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2022 PROPOSED BASE CASE MODEL FOR EASTERN ATLANTIC AND MEDITERRANEAN BLUEFIN TUNA ASSESSMENT USING STOCK SYNTHESIS

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SUMMARY

This document presents the proposed base case for the assessment of eastern Atlantic and Mediterranean population of bluefin tuna using Stock Synthesis in 2022. The model runs from 1950 to 2020 and was fitted to length composition data, conditional age-at-length (otolith and spines–length-age pairs), 16 fishing fleets and 11 indices of abundance. Growth is modeled by a Richards function with Linf fixed at 271 cm, K fixed at 0.23387, and the Richards shape parameter is estimated by the model. A Beverton-Holt stock recruitment relationship was estimated in the model with the steepness and sigmaR fixed at 0.9 and 0.6, respectively. R0 is freely estimated. Although the diagnostics indicate an acceptable stability of the model, there are important conflicts between the catch information, length composition and index data. The model fits to length compositions were not good, but the model followed most of the indices fairly well. The model results showed that the SSB decreased from 1950 until the 1970s, remaining relatively stable at low values during the 1980-2009 period, and showing a sharp and steady increase since 2010.

RÉSUMÉ

Ce document présente le cas de base proposé pour l'évaluation de la population de thon rouge de l'Atlantique Est et de la Méditerranée utilisant Stock Synthesis en 2022. Le modèle s'étend de 1950 à 2020 et a été ajusté aux données de composition par taille, aux données conditionnelles d'âge par taille (paires de longueur-âge d'otolithes et d'épines), 16 flottilles de pêche et 11 indices d'abondance. La croissance est modélisée par une fonction de Richards avec Linf fixée à 271 cm, K fixée à 0,23387 et le paramètre de forme de Richards est estimé par le modèle. Une relation stock-recrutement de Beverton-Holt a été estimée dans le modèle avec la pente et sigmaR fixés à 0,9 et 0,6, respectivement. R0 est estimé librement. Même si les diagnostics indiquent une stabilité du modèle acceptable, il existe d'importants conflits entre les informations de captures, la composition par taille et les données des indices. Les ajustements du modèle aux compositions par tailles n'étaient pas satisfaisants mais le modèle suivait la plupart des indices relativement bien. Les résultats du modèle montraient que la SSB a diminué de 1950 jusque dans les années 1970, demeurant relativement stable à de faibles valeurs au cours de la période 1980-2009 et affichant une forte augmentation régulière depuis 2010.

RESUMEN

Este documento presenta el caso base propuesto para la evaluación de stock de atún rojo del Atlántico este y del Mediterráneo utilizando Stock Synthesis en 2022. El modelo abarca desde 1950 hasta 2020 y se ha ajustado a los datos de composición por tallas, a la edad por talla condicional (pares de otolitos y espinas edad por talla), 16 flotas pesqueras y 11 índices de abundancia. El crecimiento se modela mediante una función de Richards con Linf fijado en 271 cm, K fijado en 0,23387, y el parámetro de forma de Richards es estimado por el modelo. Se

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estimó en el modelo una relación stock reclutamiento de Beverton y Holt con la inclinación, y SigmaR fijos en 0,9 y 0,6, respectivamente. R0 se estimó libremente. Aunque los diagnósticos indican una estabilidad aceptable del modelo, existen importantes conflictos entre la información de las capturas, la composición por tallas y los datos de los índices. Los ajustes del modelo a las composiciones por tallas no fueron buenos, pero el modelo siguió bastante bien la mayoría de los índices. Los resultados del modelo mostraron que la SSB disminuyó desde 1950 hasta la década de 1970, permaneciendo relativamente estable en valores bajos durante el período 1980-2009, y mostrando un aumento brusco y constante desde 2010.

KEYWORDS

Atlantic bluefin tuna, stock assessment, Stock Synthesis, diagnostics

1 Introduction

The Standing Committee on Research and Statistics (SCRS) has been requested by the Commission to provide the stock assessment for the East Atlantic and Mediterranean bluefin tuna (E-BFT) in 2022. The Bluefin Tuna Species Group (BFTSG) plans to conduct the stock assessments by applying multiple assessment methodologies.

The BFTSG tried to apply Stock Synthesis to the E-BFT stock in 2017 (Sharma *et al.*, 2017), and the intention of this study is to update this 2017 model for the 2022 E-BFT stock assessment. Although the model input data and configuration are outlined in Sharma *et al.* 2017, they were reviewed and modified considerably during the ICCAT Bluefin stock assessment session (Anon., 2018). Furthermore, BFTSG in 2018 reviewed and revised the fleet structure for the Operating Models (OMs) in the BFT Management Strategy Evaluation (MSE) (ICCAT, 2019). This study proposed a new fleet structure for the 2022 Stock Synthesis model by harmonizing the East Atlantic components of the OM structure and the 2017 models.

This document presented the model configuration, outputs and diagnostics of a proposed base-case model embedded to the Stock Synthesis (version 3.30.18) (SS) for the 2022 E-BFT stock assessment. This proposed base case model is the Run 8 that was selected from several runs performed previously to obtain the most appropriate configuration of a SS assessment model. The spatial structure of the Run 8 is one area, it is sex aggregated and it runs in an annual time-step. In total, this proposed base case model contains information from 16 fleets and 14 abundance indices, although only 11 indices are used in the model fit.

2 Material and methods

2.1 Time series of data

The Run 8 uses catch information, size composition data, conditional age-at-length data and 14 abundance indices (**Figure 1**). The available time series of catch, abundance, and length composition data considered for use in the SS model run were assigned to 16 fishing fleets and 14 surveys, that are described in **Table 1**.

The time series of catch amount (t) by fleet using Task1 in the ICCAT database were updated by the Secretariat from 1950 to 2020 (**Table 2**, **Figure 2**). The catch amount (t) by F10 (PS_MED_pre2006Q2) was provided from the modified CATDIS (Kimoto *et al.*, 2021). An error of se=0.1 for the catch is assumed in the model, except for years 1950-1969 (initial period) and 1998-2006 (estimated catches) that is set 0.15.

Task 2 size data were updated in 2022 up to 2020 by using the same screening method for Stock Synthesis in 2017 (Ortiz and Palma, 2017) and for reconditioning OMs in 2021 (Kimoto *et al.*, 2021). The length composition of the new fleet structure was provided with 5 cm bin with a lower limit (**Figure 3**). The length composition information for fleet F01_BB_BBpre2006 between 1953 and 1960 were not included in the assessment because of different size patterns compared to the size after 1961. Length data were input in straight fork length in centimetres and modeled with 5 cm length bins between 10 and 345 cm in the model. Length composition data is modeled assuming a multinomial distribution and the sample size is set equal to the natural logarithm of number of measured fish.

The Conditional Age at Length (CAAL) allows the integrated models to use the information from sparse age-length data without assuming that the data were representative of ages across the full range of sizes. The CAAL included in Run 8 was not updated from the 2017 assessment. The age-length pairs (9453 records in total, 934 from otoliths reading and 8519 from spine samples) are input as age frequency distributions by length bins (at 4 cm intervals) for each year and fishery from which the data were collected. Age-length data was assigned to 9 fleets: Fleet 1-3, 6, 11-14 and 16 (**Figure 4**). Age information was input with an ageing error vector assuming a coefficient of variation of approximately 0.1.

The 11 indices used for fitting the Run 8 are described in **Table 1** and represented in **Figure 5**. They are the same indices used in the 2017 and 2020 assessments except the index S11_WMED_GBYP_AER that is the first time that is included in the E-BFT assessment. Three indices, S12_WCMED_GBYP_AER, S13_JPN_LL_VAST1 and S14_JPN_LL_VAST2, were included in the model for exploration purposes, but they are not fit in the model likelihood (lambda = 0) of Run 8.

There are 7 fishery-dependent abundance indices (CPUE) covering different areas of the stock and time periods starting in 1962 until 2020, and four scientific surveys (S8_WMED_LARV, S9_FRA_AER1, S10_FRA_AER2, S11_WMED_GBYP_AER) that only cover the years 2000-2020 and the Mediterranean area (**Table 1**). Since 2010, the surveys S8, S10 and S11 indicate a sharp and steady increase in biomass that is not recorded by the commercial indices. The uncertainty of indices was incorporated in the model for each index as the standard error of the natural log of yearly value.

2.2 Model specifications

The proposed base model is the Run 8, that is implemented in Stock Synthesis 3.30.18 (Methot *et al.*, 2013). The proposed base model has the following structure: one spatial area, sex-aggregated and an annual time-step. The SS control file for Run 8 (after-jitter) is appended **(Annex 1**).

The model starts at 1950 and runs until 2020. Previous to 1950, equilibrium catches are assumed for three fleets, Fleet13_TP_pre2011 (7237 t), Fleet15_TP_OTH (2156 t) and Fleet16_OTHER (1384 t). After some preliminary runs to explore plausible values, the initial fishing mortalities were fixed at values of 0.03, 0.015 and 0.005 for Fleet13, Fleet15 and Fleet16, respectively, while the initial equilibrium catch are assumed to be averaged catch during 1940's.

Growth

The growth is modeled with a Richards growth curve with 3 parameters. Linf is fixed at 271 cm based on an integrated growth model for Atlantic bluefin tuna (Ailloud *et al.*, 2017), and K is fixed at 0.2334, this K value was estimated by the model in previous runs. Length at age 1 (below this size growth is assumed to be linear), the Richards shape parameter and the CV on young and old fish are estimated by the model.

Natural Mortality

Natural mortality is set as an age-varying rate derived from values recommended in the Data Preparation Meeting (ICCAT, 2022), starting at age 1: 0.41, 0.32, 0.26, 0.22, 0.19, 0.17, 0.15, 0.14, 0.13, 0.12 (ages 10-11), 0.11 (ages 13-20), and 0.10 yr^{-1} (ages 20 plus). The M for Age 0 is assumed to be the double of M Age1 (0.82). This is a interim M vector that is proposed to be changed by M internally estimated by the model using Lorenzen's method and with age 20 as reference with M=0.1.

Length-weight relationship

The length-weight relationship used in the model: $W = 3.5e\text{-}05 * L^{2.87845}$ (Rodríguez-Marín *et al.*, 2015).

Maturity

Age based early maturity ogive is used in the assessment (Anon., 2011). The 50% maturity is assumed to be age 4 and full mature at age 5: 0 (ages 0-2), 0.25 (age 3), 0.5 (age 4), 1 (ages 5-30).

Stock-recruitment relationship

A Beverton-Holt stock recruitment relationship (with a flat top) was assumed and that the spawning biomass were equal to the biomass of the mature population according to the maturity vector outlined in the biology section. Steepness and sigmaR are fixed at 0.9 and 0.6, respectively, and R0 is freely estimated by the model. Sensitivity analysis on steepness and on sigmaR were performance in this paper to explore the impact of these assumed values and to consider its change for a most plausible value.

Deviations from the stock-recruitment relationship were assumed to follow a lognormal distribution estimated on a log scale as N(0, sigmaR) variates with a min and max of -5 and 5, respectively. Zero recruitment deviations were assumed until the start of informative data about stock abundance 1961-2020. The lognormal bias correction ($-0.5\sigma_2$) for the mean of the stock recruit relationship was applied during the period 1962-2020 with a bias correction ramp applied prior to 1962 and after 2020 according to the method of Methot and Taylor (2011).

Selectivity

Selectivity is length-based parameterized and estimated directly for each of the 16 fleets (fleet 16 is mirrored to fleet 6) (**Table 1**, **Figure 6**). Fleets 3-5 (long lines) and 13-15 (traps) are modeled as double normal function which could take on either dome or asymptotic shape. To model the complex length composition observations of fleets 1-2 (bait-boats), 6 (long lines from other countries), 8-12 (purse seines), the cubic spline function implemented in the Stock Synthesis was used. In these cases, the number of nodes was selected by an iterative process that checks if an increase in the number of nodes improves the selectivity fit and the total likelihood. For nodes position the SS auto generation feature was used (Methot *et al.*, 2020). The Norwegian purse seine fishery (Fleet 07_PS_NOR) selectivity was parameterised with a logistic function that constrains the larger length classes to be fully selected (“flat top”).

Fishing mortality was modelled using the hybrid method that the harvest rate using the Pope’s approximation, then converts it to an approximation of the corresponding F (Methot and Wetzel, 2013). Most appropriate F estimation method for high F rates, the Baranov’s continuous F with each F as a model parameter (type 2) and a fleet-specific parameter hybrid F approach (type 4) were tried without good results.

2.3 Model convergence and diagnostics

Several diagnostics were performed to evaluate the convergence, goodness of fit, consistency and prediction skills of the Run 8. These diagnostic tools allow to identify data conflicts and model misspecification in the proposed base case.

2.4 Model results

Derived quantities and their associated asymptotic standard errors were obtained from model outputs.

3 Results

3.1 Model diagnostics

Convergence

The proposed base case model showed a relatively good convergence despite the maximum final gradient was slightly higher (0.00079) than the recommended value, and the Hessian matrix for the parameter estimates was positive definite (**Table 3**). Of the 139 parameters estimated in the proposed base case model, 75 were recruitment deviations, and the remaining parameters, most were selectivity parameters.

Parameter estimates, their asymptotic standard errors and their priors, if used, and status relative to impose boundary conditions are provided in **Table 4**. None of the parameters were estimated at or near bounds. Some selectivity parameters show very large standard deviations, suggesting uncertainty in the parameter estimates or model structure. There was also a strong correlation (> 0.95) in the parameters controlling the nodes position of cubic spline selectivity of Fleets 8 to 12.

A jitter analysis was run to evaluate whether the model has converged to a global solution, by applying a random deviation to starting values of 10% of all model parameters and 100 trials were run. Thirty trails converged at the same log likelihood than original Run 8 (**Figure 7)** and one run achieved a lower log likelihood. Jittering showed that the model is not fully stable when initial values of parameters are changed. The starting values of the global minimum were used to re-run the Run 8 and all the results presented in this paper are derived from the Run 8 after-jitter. Despite the possible presence of a local minimum, the results in terms of stock dynamics were similar for original Run 8 and the global minimum jitter run (**Figure 7**). There is no a statistical method to be sure that a model is not stuck in a local minimum and even a perfect jittering is not a fully guaranteed.

Goodness of fit

Plots of the observed *vs* fit data and residual plots were examined to evaluate goodness-of-fit of indices and length composition.

Overall the model fits the indices of abundance reasonably well (**Figure 8**) but there is some lack of fit for extreme observations, as the ones detected for year 2020 of S8_WMED_LAR and S10_FR_AER2. The runs tests were applied to the residuals of each index fit in order to quantitatively evaluate the randomness of the time-series of index residuals. There was no evidence ($p \geq 0.05$) to reject the hypothesis of randomly distributed residuals for all indices except for S3_SPN_BB1 and S11_WMED_GBYP_AER (**Figure 9**). Only the data point for 1996 of S6 fell outside the three-sigma limits.

The model fits over the aggregated length composition of fleets are shown in **Figure 10.** The model follows relatively fine the length composition of Fleets 05, 07, 09-11 and 14. The residual series for the mean length did not pass the runs tests for 10 Fleets (Fleet 02, 04, 06, 08, 09-13 and 15) (**Figure 11**). The early period 1962–70 and years 2000-06 of F01_BB_BB_pre2006 showed larger positive residuals that fell outside the three-sigma limit for expected mean lengths from the fishery, indicating that the model overestimates number of small fish during many years. Considering that the sequence of these larger residuals appears to follow a random pattern, these outliers are likely to have not a big influence on the stock status estimates.

Model consistency

A likelihood component profile was applied to the expected average recruitment in an unfished population (R0). The diagnostic was implemented by sequentially fixing the R0 parameter, on the natural log scale to a range of values whose limits were calculated as 95% confidence interval bounds ± 0.50 (from 8.0 to 9.1). The negative log-likelihood profiles of R0 only regarding the length composition and recruitment deviations showed a clear minimum around overall minimum, although those on the other data source have no clear minimum **(Figure 12).** The difference in the location of the minimum negative log-likelihood along the R0 profile among data sources was diagnosed as a conflict in the data or a model misspecification.

An Age Structured Population Model (APSM) was used to evaluate the information content of data about absolute abundance and assess whether the model is correctly specified. This diagnostic tool consists of comparing the results of an ASPM to those from the proposed base case. Two ASPMs for indices S5_JPN_LL_EatlMed and S6_JPN_LL1_NEA were performed as they have a series of observations > 10 and their RMSE was low in the original Run 8. Catch ASPM diagnostics show a different trend among the models (**Figure 13**). Catch ASPM suggests the drastic decrease of stock since 1990 mainly due to the inflated catch. ASPM with respective index is also showed one-way-decreasing trend. On the other hand, the proposed base case model showed somewhat increase trend after 1995. These indicate that the catch and indices have conflicted information each other.

The retrospective analysis shows that the fit was quite stable from year to year with low Mohn's rho values for SSB and F (Hurtado-Ferro *et al.*, 2015) (**Figure 14**). However, SSB is revised up when new year of data is introduced. This is may be related to the very large increase in the S8 and S10 indices in recent years. The recruitment estimates since 2011 show a huge uncertainty around the estimated value of reference case, and they are revised up with the inclusion of a new year of data.

Model prediction skills

The hind casting with cross-validation of observations allows to estimate prediction skill in combination with retrospective analysis, and is used to evaluate the ability of a model to provide advice on future catches. Only the S2_MOR_POR_TP and S10_FR_AER2 index have a good predictive power (MASE < 1) (**Figure 15**). The conflict information between indices could be the reason for not all indices have this predictive power.

For the mean length estimates, the two fleets F11_PS_MED_post2009 and F14_TP_post2012 have low MASE scores, indicating good predictive power (**Figure 16**).

3.2 Model results

The time series of summary statistics and associated 95% confidence intervals are shown in **Table 5** and **Figure 17.** SSB showed a strong decrease from 1950 to 1971, then it remained at low levels (< 150 kt) until 2010. In the last 10 years, the SSB of the stock has been increased by three times, from 187 kt estimated in 2010 to 561 kt in 2021. This sharp increase in biomass is supported by the 3 indices from scientific surveys in the West Mediterranean: S8_WMED_LARV, S10_FR_AER2 and S12 WMED_GBYP (**Figure 5**). However, this increased is not supported by other indices available for this period (S2_TP_post2012 and S7 JPN_LL2_NEA). We must rely on several indices that routinely conflict with each other and which may result in biased and uncertain outputs. A combined index proportional to the area that represents or an index derived from Dynamic Factor Analysis could help to avoid the conflicting information.

The model estimates very clearly low recruitments during 1950–1988 (**Figure 18**) probably related to the low levels of the index S3_SP_BB1 (**Figure 5)**. Since 2011 the model estimates recruitment with extremely large uncertainty (**Table 5, Figure 18**), indicating that the model does not have enough information to estimate the recruitment in the last 10 years or the model is using contradictory information. Two strong recruitments, in year 1994 and year 2003 are recorded which is in line which have been described in the literature (Rodríguez-Marín *et al.*, 2003, Suzuki *et al.*, 2013, Ailloud *et al.*, 2018).

Fishing mortality is presented as Fbar on ages 10-20 (**Figure 17**). At the beginning of the time series F estimates were low, and usually lower than 0.1. Since 1974, F has started to increase to reach a maximum of 0.93 in the year 1997 (**Table 5**). The last 10 years F was estimated around 0.7 with minor variations.

3.3 Sensitivity analysis

Three sensitivity analyses were conducted to evaluate the influence of data inputs and structural uncertainty of Run 8 by investigating how changes to the model affected the estimated values and derived quantities.

Initial Fs

Model sensitivity of Run 8 was evaluated in relation to initial Fs. The initial Fs are key parameters in Stock Synthesis that pre-determine the size of the population at the beginning of the assessment period, as well as the level of depletion over time. Two alternative runs of the proposed base case model were run: Run 8_initialF_est_wCatch, as Run 8 but the initial Fs are estimated by the model, and Run8 initialF_est_woCatch, where initial Fs are freely estimated without any specific catch input. The results indicated that the trends and fit to data were not significantly different between the models (**Figure 19**). However, biomass before 1980 in Run8_initialF_est_woCatch was much lower than those in the other models and SSB0 was higher (**Figure 19**). This would reduce the unnatural stock recruitment relationship and would influence in the values of the reference points, so stock status will be significantly different.

Steepness

A likelihood profile analysis was conducted on *steepness* parameter, considering *h* fixed values between 0.7 an 0.99 with a step = 0.01. The results indicated that the model fits better at the highest values of steepness, close to 1 (**Figure 20**). The highest values of steepness showed the most pessimists trajectories of spawning stock biomass and no relevant impact was detected varying the *steepness* value on the F estimates of last 15 years (**Figure 20**). Besides, the final gradient of the run with *h*=0.92 is the lowest of the range of steepness. Based on the results of the profiling, it could be proposed a higher value of *h* than the one used for the base case model (0.9).

SigmaR

The standard error of recruitment deviations (sigmaR) is assumed equal to 0.6. A likelihood profile analysis was conducted on sigmaR parameter, considering sigmaR fixed values between 0.4 an 0.8 with a step = 0.2. Higher input values of sigmaR gave higher output estimates of SSB except for the period 1960-2010 and resulted in higher estimated virgin biomass (**Figure 21**). Values of simagR above 0.7 allowed large recruitment estimates for years > 2010.Although, the total minimum is achieved at sigmaR=0.6, the 95% confidence interval is wide (0.5-0.7). The better final gradient of the simulated runs were recorded for sigmaR=0.52 and sigmaR=0.56.

3.4 Alternate configurations

The further modifications were identified as appropriate to be applied to the proposed base case model:

- Estimate M internally using Lorenzen's method (age 20, reference M=0.1).
- Recruitment should not be estimated for the recent years (2018-20). Ramp should be began in 1953, when abundance indices have started.
- Improve the selectivity definition for some fleets with non-random residuals.
- To deal with the catch inflated period (1998-2007). It is recommended to use the recorded catches for the period 1998-2007 of Fleet10 PS_MEDQ2 (inflated catches – nei fleet) as input and to try the catch multiplier method with a value below 1. With this approach the unreported catches should be estimated.
- To exclude the CAAL information and fit the model with the growth parameters fixed.

Alternate configurations to the proposed base model model were conducted during the 2022 EBFT assessment meeting. The description of these runs and their main results are presented in **Annex 2**.

4 Conclusions

Although the proposed base case model seems to have good stability, though there is some uncertainty in the stock status at the beginning of the assessment period and the value of SSB0. The model fits to length composition showed a non-random residual pattern for most of the fleets, and further work is needed to improve the estimates of selectivity for some fleets which may further improve model fits to the length composition data. Besides, the results of the jitter analysis indicate that there is some instability in the model that has not been identified.

The conflict between sources of information in the model is evident in the R0 profiling. There are also contrary signals among indices of abundance, especially between the three surveys, S8_WMED_LAR, S10_FR_AER2 and S11_WMED_GBYP_AER, that are driving the sharp increase in biomass since 2010 and the rest of the abundance indices.

The ASPM results indicate that the model results diverge from the expected changes in abundance given the catch, apparently the fishing is not affecting the population. This can be derived from a misspecification of the model or because the stock dynamics is strongly driven by variations in recruitment. Without an index that can inform the model about the absolute scale is not possible to have reliable outputs and catch predictions.

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Table 1. Names and fishery definitions of the fleets used in the Run 8. Selectivity: CS: cubic spline; DN: double normal: LG: logistic. * Indices not included in the fit of Run 8.

Fleet Number	Fleet Acronym	Description	Gear	start	end	Selectivity
1	F01_BB_BB_pre2006	BaitBoat (SP, FR) for 1950 to 2006	BaitBoat	1950	2006	CS
2	F02_BB_BB_post2007	BaitBoat (SP, FR) for 2007 to 2020	BaitBoat	2007	2020	CS
3	F03_LL_JPN_EATL_MED	Japanese longline in the East and Mediterranean for 1957 to 20	Longline	1957	2009	DN
4	F04_LL_JPN_NEATL_pre2009	Japanese longline in the Northeast Atlantic for 1971 to 2009	Longline	1971	2009	DN
5	F05_LL_JPN_NEATL_post2010	Japanese longline in the Northeast Atlantic for 2010 to 2020	Longline	2010	2020	DN
6	F06_LL_OTH	Other countries longliners for 1961 to 2020	Longline	1961	2020	CS
7	F07_PS_NOR	Norwegian purseiners for 1950 to 1986 (/2016-20)	Purseine	1950	2020	LG
8	F08_PS_HRV	Croatian purseiners for 1991 to 2020	Purseine	1991	2020	CS
9	F09_PS_MED_pre2008	Purseiners (SP, FR) for 1966 to 2008 1,3,4Q	Purseine	1966	2007	CS
10	F10_PS_MED_pre2008Q2	Purseiners (SP, FR) for 1966 to 2008 2Q	Purseine	1966	2008	CS
11	F11_PS_MED_post2009	Purseiners (SP, FR) for 2009 to 2020	Purseine	2009	2020	CS
12	F12_PS_OTH	Purseiners other countries	Purseine	1950	2020	CS
13	F13_TP_pre2011	Traps (SP, PT, MA) for 1950 to 2011	Traps	1950	2011	DN
14	F14_TP_post2012	Traps (SP, PT, MA) for 2012 to 2020	Traps	2012	2020	DN
15	F15_TP_OTH	Traps from other countries (DZ, LY, TN, TR, IT)	Traps	1950	2020	DN
16	F16_OTH	Other gears	Other	1950	2020	Mirror F06

Fleet Number	Survey	Area - Type (Units) - Age	start	end	Selectivity
17	S1_MOR_SPN_TP	East Atlantic & Med - CPUE (numbers) - Age 6+	1981	2011	Mirror - F13_TP_pre2011
18	S2_MOR_POR_TP	East Atlantic & Med - CPUE (numbers) - Age 10+	2012	2020	Mirror - F14_TP_post2012
19	S3_SPN_BB1	East Atlantic - CPUE (biomass) - Age 2-3	1952	2006	Mirror - F01_BB_BB_pre2006
20	S4_SPN_FR_BB2	East Atlantic - CPUE (biomass) - Age 3-6	2007	2014	Mirror - F02_BB_BB_post2007
21	S5_JPN_LL_EAtlMed	East Atlantic & Med - CPUE (numbers) - Age 6-10	1975	2009	Mirror - F03_LL_JPN_EATL_MED
22	S6_JPN_LL1_NEA	NEast Atlantic - CPUE (numbers) - Age 4-10	1990	2009	Mirror - F04_LL_JPN_NEATL_pre2009
23	S7_JPN_LL2_NEA	NEast Atlantic - CPUE (numbers) - Age 4-10	2010	2020	Mirror - F05_LL_JPN_NEATL_post2010
24	S8_WMED_LARV	West Med - Survey (numbers) - SSB	2001	2020	SSB
25	S9_FRA_AER1	West Med - Survey (numbers) - Age 2-4	2000	2003	Ages 2-4
26	S10_FRA_AER2	West Med - Survey (numbers) - Age 2-4	2009	2020	Ages 2-4
27	S11_WMED_GBYP_AER	Balearic Sea - Survey (biomass) - SSB	2010	2019	SSB
28*	S12_WCMED_GBYP_AER	WCMed - Survey (biomass) - SSB	2010	2019	SSB
29*	S13_JPN_LL_VAST1	NEast Atlantic - CPUE (numbers) - Age 4-10	1995	2009	Mirror - F04_LL_JPN_NEATL_pre2009
30*	S14_JPN_LL_VAST2	NEast Atlantic - CPUE (numbers) - Age 4-10	2010	2020	Mirror - F05_LL_JPN_NEATL_post2010

Table 2. Time series of total landings and landings by fleet (in tonnes).

