AN EXTENDED "EXTENDED SURVIVORS ANALYSIS" OF MEDITERRANEAN SWORDFISH

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SUMMARY

This document presents an updated catch-at-age (CAA) matrix for Mediterranean swordfish. Conducts a continuity stock assessment run using Extended Survivors Analysis XSA and presents a candidate run based selected on goodness of fit diagnostics. All the code used is provided as an appendix.

RÉSUMÉ

Ce document présente une matrice de prise par âge (CAA) actualisée pour l'espadon de la Méditerranée. Il fournit un scénario de continuité de l'évaluation de stock à l'aide d'une « Extended Survivors Analysis » (XSA) et présente un possible scénario fondé sur des diagnostics sélectionnés de la qualité de l'ajustement. Tous les codes utilisés sont fournis comme appendice.

RESUMEN

Este documento presenta una matriz de captura por edad (CAA) actualizada para el pez espada del Mediterráneo, proporciona un ensayo de continuidad de la evaluación de stock utilizando el Extended survivor Analysis (XSA) y presenta un posible ensayo basado en diagnósticos seleccionados de la bondad de ajuste. Todo el código utilizado se presenta como Apéndice.

KEYWORDS

Extended Survivors Analysis,
Stock Assessment, Swordfish, Virtual Population Analysis

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Introduction

This document presents an updated catch-at-age (CAA) matrix for Mediterranean swordfish, conducts an Extended Survivors Analysis for a continuity based on the last assessment and an alternative, i.e. the candidate run based on fit diagnostics. Full diagnostics are presented and a stock projection performed.

Before running XSA two catch curve analyses are conducted to explore levels of total mortality (Z) and relative F at age (i.e. selection pattern).

Material and Methods

Material

Catch-at-size (CAS) data are important inputs for stock assessment methods. For methods based on Virtual Population Analysis (VPA) CAS data first have to be converted into catch-at-age (CAA). In ICCAT age slicing using a deterministic growth model is often used. However showed that taking a statistically based approach is preferable. This assumes that the CAS is composed of a mixture of length frequency distributions. For Mediterranean swordfish it was shown that age slicing underestimated both the proportion of younger fish in the catch and uncertainty in the catch-at-age estimates. We therefore use the statistical method to derive the CAA matrix.

Methods

XSA

XSA is a variant of VPA which derives population abundance from VPA using estimates of terminal year Ns for each cohort, either the year in which it reaches the oldest age, or the final year of the assessment. N by year and age derived via cohort analysis and CPUE (U) indices are used to estimate catchability for each Catch per Unit Effort (CPUE) series allowing predictions of N to be obtained by year, age and series. Weighted averages of the predicted values of N for a particular cohort are then used to estimates the terminal populations (the oldest age in each cohort) after adjustment for mortality. Inverse variance weighting is used to down weight data from CPUE indices that do not fit well. Since estimates of N are a function of the terminal populations XSA iterates until the difference in estimates of fishing mortality between updates of the terminal populations is small.

CPUE is first transformed to relate the population abundance during the time at which the catch was taken to the population abundance at the beginning of the year. There are two models for the relationship between a CPUE index and population abundance. In the first fleet catchabilities are assumed to be constant with respect to time (the fully recruited ages of all fleets), whereas in the second, they are assumed proportional to year class abundance (used for the recruiting ages of all fleets). In this analysis the former relationship was used and a weighted linear calibration regression was used to estimate fleet-based estimates of population numbers-at-age from the fitted relationship during each iteration.

An important part of XSA is shrinkage to the mean of which there are two forms i.e. shrinkage to the mean population and shrinkage to the mean F (applied to all ages). Time series weights can be applied to discount past values.

Powell-Wetherall

Beverton and Holt (1956) developed a method to estimate population parameters such as total mortality (Z) from length data e.g.

$$Z = K\frac{L_\infty - \overline{L}}{\overline{L} - L'} \tag{1}$$

Based on this equation Powell (1979) developed a method, extended by Wetherall et al. (1987), to estimate growth and mortality parameters. This assumes that the right hand tail of a length frequency distribution was determined by the asymptotic length L and the ratio between Z and the growth rate K. The Beverton and Holt methods assumes good estimates for K and L_∞, while the Powell-Wetherall method only requires an estimate of K, since L_∞ is estimated by the method as well as Z/K.These method therefore provide estimates for each distribution of Z/K, if K is unknown and Z if K is known.

As well as assuming that growth follows the von Bertalanffy growth function, it is also assumed that the population is in a steady state with constant exponential mortality, no changes in selection pattern of the fishery and constant recruitment. In the Powell-Wetherall method L' can take any value between the smallest and largest sizes. Equation 1 then provides a series of estimates of Z. Plotting equation 2 provides an estimate of L_∞ and Z/K. If K is known then it also provides an estimate of Z

$$\overline{L} - L' = a + bL' \tag{2}$$

$$b = \frac{-K}{Z + K} \tag{3}$$

$$a = -bL_\infty \tag{4}$$

$$L_\infty = -a/b \tag{5}$$

$$Z/K = \frac{-1 - b}{b} \tag{6}$$

Catch curve analysis

Catch curve can be fitted to an actual or a “synthetic” cohort which uses catch data from a single year or a few years.

If p_a denotes the fraction of the total catch corresponding to age a then a linear regression of p_a can be fitted over a range of ages $[\alpha, \beta]$. As for the year-class curve analysis, the slope of the regression can be used to estimate the total mortality (Z), but we here applied for estimating selectivity. In theory, the ages that are not fully selected do not follow a linear to age a, then a linear regression on p_a over a.

The selectivities can be thus estimated from the ratio of observed to predicted catch proportion, re-scaled so that the maximum is 1. In other words, the selectivity is maximal (equal to 1) when there is no difference between the observed and expected curves and it becomes smaller as the difference between both curves increases.

Results

Inputs

The length frequency (CAS) data from which the CAA were derived are presented in **Figure 1** along with the statistical estimates of the modes (red) and the fitted distribution (green). The deterministic numbers-at-age derived from age slicing are shown in **Figure 2** and the statistical estimates in **Figure 3**; these are compared in **Figure 4**. The statistical estimates show a younger mean age (i.e. the distribution is shifted to the left compared to the age sliced distributions).

The corresponding residuals of the mean proportion of numbers-at-age (P_a) are presented in **Figure 5** and **Figure 6**. The intention is to check for cohort signals, i.e. a strong cohort recruiting to the fishing would be shown as a black row of dots moving diagonally from left to right. After age 5 it becomes more difficult to follow cohort structure particularly in the age-sliced data. The 2000 year-class can be followed to about age 6 in the statistical estimates but only to age 4 in the deterministic estimates.

Estimated ages for older fish is likely to be positively biased (i.e. the number of older fish is overestimated, see SCRS/2014/115) since the estimated aged distribution is skewed to the right since the slope of the growth curve decreases as fish grow. This means that there is a positive bias in the mean age of the fish and that F estimates from age slicing will be negatively biased. Which in turn means that selectivity-at-age may not actually decrease in the older ages as suggested in the Figures above.

Figure 7 checks that the CAA is consistent with total biomass estimates catch biomass derived from different procedures are compared; the sum of products (SOP, i.e. the difference between the report catch and that derived from the sum of the CAA times the weights-at-age) correction was about 2%.

Size and Age Analysis

Catch-at-size is presented by lustrum (5 year block) in **Figure 8. Figure 9** are the corresponding Powell-Whetherall plots. The plot of Z in **Figure 10** shows the estimates from each year (black line with points) and a smoother (blue continuous line).

Catch curves using the statistical estimates of CAA are plotted in **Figure 11** by lustrum and the derived selectivity patterns in **Figure 12** by lustrum and in **Figure 13** by gear and **Figure 14** by gear and lustrum.

XSA Runs

Two runs were performed, see **Tables 1a and 1b** for the specifications. These were a continuity (i.e. the specifications used in the last assessment) and the candidate run where XSA options were selected based on a variety of diagnostics.

The changes in the candidate run compare to the continuity run were

- Number of ages used in F shrinkage for the terminal age (i.e. 4) was set to 1 age, as there are only 5 actual age classes in the VPA and the selectivity analysis showed that the relative F (selection pattern) varied by age varied.
- F shrinkage across years to estimate Fs in the terminal year was set to 0.5 since in the previous assessment (when a value of 0.3 was used) this resulted in a large down weighing of the CPUE data.

Inspection of residuals allows a check for violation of models assumptions. It is assumed that the variance of the log residuals is constant, therefore the residuals are plotted against the expected value in **Figure 15 and 25**. Next to help identify patterns that may indicate problems with the fit the residuals are plotted against year in **figures 16 and 26**. There appears to be a poor fit to the Sicilian gillnet index, this series however is down weighted in the fit (see **figures 21 and 31** below). **Figures 20 and 30** and **Figures 21 and 31** check that the residuals are normally distributed, and that there is no autocorrelation between them.

XSA uses calibration regression to estimate the terminal Ns by CPUE observation, therefore in **Figures 17, 18, 19, 27, 28 and 29** the observations (CPUE observations divided by q) are plotted against the corresponding numbers-at-age adjusted by Z to the average value at the time of fishing. The he observations have been transformed by scaling them by q, the points should therefore fall along the y=x (black) line. It can be seen that the Sicilian gillnet is a particular poor fit, while the Spanish and Greek longlines are good fits. **Figure 22** shows that the Sicilian gillnet is given a very low weight in the fit and the Spanish and Greek longlines the biggest weight. This is due to the use of inverse variance weighting. XSA uses time series and inverse variance weights to calculate weighted means for the terminal Ns, these weights are presented in **Figures 22 and 32**. The fleets that are given the biggest weighting in the estimation of the terminal VPA Ns show the best fits to the data, an endearing characteristic of XSA.

Figure 23 and 33 presents time series estimated using each CPUE one at a time and **Figures 24 and 34** presents retrospective XSA time series. In the first case all the CPUE series give the same inference about the historic stock dynamics, except the Spain longline that suggests that harvest rate has decline and stock biomass increased to a greater extent than the other indices suggest. The retrospective analyses are pleasing in that no particular bias is seen in them, while in the case of the candidate run very little retrospection is seen.

Stock Status

Table 3 shows the stock estimates from XSA. **Table 4a** shows the XSA diagnostics from the continuity run and **Table 4b** the XSA diagnostics from alternative run. Estimates of stock status from the candidate run are presented in **figure 35**, a fitted Stock Recruitment Relationship (SRR) of the Beverton and Holt functional form with diagnostics is presented in **Figure 36**. The diagnostics are of the same form as used for the CPUE fits, i.e. to check for normality, systematic bias and autocorrelation that may indicate problems with the fit. There is no apparent stock recruitment relationship, although recent recruitments appear to have declined.

That there is a stock recruitment relationship (SRR) is a main assumption of many stock assessment models. However, it has also been known for nearly a century that fish stocks can fluctuate extensively over a large range of spatial and temporal scales independent of human exploitation argued that recruitment may shift between regimes independently of stock biomass and that spawning stock biomass (SSB) is a function of recruitment, i.e. periods of high or low recruitment generate periods of high or low stock biomass respectively as fish mature. This hypothesis is supported by recent meta-analyses which showed that irregular changes in productivity are common and that management targets and limits as reference points may need to be adjusted whenever productivity changes.

Figure 37a and 27a present an equilibrium analysis (i.e. that combines a per recruit analysis with a SRR) with reference points and **Figure 27a and 37b** present the equilibrium Analysis with observations.

The Kobe Phase Plot is shown in **Figure 38.**

Projections

Projections were performed using the current estimate of stock status from the candidate run, the expected values of biological parameters from the equilibrium analysis and the fitted SRR. Two selection patterns were considered corresponding to i) same as the recent selection pattern and ii) a change towards a mesopelagic fishery, i.e. the average of the current and mesopelagic selection patterns **Figure 39** and either state quo F or a reduction in F by 80%.

The procedure was similarly to previous projections where each management scenario was simulated 100 times where future recruitment was simulated using a Monte Carlo resampling from the residuals to the SRR fit. Population size and volume of landings were estimated from the commonly used exponential decay and catch equations. In addition it was assumed that: (a) annual natural mortality equals to 0.2 for all ages.

Figure 40 presents the projections for the current selection pattern and **Figure 41.** The projections for a 50:50 current: mesopelagic selection pattern.

Discussion

- As in the last assessment conversion of CAS to CAA was undertaken using a statistical method as this was shown to be preferable to the deterministic age slicing approach.
- Two XSA runs were conducted, i.e. that based on the 2010 settings and an alternative candidate run based on goodness of fit diagnostics and a preliminary analysis of the size and age data using catch curves. The main changes in the candidate run were to reduce F shrinkage to the mean, since there have been changes in both selection pattern and mean F; reduced the F shrinkage age range to 1 age as there were only 4 true ages and F varied by age.
- An important aspect of XSA is inverse variance weighting in that CPUE series with poor fits are down weighted in the fit. In the candidate run results were consistent for all CPUE indices, other than the Spanish longline as shown by a run in which a single CPUE index was used at a time.
- There was also no particular retrospective pattern. This means that the results are robust to uncertainty with respect to the CPUE indices.
- Although harvest rate and catch have decline recently the recovery is not as great as expected since recruitment appears to have declined. Therefore the robustness of reference points based on the average recruitment of the entire time series should be evaluated.

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Table 1a. XSA Control options from continuity run.

```
tol           1e-09
maxit         30
min.nse           0.3
fse           0.3
rage          1
qage          6
shk.n         TRUE
shk.f         TRUE
shk.yrs           5
shk.ages          5
window        100
tsrange           20
tspower           3
vpa           TRUE
```

Table 1b. XSA Control options from alternative run.

```
tol           1e-09
maxit         30
min.nse           0.3
fse           0.5
rage          1
qage          6
shk.n         TRUE
shk.f         TRUE
shk.yrs           5
shk.ages          2
window        100
tsrange           5
tspower           1
vpa           TRUE
```

Table 2a. Reference Points

```
An object of class "FLPar"
        quantity
refpt    harvest    yield      rec        ssb        biomass
  virgin 0.0000e+00 0.0000e+00 8.5980e+02 2.3656e+05 2.6656e+05
  msy    2.4133e-01 1.5605e+04 8.5965e+02 4.8408e+04 7.1497e+04
  crash  3.1540e+00 2.0284e-03 2.5483e-04 2.9637e-06 1.4898e-03
  f0.1   1.4688e-01 1.4658e+04 8.5973e+02 8.2931e+04 1.0842e+05
  fmax   2.4145e-01 1.5605e+04 8.5965e+02 4.8376e+04 7.1462e+04
  spr.30 1.7287e-01 1.5169e+04 8.5971e+02 7.0960e+04 9.5750e+04
units:  NA
```

Table 2b. Reference Points with 50% Mesopelagic selection pattern.

```
An object of class "FLPar"
        quantity
refpt    harvest    yield      rec        ssb        biomass
  virgin 0.0000e+00 0.0000e+00 8.5980e+02 2.3656e+05 2.6656e+05
  msy    2.4143e-01 1.6689e+04 8.5965e+02 4.7482e+04 7.1831e+04
  crash  3.7105e+00 2.2882e-03 2.6212e-04 3.0485e-06 1.8107e-03
  f0.1   1.4013e-01 1.5574e+04 8.5973e+02 8.3812e+04 1.1032e+05
  fmax   2.4157e-01 1.6689e+04 8.5965e+02 4.7448e+04 7.1794e+04
  spr.30 1.6789e-01 1.6184e+04 8.5971e+02 7.0960e+04 9.6844e+04
units:  NA
```

