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FURTHER CONSIDERATION OF CMM 2008-01 WITH RESPECT TO BIGEYE TUNA

WCPFC6-2009/IP18

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Prepared by the Secretariat of the Pacific Community

Executive Summary

In December 2008 the Commission adopted CMM2008-01 to address concerns over the high levels of fishing mortality estimated for bigeye (BET) and yellowfin (YFT) tunas. CMM2008-01 is a very complex measure with various effort and catch limits, gear restrictions, and closed areas. It also has several exemptions and special provisions which, in many instances, make it difficult to quantify the actual limits that are in place for some fleets. As part of its service agreement with the WCPFC, the Secretariat of the Pacific Community (SPC) was asked to evaluate the **potential** impacts of the provisions of the measure – recognizing that the actual outcome has not yet been observed.

Due to the complex nature of CMM2008-01, this evaluation required modifications to the software that SPC uses to undertake stock assessments of the key tuna species. This analysis, including attempts to operationalize the measure (e.g. put in numbers for the limits), was provided in WCPFC-SC-5 GN-WP-17 and reviewed by the Scientific Committee in August 2009. At WCPFC-SC5, requests were made to SPC for additional scenarios to be undertaken and for various outputs from the analysis to be presented. This paper is a response to the requests made at WCPFC-SC5.

SPC and the WCPFC-SC have identified some key uncertainties in the BET assessment, in particular trends in the reported domestic catches from Indonesia and Philippines, changes in efficiency of longline vessels, and trends in estimated recruitment. These sources of uncertainty also carry through into the projection results, e.g. levels of future recruitment. There are some results which are probably robust to these uncertainties, but others that are more sensitive.

Those results believed to be robust include:

- The measure is unlikely to result in reductions in fishing mortality for BET, and in particular, will not meet the objective of a 30% reduction in BET fishing mortality from 2001-2004 or 2004 levels;
- There will be interactions among fisheries that will impact on the effectiveness of the measure;
- The effectiveness of longline catch limits to reduce fishing mortality on older bigeye will, in part, be dependent on the reductions in fishing mortality that occur for juvenile bigeye tuna and future levels of recruitment; and
- Reductions in fishing mortality across all fishery sectors (e.g. fisheries catching juvenile BET and those catching larger individuals) will be most effective.

The results that are sensitive to key uncertainties include:

- The biomass that will support the MSY and what reductions are required to reduce the probability the stock is overfished;
- The effectiveness of purse seine measures, in particular, the real likelihood that benefits gained through reductions in purse seine effort could be offset by increased catches in Indonesian and Philippines domestic fisheries (and in other archipelagic waters) and the longline fishery; and
- Whether the current longline catch limits will result in reductions in fishing mortality on older age classes.

SPC recognizes that multi-species results are ideal to inform management, and notes that ideally, assessments that are up to date, i.e. for the current year, are best for undertaking these evaluations. The Commission had not requested a SKJ assessment in 2009, therefore GN-17 only considered bigeye (BET) and yellowfin (YFT) tunas. For the additional work requested by the WCPFC-SC to be presented to WCPFC-6, and described here, no additional resources were provided by the Commission so it was only possible to undertake further analysis for BET at this time. For 2010, the current SC work plan includes stock assessments for BET and SKJ.

The new assessment for BET in 2010 should help reduce some of these uncertainties, and/or provide managers with information on management approaches that might be robust to these uncertainties. Aspects of the assessment that should be considered include:

- Various scenarios for catches from the domestic fisheries of the Indonesia and the Philippines;
- Potential changes over time in the efficiency of longline vessels;
- Partitioning the current region 3 (western tropical region) to separate the Indonesia-Philippines region from the rest of region 3 where the majority of the purse seine fishery occurs; and
- Investigation of alternative hypotheses for any temporal trends in model parameters, e.g. recruitment.

The Commission is invited to:

- Note that these types of evaluations are new and will require time to refine;
- Note that reduced data uncertainties in the stock assessments will improve the quality of evaluations of management options;
- Note the results above that were considered to be robust to the uncertainties;
- Note that SPC recommends for management option evaluation to be based on current assessments, and that assessments are scheduled for BET and SKJ in 2010, and that a YFT assessment was undertaken in 2009;
- Note that the real outcome or impact of CMM 2008-01 on the BET stock has not yet been measured, but that scientific observations collected from the first year of its implementation should be available for the stock assessments to be undertaken in 2010 ;
- Note that the fundamental conclusion of the evaluation, that CMM-2008-01 will not achieve its stated objective of a 30% reduction in BET fishing mortality from 2001-2004 or 2004 levels, remains valid; and
- Require CCM's to provide to the Commission with as much information as possible on how they will be implementing the measures, e.g. any limits that they intend to apply, and to submit their 2009 data by the data provision deadline of 30 April 2010.

Background

CMM2008-01, adopted in December 2008, seeks to reduce fishing mortality on bigeye tuna by 30% from the 2001-2004 average level and limit yellowfin tuna fishing mortality to its 2001-2004 level, in order to maintain stocks at levels capable of producing the maximum sustainable yield (MSY). This objective is pursued though a combination of measures involving longline catch limits, purse seine effort limits, a closure relating to purse seine fishing using fish aggregation devices (FADs) and a closure of two high-seas pockets (HSP) to purse seine fishing. Most of these measures have various exemptions or alternatives built in and are to be phased in over the period 2009-2011.

