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Draft Shark Research Plan: 2016-2020

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Foreword

The first Shark Research Plan (SRP) covered 2010-2014. At its Tenth Session the Scientific Committee (SC10) agreed in 2014 on a programme of shark work for the Scientific Service Provider (SSP). This work was to be carried out in 2015, and included that the SSP draft a new SRP for consideration by SC11 to cover work in 2016-2020. This document outlines the draft 2016-2020 SRP and draws on ongoing shark research that was considered by SC11. This document was finalised after discussions at SC11.

Purpose and structure of the Shark Research Plan

This document represents a research plan for shark species of special interest (“key shark species”) to the Western and Central Pacific Fisheries Commission (WCPFC). These species are referred to here as “key sharks”, and the research plan as the “shark research plan”.

This plan is regional in scope and includes all research deemed necessary to support management of sharks as WCPFC fulfils its obligations under its convention. This plan may also support the efforts of its members to meet their obligations under other relevant international instruments. This scope draws heavily on the lessons learnt in the implementation of the first SRP.

The context and background information within this plan is primarily focussed on the current key sharks, but to maintain flexibility, it also refers to other elasmobranchs as appropriate. Furthermore, this research plan should not be viewed as one that can only be implemented through the WCPFC SSP. The WCPFC budget may not be sufficient to complete all the required work for successful implementation of the plan; member countries and other organizations will be required to undertake some of this work through funding external to the WCPFC. A large body of work is already scheduled through the Areas Beyond National Jurisdiction (ABNJ) Tuna Project (Nicol and Clark, 2014) and the International Scientific Committee for Tuna and Tuna-like species (ISC) has a Shark Working group that plans and undertakes shark research.

This Shark Research Plan is structured as follows:

1. Description of the current context for shark research and management, including the WCPFC convention and relevant Conservation and Management Measures (CMMs), other relevant international and national instruments, and a summary of progress under the first SRP (2010-14);
2. Description of the current key sharks and their status (where known), specific data gaps, and applicable management measures;
3. Summaries of the current shark data available to the work of WCPFC; and
4. A five year work plan for current key sharks.

Associated annexes include a list of ABNJ shark related work, and WCPFC related meetings, SRP related publications and shark reporting information.

Context for a Shark Research Plan for WCPFC

The Western and Central Pacific Fisheries Commission's (WCPFC) responsibilities for managing and conserving sharks in the Western and Central Pacific Ocean (WCPO) derive from *inter alia* Articles 5(d) and 10.1(c) of the Convention which state that:

"the members of the Commission shall... assess the impacts of fishing, other human activities and environmental factors on target stocks, non-target species, and species belonging to the same ecosystem or dependent upon or associated with the target stocks..."

and

"...the functions of the Commission shall be to adopt, where necessary, conservation and management measures (CMMs) and recommendations for non-target species and species dependent on or associated with the target stocks, with a view to maintaining or restoring populations of such species above levels at which their reproduction may become seriously threatened".

Other international conventions such as the Convention on International Trade in Endangered Species (CITES) and the Convention on Migratory Species (CMS) relevant to sharks have been acceded to by most WCPFC Members, CNMs and Participating Territories (CCMs). These two international conventions have listed shark species in their appendices, several of which are caught by fisheries in the WCPO. Several other non-binding international instruments, including the FAO International Plan of Action for the Conservation and Management of Sharks ("IPOA-Sharks"; FAO 1999) and United Nations General Assembly Resolutions 61/105 and 63/112 (UNGA 2006, 2008), which emphasize the responsibilities of fishing and coastal States for sustaining shark populations, ensuring full utilisation of retained shark catch and improving shark data collection and monitoring.

In an attempt to support informed management decisions, ensure sound data reporting, and support members' obligations to other conventions and agreements, the WCPFC in 2008 designated a number of species as "key shark species". The process for designating new species is outlined by Clark (2011). Once designated as key sharks, CCMs are required to report catch and effort information and support research efforts on those species (WCPFC-CMM-2010-07). Initially the list included blue shark, oceanic whitetip shark, mako sharks and thresher sharks. Silky, porbeagle (south of 30°S), hammerhead sharks (winghead, scalloped, great, and smooth) and whale sharks were added later (Table 1). At the outset it was thought that mako and thresher sharks would need to be assessed as single groups (complexes) due to species mixing in reported data. In addition, consideration was given to the possibility that blue and mako sharks may each require separate assessments for populations in the north and south Pacific. This indicates that these requirements apply to 14 species, two species complexes and two species that may have separate stocks within the Western and Central Pacific Ocean (WCPO).

In order to ensure that the research on sharks within the context of the WCPFC was appropriate and focused, the WCPFC developed a four year Shark Research Plan (SRP) that covered 2010-2014. This paper comments on progress against the former SRP, assesses the shark data holdings of the WCPFC and proposes a new SRP for the WCPFC for 2016-2020.

Current Key Shark Species in the WCPFC (including status and management)

Three of the fourteen designated key shark species (blue sharks in the north Pacific, oceanic whitetip and silky sharks) have had formal stock assessments undertaken (Rice and Harley 2012, Rice and

Harley 2013, Rice et al. 2013, ISC 2013¹, Rice *et al.* 2014), and indicator analyses have been conducted by the ISC on mako sharks in the North Pacific and by the SSP for all key sharks in the WCPO. However, hammerheads, makos and threshers were each considered as a species complex in these indicator analyses (Clarke *et al.* 2011, Rice *et al.* 2015).

The assessments found that both silky and oceanic whitetip sharks are overfished and that overfishing is occurring on both species (Rice and Harley 2012, Rice and Harley 2013). Blue sharks in the north Pacific were estimated not to be overfished and that overfishing was not taking place (Rice *et al.* 2014). The indicator analyses have shown that: overall length of mako and thresher shark complexes are declining; CPUE of the mako complex has declined relative to the 1990s south of 10° South but has remained relatively stable between 10°S and 20°N; but the thresher shark complex CPUE fluctuates without trend in most regions prior to 2010 but is low in the most recent years (Rice *et al.* 2015).

A general Conservation and Management Measure (CMM) aimed at managing sharks within the WCPFC was developed in 2006 (CMM2006-05). This measure was subsequently updated and refined in 2008 (CMM2008-06), 2009 (CMM2009-04) and 2010 (CMM2010-07). In addition, specific measures have been developed for oceanic whitetip sharks (CMM2011-04); whale sharks (CMM2012-04) and silky sharks (CMM2013-08). The general shark measure has evolved over the years but currently requires accurate reporting of key sharks, encourages live release of sharks and attempts to address issues of finning through a 5% fin to carcass ratio. In addition, CMM2014-05 was developed to reduce the use of wire traces and shark lines in tuna and billfish target longline sets. The species-specific measures all have a retention ban and reporting requirements, and the whale sharks measure also prohibits specific targeting of purse seine sets on whale sharks.

Progress against the Shark Research Plan

The Shark Research Plan (Clarke and Harley 2010) adopted by WCPFC in 2010 set out a four year plan to undertake an indicator analysis, stock status profiles, and stock assessments for the original five key sharks designated at that time. The overarching goals of the SRP included coordination of research and improvements to shark data reporting.

As the previous SRP did not cover the year 2015, SC10 recommended that: a Monte Carlo simulation of mitigation options be undertaken; an expert panel to work on the identification of appropriate life history parameters for use in shark LRPs be convened²; and a desktop examination of fins-to-carcass ratios be undertaken. In addition SC10 requested the SSP undertake an indicator analysis for all key sharks, under the SSP core shark work plan. This work (Rice *et al.* 2015) was used to inform the 2016-2020 plan below. The list below includes reporting against these work items and the major achievements of the 2010-2014 SRP:

- Two indicator analyses (2011 and 2015) for all key sharks that integrated catch rate, size, sex, maturity, distribution and species composition;
- Three accepted age-structured stock assessments for key sharks including oceanic whitetip and silky sharks, and blue sharks in the North Pacific;
- Estimated catch histories for key sharks;
- Development of CPUE and catch estimates towards the sixth planned stock assessment, for blue shark in the south Pacific;

¹ ISC. 2013. Stock assessment and future projections of blue shark in the North Pacific Ocean. WCPFC-SC9-2013/ SA-WP-11.

² Paragraph 531, SC10 summary report.

- Demonstration that the greatest longline impact on silky and oceanic whitetips is direct targeting using shark lines and not unintended bycatch;
- Two analyses of available observer data for key sharks to examine the potential for mitigation measures to reduce catch rates and increase release survival;
- Spatio-temporal analysis of whale shark interactions in the purse seine fishery;
- Inclusion of sharks within the Bycatch Mitigation Information System (BMIS);
- Development of a Shark TAGging Information System (STAGIS), a repository for information on tagging of sharks;
- Produced and distributed 400 shark identification guides to longline fleets fishing within the waters of most SIDS;
- Developed longline logsheets in multiple languages that facilitate improved reporting of key sharks;
- Numerous data summaries of SPC-held observer data to support efforts of WCPFC members;
- The WCPFC convened a Pacific shark life history expert panel workshop in April 2015; and
- A Monte Carlo simulation of mitigation options was undertaken in 2015 by the SSP.

WCPFC work related to, but outside of, the SRP include:

- The ISC has conducted an indicator analysis on NP shortfin mako;
- NOAA fisheries undertook a review of mitigation measures for shark catch in pelagic longline fisheries; and undertook an analysis collating information to inform an integrated shark conservation and management measure over the WCPO;
- New Zealand Ministry for Primary Industries assessed the New Zealand commercial catch composition of highly migratory elasmobranchs; reviewed shark meat market access; initiated work on discard mortality; and undertook a shark indicator analysis in their waters;
- The FAO undertook a global review of status and mitigation measures of bycatch in longline fisheries for tuna and tuna-like species;
- Australian Bureau of Agricultural and Resource Economics and Sciences undertook a review of shark bycatch mitigation in tuna longline fisheries; and
- International Seafood Sustainability Foundation and University of Hawaii have been undertaking collaborative work to assess post-release survival rates of silky sharks caught in purse seine fishing gear (Hutchinson *et al.* 2013³).

A full list of over 30 papers and reports produced under, and in support of, the SRP by the SSP are provided in Annex 1 and a list of meetings attended is provided in Annex 2.

Challenges for future SRP

The goal of seven shark stock assessments under the 2010-2014 SRP was not achieved, but many other activities were undertaken at the direction of the SC and WCPFC. For the first time we know the stock status of three WCPO shark stocks (blue sharks in the North Pacific, oceanic whitetip and silky sharks); experience has been gained on how best to tackle shark assessments and indicator analyses; our understanding of gears that catch (and don't catch) sharks has improved; and data collection is slowly improving.