Year	Total	F01_BB_BB_pre2006	F02_BB_BB_post2007	F03_LL_JPN_EATL_MED	F04_LL_JPN_NEATL_pre2009	F05_LL_JPN_NEATL_post2010	F06_LL_OTH	F07_PS_NOR	F08_PS_HRV	F09_PS_MED_pre2008	F10_PS_MED_pre2008Q2	F11_PS_MED_post2009	F12_PS_OTH	F13_TP_pre2011	F14_TP_post2012	F15_TP_OTH	F16_OTH
1950	26812	2975	0	0	0	0	0	2200	0	0	0	0	1390	13596	0	4051	2601
1951	30211	3872	0	0	0	0	0	6728	0	0	0	0	1191	9362	0	4228	4830
1952	39007	4685	0	0	0	0	0	14752	0	0	0	0	1667	10185	0	2514	5204
1953	39275	4135	0	0	0	0	0	10217	0	0	0	0	1796	13631	0	4327	5169
1954	37157	5500	0	0	0	0	0	12145	0	0	0	0	2283	10368	0	3391	3470
1955	44092	6559	0	0	0	0	0	13394	0	0	0	0	1583	12661	0	3569	6327
1956	30186	3409	0	0	0	0	0	5313	0	0	0	0	1215	14957	0	2816	2476
1957	35873	4017	0	33	0	0	0	6437	0	0	0	0	1097	15376	0	4657	4255
1958	33353	4241	0	2	0	0	0	3860	0	0	0	0	3571	15509	0	4414	1756
1959	26334	3800	0	56	0	0	0	3241	0	0	0	0	4241	8407	0	3574	3015
1960	26113	1374	0	481	0	0	0	4215	0	0	0	0	2960	11686	0	3462	1936
1961	28083	1597	0	204	0	0	19	8553	0	0	0	0	3810	8502	0	3143	2253
1962	29457	1702	0	2484	0	0	0	8730	0	0	0	0	2223	9596	0	3028	1693
1963	16357	1381	0	1618	0	0	800	167	0	0	0	0	3024	5490	0	1687	2190
1964	17208	1260	0	582	0	0	363	1461	0	0	0	0	3365	6044	0	2428	1705
1965	17095	1787	0	404	0	0	434	2506	0	0	0	0	1376	6596	0	2565	1428
1966	15084	3335	0	50	0	0	541	1000	0	772	228	0	2675	3383	0	2276	824
1967	19734	1771	0	100	0	0	341	2015	0	1158	342	0	3485	4790	0	4770	962
1968	13545	1314	0	13	0	0	795	753	0	1931	569	0	1308	2088	0	3895	879
1969	15024	1760	0	2	0	0	599	842	0	1158	342	0	2816	2692	0	4016	797
1970	10808	2367	0	21	0	0	322	470	0	850	250	0	1702	2100	0	1936	789
1971	11185	2255	0	156	1	0	226	653	0	1699	501	0	1736	803	0	2147	1008
1972	10830	2102	0	344	8	0	145	430	0	850	250	0	3515	593	0	1451	1141
1973	11012	2410	0	281	9	0	321	421	0	1081	319	0	3436	653	0	1002	1078
1974	19285	1648	0	3031	1359	0	261	869	0	1390	410	0	6909	96	0	2458	855
1975	21465	1912	0	3654	506	0	163	988	0	1236	364	0	9089	451	0	1663	1438
1976	22368	1012	0	2777	164	0	350	529	0	3169	631	0	10501	493	0	1753	989
1977	18980	1791	0	2062	52	0	331	764	0	2861	321	0	7043	563	0	1371	1821
1978	15115	2522	0	566	72	0	274	221	0	1260	306	0	5769	634	0	1218	2272
1979	12435	1448	0	710	19	0	241	60	0	1379	148	0	4782	624	0	1016	2008
1980	14059	1286	0	983	16	0	256	282	0	1156	545	0	6995	817	0	1198	525
1981	14105	938	0	596	19	0	350	161	0	1410	940	0	6284	1189	0	1385	833
1982	22421	914	0	3479	55	0	768	50	0	3088	2007	0	7636	2375	0	1728	321
1983	21699	2759	0	3216	70	0	320	1	0	2146	1454	0	7146	1993	0	1513	1081
1984	24473	2931	0	2518	32	0	387	243	0	2190	1459	0	7105	2923	0	1869	2816
1985	22063	2228	0	1406	20	0	546	0	0	3254	2191	0	7101	1932	0	1018	2367
1986	19260	2147	0	1017	63	0	894	31	0	3116	454	0	7791	1263	0	947	1537
1987	18271	2046	0	1150	30	0	821	0	0	3899	571	0	5817	1412	0	1010	1515
1988	24129	2561	0	1410	17	0	1195	0	0	5097	813	0	6858	2948	0	1213	2017
1989	21161	2419	0	586	379	0	1362	0	0	3972	732	0	6326	2081	0	1124	2180
1990	23599	1860	0	1002	634	0	1052	0	0	4326	972	0	6553	4092	0	794	2313
1991	26389	1589	0	1606	1460	0	3187	0	1418	4441	936	0	7056	2458	0	775	1462
1992	31831	1389	0	1883	1590	0	3290	0	1076	7339	1373	0	9254	1582	0	935	2120
1993	34258	3704	0	2213	1064	0	1995	0	1058	6671	1725	0	10635	1710	0	670	2813
1994	46769	1360	0	1658	953	0	6693	0	1410	11148	2380	0	13223	2333	0	988	4623
1995	47303	2953	0	2482	2302	0	8207	0	1220	9302	3088	0	10647	1280	0	814	5008
1996	51497	5033	0	1558	2548	0	9962	0	1360	8241	1963	0	14780	1937	0	935	3181
1997	51211	6194	0	981	2109	0	8281	0	1088	3978	4895	0	15146	4046	0	549	3945
1998	50000	2794	0	1639	1917	0	4350	0	889	7820	10024	0	13759	3626	0	1034	2147
1999	50000	1464	0	784	2287	0	3837	5	921	9966	14338	0	9294	3991	0	821	2292
2000	50000	1310	0	1005	2026	0	4129	0	914	10101	14813	0	8070	3036	0	700	3896
2001	50000	2062	0	913	1664	0	4870	0	890	8003	14867	0	9437	3893	0	870	2532
2002	50000	2136	0	1152	1774	0	3205	0	975	11612	11763	0	10580	3236	0	515	3053
2003	50000	582	0	552	2459	0	3221	0	1137	4705	21603	0	10335	2116	0	221	3069
2004	50000	1515	0	600	2053	0	2447	0	827	7136	19580	0	11405	1979	0	153	2305
2005	50000	2148	0	807	2169	0	3151	0	1017	7027	18034	0	11758	2408	0	112	1368
2006	50000	940	0	1410	1042	0	2989	0	1022	3018	25004	0	9727	2895	0	125	1829
2007	61000	0	2104	799	1279	0	2896	0	817	11991	27436	0	8751	3788	0	93	1047
2008	24460	0	2100	155	2276	0	2437	0	821	0	4182	0	8537	3169	0	149	635
2009	19818	0	993	54	1868	0	1373	0	609	0	0	4085	6755	3164	0	144	772
2010	11338	0	613	0	0	1155	1280	0	370	0	0	2349	2267	2292	0	281	730
2011	9774	0	543	0	0	1089	998	0	366	0	0	1555	2386	2137	0	165	536
2012	10934	0	219	0	0	1093	633	0	367	0	0	1712	4105	0	2311	125	370
2013	13243	0	74	0	0	1129	643	0	380	0	0	2857	4756	0	2564	222	618
2014	13261	0	2	0	0	1134	648	0	378	0	0	3066	4751	0	2376	232	673
2015	16214	0	42	0	0	1386	865	0	438	0	0	3468	6089	0	2905	192	829
2016	19175	0	752	0	0	1578	1774	42	436	0	0	3715	7198	0	2716	0	964
2017	23665	0	867	0	0	1911	1487	47	587	0	0	4843	9075	0	3362	272	1215
2018	27782	0	211	0	0	2270	1986	11	679	0	0	6362	10094	0	4258	300	1611
2019	31134	0	219	0	0	2524	2098	48	751	0	0	6831	11945	0	4594	353	1772
2020	35032	0	135	0	0	2782	2363	189	829	0	0	7263	12785	0	5891	360	2434

Table 3. Performance information indicating the log-likelihoods, parameters estimated and parameters at or close to the bounds.

		Run 8
Likelihood	Total	1585.69
	Catch	5.62E-06
	Equil_catch	3.73494
	Survey	-7.44425
	Length_comp	203.62
	Age_comp	1377.22
	Recruitment	8.08436
	InitEQ_regime	1.26E-30
	Sum_recdevs	-10.8168
	Forecast_Recruitmen	0
	Parm_priors	0.462699
	Parm_softbounds	0.0170026
	Parm_devs	0
	F_Ballpark	0
	Crash_Pen	0
Final gradient		0.000795274
Hessian inverted		Yes
Parameter estimated		139
Parameters at/close bounds		0
Warnings		F0.1 poorly estimated
		final gradient > 0.0001

Table 4. Estimated parameters (excluding deviation parameters). The phases, bounds and initial values, standard deviations and priors, if used, are also indicated.

Parameter	Value	Phase	Min	Max	Init	Parm_StDev	Gradient	Pr_type	Prior	Pr_SD	Pr_Like	Status	Afterbound
L_at_Amin_Fem_GP_1	55.7949	2	5	60	55.795	0.6365	4.17E-05	No_prio	NA	NA	NA	OK	OK
Richards_Fem_GP_1	-0.4517	3	-3	3	-0.452	0.0266	2.30E-04	No_prio	NA	NA	NA	OK	OK
CV_young_Fem_GP_1	0.08501	3	0.02	0.4	0.085	0.0052	9.48E-06	No_prio	NA	NA	NA	OK	OK
CV_old_Fem_GP_1	0.06923	3	0.02	0.4	0.069	0.0066	3.61E-06	No_prio	NA	NA	NA	OK	OK
SR_LN(R0)	8.59239	1	6	15	8.592	0.0478	7.95E-04	No_prio	NA	NA	NA	OK	OK
SizeSpline_GradLo_F01_BB_BB_pre2006(1)	0.59247	2	-0	2	0.592	0.0565	-1.33E-05	Normal	0.65	0.06	0.4597	OK	OK
SizeSpline_GradHi_F01_BB_BB_pre2006(1)	-2.2464	2	-5	0.1	-2.246	0.0642	-1.94E-04	No_prio	NA	NA	NA	OK	OK
SizeSpline_GradLo_F02_BB_BB_post2007(2)	0.54684	3	-0	2	0.547	0.2738	-1.32E-08	Sym_Be	0.6	0.001	0.0002	OK	OK
SizeSpline_GradHi_F02_BB_BB_post2007(2)	-0.3872	3	-5	0.1	-0.387	0.4439	2.28E-07	No_prio	NA	NA	NA	OK	OK
SizeSpline_Val_1_F02_BB_BB_post2007(2)	-8.8626	3	-15	7	-8.863	2.5054	2.44E-09	No_prio	NA	NA	NA	OK	OK
SizeSpline_Val_2_F02_BB_BB_post2007(2)	-4.6176	3	-9	7	-4.618	1.0844	5.10E-08	No_prio	NA	NA	NA	OK	OK
SizeSpline_Val_4_F02_BB_BB_post2007(2)	-5.1292	3	-25	7	-5.129	1.0703	-1.76E-07	No_prio	NA	NA	NA	OK	OK
SizeSpline_Val_5_F02_BB_BB_post2007(2)	-10.03	3	-100	7	-10.030	6.2783	-3.88E-07	No_prio	NA	NA	NA	OK	OK
Size_DblN_ascend_se_F03_LL_JPN_EATL_MED(3)	6.82932	2	-5	15	6.829	0.2701	2.12E-06	No_prio	NA	NA	NA	OK	OK
Size_DblN_descend_se_F03_LL_JPN_EATL_MED(3)	7.44479	2	-5	15	7.445	1.3836	8.92E-07	No_prio	NA	NA	NA	OK	OK
Size_DblN_ascend_se_F04_LL_JPN_NEATL_pre2009(4)	8.27407	2	-5	9	8.274	0.2194	-1.12E-06	No_prio	NA	NA	NA	OK	OK
Size_DblN_descend_se_F04_LL_JPN_NEATL_pre2009(4)	6.1942	2	-5	9	6.194	1.2599	3.43E-07	No_prio	NA	NA	NA	OK	OK
Size_DblN_ascend_se_F05_LL_JPN_NEATL_post2010(5)	5.28604	2	-5	9	5.286	0.4598	1.56E-07	No_prio	NA	NA	NA	OK	OK
Size_DblN_descend_se_F05_LL_JPN_NEATL_post2010(5)	6.50924	2	-5	9	6.509	0.7468	-1.87E-07	No_prio	NA	NA	NA	OK	OK
SizeSpline_GradLo_F06_LL_OTH(6)	1.24483	4	-0	2	1.245	0.1008	-1.56E-06	Sym_Be	1.1	0.001	6E-05	OK	OK
SizeSpline_GradHi_F06_LL_OTH(6)	-0.1806	4	-1	0	-0.181	0.0707	-3.31E-06	No_prio	NA	NA	NA	OK	OK
SizeSpline_Val_1_F06_LL_OTH(6)	-7.8338	3	-50	10	-7.834	1.5436	-2.19E-06	No_prio	NA	NA	NA	OK	OK
SizeSpline_Val_5_F06_LL_OTH(6)	20.4544	2	-15	200	20.454	1.0697	9.29E-05	No_prio	NA	NA	NA	OK	OK
SizeSpline_GradLo_F08_PS_HRV(8)	2.44148	4	-0	10	2.441	3.3746	-5.97E-08	Sym_Be	1.6	0.001	0.0003	OK	OK
SizeSpline_GradHi_F08_PS_HRV(8)	0.06472	4	-2	2	0.065	0.1544	-1.27E-06	No_prio	NA	NA	NA	OK	OK
SizeSpline_Val_1_F08_PS_HRV(8)	-42.056	3	-200	7	-42.056	424.9360	-1.72E-07	No_prio	NA	NA	NA	OK	OK
SizeSpline_Val_2_F08_PS_HRV(8)	-23.129	2	-50	7	-23.129	424.3080	-2.88E-06	No_prio	NA	NA	NA	OK	OK
SizeSpline_Val_3_F08_PS_HRV(8)	-25.493	2	-50	7	-25.493	424.3060	2.91E-06	No_prio	NA	NA	NA	OK	OK
SizeSpline_GradLo_F09_PS_MED_pre2008(9)	0.05089	4	-0	1	0.051	0.4284	-5.71E-07	Sym_Be	0.02	0.001	0.0016	OK	OK
SizeSpline_GradHi_F09_PS_MED_pre2008(9)	-0.0484	4	-1	0	-0.048	0.0785	-7.05E-06	No_prio	NA	NA	NA	OK	OK
SizeSpline_Val_1_F09_PS_MED_pre2008(9)	-1.9505	3	-9	7	-1.950	79.0013	-3.64E-06	No_prio	NA	NA	NA	OK	OK
SizeSpline_Val_2_F09_PS_MED_pre2008(9)	-1.274	3	-9	7	-1.274	78.9827	-4.29E-06	No_prio	NA	NA	NA	OK	OK
SizeSpline_Val_3_F09_PS_MED_pre2008(9)	-0.0335	2	-9	7	-0.033	78.9826	-2.29E-05	No_prio	NA	NA	NA	OK	OK
SizeSpline_Val_4_F09_PS_MED_pre2008(9)	-0.2657	2	-9	7	-0.266	78.9827	-2.66E-06	No_prio	NA	NA	NA	OK	OK
SizeSpline_Val_5_F09_PS_MED_pre2008(9)	-1.4813	2	-9	7	-1.481	78.9906	3.36E-05	No_prio	NA	NA	NA	OK	OK
SizeSpline_GradLo_F10_PS_MED_pre2008Q2(10)	8.24567	4	-0	50	8.246	4.9044	-8.02E-06	Sym_Be	9.6	0.001	0.0006	OK	OK
SizeSpline_GradHi_F10_PS_MED_pre2008Q2(10)	-0.1104	4	-1	1	-0.110	0.1042	-1.85E-06	No_prio	NA	NA	NA	OK	OK
SizeSpline_Val_1_F10_PS_MED_pre2008Q2(10)	-85.536	2	-999	7	-85.536	210.3000	-1.16E-05	No_prio	NA	NA	NA	OK	OK
SizeSpline_Val_2_F10_PS_MED_pre2008Q2(10)	-4.4781	2	-25	20	-4.478	204.4340	-5.05E-06	No_prio	NA	NA	NA	OK	OK
SizeSpline_Val_3_F10_PS_MED_pre2008Q2(10)	-2.7696	2	-25	20	-2.770	204.4340	-4.80E-06	No_prio	NA	NA	NA	OK	OK
SizeSpline_Val_4_F10_PS_MED_pre2008Q2(10)	-2.2324	2	-25	20	-2.232	204.4340	-7.77E-06	No_prio	NA	NA	NA	OK	OK
SizeSpline_Val_5_F10_PS_MED_pre2008Q2(10)	-2.9668	2	-25	20	-2.967	204.4340	-7.30E-06	No_prio	NA	NA	NA	OK	OK
SizeSpline_Val_6_F10_PS_MED_pre2008Q2(10)	-2.8317	2	-25	20	-2.832	204.4340	2.48E-06	No_prio	NA	NA	NA	OK	OK
SizeSpline_Val_7_F10_PS_MED_pre2008Q2(10)	-2.1643	2	-25	20	-2.164	204.4340	2.34E-05	No_prio	NA	NA	NA	OK	OK
SizeSpline_GradLo_F11_PS_MED_post2009(11)	0.37708	4	-0	1	0.377	0.0491	-4.24E-08	Sym_Be	0.17	0.001	6E-05	OK	OK
SizeSpline_GradHi_F11_PS_MED_post2009(11)	-0.0289	4	-1	0	-0.029	0.1586	8.58E-10	No_prio	NA	NA	NA	OK	OK
SizeSpline_Val_1_F11_PS_MED_post2009(11)	-5.0783	4	-9	7	-5.078	73.8483	-1.92E-08	No_prio	NA	NA	NA	OK	OK
SizeSpline_Val_2_F11_PS_MED_post2009(11)	0.05849	4	-9	7	0.058	73.8485	1.58E-08	No_prio	NA	NA	NA	OK	OK
SizeSpline_Val_3_F11_PS_MED_post2009(11)	1.73493	4	-9	7	1.735	73.8421	2.33E-08	No_prio	NA	NA	NA	OK	OK
SizeSpline_Val_4_F11_PS_MED_post2009(11)	0.30078	4	-9	7	0.301	73.8502	-1.74E-08	No_prio	NA	NA	NA	OK	OK
SizeSpline_GradLo_F12_PS_OTH(12)	0.31774	4	-0	1	0.318	0.0810	-1.32E-06	Sym_Be	0.3	0.001	0.0001	OK	OK
SizeSpline_GradHi_F12_PS_OTH(12)	-0.1133	4	-1	0	-0.113	0.1125	-4.39E-06	No_prio	NA	NA	NA	OK	OK
SizeSpline_Val_1_F12_PS_OTH(12)	-5.7457	2	-25	15	-5.746	156.6450	-5.36E-06	No_prio	NA	NA	NA	OK	OK
SizeSpline_Val_2_F12_PS_OTH(12)	-0.3435	2	-15	15	-0.343	156.6390	-2.54E-05	No_prio	NA	NA	NA	OK	OK
SizeSpline_Val_3_F12_PS_OTH(12)	-0.6718	2	-15	15	-0.672	156.6390	-1.79E-05	No_prio	NA	NA	NA	OK	OK
SizeSpline_Val_4_F12_PS_OTH(12)	0.75178	2	-15	15	0.752	156.6390	4.80E-06	No_prio	NA	NA	NA	OK	OK
SizeSpline_Val_5_F12_PS_OTH(12)	0.68165	2	-15	15	0.682	156.6410	4.25E-05	No_prio	NA	NA	NA	OK	OK
Size_DblN_ascend_se_F13_TP_pre2011(13)	7.92332	2	-15	20	7.923	0.2542	-3.92E-05	No_prio	NA	NA	NA	OK	OK
Size_DblN_descend_se_F13_TP_pre2011(13)	0.63552	2	-15	20	0.636	1.5916	1.07E-06	No_prio	NA	NA	NA	OK	OK
Size_DblN_ascend_se_F14_TP_post2012(14)	7.76085	2	-5	12	7.761	0.4820	4.07E-09	No_prio	NA	NA	NA	OK	OK
Size_DblN_descend_se_F14_TP_post2012(14)	5.67658	2	-5	15	5.677	1.9271	-1.24E-09	No_prio	NA	NA	NA	OK	OK
Size_DblN_ascend_se_F15_TP_OTH(15)	6.46401	2	-5	12	6.464	0.2665	-1.06E-05	No_prio	NA	NA	NA	OK	OK
Size_DblN_descend_se_F15_TP_OTH(15)	8.23539	2	-5	15	8.235	0.2334	2.55E-05	No_prio	NA	NA	NA	OK	OK

Table 5. Assessment summary. Weights are in tonnes. High and low refer to 95% confidence intervals. All weights are in tonnes and recruitment is in thousands.

	Recruitment (Age 0)			SSB			F_{10-20}		
Year	estimate	low	high	estimate	low	high	estimate	low	high
1950	1843	347	2260	864907	778446	951368	0.04	0.034	0.042
1951	1903	360	2330	838066	750820	925312	0.04	0.034	0.043
1952	2308	407	2871	802829	714976	890682	0.05	0.042	0.053
1953	2336	418	2896	755291	667371	843211	0.06	0.049	0.062
1954	2829	469	3565	702383	615062	789704	0.05	0.044	0.056
1955	3642	838	4235	649493	563348	735638	0.07	0.058	0.077
1956	2421	438	2995	588086	503717	672455	0.06	0.051	0.071
1957	2314	389	2908	537254	455552	618956	0.08	0.067	0.095
1958	2458	389	3124	481664	403088	560240	0.09	0.071	0.104
1959	2215	480	2621	430583	355479	505687	0.07	0.059	0.089
1960	1796	393	2119	390186	318700	461672	0.09	0.074	0.113
1961	1495	223	1921	349589	281650	417528	0.10	0.079	0.125
1962	1892	237	2499	311751	247012	376490	0.13	0.095	0.155
1963	2033	259	2679	276564	214661	338467	0.09	0.066	0.115
1964	2246	273	2979	256713	197522	315904	0.10	0.071	0.129
1965	2249	174	3134	237693	180711	294675	0.11	0.074	0.141
1966	2222	105	3197	221044	165592	276496	0.08	0.056	0.113
1967	2957	366	3912	209822	155608	264036	0.13	0.085	0.170
1968	2452	245	3334	194190	141450	246930	0.09	0.056	0.116
1969	2207	288	2899	185942	134888	236996	0.10	0.066	0.134
1970	2253	370	2843	177936	128671	227201	0.07	0.044	0.092
1971	2543	481	3115	176248	128554	223942	0.06	0.039	0.085
1972	2357	354	3024	176178	129667	222689	0.07	0.043	0.092
1973	3020	844	3287	175886	130080	221692	0.07	0.043	0.091
1974	2354	391	2964	176068	130623	221513	0.14	0.092	0.180
1975	2204	578	2456	168497	123614	213380	0.17	0.113	0.226
1976	1689	325	2060	160525	116437	204613	0.19	0.118	0.255
1977	2261	609	2494	152191	109063	195319	0.15	0.097	0.210
1978	2503	876	2457	148922	106750	191094	0.12	0.076	0.165
1979	2127	738	2098	148221	106882	189560	0.11	0.066	0.144
1980	2016	670	2033	149443	109092	189794	0.12	0.076	0.163
1981	2289	920	2069	148551	109433	187669	0.12	0.078	0.160
1982	3033	1483	2341	148594	110886	186302	0.20	0.132	0.266
1983	2532	1128	2121	140982	105145	176819	0.19	0.126	0.251
1984	2704	1228	2230	134181	100166	168196	0.23	0.153	0.311
1985	3930	1996	2920	124837	92884	156790	0.23	0.143	0.308
1986	4346	2203	3237	118069	88296	147842	0.21	0.127	0.289
1987	3998	1722	3437	114980	87346	142614	0.19	0.117	0.266
1988	3288	1126	3265	113870	88262	139478	0.27	0.169	0.367
1989	6359	2570	5722	109948	86402	133494	0.25	0.159	0.337
1990	7612	3309	6499	111750	90045	133455	0.31	0.203	0.419
1991	8168	3364	7254	112552	92641	132463	0.36	0.240	0.476
1992	9790	4081	8622	113785	95793	131777	0.45	0.300	0.592
1993	10740	5529	7870	114359	97584	131134	0.49	0.334	0.647
1994	9280	4509	7205	122896	104517	141275	0.75	0.517	0.977
1995	5874	2417	5221	126299	106061	146537	0.79	0.563	1.020
1996	5850	2701	4756	134595	114226	154964	0.89	0.616	1.170
1997	8953	5079	5850	144244	124091	164397	0.93	0.629	1.225
1998	4373	1648	4116	153402	133566	173238	0.78	0.552	1.010
1999	7686	4544	4745	157317	137748	176886	0.65	0.479	0.818
2000	5947	3014	4430	155918	136093	175743	0.61	0.454	0.757
2001	6317	3182	4734	152484	132656	172312	0.58	0.447	0.722
2002	5946	2910	4584	151059	131337	170782	0.53	0.410	0.660
2003	13383	8541	7312	143751	124633	162869	0.60	0.456	0.738
2004	10279	5848	6692	137600	118997	156203	0.62	0.458	0.779
2005	7543	4012	5333	129726	111656	147796	0.66	0.489	0.838
2006	3915	1935	2990	128326	111505	145147	0.71	0.520	0.902
2007	3389	1529	2809	132178	115651	148705	0.75	0.534	0.965
2008	4556	1824	4125	135515	115475	155555	0.40	0.286	0.513
2009	7808	2777	7599	160099	133863	186335	0.27	0.190	0.351
2010	4250	132	6218	186896	153333	220459	0.13	0.091	0.161
2011	2017	-356	3584	217705	176649	258761	0.08	0.060	0.101
2012	8974	-5729	22204	253050	203530	302570	0.07	0.052	0.090
2013	10858	-13952	37469	291241	232164	350318	0.07	0.049	0.081
2014	7246	-7147	21736	330741	260603	400879	0.06	0.042	0.069
2015	7359	-6071	20282	364193	285079	443307	0.06	0.046	0.077
2016	4374	-1193	8407	396370	310047	482693	0.07	0.048	0.083
2017	3164	-566	5633	442808	344445	541171	0.07	0.051	0.092
2018	3037	-481	5312	489441	377501	601381	0.08	0.057	0.102
2019	2811	-513	5021	523250	404306	642194	0.09	0.062	0.110
2020	2808	-514	5016	549962	418354	681570	0.09	0.066	0.120
2021				561782	416451	707113			

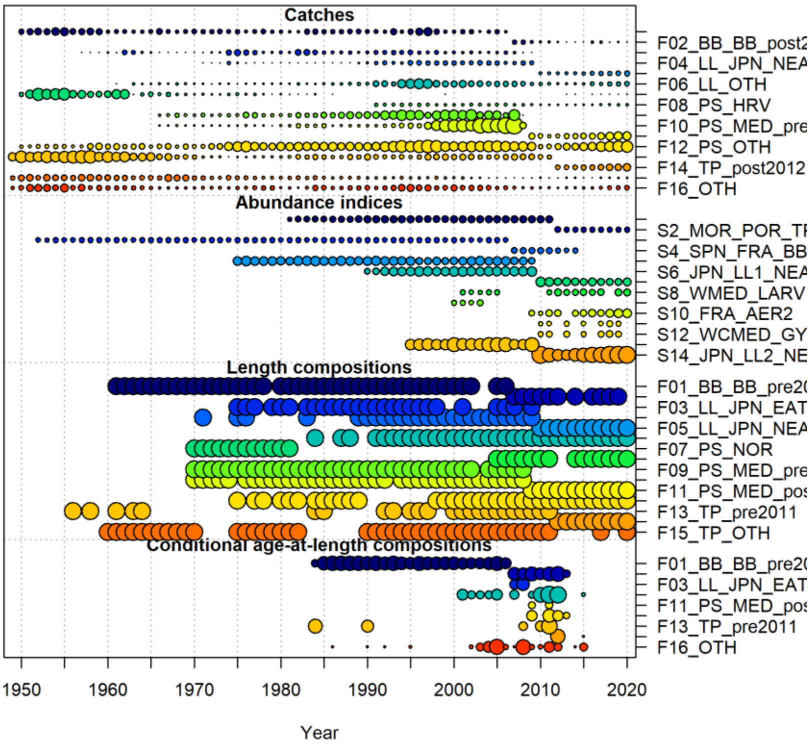


Figure 1. Time series of data inputs used in Run 8.

