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Report of the Benchmark Workshop on North Sea Stocks (WKNSEA)

6–10 February 2017

Copenhagen, Denmark

ICES
International Council for
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Contents

Executive summary

The ICES Benchmark Workshop on North Sea Stocks 2017 (WKNSEA) convened at two meetings, one data compilation workshop at ILVO in Oostende, Belgium (8–10 November 2016) and the final benchmark meeting at ICES HQ, Copenhagen (6–10 February 2017).

In WKNSEA 2017 two stocks were benchmarked: plaice in 3.a and 4 (ple.27.420) and sole in 7.d (sol.27.7d). The most important conclusions for each stock were:

Plaice in 3.a and 4

No new information on stock id or substock structure was presented during the benchmark. During a plaice benchmark in 2015, the decision was made to assess western Skagerrak plaice with North Sea plaice (area 4). Plaice migrate into 7.d during quarter 1, therefore 50% of the mature individuals were assigned to North Sea plaice stock in addition to 50% of the mature discards; this as different from previous years, when 50% of the catches were assigned to the North Sea stock.

Alternate survey indices were explored. In addition to the beam trawl and sole net surveys used in the assessment prior to the benchmark, the IBTS quarters 1 and 3 were investigated. Alternative ways of calculating standardized age-based survey indices based on GAMs and Delta distributions were explored.

A new maturity ogive was estimated using Dutch commercial landings 1957–2015, but assessment model runs showed the new ogives had limited effect on the reconstructed SSB. Therefore, the previously used, time-invariant maturity ogive was chosen.

Several methods for estimating natural mortality were investigated. The rates based on Hoenig’s Tmax-based estimator (Hoenig, 1983) were thought to be the best for this stock, but did not deviate greatly from the previous estimate, based on Beverton (1963). Therefore, natural mortality was not changed from 0.1 year^{-1} for all ages and years.

The assessment model was changed from XSA to a smoother-based age-structured stock assessment, based on Aarts and Poos (2009), but the F-at-age matrix is generated using a tensor spline. Rather than using the discards and landings-at-age as separate data sources as in Aarts and Poos (2009), the final assessment uses the catches (the sum of landings and discards) as data and the basis for the likelihood fitting.

New reference points were estimated. F_{MSY} analyses were conducted with Eqsim.

Sole in 7.d

Existing research showed that sole in 7.d are genetically distinct from sole in 7.e, but some exchange between stocks occurred with North Sea sole and sole 7.d. Within the 7.d stock, limited exchange of larvae and juveniles occurs between three regions: along the English coast, the Bay of Seine, and along the coast of northern France.

InterCatch was used for estimation of landings age composition, as well as the estimation of both discards numbers and age composition. Data from each nation were input for 2003–2015. Stock weights-at-age were generated from quarter 2 catch weights.

Research tuning indices were investigated to determine whether there was sufficient information on age 1 fish in the French YFS and UK YFS surveys. There was no evidence to revise the tuning indices and they were retained in their current form in the assessment.

The suggestions made during WKFLAT 2009 were implemented for the Belgian commercial series, which was to investigate a more realistic conversion factor for horse power for converting nominal fishing effort to effective effort. This was successfully done for 2004–2015, but resulted in truncating the tuning series in the assessment model. A new French commercial tuning series was constructed from the French otter trawl fleet targeting sole along the French coast.

A new maturity ogive was constructed using data from the UK commercial fisheries.

Three assessment models were trialled at the benchmark: XSA, SAM, and the Aart and Poos model. The final model was an XSA and included catch data (2003–2015), discards, new stock weights, new maturity ogive, three research surveys (the UK BTS survey, and the UK and French YFS surveys), and three commercial surveys (the newly constructed Belgium commercial survey 2004–2015, the new French otter trawl series 2002–2015, and the UK CBT commercial series) The new model resulted in an increase in SSB and decrease in F_{bar}, especially in more recent years.

New reference points were estimated. F_{MSY} analyses were conducted with Eqsim.

Future research and data requirements were identified, also by the external reviewers.

