Re-run of the 2024 Yellowfin Stock Assessment with Revised Longline CPUE

IOTC-2025-SC28-13

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1 Background

In 2024, the Indian Ocean Tuna Commission (IOTC) 26th Working Party of Tropical Tunas (WPTT) carried out the most recent stock assessment for Indian Ocean (IO) yellowfin (Urtizberea et al., 2024), using data presented and discussed during the WPTT Data Preparatory meeting. The results of this assessment indicated that yellowfin had recovered from its previous state of overfishing and the new status, as endorsed by the 27th Session of the IOTC Scientific Committee (SC), was estimated to be not overfished and not subject to overfishing (with 88,8% probability).

However, during the 27th SC in 2024, several concerns were raised regarding the longline CPUE index used in the yellowfin assessment. The main concern was the difference in values and trends, particularly after 1990 and in region 1 (northwest IO), between the CPUE series used in the yellowfin assessment in 2021 (Fu et al., 2021) and 2024 (see Figure 16 in Urtizberea et al. (2024)). This difference was unexpected since both indices used aggregated data and followed a similar protocol to conduct the CPUE standardization. The 2024 longline CPUE index predicted a more optimistic abundance level after 1990 compared to the assessment in 2021. Therefore, the SC provided a precautionary management advice only for 2026 and requested a revision of the 2024 longline CPUE index to evaluate its impacts on the IO yellowfin assessment model (IOTC, 2024).

In the 27th WPTT (WPTT27), Kitakado et al. (2025a) presented a revision of the standardized longline CPUE index used in the yellowfin assessment in 2024. Kitakado et al. (2025a) detected an error in the code to derive the standardized longline CPUE index in 2024. This error omitted the first component of the hurdle model, the one that models probability of presence, when predicting the standardized CPUE index. This error is the most likely reason for the difference between the 2021 and 2024 CPUE indices (Kitakado et al., 2025a); therefore, the longline CPUE index needed to be recalculated. Unlike in 2024, the revisited longline CPUE index used a subsample of operational data for the standardization. During the WPTT27, there were recommendations to further explore the potential reasons for extremely low CPUE values in region 3 (southern IO). After addressing these recommendations, Kitakado et al. (2025b) presented a final revision of the longline CPUE index, which covered the period from 1975 to 2023 as in the 2024 assessment model.

In this document, we explore the impacts of the revised standardized longline CPUE index presented by Kitakado et al. (2025b) on the IO yellowfin stock assessment output, stock status, and management advice by running the final grid of the 2024 yellowfin assessment with the revised longline CPUE.

2 Methods

As observed in Figure 1, the values and trend of the revisited longline CPUE presented by Kitakado et al. (2025b) are more similar to the CPUE index used in 2021, especially for region 1b (northwestern IO).

In the 2024 IO yellowfin assessment, the final model grid consisted of 12 models with three axes of uncertainty (Urtizberea et al., 2024):

- Effort creep in the longline (LL) CPUE indices by region: 0% or 0.5% annual rate
- Steepness: fixed at 0.7, 0.8, or 0.9

- LL selectivity: time-invariant or with two time blocks: before and after 2000.

These steps were followed to re-run the models of 2024:

1. Perform the regional scaling to the revisited 2025 LL CPUE index as done in 2024 (see Section 4.4.1 in Urtizberea et al. (2024)).
2. The LL CPUE indices by region included in the models of the 2024 final grid were replaced by the revised 2025 CPUE indices. A preprocessing of the revisited 2025 CPUE series was performed depending on the model configuration. For example, for models with an effort creep rate of 0.5%, we applied it to the CPUE series before including them in the assessment model (see Section 4.4.3 in Urtizberea et al. (2024)).
3. The updated models in the final grid were rerun.
4. A set of diagnostic metrics was calculated (Carvalho et al., 2021) to compare the performance of the 2024 assessment models and the updated 2025 models.
5. Maximum sustainable yield (MSY) reference points and stock status in 2023 were calculated following the rescaling procedure done in 2024 (see Section 7.5 in Urtizberea et al. (2024)). This rescaling procedure used the recruitment deviations in the last 20 years and aims to update the benchmarks to the most recent conditions.
6. Run a 10-year projection assuming a total annual constant catch of 421,000 tonnes during the projection period to evaluate the impact of the management advice provided in 2024 (IOTC, 2024).

3 Results

Annual recruitment, $SSB/SSBmsy$, and $SSB/SSB0$ estimates were found to be larger in the revised models before $ $2000, which were smaller after 2000 when compared to the 2024 models (Figure 2, Figure 3, and Figure 4). Conversely, $F/Fmsy$ estimates were slightly larger for the revised 2025 models after 2000 (Figure 5). Estimates of F_{2023}/F_{MSY} were larger for the revised 2025 models, while the opposite pattern was found for SSB_{2023}/SSB_{MSY} estimates (with and without rescaling, Figure 6). Regarding MSY, estimates were larger for the revised 2025 models when MSY was not rescaled; however, then the rescaling was performed, MSY values between the 2024 and revised 2025 models were similar. The revised 2025 models estimate a probability of being in the green quadrant of the Kobe plot of $\sim$ 76%, which is $\sim$ 13% lower than the estimate from the 2024 models (Figure 8). Figure 9 presents the trajectory in stock status over time for the two sets of models. Table 1 presents the median reference points.

Regarding model performance diagnostics, while all models in the 2024 assessment had a significant trend in recruitment deviates, we noticed that this trend was not detected for several revised 2025 models (Table 2). The Mohn's rho values were within the suggested range by Carvalho et al. (2021) for both set of models (Table 3), which suggests there were no retrospective patterns in SSB, F, recruitment, and SSB/SSB_{msy} estimates in any of them. Table 4 presents the root mean square error (RMSE), which was usually lower than 40% for all models. We noticed that the RMSE for the longline CPUE was slightly lower for the 2024 models, which may suggest better fits to the CPUE index. On the other side, the RMSE for mean length data was comparable between both sets of models. Regarding the predictive skill, the mean absolute square errors (MASE) were generally lower for the 2024 models, which may suggest better prediction skill when compared to the revised 2025 models (Table 5).

The 10-year projection, assuming a constant annual catch of 421,000 tonnes, produced a value of SSB_{2033}/SSB_{msy} closer to, but still larger than, 1 for the revised 2025 models (Figure 12). In addition, we observed a larger probability of $F > F_{msy}$ and $SSB < SSB_{msy}$ in 2026 and 2033 for the revised 2025 models compared to the 2024 models. However, these probabilities were always lower than 30% for both sets of models (Table 6). Regarding the probability of violating limit reference points, the estimated probabilities were always $< 1\%$ for both sets of models (Table 6).

4 Discussion

In this document, we presented the impacts of the revised longline CPUE index on the stock assessment outputs and stock status of the 2024 IO yellowfin assessment. Due to the revised CPUE index producing lower values after $\sim$ 1990, especially in region 1b (Figure 1), the estimates of biomass and stock status were slightly worse when compared to the 2024 outputs. However, the estimate of stock status remained unchanged: not overfished and not subject to overfishing in 2023. However, the probability of being in the green quadrant of the Kobe plot decreased from $\sim$ 89% (estimated in the 2024 assessment) to $\sim$ 76% (estimated in the revised 2025 models). When making the 10-years projections assuming a constant annual catch of 421,000 tonnes, the probability of violating MSY-based target reference points slightly increased for the revised 2025 models, both in 2026 and 2033 (Table 6), but kept lower than 30%. Regarding model performance, the trends in recruitment deviates were detected for all models in the 2024 assessment, which might indicate model misspecification. However, these trends were not detected in half of the revised 2025 models. On the other side, we observed worse CPUE fits and poorer predictive skill for the revised 2025 models.

