

Stock Assessment Review (STAR) Panel for Chilipepper Rockfish

Southwest Fisheries Science Center Auditorium, NOAA
110 McAllister Way | Santa Cruz CA 95060

June 23-27, 2025

1 - Request

Explore whether a flexible 2D selectivity parameterization improves model fit to age data from the California trawl fleet. Plot the fit to mean age and mean length using this run. Please also present Pearson residual plots for each.

1 - Rationale

Given the poor fit to mean ages from the mid-1980s to 2000s (~ 10 yr fish) and high selectivity of 25-30 cm fish during the same time period, changes in sex-specific selectivity may be having an effect. If this run improves the fits to mean age and mean length, it indicates that an alternative selectivity parameterization or time block structure may be considered.

1 - STAT Response

The pre-STAR base model was modified to use the “2D-AR” length-based selectivity function in Stock Synthesis for the California trawl fleet for the years 1978-2024. The standard deviation of the selectivity deviations was fixed at 1, and the model was not re-tune to allow for comparison of likelihood components. The parameters of the underlying logistic selectivity curve (from which deviations are estimated) were estimated as 32.19 cm for the inflection point and 6.57 cm for the “95% width” parameter, i.e., the difference between the mean and the 95th percentile of the logistic curve. Deviations were estimated for each year and population bin (~1360 parameters, Figure 1a). The change to a more flexible selectivity curve did not visibly improve the fit to mean age (Figure 1b), and the age composition likelihood component increased from 2002.35 to 2006.22, suggesting a slight degradation of fit to the age data. The length composition likelihood decreased from 569.09 in the pre-STAR base model to 531.01 in the model with a more flexible length-based selectivity curve. Given the addition of over 1,300 deviation parameters, an improved fit to the length composition data is not surprising. Visually, the change in overall fit to the length data is subtle, with noticeable improvement in fit for the years 1978-1983 (Figure 1c). Pearson residuals for the conditional age-at-length data showed some reduction in residual size for large males (Figures 1d and 1e), but patterns observed in the pre-STAR base model persisted. Pearson residuals for the length composition data (Figure 1f) show larger extreme deviations when using the 2D selectivity, suggesting that the improvement in fit (decrease in likelihood) is spread across multiple length bins and years. Changes in scale for the residual plots make visual comparison difficult. We plotted the $\log_{10}$ absolute value of the Pearson residuals from each model against each other, and grouped by sex (Figures 1g and 1h). These suggest that the improvement in fit using the 2D selectivity is driven by better fits to large males.

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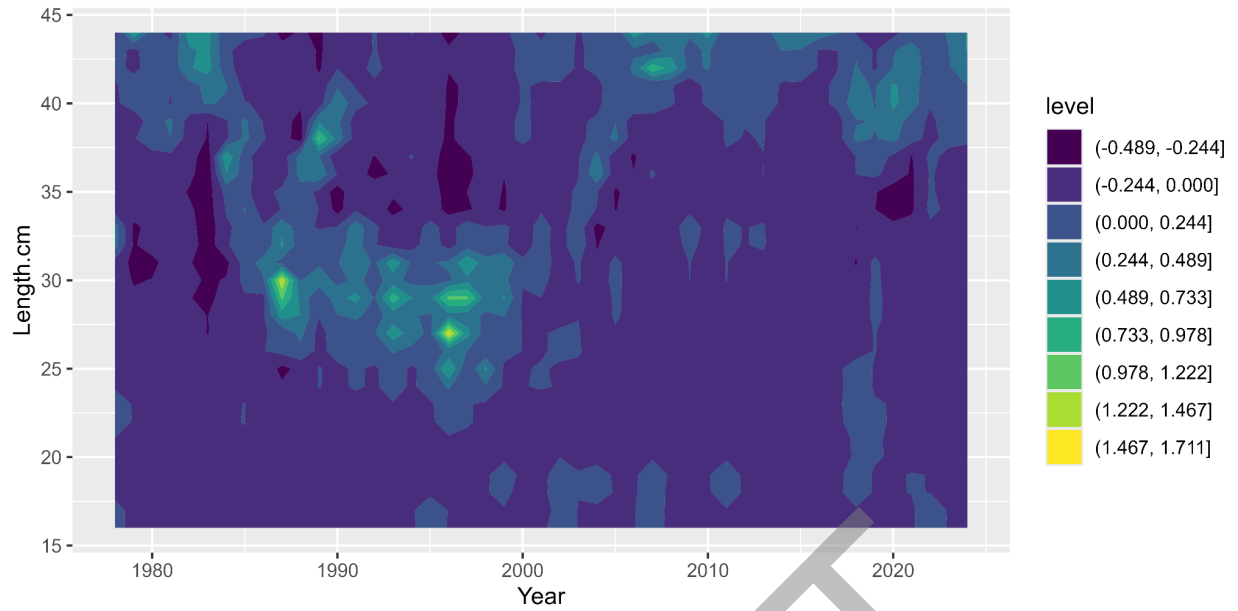


Figure 1a. Contour plot of deviations from a logistic selectivity curve estimated for the California trawl fleet.

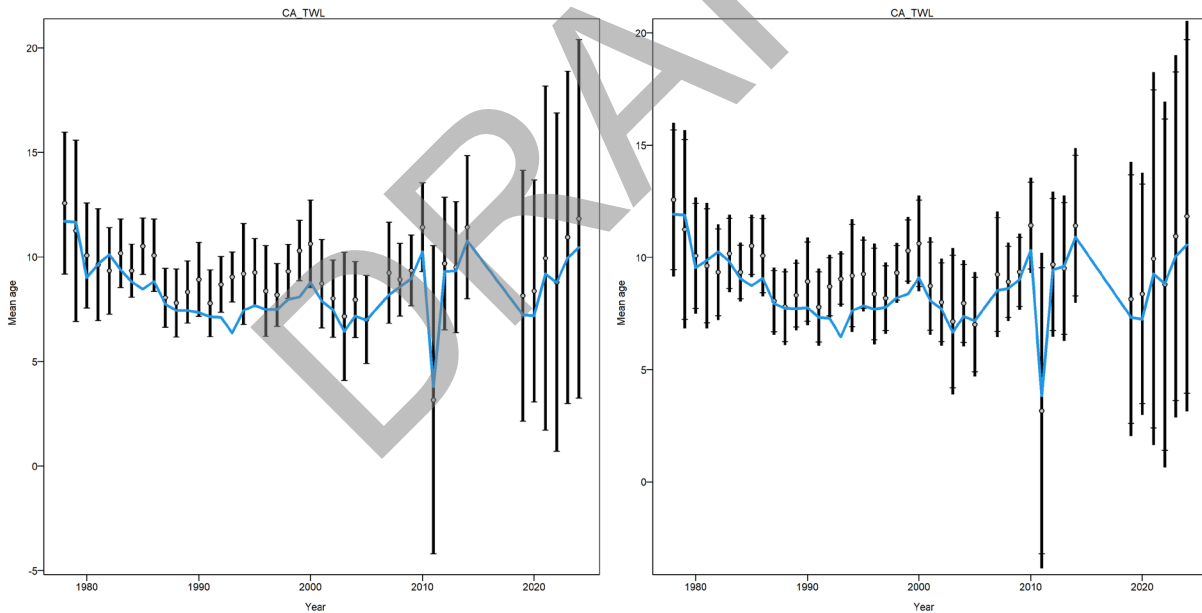


Figure 1b. Comparison of observed mean age (points) with 95% confidence intervals based on current samples sizes to model predictions of mean age (blue line) for the California trawl fleet. Left panel: pre-STAR base model tuned using Francis weights. Right panel: model with 2D-AR selectivity for the trawl fleet, using the same Francis weights as the pre-STAR base model (i.e., not re-tuned).

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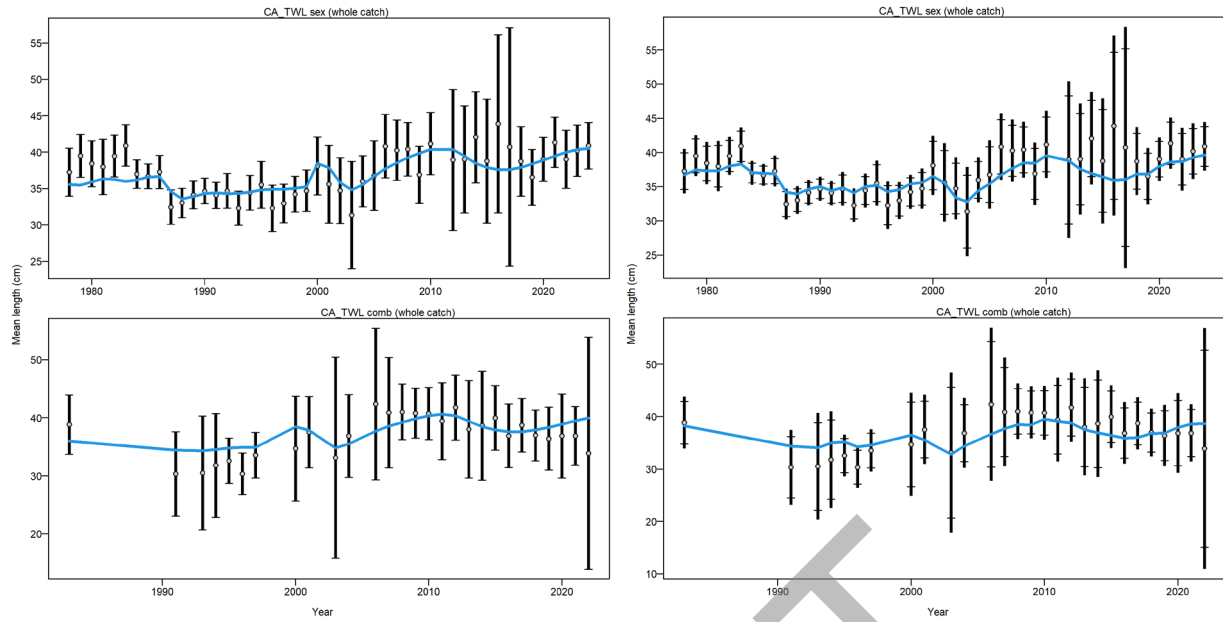


Figure 1c. Comparison of observed mean length (points) with 95% confidence intervals based on current sample sizes to model predictions of mean length (blue line) for the California trawl fleet. Left panels: pre-STAR base model tuned using Francis weights. Right panel: model with 2D-AR selectivity for the trawl fleet, using the same Francis weights as the pre-STAR base model (i.e., not re-tuned).

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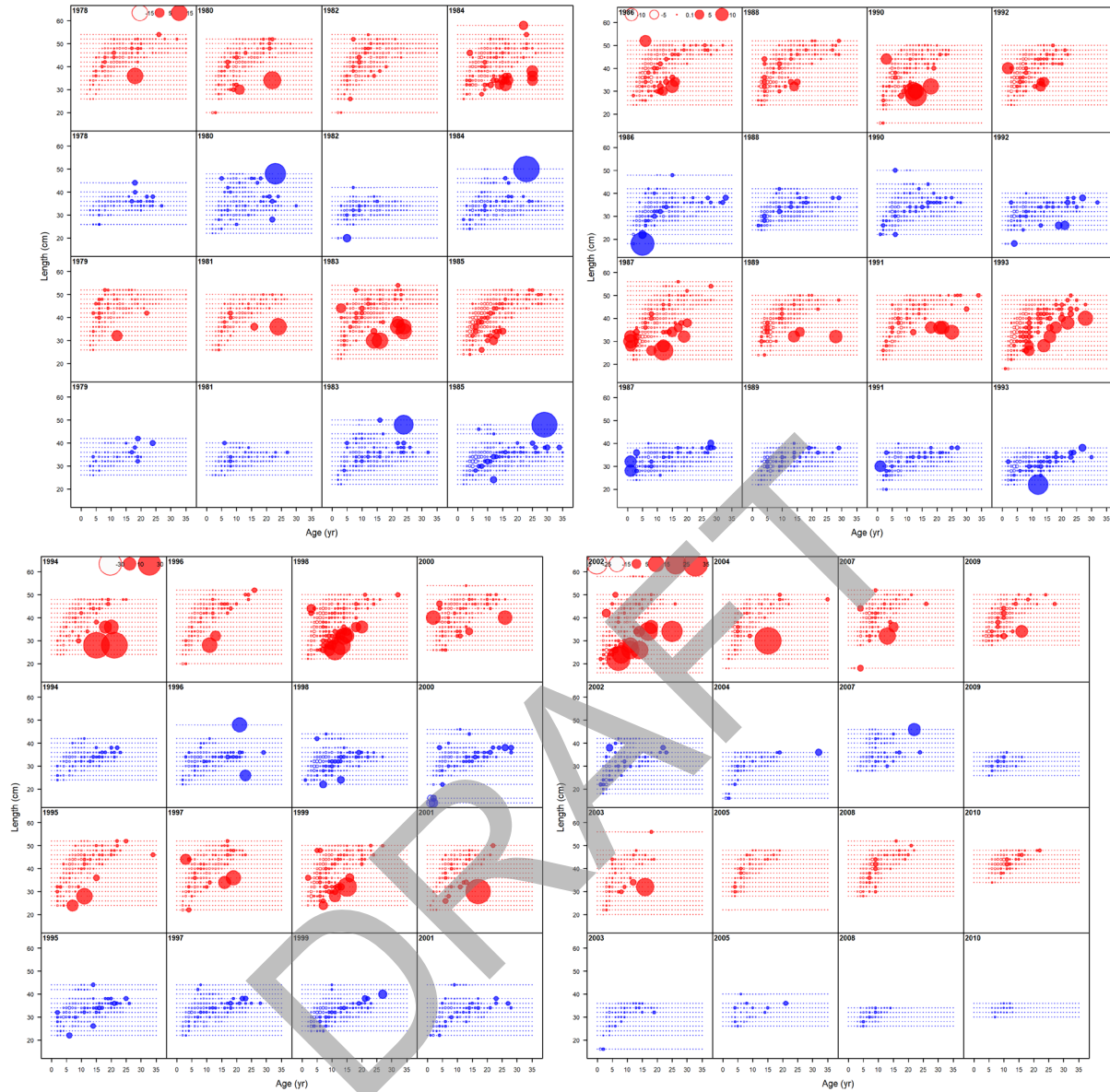


Figure 1d. Pearson residual plots for conditional age-at-length data from the California trawl fleet, 1978-2010. Trawl fleet length-based selectivity modeled using the 2D-AR option in Stock Synthesis.

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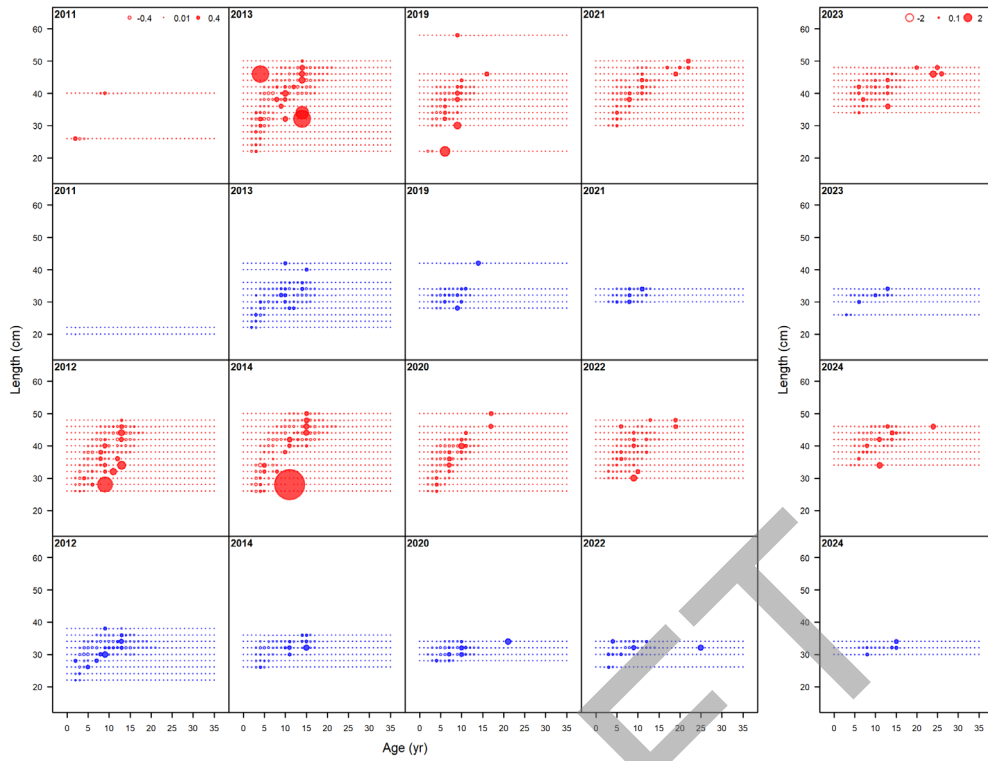


Figure 1e. Pearson residual plots for conditional age-at-length data from the California trawl fleet, 2011-2024. Trawl fleet length-based selectivity modeled using the 2D-AR option in Stock Synthesis.

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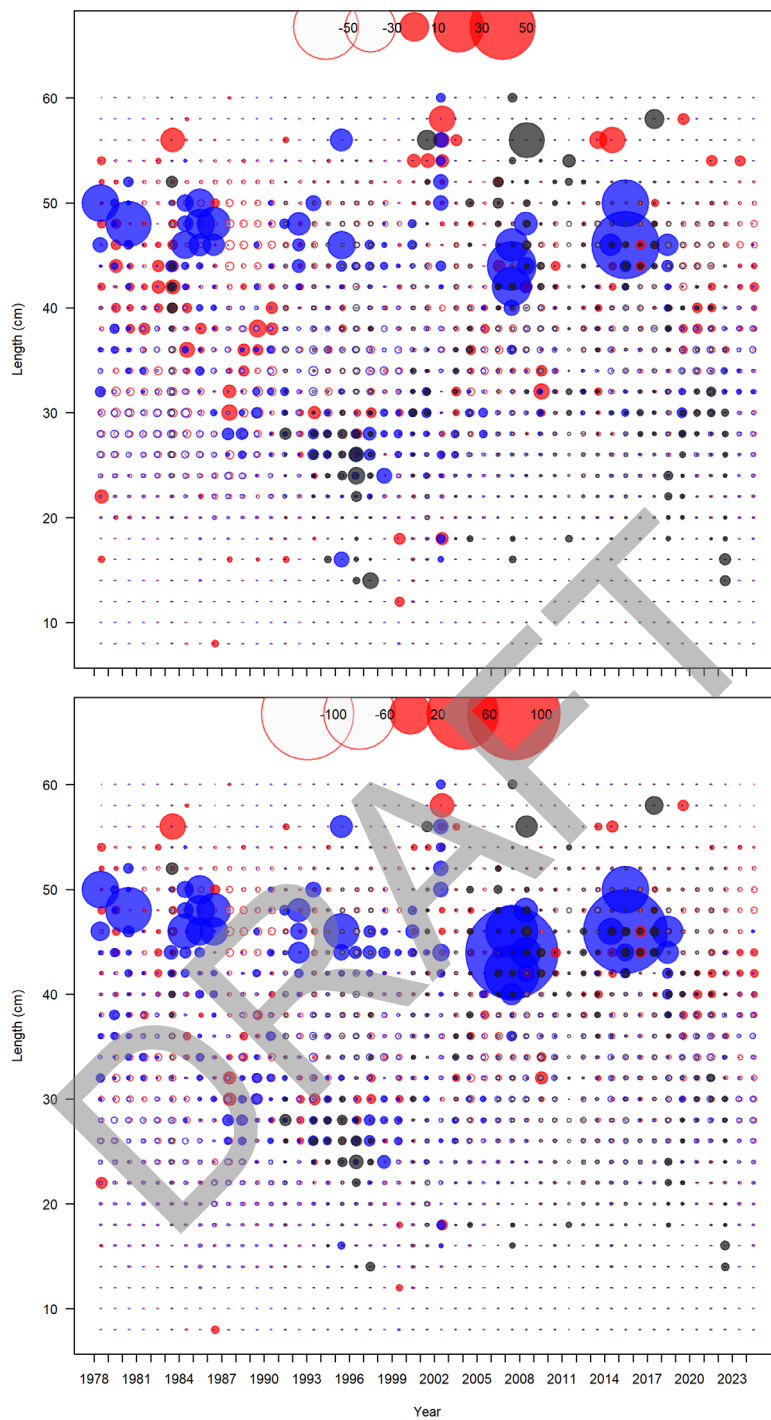


Figure 1f. Pearson residual plot for length composition data from the California trawl fleet, 1978-2024. Trawl fleet length-based selectivity was using time-blocks in the pre-STAR base model (top panel), and the 2D-AR option in Stock Synthesis (bottom panel).

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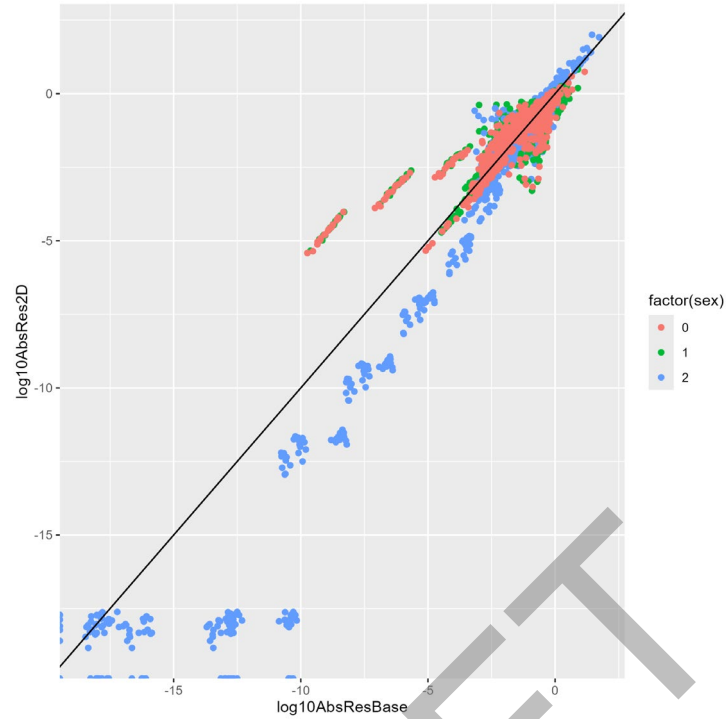


Figure 1g. Log-scale absolute Pearson residuals from the pre-STAR base model (x-axis), compared to the model with a flexible (2D) selectivity curve (y-axis). The 2D selectivity model has smaller residuals for males (sex=2), and some larger residuals for unsexed fish (sex=0) and females (sex=1).

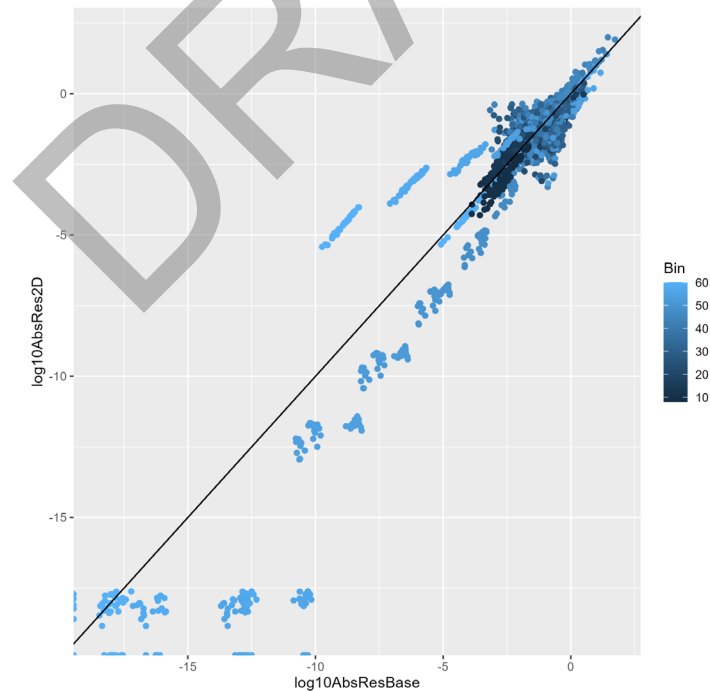


Figure 1h. Log-scale absolute Pearson residuals from the pre-STAR base model (x-axis), compared to the model with a flexible (2D) selectivity curve (y-axis). The 2D selectivity model has smaller residuals for larger males (sex=2), and some larger residuals for very large unsexed fish (sex=0) and females (sex=1).

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1 - Panel Conclusion

A freely estimated, time-varying selectivity with many deviation parameters (2d) did not improve the general fit to the mean age. There was a minor improvement to the fit to mean length. There were a few larger residuals with the 2d selectivity, especially for larger males with already large residuals in the pre-STAR base model. The 2d selectivity slightly reduced the residuals in general for larger males, but they were still large, while the fit worsened slightly for some female and unsexed fish. We therefore do not recommend to use the 2d deviation in the new base model.

There was some discussion about changes in gear type (e.g., popularization of 'rockhopper' roller gear) in the mid-1980s and 1990s (see Figure 1a), though there was inadequate information at this time to propose specific time blocking to address this.

2 - Request

Run a sensitivity analysis by replacing the dome-shaped selectivity of the commercial fleets that showed estimation issues with the descending limb parameter based on the MCMC analysis, with asymptotic selectivity. Plot the spawning output, fraction unfished, and recruitment deviations, and compare estimates with the pre-STAR base model.

2 - Rationale

The parameters for the descending limb were not well-defined based on the MCMC analysis. Using an asymptotic selectivity will also simplify the model. If overall fits and population predictions do not change with asymptotic selectivity, that would support a more parsimonious model.

2 - STAT Response

By analysis of MCMC diagnostics of the pre-STAR base model the descending scale parameter of the double normal (DN) domes shaped selectivities in the NoCA_HKL, SoCA_HK, CA_TWL, CA_NET, and NoCA_OR_WA_Rec fleets appeared to have improper posteriors. Each of these fleets were given asymptotic sigmoidal selectivity by fixing the final selectivity of the DN to $\text{inv.logit}(10)=0.9999546$ and fixing the descending scale to produce a two parameter sigmoid with the free parameters being the location the DN peak and the DN ascending scale. Time blocks in the model were preserved, allowing for changes in the 'peak' and 'ascending scale' parameters. Separate model runs were constructed to fit asymptotic selectivities for each of the fleets separately and a final model is shown fitting all of the above fleets jointly with asymptotic selectivities.

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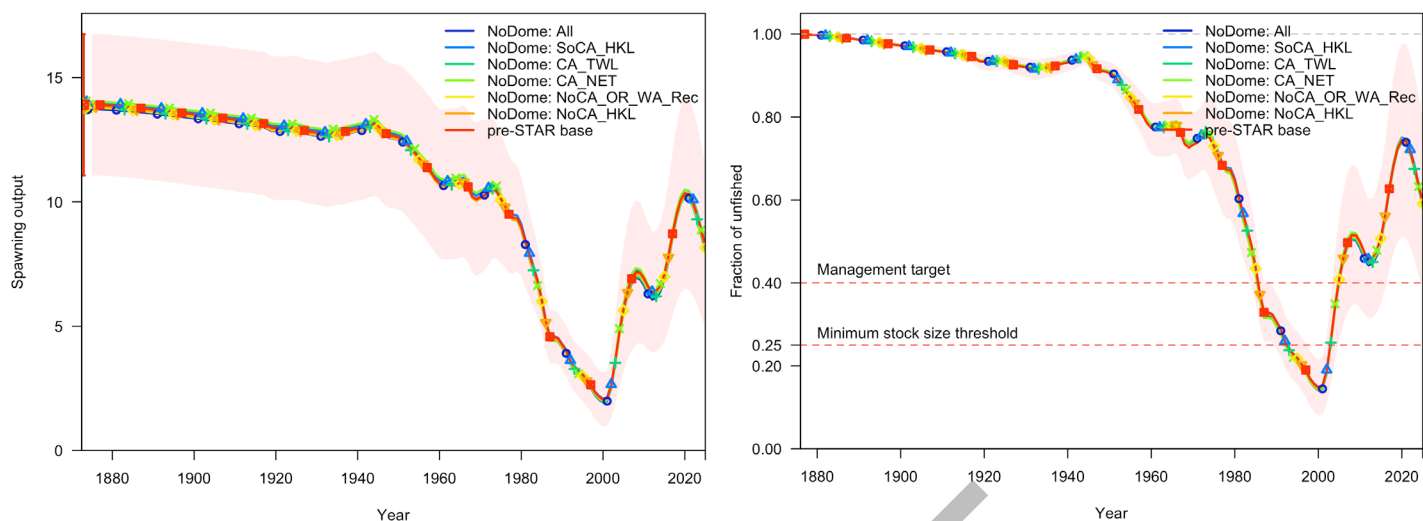


Figure 2a. Comparisons of the spawning output and fraction unfinished are almost indistinguishable between the various selectivities in the models run.

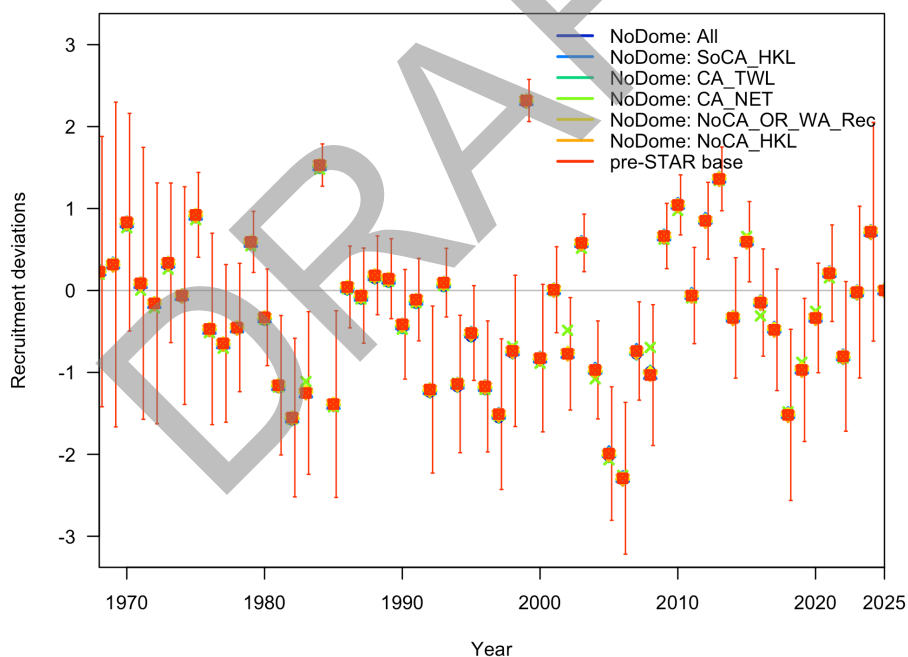


Figure 2b. Recruitment deviations of the compared models are largely indistinguishable as well. The only model to show even slight differences in recruitment deviations is the model with only asymptotic selectivity in the CA_NET fleet (and only in a minority of years).

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Table 2a. Negative log-likelihood values for each of the fit models. Likelihood components are in the rows.

Label	NoDome: All	NoDome: CA_NET	NoDome: SoCA_HKL	NoDome: CA_TWL	NoDome: NoCA_OR_WA_Rec	NoDome: NoCA_HKL	pre-STAR base
N.Parms	109	113	113	113	113	113	114
TOTAL	2624.18	2626.11	2621.95	2622.39	2620.82	2620.51	2620.26
Survey	24.2567	24.1734	24.5525	24.3505	24.4258	24.4998	24.5754
Length_comp	570.567	571.97	570.691	569.718	568.723	568.564	569.086
Age_comp	2004.83	2006.28	2002.38	2003.88	2003.37	2003.19	2002.35
Recruitment	24.4337	23.5844	24.2486	24.3614	24.2309	24.1945	24.1847

While most models are almost identical, the CA_NET only model shows the biggest increase in negative log-likelihood (NLL). The model with all asymptotic selectivity has four NLL points greater than the pre-STAR base model but it also saves four parameters and therefore seems to be a parsimonious option that doesn't substantively change results as compared with the pre-STAR base model. The weak identifiability of the dome shape selectives of the pre-STAR base model likely indicates that there is little to no information in the data to inform the descending scale parameters of the dome shaped selectivities.

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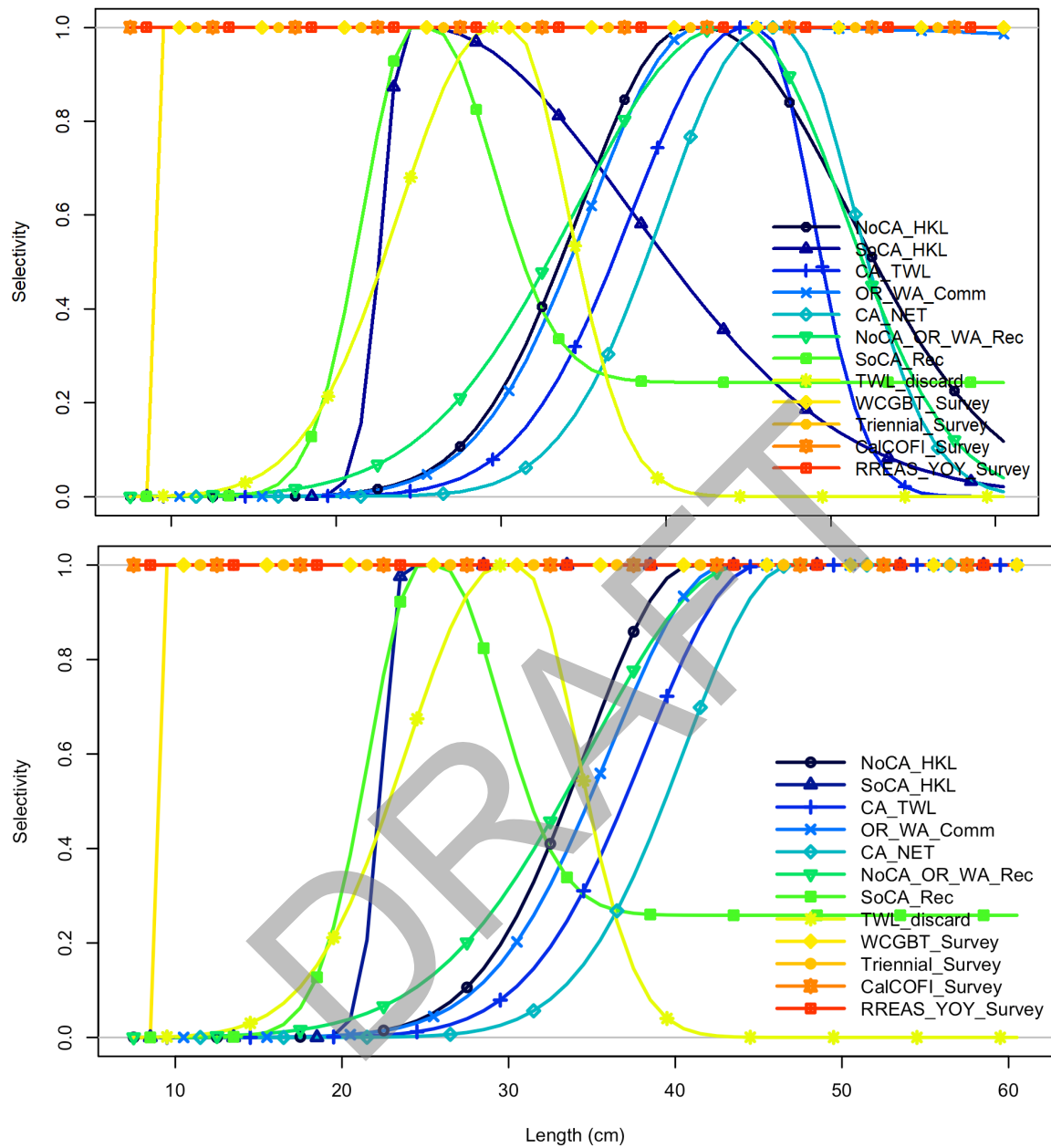


Figure 2c. Fits to pre-STAR base model dome selectivities (top) as compared with the fit asymptotic selectivities (bottom).

