Western and Central Pacific Fisheries Commission

SCIENTIFIC COMMITTEE

SIXTH REGULAR SESSION

10-19 August 2010

Nuku'alofa, Tonga

Further Analysis of CMM-2008-01

WCPFC-SC6-2010/SA-WP-5

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Executive Summary

This paper presents a series of bigeye tuna stock projections to evaluate the effects of various exemptions and exclusions in CMM-2008-01, as requested at the 5th annual session of the WCPFC scientific committee. Consistent with previous work, the projections employed two key model runs from the 2009 bigeye tuna assessment (run10 and run14) combined with two assumptions regarding future bigeye tuna recruitment (SRR recruit and AV recruit). A total of 11 projection scenarios were devised and the key indicators (F/F_{MSY} and SB/SB_{MSY} in the terminal year of the projections) estimated for each scenario/assessment model/recruitment assumption combination. For the most part, the individual exemptions have a relatively modest impact on the indicators. It is again demonstrated that measures need to be implemented across all fishery sectors with significant bigeye catches if meaningful reductions of fishing mortality are to be achieved.

1   Introduction

CMM-2008-01 is a conservation and management measure (CMM) for bigeye and yellowfin tuna that is aimed at reducing fishing mortality for bigeye tuna by 30% and ensuring no further increase in yellowfin tuna fishing mortality from their 2001-2004 (or 2004) levels. At SC5, an evaluation of the CMM was undertaken (Hampton and Harley 2009) to see if the measures that it comprises are capable of meeting the above objectives. For bigeye tuna, it was concluded that the CMM was unlikely to meet its objective for a number of reasons including: (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 CMM, 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 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. For yellowfin tuna, it was concluded that fishing mortality should remain at about 2001-2004 average levels, and therefore the CMM is likely to meet its objective for this species.

In response to these findings, SC5 recommended that further work be undertaken regarding the effects of different parts of the CMM on bigeye tuna. This recommended further work is summarized in Table 1. In response to the SC5 request, additional analyses were conducted and presented to the 6th Annual Session of the Commission (SPC 2009). This work included evaluating the composite effect of the various exemptions and exclusions. Specifically, the projections assumed that:

- Total longline catches were reduced by 30% from 2004 levels, i.e. no exemptions for SIDs, USA, China, and those with catches of less than 2000 t, in other words, a 30% reduction of the total longline catch is achieved;
- Purse seine effort occurred at 2004 levels for all fleets, e.g. no special provision for archipelagic waters or existing bilateral and multi-lateral arrangements; and
- Indonesia / Philippines domestic fisheries operated at 2004 levels.

A generic grid of projections was also conducted by varying fishing effort of the key fishery groupings – longline, purse seine associated (FAD) sets, purse seine unassociated (school) sets and Indonesia-Philippines domestic fisheries – across wide ranges.

In this paper, we complete the SC5 request by considering the impacts of a number of individual exemptions and exclusions on key indicators of stock status, the fishing mortality in relation to the fishing mortality at maximum sustainable yield (F/F_{MSY}) and the spawning biomass in relation to the spawning biomass at MSY (SB/SB_{MSY}).

Table 1. The requests for additional work from SC5 and a description of what has been done in response to those requests.

