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Joint standardisation of Japanese pole-and-line and regional purse-seine CPUE for skipjack tuna in the equatorial WCPO

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Executive Summary

The adopted WCPFC skipjack tuna management procedure uses standardised Japanese pole-and-line (JPPL) CPUE indices as inputs to the estimation method. However, spatial contraction of the JPPL fishery, particularly in the equatorial regions, has raised concerns about the long-term stock-wide representativeness and precision of the JPPL-based index. This paper develops a preliminary joint CPUE standardisation framework that integrates JPPL and all-flags free-school purse-seine (PS) data for equatorial skipjack regions, allowing both fisheries to inform a shared spatiotemporal population process while retaining fishery-specific catchability and observation-error components.

Candidate joint models were evaluated using data from 2010 onward, when all data inputs required for calculating PS CPUE were available. Positive-only joint models showed generally stable convergence behaviour and produced similar mean-centered CPUE trends across alternative catchability structures. Models with fishery-specific observation error performed better than a shared observation-error model, reflecting differences in sampling processes and residual variability between JPPL and PS data in the equatorial region. The joint index produced lower CVs than the JPPL-only index, indicating improved precision relative to relying on JPPL data alone, although it was influenced by the larger sample size and broader spatial coverage of PS data. Diagnostics for the preferred model did not indicate strong broad-scale spatial bias, although some localised residual structure and higher residual variability in PS data remained.

Overall, the results suggest that joint JPPL–PS CPUE standardisation is a feasible approach for improving the precision of equatorial skipjack abundance indices while retaining continuity with the JPPL series used in the skipjack management procedure. Noting that neither the JPPL nor PS data have stock-wide coverage, further work is needed to extend the JPPL time series historically, test sensitivity to model structure and sample-size imbalance, and assess the implications of alternative indices within the skipjack MP framework.

We invite SC22 to:

- Review the preliminary analysis and provide feedback on the joint modelling framework; and
- Consider whether further development of integrated JPPL and free-school PS CPUE indices should be prioritised to support skipjack MP monitoring before the third implementation cycle.

1 Introduction

The Western and Central Pacific Fisheries Commission (WCPFC) adopted a management procedure (MP) for skipjack tuna (*Katsuwonus pelamis*) in 2022 under CMM2022-01, following testing within a management strategy evaluation (MSE) framework. The MP relies on an estimation method derived from the 2019 skipjack stock assessment (Vincent et al., 2019), which uses standardised catch-per-unit-effort (CPUE) indices from the Japanese pole-and-line (JPPL) fishery.

Since adoption, the skipjack MP has been reviewed through the WCPFC skipjack monitoring strategy framework (Scott et al., 2024). These reviews identified the recent spatial contraction of the JPPL fishery as a key issue for further investigation, particularly in the equatorial regions.

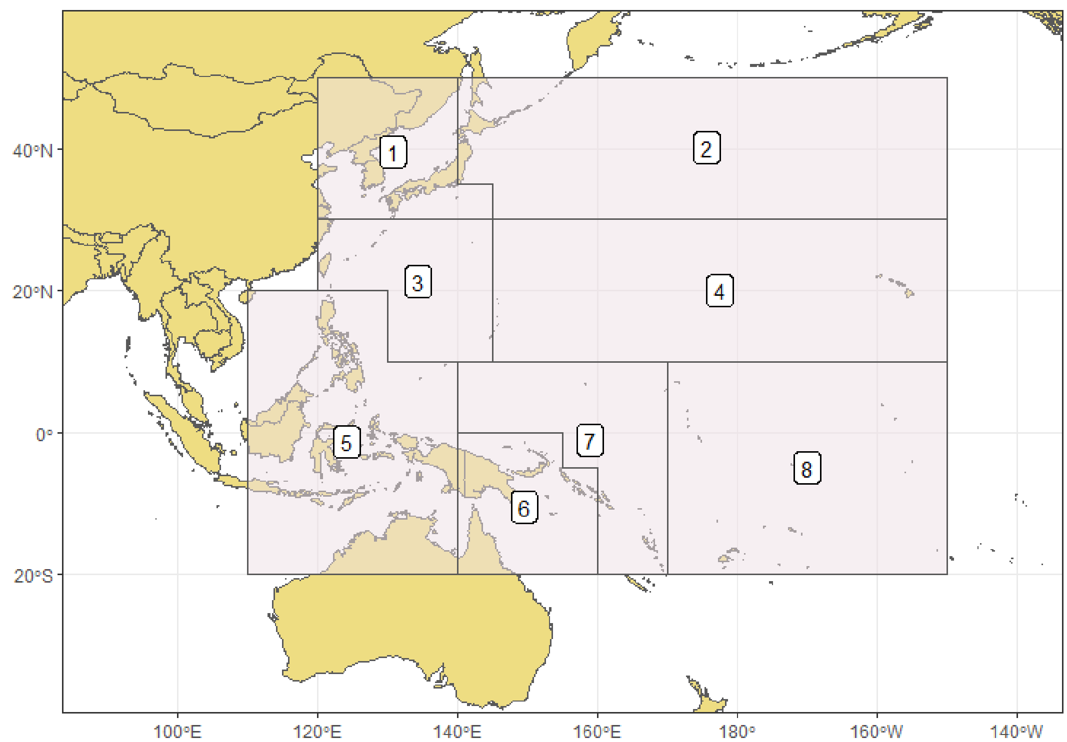


Figure 1: The geographical area covered by the stock assessment and the boundaries of the eight model regions used for the skipjack management procedure.

JPPL CPUE has historically provided an important abundance index for skipjack tuna, and the adopted MP uses standardised JPPL indices for both temperate and equatorial assessment areas (Region 1-5 and 6-8; Figure 1). However, reduced JPPL spatial coverage in the equatorial regions may affect the representativeness of its CPUE index for this region. This is particularly important in an MP context, where data inputs and the estimation method are intended to remain unchanged during implementation. Continued decline in JPPL data coverage could therefore affect MP performance. At SC21, the Scientific Committee supported continued application of the interim skipjack MP for the next implementation cycle (scheduled 2027), while emphasising the need to develop alternative indices before the third implementation cycle. Under the updated CMM2025-03, the third implementation cycle is scheduled to be run in 2029.

Free school purse-seine (PS) data provide broader spatial coverage in the equatorial region from 2010 onward, while JPPL data provide the longer historical time series and remain the basis for the adopted skipjack MP. A joint JPPL–PS index may therefore improve precision in areas where JPPL data have become spatially and temporally sparse, while retaining continuity with the JPPL series. This is consistent with the 2025 skipjack stock assessment, where free-school PS CPUE indices were used as the abundance index for the equatorial region from 2010 onward, partly to address concerns about reduced JPPL coverage (Teears et al., 2025a). However, replacing JPPL directly with a PS-only index is not the preferred option for MP monitoring, because it would require accounting for a different fishery-specific catchability process and would not provide a full historical time series or spatial coverage across the stock distribution. To address this complex issue, we therefore developed a joint CPUE standardisation framework that combines PS and JPPL data within a shared spatiotemporal population process.