Key lessons that have been learned through this work are:

- WCPFC funding has in the past not been sufficient to deliver all the work in the SRP and annual WCPFC-SPC shark work plan. On average 30-40% of the annual SSP resources

³ Hutchinson, M., Itano, D., Muir, D., Leroy, B. and Holland, K. 2013. Fishery interactions and post-release survival rates of silky sharks caught in purse seine fishing gear. WCPFC-SC9-2013-EB-WP-12.

required to deliver the WCPFC shark-related services needed to be sourced from other SPC donors to meet the WCPFC requests;

- The shark stock assessments require at least as many resources as the tuna assessments. Unfortunately shark data have been inconsistently provided to the WCPFC and/or SPC, as a result the SSP was required to often estimate catch for the WCPO from limited data which adds to the uncertainty of model outputs and increases the workload and time required for these assessments;
- The shark assessments rely more heavily (than the tuna assessments) on data not held by WCPFC or SPC. For the two assessments that required iteration, data not held by SPC were key drivers in the requests for further work, which added to the expense of the assessments and time required to complete them;
- Collaboration between the SPC and ISC is productive, but is extremely resource intensive. Between the ISC Shark WG and ISC plenary, there can be 3-4 meetings per year which the SSP did not have sufficient resources to attend;
- The SC and WCPFC concern for sharks is reflected in their desire for science-based management. The unscheduled work e.g. the work required on shark mitigation measures and whale sharks are two examples of WCPFC's requests to the SSP over and above the SSP core shark work; and
- CCMs have been slow to pick-up some of the work such as mitigation and release survival. This work should be co-ordinated through the SRP to achieve the best overall results, and reduce duplication.

Summary of SPC/WCPFC⁴ shark data holdings

The shark data holdings by SPC and WCPFC are reviewed annually through the WCPFC Data Catalogue (<http://www.wcpfc.int/wcpfc-data-catalogue>). Relevant statistics are highlighted below.

The provision of annual catch estimates for key sharks has been a WCPFC requirement since 2007. Submissions are summarized in Table 2. The annual coverage of shark catch data across the raised aggregate longline data set, that includes actual and estimated effort for all fleets operating in the Convention Area, are presented in Figure 1. These include sets with no reported shark catch, which will include both true zeros and non-reporting of sharks. Note that changes between zero, generic shark and key sharks reported are assumed to be changes in reporting rates and not changes in species composition of the catch.

Prior to 1990 there was very little information on shark catch and what was available was not species-specific, as almost all sharks that were reported were reported to the generic shark code SHK (Figure 1). Since then there has been a sustained and continuing increase in the reporting of sharks, both to generic and species-specific codes. Despite this, over the past ten years less than a third of the reporting is species-specific and it is not clear whether these reports include discards. This indicates that reporting is improving but challenges remain in assessing sharks and generating plausible catch and CPUE time series. Since 2010, however, species-specific reporting of key sharks jumped and now averages just over 50% of reported sharks (Figure 1), this may reflect a change in logsheet form use to the SPC extended format longline logsheet (see below) and/or WCPFC members developing their own logsheets that require species specific reporting. However, some fleets, while reporting key sharks to species level, may report all other sharks as SHK. Note that some fleets may record all sharks to species level, but the WCPFC data reporting requirements only require species-specific reporting of key shark species, so the category SHK could include some non-key sharks aggregated to SHK prior to data submission.

⁴ These are the combined data holdings. Some are SPC-only data, some WCPFC-only, and some are both.

The requirement to increase longline observer coverage to 5% had been in effect since 1 June 2012. While only 50%⁵ of members are meeting this obligation (WCPFC Circular No.: 2015/35), full implementation and compliance with this measure will be critical to improving data on sharks and other bycatch. In addition, in order to assess shark and other bycatch quantitatively, 5% coverage of hooks set⁶ that is spatially and temporally representative of the fishing effort will be required⁷ though we recognize that there is flexibility (in term of metrics) in how states implement their observer coverage against the 5% level.

Table 3 provides a summary by flag and EEZ of any reported key sharks from either logsheet or observer data and includes both purse seine and longline.

The Data Collection Committee (a joint SPC/FFA initiative) develops forms that can be used across the region. These forms are developed to be consistent with the WCPFC guidelines for the provision of data. The expanded longline logsheet, developed in 2009, allows the collection of data for all key sharks⁸. These forms are being used increasingly by coastal states in the region and are available in English, Japanese, Korean, Spanish and Mandarin. They are also being trialled as electronic forms by a number of states. Copies of the expanded longline logsheet are freely available through the SPC website⁹. Please contact SPC if versions in other languages are required.

Research Plan for WCPFC Key sharks: 2016-2020

This section includes a list of work and aimed at guiding the Scientific Committee while formalising the SRP project list, the list is somewhat generic in nature to allow the SRP flexibility to respond to upcoming needs of the Commission. Nevertheless specific projects are required for the Scientific Committee's annual research planning and budgeting. Table 5 lists the proposed work under the SRP for 2016 with indicative budgets, while Table 6 includes proposed work. It is envisaged that SC11 will review and finalise the 2016 project list and the SC will then review the next year's proposed work (listed in Table 6) annually thereafter. A draft list of scheduled work under the SRP appears in Annex 5.

Stock assessments

- **Stock assessments for blue and mako sharks in the South Pacific Ocean:** Noting that current WCPFC resources only allow for one shark assessment per year and taking into consideration changes in available data and stock status, SC11 should develop a schedule of shark assessments. The SRP proposes that assessments be scheduled along with the tuna assessments (Table 4). This proposal recommends an assessment for blue sharks in the south Pacific in 2016 and mako sharks in the south Pacific in 2017. Both of these species have had CPUE standardisations attempted and the catch histories for blue sharks have been constructed. Both species (particularly blue shark) are relatively data rich (compared to other sharks) and have data in numerous regions going back in some instances to 1995. As a result the SSP is well placed to attempt these assessments within its current core shark funding. There is some urgency to undertake these assessments as stock status is currently unknown and extractions have been relatively high over the last decade;

⁵ Note members calculated their coverage rates using different units.

⁶ Observed hooks set is used here because it is a "common currency" and allows for the standardisation of observer coverage rates between fleets when undertaking analyses.

⁷ Note that the SC recommends that to assess rare events 20% coverage is required.

⁸ Note that the mako, hammerhead and thresher sharks are included in the logsheet, but not separated to species level. However, there is provision made for "other species" where these data can be captured if fishing captains can identify the different species and are instructed to fill the forms out in a way that will capture these data.

⁹ <http://www.spc.int/oceanfish/en/data-collection/241-data-collection-forms>

- **Stock assessments for silky and oceanic whitetip sharks in the Western and Central Pacific Ocean:** Both silky and oceanic whitetip sharks have had assessments undertaken in recent years. As a result there is a lower priority for assessments of these species in the next two years. It is recommended that these assessments be undertaken in 2018 and 2020 respectively;
- **Assessment methods (Stock assessment model type):** The stock assessments should be age-structured assessments that integrate various data sources. These assessments should provide stock status estimates against $SB/SB_{F=0}$ and F/F_{MSY} ratios as per the discussions at SC10, until such time as elasmobranch specific reference points are developed and accepted by the WCPFC;
- **Assessment methods (Initial levels of depletion):** It is important to determine the initial depletion levels at the start of a stock assessment period, as this places the current stock biomass in context of historical levels. All of the shark stock assessments carried out to date have input data starting more recently than the tuna assessments and therefore can be expected to begin well into the time period under which sharks have been exploited. An investigation therefore needs to be undertaken to estimate the initial depletion levels for assessed shark stocks, and make recommendations as to how to deal with this issue in future assessments;
- **Assessment methods (Limit reference points for elasmobranchs):** Article 10.1(c) of the convention text notes that for non-target species the aim should be "*maintaining or restoring populations of such species above levels at which their reproduction may become seriously threatened*". Defining this and determining what level this will represent on a $SB/SB_{F=0}$ scale is an important step and will allow the Scientific Committee to better advise on shark stock status for assessing the level of stock depletion. Taking into account the limit reference point framework adopted by the WCPFC for target species, this work should develop and recommend a suite of limit reference points for the Scientific Committee's consideration for elasmobranchs.
- **Assessment methods (Spawner recruit relationship):** The spawner recruitment relationship for elasmobranchs is particularly opaque and difficult to estimate in assessments. This opacity resulted in particular problems in some previous assessments, particularly for the blue shark assessment in the North Pacific model that used the low fecundity spawner recruitment relationship, where the resulting stock status conclusions were extremely sensitive to the shape of the curve. An assessment of the appropriate way to model elasmobranch stock recruitment relationships should be undertaken. Note the ISC SHARKWG has planned work using a meta-analysis to assess shark stock recruitment relationships in general;
- **Shark Indicator analyses:** If shark indicator analyses are to be used as quantitative assessments for data poor stocks, 5% observer coverage of hooks set⁴ that is spatially and temporally representative of the fishing effort will be required. Without this level of observer coverage, the data are biased by observer program effort and will not be representative of all the WCPO longline fisheries. Observer data on sharks should be effectively collected and standardised to the extent possible (see below). Once all flag states consistently achieve 5% observer coverage of hooks set and provide the data to the WCPFC/SPC, it is recommended that annual indicator analyses be undertaken using observer data for all key sharks not being assessed with an age structured model in any given year;
- **Hammerhead shark analysis:** Data on hammerhead sharks are extremely sparse; these species are both oceanic and coastal and are very patchy in time and space (Rice *et al.* 2015). As a result an age-structured modelling approach is unlikely to result in a reliable estimate of stock status. Work on hammerhead sharks should focus on improving the data for these species, quantifying the catch and illuminating the species composition;

- **Thresher shark analysis:** Thresher shark sample sizes were small and mainly comprised of juveniles in tropical areas (Rice *et al.* 2015). There are patchy observer records going back to 1995 in the western and eastern equatorial regions of the WCPO. In the eastern WCPO thresher sharks can comprise as much as 12% of the shark catch (Rice *et al.* 2015). In addition thresher shark records occur in both deep and shallow sets (as determined by the number of hooks between floats). An attempt should be made to assess the thresher shark species composition in deep and shallow sets regionally as this may allow catch estimates to be separated by species and scaled by set type when no species specific data are available. This may also provide an opportunity for more detailed analyses on these species in a limited region. It is recommended that species separation work and CPUE standardisations be attempted for these species;
- **Review data for non-key shark elasmobranchs:** Assess the data available to review elasmobranch species composition and catch by longline and purse seine set type. This may also provide an opportunity for more detailed analyses on these species in a limited region. The work should include an assessment of mobulid species and their interactions with fisheries managed by the WCPFC and prepare a paper for SC12 for consideration of these species for designation as WCPFC key sharks.
- **Shark catch histories:** As the data for many key sharks is sparse (Rice *et al.* 2015) considerable effort is required to construct a catch history for each species. A dedicated project that develops methods to construct shark catch histories and apply them to the current key sharks will be extremely valuable and result in an accepted catch history for each species. It is recommended that a project to construct catch histories using analytical approaches that use all available information for all key sharks be undertaken. This work should account for changes in biomass, if known, and include high and low series that can be used as sensitivity analyses during future stock assessments. For some species this may be possible in the short-term, while for others e.g. threshers and hammerheads, clarifying the species composition of the catch first may be appropriate; and
- **CPUE analyses:** Standardised CPUE indices can be an informative way to assess changes in stock biomass in the absence of any other information. It is recommended that building on the 2015 indicator analysis (Rice *et al.* 2015) CPUE standardisation be undertaken for whale sharks and thresher sharks.