Item	Response
General requests	
1. Further presentation of the outputs of the projections, in particular spawning biomass trajectories and predicted catches	Provided in WCPFC6-2009/IP18 and this paper
2. Examination of the impacts of various exemptions and 'special' provisions in CMM2008-01	Provided in composite in WCPFC6-2009/IP18 and in more detail this paper
3. Examination of the predicted impacts of additions/ changes to CMM-2008-01 provisions	See below under 'CMM-2008-01 alternatives'
4. Inclusion of skipjack	Not yet done – awaiting new skipjack assessment
Further outputs	
1. Predicted annual catches by broad fisheries groups	Provided in WCPFC6-2009/IP18
2. Spawning biomass	Provided in WCPFC6-2009/IP18
Exemptions and special provisions	
1. Longline 1.1 No 2,000 mt limit for the longline catch reductions (e.g. reductions for all longline from 2001-04 or 2004)	This paper
1.2 Remove exemptions for the US and Chinese longline fleets	This paper
2. Purse seine 2.1 Effort at 2004 levels for all fleets (including Archipelagic waters)	This paper
2.2 Remove Archipelagic waters exemption	This paper
2.3 Removal of the 'existing arrangements' provision	This paper
2.4 FAD closure includes Archipelagic waters in Indonesia	This paper
2.5 Appropriate domestic Philippines purse seine fleet	This paper
3. Other fisheries 3.1 Set catches and or effort for all other fisheries to 2001-04 or 2004 levels	This paper for Indonesian and Philippines, others are inconsequential
CMM 2008-01 alternatives	
1. Longline (with and without exemptions) 1.1 40-100% reductions in catch	Provided in WCPFC6-2009/IP18

2. Purse seine (with and without exemptions)
    2.1   4-12 month FAD closures
    2.2   Percentage reductions in effort from 2004 levels
	Covered in 2.2
	Provided in WCPFC6-2009/IP18

3. Other fisheries 3.1 Percentage reductions in catch/effort from 2004	This paper - 30% reduction from 2001-2004 effort for Indonesia and Philippines, others are inconsequential

2   Methods

2.1   Additional projection scenarios

The additional projections considered in this paper mostly deal with the specific exemptions written into CMM-2008-01. As a base for comparison, we have re-run projection 6a from Hampton and Harley (2009). This scenario incorporated all of the features of CMM-2008-01, as best could be estimated, and assumed that purse seine effort from the closed high-seas pockets is removed from the fishery. In addition to projection scenarios for individual exemptions/exclusions, we have also conducted some additional reference scenarios setting fishing effort for the key fishery groups both at, and 30% below the 2001-2004 average levels. Descriptions of all projections conducted are summarized in Table 2.

Table 2. Descriptions of the projections conducted.

Projection scenario	Description
0. Run 6a	Scenario 6a from Hampton and Harley (2009). This scenario incorporated all features of CMM-2008-01, and assumed that purse seine effort from the high-seas pockets is removed from the fishery following closure of the HSP.
1. No LL exempt	The various exemptions relating to longline catch in CMM-2008-01 are removed, including the 2,000 t exemption, the SIDs exemption, the China exemption, the fresh fish exemption, and the exclusion of archipelagic waters, in particular of Indonesia. Longline catches for all fleets were set at the 2001-2004 average levels. This resulted in a 14% reduction in longline catch compared to the base secario.
2. No FF LL exempt	Only the fresh-fish exemption is removed, effectively applying the 10%, 20% and 30% reductions in bigeye longline catch in 2009, 2010 and 2011, respectively to the US longline fleet.
3. LL effort 2001-04	Instead of specifying constant catches in the projections, the average level of longline effort in 2001-2004 for all longline fleets is specified.
4. LL effort 2001-04 – 30%	A 30% reduction in the levels of longline effort used in (3) above is applied to all longline fleets.
5. IDPH 2001-04	The estimated average level of fishing effort by Indonesian and Philippines domestic fleets in 2001-2004 is applied in the projections, as opposed to the 2007 level.
6. IDPH 2001-04 -30%	A 30% reduction in the fishing effort by Indonesian and Philippines domestic fleets from the 2001-2004 average level is applied.
7. PS effort 2001-04	The level of purse seine effort, by set type and model region, occurring in 2001-2004 is applied in the projections.
8. PS effort 2001-04 -30%	A 30% reduction from the 2001-2004 level of purse seine effort is applied.
9. No AW exempt	The provisions of CMM-2008-01 are assumed to apply in

	archipelagic waters as they do in EEZs and on the high seas. This applies in particular to the FAD closure.
10. No EA exempt	The exemption for existing arrangements is removed, thus restricting US purse seine effort to the 2004 levels.
11. 4+6+8	This is a composite projection combining the reductions of longline, Indonesia-Philippines domestic and purse seine effort from runs 4, 6 and 8 in a single run.