The joint model allows both data sources to inform the underlying relative population density surface, while retaining fishery-specific observation and catchability components. This structure aims to separate variation in observed CPUE associated with population density from variation caused by the differences in fleet behaviour, fishing operations, and sampling coverage.

In this paper, we: (i) develop a joint CPUE standardisation framework for JPPL and PS data in the equatorial skipjack regions (regions 6–8); (ii) evaluate candidate model configurations and identify a preferred model; (iii) assess whether the joint analysis improves the stability and precision of the equatorial CPUE index relative to a JPPL-only analysis; and (iv) identify modelling, diagnostic, and data issues requiring further development before the index is considered for MP monitoring, the MP estimation method, or stock assessment applications.

2 Data exploration

2.1 Spatial and temporal scope

This paper focuses on skipjack tuna in the equatorial Western and Central Pacific Ocean, corresponding to skipjack assessment regions 6–8 (Figure 1). These regions encompass the equatorial and near-equatorial areas where skipjack abundance is high and where JPPL and PS fishing effort spatially overlap. Restricting the analysis to this common spatial domain was necessary for the joint standardisation framework, because the approach estimates a shared spatiotemporal population process informed by both fisheries while allowing fishery-specific catchability and observation-error components. Areas outside regions 6–8 were therefore excluded from the current analysis, including temperate regions used in the existing JPPL-based skipjack MP index. The primary time period analysed was 2010–2024, corresponding to the period over which all data inputs required for calculating PS CPUE were available for the joint analysis.

2.2 Japanese pole-and-line data

The JPPL dataset was sourced from Japanese logbook data. Spatial resolution was 1° × 1° latitude and longitude. During filtering, records in which albacore tuna were caught but skipjack was absent were excluded to remove catch and effort likely associated with albacore-targeting rather than skipjack-targeting.

Data were aggregated to quarterly time steps by assigning each record to the appropriate quarter based on the month of operation. CPUE was defined as catch weight per fishing day. Raw catch records in kilograms were converted to metric tonnes prior to analysis.

Key standardisation variables included month of operation, vessel identifier, gross registered tonnage (GRT), class (Domestic or Distant), log-transformed number of poles (as a proxy for vessel fishing power), and sea surface temperature (SST) at the fishing location.

The proportion of zero-catch observations in the JPPL data varied by year but was generally not high, ranging from 8% to 40%, with a median of 19%. These zeros may reflect either genuine absence of skipjack at the fishing location or unsuccessful fishing despite skipjack being present, as pole-and-line operations require active school detection and engagement. Consequently, zero catches cannot be interpreted unambiguously as true absences. For this preliminary positive-only analysis, zero-catch records were therefore removed.

2.3 Purse-seine data

PS CPUE data were derived from operational set-level catch and effort records for skipjack tuna. The analysis focused on free-school sets from 2010 onward, coinciding with the period of 100% observer coverage in the PS fishery. To reduce the influence of changing FAD fishing technology and targeting behaviour, associated sets were excluded and vessels identified as long-term FAD specialists (conducted 70% or more of their sets on FADs over the time series) were removed from the dataset.

Fishing effort was defined using Vessel Monitoring System (VMS)-based daytime distance travelled between successful free-school sets, providing a measure of search effort prior to setting. Following the approach of Teears et al. (2025b), failed sets and low skipjack catch sets (<5 tonnes of skipjack per set) were excluded to maintain consistency with the positive free-school PS CPUE series and its associated search-effort definition. As a result, the PS analysis included only positive CPUE observations. The resulting dataset represents a free-school PS CPUE series for tropical skipjack, with broad spatial coverage across the equatorial regions from 2010 to 2024.

2.4 Interaction between two datasets

The JPPL and PS datasets differ substantially in their temporal, spatial, and sampling characteristics, with important implications for joint standardisation.

Both datasets span 2010–2024, but JPPL data show notable gaps in the third quarter (July–September) of each year. This reflects the seasonal contraction of JPPL fishing activity in the equatorial regions as vessels shift their targeting toward albacore in temperate waters during summer months. By contrast, PS data provided continuous quarterly coverage throughout the analysis period (Figure 2).

