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SOUTH PACIFIC ALBACORE MANAGEMENT PROCEDURE: 2026 MP RUN

WCPFC-SC22-2026-MI-WP07
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Submitted by N. Yao[1], R. Scott[1], F. Scott[1], A. Dabea[1], G. Pilling[1]

[1] Oceanic Fisheries Programme, The Pacific Community

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Executive Summary

The South Pacific albacore (SPA) management procedure (MP) was run using updated data through 2024, in accordance with the agreed Conservation and Management Measure (CMM2025-01). The Pacific Community (SPC), as the Scientific Services Provider, implemented the agreed estimation method (EM) and applied the adopted harvest control rule (HCR) to define fishing levels for the period 2027–2029 for SC22's technical review.

The EM converged successfully, with no major diagnostic issues identified. The estimated relative stock status metric (defined as the mean $SB/SB_{F=0}$ over the most recent three years (2022-2024) relative to the 2017–2019 reference period) was 1.2698. Application of the HCR resulted in a catch limit of 56,096 mt.

The meta-rules specify that the catch limit may not increase by more than 10% or decrease by more than 5% relative to the most recent catch. For the first implementation of the MP, this reference year is 2024. These meta-rule constraints were not necessarily applied in this case.

The resulting catch limit of 56,096 mt applies to longline and troll fisheries operating south of 10°S in the WCPFC-CA, excluding those operating within the EEZs of Tokelau and Tuvalu.

All required input datasets were available and consistent with expectations under the MP testing framework. No exceptional circumstances were identified. However, ongoing issues relating to CPUE representativeness and spatial coverage remain relevant for consideration within the monitoring strategy, and are discussed further in the WCPFC South Pacific albacore monitoring strategy report.

We invite SC22 to:

- note the results of the estimation method and the output of the HCR with respect to the scheduled implementation of the South Pacific albacore MP, which indicate the annual total catch in the WCPFC-CA south of 10°S for the period 2027-2029 should be set at 56,096 mt.
- provide additional feedback as necessary through the SPA MP monitoring strategy.
- provide advice to WCPFC23 based upon the outcomes presented in this paper.

1 Introduction

Following the adoption of the South Pacific albacore management procedure (MP) by WCPFC22 (CMM2025-01), SPC was tasked with running the MP in 2026, with implementation of the resulting management measures scheduled for 2027. The objective of this paper is to document the MP run using the most recent data (updated to include 2024), assess the consistency of inputs and procedures, and provide information to support SC22 review and advice to WCPFC23.

The MP is a pre-agreed, simulation-tested procedure linking observed data (via the estimation method, EM) to management action (via the harvest control rule, HCR), ensuring consistent and transparent decision-making.

The South Pacific albacore EM relies on input data comprising catch information and standardised CPUE indices. These inputs evolve over time due to the accumulation of new data and re-standardisation of the CPUE time series, which may influence estimated stock status. Identifying and evaluating such changes, and their impacts, is a key component of the South Pacific albacore MP monitoring strategy (SPC-OFP, 2026).

This paper updates the analysis using data updated to include 2024, following the procedures specified in the CMM2025-01. A dry run of the MP was conducted last year and presented to WCPFC22 to demonstrate the procedures for running the EM and applying the HCR (SPC-OFP, 2025). Relative to the dry run, the updated inputs reflect routine data additions and revisions, including updates to CPUE indices. In addition, a containerised workflow has been adopted to ensure reproducibility, addressing previous issues associated with software and package updates in the CPUE analyses.

2 Flowchart of the Management Procedure

The South Pacific albacore MP run follows a structured three-step workflow (Figure 1). In Step 1, Pacific-wide operational longline data are used to generate standardised CPUE indices and associated coefficient of variation (CVs), alongside catch data extracted from the SPC database. In Step 2, these inputs are combined to construct the `.frq` file, which defines the data inputs for the estimation method (EM). In Step 3, the EM is run using this input file to estimate stock status, which is then passed to the adopted HCR (CMM2025-01). The HCR applies the pre-agreed decision rule to derive an overall catch limit, representing the MP output for management implementation.