Table 3. Stock information

```
An object of class "FLStock"
Slot "catch":
An object of class "FLQuant"
, , unit = unique, season = all, area = unique

     year
age   1985  1986  1987  1988  1989  1990  1991  1992  1993  1994  1995
  all 15292 16765 18320 20365 17762 16018 15746 14709 13265 16082 13015
     year
age   1996  1997  1998  1999  2000  2001  2002  2003  2004  2005  2006
  all 12053 14693 14369 13699 15569 15006 12814 15674 14405 14601 14893
     year
age   2007  2008  2009  2010  2011  2012  2013
  all 14227 12164 11840 13430 11423  9888 11254

units:  NA

Slot "catch.n":
An object of class "FLQuant"
, , unit = unique, season = all, area = unique

   year
age 1985     1986     1987     1988     1989     1990     1991
  0  21.4729  20.6035  44.3813  63.1249  74.3797  15.3243  27.4159
  1 134.5648  90.5752 153.1706 265.5847 197.1327 234.2886 174.9776
  2 134.6194 177.6181 133.4858 168.8764 176.0136 289.0440 196.6749
  3  79.1531  76.0513  81.8548  87.5656  86.8658  74.0081  92.0008
  4  42.6496  45.2544  59.8951  65.5141  54.4569  24.5272  36.7259
  5  51.0371  58.7734  65.9006  59.3421  45.0798  24.1648  32.4736
   year
age 1992     1993     1994     1995     1996     1997     1998
  0  56.2606  47.2734  67.7528  53.5708  27.6208  26.5902  46.3369
  1 172.1673 239.6096 190.6157 246.8151 176.5885 156.1288 248.9399
  2 219.3156 198.0215 251.2519 164.9636 162.4746 195.0504 160.8919
  3  64.1896  49.8246  69.1512  57.0136  68.1938  87.2302  55.0914
  4  30.4537  23.7044  26.3690  23.1110  23.1912  40.6634  32.5162
  5  33.1255  27.0431  35.9536  26.2792  21.6804  24.0022  38.8505
   year
age 1999     2000     2001     2002     2003     2004     2005
  0  31.6699  10.2255  20.6051   9.1971  56.6800  60.4517  14.2259
  1 177.5012 208.9787 193.4171 288.4701 203.1130 245.1487 221.9711
  2 155.8745 184.8450 200.5366 215.1277 270.0108 174.7456 207.5041
  3  66.5933  75.2087  81.1425  46.1867  77.5790  66.1635  64.2196
  4  35.2808  38.1185  29.4873  17.7672  30.3505  31.7959  28.6761
```

```
  5  33.5977  36.8194  29.8884  20.7071  21.6038  31.4460  29.8566
   year
age 2006     2007     2008     2009     2010     2011     2012
  0  27.1267  24.4187   9.5989  12.7435  26.3902  87.4014  21.9434
  1 161.6561 267.5342 274.0811 182.0861 151.5678 123.6516 113.8618
  2 200.6652 160.1002 184.8834 153.2820 138.1137 131.1289  95.5075
  3  60.1729  68.8383  58.8265  57.7290  78.5488  75.0686  42.5593
  4  31.3468  31.1331  21.6520  32.8373  42.3556  23.5957  20.2280
  5  39.2381  28.2827  14.0846  20.9188  28.7229  22.5787  26.3230
   year
age 2013
  0   3.1197
  1 128.6195
  2 159.9425
  3  51.9627
  4  25.0570
  5  25.7617

units:  NA

Slot "catch.wt":
An object of class "FLQuant"
, , unit = unique, season = all, area = unique

   year
age 1985     1986     1987     1988     1989     1990     1991
  0   3.5973   3.3550   3.8595   4.1875   3.3635   3.5320   3.6676
  1  10.7577  10.7182   9.9559  10.2292  10.6368  10.7895  10.9384
  2  22.8482  23.3794  23.3902  22.3407  22.6277  22.5130  22.9624
  3  39.9227  39.9683  40.8690  41.1086  40.7663  39.8577  39.8578
  4  60.2237  61.2643  62.0729  60.7125  59.9180  59.6007  59.5622
  5  92.5657  94.9294  95.9938  95.6335  95.8431  93.1051  96.6367
   year
age 1992     1993     1994     1995     1996     1997     1998
  0   3.5290   3.7548   3.6669   3.4276   3.7449   3.6454   3.4840
  1  11.7756  11.0303  11.7135  10.3914  10.4839  10.7970   9.8658
  2  21.0501  21.0571  21.5953  22.7362  22.7384  23.3870  22.5815
  3  39.8598  39.8651  39.8655  39.8577  39.8577  39.8577  40.4127
  4  59.8357  59.9089  59.7883  59.7285  59.5101  59.6189  59.9181
  5  97.3624  97.3884  98.8695  98.1105  97.6339  91.9874  96.0047
   year
age 1999     2000     2001     2002     2003     2004     2005
  0   4.1242   3.7035   3.7259   3.6340   3.2894   3.4900   3.4467
  1  11.1596  10.7847  10.9189  10.3710  11.6721   9.9678  11.4007
  2  21.9276  22.7796  22.7163  21.7204  21.7040  22.5322  21.5889
  3  39.8610  39.9498  39.8579  39.8577  39.8586  39.8591  39.8795
  4  59.8914  59.9181  59.4784  59.7334  59.5068  59.8700  59.7541
  5  94.9498  95.6923 101.7694 101.2668  98.2296  97.4292 101.0340
   year
age 2006     2007     2008     2009     2010     2011     2012
  0   3.3710   3.4884   3.5483   4.1936   4.0896   3.5494   3.6247
  1  11.7997  10.4942  10.9215  10.5780  10.4251  10.6537  11.3421
  2  21.7698  22.7073  21.6111  22.0457  22.7801  22.3551  21.9654
  3  39.8665  40.1303  39.8578  39.8599  39.8629  39.9490  40.2181
  4  60.0432  59.5603  59.4830  60.3255  59.6308  58.8395  59.6101
  5 100.9875 101.1686  95.5016  94.6294  95.1012  99.6323  99.8336
   year
age 2013
  0   3.6779
  1  11.3741
  2  22.2070
```

```
  3  39.8856
  4  59.4617
  5  99.6322

units:  NA

Slot "discards":
An object of class "FLQuant"
, , unit = unique, season = all, area = unique

     year
age   1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997
  all 0    0    0    0    0    0    0    0    0    0    0    0    0
     year
age   1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010
  all 0    0    0    0    0    0    0    0    0    0    0    0    0
     year
age   2011 2012 2013
  all 0    0    0

units:  NA

Slot "discards.n":
An object of class "FLQuant"
, , unit = unique, season = all, area = unique

   year
age 1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998
  0 0    0    0    0    0    0    0    0    0    0    0    0    0    0
  1 0    0    0    0    0    0    0    0    0    0    0    0    0    0
  2 0    0    0    0    0    0    0    0    0    0    0    0    0    0
  3 0    0    0    0    0    0    0    0    0    0    0    0    0    0
  4 0    0    0    0    0    0    0    0    0    0    0    0    0    0
  5 0    0    0    0    0    0    0    0    0    0    0    0    0    0
   year
age 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012
  0 0    0    0    0    0    0    0    0    0    0    0    0    0    0
  1 0    0    0    0    0    0    0    0    0    0    0    0    0    0
  2 0    0    0    0    0    0    0    0    0    0    0    0    0    0
  3 0    0    0    0    0    0    0    0    0    0    0    0    0    0
  4 0    0    0    0    0    0    0    0    0    0    0    0    0    0
  5 0    0    0    0    0    0    0    0    0    0    0    0    0    0
   year
age 2013
  0 0
  1 0
  2 0
  3 0
  4 0
  5 0

units:  NA

Slot "discards.wt":
An object of class "FLQuant"
, , unit = unique, season = all, area = unique

   year
age 1985    1986    1987    1988    1989    1990    1991    1992   
  0  3.5973  3.3550  3.8595  4.1875  3.3635  3.5320  3.6676  3.5290
  1 10.7577 10.7182  9.9559 10.2292 10.6368 10.7895 10.9384 11.7756
```

```
  2 22.8482 23.3794 23.3902 22.3407 22.6277 22.5130 22.9624 21.0501
  3 39.9227 39.9683 40.8690 41.1086 40.7663 39.8577 39.8578 39.8598
  4 60.2237 61.2643 62.0729 60.7125 59.9180 59.6007 59.5622 59.8357
  5  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
   year
age 1993    1994    1995    1996    1997    1998    1999    2000
  0  3.7548  3.6669  3.4276  3.7449  3.6454  3.4840  4.1242  3.7035
  1 11.0303 11.7135 10.3914 10.4839 10.7970  9.8658 11.1596 10.7847
  2 21.0571 21.5953 22.7362 22.7384 23.3870 22.5815 21.9276 22.7796
  3 39.8651 39.8655 39.8577 39.8577 39.8577 40.4127 39.8610 39.9498
  4 59.9089 59.7883 59.7285 59.5101 59.6189 59.9181 59.8914 59.9181
  5  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
   year
age 2001    2002    2003    2004    2005    2006    2007    2008
  0  3.7259  3.6340  3.2894  3.4900  3.4467  3.3710  3.4884  3.5483
  1 10.9189 10.3710 11.6721  9.9678 11.4007 11.7997 10.4942 10.9215
  2 22.7163 21.7204 21.7040 22.5322 21.5889 21.7698 22.7073 21.6111
  3 39.8579 39.8577 39.8586 39.8591 39.8795 39.8665 40.1303 39.8578
  4 59.4784 59.7334 59.5068 59.8700 59.7541 60.0432 59.5603 59.4830
  5  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
   year
age 2009    2010    2011    2012    2013
  0  4.1936  4.0896  3.5494  3.6247  3.6779
  1 10.5780 10.4251 10.6537 11.3421 11.3741
  2 22.0457 22.7801 22.3551 21.9654 22.2070
  3 39.8599 39.8629 39.9490 40.2181 39.8856
  4 60.3255 59.6308 58.8395 59.6101 59.4617
  5  0.0000  0.0000  0.0000  0.0000  0.0000

units:  NA

Slot "landings":
An object of class "FLQuant"
, , unit = unique, season = all, area = unique

     year
age   1985  1986  1987  1988  1989  1990  1991  1992  1993  1994  1995
  all 15292 16765 18320 20365 17762 16018 15746 14709 13265 16082 13015
     year
age   1996  1997  1998  1999  2000  2001  2002  2003  2004  2005  2006
  all 12053 14693 14369 13699 15569 15006 12814 15674 14405 14601 14893
     year
age   2007  2008  2009  2010  2011  2012  2013
  all 14227 12164 11840 13430 11423  9888 11254

units:  NA

Slot "landings.n":
An object of class "FLQuant"
, , unit = unique, season = all, area = unique

   year
age 1985     1986     1987     1988     1989     1990     1991
  0  21.4729  20.6035  44.3813  63.1249  74.3797  15.3243  27.4159
  1 134.5648  90.5752 153.1706 265.5847 197.1327 234.2886 174.9776
  2 134.6194 177.6181 133.4858 168.8764 176.0136 289.0440 196.6749
  3  79.1531  76.0513  81.8548  87.5656  86.8658  74.0081  92.0008
  4  42.6496  45.2544  59.8951  65.5141  54.4569  24.5272  36.7259
  5  51.0371  58.7734  65.9006  59.3421  45.0798  24.1648  32.4736
   year
age 1992     1993     1994     1995     1996     1997     1998
```

```
  0  56.2606  47.2734  67.7528  53.5708  27.6208  26.5902  46.3369
  1 172.1673 239.6096 190.6157 246.8151 176.5885 156.1288 248.9399
  2 219.3156 198.0215 251.2519 164.9636 162.4746 195.0504 160.8919
  3  64.1896  49.8246  69.1512  57.0136  68.1938  87.2302  55.0914
  4  30.4537  23.7044  26.3690  23.1110  23.1912  40.6634  32.5162
  5  33.1255  27.0431  35.9536  26.2792  21.6804  24.0022  38.8505
   year
age 1999     2000     2001     2002     2003     2004     2005
  0  31.6699  10.2255  20.6051   9.1971  56.6800  60.4517  14.2259
  1 177.5012 208.9787 193.4171 288.4701 203.1130 245.1487 221.9711
  2 155.8745 184.8450 200.5366 215.1277 270.0108 174.7456 207.5041
  3  66.5933  75.2087  81.1425  46.1867  77.5790  66.1635  64.2196
  4  35.2808  38.1185  29.4873  17.7672  30.3505  31.7959  28.6761
  5  33.5977  36.8194  29.8884  20.7071  21.6038  31.4460  29.8566
   year
age 2006     2007     2008     2009     2010     2011     2012
  0  27.1267  24.4187   9.5989  12.7435  26.3902  87.4014  21.9434
  1 161.6561 267.5342 274.0811 182.0861 151.5678 123.6516 113.8618
  2 200.6652 160.1002 184.8834 153.2820 138.1137 131.1289  95.5075
  3  60.1729  68.8383  58.8265  57.7290  78.5488  75.0686  42.5593
  4  31.3468  31.1331  21.6520  32.8373  42.3556  23.5957  20.2280
  5  39.2381  28.2827  14.0846  20.9188  28.7229  22.5787  26.3230
   year
age 2013
  0   3.1197
  1 128.6195
  2 159.9425
  3  51.9627
  4  25.0570
  5  25.7617

units:  NA

Slot "landings.wt":
An object of class "FLQuant"
, , unit = unique, season = all, area = unique

   year
age 1985     1986     1987     1988     1989     1990     1991
  0   3.5973   3.3550   3.8595   4.1875   3.3635   3.5320   3.6676
  1  10.7577  10.7182   9.9559  10.2292  10.6368  10.7895  10.9384
  2  22.8482  23.3794  23.3902  22.3407  22.6277  22.5130  22.9624
  3  39.9227  39.9683  40.8690  41.1086  40.7663  39.8577  39.8578
  4  60.2237  61.2643  62.0729  60.7125  59.9180  59.6007  59.5622
  5  92.5657  94.9294  95.9938  95.6335  95.8431  93.1051  96.6367
   year
age 1992     1993     1994     1995     1996     1997     1998
  0   3.5290   3.7548   3.6669   3.4276   3.7449   3.6454   3.4840
  1  11.7756  11.0303  11.7135  10.3914  10.4839  10.7970   9.8658
  2  21.0501  21.0571  21.5953  22.7362  22.7384  23.3870  22.5815
  3  39.8598  39.8651  39.8655  39.8577  39.8577  39.8577  40.4127
  4  59.8357  59.9089  59.7883  59.7285  59.5101  59.6189  59.9181
  5  97.3624  97.3884  98.8695  98.1105  97.6339  91.9874  96.0047
   year
age 1999     2000     2001     2002     2003     2004     2005
  0   4.1242   3.7035   3.7259   3.6340   3.2894   3.4900   3.4467
  1  11.1596  10.7847  10.9189  10.3710  11.6721   9.9678  11.4007
  2  21.9276  22.7796  22.7163  21.7204  21.7040  22.5322  21.5889
  3  39.8610  39.9498  39.8579  39.8577  39.8586  39.8591  39.8795
  4  59.8914  59.9181  59.4784  59.7334  59.5068  59.8700  59.7541
  5  94.9498  95.6923 101.7694 101.2668  98.2296  97.4292 101.0340
```

```
   year
age 2006     2007     2008     2009     2010     2011     2012    
  0   3.3710   3.4884   3.5483   4.1936   4.0896   3.5494   3.6247
  1  11.7997  10.4942  10.9215  10.5780  10.4251  10.6537  11.3421
  2  21.7698  22.7073  21.6111  22.0457  22.7801  22.3551  21.9654
  3  39.8665  40.1303  39.8578  39.8599  39.8629  39.9490  40.2181
  4  60.0432  59.5603  59.4830  60.3255  59.6308  58.8395  59.6101
  5 100.9875 101.1686  95.5016  94.6294  95.1012  99.6323  99.8336
   year
age 2013    
  0   3.6779
  1  11.3741
  2  22.2070
  3  39.8856
  4  59.4617
  5  99.6322

units:  NA 

Slot "stock":
An object of class "FLQuant"
, , unit = unique, season = all, area = unique

     year
age   1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997
  all NA   NA   NA   NA   NA   NA   NA   NA   NA   NA   NA   NA   NA  
     year
age   1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010
  all NA   NA   NA   NA   NA   NA   NA   NA   NA   NA   NA   NA   NA  
     year
age   2011 2012 2013
  all NA   NA   NA  

units:  NA * NA 

Slot "stock.n":
An object of class "FLQuant"
, , unit = unique, season = all, area = unique

   year
age 1985     1986     1987     1988     1989     1990     1991    
  0  765.366  800.120  999.174 1133.759  970.817  827.703  843.546
  1  820.176  607.241  636.480  777.997  871.280  727.747  663.828
  2  567.780  550.348  415.591  383.445  398.911  536.111  385.708
  3  336.816  343.860  291.294  220.539  163.026  169.315  181.574
  4  181.484  204.613  213.146  165.000  102.201   56.112   72.480
  5  217.175  265.738  234.518  149.455   84.603   55.283   64.088
   year
age 1992     1993     1994     1995     1996     1997     1998    
  0 1036.831  900.886 1032.823  903.839  809.627  916.908  894.445
  1  665.887  798.116  694.922  784.477  691.663  637.932  726.694
  2  386.326  390.517  438.423  397.784  420.876  407.636  381.989
  3  140.475  121.260  143.192  135.565  178.138  199.140  159.672
  4   66.641   57.682   54.712   55.532   60.009   84.795   85.085
  5   72.487   65.806   74.599   63.145   56.100   50.052  101.659
   year
age 1999     2000     2001     2002     2003     2004     2005    
  0  889.401  923.087 1126.060  865.697 1032.159 1003.277  788.406
  1  690.493  699.590  746.525  903.333  700.466  793.912  766.868
  2  371.835  405.865  385.236  437.450  480.855  391.175  430.061
  3  168.878  165.042  167.197  136.720  166.258  153.506  164.143
```

```
  4   81.352   78.668   67.951   64.492   70.533   66.856   66.536
  5   77.471   75.987   68.876   75.163   50.206   66.120   69.275
   year
age 2006     2007     2008     2009     2010     2011     2012
  0  987.260  941.323  784.538  702.436  661.855  872.543  762.029
  1  632.646  783.808  748.643  633.656  563.598  518.060  635.579
  2  428.611  372.733  401.921  367.438  355.339  325.311  313.015
  3  166.945  171.768  162.047  163.959  163.751  167.300  149.020
  4   76.910   82.776   79.037   79.976   82.508   63.971   69.909
  5   96.272   75.198   51.414   50.948   55.952   61.214   90.974
   year
age 2013
  0  679.782
  1  604.085
  2  417.887
  3  170.581
  4   83.801
  5   86.158

units:  NA

Slot "stock.wt":
An object of class "FLQuant"
, , unit = unique, season = all, area = unique

   year
age 1985     1986     1987     1988     1989     1990     1991
  0   3.5973   3.3550   3.8595   4.1875   3.3635   3.5320   3.6676
  1  10.7577  10.7182   9.9559  10.2292  10.6368  10.7895  10.9384
  2  22.8482  23.3794  23.3902  22.3407  22.6277  22.5130  22.9624
  3  39.9227  39.9683  40.8690  41.1086  40.7663  39.8577  39.8578
  4  60.2237  61.2643  62.0729  60.7125  59.9180  59.6007  59.5622
  5  92.5657  94.9294  95.9938  95.6335  95.8431  93.1051  96.6367
   year
age 1992     1993     1994     1995     1996     1997     1998
  0   3.5290   3.7548   3.6669   3.4276   3.7449   3.6454   3.4840
  1  11.7756  11.0303  11.7135  10.3914  10.4839  10.7970   9.8658
  2  21.0501  21.0571  21.5953  22.7362  22.7384  23.3870  22.5815
  3  39.8598  39.8651  39.8655  39.8577  39.8577  39.8577  40.4127
  4  59.8357  59.9089  59.7883  59.7285  59.5101  59.6189  59.9181
  5  97.3624  97.3884  98.8695  98.1105  97.6339  91.9874  96.0047
   year
age 1999     2000     2001     2002     2003     2004     2005
  0   4.1242   3.7035   3.7259   3.6340   3.2894   3.4900   3.4467
  1  11.1596  10.7847  10.9189  10.3710  11.6721   9.9678  11.4007
  2  21.9276  22.7796  22.7163  21.7204  21.7040  22.5322  21.5889
  3  39.8610  39.9498  39.8579  39.8577  39.8586  39.8591  39.8795
  4  59.8914  59.9181  59.4784  59.7334  59.5068  59.8700  59.7541
  5  94.9498  95.6923 101.7694 101.2668  98.2296  97.4292 101.0340
   year
age 2006     2007     2008     2009     2010     2011     2012
  0   3.3710   3.4884   3.5483   4.1936   4.0896   3.5494   3.6247
  1  11.7997  10.4942  10.9215  10.5780  10.4251  10.6537  11.3421
  2  21.7698  22.7073  21.6111  22.0457  22.7801  22.3551  21.9654
  3  39.8665  40.1303  39.8578  39.8599  39.8629  39.9490  40.2181
  4  60.0432  59.5603  59.4830  60.3255  59.6308  58.8395  59.6101
  5 100.9875 101.1686  95.5016  94.6294  95.1012  99.6323  99.8336
   year
age 2013
  0   3.6779
  1  11.3741
```

```
  2  22.2070
  3  39.8856
  4  59.4617
  5  99.6322

units:  Tonnes

Slot "m":
An object of class "FLQuant"
, , unit = unique, season = all, area = unique

   year
age 1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998
  0 0.2  0.2  0.2  0.2  0.2  0.2  0.2  0.2  0.2  0.2  0.2  0.2  0.2  0.2
  1 0.2  0.2  0.2  0.2  0.2  0.2  0.2  0.2  0.2  0.2  0.2  0.2  0.2  0.2
  2 0.2  0.2  0.2  0.2  0.2  0.2  0.2  0.2  0.2  0.2  0.2  0.2  0.2  0.2
  3 0.2  0.2  0.2  0.2  0.2  0.2  0.2  0.2  0.2  0.2  0.2  0.2  0.2  0.2
  4 0.2  0.2  0.2  0.2  0.2  0.2  0.2  0.2  0.2  0.2  0.2  0.2  0.2  0.2
  5 0.2  0.2  0.2  0.2  0.2  0.2  0.2  0.2  0.2  0.2  0.2  0.2  0.2  0.2
   year
age 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012
  0 0.2  0.2  0.2  0.2  0.2  0.2  0.2  0.2  0.2  0.2  0.2  0.2  0.2  0.2
  1 0.2  0.2  0.2  0.2  0.2  0.2  0.2  0.2  0.2  0.2  0.2  0.2  0.2  0.2
  2 0.2  0.2  0.2  0.2  0.2  0.2  0.2  0.2  0.2  0.2  0.2  0.2  0.2  0.2
  3 0.2  0.2  0.2  0.2  0.2  0.2  0.2  0.2  0.2  0.2  0.2  0.2  0.2  0.2
  4 0.2  0.2  0.2  0.2  0.2  0.2  0.2  0.2  0.2  0.2  0.2  0.2  0.2  0.2
  5 0.2  0.2  0.2  0.2  0.2  0.2  0.2  0.2  0.2  0.2  0.2  0.2  0.2  0.2
   year
age 2013
  0 0.2
  1 0.2
  2 0.2
  3 0.2
  4 0.2
  5 0.2

units:  NA

Slot "mat":
An object of class "FLQuant"
, , unit = unique, season = all, area = unique

   year
age 1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998
  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
  1 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
  2 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
  3 0.5  0.5  0.5  0.5  0.5  0.5  0.5  0.5  0.5  0.5  0.5  0.5  0.5  0.5
  4 1.0  1.0  1.0  1.0  1.0  1.0  1.0  1.0  1.0  1.0  1.0  1.0  1.0  1.0
  5 1.0  1.0  1.0  1.0  1.0  1.0  1.0  1.0  1.0  1.0  1.0  1.0  1.0  1.0
   year
age 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012
  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
  1 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
  2 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
  3 0.5  0.5  0.5  0.5  0.5  0.5  0.5  0.5  0.5  0.5  0.5  0.5  0.5  0.5
  4 1.0  1.0  1.0  1.0  1.0  1.0  1.0  1.0  1.0  1.0  1.0  1.0  1.0  1.0
  5 1.0  1.0  1.0  1.0  1.0  1.0  1.0  1.0  1.0  1.0  1.0  1.0  1.0  1.0
   year
age 2013
  0 0.0
```

```
  1 0.0
  2 0.0
  3 0.5
  4 1.0
  5 1.0

units:  NA

Slot "harvest":
An object of class "FLQuant"
, , unit = unique, season = all, area = unique

   year
age 1985      1986      1987      1988      1989      1990      1991
  0 0.0314273 0.0288087 0.0502063 0.0633297 0.0881848 0.0206317 0.0364953
  1 0.1989678 0.1792240 0.3067567 0.4679847 0.2856232 0.4348728 0.3413404
  2 0.3014985 0.4362168 0.4336290 0.6552870 0.6569795 0.8826768 0.8100540
  3 0.2984136 0.2782570 0.3683882 0.5691284 0.8665624 0.6484455 0.8023506
  4 0.2984144 0.2782580 0.3683900 0.5691326 0.8665749 0.6484642 0.8023960
  5 0.2984144 0.2782580 0.3683900 0.5691326 0.8665749 0.6484642 0.8023960
   year
age 1992      1993      1994      1995      1996      1997      1998
  0 0.0616707 0.0595793 0.0750337 0.0675525 0.0383424 0.0325016 0.0587975
  1 0.3336489 0.3990706 0.3578897 0.4226792 0.3287246 0.3128393 0.4700555
  2 0.9587446 0.8032840 0.9737336 0.6033505 0.5483310 0.7372503 0.6162156
  3 0.6900867 0.5958574 0.7472263 0.6149571 0.5423184 0.6503621 0.4743366
  4 0.6901641 0.5959775 0.7450457 0.6062457 0.5491225 0.7396164 0.5411092
  5 0.6901641 0.5959775 0.7450457 0.6062457 0.5491225 0.7396164 0.5411092
   year
age 1999      2000      2001      2002      2003      2004      2005
  0 0.0400529 0.0122949 0.0203888 0.0117886 0.0624345 0.0687119 0.0201024
  1 0.3313849 0.3966375 0.3344656 0.4305262 0.3825903 0.4130462 0.3817659
  2 0.6122505 0.6868513 0.8359214 0.7674239 0.9418250 0.6684161 0.7462613
  3 0.5639441 0.6874070 0.7526321 0.4618554 0.7109958 0.6359931 0.5581027
  4 0.6414244 0.7509032 0.6419700 0.3597564 0.6345456 0.7307663 0.6359317
  5 0.6414244 0.7509032 0.6419700 0.3597564 0.6345456 0.7307663 0.6359317
   year
age 2006      2007      2008      2009      2010      2011      2012
  0 0.0307690 0.0290247 0.0135882 0.0202127 0.0449558 0.1168759 0.0322696
  1 0.3290484 0.4679090 0.5117080 0.3784347 0.3495593 0.3038385 0.2193244
  2 0.7144020 0.6329787 0.6966396 0.6082059 0.5532836 0.5807012 0.4070443
  3 0.5015237 0.5762266 0.5061593 0.4867182 0.7399226 0.6725922 0.3756363
  4 0.5893967 0.5299316 0.3573419 0.5952712 0.8183516 0.5166789 0.3815999
  5 0.5893967 0.5299316 0.3573419 0.5952712 0.8183516 0.5166789 0.3815999
   year
age 2013
  0 0.0050759
  1 0.2664159
  2 0.5421825
  3 0.4062308
  4 0.3971059
  5 0.3971059

units:  f

Slot "harvest.spwn":
An object of class "FLQuant"
, , unit = unique, season = all, area = unique

   year
age 1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998
```

```
  0 0.5  0.5  0.5  0.5  0.5  0.5  0.5  0.5  0.5  0.5  0.5  0.5  0.5  0.5
  1 0.5  0.5  0.5  0.5  0.5  0.5  0.5  0.5  0.5  0.5  0.5  0.5  0.5  0.5
  2 0.5  0.5  0.5  0.5  0.5  0.5  0.5  0.5  0.5  0.5  0.5  0.5  0.5  0.5
  3 0.5  0.5  0.5  0.5  0.5  0.5  0.5  0.5  0.5  0.5  0.5  0.5  0.5  0.5
  4 0.5  0.5  0.5  0.5  0.5  0.5  0.5  0.5  0.5  0.5  0.5  0.5  0.5  0.5
  5 0.5  0.5  0.5  0.5  0.5  0.5  0.5  0.5  0.5  0.5  0.5  0.5  0.5  0.5
   year
age 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012
  0 0.5  0.5  0.5  0.5  0.5  0.5  0.5  0.5  0.5  0.5  0.5  0.5  0.5  0.5
  1 0.5  0.5  0.5  0.5  0.5  0.5  0.5  0.5  0.5  0.5  0.5  0.5  0.5  0.5
  2 0.5  0.5  0.5  0.5  0.5  0.5  0.5  0.5  0.5  0.5  0.5  0.5  0.5  0.5
  3 0.5  0.5  0.5  0.5  0.5  0.5  0.5  0.5  0.5  0.5  0.5  0.5  0.5  0.5
  4 0.5  0.5  0.5  0.5  0.5  0.5  0.5  0.5  0.5  0.5  0.5  0.5  0.5  0.5
  5 0.5  0.5  0.5  0.5  0.5  0.5  0.5  0.5  0.5  0.5  0.5  0.5  0.5  0.5
   year
age 2013
  0 0.5
  1 0.5
  2 0.5
  3 0.5
  4 0.5
  5 0.5

units:  prop

Slot "m.spwn":
An object of class "FLQuant"
, , unit = unique, season = all, area = unique

   year
age 1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998
  0 0.5  0.5  0.5  0.5  0.5  0.5  0.5  0.5  0.5  0.5  0.5  0.5  0.5  0.5
  1 0.5  0.5  0.5  0.5  0.5  0.5  0.5  0.5  0.5  0.5  0.5  0.5  0.5  0.5
  2 0.5  0.5  0.5  0.5  0.5  0.5  0.5  0.5  0.5  0.5  0.5  0.5  0.5  0.5
  3 0.5  0.5  0.5  0.5  0.5  0.5  0.5  0.5  0.5  0.5  0.5  0.5  0.5  0.5
  4 0.5  0.5  0.5  0.5  0.5  0.5  0.5  0.5  0.5  0.5  0.5  0.5  0.5  0.5
  5 0.5  0.5  0.5  0.5  0.5  0.5  0.5  0.5  0.5  0.5  0.5  0.5  0.5  0.5
   year
age 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012
  0 0.5  0.5  0.5  0.5  0.5  0.5  0.5  0.5  0.5  0.5  0.5  0.5  0.5  0.5
  1 0.5  0.5  0.5  0.5  0.5  0.5  0.5  0.5  0.5  0.5  0.5  0.5  0.5  0.5
  2 0.5  0.5  0.5  0.5  0.5  0.5  0.5  0.5  0.5  0.5  0.5  0.5  0.5  0.5
  3 0.5  0.5  0.5  0.5  0.5  0.5  0.5  0.5  0.5  0.5  0.5  0.5  0.5  0.5
  4 0.5  0.5  0.5  0.5  0.5  0.5  0.5  0.5  0.5  0.5  0.5  0.5  0.5  0.5
  5 0.5  0.5  0.5  0.5  0.5  0.5  0.5  0.5  0.5  0.5  0.5  0.5  0.5  0.5
   year
age 2013
  0 0.5
  1 0.5
  2 0.5
  3 0.5
  4 0.5
  5 0.5

units:  NA

Slot "name":
[1] "Swordfish MED                                       "

Slot "desc":
[1] "Imported from a VPA file. ( /home/laurie/Desktop/Dropbox/swo-
```

```
med/analysis/Inputs/swo.idx ).  Wed Jul 30 16:18:38 2014 + FLAssess:  +
FLAssess: "

Slot "range":
      min       max plusgroup   minyear   maxyear   minfbar   maxfbar
        0         5         5      1985      2013         2         4
```