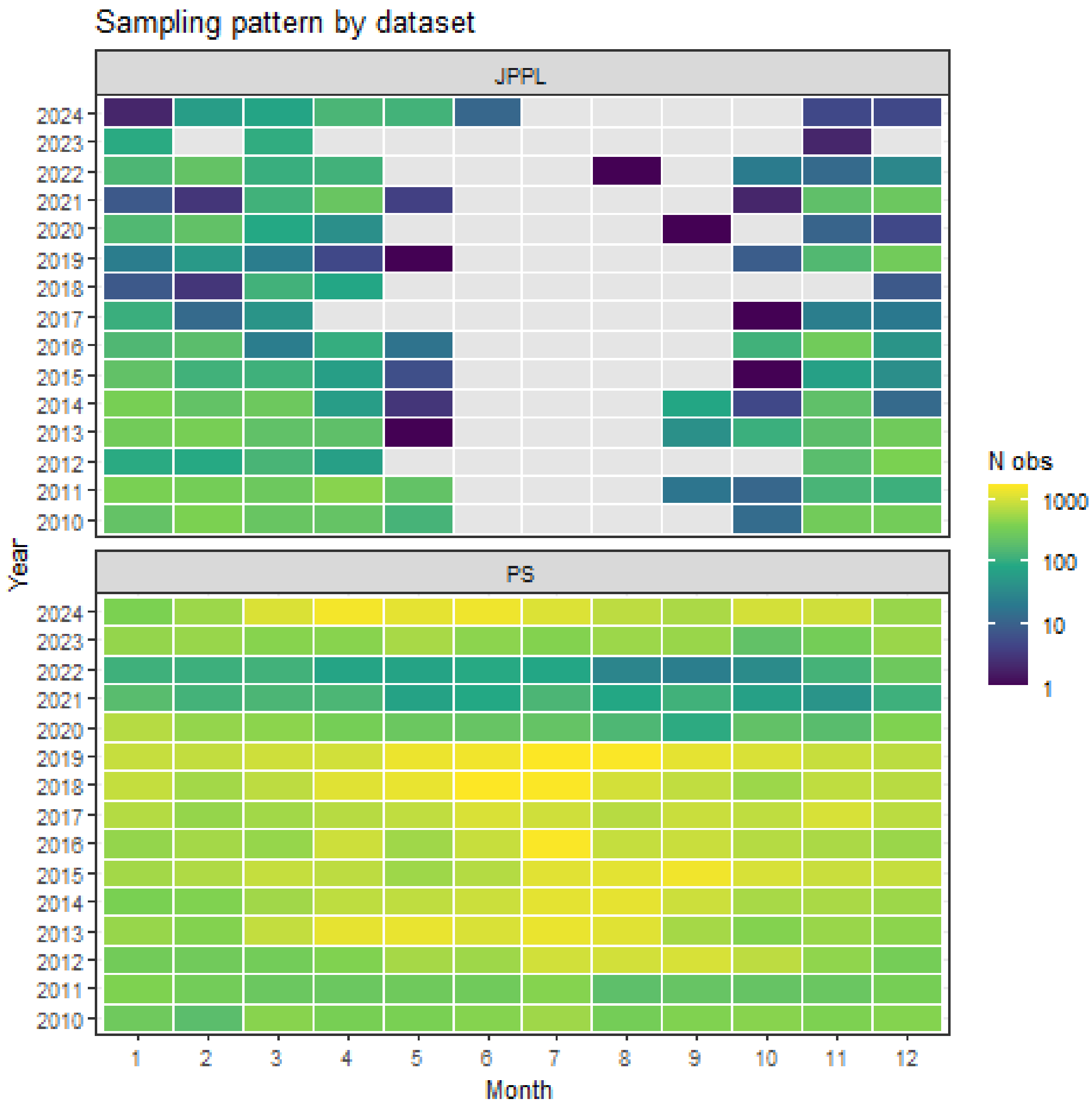


Figure 2: Record composition by year and month for both Japanese pole-and-line and purse-seine fisheries.

Spatially, the two fisheries show partially overlapping but broadly complementary distributions. JPPL effort has historically been concentrated in the western tropical Pacific and has undergone progressive spatial contraction over the analysis period, with reduced representation in the central equatorial Pacific in recent years. PS effort, by contrast, covers a broader equatorial area extending further into the central Pacific, providing spatial information in areas and periods where JPPL data are absent or sparse. This spatial overlap is a key motivation for the joint standardisation approach (Figure 3).

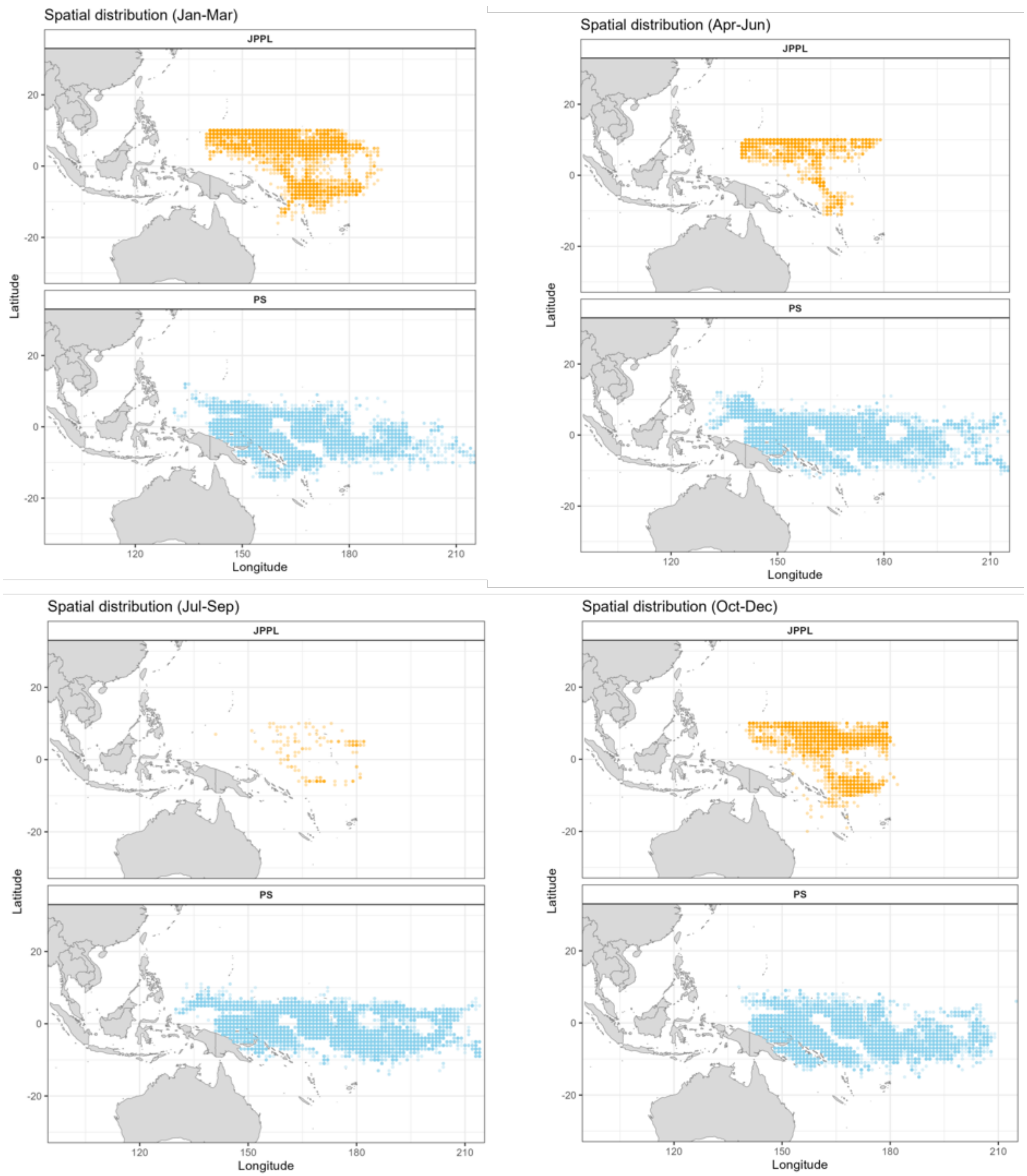


Figure 3: Seasonal spatial distribution of the Japanese pole-and-line and purse-seine fisheries from 2010 to 2024.

A pronounced sample size imbalance exists between the two datasets. Over the 2010–2024 period, the PS dataset contributed 106,181 records compared with 10,517 JPPL records, representing approximately 91% and 9% of the combined dataset respectively. This imbalance means that the joint model is strongly influenced by the PS data.

