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An assessment of the chairman's draft CMM for tropical tunas

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Introduction

This paper provides the results of projections of WCPO tropical tuna stocks using the reference case models for bigeye, skipjack, and yellowfin tunas. The purpose of these analyses is to inform the development of a Conservation and Management Measure (CMM) for tropical tunas. The paper outlines the technical specifications of the projections and then outlines the suite of management options simulated. The Chairman's draft CMM "WCPFC9-2012-12" provided the basis for these analyses.

Methodology

Similar methodological assumptions were made in the current projections as in previous analyses (e.g. WCPFC7-2010-15). The main assumptions were:

- The reference case models from the 2011 bigeye (WCPFC-SC7-2011-SA-WP-02) yellowfin (WCPFC-SC7-2011-SA-WP-03) and skipjack (WCPFC-SC7-2011-SA-WP-04) stock assessments were used - these models were those adopted by SC7 for the provision of management advice in 2011;
- The projections were deterministic in that no process or estimation error was assumed;
- The projections were run for eight years (2011-2018) from the end of the assessment model. Key issues of note are:
    - Actual catch and effort for 2011 was included in the model and these levels were also assumed to apply to 2012;
    - Catch and effort for 2013-2018 varied depending on the suite of management options simulated; and
    - A final year of 2018 (rather than 2021) was chosen for the final year of the projections to reflect the specific mention of this year in the draft CMM.
- One hypothesis regarding future recruitment was evaluated, i.e., future recruitment was assumed to occur at the average of the level estimated over the period 2000-2009, as recommended by SC6.

A "base year" is chosen in order to express the catch and effort values for 2013 - 2018, which make up the particular fishing strategy or management option being projected into the future, in relative terms. These relative catch or effort values are referred to as scalars. Therefore, a scalar of 1.0 would mean a catch or effort level for a particular fishery group equivalent to that in 2009. As recommended by SC7, we chose 2009 as the base year rather than 2010 for several reasons: a) at the time the projections were undertaken there was considerable uncertainty in reported longline catches for 2010 and final estimates were not available for some key fleets; and b) the proportion of total purse seine effort that was based on FADs was abnormally low in 2010 and has subsequently been shown to be very different to anything seen in recent years.

We stress that the choice of base year is not critical for the projections. As stated above, the choice of 2009 as the base year simply means that all other catch or effort levels used in the projections are expressed relative to their respective levels in 2009.

Catch was used as the basis of the projections for all fisheries except the main tropical purse seine fishery, the pole and line fisheries, and the Japanese coastal purse seine fishery. Historical estimates of catch and effort that we used to calculate the scalars are the same as those provided in WCPFC-TCC8-2012-IP04 AttB_rev1, but the absolute magnitude of the catch and effort used in the assessments can vary due to a) slightly differing definitions of the fleets; b) the exclusion of the fishing from the overlap area from the assessments; c) the

input into the models of longline catch in units of numbers of fish rather than catch in weight; and d) subsequent revisions to the historical catch and effort data since the assessments were undertaken. There have been slight revisions to purse seine effort, but more substantial revisions to longline data. The revised data for longline gives 18-20% higher catches for yellowfin and 6-12% higher catches for bigeye tuna in 2009-10 than were used in the 2011 assessments.

Scenarios examined

The Draft CMM contained several key elements that can be examined in the context of projections. These were identified as:

- Total levels of purse seine effort;
- The duration and timing of the FAD closures;
- The total level of longline catches; and
- The levels of catch or effort for the other fisheries

We describe the approaches taken for each of these below.

Purse seine effort

Total purse seine effort in the tropical region[1] can be comprised of the following components: 1) PNA EEZs, 2) PNA archipelagic waters and territorial seas, 3) High Seas; and 4) Other EEZs. Based on the CMM2008-01 evaluation tables of catch and effort, the levels specified under the Draft CMM are provided below.

Table 1: Levels of purse seine effort that could occur under the draft CMM.

