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Australian Government
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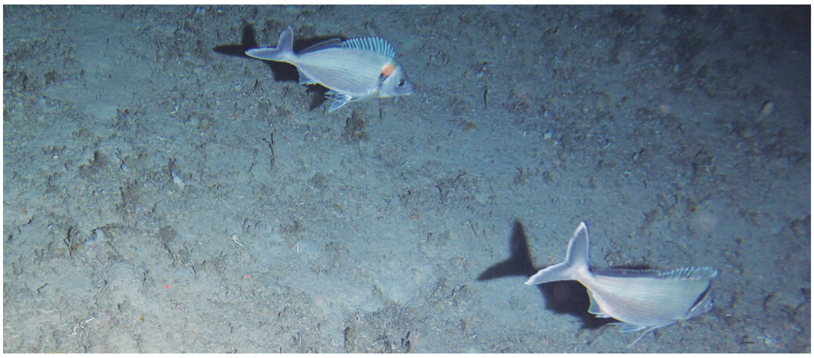
2019/0800 May 2022

Stock Assessment for the Southern and Eastern Scalefish and Shark Fishery: 2020 and 2021



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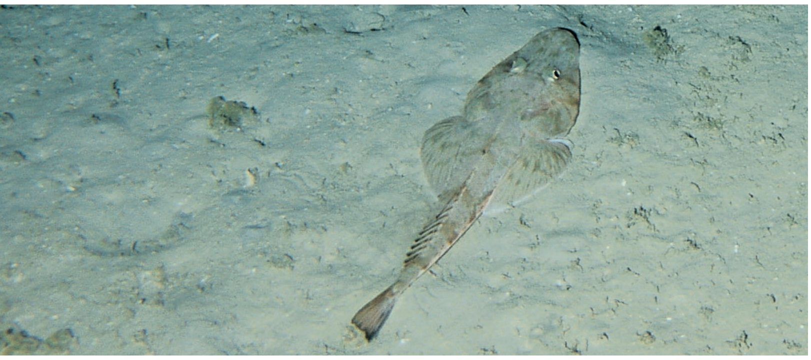

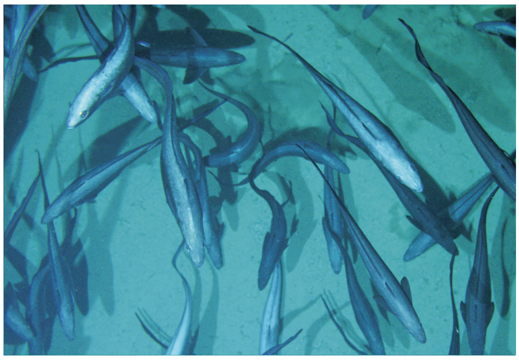

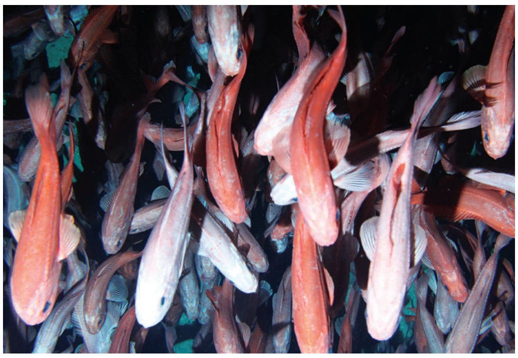

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Cover photographs

Front cover, jackass morwong, orange roughy, blue grenadier, and flathead.

Report structure

Part 1 of this report describes the Tier 1 assessments of 2021. Part 2 describes the Tier 4 and Tier 5 assessments, catch rate standardisations and other work contributing to the assessment and management of SESSF stocks in 2021.

Stock Assessment for the Southern and Eastern Scalefish and Shark Fishery 2020 and 2021

Part 1: 2021

G.N. Tuck
May 2022
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Australian Fisheries Management Authority

Stock Assessment for the Southern and Eastern Scalefish and Shark Fishery: 2021

TABLE OF CONTENTS

7. Eastern Jackass Morwong (*Nemadactylus macropterus*) stock assessment based on data up to 2020 – development of a preliminary base case

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7.1 Executive Summary

This document presents a suggested base case for an updated quantitative Tier 1 assessment of eastern Jackass Morwong (*Nemadactylus macropterus*) for presentation at the October SERAG meeting in 2021. The last full assessment was presented in Day and Castillo-Jordán (2018). The preliminary base case has been updated by the inclusion of data up to the end of 2020, which entails an additional three years of catch, discard, CPUE, length-composition and conditional age-at length data and updates to the ageing error matrices since the 2018 assessment. This document describes the process used to develop a preliminary base case for Jackass Morwong through the sequential updating of recent data to the stock assessment, using the stock assessment package Stock Synthesis (SS-V3.30.17).

Results show good fits to the abundance data (CPUE and FIS), especially the CPUE data for the most recent years for the active CPUE fleets (eastern and Tasmanian trawl), where the additional CPUE data points have continued to decline for both fleets. The fits to the length composition and conditional age-at-length data are good. This assessment estimates that the projected 2022 spawning stock biomass will be 22% of virgin stock biomass (projected assuming 2020 catches in 2021), which is considerably lower than the estimated stock status of 35% at the start of 2019 obtained from the last assessment (Day and Castillo-Jordán, 2018). Recent recruitment estimates (2007-2012) have been revised downwards with the inclusion of new data, with the three additional newly estimated recruitment deviations (2013-2015) all below average.

With this updated assessment, the last 12 estimated recruitment deviations are now all below average, indicating a continuing decline in productivity for this stock, which may require a review of the productivity shift previously adopted for this assessment.

7.2 Introduction

7.2.1 *Eastern Jackass Morwong assessment base case in 2021*

The 2021 preliminary base case assessment of eastern Jackass Morwong uses an age- and size-structured model implemented in the generalized stock assessment software package, Stock Synthesis (SS-V3.30.12.00, Methot et al. (2021)). The methods utilised in Stock Synthesis are based on the integrated analysis paradigm. Stock Synthesis can allow for multiple seasons, areas and fleets, but most applications are based on a single season and area. Recruitment is governed by a stochastic Beverton-Holt stock-recruitment relationship, parameterized in terms of the steepness of the stock-recruitment function (h), the expected average recruitment in an unfished population (R_0), and the degree of variability about the stock-recruitment relationship (σ_r). Stock Synthesis allows the user to choose among a large number of age- and length-specific selectivity patterns. The values for the parameters of Stock Synthesis are estimated by fitting to data on catches, catch-rates, discard rates, discard and retained catch length-frequencies, and conditional age-at-length data. The population dynamics model and the statistical approach used in fitting the model to the various data types are given in the Stock Synthesis technical documentation (Methot, 2005).

The base case model includes the following key features:

A single region, single stock model is considered with three currently active fleets: a trawl fleet in the east operating in SESSF zones 10 and 20 in NSW and Vic (eastern trawl); a Danish seine fleet operating in zones 10, 20 and 30 (Danish seine); and a trawl fleet operating off eastern Tasmania in zone 30 (Tasmanian trawl). Selectivity is modelled separately for each fleet, with all selectivity patterns assumed to be length-specific and logistic. The parameters of the selectivity function for each fleet were estimated within the assessment.

The model does not account for males and females separately and fits one growth curve across both sexes.

The initial and final years are 1915 and 2020.

The CVs of the CPUE indices are initially set at a value equal to the standard error from a loess fit (0.143 (eastern trawl), 0.367 (Tasmanian trawl); Sporcic (2021)), before being re-tuned to the model-estimated standard errors within Stock Synthesis.

Discard weight (t) is estimated through a retention function. This is defined as a logistic function of length, and the inflection and slope of this function are estimated where discard information was available.

The rate of natural mortality, M, is assumed to be time- and age-invariant. The value for M is assumed to be 0.15 y^{-1}.

Recruitment to the stock is assumed to follow a Beverton-Holt stock-recruitment relationship, parameterised by the average recruitment at unexploited spawning biomass, R_0, and the steepness parameter, h. Steepness for the base case analysis is fixed at 0.7.

The initial value of the parameter determining the magnitude of the process error in annual recruitment, σ_r, is set to 0.7.

The population plus-group is modelled at age 30 years.

Growth is assumed to follow a von Bertalanffy length-at-age relationship, with the parameters of the growth function estimated together for females and males inside the assessment model.

Retained and discarded onboard length sample sizes, based on numbers of trips sampled, are capped at 200 trips, with a requirement that greater than 100 individual fish are sampled each year, if length data for that year is to be included in the model. For port samples, the number of trips is used as the sampling unit, with a cap of 100 trips (which was not reached). The number of shots or trips is used as the sample size because the appropriate sample size for length frequency data is probably more closely related to the number of shots (onboard) or trips (port) sampled, rather than the number of fish measured per year.

The values assumed for selected fixed parameters of the base case models are shown in Table 7.1.

Table 7.1. Parameter values assumed for selected fixed parameters in the base-case model.

Parameter	Description	Value
M	Natural mortality	0.15
h	steepness' of the Beverton-Holt stock-recruit curve	0.7
x	age observation plus group	30 years
a	allometric length-weight equations	0.000017 g^{-1} cm
b	allometric length-weight equations	3.031
l_m	Female length at 50% maturity	24.5 cm

7.3 Bridging analysis

7.3.1 *Bridging from 2018 to 2021 assessments*

The previous full quantitative assessment for eastern Jackass Morwong was conducted during 2018 (Day and Castillo-Jordán, 2018) using Stock Synthesis (SS-V3.30.12.00, Methot et al., 2018). The 2021 assessment uses the current version of Stock Synthesis (SS-V3.30.17.00, Methot et al., 2021), which has relatively minor changes from SS-V3.30.12.

As a first step in the process of bridging to a new model, the model was translated from version SS-V3.30.12 (Methot et al., 2018) to version SS-V3.30.17 (Methot et.al., 2021) using the same data and model structure used in the 2018 assessment. Once this translation was complete, minor changes to the implementation of the productivity shift and improved features unavailable in SS-V3. 30.12 were incorporated into the SS-V3.30.17 assessment. Following this step, the model was re-tuned using the most recent tuning protocols (Pacific Fishery Management Council, 2018), thus allowing the examination of changes to both assessment practices and the tuning procedure on the previous model structure. These changes to software and tuning practices are likely to lead to changes to key model outputs, such as the estimates of stock status and the trajectory of spawning biomass. This initial bridging phase (Bridge 1) highlights changes that have occurred since 2018 simply through changes to software and assessment practices. The subsequent bridging exercise (Bridge 2) then sequentially updates the model with new data through to 2020.

The second part of the bridging analysis includes updating historical data (up to 2017), followed by including the data from 2018-2020 into the model. These additional data included new catch, discard, CPUE, length composition data, conditional age-at-length data, and an updated ageing error matrix. The last year of recruitment estimation was extended to 2015 (from 2012 in the 2018 assessment). The use of updated software and the inclusion of additional data resulted in some differences in the fits to CPUE, conditional age-at-length data and length composition data. The usual process of bridging to a new model by adding new data piecewise and analysing which components of the data could be attributed to changes in the assessment outcome was conducted with the details outlined below.

7.4 Bridge 1: Update to Stock Synthesis version and update catch history

The 2018 eastern Jackass Morwong assessment (MOW2018BaseCase_3.30.12) was initially translated to the most recent version of the software, Stock Synthesis version SS-V3.30.17 (MOW2018BaseCase_3.30.17). Figure 7.1 shows that the differences in the assessment results from this step were minimal.

New features available in the new version of Stock Synthesis were incorporated, including changes to the implementation of the 1988 productivity shift (MOW2018_3.30.17_New), followed by updating the catch history up to 2017, incorporating revisions to the catch history in the period 1986-2017 and replacing the estimated 2018 catch with the actual 2018 catch, (MOW2018_3.30.17_ReviseCatch), and finally retuning using the latest tuning protocols (MOW2018_3.30.17_Retuned). Details of the tuning procedure used are listed in Section 1.2.1. This process demonstrates the outcomes that could theoretically have been achieved with the last assessment if we had the latest software, tuning protocols and corrected data available in 2018. This initial bridging step, Bridge 1, does not incorporate any data after 2017 or any structural changes to the assessment, other than the changes to the implementation of the 1988 productivity shift.

When these time series are plotted together, there are virtually no changes in the translation to SS-V3.30.17, but considerable changes when the new features were added, largely due to differences in implementation of the 1988 productivity shift, followed by further minor changes when updating the catch history and the model was retuned using current model tuning protocols (Figure 7.2 and Figure 7.3).

The results of Bridge 1 suggest that there was essentially no change, from around 1980 to the end of the time series, in both the absolute abundance estimates and the relative stock status, relative to the new B_0 associated with the 1988 productivity shift.

Fits to the abundance indices (Figure 7.4 to Figure 7.8) show very limited changes to the fits through this process during Bridge 1, although the fits to the earliest steam trawl CPUE are improved at step "New" (Figure 7.6). The FIS indices show virtually no change to fits during Bridge 1 (Figure 7.9 to Figure 7.10). The estimated recruitment series (absolute number of recruits) shows very little change in broad trends during Bridge 1, although the initial recruitment estimate (R_0) increases slightly at step "New" from the start of the time series through until 1940, well before the productivity shift is incorporated (Figure 7.11). The recruitment deviations are slightly modified, mostly due to changes at step "New" (Figure 7.12), but the changes are so small that this is hard to see in absolute numbers of recruits.

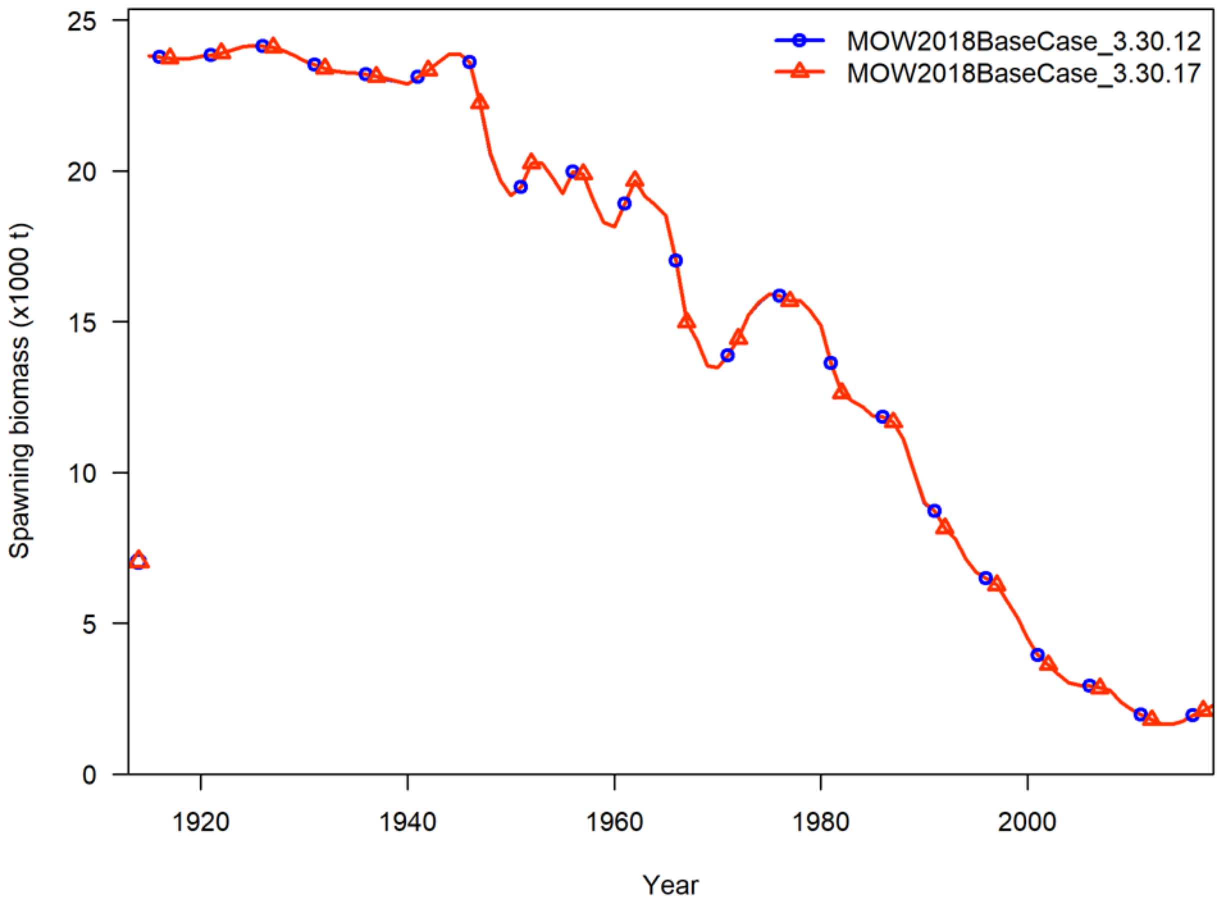

Figure 7.1. Comparison of the time-series of absolute spawning biomass from the 2018 assessment (MOW2018BaseCase_3.30.12 – in blue), and a model with the same data converted to SS-V3.30.17 (MOW2018BaseCase_3.30.17– in red).

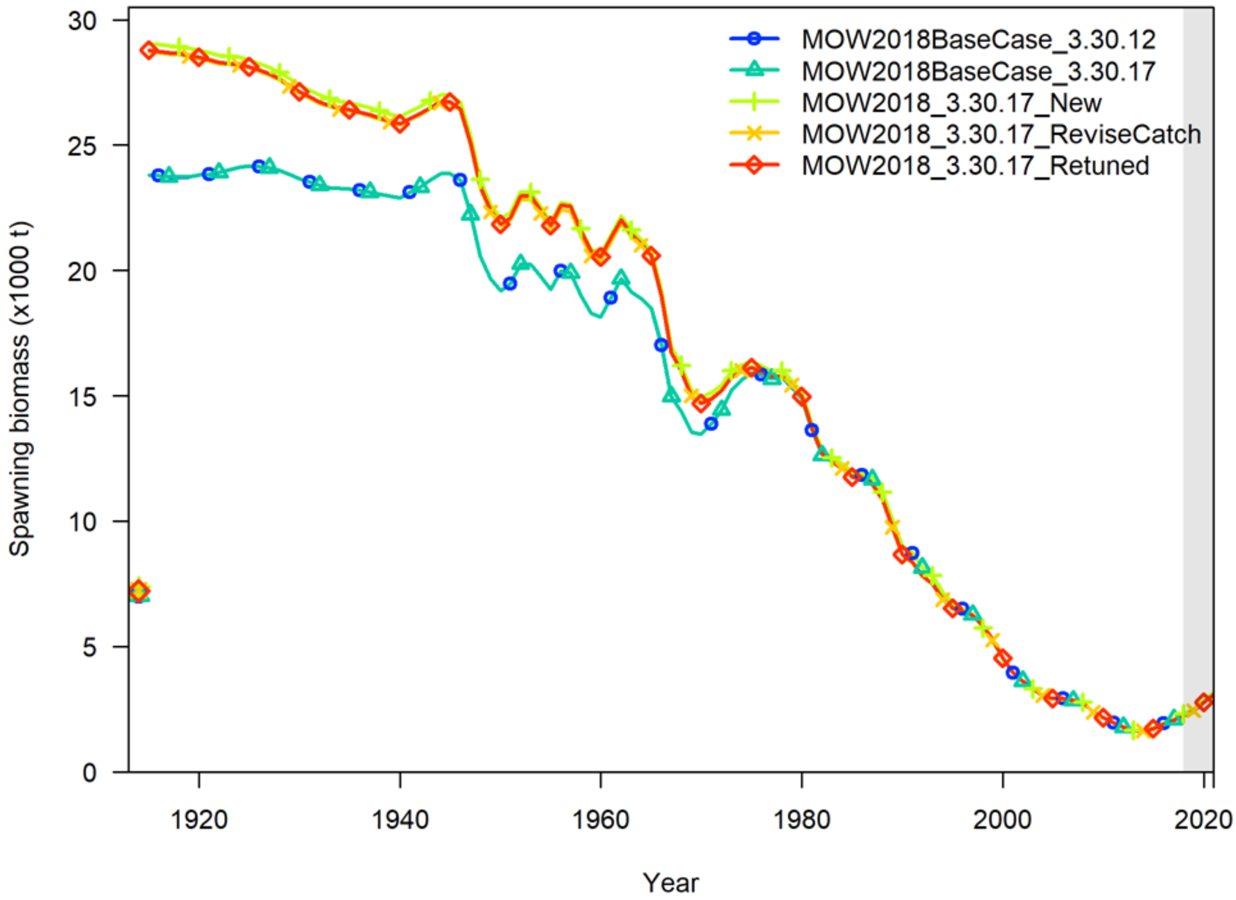

Figure 7.2. Comparison of the time-series of absolute spawning biomass from the 2018 assessment (MOW2018BaseCase_3.30.12 – in royal blue), converting to SS-V3.30.17 (MOW2018BaseCase_3.30.17 – in light blue), incorporating new features (MOW2018_3.30.17_New – in green), revising the historical catch to 2017 and the projected catch in 2018 (MOW2018_3.30.17_ReviseCatch – in orange) retuning the model using the latest tuning protocols (MOW2018_3.30.17_Retuned – in red). The changes shown are largely due to changes in the implementation of the 1988 productivity shift in the updated version of Stock Synthesis.

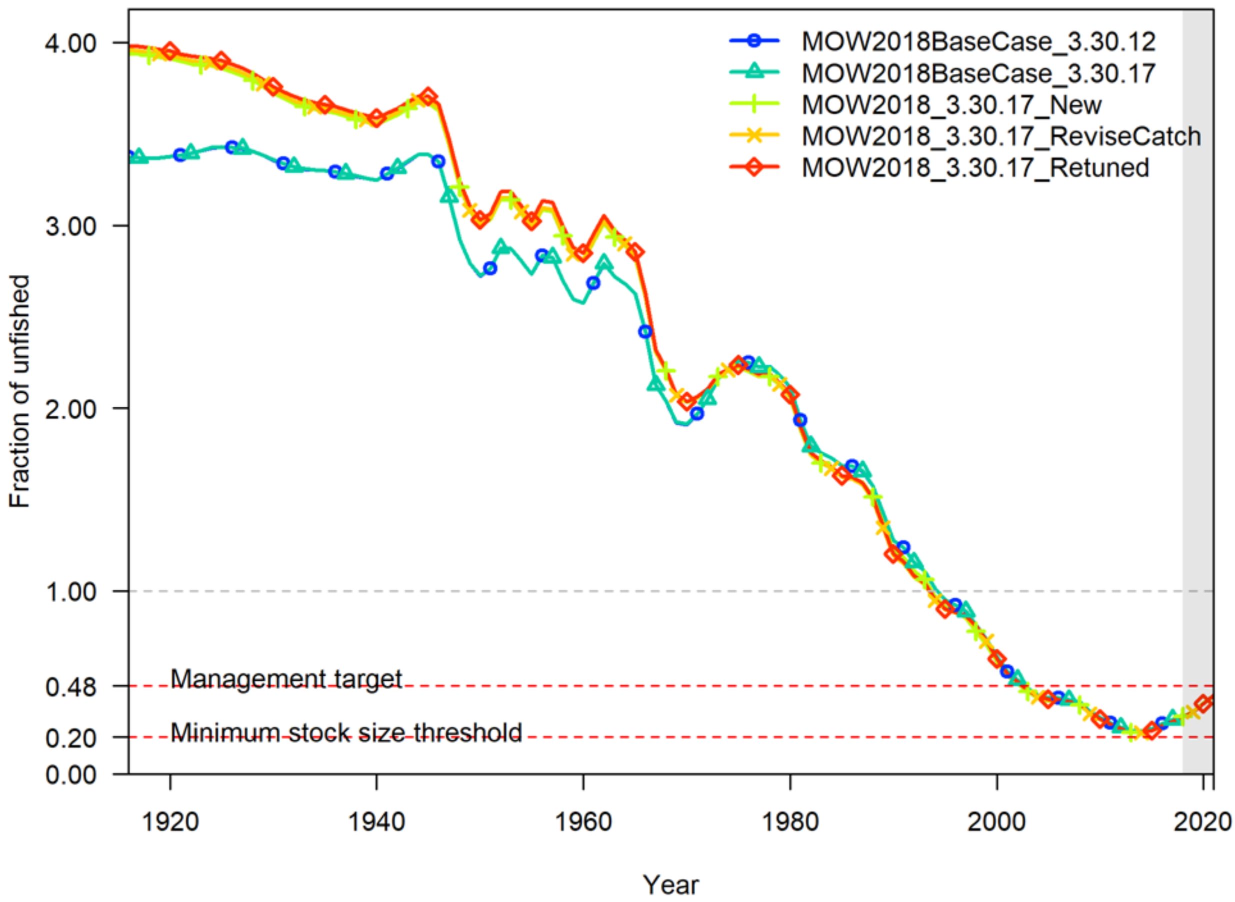

Figure 7.3. Comparison of the time-series of relative spawning biomass from the 2018 assessment (MOW2018BaseCase_3.30.12 – in royal blue), converting to SS-V3.30.17 (MOW2018BaseCase_3.30.17 – in light blue), incorporating new features (MOW2018_3.30.17_New – in green), revising the historical catch to 2017 and the projected catch in 2018 (MOW2018_3.30.17_ReviseCatch – in orange) retuning the model using the latest tuning protocols (MOW2018_3.30.17_Retuned – in red).

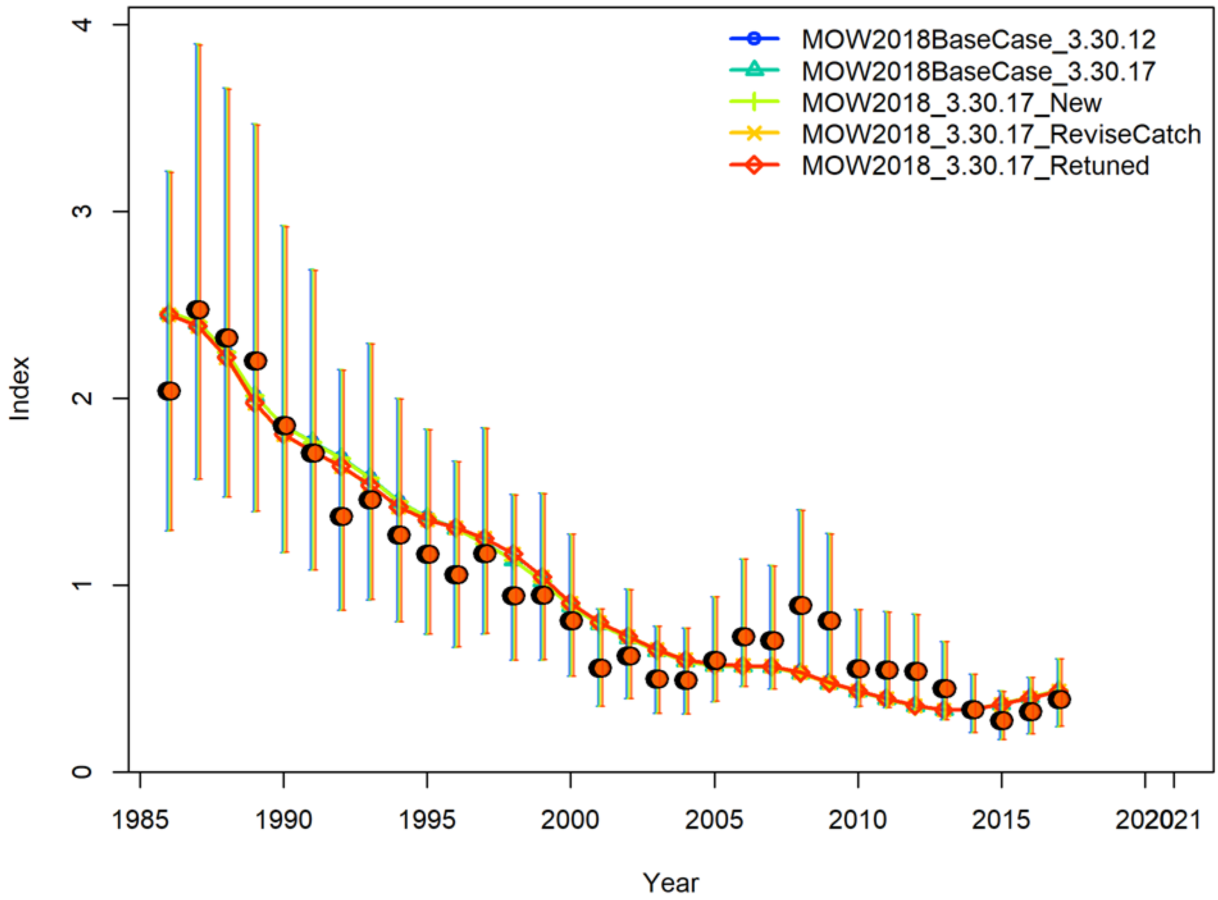

Figure 7.4. Comparison of the fit to the Eastern trawl CPUE index for the 2018 assessment (MOW2018BaseCase_3.30.12 – in royal blue), converting to SS-V3.30.17 (MOW2018BaseCase_3.30.17 – in light blue), incorporating new features (MOW2018_3.30.17_New – in green), revising the historical catch to 2017 and the projected catch in 2018 (MOW2018_3.30.17_ReviseCatch – in orange) retuning the model using the latest tuning protocols (MOW2018_3.30.17_Retuned – in red).

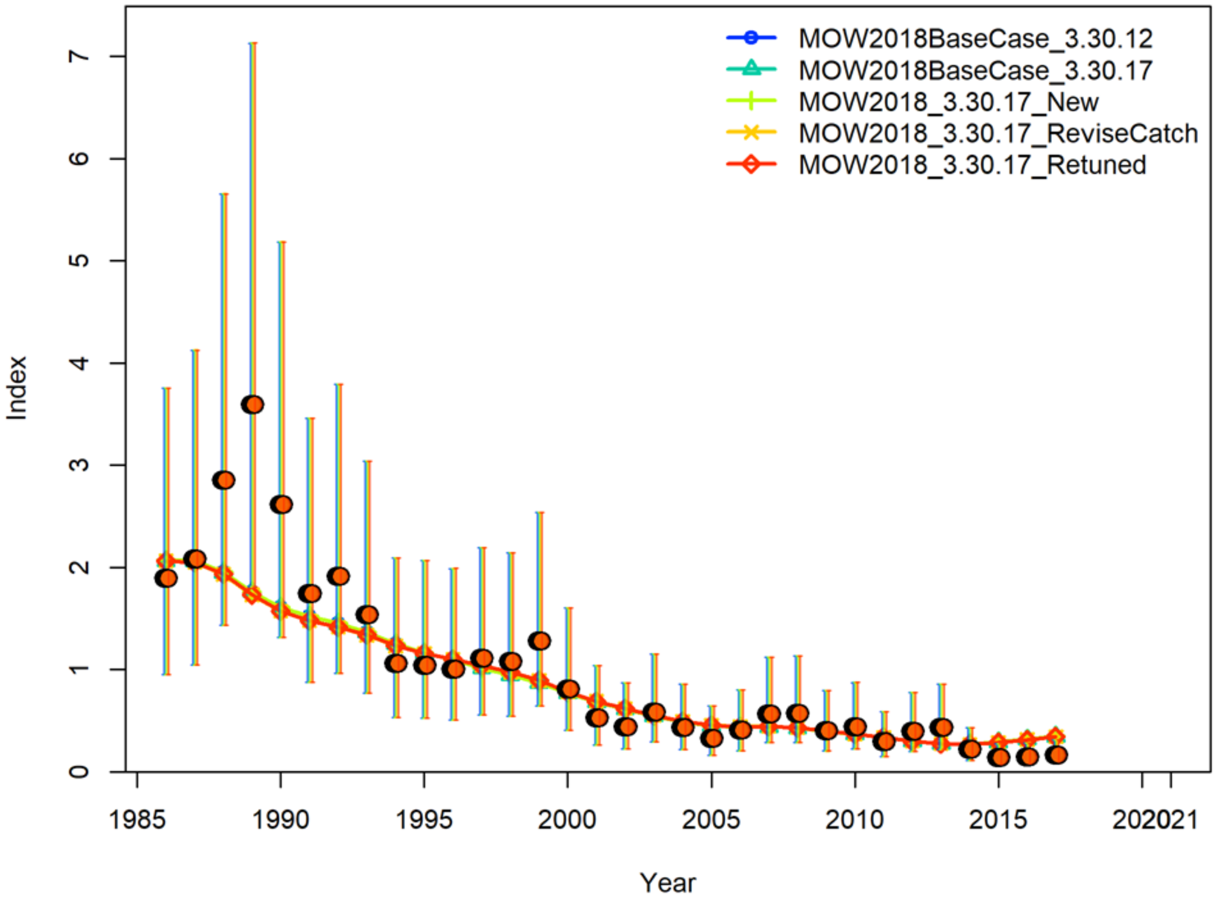

Figure 7.5. Comparison of the fit to the Tasmanian trawl CPUE index for the 2018 assessment (MOW2018BaseCase_3.30.12 – in royal blue), converting to SS-V3.30.17 (MOW2018BaseCase_3.30.17 – in light blue), incorporating new features (MOW2018_3.30.17_New – in green), revising the historical catch to 2017 and the projected catch in 2018 (MOW2018_3.30.17_ReviseCatch – in orange) retuning the model using the latest tuning protocols (MOW2018_3.30.17_Retuned – in red).

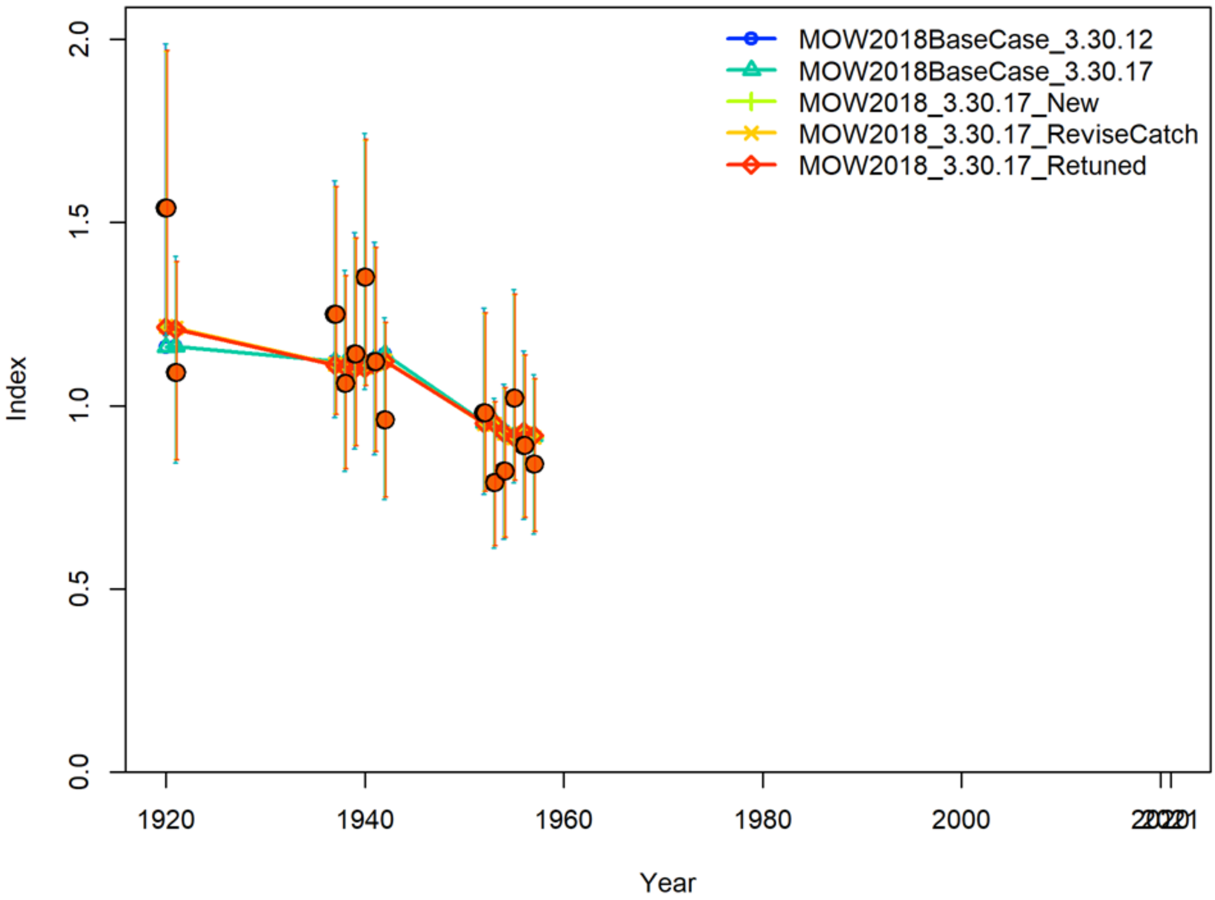

Figure 7.6. Comparison of the fit to the Steam trawl CPUE index for the 2018 assessment (MOW2018BaseCase_3.30.12 – in royal blue), converting to SS-V3.30.17 (MOW2018BaseCase_3.30.17 – in light blue), incorporating new features (MOW2018_3.30.17_New – in green), revising the historical catch to 2017 and the projected catch in 2018 (MOW2018_3.30.17_ReviseCatch – in orange) retuning the model using the latest tuning protocols (MOW2018_3.30.17_Retuned – in red).

