Updates to the Estimation Method for Bigeye Tuna in the WCPO

WCPFC-SC22-2026-MI-WP-02

SPC-OFP

SC22 is invited to:

- Consider the results of the proposed estimation method for the bigeye tuna management procedure, noting the improvements gained over the results presented to SC21, and
- Endorse the use of the proposed estimation method within the bigeye tuna management strategy evaluation design and testing.

Previous Work

SC21 "*endorsed the general approach of using an ASPM for the EM but made a number of technical suggestions for consideration in future work to refine the EM (e.g., model settings for sigma R, natural mortality, steepness, construction of CPUE indices) for further analysis, including re-evaluation of the EM under any expanded OM grid and taking into account the outcomes of agenda item 5.1.3.1.*"

The outcomes of agenda item 5.1.3.1 refer to the development of additional sources of uncertainty in the OMs.

Updates

Several improvements, as recommended by SC21, were made to the estimation method including:

1. Updated OMs as described in Scott et al (2026) MI-WP-01,
2. Stronger support for the coefficient of variation (CV) of catch-per-unit effort (CPUE) indices,
3. Increased recruitment deviation variation ($\sigma_R = 0.6$),
4. Placed normal priors on natural mortality and steepness, and
5. Used selectivity patterns estimated with a single-region model,

1. Updated OMs

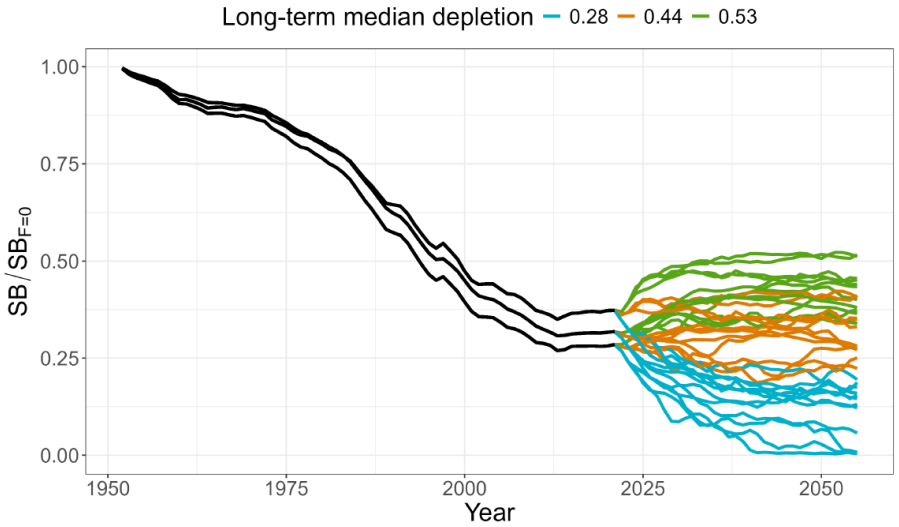

Figure 1: Simulated historical and projected bigeye tuna spawning biomass relative to unfished spawning biomass ($SB/SB_{F=0}$) of three example models from the OM set. Each projected trajectory is coloured by the long-term median depletion achieved across all OMs.

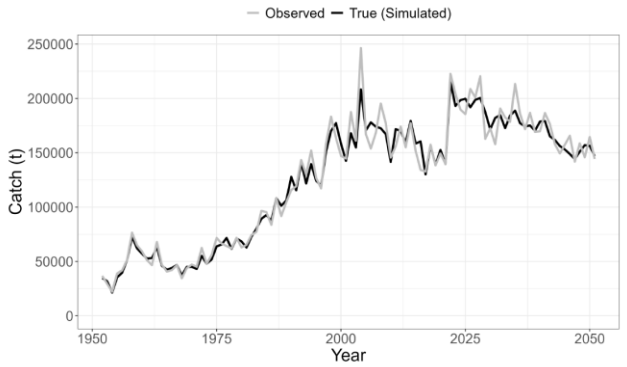

Figure 2: Illustrative example of true catch from the simulated population and observed catch provided to the EM.

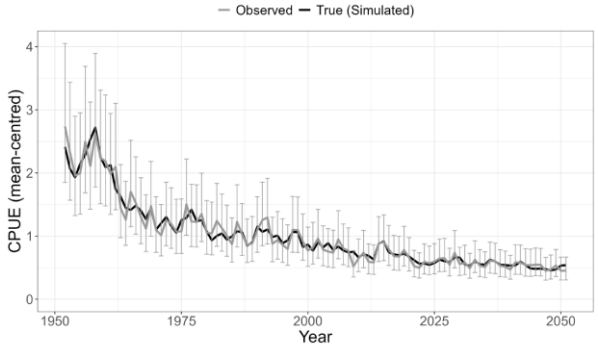

Figure 3: Illustrative example of true catch-per-unit-effort (CPUE) from the simulated population and observed catch-per-unit-effort provided to the EM. Error bars show the 95% confidence interval provided to the EM.