Table 4a. XSA diagnostics from continuity run.

```
FLR XSA Diagnostics 2014-07-30 16:20:14

CPUE data from indices

Catch data for 29 years 1985 to 2013. Ages 0 to 5.

             fleet first age last age first year last year alpha beta
1 Moroccan Longline         2        4       1999      2011  <NA> <NA>
2  Spanish Longline         2        4       1988      2013  <NA> <NA>
3  Scilian Longline         2        4       1991      2009  <NA> <NA>
4   Scilian Gillnet         2        4       1990      2009  <NA> <NA>
5    Greek Longline         2        4       1987      2013  <NA> <NA>
6 Ligurian Longline         2        4       1991      2009  <NA> <NA>


 Time series weights :

   Tapered time weighting applied
  Power =   1 over  5 years

 Catchability analysis :

     Catchability independent of size for ages >   1

     Catchability independent of age for ages >   4

 Terminal population estimation :

     Survivor estimates shrunk towards the mean F
    of the final   5 years or the  2 oldest ages.

    S.E. of the mean to which the estimates are shrunk =   0.5

    Minimum standard error for population
    estimates derived from each fleet =  0.3

    prior weighting not applied

Regression weights
     year
age   2004 2005 2006 2007 2008 2009 2010 2011 2012 2013
  all -0.8 -0.6 -0.4 -0.2    0  0.2  0.4  0.6  0.8    1


 Fishing mortalities
   year
age  2004  2005  2006  2007  2008  2009  2010  2011  2012  2013
  0 0.073 0.020 0.031 0.029 0.014 0.021 0.048 0.128 0.037 0.006
  1 0.433 0.415 0.332 0.467 0.523 0.393 0.372 0.332 0.245 0.308
  2 0.705 0.814 0.829 0.641 0.695 0.631 0.587 0.644 0.464 0.641
  3 0.676 0.617 0.591 0.779 0.518 0.484 0.797 0.753 0.445 0.497
  4 0.691 0.715 0.710 0.710 0.606 0.619 0.811 0.595 0.465 0.516
```

```
  5 0.691 0.715 0.710 0.710 0.606 0.619 0.811 0.595 0.465 0.516


 XSA population number (Thousand)
      age
year     0   1   2   3  4  5
  2004 942 764 377 147 70 69
  2005 783 717 406 152 61 64
  2006 988 628 388 147 67 84
  2007 927 785 369 139 67 61
  2008 761 737 403 159 52 34
  2009 667 615 358 165 78 49
  2010 615 535 340 156 83 56
  2011 800 480 302 155 58 55
  2012 674 576 282 130 60 78
  2013 617 532 369 145 68 70


 Estimated population abundance at 1st Jan  2014
      age
year    0   1   2   3  4  5
  2014 33 503 320 159 72 33


 Fleet:  Moroccan Longline

 Log catchability residuals.

   year
age   1999  2000   2001   2002   2003  2004  2005  2006  2007  2008   2009
  2  0.107 0.228 -0.152 -0.136 -0.268 0.043 0.205 0.191 0.113 0.141  0.013
  3  0.053 0.414  0.109  0.288 -0.123 0.206 0.336 0.292 0.387 0.226 -0.041
  4 -0.048 0.261  0.254  0.626  0.191 0.153 0.482 0.320 0.281 0.576 -0.038
   year
age   2010   2011
  2 -0.023  0.011
  3  0.080 -0.040
  4 -0.092  0.074


 Mean log catchability and standard error of ages with catchability
 independent of year class strength and constant w.r.t. time

                2       3      4
Mean_Logq -1.4879 -0.7222 0.0850
S.E_Logq   0.2013  0.2013 0.2013


 Fleet:  Spanish Longline

 Log catchability residuals.

   year
age   1988   1989   1990   1991   1992   1993   1994   1995   1996   1997
  2 -0.032 -0.442 -0.497 -0.406 -0.571 -0.361 -0.301 -0.436 -0.683 -0.560
  3 -0.393 -0.187 -0.251 -0.396 -0.409 -0.010 -0.077 -0.148 -0.666 -0.668
  4 -0.777 -0.668  0.235 -0.291 -0.310  0.065  0.240 -0.046 -0.350 -0.635
   year
age   1998   1999   2000   2001   2002   2003   2004   2005   2006   2007
  2 -0.471 -0.481 -0.501 -0.513 -0.400 -0.727 -0.716 -0.464 -0.220 -0.053
  3 -0.494 -0.571 -0.350 -0.287 -0.012 -0.618 -0.588 -0.369 -0.155  0.185
```

```
  4 -0.597 -0.652 -0.485 -0.122  0.345 -0.285 -0.622 -0.203 -0.107  0.098
    year
age  2008   2009   2010  2011  2012   2013
  2 0.104 -0.117 -0.069 0.119 0.213 -0.190
  3 0.154 -0.206 -0.002 0.033 0.179 -0.121
  4 0.523 -0.185 -0.154 0.166 0.177 -0.143


 Mean log catchability and standard error of ages with catchability
 independent of year class strength and constant w.r.t. time

                2     3      4
Mean_Logq -0.7174 0.084 0.8719
S.E_Logq   0.2980 0.298 0.2980


 Fleet:  Scilian Longline

 Log catchability residuals.

    year
age  1991  1992 1993   1994  1995 1996   1997  1998  1999   2000  2001
  2 0.057 0.086   NA -0.063 0.088   NA -0.359 0.201 0.471 -0.027 0.461
  3 0.157 0.337   NA  0.251 0.464   NA -0.377 0.267 0.471  0.213 0.776
  4 0.240 0.414   NA  0.546 0.545   NA -0.366 0.142 0.368  0.057 0.919
    year
age  2002   2003  2004  2005  2006   2007   2008 2009
  2 0.569 -0.325 0.095 0.169 0.353 -0.229 -0.222    0
  3 1.047 -0.127 0.312 0.354 0.508  0.099 -0.083    0
  4 1.382  0.185 0.256 0.498 0.533 -0.010  0.265    0


 Mean log catchability and standard error of ages with catchability
 independent of year class strength and constant w.r.t. time

                2       3      4
Mean_Logq -0.8963 -0.1843 0.6255
S.E_Logq   0.3519  0.3519 0.3519


 Fleet:  Scilian Gillnet

 Log catchability residuals.

    year
age  1990  1991  1992  1993  1994  1995  1996  1997  1998  1999  2000
  2 1.186 1.649 2.239 1.873 1.506 1.869 1.361 1.872 1.585 1.911 2.058
  3 1.521 1.749 2.491 2.313 1.819 2.245 1.468 1.854 1.651 1.911 2.297
  4 1.986 1.832 2.568 2.366 2.115 2.325 1.761 1.864 1.526 1.808 2.141
    year
age  2001 2002 2003  2004  2005  2006 2007  2008 2009
  2 1.979   NA   NA 2.020 1.764 2.751   NA 0.422    0
  3 2.294   NA   NA 2.237 1.949 2.905   NA 0.561    0
  4 2.437   NA   NA 2.181 2.093 2.931   NA 0.908    0


 Mean log catchability and standard error of ages with catchability
 independent of year class strength and constant w.r.t. time

                2       3       4
Mean_Logq -4.8146 -4.1026 -3.2928
```

```
S.E_Logq   0.6705  0.6705  0.6705


 Fleet:  Greek Longline

 Log catchability residuals.

   year
age   1987   1988 1989   1990  1991   1992   1993  1994   1995 1996 1997
  2 -0.303  0.102   NA -0.237 0.340 -0.524 -0.045 0.185 -0.375   NA   NA
  3 -0.708 -0.259   NA  0.008 0.351 -0.362  0.305 0.409 -0.087   NA   NA
  4 -1.136 -0.643   NA  0.495 0.455 -0.263  0.381 0.726  0.015   NA   NA
   year
age  1998  1999   2000  2001   2002   2003   2004   2005   2006  2007
  2 0.362 0.189 -0.067 0.038 -0.424 -0.207 -0.081 -0.131 -0.021 0.003
  3 0.338 0.099  0.084 0.263 -0.036 -0.098  0.046 -0.035  0.044 0.241
  4 0.235 0.018 -0.051 0.428  0.321  0.235  0.013  0.131  0.091 0.153
   year
age   2008   2009   2010   2011   2012  2013
  2 -0.124 -0.171  0.033 -0.072 -0.091 0.137
  3 -0.075 -0.261  0.100 -0.159 -0.125 0.207
  4  0.295 -0.239 -0.052 -0.026 -0.126 0.185


 Mean log catchability and standard error of ages with catchability
 independent of year class strength and constant w.r.t. time

               2      3      4
Mean_Logq -0.6513 0.1502 0.9381
S.E_Logq   0.2979 0.2979 0.2979


 Fleet:  Ligurian Longline

 Log catchability residuals.

   year
age   1991   1992   1993   1994   1995   1996   1997  1998   1999  2000
  2 -0.288 -0.533 -0.602 -0.375 -0.403 -0.463 -0.291 0.109 -0.145 0.120
  3 -0.188 -0.281 -0.162 -0.062 -0.027 -0.356 -0.310 0.175 -0.145 0.360
  4 -0.105 -0.204 -0.109  0.234  0.054 -0.062 -0.299 0.050 -0.248 0.204
   year
age  2001   2002  2003   2004   2005  2006  2007  2008 2009
  2 0.474 -0.028 0.073 -0.241 -0.472 0.017 0.638 0.432    0
  3 0.789  0.449 0.271 -0.025 -0.287 0.171 0.965 0.571    0
  4 0.932  0.785 0.582 -0.080 -0.143 0.197 0.856 0.919    0


 Mean log catchability and standard error of ages with catchability
 independent of year class strength and constant w.r.t. time

               2      3      4
Mean_Logq -0.6773 0.0347 0.8445
S.E_Logq   0.3981 0.3981 0.3981


 Terminal year survivor and F summaries:

 ,Age 0 Year class =2013

source
```

```
     scaledWts survivors yrcls
fshk      0.03        55  2013
nshk      0.97       538  2013

 ,Age 1 Year class =2012

source
     scaledWts survivors yrcls
fshk         1       255  2012

 ,Age 2 Year class =2011

source
                 scaledWts survivors yrcls
Spanish Longline     0.373       132  2011
Greek Longline       0.373       183  2011
fshk                 0.255       172  2011

 ,Age 3 Year class =2010

source
                 scaledWts survivors yrcls
Spanish Longline     0.386        64  2010
Greek Longline       0.386        89  2010
fshk                 0.228        57  2010

 ,Age 4 Year class =2009

source
                 scaledWts survivors yrcls
Spanish Longline     0.384        29  2009
Greek Longline       0.384        40  2009
fshk                 0.232        29  2009
```

Table 4b. XSA diagnostics from alternative run.

```
FLR XSA Diagnostics 2014-07-30 16:20:16

CPUE data from indices

Catch data for 29 years 1985 to 2013. Ages 0 to 5.

              fleet first age last age first year last year alpha beta
1 Moroccan Longline         2        4       1999      2011  <NA> <NA>
2  Spanish Longline         2        4       1988      2013  <NA> <NA>
3  Scilian Longline         2        4       1991      2009  <NA> <NA>
4   Scilian Gillnet         2        4       1990      2009  <NA> <NA>
5    Greek Longline         2        4       1987      2013  <NA> <NA>
6 Ligurian Longline         2        4       1991      2009  <NA> <NA>


 Time series weights :

    Tapered time weighting applied
   Power =   1 over  5 years

 Catchability analysis :

     Catchability independent of size for ages >   1

     Catchability independent of age for ages >   4
```

Terminal population estimation :

Survivor estimates shrunk towards the mean F
of the final 5 years or the 2 oldest ages.