Stock discrimination

- **Stock discrimination of key sharks:** Stock discrimination work is important for assessing the boundaries of the assessment models and the management framework. Stock discrimination can be assessed using a number of tools e.g., tagging, genetics or inferred from trends in fisheries data. SC11 should discuss which of these methods would be the most appropriate. However, if this work is linked to the tagging component of post-release survival work (above), the tags could be set with a long delay in the pop-off date and resulting movement information could assist in informing stock boundaries. If this dual purpose of the tagging component is desirable, careful consideration will need to be taken as to the spatio-temporal distribution of released fish in order for those releases to be informative from a stock discrimination perspective, as well as informing mortality. In this scenario additional tags (to the ones used in the post-release survival work) would need to be purchased as that component of the work would have to be focused on healthy, lively fish, but cost savings may occur through the use of the same research platform or observers experienced in tagging fish.

Biological research

- The WCPFC Pacific shark life history expert panel workshop recommended that:

- **Review conversion factors:** Review all available length-length and length-weight conversion factors in detail, comparing coefficients and excluding any dubious values. The goal of this study would be to identify which conversion factors are most appropriate for each species and region. These could then be applied consistently across the region;
- **Age and growth analyses:** Undertake studies to reduce the uncertainty associated with understanding the population age structure. A detailed review should be conducted first, using the findings and references from the WCPFC Pacific shark life history expert panel workshop as a starting point. The analysis should identify which species, for which ages within those species and for which regions, the age and growth uncertainties are highest.
- **Shortfin mako shark fecundity:** Assess the relationship between maternal length and litter size in shortfin mako sharks and assess pupping frequency; and
- **Shark biology:** Biological parameters of longfin mako, the three threshers and the smooth hammerhead are still unknown. As these issues are major contributors to uncertainty in population assessments and our understanding of their susceptibility to exploitation, further studies on reproductive periodicity, age and growth are urgently required.

Mitigation work

- **Post-release survival:** Undertake experiments to estimate post-release survival of key sharks. This work should include: fish released from both longline and purse seine gear; specific information on each individuals' release condition; include individuals released that are "lively and likely to survive" as well as those "alive but moribund"; include a detailed account of the gear that caught the fish (e.g. hook type, leader type...); and be undertaken across a representative selection of the size range in the catch. It is envisaged that a two-staged approach be used to investigate this. Firstly tagging with PSAT or mortality tags (after taking a blood sample), and secondly, using blood chemistry to estimate mortality rates on a larger sample size e.g. Hutchinson *et al.* (2013). Note that Clarke *et al.* (2013)¹⁰ calculated that the "*minimum number of tags required to obtain a reasonable estimate of mortality rate for each condition class and stratum is 12. This allows for failure of two tags, leaving 10 results from which to estimate mortality. We stress that this number of tags may not provide a precise estimate of mortality rate, and the estimate may also be adversely affected (biased) by other factors not accounted for in the experiment (e.g. shark size, soak time, different handling practices aboard vessels). For example, a sample size of 10 means that mortality rates are calculated in increments of 10%, and the error around that percentage would depend on the actual proportional mortality. The key to getting reasonable mortality estimates from small tag numbers is the consistent application of condition criteria across observers*". This would indicate that for silky sharks with a 3-class condition scale 36 tags would be required to be deployed in each Region assessed;
- **Effectiveness of shark mitigation:** Undertake specific experimentation to assess the effectiveness of shark mitigation in longline and purse seine fisheries. As a first step, this should include experimentation to assess the impact of varying hook type and branchline leader material on shark catch (Harley *et al.* 2015). In order to save costs there may be opportunities to link the field component of this work to the post release survival work; and
- **Mortality estimates of released key sharks:** Using the information from the preceding elements, develop regional and annual mortality estimates (numbers of fish) of released key sharks in the WCPO.

¹⁰ Clarke, S.C, Francis, M.P. and Griggs, L.H. 2013. Review of shark meat markets, discard mortality and pelagic shark data availability, and a proposal for a shark indicator analysis. New Zealand Fisheries Assessment Report 2013/65.

- **Monte Carlo simulation:** Undertake a Monte Carlo simulation analysis to assess the effectiveness of shark mitigation. This work should expand on the work presented to SC11 and should a) account for flag-state choice between prohibition of shark lines and/or of wire leader with respect to CMM 2014-05; b) add additional modeling of combinations of available mitigation options; and c) inclusion of purse seine fisheries to assess the effects on fishing mortality of sharks when effort on FAD sets was re-distributed to unassociated sets.

Improved data quality and availability

- **Observer form re-development:** Observers recording shark discards and releases should record details of the shark condition that can be linked to the release survival work, as well as detailed information on the gear that caught the shark. It is recommended that an observer form re-development process be undertaken to ensure that observers collect the appropriate data on handling and release of sharks and gear specifics. We note that this may require a decision of WCPFC.;
- **Shark identification material development:** Development of materials that may lead to better reporting of species-specific catch and discards of sharks on commercial logbooks (e.g., ID guides and posters);
- **Shark processed state identification material development:** Development of materials that assist species identification of sharks in various processed states for port and transshipment monitoring. The FAO has developed an electronic shark fin species identification system, this should be tested within the context to the WCPFC and additional supporting material on other processed states e.g. trunks should be developed; and
- **Research co-ordination:** Ongoing coordination of research activities and provision of a central repository for scientific information on sharks in the Pacific and beyond (e.g. BMIS and STAGIS).

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Table 1. WCPFC key sharks, the years in which they were designated as key species and most recently assessed, and the year each was listed by CITES (if applicable) and the stock status[†] (Modified from Clarke et al. (2014)). NP = North Pacific.

WCPFC Key sharks	WCPFC Key Species Listing	Accepted Stock Assessment	Indicator or Other Analysis Produced?	CITES Listed (Appendix)	Stock status
Blue shark (<i>Prionace glauca</i>)	2008	NP Finalized (2014)	2011, 2015		Not overfished No overfishing
Mako shark (<i>Isurus</i> sp.)	2008		2011, 2015		Length declining* CPUE low relative to 1990s*
Shortfin mako shark (<i>Isurus oxyrinchus</i>)	2008		2011, 2015 (<i>Isurus</i> spp. only)		Unknown
Longfin mako shark (<i>Isurus paucus</i>)	2008		2011, 2015 (<i>Isurus</i> spp. only)		Unknown
Oceanic whitetip shark (<i>Carcharhinus longimanus</i>)	2008	Finalized (2012)	2011, 2015	2013 (II)	Overfished Overfishing
Thresher shark (<i>Alopias</i> sp.)	2008		2011, 2015		Length declining* No change in CPUE
Bigeye thresher shark (<i>Alopias superciliosus</i>)	2008		2011, 2015 (<i>Alopias</i> spp. only)		Unknown
Common thresher shark (<i>Alopias vulpinus</i>)	2008		2011, 2015 (<i>Alopias</i> spp. only)		Unknown
Pelagic thresher shark (<i>Alopias pelagicus</i>)	2008		2011, 2015 (<i>Alopias</i> spp. only)		Unknown
Silky shark (<i>Carcharhinus falciformis</i>)	2009	Finalized (2013)	2011, 2015		Overfished Overfishing
Porbeagle shark (<i>Lamna nasus</i>)	2010		2015	2013 (II)	Unknown
Great hammerhead shark (<i>Sphyrna mokarran</i>)	2010		2015 (all hammerhead sharks pooled)	2013 (II)	Unknown
Scalloped hammerhead shark (<i>Sphyrna lewini</i>)	2010		2015 (all hammerhead sharks pooled)	2013 (II)	Unknown
Smooth hammerhead shark (<i>Sphyrna zygaena</i>)	2010		2015 (all hammerhead sharks pooled)	2013 (II)	Unknown
Winghead shark (<i>Eusphyra blochii</i>)	2010		2015 (all hammerhead sharks pooled)		Unknown
Whale shark (<i>Rhincodon typus</i>)	2012		2013, 2015	2002 (II)	Unknown

[†] For species with an indicator analysis and a stock assessment, the stock assessment results are used.

* The trends from Rice *et al.* (2015); the trends here are for most but not necessarily all regions.

Table 2: Provision of annual catch estimates of blue, mako, silky and/or oceanic whitetip sharks. Note this does not include the full list of key sharks, but see Annex 4 for details.

Country	Years
Australia	1991-2014
Belize	2011-2014
Cook Islands	2009-2014
China	2010-2014
Spain (EC)	2006-2014
Fiji	2011-2014
Federated states of Micronesia	2009-2013
Japan	2006-2014
Kiribati	2010-2014
Republic of Korea	2011-2014
Marshall Islands	2009-2013
New Caledonia	2001-2014
New Zealand	2000-2014
French Polynesia	2009-2014
Papua New Guinea	2009-2014
Portugal (EC)	2011-2014
Tonga	2009-2014
Taiwan	2009-2014
USA	2005-2014
Vanuatu	2009-2014
Samoa	2009-2014

Table 3: Longline reported and observed shark catch by location (all flags in EEZs or International Waters; left) and by flag (in all areas; right). The cell shading represents either zero (light blue), low numbers less than 100 sharks (medium blue) or high numbers (more than 100) reported and observed for 2010-2014. Based on WCPFC/SPC data holdings (i.e., logsheet and aggregate catch data plus observer records) for longline fisheries. BSH=blue shark, OCS=oceanic whitetip shark, FAL=silky shark, SMA=short-fin mako, LMA=long-fin mako, MAK=mako, ALV=common thresher, PTH=pelagic thresher, BTH=bigeye thresher, THR=thresher, SPK=great hammerhead shark, SPZ=smooth hammerhead shark, SPL=scalloped hammerhead, SPN=hammerhead shark, POR=porbeagle shark, RHN=whale shark.