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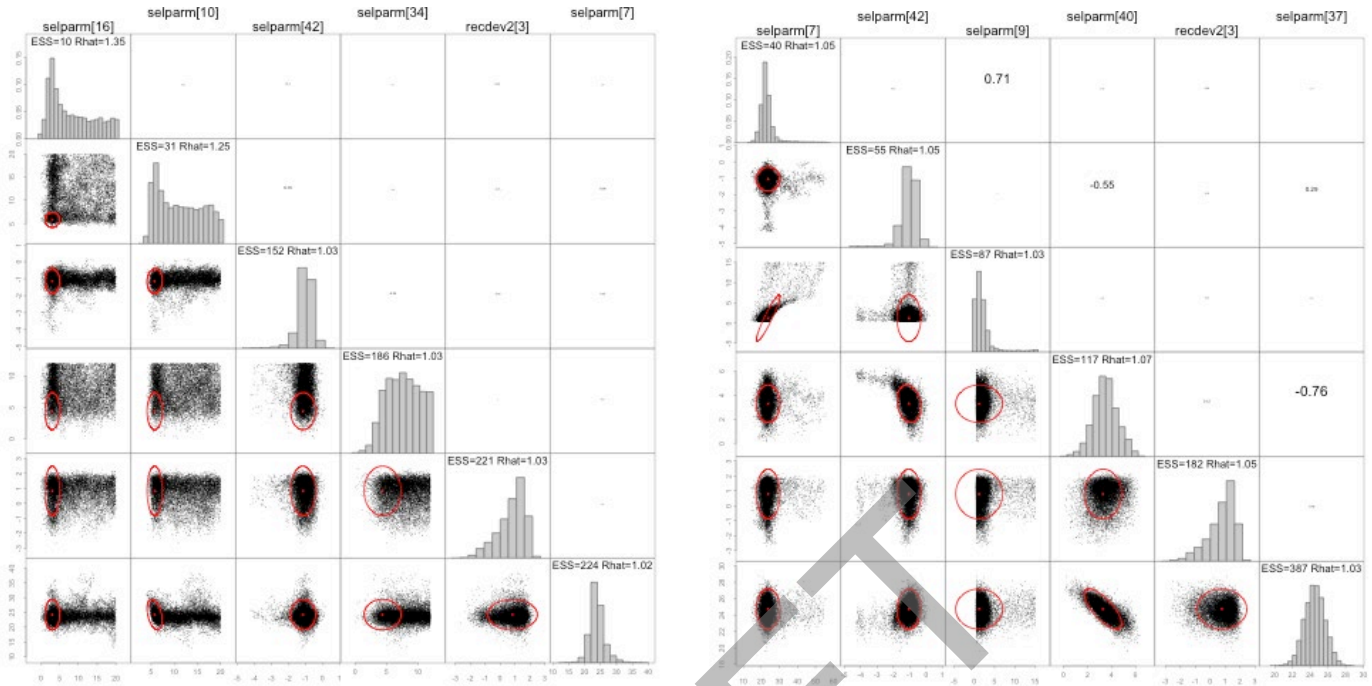


Figure 2d. Above shows the slowest converging parameters from the MCMC diagnostics for the pre-STAR base model (left) and the all asymptotic selectivity model (right). While convergence is not perfect, the asymptotic selectivities largely remove the improper posteriors that were present in the pre-STAR base model.

2 - Panel Conclusion

The new base model should update selectivity from dome-shaped to asymptotic for all commercial fleets, except for the southern California recreational and trawl discard fleets in defining a new base model. This is supported by a more parsimonious model showing an insignificant increase in the likelihood (approximately 4 units of likelihood resulting from a reduction of 5 parameters).

3 - Request

Re-compute the WCBTS index by including the depth effect (WCBTS_depth). Compare the time series estimate between the current index and the WCBTS_depth in a single plot including confidence intervals.

3 - Rationale

Depth is an important habitat variable for rockfish species. Although the spatial model can capture much of the depth effects (via anisotropy and spatial field), previous work ([Johnson et al. 2019](#)) has shown that it may be beneficial to include.

3 - STAT Response

[Chantel & Eric]

3 - Panel Conclusion

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The Panel greatly appreciated being able to see the WCGBTS index with and without a depth effect. The discussion about responses to Request 3 resulted in a new request (see Request 12).

4 - Request

Calculate the average of the main period recruitment deviations in the pre-STAR base model. Present results from a run with the constraint for the recruitment deviations to sum to zero. Provide a table showing the parameters for these two runs along with the sensitivity with recruitment deviations fixed at zero (3 runs). Please include reference points. Plot dynamic B_0 for these three runs.

4 - Rationale

The constraint to sum recruitment deviations to zero ensures that the reference points are consistent with the assumptions of the model. Without that constraint, the reference points implied by the main recruitment period may differ considerably from the reported reference points. This request will provide insight into the magnitude of this potential discrepancy.

4 - STAT Response

The average of the main period recruitment deviations (1968-2024) in the pre-STAR base model is -0.24498. This model was modified by setting the “Do Recruitment Deviations” option to “Deviation Vector” (option 1) that imposes a sum-to-zero constraint on the recruitment deviations. An initial run was completed without ‘tuning’ the model so likelihood components could be compared directly to the pre-STAR base model. A subsequent model run adjusted the bias ramp and tuned the Francis weights using the same methods applied to the pre-STAR base model. Finally, a model run using the pre-STAR base model (with triennial ages added) and no recruitment deviations was run without tuning.

Compared to the pre-STAR base model, models with a sum-to-zero constraint on recruitment deviations have a lower estimate of unfished spawning output, and a similar end-year estimate of spawning output. Therefore, relative spawning output is higher (less depleted relative to unfished levels) in the models with the sum-to-zero constraint (Figure 4a). Recruitment deviations without a sum-to-zero constraint have a negative offset relative to the constrained deviations, resulting in a higher estimate of unfished equilibrium recruitment (R_0). Estimates of long-term sustainable yield from the pre-STAR base model are around 2500 mt, whereas estimates from models with a sum-to-zero constraint are around 2000 mt (similar to the previous assessment, which also used a sum-to-zero constraint). Likelihood components, estimated parameter values, and derived quantities from the four models are provided in Table 4a. Estimates of natural mortality are lower for females, and higher for males, in the models with a sum-to-zero constraint. All models assume steepness = 0.72.

Both models with sum-to-zero constraints, as well as the pre-STAR base model, include a bias adjustment following the methods of Methot and Taylor (2011). Methot and Taylor estimated deviations in that paper using a sum-to-zero constraint, so it is unclear to the STAT whether the Methot and Taylor bias adjustment is appropriate for the pre-STAR base model and other models fit using maximum likelihood that do not impose a sum-to-zero constraint. Posterior distributions for the logarithm of R_0 , based on the diagnostic MCMC runs that did not use a

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sum-to-zero constraint, suggest a value between 10 and 11, with a mode near 10.3 (Figure 4c). The $\log(R_0)$ value estimated by the pre-STAR base model, without a sum-to-zero constraint and with a bias correction, is 10.24. The $\log R_0$ values estimated by models with a sum-to-zero constraint are slightly below 10 (Table 4a).

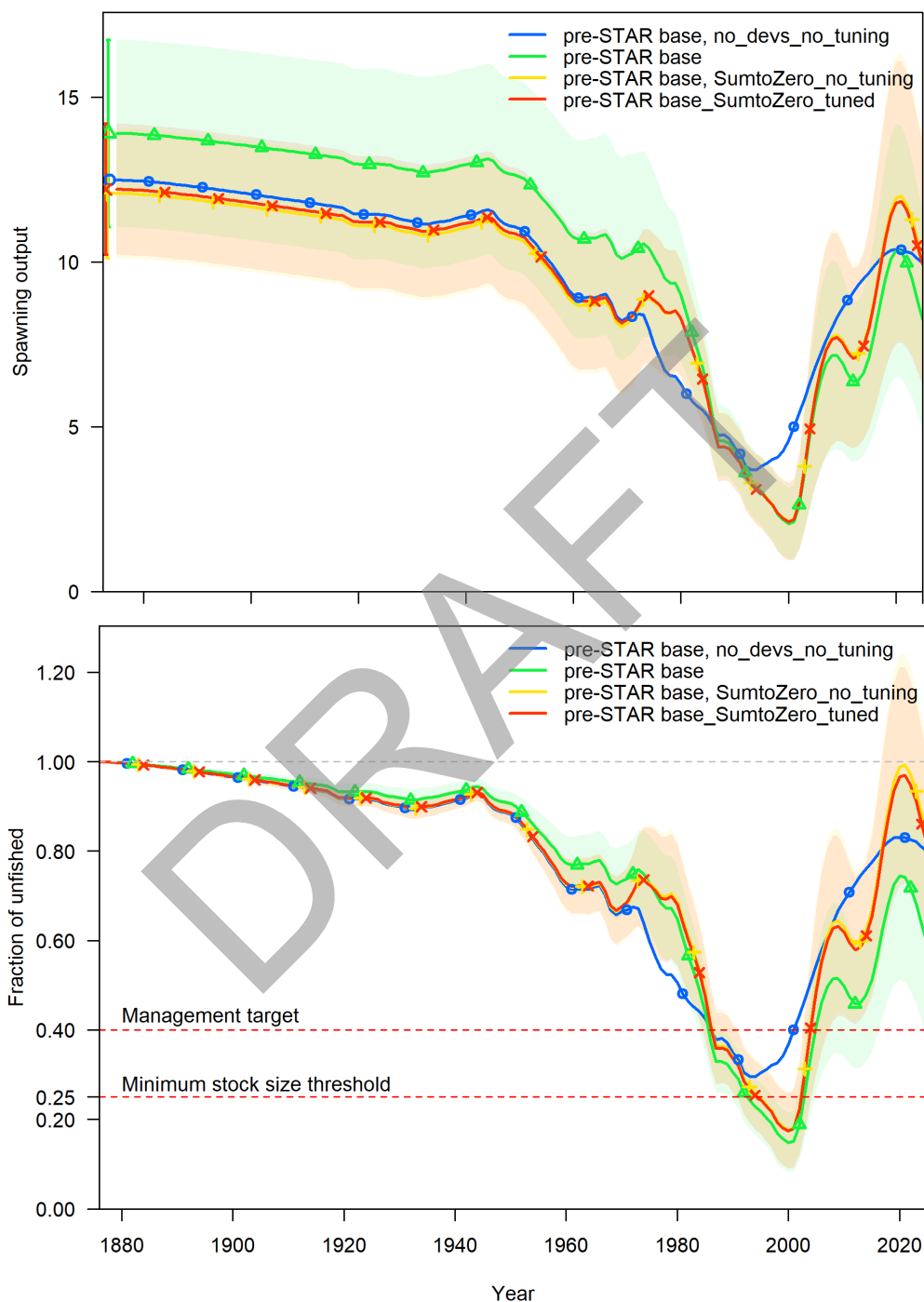


Figure 4a. Comparison of time series of spawning output (trillions of eggs; upper panel) and relative spawning output (lower panel) for models with and without recruitment deviations, and with and without a sum-to-zero constraint imposed on the recruitment deviations.

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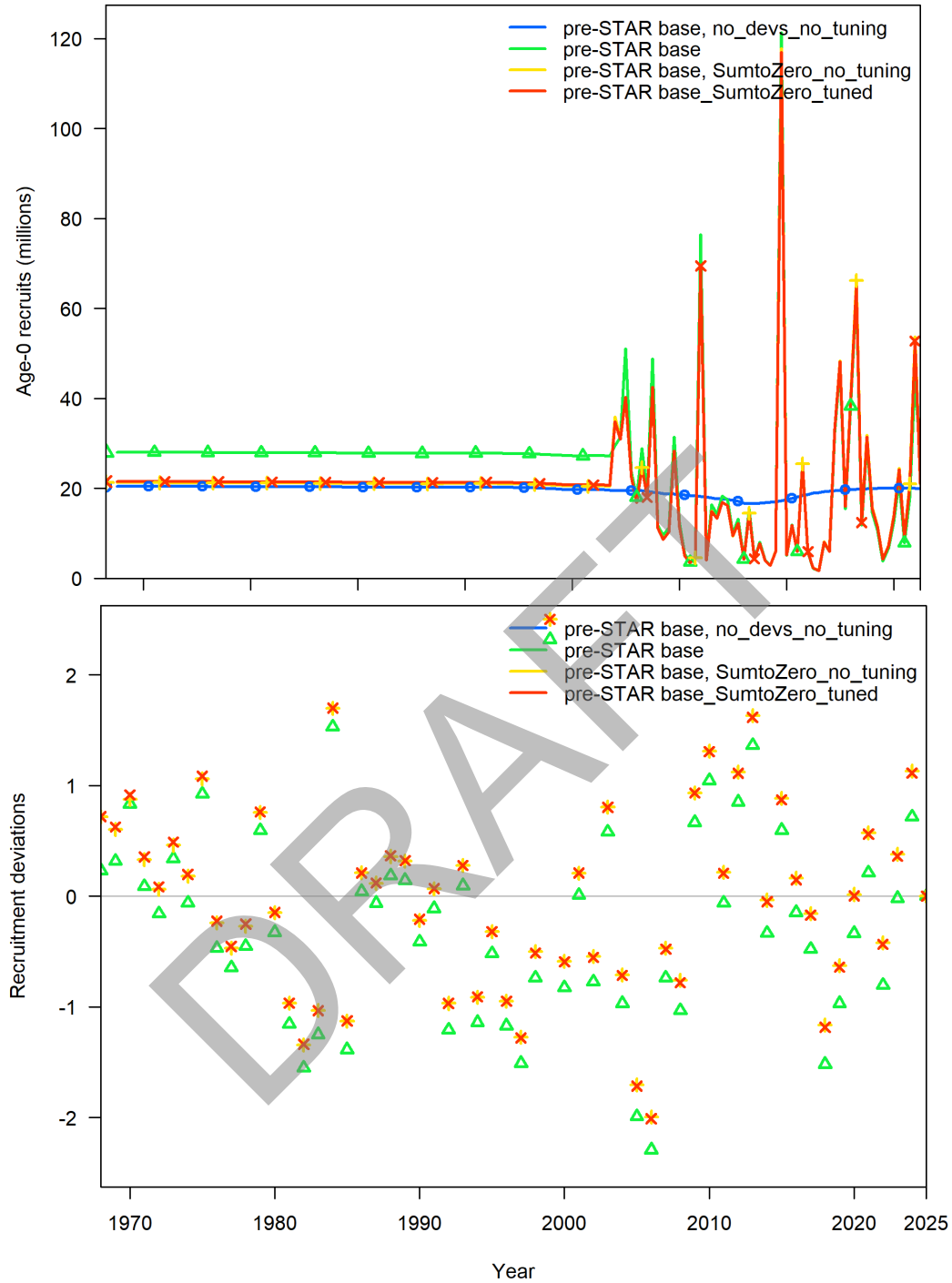


Figure 4b. Comparison of time series of recruitment (upper panel) and deviations from the spawner-recruit curve (lower panel) for models with and without a sum-to-zero constraint imposed on the recruitment deviations.

Table 4a. Comparison of likelihood components, parameter estimates, and derived quantities from models with and without recruitment deviations, as well as unconstrained or 'sum-to-zero' recruitment deviations.

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Label	pre-STAR base, no_devs_no_tuning	pre-STAR base	pre-STAR base, SumtoZero_no_tuning	pre-STAR base, SumtoZero_tuned
N.Pams	45	114	114	114
TOTAL	3119.280	2620.260	2623.630	2628.760
Survey	47.220	24.575	29.211	28.844
Length_comp	667.444	569.086	569.314	569.318
Age_comp	2404.610	2002.350	2003.130	2008.480
Recruitment	0.000	24.185	21.961	22.102
Pam_priors	0.000	0.053	0.007	0.008
NatM_uniform_Fem_GP_1	0.155	0.171	0.160	0.160
L_at_Amax_Fem_GP_1	48.574	48.169	48.223	48.234
VonBert_K_Fem_GP_1	0.189	0.194	0.194	0.193
CV_young_Fem_GP_1	0.102	0.108	0.109	0.110
CV_old_Fem_GP_1	0.034	0.038	0.037	0.037
NatM_uniform_Mal_GP_1	0.271	0.266	0.291	0.291
L_at_Amax_Mal_GP_1	-0.353	-0.333	-0.333	-0.334
VonBert_K_Mal_GP_1	0.610	0.540	0.542	0.543
CV_young_Mal_GP_1	-0.131	0.203	0.198	0.195
CV_old_Mal_GP_1	0.665	0.112	0.118	0.117
SR_LN(R0)	9.924	10.240	9.964	9.976
Q_extraSD_CalCOFI_Survey(11)	0.421	0.313	0.368	0.363
Q_extraSD_RREAS_YOY_Survey(12)	1.740	1.234	1.217	1.219
Size_DblN_peak_NoCA_HKL(1)	42.278	41.254	41.202	41.222
Size_DblN_ascend_se_NoCA_HKL(1)	4.452	4.438	4.438	4.440
Size_DblN_descend_se_NoCA_HKL(1)	4.270	5.042	4.960	4.943
Size_DblN_peak_SoCA_HKL(2)	24.218	24.245	24.220	24.209
Size_DblN_ascend_se_SoCA_HKL(2)	1.415	1.403	1.392	1.387
Size_DblN_descend_se_SoCA_HKL(2)	5.779	5.766	5.725	5.723
Size_DblN_peak_CA_TWL(3)	44.110	44.699	44.520	44.512
Size_DblN_ascend_se_CA_TWL(3)	4.494	4.512	4.505	4.505
Size_DblN_descend_se_CA_TWL(3)	2.874	2.987	2.983	2.981
Size_DblN_peak_OR_WA_Comm(4)	39.771	42.043	41.527	41.492
Size_DblN_ascend_se_OR_WA_Comm(4)	4.135	4.496	4.447	4.444
Size_DblN_peak_CA_NET(5)	46.184	45.969	45.927	45.919
Size_DblN_ascend_se_CA_NET(5)	4.289	4.321	4.320	4.319
Size_DblN_descend_se_CA_NET(5)	3.949	3.686	3.655	3.642
Size_DblN_peak_NoCA_OR_WA_Rec(6)	44.908	43.503	43.339	43.333
Size_DblN_ascend_se_NoCA_OR_WA_Rec(6)	5.117	5.099	5.094	5.093
Size_DblN_descend_se_NoCA_OR_WA_Rec(6)	3.589	4.373	4.318	4.299
Size_DblN_peak_SoCA_Rec(7)	24.536	24.673	24.628	24.626
Size_DblN_ascend_se_SoCA_Rec(7)	2.973	2.920	2.910	2.909
Size_DblN_descend_se_SoCA_Rec(7)	3.160	3.352	3.397	3.400
Size_DblN_end_logit_SoCA_Rec(7)	-0.700	-1.135	-1.186	-1.189
Size_DblN_peak_TWL_discard(8)	29.509	29.501	29.457	29.453
Size_DblN_ascend_se_TWL_discard(8)	4.325	4.173	4.170	4.170
Size_DblN_descend_se_TWL_discard(8)	3.321	3.203	3.208	3.208
Size_DblN_peak_NoCA_HKL(1)_BLK1repl_1875	49.997	50.291	50.412	50.357
Size_DblN_ascend_se_NoCA_HKL(1)_BLK1repl_1875	3.970	4.053	4.062	4.057
Size_DblN_peak_SoCA_HKL(2)_BLK2repl_1875	49.777	47.563	47.511	47.506
Size_DblN_ascend_se_SoCA_HKL(2)_BLK2repl_1875	4.814	4.734	4.736	4.735
Size_DblN_peak_CA_TWL(3)_BLK3repl_1875	36.345	33.490	33.421	33.422
Size_DblN_ascend_se_CA_TWL(3)_BLK3repl_1875	3.792	3.213	3.201	3.201
Size_DblN_peak_SoCA_Rec(7)_BLK2repl_1875	32.168	30.454	30.488	30.482
Size_DblN_ascend_se_SoCA_Rec(7)_BLK2repl_1875	4.059	3.712	3.723	3.722
Bratio_2025	0.798	0.593	0.836	0.813
SSB_unfished	12484	13904	12081	12203
Totbio_unfished	52519	60831	51324	51833
Recr_unfished	20422	27998	21247	21493
Dead_Catch_SPR	1960	2494	2000	2022
OFLCatch_2025	3087	2834	3200	3143

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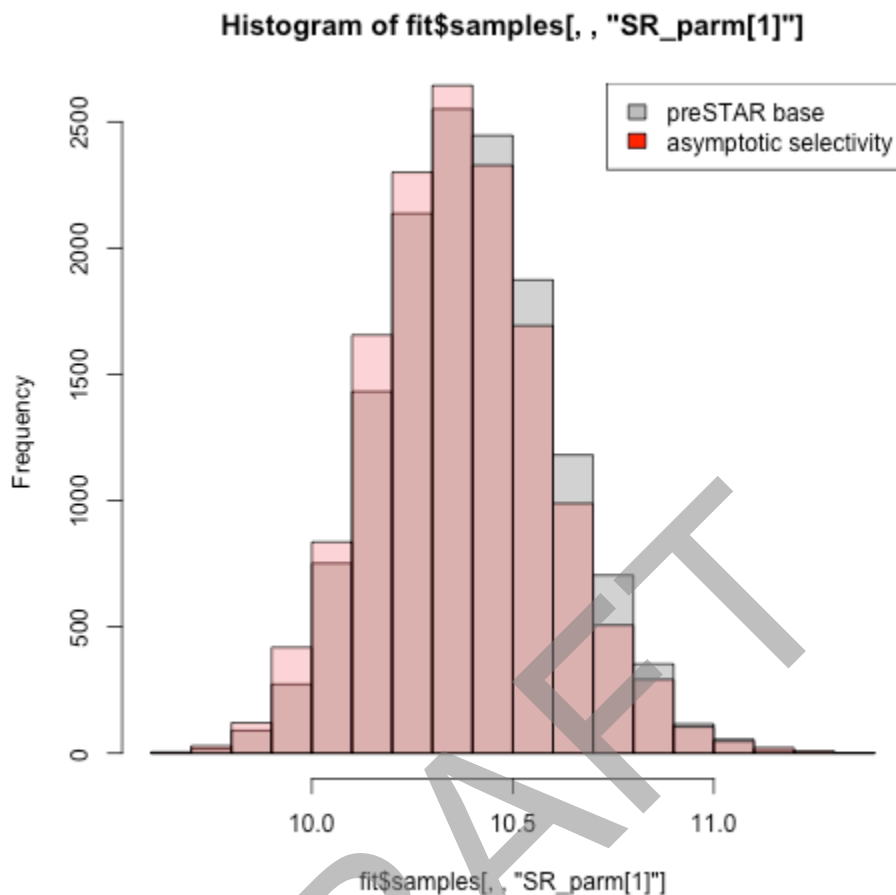


Figure 4c. Posterior distributions for unfished equilibrium recruitment from diagnostic MCMC runs. Recruitment deviations were not constrained to sum to zero in either run.

4 - Panel Conclusion

The Panel and STAT discussed this at length without coming to a conclusion. Therefore, a new request was made to further investigate this (see Request 13). The Panel agreed that estimation of the requested dynamic B_0 was no longer required.

5 - Request

Replot fits to the CalCOFI index (absolute) without confidence intervals.

5 - Rationale

This will enable additional scope for interpretation of the model fit to the time series. Including the confidence intervals compresses the y-axis.

5 - STAT Response

The requested figure without confidence intervals (Figure 5a) is shown below.

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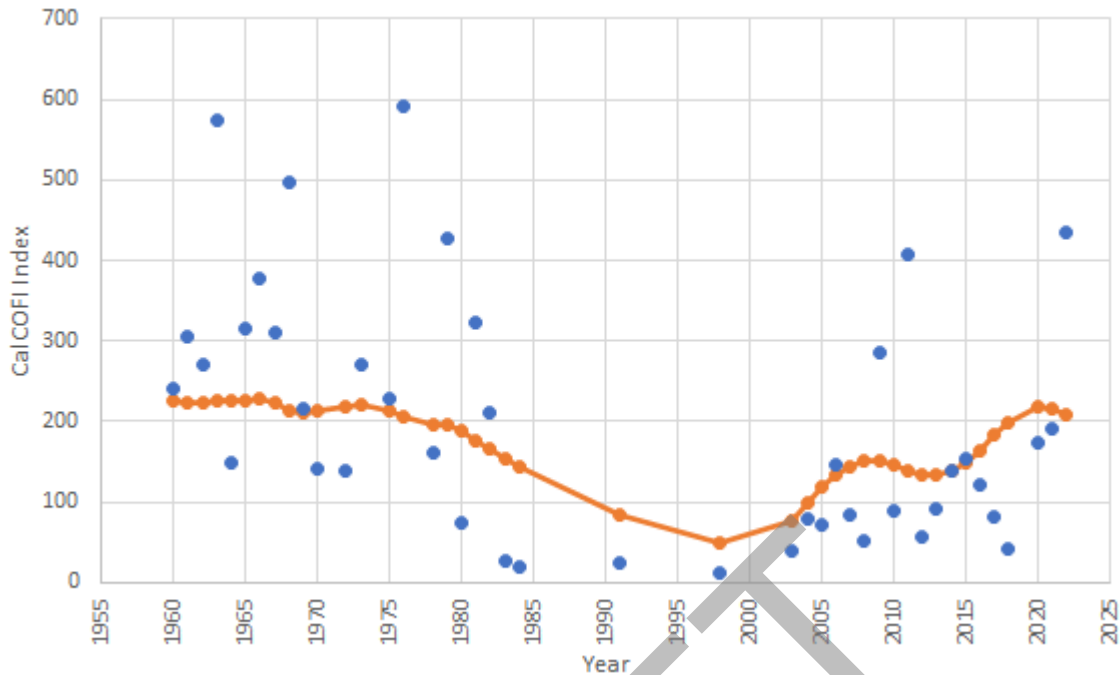


Figure 5a. Observed CalCOFI index of spawning output (blue points) and pre-STAR base model fit to the index (orange points and interpolated line).

5 - Panel Conclusion

This plot clarifies the fit of the model to this index and sufficiently fulfills the request.

6 - Request

Run an additional sensitivity replacing the CalCOFI index with the Southern CaCOFI index but without the early (1950s) estimates. Please plot fits without confidence intervals. Investigate why the terminal years in the coastwide index are increasing while the separate indices are decreasing.

6 - Rationale

To inform on why removing the whole area CalCOFI index results in an increase in stock status and why adding central and southern CalCOFI separately results in a decrease, when covering different time periods.

6 - STAT Response

The odd terminal year discrepancies were an error! The STAT inadvertently used the short southern index rather than the central in the sensitivity runs. The corrected runs and additional runs are shown and results are now a bit more intuitive. The requested runs and graphs were provided. With the correct data, the run with central only is more optimistic than the base model (all data, but only years with data from both regions), and the south only model is more pessimistic. The “Short south” model is slightly more pessimistic than the southern model with all data (makes sense as the “Long south” model would scale down unfished biomass). The data with all years (all data, regions) is still nearly identical to the base model.

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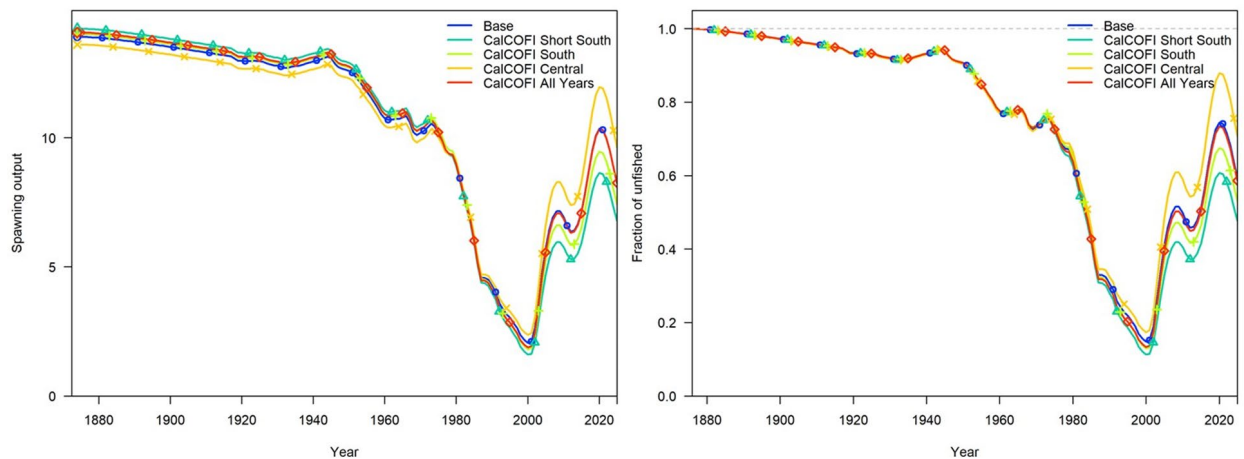


Figure 6a. Spawning output (left) and depletion (right) estimates for current base model, model using CalCOFI central, south, “short” south (starting in 1960) and all years time series. With the correct data, the run with central only is more optimistic than the base model, while the south only model is more pessimistic. The model with the “short” south index is slightly more pessimistic than the model with the entire southern index, consistent with the indication of lower spawning output in the south during the 1950s. The data with all years (all data, regions) is still nearly identical to the base model.

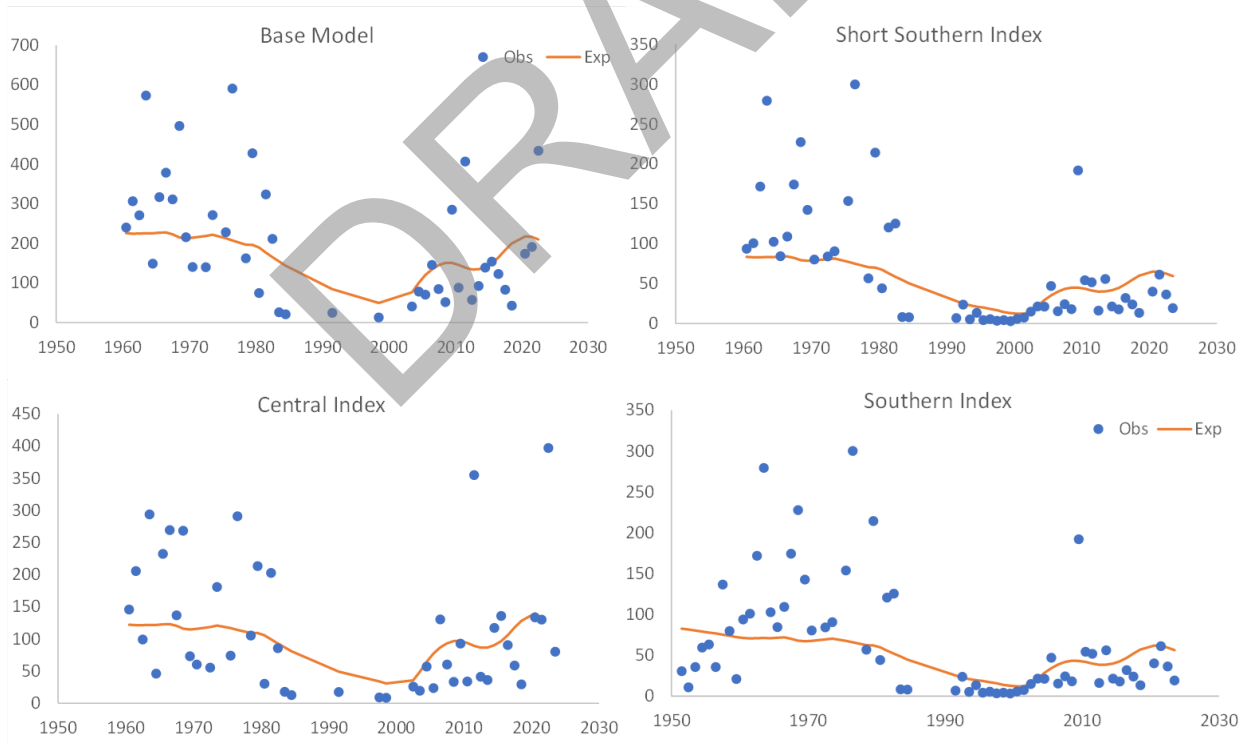


Figure 6b. Model fits (lines) to CalCOFI indices in the four sensitivity models (base model, and models including CalCOFI central, south, and “short” south indices, as above), plotted in arithmetic scale without error bars.

6 - Panel Conclusion

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The odd terminal year discrepancies are now gone and the Panel has no longer any issues with this request. The influence of the different regional components of the CalCOFI indices (overall, southern, central) on the model outcomes are more understandable.

7 - Request

Run an additional sensitivity estimating the additional variance for the WCGBT survey as well.

7 - Rationale

Although there is some justification for estimating additional variance for the CalCOFI index, the justification of not estimating additional variance on the WCGBT survey is missing (high, early index points; high q).

7 - STAT Response

When estimating an added variance (“extraSD”) parameter for the WCGBTS, the estimate was 0.145, slightly reducing the influence of the trawl survey index. The change had little effect on the time series of spawning biomass, but resulted in a slightly poorer fit to the early years of the index (Figure 7a). The STAT would prefer not to downweight the index, and instead search for alternative model configurations that improve the fit.