S.E. of the mean to which the estimates are shrunk = 0.5

Minimum standard error for population
estimates derived from each fleet = 0.3

prior weighting not applied

Regression weights

age \ year	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
all	-0.8	-0.6	-0.4	-0.2	0	0.2	0.4	0.6	0.8	1

Fishing mortalities

age \ year	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
0	0.073	0.020	0.031	0.029	0.014	0.021	0.048	0.128	0.037	0.006
1	0.433	0.415	0.332	0.467	0.523	0.393	0.372	0.332	0.245	0.308
2	0.705	0.814	0.829	0.641	0.695	0.631	0.587	0.644	0.464	0.641
3	0.676	0.617	0.591	0.779	0.518	0.484	0.797	0.753	0.445	0.497
4	0.691	0.715	0.710	0.710	0.606	0.619	0.811	0.595	0.465	0.516
5	0.691	0.715	0.710	0.710	0.606	0.619	0.811	0.595	0.465	0.516

XSA population number (Thousand)

year \ age	0	1	2	3	4	5
2004	942	764	377	147	70	69
2005	783	717	406	152	61	64
2006	988	628	388	147	67	84
2007	927	785	369	139	67	61
2008	761	737	403	159	52	34
2009	667	615	358	165	78	49
2010	615	535	340	156	83	56
2011	800	480	302	155	58	55
2012	674	576	282	130	60	78
2013	617	532	369	145	68	70

Estimated population abundance at 1st Jan 2014

year \ age	0	1	2	3	4	5
2014	33	503	320	159	72	33

Fleet: Moroccan Longline

Log catchability residuals.

age \ year	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
2	0.107	0.228	-0.152	-0.136	-0.268	0.043	0.205	0.191	0.113	0.141	0.013
3	0.053	0.414	0.109	0.288	-0.123	0.206	0.336	0.292	0.387	0.226	-0.041
4	-0.048	0.261	0.254	0.626	0.191	0.153	0.482	0.320	0.281	0.576	-0.038

year

```
age   2010   2011
  2 -0.023  0.011
  3  0.080 -0.040
  4 -0.092  0.074


 Mean log catchability and standard error of ages with catchability
 independent of year class strength and constant w.r.t. time

                2       3      4
Mean_Logq -1.4879 -0.7222 0.0850
S.E_Logq   0.2013  0.2013 0.2013


 Fleet:  Spanish Longline

 Log catchability residuals.

   year
age   1988   1989   1990   1991   1992   1993   1994   1995   1996   1997
  2 -0.032 -0.442 -0.497 -0.406 -0.571 -0.361 -0.301 -0.436 -0.683 -0.560
  3 -0.393 -0.187 -0.251 -0.396 -0.409 -0.010 -0.077 -0.148 -0.666 -0.668
  4 -0.777 -0.668  0.235 -0.291 -0.310  0.065  0.240 -0.046 -0.350 -0.635
   year
age   1998   1999   2000   2001   2002   2003   2004   2005   2006   2007
  2 -0.471 -0.481 -0.501 -0.513 -0.400 -0.727 -0.716 -0.464 -0.220 -0.053
  3 -0.494 -0.571 -0.350 -0.287 -0.012 -0.618 -0.588 -0.369 -0.155  0.185
  4 -0.597 -0.652 -0.485 -0.122  0.345 -0.285 -0.622 -0.203 -0.107  0.098
   year
age  2008   2009   2010  2011  2012   2013
  2 0.104 -0.117 -0.069 0.119 0.213 -0.190
  3 0.154 -0.206 -0.002 0.033 0.179 -0.121
  4 0.523 -0.185 -0.154 0.166 0.177 -0.143


 Mean log catchability and standard error of ages with catchability
 independent of year class strength and constant w.r.t. time

                2     3      4
Mean_Logq -0.7174 0.084 0.8719
S.E_Logq   0.2980 0.298 0.2980


 Fleet:  Scilian Longline

 Log catchability residuals.

   year
age  1991  1992 1993   1994  1995 1996   1997  1998  1999   2000  2001
  2 0.057 0.086   NA -0.063 0.088   NA -0.359 0.201 0.471 -0.027 0.461
  3 0.157 0.337   NA  0.251 0.464   NA -0.377 0.267 0.471  0.213 0.776
  4 0.240 0.414   NA  0.546 0.545   NA -0.366 0.142 0.368  0.057 0.919
   year
age  2002   2003  2004  2005  2006   2007   2008 2009
  2 0.569 -0.325 0.095 0.169 0.353 -0.229 -0.222    0
  3 1.047 -0.127 0.312 0.354 0.508  0.099 -0.083    0
  4 1.382  0.185 0.256 0.498 0.533 -0.010  0.265    0


 Mean log catchability and standard error of ages with catchability
 independent of year class strength and constant w.r.t. time
```

```
                2       3      4
Mean_Logq -0.8963 -0.1843 0.6255
S.E_Logq   0.3519  0.3519 0.3519


 Fleet:  Scilian Gillnet

 Log catchability residuals.

   year
age  1990  1991  1992  1993  1994  1995  1996  1997  1998  1999  2000
  2 1.186 1.649 2.239 1.873 1.506 1.869 1.361 1.872 1.585 1.911 2.058
  3 1.521 1.749 2.491 2.313 1.819 2.245 1.468 1.854 1.651 1.911 2.297
  4 1.986 1.832 2.568 2.366 2.115 2.325 1.761 1.864 1.526 1.808 2.141
   year
age  2001 2002 2003  2004  2005  2006 2007  2008 2009
  2 1.979   NA   NA 2.020 1.764 2.751   NA 0.422    0
  3 2.294   NA   NA 2.237 1.949 2.905   NA 0.561    0
  4 2.437   NA   NA 2.181 2.093 2.931   NA 0.908    0


 Mean log catchability and standard error of ages with catchability
 independent of year class strength and constant w.r.t. time

                2       3       4
Mean_Logq -4.8146 -4.1026 -3.2928
S.E_Logq   0.6705  0.6705  0.6705


 Fleet:  Greek Longline

 Log catchability residuals.

   year
age   1987   1988 1989   1990  1991   1992   1993  1994   1995 1996 1997
  2 -0.303  0.102   NA -0.237 0.340 -0.524 -0.045 0.185 -0.375   NA   NA
  3 -0.708 -0.259   NA  0.008 0.351 -0.362  0.305 0.409 -0.087   NA   NA
  4 -1.136 -0.643   NA  0.495 0.455 -0.263  0.381 0.726  0.015   NA   NA
   year
age  1998  1999   2000  2001   2002   2003   2004   2005   2006  2007
  2 0.362 0.189 -0.067 0.038 -0.424 -0.207 -0.081 -0.131 -0.021 0.003
  3 0.338 0.099  0.084 0.263 -0.036 -0.098  0.046 -0.035  0.044 0.241
  4 0.235 0.018 -0.051 0.428  0.321  0.235  0.013  0.131  0.091 0.153
   year
age   2008   2009   2010   2011   2012  2013
  2 -0.124 -0.171  0.033 -0.072 -0.091 0.137
  3 -0.075 -0.261  0.100 -0.159 -0.125 0.207
  4  0.295 -0.239 -0.052 -0.026 -0.126 0.185


 Mean log catchability and standard error of ages with catchability
 independent of year class strength and constant w.r.t. time

                2      3      4
Mean_Logq -0.6513 0.1502 0.9381
S.E_Logq   0.2979 0.2979 0.2979


 Fleet:  Ligurian Longline
```

```
 Log catchability residuals.

   year
age   1991   1992   1993   1994   1995   1996   1997  1998   1999  2000
  2 -0.288 -0.533 -0.602 -0.375 -0.403 -0.463 -0.291 0.109 -0.145 0.120
  3 -0.188 -0.281 -0.162 -0.062 -0.027 -0.356 -0.310 0.175 -0.145 0.360
  4 -0.105 -0.204 -0.109  0.234  0.054 -0.062 -0.299 0.050 -0.248 0.204
   year
age  2001   2002  2003   2004   2005  2006  2007  2008 2009
  2 0.474 -0.028 0.073 -0.241 -0.472 0.017 0.638 0.432    0
  3 0.789  0.449 0.271 -0.025 -0.287 0.171 0.965 0.571    0
  4 0.932  0.785 0.582 -0.080 -0.143 0.197 0.856 0.919    0


 Mean log catchability and standard error of ages with catchability
 independent of year class strength and constant w.r.t. time

                2      3      4
Mean_Logq -0.6773 0.0347 0.8445
S.E_Logq   0.3981 0.3981 0.3981


 Terminal year survivor and F summaries:

 ,Age 0 Year class =2013

source
     scaledWts survivors yrcls
fshk      0.03        55  2013
nshk      0.97       538  2013

 ,Age 1 Year class =2012

source
     scaledWts survivors yrcls
fshk         1       255  2012

 ,Age 2 Year class =2011

source
                 scaledWts survivors yrcls
Spanish Longline     0.373       132  2011
Greek Longline       0.373       183  2011
fshk                 0.255       172  2011

 ,Age 3 Year class =2010

source
                 scaledWts survivors yrcls
Spanish Longline     0.386        64  2010
Greek Longline       0.386        89  2010
fshk                 0.228        57  2010

 ,Age 4 Year class =2009

source
                 scaledWts survivors yrcls
Spanish Longline     0.384        29  2009
Greek Longline       0.384        40  2009
fshk                 0.232        29  2009
```

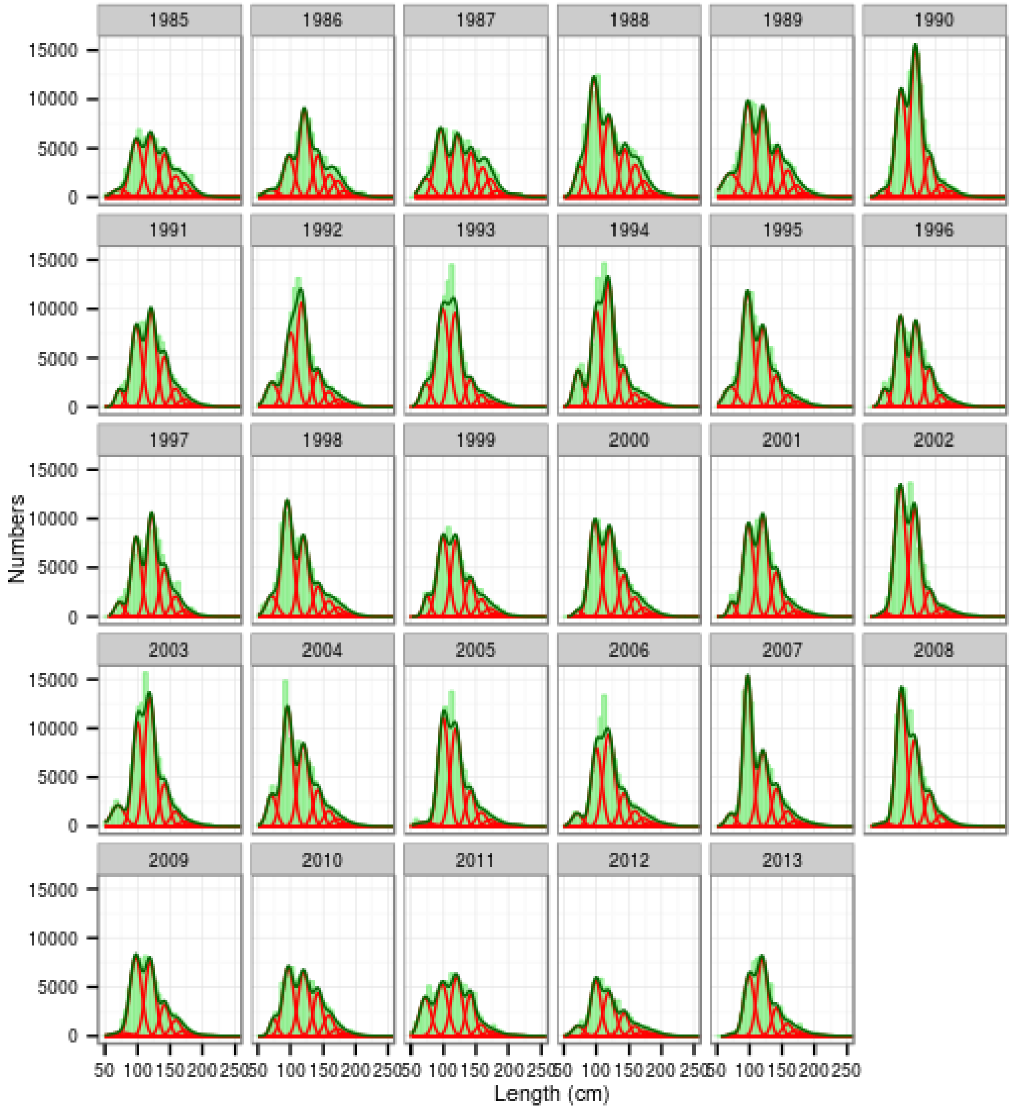

Figure 1. Length Frequencies with age modes (red) and total distributions (green) from the statistical estimation overlayed.

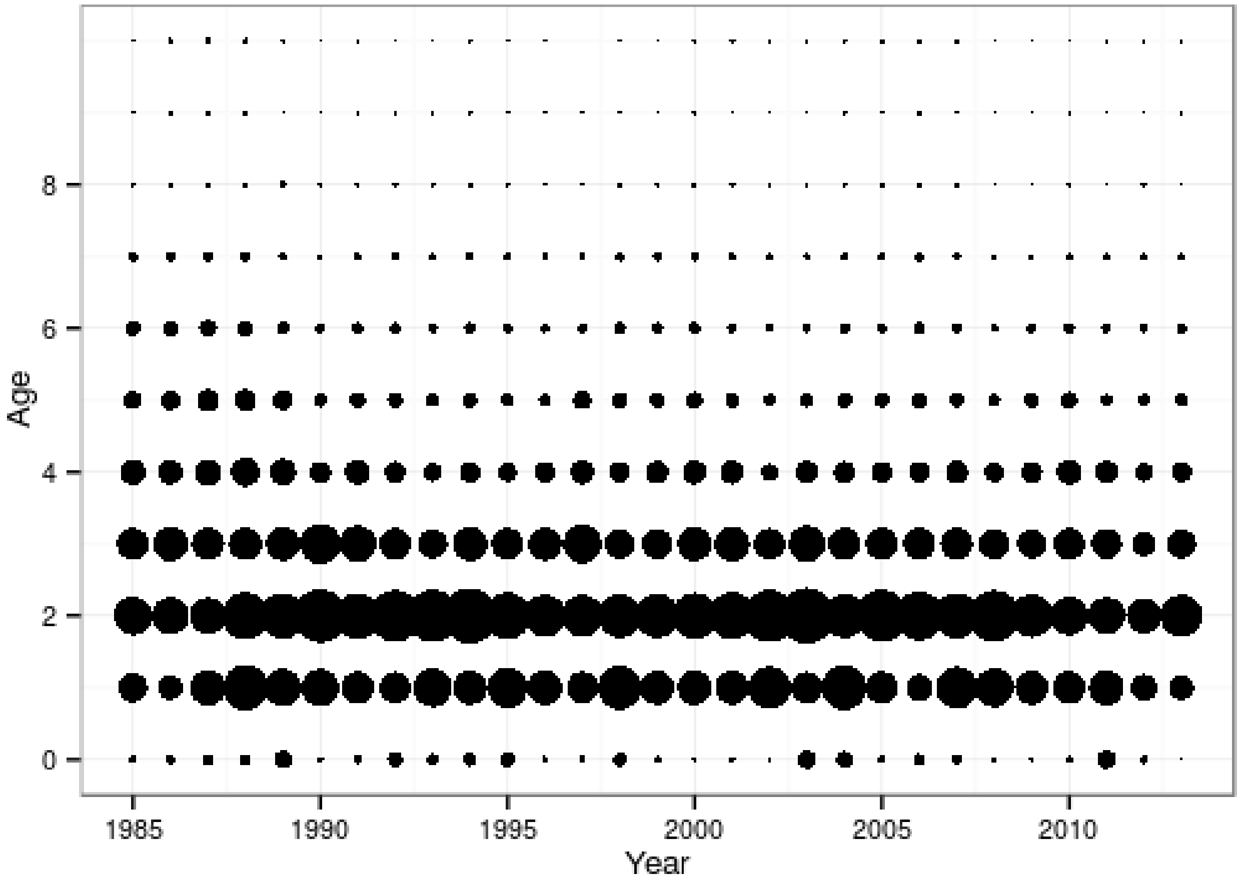

Figure 2. Deterministic numbers-at-age from age slicing procedure.

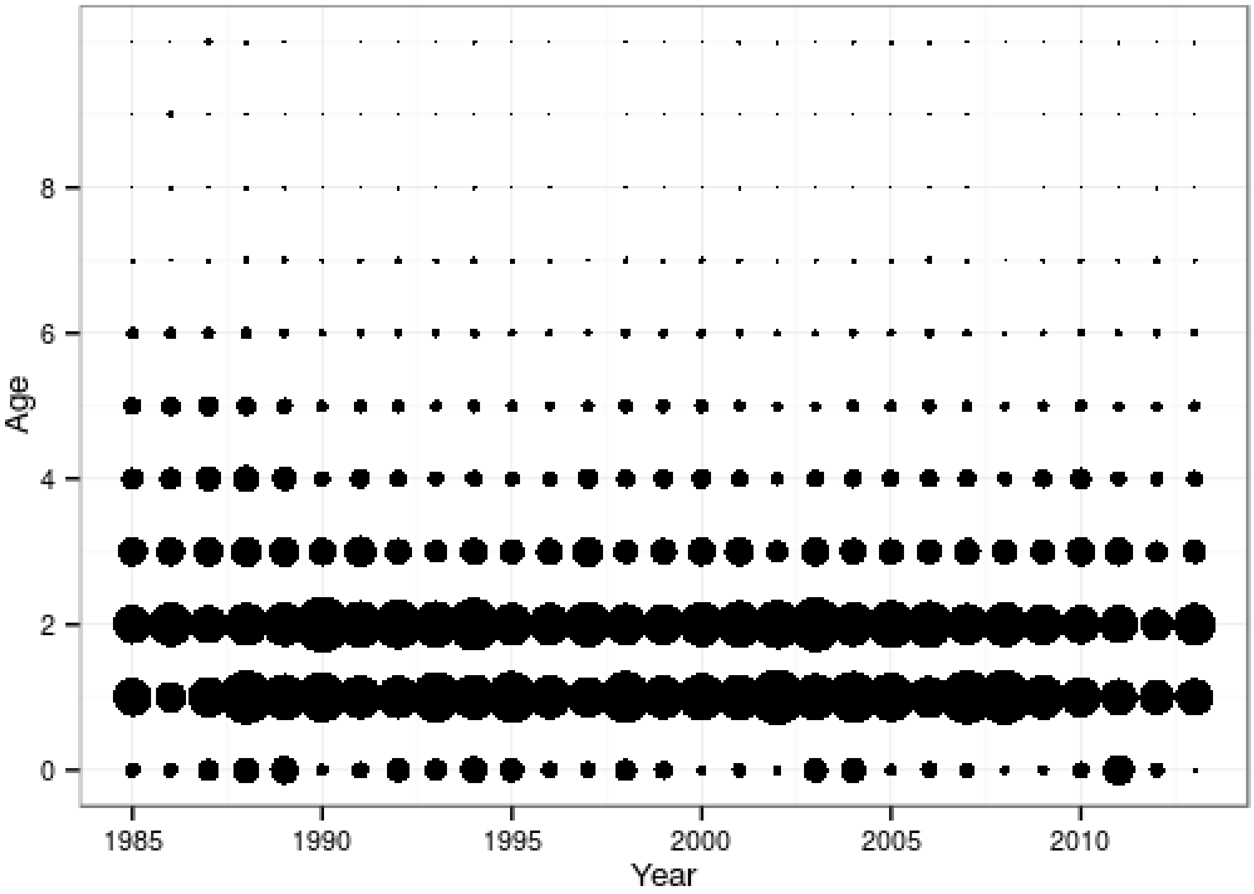

Figure 3. Statistical estimates of numbers-at-age from the mixture distribution analysis.

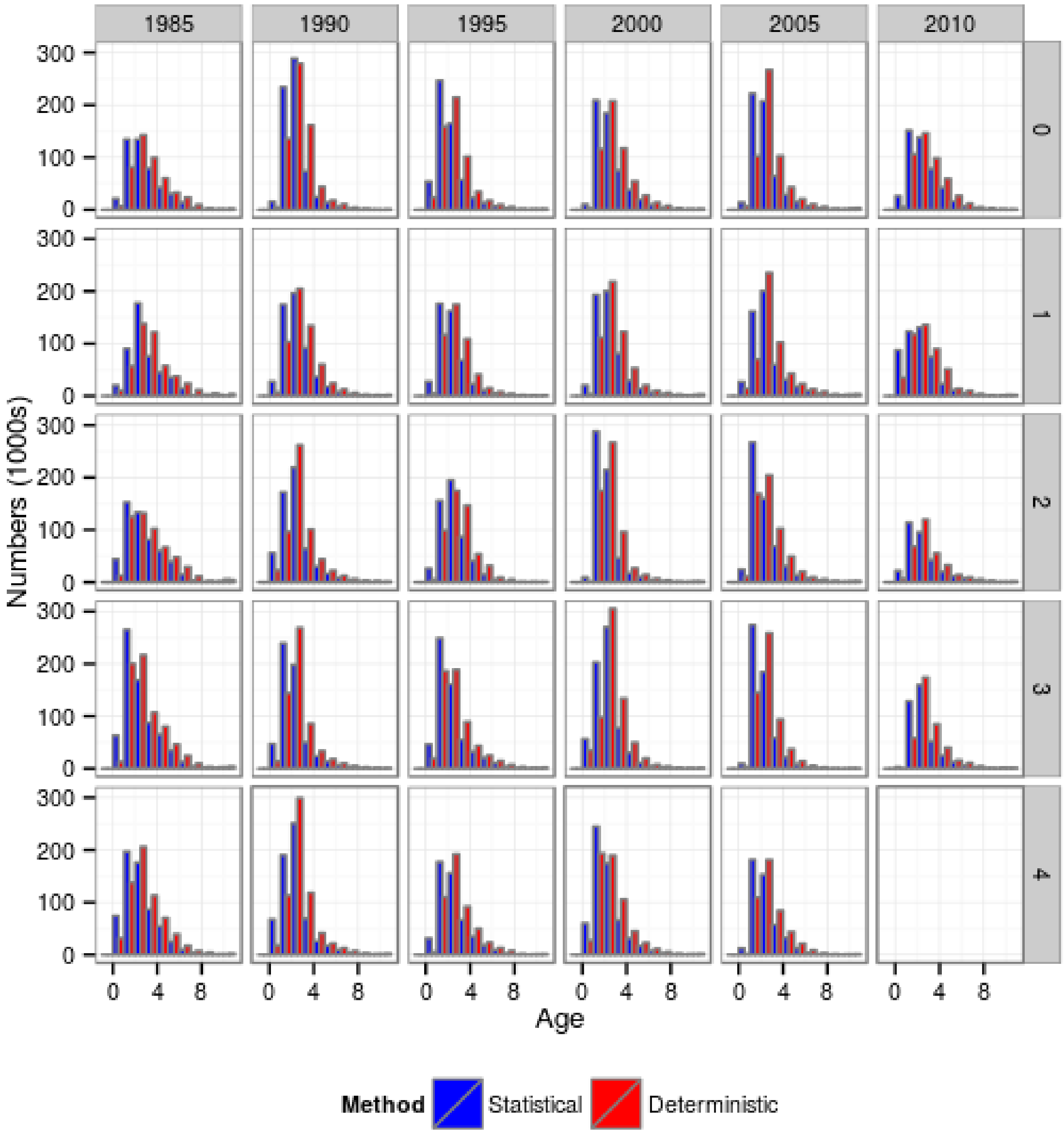

Figure 4. A comparison of catch numbers-at-age from the statistical and deterministic ageing procedures.

