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A report on the activities completed for Shark Research Plan by the SPC-OFP

WCPFC-SC10-2014/EB-WP-04

SPC-OFP

Secretariat of the Pacific Community – Oceanic Fisheries Programme

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Oceanic Fisheries Programme, Secretariat of the Pacific Community

Summary

The first Shark Research Plan (SRP) covered the years 2010-14 and included an indicator analysis, stock status profiles, and stock assessments for the original five key shark species / species-groups. Important considerations were that mako and thresher sharks were expected to be assessed as a single group and that blue sharks and mako sharks likely represent northern and southern stocks that require separate assessments and collaboration with other bodies such as the ISC and IATTC. Further goals of the SRP included coordination of research and seeking improvements to shark data.

This paper focuses on the contribution of SPC-OFP to the SRP through its joint roles as the WCPFC Scientific Service provider and a provider of technical advice to its own members. The paper has three goals 1) to summarize the highlights of the past four years work; 2) highlight some of the challenges SPC-OFP faced and potential lessons to be learned for WCPFC; 3) make recommendations to the Scientific Committee as to how the SRP could be reviewed and repackaged as a more overarching WCPFC Shark Plan. We also include the regular section in the paper summarizing SPC shark data holdings.

Five stock assessments were conducted for three key shark stocks and in addition several auxiliary analyses were conducted in support of direct requests from WCPFC outside of the original SRP. The main challenges encountered were that the complexity and resources needed for the shark assessments were much greater than expected and some of the key data for the assessments was held by neither SPC nor WCPFC. We believe that WCPFC would be better served by an overarching Shark Plan (e.g., that includes science, compliance, management, and a set of goals) than a simple update of the current SRP. We recommend that SC10 begin the process of developing a new Shark Plan, potentially expedited by a small working group in the margins of SC10.

For 2015, and considering the resources typically available to fund shark activities by WCPFC, we suggest that an indicator analysis for all key shark species and an assessment for blue shark in the South Pacific Ocean (in collaboration with IATTC if possible) be the highest priorities.

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 shark species / species groups designated as key at that time (see Table 8 of Clarke and Harley 2010). Important considerations were that mako and thresher sharks were expected to be assessed as a single group and that blue sharks and mako sharks likely represent northern and southern stocks that require separate assessments and collaboration with other bodies such as the ISC and IATTC. Further goals of the SRP included coordination of research and seeking improvements to shark data.

Over the four years of the SRP the major achievements have included:

- One indicator analysis for all key shark species that integrated catch rate, size, sex, maturity, distribution and species composition;
- Five age-structured stock assessments for key shark species including updated assessments for silky and blue sharks in the North Pacific to address data issues in the initial assessments;

- Estimated catch histories for key shark species;
- Development of CPUE and catch estimates towards the sixth planned stock assessment, for blue shark in the south Pacific;
- 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 shark species 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 shark species; and
- Numerous data summaries of SPC-held observer data to support efforts of WCPFC members.

A full list of over 30 papers and reports produced by SPC under the SRP are provided in Annex 1 and a list of meetings that we participated in is provided in Annex 2.

Since the adoption of the SRP, the list of key shark species has expanded to 14 (Table 1).

Challenges and lessons to be learned

At a basic level the goal of seven stock assessments was not achieved, but it will also be clear from the section above that many other activities were undertaken at the direction of the SC and WCPFC.

Key lessons that we have learned through this work are provided below:

- WCPFC funding was not sufficient to deliver all the work in the SRP and annual WCPFC-SPC workplan or all of the work accomplished above. On average 30-40% annually of resources devoted to WCPFC shark-related services was from other SPC donors;
- The shark stock assessments undertaken required at least as much resources as the tuna assessment: we chose to undertake age-structured integrated assessments that use catch, effort, and size data across multiple fleets as opposed to the more commonly used Surplus Production models. Further the data are messy and we are often estimating catches;
- The shark assessments relied 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 request for further work;
- Collaboration with the ISC can be productive, but is extremely resource intensive. Between the ISC Shark WG and ISC plenary, there can be 4-5 meetings per year which we 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 on mitigation measures and whale sharks are two examples of SPC's response to WCPFC's need for scientific studies to inform management.

Suggestions for the next step in shark research planning for WCPFC

The original SRP only planned activities through until the end of 2014 and therefore it is important that SC10 consider a process to update the SRP for the next period of work. Also as WCPFC 9 in December 2012 agreed to extend SRP activities beyond 2013, there is a need to identify shark deliverables for SPC-OFP to be included in the 2015 service agreement.