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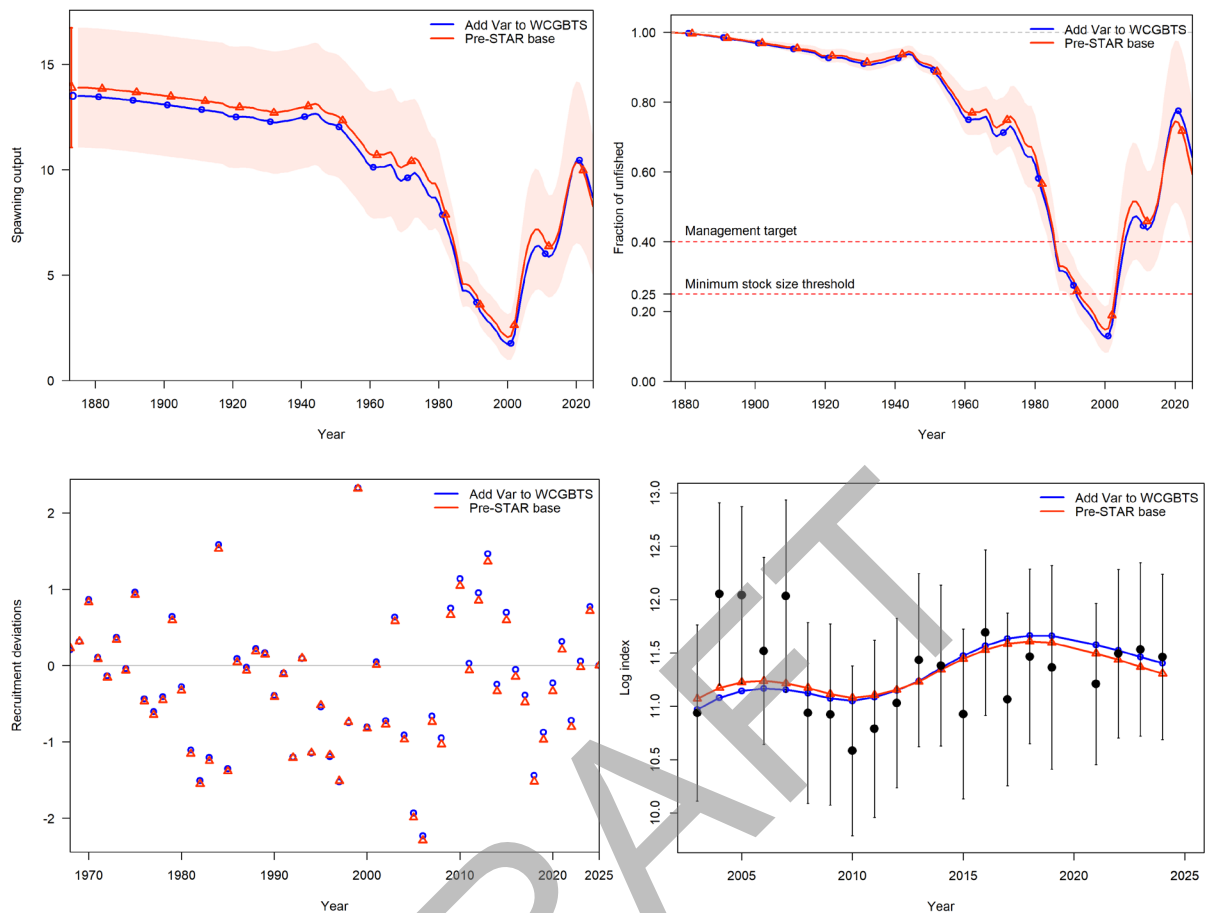


Figure 7a. Comparison of the pre-STAR base model to a model with additional variance estimated for the WCGBTS. Time series of spawning output (upper left), relative spawning output (upper right), recruitment deviations (lower left), and fit to the WCGBTS (lower right).

7 - Panel Conclusion

The STAT should explore the depth effect in the WCGBTS index (see Request 3) before making a conclusion about adding variance (prior to COB on 6/26; see Request 12). The Panel agreed that estimation of the requested $\ln Q$ was no longer required.

8 - Request

Provide two runs with all length composition data and age composition data down-weighted by a factor of 2 and 10 using the input sample multiplier (from the final Francis tuned multipliers). Present length and age Pearson residual plots for the Commercial CA trawl fleet and the fits to all fishery-independent indices compared to the pre-STAR base model.

8 - Rationale

It is possible that the composition data are over-weighted.

8 - STAT Response

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Two models were run, with Francis weights from the pre-STAR base model divided by 2 and 10 (Table 8a). Downweighting the composition data resulted in a more depleted population and less variable recruitment deviations (Figure 8).

Table 8a. Francis weights from the pre-STAR base model, a model with the weights cut in half, and a model with weights equal to one-tenth the pre-STAR Panel values.

Fleet	Component	Pre-STAR base	Weights / 2	Weights / 10
NoCA_HKL	Lengths	0.54034	0.27017	0.054034
SoCA_HKL	Lengths	2.43888	1.21944	0.243888
CA_TWL	Lengths	0.23845	0.119225	0.023845
OR_WA_Comm	Lengths	0.09089	0.045445	0.009089
CA_NET	Lengths	0.41067	0.205335	0.041067
NoCA_OR_WA_Re	Lengths	0.383	0.1915	0.0383
SoCA_Rec	Lengths	0.17159	0.085795	0.017159
TWL_discard	Lengths	0.0205	0.01025	0.00205
WCGBT_Survey	Lengths	0.03578	0.01789	0.003578
Triennial_Survey	Lengths	0.05515	0.027575	0.005515
NoCA_HKL	Ages	0.02971	0.014855	0.002971
CA_TWL	Ages	0.01572	0.00786	0.001572
OR_WA_Comm	Ages	1	0.5	0.1
CA_NET	Ages	0.06535	0.032675	0.006535
NoCA_OR_WA_Re	Ages	1	0.5	0.1
WCGBT_Survey	Ages	0.09373	0.046865	0.009373
Triennial_Survey	Ages	0.06838	0.03419	0.006838

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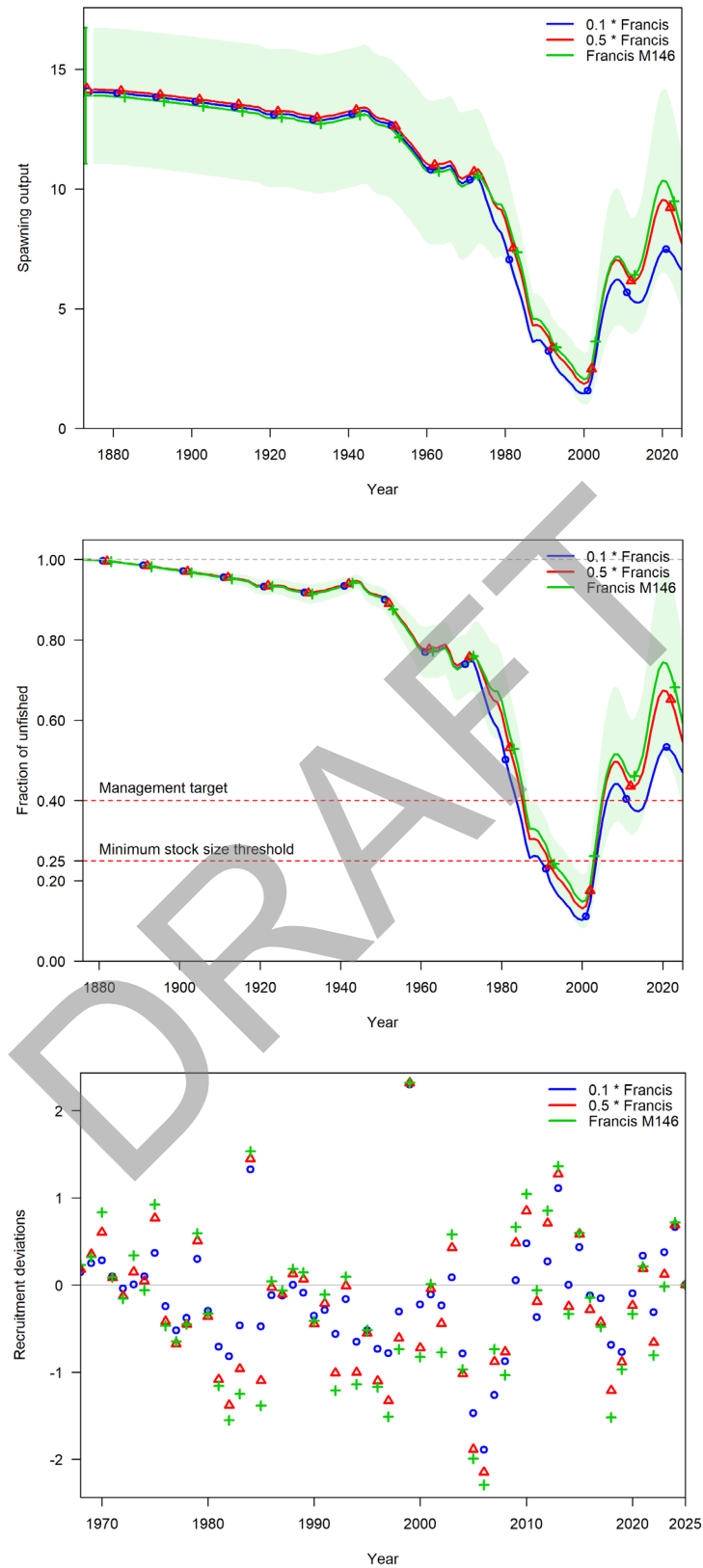


Figure 8. Comparison of time series of spawning output, relative spawning output, and recruitment deviations for the pre-STAR base and models with Francis weights equal to 1/2 and 1/10th the value in the pre-STAR base (i.e. composition data downweighted).

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8 - Panel Conclusion

Downweighting the length data seems to decrease recruitment deviations (Figure 8, bottom panel). The downweighting also allows the other data to change the population trajectory and stock status (Figure 8 top two panels), which suggests that there may be some limited over-weighting of the composition data in the model. The STAT did not have time to show the Pearson residuals and fits to the fishery-independent indices and the Panel acknowledges there are more important requests to be tackled first.

9 - Request

Present length-fecundity relationships that depict the variability in estimates given different environment regimes alongside the assumed length-fecundity relationship in the pre-STAR base model. Conduct sensitivities using the alternative values of the exponent of the fecundity-length relationship, with M fixed at the value from the pre-STAR base model for all of the runs. Plot the spawning output, fraction unfished, and recruitment deviations, and compare estimates with the pre-STAR base model.

9 - Rationale

This will help to characterize the uncertainty in fecundity estimates under varying environmental conditions. These results could be used to identify an appropriate axis of uncertainty.

9 - STAT Response

We ran the pre-STAR base model with the highest and the lowest fecundity relationships (b parameters only) from the Beyer et al. 2024 analysis. We included the multiple brooding multiplier, however for completeness we included a “very low” fecundity relationship in the low fecundity scenario in which only a single brood was assumed. We ran the high and low scenarios with both M estimated (as in the base model) and fixed at the base model estimate. The results dramatically scaled the estimates of larval production, but had only a modest influence on relative abundance (depletion). The estimate of natural mortality changed only trivially in the low fecundity model with M estimated (from 0.1706 to 0.17089), but changed more substantively for the high fecundity model with M estimated (from 0.1706 to 0.1772), which is reflected in the increase in age 3+ biomass.

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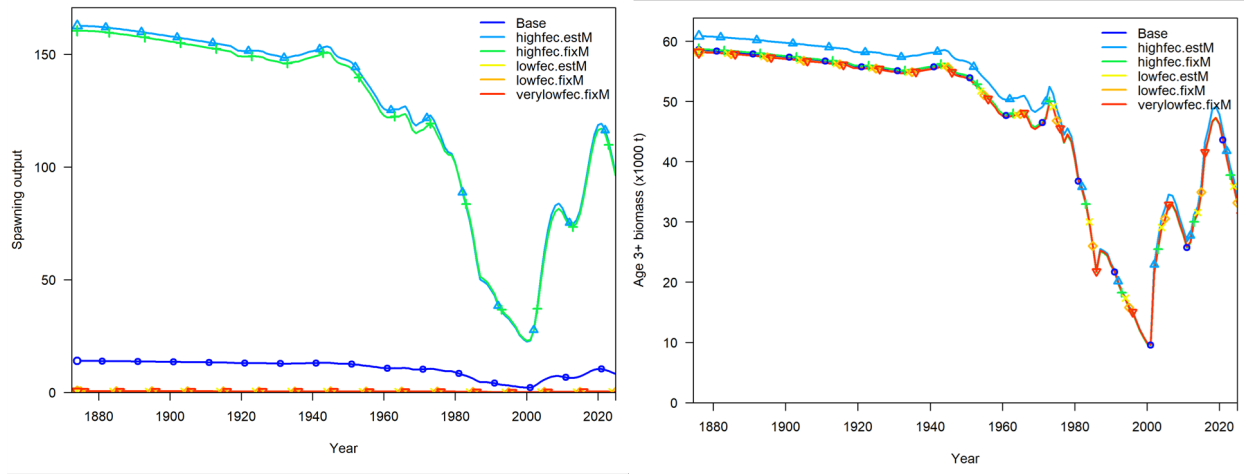


Figure 9.a Spawning output (left) and age 3 biomass (right) from the suite of models with alternative fecundity functions.

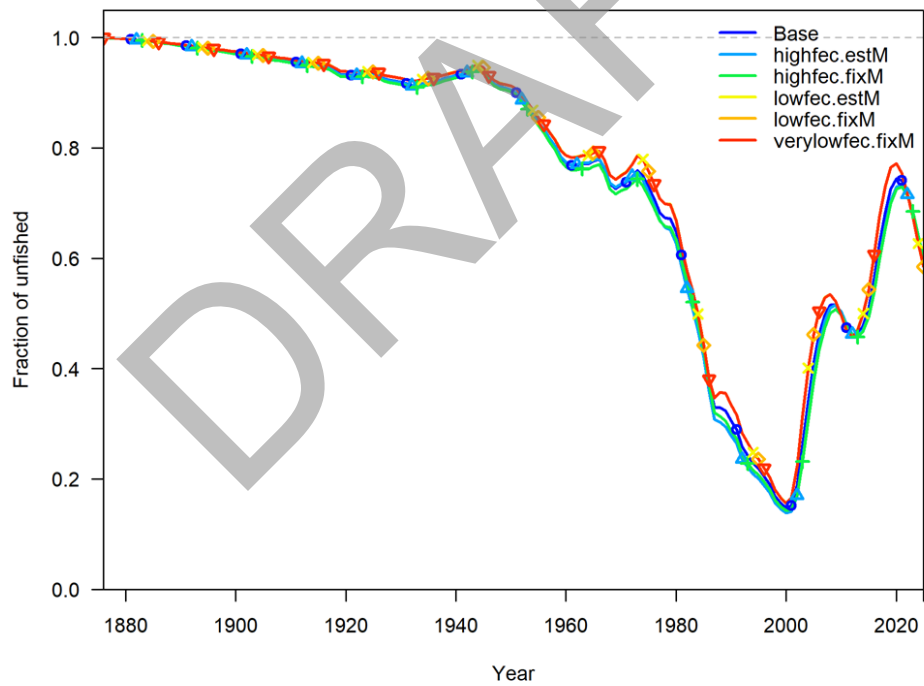


Figure 9.b Estimated depletion from the suite of models with alternative fecundity functions

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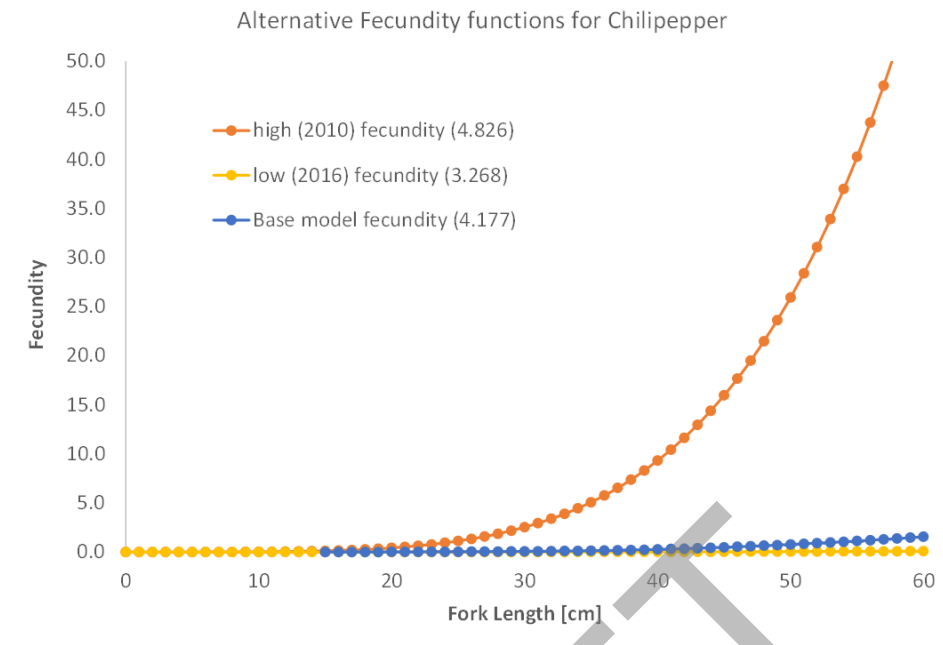


Figure 9.c Fecundity functions used to run the models (these account for multiple brooding using the same approach as the base model, model with a single brood not shown but you know where that will sit).

9 - Panel Conclusion

These results were very useful to understand how variability in fecundity translates to uncertainty in the stock assessment. It appears that variability in fecundity is a small component of the uncertainty.

10 - Request

Create a squid plot using a 15-year retrospective analysis. This plot has the recruitment deviation on the y-axis and age on the x-axis, which shows the age at which estimated recruitment begins to be informed by data.

10 - Rationale

There are a few large year classes that are important to the population trend, one of which is a recent 2013 year class. It is useful to know how long it takes to have a reasonable estimate of recruitment, whether low or high.

10 - STAT Response

The STAT ran 15 year retrospectives with and without the RREAS YOY index, the difference was surprisingly small. On a bit more investigation it appears that there is quite a bit of information in the WCGTBS for age 0 and 1 fish, and the combination of tuning RREAS and not tuning WCGTBS essentially upweights the trawl information. The STAT did several additional runs with WCGTBS tuned, and RREAS upweighted, to better understand how each index is informing near term recruitments. The STAT explored other options to better understand the relative influence of the two indices informing early recruitment deviations, including tuning the

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WCG BTS (which was untuned in base) to slightly reduce that survey's estimate of recruitment, and reducing the tuning on the RREAS index.

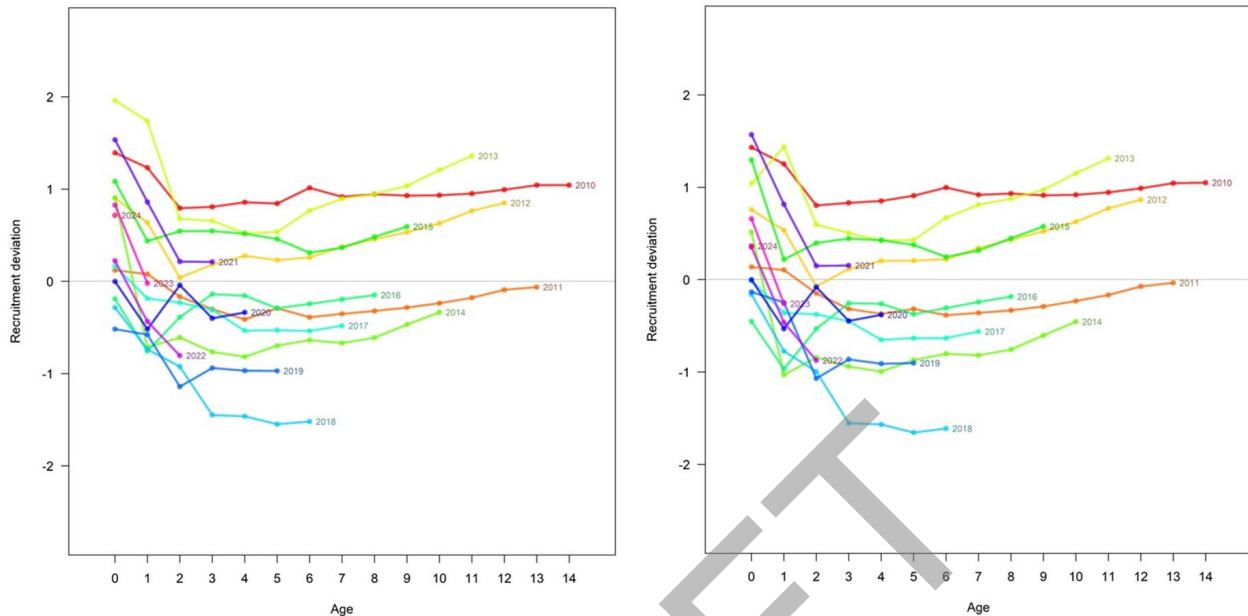


Figure 10a. Squid diagnostic plots, plot on left is from base model with a 15 year retrospective, including the RREAS pelagic young-of-the-year index, plot on the right is with RREAS turned off, demonstrating that there is still apparently quite a bit of recruitment signal in the model (presumably signal from age 0 and 1 fish from WCG BTS).

10 - Panel Conclusion

The Panel appreciated this work. It showed the importance of the WCG BTS in predicting year class strength and that there was information when the cohort was age zero. Although the RREAS YOY survey was appropriately weighted, including some additional variance, the outcome was that this index had very little weight and virtually no influence. The RREAS index became appropriately more influential when either removing the additional variance or when downweighting the WCG BTS index. There was concern that the strength of a cohort when it was age 0 was estimated above average and tended to be reduced as the cohort aged in the pre-STAR base model. The Panel realized that changes to the base model from other requests could modify these outcomes, thus may need to revisit updated figures following responses to future requests.

11 - Request

Estimate steepness with and without a sum-to-zero constraint on recruitment deviations. Please use the revised model based on conclusions from earlier requests. Calculate the average of the main period recruitment deviations in these two models. Present spawning output, fraction unfished, recruitment, and recruitment deviations for these two runs. Provide a table showing the parameters with reference points including SPR proxy yield.

11 - Rationale

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The main period of recruitment deviations average to less than 0 without a sum-to-zero constraint, which is during a period with some years of low predicted spawning biomass. The base model with a fixed steepness of 0.72 may be attempting to reduce recruitment during this period when the reduced recruitment is actually a result of reduced spawning biomass.

11 - STAT Response

The revised base model (i.e., pre-STAR base with asymptotic selectivity curves for fleets with poor MCMC diagnostics in the descending scale parameter; “M160”) was used to complete this request. Estimates of steepness were lower than the prior mean in both runs, resulting in a more depleted stock status. With steepness estimated, the change in model scale and trend is less pronounced between models with and without the sum-to-zero constraint for recruitment deviations (Figure 11a), compared to the models with steepness fixed at the prior mean of 0.72 (Figure 11b). With steepness estimated, the average recruitment deviation without the sum-to-zero constraint is -0.14. With the constraint, the mean is near zero, as expected (7×10^{-8}). By fixing steepness at a value that is slightly less consistent with the data, the simple deviations are scaled down to best fit the data (i.e. reducing productivity; Figure 11b), resulting in higher estimates of R_0 and M (Table 11).

The current model does not have a precise estimate of steepness (see bivariate likelihood profile over steepness and female M , in the main document). The STAT therefore recommends that the assessment continue to fix steepness at 0.72. The current accepted practices also recommend that the method of Methot and Taylor (2011) be applied to reduce bias in estimates of unfished equilibrium recruitment. However, that method was developed using the sum-to-zero constraint (“deviation vector” option) in Stock Synthesis. Therefore, the STAT recommends that a new base model be constructed that 1) continues to fix steepness at 0.72, 2) continues to use the bias adjustment, and 3) enforces a sum-to-zero constraint on the recruitment deviations.

Given that the model is sensitive to the treatment of recruitment deviations (sum-to-zero, or unconstrained), the STAT recommends that a new assessment be conducted if future research clarifies which approach to estimating recruitment deviations is the preferred method, whether bias adjustment is needed when using maximum likelihood but without a sum-to-zero constraint, and which type of deviation vector gives unbiased parameter estimates when using MCMC. From the results of this analysis, it appears that assumptions about steepness also need to be considered as part of the above-mentioned research recommendations.

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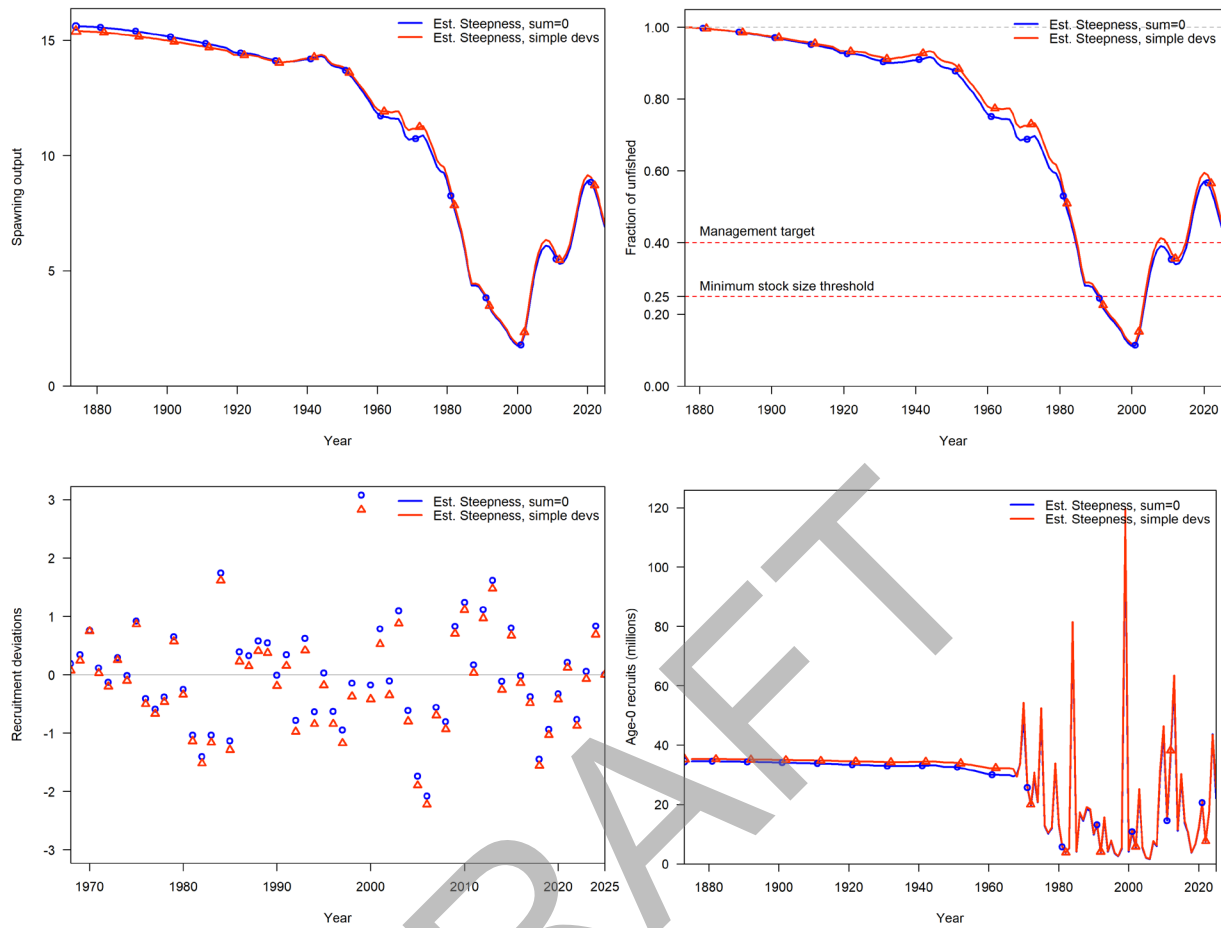


Figure 11a. Time series of spawning output for models with steepness estimated, and either unconstrained recruitment deviations (red lines and points), or deviations with a sum-to-zero constraint (blue lines and points).

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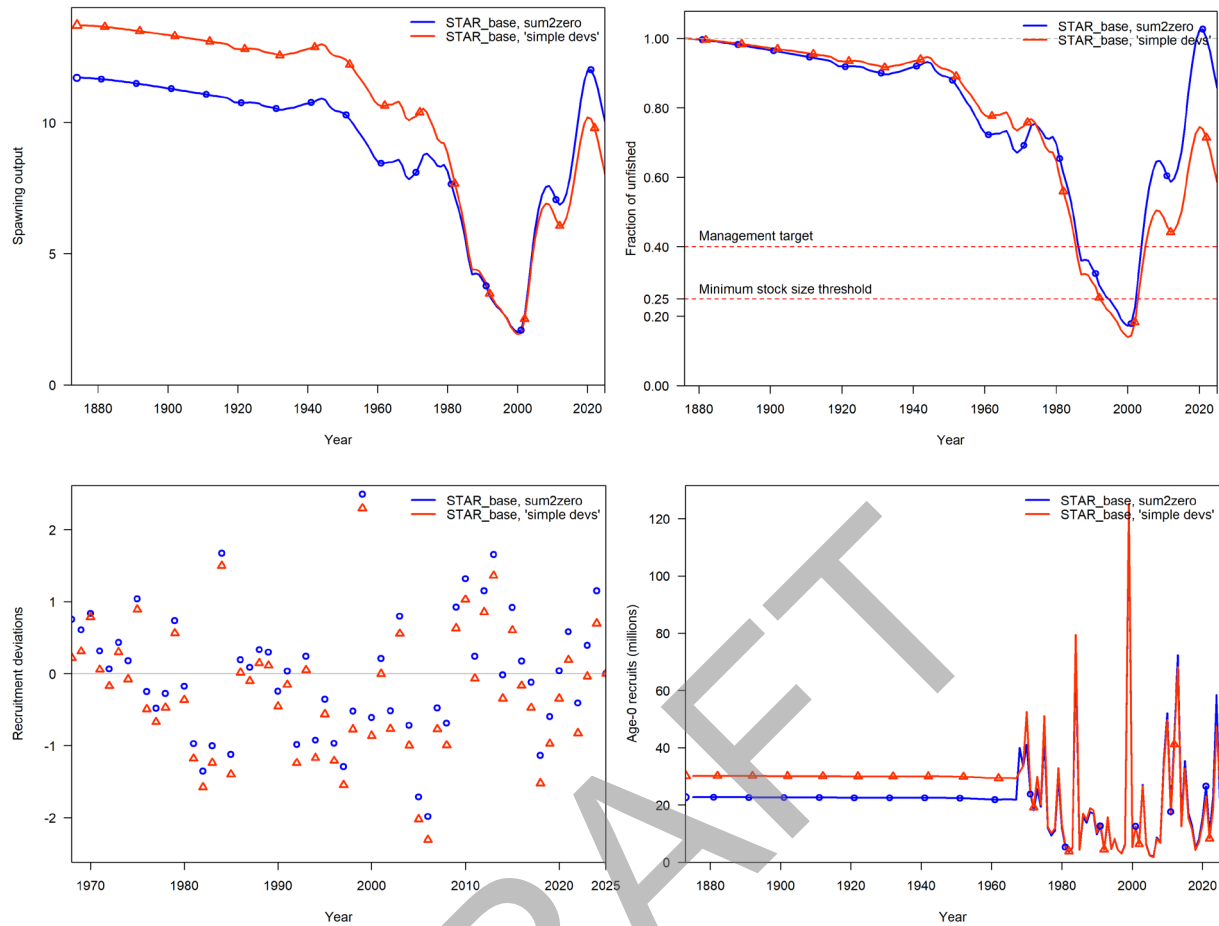


Figure 11b. Time series of spawning output for models with steepness fixed at the prior mean of 0.72, and either unconstrained recruitment deviations (red lines and points), or deviations with a sum-to-zero constraint (blue lines and points).

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Table 11. Likelihood components, parameter estimates, and derived quantities from models with steepness fixed and estimated, and recruitment deviations either unconstrained or forced to sum to zero.