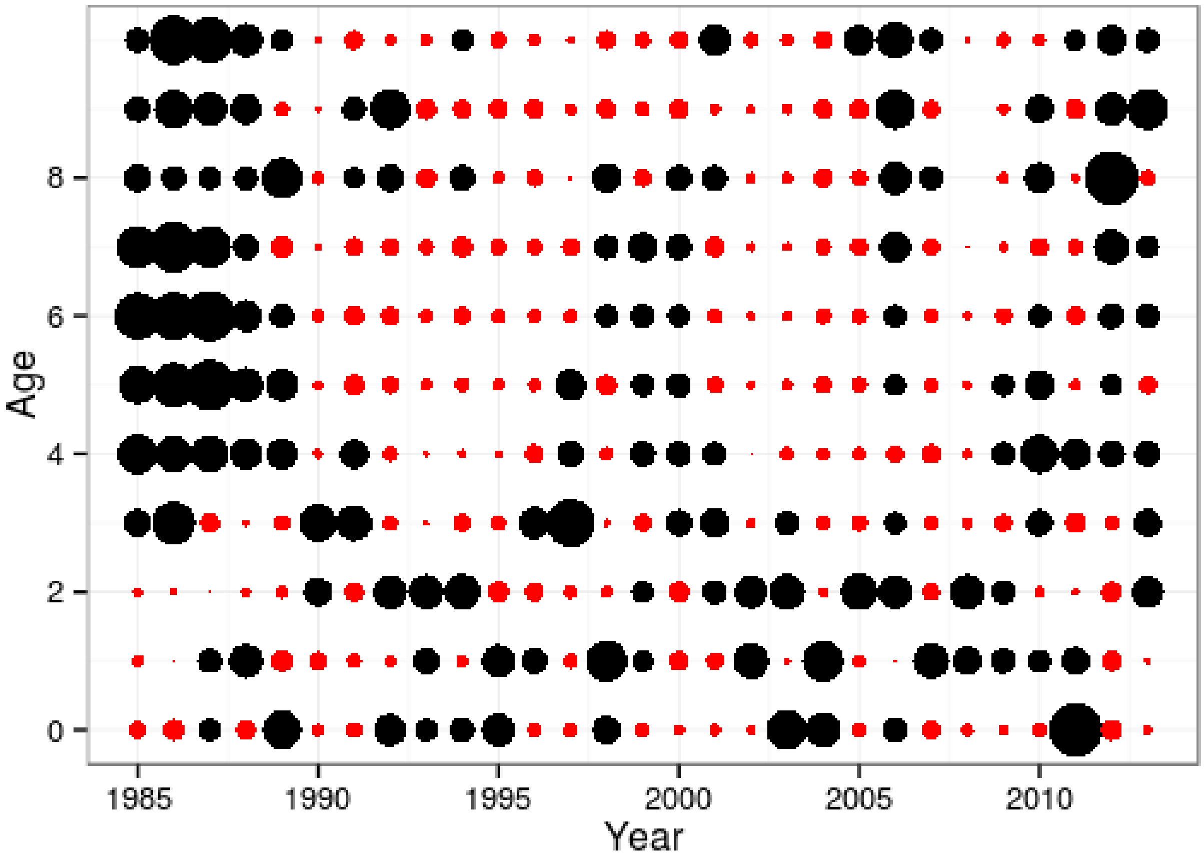

Figure 5. Standardised residuals of the proportion of numbers-at-age from the deterministic age slicing procedure (red negative and black positive residuals).

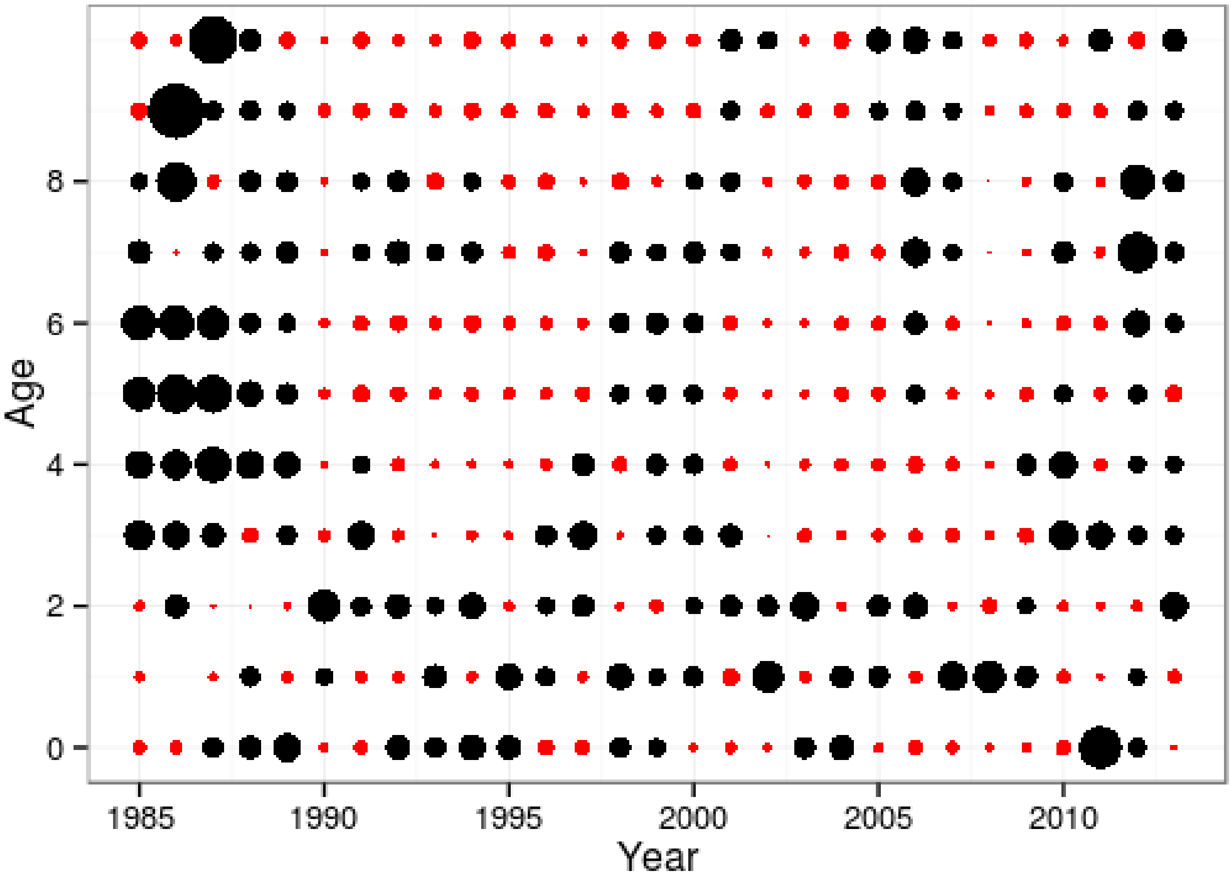

Figure 6. Standardised residuals for the proportion of numbers-at-age from the statistical mixture distribution analysis (red negative and black positive residuals).

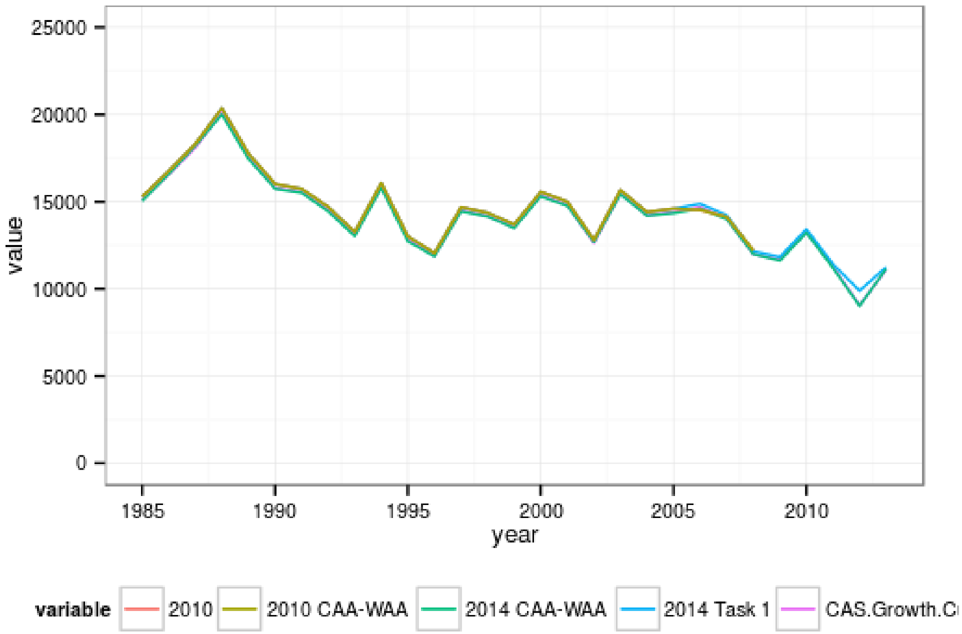

Figure 7. Comparison of total catch biomass derived from different procedures.

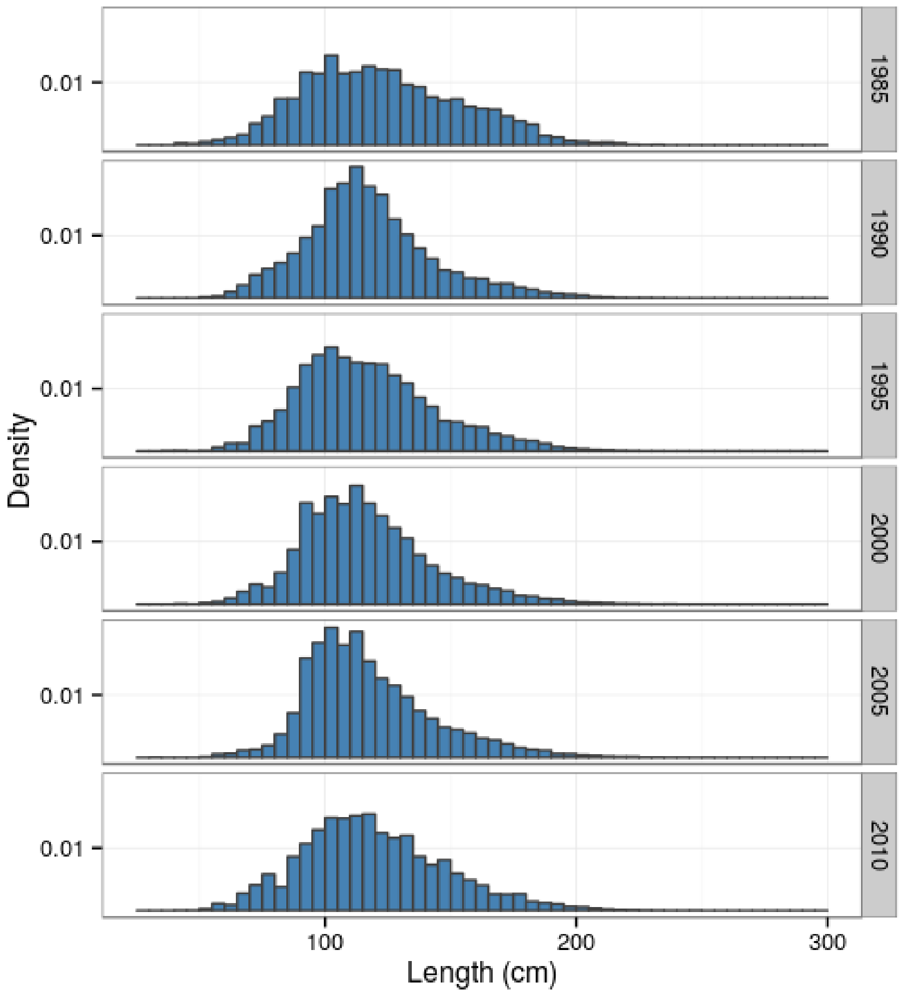

Figure 8. Catch-at-size by lustrum (5 year block).

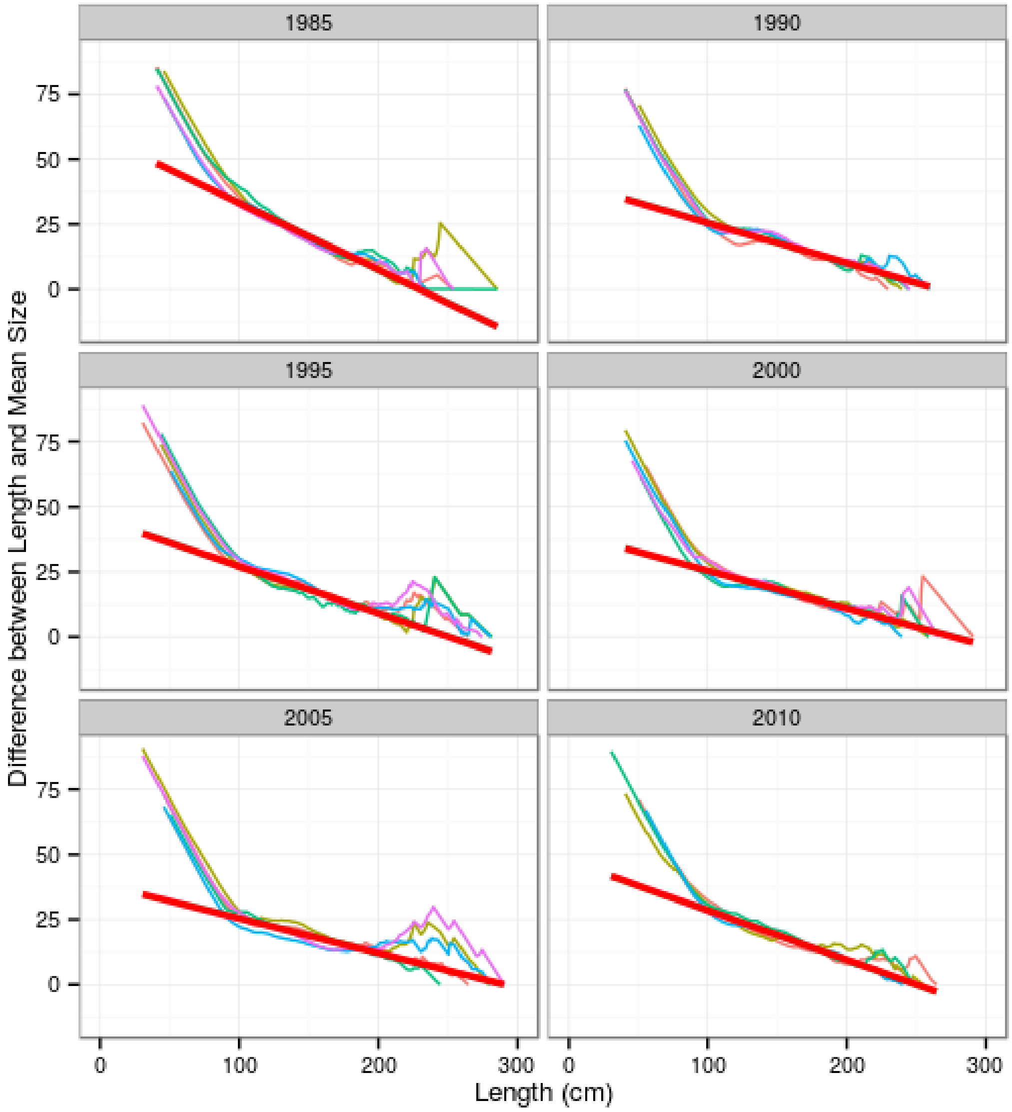

Figure 9. Powell-Wheatherall plots

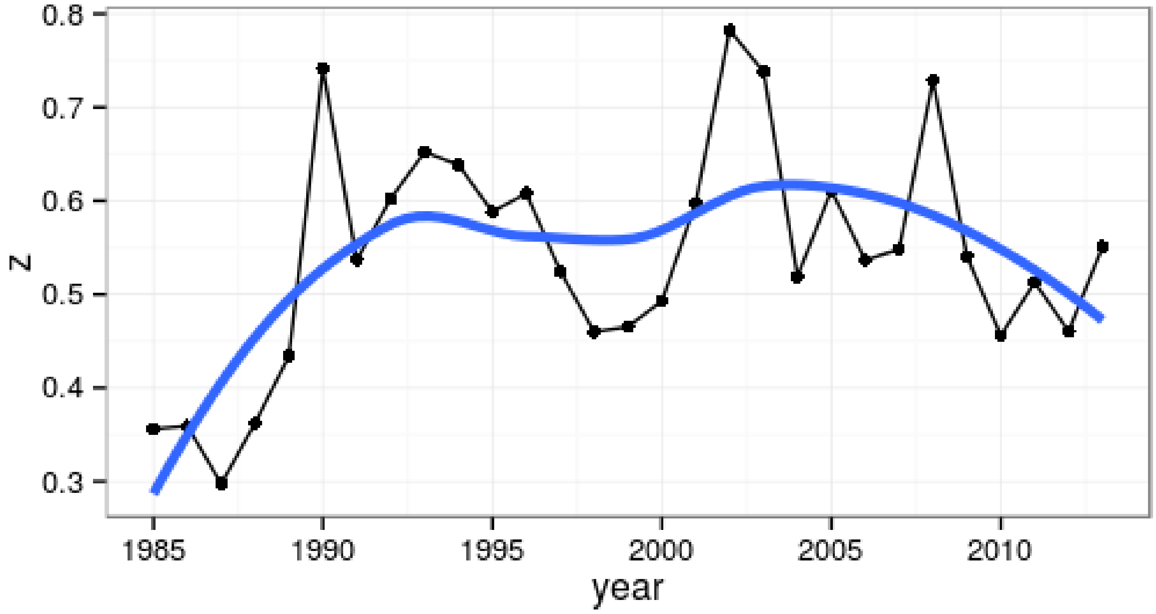

Figure 10. Estimates of Z derived from the Powell-Wetherall plots; showing the estimates from each year (black line with points) and a smoother (blue continuous line).