2.2   Projection models

As was the case in Hampton and Harley (2009), we have used two alternative bigeye tuna assessment models as the basis of the projections: (1) the base-case assessment (run10) as reported in the 2009 bigeye tuna assessment (Harley et al. 2009); and (2) the assessment run in which purse seine catches were adjusted upwards as indicated by observer-based spill-sampling trials (run14 in Harley et al. 2009).

Again consistent with Hampton and Harley (2009), projections were conducted using two alternative assumptions regarding future recruitment: (1) recruitment determined using the Beverton & Holt stock recruitment relationship (SRR) estimated/assumed in the stock assessment model; and (2) recruitment determined as the average recruitment for each model region during 1998-2007, i.e. the most recent ten years of the model excluding the last year. These alternative recruitment assumptions were tested separately because future recruitment is highly uncertain, and the recent decade of bigeye recruitment has been well above that predicted by the SRR.

All other modeling assumptions and data used in the projections are identical to those described in Hampton and Harley (2009). We also use the same indicators for evaluating the various scenarios – F/F_{MSY} and SB/SB_{MSY} computed for the last year (2018) of the projections.

3   Results and Discussion

The results of the projections are summarized in Figure 1, which plots F_{2018}/F_{MSY} and SB_{2018}/SB_{MSY} for each combination of projection scenario, future recruitment assumption and stock assessment model. The main observations from the scenarios are:

- Removal of the longline exemptions (scenario 1) results in a small (6-7%) reduction in F_{2018}/F_{MSY} and a moderate (16%) increase in SB_{2018}/SB_{MSY} for the 'AV recruit' projections consistent with the reduction (14%) in longline catch compared to the base scenario. For the 'SRR recruit' projections, there is little effect because even the reduced longline catches cannot be achieved under this lower recruitment assumption.
- Removal of the 'fresh fish' exemption (scenario 2) has little impact on either indicator, regardless of the choice of model or recruitment assumption.
- Replacing the longline catch limit with an effort limit consistent with the average of 2001-2004 for all longline fleets (scenario 3) results in a small (5-6%) reduction in F_{2018}/F_{MSY} and a 6-13% increase in SB_{2018}/SB_{MSY} for the 'SRR recruit' projections, but has a reverse impact for the 'AV

recruit' projections. This again results from the interaction between recruitment level and type of longline limit.

- A reduction in longline effort of 30% from the 2001-2004 average level for all fleets (scenario 4) results in a reduction of 8-15% in F_{2018}/F_{MSY} and a 19-39% increase in SB_{2018}/SB_{MSY}.
- Application of 2001-2004 relative effort for the Indonesia-Philippines domestic fleets (scenario 5) results in a reduction of 8-18% in F_{2018}/F_{MSY} and a 14-42% increase in SB_{2018}/SB_{MSY}.
- A reduction in relative effort for the Indonesia-Philippines domestic fleets of 30% from the 2001-2004 level (scenario 6) results in a reduction of 12-23% in F_{2018}/F_{MSY} and a 20-59% increase in SB_{2018}/SB_{MSY}.
- Application of 2001-2004 relative effort for all purse seine fleets (scenario 7) results in slight increases in F_{2018}/F_{MSY} and decreases in SB_{2018}/SB_{MSY}. A reduction in effort of 30% from this level (scenario 8) reverses this result, with slight decreases in F_{2018}/F_{MSY} and increases in SB_{2018}/SB_{MSY}.
- The removals of the 'archipelagic waters' and 'existing arrangements' exemptions (scenarios 9 and 10, respectively) result in very slight improvements in both indicators.
- The strongest improvement in both MSY-based indicators was obtained in scenario 11, which combined the reductions in longline, Indonesia-Philippines and purse seine effort from scenarios 4, 6 and 8, respectively. In this scenario, reductions in F_{2018}/F_{MSY} of 18-34% and increases in SB_{2018}/SB_{MSY} of 47-95% were obtained. However F_{2018}/F_{MSY} remains >1 for all model/recruitment assumption combinations, and SB_{2018}/SB_{MSY} remains <1 for all except the run10/AV recruit combination.