1 Introduction

A **Benchmark Workshop for North Sea Stocks** (WKNSEA), chaired by External Chair Liz Brooks, US and ICES Chair Jennifer Devine, Norway, and attended by two invited external experts John Wiedenmann, US and Nathan Taylor, Canada met at ILVO in Oostende, Belgium 8–10 November 2016 for a three-day data evaluation meeting and at ICES HQ, Copenhagen, Denmark for a five-day Benchmark meeting 6–10 February 2017 to:

a) Evaluate the appropriateness of data and methods to determine stock status and investigate methods for short-term outlook taking agreed or proposed management plans into account for the stocks listed in the text table below. The evaluation shall include consideration of:
  i) Stock identity and migration issues;
  ii) Life-history data;
  iii) Fishery-dependent and fishery-independent data;
  iv) Further inclusion of environmental drivers, multispecies information, and ecosystem impacts for stock dynamics in the assessments and outlook.

b) Agree and document the preferred method for evaluating stock status and (where applicable) short-term forecast and update the stock annex as appropriate. Knowledge of environmental drivers, including multispecies interactions, and ecosystem impacts should be integrated in the methodology
  i) If no analytical assessment method can be agreed, then an alternative method (the former method, or following the ICES data-limited stock approach) should be put forward;

c) Re-examine and update (if necessary) MSY and PA reference points according to ICES guidelines (see Technical document on reference points);

d) Develop recommendations for future improving of the assessment methodology and data collection;

e) As part of the evaluation:
  i) Conduct a three-day data evaluation workshop (DEWK). Stakeholders are invited to contribute data (including data from non-traditional sources) and to contribute to data preparation and evaluation of data quality. As part of the data evaluation workshop consider the quality of data including discard and estimates of misreporting of landings;
  ii) Following the DEWK, produce working documents to be reviewed during the Benchmark meeting at least seven days prior to the meeting.

STOCKS	STOCK LEADER
Plaice (*Pleuronectes platessa*) in Subarea 4 (North Sea) and Division 3.a (Skagerrak)	Jan Jaap Poos
Sole (*Solea solea*) in Division 7.d (Eastern English Channel)	Lies Vansteenbrugge

The Benchmark Workshop will report by 1 April 2017 for the attention of ACOM.

2 Adoption of the agenda

The following were dropped from the agenda:

> Further inclusion of environmental drivers, multispecies information, and ecosystem impacts for stock dynamics in the assessments and outlook.

3 Description of the Benchmark Process

The ICES benchmark on North Sea stocks included the following steps:

1) A data call was issued 16 August 2016 for the North Sea stocks to be benchmarked in WKNSEA. The deadline of the data call was 7 October 2016.

2) Two skype meetings, one for each stock, were held on October 14th and 21st, 2016, to go through the data issues list and verify all data had been provided at the close of the data call. External reviewers and chair were invited to attend. A summary of each meeting was sent to all WKNSEA participants.

3) Data compilation workshop 8–10 November 2016.

4) A Skype meeting was held on December 12, 2016 to check on progress after the data workshop. Externals were invited to attend. A summary of each meeting was sent to all WKNSEA participants.

5) A Skype meeting was held on January 18, 2017 to check on progress after the data workshop. Externals were invited to attend. A summary of each meeting was sent to all WKNSEA participants.

6) Several other skype meetings were arranged between smaller subgroups that did not involve the external chair and reviewers to work on issues surrounding specific working documents. These included: maturity ogives for sole and plaice, Belgium cpue index estimation, generating plaice indices for the BTS and IBTS survey series, and InterCatch procedures for sole.

7) The deadline for working documents was February 2, 2017. All documents except one were completed by the deadline.

The data issues and subsequent working papers for plaices 3.a4 and sole 7.d are detailed below.

PLAICE 3A4

Title	Description	Contributors
1. Biological data	a) Natural mortality b) Maturity ogive	Jan Jaap Poos, Chun Chen, Holger Haslob
2. Survey indices	a) IBTS Q1 & Q3 b) BTS combined index c) Industry surveys d) Belgian survey effect	Casper Berg, Clara Ulrich, Jan Jaap Poos, Holger Haslob, Bart Vanelslander
3. Assessment models	a) Discard estimation (2 alternates: historically modelled (SPALY), model internal within assessment model b) AAP model c) Sequential runs incorporating changes to input data	Jan Jaap Poos, Holger Haslob, Chun Chen, Casper Berg

