Australia's National
Science Agency

Tiger Flathead (*Neoplatycephalus richardsoni*) stock assessment based on data up to 2021 – development of a preliminary base case

For discussion at SERAG, 5-6 October 2022, Melbourne, Victoria

Version 1.2

Pia Bessell-Browne

28 September 2022

Citation

Bessell-Browne, P. (2022) Tiger Flathead (*Neoplatycephalus richardsoni*) stock assessment based on data up to 2021 – development of a preliminary base case. Technical paper presented to the SERAG, 5-6 October 2022, Melbourne, Australia. 94 pp.

Copyright

© Commonwealth Scientific and Industrial Research Organisation 2022. To the extent permitted by law, all rights are reserved and no part of this publication covered by copyright may be reproduced or copied in any form or by any means except with the written permission of CSIRO.

Important disclaimer

CSIRO advises that the information contained in this publication comprises general statements based on scientific research. The reader is advised and needs to be aware that such information may be incomplete or unable to be used in any specific situation. No reliance or actions must therefore be made on that information without seeking prior expert professional, scientific and technical advice. To the extent permitted by law, CSIRO (including its employees and consultants) excludes all liability to any person for any consequences, including but not limited to all losses, damages, costs, expenses and any other compensation, arising directly or indirectly from using this publication (in part or in whole) and any information or material contained in it.

CSIRO is committed to providing web accessible content wherever possible. If you are having difficulties with accessing this document please contact csiroenquiries@csiro.au.

Contents

Acknowledgments

Age data were provided by Kyne Krusic-Golub (Fish Ageing Services), ISMP and AFMA logbook and CDR data were provided by Matthew Duncan and Derek Newman (AFMA). Mike Fuller, Paul Burch, Robin Thomson, Roy Deng, Franzis Althaus, Toni Cannard and Caroline Sutton (CSIRO) pre-processed the data. Miriana Sporcic provided standardised CPUE. Malcolm Haddon provided useful code for auto-balancing, Athol Whitten provided useful R code for organising plots. Geoff Tuck, Robin Thomson, Paul Burch, Sandra Curin-Osorio (CSIRO) and Neil Klaer provided valuable review and discussion of this work. Ian Taylor, Chantel Wetzel, Kathryn Doering and Kelli Johnson (NOAA) are thanked for helpful reccomendations and fixes in relation to the the r4ss package. The r4ss package maintained by Ian Taylor (https://github.com/r4ss/r4ss) was critical for producing multiple diagnostic plots, and tuning models.

1 Executive Summary

This document presents a base case for an updated quantitative Tier 1 assessment of Tiger Flathead (*Neoplatycephalus richardsoni*) for presentation at the first SERAG meeting in 2022. The last full assessment was presented in 2019 (Day, 2019a). The preliminary base case has been updated with the inclusion of data up to the end of 2021, which entails an additional three years of catch, discard, catch per unit effort (CPUE), length and age data and ageing error updates since the 2019 assessment. This document describes the process used to develop a preliminary base case for Tiger Flathead through the sequential updating of recent data to the stock assessment, using the stock assessment package Stock Synthesis (SS-V3.30, Methot and Wetzel (2013)).

The only change to the 2019 base case stock assessment, other than the inclusion of new data, is extending the maximum length bin from 59 cm to 65 cm to reduce the accumulation of individuals in the length plus group, with this particularity apparent in the Tasmanian Trawl and East Trawl fleets.

Results show reasonably good fits to the catch rate, discard, length and conditional age-at-length data. This assessment estimates that the projected 2023 spawning stock biomass will be 43% of unfished spawning stock biomass (projected assuming 2021 catches in 2022), compared to 34% at the start of 2020 from the 2019 assessment (Day, 2019a) and 43% at the start of 2017 from the 2016 assessment (Day, 2016). This change in stock status is largely due to a higher estimate of stock recruitment steepness (h) than in the previous assessment along with the updated CPUE, length frequency and conditional age at length data.

Likelihood profiles of h from the 2019 assessment and the current base case suggest that there is insufficient data informing the estimation of this parameter. These results suggest that h should be fixed in future iterations of the assessment. Fixing h has implications for the target of the harvest control rule (HCR), which is currently set to $0.4B_0$, lower than the default target used in the SESSF of $0.48B_0$. This deviation from the target for Tiger Flathead resulted from estimation of h in previous assessments, which allowed maximum sustainable yield (MSY) to be calculated. Without estimation of h or an alternative bio-economic analysis the target would return to the default value of $0.48B_0$. A decision on whether to fix this parameter and the associated consequences requires discussion and feedback from the SERAG at the October meeting.

2 Introduction

2.1 2022 Tiger Flathead assessment base case

The 2022 preliminary base case assessment of Tiger Flathead uses an age- and size-structured model implemented in the generalised stock assessment software package, Stock Synthesis (SS) (Version 3.30.19.01, Methot et al. (2022)). The methods utilised in SS are based on the integrated analysis paradigm. SS 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, parameterised 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). SS allows the user to choose among a large number of age- and length-specific selectivity patterns. The values for the parameters are estimated by fitting to data on catches, catch-rates, discard rates, discard and retained 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 SS technical documentation (Methot, 2005).

The base case model includes the following key features:

A single region, single stock model is considered with six fleets. These fleets represent one or more temporal, spatial or gear differences in the fishery. Details of each fleet are provided below:

1. Steam trawl: steam trawlers 1915-1961.
2. Danish seine: Danish seine from NSW, eastern Victoria and Bass Strait 1929-2021.
3. East trawl: diesel otter trawlers from NSW, eastern Victoria and Bass Strait 1971-2021.
4. Tasmanian trawl: diesel trawlers from eastern Tasmania 1971-2021.
5. Fishery independent survey east: fishery independent survey operating in NSW, eastern Victoria and Bass Strait 2008-2016.
6. Fishery independent survey Tasmania: fishery independent survey operating eastern Tasmania 2008-2016.

Selectivity is assumed to vary among fleets, with the selectivity pattern for each separate fleet modelled as length-specific, logistic and for most fleets time-invariant. The selectivity for Danish seine is allowed to change in 1978, and eastern diesel trawl in 1985. The two parameters of the selectivity function for each fleet are estimated within the assessment.

Retention is also defined as a logistic function of length, and the inflection and slope of this function are estimated for the three fleets where discard information is available (Danish seine, East trawl and Tasmanian trawl). Retention for the Steam trawl fleet was implicitly assumed to be independent of length as no length frequency composition data is available on discards for this fleet.

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

The initial and final years are 1915 and 2021.

The CVs of the CPUE indices were initially set at a value equal to the standard error from a loess fit (0.1 for steam trawl, 0.1 for the historic Danish seine, 0.177 for Danish seine, 0.143 for East trawl, 0.188 for Tas trawl, 0.185 for FIS east and 0.143 for FIS Tas; Sporcic (2022)), before being re-tuned to the model-estimated standard errors by estimating an additional variance parameter within SS.

The rate of natural mortality, M, is assumed to be constant with age, and also time-invariant. The value for M is fixed at 0.27 yr^{-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 estimated.

The initial value of the parameter determining the magnitude of the process error in annual recruitment, σ_r, is set to 0.699.

The population plus-group is modelled at age 20 years.

For retained and discarded onboard lengths, the number of shots is used as the sampling unit and sample sizes were capped at 200, with greater than 100 fish sampled annually required for inclusion in the model. For port samples, numbers of trips were used as the sampling unit, with a cap of 200. The sample size is reduced 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.

The values assumed and estimated for some of the key parameters of the base case models are shown in Table 1.

Table 1 Parameter values assumed for some of the non-estimated parameters of the base-case model

PARAMETER	DESCRIPTION	ESTIMATED	VALUE
M	Natural mortality	Fixed	0.27
h	Stock recruitment steepness	Estimated	0.84
ln(R_0)	log unfished recruitment	Estimated	9.85
σ_r	recruitment variability	Fixed	0.699
x	age observation plus group	Fixed	20 years
a	allometric length-weight equations	Fixed	0.00000588 g^{-1} cm
b	allometric length-weight equations	Fixed	3.31
l_m	Female length at 50% maturity	Fixed	30 cm

3 Bridging methodology

The previous full quantitative assessment for Tiger Flathead was performed in 2019 Day (2019a) using Stock Synthesis (version SS-V3.30.14.00, Methot et al. (2018)). The 2021 assessment uses the current version of Stock Synthesis (version SS-V3.30.19.01, Methot et al. (2022)).

As a first step in the process of bridging to a new model, with the data used in the 2019 assessment used in the new software (SS-V3.30.19.01). Once this translation was complete, improved features unavailable in SS-V3.14 were incorporated into the SS-V3.30.19 assessment. The catch series was then updated to include any amended estimates for the historical period from 2000 to 2019 since the 2019 assessment. These changes we due to inclusion of non-trawl catches in the assessment that were previously excluded. Following this step, the model was re-tuned (data sources re-weighted in the likelihood) 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 may lead to changes to key model outputs, such as the estimates of depletion and the trajectory of spawning biomass. This initial bridging phase (Bridge 1) highlights changes that have occurred since 2019 simply through changes to software and assessment practices.

The subsequent bridging exercise (Bridge 2) then sequentially updates the model with new data through to 2021. These additional data included new catch, discard estimates, CPUE, length composition data, conditional age-at-length data and an updated ageing error matrix. The last year of recruitment estimation was extended to 2017 (from 2015 in Day (2019a)). An additional step extending the maximum length bin from 59 cm to 65 cm was then included. The final step was to re-tune the model.

4 Bridge 1

4.1 Updating Stock Synthesis

The 2018 Tiger Flathead assessment was converted to the most recent version of the Stock Synthesis software, version SS-V3.30.19.01. This resulted in no changes to the stock status estimates throughout the time series (Figure 1).

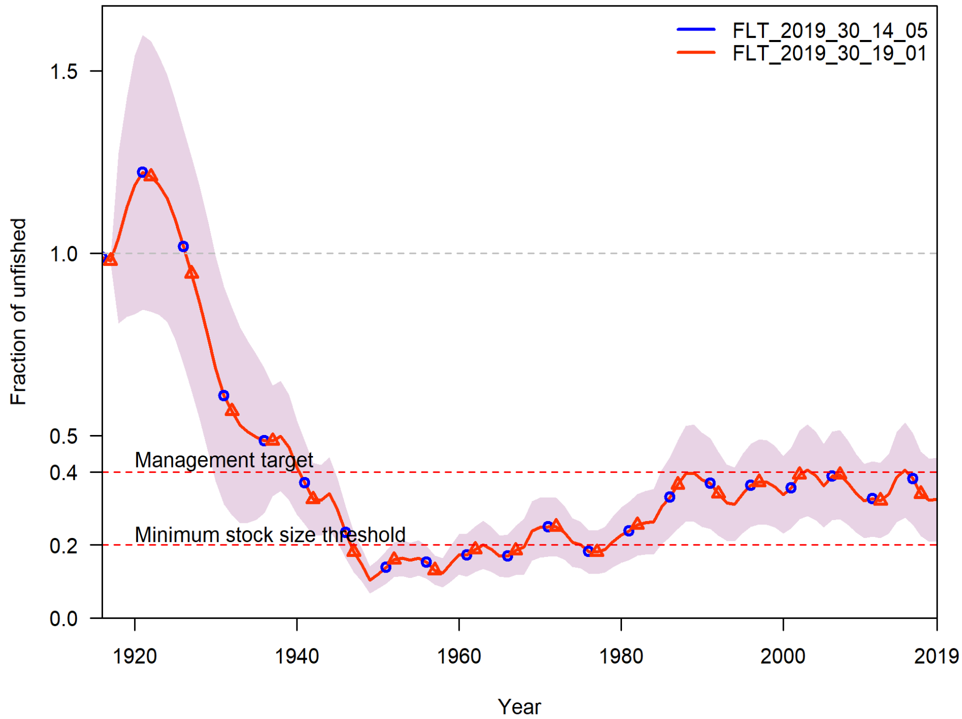


Figure 1 Comparison of the stock status time series for the 2019 assessment (SS3-30.14) and a model converted to SS-V3.30.19.01.

4.2 Incorporating new features in Stock Synthesis

New features available in the latest versions of Stock Synthesis, such as allowing smaller lower bounds on minimum sample sizes and estimating additional standard deviation to abundance indices were then incorporated (labelled 'New'). This step resulted in a small increase in the estimated stock status trajectory between 1920 and 1940, and again between 1985 and 2019 (Figure 2).

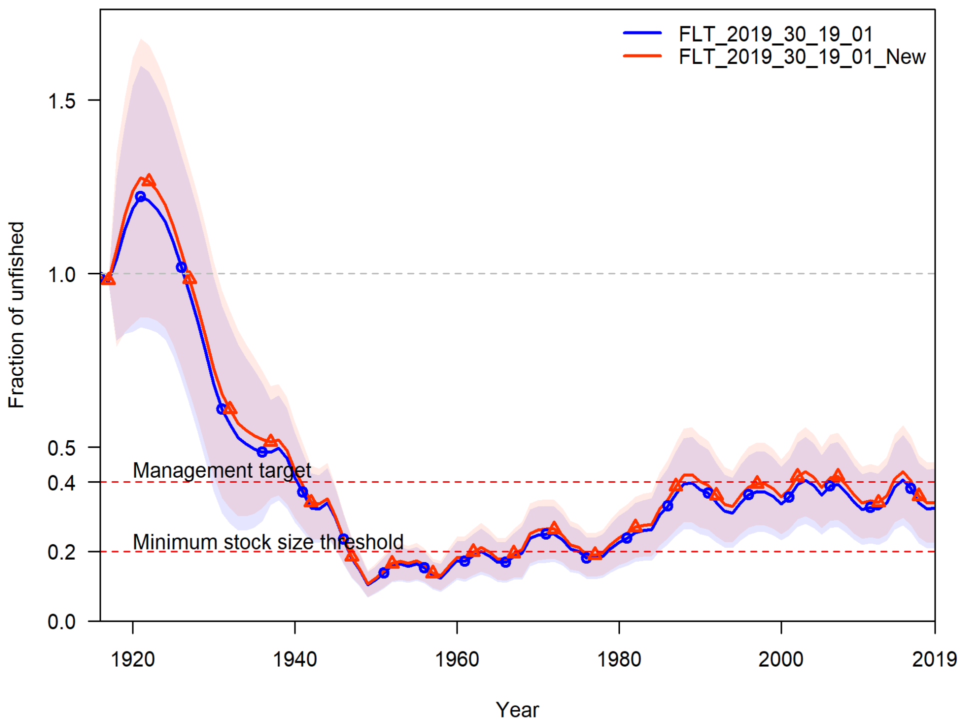


Figure 2 Comparison of the stock status time series for the 2019 assessment updated to the latest Stock Synthesis version (SS-V3.30.119.01), with new settings applied to the model (New).

4.3 Updating catches

Incorporating amended historical catches from 2000 resulted in minor changes to stock status estimates, which are only just evident (Figure 3). The small increase in catches across the three current fleets was due to incorporation of non-trawl catches that were previously excluded from the assessment. This change also resulted in minor revision of recruitment deviations between 1935-1945 and 2000-2019 (Figure 4).

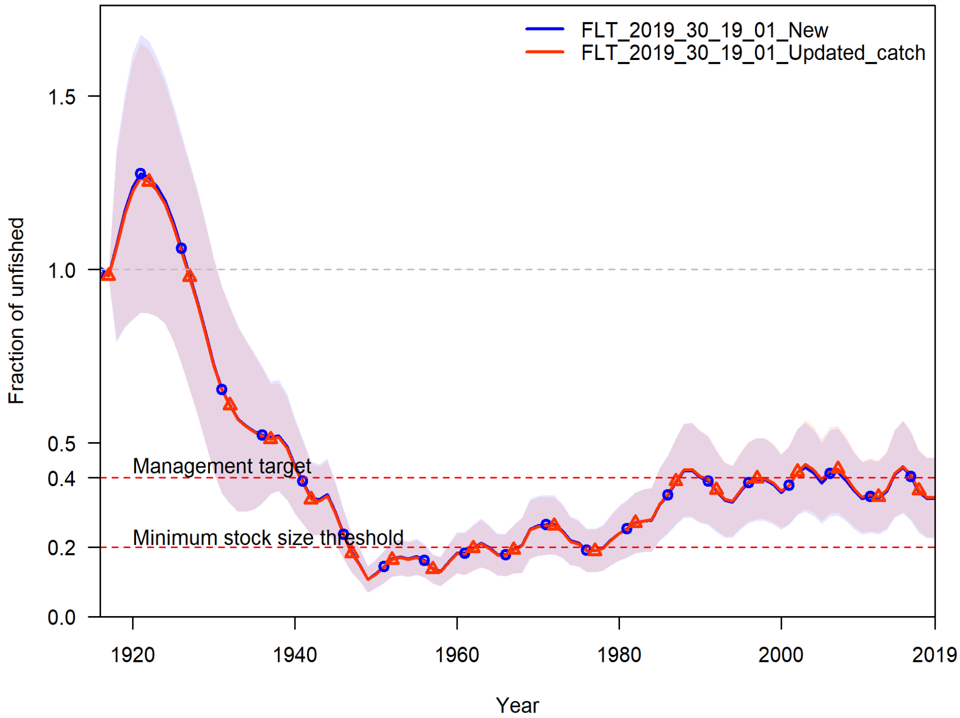


Figure 3 Comparison of the stock status time series for the 2019 assessment with updated settings (New) with both updated settings and amended historical catch series (Updated catch).

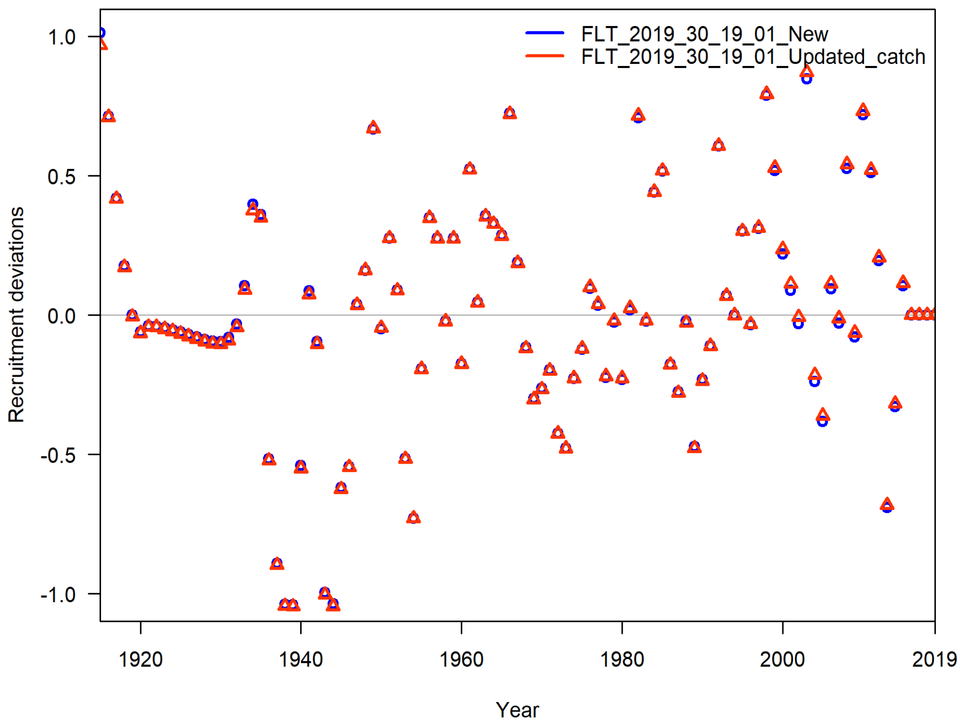


Figure 4 Comparison of the estimated recruitment deviations for the 2019 assessment with updated settings (New) with both updated settings and amended historical catch series (Updated catch).

4.4 Tuning

The assessment was then tuned using the latest tuning protocol (labelled 'Tuned') (Figure 5, Figure 6). This process demonstrates the outcomes that could theoretically have been achieved with the last assessment if the latest software, tuning protocols and corrected data were available in 2019. This initial bridging step, Bridge 1, does not incorporate any data after 2019 for catches or 2018 for other data or any structural changes to the assessment.

When these series are all plotted together, there are minor changes resulting from incorporating new features and updating catches (Figure 5, Figure 6). The new tuning procedures resulted in no change to the stock status estimates or estimated recruitment deviations (Figure 5, Figure 6, orange and red lines).

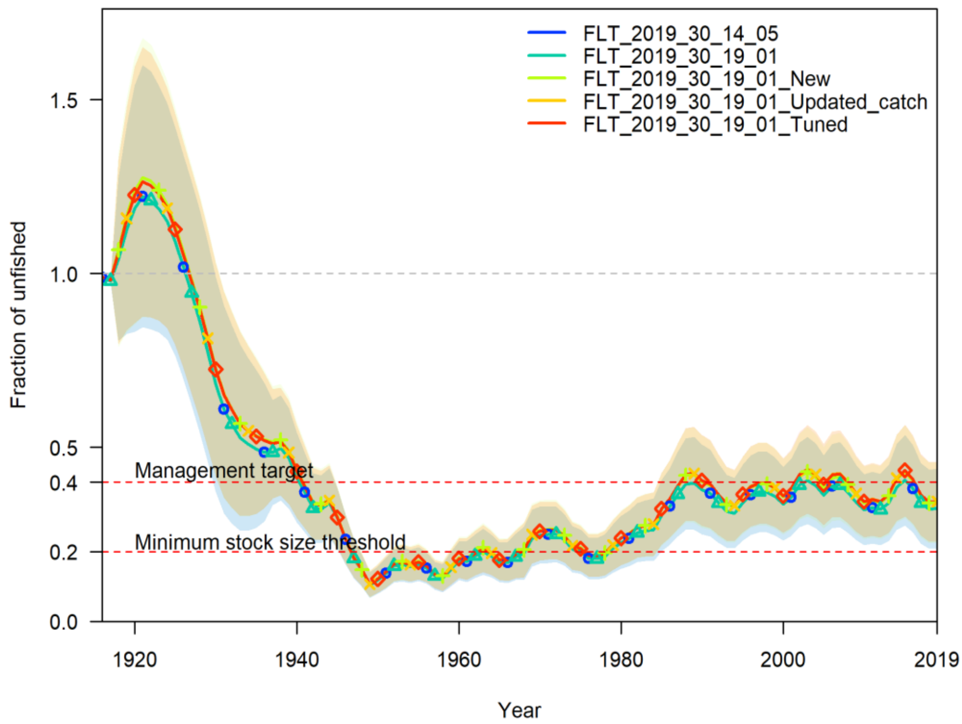


Figure 5 Comparison of the stock status time series for the four steps included in the first bridging.

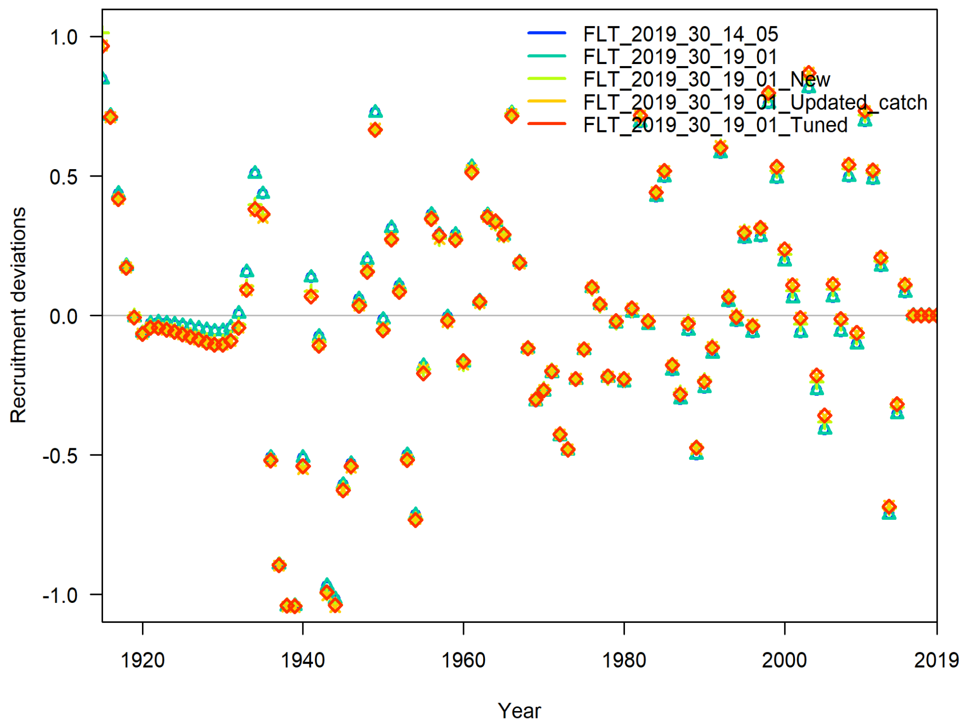


Figure 6 Comparison of the estimate recruitment deviations for the four steps included in the first bridging.

5 Bridge 2

5.1 Inclusion of new data

The data inputs to the assessment comes from multiple sources, including: the annual total mass landed, discard rates, updated standardized CPUE series (Sporcic, 2022), length frequency and conditional age-at-length data, and updated age-reading error. Data were formulated by calendar year (i.e. 1 Jan to 31 Dec) and were split into six fleets: Steam trawl, Danish seine, East trawl, Tas trawl, FIS east and FIS Tas.

Starting from the converted 2019 base case model (labelled FLT_2019_Updated) additional and updated data to 2021 were added sequentially to develop a preliminary base case for the 2022 assessment, these steps included:

1. Change final assessment year to 2021, add catch to 2021 (addCatch2021).
2. Add CPUE to 2021 (from Sporcic (2022)) (addCPUE2021).
3. Add updated discard fraction estimates to 2021 (add_Discards2021).
4. Update length frequency data, including both port and onboard length frequencies (addLengths2021).
5. Add updated age-at-length data to 2021 and a updated age error matrix (addAge2021).
6. Change the final year for which recruitment deviations are estimated from 2015 to 2017 (extendRec2017).
7. Extend the length bins from a maximum length of 59 cm to 65 cm (extendLenBins).
8. Retune using latest tuning protocols, including Francis weighting on length-compositions and conditional age-at-length data (Tuned).

Catch estimates were updated with values from the database from 2000 to include non-trawl catches in the catch series. CPUE estimates were updated for the three currently active fleets (Danish seine, East trawl and Tas trawl), while the other series remain the same as in previous assessments. All discard estimates were updated with newly calculated values. Length data for Danish seine, East Trawl, Tas trawl and FIS east were updated with values provided by AFMA, while historical estimates for the Steam trawl, early Danish seine and Sydney Fish Market port measurements remained the same. Conditional age at length data has also been re-processed for all years. Differences between the input values into the previous assessment and those processed here were examined and found to be minor.

5.2 Extending length bins

When examining the compiled length frequencies that are included in the assessment it was apparent that in both the Tas trawl and to a lesser extent the East trawl fleets a considerable proportion of the data was ending up in the maximum length bin, resulting in a large plus group. Ideally the maximum length bin should be high enough that it does not include a large proportion of the observations so the model can accurately model growth in the larger size classes. The difference between the length frequencies with a maximum length of 59 cm and 65 cm for the Tas trawl fleet from 2010 onwards are presented in Figure 7.

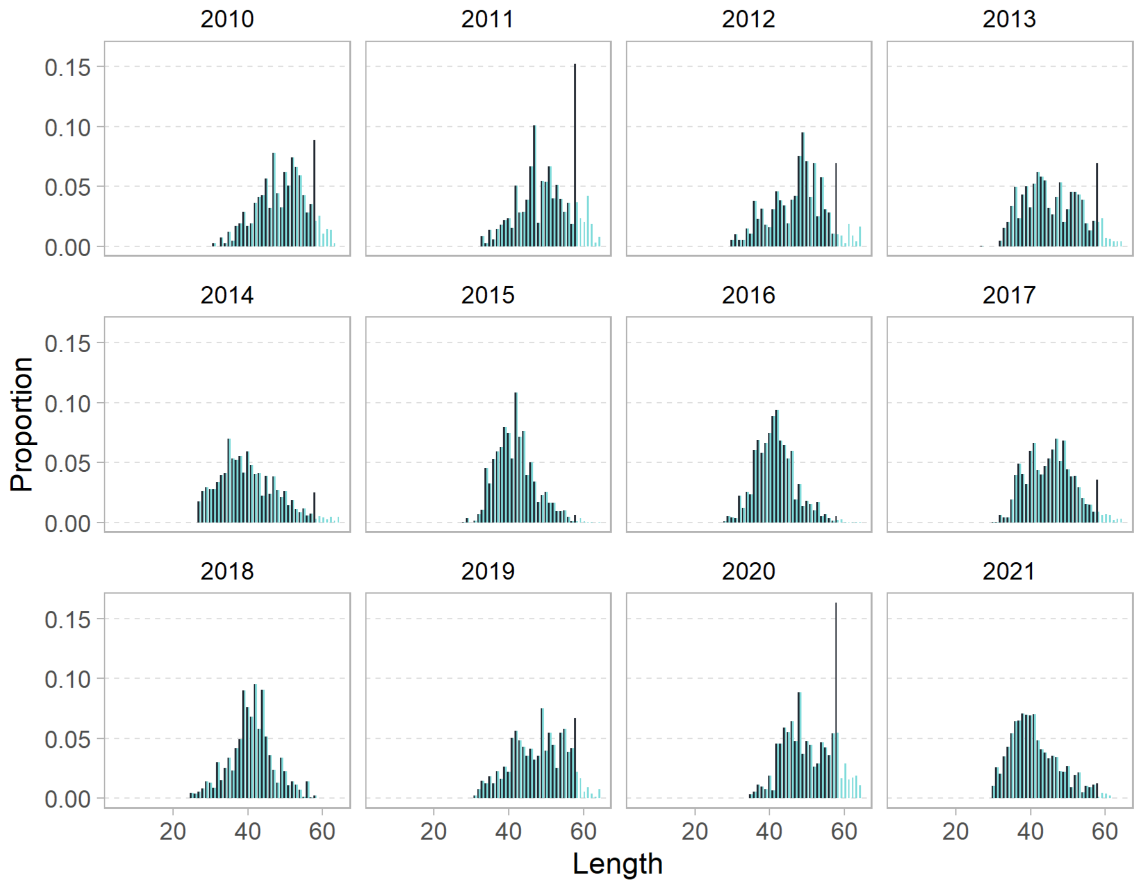


Figure 7 Comparison of length data summarised with a maximum length bin of 59 cm (black) and one with a maximum of 65 cm (blue) for the Tas trawl fleet.

5.3 Results

Inclusion of the new data resulted in a series of changes to the outputs of the model. The addition of catch data made no difference to estimated spawning biomass and stock status (Figure 8-9). The addition of updated CPUE series resulted in decreased spawning biomass from 2018 (Figure 8-9). The addition of updated discard data reduced estimates of spawning biomass between 1985 and 1995

(Figure 8-9). The addition of length data decreased spawning biomass and stock status from 1915 to 1945 before increasing estimates from 1995 (Figure 8-9). Including updating conditional age at length data further increased estimates of spawning biomass from 2000 (Figure 8-9). Extending recruitment deviations and then tuning resulted in a downward revision of spawning biomass and stock status from 2018 through to 2021 (Figure 8-9).

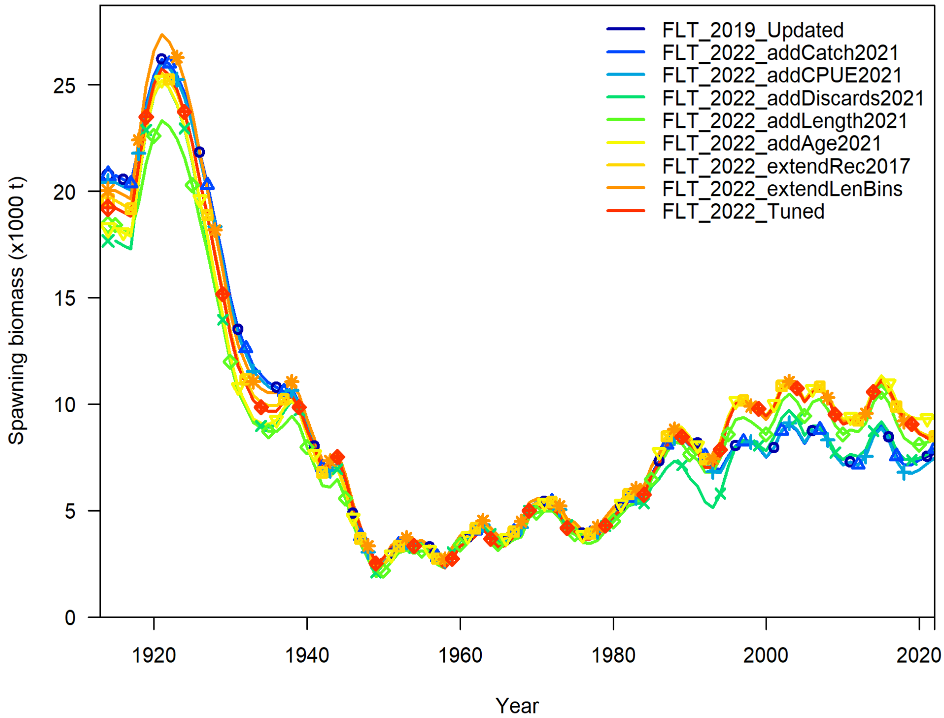


Figure 8 Comparison of the absolute spawning biomass for the updated 2019 assessment converted to SS-V3.30.19 (FLT_2019_Updated - blue) with various bridging models leading to the 2022 preliminary base case (FLT_2022_Tuned - red).

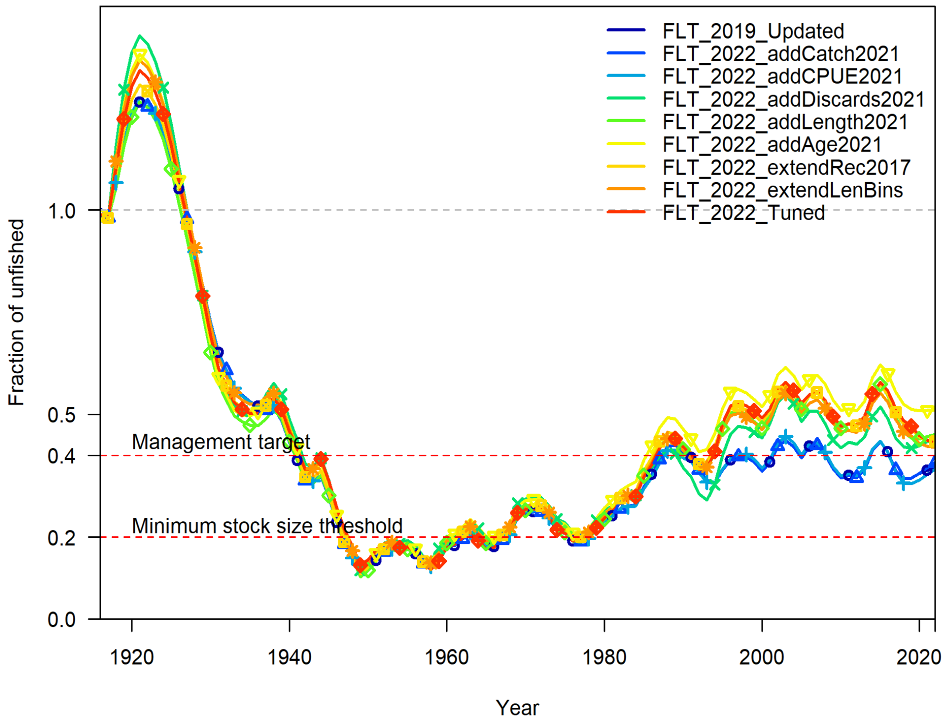


Figure 9 Comparison of the fit to the relative spawning biomass for the updated 2019 assessment model converted to SS-V3.30.19 (FLT_2019_Updated - blue) with various bridging models leading to the 2022 preliminary base case (FLT_2022_Tuned - red).

The sequential addition of data resulted in variation in recruitment estimates throughout the entire time series, with some estimates revised up while others are revised down, with this also apparent in the recruitment deviations (Figure 10-11). There is no clear pattern in these revisions through time, although larger changes are apparent when extending the recruitment deviations and tuning (Figure 10-11).

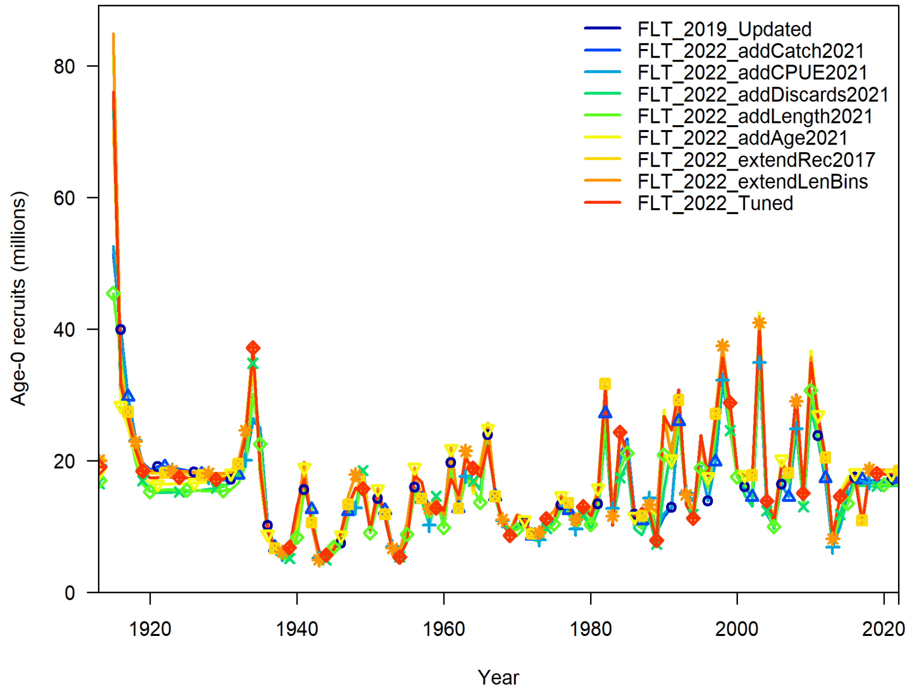


Figure 10 Comparison of the estimated recruitments for the updated 2019 assessment model converted to SS-V3.30.19 (FLT_2019_Updated - blue) with various bridging models leading to the 2022 preliminary base case (FLT_2022_Tuned - red).