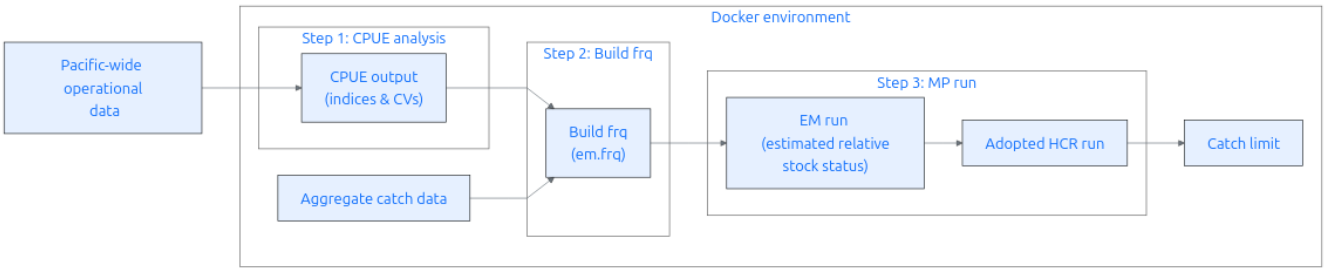

Figure 1: Flowchart of the South Pacific albacore management procedure run.

The EM was consistent with the configuration used during MP development and testing, as specified within CMM2025-01 (Appendix Table 2). To support reproducibility, all components of the workflow—excluding confidential operational CPUE data—are implemented within a containerised environment. Due to data access restrictions, operational data are stored on a secure system with limited access and are therefore not included in the container, while all other processing steps and code are accessible from ofp-sam-alb-MP.

3 Estimation Method Input Data

Data inputs for the EM comprise fishery-specific catch data for the period 1954–2024 and operational longline data over the same period for CPUE standardisation. These inputs are organised using the quarterly temporal stratification, two-region spatial structure (Figure 2), and fishery definitions (Table 1) defined by the 2024 South Pacific albacore assessment (Teears et al., 2024). The resulting input files provide the catch and abundance-index information required to run the EM. Details of the fixed model configuration and fitting procedure are provided in the appendix.

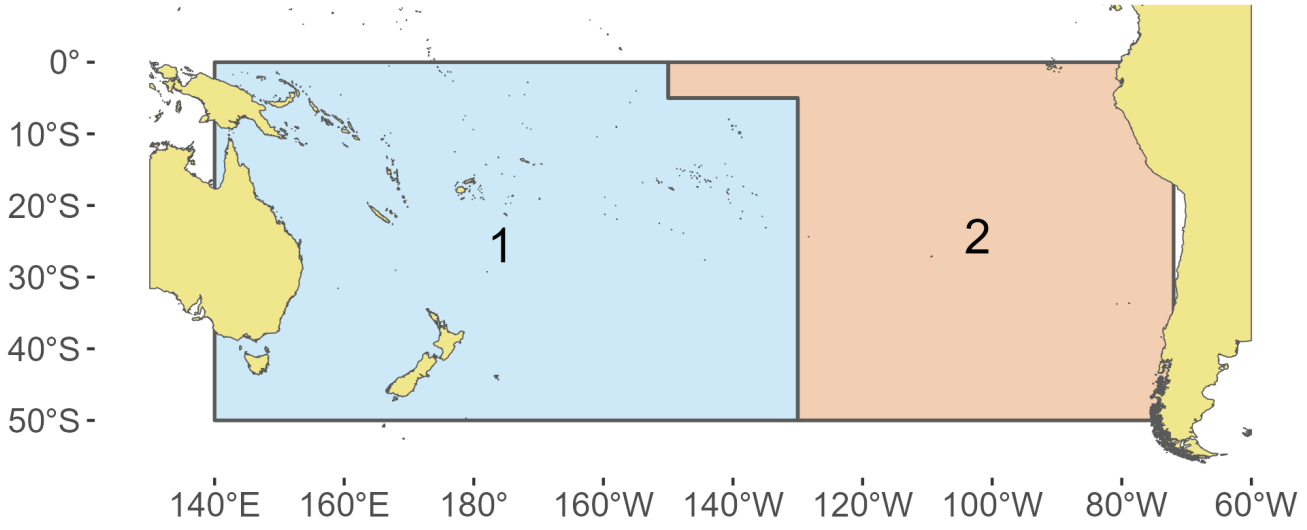

Figure 2: The geographical area covered by the stock assessment and the boundaries of the two model regions used for the South Pacific-wide 2024 albacore assessment.

3.1 Catch Data

Catch data updated to 2024 were compiled by year and quarter according to the fishery definitions (Table 1) based upon SPC's data holding as of 28/5/2026 [2]. Catch for all fisheries is expressed in weight to be consistent with the management implementation. As the EM is a biomass dynamic model, effort data and length data are not required.