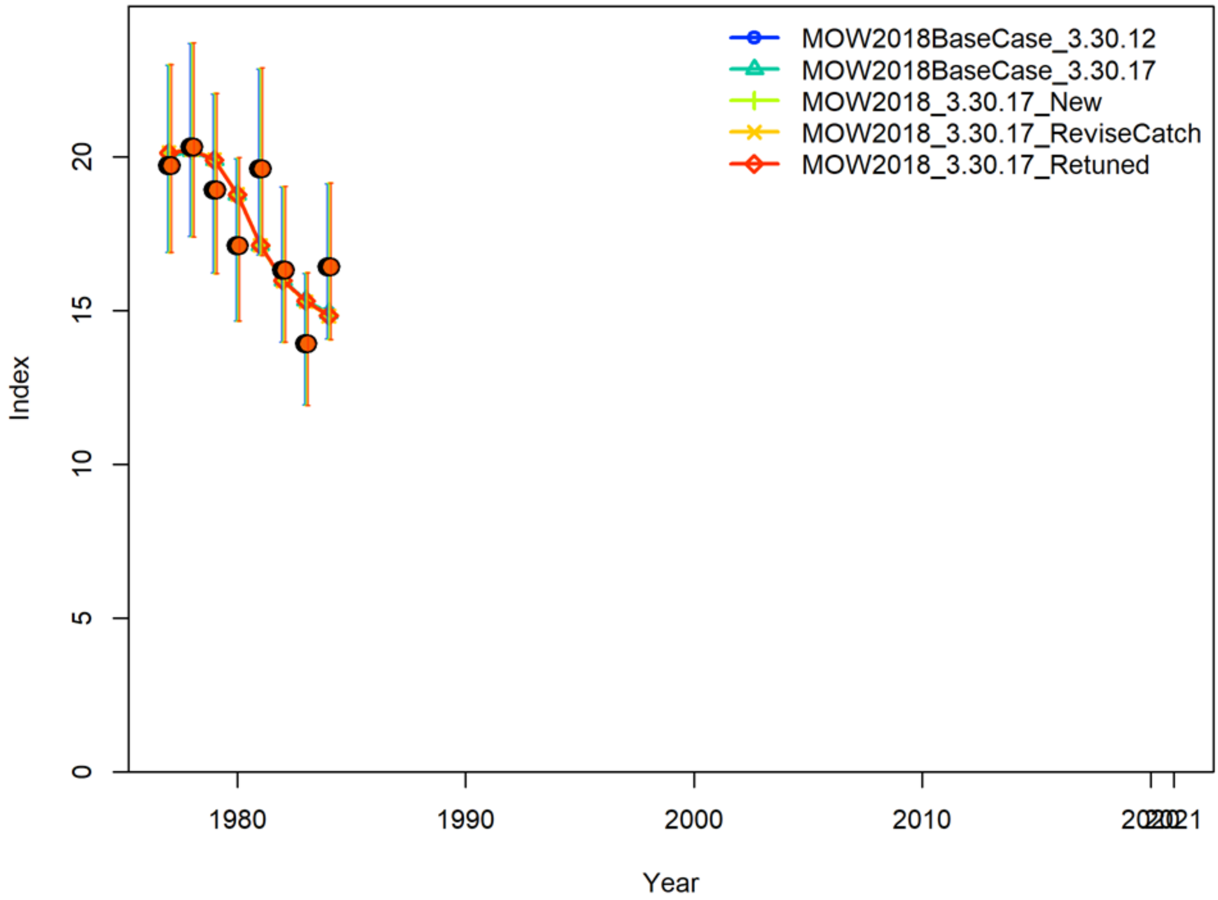

Figure 7.7. Comparison of the fit to the mixed CPUE index for the 2018 assessment (MOW2018BaseCase_3.30.12 – in royal blue), converting to SS-V3.30.17 (MOW2018BaseCase_3.30.17 – in light blue), incorporating new features (MOW2018_3.30.17_New – in green), revising the historical catch to 2017 and the projected catch in 2018 (MOW2018_3.30.17_ReviseCatch – in orange) retuning the model using the latest tuning protocols (MOW2018_3.30.17_Retuned – in red).

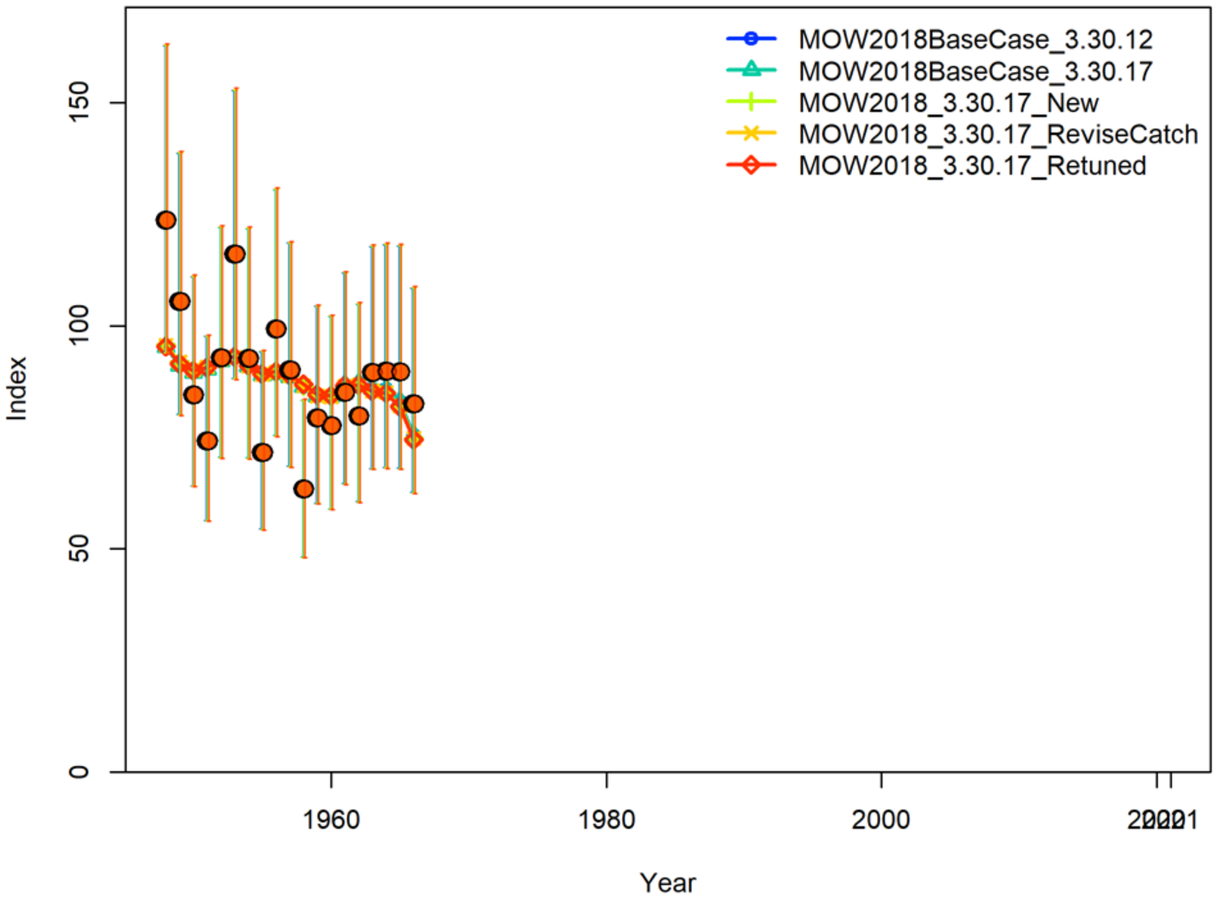

Figure 7.8. Comparison of the fit to the Smith CPUE index for the 2018 assessment (MOW2018BaseCase_3.30.12 – in royal blue), converting to SS-V3.30.17 (MOW2018BaseCase_3.30.17 – in light blue), incorporating new features (MOW2018_3.30.17_New – in green), revising the historical catch to 2017 and the projected catch in 2018 (MOW2018_3.30.17_ReviseCatch – in orange) retuning the model using the latest tuning protocols (MOW2018_3.30.17_Retuned – in red).

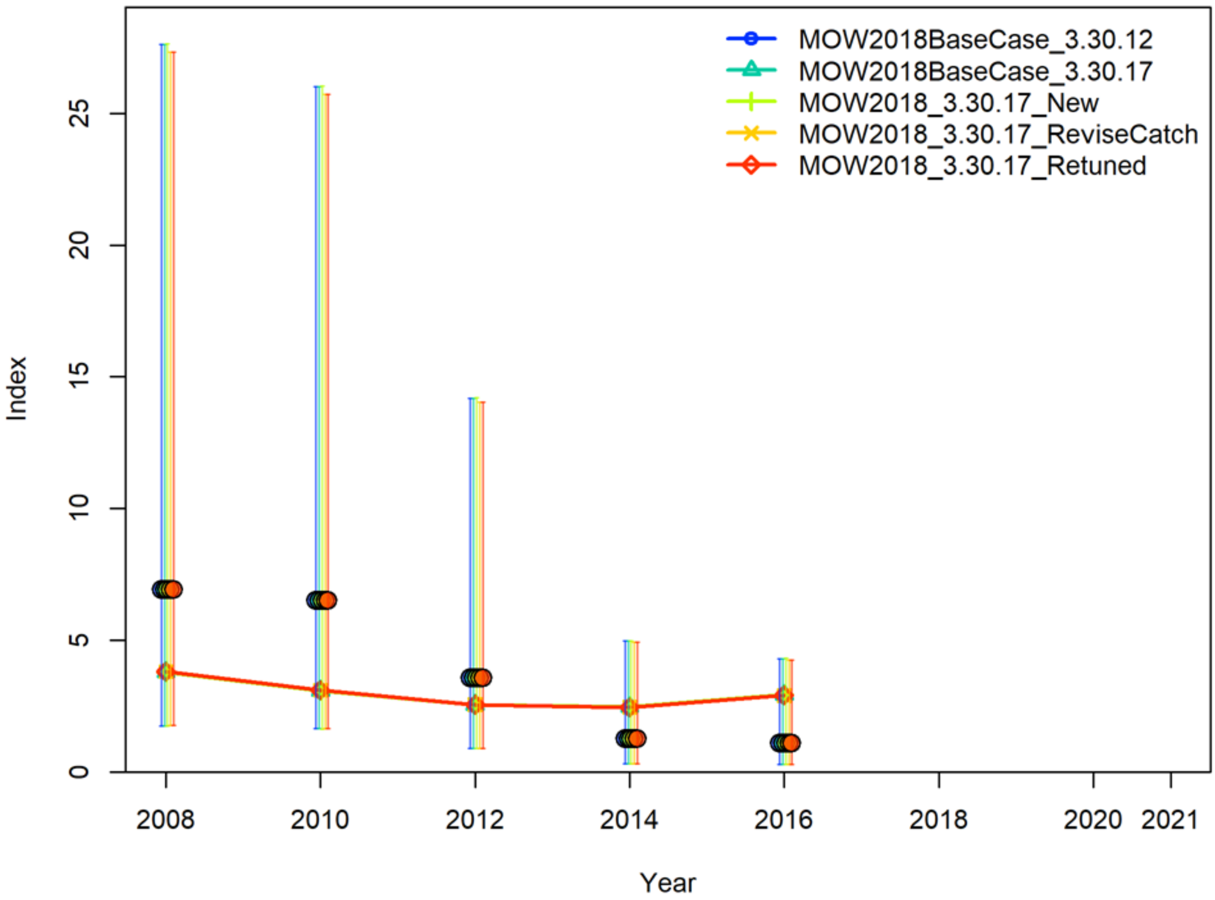

Figure 7.9. Comparison of the fit to the FIS_East (zones 10 and 20) abundance index for the 2018 assessment (MOW2018BaseCase_3.30.12 – in royal blue), converting to SS-V3.30.17 (MOW2018BaseCase_3.30.17 – in light blue), incorporating new features (MOW2018_3.30.17_New – in green), revising the historical catch to 2017 and the projected catch in 2018 (MOW2018_3.30.17_ReviseCatch – in orange) retuning the model using the latest tuning protocols (MOW2018_3.30.17_Retuned – in red).

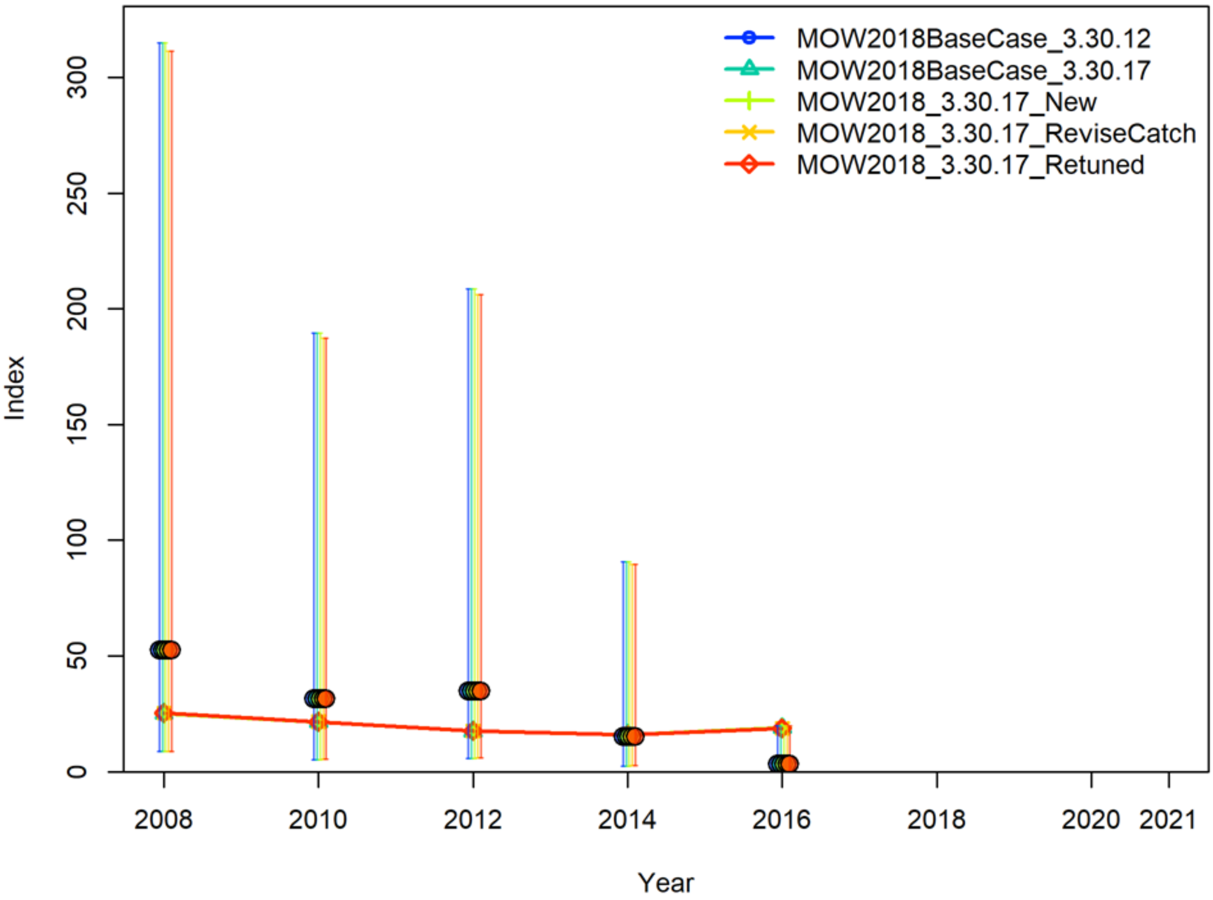

Figure 7.10. Comparison of the fit to the FIS_Tas (zone 30) abundance index for the 2018 assessment (MOW2018BaseCase_3.30.12 – in royal blue), converting to SS-V3.30.17 (MOW2018BaseCase_3.30.17 – in light blue), incorporating new features (MOW2018_3.30.17_New – in green), revising the historical catch to 2017 and the projected catch in 2018 (MOW2018_3.30.17_ReviseCatch – in orange) retuning the model using the latest tuning protocols (MOW2018_3.30.17_Retuned – in red).

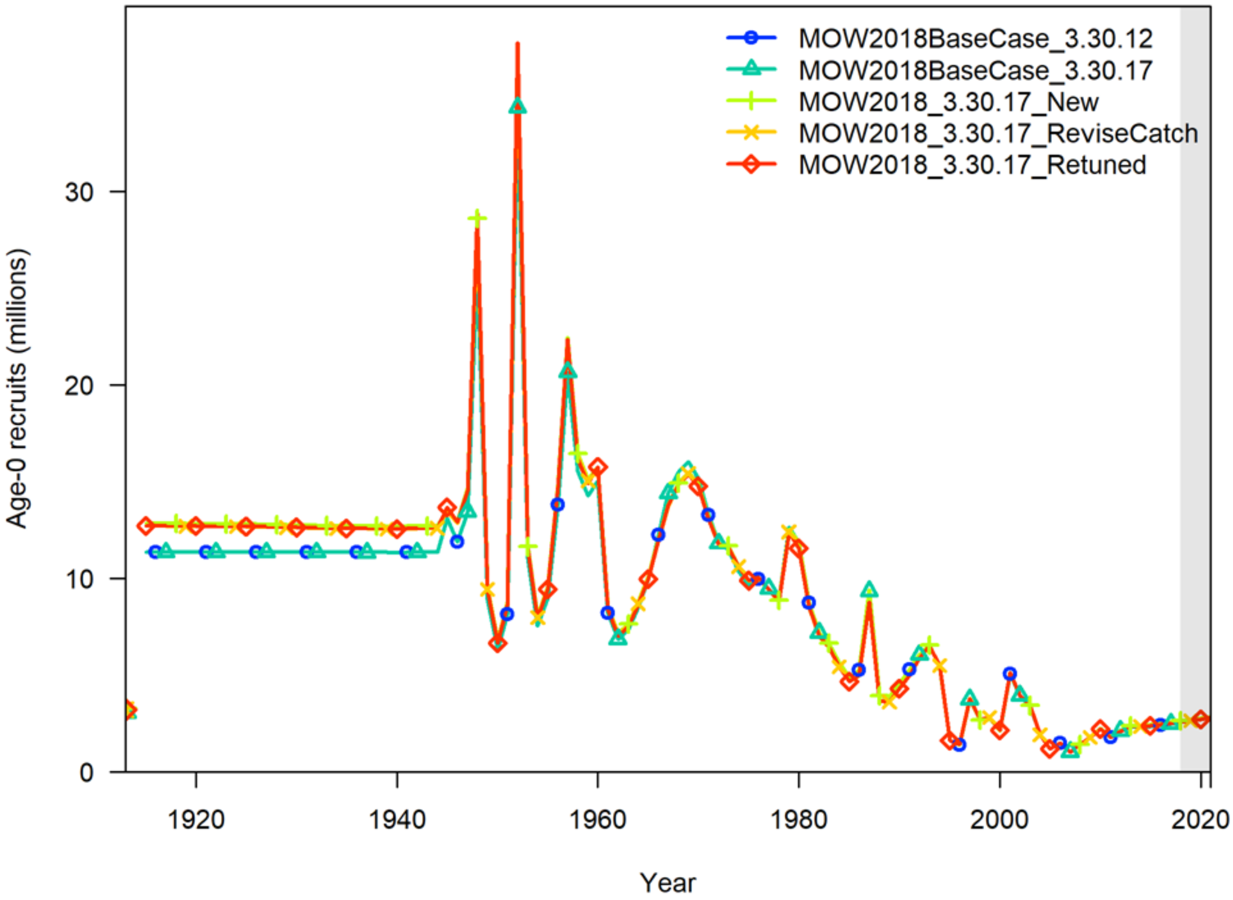

Figure 7.11. Comparison of the time series of absolute recruitment from the 2018 assessment (MOW2018BaseCase_3.30.12 – in royal blue), converting to SS-V3.30.17 (MOW2018BaseCase_3.30.17 – in light blue), incorporating new features (MOW2018_3.30.17_New – in green), revising the historical catch to 2017 and the projected catch in 2018 (MOW2018_3.30.17_ReviseCatch – in orange) retuning the model using the latest tuning protocols (MOW2018_3.30.17_Retuned – in red).

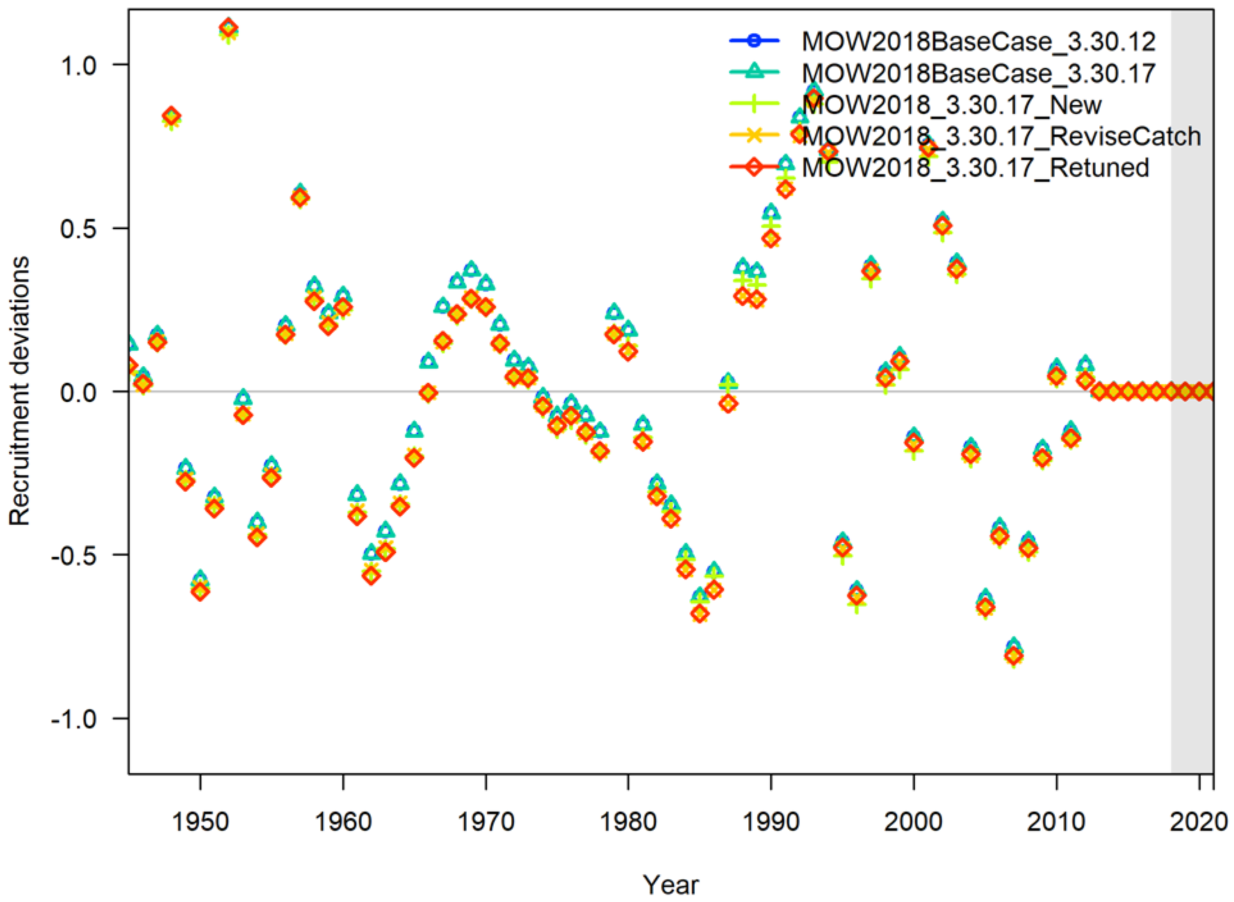

Figure 7.12. Comparison of the time series of estimated recruitment deviations from the 2018 assessment (MOW2018BaseCase_3.30.12 – in royal blue), converting to SS-V3.30.17 (MOW2018BaseCase_3.30.17 – in light blue), incorporating new features (MOW2018_3.30.17_New – in green), revising the historical catch to 2017 and the projected catch in 2018 (MOW2018_3.30.17_ReviseCatch – in orange) retuning the model using the latest tuning protocols (MOW2018_3.30.17_Retuned – in red).

7.4.1 *Tuning method*

Iterative rescaling (reweighting) of input and output CVs or input and effective sample sizes is a repeatable method for ensuring that the expected variation of the different data streams is comparable to what is input (Pacific Fishery Management Council, 2018). Most of the indices (CPUE, surveys and composition data) used in fisheries underestimate their true variance by only reporting measurement or estimation error and not including process error.

In iterative reweighting, the effective annual sample sizes are tuned/adjusted so that the input sample size is equal to the effective sample size calculated by the model. In SS-V3.30 it is possible to estimate an additional standard deviation parameter to add to the input CVs for the abundance indices (CPUE). The tuning steps undertaken are detailed below:

1. Set the standard error for the log of relative abundance indices (CPUE or FIS) to their estimated standard errors to the standard deviation of a loess curve fitted to the original data - which will provide a more realistic estimate to that obtained from the original statistical analysis. SSV-3.30

then allows an estimate to be made for an additional adjustment to the relative abundance variances appropriately.

An automated iterative tuning procedure was used for the remaining adjustments. For the recruitment bias adjustment ramps:

2. Adjust the maximum bias adjustment and the start and finish bias adjustment ramps as predicted by SSV-3.30 at each step.

For the age and length composition data:

3. Multiply the stage-1 (initial) sample sizes for the conditional age-at-length data by the sample size multipliers using the approach of Punt (2017).
4. Similarly multiply the initial samples sizes by the sample size multipliers for the length composition data using the 'Francis method' (Francis, 2011).
5. Repeat steps 2 - 4, until all are converged and stable (with proposed changes < 1 – 2%).

This procedure constitutes current best practice for tuning assessments.

7.5 Bridge 2: Inclusion of new data (2018-2020)

Starting from the final step of Bridge 1, the retuned 2018 base case model with updated data to 2017 (MOW2018_3.30.17_Retuned), additional data from 2018-2020 were added sequentially to build a preliminary base case for the 2021 assessment:

1. Change final assessment year to 2020, add catch to 2020 (MOW2021_addCatch2020).
2. Add CPUE to 2020 (from Sporcic (2021)), (MOW2021_addCPUE2020).
3. Add new discard fraction estimates from 1993 to 2020 (MOW2021_addDiscards2020).
4. Add updated length frequency data to 2020 (MOW2021_addLength2020).
5. Add updated age error matrix and conditional age-at-length data to 2020 (MOW2021_addAge2020).
6. Change the final year for which recruitments are estimated from 2012 to 2015 (MOW2021_extendRec2015).
7. Retune using current tuning protocols, including Francis weighting on length-compositions and Punt weighting on conditional age-at-length data (MOW2021_Tuned).
8. Update the FIS abundance indices to FIS2 abundance indices (Sporcic et al., 2019), add FIS length composition data for the two FIS fleets (East FIS and Tas FIS), estimate selectivity for these two fleets and retune (MOW20201_FIS_Tuned). This final step is recommended as the preliminary 2021 base case.

Inclusion of the new data resulted in a series of changes to the estimates of recruitment and hence to the time-series of both absolute and relative spawning biomass (Figure 7.13 and Figure 7.14), with relatively large changes in spawning biomass time-series in the period from 1915 through to around 1990, then fairly consistent estimates from all bridging steps from 1990 through to around 2015, followed by some divergence from 2015-2021. For the early years of the spawning biomass series, updating the CPUE resulted in an increase to spawning biomass, a pattern largely reversed by adding new discard data, with minor changes from the next few bridging steps and then a decline when recruitment is extended to 2015. For the most recent years of the spawning biomass series, from 2015 to 2021, there was a revision of spawning biomass downwards at the step when the CPUE data was updated, with minor adjustments to this part of the series in the following bridging steps. Note that the 1915 stock status shown in Figure 7.14 is plotted relative to the 1988 equilibrium spawning biomass, post productivity shift, rather than relative to the 1915 unfished equilibrium spawning biomass. Equilibrium spawning biomass in 1988 is shown in Figure 7.13 as individual plotted points for each bridging step, with values ranging between 5,000 and 8000 t, shown just next to the y-axis in 1915 (Figure 7.13, bottom left corner).

Changes to the recruitment series are shown in Figure 7.15. These relative changes are easier to see in the changes to the recruitment deviations (Figure 7.16). The revisions to recruitment typically occur over a number of bridging steps, and are especially noticeable in the years 2008-2012, the last five years of estimated recruitment deviations from the 2018 assessment. All of the revisions from 2008-2012 result in reduced estimated recruitment. When three additional recruitment deviations are estimated through until 2015, the three new estimates are all well below average, with 2013 and 2014 featuring the lowest estimated recruitment deviations in the whole series, with the last 12 estimated recruitment deviations being below average. This appears consistent with a continued decline in productivity in recent years, with some evidence to suggest that this decline began around 1980 and has continued steadily since then, allowing for the fact that a step reduction in productivity is modelled in 1988 in Figure 7.16.

Fits to the CPUE indices (Figure 7.17 to Figure 7.21) and the FIS abundance index (Figure 7.22 and Figure 7.23) generally feature relatively minor changes as data are added, with the most significant change in the early years due to updating the discard data for the eastern trawl and Tasmanian trawl fleets (Figure 7.17 and Figure 7.18), and in extending recruitment estimates to 2015 in the final years for eastern trawl Figure 7.17) and to a lesser extent for Tasmanian trawl (Figure 7.18). The changes resulting from extending recruitment estimates, also result in better fits to the last few years of CPUE data for both the eastern trawl and Tasmanian trawl CPUE series (Figure 7.17 and Figure 7.18).

There are minimal changes to the historical CPUE series which have no new data. The fits to the FIS abundance index (Figure 7.22 and Figure 7.23) are not very good. Given the variability from point to point, it would be hard to get good fits to these series, and to fit the species biology and the rest of the data in the assessment. However, both FIS series suggest there is a larger decline in biomass from 2008-2016 than the model estimates. If the model could fit the FIS abundance data better, it would produce even lower stock status estimates. It appears that the fits to the much longer recent trawl CPUE indices are much more influential. The fits to the historic CPUE indices are reasonable. The fit to the eastern trawl CPUE series from the 2018 assessment, matched the slight increase seen in the last two CPUE data points (2017 and 2018) in the 2018 assessment. The additional CPUE data points (2018-2020) are all lower than the CPUE in 2017 for eastern trawl, and the 2021 assessment fits this decline in CPUE from 2017-2020.

7.5.1 *Results from Bridge 2 from the 2018 assessment*

Inclusion of three years of new data in the 2018 assessment (Day and Castillo-Jordán, 2018) resulted in relatively small changes to estimates of recruitment and the spawning biomass time series, with the time series of spawning biomass showing a minimum stock biomass level in 2013 and 2014 of around 23% but with an apparent recovery since then, with stronger recruitment and low fishing pressure up until 2017. Recruitment was only able to be estimated for one additional year at that time, despite using three more years of additional data, with upward revisions to the recruitment estimates from 2010 and 2011 and slightly higher than average recruitment estimated for 2012. The 2018 assessment stated that "these latest recruitment estimates may be further revised with the inclusion of additional data in future assessments, with new data that may help inform these recruitment estimates", and indeed these latest recruitment estimates were all revised down in the new 2021 proposed base case.

The 2015 assessment (Tuck et al., 2015) estimated the stock status at the start of 2016 to be 36%. The 2018 base case has an estimate of stock status at the start of 2019 of 35% of unexploited stock biomass, SSB_0, (projected assuming 2017 catches in 2018) with the equilibrium female spawning biomass in 1988 (post productivity shift) estimated at 3,523 t (reduced from 3,977 t from the 2015 assessment) and in 2019 the female spawning biomass is projected to be 1,237 t (reduced from the 2019 projected value of 1,560 t from the 2015 assessment).

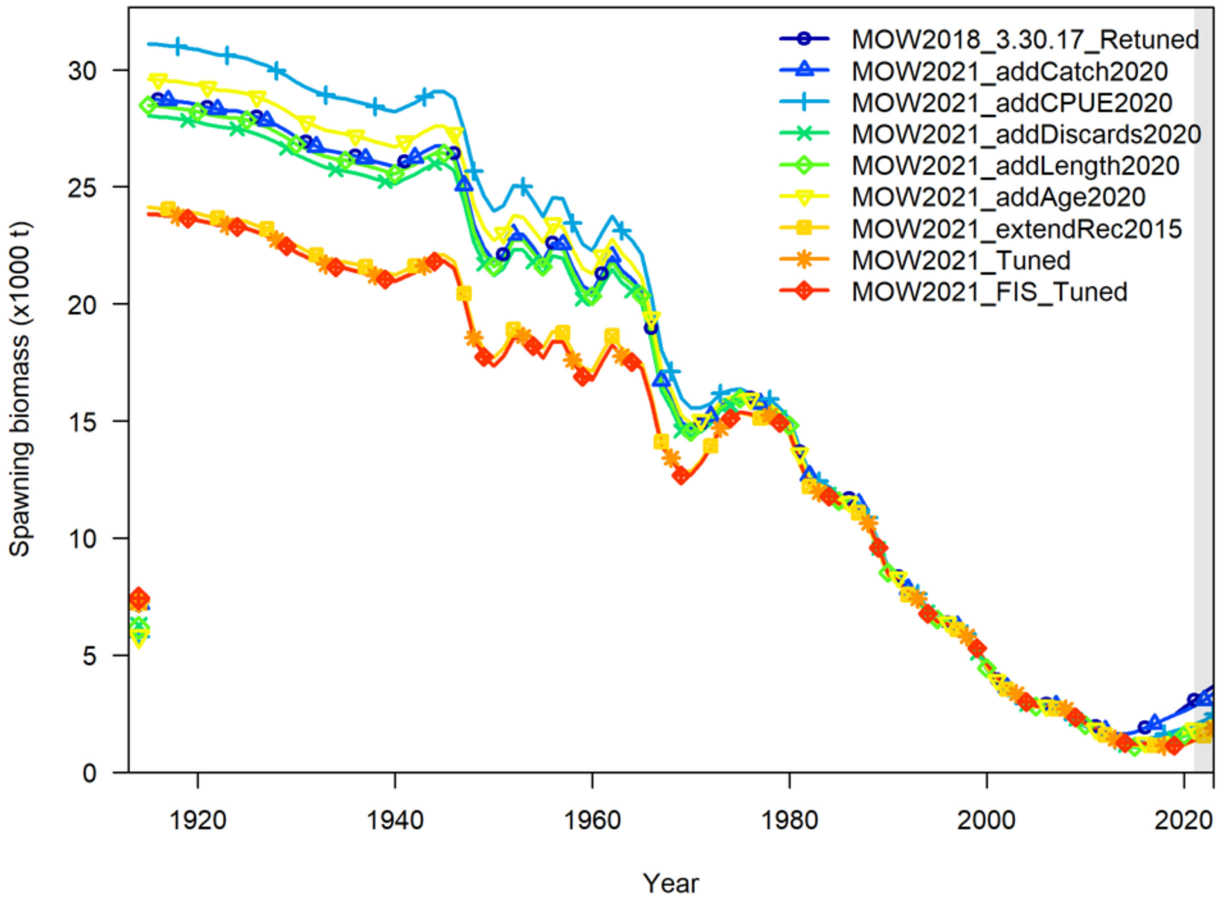

Figure 7.13. Comparison of the time series of absolute spawning biomass for the updated 2018 assessment model converted to SS-V3.30.17 (MOW2018_3.30.17_Retuned – dark blue) with various bridging models leading to a proposed 2018 base case model (MOW2021_FIS_Tuned - red).

7.5.2 *Results from Bridge 2 from the 2021 assessment*

While the inclusion of three years of new data in the 2021 assessment may superficially appear to result in relatively minor changes to the spawning biomass and recruitment time series, these changes require careful scrutiny. Due to the productivity shift resulting in a very large initial stock status in 1915, relative to the 1988 equilibrium spawning biomass (three to five times higher), apparently small changes to the spawning biomass after 2010 shown in Figure 7.13 and Figure 7.14 actually result in substantial changes, relative to the target and limit reference points (B_{48} and B_{20}). For the preliminary base case for 2021, the spawning biomass is now estimated to be below the limit reference point (B_{20}) for the period 2013-2021, with a minimum stock status of 15% in 2018 and 2019, 17% in 2016, 19% in 2021 and at the start of 2022 the projected stock status is 21%, assuming average recruitment has occurred since 2016. This is a change to the model estimated stock status of around 35% in the period between 2016 and 2019 which was produced from the 2018 and 2015 stock assessments. If this stock status is compared to the pre-productivity shift biomass, the minimum stock status would be 4.8% in both 2018 and 2019 with a 2022 stock status of 6.7%, and with all values of stock status below 20% since the year 2000.

Similarly, there are considerable revisions downwards to recent recruitment deviations (Figure 7.16), starting with the addition of updated discard data and continuing as more steps are undertaken in Bridge 2. These downwards revisions of recent recruitment deviations apply especially for the period 2007-2012, which are the last 6 years of estimated recruitment deviations from the 2018 assessment. Noticeably the three new years with recruitment deviations estimated, 2013-2015 are all well below average, with estimates for the 2013 and 2014 recruitment deviations resulting in the largest negative recruitment deviations in the whole recruitment deviation time series. Given this run of 12 years of below average recruitments, even with a 1988 productivity shift already implemented, considerable caution is required when interpreting results of models projecting forwards applying average recruitment since 2016, as these projections may be misleading, if recruitment has not returned to average since 2016.

The 2021 preliminary base case estimates the stock status at the start of 2022 (projected assuming 2020 catches in 2021) to be 22%. The 2021 preliminary base case estimates stock status at the start of 2019 to be 15% (compared to projected values of 35% and 39% respectively from the 2018 and 2015 assessments for 2019). The equilibrium female spawning biomass in 1988 (post productivity shift) is estimated to be 3,715 t (compared to 3,523 t from the 2018 assessment and 3,977 t from the 2015 assessment) and in 2022 the female spawning biomass is estimated to be 801 t (compared to projections in 2022 of 1,366 t from the 2018 assessment and 1,667 t from the 2015 assessment).

The changes to the predicted stock status between the 2021 preliminary base case and the 2018 and 2015 assessment appear to be largely driven by recent CPUE data for both the eastern trawl and Tasmanian trawl fleets. Extending recruitment estimates to 2015 allowed improvements to the fit to the three new CPUE data points (2018-2020) for the eastern trawl fleet (Figure 7.17), overriding the apparent increase in eastern trawl CPUE at the end of this previous CPUE series (2015-2017) from the 2018 assessment, an increase which the model appeared to fit to in 2018. Similarly, the additional three CPUE points for the Tasmanian trawl series result in an adjustment (compared to the 2018 assessment) to the biomass projections in 2015-2017 (Figure 7.18), which was the end of the series from the 2018 assessment. The slightly optimistic model estimates for 2015-2017 (fitted series higher than the CPUE data points) from the 2018 assessment have been revised down in 2021, as the model has additional CPUE points (2018-2020) which do not support or allow this increase in biomass to be fitted at the end of the series. There is clearly no strong signal in the length and age data, indicating good recent recruitment, which would prevent the model fitting the recent CPUE data for both the eastern and Tasmanian trawl fleets. Of course, the most recent estimates of recruitment may be revised in subsequent stock assessments, as additional data becomes available to further inform these recruitment estimates.