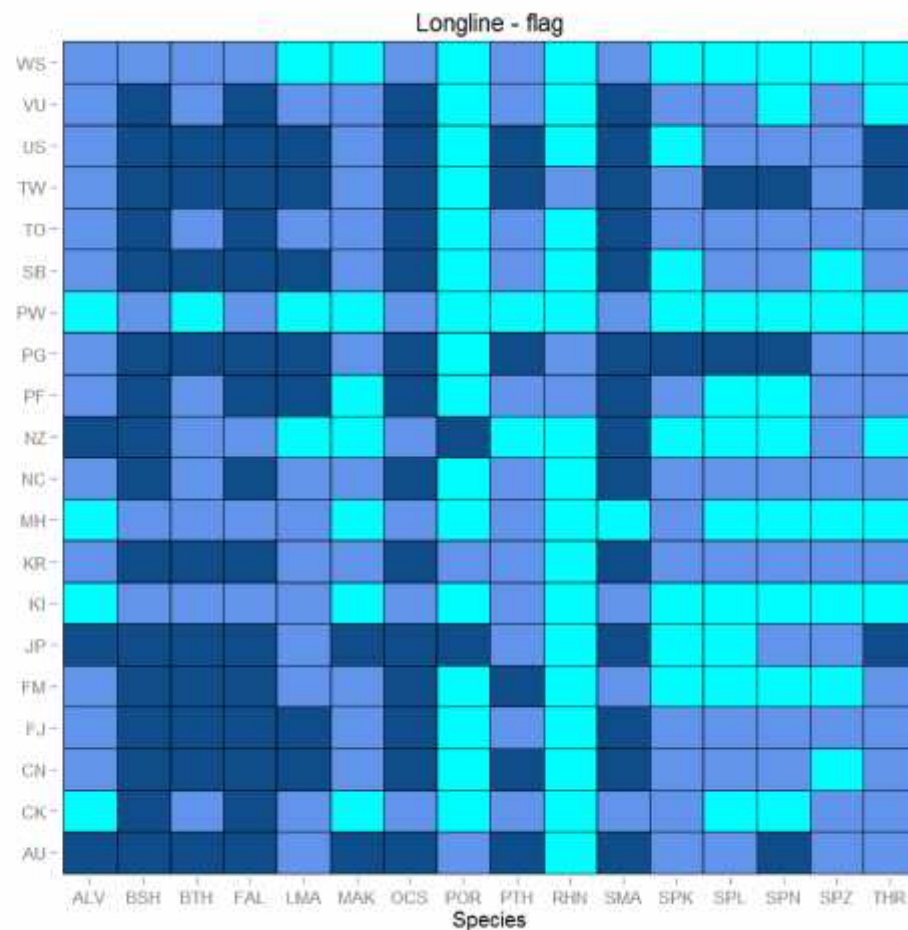
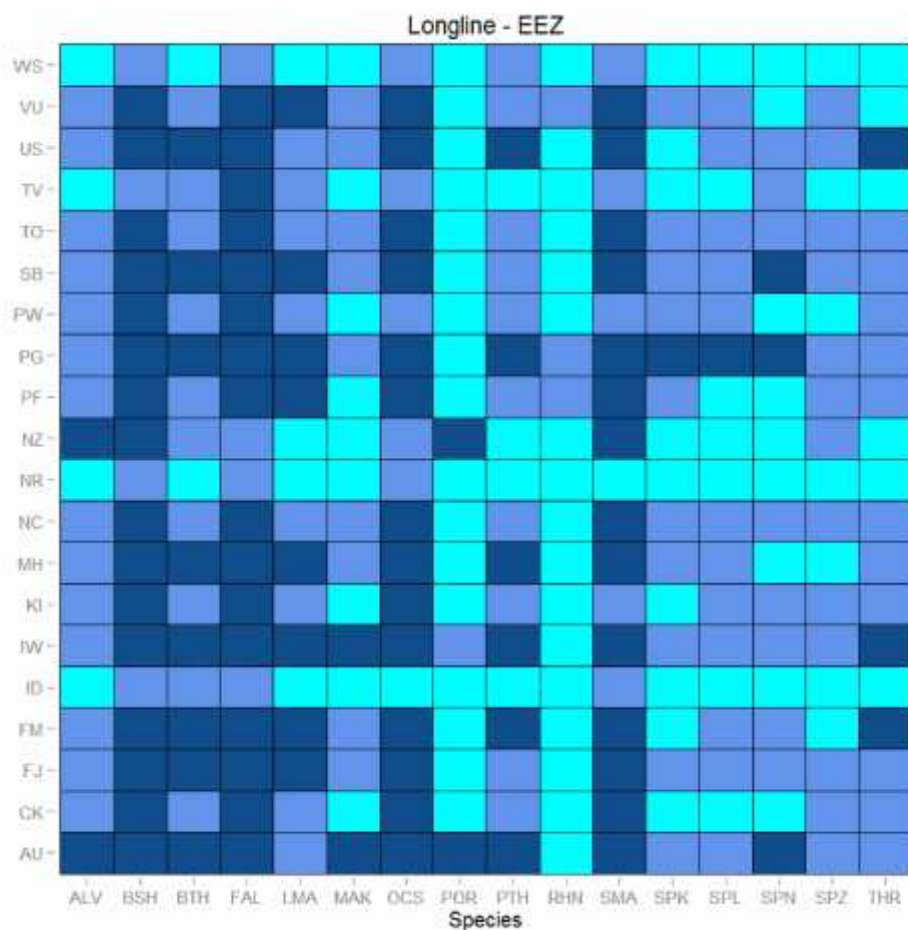


Table 4: Purse seine reported and observed shark catch by location (all flags in EEZs or International Waters; left) and by flag (in all areas; right). The cell shading represents either zero (light blue), low numbers less than 100 sharks (medium blue) or high numbers (more than 100) reported and observed for 2010-2014. Based on WCPFC/SPC data holdings (i.e., logsheet and aggregate catch data plus observer records) for purse seine fisheries. BSH=blue shark, OCS=oceanic whitetip shark, FAL=silky shark, SMA=short-fin mako, LMA=long-fin mako, MAK=mako, ALV=common thresher, PTH=pelagic thresher, BTH=bigeye thresher, THR=thresher, SPK=great hammerhead shark, SPZ=smooth hammerhead shark, SPL=scalloped hammerhead, SPN=hammerhead shark, POR=porbeagle shark, RHN=whale shark.

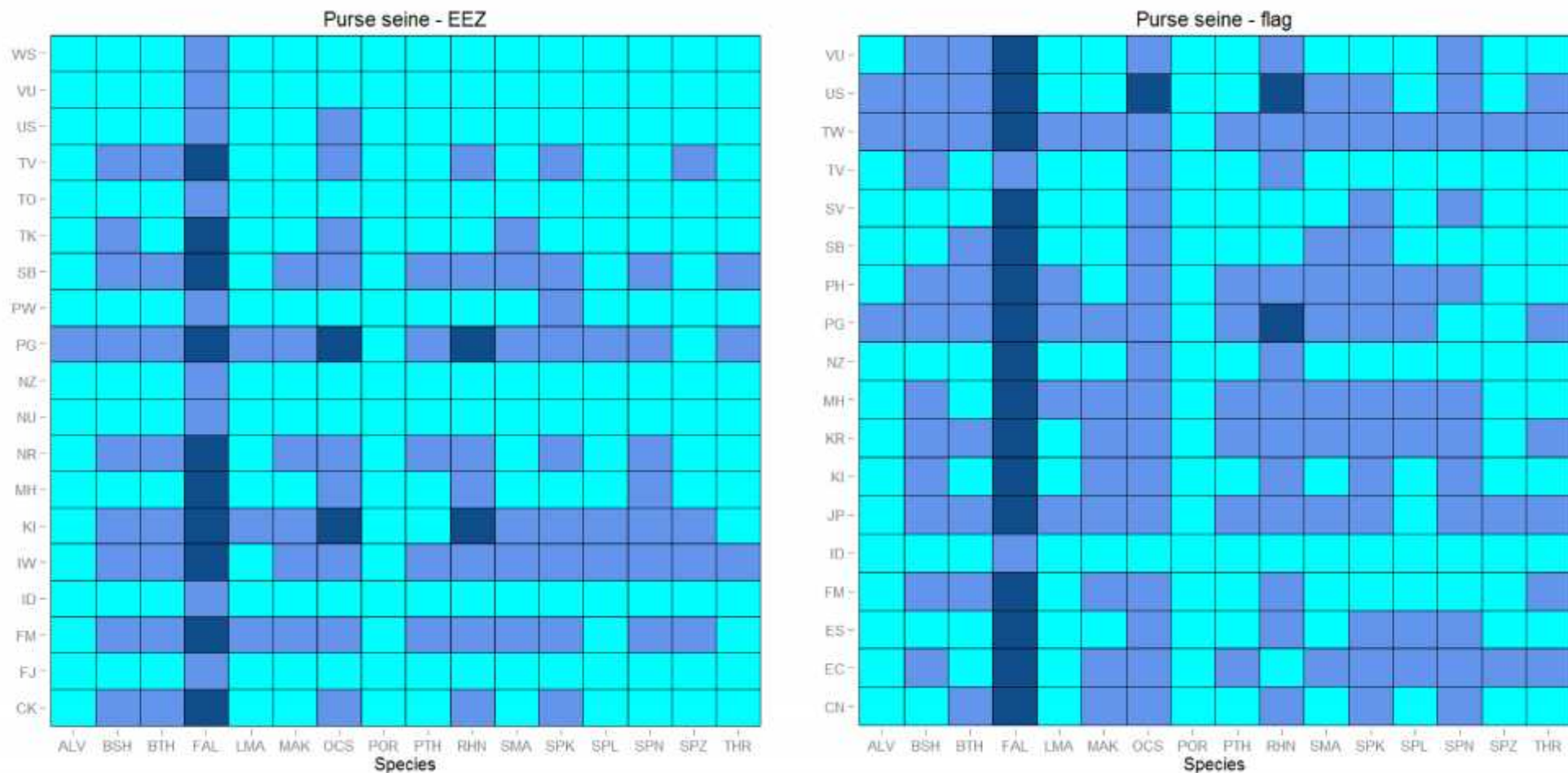


Table 4: WCPFC SC stock assessment schedule 2013-2020. X = scheduled by SC; ? = proposed by ISG1/SRP, but still to be confirmed by SC.

Species	Stock	Last assessment	2013	2014	2015	2016	2017	2018	2019	2020
Bigeye tuna	WCPO	2014		X			X			X
	Pacific-wide	-			X					
Skipjack tuna	WCPO	2014		X		X			X	
Yellowfin tuna	WCPO	2014		X			X			X
Albacore	South Pacific	2012			X			X		
Striped marlin	Southwest Pacific	2012						X		
	Northwest Pacific	2012						?		
Swordfish	Southwest Pacific	2013	X				X			
Silky shark	WCPO	2013	X					?		
	Pacific-wide	-								
Oceanic whitetip shark	WCPO	2012							?	
	South Pacific								?	
Blue shark	Southwest Pacific	-				X				
	Northwest Pacific	2014		X			X			
Mako shark (shortfin)	Southwest Pacific	-						?		
	Northwest Pacific	-						X		
Porbeagle	Southern Ocean	-			X*					
Thresher	WCPO	-								
	Pacific-wide	-				X*				
Hammerhead	WCPO	-	No assessment scheduled but other work proposed in Table 6							
	Pacific-wide	-	No assessment scheduled							
Whaleshark	WCPO	-	No assessment scheduled but other work proposed in Table 6							
	Pacific-wide	-	No assessment scheduled							

* co-ordinated through the ABNJ

Table 5: Projects identified by the Shark Research Plan to be carried out in 2016. If approved at SC11 the terms of reference for these projects can be developed by the Secretariat at SC11. Note this does not include work being conducted under the ABNJ Tuna Project or the ISC, the ISC projects will be included (for information and to avoid duplication of work) after the meeting of the 2015 ISC SHARK WG; ABNJ projects are listed in Annex 3.

