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# PRELIMINARY 2017 STOCK ASSESSMENT RESULTS FOR THE EASTERN AND MEDITERRANEAN ATLANTIC BLUEFIN TUNA STOCK

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*SUMMARY*

*Compared to 2014, the present assessment differs on several respects. During the 2017 data preparatory meetings, number of changes have been presented, among which the revision of the task I and task II statistics, the selection of the indices of abundance. In particular, this led to completely revisit the catch at age matrix. As a consequence, previous model specifications could not be used anymore. Whereas the 2014 assessment updated the catch and abundance index data up to 2013 and used the same model specifications as in the 2012 stock assessment, the present assessment present a complete revisitation of these. VPA2-Box was used to estimate the stock status, using a broad spectrum of settings. The resulting models were tested and compared on the basis of their diagnostics, so that the best models could be identified. In particular, different scenarios for Fratio, variance scaling for indices, recruitment constraints and vulnerability were tested. This document will serve as a basis for the 2017 EBFT stock assessment.*

*RÉSUMÉ*

*Par rapport à 2014, la présente évaluation diffère à plusieurs égards. Pendant les réunions de préparation des données de 2017, plusieurs modifications ont été présentées, parmi lesquelles la révision des statistiques de la tâche I et tâche II, ainsi que la sélection des indices d'abondance. En particulier, cela a conduit à revoir complètement la matrice de prise par âge. En conséquence, les spécifications antérieures du modèle ne pouvaient plus être utilisées. Alors que l'évaluation de 2014 mettait à jour les données de l'indice d'abondance et de capture jusqu'en 2013 et utilisait les mêmes spécifications du modèle que celles de l'évaluation du stock de 2012, la présente évaluation en fournit un remaniement complet. VPA2-Box a été utilisé pour estimer l'état du stock, à l'aide d'un large éventail de paramètres. Les modèles résultants ont été testés et comparés sur la base de leurs diagnostics, afin que les meilleurs modèles puissent être identifiés. On a testé en particulier différents scénarios de Fratio, la mise à l'échelle de la variance pour les indices, les contraintes du recrutement et la vulnérabilité. Ce document servira de base pour l'évaluation du stock de thon rouge de l'Est de 2017.*

*RESUMEN*

*En comparación con 2014, la presente evaluación difiere en varios aspectos. Durante la reunión de preparación de datos de 2017, se presentaron varios cambios, entre ellos la revisión de las estadísticas de Tarea I y Tarea II y la selección de los índices de abundancia. En particular, esto condujo a reexaminar completamente la matriz de captura por edad. Como consecuencia, las especificaciones previas del modelo ya no pudieron utilizarse. Mientras que la evaluación de 2014 actualizaba los datos del índice de abundancia y de captura hasta 2013 y utilizaba las mismas especificaciones del modelo que en la evaluación de stock de 2012, la evaluación actual presenta una completa revisión de ellas. Se utilizó el VPA2-Box para estimar el estado del stock, utilizando una amplia gama de ajustes. Se probaron los modelos resultantes y se compararon*

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*basándose en sus diagnósticos, para poder identificar los mejores modelos. En particular, se probaron diferentes escenarios para Fratio, varianza escalada para los índices, restricción del reclutamiento y la vulnerabilidad. Este documento servirá como base para la evaluación del stock de atún rojo del Atlántico este de 2017.*

*KEYWORDS*

*Atlantic bluefin tuna; stock assessment*

## 1. Introduction

The update assessment of the East and Mediterranean stock of Atlantic bluefin Tuna (EBFT) stock has been performed during an intersessional meeting in July 2017. This update builds upon decisions made during the 2017 data preparatory meeting held in March 6-11 2017 in Madrid. It includes updated and revisited catch data, which were obtained from a revision of task I and task II statistics. As proposed during the data preparatory meeting, a suite of different specifications have been investigated to test the sensitivity of the VPA to different technical assumptions and the choice of the CPUE series so that a broad spectrum of models could be compared and model selection made on the most objective basis.

In 2014, Run 1 was used to assess the impact of each change in data (catch-at-age, weight-at-age, partial catch-at-age, and CPUEs). Other runs were then set-up to test effects of splitting some indices, leaving out several years for some indices, different age plus and different Fratios scenarios etc... In the present assessment, due to the amount of changes in the original data, such gradual changes could not be made. For instance, as the catch at age matrix was completely new following the update of the task I and task II statistics and the decision to start the VPA in 1968, technical assumptions such as the Fratio scenarios used in the past could not be used anymore and had to be re-investigated. In addition, the indices of abundance used in the past were also changed and their relative weighting in the VPA was also investigated.

Investigating such a broad spectrum of technical settings led to the definition of a large number of runs, which could not be handled by simply looking at results. A model selection approach was then used to eliminate unrealistic runs or runs plagued with bad retrospectives. A reduced set of models was then identified by model classification based on the Akaike Information Criterion. For this set, the diagnostics were closely investigated and compared (Walter 2017). Several sensitivity runs were performed to compare their performance and choose the most appropriate best case model. In order to focus on model structure and performance, no status determination or projections are presented here.

## 2. Materials and method

### *2.1 Data inputs*

#### *2.1.1 Catch at age*

The updated catch-at-size takes into account only the new/revised series submitted before the deadline of June 13$^{th}$ 2016 (Annex 1). The substitution rules used for the 2017 assessment can be found in Anon. (in press b) One important aspect is that compared to 2014, the inflated catch were chosen as a base case, as it was well known that the catch were under-reported (Anon. (in press a)). The age structure of the 2014 catch-at-age and the updated one displayed some important differences (**Figure 1**). In the 2014 assessment a very large number of age 1 fish was found in 2000 compared to the other years. However, after the revision of task I and task II statistics, particularly the size structure of purse-seine catches (Gordoa *et al.* 2017), the new data did not display such a feature (**Figure 2**). Comparing the catch for the different ages over time displayed main differences for ages 2 and 3, for which less individuals were attributed in the 2017 data (**Figure 1**). Overall, the 2017 catch at age matrix displayed less individuals for the younger ages (1-4) from 1968 up to 2007 and for older ages from 2007 onwards (**Figure 2**).

*2.1.2 Catch per unit of effort and indices*

Very important changes were made in the CPUE indices that were used. During the data preparatory meeting, a new set of indices was decided. Nine indices were included in the 2017 assessment: the French Aerial survey, the Japanese longline operating in the North of 40 degrees (splitted in 2009/2010), the Japanese longline that operated in the south of 40 degrees, the Japanese longline that operated in the Mediterranean, the Moroccan and Portuguese traps, the Moroccan and Spanish traps, the Spanish baitboats in the Bay of Biscay (historical period), the Spanish and French baitboats in the Bay of Biscay (recent period) and the Western Mediterranean Larval index (Annex 2). The Moroccan and Portuguese trap, French aerial survey, and Western Med larval index were not used in the 2014 assessment (**Figure 3**). Details about the discussion on their selection and their construction can be found in the report of the 2017 data preparatory meeting.

*2.1.3 Weight at age*

In the 2014 assessment, the weight at age (WAA) was computed as the total yield at age divided by numbers at age. In the present assessment, this method was employed to compute the WAA for the indices of abundance. However, for the spawning stock biomass (SSB) it also makes sense to use the growth curve as the catches might not be representative of the spawning stock biomass. As it was no strong rational basis to favour one approach instead of the other and since the assessment results were likely to be sensitive to this assumption, the weight at age were thus computed following two methods.

Method 1 used the growth curve approach. The growth curve (**Table 1**) was used to compute the weight at age for the first ages. The plus group was calculated as a weighted average of the weights of the older ages from the growth curve (Annex 3). The weighting used was obtained as the relative contribution to the catch of each age in the plus group. The weighting was necessary as equal weights attributed to all the ages in the plus group, led to very high weight at age for the plus group as for instance 29 year-old fish were attributed the same importance as 12 year-old fish. Method 2 was similar to the 2014 method; the WAA was computed as the aggregated total yield at age divided by the catch numbers at age (Annex 3).

The weight at age obtained from both methods were substantially different from each other, but also from the weight at age used in 2014 (**Figure 4**). The WAA obtained by method 1 provided larger estimates for all ages compared to 2014 and to method 2, particularly for age 3 to 9. On the contrary, method 2 provided lower weights for ages 4 to 10 plus compared to the 2014 weight at age. Similar results could be obtained when using 16 plus age group.

*2.1.4 Partial catch at age*

As the indices were not simply updated and substantially changed from the 2014 assessment, a direct comparison between the PCAA used for both assessments was not possible (**Figure 5**, **Figure 6** and Annex 4).

***2.2 Model and hypotheses***

*2.2.1 R and the VPA*

The model used was VPA-2Box (Porch 1998). The model was run from a suite of R codes allowing for launching a large number of runs. This allowed to use parallel computing to perform model selection on a large range of models and to analyze the sensitivity to different specifications.

*2.2.2 Base case hypotheses*

The base case hypotheses were decided during the data preparatory meeting (ICCAT 2017) are summarized in the following table (**Table 1**). The natural mortality was changed compared to 2014, as was the maturity schedule.

*2.2.3 Sensitivity runs*

Other or previous parameter values were used to run sensitivity runs. These different values are summarized in the following table (**Table 2**).

*2.2.4 VPA specifications*

As the VPA is known to be very sensitive to the Fratio and technical parameters (Bonhommeau *et al.* 2015) and knowing that a large part of the input data was updated since the last assessment (ICCAT 2017), it was chosen to test a large spectrum of specifications. As there was only little *a priori* rules on how to set the VPA in such a context, this approach aimed at identifying models that could provide stable results.

The technical parameters investigated were:

- Fratio scenarios
- The number of years for recruitment penalty
- The number of years for vulnerability penalty
- The strength of the vulnerability penalty
- The variance scaling for indices

The Fratio is known to have a substantial effect on the VPA results, 20 scenarios were then set-up to investigate various possibilities (**Table 3**). All the random walk scenarios presented used type 3 estimate, as in a random deviation from the previous constant parameter. The number of years for recruitment penalty controls the departures of recruitment estimates between successive years. It was either set to 0,2 (as in 2014), or 8 years (Walter *et al.* 2017). The number of years for vulnerability penalty controls departures of vulnerabilities between consecutive years. It was either set to 0, 3 (as in 2014) or 8 years. The Strength of the vulnerability penalty allows to control the strength of the constraints for the vulnerability penalty. Values ranging from 0.1 to 0.5 were tested. The variance scaling allows to control the weighting allocated to each CPUE. In the 2014 assessment and before, all CPUEs and indices were attributed the same value. The present work also explored that possibility to group the fleets by gear/type so that different weights could be estimated for each of these groups. The groups of fleets were the two traps (Moroccan and Spanish, Moroccan and Portuguese), the three Japanese longline indices (East and Med, North of 40, South of 40), the two Spanish baitboat series (before and after 2007), the French aerial survey and the Western Mediterranean larval survey.

***2.3 Model selection/filtering***

As it was explained previously, the approach chosen led to produce a large amount of runs. In order to make sense of these a model selection approach was chosen to filter out the unsuitable models. For each of the two methods to produce the WAA, the runs were investigated separately. A first selection was made to filter out the models for which the median spawning stock biomass was unrealistically high (>500.000) and for which the variability across the SSB retrospective runs were the highest. To do so, the variability across SSB retrospectives was quantified as follows. The median SSB of each SSB retrospective was calculated and then the distance between the $25^{th}$ and $75^{th}$ quantiles of these values was computed. The median of the distribution of this variability was computed across all models. Only the models that displayed a variability below the median were kept. The models were then ordered by increasing AIC and the three best models were selected according to their ranking and their diagnostics. A best model for each method to compute the WAA was then selected by inspecting and comparing the three best models.

***2.4 Sensitivity analyses***

The two best models were then subjected to different sensitivity analyses. To investigate the stability of the models selected, the effect of removing each index (Jackknife for indices) and then the effect of successively removing each single point of each single index (Jackknife year for indices) were inspected. In addition, 100 different seed numbers were run for each model to investigate whether a global or local solution was found. Finally A 100 different random assumptions for the terminal F (random draws of values in a uniform distribution between 0.2 and 0.45) were tested to further investigate the stability of the solution.

## 3. Results

### *3.1 Selection of models for the weight at age method 1*

The SSB from all the different VPA settings were first visualised inspect the different trends obtained (**Figure 7**). The runs with the age plus group set at 16 seemed to produce more variable patterns depending on the Fratio scenario used. Some of the patterns obtained displayed very large changes in SSB over the time series. When the age plus group was set at 10, two main trends were obtained. These two trends were less variable than for the 16 plus, particularly in the historical period.

The filtering procedure preserved 49 models out of 480. These models did not seem to favour any particular set of settings except that not many models with age plus 16 were kept in the final set and they further displayed relatively higher AIC values (**Figure 8**). The models for which the Fratios were estimated by random walks seemed to display lower AIC values. The diagnostics for the runs with the best ranking were then inspected in order to select three best models. The retrospective patterns of the models were inspected and if no major issue could be found in the retrospective, then the model was kept.

The three selected models were all for age 10 plus and featured Fratios estimated by random walks (Table 4). However, the Fratio scenario used for the model 410 did not allow to estimate the Fratios for each year, but by 3 year time blocks (Table 4). For these three models, the variance scaling option was such that all CPUE indices were given the same weight. These three models all displayed the same general trends for the main variable of interest. They mainly differed by an offset in the SSB for Run 4690 and in the estimated F for the plus group (**Figure 9** and **Figure 10**). It has to be noted that the trend in recruitment for Run 4690 differed from the other runs in the recent years as it displayed a high recruitment in 2008. The general trend of the models displayed an increase in SSB until 1975, then a decrease until 2007 and finally a sharp increase until 2015. The same consistency across the selected models was observed when considering the estimated Fratios, which all displayed a similar trend, lower than 1 from 1980 to 1995 and increasing up to 2 until 2015 (**Figure 11**). It has to be noted that the fluctuations of the Fratio were comparable to those of the recruitment. The three models looked stable as the AIC values obtained for 100 seed numbers were found to be very close to each other (**Figure 12**).

### *3.2 Selection of models for the weight at age method 2*

The SSB from all the different VPA settings were first visualised inspect the different trends obtained (**Figure 13**). Similarly as for the weight at age method 1, the runs with the age plus group set at 16 seemed to produce more variable patterns depending on the Fratio scenario used. Some of the patterns obtained displayed very large changes in SSB over the time series. When the age plus group was set at 10, two main trends were obtained. These two trends were less variable than for the 16 plus, particularly in the historical period.

The filtering procedure preserved 92 models out of 480. As for the models using the method 1 for WAA, it did not appear that any particular set of settings were favoured (**Figure 14**). Not many models with age plus 16 were kept in the final set and they further displayed relatively higher AIC values. The models for which the Fratios were estimated by random walks seemed to displayed lower AIC values. The diagnostics for the runs with the best ranking in terms of AIC were then inspected in order to select the three best models. The retrospective patterns of the models were inspected and if no major issue could be found in the retrospective, then the model was kept.

The three selected models were all for age 10 plus and featured Fratios estimated by random walks (**Table 5**). All models 410 allowed to estimate the Fratios for each year using the Fratio scenario 20 (**Table 5**). For these three models, the variance scaling option was such that all CPUE indices were given the same weight. These three models all displayed the same general trends for the main variable of interest (**Figure 15** and **Figure 16**). The models displayed an increase in SSB until 1975, then a decrease until 2007 and finally a sharp increase until 2015. The same consistency across the selected models was observed when considering the estimated Fratios, which all displayed a similar trend, lower than 1 from 1980 to 1995 and increasing up to 2 until 2015 (**Figure 17**). The three models looked stable as the AIC values obtained for 100 seed numbers were found to be very close to each other (**Figure 18**).

### *3.3 Best model for each weight at age method*

The three models obtained for method 1 displayed very similar trends for each variable. The run 4690 displayed the lowest AIC, but it also displayed a sharper recruitment peak in 2008, which was not present for the other two models (**Figure 10**). In addition, run 4690 displayed larger departures from the two other models for the SSB and

Fplusgroup. The run 4688 was thus preferred as the best model for the weight at age method 1. The three models obtained for method 2 displayed very similar trends for each variable (**Figure 16**). The run 14562 displayed the lowest AIC and was kept as the best model for the weight at age method 2. The two runs displayed very similar fit to residuals (**Figure 19**). The variance estimated for each index of run 14562 did not show large differences between indices but generally less weight was attributed to the two surveys (French aerial and western Mediterranean larval), whereas more weight was given to the longliners (**Figure 20**). The reference points F01 and SSB01 were calculated for both models, which displayed higher values for F01 and SSB01 for run 4688 (Table 6).

### *3.4 Comparison to the 2014 assessment (Run 0)*

The two best models were then compared to the 2014 assessment (**Figure 21**). The three models displayed comparable general trends for most variables. However, the runs 14562 (WAA method 2) and 4688 (WAA method 1) displayed even closer trends for all variables excepted for SSB, for which the Run 14562 was closer to run 0 than to Run 4688. The most salient deviations for fishing mortality were observed on the historical part of the time series. For the recruitment estimates, the most important differences were found around the year 2000. This last aspect might be explained by the revision of the size structure, which previously included a large number of young fishes around that period. The fishing mortality estimated for the plus group displayed the same pattern for each model, but between 1994 and 2007, run 14562 was closer to run 0 than to run 4688. The Fratios estimated for runs 14562 and 4688 displayed very similar trends (**Figure 22**). The different periods with low/high Fratios were also found consistent with the value fixed for the 2014 assessment (**Figure 22**).

### *3.5 Jackknife analysis by the removal of each index*

The effect of each of the 9 indices used in the assessment were investigated by successively removing each of them and leaving the others (**Figure 23**). The results showed that the general features of the models were preserved. However, tor the SSB and the recruitment, the French aerial surveys seemed to affect the trend. Removing this survey was associated to less important SSB and recruitment in the recent years. The fishing mortality in the plus group seemed to be affected by the Moroccan and Spanish traps series, whose removal was associated to an increase in fishing mortality between 1994 and 2010.

### *3.6 Jackknife analysis by the removal of each point of each index*

The stability of models 14562 and 4688 was further inspected by removing each point of each index and leaving the rest. The analysis showed that the trends of each variable were generally preserved (**Figure 24**). The most important effects were found for the fishing mortality of the plus group between 1994 and 2007. During that period the fishing mortality displayed different offsets for each run, but the inter-annual fluctuations were very similar to the original run.

### *3.7 Sensitivity to terminal F*

The stability of the two best models were then further investigated by jittering the terminal F assumptions. To do so, 100 runs were produced with the same specifications than run 14562 and 4688, but with drawing random values for terminal F out of a uniform distribution between 0.2 and 0.45. The results did not display a very strong variability of the solution, which confirmed the relative stability of the two models (**Figure 25**).

### *3.8 Sensitivity to the catch at age matrix: using reported catch*

The sensitivity of the two best runs to the catch at age matrix was investigated by comparing the original runs to runs with the same specifications that used the reported catch (**Figure 26**). A substantial effect could be observed as the level of SSB and recruitment decreased for both runs. The fishing mortality for ages 2 to 5 displayed similar patterns, but the shape of the fishing mortality of the plus group time series substantially changed from 1994 to 2000.

### *3.9 Sensitivity to biological assumptions*

The sensitivity to different biological assumptions made (**Table 2**) were investigated for the two best runs by looking at the time series of the different variables for each combination (**Figure 27**). Changing the biological assumptions did not appear to affect the shape of the runs. However, they seemed to offset the SSB and shrink/expand the fishing mortality. As expected, a later maturity was associated with a decrease in the general level of the SSB, but it did not seem to affect the fishing mortality. As expected, a change in natural mortality seemed to affect the fishing mortality levels. For instance, a lower natural mortality for younger ages was associated to a higher fishing mortality of ages 2 to 5 and a lower natural mortality for older ages associated to a higher fishing mortality for the age plus group (e.g. mortality=1 and mortality=2) .

**References**

Anon. (in press a). Report of the 2017 ICCAT Bluefin Tuna Data Preparatory Meeting. ICCAT, Madrid, Spain 6-11 March, (2017). Document SCRS/2017/01. 60p.