SOLE 7D

Title	Description	Contributors
1. Biological data	Maturity ogive	Lies Vansteenbrugge, Chun Chen, Holger Haslob
2. Belgian cpue index	Replicating simple GLM model from last benchmark, incorporating spatial aspect to data, may try to account for autocorrelation in catch rates, spatial plots of catch and effort by year	Sofie Nimmegeers, Bart Vanelslander
3. Survey indices	YFS series (UK 1987–2006 Q3, FRA 1987–2015 Q3). YFS ages 0–1. No spatial overlap BTS 1988–2016 Q3. BTS – ages 1–6 VCBT – comm, 2 series; 1986–2003, 2003–2015) UK comm – used in assessment (1986–now) FRA comm – 2002–now	Bart Vanelslander, Lies Vansteenbrugge, Marie Savina-Rolland Youen Vermard
4. Raising of discards	Raising procedure for discards, Discard & age allocations	Sofie Nimmegeers, Lies Vansteenbrugge
5. Subpopulation definition/mixing of stocks	Investigation of English tagging data	Marie Savina-Rolland
6. Assessment models	a) AAP model b) SAM model c) sequential runs incorporating changes to input data	Jan Jaap, Anders Nielsen, Casper Berg, Lies Vansteenbrugge, Sofie Nimmegeers, Bart Vanelslander, Marie Savina-Rolland

The first two days of the benchmark were devoted to biological parameters, survey and cpue indices, and the InterCatch raising and allocation procedures. After each presentation, discussions were held and participants reached a consensus on the outcome, e.g. which maturation ogive(s) to use in the assessment runs. This process involved several iterations, where more work was completed on a topic until a consensus was reached.

The second two days of the benchmark were devoted to presentations of assessments and reference points.

The final day was finalization of reference points, including a skype meeting with **WKIrish3 and Carmen Fernandez (ACOM vice-chair)**, checking the short-term forecast with the new assessment model, and writing the report and stock annex. The externals drafted their recommendations and conclusions.

Notes on the benchmark process

Not all of the data arrived by the deadline of the data call or the data workshop. There were also errors in InterCatch due to one country not removing data before re-uploading data with different métiers. Despite these issues, nearly all of the working documents for both species were completed by the deadline.

4 Plaice in 3.a and 4

This section relates to the plaice stock in the North Sea (Subarea 4) and the Skagerrak (Division 3.a–20).

4.1 Stock ID and substock structure

No results were presented on the stock ID during the benchmark. The flatfish benchmark group (WKFLAT, ICES, 2010) recommended to explore the potential to perform an integrated assessment of the continuum of plaice stocks from the Baltic to the English Channel. ICES evaluated the stock identity of plaice in the Skagerrak and Kattegat during a dedicated workshop (WKPESTO, ICES, 2012b) for which until now combined advice was given.

Plaice in the Skagerrak is considered to have two components: an eastern and a western. The latter occurs in a mix with plaice migrating in from the North Sea (Ulrich *et al.*, 2013) and the predominance of catches occurs on summer feeding aggregations in the Western Skagerrak. In a benchmark (WKPLE 2015, ICES, 2015), it was decided that plaice in the Skagerrak would be assessed together with the North Sea stock.

In addition, as in previous years, part of the catches in the 7.d area in the first quarter are included in the North Sea plaice assessment because North Sea plaice migrates into the area in that season (ICES, 2010). This year, 50% of the mature animals from 7.d in Q1 were added to the North Sea stock, whereas before, 50% of the total catches were added. Moreover, this year 50% of the mature discards in Q1 were also added to the North Sea stock.

4.2 Issue list

The issue list is taken from Annex 6 of ICES, WGNSSK (2016). The ‘Comments’ column indicates whether the issue was handled during this benchmark and, if yes, where it can be found.

Issue	Problem/Aim	Work needed/ possible direction of solution	Data needed to be able to do this: are these available / where should these come from?	Comments
(New) data to be considered and/or quantified	Additional M - predator relations	Review of basis for natural mortality		The natural mortality estimates were evaluated. Results can be found in WD 1 and Section 4.6.3.3
	Prey relations			
	Ecosystem drivers			
	Other ecosystem parameters that may need to be explored?			
Tuning series	Exclusion of SNS or combine SNS with BTS	Make a combined index SNS/BTS and explore assessments with or without SNS and combined index	SNS, BTS indices	Combining the BTS indices was evaluated. Results can be found in WD 2 and in Section 4.6.2.1
Tuning series	Inclusion of IBTS as tuning fleet	IBTS index	IBTS index	Combining athe IBTS indices was evaluated. Results can be found in WD 2 and in Section 4.6.2.1
Discards				
Biological Parameters	Natural mortality Maturity	Review of basis for natural mortality. Literature review, model estimates of M Review of basis for maturity. Literature review, model estimates of maturity		The natural mortality estimates were evaluated. Results can be found in WD 1 and in section 4.6.3.3. Maturity can be found in WD 3 and Section 4.6.3.2.
Assessment method	Explore other models (SCAA, SAM, Aarts and Poos).			A new assessment method was evaluated. Results can be found in WD 4 and in Section 4.6.4
Biological Reference Points	Revision F_{MSY} and $MSYB_{trigger}$ after inclusion of Skagerrak			New reference points were evaluated baed on the assessment and results are in Section 4.7
Management plan	Revision of the North Sea management plan after adding SK AND Implementation of stage 2 of the MP			

4.3 Scorecard on data quality

A scorecard was not used for this benchmark.