These results are all consistent with the previous evaluations of CMM-2008-01. They reinforce the key conclusion that measures need to be implemented across all fishery sectors with significant bigeye catches if meaningful reductions of fishing mortality are to be achieved.

4   References

Hampton, J., and S. Harley. 2009. Assessment of the potential implications of application of CMM-2008-01 for bigeye and yellowfin tuna. WCPFC-SC5-2009/GN-WP-10.

Harley, S., S. Hoyle, A. Langley, J. Hampton, and P. Kleiber. 2009. Stock assessment of bigeye tuna in the western and central Pacific Ocean. WCPFC-SC5-2009/SA-WP-4.

SPC. 2009. Further consideration of CMM-2008-01 with respect to bigeye tuna. WCPFC6-2009/IP-18.
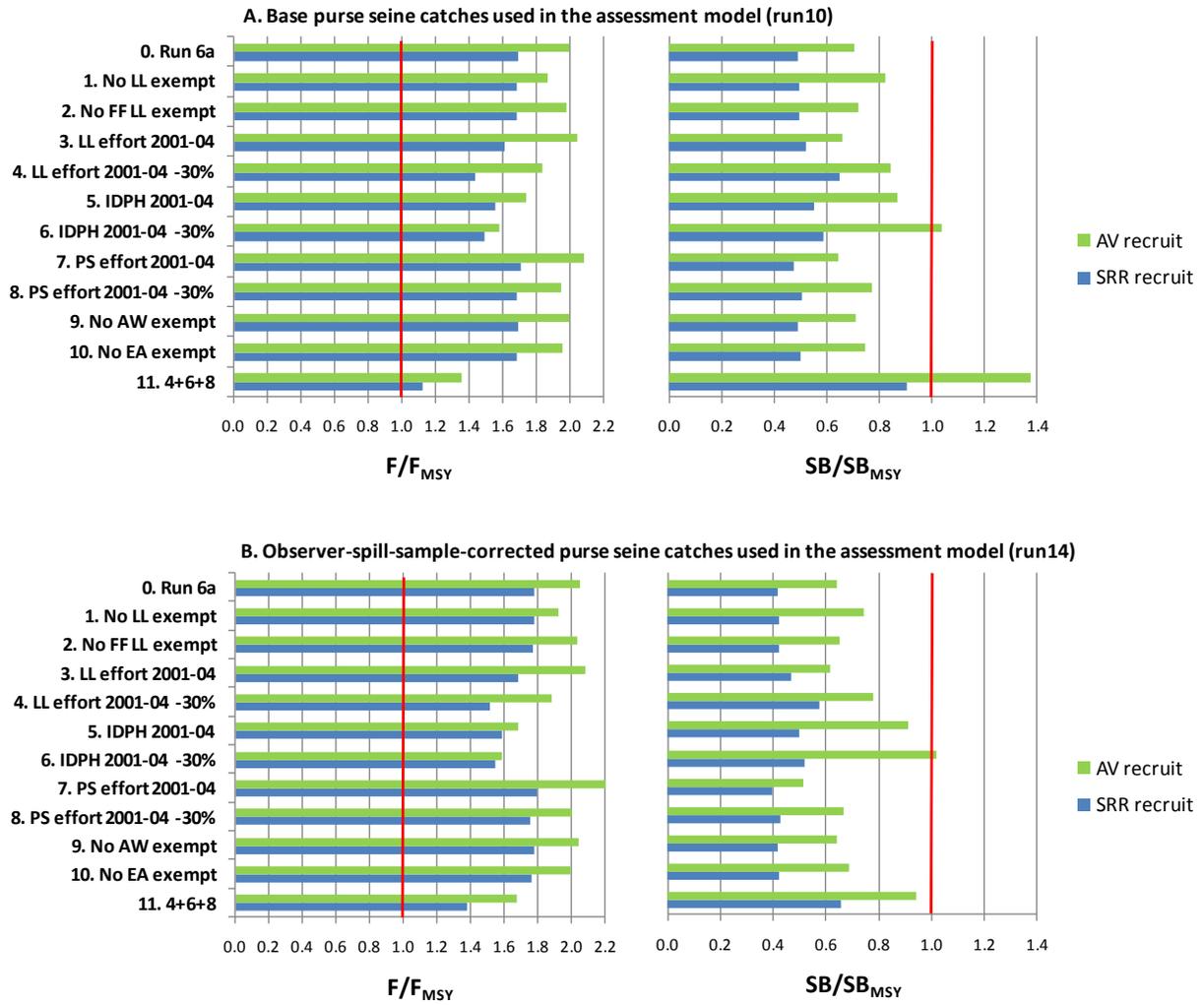
Figure 1. Summary of additional projections using two alternative assessment model runs: A. the base case purse seine catch assessment run, and B. the observer-spill-sample-corrected purse seine catches assessment run. For each model, projections were undertaken assuming deterministic recruitment as specific by the estimated stock recruitment relationship (SRR recruit) and by the average recruitment over the period 1998-2007 (AV recruit). The projection runs are described in Table 2.

