

TUNA RESOURCE MANAGEMENT

Management options for yellowfin and bigeye tuna in the WCPO fishery

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At the second meeting of the Scientific Committee (SC2) of the Western and Central Pacific Fisheries Commission (WCPFC), the stock assessments for yellowfin tuna and bigeye tuna in the Western and Central Pacific Ocean (WCPO) were presented (see Hampton et al. 2006a, 2006b). On the basis of these assessments, SC2 provided the following management advice to the Commission.

- In order to maintain the bigeye stock at a level capable of producing the maximum sustainable yield the Scientific Committee recommends a 25 per cent reduction in fishing mortality from the average levels for 2001–2004.
- In order to maintain the yellowfin stock at a level capable of producing the maximum sustainable yield the Scientific Committee recommends a 10 per cent reduction in fishing mortality from the average levels for 2001–2004.

The SC2 did not provide any direction as to how these reductions in fishing mortality should or could be implemented. The

simplest interpretation would be to implement the advice by a direct reduction of fishing effort in all fisheries to 75 per cent of the average level of effort in 2001–2004. However, this approach is overly simplistic as it unduly impacts those fisheries that are not causing a significant impact on either the bigeye or yellowfin stocks, particularly the fisheries outside of the equatorial regions where fishing mortality rates are low.

There are a wide range of potential management measures that could be introduced to achieve the recommended reductions in fishing mortality in these two stocks. The simplest approach is to identify the main fisheries responsible for these impacts and explore the range of effort reductions required to achieve the fisheries management target. For the purpose of this analysis, the target reference point was considered to be an overall fishing mortality rate equivalent to F_{MSY} (that is, the level of fishing mortality that will produce the maximum sustainable yield). However, the SC2 also recognises that the Commission may decide to maintain stocks at a level

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higher than B_{MSY} (that is, the equilibrium level of total biomass for a stock fished at the F_{MSY} level) and this would require fishing mortality to be at a corresponding level below F_{MSY} . Under that management objective, a larger reduction in overall fishing mortality would be required.

Methods

A wide range of potential management options for yellowfin and bigeye were investigated within the framework of the stock assessments presented at SC2. The analysis involved varying the fishing effort for four main fishery groups (longline, purse-seine associated sets, purse-seine unassociated sets, and Indonesian and Philippines fisheries) relative to a base-line level of effort ('base-line scenario'). The baseline effort was comparable to the effort series formulated for the projections undertaken in the two stock assessments (see Hampton et al. 2006a, 2006b). The projections also assumed equilibrium conditions, that is, long-term average recruitment, mediated by the stock recruitment relationship (SRR).

The outcomes of each management scenario were summarised by determining F/F_{MSY} , the change in fishery specific catch

(and catch per unit effort, or CPUE) relative to the base-line scenario, the change in maximum sustainable yield (MSY), and the corresponding (equilibrium) biomass level relative to the B_{MSY} level.

For the analysis, the base-line levels of fishing effort are defined as follows.

- Total purse-seine effort levels (days) equivalent to the 2004 level. The distribution of effort (days) among regions, quarters and set types was specified according to the average distributions for the period 2001–2004.
- Longline effort levels equivalent to the average of 2001–2004.
- Relative effort levels for the Philippines and Indonesian domestic fisheries at 2004 levels (due to increases in estimated effective effort for those fisheries during 2001–2004).
- For fisheries with estimated time-series variation in catchability, the estimated catchability for the last data year (2005) was assumed.

Projections were undertaken using multiples of the levels of effort for the four fishery groups: longline (LL), purse-seine associated sets (PS ASSOC), purse-seine unassociated sets (PS UNASSOC), and the Philippines/Indonesian fisheries (ID/PH).

Table 1 Multiples of base-line effort

Fishery group	Multiples of base-line effort
LL	0.50, 0.55, 0.60, 0.65, 0.70, 0.75, 0.80, 0.85, 0.90, 0.95, 1.0, 1.1*, 1.2*
PS ASSOC	0.50, 0.55, 0.60, 0.65, 0.70, 0.75, 0.80, 0.85, 0.90, 0.95, 1.0, 1.1*, 1.2*
PS UNASSOC	0.50, 0.55, 0.60, 0.65, 0.70, 0.75, 0.80, 0.85, 0.90, 0.95, 1.0, 1.1*, 1.2*
ID/PH	0.75, 1.0

* only undertaken for runs with ID/PH effort at 0.75.

This resulted in a total of 3,528 ($11 \times 11 \times 11 \times 1 + 13 \times 13 \times 13 \times 1$) different scenarios of effort in the projection period. Each scenario was undertaken for both bigeye and yellowfin.

