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Towards an Integrated Shark Conservation and Management Measure for the Western and Central Pacific Ocean

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Abstract

The WCPFC has recently initiated a Shark Research Plan and adopted three conservation and management measures (CMMs) requiring controls on finning, encouragement of live release and data provision (CMM 2010-07); no-retention of oceanic whitetip sharks (CMM 2011-04); and a prohibition on deliberately setting purse seines on whale sharks (CMM 2012-04). In parallel with these WCPFC-led shark activities, some members (CCMs) have instituted shark catch limits, established rules for no-retention of any sharks whether dead or alive, and/or banned the use of wire leaders. This current situation represents a patchwork of controls and the net benefit in terms of reduced shark mortality is yet to be determined.

This paper examines three existing WCPFC shark measures in terms of their implementation and effectiveness. This analysis is complicated by a lack of specific objectives in each measure as well as a lack of verification data and review processes. Current implementation of CMM requirements appears to be at best ~60% and in several cases considerably lower. This is partially due to ambiguities in interpretation of the CMMs such that opposite outcomes can both be considered compliant. Extremely low regional observer program coverage (<2%) in the longline fishery, which catches over ten times as many of the key shark species as the purse seine fishery does, further hampers assessment of effectiveness. Nevertheless, it appears that the Commission's finning controls provide only a negligible benefit to shark survival. Lack of consistent recording of shark discards/releases will similarly impede a future assessment of the effectiveness of the oceanic whitetip and whale shark measures.

It is thus concluded that although WCPO assessments have demonstrated the need for shark mortality reductions, these are not yet being delivered by the WCPFC CMMs. Protectionistic measures (e.g. no-retention whether dead or alive) adopted by some CCMs for national waters are fundamentally different from the "full utilization" approach outlined in the International Plan of Action-Sharks (the basis of the cornerstone WCPFC CMM) and highlight the need for a new, integrated regional framework in the form of a comprehensive shark CMM. By using shark fishing mortality as a single "currency", such a framework can help to find common ground between measures adopted in different national jurisdictions and extend these principles into high seas areas. It can also avoid decision-making stalemates arising from one-size-fits-all proposals which suit some fisheries but not others. An approach similar to that used for tropical tunas is proposed whereby a fishing mortality management goal is set based on assessment results, and a package of mitigation measures designed to reach the goal is negotiated and implemented on an interim basis. Verification data are generated and retrospective analysis leads to periodic revisiting of the measure.

The paper concludes with recommendations for a) improving the Commission's ability to confirm compliance with the existing measures; b) maximizing the effectiveness of the existing measures; and c) creating a framework within which the effectiveness of all measures (existing or proposed) can be judged on their ability to control fishing mortality for overfished shark stocks. The WCPFC has the opportunity and the responsibility to manage highly migratory shark stocks in a comprehensive and integrated manner across the Convention Area, and must therefore take actions which are not only expedient, but also meaningful and effective.

List of Acronyms

AR2	Annual Report-Part 2 (WCPFC)
CCSBT	Commission for the Conservation of Southern Bluefin Tuna
CITES	Convention on International Trade in Endangered Species
CCM	WCPFC member, participating territory or cooperating non-member
CMM	Conservation and Management Measure (WCPFC)
CMS	Compliance Monitoring Scheme (WCPFC)
COP	Conference of Parties (CITES)
EEZ	Exclusive Economic Zone
EU	European Union
FFA	Pacific Islands Forum Fisheries Agency
IATTC	Inter-American Tropical Tuna Commission
ICCAT	International Commission for the Conservation of Atlantic Tunas
IOTC	Indian Ocean Tuna Commission
IPOA	International Plan of Action-Sharks
NOAA	National Oceanic and Atmospheric Administration (US)
NPOA	National Plan of Action-Sharks
PIC	Pacific Island Countries
PIRO	Pacific Islands Regional Office (NOAA)
PNA	Parties to the Nauru Agreement
RFMO	Regional Fisheries Management Organization
ROP	Regional Observer Program
RP	Reference Point
SC	Scientific Committee (WCPFC)
SPC-OFP	Secretariat of the Pacific Community, Oceanic Fisheries Programme
SRP	Shark Research Plan (WCPFC)
WCPFC	Western and Central Pacific Fisheries Commission
WCPO	Western and Central Pacific Ocean

1. Introduction

In response to international concerns WCPFC has adopted shark CMMs and undertaken a Shark Research Plan

The Western and Central Pacific Fisheries Commission (WCPFC) is required by its Convention to assess and manage impacts to non-target species and species associated with tuna stocks. Elasmobranch fishes (sharks and rays; referred to as "sharks" in this paper) are among the most frequently encountered and vulnerable of these non-target species, and their status is increasingly generating concern among both scientists and the wider public. With the initiation of its Shark Research Plan (SRP) (Clarke and Harley 2010), the WCPFC initiated a comprehensive and proactive shark assessment programme involving both stock assessments and other analyses of existing data (Kirby and Molony 2006; Kirby and Hobday 2007; Manning et al. 2009; Clarke 2011; Clarke et al. 2011a, 2011b, 2013; SPC-OFP 2012a, 2012b; Rice and Harley 2012a, 2012b, 2013a, 2013b; Rice et al. 2013). These analyses have informed the cornerstone WCPFC shark Conservation and Management Measure (CMM 2006-05, now CMM 2010-07), as well as led to new CMMs for oceanic whitetip (*Carcharhinus longimanus*, CMM 2011-04) and whale sharks (*Rhincodon typus*, CMM 2012-04). A stock assessment for oceanic whitetip sharks was produced in 2012 (Rice and Harley 2012a) and stock assessments for silky (*C. falciformis*) and blue sharks (*Prionace glauca*) will be presented in 2013 (Rice and Harley 2013a, Rice et al. 2013).

WCPFC CCMs have also implemented their own shark measures

In parallel with these WCPFC-led shark activities there have been a number of other developments in shark conservation and management in the region. Some WCPFC members, participating territories and cooperating non-members (CCMs) have instituted shark catch limits, required discarding of any sharks whether dead or alive, and/or banned the use of wire leaders in longline fisheries. This combination of WCPFC and CCM measures has resulted in a patchwork of species-specific controls, area-specific prohibitions, and operational constraints across the region. Beyond evaluation of the implementation and effectiveness of individual measures and policies, the net benefit to shark stocks in terms of reduced mortality across all measures is still to be determined.

Other tuna RMFOs have similar shark measures

Stepping back from a Western and Central Pacific (WCPO) focus, other regional and global initiatives are also underway for shark conservation and management. Within tuna Regional Fisheries Management Organizations (RFMOs), all five adopted at approximately the same time (i.e. 2004-2008) a nearly identical, cornerstone shark CMM aimed primarily at controlling shark finning[1] and promoting data collection. Since that time some tuna RFMOs have conducted stock assessments (i.e. blue, shortfin mako (*Isurus oxyrinchus*), and porbeagle sharks by ICCAT, and silky sharks by IATTC)[2] and/or adopted specific conservation and management measures for some species on the basis of ecological risk assessments. Like WCPFC, no-retention measures have been adopted for the oceanic whitetip shark by IATTC, ICCAT and IOTC. ICCAT has also adopted no-retention measures for bigeye thresher, hammerhead (except

[1] In line with standard international usage, finning is defined in this report as the practice of removing and retaining shark fins and discarding the remainder of the carcass at sea.

[2] A stock assessment for North Pacific blue sharks was conducted for data through 2002 (Kleiber et al. 2009) and the International Scientific Committee is currently finalizing a new version of this assessment (ISC 2013).

S. tiburo), and silky sharks, and IOTC has adopted a no-retention measure for all thresher sharks[3].

International wildlife protection treaties are increasingly listing species caught in tuna fisheries

Some of these species have also been given global attention through their inclusion in international wildlife protection treaties. At the Convention on International Trade in Endangered Species Conference of Parties (CITES COP) in March 2013, a number of elasmobranch species including oceanic whitetip, scalloped hammerhead (*Sphyrna lewini* and look-alikes great (*S. mokarran*) and smooth (*S. zygaena*) hammerheads), and porbeagle (*Lamna nasus*) sharks, and the manta rays (*Manta birostris* and *M. alfredi*) were listed on CITES Appendix II. These listings, which in general require export and re-export permits based on national non-detriment findings (Clarke 2004), will enter into force 18 months from the close of the COP, i.e. in mid-September 2014. These seven species will then join other CITES-listed sharks including the basking shark (*Cetorhinus maximus*), whale shark (*Rhincodon typus*), and great white shark (*Carcharodon carcharias*) on CITES Appendix II and the sawfishes (Pristidae) on CITES Appendix I (which prohibits commercial international trade). The Convention on Migratory Species has also designated three elasmobranch species as either threatened with extinction (CMS Appendix I; basking shark, great white shark and manta ray) or able to significantly benefit from international cooperation (CMS Appendix II; basking shark, great white shark, whale shark, shortfin and longfin makos (*Isurus* spp.), porbeagle (*Lamna nasus*), northern hemisphere spiny dogfish (*Squalus acanthias*) and giant manta[4].

This paper examines the three existing WCPFC shark CMMs and proposes short-term remedies as well as a longer-term framework

This paper evaluates the existing WCPFC shark CMMs and makes recommendations for integrating these measures with the spectrum of national, regional and international shark initiatives. First, this paper examines the three WCPFC shark CMMs in terms of their implementation and effectiveness (Section 2). This analysis highlights how the lack of outcome-focused objectives, in combination with a lack of verification, results in little certainty about the degree to which shark stocks are being managed or conserved. Second, this paper outlines a management framework that could serve as a basis for consensus between CCMs with different approaches to shark conservation and management (Section 3). This kind of framework can help to find common ground between measures adopted in different national jurisdictions and extend these principles into high seas areas. It would also provide an explicit basis for cooperation between WCPFC and other tuna RMFOs as well as assist WCPFC CCMs in meeting commitments in other regional organizations and international forums. The paper concludes with recommendations pertaining to remedying some of the shortcomings of the existing CMMs in the short term, as well as moving toward a more comprehensive and integrated framework in the longer term (Section 4).

[3] The specific measures are IATTC Resolution C-11-10; ICCAT Recommendations 09-07, 10-07, 10-8 and 11-08; IOTC Resolutions 12/09 and 13/06. It should be noted that the ICCAT no-retention measures for hammerhead and silky sharks exempt catches by developing coastal members under some conditions.
[4] http://www.cms.int/documents/appendix/additions_table1.pdf

2. Implementation and Effectiveness of Existing WCPFC Measures

WCPFC has three shark CMMs: the cornerstone CMM, an oceanic whitetip CMM and a whale shark CMM

There are currently three WCPFC CMMs which are directly relevant to sharks (Table 1). The cornerstone CMM (first adopted as CMM 2006-05 and now implemented as CMM 2010-07) is formulated as two parts: non-binding resolutions and binding requirements. Non-binding resolutions include implementation of the IPOA-Sharks through NPOAs or other relevant policies, as well as reporting of retained and discarded key species and any bycatch mitigation research conducted. Binding requirements include ensuring full utilization; controlling finning by applying a 5% fins-to-carcass weight ratio limit or other means; shark stock assessment research; and reporting on implementation of the measure or alternative measures. The two other measures consist of a prohibition on retention of oceanic whitetip sharks (CMM 2011-04) and a prohibition on deliberately setting a purse seine on whale sharks (CMM 2012-04).