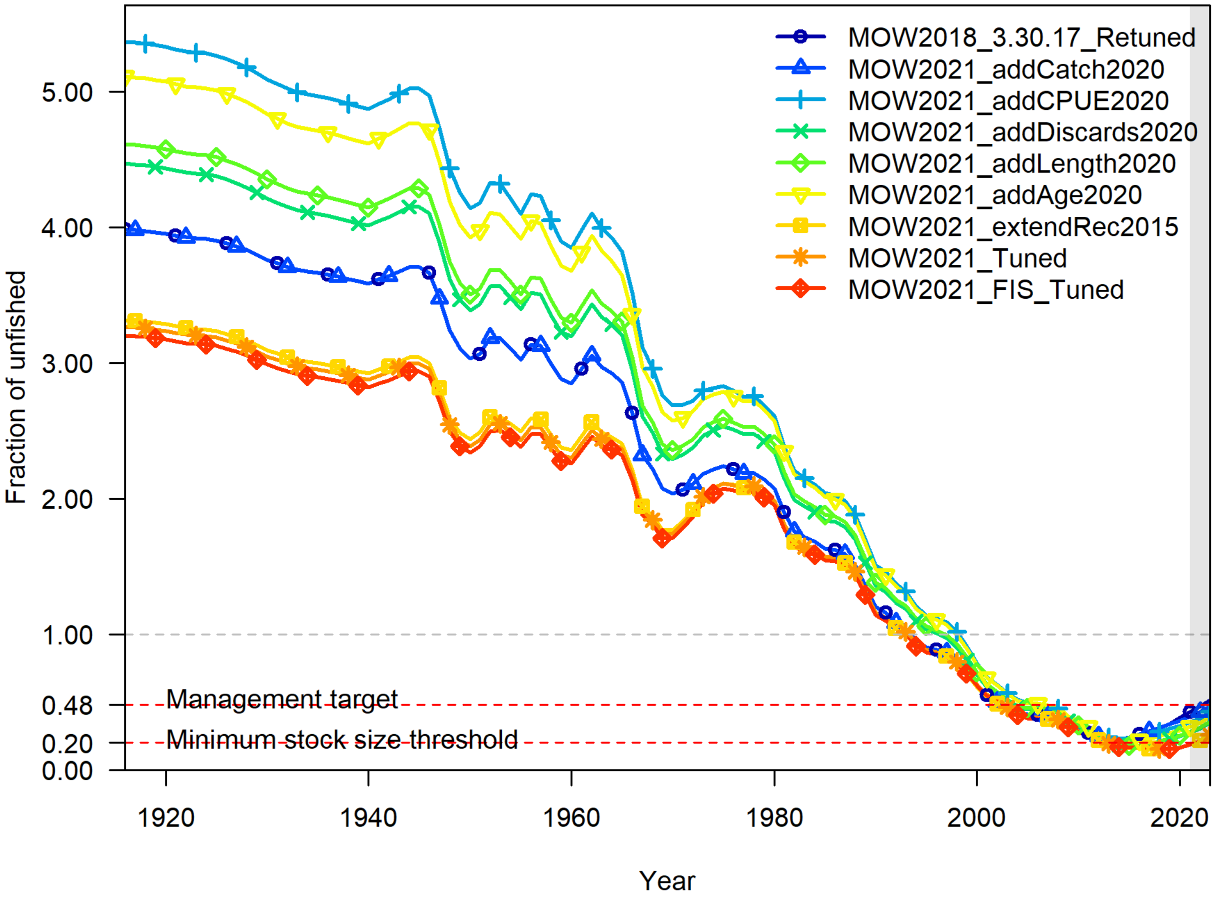

Figure 7.14. Comparison of the time series of relative spawning biomass for the updated 2018 assessment model converted to SS-V3.30.17 (MOW2018_3.30.17_Retuned – dark blue) with various bridging models leading to a proposed 2018 base case model (MOW2021_Tuned - red).

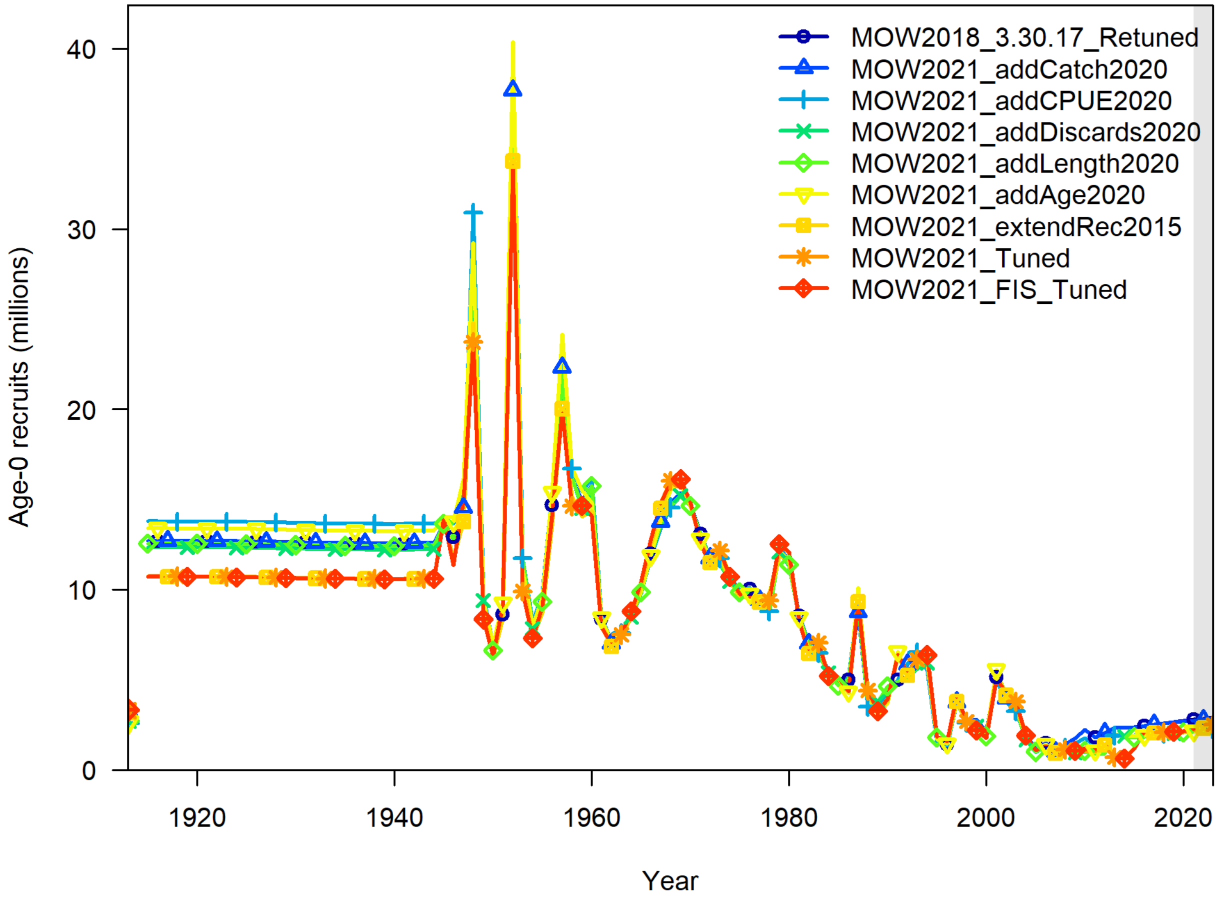

Figure 7.15. Comparison of the time series of absolute recruitment from the updated 2018 assessment model converted to SS-V3.30.17 (MOW2018_3.30.17_Retuned – dark blue) with various bridging models leading to a proposed 2018 base case model (MOW2021_Tuned - red).

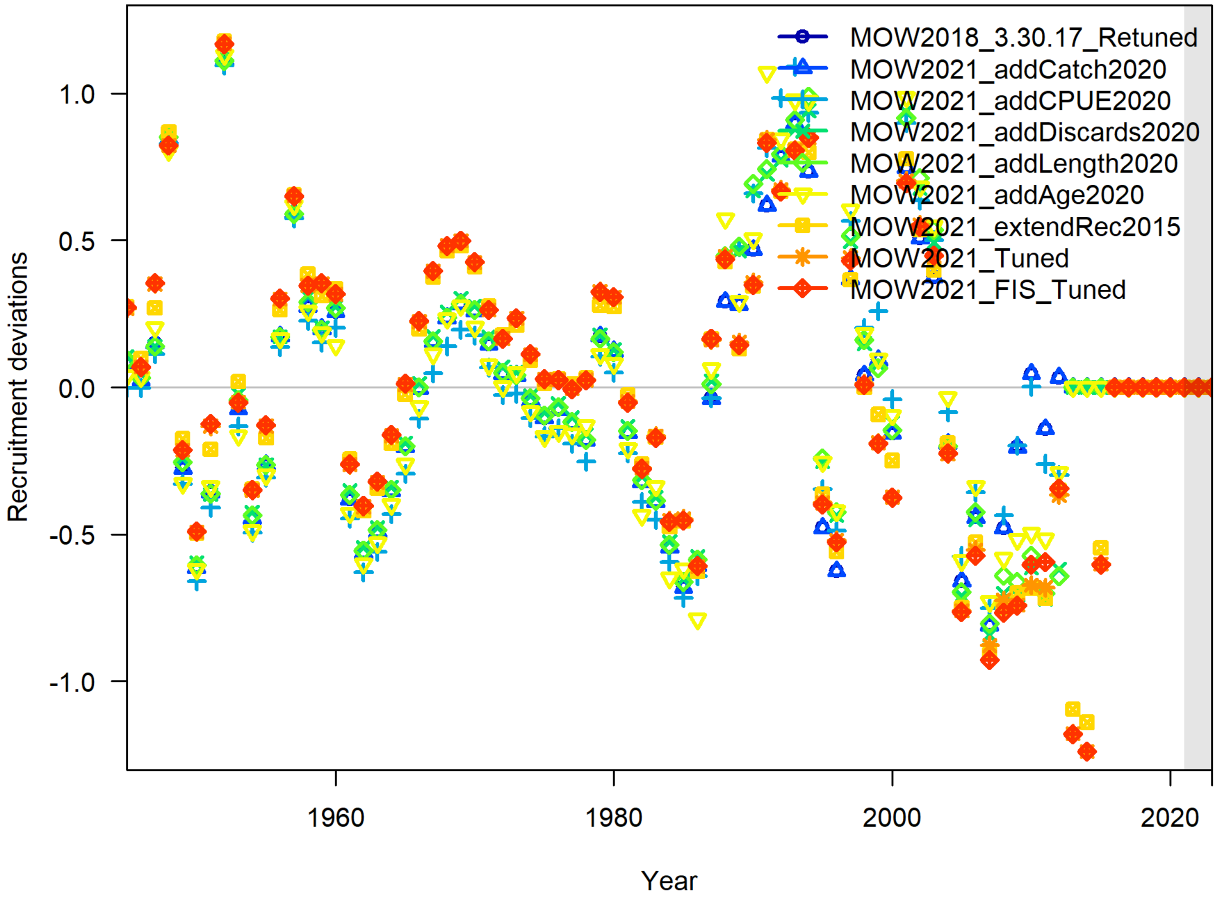

Figure 7.16. Comparison of the time series of estimated recruitment deviations from the updated 2018 assessment model converted to SS-V3.30.17 (MOW2018_3.30.17_Retuned – dark blue) with various bridging models leading to a proposed 2018 base case model (MOW2021_Tuned - red).

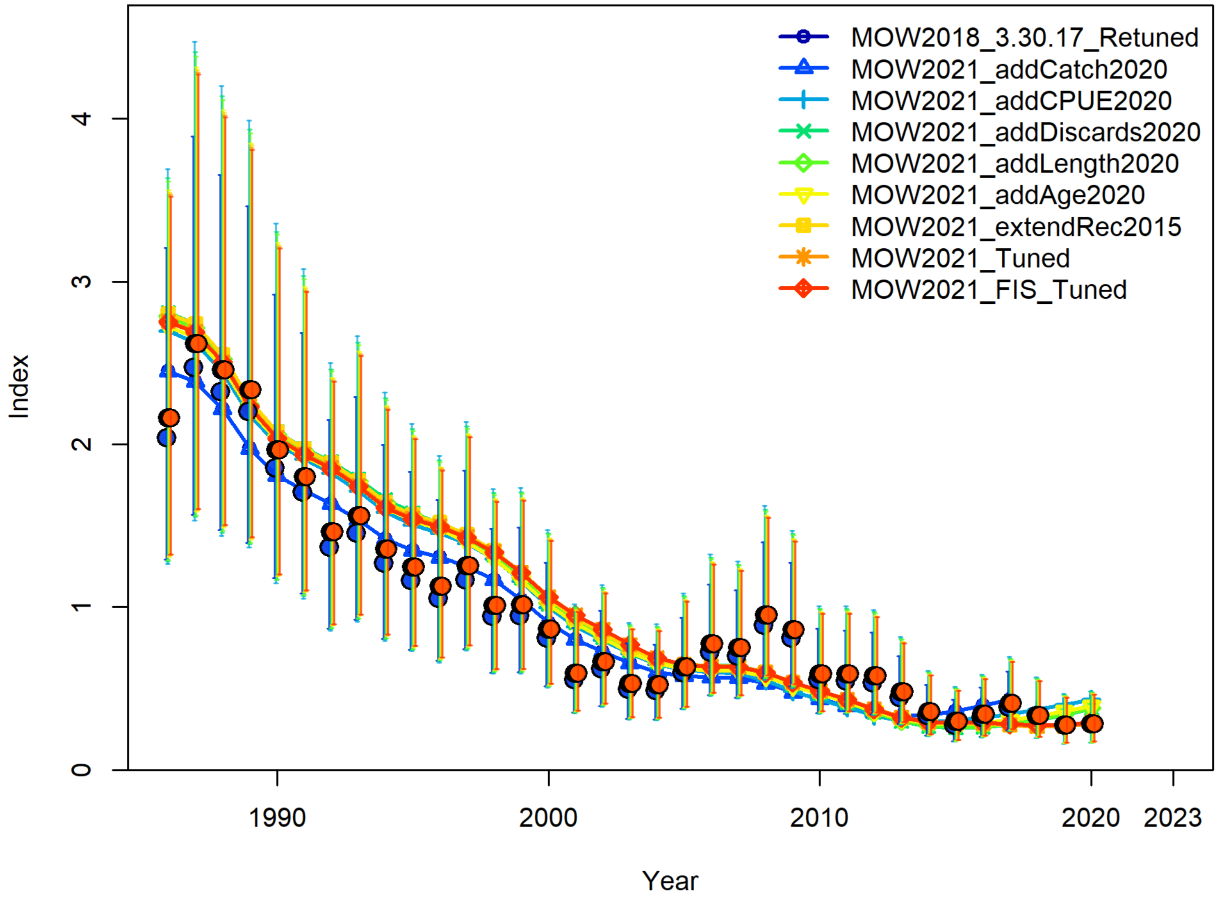

Figure 7.17. Comparison of the fit to the eastern trawl CPUE index for the updated 2018 assessment model converted to SS-V3.30.17 (MOW2018_3.30.17_Retuned – dark blue) with various bridging models leading to a proposed 2018 base case model (MOW2021_Tuned - red).

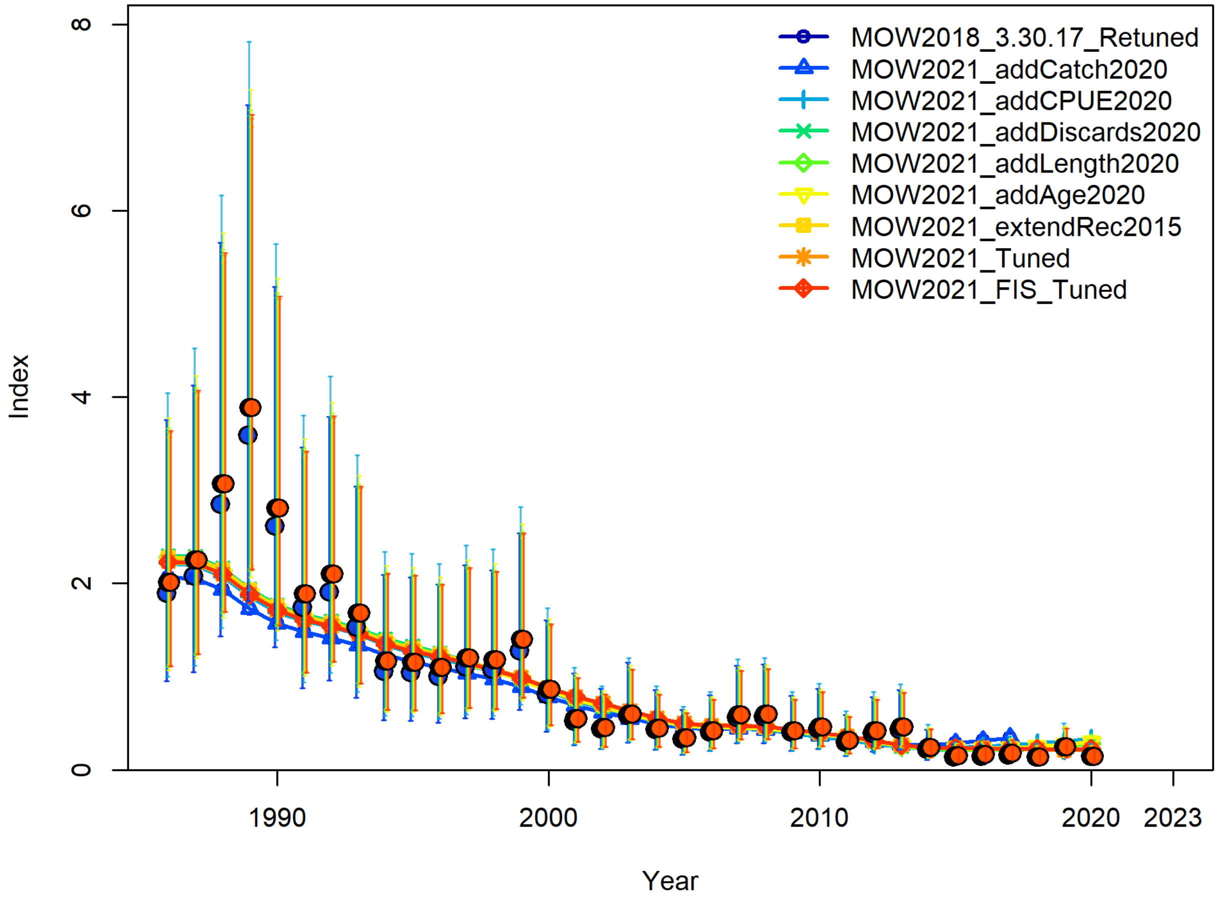

Figure 7.18. Comparison of the fit to the Tasmanian trawl CPUE index for the updated 2018 assessment model converted to SS-V3.30.17 (MOW2018_3.30.17_Retuned – dark blue) with various bridging models leading to a proposed 2018 base case model (MOW2021_Tuned - red).

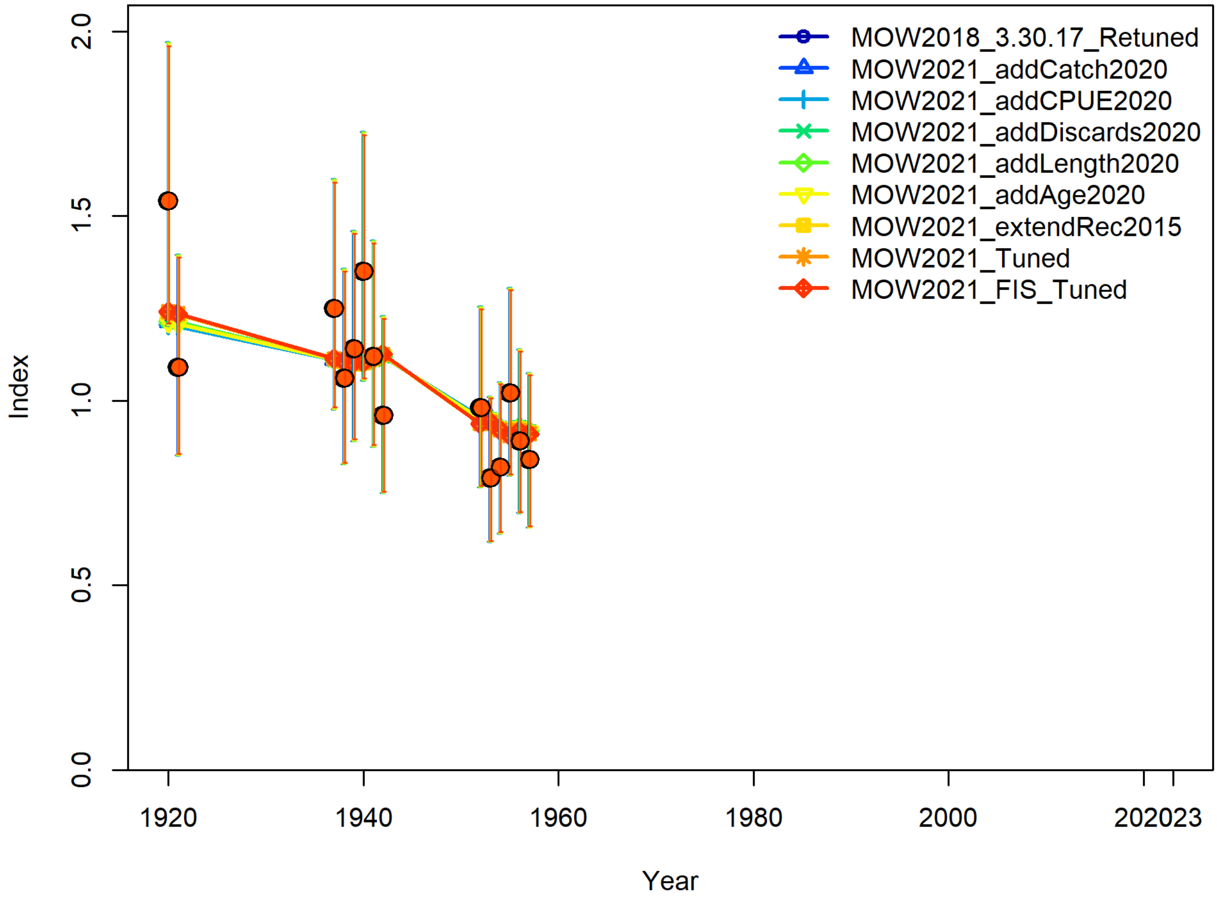

Figure 7.19. Comparison of the fit to the steam trawl CPUE index for the updated 2018 assessment model converted to SS-V3.30.17 (MOW2018_3.30.17_Retuned – dark blue) with various bridging models leading to a proposed 2018 base case model (MOW2021_Tuned - red).

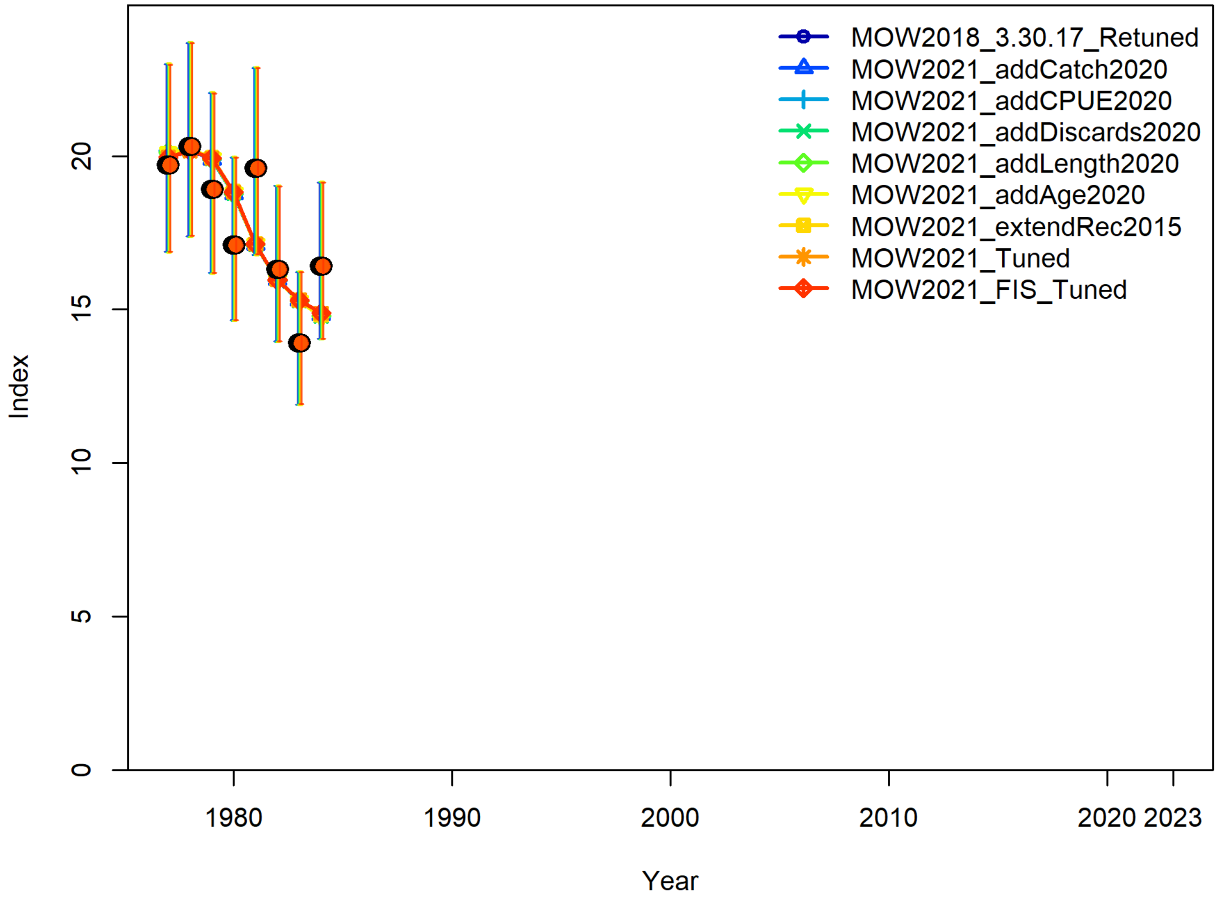

Figure 7.20. Comparison of the fit to the mixed CPUE index for the updated 2018 assessment model converted to SS-V3.30.17 (MOW2018_3.30.17_Retuned – dark blue) with various bridging models leading to a proposed 2018 base case model (MOW2021_Tuned - red).

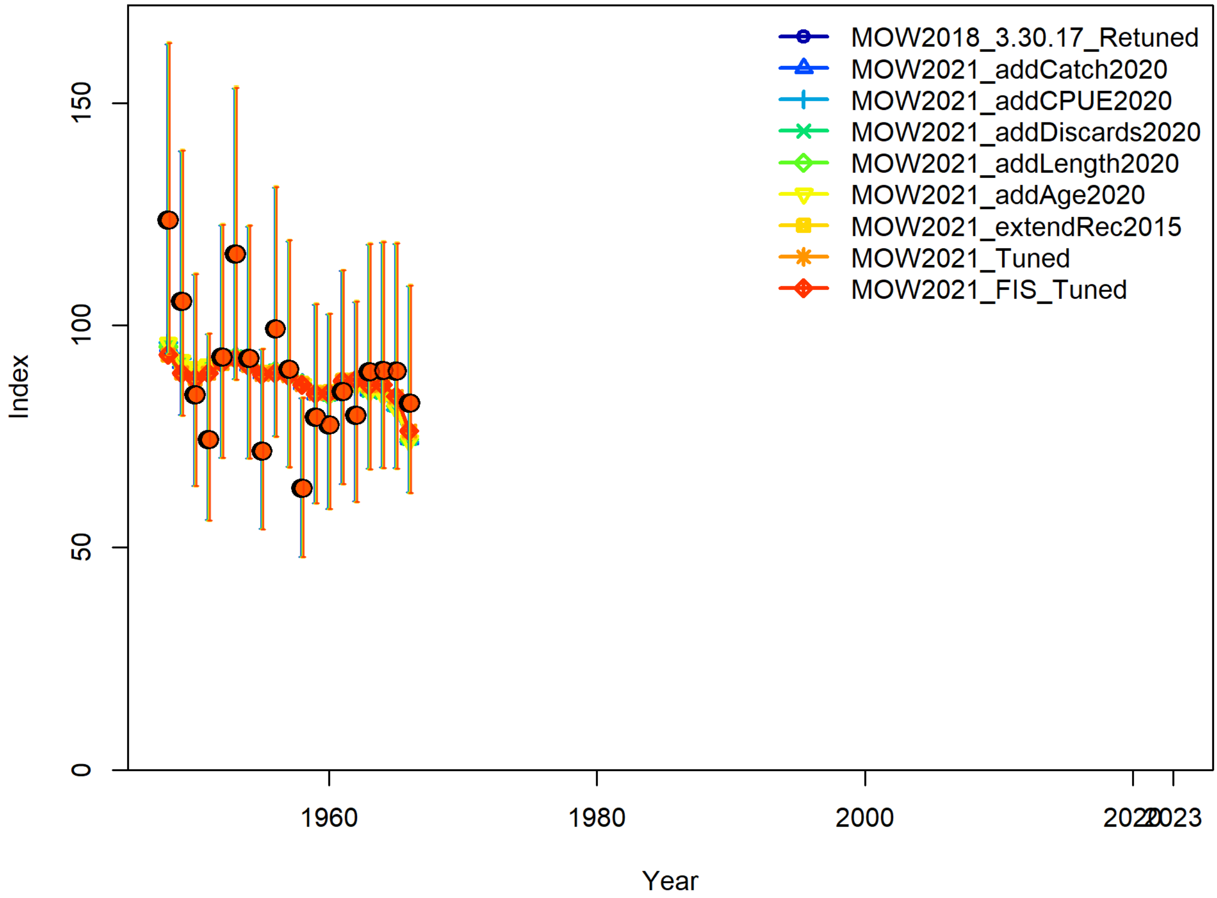

Figure 7.21. Comparison of the fit to the Smith CPUE index for the updated 2018 assessment model converted to SS-V3.30.17 (MOW2018_3.30.17_Retuned – dark blue) with various bridging models leading to a proposed 2018 base case model (MOW2021_Tuned - red).

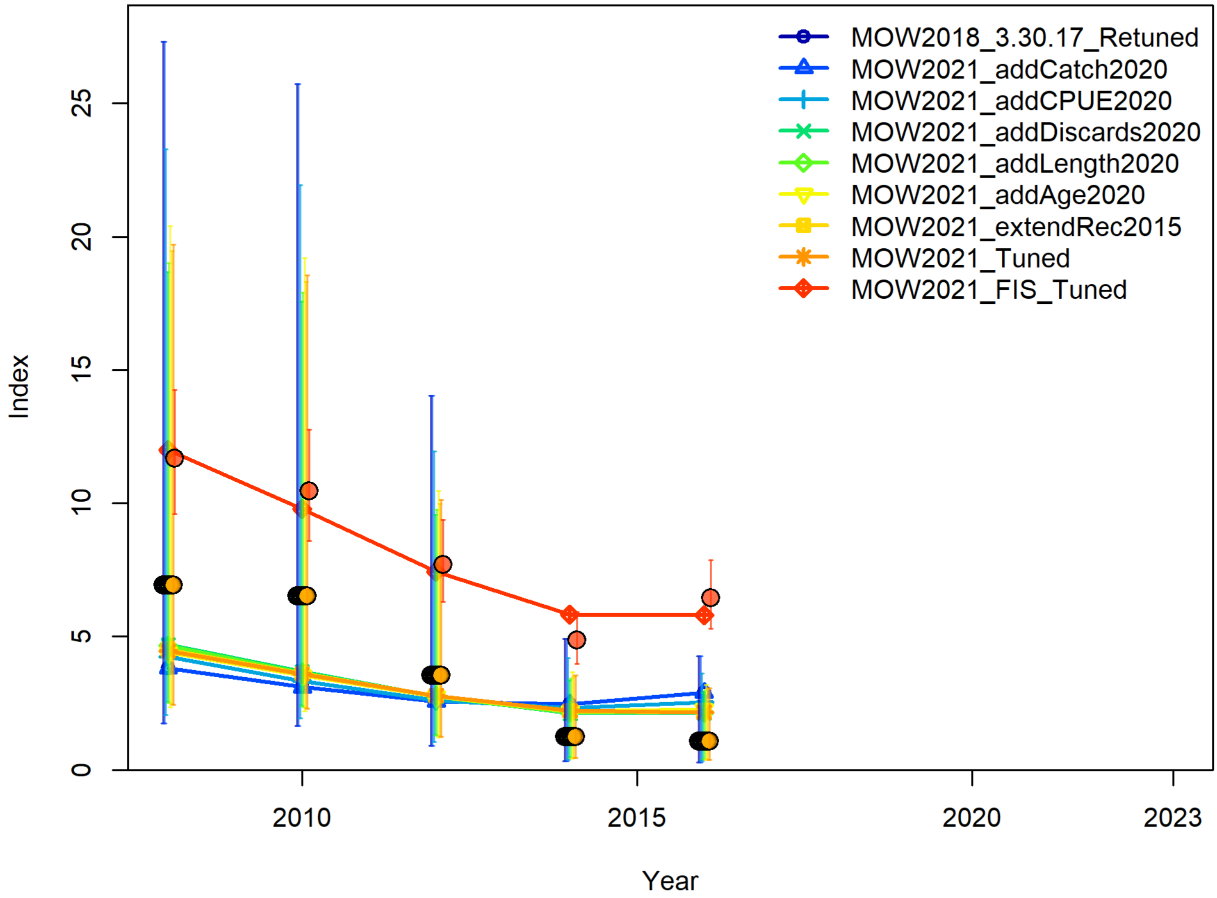

Figure 7.22. Comparison of the fit to the FIS east (Zones 10 and 20) index for the updated 2018 assessment model converted to SS-V3.30.17 (MOW2018_3.30.17_Retuned – dark blue) with various bridging models leading to a proposed 2018 base case model (MOW2021_Tuned - red).

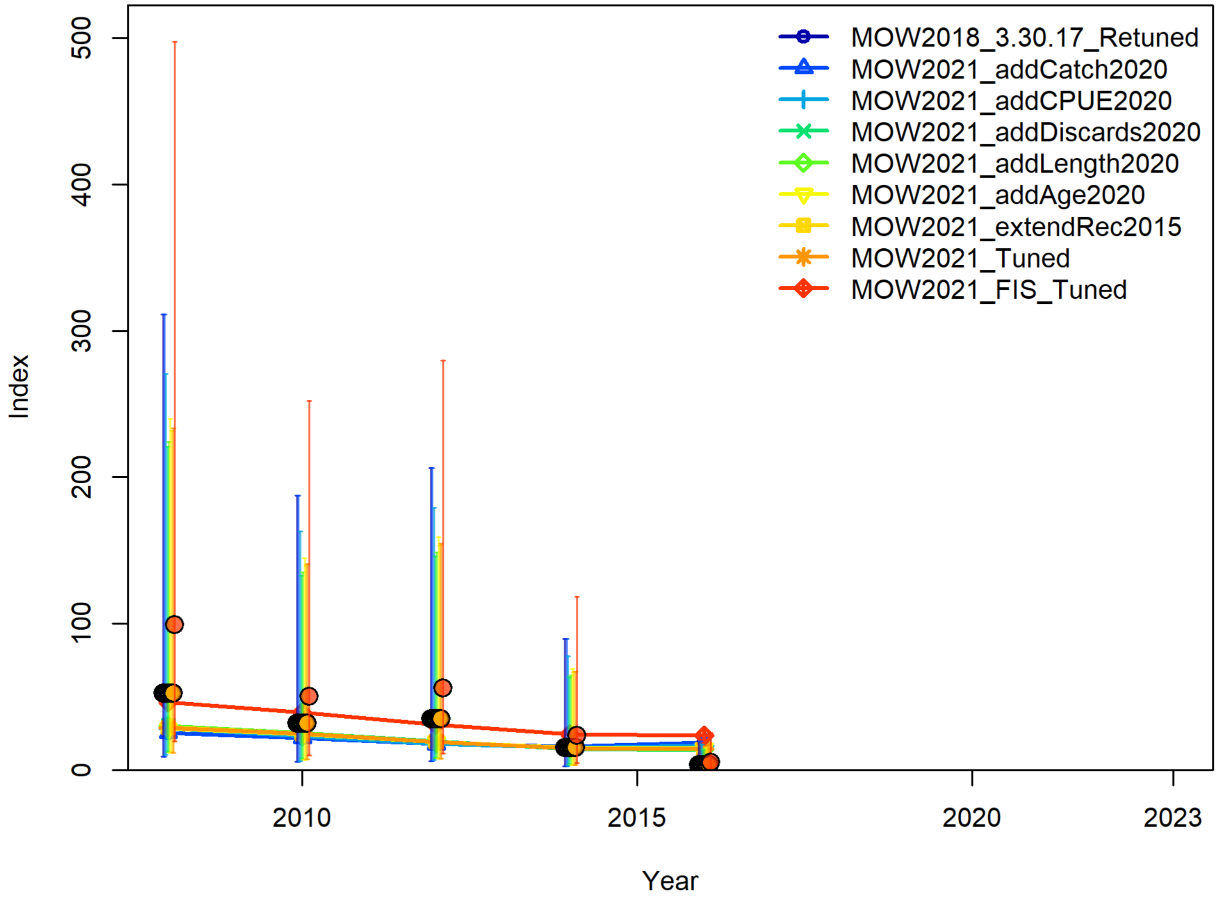

Figure 7.23. Comparison of the fit to the FIS Tas (Zone 30) index for the updated 2018 assessment model converted to SS-V3.30.17 (MOW2018_3.30.17_Retuned – dark blue) with various bridging models leading to a proposed 2018 base case model (MOW2021_Tuned - red).

7.6 Dynamic B_0

It is possible to calculate dynamic B_0 (Bessell-Browne et al., 2021, in prep.) by projecting the population forward from its initial state without applying fishing mortality, assuming that the deviations in recruitment about the stock-recruitment relationship are not influenced by fishing pressure and are only influenced by non-fishing related factors, such as environmental drivers. These annual deviations are therefore assumed to be the same in both the fished and unfished cases. This explicitly assumes that fishing affects the numbers-at-age, but not the deviations in biological parameters about their expected values for any particular year. Dynamic B_0 is another way to account for the changing productivity of a stock without having to specify a specific year to implement a productivity shift, as is done in the current assessment. It also allows for trends in productivity to occur through time, rather than assuming a step function where there is a disconnect between two different productivity states.

