Pacific Community
Communauté du Pacifique

Operating Models for Yellowfin Tuna in the WCPO

WCPFC-SC22-2026-MI-WP-05

SPC-OFP

SC22 is invited to:

- Note that the reference set of OMs reflects the most important sources of uncertainty and plausible states of nature for WCPO yellowfin tuna,
- Agree the reference set of OMs as the basis for evaluating yellowfin outcomes under the WCPFC mixed fishery harvest strategy framework, and
- Provide guidance on additional robustness and sensitivity testing, and
- Note that work will continue in the longer-term to further develop the OMs and this can be managed through an agreed monitoring strategy.

Previous Work

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SC21 recommended that the yellowfin OMs be

"constructed around the 2023 stock assessment grid, consistent with the approach used for the other key tuna species. Additionally, it was recommended that the proposed OM grid be expanded to also take into account similar additional uncertainties as suggested for the bigeye OM grid, as well as recommendations from the past tuna assessment peer reviews."

SC21 identified eight areas of uncertainty for further consideration in the bigeye OM grid (Table 1).

Table 1: List and priorities of uncertainties to be considered in bigeye tuna and yellowfin tuna operating models.

Uncertainty	Priority	Timing
Growth	High	Short (preferably by 2026)
Natural mortality	High	Short (preferably by 2026)
Movement dynamics	High	Short (preferably by 2026)
Hyperstability in CPUE	High	Short (preferably by 2026)
Variability in recruitment	High	Short (preferably by 2026)
Spatial structure	High	Long
Uncertainty in domestic catch level	High	Long
Effect of climate change	High	Long

Previous Work Continued

The 54-model grid from the 2023 assessment contained different settings for the **steepness** of the stock recruitment relationship, **weighting of the size composition data and conditional age-at-length data**, and **tag mixing period**.

Within the 2023 stock assessment grid, steepness and tag mixing period were most influential on stock status ($SB/SB_{F=0}$) so these uncertainties were retained for the OMs.

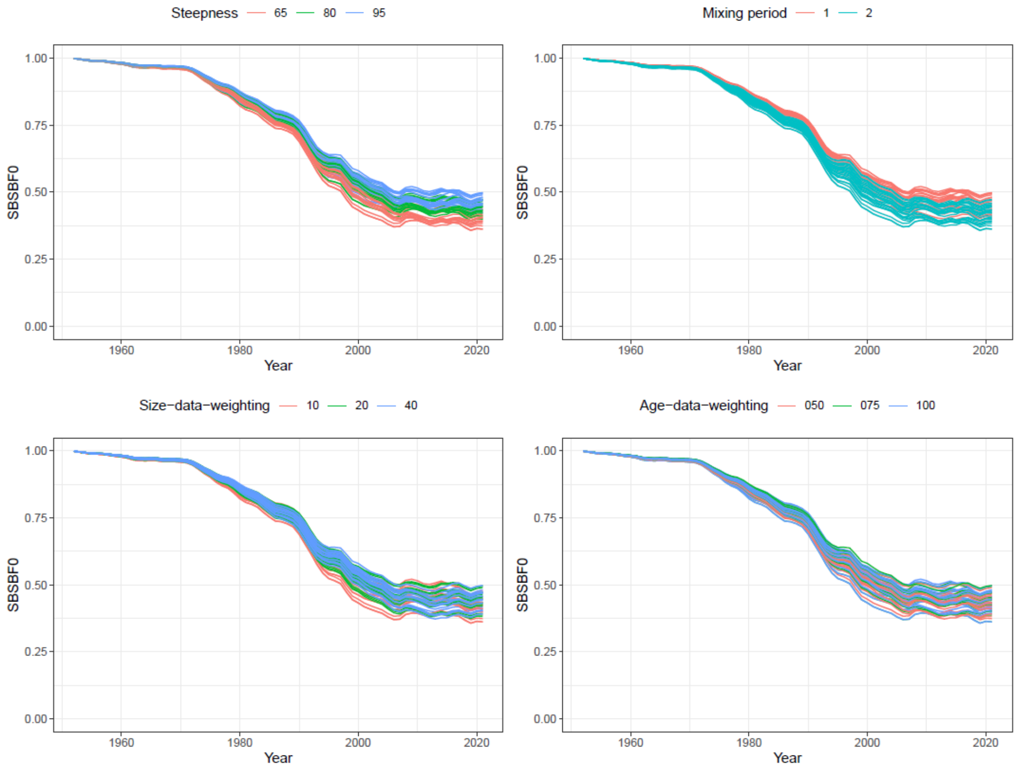

Figure 4: Impact of uncertainties from the 2023 stock assessment grid on depletion ($SB/SB_{F=0}$).