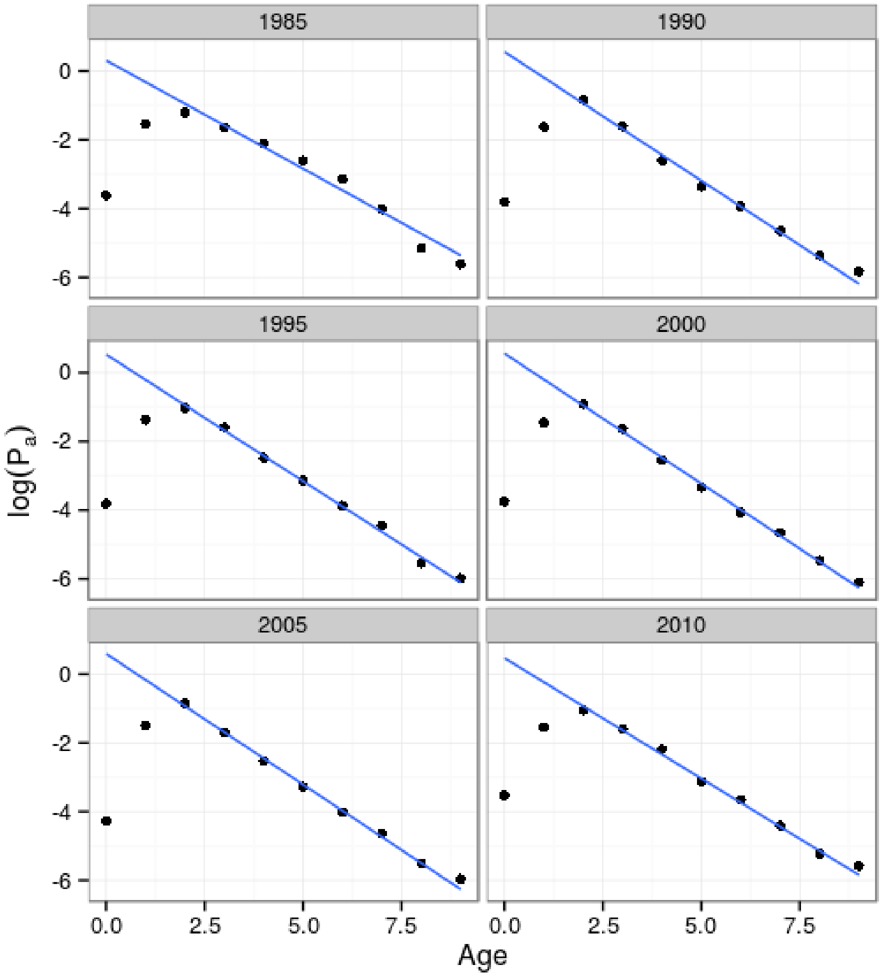

Figure 11. Catch curves by lustrum from statisical age estimates.

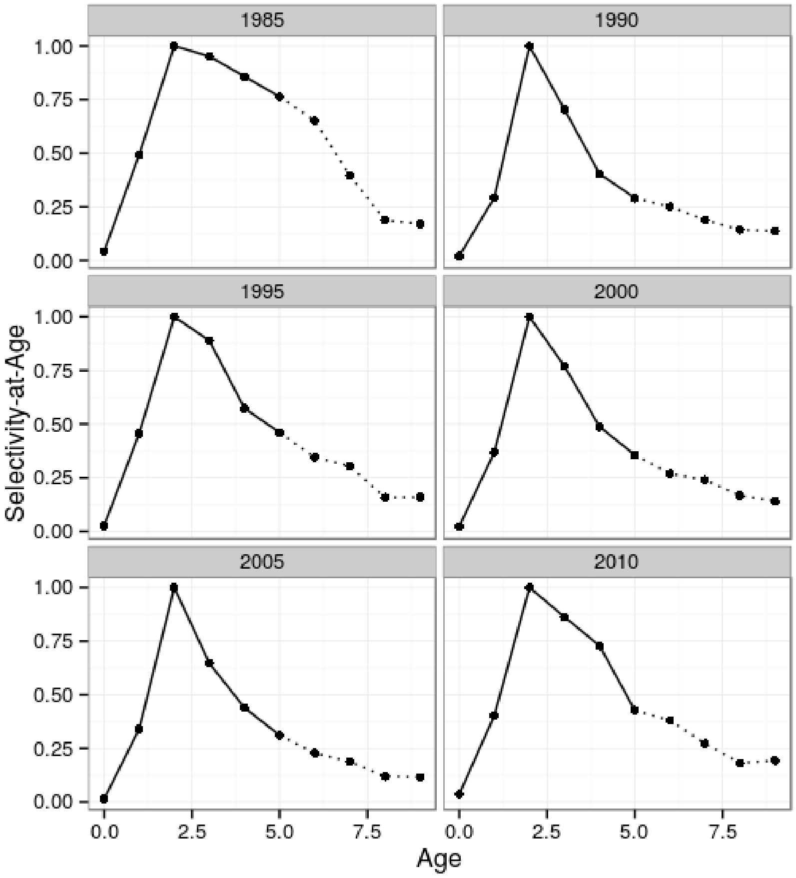

Figure 12. Estimated selectivity by lustrum.

Selectivity by gear

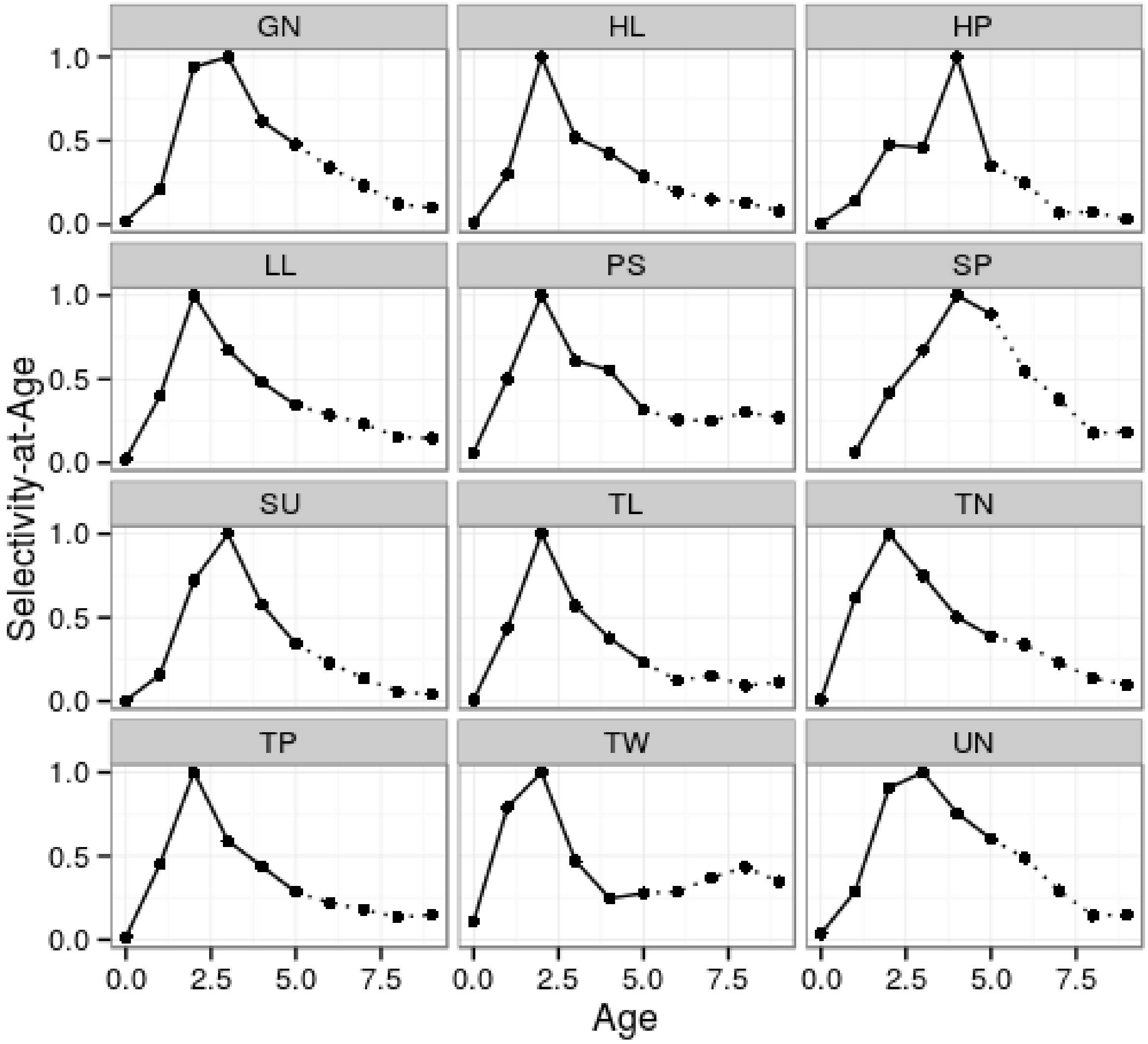

Figure 13. Catch curves by gear based on age estimates

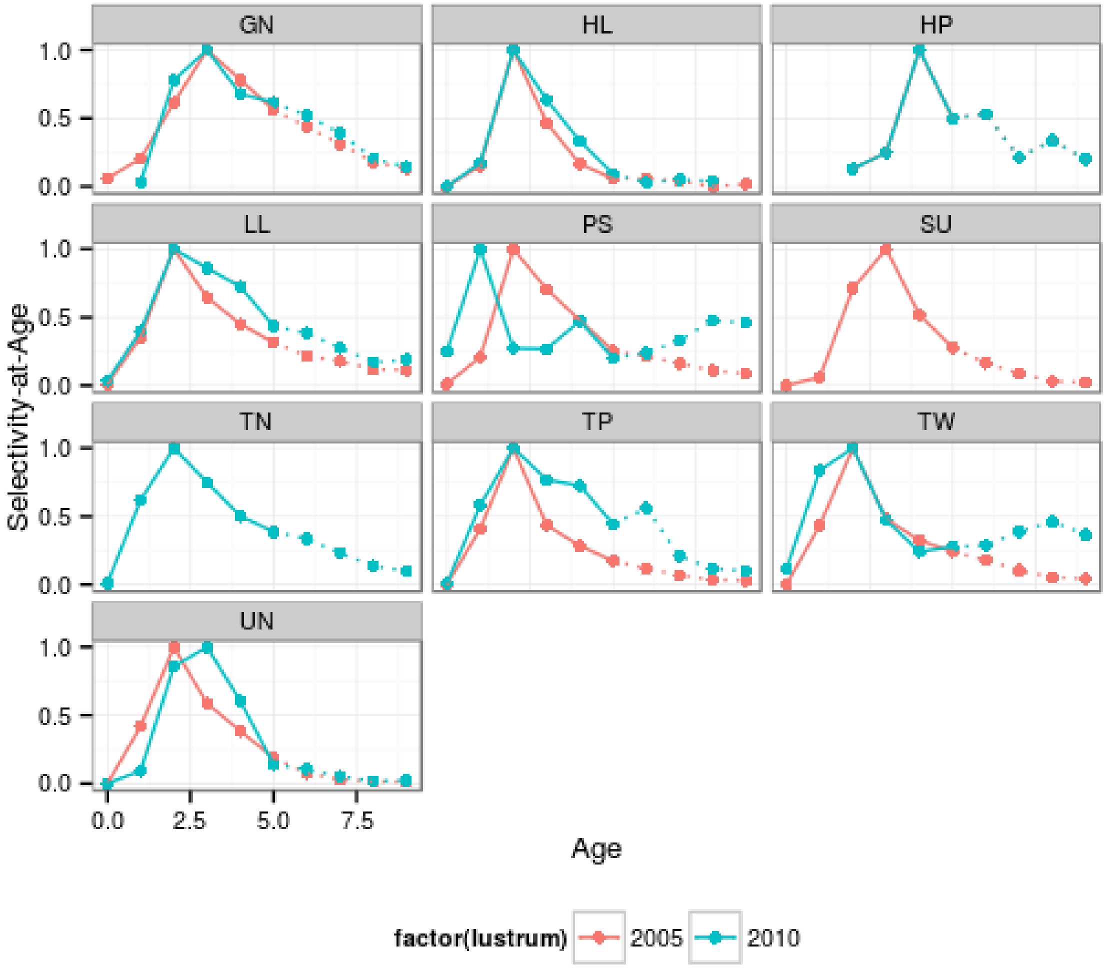

Figure 14. Catch curves by gear and lustrum based on statistical age estimates.

XSA Continuity Run

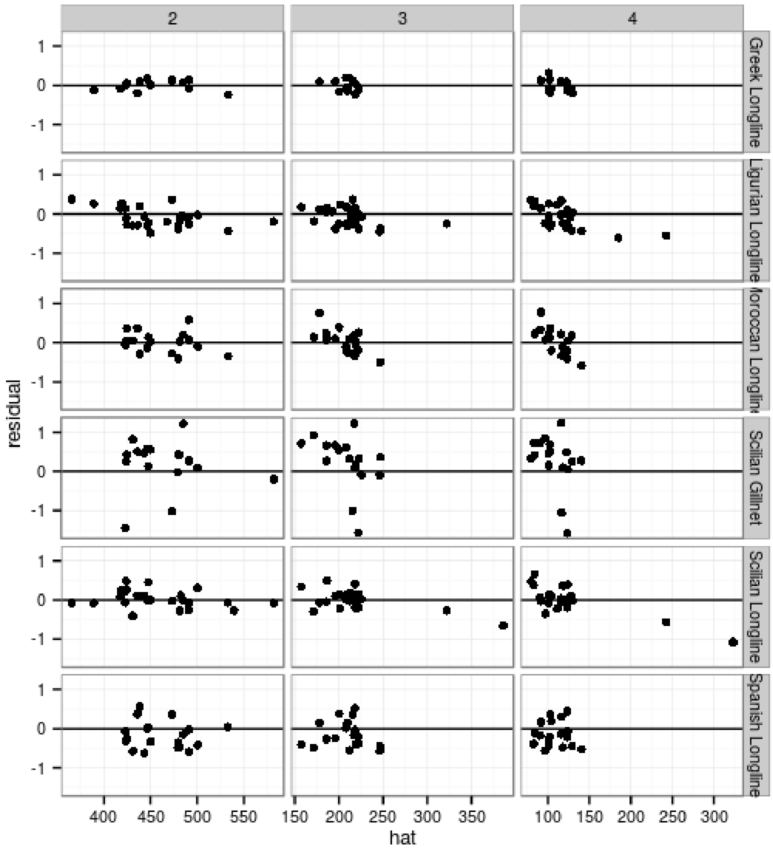

Figure 15. XSA diagnostics from continuity run; residuals against fitted value.

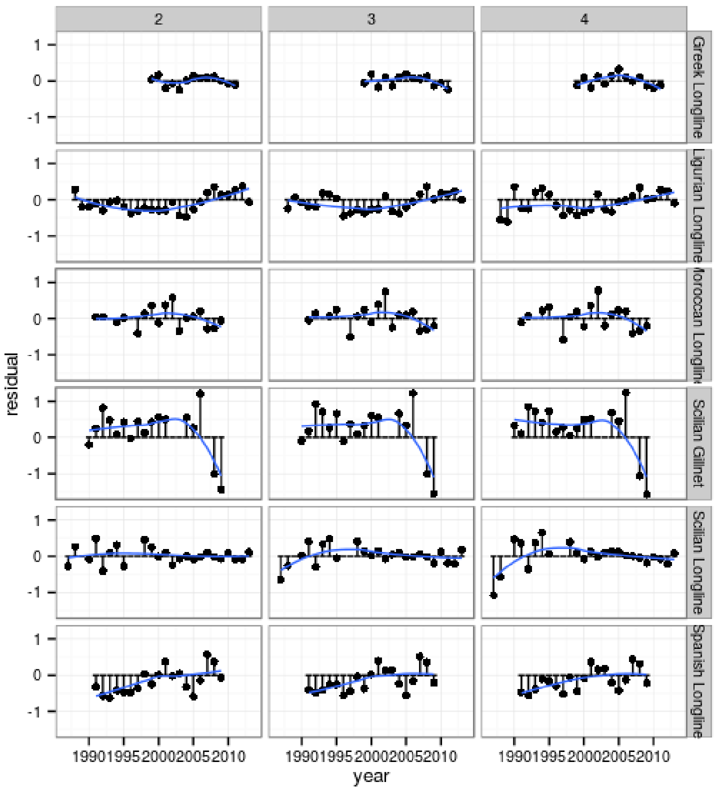

Figure 16. XSA diagnostics from continuity run; residuals against year.

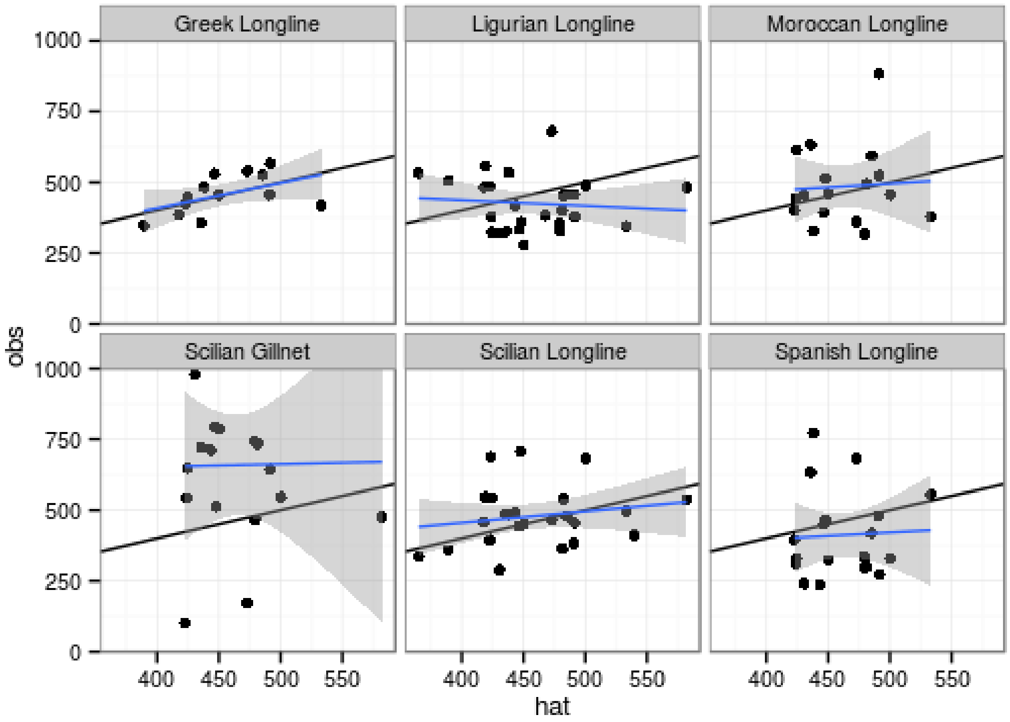

Figure 17. XSA diagnostics from continuity run; Calibration regression plots for age 2 (outlier for Scilian gillnet removed).

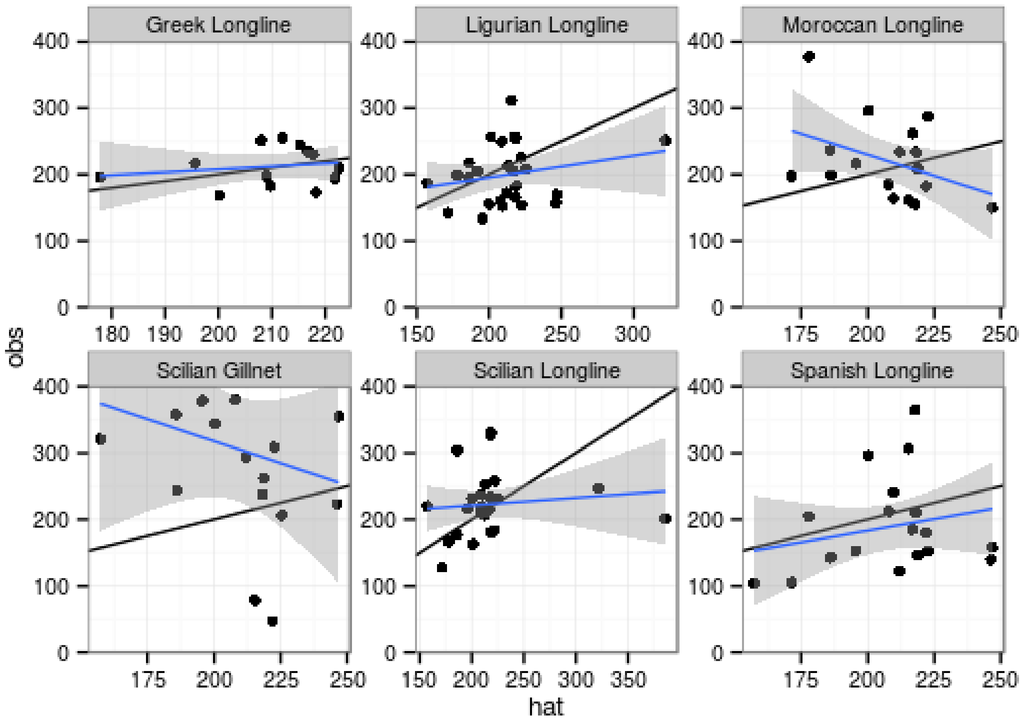

Figure 18. XSA diagnostics from continuity run; Calibration regression plots for age 3 (outlier for Scilian gillnet removed).

