7 Feasibility of Stock Assessments

Fisheries stock assessments are designed to provide stock status and management information via a population model that is scaled to the available data. Tradionally the data requirements include landings record or estimates of catch, abundance indices and biological information. For stocks that are not tradionally managed and considered bycatch (i.e. sharks), there are often short data series and data gaps for many species, estimates of removals are often highly uncertain and data poor methods or other alternatives may be more appropriate than full stock assessments. Here we consider each of the key shark species and the viability of a stock assessment or other population level study to provide stock status and management information.

Blue shark (Prionace glauca) in the north Pacific. This species has been the subject of multiple stock assessments using both basic Bayesian production models and length based methods (SS3 and MFCL), there is sufficient data to develop reliable inputs for abundance indices and removals. Particular challenges exist for estimating catch and indices of abundance in areas where fishing behaviour has shifted towards targeting of sharks.

Blue shark (Prionace glauca) in the south Pacific. An analysis of the potential catch and CPUE series to support a stock assessment of blue shark in the south Pacific Ocean was presented at the SC9 (WCPFC-SC9-2013/SA-WP-04) and noted that in general the data exist to complete a stock assessment, however all data sets (observer, logsheet, aggregate) share the same characteristics of poor coverage with respect to space, time, or species identification. This study analysed only data from the WCPO convention area in the south Pacific, and it is likely that blue shark in the south Pacific are well mixed and would support a single south Pacific wide stock assessment. Although fisheries data in the south eastern Pacific exist, the data have not been analysed and no indication as to whether they would support a south pacific wide stock assessment can be given.

Mako shark (Isurus oxyrinchus and Isurus paucus) in the north Pacific. The shark working group of the International Statistical Committee is currently working on an INDICATOR-BASED ANALYSIS OF THE STATUS OF SHORTFIN MAKO SHARK IN THE NORTH PACIFIC OCEAN. Preliminary results indicate that the indices of abundance, length information and size frequency data exist, though the extent to which this data can represent the entire north Pacific is unclear, there are connecting trends in abundance and problems with both shortfin and longfin mako being recorded as simply 'mako' shark.

Mako shark (Isurus oxyrinchus and Isurus paucus) in the south Pacific. Although no detailed study of the available data for mako sharks has been undertaken, this indicator analysis combined with the fact that mako sharks are often caught in the same fisheries as blue shark would indicated that sufficient data exist for a basic length based stock assessment in the southern portion of the WCPO.

-length composition data by sex in the south Pacific indicate that the majority of females, and recently the majority of males observed are immature. Observed nominal CPUE (region 6) is declining throughout the time period, while the proportion of positive sets is increasing.

Oceanic whitetip shark (Carcharhinus longimanus). Oceanic whitetip sharks in the WCPO were most recently assessed in 2012 (SC8) and at that time there was sufficient data to support an assessment for the period 1995-2009. In recent years longline observer coverage has dropped in the WCPO as observers have moved to purse seine vessels. At the same time increased reporting by species in the operational level logsheets has increased. It is unclear as to what the effect of these changes in data availability would have on a stock assessment, but given the exceptionally poor stock status based on the last assessment, another assessment is likely not to result in a significant change to stock status, so delaying a new assessment would be prudent.

Silky shark (Carcharhinus falciformis). Silky sharks in the WCPO were most recently assessed in 2013 (SC9) and similar to oceanic whitetip, at that time there were sufficient data to support an assessment for the period 1995-2009. In recent years longline observer coverage has dropped in the WCPO as observers moved to purse seine vessels. At the same time increased reporting by species in the operational level logsheets has increased. It is unclear as to what the effect of these changes in data availability would have on a stock assessment, however silky sharks continue to be the most commonly observed shark it region 3 for both longline and purse seine, as well as in region 4 for purse seine. These factors indicate that a stock assessment of silky sharks is feasible.

Thresher shark (Alopias superciliousus, A. vulpinus, & A. pelagicus). Thresher sharks are mainly present in the longline observer data in region 4 and even then are represented by three species, or often identified only as 'Thresher'. Catch rate analysis by species is constrained by limited data in space and time and would be better performed by species but was constrained due to limited data and produced no clear trends for the group. A limited stock assessment for all combined species is possible, though the results would be difficult to interpret on a species specific level, and therefore would have limited ability to inform management decisions.

Hammerhead Sharks (Sphyrna mokarran, lewini, zygaena & Eusphyra blochii). Observations of hammerhead sharks are virtually non-existent in the purse seine database and mainly limited to regions 3 and 5 in the longline database. Further complicating the analysis is that more than half of the observations in the study period (1995-2014) were recorded as generic 'hammerhead' category. A stock assessment for this species is not feasible given the current data.