3 Methods

3.1 CPUE standardisation framework

A joint CPUE standardisation model was developed to integrate JPPL and PS data for equatorial skipjack tuna. The model assumes that both fisheries provide information on a shared underlying relative population density surface, while allowing fishery-specific catchability and observation-error components to account for differences in fishing gear, spatial coverage, targeting behaviour, and operational characteristics. Conceptually, CPUE for each fishery was represented as:

$$\mathrm{CPUE}_{\mathrm{JPPL}}(s_i, t_i) = \mathrm{q}_{\mathrm{JPPL}} B(s_i, t_i), \tag{1}$$

$$\mathrm{CPUE}_{\mathrm{PS}}(s_i, t_i) = \mathrm{q}_{\mathrm{PS}} B(s_i, t_i), \tag{2}$$

where $B(s_i, t_i)$ is the shared latent relative biomass process at location s_i and time t_i, and $\mathrm{q}_{\mathrm{JPPL}}$ and q_{PS} are fishery-specific catchability terms.

The joint model was implemented in `intCPUE` (Bi, 2026) as a spatiotemporal lognormal generalized linear mixed model. Positive CPUE observations were modelled as:

$$\log(c_i) \sim \mathrm{Normal}(\eta_i, \sigma^2). \tag{3}$$

where c_i is the positive CPUE observation, η_i is the linear predictor, and σ^2 is the observation variance. Candidate models considered either a shared observation variance across fisheries or fishery-specific observation variances for JPPL and PS.

The linear predictor included quarterly time effects, time-invariant spatial effects, time-varying spatiotemporal effects, vessel effects, population-specific covariates, and fishery-specific catchability effects. The spatiotemporal random effect was modelled as a Gaussian random field evolving through time as a random walk. Alternative spatial and spatiotemporal structures were also explored during model development. In the joint model, JPPL was used as the reference gear, such that PS catchability effects were estimated relative to JPPL. This specification was required by the likelihood structure implemented in the `intCPUE` package, where the fishery associated with the delta-data component must serve as the reference gear.

Catchability covariates were based on those used in the previous individual JPPL and PS standardisation analyses (for details see Teears et al. (2025b) and Nishimoto et al. (2025)), with modifications for the joint framework. In particular, a gear-by-month interaction was used to allow seasonal catchability patterns to differ between JPPL and PS. Candidate catchability terms included detection code for PS, number of poles and vessel gross registered tonnage (GRT) for JPPL, and gear-by-month effects for both fisheries.

Single-fishery models were also fitted for JPPL and PS separately using the same general modelling framework where possible. These models were used as reference cases to evaluate how the joint analysis differed from indices estimated from each data source independently.

3.2 Candidate model comparison

During model development, a broader set of configurations was explored, including alternative catchability covariates, environmental covariates, and spatial and spatiotemporal structures. A smaller set of models with acceptable convergence, diagnostic performance, and interpretable effects was then refitted using the final mesh configuration, in which the number of knots was increased from 80 to 120, and using extended optimization settings that allowed up to 100,000 iterations and 100,000 function evaluations. The models retained for final comparison are summarised in Table 1.

Model comparison was based on AIC, optimizer convergence, positive-definite Hessian status, maximum gradient, model parsimony, and the mean and median CVs of the standardised quarterly index.

3.3 Single fishery model comparison

The joint CPUE index was compared with JPPL-only and PS-only indices over the overlapping time period. The single-fishery reference models followed the configurations used in the 2025 skipjack stock assessment (Nishimoto et al., 2025; Teears et al., 2025b), with minor modifications where needed for consistency with the joint modelling framework. Comparisons focused on the temporal patterns of the mean-centred indices and their associated CVs. The JPPL-only comparison was used to assess whether incorporating PS data improved the stability and precision of the JPPL-based equatorial index, while the PS-only comparison was used as a recent-period reference.

Table 1: Selected candidate model settings for the joint JPPL–PS CPUE standardisation analysis. RW = random walk.

Model	**Model type**	**Catchability covariates**	**Population covariate**	**Spatial effect**	**Spatiotemporal effect**	**Observation SD**
M1	Positive-only	Gear × month + detection code + npoles + GRT	SST	Off	RW, quarterly	Fishery-specific
M2	Positive-only	Gear × month + detection code + npoles	SST	Off	RW, quarterly	Fishery-specific
M3	Positive-only	Gear × month + detection code	SST	Off	RW, quarterly	Fishery-specific
M4	Positive-only	Gear × month + npoles	SST	Off	RW, quarterly	Fishery-specific
M5	Positive-only	Gear × month only	SST	Off	RW, quarterly	Fishery-specific
M6	Positive-only	Gear × month + detection code + npoles + GRT	SST	On	RW, quarterly	Fishery-specific
M7	Delta	Gear × month + detection code + npoles + GRT	SST	Off	RW, quarterly	Shared

4 Results

4.1 Joint model results

Diagnostics for the retained candidate models after final refitting are summarised in Table 2. The delta model (M7) was not retained for further comparison because the Hessian was not positive definite. Among the positive-only joint models, all retained candidates achieved nominal convergence and positive-definite

Hessians. M1, which included gear-by-month, detection code, number of poles, and GRT, had the lowest AIC. The difference in AIC between M1 and M2, which excluded GRT, was small. M1 produced higher mean and median CVs than M2 and M3, while M2 and M3 produced similar CVs. The shared observation-error model had a higher AIC than the corresponding fishery-specific observation-error model.

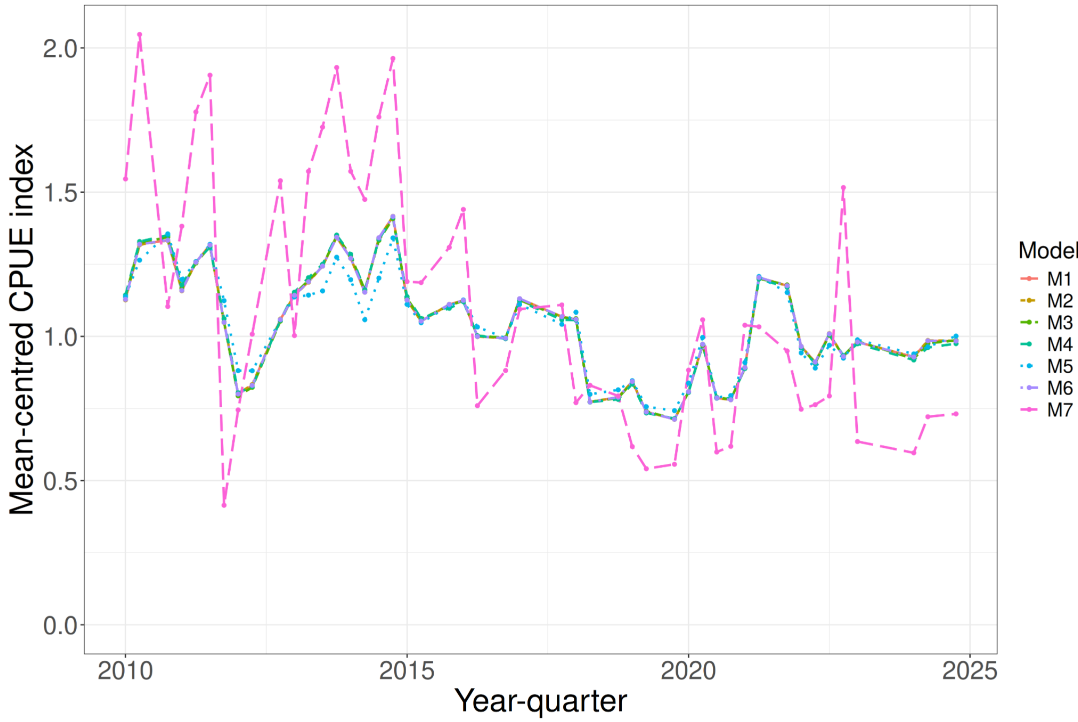
Table 2: Candidate positive-only joint model configurations and diagnostics. All models used a lognormal likelihood for positive CPUE observations, a shared quarterly spatiotemporal population process, and quarterly random-walk spatiotemporal effects. AIC comparisons are only made among the positive-only models.

