broad review, the Regional Shark Assessment, of shark fisheries and management in the Western and Central Pacific Ocean (WCPO) has been conducted as the platform for development of the Pacific Island's Regional Plan of Action for Sharks (PI-RPOA Sharks).

The Regional Shark Assessment collates the available information on the:

- species of sharks occurring in the region
- understanding of the status of shark stocks;
- impacts on sharks in the region;
- utilization of shark products;
- shark management measures in place; and
- monitoring, control and surveillance (MCS) in support of those measures.

SHARK SPECIES

The IUCN's Shark Specialist Group report on the conservation status of Australasian chondrichthyans (Cavanagh, *et al.*, 2003) provides a basis for identifying the range of species that are likely to occur in the waters of the Pacific Island Countries and Territories (PICTs). The PICTs are located in FAO Fishing Area 71, the south western part of Area 77 and the northern part of Area 81. Shark species identified in Cavanagh *et al*. (2003) as being found in any of these three areas were extracted and the resultant list was reviewed based on additional information in that report on the likely extent of distribution within those areas. Species considered likely to be confined to the southern parts of area 81, the Asian part of area 71 or to be endemic to specific countries such as Australia and New Zealand were excluded. Information in Last and Stevens (2009), Camhi *et al*. (2009) and data held in the Secretariat of the Pacific Community's (SPC) observer database for the WCPO and, in particular for the PICTs, was then used to refine the list (see Table A2.1). Nearly 80 species of sharks were identified as likely to occur in the national waters of the PICTs. Around half of those species are classified as highly migratory species (HMS) by Annex I of the United Nations Convention on the Law of the Sea of 10 December 1982

(UNCLOS). Eighteen species are assessed as being oceanic[11] species while a further 15 are considered semi-pelagic[12] and the remainder are considered coastal species.

[11] Species that live in the open ocean, mainly beyond the edge of the continental shelf (Camhi *et al.,* 2009)
[12] Species that penetrate oceanic waters but are concentrated close to continental landmasses over the continental slopes and rises (Camhi *et al.,* 2009)

Table A2.1 Shark species likely to occur in waters of the PICTs

Common name	Scientific name	PICTs identified in distribution (Cavanagh *et al*., 2003; Last and Stevens, 2009)	Identified by observers in PICTs in longline (LL) or purse seine (PS) fisheries	Classification	UNCLOS Annex 1
Banded eagle ray	*Aetomylaeus nichofii*	PNG		Coastal	
Basking shark	*Cetorhinus maximus*		LL (PNG only)	Coastal/Semi-pelagic	HMS
Bigeye sand shark	*Odontaspis noronhai*		LL (PNG only)		
Bigeye thresher	*Alopias superciliosus*	New Caledonia	LL, PS	Oceanic	HMS
Bignose shark	*Carcharhinus altimus*		LL, PS	Coastal/Semi-pelagic	HMS
Blackspot shark	*Carcharhinus sealei*	PNG		Coastal	
Blacktailed spurdog	*Squalus melanurus*	New Caledonia, Vanuatu		Coastal	
Blacktip reef shark	*Carcharhinus melanopterus*	Marshall Islands	LL, PS	Coastal	HMS
Blacktip shark	*Carcharhinus limbatus*		LL, PS	Coastal/Semi-pelagic	HMS
Blue shark	*Prionace glauca*		LL, PS	Oceanic	HMS
Blue-spotted fantail ray	*Taeniura lymma*	PNG, Solomon Islands		Coastal	
Bronze whaler	*Carcharhinus brachyurus*		LL, PS	Coastal/Semi-pelagic	HMS
Brown-banded bamboo shark	*Chiloscyllium punctatum*	PNG		Coastal	
Bull shark	*Carcharhinus leucas*		LL, PS	Coastal/Semi-pelagic	HMS
Bullhead sharks	*Heterodontiformes*		LL	Coastal	
Cookie-cutter shark	*Isistius brasiliensis*	Fiji, Cook Islands	LL	Oceanic	
Coral catshark	*Atelomycterus marmoratus*	PNG		Coastal	
Crocodile shark	*Pseudocarcharias kamoharai*		LL, PS	Oceanic	
Cyrano spurdog	*Squalus rancureli*	Vanuatu		Coastal	
Darksnout hound shark	*Hemitriakis abdita*	New Caledonia		Coastal	
Dusky shark	*Carcharhinus obscurus*		LL (PNG only), PS	Coastal/Semi-pelagic	HMS
Endeavour dogfish	*Centrophorus moluccensis*	New Caledonia		Coastal	
Epaulette shark	*Hemiscyllium ocellatum*	PNG and possibly Solomon Islands		Coastal/Semi-pelagic	
False pygmy shark	*Etmopterus pseudosqualiolus*	New Caledonia		Oceanic	
Galapagos shark	*Carcharhinus galapagensis*	Samoa, Cook Islands, French Polynesia	LL, PS	Coastal/Semi-pelagic	HMS
Giant shovelnose ray	*Rhinobatos typus*	PNG, Solomon Islands		Coastal	
Graceful shark	*Carcharhinus amblyrhynchoides*	PNG		Coastal	HMS
Great hammerhead	*Sphyrna mokarran*	PNG, New Caledonia, French Polynesia	LL, PS	Coastal/Semi-pelagic	
Great white shark	*Carcharodon carcharias*		LL	Oceanic	HMS
Grey bamboo shark	*Chiloscyllium griseum*	PNG		Coastal	
Grey reef shark	*Carcharhinus amblyrhynchos*		LL, PS	Coastal	HMS
Hardnose shark	*Carcharhinus macloti*	PNG		Coastal	HMS
Hooded carpet shark	*Hemiscyllium strahani*	PNG		Coastal	
Indonesian speckled carpet shark	*Hemiscyllium freycineti*	PNG		Coastal	
Longfin mako	*Isurus paucus*		LL, PS	Oceanic	HMS
Longnose hound shark	*Iago garricki*	Vanuatu		Coastal	
Mandarin shark	*Cirrhigaleus barbifer*	Vanuatu		Coastal	
Megamouth shark	*Megachasma pelagios*		PS	Oceanic	HMS
Milk shark	*Rhizoprionodon acutus*	PNG		Coastal	HMS
Nervous shark	*Carcharhinus cautus*	PNG, Solomon Islands		Coastal	
New Caledonia catshark	*Aulohalaelurus kanakorum*	New Caledonia		Coastal	

Oceanic whitetip shark	*Carcharhinus longimanus*		LL, PS	Oceanic	HMS
Papuan epaulette shark	*Hemiscyllium hallstromi*	PNG		Coastal	
Pelagic stingray	*Dasyatis violacea*	PNG	LL, PS	Oceanic	
Pelagic thresher	*Alopias pelagicus*	New Caledonia	LL, PS	Oceanic	HMS
Pigeye shark	*Carcharhinus amboinensis*	PNG, Solomon Islands		Coastal	HMS
Pink lantern shark	*Etmopterus dianthus*	New Caledonia		Coastal	
Pondicherry shark	*Carcharhinus hemiodon*	PNG		Coastal	
Pygmy devilray	*Mobula eregoodootenke*	PNG		Oceanic	
Salmon shark	*Lamna ditropis*		LL (PNG only), PS	Oceanic	HMS
Sandbar shark	*Carcharhinus plumbeus*		LL, PS	Coastal/Semi-pelagic	HMS
Scalloped hammerhead	*Sphyrna lewini*	PNG	LL, PS	Coastal/Semi pelagic	HMS
Seal shark	*Dalatias licha*		LL (Cook Isl. only)	Coastal	
Shark ray	*Rhina ancylostoma*	PNG		Coastal	
Sharptooth lemon shark	*Negaprion acutidens*	PNG; other Pacific Islands		Coastal	HMS
Shortfin mako	*Isurus oxyrinchus*		LL, PS	Oceanic	HMS
Silky shark	*Carcharhinus falciformis*		LL, PS	Oceanic	HMS
Silvertip shark	*Carcharhinus albimarginatus*	PNG, Solomon Islands	LL, PS	Coastal/Semi-pelagic	HMS
Slender bamboo shark	*Chiloscyllium indicum*	PNG, Solomon Islands		Coastal	
Sliteye shark	*Loxodon macrorhinus*	PNG		Coastal	HMS
Smooth hammerhead	*Sphyrna zygaena*		LL, PS	Coastal/Semi-pelagic	HMS
Spinner shark	*Carcharhinus brevipinna*	Pacific Islands		Coastal/Semi-pelagic	HMS
Spurdog	*Squalus megalops*		PS	Coastal	
Tailspot lantern shark	*Etmopterus caudistigmus*	New Caledonia		Coastal	
Tasselled wobbegong	*Eucrossorhinus dasypogon*	PNG		Coastal	
Tawny nurse shark	*Nebrius ferrugineus*	PNG, New Caledonia, Samoa, Palau, Marshall Islands		Coastal	
Thresher shark	*Alopias vulpinus*		LL, PS	Oceanic	HMS
Tiger shark	*Galeocerdo cuvier*		LL, PS	Coastal/Semi-pelagic	HMS
Whale shark	*Rhincodon typus*		LL (PNG only), PS	Oceanic	HMS
Whip stingray	*Dasyatis akajei*		LL, PS	Coastal	
Whitecheek shark	*Carcharhinus dussumieri*	PNG		Coastal	HMS
Whitenose shark	*Nasolamia velox*		LL (PNG only)	Coastal	HMS
White-spotted eagle ray	*Aetobatus narinari*	Pacific Islands		Coastal	
White-spotted guitarfish	*Rhynchobatus australiae*	PNG		Coastal	
Whitetip reef shark	*Triaenodon obesus*		LL (PNG only)	Coastal	HMS
Whitish catshark	*Apristurus albisoma*	New Caledonia		Coastal	
Winghead shark	*Eusphyra blochii*	PNG		Coastal	HMS
Zebra shark	*Stegostoma fasciatum*	PNG, New Caledonia, Palau	LL(PNG only)	Coastal	

Source: Cavanagh *et al*. (2003); Last and Stevens (2009); Camhi *et al*. (2009); IUCN (the World Conservation Union) Shark Specialist Group (2007); Froese and Pauly (2009); SPC observer database

UNDERSTANDING OF THE STATUS OF SHARK STOCKS

Currently, the level of understanding of the status of shark stocks in the WCPFC Convention Area (WCPFC-CA) is low. A stock assessment has been conducted only for the north Pacific stock of blue shark. However, analysis of available information for specific shark stocks and the results of the ecological risk assessment (ERA) being conducted by the SPC for the WCPFC, together with assessments of shark species conducted by the IUCN and the listing of shark species on various international conventions provide some guidance as to the relative risk and/or status of shark stocks in the region. These are reviewed below together with an overview of the SPC's assessment of the feasibility of providing preliminary advice to the WCPFC on the status of key shark species by 2010 (Manning *et al*., 2009).

Stock status

The only shark stock for which a full quantitative stock assessment has been carried out in the WCPO is the north Pacific blue shark stock (Kleiber *et al.,* 2009). Both the surplus production model and the integrated age and spatial structured model were found to be in general agreement. The trends in abundance in the production model and all alternate runs of the integrated model show the same pattern of decline in the 1980s followed by recovery to above the level at the start of the time series. The integrated model analyses indicated some probability (around 30%) that the stock was overfished and that there was a lesser probability that overfishing was occurring. The overall conclusion, acknowledging that considerable uncertainty persists, is that it would be prudent to assume that the population is at least close to maximum sustainable yield (MSY) level and fishing mortality may be approaching the MSY level in the future.

Molony (2008) has summarized the available biological and ecological information on highly migratory shark species that commonly interact with longline and purse seine fisheries in the WCPO. An overview of his comments on stock status of blue shark, silky shark, oceanic whitetip shark, shortfin mako shark and pelagic stingray in the WCPO is provided in Table A2.2. The analysis confirms that the stock status of these species is uncertain however, in the case of silky shark, oceanic whitetip and shortfin mako, some indicators suggest that current catch levels may be unsustainable.

Ecological risk assessment

The ERA is being conducted to identify highly migratory species and associated /dependent species that are at relatively high risk of adverse effects due to fishing. As part of the ERA, a preliminary assessment of the relative risk of key shark species has been made. To date, productivity-susceptibility analyses (PSAs) have been carried out for two fishery categories (deep and shallow) in the longline fisheries.

Table A2.2 Indicators of stock status of commonly caught shark species in the WCPO

Species	Stock status (WCPO)
Blue shark	Data and trends suggest that the WCPO stock may be stable, albeit at a lower level than in the 1990s. However stock status is uncertain due to uncertainties in biological and fishery parameters. A precautionary approach to further exploitation should be considered until more robust information is available.
Silky shark	Catch rate data (Molony, 2005) suggest that there are considerable fluctuations in local abundances. However, the patchy distribution does not permit catch-per-unit-effort (CPUE) to be a reliable index of abundance. Median sizes of silky sharks captured by the longline and purse-seine fisheries of the WCPO have been relatively stable since at least the late 1990s. The median size of silky sharks captured in equatorial areas has been relatively stable since the mid 1990s. However, declines in median size of silky sharks have been observed in sub-equatorial areas of the western WCPO (Areas 7 and 8) and Area 14 (10–20ºN, east of 170ºE). This suggests that some degree of local depletion may be occurring. Purse-seine catches of silky sharks in the WCPO have increased since 1994 while longline catches have declined since 2000. This suggests that the longline-vulnerable proportion of the WCPO stock may not be able to sustain the recent levels of longline effort.
Oceanic whitetip shark	There are no known stock assessments for this species and the stock status is currently unknown. Molony (2005) estimated the that nominal catch rates from the tropical deep longline fishery and the sub-tropical albacore fisheries were low and stable since the early 1990s. Catch rates were highly variable for the tropical shallow longline fishery. Median size data reveals steadily decreasing median sizes. In addition, longline catches have declined since 2002. This suggests that there may be a reduction in the abundance of larger sharks. However, the median size of oceanic whitetip sharks captured by the longline fishery is above the size at maturity estimated for the Pacific Ocean (Seki *et al*., 1998), although this is based on a few samples. The median size of oceanic whitetip sharks captured by the purse-seine fisheries in the WCPO is below the size of first maturity. In addition, overall estimates from the WCPFC longline and purse-seine fisheries reveal a decline in catches and catch rates since the late 1990s. This suggests that the level of effort and catches of this species may be higher than the WCPFC stock can sustain.
Shortfin mako shark	Limited information of the status of shortfin mako stocks is available. Catches and catch rates have steadily increased in the tropical deep longline fishery since 1998 (Molony, 2005), while catches and catch rates have shown large interannual fluctuation in the tropical shallow fishery. Increasing catches of this species have also been recorded in the sub-equatorial albacore longline fisheries (Molony, 2005). Estimates from the combined longline fisheries of the WCPFC show a steady decline in catches and catch rates of combined mako sharks (shortfin, longfin and unidentified mako sharks) since the late 1990s. This suggests that the recent levels of fishing effort on mako sharks may be higher than the stocks can sustain. However, thorough assessments have not been undertaken on shortfin mako in the Pacific Ocean (Francis *et al.,* 2001).
Pelagic stingray	Limited assessments of pelagic stingrays have been undertaken. Ward and Myers (2005) present data that suggests pelagic stingrays in the north-central region of the Pacific Ocean have increased in abundance since the advent of commercial longline fishing. The nominal catch rates of pelagic stingrays have been stable early 1990s from the sub-tropical albacore and the tropical shallow longline fisheries (Molony, 2005). In contrast, the catch rates of pelagic stingrays have showed a steady decline since the mid 1990s in the WCPO deep-setting tropical longline fishery (Molony, 2005). However, a majority of hooks set by this fishery are beyond the preferred depth of pelagic stingrays (less than 100 m) and thus catch rates are expected to be low. Limited length-frequency data have displayed a relatively stable median size in all areas throughout the time-series of the data. Pooled data (across all times and areas) reveals a similar, stable pattern, with a trend of increasing median size since 2000. The stable median size is above the size of first recruitment (Hemida *et al*. 2003), coupled with the relatively low catch rates of this species, suggests that the impacts of industrialized tuna fisheries on this species are potentially sustainable. However, stock structure remains uncertain.

Source: Molony (2008).