Project title	Start date	Completion date	Organisation	Budget (US\$)
Blue shark stock assessment in the south Pacific	January 2016	August 2016	SPC-OFP	‡
Thresher shark indicators/assessment Pacific-wide.	Jan 2016	December 2016	ABNJ-Sharks	
Length-weight conversion factor review	January 2016	August 2016		10,000
Develop proposed target and limit reference points for elasmobranchs	January 2016	December 2016		25,000
Monte Carlo analysis of mitigation approaches: extension of longline analysis and develop model for purse seine	Jan 2016	August 2016	SPC-OFP	25,000
Maternal length and litter size in shortfin mako sharks	January 2016	December 2016	ISC (TBC)	30,000
Post-release survival of silky and oceanic whitetip sharks from longline sets	January 2016	December 2017	SPC-OFP + collaborators	250,000+
Post release mortality of sharks and rays from longline and purse seine vessels (EU)	Jan 2016	December 2017	?	44,000 (per anum)
Experimental assessment of hook type and branchline leader material on shark catch	January 2016	December 2017	SPC-OFP + collaborators	150,000
Observer form re-development to collect data on handling and release of sharks	January 2016	December 2016	SPC-OFP+FFA	‡
Review data for non-key sharks elasmobranchs	January 2016	December 2016	SPC-OFP	‡

‡ SPC core shark funding.

Table 6: Schedule of WCPFC shark projects for 2016-2020. CCMs who have committed to undertaking any of this work should inform the Secretariat and the SC to avoid duplication of effort and work toward standardisation of parallel work. A full project list appears in Annex 5.

Species	Stock	2016	2017	2018	2019	2020
Blue shark	Southwest Pacific	Stock assessment				
	Northwest Pacific		Stock assessment			
Mako shark	Southwest Pacific	Litter size and birth frequency		Stock assessment		
	Northwest Pacific		Update catch history	Stock assessment		
Porbeagle	Southern Ocean?					
Silky shark	WCPO	Post-release survival		Stock assessment; Post-release mortality from longline sets		
	Pacific-wide				Stock discrimination	
Oceanic whitetip shark	WCPO	Post-release survival		Post-release mortality from longline sets	Stock assessment	
Thresher	WCPO		Update catch history		Stock discrimination	
	Pacific-wide	Indicators analysis		Biological research to determine species specific age, growth and reproductive parameters		
Hammerhead	WCPO	Improve data collection by observers	Species composition of the catch	Update catch history	Stock discrimination	
	Pacific-wide			Biological research to determine species specific age, growth and reproductive parameters		
Whale shark	WCPO		Develop standardised CPUE index	Stock discrimination		
	Pacific-wide					
General shark work	WCPO	Review data available for non-key shark elasmobranchs; Observer form re-development; Conversion factor review; Target and limit reference points; Monte Carlo analysis of mitigation; Post release mortality of sharks and rays from longline and purse seine gear	Investigate the initial depletion levels for assessed shark stocks; Update catch histories; Development of materials for species identification of sharks in processed states; Post release mortality of sharks and rays from longline and purse seine	Assess spawner recruit relationships; Shark indicator analysis*; SRP mid-term review		Develop a 2021-2025 shark research plan to be presented to SC16 in 2020

* SC to assess if all flags have achieved at least 5% observer coverage (of hooks set) and are submitting their observer data to WCPFC and/or SPC, prior to proceeding with this work.

Shark catch data coverage for the longline fishery (1950-2014)

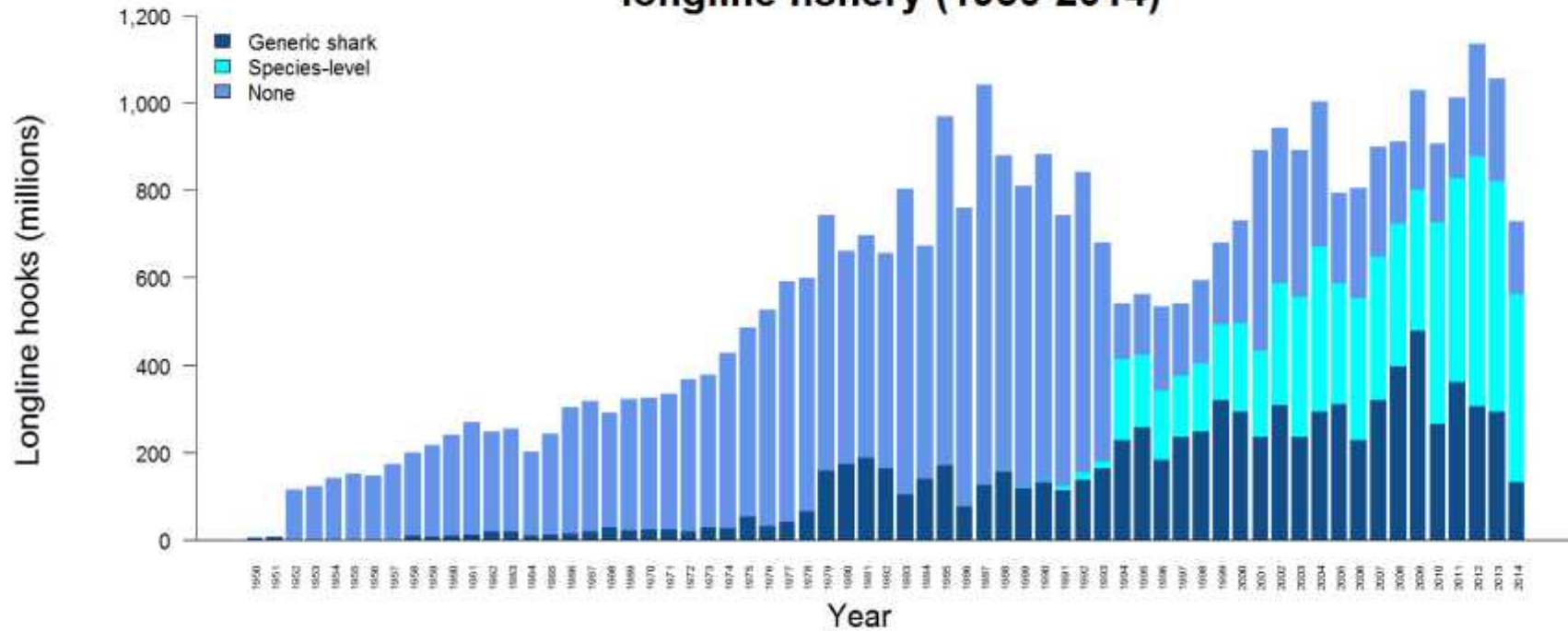


Figure 1: Shark reporting as shark or species-specific reporting from aggregate longline catch and effort data for all WCPFC CCMs pooled. Generic shark = reporting to the generic shark code SHK; Species-level = reporting sharks to species level; and None = the number of longline sets that reported no shark catch this category will include real zeros and non-reporting. Data for 2014 are incomplete. The CCM specific data are included in Annex 4.

Annex 1: Scientific papers and reports produced under, and in support of, the Shark Research Plan by SPC-OFP.

- Bromhead, D., et al. 2013. Potential approaches to mitigate bycatch of oceanic whitetip and silky sharks from longline fisheries. WCPFC-SC9-EB-WP-02.
- Caneco et al. 2014. Analysis of WCPO longline observer data to determine factors impacting catchability and condition on retrieval of oceanic white-tip, silky, blue, and thresher sharks.
- Clarke, S. 2011. A Proposal for a Process for Designating WCPFC Key Shark Species for Data Provision and Assessment. WCPFC-SC7-EB-WP-05.
- Clarke, S. 2011. A status snapshot of key shark species in the western and central pacific and potential mitigation options. WCPFC-SC7-EB-WP-04.
- Clarke, S., et al. 2011. A progress report on the shark research plan. WCPFC-SC7-EB-IP-01.
- Clarke, S., et al. 2011. An indicator-based analysis of key shark species based on data held by SPC-OFP. WCPFC-SC7-EB-WP-01.
- Clarke, S., et al. 2011. Analysis of North Pacific Shark Data from Japanese Commercial Longline and Research/Training Vessel Records. WCPFC-SC7-EB-WP-02.
- Clarke, S., et al. 2013. Population Trends in Pacific Oceanic Sharks and the Utility of Shark Finning Regulations. *Conservation Biology* 27(1) 197-209.
- Clarke, S.C. and S.J. Harley. 2010. A Proposal for a Research Plan to Determine the Status of the Key Shark Species. WCPFC-SC6-2010/EB-WP-01. Accessed online at www.wcpfc.int/.../WCPFC-SC6-2010_EB-WP-01_Research_Plan_to_determine_status_of_Key_Shark_Species.pdf
- Clarke, S.C. and S. Hoyle. 2014. Development of Limit Reference Points for Elasmobranchs. WCPFC-SC10-2014-MI-WP-07.
- Clarke, S.C., T. Lawson, D. Bromhead and S.J. Harley. 2010. Progress toward Shark Assessments. WCPFC7-2010-16.
- Harley, S. J., and Rice, J. 2013. Progress report on the Shark Research plan. WCPFC-SC9-EB-WP-06.
- Harley, S. J., and Williams, P. 2013. Spatial and temporal distribution of whale sharks in the WCPO based on observer data and other data sources. WCPFC-SC9-EB-WP-01.
- Harley, S.J, Donovan, C. and Caneco, B. 2015. Monte Carlo analysis of measures to mitigate longline impacts on silky and oceanic whitetip sharks. WCPFC-SC11-EB-WP-02.
- Lawson, T. 2011. Estimation of Catch Rates and Catches of Key Shark Species in Tuna Fisheries of the Western and Central Pacific Ocean Using Observer Data. WCPFC-SC7-EB-IP-02.
- Manning, M.J., Bromhead, D.B., Harley, S.J., Hoyle, S.D. 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.
- Nicol and Clark 2014. Annual WCPFC Report: Joint Tuna RFMO Bycatch Technical Working Group. WCPFC-SC10-EB-WP-03
- OFP. 2012a. Preliminary analysis of the potential impacts of wire traces on shark catches in WCPO tuna longline fisheries. WCPFC9-2012-IP14.
- OFP. 2012b. Progress on the updated silky shark stock assessment in the WCPO. WCPFC9-2012-IP13.
- Rice J and Semba, Y., 2014. Age and sex specific natural mortality of the blue shark (*Prionace glauca*) in the North Pacific Ocean. ISC/14/SHARKWG-1/03.
- Rice, J. 2012a. Catch per unit effort of oceanic whitetip sharks in the Western and Central Pacific Ocean. WCPFC-SC8-SA-IP-10.
- Rice, J. 2012b. Catch per unit effort of silky sharks in the Western and Central Pacific Ocean. WCPFC-SC8-SA-IP-11.
- Rice, J. 2012c. Alternative catch time series for oceanic whitetip and silky sharks in the Western and Central Pacific Ocean. WCPFC-SC8-SA-IP-12.
- Rice, J. 2013. Catch per unit effort of silky sharks in the Western and Central Pacific Ocean. WCPFC-SC9-SA-IP-02.
- Rice, J. 2014. Standardization of blue shark catch per unit effort in the North Pacific Ocean based on SPC held longline observer data for use as an index of abundance. ISC/14/SHARKWG-1/xx & WCPFC-SC10-2014/ SA-IP-04.
- Rice, J. and Harley, S. 2014. Standardization of blue shark catch per unit effort in the North Pacific Ocean based on SPC held longline observer data for use as an index of abundance. ISC/14/SHARKWG-1/04.
- Rice, J., and Harley, S. J. 2012. Assessment of the whale shark as a key shark species. WCPFC-SC8-EB-WP-04.
- Rice, J., and Harley, S. J. 2012. Progress report on the Shark Research plan. WCPFC-SC8-EB-WP-03.
- Rice, J., and Harley, S. J. 2012. Stock assessment of oceanic whitetip sharks in the Western and Central Pacific Ocean. WCPFC-SC8-SA-WP-06.