Dynamic B_0 for Jackass Morwong is initially the same as static B_0 between 1915 and 1945 as recruitment deviations are not estimated over this period (Figure 7.24, top panel). Between 1946 and 1988 dynamic B_0 is higher than static B_0, before dropping sharply for the remainder of the timeseries (Figure 7.24, top panel). Note that in the assessment model a productivity shift is implemented in 1988, altering the estimated value of B_0.

Estimated relative stock status varies considerably between the base case model with a productivity shift using static B_0 compared to that estimated using dynamic B_0 (Figure 7.24, bottom panel). Under dynamic B_0 the relative stock status falls below the target reference point (B_{48}) initially in the late 1960s, then recovers to values just above B_{48} in the early 1970s, then in 1981 falls below B_{48} and stays below B_{48} until the end of the time series. Relative to the limit reference point (B_{20}), the relative stock status under dynamic B_0 drops below the B_{20} from 2013-2015, and then increases to above (B_{20}) at the end of the time series (2020 in this case). This series is in stark contrast to the relative depletion series estimated using the productivity shift, where stock status is not estimated to fall below the target reference point until 2003, then falling below the limit reference point in 2013, the same year as estimated using dynamic B_0 (Figure 7.24, lower plot). Stock status using the productivity shift is then estimated to stay below the limit reference point until 2022, when it is projected to recover to a value greater than B_{20}, seven years after the population was estimated to recover to a value greater than B_{20} under dynamic B_0 (Figure 7.24).

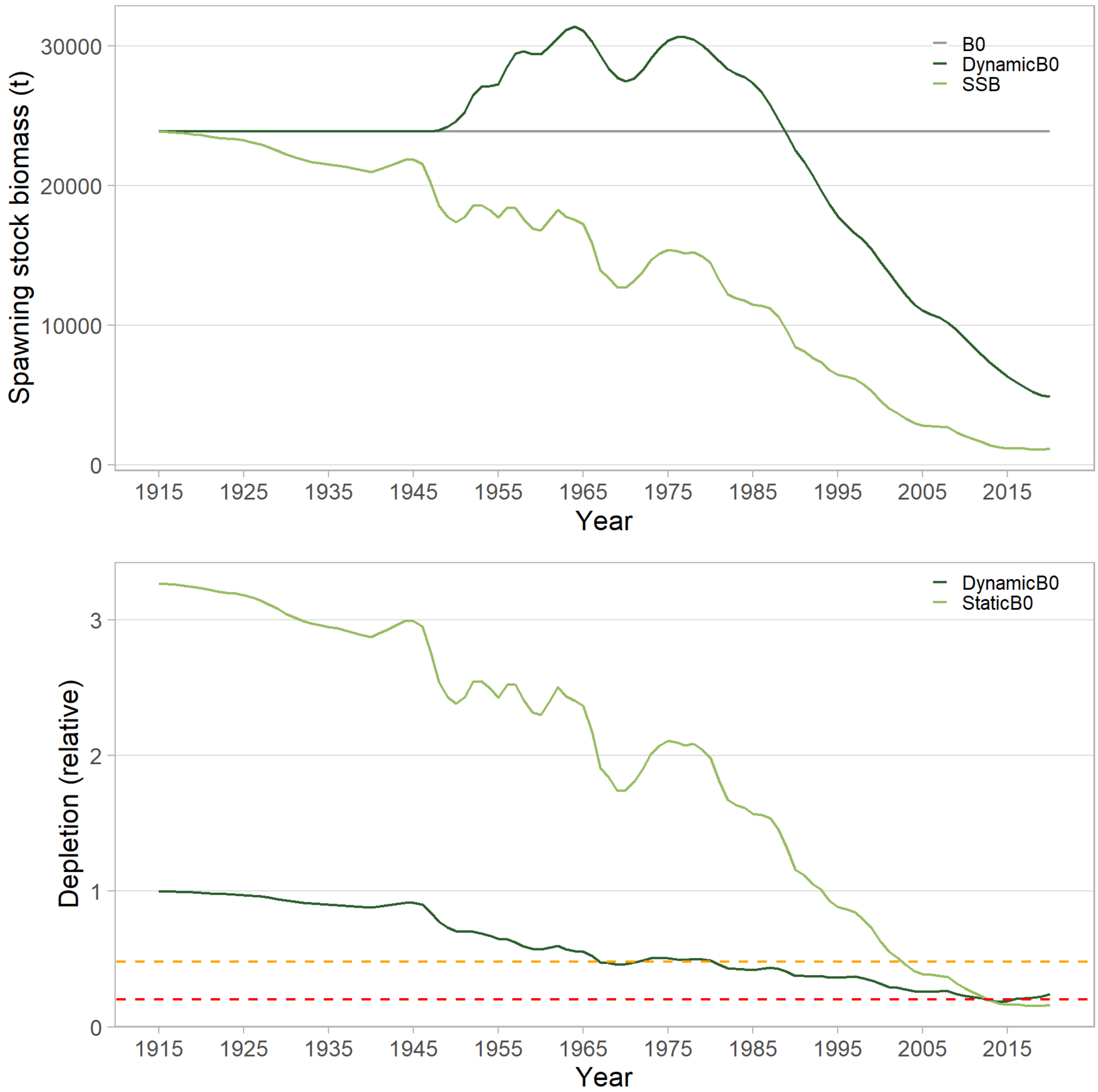

Figure 7.24. Dynamic B_0 for Jackass Morwong: spawning stock biomass (top) showing the trajectory of "dynamic B_0" (dark green) and the preliminary base case model predicted spawning stock biomass (light green), and; stock status (bottom) showing the trajectory of relative stock status, with a productivity shift implemented as a step function in 1988, under static B_0 (light green) and under dynamic B_0 (dark green). The orange dashed line is the target reference point (B_{48}) and the red dashed line is the limit reference point (B_{20}).

7.7 Future work and unresolved issues

There are still some unresolved issues relating to allocation of recent state catches for the period 2014-2020 between eastern and western fleets, especially for Tasmanian and Victorian state catches, but these catches are relatively small compared to other catches in the same period, and any future revisions are unlikely to have a noticeable influence on the assessment outcomes. Some of these catches are currently masked, with assumptions made about this catch data, due to concerns about use of confidential data and the five-boat rule. Ideally, appropriate use of the actual data will be negotiated for future assessments, ensuring that the confidentiality requirements of the data owners are respected. It would be good to resolve these issues to ensure the best possible data is available for use in the future stock assessments.

There are also some unresolved issues relating to NSW state catches in the period 1986-1999. In 2007, an attempt was made to account for double counting (i.e. recording catches in both state and Commonwealth logbooks) catches reported to NSW state in the period 1986-2009 (Kevin Rowling, pers comm. 2021, Sally Wayte, pers. comm. 2021). While the details are not fully documented in the relevant stock assessment reports, and alternative catch series could be constructed for this period using different assumptions to account for double counting, it appears that the changes to these potential catch series would be relatively small. Larger revisions to the catch history back to 1986 incorporated in Bridge 2 in 2021 had very little impact on both the spawning biomass time series and the recruitment estimates (Figure 7.13 and Figure 7.14), so it is likely such revisions would have no material impact on the assessment results.

There appear to be convergence issues with the updated ageing error matrix, relating to potential outliers in the data. This requires further investigation.

Any results from this assessment should be treated with some caution given the recent data quality available for this assessment and the quality of the eastern trawl CPUE data. Sporcic (2021) state that "The structural adjustment altered the effect of the vessel factor on the standardised result. However, log(CPUE) has also changed in character from 2014 - 2020, with spikes of low catch rates arising" and "Annual standardized CPUE has been below the long-term average since about 2000 with apparent periodicity. Both the recorded catch (36.6 t) and number of records (956) in 2020 were the lowest in the series."

Note that the preliminary base case model fit to the FIS abundance indices are generally poor (Figure 7.22 and Figure 7.23), although these are considerably improved for the Eastern FIS series in the final step of Bridge 2, when the FIS2 series is used, with additional CVs on these abundance series estimated within the model at 0.37 and 0.59 respectively for the MOW2021_Tuned step of the bridging (slightly smaller than the values estimated in the 2018 assessment), and then 0.003 and 0.62 respectively, for the MOW2021_FIS_Tuned step of the bridging. The additional CV estimated to the eastern trawl CPUE index was 0.11, with a negative value estimated for all other CPUE indices, indicating the initial CV values were too broad for these other fleets.

7.8 Acknowledgements

Age data were provided by Kyne Krusic-Golub (Fish Ageing Services), ISMP and AFMA logbook and CDR data were provided by John Garvey (AFMA). Mike Fuller, Paul Burch, Robin Thomson, Roy Deng, Franzis Althaus, Toni Cannard and Caroline Sutton (CSIRO) were all involved in pre-processing the data. Malcolm Haddon provided useful code for auto-tuning, Athol Whitten provided useful R code for organising plots. André Punt, Paul Burch and Sandra Curin-Osorio provided an updated ageing error matrix. André Punt, Geoff Tuck, Miriana Sporcic, Sandra Curin-Osorio, Paul Burch, Robin Thomson and Brett Stacy and are thanked for helpful discussions on this work. Ian Taylor, Richard Methot and Chantel Wetzel (NOAA Fisheries) are thanked for all the Stock Synthesis support and advice. The r4ss package maintained by Ian Taylor (https://github.com/r4ss/r4ss) was critical for producing multiple diagnostic plots, and tuning models. Geoffrey Liggins contributed to useful discussions on the catch history.

7.9 References

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7.10 Appendix A

7.10.1 Preliminary base case diagnostics

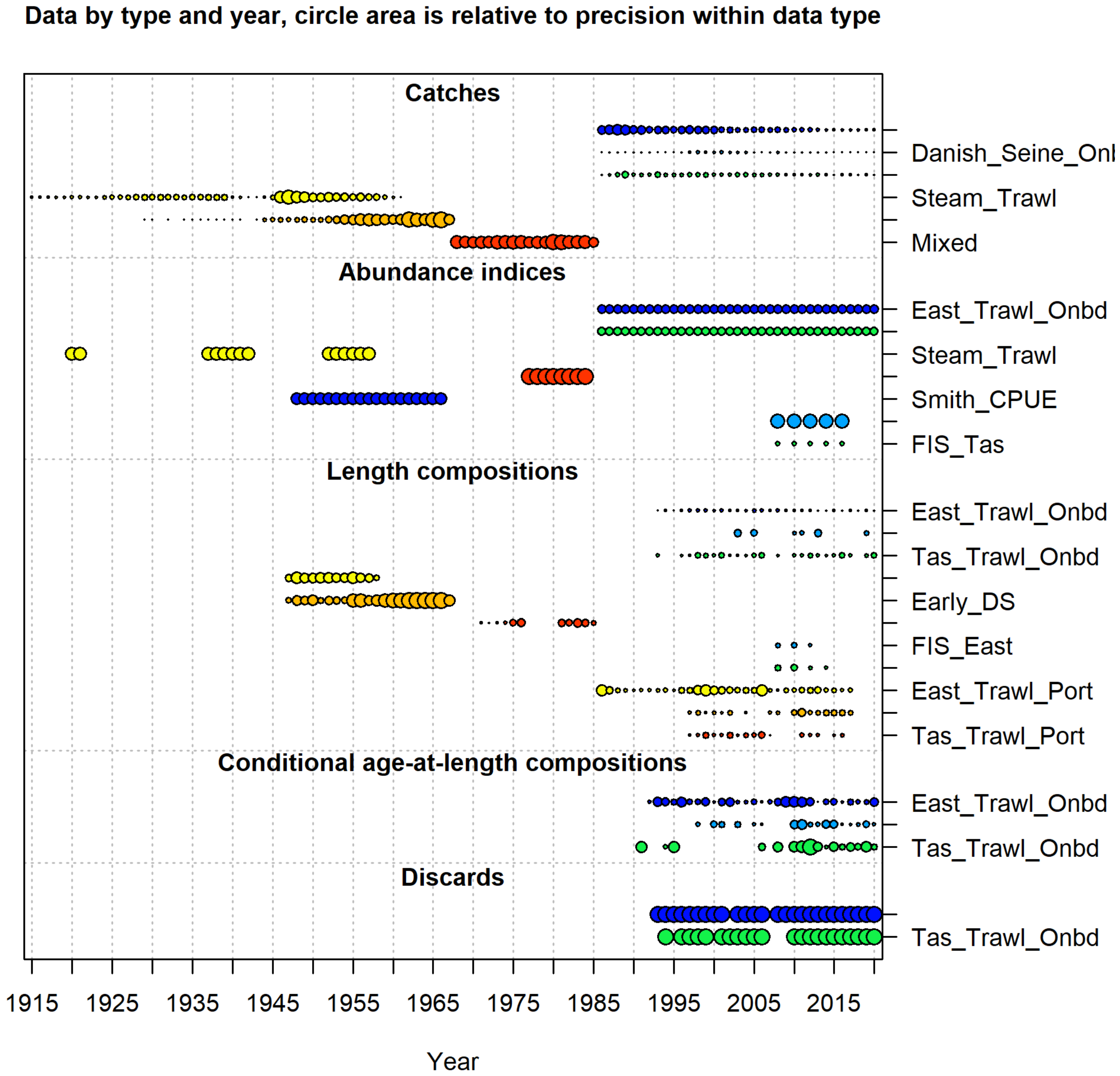


Figure A 7.1. Summary of data sources for eastern Jackass Morwong stock assessment.

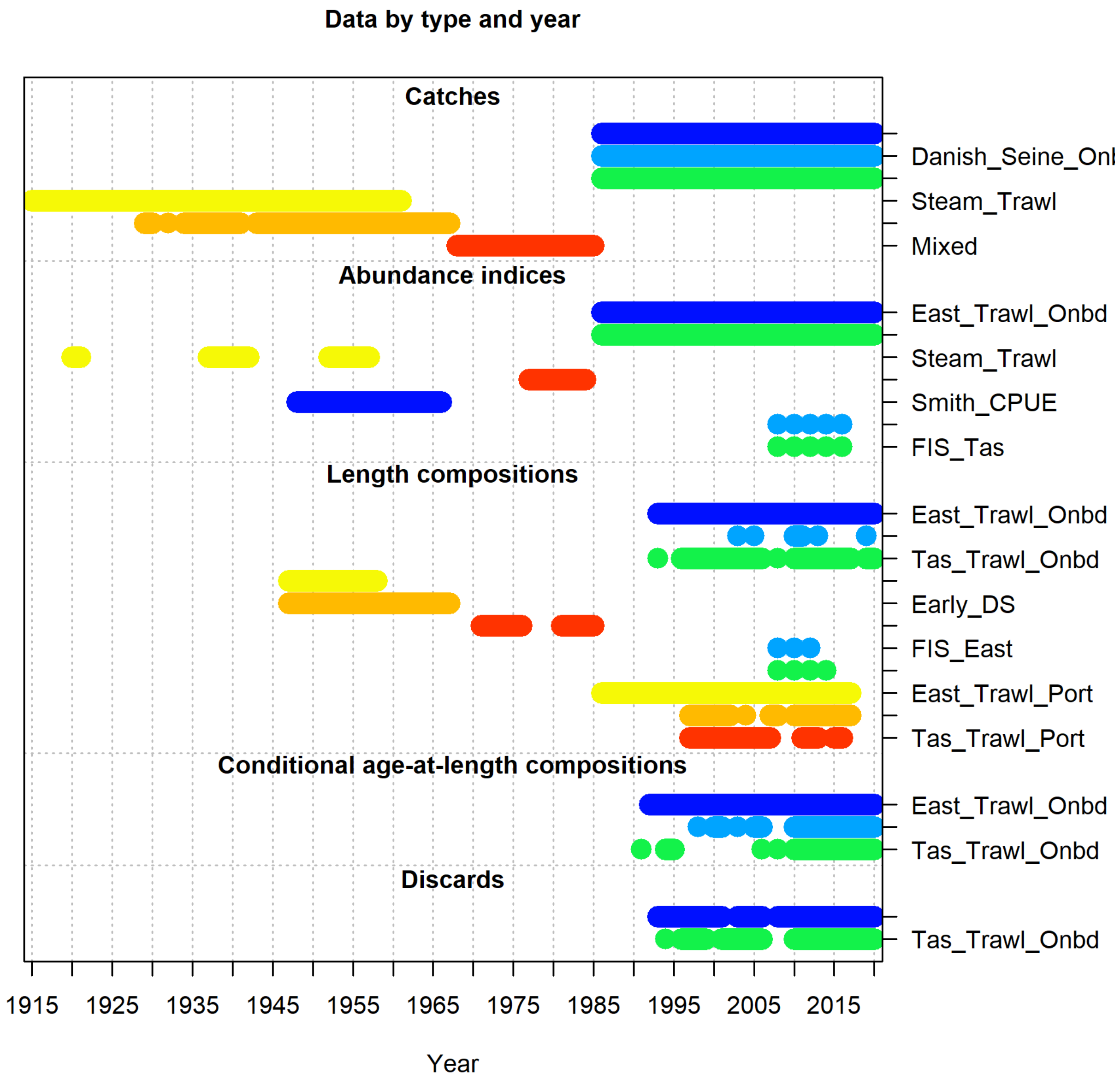


Figure A 7.2. Summary of data sources for eastern Jackass Morwong stock assessment.

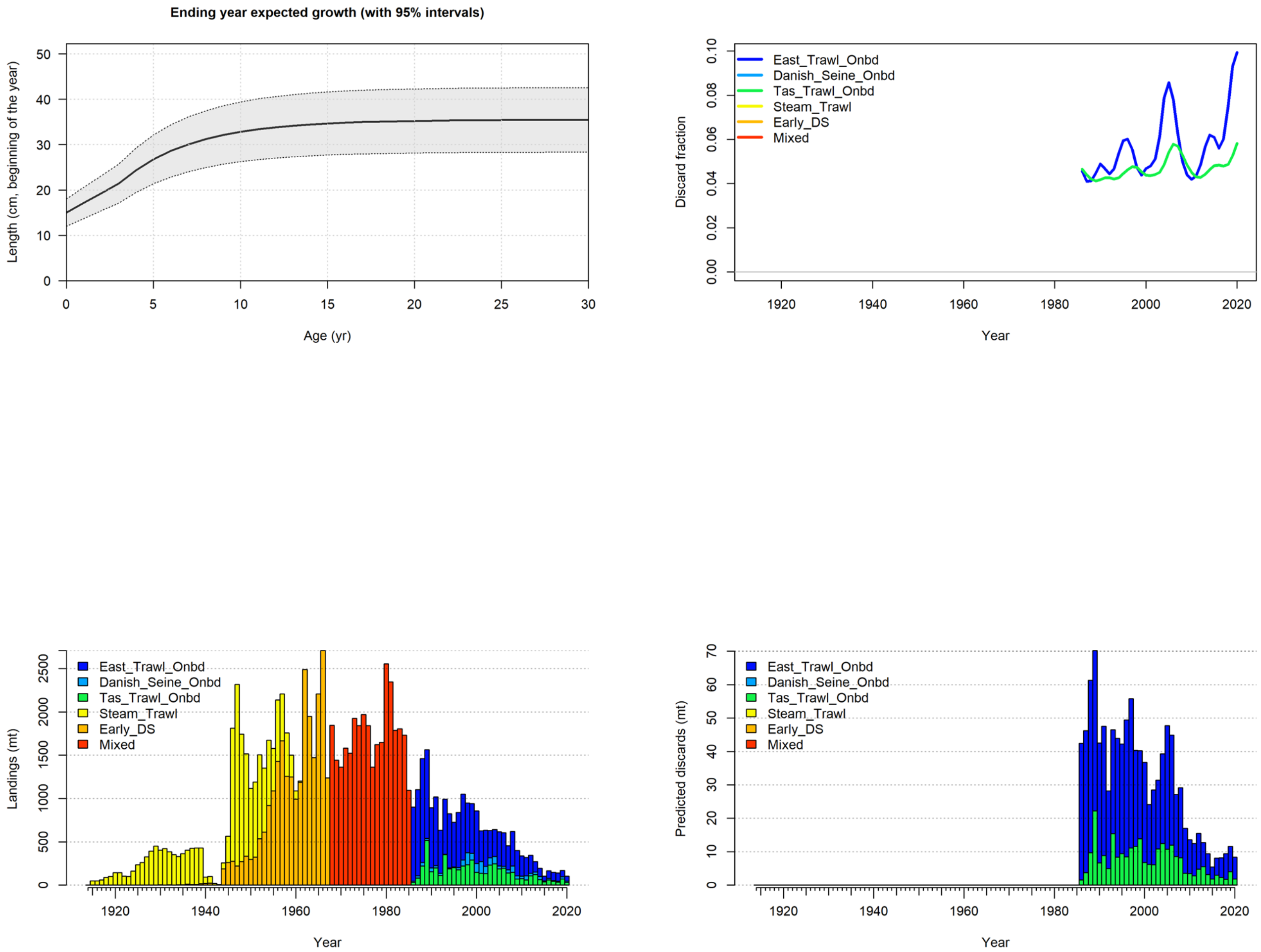


Figure A 7.3. Growth, discard fraction estimates, landings by fleet and predicted discards by fleet for eastern Jackass Morwong.

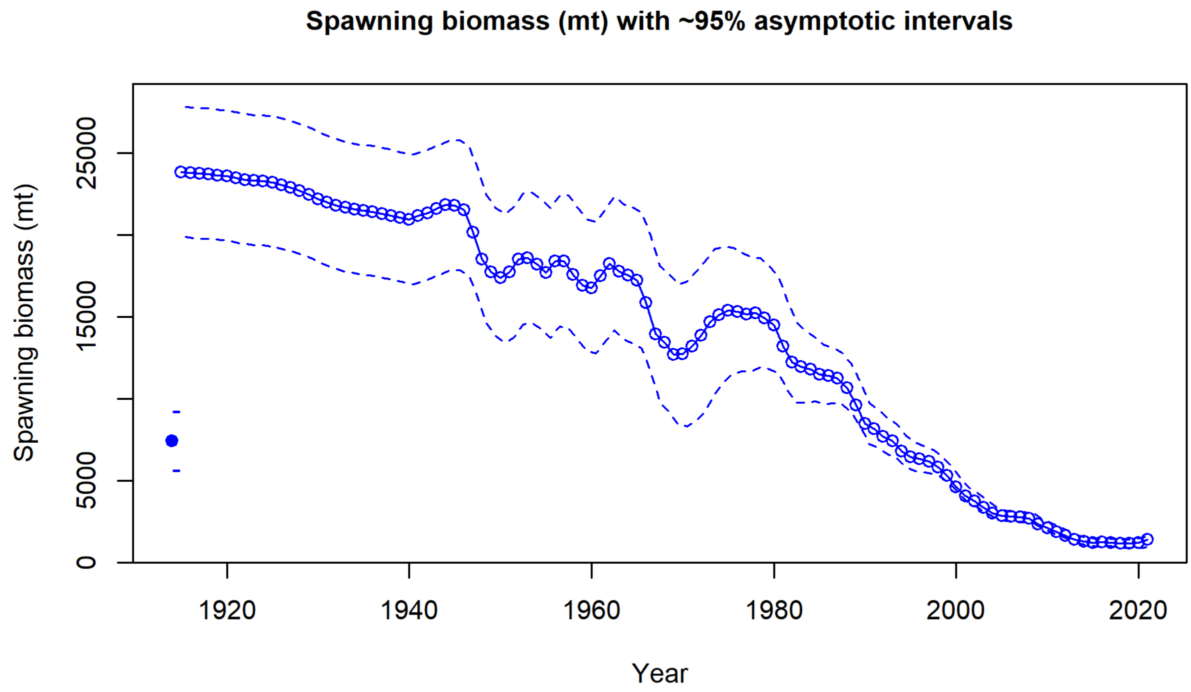


Figure A 7.4. Time series showing absolute spawning biomass with confidence intervals.

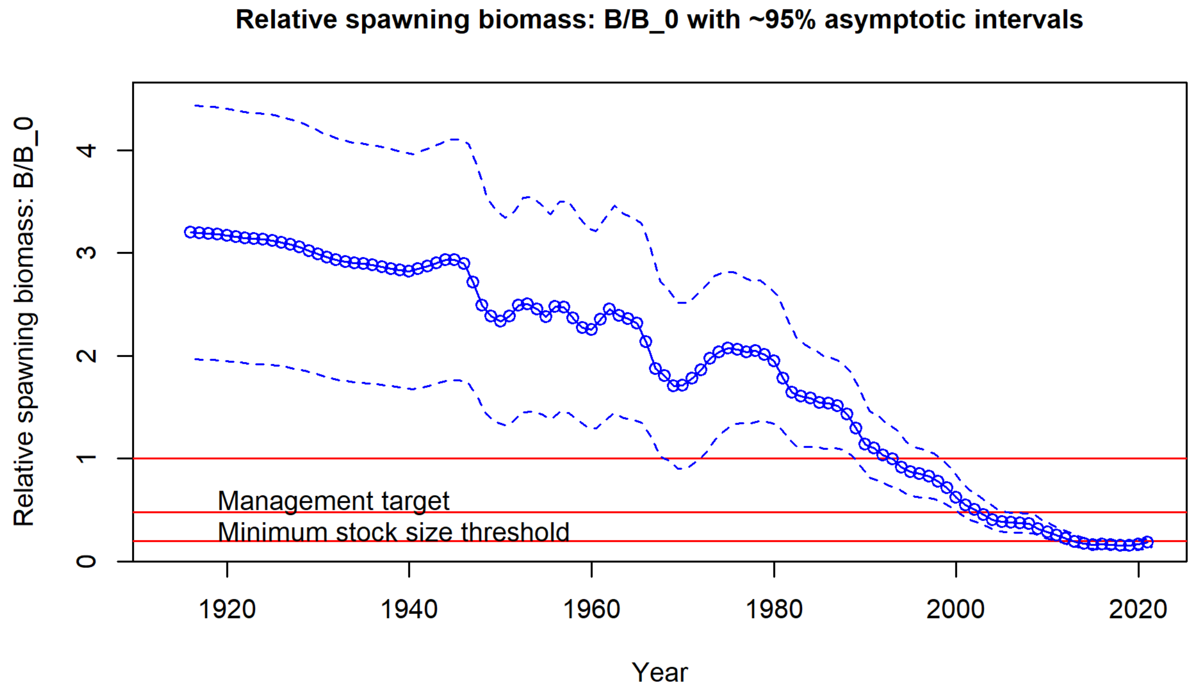


Figure A 7.5. Time series showing relative spawning biomass with confidence intervals.

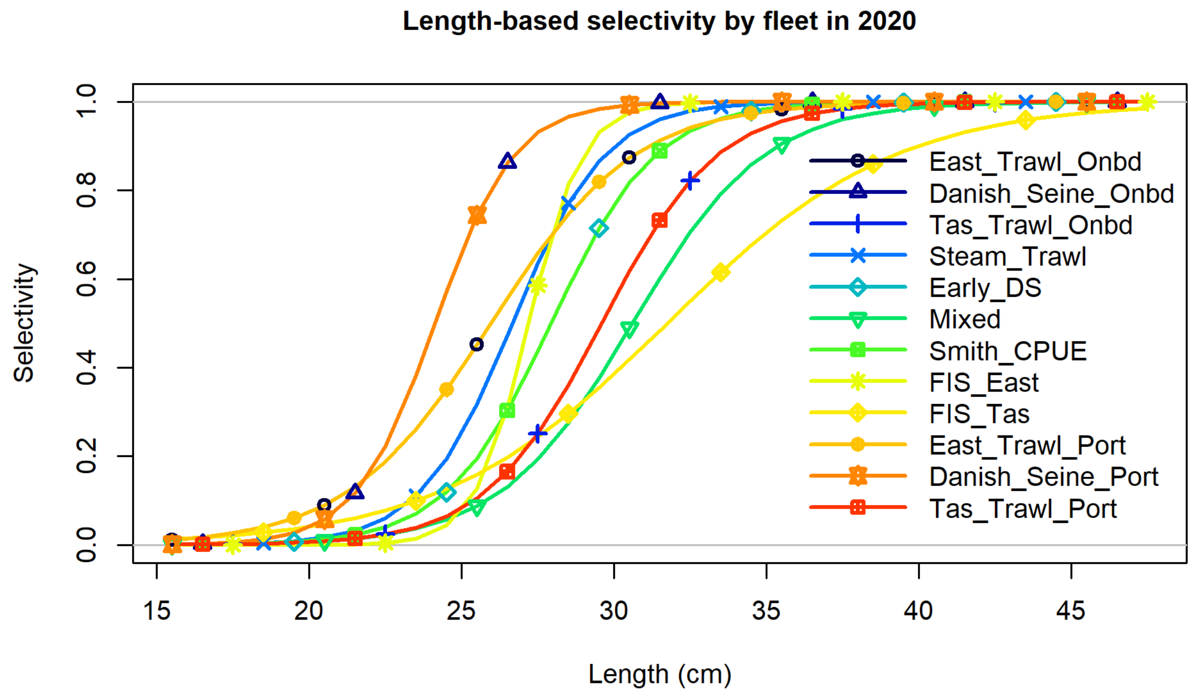
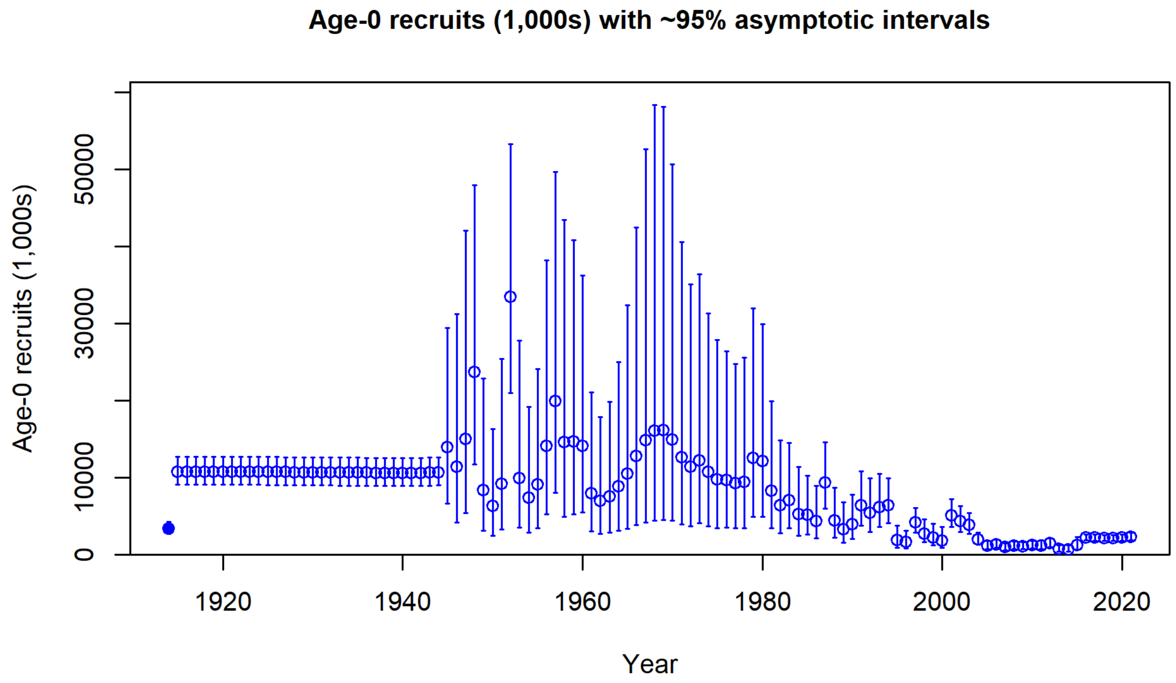


Figure A 7.6. Estimated selectivity and retention curves for eastern Jackass Morwong by fleet.



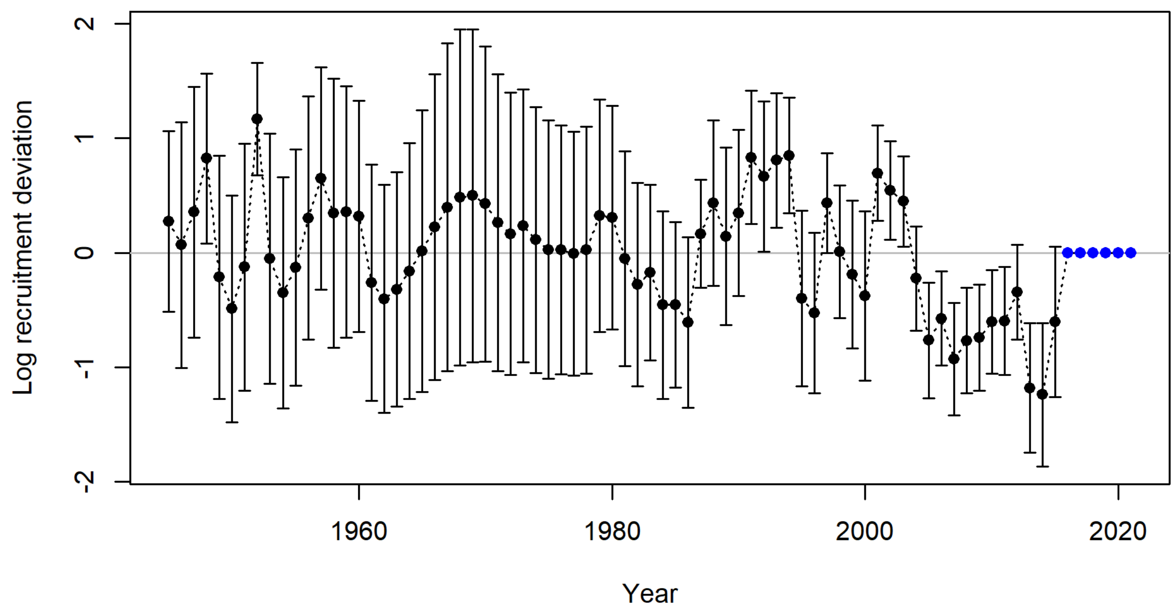


Figure A 7.7. Time series showing absolute recruitment estimates with confidence intervals (top) and recruitment deviations with confidence intervals (bottom) for Jackass Morwong.

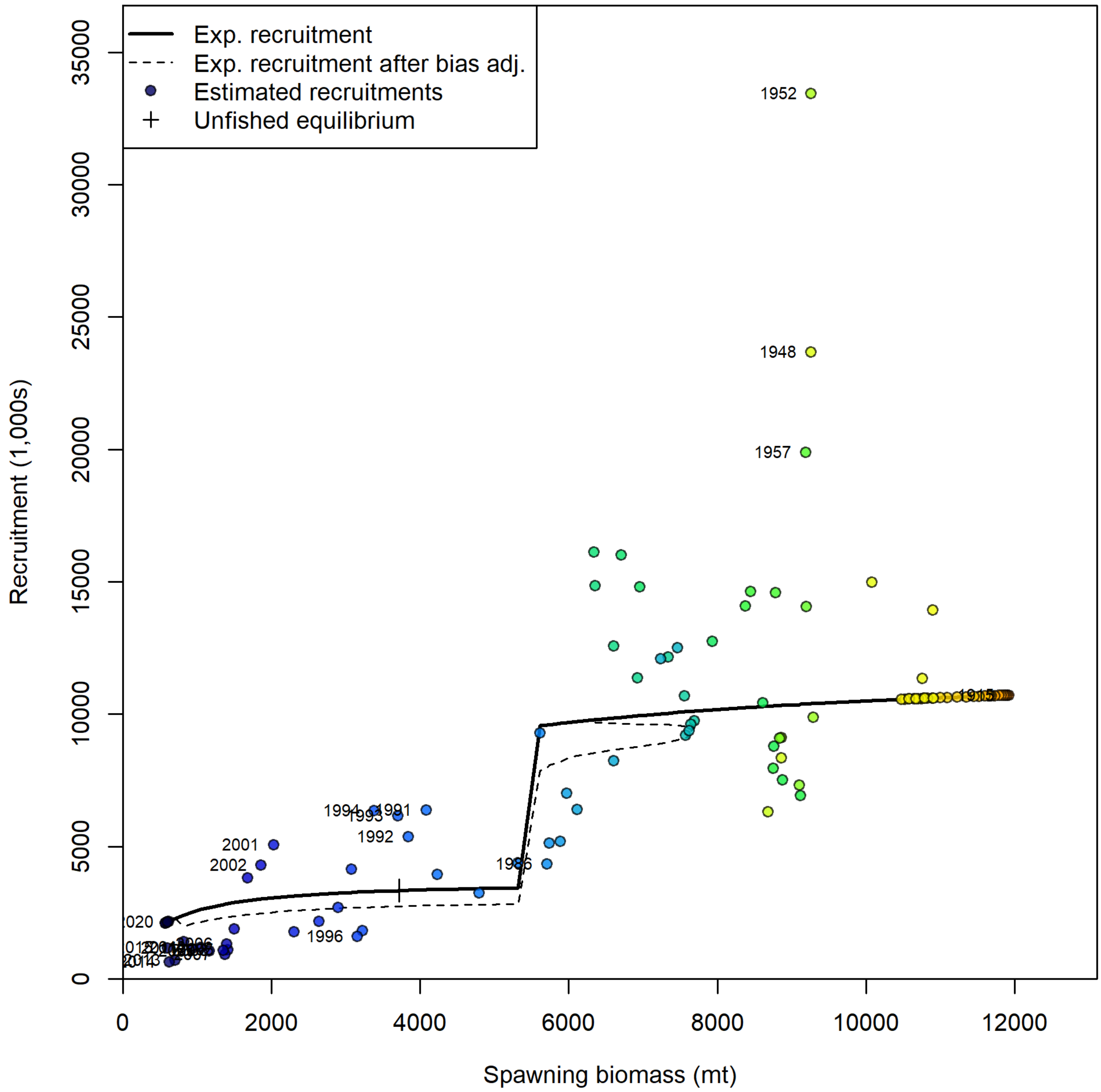


Figure A 7.8. Time series showing stock recruitment curve for Jackass Morwong.