The oceanic whitetip and whale shark CMMs have not been in effect long enough to evaluate

Formal evaluation of the implementation of the WCPFC shark measures is only possible for the cornerstone CMM. This is because the whale shark CMM has not yet gone into effect (although prohibitions on setting purse seines on whale sharks are already in place in Parties to the Nauru Agreement (PNA) waters (PNA 2011)), and the oceanic whitetip shark CMM went into effect in January 2013 and will be not reported on by CCMs until July 2014 (i.e. submission deadline for Annual Reports-Parts 1 and 2 covering 2013). It follows that evaluation of actual effectiveness (i.e. not only implementation) is similarly difficult for these two new measures, but they can be discussed in terms of expected results. The following two sections thus present: a) an evaluation of the implementation of the cornerstone measure; b) an evaluation of the effectiveness of the cornerstone measure; and c) the expected effectiveness of the oceanic whitetip and whale shark measures.

2.1. Implementation of the cornerstone Shark CMM

The cornerstone CMM contains five binding and non-binding provisions

As described in Table 1 there are several components to the cornerstone shark CMM calling for action on the part of the Commission or its CCMs. These can be broadly classified under five headings: a) implementation of the IPOA/NPOA-Sharks (non-binding); b) data provision for key species (non-binding); c) full utilization and encouraging live release (binding); d) reporting on alternative measures for "exploring, exploiting, conserving and managing" sharks (binding); and e) research (non-binding).

Implementation can be evaluated through both self-reporting (AR2s) and Commission or other independent sources

There are two ways to evaluate implementation of this measure. The first way is through self-reporting by CCMs in the form of Annual Reports-Part 2 (AR2s) submitted each July to the WCPFC Secretariat. These AR2s are not in the public domain but were accessed for this paper under a data confidentiality agreement with NOAA PIRO. The second way is through a Commission review, e.g. by the Scientific Services Provider (SPC) or the WCPFC Compliance Monitoring Scheme (CMS)[5]. Although Commission

[5] The CMS is operated on an interim, year-by-year basis and currently involves a review process led by the WCPFC Technical and Compliance Committee (TCC) covering catch and effort limits; catch and effort reporting; spatial and temporal closures and restriction on the use of FADs; observer and vessel

reviews are available for some aspects of the measure as described below, in other cases there are insufficient sources of information upon which to base independent conclusions about national implementation.

Table 1. WCPFC CMMs directly relevant to sharks (green shading: cornerstone CMM; yellow shading: oceanic whitetip shark CMM; blue shading: whale shark CMM) showing date of implementation, content, and the CCM Annual Reports which reported/will report against each measure. *=CMM 2006-05 was implemented as a resolution for 2007.

CMM	Effective as of	Summarized Content	CCM Annual Reports
2006-05	January 2008	Non-binding: • Implement IPOA/NPOA • Report catch and effort of key species • Assist SIDS with NPOAs and reporting Binding: • Full utilization • Requires maintaining a 5% fins-to-carcass weight ratio as a means of controlling finning, or similar national measures • Encourage live release when sharks are not directly targeted • Report on implementation including any alternative measures • Review implementation and revise, if necessary • Only applies to vessels >24m	2007*, 2008
2008-06	February 2009	Same as CMM 2006-05 plus: Non-binding: • Report catch of key species as discards and retained sharks • Defines key species as blue, oceanic whitetip, mako and thresher sharks • Report on bycatch mitigation research Binding: • Shark research plan and stock assessments • Applies to all vessels	2009
2009-04	February 2010	Same as CMM 2008-06 plus: Non-binding: • Defines key species as blue, silky, oceanic whitetip, mako and thresher sharks	2010
2010-07	February 2011	Same as CMM 2009-04 plus: Non-binding: • Defines key species as blue, silky, oceanic whitetip, mako, thresher, porbeagle (south of 20°S, until biological data shows this or another geographic limit to be appropriate) and hammerhead sharks (winghead, scalloped, great and smooth)	2011, 2012
2011-04	January 2013	• No retention, transshipping, storing or landing of oceanic whitetip sharks whole or in part • Release with as little harm as possible • Report releases as dead or alive • Biological sampling only with permission of WCPFC SC	2013
2012-04	January 2014	• Purse seine sets prohibited if a whale shark is sighted prior to the set • Implemented in PNA waters according to PNA rules • Requires safe release and reporting of the incident	2014

monitoring system coverage; and provision of scientific data. Each CCM is reviewed against these five categories and rated as either "Compliant" (no compliance issue was identified) or "Compliance Review" (where at least one of the five categories was evaluated as "potential compliance or implementation issue identified"). For 2011, 20 CCMs were rated as "Compliant" and 17 CCMs were rated as "Compliance Review". The results of the 2012 CMS will be finalized in December 2013.

2.1.1. Implementation of the IPOA-Sharks/NPOA-Sharks

It may not be necessary to have an NPOA-Sharks

Although the portion of the measure which refers to implementation of the IPOA-Sharks and adoption of an NPOA-Sharks (CMM 2010-07, Clauses 1 & 2) is non-binding[6], CCMs are expected to report against it as specified in the WCPFC AR2 templates. This issue aside, it may not be necessary to have implemented an NPOA-Sharks in order to be in compliance. This is because the IPOA-Sharks calls for adoption of an NPOA-Sharks for States whose "vessels conduct directed fisheries for sharks or…regularly catch sharks in non-directed fisheries". Therefore, a CCM whose vessels do not meet these criteria (or a CCM with no vessels of its own) could be compliant if they confirm that they have considered the need for an NPOA-Sharks but concluded that such a plan is unnecessary.

Self-reporting indicates that less than half of CCMs have NPOA-Sharks

A review of AR2 reports for 2011 indicates that slightly less than half (18/37[7]=49%) of WCPFC CCMs confirmed that they are implementing the IPOA-Sharks or have an NPOA-Sharks. An incomplete set of AR2s for 2012[8] shows that 49% (19 of 39) of CCMs have so confirmed. However, these figures may not be particularly accurate as they depend on each CCM's interpretation of the requirement. For example, some CCMs declined to answer affirmatively but have implemented stricter measures (e.g. ban on retention of all sharks) or flag no vessels catching sharks. Therefore, some of these CCMs might claim compliance on the basis that an NPOA is unnecessary.

It is likely that >50% of all WCPFC CCMs either comply with the spirit of the IPOA-Sharks or have stricter measures

Using non-AR2 data sources, 15 CCMs have NPOAs (Australia, Canada, Ecuador, the European Union, Fiji[9], Indonesia, Japan, Korea, Mexico, New Zealand, Panama, Samoa, Senegal, Chinese Taipei and the United States; Fischer et al. 2012, I. Freeman, Forum Fisheries Agency (FFA), personal communication) and another five have implemented bans on retention of all sharks by commercial fishermen and so may believe that an NPOA-Sharks is unnecessary (Cook Islands, French Polynesia, Republic of the Marshall Islands, New Caledonia, Palau[10]; Eilperin 2012, Agence France-Press 2013)[11]. Other CCMs may also be able to claim that an NPOA-Sharks is not necessary because they do not flag any vessels which catch sharks. If all of these issues are taken into consideration it is likely that more than half of all WCPFC CCMs either comply with the spirit of the IPOA-Sharks or have implemented stricter measures (e.g. 15 CCMs with NPOAs +5 CCMs who have stricter measures)/37=54%). It should be noted, however, that a ban on retention of all sharks does not reduce shark mortality to zero and thus the impact to shark populations and the need for additional

[6] It should also be noted that the IPOA-Sharks itself is voluntary (FAO 1999).
[7] The 37 CCMs included in the analyses for 2011 in this paper are those that were included in the 2011 CMS (see Appendix B). For 2012 data, the number of CCMs increased by two (St. Kitts and Nevis and the Democratic People's Republic of Korea).
[8] Analysis of AR2s for 2012 in this paper are based on reports posted on the WCPFC website as of 19 July 2013 (9 AR2s missing).
[9] Fiji's National Plan of Action-Sharks is reportedly in the final stages of approval and may be formally adopted prior to WCPFC SC9.
[10] Information from Tokelau confirms that dead sharks may be retained therefore Tokelau's policy differs from the other no-retention policies listed here.
[11] It should be noted that some of these CCMs' shark regulations allow retention of sharks by non-commercial fishing operations.

management measures may require consideration in an NPOA-Sharks or other plan.

2.1.2. Data Provision for Key Species

CCMs must provide catch and effort data for key shark species

The second component of the cornerstone measure is designed to provide better information for shark management by requiring provision of catch and effort data for key shark species (CMM 2010-07, Clause 4). Although this component is in the non-binding section of CMM 2010-07, subsequent inclusion of shark data reporting requirements in the "Scientific Data to be Provided to the Commission" document, and evaluation against these requirements in the CMS process, suggest that provision of shark data is expected, if not required.

According to self-reporting for 2011, 54% of CCMs comply with shark data provision requirements; for 2012 the confirmed compliance rate is 44% (with 9 reports outstanding)

According to self-reporting in the AR2s, 20 of 37 CCMs reporting for 2011 confirmed that they complied with the data provision requirements for sharks (54%). Of the remainder, one CCM answered "no", one CCM answered "partially", seven CCMs answered "not applicable" and eight CCMs did not directly address the issue. Of the available AR2s for 2012, 17 confirm compliance, five CCMs answered "no" and eight CCMs answered "not applicable". In combination with the nine outstanding reports, this equates to a confirmed compliance rate for 2012 of 44%.

Commission evaluation suggests that only 39% of CCMs were fully compliant in shark data provision for 2011 but this improved to 50% for 2012

Annual Commission assessments of shark data provision are available from the WCPFC[12]. These data provision summaries indicate that of the 33 CCMs evaluated for 2011, only 13 CCMs (39%) reported what appeared to be complete data for key species for all gear types (catch estimates and aggregate data). However, this had improved to 17 CCMs (50%) reporting complete shark data for 2012 (n=34). Although the Commission did not formally evaluate whether information on discards was provided in 2011, mention of discards could only be found in 6 CCMs' AR2s as required. However, again, this appears to have improved as the Commission's review for 2012 found only 7 CCMs did not report any shark discards[13]. It is noted that there are still some CCMs who report that they are fully compliant with the data submission requirements in their AR2s but are not found to be so in the Commission assessment. The reporting of eleven CCMs for 2011 and three CCMs for 2012 showed this discrepancy.