Paper WCPFC-SC5 GEN-17, presented to the WCPFC Scientific Committee in Port Vila, attempted to evaluate the potential impact of the measure in addressing overfishing of the bigeye tuna stock. The paper concluded:

> *"that CMM2008-01 is highly unlikely to meet its objectives of a 30% reduction in bigeye tuna fishing mortality from the 2001-2004 level, or maintenance of the bigeye tuna stock at a level capable of producing MSY over the long term. The measures are predicted to result in little if any reduction in bigeye tuna* F/F_{MSY} *from the high levels in excess of 2.0 estimated for 2007-2008, and accordingly, SB* [spawning biomass] *is predicted to fall to around 0.4-0.6 of* SB_{MSY}*. The main reasons for the lack of effectiveness of the measure are (i) the reductions in longline catch do not result in the required reduction in fishing mortality on adult bigeye tuna; (ii) the increase in purse seine effort allowed under the measure, and the increase in purse seine catchability (fishing mortality per unit effort) that has occurred since 2001-2004, is not sufficiently offset by the FAD and HSP* [high seas pockets] *closures to reduce purse seine fishing mortality below 2001-2004 average levels; and (iii) the exclusion of archipelagic waters, which encompasses most of the fishing activity of the Indonesian and Philippines domestic fleets and significant amounts of purse seine effort in Papua New Guinea and Solomon Islands, from the measure effectively quarantines an important source of fishing mortality on juvenile bigeye tuna."*

The WCPFC-SC made several responses to this paper including the following:

> *11. The SC supported an evaluation of CMM-2008-01 (WCPFC-SC5-2009/GN-WP-17) which indicates that the objective of a 30% reduction in fishing mortality on bigeye by 2011 will not be achieved. The lack of effectiveness of CMM-2008-01 is broadly related to: 1) reductions in longline catch that do not result in the required reduction in fishing mortality; 2) increases in both purse seine effort allowed under the measure, and purse seine efficiency since 2001-2004; and 3) exclusion of archipelagic waters, which encompasses most of the fishing activity of the Indonesian domestic fisheries and some activity by the Philippines domestic fleets.*
>
> *12. …… While members agreed that consistent advice should be provided to the WCPFC on necessary reductions of fishing mortality, some members indicated that the evaluation of newly introduced measure (CMM-2008-01) is based on a variety of*

assumptions and the actual behavior of the fisheries and consequent effects on the stocks have not been evaluated yet.

13. A significant time-lag exists between the implementation of a management measure and the detection of a stock response from an assessment. Results of management implemented in 2009 will only be detected in a 2011/2012 assessment due to delays in the provision of data and significant uncertainty in estimates of fishing mortality and biomass in the last year of the assessment.

14. ……. The SC views the identification and implementation of effective management measures to address the inadequacy of CMM-2008-01 as the most urgent issue facing the Commission with regard to maintaining the sustainability of target tuna stocks.

iv. The SC recommends that the Science Services Provider (SPC) conduct analyses for WCPFC6 (Attachment M) on the predicted annual catches and resulting fishing mortality and spawning biomass for a range of scenarios that include illustrating the impacts of:

a. The various exemptions, special considerations and areas not covered by the CMM by modelling the factors above with and without them incorporated into the measure; and

b. Potential management options to strengthen the CMM, such as various percentage reductions in longline and purse seine FAD catch/effort.

v. The SC endorsed a draft work plan prepared by SPC-OFP to guide this work.

This response included the request for the evaluation of additional scenarios which investigated alternative measures, increasing the scope of existing measures, and evaluating the impact of the various exemptions and special considerations. Attachment M, referred to above is provided as Attachment A of this document.

Methodology

Given the resources available to SPC it was not possible to undertake the full scope of the work described in Attachment A of this document and reflected in the SC report in the paragraphs above, in particular the simultaneous exploration of impacts for skipjack tuna fisheries.

Instead we have taken a two-stage approach to this request for additional work: 1) a small number of projections reflecting specific scenarios raised either at the WCPFC-SC or by specific CNM's, and 2) a large number of generic projections (almost 1400) reflecting various combinations of longline catch reductions, purse seine effort reductions, and effort reductions from the domestic fisheries of Indonesia and the Philippines.

We are confident that the combinations of catch and effort reductions considered in the generic projections will be able to approximate any specific set of management measures that the Commission might wish to consider. For any particular set of management measures, we can interrogate the

Commission's catch and effort data and determine the projection that best represents it, e.g. the impact of closing particular regions can also approximated by using the historical distribution of fishing effort to estimate the potential effort reduction resulting from the closure.

As noted above, these projections were only run for bigeye tuna. Further, the projections were restricted to 'run 14' (with higher purse seine catches estimated from the spill sampling correction factors) which we consider the more realistic of the two scenarios considered in GN-WP-17. We have conducted the analysis for the two recruitment scenarios: a) long term average, and b) average for the last 10 years.