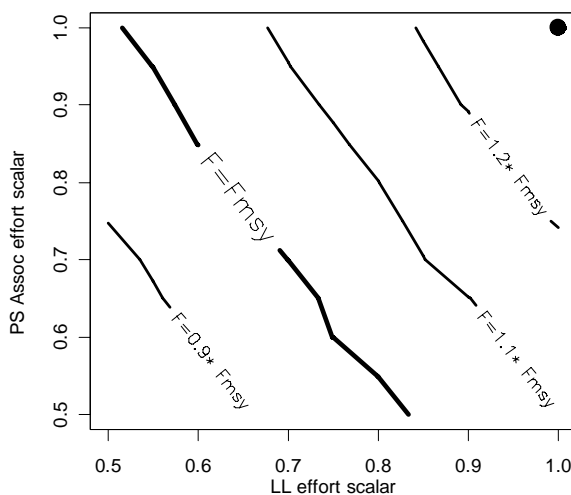
Summary and conclusions

The analysis generates a large amount of output and the results of individual runs can be examined in detail. However, this report focuses on the key outcomes of the analysis, in particular the performance of the various model scenarios were assessed relative to the main (assumed) fisheries management objective; that is, achieving a level of overall fishing mortality equivalent or below the F_{MSY} level.

Bigeye

- Bigeye tuna are not caught in purse-seine unassociated sets and, consequently, the level of purse-seine unassociated effort does not affect the overall level of fishing mortality for bigeye.
- For scenarios without a reduction in Indonesian/Philippines effort (effort scalar 1.0), a large (50+ per cent) reduction in effort of either longline or purse-seine associated effort is required to reduce exploitation rates to the F_{MSY} level (Figure 1).
- Considerably smaller reductions (30+ per cent) in effort for these two fishery groups are required to achieve F_{MSY} if effort in the Indonesian/Philippines fisheries is reduced by 25 per cent (effort scalar 0.75) (Figure 2).
- A wide range of effort scenarios applied to both the longline and purse-seine associated fisheries will achieve the F_{MSY} level. For example, at current levels of effort for the Indonesian and Philippines fishery, F_{MSY} can be achieved by effort

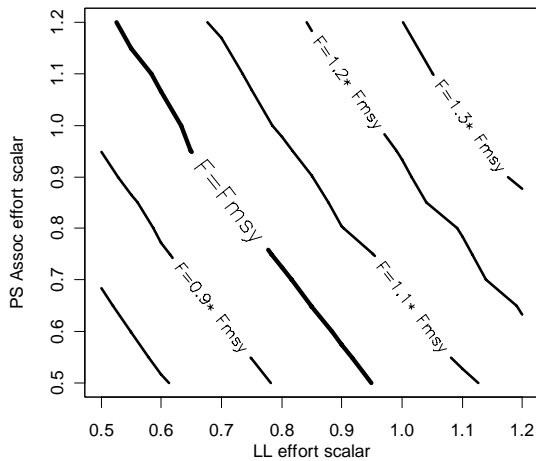
Figure 1 Total WCPO bigeye tuna fishing mortality rates relative to F_{MSY} for differing levels of longline and purse-seine (associated sets) fishing effort and recent Philippines and Indonesian effort levels.



Note: Effort is expressed as multiples of the baseline effort. Effort levels for the Philippines and Indonesian fisheries are held at the baseline level (1.0). The lines represent contours of fishing mortality relative to the F_{MSY} level of effort. The point represents the current effort level.

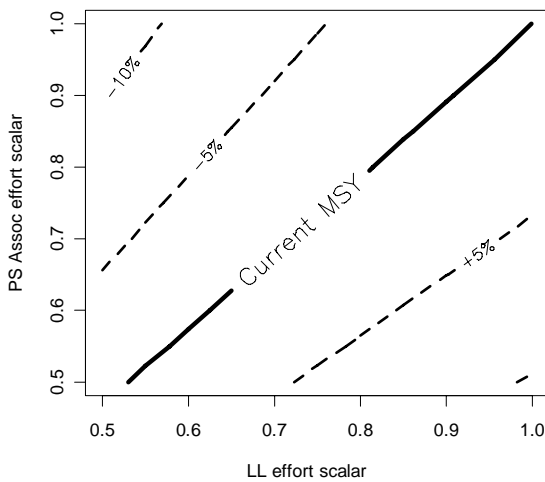
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Figure 2 Total WCPO bigeye tuna fishing mortality rates relative to F_{MSY} for differing levels of longline and purse-seine (associated sets) fishing effort and 75 per cent of recent Philippines and Indonesian effort levels



Note: Effort is expressed as multiples of the baseline effort. Effort levels for the Philippines and Indonesian fisheries are at 75 per cent of the recent level. The lines represent contours of fishing mortality relative to the F_{MSY} level of effort.

