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Relative impacts of FAD and free-school purse seine fishing on skipjack tuna stock status

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Abstract

Following presentation of advice to the Commission on the relative impact on yellowfin tuna stock status of different ratios of purse seine set types, i.e. FAD, or associated sets versus free-school or unassociated sets, SC10 requested a similar analysis be performed for skipjack tuna. To address this issue, we undertook deterministic stock projections using the 2014 skipjack tuna assessment assuming 2010-2012 average purse seine effort and catch or effort by non-purse seine gears. Separate projections were run using different percentages (0%, 20%, 40%, 60%, 80% and 100%) of the total tropical purse seine effort (in assessment model regions 2 to 5) being attributed to associated sets and the complementary percentage to unassociated sets. The equilibrium tropical purse seine catch of skipjack decreases marginally with increasing percentages of associated sets in the tropical purse seine fishery. The three stock status indicators examined – spawning biomass at the end of the projection period in relation to the average unexploited spawning biomass in 2002-2011; the spawning biomass at the end of the projection period in relation to the spawning biomass at MSY; and the fishing mortality at the end of the projection period in relation to the fishing mortality at MSY – were all relatively insensitive to changes in the set type composition of tropical purse seine effort. Slightly better stock status – higher spawning biomass indicators and lower fishing mortality – and higher maximum sustainable yield occurred for purse seine effort compositions favouring unassociated sets. This is attributed to the larger average size of skipjack caught in unassociated sets.

Introduction

Conservation and Management Measure (CMM) 2014-01[2] specifies a combination of seasonal closures on the use of fish aggregations devices (FADs) and FAD set limits by purse seiners to reduce fishing mortality on bigeye tuna. In addition to impacts on bigeye tuna, purse seine set type (FAD, or associated sets versus free-school or unassociated sets) could have impacts on other tuna species, because unassociated sets tend on average to catch larger tuna than associated sets (Figure 1). To address the requirement under paragraph 29 of CMM 2013-01, a paper was provided to SC10 on the relative impact on fishing mortality for yellowfin, of FAD set measures and any increases of yellowfin purse seine catch in unassociated schools. Following review of that paper, SC10 recommended that the same impact analysis should be conducted for skipjack *(*para 108 of the SC10 report*).*

This paper therefore provides SC11 with information on the relative average impact of different percentages of associated and unassociated purse seine sets on the skipjack tuna catch and various skipjack tuna stock status indicators, using the 2014 skipjack tuna reference case assessment.

[2] http://www.wcpfc.int/system/files/CMM%202014-01%20Conservation%20and%20Management%20Measure%20for%20Bigeye%2C%20Yellowfin%20and%20Skipjack%20Tuna.pdf

Methods

The following methods were used for this evaluation:

i. The 2014 skipjack tuna reference case assessment model (Rice et al. 2014) operating in projection mode was used as the basis of the evaluation.
ii. Deterministic projections were run over a 10-year period, 2013-2022, assuming future recruitment levels at the estimated average recruitment by model region for the period 2002-2011 (the penultimate 10-year period of the assessment model). Deterministic rather than stochastic projections were considered to be adequate for the purpose of this evaluation, since the objective is to provide advice on long-term average impacts.
iii. The base conditions for the projections were the 2010-2012 average catch and effort, by model fishery. All non-purse seine fisheries, and the domestic purse seine fisheries in Indonesia and Philippines, were projected using their average 2010-2012 catch or effort; purse seine fisheries were projected using effort (days).
iv. Separate projections were run using different percentages (0%, 20%, 40%, 60%, 80% and 100%) of the total tropical purse seine effort (regions 2 to 5 of the stock assessment model) being attributed to associated sets and the complementary percentage to unassociated sets. Within each run, the percentage of effort attributed to each set type was held constant. Total purse seine effort (i.e. the sum of associated and unassociated effort) was assumed to remain at the 2010-2012 average level throughout the projections. For reference, the average percentage of the total tropical purse seine effort attributed to associated sets for 2010-2012 was 42%.
v. The skipjack tuna tropical purse seine catch by set type and three stock status indicators – the spawning biomass at the end of the projection period in relation to the average unexploited spawning biomass in 2002-2011 ($SB_{2022}/SB_{F=0,2002-2011}$); the spawning biomass at the end of the projection period in relation to the spawning biomass at MSY (SB_{2022}/SB_{MSY}); and the fishing mortality at the end of the projection period in relation to the fishing mortality at MSY (F_{2022}/F_{MSY}) – were monitored. We also monitored the MSY itself as an additional quantity of interest.