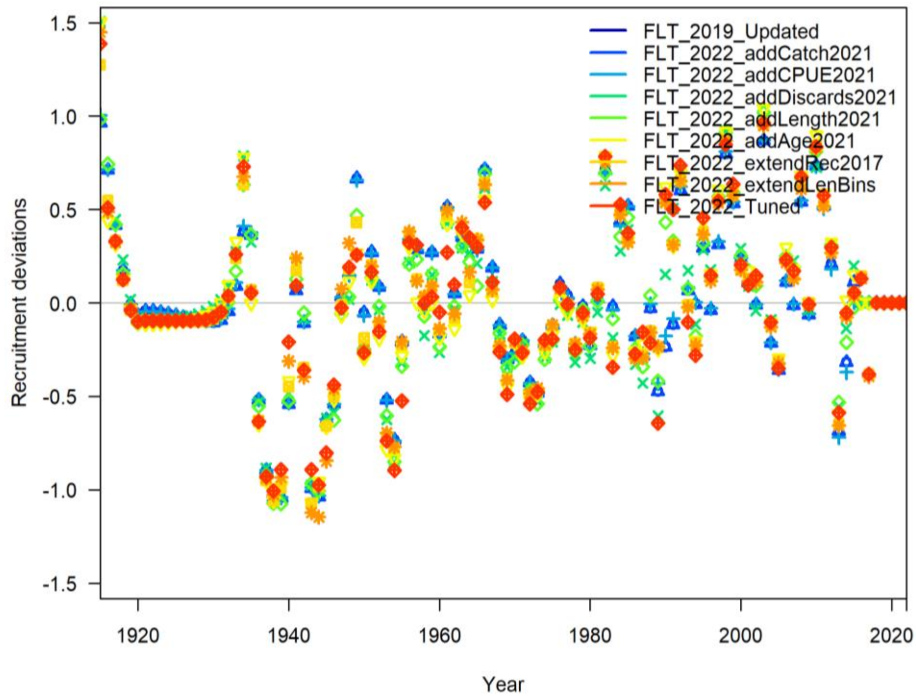


Figure 11 Comparison of the estimated recruitment deviations for the updated 2019 assessment model converted to SS-V3.30.19 (TRS_2018_Updated - blue) with various bridging steps leading to the 2022 preliminary base case (FLT_2022_Tuned - red).

The impacts of inclusion of new data on fits to CPUE series were generally small. Fits to the steam trawl fleet CPUE series did not change with the inclusion of additional data (Figure 12). There was a small change to fits to the historic Danish seine CPUE series when the model was tuned, with improved fits to points in the late 1960s (Figure 13). Fits to the current Danish seine CPUE deteriorated from the late 1980s to early 1990s, with reduced estimates where the model has improved fits to the Tas trawl CPUE series (Figure 14 and 16). The model fits this series well in the middle of the series between 1995 and 2012, however fits on each end are poor, with the model fitting higher than the input CPUE between 2013 and 2021 (Figure 14). Fits to the east trawl CPUE series are poor between 1985 and 1999, with the model fitting below the input CPUE between 1985 and 1993, while fitting above between 1995 and 1998 (Figure 15). As with the modern Danish seine fleet, estimates of early east trawl CPUE values are lower than input CPUE from 1985 to 1993 with the addition of discard data, with improved fits observed over this period to the Tas trawl CPUE series (Figure 15 and 16). Fits to the Tas trawl CPUE series have improved between 1986 and 1997 with the inclusion of updated discard data with the model fitting the closer to the lower point estimates (Figure 16). Between 1998 and 2021 the model has slightly increased estimates of CPUE throughout, with poor fits to the data between 2002-2006, fitting well from 2007-2011, fitting below input CPUE from 2012-2014 and improving fits at the end of the series with the 2021 estimate fitting almost perfectly, noting that this data hasn't changed since the previous assessment (Figure 16). Fits to the FIS east and FIS Tas series have changed very little from the 2019 assessment and both fit the data within the confidence intervals (Figure 17-18). Given the large number of CPUE series that the model is fitting simultaneously it is not surprising that there are periods within each series that have poor fits, however, overall fits to the series are generally good.

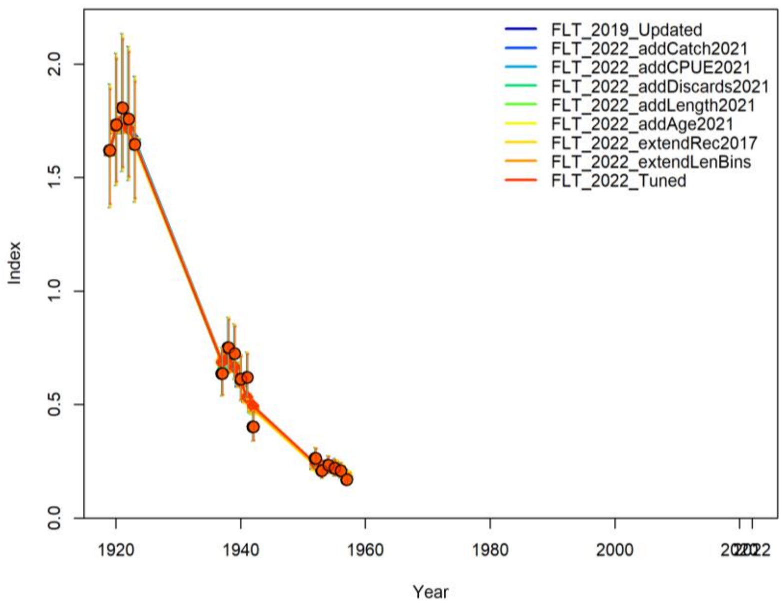


Figure 12 Comparison of the fit to the steam trawl CPUE index for the updated 2019 assessment model converted to SS-V3.30.19 (FLT_2019_Updated - blue) with various bridging models leading to the 2022 preliminary base case (FLT_2022_Tuned - red).

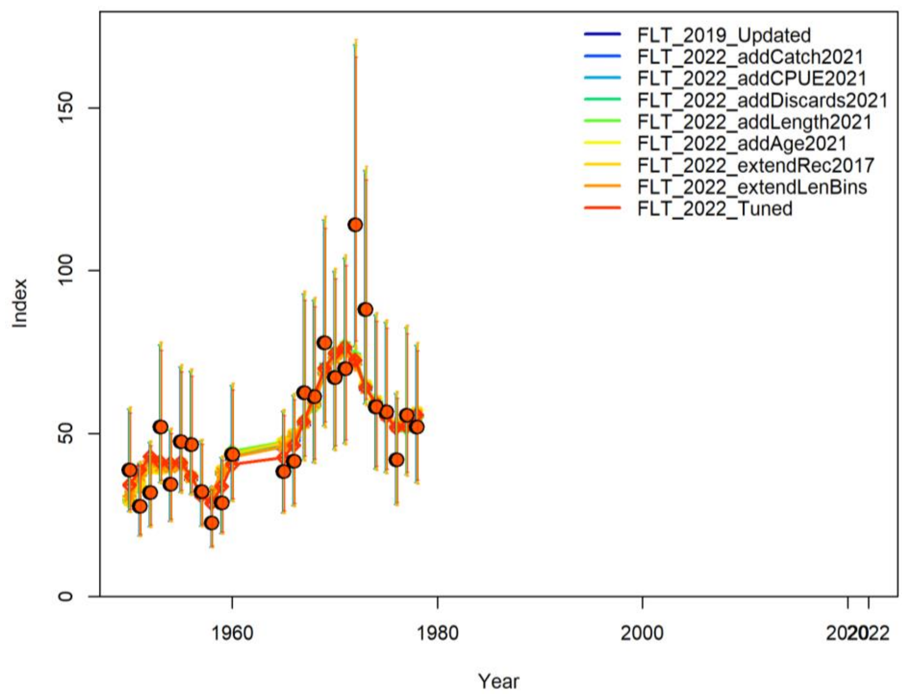


Figure 13 Comparison of the fit to the historic Danish seine CPUE index for the updated 2019 assessment model converted to SS-V3.30.19 (FLT_2019_Updated - blue) with various bridging models leading to the 2022 preliminary base case (FLT_2022_Tuned - red).

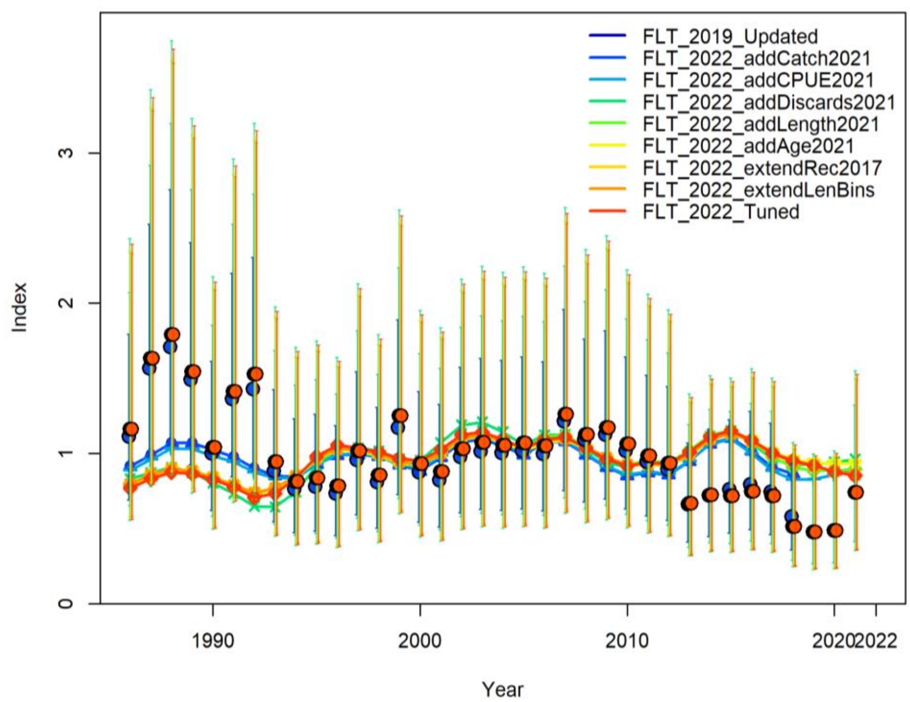


Figure 14 Comparison of the fit to the Danish seine CPUE index for the updated 2019 assessment model converted to SS-V3.30.19 (FLT_2019_Updated - blue) with various bridging models leading to the 2022 preliminary base case (FLT_2022_Tuned - red).

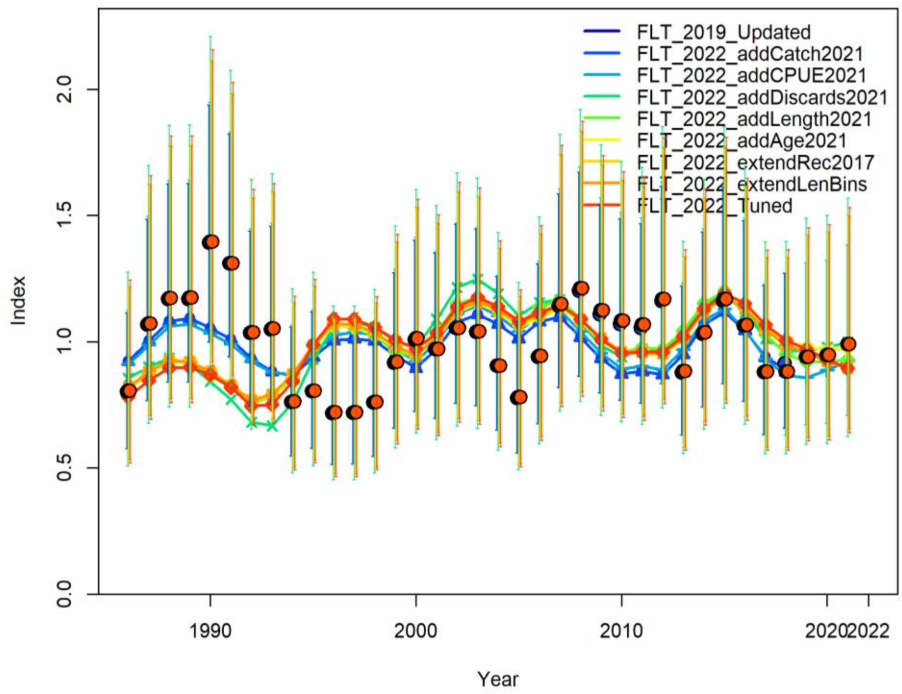


Figure 15 Comparison of the fit to the east trawl CPUE index for the updated 2019 assessment model converted to SS-V3.30.19 (FLT_2019_Updated - blue) with various bridging models leading to the 2022 preliminary base case (FLT_2022_Tuned - red).

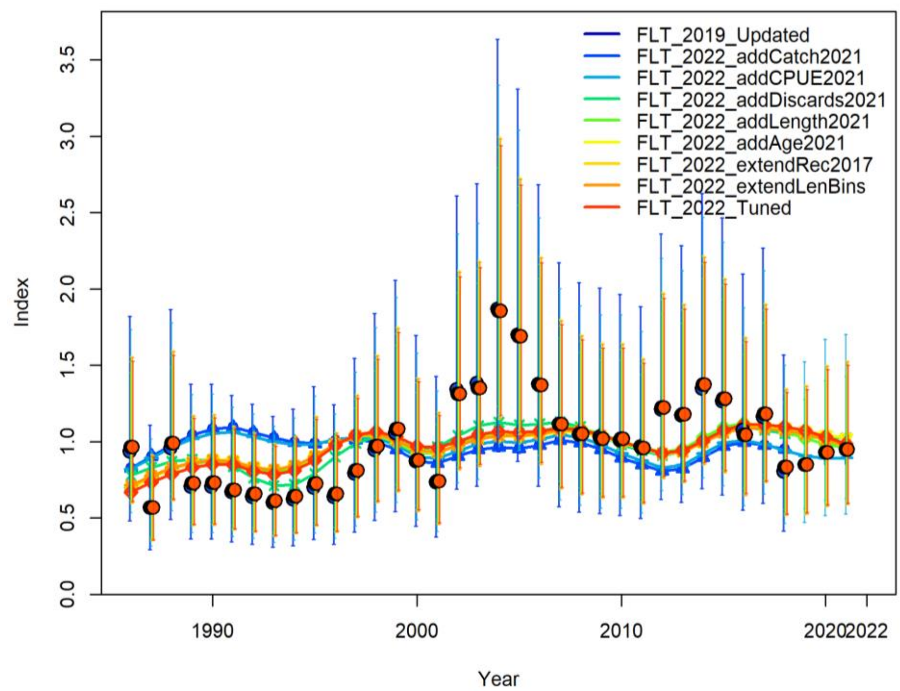


Figure 16 Comparison of the fit to the Tas trawl CPUE index for the updated 2019 assessment model converted to SS-V3.30.19 (FLT_2019_Updated - blue) with various bridging models leading to the 2022 preliminary base case (FLT_2022_Tuned - red).

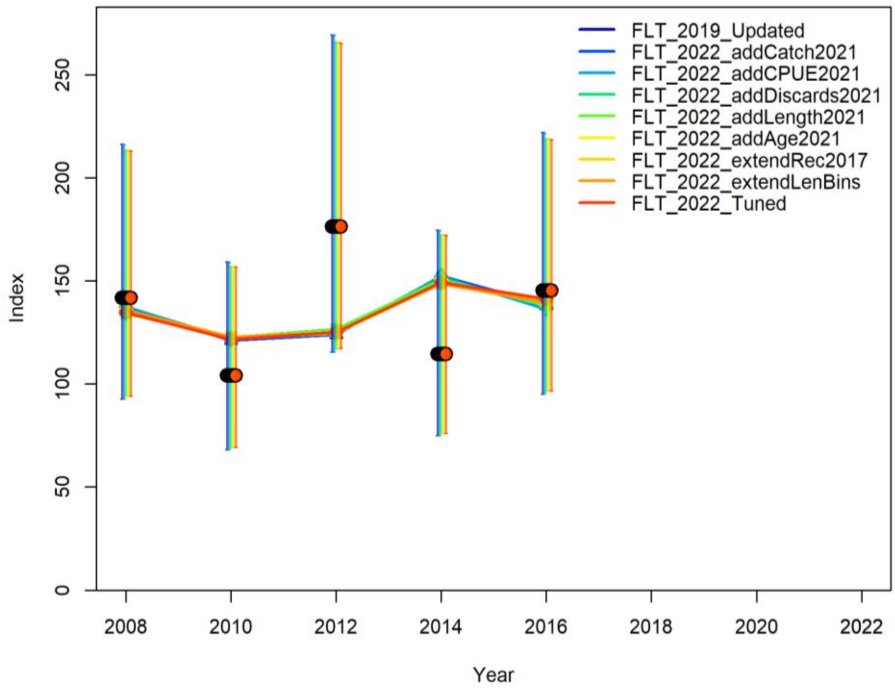


Figure 17 Comparison of the fit to the FIS east index for the updated 2019 assessment model converted to SS-V3.30.19 (FLT_2019_Updated - blue) with various bridging models leading to the 2022 preliminary base case (FLT_2022_Tuned - red).

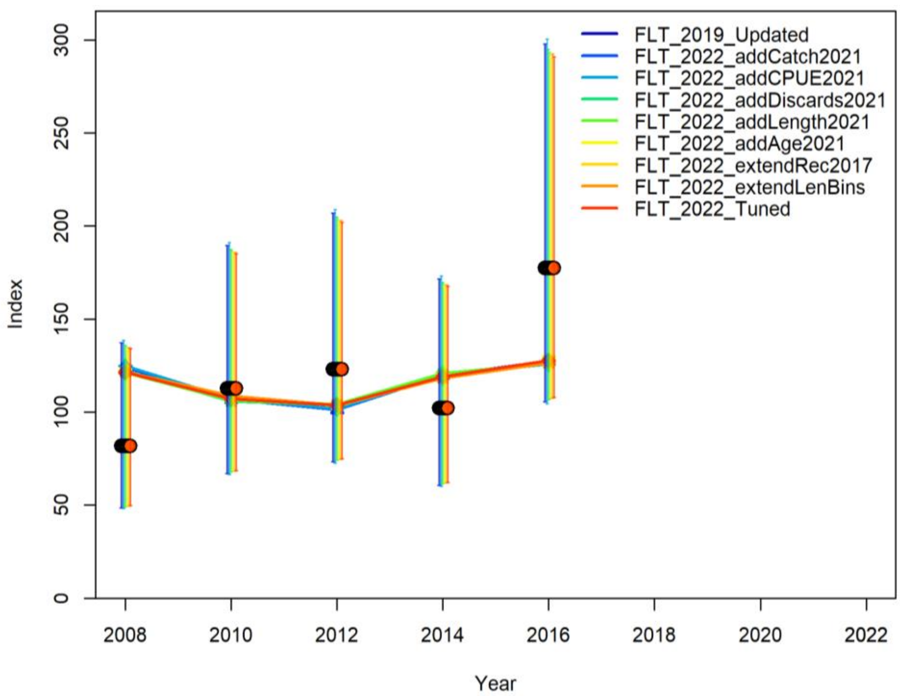


Figure 18 Comparison of the fit to the FIS Tas index for the updated 2019 assessment model converted to SS-V3.30.19 (FLT_2019_Updated - blue) with various bridging models leading to the 2022 preliminary base case (FLT_2022_Tuned - red).

5.3.1 Recruitment deviations

Standard practice for bridge 2 is to include the same number of recruitment deviations as the number of years of data that are included. In this case, as there was an additional three years of data it is standard practice to include an additional three recruitment deviations. However, in some circumstances there may not be sufficient information in the newly incorporated data to inform estimation of all of the extra recruitment deviations. In these circumstances, it is better to only estimate additional deviations that are well informed and have a low associated variance.

When including the three additional recruitment deviations for the 2022 base case the first two (2016 and 2017) were well estimated with low variance, however the third (2018) was poorly estimated, with a high variance and an extremely low estimate (Figure 19-20). This extreme recruitment deviation estimate also resulted in a dramatic decline in stock status (Figure 21).

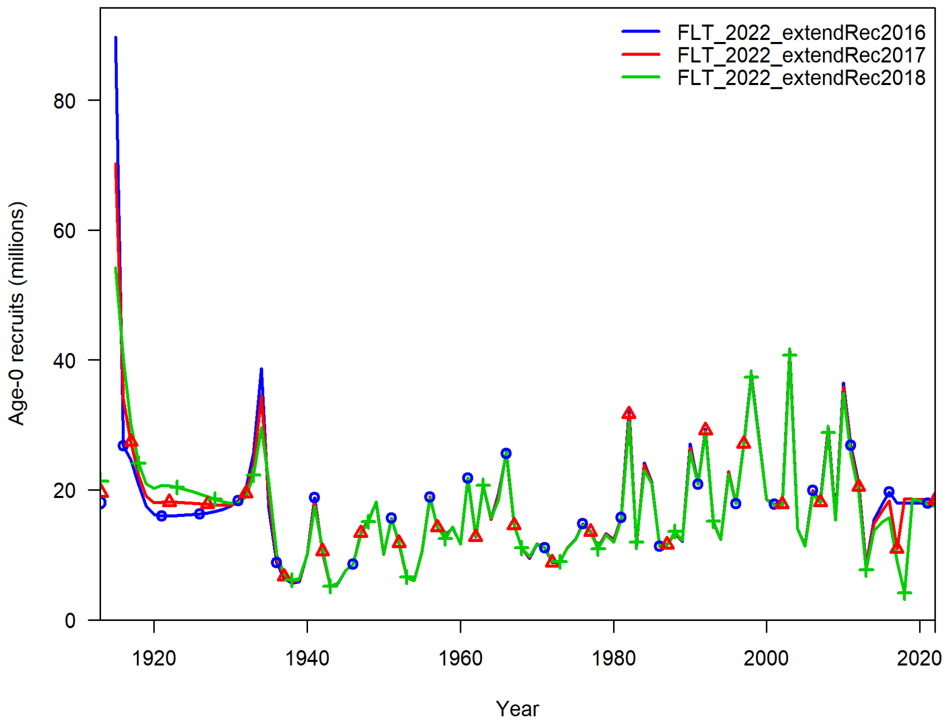


Figure 19 Comparison of the estimated recruitment when extending the year of estimation to 2015, 2016 and 2017 (blue, red and green respectively).

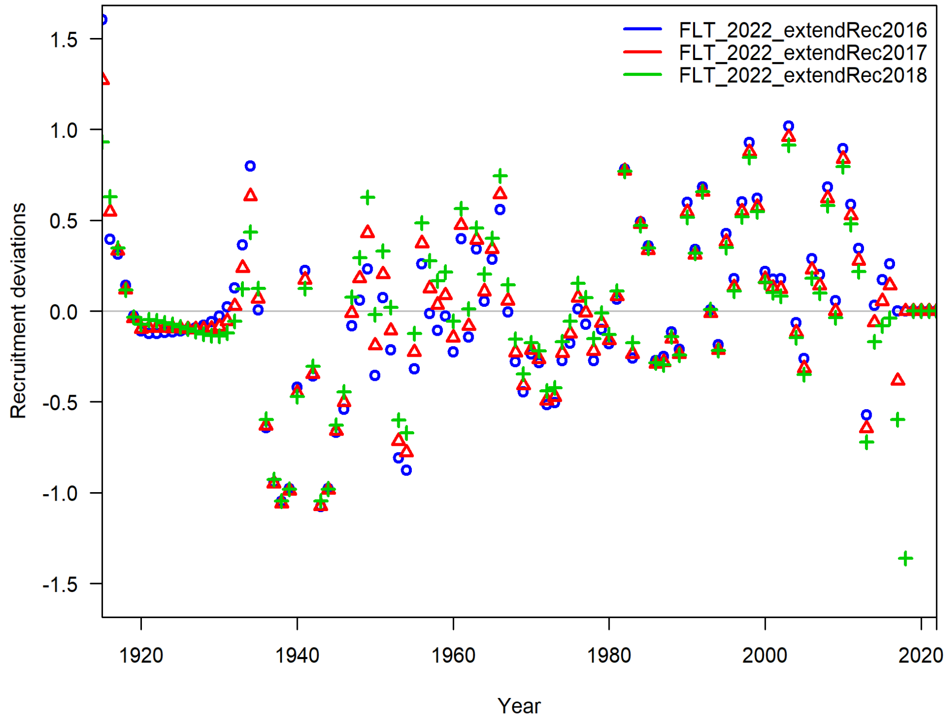


Figure 20 Comparison of the estimated recruitment deviations when extending the year of estimation to 2015, 2016 and 2017 (blue, red and green respectively).

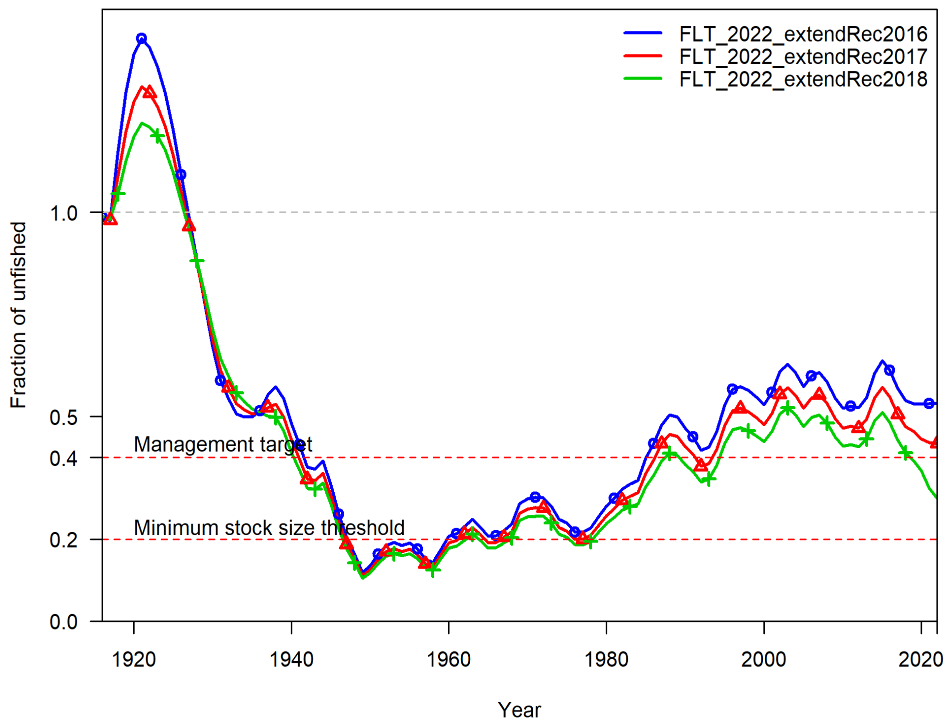


Figure 21 Comparison of stock status estimates when extending recruitment deviations to 2016, 2017 and 2018 (blue, red and green respectively).

When investigating how well each of the new recruitment deviations have been estimated and their associated variance there is a clear deterioration in the estimation between the final recruitment deviation in 2017 and 2018 (Figure 22-23). The large variance associated with the 2018 recruitment deviation suggests there is insufficient data in the assessment to inform reliable estimation of this parameter, so recruitment deviations have only been extended to 2017 for the 2022 base case.

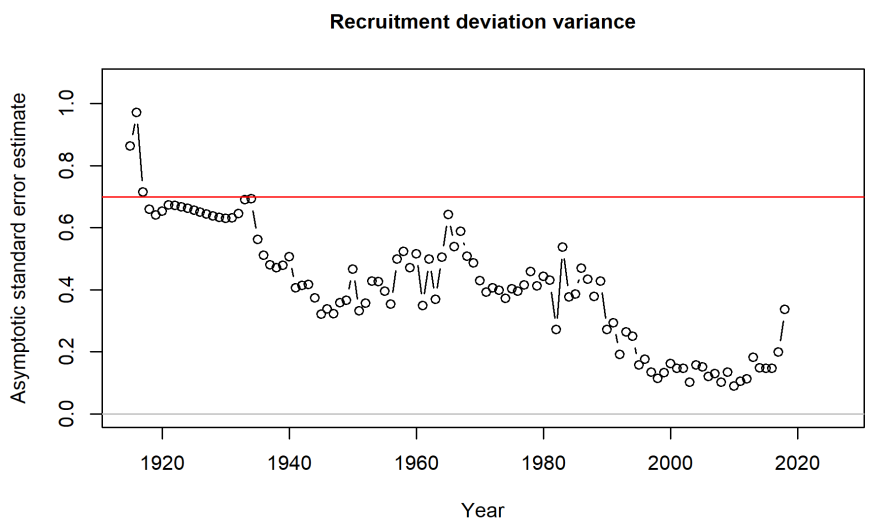


Figure 22 Estimated variance of each recruitment deviation in the model with recruitment deviations extended to 2018.

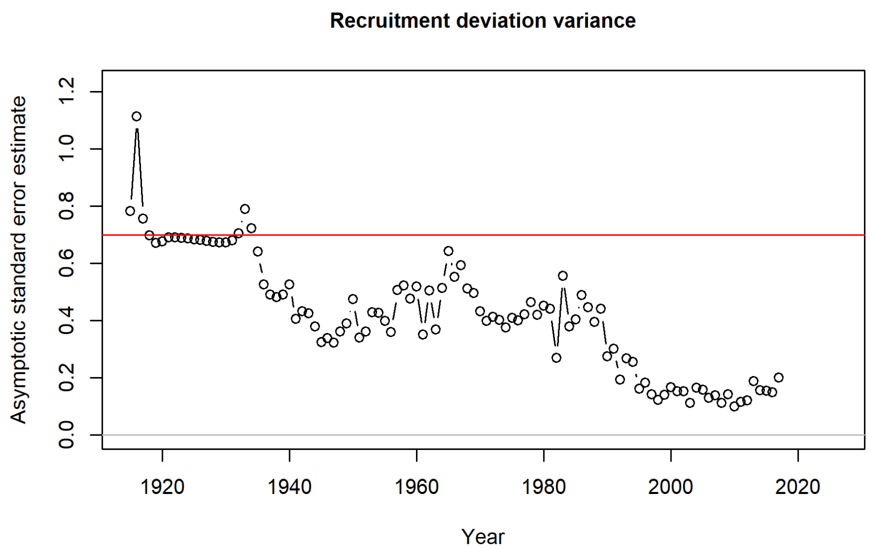


Figure 23 Estimated variance of each recruitment deviation in the model with recruitment deviations extended to 2017.

5.4 Base case

5.4.1 Fits to data

Estimated outputs and fits to data for the preliminary base case are presented in Figures 24–38. While most fits are comparable to those in the previous assessment (see Day (2019a)), there have been some changes to the fits to different CPUE indices through time as described above. Overall the fits to the different data sources are good and further diagnostics are presented in the Appendix.

5.4.2 Assessment outcomes

The estimated virgin female spawning stock biomass (SSB_0) is 19,220 tonnes (compared to 21,737 tonnes in the 2019 assessment) and the projected 2023 stock status will be 43% (projected assuming 2021 catches in 2022), compared to 34% for 2022 in the 2019 assessment (Day, 2019a). This change in stock status is largely due to a higher estimate of h, along with the updated CPUE, length frequency and conditional age at length data, despite continued estimation of low recruitment deviations. In the final tuned base case stock recruitment steepness (h) is estimated to be 0.84, compared to 0.72 in the 2019 assessment (Day, 2019a).

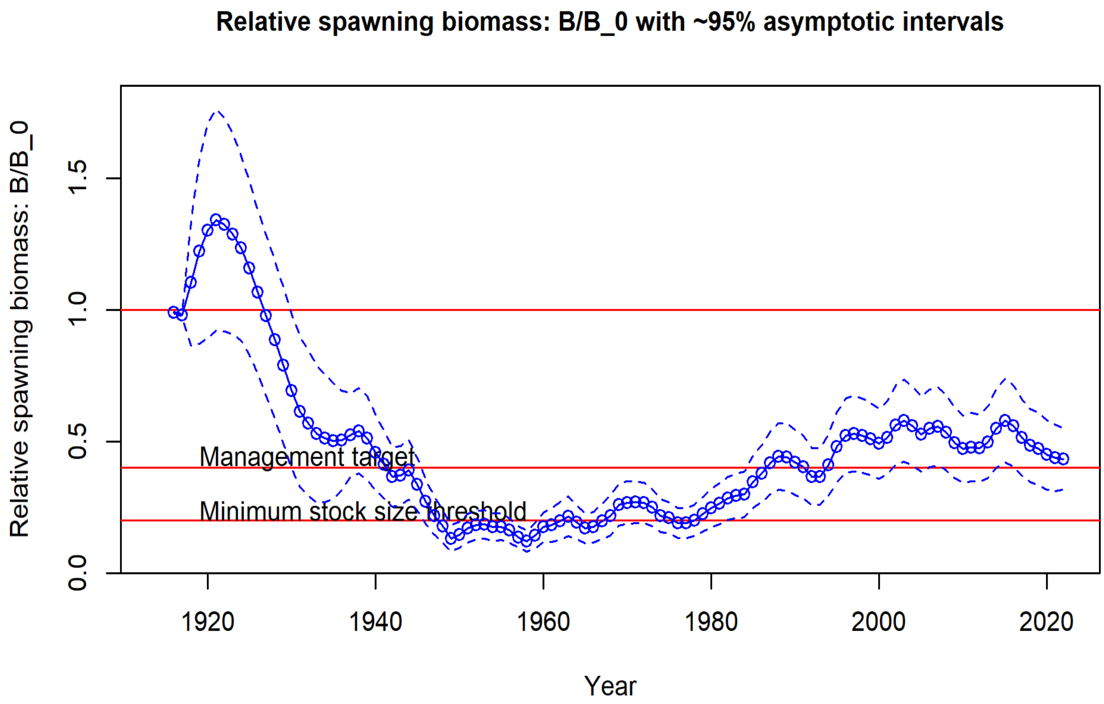


Figure 24 The estimated time-series of relative spawning biomass for the 2022 preliminary base case assessment.

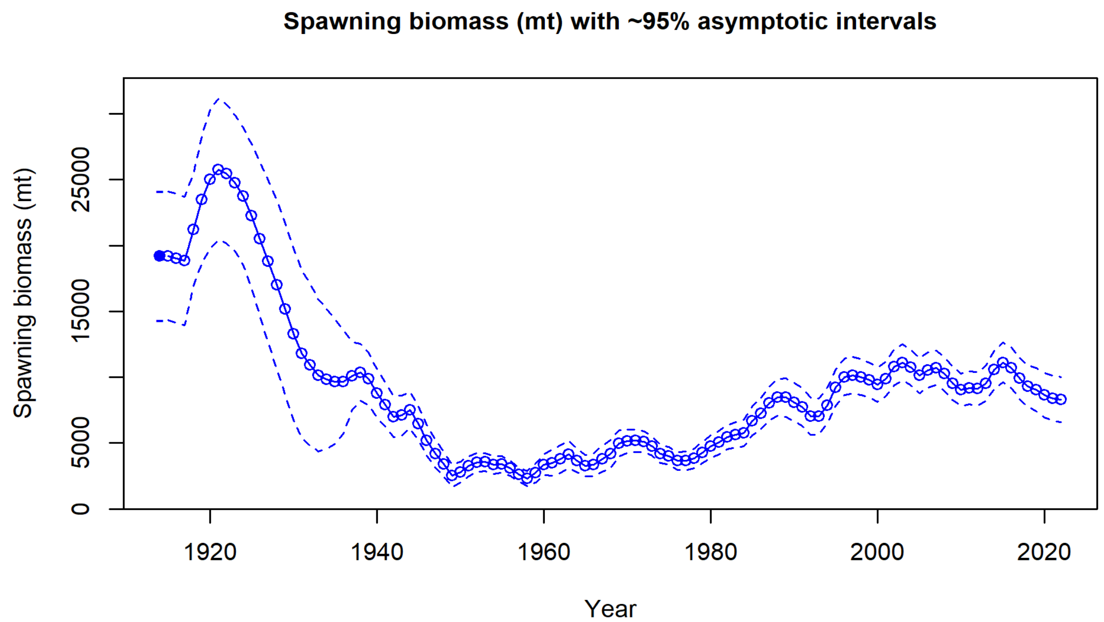


Figure 25 The estimated time-series of relative spawning biomass for the 2022 preliminary base case assessment.