Growth

Over 300 new age-length samples.

The data supported a narrow range of plausible growth models.

The OMs use the two most different growth models:

1) the mean growth estimated in the 2023 stock assessment, and
2) the growth model estimated by Farley et al. (2020).

These parameters were fixed in the OM grid.

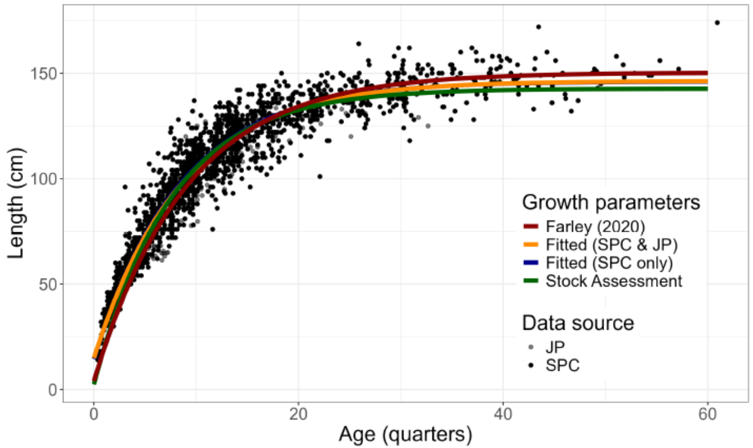

Figure 1: Alternative growth models for yellowfin tuna determined from a range of sources

Natural Mortality

In the proposed OM set, three values of natural mortality were used:

- 0.173 from the 2023 stock assessment,
- 0.25 from the 2020 stock assessment, and
- 0.2 as a plausible middle ground.

The corresponding Lorenzen parameter was set to maintain the Lorenzen relationship between natural mortality and growth.

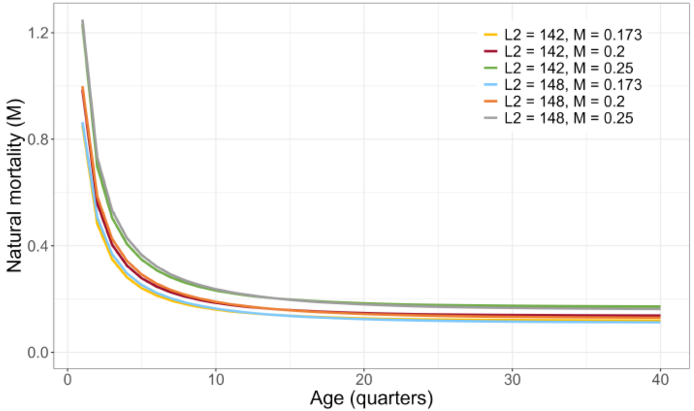

Figure 2: Natural mortality-at-age resulting from six combinations of growth and natural mortality. L2 is the mean length of the oldest age class and M is the mean natural mortality across length classes.

Recruitment Variability

Since it is unclear what overall level of recruitment may occur in the future, two options were considered and included in the OM grid

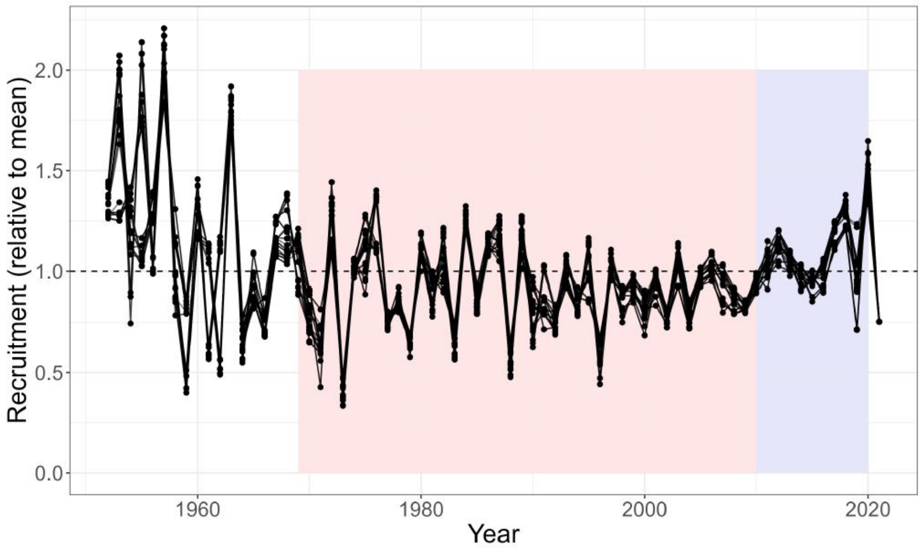

Figure 9: Recruitment relative to the mean recruitment for 36 OMs. Shaded regions show the sampling period for the long term (1969–2020) and short term (2010–2020) recruitment used for the projections.