Historical catch estimates are broadly consistent with those used in the previous dry run (Figure 3). Minor

[2]The data extraction is available in MD2 ALB model 420

Table 1: Definition of fisheries for the 2024 MULTIFAN-CL South Pacific albacore stock assessment (refer to Figure 2).

Fishery Number	Gear	Model Code-Fleets	Flags	Model Region
1	LL	1.LL.DWFN.1	DWFN	1
2	LL	2.LL.DWFN.1	DWFN	1
3	LL	3.LL.DWFN.1	DWFN	1
4	LL	4.LL.DWFN.1	DWFN	1
5	LL	5.LL.PICT.1	PICT	1
6	LL	6.LL.PICT.1	PICT	1
7	LL	7.LL.AZ.1	AU/NZ	1
8	LL	8.LL.DWFN.1	DWFN	1
9	LL	9.LL.PICT.1	PICT	1
10	LL	10.LL.AZ.1	AU/NZ	1
11	TR	11.TR.ALL.1	ALL	1
12	TR	12.TR.ALL.1	ALL	1
13	DN	13.DN.ALL.1	ALL	1
14	LL	14.LL.EPO.2	ALL	2
15	LL	15.LL.EPO.2	ALL	2
16	LL	16.LL.EPO.2	ALL	2
17	TR	17.TR.EPO.2	ALL	2
18	LL	18.LL.INDEX.1	INDEX	1
19	TR	19.TR.INDEX.1	INDEX	1
20	LL	20.LL.INDEX.2	INDEX	2

DWFN: BZ, CN, ES, JP, JP-DW, KR, SU, TW, US, VN, VU.
PICT: CK, FJ, FM, ID, KI, NC, NU, PF, PG, PH, SB, TO, TV, WS.

differences are observed in both the WCPFC-CA and EPO excluding overlap area in recent years, likely reflecting data revisions. However, these differences are relatively small, with a total difference of around 3.8% over this period.

3.2 CPUE Indices

Standardised CPUE indices for South Pacific albacore were derived using a spatiotemporal modelling approach applied to Pacific-wide operational longline data consistent with the latest South Pacific albacore stock assessment (Teears et al., 2024). The dataset extends from 1954 to 2024 and includes fishing activity from distant-water fishing nations (DWFNs), Pacific Island countries and territories (PICTs), and Australian and New Zealand fleets.

One standardised CPUE index per region (2 regions: WCPFC-CA and EPO excluding overlap area) was used as the abundance indicator in the South Pacific albacore estimation method. Raw CPUE time series were not considered appropriate for this purpose because catch rates can be substantially influenced by factors such as targeting strategy and flag-specific fishing practices, rather than underlying stock biomass. CPUE standardisation was therefore applied to reduce the influence of these confounding effects and improve the representation of relative abundance trends, consistent with the approach used in MP