The specific scenarios examined where:

- CMM2008-01 with no exemptions or special provisions[***no-exemp***] (based on GNWP-17 model run 6a):
    - Total longline catches reduced by 30% from 2004 levels, e.g. no exemptions for SIDs, USA, Japan, and those with catches of less than 2000 mt, in other words, a 30% reduction of the total longline catch is achieved
    - Purse seine effort at 2004 levels for all, e.g. no special provision for archipelagic waters or existing bilateral and multi-lateral arrangements
    - Indonesia / Philippines fisheries at 2004 levels.
- CMM2008-01 with all high seas between 20N and 20S closed to purse seining [***close high seas***]
- CMM2008-01 with no FAD sets by foreign vessels in FFA waters [***FFA FAD ban***]
- CMM2008-01 with no FAD sets for those flag states with > 4000 mt of longline BET catches [***FAD -- LL BET***]
- A 50% reduction in longline catches from 2007 levels, a 80% reduction in FAD effort from 2007 levels, and a 50% reduction in effort from the domestic fisheries in Indonesia and the Philippines for 2007 levels [***large cut***]

The generic grid of projections undertaken were based on the following reductions from **2007** levels:

- Longline catch: 0 to 50% reduction in annual catch in 10% steps (6 levels)
- Purse seine FAD effort in the western equatorial Pacific (model region 3): 0 to 80% reduction in 10% steps (9 levels), with an equivalent number of days added to non-FAD effort
- Purse seine effort in the central equatorial Pacific (model region 4): 0 to 80% reduction in 10% steps (9 levels), with an equivalent number of days added to non-FAD effort
- Indonesia and Philippines domestic fishery effort: 0 to 50% reduction in 25% steps (3 levels)

This design leads to 2916 projections (6x9x9x3 [1458] x2 recruitment scenarios).

Projections were run to 2018 to ensure stability in the projections. For each projection the following performance indicators were calculated:

- F_{2018}/F_{MSY}

- SB_{2018}/SB_{MSY}[1]
- SB_{2018}/SB_{2008}
- $LLcatch_{2018}$
- $PScatch_{2018}$
- $IDPHcatch_{2018}$
- Other catch $_{2018}$
- SB_{2018} (western equatorial) /SB_{1952}(western equatorial)
- SB_{2018} (eastern equatorial) /SB_{1952}(eastern equatorial)

Results and Discussion

The general conclusion of these evaluations is that the mix of catch and effort limits contained within CMM2008-01 leads to complex interactions between fisheries in terms of achieving the necessary reductions in fishing mortality. We will discuss both the specific results of the model runs below and the general patterns that emerge.

One key conclusion was that while reductions in effort from surface fisheries can be translated into reductions in fishing mortality, the resulting impact of the longline catch limits on fishing mortality is less straight forward. Depending on the level of reduction of fishing mortality on younger bigeye tuna or future level of recruitment, a given longline catch limit could lead to a reduction in fishing mortality for older bigeye tuna OR an increase in fishing mortality, e.g. if the stock size was increased then the longline fleet may have to reduce its effort to remain within a catch limit (i.e. fishing mortality should be reduced) or alternatively, if stock sizes declined then higher levels of effort (and therefore fishing mortality) might be necessary to take the catch limit. In many of the scenarios examined, it was not possible for the longline fleet to take their catch limit because predicted abundance was so low.

Specific scenarios

The reference points from the specific model projections are provided in Table 1 and Figures 1 and 2. The exemptions and special provisions within CMM2008-01 are predicted to play a role in keeping fishing mortality high, but we have not looked at these individually to see which have the greatest influence.

The other specific scenarios: ***close high seas***; ***FFA-FAD ban***; and, ***FAD - LL BET***; are all predicted to have negligible effect on reducing overfishing or moving the stock away from an overfished state. This result may be expected for the run **close high seas** since a large proportion of purse seine effort on the high seas occurs inside the high seas pockets (75%) which are already assumed to be closed from 2010 and therefore further closures on the high seas will have limited additional impact on overfishing. Such additional closures may, however, limit movement of purse seine effort into the eastern portion of the

[1] For the runs with recent average recruitment, there is a mis-match between the projected recruitment and the MSY-related quantities. To ensure that the SB_{2018}/SB_{MSY} calculations were consistent, the estimate of SB_{MSY} was rescaled to reflect the level that resulted from fishing at F_{MSY} under these elevated levels of recruitment.

WCPFC Convention Area. Any increase in effort in this eastern portion could exacerbate bigeye overfishing because of the apparently higher vulnerability of bigeye to purse seine fishing in this area – though at present we have not determined whether this is an area or fleet effect, e.g. are bigeye in this area more vulnerable to purse seining than those caught elsewhere, or are the vessels fishing there more efficient at catching bigeye tuna than those that fish elsewhere.

Other reasons for the apparent lack of effectiveness of purse seine measures can be seen through the generic projections with purse seine reductions provided in Figures 5 and 6. Reductions in purse seine effort result in increased catches from Indonesia and the Philippines (because more fish are now available for these fleets). Longline catches that are predicted to be constrained BELOW their limit, because the abundance of older fish is predicted to be so low, subsequently increase when purse seine reductions occur.

Based on the current bigeye tuna assessment, the very large reductions contained within the ***large cut*** scenario indicate the levels of reduction among the fisheries that are necessary to reduce fishing mortality to near F_{MSY} levels and ensure that in the long term that spawning biomass is around the level capable of supporting the MSY.

Generic grid

It was not possible to undertake all 1458 projections specified in the grid. There were around 50 scenarios, where purse seine effort in region 3 and the effort for the Indonesia and Philippines domestic fisheries were kept at 2007 levels, where the population in region 3 crashed due to a lack of fish at older ages. In Figures 4-7 we provide key results along some of the major 'axes' in the grid. These results provide an insight into the predicted interactions amongst gears.