Results: Depletion

- The 2023 yellowfin stock assessment grid resulted in a depletion range of **36.2% to 49.8%** in 2021.

- The set of proposed yellowfin OMs resulted in a depletion range of **34.8% to 54.3%** in 2021.

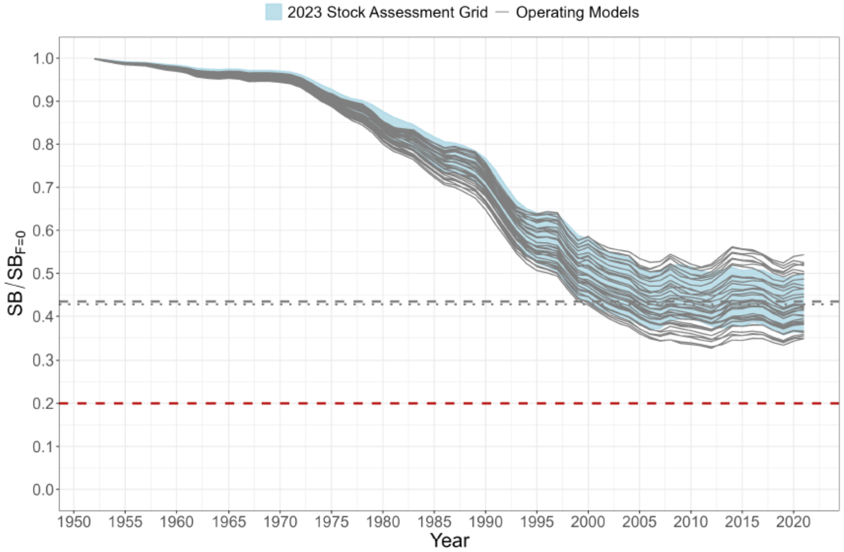

Figure 5: Relative depletion (SB/SB_{F0}) of the 36 OMs (grey lines) compared to the 2023 stock assessment grid (blue shaded). Horizontal dashed lines show the LRP (red) and the average of 2012 to 2015 depletion for the OM grid (dashed) and the average of 2019 to 2021 depletion for the OM grid (dotted).

Results: Fit to data

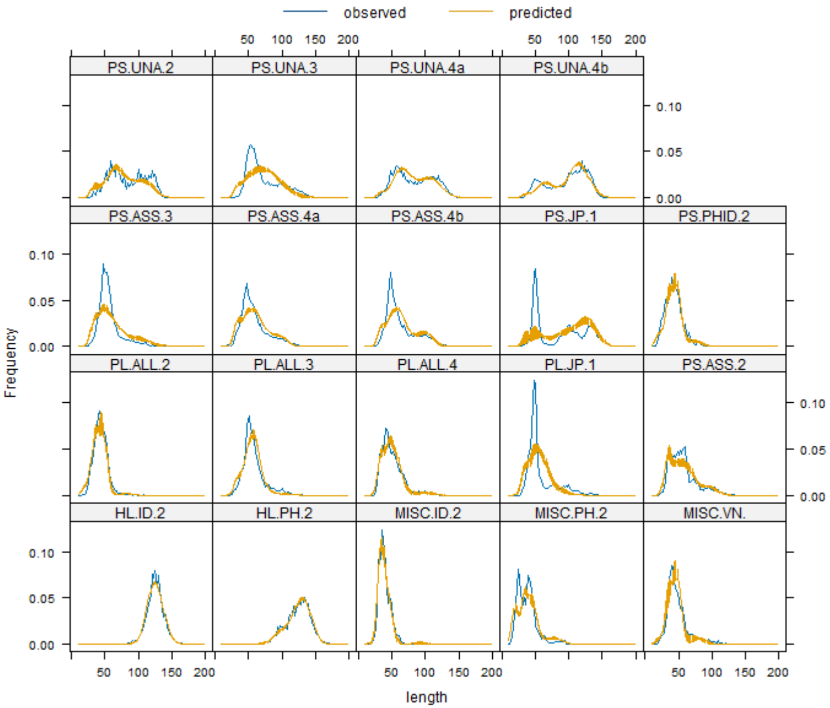

Figure 13: MFCL fit to length composition data across all yellowfin OMs.