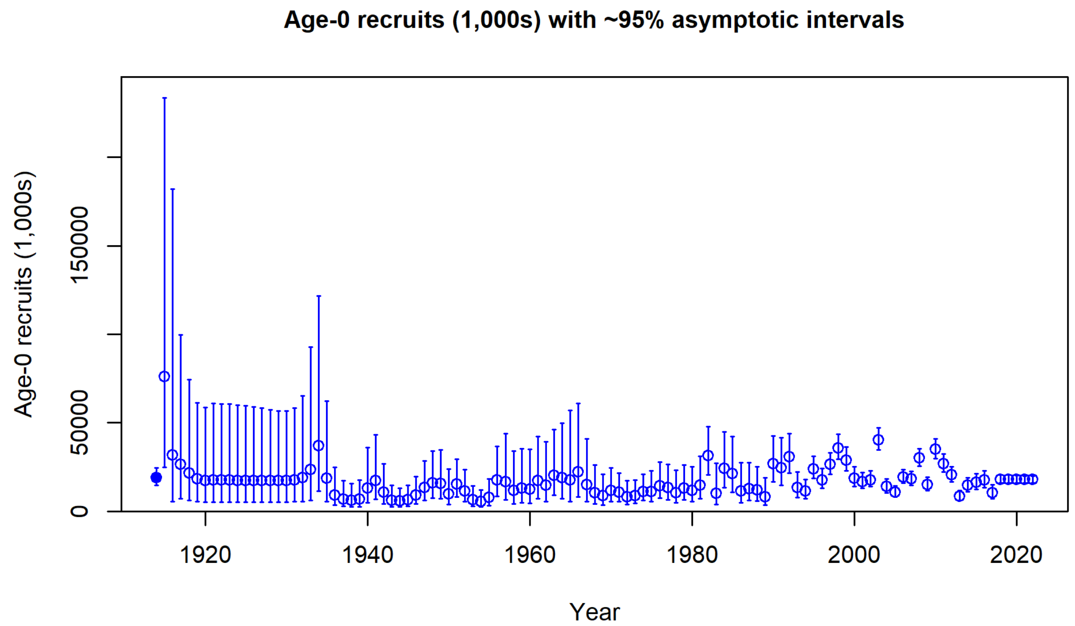


Figure 26 The estimated time-series of recruitment for the 2022 preliminary base case assessment.

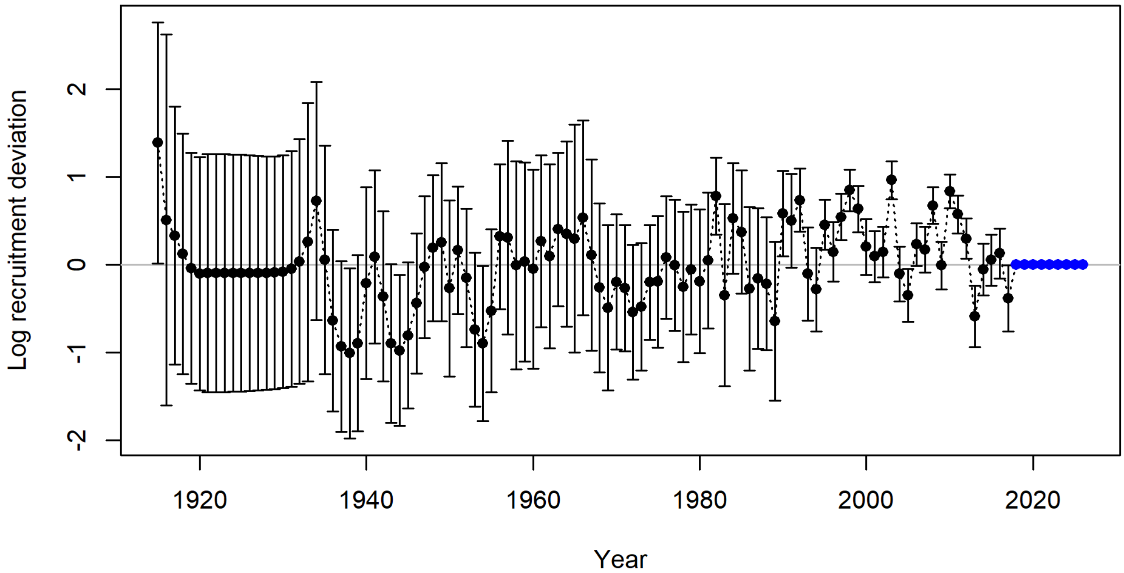


Figure 27 The estimated time-series of recruitment deviations for the 2022 preliminary base case assessment.

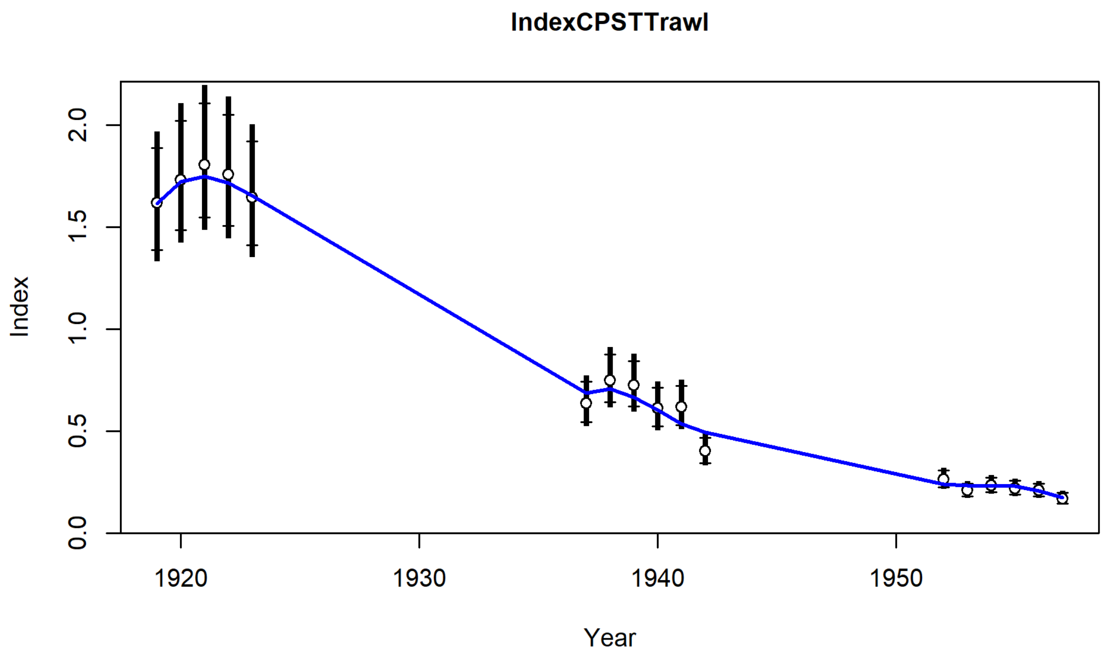


Figure 28 Fits to the steam trawl CPUE for the 2022 preliminary base case assessment.

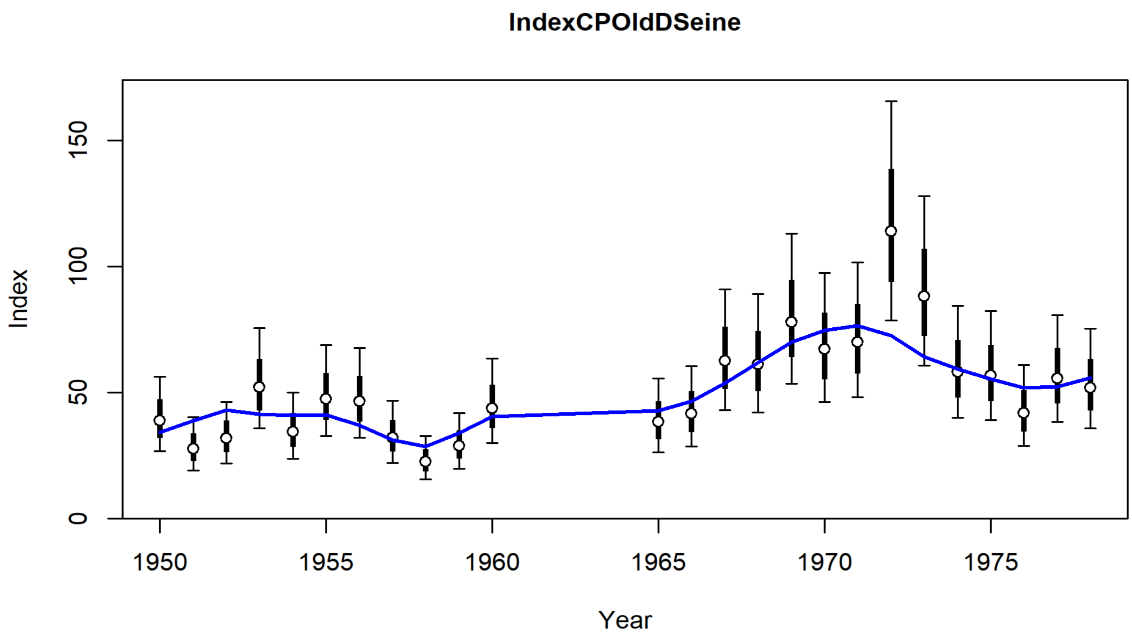


Figure 29 Fits to the early Danish seine CPUE for the 2022 preliminary base case assessment.

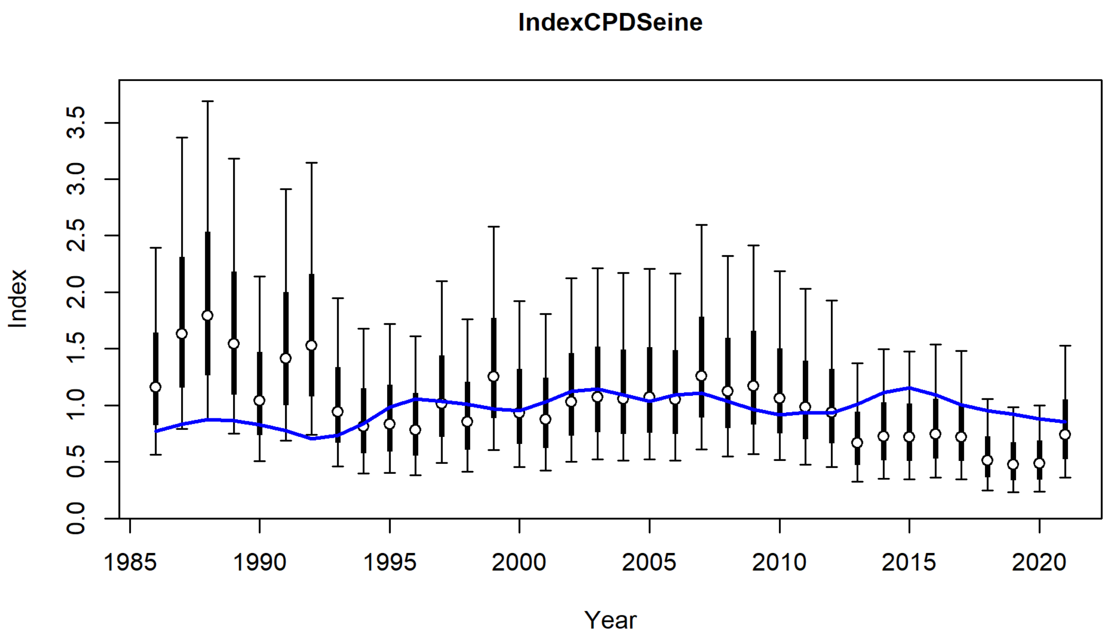


Figure 30 Fits to the Danish seine CPUE for the 2022 preliminary base case assessment.

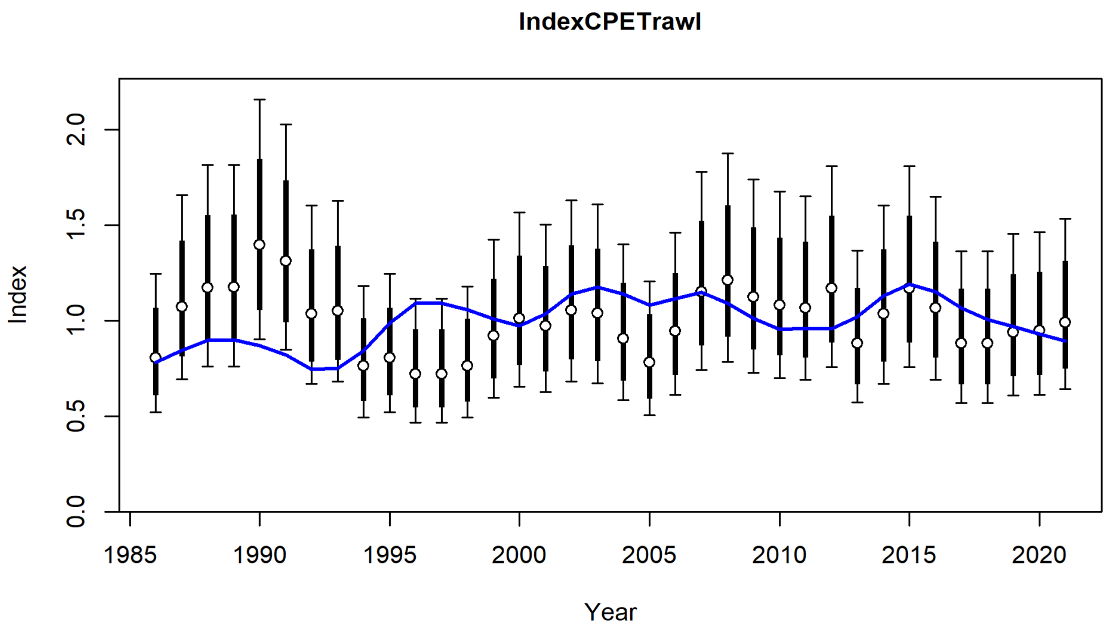


Figure 31 Fits to the East trawl CPUE for the 2022 preliminary base case assessment.

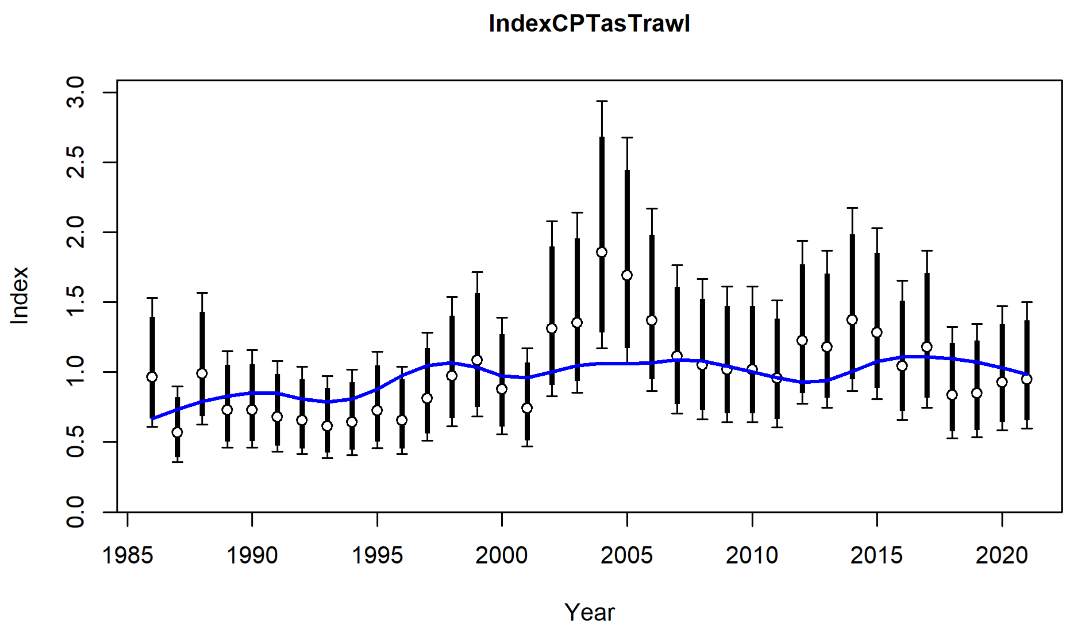


Figure 32 Fits to the Tas trawl CPUE for the 2022 preliminary base case assessment.

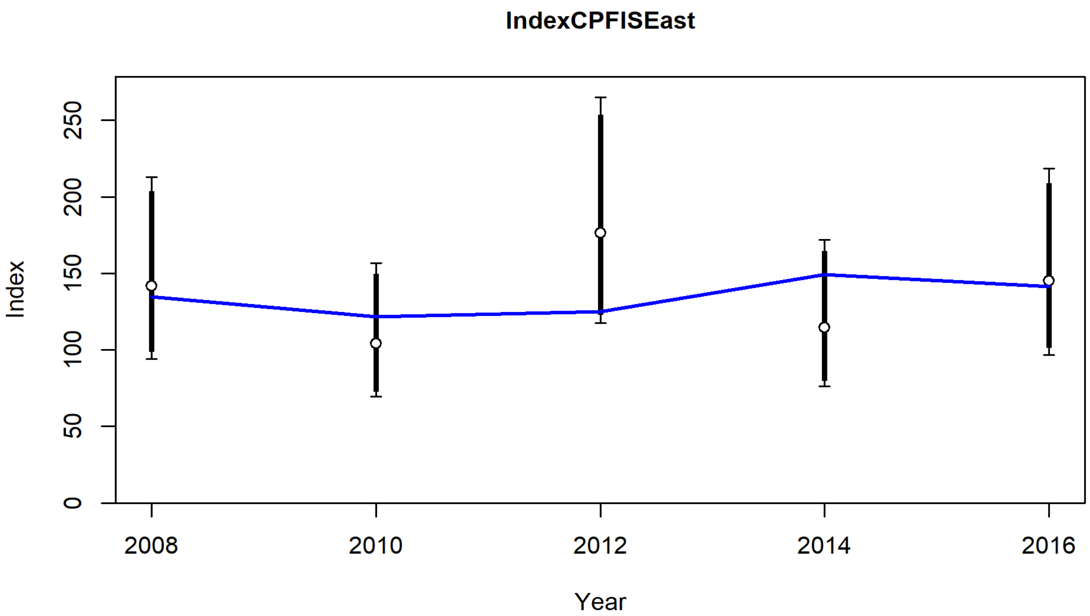


Figure 33 Fits to the FIS east index for the 2022 preliminary base case assessment.

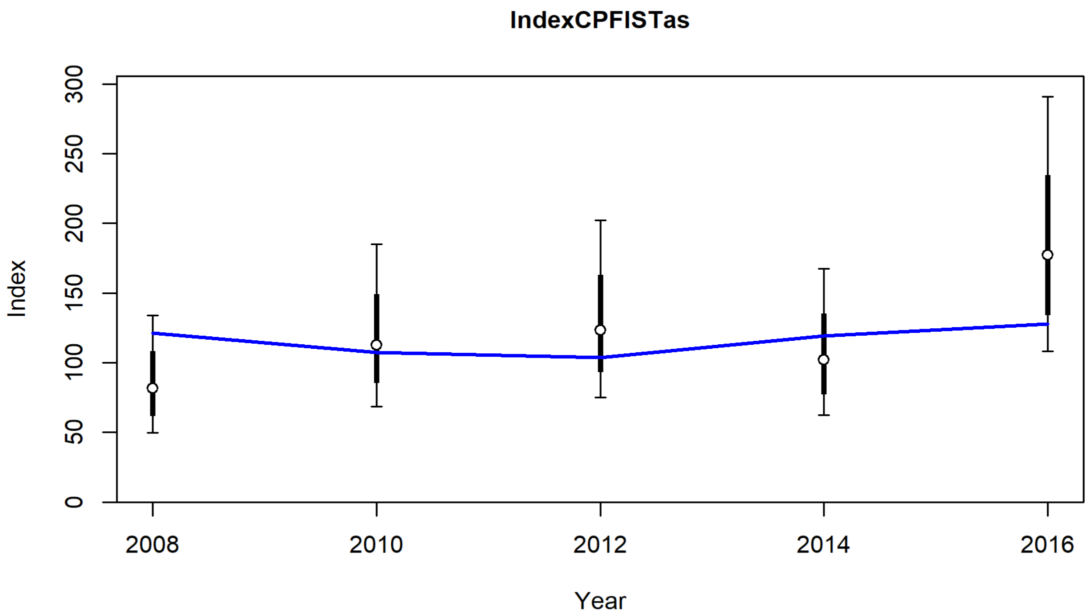


Figure 34 Fits to the FIS Tas index for the 2022 preliminary base case assessment.

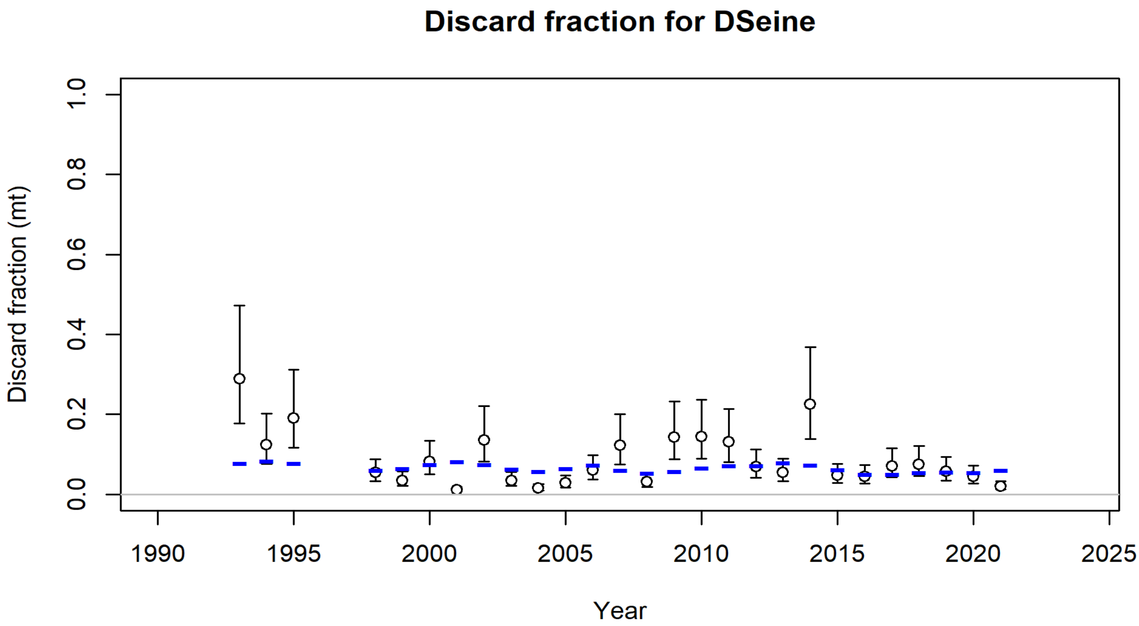


Figure 35 Fits to the Danish seine discards for the 2022 preliminary base case assessment.

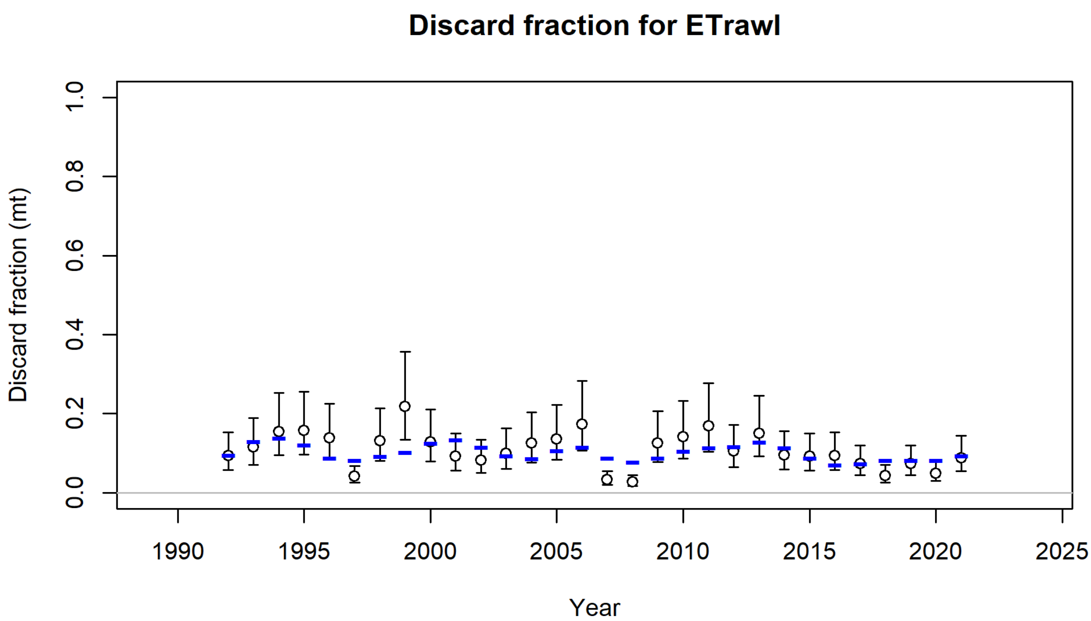


Figure 36 Fits to the East trawl discards for the 2022 preliminary base case assessment.

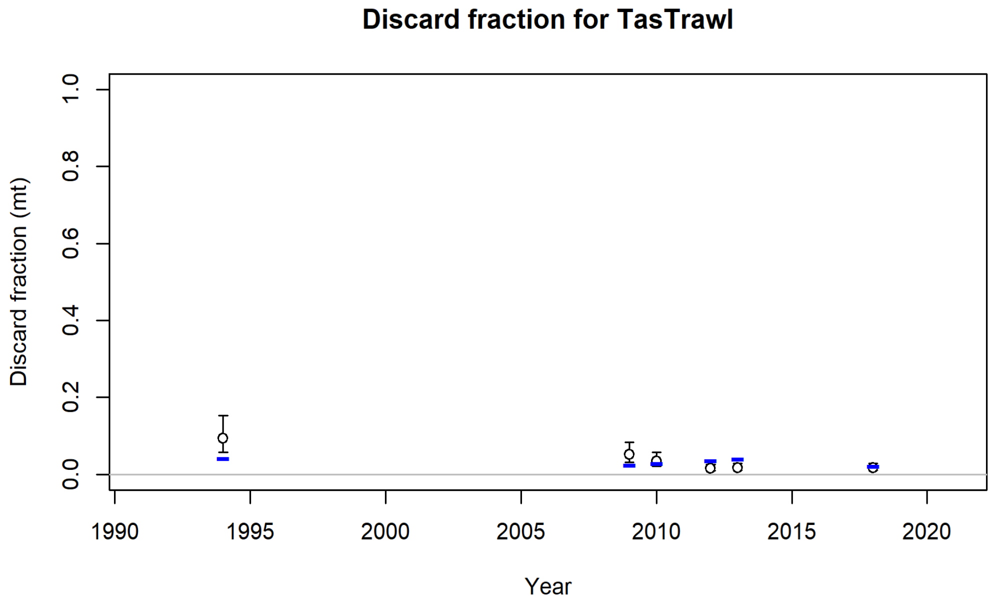


Figure 37 Fits to the Tas trawl discards for the 2022 preliminary base case assessment.

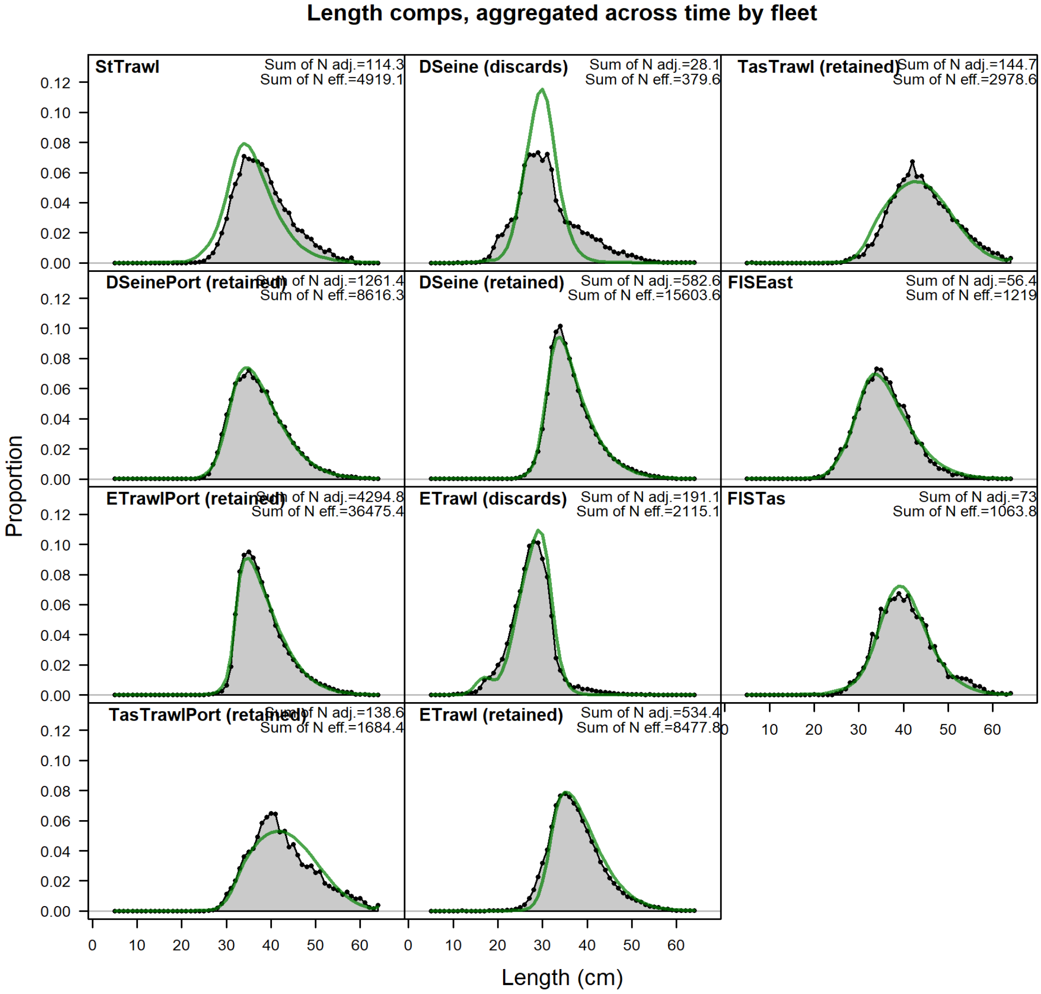


Figure 38 Fits to the aggregated length data for the 2022 preliminary base case assessment.

6 Fixing stock recruitment steepness

A likelihood profile completed on stock recruitment steepness (h) in the 2019 assessment revealed a flat profile with a large range of plausible estimates suggesting there is insufficient information in the data to inform estimation of this parameter (Day, 2019a). The assessment suggested that it should be fixed in the next assessment and this was subsequently agreed at SERAG3 in December 2021 (Day, 2019a).

Subsequently it was identified that there are further management related consequences associated with fixing this parameter in the assessment. This is because the alternative target for Tiger Flathead, of $0.40B_0$ is based on maximum sustainable yield (MSY) estimated by early iterations of the assessment. MSY cannot be estimated when h is fixed so the target reference point should either return to the default value or be based on other bio-economic assessments.

The impacts of consequences of fixing h need to be discussed within SERAG before proceeding with fixing this parameter and applying the outcomes of this action on the target reference point used by the assessment.

7 Likelihood profiles

7.1 Methods

Likelihood profiles are a standard component of the toolbox of applied statisticians and are most often used to obtain a 95% confidence interval for a parameter of interest (Punt, 2018). Many stock assessments “fix” key parameters such as natural mortality and steepness based on a priori considerations. Likelihood profiles can be used to evaluate whether there is evidence in the data to support fixing a parameter at a chosen value. If the parameter is within the range of the 95% confidence interval of the total likelihood profile, this provides no support from the data to change the fixed value. If the fixed value is outside the 95% confidence interval, and there is evidence that the data holds information about this parameter, it would be reasonable for a review panel to ask why the parameter was fixed and not estimated, and if the value is to be fixed, on what basis should inconsistency with the data be ignored. Integrated stock assessments include multiple data sources (e.g., commonly catch-rates, length-compositions, and age-compositions) that may be in conflict, due to inconsistencies in sampling, but more commonly owing to incorrect assumptions (e.g., assuming that catch-rates are linearly related to abundance), i.e. model-misspecification. Likelihood profiles can be used as a diagnostic to identify these data conflicts (Punt, 2018).

7.2 Results

The likelihood profile for M suggests that this parameter could range from 0.300 and 0.425 year^{-1}, with these bounds higher than the fixed value in the model of 0.27 year^{-1} (Figure 39). The preferred values of M from the profile is 0.375, with this driven by both the index and age data (Figure 39). Length data appears highly informative and representative of the overall profile shape (Figure 39). Discard data conflicts with other data sources and suggests lower estimates of M are preferable (Figure 39). This high estimate of M is unrealistic compared to the biology of the species, with a plus group age of 20, and as a result M has remained fixed at 0.27 year^{-1} in the preliminary base case as has been done in previous assessments and until the outcomes of potentially fixing h have been ascertained.

The fleet contribution to each of the likelihood components are presented in Figure 40. For survey or index likelihoods the high M estimates are driven by the Steam trawl, Danish seine and East trawl fleets, while lower estimates are preferred by the old Danish seine and Tas trawl indices (Figure 40).

For the discard component of the likelihood, lower of M are suggested by all fleets (Figure 40). Higher values of M in the length component of the likelihood are driven by the Steam trawl fleet, with conflicting trends from FIS Tas data, with little information in the remaining fleets (Figure 40). Age composition data suggests higher M from the Danish seine and East trawl fleets, while there is very little data to inform M in the Tas trawl and FIS east data (Figure 40).

Overall, there is considerable conflicting data informing the estimation of M in the assessment and the suggested preference for higher values of M above those considered biologically sensible for this species are unrealistic. This suggests that M should either remain fixed in the assessment at its current value of 0.27 year^{-1}, or an informative prior should be developed for use in future assessments.

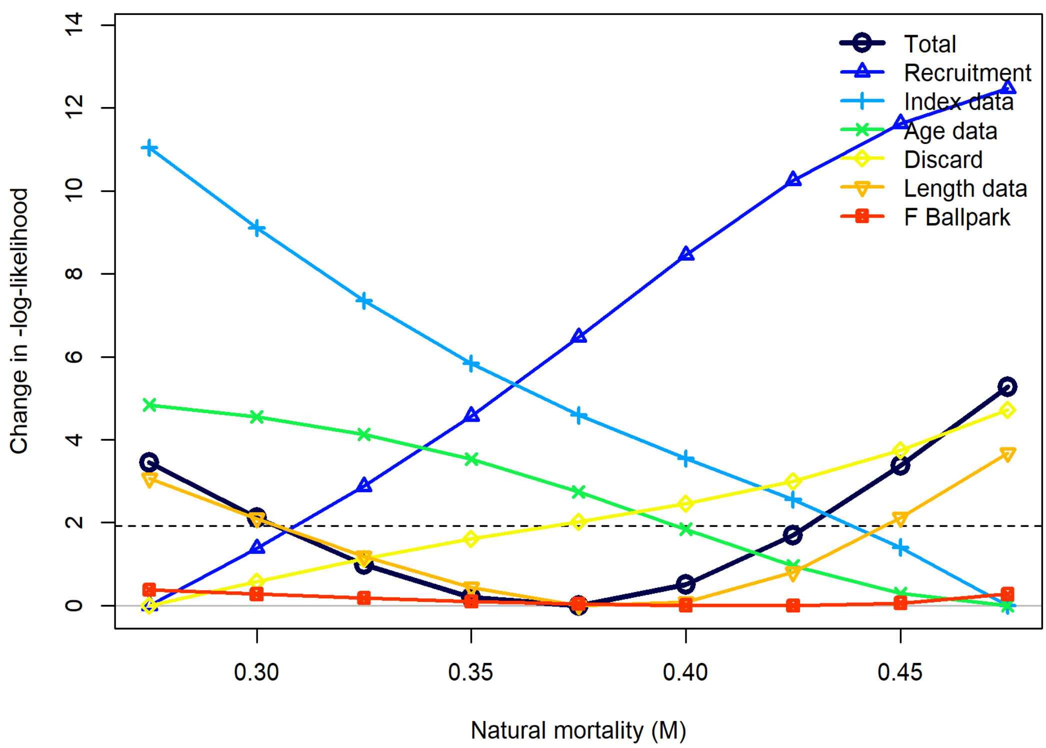


Figure 39 The likelihood profile for natural morality (M). M is fixed in the base case at 0.27 year^{-1}.