2. Stronger support for the CV of CPUE indices

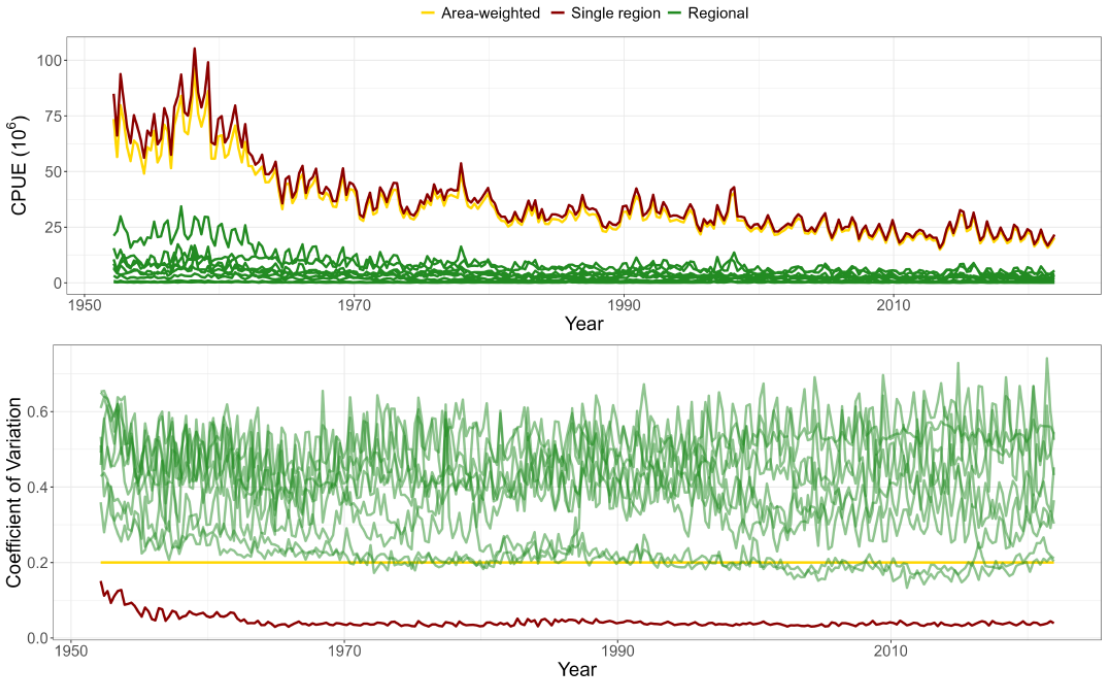

Figure 4: Coefficient of variation resulting from different CPUE methods. The area-weighted method aligns with the observations from the simulation. The single region method is the result from the sdmTMB model. The regional method produces indices for each model region from the sdmTMB model with CVs adjusted via MLE regression.

3. Increased recruitment deviation variation ($\sigma_R = 0.6$)

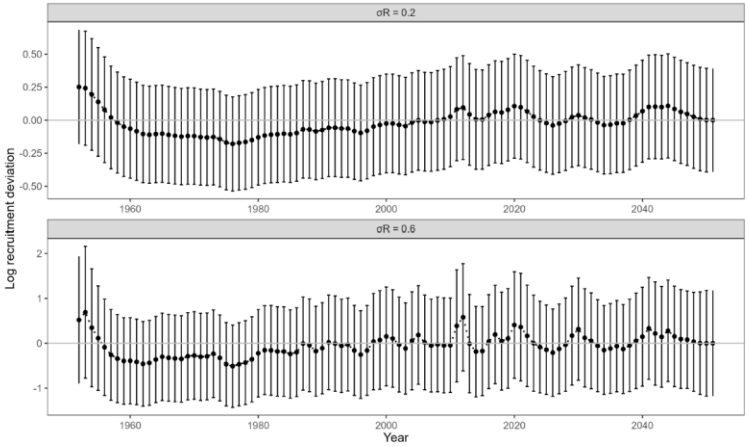

Figure 11: Illustrative estimates of recruitment deviation with different variation parameter σ_R.