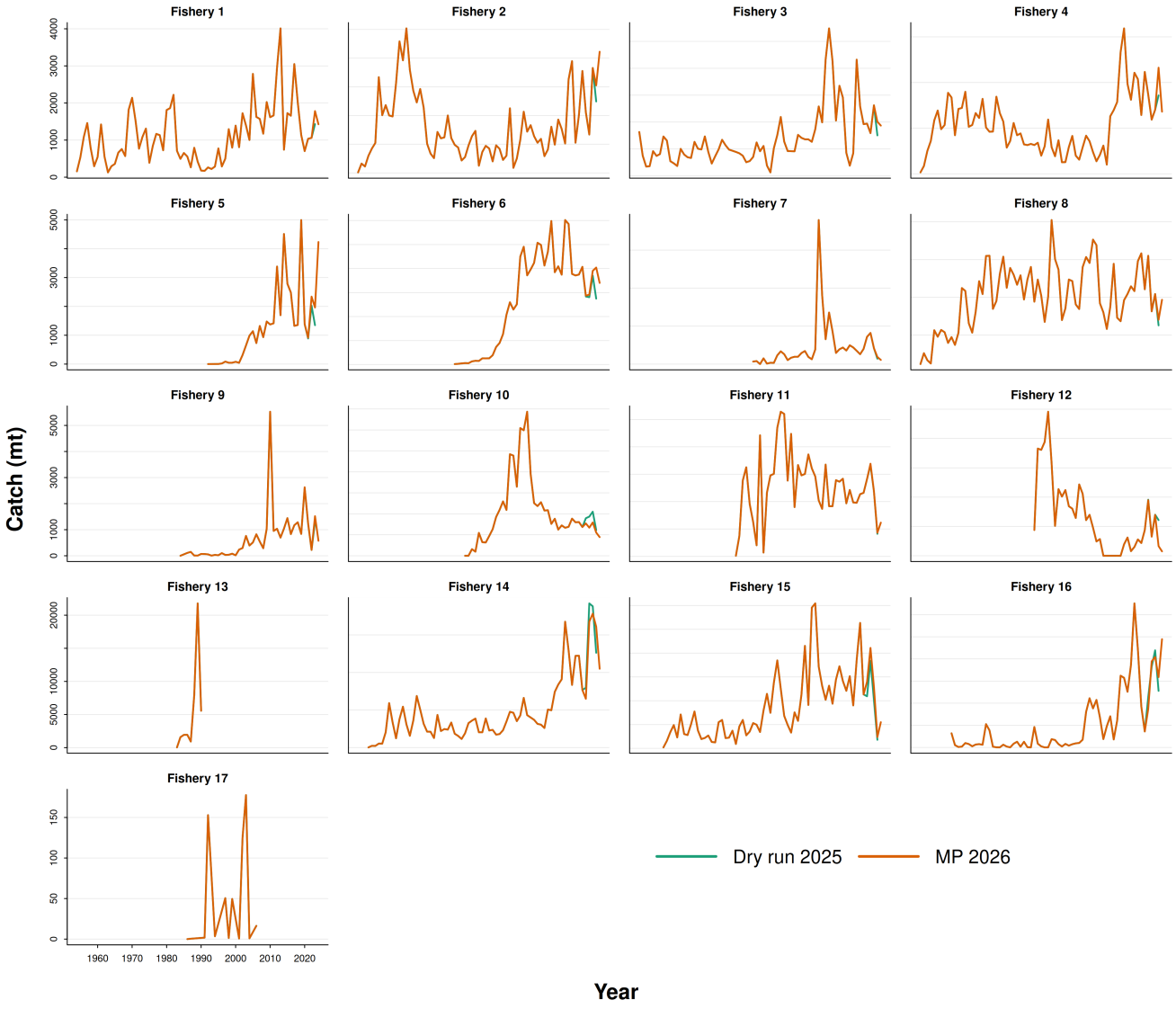

Figure 3: Fisheries-specific catch comparison between the 2025 dry run and 2026 MP run.