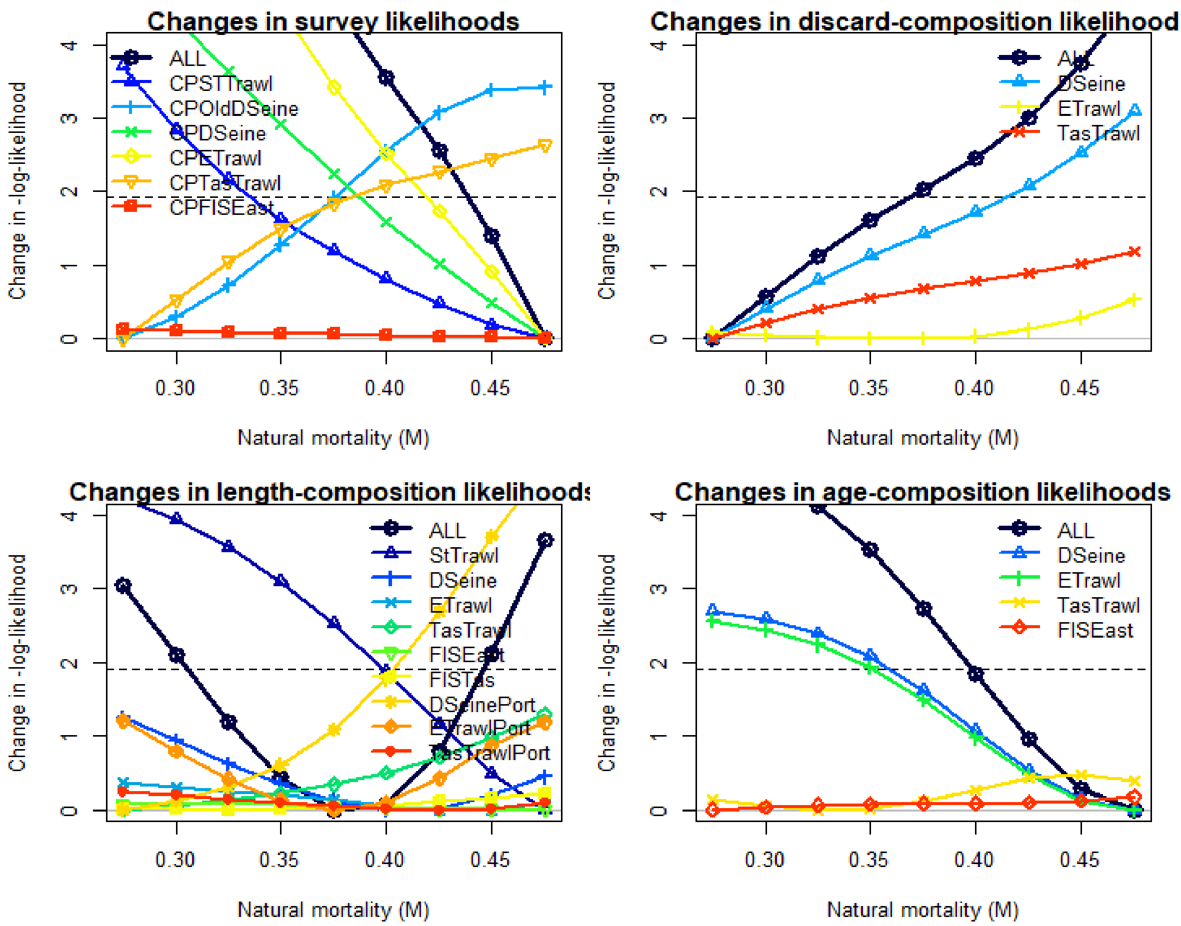


Figure 40 Piner plot for likelihood profile on M.

The likelihood profile on h suggests there is little information in the model that can inform estimation of this parameter (currently estimated at 0.84 in the assessment, Figure 41). The model suggests that h could range between below 0.65 to well above 0.95, demonstrating a large range of plausible values (Figure 41). There is conflict in the data inputs, with recruitment and to a lesser extent length data suggesting a lower value of h is preferable, while discard, age and index data suggest higher values are more appropriate, although there is little contrast in this data (Figure 41).

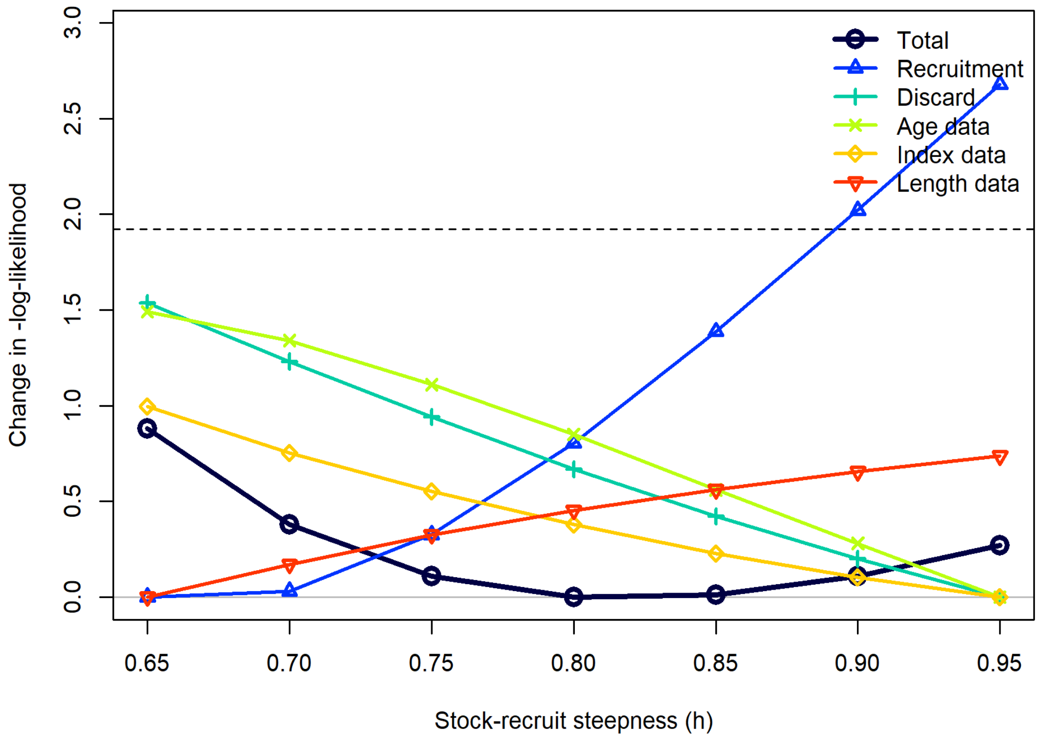


Figure 41 The likelihood profile for stock-recruitment steepness (h), h is estimated in the base case at 0.84.

For survey or index likelihoods, there is little information in any of the indices although the Steam trawl and to a lesser extent the historic Danish seine indices are having the greatest impact driving the likelihood profile towards higher estimate of h (Figure 42). From the discard likelihood, there is again little information to inform this parameter but the Danish seine and East trawl fleets again suggest higher estimates are preferable (Figure 42). For the length component of the likelihood there is again very little information although the largest influence is again from the Steam trawl fleet (Figure 42). The most information from age composition data are provided by the Danish seine and East trawl fleets, which suggest higher estimates of h are preferred (Figure 42).

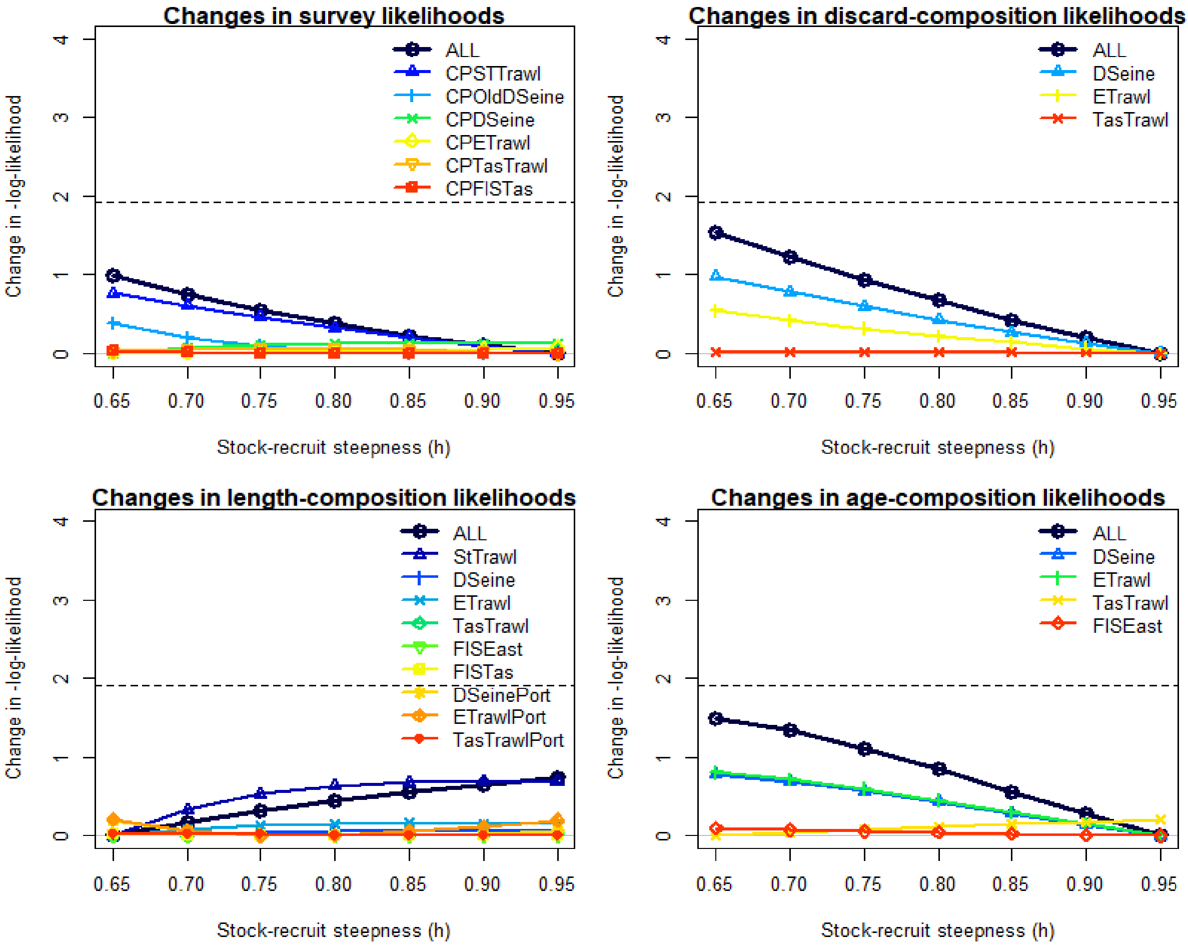


Figure 42 Piner plot for likelihood profile on h.

8 Appendix

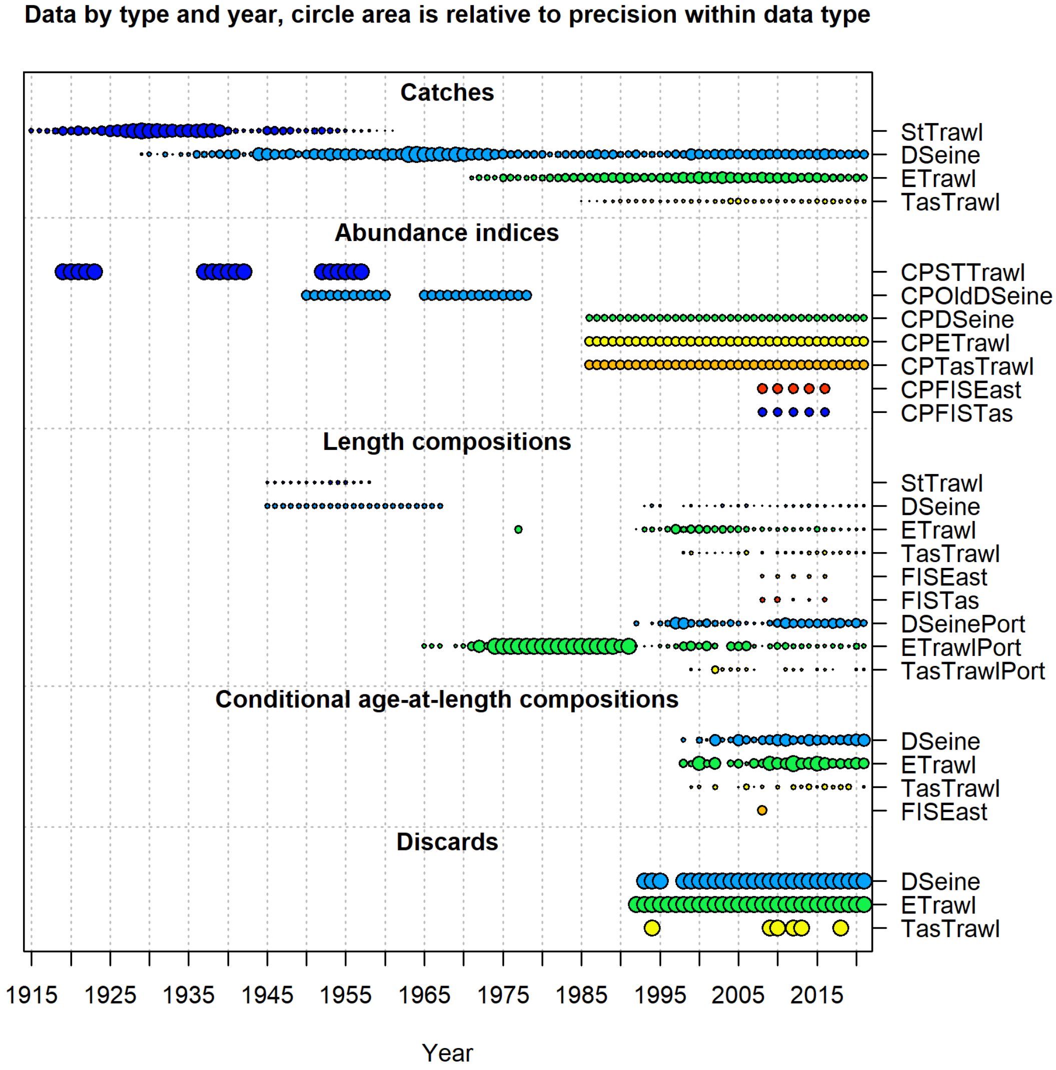


Figure 43 Summary of Tiger Flathead data sources.

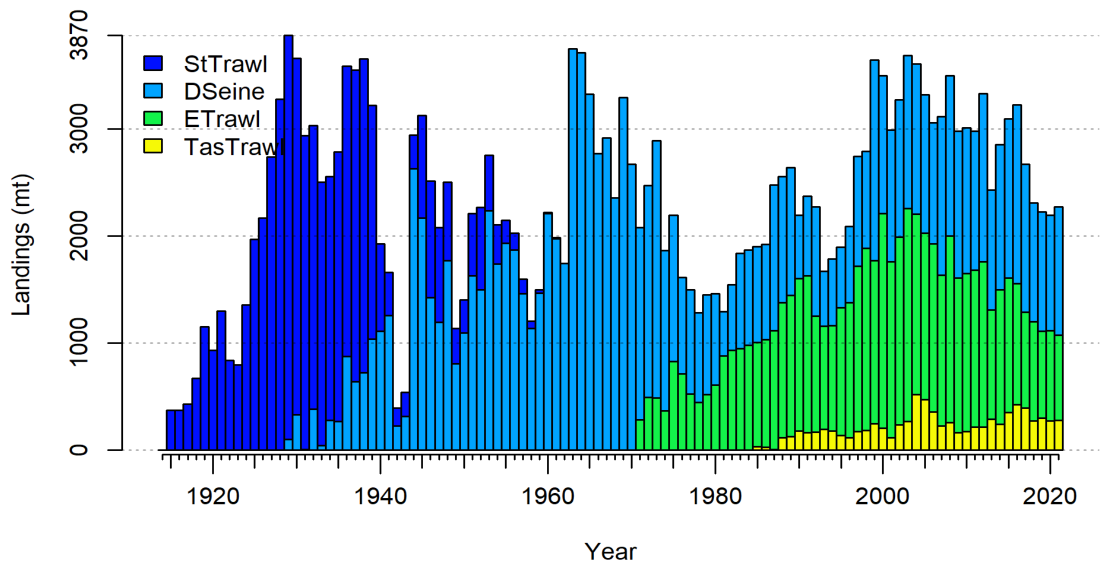


Figure 44 Summary of catch by fleet.

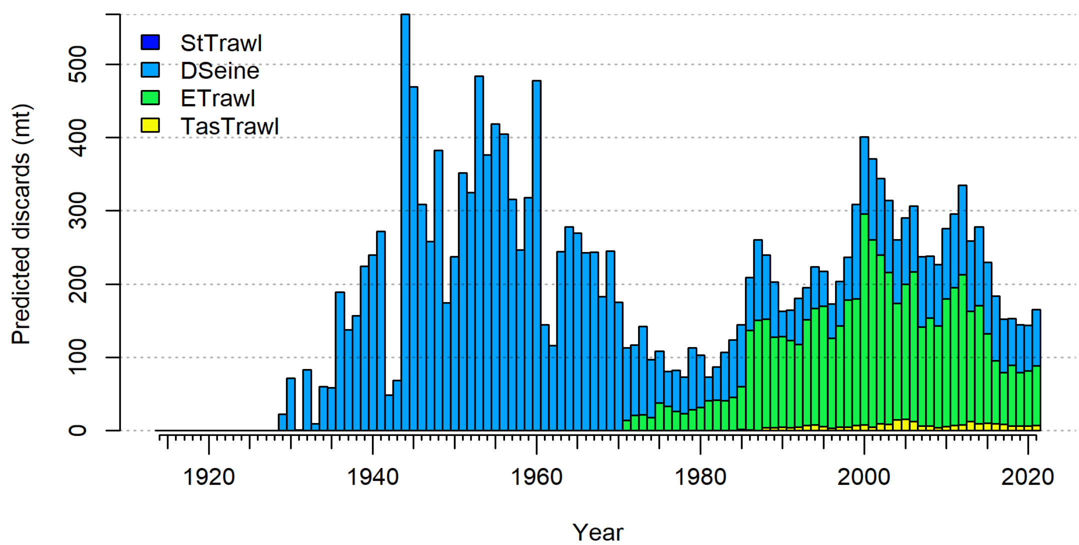


Figure 45 Summary of total estimated discards by fleet.

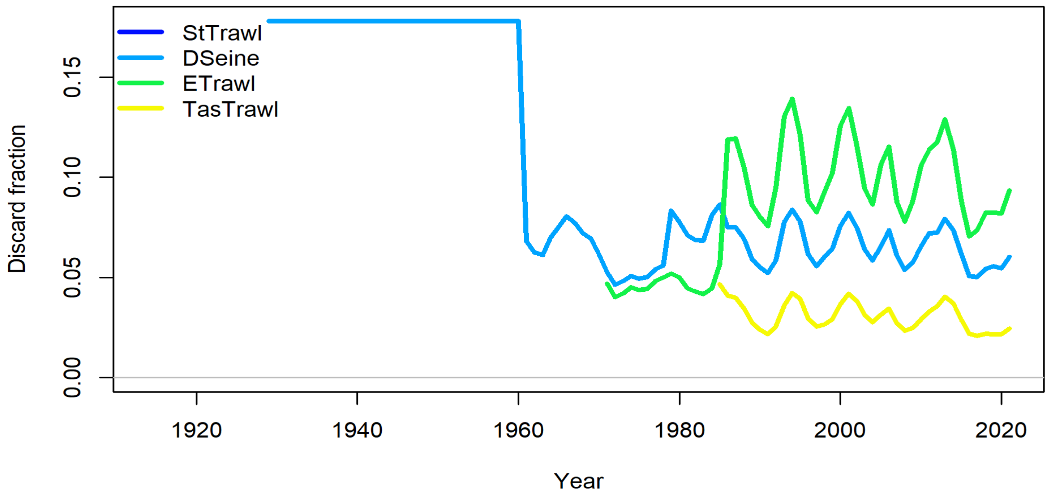


Figure 46 Summary of estimated discard proportion fleet.

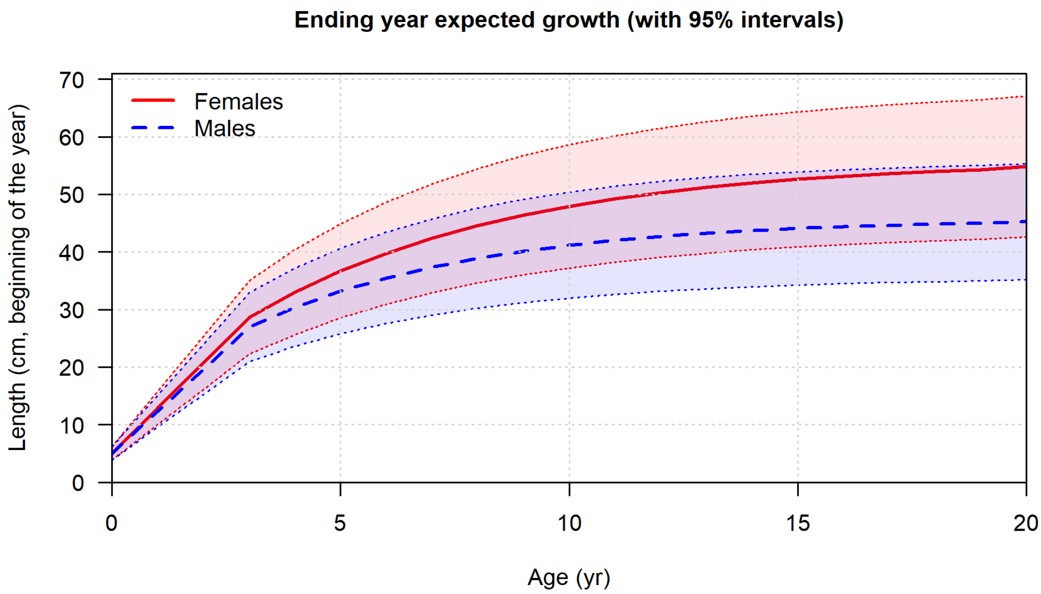


Figure 47 Estimated growth curve for males and females.

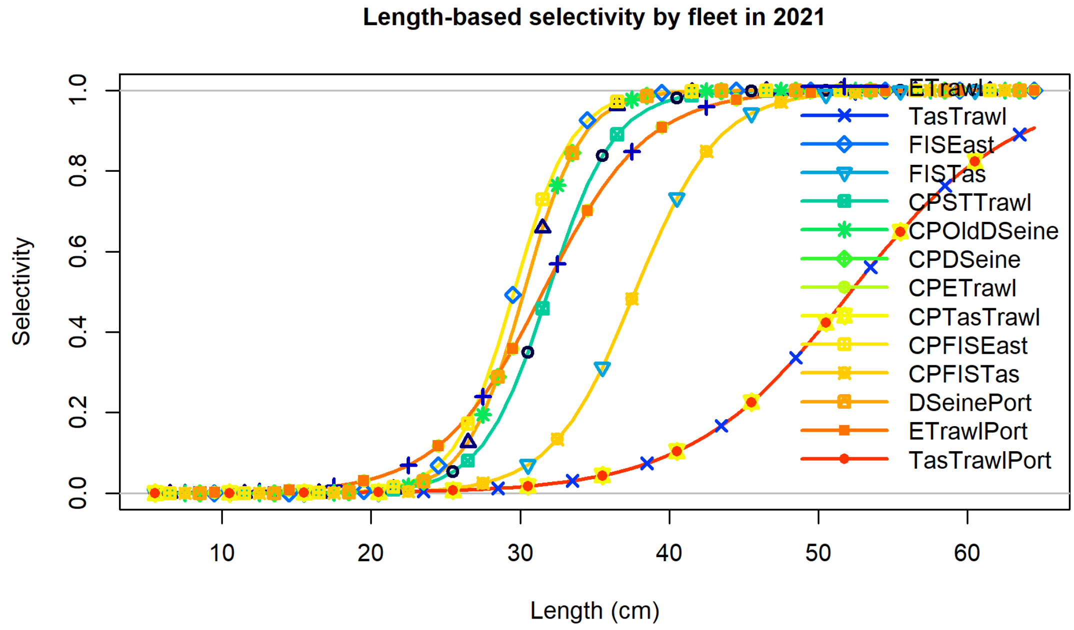


Figure 48 Estimated selectivity at length by fleet.

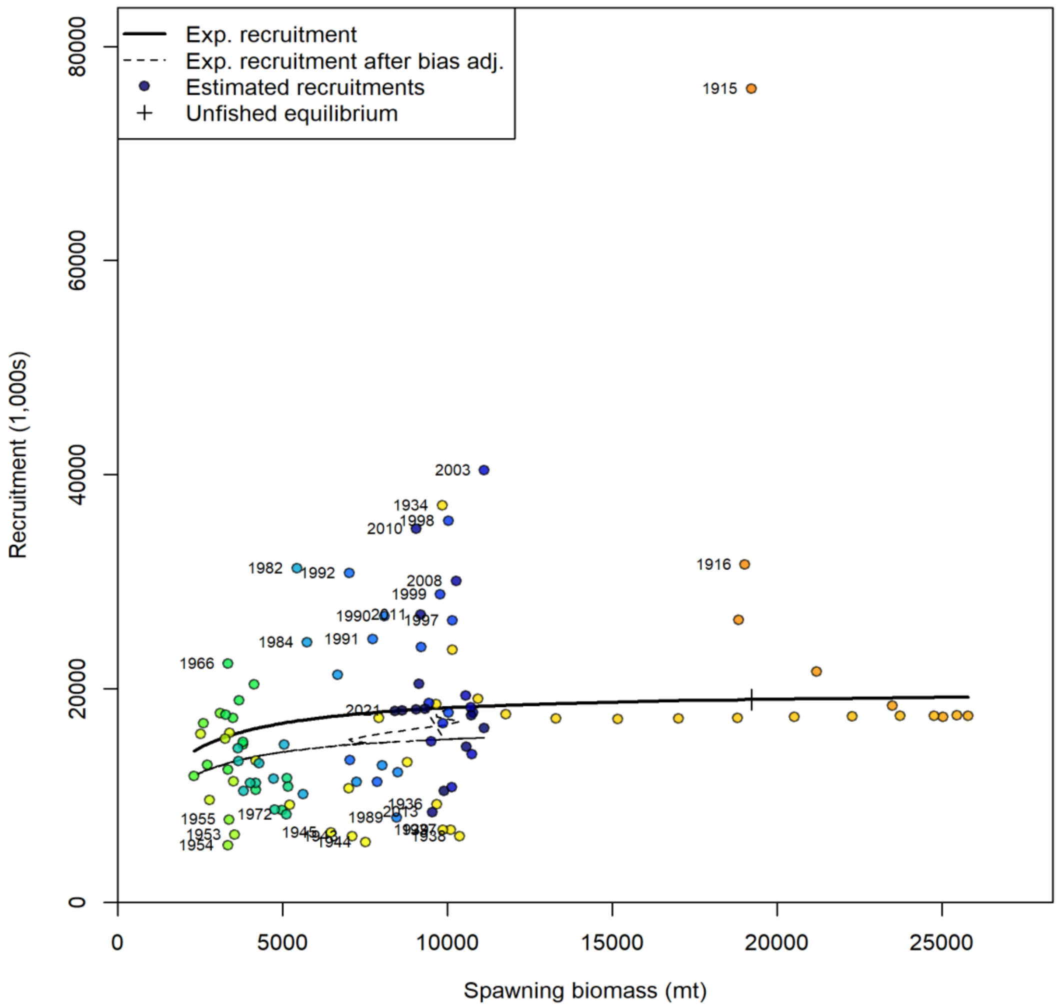


Figure 49 Time series showing stock recruitment curve.

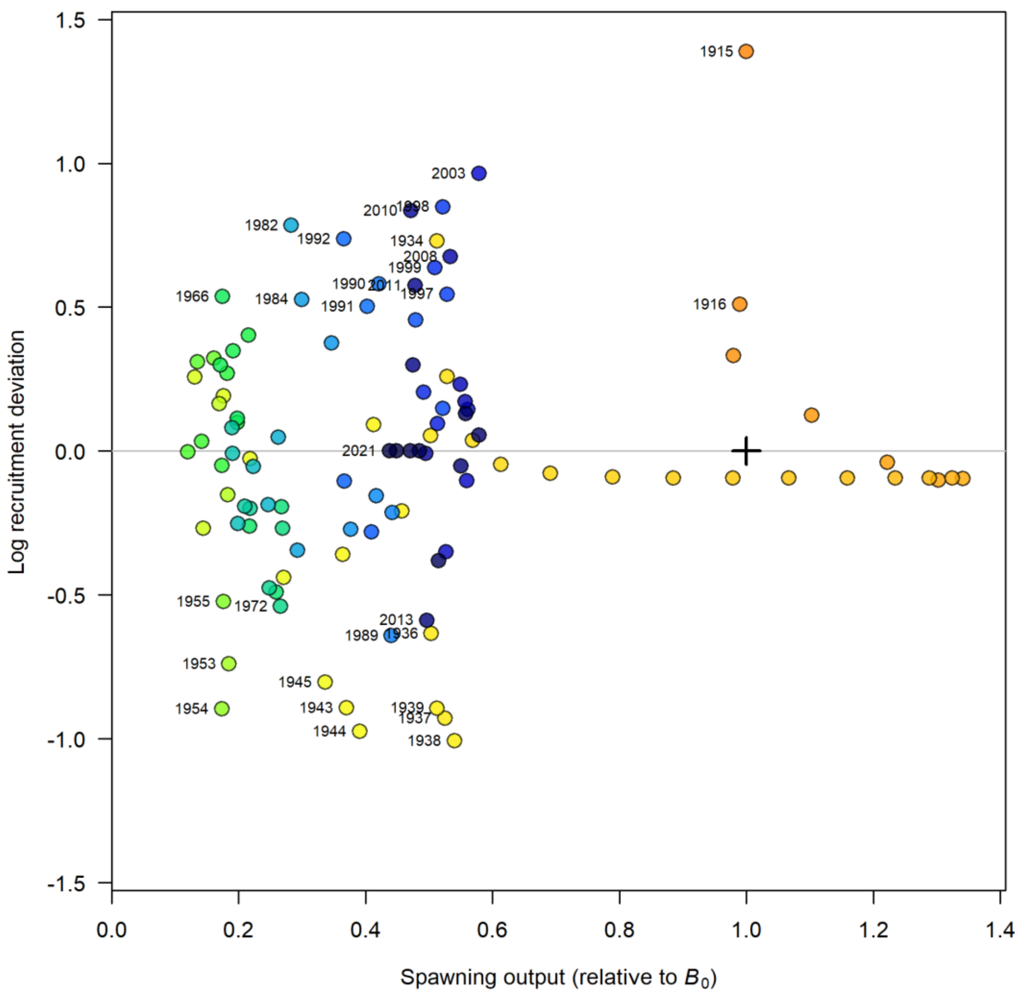


Figure 50 Time series showing stock recruitment deviations

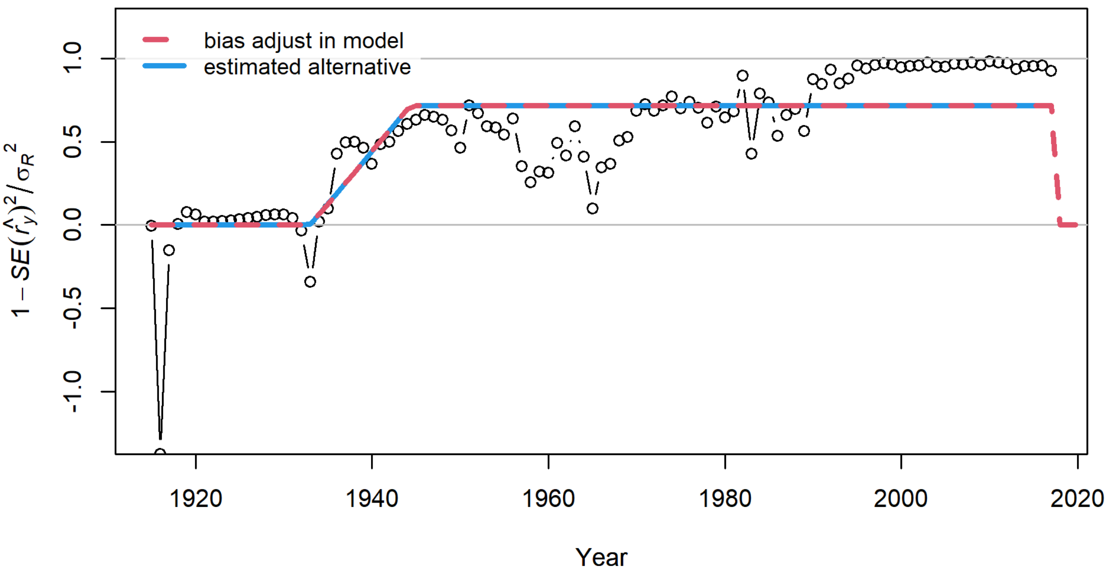


Figure 51 Recruitment deviation bias ramp adjustment.

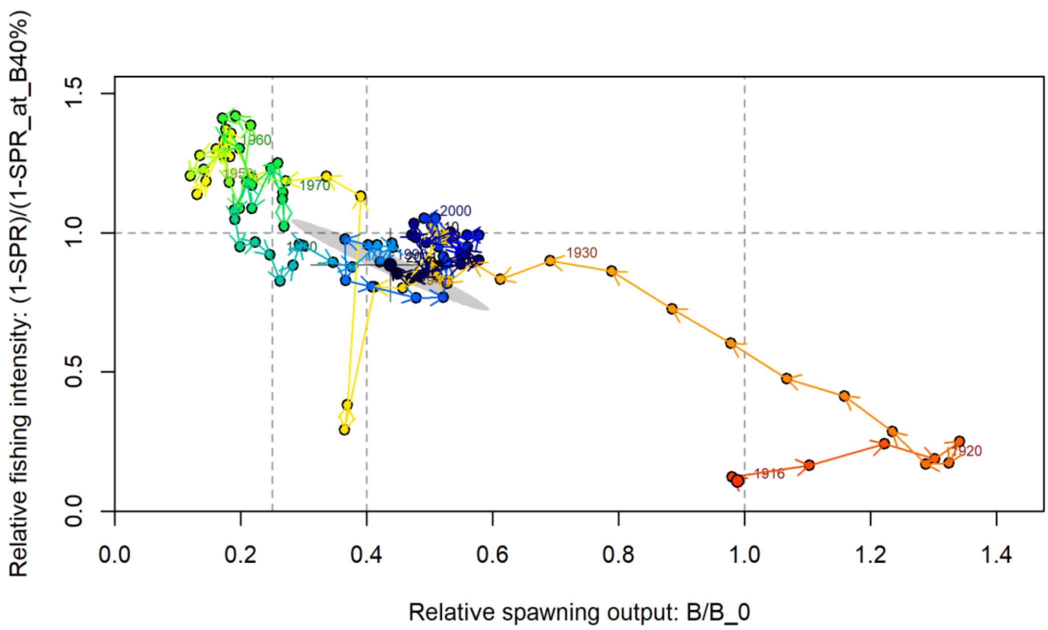


Figure 52 Phase plot of biomass vs SPR ratio.

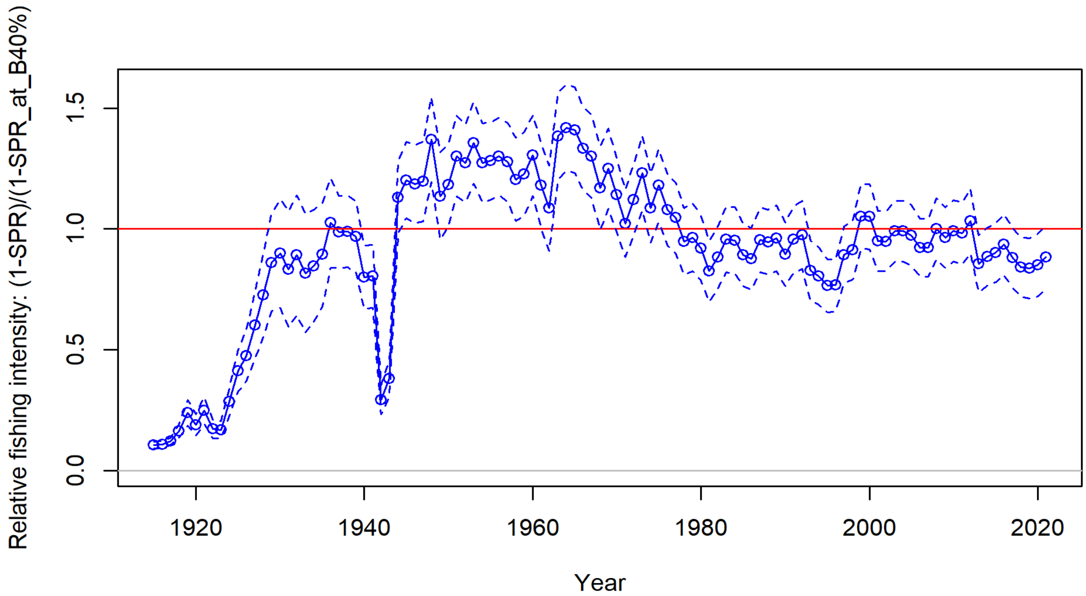


Figure 53 SPR ratio through time, the red line represents the target fishing mortality and each point is a year in the model, starting on the left hand side of the figure.