Porbeagle Sharks (Lamna nasus). Porbeagle sharks are generally considered a wide ranging oceanic species, in the Pacific they are distributed throughout the southern temperate and cold waters. Observed catch of porbeagle sharks are mainly limited to the Australian and New Zealand EEZs, however, other data do exist, such as operational logsheet data and potentially observer data from the CCSBT. Given the current SPC data holdings limited analysis for the WCPO would be feasible, but it is likely that other organisations could undertake a Southern Ocean wide assessment.

Whale Shark (Rhincodon typus). Whale sharks are observed in small numbers in the purse seine fishery, however, large data gaps exist from some key areas. A formal stock assessment for them is unlikely to be successful at this time, however, with prolonged and complete observer coverage one may become possible in future.

8 Impact of Recent Shark Management Measures

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

include;

CMM 2010-07 Conservation and Management Measure for Sharks. This CMM was originally designed to encourage full utilization of retained sharks, among the components of this measure was the requirement that vessels shall have on board fins that total no more than 5% of the weight of sharks on board up to the first point of landing. This CMM replaced Conservation and Management Measure 2009-04, which was similar and an extension of CMM 2008-06, which was an extension of CMM 2006-05, which originally went into force on January 1st 2008. Observer records indicate a change in the observed practices of dealing with sharks in the purse seine fishery from the year 2008 to 2009 (Figure 8, bottom panel). The proportion of sharks that were finned was significantly reduced and the proportion discarded increased and has been approximately 80-100% from 2009-2014. During this time the coverage of the purse seine fleet increased significantly, so the dramatic decrease in the proportion finned may partly be an artefact of a more extensive sample of the fleet, thought the CMM likely had some impact in the changes of handling sharks. Observer data for the key shark species in the longline fishery indicates that the years preceding the CMM were similar (with respect to the fate of sharks) as to those after, with an increase in the number of sharks retained (carcass along with fins as per the CMM) evident in recent years.

CMM 2011-04 Conservation and Management Measure of Oceanic Whitetip Shark. This CMM went into force on January 1, 2013, as such there should be a reduction in the proportion of retained and finned oceanic white tip sharks over the period 2013 and 2014. The measure aimed at the reduction in mortality of oceanic whitetip sharks in part because it was noted that the 5% fin to carcass requirement doesn't necessarily lead to a reduction in mortality, as a result this measure was designed to prohibit the retention (and finning) of oceanic whitetip. Observations of oceanic white tip sharks in the longline fishery have generally indicated reduction in the proportion finned since the mid-2000s (Figure 9). However, proportionally more oceanic whitetip sharks were retained in 2013 (the first year of the CMM). With respect to the purse seine fishery, the proportion of oceanic whitetip sharks that were either finned or discarded increased, but the proportion retained decreased (Figure 9). It seems that this measure is partially successful.

CMM 2013-08: Conservation and Management Measure for Silky Shark. This measure is specifically a no retention measure for silky sharks, and went into effect July 1 2014. We do not expect to see the impact of this measure as the most recent data are from December 2014.

Conservation and Management Measure 2014-05. Measures for longline fisheries targeting tuna and billfish, states:

CCMs shall ensure that their vessels comply with at least one of the following options:

1. do not use or carry wire trace as branch lines or leaders; or

2. do not use branch lines running directly off the longline floats or drop lines, known as shark lines.

This CMM goes into effect on July 1 2015so no assessment of it is possible at this stage. However the analysis carried out by SPC OFP (Rice and Harley 2012, Bromhead et al 2013, Canaco & Donovan 2014) in recent years showing the effect of wire trace and shark lines on the catch rate of sharks indicates that if the measure is adhered to it should reduce the catch rates of silky and oceanic whitetip sharks.

9 Conclusions

This paper examines data held by the SPC-OFP for longline and purse seine fisheries in the WCPO to makes inferences regarding the populations of key shark species in the WCPO. The data sets analysed - observer, logsheet and aggregated data - vary in coverage, representativeness and detail, and in general are not oriented at reporting information on bycatch species such as sharks. Logsheet data at the operational level is most useful in assessing shark catch and catch rates in the WCPO as a whole, however, such data are available in the longline fishery for 41% of the sets in 1995-2014 for the WCPFC Statistical Area as a whole, but there is little or no coverage in the northwest Pacific. Most of the operational-level longline logsheet sets (59%) did not record sharks, in contrast XX% observer data for longline did, possible explanations for this discrepancy include underreporting of sharks or that the observer data are not representative of the fishing methods/areas/time periods of the longline fleet as a whole.