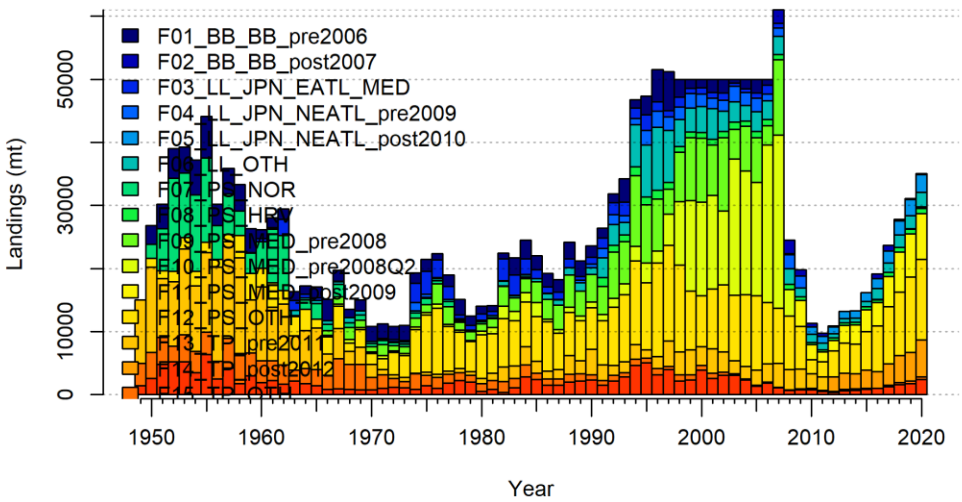
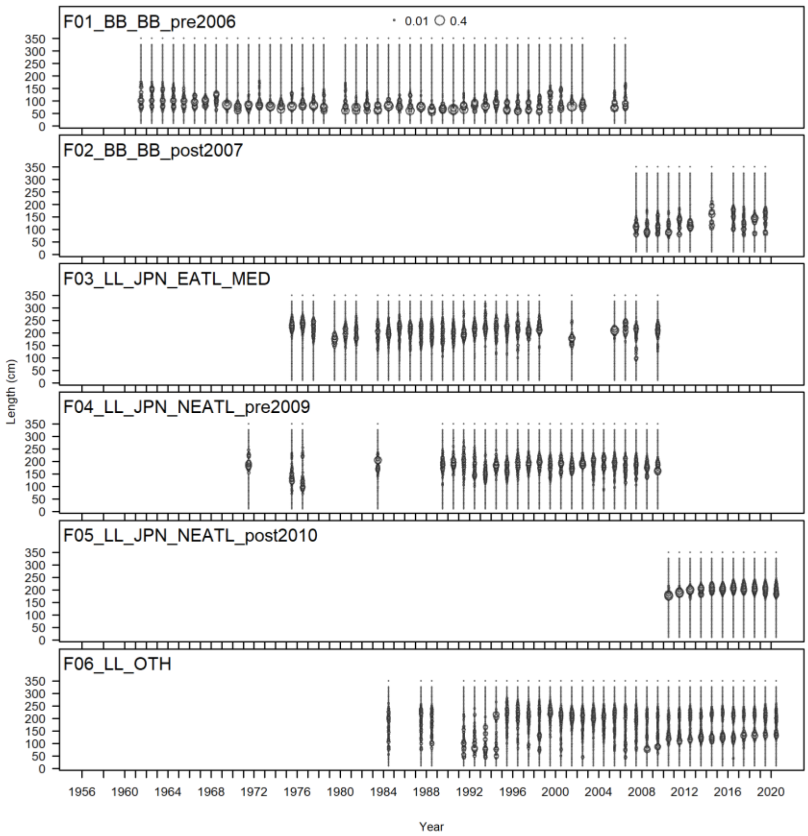
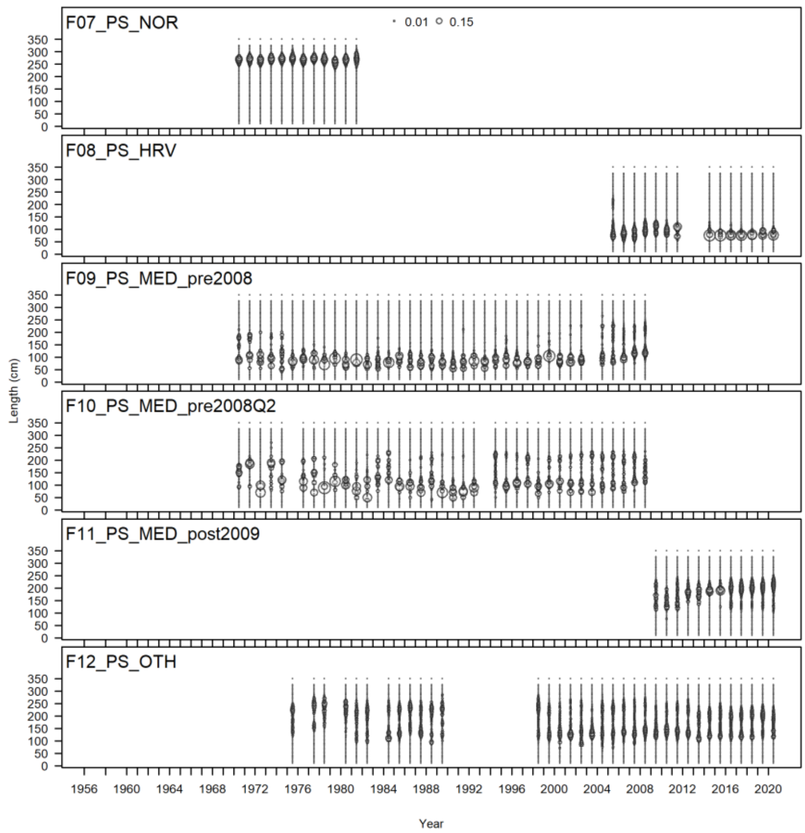


Figure 2. Landings (mt) for each of the fleets defined in Run 8.


F01_BB_BB_pre2006
0.01
0.4
F02_BB_BB_post2007
F03_LL_JPN_EATL_MED
F04_LL_JPN_NEATL_pre2009
F05_LL_JPN_NEATL_post2010
F06_LL_OTH
Length (cm)
Year


F07_PS_NOR
0.01
0.15
F08_PS_HRV
F09_PS_MED_pre2008
F10_PS_MED_pre2008Q2
F11_PS_MED_post2009
F12_PS_OTH
Length (cm)
Year

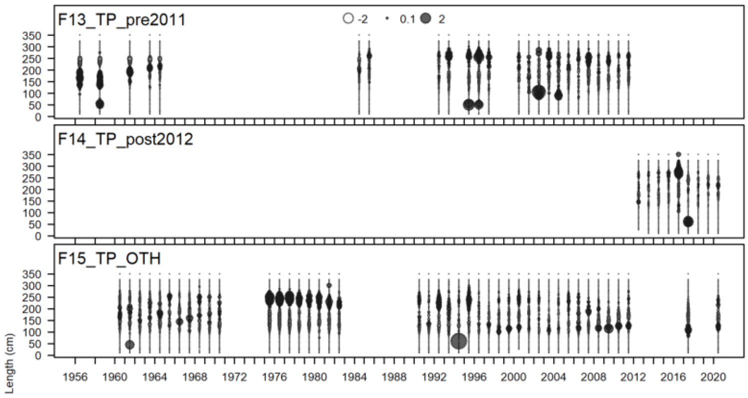


Figure 3. Time series of length composition by fleet used as input in Run 8.

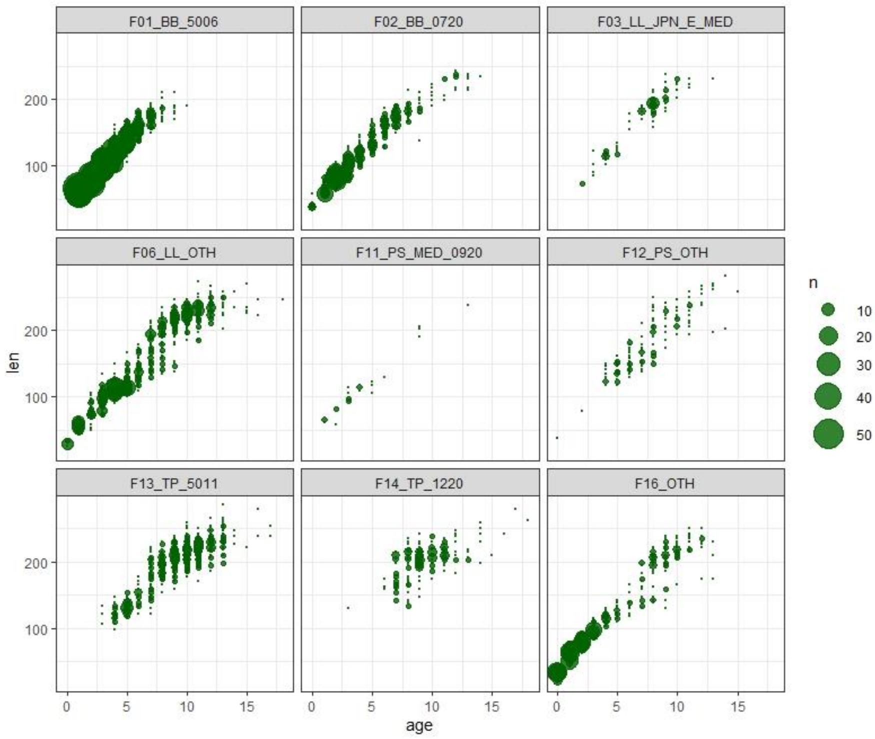


Figure 4. Age-length data from spines and otoliths readings used as conditional age-at-length in Run 8.

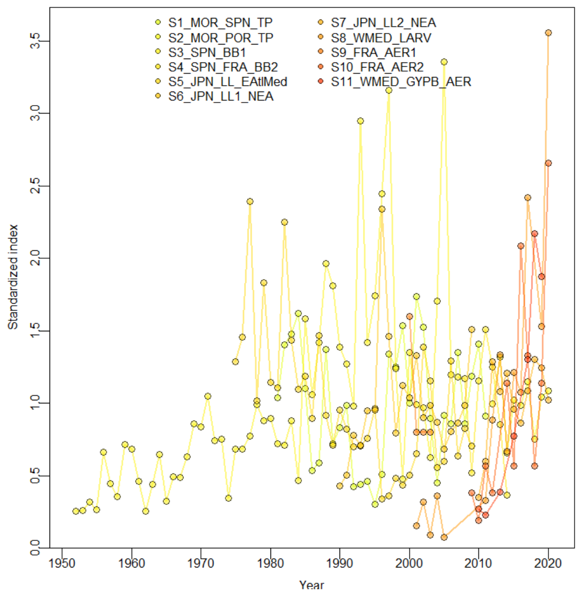


Figure 5. Standardized commercial and survey indices used in the fit of Run 8. Each index is scaled to have a mean observation = 1.

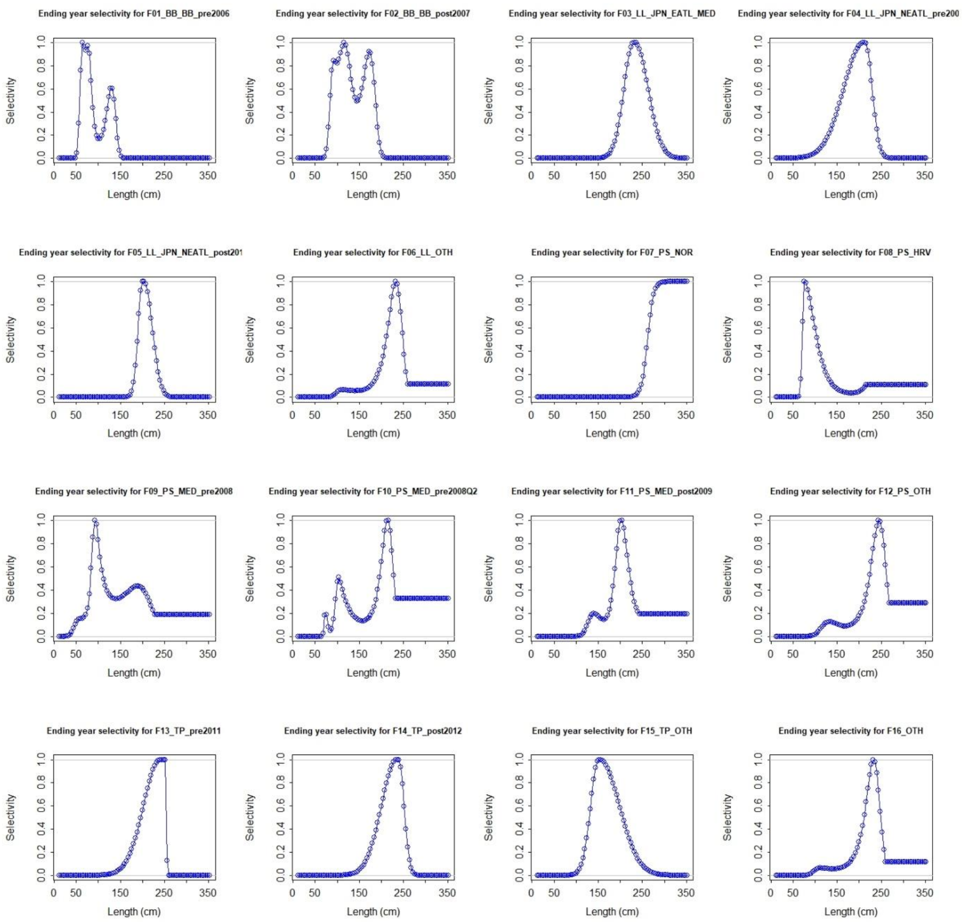


Figure 6. Estimated length based selectivities by fleet.

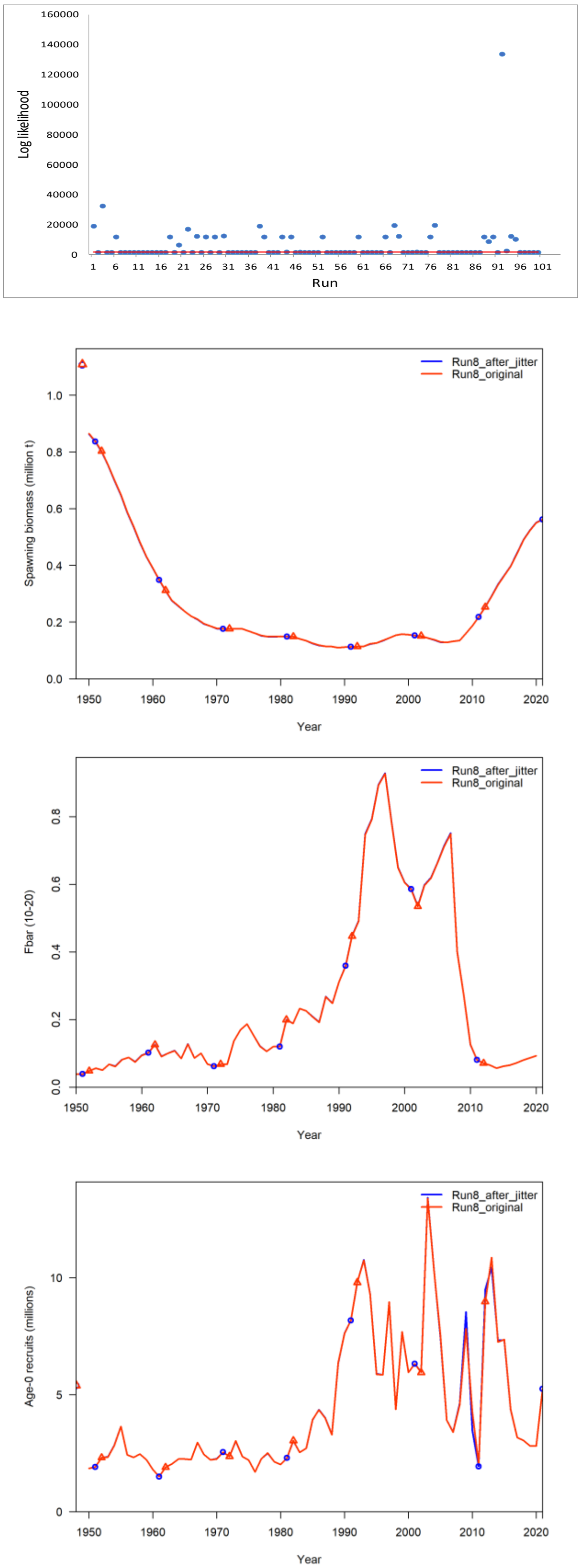


Figure 7. Top: Jitter analysis results, red line indicates the likelihood of the original run. Bottom plots: Comparison of model trajectories for Run8-original and Run 8-after jitter.

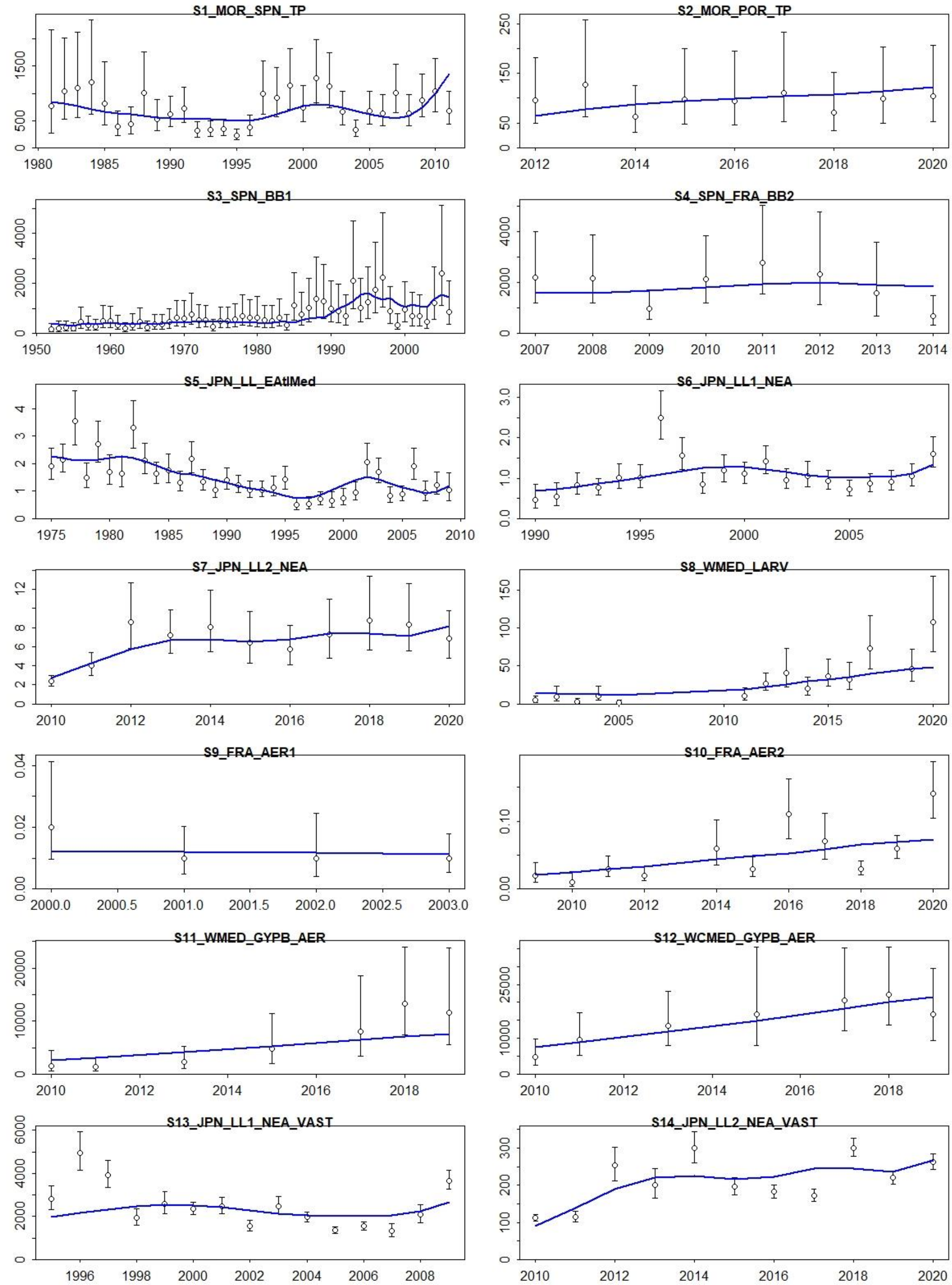


Figure 8. Observed (black points) vs. fit abundance indices (blue line).

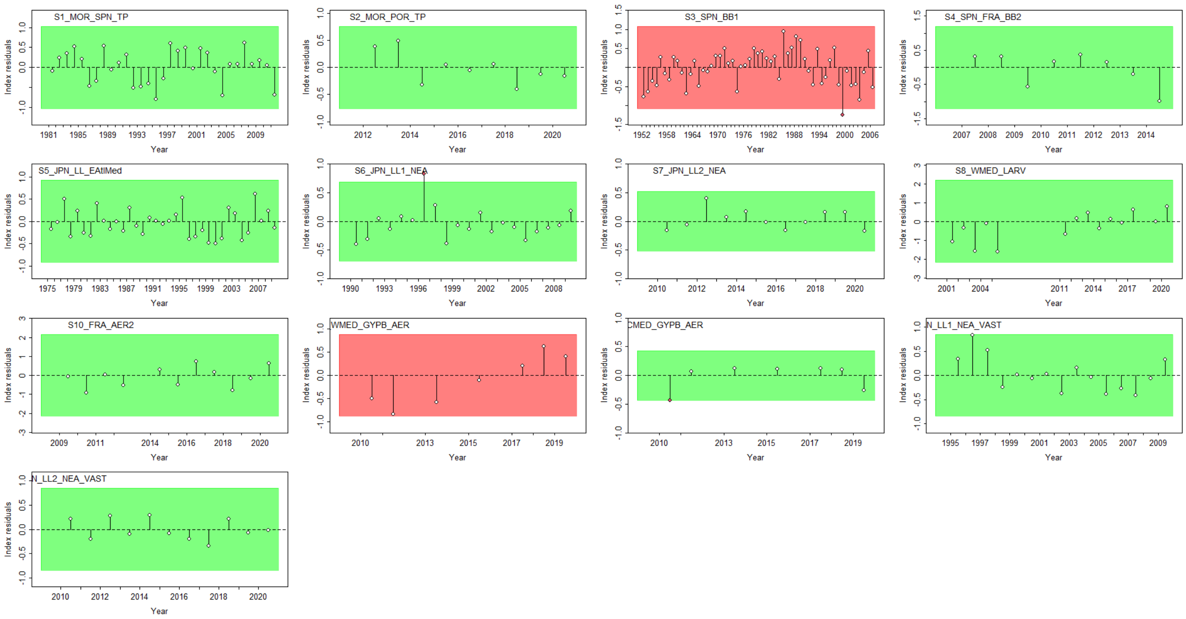


Figure 9. Runs test results for index fits. Green shading is no evidence ($p \geq 0.05$) and red shading is evidence ($p < 0.05$) to reject the hypothesis of a randomly distributed residuals. The shaded (green/red) area spans three residual standard deviations from zero, and the red points outside of the shading violate the '3-sigma limit' for that series.