Analysis of the available data, including ERA results and observer data, indicates that in the WCPO:

- sharks constitute a group of relatively low-productivity species that are often subject to fishing induced mortality and are at higher risk from fishing than are the tuna and billfish species with which they are taken (see Figure 3);
- most sharks caught by longlines are juveniles, the life-history stage that is most important for population growth in sharks;
- sharks are encountered wherever longlining occurs although the species composition of the shark catch varies spatially;
- most shark are not dead at the time of capture;
- some sharks are rarely encountered (e.g. guitarfishes) while others are frequently encountered (blue shark, silky shark); and
- frequency of occurrence of shark species in observer data is likely to reflect the productivity of the species with more productive species such as blue shark occurring more frequently in the data, i.e. frequency of reporting may not reflect the impact of fishing on all species of sharks. For example, while blue sharks, silky sharks and oceanic whitetip sharks figure prominently in catch and observer data they are not necessarily the highest risk species (see Table A2.3)
    - the observer data for the longline fisheries in the PICTs indicates that the 12 highest risk shark species comprise less than 15% of the observed shark catch and in the purse fishery the corresponding figure is less than 1%. This poses a problem for management since it means that management needs are greater for species that are relatively rarely encountered and for which there is less information. Of the 20 shark species considered at highest risk, some are not recorded in longline (LL) or purse seine (PS) observer data for the PICTs (e.g. neither porbeagle shark nor school shark are recorded) and a number of others are predominantly coastal species which are less likely to be taken in the offshore longline and purse seine fisheries.
    - these oceanic or semi-pelagic shark species likely to be at highest risk from industrial fishing in the waters of the PICTs are bigeye thresher shark, blacktip shark, salmon shark, thresher shark, pelagic stingray, silky shark, oceanic whitetip shark, silvertip shark, sandbar shark, shortfin mako, longfin mako and Galapagos shark (Manning, et *al*., 2009; Kirby and Molony, 2006; WCPFC Scientific Committee, 2007).

In 2008, based on ERA results and analyses of longline and purse seine fisheries for Pacific Island countries, the WCPFC's Scientific Committee identified silky shark and oceanic whitetip shark as two species warranting greater attention and recommended that blue shark, oceanic whitetip shark, mako

sharks and thresher sharks should be identified to the lowest possible taxonomic level by observers and should be recorded in logbooks by fishermen (WCPFC Scientific Committee, 2008). In the same year, the WCPFC agreed that blue shark, oceanic whitetip shark, mako sharks and thresher sharks should comprise the 'key shark species' for both reporting and stock assessment purposes.

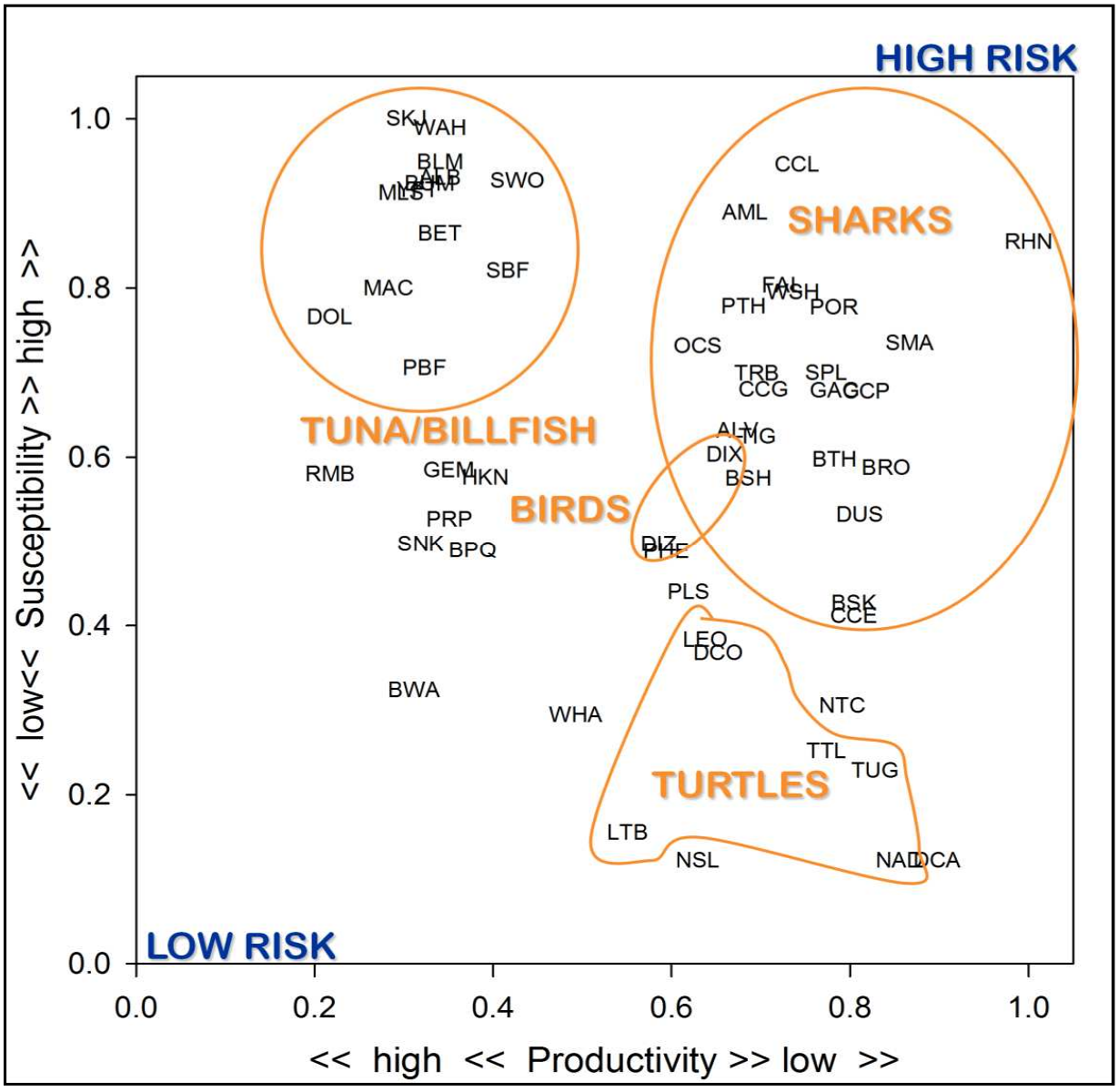

Figure 3: Productivity-susceptibility analysis for several groups of large vertebrates in the WCPO (Kirby and Molony, 2006). The productivity risk score was based on age-at-maturity, longevity and reproductive strategy (with live bearers considered high risk; the susceptibility risk score was based on an index of total mortality, i.e., encounters × condition × fate. CCL: Blacktip shark; AML: Grey reef shark; RHN: Whale shark; FAL: Silky shark; WSH: Great white shark; PTH: Pelagic thresher shark; POR: Porbeagle shark; OCS: Oceanic whitetip shark; SMA: Shortfin mako shark; TRB: Whitetip reef shark; SPL: Scalloped hammerhead; CCG: Galapagos shark; GAG: School shark; CCP: Sandbar shark; ALV: Thresher shark; TIG: Tiger shark; BTH: Bigeye thresher shark; BRO: Bronze whaler shark; BSH: Blue shark; DUS: Dusky shark; BSK: Basking shark; CCE: Bull shark.

Table A2.3 Preliminary risk ranking of shark species taken in the WCPO[1]

	Species Code	Common Name	Scientific name
LOW RISK → HIGH RISK	TRB	Whitetip reef shark	*Triaenodon obesus*
	BTH	Bigeye thresher	*Alopias superciliosus*
	BLR	Blacktip reef shark	*Carcharhinus melanopterus*
	POR	Porbeagle shark	*Lamna nasus*
	CCL	Blacktip shark	*Carcharhinus limbatus*
	AML	Grey reef shark	*Carcharhinus amblyrhynchos*
	LMD	Salmon shark	*Lamna ditropis*
	CNX	Whitenose shark	*Nasolamia velox*
	HDQ	Bullhead sharks	*Heterodontiformes*
	GAG	School shark	*Galeorhinus galeus*
	ALV	Thresher	*Alopias vulpinus*
	PLS	Pelagic stingray	*Dasyatis violacea*
	FAL	Silky shark	*Carcharhinus falciformis*
	OCS	Oceanic whitetip shark	*Carcharhinus longimanus*
	ALS	Silvertip shark	*Carcharhinus albimarginatus*
	WST	Whip stingray	*Dasyatis akajei*
	CCP	Sandbar shark	*Carcharhinus plumbeus*
	SMA	Shortfin mako	*Isurus oxyrhinchus*
	LMA	Longfin mako	*Isurus paucus*
	CCG	Galapagos shark	*Carcharhinus galapagensis*
	ISB	Cookie cutter shark	*Isistius brasiliensis*
	BRO	Bronze whaler shark	*Carcharhinus brachyurus*
	BSH	Blue shark	*Prionace glauca*
	SPL	Scalloped hammerhead	*Sphyrna lewini*
	DUS	Dusky shark	*Carcharhinus obscurus*
	TIG	Tiger shark	*Galeocerdo cuvier*
	WSH	Great white shark	*Carcharodon carcharias*
	CCA	Bignose shark	*Carcharhinus altimus*
	SPZ	Smooth hammerhead	*Sphyrna zygaena*
	CYW	Smooth skin dogfish	*Centroscymnus owstoni*

Source: D. S. Kirby, presentation to WCPFC Scientific Committee, Manila, 2006.

1. Rankings may differ from that described in Figure 3. The results in Figure 3 arise from an analysis of several different species groups, where 'reproductive strategy' was one of the risk factors along the productivity axis – with live bearers, such as sharks, considered high risk. The analysis underpinning the rankings in Table A2.3 applies only to sharks and includes fecundity and weights the species according to their litter size and reproductive frequency.

IUCN assessments and convention listings

Other indicators of the status of shark stocks in the WCPO include assessments by the IUCN and the listing of shark species on various international conventions. The global and, where available, regional (Central Eastern Pacific (CEP), the Central Western Pacific (CWP) and the South Western Pacific (SWP)) IUCN status of the shark species identified by observers in the WCPO (Manning *et al*., 2009) is provided in Table A2.4 (key WCPFC shark species in bold). Species currently listed under the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) and the Convention on Migratory Species (CMS) are also included. Of the nearly 50 species identified:

- two are assessed, globally, as Endangered by the IUCN (great hammerhead and smooth hammerhead sharks); 15 are assessed as Vulnerable and a further 12 as near threatened;
- regional IUCN assessments or draft assessments are available for only 17 species in one or more of the three relevant regions of the Pacific;
    - one species (smooth hammerhead) is assessed as Endangered;
    - three are considered Vulnerable (bigeye thresher, shortfin mako and whale shark); and
    - four are considered Near Threatened (dusky shark, porbeagle, sandbar shark and silky shark);
- two of the WCPFC's seven key shark species, shortfin mako and longfin mako are listed on Appendix II of the CMS and the remaining five have been identified by the IUCN as potentially benefitting from a CMS listing; and
- basking shark and great white shark are listed on Appendices I and II of the CMS and on Appendix II of CITES and whale shark is listed on Appendix II of both CITES and the CMS.

Table A2.4: IUCN and listing status of shark species observed in the WCPO

Common name	Scientific name	Global status[1]	CEP	CWP	SWP	Listing
Australian blacktip shark	*Carcharhinus tilstoni*					
Basking shark	*Cetorhinus maximus*	VU				CITES/II CMS/I/II
Bigeye sand shark	*Odontaspis noronhai*	DD				
Bigeye thresher	***Alopias superciliosus***	**VU**	**VU**			
Bignose shark	*Carcharhinus altimus*	DD			LC	
Blacktip reef shark	*Carcharhinus melanopterus*	LR/NT				
Blacktip shark	*Carcharhinus limbatus*	NT				
Blue shark	***Prionace glauca***	**NT**				
Broadsnouted sevengill shark	*Notorynchus cepedianus*	DD				
Bronze whaler shark	*Carcharhinus brachyurus*	NT			LC	
Bull shark	*Carcharhinus leucas*	NT				
Carpet shark	*Cephaloscyllium isabella*	LC				
Cookie cutter shark	*Isistius brasiliensis*	LC				
Crocodile shark	*Pseudocarcharias kamoharai*	NT				
Dusky shark	*Carcharhinus obscurus*	VU			NT draft	
Galapagos shark	*Carcharhinus galapagensis*	NT			DD	
Great hammerhead	*Sphyrna mokarran*	EN			DD draft	

Common name	Scientific name	Global status[1]	CEP	CWP	SWP	Listing
Great white shark	*Carcharodon carcharias*	VU				CITES/II CMS/I & II
Greenback stingaree	*Urolophus viridis*					
Grey reef shark	*Carcharhinus amblyrhynchos*	LR/NT				
Longfin mako	***Isurus paucus***	**VU**				**CMS/II**
Megamouth shark	*Megachasma pelagios*	DD				
Oceanic whitetip shark	***Carcharhinus longimanus***	**VU**				
Pelagic stingray	*Dasyatis violacea*	LC				
Pelagic thresher	***Alopias pelagicus***	**VU**				
Plunkets shark	*Scymnodon plunketi*	NT				
Porbeagle shark	*Lamna nasus*	VU			NT	CMS/II
Salmon shark	*Lamna ditropis*	LC				
Sandbar shark	*Carcharhinus plumbeus*	VU			NT draft	
Scalloped hammerhead	*Sphyrna lewini*	EN	EN draft		LC draft	
School shark	*Galeorhinus galeus*	VU			VU	
Seal shark	*Dalatias licha*	DD				
Sharpsnouted sevengill shark	*Heptranchias perlo*	NT				
Shortfin mako	***Isurus oxyrhinchus***	**VU**		**VU draft**		**CMS/II**
Shovelnose dogfish	*Deania calcea*					
Silky shark	*Carcharhinus falciformis*	NT	VU	NT	NT draft	
Silvertip shark	*Carcharhinus albimarginatus*	NT			LC	
Smooth hammerhead	*Sphyrna zygaena*	VU			LC draft	
Spinner shark	*Carcharhinus brevipinna*	NT				
Spiny dogfish	*Squalus acanthias*	VU			LC	
Spurdog	*Squalus megalops*	DD			LC	
Thresher shark	***Alopias vulpinus***	**VU**				
Tiger shark	*Galeocerdo cuvier*	NT				
Velvet dogfish	*Scymnodon squamulosus*	DD				
Whale shark	*Rhincodon typus*	VU	VU draft	VU draft	VU draft	CITES/II CMS/II
Whip stingray	*Dasyatis akajei*					
Whitenose shark	*Nasolamia velox*					
Whitetip reef shark	*Triaenodon obesus*	LR/NT				
Zebra shark	*Stegostoma fasciatum*	VU				

Source: IUCN Species Survival Commission, 2007; Camhi *et al*., 2009.

1. EN: endangered; VU: vulnerable; NT: near threatened; LR/NT: lower risk/near threatened; DD: data deficient; LC: least concern. Explanations of the IUCN categories can be found at: http://www.iucnredlist.org/static/categories_criteria

Proposed stock assessments for key shark species

WCPFC's CMM, *Conservation and Management of Sharks* (CMM 2008-06) (see Annex 1) requires the Scientific Committee to provide preliminary stock advice on key shark species (blue shark, oceanic whitetip shark, shortfin and longfin mako sharks, pelagic thresher shark, bigeye thresher shark and thresher shark) by 2010. In addition, the SPC has indicated that silky shark should be included in this list given its prevalence in the catch (Manning *et al.,* 2009).

Stock assessment of the key shark species requires an understanding of:

- their biological characteristics;
- their stock boundaries; and
- the impact of fishing on those stocks.

Biological characteristics

As part of the WCPFC Bycatch Information System, the Oceanic Fisheries Programme of the SPC (SPC-OFP) has compiled a database of life-history characteristics (e.g. size, age at maturity, lifespan, litter size etc) of a wide range of species, including sharks, caught in the tuna fisheries in the WCPO. A baseline set of life history information therefore exists for sharks although it requires ongoing updating to ensure that it reflects the latest available information. However, there remains a general lack of biological data for most bycatch species, including sharks (length and weight, length and age at maturity, longevity, growth rate, fecundity, habitat use, and trophic interactions) (SPC-OFP, 2009b).

Stock boundaries

The spatial definition of the stocks is a key factor in undertaking stock assessment. SPC hypothesizes that key tropical species such as silky shark, which are large, mobile and have a pelagic habitat, are likely to constitute a single trans-Pacific stock and that key temperate species such as mako sharks are likely to have separate stocks north and south of the equator. SPC proposes to test these hypotheses through the analysis of all available data in the preliminary assessments of stock status to be undertaken in 2010. This analysis will inform the nature of the models that can be used or will identify key gaps in understanding of stock structure that need to be addressed before meaningful stock assessment advice can be provided.

Fisheries data

Key information on the nature of fisheries and catch of sharks required for stock assessment purposes includes:

- fishing methods
- fishing effort
- the level and composition of the catch(e.g. species, length, age, sex)
- catch-rate
- the level of retention and discards
- the life status and condition of sharks at the time of capture and release

The sources and status of these data are discussed in the following section. Essentially, the availability of data on the key shark species in the WCPO is relatively low and there is likely to be a high level of uncertainty in the data available to underpin preliminary stock assessment advice.

IMPACTS ON SHARKS

In the PICTS sharks are affected by a range of factors including:

- industrial fishing
    - by vessels flagged to the PICTs
    - by foreign flagged vessels operating under access agreements
    - by illegal, unreported and unregulated (IUU) fishers;
- small scale and artisanal fishing;
- recreational and charter fishing;
- cultural uses of shark; and
- tourism operations.