- Rice, J., and Harley, S. J. 2012. Stock assessment of silky sharks in the Western and Central Pacific Ocean. WCPFC-SC8-SA-WP-07.
- Rice, J., and Harley, S. J. 2013. Potential catch and CPUE series to support a stock assessment of blue shark in the South Pacific Ocean. WCPFC-SC9-SA-WP-04.
- Rice, J., and Harley, S. J. 2013. Stock assessment of silky sharks in the Western and Central Pacific Ocean. WCPFC-SC9-SA-WP-03.
- Rice, J., Harley, S. J., Maunder, M., and Aires Da-Silva. 2013. Stock assessment of blue shark in the North Pacific Ocean. WCPFC-SC9-SA-WP-02.
- Rice, J., Harley, S., Kai, M. 2014. Stock assessment of blue shark in the North Pacific Ocean using Stock Synthesis. WCPFC-SC10-2014/ SA-WP-08.
- Tremblay-Boyer, L., Rice, J., Scott, R, Hare, S, and Tidd A. H. 2015. Analysis of stock status and related indicators for key shark species of the Western Central Pacific Fisheries Commission. WCPFC-SC11-2015/SA-IP-05.

Annex 2: Research meetings undertaken in support of the Shark Research Plan (reverse chronological order)

Meeting	Comments
ISC shark working group, Keelung, Chinese Taipei (June 2014)	Participated in meeting, in particular the development of a Stock Synthesis model for blue shark in the North Pacific to compliment the production model also being used.
CITES/FAO Asian regional consultative workshop on capacity assessments for the implementation of new CITES listings of sharks and manta rays. Xiamen, China (May 2014)	Participated in meeting, provided information from the Pacific, and assisted in the development of a roadmap for capacity development in the region.
ISC shark working group, La Jolla, USA (Jan 2014)	Participated in meeting, in particular the development of a Stock Synthesis model for blue shark in the North Pacific to compliment the production model also being used.
ISC shark working group, Shimizu, Japan (Apr 2013)	Participated in meeting, in particular the development of a Stock Synthesis model for blue shark in the North Pacific to compliment the production model also being used.
IATTC 4th annual technical meeting on sharks, La Jolla, USA (Feb 2013)	In addition to participating in the workshop, collaborative work was undertaken with IATTC and NMFS scientists in support of blue and silky shark assessment work, in particular the use of stock synthesis to conduct shark stock assessments.
Management of marine megafauna affected by fisheries bycatch, La Jolla, USA (Mar 2012)	Meeting brought together experts from across RFMOs and other fields (e.g. sea turtles, sea birds, and marine mammals) to discuss ways to assess these species groups.
Australasian mako shark workshop, Hobart, AUS (Feb 2012)	Scoping workshop to determine data availability and gaps and the potential timeline for a stock assessment for mako sharks in the South Pacific Ocean.
Joint SPC/IATTC workshop on assessment of silky sharks, La Jolla, USA (Dec 2011)	Collaborative work on stock assessment approaches using Stock Synthesis to assess silky sharks stocks in the Pacific Ocean.
ISC shark working group, La Jolla, USA (Nov 2011)	These meetings focused on the blue and mako assessments for the North Pacific Ocean.
Joint work on Hawaiian observer data for oceanic whitetip and silky sharks, Noumea, New Caledonia (Apr 2011)	William Walsh of the NMFS PIFSC visited Noumea to work on analyses of these data that are currently not available to SPC or WCPFC.
Joint SPC/NRIFSF works on sharks, Shimizu, (January and March 2011)	Collaborative analyses of Japanese commercial logsheets records of shark catches and the research and training vessel database.

Annex 3: ABNJ work plan 2015-2016

Output 3.1.1 Shark Data Improvement and Harmonization

Work in Year 2 will comprise taking forward initiatives begun in Year 1 as well as launching new projects. The Global Shark Browser product will be released as an heuristic tool for comparing data holdings and shark status between regions. Efforts toward agreeing a harmonization of longline observer fields and data exchange (compilation) of bycatch data across all five t-RFMOs will continue. Shark post-release mortality tagging studies will continue with NOAA for whale sharks and be expanded to other species. Shark biological data studies may become possible with external funding.

	2015						2016					
	7	8	9	10	11	12	1	2	3	4	5	6
ST1.3 Establish a pan-Pacific shark Steering Committee with representation from WCPFC and IATTC Secretariats (in conjunction with Output 3.1.2, ST1.3)	X						X					
ST1.5 Establish an annual ABNJ Tuna Project-Sharks and Bycatch Consultative Committee to consult member countries on work elements (in conjunction with Ouput 3.1.2, ST 1.4)						X						
ST2.1 Develop and catalogue available shark data holdings at 4 t-RFMOs and institutions	X	X	X	X	X							
ST2.2a Make recommendations for harmonization of data types and formatting for 4 t-RFMOs (WCPFC, IOTC, CCSBT and ICCAT)	X	X	X	X	X	X						
ST2.2b Review t-RFMO responses to proposals for harmonization of data types and formatting related to sharks		X	X	X	X	X	X	X	X	X	X	X
ST2.3a Identify and prioritize gaps in data holdings by species, fishery and region in WCPFC and IOTC, CCSBT, ICCAT	X	X	X	X	X	X	X	X	X	X	X	X
ST2.3b Review t-RFMO responses to proposals for data improvement related to sharks							X	X	X	X	X	X
ST3.1 Explore needs and opportunities for data improvement in WCPFC under existing programmes, e.g. logsheet reporting, observers, port sampling, trade data, etc., then identify and initiate activities including specific activities under Shark Data Inventory Studies, Shark Data Improvement Studies (minimum standards, data mining, data harmonization, identification guides and post-release mortality tagging)	X	X	X	X	X	X	X	X	X	X	X	X
ST3.2 Plan and undertake field studies designed to improve data for stock status assessments in WCPFC	X	X	X	X	X	X	X	X	X	X	X	X
ST4.1 Half yearly progress report for WCPFC activities	X						X					

Output 3.1.2 Shark Methods and Assessment Work

Work is already underway (ahead of schedule) on the first of four Pan-Pacific shark status assessments and this study of porbeagle shark is expected to be nearly completed during Year 2. Another of the four will be initiated in Year 2 once priorities are further clarified. It is likely that the formulation of new conservation and management measures will begin in Year 3. Future work in the area of assessment methods will be discussed and planned with IATTC, with recognition that there are no unobligated funds available to support work outside of the WCPFC and IATTC Secretariats on these assessment methods tasks.

	2015						2016					
	7	8	9	10	11	12	1	2	3	4	5	6
ST1.3 Establish a pan-Pacific shark Steering Committee with representation from WCPFC and IATTC Secretariats (in conjunction with Output 3.1.2, ST1.3)	X						X					
ST1.4 Establish an annual ABNJ Tuna Project-Sharks and Bycatch Consultative Committee to consult member countries on work elements (in conjunction with Output 3.1.2, ST 1.4)						X						
ST2.1 Work with WCPFC/SPC and IATTC to develop format and specifications for the assessment methods catalogue					?	?	?	?	?	?	?	?
ST2.2 Explore potential for harmonization between methodological approaches by different t-RMFOs as well as with other assessment programmes such as NDFs for CITES												→
ST2.3 Produce compendium on methods and global status of shark species caught in t-RFMO fisheries												→
ST3.1 Conduct the first of four new shark stock status assessments (porbeagle)	X	X	X	X	X	X	X	X	X	X	X	X
ST3.2 Conduct the second of four new shark stock status assessments (TBD)							X	X	X	X	X	X
ST4.1 Formulate new conservation and management measures reflecting the technical progress delivered by the project												→
ST4.1 Half yearly progress report for WCPFC activities	X						X					

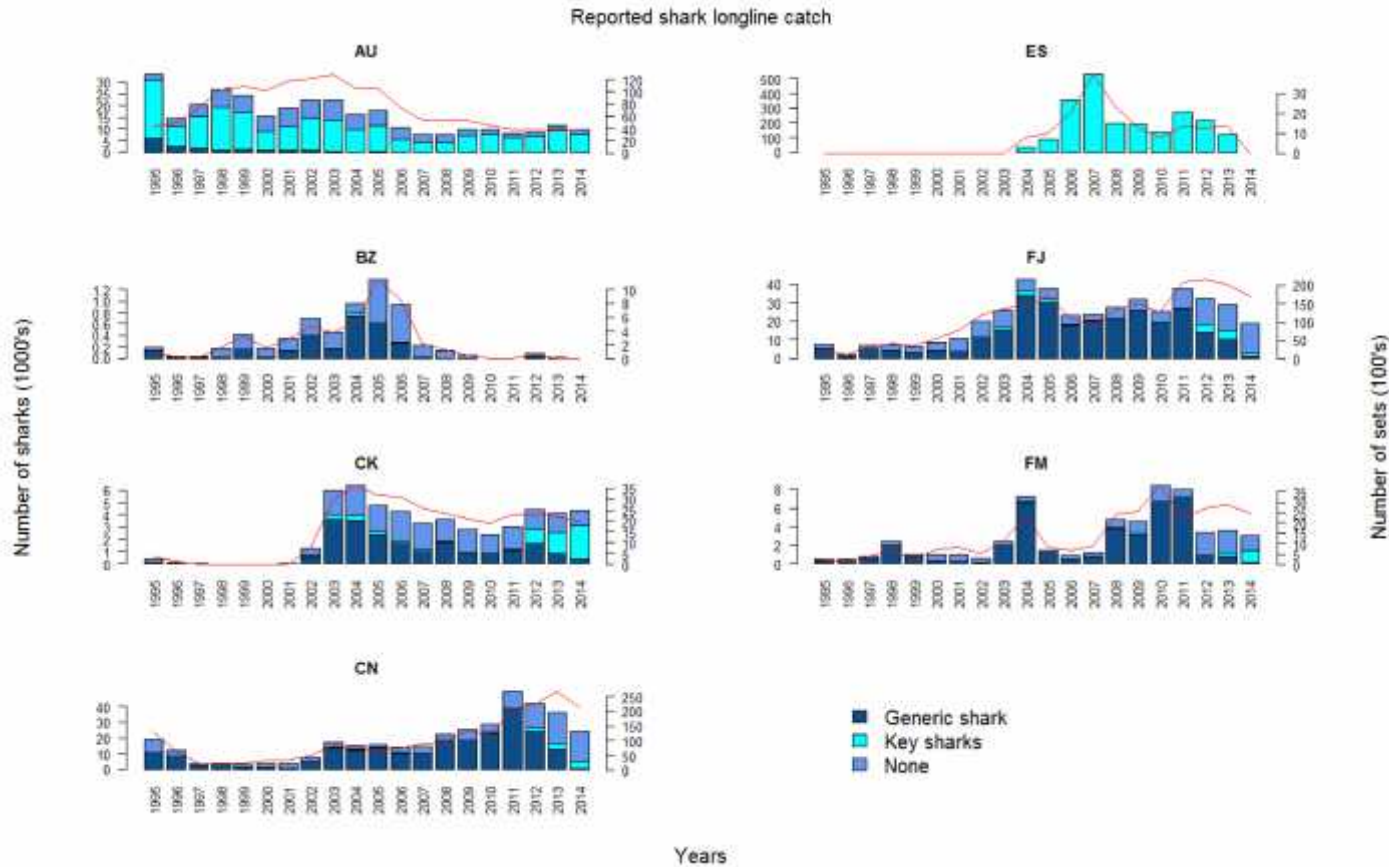
Output 3.1.3 Bycatch Management Information System