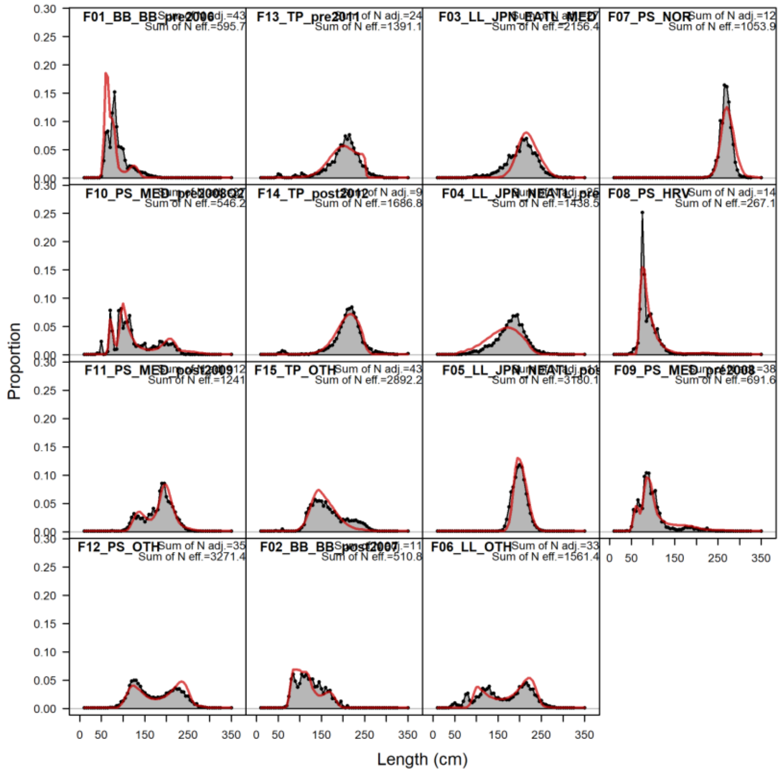


Figure 10. Aggregated length composition and the fit (red line) of the proposed base case by fleet.

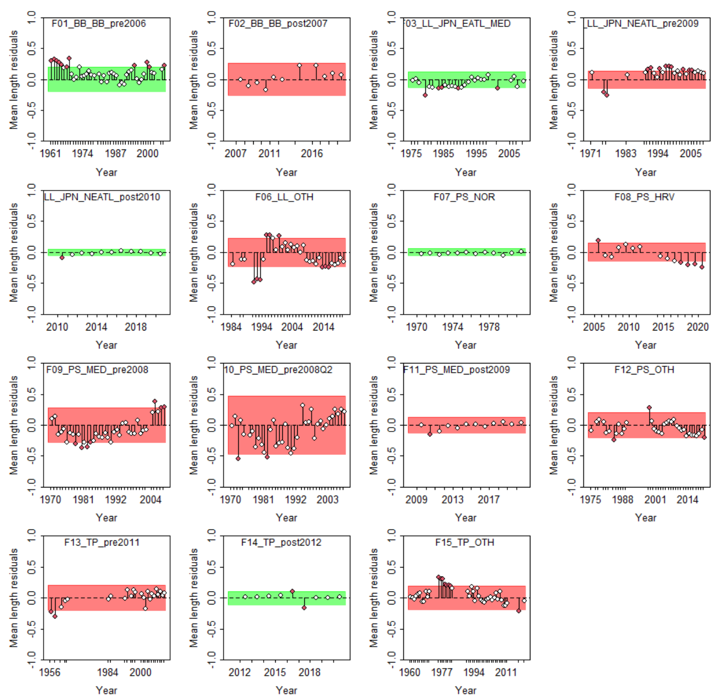


Figure 11. Runs test results for mean lengths of the 15 fleets. Green shading is no evidence ($p \geq 0.05$) and red shading is evidence ($p < 0.05$) to reject the hypothesis of a randomly distributed time-series of residuals. The shaded (green/red) area spans three residual standard deviations from zero, and the red points outside of the shading violate the '3-sigma limit' for that series.

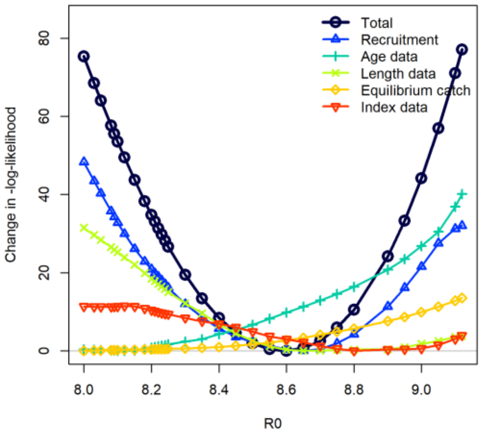


Figure 12. Log-likelihood profiles for log(R0) for the various data components included in the Run 8, showing the contribution of all data likelihood components.

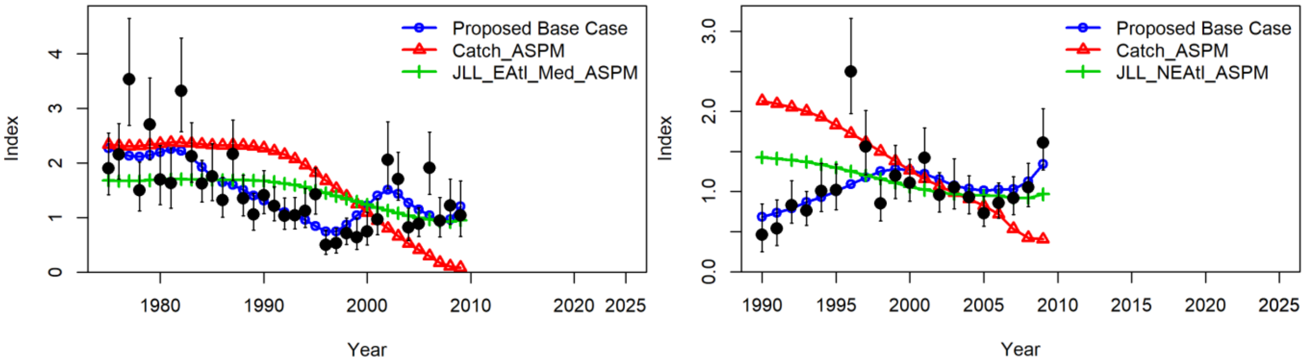


Figure 13. Comparison between the proposed base case and the deterministic Age Structured Production Model showing observed and predicted values for the S5_JPN_LL_EatlMed (left) and the S6_JPN_LL1_NEA (right).

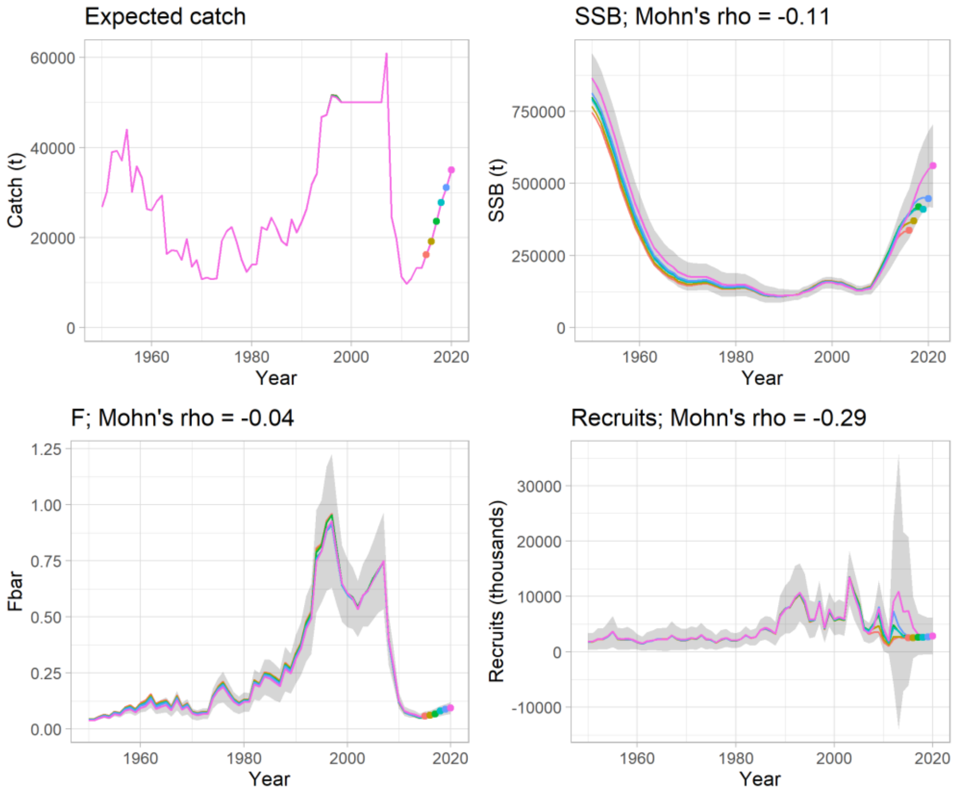


Figure 14. Retrospective analysis results. Mohn's rho statistics, calculated following Hurtado-Ferro *et al.* (2015), are printed at the top of the plots. Grey shaded areas are the 95% confidence intervals from the reference model (Run 8).

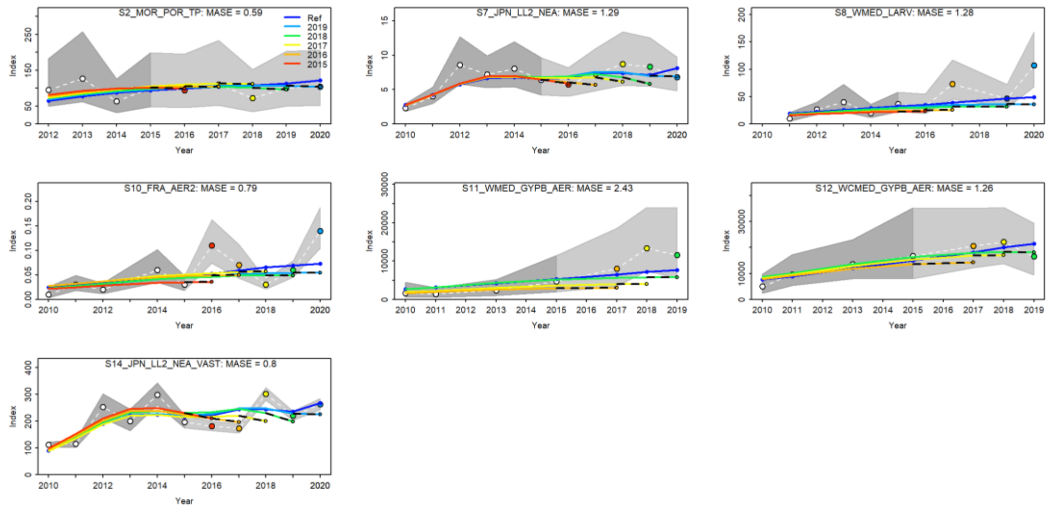


Figure 15. Hind casting cross-validation results for seven index fits, showing observed (large points connected with dashed line), fitted (solid lines) and one-year-ahead forecast values (small terminal points). The observations used for cross validation are highlighted as colour-coded solid circles with associated 95 % confidence intervals (light-gray shading). The mean absolute scaled error (MASE) score associated with each index is indicated.

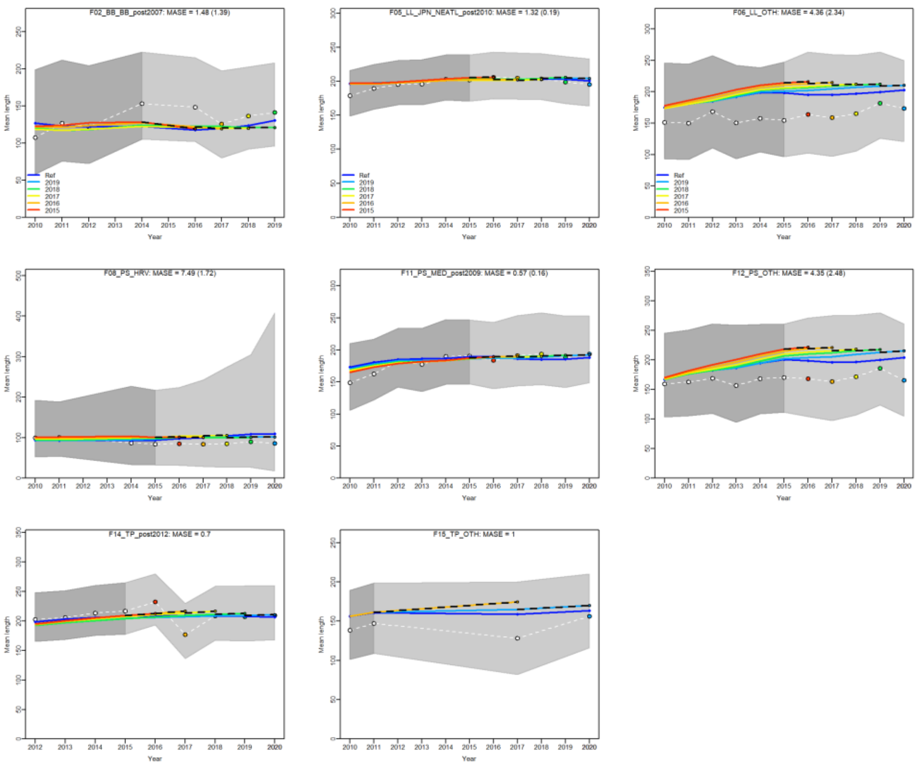


Figure 16. Hind casting cross-validation results for eight mean lengths of size, composition data, showing observed (large points connected with dashed lines), fitted (solid lines) and one-year-ahead forecast values (small terminal points). The observations used for cross validation are highlighted as colour-coded solid circles with associated 95 % confidence intervals (light-grey shading). The mean absolute scaled error (MASE) score associated with each index is indicated.

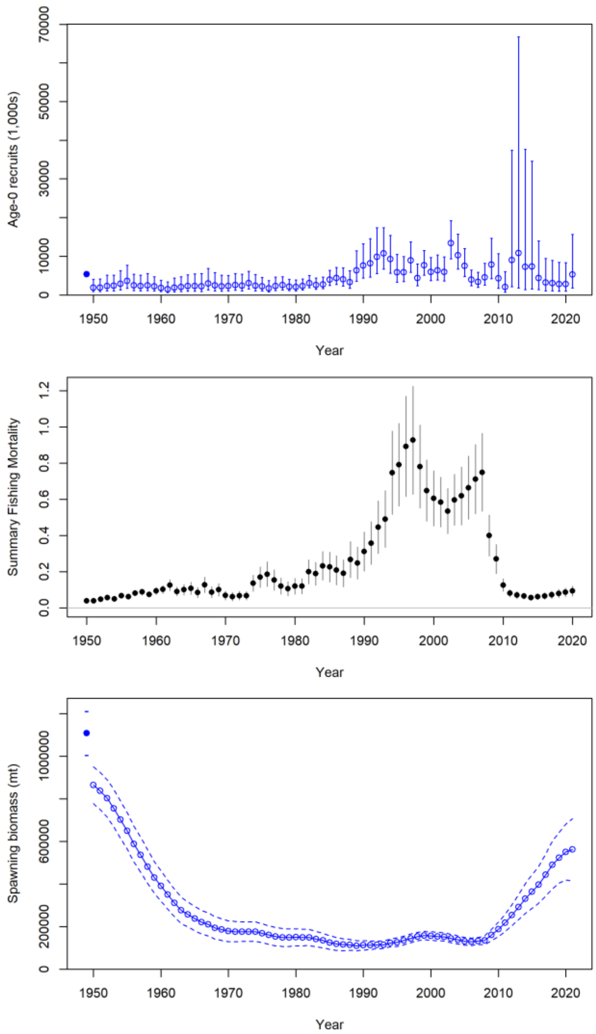
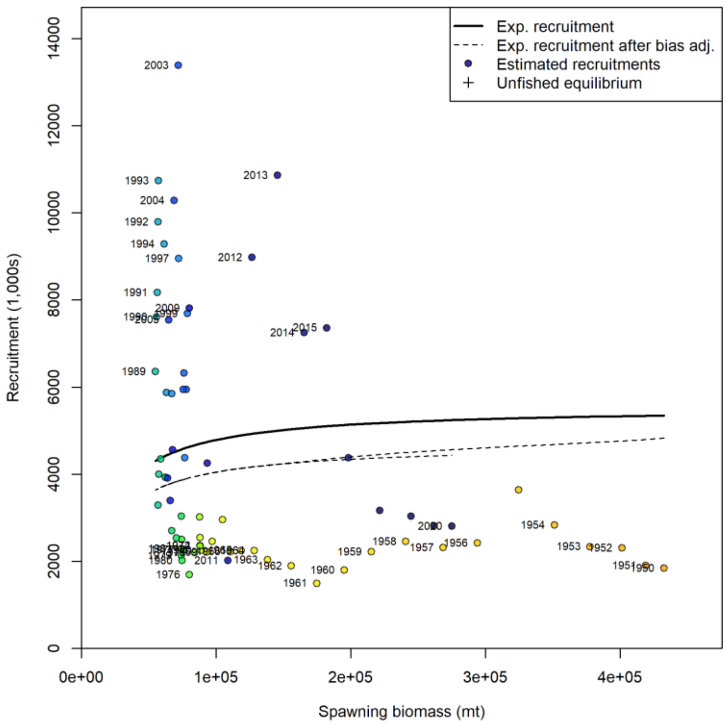


Figure 17. Time series of Recruitment (Age 0), F (averages on ages 10-20) and SSB with associated 95% confidence intervals.



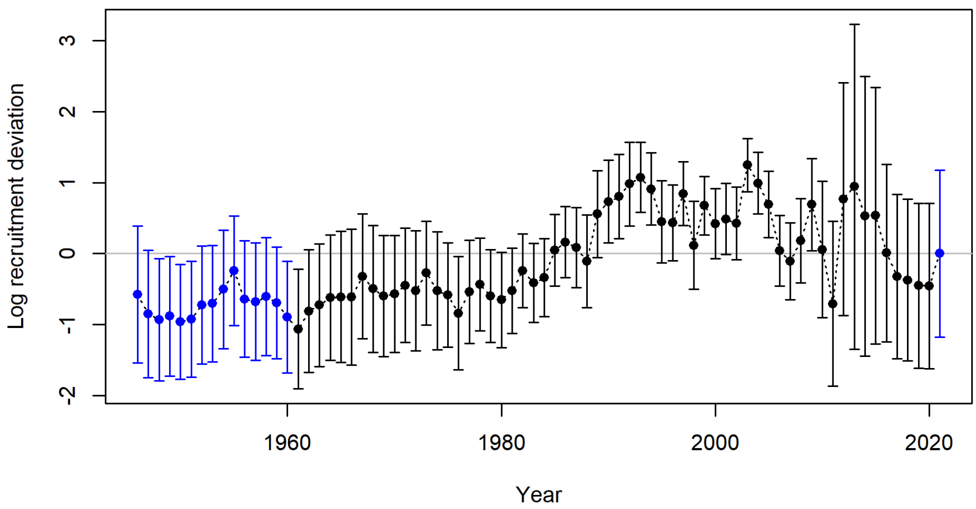


Figure 18. Top: Estimated Beverton-Holt spawner-recruit relationship and recruitment (Age 0) estimates for Run 8. Stock-recruit curve with labels on first, last, and years with (log) deviations > 0.5. Point colours indicate the year, with warmer colours indicating earlier years and cooler colours in showing later years. **Bottom**: Recruitment deviates from the SRR and the associated 95% confidence interval.

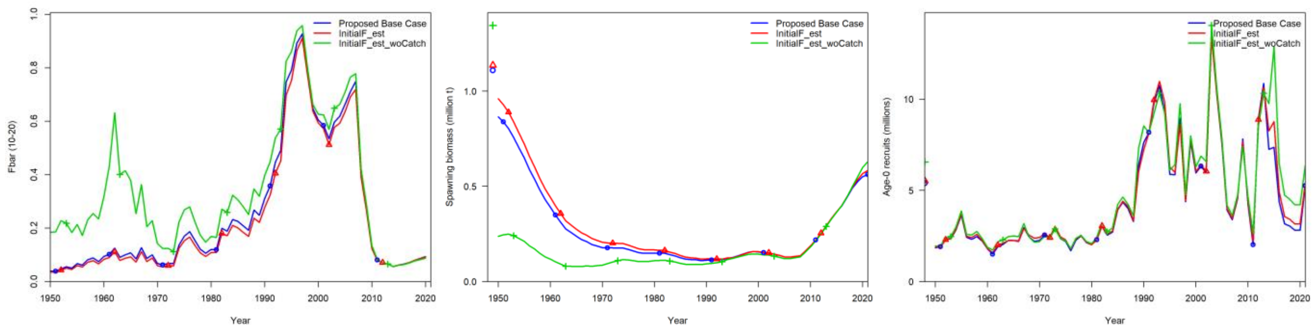


Figure 19. Effect of alternative assumptions for initial Fs on trends in Fbar (10-20), SSB and recruitment for proposed base case model.

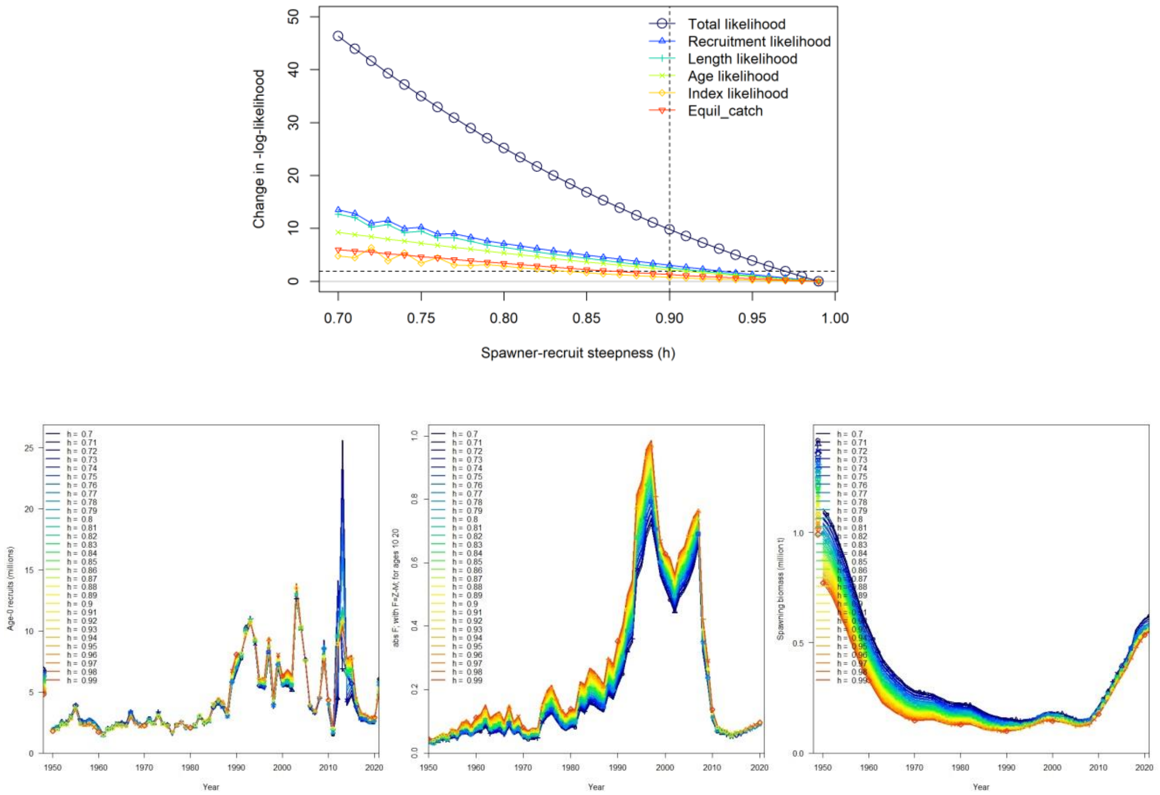


Figure 20. Top: Likelihood profiles for steepness. The assumed value for steepness in the proposed base case is indicated with a vertical dashed line (h = 0.9). Bottom: Trajectories of the derived quantities for different values of steepness from 0.7 to 0.99, represented from cool to warm colours.

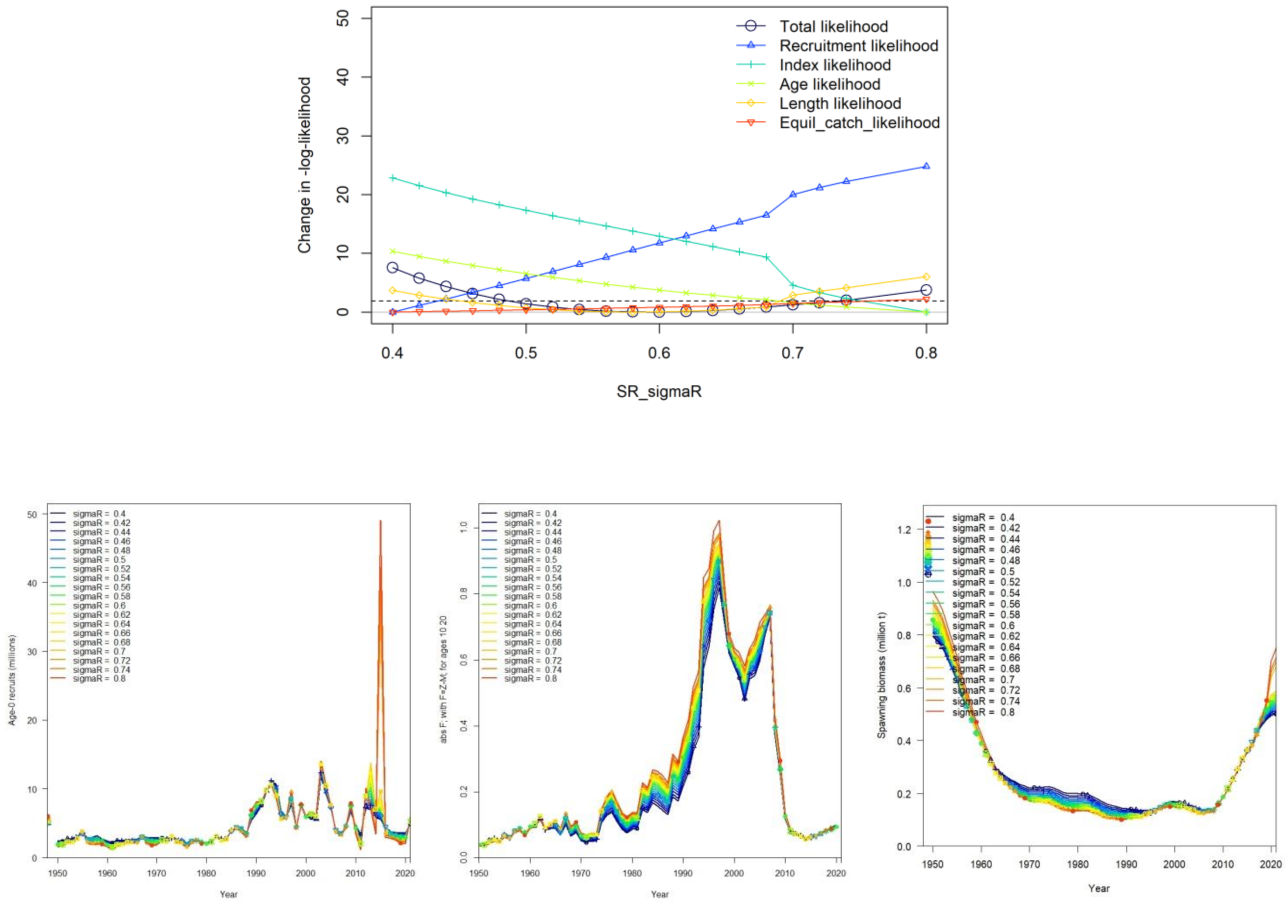


Figure 21. Top: Likelihood profiles for sigmaR. Assumed value for sigmaR in the proposed base case is 0.6. Bottom: Trajectories of the derived quantities for different values of steepness from 0.4 to 0.8, represented from cool to warm colours. Only runs that achieved the convergence are shown.