5 References

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6 Tables

Table 1: Comparison of indicators regarding stock status between the 2024 assessment and the revised 2025 model. Values are the median among models in the final grid. MSY and SSB_{msy} are reported in 1,000 tonnes.

Indicator	Assessment	Value
MSY	2024	421
MSY	Revised 2025	420
SSBmsy	2024	1063
SSBmsy	Revised 2025	1111
SSB2023/SSBmsy	2024	1.32
SSB2023/SSBmsy	Revised 2025	1.18
F2023/Fmsy	2024	0.75
F2023/Fmsy	Revised 2025	0.83

Table 2: Information on the final gradient, total likelihood, and trend in recruitment deviates.

Model	Assessment	Max gradient	NLL	Trend in recdevs?
1_NoSplit_tag01_EC0_h0.7	2024	0.002	3756	TRUE
1_NoSplit_tag01_EC0_h0.7	Revised 2025	0.002	4660	FALSE
2_SplitCPUE_tag01_EC0_h0.7	2024	0.012	4213	TRUE
2_SplitCPUE_tag01_EC0_h0.7	Revised 2025	0.016	5110	TRUE
3_NoSplit_tag01_EC1_h0.7	2024	0.001	3757	TRUE
3_NoSplit_tag01_EC1_h0.7	Revised 2025	< 1e-03	4668	FALSE
4_SplitCPUE_tag01_EC1_h0.7	2024	0.004	4193	TRUE
4_SplitCPUE_tag01_EC1_h0.7	Revised 2025	0.079	5110	TRUE
5_NoSplit_tag01_EC0_h0.8	2024	< 1e-03	3751	TRUE
5_NoSplit_tag01_EC0_h0.8	Revised 2025	< 1e-03	4656	FALSE
6_SplitCPUE_tag01_EC0_h0.8	2024	0.048	4183	TRUE
6_SplitCPUE_tag01_EC0_h0.8	Revised 2025	0.066	5102	TRUE
7_NoSplit_tag01_EC1_h0.8	2024	0.001	3753	TRUE
7_NoSplit_tag01_EC1_h0.8	Revised 2025	< 1e-03	4665	FALSE
8_SplitCPUE_tag01_EC1_h0.8	2024	0.002	4184	TRUE
8_SplitCPUE_tag01_EC1_h0.8	Revised 2025	0.036	5103	TRUE
9_NoSplit_tag01_EC0_h0.9	2024	< 1e-03	3748	TRUE
9_NoSplit_tag01_EC0_h0.9	Revised 2025	< 1e-03	4654	FALSE
10_SplitCPUE_tag01_EC0_h0.9	2024	0.025	4177	TRUE
10_SplitCPUE_tag01_EC0_h0.9	Revised 2025	< 1e-03	5118	TRUE
11_NoSplit_tag01_EC1_h0.9	2024	< 1e-03	3750	TRUE
11_NoSplit_tag01_EC1_h0.9	Revised 2025	< 1e-03	4664	FALSE
12_SplitCPUE_tag01_EC1_h0.9	2024	< 1e-03	4178	TRUE
12_SplitCPUE_tag01_EC1_h0.9	Revised 2025	0.007	5133	TRUE

Table 3: Retrospective analysis on SSB, fishing mortality, recruitment, and biomass ratio (SSB/SSB_{msy}). Mohn rho values are reported per variable.

Model	Assessment	Mohn rho SSB	Mohn rho F	Mohn rho Rec	Mohn rho Bratio
1_NoSplit_tag01_EC0_h0.7	2024	-0.09	0.23	-0.29	-0.07
1_NoSplit_tag01_EC0_h0.7	Revised 2025	-0.09	0.16	-0.23	-0.07
2_SplitCPUE_tag01_EC0_h0.7	2024	-0.08	0.13	-0.27	-0.04
2_SplitCPUE_tag01_EC0_h0.7	Revised 2025	-0.07	0.15	-0.29	-0.04
3_NoSplit_tag01_EC1_h0.7	2024	-0.06	0.10	-0.19	-0.05
3_NoSplit_tag01_EC1_h0.7	Revised 2025	-0.08	0.12	-0.18	-0.07
4_SplitCPUE_tag01_EC1_h0.7	2024	-0.06	0.10	-0.23	-0.04
4_SplitCPUE_tag01_EC1_h0.7	Revised 2025	-0.03	0.02	-0.20	-0.01
5_NoSplit_tag01_EC0_h0.8	2024	-0.06	0.11	-0.22	-0.05
5_NoSplit_tag01_EC0_h0.8	Revised 2025	-0.09	0.15	-0.21	-0.07
6_SplitCPUE_tag01_EC0_h0.8	2024	-0.05	0.08	-0.23	-0.03
6_SplitCPUE_tag01_EC0_h0.8	Revised 2025	-0.03	0.04	-0.21	-0.02
7_NoSplit_tag01_EC1_h0.8	2024	-0.05	0.08	-0.17	-0.05
7_NoSplit_tag01_EC1_h0.8	Revised 2025	-0.07	0.10	-0.15	-0.06
8_SplitCPUE_tag01_EC1_h0.8	2024	-0.03	0.03	-0.18	-0.02
8_SplitCPUE_tag01_EC1_h0.8	Revised 2025	-0.02	0.00	-0.18	-0.01
9_NoSplit_tag01_EC0_h0.9	2024	-0.06	0.10	-0.21	-0.04
9_NoSplit_tag01_EC0_h0.9	Revised 2025	-0.08	0.11	-0.18	-0.06
10_SplitCPUE_tag01_EC0_h0.9	2024	-0.05	0.06	-0.21	-0.02
10_SplitCPUE_tag01_EC0_h0.9	Revised 2025	-0.04	0.01	-0.19	-0.03
11_NoSplit_tag01_EC1_h0.9	2024	-0.04	0.05	-0.14	-0.04
11_NoSplit_tag01_EC1_h0.9	Revised 2025	-0.06	0.07	-0.13	-0.05
12_SplitCPUE_tag01_EC1_h0.9	2024	-0.07	0.07	-0.16	-0.06
12_SplitCPUE_tag01_EC1_h0.9	Revised 2025	-0.04	0.03	-0.16	-0.01

Table 4: Root mean square error (RMSE) for CPUE indices and mean length. Only combined RMSE values are reported per model configuration.