One of the key results of the generic model runs is the finding that if recruitment does return to the estimated long-term average levels then the current longline catch limit will be ineffective at reducing fishing mortality. In many instances, it is the low abundance of large bigeye available to the longline fleet which is limiting catch more than the longline catch limit itself. This can be seen in Figures 3 and 4 where the % reduction in the longline catch limit does not result in the same actual reduction in catch. In fact, even under the higher recruitment estimated for the past 10 years, this pattern is still evident.

As noted above the other major result is that purse seine effort reductions do not seem to have much impact, because as some of the catch is taken up through increased longline catches. Unless fishing mortality due to the domestic fisheries of Indonesia and the Philippines is reduced, an 80% reduction in purse seine effort is required to allow the longline fishery to approach its catch limit – and this is only possible under the recent recruitment scenario.

It is only when reductions are simultaneously made across all fleets that significant reductions in fishing mortality are achieved.

Table 1: Key performance indicators from the specific projections evaluated. Long-term average (top) and recent average (bottom) recruitment.

	Long-term recruitment					
	run6a	**no-exemp**	**close high seas**	**FFA - FAD ban**	**FAD - LL BET**	**large cut**
F_{2018}/F_{MSY}	1.80	1.54	1.79	1.74	1.74	1.00
SB_{2018}/SB_{MSY}	0.04	0.52	0.40	0.42	0.41	1.05
SB_{2018}/SB_0	0.08	0.10	0.08	0.09	0.08	0.25
$SB_{2018\ (reg\ 3)}/SB_0$	0.02	0.01	0.02	0.03	0.03	0.20
$SB_{2018\ (reg\ 4)}/SB_0$	0.02	0.13	0.02	0.03	0.02	0.48
C_{2018}	54830	71232	55851	58889	57539	65957
LL C_{2018}	33480	44534	34706	36677	34752	37625
PS C_{2018}	10218	17704	9971	8574	8868	9583
IDPH C_{2018}	8958	6847	8998	11453	11737	16328
OT C_{2018}	2173	2147	2176	2185	2183	2421

	Recent recruitment					
	run6a	**no-exemp**	**close high seas**	**FFA - FAD ban**	**FAD - LL BET**	**large cut**
F_{2018}/F_{MSY}	2.09	1.49	2.05	1.95	2.01	1.01
SB_{2018}/SB_{MSY}	0.28	0.54	0.30	0.33	0.30	1.00
SB_{2018}/SB_0	0.15	0.27	0.17	0.18	0.16	0.55
$SB_{2018\ (reg\ 3)}/SB_0$	0.06	0.27	0.07	0.09	0.09	0.80
$SB_{2018\ (reg\ 4)}/SB_0$	0.34	0.67	0.38	0.42	0.35	1.29
C_{2018}	105192	129937	105339	110769	111363	115944
LL C_{2018}	52020	57638	52759	55121	54306	41127
PS C_{2018}	26648	49577	25996	22524	23090	28204
IDPH C_{2018}	23928	20032	23986	30510	31354	43382
OT C_{2018}	2595	2691	2598	2614	2612	3231