Many small-scale, artisanal and subsistence fisheries for sharks exist throughout the South Pacific region, however there is limited information on the nature and extent of these fisheries. Likewise there is very little information available on recreational and charter fishing, cultural uses of sharks and the non-extractive use of sharks for tourism purposes in the PICTs. However, Juncker (2006) reviewed the available information on coastal shark fisheries in the Pacific identifying that:

- artisanal fisheries for sharks exist in American Samoa, Cook Islands, FSM, French Polynesia, New Caledonia, Northern Mariana Islands, Solomon Islands, Tonga, and Vanuatu;
- subsistence shark fishing is carried out by Polynesian, Micronesian and to a lesser extent, Melanesian countries with shark flesh used for domestic consumption and teeth and jaws commonly sold as curios to the tourist industry;
- sharks form an important part of the island culture in many countries, for example, in some parts of Kiribati sharks play a prominent role in mythology, there is a traditional taboo on the use of shark flesh in some communities in Fiji and shark worship has traditionally been common in the Solomon Islands and still continues on some islands;
- shark catches are poorly documented; and
- mako sharks are important to sport fishing in Vanuatu and PNG.

With respect to tourism it is known that countries such as Palau and Fiji place a high value on sharks as a drawcard for tourism, particularly for diving-based tourism operations. Other PICTs identified as tourism hot spots, for diving or natural observation of shark, include French Polynesia, Marshall Islands and PNG (Gaffney, 2000).

Factors such as coastal development and pollution, which may also affect the habitat of shark species, are likely to have the greatest impact on coastal shark species. These and other fishing and cultural impacts on sharks are not dealt with in detail in the PI-RPOA but further analysis of these issues will be an important component of any national-level shark assessments conducted by individual PICTs in conjunction with regional measures adopted for offshore shark fisheries under the PI-RPOA.

The major impact on oceanic species of sharks is commercial, targeted fishing for skipjack tuna (*Katsuwonus pelamis)*, yellowfin tuna (*Thunnus albacares*), bigeye tuna (*T. obesus*) and albacore tuna (*T. alalunga*) by domestic and foreign flagged vessels. In these fisheries sharks are commonly taken as incidental catch and it is possible that some targeted fishing of sharks may also occur. Since, most of the oceanic shark species occurring in the region are highly migratory these species are affected by fishing operations for tuna in the waters under the national jurisdiction of the PICTs as well as on the high seas.

It is estimated (Williams and Terawasi, 2009) that the total catch of the four main tuna species in the WCPFC-CA in 2008 was 2,426,195t, the highest on record. Of this, the purse seine fishery took nearly 1,800,000t (74%) and the longline fishery around 230,000t (10%). This overall result reflected increasing catches in the purse seine fleet but lower catches in the longline fleets, which were the lowest since 2000. The analysis of impacts of commercial fishing on sharks has been confined to the impact of purse seine and longline operations since only a very small proportion (<1% in recent years) (SPC-OFP, 2009b) of the catch of the target species of tunas and billfish is taken by trolling and, while pole and line accounted for around 8% of the catch of target tunas in recent years (SPC-OFP, 2009), very little of this activity occurs in the waters of the PICTs. In addition, pole and line is regarded as a relatively selective method of fishing where high levels of incidental catches of shark are unlikely.

The combined Pacific Islands' purse seine fleets fishing under the FSM Arrangement[13] are, with the Korean purse seine fleet, the highest producers of purse seine caught tunas in the WCPFC-CA. The total number of Pacific Island domestic purse seine vessels peaked at 75 vessels in 2005 but fell back to 59 vessels in 2008. This number included 28 vessels fishing under the FSM Arrangement, five Vanuatu vessels operating under bilateral arrangements and domestic vessels operating in PNG and Solomon Islands waters. In recent years environmental conditions have meant that purse seine fishing activity has been concentrated in the areas around PNG, FSM and the Solomon Islands (Williams and Terawasi, 2009). Other significant purse seine fleets in the WCPO includes vessels flagged to Japan, Chinese Taipei and the USA. Incidental catch of shark in the purse seine fleet in the WCPFC-CA has been estimated, from observer data, at around 0.02% (by weight) of the purse fisheries with catches dominated by silky sharks, oceanic whitetip sharks and manta rays (Molony, 2007). Despite the relatively low proportion of sharks in the total catch recent research has suggested that, in some fisheries, reported purse seine interactions with species such as silky shark and oceanic whitetip may be resulting in detrimental impacts upon populations (Nicol *et al.,* 2009).

In recent years between 3500 and 4500 longline vessels have operated in the WCPFC-CA each year. Many of these are distant water vessels flagged to States such as China, Chinese Taipei, Japan and Korea. A significant feature of the longline fishery over the last decade has been the increase in the Pacific Islands' domestic longline fishery for albacore. The Pacific Islands' albacore fleet now comprises

[13] The FSM Arrangement fleet comprises vessels managed by PNG (16 vessels), the Marshall lslands (5 vessels), FSM (3 vessels), Kiribati (1 vessel) and Solomon Islands (3 vessels) which fish over a broad area of the WCPFC-CA.

around 300 mainly small 'offshore' vessels with the most significant growth occurring in the fleets of Samoa, Fiji and French Polynesia. The fleet now accounts for between 50 and 60% of the annual south Pacific albacore catch (Williams and Terawasi, 2009). Incidental catch of shark in the longline fleet in the WCPFC-CA has been estimated at approximately 25% (by weight) of the total longline catch by weight with blue sharks, silky sharks and pelagic stingrays dominating the observer data (Molony, 2007).

There is evidence that illegal, unreported and unregulated (IUU) fishing for sharks also has an impact on shark stocks in the WCPO. Media reports and studies of IUU fishing have identified IUU fishing for sharks in the waters of Cook Islands, Fiji, FSM, Guam, Marshall Islands, New Caledonia, Palau, Papua New Guinea and Tonga (Lack and Sant, 2008; Oceana, 2007; Gilman *et al.*, 2007a; Jaynes, 2008; Paul, 2009).

The available information on the nature and extent of industrial fisheries in which sharks are taken in waters under the national jurisdiction of the PICTs is collated below.

Industrial fisheries affecting sharks

Sources of data

As is the case for shark catch globally, the extent and species composition of shark catches in the WCPO are not well understood. There are four main methods of collecting catch data in the industrial tuna fisheries of the WCPO: catch logsheets submitted by fishing vessels; landings data collected in port; data collected by observers; and port sampling. The data collected under these programmes are maintained and analyzed by SPC. These data collections provide a platform for the PICT's management of their fisheries, for reporting to the WCPFC on catches and, for those that are members of the FAO, for reporting on annual catch of marine products including sharks.

In addition, to these catch-based sources of data a recent trade-based estimate of catch of a limited number of shark species in the WCPO has been made (Clarke, 2009). The information available from the data collections, the public reporting of shark catch and the trade-based estimates are summarized below.

LOGSHEETS

The standardized regional catch logsheet forms for longline and purse seine fishing include provisions for the recording of 'shark' catch in numbers and weight and the number of shark discarded at the fishing operation level.

- The standard *SPC/FFA Regional Longline Logsheet* does not provide explicitly for the recording of species-specific shark catch but provides for the recording of the numbers of 'sharks' retained and discarded. In addition a column is available for the recording of numbers and kilograms retained of 'other species'. Shark species could be listed there but no discard information could be recorded.

- There is no specific provision for the recording of shark catch on the SPC/*FFA Regional Purse seine Logsheet*. Weight of retained sharks and number and weight of discard shark catch could be recorded under "other species".
- A specific *SPC/FFA Regional Shark Longline Logsheet* is provided for recording of catches in target shark longline fisheries (such as that in PNG).
- The *SPC/FFA Regional Longline Logbook - Daily Form* provides for the recording of:
    - whether sharks are the primary target species; and
    - the number and weight retained, the number and reason for discards and the number returned alive of silky shark, blue shark, oceanic whitetip shark, hammerhead sharks, mako sharks, thresher sharks and pelagic stingrays.

  However the Logbook is not used widely since it is considered too onerous.
- The 2007 meeting of the SPC/FFA Data Collection Committee noted that the forms currently used by FFA/SPC observer sub-regional and national programmes, already recorded most of the required details required under the finning controls measures of the WCPFC, except for the fin weight (SPC, 2007).

The logsheets are widely used by domestic fleets in the PICTs, by most foreign fishing vessels operating in the waters of coastal States in the region under bilateral agreements, and by purse seine vessels operating under the US Treaty[14]. However, there remain a number of longline and purse seine fleets that do not use the standards regional logsheets (SPC, 2007). In addition, completion of data records on shark catch and discards has been poor. The available logsheet data for longline and purse seine fleets operating in PICT waters are presented in Tables A2.5 and A2.6 respectively. The logbook data indicate that around 1630t of shark catch was reported as taken in the waters of the PICTs in 2007. Since 2000 the annual reported catch has ranged between 1244t in 2001 to 1958t in 2005. The highest recorded catches of shark in 2007 were in Tuvalu, Solomon Islands, Fiji, FSM, PNG and Marshall Islands.

Only rarely have shark catches been recorded in longline logsheets on a species basis. The available species data for the period 2000-2007 indicates that, of a total number of 463,000 sharks recorded in logsheets, less than 2% were recorded by species. Twelve PICTs reported some species-specific data in at least one year of that period. Only two reported species-specific data in each year of the period (all in relation to mako sharks). Seven species/groups were separately identified: bigeye thresher shark; mako sharks; blue shark; grey reef shark; thresher sharks; shortfin mako shark; and oceanic whitetip shark. Mako sharks comprised nearly 75% of the number identified by species and blue shark a further 20%. The data available provide no indication of an upward trend in the proportion of shark catch identified by species.

[14] Treaty on Fisheries between the Governments of Certain Pacific Island States and the United States of America

Table A2.5 Shark catch reported in longline logsheets in PICT waters (t)

PICT	2000	2001	2002	2003	2004	2005	2006	2007
Cook Islands	0.00	0.88	6.73	43.35	27.68	26.34	3.01	4.70
Fiji	73.20	121.40	411.28	75.79	90.55	274.71	270.16	228.98
French Polynesia	288.09	198.45	179.29	219.65	226.08	149.29	91.31	89.36
FSM	169.87	146.82	143.19	469.46	321.80	115.01	188.78	135.43
Kiribati	78.81	98.95	62.82	37.38	26.09	18.75	31.27	24.33
Marshall Islands	3.40	4.54	44.83	179.42	125.79	156.92	66.19	119.03
New Caledonia	4.04	0.30	20.21	57.66	42.25	27.77	15.94	18.06
Niue	0.00	0.00	0.04	0.11	0.73	3.30	0.65	0.35
Palau	6.65	15.36	15.42	6.58	0.46	3.15	8.36	1.09
PNG	941.62	560.66	914.35	81.46	36.08	39.73	52.72	51.56
Samoa	0.00	0.00	0.06	0.00	0.03	0.17	0.00	0.00
Solomon Islands	18.42	19.41	55.24	60.53	168.92	393.24	404.25	358.95
Tonga	13.96	9.02	6.68	2.49	15.56	23.37	0.12	16.62
Tuvalu	33.15	31.31	43.03	67.13	125.70	438.33	533.73	436.58
Vanuatu	0.48	0.00	2.97	0.00	0.19	0.28	0.07	0.06
Total	**1631.68**	**1207.08**	**1906.14**	**1301.00**	**1207.88**	**1670.35**	**1666.55**	**1485.10**

Source: SPC logsheet database

Table A2.6 Shark catch reported in purse seine logsheets, from PICT waters (t)

PICT	2000	2001	2002	2003	2004	2005	2006	2007
American Samoa		0.01						
Cook Islands	0.31		0.02					
Fiji						0.70	0.05	
FSM		2.04	1.74	5.33	7.95	140.93	4.91	11.42
Kiribati	10.16	5.94	6.02	26.65	67.59	18.95	14.55	3.29
Marshall Islands		1.02		5.29		1.24		0.25
Nauru	189.65	0.17	1.73	3.65	150.41	4.14	3.09	2.38
PNG	101.08	11.87	16.81	10.17	13.00	64.49	129.54	80.37
Samoa							0.01	0.07
Solomon Islands	0.06	0.11	1.31	1.78	62.67	4.79	10.94	3.74
Tokelau	0.93	0.22	1.76	0.40	0.62	0.03	0.58	0.40
Tuvalu	8.13	4.49	17.40	110.00	80.01	2.86	7.31	2.89
Total	**310.33**	**25.87**	**46.77**	**163.27**	**382.25**	**238.13**	**170.96**	**104.82**

Source: SPC logsheet database

Nearly 9% of the 20,000 sharks reported in purse seine logbooks was identified by species over the same period. Seven PICTs reported some species-specific data in at least one year over the period. The higher rate of reporting in the purse seine fishery may reflect that, overall, sharks make up a far lower proportion of the catch in the purse seine sector and that the range of shark species taken by the purse seine fleet is narrower than in the longline fleet. Twelve species were identified in the data: bignose shark; blacktip reef shark; blacktip shark; dusky shark; longfin mako shark; oceanic whitetip shark; pelagic stingray; pelagic thresher shark; silky shark; shortnose spurdog; thresher shark; and whale shark. Silky sharks represented around 75% of the numbers of sharks identified by species.

Data on tuna catches within the waters of the PICTs provided by PICTs in Part 1 of their Annual Reports to the WCPFC[15] indicate that in 2007, around 50,000t of catch was taken by longline operations and nearly 775,000t by purse seine. The catch of sharks reported in logbooks as being taken from PICT waters in that year was 1523t (representing around 3% of total catch) by longline and 105t (0.01% of total catch) by purse seine. These percentages are much lower than broader observer data would suggest. As noted above, SPC-OFP has estimated that sharks represent approximately 25% of longline catches by weight in the WCPFC-CA and about 0.2% by weight of the purse seine catch. It seems likely, therefore, that the available logsheet data is significantly under-reporting shark catch in PICT waters.

OBSERVER DATA

Observer coverage of the tuna fishing operations in the WCPO has increased since 1995 when the South Pacific Regional Tuna Resource Assessment and Monitoring Project commenced. Since that time national observer programmes have been established in 12 PICTs. However, the level and consistency of observer coverage and the capacity to retain observers varies across the PICTs. Overall the level of observer coverage of both the longline and purse seine fleets has been low (see Table A2.7). The coverage of purse seine operations is markedly higher than that in the longline sector. This reflects, in part, the 20% coverage of purse seine operations required under the US Treaty and the relatively high observer coverage rates on vessels operating under the FSM Arrangement.

Table A2.7 Recent observer coverage rates by method and PICT

Method/PICT	Year	Observer coverage (%)
Longline		
Cook Islands	2007	0.0
Fiji	2006	1.9
French Polynesia	2007	17.3
FSM	2007	1.0
New Caledonia	2007	2.2
PNG	2007	0.9
Samoa	2006	0.3
Solomon Islands	2007	0.0
Tonga	2006	4.6
Vanuatu	2007	0.0
Purse seine		
FSM	2007	12.3
Kiribati	2007	0.0
Marshall Islands	2007	27.6
PNG	2007	17.0
Solomon Islands	2007	4.2
Vanuatu	2007	9.1

Source: WCPFC Regional Observer Programme (ROP) Working Group (2009)

The available observer data on shark catch are limited and the spatial coverage of observer data is not necessarily representative of the spatial distribution of fishing effort for each fishing method. Therefore the proportions of species reported by observers may not be representative of the entire WCPFC-CA

[15] Available on the website of the WCPFC Scientific Committee's annual meeting: http://www.wcpfc.int/meetings/2 .

(Moloney, 2007). Despite these constraints, the data are proving to be reasonably consistent over time as indicators of the species composition of the catch (P. Williams, SPC, pers. comm., June 2009). In addition, the life status of sharks upon capture and release in the longline fisheries and upon release in the purse seine fishery has been recorded for a high proportion of observed shark catch of commonly observed species. Currently observer data provides the best information available on the species composition of the shark catch and it has been used by SPC as the basis to estimate total shark catch in the WCPFC-CA. An overview of what the data are showing is provided below. .

Species composition

The species or species groups identified in the SPC observer database, together with an indication of the fishing method by which they are taken and whether they have been identified in the waters of one or more PICTs are listed in Table A2.8. Shark species identified by the WCPFC as 'key shark species' for reporting and stock assessment purposes are identified in bold type.