Region	Purse seine effort (days)	Comments
PNA EEZs	43,818	2010 levels
PNA APWs	8,627	2011 levels
High Seas	2,000	This does not include the days allocated to the Philippines fleet for HSP1. This fishery is modelled separately to the other purse seine fleets
Other EEZs	1,156	This is the 2011 level
TOTAL	**55,601**	

Based on annual effort estimates provided in the CMM tables, this level represents a 27% increase over 2004, an 8% increase over 2010, and a 3% decrease over 2011.

FAD closures

CMM2008-01 included a three month FAD closure during the third quarter for the EEZs and High Seas between 20°S and 20°N. The draft CMM includes a proposal for an additional month to be added to this closure in October. As has been done in previous analyses, effort was reallocated from the associated set fishery to the unassociated free school in the same area and quarter.

As we understand that the FAD closures do not apply to archipelagic waters or territorial seas (APWs), the projections allowed a minimum level of FAD sets to remain during the closure. This only applied to the western equatorial region, and was calculated based on the assumption that effort in these areas were uniformly distributed throughout the year, and that 75% of this effort was directed at FADs (as determined from operational logsheet data). Currently the stock assessment does not

[1] 20S – 20N, but excluding those purse seine vessels from Indonesia and the Philippines for which we do not have sufficient effort data, and which are modelled separately using their catches only.

distinguish between the effort in APWs and other areas, but available logsheet data suggest that the catch per day fished in APWs is much lower than elsewhere. Therefore the analyses in this paper likely overestimate the negative impact on the stock of the FAD closure not applying to APWs.

Longline catches

The new draft CMM provides two options for future longline catches: a) no further reductions in longline catches beyond CMM2008-01 levels; and b) a 10% reduction to all fleets catching more than 2000 t. It is important to note that not all CCMs have limits under the measure. Our approximation of the levels specified under the draft CMM were based on actual limits where those were specified, and 2011 catch levels for those flags that do not currently have limits specified. For bigeye tuna this limit and the 10% reduction were calculated at 76,298 t and 70,422 t respectively, while for yellowfin tuna this was calculated as 91,978 t and 84,300 t respectively.

Noting that many fleets are taking lower catches than their specified limit, and given that 2011 catch levels were lower than those levels estimated as permissible under the draft CMM, the impact of those lower 2011 longline catches were also examined.

Other fisheries

Estimates of catch and/or effort are often problematic for other fisheries and less certain the further you go back in time. We examined two alternative assumptions relating to 2009 catch or effort levels and 2011 catch or effort levels.

The fisheries for which this assumptions provides the greatest impact on the evaluation is for the small scale fisheries operating in the archipelagic waters of Indonesia and the Philippines. For the projections undertaken in 2011 for WCPFC8, the decline of almost 30% from 2009 to 2010 in bigeye catches from these fleets was an important part of the optimistic projections based on 2010 conditions. In 2011, the estimated catches have increased to a level marginally higher than the 2009 level and therefore the current suite of projections do not include that one year (2010) of reduced reported catches.

Summary of projection options

The table below summarises the various options described above. In the case of bigeye and yellowfin tuna these options represent 12 combinations of management options. For skipjack tuna, we do not include alternative longline scenarios so only 4 combinations were run.

Projection outputs

Performance statistics for all projections included F_{2018}/F_{MSY}, estimates of spawning biomass, and catches for different fisheries groups. Due to the use of recent average recruitment in the projections, the historical estimates of SB_{MSY} and SB_0 are no longer valid, especially when there is a considerable difference between the recent average recruitment level and the long-term average level (e.g. in the bigeye tuna assessment). In this circumstance, a depletion estimate ($SB_y/SB_{F=0}$) would be more appropriate and this is included in the spreadsheet columns labelled “SB2018_SBF0”. Also included are spawning biomass per recruit (SPR) levels (compared to the spawning biomass per recruit in the absence of fishing).