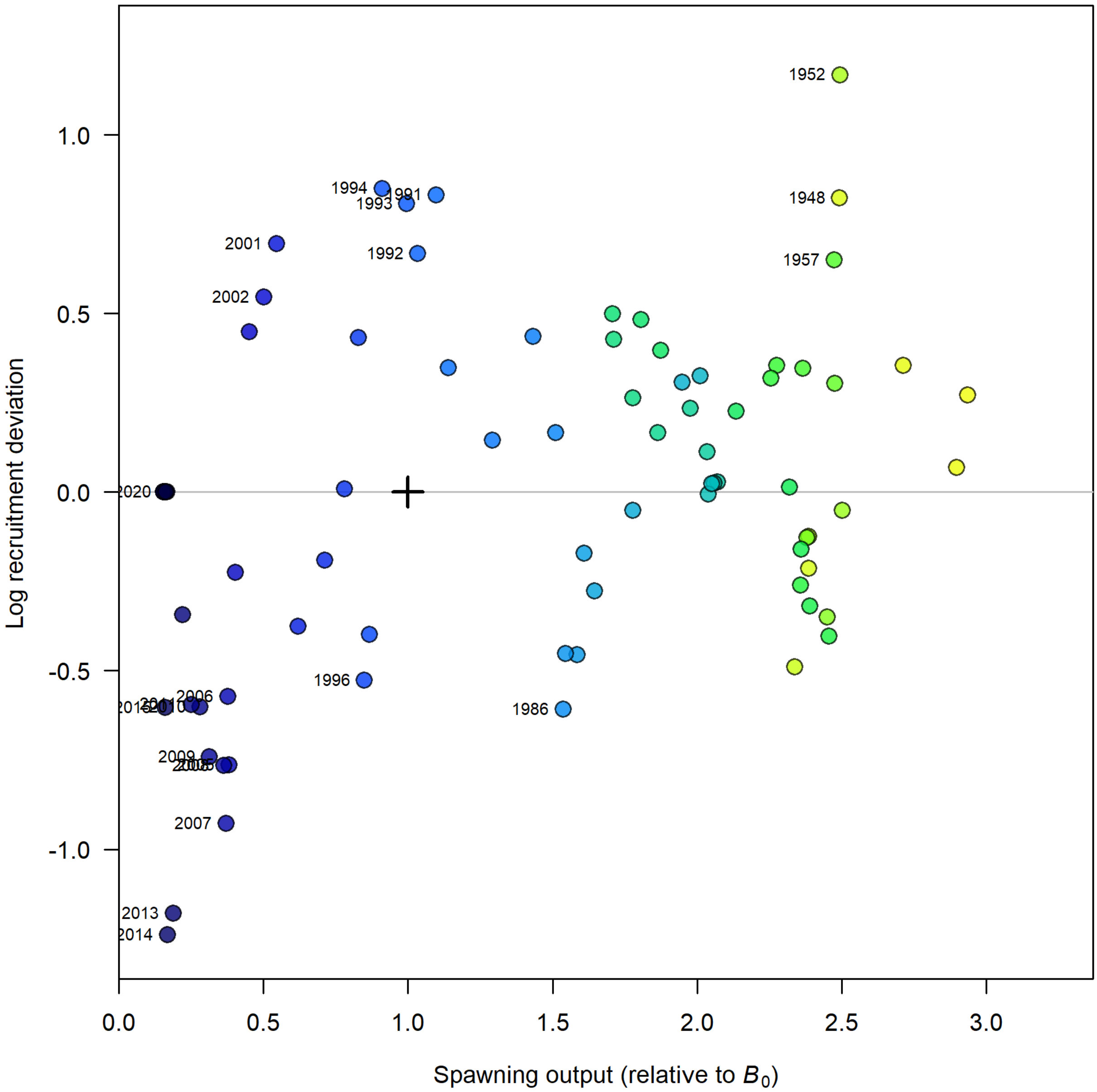


Figure A 7.9. Time series showing stock recruitment deviations for Jackass Morwong.

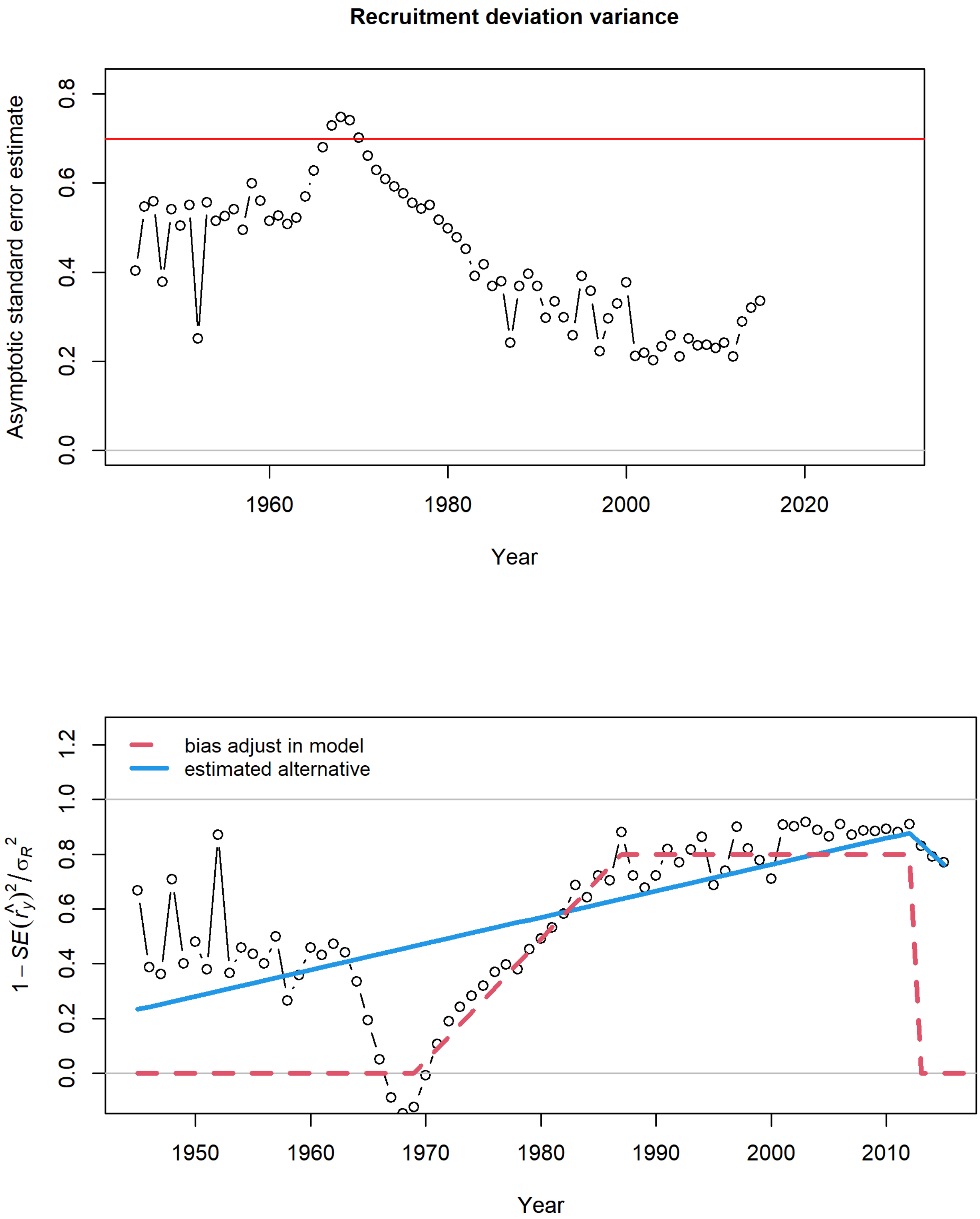


Figure A 7.10. Recruitment deviation variance check and bias ramp adjustment for Jackass Morwong.

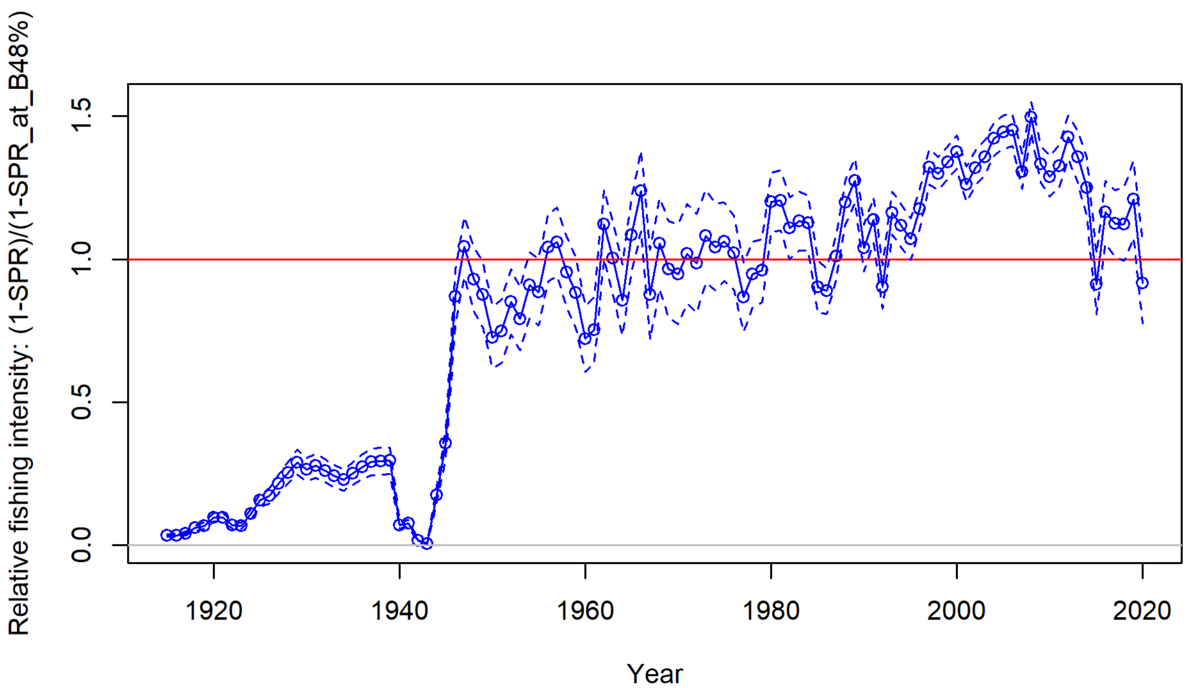


Figure A 7.11. Time series of SPR ratio for Jackass Morwong.

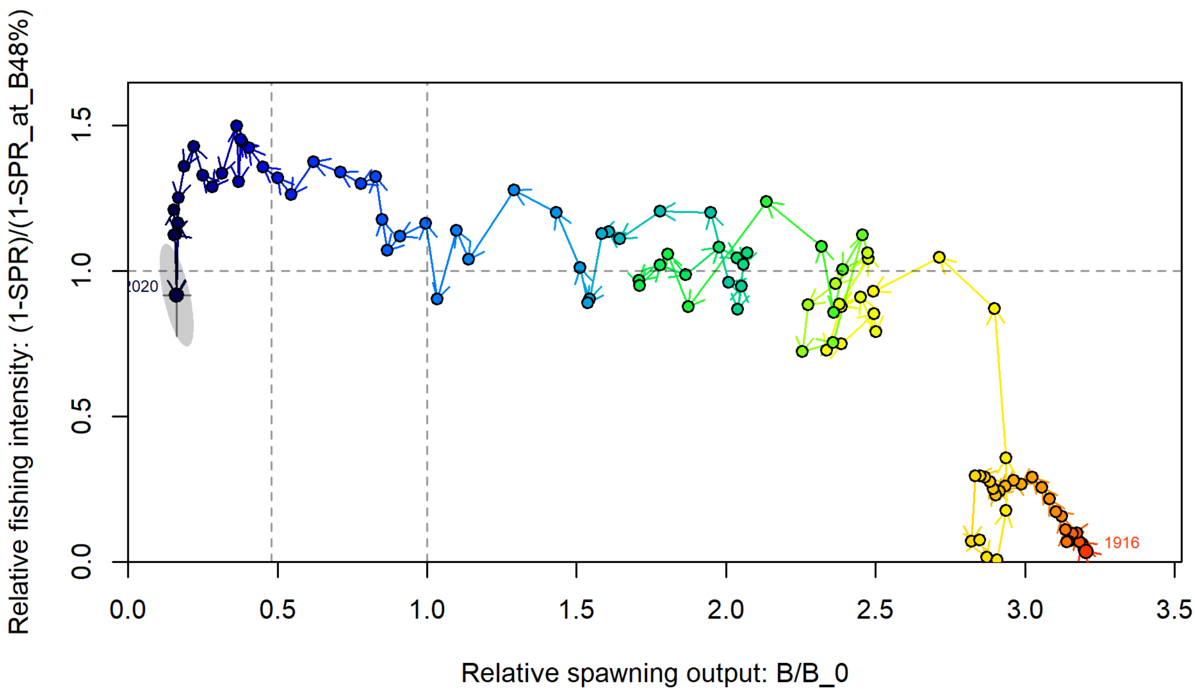


Figure A 7.12. Phase plot of biomass vs SPR ratio for Jackass Morwong.

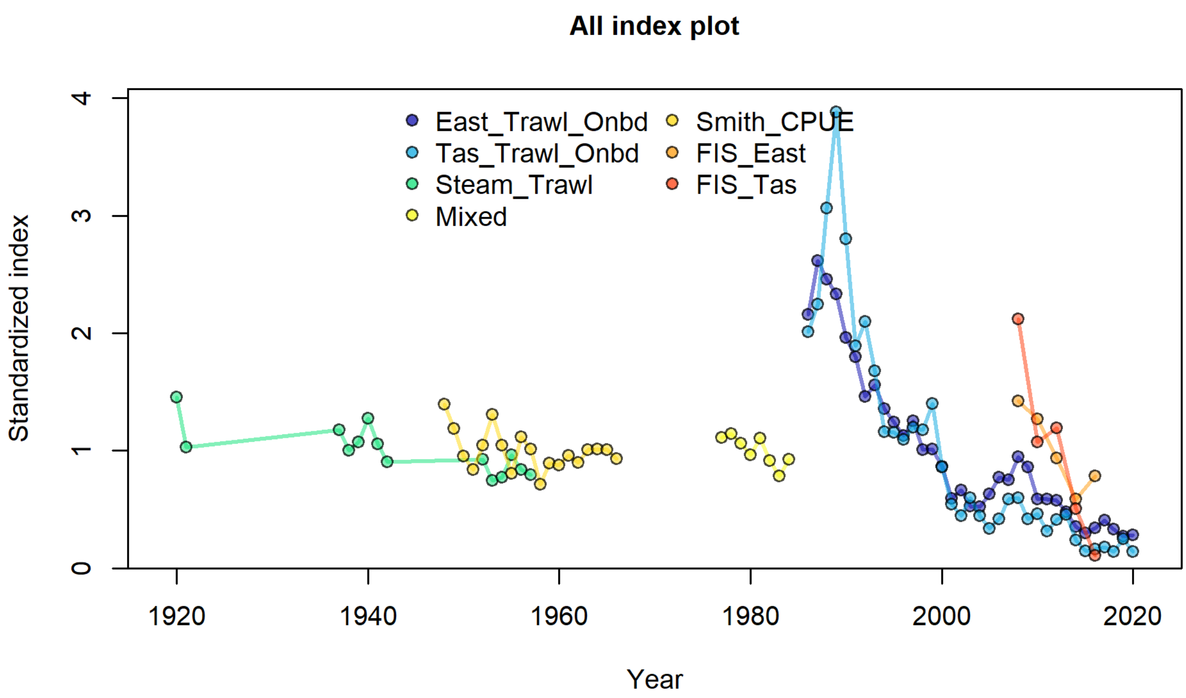


Figure A 7.13. Time series showing all CPUE and FIS abundance series for Jackass Morwong.

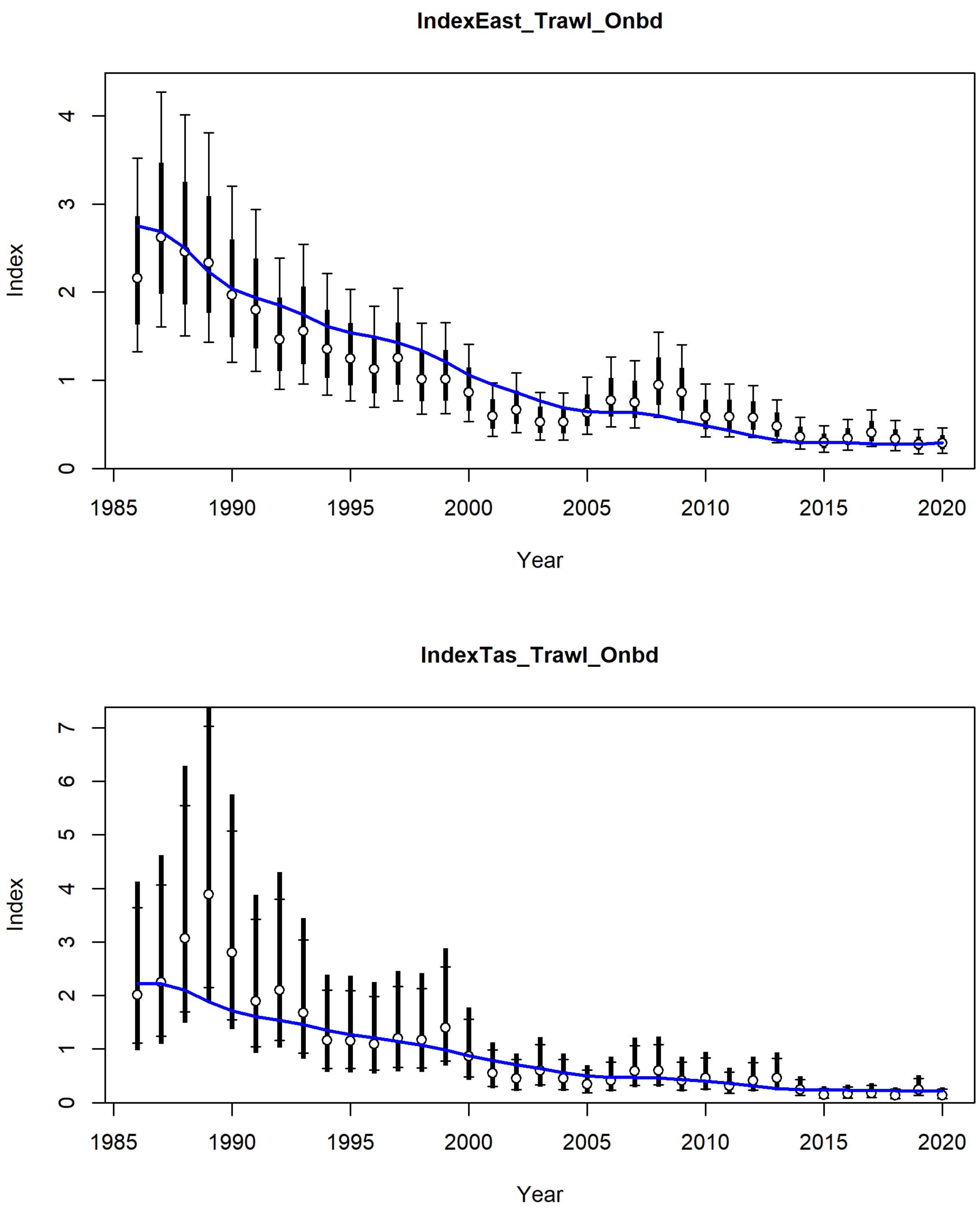
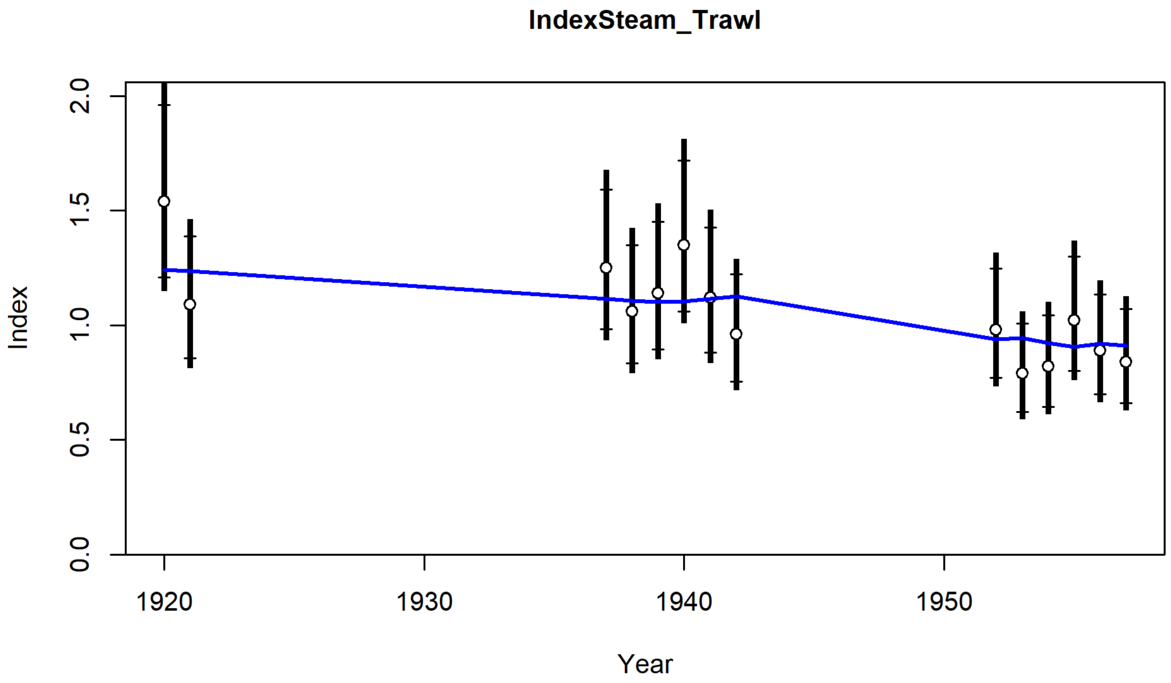


Figure A 7.14. Fits to CPUE by fleet for eastern Jackass Morwong: eastern trawl (top) and Tasmanian trawl (bottom).



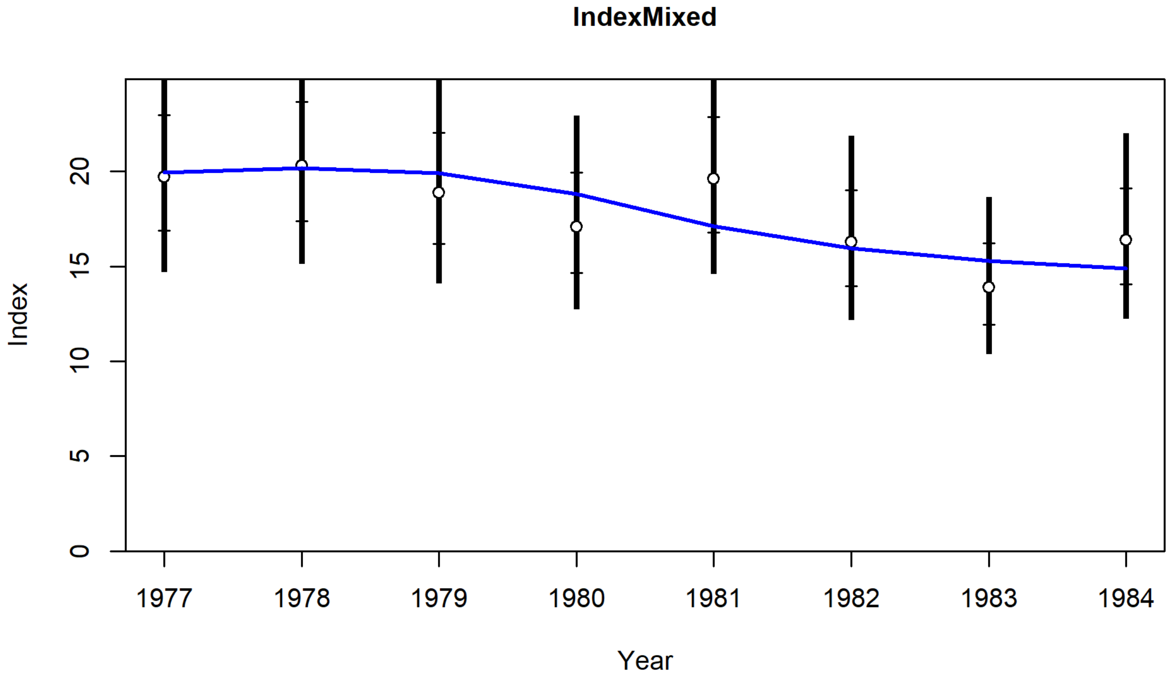


Figure A 7.15. Fits to CPUE by fleet for eastern Jackass Morwong: steam trawl (top) and mixed (bottom).

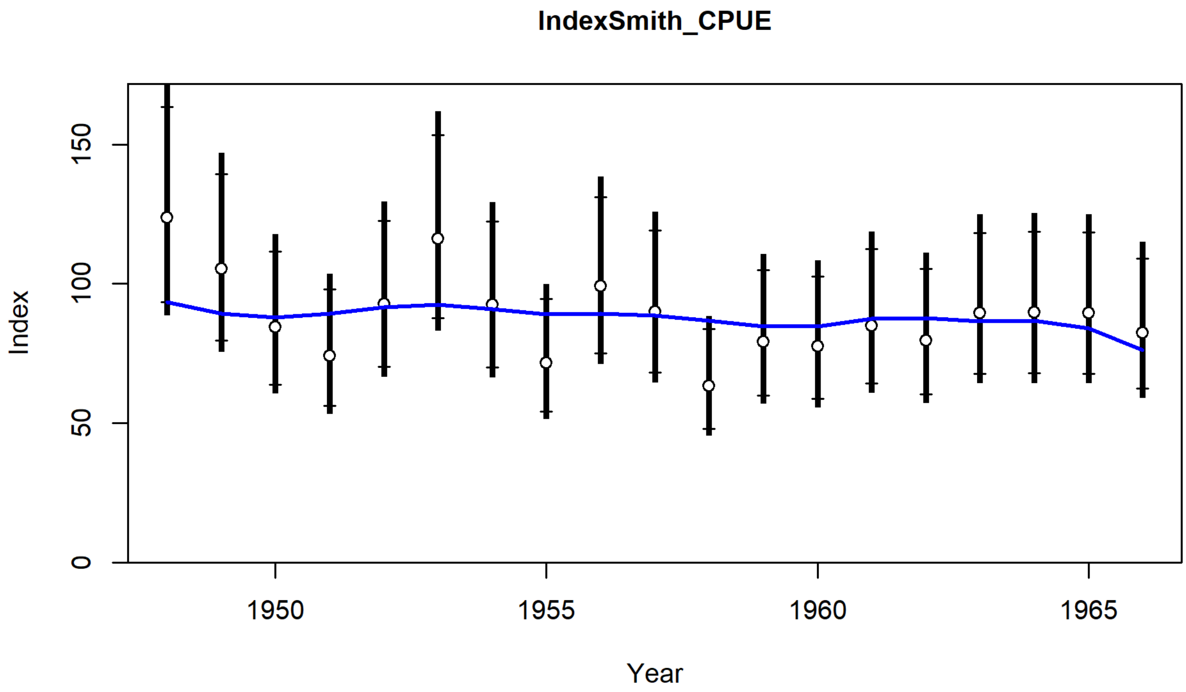


Figure A 7.16. Fits to CPUE by fleet for eastern Jackass Morwong: Smith CPUE.

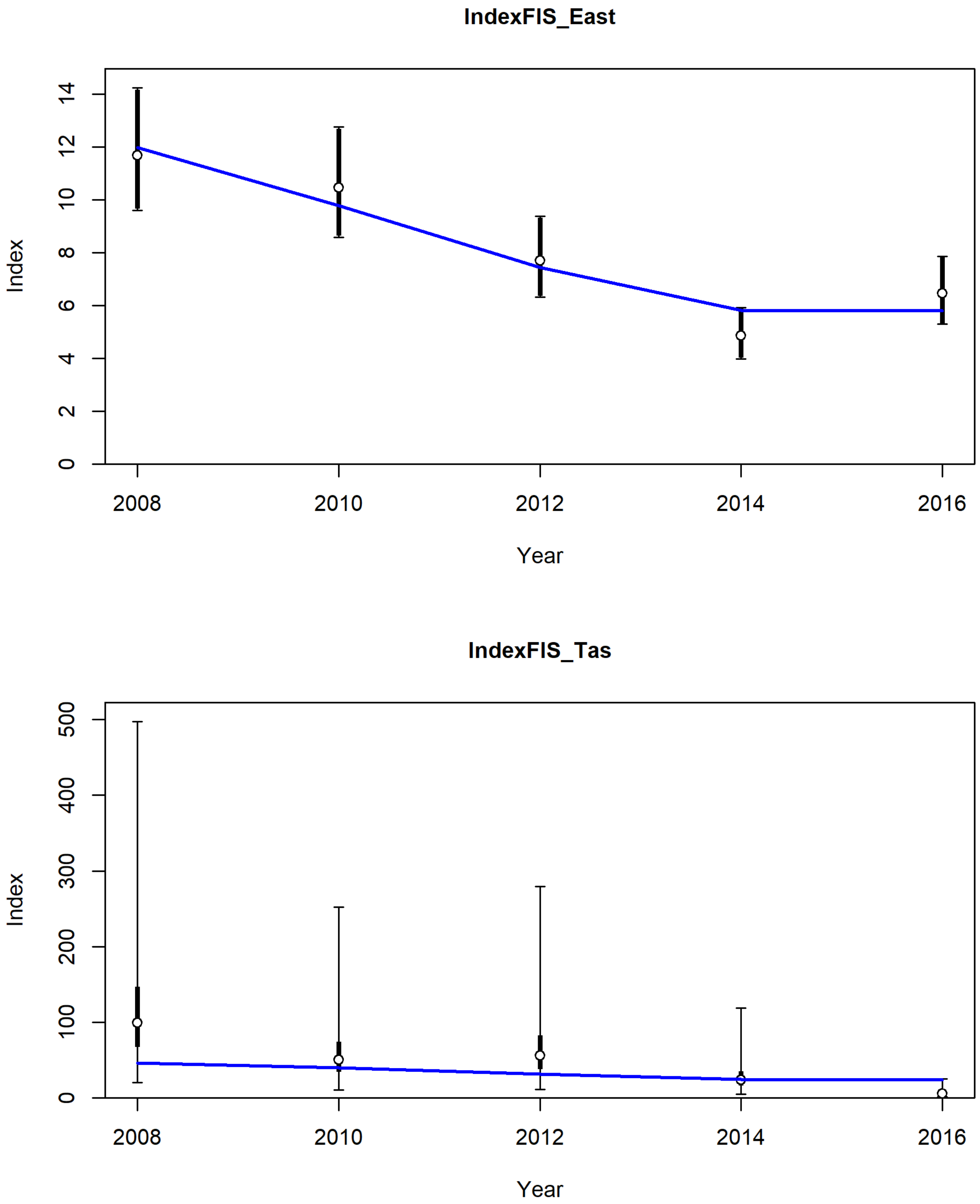
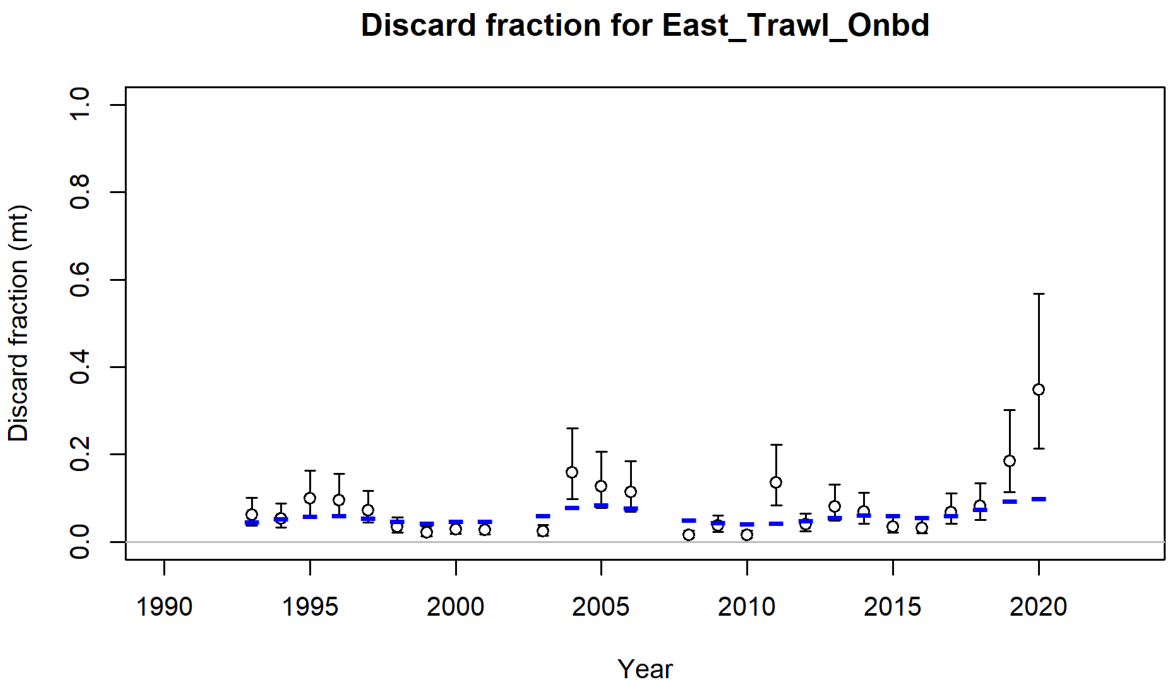


Figure A 7.17. Fits to FIS by fleet for eastern Jackass Morwong: eastern trawl (top) and Tasmanian trawl (bottom).



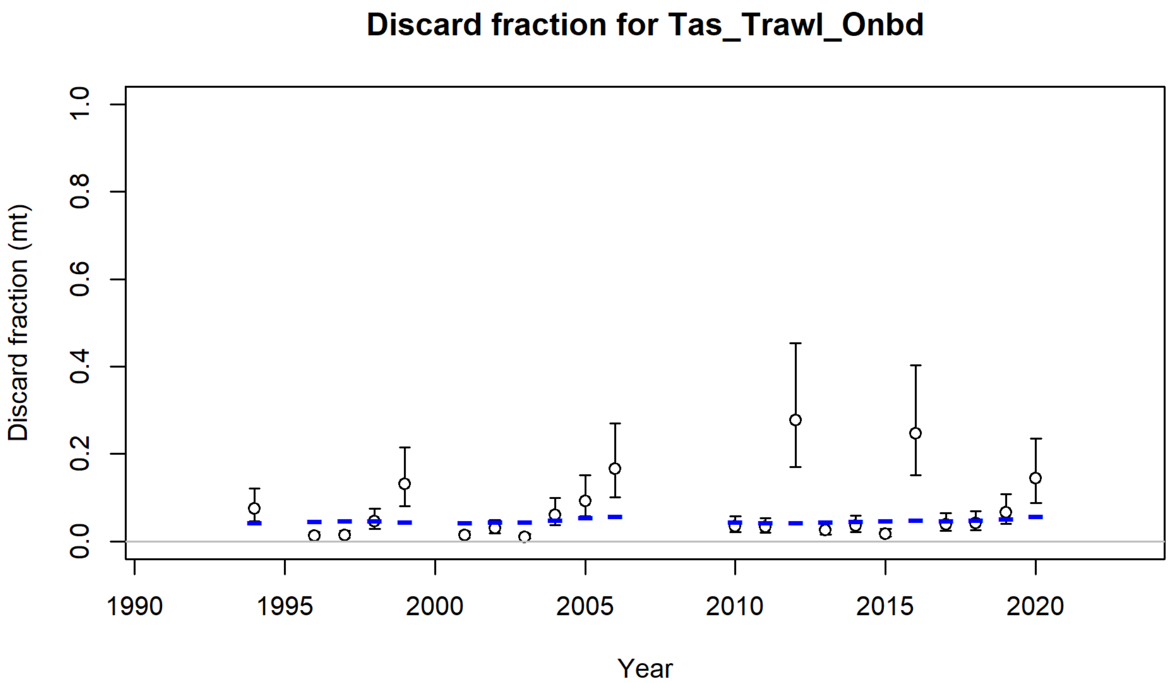


Figure A 7.18. Fits to discard rates for eastern trawl (top) and Tasmanian trawl (bottom) for eastern Jackass Morwong.

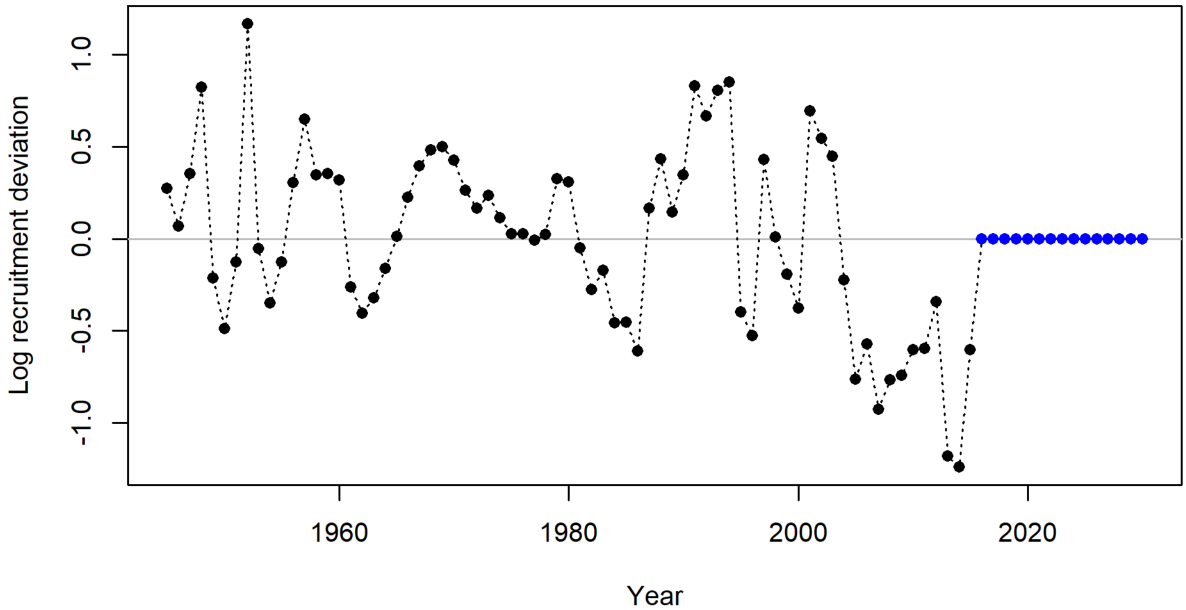


Figure A 7.19. Recruitment deviations for eastern Jackass Morwong.