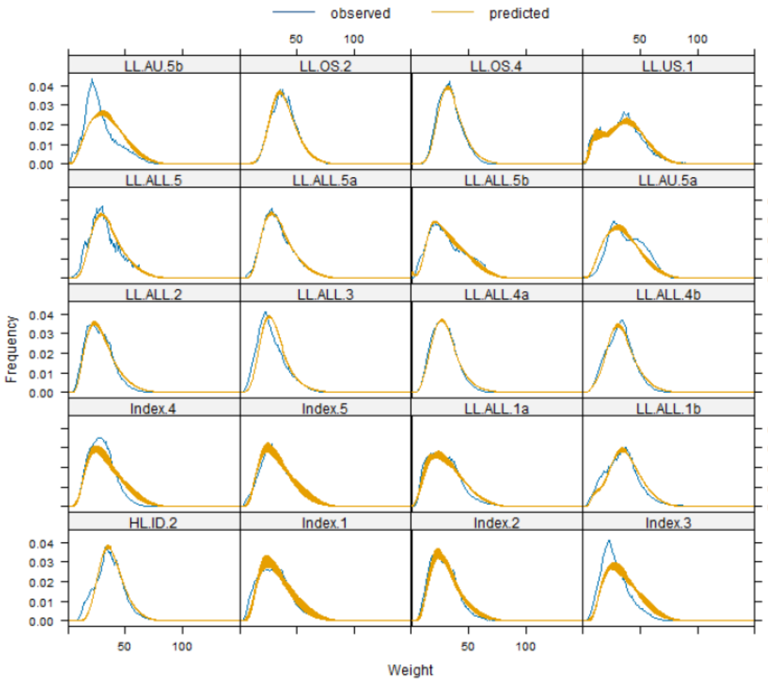

Figure 14: MFCL fit to weight composition data across all yellowfin OMs.

Results: Fit to data

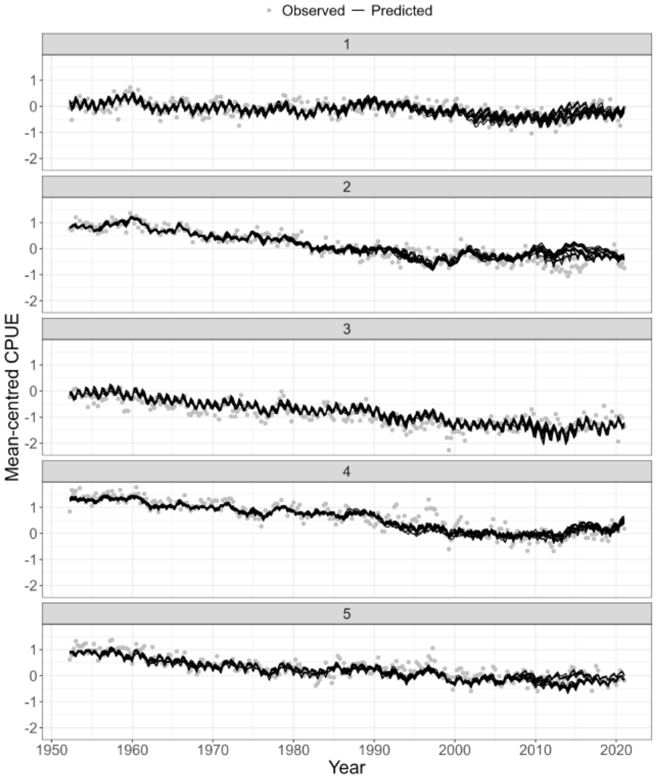

Figure 12: CPUE fit for the longline index fleets in each region of all yellowfin OMs