Key results from a reduced set of the projections are given within this paper to assist in the interpretation of the results. The summary results for all simulations are provided in a set of

accompanying excel spreadsheets. MULTIFAN-CL input and output files for all of the projections are available from the service provider (each scenario comprises about 5-8mb of files).

Table 2: Scenarios examined in the projection modelling.

Factor	Options considered	Comments
Purse seine total effort	- CMM permitted (55,601 days) - Actual 2011 effort (57,343 days)	- There is uncertainty as to how much effort could occur on the high seas
Longline catch limits – bigeye tuna	- CMM permitted (76,298 t) - 10% reduction (70,422 t) - Actual 2011 catches (65,219 t)	- The 2000 t limit has been used - There is uncertainty as to how much catch might occur in the overlap area which is not included in the assessment
Longline catch limits – yellowfin tuna	- CMM permitted (91,978 t) - 10% reduction (84,300 t) - Actual 2011 catches (75,812 t)	- A 2000 t limit has been included here.
FAD closure	- A four month closure from July to October	- these closures were not assumed to apply to the APWs
Other fisheries	- 2011 levels of catch / effort	- These estimates are typically uncertain. The values for 2011 should reflect the final year of implementing CMM2008-01.

Results

The following scenarios (Table 3) were chosen to illustrate the general patterns in the projection results.

Overall none of the scenarios examined removed overfishing of bigeye tuna within five years, but do get slightly closer to the goal of 1.2 times FMSY than CMM2008-01 conditions. This is in contrast to previous projections based on 2010 conditions which did result in the removal of bigeye overfishing. That success was primarily driven by a combination of factors that occurred in 2010, but that did not persist through 2011; e.g. the very low FAD use in 2010 and the significant reduction in reported catches from Indonesian and the Philippines. In addition APW purse seine effort increased in 2011.

Table 3: A subset of scenarios for demonstration purposes

Run code[2]		Purse seine effort	Longline catch	Other effort	FAD closure	Comment
CMMa	101010102	New CMM	New CMM	2011	4 month FAD closure	Approximation of the draft measure (option a)
CMMb	101020102 (BY)	New CMM	New CMM minus 10% for 'large' fleets	2011	4 month FAD closure	Approximation of the draft measure (option b)
2011	102030101 (BY) 102010101 (S)	2011 effort	2011 catches	2011	3 month FAD closure	Approximation to the end of CMM2008-01

[2] Note the slight difference in model run code for the skipjack model as we did not run alternative longline catch scenarios for it.

Table 4: Some key reference points for the scenarios described in the table above.

Species		F/Fmsy	$SB_{2012}/SB_{2012,F=0}$	$SB_{2018}/SB_{2018,F=0}$	$SPR_{2012}/SPR_{F=0}$	$SPR_{2018}/SPR_{F=0}$
Bigeye tuna	CMMa	1.33	0.25	0.24	0.21	0.24
	CMMb	1.30	0.25	0.25	0.21	0.24
	2011	1.38	0.25	0.23	0.21	0.22
Yellowfin tuna	CMMa	0.71	0.48	0.46	0.46	0.45
	CMMb	0.70	0.48	0.47	0.46	0.46
	2011	0.69	0.48	0.47	0.46	0.46
Skipjack tuna	CMMa	0.41	0.57	0.56	0.57	0.56
	CMMb					
	2011	0.42	0.57	0.55	0.57	0.54

Table 5: Estimates of purse seine effort and catches by gear type from the scenarios described in the table above.