Figure 3 Changes in maximum sustainable yield (MSY) for the WCPO bigeye tuna fishery for differing levels of longline and purse-seine (associated sets) fishing effort and recent Philippines and Indonesian effort levels



Note: Expressed as the percentage difference from the MSY from the base-case assessment ('current MSY'). Effort is expressed as multiples of the baseline effort. Effort levels for the Philippines and Indonesian fisheries are held at the baseline level (1.0).

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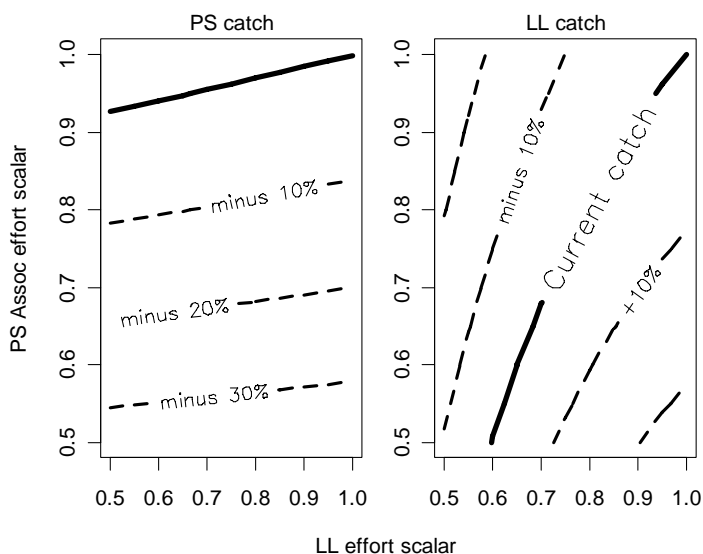
reductions of 45 per cent and 20 per cent in the purse-seine associated and longline fisheries, respectively. Alternatively, the same target can be achieved by effort reductions of 15 per cent and 40 per cent, respectively.

- At current levels of effort for the Indonesian and Philippines fishery, the level of Maximum Sustainable Yield (MSY) from the bigeye stock would be marginally increased by an increase in the total effort that is apportioned to the longline fishery, at the expense of the purse-seine associated fishery. This is evident from scenarios that include an effort reduction in the purse-seine associated fishery (Figure 3). Conversely, a proportional shift to purse-seine

associated effort will result in a marginal reduction in MSY from the stock.

- At current levels of effort for the Indonesian and Philippines fishery, the level of bigeye catch from the purse-seine fishery is predicted to decline with reduced levels of purse-seine unassociated effort (Figure 4). Declines in longline effort do not result in a significant increase in bigeye purse-seine catch.
- At current levels of effort for the Indonesian and Philippines fishery, decreases in longline effort result in declines in bigeye longline catch at current levels of purse-seine associated effort (Figure 4). However, current levels of bigeye longline catch are predicted to be achieved at lower levels of longline

Figure 4 Estimated change in purse-seine (left) and longline (right) catch for the WCPO bigeye tuna fishery at differing levels of longline and purse-seine (associated sets) fishing effort and recent Philippines and Indonesian effort levels



Note: Expressed as the percentage difference from the catches at obtained at the baseline level of fishing effort ('current catch'). Effort is expressed as multiples of the baseline effort. Effort levels for the Philippines and Indonesian fisheries are held at the baseline level (1.0).