Annex 1

Stock Synthesis control file for Run8

```
#V3.30.18.00;_fast(opt);_compile_date:_Sep 30 2021;_Stock_Synthesis_by_Richard_Methot_(NOAA)_using_ADMB_12.3
#_Stock_Synthesis_is_a_work_of_the_U.S._Government_and_is_not_subject_to_copyright_protection_in_the_United_States.
#_Foreign_copyrights_may_apply._See_copyright.txt_for_more_information.
#_User_support_available_at:NMFS.Stock.Synthesis@noaa.gov
#_User_info_available_at:https://vlab.noaa.gov/group/stock-synthesis
#_Source_code_at:_https://github.com/nmfs-stock-synthesis/stock-synthesis
#C growth parameters are estimated
#C spawner-recruitment bias adjustment Not tuned For optimality
#_data_and_control_files: data.ss // control.ss
0  # 0 means do not read wtatage.ss; 1 means read and use wtatage.ss and also read and use growth parameters
1  #_N_Growth_Patterns (Growth Patterns, Morphs, Bio Patterns, GP are terms used interchangeably in SS)
1 #_N_platoons_Within_GrowthPattern
#_Cond 1 #_Platoon_within/between_stdev_ratio (no read if N_platoons=1)
#_Cond  1 #vector_platoon_dist_(-1_in_first_val_gives_normal_approx)
#
4 # recr_dist_method for parameters:  2=main effects for GP, Area, Settle timing; 3=each Settle entity; 4=none (only when N_GP*Nsettle*pop==1)
1 # not yet implemented; Future usage: Spawner-Recruitment: 1=global; 2=by area
1 #  number of recruitment settlement assignments
0 # unused option
#GPattern month  area  age (for each settlement assignment)
 1 1 1 0
#
#_Cond 0 # N_movement_definitions goes here if Nareas > 1
#_Cond 1.0 # first age that moves (real age at begin of season, not integer) also cond on do_migration>0
#_Cond 1 1 1 2 4 10 # example move definition for seas=1, morph=1, source=1 dest=2, age1=4, age2=10
#
1 #_Nblock_Patterns
 1 #_blocks_per_pattern
# begin and end years of blocks
 1949 1949
#
# controls for all timevary parameters
1 #_time-vary parm bound check (1=warn relative to base parm bounds; 3=no bound check); Also see env (3) and dev (5) options to constrain with base bounds
#
# AUTOGEN
 1 1 1 1 1 # autogen: 1st element for biology, 2nd for SR, 3rd for Q, 4th reserved, 5th for selex
# where: 0 = autogen time-varying parms of this category; 1 = read each time-varying parm line; 2 = read then autogen if parm min==-12345
#
#_Available timevary codes
#_Block types: 0: P_block=P_base*exp(TVP); 1: P_block=P_base+TVP; 2: P_block=TVP; 3: P_block=P_block(-1) + TVP
#_Block_trends: -1: trend bounded by base parm min-max and parms in transformed units (beware); -2: endtrend and infl_year direct values; -3: end and infl as fraction of base range
#_EnvLinks:  1: P(y)=P_base*exp(TVP*env(y));  2: P(y)=P_base+TVP*env(y);  3: P(y)=f(TVP,env_Zscore) w/ logit to stay in min-max;  4: P(y)=2.0/(1.0+exp(-TVP1*env(y) - TVP2))
#_DevLinks:  1: P(y)*=exp(dev(y)*dev_se;  2: P(y)+=dev(y)*dev_se;  3: random walk;  4: zero-reverting random walk with rho;  5: like 4 with logit transform to stay in base min-max
#_DevLinks(more):  21-25 keep last dev for rest of years
#
#_Prior_codes:  0=none; 6=normal; 1=symmetric beta; 2=CASAL's beta; 3=lognormal; 4=lognormal with biascorr; 5=gamma
#
# setup for M, growth, wt-len, maturity, fecundity, (hermaphro), recr_distr, cohort_grow, (movement), (age error), (catch_mult), sex ratio
#_NATMORT
3 #_natM_type:_0=1Parm; 1=N_breakpoints;_2=Lorenzen;_3=agespecific;_4=agespec_withseasinterpolate;_5=BETA:_Maunder_link_to_maturity
 #_Age_natmort_by sex x growthpattern (nest GP in sex)
 0.82 0.41 0.32 0.26 0.22 0.19 0.17 0.15 0.14 0.13 0.12 0.12 0.11 0.11 0.11 0.11 0.11 0.11 0.11 0.11 0.11 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1
#
2 # GrowthModel: 1=vonBert with L1&L2; 2=Richards with L1&L2; 3=age_specific_K_incr; 4=age_specific_K_decr; 5=age_specific_K_each; 6=NA; 7=NA; 8=growth cessation
1 #_Age(post-settlement)_for_L1;linear growth below this
30 #_Growth_Age_for_L2 (999 to use as Linf)
-999 #_exponential decay for growth above maxage (value should approx initial Z; -999 replicates 3.24; -998 to not allow growth above maxage)
0  #_placeholder for future growth feature
#
0 #_SD_add_to_LAA (set to 0.1 for SS2 V1.x compatibility)
0 #_CV_Growth_Pattern:  0 CV=f(LAA); 1 CV=F(A); 2 SD=F(LAA); 3 SD=F(A); 4 logSD=F(A)
#
3 #_maturity_option:  1=length logistic; 2=age logistic; 3=read age-maturity matrix by growth_pattern; 4=read age-fecundity; 5=disabled; 6=read length-maturity
#_Age_Maturity by growth pattern
 0 0 0 0.25 0.5 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
3 #_First_Mature_Age
1 #_fecundity option:(1)eggs=Wt*(a+b*Wt);(2)eggs=a*L^b;(3)eggs=a*Wt^b; (4)eggs=a+b*L; (5)eggs=a+b*W
0 #_hermaphroditism option:  0=none; 1=female-to-male age-specific fxn; -1=male-to-female age-specific fxn
1 #_parameter_offset_approach for M, G, CV_G:  1- direct, no offset**; 2- male=fem_parm*exp(male_parm); 3: male=female*exp(parm) then old=young*exp(parm)
#_** in option 1, any male parameter with value = 0.0 and phase <0 is set equal to female parameter
#
#_growth_parms
#_ LO HI INIT PRIOR PR_SD PR_type PHASE env_var&link dev_link dev_minyr dev_maxyr dev_PH Block Block_Fxn
# Sex: 1  BioPattern: 1  NatMort
# Sex: 1  BioPattern: 1  Growth
 5 60 55.7949 0 0 0 2 0 0 0 0 0 0 0 # L_at_Amin_Fem_GP_1
 250 320 271 0 0 0 -2 0 0 0 0 0 0 0 # L_at_Amax_Fem_GP_1
```

```
 0.01 0.4 0.233871 0 0 0 -2 0 0 0 0 0 0 0 # VonBert_K_Fem_GP_1
 -3 3 -0.451733 0 0 0 3 0 0 0 0 0 0 0 # Richards_Fem_GP_1
 0.02 0.4 0.085006 0 0 0 3 0 0 0 0 0 0 0 # CV_young_Fem_GP_1
 0.02 0.4 0.0692333 0 0 0 3 0 0 0 0 0 0 0 # CV_old_Fem_GP_1
# Sex: 1  BioPattern: 1  WtLen
 -3 3 3.5e-05 3.5e-05 0.8 0 -3 0 0 0 0 0 0 0 # Wtlen_1_Fem_GP_1
 -3 4 2.87845 2.87845 0.8 0 -3 0 0 0 0 0 0 0 # Wtlen_2_Fem_GP_1
# Sex: 1  BioPattern: 1  Maturity&Fecundity
 3 5 4 4 0.8 0 -3 0 0 0 0 0 0 0 # Mat50%_Fem_GP_1
 -7 -3 -5 -5 0.8 0 -3 0 0 0 0 0 0 0 # Mat_slope_Fem_GP_1
 -3 3 1 1 0.8 0 -3 0 0 0 0 0 0 0 # Eggs/kg_inter_Fem_GP_1
 -3 3 0 0 0.8 0 -3 0 0 0 0 0 0 0 # Eggs/kg_slope_wt_Fem_GP_1
# Hermaphroditism
#  Recruitment Distribution
#  Cohort growth dev base
 0.1 10 1 1 1 0 -1 0 0 0 0 0 0 0 # CohortGrowDev
#  Movement
#  Age Error from parameters
#  catch multiplier
#  fraction female, by GP
 1e-06 0.999999 0.5 0.5 0.5 0 -99 0 0 0 0 0 0 0 # FracFemale_GP_1
#  M2 parameter for each predator fleet
#
#_no timevary MG parameters
#
#_seasonal_effects_on_biology_parms
 0 0 0 0 0 0 0 0 0 0 #_femwtlen1,femwtlen2,mat1,mat2,fec1,fec2,Malewtlen1,malewtlen2,L1,K
#_ LO HI INIT PRIOR PR_SD PR_type PHASE
#_Cond -2 2 0 0 -1 99 -2 #_placeholder when no seasonal MG parameters
#
6 #_Spawner-Recruitment; Options: 1=NA; 2=Ricker; 3=std_B-H; 4=SCAA; 5=Hockey; 6=B-H_flattop; 7=survival_3Parm; 8=Shepherd_3Parm; 9=RickerPower_3parm
0  # 0/1 to use steepness in initial equ recruitment calculation
0  #  future feature:  0/1 to make realized sigmaR a function of SR curvature
#_       LO        HI      INIT     PRIOR     PR_SD   PR_type     PHASE   env-var   use_dev  dev_mnyr  dev_mxyr    dev_PH     Block   Blk_Fxn #  parm_name
          6        15   8.59239         0         0         0         1         0         0         0         0         0         0         0 # SR_LN(R0)
        0.2         1       0.9         0         0         0        -3         0         0         0         0         0         0         0 # SR_BH_flat_steep
          0         2       0.6         0         0         0        -5         0         0         0         0         0         0         0 # SR_sigmaR
         -5         5         0         0         1         0        -2         0         0         0         0         0         0         0 # SR_regime
          0         0         0         0         0         0       -99         0         0         0         0         0         0         0 # SR_autocorr
#_no timevary SR parameters
1 #do_recdev:  0=none; 1=devvector (R=F(SSB)+dev); 2=deviations (R=F(SSB)+dev); 3=deviations (R=R0*dev; dev2=R-f(SSB)); 4=like 3 with sum(dev2) adding penalty
1961 # first year of main recr_devs; early devs can preceed this era
2020 # last year of main recr_devs; forecast devs start in following year
3 #_recdev phase
1 # (0/1) to read 13 advanced options
 -15 #_recdev_early_start (0=none; neg value makes relative to recdev_start)
 5 #_recdev_early_phase
 0 #_forecast_recruitment phase (incl. late recr) (0 value resets to maxphase+1)
 1 #_lambda for Fcast_recr_like occurring before endyr+1
 1931 #_last_yr_nobias_adj_in_MPD; begin of ramp
 1962 #_first_yr_fullbias_adj_in_MPD; begin of plateau
 2020.8 #_last_yr_fullbias_adj_in_MPD
 2021 #_end_yr_for_ramp_in_MPD (can be in forecast to shape ramp, but SS sets bias_adj to 0.0 for fcast yrs)
 0.93 #_max_bias_adj_in_MPD (typical ~0.8; -3 sets all years to 0.0; -2 sets all non-forecast yrs w/ estimated recdevs to 1.0; -1 sets biasadj=1.0 for all yrs w/ recdevs)
 0 #_period of cycles in recruitment (N parms read below)
 -5 #min rec_dev
 5 #max rec_dev
 0 #_read_recdevs
#_end of advanced SR options
#
#_placeholder for full parameter lines for recruitment cycles
# read specified recr devs
#_Yr Input_value
#
# all recruitment deviations
#  1946E 1947E 1948E 1949E 1950E 1951E 1952E 1953E 1954E 1955E 1956E 1957E 1958E 1959E 1960E 1961R 1962R 1963R 1964R 1965R 1966R 1967R 1968R 1969R 1970R 1971R
1972R 1973R 1974R 1975R 1976R 1977R 1978R 1979R 1980R 1981R 1982R 1983R 1984R 1985R 1986R 1987R 1988R 1989R 1990R 1991R 1992R 1993R 1994R 1995R 1996R 1997R 1998R
1999R 2000R 2001R 2002R 2003R 2004R 2005R 2006R 2007R 2008R 2009R 2010R 2011R 2012R 2013R 2014R 2015R 2016R 2017R 2018R 2019R 2020R 2021F
#  -0.576854 -0.851677 -0.933051 -0.882482 -0.962825 -0.924301 -0.724394 -0.704608 -0.504495 -0.243085 -0.641076 -0.67614 -0.603984 -0.695263 -0.892594 -1.06224 -0.810858 -
0.7274 -0.619902 -0.609653 -0.613248 -0.320663 -0.497233 -0.596313 -0.56927 -0.446635 -0.522738 -0.274356 -0.5236 -0.582955 -0.841004 -0.540673 -0.435181 -0.597038 -0.651897
-0.523728 -0.242654 -0.413597 -0.338592 0.0493366 0.161633 0.0837124 -0.109515 0.557636 0.733916 0.802818 0.98165 1.07312 0.911868 0.449003 0.432436 0.845168 0.117929
0.677491 0.422465 0.486628 0.427733 1.24778 0.991976 0.693759 0.0400298 -0.109963 0.18105 0.690386 0.0581307 -0.707803 0.76686 0.942789 0.526546 0.533908 0.00721595 -
0.324367 -0.371759 -0.453088 -0.457051 0
#
#Fishing Mortality info
1 # F ballpark value in units of annual_F
-2001 # F ballpark year (neg value to disable)
3 # F_Method:  1=Pope midseason rate; 2=F as parameter; 3=F as hybrid; 4=fleet-specific parm/hybrid (#4 is superset of #2 and #3 and is recommended)
1 # max F (methods 2-4) or harvest fraction (method 1)
4  # N iterations for tuning in hybrid mode; recommend 3 (faster) to 5 (more precise if many fleets)
#
#_initial_F_parms; for each fleet x season that has init_catch; nest season in fleet; count = 3
```