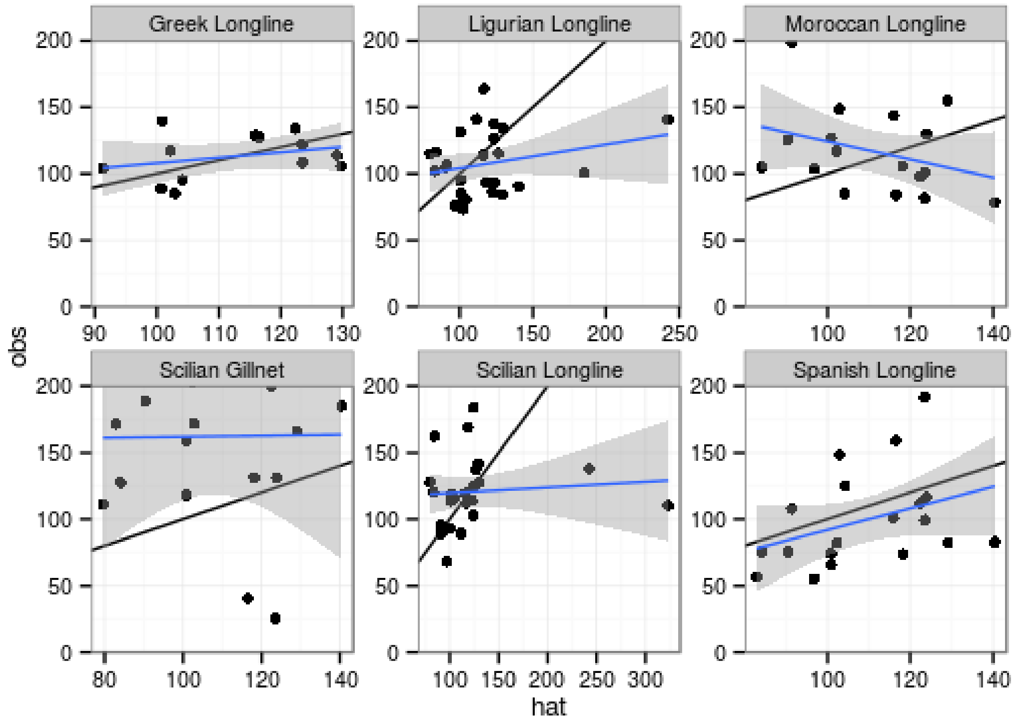

Figure 19. XSA diagnostics from continuity run; Calibration regression plots for age 4 (outlier for Scilian gillnet removed).

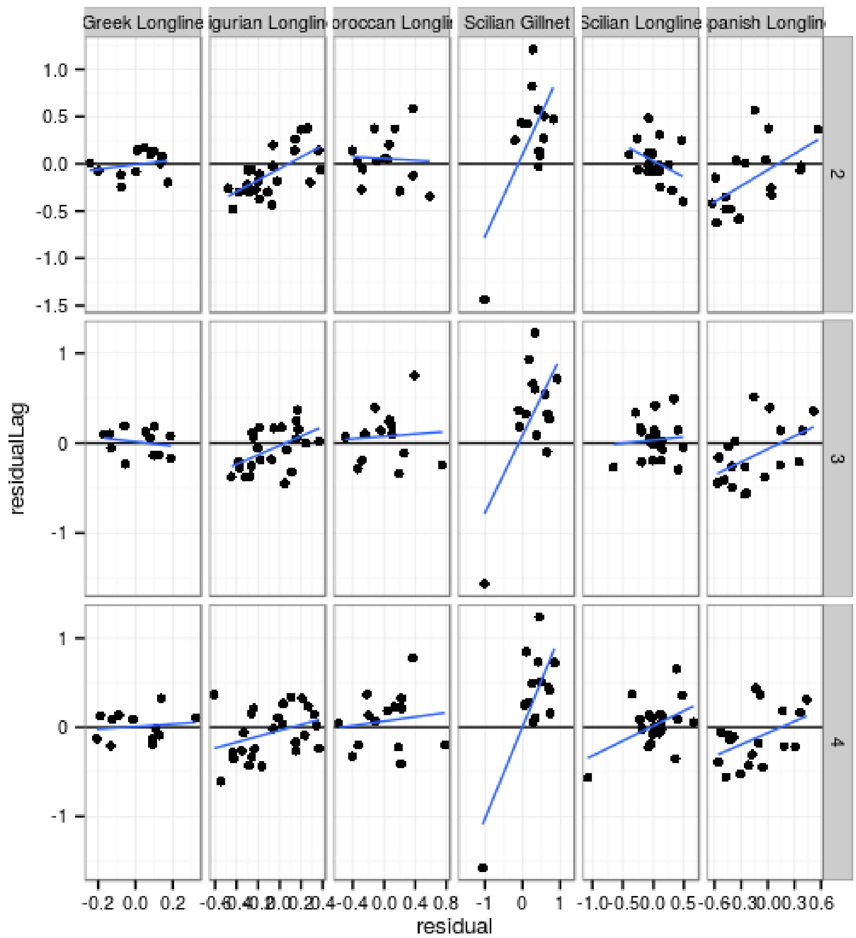

Figure 20. XSA diagnostics from continuity run; AR plots of lagged residuals

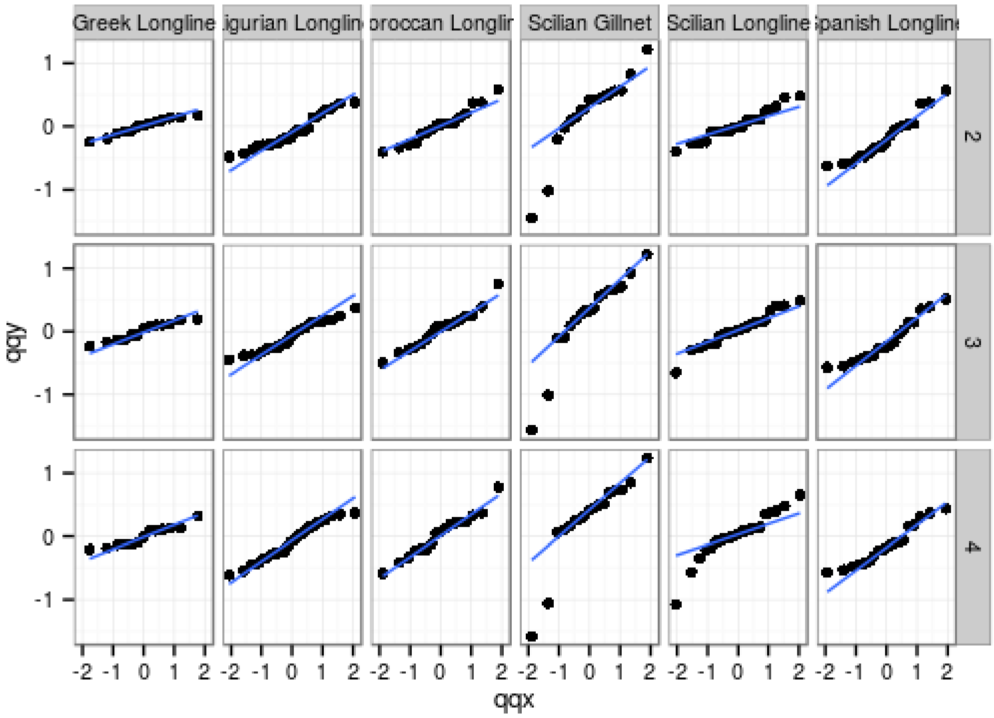

Figure 21. XSA diagnostics from continuity run; QQ plots to check for normality

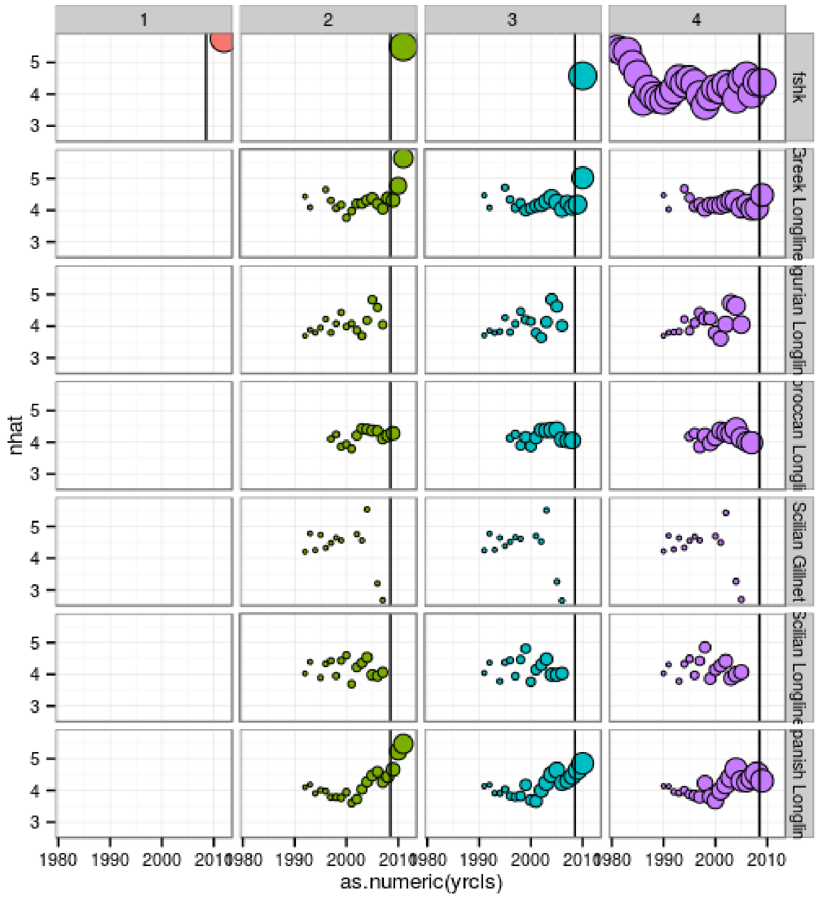

Figure 22. XSA diagnostics from continuity run; weights for terminal year Ns for each CPUE observation and shrinkage

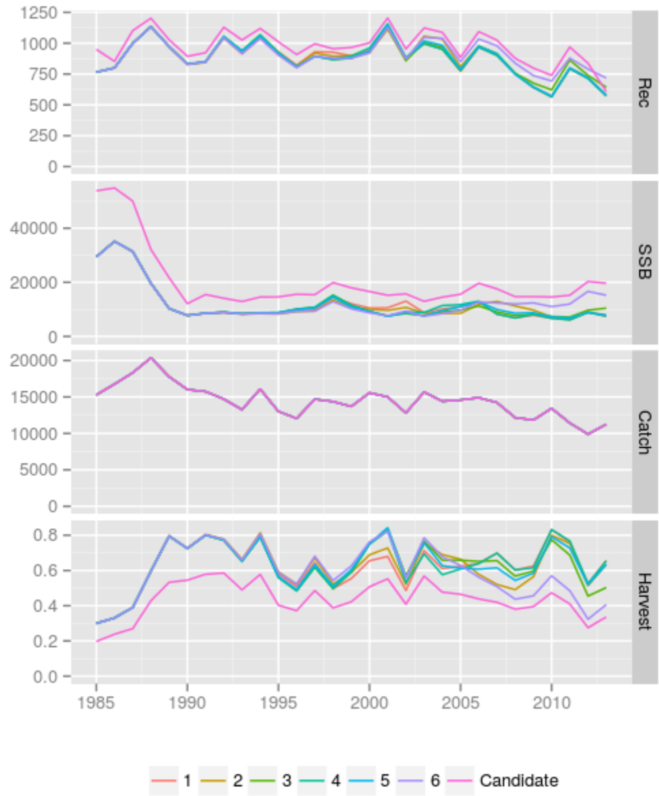

Figure 23. XSA time series estimates by CPUE series.

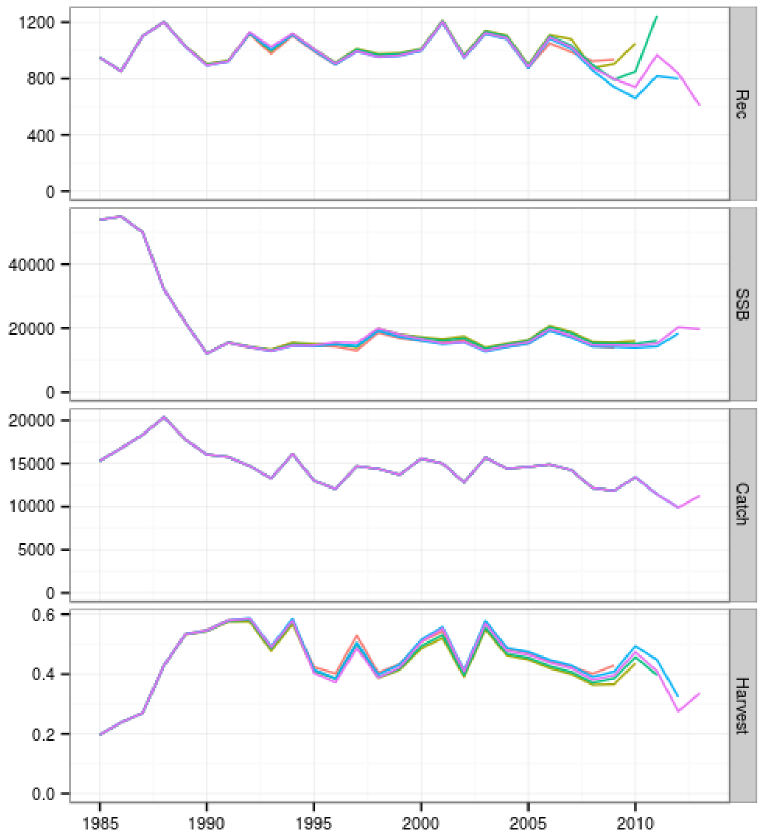

Figure 24. Retrospective XSA time series estimates.

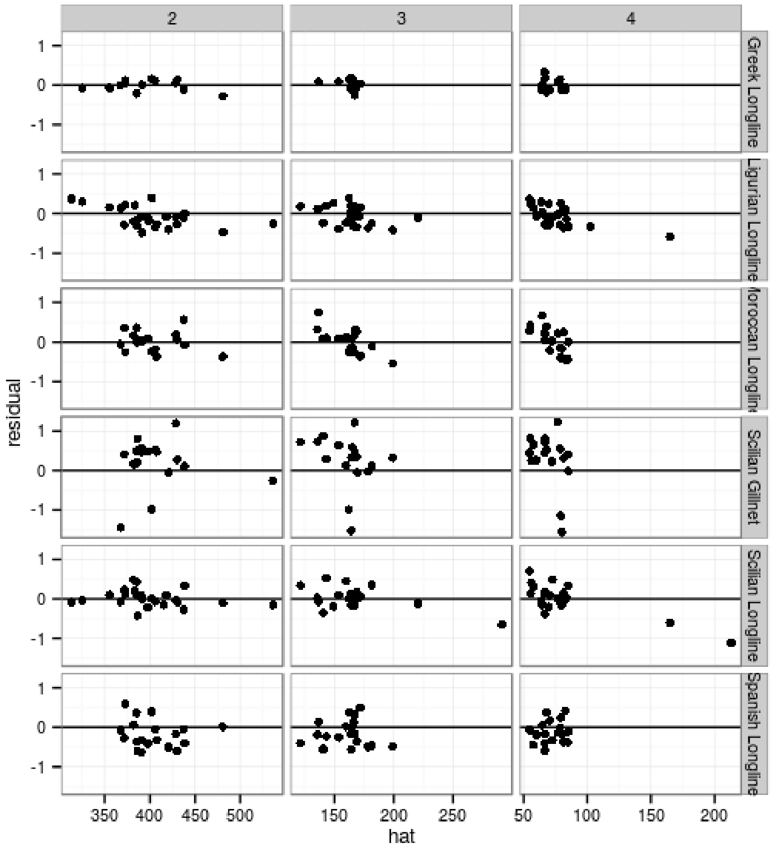

Figure 25. XSA diagnostics from alternative run; residuals against fitted value.

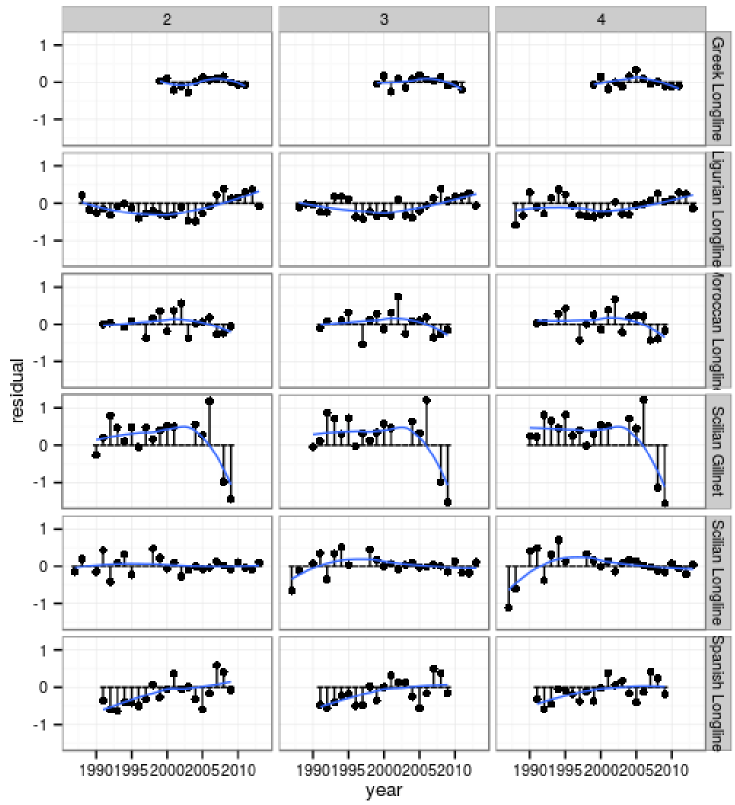

Figure 26. XSA diagnostics from from alternative run; residuals against year.

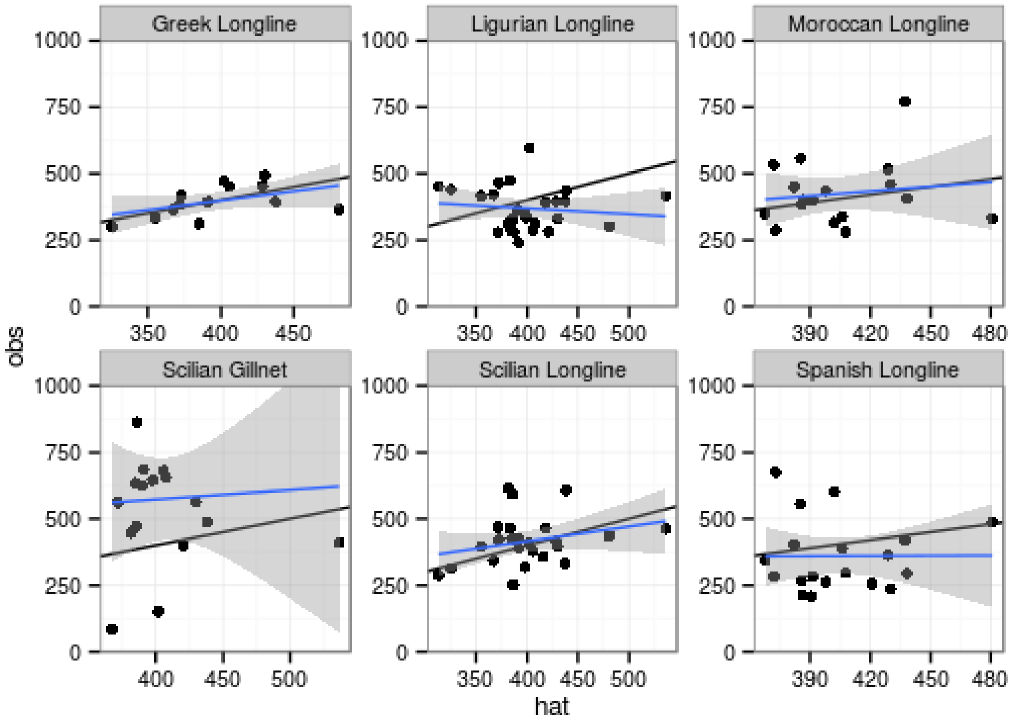

Figure 27. XSA diagnostics from from alternative run; Calibration regression plots for age 2.