Results

The tropical purse seine catch of skipjack is insensitive to the composition of tropical purse seine effort by set type (Figure 2). Total catch at equilibrium ranges from 1,019,000 mt with 0% associated sets to 1,000,000 mt with 100% associated sets. The higher catches related to the use of unassociated sets result primarily from the yield-per-recruit gains predicted to occur if capture is delayed until the larger average sizes typical of unassociated sets. These catches are slightly lower than the 2010-2012 average catch within the assessment model (approximately 1.1 million mt), as the stock declines slightly from that level within the projection period.

The time-series plots of the three stock status indicators, for different percentages of associated sets, are shown in Figure 3. The recent historical estimates (2001-2012) from the skipjack tuna assessment are also plotted for reference. The indicators projected for 2022 (i.e. the terminal points of the trajectories in Figure 3) are shown in Figure 4. These figures show that skipjack tuna stock status is slightly enhanced (i.e. higher spawning biomass and lower fishing mortality) by lower percentages of associated sets (and higher percentages of unassociated sets). However, the effect is relatively slight, for example $SB/SB_{F=0,\ 2002-2011}$ ranges from a low of 0.443 if 100% of purse seine effort is associated sets, to a high of 0.500 (range of about 12%) if there is zero associated sets and all purse seine effort is on

unassociated sets. The MSY-based spawning biomass and fishing mortality indicators showed similar changes between these extremes of possible purse seine set type proportions (range of about 12% for F/F_{MSY}, 7% for SB/SB_{MSY}). Note that the variation in MSY-based indicators for the historical period evident in Figures 3b and c is because varying the proportion of associated and unassociated purse seine sets changes the overall fishery selectivity (age-specific pattern of fishing mortality), which in turn changes the MSY-based reference points. This is also highlighted in the effect of purse seine set type on the MSY itself (Figure 5), which shows that higher MSY results with tropical purse seine effort composition favouring unassociated sets (range of about 7%). This occurs because of the larger average size of skipjack tuna caught in unassociated purse seine sets (Figure 1).

Conclusion

Skipjack tuna stock status is relatively insensitive to whether tropical purse seine effort is comprised of mainly associated sets or unassociated sets. Slightly better stock status – higher spawning biomass indicators and lower fishing mortality –, higher average catch and higher MSY occurred for tropical purse seine effort compositions favouring unassociated sets. These results are qualitatively comparable to those seen within the yellowfin tuna analysis (SC10- MI-WP-05).

References

Rice, J., Harley, S., Davies, N. and Hampton, J. 2014. Stock assessment of skipjack tuna in the western and central Pacific Ocean. WCPFC SC10-SA-WP-05, Majuro, Republic of the Marshall Islands, 6 – 14 August 2014.