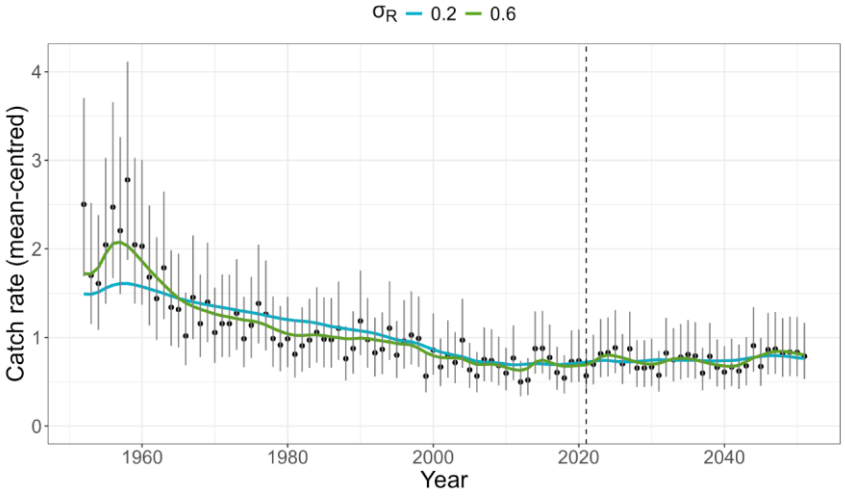

Figure 12: Illustrative fit to truncated CPUE data from EM with $\sigma_R = 0.2$ and $\sigma_R = 0.6$.

4. Placed normal priors on natural mortality and steepness

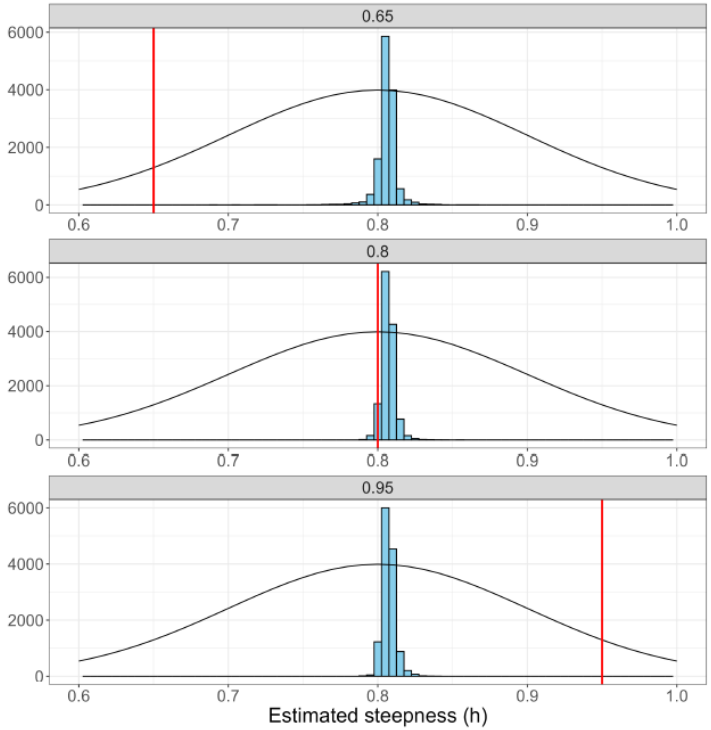

Figure 13: Estimated steepness (h) from all EM evaluations compared to the 'true' value (red line) and the prior (black curve).