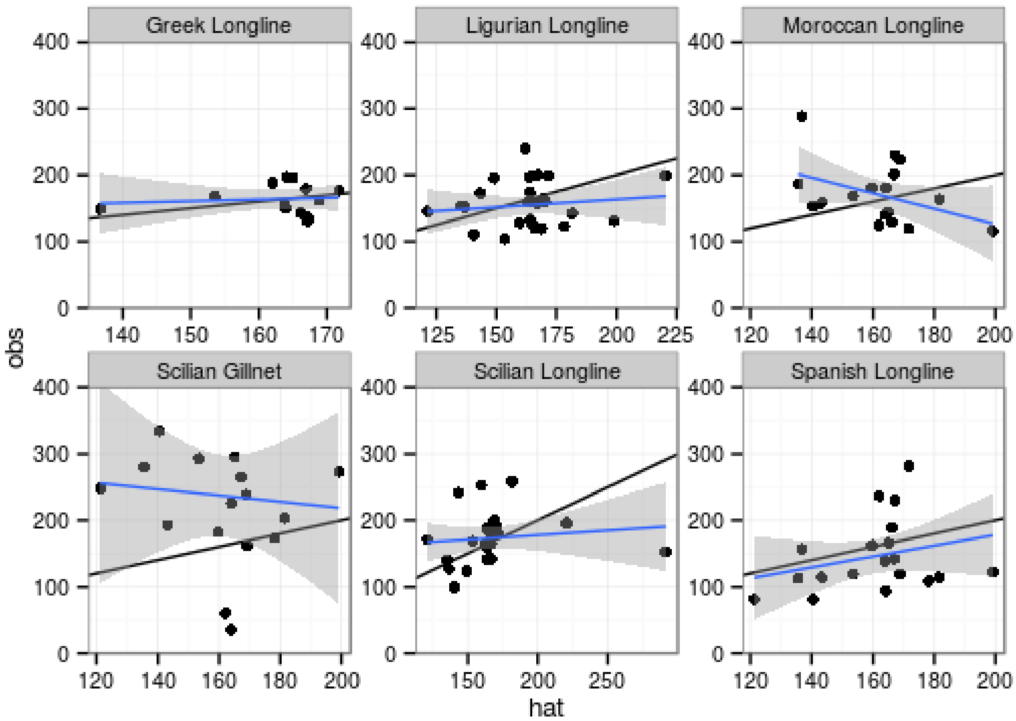

Figure 28. XSA diagnostics from alternative run; Calibration regression plots for age 3.

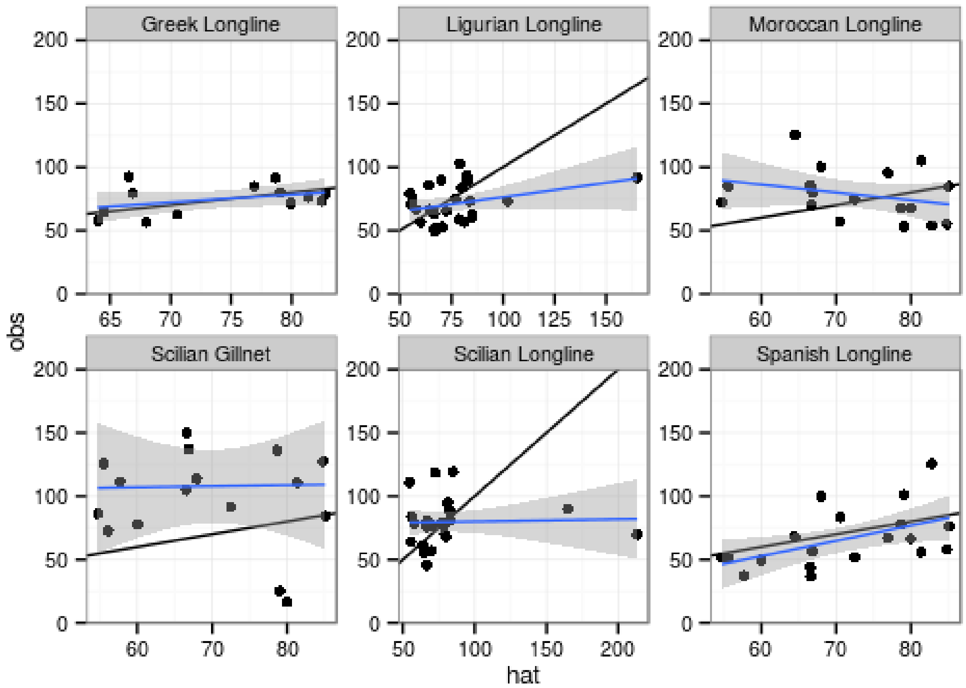

Figure 29. XSA diagnostics from alternative run; Calibration regression plots for age 4.

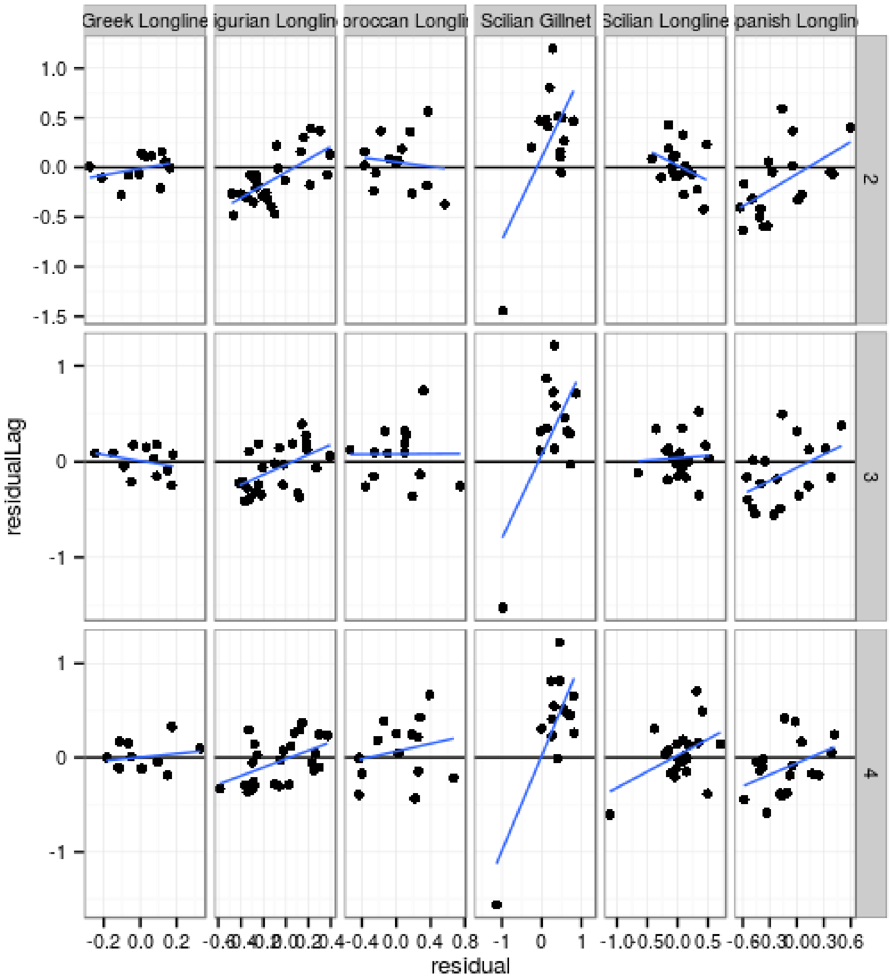

Figure 30. XSA diagnostics alternative run; AR plots of lagged residuals

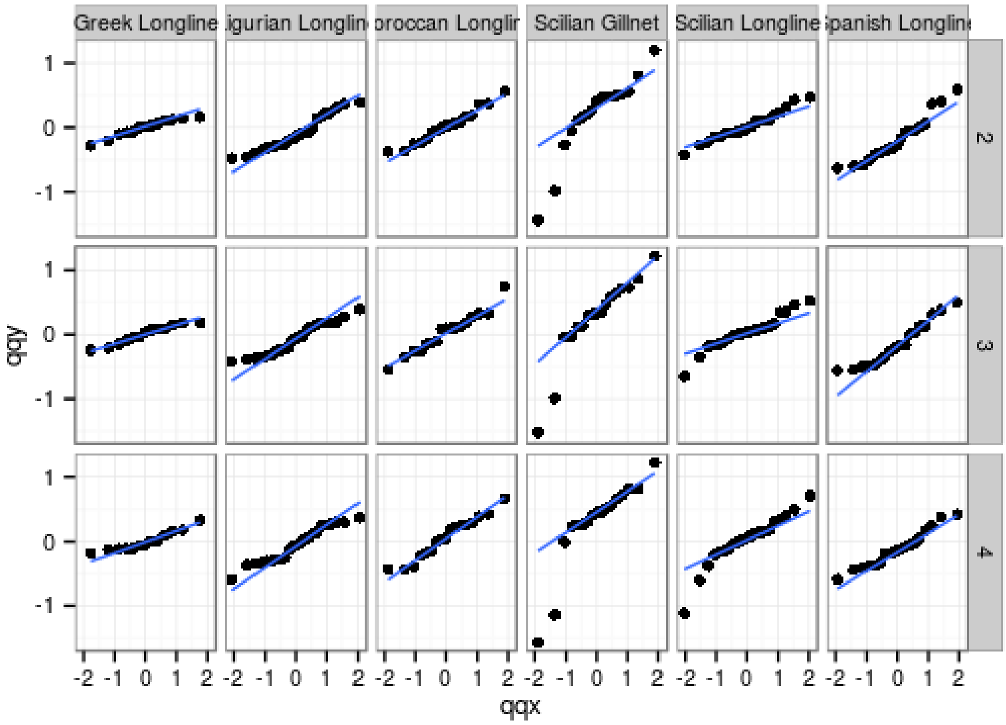

Figure 31. XSA diagnostics alternative run; QQ plots to check for normality

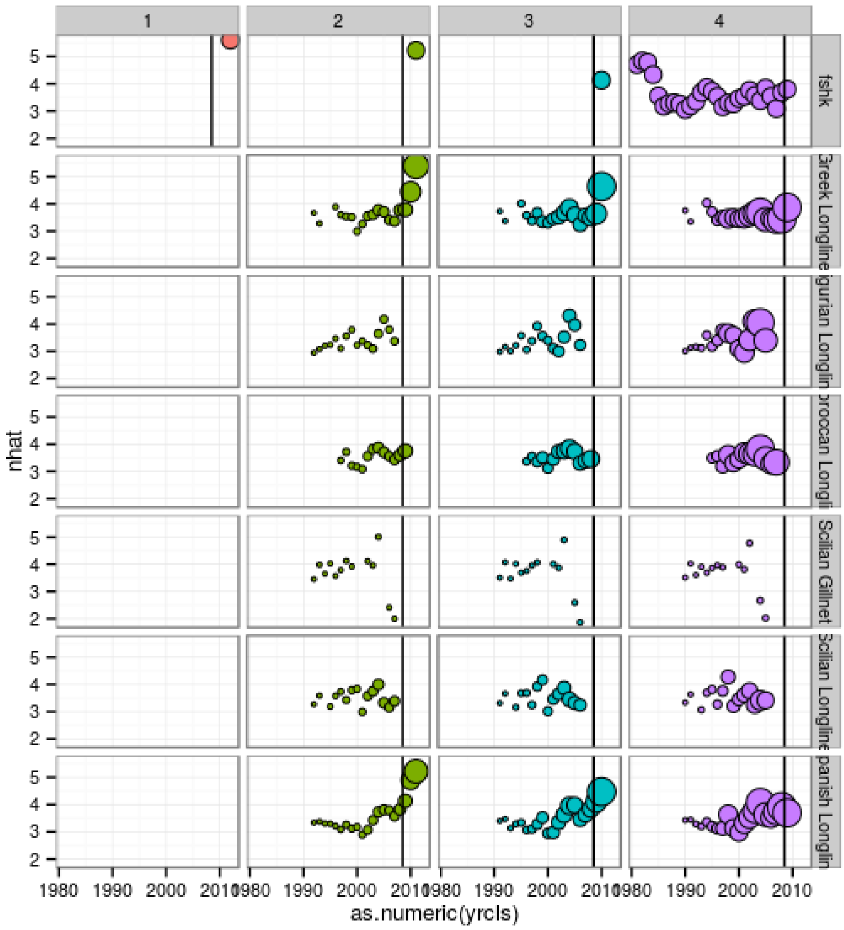

Figure 32. XSA diagnostics alternative run; weights for terminal year Ns for each CPUE observation and shrinkage

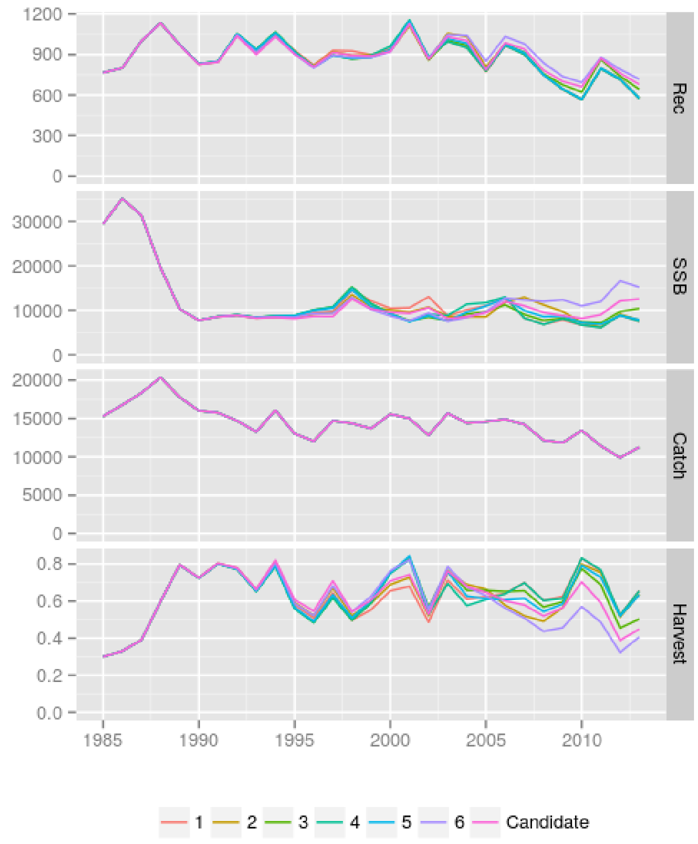

Figure 33. XSA time series estimates by CPUE series.

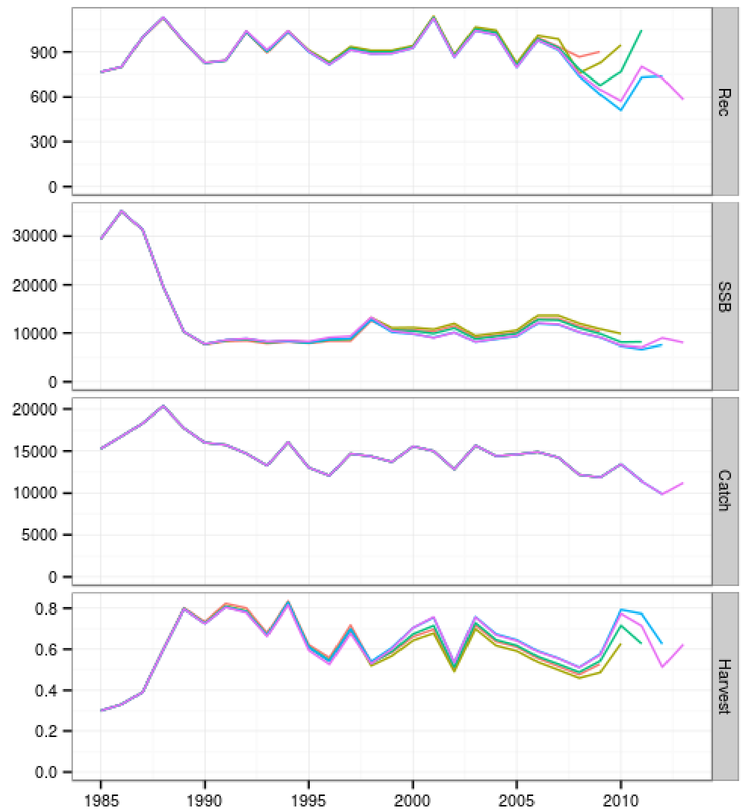

Figure 34. Retrospective XSA time series estimates.

Stock Status

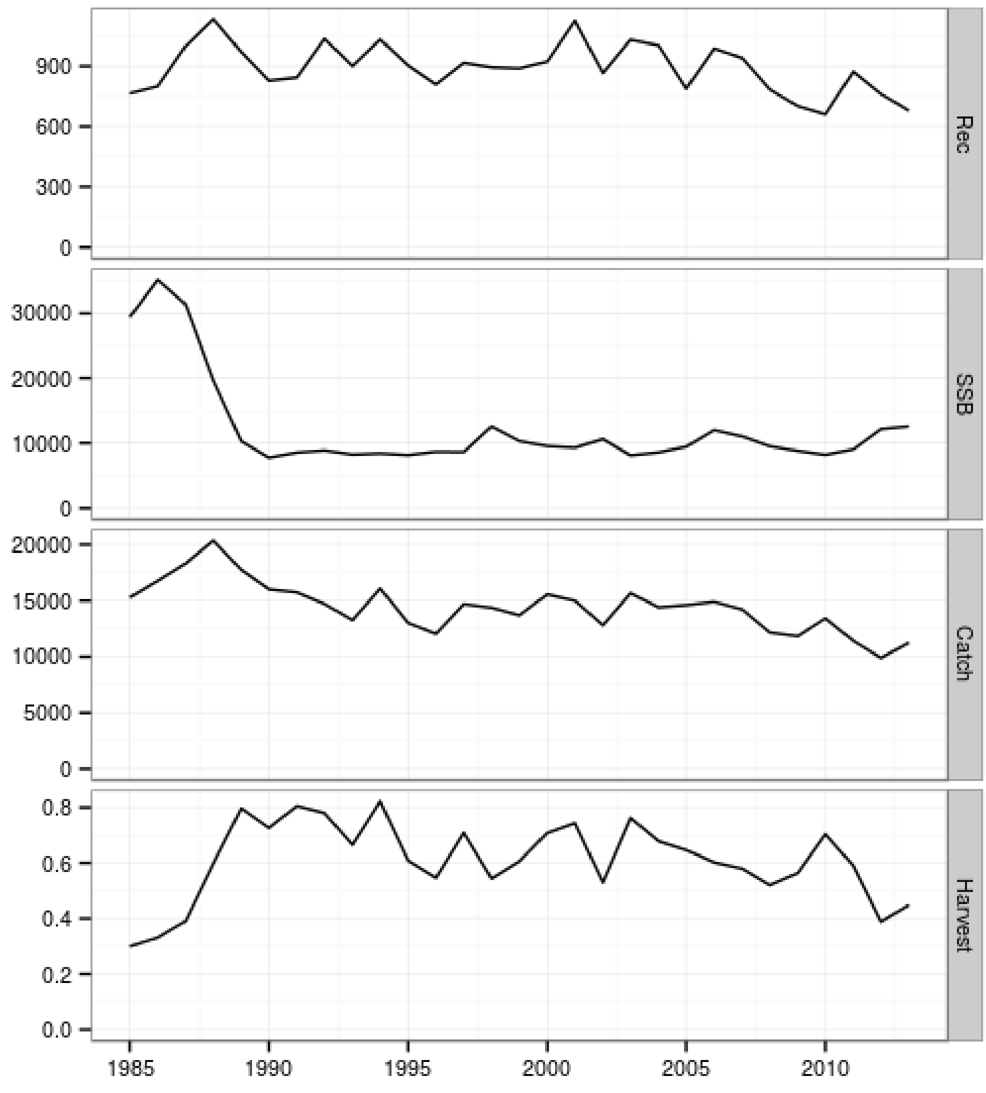

Figure 35. XSA alternative run.