2.1.3. Full Utilization and Encouraging Live Release

WCPFC requires full use of retained catches but the IPOA-Sharks calls for full use of dead sharks

There are five clauses within the binding portion of CMM 2010-07 which pertain to the handling of sharks (Clauses 6-10). These clauses refer to two principles: full utilization of retained catches and live release of incidental, unused catches. Under the IPOA-Sharks, utilization issues are articulated as three aims: a) minimize unutilized incidental catches of sharks; b) minimize waste and discards […]; and c) encourage full use of dead sharks. Live release is not mentioned (FAO 1999).

Some CCMs may choose to apply both full utilization and live release principles by fully utilizing as much of the shark catch as possible, and

[12] http://www.wcpfc.int/Provision-data for 2011 and draft 2012 tables provided by the WCPFC Scientific Services Provider (SPC) for this analysis

[13] Note that this count does not include CCMs that reported some shark discards but did not report discards for all key shark species.

releasing alive only those sharks which cannot be fully utilized. In contrast, other CCMs require all sharks to be discarded, whether alive or dead, and therefore while maximizing live release, allow the whole carcass of sharks that are already dead to be wasted. It should be noted that both approaches are compatible with a ban on finning. It should further be noted that although both approaches are compatible with the WCPFC measure, the latter approach appears to be inconsistent with the IPOA-Sharks because it does not minimize waste.

CCMs apply the full utilization principle differently, particularly with regard to dead sharks

These differing approaches complicate a simple yes or no response to questions about the implementation of the measure. Of 37 CCMs reporting for 2011, 16 (43%) answered affirmatively that they require full utilization (Clause 6) and implement a 5% fins-to-carcass weight ratio to control finning (Clause 7). Seven CCMs answered negatively to implementation of one or both of these clauses, and 14 CCMs did not address the issue. For 2012, 18 CCMs (46%) answered affirmatively to both clauses, two answered negatively to at least one of the clauses, and ten did not address the issue. As with the implementation of the IPOA-Sharks, it is not clear whether those CCMs which do not confirm implementation also do not require full utilization and do not control finning, or they have a stricter policy such as a ban on all commercial catches. Encouraging the live release of sharks was confirmed for 2011 by 23 CCMs (62%, n=37) and for 2012 by 23 CCMs (59%, n=39). It should be noted that affirmative answers are expected to apply to all sharks in some cases, and only those sharks which cannot be fully utilized in others.

For 2011, self-reporting suggests that 43% (46% for 2012) of CCMs require full utilization and control finning, and 62% (59% for 2012) encourage live release

Although some information on national shark policies is available from media sources, this information does not provide a sufficient basis for an independent evaluation of the extent of implementation of full utilization and live release provisions of the WCPFC measure. Therefore, such an evaluation could not be conducted.

An independent evaluation of the extent of implementation was not possible

2.1.4. Alternative Measures for "Exploring, Exploiting, Conserving and Managing" Sharks

Clause 11 of the cornerstone CMM allows for coastal States to implement "alternative measures for the purpose of exploring, exploiting, conserving and managing sharks…within areas under their jurisdiction". Clause 12 requires that CCMs report to the WCPFC annually on their implementation of the measure and any alternative measures adopted.

Under the CMM, alternative measures may be adopted for national waters

For 2011, of the 37 CCMs, 20 (54%) answered "yes" to implementation of the measure and any alternatives, three answered "no", seven replied with "not applicable" and seven did not address the issue in their AR2s. For 2012, nine CCMs answered "yes" (23%), two answered "no", and 19 replied with "not applicable". This wide variation from one year to the next can likely be attributed to different interpretations of what should be reported (i.e. implementation of the CMM versus implementation of an alternative) and the changing AR2 formats. Of those responding affirmatively some, but not all, provided further information about their national policies. This information ranged in length from a few sentences to several hundred pages of regulations. Similar to the evaluation of implementation of full utilization and live release, there is insufficient information for an independent evaluation of national implementation.

Slightly over half of CCMs (54%) confirmed implementation of the measure or alternatives in 2011

2.1.5. Research

Bycatch mitigation and stock status research is being done

The measure's requirement for research into bycatch mitigation is non-binding on CCMs (Clause 4) and is not specifically reported against by most CCMs. Nevertheless there is independent confirmation that relevant bycatch mitigation research is being conducted by a number of government and non-government sponsored projects. The measure also refers to research in the form of stock status assessments by the Scientific Committee (Clause 14). This is reported on through annual reports on the Shark Research Plan by the Scientific Services Provider to the Scientific Committee which are in the public domain (e.g. Rice and Harley 2012b, 2013b).

2.2. Effectiveness of the Shark Conservation and Management Measures

2.2.1. Effectiveness of the Cornerstone Measure

Effectiveness can be demonstrated through a reduction in finning rates, an increase in live releases and greater availability of catch data

In order to evaluate the effectiveness of the cornerstone measure, it is first necessary to pinpoint its objectives. The main objective appears to be to promote full utilization and reduce waste by controlling finning. This objective can be evaluated by examining finning rates before and after adoption of the measure. There may also have been the expectation among some CCMs and stakeholders that controlling finning would reduce fishing mortality for sharks. However, one possible outcome of a finning ban is that shark mortality would be unaffected (i.e. sharks which previously would have been finned are now retained whole or discarded whole but dead), therefore it cannot be assumed that a reduction in finning equates to a reduction in mortality. A second objective appears to be to increase the proportion of sharks released alive. Meeting this objective would indicate a direct reduction in shark mortality. A third objective appears to be to increase the amount of scientific data for stock status evaluation.

Observer coverage in the purse seine fishery is now 100% but coverage in the longline fishery is under 2% and not representative

The effectiveness of the cornerstone measure in meeting the first two objectives can be evaluated only on the basis of available observer data. These data are limited for several reasons. First, coverage in the longline fishery since 2009 has contracted as observer deployment in the purse seine fishery has increased to meet requirements for 100% coverage as of 1 January 2010[14]. Second, only observer data collected under the WCPFC's Regional Observer Program (ROP) could be made available for analysis in this paper. These ROP data do not include observer trips on a vessel fishing in waters under the national jurisdiction of its flag State. Therefore only observer trips on the high seas and on non-nationally flagged vessels in EEZs could be analyzed. Third, observer coverage on the high seas is very low, and observer coverage of non-nationally flagged vessels in EEZs is in some cases also very low (Table 2). Therefore, although coverage equivalent to 5% of the effort in each longline fishery under the jurisdiction of the Commission is required by June 2012 (see CMM 2007-01, Attachment K, Annex C, Clause 6), it is not clear whether this requirement is being met, and the data available for this analysis represents even lower coverage. Furthermore, even if all observer data

[14] The requirement for 100% observer coverage in the purse seine fishery does not apply to vessels fishing exclusively in one EEZ.

were available for analysis (i.e. including non-ROP data), summaries suggest that even with these additional data, overall coverage would be low and unrepresentative. In particular, based on data received by the Scientific Services Provider for 2010-2012, some Pacific Island countries (including some with declared shark "sanctuaries") appear to have 0% longline observer coverage for their own flagged vessels (perhaps due to national prioritization of purse seine coverage), and high seas fisheries are not well-represented (Williams et al. 2013; P. Williams, SPC, personal communication).

Table 2. Longline observer coverage in PICs by latitudinal band, 2005-2012. Tropical EEZs include Palau, the Federated States of Micronesia, Papua New Guinea, the Republic of the Marshall Islands, Kiribati and the Solomon Islands. Subtropical EEZs include Vanuatu, New Caledonia, Fiji, Samoa, the Cook Islands, French Polynesia and Tonga. (Data provided by the WCPFC Scientific Services Provider (SPC) in July 2013 in generalized form to protect data confidentiality.)

Year	Tropical EEZs (10°S-15°N)	Sub-tropical EEZs (10°S-25°S)
2005	1.1%	2.2%
2006	1.5%	2.4%
2007	1.2%	1.5%
2008	1.3%	2.4%
2009	0.4%	2.0%
2010	0.1%	2.1%
2011	0.2%	1.2%
2012	0.0%	0.3%

Finning rates do not appear to be falling and are currently ~15-25% in the purse seine fishery and 30-40% in the longline fishery

With regard to a reduction in finning, based on ROP data available for this analysis, in the purse seine fishery the percentage of sharks finned decreased from a high of 72% (5,394 of 7,448) in 2006 (before the CMM was adopted) to a low of 9% (999 of 11,692) in 2009 (the second year of implementation); however it rose again in 2010 (14%; 4,091 of 29,053) and 2011 (23%, 5,890 of 25,805; Figure 1). It is therefore concluded that finning rates in purse seine operations do not appear to be decreasing and are currently over 20%. In the longline fishery the proportion of sharks finned remained within the range of values observed prior to implementation of the measure (2005-2007, 44-70% from total sample sizes of 3,067 to 10,283) during the first two years of implementation (2008-2009, 55-56% from total sample sizes of 2,383 to 3,453), and dropped only slightly in the next two years of implementation (2010-2011, 32-38% from total sample sizes of 2,011 to 2,952). Drawing conclusions for the entire longline fishery based on longline observer data since 2009 is problematic due to the coverage issues discussed above, however, it is clear that finning rates continue to exceed 30% in observed longline operations.

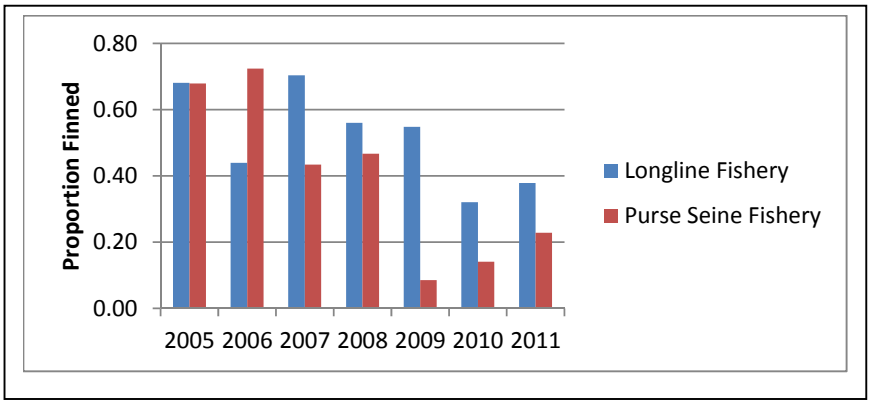

Figure 1. Proportion of sharks finned in WCPFC longline and purse seine fisheries based on ROP data, 2005-2011 (2012 data are incomplete) (Source: ROP data provided by the WCPFC Scientific Services Provider (SPC) in July 2013, subset to remove non-shark species and those of unknown fate)

The proportion of sharks released alive in the purse seine fishery is unknown due to lack of data, however the number of sharks surviving release is expected to be low.