Model	**Convergence**	**Max. gradient**	**pdHess**	**No. parameters**	**AIC**	**ΔAIC**	**Mean CV**	**Median CV**
M1	Yes	0.0424	TRUE	75	362066.4	0	0.137	0.128
M2	Yes	0.0587	TRUE	74	362069.5	3.1	0.115	0.105
M3	Yes	0.0314	TRUE	72	362087.4	21	0.115	0.105
M4	Yes	0.0628	TRUE	71	362342.2	275.8	0.115	0.105
M5	Yes	0.0487	TRUE	74	363918.2	1851.8	0.126	0.118
M6	Yes	0.0817	TRUE	76	362068.4	2	0.137	0.128
M7	Yes	0.2227	FALSE	143	373350.2	–	NA	NA

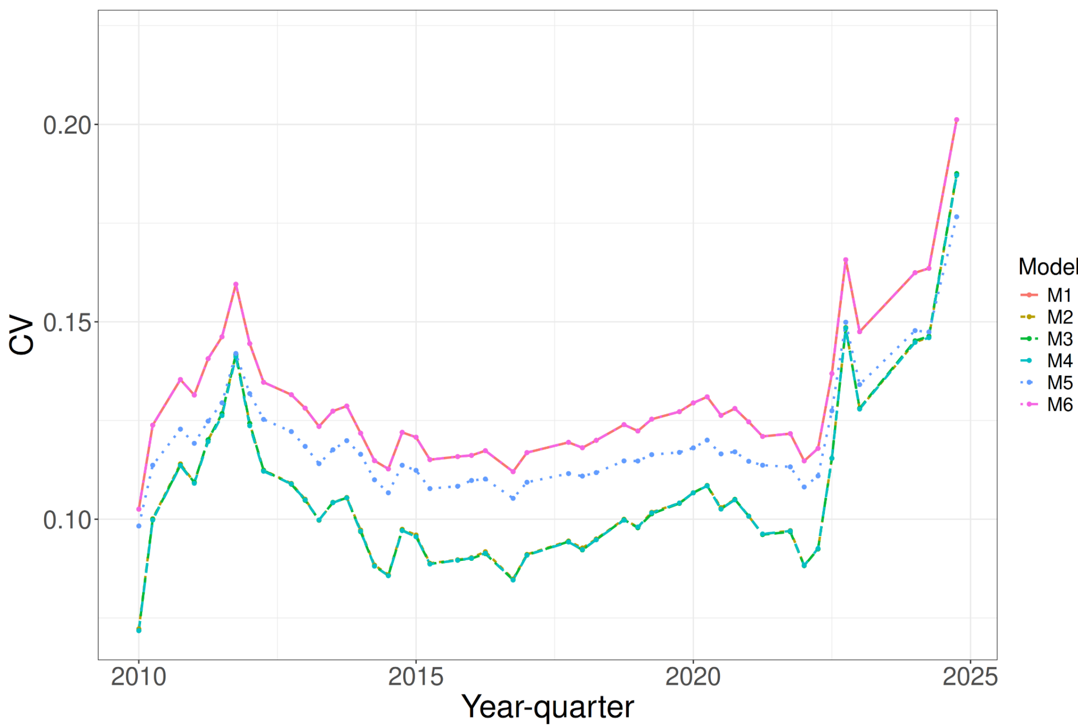
M1 was selected as the preferred model based on AIC, while M2 was retained as a sensitivity model with lower index CVs. Refitting the preferred model with a finer mesh did not materially change either AIC or index CVs.

The positive-only candidate models produced broadly similar standardised CPUE trends (Figure 4a). Differences among these models were mainly in the level of estimated uncertainty rather than the temporal pattern of the index. Models excluding GRT generally produced lower CVs than the model including GRT, particularly through the middle of the time series (Figure 4b). The delta model produced a more variable index and was excluded from further comparison due to the non-positive-definite Hessian.

Additional diagnostics for the preferred joint model are shown in Figure 5. The spatial residual plot did not indicate strong broad-scale clustering. Some localised residual structure remained in parts of the northern and eastern tropical region, but residuals were generally small and spatially dispersed. Bias-corrected log-residuals were broadly centred around zero for both JPPL and PS. JPPL residuals were more narrowly distributed and slightly right-shifted, while PS residuals were more dispersed. Both fisheries showed some evidence of a skewed left tail.