4.4 Multispecies and mixed fisheries issues

No new information was presented at the benchmark meeting.

4.5 Ecosystem drivers

No new information was presented at the benchmark meeting.

4.6 Stock assessment

4.6.1 Catch: quality, misreporting, discards

No new information was presented at the benchmark meeting.

4.6.2 Surveys

4.6.2.1 Research surveys

Several survey time-series exist which are potentially useful for the North Sea plaice stock assessment model to be used as tuning indices. The most important ones for demersal fish species in the greater North Sea area are the different Beam Trawl Surveys (BTS, 3rd Quarter) and the International Bottom-trawl Survey (IBTS, 1st and 3rd Quarter). While the different BTS cover areas 4.b, 4.c and the Channel, the IBTS also covers area 4.a and the Skagerrak and Kattegat (area 3.a). Historically the following Dutch survey indices were used in the plaice assessment:

- Beam Trawl Survey combined for RV Tridens and ISIS (BTS-combined); (1996–2015); Age 1–9;
- Beam Trawl Survey RV Isis (BTS–Isis) for the older part of the time-series; (1985–1995); Age 1–8;
- Sole Net Survey 1 (SNS1); (1982–1999); Age 1–3;
- Sole Net Survey 2 (SNS2); (2000–2015); Age 1–3.

In previous years, some problems were encountered with these survey indices due to different reasons (ICES, 2015a), but the current settings with the combined BTS and the split of the SNS (ICES, 2015b) solved these issues and the currently used survey indices, in general, performed well in the used assessment model. However, it was decided by the benchmark working group to test also other existing survey time-series to: (1) enlarge the spatial coverage of the survey within the North Sea and, (2) to include more haul information, (3) to include also information from the Skagerrak (area 3.a), which is not covered by the BTS. This latter aspect has become especially relevant since the inter-benchmark work shop on plaice in 2014 (ICES, 2015a), where it was decided to combine the former separated plaice stock units form area 4 and Division 3.a. The existing time-series were compared in a first step directly to evaluate their ability to follow cohorts and to evaluate their internal consistencies. The following survey indices were presented and discussed during the meeting:

- Beam Trawl Survey RV Solea; Age 1–9; (2002–2005, 2007–2015); (WD 2);
- Beam Trawl Survey RV Belgica; Age 0–11; (2010–2015);

- Combined BTSQ3 index including all available data from DATRAS; 1996–2015; Age 1–6; (WD 2);
- IBTS Q1 plaice index; 1983–2015; Age 1–5; (WD 2);
- IBTS Q3 plaice index; 1996–2015; Age 1–5; (WD 2);
- Combined BTSQ3 and IBTSQ3; 1996–2015; Age 1–5; (WD 2).

In general, the BTS Solea index displays similar trends for the single age groups compared to the combined Dutch BTS index (Figure 1). Some larger discrepancies occur for the older age groups (>age 6). The Belgian index, although only available for few years, follows the general trends, but there are also some large discrepancies compared to the two other survey indices, e.g. the last two years for age group 8. Further, the Belgium data for 2015 were collected with a different ship and gear (ICES, WGBEAM 2016). However, it was concluded that both time-series potentially provide reasonable information and could be included into the assessment model.

A GAM model approach (Berg *et al.*, 2014; WD 2) was applied to construct different age-based survey indices making use of the DATRAS database. All these GAM indices seem to provide useful information for plaice, given that they all give consistent estimates of increasing abundances since around 2005 and it is possible to follow cohorts within and between all surveys (based on high internal and external consistencies). Some issues with regard to combining survey time-series by applying the GAM model approach were discussed: (1) which plus group should be used, (2) how suitable is it to borrow age–length keys (from years and areas) to extend the IBTS time-series, (3) the Belgian and German time-series have only partly been uploaded to DATRAS, but the national institutes are currently working on their databases in order to upload more historical data. Therefore, the group agreed that when constructing combined indices, only data which are currently available in DATRAS must be used. Extended time-series taking more historical data into account should be evaluated by the next benchmark or inter-benchmark work shop, (4) the last data year of the Belgian time-series (2015) was excluded from the combined indices, because in this year a different gear (BT4S) and ship was used. It was not possible to estimate a possible gear effect for this single data year but it should be analysed in future if these data can be included, (5) when combining indices, it was recommended to nevertheless evaluate the separate indices in order to detect suspect patterns which might lead to the exclusion of a time-series, if the informative value is in doubt.