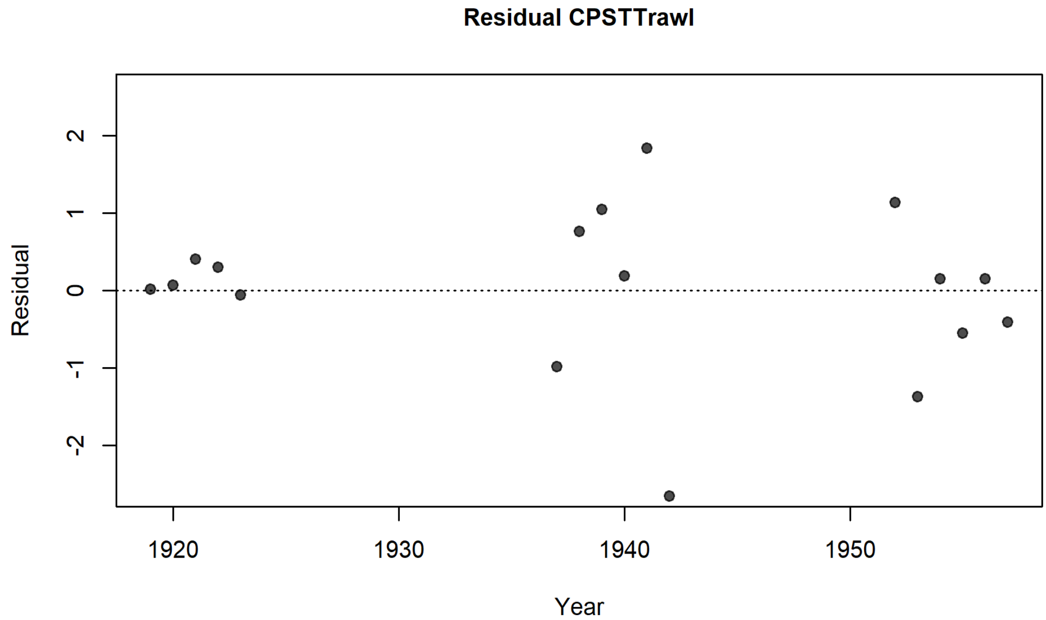


Figure 54 Residuals for fits to CPUE for the Steam trawl fleet.

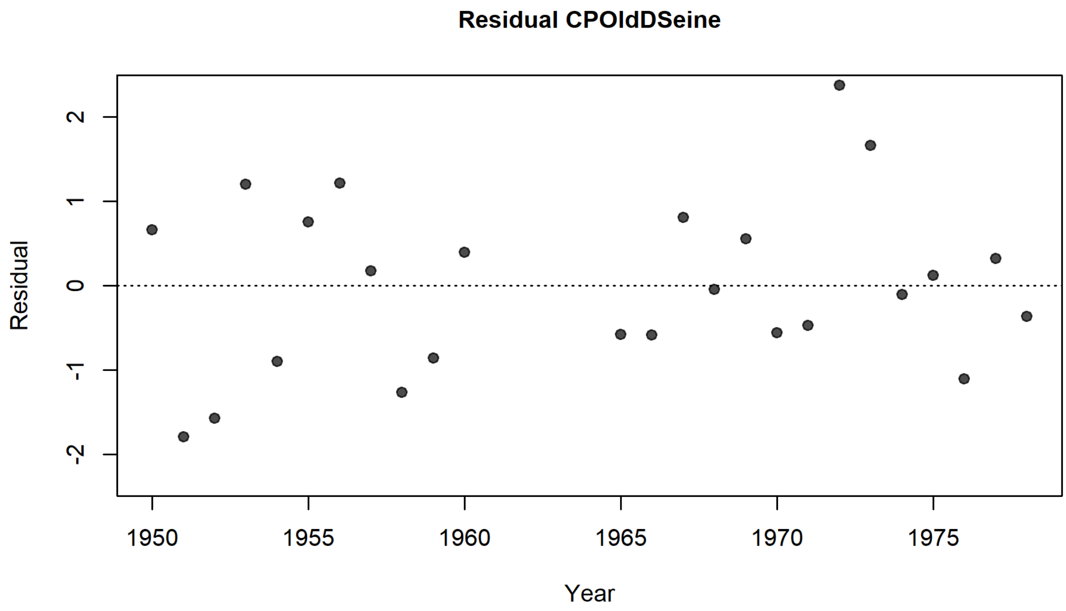


Figure 55 Residuals for fits to CPUE for the early Danish seine fleet.

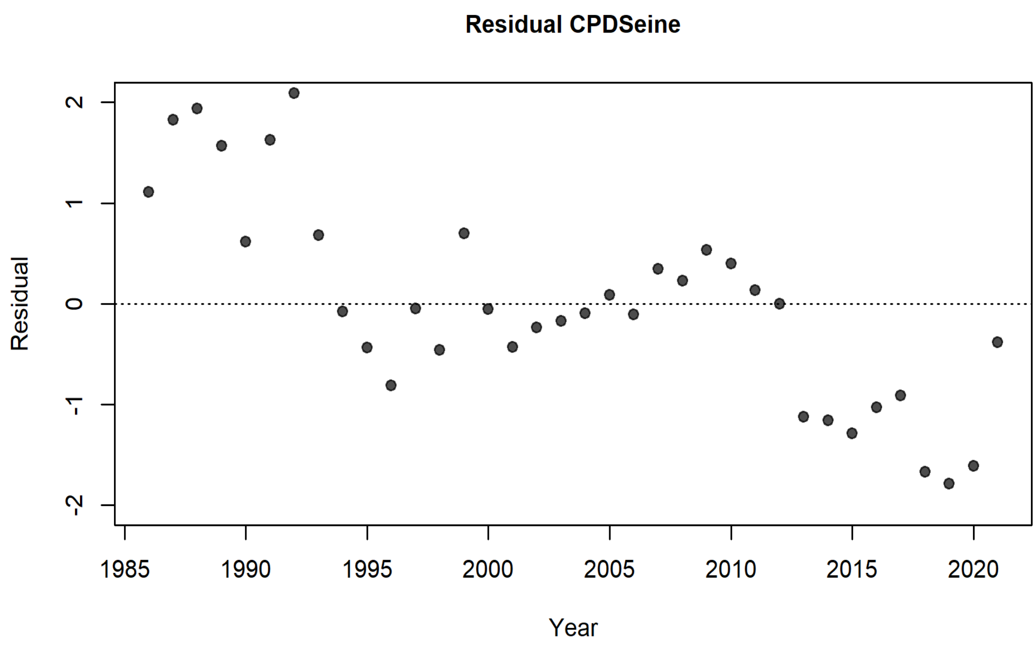


Figure 56 Residuals for fits to CPUE for the Danish seine fleet.

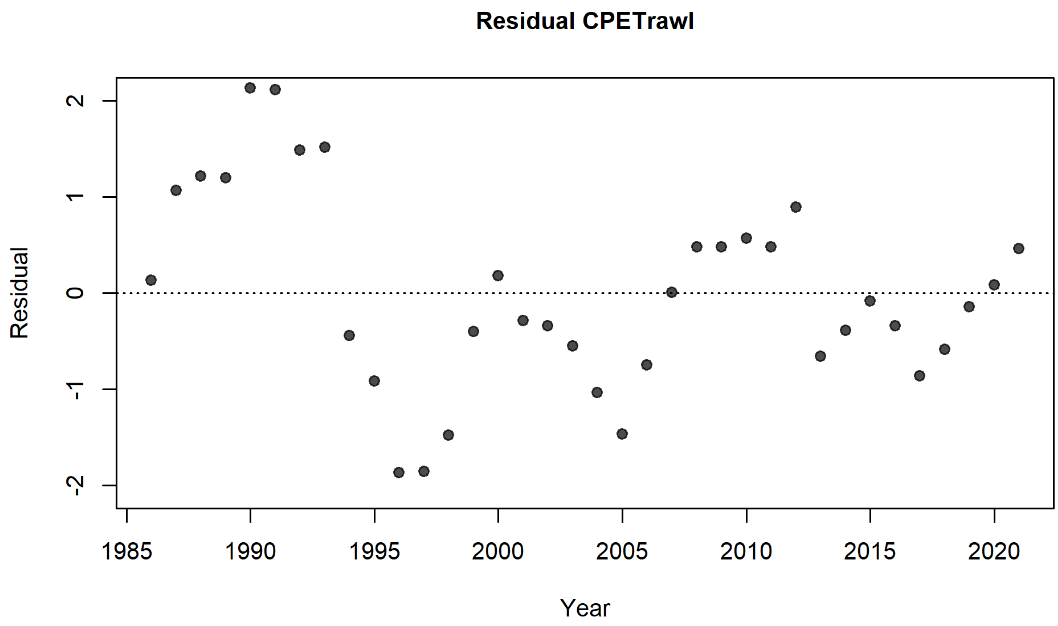


Figure 57 Residuals for fits to CPUE for the east trawl fleet.

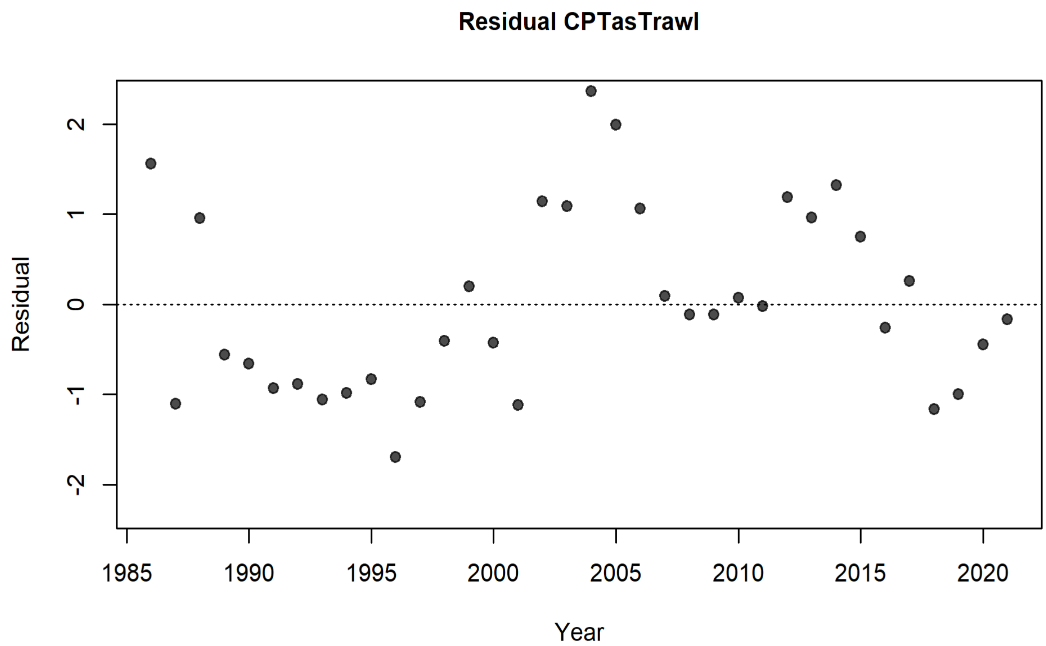


Figure 58 Residuals for fits to the index for the Tas trawl fleet.

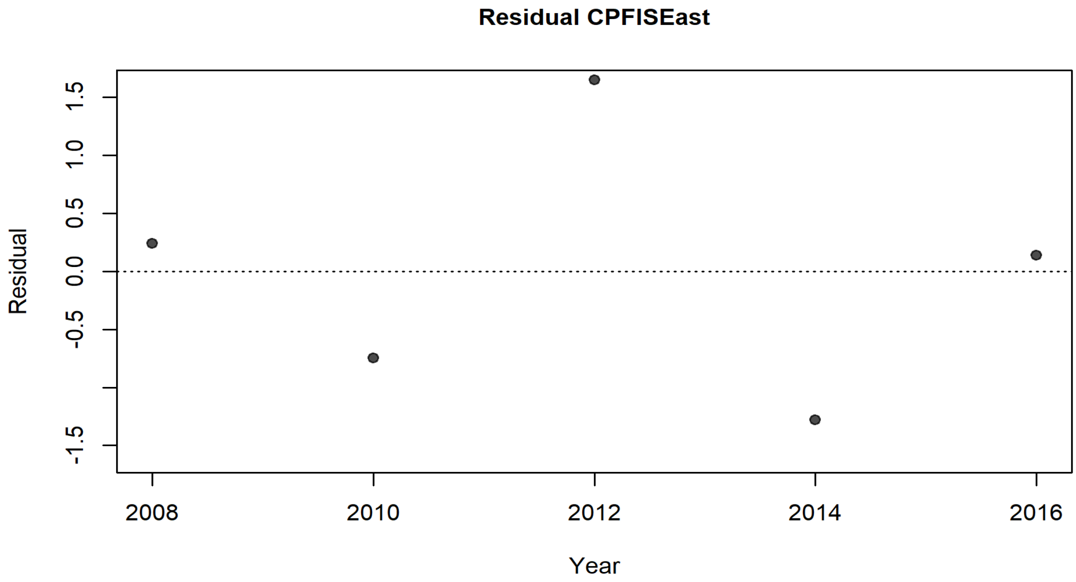


Figure 59 Residuals for fits to the index for the FIS east fleet.

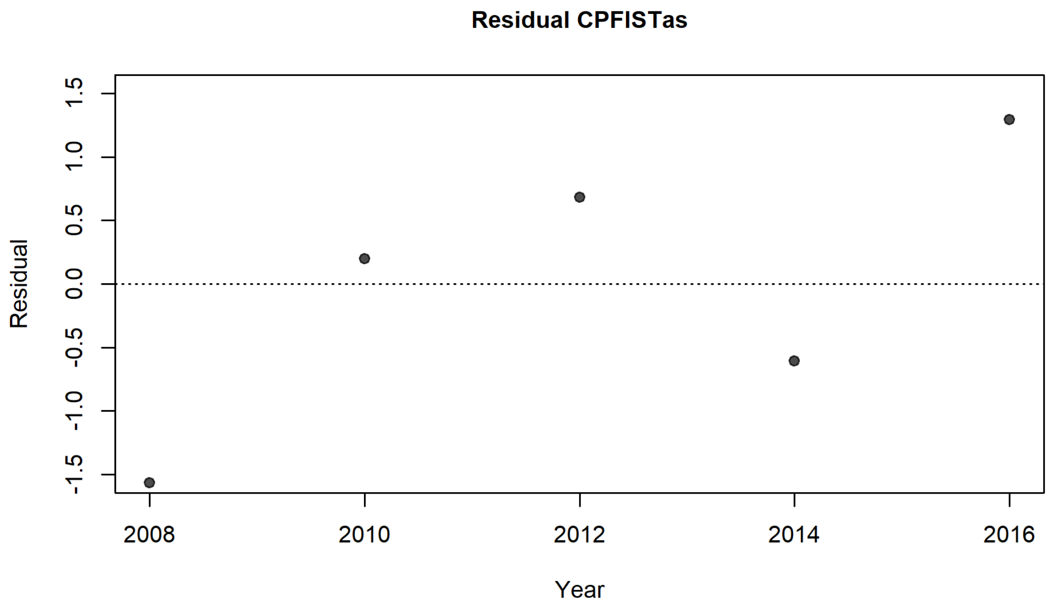


Figure 60 Residuals for fits to CPUE for the FIS Tas fleet.

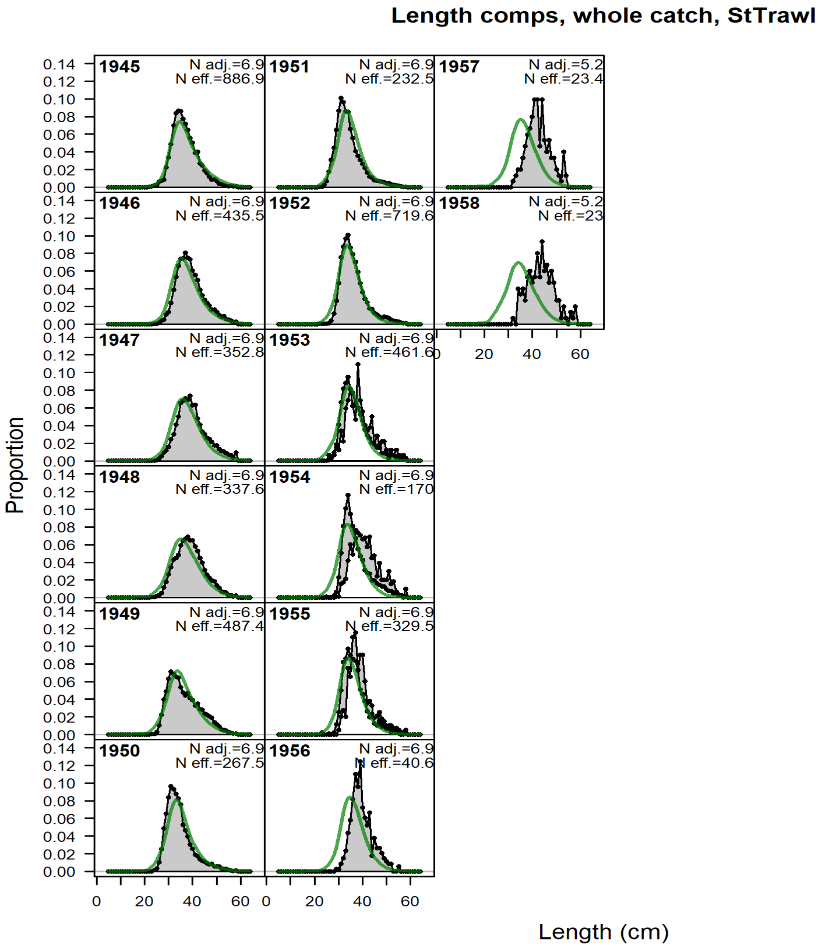


Figure 61 Fits to onboard retained length compositions for the steam trawl fleet.

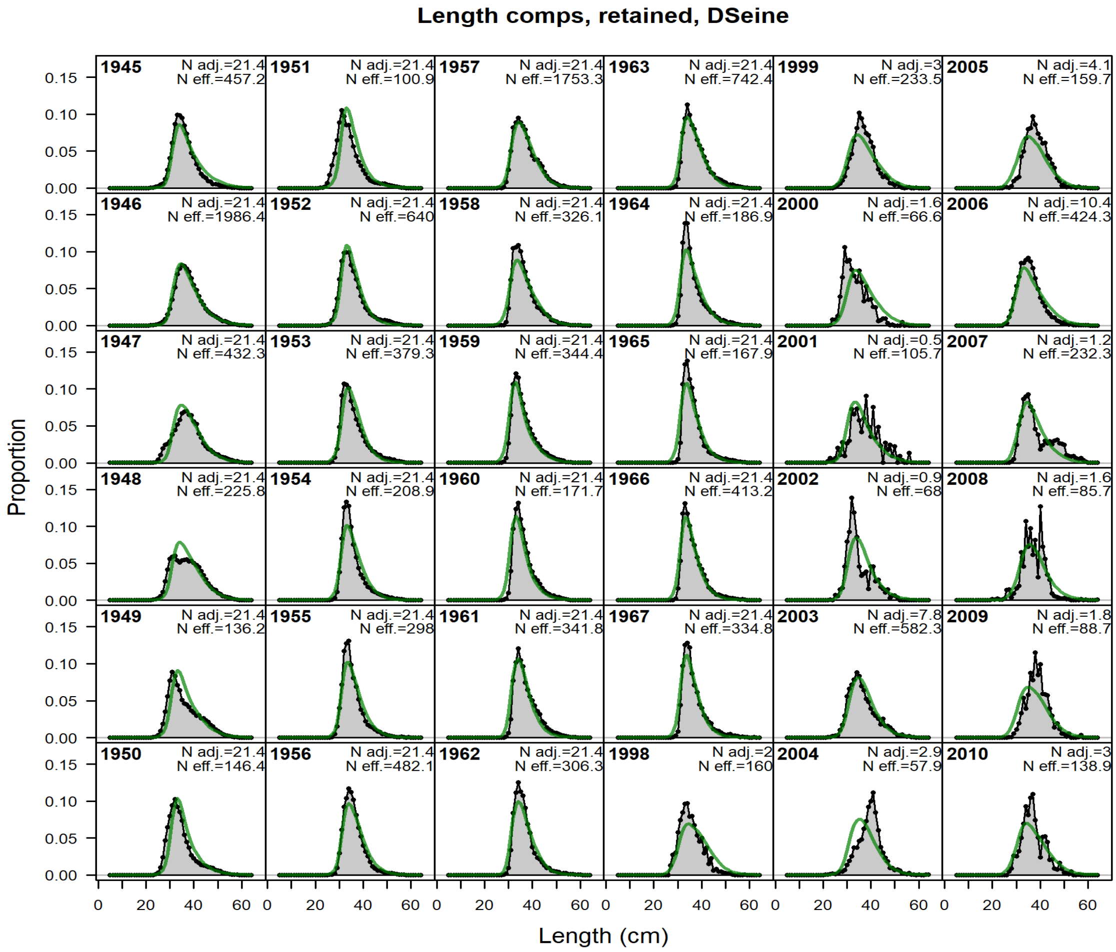


Figure 62 Fits to onboard discarded length compositions for the Danish seine fleet.

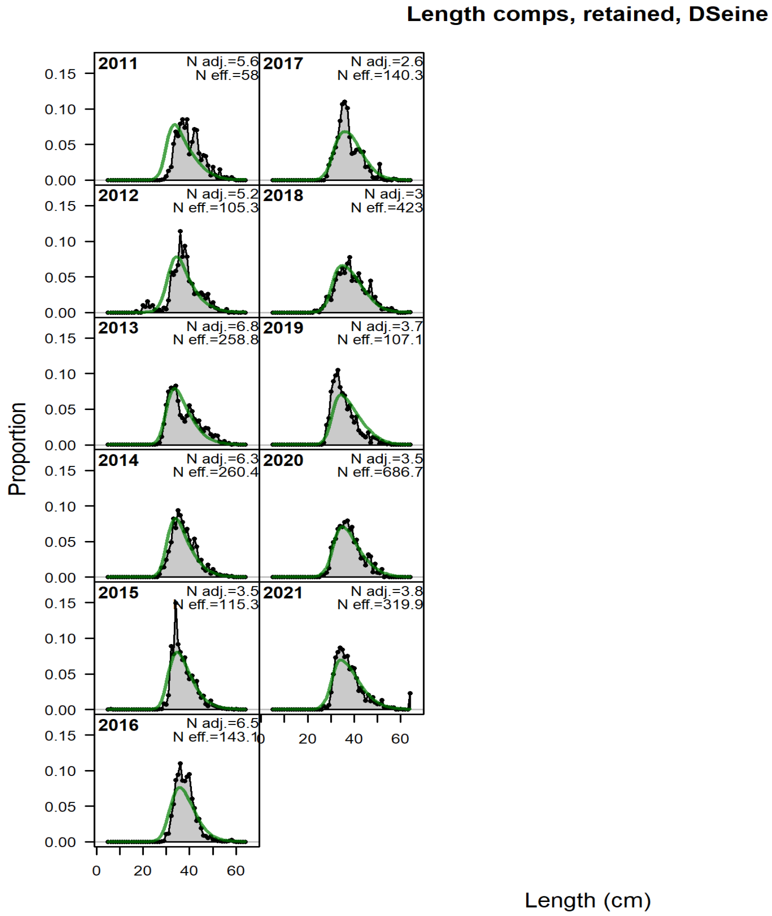


Figure 63 Fits to onboard discarded length compositions for the Danish seine fleet.

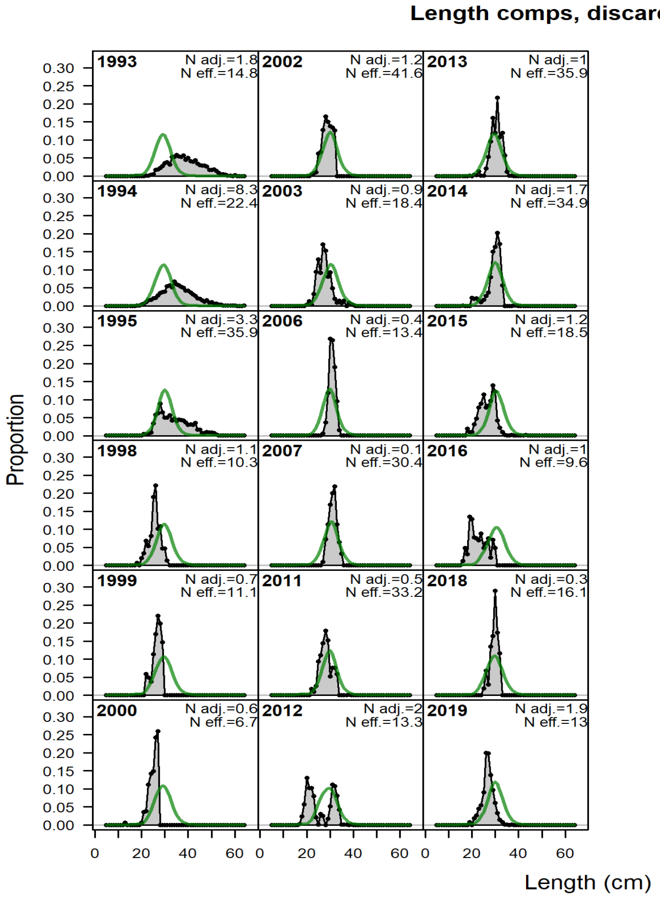


Figure 64 Fits to onboard discarded length compositions for the Danish seine fleet.

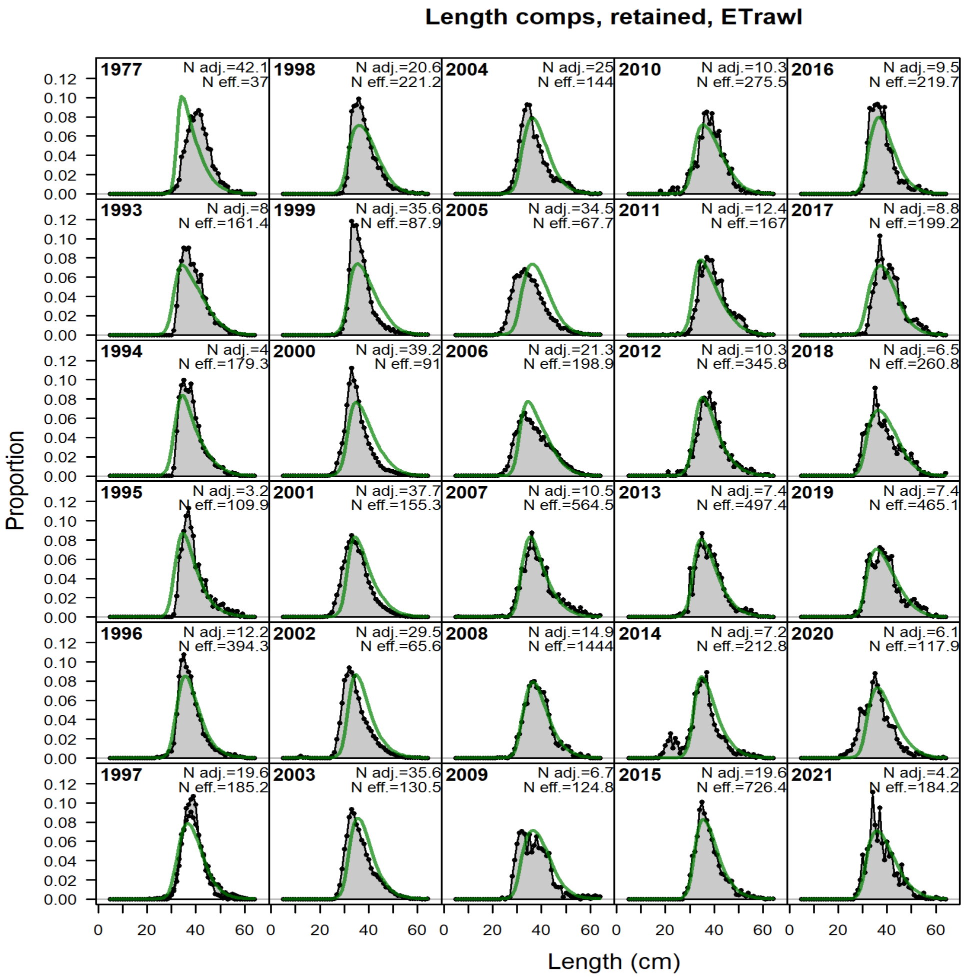


Figure 65 Fits to onboard discarded length compositions for the east trawl fleet.

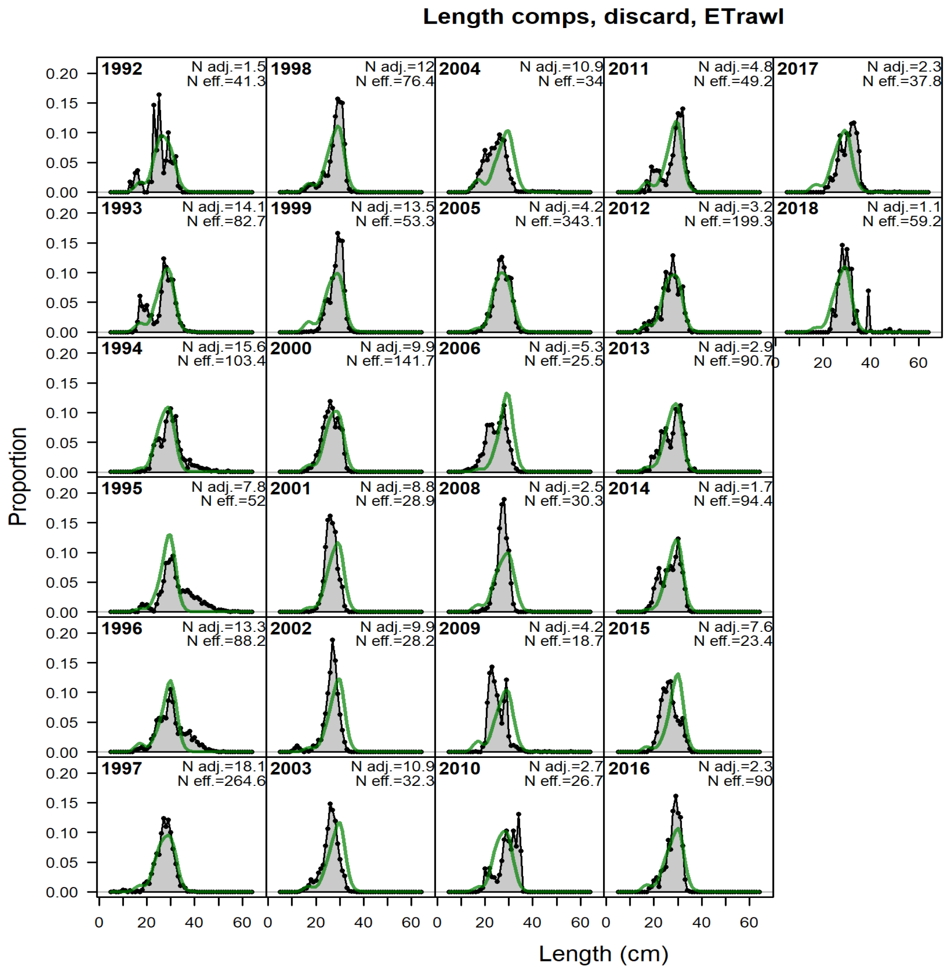


Figure 66 Fits to onboard discarded length compositions for the east trawl fleet.

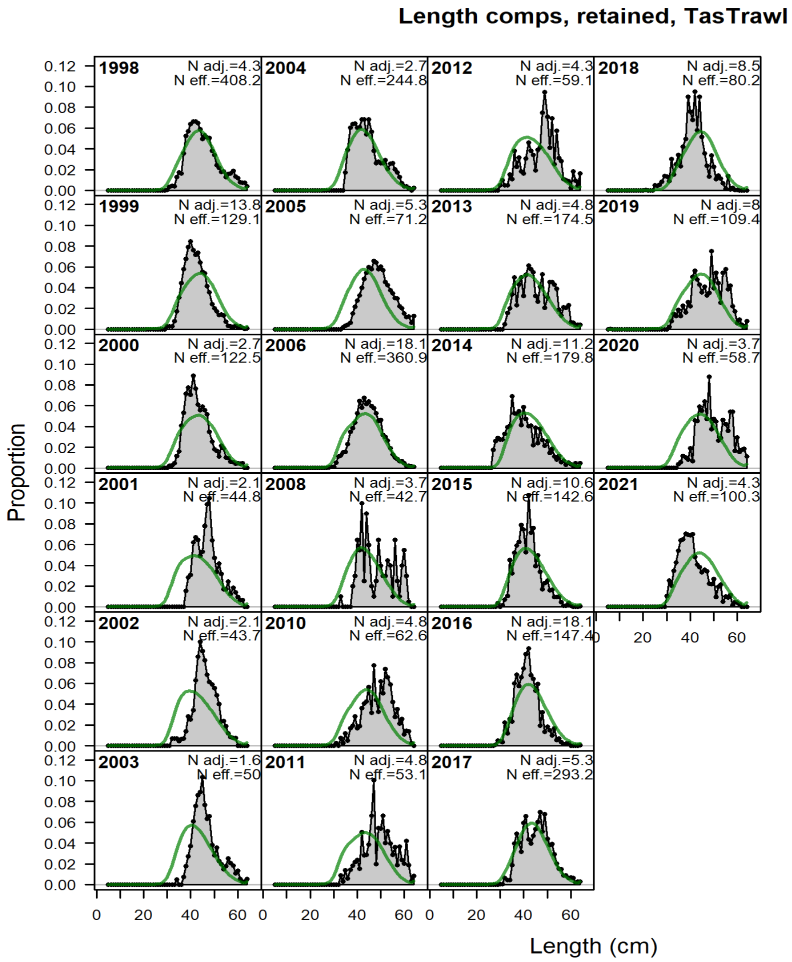


Figure 67 Fits to onboard retained length compositions for the Tas trawl fleet.

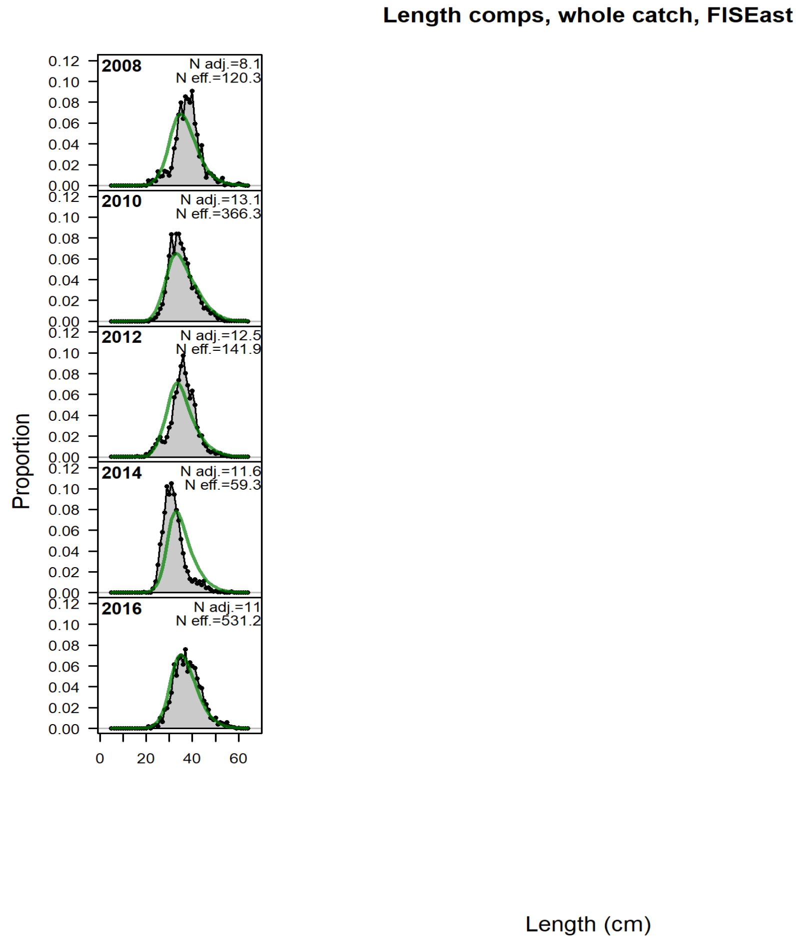
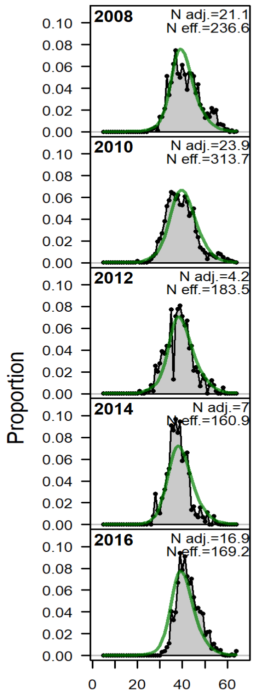


Figure 68 Fits to onboard retained length compositions for the FIS east fleet.

Length comps, whole catch, FISTas



Length (cm)

Figure 69 Fits to onboard retained length compositions for the FIS Tas fleet.