Although it is possible that a reduction in finning would coincide with an increase in the percentage of sharks released alive, this is not necessarily the case. In fact, an analysis of longline observer data from 1995-2010 indicated that mako, silky and oceanic whitetip sharks were more likely to be retained than finned (Clarke et al. 2013), with both outcomes resulting in mortality. It remains impossible to evaluate the proportion of sharks released alive in WCPFC purse seine fisheries because purse seine observers do not record the sharks' condition at release. However, studies of shark mortalities in various purse seine fisheries have shown that ~60-80% of sharks are dead when they are first observed at net retrieval and approximately half of those which survive retrieval die after release (Poisson et al. 2011, Dagorn et al. 2012, Hutchinson et al. 2012). Therefore even if live release is strictly practiced in purse seine fisheries, the number of sharks surviving is expected to be low.

For the longline fishery the percentage of observed sharks released alive is highly variable but may be increasing

Analysis of the potential survival of sharks in longline fisheries was undertaken based on ROP data provided by the WCPFC Scientific Services Provider (SPC) for 2005-2011. Following the methodology in Clarke (2011), all sharks which were recorded as cut free or escaped (and were not recorded with an initial or final condition of "dead or dying"), as well as all sharks which were discarded and recorded with an initial condition of "alive" or "unknown", and a final condition of "alive", were considered to be live releases[15]. It should be noted, however, that these assumptions are conservative and not all live releases are expected to survive. Annual figures for the percentage of observed sharks released alive show considerable variability from year to year, particularly since 2009 (Figure 2). For example in 2010, the percentage of live-releases increased to 51% from 27% in 2009, but fell again to 15% in 2011. The reason for this is unknown but it is noted that the increased variability coincides with the reduction in longline observer coverage as discussed above. For whatever reason, it does appear that the percentage of observed sharks released

[15] For this analysis sharks considered to be "alive" were recorded as one of the following codes: A0 (alive, not elsewhere indicated), A1 (alive and healthy) or A2 (alive but injured/distressed). Sharks recorded as A3 (alive but dying) were considered to be "dead".

alive has increased since the adoption of the measure in 2008. However, during this same period the percentage of observed sharks with confirmed mortality (finned, retained or discarded dead) remained above 72% with the exception of 2010 where it fell to 49%.

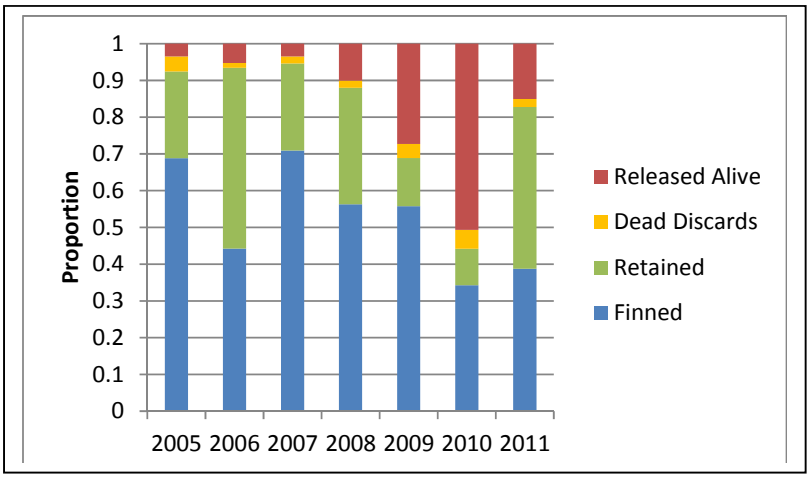

Figure 2. Proportion of sharks recorded by ROP longline observers as finned or retained or discarded dead (mortalities), versus released alive (potential survivors, see text), 2005-2011 (2012 data are incomplete). All other unknown fates and conditions were removed from the analysis.

The finning and live release components of the cornerstone measure may represent only a negligible benefit to shark survival

As the analysis above indicates, finning rates are lower than they were prior to the effective date of the cornerstone measure but they do not appear to be continually decreasing. Furthermore, finning continues at levels of ~15-25% in the purse seine fishery and 30-40% in the longline fishery. Although the reduced finning rates in the purse seine fishery are encouraging, most sharks in the purse seine fishery will already be dead when they reach the vessel, therefore this reduction in finning is likely to translate into only a very small increase in survival. Furthermore, according to catch estimates for 2010, the longline fishery catches over ten times as many of the key shark species as the purse seine fishery does (Lawson 2011), and therefore effects in the longline fishery will be considerably more important to shark populations. With the reduction in finning rates, it appears that the percentage of observed sharks that are released alive in the longline fishery has increased, but it is not known how many of these survive and the percentage of sharks with confirmed mortality remains above 72% in all but one year (2010). In summary, on the basis of existing information the expected benefit of the cornerstone measure to sharks in terms of increased survival appears negligible.

With respect to the third objective, in parallel with the improvements in data provision, the amount of shark catch data available for analysis is steadily increasing with time. This is particularly evident with regard to recent data submissions by Pacific Island countries for silky, oceanic whitetip and thresher sharks[16], and can be attributed to adoption of the extended regional longline logsheet categorizing the key shark species, and

[16] Based on a comparison of the WCPFC Data Catalogue as of November 2012 (http://www.wcpfc.int/wcpfc-data-catalogue) and updated tables received from the WCPFC Scientific Services Provider (SPC) in June 2013.

Although shark data provision has improved, most analyses rely on longline observer data for which coverage remains low and unrepresentative

to the distribution of species identification guides[17]. Nevertheless, at present most shark status assessments rely almost exclusively on longline observer data. In fact, the quantity and representativeness of these data have actually decreased since the measure was implemented and the program as a whole currently appears to fall well short of the target of 5% longline coverage set by the Commission. Recent and ongoing deficiencies in both the coverage and representativeness of the longline observer dataset thus not only jeopardize the reliability of stock status assessments, they prevent drawing robust conclusions about the effectiveness of any current or proposed shark-related conservation and management measures.

2.2.2. Effectiveness of the Oceanic Whitetip No-Retention Measure

With regard to the expected effectiveness of the no-retention measure for oceanic whitetip sharks, a previous analysis of longline observer data from 1995-2010 suggested that without a no-retention measure the mortality rate for oceanic whitetip shark catches would be 87%. Assuming full implementation of no-retention and prompt release unharmed requirements for this species the mortality rate was estimated to fall to 31%[18] (Clarke 2011). The recent oceanic whitetip shark stock assessment found that overfishing is occurring ($F_{current}/F_{MSY}$ = 6.5) and the stock is in an overfished state ($SB_{current}/SB_{MSY}$ = 0.153; WCPFC 2012a). Given the severely depleted state of the oceanic whitetip shark population, even if no-retention measures reduced mortality by more than 50% (i.e. from 87% to 31%), it is not clear how quickly and to what extent these conditions would allow the oceanic whitetip shark population to recover because model projections were not conducted (Rice and Harley 2012a). Compounding this uncertainty, less-than-full implementation will erode the benefits of any mitigation measure.

The no-retention measure for oceanic whitetip sharks was estimated to reduce mortality by >50% but its sufficiency for population rebuilding is unknown

In addition, broad-scale monitoring of the oceanic whitetip shark no-retention measures may be problematic. This is because even though the measure (CMM 2011-04) requires that releases and their status be "estimated", and even though the cornerstone measure (CMM 2010-07) requires CCMs to report retained and discarded catches of key shark species, many CCM logsheets are not designed to do this. As a result, in cases of zero reported catches by CCMs whose logsheets do not provide for recording of discards, it may not be clear whether the species is now being discarded or is not being caught at all. For example, China reported to the WCPFC in 2012 that it notified fishermen of the measure and that catches of oceanic whitetip of 532 t in 2010 had dropped to zero for 2011 (WCPFC 2012a). One option is that in the absence of logsheet recording, CCMs may use observer data to estimate releases (i.e. mentioned under CMM 2011-04, but not explicit under CMM 2010-07). This interpretation would place more emphasis on the longline observer records which, as described above, are not adequately representative of all fleets and areas.

When logsheets do not explicitly record discards, a zero may represent a true zero catch or 100% discarding

[17] Peter Williams, SPC, personal communication, July 2013

[18] This lower estimate assumes that mortality only occurs during haulback, not during handling. Any rough handling, e.g. to retrieve the terminal tackle, would tend to increase the mortality rate.

2.2.3. Effectiveness of the Whale Shark Measure

The measure prohibiting deliberate setting on whale sharks was informed by an analysis of observer and logsheet data conducted by the WCPFC Scientific Services Provider (SPC) prior to its adoption (SPC-OFP 2012a). This analysis found interaction rates of 10.4 whale sharks per 1000 sets in 2007-2009 and 8.5 whale sharks per 1000 sets in 2010[19]. It can reasonably be expected that the effectiveness of the measure, once it enters into force in January 2014, can be measured by the extent to which the interaction rate drops from the 2007-2009 baseline. The measure contains a prohibition on setting "if the animal [whale shark] is sighted prior to the commencement of the set". Assuming full implementation and compliance with the measure, only those sets where the whale shark is known to be present prior to setting will be affected. Based on observer data from 2007-2010, SPC-OFP (2012a) suggests that as many as two-thirds of the sets with whale shark interactions were not known by the observer to be set on a whale shark until the animal was discovered in the net during the brailing process. Assuming that the observer's knowledge is similar to the fishing master's, it may be presumed that only one-third of the interactions can be knowingly avoided. The degree to which the remaining two-thirds of the interactions which will still occur will cause harm, either immediately or post-release, to whale sharks will largely depend on what release protocols are used. At this time, the Commission has not adopted any safe release guidelines or performance standards to define what behavior is required and what results are expected.

It is not clear what mitigation effects can be expected from the whale shark measure as many sets take place unknowingly and safe release methods and performance standards are unspecified

2.3. Summary of Implementation and Effectiveness

Implementation is at best ~60% and in several cases considerably lower

A summary of the details of the preceding analysis is shown in Table 3 below. Both self-reported and independently-confirmed implementation rates are at best ~60% and in several cases considerably lower. Summaries of CCM self-reported compliance based on AR2s are shown for 2012 (Figure 3) and 2008-2011 (Appendix A).

[19] The lower interaction rate in 2010 may be due to the adoption of a ban on "fishing or related activity in order to catch tuna associated with whale sharks" by the Parties to the Nauru Agreement (PNA) Third Implementing Arrangement in September 2010 (PNA 2011).