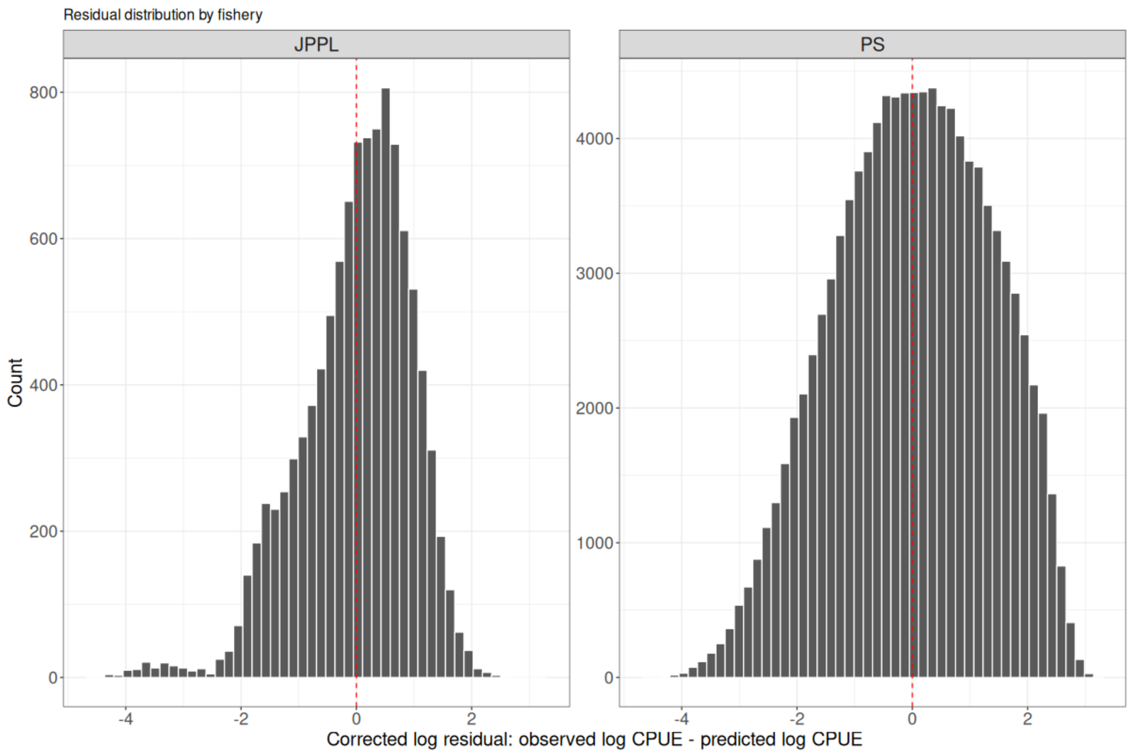


(a) Standardised CPUE trends. M1 to M7 produced very similar indices.

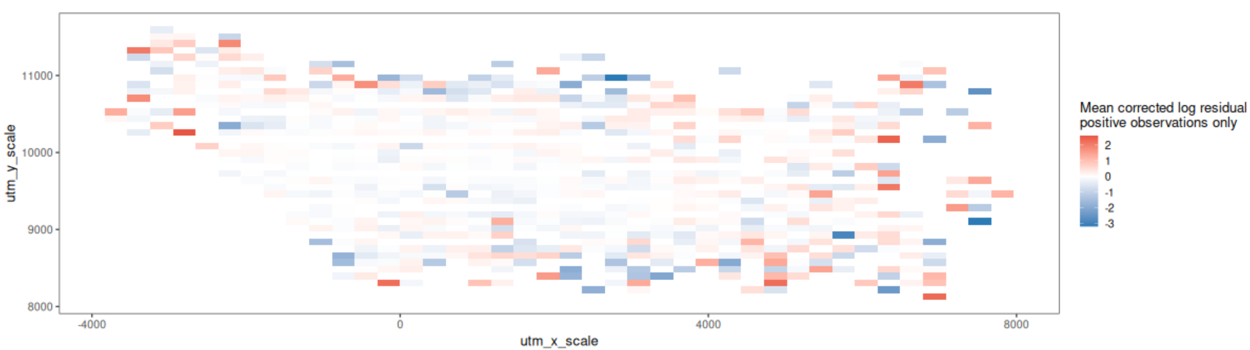


(b) Coefficient of variation. CVs were not calculated for M7 (delta model) because bias correction could not be completed. M2, M3, and M4 produced very similar CVs, resulting in overlapping lines. M1 and M6 also overlapped for the same reason.

Figure 4: Comparison of standardised CPUE trends and CVs among retained candidate joint models.



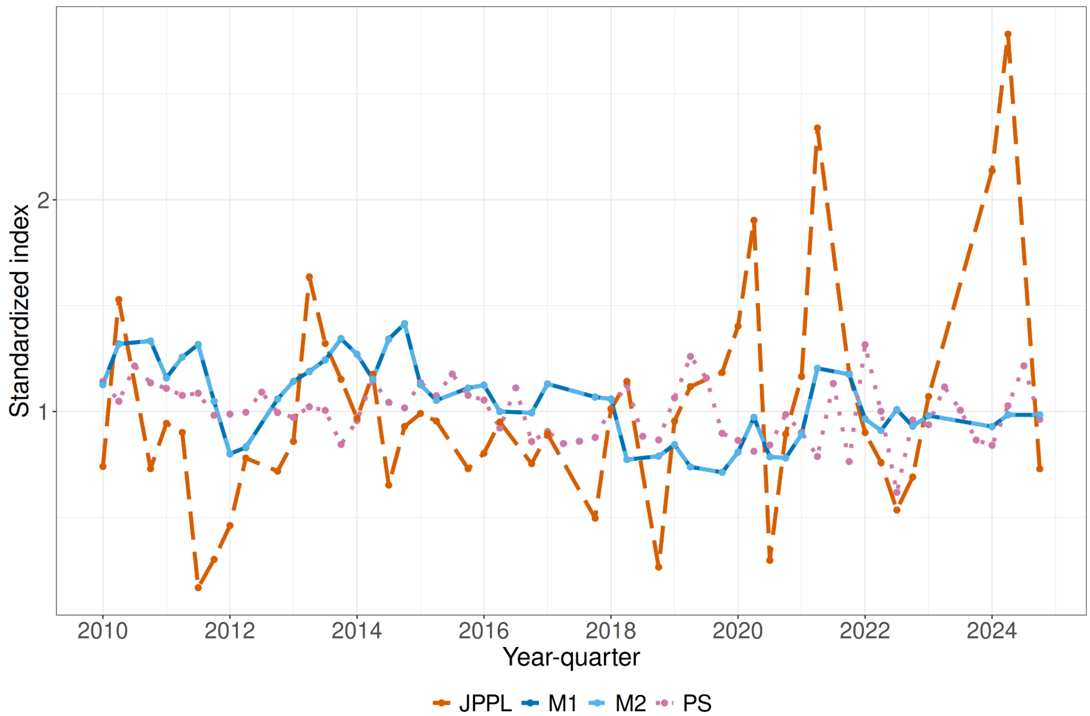
(a) Distribution of corrected log-residuals for Japanese pole-and-line and purse-seine fisheries for the preferred joint model (M1).