Table A2.8: Shark species observed in longline and purse seine catches in the WCPO

Common name	Longline		Purse seine	
	WCPO	PICT waters	WCPO	PICT waters
Australian blacktip	✓			
Basking shark	✓	✓		
Bigeye sand shark	✓	✓		
Bigeye thresher	✓	✓	✓	✓
Bignose shark	✓	✓	✓	✓
Blacktip reef shark	✓	✓	✓	✓
Blacktip shark	✓	✓	✓	✓
Blue shark	✓	✓	✓	✓
Broadsnouted sevengill shark	✓			
Bronze whaler shark	✓	✓	✓	✓
Bull shark	✓	✓	✓	✓
Bullhead sharks	✓	✓		
Carpet shark	✓			
Cookie cutter shark	✓	✓		
Crocodile shark	✓	✓	✓	✓
Dogfish sharks	✓	✓	✓	✓
Dusky shark	✓	✓	✓	✓
Galapagos shark	✓	✓	✓	✓
Great hammerhead	✓	✓	✓	✓
Great white shark	✓	✓	✓	
Greenback stingaree	✓			
Grey reef shark	✓	✓	✓	✓
Hammerhead sharks	✓	✓	✓	✓
Longfin mako	✓	✓	✓	✓
Mako sharks	✓	✓	✓	✓
Manta rays (unidentified)	✓	✓	✓	✓
Megamouth shark	✓		✓	✓
Oceanic whitetip shark	✓	✓	✓	✓
Pelagic stingray	✓	✓	✓	✓
Pelagic thresher	✓	✓	✓	✓
Plunkets shark	✓			

Common name	Longline		Purse seine	
Porbeagle shark	✓			
Rays, skates and mantas	✓	✓	✓	✓
Salmon shark	✓	✓	✓	✓
Sandbar shark	✓	✓	✓	✓
Scalloped hammerhead	✓	✓	✓	✓
School shark	✓			
Seal shark	✓	✓		
Sharks (unidentified)	✓	✓	✓	✓
Sharpsnouted sevengill shark	✓			
Shortfin mako	✓	✓	✓	✓
Shovelnose dogfish	✓			
Silky shark	✓	✓	✓	✓
Silvertip shark	✓	✓	✓	✓
Smooth hammerhead	✓	✓	✓	✓
Spinner shark	✓			
Spiny dogfish	✓			
Spurdog			✓	✓
Thresher shark	✓	✓	✓	✓
Thresher sharks	✓	✓	✓	✓
Tiger shark	✓	✓	✓	✓
Velvet dogfish	✓			
Whale shark	✓	✓	✓	✓
Whip stingray	✓	✓	✓	
Whitenose shark	✓	✓		
Whitetip reef shark	✓	✓		
Zebra shark	✓	✓		

Source: Manning *et al*. (2009); SPC observer database.

Longline sector observer data were available for 15 PICT for the period 2001 to 2008. Those data identified 43 species or species groups of sharks. Blue shark was the most frequently observed shark in 12 PICTs (accounting for between 24% and 60% of observations). The observer data showed that 11 species/groups in total accounted for 80% or more of the shark catch in each PICT (see Table A2.9). Those species were: blue shark; bigeye thresher; blacktip shark; grey reef shark; longfin mako; oceanic whitetip; pelagic stingray; pelagic thresher shark; unidentified sharks; shortfin mako shark and silky shark. However, the species contribution varied across the PICTs. Blue shark comprised the highest proportion of the observed catch in 12 of the 15 PICTs while silky shark comprised the highest proportion in PNG and Tuvalu. Total observations of longline catch in the PICTs indicated that the most frequently observed species were silky shark (53%), blue shark (14%), oceanic whitetip shark (6%), pelagic stingray (4%) and bigeye thresher shark (3%). This differs significantly from the picture painted by analysis of observer data for the whole of the WCPFC-CA which indicates that blue shark comprises around 65% of the shark catch in the longline fleet and silky shark around 10% (Molony, 2007). The primary explanation for the difference is that PNG accounts for more than half the observations of longline shark catch across the PICTs and silky shark comprises more than 72% of the sharks observed in PNG while blue shark comprised less than 2% of the sharks observed.

Observer data for purse seine operations were available for 13 PICTs however in four of those countries only 1 or 2 sets had been observed. The data indicated that 35 species or species groups of sharks were identified in the purse seine sector but that four species/groups in total (oceanic whitetip shark, sharks, silky shark, and silvertip shark) comprised more than 80% of the shark catch observed in each PICT (see Table A2.10). Silky shark was by far the predominant species observed (accounting for more than 40% of the observed shark catch in nine PICTs). Total observations of purse seine catch in the PICTs indicated that the most frequently observed species were silky shark (81%), unidentified sharks (8%), oceanic whitetip shark (6%) and manta rays (3%). As in the longline data, the species composition differed somewhat from the analysis of observer data for the WCPFC-CA as a whole where silky shark comprised around 50% of the observed catch and oceanic whitetip around 10% (Molony, 2007). Again the primary explanation for the difference is that PNG accounts for more than half the observations of purse seine shark catch across the PICTs and silky shark comprises around 85% of the sharks observed in PNG while oceanic whitetip shark comprised around 6% of the catch.

Observer-based catch estimates

Observer data collected since 1994/1995 have been used by SPC to provide estimates of shark catch in the WCPFC Statistical Area[16]. The most recent estimates are provided in Tables A2.11 and A2.12 for longline and purse seine vessels respectively. These estimates suggest that:

- longline catch of sharks peaked in 1999 at around 156,000t and had declined to around 100,000t by 2006
- purse seine catch is much lower with a maximum catch of around 2500t since 1995 with catches considerably more stable than in the longline sector;
- five species (blue shark, oceanic white tip shark, silky sharks and two species of mako sharks) comprise over 90% of the catch of longline species, with blue shark alone comprising 65%; and
- since 2000, silky shark has comprised around 50% of purse seine catch of shark while whale shark comprising around 30% (The estimated whale shark component of the purse seine catch in the Statistical Area is significantly different from that observed in the PICTs alone, where only 265 of 62,000 (around 0.5%) recorded observations were of whale shark).

[16] Given the lack of a north and west boundary in the WCPFC-CA, the WCPFC Statistical Area is an area that has been formally adopted by the Commission for "statistical purposes" only.

Table A2.9: Shark species comprising, in aggregate, 80% or more of observed longline shark catch in PICT waters (%)

PICT	Total no. of sharks observed	Oceanic whitetip	Longfin mako	Sharks	Silky shark	Shortfin mako	Blue shark	Pelagic stingray	Pelagic thresher	Bigeye thresher	Grey reef shark	Blacktip shark
American Samoa	2	100.00										
Cook Islands	191	16.23	7.85	9.95	10.47	12.04	24.08					
Fiji	2659	17.68			12.82		46.41	9.97				
FSM	4692					27.00	39.73	18.37				
Kiribati	1005	15.72			9.45		59.70					
Marshall Islands	10676				27.31		29.77		10.85	14.54		
New Caledonia	825	6.55				7.88	55.15	11.52				
French Polynesia	1974	16.21			6.64		38.86	20.67				
PNG	45821	4.02			72.21						4.54	
Palau	153				18.30	6.54	35.29	26.14				
Samoa	16	12.50				12.50	31.25	25.00				
Solomon Islands	3717	8.69			22.76	7.83	25.59	18.67				
Tonga	1303	28.01				7.37	32.92					13.28
Tuvalu	239	31.38			34.73		20.50					
Vanuatu	225	18.67			22.67	9.78	36.44					

Source: SPC observer database

Table A2.10: Shark species comprising, in aggregate, 80% or more of observed purse seine shark catch in PICT waters (%)

PICT	Total no. of sharks observed	Oceanic whitetip	Silvertip shark	Sharks	Silky shark
American Samoa	8				100
Cook Islands	84			51.19	45.24
Fiji	27	29.63		62.96	
FSM	5501				92.56
Kiribati	6516	7.26			72.34
Marshall Islands	1143				91.25
Nauru	2374			9.10	79.87
PNG	32223				84.76
Palau	1	100.00			
Samoa	6		100		
Solomon Islands	11315				83.86
Tuvalu	3243			46.65	41.66
Wallis and Futuna	16				100.00
Total	62457				

Source: SPC observer database

Table A2.11: Estimates of non-target catches of sharks by longliners in the WCPFC Statistical Area (excluding the domestic fleets of Indonesia, the Philippines and Chinese Taipei) (t)

Species/Species Group	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	Average
Blue shark	46854	73096	69325	83112	96438	110459	93076	67975	53903	47346	51920	41336	39556	67261
Mako sharks	5640	6505	6493	7391	8951	10664	10374	9706	9081	8106	6773	5257	5454	7723
Oceanic whitetip shark	10364	13999	13651	11776	15338	13860	12268	9054	9035	6551	6124	4627	3586	10018
Silky shark	1080	13940	11111	7603	8266	10579	10487	8887	8352	6863	7268	6062	4993	8115
Other sharks and rays	12654	12839	8341	6120	8583	10689	10633	9350	8370	5929	5579	7218	7308	8739
Total sharks	76592	120379	108921	116002	137576	156251	136838	104972	88741	74795	77664	64500	60897	101856

Source: SPC-OFP (2008).

Table A2.12: Estimates of non-target catches of sharks by purse seiners in the WCPFC Statistical Area (excluding the domestic fleets of Indonesia and the Philippines) (t)

Species/Species Group	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	Average
Silky shark	145	236	427	455	786	685	753	941	944	1366	1087	1060	889	752
Whale shark	166	157	252	285	248	214	272	411	510	636	694	694	781	409
Other sharks and rays	1361	1361	1901	1115	1114	734	589	561	404	467	383	274	192	804
Total sharks	1672	1754	2580	1855	2148	1633	1614	1913	1858	2469	2164	2028	1862	1965

Source: SPC-OFP (2008)

Life status

Data on the condition of sharks upon capture and release is collected under national and regional observer programmes. Information on the life status of discarded sharks is particularly important in estimating total fishing mortality. For the 10 most commonly observed shark species observers have recorded life status upon capture and release of over 80% of sharks observed in the longline fisheries since 1981. Life status upon release has been recorded for more than 99% of sharks observed in the purse seine fishery since 1994 (Manning *et al.,* 2009).

Kirby and Molony (2006) reported that:

- the average proportion of sharks landed alive for all shark categories in longline fisheries was 64%;
- the average whole-body retention rate for all shark categories was 43% of observed catch;
- the rest was discarded but a large proportion (on average 50% in longline and 70% in purse seine) of these sharks have had their fins removed; and
- the average proportion discarded alive is 31% for longline and 39% for purse seine.

PORT SAMPLING

The SPC-OFP compiles landings and port sampling data collected by national programmes in ports throughout the region. Port sampling data (species composition, form (whole, headed/gutted, fins etc) weight and length frequency of landed catch) is collected from ports in FSM, Fiji, French Polynesia, Kiribati, Marshall Islands, New Caledonia, Palau, PNG, Solomon Islands and Tonga. However relatively few sharks have been sampled under these programmes. Between 2000 and 2007 just over 4000 sharks were sampled. This represents less than 1% of the 481,000 sharks recorded in logsheets over this period. More than half the sharks sampled were identified only as 'sharks' and a further 35% were identified as' mako sharks'. Eleven PICTs reported some shark sampling data in at least one year of the period 2000-2007. Nearly 90% of the sampling occurred between 2000 and 2004, with the number of sharks sampled annually having declined significantly since that time.

SHARK LANDINGS

Landings data is collected through SPC/FFA Unloading and Unloading Destination forms for longline vessels and Unloading forms for purse seine vessels. Unloadings of around 41,000 sharks weighing 894t were monitored across the PICTs between 2000 and 2007. This represents less than 10% of the number of sharks reported in logsheets. Nine PICTs reported unloading data in one or more years between 2000 and 2007 but data recorded by the Marshall Islands accounted for more than half the shark reported. Less than 1% of the data was identified by species or species group.

REPORTING TO WCPFC

In 2006 the members of the WCPFC adopted a Conservation and Management Measure (CMM 2006-05) for sharks. The CMM encouraged, although did not require, members, participating territories and cooperating non-members (CCMs) of the WCPFC, to submit data on key shark species (which were not specified in the CMM) in their annual reporting to the Commission. The CMM came into force on I January 2008 and later that year the Ecosystem and Bycatch Working Group of the WCPFC Scientific Committee assessed the submission of bycatch information required by CMMs, including CMM 2006-05. Of the 34 members/co-operating non-members, 27 had submitted their annual reports to the Commission and only 10 had included estimates of shark catch. Of the PICTs, the Cook Islands, Fiji, French Polynesia, FSM, Marshall Islands, New Caledonia, PNG, Samoa, Tonga, American Samoa, Guam and the Northern Mariana Islands (NMI), have provided estimates of shark catch in their 2008 or 2009 Annual Reports. The catches reported in Annual Reports in those two years are presented in Table A2.13[17].

Table A 2.13: Shark catch reported by the PICTs in Part 1 Annual Reports to WCPFC (2008 and 2009) (t)

	Cook Islands	Fiji[1]	French Polynesia[2]	Marshall Islands	New Caledonia	PNG	Samoa	American Samoa	Guam	NMI	FSM	Tonga
2003		453					2					
2004	85	2411	354 (37)				2		0	0	113	42
2005	81	1443	242 (25)	605			2	0	0	0	11	98
2006	42	1256	134 (26)	1286		1591	3	2	0	0	0	33
2007	18	581	166 (18)	1565	13	776	6	2	0	0	2	38
2008	48	984	136 (10)	2726	13		2	1	0	0	39	21

1. Not all from inside Fiji waters. 2. Of these catches only mako sharks (bracketed figures) are retained.

Annual Reports (Part 1) to the WCPFC Scientific Committee of distant water fishing nations that are known to fish in both waters under national jurisdiction of the PICTs and on the high seas in the WCPFC-CA provide some indication of the level of shark in the broader region. For example:

- the Spanish purse seine fleet took 51t (46t silky shark, 4t whale shark, 1t oceanic whitetip) from the WCPFC-CA in 2008 and the Spanish longline fleet took 4693t and 3285t of sharks in 2007 and 2008 respectively (EU Part 1 Annual Report, 2009);
- the Chinese longline fleet in the WCPFC-CA took 1181t of blue shark and 295t of shortfin mako shark as bycatch in 2008 (China Part 1 Annual Report, 2009);
- preliminary estimates indicate that the Chinese Taipei longline fleet in the Convention Area took a total of 19,000t of sharks in 2008 (9300t of blue shark, 657t of mako sharks, 536t of thresher sharks, 421t of silky shark and 8,000t of other sharks) (Chinese Taipei Part 1 Annual Report, 2009); and

[17] At the time of writing not all 2009 Annual Reports were available on the WCPFC website.

- US longline vessels operating in the WCPO landed 160t of sharks (mako sharks 109t, thresher sharks 39t, blue shark 7t, other sharks 4t) in 2008 while no sharks were retained in its purse seine fleet operation in the WCPO (USA Part 1 Annual Report, 2009).

These data suggest that these four fleets alone took around 24,000t of sharks from the region in 2008.

FAO CATCH DATA

All of the PICTs are members of the FAO and have an obligation to provide annual data on catch of marine species. Only eight PICTs reported shark catch in the WCPO or the Eastern Central Pacific Ocean (ECPO) by their flag vessels to the FAO between 2000 and 2007 (see Table A2.14). The total reported catch has declined markedly since 2000. This is mainly attributable to declines in reported catch in Kiribati, Samoa and French Polynesia. Such declines could be indicative of changes in fishing practices, reductions in fishing effort, introduction of management measures, changes in reporting procedures or a decline in abundance.

Table A2.14: Capture production of sharks reported to FAO by PICTs, 2000-2007 (t)

Country	Species	Fishing area	2000	2001	2002	2003	2004	2005	2006	2007
Cook Islands	Sharks, rays, skates, etc. nei	ECPO	20	20	20	20	20	20	20	20
French Polynesia	Sharks, rays, skates, etc. nei	ECPO	582	705	1,063	700	309	227	139	148
French Polynesia	Shortfin mako	ECPO	27	53	41	40	36	26	27	18
Samoa	Sharks, rays, skates, etc. nei	ECPO	250	250	250	250	170	100	33	6
Guam	Sharks, rays, skates, etc. nei	WCPO	<0.5	<0.5	<0.5					
Kiribati	Sharks, rays, skates, etc. nei	WCPO	1581	1273	2769	1334	1150	850	600	408
Nauru	Sharks, rays, skates, etc. nei	WCPO			<0.5	2	<0.5	1	1	1
New Caledonia	Shortfin mako	WCPO				38	34	26	14	13
Solomon Islands	Sharks, rays, skates, etc. nei	WCPO	19	10	5	2	9	10	10	10
Total			**2479**	**2311**	**4148**	**2386**	**1728**	**1260**	**844**	**624**

Source: FAO Fisheries and Aquaculture Information and Statistics Service (2009)

Total reported shark catch in the WCPO/ECPO is reported in Table A2.15. In order to minimize the contribution of catch in the ECPO outside the WCPFC-CA, CCMs of the WCPFC during any part of the period 2000-2007 have been included in the ECPO catch. However these data may continue to overstate shark catch in that portion of the Convention Area. The data show that the reported shark catch in the WCPO peaked at around 176,000t in 2003 and had declined by around 33% by 2007, while reported catch in the ECPO has declined slightly over the period. In comparison to the catch estimates in Tables A2.11 and A2.12, the FAO data includes any reported catches by domestic fleets of Indonesia, the Philippines and Chinese Taipei. However even after excluding the catch of these two countries from the

FAO data there are significant differences between the level of, and trends, in the observer-based estimates of catch and reported catch to FAO.

The data suggest clearly that the catch of shark by vessels flagged to the PICTs represents a very small proportion of the total catch of sharks in the WCPO. Of the other countries reporting shark catch in the region, Chinese Taipei, Japan, Korea, New Zealand, Spain and the USA are known to fish under access agreements or treaties in the national waters of one or more of the PICTs.