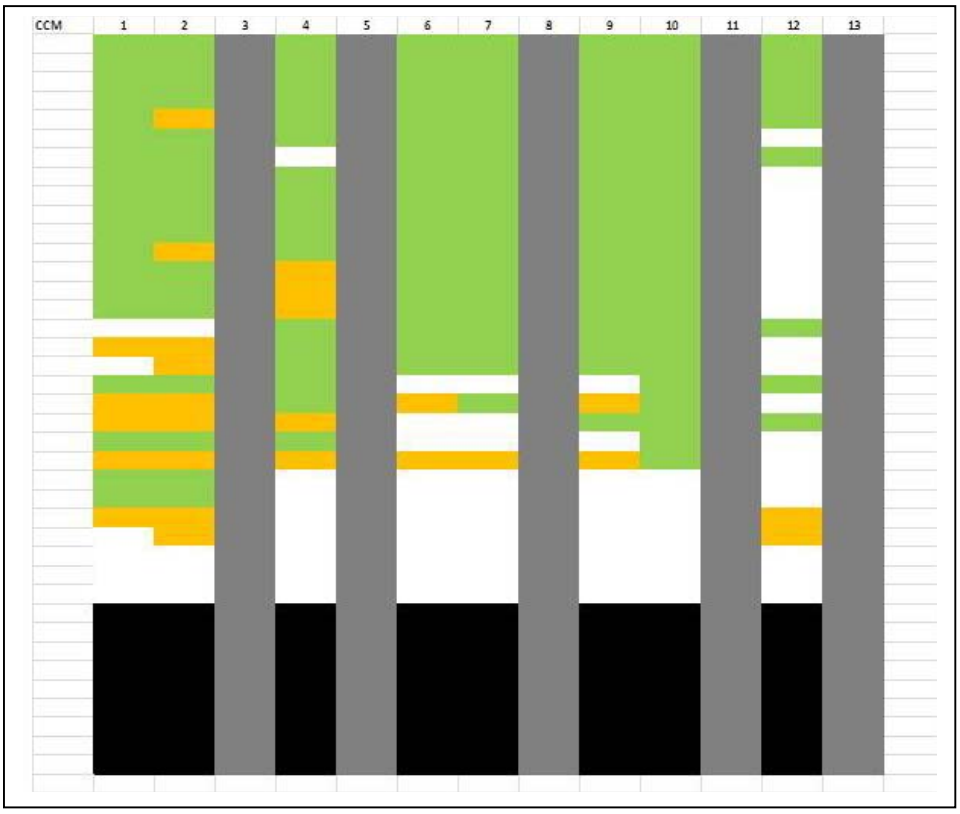

Figure 3. Summary of compliance reporting in the AR2s for 2012 (n=39) against the cornerstone shark measure (CMM 2010-07, see Appendix A for Clauses 1-13). CCMs are arranged in rows (identity masked) and clauses of the cornerstone measure are arranged in columns. Clauses 3, 5, 8, 11 and 13 do not require reporting for 2012. Green cells represent affirmative responses, orange cells represent negative responses, white cells represent "not applicable" responses, and black cells represent no response (including no AR2 submission; for this paper 9 CCMs' AR2s for 2012 are outstanding). Rows have been sorted to move affirmative responses toward the top and missing responses toward the bottom. See Appendix A for more explanation and comparison to results for 2008-2011.

Table 3. Summary of implementation and effectiveness analysis for the three WCPFC shark conservation and management measures.

CMM	Self-Reported Implementation Rate (from 2011-2012 AR2s)	Independently Confirmed Implementation Rate	Effectiveness Considerations
2010-07 (cornerstone)			
IPOA/NPOA-Sharks	49% for 2011 and 2012	≥54%	Compliance may not require an NPOA
Data Provision	54% for 2011 44% for 2012	39% in full compliance for 2011 improving to 50% for 2012	Some missing data can be estimated by the WCPFC Scientific Services Provider (SPC)
Full Utilization + Finning Ban	43% for 2011 46% for 2012	Not possible to independently confirm implementation	Finning rates have decreased from pre-adoption levels but are still 20-40%
Live Release	62% for 2011 59% for 2012	Not possible to independently confirm implementation	There is some evidence for increased live release but increases in shark survival appear negligible
Confirm Implementation and/or Alternative Measures	54% for 2011 23% for 2012	Not possible to independently confirm implementation	In some cases what has been implemented is unclear; there is little basis for distinguishing between strong or weak policies, and between strong or weak implementation
Research	Often not specifically reported against	Many instances confirmed in published literature	WCPFC Shark Research Plan underway
2011-04 (Oceanic Whitetip)			
All	Too early to evaluate	Too early to evaluate	Mortality may be reduced by >50%, but is this sufficient?
2012-04 (Whale Shark)			
All	Not yet in force	Not yet in force	Some impact mitigation expected but extent depends on ability to sense the presence of a whale shark and on the implementation and effectiveness of safe release guidelines

A lack of specific objectives in the shark CMMs leads to ambiguous interpretation of requirements

In general, evaluating the implementation and effectiveness of WCPFC shark CMMs is complicated by two issues: a lack of specific objectives in each measure, and a lack of monitoring data and review processes. First, the lack of explicit objectives leads to ambiguities in interpretation of requirements such that opposite outcomes can both be considered compliant or successful. For example:

- By focusing on the existence of an NPOA-Sharks, the cornerstone measure treats CCMs which have no shark regulations or policies, and those which have highly protective policies such as bans on retention of all sharks but no NPOA per se, similarly (Section 2.1.1).

- The cornerstone measure, which appears to promote both full utilization and live release, treats CCMs which maximize mortality

but practice full utilization, and CCMs which minimize mortality but allow waste by requiring all sharks (including dead sharks) to be discarded, similarly (Section 2.1.3).

- CCMs which control finning in full compliance with the measure, and those which still allow finning, may have equal effects on shark populations (e.g. in the potential case that shark mortality rates are similar; Section 2.1.3).

- By not including specific handling requirements in the oceanic whitetip and whale shark measures, CCMs causing high mortality rates and CCMs causing low mortality rates could both be considered fully compliant (Section 2.2).

Second, despite the explicit requirement in the cornerstone measure (CMM 2010-07) to review its effectiveness, there is no specification of how effectiveness is to be measured, and more importantly, few data available upon which to base any type of effects analysis. For example:

There is also no specification of how effectiveness is to be measured and few data which can help judge effectiveness

- Most avoidable shark mortality occurs in the longline fishery, but ROP longline observer coverage not only appears not to meet Commission requirements for 5%, in many cases it is <2% and in several cases near zero (Section 2.2.1).

- Although 20 CCMs were evaluated as "Compliant" in the 2011 CMS (conducted in 2012)[20], only six of these provided all required shark data, i.e. including discards (Section 2.1.2).

- No-retention measures for species such as the oceanic whitetip shark may lead to under-reporting of retained and discarded/released catches (particularly when logsheets do not provide for explicit recording of this information), thus providing no data for science or compliance purposes (Section 2.2.2).

- Although each measure should be periodically reviewed, there is no expected effect articulated (e.g. degree of mortality reduction), and no process or baseline specified for evaluating whether this effect is being achieved (Section 2.2).

These shortcomings highlight the need for a more effective approach

The high level of international concern surrounding shark populations in combination with the shortcomings highlighted by this analysis emphasize the need for a more effective approach to managing and conserving shark populations in the WCPO. The following section outlines one such approach; recommendations for operationalizing this approach and for remedying the issues associated with the current measures are then discussed.

[20] Under the Compliance Monitoring Scheme as implemented in 2012, CCMs' provision of scientific data to the Commission in 2011 was evaluated, and the provision of data on sharks formed a part of this evaluation. However, given the breadth of the CMS review process the shark-specific evaluation was limited to whether any shark catch and effort data were provided and whether these data were species-specific for the designated key species. The review did not consider whether sharks were reported as retained or discarded (or any other data quality issues, e.g. whether all shark catches were reported as zero), whether historical data were provided, and whether bycatch mitigation research was conducted.

3. Framework for an Integrated WCPFC Shark Plan

3.1. The Need for a Consistent Framework

Although WCPO assessments have demonstrated the need for mortality reductions these are not yet being delivered

As discussed above, the WCPFC's cornerstone CMM covering all sharks (CMM 2010-07), and the two species-specific CMMs (CMM 2011-04 and CMM 2012-04), cannot yet demonstrate any significant reduction in shark mortality. For the species-specific CMMs this is because the measures have only been adopted recently. For the cornerstone CMM, a more fundamental issue is that it does not appear to be designed to achieve a reduction in shark mortality. At the same time, two stock assessments produced thus far under the WCPFC Shark Research Plan have documented that oceanic whitetip and silky shark stocks are overfished ($F_{current}/F_{MSY}$ of 6.5 for oceanic whitetip and 4.48 for silky sharks) and overfishing is occurring ($SB_{current}/SB_{MSY}$ = 0.153 for oceanic whitetip and 0.7 for silky sharks; Rice and Harley 2012a, 2013a). In addition, an indicators-based assessment has shown statistically significant declines in catch rates of 5-7% per year for blue and mako sharks in the North Pacific between 1995-2010 (Clarke et al. 2013) and the latest stock assessments for blue shark show contradictory results (Rice et al. 2013, ISC 2013).

It is also not clear what mortality reductions are being delivered by national measures

In response to concerns about the status of shark populations throughout the region, a number of coastal States have implemented national measures ranging from catch limits to no-retention policies to bans on the use of wire leaders (summarized in Appendix B). Like the WCPFC measures, the effectiveness of most of these national measures in reducing mortality is not well-documented, and it is not clear whether existing monitoring systems are sufficient to answer such questions.

Because the concepts underlying the IPOA-Sharks and some national measures are not consistent, a new integrated framework is needed

One consequence of some of the recent national measures has been a divergence between the approach to shark management embodied in the FAO IPOA-Sharks and that implemented in individual countries. In particular, the IPOA-Sharks, and several CCMs' NPOA-Sharks, emphasize maintaining "total fishing mortality for each stock within sustainable levels" and "full use of dead sharks". In contrast, several of the national measures have adopted a protectionistic approach, often referred to in the press as "sanctuaries", involving no retention of any shark species thus requiring discarding of all sharks whether dead or alive. Given these essential differences, and the role of the WCPFC in facilitating a coordinated and consistent approach to highly migratory species management in the Convention Area, it is critically important to integrate both approaches into a common framework whose outcomes can be measured and verified. Failure to do so is likely to perpetuate current problems associated with confirming that effective mitigation is actually being delivered to those species which require it.