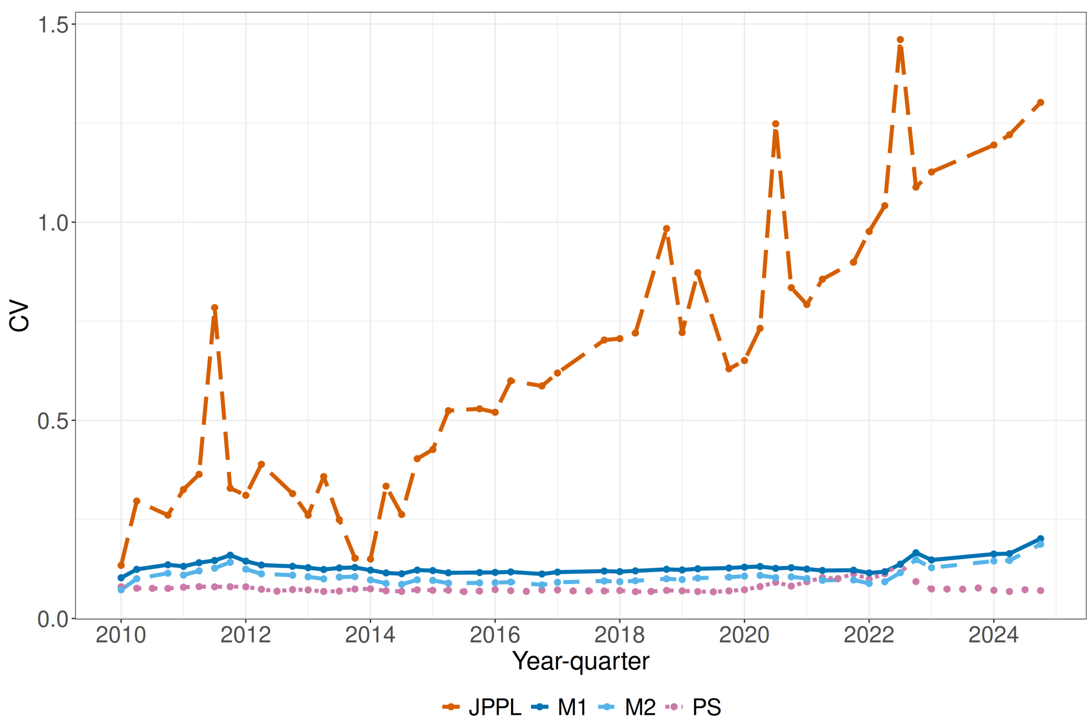
(b) Spatial distribution of residuals for the preferred joint model (M1).

Figure 5: Additional residual and spatial residual diagnostics for the preferred joint model (M1).

4.2 CPUE index comparison



(a) Mean-centred CPUE indices.



(b) Coefficient of variation.

Figure 6: Comparison of mean-centred CPUE indices and CVs from the joint, Japanese pole-and-line-only, and purse-seine-only analyses.

The CPUE index from the joint analysis generally followed the trend of the PS-only index, while the JPPL-only index showed greater seasonal variability (Figure 6a). The joint analysis produced lower CVs than the JPPL-only model. CVs from the PS-only and joint analyses were broadly comparable (Figure 6b).

5 Discussion

This paper developed a joint CPUE standardisation framework to integrate JPPL and PS data for equatorial skipjack regions. The analysis evaluated whether the broader spatial coverage of PS data could help address the increasing spatial contraction of JPPL data, while retaining continuity with the JPPL series that underpins the adopted skipjack MP. Overall, the results indicate that the joint framework is feasible and can improve precision and reduce index uncertainty relative to a JPPL-only analysis.

5.1 Model selection and performance

The covariates used in the joint analysis broadly followed those used in the 2025 skipjack stock assessment, with modifications required for the joint JPPL–PS framework. A key challenge in developing the joint model was identifying a set of covariates that could be applied consistently across both fisheries while still accounting for fishery-specific operational differences. Population covariates used in only one fishery-specific analysis, such as ENSO and chlorophyll-a in the PS analysis, were not retained in the joint model. Instead, the joint model used SST as a common population covariate that could be applied consistently across both fisheries. A gear-by-month effect was also included to allow seasonal catchability patterns to differ between JPPL and PS, rather than assuming a common monthly effect across fisheries. Fishery-specific catchability covariates were retained where appropriate to account for operational differences between gear types.

The comparison between fishery-specific and shared observation-error structures highlighted the importance of allowing JPPL and PS data to have separate residual variances. The shared observation-error model had a substantially higher AIC, indicating that a common observation standard deviation was not appropriate for the two fisheries. This is consistent with differences in fishing methods, sampling processes, catchability mechanisms, and residual variability between JPPL and PS, and supports the use of fishery-specific uncertainty structures in the joint model.

Models with the stationary spatial effect turned on and off were also evaluated. The model with the spatial effect turned on produced a higher AIC than the spatial-off model, indicating that the stationary spatial component did not improve model fit. Under the `intCPUE` framework (Bi, 2026), both stationary spatial and spatiotemporal effects are included in the latent relative biomass and catchability processes, such that much of the variation explained by a stationary spatial effect may already be captured by the spatiotemporal component. As longer JPPL time series become available, the relative importance of these components should be re-evaluated. Preliminary analyses using an AR1 spatiotemporal structure produced little improvement in model fit but substantially increased computation time. The random-walk spatiotemporal structure was therefore retained for the current analysis.

The delta model was not retained because the Hessian was not positive definite, indicating unreliable uncertainty estimates. This result was not entirely unexpected given the characteristics of the JPPL dataset. Zero-catch observations in the JPPL data were not particularly common, and their information may be limited because it is often difficult to distinguish between true zero catches and periods when little or no fishing activity occurred in the tropical region. Under these circumstances, modelling the encounter process separately may provide little additional information beyond that contained in the positive observations. The suitability of a delta formulation could be re-evaluated in the future if extension of the JPPL time series provides a more informative set of zero-catch observations.

5.2 Interpretation of the joint index

The joint index generally followed the pattern of the PS-only index during the overlapping period from 2010 onward, while the JPPL-only index exhibited greater seasonal variability. This outcome is not unexpected given the substantially larger sample size and broader spatial coverage of the PS dataset in the equatorial region.

Importantly, the joint model produced lower CVs than the JPPL-only analysis, indicating reduced uncertainty in the estimated CPUE indices when PS information was incorporated. This result suggests that integrating complementary fishery data can help stabilise abundance estimates in regions where JPPL coverage has become increasingly limited.

Although the joint model produced slightly higher CVs than the PS-only analysis, this should not necessarily be interpreted as poorer performance. The PS-only model estimates abundance trends from a single fishery over a relatively short time period, whereas the joint framework simultaneously estimates a common population signal from two fisheries with different catchability processes, sampling coverage, and residual variance structures in the same time period. The additional uncertainty therefore reflects the complexity of integrating multiple data sources rather than a deficiency of the joint approach itself.

Model diagnostics supported this interpretation. Residuals showed no evidence of strong broad-scale spatial bias, and corrected log-residuals were generally centred around zero for both fisheries. While some localised residual structure remained, particularly in portions of the northern and eastern tropical region, the overall diagnostic results suggest that the preferred model adequately captured the dominant patterns in both datasets.

5.3 Potential use in the skipjack MP

The joint JPPL–PS index could be considered as a candidate alternative index for the equatorial region in future skipjack MP monitoring. Its main potential benefit is that it retains continuity with the JPPL series used in the adopted MP, while using PS data to improve spatial coverage and reduce index uncertainty where JPPL coverage has declined.