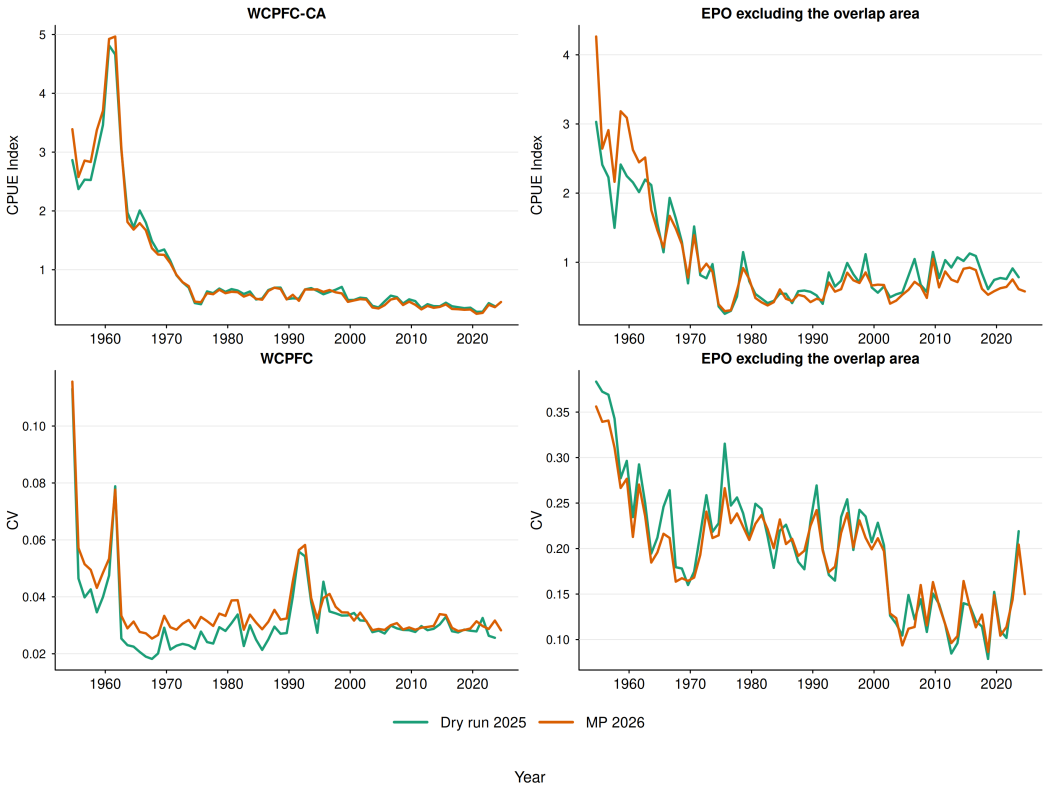

Figure 4: CPUE standardisation results comparison between the 2025 dry run and 2026 MP run.

testing.

CPUE indices were standardised using a spatiotemporal delta-GLMM that accounts for spatial, temporal, targeting (HBF), and flag effects. Indices were normalised, and estimation uncertainty was represented using CVs. Full model specifications are provided in Appendix, Table 3.

Compared with the previous dry run, the CPUE trends remain broadly consistent. In the WCPFC-CA, the indices for the most recent year are identical to those used in the dry run, whereas for the EPO excluding overlap area, modest differences are observed in the beginning of the time series and recent years between the dry run and MP run. Penalty terms are also consistent, particularly over the recent period, and no material differences are evident between the two analyses (Figure 4).

4 Running the Estimation Method

The EM is an age-structured production model implemented in `MULTIFAN-CL`, configured as a simplified and fixed representation of the stock assessment model (Teears et al., 2024). It uses two index fisheries: a longline index in the WCPFC-CA region and a longline index in the EPO excluding overlap area.

The EM is applied as a fixed algorithm, with model structure and settings unchanged from those used during MP development (Appendix Table 2). The model is initialised using parameter estimates from the 2024 stock assessment and fitted over three phases, with progressively increasing catch penalties to ensure stable convergence.

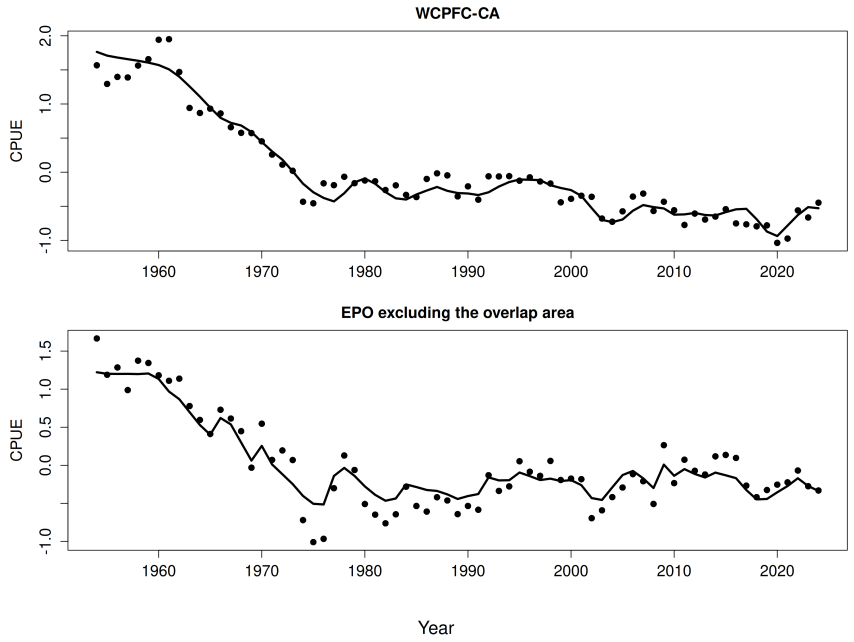

Figure 5: Observed (points) and predicted (lines) CPUE for the index fisheries (top panel is in the WCPFC-CA, bottom panel is in the EPO excluding overlap area) from the EM fit.

The input to the HCR is a relative measure of stock status in the WCPFC-CA, defined as the mean $SB/SB_{F=0}$ over the most recent three years (2022-2024) relative to the 2017–2019 reference period.

The EM converged successfully, with a maximum gradient of 8×10^{-7}. The resulting estimate of relative stock status was 1.2698. Diagnostic checks indicate an overall adequate fit to the CPUE indices (Figure 5).

5 Applying the Harvest Control Rule

Once the EM has been run and an estimate of relative stock status obtained, the HCR is applied to determine the management response. The HCR translates the estimated stock status into a catch limit, with additional adjustments applied through agreed meta-rules.