The expected degree of mortality reduction and the residual mortality should be defined for all mitigation policies

A key element missing from both the existing WCPFC measures and the national measures is the specification of target and limit levels of fishing mortality. In most cases there is an implicit expectation that the measures will reduce fishing mortality, but the extent of the reduction, and whether it would be sufficient to rebuild depleted shark population(s) to desirable levels is not stated and often has not even been explored. It might be argued that the protectionistic approaches do not need to refer to sustainable levels of fishing mortality because they represent a zero take

policy. However, even these policies allow some shark mortality because some sharks will be caught, and some will die, through no-retention commercial fishing activities for tuna and through otherwise non-proscribed artisanal fisheries. Therefore, in theory, each shark mitigation policy has some expected degree of mortality reduction, as well as some level of residual mortality, whether or not this is made explicit. It is only by evaluating the absolute, rather than relative, mortality rates that overfishing can be prevented[21].

A framework can be built around using mortality as a single "currency"

It is thus proposed that a comprehensive WCPFC Shark CMM be built around a framework which translates disparate policies into a single "currency" of mortality management expectations and achievements. An overview of the proposed framework is provided below.

3.2. Overview of a Single "Currency" Framework

A single "currency" mortality management framework for sharks faces many of the same issues as the WCPFC CMMs for bigeye, yellowfin and skipjack tunas and could in principle follow a similar approach. In overview, a comprehensive WCPFC Shark CMM could be built around an agreed (interim) fishing mortality (F) goal set with reference to sustainability, or if this proves impossible, around an agreed reduction in F from current levels, for the most vulnerable key shark stocks according to completed stock assessments[22]. Various mitigation measures that could be taken by CCM fleets would be quantified in terms of their ability to control F and then assembled in a package expected to meet (or approximate) the goal. CCM fleets which have already made efforts to control F would be credited, either through specification of the baseline or more explicitly in fleet-specific measures, whereas those fleets which have not would need to implement stronger measures. After the mitigation package is implemented and verification data are assembled, retrospective analysis would evaluate whether the package was effective in achieving or advancing toward the goal, and any necessary adjustments would be discussed for the subsequent period. Advantages and disadvantages of this approach are outlined below.

A mortality reduction framework for sharks could follow a similar approach to tropical tunas

3.2.1. Advantages of a Single "Currency" Framework

The advantages of this approach are considered to be as follows:

Measures would be selected based on expected reductions in F

- Outcome-based - It aims explicitly at managing mortality and maintaining it at or below sustainable levels rather than specifying operational practices (e.g. controls on finning) which may or may not achieve a mortality reduction. This focus on outcomes would also encourage and reward robust verification systems.

[21] For example, in a recent paper on reference points for data-limited bycatch populations Moore et al. (2013) make the point that "reducing incidental mortality to relatively low levels may not be sufficient, as in the case of rare and highly vulnerable species or when reduced bycatch may simply be the result of declines in population abundance".

[22] Although such agreements would be similar to agreeing reference points (RP) for sharks, and this should be a long-term objective, it is proposed that at first the F goal be agreed on an interim basis similar to the situation for the bigeye, yellowfin and skipjack CMMs for which there are also as yet no agreed RPs. Definition of formal shark RPs will benefit from the ongoing WCPFC discussions of RPs for target tuna species.

Each CCM can propose its own appropriate measures

- Flexible - Each CCM would be able to agree its own contribution to shark mortality control based on the mitigation measures which are most appropriate for its fleets and operations. This avoids decision-making stalemates arising from one-size-fits-all proposals (e.g. banning wire leaders) which suit some fisheries but not others.

Existing measures that already reduce F would be credited

- Equitable - CCMs which have already implemented measures for national fleets to control F on sharks would shoulder less of the management and conservation burden than CCMs which currently do not implement such measures. CCMs which implement measures which are more easily enforced/verified (e.g. fins attached versus fins-to-carcass ratios), or take steps to ensure robust enforcement/verification (e.g. sufficient levels of observer coverage) can also be credited.

Applying measures to the high seas will promote regional consistency

- Promotes Regional Consistency - Mitigation would be implemented across the Convention Area, including the high seas, rather than clustered in specific areas as is now the case with some national measures. This consistency would not, however, preclude the definition of spatial or temporal mitigation priorities (e.g. in nursery grounds or during mating seasons) if these are found to be important in the stock assessments.

A consistent regional policy will facilitate cooperation

- Facilitates Broader Cooperation - By creating a consistent system for the Convention Area as a whole the framework would facilitate cooperation and compatibility with IATTC and CCSBT in managing straddling shark stocks, and provide for greater measurability, accountability and transparency. By making clear how each CCM's contribution supports the regional goal, the system could also simplify each CCMs' reporting responsibilities to international systems such as CITES, CMS, FAO instruments, Marine Stewardship Council certifications, etc.

3.2.2. Disadvantages of a Single "Currency" Framework

The disadvantages of a comprehensive shark CMM-based approach are considered to be as follows:

Need to account for uncertainty in shark stock assessments

- Adequacy of Data – The usefulness of the framework will depend on the quality of the data supporting the stock assessments, and the resulting uncertainties associated with stock status. Although the shark stock assessments are more uncertain than the stock assessments for tropical tunas, they should provide an adequate basis for initial management decision-making[23].

Stock and mitigation scenarios need to explicitly estimate fishing mortality

- Necessary Analytical Work – To support management decision-making, each shark stock assessment would need to explore the population consequences of varying degrees of controlling F. In addition, proposals for mitigation measures would need to be quantified in terms of their ability to control F and modelled as projections to assess the combined effects of various mitigation packages. Again, this is expected to be similar to, though less labor-intensive than, the ongoing projection work for tropical tunas. Although additional resources would be required to support the framework in the form of additional scientific services and

[23] As noted above, the incentive provided by such a framework for better verification data would likely have a positive effect on the data quantity and quality available for stock assessment.

Additional resources will be required but can be justified on the basis of global concern

Commission time to establish and monitor the system, the potential cost should be weighed against the current international conservation concerns regarding sharks and the potential for management measures to be determined in other, non-RFMO forums.

Managers need to agree a desired F, at least for an interim period

- Need to Agree on an F Goal – Managers would need to agree a desired F for at least an interim period. Noting that there are not yet agreed limit or target reference points for WCPFC tuna stocks, and that there are few examples worldwide of stock assessment reference points for sharks, it is considered that the desired F value would not need to be a formal reference point (RP). Although definition of a formal RP would be a useful long-term objective, the WCPFC's ongoing progress toward RPs for tunas will inform development of RPs for sharks. It is also noted that the absence of formal RPs for bigeye, yellowfin and skipjack tunas have not precluded adoption of F-based mitigation measures for these species (e.g. CMM 2012-01).

As for tunas, species-specific vulnerabilities and trade-offs must be considered

- Multi-species Trade-offs – As is the case for the tropical tunas, species requiring mitigation (e.g. oceanic whitetip sharks or juvenile bigeye tuna) may be inadvertently caught when targeting other species (e.g. skipjack). It will thus be necessary to grapple with species-specific vulnerabilities and trade-offs not only among shark species but between sharks and target tunas. This type of decision-making is hampered under a species-by-species approach to CMMs but would be facilitated by development of a comprehensive shark CMM. Such considerations will need to be made by managers when setting an F goal and agreeing to a package of mitigation measures.

Reductions in F would be agreed and managed by fleet/flag States

- Fleet-based Control – Although applying the mitigation measures on a fleet-by-fleet basis could be a challenge, each CCM with vessels catching sharks would be responsible for controlling F while complying with all other applicable national and regional regulations. Clearly, each national authority would have the ability to impose additional measures on vessels it flags or those fishing in its waters (e.g. through license conditions). Such measures could be used to offset the flag States' F reduction elsewhere.

3.3. Compatibility with Other Tuna RFMO Shark Management Systems

Most tuna RFMOs have adopted almost identical measures to those adopted by the WCPFC

The single "currency" mortality framework outlined above represents a departure from the approaches to shark management applied thus far in other tuna RFMOs. To date the majority of measures implemented in other tuna RFMOs have been almost identical to those adopted by the WCPFC and described in Section 2 above, i.e. controls on finning and no-retention of certain shark species[24]. The only measure adopted thus far which refers explicitly to controlling fishing mortality is ICCAT's Recommendation 07-06 which calls for members to take "appropriate measures to reduce fishing mortality in fisheries targeting porbeagle (*Lamna nasus*) and North Atlantic shortfin mako sharks (*Isurus oxyrinchus*)". The following two sections describe the situation in other tuna RFMOs with regard to

[24] Neither the WCPFC whale shark measure, which takes effect in January 2014, nor a similar IOTC measured adopted in May 2013 and binding as of 14 September 2013, is yet in place.

implementation and evaluation of their measures. Many of the issues raised are equally applicable to the WCPFC.

3.3.1. Finning Control Measures in other Tuna RFMOs

All of the tuna RFMOs have similar finning controls

Starting with ICCAT in 2004, and followed by IATTC and IOTC in 2005, and CCSBT in 2008, all of the other tuna RFMOs have adopted a 5% fins-to-carcass ratio as a means of controlling shark finning. Most of these measures have similar provisions relating to the mitigation of fishing impacts to sharks including waste minimization and encouraging live release.

Dissatisfaction with application of the 5% fins-to-carcass ratio has led some countries to require fins be attached, but no tuna RFMOs have yet adopted this

Several problems have arisen with regard to interpretation of the 5% fins-to-carcass ratio (Fowler and Séret 2010, Biery and Pauly 2012, Santana-Garcon et al. 2012). First, while provision is made in the measures for the ratio to be reviewed and modified, it is now well-understood that the actual ratio of fins-to-carcass weight will vary by species, the number of fins utilized from each shark, and the type of cut used to remove the fins from the carcass. Nevertheless, none of the ratios have been amended since the measures were adopted. Second, the measures do not make clear whether the ratio applies to fresh or dried fins, and to what form of the carcass (i.e. whole weight, dressed or partially dressed carcass) the fins are to be compared. These interpretation issues, along with the difficulties of weighing fins and carcasses in an enforcement setting, have led some countries to replace fins-to-carcass ratios with national requirements for fins to remain attached to the carcass until landing (IUCN SSG 2013). Although similar measures have been discussed within tuna RFMO forums for several years, to date no tuna RFMO has adopted a fins-attached policy.

None of the other tuna RFMOs have yet formally reviewed their finning controls

As discussed in Section 2.2.1, the WCPFC has taken some steps toward evaluating compliance with its finning controls. None of the other tuna RFMOs are known to have yet conducted a review of the implementation or effectiveness of their finning controls.