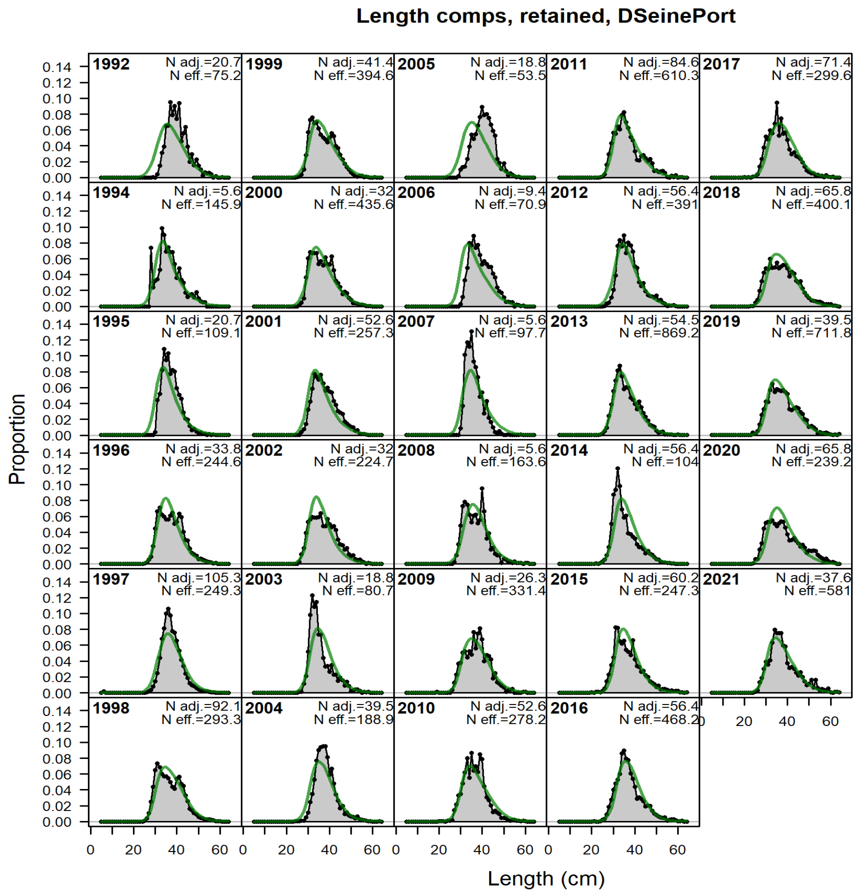


Figure 70 Fits to port length compositions for the Danish seine fleet.

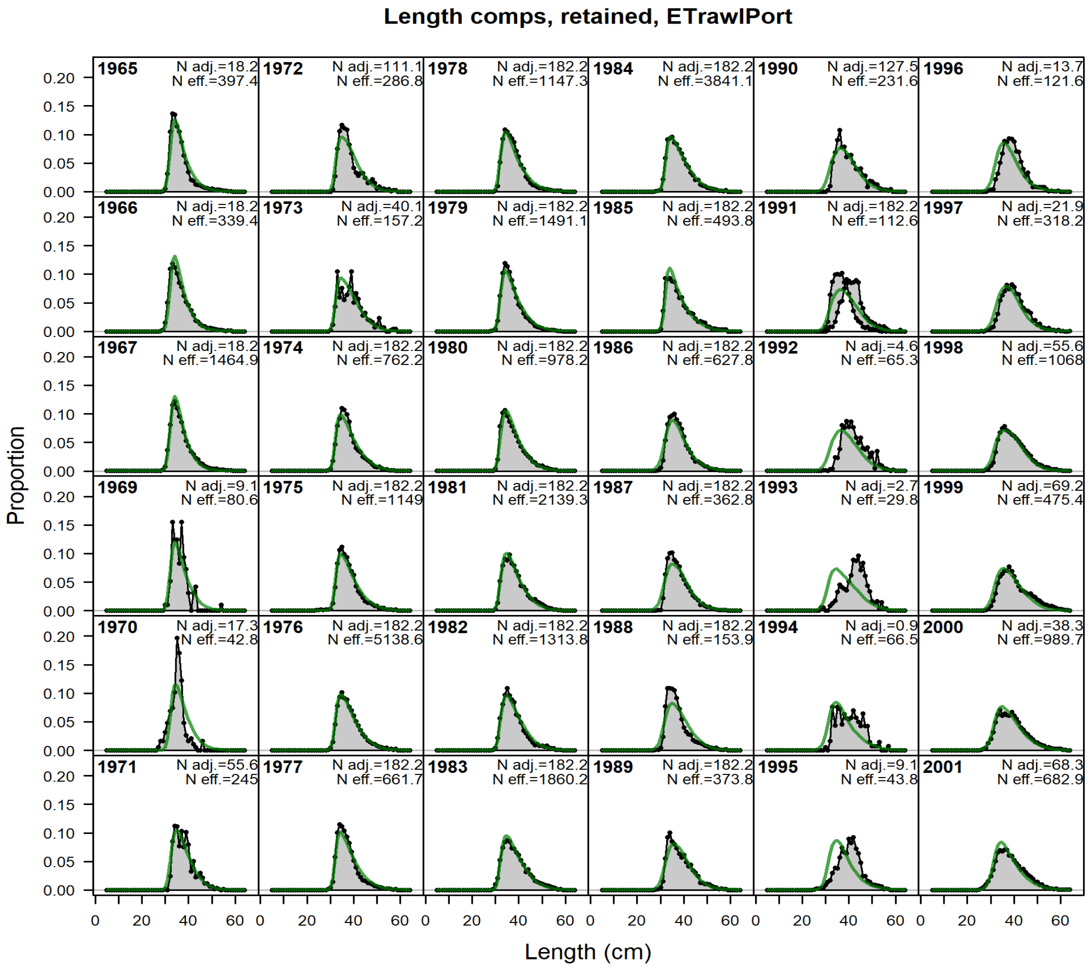


Figure 71 Fits to port length compositions for the east trawl fleet 1965-2001.

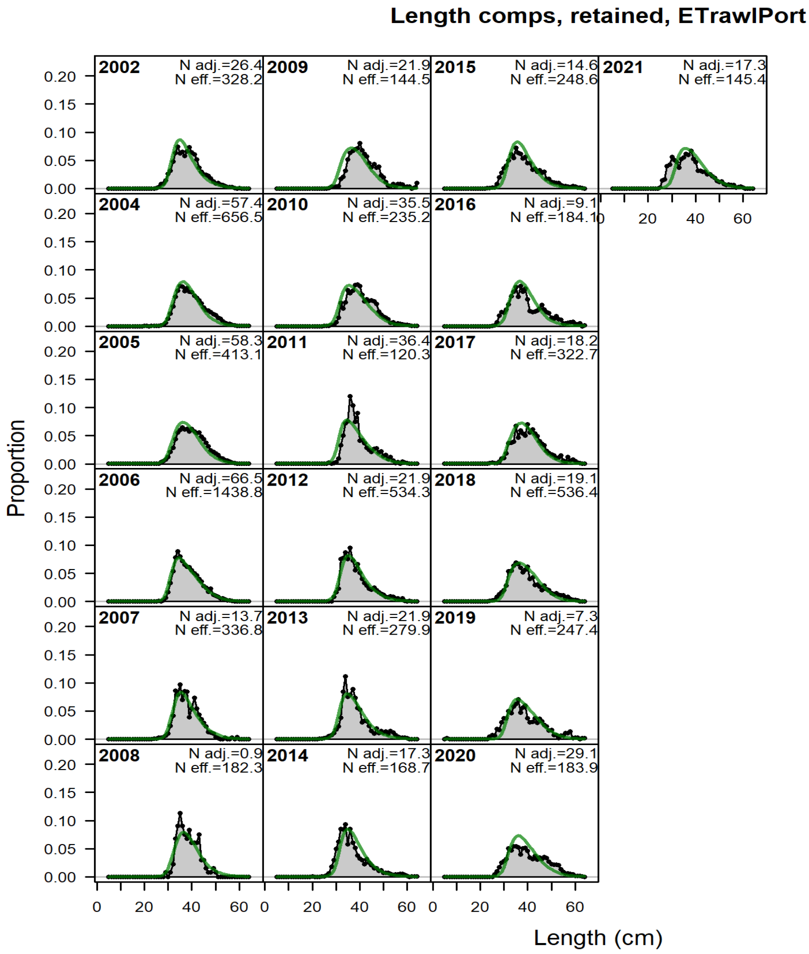


Figure 72 Fits to port length compositions for the east trawl fleet 2002-2021.

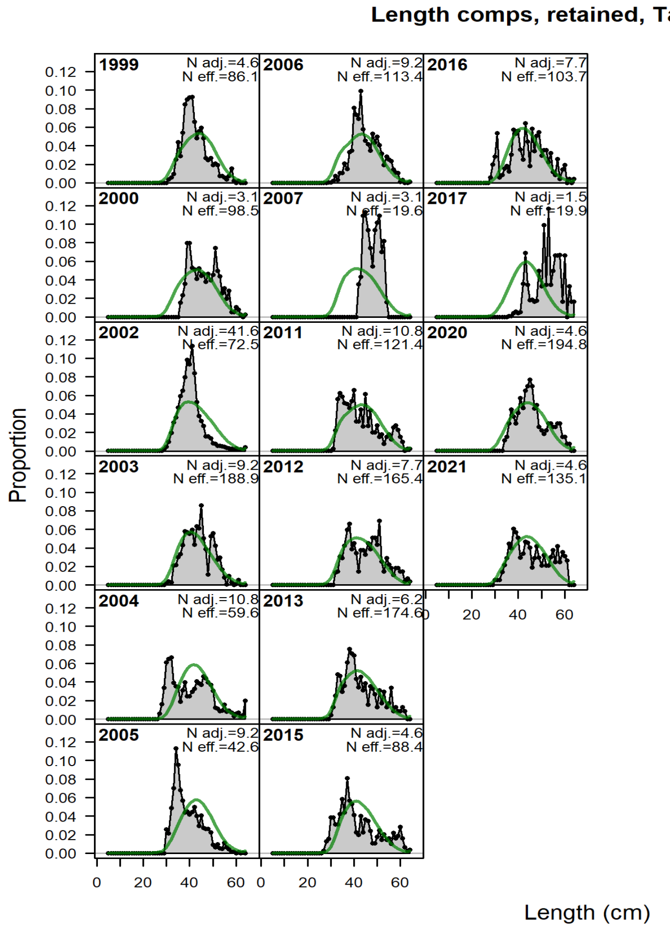


Figure 73 Fits to port length compositions for the Tas trawl fleet.

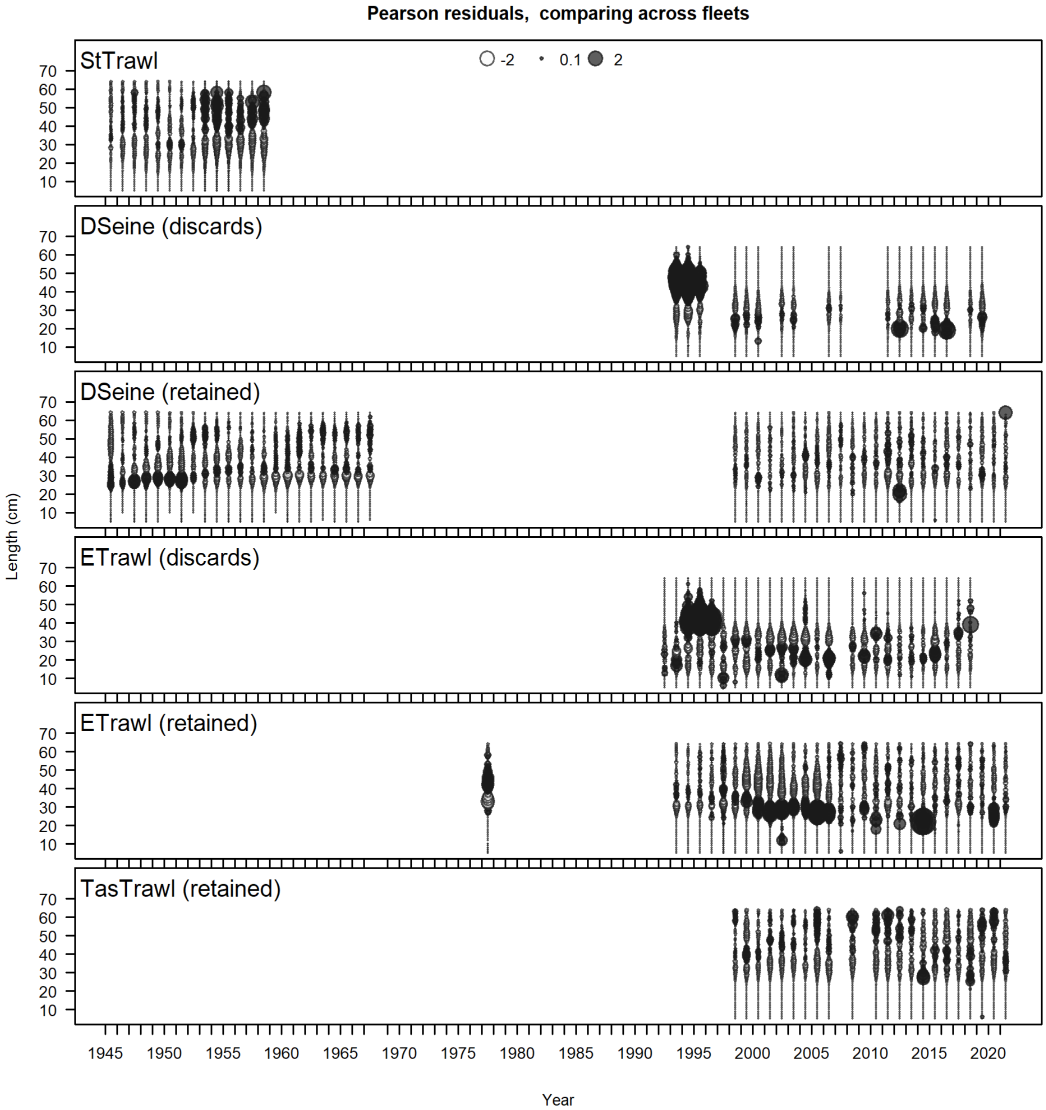


Figure 74 Residuals from the annual length compositions across all fleets.

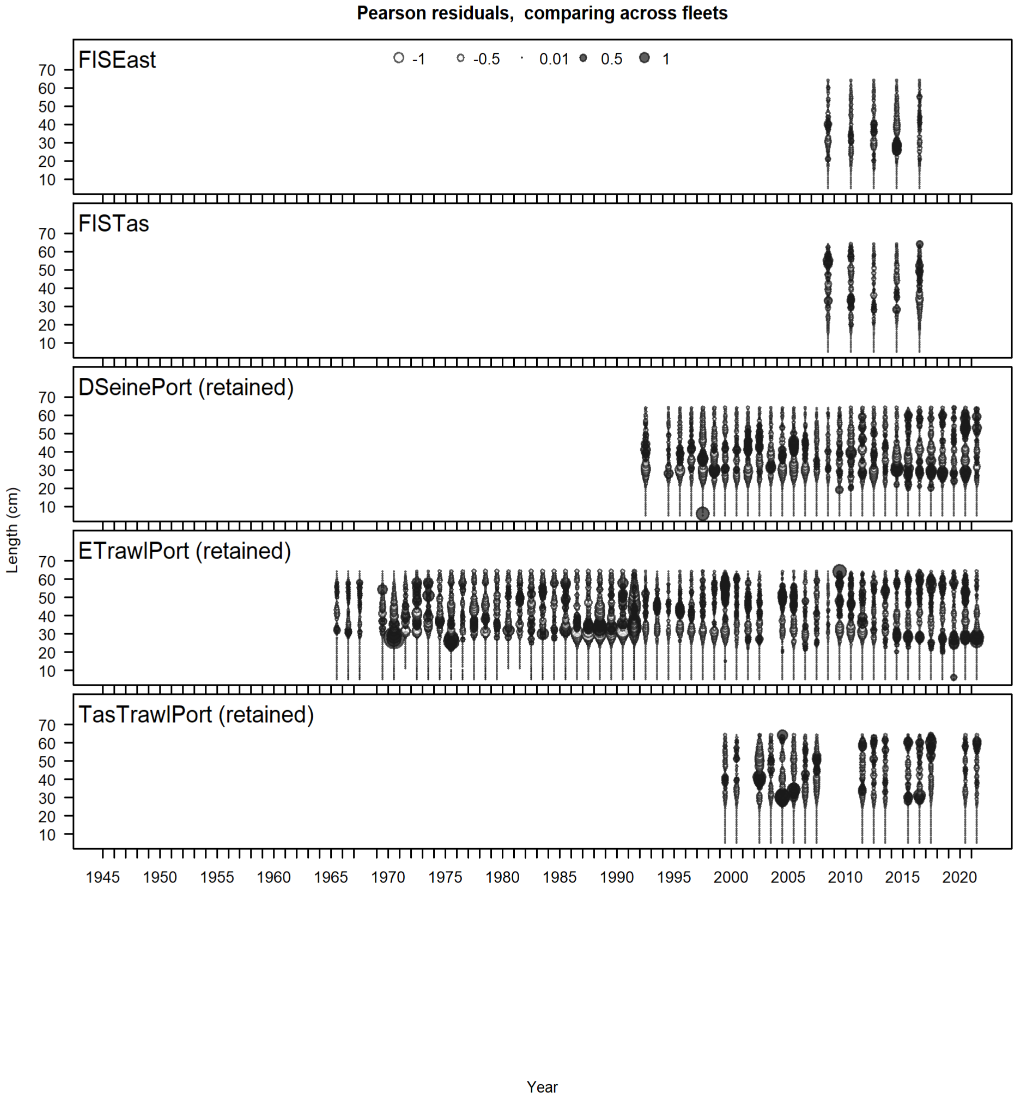


Figure 75 Residuals from the annual length compositions across all fleets.

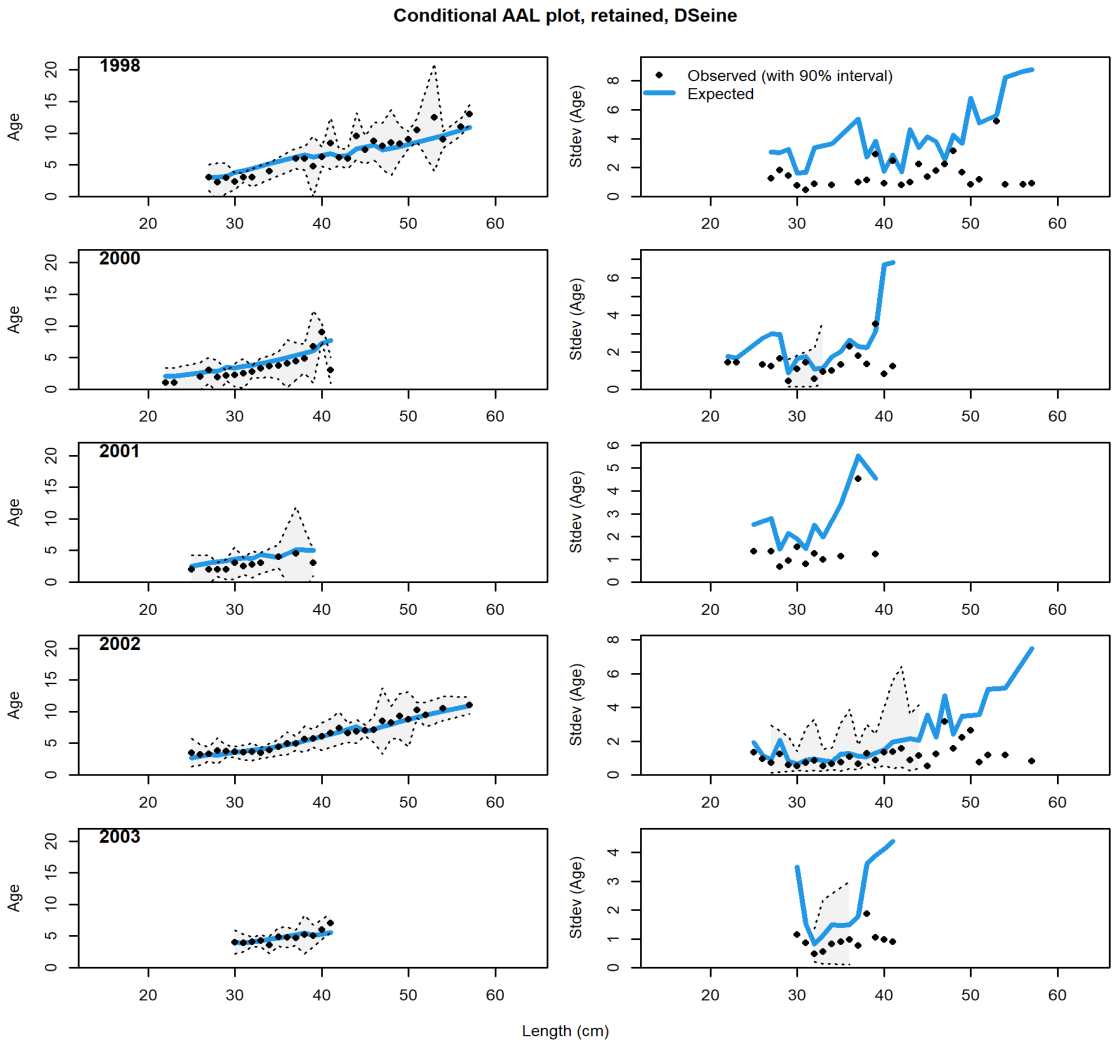


Figure 76 Fits to conditional age at length data for the Danish seine fleet 1998-2003.

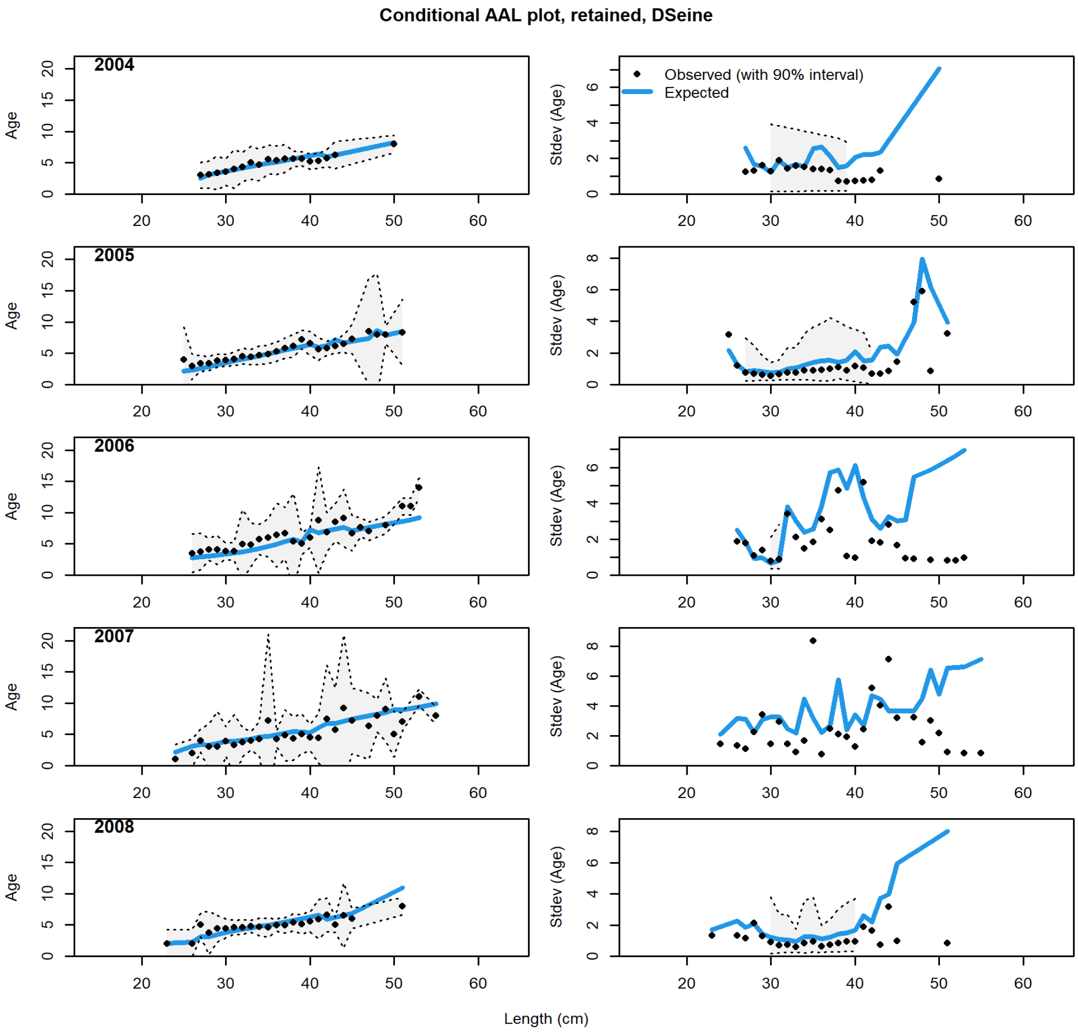


Figure 77 Fits to conditional age at length data for the Danish seine fleet 2004-2008.

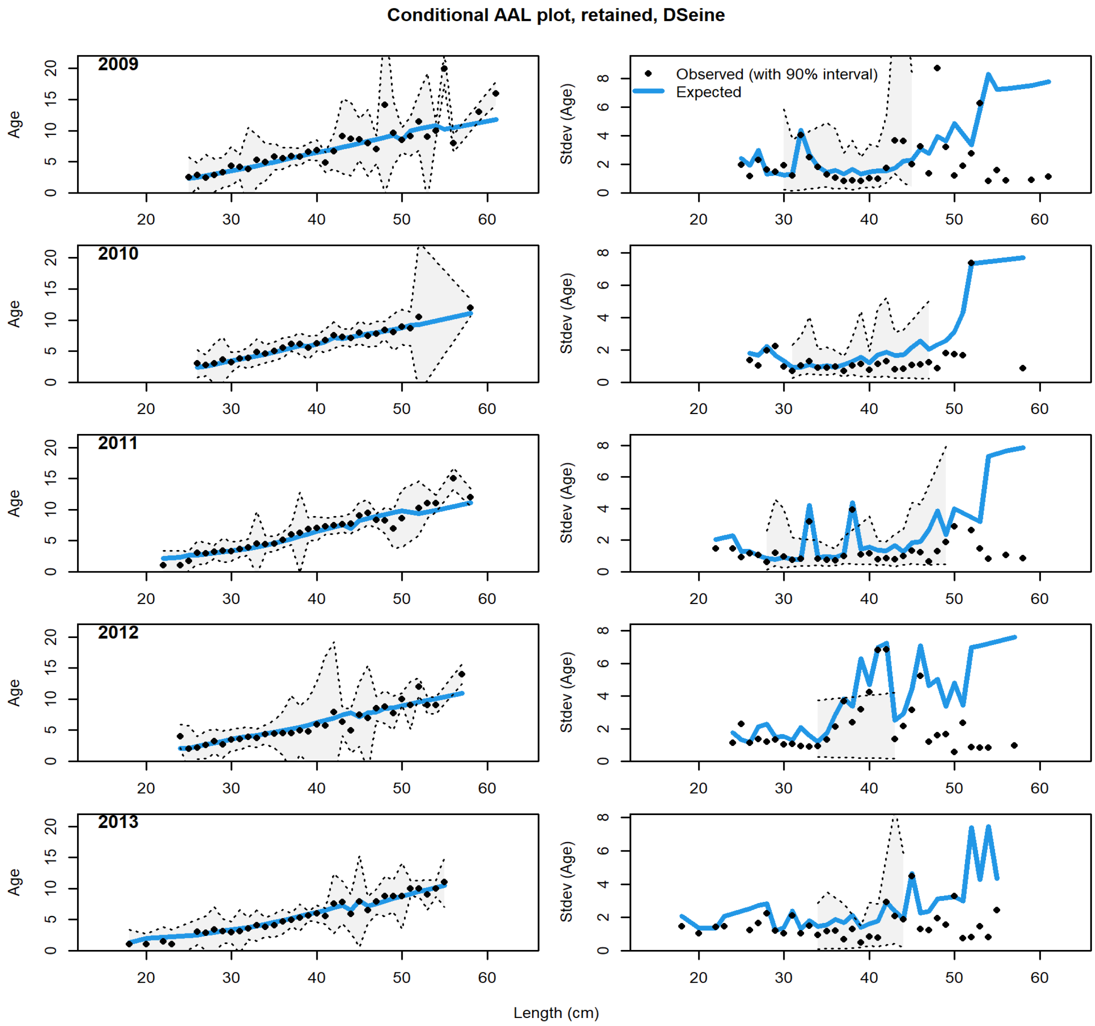


Figure 78 Fits to conditional age at length data for the Danish seine fleet 2009-2013.

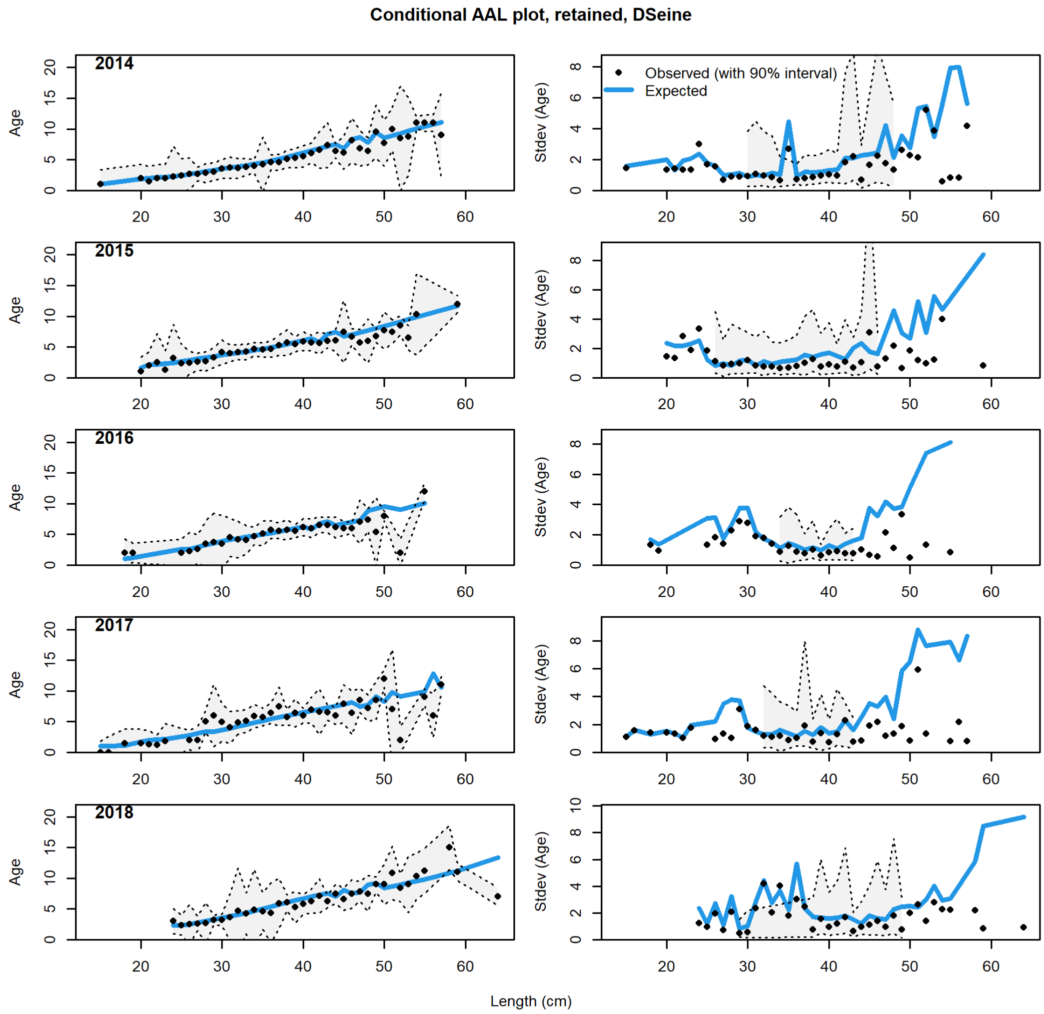


Figure 79 Fits to conditional age at length data for the Danish seine fleet 2014-2018.

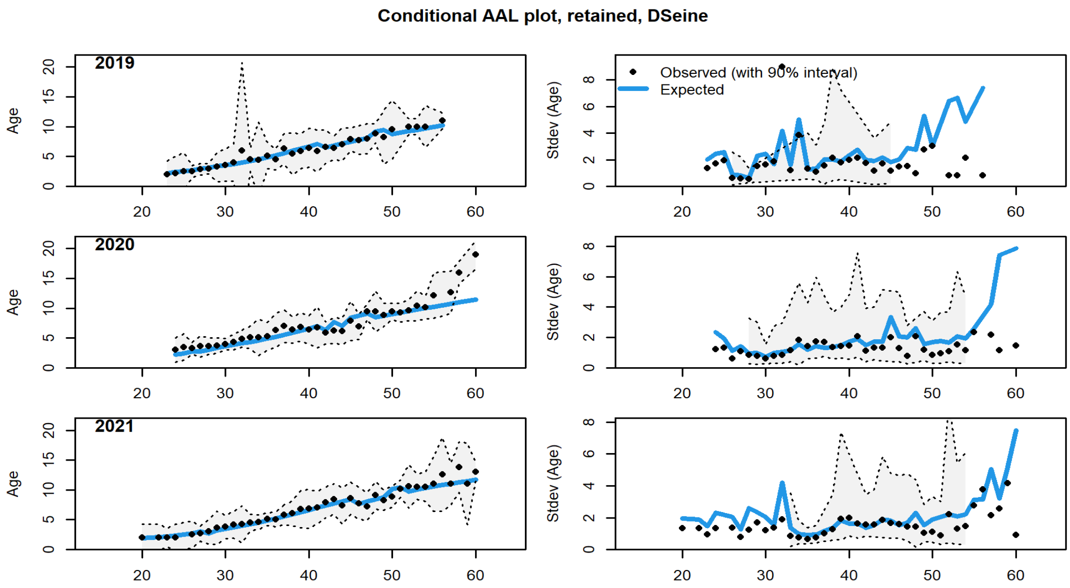


Figure 80 Fits to conditional age at length data for the Danish seine fleet 2019-2021.

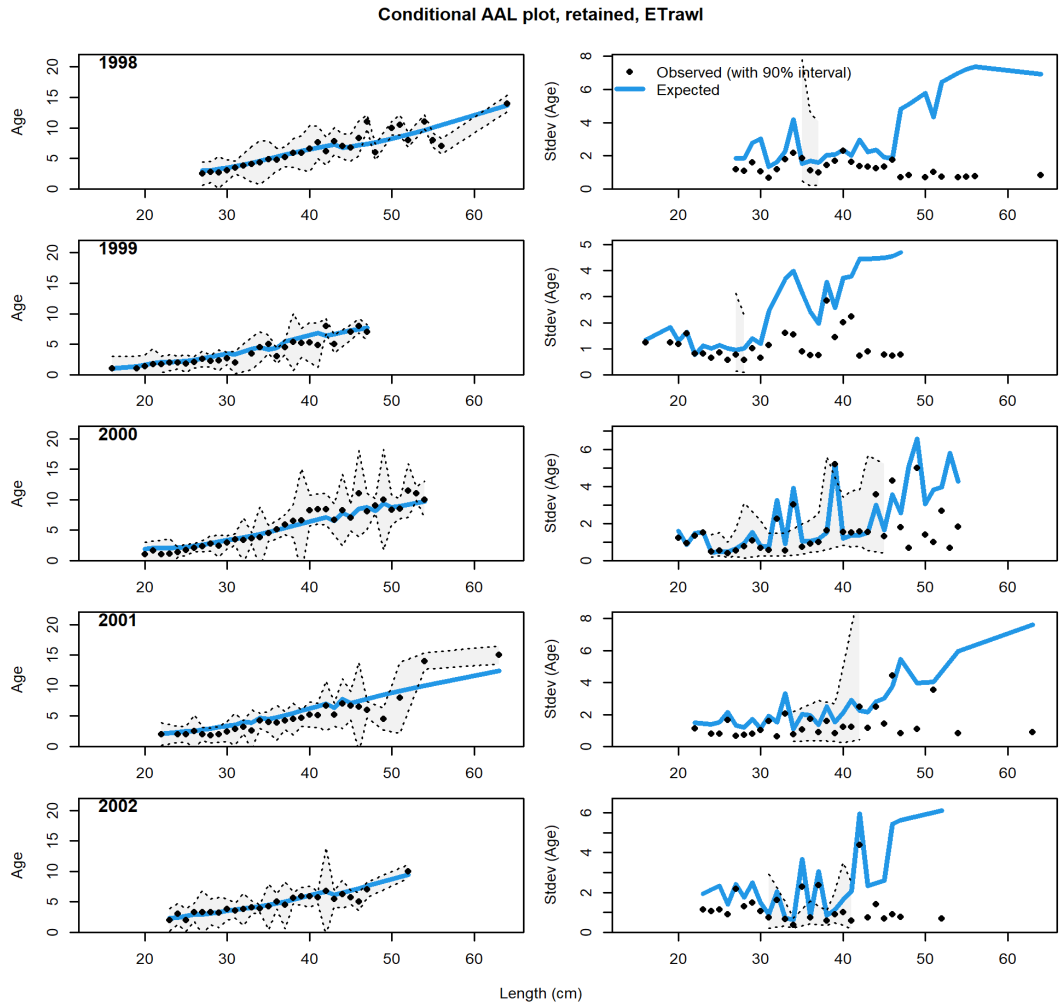


Figure 81 Fits to conditional age at length data for the east trawl fleet 1998-2002.