Model	Assessment	RMSE	Type
1_NoSplit_tag01_EC0_h0.7	2024	25.2	cpue
1_NoSplit_tag01_EC0_h0.7	Revised 2025	36.7	cpue
1_NoSplit_tag01_EC0_h0.7	2024	13.6	len
1_NoSplit_tag01_EC0_h0.7	Revised 2025	13.8	len
2_SplitCPUE_tag01_EC0_h0.7	2024	25.0	cpue
2_SplitCPUE_tag01_EC0_h0.7	Revised 2025	36.0	cpue
2_SplitCPUE_tag01_EC0_h0.7	2024	13.4	len
2_SplitCPUE_tag01_EC0_h0.7	Revised 2025	13.6	len
3_NoSplit_tag01_EC1_h0.7	2024	25.1	cpue
3_NoSplit_tag01_EC1_h0.7	Revised 2025	36.7	cpue
3_NoSplit_tag01_EC1_h0.7	2024	13.6	len
3_NoSplit_tag01_EC1_h0.7	Revised 2025	13.9	len
4_SplitCPUE_tag01_EC1_h0.7	2024	25.1	cpue
4_SplitCPUE_tag01_EC1_h0.7	Revised 2025	36.0	cpue
4_SplitCPUE_tag01_EC1_h0.7	2024	13.4	len
4_SplitCPUE_tag01_EC1_h0.7	Revised 2025	13.6	len
5_NoSplit_tag01_EC0_h0.8	2024	25.1	cpue
5_NoSplit_tag01_EC0_h0.8	Revised 2025	36.7	cpue
5_NoSplit_tag01_EC0_h0.8	2024	13.6	len
5_NoSplit_tag01_EC0_h0.8	Revised 2025	13.9	len
6_SplitCPUE_tag01_EC0_h0.8	2024	25.0	cpue
6_SplitCPUE_tag01_EC0_h0.8	Revised 2025	36.0	cpue
6_SplitCPUE_tag01_EC0_h0.8	2024	13.4	len
6_SplitCPUE_tag01_EC0_h0.8	Revised 2025	13.6	len
7_NoSplit_tag01_EC1_h0.8	2024	25.1	cpue
7_NoSplit_tag01_EC1_h0.8	Revised 2025	36.7	cpue
7_NoSplit_tag01_EC1_h0.8	2024	13.6	len
7_NoSplit_tag01_EC1_h0.8	Revised 2025	13.9	len
8_SplitCPUE_tag01_EC1_h0.8	2024	25.1	cpue

Table 4: Root mean square error (RMSE) for CPUE indices and mean length. Only combined RMSE values are reported per model configuration.

Model	Assessment	RMSE	Type
8_SplitCPUE_tag01_EC1_h0.8	Revised 2025	36.0	cpue
8_SplitCPUE_tag01_EC1_h0.8	2024	13.4	len
8_SplitCPUE_tag01_EC1_h0.8	Revised 2025	13.6	len
9_NoSplit_tag01_EC0_h0.9	2024	25.1	cpue
9_NoSplit_tag01_EC0_h0.9	Revised 2025	36.7	cpue
9_NoSplit_tag01_EC0_h0.9	2024	13.6	len
9_NoSplit_tag01_EC0_h0.9	Revised 2025	13.9	len
10_SplitCPUE_tag01_EC0_h0.9	2024	25.0	cpue
10_SplitCPUE_tag01_EC0_h0.9	Revised 2025	36.3	cpue
10_SplitCPUE_tag01_EC0_h0.9	2024	13.4	len
10_SplitCPUE_tag01_EC0_h0.9	Revised 2025	13.6	len
11_NoSplit_tag01_EC1_h0.9	2024	25.1	cpue
11_NoSplit_tag01_EC1_h0.9	Revised 2025	36.7	cpue
11_NoSplit_tag01_EC1_h0.9	2024	13.6	len
11_NoSplit_tag01_EC1_h0.9	Revised 2025	13.9	len
12_SplitCPUE_tag01_EC1_h0.9	2024	25.1	cpue
12_SplitCPUE_tag01_EC1_h0.9	Revised 2025	35.9	cpue
12_SplitCPUE_tag01_EC1_h0.9	2024	13.4	len
12_SplitCPUE_tag01_EC1_h0.9	Revised 2025	13.7	len

Table 5: Mean absolute square error (MASE) for CPUE. Only joint MASE values are reported per model configuration.

Model	Assessment	MASE	Type
1_NoSplit_tag01_EC0_h0.7	2024	0.89	cpue
1_NoSplit_tag01_EC0_h0.7	Revised 2025	1.04	cpue
2_SplitCPUE_tag01_EC0_h0.7	2024	0.88	cpue
2_SplitCPUE_tag01_EC0_h0.7	Revised 2025	1.09	cpue
3_NoSplit_tag01_EC1_h0.7	2024	0.84	cpue
3_NoSplit_tag01_EC1_h0.7	Revised 2025	1.03	cpue
4_SplitCPUE_tag01_EC1_h0.7	2024	0.90	cpue
4_SplitCPUE_tag01_EC1_h0.7	Revised 2025	1.08	cpue
5_NoSplit_tag01_EC0_h0.8	2024	0.83	cpue
5_NoSplit_tag01_EC0_h0.8	Revised 2025	1.09	cpue
6_SplitCPUE_tag01_EC0_h0.8	2024	0.87	cpue
6_SplitCPUE_tag01_EC0_h0.8	Revised 2025	1.06	cpue
7_NoSplit_tag01_EC1_h0.8	2024	0.82	cpue
7_NoSplit_tag01_EC1_h0.8	Revised 2025	1.09	cpue
8_SplitCPUE_tag01_EC1_h0.8	2024	0.88	cpue
8_SplitCPUE_tag01_EC1_h0.8	Revised 2025	1.06	cpue
9_NoSplit_tag01_EC0_h0.9	2024	0.84	cpue
9_NoSplit_tag01_EC0_h0.9	Revised 2025	1.07	cpue
10_SplitCPUE_tag01_EC0_h0.9	2024	0.86	cpue
10_SplitCPUE_tag01_EC0_h0.9	Revised 2025	1.06	cpue
11_NoSplit_tag01_EC1_h0.9	2024	0.82	cpue
11_NoSplit_tag01_EC1_h0.9	Revised 2025	1.08	cpue
12_SplitCPUE_tag01_EC1_h0.9	2024	0.97	cpue
12_SplitCPUE_tag01_EC1_h0.9	Revised 2025	1.02	cpue

Table 6: Probability of violating the MSY-based target and limit reference points ($SSB_{lim} = 0.4SSB_{msy}$ and $F_{lim} = 1.4F_{msy}$) assuming a constant catch in the projection period of 421,000 tonnes.

Type	Reference Point and timeframe	Assessment	Probability
Target	F2026>Fmsy	2024	6.4
Target	F2026>Fmsy	Revised 2025	22.5
Target	F2033>Fmsy	2024	10.7
Target	F2033>Fmsy	Revised 2025	29.0
Target	SB2026<SBmsy	2024	0.7
Target	SB2026<SBmsy	Revised 2025	10.3
Target	SB2033<SBmsy	2024	1.2
Target	SB2033<SBmsy	Revised 2025	17.0
Limit	F2026>Flim	2024	0.0
Limit	F2026>Flim	Revised 2025	0.3
Limit	F2033>Flim	2024	0.0
Limit	F2033>Flim	Revised 2025	0.1
Limit	SB2026<SBlim	2024	0.0
Limit	SB2026<SBlim	Revised 2025	0.0
Limit	SB2033<SBlim	2024	0.0
Limit	SB2033<SBlim	Revised 2025	0.0