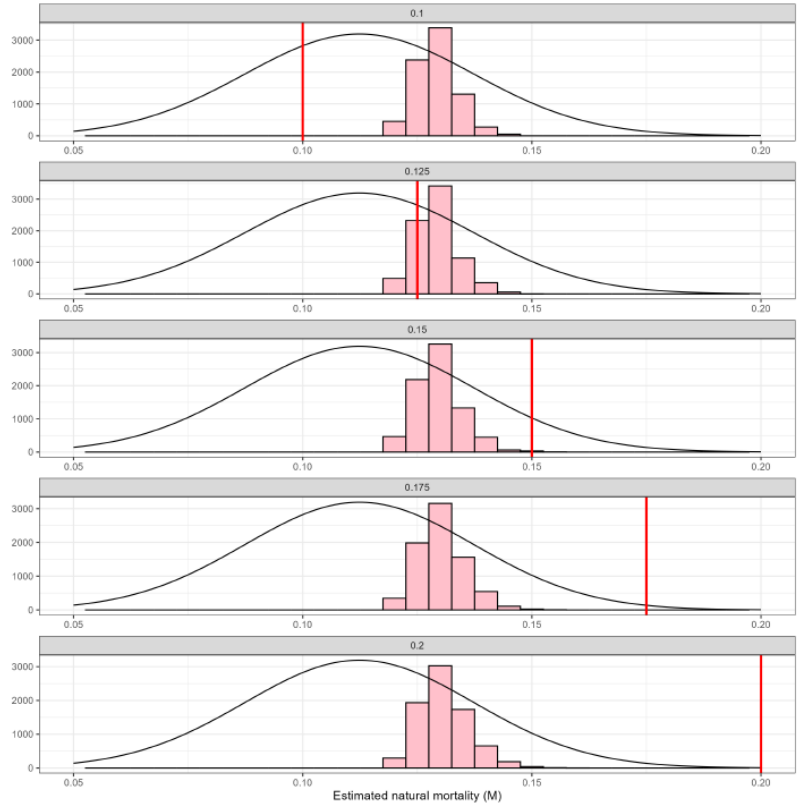

Figure 14: Estimated asymptotic natural mortality (M) from all EM evaluations compared to the 'true' value (red line) and the prior (black curve).

5. Used selectivity patterns estimated with a single-region model

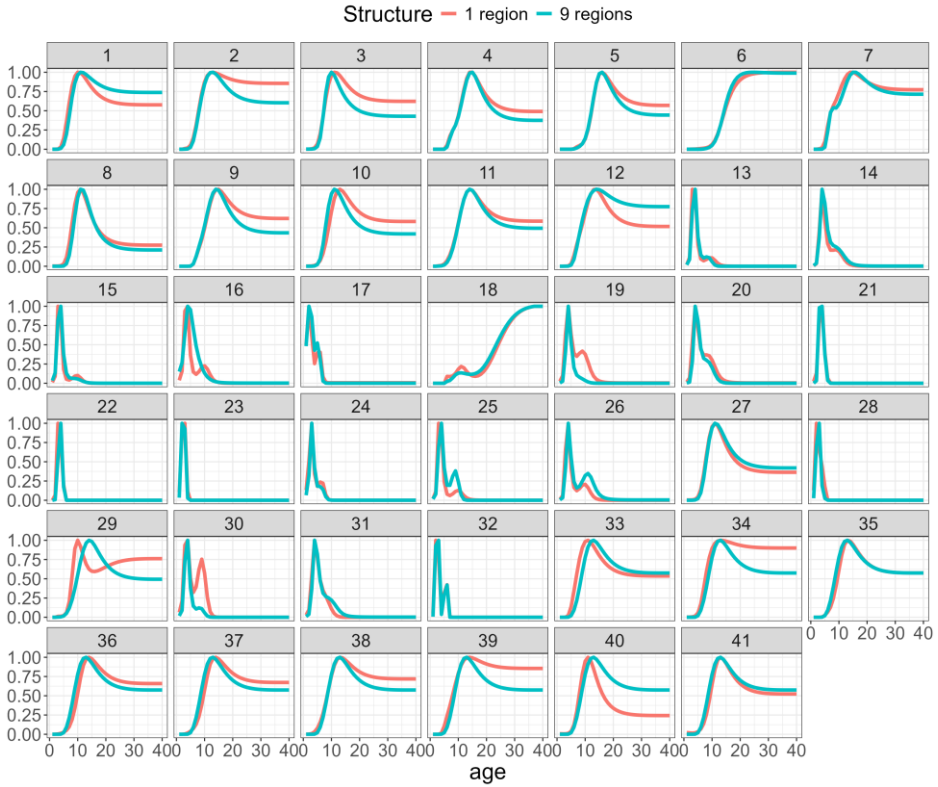

Figure not presented in report MI-WP-02. Comparison of fishery selectivities estimated with a 9-region and single-region conditioning model.

Results

The updates to the EM demonstrated:

- A higher convergence rate (< 0.1% models finished with mgc > 0.001),
- Little sensitivity to initial conditions,
- Recovery of the stock status with improved accuracy across a wider range of terminal depletions,
- Less bias.

The model was able to detect changes in biomass, even when the stock was at or below the limit reference point.

The proposed EM metric ($SB/SB_{2012-2015}$) had a reasonable R^2 value of 0.76 from the linear model fit to the estimated and true stock status metric.