For this MP run, the estimated relative stock status of 1.2698 corresponds to a catch limit of 56,096 mt (Figure 6).

5.1 Application of Meta-rules Constraint

This catch limit is then compared to the most recent observed catch estimate (2024), which is 56,277 mt[3], to determine whether the meta-rule constraint applies. In this management cycle, the catch limit falls within the allowable meta-rule bounds[4]; therefore, the constraint does not apply. The specified catch limit of 56,096 mt applies to longline and troll fisheries operating south of 10°S in the WCPFC-CA, excluding those operating within the EEZs of Tokelau and Tuvalu.

[3]This refers to the 2024 catch below 10°S in WCPFC-CA (56,290 mt), with the estimated catches of TK (0) and TV (13 mt) below 10S removed.

[4]The meta-rule bounds were 53,463–61,905 mt, calculated as 0.95 and 1.10 times the 2024 catch of 56,277 mt; the catch limit of 56,096 mt falls within this range.

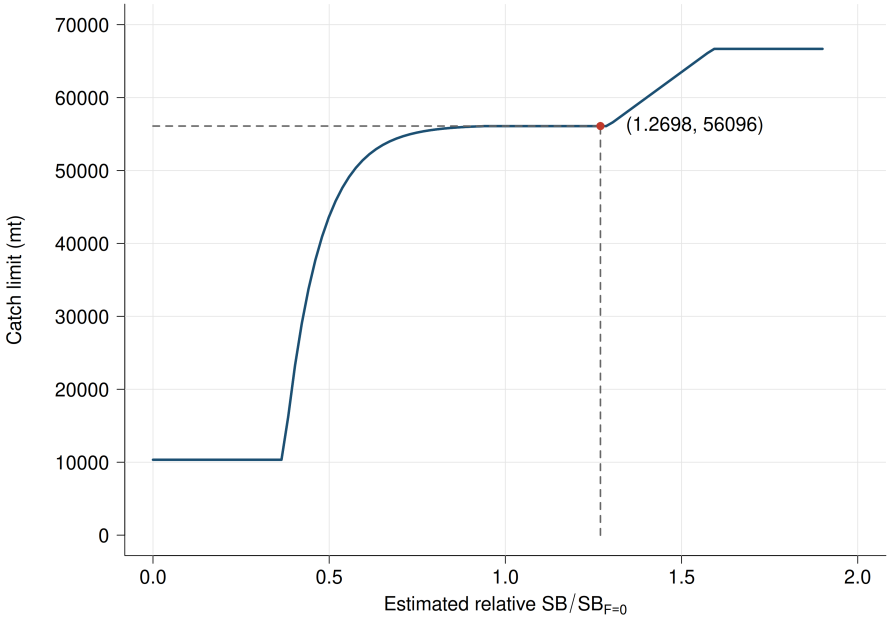

Figure 6: Application of the adopted Harvest Control Rule (HCR) to the 2026 MP run stock status estimate.

6 Application of the Docker Environment

Ensuring reproducibility has been a key consideration in the implementation of the MP, particularly for CPUE analyses, where software and package updates can affect results. To address this, a containerised workflow has been adopted following recommendations at SC21.

The Docker container encapsulates the computational environment required to run the CPUE standardisation and estimation method, ensuring consistent and repeatable results across MP runs. The container image is available at SPA MP container, and the associated code base is maintained on GitHub https://github.com/PacificCommunity/ofp-sam-spamp.

Due to data confidentiality constraints, operational data used in the CPUE analysis are not included within the container and are stored on a secure system with restricted access. All other components of the workflow are fully reproducible within the container environment.

7 Data Availability

Two key sources of Pacific-wide fishery data are used within the South Pacific albacore MP: aggregate catch data and operational-level catch and effort data. Aggregate catch data are used to determine fishery-specific total removals, while the finer-resolution operational data are used to generate region-specific indices of abundance.

With specific reference to the "EPO excluding overlap area" component of these datasets:

- Aggregate catch data are available through the IATTC.
- Operational data used within the estimation method are provided to SPC by CCMs.

The coverage of aggregate catch data from IATTC is assumed to be complete. However, there can be lags in the availability of these data through the IATTC website. The IATTC–WCPFC Joint Working Group on South Pacific Albacore may wish to consider mechanisms to support more frequent exchange of these data.

