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

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John Hampton[1] and Graham Pilling[1]

[1]Secretariat of the Pacific Community, Noumea, New Caledonia

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Abstract

Conservation and Management Measure 2013-01 requires that the Scientific Committee in 2014 provide 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. To address this issue, we undertook deterministic stock projections using the 2014 yellowfin tuna assessment assuming 2010-2012 average purse seine effort and catch by non-purse seine gears. Separate projections were run using different percentages (0%, 20%, 40%, 60%, 80% and 100%) of the total purse seine effort being attributed to associated sets and the complementary percentage to unassociated sets. The equilibrium purse seine catch of yellowfin decreases with increasing percentages of associated sets in the 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 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.

Introduction

Conservation and Management Measure (CMM) 2013-01[1] 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 yellowfin tuna as well, because unassociated sets tend on average to catch larger yellowfin tuna than associated sets (Figure 1). CMM 2013-01 requires that (paragraph 29):

> *The Scientific Committee at its 2014 regular session will provide advice to the Commission on the relative impact on fishing mortality for yellowfin, of FAD set measures and any increases of yellowfin purse seine catch in unassociated schools.*

This paper therefore provides SC10 with information on the relative average impact of different percentages of associated and unassociated purse seine sets on the yellowfin tuna catch and various yellowfin tuna stock status indicators, using the 2014 yellowfin tuna reference case assessment.

Methods

The following methods were used for this evaluation:

[1] http://www.wcpfc.int/system/files/CMM%202013-01%20CMM%20for%20bigeye%20yellowfin%20%26%20skipjac%20tuna.pdf

i. The 2014 yellowfin tuna reference case assessment model (Davies 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 were projected using their average 2010-2012 catches; 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 purse seine effort 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 purse seine effort attributed to associated sets for 2010-2012 was 41%.
v. The yellowfin tuna 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 purse seine catch of yellowfin is sensitive to the composition of purse seine effort by set type (Figure 2). Total catch at equilibrium ranges from 373,000 mt with 0% associated sets to 290,000 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.

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 yellowfin 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 yellowfin 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 0.397 if 100% of purse seine effort is associated sets, to a high of 0.435 (range of about 10%) if there is zero associated sets and all purse seine effort is on unassociated sets. The MSY-based spawning biomass and fishing mortality indicators are even less affected between these extremes of possible purse seine set type proportions (range of 2-4%). 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 purse seine effort composition favouring unassociated sets (range of about 14%). This occurs because of the larger average size of yellowfin tuna caught in unassociated purse seine sets (Figure 1).

Conclusion

Yellowfin tuna stock status is relatively insensitive to whether 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 purse seine effort compositions favouring unassociated sets.

References

Davies, N., Harley, S., Hampton, J., and McKechnie, S. 2014. Stock assessment of yellowfin tuna in the western and central Pacific Ocean. WCPFC SC10-SA-WP-04, Majuro, Republic of the Marshall Islands, 6 – 14 August 2014.