In considering the potential form of the next SRP we came up with three initial options:

1. A 4-5 year workplan for the Scientific Services provider that SC can revise depending on priorities and available budget allocations; OR
2. A 4-5 year term research plan that covers all the research the SC think is needed on sharks. It could be funded from various sources, e.g., CMMs could use an items presence on the list as a basis to secure funding. SC would use this to create the SPC annual workplan; OR
3. A 4-5 term plan for sharks – wider than just research, i.e., where does the WCPFC want to be with respect to sharks by 2020 and how does it plan to get there. This would include the research plan above, plus, monitoring, mitigation, data provision, and CMM's. This should include targets against which progress can be assessed.

It is our view, that option 3 reflects the state of where WCPFC is now and we recommend that SC10 begin the process of developing a new Shark Plan, potentially expedited by a small working group in the margins of SC10.

In considering the research component of any new plan we offer the following as three potential key areas to consider:

Stock assessments

- The frequency of shark assessments noting that current WCPFC resources only allow for one shark assessment per year and taking into consideration changes in available data and stock status, including the relative needs of re-assessing stocks versus assessing those who have not yet been assessed;
- The form of stock assessments to be used, e.g., age-structured assessments that integrate various data sources versus aggregate or surplus production models, noting the different data and resource requirements.
- Annual classic indicator analyses using observer data for species not being assessed in any given year;
- Analytical approaches that use all available information to construct catch histories for stock assessments.

Mitigation work

- Analyses to date have confirmed that data collected through the implementation of observer programs is very poorly suited to address key questions regarding mitigation and therefore specific mitigation experiments are likely required; and
- Such experiments may also provide opportunities to estimate post-release mortality which will be a critical area of uncertainty in future silky and oceanic whitetip shark assessments.

Improved data quality and availability

- Development of materials that may lead to better reporting of species-specific catches of sharks on commercial logbooks (e.g., guides and posters);
- Development of materials that assist species identification of sharks in various processed states for port and transshipment monitoring; and
- Coordination of research activities and providing a central repository for scientific information on sharks in the Pacific and beyond (e.g. BMIS and STAGIS).

For 2015, and considering the resources typically available to fund shark activities by WCPFC, we suggest that an indicator analysis for all key shark species and an assessment for blue shark in the South Pacific Ocean be the highest priorities, but note the need for collaboration with IATTC if the assessment is to cover the entire South Pacific.

Summary of SPC/WCPFC1 shark data holdings

Here we provide a summary of shark data holdings by SPC and WCPFC and data submissions to WCPFC with respect to the new requirements to submit shark catches and updated information is now available annually through the online accessible WCPFC Data Catalogue (<http://www.wcpfc.int/wcpfc-data-catalogue>). We will simply highlight a few relevant statistics.

The provision of annual catch estimates is now a WCPFC requirement and submissions are summarized in Table 2. In Figure 1 we examine the 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. This includes sets with no reported shark catch, which will include both true zeros and non-reporting of sharks.

Prior to 1990 there is very little information on shark catches and what is available is not species-specific – it is just generic shark. Since then there has been an increase in the reporting of sharks, both generic and species-specific, but when longline effort over the past ten years is considered, less than a third of it is associated with species-specific estimates of catch – and for these it is not clear whether discards are included or not. This indicates the level of challenge in assessing sharks and generating plausible catch and CPUE time series.

The requirement to increase longline observer coverage to 5% by 1 June 2012 throughout most of the WCPF Convention area is now in effect. Implementation and compliance with this measure of this will be critical to improving data on sharks and other bycatch.

Table 3 provides a summary by flag and EEZ of any reported key shark species catches from either logsheet or observer data and either purse seine or longline.

Finally, we again draw attention to the work of the Data Collection Committee (a joint SPC/FFA initiative) which 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. One important form recently developed is the expanded logsheet form which allows the collection of data for all key shark species (note that the makos, hammerheads and thresher sharks are included, but not separated to species), however there is provision made for “other species” where these data can be captured if fishing captains are instructed to fill the forms out in a way that will capture these data. These forms are being increasingly used by coastal states in the region and are available in English, Japanese, Korean, Spanish, and Mandarin. These are freely available through the SPC website². Please contact us if versions in other languages are required.