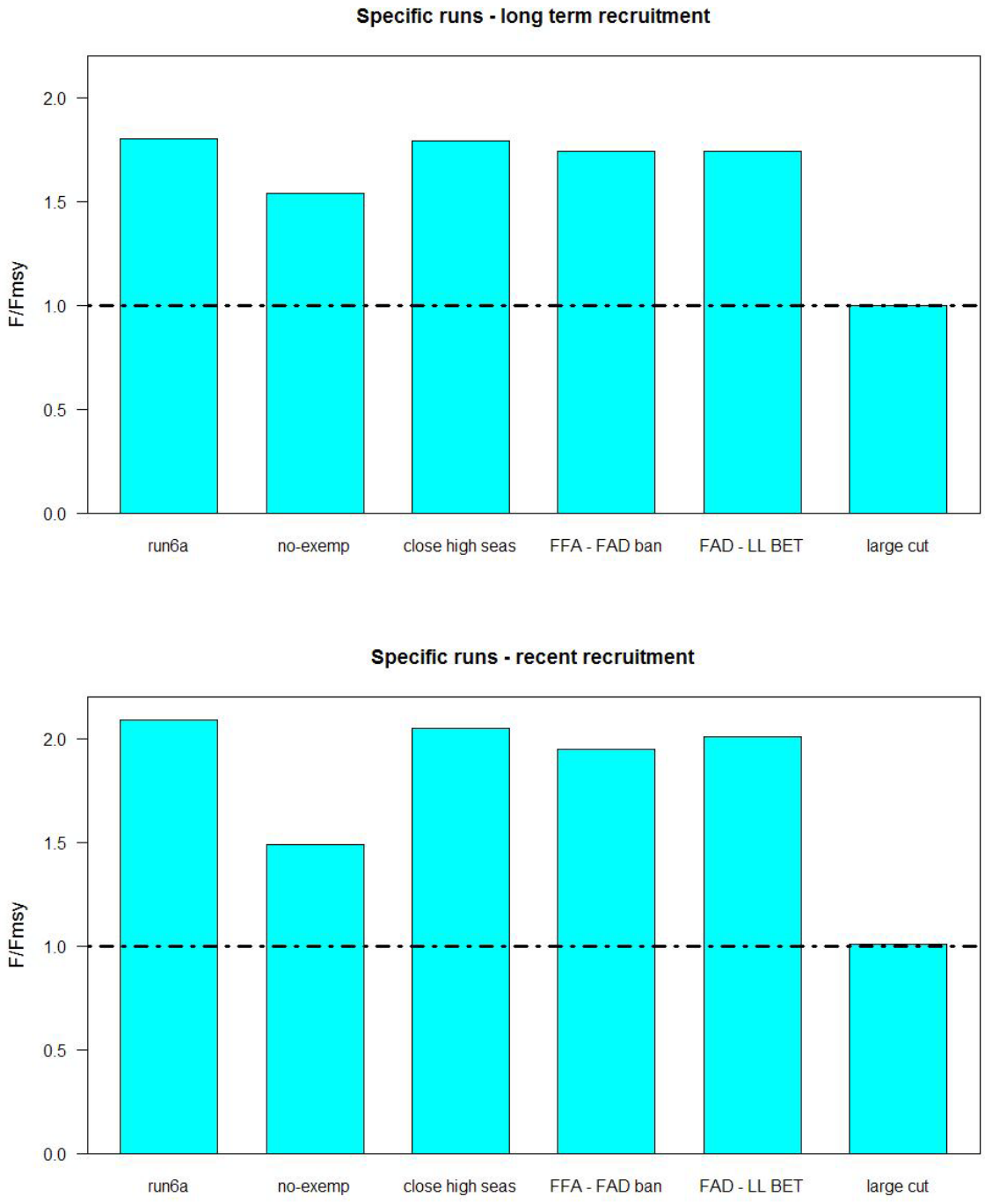

Figure 1: Predicted levels of F_{2018}/F_{MSY} for various sets of management measures.

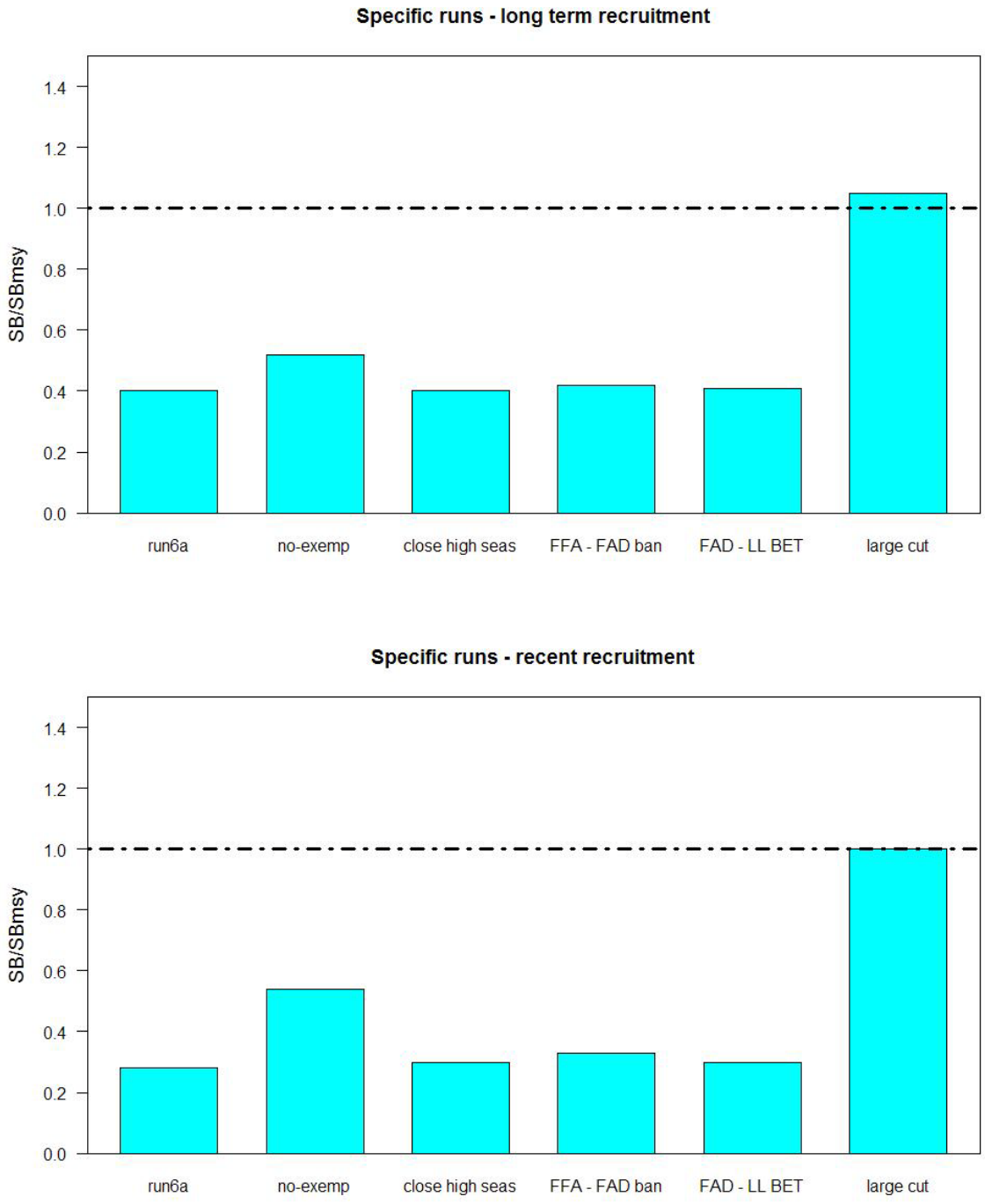

Figure 2: Predicted levels of SB/SB_{MSY} for various sets of management measures