		Purse seine effort			Longline catch		Purse seine ASS catch		Purse seine UNA catch		ID/PH APW catch		Other catch	
Species	Scenario	ASS	UNA	Catch2018	2012	2018	2012	2018	2012	2018	2012	2018	2012	2018
Bigeye tuna	CMMa	23,088	31,173	138,060	55,327	62,278	51,426	49,758	8,996	9,164	9,405	9,405	7,343	7,455
	CMMb	23,088	31,173	134,328	55,327	58,173	51,426	49,927	8,996	9,338	9,405	9,405	7,343	7,485
	2011	26,638	29,322	132,536	55,327	54,196	51,426	53,473	8,996	7,957	9,405	9,405	7,343	7,506
Yellowfin tuna	CMMa	23,088	31,173	547,423	63,225	88,039	160,139	144,914	177,359	210,844	75,388	75,388	28,068	28,238
	CMMb	23,088	31,173	542,225	63,225	80,899	160,139	145,281	177,359	212,380	75,388	75,388	28,068	28,277
	2011	26,638	29,322	520,838	63,225	55,525	160,139	163,304	177,359	198,252	75,388	75,388	28,068	28,368
Skipjack tuna	CMMa	20,618	29,515	1,589,035			615,222	550,071	493,836	681,807	232,116	232,116	124,135	125,005
	CMMb													
	2011	23,767	27,937	1,615,631			615,222	626,793	493,836	632,445	232,116	232,116	124,135	124,241

Analysis of loss bigeye tuna yield through overfishing

In response to a request from TCC8, an analysis was undertaken to estimate the loss in bigeye yield that might result from overfishing. Run 21 from the 2011 bigeye tuna assessment which estimated the spawner recruitment curve over a recent period provides the closest population dynamics which are assumed in the projections and provides the best basis for addressing the question of the impacts of overfishing on equilibrium yields (Figure 1). These calculations are equilibrium and 'on average' and particular care should be given to interpreting the predictions from fishing at rates higher than FMSY given that we know that recruitment is variable.

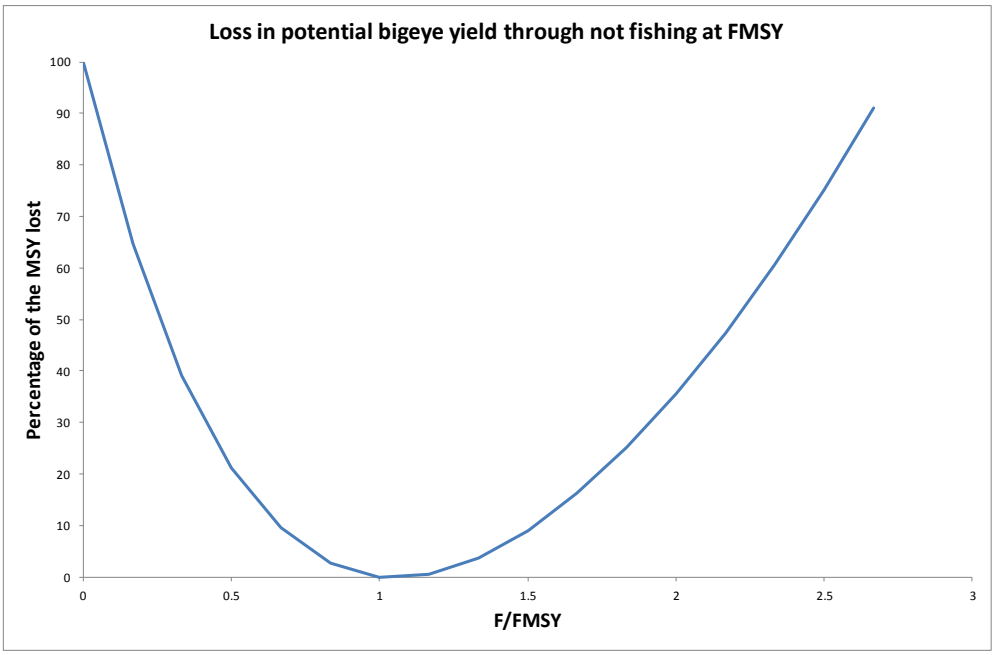

Figure 1: Loss in potential bigeye tuna yield due to not fishing at the F_{MSY} level. This is based on the estimated yield curve from "run 21" of the 2011 bigeye tuna assessment.