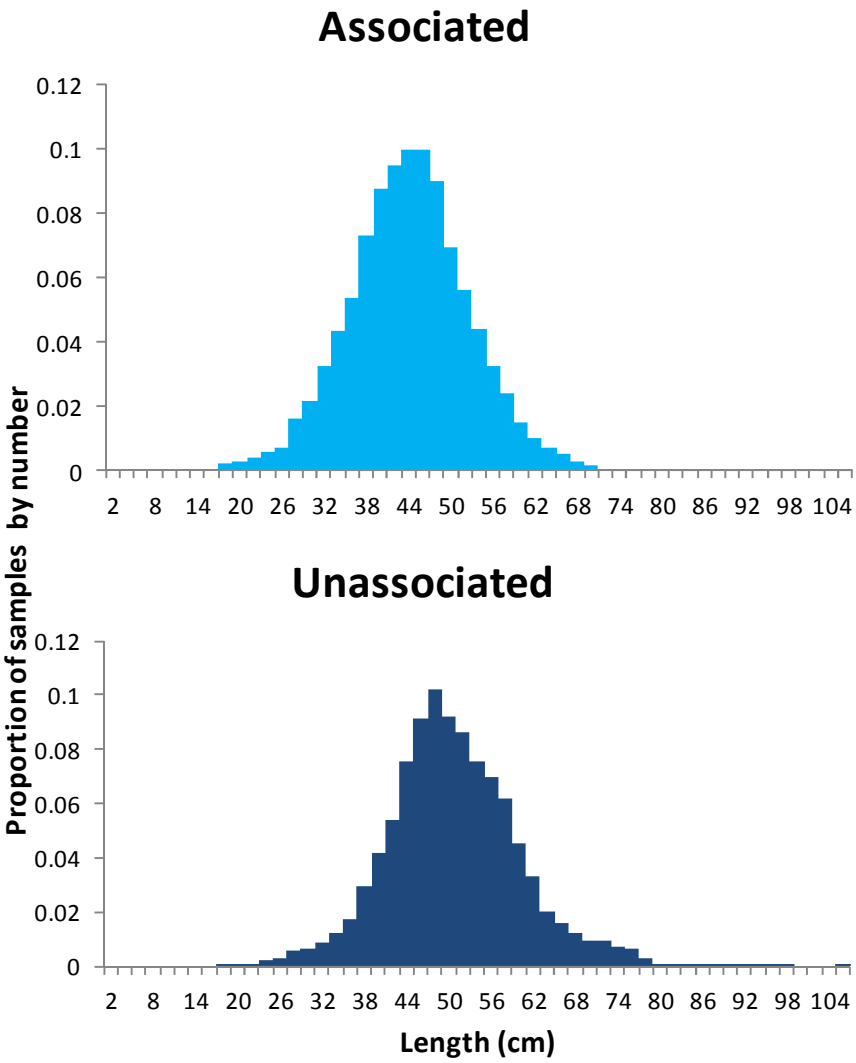

Figure 1. Size composition (by number) of skipjack tuna sampled in associated and unassociated sets, 2010-2012.

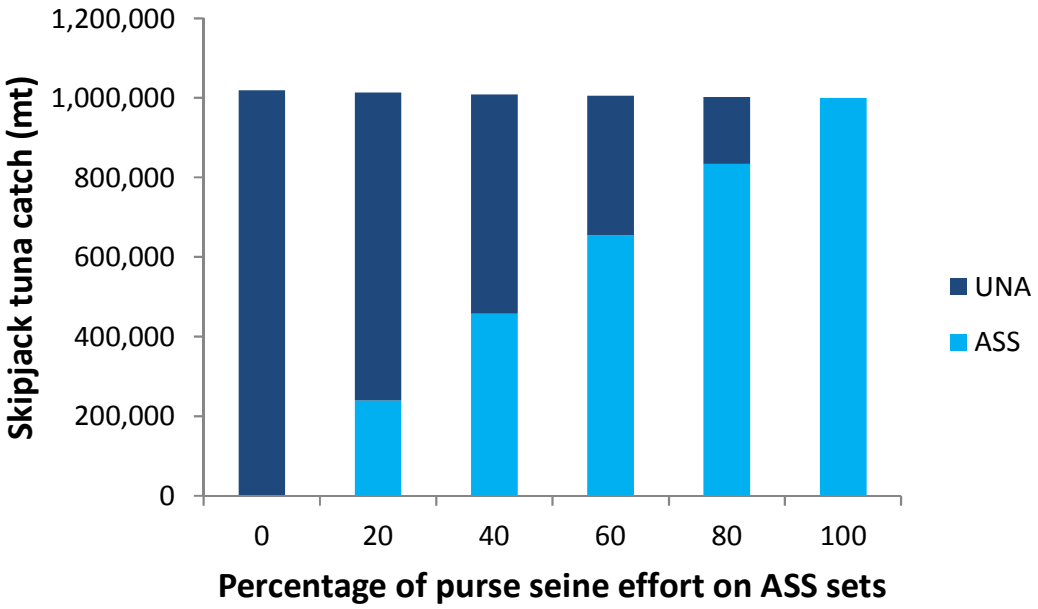

Figure 2. Projected annual purse seine skipjack tuna catch in 2022, for associated (ASS) and unassociated (UNA) sets, for different percentages of total purse seine effort represented by associated sets.