Following the work plan developed by the consultant in Year 1, and presented to WCPFC SC11, BMIS will be updated and expanded with more current and new types of information (e.g. management reviews, static maps, etc). This development will facilitate and adapt to new agreements on data harmonization, data exchange and basic bycatch metrics as they occur. Planning for mitigation workshops on sea turtles, now planned for the Pacific, will continue with an intention to hold the first of two workshops in early 2016. Planning for the second series of (2) workshops on Pacific shark mitigation will begin in 2016 with an intention to hold the first of these shark workshops early in the second half of 2016.

	2015						2016					
	7	8	9	10	11	12	1	2	3	4	5	6
ST2.1 Enter new information into the BMIS	X	X	X	X	X	X	X	X	X	X	X	X
ST2.2 Develop new modules to store new types of information in the BMIS	X	X	X	X	X	X	X	X	X	X	X	X
ST2.3 Enhance the BMIS interface	X	X	X	X	X	X	X	X	X	X	X	X
ST3.1 Assist with and adapt to the harmonization of existing data fields and/or information being collected							X	X	X	X	X	X
ST3.2 Assist with developing methods to calculate basic metrics from bycatch data for use in more complex analyses												→
ST4.1 Plan for (x) and hold (X) two workshop analyzing data on the effectiveness of bycatch mitigation measures (Pacific sea turtles)	x	x	x	x	x	x	X	X	X	x	x	x
ST4.2 Plan for (x) and hold (X) a workshop analyzing data on the effectiveness of bycatch mitigation measures (Pacific sharks)							x	x	x	x	x	x
ST4.2 Half yearly progress report for WCPFC activities	X						X					

Annex 4: Longline logsheet reporting.

Figure A4-1: Shark data recorded as shark or species-specific reporting from longline logsheets held by the SPC-OPF catch and effort data aggregated by year for 1995-2014 for each WCPFC CCM. Generic shark = reporting to the generic code SHK¹¹; Key sharks = reporting of WCPFC key shark species; and None = the number of longline sets that reported no shark catch this category will include real zeros and non-reporting. Data for 2014 are incomplete.



¹¹ CNMs may have recorded all species as the generic shark category; or may have reported the key shark species to species level, and recorded the remaining species as SHK; or may record all species on logsheets but aggregate non-key shark species to SHK in data submissions; note that as per CMM2006-05, the requirement which began in 2007 is to report key shark species.

Figure A4-1 Continued...

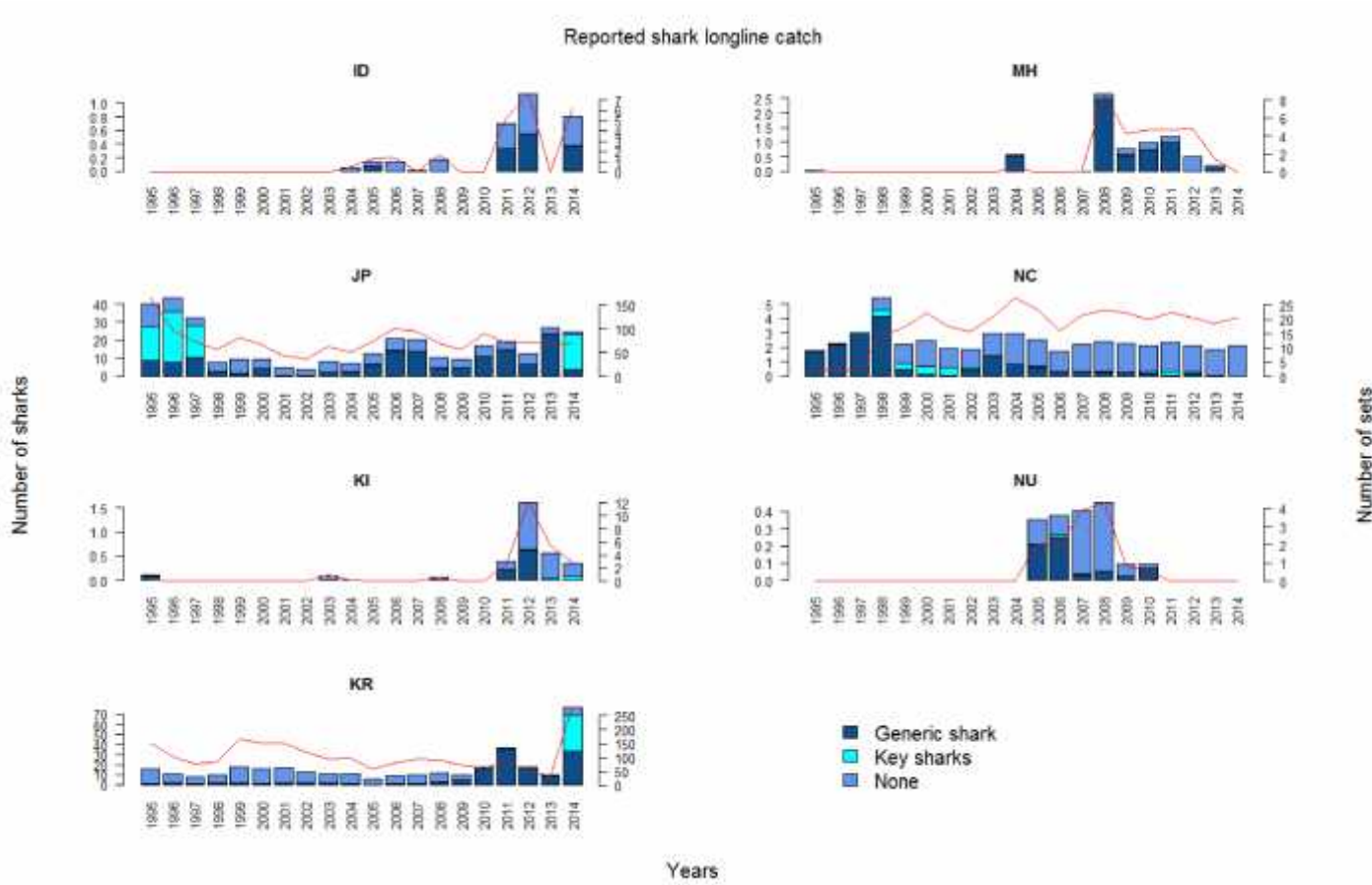


Figure A4-1 Continued...