Anon. (in press b). Report of the 2017 ICCAT Bluefin Tuna Stock Assessment Meeting. ICCAT, Madrid, Spain 20-28 July, (2017). Document SCRS/2017/10. 106p.

Bonhommeau, S., Kimoto. A., Fromentin, J.M., Kell, L., Arrizabalaga., H., Walter, J.F., Ortiz de Urbina, J., Zarrad, R., Kitakado, T., Takeuchi, Y., AbidN., Ortiz, M., Palma, C., Pallares, P. 2015. Update of the Eastern and Mediterranean Atlantic Bluefin Tuna Stock. ICCAT, Collect. Vol. Sci. Pap. ICCAT, 71(3):1366-1382.

Ortiz, M.(2017). Catch Curve Analysis. Document SCRS/2017/23 (withdrawn).

Porch, CE. 1998. Virtual population analyses of Atlantic bluefin tuna with alternative models of trans-Atlantic migration: 1970-1997. ICCAT Collect. Vol. Sci. Pap. 52(3): 1022–1045.

Gordoa, A., Rouyer, T., and Ortiz, M. (2017). Review and update of the French and Spanish purse seine size at catch for the Mediterranean bluefin tuna fisheries 1970 to 2010. SCRS/2017/171 (withdrawn).

Walter, J. (2017). Proposals for Atlantic Bluefin Tuna Stock Assessment Models for 2017. Document SCRS/2017/036 (withdrawn).

**Table 1.** Description of the different base case assumptions.

| Parameter | Description |
|---|---|
| Natural Mortality | Lorenzen (0.38,0.3,0.24,0.2,0.18,0.16,0.14,0.13,0.12,0.12) |
| Age plus | 10 or 16 |
| Maturity | 0,0,0.25,0.5,1,1,1,1,1,1 |
| Growth curve | Linf = 318.9, K = 0.093, t0 = -0.97 |
| Length Weight | a = 0.0000196, b = 3.0092 |

**Table 2.** Description of the different parameters used for sensitivity analysis.

| Parameter | Description |
|---|---|
| Natural Mortality | Lorenzen (0.33,0.25,0.19,0.15,0.13,0.11,0.09,0.08,0.07,0.07,0.06,0.06,0.06,0.05,0.05,0.05) |
| | 2014 assessment (0.49,0.24,0.24,0.24,0.24,0.2,0.17,0.15,0.125,0.1,0.1,0.1,0.1,0.1,0.1,0.1) |
| | New SBT (0.4,0.4,0.25,0.21,0.18,0.15,0.13,0.11,0.1,0.09,0.07,0.07,0.07,0.07,0.07,0.07) |
| | Gislason (1.07,0.59,0.40,0.30,0.24,0.2,0.17,0.15,0.14,0.12,0.11,0.11,0.10,0.10,0.10,0.09) |
| Maturity | Later maturing 0,0,0.15,0.30,0.45,0.60,0.75,0.90,1.00,1.00,1.00 |

**Table 3.** Description of the different parameters used for sensitivity analysis.

| Scenario | Description |
|---|---|
| 1 | Fratio fixed to one for the whole time period |
| 2 | Fratio fixed to the 50$^{th}$ percentile ( = 1.5) of catch-curve analysis |
| 3 | Fratio fixed to the 75$^{th}$ percentile ( = 2.3) of catch-curve analysis |
| 4 | Fratio fixed to a shape that approxiamted the catch-curve analysis (3). Increase from 1.2 to 1.6 in 1990, then decrease to 0.6 in 2015 |
| 5 | Fratio fixed to a shape that approxiamted the catch-curve analysis (3). Increase from 1.2 to 1.5 in 1980. Plateau to 1.5 for 20 years, then decrease to 0.6. |
| 6 | Fratio estimated as a random walk with 5 years time blocks. The first block is fixed to 1, the other blocks are estimated as random deviations from the previous block |
| 7 | Fratio estimated as a random walk with 10 years time blocks. The first block is fixed to 1, the other blocks are estimated as random deviations from the previous block |
| 8 | Fratio estimated as a random walk with 3 years time blocks. The first block is fixed to 1, the other blocks are estimated as random deviations from the previous block |
| 9 | Fratio estimated as a random walk with 10 years time blocks for the 40 first years and 3 years blocks for the last 8 years. The first block is fixed to 1, the other blocks are estimated as random deviations from the previous block |
| 10 | Fratio estimated as a random walk with 10 years time blocks for the 40 first years and 1 year blocks for the last 8 years. The first block is fixed to 1, the other blocks are estimated as random deviations from the previous block |
| 11 | Fratio fixed to 1 for the 40 first years and estimated as 3 years blocks for the last 8 years. |
| 12 | Fratio fixed to 1 for the 40 first years and estimated as 1 year blocks for the last 8 years. |
| 13 | Fratio estimated as a random walk with 5 years time blocks. The first block is estimated, the other blocks are estimated as random deviations from the previous block |
| 14 | Fratio estimated as a random walk with 10 years time blocks. The first block is estimated, the other blocks are estimated as random deviations from the previous block |
| 15 | Fratio estimated as a random walk with 3 years time blocks. The first block is estimated, the other blocks are estimated as random deviations from the previous block |
| 16 | Fratio estimated as a random walk with 10 years time blocks for the 40 first years and 3 years blocks for the last 8 years. The first block is estimated, the other blocks are estimated as random deviations from the previous block |
| 17 | Fratio estimated as a random walk with 10 years time blocks for the 40 first years and 1 year blocks for the last 8 years. The first block is estimated, the other blocks are estimated as random deviations from the previous block |
| 18 | Fratio estimated for the 40 first years and estimated as 3 years blocks for the last 8 years. |
| 19 | Fratio estimated for the 40 first years and estimated as 1 year blocks for the last 8 years. |
| 20 | Fratio fixed at 1 for the first year and estimated as 1 year blocks for the whole series. |

**Table 4.** Specifications for the 3 best models selected after investigating the diagnostics. The models were obtained with the weight at age computed with the method 1.

| Run | Fratio | Age plus | Penalty | SDpen | PenaltyR | VarScal | Mortality | Maturity | AIC | Obj Func |
|---|---|---|---|---|---|---|---|---|---|---|
| Run_4690 | 20 | 10 | 0 | 0.5 | 8 | 0 | 1 | 1 | 208.25 | -110.74 |
| Run_4688 | 20 | 10 | 3 | 0.5 | 2 | 0 | 1 | 1 | 219.03 | -105.35 |
| Run_410 | 8 | 10 | 3 | 0.4 | 0 | 0 | 1 | 1 | 221.61 | -72.06 |

**Table 5.** Specifications for the 3 best models selected after investigating the diagnostics. The models were obtained with the weight at age computed with the method 2.

| Run | Fratio | Age plus | Penalty | SDpen | PenaltyR | VarScal | Mortality | Maturity | AIC | Obj Func |
|---|---|---|---|---|---|---|---|---|---|---|
| Run_14562 | 20 | 10 | 3 | 0.4 | 0 | 1 | 1 | 1 | 198.53 | -119.60 |
| Run_14548 | 20 | 10 | 3 | 0.5 | 0 | 1 | 1 | 1 | 202.99 | -117.37 |
| Run_14540 | 20 | 10 | 3 | 0.5 | 2 | 0 | 1 | 1 | 219.23 | -105.25 |

**Table 6.** Reference points and associated uncertainty for the two best runs.

| **F01** | **10%** | **50%** | **90%** |
|---|---|---|---|
| Run_4688 | 0.09080 | 0.09702 | 0.10360 |
| Run_14562 | 0.08487 | 0.09038 | 0.09653 |
| **SSB01** | **10%** | **50%** | **90%** |
| Run_4688 | 1508000 | 1543000 | 1578000 |
| Run_14562 | 1219000 | 1237000 | 1254000 |

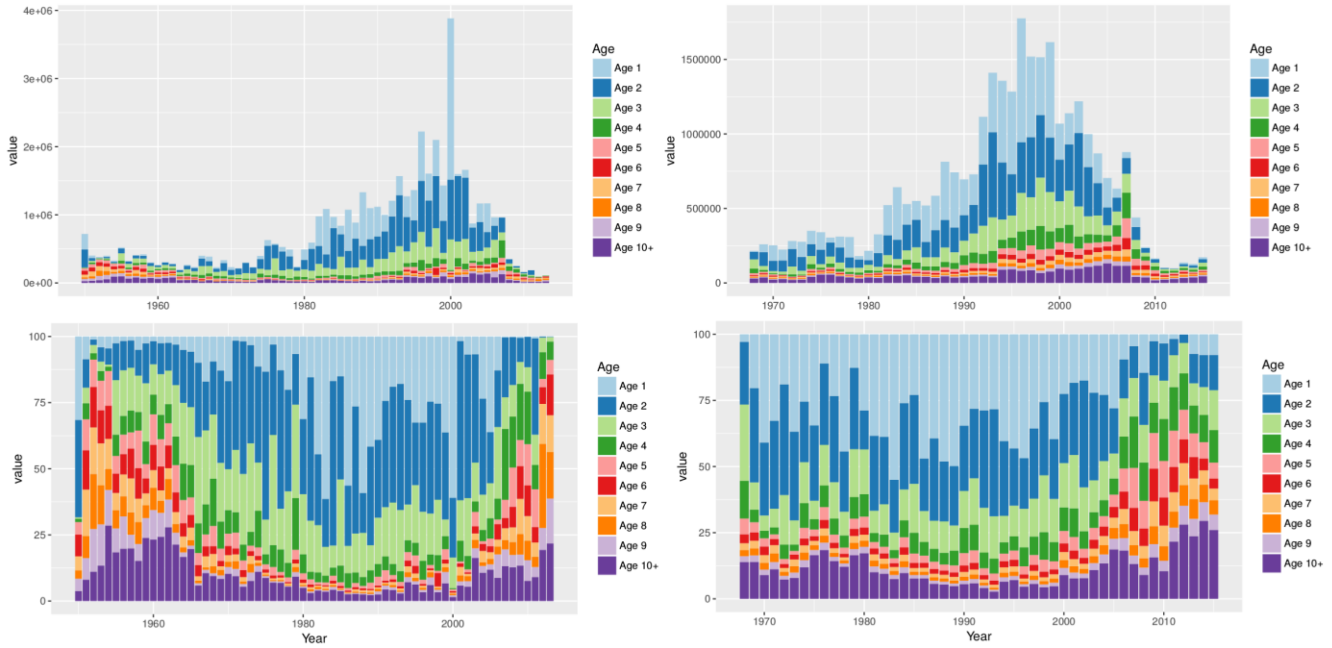


**Figure 1.** Main characteristics of the 2014 and updated (2017) catch-at-age. The top panel presents the age structure of the 2014 (left) and 2017 (right) catch-at-age in number. The bottom panel presents the age structure of the 2014 (left) and 2017 (right) in %.

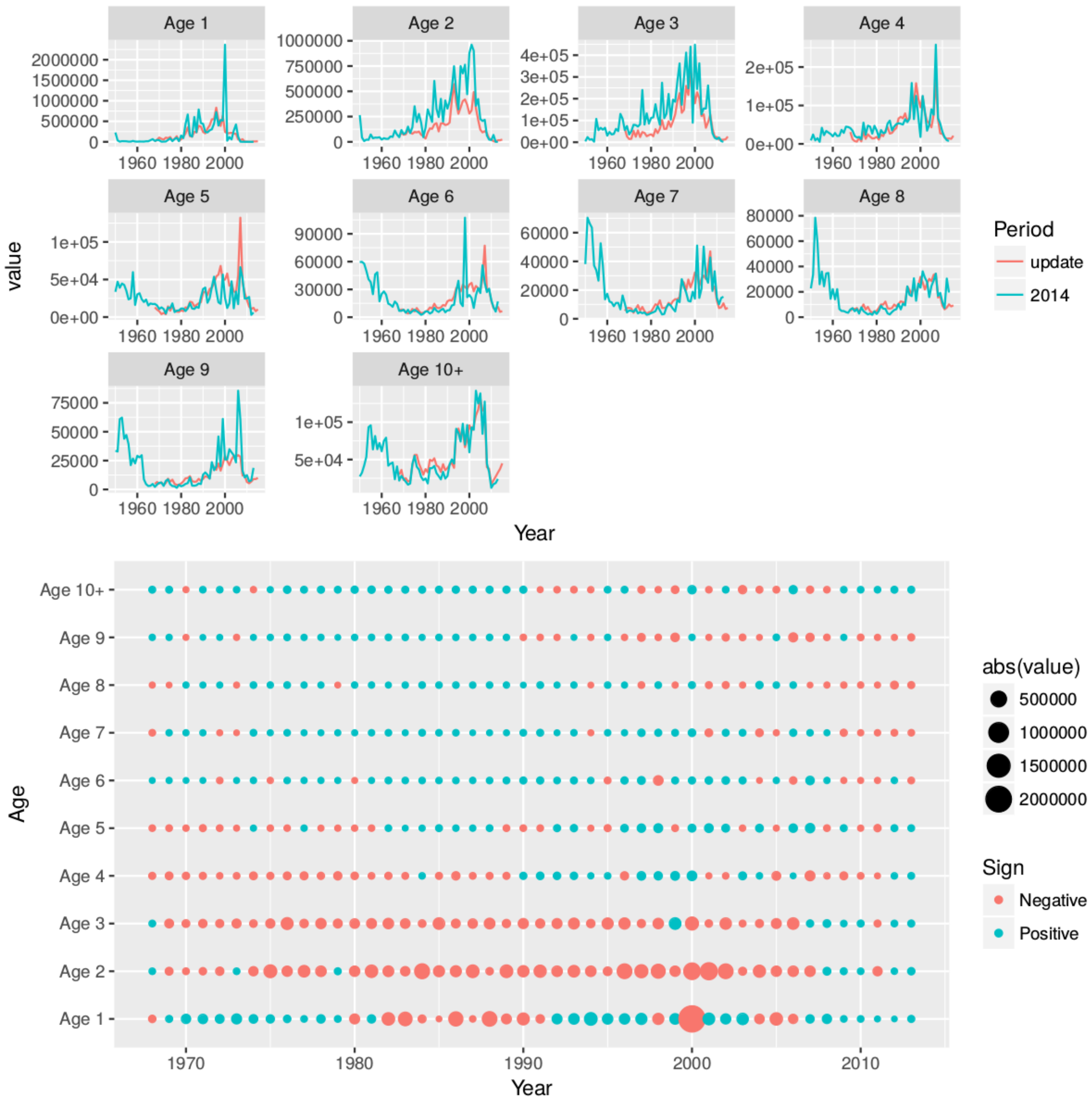


**Figure 2.** Comparison of the 2017 and the 2014 catch-at-age. The top panel presents the comparison for each age. The bottom panel presents the anomalies between both data over their common period.

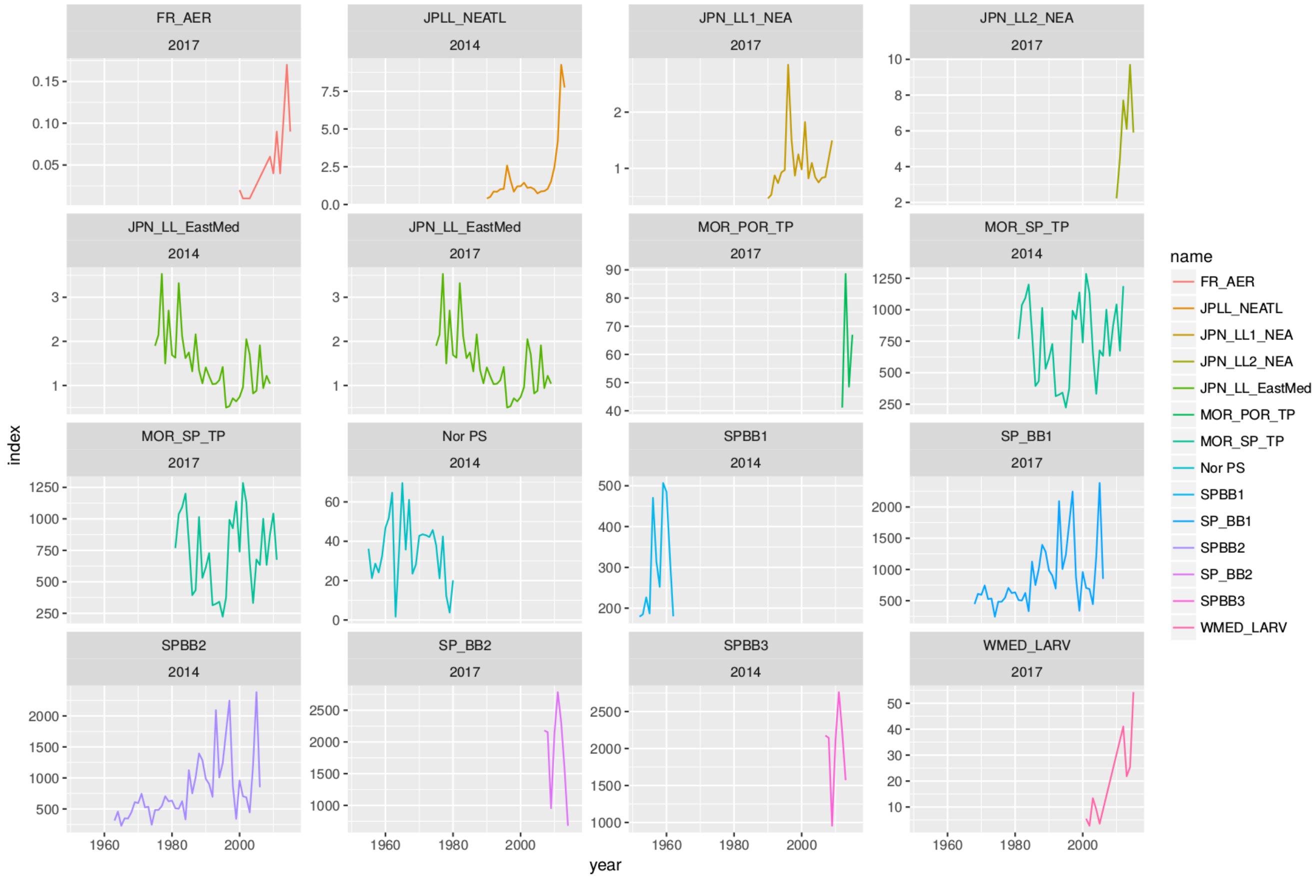


**Figure 3.** Comparison of the catch per unit of efforts (CPUEs) in the 2014 ABFT stock assessment and the CPUEs for the 2017 assessment.