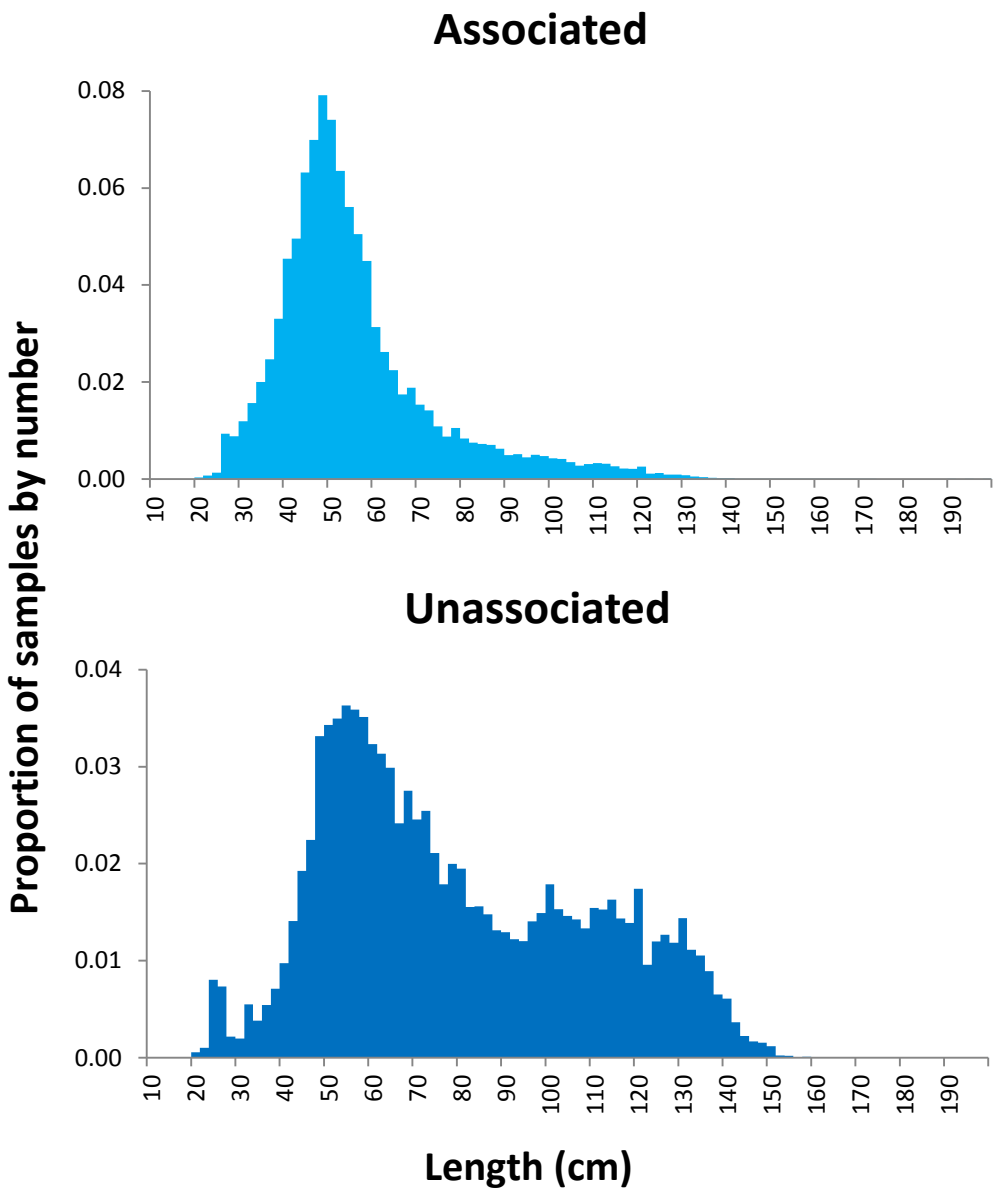


Figure 1. Size composition (by number) of yellowfin tuna sampled in associated and unassociated sets, 2010-2012.

