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Evaluation of proposed modification to Swordfish Harvest Strategy

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1 Introduction

At the previous Tropical Tuna Resource Assessment Group (TTRAG) meeting it was agreed that the extent of the persistent under-catch of the Broadbill Swordfish Total Allowable Catch (TAC) in the Eastern Tuna and Billfish Fisheries (ETBF) during the last several years triggered Exceptional Circumstances. As such, it was agreed that a modification to the currently adopted Broadbill Swordfish Harvest Strategy (HS) would be tested using Management Strategy Evaluation (MSE). The current HS implements a pre-specified mean ratio of catch-to-TAC which is well above recent levels.

The decline in the CPUE index used to inform the HS (broadbill sub-adults) in recent years appears to be primarily driven by recent low recruitment, which has only recently shown some signal of reversal. As a result, we might expect that it will take a number of years for the sub-adult index to respond to this increase in recruitment—if it does indeed eventuate. This lag between an observed increase in recruitment and the subsequent response of the sub-adult index means that the TAC could continue to decrease in the future given the recent low levels of the mean sub-adult CPUE. However, as the TAC is under-caught well below the level tested for in the initial HS MSE work, a modification to the HS was proposed considering the three following factors:

1. The HS is correctly attempting to reduce the overall catch (via the ETBF TAC) to improve the declining signal in the sub-adult CPUE
2. The current historically low ratio of catch-to-TAC is effectively doing the same thing the HS would try to do by reducing the TAC
3. If the recruitment level returned to historically normal levels but we still applied the HS (even with historically high TAC under-catch), we could end up with a future TAC that is much lower than if we did nothing with the current TAC and let the under-catch do the short-term job of the HS TAC reductions

2 Proposed Harvest Strategy modification

The 2021 TTRAG agreed that both the modification and testing details of the proposed augmented HS needed to be very specific, i.e., the modification needs to be able to deal with the low recruitment scenario without unduly reducing the TAC and future industry opportunities if better conditions do return. The modification to the HS was thus defined as follows:

- **If** the HS suggests a decrease to the TAC **during the extreme under-catch period** then:
    1. If the proposed TAC is **above** the low recent mean catch level **and** the required reduction in TAC is less than the difference between the current TAC and the low recent mean catch level: **maintain the TAC at the current level**
    2. If the proposed TAC is **above** the low recent mean catch level **but** the required reduction in TAC is more than the difference between the current TAC and the low recent mean catch level: **reduce the TAC only by the difference between the reduced TAC and the low mean recent catch level**
    3. If the current TAC has already been reduced **below** the recent mean catch level, the HS is applied in its current form but we assume the TAC is all taken—i.e., it is assumed that no more under-catch is taking place
- **If** the HS suggests an increase in the TAC **during the extreme under-catch period**, the

increase is applied but the low recent mean catch level is the catch actually taken given under-catch

- **If** we are outside the extreme under-catch period, the HS applies in the same way as it was adopted and originally implemented

The low recruitment scenario applies as follows: for the first four years after the last year of data (2016), mean recruitment is reduced to half of the estimated level, then returns to normal afterwards. The recent low mean catch level we assumed was 600 tons (an approximate of the last two years catches). We apply this low mean catch level for the 2022–2024 period and assume that general market conditions return to similar pre-COVID levels after this. The specifications of the overall MSE scenario are to test the modification of the HS; there are going to be different assumptions we could make that differ slightly from these settings. The point of this analysis is not to produce a detailed view of what *could* happen, but to explore whether the modification to the HS performs as expected given a plausible suite of scenarios for current fishery conditions eventually returning to a more normal-like state.

3 Results

The augmentation of the HS was added to the MSE software suite used previously [1] and the underlying suite of operating models (OMs) we used for the test were defined as:

- For fisheries we assumed the reference case scenario: the Northern Distant Water fishery in area 2 was removed
- The reference OM was assumed: 3 steepness values, a single natural mortality vector and zero movement across 165E longitude (the border between area 1 (ETBF area) and 2)
- The “CPUE tuned” HS parameters were used and the TAC is changed every year with a 10% maximum change, both up and down
- Both HS’s are implemented from 2022 to 2030, with 2021 the last year with observed catch data

The two scenarios explored are: (i) assume no modification to the HS *or* continued extreme under-catch of the TAC and simply update the catch and CPUE data; and (ii) simulate the modified HS for the same updated data. Figures 3.1 and 3.2 display the overall summaries for current and modified Swordfish HS, respectively. Figure 3.3 compares the current and modified HS for catch take, TAC and overall SSB depletion.

The focus of this work is to see if the modified HS can avoid long-term reductions in TAC under a low recruitment scenario, given the current low catch levels compared to the TAC effectively implement a TAC reduction. Figure 3.3 compares the current and modified HS for key metrics (catch, TAC, and spawning stock biomass (SSB) depletion). In terms of catch taken, for the current HS we see an initial increase in the catches (recall we assume that there is no special low catch period here just for comparison’s sake) but a steady decline in catch as the TAC decreases while the low recruitments fully make their way through and beyond the sub-adult age range. For the current HS the TACs settle at a median of around 800-850 tonnes from 2024 onwards. For the modified HS, because the recent low catch levels (assumed to be 600t from 2022–2024) are lower than the TAC reductions coming from the harvest control rule the TAC is not reduced during this time. In fact the median TAC stays at the current level and remains above the median levels predicted by the current TAC with a high (approximately 90%) probability into