Results Continued

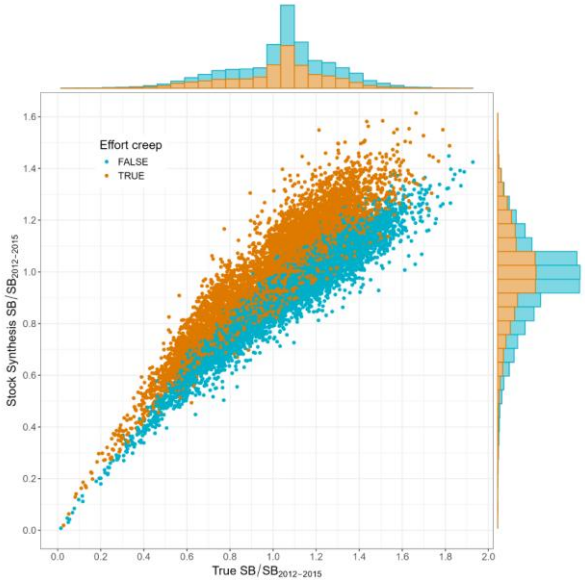

*Figure 8: Comparison of 'true' OM stock status and estimate of stock status from SS3 using $SB/SB_{2012-2015}$ coloured by whether **effort creep** was included in the projection.*

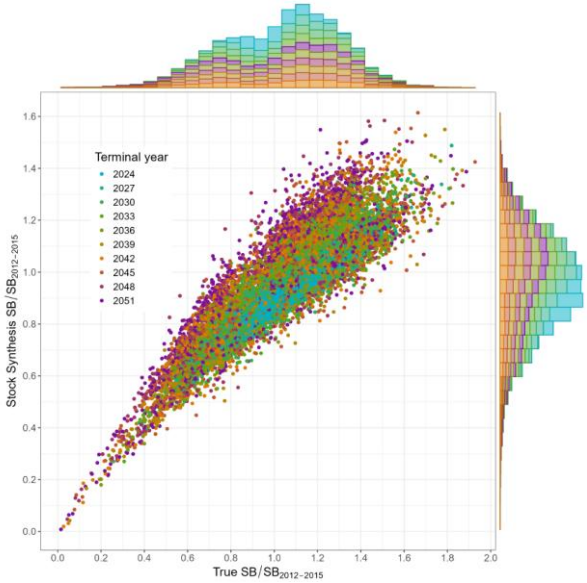

*Figure 9: Comparison of 'true' OM stock status and estimate of stock status from SS3 using $SB/SB_{2012-2015}$ coloured by the **last year** of data supplied to the EM.*

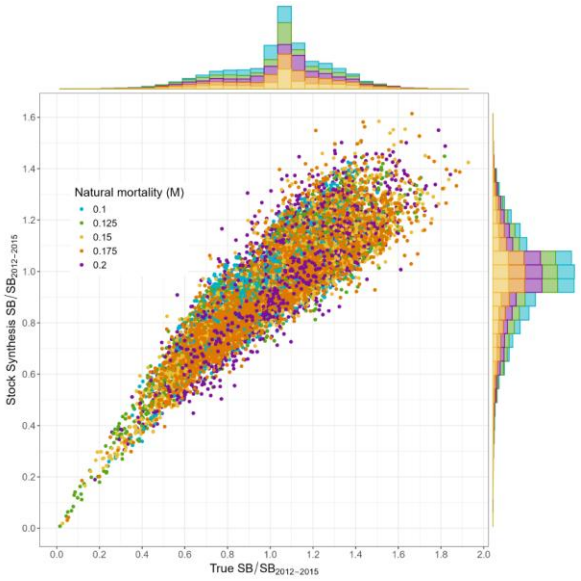

*Figure 10: Comparison of 'true' OM stock status and estimate of stock status from SS3 using $SB/SB_{2012-2015}$ coloured by the true **natural mortality** of the OM.*

Future Considerations

The WCPFC harvest strategy workplan schedules the adoption of the bigeye tuna MP by the end of 2026 and the MP run in 2027.

The EM requires annual catch for all fisheries and operational data for longline CPUE indices.

Developments to the EM will go through the monitoring strategy.

Conclusion

SC22 is invited to:

- Consider the results of the proposed estimation method for the bigeye tuna management procedure, noting the improvements gained over the results presented to SC21, and
- Endorse the use of the proposed estimation method within the bigeye tuna management strategy evaluation design and testing.

We gratefully acknowledge funding for this work from the New Zealand Ministry of Foreign Affairs and Trade (MFAT) funded project "Sustainable Pacific Fisheries".