Label	STAR_base, sum2zero	STAR_base, simple devs	Est. Steepness, sum2zero	Est. Steepness, simple devs
N.Pams	109	109	110	110
TOTAL	2625.350	2621.330	2620.330	2619.620
Survey	29.383	24.307	22.831	22.724
Length_comp	572.553	572.015	572.476	572.356
Age_comp	2001.450	2000.480	1999.830	1999.750
Recruitment	21.928	24.425	23.155	23.498
Parm_priors	0.030	0.096	2.035	1.289
NatM_uniform_Fem_GP_1	0.166	0.177	0.177	0.180
L_at_Amax_Fem_GP_1	47.887	47.860	47.852	47.848
VonBert_K_Fem_GP_1	0.197	0.197	0.197	0.197
CV_young_Fem_GP_1	0.105	0.105	0.104	0.104
CV_old_Fem_GP_1	0.039	0.039	0.039	0.039
NatM_uniform_Mal_GP_1	0.263	0.241	0.241	0.235
L_at_Amax_Mal_GP_1	-0.329	-0.329	-0.328	-0.329
VonBert_K_Mal_GP_1	0.528	0.528	0.528	0.528
CV_young_Mal_GP_1	0.234	0.235	0.236	0.236
CV_old_Mal_GP_1	0.101	0.100	0.098	0.099
SR_LN(R0)	10.027	10.314	10.450	10.471
SR_BH_steep	0.720	0.720	0.355	0.436
Q_extraSD_CalCOFI_Survey(11)	0.369	0.310	0.291	0.292
Q_extraSD_RREAS_YOY_Survey(12)	1.210	1.230	1.227	1.233
Size_DbIN_peak_NoCA_HKL(1)	40.931	41.080	41.117	41.119
Size_DbIN_ascend_se_NoCA_HKL(1)	4.393	4.405	4.412	4.409
Size_DbIN_peak_SoCA_HKL(2)	23.720	23.788	23.802	23.817
Size_DbIN_ascend_se_SoCA_HKL(2)	1.155	1.195	1.203	1.212
Size_DbIN_peak_CA_TWL(3)	44.864	45.102	45.191	45.218
Size_DbIN_ascend_se_CA_TWL(3)	4.554	4.563	4.570	4.570
Size_DbIN_peak_OR_WA_Comm(4)	42.470	43.109	43.312	43.424
Size_DbIN_ascend_se_OR_WA_Comm(4)	4.538	4.600	4.618	4.628
Size_DbIN_peak_CA_NET(5)	46.982	46.979	46.999	46.976
Size_DbIN_ascend_se_CA_NET(5)	4.425	4.420	4.422	4.419
Size_DbIN_peak_NoCA_OR_WA_Rec(6)	43.836	44.110	44.233	44.248
Size_DbIN_ascend_se_NoCA_OR_WA_Rec(6)	5.132	5.145	5.154	5.152
Size_DbIN_peak_SoCA_Rec(7)	24.698	24.731	24.749	24.754
Size_DbIN_ascend_se_SoCA_Rec(7)	2.929	2.936	2.939	2.940
Size_DbIN_descend_se_SoCA_Rec(7)	3.317	3.278	3.267	3.260
Size_DbIN_end_logit_SoCA_Rec(7)	-1.094	-1.049	-1.033	-1.025
Size_DbIN_peak_TWL_discard(8)	29.531	29.572	29.603	29.606
Size_DbIN_ascend_se_TWL_discard(8)	4.178	4.181	4.183	4.183
Size_DbIN_descend_se_TWL_discard(8)	3.199	3.194	3.188	3.188
Size_DbIN_peak_NoCA_HKL(1)_BLK1repl_1875	51.711	51.396	51.317	51.276
Size_DbIN_ascend_se_NoCA_HKL(1)_BLK1repl_1875	4.166	4.141	4.135	4.132
Size_DbIN_peak_SoCA_HKL(2)_BLK2repl_1875	48.816	48.776	48.825	48.772
Size_DbIN_ascend_se_SoCA_HKL(2)_BLK2repl_1875	4.822	4.814	4.819	4.813
Size_DbIN_peak_CA_TWL(3)_BLK3repl_1875	33.818	33.920	33.905	33.930
Size_DbIN_ascend_se_CA_TWL(3)_BLK3repl_1875	3.295	3.315	3.313	3.317
Size_DbIN_peak_SoCA_Rec(7)_BLK2repl_1875	30.698	30.648	30.616	30.609
Size_DbIN_ascend_se_SoCA_Rec(7)_BLK2repl_1875	3.755	3.742	3.737	3.734
Bratio_2025	0.858	0.587	0.443	0.456
SSB_unfished	11695	13702	15608	15395
Totbio_unfished	51221	61698	70333	69920
Recr_unfished	22633	30156	34542	35271
Dead_Catch_SPR	2089	2633	570	1772
OFLCatch_2025	3663	3160	2742	2838

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11 - Panel Conclusion

The Panel generally agrees with the STAT's proposed way forward. That is to consider best practices of using bias correction in recruitment deviations and modelling of recruitment deviations along with a steepness fixed at the mean of the prior. It is uncertain whether the bias correction method is appropriate without a constraint on recruitment deviations to sum to zero. It was also noted that when estimating steepness, the difference between constraining recruitment deviations or not was much smaller than when fixing steepness at a larger value. This topic deserves further research in the future.

12 - Request

Predict the WCGBTS index with depth as a covariate and assuming isotropy (all other model configurations unchanged). If a suitable alternative index (as determined by the STAT) is achieved, please run a model (with the new base model) using this new index. Please include information about how the depth effect was modeled and show the marginal effect of depth.

12 - Rationale

An initial new WCGBTS index with depth effect from Request 3 showed a large difference in scale compared to the pre-STAR index as well as a large confidence interval. The analysis was preliminary and changes to the index model setting needs to be further explored.

12 - STAT Response

Further investigation revealed that due to a difference in sign, the scaled depth range of the prediction grid for the index model was incorrect. Thus, the model was extrapolating to unobserved depth values, leading to the large difference in scale, high uncertainty, and different trends. This was corrected and a new index was produced.

Depth was standardized and included as a quadratic covariate applied to both the binomial and positive models. Isotropy was also assumed, as requested. Specifically, the model was the following:

```
newfit1 <- sdmTMB(  
  formula = catch_weight ~ 0 + fyear + pass_scaled + depth_scaled +  
  depth_scaled_squared,  
  data = data_truncated,  
  mesh = mesh,  
  time = "year",  
  family = delta_lognormal(type="standard"),  
  spatial = "on",  
  spatiotemporal = list("iid", "off"),  
  share_range = TRUE,  
  offset = log(data_truncated$effort),  
  anisotropy = FALSE  
)
```

The relationship between the model residuals and depth was explored for the original model (without depth, with anisotropy), the original model without anisotropy, and the new model with depth and without anisotropy (Figure 12a). In both models without depth, there was a

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relationship between the residuals and depth, particularly for the positive component of the delta model, suggesting that anisotropy alone does not account for depth effects, and that the depth covariate is providing information.

The new index (using the correct depth values) had a similar trend and variance as the original index, but was somewhat lower in scale (Figure 12b).

Marginal effects could not be produced as this required regenerating the mesh, and we did not have information on the parameters used to generate the original. As a substitute, we computed the conditional effect depth by predicting biomass across the range of observed depths at the mean latitude and longitude of the prediction grid for the first year of the survey (Figure 12c). This shows a peak in biomass around 200 m, with few fish observed at shallow depths and below 350 m.

The new base model was run with the new index, without re-tuning (Figure 12d). Catchability (q) for the revised index was 1.84, compared to a value >2 for the model without depth. Fits to the survey component and total likelihood improved by a bit over 2 likelihood points (Table 12; no change in number of parameters), suggesting that the index with depth effect is more consistent with other data sources and parameters in the model. The model fit to the index with depth effects did not require tuning, as the Francis weights were unchanged to the third decimal place.

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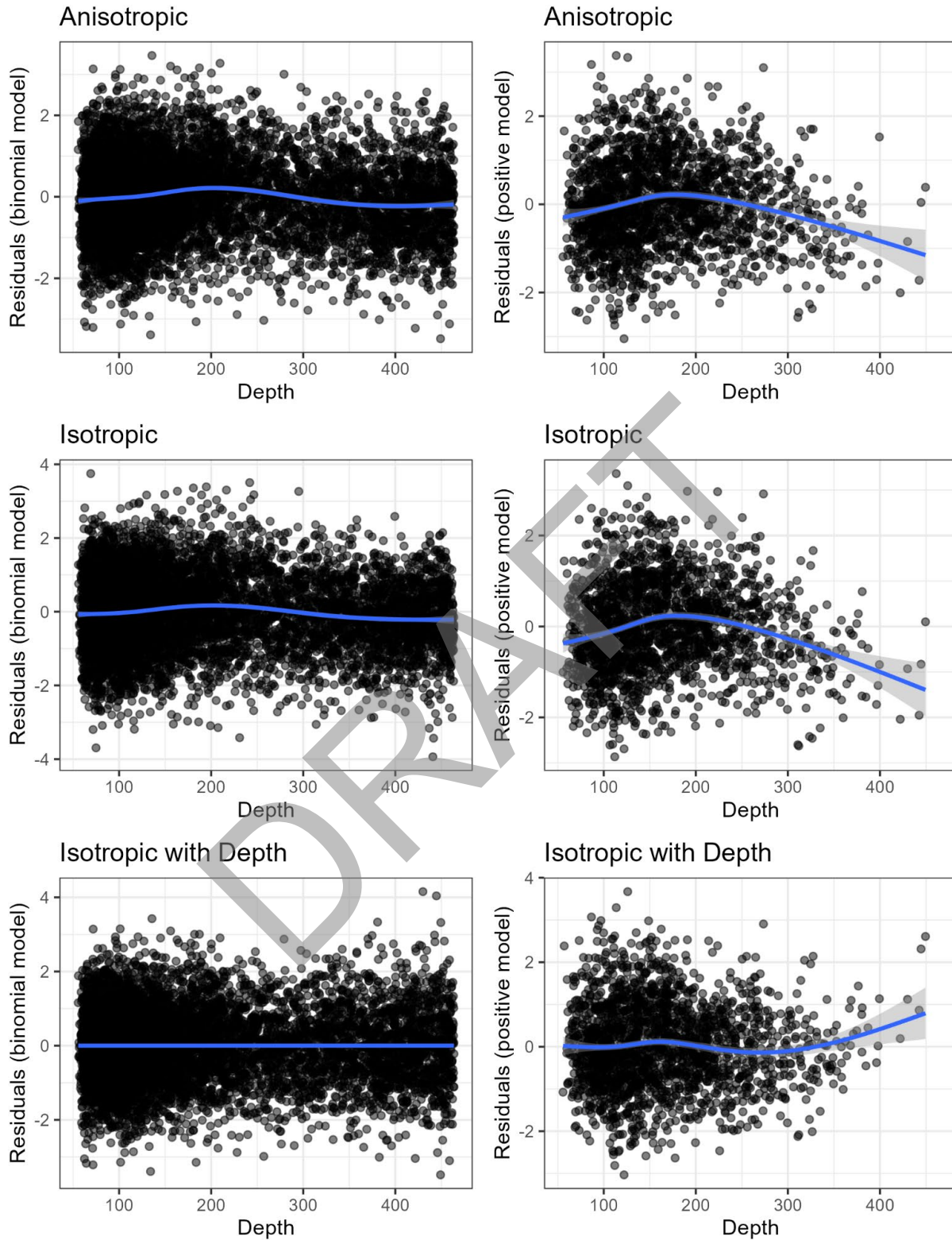


Figure 12a. Plots of model residuals in relation to depth for the original WCG BTS index model (top row: without depth, with anisotropy), the original model without anisotropy (middle row), and the new index model with depth (corrected) and without anisotropy (bottom row). Left panels are for the binomial model and right panels are for the positive model.

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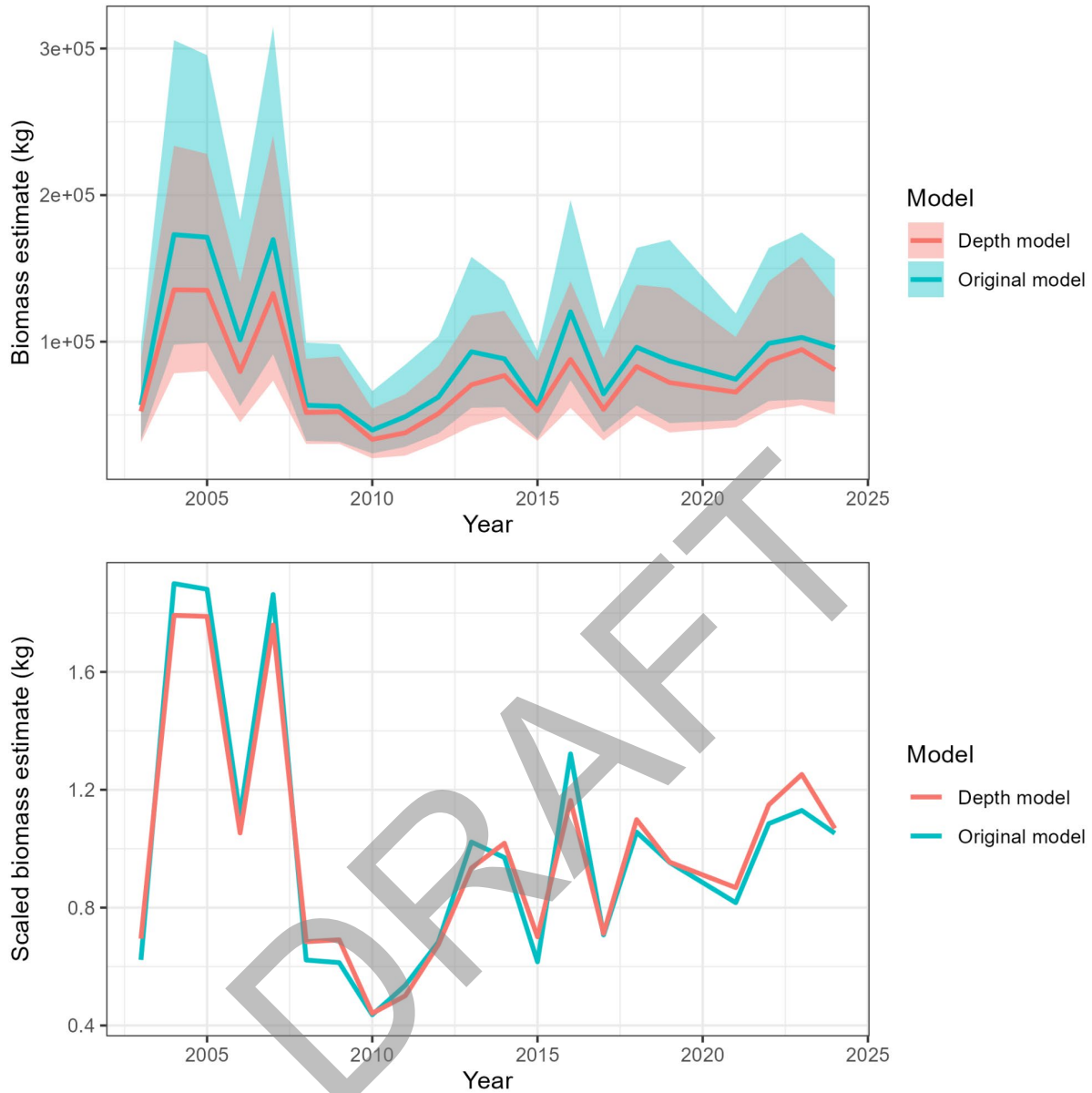


Figure 12b. Original index from the WCGBTS and new index using depth as a covariate and assuming isotropy. The depth model now uses the correct prediction depths. In the bottom panel, the indices are divided by their respective means to facilitate comparison of trends.

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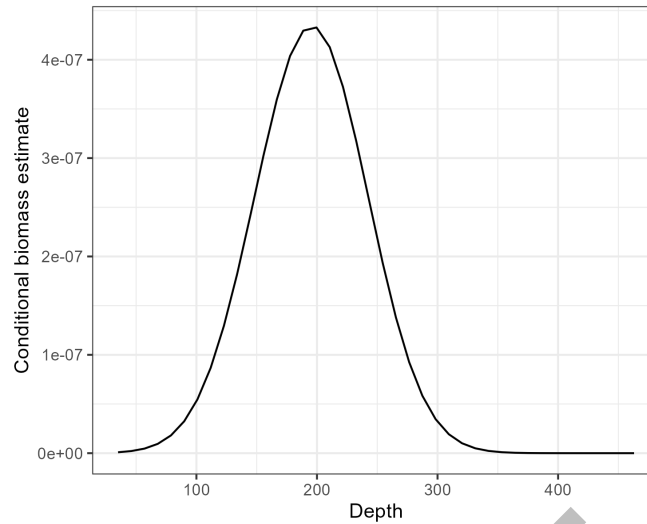


Figure 12c. Conditional effect of depth in the WCGBTS index model. Plot shows the predicted biomass density across the full range of observed depths at the mean latitude and longitude of the prediction grid for the first year of the survey. The effect is quadratic on the link scale.

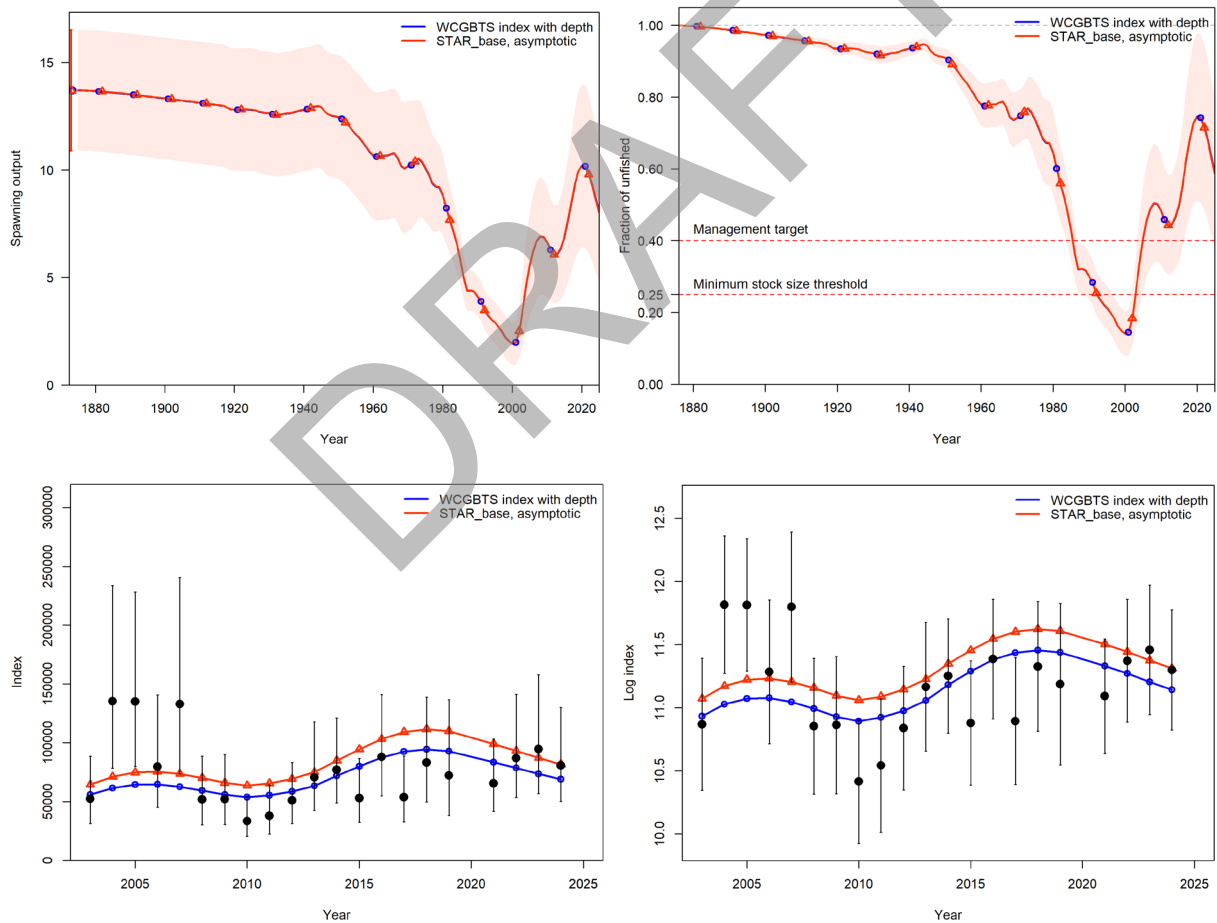


Figure 12d. Comparison of time series of spawning output (top left), relative spawning output (top right), arithmetic scale fits to the data (bottom left; note that fits are not comparable due to a change in index scale when adding depth effect), and log-scale fits (bottom right; note that fits are not comparable due to a change in index scale when adding depth effect). The difference between the two fits in each plot may be a plotting issue and not a lack of fit.

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Table 12. Likelihood components, parameter estimates, and derived quantities for models fit to WCGBTS indices with and without a depth effect.

Label	WCGBTS index with depth	STAR_base, asymptotic
N.Parms	109	109
TOTAL	2618.920	2621.330
Survey	21.805	24.307
Length_comp	572.090	572.015
Age_comp	2000.530	2000.480
Recruitment	24.400	24.425
Parm_priors	0.093	0.096
NatM_uniform_Fem_GP_1	0.176	0.177
L_at_Amax_Fem_GP_1	47.861	47.860
VonBert_K_Fem_GP_1	0.197	0.197
CV_young_Fem_GP_1	0.105	0.105
CV_old_Fem_GP_1	0.039	0.039
NatM_uniform_Mal_GP_1	0.241	0.241
L_at_Amax_Mal_GP_1	-0.329	-0.329
VonBert_K_Mal_GP_1	0.528	0.528
CV_young_Mal_GP_1	0.235	0.235
CV_old_Mal_GP_1	0.100	0.100
SR_LN(R0)	10.309	10.314
Q_extraSD_CalCOFI_Survey(11)	0.310	0.310
Q_extraSD_RREAS_YOY_Survey(12)	1.224	1.230
Size_DbIN_peak_NoCA_HKL(1)	41.088	41.080
Size_DbIN_ascend_se_NoCA_HKL(1)	4.406	4.405
Size_DbIN_peak_SoCA_HKL(2)	23.803	23.788
Size_DbIN_ascend_se_SoCA_HKL(2)	1.203	1.195
Size_DbIN_peak_CA_TWL(3)	45.106	45.102
Size_DbIN_ascend_se_CA_TWL(3)	4.564	4.563
Size_DbIN_peak_OR_WA_Comm(4)	43.154	43.109
Size_DbIN_ascend_se_OR_WA_Comm(4)	4.602	4.600
Size_DbIN_peak_CA_NET(5)	46.981	46.979
Size_DbIN_ascend_se_CA_NET(5)	4.420	4.420
Size_DbIN_peak_NoCA_OR_WA_Rec(6)	44.140	44.110
Size_DbIN_ascend_se_NoCA_OR_WA_Rec(6)	5.147	5.145
Size_DbIN_peak_SoCA_Rec(7)	24.734	24.731
Size_DbIN_ascend_se_SoCA_Rec(7)	2.936	2.936
Size_DbIN_descend_se_SoCA_Rec(7)	3.278	3.278
Size_DbIN_end_logit_SoCA_Rec(7)	-1.050	-1.049
Size_DbIN_peak_TWL_discard(8)	29.586	29.572
Size_DbIN_ascend_se_TWL_discard(8)	4.181	4.181
Size_DbIN_descend_se_TWL_discard(8)	3.191	3.194
Size_DbIN_peak_NoCA_HKL(1)_BLK1repl_1875	51.389	51.396
Size_DbIN_ascend_se_NoCA_HKL(1)_BLK1repl_1875	4.140	4.141
Size_DbIN_peak_SoCA_HKL(2)_BLK2repl_1875	48.777	48.776
Size_DbIN_ascend_se_SoCA_HKL(2)_BLK2repl_1875	4.814	4.814
Size_DbIN_peak_CA_TWL(3)_BLK3repl_1875	33.915	33.920
Size_DbIN_ascend_se_CA_TWL(3)_BLK3repl_1875	3.314	3.315
Size_DbIN_peak_SoCA_Rec(7)_BLK2repl_1875	30.642	30.648
Size_DbIN_ascend_se_SoCA_Rec(7)_BLK2repl_1875	3.741	3.742
Bratio_2025	0.591	0.587
SSB_unfished	13694	13702
Totbio_unfished	61608	61698
Recr_unfished	30000	30156
Dead_Catch_SPR	2626	2633
OFLCatch_2025	3178	3160

12 - Panel Conclusion

Proceed with the new index that includes a depth effect as part of the revised base model.

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13 - Request

Estimate the peak and ascending variance parameters for selectivity of the WCGBT and Triennial surveys and use the quick MCMC algorithm to determine how well these parameters are estimated and what reasonable values may be. Keep these survey selectivities as asymptotic and use the assumptions for commercial selectivities as in the "No Dome: All" run from Request 2.

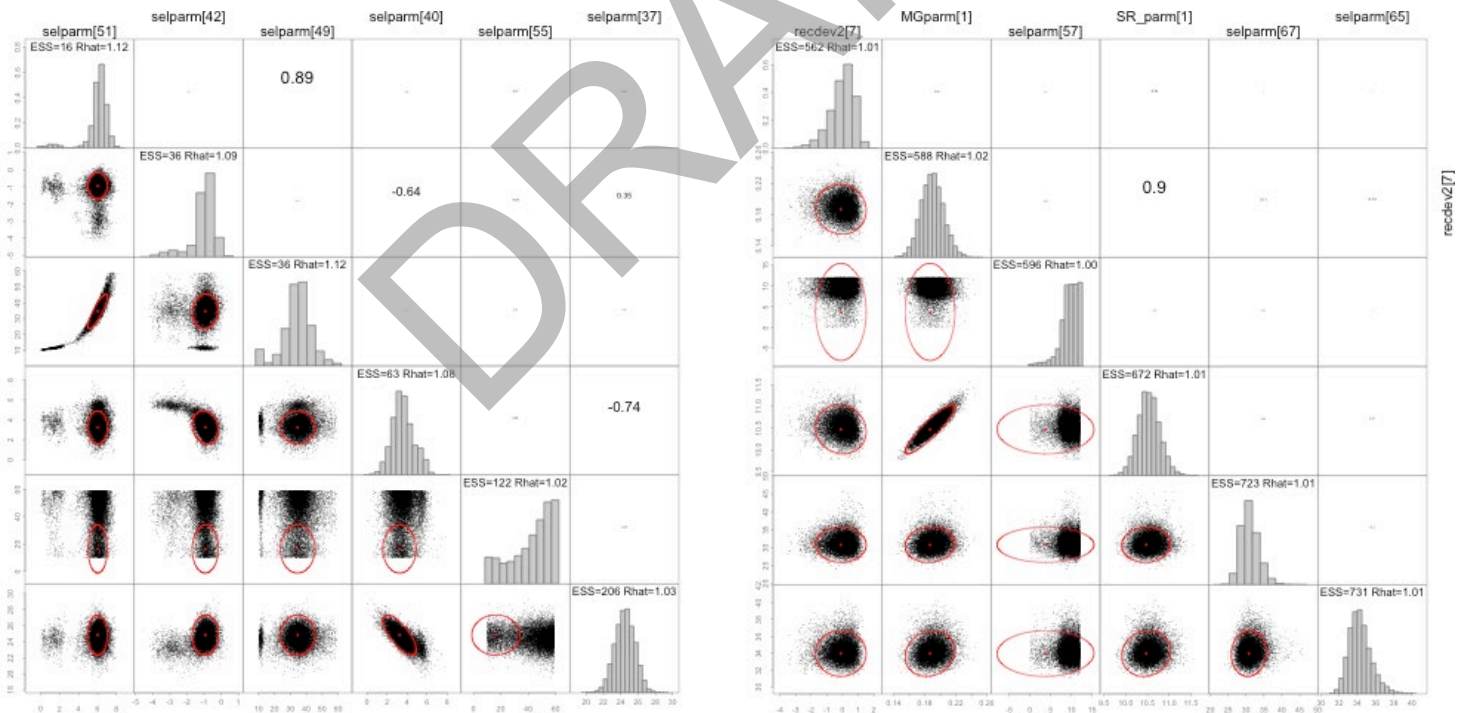
13 - Rationale

The selectivity for these two trawl surveys were not estimated in the pre-STAR base model. Forcing many of the commercial selectivities to be asymptotic (as done for Request 2) may improve the ability to estimate the survey selectivities.

13 - STAT Response

Using the asymptotic selectivity base model established in Request 2, asymptotic selectivity was added for the Triennial and WCGBT survey selectivities. The ascending scale and peak parameters were estimated in the double normal functional form with the other parameters fixed as asymptotic.

v WCGBT Peak v Triennial Ascending

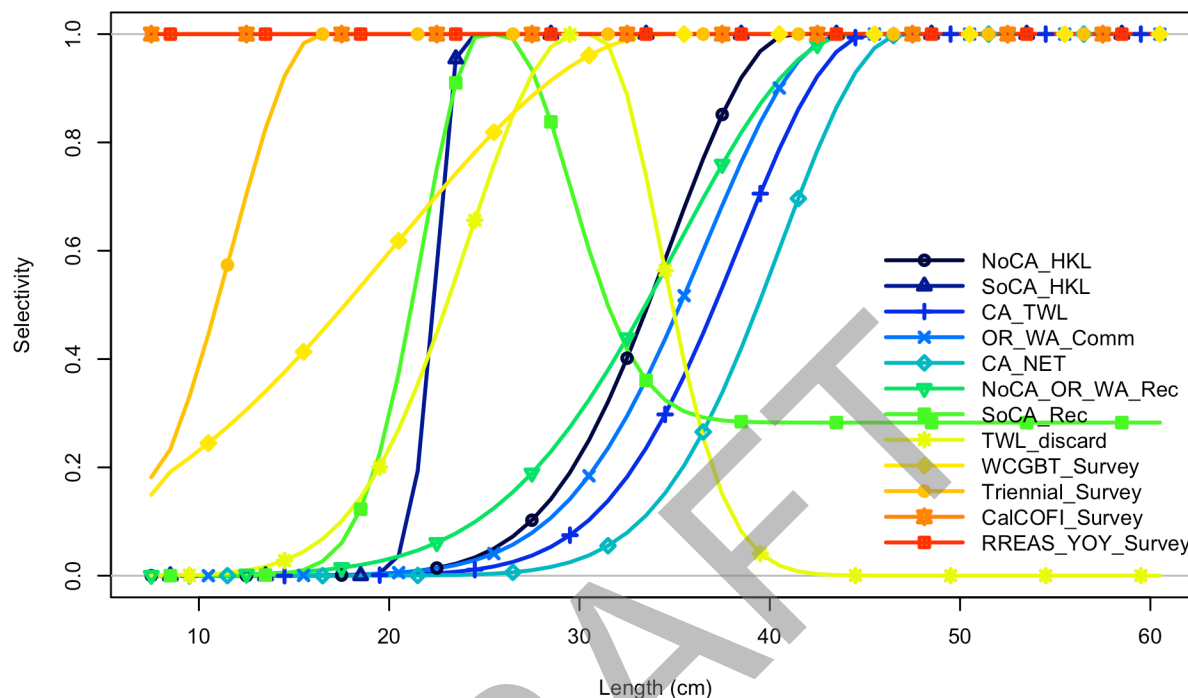


^ WCGBT Ascending Scale ^ Triennial Peak

Selparm[55] and selparm[57] are the Triennial peak and ascending scale parameters respectively. The Triennial survey selectivities are poorly estimated with posterior modes against parameter bounds and a very thick tail in the peak parameter. Triennial parameter MLEs are not

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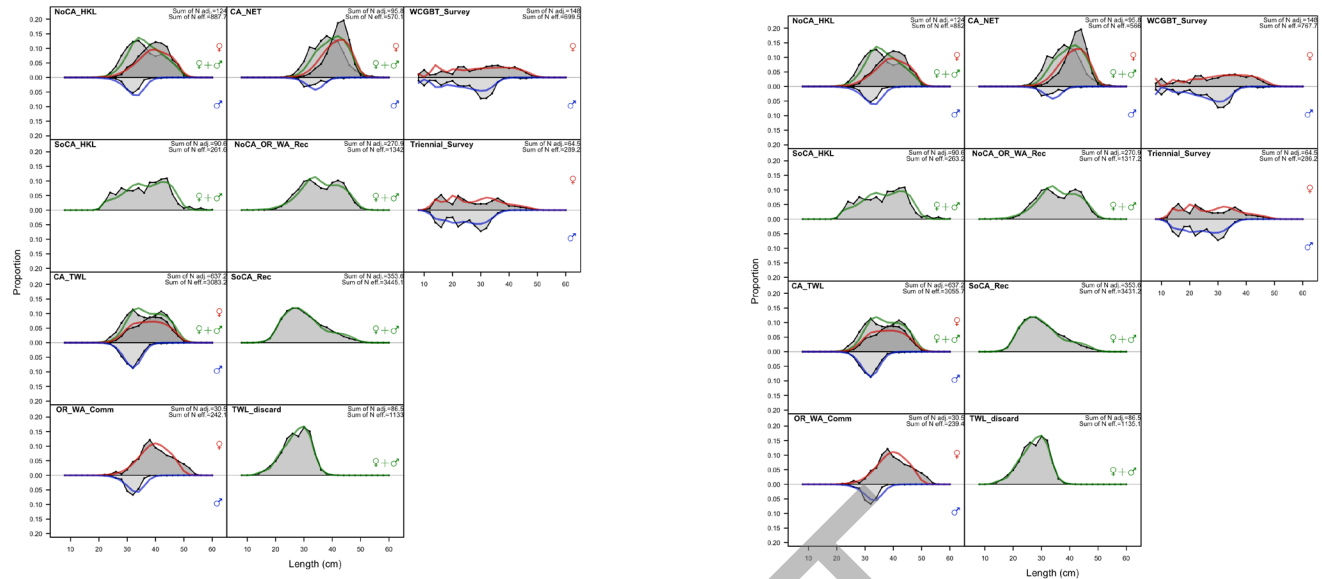
well reflected in the posteriors. Selparm[51] and selparm[49] are WCGBT ascending scale and peak respectively. The WCGBT survey selectivity parameters display some multimodality, but could possibly be estimated with reasonable posterior health. Multimodality is evidence of a nearby local mode, but the prominent mode seems well defined and reasonably well captured by the MLE estimates.



Above are the fitted MLE selectivities with the added asymptotic selectivity for Triennial and WCGBT surveys.

Asymptotic Base Added Asymptotic Surveys

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Marginal length composition fit using the base model (left), and with the added asymptotic selectivities (right) shown above. A small improvement to marginal length composition fit at small sizes resulted from fitting the WCGBT selectivity.

13 - Panel Conclusion

The Panel appreciates the work done by the STAT. The MCMC run is really informative and shows that there might be some multimodality in the selectivity parameter estimates. This leads to Request 16 and looking at predicted spatial fields.

14 - Request

Examine catch rates in early years of the WCBTS and compare those to the catch rates in later years. This may include creating maps of raw catch rates (bubble plots), identifying the locations and magnitude of the 10 highest catch rates for each year, proportion of zero catch, and stratified by depth.

14 - Rationale

The early years of the WCBTS show high index values that are not fit well by the model. A better understanding of these years will be helpful to determine how likely these years are to reflect population abundance.

14 - STAT Response

The STAT worked with our GIS analyst, Rebecca Miller, to update plots that were initially developed for the 2015 assessment update, showing catch rates from the survey off of the California coastline (region of greatest abundance) for two time periods, 2004-2007 and 2008-2024. There is also a set of figures in which a closer look at central California survey data are provided. The results highlight that the highest catches of chilipepper in the survey are most frequently encountered close to the shelf break (between approximately 125-275 m depth), particularly in regions where the continental slope is steep. The results do not visually suggest substantive changes in the distribution of high and low catches between these two time periods,

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although this is difficult to discern from the figure alone. A provisional table of the total number of WCG BTS trawls, the number of trawls positive for chilipepper, and the mean cpue by three depth bins and for CA waters between 34 and 42 N (by year) is also provided, as well as a provisional table showing the year, location and cpue of the top 15 catches of chilipepper in the WCG BTS during the survey period.