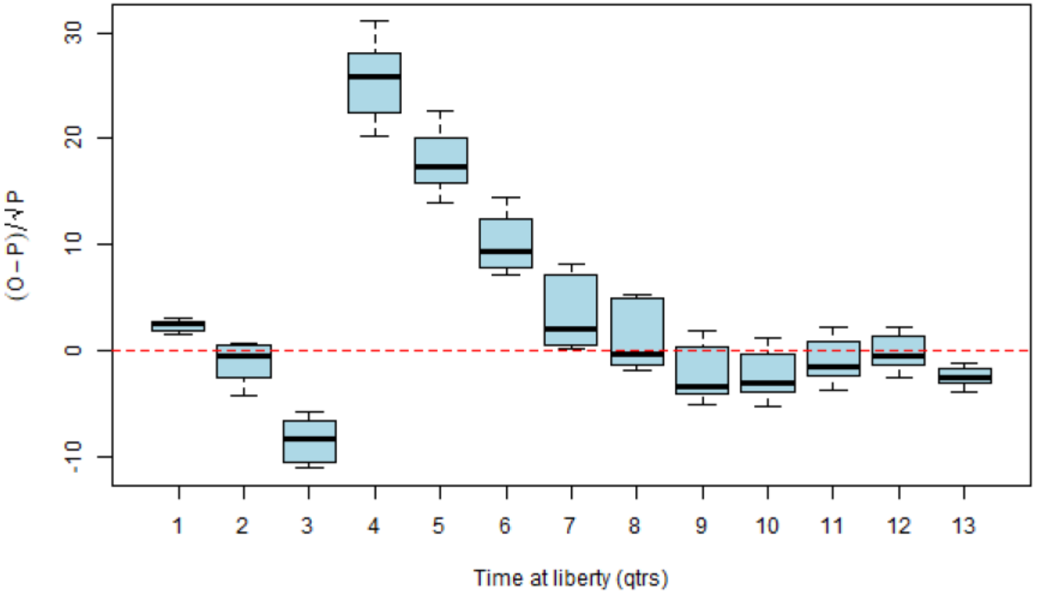

Figure 18: Standardised residuals for tag recapture estimates with time at liberty across the OM set (36 models).

Results: Likelihood profile

The likelihoods profiles indicate conflicts within the data which have not been resolved.

In OM4, weight composition data conflicts with length composition data.

In OM31, weight and length compositions align but tagging data conflicts.

OM	Lmin	Lmax	k	M	h	tmix
4	19.8	141.96	0.13	0.17	0.80	2
31	19.3	148.50	0.11	0.25	0.65	1

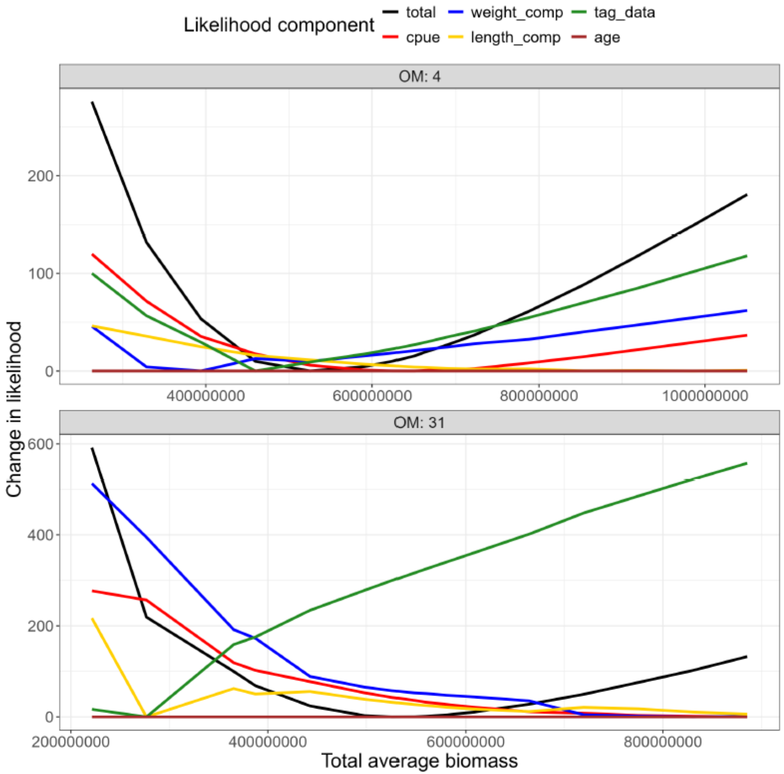

Figure 20: Likelihood profiles of OM4 and OM31.

Sensitivity Scenarios

Four sensitivity scenarios were run to investigate the model's sensitivity to plausible scenarios not included in the OM set:

- Earlier maturity
- Gear allocation of Indonesian domestic catch
- Increased Indonesian domestic catch
- Longer tag mixing.

The sensitivity scenarios explored in this report indicated relatively little impact on estimates of depletion for the stock as a whole.