7 Figures

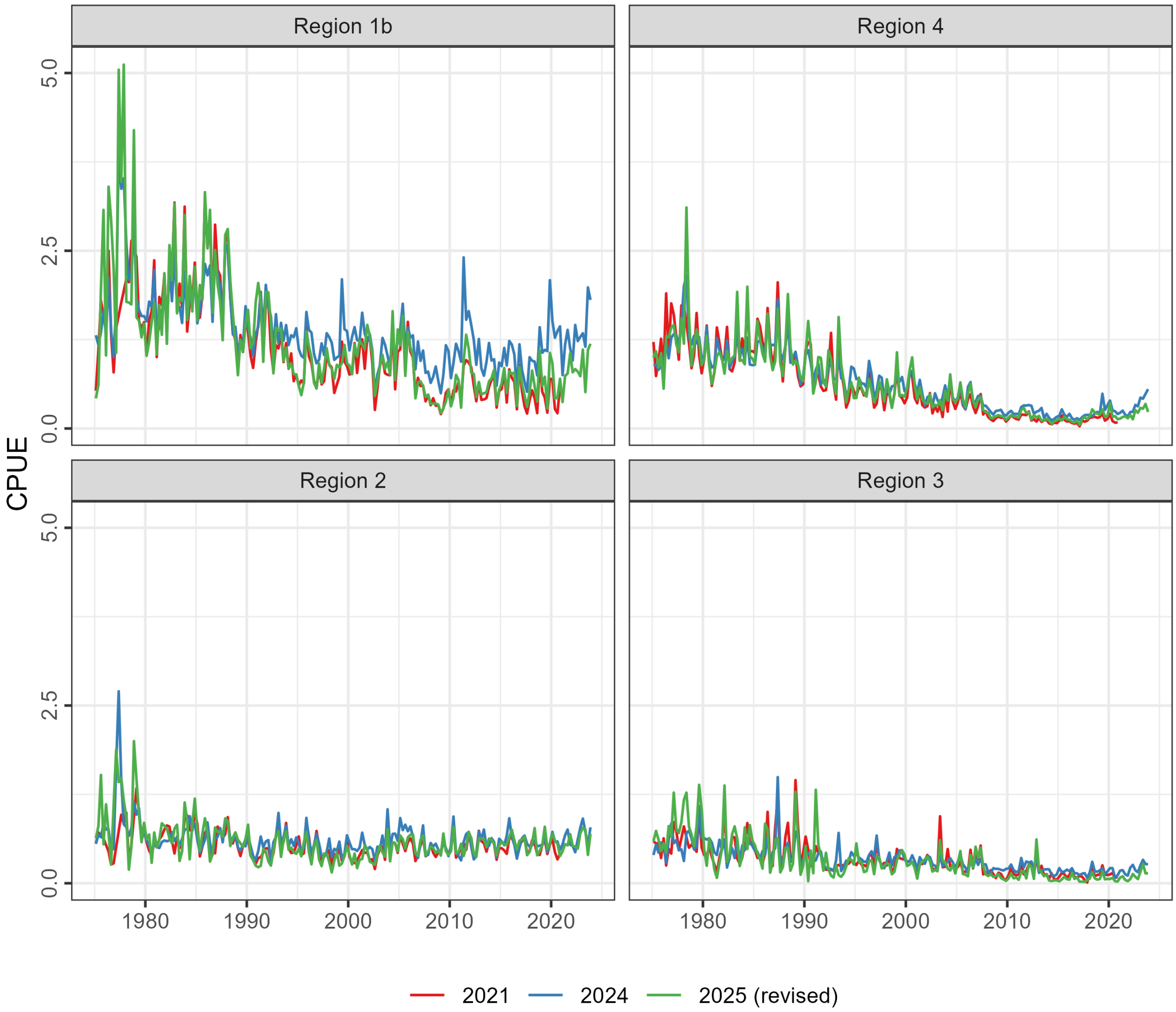

Figure 1: Standardized longline CPUE series used in the 2021 and 2024 IO yellowfin assessments by model region. The revised 2025 CPUE series presented by Kitakado et al. (2025b) and used in this document is also shown. Note that the regional scaling was performed for the three indices.

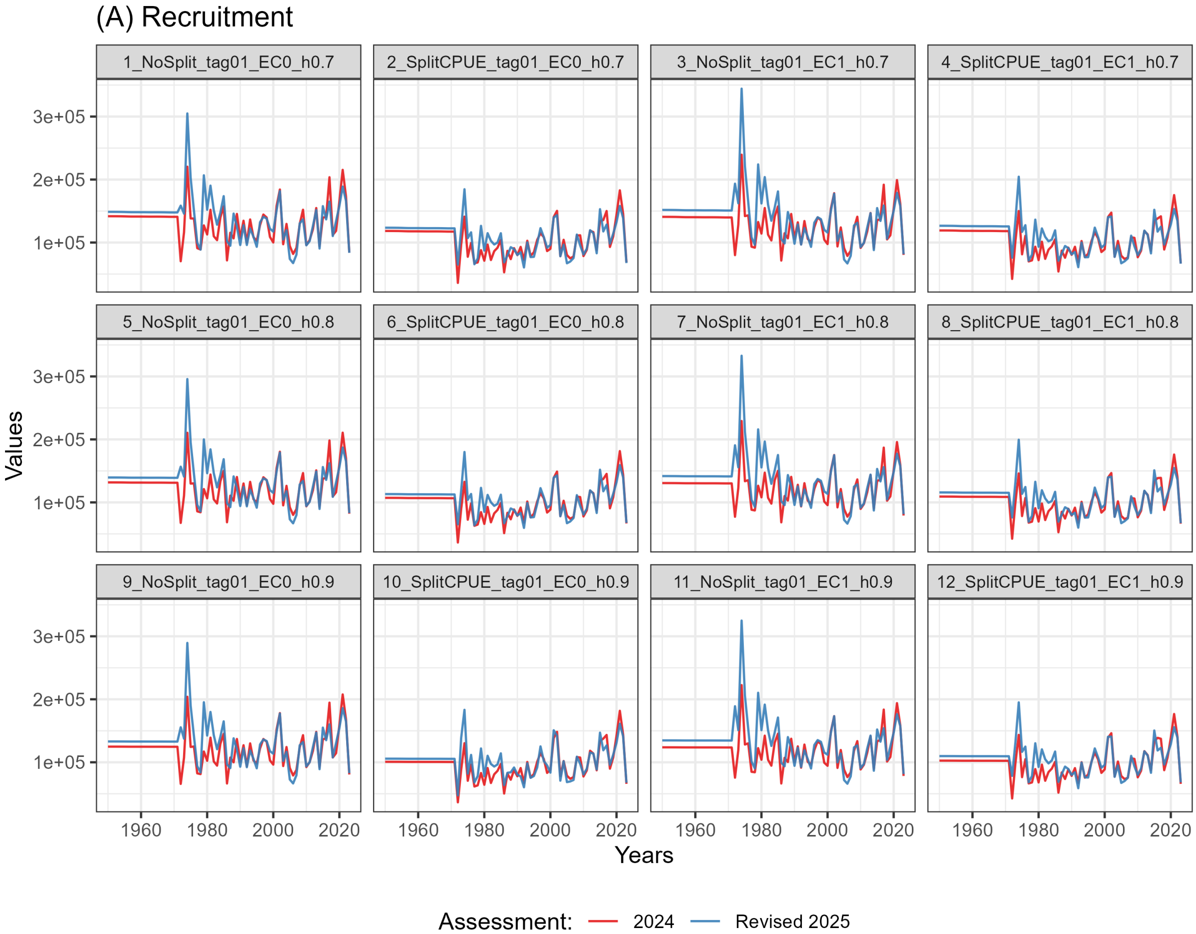

Figure 2: Comparison of recruitment estimates between the 2024 assessment and the revised 2025. Values shown by model configuration and were averaged by year.