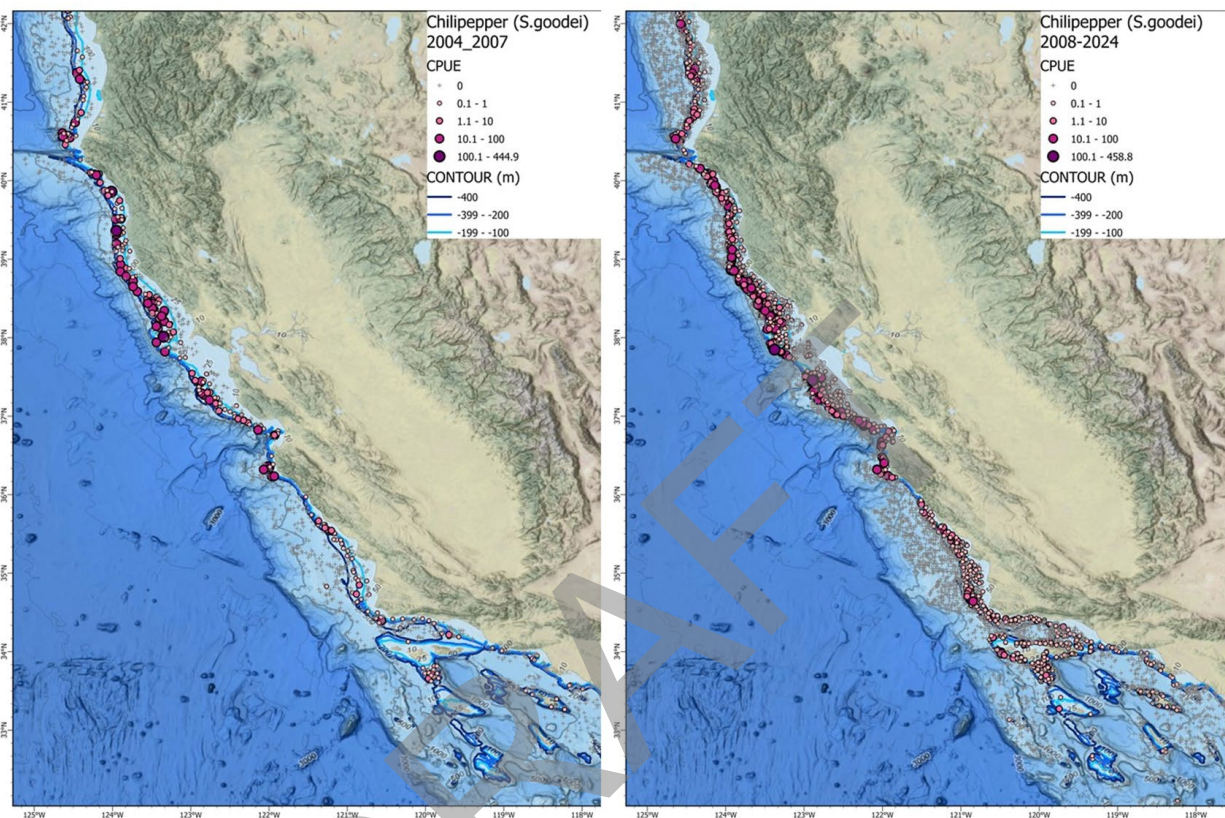


Figure 14a. Plot of California wide WCG BTS catch rates from 2004-2007 (years in which index underfit) and 2008-2024 (years in which index reasonably well fit). Figure includes 100, 200 and 400m depth contours. CPUE is kg/ha (binned), results show the relatively narrow concentration of high biomass between approximately 125- 275 m depth. High resolution pdfs are included in the google drive folder.

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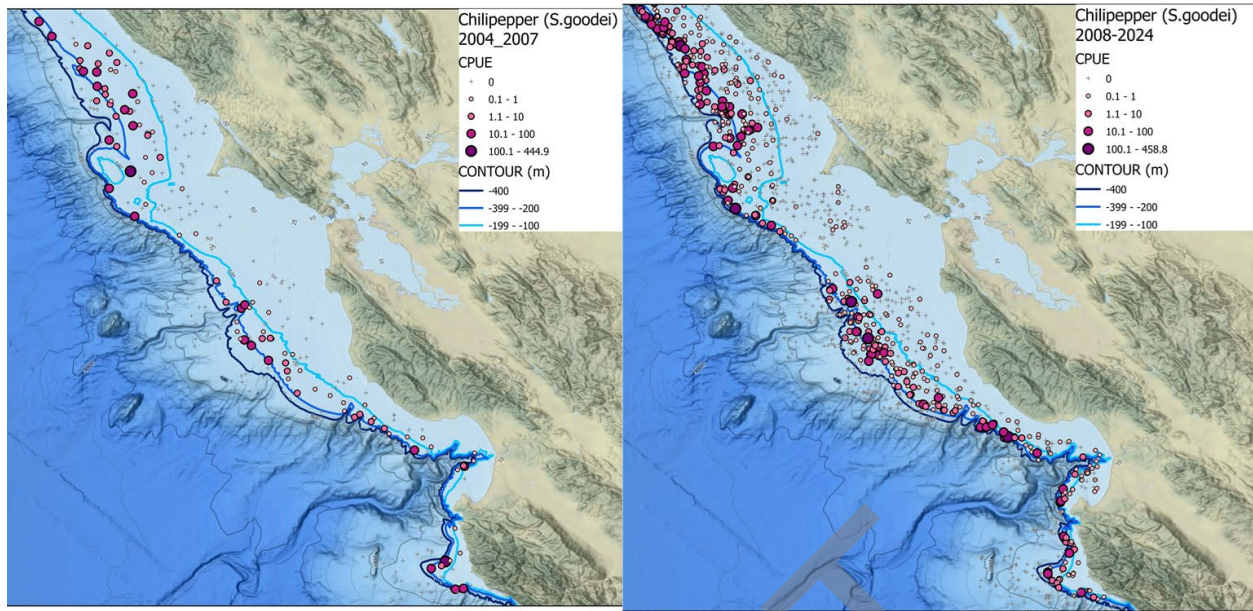


Figure 14b. Plot of Central California WCG BTS catch rates from 2004-2007 (years in which index underfit) and 2008-2024 (years in which index reasonably well fit). Figure includes 100, 200 and 400m depth contours. CPUE is kg/ha (binned), results show the relatively narrow concentration of high biomass between approximately 125- 275 m depth. High resolution pdfs are included in the google drive folder.

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Table 14a. Table of WCGBTS data, summarizing the % positive tows, mean cpue (kg/ha) per tow and the number of tows (here constrained to the area of highest density, between 34 and 42 N, excluding waters off of Oregon and Washington, as well as the Southern part of the Southern California Bight).

year	% pos 50-125 m	mean cpue pos 50-125m	# tows	% pos 125-275 m	mean cpue pos 125-275m	# tows	% pos 275-550m	mean cpue pos 275-550	# tows
2003	38.18%	0.01	55	83.33%	11.78	54	18.03%	0.02	61
2004	48.33%	0.70	60	75.61%	10.26	41	8.33%	0.00	36
2005	33.72%	5.57	86	76.92%	6.75	52	3.28%	0.01	61
2006	26.23%	2.93	61	69.57%	6.25	46	3.28%	0.02	61
2007	18.18%	0.40	66	66.04%	7.36	53	8.20%	0.00	61
2008	28.40%	0.28	81	72.73%	5.51	44	6.49%	0.02	77
2009	24.18%	0.19	91	58.62%	2.26	58	13.04%	0.14	69
2010	32.94%	0.06	85	73.44%	1.04	64	8.45%	0.03	71
2011	18.52%	0.06	81	77.05%	5.19	61	5.08%	0.01	59
2012	36.73%	0.11	98	85.45%	4.77	55	8.45%	0.26	71
2013	65.52%	1.76	58	90.24%	3.03	41	13.16%	0.02	38
2014	49.37%	0.27	79	77.97%	9.99	59	16.42%	0.01	67
2015	27.47%	0.07	91	74.47%	4.13	47	17.81%	0.38	73
2016	35.21%	0.69	71	88.52%	9.32	61	4.11%	0.05	73
2017	30.95%	0.20	84	74.51%	4.83	51	13.70%	0.34	73
2018	31.25%	0.30	80	68.52%	14.53	54	10.00%	0.01	70
2019	29.41%	0.02	34	73.17%	9.22	41	3.03%	0.00	33
2021	53.61%	0.52	97	68.42%	4.71	57	11.11%	0.37	63
2022	45.35%	0.35	86	73.47%	3.21	49	5.33%	0.01	75
2023	32.10%	0.40	81	71.70%	4.34	53	10.67%	0.11	75
2024	45.00%	0.59	80	81.48%	9.70	54	12.96%	0.07	54

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Table 14b. Year, location, depth and raw cpue (kg/ha) of the 15 highest chilipepper catches in WCGBTS between 2003-2024.

year	cpue	longitude	latitude	depth
2014	458.78	-123.93	38.87	265
2005	444.86	-124.01	39.86	114
2003	257.61	-123.46	38.10	174
2018	193.78	-123.81	38.72	255
2018	168.31	-123.61	38.53	168
2006	167.84	-123.35	38.01	112
2019	153.89	-122.23	36.89	145
2011	147.42	-122.89	37.46	150
2004	128.41	-122.01	36.35	133
2007	118.87	-123.95	39.36	180
2024	115.79	-122.89	37.46	150
2022	115.00	-124.69	42.51	126
2024	111.64	-123.38	37.85	153
2021	107.96	-122.82	37.30	158
2006	99.62	-123.44	37.94	142

14 - Panel Conclusion

The Panel appreciates the work done by the STAT. However, the raw data plots presented by the STAT could not, on their own, explain the reason for a higher index in 2004-2007 (i.e., the distribution is much more contracted in spatial range, the overall mean does not seem consistently higher in these years, and fish are found in shallow waters in this period). This leads to Request 17.

15 - Request

Estimate the WCGBTS peak and ascending variance selectivity parameters starting the MLE optimization routine at 35 and 6, respectively. Fix the Triennial survey peak selectivity parameter at 58 and the ascending limb parameter at 10 (or a different value if 10 presents any issues). Present r4ss output. Also compare likelihoods to the current base model. Please also try a run estimating the WCGBTS peak and ascending limb and removing the Triennial index, length data, and age data (e.g., setting lambdas to zero).

15 - Rationale

The MCMC analysis supported shallower (slower ascending) survey selectivities with a peak at 30cm or greater, although did show a small mode at a steeper selectivity with a smaller peak. This will help understand the uncertainty across these two scenarios.

15 - STAT Response

The pre-STAR model with asymptotic selectivities and unconstrained recruitment deviations was the starting point for this request. The first part of the request, with estimated parameters for the WCGBTS and fixed parameters for the Triennial, produced selectivity WCGBTS estimates that were consistent with the 'mode' of the MCMC reported in Request 13 (Figure 15a, Table 15). The fixed parameter estimates for the Triennial (chosen by visual inspection of the MCMC results in Request 13) produced a curve very similar to the curve in the pre-STAR

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base, where only age-0 fish are excluded, and all other ages have selectivity equal to one (Figure 15a). The STAT views this as support for a simple selectivity curve in the Triennial survey, and suggests keeping the original curve (i.e., selectivity = 1 for age1+ fish). The STAT modified the request slightly, adding an age-based selectivity that set selectivity=0 for age-0 fish, as the length-based selectivity curve requested by the panel predicted a large number of age-0 fish that were not seen by the survey (see r4ss output for aggregated length compositions). The fits to the lengths for the WCGBTS were ultimately degraded by the estimated curve relative to the original pre-STAR base, as determined by an increase of roughly 4 points in the negative log likelihood component for lengths from the survey (Table 15). There was a small improvement in the fit to the WCGBTS index, as seen by a -0.6 change in the survey component (Table 15).

For the second part of the request, the model from part 1 was modified to remove all data types from the Triennial survey. This had no effect on estimated selectivity curves for the remaining fleets (Figure 15b). Comparison plots of the three runs (pre-STAR base with asymptotic selectivities, part 1 of this request, and part 2 of this request) show that the model scale is affected removal of the triennial, caused in part by a shift of rec devs toward more negative values when the triennial is removed, resulting in a positive shift in R_0 to offset the effect. A similar, but much smaller, effect is associated with the changes to survey selectivity in part 1 of the request, relative to the pre-STAR base.

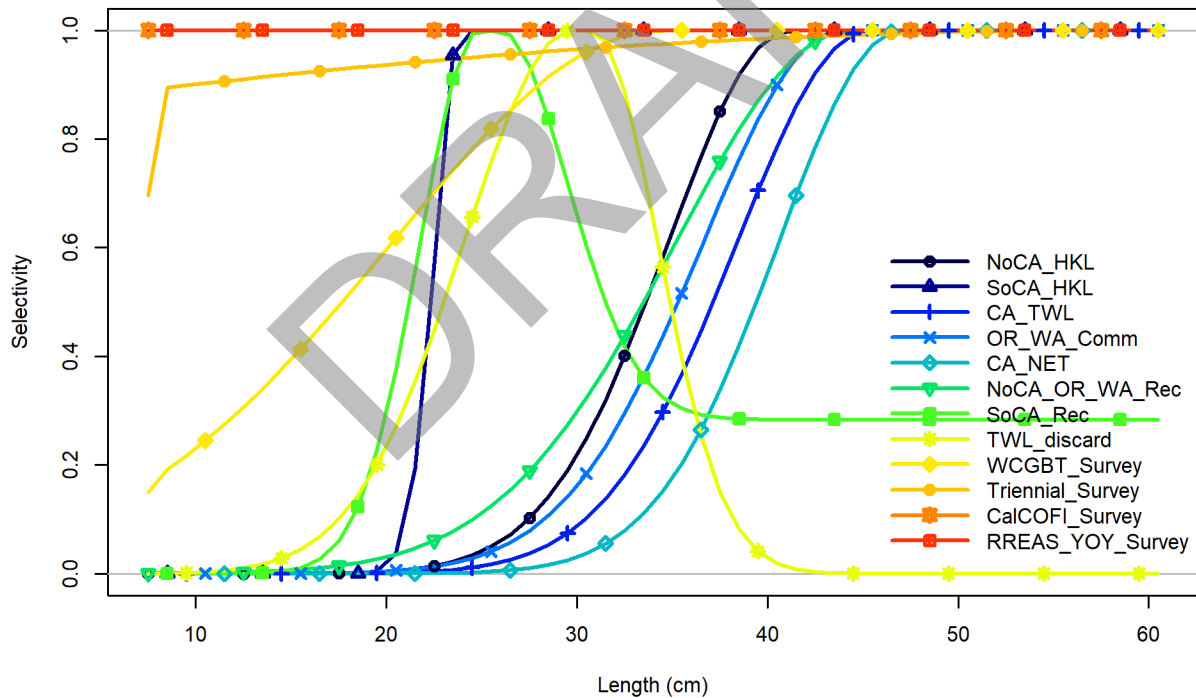


Figure 15a. End-year selectivity curves from the pre-STAR base with estimated peak and ascending width parameters for the WCGBTS, and fixed selectivity parameters (see Request) for the Triennial survey.

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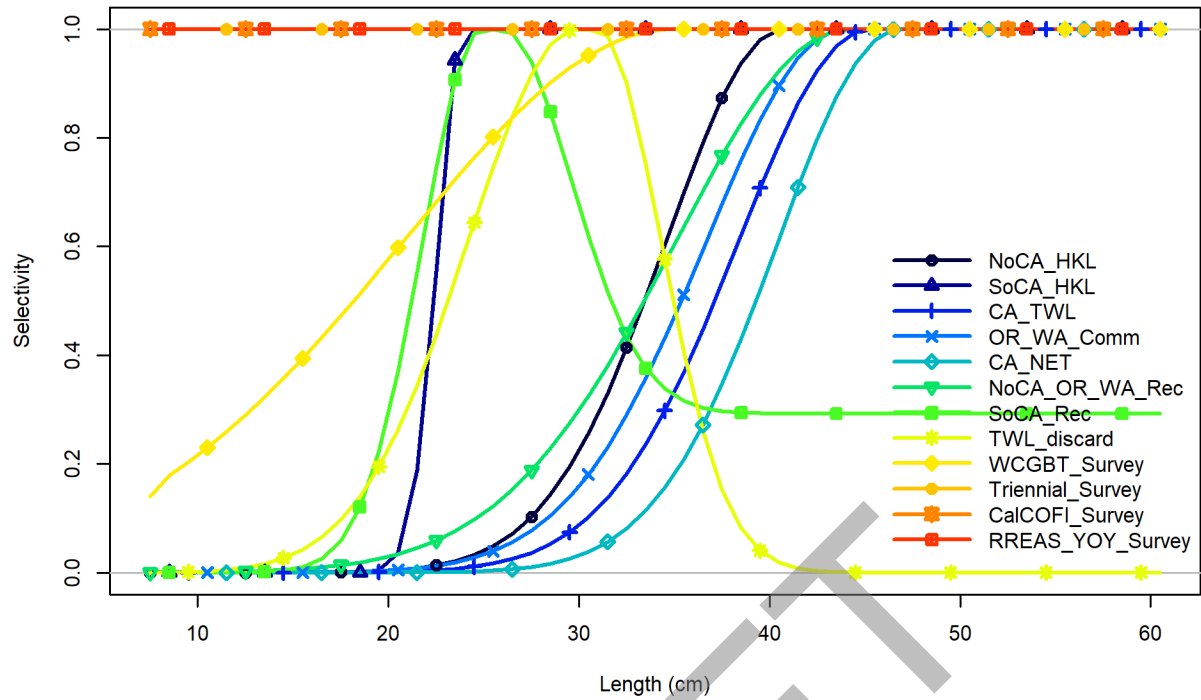


Figure 15b. End-year selectivity curves from the pre-STAR base with estimated peak and ascending width parameters for the WCGBTs, and the Triennial survey removed from the model.

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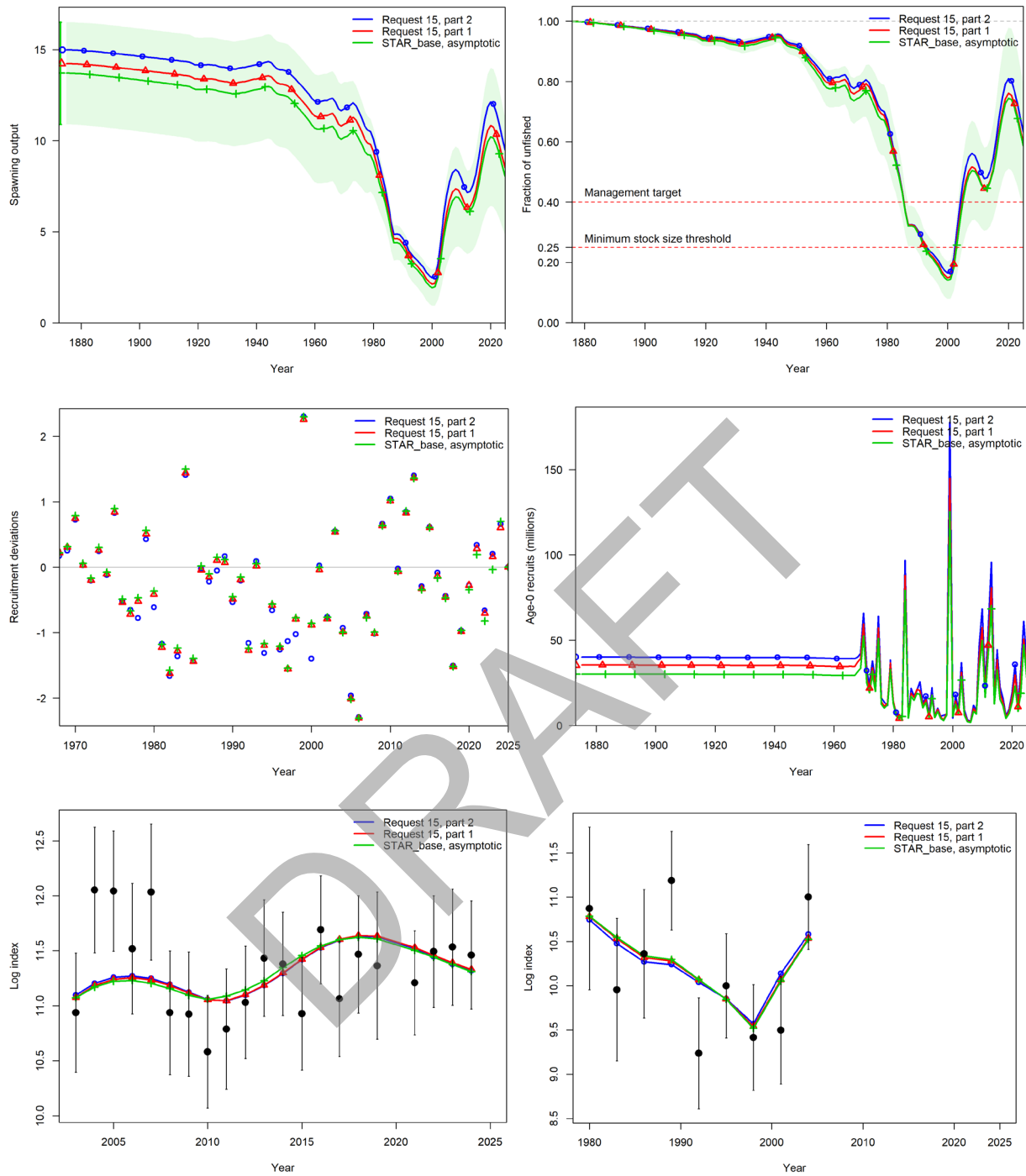


Figure 15c. Time series of spawning output, relative spawning output, recruitment devs and time series, and log-scale fits to the WCGBTS and Triennial survey based on Request 15. “Fit” to the Triennial survey index for part 2 is implied, as the lambda was set equal to zero.

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Table 15. Likelihood components, estimated parameters, and derived quantities associated with Request 15.

Label	Request 15, part 2	Request 15, part 1	STAR_base, asymptotic
N.Parms	111	111	109
TOTAL	2504.080	2623.980	2621.330
Survey	20.881	23.745	24.307
Length_comp	547.765	576.047	572.015
Age_comp	1910.190	1999.490	2000.480
Recruitment	24.978	24.495	24.425
Parm_priors	0.262	0.191	0.096
NatM_uniform_Fem_GP_1	0.193	0.187	0.177
L_at_Amax_Fem_GP_1	47.948	47.890	47.860
VonBert_K_Fem_GP_1	0.195	0.196	0.197
CV_young_Fem_GP_1	0.106	0.105	0.105
CV_old_Fem_GP_1	0.038	0.039	0.039
NatM_uniform_Mal_GP_1	0.211	0.221	0.241
L_at_Amax_Mal_GP_1	-0.332	-0.329	-0.329
VonBert_K_Mal_GP_1	0.515	0.522	0.528
CV_young_Mal_GP_1	0.283	0.241	0.235
CV_old_Mal_GP_1	0.098	0.099	0.100
SR_LN(R0)	10.598	10.474	10.314
Q_extraSD_CalCOFI_Survey(11)	0.319	0.311	0.310
Q_extraSD_RREAS_YOY_Survey(12)	1.219	1.221	1.230
Size_DbIN_peak_NoCA_HKL(1)	40.742	41.136	41.080
Size_DbIN_ascend_se_NoCA_HKL(1)	4.345	4.401	4.405
Size_DbIN_peak_SoCA_HKL(2)	23.962	23.906	23.788
Size_DbIN_ascend_se_SoCA_HKL(2)	1.289	1.259	1.195
Size_DbIN_peak_CA_TWL(3)	45.243	45.296	45.102
Size_DbIN_ascend_se_CA_TWL(3)	4.557	4.565	4.563
Size_DbIN_peak_OR_WA_Comm(4)	43.881	43.833	43.109
Size_DbIN_ascend_se_OR_WA_Comm(4)	4.651	4.654	4.600
Size_DbIN_peak_CA_NET(5)	46.794	46.973	46.979
Size_DbIN_ascend_se_CA_NET(5)	4.400	4.414	4.420
Size_DbIN_peak_NoCA_OR_WA_Rec(6)	44.128	44.372	44.110
Size_DbIN_ascend_se_NoCA_OR_WA_Rec(6)	5.108	5.140	5.145
Size_DbIN_peak_SoCA_Rec(7)	24.873	24.844	24.731
Size_DbIN_ascend_se_SoCA_Rec(7)	2.956	2.954	2.936
Size_DbIN_descend_se_SoCA_Rec(7)	3.282	3.249	3.278
Size_DbIN_end_logit_SoCA_Rec(7)	-0.884	-0.929	-1.049
Size_DbIN_peak_TWL_discard(8)	29.887	29.757	29.572
Size_DbIN_ascend_se_TWL_discard(8)	4.190	4.185	4.181
Size_DbIN_descend_se_TWL_discard(8)	3.126	3.158	3.194
Size_DbIN_peak_WCGBT_Survey(9)	35.007	34.585	NA
Size_DbIN_top_logit_WCGBT_Survey(9)	-6.000	-6.000	NA
Size_DbIN_ascend_se_WCGBT_Survey(9)	6.013	6.022	NA
Size_DbIN_descend_se_WCGBT_Survey(9)	7.000	7.000	NA
Size_DbIN_start_logit_WCGBT_Survey(9)	-999.000	-999.000	NA
Size_DbIN_end_logit_WCGBT_Survey(9)	10.000	10.000	NA
Size_DbIN_peak_NoCA_HKL(1)_BLK1repl_1875	51.194	51.365	51.396
Size_DbIN_ascend_se_NoCA_HKL(1)_BLK1repl_1875	4.122	4.135	4.141
Size_DbIN_peak_SoCA_HKL(2)_BLK2repl_1875	48.393	48.771	48.776
Size_DbIN_ascend_se_SoCA_HKL(2)_BLK2repl_1875	4.775	4.806	4.814
Size_DbIN_peak_CA_TWL(3)_BLK3repl_1875	33.940	33.997	33.920
Size_DbIN_ascend_se_CA_TWL(3)_BLK3repl_1875	3.299	3.322	3.315
Size_DbIN_peak_SoCA_Rec(7)_BLK2repl_1875	30.960	30.791	30.648
Size_DbIN_ascend_se_SoCA_Rec(7)_BLK2repl_1875	3.775	3.757	3.742
Size_DbIN_peak_Triennial_Survey(10)	NA	58.000	NA
Size_DbIN_top_logit_Triennial_Survey(10)	NA	-6.000	NA
Size_DbIN_ascend_se_Triennial_Survey(10)	NA	10.000	NA
Size_DbIN_descend_se_Triennial_Survey(10)	NA	7.000	NA
Size_DbIN_start_logit_Triennial_Survey(10)	NA	-999.000	NA
Size_DbIN_end_logit_Triennial_Survey(10)	NA	10.000	NA
SizeSel=1_BinLo_WCGBT_Survey(9)	NA	NA	3.000
SizeSel=1_BinHi_WCGBT_Survey(9)	NA	NA	54.000
Bratio_2025	0.633	0.597	0.587
SSB_unfished	14983	14233	13702
Totbio_unfished	70061	65718	61698
Recr_unfished	40069	35386	30156
Dead_Catch_SPR	3198	2927	2633
OFLCatch_2025	4170	3613	3160

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15 - Panel Conclusion

The likelihood when estimating the WCGBTS was slightly higher than when fixing these selectivity parameters to produce a knife-edge selectivity. The MCMC results from Request 13 were likely not fully converged on a parameter space that was correlated with two similar peaks. The assumed (fixed) Triennial survey selectivity based on the MCMC results from Request 13 was practically the same as assumed in the preSTAR model. The Triennial survey has some influence on the model and the Panel does not see sufficient reason to remove it. Therefore, the Panel supports the survey selectivity assumptions as in the preSTAR model.

16 - Request

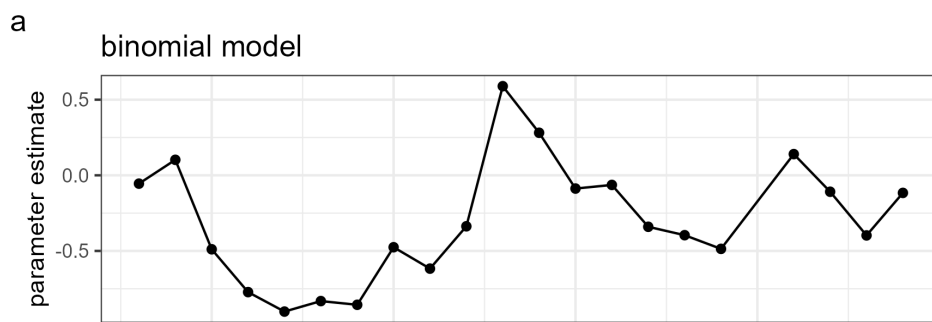
Provide plots of estimated spatial and spatio-temporal fields for both components of the delta-lognormal model used for the WCGBT survey. It is to be noted that the spatio-temporal field will only be available for the presence/absence model. The STAT can choose which years to present if there are too many plots but please provide a justification for the choice of years. Please focus on evaluating the difference between the early period (2004-2007) and later period (after 2008) in order to understand the reason for the higher index in 2004-2007. Please also show the values of the estimated “year” effect.

16 - Rationale

The raw data plot presented by STAT in request 14 was informative but alone could not explain the reason for a higher index in 2004-2007 (i.e., the distribution is much more contracted in spatial range, the overall mean is not higher in these years, and fish are found in shallow waters in the 2004-2007). It is therefore needed to look at the impact of these observations to the estimates obtained by the survey index standardization model. This requires a further dive into the examination of the estimated spatio-temporal field which is the only component of the model that is allowed to vary in space and time.

16 - STAT Response

Plots are provided below of the ‘year’ effects and spatial random fields for the binomial and positive models, as well as the spatial-temporal random field for the binomial model. A plot for both models is also provided of the ‘non-random fields’, which correspond to the depth effect (plotted over space). It appears that the trend in the index is driven primarily by the fixed year effects of the positive model, which resemble (roughly) the raw geometric mean of the positive catch data. The spatio-temporal random field in the binomial model (and the binomial model in general) does not appear to be contributing as much to overall trends.



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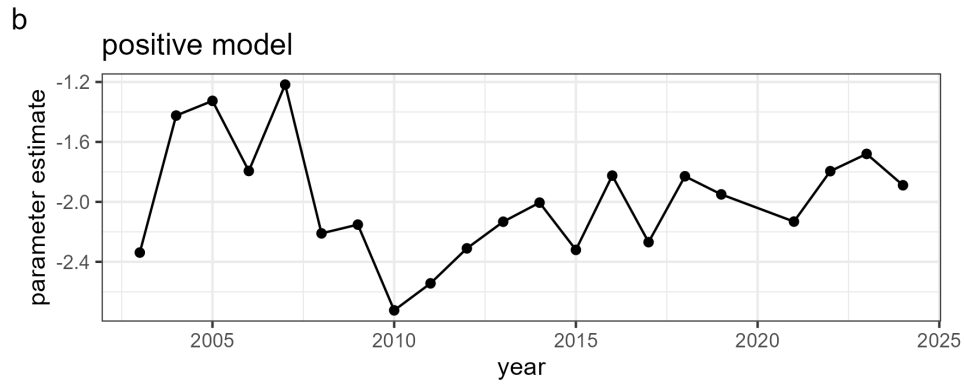


Figure 16a. Parameter estimates for the year coefficients from the binomial component (a) and positive component (b) of the WCG BTS index model. Values are on the link scale.

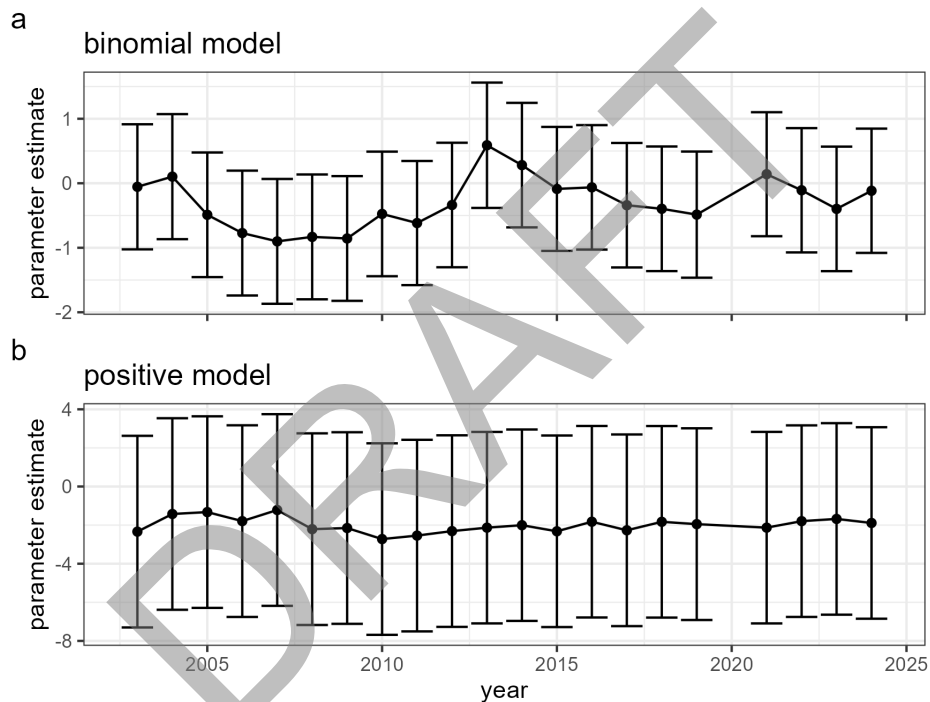
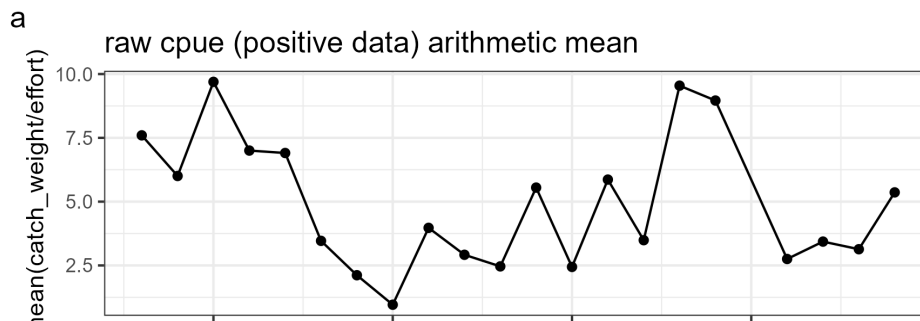


Figure 16b. Same as Figure 16a, parameter estimates for the year coefficients from the binomial component (a) and positive component (b) of the WCG BTS index model, but with standard errors. The resemblance of the positive model coefficients to the index is less obvious when the error bars are included.