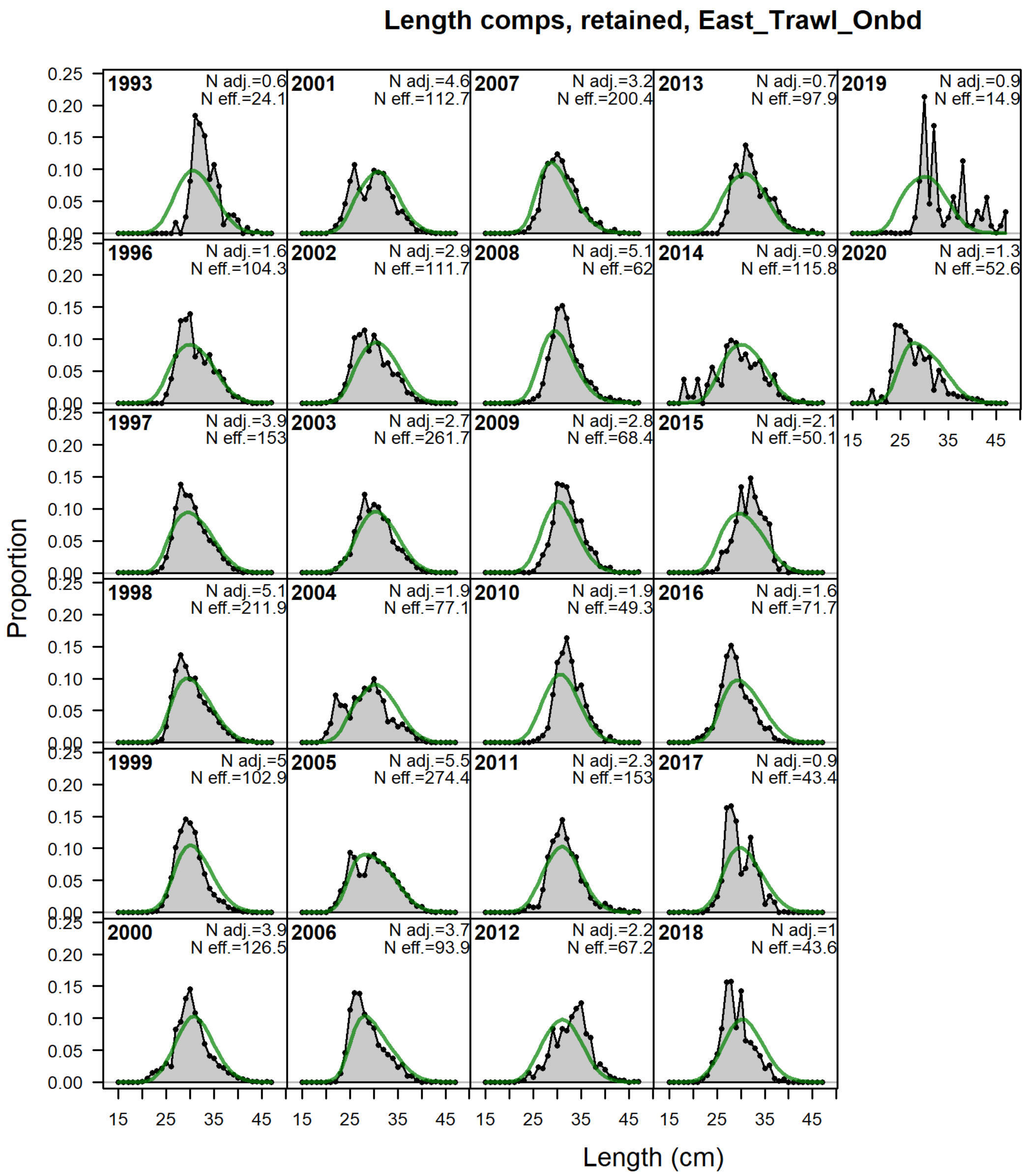


Figure A 7.20. Eastern Jackass Morwong length composition fits: eastern trawl onboard retained.

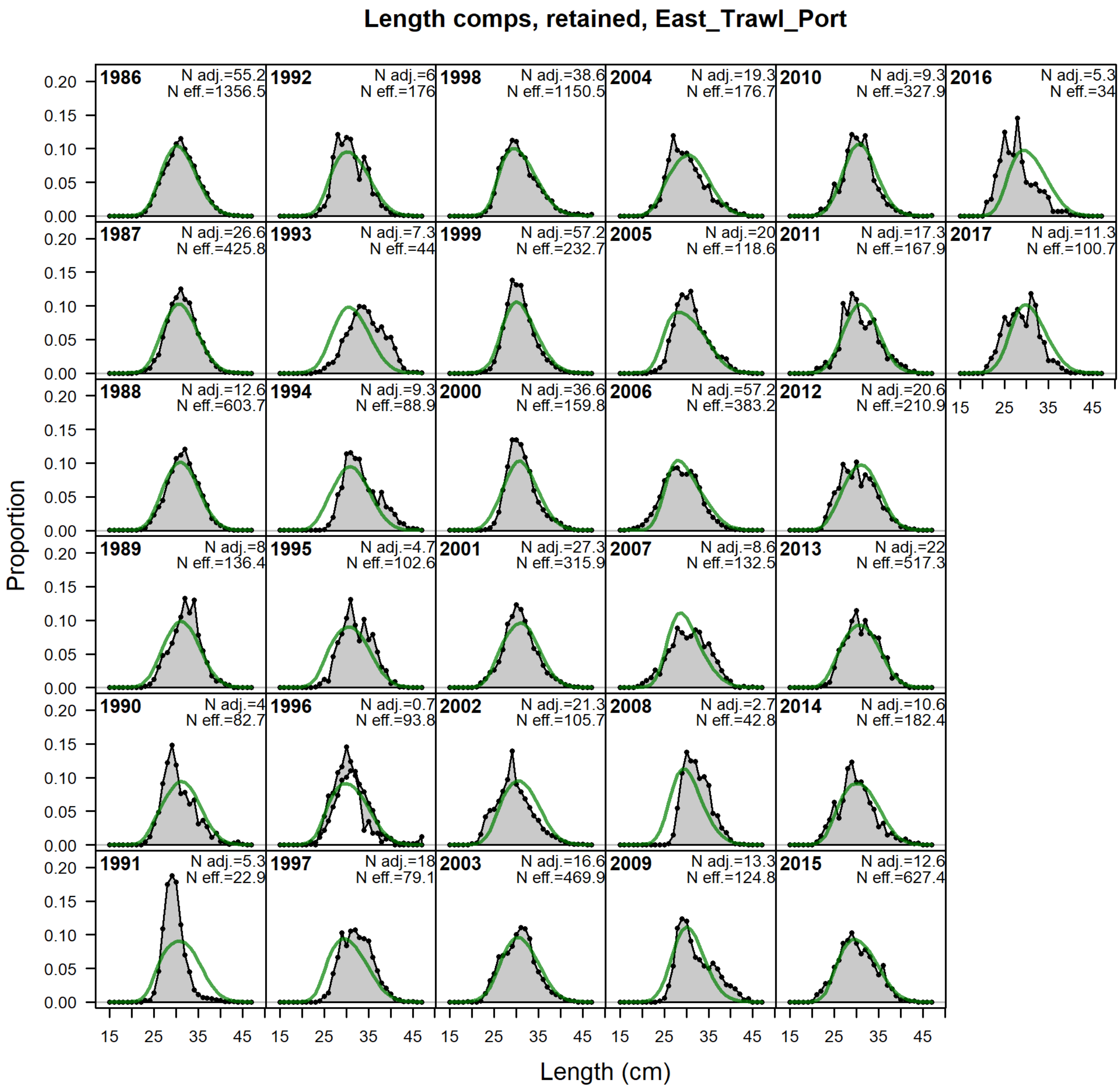


Figure A 7.21. Eastern Jackass Morwong length composition fits: eastern trawl port retained.

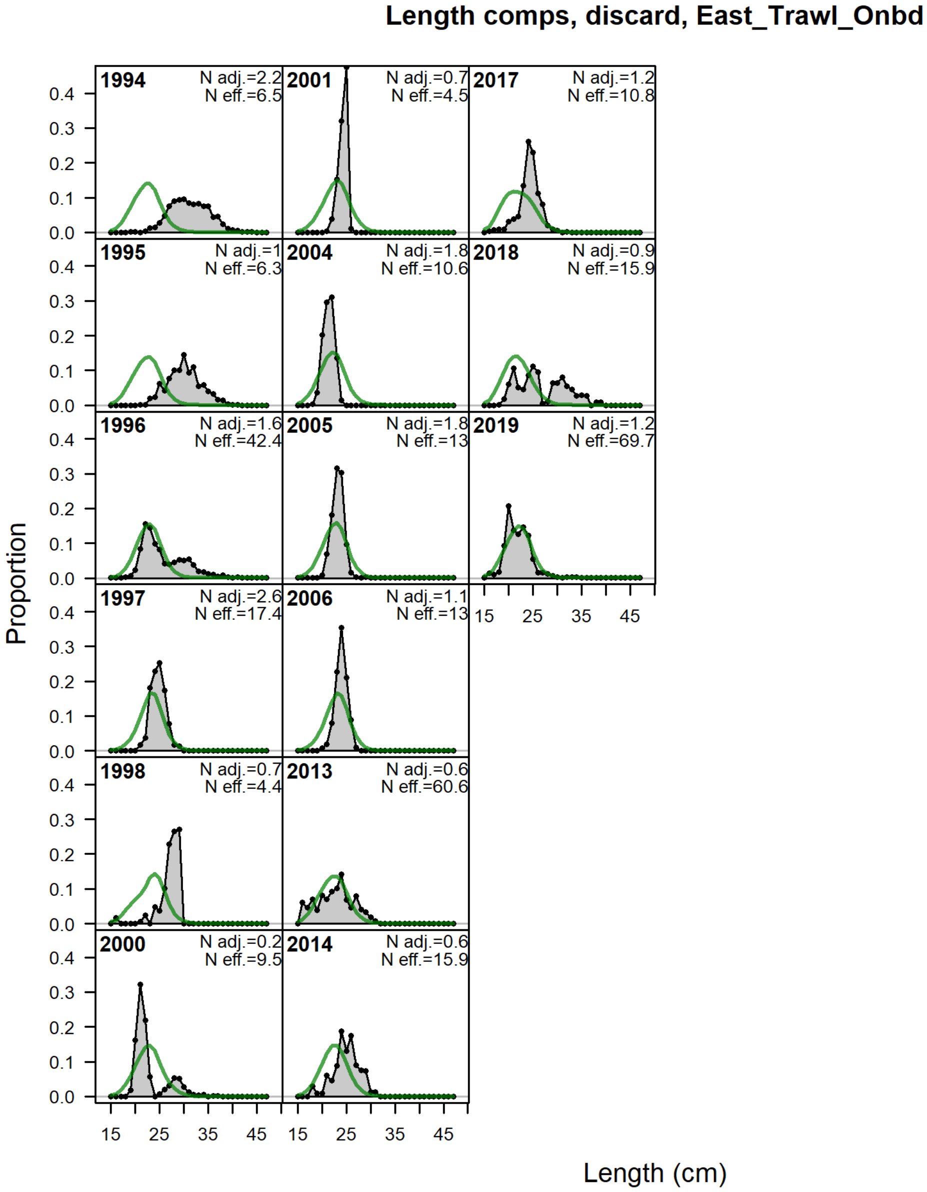


Figure A 7.22. Eastern Jackass Morwong length composition fits: eastern trawl discarded.

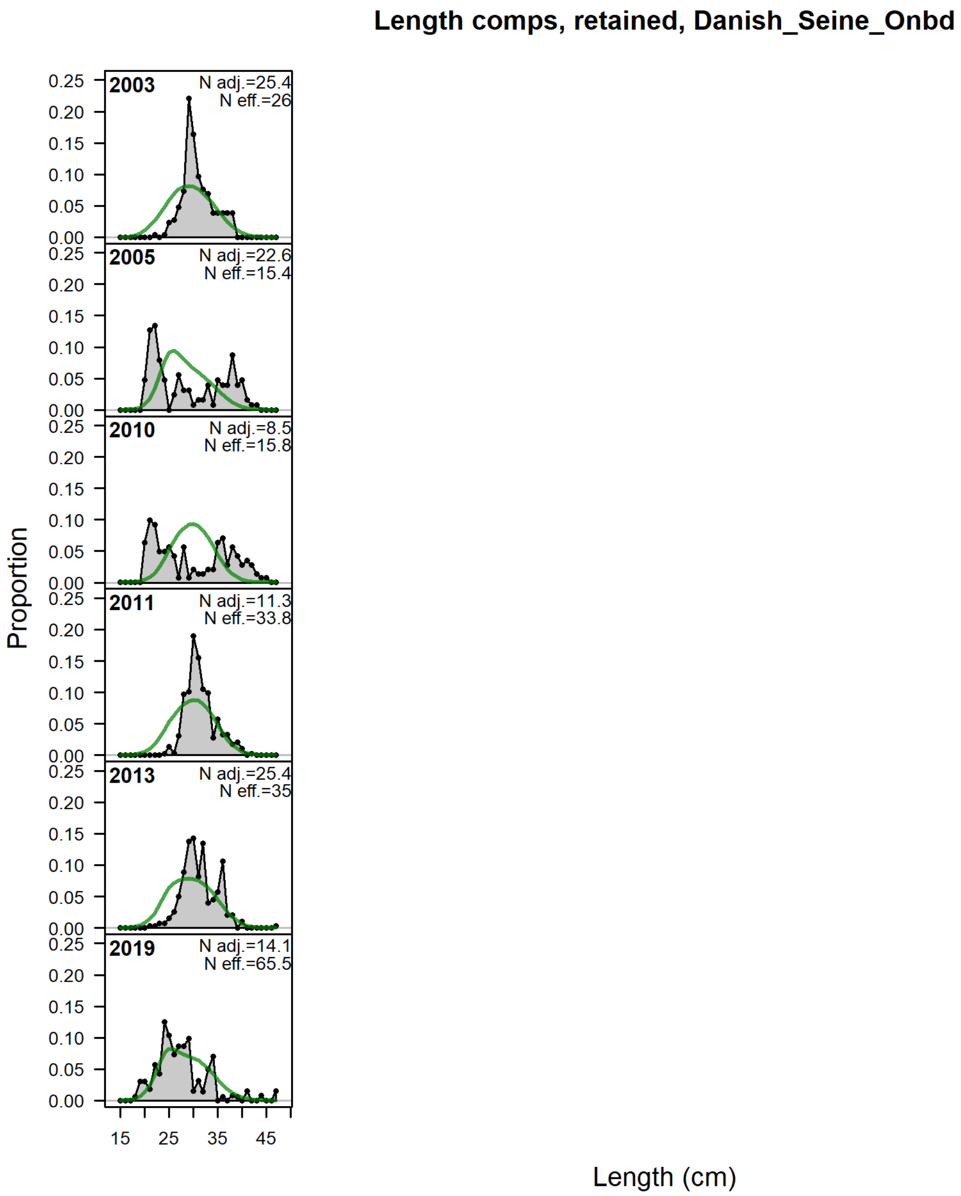


Figure A 7.23. Eastern Jackass Morwong length composition fits: Danish seine onboard retained.

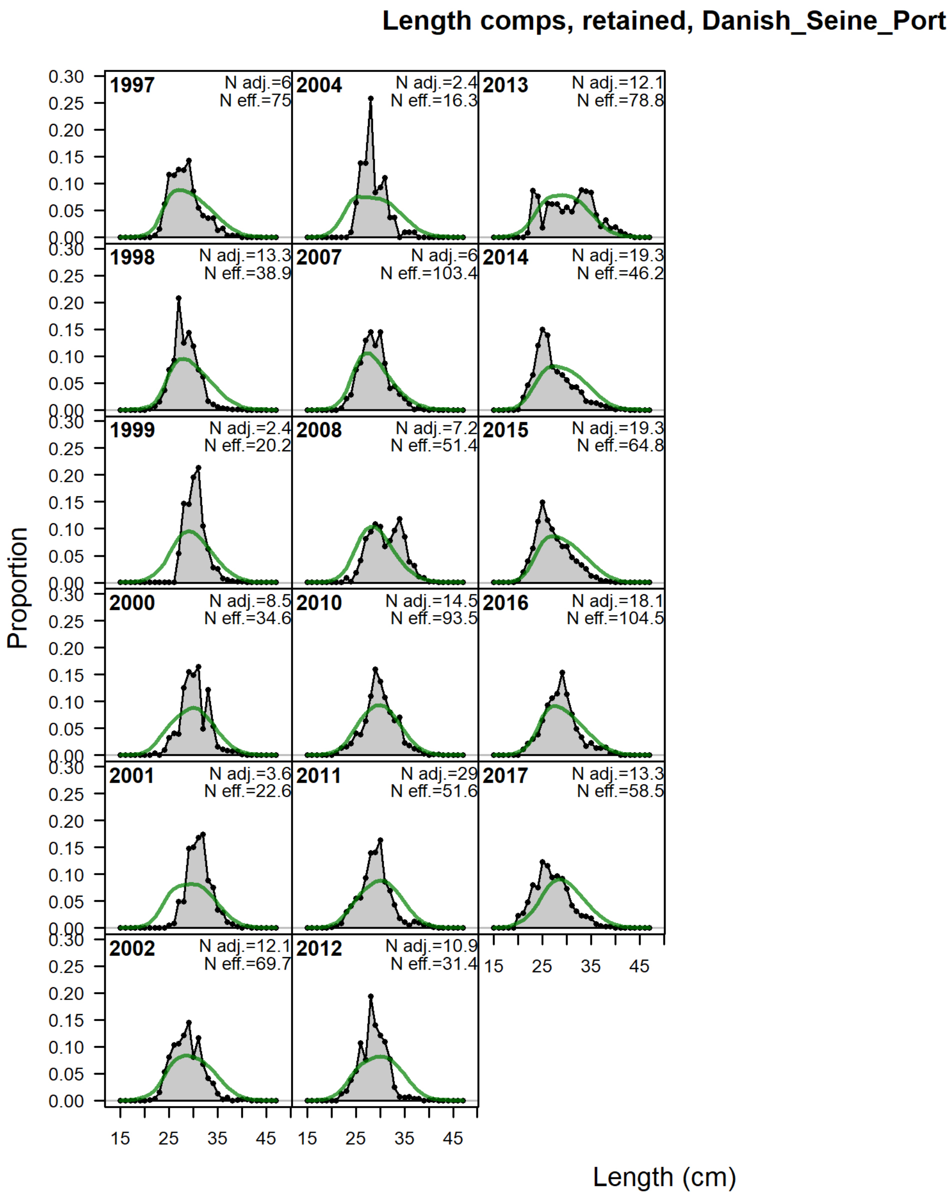


Figure A 7.24. Eastern Jackass Morwong length composition fits: Danish seine port retained.

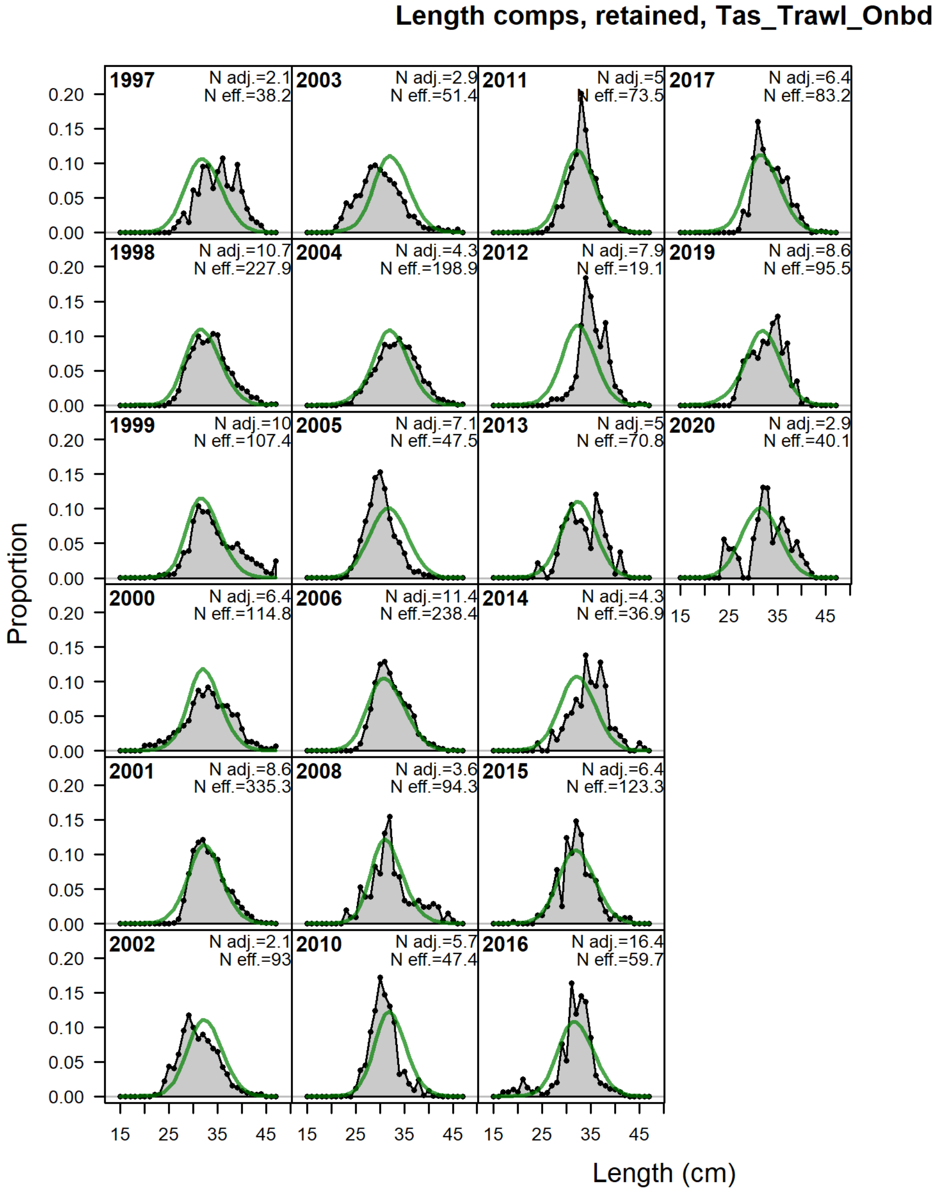


Figure A 7.25. Eastern Jackass Morwong length composition fits: Tasmanian trawl onboard retained.

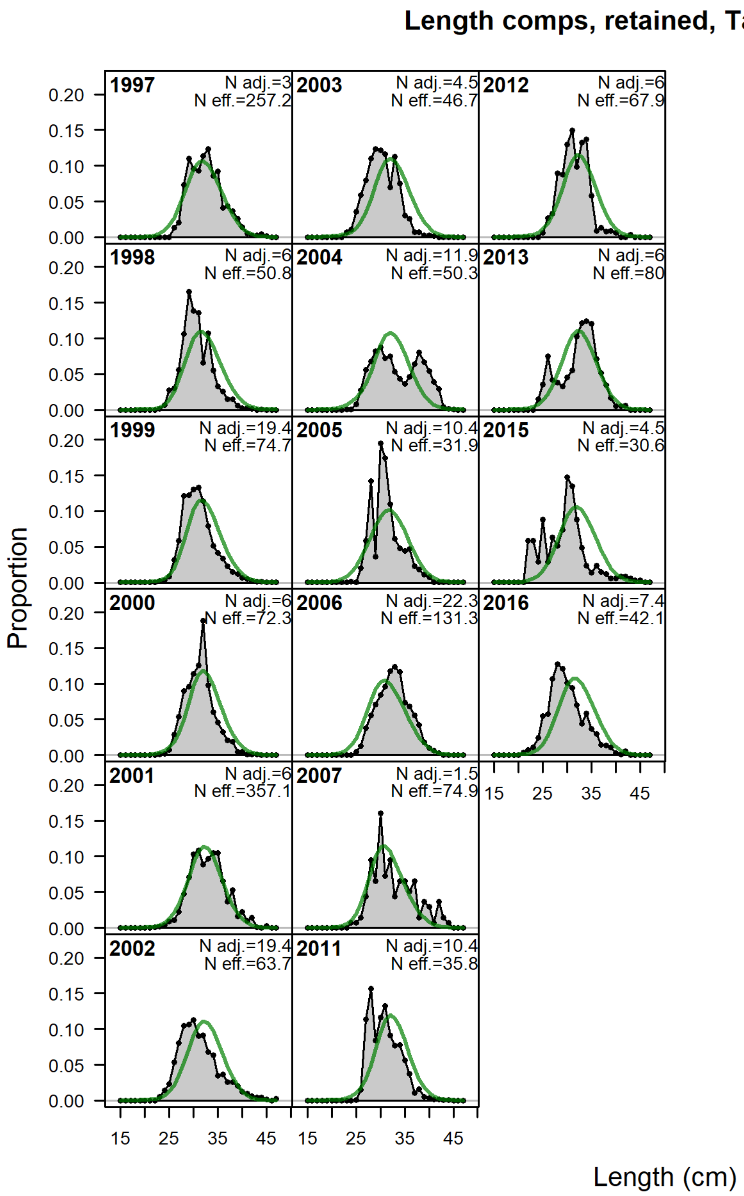


Figure A 7.26. Eastern Jackass Morwong length composition fits: Tasmanian trawl port retained.

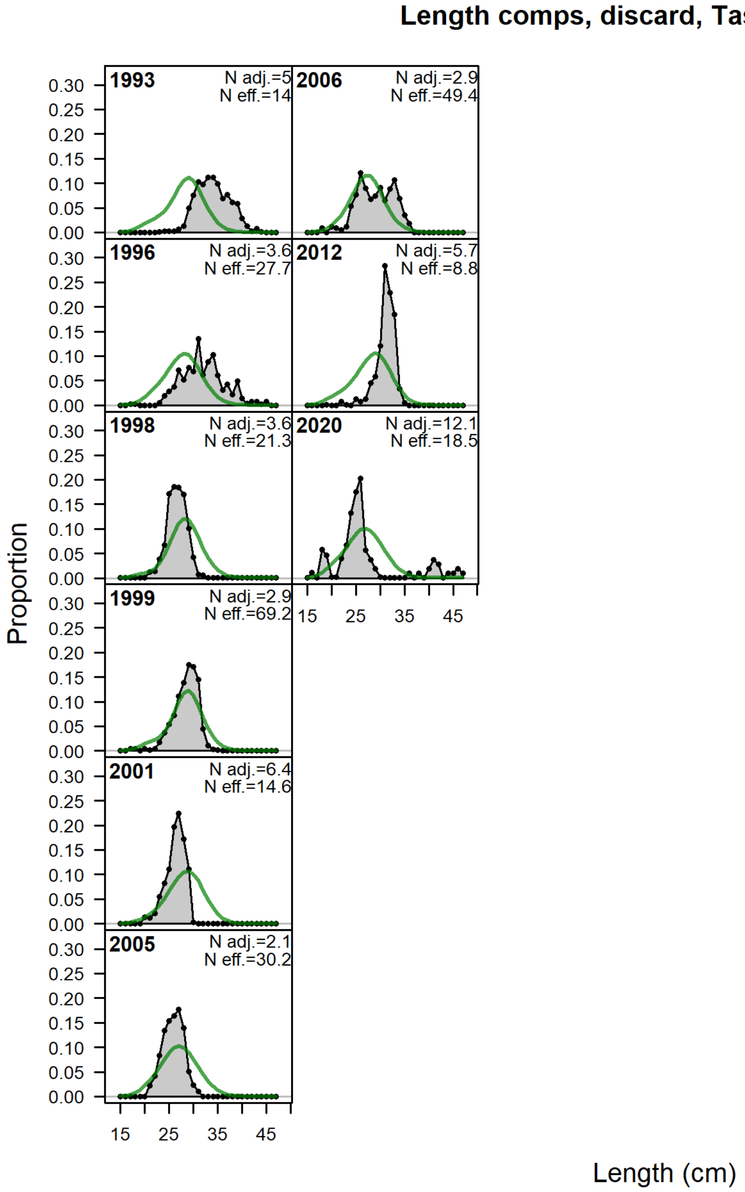


Figure A 7.27. Eastern Jackass Morwong length composition fits: Tasmanian trawl discarded.

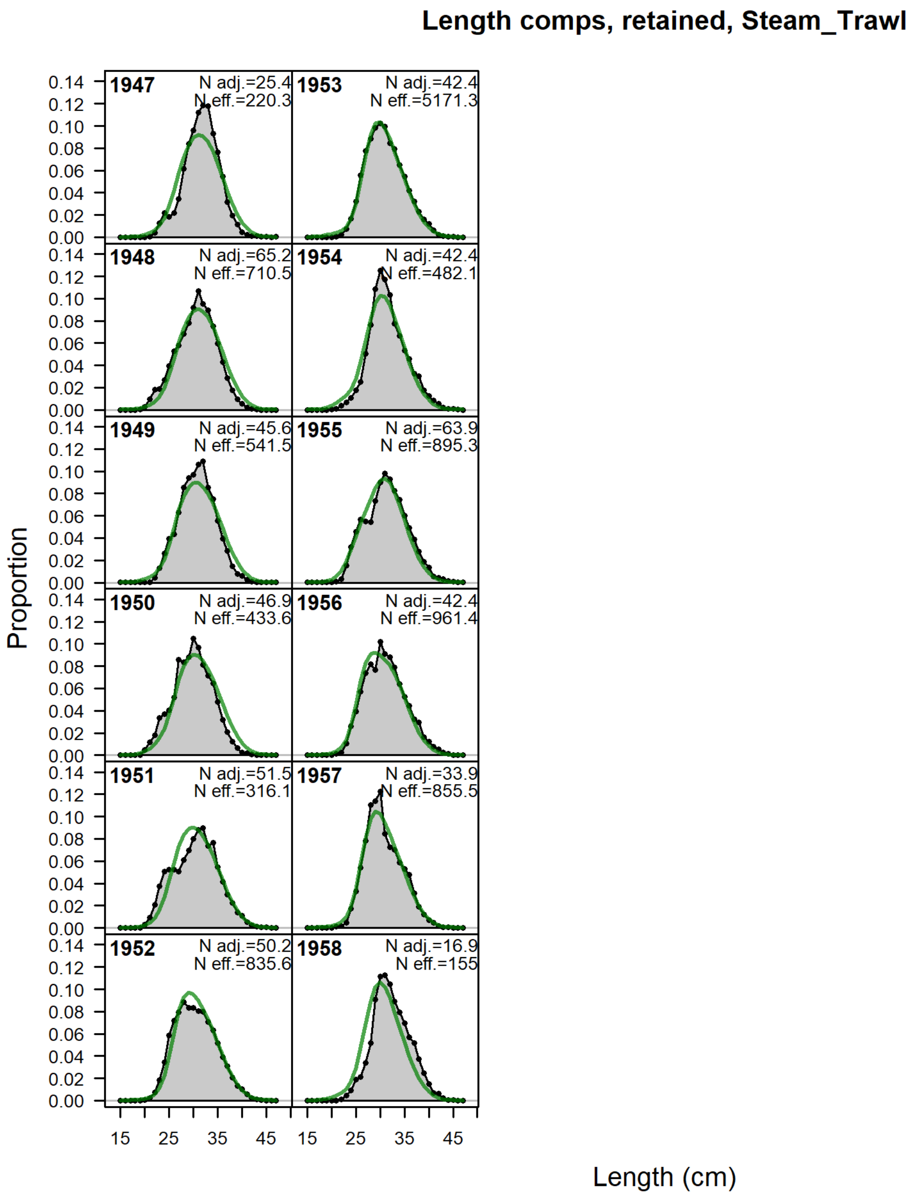


Figure A 7.28. Eastern Jackass Morwong length composition fits: steam trawl retained.

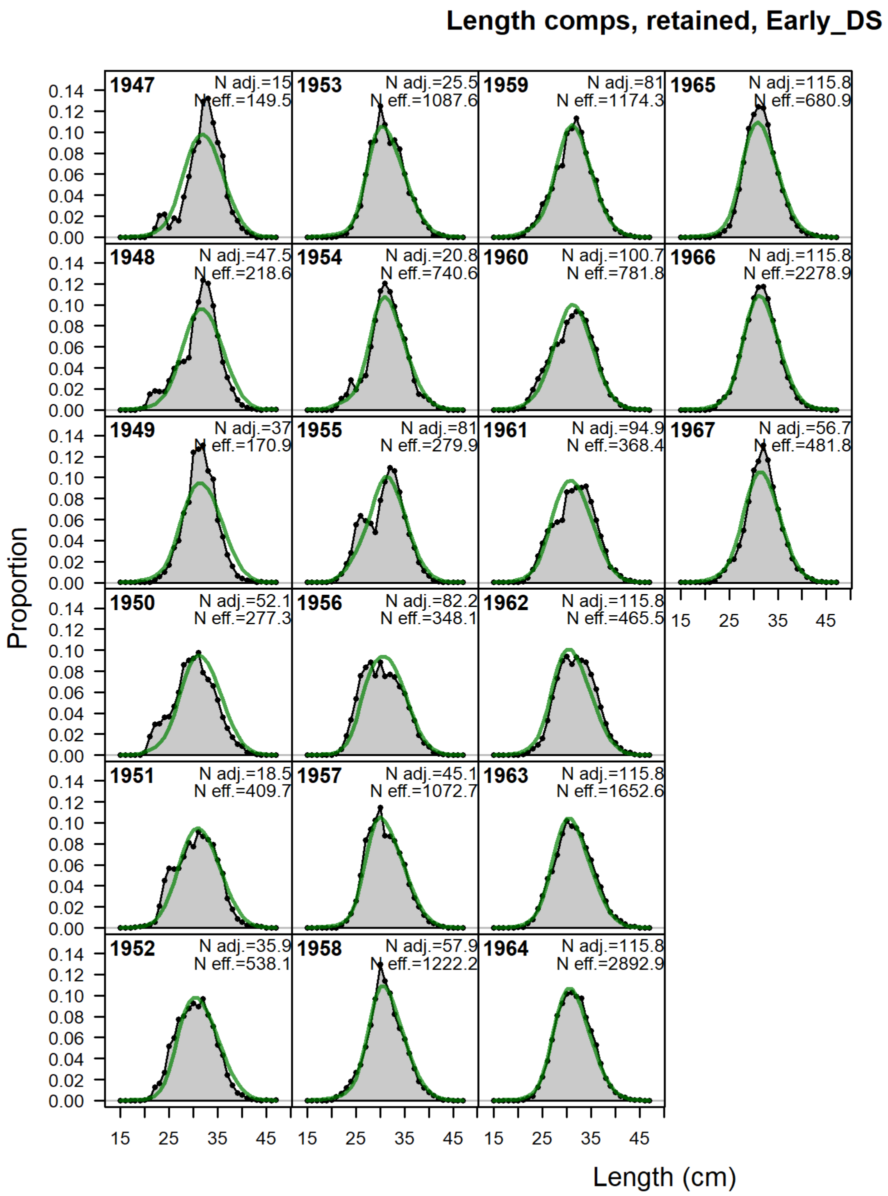


Figure A 7.29. Eastern Jackass Morwong length composition fits: early Danish seine retained.

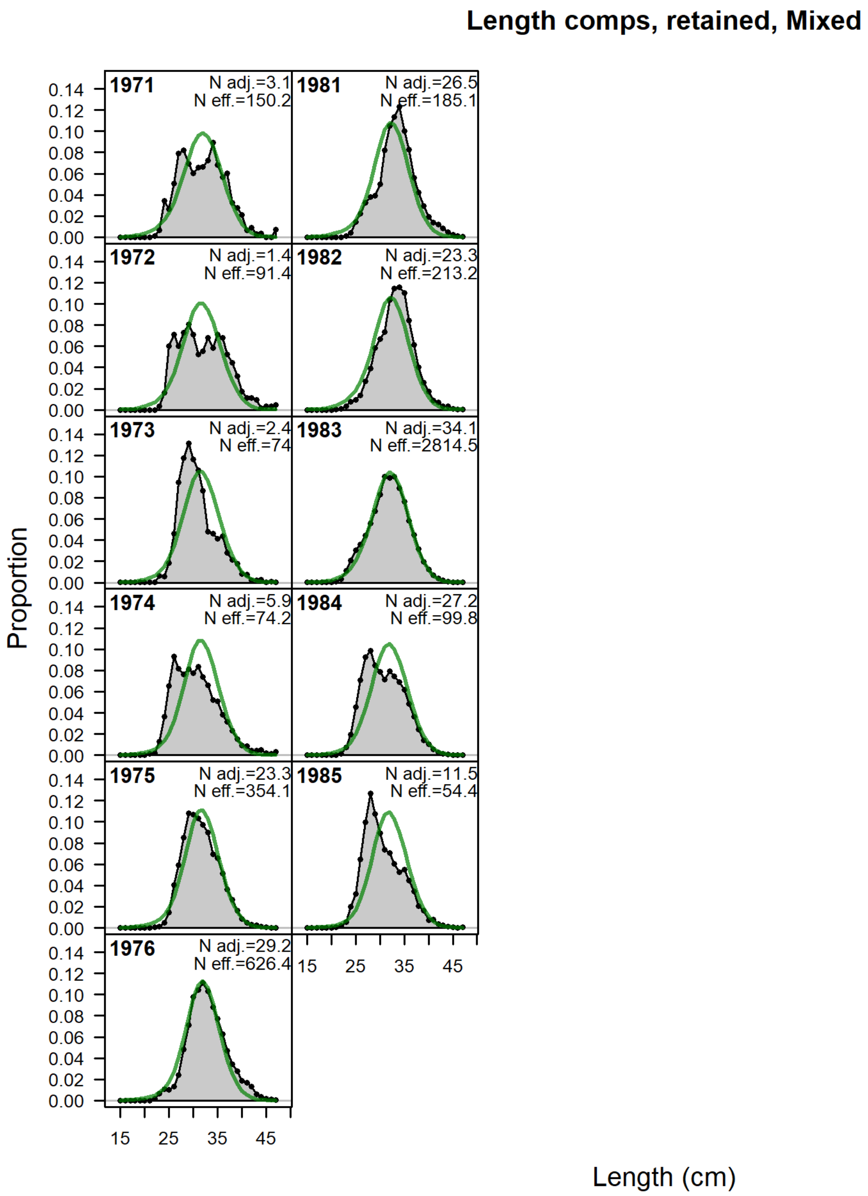


Figure A 7.30. Eastern Jackass Morwong length composition fits: mixed retained.