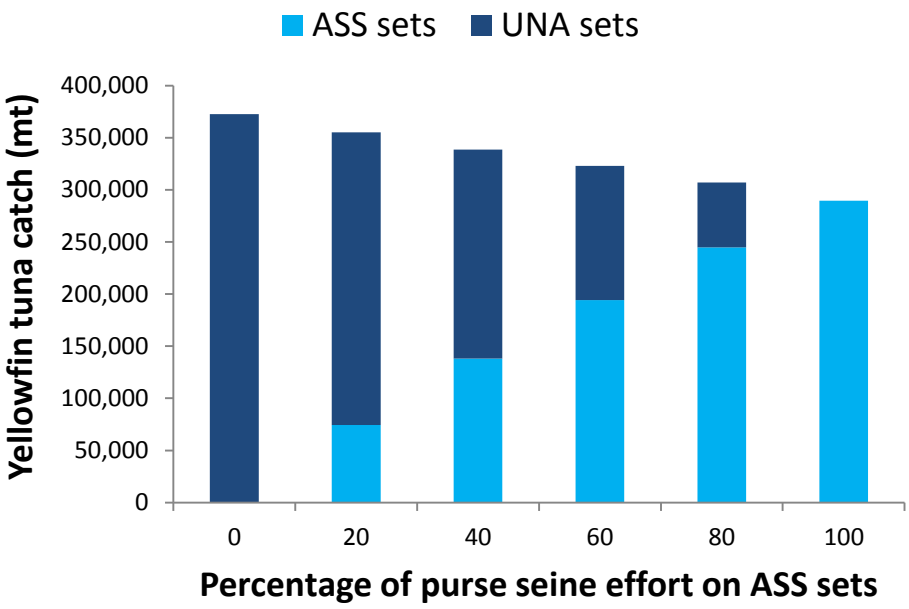


Figure 2. Projected annual purse seine yellowfin tuna catch in 2022, for associated (ASS) and unassociated (UNA) sets, for different percentages of total purse seine effort represented by associated sets.