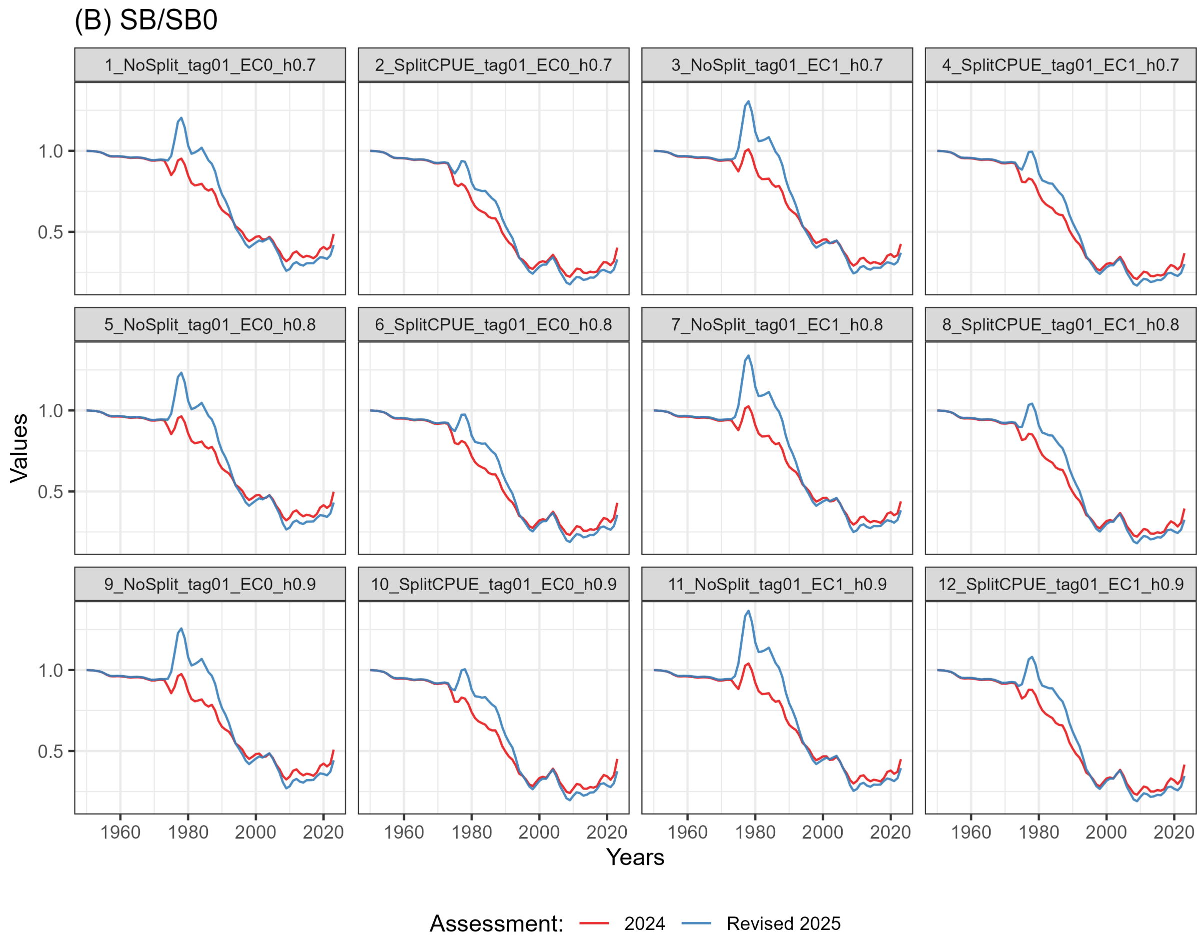

Figure 3: Comparison of SSB/SSB0 estimates between the 2024 assessment and the revised 2025. Values shown by model configuration and were averaged by year.

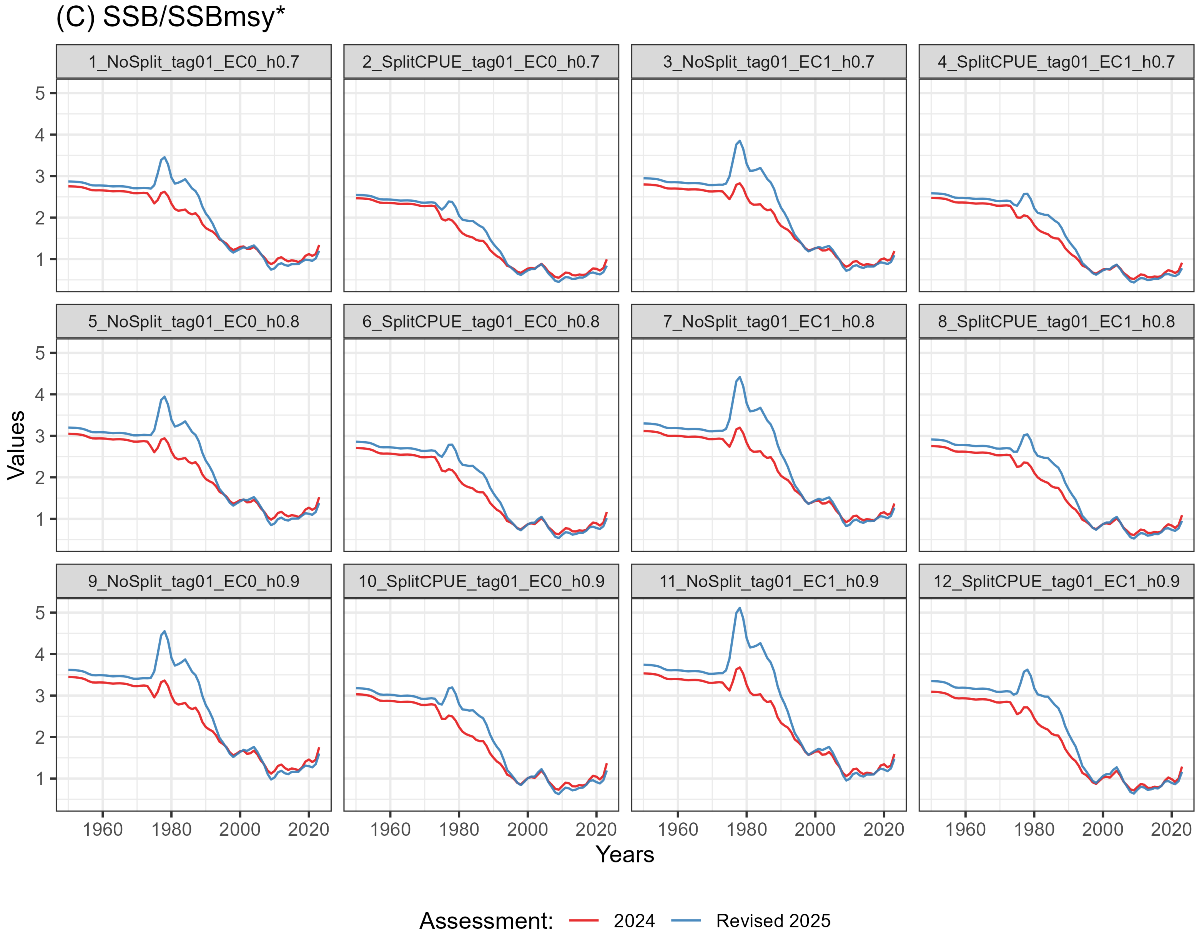

Figure 4: Comparison of SSB/SSBmsy estimates between the 2024 assessment and the revised 2025. Values shown by model configuration and were averaged by year. SSBmsy was rescaled using the last 20 years of recruitment deviations.