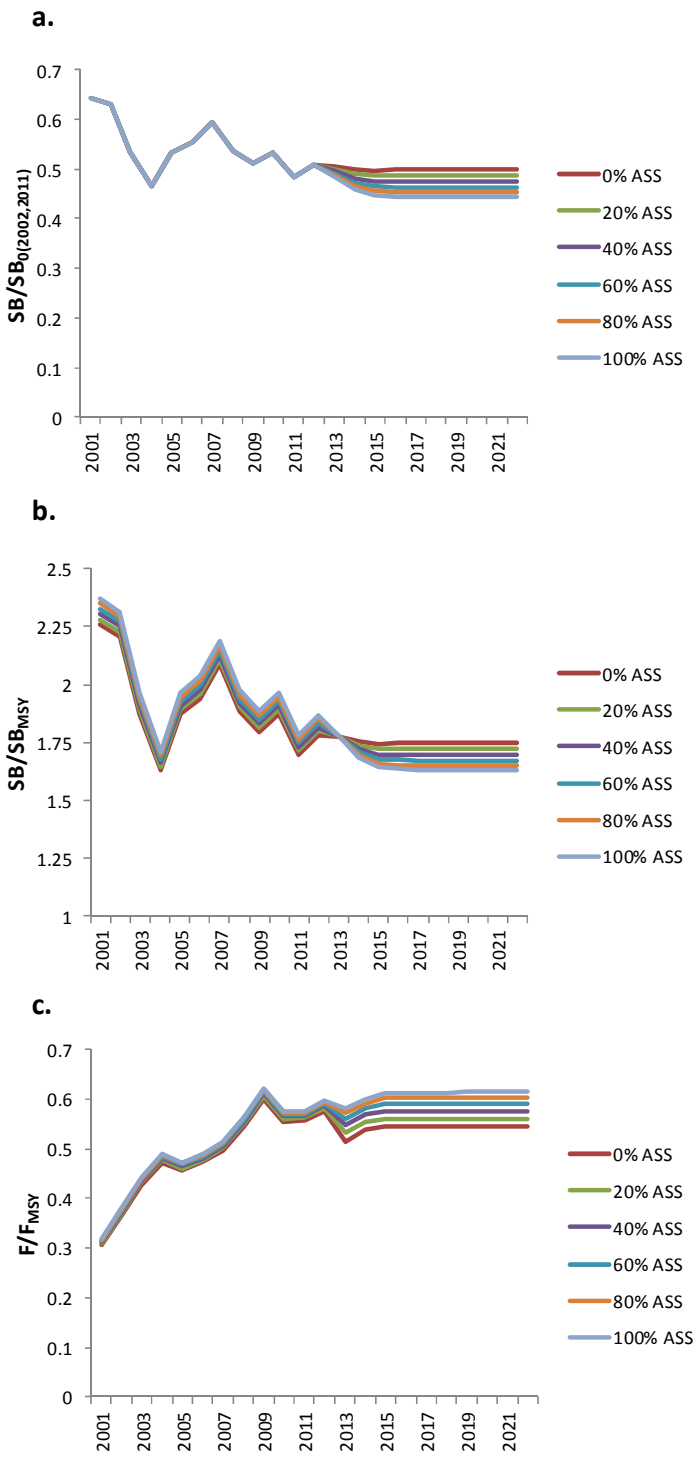

Figure 3. Projections of a) $SB/SB_{0\ (2002\text{-}2011)}$; b) SB/SB_{MSY}; and c) F/F_{MSY} with different percentages of total purse seine effort represented by associated (ASS) sets.