Long term recruitment **Recent recruitment**

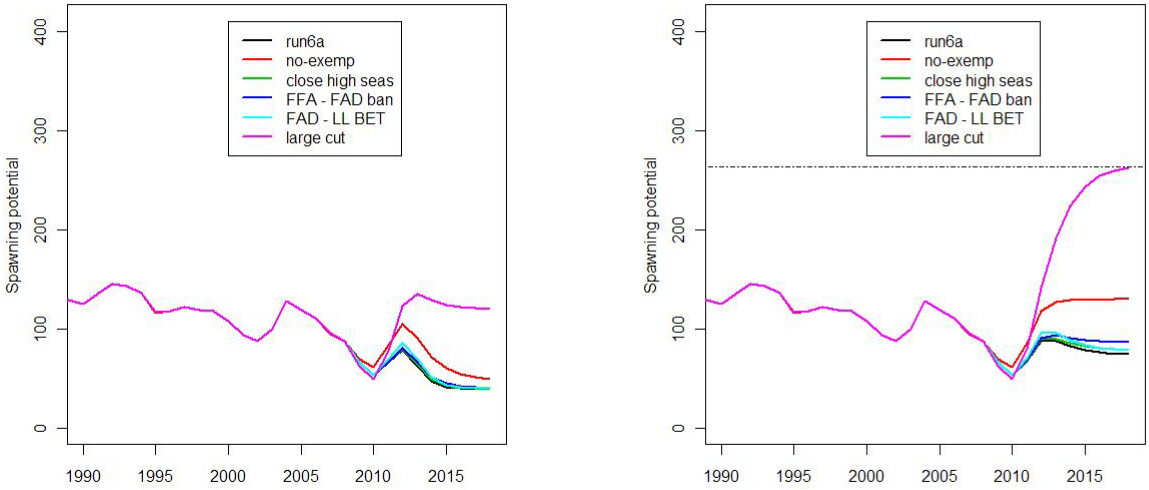

Figure 3: Predicted spawning biomass trajectories for the specific model runs for the period 1990-2018 assuming long term average recruitment in the future (left) and recent average recruitment (right).

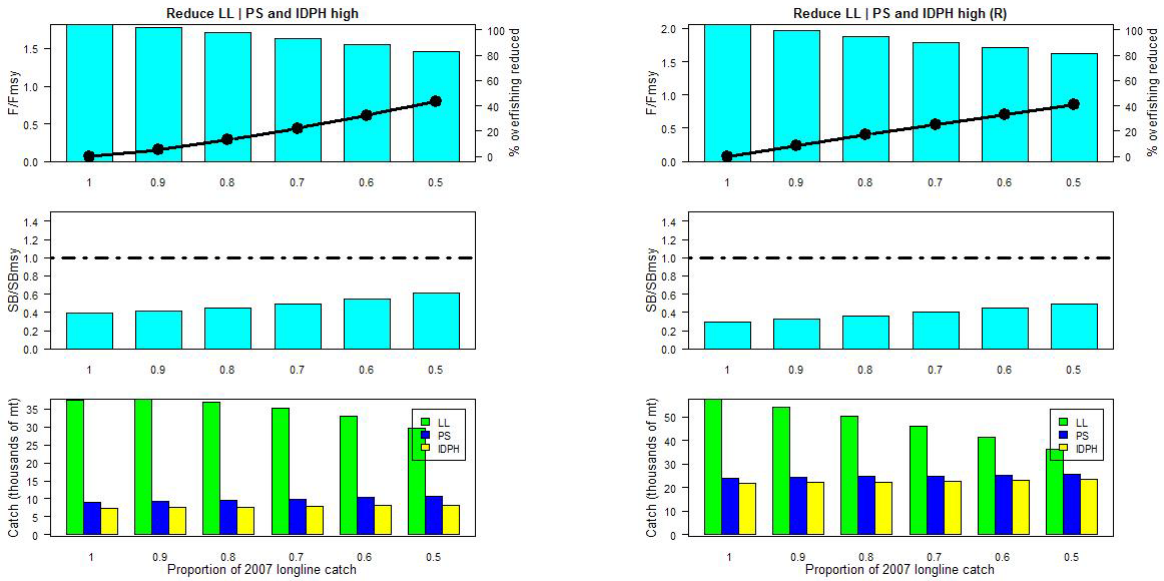

Figure 4: Key performance indicators for scenarios where longline catch is reduced incrementally from 2007 levels while purse seine and IDPH effort level remain at 2007 levels. Indicators presented are predicted levels of F_{2018}/F_{MSY} (top), SB_{2018}/SB_{MSY} (middle), gear specific catches (bottom). Future recruitment is assumed to be at either long term average (left) or recent average (right) levels.