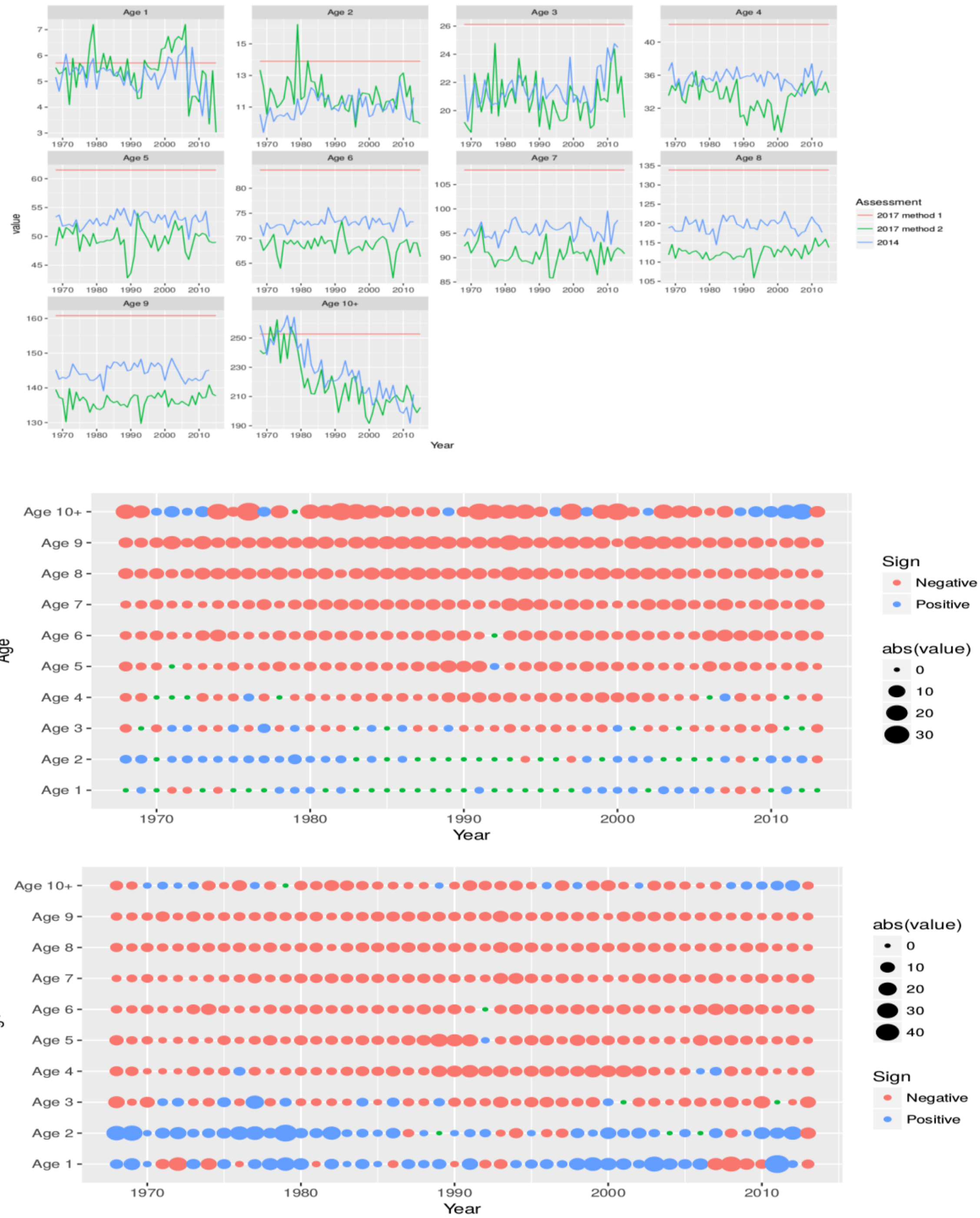


**Figure 4.** Weight ata age data. The top panel presents the comparison of the 2017 weight at age obtained by the 2 methods (growth curve and total yield divided by the catch numbers) for the 2017 and the 2014 weight at age data. The middle panel represents the anomalies in numbers between the 2014 and the 2017 weight-at-age obtained with method 2. The bottom panel represents anomalies in % between the 2014 and the 2017 weight-at-age obtained with method 2.

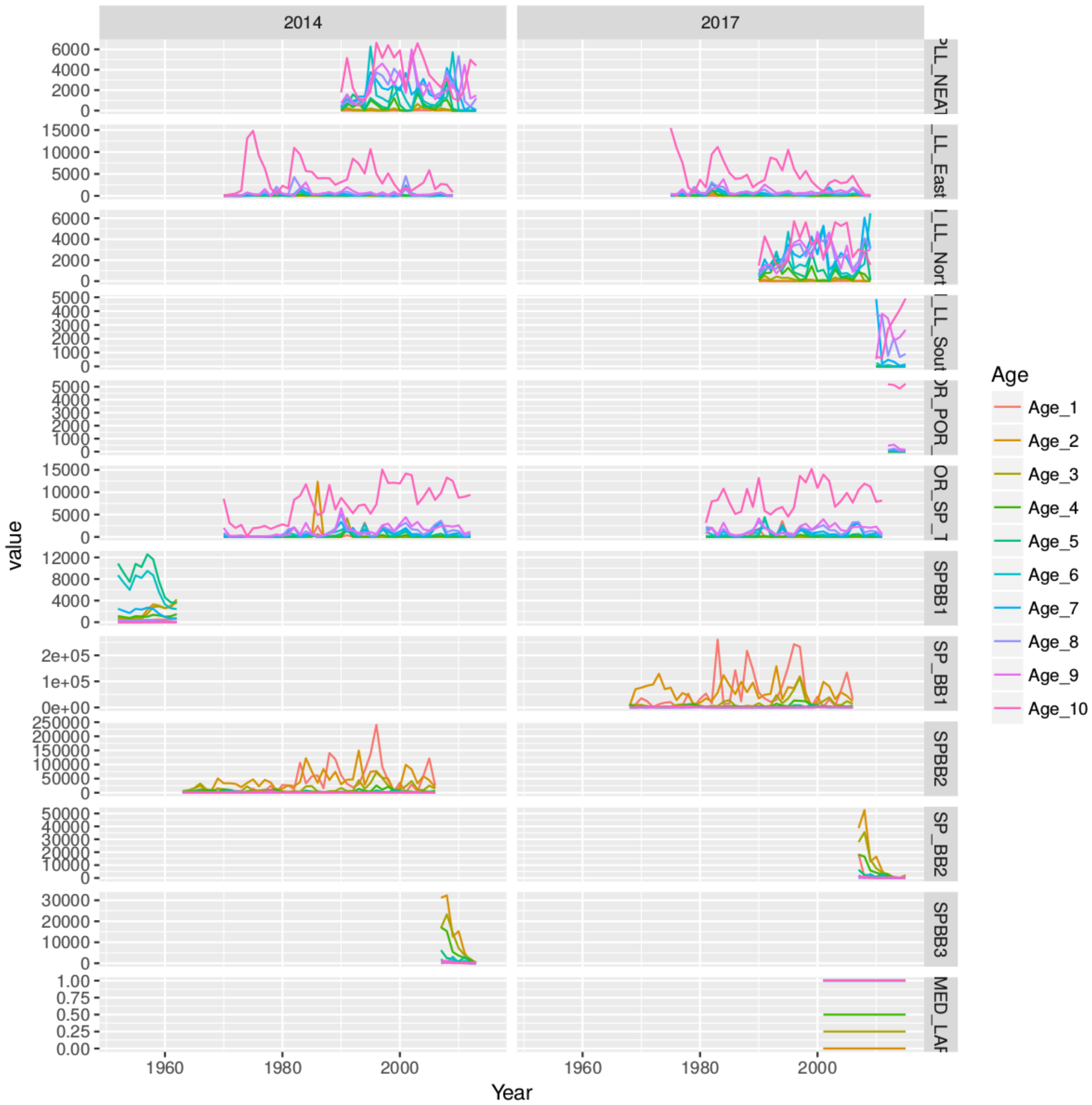


**Figure 5.** Partial catch-at-age for the 2014 (left) and 2017 (right) assessments.


**Figure 6.** Partial catch-at-age for the 2017 assessment for each fleet and age.

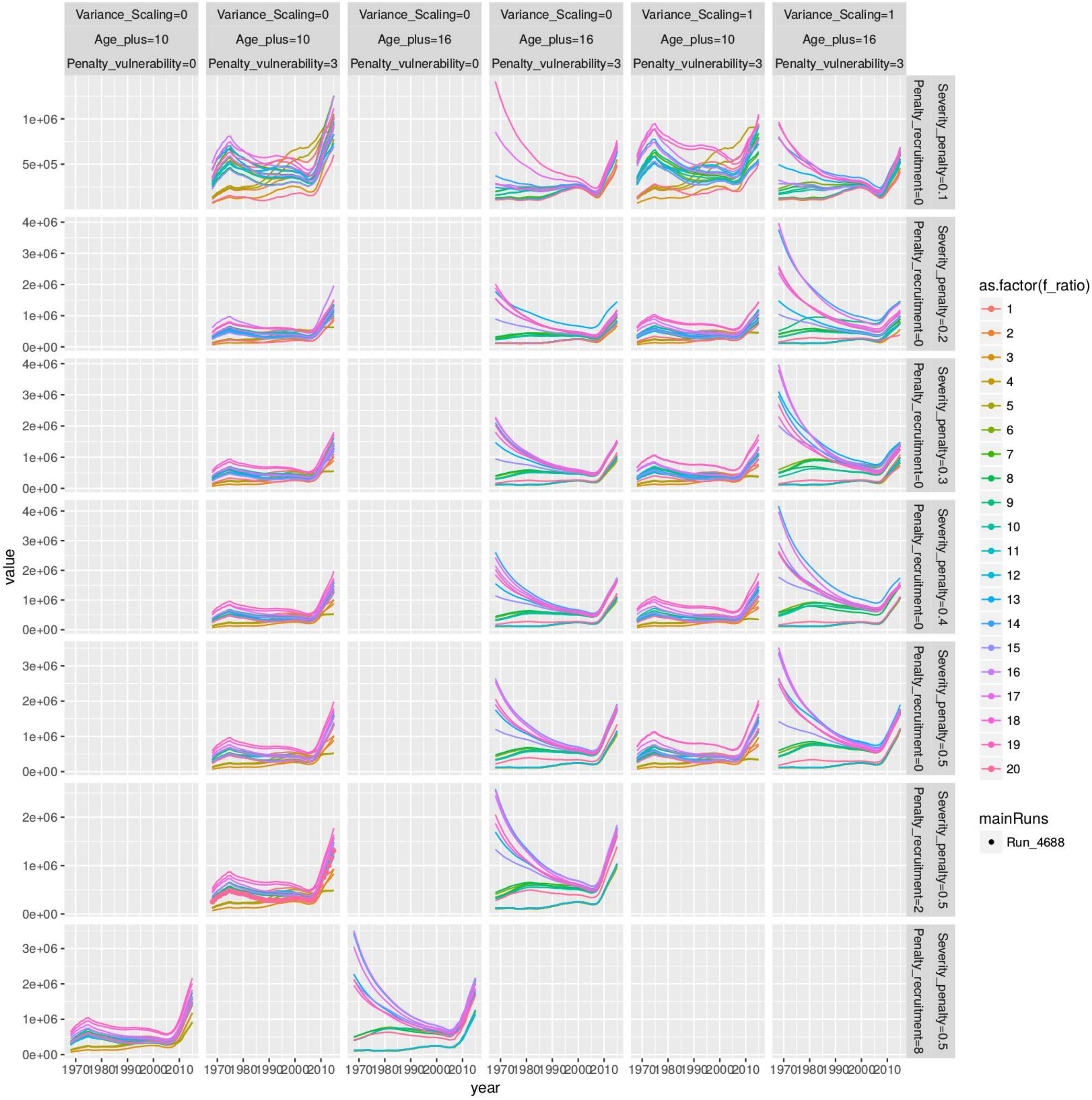


**Figure 7.** SSB obtained for the different settings using method 1 for the weight at age. The dotted line represents the best model for method 1.


**Figure 8.** Best models selected presented as a function of the different VPA settings and hypotheses using WAA method 1.

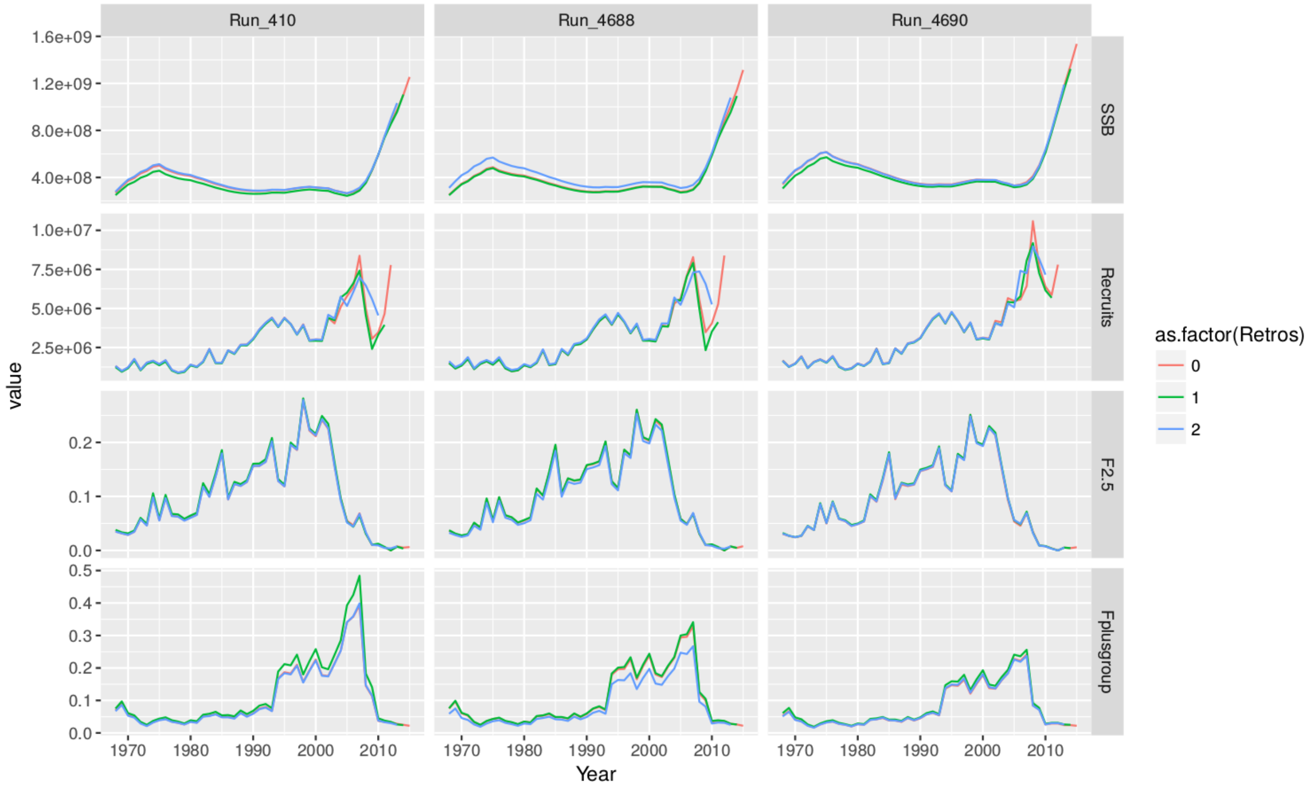


**Figure 9.** Retrospective patterns of the 3 best models selected, for WAA method 1.

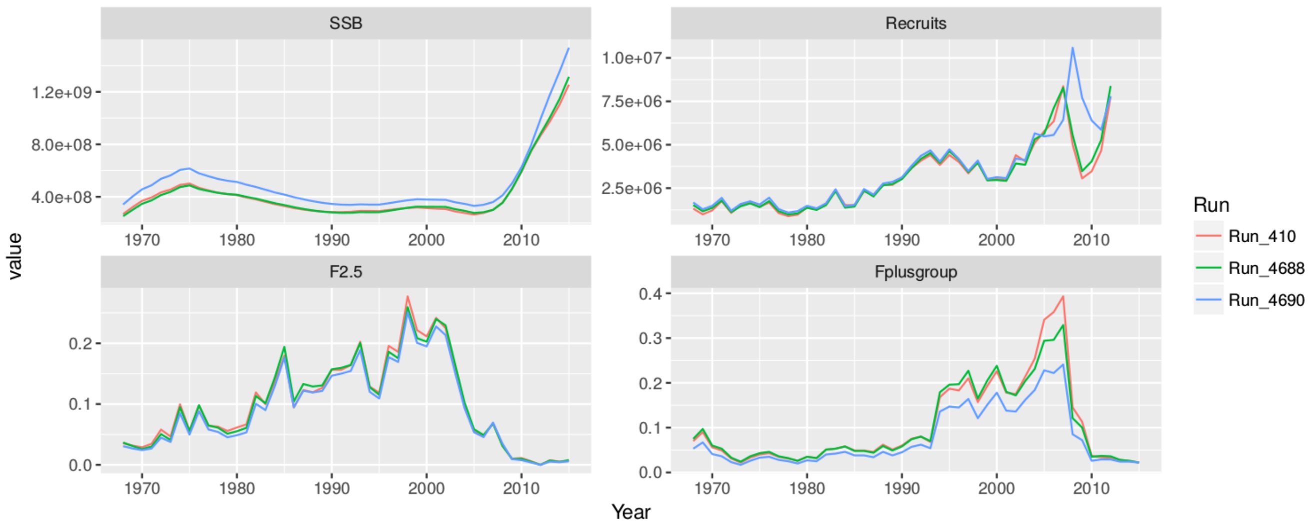


**Figure 10.** Time series of estimated variables of interest for the three best models obtained with WAA method 1.

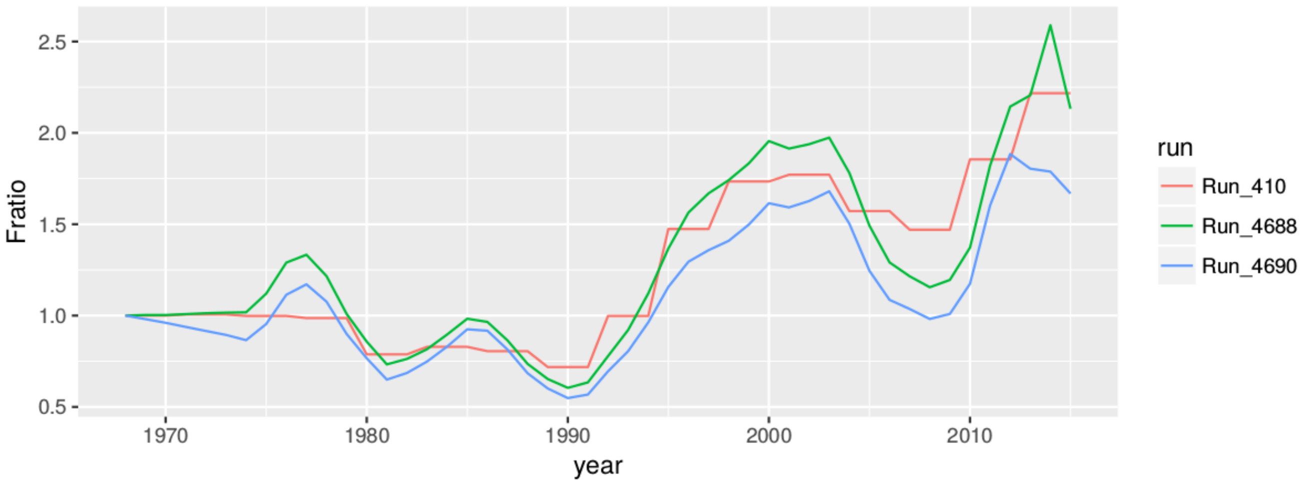


**Figure 11.** Time series of estimated Fratios for the three best models obtained with WAA method 1.

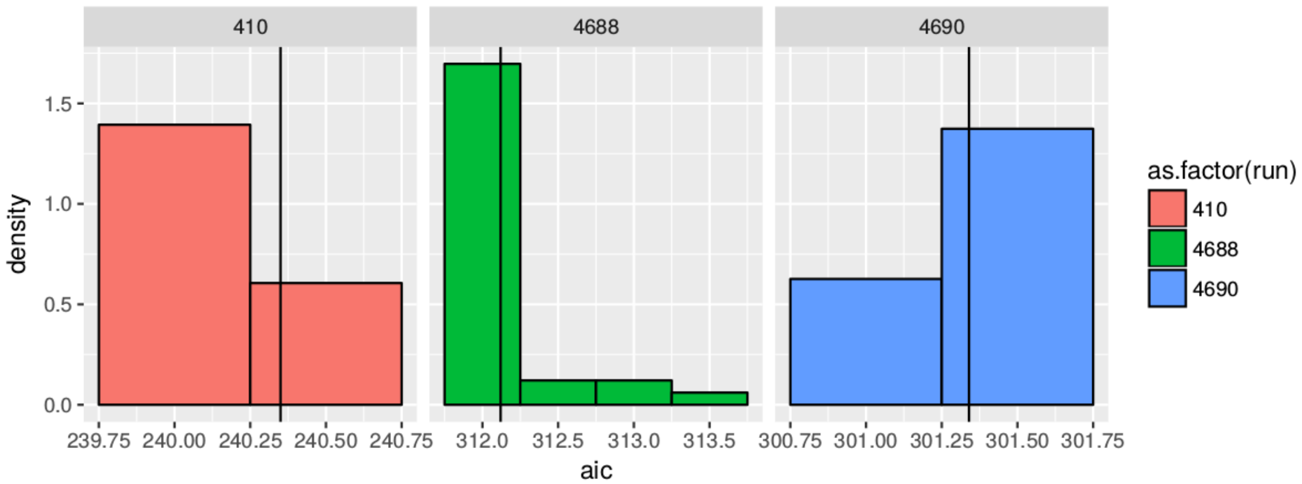


**Figure 12.** Histograms of AIC values obtained using 100 seed numbers for the three best models using WAA method 1. The vertical line indicates the 911 seed number used as the reference.