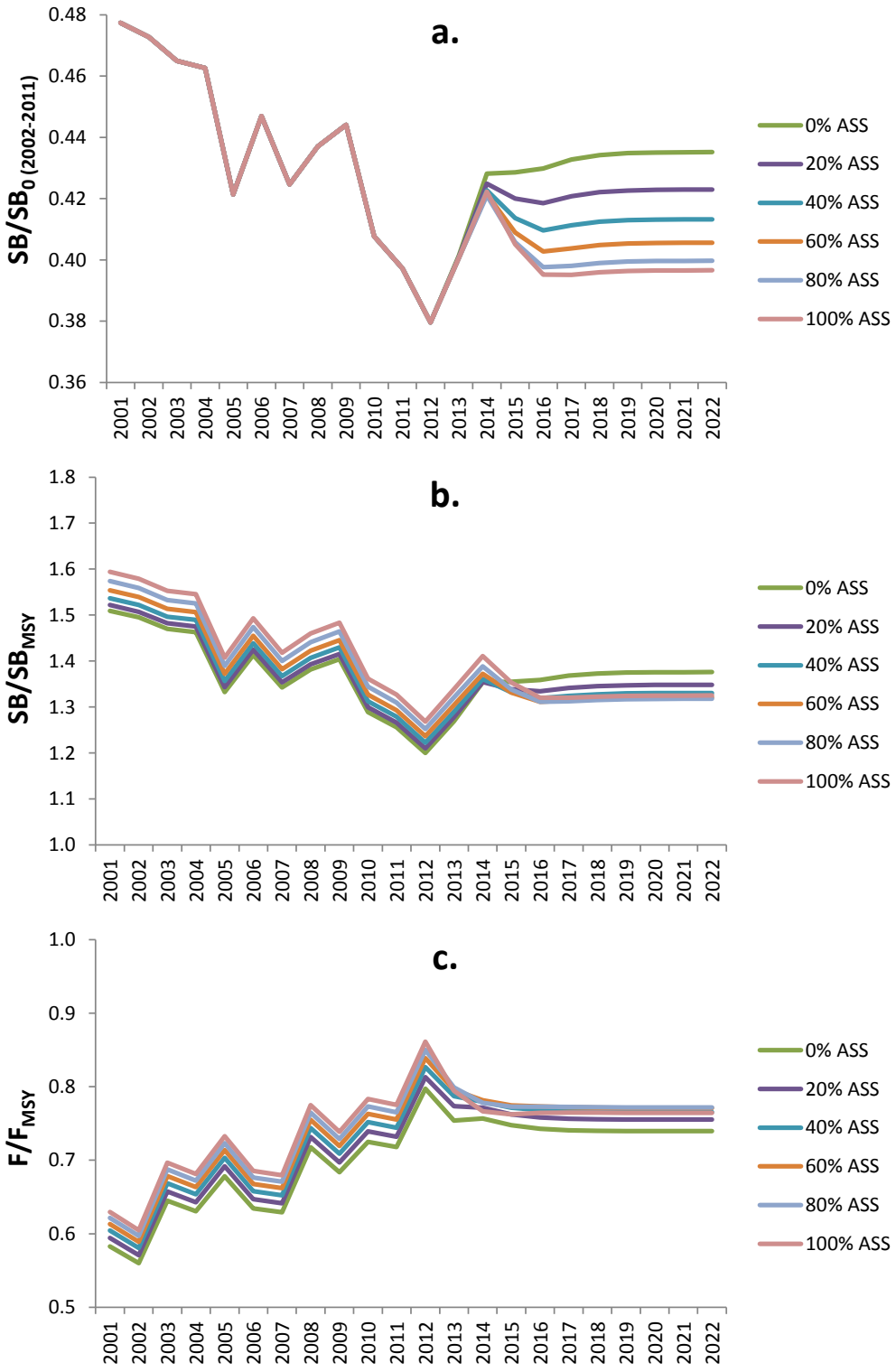
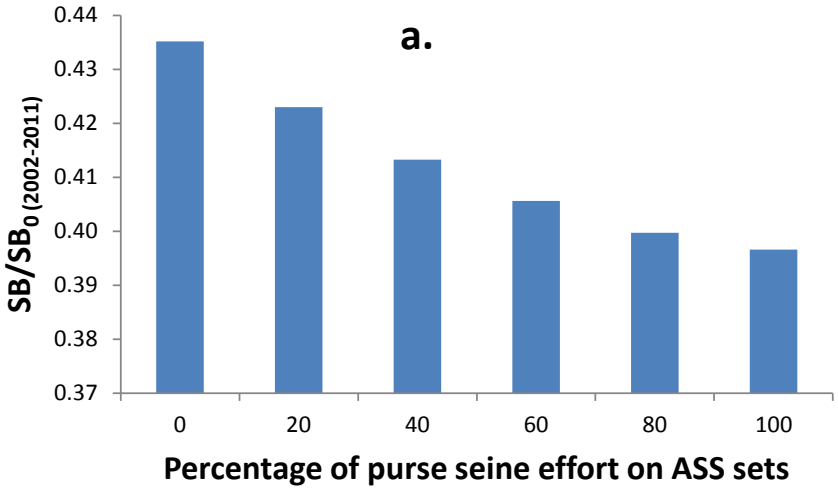
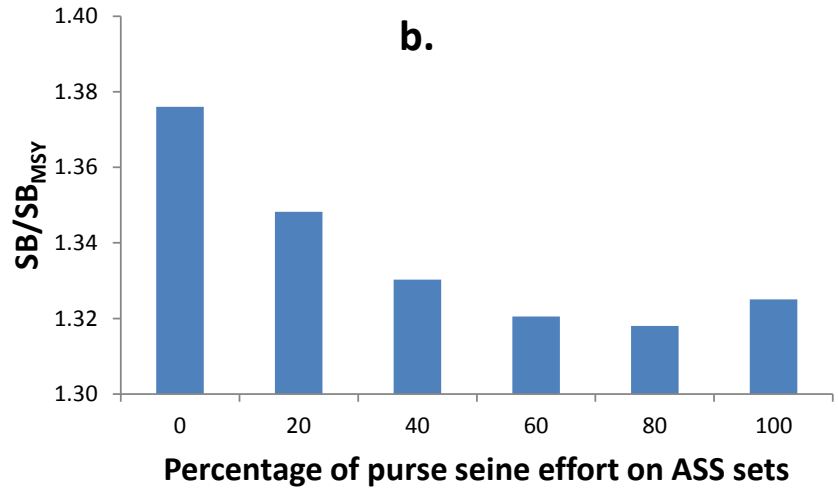


Figure 3. Projections of a) $SB/SB_{0\ (2002\text{-}2011)}$; b) SB/SB_{MSY}; and c) F/F_{MSY} with different percentages of total purse seine effort represented by associated (ASS) sets.