Table A2.15: Reported shark catch in the WCPO/ECPO 2000-2007 (t)

	2000	2001	2002	2003	2004	2005	2006	2007
WCPO								
Australia	1,495	2,223	2,279	2,730	3,198	3,032	2,623	2,564
Chinese Taipei	20,650	29,961	29,952	44,699	4,891	3,771	9,521	3,041
Guam	<0.5	<0.5	<0.5	-	-	-	-	-
Indonesia	69,468	65,713	67,947	74,181	70,236	68,865	76,734	81,305
Japan	203	155	325	163	163	72	136	164
Kiribati	1,581	1,273	2,769	1,334	1,150	850	600	408
Korea	1,502	1,534	1,871	1,296	1,500	1,722	1,136	704
Malaysia	17,861	18,914	17,893	21,724	19,082	20,687	16,394	15,519
Nauru	.	.	<0.5	2	<0.5	1	1	1
New Caledonia	.	.	.	38	34	26	14	13
Philippines	4,319	5,275	5,668	6,177	5,776	4,746	5,309	5,197
Singapore	304	219	192	157	185	187	233	222
Solomon Islands	19	10	5	2	9	10	10	10
Spain	-	-	-	-	1	-	-	-
Thailand	15,939	14,832	20,152	24,229	16,905	9,051	8,500	7,572
Total WCPO	**133,341**	**140,109**	**149,053**	**176,732**	**123,130**	**113,020**	**121,211**	**116,720**
Total WCPO exc. Indonesia and the Philippines	**59,554**	**69,121**	**75,438**	**96,374**	**47,118**	**47,600**	**43,261**	**30,218**
ECPO (WCPFC CCMs only)								
American Samoa	-	-	-	-	-	-	-	-
Chinese Taipei	72	105	96	327	1,301	1,234	1,723	1,054
Cook Islands	20	20	20	20	20	20	20	20
French Polynesia	609	758	1,104	740	345	253	166	166
Japan	1,163	956	2,121	2,485	1,934	1,250	1,715	1,228
Korea	1,448	809	314	180	25	-	-	-
Samoa	250	250	250	250	170	100	33	6
Spain	-	-	-	-	71	19	7	52
USA	2,104	686	557	576	383	438	429	501
Total ECPO	**5,666**	**3,584**	**4,462**	**4,578**	**4,249**	**3,314**	**4,093**	**3,027**
TOTAL WCPO & ECPO	**139,007**	**143,693**	**153,515**	**181,310**	**127,379**	**116,334**	**125,304**	**119,747**

Source: FAO Fisheries and Aquaculture Information and Statistics Service (2009)

TRADE-BASED ESTIMATES OF SHARK CATCH

Given the lack of reliable shark catch data and the WCPFC's request for advice on the stock status of key shark species by 2010, an alternative, trade-based estimate of shark catch in the WCPO has been made by Clarke (2009) based on shark fin trade data. The trade-based estimates are not directly comparable with the observer based estimates of catch made by SPC since the latter exclude catches by the domestic longline and purse seine fleets of Indonesia and the Philippines and the domestic longline fleet of Chinese Taipei, and the former necessarily excludes any catch that does not enter international trade and shark for which fins are not retained (regardless of whether the meat is retained or discarded). Nevertheless, a comparison of the two data sets indicates that the trade-based estimates of catch of blue-shark, oceanic whitetip shark, mako sharks, thresher sharks and silky shark are reasonably similar to the SPC's observer-based estimates during the period 1998-2000. However, after that time median trade-based estimates are up to two to three times higher than the observer-based estimates. These findings are not inconsistent with the trends in the total catch data for the region reported to FAO.

Nature of the fisheries

A profile of the available information on the nature of the fishing fleets taking sharks in each PICT and a summary of the size and nature (method, domestic/foreign) of the fleet by is provided in Table A2.16.

The information available suggests that:

- 13 of the 21 PICTs have domestic commercial longline fisheries;
- six have domestic commercial purse seine fisheries;
- eight have foreign longline fleets operating in their waters;
- ten have foreign purse seine fleets operating in their waters;
- seven have both foreign longline and purse seine fleets operating in their waters;
- nine PICTs have no foreign fleets operating in their waters; and
- a number of PICTs, in addition to the members of the FSM Arrangement, have domestic vessels that are authorized to operate outside their waters of national jurisdiction (e.g. Cook Islands, Fiji, Vanuatu)

Table A2.16: Profile of longline and purse seine fishing impacts on sharks in the PICTs

PICT	Fishing fleet		Shark Catch (t)[1]		Top 10 shark species identified by observers[2]	
	Commercial domestic	Foreign fleet	Highest since 2000	2007	LL	PS
American Samoa	29 US-LL					Silky shark
Cook Islands	23 LL (tuna)	None since 2000	43 (2003)	4.7	Blue shark Oceanic whitetip Shortfin mako Silky shark Unidentified sharks Longfin mako Pelagic thresher Pelagic stingray Bigeye thresher Crocodile shark	Unidentified sharks Silky Oceanic whitetip
FSM	26 LL 5 PS	2008: 105 LL 166 PS	475 (2003)	147	Blue shark Silky shark Pelagic stingray Bigeye thresher shark Oceanic whitetip shark Pelagic thresher shark Crocodile shark Shortfin mako shark Longfin mako shark Mako sharks	Silky shark Oceanic whitetip shark Manta rays Unidentified sharks Blue shark Pelagic stingray Whale shark Shortfin mako Mako sharks Thresher sharks
Fiji	96 LL licensed for either Fiji waters or authorized to operate outside Fiji)	US Treaty PS vessels	411 (2006)	229	Blue shark Oceanic whitetip shark Silky shark Pelagic stingray Shortfin mako shark Blacktip shark Bigeye thresher Longfin mako shark Great hammerhead Scalloped hammerhead	Unidentified sharks Oceanic whitetip shark Silky shark Hammerhead sharks
French Polynesia	34 fresh fish LL 34 freezer LL	None since 2000	288 (2000)	89	Blue shark Pelagic stingray Oceanic whitetip shark Silky shark Shortfin mako shark Silvertip shark	

PICT	Fishing fleet		Shark Catch (t)[1]		Top 10 shark species identified by observers[2]	
	Commercial domestic	Foreign fleet	Highest since 2000	2007	LL	PS
					Blacktip reef shark Longfin mako shark Grey reef shark Pelagic thresher shark	
Guam						
Kiribati	1 PS (fishes mainly outside exclusive economic zone (EEZ)) 3 LL (operate from overseas ports)	186 LL 178 PS	105 (2001)	28	Blue shark Oceanic whitetip shark Silky shark Tiger shark Short fin mako shark Pelagic stingray Hammerhead sharks Bigeye thresher shark Longfin mako shark Manta rays	Silky shark Unidentified sharks Oceanic whitetip shark Manta rays Blacktip shark Silvertip shark Thresher sharks Whale shark Mako sharks Pelagic stingray
Marshall Islands	5 PS 4 LL	149 PS 53 LL	185 (2003)	119	Blue shark Silky shark Bigeye thresher shark Pelagic thresher shark Oceanic whitetip shark Pelagic stingray Shortfin mako shark Longfin mako shark Crocodile shark Manta rays	Silky shark Unidentified sharks Manta rays Oceanic whitetip shark Mako sharks Hammerhead sharks Whale shark
Nauru		130PS	2 (2002)	0.4		Silky shark Unidentified sharks Oceanic whitetip shark Manta rays Whale shark Blacktip shark Pelagic stingray Galapagos shark Hammerhead shark Rays, skates and mantas
New Caledonia	27 LL licensed (23 active)	None since 2001	58 (2003)	18	Blue shark Pelagic stingray Shortfin mako Oceanic whitetip	

PICT	Fishing fleet		Shark Catch (t)[1]		Top 10 shark species identified by observers[2]	
	Commercial domestic	Foreign fleet	Highest since 2000	2007	LL	PS
					Silky shark Grey reef shark Tiger shark Shortfin mako Longfin mako Bigeye thresher	
Niue	1 LL (joint venture)		3 (2005)	0 .35		
Northern Mariana Islands						
Palau		166 LL 29 PS	15 (2002)	1	Blue shark Pelagic stingray Silky shark Shortfin mako Bigeye thresher Longfin mako Thresher shark Pelagic thresher Crocodile shark	Silky shark
PNG	9 shark LL vessels 42 tuna LL vessels (12 active) 9 PS	32 locally-based PS	1042 (2000)	134	Silky shark Grey reef shark Oceanic whitetip shark Hammerhead sharks Silvertip shark Blacktip shark Blacktip reef shark Galapagos shark Unidentified sharks Blue shark	Silky shark Oceanic whitetip shark Rays, skates and mantas Unidentified Sharks Whale shark Silvertip shark Pelagic stingray Shortfin mako shark Blue shark Salmon shark
Samoa	44 LL		0.17 (2005)	0.07	Blue shark Pelagic stingray Shortfin mako shark Oceanic whitetip shark Silky shark Unidentified sharks	Silvertip shark
Solomon Islands	4 PS	175 LL 142 PS	415 (2006)	363	Blue shark Silky shark Pelagic stingray	Silky shark Unidentified sharks Oceanic whitetip shark

PICT	Fishing fleet		Shark Catch (t)[1]		Top 10 shark species identified by observers[2]	
	Commercial domestic	Foreign fleet	Highest since 2000	2007	LL	PS
					Oceanic whitetip Shortfin mako Bigeye thresher Longfin mako Manta rays Rays, skates and mantas Great White shark	Mako sharks Rays, skates and mantas Blacktip shark Shortfin mako shark Pelagic stingray Whale shark Hammerhead shark
Tokelau		US multilateral treaty PS 3 PS and 2LL in 2007	80 (2004)	38		Unidentified sharks Silky shark Silvertip shark Oceanic whitetip shark Thresher sharks Mako sharks Manta rays Blue shark Whale shark
Tonga	11 LL	None since 2004	23 (2005)	17	Blue shark Oceanic whitetip Blacktip shark Shortfin mako shark Silky shark Pelagic stingray Hammerhead sharks Longfin mako shark Bigeye thresher shark Smooth hammerhead	
Tuvalu		68 LL 136 PS	541 (2006)	440	Silky shark Oceanic whitetip shark Blue shark Blacktip shark Tiger shark Hammerhead sharks Manta rays Pelagic stingray	Shark Silky shark Oceanic whitetip shark Blacktip shark Silvertip shark Mako sharks Whale shark Rays, skates and mantas Pelagic stingray Manta rays
Vanuatu	60 LL	112 LL	3 (2002)	<1	Blue shark	

PICT	Fishing fleet		Shark Catch (t)[1]		Top 10 shark species identified by observers[2]	
	Commercial domestic	Foreign fleet	Highest since 2000	2007	LL	PS
	18 PS				Silky shark Oceanic whitetip shark Shortfin mako shark Pelagic stingray Bigeye thresher Manta rays Blacktip shark Pelagic thresher	
Wallis and Futuna						

1. Highest annual catch since 2000, and catch in 2007 as reported in logsheet data supplied by SPC.
2. In decreasing order of numbers observed between 2000 and 2007

Sources: Part 1 Annual Reports to WCPFC 2008 and 2009; Juncker, 2006; SPC observer database; SPC logsheet database.

SHARK UTILIZATION

Sharks can be utilized for their fins, meat, liver oil, cartilage and skin. In addition, teeth, jaws and sometimes gills can be used as jewellery or curios. A summary of reported uses of shark products of species taken in PICT waters is provided in Table A2.17. This information does not, however, imply that these species are utilized for these purposes in the PICTs, but rather that markets are known to exist for these products. In addition, this information is drawn from a number of sources but should not be interpreted as a comprehensive assessment of the use or potential use of shark species taken in the region. It is possible that some products from other shark species occurring in PICT waters are also utilized; however, no documentation of such use was identified.

Table A2.17: Utilization of shark species

Common name	Uses				
	Meat	Fins	Liver oil	Skin	Other
Basking shark		Yes	Yes+	Yes	
Bigeye thresher	Yes	Yes		Yes	
Blacktip shark		Yes			
Blue shark	Yes	Yes		Yes	
Bronze whaler shark	Yes	Yes			
Bull shark		Yes		Yes	
Dusky shark		Yes		Yes	
Great hammerhead	Yes	Yes	Yes+	Yes+	
Great white shark		Yes	Yes	Yes	Teeth, jaws
Hammerhead sharks	Yes	Yes	Yes	Yes	
Longfin mako	Yes	Yes	Yes+		
Mako sharks	Yes	Yes	Yes	Yes	Teeth, jaws

Common name	Uses				
	Meat	**Fins**	**Liver oil**	**Skin**	**Other**
Oceanic whitetip shark		Yes	Yes	Yes	
Pelagic thresher	Yes	Yes		Yes	
Salmon shark	Yes	Yes	Yes		
Sandbar shark		Yes		Yes	
Scalloped hammerhead	Yes	Yes	Yes+	Yes+	
Shortfin mako	Yes+	Yes	Yes	Yes+	Teeth, jaws
Silky shark		Yes	Yes		
Smooth hammerhead	Yes	Yes	Yes+	Yes+	
Spiny dogfish	Yes			Yes	
Thresher shark	Yes+	Yes	Yes	Yes	
Thresher sharks nei	Yes	Yes		Yes	
Tiger shark		Yes		Yes	
Whale shark	Yes	Yes	Yes	Yes	Gills

Sources: Camhi *et al.* (2009); McCoy (2007); Oceana (2008); Clarke *et al.* (2006)
+ means preferred species, can vary regionally

In the absence of any management measures, shark taken as incidental catch is likely to be either:

- discarded either dead or alive ;
- finned and the carcass discarded;
- headed and gutted and finned and the carcass and fins retained.

It is well established that the main commercial value of most shark species lies in their fins rather than their meat. With some exceptions, for example porbeagle, spiny dogfish and school shark), the meat of shark species is, at best, of low commercial value, particularly relative to the value of target species. For this reason the finning and discarding of carcasses has become common practice, particularly in longline fishing operations, globally.

There is a low level of domestic demand for meat and other shark parts in some PICTs. Juncker (2006) and McCoy (2007) report that shark meat may be used for subsistence consumption (e.g. in FSM, Kiribati, Marshall Islands, New Caledonia, Tonga) or sold on domestic markets (e.g. Fiji, PNG, Vanuatu). Other shark products, such as teeth and jaws may also be sold locally (e.g. in New Caledonia).

Shark catch from domestic fishing operations in the PICTs is also exported. McCoy (2007), reports that the major export shark commodity from domestic-based longline operations in the PICTs is frozen shark trunks shipped by refrigerated containers. Trade data reported to FAO by the PICTs (see Table A2.18) supports this finding. The trade data indicate that 11 PICTs reported exports of shark products in the 2000-2006 period. Five PICTs (Fiji, Marshall Islands, FSM, PNG and Tonga) that did not report shark catch by their flag vessels to FAO did report shark exports.

Table A2.18: Exports of shark products by PICTs, 2000-2006 (t)

Country	Commodity	2000	2001	2002	2003	2004	2005	2006
Cook Islands	Sharks nei, frozen	.	.	.	.	.	.	72
Fiji	Sharks nei, fresh or chilled	20	10	131	4	-	-	-
Fiji	Sharks nei, frozen	217	83	64	408	181	35	11
FSM	Sharks nei, frozen	.	.	.	.	9	-	-
Kiribati	Shark fins, dried, salted, etc.	1	1	-	1	-	1	1
Marshall Islands	Shark fins, dried, salted, etc.	.	.	21	21	1	.	.
Marshall Islands	Sharks nei, frozen	.	.	14	80	112	146	48
Palau	Shark fins, dried, salted, etc.	2	-	-	-	-	-	-
PNG	Shark fins, dried, salted, etc.	14	2	1	3	12	9	10
PNG	Sharks nei, fresh or chilled	.	.	.	-	156	2	-
PNG	Sharks nei, frozen	-	38	-	4	29	-	-
Samoa	Shark fins, dried, salted, etc.	6	-	-	-	-	-	1
Solomon Islands	Shark fins, dried, salted, etc.	-	2	1	2	2	3	3
Tonga	Shark fins, dried, salted, etc.	1	8	5	5	4	3	5
Vanuatu	Sharks nei, frozen	.	4	11	-	63	25	58
Total		**261**	**148**	**248**	**528**	**569**	**224**	**209**

Source: FAO Fisheries and Aquaculture Information and Statistics Service (2008)

Import data from the major consumers of shark fins, Hong Kong and China, are not readily available. However, In addition to the trade reflected in Table A2.18 other available trade data indicate that:

- French Polynesia exported small quantities (up to 5 t) of frozen shark fillets to the EU annually between 2000 and 2004 (European Commission, 2009);
- New Caledonia and Samoa each exported small quantities of frozen shark product to the EU and the United States in one year between 2000 and 2008 (Personal communication from the National Marine Fisheries Service, Fisheries Statistics Division, Silver Spring, MD; 2009; European Commission, 2009);
- small quantities of shark fin (up to half a tonne) were exported from Vanuatu annually between 2001 and 2004 (Amos, 2007);
- PNG's Annual Reports to the WCPFC indicate substantially higher exports than those reported to FAO. For example, in 2009 PNG reported that since 2006 it has exported over 1800t of frozen shark meat annually and over the same period annual exports of frozen shark fins had ranged between 125 and 144t. The data excluded dried shark fin exports. Most shark products are exported to Chinese Taipei (PNG Part 1 Annual Report, 2009). These exports include product taken from PNG's managed target longline shark fishery and may include products from sharks taken in the tuna longline fishery although these operators are not authorized to export; and

- substantial quantities (one to two 20 foot containers per month) of frozen shark meat are regularly exported from Fiji to Korea (McCoy.2007).