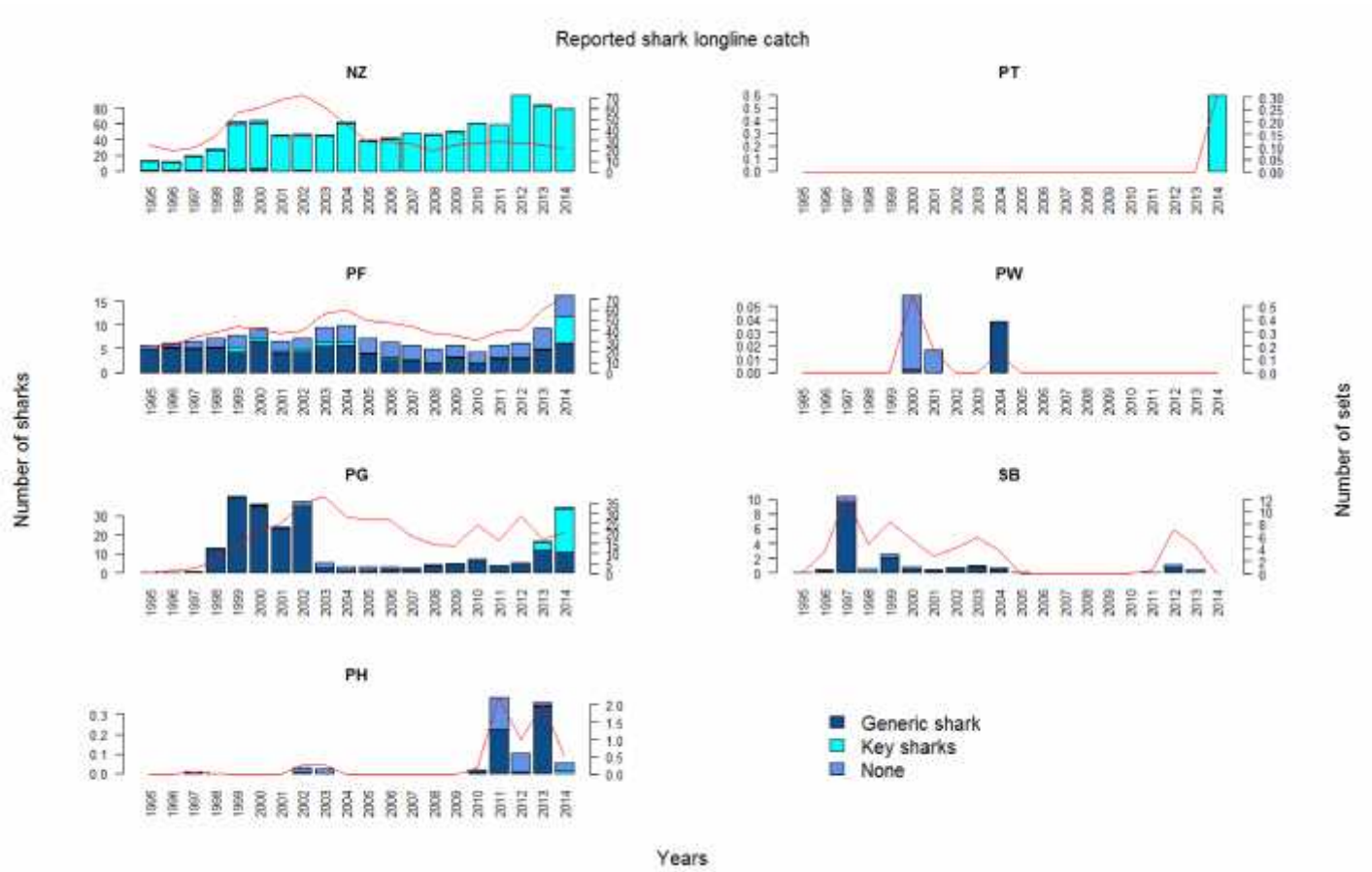
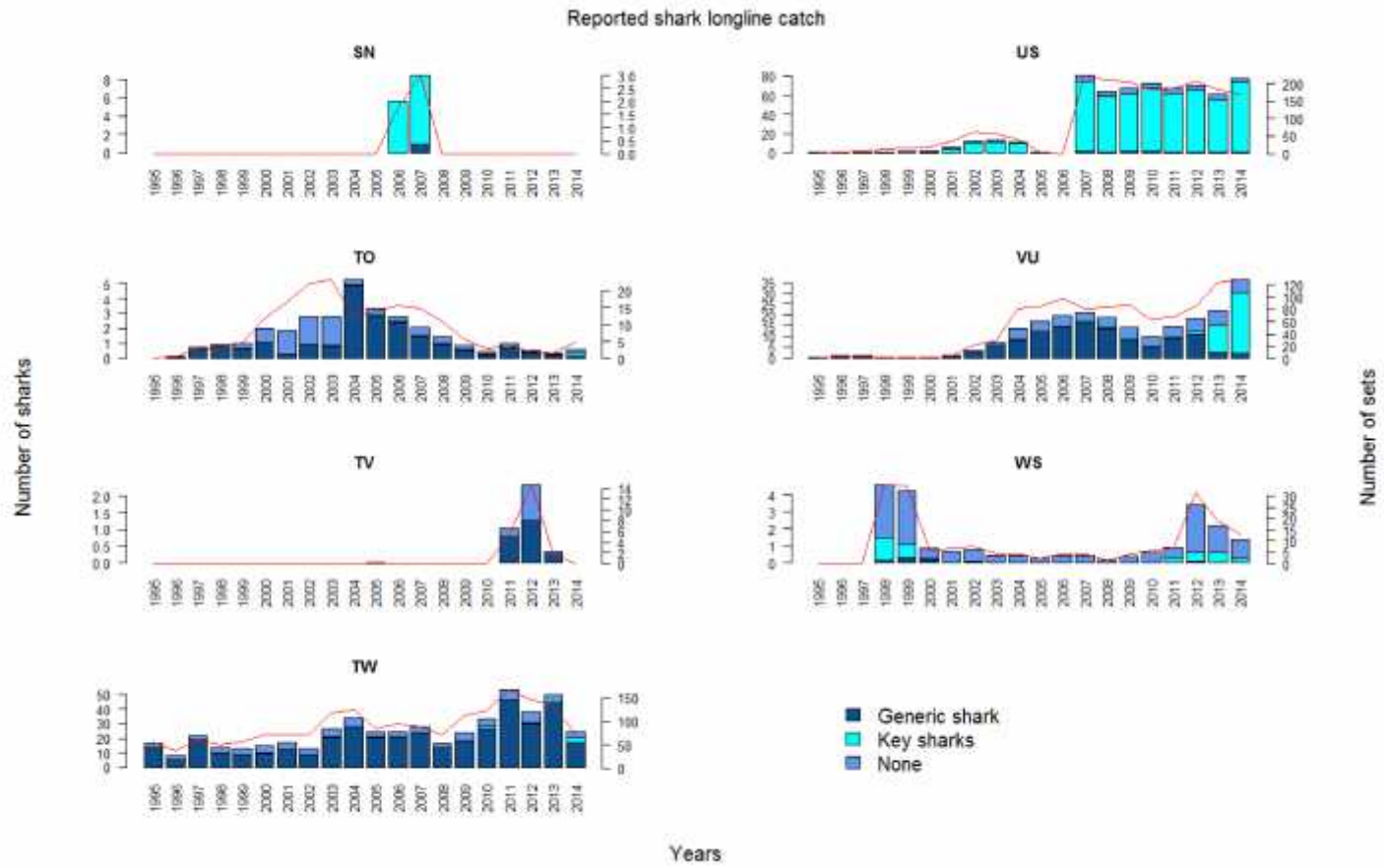


Figure A4-1 Continued...



Annex 5: Shark Research plan project list 2016-2020. ** To be confirmed by the ISC once the ISC SHARKW has met.

Stock assessment			
Project title	Objectives/supporting text	Start date	Duration (years)
Blue shark stock assessment in the South Pacific	Estimate population parameters, such as time series of recruitment, biomass and fishing mortality, which indicate the stock status and fishing impacts. Provide stock status estimates against $SB/SB_{F=0}$ and F/F_{MSY} ratios, or other reference points requested by the WCPFC.	January 2016	1
Develop proposed limit reference points for elasmobranchs	Taking into account the limit reference point framework adopted by the WCPFC for target species, recommend a suite of limit reference points for elasmobranchs.	January 2016	1
Thresher shark indicators analysis	Undertake a thresher shark analyzing all observer data to species level.	January 2016	1
Review data for non-key sharks elasmobranchs	Assess the catch records for non-key shark elasmobranchs using existing observer and reported catch from longline and purse seine data.	January 2016	1
Mako shark stock assessment in the South Pacific	Estimate population parameters, such as time series of recruitment, biomass and fishing mortality, which indicate the stock status and fishing impacts. Provide stock status estimates against $SB/SB_{F=0}$ and F/F_{MSY} ratios, or other reference points requested by the WCPFC.	January 2018	1
Shark catch histories	Construct catch histories using analytical approaches that use all available information for all key sharks.	January 2017	1
Whale shark CPUE	Use purse seine observer data, and reported setting information to develop standardised CPUE estimates for whale sharks.	January 2017	1
Blue shark stock assessment in the North Pacific	Estimate population parameters, such as time series of recruitment, biomass and fishing mortality, which indicate the stock status and fishing impacts. Provide stock status estimates against $SB/SB_{F=0}$ and F/F_{MSY} ratios, or other reference points requested by the WCPFC.	January 2017	1
Investigate the initial depletion levels for assessed shark stocks	Estimate the initial depletion levels for assessed shark stocks, and make recommendations as to how to deal with this issue in future assessments.	January 2017	1
Update hammerhead shark catch history	Use the species splits developed under the hammerhead shark species composition project to update thresher shark catch histories.	January 2018	1
Hammerhead shark species composition	Assess the hammerhead shark species composition by depth and region to determine the feasibility of splitting grouped hammerhead shark catch.	January 2017	1
Mako shark stock assessment in the North Pacific	Estimate population parameters, such as time series of recruitment, biomass and fishing mortality, which indicate the stock status and fishing impacts. Provide stock status estimates against $SB/SB_{F=0}$ and F/F_{MSY} ratios, or other reference points requested by the WCPFC.	January 2018	1
Silky shark stock assessment in the South Pacific	Estimate population parameters, such as time series of recruitment, biomass and fishing mortality, which indicate the stock status and fishing impacts. Provide stock status estimates against $SB/SB_{F=0}$ and F/F_{MSY} ratios, or other reference points requested by the WCPFC.	January 2018	1
Pacific wide stock assessment oceanic whitetip shark	Estimate population parameters, such as time series of recruitment, biomass and fishing mortality, which indicate the stock status and fishing impacts. Provide stock status estimates against $SB/SB_{F=0}$ and F/F_{MSY} ratios, or other reference points requested by the WCPFC.	January 2019	1
Develop release mortality estimates for OWT and FAL	Using the post-release survival work, determine mortality estimates of released fish and develop a mortality history for this species.	January 2018	1
Oceanic whitetip shark stock assessment in the South Pacific	Estimate population parameters, such as time series of recruitment, biomass and fishing mortality, which indicate the stock status and fishing impacts. Provide stock status estimates against $SB/SB_{F=0}$ and F/F_{MSY} ratios, or other reference points requested by the WCPFC.	January 2019	1

Stock discrimination			
Project title	Objectives/supporting text	Start date	Duration (years)
Stock discrimination of whale sharks	Determine the stock links and boundaries for WCPO whale sharks.	January 2018	2
Stock discrimination of silky sharks	Determine the stock links and boundaries for WCPO silky sharks.	January 2019	2
Stock discrimination of hammerhead sharks	Determine the stock links and boundaries for WCPO hammerhead sharks.	January 2019	2
Stock discrimination of thresher sharks	Determine the stock links and boundaries for WCPO thresher sharks.	January 2019	2-3

Biological research			
Project title	Objectives/supporting text	Start date	Duration (years)
Length-weight conversion factor review	Identify the appropriate length-length and length-weight conversion factors for key sharks.	January 2016	1
Maternal length, litter size and birth frequency in shortfin mako sharks	Assess the relationship between maternal length and litter size in shortfin mako sharks and assess pupping frequency.	January 2016	1
Age, growth and reproduction of thresher sharks	Conduct a detailed review, using the findings and references from the WCPFC Pacific shark life history expert panel workshop to identify which species, for which ages within those species and for which regions the age and growth uncertainties are highest. Then undertake biological sampling and age and growth analysis to fill those gaps.	January 2018	2-3
Age, growth and reproduction of hammerhead sharks	Conduct a detailed review, using the findings and references from the WCPFC Pacific shark life history expert panel workshop to identify which species, for which ages within those species and for which regions the age and growth uncertainties are highest. Then undertake biological sampling and age and growth analysis to fill those gaps.	January 2018	2-3

Mitigation work			
Project title	Objectives/supporting text	Start date	Duration (years)
Post-release survival of silky and oceanic whitetip sharks from longline sets	Undertake experiments to estimate post-release survival of silky and oceanic whitetip sharks.	January 2016	1
Experimental assessment of hook type and branchline leader material on shark catch	Undertake specific experimentation to assess the effectiveness of varying hook type and branchline leader material on shark catch.	January 2016	1
Post release mortality of sharks and rays from longline and purse seine vessels	Undertake experiments to estimate post-release survival of sharks and rays from longline and purse seine vessels.	January 2016	2
Monte Carlo simulation	Assess the effectiveness of shark mitigation through Monte Carlo simulation.	January 2016	1

Data improvements			
Project title	Objectives/supporting text	Start date	Duration (years)
Development of materials for species identification of sharks in processed states	Development of materials that will assist species-specific reporting accuracy of catch and discards of sharks in commercial logbooks (e.g., ID guides and posters).	January 2017	1
Observer form re-development to collect data on handling and release of sharks	Update the observer forms to ensure that observers collect the appropriate data on handling and release of sharks and gear specifics.	January 2016	1

SRP developments			
Project title	Objectives	Start date	Duration (years)
SRP mid-term review	Review progress against the SRP 2016-2018	January 2018	1
Shark indicator analysis	Undertake an indicator analysis for key shark species that are not being assessed with a stock assessment in this year.	January 2018	1
SPR review	Review the 2016-2020 SRP	January 2020	1
Develop shark research plan for 2021-2025	Develop a shark research plan for 2021-2025 drawing on the experience of the 2016-2020 SRP and emerging management needs of the Commission.	January 2020	1