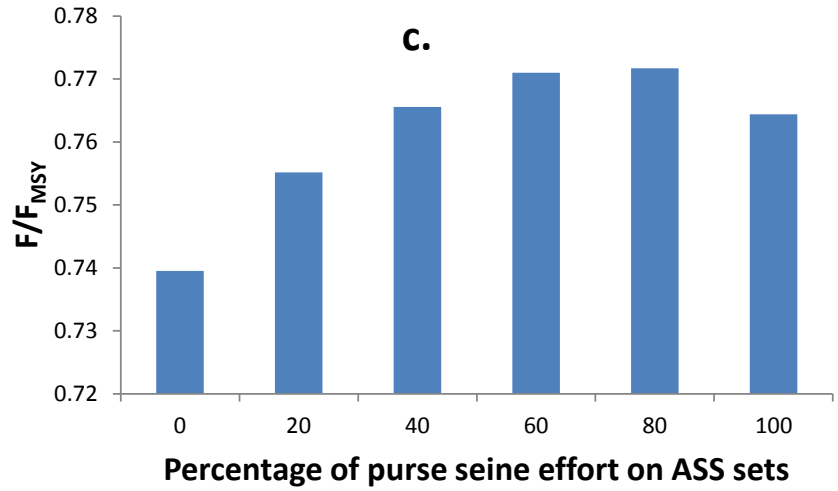


Figure 4. Response of stock status indicators a) $SB/SB_{0\ (2002\text{-}2011)}$; b) SB/SB_{MSY}; and c) F/F_{MSY} to different percentages of total purse seine effort represented by associated (ASS) sets.

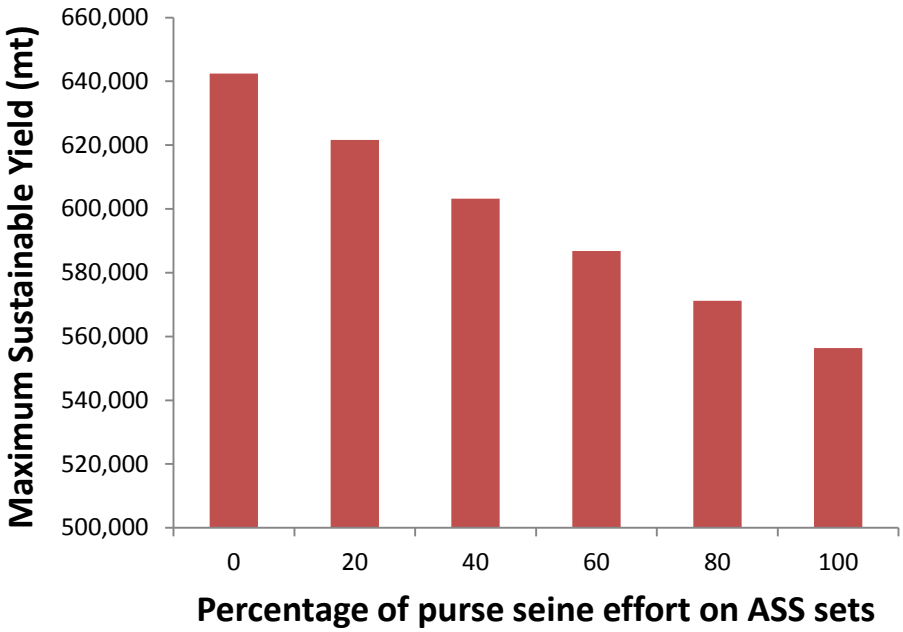


Figure 5. Response of maximum sustainable yield to different percentages of total purse seine effort represented by associated (ASS) sets.