For most PICTs the available data, while not conclusive, suggest that, the export of shark products is not a major source of export earnings. Even in those countries where substantial shark exports have been identified, their value is relatively insignificant compared to exports of other tuna products. For example, the value of PNG's shark exports in 2008 was US$1.7m. This represented around 1% of the export value (US$143.6m) of products exported from PNG's tuna fisheries (PNG Part 1 Annual Report, 2009).

Constraints on port, transport and processing infrastructure and the lack of access to markets inhibit the capacity of many of the PICTs to promote utilization of sharks taken as incidental catch (McCoy 2007). There have been reports in the PICTs of onshore dumping of shark carcasses that are now required to be landed in compliance with CMM 2008-06 (David Kirby, SPC pers. comm., June 2009).

The level of discards of shark products at sea or after landing, when unmarketable shark carcasses are landed in accordance with fin:carcass ratios, remains largely unquantified. McCoy (2007) analyzed SPC observer data for the tropical shallow longline fishery (TSL), the tropical deep longline fishery (TDL) and the Tropical Albacore longline fishery (TAL) in the Pacific Islands for the period 1995-2005. The retention and discarding of shark by species in each of these fisheries was analyzed (see Table A2.19). The data suggest that the bulk of blue sharks were finned and discarded in each of the three fisheries. However, the data indicate variation across the fleets with respect to the rate of retention of total shark catch and of individual species. For example, in the TSL a much higher proportion (34% across all species) of total shark catch is retained (carcass and fins) than in the TDL (12%) and TAL (17%). Nearly 60% of shark catch was finned and discarded in the TSL and around 75% in each of the TDL and TAL. The rate of retention of silky shark and oceanic whitetip shark was considerably higher in the TSL than in the TDL and TAL.

Table A2.19 Estimated rates of retention and discarding of sharks

Most commonly taken species	Tropical shallow longline			Tropical deep longline			Tropical albacore longline		
	% of shark numbers observed	% trunks and fins retained	% finned and discarded	% of shark numbers observed	% trunks and fins retained	% finned and discarded	% of shark numbers observed	% trunks and fins retained	% finned and discarded
Blue shark	42	11	84	43	3	90	56	8	86
Silky shark	29	55	40	20	32	63	9	23	68
Oceanic whitetip shark	9	47	51	7	28	68	16	21	76
Grey reef shark	2	72	22	<1	12	62	<1	22	69
Bigeye thresher shark	2	29	56	9	3	83	1	19	34
Shortfin mako shark	2	43	48	5	14	79	6	61	34
Pelagic thresher shark	1	46	48	5	5	83	<1	8	39

Source: Based on SPC observer data in the PICTs cited in McCoy (2007)

Different fishing fleets adopt a range of practices in respect to retention and use of shark products. McCoy (2007) noted that, Chinese longliners operating out of Micronesian ports in Majuro and Pohnpei, using only ice for refrigeration of target catch and do not retain blue sharks as their value is deemed too low for freezing and later shipment. However, McCoy reports that some Chinese vessels have begun processing sharks, probably blue sharks which are reportedly preferred in Japan for the production of leather onboard for their skins, as well as retaining fins.

Gilman *et al.* (2007a) reported that Japan's distant water fishing fleet retain whole shortfin mako carcasses and transport them back to Japan because of their high value meat and that, until recently, all other carcasses were discarded. However in recent years, markets for shark meat have developed in South Africa, Peru, Spain, Panama, Venezuela and Mauritius and Japanese vessels now offload meat in some or all of these ports. Most fins are retained until return to Japan, but some are transshipped. The introduction of finning regulations has led to a change in practice from drying fins in open on the deck to freezing (which is less conspicuous). Most fishers retaining shark carcasses leave the fins intact and have no difficulty with storage. Mejuto *et al.* (2007) report that the Spanish longline fleet targeting swordfish in the Pacific Ocean now retains nearly all its shark catch and that blue shark in particular is being increasingly retained.

FAO's global capture production and trade data supports the contention that increasing quantities of shark may be being retained. While reported global capture production declined from 890,000t to 780,000t between 2000 and 2007 exports of shark meat products increased from 72,000t in 2000 to 93,000t in 2006.

SHARK MANAGEMENT

International Management of Sharks

As indicated earlier in this review around half of the shark species likely to occur in the WCPO are HMS under Annex 1 of UNCLOS. The United Nations Fish Stocks Agreement (UNFSA) specifies that States should cooperate to manage these species across national maritime boundaries and on the high seas. The need for regional and international management of some of these species is also reflected in their listing in CITES and the CMS. Shark species identified as HMS and those listed under CITES and/or the CMS are identified in Table A2.20. Participation in these conventions by the PICTs is summarized in Appendix 1.

Table A2.20: Listings of shark species in international conventions

Instrument	Species	Listing
UNCLOS	Bluntnose sixgill shark *Hexanchus griseus* Basking shark *Cetorhinus maximus* Thresher sharks Family *Alopiidae* Whale shark *Rhincodon typus* Requiem sharks Family *Carcharhinidae* Hammerhead sharks Family *Sphyrnidae* Mackerel sharks Family *Isurida (Lamnidae)*	Each listed in Annex I of UNCLOS (1982) as a Highly Migratory Species
CITES[1]	Basking shark Whale shark Great white shark *Carcharodon carcharias* Narrow sawfish *Anoxypristis cuspidata* Dwarf sawfish *Pristis clavata* Wide sawfish *P. pectinata* Largetooth sawfish *P. perotteti* Common sawfish *P. pristis* Green sawfish *P. zijsron* Freshwater sawfish *P. microdon*	Appendix II (2003) Appendix II (2003) Appendix II (2005) Appendix I (2007) Appendix I (2007) Appendix I (2007) Appendix I (2007) Appendix I (2007) Appendix I (2007) Appendix II (2007)
CMS	Whale shark Great white shark Basking shark Shortfin mako Longfin mako Porbeagle *Lamna nasus* Spiny dogfish *Squalus acanthias* (Northern Hemisphere populations)	Appendix II (1999) Appendices I and II (2002) Appendices I and II (2005) Appendix II (2008) Appendix II (2008) Appendix II (2008 Appendix II (2008)

With one exception (Guam (USA)), each of the PICTs has either acceded to or ratified UNCLOS and, with one exception (Vanuatu), each of the PICTs has either acceded to or ratified the UNFSA.

Ten PICTs (Fiji, French Polynesia, Guam, New Caledonia, Palau, PNG, Samoa, Solomon Islands, Tokelau and Vanuatu) are Parties to CITES. Three (basking shark, whale shark and great white shark) of the 10 shark species listed on CITES are known to occur in the waters of the PICTs. Each of these species has been recorded in the observer data for longline fisheries and whale shark has been observed in the purse seine fisheries. In longline fisheries great white shark represented 0.1% of the total number of sharks observed, basking shark 0.01% and whale shark 0.002%. In the purse seine fisheries whale sharks represented 0.4% of observed sharks. A number of other shark species taken in the WCPO are under consideration for nomination for CITES listing. The United States is currently considering whether

dusky shark, sandbar shark, oceanic whitetip and scalloped, great and smooth hammerhead sharks qualify for inclusion in Appendix II of CITES (United States Department of the Interior, *in litt*. 2009).

Six PICTs (Cook Islands, French Polynesia, New Caledonia, Samoa and Tokelau) are Parties to the CMS while the remaining 15 participate in one or more of the agreements or memoranda of understanding (MOU) developed under the CMS. The Parties of the CMS are currently working on the development of a non-binding MOU on the Conservation of Migratory Sharks. The objective, as stated in the latest draft of the MOU, is to "achieve and maintain a favourable conservation status for migratory sharks and their habitats, based on the best scientific evidence, taking into account the socio-economic and other values of these species for the people of the Signatory states". Currently five of the species listed on the CMS Appendices are known to be taken in the waters of the PICTs. Two of those species, great white shark and basking shark, are listed on both Appendix I and II of the CMS and the remaining three species (whale shark, shortfin mako shark and longfin mako shark are listed only on Appendix II. Shortfin mako sharks represented less than 2% of the observed catch in the longline sector and 0.1% in the purse seine fishery. Longline mako represented less than 0.8% of the observed catch in the longline sector and 0.005% in the purse seine fishery.

The need for increased cooperation on management of sharks was recognized by the 2009 joint meeting of the tuna RFMOs. The participants to the meeting, including representatives from the WCPFC, identified the need for immediate action by the tuna RFMOs to establish:

> "precautionary, science-based conservation and management measures for sharks taken in fisheries within the convention areas of each tuna RFMO, including as appropriate:
>
> - measures to improve the enforcement of existing finning bans;
> - prohibitions on retention of particularly vulnerable or depleted sharks species, based on advice from scientists and experts;
> - concrete management measures in line with best available scientific advice with priority given to overfished populations;
> - precautionary fishing controls on a provisional basis for shark species for which there is no scientific advice; and
> - measures to improve the provision of data on sharks in all fisheries and by all gears" (Anon., 2009a).

These issues will be considered further by the RFMOs at a workshop on Tuna RFMO Management Issues Relating to Bycatch to be held in 2010. The workshop will review available information on incidental catch, provide advice on shark bycatch mitigation measures, develop and coordinate relevant research and observer programmes, and identify mechanisms to avoid duplication of efforts in these areas.

Regional management of sharks

CMM 2008-06

CMMs are binding on members, cooperating non-members and participating territories of the WCPFC. However, CMM 2008-06, includes both binding and non-binding measures. The non-binding measures relate to:

- implementation of the IPOA Sharks;
- reporting to the WCPFC in Part 2 of Annual CCM reports, on implementation of the IPOA Sharks, including results of their assessment of the need for a National Plan of Action for sharks (NPOA Sharks) and/or the status of that plan;
- the inclusion in any NPOA Sharks of measures to minimize waste and discards from shark catches and encourage the live release of incidental catches of sharks;
- the reporting of catch and effort statistics by gear type on the key shark species (blue shark, oceanic whitetip shark, mako sharks and thresher sharks) in accordance with WCPFC reporting requirements;
- the reporting of retained and discarded catches of key shark species in Part 2 of Annual CCM reports; and
- support for research and development of strategies to avoid unwanted shark captures (e.g. chemical, magnetic and rare earth metal shark deterrents).

The binding measures applying to CCMs relate to:

- the full utilization of any retained catches of sharks[18] where full utilization is defined as retention of all parts of the shark except head, guts and skin to the point of first landing or transshipment;
- the weight of fins on board a vessel must not total more than 5% of the weight of sharks on board up to the first point of landing. Where fins and carcasses are not required to be offloaded together at point of first landing measures must be taken to ensure compliance with the 5% ratio through certification, monitoring by an observer or other measures OR fins must be landed attached to the carcass OR fins must not be landed without the corresponding carcass;
- coastal States may apply alternative measures for the conservation and management of sharks within areas under their national jurisdiction;
- fishing vessels must be prohibited from retaining on board, transshipping, landing or trading any fins harvested in contravention of the CMM;

[18] Sharks caught in association with fisheries managed by the WCPFC and to sharks listed in Annex 1 of UNCLOS (see table A1.21)

- in tuna and tuna-like fisheries not directed at sharks, fishers shall be encouraged to release live sharks caught incidentally that are not used for food or other purposes; and
- CCMs must report on implementation of the CMM and any alternative measures adopted in national waters, in Part 2 of their annual reports to the WCPFC.

The provision in the CMM for coastal States to implement alternative management measures in waters under their national jurisdiction must be interpreted in the context of Article 8 of the WCPF Convention which requires compatibility between management measures adopted for the high seas and those applying in waters under national jurisdiction. Thus any 'alternative measures' adopted by coastal states under CMM 2008-06 must be compatible with those applied to the high seas by the CMM. In a presentation to the WCPFC in 2008 on how 'compatibility' should be interpreted, Professor Martin Tsamenyi[19] indicated that different measures adopted by coastal States, to those agreed by the RFMO for the high seas, must have 'equivalent effect' as those applying on the high seas and that the assessment of 'equivalency' was a matter for management. CMM 2008-06 provides for coastal States to report on any alternative measures adopted and for the review of the implementation and effectiveness of the CMM including any alternative measures adopted. This would appear to provide a mechanism for assessment of the 'equivalency' of the "different" measures referred to by Professor Tsamenyi.

Regional management of tuna stocks

Because much of the shark taken in the WCPO is taken as incidental catch to other managed fisheries the regional management arrangements in place in those fisheries may have an impact on shark stocks. Measures adopted by the WCPFC or by sub-regional groupings in the Pacific in respect of target stocks can vary the level of fishing effort on and/or the level of available catch of those stocks. As a result changes to these management measures can affect, positively or negatively, the impact of fishing on sharks.

In December 2007 the parties to the Nauru Agreement Concerning Cooperation in the Management of Fisheries of Common Interest (FSM, Kiribati, Marshall Islands, Nauru, Palau, PNG, Solomon Islands Tuvalu) implemented a purse seine vessel day scheme (VDS) which replaced a previous limit on purse seine vessel numbers. The scheme allocates vessel days across the Exclusive Economic Zones (EEZs) of the eight parties. The scheme has subsequently been incorporated into the WCPFC's 2008 CMM for bigeye and yellowfin tuna (CMM 2008-01). CMM 2008-01 sets an objective of decreasing longline fishing mortality on bigeye tuna by 30% within the period 2009-2011 as well as imposing temporal closures on purse seine fishing on fish aggregating devices (FADs). Reduced catches of bigeye tuna, particularly by the longline fleet, should be accompanied by a corresponding reduction in the incidental catch of sharks. However it is possible that a reduction in the allowable take of bigeye tuna will provide an increased incentive to retain sharks that might otherwise have been discarded alive or to increase targeting of

[19] WCPFC Secretariat, Legal Services Provider

sharks in order to compensate for decreased returns from the target catch. If the latter was to occur, the WCPFC and the PICTs would be required to manage the targeted shark fishing operations.

National management by the PICTs

An overview of the management measures applying to fishing for sharks in the waters of the PICTs is provided in Table A2.21. Of those PICTs that have foreign and/or domestic longline or purse seine fleets operating in their waters:

- two have drafted but not finalized an NPOA Sharks;
- six have banned shark finning and/or apply the 5% fin:carcass ratio;
- two have prohibited targeting of sharks;
- three control/prohibit the use of wire leaders;
- two have prohibited the retention of some or all sharks;
- one has placed an upper limit on the proportion of shark bycatch of total catch;
- one manages a target shark fishery under a statutory management plan; and
- four have no management measures directly applying to sharks.

National management of sharks in the PICTs is subject to the same constraints as broader management of marine resources. Limited human and financial capacity to develop, implement and enforce fisheries management measures is common to many PICTs. These capacity constraints have also been noted in relation to the implementation of obligations under CITES (see for example, Hay, 2009). In addition, the economies of many of the PICTs are highly reliant on revenue gained from fishing access agreements and they may be unwilling to compromise those returns by the imposition of more stringent shark management measures on foreign fleets. Further, the need to maximize revenue may result in actions that are not consistent with better management outcomes for sharks. For example, it is reported (Gilman *et al*., 2007a) that one PICT provides tax incentives to offload shark products. Such measures actively encourage the fin trade and without effective management of sustainability this is likely to compromise shark stocks.

Like many other countries the PICTs' capacity to manage sharks is also constrained by the high level of uncertainty in the level and species composition of shark catches in their waters, in their understanding of the relative vulnerability of those stocks to fishing and the status of those stocks. The PICTs have, however, demonstrated effective regional cooperation on fisheries management and have access to strong scientific and management advice scientific advice to support their attempts to better manage their shark stocks. The development of common measures across the PICTs would bolster their negotiating position in relation to access agreements and their influence on WCPFC discussions on shark management.