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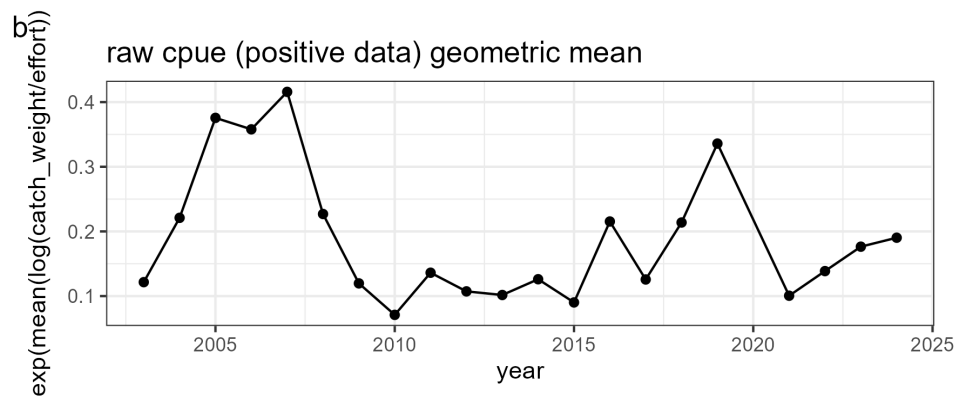


Figure 16c. Time series of raw mean CPUE from the WCGBTS, using the arithmetic mean (a) and geometric mean (b).

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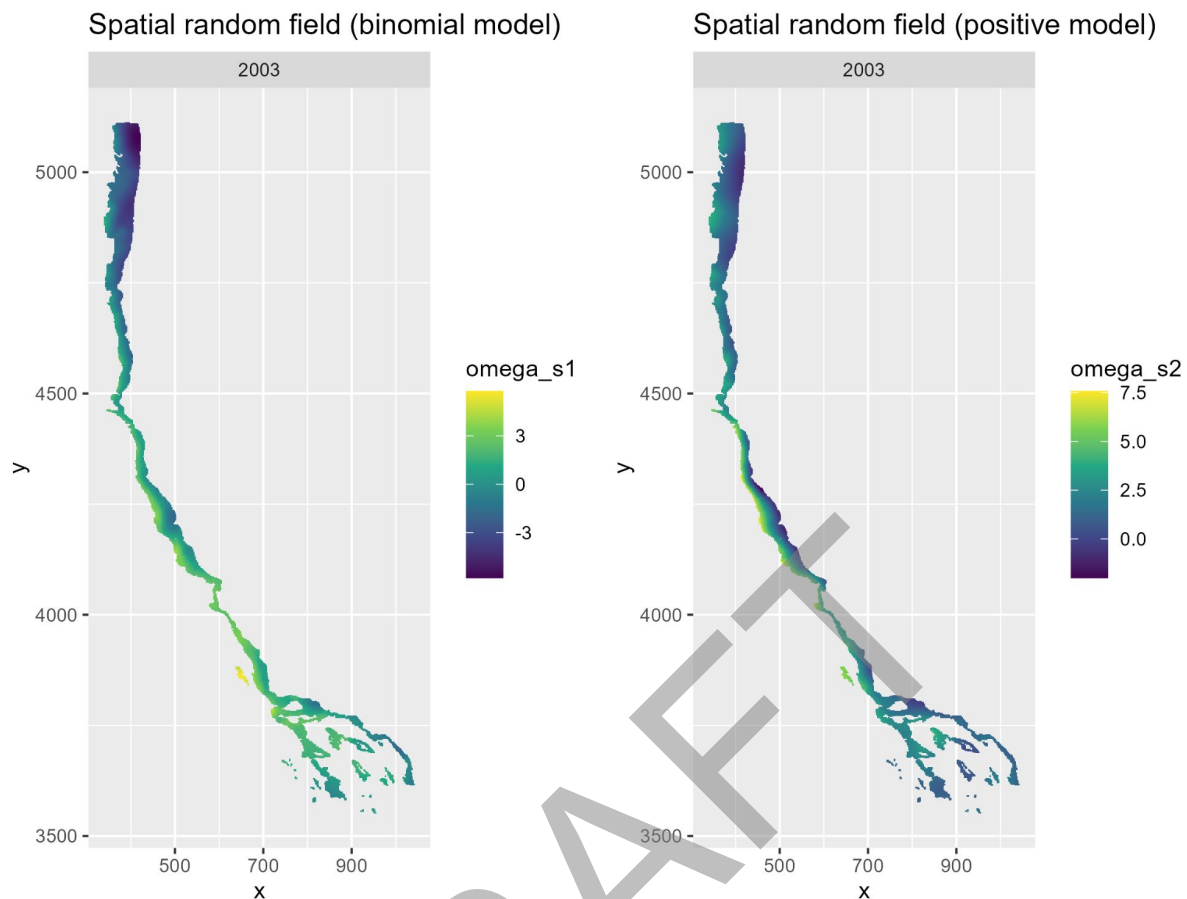


Figure 16d. Spatial random fields for the binomial component (left panel) and positive component (right panel) of the WCGBTS index model. This effect is the same for all years of the survey. Values are on the link scale.

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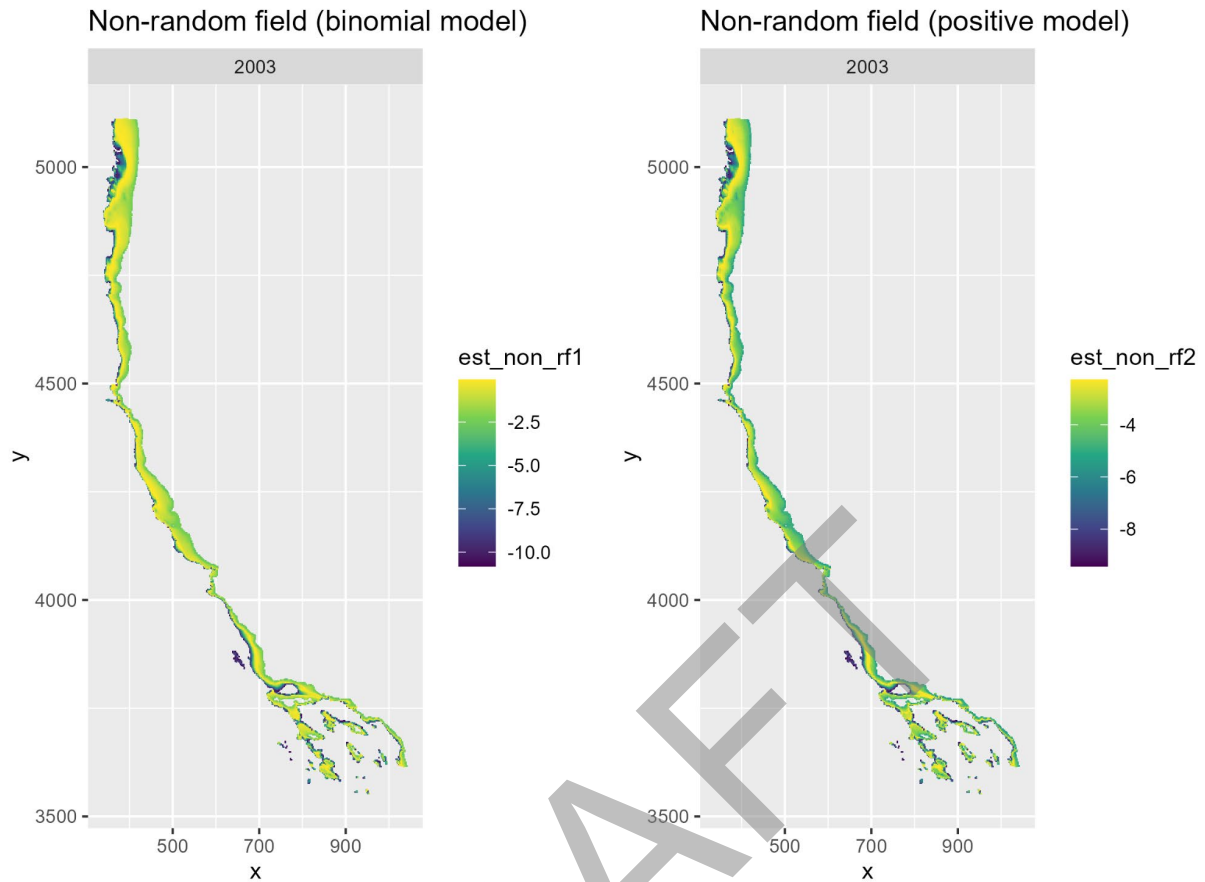


Figure 16e. Non-random fields for the binomial component (left panel) and positive component (right panel) of the WCG BTS index model for the first year of the survey. These represent depth effects, which will be the same for all years of the survey, but scaled up or down by fixed year effects. Values are on the link scale.

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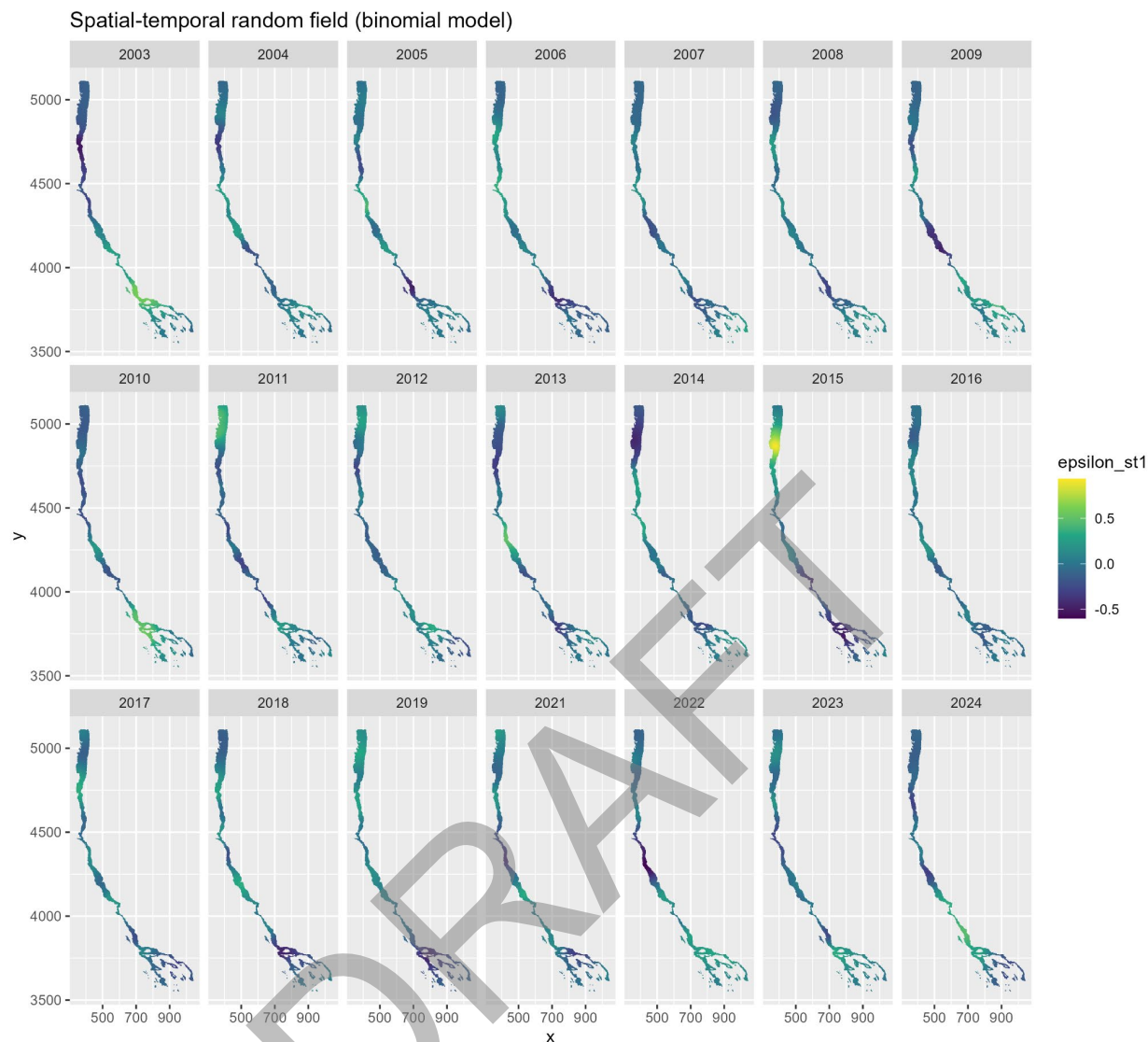


Figure 16f. Spatial-temporal random fields for the binomial component of the WCG BTS index model for all years. Values are on the link scale.

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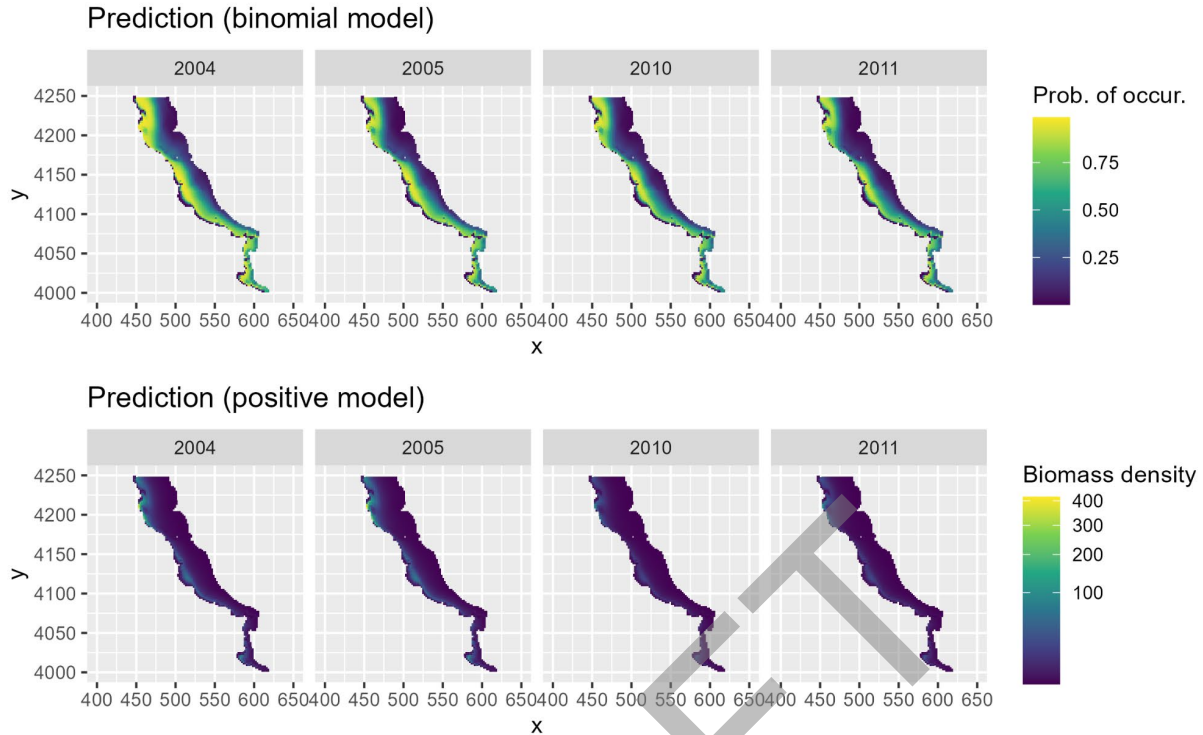


Figure 16g. Predictions from the index model for two ‘high years’ (2004, 2005) and two ‘low years’ (2010, 2011) for the WCG BTS for the binomial model (a) and positive model (b), zooming in on central California. Values are on the response scale (probability of occurrence for binomial, biomass density for positive).

16 - Panel Conclusion

The Panel appreciates this detailed investigation. It is useful to know where the differences in biomass density originated.

17 - Request

Provide a model with asymptotic commercial and northern recreational selectivities, recruitment deviations constrained to sum to zero, recruitment bias correction tuned, the WCG BTS index that includes a depth effect with isotropy, fixing the additional standard error for the RREAS index such that total standard error across all years averages to 1.0 (the fixed value of σ_R), and the selectivity for WCG BTS and Triennial surveys either estimated or fixed at appropriate values as determined by the STAT. Please tune this model.

17 - Rationale

The STAT has provided many investigations, sensitivities, and responses to requests that support changing the pre-STAR base model in this way. Request 2 supported asymptotic commercial selectivity, Requests 4 and 11 investigated the sum to zero constraint on recruitment deviations, Request 12 examined the depth effect in the WCG BTS spatio-temporal model, Request 10 examined the influence of the RREAS index, and Request 13 examined survey selectivities. Investigations of survey selectivity are pending (Request 15) and the Panel

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encourages the STAT to provide their recommendations for these. This run will be examined as a potential base model.

17 - STAT Response

The STAT constructed a model with the previously mentioned asymptotic selectivity curves, a sum-to-zero constraint on recruitment deviations, steepness fixed at 0.72, a revised WCGBTS, an additive variance parameter for the RREAS survey (fixed so total average $\log SE = \sigma_R = 1$), and trawl survey selectivities fixed at 1 for age 1+ fish (Triennial) and size 9.5cm+ fish (WCGBTS). The model was less stable than the previous base, with multiple minima in the region of the best identified solution. Attempts to estimate the hessian for the best available solution after tuning the composition data failed. In an effort to stabilize the model, the STAT examined the parameter standard errors from a previous run and identified two parameters with standard errors greater than the MLE: the ascending limb of selectivity for the Southern California hook-and-line fleet, and the male offset for the CV of length at age 20 (Table 17a).

Table 17a. Method used to identify potentially problematic parameters. Grey lines are parameter with standard errors greater than the maximum likelihood estimate.

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Parameter	Value	Parm_StDev	Parm_StDev/Value
NatM_uniform_Fem_GP_1	0.166	0.012	0.07
L_at_Amax_Fem_GP_1	47.924	0.213	0.00
VonBert_K_Fem_GP_1	0.196	0.003	0.02
CV_young_Fem_GP_1	0.105	0.004	0.04
CV_old_Fem_GP_1	0.038	0.003	0.08
NatM_uniform_Mal_GP_1	0.251	0.044	0.18
L_at_Amax_Mal_GP_1	-0.325	0.009	-0.03
VonBert_K_Mal_GP_1	0.510	0.036	0.07
CV_young_Mal_GP_1	0.213	0.067	0.32
CV_old_Mal_GP_1	0.104	0.170	1.63
SR_LN(R0)	10.049	0.189	0.02
Q_extraSD_CalCOFI_Survey(11)	0.364	0.082	0.22
Size_DbIN_peak_NoCA_HKL(1)	40.677	2.315	0.06
Size_DbIN_ascend_se_NoCA_HKL(1)	4.382	0.324	0.07
Size_DbIN_peak_SoCA_HKL(2)	23.828	2.504	0.11
Size_DbIN_ascend_se_SoCA_HKL(2)	1.208	2.199	1.82
Size_DbIN_peak_CA_TWL(3)	44.921	1.672	0.04
Size_DbIN_ascend_se_CA_TWL(3)	4.556	0.208	0.05
Size_DbIN_peak_OR_WA_Comm(4)	43.111	6.340	0.15
Size_DbIN_ascend_se_OR_WA_Comm(4)	4.592	0.844	0.18
Size_DbIN_peak_CA_NET(5)	46.829	1.756	0.04
Size_DbIN_ascend_se_CA_NET(5)	4.422	0.220	0.05
Size_DbIN_peak_NoCA_OR_WA_Rec(6)	43.810	2.473	0.06
Size_DbIN_ascend_se_NoCA_OR_WA_Rec(6)	5.138	0.231	0.05
Size_DbIN_peak_SoCA_Rec(7)	24.768	1.023	0.04
Size_DbIN_ascend_se_SoCA_Rec(7)	2.937	0.363	0.12
Size_DbIN_descend_se_SoCA_Rec(7)	3.270	0.645	0.20
Size_DbIN_end_logit_SoCA_Rec(7)	-1.107	0.303	-0.27
Size_DbIN_peak_TWL_discard(8)	29.520	1.585	0.05
Size_DbIN_ascend_se_TWL_discard(8)	4.153	0.376	0.09
Size_DbIN_descend_se_TWL_discard(8)	3.201	0.600	0.19
Size_DbIN_peak_NoCA_HKL(1)_BLK1repl_1875	51.733	5.167	0.10
Size_DbIN_ascend_se_NoCA_HKL(1)_BLK1repl_1875	4.163	0.616	0.15
Size_DbIN_peak_SoCA_HKL(2)_BLK2repl_1875	48.483	4.369	0.09
Size_DbIN_ascend_se_SoCA_HKL(2)_BLK2repl_1875	4.811	0.436	0.09
Size_DbIN_peak_CA_TWL(3)_BLK3repl_1875	33.658	1.255	0.04
Size_DbIN_ascend_se_CA_TWL(3)_BLK3repl_1875	3.268	0.352	0.11
Size_DbIN_peak_SoCA_Rec(7)_BLK2repl_1875	30.798	2.075	0.07
Size_DbIN_ascend_se_SoCA_Rec(7)_BLK2repl_1875	3.767	0.464	0.12

The STAT fixed the “CV_old_Mal_GP_1” parameter at a value of 0.1, and the “Size_DbIN_ascend_se_SoCA_HKL(2)” parameter at a value of 1.2, and re-estimated and tuned the model. This change appeared to stabilize the model, facilitating tuning, and allowing estimation of the hessian and for use of the “-hess_step” option to minimize the final gradient. The tuned model was used for a “jitter” analysis of 100 runs with “jitter fraction” equal to 0.2. The jitter analysis did not find a smaller NLL value than the proposed base model, and 97 of the 100 runs found the same solution (NLL = 2633.05). This is evidence (but not proof) that the optimizer has found a global solution, and also suggests that fixing the two parameters resolved the issues with convergence. Given that the new model enforces a sum-to-zero constraint, it is unclear to the STAT if the use of MCMC diagnostics to further diagnose the issue is appropriate.

Reference points from the proposed base suggest a less-depleted, but smaller, stock than the pre-STAR base (Table 17b and 17c). This change is largely attributed to the change from unconstrained recruitment deviations to sum-to-zero deviations, while fixing steepness at a value greater than the estimated value, as described in Request 11 (Figures 17a and 17b).

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Equilibrium sustainable yields under the proposed base are similar to those estimated in the previous assessment (Field 2017). The yield based on an SPR50% harvest rate and applied to the equilibrium biomass at that rate was 2042 mt, compared to 2114 mt in the proposed base (Table 17b).

Table 17b. Reference points from the proposed final base model.

Reference Point	Estimate	Lower Interval	Upper Interval
Unfished Spawning Output (billions of eggs)	11,922	10,006	13,839
Unfished Age 3+ Biomass (mt)	50,121	41,265	58,976
Unfished Recruitment (R0, 1000s)	22,734	14,697	30,770
Spawning Output (2025, billions of eggs)	9,925	6,263	13,587
Fraction Unfished (2025)	0.832	0.628	1.037
Reference Points Based SB40%			
Proxy Spawning Output SB40%	4,769	4,002	5,536
SPR Resulting in SB40%	0.458	0.458	0.458
Exploitation Rate Resulting in SB40%	0.089	0.080	0.098
Yield with SPR Based On SB40% (mt)	2,230	1,672	2,787
Reference Points Based on SPR Proxy for MSY			
Proxy Spawning Output (SPR50)	5,319	4,464	6,174
SPR50	0.5	--	--
Exploitation Rate Corresponding to SPR50	0.077	0.070	0.085
Yield with SPR50 at SB SPR (mt)	2,114	1,588	2,639
Reference Points Based on Estimated MSY Values			
Spawning Output at MSY (SB MSY)	3,056	2,563	3,548
SPR MSY	0.329	0.323	0.334
Exploitation Rate Corresponding to SPR MSY	0.136	0.121	0.151
MSY (mt)	2,421	1,807	3,035

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Table 17c. Comparison of likelihood components, parameter estimates, and derived quantities from the proposed final base model and the model with unconstrained recruitment deviations (and other changes, as noted above). Three parameters fixed in the proposed base model are outlined in black, and described in the request and STAT response.

Label	proposed final base	STAR_base, asymptotic
N.Parms	106	109
TOTAL	2633.050	2621.330
Survey	29.272	24.307
Length_comp	569.289	572.015
Age_comp	2011.060	2000.480
Recruitment	23.397	24.425
Parm_priors	0.025	0.096
NatM_uniform_Fem_GP_1	0.165	0.177
L_at_Amax_Fem_GP_1	47.901	47.860
VonBert_K_Fem_GP_1	0.197	0.197
CV_young_Fem_GP_1	0.105	0.105
CV_old_Fem_GP_1	0.039	0.039
NatM_uniform_Mal_GP_1	0.266	0.241
L_at_Amax_Mal_GP_1	-0.328	-0.329
VonBert_K_Mal_GP_1	0.526	0.528
CV_young_Mal_GP_1	0.236	0.235
CV_old_Mal_GP_1	0.1	0.100
SR_LN(R0)	10.032	10.314
Q_extraSD_CalCOFI_Survey(11)	0.355	0.310
Q_extraSD_RREAS_YOY_Survey(12)	0.683	1.230
Size_DblN_peak_NoCA_HKL(1)	40.974	41.080
Size_DblN_ascend_se_NoCA_HKL(1)	4.399	4.405
Size_DblN_peak_SoCA_HKL(2)	23.799	23.788
Size_DblN_ascend_se_SoCA_HKL(2)	1.2	1.195
Size_DblN_peak_CA_TWL(3)	44.904	45.102
Size_DblN_ascend_se_CA_TWL(3)	4.556	4.563
Size_DblN_peak_OR_WA_Comm(4)	42.753	43.109
Size_DblN_ascend_se_OR_WA_Comm(4)	4.559	4.600
Size_DblN_peak_CA_NET(5)	46.991	46.979
Size_DblN_ascend_se_CA_NET(5)	4.426	4.420
Size_DblN_peak_NoCA_OR_WA_Rec(6)	43.894	44.110
Size_DblN_ascend_se_NoCA_OR_WA_Rec(6)	5.136	5.145
Size_DblN_peak_SoCA_Rec(7)	24.708	24.731
Size_DblN_ascend_se_SoCA_Rec(7)	2.924	2.936
Size_DblN_descend_se_SoCA_Rec(7)	3.318	3.278
Size_DblN_end_logit_SoCA_Rec(7)	-1.112	-1.049
Size_DblN_peak_TWL_discard(8)	29.552	29.572
Size_DblN_ascend_se_TWL_discard(8)	4.167	4.181
Size_DblN_descend_se_TWL_discard(8)	3.193	3.194
Size_DblN_peak_NoCA_HKL(1)_BLK1repl_1875	51.604	51.396
Size_DblN_ascend_se_NoCA_HKL(1)_BLK1repl_1875	4.157	4.141
Size_DblN_peak_SoCA_HKL(2)_BLK2repl_1875	48.830	48.776
Size_DblN_ascend_se_SoCA_HKL(2)_BLK2repl_1875	4.824	4.814
Size_DblN_peak_CA_TWL(3)_BLK3repl_1875	33.792	33.920
Size_DblN_ascend_se_CA_TWL(3)_BLK3repl_1875	3.290	3.315
Size_DblN_peak_SoCA_Rec(7)_BLK2repl_1875	30.678	30.648
Size_DblN_ascend_se_SoCA_Rec(7)_BLK2repl_1875	3.752	3.742
Bratio_2025	0.832	0.587
SSB_unfished	11922	13702
Totbio_unfished	52043	61698
Recr_unfished	22734	30156
Dead_Catch_SPR	2114	2633
OFLCatch_2025	3617	3160

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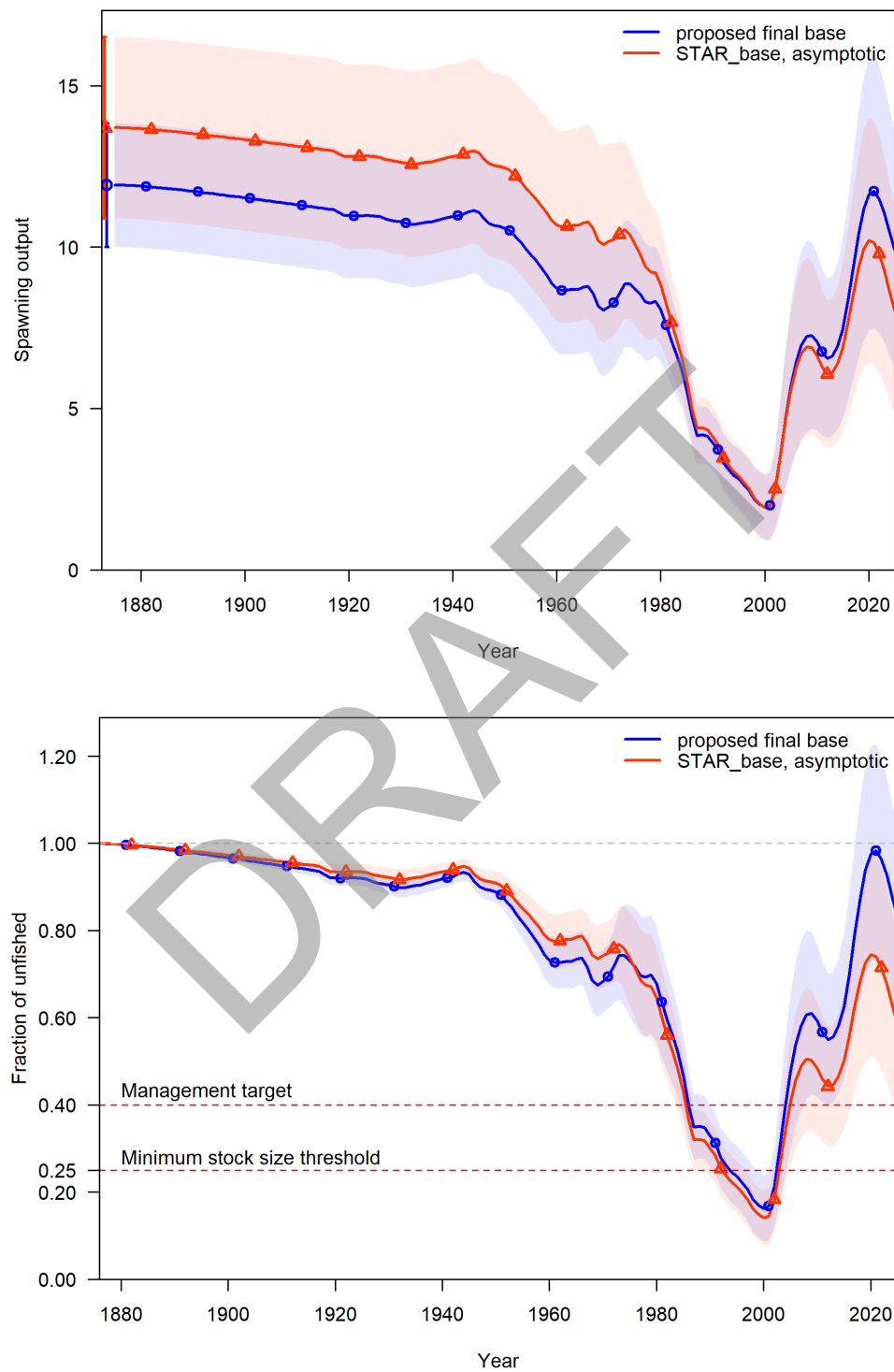


Figure 17a. Comparison of time series of spawning output (trillions of eggs; upper panel) and relative spawning output (lower panel) from the model with unconstrained recruitment deviations (red) and the proposed final base model with sum-to-zero deviations and other changes as described above (blue). Shaded areas represent 95% asymptotic confidence intervals.

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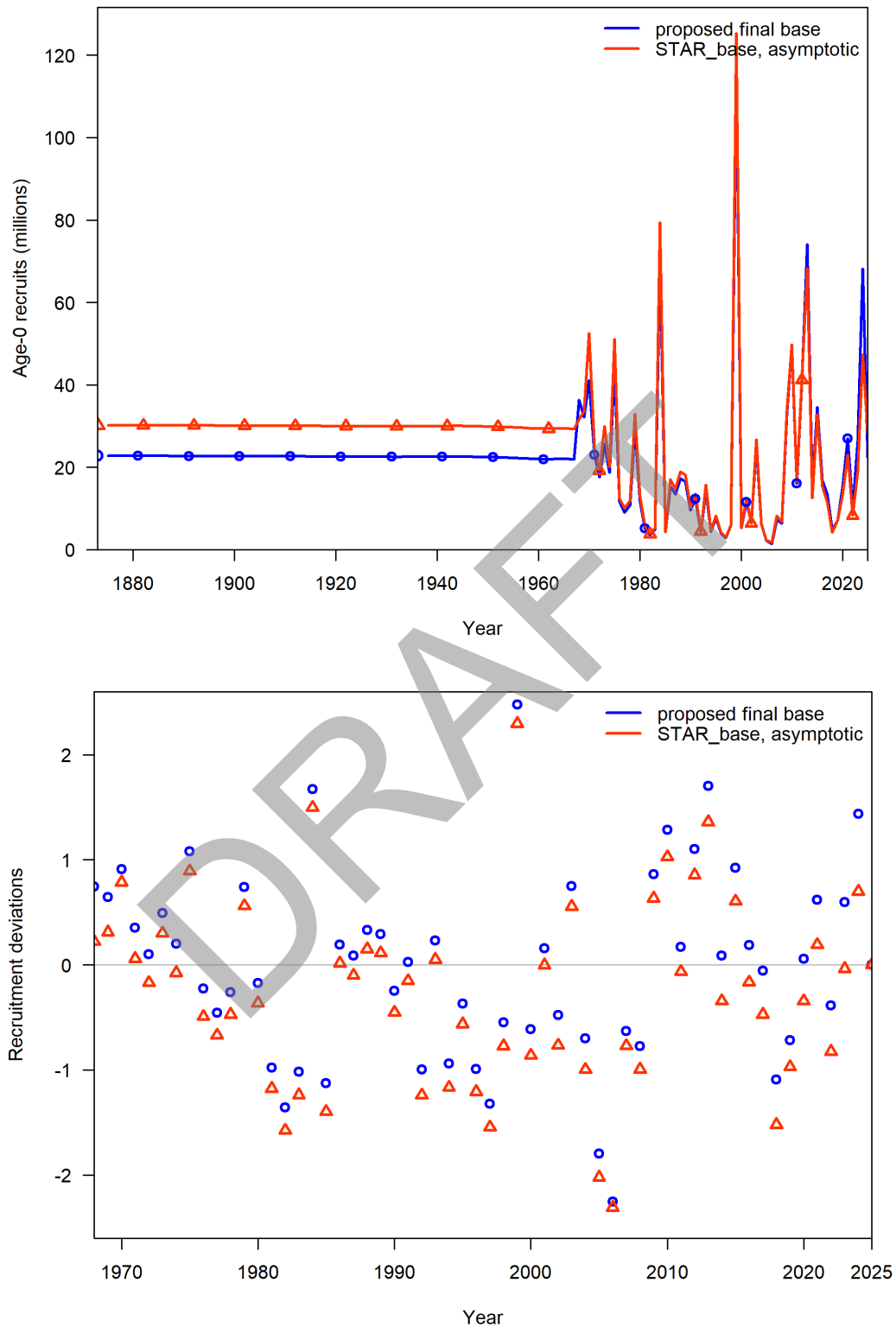


Figure 17b. Comparison of time series of recruitment; upper panel) and recruitment deviations (lower panel) from the model with unconstrained recruitment deviations (red) and the proposed final base model with sum-to-zero deviations and other changes as described above (blue). Shaded areas represent 95% asymptotic confidence intervals. See also Request 11.