3.3.2. No-Retention Measures in other Tuna RFMOs

Other tuna RFMOs have no-retention measures for oceanic whitetip, thresher, silky and hammerhead sharks

Most tuna RFMOs also have at least one "no-retention" measure which prohibits retaining any part or whole carcass of the designated shark species. Measures have been adopted by IATTC for the oceanic whitetip shark; by ICCAT for bigeye thresher, oceanic whitetip, hammerhead (except *S. tiburo*), and silky sharks; and by IOTC for all thresher sharks and the oceanic whitetip shark[25]. Most of the measures (i.e. all except the ICCAT oceanic whitetip shark measure) also have language calling for the sharks to be released promptly and unharmed. Despite their general similarities, these no-retention measures vary in the details of their proscriptions and exemptions. For example, the ICCAT measures for bigeye thresher, hammerhead and silky sharks contain exemptions for catches by developing coastal States which either remain below a catch limit (bigeye thresher shark measure), or are using the sharks for consumption, do not increase catches, report catch data and do not internationally trade the products (hammerhead and silky shark

[25] The specific measures are IATTC Resolution C-11-10; ICCAT Recommendations 09-07, 10-07, 10-8 and 11-08; and IOTC Resolutions 12/09 and 13/06.

measures). The IOTC oceanic whitetip measure exempts "artisanal fisheries operating exclusively in their respective EEZ for the purpose of local consumption". The ICCAT silky shark measure is noteworthy because it contains provisions for the Commission to monitor whether the conditions of the exemption are being met. Another point of difference is that some of the no-retention measures ban the "selling or offering for sale" of any products from the specified shark species, whereas the WCPFC and IOTC oceanic whitetip shark and ICCAT silky shark measures do not.

As yet no reviews of no-retention measures have been conducted, but ICCAT will undertake one later this year

None of the tuna RFMOs are known to have yet conducted any review of compliance with these no-retention measures. In fact, in response to concerns that required shark data reporting thus far has been incomplete and inconsistent (ICCAT 2013), ICCAT has recently implemented two measures which require improvements in shark data submissions and are designed to support compliance reviews beginning later in 2013. The first measure (Recommendation 11-15) states that the ICCAT Compliance Committee will annually review members' data submissions (including for sharks) beginning in 2013 and those members which have not reported any catches (zero or otherwise) for one or more species for a given year will be prohibited from future retention of those species until the catch data are submitted. The second measure (Recommendation 12-05) requires that all members submit details of their implementation of and compliance with all shark CMMs (including the finning controls, all no-retention measures and the reduction of F for shortfin mako and porbeagle sharks) prior to the 2013 annual meeting.

4. Recommendations

Recommendations are provided for improving the existing CMMs and establishing a comprehensive shark CMM based on a framework of fishing mortality reduction

The recommendations resulting from this analysis are provided below in two sets. In the short-term, the three existing WCPFC shark CMMs will remain the only existing management tools available to the Commission. Therefore, the first set of recommendations focuses on remedying shortcomings in these existing CMMs to ensure that they work effectively. In the longer term, it is recommended that the Commission move toward formulating a comprehensive shark CMM based on a framework in which all mitigation measures are quantified in terms of their effectiveness in controlling shark fishing mortality. By articulating specific F control goals, the effectiveness of the comprehensive shark CMM in shifting WCPO fisheries toward a more sustainable level of shark take can be monitored and assessed. Suggestions for some initial steps toward operationalizing a comprehensive shark CMM are provided in the second set of recommendations.

4.1. Recommendations regarding the existing CMMs

Six recommendations for strengthening the existing WCPFC shark CMMs are as follows:

a. Improve Compliance Reporting Format - As described in Section 2, there are several issues with the cornerstone shark CMM (CMM 2010-07) which prevent accurate evaluation of whether it has been implemented and is working effectively. Instead of the current clause-by-clause "yes"/"no" format of the AR2 reports, which provides ambiguous results based on each CCM's interpretation of the CMM, a

An improved compliance reporting format for the cornerstone measure is suggested in Appendix C

more explicit, but still streamlined, compliance format is provided in Appendix C. The format is based on providing the same information as required in the current format but allows for clear interpretation thus saving time for both CCMs and the Commission. CCMs who wish to increase the transparency of their compliance reporting against this measure could be encouraged to use the proposed format on a voluntary basis until such time as it might be adopted by the Commission within the AR2 reporting format.

Development of safe release guidelines for oceanic whitetip and whale sharks should be a priority

b. Define Safe Release – Both the oceanic whitetip and whale shark measures call for safe release of sharks but neither specifies requirements for how this should be accomplished. Without such requirements, implementation and effectiveness are difficult to confirm. Therefore safe release guidelines should be developed and adopted as a matter of priority. It is noted that SC8 already adopted safe release guidelines for whale sharks (WCPFC 2012a) but these have not yet been adopted by the Commission. Safe release guidelines for sharks may be informed by national guidelines such as those used in the United States (NOAA 2013).

Accurate recording of shark discards/ releases is urgently required for scientific and compliance purposes

c. Require Recording of Discards – In the recent ICCAT Recommendation 12-05 it was noted that no-retention shark measures have been in place for up to three years and yet there are few records of compliance. The same situation will occur for the WCPFC oceanic whitetip no-retention measure unless CCMs are required to take a more consistent approach to recording discarded/released catches rather than simply reporting zero retained individuals. Similarly, a consistent approach to recording whale shark interactions will also be necessary. Although it is appreciated that revising national logbook formats is not a trivial matter, this or another solution to accurate recording of discards/releases is urgently required for both scientific and compliance purposes.

The Scientific Services Provider should take the lead in annually identifying and assessing nominations for key species (e.g. mantas)

d. Nominate Key Species – Several of the amendments to the cornerstone shark measure have been made to add new key species to the measure. Subsequent to WCPFC9 there is now a process for designating key species (WCPFC 2012b) which envisages that a particular species of chondrichthyan fish (shark, skate, ray or chimaera) be nominated by a proponent, presumably a CCM. However, it is unlikely that any given proponent will have sufficient WCPO-wide data to document the impact of fishing activities, the ecological concern, or the data availability for the nominated species as required by the process. For example, with the listing of manta rays by both CITES (*Manta birostris* and *M. alfredi*) and CMS (*M. birostris* only), the Commission may wish to consider whether there are sufficient grounds to designate any ray or skate species as WCPFC key species, but it is likely that only the Scientific Services Provider would have sufficient data to inform the nomination[26].

[26] Mantas (as a group) were the only ray or skate species comprising an identified and substantial component of the catch of either WCPFC purse seine (21 taxa listed) or longline (30 taxa listed) fisheries from 1994-2009 (based on observer data; SPC 2010). Analysis showed that mantas (as a group) interact only with purse seine fisheries and comprise 0.02% of the total catch. By set type, the percentage of the non-target species catch composed of mantas varied from 1% in log-associated and drifting FAD sets, to 2% in anchored FAD sets, and to 11% in unassociated sets.

Therefore, it is recommended that the Scientific Services Provider be tasked with undertaking a brief annual review of shark data holdings within its Progress Report on the Shark Research Plan (e.g. Rice and Harley 2012b, 2013b). Any CCM wishing to nominate a candidate for key species designation should communicate with the Scientific Services Provider prior to SC to allow time for evaluation of the nomination.

e. Verify the Finning Controls – As discussed in Section 3.3.1 most of the tuna RFMOs are grappling with the issue of how to evaluate whether their shark finning controls are working. On the basis of substantial, mounting evidence that no single ratio can be effective (see Section 3.3.1), several countries[27] have determined that the most effective means of verifying that finning is not occurring is to require that sharks be landed with their fins attached. Although as discussed in Section 2, controlling finning will not necessarily lead to a reduction in shark mortality, a fins attached policy is a simple and effective means of verifying compliance with full utilization requirements, and facilitates species-specific data collection by port sampling staff. For these reasons, it should be considered as a short-term approach to strengthening the existing cornerstone CMM.

A fins attached policy should be considered for its ease of enforcement and scientific data collection benefits

f. Strengthen the Observer Program for Longline Fisheries – The observer program is a critical component of the Commission's ability to manage the fishery. In recent years longline observer coverage appears not to have met its 5% target, and since the longline fishery catches over ten times as many of key shark species as the purse seine fishery, this lack of coverage has resulted in a serious shortfall in the data available for both scientific and compliance purposes relating to sharks. As a first step, obtaining an adequate, representative sample of longline shark catches and disposition should be added to the list of reasons why the Commission's required level of longline observer coverage (i.e. 5% by June 2012) needs to be achieved as an urgent priority.

Meeting the Commission's goal for longline observer coverage is critical for ongoing assessment of shark status

4.2. Recommendations regarding a WCPFC Shark Plan

Recommendations for moving toward a comprehensive WCPFC Shark CMM are presented as six steps:

a. Include F Projections in Stock Assessments – The Scientific Services Provider and the Scientific Committee should ensure that stock assessments conducted under the Shark Research Plan provide some basis for evaluating what degree of reduction in F would be necessary to allow for overfished shark stocks (e.g. oceanic whitetip (Rice and Harley 2012a) and silky sharks (Rice and Harley 2013a)) to rebuild over a reasonable timeframe. As it is understood that the shark stock assessments represent considerable uncertainty, these projections would be used as a starting point for defining quantitative objectives for a package of mitigation measures, rather than for defining formal RPs.

F projections should be included in shark stock assessments

[27] These countries include the United States, the European Union, Chinese Taipei, and several central and south American countries.

A decision on an interim F goal is required

b. Specify an Interim F Goal – Through consultation either during regularly scheduled Commission meetings, or through a specially convened workshop, a management decision will need to be taken with regard to the desired level of F based on consideration of the time required for rebuilding, the differing characteristics and states of the stocks (e.g. oceanic whitetip sharks may require a lower F), and the acceptable degree of uncertainty/risk. This F goal can be used in initial modelling of mitigation scenarios before being formally agreed.

All mitigation measures should be quantified in terms of their expected F

c. Quantify the Effects of Mitigation Policies – Working from a master list of actual and proposed mitigation measures including no-retention, catch limits, bans on wire leaders and other gear components (see Bromhead et al. 2013), various forms of finning controls, effort control, etc., the expected degree of F associated with each measure for each fleet which implements it would be quantified. Wherever possible, these quantifications would be based on existing data (e.g. observer data) but it is recognized that in some cases assumptions will be necessary. As part of this exercise a baseline value of F will need to be defined for interim use before being formally agreed later.

Packages of mitigation measures designed to achieve the F goal should be discussed and tested

d. Develop a Package of Mitigation Measures – Once the effects of various policies have been quantified, another consultation would be held to allow CCMs to commit to, or re-affirm their commitment to, various mitigation measures. The combined effects of these measures (perhaps under various scenarios of implementation/verification) would be modelled and compared to the F goal. If necessary, the package of mitigation measures would be iteratively assessed to optimize CCM commitments and F reductions.

A draft CMM can then be formulated for the consideration of the Commission

e. Draft a CMM – The package of mitigation measures, covering a variety of techniques and shark species as necessary, would then be drafted as a comprehensive shark CMM for the consideration of the Commission. Its format could be designed to be applied as an interim measure, but still provide a framework for a more permanent measure eventually. Retrospective analysis, i.e. to determine whether the mitigation measures are having the desired effect and if not whether this is due to mis-specification or lack of implementation, should be built into the measure. Robust requirements for verification data, and penalties (similar to the system adopted by ICCAT) for failure to submit data, should also be built into the draft measure.

f. Adoption of the CMM – Ideally, the draft CMM would then be considered by the Commission, modified as necessary, and adopted for interim implementation.