Table A2.21 Management of sharks in the PICTs

PICT	Fishing fleet (LL and PS)		Shark Management measures
	Commercial domestic	Foreign fleet	
Cook Islands	23 LL (tuna)		Draft NPOA Sharks (2008) 5%fin:carcass ratio applies to Cook Islands vessels operating in the EEZ and on the high seas
FSM	26 LL 5 PS	105 LL 166 PS	Targeting of sharks not permitted (use of wire traces or leaders regarded as prima facie evidence of such targeting) (McCoy, 2006); applies to domestic and foreign vessels
Fiji	96 LL (licensed for either Fiji waters or to operate outside Fiji)	US Treaty PS vessels	
French Polynesia	34 fresh fish LL 34 freezer LL		Retention of all sharks, except mako sharks, prohibited Shark finning prohibited (S. Shanks, FFA, *in litt*. July 2009))
Kiribati	1 PS 3 LL	186 LL 178 PS	
Marshall Islands	5 PS 4 LL	149 PS 53 LL	Tuna Management Plan 2004 (revised in 2008) (Steve Shanks in litt. 2009) Draft NPOA Sharks (2004) Banned targeting shark fishing in 2004
Nauru		130 PS	
New Caledonia	27 LL licensed (23 active)		Prohibition on shark finning in the territorial sea of the Southern Provence applies to vessels except tuna longliners (S. Shanks, FFA *in litt*. July 2009). Fleet has moved to use of monofilament as a shark avoidance measure.
Niue	7 LL (joint venture)		Shark finning prohibited (S. Shanks, FFA *in litt*. July, 2009)
Palau		166 LL 29 PS	Prohibition on the take/retention of shark (S. Shanks, FFA *in litt.*, July 2009)
Papua New Guinea	9 shark LL 42 tuna LL (12 active) 9 PS	32 locally-based PS	Shark Management Plan 2002 Total allowable catch (TAC) 2000t (dressed weight) (includes an allowance for discards of sharks by non-shark licensed fishers) Observer coverage set at 20% of fishing days of active vessels Longliners not authorized under the Shark Management Plan cannot target sharks; cannot use wire leaders and do not have an export licence for shark (S. Shanks, FFA in *litt.*, July 2009)
Samoa	44 LL vessels		5% fin:carcass ratio
Solomon Islands	4 PS	175 LL 142 PS	Licences shark fin exporters (McCoy, 2006)
Tokelau		US multilateral treaty PS 3 PS and	New Zealand requirements apply to foreign vessels
Tonga	11 LL		Tuna Management plan: cap of 30 vessels; wire leaders prohibited and only 10% of the total catch in weight can be shark (S. Shanks, FFA *in litt*., July 2009).
Tuvalu		68 LL	

PICT	Fishing fleet (LL and PS)		Shark Management measures
	Commercial domestic	Foreign fleet	
		136 PS	
Vanuatu	60 LL 18 PS	112 LL	Shark finning ban in place (McCoy,2006)

MONITORING, CONTROL AND SURVEILLANCE

Members of the Forum Fisheries Agency (FFA) undertake their own MCS activities in their waters and their MCS operations are supported by the FFA Secretariat. The FFA maintains the FFA Vessel Register, undertakes training of MCS officers, manages the regional observer programme, maintains the regional vessel monitoring system (VMS), provides investigators and legal assistance where required and coordinates third party MCS assets and regional surveillance activities. Key elements of regional MCS arrangements that may influence the feasibility and effectiveness of shark management measures are discussed briefly below.

Harmonised terms of access for foreign vessels

FFA members have agreed to Harmonised Minimum Terms and Conditions for Foreign Fishing Vessels Access (MTCs). These Conditions include specifications relating to licensing, being on Good Standing on the FFA Vessel Register, transshipment, catch reporting, vessel reporting, the carriage, duties and coverage of observers, enforcement, the operation of the FFA's VMS, identification of fish aggregating devices (FADs) and pre-fishing inspections. The MTCs provide a mechanism that could be used to deliver common management arrangements for sharks across all foreign vessels operating in the waters of the PICTs.

VMS

The FFA Regional VMS must be operated by vessels on the FFA Regional Vessel Register. It applies to foreign or foreign domestic-based vessels which are required to have a VMS reporting to the coastal State via the FFA regional VMS. The FFA VMS also provides the infrastructure for the WCPFC's high seas VMS which began operation on 1 April 2009.

Regional MCS strategy

In 2007 the Forum Fisheries Committee agreed to develop a regional Fisheries Monitoring, Control and Surveillance strategy. The focus of the Strategy will be on providing effective compliance with national and WCPFC fisheries management measures and minimizing IUU fishing. It is expected that the Strategy will be finalized on 2009.

Observer programmes

While not strictly an MCS tool, the use of observers on vessels can complement MCS measures. Most of the PICTs have a national observer programme in place, although the level and capability of the programmes vary. The use of observers in the national waters of the PICTs and on the high seas in the WCPO is increasing. The national observer programmes run by many of the PICTs and supported by FFA will be augmented by a Regional Observer Programme (ROP) introduced by the WCPFC. The ROP is based on the use of existing regional, sub-regional and national observer programmes already in place when the *Conservation and Management Measure for the Regional Observer Programme* (CMM 2007-01) entered into force on 15 February 2008. CMM 2007-01 provides for gradual development of the ROP through to 2012.

Across all purse seine fleets the ROP coverage target in 2009 is 20% increasing to 100% in 2010 and 2011 and the coverage target for the longline fleet is 5% by 2012 (Anon, 2009a). In addition, the adoption of CMM 2008-01 for bigeye and yellowfin tuna changed the observer coverage required by purse seiners for certain areas. Except for those Members qualifying for alternative arrangements under paragraph 15 of the CMM, all purse seine fleets that intend to fish between 20°N and 20°S during the period 1 Augus t to 30 September 2009 (and 1 July 2010 to 30 September 2010) will require 100% observer coverage by ROP observers. In addition to collecting data already agreed by the Commission the primary role of observers during this period will be to monitor compliance with the two-month prohibition for setting on FADs and, from 2010, the catch retention provisions of the CMM (Anon, 2009b).

CMM 2007-01 specifies that observers appointed under the ROP shall be independent and impartial observers qualified in accordance with criteria approved by the Commission. Observers operating under the ROP are charged with collecting catch data and other scientific data, monitoring the implementation of the conservation and management measures adopted by the Commission and collecting any additional information related to the fishery that may be approved by the Commission. So, while observers will not fill an enforcement role directly, they provide a presence and a mechanism for feedback to the flag State of the level of compliance of their vessels with CMMs and, when in the waters of a PICT, of compliance with any national measures. As a result, increased observer coverage will provide a basis for consideration of management measures for sharks that might otherwise have been considered unenforceable.

Appendix 1 Membership of key international instruments (as at 15 May 2009)

PICT	CITES	CMS		FAO	UNCLOS	UNFSA
		Party	Participates[1]			
American Samoa	R(US)	X	✓(US)	✓(US)	X	R(US)
Cook Islands	X	✓		✓	R[2]	A
FSM	X	X	✓	✓	A	R
Fiji	A	X	✓	✓	R	R
French Polynesia	✓ (France)	✓ (France)		✓ (France)	R (France)	R (France)
Guam	R(US)	X	✓(US)	✓ (US)	X	R (USA)
Kiribati	X	X	✓	✓	A	A
Marshall Islands	X	X	✓	✓	A	R
Nauru	X	X	✓	✓	R	A
Niue	X	X	✓	✓	R[2]	R
New Caledonia	Approval (France)	✓ (France)		✓ (France)	R (France)	R (France)
NMI	R (US)		✓(US)	✓(US)	X	R (USA)
Palau	A	X	✓	✓	A	A
PNG	A	X	✓	✓	R	R
Samoa	A	✓		✓	R	R
Solomon Islands	A	X	✓	✓	R	A
Tokelau	A (New Zealand)	✓ (New Zealand)		✓ (New Zealand)	R (New Zealand)	R (New Zealand)
Tonga	X	X	✓	✓	A	R
Tuvalu	X	X	✓	✓	R	A
Vanuatu	A	X	✓	✓	R	X
Wallis and Futuna	Approval (France)	✓ (France		✓ (France)	R (France)	R (France)

1. Participates in one or more CMS Agreements or MOUs
2. Not a member of the United Nations

R= Ratified; A= Acceded

ANNEX 3 MANAGEMENT MEASURES

Direct limits on the level of catch or fishing effort

Measures include:

- Prohibit targeting of sharks
- Prohibit retention of sharks or any part of shark (no take)
- Require discard of all live shark
- Global total allowable catch (TAC) of sharks
- Allocated quotas for sharks
- Trip limits
- Move on provisions

Some PICTs (e.g. FSM) **prohibit the targeting of sharks** in their waters. The Commission for the Conservation of Antarctic Marine Living Resource (CCAMLR) has also prohibited "directed fishing on shark species" in its Convention Area however it has not defined how it would identify such fishing. The bulk of sharks taken in the WCPO are considered to be taken as incidental catch to tuna fishing, particularly by longline. However it is possible that sharks are being specifically targeted by longline fishing. Molony (2007), for example, reports that some longline fisheries, particularly the tropical shallow longline fishery targeting yellowfin tuna, also target shark. Prohibitions on targeting of sharks would require the adoption of a definition of targeting. Indicators of targeted longline fishing could be the relative proportions of shark and tuna catches by fleets or the nature of the gear used. For example, FSM uses wire traces as prima facie evidence of shark targeting (McCoy, 2006). Another indicator might be the depth of the set of longline gear, with shallower sets in target tuna fisheries being regarded as indicative of shark targeting. In circumstances where presence of shark on board a vessel can legitimately or otherwise be claimed as incidental catch, prohibition on targeting in itself can only be enforced cost-effectively if the carriage of particular gear type is used as the indicator of targeting.

The retention of some or all sharks taken in their waters is prohibited by some PICTs (French Polynesia, Palau). This effectively precludes targeted shark fishing and is a direct attempt to maximize post-capture survival by encouraging fishers to release more sharks alive than is currently the case. However, it also involves the discard of sharks that are dead upon capture and therefore encourages wastage of shark products. This waste is avoided under the alternative strategy of requiring the **discard of all live shark** or live shark of some species, which is the practice in New Zealand for certain shark species in some fisheries (Brouwer and Griggs, 2009). The International Commission for the Conservation of Atlantic Tunas (ICCAT) has also introduced this measures for bigeye thresher shark (ICCAT Resolution 08-07) along with the requirements that al incidental catch and live releases be

recorded. The requirement to discard all live shark acknowledges the reality that incidental mortality of sharks will occur in targeted tuna fishing but seeks to minimize the mortality by precluding the killing of shark captured alive. However, its effectiveness will depend in part on the post-release survival of live sharks and therefore may be most effective as a species-specific measure where the post-release survival has been established. In addition, in the absence of onboard surveillance non-compliance is likely to be high and difficult to detect but the capacity to detect non-compliance will be higher under increased observer coverage..

The setting of global or allocated quotas is an attempt to directly control the amount of shark taken. The imposition of a TAC of 'sharks' that all fleets could take in the waters of a PICT would at this stage be arbitrarily set and apply indiscriminately to all shark species. It could be applied in a number of ways. For example, after the shark TAC is reached fishing for target species could be required to cease. This would have an unacceptable impact on targeted tuna fishing operations which may be hard to justify in terms of demonstrable benefit to shark stocks given the generic nature of the measure. In addition, this approach provides a strong incentive for highgrading. Alternatively, after the TAC is reached all sharks taken, whether dead or alive, would be required to discarded. In that sense it may make little impact on conservation and, in the absence of high levels of observer coverage and/or enforcement, highgrading would be likely. It may also encourage shark targeting as individual vessels seek to maximize their take of shark prior to the TAC being reached. Either option would require near real-time reporting of catch to ensure that the TAC was not exceeded.

The allocation of fleet specific quotas for 'sharks' to distant water fishing fleets would have similar deficiencies and monitoring difficulties but also involves the complexities associated with allocation of access rights. The allocation of shark bycatch quotas to the domestic fleet would be more achievable but would also require high levels of enforcement and reporting. Conservation and utilization outcomes would still potentially be compromised by highgrading and the necessity to discard even dead sharks. Overall, in the context of sharks being taken predominantly as incidental catch, TACs whether allocated or not, are more likely to be justifiable and cost-effective on a species-specific basis.

Trip limits, which prescribe the number of sharks or proportion of sharks in the total catch, may be feasible for application in the domestic fleets of the PICTs which are at sea for relatively short periods but are unlikely to be feasible for distant water fishing fleets. In both cases, enforcement would require a high level of inspection of landings and, in the case of distant water fishing fleets, of transshipment. In addition, trip limits have similar disadvantages to allocated quotas in that after reaching the limit highgrading is likely to occur and dead shark will be discarded.

In an environment where incidental shark catch is often valued, rather than avoided, **move-on provisions** that require vessels to leave a certain area when catch rates of sharks reach a specified level are unlikely to be complied with voluntarily. While movement from an area could be monitored via VMS, identifying that the specified catch rate had been triggered would be difficult. If operators were keen to

avoid high rates of shark catches they would be, and possibly are, taking such steps on their own initiative.

Time or area closures

These measures involve closing certain areas to fishing, either permanently or for specified periods, to minimize interactions with sharks. The time/area of the closure would coincide with those where interactions with sharks are known to be high. Permanent closures have been used to protect shark nursery areas. It is unlikely that the data currently available on shark catches could support the identification of temporary area/seasonal closures in the WCPO. However closures would be a cost-effective option in terms of monitoring and enforcement. They may also be a useful addition to management measures for coastal species for which coastal nursery areas can be identified.

Controls on gear or fishing practices

In the longline sector a number of measures are available to minimize interactions with sharks. These include:

- Controls on depth of set by longline vessels
- Specifications on longline gear type
- Controls on bait
- Controls on use of light sticks
- Controls on time of setting
- Controls on soaking and haulage times
- Shark deterrents

There may be a correlation between the **depth of set** and the extent of shark catch. Gilman *et al.* (2007a) reviewed techniques used by fishers in 12 longline fisheries to avoid shark interactions and identified setting gear deeper as a method used by fishers actively seeking to avoid shark bycatch. In contrast however, Beverley *et al.,* 2009 found no significant changes in catch rates of shark in commercial tuna longline catches where all shallow set hooks (less than 100m depth) were eliminated. Walsh *et al*. (2009) have, however, shown that the shark species taken varied according to the depth of set. Catch rates of blue shark and shortfin mako shark were significantly greater in the shallow-set longlines in the swordfish fishery while catch rates of the deeper-dwelling bigeye thresher shark and crocodile shark were greater in the deep-set fishery for bigeye tuna. They concluded that set depth is highly influential on shark catch rates, noting that setting longline gear deep may prove to be an affective bycatch mitigation technique for epipelagic (those living in 0-200m depth) species. However, unless there is a clear management objective to minimize catch of certain species of sharks, moving to deeper set depths may

simply impose increased fishing impact on sharks found in deeper waters and runs the risk of inadvertently targeting new species that inhabit deeper waters and may result in higher mortality rates (Patterson and Tudman, in prep.). In addition, increased observer coverage and/or the use of equipment such as depth loggers would be required to ensure compliance.

The **time of setting** may also be a factor in determining shark catch rates. Shark species generally spend more time near the surface at night so it is possible that catch rates may be higher under night setting practices. However any switch from night to day setting would need to take into account the potential impact on other species, such as seabirds for which night setting is an optional bycatch mitigation measure.

Aspects of **gear type,** such as nylon leaders rather than wire leaders, circle or J hook and hook size may also influence shark catch and post release survival of sharks. The US is currently investigating operational differences that might reduce shark bycatch. Factors being investigated include hook type, branch line material, bait type, the presence of light sticks and soak time.

Some studies have shown that the banning of **wire leaders**, and their replacement with nylon, can significantly reduce the incidental catch of shark and increase the catchability of bigeye tuna. Ward *et al.,* (2008a) found that catch rates were higher on wire leaders for eight out of ten shark species and significantly higher for all sharks combined. In addition, the catch rate of bigeye tunas was higher on nylon leader than on wire leader. In these circumstances the analysis indicated that the increased returns outweighed the costs of replacing lost gear and repairing damaged gear. Research by Vega and Licandeo (2009) in the eastern South Pacific swordfish fishery also suggests that the use of monofilament leaders rather than wire leaders in surface longlines might be an effective way to reduce shark bycatch. However the impact on the relative catchability of sharks and tuna of the change in gear may be affected by other aspects of gear and fishing operations including the weight of the swivel attached to the wire leader, the construction of the nylon leader, the soak time of baited hooks and the light available at setting (time of setting). This measure is in place in a number of fisheries including in longline tuna fisheries in Australia and South Africa.

It has been suggested that the use of **circle hooks** rather than the traditional J hook may increase the survivability of sharks and reduce the capture of some shark species. The circle hook may increase survivorship after capture and release since it lodges in the mouth region of the shark rather than being ingested. As a result, the circle hook will eventually corrode in the mouth of the cut away shark while the J hook may cause internal damage and decrease survivorship. However, the definitive impact of circle hooks on survivorship has not been established. The use of corrodible hooks has also been suggested as a possible means of increasing survivorship of sharks cut off. However, the impact on mortality rates of released sharks has not been determined.

The results of analyses of the relative impacts of circle hooks and J hooks on shark capture rates are inconclusive. For example, Watson *et al.* (2005), Bolten and Bjorndal (2002 and 2003) and Ward *et al.*

(2008b) found higher capture rates (of blue sharks) with circle hooks than with J hooks while Yokota *et al.* (2006), Kerstetter *et al*. (2007) and Kerstetter and Graves (2006) found no difference in the catch rates of blue shark using the two hooks. In contrast, Piovano *et al.* (2008) found that the use of circle hooks can effectively reduce the negative impact of longline fishing operations on pelagic stingrays with a mean capture rate significantly lower than J hooks. Kim *et al.* (2006) also found lower shark catch rates on circle hooks. The catch rate of sharks as a group per 1000 hooks using circle hooks (size C15) was found to be 2.8 compared to 4.4 using the J4 hook. The results varied across species with the impact of the circle hook lowest on blue shark and most marked for bigeye thresher and salmon shark.