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Despite having a smaller population scale, the proposed base model estimates larger recruitments in recent years, reflecting the increased influence of the RREAS survey (Figure 17b). The additive variance (“extraSD”) parameter in the proposed base is fixed at 0.7, using the method described in the request, compared to 1.2 when freely estimated.

Likelihood profile results for the Beverton-Holt steepness parameter are presented in Figures 17c and 17d, as well as Table 17d. Note that steepness values of 0.3 and lower are inconsistent with the $F_{SPR=50\%}$ proxy MSY harvest rate, as indicated by an equilibrium yield (“Dead_Catch_SPR”) of zero in Table 17d. When estimated, steepness in the proposed final base model is 0.383. Some likelihood components exhibit bi-modality, e.g., several sources of age data, as well as the index likelihood for the WCGBT survey.

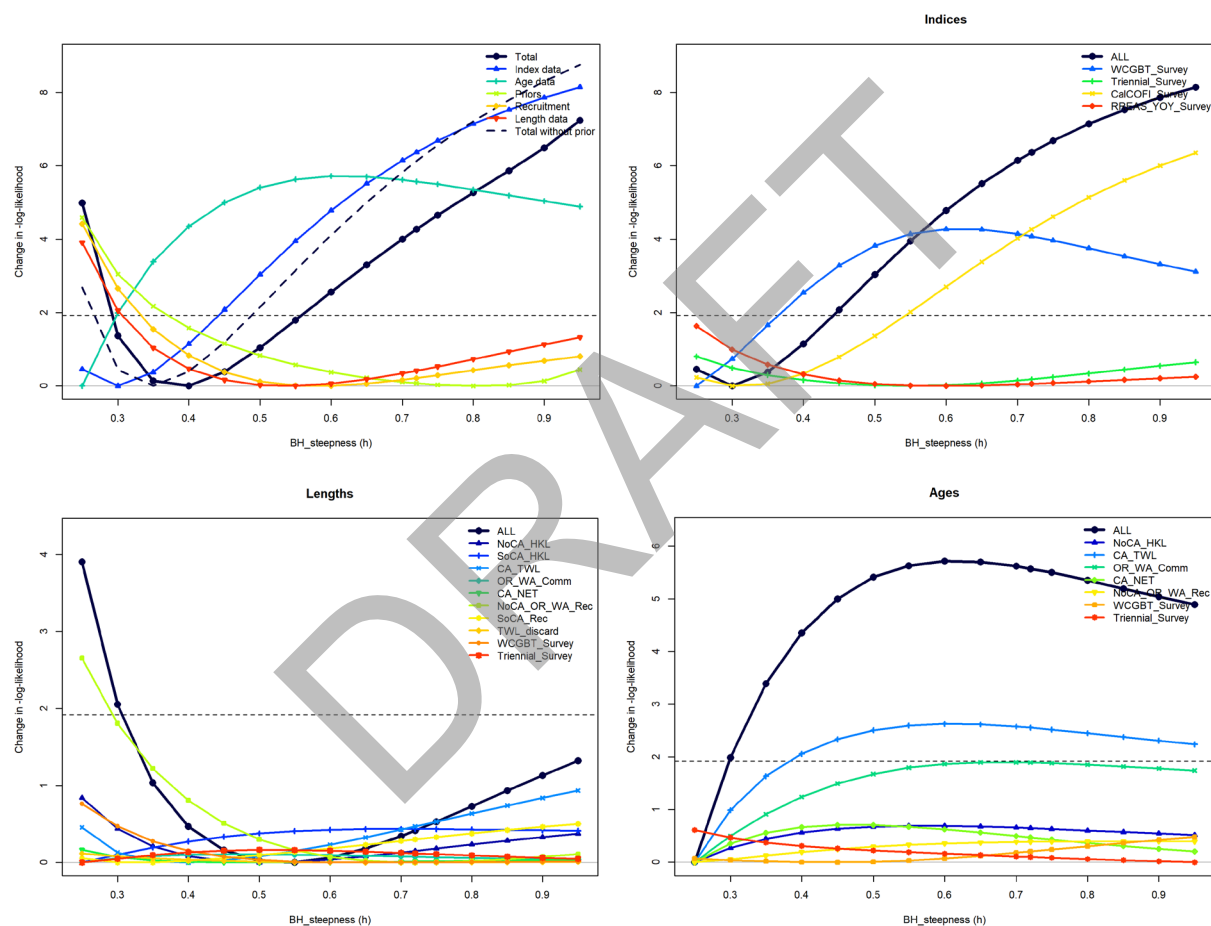


Figure 17c. Likelihood profiles over the Beverton-Holt steepness parameter. Likelihood components are organized by data type (top left), fleets with indices (top right), fleets with length composition data (bottom left), and fleets with age composition data (lower left). Components or fleets that show little change over the range of parameter values are excluded from the plots.

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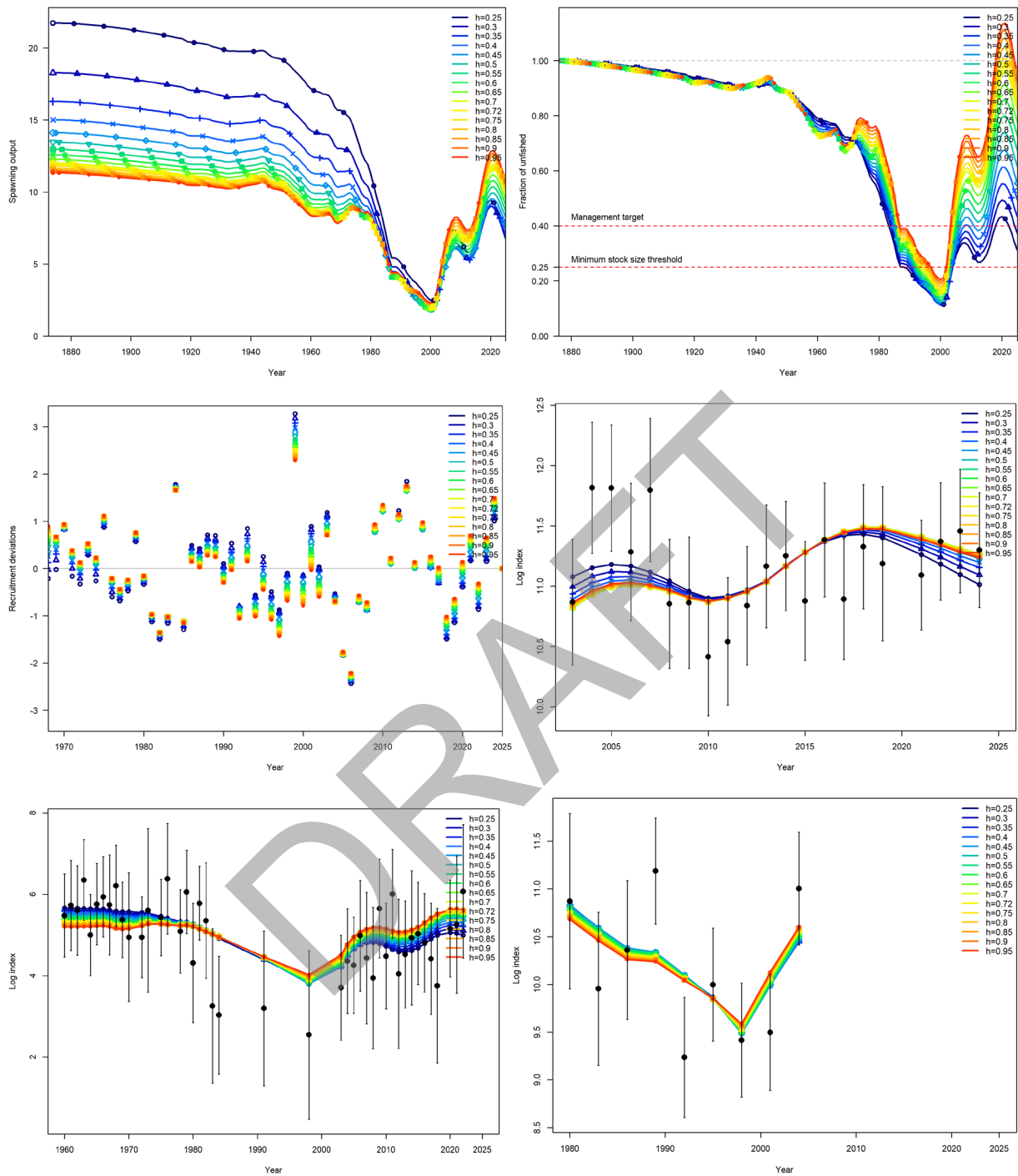


Figure 17d. Likelihood profile results for the Beverton-Holt steepness parameter. Time series of spawning output (trillions of eggs; top left), relative spawning output (top right), recruitment deviations (middle left), log-scale fit to WCGBTS index (middle right), log-scale fit to CalCOFI index (bottom left), and log-scale fit to Triennial survey (bottom right).

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Table 17d. Likelihood components, parameter values, and derived quantities from a likelihood profile over steepness.

Label	h=0.3	h=0.35	h=0.4	h=0.45	h=0.5	h=0.55	h=0.6	h=0.65	h=0.7	h=0.72	h=0.75	h=0.8	h=0.85	h=0.9	h=0.95
N.Parms	106	106	106	106	106	106	106	106	106	106	106	106	106	106	106
TOTAL	2630.15	2628.92	2628.78	2629.17	2629.82	2630.57	2631.34	2632.08	2632.78	2633.05	2633.44	2634.05	2634.65	2635.27	2636.02
Survey	22.901	23.276	24.048	24.979	25.939	26.852	27.683	28.414	29.046	29.272	29.585	30.043	30.431	30.762	31.046
Length_comp	570.928	569.911	569.343	569.037	568.899	568.875	568.935	569.055	569.216	569.289	569.403	569.603	569.807	570.007	570.199
Age_comp	2007.48	2008.88	2009.84	2010.49	2010.90	2011.12	2011.21	2011.19	2011.11	2011.06	2010.99	2010.84	2010.68	2010.53	2010.38
Recruitment	25.838	24.725	24.010	23.561	23.306	23.192	23.182	23.243	23.348	23.398	23.476	23.612	23.745	23.872	23.989
Parm_priors	3.000	2.125	1.536	1.108	0.782	0.528	0.328	0.174	0.059	0.025	-0.015	-0.046	-0.022	0.090	0.398
NatM_uniform_Fem_GP_1	0.189	0.180	0.174	0.169	0.166	0.165	0.164	0.164	0.165	0.165	0.166	0.167	0.168	0.169	0.170
L_at_Amax_Fem_GP_1	47.859	47.865	47.872	47.878	47.884	47.889	47.893	47.897	47.900	47.901	47.902	47.904	47.906	47.908	47.909
VonBert_K_Fem_GP_1	0.197	0.197	0.197	0.197	0.197	0.197	0.197	0.197	0.197	0.197	0.197	0.197	0.197	0.197	0.197
CV_young_Fem_GP_1	0.105	0.105	0.105	0.105	0.105	0.105	0.105	0.105	0.105	0.105	0.105	0.105	0.105	0.105	0.105
CV_old_Fem_GP_1	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.039
NatM_uniform_Mal_GP_1	0.217	0.235	0.248	0.264	0.268	0.268	0.269	0.268	0.267	0.266	0.264	0.262	0.259	0.256	0.254
L_at_Amax_Mal_GP_1	-0.328	-0.328	-0.328	-0.328	-0.328	-0.328	-0.328	-0.328	-0.328	-0.328	-0.328	-0.328	-0.328	-0.328	-0.328
VonBert_K_Mal_GP_1	0.526	0.526	0.527	0.527	0.527	0.527	0.527	0.527	0.526	0.526	0.526	0.526	0.526	0.526	0.526
CV_young_Mal_GP_1	0.237	0.237	0.237	0.237	0.237	0.237	0.237	0.236	0.236	0.236	0.236	0.235	0.235	0.235	0.235
SR_LN(R0)	10.751	10.528	10.366	10.249	10.166	10.108	10.070	10.047	10.034	10.032	10.029	10.029	10.032	10.037	10.042
SR_BH_steep	0.3	0.35	0.4	0.45	0.5	0.55	0.6	0.65	0.7	0.72	0.75	0.8	0.85	0.9	0.95
Q_extraSD_CalCOFI_Survey(11)	0.289	0.289	0.293	0.299	0.308	0.318	0.329	0.340	0.351	0.355	0.361	0.370	0.378	0.385	0.391
Size_DbIN_peak_NoCA_HKL(1)	40.929	41.079	41.146	41.168	41.160	41.133	41.094	41.047	40.995	40.974	40.942	40.889	40.839	40.791	40.747
Size_DbIN_ascend_se_NoCA_HKL(1)	4.387	4.407	4.417	4.421	4.421	4.419	4.414	4.408	4.402	4.399	4.395	4.389	4.382	4.377	4.371
Size_DbIN_peak_SoCA_HKL(2)	23.864	23.843	23.827	23.816	23.808	23.803	23.800	23.799	23.799	23.799	23.800	23.802	23.803	23.805	23.807
Size_DbIN_peak_CA_TWL(3)	45.343	45.258	45.178	45.107	45.048	45.000	44.962	44.933	44.911	44.904	44.896	44.884	44.875	44.869	44.864
Size_DbIN_ascend_se_CA_TWL(3)	4.573	4.572	4.569	4.567	4.564	4.562	4.560	4.558	4.557	4.556	4.556	4.555	4.555	4.554	4.554
Size_DbIN_peak_OR_WA_Comm(4)	44.496	43.912	43.460	43.206	43.018	42.890	42.811	42.768	42.753	42.752	42.757	42.772	42.794	42.820	42.846
Size_DbIN_ascend_se_OR_WA_Comm(4)	4.721	4.668	4.625	4.602	4.585	4.573	4.566	4.561	4.560	4.559	4.560	4.561	4.563	4.565	4.567
Size_DbIN_peak_CA_NET(5)	46.849	46.953	47.009	47.038	47.048	47.045	47.034	47.018	46.999	46.991	46.978	46.958	46.937	46.918	46.900
Size_DbIN_ascend_se_CA_NET(5)	4.410	4.419	4.424	4.427	4.428	4.429	4.428	4.427	4.426	4.426	4.426	4.425	4.423	4.421	4.419
Size_DbIN_peak_NoCA_OR_WA_Rec(6)	44.318	44.294	44.233	44.164	44.097	44.037	43.986	43.943	43.907	43.894	43.877	43.852	43.832	43.814	43.798
Size_DbIN_ascend_se_NoCA_OR_WA_Rec(6)	5.150	5.154	5.154	5.152	5.150	5.147	5.143	5.140	5.137	5.136	5.135	5.132	5.130	5.128	5.126
Size_DbIN_peak_SoCA_Rec(7)	24.799	24.773	24.753	24.737	24.725	24.717	24.711	24.709	24.708	24.708	24.708	24.710	24.711	24.713	24.715
Size_DbIN_ascend_se_SoCA_Rec(7)	2.940	2.936	2.932	2.930	2.927	2.926	2.925	2.924	2.924	2.924	2.924	2.924	2.924	2.924	2.924
Size_DbIN_descend_se_SoCA_Rec(7)	3.237	3.259	3.277	3.291	3.301	3.309	3.314	3.317	3.318	3.318	3.318	3.318	3.317	3.316	3.315
Size_DbIN_end_logit_SoCA_Rec(7)	-1.006	-1.035	-1.060	-1.078	-1.092	-1.101	-1.107	-1.110	-1.112	-1.112	-1.112	-1.111	-1.110	-1.108	-1.107
Size_DbIN_peak_TWL_discard(8)	29.679	29.645	29.617	29.595	29.579	29.567	29.559	29.555	29.553	29.552	29.552	29.553	29.554	29.556	29.558
Size_DbIN_ascend_se_TWL_discard(8)	4.172	4.172	4.171	4.170	4.170	4.169	4.168	4.168	4.167	4.167	4.167	4.166	4.166	4.166	4.165
Size_DbIN_descend_se_TWL_discard(8)	3.175	3.179	3.183	3.186	3.188	3.190	3.192	3.192	3.193	3.193	3.193	3.193	3.193	3.193	3.193
Size_DbIN_peak_NoCA_HKL(1)_BLK1repl_1875	51.074	51.188	51.277	51.349	51.409	51.461	51.507	51.551	51.590	51.605	51.623	51.649	51.671	51.688	51.702
Size_DbIN_ascend_se_NoCA_HKL(1)_BLK1repl_1875	4.116	4.125	4.132	4.137	4.142	4.146	4.149	4.153	4.156	4.157	4.158	4.160	4.162	4.163	4.164
Size_DbIN_peak_SoCA_HKL(2)_BLK2repl_1875	48.511	48.723	48.843	48.906	48.932	48.931	48.913	48.882	48.845	48.830	48.805	48.764	48.723	48.684	48.648
Size_DbIN_ascend_se_SoCA_HKL(2)_BLK2repl_1875	4.794	4.811	4.821	4.827	4.830	4.831	4.830	4.828	4.825	4.824	4.823	4.820	4.817	4.814	4.811
Size_DbIN_peak_CA_TWL(3)_BLK3repl_1875	33.900	33.890	33.868	33.846	33.828	33.814	33.805	33.798	33.793	33.791	33.789	33.786	33.783	33.780	33.777
Size_DbIN_ascend_se_CA_TWL(3)_BLK3repl_1875	3.306	3.308	3.306	3.303	3.300	3.297	3.295	3.292	3.291	3.290	3.289	3.287	3.285	3.284	3.282
Size_DbIN_peak_SoCA_Rec(7)_BLK2repl_1875	30.598	30.600	30.600	30.604	30.611	30.622	30.636	30.653	30.671	30.678	30.689	30.706	30.723	30.738	30.752
Size_DbIN_ascend_se_SoCA_Rec(7)_BLK2repl_1875	3.728	3.733	3.736	3.738	3.741	3.743	3.746	3.748	3.751	3.752	3.753	3.755	3.757	3.759	3.761
Bratio_2025	0.371	0.432	0.493	0.555	0.615	0.672	0.726	0.774	0.817	0.832	0.854	0.885	0.912	0.934	0.952
SSB_unfished	18271	16285	15002	14108	13453	12953	12563	12254	12007	11922	11809	11649	11521	11417	11332
Totbio_unfished	84990	73957	66957	62221	58881	56460	54678	53353	52365	52044	51627	51076	50663	50353	50121
Recr_unfished	46656	37329	31756	28249	25990	24536	23625	23084	22797	22734	22681	22675	22740	22847	22979
Dead_Catch_SPR	0	479	1266	1614	1796	1905	1981	2042	2094	2114	2142	2186	2226	2265	2300
OFLCatch_2025	2929	2865	2883	2953	3056	3178	3309	3442	3568	3617	3686	3792	3887	3971	4045

Stock Assessment Review (STAR) Panel for Chilipepper Rockfish

Likelihood profile results for the female natural mortality (M) parameter are presented in Figures 17e and 17f, as well as Table 17e.

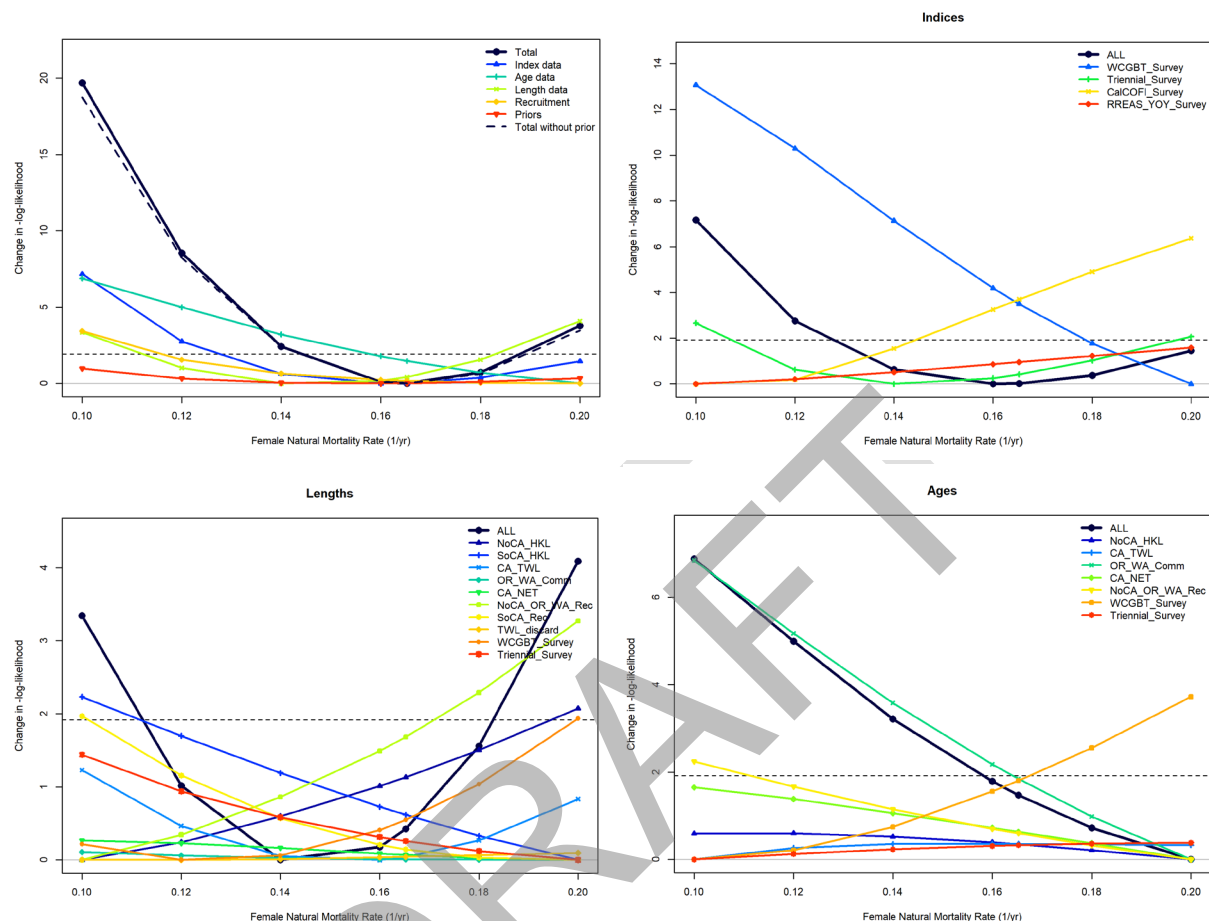


Figure 17e. Likelihood profiles over the female natural mortality (M) parameter. Likelihood components are organized by data type (top left), fleets with indices (top right), fleets with length composition data (bottom left), and fleets with age composition data (lower left). Components or fleets that show little change over the range of parameter values are excluded from the plots.

Stock Assessment Review (STAR) Panel for Chilipepper Rockfish

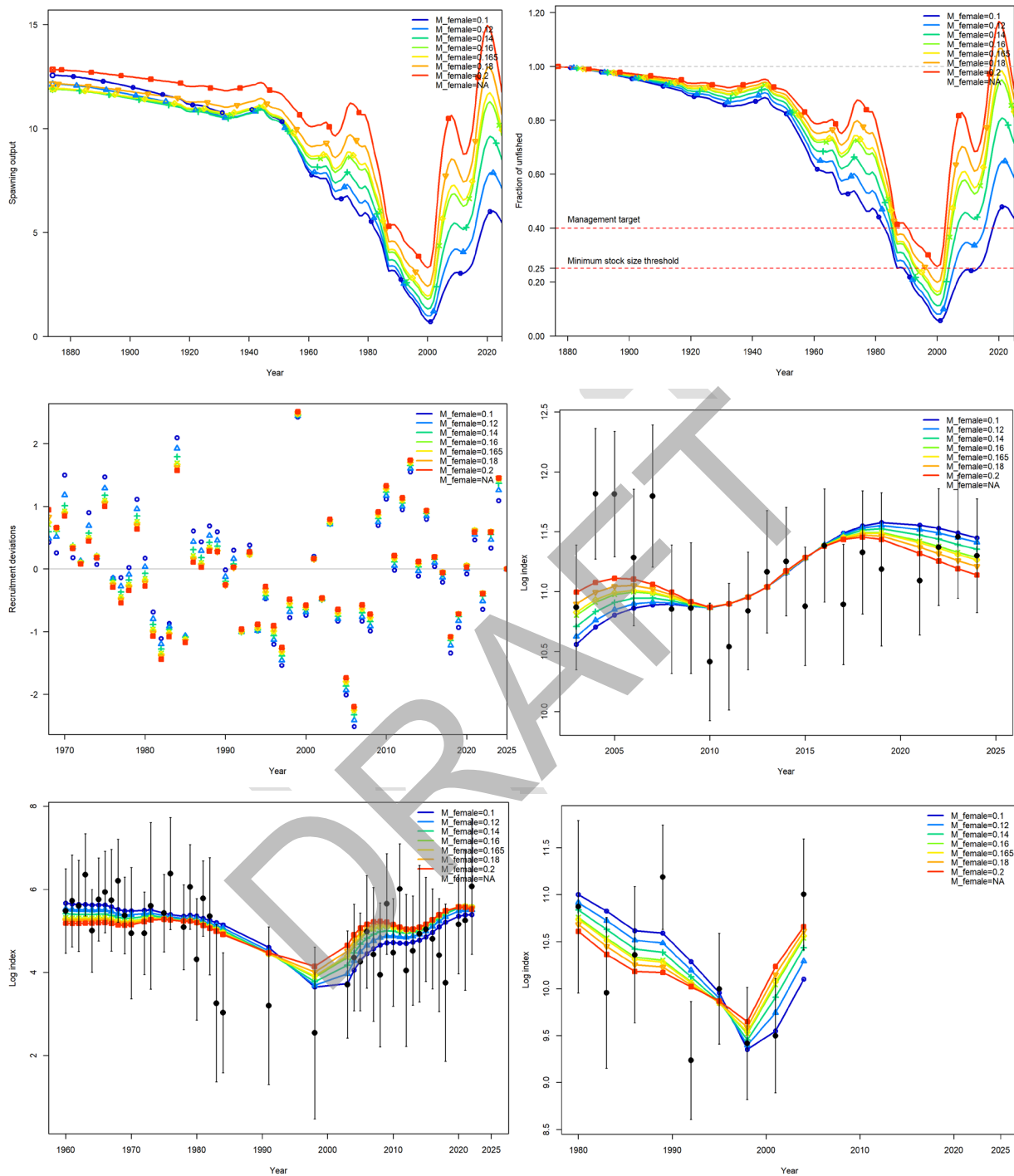


Figure 17f. Likelihood profile results for the female natural mortality (M) parameter. Time series of spawning output (trillions of eggs; top left), relative spawning output (top right), recruitment deviations (middle left), log-scale fit to WCGBTS index (middle right), log-scale fit to CalCOFI index (bottom left), and log-scale fit to Triennial survey (bottom right).

Stock Assessment Review (STAR) Panel for Chilipepper Rockfish

Table 17e. Likelihood components, parameter values, and derived quantities from a likelihood profile over female natural mortality (M). M=0.165 is the estimate from the proposed base.

Label	M_female=0.1	M_female=0.12	M_female=0.14	M_female=0.16	M_female=0.165	M_female=0.18	M_female=0.2
N.Parms	106	106	106	106	106	106	106
TOTAL	2652.75	2641.59	2635.48	2633.15	2633.05	2633.78	2636.84
Survey	36.425	32.014	29.893	29.257	29.272	29.631	30.717
Length_comp	572.210	569.880	568.864	569.040	569.289	570.424	572.955
Age_comp	2016.47	2014.58	2012.80	2011.38	2011.06	2010.31	2009.59
Recruitment	26.663	24.790	23.879	23.460	23.398	23.288	23.232
Parm_priors	0.978	0.329	0.049	0.007	0.025	0.124	0.350
NatM_uniform_Fem_GP_1	0.100	0.120	0.140	0.160	0.165	0.180	0.200
L_at_Amax_Fem_GP_1	47.861	47.884	47.896	47.900	47.901	47.901	47.899
VonBert_K_Fem_GP_1	0.199	0.198	0.198	0.197	0.197	0.197	0.196
CV_young_Fem_GP_1	0.106	0.105	0.105	0.105	0.105	0.105	0.105
CV_old_Fem_GP_1	0.038	0.038	0.038	0.039	0.039	0.039	0.039
NatM_uniform_Mal_GP_1	0.516	0.418	0.342	0.280	0.266	0.228	0.184
L_at_Amax_Mal_GP_1	-0.323	-0.325	-0.327	-0.328	-0.328	-0.329	-0.330
VonBert_K_Mal_GP_1	0.522	0.523	0.525	0.526	0.526	0.527	0.528
CV_young_Mal_GP_1	0.238	0.238	0.238	0.236	0.236	0.235	0.234
SR_LN(R0)	9.125	9.419	9.693	9.961	10.032	10.232	10.518
Q_extraSD_CalCOFI_Survey(11)	0.292	0.296	0.319	0.347	0.355	0.376	0.402
Size_DblN_peak_NoCA_HKL(1)	40.325	40.624	40.817	40.950	40.974	41.019	41.033
Size_DblN_ascend_se_NoCA_HKL(1)	4.393	4.405	4.406	4.401	4.399	4.391	4.377
Size_DblN_peak_SoCA_HKL(2)	23.594	23.656	23.719	23.783	23.799	23.845	23.907
Size_DblN_peak_CA_TWL(3)	44.168	44.339	44.577	44.833	44.904	45.114	45.411
Size_DblN_ascend_se_CA_TWL(3)	4.575	4.562	4.558	4.556	4.556	4.558	4.561
Size_DblN_peak_OR_WA_Comm(4)	40.435	40.979	41.658	42.481	42.753	43.558	45.263
Size_DblN_ascend_se_OR_WA_Comm(4)	4.392	4.425	4.473	4.537	4.559	4.625	4.773
Size_DblN_peak_CA_NET(5)	47.112	47.073	47.034	47.001	46.991	46.960	46.906
Size_DblN_ascend_se_CA_NET(5)	4.476	4.459	4.443	4.429	4.426	4.416	4.402
Size_DblN_peak_NoCA_OR_WA_Rec(6)	42.067	42.702	43.254	43.769	43.894	44.244	44.678
Size_DblN_ascend_se_NoCA_OR_WA_Rec(6)	5.088	5.109	5.123	5.134	5.136	5.142	5.147
Size_DblN_peak_SoCA_Rec(7)	24.340	24.461	24.576	24.681	24.708	24.783	24.880
Size_DblN_ascend_se_SoCA_Rec(7)	2.850	2.876	2.899	2.919	2.924	2.938	2.955
Size_DblN_descend_se_SoCA_Rec(7)	3.529	3.473	3.409	3.338	3.318	3.261	3.182
Size_DblN_end_logit_SoCA_Rec(7)	-1.540	-1.407	-1.275	-1.145	-1.112	-1.019	-0.894
Size_DblN_peak_TWL_discard(8)	29.102	29.238	29.379	29.515	29.552	29.659	29.801
Size_DblN_ascend_se_TWL_discard(8)	4.151	4.155	4.160	4.165	4.167	4.171	4.177
Size_DblN_descend_se_TWL_discard(8)	3.233	3.223	3.210	3.197	3.193	3.181	3.164
Size_DblN_peak_NoCA_HKL(1)_BLK1repl_1875	51.277	51.321	51.428	51.564	51.604	51.709	51.830
Size_DblN_ascend_se_NoCA_HKL(1)_BLK1repl_1875	4.148	4.147	4.151	4.155	4.157	4.160	4.163
Size_DblN_peak_SoCA_HKL(2)_BLK2repl_1875	48.716	48.767	48.796	48.825	48.829	48.832	48.812
Size_DblN_ascend_se_SoCA_HKL(2)_BLK2repl_1875	4.869	4.854	4.840	4.827	4.824	4.815	4.801
Size_DblN_peak_CA_TWL(3)_BLK3repl_1875	33.110	33.300	33.473	33.727	33.792	33.962	34.168
Size_DblN_ascend_se_CA_TWL(3)_BLK3repl_1875	3.169	3.202	3.229	3.278	3.290	3.319	3.352
Size_DblN_peak_SoCA_Rec(7)_BLK2repl_1875	30.057	30.210	30.393	30.612	30.678	30.871	31.152
Size_DblN_ascend_se_SoCA_Rec(7)_BLK2repl_1875	3.684	3.699	3.719	3.744	3.752	3.775	3.809
Bratio_2025	0.435	0.587	0.715	0.812	0.832	0.878	0.916
SSB_unfished	12550	12131	11895	11883	11922	12150	12825
Totbio_unfished	45401	46545	48345	51111	52044	55274	61682
Recr_unfished	9184	12317	16210	21189	22734	27781	36982
Dead_Catch_SPR	1263	1486	1734	2026	2114	2392	2885
OFLCatch_2025	1180	1831	2567	3385	3617	4317	5457

Likelihood profile results for the log of unfished recruitment (logR0) parameter are presented in Figures 17g and 17h, as well as Table 17f.