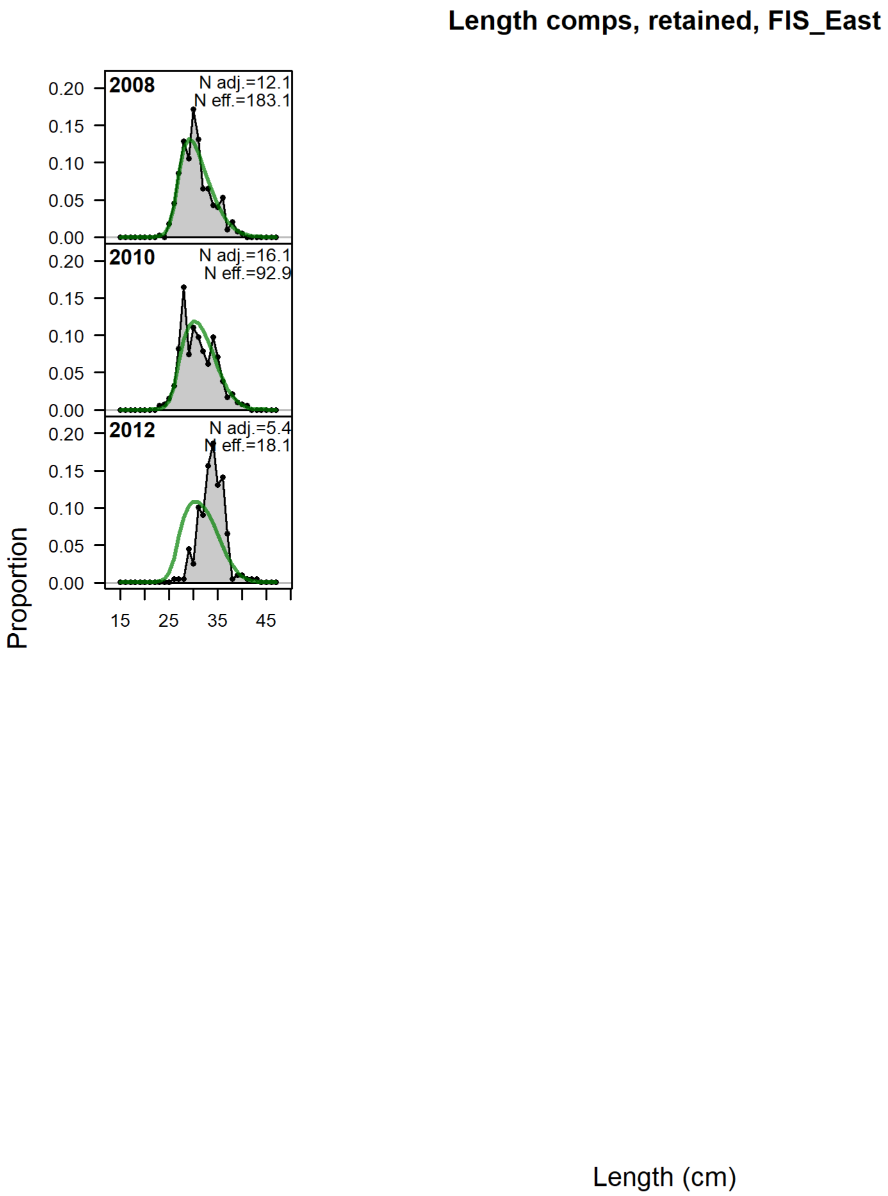


Figure A 7.31. Eastern Jackass Morwong length composition fits: FIS eastern trawl retained.

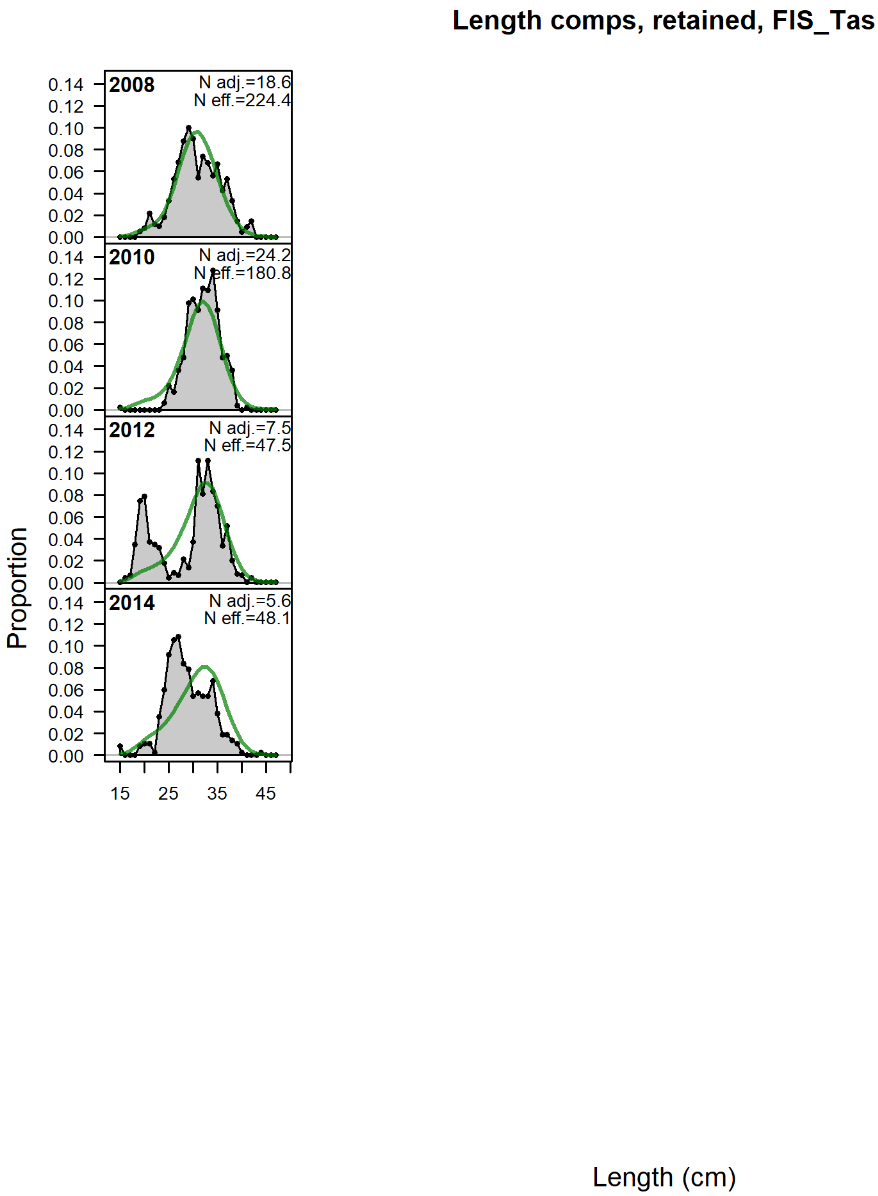


Figure A 7.32. Eastern Jackass Morwong length composition fits: FIS Tasmanian trawl retained.

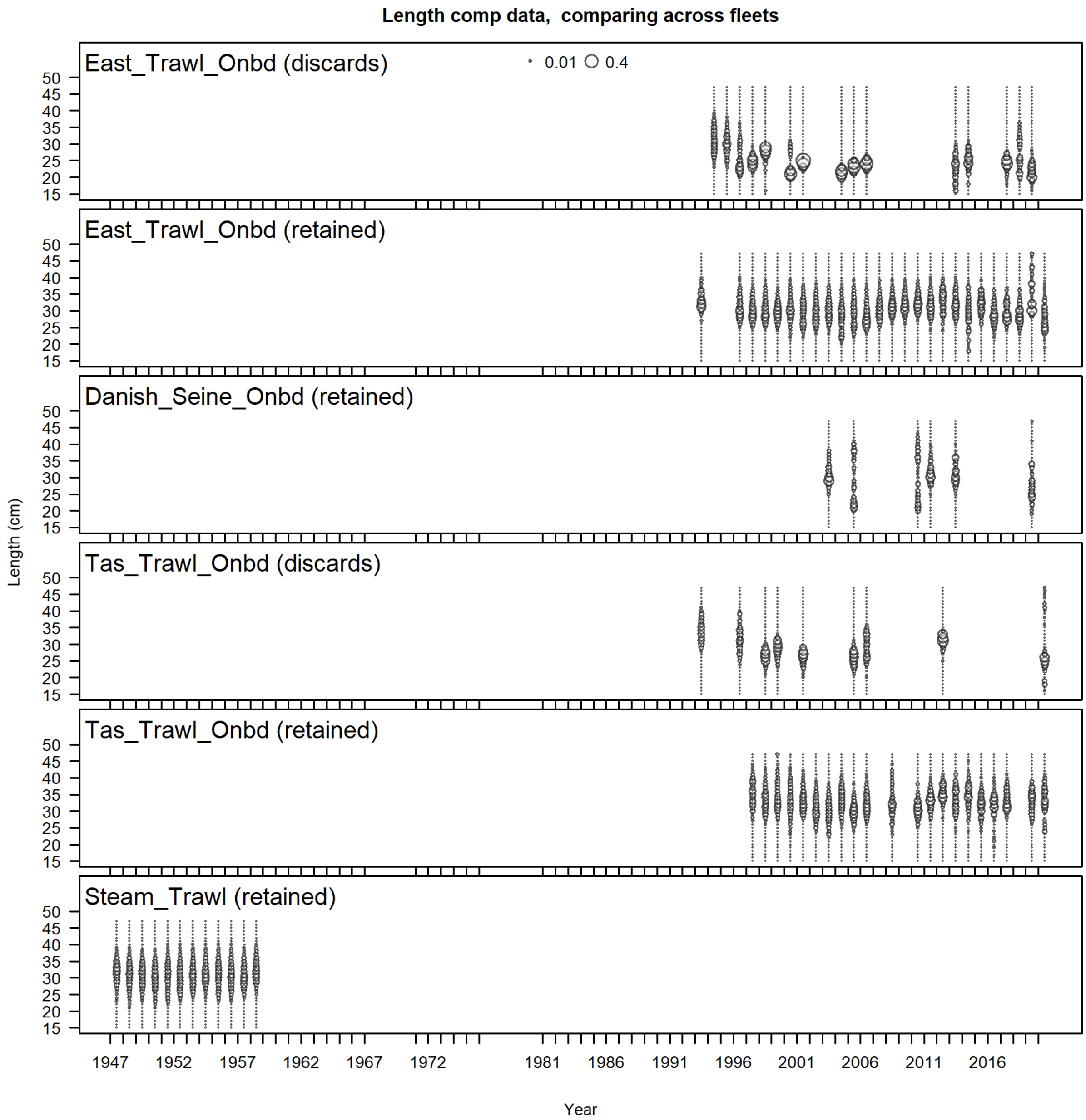


Figure A 7.33. Residuals from the annual length compositions (retained and discarded) for eastern Jackass Morwong displayed by year for trawl and Danish seine fleets.

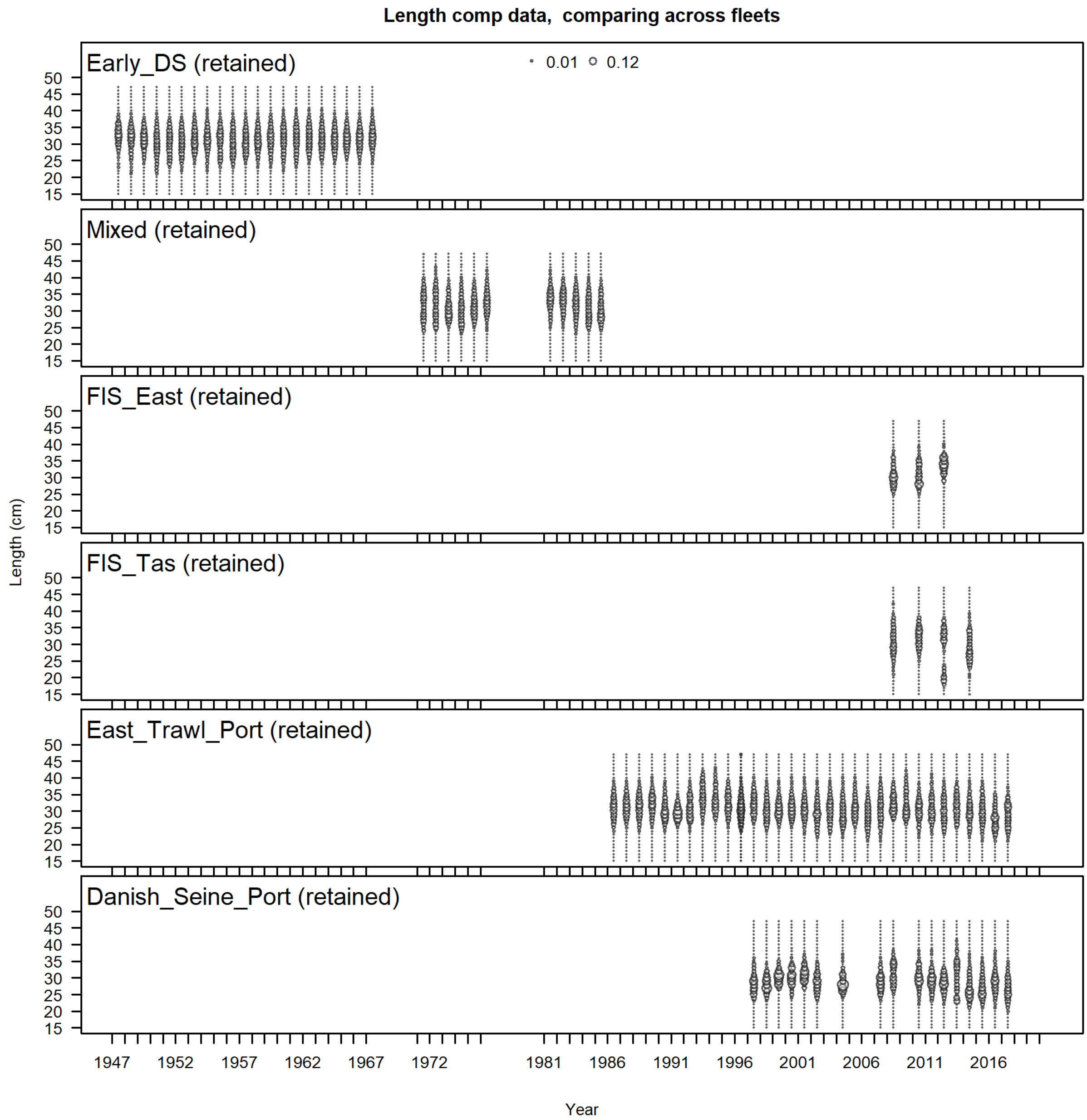


Figure A 7.34. Residuals from the annual length compositions (retained) for eastern Jackass Morwong displayed by year for trawl and Danish seine fleets.

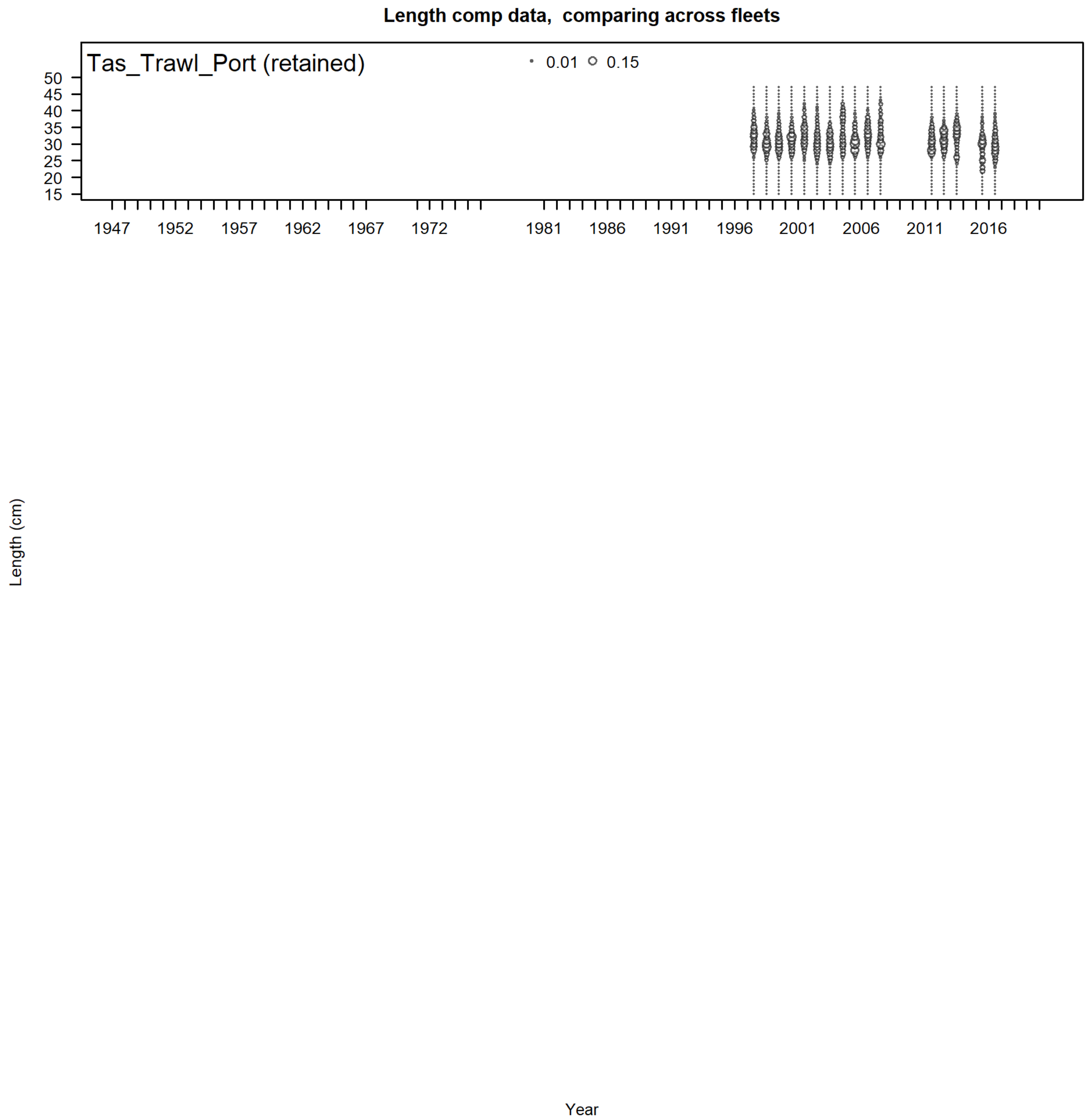


Figure A 7.35. Residuals from the annual length compositions (retained) for eastern Jackass Morwong displayed by year for trawl fleets.

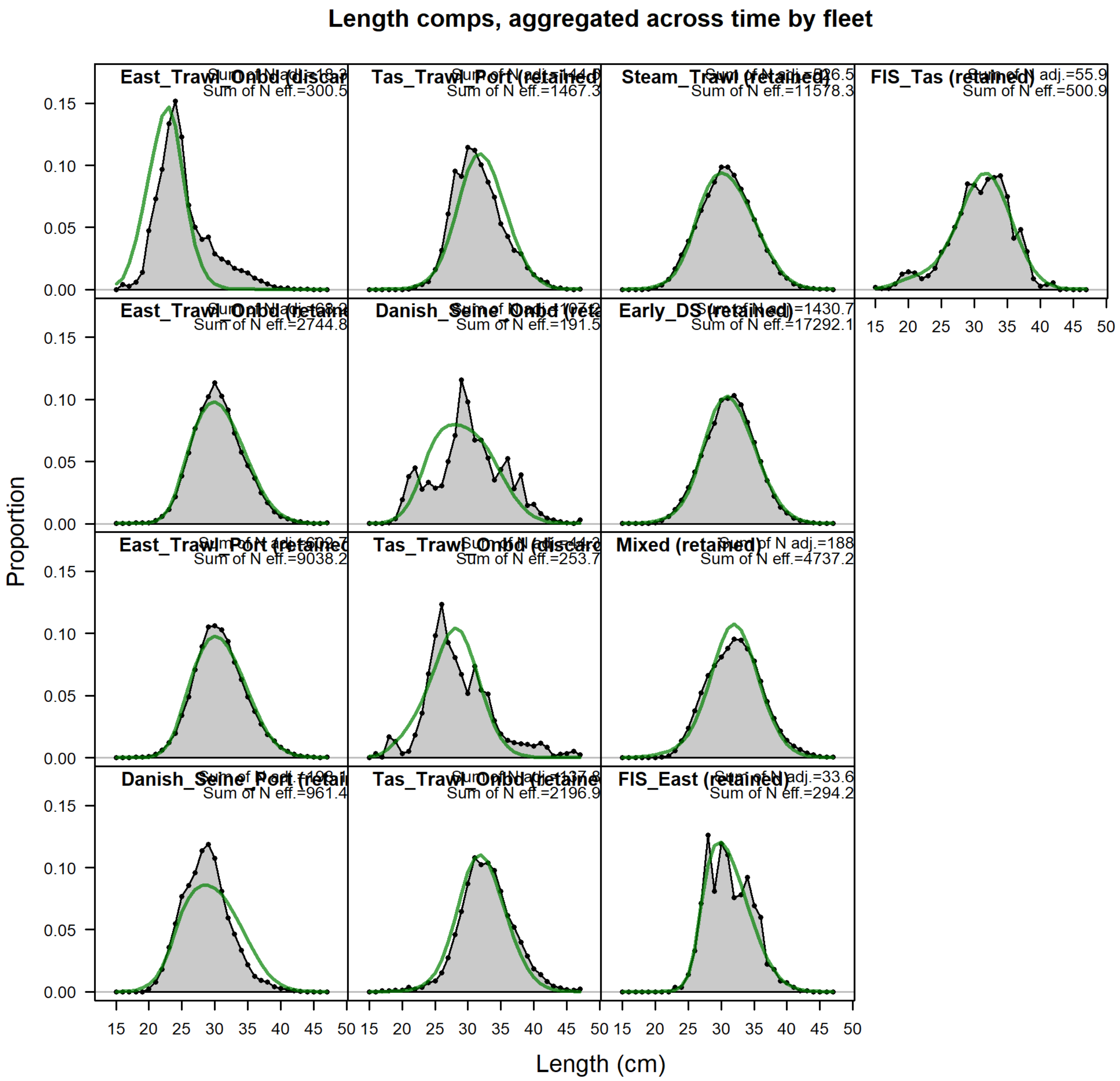


Figure A 7.36. Aggregated fits (over all years) to the length compositions for eastern Jackass Morwong displayed by fleet.

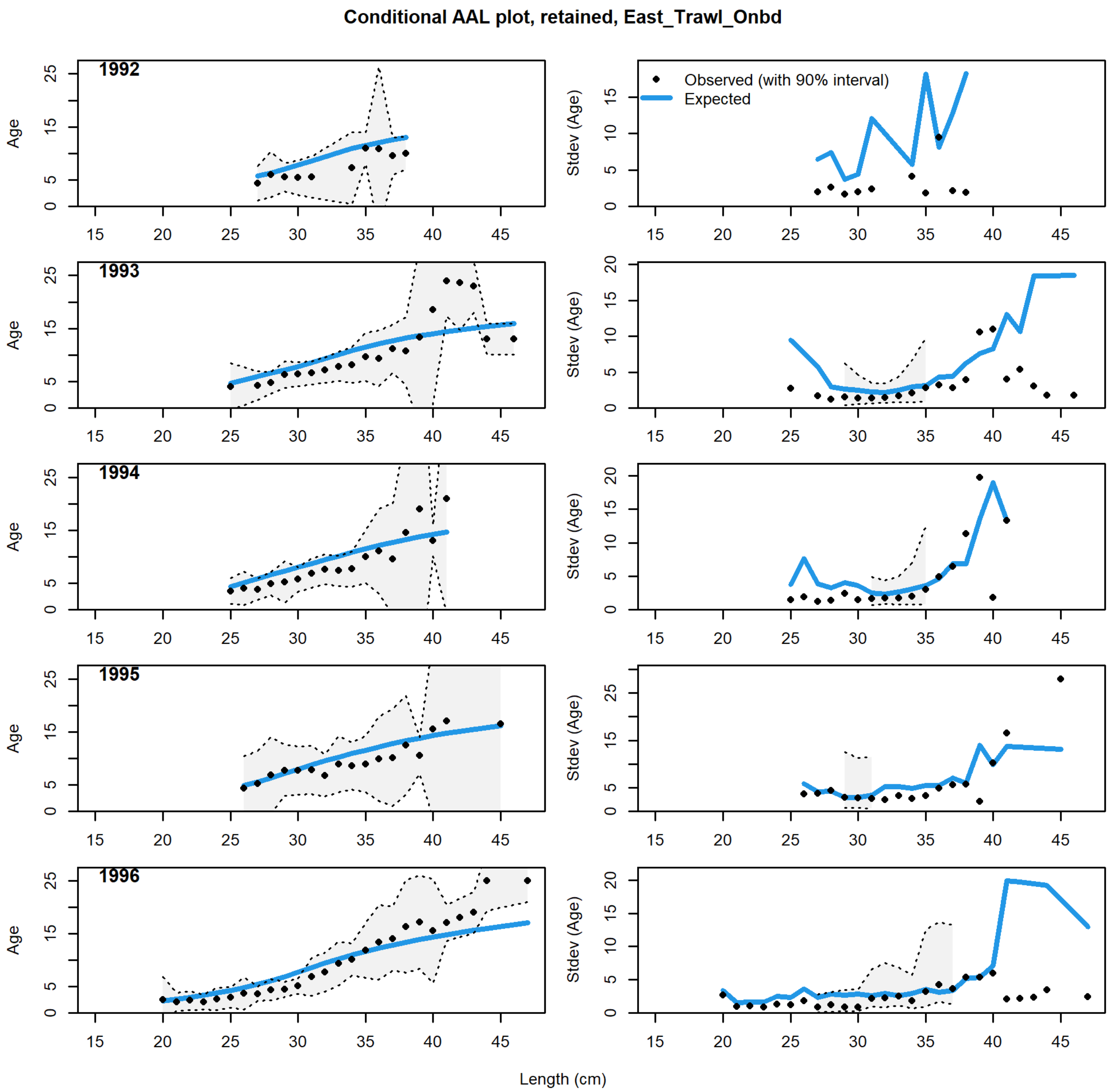


Figure A 7.37. Eastern Jackass Morwong conditional age-at-length fits: eastern trawl part 1.

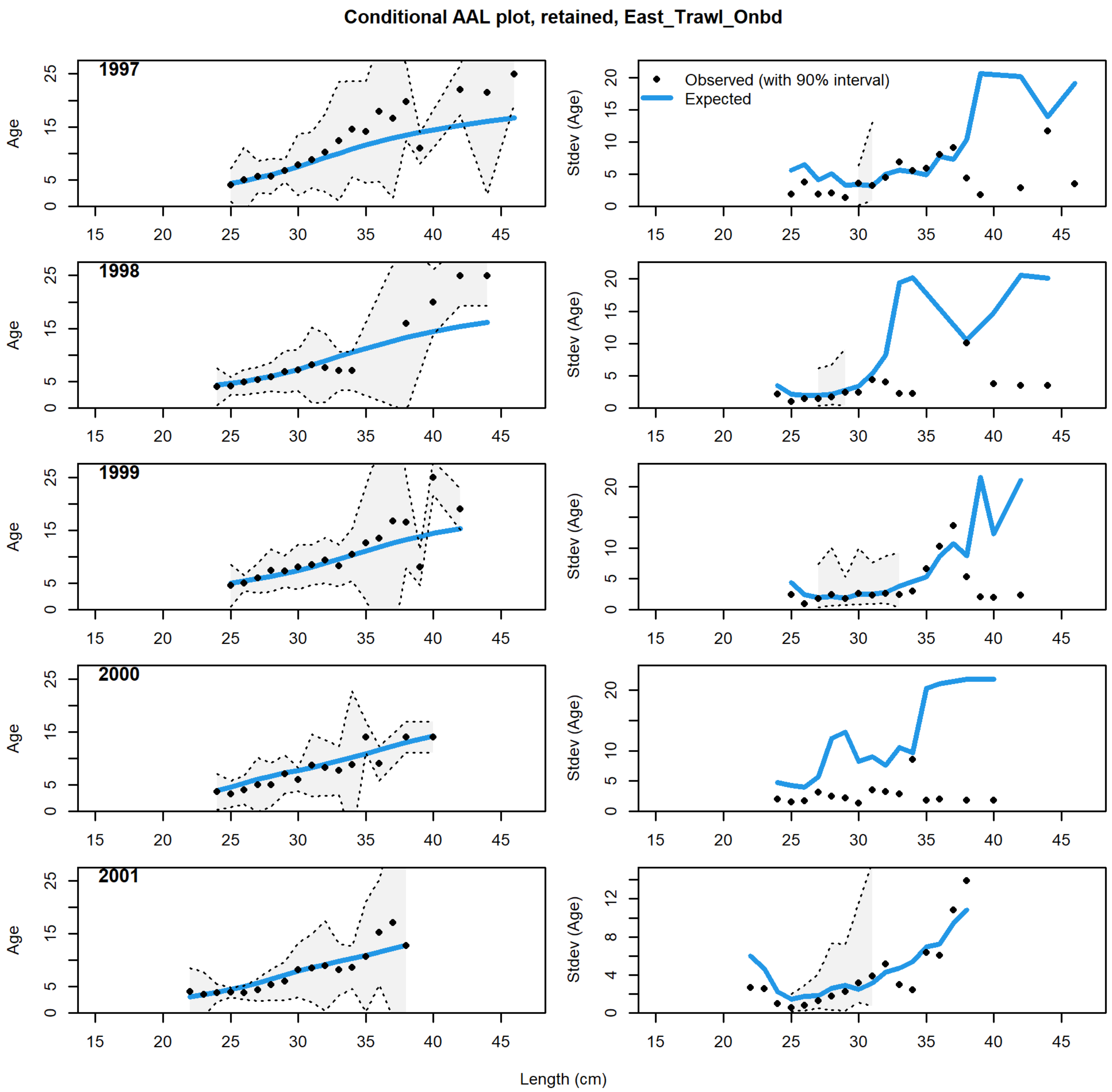


Figure A 7.38. Eastern Jackass Morwong conditional age-at-length fits: eastern trawl part 2.

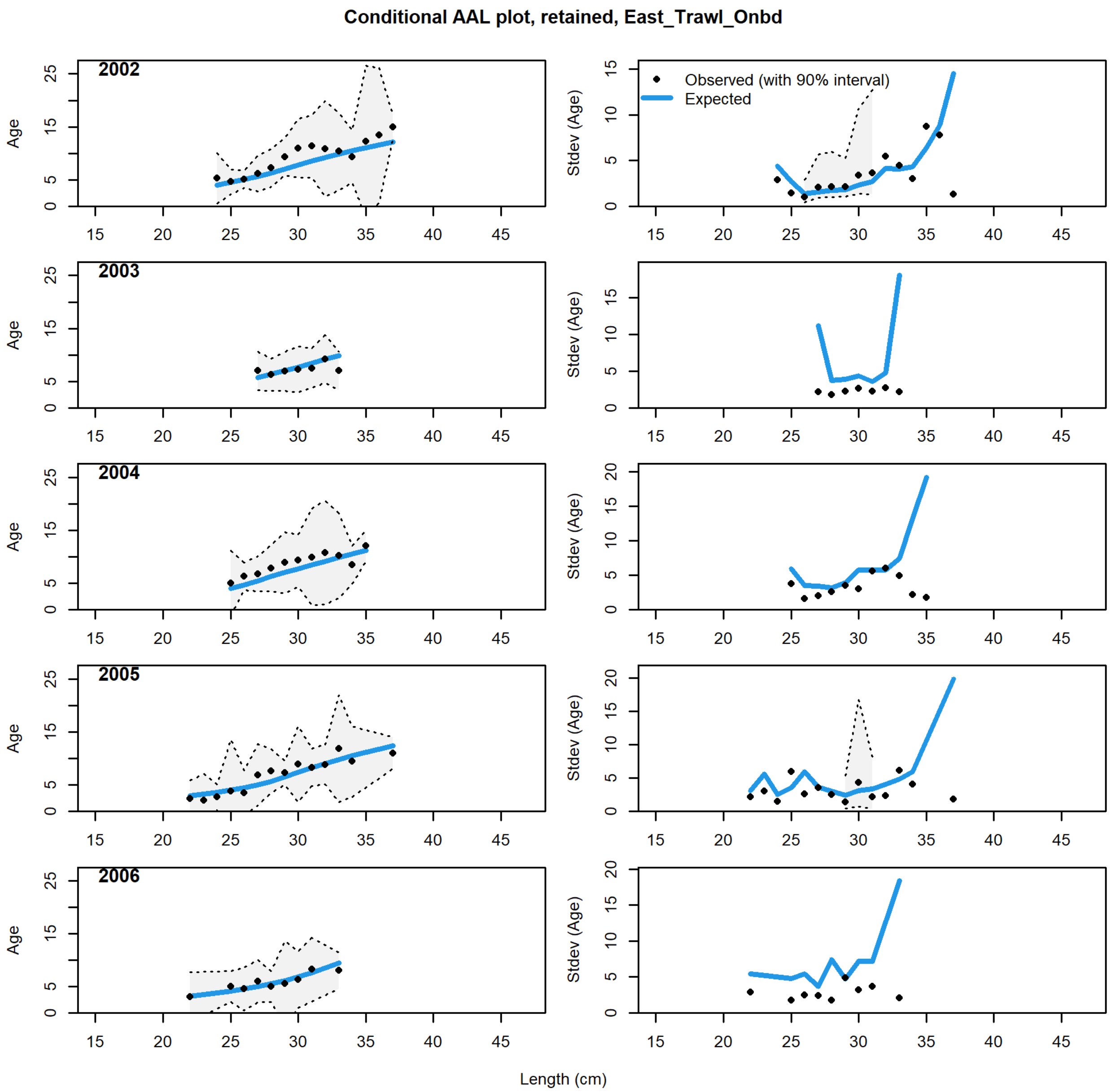


Figure A 7.39. Eastern Jackass Morwong conditional age-at-length fits: eastern trawl part 3.

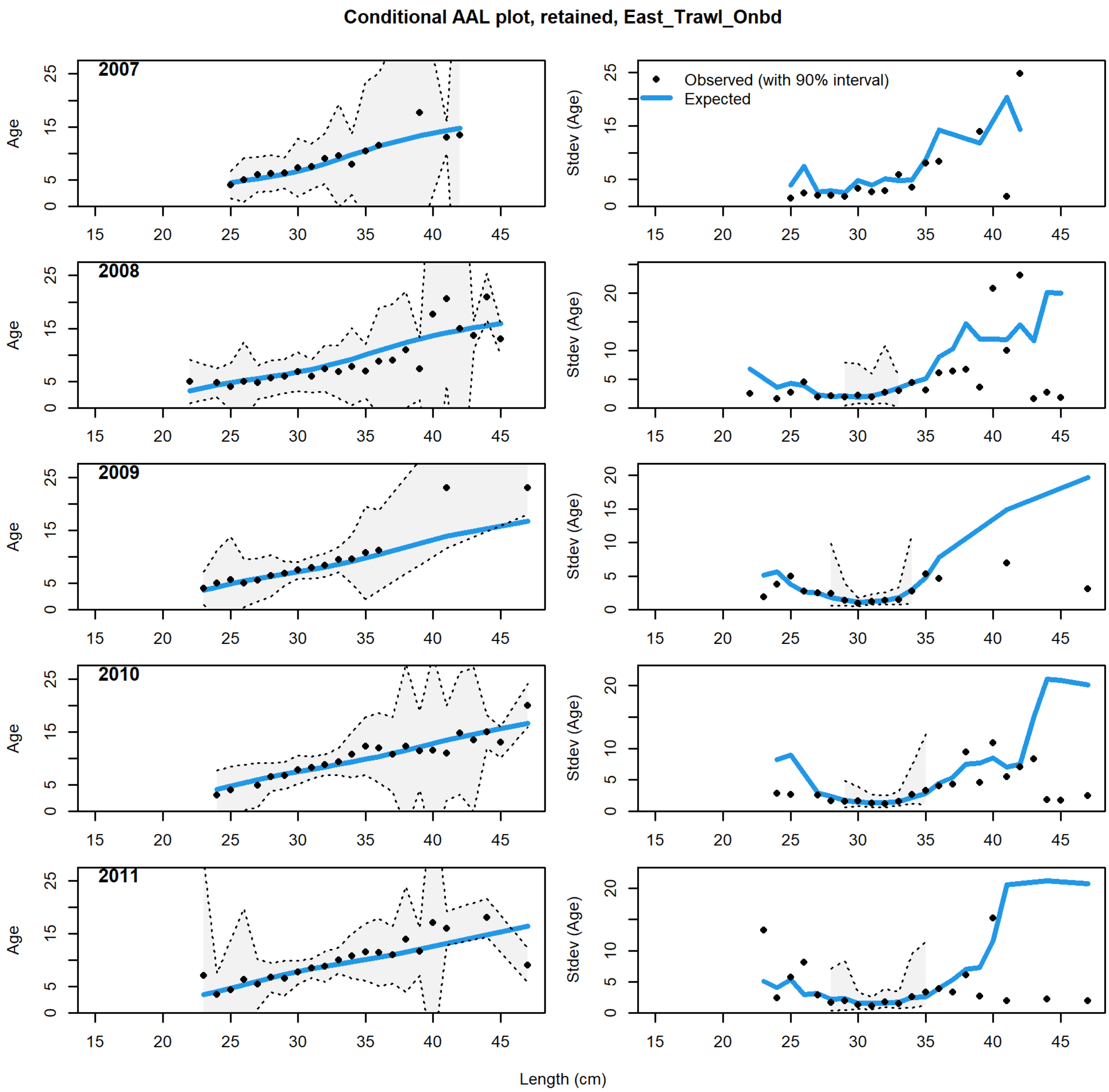


Figure A 7.40. Eastern Jackass Morwong conditional age-at-length fits: eastern trawl part 4.