The size of the circle hook has also been identified as a possible factor in determining shark capture rates. Patterson and Tudman (in press) suggest that the use of larger circle hooks could potentially reduce the capture of some species, such as crocodile sharks, possibly smaller sharks and also turtles although this has not been tested. The WCPFC's CMM 2008-03 for the Conservation and Management of Sea Turtles currently lists the use of only large circle hooks as an optional mitigation measure in shallow set (generally considered to be where the majority of hooks fish at a depth shallower than 100m) swordfish fisheries.

A requirement to change to circle hooks would be relatively cost-effective to enforce but voluntary compliance would depend on the impact on catch rates of target species and on the extent to which operators had come to rely on incidental shark catch as supplementary income.

Bait type has also been demonstrated to be an important determinant of shark catch rates. Switching from the use of squid bait to mackerel in the Hawaii longline swordfish fishery has been credited with a sharp decrease in CPUE of sharks (Gilman, 2007). However, Patterson and Tudman (in press) conclude that the available data on the impact of bait on shark catch is insufficient to draw conclusions. In addition, the impact on catch rates of target species would be a key factor for operators. Watson *et al.* (2005) recorded a reduction in the catch rate of blue sharks on both circle and J hooks using mackerel baits compared to squid baits. Gilman *et al*. (2007b) recorded a 36% reduction in blue shark catch using fish baits with circle hooks versus squid baits with J hooks. Gilman (2007) reports that after the Hawaiian swordfish longline fishery was required to use wider (18/0) circle hooks with mackerel type bait, instead of 9/0 J hooks and squid bait, there has been a significant (36%) decrease on their shark catch rate. He notes that this decrease is consistent with controlled and comparative studies, which found that switching from squid to fish for bait resulted in large, significant reductions in shark CPUE, while switching from J hooks to circle hooks caused no change or a significant but small increase in shark CPUE.

However other studies have found a very weak or positive effect on shark catch as a result of using fish bait. For example, Harley (2006) analysed catch and effort data in the New Zealand longline fishery to assess the impact of bait type on catch of species including porbeagle, mako and blue sharks. The analysis found that bait had a significant effect on catch rates of only one shark species, mako shark.

The estimated effect for mako sharks was very weak with some suggestion of an increase in mako shark catch rates with increased use of fish bait.

The WCPFC's CMM 2008-03 for the Conservation and Management of Sea Turtles currently lists the use of only finfish for bait as an optional mitigation measures in shallow set swordfish fisheries. However, enforcement of controls on the type of bait used for bycatch mitigation purposes could be difficult and not cost-effective depending on the operational practices of fishers with respect to the taking on board of bait.

Gilman *et al*. (2007a) identified that fishers in one longline fishery avoided the use of **light sticks** as a means of reducing shark catch rates. However, overall, there appears to be little information upon which to determine the relationship between light stick use and shark catch rates. Further, light sticks are used predominantly in swordfish fisheries and there are not extensive fisheries for swordfish in the waters of the PICTs.

It has been suggested that **reducing soak times** may reduce the number of interactions with sharks and may increase survivorship of sharks, and potentially other species such as turtles. For example, Ward et *al.* (2004) found that the capture rates of blue shark increased with soak time. However, restricting soak times may only result in fishers setting more frequently so that, overall, the level of effort on sharks may not decrease. In addition it would be difficult and costly to enforce.

The use of chemical, magnetic, electropositive rare earth metals and electrical **deterrents** show some promise in reducing fishing interactions with sharks. The US has been testing the ability of electropositive metals to repel sharks from longline hooks in Hawaii. Results to date have indicated that Galapagos sharks and sandbar sharks significantly reduced their biting of bait on hooks close to electropositive metal objective and exhibited significantly more aversion behaviour as they approached those baits. Similarly, preliminary results using electropositive ingots found that catch rates of juvenile scalloped hammerhead sharks fell by 63% on branch lines when the ingot is attached to branch lines compared to lead-weight controls (USA Annual Report to WCPFC 2009). The effectiveness of such measures, their impact on target stocks and their cost-effectiveness in commercial fishing operations is yet to be established (Gilman *et al.,* 2008).

The use of **de-hookers** may increase the survival rate of released live sharks. While Gilman *et al.* (2008) found that most fishers regard commercially available de-hookers to be impractical and potentially dangerous for sharks, research in the United States has developed a new de-hooker which was more than 90% effective in removing both barbed and barbless circle hooks from sharks (USA Annual Report to WCPFC 2008).

The WCPFC's CMM 2008-03 for the Conservation and Management of Sea Turtles requires all longline vessels to carry turtle de-hookers and line cutters.

In the purse seine fleet bycatch of sharks appears to be higher in sets made on **floating objects** including FADs (Molony, 2007; Scott, 2007; Nicol *et a*l., 2009; IATTC, 2008). There is also a small

proportion of purse-seine fishing that target tuna schools associated with whales and whale sharks, increasing the interactions between the fishery and marine mammals and the protected, whale shark (Molony, 2007). Innovative methods are being explored to reduce the bycatch of shark including the investigation of the use of a **bait station** to attract sharks away from FADs prior to a set (Scott, 2007).

Size limits

Minimum or maximum size limits for sharks would need to be applied on a species-specific basis. Maximum size limits would involve return of sharks at or above a certain size to the sea. Given that larger sharks are more likely to survive after cut off this may have a positive impact on the breeding stock. However, the knock-on effect may be that the mortality of smaller sharks is increased as more are retained to compensate for the reduced retention of larger sharks (Patterson and Tudman, in press). Most of the sharks taken in WCPO fisheries are juveniles so minimum size limits may have a role to play in management of shark stocks on the Pacific. However, to be effective both maximum and minimum size limits need to be species specific.

Market/economic measures

Measures that provide economic or market disincentives to retain incidental shark catch or to target sharks include

- Controls on shark finning, including the requirement to land carcasses of retained sharks together with the application of a fin/carcass ratio applied to retained shark catch
- Prohibit landing, trade and/or export of shark
- Tax landings/trade of sharks

Controls on shark finning

Controls on finning may, where markets for shark products other than fins exist and the financial return justifies storage, handling and transport costs, reduce wastage and increase utilization of sharks. However, often these conditions are not met and there is no or limited increase in utilization resulting from such controls. Further, depending on the rigor with which the measures are applied (fins removed at sea, fins landed attached to the carcass) controls on finning may have little impact on reducing shark mortality.

Despite these shortcomings fin:carcass ratios have been adopted widely, including in the WCPFC, as a means of promoting utilization and minimizing wastage of shark trunks and, ostensibly, as a conservation measure for sharks.

The ‘utilization’ provision of the WCPFC’s CMM 2008-06 (Paragraph 6) allows retained carcasses to be headed, gutted and skinned at sea and requires that those carcasses be retained until the point of first landing or transshipment. The fin:carcass ratio provision (Paragraph 7) allows for the fins to be removed

from the shark at sea but seeks to ensure that the corresponding weight of carcasses are also retained. Paragraph 7 of the CMM requires CCMs to 'encourage' their fishers to return incidental catch of sharks taken alive and not used for feed or other purposes to be released alive. The objectives of these requirements are twofold:

1. *to prevent wastage of the carcass*, acknowledging that in many cases the sharks are retained for the value of their fins rather than their meat and other products; and
2. *to reduce shark mortality* in tuna fishing operations by providing an economic incentive to return live sharks to the water and to avoid taking sharks incidentally, and to provide a disincentive to targeting sharks only for their fins.

These provisions:

- seek to reduce shark mortality through indirect means;
- provide no guarantee that shark products are ultimately utilized;
- are applied to sharks generically rather than being capable of addressing species-specific issues; and
- provide no indication of the intended level of reduction in mortality, whether the reductions achieved are consistent with sustainable levels of take, or in the absence of information about sustainable levels of take, whether they are consistent with a precautionary approach.

In order for fin:carcass ratios to be successful in achieving improved utilization of shark and reducing shark mortality a number of assumptions have to hold true. These assumptions, along with a consideration of their validity, are provided in Table A3.1.

Table A3.1 Analysis of assumptions underlying fin:carcass ratio measures

Assumption	Validity
The market for shark carcasses is limited and acts as a constraint on the retention of shark carcasses and, through application of the ratio, retention of fins and provides an incentive to return incidental catch of sharks to the water and a disincentive to target shark	Valid in part. Markets for most shark meat are limited. Although these markets appear to be growing. For example Mejuto *et al.* (2007) found that shark discards were now nearly nil in the Spanish surface longline fleet targeting swordfish in the Pacific and that blue shark, in particular, was being increasingly retained. Fin:carcass ratios provide for fins to be removed from the shark carcass at sea provided that the required ratio of fin to carcass is not exceeded upon landing. Such ratios are not species-specific, and ignore the variation in fin:weight ratios across shark species. As a result it is possible to mix and match fins and carcasses to ensure that highest total value of shark products is retained while still complying with the fin:carcass ratio. Kirby (2009) estimates that where fins are allowed to be separated from the carcass at sea a 5% fin:carcass ratio allows roughly twice as many sharks to be killed as there are carcasses on board. Walsh *et a*l. (2009) report that since the introduction of a finning ban (preventing the discard of the shark carcass at sea) in the Hawaiian longline swordfish fishery there have been very large reductions in the minimum mortality estimates of sharks. Bycatch mortality (excluding post-release

Assumption	Validity
	mortality) in this fishery now consists primarily of sharks caught and subsequently released dead. However there were strong differences between the reduction in mortality (excluding post-release mortality) across shark species with the most dramatic declines (e.g. from 62% to 4% in deep sets) apparent in the mortality of blue shark which appears to be very resilient to the stress of capture. Mortality rates for other shark also declined but species remain considerably higher than that of blue sharks. For example, from deep sets the mortality rate of shortfin mako is 47%, of oceanic whitetip 26%, of bigeye thresher shark 24%, of silky shark 27% and of crocodile shark 15%. It should be noted that this fishery is also subject to 100% observer coverage, requires the use of circle hooks and has seen a significant shift to the use of mackerel rather than squid bait. All of these factors may have affected shark capture rates and/or the life status of the shark on capture. To the extent that finning controls do result in more sharks being returned to the water alive, the impact on mortality will depend on post-release survival, which will vary across species. For example, Walsh *et al*. (2009) found that reductions in bycatch mortality attained by finning prohibitions would probably be species-specific, for example while blue sharks demonstrated a strong capacity to resist the stress of capture on longline gear, all other common sharks exhibited greater sensitivity to the stress of capture or handling than blue shark. As a result reductions in bycatch mortality attained by finning prohibitions would for most species be smaller than those attained with blue shark.
The value of shark carcasses is low relative to target species and therefore competition for hold space will result in target species being retained in favour of shark species, acting as a disincentive to retain sharks	Valid in part. On its own shark meat/other shark products are generally much lower value than the target stocks with which they compete for storage space. However, the high value of fins may justify the retention of the carcass which may be either discarded or sold for low return upon landing or transshipment. Further, as restrictions on target species such as bigeye and yellowfin tunas begin to have effect, competition for hold space may not be as strong and the likelihood that sharks will be retained may increase.
The ratios are enforced	Unlikely to be valid across all fleets and even where enforcement levels are high the ratios can be extremely difficult to monitor accurately. Where fins can be removed from the carcass at sea and the fins and carcass stored separately, or unloaded separately, the likelihood of ensuring full compliance with ratios is low and enforcement costs high.
Fishers will not kill sharks taken alive prior to discarding them whole	Probably valid. Quite high proportions of sharks taken are discarded alive (see Annex 2)
Retained shark carcasses will be utilized	Not Valid. There is no restriction on the dumping of carcasses after landing or transshipment.

The CMM provides for fins to be removed from the carcass at sea and landed subject to compliance with the 5% fin:carcass ratio. However the CMM also recognizes that CCMs may require that fins be landed with their corresponding carcasses or require carcasses to be landed with fins attached in which case the 5% fin:carcass ratio would not apply. The CMM is silent on whether the ratio applies to dry or wet fin weight or to the dressed or live weight of the shark.

Allowing fins to be removed at sea but requiring that they be landed with the corresponding carcass (e.g. place fins in plastic bags and re-attach to the carcass or require that the fins and corresponding carcass be marked in such as way as they can be matched), can leave the way open for highgrading since the

enforcement officer is often not in a position to confirm that the fins and the trunk are from the same species/or animal. This approach was tried in Costa Rica but resulted in highgrading of fins (IUCN, 2008). At a minimum this approach would need to be supported by the fin:carcass ratio.

A requirement that the fins are naturally attached represents a significant strengthening of the minimum provisions since it reduces the highgrading that can occur when fins can be removed at sea and significantly eases the enforcement burden. As a result, it is more likely to act as a disincentive to retain live sharks and therefore may reduce mortality. This approach has been adopted in a number of fisheries including:

- in Australia's Commonwealth-managed fisheries operating in domestic waters and on the high seas;
- in Japan's and Taiwan's nearshore longline fleets (Hareide *et al*., 2007);
- in US Federal shark fisheries in the Atlantic Ocean and the Gulf of Mexico; and
- in fisheries in Costa Rica, Panama, El Salvador and Colombia (IUCN, 2008)

In addition:

- the IOTC Scientific Committee has identified it as the preferred method for implementing finning controls on the basis that it provides the opportunity for collection of the most information for the purposes of stock assessment and provides the greatest disincentive, in terms of storage space, to retaining sharks (IOTC, 2008);
- the *Shark Conservation Act of 2008* seeks to amend US legislation to require that all sharks taken and retained by US flagged vessels be landed with fins naturally attached. The Act has passed the House of Representatives but is yet to be voted on in the Senate;
- landing sharks with fins attached is supported by the IUCN and the European Elasmobranch Association (Hareide *et al*., 2007); and
- the 2008 United Nations General Assembly resolution on sustainable fisheries (INFA A/Res/62/177)[20] encouraged States to take immediate action to improve compliance with RFMOs measures to regulate shark fisheries by taking measures such as requiring that all sharks be landed with each fin naturally attached.

In addition to the increased potential for a 'fins attached' policy to deliver better conservation outcomes than a fin:carcass ratio it also provides a better opportunity for correctly identifying the species composition of the catch, for determining the extent of the catch on a species basis and for collecting species-specific biological and morphometric information. This information facilitates stock assessments and informs management more generally. Fishers commonly oppose the use of a fins attached policy on

[20] Available at: http://www.un.org/ga/62/resolutions.shtml

the grounds that imposes too large an impost on storage capacity. On the one hand, this is one of the inherent attractions of the policy in that it maximizes the disincentive to retain live sharks. On the other hand, the impost can be reduced by allowing the fins to be partially severed and folded back against the trunk for storage.

The fins attached policy is however no panacea for shark conservation. It does not fully remove, for example the capacity for highgrading of retained carcasses with fins attached as more valuable specimens are taken. Like all other fining controls, it has no capacity to provide protection for higher risk shark species. Further its effectiveness remains subject to the extent to which economically viable markets for shark products are available.

Ultimately, management alone cannot guarantee full utilization of any species taken, markets will determine this. Management should, however recognize its limitations in this respect and, where it is clear that utilization is not being significantly enhanced by management measures, as appears to be the case with sharks, it should adopt measures that seek to minimize the waste such as either decreasing the incidental take of shark and increasing the survival of the incidental catch of live sharks.

Taxes or prohibitions on landing or trade

Other economic disincentives to take sharks include taxes on landings or prohibitions on the trade, landing or export of sharks. Unless taxes are imposed uniformly across the PICTs, foreign fleets may simply chose to land shark products where no tax or the lowest tax is in place. Even if the tax was uniform across the PICTs foreign fleets could chose to land/transship product elsewhere. Tax collection can also impose a high administrative burden on collection agencies. Prohibitions on trade or landings would be subject to similar avoidance strategies by foreign fleets although they would be simpler to administer and enforce. Such measures do nothing to minimize interactions with captured shark and their impact will depend on how easily they can be avoided and the survival rate of additional sharks returned to the sea alive.

Prohibition on dumping after landing

The contribution of finning controls to minimizing wastage and improving utilization is compromised by the fact that after landing, shark carcasses can be discarded with no further utilization. If the value of the fins alone justifies the additional cost of storing and unloading the carcasses then, in the absence of local markets for the carcass, the economically rational decision is to discard the carcass after landing. The prohibition of such discards after landing would add a further disincentive to catching and retaining sharks. However the effectiveness of this as a measure by the PICTs will depend on the extent to which shark carcasses are currently landed in the PICTs by either domestic or foreign fleets and the available alternative landing/transshipment opportunities.

Reductions in effort in target fisheries

Management measures for target species in fisheries where sharks are taken as incidental catch have the potential to provide protection for sharks. The WCPFC's CMM 2008-01 for bigeye and yellowfin tuna seeks to reduce bigeye fishing tuna mortality by 30% over 2009-2011 and to maintain the level of mortality of yellowfin tuna. Such measures, if effective in reducing effort for target tuna stocks and if enforced by flag States, may reduce incidental catches of sharks. However, depending on the impact of these measures on the economics of fishing, they may provide an added incentive to increase retention of incidental catch of sharks and or to target sharks in order to compensate financially.