#_for unconstrained init_F, use an arbitrary initial catch and set lambda=0 for its logL
#_ LO HI INIT PRIOR PR_SD PR_type PHASE
 0 1 0.03 0.03 99 0 -1 # InitF_seas_1_flt_13F13_TP_pre2011
 0 1 0.015 0.015 99 0 -1 # InitF_seas_1_flt_15F15_TP_OTH
 0 1 0.005 0.005 99 0 -1 # InitF_seas_1_flt_16F16_OTH
#
F rates by fleet x season
Yr: 1950 1951 1952 1953 1954 1955 1956 1957 1958 1959 1960 1961 1962 1963 1964 1965 1966 1967 1968 1969 1970 1971 1972 1973 1974 1975 1976 1977 1978 1979 1980 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021
seas: 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
F01_BB_BB_pre2006 0.110949 0.203552 0.317944 0.311123 0.449162 0.571121 0.250624 0.28498 0.320725 0.25846 0.0890257 0.111274 0.125532 0.097688 0.0870085 0.125604 0.235169 0.122032 0.0804431 0.103218 0.143402 0.132206 0.118472 0.142066 0.0941424 0.106323 0.0584308 0.107974 0.155468 0.0883631 0.0817661 0.0616077 0.0556903 0.156245 0.172657 0.134139 0.110099 0.0901704 0.108765 0.101578 0.0621753 0.0423007 0.0333182 0.0757321 0.0233806 0.0485057 0.0915177 0.122731 0.05296 0.0326632 0.0325905 0.0478724 0.0525045 0.0146535 0.0290706 0.0365328 0.0174087 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
F02_BB_BB_post2007 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0.0196193 0.0199316 0.00888795 0.00509024 0.00421262 0.00165058 0.000584737 1.88388e-05 0.000295667 0.00448936 0.00504562 0.00121885 0.00118595 0.000749844 0.000749844
F03_LL_JPN_EATL_MED 0 0 0 0 0 0 0 0.000112573 7.90637e-06 0.000257917 0.00259114 0.00129776 0.0186976 0.0139472 0.00550139 0.00411983 0.000536856 0.00112316 0.000152587 2.44183e-05 0.000266528 0.00202338 0.00452621 0.00371179 0.0408115 0.0515158 0.0411123 0.031723 0.00880934 0.0109209 0.0148605 0.00884317 0.0523781 0.0511122 0.0432976 0.0266495 0.0207021 0.0243402 0.0317168 0.0142836 0.0264232 0.0468076 0.0617026 0.0797675 0.0665575 0.116528 0.0851278 0.0564004 0.0833607 0.0330879 0.0354792 0.0275861 0.0314595 0.0153107 0.0186431 0.0280554 0.0544783 0.0347647 0.00658311 0.00186038 0 0 0 0 0 0 0 0 0 0 0 0
F04_LL_JPN_NEATL_pre2009 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1.80841e-05 0.000137467 0.000144771 0.0209958 0.00777421 0.00254669 0.00081903 0.00112626 0.000289155 0.000236533 0.00027716 0.00082908 0.00112359 0.000549622 0.000364892 0.00118238 0.000567043 0.000329056 0.007465 0.0123731 0.0276922 0.0289416 0.0183198 0.0159566 0.0379173 0.039362 0.0294615 0.0239387 0.0261882 0.0221482 0.0182185 0.020306 0.0305843 0.0277085 0.0309872 0.0154791 0.0195999 0.0320719 0.0209598 0 0 0 0 0 0 0 0 0 0 0
F05_LL_JPN_NEATL_post2010 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0.0251157 0.015426 0.0110895 0.00957608 0.00923486 0.0115764 0.0129227 0.0143794 0.0168074 0.0193265 0.019318 0.019318
F06_LL_OTH 0 0 0 0 0 0 0 0 0 0 0 0.000221501 0 0.0123707 0.00598126 0.00744417 0.00945849 0.00608451 0.0145264 0.0112006 0.00618346 0.00439603 0.00283332 0.00620659 0.0050627 0.00325544 0.00718707 0.00691798 0.00572836 0.00497135 0.00518842 0.0069482 0.0154297 0.00675803 0.00880936 0.0136463 0.0239278 0.0226354 0.034417 0.0415609 0.0339857 0.110498 0.122218 0.0768806 0.269528 0.353628 0.450367 0.375304 0.182614 0.143424 0.136448 0.145859 0.0896901 0.0915807 0.0769869 0.110149 0.110671 0.114128 0.0928384 0.0430978 0.031078 0.0175106 0.00792272 0.00606005 0.00500022 0.00590749 0.0113032 0.00901214 0.0114724 0.0117029 0.012869 0.012869
F07_PS_NOR 0.00797479 0.0247578 0.055772 0.0399468 0.0490329 0.0561293 0.0230725 0.0290276 0.0183861 0.016466 0.0231942 0.0523451 0.0610001 0.00132766 0.013035 0.0252143 0.0112537 0.0253966 0.0105628 0.0129246 0.00781989 0.011573 0.00812386 0.00845747 0.0189484 0.0243688 0.0150085 0.0245722 0.00770572 0.00217827 0.0105568 0.006208 0.00202464 4.35334e-05 0.0114371 0 0.00173693 0 0 0 0 0 0 0 0 0 0 0 0 0.00750974 0 0 0 0 0 0 0 0 0 0 0 0 0 1.43341e-05 8.12148e-06 0 0.00134976 0.00114507 0.000206275 0.000798122 0.00282685 0.00282685
F08_PS_HRV 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0.0421727 0.0264325 0.0226793 0.0270458 0.0212712 0.024205 0.0229366 0.0213064 0.0209443 0.0229655 0.0214774 0.024046 0.0286911 0.0201743 0.0186164 0.01724 0.0156594 0.0196796 0.0164728 0.0094667 0.00747297 0.00716232 0.00770383 0.00598095 0.00543204 0.00506722 0.00678925 0.00846528 0.0104028 0.012453 0.012453
F09_PS_MED_pre2008 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0.0126863 0.019997 0.0347388 0.0210875 0.0153824 0.0309891 0.0154917 0.0193421 0.0246881 0.0222654 0.0584061 0.0551138 0.0249701 0.0274634 0.022442 0.0270391 0.0612553 0.0445735 0.0471569 0.0723222 0.0704955 0.0853428 0.10625 0.0809654 0.0864216 0.082453 0.118106 0.0950747 0.146663 0.113231 0.0956783 0.047481 0.0976521 0.123268 0.123468 0.102979 0.152005 0.0655349 0.0997212 0.0908145 0.0348249 0.146644 1.29858e-09 0 0 0 0 0 0 0 0 0 0 0 0 0
F10_PS_MED_pre2008Q2 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0.00278489 0.00434835 0.00760197 0.00477782 0.00361112 0.00730745 0.00368061 0.00465835 0.00600667 0.00545197 0.00967489 0.00510827 0.00502223 0.00243966 0.00882429 0.0148126 0.0320996 0.0247097 0.0268211 0.0432199 0.00927308 0.0117556 0.0169434 0.0155305 0.0209282 0.0206768 0.0295399 0.0343018 0.0451384 0.057924 0.0362637 0.0896312 0.183628 0.256655 0.244278 0.236389 0.183223 0.358111 0.354184 0.334392 0.431862 0.480237 0.0743582 0 0 0 0 0 0 0 0 0 0 0 0 0
F11_PS_MED_post2009 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0.0790775 0.0351497 0.0170706 0.0146518 0.0210576 0.0213087 0.0239955 0.0245576 0.0287598 0.0359098 0.0381251 0.0370764 0.0370764
F12_PS_OTH 0.00366205 0.00319884 0.00460483 0.00513927 0.00680584 0.00500096 0.00415251 0.00415546 0.0154037 0.0209985 0.0169387 0.0255447 0.0175791 0.0275286 0.0340331 0.0152141 0.0315326 0.0435135 0.0171813 0.0383894 0.0239845 0.0249355 0.0514548 0.0510392 0.105968 0.148148 0.182267 0.12735 0.105253 0.0864735 0.125631 0.112115 0.138747 0.136407 0.145239 0.158597 0.187057 0.146065 0.182014 0.178605 0.195755 0.228327 0.33165 0.411521 0.547602 0.474646 0.684992 0.698907 0.602912 0.385107 0.313863 0.337442 0.355261 0.343351 0.403138 0.456499 0.405603 0.372933 0.339119 0.221799 0.0597882 0.0481451 0.0612136 0.0524197 0.0408935 0.0439906 0.0458504 0.0524957 0.0544364 0.0612613 0.0634764 0.0634764
F13_TP_pre2011 0.0409354 0.0285925 0.0318205 0.044407 0.0360528 0.0485962 0.0657282 0.0800585 0.0987769 0.0656827 0.111352 0.0978525 0.130015 0.0827815 0.0956418 0.10682 0.0547027 0.0778852 0.0346089 0.0454956 0.0361532 0.0138228 0.0101038 0.0108338 0.00156463 0.00750707 0.0084058 0.00977341 0.010946 0.0104893 0.0133634 0.0189892 0.0385997 0.0342832 0.054244 0.0391335 0.027183 0.031343 0.0687618 0.0515892 0.107156 0.068445 0.0465619 0.0517547 0.0745746 0.044856 0.0711915 0.142979 0.112509 0.106114 0.0706161 0.082759 0.06656 0.0456477 0.0472095 0.0632423 0.0830962 0.119389 0.0961124 0.0760551 0.0401226 0.0262997 0 0 0 0 0 0 0 0 0 0
F14_TP_post2012 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0.0203199 0.0177782 0.014019 0.0154624 0.0135036 0.0158832 0.0193596 0.020134 0.0244876 0.0244876
F15_TP_OTH 0.0176561 0.01983 0.0133537 0.0271645 0.0258166 0.0335711 0.0328188 0.0660683 0.0746969 0.0674112 0.0672346 0.0612015 0.0592574 0.0323548 0.0451256 0.0476756 0.0433029 0.0949509 0.0803049 0.0836469 0.039668 0.041739 0.0261946 0.0169862 0.0412319 0.0285257 0.0306661 0.02405 0.0208 0.0169056 0.0198661 0.0235812 0.0307075 0.0278319 0.0357753 0.0204388 0.0194719 0.0206856 0.0249932 0.0228734 0.015086 0.0134337 0.0153081 0.0105173 0.0144456 0.0107466 0.010992 0.00577338 0.00987291 0.00758784 0.00679317 0.0091313 0.00573306 0.002622 0.00190527 0.00145124 0.00167756 0.00121913 0.00164508 0.00125351 0.00204157 0.00108509 0.000796091 0.00135999 0.0013195 0.00104691 1.1935e-06 0.00135792 0.0013178 0.00140025 0.00136894 0.00136894
F16_OTH 0.0091001 0.017194 0.0189584 0.0195072 0.0137835 0.0273063 0.012059 0.0241703 0.0119557 0.0246462 0.0189282 0.0262704 0.0232465 0.0338676 0.0280949 0.0244893 0.0144063 0.0171651 0.0160613 0.0149029 0.0151524 0.0196051 0.0222992 0.0208511 0.0165878 0.0287253 0.020301 0.0380685 0.0475029 0.041425 0.0106473 0.0165305 0.00644735 0.0228248 0.0640955 0.0592011 0.0411397 0.0418008 0.0580996 0.066547 0.0747404 0.0507013 0.0787605 0.108416 0.186143 0.215778 0.143807 0.178783 0.0901384 0.0856571 0.128769 0.0758358 0.0854356 0.087247 0.0725205 0.0478214 0.0677145 0.0412505 0.0241941 0.0242296 0.0177218 0.00940934 0.00462982 0.00582082 0.00519366 0.00566396 0.00613878 0.00736251 0.00931046 0.00988291 0.0132555 0.0132555
#
#_Q_setup for fleets with cpue or survey data
#_1: fleet number
#_2: link type: (1=simple q, 1 parm; 2=mirror simple q, 1 mirrored parm; 3=q and power, 2 parm; 4=mirror with offset, 2 parm)
#_3: extra input for link, i.e. mirror fleet# or dev index number
#_4: 0/1 to select extra sd parameter
#_5: 0/1 for biasadj or not
#_6: 0/1 to float
#_   fleet   link link_info extra_se   biasadj   float # fleetname
       17   1   0   0   0   1 # S1_MOR_SPN_TP
       18   1   0   0   0   1 # S2_MOR_POR_TP
       19   1   0   0   0   1 # S3_SPN_BB1
       20   1   0   0   0   1 # S4_SPN_FRA_BB2
       21   1   0   0   0   1 # S5_JPN_LL_EAtlMed

```
      22       1       0       0       0       1  #  S6_JPN_LL1_NEA
      23       1       0       0       0       1  #  S7_JPN_LL2_NEA
      24       1       0       0       0       1  #  S8_WMED_LARV
      25       1       0       0       0       1  #  S9_FRA_AER1
      26       1       0       0       0       1  #  S10_FRA_AER2
      27       1       0       0       0       1  #  S11_WMED_GYPB_AER
      28       1       0       0       0       1  #  S12_WCMED_GYPB_AER
      29       1       0       0       0       1  #  S13_JPN_LL1_NEA_VAST
      30       1       0       0       0       1  #  S14_JPN_LL2_NEA_VAST
-9999 0 0 0 0 0
#
#_Q_parms(if_any);Qunits_are_ln(q)
#_        LO        HI      INIT      PRIOR      PR_SD      PR_type      PHASE    env-var    use_dev    dev_mnyr    dev_mxyr      dev_PH      Block    Blk_Fxn  #  parm_name
         -15        15    0.901419         0          1         0       -1       0       0       0       0       0       0  #  LnQ_base_S1_MOR_SPN_TP(17)
         -15        15    -2.39514         0          1         0       -1       0       0       0       0       0       0  #  LnQ_base_S2_MOR_POR_TP(18)
         -15        15    -3.62338         0          1         0       -1       0       0       0       0       0       0  #  LnQ_base_S3_SPN_BB1(19)
         -15        15    -4.19569         0          1         0       -1       0       0       0       0       0       0  #  LnQ_base_S4_SPN_FRA_BB2(20)
         -15        15    -4.89969         0          1         0       -1       0       0       0       0       0       0  #  LnQ_base_S5_JPN_LL_EAtlMed(21)
         -15        15    -6.62756         0          1         0       -1       0       0       0       0       0       0  #  LnQ_base_S6_JPN_LL1_NEA(22)
         -15        15     -4.7031        0          1         0       -1       0       0       0       0       0       0  #  LnQ_base_S7_JPN_LL2_NEA(23)
         -15        15    -9.33062         0          1         0       -1       0       0       0       0       0       0  #  LnQ_base_S8_WMED_LARV(24)
         -17        15    -16.3585         0          1         0       -1       0       0       0       0       0       0  #  LnQ_base_S9_FRA_AER1(25)
         -17        15    -15.8315         0          1         0       -1       0       0       0       0       0       0  #  LnQ_base_S10_FRA_AER2(26)
         -15        15    -4.22334         0          1         0       -1       0       0       0       0       0       0  #  LnQ_base_S11_WMED_GYPB_AER(27)
         -15        15     -3.1911        0          1         0       -1       0       0       0       0       0       0  #  LnQ_base_S12_WCMED_GYPB_AER(28)
         -15        15    0.966688         0          1         0       -1       0       0       0       0       0       0  #  LnQ_base_S13_JPN_LL1_NEA_VAST(29)
         -15        15    -1.20427         0          1         0       -1       0       0       0       0       0       0  #  LnQ_base_S14_JPN_LL2_NEA_VAST(30)
#_no timevary Q parameters
#
#_size_selex_patterns
#Pattern:_0;  parm=0; selex=1.0 for all sizes
#Pattern:_1;  parm=2; logistic; with 95% width specification
#Pattern:_2;  parm=6; modification of pattern 24 with improved sex-specific offset
#Pattern:_5;  parm=2; mirror another size selex; PARMS pick the min-max bin to mirror
#Pattern:_11; parm=2; selex=1.0  for specified min-max population length bin range
#Pattern:_15; parm=0; mirror another age or length selex
#Pattern:_6;  parm=2+special; non-parm len selex
#Pattern:_43; parm=2+special+2;  like 6, with 2 additional param for scaling (average over bin range)
#Pattern:_8;  parm=8; double_logistic with smooth transitions and constant above Linf option
#Pattern:_9;  parm=6; simple 4-parm double logistic with starting length; parm 5 is first length; parm 6=1 does desc as offset
#Pattern:_21; parm=2+special; non-parm len selex, read as pairs of size, then selex
#Pattern:_22; parm=4; double_normal as in CASAL
#Pattern:_23; parm=6; double_normal where final value is directly equal to sp(6) so can be >1.0
#Pattern:_24; parm=6; double_normal with sel(minL) and sel(maxL), using joiners
#Pattern:_25; parm=3; exponential-logistic in length
#Pattern:_27; parm=special+3; cubic spline in length; parm1==1 resets knots; parm1==2 resets all
#Pattern:_42; parm=special+3+2; cubic spline; like 27, with 2 additional param for scaling (average over bin range)
#_discard_options:_0=none;_1=define_retention;_2=retention&mortality;_3=all_discarded_dead;_4=define_dome-shaped_retention
#_Pattern Discard Male Special
 27 0 0 5 # 1 F01_BB_BB_pre2006
 27 0 0 5 # 2 F02_BB_BB_post2007
 24 0 0 0 # 3 F03_LL_JPN_EATL_MED
 24 0 0 0 # 4 F04_LL_JPN_NEATL_pre2009
 24 0 0 0 # 5 F05_LL_JPN_NEATL_post2010
 27 0 0 5 # 6 F06_LL_OTH
 1 0 0 0 # 7 F07_PS_NOR
 27 0 0 3 # 8 F08_PS_HRV
 27 0 0 5 # 9 F09_PS_MED_pre2008
 27 0 0 7 # 10 F10_PS_MED_pre2008Q2
 27 0 0 4 # 11 F11_PS_MED_post2009
 27 0 0 5 # 12 F12_PS_OTH
 24 0 0 0 # 13 F13_TP_pre2011
 24 0 0 0 # 14 F14_TP_post2012
 24 0 0 0 # 15 F15_TP_OTH
 15 0 0 6 # 16 F16_OTH
 15 0 0 13 # 17 S1_MOR_SPN_TP
 15 0 0 14 # 18 S2_MOR_POR_TP
 15 0 0 1 # 19 S3_SPN_BB1
 15 0 0 2 # 20 S4_SPN_FRA_BB2
 15 0 0 3 # 21 S5_JPN_LL_EAtlMed
 15 0 0 4 # 22 S6_JPN_LL1_NEA
 15 0 0 5 # 23 S7_JPN_LL2_NEA
 0 0 0 0 # 24 S8_WMED_LARV
 0 0 0 0 # 25 S9_FRA_AER1
 0 0 0 0 # 26 S10_FRA_AER2
 0 0 0 0 # 27 S11_WMED_GYPB_AER
 0 0 0 0 # 28 S12_WCMED_GYPB_AER
 15 0 0 4 # 29 S13_JPN_LL1_NEA_VAST
 15 0 0 5 # 30 S14_JPN_LL2_NEA_VAST
#
#_age_selex_patterns
#Pattern:_0; parm=0; selex=1.0 for ages 0 to maxage
```

```
#Pattern:_10; parm=0; selex=1.0 for ages 1 to maxage
#Pattern:_11; parm=2; selex=1.0  for specified min-max age
#Pattern:_12; parm=2; age logistic
#Pattern:_13; parm=8; age double logistic
#Pattern:_14; parm=nages+1; age empirical
#Pattern:_15; parm=0; mirror another age or length selex
#Pattern:_16; parm=2; Coleraine - Gaussian
#Pattern:_17; parm=nages+1; empirical as random walk  N parameters to read can be overridden by setting special to non-zero
#Pattern:_41; parm=2+nages+1; // like 17, with 2 additional param for scaling (average over bin range)
#Pattern:_18; parm=8; double logistic - smooth transition
#Pattern:_19; parm=6; simple 4-parm double logistic with starting age
#Pattern:_20; parm=6; double_normal,using joiners
#Pattern:_26; parm=3; exponential-logistic in age
#Pattern:_27; parm=3+special; cubic spline in age; parm1==1 resets knots; parm1==2 resets all
#Pattern:_42; parm=2+special+3; // cubic spline; with 2 additional param for scaling (average over bin range)
#Age patterns entered with value >100 create Min_selage from first digit and pattern from remainder
#_Pattern Discard Male Special
 10 0 0 0 # 1 F01_BB_BB_pre2006
 10 0 0 0 # 2 F02_BB_BB_post2007
 10 0 0 0 # 3 F03_LL_JPN_EATL_MED
 10 0 0 0 # 4 F04_LL_JPN_NEATL_pre2009
 10 0 0 0 # 5 F05_LL_JPN_NEATL_post2010
 10 0 0 0 # 6 F06_LL_OTH
 10 0 0 0 # 7 F07_PS_NOR
 10 0 0 0 # 8 F08_PS_HRV
 10 0 0 0 # 9 F09_PS_MED_pre2008
 10 0 0 0 # 10 F10_PS_MED_pre2008Q2
 10 0 0 0 # 11 F11_PS_MED_post2009
 10 0 0 0 # 12 F12_PS_OTH
 10 0 0 0 # 13 F13_TP_pre2011
 10 0 0 0 # 14 F14_TP_post2012
 10 0 0 0 # 15 F15_TP_OTH
 10 0 0 0 # 16 F16_OTH
 10 0 0 0 # 17 S1_MOR_SPN_TP
 10 0 0 0 # 18 S2_MOR_POR_TP
 10 0 0 0 # 19 S3_SPN_BB1
 10 0 0 0 # 20 S4_SPN_FRA_BB2
 10 0 0 0 # 21 S5_JPN_LL_EAtlMed
 10 0 0 0 # 22 S6_JPN_LL1_NEA
 10 0 0 0 # 23 S7_JPN_LL2_NEA
 10 0 0 0 # 24 S8_WMED_LARV
 11 0 0 0 # 25 S9_FRA_AER1
 11 0 0 0 # 26 S10_FRA_AER2
 10 0 0 0 # 27 S11_WMED_GYPB_AER
 10 0 0 0 # 28 S12_WCMED_GYPB_AER
 10 0 0 0 # 29 S13_JPN_LL1_NEA_VAST
 10 0 0 0 # 30 S14_JPN_LL2_NEA_VAST
#
#_   LO   HI   INIT   PRIOR   PR_SD   PR_type   PHASE   env-var   use_dev   dev_mnyr   dev_mxyr   dev_PH   Block   Blk_Fxn  #  parm_name
# 1   F01_BB_BB_pre2006 LenSelex
     0    2    1    0    0    0    -99    0    0    0    0    0    0    0  #  SizeSpline_Code_F01_BB_BB_pre2006(1)
  -0.001    2    0.59247    0.65    0.06    6    2    0    0    0    0    0    0    0  #  SizeSpline_GradLo_F01_BB_BB_pre2006(1)
    -5    0.1    -2.24639    0    0    0    2    0    0    0    0    0    0    0  #  SizeSpline_GradHi_F01_BB_BB_pre2006(1)
    10    340    52.2958    0    0    0    -3    0    0    0    0    0    0    0  #  SizeSpline_Knot_1_F01_BB_BB_pre2006(1)
    10    340    70.1666    0    0    0    -3    0    0    0    0    0    0    0  #  SizeSpline_Knot_2_F01_BB_BB_pre2006(1)
    10    340    79.1405    0    0    0    -3    0    0    0    0    0    0    0  #  SizeSpline_Knot_3_F01_BB_BB_pre2006(1)
    10    340    95.9465    0    0    0    -3    0    0    0    0    0    0    0  #  SizeSpline_Knot_4_F01_BB_BB_pre2006(1)
    10    340    197.895    0    0    0    -3    0    0    0    0    0    0    0  #  SizeSpline_Knot_5_F01_BB_BB_pre2006(1)
   -15    7    -5.42385    0    0    0    -3    0    0    0    0    0    0    0  #  SizeSpline_Val_1_F01_BB_BB_pre2006(1)
    -9    7    -2.60459    0    0    0    -3    0    0    0    0    0    0    0  #  SizeSpline_Val_2_F01_BB_BB_pre2006(1)
   -25    10    -2.59662    0    0    0    -3    0    0    0    0    0    0    0  #  SizeSpline_Val_3_F01_BB_BB_pre2006(1)
   -25    7    -4.16451    0    0    0    -3    0    0    0    0    0    0    0  #  SizeSpline_Val_4_F01_BB_BB_pre2006(1)
  -100    7    -61.3402    0    0    0    -3    0    0    0    0    0    0    0  #  SizeSpline_Val_5_F01_BB_BB_pre2006(1)
# 2   F02_BB_BB_post2007 LenSelex
     0    2    1    0    0    0    -99    0    0    0    0    0    0    0  #  SizeSpline_Code_F02_BB_BB_post2007(2)
  -0.001    2    0.546836    0.6    0.001    1    3    0    0    0    0    0    0    0  #  SizeSpline_GradLo_F02_BB_BB_post2007(2)
    -5    0.1    -0.387162    0    0    0    3    0    0    0    0    0    0    0  #  SizeSpline_GradHi_F02_BB_BB_post2007(2)
    10    340    71.7259    0    0    0    -3    0    0    0    0    0    0    0  #  SizeSpline_Knot_1_F02_BB_BB_post2007(2)
    10    340    97.8719    0    0    0    -3    0    0    0    0    0    0    0  #  SizeSpline_Knot_2_F02_BB_BB_post2007(2)
    10    340    119.016    0    0    0    -3    0    0    0    0    0    0    0  #  SizeSpline_Knot_3_F02_BB_BB_post2007(2)
    10    340    144.814    0    0    0    -3    0    0    0    0    0    0    0  #  SizeSpline_Knot_4_F02_BB_BB_post2007(2)
    10    340    208.403    0    0    0    -3    0    0    0    0    0    0    0  #  SizeSpline_Knot_5_F02_BB_BB_post2007(2)
   -15    7    -8.86261    0    0    0    3    0    0    0    0    0    0    0  #  SizeSpline_Val_1_F02_BB_BB_post2007(2)
    -9    7    -4.61761    0    0    0    3    0    0    0    0    0    0    0  #  SizeSpline_Val_2_F02_BB_BB_post2007(2)
   -25    10    -4.43031    0    0    0    -3    0    0    0    0    0    0    0  #  SizeSpline_Val_3_F02_BB_BB_post2007(2)
   -25    7    -5.12915    0    0    0    3    0    0    0    0    0    0    0  #  SizeSpline_Val_4_F02_BB_BB_post2007(2)
  -100    7    -10.0303    0    0    0    3    0    0    0    0    0    0    0  #  SizeSpline_Val_5_F02_BB_BB_post2007(2)
# 3   F03_LL_JPN_EATL_MED LenSelex
    40    310    230    0    0    0    -3    0    0    0    0    0    0    0  #  Size_DblN_peak_F03_LL_JPN_EATL_MED(3)
   -10    3    -8.37543    0    0    0    -3    0    0    0    0    0    0    0  #  Size_DblN_top_logit_F03_LL_JPN_EATL_MED(3)
    -5    15    6.82932    0    0    0    2    0    0    0    0    0    0    0  #  Size_DblN_ascend_se_F03_LL_JPN_EATL_MED(3)
    -5    15    7.44479    0    0    0    2    0    0    0    0    0    0    0  #  Size_DblN_descend_se_F03_LL_JPN_EATL_MED(3)
```

```
 -999   15   -999   0   0   0   -3   0   0   0   0   0   0   0 # Size_DblN_start_logit_F03_LL_JPN_EATL_MED(3)
 -999   10   -999   0   0   0   -3   0   0   0   0   0   0   0 # Size_DblN_end_logit_F03_LL_JPN_EATL_MED(3)
# 4  F04_LL_JPN_NEATL_pre2009 LenSelex
 40   250   210   0   0   0   -3   0   0   0   0   0   0   0 # Size_DblN_peak_F04_LL_JPN_NEATL_pre2009(4)
 -10   3   -8.97948   0   0   0   -3   0   0   0   0   0   0   0 # Size_DblN_top_logit_F04_LL_JPN_NEATL_pre2009(4)
 -5   9   8.27407   0   0   0   2   0   0   0   0   0   0   0 # Size_DblN_ascend_se_F04_LL_JPN_NEATL_pre2009(4)
 -5   9   6.1942   0   0   0   2   0   0   0   0   0   0   0 # Size_DblN_descend_se_F04_LL_JPN_NEATL_pre2009(4)
 -999   15   -999   0   0   0   -3   0   0   0   0   0   0   0 # Size_DblN_start_logit_F04_LL_JPN_NEATL_pre2009(4)
 -999   10   -999   0   0   0   -3   0   0   0   0   0   0   0 # Size_DblN_end_logit_F04_LL_JPN_NEATL_pre2009(4)
# 5  F05_LL_JPN_NEATL_post2010 LenSelex
 40   250   200   0   0   0   -3   0   0   0   0   0   0   0 # Size_DblN_peak_F05_LL_JPN_NEATL_post2010(5)
 -10   3   -7.95223   0   0   0   -3   0   0   0   0   0   0   0 # Size_DblN_top_logit_F05_LL_JPN_NEATL_post2010(5)
 -5   9   5.28604   0   0   0   2   0   0   0   0   0   0   0 # Size_DblN_ascend_se_F05_LL_JPN_NEATL_post2010(5)
 -5   9   6.50924   0   0   0   2   0   0   0   0   0   0   0 # Size_DblN_descend_se_F05_LL_JPN_NEATL_post2010(5)
 -999   15   -999   0   0   0   -2   0   0   0   0   0   0   0 # Size_DblN_start_logit_F05_LL_JPN_NEATL_post2010(5)
 -999   10   -999   0   0   0   -2   0   0   0   0   0   0   0 # Size_DblN_end_logit_F05_LL_JPN_NEATL_post2010(5)
# 6  F06_LL_OTH LenSelex
 0   2   1   0   0   0   -99   0   0   0   0   0   0   0 # SizeSpline_Code_F06_LL_OTH(6)
 -0.001   2   1.24483   1.1   0.001   1   4   0   0   0   0   0   0   0 # SizeSpline_GradLo_F06_LL_OTH(6)
 -1   0.001   -0.180618   0   0   0   4   0   0   0   0   0   0   0 # SizeSpline_GradHi_F06_LL_OTH(6)
 10   340   49.7851   0   0   0   -3   0   0   0   0   0   0   0 # SizeSpline_Knot_1_F06_LL_OTH(6)
 10   340   117.521   0   0   0   -3   0   0   0   0   0   0   0 # SizeSpline_Knot_2_F06_LL_OTH(6)
 10   340   167.857   0   0   0   -3   0   0   0   0   0   0   0 # SizeSpline_Knot_3_F06_LL_OTH(6)
 10   340   210.486   0   0   0   -3   0   0   0   0   0   0   0 # SizeSpline_Knot_4_F06_LL_OTH(6)
 10   340   259.965   0   0   0   -3   0   0   0   0   0   0   0 # SizeSpline_Knot_5_F06_LL_OTH(6)
 -50   10   -7.83376   0   0   0   3   0   0   0   0   0   0   0 # SizeSpline_Val_1_F06_LL_OTH(6)
 -15   200   19.8304   0   0   0   -3   0   0   0   0   0   0   0 # SizeSpline_Val_2_F06_LL_OTH(6)
 -15   200   20.0363   0   0   0   -3   0   0   0   0   0   0   0 # SizeSpline_Val_3_F06_LL_OTH(6)
 -15   200   21.89   0   0   0   -2   0   0   0   0   0   0   0 # SizeSpline_Val_4_F06_LL_OTH(6)
 -15   200   20.4544   0   0   0   2   0   0   0   0   0   0   0 # SizeSpline_Val_5_F06_LL_OTH(6)
# 7  F07_PS_NOR LenSelex
 100   300   262   0   0   0   -3   0   0   0   0   0   0   0 # Size_inflection_F07_PS_NOR(7)
 0.01   25   19.6423   0   0   0   -2   0   0   0   0   0   0   0 # Size_95%width_F07_PS_NOR(7)
# 8  F08_PS_HRV LenSelex
 0   2   1   0   0   0   -99   0   0   0   0   0   0   0 # SizeSpline_Code_F08_PS_HRV(8)
 -0.001   10   2.44148   1.6   0.001   1   4   0   0   0   0   0   0   0 # SizeSpline_GradLo_F08_PS_HRV(8)
 -2   2   0.0647168   0   0   0   4   0   0   0   0   0   0   0 # SizeSpline_GradHi_F08_PS_HRV(8)
 10   340   55.544   0   0   0   -3   0   0   0   0   0   0   0 # SizeSpline_Knot_1_F08_PS_HRV(8)
 10   340   78.8784   0   0   0   -3   0   0   0   0   0   0   0 # SizeSpline_Knot_2_F08_PS_HRV(8)
 10   340   213.638   0   0   0   -3   0   0   0   0   0   0   0 # SizeSpline_Knot_3_F08_PS_HRV(8)
 -200   7   -42.0558   0   0   0   3   0   0   0   0   0   0   0 # SizeSpline_Val_1_F08_PS_HRV(8)
 -50   7   -23.1292   0   0   0   2   0   0   0   0   0   0   0 # SizeSpline_Val_2_F08_PS_HRV(8)
 -50   7   -25.493   0   0   0   2   0   0   0   0   0   0   0 # SizeSpline_Val_3_F08_PS_HRV(8)
# 9  F09_PS_MED_pre2008 LenSelex
 0   2   1   0   0   0   -99   0   0   0   0   0   0   0 # SizeSpline_Code_F09_PS_MED_pre2008(9)
 -0.001   1   0.0508895   0.02   0.001   1   4   0   0   0   0   0   0   0 # SizeSpline_GradLo_F09_PS_MED_pre2008(9)
 -1   0.001   -0.0484434   0   0   0   4   0   0   0   0   0   0   0 # SizeSpline_GradHi_F09_PS_MED_pre2008(9)
 10   340   50.9792   0   0   0   -3   0   0   0   0   0   0   0 # SizeSpline_Knot_1_F09_PS_MED_pre2008(9)
 10   340   76.3774   0   0   0   -3   0   0   0   0   0   0   0 # SizeSpline_Knot_2_F09_PS_MED_pre2008(9)
 10   340   88.0401   0   0   0   -3   0   0   0   0   0   0   0 # SizeSpline_Knot_3_F09_PS_MED_pre2008(9)
 10   340   104.119   0   0   0   -3   0   0   0   0   0   0   0 # SizeSpline_Knot_4_F09_PS_MED_pre2008(9)
 10   340   226.373   0   0   0   -3   0   0   0   0   0   0   0 # SizeSpline_Knot_5_F09_PS_MED_pre2008(9)
 -9   7   -1.95046   0   0   0   3   0   0   0   0   0   0   0 # SizeSpline_Val_1_F09_PS_MED_pre2008(9)
 -9   7   -1.27402   0   0   0   3   0   0   0   0   0   0   0 # SizeSpline_Val_2_F09_PS_MED_pre2008(9)
 -9   7   -0.033452   0   0   0   2   0   0   0   0   0   0   0 # SizeSpline_Val_3_F09_PS_MED_pre2008(9)
 -9   7   -0.265664   0   0   0   2   0   0   0   0   0   0   0 # SizeSpline_Val_4_F09_PS_MED_pre2008(9)
 -9   7   -1.4813   0   0   0   2   0   0   0   0   0   0   0 # SizeSpline_Val_5_F09_PS_MED_pre2008(9)
# 10  F10_PS_MED_pre2008Q2 LenSelex
 0   2   1   0   0   0   -99   0   0   0   0   0   0   0 # SizeSpline_Code_F10_PS_MED_pre2008Q2(10)
 -0.001   50   8.24567   9.6   0.001   1   4   0   0   0   0   0   0   0 # SizeSpline_GradLo_F10_PS_MED_pre2008Q2(10)
 -1   1   -0.110379   0   0   0   4   0   0   0   0   0   0   0 # SizeSpline_GradHi_F10_PS_MED_pre2008Q2(10)
 10   340   47.6756   0   0   0   -3   0   0   0   0   0   0   0 # SizeSpline_Knot_1_F10_PS_MED_pre2008Q2(10)
 10   340   83.4909   0   0   0   -3   0   0   0   0   0   0   0 # SizeSpline_Knot_2_F10_PS_MED_pre2008Q2(10)
 10   340   94.7054   0   0   0   -3   0   0   0   0   0   0   0 # SizeSpline_Knot_3_F10_PS_MED_pre2008Q2(10)
 10   340   109.202   0   0   0   -3   0   0   0   0   0   0   0 # SizeSpline_Knot_4_F10_PS_MED_pre2008Q2(10)
 10   340   130.131   0   0   0   -3   0   0   0   0   0   0   0 # SizeSpline_Knot_5_F10_PS_MED_pre2008Q2(10)
 10   340   183.48   0   0   0   -3   0   0   0   0   0   0   0 # SizeSpline_Knot_6_F10_PS_MED_pre2008Q2(10)
 10   340   228.895   0   0   0   -3   0   0   0   0   0   0   0 # SizeSpline_Knot_7_F10_PS_MED_pre2008Q2(10)
 -999   7   -85.5357   0   0   0   2   0   0   0   0   0   0   0 # SizeSpline_Val_1_F10_PS_MED_pre2008Q2(10)
 -25   20   -4.4781   0   0   0   2   0   0   0   0   0   0   0 # SizeSpline_Val_2_F10_PS_MED_pre2008Q2(10)
 -25   20   -2.76956   0   0   0   2   0   0   0   0   0   0   0 # SizeSpline_Val_3_F10_PS_MED_pre2008Q2(10)
 -25   20   -2.23237   0   0   0   2   0   0   0   0   0   0   0 # SizeSpline_Val_4_F10_PS_MED_pre2008Q2(10)
 -25   20   -2.96676   0   0   0   2   0   0   0   0   0   0   0 # SizeSpline_Val_5_F10_PS_MED_pre2008Q2(10)
 -25   20   -2.83165   0   0   0   2   0   0   0   0   0   0   0 # SizeSpline_Val_6_F10_PS_MED_pre2008Q2(10)
 -25   20   -2.16427   0   0   0   2   0   0   0   0   0   0   0 # SizeSpline_Val_7_F10_PS_MED_pre2008Q2(10)
# 11  F11_PS_MED_post2009 LenSelex
 0   2   1   0   0   0   -99   0   0   0   0   0   0   0 # SizeSpline_Code_F11_PS_MED_post2009(11)
 -0.001   1   0.377084   0.17   0.001   1   4   0   0   0   0   0   0   0 # SizeSpline_GradLo_F11_PS_MED_post2009(11)
 -1   0.001   -0.0288854   0   0   0   4   0   0   0   0   0   0   0 # SizeSpline_GradHi_F11_PS_MED_post2009(11)
 10   340   105.053   0   0   0   -3   0   0   0   0   0   0   0 # SizeSpline_Knot_1_F11_PS_MED_post2009(11)
 10   340   169.619   0   0   0   -3   0   0   0   0   0   0   0 # SizeSpline_Knot_2_F11_PS_MED_post2009(11)
 10   340   194.838   0   0   0   -3   0   0   0   0   0   0   0 # SizeSpline_Knot_3_F11_PS_MED_post2009(11)
```

```
 10  340  240.961  0  0  0  -3  0  0  0  0  0  0  0 # SizeSpline_Knot_4_F11_PS_MED_post2009(11)
 -9  7  -5.0783  0  0  0  4  0  0  0  0  0  0  0 # SizeSpline_Val_1_F11_PS_MED_post2009(11)
 -9  7  0.0584926  0  0  0  4  0  0  0  0  0  0  0 # SizeSpline_Val_2_F11_PS_MED_post2009(11)
 -9  7  1.73493  0  0  0  4  0  0  0  0  0  0  0 # SizeSpline_Val_3_F11_PS_MED_post2009(11)
 -9  7  0.300782  0  0  0  4  0  0  0  0  0  0  0 # SizeSpline_Val_4_F11_PS_MED_post2009(11)
# 12  F12_PS_OTH LenSelex
 0  2  1  0  0  0  -99  0  0  0  0  0  0  0 # SizeSpline_Code_F12_PS_OTH(12)
 -0.001  1  0.317742  0.3  0.001  1  4  0  0  0  0  0  0  0 # SizeSpline_GradLo_F12_PS_OTH(12)
 -1  0.001  -0.113309  0  0  0  4  0  0  0  0  0  0  0 # SizeSpline_GradHi_F12_PS_OTH(12)
 10  340  86.5048  0  0  0  -3  0  0  0  0  0  0  0 # SizeSpline_Knot_1_F12_PS_OTH(12)
 10  340  127.509  0  0  0  -3  0  0  0  0  0  0  0 # SizeSpline_Knot_2_F12_PS_OTH(12)
 10  340  166.655  0  0  0  -3  0  0  0  0  0  0  0 # SizeSpline_Knot_3_F12_PS_OTH(12)
 10  340  216.021  0  0  0  -3  0  0  0  0  0  0  0 # SizeSpline_Knot_4_F12_PS_OTH(12)
 10  340  266.659  0  0  0  -3  0  0  0  0  0  0  0 # SizeSpline_Knot_5_F12_PS_OTH(12)
 -25  15  -5.74563  0  0  0  2  0  0  0  0  0  0  0 # SizeSpline_Val_1_F12_PS_OTH(12)
 -15  15  -0.343463  0  0  0  2  0  0  0  0  0  0  0 # SizeSpline_Val_2_F12_PS_OTH(12)
 -15  15  -0.671736  0  0  0  2  0  0  0  0  0  0  0 # SizeSpline_Val_3_F12_PS_OTH(12)
 -15  15  0.751798  0  0  0  2  0  0  0  0  0  0  0 # SizeSpline_Val_4_F12_PS_OTH(12)
 -15  15  0.681669  0  0  0  2  0  0  0  0  0  0  0 # SizeSpline_Val_5_F12_PS_OTH(12)
# 13  F13_TP_pre2011 LenSelex
 40  270  240  0  0  0  -3  0  0  0  0  0  0  0 # Size_DblN_peak_F13_TP_pre2011(13)
 -10  3  -2.24289  0  0  0  -3  0  0  0  0  0  0  0 # Size_DblN_top_logit_F13_TP_pre2011(13)
 -15  20  7.92332  0  0  0  2  0  0  0  0  0  0  0 # Size_DblN_ascend_se_F13_TP_pre2011(13)
 -15  20  0.635516  0  0  0  2  0  0  0  0  0  0  0 # Size_DblN_descend_se_F13_TP_pre2011(13)
 -999  15  -999  0  0  0  -3  0  0  0  0  0  0  0 # Size_DblN_start_logit_F13_TP_pre2011(13)
 -999  10  -999  0  0  0  -2  0  0  0  0  0  0  0 # Size_DblN_end_logit_F13_TP_pre2011(13)
# 14  F14_TP_post2012 LenSelex
 40  270  235  0  0  0  -3  0  0  0  0  0  0  0 # Size_DblN_peak_F14_TP_post2012(14)
 -10  3  -5.06551  0  0  0  -3  0  0  0  0  0  0  0 # Size_DblN_top_logit_F14_TP_post2012(14)
 -5  12  7.76085  0  0  0  2  0  0  0  0  0  0  0 # Size_DblN_ascend_se_F14_TP_post2012(14)
 -5  15  5.67658  0  0  0  2  0  0  0  0  0  0  0 # Size_DblN_descend_se_F14_TP_post2012(14)
 -999  15  -999  0  0  0  -2  0  0  0  0  0  0  0 # Size_DblN_start_logit_F14_TP_post2012(14)
 -999  10  -999  0  0  0  -2  0  0  0  0  0  0  0 # Size_DblN_end_logit_F14_TP_post2012(14)
# 15  F15_TP_OTH LenSelex
 40  270  150.86  0  0  0  -3  0  0  0  0  0  0  0 # Size_DblN_peak_F15_TP_OTH(15)
 -10  3  -9.07897  0  0  0  -3  0  0  0  0  0  0  0 # Size_DblN_top_logit_F15_TP_OTH(15)
 -5  12  6.46401  0  0  0  2  0  0  0  0  0  0  0 # Size_DblN_ascend_se_F15_TP_OTH(15)
 -5  15  8.23539  0  0  0  2  0  0  0  0  0  0  0 # Size_DblN_descend_se_F15_TP_OTH(15)
 -999  15  -999  0  0  0  -2  0  0  0  0  0  0  0 # Size_DblN_start_logit_F15_TP_OTH(15)
 -999  10  -999  0  0  0  -2  0  0  0  0  0  0  0 # Size_DblN_end_logit_F15_TP_OTH(15)
# 16  F16_OTH LenSelex
# 17  S1_MOR_SPN_TP LenSelex
# 18  S2_MOR_POR_TP LenSelex
# 19  S3_SPN_BB1 LenSelex
# 20  S4_SPN_FRA_BB2 LenSelex
# 21  S5_JPN_LL_EAtlMed LenSelex
# 22  S6_JPN_LL1_NEA LenSelex
# 23  S7_JPN_LL2_NEA LenSelex
# 24  S8_WMED_LARV LenSelex
# 25  S9_FRA_AER1 LenSelex
# 26  S10_FRA_AER2 LenSelex
# 27  S11_WMED_GYPB_AER LenSelex
# 28  S12_WCMED_GYPB_AER LenSelex
# 29  S13_JPN_LL1_NEA_VAST LenSelex
# 30  S14_JPN_LL2_NEA_VAST LenSelex
# 1  F01_BB_BB_pre2006 AgeSelex
# 2  F02_BB_BB_post2007 AgeSelex
# 3  F03_LL_JPN_EATL_MED AgeSelex
# 4  F04_LL_JPN_NEATL_pre2009 AgeSelex
# 5  F05_LL_JPN_NEATL_post2010 AgeSelex
# 6  F06_LL_OTH AgeSelex
# 7  F07_PS_NOR AgeSelex
# 8  F08_PS_HRV AgeSelex
# 9  F09_PS_MED_pre2008 AgeSelex
# 10  F10_PS_MED_pre2008Q2 AgeSelex
# 11  F11_PS_MED_post2009 AgeSelex
# 12  F12_PS_OTH AgeSelex
# 13  F13_TP_pre2011 AgeSelex
# 14  F14_TP_post2012 AgeSelex
# 15  F15_TP_OTH AgeSelex
# 16  F16_OTH AgeSelex
# 17  S1_MOR_SPN_TP AgeSelex
# 18  S2_MOR_POR_TP AgeSelex
# 19  S3_SPN_BB1 AgeSelex
# 20  S4_SPN_FRA_BB2 AgeSelex
# 21  S5_JPN_LL_EAtlMed AgeSelex
# 22  S6_JPN_LL1_NEA AgeSelex
# 23  S7_JPN_LL2_NEA AgeSelex
# 24  S8_WMED_LARV AgeSelex
# 25  S9_FRA_AER1 AgeSelex
 1  25  2  2  99  0  -99  0  0  0  0  0  0  0 # minage@sel=1_S9_FRA_AER1(25)
 1  25  4  4  99  0  -99  0  0  0  0  0  0  0 # maxage@sel=1_S9_FRA_AER1(25)
```

```
# 26   S10_FRA_AER2 AgeSelex
   1   26   2   2   99   0   -99   0   0   0   0   0   0   0  #  minage@sel=1_S10_FRA_AER2(26)
   1   26   4   4   99   0   -99   0   0   0   0   0   0   0  #  maxage@sel=1_S10_FRA_AER2(26)
# 27   S11_WMED_GYPB_AER AgeSelex
# 28   S12_WCMED_GYPB_AER AgeSelex
# 29   S13_JPN_LL1_NEA_VAST AgeSelex
# 30   S14_JPN_LL2_NEA_VAST AgeSelex
#_No_Dirichlet parameters
#_no timevary selex parameters
#
0   #  use 2D_AR1 selectivity(0/1)
#_no 2D_AR1 selex offset used
#
# Tag loss and Tag reporting parameters go next
0  # TG_custom:  0=no read and autogen if tag data exist; 1=read
#_Cond -6 6 1 1 2 0.01 -4 0 0 0 0 0 0 0  #_placeholder if no parameters
#
# no timevary parameters
#
#
# Input variance adjustments factors:
 #_1=add_to_survey_CV
 #_2=add_to_discard_stddev
 #_3=add_to_bodywt_CV
 #_4=mult_by_lencomp_N
 #_5=mult_by_agecomp_N
 #_6=mult_by_size-at-age_N
 #_7=mult_by_generalized_sizecomp
#_Factor  Fleet  Value
    4    1   0.0001
    5    1     0.01
    4    2   0.0001
    5    2     0.01
    4    3   0.0001
    5    3     0.01
    4    4   0.0001
    5    4     0.01
    4    5   0.0001
    5    5     0.01
    4    6   0.0001
    5    6     0.01
    4    7   0.0001
    5    7     0.01
    4    8   0.0001
    5    8     0.01
    4    9   0.0001
    5    9     0.01
    4   10   0.0001
    5   10     0.01
    4   11   0.0001
    5   11     0.01
    4   12   0.0001
    5   12     0.01
    4   13   0.0001
    5   13     0.01
    4   14   0.0001
    5   14     0.01
    4   15   0.0001
    5   15     0.01
    4   16   0.0001
    5   16     0.01
    4   17   0.0001
    5   17     0.01
    4   18   0.0001
    5   18     0.01
    4   19   0.0001
    5   19     0.01
    4   20   0.0001
    5   20     0.01
    4   21   0.0001
    5   21     0.01
    4   22   0.0001
    5   22     0.01
    4   23   0.0001
    5   23     0.01
    4   24   0.0001
    5   24     0.01
    4   25   0.0001
    5   25     0.01
    4   26   0.0001
    5   26     0.01
    4   27   0.0001
```

```
   5    27     0.01
   4    28   0.0001
   5    28     0.01
   4    29   0.0001
   5    29     0.01
   4    30   0.0001
   5    30     0.01
 -9999   1    0  # terminator
#
4 #_maxlambdaphase
1 #_sd_offset; must be 1 if any growthCV, sigmaR, or survey extraSD is an estimated parameter
# read 50 changes to default Lambdas (default value is 1.0)
# Like_comp codes:  1=surv; 2=disc; 3=mnwt; 4=length; 5=age; 6=SizeFreq; 7=sizeage; 8=catch; 9=init_equ_catch;
# 10=recrdev; 11=parm_prior; 12=parm_dev; 13=CrashPen; 14=Morphcomp; 15=Tag-comp; 16=Tag-negbin; 17=F_ballpark; 18=initEQregime
#like_comp fleet  phase  value  sizefreq_method
 1 17 1 1 1
 1 18 1 1 1
 1 19 1 1 1
 1 20 1 1 1
 1 21 1 1 1
 1 22 1 1 1
 1 23 1 1 1
 1 24 1 1 1
 1 25 1 1 1
 1 26 1 1 1
 1 27 1 1 1
 1 28 1 0 1
 1 29 1 0 1
 1 30 1 0 1
 4 1 1 1 1
 5 1 1 1 1
 4 2 1 1 1
 5 2 1 1 1
 4 3 1 1 1
 5 3 1 1 1
 4 4 1 1 1
 5 4 1 1 1
 4 5 1 1 1
 5 5 1 1 1
 4 6 1 1 1
 5 6 1 1 1
 4 7 1 1 1
 5 7 1 1 1
 4 8 1 1 1
 5 8 1 1 1
 4 9 1 1 1
 5 9 1 1 1
 4 10 1 1 1
 5 10 1 1 1
 4 11 1 1 1
 5 11 1 1 1
 4 12 1 1 1
 5 12 1 1 1
 4 13 1 1 1
 5 13 1 1 1
 4 14 1 1 1
 5 14 1 1 1
 4 15 1 1 1
 5 15 1 1 1
 4 15 1 1 1
 5 15 1 1 1
 4 16 1 1 1
 5 16 1 1 1
 11 1 1 1 1
 12 1 1 1 1
-9999  1  1  1  1  #  terminator
0 # (0/1/2) read specs for more stddev reporting: 0 = skip, 1 = read specs for reporting stdev for selectivity, size, and numbers, 2 = add options for M,Dyn. Bzero, SmryBio
 # 0 2 0 0 # Selectivity: (1) fleet, (2) 1=len/2=age/3=both, (3) year, (4) N selex bins
 # 0 0 # Growth: (1) growth pattern, (2) growth ages
 # 0 0 0 # Numbers-at-age: (1) area(-1 for all), (2) year, (3) N ages
 # -1 # list of bin #'s for selex std (-1 in first bin to self-generate)
 # -1 # list of ages for growth std (-1 in first bin to self-generate)
 # -1 # list of ages for NatAge std (-1 in first bin to self-generate)
999
```