The coverage and representativeness of operational data available for the EPO excluding overlap area has been identified as a key issue for the monitoring strategy (SPC-OFP, 2026). During MP testing, the estimation method used data for the EPO excluding overlap area that were consistent with the data used in the 2024 South Pacific albacore stock assessment. The implementation of the MP, as reported here, is therefore consistent with the testing framework, and the performance of the MP is as expected.

For consideration within the monitoring strategy, analyses indicate that the amount of operational data available for the Chinese longline fleet has declined in recent years. Historically, China provided operational data to SPC under an SPC–China-specific memorandum of understanding (MOU), similar to arrangements developed with other CCMs, for the secure provision of historical operational data for specific assessment purposes. However, following the provision of historical operational data for the WCPFC-CA in accordance with WCPFC scientific data requirements, the provision of Pacific-wide operational data declined.

This issue is particularly important because the Chinese longline fleet has become a major contributor to EPO catch since 2014. As a result, understanding the impact of the decline in the availability of the Chinese longline operational data is important for assessing the representativeness of CPUE indices for the EPO excluding overlap area and, consequently, the stock status estimates derived from the EM.

To evaluate the potential impact of this issue, a sensitivity analysis was conducted in which the sampling representation of the Chinese longline fleet was increased to 70% for the period 2014–2024. The CPUE standardisation and estimation method were then rerun following the specified MP procedure. The results suggested that the CPUE trend from the sensitivity analysis was very similar to the original 2026 MP CPUE trend and remained within the confidence interval of the 2026 MP CPUE standardisation (Figure 7).

The relative stock status estimated by the EM under this alternative EPO sampling assumption was 1.275, less than 1% higher than the MP 2026 EM estimate. However, the resulting catch limit remained at 56,096 mt, identical to the MP 2026 run. These results suggest that the CPUE standardisation is not largely affected by increased representation of Chinese longline operational data in this sensitivity test, and that the HCR output is unaffected.

Separately, SPC has entered into a specific MOU with China to receive operational data for the region outside the WCPFC-CA. These data will be important for future South Pacific-wide assessments and for ensuring that the operational data used in the South Pacific albacore estimation method remain consistent and representative over time.

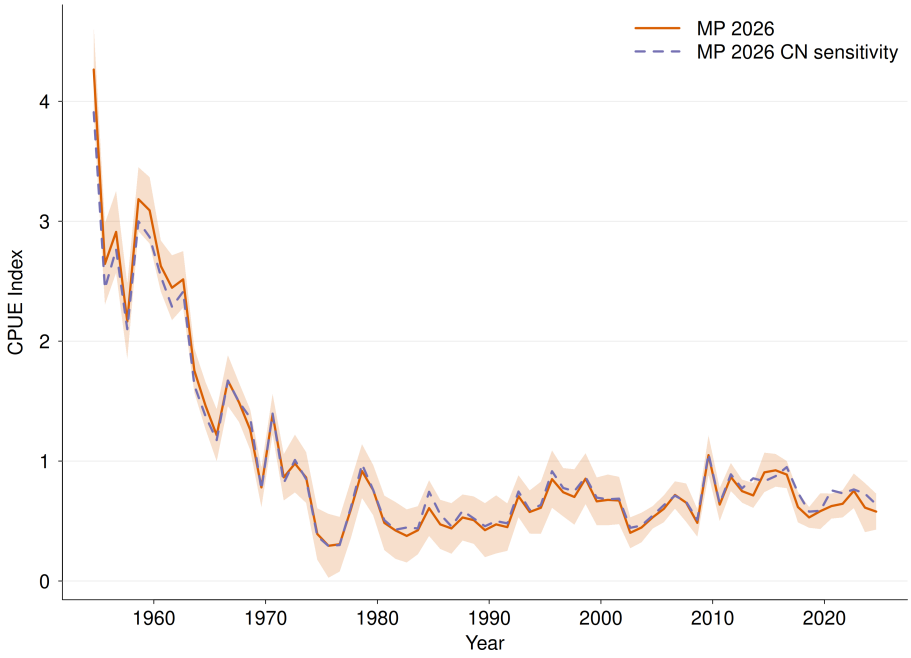

Figure 7: Sensitivity analysis using an alternative sampling assumption for the EPO excluding the overlap area.

In this report, we focus on aspects of the monitoring strategy relating to the application of the MP. We consider the consistency of data availability and the procedures for compiling and running the EM. Of primary concern is the consistency with which the actual implementation of the MP corresponds to the simulated conditions under which the MP was tested.