4.3. Conclusion

The value of unimplemented and ineffective CMMs is minimal

Managing WCPO shark populations through CMMs which cannot be confirmed to be implemented or effective has a high risk of allowing further damage to shark stocks through continued overfishing. Unsupported assertions of compliance and conservation benefit are not likely to withstand external scrutiny, particularly given heightened global concerns about shark status. Furthermore, even if the implementation and intended effectiveness of existing CMMs is confirmed, if the mitigation is

not sufficient to cause a meaningful reduction in fishing mortality and an improvement in stock status, are the Commission's limited resources being used in the most appropriate way?

A Commission commitment to sustaining shark populations requires that measures not only be expedient but also meaning and

This paper has attempted to address these issues and made a number of recommendations focused on a) improving the Commission's ability to confirm compliance with existing measures; b) maximizing the effectiveness of the existing measures; and c) creating a framework within which the effectiveness of all measures (existing or proposed) can be judged on their ability to control fishing mortality for overfished shark stocks. The WCPFC has the opportunity and the responsibility to manage highly migratory shark stocks in a comprehensive and integrated manner across the Convention Area, including monitoring whether strict protections in some areas are being offset by shifts in fishing effort to others. Although the Commission has taken some initial steps in this direction, a commitment to sustaining shark populations will require adopting, implementing and verifying conservation and management measures which are not only expedient, but meaningful and effective.

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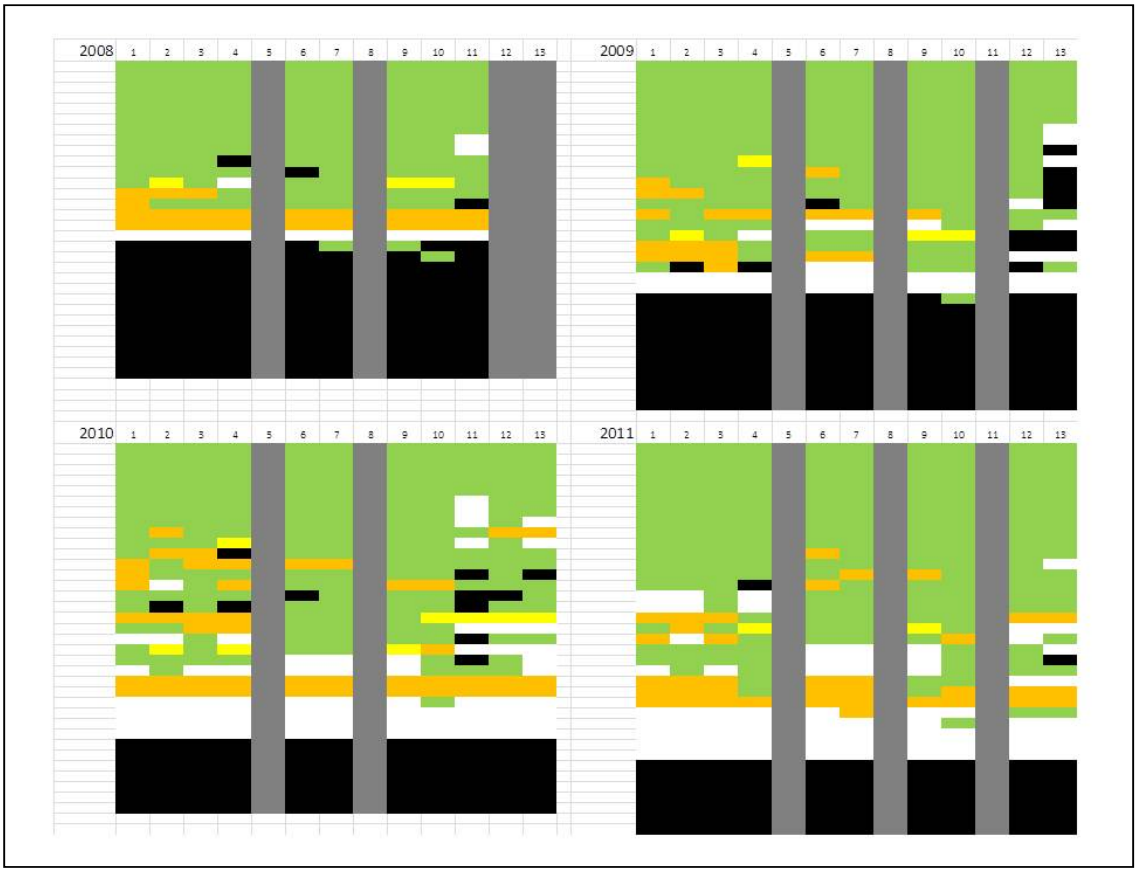
APPENDIX A. Compilation of AR2 Compliance Reporting against the cornerstone measure for 2008-2011

The diagrams below were compiled by arranging the clauses of the cornerstone shark CMM as columns and CCMs as rows, and coding "yes" responses as green, "partially" as yellow, "no" as orange, "not applicable" as white, and blanks as "black". Each annual table was then sorted to move affirmative responses toward the top and missing responses toward the bottom (i.e. "yes">"partially">"no">"not applicable">"blank"). Therefore, each row represents a CCM but the order of CCMs is randomized in each annual table. Note that the clauses which required reporting against changed as the AR2 reporting formats changed and as the measure itself was amended; for example, in 2008 clauses 5, 8, 12 and 13 did not require reporting (gray shading). The text of the current clauses for CMM 2010-07 follows the diagrams.

As discussed in Section 2.3, there are several ambiguities in the measures and the reporting formats which reduce the usefulness of a detailed analysis, however, over time the following can be observed:

- The number of CCMs which provide no answer (black shading) has decreased (note that the number of CCMs grew from 30 in 2008 to 37 in 2011);
- The number of CCMs which consider certain clauses of the measure not applicable (white shading) has increased;
- The number of CCMs answering "no" (orange shading) doubled between the first two-year period (2008-2009) and the second two-year period (2010-2011), with many of the new "no" responses associated with implementation of the IPOA/NPOA-Sharks (Clauses 1-3).



Relevant Clauses of the Most Recent "Cornerstone" CMM (2010-07) for Reference
(previous versions, i.e. CMM 2006-05, CMM 2008-06 and CMM 2009-04, differ slightly)

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

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

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

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

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

6. CCMs shall take measures necessary to require that their fishers fully utilize any retained catches of sharks. Full utilization is defined as retention by the fishing vessel of all parts of the shark excepting head, guts, and skins, to the point of first landing or transshipment.

7. CCMs shall require their vessels to have on board fins that total no more than 5% of the weight of sharks on board up to the first point of landing. CCMs that currently do not require fins and carcasses to be offloaded together at the point of first landing shall take the necessary measures to ensure compliance with the 5% ratio through certification, monitoring by an observer, or other appropriate measures. CCMs may alternatively require that their vessels land sharks with fins attached to the carcass or that fins not be landed without the corresponding carcass.

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

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

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

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

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

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

APPENDIX B. Selected national fishery-based measures for shark conservation and management beyond those required by WCPFC CMMs which are implemented or soon-to-be implemented by WCPFC CCMs[28]

	NPOA	Catch Limits	No-Retention Policy	Ban on Wire Leaders	Fins Attached Policy
Australia	X	X		X	X (some)
Belize					
Canada	X				
China					
Cook Islands			X	X	
Ecuador	X				
El Salvador					X
European Union	X				X
Fiji	(final stages of approval)	(proposed in NPOA)		X (some; full ban proposed)	
French Polynesia			X		
FS Micronesia			X (some)		
Indonesia	X				
Japan	X				
Kiribati					
Republic of Korea	X				
Marshall Islands			X	X	
Mexico	X				
Nauru					
New Caledonia			X		
New Zealand	X	X			
Niue					
Palau			X	X	
Panama	X				X (some)
Papua New Guinea		X			
Philippines					
Samoa	X	X		X	
Senegal	X				
Solomon Islands					
Thailand					
Tokelau				X	
Tonga		X			
Tuvalu					
Chinese Taipei	X				X
United States	X				X (being implemented)
Vanuatu					
Vietnam					
Wallis and Futuna					

[28] This table was compiled from numerous published and unpublished sources and represents the situation to the best of the author's knowledge at the time of writing. There are likely to be other measures which were not discovered and could be added to the table shown here.

APPENDIX C. Suggested compliance reporting format for the cornerstone shark CMM (2010-07)

(Note: this format does not attempt in any way to change the requirements of CMM 2010-07; it only seeks to rephrase questions regarding compliance in a more readily interpretable form)

1. Regarding Clauses 1-3
   a. Does the CCM have a formally endorsed NPOA-Sharks? (If yes, stop here; if no, continue to 1b)
   b. Does the CCM have an equivalent suite of regulations or policies that ensure conservation and management of sharks at sustainable levels? (If yes, stop here; if no, continue to 1c)
   c. Does the CCM consider than an NPOA-Sharks is not applicable because it does not flag any fishing vessels regularly catching sharks? (Yes/No)

2. Regarding Clause 4
   a. Did the CCM provide shark data in compliance with the WCPFC Data Provision Rules (including annual retained and discarded catches of the key shark species) for the reporting year? (If yes, continue to 2b; if no, stop here)
   b. How did the CCM compile data on discarded and released sharks (e.g. logsheets, observers, other)?
   c. Did the Scientific Services Provider's evaluation of the CCM's shark data provision for the reporting year indicate any shortfalls (check http://www.wcpfc.int/Provision-data)? (If yes, continue to 2d; if no, stop here)
   d. Please provide a description of what has been done to remedy the identified shortfalls, or an explanation of why no remedy is possible.

3. Regarding Clauses 6-7 and 9
   a. Does the CCM control finning? (If yes, continue to 3c; if no, continue to 3b)
   b. Does the CCM implement an alternative measure designed to promote full utilization? (If yes, continue to 3c; if no, stop here)
   c. Explain the national mechanism for requiring either the finning control or the alternative measure.
   d. Explain the verification program for either the finning control or the alternative measure.

4. Regarding Clause 10
   a. Does the CCM encourage live release? (If yes, continue to 4c; if no, continue to 4b)
   b. Does the CCM implement an alternative measure designed to encourage live release? (If yes, continue to 4c; if no, stop here)
   c. Explain the national mechanism for requiring either encouraging live release or the alternative measure.
   d. Explain the verification program for either encouraging live release or the alternative measure.

5. Regarding Clause 12
   a. List any other alternative or supplemental measures aimed at shark conservation and management