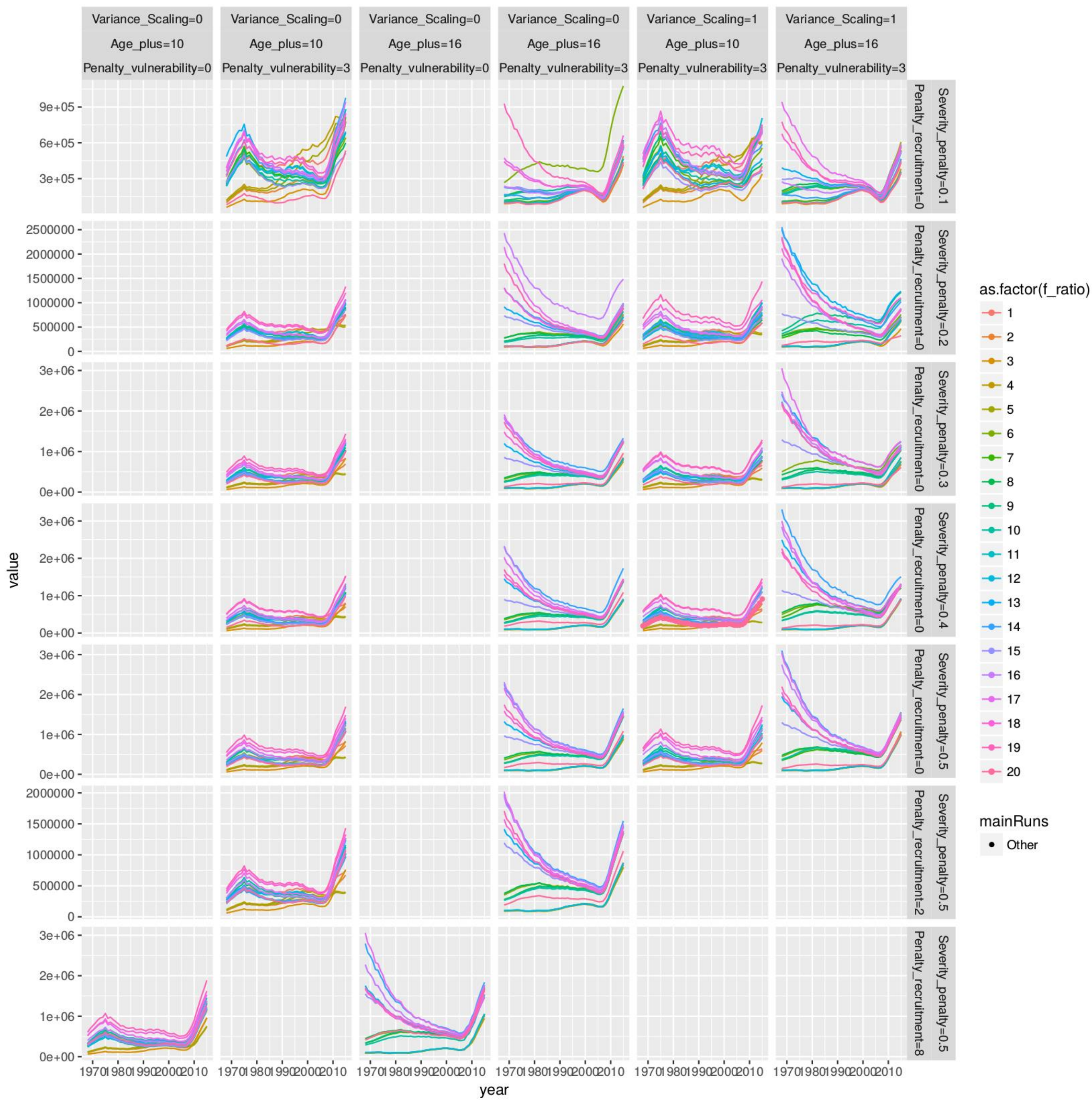


**Figure 13.** SSB obtained for the different settings using method 2 for the weight at age. The dotted line represents the best model for method 1.


**Figure 14.** Best models selected presented as a function of the different VPA settings and hypotheses using WAA method 2.

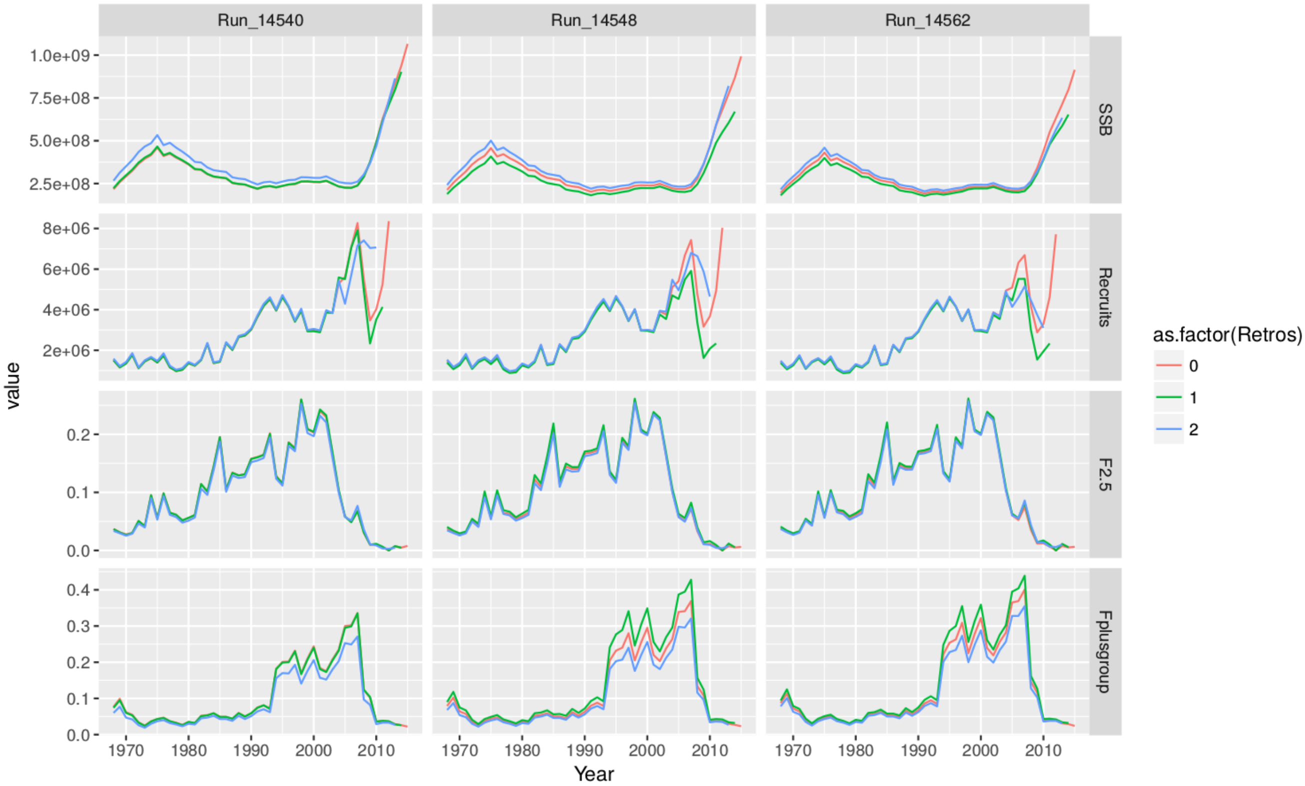


**Figure 15.** Retrospective patterns of the 3 best models selected, for WAA method 2.

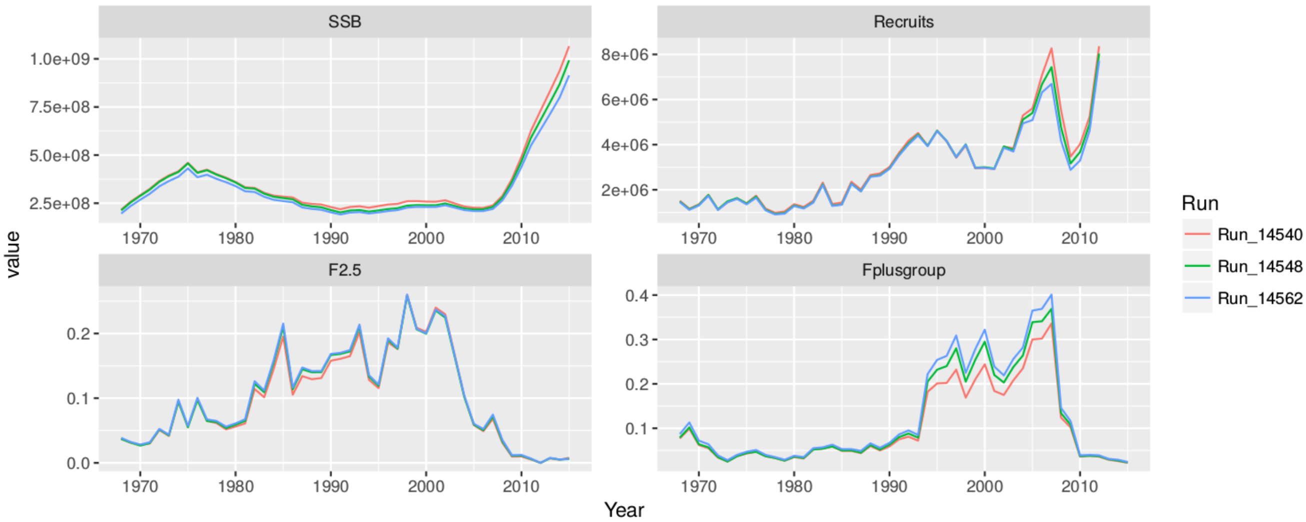


**Figure 16.** Time series of estimated variables of interest for the three best models obtained with WAA method 2.

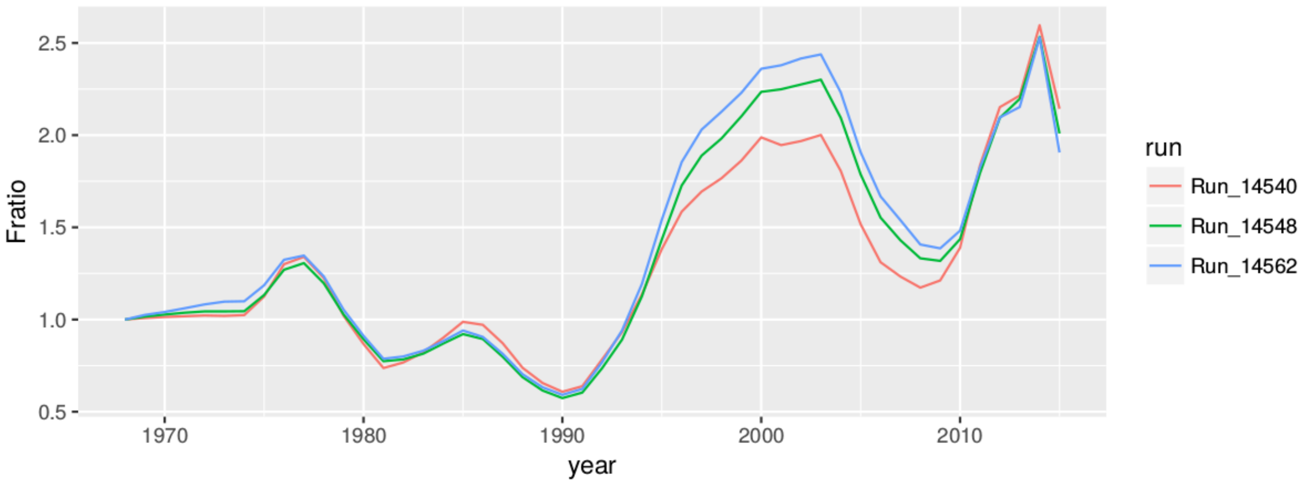


**Figure 17.** Time series of estimated Fratios for the three best models obtained with WAA method 2.

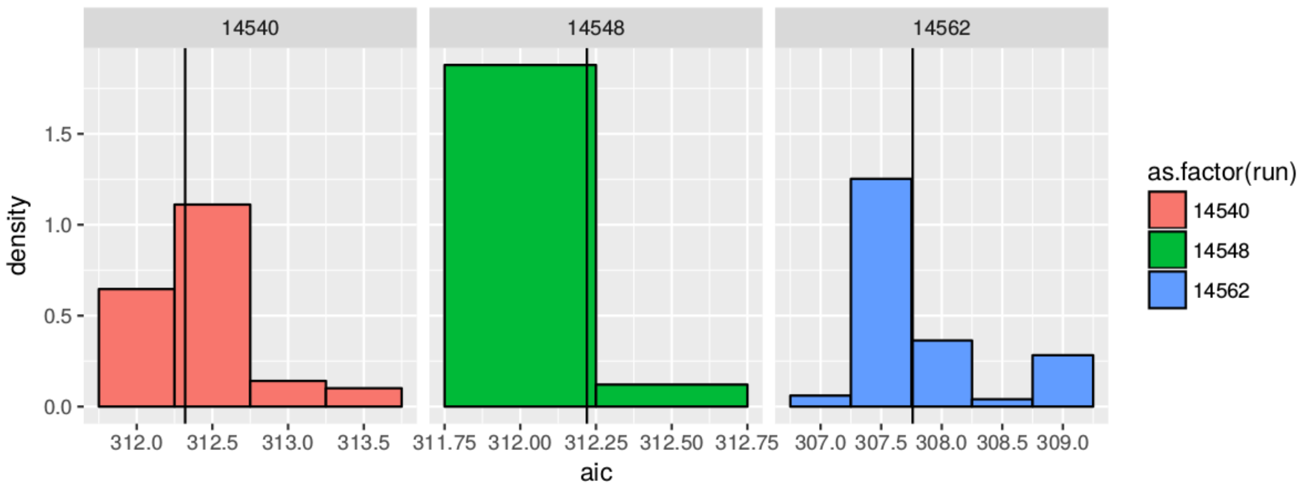


**Figure 18.** Histograms of AIC values obtained using 100 seed numbers for the three best models using WAA method 2. The vertical line indicates the 911 seed number used as the reference.