-Operational-level coverage in the purse seine fishery is considerably higher (87%), but only 2.5% of purse seine operational-level logsheet sets reported any shark interactions. In both fisheries, most reported shark interactions are not species-specific, given these limitations, aggregated data (5x5 degree square) were used to characterize effort, observer coverage and re-ported shark catch by flag for both longline and purse seine fisheries. For longlines, this analysis showed clear evidence of non-/under-reporting of sharks by several major longline fleets. It also demonstrated that observer coverage is disproportional by region and flag and to an extent month thus they are not entirely representative of the fishery. Although the same non-/under-reporting patterns were observed in the purse seine aggregated data, observer coverage in the purse seine fishery is more representative by region and flag. Nevertheless observer data on purse seine-caught sharks are limited by the physical practicalities of on board sampling and the lower diversity of sharks encountered relative to the longline fishery.

-With the exception of 2014 total effort in the longline fleet has increased, through the study period (1995-2014) to approximately 800 million hooks annually with nearly half occurring in regions 3 and 4. With the exception of blue shark the high-CPUE indicat more or less steady trends for all species in all regions, however, this analysis was hampered by the lack of data throughout the region for species. Notably the proportion of high-CPUE cells for blue shark was decreasing thought the study period for regions 3, 5 and 6 with steady or slightly decreasing trends in region 3 and 4, region 1 was data deficient. Interestingly the percentage of positive sets for blue shark showed the opposite trend, increases in regions 3, 5 and 6 with flat trends in regions 2 and 5. For silky shark there seems to be a slight declining trend in the core regions of 3 and 4, while oceanic whitetip sharks show flat to slightly increasing trends throughout all of the regions. Porbeagle sharks in region 5 and 6 show slightly increasing to stable trends. Mako sharks show slightly increasing trends in region 5 and 6, stable trends in regions 3 & 4 and a slightly decreasing trend in region 2, though data is lacking for years 2012-2014. The proportion of positive sets for thresher sharks showed steady trends throughout the regions, however, region 4 where the majority of threshers were observed in recent years, an increase in the proportion of positive sets was evident. Hammerhead sharks had consistent, near zero proportion of positive sets.

The observed longline catch composition plots illustrate that blue shark continue to dominate the observed catch in most regions. An exception to this pattern is Region 3 where silky sharks, primarily from shallow sets, are the most frequently observed species. Although there are some minor differences in species composition between observed shallow and deep sets in other regions (e.g. Regions 2 and 4), these may be related to sample representativeness. Note that declining trends in the number of sharks observed in all regions (except region 3) are partially a result of the reduction in observer coverage since 2010. In recent years more silky sharks have been observed in region 3 than prior to 2008, while the proportion of blue sharks observed during 2014 in regions 2-5 is one of the lowest on record. The analysis of observed purse seine shark catch revealed that silky sharks are the most common shark species observed with the majority of the catch occurring in associated sets. In previous years, oceanic whitetip shark was the second-most commonly identified shark in associated sets but this species is now rarely observed. Substantial numbers of sharks caught by purse seines were unidentified prior to 2002-2003.

10 Research Recommendations and Management Implications

This indicator analysis provides informative insights into silky shark, oceanic whtitetip, mako shark, blue shark, whale sharks and porbeagle sharks, but is somewhat limited in the amount of inference possible for hammerhead and thresher sharks largely due to lack of data. These species are not commonly caught in the primary fisheries in the WCPO, and are historically not well reported. Increased observer monitoring is vital to the continued understanding of the less common key shark species. Specific research recommendations include:

* Research to assess the discrepancy between shark reporting in logbooks and observer data.
* Silky shark and oceanic whitetip sharks have been declining under recent fishing pressure, and likely maintain their overfished status. The last assessment for both of these species used data from 1995-2009, at this point we could easily add another 5 years of data to these assessments, though this would be most useful for silky shark to understand how its stock status has changed in recent years in conjunction with the new CMM's. If the population of oceanic whitetip shark doubled or halved, it would still be overfished.
* The authors recommend that stock assessments be scheduled for blue sharks in the south Pacific, mako sharks, oceanic whitetip sharks (in the WCPO and Pacific wide) and silky sharks within the next five years.
* As the assessments generally start well into the catch histories of these species (e.g. the longline fisheries began in the 1950s but the assessment periods start in the 1990s), an investigation the initial depletion levels for assessed shark stocks should be undertaken. This would include developing catch histories for these species.
* Catch histories for all species, and an analysis of species composition of the catch for hammerhead and thresher sharks would also be informative and make some informative analyses possible in future.
* Assessing overall mortality rates is an important component of assessing the stocks. We currently have no informative data on post-release mortality rates of silky, oceanic whitetip and whale sharks. As all three species have non-retention management arrangements post-release survival rates are essential for monitoring the effectiveness of these measures. This work will also require an update to the wat the observers collect release information and an update of the observer forms and data collection procedures will be required.