Annex 2

Runs performed during the 2022 E-BFT assessment meeting based on proposed base case (run 8) are outlined in **Table A2.1**. The key information for the evaluation of the performance of each run is presented in **Table A2.2**.

Table A2.1. Definition of the proposed base model and runs performed during the 2022 E-BFT assessment meeting.

Run	Definition	Description of changes
Run 8	Proposed Base Model	Based on Run 82 of EBFT assessment meeting in 2017: 1) Model runs from 1950-2020; 2) Updating information 2016-2020; 3) 16 fishing fleets 4) 11 abundance indices, including the new index GBYP - WMED; 4) All fleet selectivity models were redefined and assumption of logistic selectivity for Norwegian Purseines; 5) Linf fixed at 271 cm; K fixed at 0.233871; 6) M from age0 : 0.82, 0.41. 0.32, 0.26, 0.22, 0.19, 0.17, 0.15, 0.14, 0.13, 0.12, 0.12; age12-20: 0.11; age21-30: 0.1
Run 16	Natural mortality internally estimated	Based on Run 8: 1) Natural mortality is estimated by the model by Lorenzen's method and using Mage20=0.1 as reference age.
Run 16noCAAL	Impact of removing age information	Based on Run 16: 1) Conditional-at-length information excluded.
Run 17	Growth fixed using Ailloud et al. (2017) and no age information included	Based on Run 16: 1) Growth parameters fixed (Ailloud et al., 2017): Linf=271; K=0.22; Richards shape parameter=-0.11; 2) Conditional age-at-length (CAAL) excluded.
Run 18	Growth fixed using WBFT assessment 2021 and no age information included	Based on Run 16: 1) Growth parameters fixed using WBFT assessment 2021 parameters: Linf=284 cm; K=0.295175; Richards parameter=-0.993398; 2) CAAL excluded; 3) Improve selectivity parameters definition.
Run 18CAAL	Impact of including age information	Based on Run 18: 1) Including information of conditional age-at-length.
Run 19	Considering an offset for R0	Based on Run 18: 1) Include an offset for R0 with two periods : 1950-1985 / 1986-2020.
Run 20	Initial Fs estimated by the model	Based on Run 18: 1) initial Fs for fleets 13, 15 and 16 are estimated by the model.
Run 21	Recruitment deviations start in 1988	Based on Run 18: 1) Recruitment deviations estimates start in 1988.
Run 16 reweight	Base model	Based on Run 16: 1) Initial Fs are estimated by the model; 2) K is estimated by the model; 3) Selectivity parameters for some fleets were re-defined and priors included ; 4) Model was balanced (length composition reweighting) using Francis' method

Table A2.2. Likelihood components and other key information for the proposed base case and runs performed during the 2022 E-BFT assessment meeting.

	Run 8 (proposed base case)	Run 16	Run 16noCAAL	Run 17	Run 18	Run 18CAAL	Run 19	Run 20	Run 21	Run 16 reweight
Likelihood										
Total	1586	1590	201	183	1309	20387	1263	1295	1417	5387
Catch	5.62E-06	1.54E-05	2.83E-06	5.79E-02	6.30E-07	4.24E-06	7.13E-07	6.60E-07	1.04E-06	2.04E-04
Equil_catch	3.73	4.28	4.46	6.89	9.48	6.19	3.77	0.02	10.86	0.16
Survey	-7.44	-5.54	-11.16	-28.34	41.79	81.30	25.35	39.49	117.05	21.44
Length_comp	203.6	204.8	205.3	205.8	1251.3	1541.0	1247.4	1246.8	1274.0	1076.0
Age_comp	1377.2	1377.9	0.0	0.0	0.0	18724.4	0.0	0.0	0.0	4265.0
Recruitment	8.1	8.4	1.9	-1.1	6.6	33.7	-13.6	8.2	15.0	24.7
InitEQ_regime	1.26E-30	0.00E+00	1.40E-30	0.00E+00	0.00E+00	0.00E+00	2.94E-03	0.00E+00	0.00E+00	0.00E+00
Sum_recdevs	-10.82		-9.48		-7.22					
Forecast_Recruitment	0.000	0.000	0.000	0.000	0.001	0.001	0.001	0.000	0.017	0.194
Parm_priors	0.463	0.414	0.000	0.057	0.000	0.000	0.069	0.000	0.000	0.017
Parm_softbounds	0.017	0.017	0.000	0.036	0.029	0.000	0.003	0.029	0.029	0.005
Final gradient	7.95E-04	5.11E-04	8.54E-05	9.61E-05	8.63E-05	3.37E-04	9.81E-05	4.73E-05	2.12E-06	5.85E-05
Hessian inverted	Yes	Yes	Yes	Yes	Yes	Yes	Yes	n/a	n/a	Yes
Parameter estimated	139	139	77	136	159	86	162	162	124	156

Run 16

The run 16 uses the same model configuration than run 8 but natural mortality was internally estimated by the model using the Lorenzen's method. The natural mortality values estimated for ages 0 to 6 were lower than the assumed values in previous runs (**Figure A2.1).** Because the M vector calculated internally is in line with the updated growth parameters (Linf=271 cm and K=0.234), it was considered that the use of this new M vector is appropriate. Although the trends in SSB, F and recruitment are similar to the proposed base case ones, the recruitment estimates were higher through the whole time series (**Figure A2.2**). No relevant changes in the retrospective analysis were observed (**Figure A2.3).** On the other hand, the log (R0) was estimated at 8.0 (**Figure A2.4**) being a lower than the log(R0) estimated by run 8 (8.6). The lower Mage0 estimated could explain the higher values of the recruitment observed in run 16 respect to proposed base case (**Figure A2.5**).

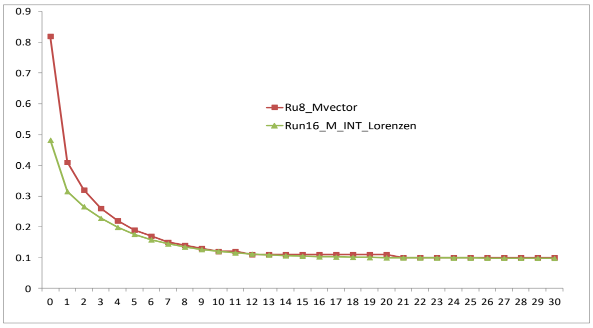


Figure A2.1. Natural mortality estimated by the model using Lorenzen's method (green line) and M vector used in run 8 (red line).

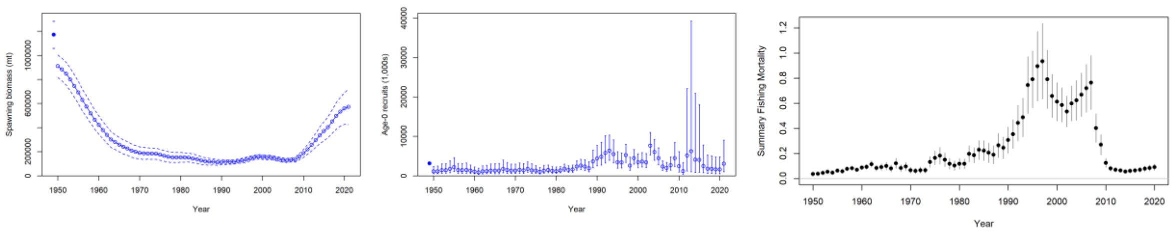


Figure A2.2. Run16. Summary statistics.

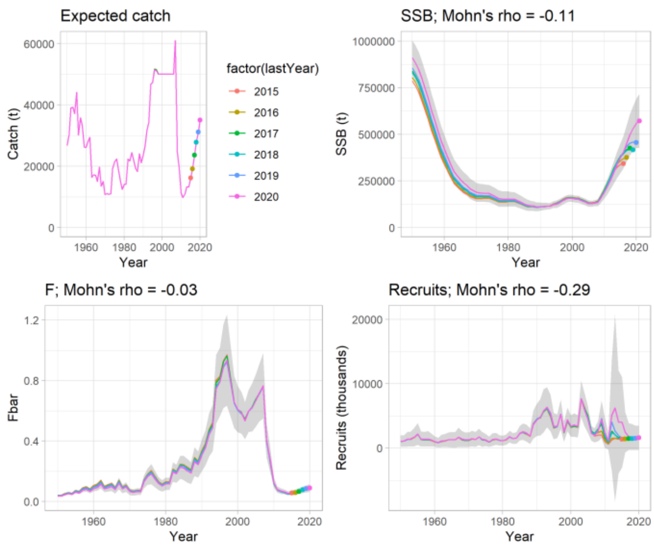


Figure A2.3. Run16. Retrospective Analysis.

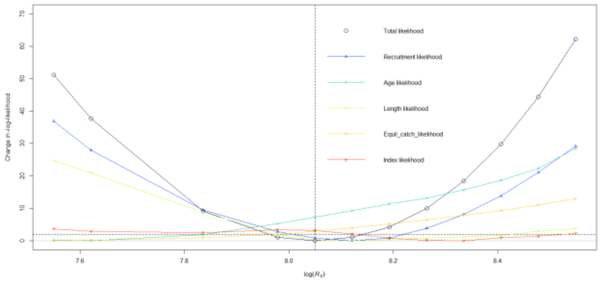


Figure A2.4. Run16. R0 profile.

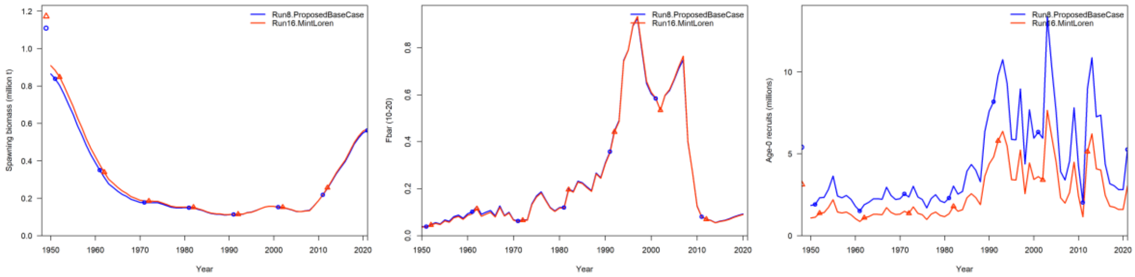


Figure A2.5. Comparison of results from proposed base case (run 8) and run 16.

Run16noCAAL

This run excluded the conditional age-at-length used in previous runs. The recruitment estimates reached extreme values in some years, as in 1992, and the uncertainty associated with recruitment estimates increases (**Figure A2.6**, **Figure A2.7**). It seems that the age information is contributing to a more precise calculation of recruitment.

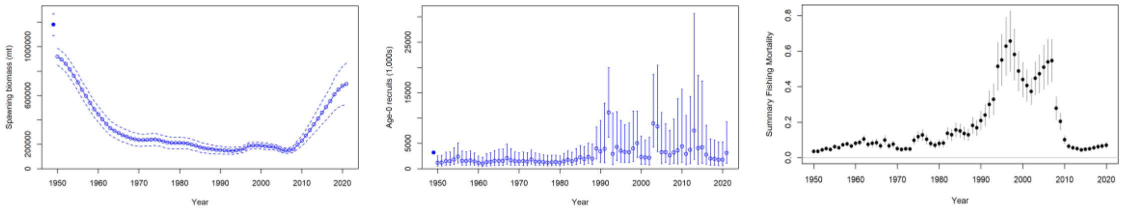


Figure A2.6. Run16noCAAL. Summary statistics.