Stock Assessment Review (STAR) Panel for Chilipepper Rockfish

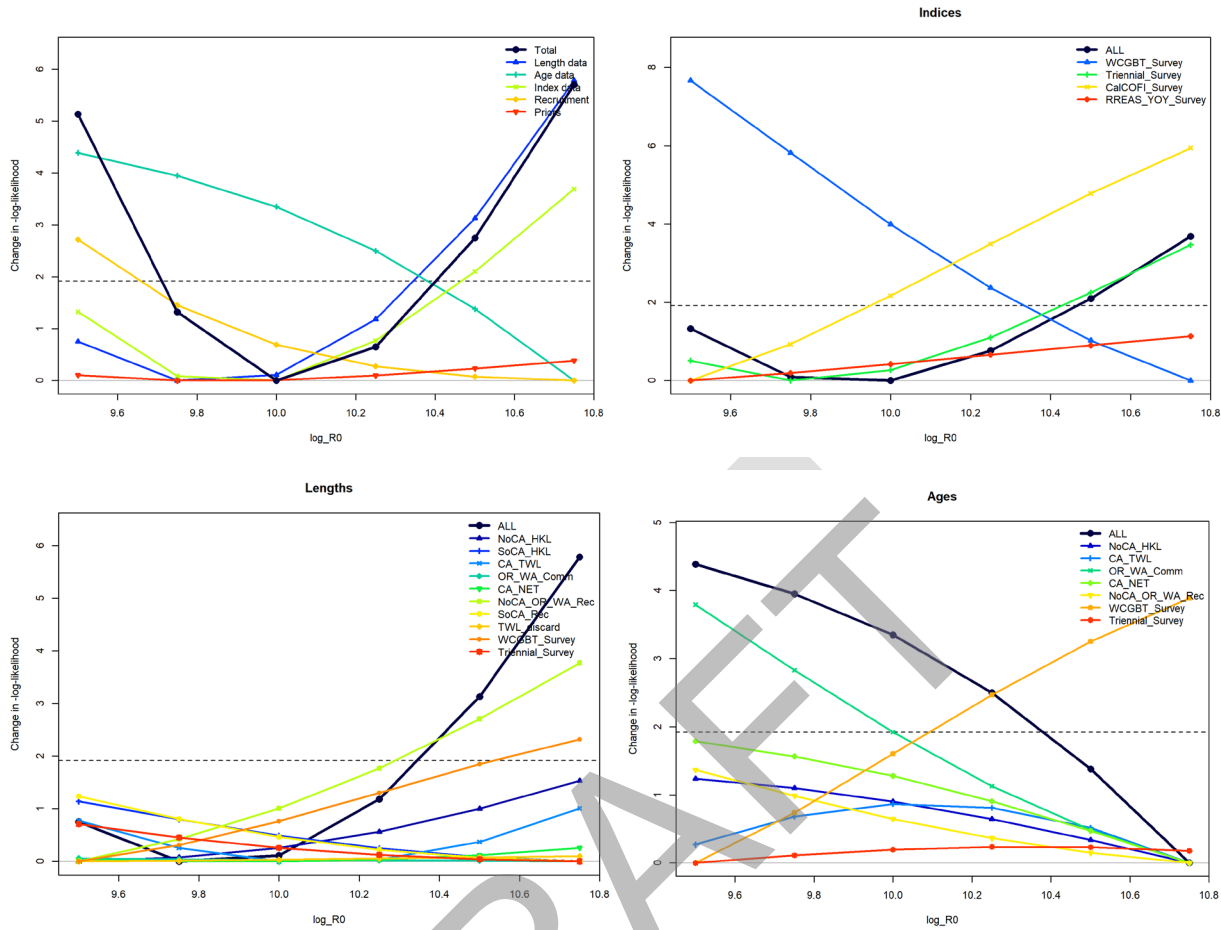


Figure 17g. Likelihood profiles over the log of unfished recruitment ($\log R_0$) parameter. Likelihood components are organized by data type (top left), fleets with indices (top right), fleets with length composition data (bottom left), and fleets with age composition data (lower left). Components or fleets that show little change over the range of parameter values are excluded from the plots.

Stock Assessment Review (STAR) Panel for Chilipepper Rockfish

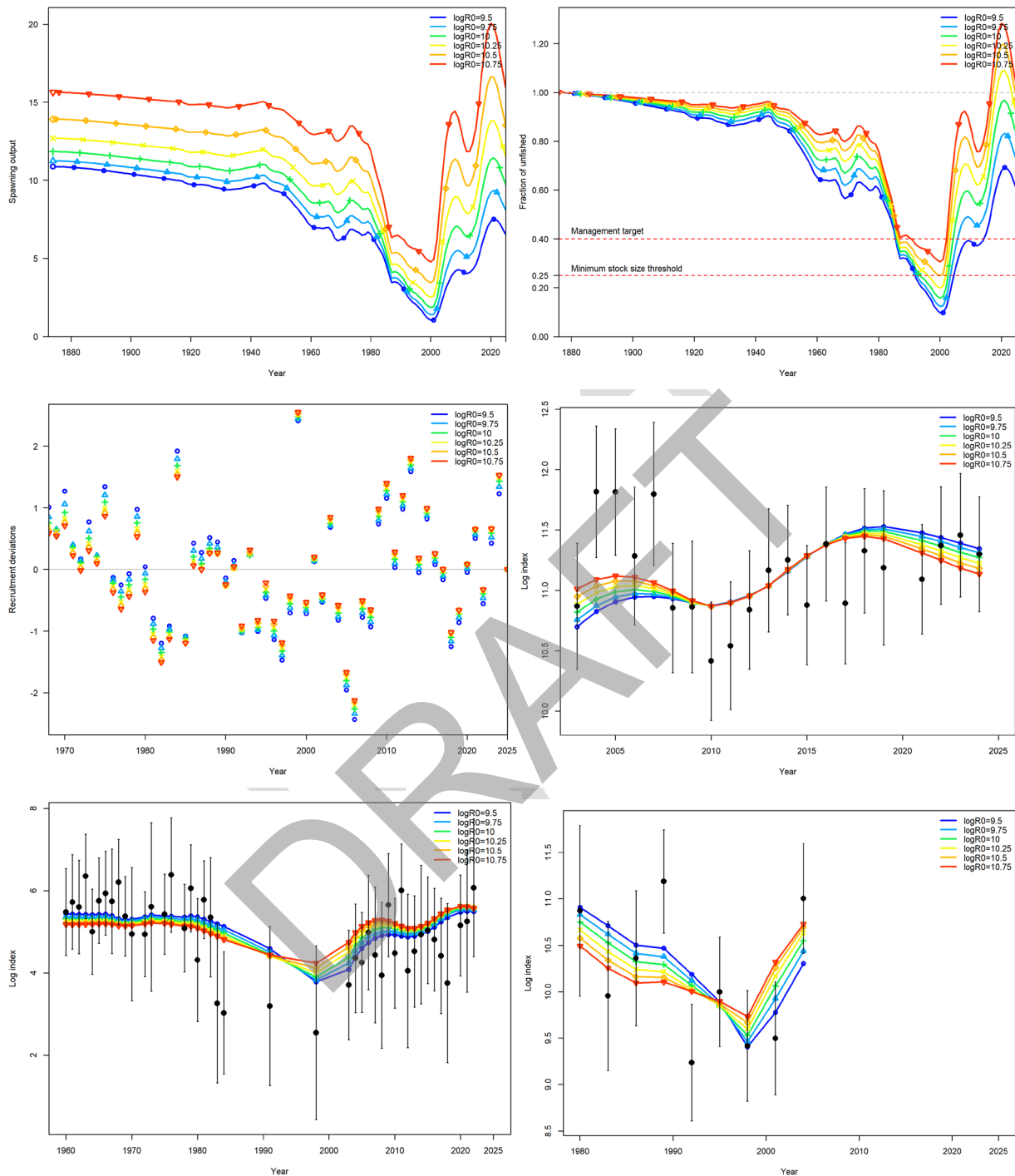


Figure 17h. Likelihood profile results for the log of unfished recruitment ($\log R_0$) parameter. Time series of spawning output (trillions of eggs; top left), relative spawning output (top right), recruitment deviations (middle left), log-scale fit to WCG BTS index (middle right), log-scale fit to CalCOFI index (bottom left), and log-scale fit to Triennial survey (bottom right).

Table 17f. Likelihood components, parameter values, and derived quantities from a likelihood profile over the log of R_0 .

Stock Assessment Review (STAR) Panel for Chilipepper Rockfish

Label	logR0=9.5	logR0=9.75	logR0=10	logR0=10.25	logR0=10.5	logR0=10.75
N.Parms	106	106	106	106	106	106
TOTAL	2638.20	2634.39	2633.07	2633.72	2635.82	2638.77
Survey	30.541	29.307	29.216	29.986	31.318	32.907
Length_comp	569.843	569.091	569.205	570.272	572.219	574.874
Age_comp	2012.20	2011.76	2011.16	2010.31	2009.19	2007.81
Recruitment	25.490	24.226	23.466	23.050	22.851	22.773
Parm_priors	0.116	0.008	0.017	0.105	0.240	0.393
NatM_uniform_Fem_GP_1	0.133	0.148	0.163	0.178	0.191	0.203
L_at_Amax_Fem_GP_1	47.912	47.907	47.901	47.898	47.898	47.901
VonBert_K_Fem_GP_1	0.198	0.197	0.197	0.197	0.196	0.196
CV_young_Fem_GP_1	0.106	0.105	0.105	0.105	0.105	0.105
CV_old_Fem_GP_1	0.038	0.038	0.039	0.039	0.039	0.039
NatM_uniform_Mal_GP_1	0.362	0.313	0.271	0.235	0.206	0.182
L_at_Amax_Mal_GP_1	-0.326	-0.327	-0.328	-0.329	-0.329	-0.329
VonBert_K_Mal_GP_1	0.526	0.526	0.526	0.526	0.525	0.524
CV_young_Mal_GP_1	0.236	0.236	0.236	0.236	0.236	0.236
SR_LN(R0)	9.500	9.750	10.000	10.250	10.500	10.750
Q_extraSD_CalCOFI_Survey(11)	0.312	0.330	0.352	0.376	0.399	0.420
Size_DbIN_peak_NoCA_HKL(1)	40.926	40.991	40.982	40.862	40.626	40.290
Size_DbIN_ascend_se_NoCA_HKL(1)	4.430	4.419	4.402	4.375	4.337	4.292
Size_DbIN_peak_SoCA_HKL(2)	23.695	23.744	23.793	23.839	23.879	23.912
Size_DbIN_peak_CA_TWL(3)	44.611	44.736	44.885	45.036	45.169	45.266
Size_DbIN_ascend_se_CA_TWL(3)	4.569	4.561	4.557	4.555	4.554	4.554
Size_DbIN_peak_OR_WA_Comm(4)	41.566	42.074	42.664	43.362	44.190	45.115
Size_DbIN_ascend_se_OR_WA_Comm(4)	4.474	4.509	4.552	4.608	4.679	4.759
Size_DbIN_peak_CA_NET(5)	47.167	47.095	47.005	46.880	46.715	46.514
Size_DbIN_ascend_se_CA_NET(5)	4.456	4.442	4.428	4.412	4.397	4.381
Size_DbIN_peak_NoCA_OR_WA_Rec(6)	43.343	43.624	43.867	44.046	44.131	44.102
Size_DbIN_ascend_se_NoCA_OR_WA_Rec(6)	5.143	5.141	5.137	5.130	5.120	5.106
Size_DbIN_peak_SoCA_Rec(7)	24.543	24.621	24.698	24.772	24.836	24.889
Size_DbIN_ascend_se_SoCA_Rec(7)	2.894	2.908	2.922	2.935	2.946	2.955
Size_DbIN_descend_se_SoCA_Rec(7)	3.407	3.369	3.324	3.277	3.234	3.199
Size_DbIN_end_logit_SoCA_Rec(7)	-1.322	-1.222	-1.124	-1.034	-0.957	-0.898
Size_DbIN_peak_TWL_discard(8)	29.300	29.421	29.537	29.651	29.747	29.822
Size_DbIN_ascend_se_TWL_discard(8)	4.156	4.161	4.166	4.171	4.174	4.176
Size_DbIN_descend_se_TWL_discard(8)	3.220	3.208	3.195	3.180	3.167	3.156
Size_DbIN_peak_NoCA_HKL(1)_BLK1repl_1875	51.846	51.722	51.617	51.509	51.403	51.283
Size_DbIN_ascend_se_NoCA_HKL(1)_BLK1repl_1875	4.183	4.170	4.158	4.147	4.137	4.128
Size_DbIN_peak_SoCA_HKL(2)_BLK2repl_1875	49.115	48.999	48.853	48.637	48.389	48.128
Size_DbIN_ascend_se_SoCA_HKL(2)_BLK2repl_1875	4.869	4.848	4.827	4.803	4.780	4.761
Size_DbIN_peak_CA_TWL(3)_BLK3repl_1875	33.381	33.556	33.770	33.911	33.975	33.957
Size_DbIN_ascend_se_CA_TWL(3)_BLK3repl_1875	3.213	3.244	3.286	3.309	3.314	3.302
Size_DbIN_peak_SoCA_Rec(7)_BLK2repl_1875	30.446	30.547	30.663	30.776	30.877	30.952
Size_DbIN_ascend_se_SoCA_Rec(7)_BLK2repl_1875	3.730	3.739	3.750	3.761	3.770	3.774
Bratio_2025	0.601	0.717	0.821	0.906	0.972	1.017
SSB_unfished	10867	11247	11831	12688	13909	15634
Totbio_unfished	43340	46831	51376	57344	65206	75658
Recr_unfished	13360	17154	22027	28283	36316	46630
Dead_Catch_SPR	1494	1753	2069	2460	2952	3581
OFLCatch_2025	1876	2600	3491	4573	5877	7448

Stock Assessment Review (STAR) Panel for Chilipepper Rockfish

The STAR was curious if having unconstrained recruitment deviations would affect likelihood profiles for steepness and/or M . A comparison of bivariate likelihood profiles for steepness and M from the pre-STAR base and the proposed final base is shown in Figure 17i. The proposed final base includes other changes, as noted above, but Request 11 results suggest that recruitment deviation estimates are more negative when steepness is fixed at 0.72, relative to the estimated value in each run. This would allow the model to maintain a similar fit across a wider range of steepness values.

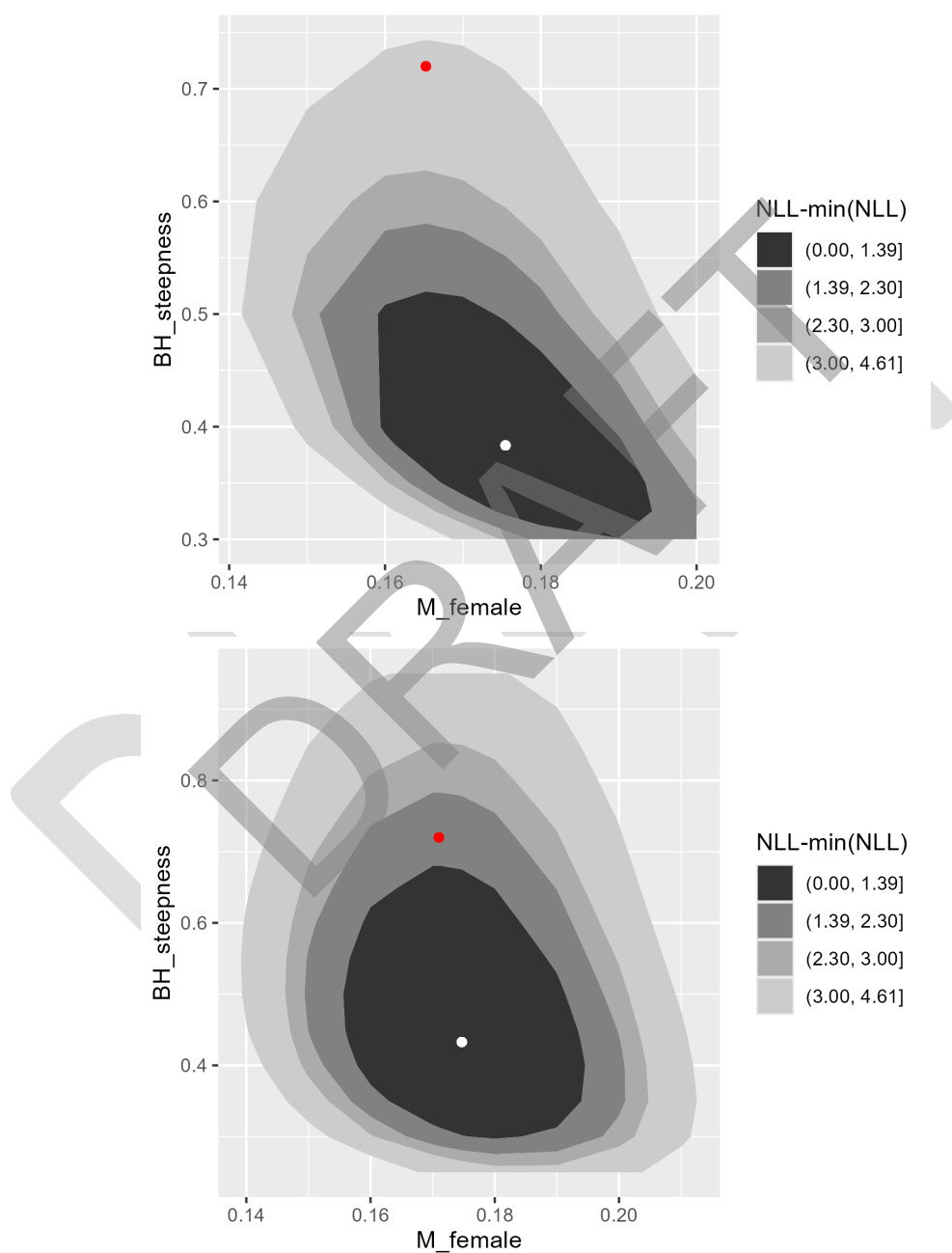


Figure 17i. Comparison of bivariate likelihood profiles (Beverton-Holt steepness and female natural mortality) from the proposed base model (upper panel) with a sum-to-zero constraint on recruitment deviations, to a similar profile from the pre-STAR base with unconstrained recruitment deviations (lower panel). White points indicate the minimum NLL, and red points indicate the base model, for each model run. Contours represent 75%, 90%, 95%, and 99% bivariate confidence regions.

Stock Assessment Review (STAR) Panel for Chilipepper Rockfish

17 - Panel Conclusion

These results are informative and there are no concerns for the proposed base model. The Panel noted that steepness values changed equilibrium values (but also have an effect, although smaller, on the recent spawning output) while the range of natural mortality had mostly an effect on recent spawning output (and thus OFL). The likelihood for steepness was useful to help determine values for use in the decision table, and low and high states of nature, however, alternative sources were used to determine the values chosen.

18 - Request

Provide a decision table using steepness as the primary axis of uncertainty (low 0.38, high = 0.97), with the decision table based on the catch time series reflecting full attainment (=ACL) as required by the TOR, as well as alternative catch projections based on constant catch at the MSY proxy yield (2114 t) to bracket the range of catch alternatives in the decision table. If possible, plot spawning output, fraction of unfished spawning output, age 3+ biomass (t), and relative fishing intensity $(1-SPR)/(1-SPR_{50\%})$, with management reference points where appropriate for the six forecasts. Please provide this in the post-STAR assessment document and to the STAR Panel, if possible, for inclusion in the STAR Panel report.

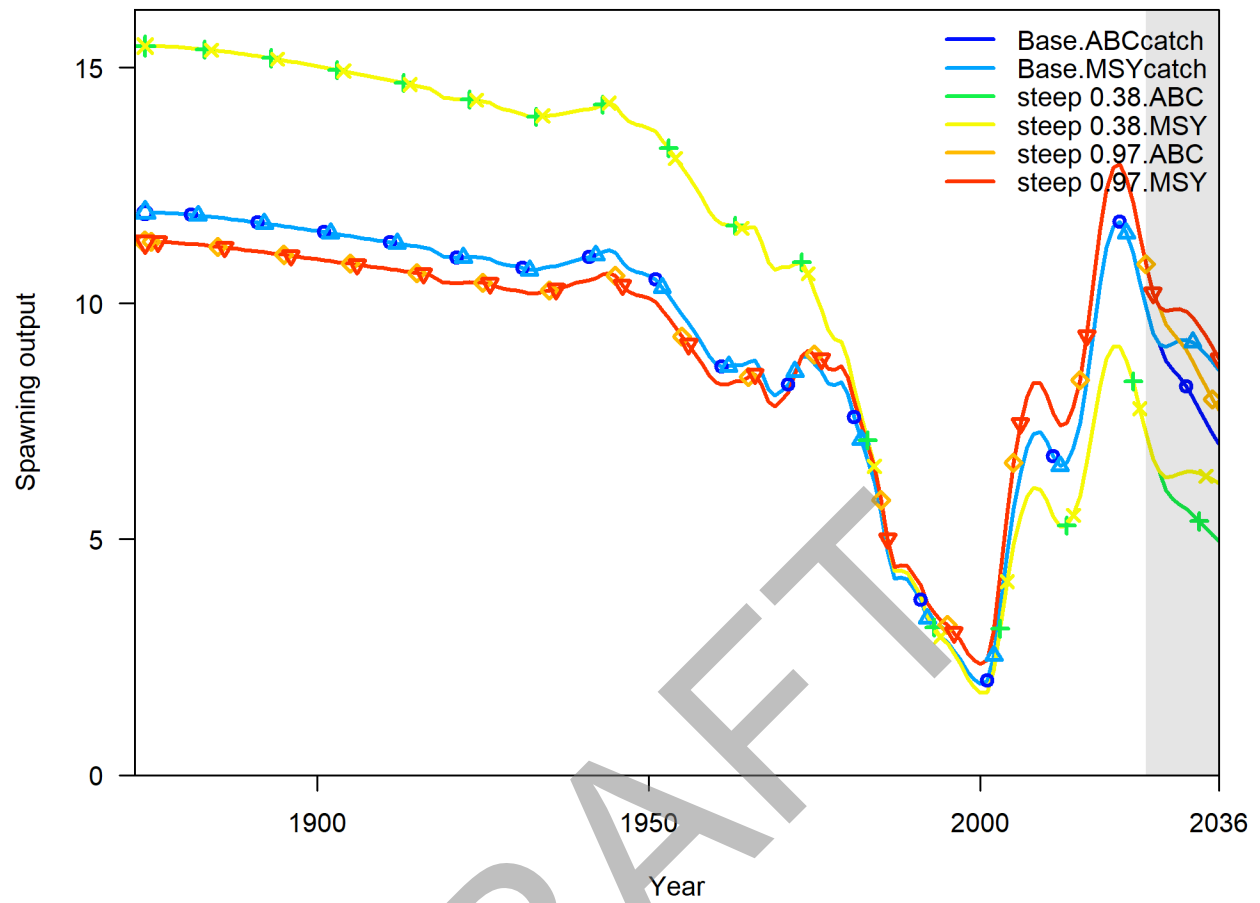
18 - Rationale

These outputs are necessary to satisfy the Terms of Reference.

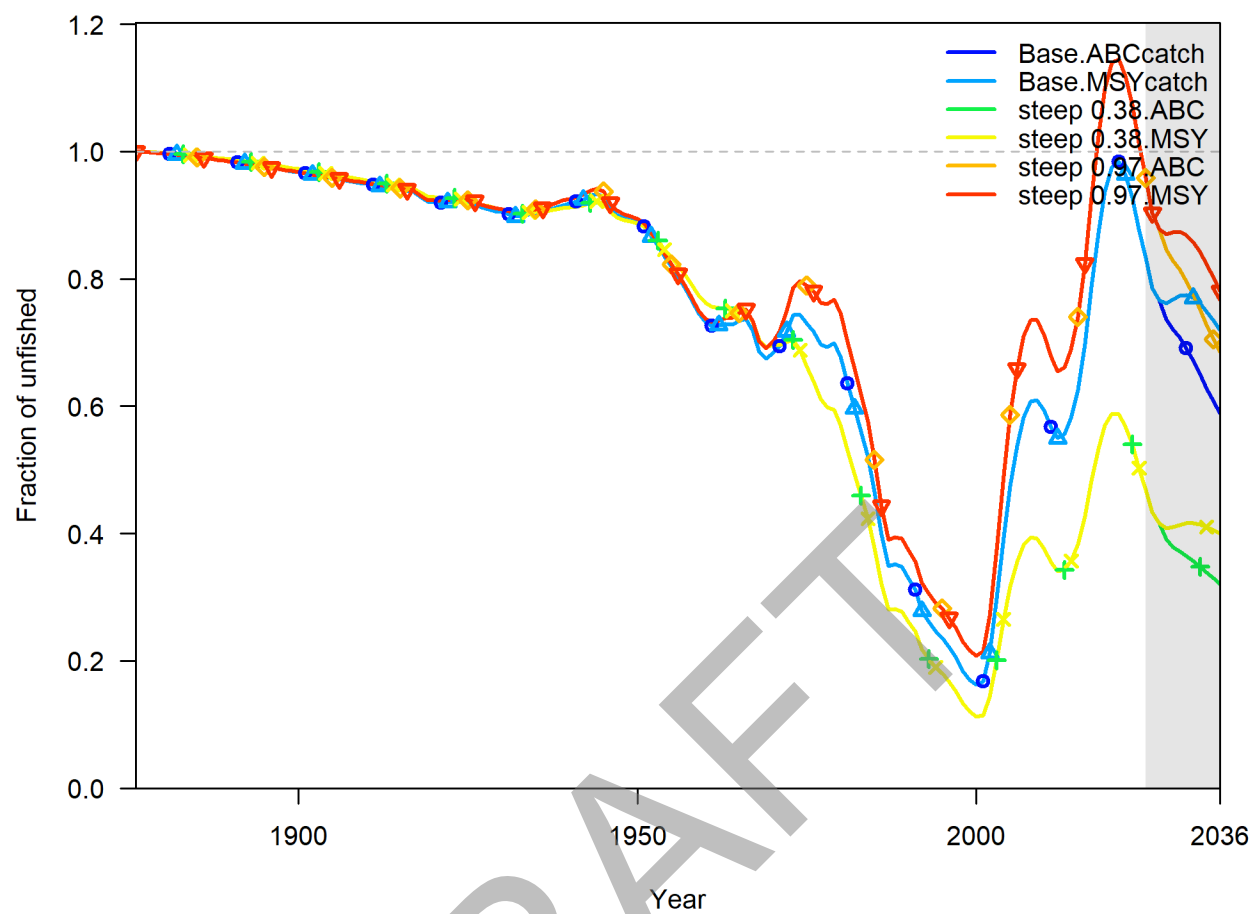
18 - STAT Response

Runs with the three states of nature (base with steepness 0.72, high with steepness 0.97 and low with steepness 0.38) were conducted. The two catch streams used were the equilibrium MSY estimate from the base model (2114 tons) and the ABC catch stream from the base model (in which 2027 ABC is 3211 tons and the 2036 ABC is 2431 tons). Catch apportionments were identical to those used for the 2025-2026 forecasts.

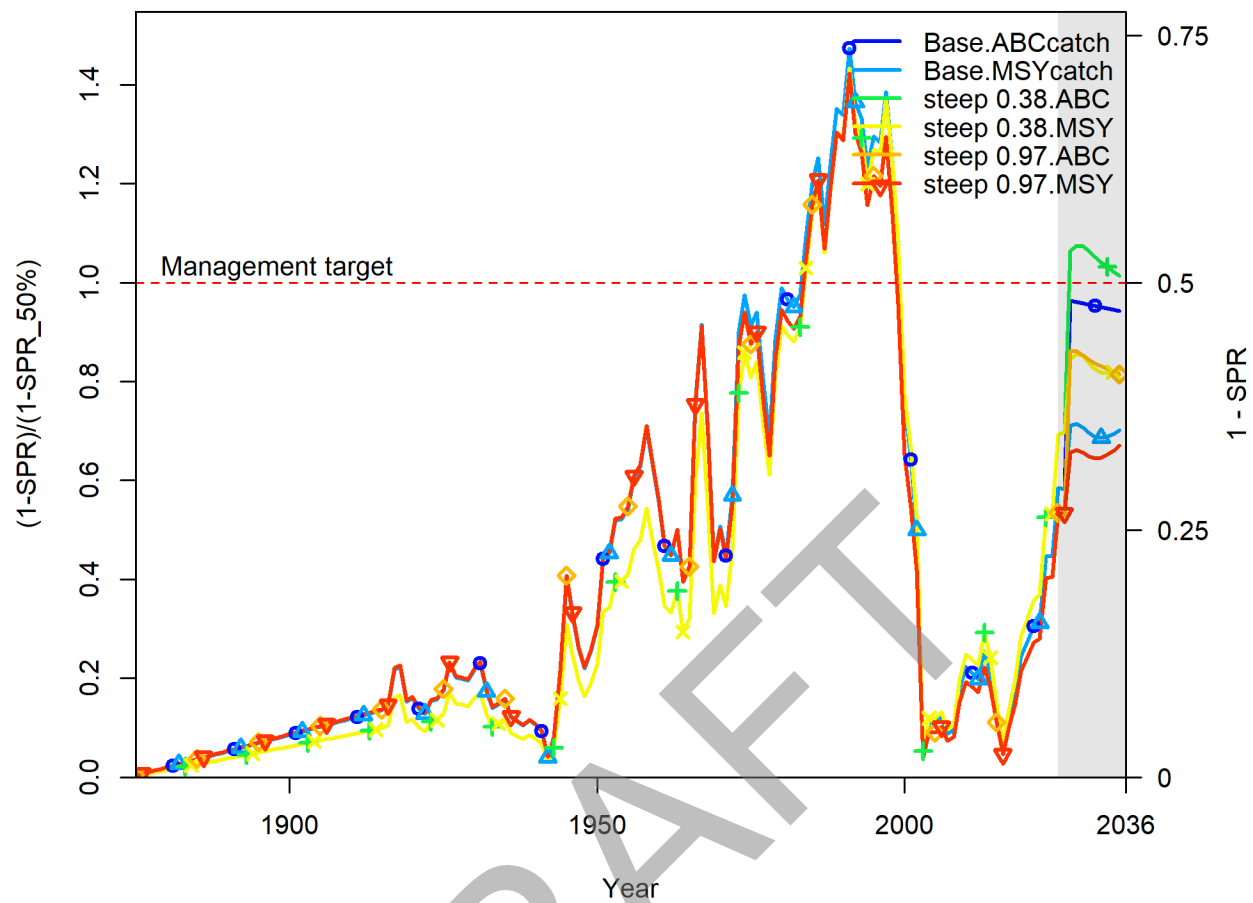
Stock Assessment Review (STAR) Panel for Chilipepper Rockfish



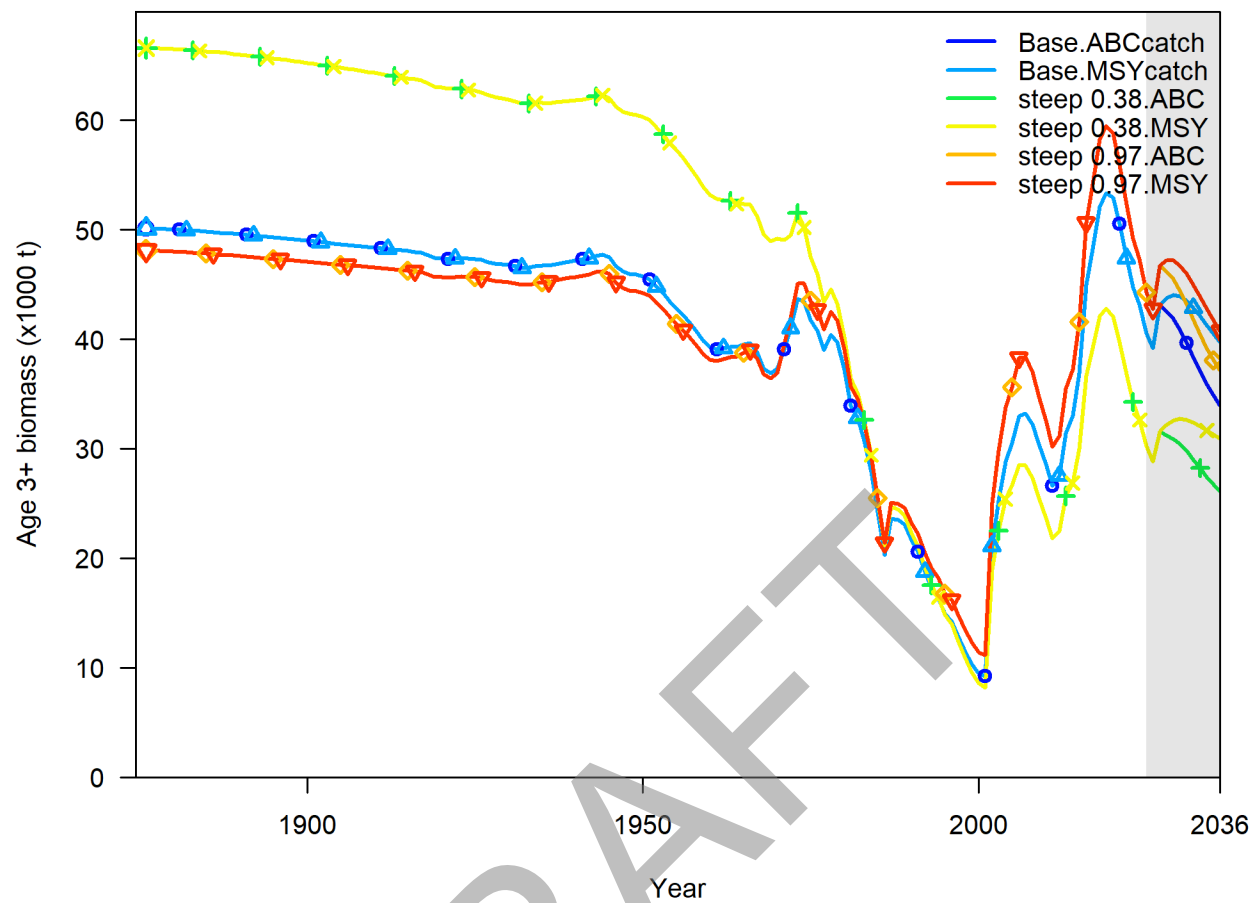
Stock Assessment Review (STAR) Panel for Chilipepper Rockfish



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	MSY catch	low steepness	base model	high steepness
2025	1599	46.89%	83.25%	95.87%
2026	1522	43.38%	78.58%	90.35%
2027	2114	41.64%	76.61%	87.83%
2028	2114	40.84%	76.14%	87.02%
2029	2114	40.98%	76.73%	87.26%
2030	2114	41.35%	77.31%	87.37%
2031	2114	41.61%	77.43%	86.91%
2032	2114	41.63%	77.00%	85.83%
2033	2114	41.41%	76.09%	84.22%
2034	2114	41.02%	74.84%	82.28%
2035	2114	40.53%	73.41%	80.17%
2036	2114	40.01%	71.90%	78.05%
	base ABC catch	low steepness	base model	high steepness
2025	1599	46.89%	83.25%	95.87%
2026	1522	43.38%	78.58%	90.35%
2027	3211	41.64%	76.61%	87.83%
2028	3086	39.09%	73.63%	84.57%
2029	3010	37.87%	72.11%	82.89%
2030	2960	37.17%	70.77%	81.44%
2031	2901	36.51%	69.13%	79.68%
2032	2821	35.72%	67.16%	77.54%
2033	2725	34.81%	64.97%	75.15%
2034	2621	33.85%	62.76%	72.74%
2035	2525	32.94%	60.69%	70.47%
2036	2439	32.10%	58.83%	68.45%

18 - Panel Conclusion

The Panel thanks the STAT for the timely provision of these outputs.