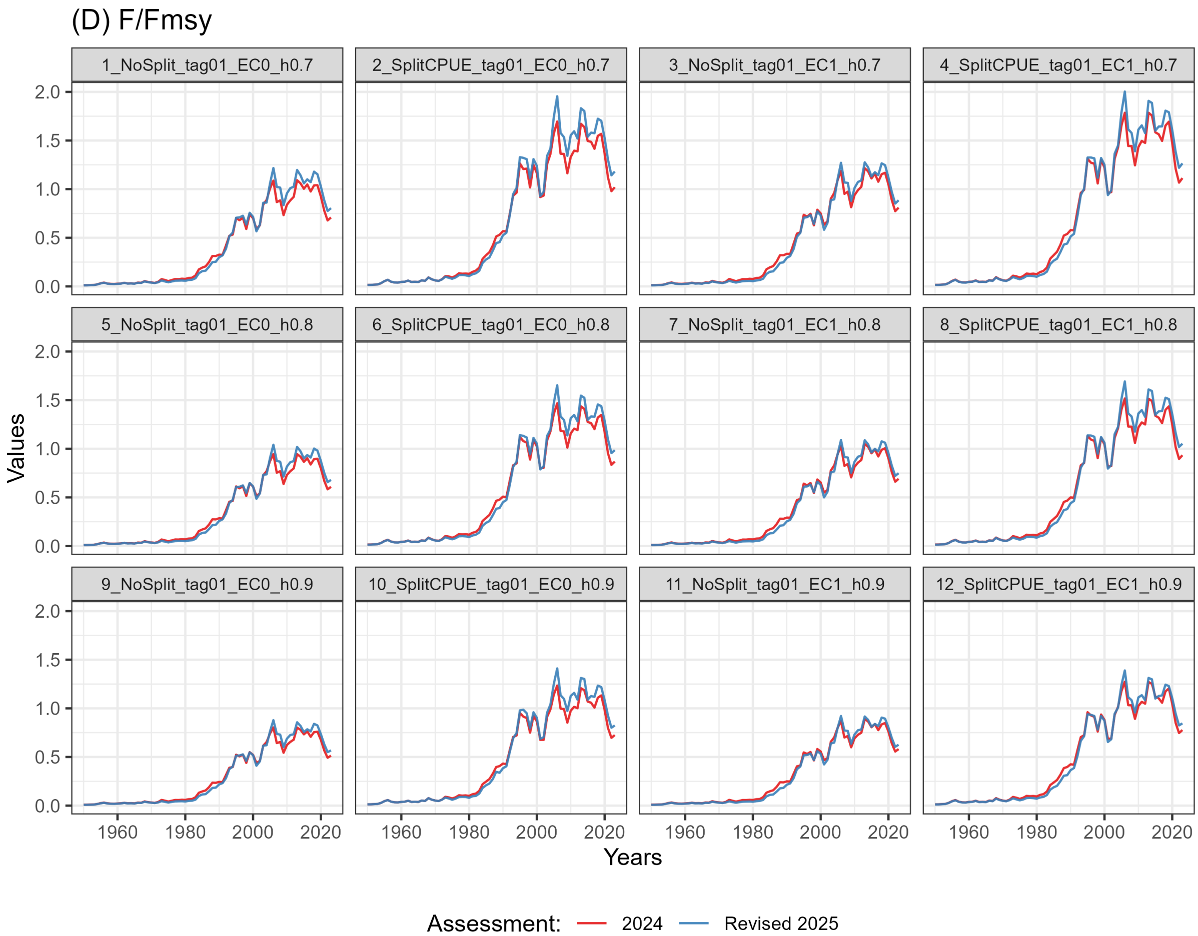

Figure 5: Comparison of F/Fmsy estimates between the 2024 assessment and the revised 2025. Values shown by model configuration and were averaged by year.

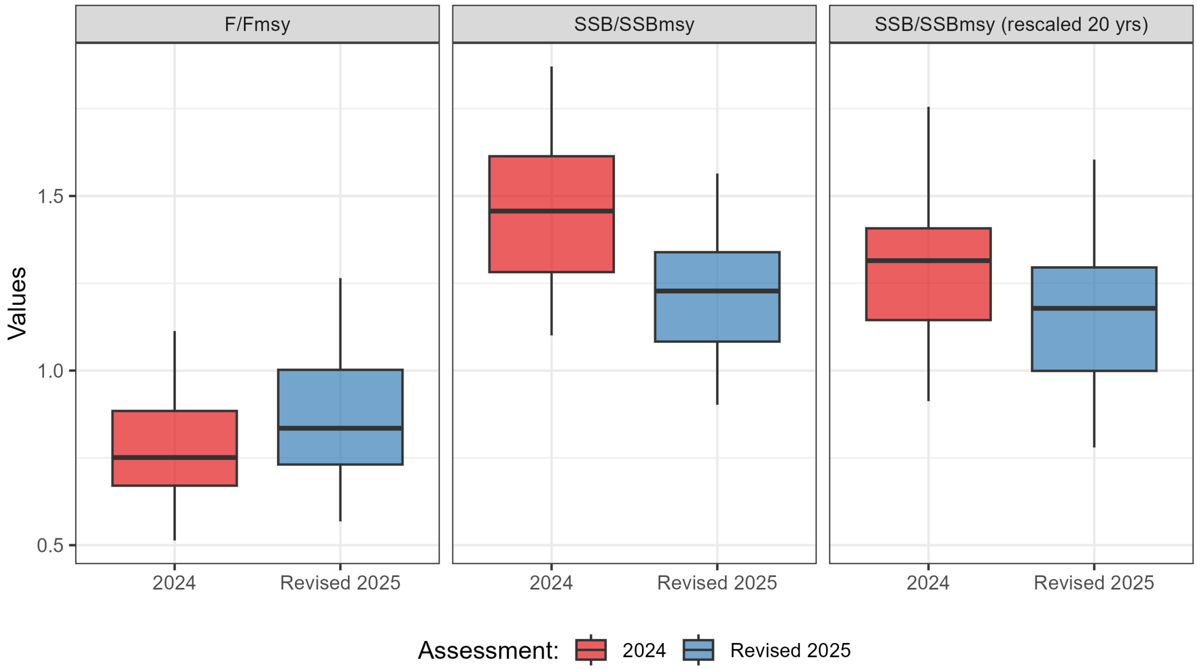

Figure 6: Comparison of F_{2023}/F_{msy} and SSB_{2023}/SSB_{msy} (without and with rescaling) estimates between the 2024 assessment and the revised 2025. Values in the boxplots come from the 12 models in the grid.