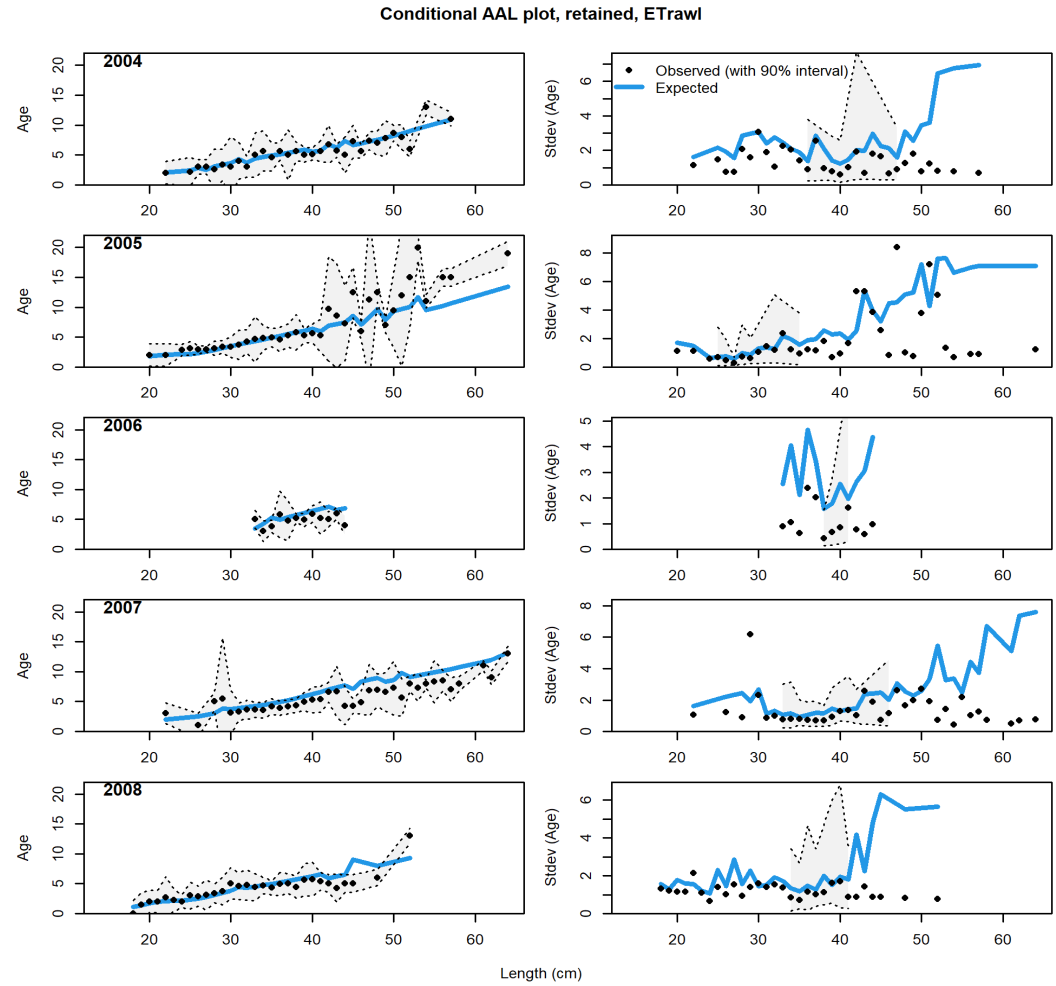


Figure 82 Fits to conditional age at length data for the east trawl fleet 2004-2008.

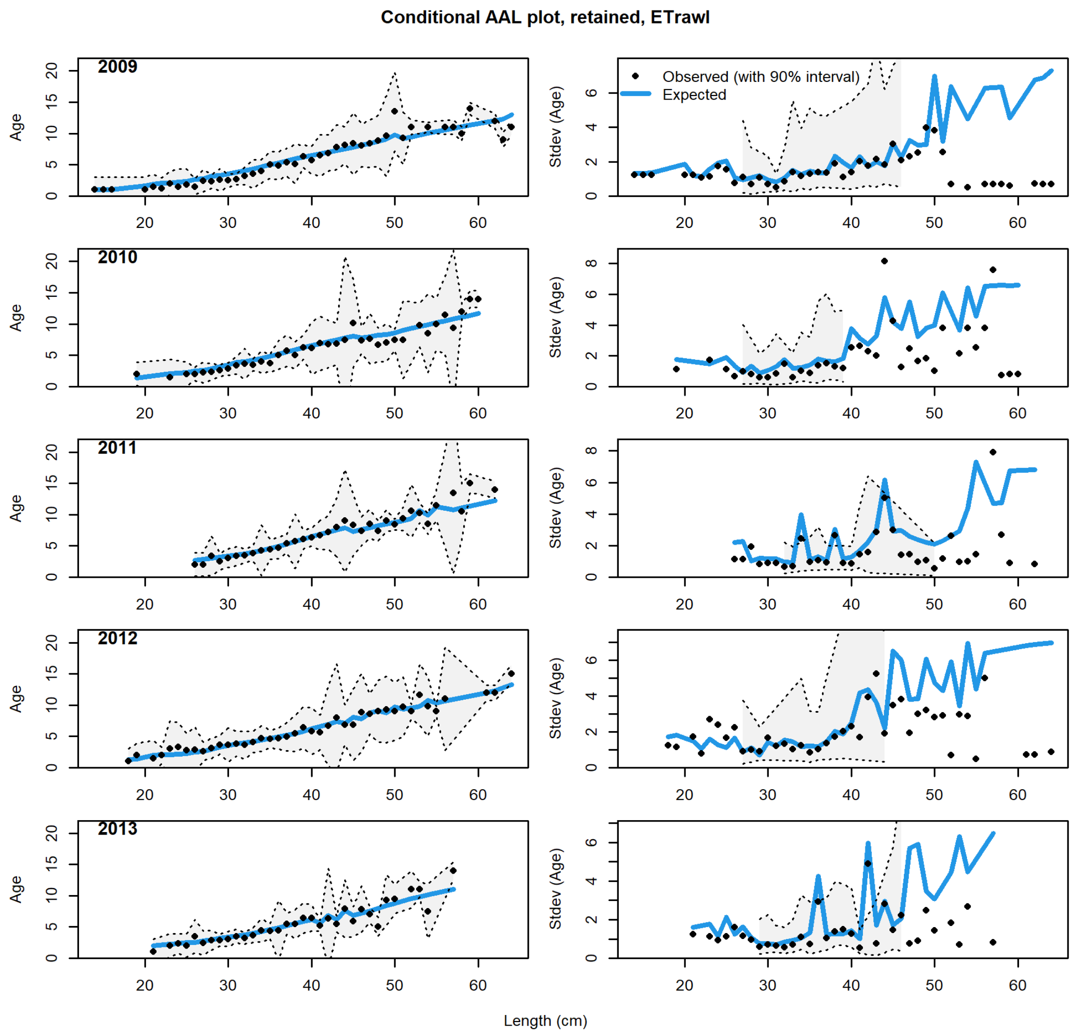


Figure 83 Fits to conditional age at length data for the east trawl fleet 2009-2013.

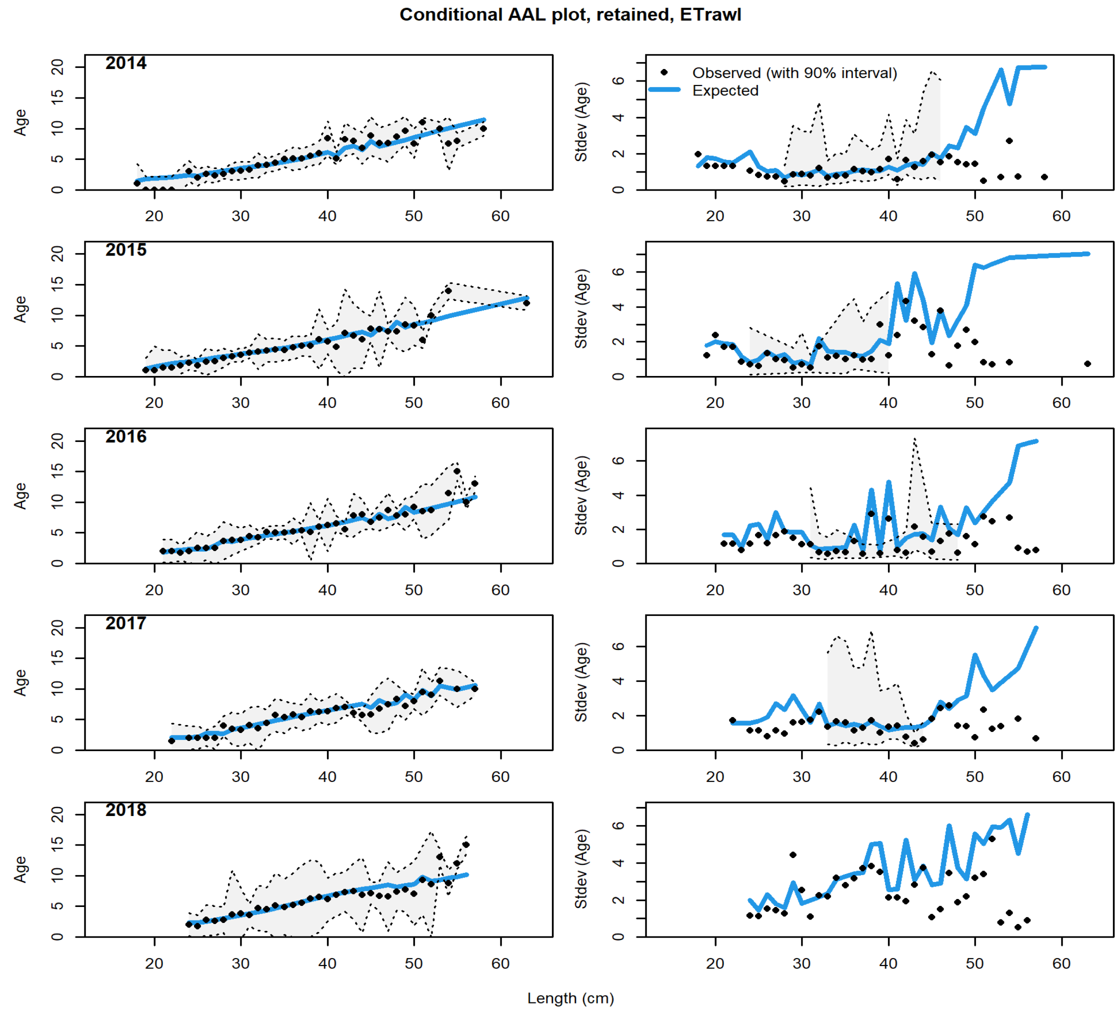


Figure 84 Fits to conditional age at length data for the east trawl fleet 2014-2018.

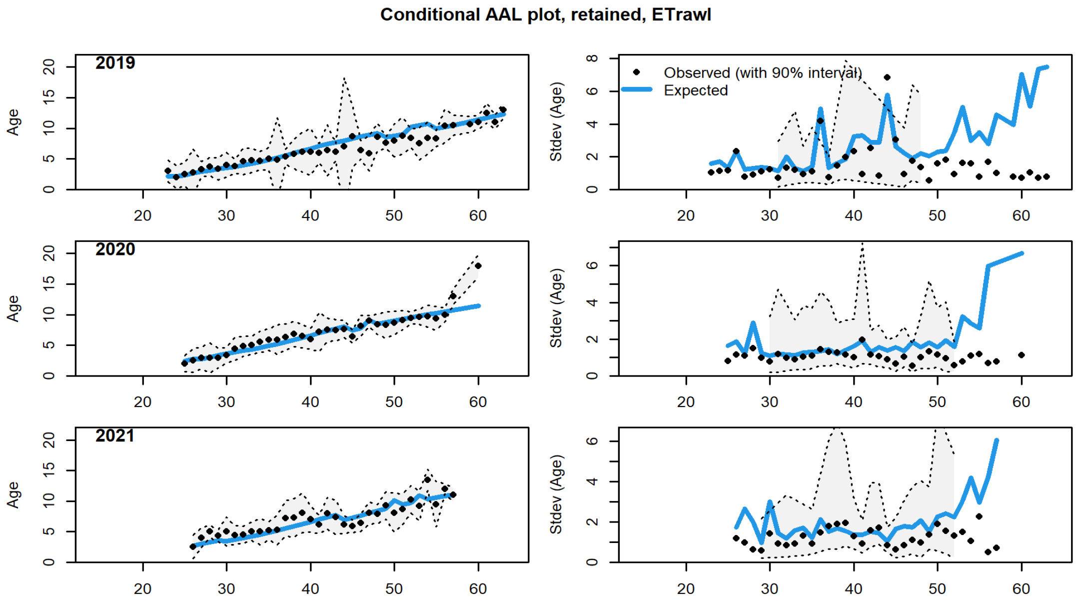


Figure 85 Fits to conditional age at length data for the east trawl fleet 2019-2021.

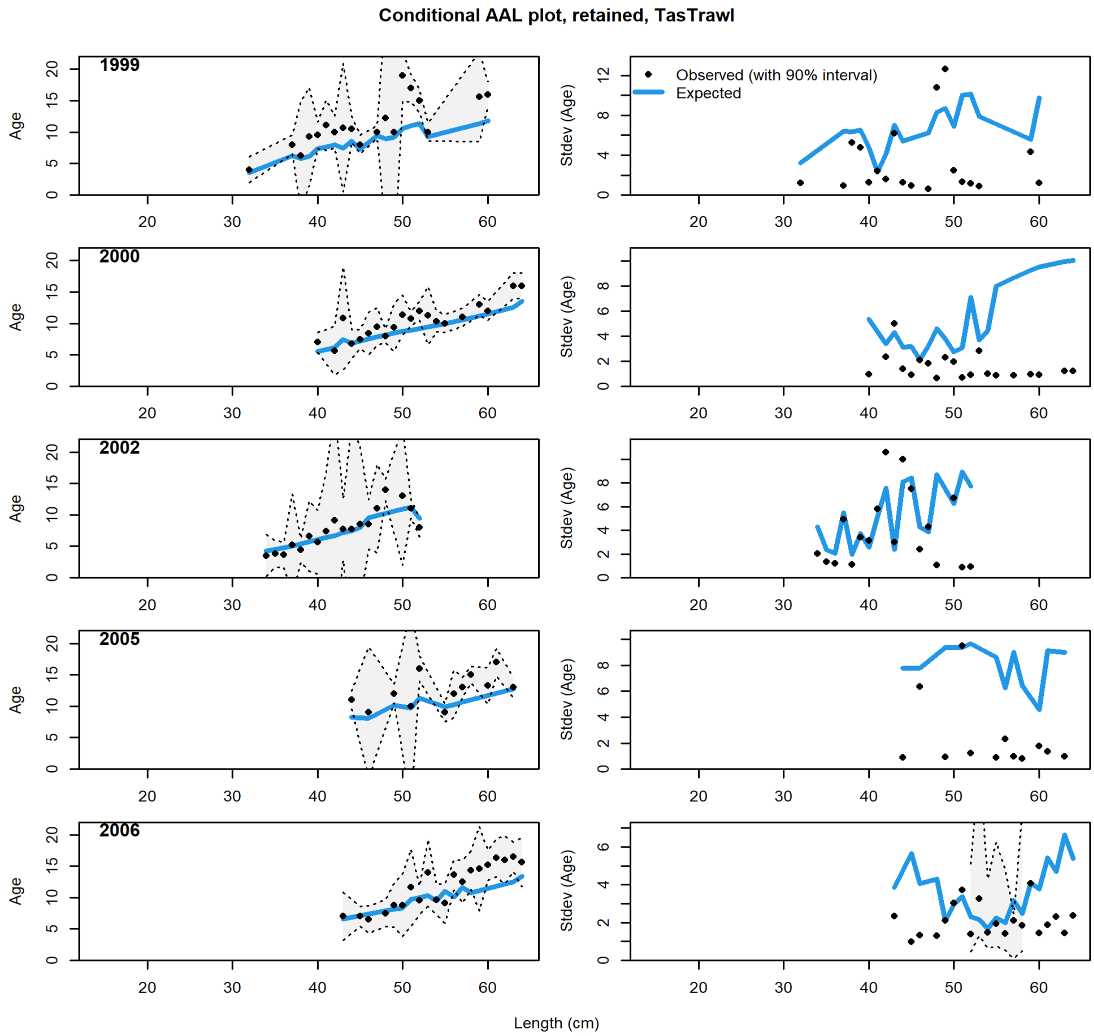


Figure 86 Fits to conditional age at length data for the Tas trawl fleet 1999-2006.

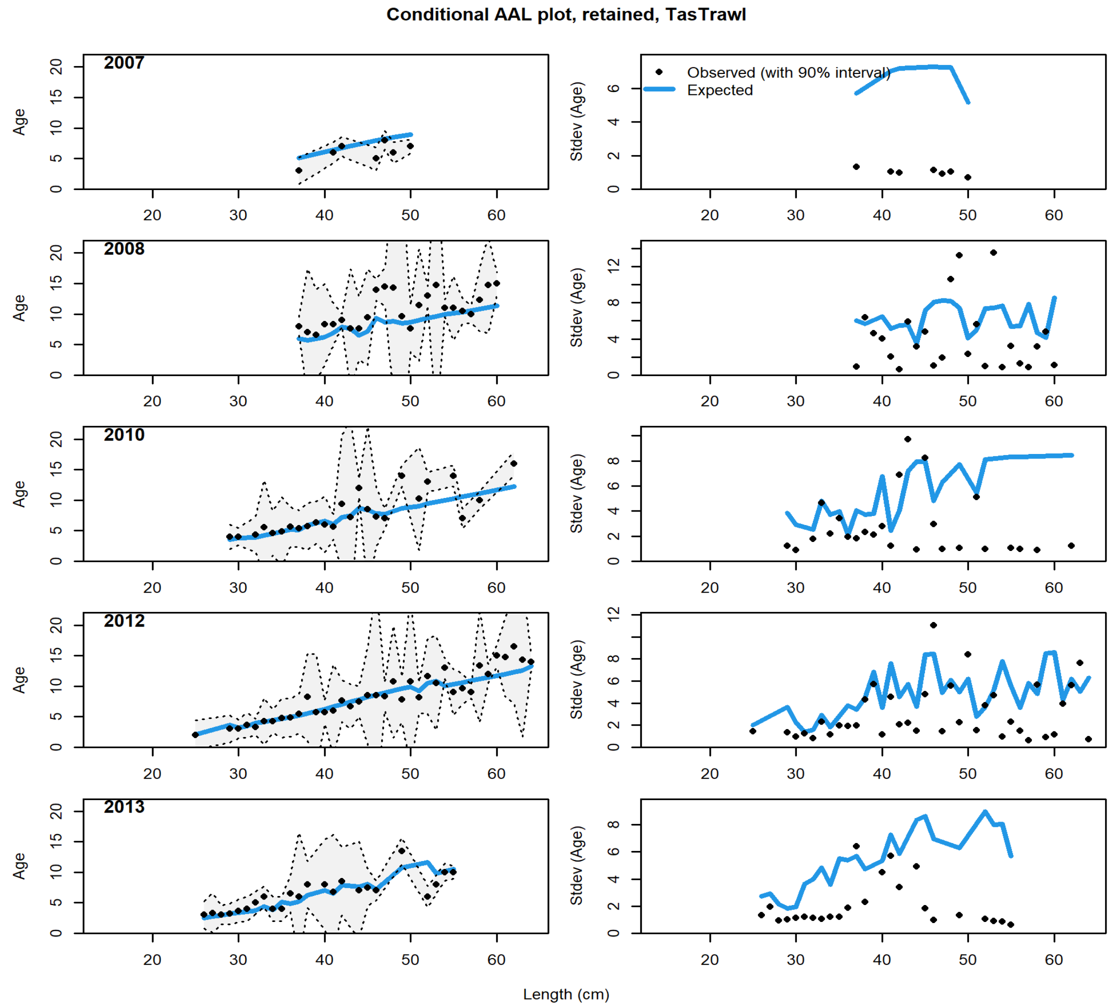


Figure 87 Fits to conditional age at length data for the Tas trawl fleet 2007-2013.

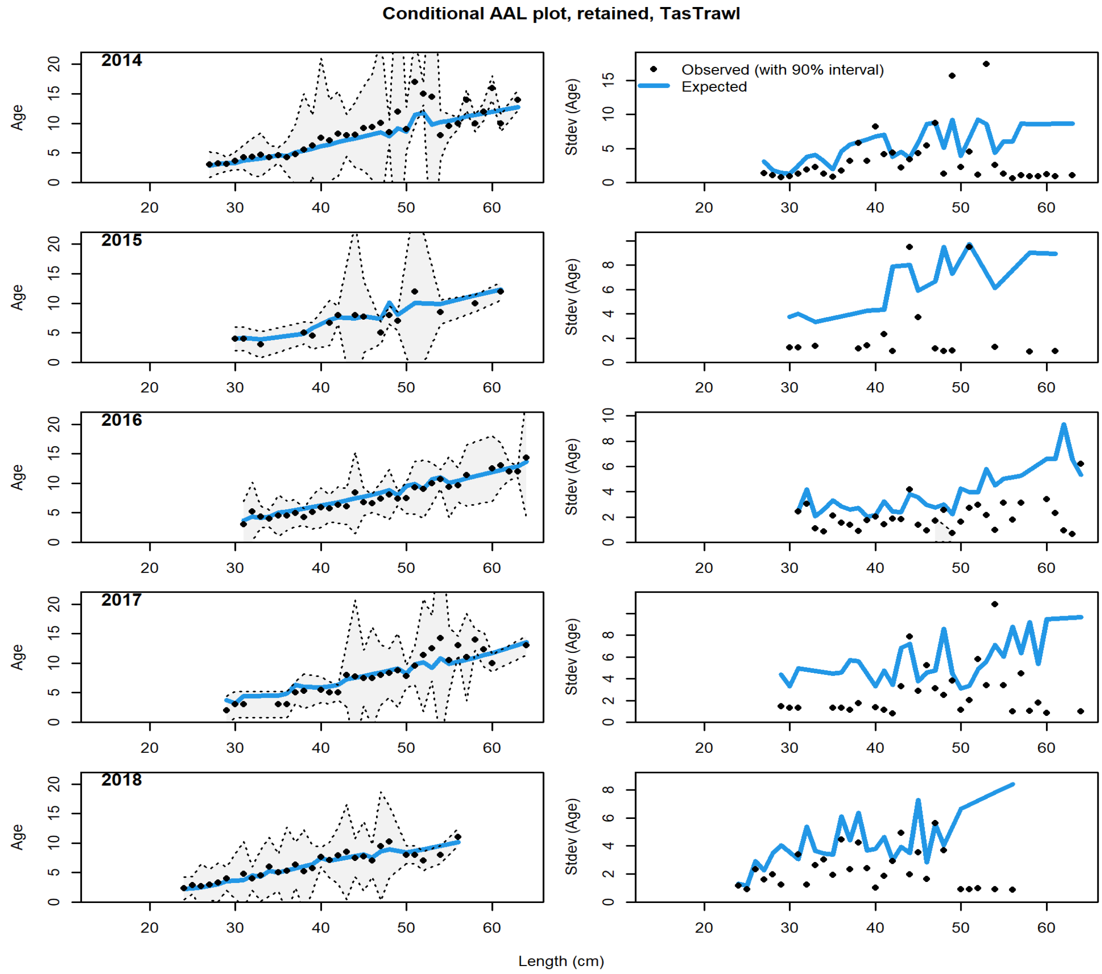


Figure 88 Fits to conditional age at length data for the Tas trawl fleet 2014-2018.

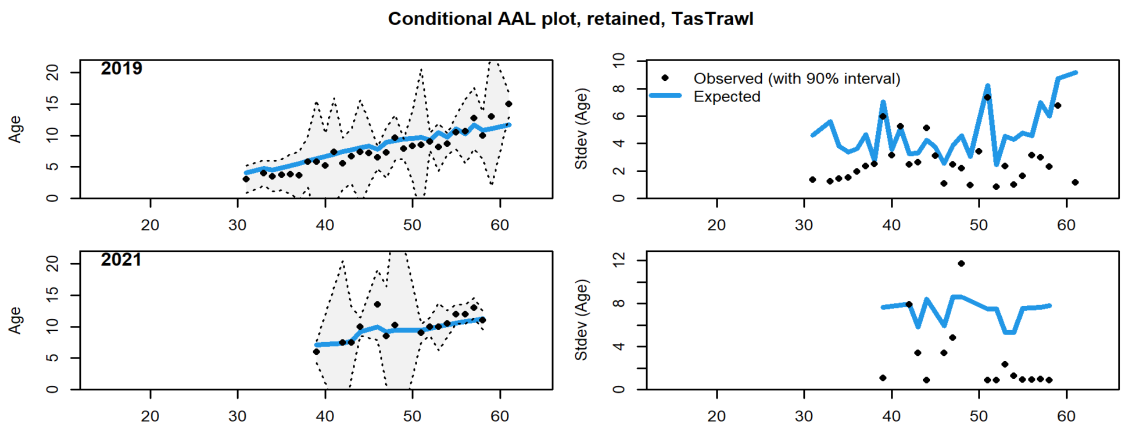


Figure 89 Fits to conditional age at length data for the Tas trawl fleet 2019-2021.

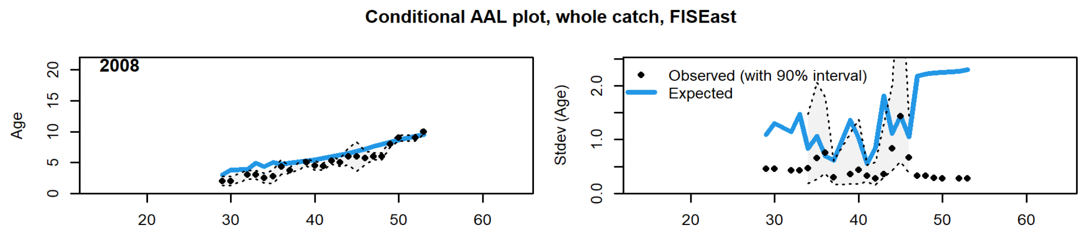


Figure 90 Fits to conditional age at length data for the FIS east fleet.

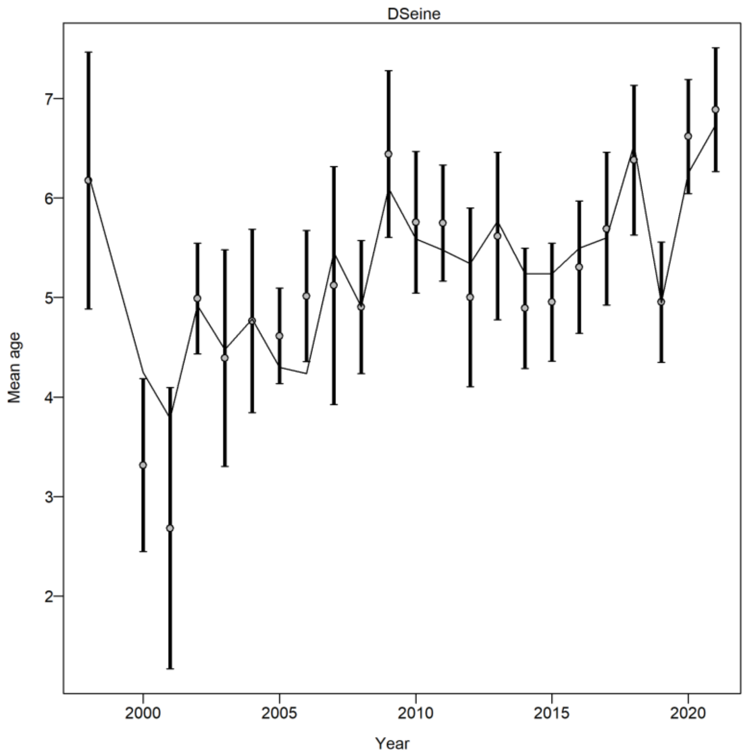


Figure 91 Data weighting of conditional age at length data for the Danish seine fleet.

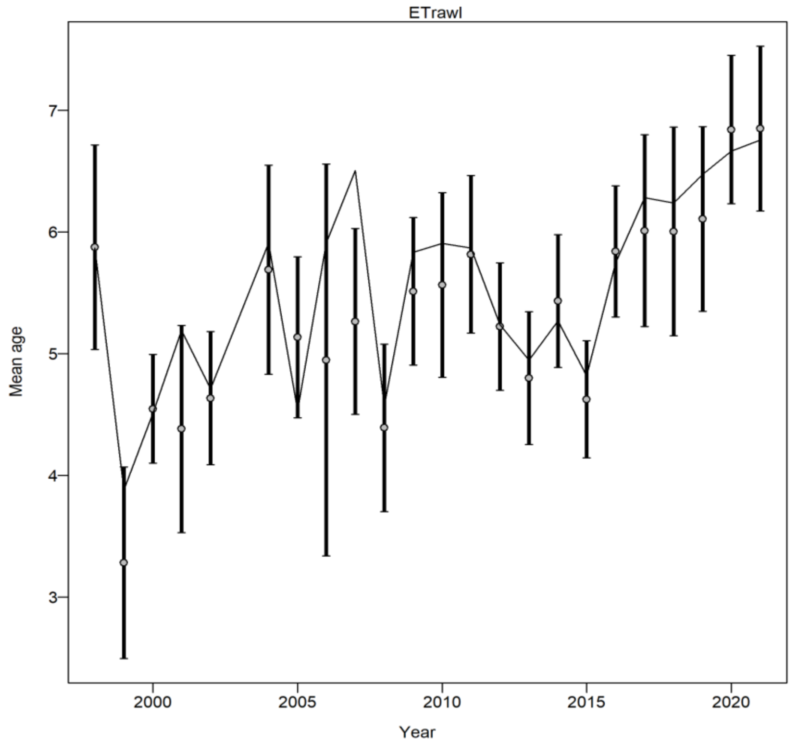


Figure 92 Data weighting of conditional age at length data for the east trawl fleet.

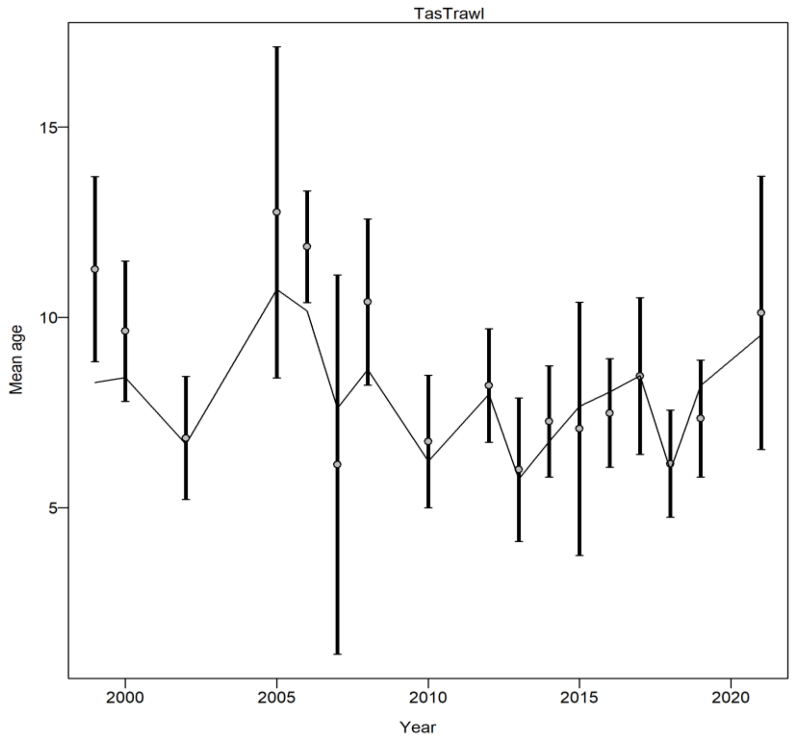


Figure 93 Data weighting of conditional age at length data for the Tas trawl fleet.

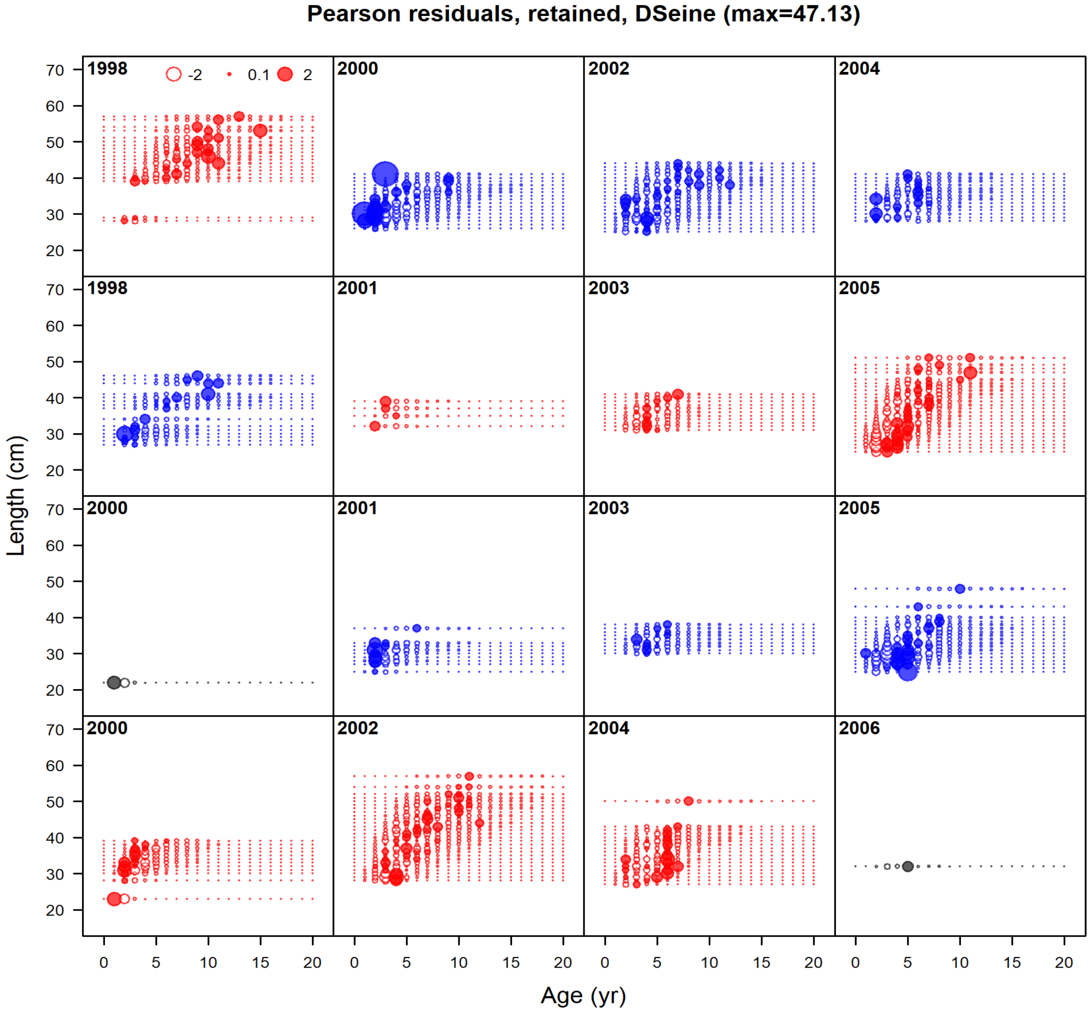


Figure 94 Pearson residuals of conditional age at length data for the Danish seine fleet 1998-2006. Red dots are females, blue is males and grey is unknown sex.

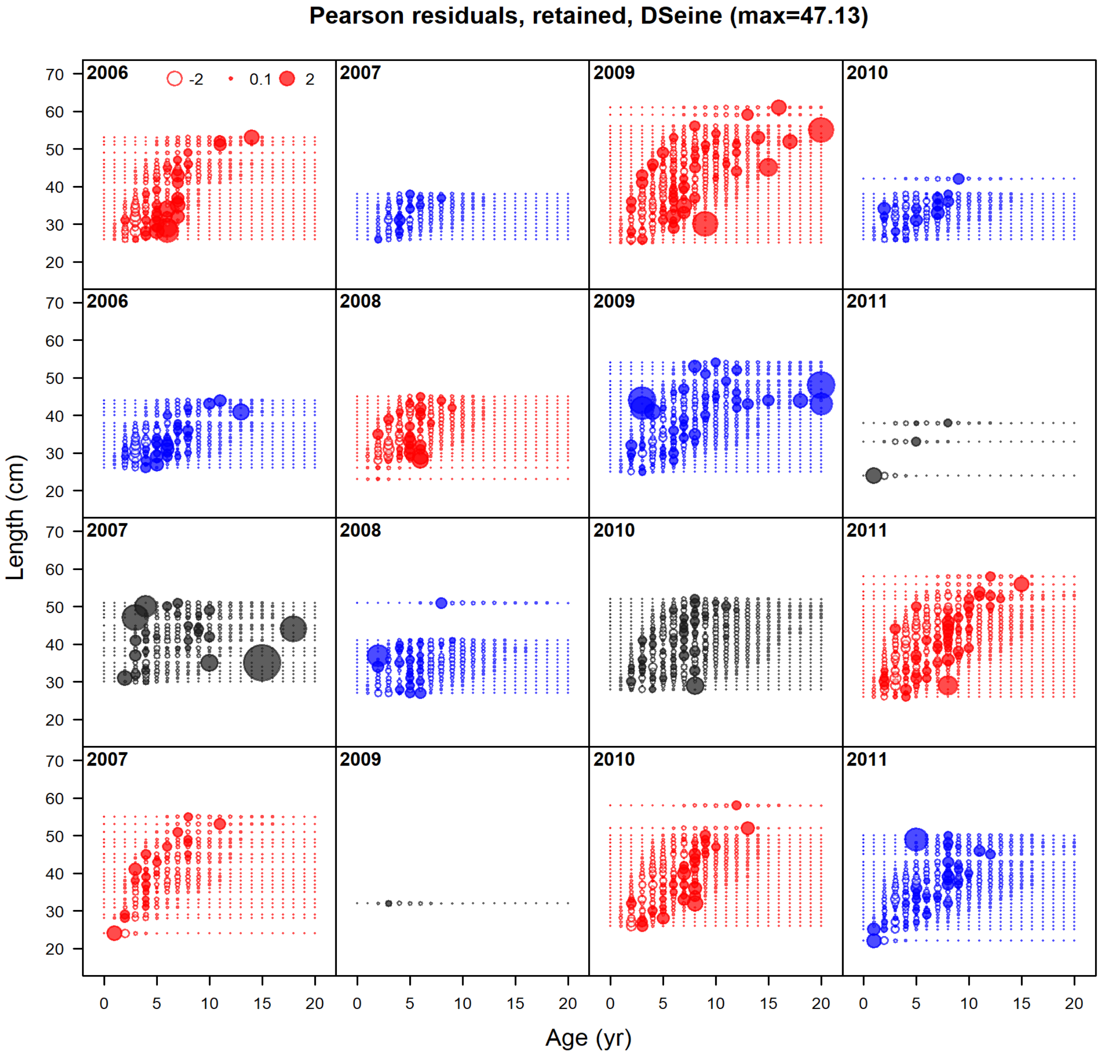


Figure 95 Pearson residuals of conditional age at length data for the Danish seine fleet 2006-2011. Red dots are females, blue is males and grey is unknown sex.