8 Conclusions

Sufficient data were available to generate the required inputs for the EM and to apply the HCR. The EM converged successfully and returned an estimated relative stock status of 1.2698. Under the adopted South Pacific albacore MP (CMM2025-01), this corresponds to a catch limit of 56,096 mt. The catch limit applies to longline and troll fisheries operating south of 10°S in the WCPFC-CA, excluding those operating within the EEZs of Tokelau and Tuvalu.

Some uncertainty remains regarding the operational data used in the CPUE analyses in the EPO excluding overlap area. Ongoing work to improve data availability and access arrangements is expected to support future analyses, while the implications of any changes in data inputs should continue to be considered within the South Pacific albacore MP monitoring strategy.

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Declaration of generative AI and AI-assisted technologies in the SC paper preparation process

The authors used ChatGPT to assist with language editing. The authors take full responsibility for the accuracy and originality of the work.

9 References

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Appendix: Estimation Method Settings

Following the update presented in (SPC-OFP, 2025), the estimation method uses two index fisheries: longline indices in the WCPFC-CA and EPO regions, with the troll index removed. This removes reliance on the troll index and helps to "future proof" the MP. This change was not found to impact the performance of the estimation method. The estimation method and CPUE standardisation settings are summarised in Tables 2 and 3.

The estimation method is fitted over multiple phases, in which key parameters (e.g., maximum allowable fishing mortality) are progressively relaxed. Convergence is assessed using a gradient criterion of 10^{-5} or when a maximum of 3000 function evaluations in the final phase is reached.

Table 2: Settings for the estimation method

Model setting	**Value**
Regional structure	2 regions
Number of fisheries	19
Longline	13
Troll / Driftnet	4
Index fisheries	2 (longline only)
Steepness	0.8
Natural mortality	Lorenzen, $M_{1.2} = 0.36$
Growth	Fixed
ML_1	45.538
ML_2	100.115
K	0.3932
Movement rates	Fixed (2024 assessment)
Selection patterns	Fixed (2024 assessment)
Average recruitment	Last 2 years
Recruitment distribution	0.819, 0.181

Table 3: Model settings and post-processing steps used in the CPUE standardisation for South Pacific albacore estimation method. Of the two index fisheries, Fishery 18 (WCPFC-CA) is derived from the north model, while fishery 20 (EPO excluding overlap area) is derived from the global model.

Model Setting	**Description**
Model Type	A spatiotemporal delta-gamma generalized linear mixed model (delta-GLMM), implemented in two model configurations: a global model and a north model.
Spatial Knot Configuration	A mesh with 157 spatial knots for the global model and 85 knots for the northern model.
Model Equations	$$y_i \sim \text{Bernoulli}(p_i)$$ $$\log\left(\frac{p_i}{1-p_i}\right) = \text{Year}_i + s(\text{month}_i) + \omega_1(s_i) + \phi_1(s_i, t_i) + s(\text{HBF}_i) + \text{Flag}_i + \varepsilon_1$$ $$c_i \sim \Gamma(\log \mu_i, \sigma^{-2}, \eta_i \sigma^2)$$ $$\log \eta_i = \text{Year}_i + s(\text{month}_i) + \omega_2(s_i) + \phi_2(s_i, t_i) + s(\text{HBF}_i) + \text{Flag}_i + \varepsilon_2$$ where σ is the coefficient of variation for positive catch rate measurement errors, y is the encounter probability, c is the CPUE, and i indexes individual records. *Year* is the year effect; $s(month)$ is a spline function for month effect; ω is the spatial random effect at location x; ϕ is the spatiotemporal random effect at location x and time t; $s(HBF)$ is a spline function for hook-based fishing effort; and *Flag* is the additive effect of the flag group. The spatial variation terms $\omega_2(x_i)$ are modeled as a Gaussian random field with a Matérn covariance function to account for spatial autocorrelation.
HBF Imputation	Missing HBF values are predicted using a random forest approach (Breiman, 2001) implemented via the `randomForest` R package (Liaw and Wiener, 2002). The model uses predictors including year, month, latitude, longitude, number of hooks fished, vessel flag, the proportional catch of the four main species (albacore, yellowfin, bigeye, swordfish), and total catch value, with 500 trees.
Implementation Platform	`sdmTMB` version 0.3.0 (R package).
Normalisation Method	CPUE values are mean-centered using absolute values.
Penalty Term Calculation	Penalty terms are applied as the coefficient of variation (CV) for the catch-conditioned model.