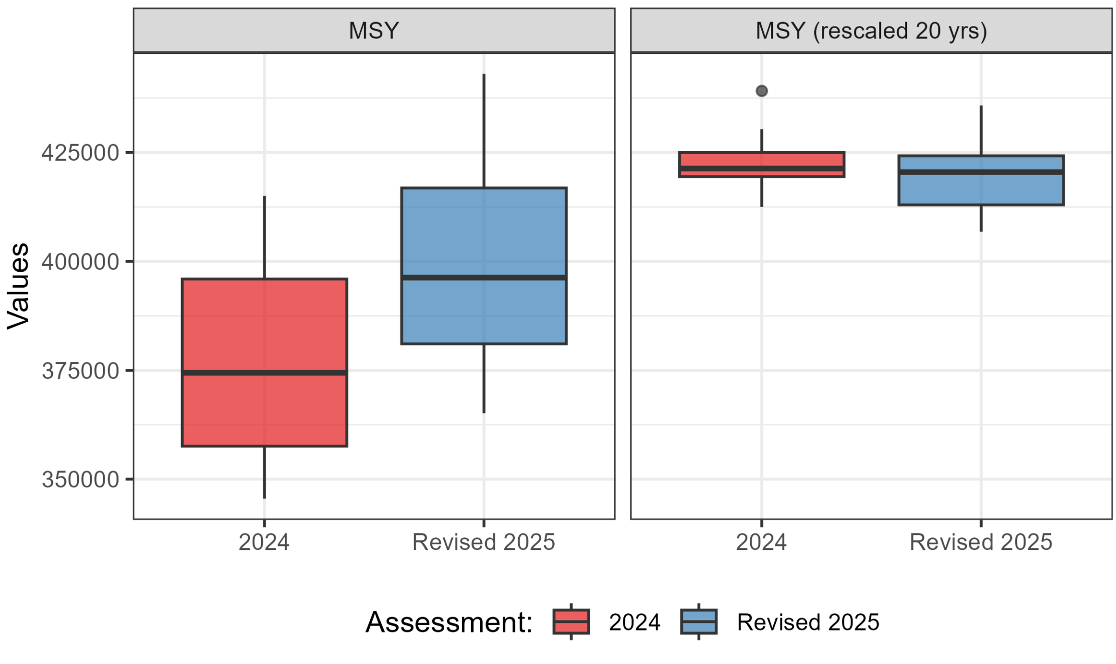

Figure 7: Comparison of MSY estimates (without and with rescaling) between the 2024 assessment and the revised 2025. Values in the boxplots come from the 12 models in the grid.

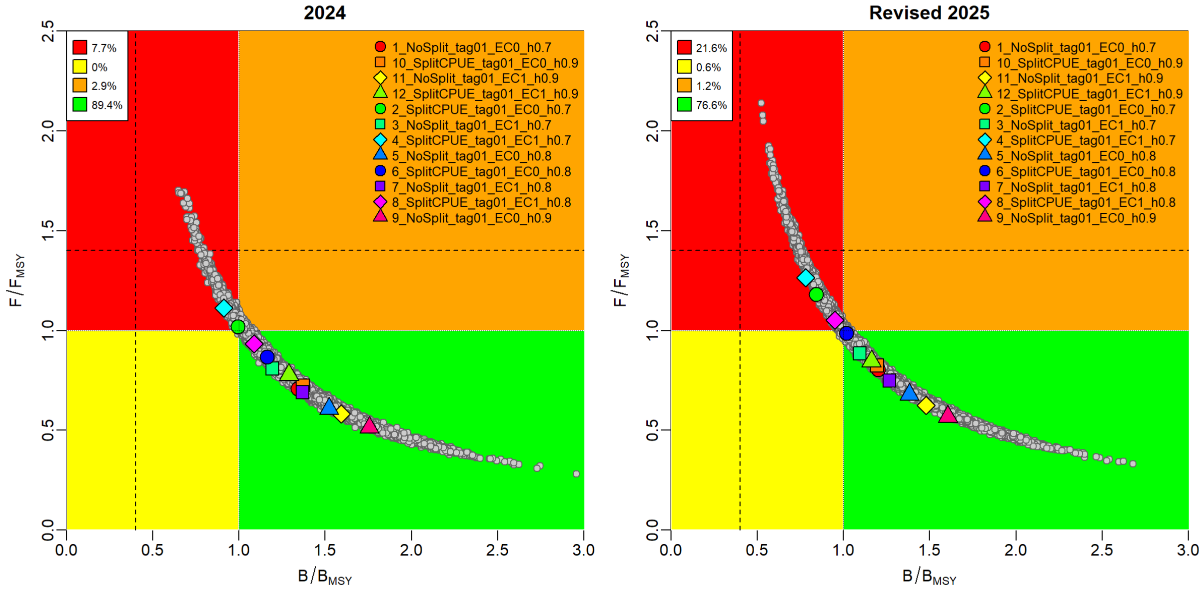

Figure 8: Kobe plot for the 2024 assessment (left) and the revised 2025 (right). Probabilities by quadrant are also shown.

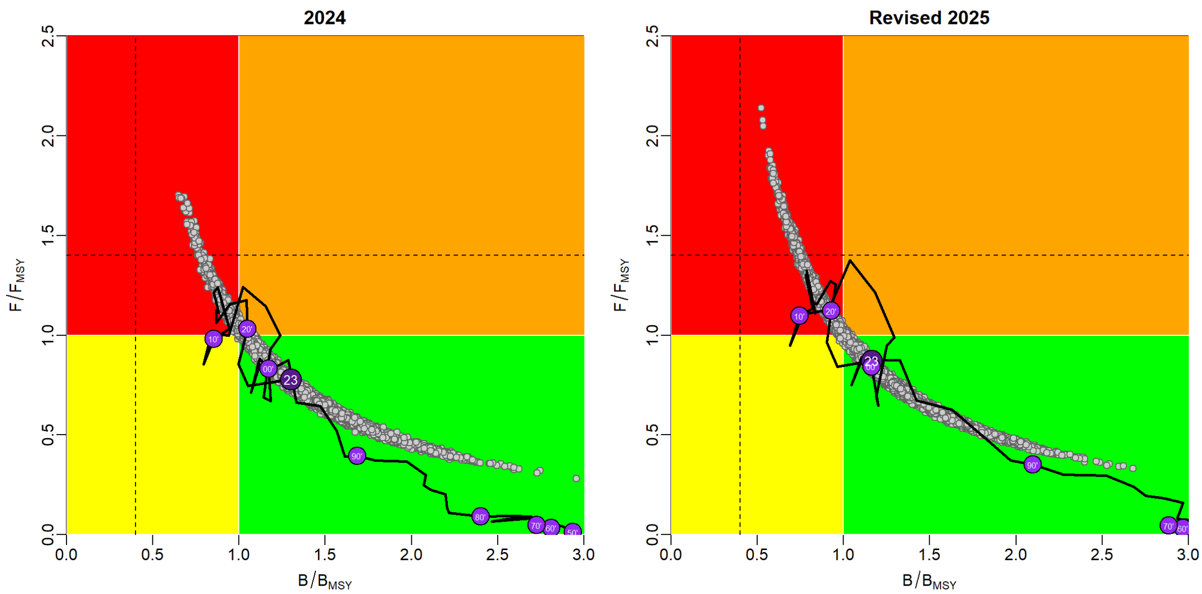

Figure 9: Trajectory of stock status for the 2024 assessment (left) and the revised 2025 (right).