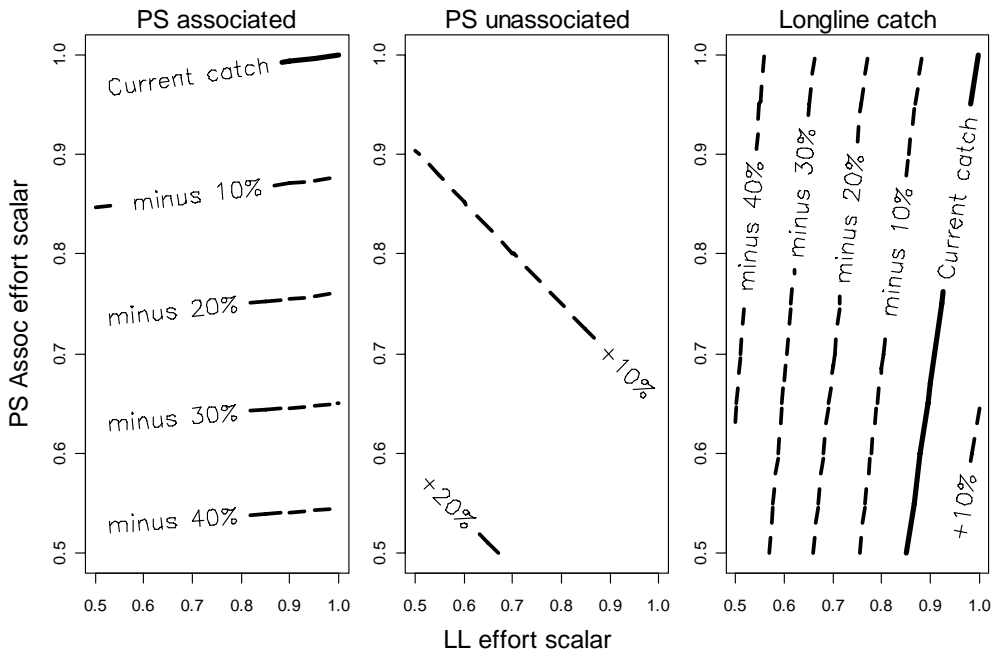
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effort (for example, 80 per cent of baseline effort) if corresponding reductions in effort are applied to the purse-seine associated fishery. This would result in a corresponding increase in bigeye longline CPUE. Significant (greater than 10 per cent) increases in longline catch (and CPUE) are achieved at current levels of longline effort if higher (greater than 40 per cent) reductions were applied to the purse-seine associated fishery.

Yellowfin

- Unlike bigeye, significant catches of (large) yellowfin are taken by purse-seine unassociated sets. Accordingly, this element of the fishery also needs to be considered in the range of effort scenarios considered for yellowfin tuna.
- A range of effort reductions were considered for the three fishery groups—longline, purse-seine associated, and

Figure 5 Change in yellowfin catch by purse-seine associated (left), purse-seine unassociated, and longline (right) from the WCPO yellowfin tuna fishery at differing levels of longline and purse-seine (associated sets) fishing effort and recent levels of purse-seine unassociated, Philippines, and Indonesian effort



Note: Expressed as the percentage difference from the catches obtained at the baseline level of fishing effort ('current catch'). Effort is expressed as multiples of the baseline effort. Effort levels for the purse-seine unassociated, Philippines and Indonesian fisheries are held at the baseline level (1.0).

purse-seine unassociated sets—at two levels of effort for the Indonesian and Philippines fisheries (0 per cent and 25 per cent reduction). For the scenarios with no effort reduction in Indonesia and Philippines, the target level of fishing mortality (F_{MSY}) is estimated to be achieved from a wide range of different effort scenarios. Compared to the two purse-seine fisheries, the reduction of longline fishing effort makes a smaller contribution to the overall fishing mortality for the WCPO stock.

- For scenarios that reduce Indonesian and Philippines effort by 25 per cent (0.75 of recent effort), the F_{MSY} for yellowfin is achieved at current levels of effort for the other three fisheries.
- An example of the change in yellowfin catch by fishery group for a range of effort scenarios is presented in Figure 5. The scenarios include the range of longline and purse-seine associated sets, while maintaining recent (base-line) effort levels for purse-seine unassociated sets and Indonesian and Philippines fisheries. Catches from both the purse-seine associated sets fishery and the longline fishery decline in proportion to the level of effort reduction. Declines in effort for both these fisheries result in an increase in predicted catch from the purse-seine unassociated set fishery.

Summary

The various scenarios included in the analysis enable a wide range of potential management options to be considered. The details of individual scenarios can be examined in further detail to assess the impact on individual fisheries as well as on the four fishery groupings. The various scenarios can also be applied to consider the impact of effort reductions achieved via a

range of mechanisms such as time and area closures. More complex scenarios can also be explored through this approach, although, as with all these analyses, it is assumed that there is no compensatory behaviour by the individual fisheries that may result in an increase in the effectiveness of the fishing effort.

Overall, all the management measures investigated that achieved the F_{MSY} for bigeye also resulted in levels of fishing mortality for yellowfin that were below the F_{MSY} level. Nevertheless, more sophisticated effort scenarios, such as those that divert purse-seine effort from associated to unassociated sets, may achieve the F_{MSY} target for bigeye, but may not result in a significant reduction in the overall level of fishing mortality for yellowfin.

References

- Hampton, J., Langley, A., Kleiber, P., 2006a. *Stock assessment of yellowfin tuna in the western and central Pacific Ocean, including an analysis of management options*, WCPFC SC2 SA WP-1, Manila, 7–18 August.
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