Acknowledgements

We thank WCPFC and other donors for funding SPC to undertake work under the Shark Research Plan. We acknowledge those past SPC-OFP staffers, Dr Shelley Clarke, Dr Don Bromhead, and the late Michael Manning who were instrumental in the development and implementation of the Shark Research Plan. Finally, we thank Dr Shelley Clarke (again) and Ian Freeman (aka Freemo) for useful comments on how best to prepare this paper.

¹ This is the combined data holdings. Some are SPC-only data, some WCPFC-only, and some are both.

² <http://www.spc.int/oceanfish/en/data-collection/241-data-collection-forms>

Table 1. WCPFC key shark species, the years in which they were designated as key species and most recently assessed, and the year each was listed by CITES (if applicable). (From Clarke et al. (2014)).

WCPFC Key Shark Species	WCPFC Key Species Listing	Stock Assessment Agreed?	Indicator or Other Analysis Produced?	Year Listed by CITES? (CITES Appendix)
Blue shark (<i>Prionace glauca</i>)	2008	In progress (N. Pacific only)	2011	
Shortfin mako shark (<i>Isurus oxyrinchus</i>)	2008		2011 (<i>Isurus</i> spp. only)	
Longfin mako shark (<i>Isurus paucus</i>)	2008		2011 (<i>Isurus</i> spp. only)	
Oceanic whitetip shark (<i>Carcharhinus longimanus</i>)	2008	Finalized (2012)	2011	2013 (II)
Bigeye thresher shark (<i>Alopias superciliosus</i>)	2008		2011 (<i>Alopias</i> spp. only)	
Common thresher shark (<i>Alopias vulpinus</i>)	2008		2011 (<i>Alopias</i> spp. only)	
Pelagic thresher shark (<i>Alopias pelagicus</i>)	2008		2011 (<i>Alopias</i> spp. only)	
Silky shark (<i>Carcharhinus falciformis</i>)	2009	Finalized (2013)	2011	
Porbeagle shark (<i>Lamna nasus</i>)	2010			2013 (II)
Great hammerhead shark (<i>Sphyrna mokarran</i>)	2010			2013 (II)
Scalloped hammerhead shark (<i>Sphyrna lewini</i>)	2010			2013 (II)
Smooth hammerhead shark (<i>Sphyrna zygaena</i>)	2010			2013 (II)
Winghead shark (<i>Eusphyra blochii</i>)	2010			
Whale shark (<i>Rhincodon typus</i>)	2012		2013	2002 (II)

Table 2: Provision of annual catch estimates of sharks.

Entity	Years
Australia	1991-2013
Belize	2011-2013
Cook Islands	2009-2012
China	2010-2013
Spain (EC)	2006-2013
Fiji	2011-2013
Federated States of Micronesia	2009-2013
Japan	2006-2013
Kiribati	2010-2013
Republic of Korea	2011-2013
Republic of the Marshall Islands	2009-2011
New Caledonia	2001-2013
New Zealand	2000-2013
French Polynesia	2009-2013
Papua New Guinea	2009-2013
Portugal (EC)	2011-2013
Tokelau	2009-2013
Tuvalu	2009-2013
USA	2005-2013
Vanuatu	2009-2013
Samoa	2009-2013

Table 3: Flag States catching key shark species and the location (EEZ or International Waters) of catch for 2010-2012 based on WCPFC/SPC data holdings (i.e., logsheet and aggregate catch data plus observer data). 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.

Composite of Five Datasets	BSH	OCS	FAL	SMA	LMA	MAK	AVL	PTH	BTH	THR	SPK	SPZ	SPL	SPN	POR	RHN
Flag																
Australia																
China																
Chinese Taipei																
Cook Islands																
El Salvador																
European Union																
Fed States Micronesia																
Fiji																
French Polynesia																
Japan																
Kiribati																
Korea																
Marshall Is.																
New Caledonia																
New Zealand																
Papua New Guinea																
Philippines																
Samoa																
Solomon Islands																
Tonga																
Tuvalu																
United States																
Vanuatu																
EEZ																
Australia																
CNMI																
Cook Islands																
Fed States Micronesia																
Fiji																
French Polynesia																
International Waters																
Japan																
Kiribati																
Marshall Is.																
Matthew & Hunter																
Nauru																
New Caledonia																
New Zealand																
Niue																
Palau																
Papua New Guinea																
Pitcairn																
Samoa																
Solomon Islands																
Tokelau																
Tonga																
Tuvalu																
United States																
Vanuatu																
Wallis & Futuna																