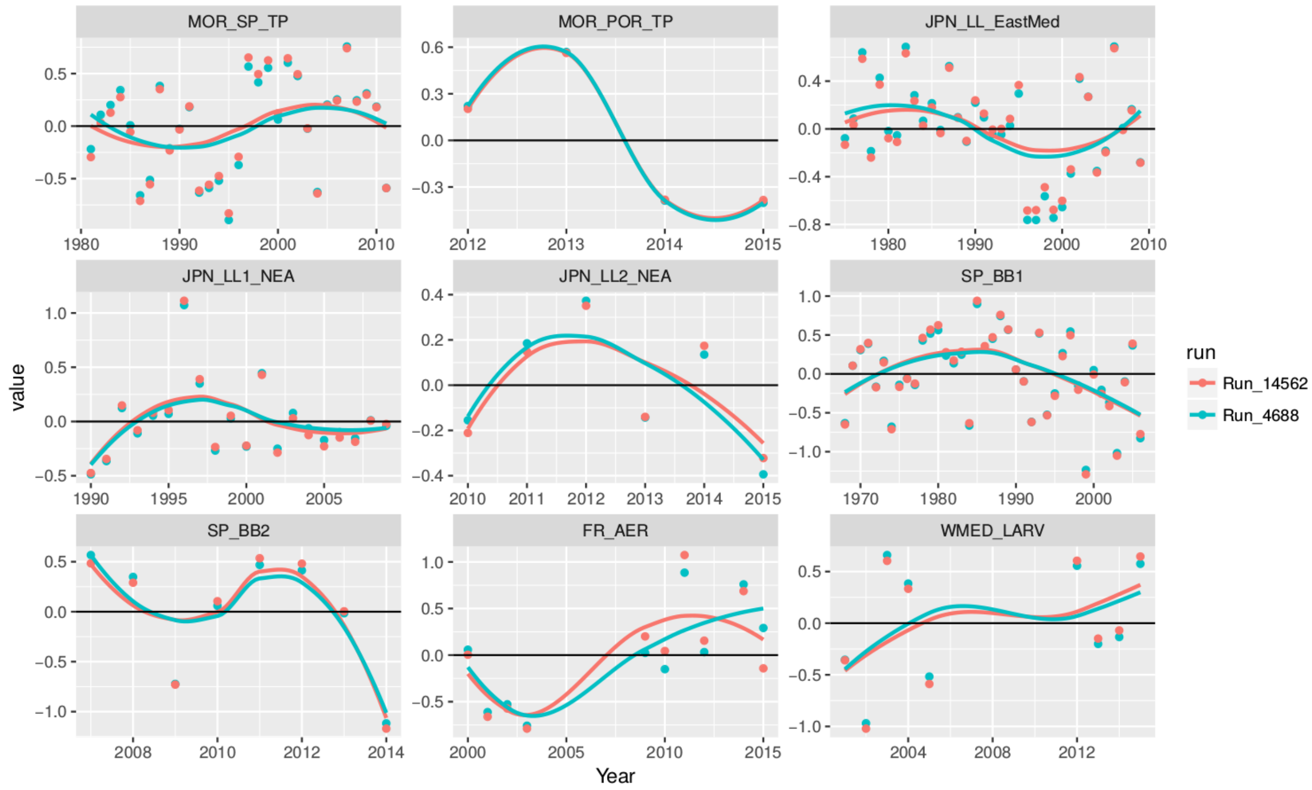


**Figure 19.** Fit of residuals for the two best runs for each method, 4688 for method 1 and 14562 for method 2.

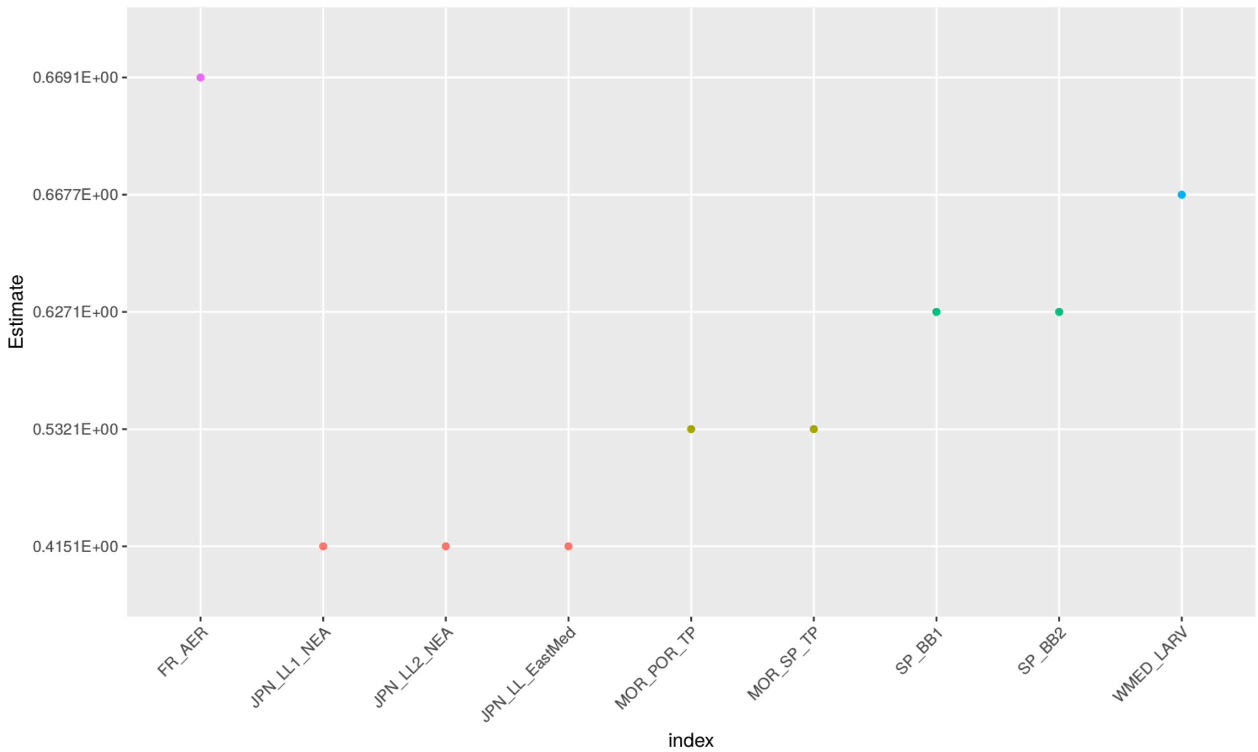


**Figure 20.** Variance estimated for each index of run 1456.

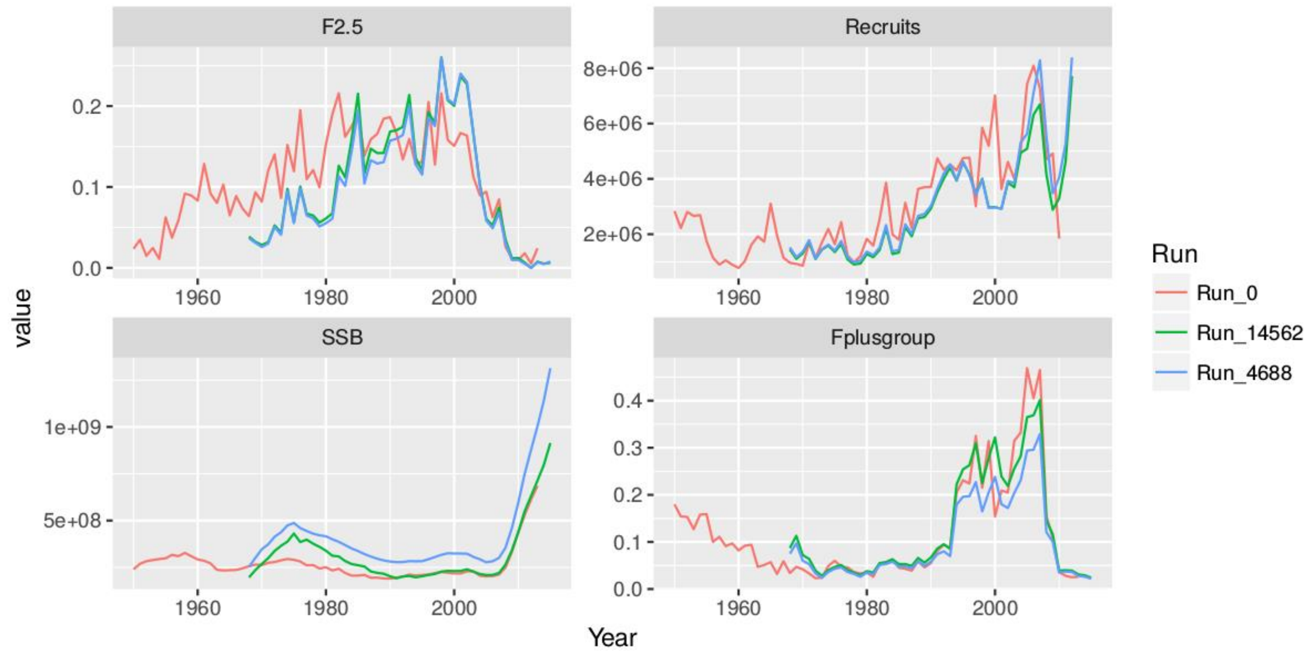


**Figure 21.** Comparison of the models selected for each WAA method to the 2014 assessment.

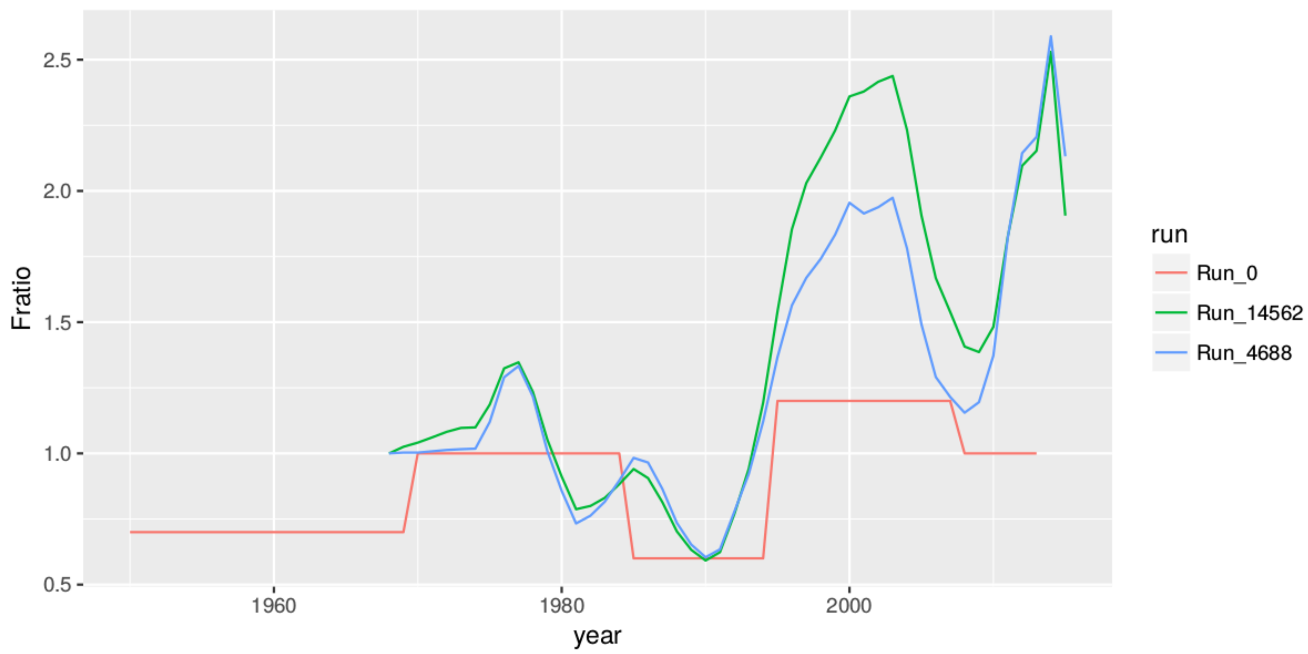


**Figure 22.** $F_{ratios}$ for each run. $F_{ratios}$ were estimated for runs 14562 and 4688, but were fixed for run 0 in 2014.

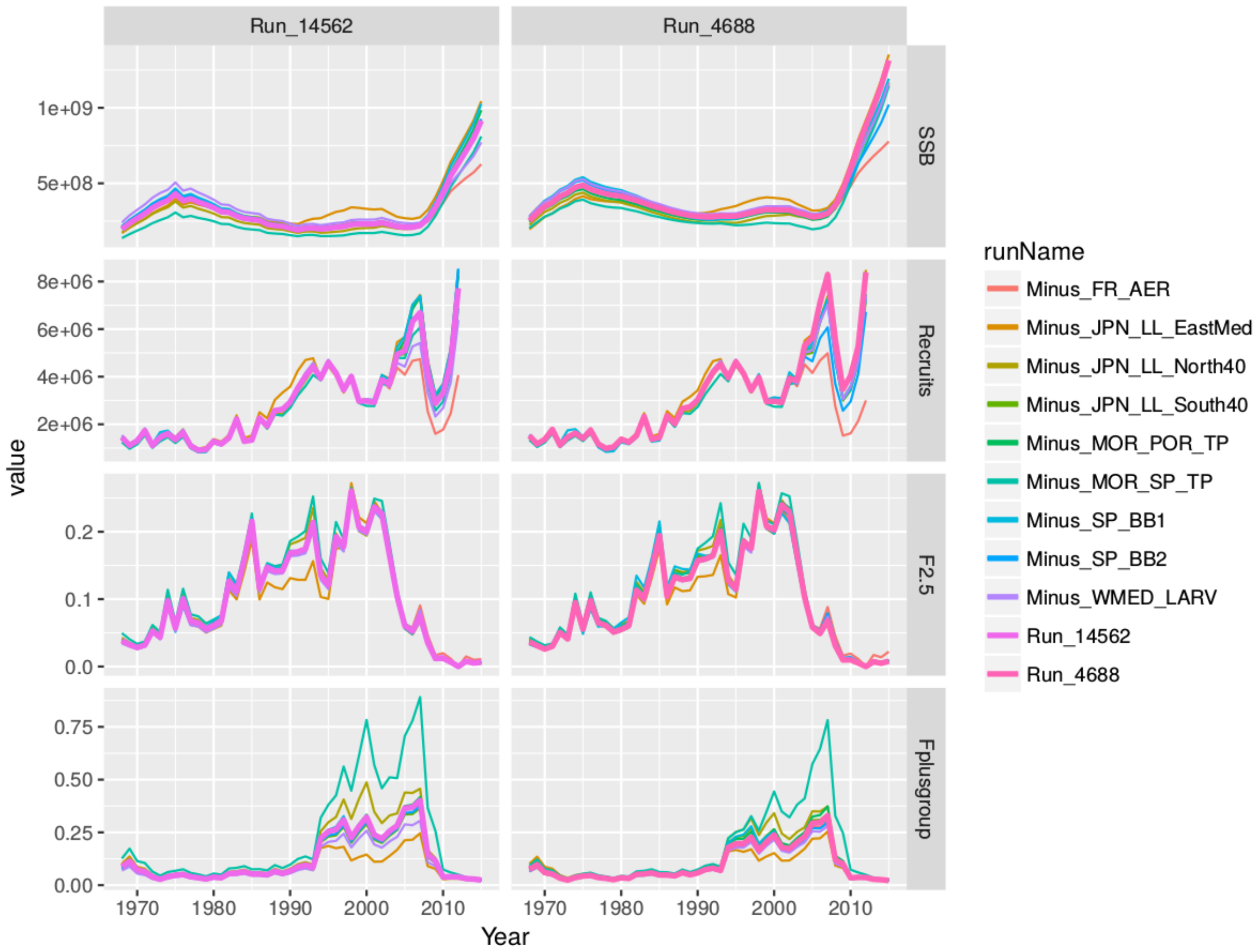


**Figure 23.** Jackknife analysis for the best models for each WAA method. Each line represent the results obtained by removing each index and leaving the others. The lines in bold indicate the original. runs.

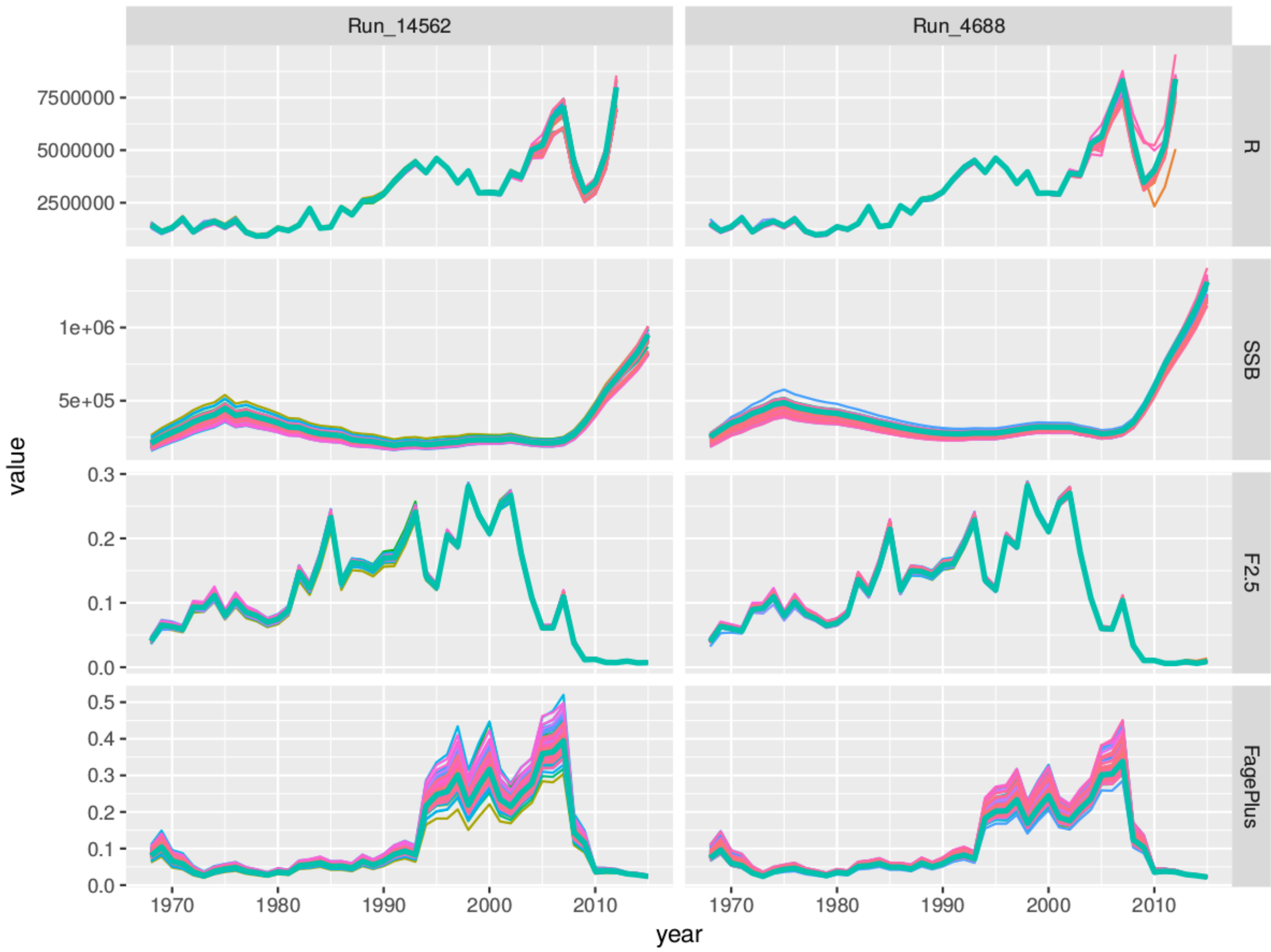


**Figure 24.** Jackknife analysis for the best models for each WAA method. The model outputs were obtained by removing sequentially each point for each index. The lines in bold indicate the original runs.


**Figure 25.** Sensitivity analysis of the two models selected for each WAA method, to different terminal F assumptions.

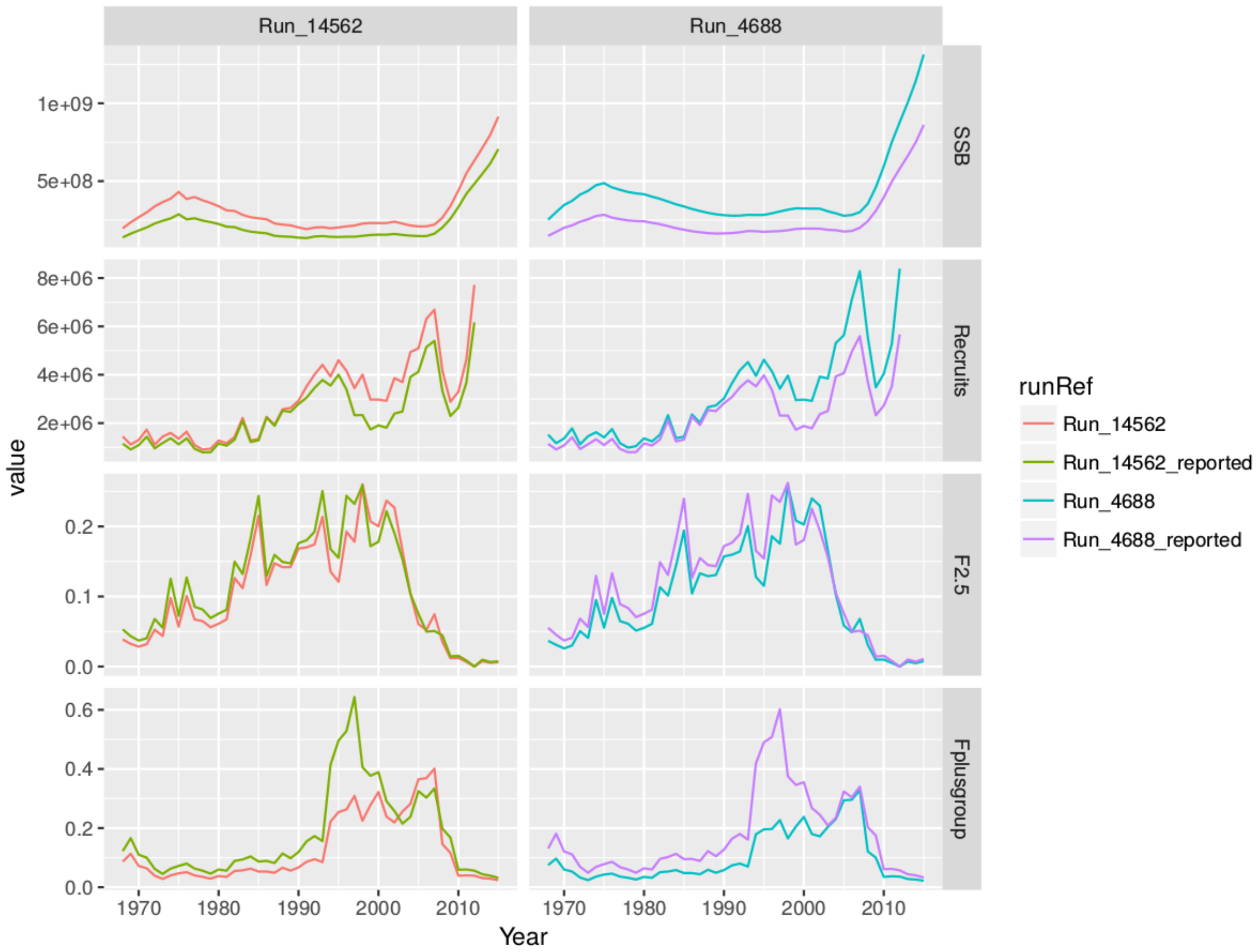


**Figure 26.** Effect of using the reported catch instead of the inflated catch for the model selected for each WAA method.