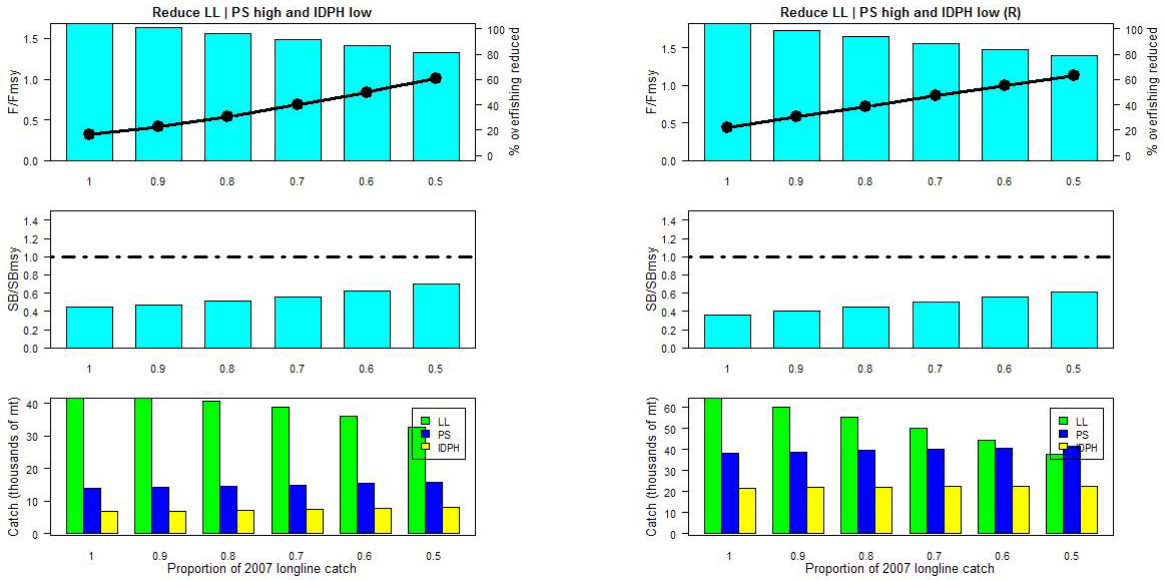

Figure 5: Key performance indicators for scenarios where longline catch is reduced incrementally from 2007 levels, purse seine effort remains at 2007 levels, but IDPH effort is reduced by 50% from 2007 levels. Indicators presented are predicted levels of F_{2018}/F_{MSY} (top), SB_{2018}/SB_{MSY} (middle), gear specific catches (bottom). Future recruitment is assumed to be at either long term average (left) or recent average (right) levels.

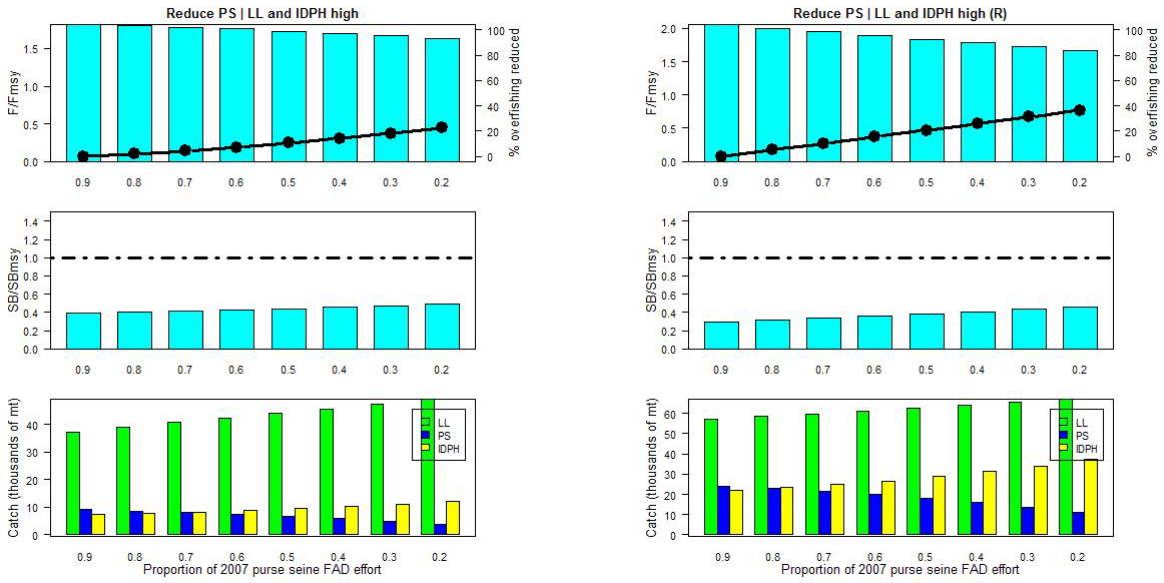

Figure 6: Key performance indicators for scenarios where purse seine effort is reduced incrementally from 2007 levels, longline catch is limited to 2007 levels, and IDPH effort is at 2007 levels. Indicators presented are predicted levels of F_{2018}/F_{MSY} (top), SB_{2018}/SB_{MSY} (middle), gear specific catches (bottom). Future recruitment is assumed to be at either long term average (left) or recent average (right) levels.