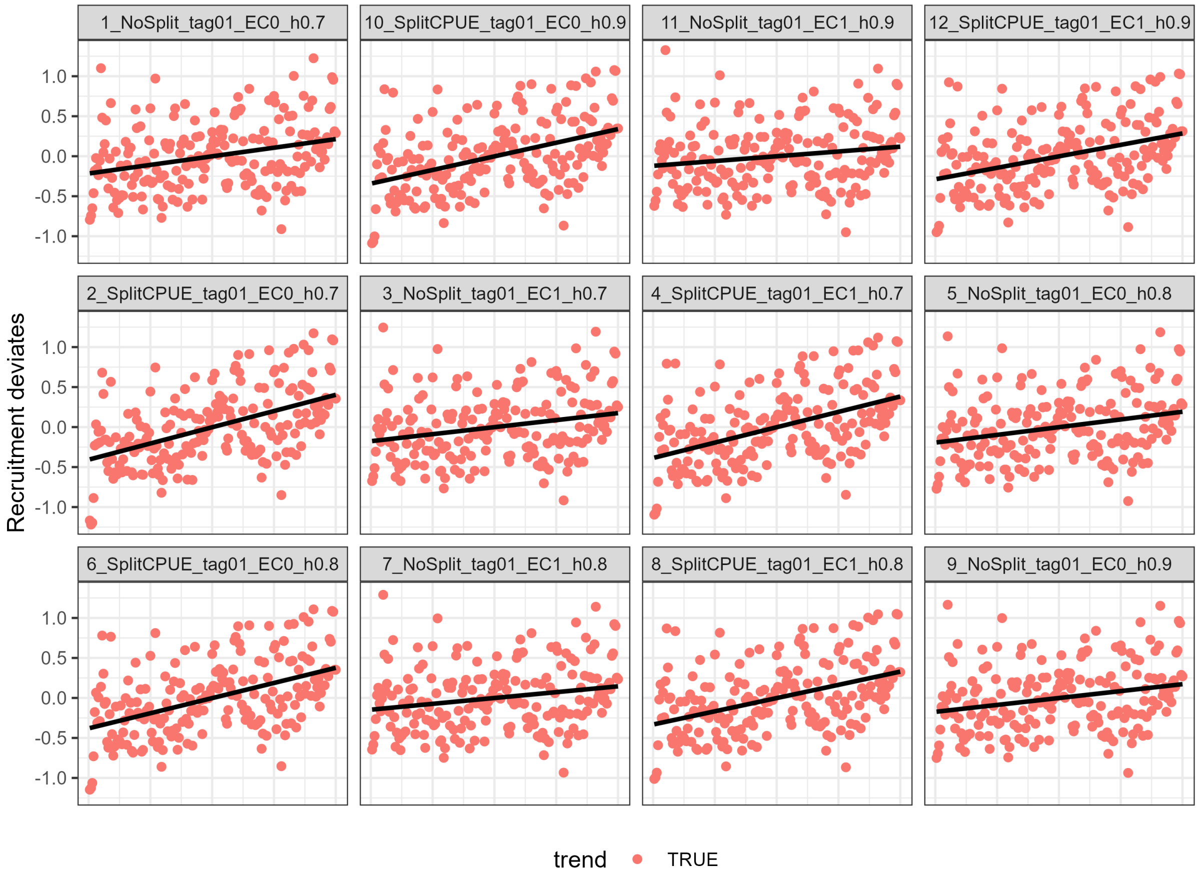

Figure 10: Trends in recruitment deviates for each model configuration in the 2024 assessment.

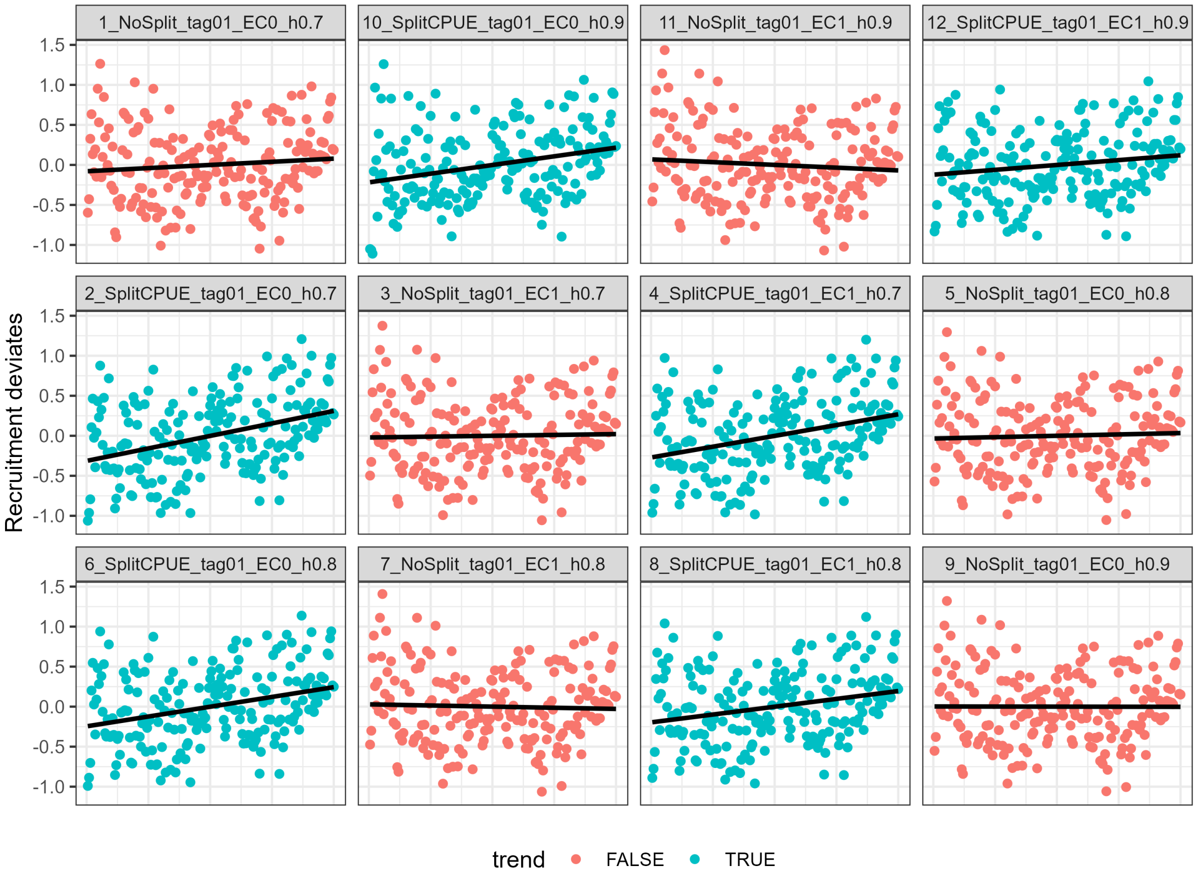

Figure 11: Trends in recruitment deviates for each model configuration in the revised 2025 models.

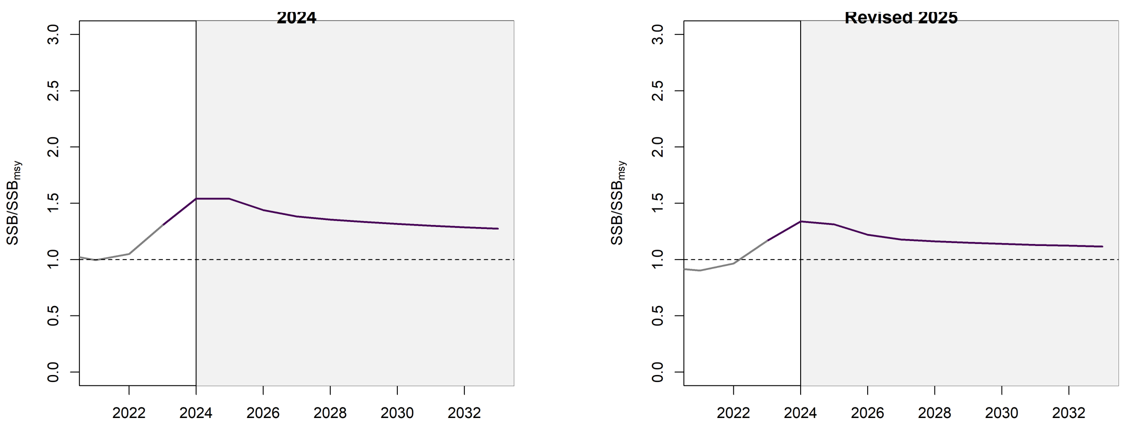

Figure 12: Annual projected SSB/SSB_{msy} assuming an annual projected catch of 421,000 tonnes for the 2024 (left) and the revised 2025 (right) models. The gray line indicates the model period, while the purple line indicates the projection period (2024-2033).