The relative stock status of the scenarios run with a 3-quarter tag mixing period was generally less depleted than the OM reference set.

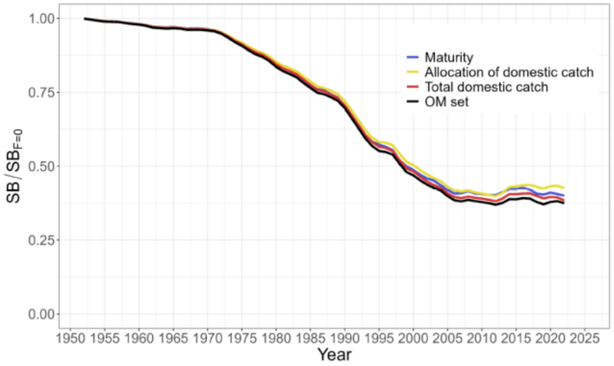

Figure 22: Biomass depletion from sensitivity models compared to the equivalent model from the OM set.

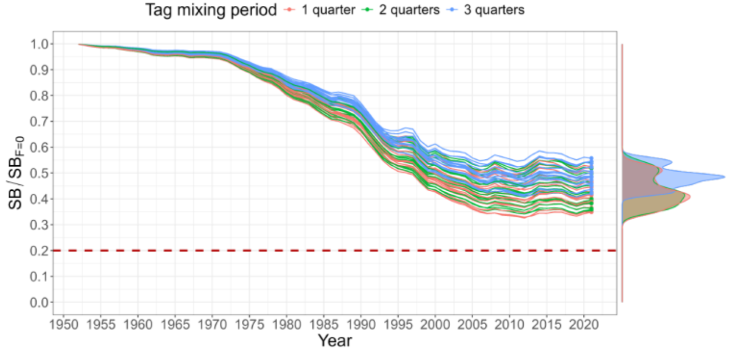

Figure 28: Relative depletion ($SB/SB_{F=0}$) of the 18 additional models run with a 3 quarter tag mixing period compared to the OM set with a 1 quarter and 2 quarter tag mixing period.

Further Work

Additional sources of uncertainty have been identified that should be considered for future inclusion in the OM grid. These include:

- alternative spatial structures and movement dynamics;
- recruitment distribution,
- assumptions on population biology including reproductive potential,
- climate change scenarios.

Additional sensitivity and robustness scenarios can also be developed.

Furthermore, the 2026 stock assessment for yellowfin may inform additional uncertainties to be included in the OM grid.

Conclusion

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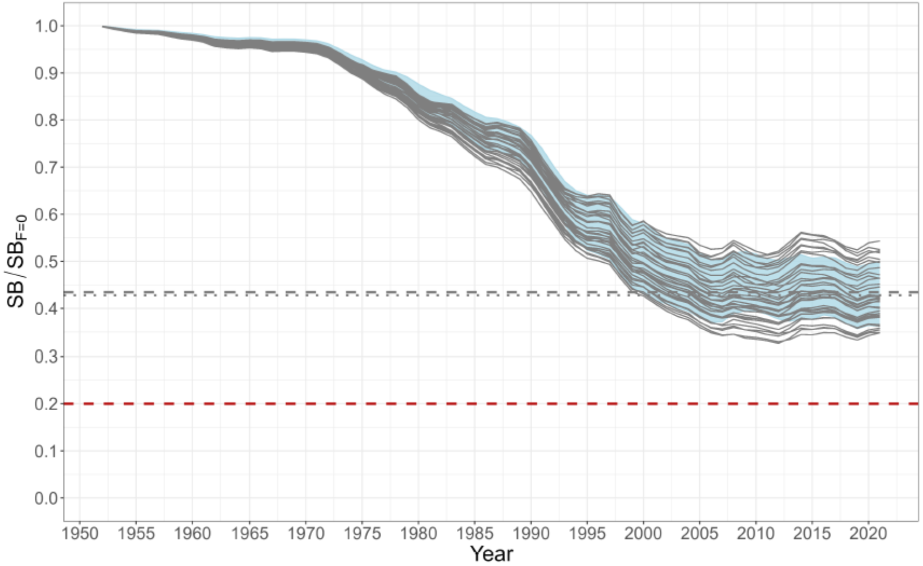
We gratefully acknowledge funding for this work from the New Zealand Ministry of Foreign Affairs and Trade (MFAT) funded project "Sustainable Pacific Fisheries".

Comparison to 2026 Stock Assessment

OMs & 2023 Stock Assessment



2026 Stock Assessment