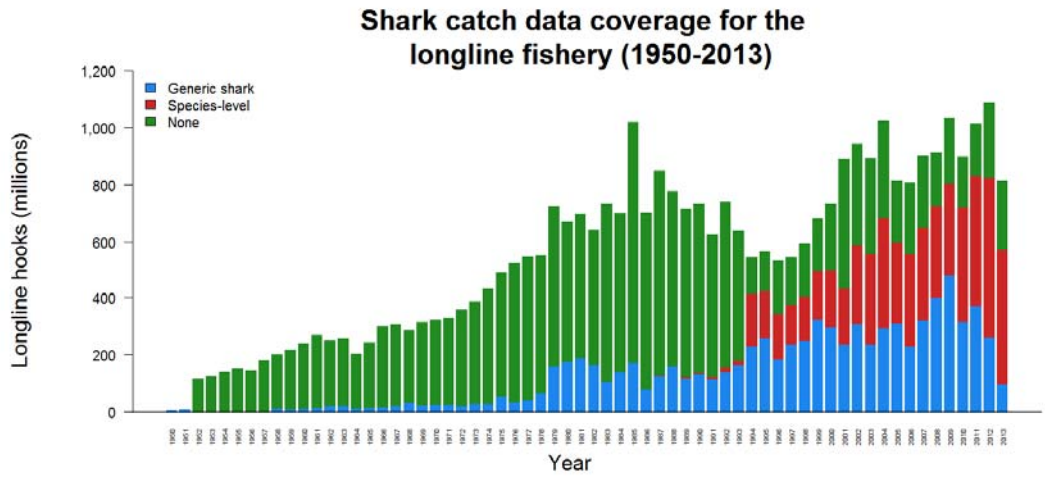


Figure 1: Coverage of shark catches (aggregate and species-specific) for the aggregate longline catch and effort data. Generic shark = reporting to the generic code SHK; Species-level = reporting sharks to species level; and None = the number of longline sets that reported no shark catch. Data for 2013 are incomplete.

Annex 1: Scientific papers and reports produced under, and in support of, the Shark Research Plan by SPC-OFP (chronological order with most recent first).

- 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., Harley, S., Kai, M. 2014. Stock assessment of blue shark in the North Pacific Ocean using Stock Synthesis. WCPFC-SC10-2014/ SA-WP-08.
- 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.
- Bromhead, D., et al. 2013. Potential approaches to mitigate bycatch of oceanic whitetip and silky sharks from longline fisheries. WCPFC-SC9-EB-WP-02.
- Rice, J. 2013. Catch per unit effort of silky sharks in the Western and Central Pacific Ocean. WCPFC-SC9-SA-IP-02.
- 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., Harley, S. J., Maunder, M., and Aires Da-Silva. 2013b. Stock assessment of blue shark in the North Pacific Ocean. WCPFC-SC9-SA-WP-02.
- Rice, J., and Harley, S. J. 2013. Stock assessment of silky sharks in the Western and Central Pacific Ocean. WCPFC-SC9-SA-WP-03.
- 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.
- 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 Harley, S. J. 2012. Progress report on the Shark Research plan. WCPFC-SC8-EB-WP-03.
- 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. Stock assessment of silky sharks in the Western and Central Pacific Ocean. WCPFC-SC8-SA-WP-07.
- 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. 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.
- 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., 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. 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. Analysis of North Pacific Shark Data from Japanese Commercial Longline and Research/Training Vessel Records. WCPFC-SC7-EB-WP-02.
- 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 Proposal for a Process for Designating WCPFC Key Shark Species for Data Provision and Assessment [updated after SC7]. WCPFC8-2011-IP-05.
- Walsh, W., and Clarke, S. 2011. Analyses of Catch Data for Oceanic Whitetip and Silky Sharks reported by Fishery Observers in the Hawaii-based Longline Fishery in 1995-2010. WCPFC-SC7-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.
- Clarke, S.C., T. Lawson, D. Bromhead and S.J. Harley. 2010. Progress toward Shark Assessments. WCPFC7-2010/16.

- 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
- 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.

Annex 2: Research meetings undertaken by SPC-OFP in support of the Shark Research Plan (chronological order with most recent first)

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 workshop 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 workshop on sharks, Shimizu, (March 2011)	Collaborative analyses of Japanese commercial logsheets records of shark catches and the research and training vessel database.