5   Appendix: Spawning biomass Trajectories for Projections

run10 - SRR recruit

run10 - AV recruit
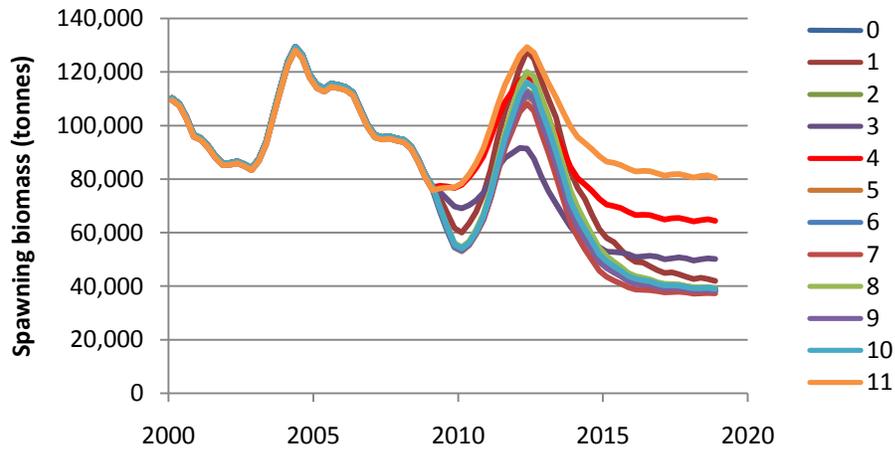
run14 - SRR recruit
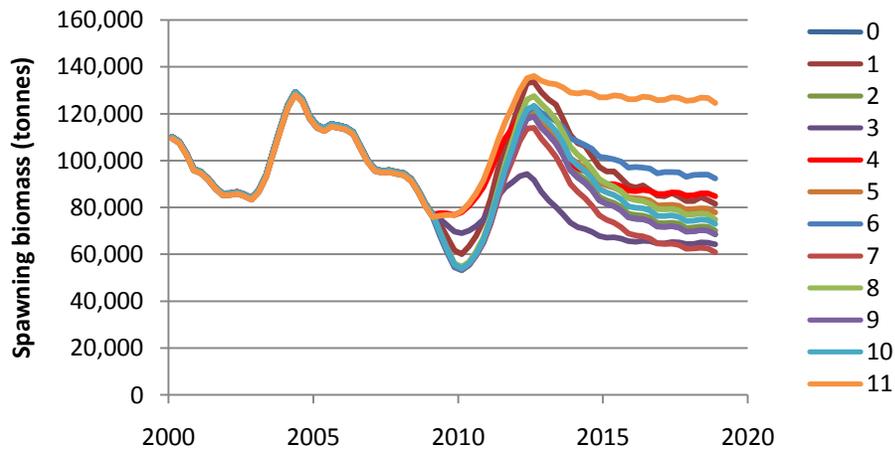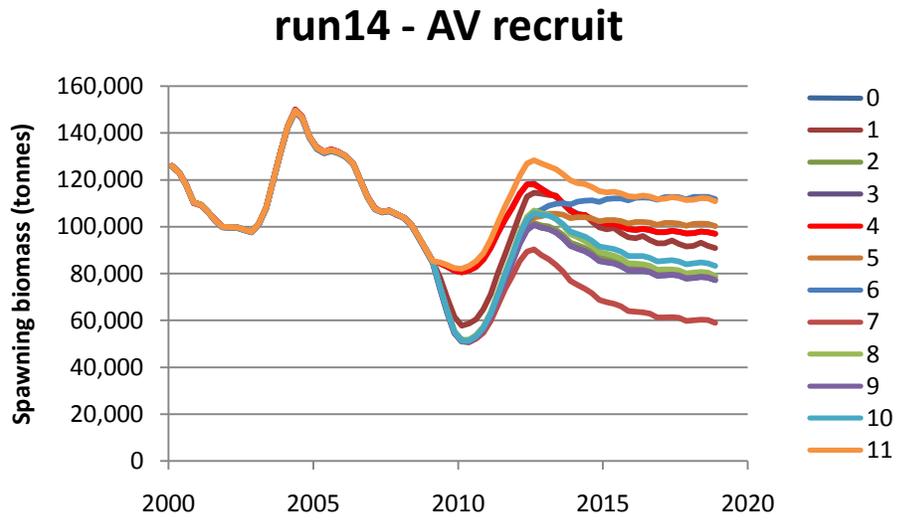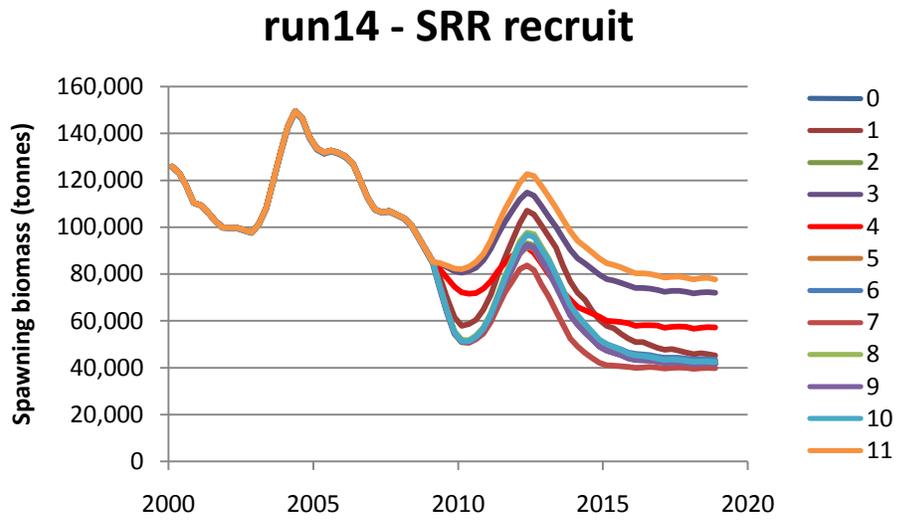
run14 - AV recruit

Appendix Figure 1. Spawning biomass trajectories for the two model runs (run10 and run14) and two future recruitment assumptions (SRR recruit and AV recruit). Projection scenarios are numbered according to Table 2.