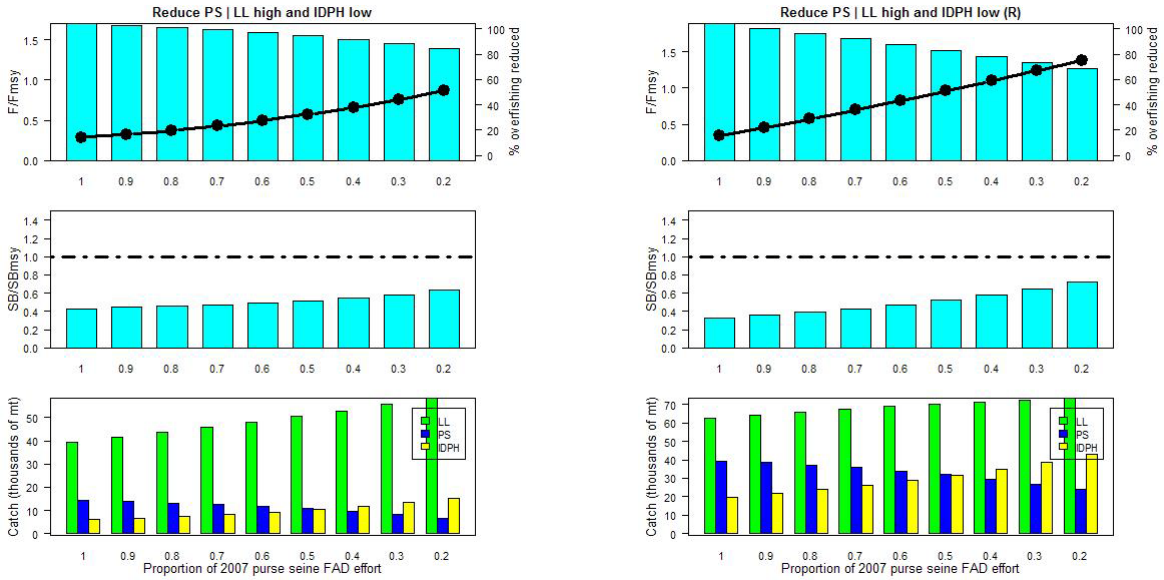

Figure 7: Key performance indicators for scenarios where purse seine effort is reduced incrementally from 2007 levels, longline catch is limited to 2007 levels, and IDPH effort is reduced 50% from 2007 levels. Indicators presented are predicted levels of F_{2018}/F_{MSY} (top), SB_{2018}/SB_{MSY} (middle), gear specific catches (bottom). Future recruitment is assumed to be at either long term average (left) or recent average (right) levels.

Attachment B. Bigeye Projections for WCPFC6 to be conducted by the Scientific Provider

Background

Previous analysis of potential management option (e.g. TCC paper) were based on evaluating fishery-specific fishing mortality changes though a yield-based framework. Due to the complex nature of CMM 2008-01 (e.g. a mixture of catch and effort limits, time/area closures, and stepped reductions), this approach was no longer considered sufficient to provide the detailed investigation of management measures requested by the Commission.

In response SPC developed the capacity within MULTIFAN-CL in order to undertake mixed catch and effort projections. While these analyses are more demanding in terms of the time required to prepare the projection data sets, in particular the stepped reductions, we feel that the additional work is warranted to more accurately reflect the provisions in CMM 2008-01. The first consideration of this approach is described in GN-WP-17.

Requests from SC

Following the presentation of GN-WP-17 at SC-5, the general requests for additional information were requested:

1. Further presentation of the outputs of the projections, in particular spawning biomass trajectories and predicted catches;
2. Examination of the impacts of various exemptions and 'special' provisions in CMM2008-01; and
3. Examination of the predicted impacts of additions/ changes to CMM-2008-01 provisions
4. Inclusion of SKJ

In order to meet these information needs, the following analyses were requested:

Further outputs

The following outputs could be made available:

- Predicted annual catches by broad fisheries groups (see fishery definitions in Table 2 of the BET assessment report)
- Total spawning biomass

In addition some plots of regional biomass trends and projected fishery impact plots could be included in future reports.

Exemptions and special provisions

Repeat of some of the scenarios presented in CMM2008-01 (maybe just 5 and 6), with the following exemptions and provisions excluded to illustrate their impacts (one at a time and then combined)[1]:

- Longline
    - No 2000mt limit for the longline catch reductions (e.g. reductions for all longline from 2001-04 or 2004)
    - Remove exemptions for the Hawaiian and Chinese longline fleets
- Purse seine
    - Effort at 2004 levels for all fleets (including Archipelagic waters)
    - Remove Archipelagic waters exemption
    - Removal of the 'existing arrangements' provision
    - FAD closure includes Archipelagic waters in Indonesia,
    - Appropriate domestic Philippines purse seine fleet]
- Other fisheries
    - Set catches and or effort for all other fisheries to 2001-04 or 2004 levels.

CMM 2008-01 alternatives

In order to examine potential impact of strengthening CMM2008-01, the following be included from 2010 in the projections:

- Longline (with and without all LL exemptions)
    - 40 to 100% reductions in longline catches over 2009-2011
- Purse seine (with and without all PS exemptions)
    - 4 to 12 month FAD closures
    - Percentage reductions in effort from 2004 levels
- Other fisheries
    - Percentage reductions in catch / effort from 2004 levels

[1] Some of the scenarios below might be redundant (covered by another scenario)