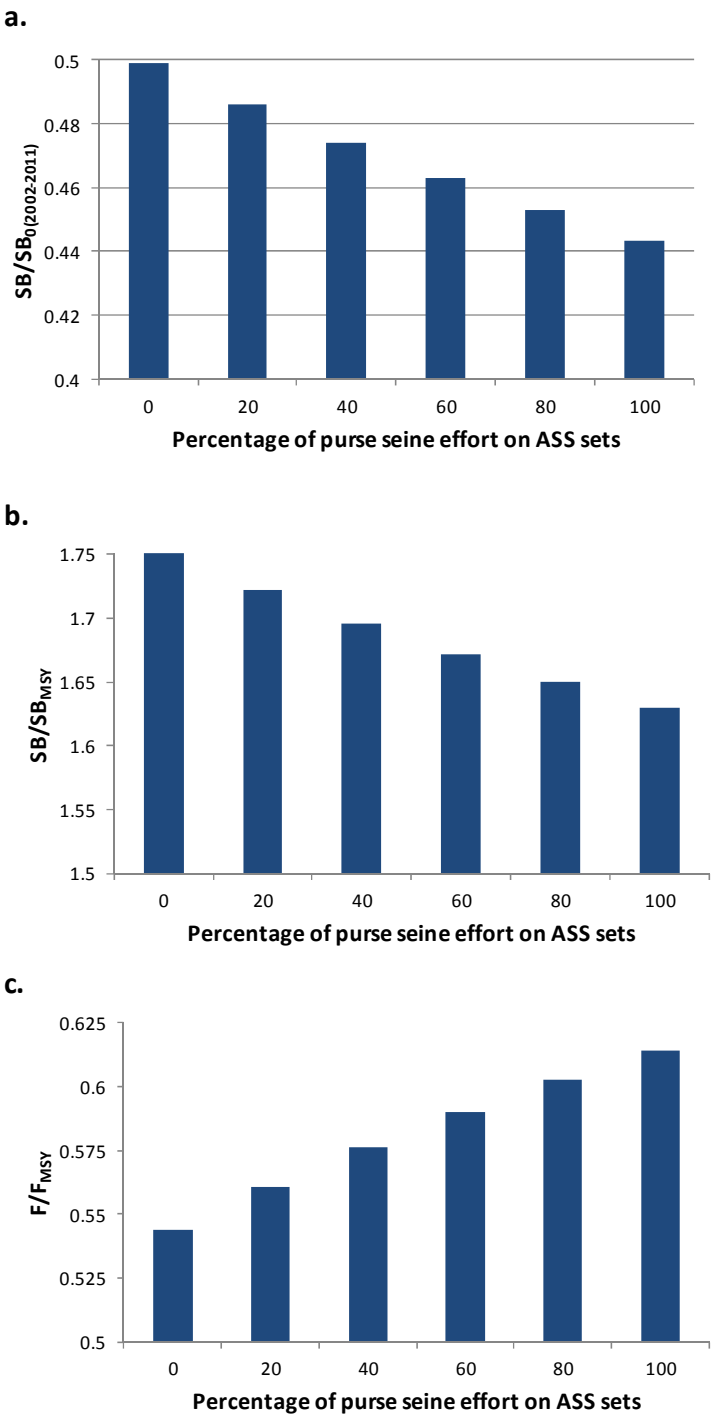

Figure 4. Response of stock status indicators a) $SB/SB_{0\ (2002\text{-}2011)}$; b) SB/SB_{MSY}; and c) F/F_{MSY} to different percentages of total purse seine effort represented by associated (ASS) sets.

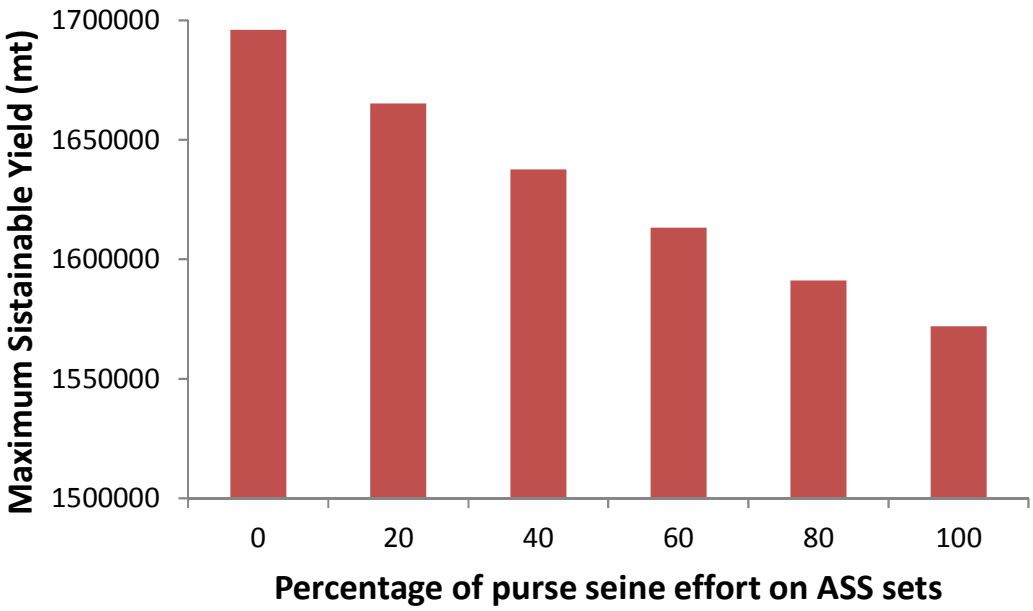

Figure 5. Response of maximum sustainable yield to different percentages of total purse seine effort represented by associated (ASS) sets.