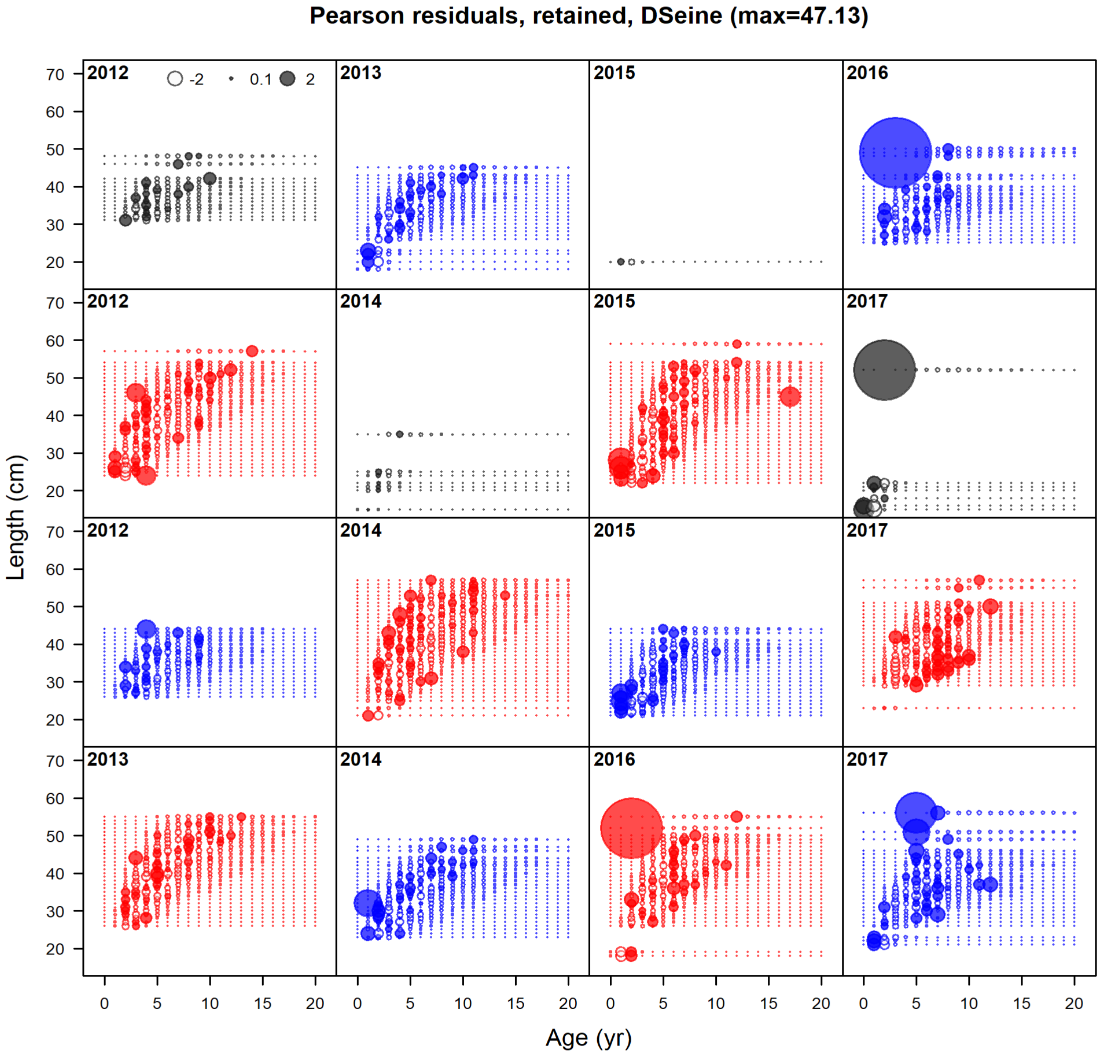


Figure 96 Pearson residuals of conditional age at length data for the Danish seine fleet 2012-2017. Red dots are females, blue is males and grey is unknown sex.

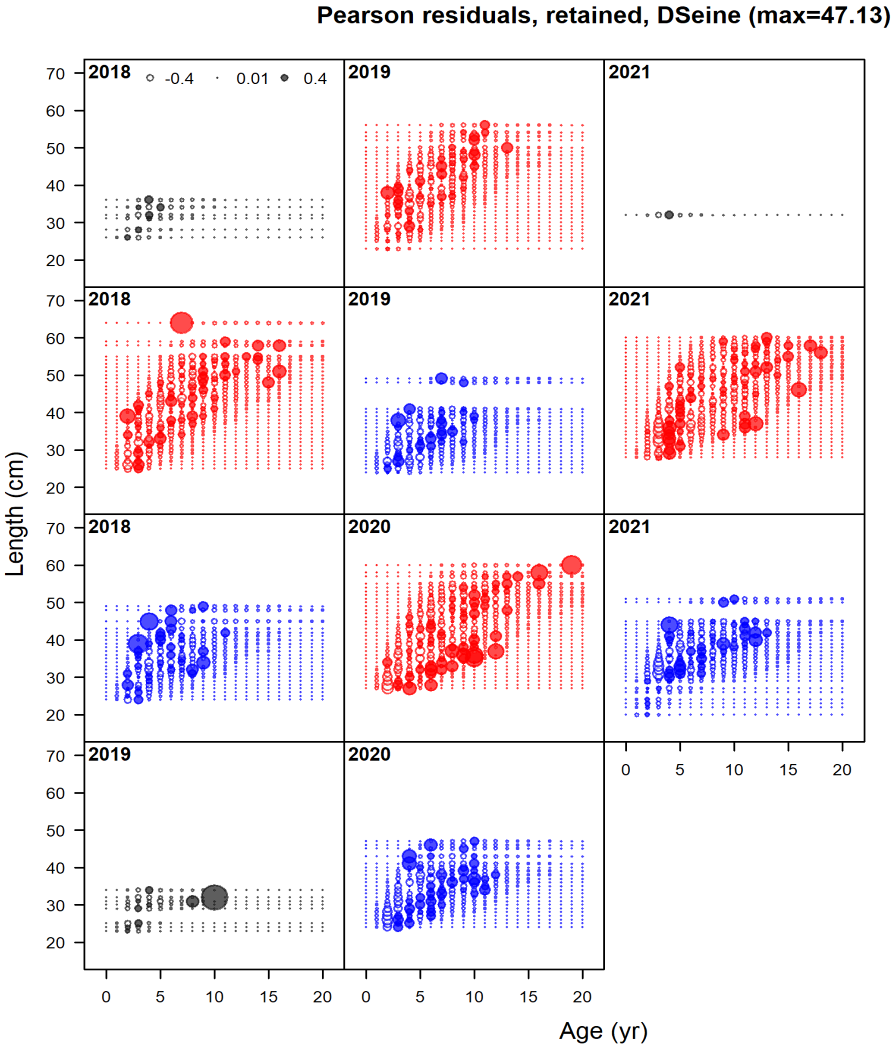


Figure 97 Pearson residuals of conditional age at length data for the Danish seine fleet 2017-2021. Red dots are females, blue is males and grey is unknown sex.

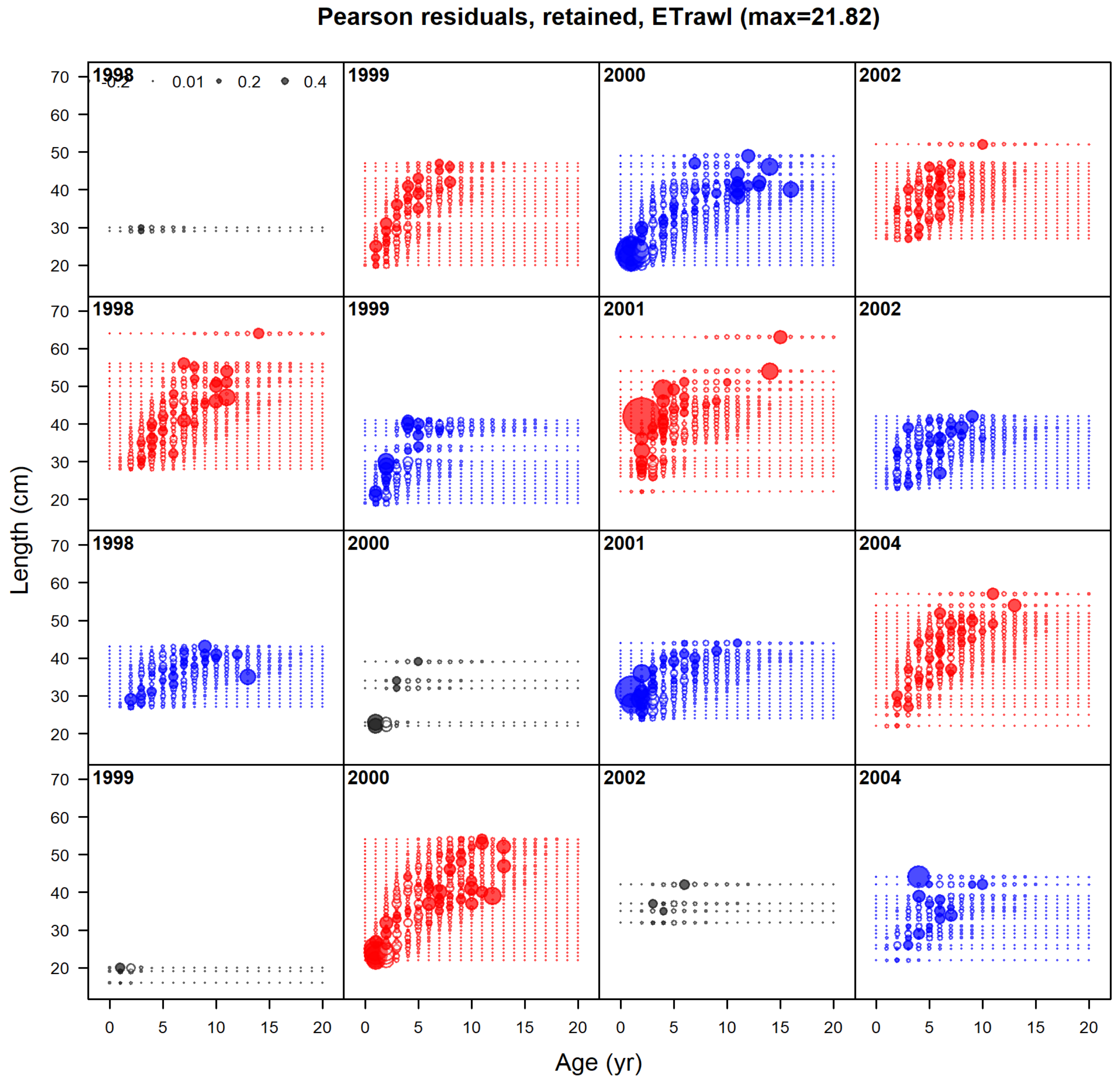


Figure 98 Pearson residuals of conditional age at length data for the east trawl fleet 1998-2004. Red dots are females, blue is males and grey is unknown sex.

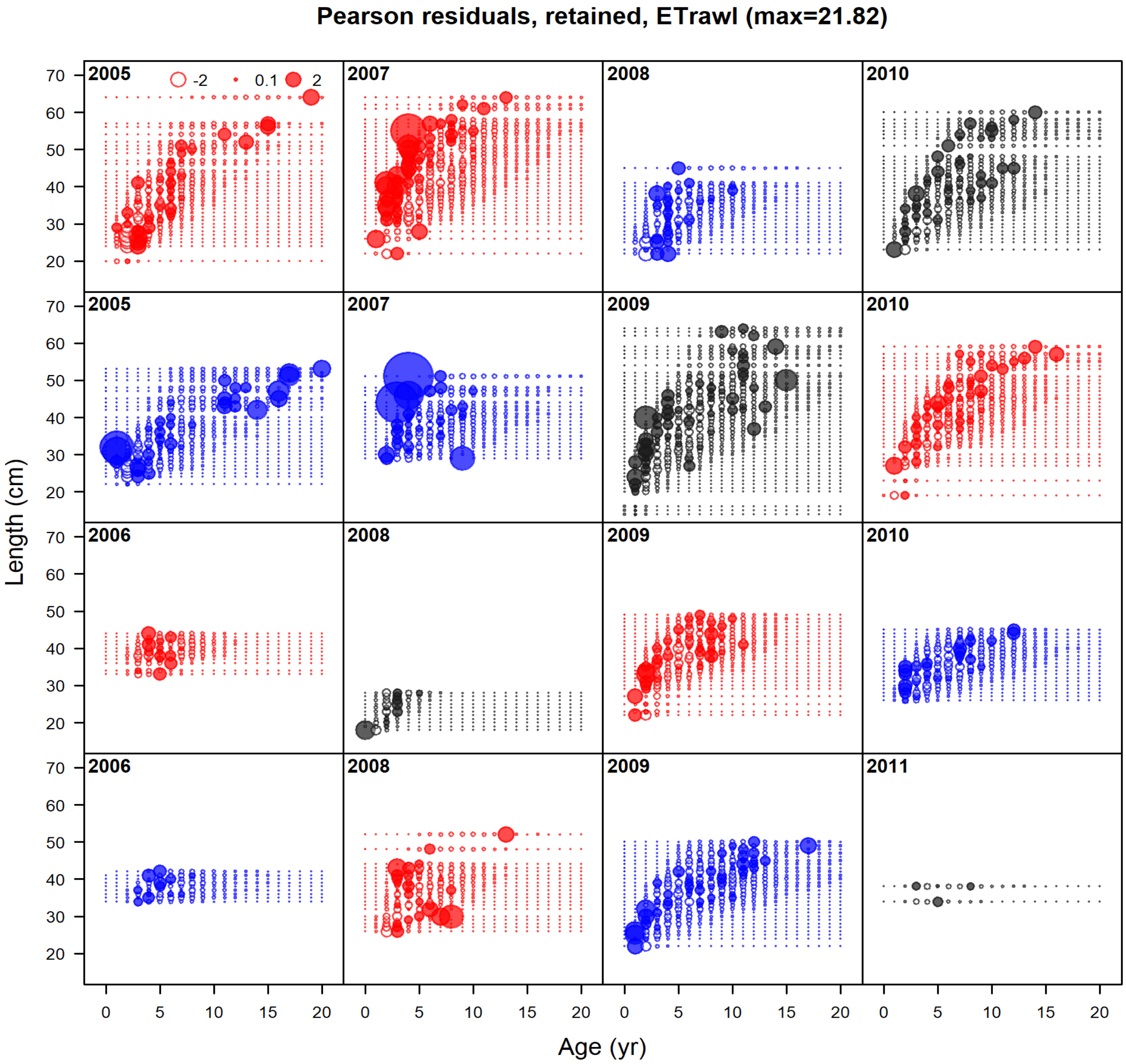


Figure 99 Pearson residuals of conditional age at length data for the east trawl fleet 2005-2011. Red dots are females, blue is males and grey is unknown sex.

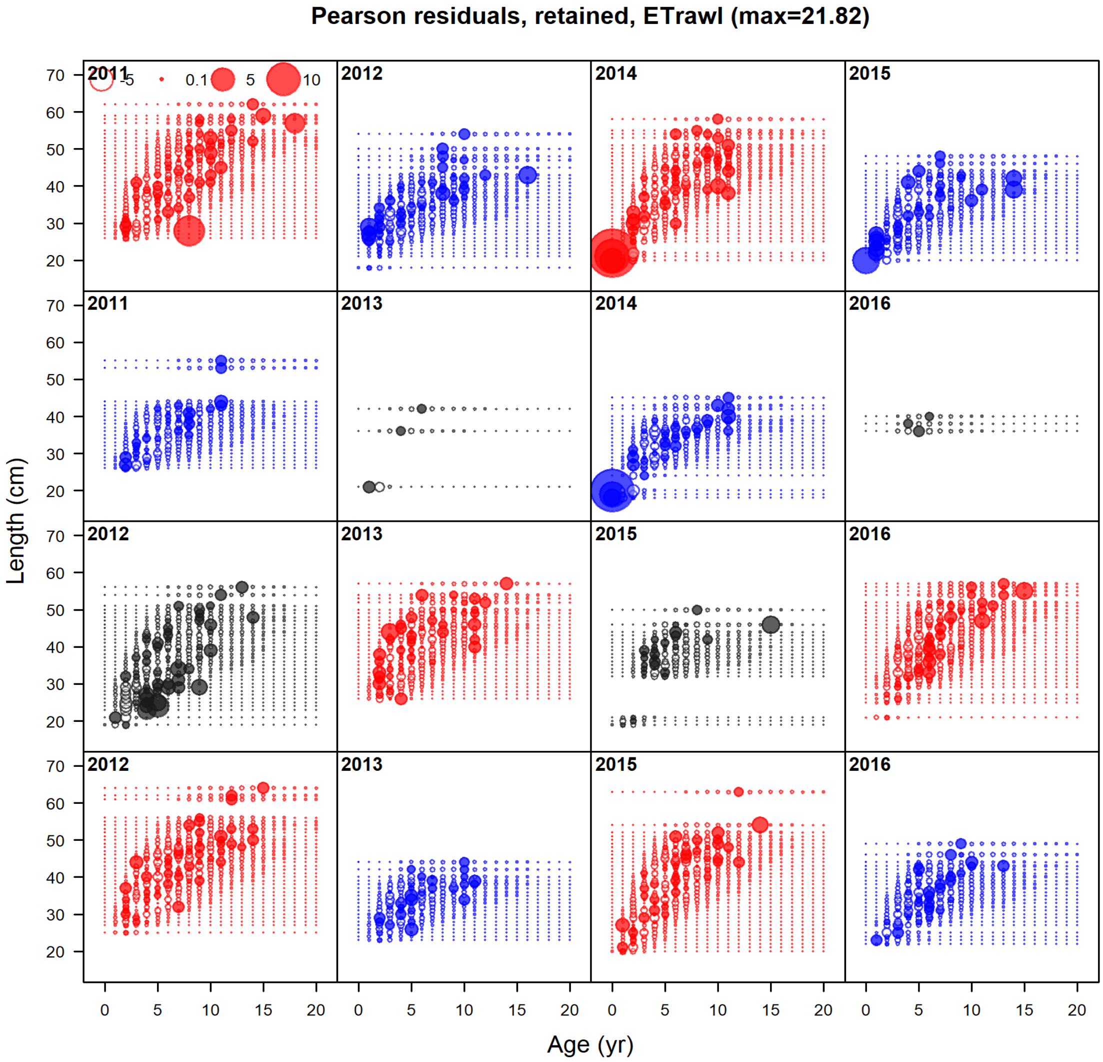


Figure 100 Pearson residuals of conditional age at length data for the east trawl fleet 2011-2016. Red dots are females, blue is males and grey is unknown sex.

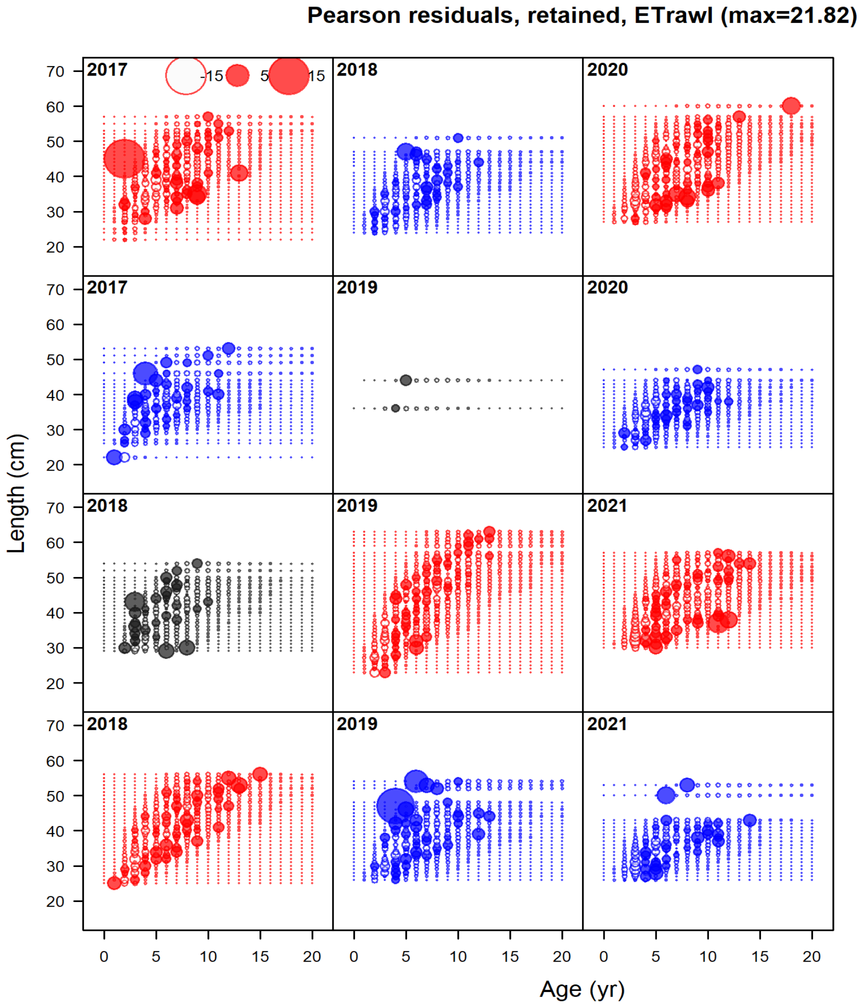


Figure 101 Pearson residuals of conditional age at length data for the east trawl fleet 2017-2021. Red dots are females, blue is males and grey is unknown sex.

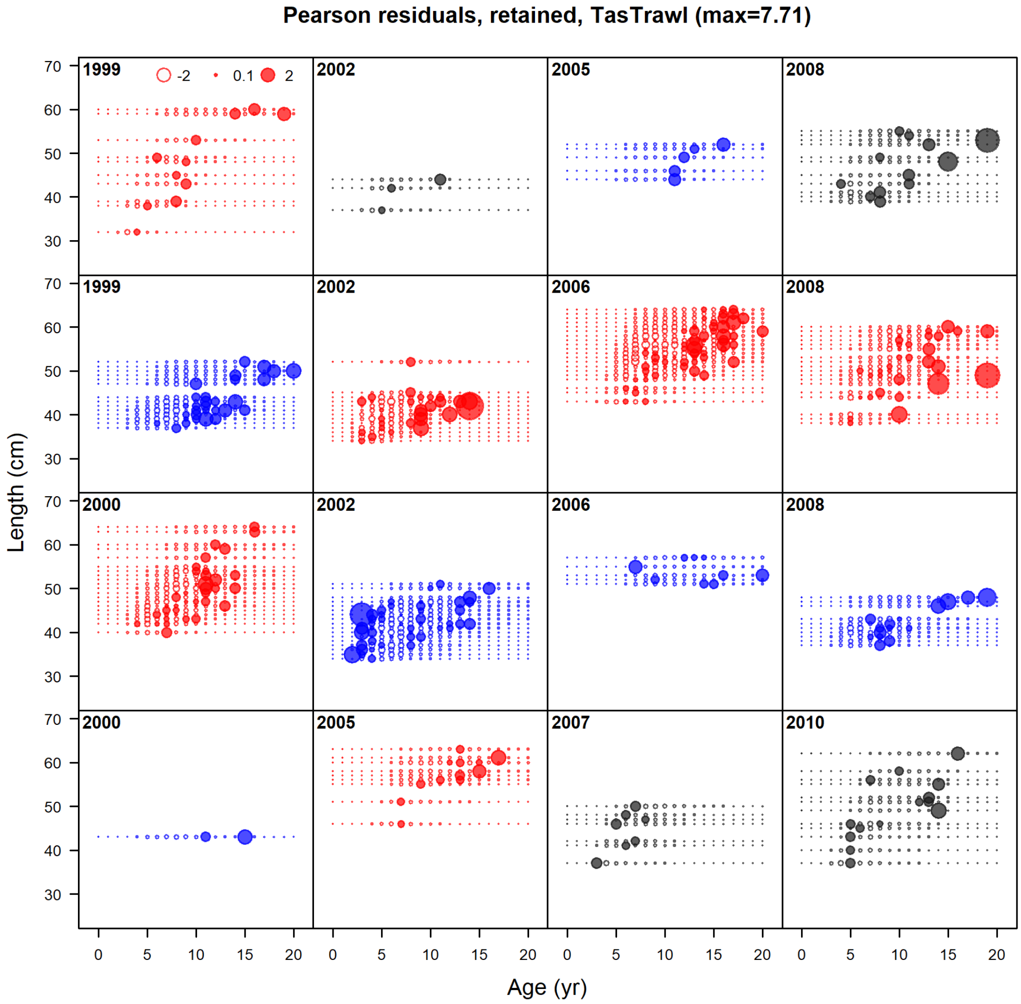


Figure 102 Pearson residuals of conditional age at length data for the Tas trawl fleet 1999-2010. Red dots are females, blue is males and grey is unknown sex.

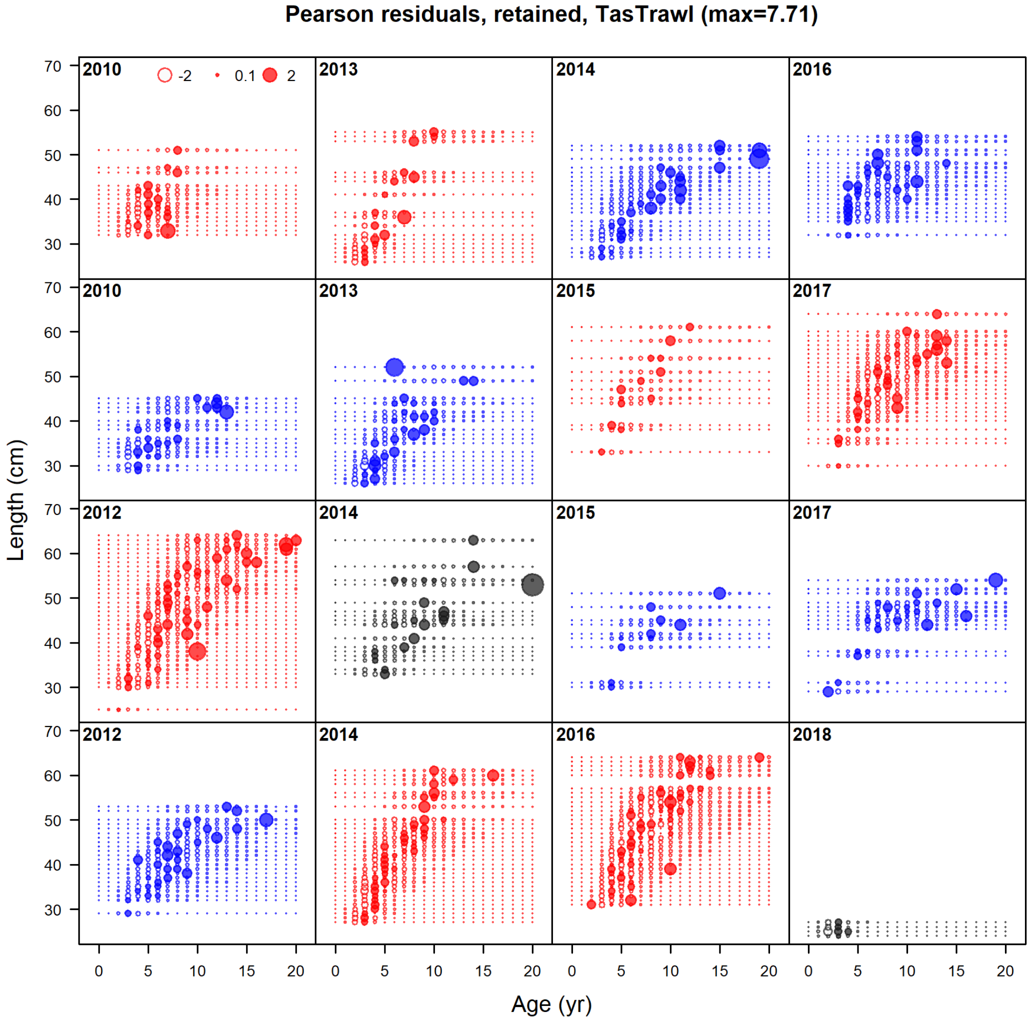


Figure 103 Pearson residuals of conditional age at length data for the Tas trawl fleet 2010-2018. Red dots are females, blue is males and grey is unknown sex.

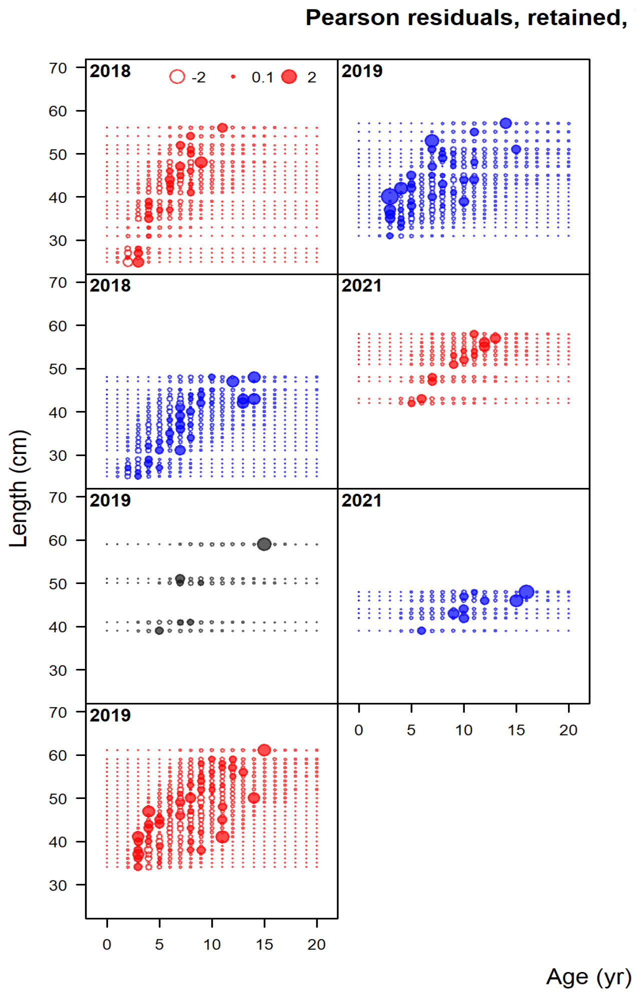


Figure 104 Pearson residuals of conditional age at length data for the Tas trawl fleet 2018-2021. Red dots are females, blue is males and grey is unknown sex.

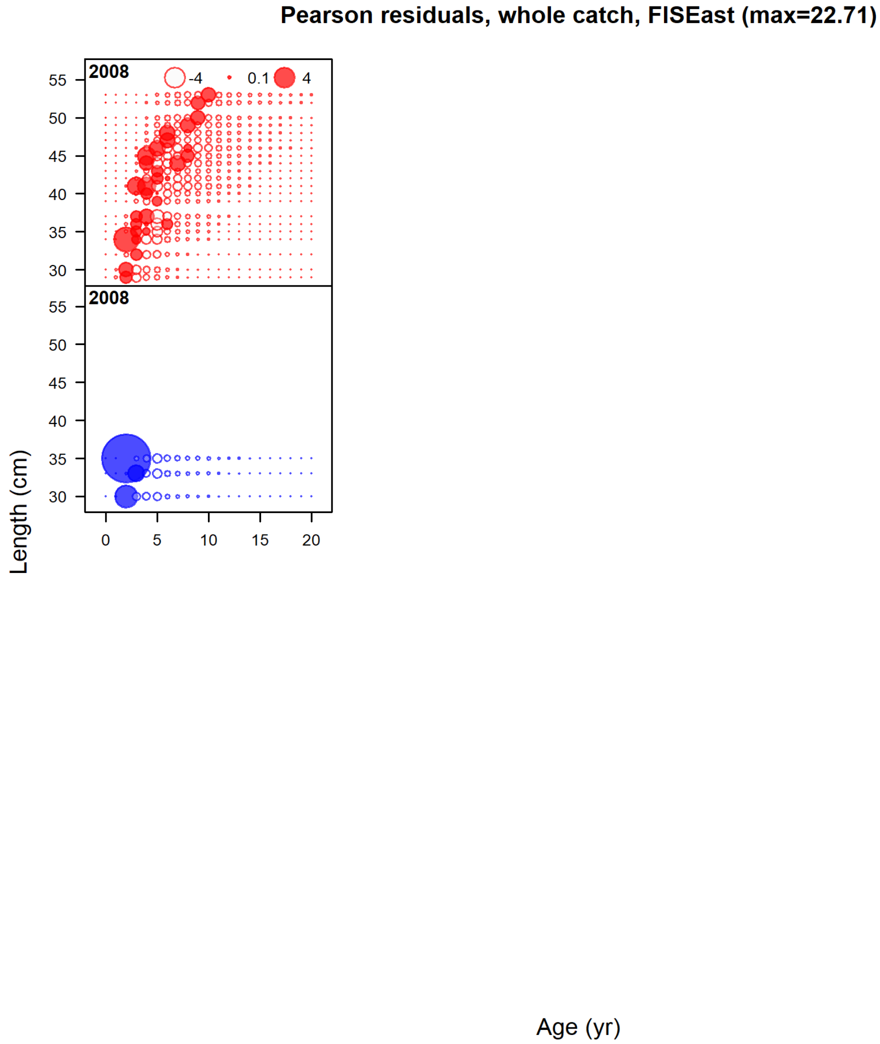


Figure 105 Pearson residuals of conditional age at length data for the FIS east fleet. Red dots are females, blue is males and grey is unknown sex.

9 References

Day, J., 2019a. Tiger Flathead (*Neoplatycephalus richardsoni*) stock assessment based on data up to 2018. Report for the Australian Fisheries Management Authority. CSIRO Oceans and Atmosphere.

Day, J., 2019b. Tiger Flathead (*Neoplatycephalus richardsoni*) stock assessment based on data up to 2018 – development of a preliminary base case. Report for the Australian Fisheries Management Authority. CSIRO Oceans and Atmosphere.

Day, J., 2016. Tiger flathead (*Neoplatycephalus richardsoni*) stock assessment based on data up to 2015. Unpublished report to Shelf RAG. CSIRO Oceans and Atmosphere.

Methot, R.D., 2005. Technical Description of the Stock Synthesis II Assessment Program. NOAA Fisheries Service, Seattle. 54 pp.

Methot, R.D., Wetzel, C.R., 2013. Stock Synthesis: a biological and statistical framework for fish stock assessment and fishery management. Fisheries Research 142, 86–90.

Methot, R.D., Wetzel, C.R., Taylor, I., 2018. Stock Synthesis User Manual Version 3.30.12. NOAA Fisheries, Seattle, WA USA. 230pp.

Methot, R.D., Wetzel, C.R., Taylor, I., Doering, K.L., Johnson, K.F., 2022. Stock Synthesis User Manual Version 3.30.19. NOAA Fisheries, Seattle, WA USA. 243pp.

Pacific Fishery Management Council, 2018. Terms of Reference for the Groundfish and Coastal Pelagic Species Stock Assessment Review Process for 2017-2018. http://www.pcouncil.org/wp-content/uploads/2017/01/Stock_Assessment_ToR_2017-18.pdf.

Punt, A.E., 2018. On the Use of Likelihood Profiles in Fisheries Stock Assessment. Technical paper for SESSFRAG, August 2018.

Sporcic, M., 2022. Draft CPUE standardizations for selected SESSF Species (data to 2021), Hobart, 391 p (Report for the Australian Fisheries Management Authority). CSIRO Oceans; Atmosphere.

As Australia's national science agency and innovation catalyst, CSIRO is solving the greatest challenges through innovative science and technology.

CSIRO. Unlocking a better future for everyone.

Contact us

1300 363 400
+61 3 9545 2176
csiroenquiries@csiro.au
https://www.csiro.au

Oceans & Atmosphere
Pia Bessell-Browne
+61 3 6362 5100
Pia.Bessell-Browne@csiro.au
https://www.csiro.au/OandA