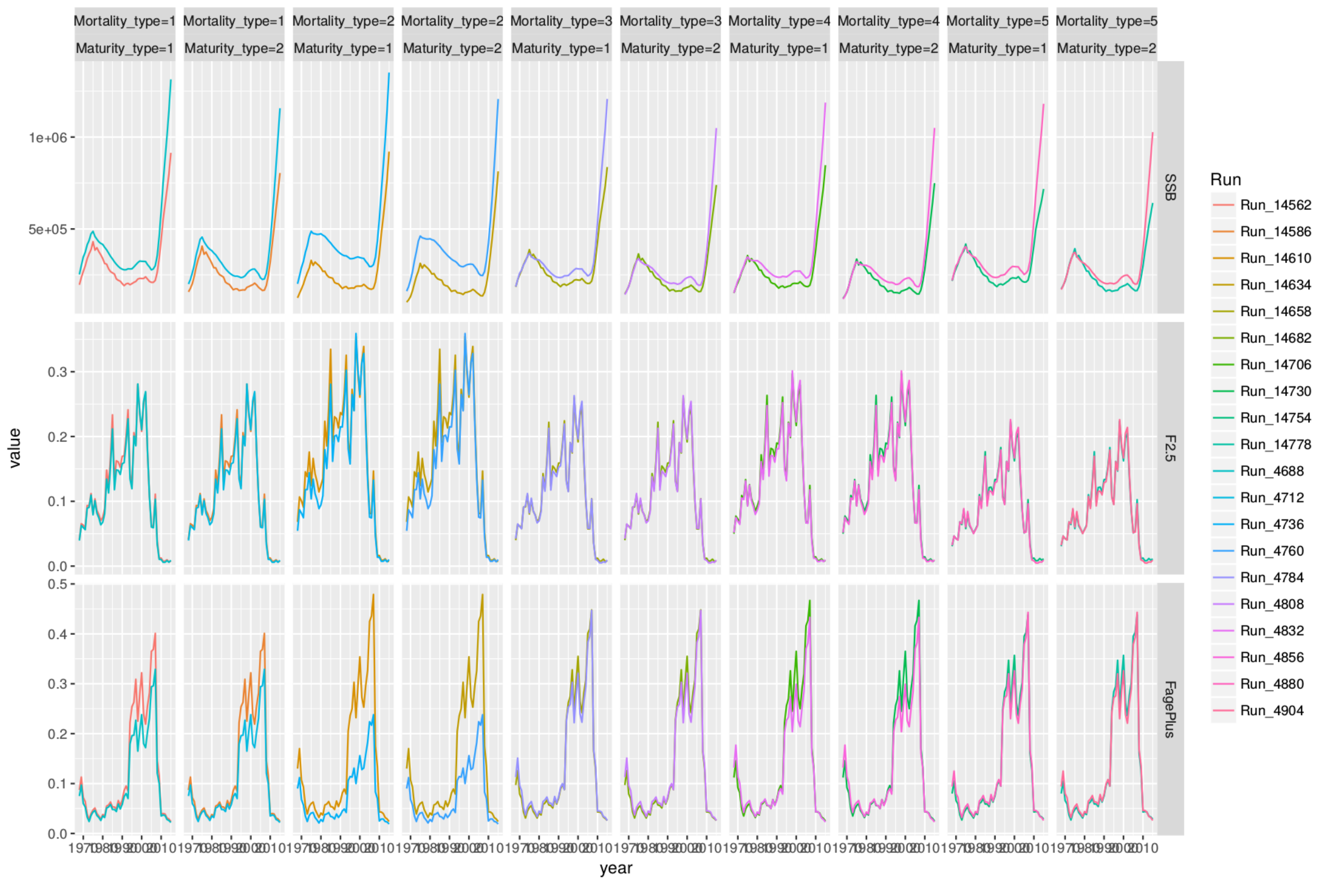


**Figure 27.** Effect of using different assumptions for maturity and mortality. Natural mortality equal to 1refers to the best case, 2 refers to Lorenzen, 3 refers to the 2014 assessment values, 4 refers to the new Southern Bluefin vector and 5 refers to the maturity computed with the Gislason relationship. Maturity equal to 1 refers to the base case and 2 refers to the later maturity.

**ANNEX 1** – **Catch at age Matrix**

| *Year* | *Age 1* | *Age 2* | *Age 3* | *Age 4* | *Age 5* | *Age 6* | *Age 7* | *Age 8* | *Age 9* | *Age 10+* |
|---|---|---|---|---|---|---|---|---|---|---|
| 1968 | 6252 | 51012 | 62089 | 30813 | 12851 | 7265 | 5575 | 4967 | 4768 | 30000 |
| 1969 | 52761 | 92481 | 26676 | 12380 | 9923 | 8230 | 7448 | 6938 | 6432 | 36141 |
| 1970 | 103288 | 69625 | 14564 | 7176 | 7806 | 8210 | 7525 | 6326 | 5137 | 22736 |
| 1971 | 73203 | 74471 | 15790 | 5904 | 3892 | 5217 | 7098 | 7223 | 6080 | 25050 |
| 1972 | 53276 | 117743 | 52647 | 15259 | 5526 | 4095 | 4168 | 4174 | 3886 | 20617 |
| 1973 | 101774 | 92660 | 25230 | 6683 | 3785 | 5132 | 6833 | 6817 | 5653 | 21789 |
| 1974 | 89275 | 79988 | 54228 | 32707 | 14207 | 8984 | 9485 | 10023 | 9339 | 41846 |
| 1975 | 117222 | 97076 | 23770 | 13233 | 8508 | 6184 | 5629 | 6055 | 6750 | 56141 |
| 1976 | 33696 | 93730 | 46698 | 24930 | 14717 | 9873 | 8225 | 8122 | 8467 | 56253 |
| 1977 | 72614 | 101350 | 42840 | 18813 | 9487 | 6586 | 5269 | 4816 | 4852 | 44522 |
| 1978 | 136641 | 70271 | 27617 | 14164 | 7144 | 4209 | 3513 | 3602 | 3898 | 37386 |
| 1979 | 22924 | 55499 | 32648 | 14711 | 6930 | 4926 | 4559 | 4383 | 4180 | 29742 |
| 1980 | 62081 | 31778 | 36489 | 18286 | 8879 | 5821 | 4941 | 4935 | 5187 | 37200 |
| 1981 | 125079 | 92438 | 27362 | 11217 | 7871 | 7346 | 7471 | 7413 | 7009 | 32907 |
| 1982 | 202495 | 133310 | 59825 | 24117 | 12902 | 10452 | 10104 | 10005 | 9663 | 49698 |
| 1983 | 353454 | 128336 | 42108 | 20111 | 11974 | 9396 | 9426 | 9941 | 9909 | 48023 |
| 1984 | 137763 | 172952 | 61702 | 33842 | 20363 | 14567 | 12823 | 12293 | 11539 | 51644 |
| 1985 | 126183 | 184891 | 101583 | 43339 | 19708 | 10523 | 7521 | 7058 | 7251 | 42203 |
| 1986 | 244019 | 103246 | 60801 | 26833 | 14212 | 9737 | 7483 | 6703 | 6625 | 40129 |
| 1987 | 230300 | 182171 | 61870 | 28624 | 16119 | 10514 | 8070 | 7224 | 6852 | 33358 |
| 1988 | 391268 | 184373 | 96437 | 36177 | 18307 | 13211 | 11075 | 9954 | 9171 | 43782 |
| 1989 | 369861 | 166747 | 70461 | 41579 | 19787 | 12364 | 9912 | 8503 | 7476 | 35732 |
| 1990 | 240305 | 171685 | 97289 | 66015 | 32249 | 17234 | 12394 | 10511 | 9172 | 38660 |
| 1991 | 205080 | 191689 | 128064 | 70527 | 34252 | 18550 | 13645 | 12509 | 11547 | 43003 |
| 1992 | 320701 | 410882 | 188483 | 66425 | 29140 | 17955 | 13546 | 11819 | 10719 | 45709 |
| 1993 | 399243 | 571509 | 225584 | 79454 | 37423 | 22385 | 15128 | 11627 | 9614 | 38916 |
| 1994 | 548245 | 383200 | 135402 | 58210 | 39070 | 31519 | 26827 | 24116 | 21907 | 88624 |
| 1995 | 554136 | 277808 | 148751 | 69379 | 44593 | 32371 | 25114 | 21443 | 19429 | 91361 |
| 1996 | 832036 | 339393 | 258785 | 127365 | 54051 | 27735 | 19985 | 18004 | 16958 | 81513 |
| 1997 | 540766 | 403321 | 217445 | 105807 | 56485 | 35150 | 27353 | 24681 | 22424 | 85865 |
| 1998 | 387645 | 419954 | 325099 | 157887 | 68088 | 32651 | 21966 | 18576 | 16310 | 66542 |
| 1999 | 639971 | 365833 | 263610 | 117407 | 49149 | 30359 | 26173 | 24809 | 22300 | 76562 |
| 2000 | 241335 | 279236 | 178983 | 95190 | 49862 | 35273 | 32283 | 31820 | 29144 | 95866 |
| 2001 | 208599 | 311031 | 229700 | 123571 | 57886 | 37071 | 30312 | 27601 | 24841 | 88444 |
| 2002 | 212729 | 492763 | 202002 | 80527 | 41632 | 27916 | 23031 | 21855 | 21103 | 95502 |
| 2003 | 220683 | 330721 | 120294 | 59334 | 44768 | 33705 | 27860 | 26553 | 25846 | 109055 |
| 2004 | 199000 | 217709 | 128204 | 52774 | 34201 | 31290 | 30094 | 30266 | 29343 | 116630 |
| 2005 | 197040 | 120403 | 66418 | 43147 | 32772 | 28422 | 27735 | 28488 | 28303 | 131646 |
| 2006 | 60022 | 93381 | 91511 | 76247 | 55247 | 41562 | 36216 | 33426 | 29734 | 115674 |
| 2007 | 39511 | 105745 | 127435 | 171028 | 132177 | 77254 | 46958 | 34235 | 28281 | 115581 |
| 2008 | 63936 | 86574 | 62400 | 63700 | 45781 | 29152 | 20392 | 15528 | 12065 | 39818 |
| 2009 | 6340 | 30965 | 24845 | 27406 | 32247 | 29711 | 22488 | 16293 | 12083 | 37528 |
| 2010 | 5724 | 23099 | 23857 | 26111 | 22703 | 17508 | 12757 | 9100 | 6480 | 17191 |
| 2011 | 1785 | 6293 | 12291 | 16797 | 13938 | 9792 | 7445 | 6208 | 5355 | 22078 |
| 2012 | 99 | 3089 | 11126 | 13261 | 10846 | 8656 | 8001 | 7581 | 6852 | 27153 |
| 2013 | 10132 | 15296 | 11573 | 14387 | 12282 | 11133 | 10769 | 10141 | 8999 | 32499 |
| 2014 | 9973 | 15469 | 13444 | 13082 | 7829 | 5753 | 6839 | 8489 | 9011 | 37521 |
| 2015 | 13468 | 22995 | 25972 | 21217 | 10306 | 6617 | 7577 | 9358 | 10018 | 44915 |

**ANNEX 2 - Indices and CPUES**

| *INDEX* | *YEAR* | *VALUE* | *CV* |
|---|---|---|---|
| MOR_SP_TP | 1981 | 768.36 | 0.57 |
| MOR_SP_TP | 1982 | 1038.12 | 0.35 |
| MOR_SP_TP | 1983 | 1092.05 | 0.35 |
| MOR_SP_TP | 1984 | 1200.27 | 0.35 |
| MOR_SP_TP | 1985 | 814.46 | 0.35 |
| MOR_SP_TP | 1986 | 394.33 | 0.28 |
| MOR_SP_TP | 1987 | 433.53 | 0.28 |
| MOR_SP_TP | 1988 | 1014.56 | 0.28 |
| MOR_SP_TP | 1989 | 531.45 | 0.26 |
| MOR_SP_TP | 1990 | 614.37 | 0.23 |
| MOR_SP_TP | 1991 | 727.86 | 0.23 |
| MOR_SP_TP | 1992 | 313.95 | 0.23 |
| MOR_SP_TP | 1993 | 325.36 | 0.23 |
| MOR_SP_TP | 1994 | 341.9 | 0.23 |
| MOR_SP_TP | 1995 | 223.43 | 0.23 |
| MOR_SP_TP | 1996 | 375.22 | 0.25 |
| MOR_SP_TP | 1997 | 992.41 | 0.25 |
| MOR_SP_TP | 1998 | 925.14 | 0.25 |
| MOR_SP_TP | 1999 | 1137.45 | 0.25 |
| MOR_SP_TP | 2000 | 739.23 | 0.23 |
| MOR_SP_TP | 2001 | 1284.62 | 0.23 |
| MOR_SP_TP | 2002 | 1130.42 | 0.23 |
| MOR_SP_TP | 2003 | 662.66 | 0.24 |
| MOR_SP_TP | 2004 | 332.36 | 0.23 |
| MOR_SP_TP | 2005 | 677.39 | 0.23 |
| MOR_SP_TP | 2006 | 633.94 | 0.23 |
| MOR_SP_TP | 2007 | 1000.6 | 0.23 |
| MOR_SP_TP | 2008 | 634.18 | 0.23 |
| MOR_SP_TP | 2009 | 876.71 | 0.23 |
| MOR_SP_TP | 2010 | 1042.24 | 0.24 |
| MOR_SP_TP | 2011 | 674.97 | 0.23 |
| MOR_POR_TP | 2012 | 41.15 | 0.49 |
| MOR_POR_TP | 2013 | 88.58 | 0.54 |
| MOR_POR_TP | 2014 | 48.54 | 0.5 |
| MOR_POR_TP | 2015 | 66.98 | 0.54 |
| JPN_LL_EastMed | 1975 | 1.9 | 0.15 |
| JPN_LL_EastMed | 1976 | 2.15 | 0.12 |
| JPN_LL_EastMed | 1977 | 3.53 | 0.14 |
| JPN_LL_EastMed | 1978 | 1.5 | 0.15 |
| JPN_LL_EastMed | 1979 | 2.7 | 0.14 |
| JPN_LL_EastMed | 1980 | 1.69 | 0.16 |
| JPN_LL_EastMed | 1981 | 1.63 | 0.17 |
| JPN_LL_EastMed | 1982 | 3.32 | 0.13 |
| JPN_LL_EastMed | 1983 | 2.12 | 0.13 |
| JPN_LL_EastMed | 1984 | 1.62 | 0.12 |
| JPN_LL_EastMed | 1985 | 1.75 | 0.15 |
| JPN_LL_EastMed | 1986 | 1.32 | 0.14 |
| JPN_LL_EastMed | 1987 | 2.16 | 0.13 |
| JPN_LL_EastMed | 1988 | 1.35 | 0.14 |
| JPN_LL_EastMed | 1989 | 1.05 | 0.16 |

| | | | |
|---|---|---|---|
| JPN_LL_EastMed | 1990 | 1.41 | 0.14 |
| JPN_LL_EastMed | 1991 | 1.21 | 0.13 |
| JPN_LL_EastMed | 1992 | 1.03 | 0.14 |
| JPN_LL_EastMed | 1993 | 1.04 | 0.14 |
| JPN_LL_EastMed | 1994 | 1.12 | 0.16 |
| JPN_LL_EastMed | 1995 | 1.42 | 0.15 |
| JPN_LL_EastMed | 1996 | 0.5 | 0.22 |
| JPN_LL_EastMed | 1997 | 0.53 | 0.21 |
| JPN_LL_EastMed | 1998 | 0.71 | 0.17 |
| JPN_LL_EastMed | 1999 | 0.64 | 0.22 |
| JPN_LL_EastMed | 2000 | 0.74 | 0.2 |
| JPN_LL_EastMed | 2001 | 0.96 | 0.17 |
| JPN_LL_EastMed | 2002 | 2.05 | 0.15 |
| JPN_LL_EastMed | 2003 | 1.7 | 0.13 |
| JPN_LL_EastMed | 2004 | 0.82 | 0.18 |
| JPN_LL_EastMed | 2005 | 0.88 | 0.15 |
| JPN_LL_EastMed | 2006 | 1.91 | 0.15 |
| JPN_LL_EastMed | 2007 | 0.94 | 0.19 |
| JPN_LL_EastMed | 2008 | 1.22 | 0.17 |
| JPN_LL_EastMed | 2009 | 1.04 | 0.24 |
| JPN_LL1_NEA | 1990 | 0.47 | 0.35 |
| JPN_LL1_NEA | 1991 | 0.53 | 0.31 |
| JPN_LL1_NEA | 1992 | 0.88 | 0.24 |
| JPN_LL1_NEA | 1993 | 0.74 | 0.22 |
| JPN_LL1_NEA | 1994 | 0.93 | 0.23 |
| JPN_LL1_NEA | 1995 | 0.97 | 0.22 |
| JPN_LL1_NEA | 1996 | 2.84 | 0.22 |
| JPN_LL1_NEA | 1997 | 1.51 | 0.24 |
| JPN_LL1_NEA | 1998 | 0.87 | 0.25 |
| JPN_LL1_NEA | 1999 | 1.25 | 0.22 |
| JPN_LL1_NEA | 2000 | 0.98 | 0.22 |
| JPN_LL1_NEA | 2001 | 1.83 | 0.21 |
| JPN_LL1_NEA | 2002 | 0.82 | 0.22 |
| JPN_LL1_NEA | 2003 | 1.1 | 0.24 |
| JPN_LL1_NEA | 2004 | 0.84 | 0.22 |
| JPN_LL1_NEA | 2005 | 0.75 | 0.21 |
| JPN_LL1_NEA | 2006 | 0.83 | 0.22 |
| JPN_LL1_NEA | 2007 | 0.84 | 0.22 |
| JPN_LL1_NEA | 2008 | 1.17 | 0.21 |
| JPN_LL1_NEA | 2009 | 1.5 | 0.21 |
| JPN_LL2_NEA | 2010 | 2.22 | 0.22 |
| JPN_LL2_NEA | 2011 | 4.45 | 0.26 |
| JPN_LL2_NEA | 2012 | 7.7 | 0.31 |
| JPN_LL2_NEA | 2013 | 6.11 | 0.26 |
| JPN_LL2_NEA | 2014 | 9.7 | 0.3 |
| JPN_LL2_NEA | 2015 | 5.91 | 0.3 |
| SP_BB1 | 1968 | 447 | 0.42 |
| SP_BB1 | 1969 | 610.62 | 0.4 |
| SP_BB1 | 1970 | 594.66 | 0.43 |
| SP_BB1 | 1971 | 744.71 | 0.4 |
| SP_BB1 | 1972 | 525.63 | 0.41 |
| SP_BB1 | 1973 | 535.63 | 0.4 |
| SP_BB1 | 1974 | 245.39 | 0.44 |

| | | | |
|---|---|---|---|
| SP_BB1 | 1975 | 484.22 | 0.41 |
| SP_BB1 | 1976 | 483.96 | 0.41 |
| SP_BB1 | 1977 | 547.56 | 0.41 |
| SP_BB1 | 1978 | 705.26 | 0.41 |
| SP_BB1 | 1979 | 623.01 | 0.41 |
| SP_BB1 | 1980 | 634.81 | 0.45 |
| SP_BB1 | 1981 | 510.66 | 0.42 |
| SP_BB1 | 1982 | 503.78 | 0.42 |
| SP_BB1 | 1983 | 625.14 | 0.43 |
| SP_BB1 | 1984 | 331.71 | 0.45 |
| SP_BB1 | 1985 | 1125.74 | 0.41 |
| SP_BB1 | 1986 | 751.21 | 0.42 |
| SP_BB1 | 1987 | 1008.43 | 0.42 |
| SP_BB1 | 1988 | 1394.68 | 0.42 |
| SP_BB1 | 1989 | 1285.6 | 0.4 |
| SP_BB1 | 1990 | 986.51 | 0.41 |
| SP_BB1 | 1991 | 901.2 | 0.42 |
| SP_BB1 | 1992 | 695.16 | 0.43 |
| SP_BB1 | 1993 | 2093.55 | 0.4 |
| SP_BB1 | 1994 | 1007.03 | 0.42 |
| SP_BB1 | 1995 | 1235.91 | 0.41 |
| SP_BB1 | 1996 | 1739.29 | 0.4 |
| SP_BB1 | 1997 | 2246.41 | 0.4 |
| SP_BB1 | 1998 | 879.51 | 0.41 |
| SP_BB1 | 1999 | 339.77 | 0.44 |
| SP_BB1 | 2000 | 960.44 | 0.4 |
| SP_BB1 | 2001 | 704.49 | 0.45 |
| SP_BB1 | 2002 | 687.42 | 0.42 |
| SP_BB1 | 2003 | 444.91 | 0.48 |
| SP_BB1 | 2004 | 1210.46 | 0.42 |
| SP_BB1 | 2005 | 2383.57 | 0.4 |
| SP_BB1 | 2006 | 850.09 | 0.48 |
| SP_BB2 | 2007 | 2179.98 | 0.31 |
| SP_BB2 | 2008 | 2154.01 | 0.3 |
| SP_BB2 | 2009 | 955.38 | 0.3 |
| SP_BB2 | 2010 | 2126.2 | 0.31 |
| SP_BB2 | 2011 | 2785.47 | 0.3 |
| SP_BB2 | 2012 | 2306.99 | 0.39 |
| SP_BB2 | 2013 | 1569.13 | 0.44 |
| SP_BB2 | 2014 | 678.29 | 0.41 |
| FR_AER | 2000 | 0.02 | 0.39 |
| FR_AER | 2001 | 0.01 | 0.37 |
| FR_AER | 2002 | 0.01 | 0.5 |
| FR_AER | 2003 | 0.01 | 0.35 |
| FR_AER | 2009 | 0.06 | 0.42 |
| FR_AER | 2010 | 0.04 | 0.52 |
| FR_AER | 2011 | 0.09 | 0.34 |
| FR_AER | 2012 | 0.04 | 0.32 |
| FR_AER | 2014 | 0.17 | 0.38 |
| FR_AER | 2015 | 0.09 | 0.34 |
| WMED_LARV | 2001 | 5.5 | 0.19 |
| WMED_LARV | 2002 | 2.76 | 0.26 |
| WMED_LARV | 2003 | 13.4 | 0.25 |

| | | | |
|---|---|---|---|
| WMED_LARV | 2004 | 9.03 | 0.2 |
| WMED_LARV | 2005 | 3.56 | 0.17 |
| WMED_LARV | 2012 | 41.05 | 0.07 |
| WMED_LARV | 2013 | 21.83 | 0.08 |
| WMED_LARV | 2014 | 25.41 | 0.1 |
| WMED_LARV | 2015 | 54.29 | 0.07 |