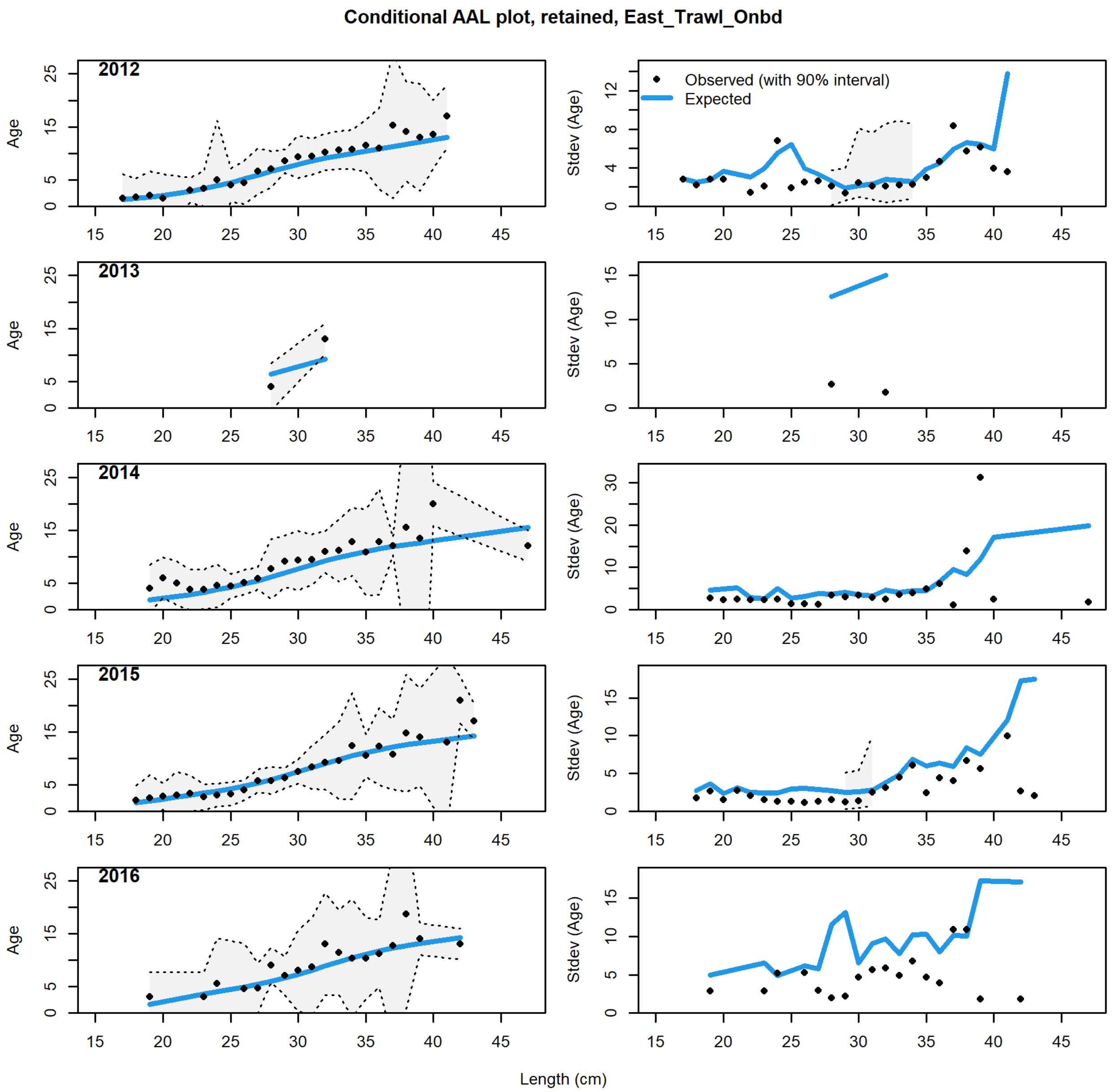


Figure A 7.41. Eastern Jackass Morwong conditional age-at-length fits: eastern trawl part 5.

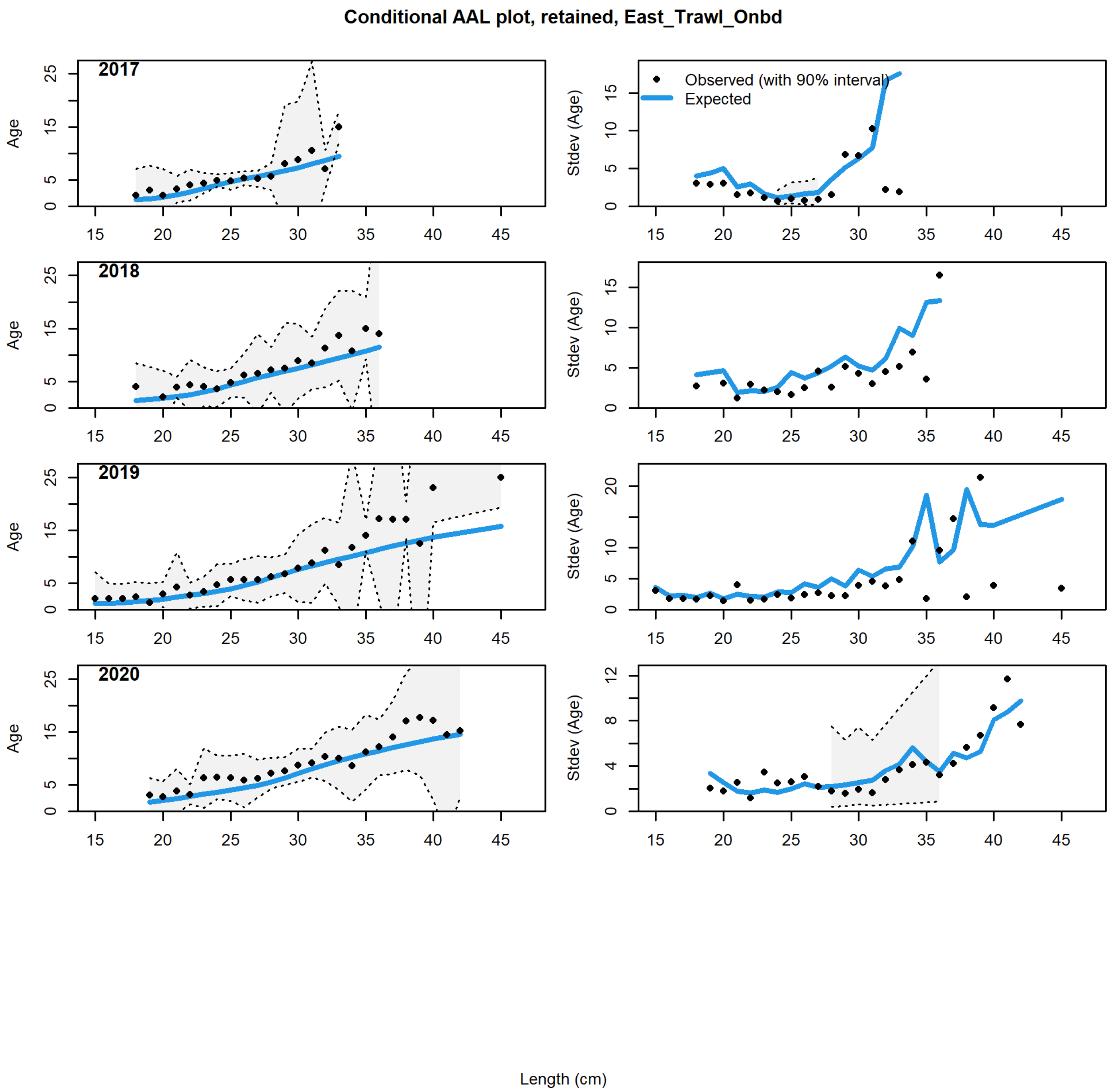


Figure A 7.42. Eastern Jackass Morwong conditional age-at-length fits: eastern trawl part 6.

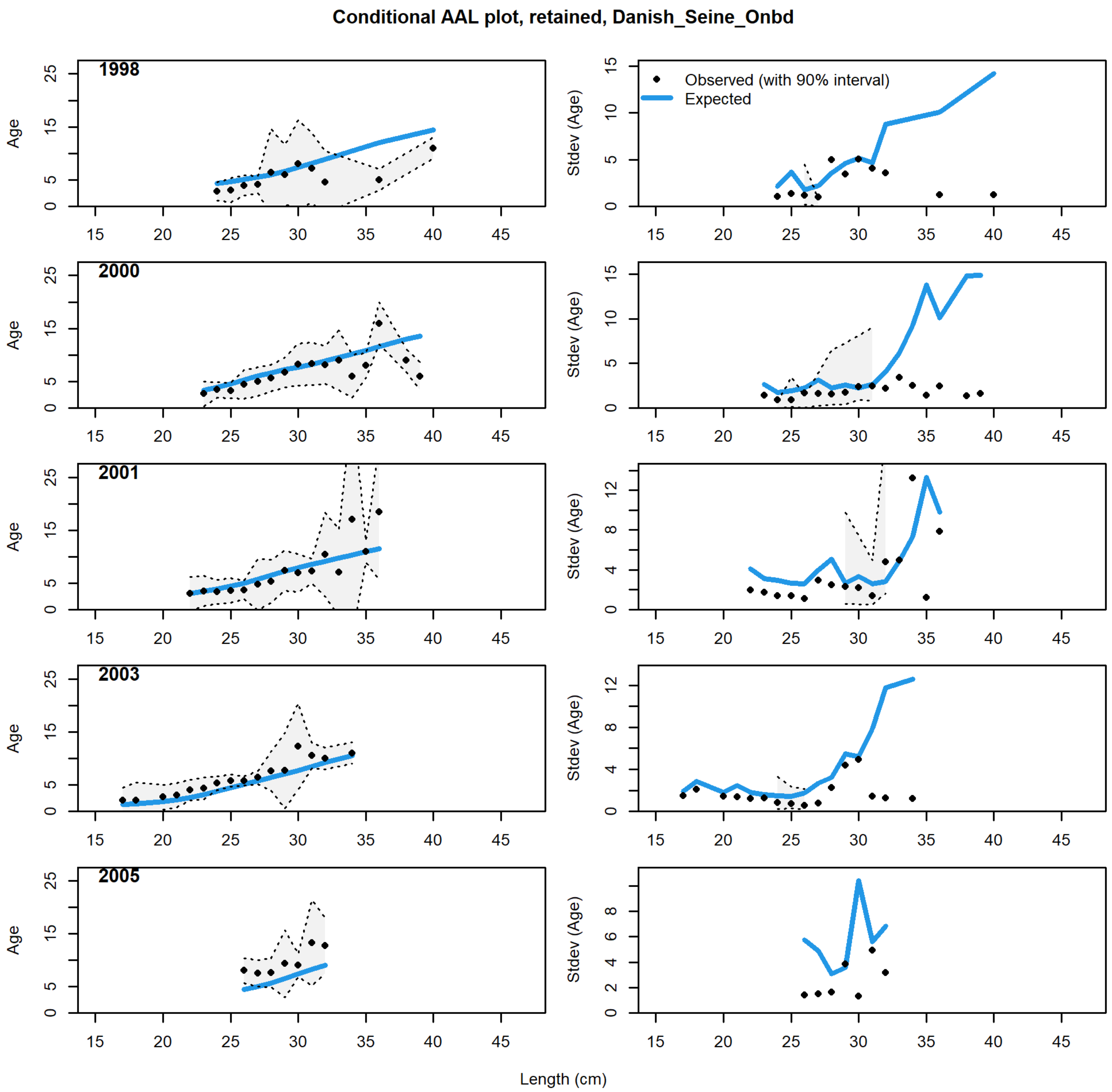


Figure A 7.43. Eastern Jackass Morwong conditional age-at-length fits: Danish seine part 1.

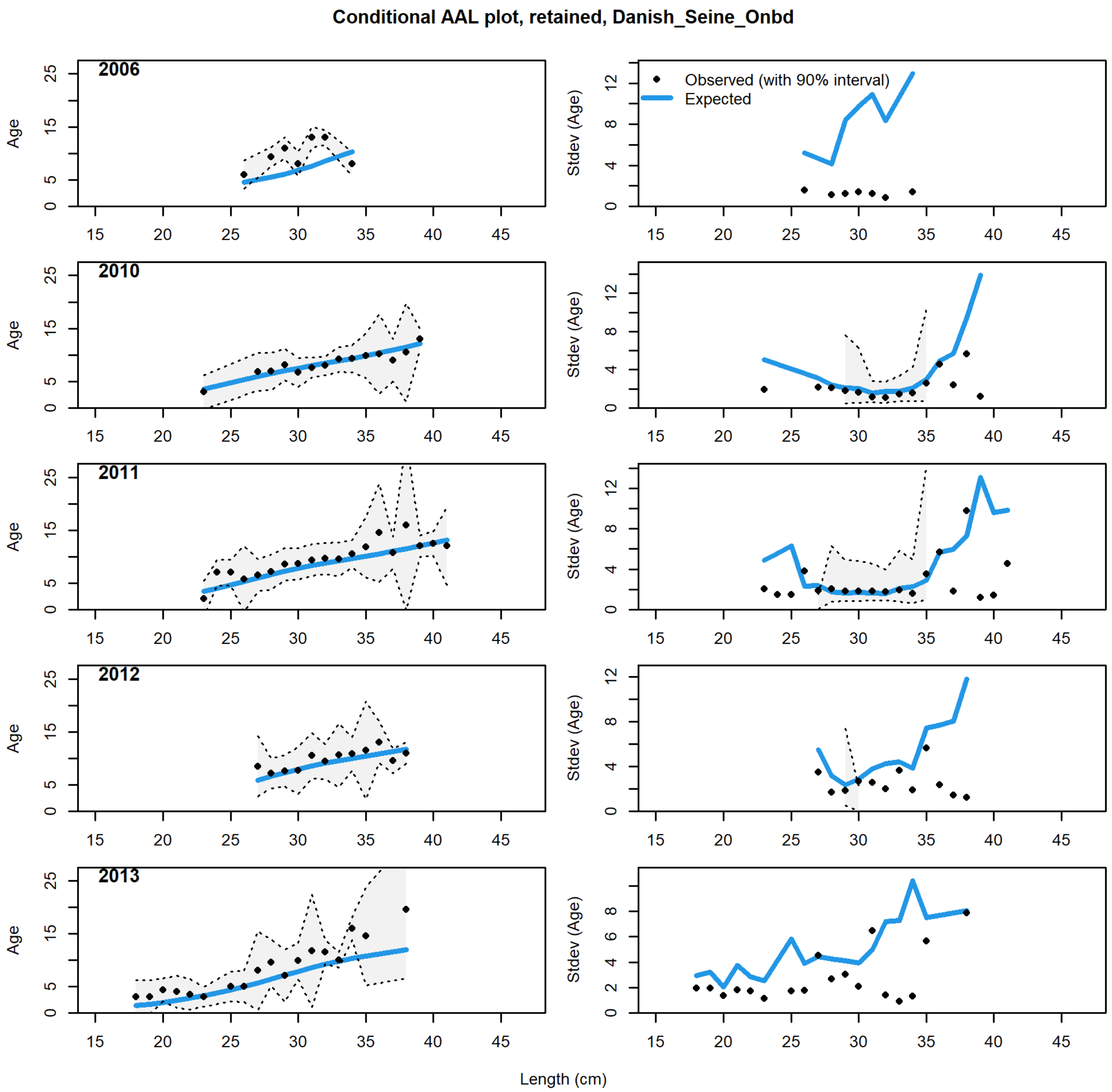


Figure A 7.44. Eastern Jackass Morwong conditional age-at-length fits: Danish seine part 2.

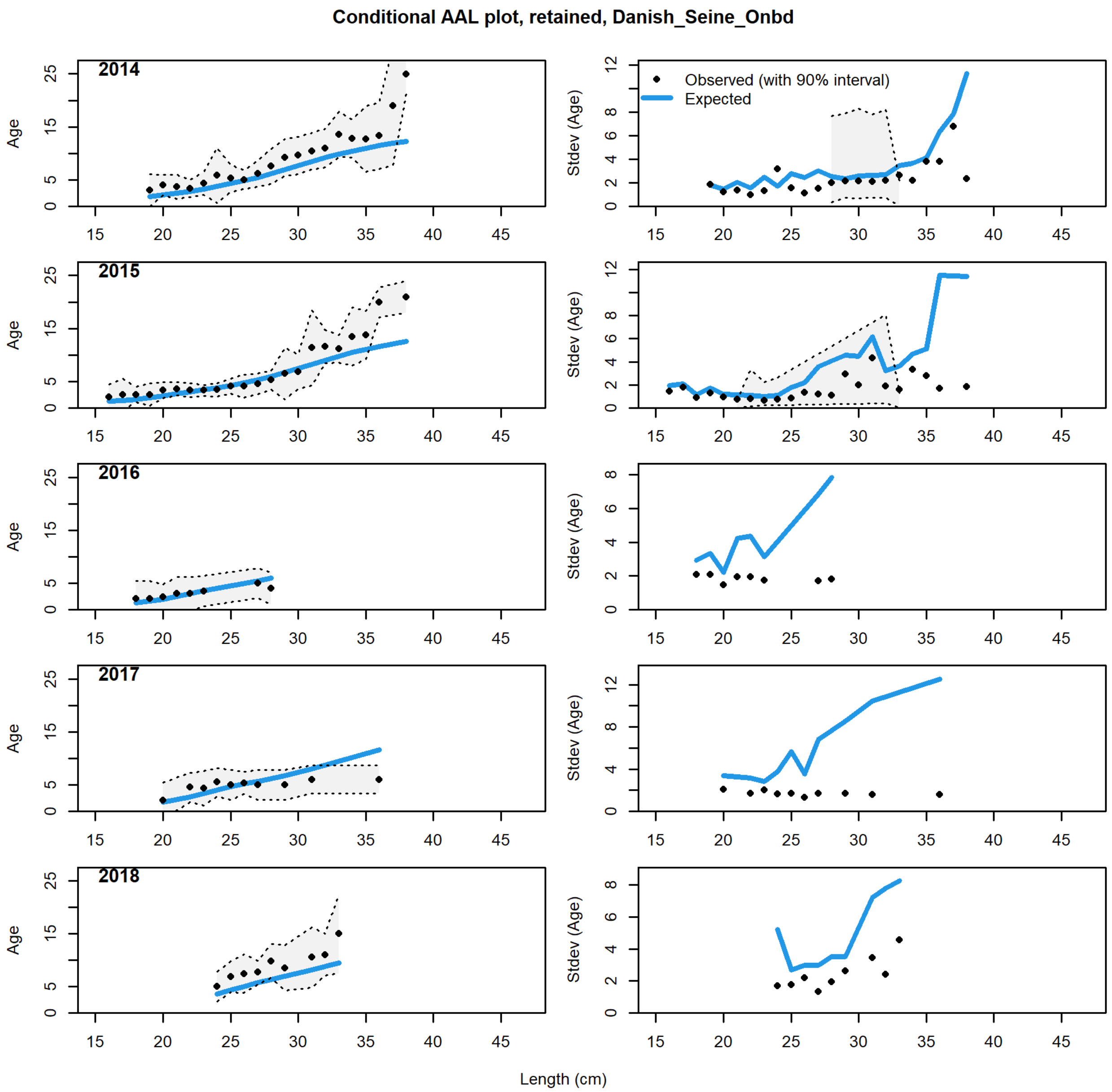


Figure A 7.45. Eastern Jackass Morwong conditional age-at-length fits: Danish seine part 3.

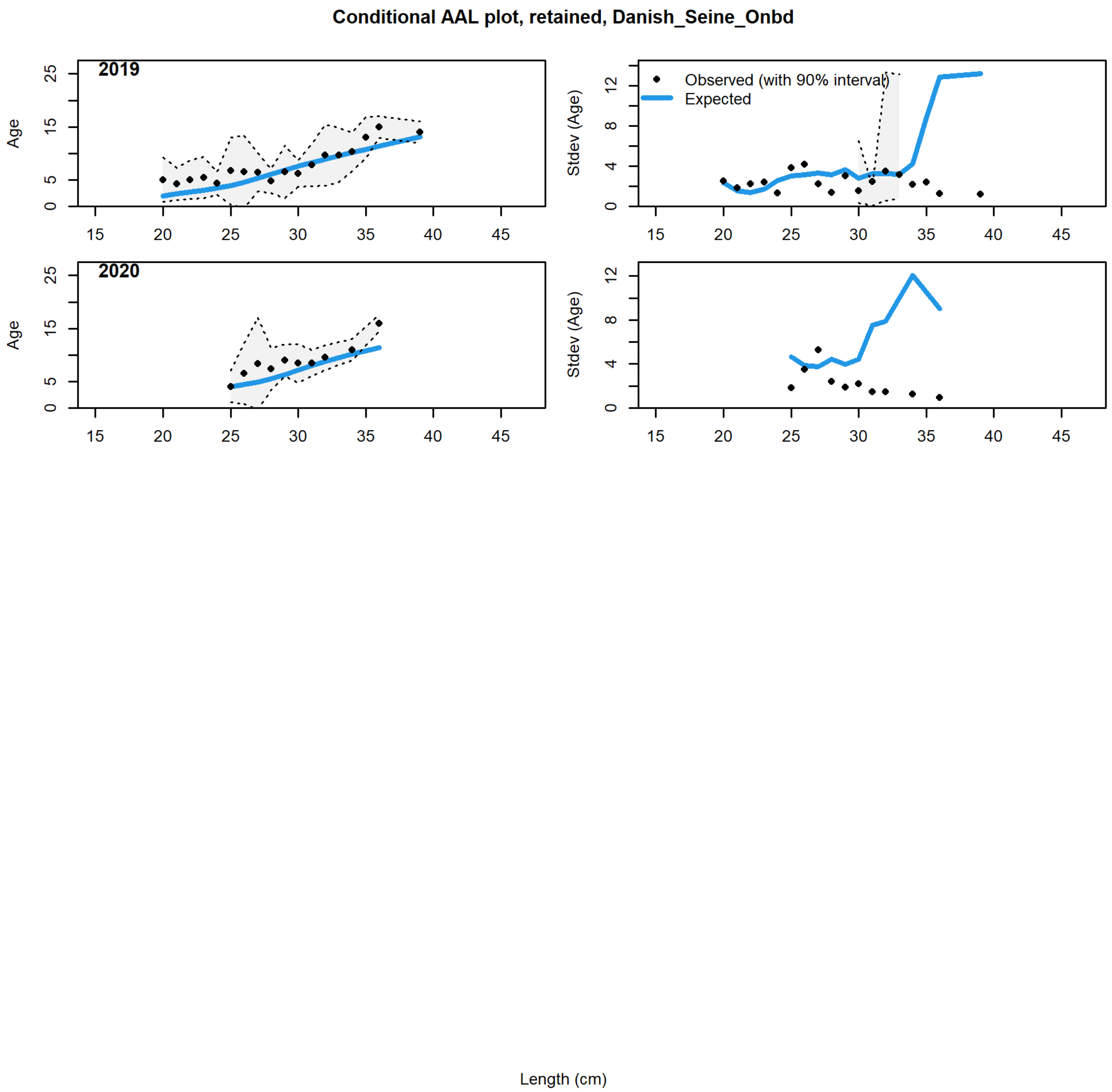


Figure A 7.46. Eastern Jackass Morwong conditional age-at-length fits: Danish seine part 4.

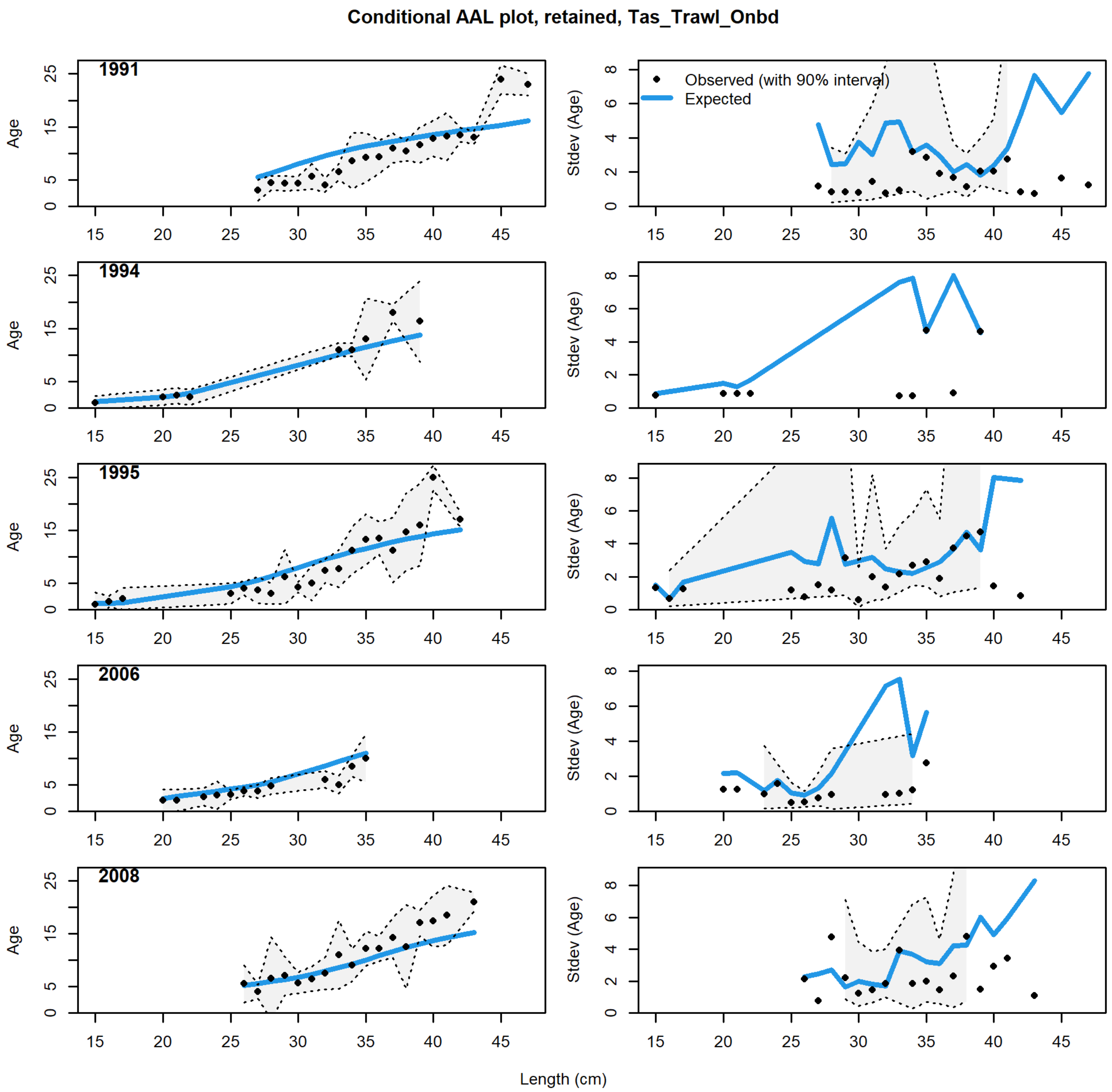


Figure A 7.47. Eastern Jackass Morwong conditional age-at-length fits: Tasmanian trawl part 1.

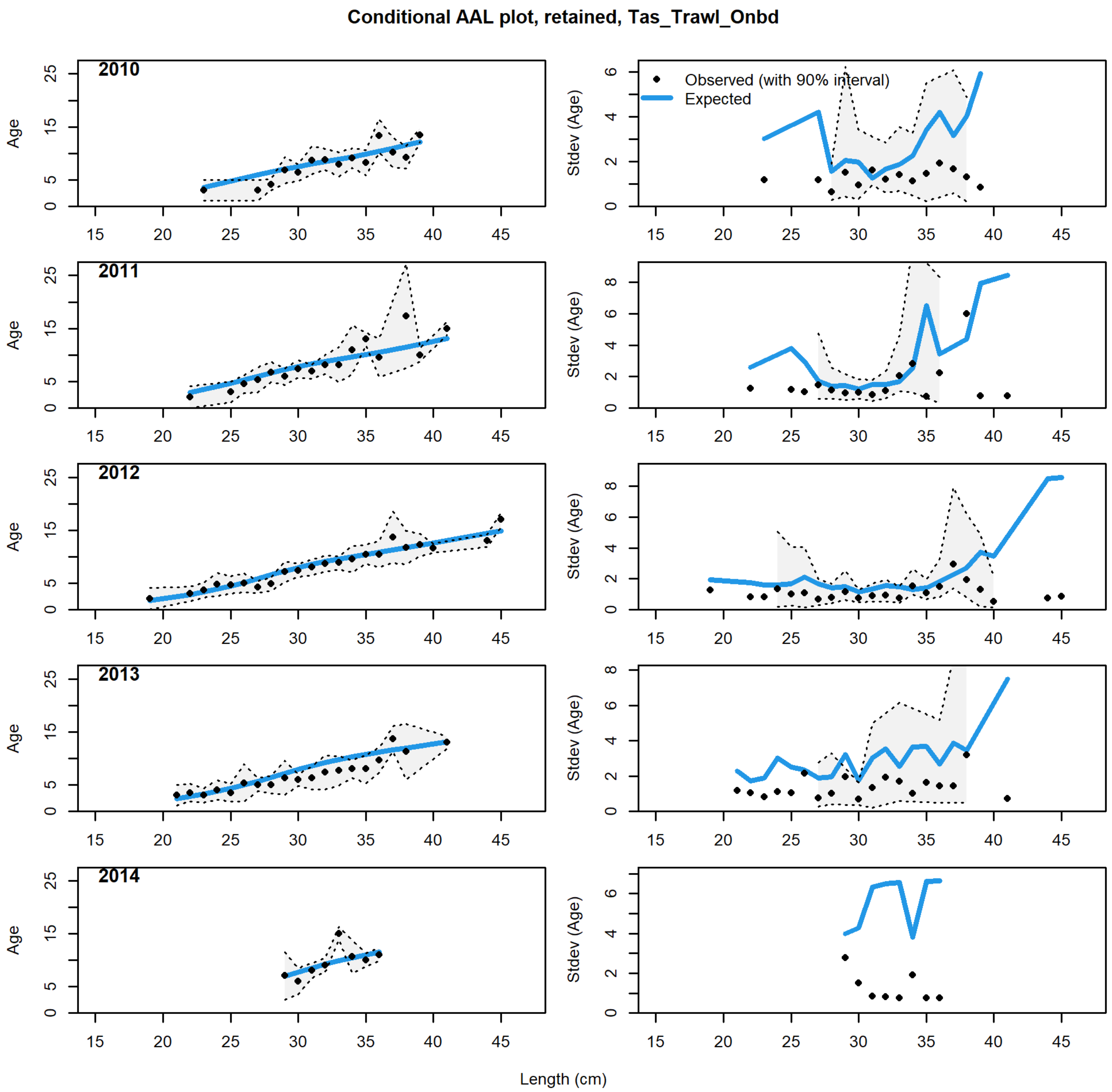


Figure A 7.48. Eastern Jackass Morwong conditional age-at-length fits: Tasmanian trawl part 2.

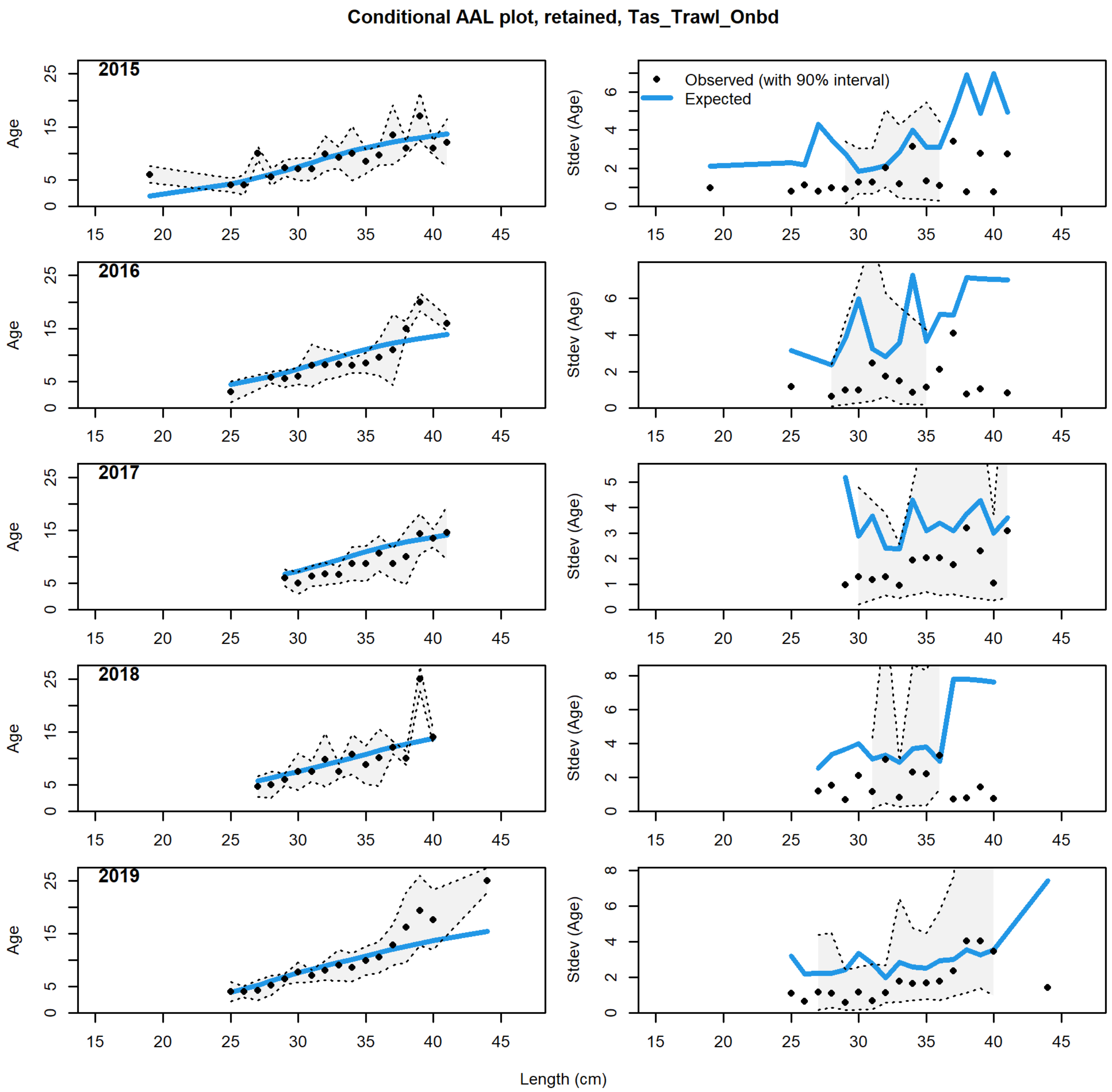


Figure A 7.49. Eastern Jackass Morwong conditional age-at-length fits: Tasmanian trawl part 3.

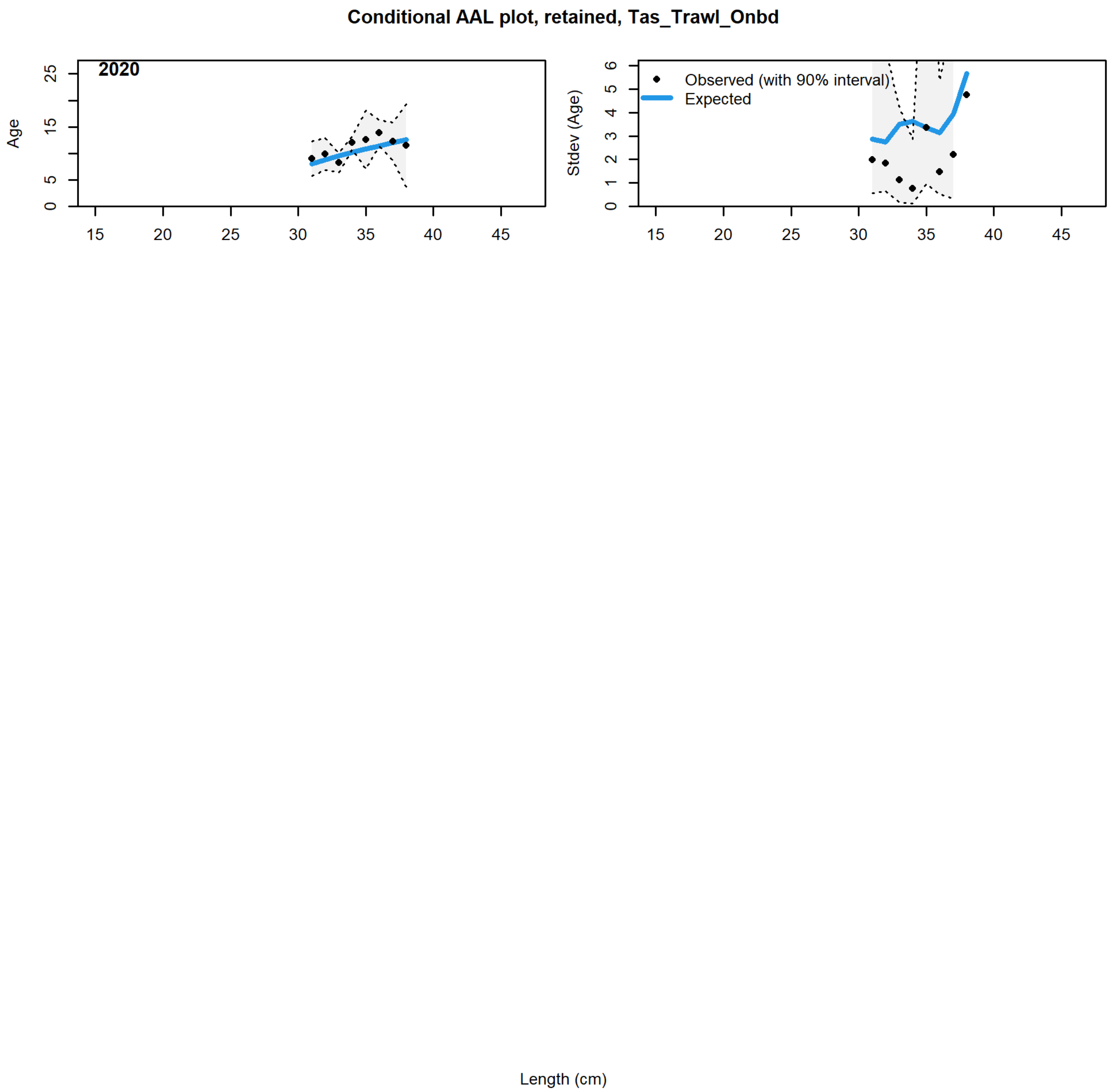


Figure A 7.50. Eastern Jackass Morwong conditional age-at-length fits: Tasmanian trawl part 4.