Further testing is required before operational use. The current skipjack MP uses JPPL CPUE across both equatorial and temperate regions, whereas the joint index developed here applies only to assessment regions 6–8, where JPPL and PS effort overlap. Testing the joint index within the current MP framework is therefore needed to evaluate its effects on MP performance, robustness, and resulting management output.

5.4 Limitations and future development

The current analysis has several limitations that should be addressed in future work. First, the time series is relatively short, beginning in 2010, mainly due to the availability of suitable PS effort data. PS effort was calculated as distance travelled between free-school sets, which relies on high-quality observer and VMS data. Future work should explore alternative effort definitions or data sources that could allow the PS time series to be extended further back in time.

Second, there is a substantial imbalance in sample size between the JPPL and PS datasets. Since 2010, PS has been the dominant fishery in the equatorial region, with approximately ten times more observations than JPPL. A sensitivity analysis reducing the PS sample size produced a more balanced influence between fisheries, but also increased index CVs due to the reduced sample size. The full PS dataset was therefore retained for the main analysis, although the influence of sample-size imbalance should be further evaluated.

A further limitation is the potential difference in selectivity between JPPL and PS. Length-composition comparisons for the equatorial region indicate substantial overlap between the two fisheries, suggesting broadly similar size selectivity over the period examined (Appendix, Figure S1). However, the ability of the joint model to accommodate differences in selectivity has not been formally evaluated and should be investigated through simulation.

Future work should also extend the JPPL time series prior to the 2010–2024 period examined here, while retaining PS data from 2010 onward. Longer historical runs, progressively extending the JPPL series back toward the full MP time horizon, would allow model behaviour to be evaluated when one fishery is absent for part of the time series. Additional methodological work should evaluate alternative spatial and spatiotemporal structures, alternative observation distributions, and sensitivity to sample-size imbalance and selectivity assumptions. Finally, the implications of alternative CPUE indices should be assessed within the skipjack MP framework.

6 Conclusions

This paper developed a preliminary joint CPUE standardisation framework integrating JPPL and PS data for equatorial skipjack regions. The results indicate that the joint framework is feasible and can produce stable CPUE indices from the two data sources. The joint index had lower CVs than the JPPL-only index, suggesting reduced uncertainty relative to relying on JPPL data alone, although the index was strongly influenced by PS data during the overlapping period.

The analysis supported the use of fishery-specific observation-error structures and a positive-only formulation for this preliminary application. Diagnostics for the preferred model did not indicate strong broad-scale spatial bias, although some localised residual structure remained. Further work is needed to extend the JPPL time series, evaluate longer historical runs, test sensitivity to model structure and sample-size imbalance, and assess the implications of alternative indices within the skipjack MP framework.

We invite SC22 to:

- Review the preliminary analysis and provide feedback on the joint modelling framework,

- Consider whether further development of integrated JPPL and PS CPUE indices should be prioritised to support skipjack MP monitoring before the third implementation cycle.

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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.

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Appendix

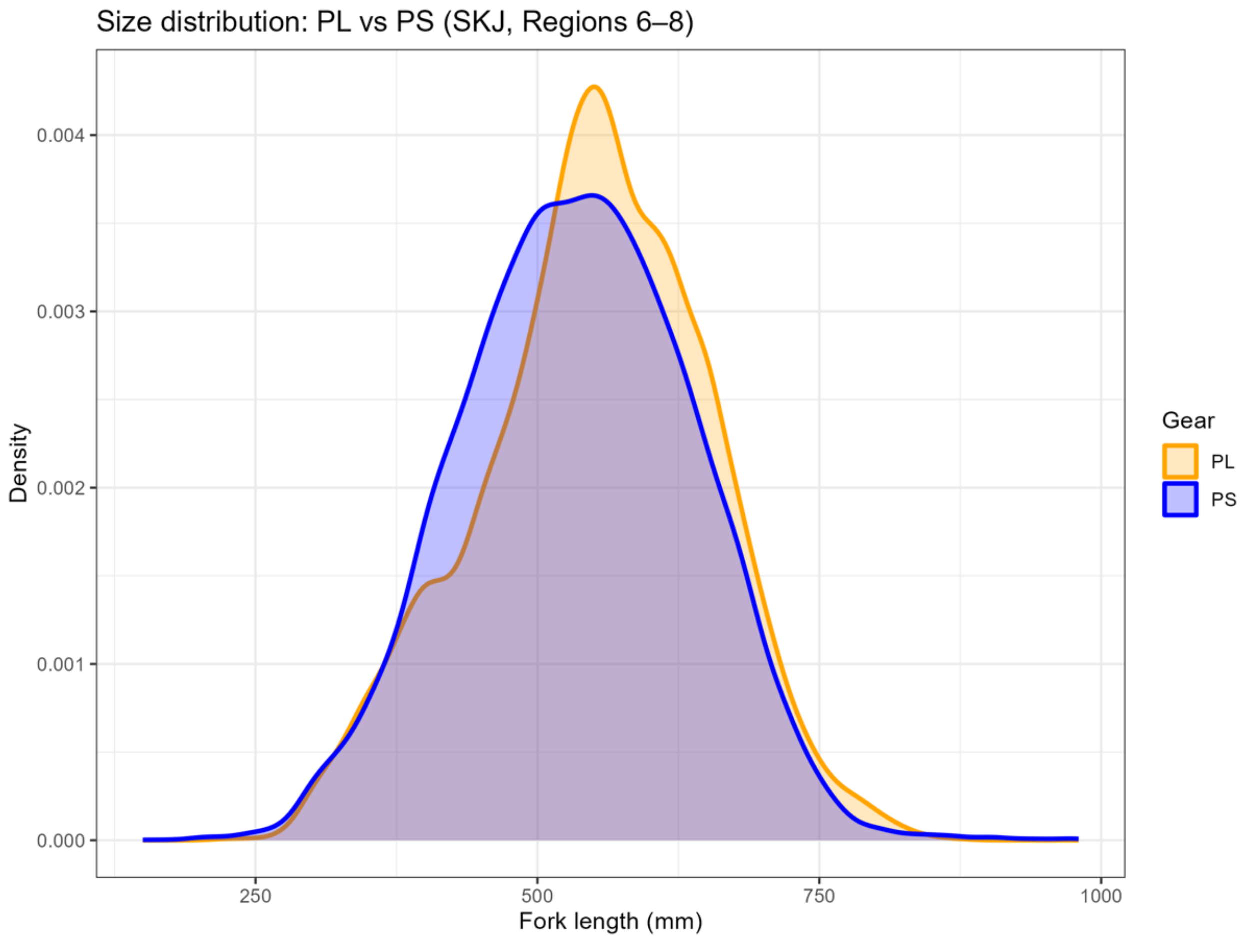

Figure S1: Size composition of the JPPL and PS fisheries in the equatorial WCPO.