## ANNEX 3 – Weight at Age Used for the Spawning Stock Biomass

**Method 1**

| Year | Age 1 | Age 2 | Age 3 | Age 4 | Age 5 | Age 6 | Age 7 | Age 8 | Age 9 | Age 10 plus |
|---|---|---|---|---|---|---|---|---|---|---|
| 1968-2015 | 5.710 | 13.898 | 26.114 | 42.132 | 61.498 | 83.644 | 107.967 | 133.882 | 160.843 | 252.729 |

**Method 2**

| Year | Age 1 | Age 2 | Age 3 | Age 4 | Age 5 | Age 6 | Age 7 | Age 8 | Age 9 | Age 10 plus |
|---|---|---|---|---|---|---|---|---|---|---|
| 1968 | 5.528 | 13.350 | 19.178 | 33.527 | 48.362 | 69.747 | 92.360 | 111.871 | 139.522 | 241.500 |
| 1969 | 5.287 | 12.297 | 18.785 | 34.761 | 51.578 | 67.563 | 93.221 | 114.565 | 137.239 | 239.357 |
| 1970 | 5.360 | 10.539 | 18.456 | 34.136 | 49.687 | 68.472 | 90.945 | 110.958 | 136.908 | 240.418 |
| 1971 | 5.534 | 12.188 | 22.649 | 35.164 | 51.529 | 69.517 | 92.153 | 113.599 | 130.197 | 257.689 |
| 1972 | 4.097 | 11.730 | 21.182 | 33.036 | 51.123 | 70.797 | 93.535 | 112.870 | 139.834 | 247.828 |
| 1973 | 5.891 | 10.962 | 19.904 | 32.619 | 50.366 | 66.523 | 96.561 | 113.012 | 133.733 | 262.603 |
| 1974 | 4.761 | 11.190 | 21.041 | 34.845 | 52.273 | 64.016 | 91.123 | 112.114 | 138.804 | 232.956 |
| 1975 | 5.700 | 11.524 | 22.661 | 34.623 | 47.408 | 69.546 | 91.115 | 112.623 | 136.284 | 253.167 |
| 1976 | 5.510 | 12.945 | 19.800 | 36.524 | 50.341 | 68.853 | 90.086 | 112.898 | 137.368 | 235.825 |
| 1977 | 5.119 | 12.571 | 24.771 | 33.028 | 49.556 | 69.640 | 88.047 | 112.184 | 136.309 | 257.722 |
| 1978 | 6.419 | 11.180 | 19.616 | 35.551 | 48.294 | 68.793 | 89.491 | 110.789 | 132.962 | 251.915 |
| 1979 | 7.195 | 16.227 | 22.225 | 34.222 | 50.512 | 69.461 | 89.583 | 112.556 | 135.378 | 242.455 |
| 1980 | 5.330 | 11.477 | 20.237 | 33.961 | 48.759 | 68.421 | 89.320 | 110.491 | 134.000 | 228.911 |
| 1981 | 5.431 | 11.661 | 21.159 | 34.046 | 49.041 | 67.902 | 89.542 | 110.906 | 133.744 | 215.897 |
| 1982 | 6.083 | 13.933 | 21.583 | 35.236 | 49.052 | 69.509 | 90.402 | 111.729 | 134.454 | 222.410 |
| 1983 | 5.464 | 12.640 | 20.514 | 33.120 | 49.324 | 67.870 | 92.370 | 111.787 | 137.885 | 211.949 |
| 1984 | 5.973 | 12.576 | 23.714 | 33.175 | 49.312 | 70.002 | 90.037 | 112.555 | 136.408 | 211.652 |
| 1985 | 5.236 | 11.611 | 21.761 | 34.649 | 49.625 | 68.397 | 89.243 | 112.465 | 135.726 | 218.884 |
| 1986 | 5.191 | 13.074 | 22.481 | 32.708 | 51.500 | 70.443 | 89.356 | 111.879 | 136.157 | 228.449 |
| 1987 | 5.565 | 10.986 | 19.877 | 34.130 | 48.578 | 68.901 | 89.105 | 110.686 | 134.934 | 212.179 |
| 1988 | 5.014 | 11.777 | 20.742 | 35.525 | 49.448 | 69.537 | 88.720 | 111.382 | 135.258 | 215.422 |
| 1989 | 5.870 | 10.834 | 22.809 | 30.958 | 42.799 | 69.550 | 91.212 | 111.548 | 134.427 | 224.149 |
| 1990 | 4.842 | 11.062 | 18.863 | 31.193 | 43.622 | 66.954 | 89.611 | 111.215 | 136.905 | 215.015 |
| 1991 | 5.329 | 11.145 | 21.032 | 29.907 | 46.555 | 71.104 | 91.452 | 113.281 | 137.986 | 199.052 |
| 1992 | 4.326 | 11.731 | 19.995 | 32.282 | 53.989 | 73.439 | 94.883 | 113.613 | 137.756 | 210.016 |
| 1993 | 4.357 | 10.871 | 18.663 | 31.693 | 51.433 | 69.644 | 85.904 | 105.876 | 129.742 | 219.296 |
| 1994 | 5.817 | 10.710 | 20.740 | 32.932 | 50.491 | 66.825 | 85.845 | 109.162 | 135.218 | 206.840 |
| 1995 | 5.570 | 11.745 | 19.950 | 31.985 | 49.430 | 67.677 | 88.965 | 111.869 | 137.521 | 222.486 |
| 1996 | 5.471 | 9.738 | 19.301 | 30.889 | 48.043 | 68.074 | 91.801 | 114.119 | 137.822 | 223.826 |
| 1997 | 5.484 | 11.454 | 19.284 | 33.079 | 50.238 | 68.399 | 89.562 | 113.989 | 137.016 | 204.761 |
| 1998 | 5.419 | 11.894 | 19.482 | 32.543 | 47.439 | 67.494 | 90.955 | 113.542 | 138.606 | 216.784 |
| 1999 | 6.244 | 11.857 | 21.776 | 29.331 | 48.484 | 69.558 | 94.436 | 111.294 | 137.274 | 196.196 |
| 2000 | 6.290 | 11.819 | 21.144 | 31.188 | 50.120 | 68.405 | 90.817 | 113.278 | 139.368 | 191.551 |
| 2001 | 6.740 | 11.144 | 21.033 | 29.091 | 48.657 | 67.744 | 91.263 | 112.534 | 134.531 | 198.767 |
| 2002 | 6.108 | 12.327 | 19.290 | 31.263 | 50.683 | 69.144 | 90.851 | 114.193 | 136.920 | 208.952 |
| 2003 | 6.590 | 11.637 | 20.551 | 33.405 | 52.740 | 69.898 | 91.108 | 113.363 | 135.466 | 203.625 |
| 2004 | 6.735 | 10.703 | 20.622 | 33.805 | 51.044 | 70.346 | 89.334 | 111.589 | 135.334 | 197.262 |
| 2005 | 6.607 | 11.356 | 18.748 | 33.405 | 51.858 | 69.759 | 91.684 | 113.477 | 136.127 | 207.906 |
| 2006 | 7.198 | 11.381 | 18.987 | 34.168 | 47.272 | 66.563 | 89.627 | 112.532 | 135.475 | 205.870 |
| 2007 | 3.653 | 11.525 | 22.243 | 35.045 | 45.976 | 62.074 | 86.494 | 110.836 | 134.835 | 209.103 |
| 2008 | 4.417 | 10.864 | 20.716 | 33.771 | 48.300 | 67.211 | 93.141 | 114.433 | 137.757 | 210.887 |
| 2009 | 4.421 | 12.933 | 20.863 | 34.762 | 50.511 | 68.899 | 88.553 | 111.977 | 135.133 | 207.428 |
| 2010 | 4.202 | 13.161 | 20.624 | 35.285 | 50.029 | 69.231 | 92.204 | 113.154 | 138.687 | 206.300 |
| 2011 | 5.413 | 11.642 | 23.512 | 33.530 | 50.541 | 69.764 | 89.296 | 116.271 | 137.047 | 217.738 |
| 2012 | 5.261 | 12.352 | 24.394 | 34.336 | 50.293 | 67.102 | 91.281 | 114.070 | 137.289 | 212.811 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 2013 | 3.349 | 10.082 | 21.220 | 34.233 | 49.124 | 69.114 | 92.004 | 114.838 | 140.854 | 203.318 |
| 2014 | 5.413 | 10.084 | 22.440 | 35.189 | 48.921 | 69.070 | 91.556 | 115.931 | 138.202 | 198.929 |
| 2015 | 3.025 | 9.944 | 19.507 | 33.878 | 48.971 | 66.333 | 90.823 | 113.783 | 137.719 | 202.524 |