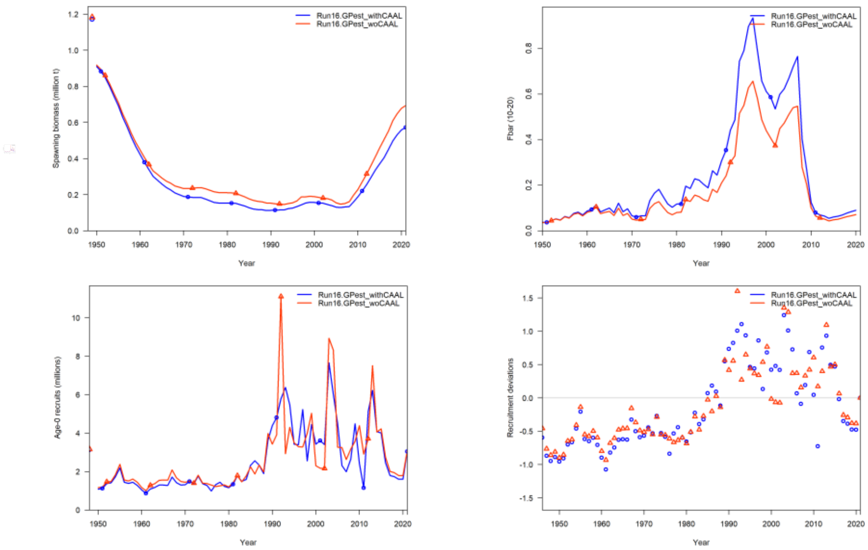


Figure A2.7. Comparison of results from run 16 and run 16noCAAL.

Run 17

This run fixes the three growth parameters to the values estimated by Ailloud *et al.* (2017) and excludes the age information from the model. The recruitment varied drastically from year to year and a very high uncertainty associated with recruitment estimates is observed (**Figure A2.8, Figure A2.9).** The SSB experienced a sharply increase since 2011 and F values were estimated at a low levels compared with Run 16. The R0 profile showed that the total minimum is driven by recruitment deviations and index information, but the length composition would indicate a greater value of log (R0) (**Figure A2.10**).

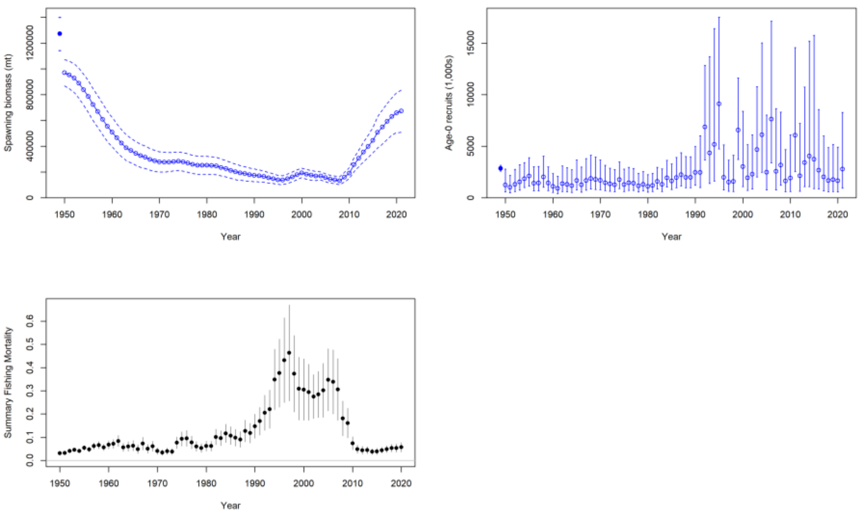


Figure A2.8. Run17. Summary statistics.

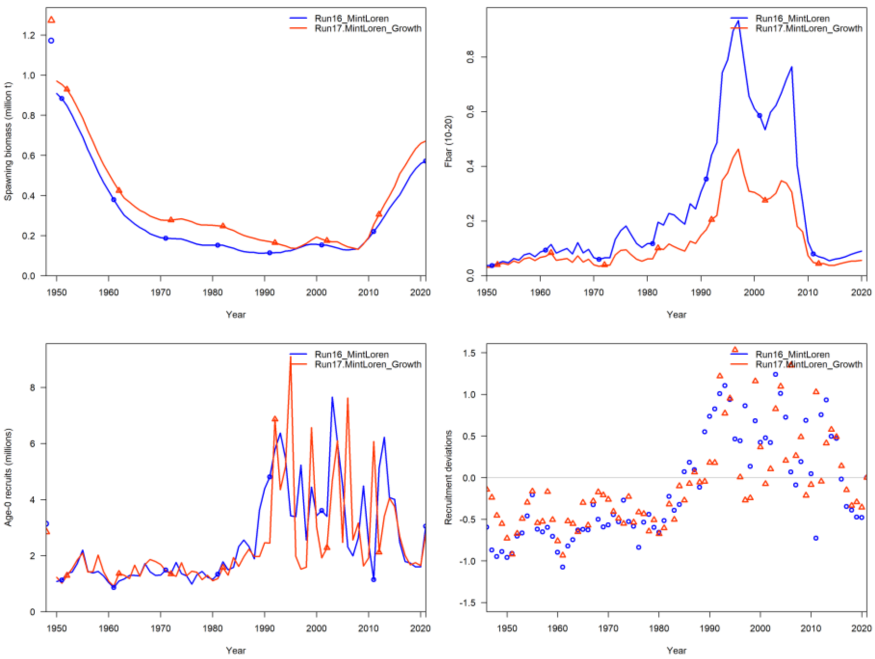


Figure A2.9. Comparison of results from Run 17 and Run 16.

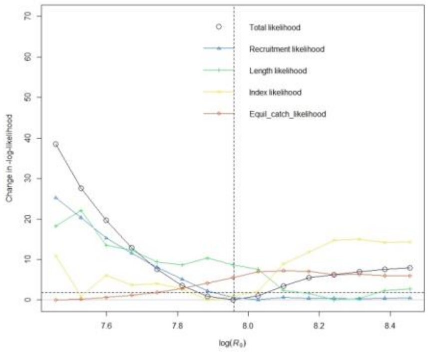


Figure A2.10. Run 17. R0 profile.

Run 18

This run fixes the growth parameters at the values estimated by 2021 W-BFT assessment and excludes the age information (CAAL) from the model. The higher likelihood of this run respect to previous runs is indicating a worse fit of the model to the indices and length composition data (**Table A2.2**). The recruitment is estimated with very high uncertainty and the values are higher compared with those calculated by run 16 (**Figure A2.11**, **Figure A2.12**). Compared with run16, fishing mortality showed low values for the period 1970-2010 and SSB higher estimates for the period 1970-2020.

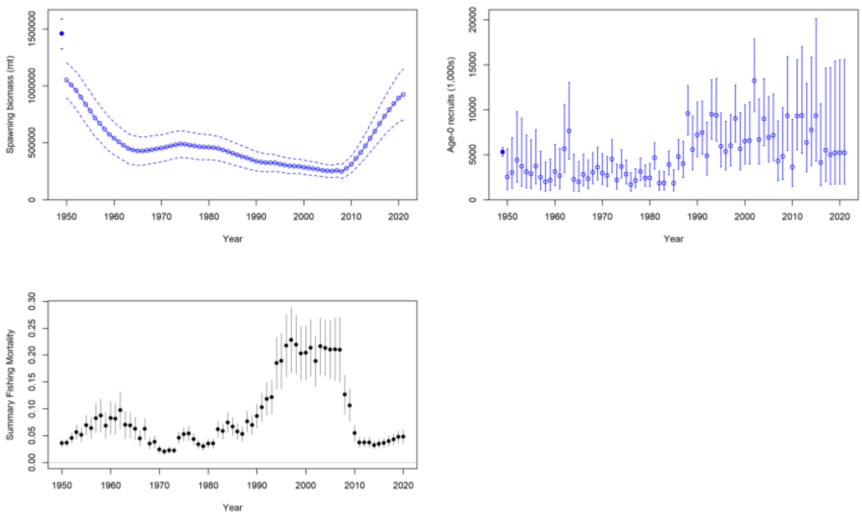


Figure A2.11. Run18. Summary statistics.

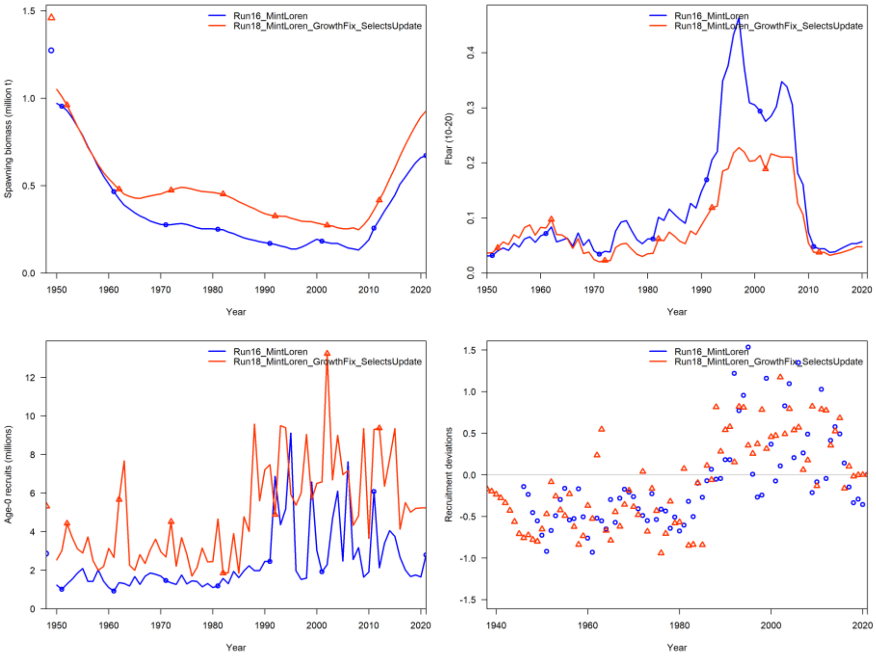


Figure A2.12. Comparison of results from Run 18 and Run 16.

Run18CAAL

This run is based on run 18 and includes the CAAL information. The high value of likelihood for age composition are pointing out to a poor fit of this run (**Table A2.2**).

Run 19

Based on run 18 an offset is included for R0 with two periods: 1950-1988 and 1989-2020. The non-random pattern of the recruitment deviations observed in all previous runs, has disappeared in this run (**Figure A2.13**). However, the biomass increase in recent years are extremely high and the recruitment estimates reached maximum values, above 10^^{6} individuals, the last ten years.

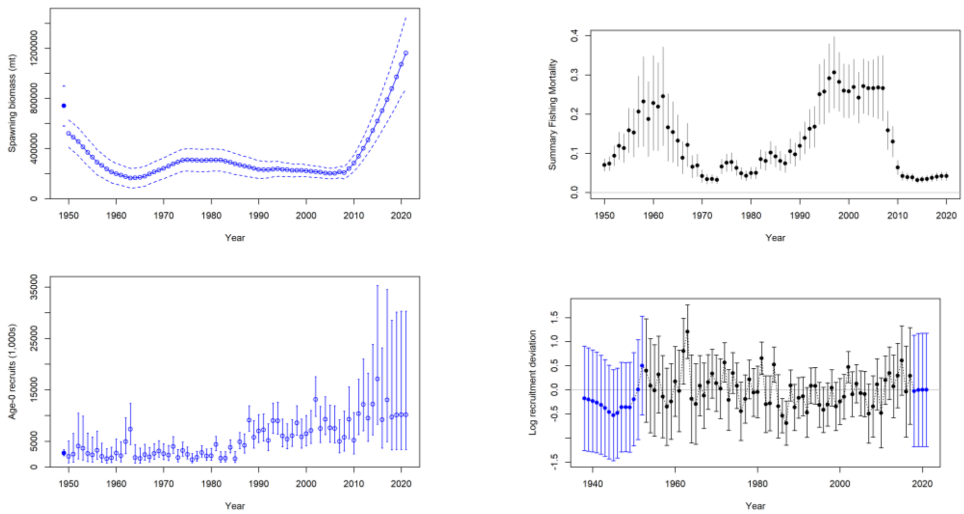


Figure A2.13. Run 19. Summary statistics and recruitment deviations (bottom-right).

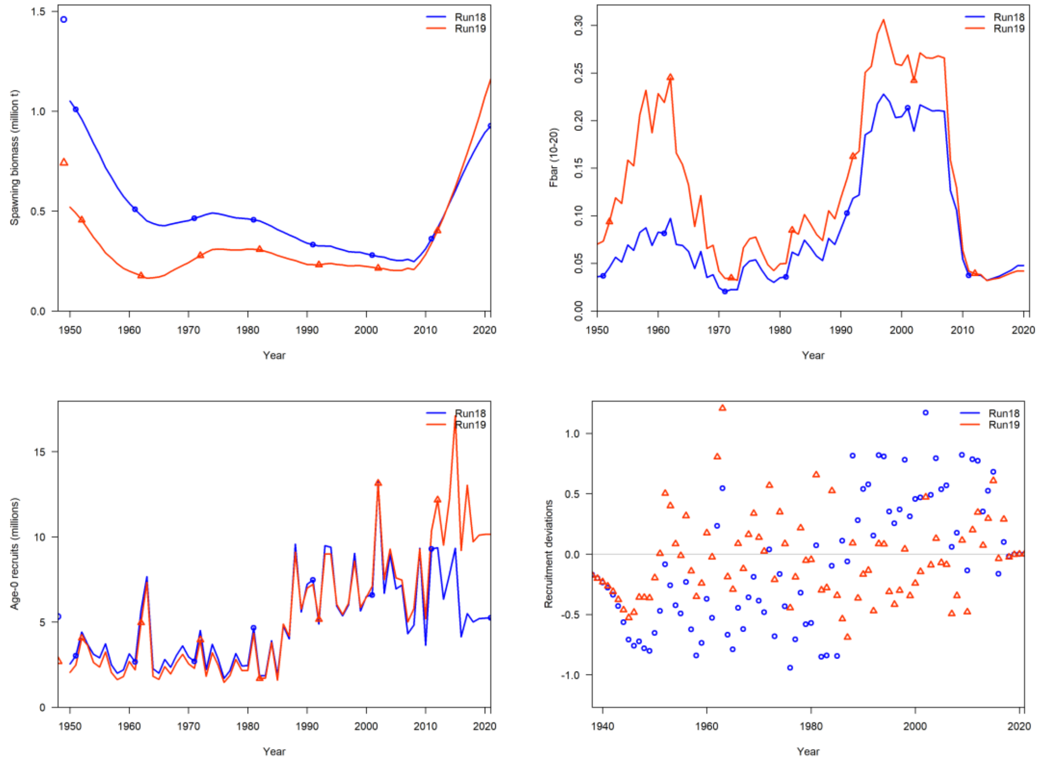


Figure A2.14. Comparison of results from Run 19 and Run 18.

Run 20

Based on run18, the initial Fs for Fleets 13, 15 and 16 are estimated by the model. When the model is allowed to estimate initial Fs, the SSB and recruitment estimates in recent years are slightly higher (**Figure A2.15**).

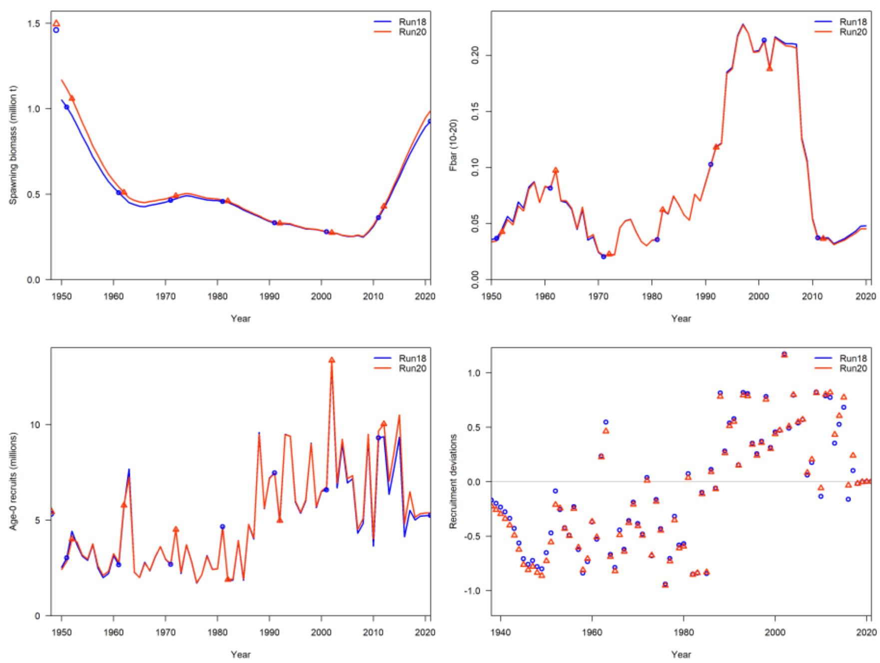


Figure A2.15. Comparison of results from run 20 and run 18.

Run 21

Based on run18, main recruitments are estimated since 1988 instead of 1962. This change caused a huge impact on SSB and F. SSB estimates are higher and the opposite effect is observed for F (**Figure A2.16**). Besides, since 2011 the recruitment trends and estimates are fully changed.

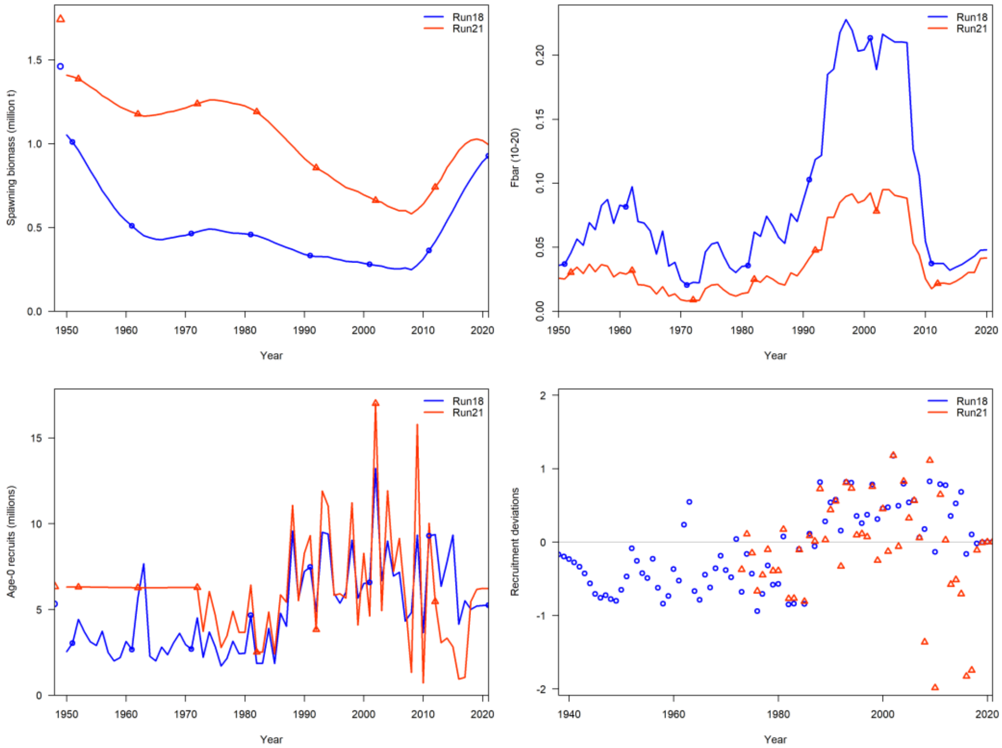


Figure A2.16. Comparison of results from run 21 and run 18.

Run 16 reweight

Based on run 16, the model 16 reweight estimates internally the initial Fs and the growth parameter K. The definition of the selectivity parameters was improved and a reweighting process was applied to length composition. This model was considered as base case by the assessment meeting to provide the stock status of E-BFT. Due to the significant retrospective pattern of the recruitment and the uncertainty on recruitment estimates in recent years, the projections were not considered.

The SSB shows a decline trend from 1950 to 1990 then a slight increase is observed for the period 1990-2010 and in the last ten years the biomass showed a sharp increase (**Figure A2.17)**. The fishing mortality, represented here as Fbar over ages 10 to 20, was low (< 0.2) until 1980, then increased until a maximum of 1 recorded in 1996and 1997. F remained at high levels until 2007 and the last ten years the estimates were less than 0.11. The recruitment showed a first period, from 1950 to 1989, of regular low levels. The recruitment was estimated above $6x10^{\wedge 6}$ individuals in years 1990, 1994, 1999 and 2003. However, the recruitment estimates showed a very high level of uncertainty in the most recent estimates.

SSB and F show a moderate to low retrospective pattern, with acceptable Mohn's rho values **(Figure A2.18**). On the other hand, there is a high retrospective pattern in the recruitment that is evident since 2008. The recruitment estimates are revised up with the adding of a new year of data.

The R0 profile indicates that there is a conflict between different source of information. The R0 estimate is driven by the equilibrium catch but length composition and indices information likelihood is minimum at high values of R0 (**Figure A2.19)**.

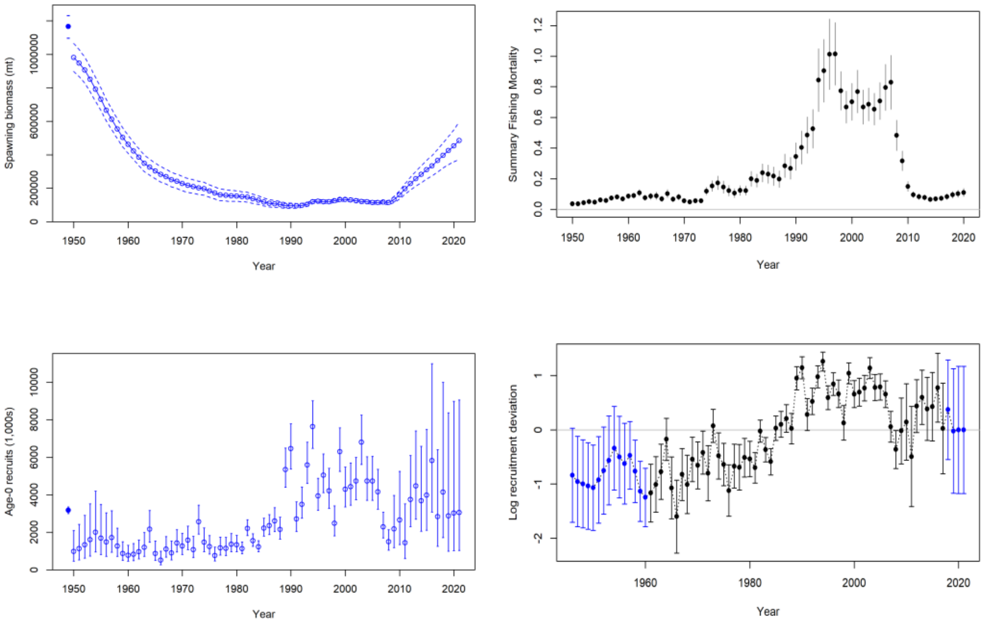


Figure A2.17. Run 16 reweight. Summary statistics and recruitment deviations (bottom-right).

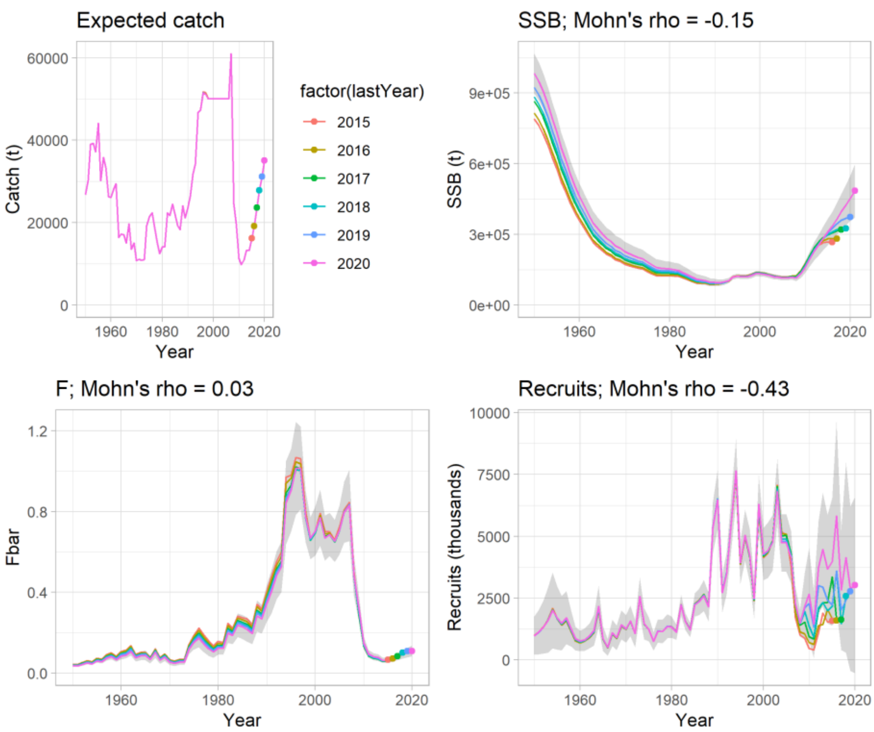


Figure A2.18. Run 16 reweight. Retrospective analysis.

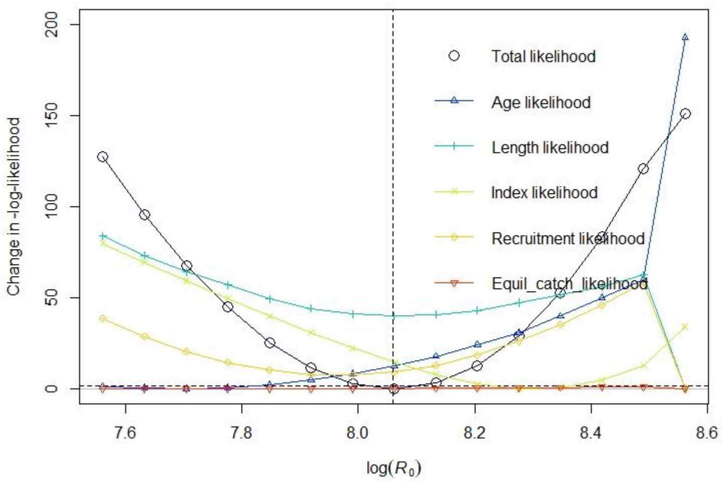


Figure A2.19. Run 16 reweight. R0 profile.