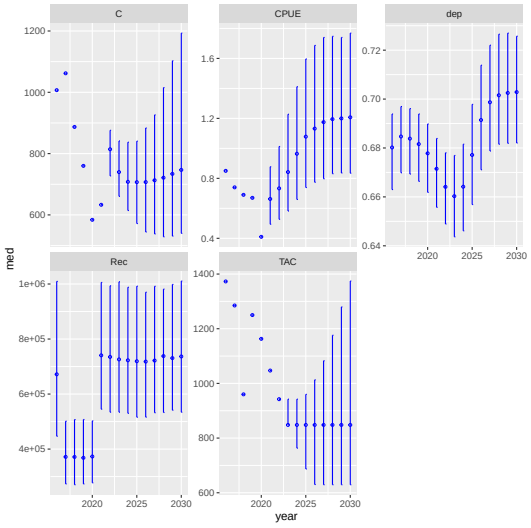

Figure 3.1: *Summary (median and 90%CI) of the current HS for the updated catch (C), CPUE, SSB depletion (dep), recruitment (R) and TAC for the reference OMs on the low recruitment robustness test.*

the future–even when we assume the low catch period ceases from 2025 onwards. The SSB depletion levels are very similar for both cases. For the current HS they are slightly lower (2022–2025 catches are higher) until around 2028 when the higher post-2024 catches for the modified HS have an impact, but the differences overall remain small.

4 Summary

The modification to the Broadbill Swordfish HS appears to perform as expected–at least for the specific MSE testing scenario the TTRAG agreed to explore. The current low catch levels (assumed to cease from 2025 onwards) effectively do the job of the current HS in dealing with the low recruitments without reducing the TAC at the same time. The higher TACs and catches in the post-2025 period do not appear to be causing more rapid depletion of the SSB by at least 2030.

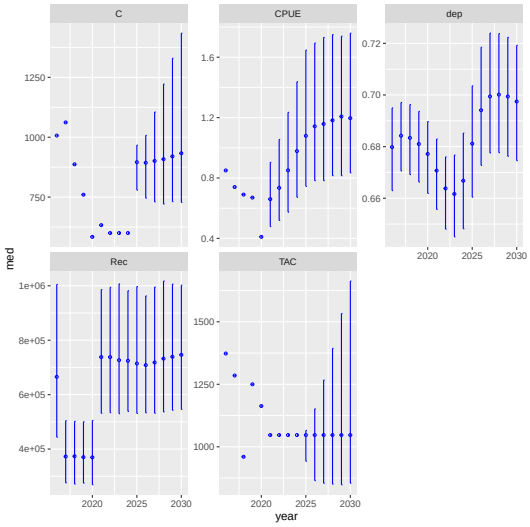

Figure 3.2: *Summary (median and 90%CI) of the modified HS for the updated catch (C), CPUE, SSB depletion (dep), recruitment (R) and TAC for the reference OMs on the low recruitment robustness test.*

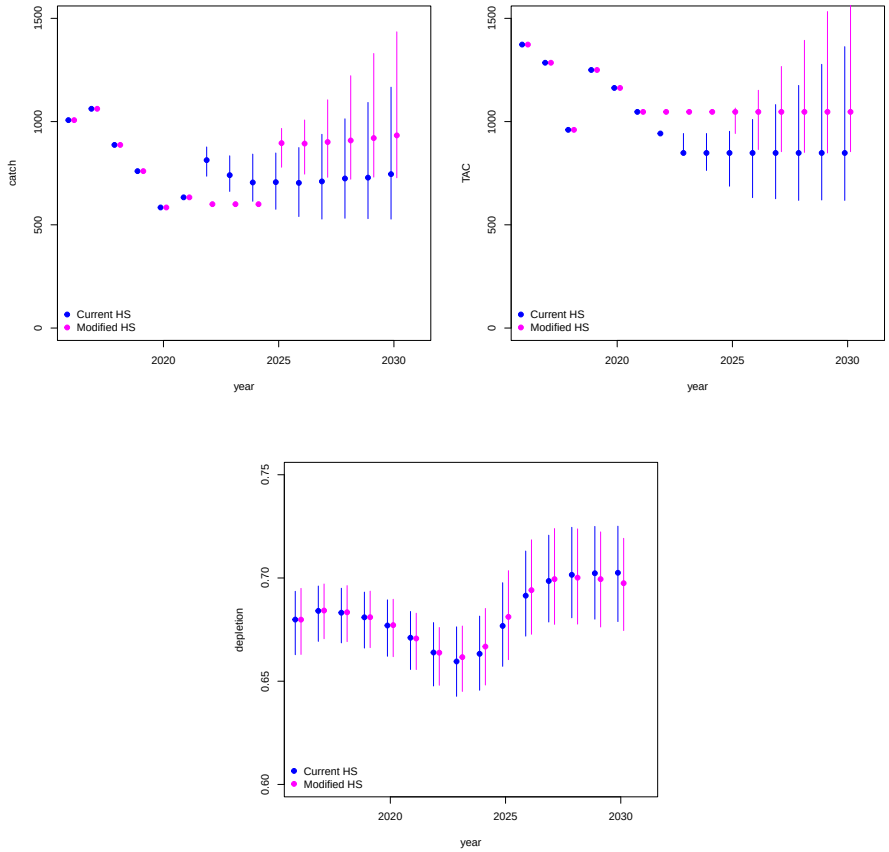

Figure 3.3: *Median (points) and 90%CI for the current (blue) and modified (magenta) HS for catch taken (top left), TAC (top right), and overall SSB depletion (bottom).*

References

[1] Hillary, R.M. (2020) Management Strategy Evaluation of the Broadbill Swordfish ETBF harvest strategies. *TTRAG* March 2020.

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