**ANNEX 4 – Partial Catch at Age**

| *Index* | *Year* | *Age 2* | *Age 3* | *Age 4* | *Age 5* | *Age 6* | *Age 7* | *Age 8* | *Age 9* | *Age 10* | *Age 11* |
|---|---|---|---|---|---|---|---|---|---|---|---|
| MOR_SP_TP | 1981 | 0.000 | 0.000 | 0.000 | 0.153 | 183.824 | 1138.811 | 1668.342 | 2250.847 | 748.874 | 3153.915 |
| MOR_SP_TP | 1982 | 0.000 | 0.000 | 0.000 | 3.375 | 151.792 | 552.630 | 1977.553 | 1963.656 | 2079.274 | 7953.525 |
| MOR_SP_TP | 1983 | 0.000 | 0.000 | 0.000 | 1.892 | 7.568 | 18.447 | 45.975 | 299.683 | 501.279 | 8247.323 |
| MOR_SP_TP | 1984 | 0.000 | 0.000 | 0.000 | 31.755 | 240.008 | 436.721 | 1223.596 | 1777.706 | 3167.885 | 10810.641 |
| MOR_SP_TP | 1985 | 0.000 | 0.000 | 0.000 | 0.000 | 91.599 | 410.728 | 358.042 | 502.173 | 709.299 | 7633.485 |
| MOR_SP_TP | 1986 | 0.000 | 2.663 | 0.000 | 0.000 | 2.719 | 76.366 | 251.493 | 242.431 | 359.729 | 5122.522 |
| MOR_SP_TP | 1987 | 0.000 | 2.620 | 0.000 | 0.000 | 4.910 | 102.232 | 329.858 | 332.524 | 474.738 | 5662.663 |
| MOR_SP_TP | 1988 | 168.570 | 38.536 | 55.524 | 40.123 | 115.979 | 833.762 | 934.979 | 965.362 | 803.613 | 10743.396 |
| MOR_SP_TP | 1989 | 707.102 | 0.000 | 2.163 | 9.633 | 190.339 | 884.389 | 1461.493 | 1601.730 | 1070.756 | 6714.265 |
| MOR_SP_TP | 1990 | 1903.927 | 0.000 | 0.000 | 62.151 | 377.902 | 876.364 | 1583.073 | 3383.174 | 4174.974 | 13189.316 |
| MOR_SP_TP | 1991 | 0.000 | 0.000 | 0.000 | 227.856 | 4415.834 | 3863.604 | 2140.406 | 1962.691 | 2120.192 | 5826.326 |
| MOR_SP_TP | 1992 | 0.000 | 0.000 | 2.677 | 33.995 | 369.867 | 830.220 | 1385.732 | 1417.613 | 1161.934 | 5015.730 |
| MOR_SP_TP | 1993 | 0.000 | 0.000 | 0.000 | 65.364 | 171.620 | 349.767 | 366.752 | 374.970 | 502.812 | 6161.034 |
| MOR_SP_TP | 1994 | 3524.408 | 0.000 | 28.195 | 84.586 | 1924.678 | 2672.691 | 2073.400 | 962.664 | 848.332 | 6697.656 |
| MOR_SP_TP | 1995 | 0.000 | 0.000 | 18.652 | 182.959 | 281.304 | 299.281 | 215.905 | 315.187 | 879.157 | 4548.496 |
| MOR_SP_TP | 1996 | 0.000 | 0.000 | 4.767 | 111.143 | 278.901 | 222.144 | 227.122 | 260.023 | 599.794 | 6577.087 |
| MOR_SP_TP | 1997 | 0.000 | 0.000 | 29.853 | 485.183 | 1942.057 | 2184.649 | 1382.756 | 2175.491 | 2359.506 | 13667.321 |
| MOR_SP_TP | 1998 | 0.000 | 0.000 | 13.018 | 269.498 | 713.435 | 1153.735 | 1544.784 | 1759.425 | 2955.474 | 12191.202 |
| MOR_SP_TP | 1999 | 0.000 | 0.000 | 4.397 | 41.805 | 122.318 | 631.203 | 826.029 | 1501.085 | 1639.524 | 15189.168 |
| MOR_SP_TP | 2000 | 0.000 | 0.000 | 5.531 | 24.920 | 365.659 | 461.457 | 1043.057 | 2127.494 | 2618.378 | 10958.549 |
| MOR_SP_TP | 2001 | 0.000 | 0.000 | 43.542 | 189.549 | 184.631 | 529.664 | 1225.929 | 2628.962 | 3951.970 | 13948.648 |
| MOR_SP_TP | 2002 | 0.000 | 0.000 | 0.000 | 5.817 | 67.376 | 183.708 | 542.398 | 1549.154 | 2140.509 | 12510.051 |
| MOR_SP_TP | 2003 | 0.000 | 0.000 | 0.000 | 4.880 | 224.919 | 531.767 | 602.408 | 1457.676 | 3106.414 | 6733.798 |
| MOR_SP_TP | 2004 | 0.000 | 0.000 | 0.031 | 0.609 | 55.947 | 156.354 | 164.979 | 413.007 | 1538.032 | 8063.140 |
| MOR_SP_TP | 2005 | 0.000 | 0.000 | 11.291 | 2.258 | 49.118 | 232.040 | 597.885 | 1211.013 | 1295.135 | 9865.947 |
| MOR_SP_TP | 2006 | 0.000 | 0.000 | 0.000 | 164.881 | 544.106 | 2561.463 | 2703.067 | 3254.014 | 2197.788 | 7683.823 |
| MOR_SP_TP | 2007 | 0.000 | 0.000 | 0.000 | 197.403 | 651.430 | 3050.972 | 3090.517 | 3321.886 | 2255.910 | 10538.457 |
| MOR_SP_TP | 2008 | 0.000 | 0.000 | 1.468 | 3.524 | 61.688 | 136.293 | 325.876 | 941.343 | 2226.716 | 11926.596 |
| MOR_SP_TP | 2009 | 0.000 | 0.000 | 0.000 | 21.954 | 369.181 | 630.993 | 564.920 | 1365.665 | 2061.500 | 11257.452 |
| MOR_SP_TP | 2010 | 0.000 | 0.000 | 1.957 | 4.350 | 47.195 | 247.571 | 811.920 | 1197.879 | 2317.744 | 7865.557 |
| MOR_SP_TP | 2011 | 0.000 | 0.000 | 0.000 | 9.338 | 16.978 | 40.336 | 77.924 | 263.390 | 635.999 | 8126.116 |
| MOR_POR_TP | 2012 | 0.000 | 0.000 | 0.000 | 0.000 | 2.882 | 25.935 | 76.709 | 128.995 | 456.717 | 5189.648 |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| MOR_POR_TP | 2013 | 0.000 | 0.000 | 1.863 | 1.397 | 1.397 | 27.940 | 152.829 | 234.365 | 536.557 | 5133.673 |
| MOR_POR_TP | 2014 | 0.000 | 0.000 | 1.029 | 0.000 | 1.029 | 3.086 | 19.547 | 56.903 | 193.935 | 4862.566 |
| MOR_POR_TP | 2015 | 0.000 | 0.000 | 0.000 | 5.760 | 7.679 | 23.998 | 42.237 | 91.493 | 152.628 | 5227.842 |
| JPN_LL_EastMed | 1975 | 0.000 | 15.696 | 27.200 | 107.760 | 26.159 | 106.719 | 86.832 | 326.880 | 470.237 | 15476.414 |
| JPN_LL_EastMed | 1976 | 9.357 | 111.646 | 367.065 | 307.351 | 294.862 | 299.965 | 202.457 | 214.884 | 299.121 | 10978.542 |
| JPN_LL_EastMed | 1977 | 0.001 | 0.018 | 30.397 | 23.786 | 43.320 | 276.958 | 581.917 | 1015.313 | 1503.210 | 7569.438 |
| JPN_LL_EastMed | 1978 | 0.258 | 16.090 | 119.666 | 238.874 | 288.047 | 239.566 | 100.701 | 62.622 | 31.076 | 1920.861 |
| JPN_LL_EastMed | 1979 | 0.412 | 4.279 | 28.348 | 60.494 | 133.538 | 918.769 | 1247.736 | 2035.634 | 1237.288 | 690.182 |
| JPN_LL_EastMed | 1980 | 0.000 | 0.203 | 68.900 | 55.271 | 91.435 | 262.377 | 461.660 | 730.618 | 619.769 | 3678.910 |
| JPN_LL_EastMed | 1981 | 3.548 | 26.420 | 68.966 | 62.726 | 68.540 | 120.037 | 249.529 | 608.835 | 463.625 | 1940.824 |
| JPN_LL_EastMed | 1982 | 23.140 | 558.367 | 1127.250 | 1442.211 | 1189.842 | 3086.739 | 2704.287 | 2922.582 | 1591.186 | 9516.696 |
| JPN_LL_EastMed | 1983 | 0.001 | 26.299 | 172.996 | 298.505 | 1082.841 | 1306.628 | 1728.081 | 2158.942 | 2019.832 | 11137.466 |
| JPN_LL_EastMed | 1984 | 0.012 | 0.847 | 45.735 | 189.736 | 355.145 | 737.186 | 1109.651 | 2037.362 | 3797.158 | 7984.152 |
| JPN_LL_EastMed | 1985 | 8.587 | 57.288 | 174.777 | 127.388 | 285.698 | 346.039 | 580.863 | 373.789 | 523.898 | 5226.916 |
| JPN_LL_EastMed | 1986 | 0.210 | 18.490 | 51.629 | 100.665 | 364.244 | 366.975 | 328.036 | 427.918 | 431.379 | 3880.382 |
| JPN_LL_EastMed | 1987 | 0.001 | 0.006 | 14.492 | 43.675 | 136.133 | 505.664 | 839.556 | 760.223 | 677.244 | 4023.020 |
| JPN_LL_EastMed | 1988 | 0.263 | 8.766 | 47.978 | 142.973 | 99.958 | 389.380 | 841.835 | 1037.647 | 987.820 | 4815.388 |
| JPN_LL_EastMed | 1989 | 0.000 | 0.256 | 20.534 | 114.260 | 157.605 | 256.520 | 634.524 | 512.289 | 397.646 | 1945.530 |
| JPN_LL_EastMed | 1990 | 0.041 | 6.538 | 34.221 | 72.837 | 375.185 | 529.128 | 742.468 | 1014.233 | 1057.620 | 2980.400 |
| JPN_LL_EastMed | 1991 | 7.906 | 3.935 | 28.066 | 24.198 | 55.360 | 141.047 | 588.858 | 1446.040 | 2567.844 | 3630.974 |
| JPN_LL_EastMed | 1992 | 0.129 | 0.183 | 80.190 | 276.337 | 71.272 | 195.138 | 275.906 | 541.258 | 1618.131 | 8727.312 |
| JPN_LL_EastMed | 1993 | 0.000 | 34.093 | 36.530 | 75.826 | 84.638 | 244.900 | 153.144 | 170.515 | 638.904 | 8275.440 |
| JPN_LL_EastMed | 1994 | 0.000 | 0.000 | 78.724 | 247.575 | 189.270 | 180.112 | 537.037 | 663.690 | 759.728 | 5801.075 |
| JPN_LL_EastMed | 1995 | 2.917 | 6.172 | 13.308 | 327.762 | 178.264 | 324.462 | 955.640 | 1130.741 | 1087.685 | 10504.403 |
| JPN_LL_EastMed | 1996 | 0.000 | 0.000 | 78.435 | 101.094 | 321.946 | 252.469 | 195.178 | 354.158 | 503.174 | 6147.222 |
| JPN_LL_EastMed | 1997 | 0.000 | 75.331 | 298.740 | 292.202 | 184.106 | 59.073 | 132.746 | 318.227 | 649.108 | 3835.898 |
| JPN_LL_EastMed | 1998 | 0.000 | 0.000 | 10.563 | 18.014 | 65.176 | 121.233 | 175.212 | 301.920 | 644.135 | 5685.048 |
| JPN_LL_EastMed | 1999 | 0.000 | 0.000 | 0.000 | 2.258 | 162.590 | 272.589 | 351.904 | 474.871 | 1001.131 | 3301.180 |
| JPN_LL_EastMed | 2000 | 0.000 | 0.000 | 0.000 | 13.902 | 688.762 | 520.095 | 493.063 | 287.845 | 427.663 | 1986.402 |
| JPN_LL_EastMed | 2001 | 0.331 | 0.000 | 2.308 | 44.342 | 94.768 | 782.369 | 930.181 | 1287.599 | 743.128 | 980.448 |
| JPN_LL_EastMed | 2002 | 0.840 | 0.840 | 3.822 | 59.149 | 598.742 | 439.561 | 1938.549 | 1225.198 | 686.167 | 2945.967 |
| JPN_LL_EastMed | 2003 | 0.000 | 0.000 | 55.901 | 184.385 | 206.185 | 123.514 | 327.039 | 542.082 | 983.023 | 3591.918 |
| JPN_LL_EastMed | 2004 | 0.000 | 0.000 | 11.777 | 65.771 | 204.511 | 233.321 | 578.770 | 542.621 | 1274.806 | 2873.871 |
| JPN_LL_EastMed | 2005 | 1.485 | 34.124 | 56.117 | 68.034 | 105.613 | 161.004 | 459.862 | 561.250 | 827.737 | 3125.108 |
| JPN_LL_EastMed | 2006 | 52.964 | 0.000 | 312.561 | 105.795 | 465.049 | 526.577 | 1655.002 | 1927.258 | 1728.150 | 4584.968 |
| JPN_LL_EastMed | 2007 | 5.073 | 59.370 | 670.249 | 505.706 | 294.872 | 274.201 | 413.808 | 1043.599 | 838.763 | 2147.156 |
| JPN_LL_EastMed | 2008 | 0.000 | 9.742 | 70.756 | 51.272 | 10.596 | 0.000 | 30.507 | 101.263 | 81.779 | 244.057 |
| JPN_LL_EastMed | 2009 | 0.000 | 0.000 | 1.076 | 3.650 | 11.329 | 12.280 | 3.188 | 19.140 | 44.598 | 224.576 |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| JPN_LL1_NEA | 1990 | 0.002 | 19.188 | 99.013 | 106.166 | 371.501 | 584.962 | 559.232 | 586.257 | 1002.325 | 1481.688 |
| JPN_LL1_NEA | 1991 | 0.021 | 141.538 | 515.242 | 749.845 | 923.114 | 1551.807 | 2070.247 | 1173.635 | 1472.377 | 4275.442 |
| JPN_LL1_NEA | 1992 | 0.170 | 18.545 | 117.083 | 815.714 | 1609.782 | 1165.905 | 1057.938 | 1236.216 | 1573.716 | 2909.612 |
| JPN_LL1_NEA | 1993 | 0.000 | 22.009 | 434.629 | 1920.685 | 2482.628 | 2816.781 | 2029.454 | 1176.162 | 740.523 | 1545.831 |
| JPN_LL1_NEA | 1994 | 9.255 | 14.378 | 306.004 | 687.391 | 1123.074 | 1003.740 | 2060.314 | 1948.372 | 1318.710 | 1450.743 |
| JPN_LL1_NEA | 1995 | 1.967 | 13.104 | 305.642 | 1264.649 | 2060.099 | 4702.686 | 3495.901 | 3068.165 | 2483.528 | 1924.928 |
| JPN_LL1_NEA | 1996 | 0.000 | 0.000 | 162.039 | 628.789 | 843.625 | 1216.874 | 2568.593 | 3405.594 | 3670.455 | 5716.054 |
| JPN_LL1_NEA | 1997 | 1.773 | 11.823 | 17.776 | 100.940 | 608.052 | 1589.412 | 2279.007 | 3544.973 | 3949.507 | 4132.672 |
| JPN_LL1_NEA | 1998 | 1.252 | 0.099 | 149.617 | 246.850 | 388.693 | 1387.243 | 2751.122 | 2338.417 | 3218.176 | 5614.214 |
| JPN_LL1_NEA | 1999 | 0.000 | 109.054 | 122.911 | 1434.834 | 2756.708 | 2784.733 | 4252.734 | 3473.901 | 2204.936 | 3450.180 |
| JPN_LL1_NEA | 2000 | 0.000 | 11.071 | 17.400 | 51.622 | 917.201 | 3779.250 | 2560.516 | 4035.250 | 4708.553 | 3987.605 |
| JPN_LL1_NEA | 2001 | 50.233 | 23.679 | 3.330 | 104.592 | 1078.158 | 5218.086 | 5284.120 | 3799.436 | 2033.794 | 2294.144 |
| JPN_LL1_NEA | 2002 | 0.004 | 6.480 | 33.826 | 55.435 | 27.961 | 206.706 | 1083.164 | 4638.480 | 4481.506 | 3421.957 |
| JPN_LL1_NEA | 2003 | 10.035 | 104.364 | 351.147 | 1105.856 | 1529.097 | 1904.714 | 1690.184 | 2116.456 | 2802.213 | 5623.928 |
| JPN_LL1_NEA | 2004 | 18.018 | 303.551 | 137.940 | 358.274 | 407.730 | 702.347 | 2682.677 | 2302.453 | 1202.530 | 5267.181 |
| JPN_LL1_NEA | 2005 | 7.064 | 162.301 | 266.903 | 323.585 | 502.314 | 765.764 | 2187.187 | 2475.445 | 3378.247 | 5580.285 |
| JPN_LL1_NEA | 2006 | 44.297 | 0.000 | 233.878 | 83.732 | 388.950 | 408.122 | 1029.020 | 1159.863 | 873.688 | 2275.398 |
| JPN_LL1_NEA | 2007 | 21.205 | 10.840 | 1077.931 | 864.798 | 974.408 | 1146.118 | 986.510 | 1895.328 | 1513.781 | 3029.618 |
| JPN_LL1_NEA | 2008 | 0.000 | 3.222 | 8.487 | 663.605 | 3971.146 | 1663.235 | 6060.392 | 4077.177 | 2798.770 | 2766.862 |
| JPN_LL1_NEA | 2009 | 0.000 | 1.062 | 14.271 | 16.351 | 137.117 | 6477.691 | 3089.950 | 3086.708 | 3007.281 | 1551.535 |
| JPN_LL2_NEA | 2010 | 0.000 | 0.000 | 0.000 | 0.000 | 8.288 | 232.807 | 4875.241 | 3778.466 | 518.317 | 702.671 |
| JPN_LL2_NEA | 2011 | 0.000 | 0.000 | 0.000 | 0.000 | 2.144 | 37.412 | 181.058 | 3595.002 | 3814.115 | 602.240 |
| JPN_LL2_NEA | 2012 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 92.947 | 481.131 | 757.691 | 3472.589 | 2673.202 |
| JPN_LL2_NEA | 2013 | 0.000 | 0.000 | 0.000 | 0.000 | 1.086 | 5.431 | 339.554 | 2052.205 | 1849.081 | 3398.255 |
| JPN_LL2_NEA | 2014 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 3.279 | 45.913 | 678.851 | 2106.514 | 4092.781 |
| JPN_LL2_NEA | 2015 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 10.946 | 140.114 | 900.891 | 2634.805 | 4910.566 |
| SP_BB1 | 1968 | 2181.058 | 4766.437 | 8097.817 | 13513.446 | 3257.350 | 233.481 | 51.252 | 34.168 | 22.779 | 841.474 |
| SP_BB1 | 1969 | 11211.942 | 70060.263 | 9410.654 | 2143.979 | 446.940 | 91.002 | 10.193 | 0.000 | 0.000 | 952.965 |
| SP_BB1 | 1970 | 35184.816 | 75829.887 | 10156.383 | 3699.429 | 3014.001 | 1143.962 | 204.912 | 563.156 | 0.000 | 1934.914 |
| SP_BB1 | 1971 | 23820.183 | 83281.365 | 3528.737 | 5074.609 | 1981.643 | 492.552 | 110.006 | 16.523 | 0.000 | 2311.224 |
| SP_BB1 | 1972 | 1545.732 | 88179.080 | 2184.888 | 750.950 | 891.369 | 796.664 | 583.251 | 210.252 | 26.292 | 2859.026 |
| SP_BB1 | 1973 | 12125.293 | 129129.401 | 2146.555 | 490.262 | 323.524 | 568.571 | 699.477 | 795.957 | 662.171 | 2621.069 |
| SP_BB1 | 1974 | 18331.986 | 70421.139 | 3819.176 | 639.872 | 1334.762 | 44.484 | 279.843 | 0.000 | 0.000 | 1549.190 |
| SP_BB1 | 1975 | 20496.675 | 75885.792 | 3582.306 | 1400.119 | 1400.008 | 124.312 | 269.713 | 0.000 | 0.000 | 3325.176 |
| SP_BB1 | 1976 | 1491.315 | 28152.945 | 9525.093 | 1687.909 | 1419.815 | 940.133 | 373.553 | 41.588 | 0.000 | 2739.855 |
| SP_BB1 | 1977 | 6613.610 | 55150.407 | 12510.315 | 6728.479 | 643.709 | 242.016 | 173.427 | 71.200 | 0.000 | 3957.470 |
| SP_BB1 | 1978 | 52977.921 | 45839.777 | 8044.893 | 12076.816 | 6016.011 | 1537.381 | 160.790 | 33.475 | 70.148 | 5602.732 |
| SP_BB1 | 1979 | 2882.386 | 9706.954 | 14641.055 | 12802.447 | 3318.529 | 1295.966 | 488.196 | 260.210 | 644.551 | 2197.244 |

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|---|---|---|---|---|---|---|---|---|---|---|---|
| SP_BB1 | 1980 | 32918.116 | 18248.193 | 6874.019 | 2019.946 | 2767.010 | 2423.379 | 1369.727 | 207.060 | 83.812 | 1522.834 |
| SP_BB1 | 1981 | 53134.133 | 34441.032 | 2924.223 | 1515.015 | 847.162 | 524.559 | 325.264 | 176.274 | 7.978 | 1896.796 |
| SP_BB1 | 1982 | 15491.584 | 25338.602 | 5845.199 | 2333.359 | 1470.703 | 498.992 | 463.811 | 246.031 | 17.755 | 161.809 |
| SP_BB1 | 1983 | 260315.645 | 57094.705 | 5106.403 | 1569.293 | 215.928 | 102.641 | 15.819 | 21.894 | 0.000 | 1335.517 |
| SP_BB1 | 1984 | 12440.684 | 123616.774 | 22020.995 | 3898.224 | 2071.759 | 374.301 | 173.028 | 117.192 | 17.048 | 8.757 |
| SP_BB1 | 1985 | 15214.505 | 85475.602 | 27987.595 | 5193.554 | 1311.967 | 596.945 | 98.430 | 8.314 | 12.342 | 567.710 |
| SP_BB1 | 1986 | 142511.172 | 51194.210 | 6060.817 | 5629.801 | 1095.988 | 441.722 | 55.835 | 1.417 | 15.877 | 333.421 |
| SP_BB1 | 1987 | 23534.759 | 98350.878 | 1906.691 | 2945.813 | 1687.745 | 1165.567 | 142.143 | 18.435 | 0.000 | 121.163 |
| SP_BB1 | 1988 | 217220.004 | 58762.008 | 6414.609 | 1196.114 | 1380.811 | 744.976 | 348.135 | 9.963 | 0.000 | 445.880 |
| SP_BB1 | 1989 | 145376.613 | 95506.452 | 4326.091 | 2335.431 | 422.043 | 304.046 | 120.253 | 8.927 | 2.626 | 1284.329 |
| SP_BB1 | 1990 | 57094.756 | 34513.457 | 16284.873 | 3353.038 | 4346.880 | 615.179 | 43.381 | 277.182 | 135.698 | 398.883 |
| SP_BB1 | 1991 | 34542.464 | 48838.342 | 3546.074 | 3677.421 | 1813.768 | 645.626 | 357.943 | 159.516 | 63.979 | 194.497 |
| SP_BB1 | 1992 | 21716.658 | 51766.216 | 5920.862 | 1624.567 | 608.048 | 171.353 | 23.952 | 69.880 | 32.733 | 95.600 |
| SP_BB1 | 1993 | 28871.685 | 157853.480 | 47785.222 | 14582.551 | 3243.721 | 1280.599 | 156.697 | 79.002 | 33.616 | 102.193 |
| SP_BB1 | 1994 | 84039.313 | 31449.314 | 15752.819 | 7392.120 | 3961.062 | 364.294 | 5.204 | 23.754 | 20.586 | 212.724 |
| SP_BB1 | 1995 | 155047.280 | 78036.842 | 34811.828 | 3946.193 | 398.958 | 193.826 | 6.000 | 5.078 | 1.470 | 15.195 |
| SP_BB1 | 1996 | 242427.528 | 73522.498 | 68450.873 | 26614.201 | 8286.554 | 439.203 | 46.021 | 27.508 | 53.496 | 641.370 |
| SP_BB1 | 1997 | 232586.396 | 119134.844 | 116331.100 | 25327.805 | 8416.306 | 472.630 | 32.922 | 23.695 | 39.128 | 1347.848 |
| SP_BB1 | 1998 | 49751.677 | 53718.483 | 26785.583 | 23449.606 | 1217.099 | 875.470 | 571.415 | 201.346 | 28.016 | 725.889 |
| SP_BB1 | 1999 | 4844.727 | 4374.066 | 3299.429 | 10396.332 | 10710.615 | 2232.505 | 577.013 | 94.203 | 60.293 | 170.832 |
| SP_BB1 | 2000 | 41477.775 | 22673.833 | 12149.339 | 4341.027 | 5862.376 | 3415.653 | 956.978 | 1277.226 | 778.819 | 596.302 |
| SP_BB1 | 2001 | 2349.005 | 98275.493 | 24419.592 | 5217.017 | 1529.907 | 1837.213 | 1085.981 | 283.209 | 614.469 | 867.881 |
| SP_BB1 | 2002 | 30757.774 | 81019.683 | 39021.222 | 4163.217 | 1030.961 | 239.219 | 172.797 | 411.184 | 435.101 | 840.849 |
| SP_BB1 | 2003 | 7042.124 | 32260.438 | 11175.112 | 974.482 | 1547.608 | 877.075 | 170.751 | 387.543 | 1301.243 | 1287.329 |
| SP_BB1 | 2004 | 65715.097 | 57991.083 | 8486.855 | 5715.550 | 1453.018 | 678.649 | 323.694 | 100.525 | 205.211 | 1296.042 |
| SP_BB1 | 2005 | 133943.015 | 44372.151 | 23971.974 | 3461.694 | 2685.263 | 520.792 | 155.707 | 64.819 | 39.897 | 529.299 |
| SP_BB1 | 2006 | 30906.800 | 23325.203 | 13921.525 | 6359.722 | 1204.216 | 967.034 | 434.236 | 80.744 | 59.407 | 440.325 |
| SP_BB2 | 2007 | 18803.040 | 38677.457 | 27817.417 | 17969.568 | 6343.453 | 1891.277 | 665.170 | 156.560 | 98.956 | 894.008 |
| SP_BB2 | 2008 | 298.838 | 52587.281 | 35478.609 | 16611.151 | 2351.542 | 102.990 | 397.691 | 233.180 | 300.226 | 1070.880 |
| SP_BB2 | 2009 | 44.467 | 12772.378 | 14152.141 | 5763.972 | 2068.793 | 3064.159 | 936.386 | 331.164 | 301.775 | 533.189 |
| SP_BB2 | 2010 | 122.767 | 16606.885 | 7517.981 | 4134.842 | 901.151 | 285.710 | 608.584 | 116.543 | 99.611 | 206.712 |
| SP_BB2 | 2011 | 0.000 | 5604.526 | 4193.105 | 2763.694 | 3140.259 | 1237.593 | 224.208 | 267.327 | 86.397 | 289.384 |
| SP_BB2 | 2012 | 0.000 | 0.000 | 3120.407 | 2506.080 | 861.316 | 103.985 | 55.007 | 25.393 | 55.699 | 211.347 |
| SP_BB2 | 2013 | 0.000 | 7.861 | 90.975 | 564.728 | 399.639 | 224.428 | 37.459 | 118.274 | 17.651 | 732.131 |
| SP_BB2 | 2014 | 0.000 | 37.156 | 110.068 | 268.796 | 141.636 | 37.876 | 14.088 | 9.873 | 15.951 | 326.441 |
| SP_BB2 | 2015 | 0.000 | 166.079 | 2218.905 | 163.938 | 49.358 | 5.977 | 2.121 | 6.979 | 20.973 | 583.938 |
| WMED_LARV | 2001 | 0 | 0 | 0.25 | 0.5 | 1 | 1 | 1 | 1 | 1 | 1 |
| WMED_LARV | 2002 | 0 | 0 | 0.25 | 0.5 | 1 | 1 | 1 | 1 | 1 | 1 |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| WMED_LARV | 2003 | 0 | 0 | 0.25 | 0.5 | 1 | 1 | 1 | 1 | 1 | 1 |
| WMED_LARV | 2004 | 0 | 0 | 0.25 | 0.5 | 1 | 1 | 1 | 1 | 1 | 1 |
| WMED_LARV | 2005 | 0 | 0 | 0.25 | 0.5 | 1 | 1 | 1 | 1 | 1 | 1 |
| WMED_LARV | 2006 | 0 | 0 | 0.25 | 0.5 | 1 | 1 | 1 | 1 | 1 | 1 |
| WMED_LARV | 2007 | 0 | 0 | 0.25 | 0.5 | 1 | 1 | 1 | 1 | 1 | 1 |
| WMED_LARV | 2008 | 0 | 0 | 0.25 | 0.5 | 1 | 1 | 1 | 1 | 1 | 1 |
| WMED_LARV | 2009 | 0 | 0 | 0.25 | 0.5 | 1 | 1 | 1 | 1 | 1 | 1 |
| WMED_LARV | 2010 | 0 | 0 | 0.25 | 0.5 | 1 | 1 | 1 | 1 | 1 | 1 |
| WMED_LARV | 2011 | 0 | 0 | 0.25 | 0.5 | 1 | 1 | 1 | 1 | 1 | 1 |
| WMED_LARV | 2012 | 0 | 0 | 0.25 | 0.5 | 1 | 1 | 1 | 1 | 1 | 1 |
| WMED_LARV | 2013 | 0 | 0 | 0.25 | 0.5 | 1 | 1 | 1 | 1 | 1 | 1 |
| WMED_LARV | 2014 | 0 | 0 | 0.25 | 0.5 | 1 | 1 | 1 | 1 | 1 | 1 |
| WMED_LARV | 2015 | 0 | 0 | 0.25 | 0.5 | 1 | 1 | 1 | 1 | 1 | 1 |