There were two opposite opinions regarding the plus group to be used. One argument was not to use older age groups (>6 years) for the index constructions because usually the samples in the older age groups are not independent. The other opinion was to use also the older age groups because otherwise too much information on the cohorts would be lost. In the end, it was agreed to use age 9 as a plus group for the combined Q3BTS and the Q3IBTS survey indices and age 7 as plus group for Q1IBTS index. With regard to the possibility of borrowing age–length keys to fill data gaps, it was agreed that the IBTS GAM survey indices should be restricted to that time periods for which a good sampling coverage is available. This is 2007–2015 for IBTSQ1 and 1997–2015 for IBTSQ3.

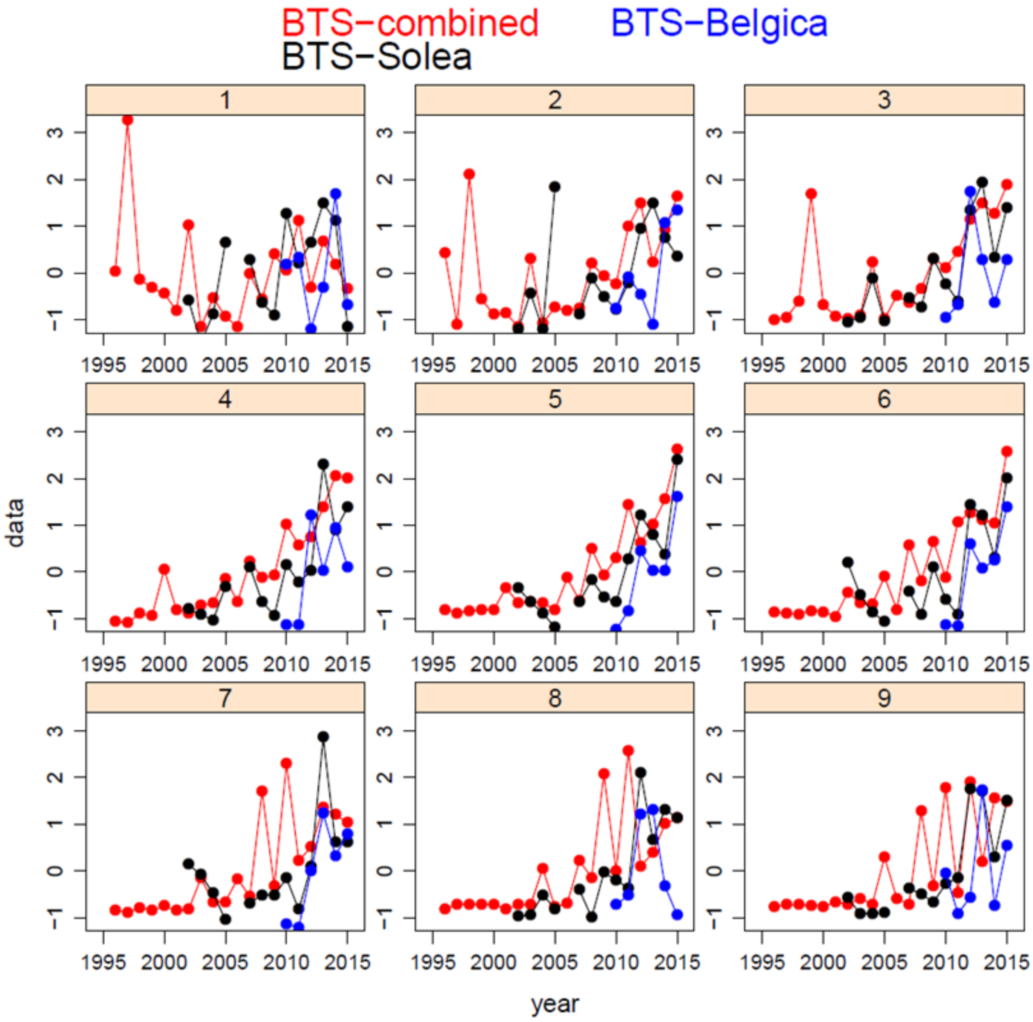

Figure 1. Comparing the currently used combined BTS index (RV Isis & RV Tridens) with the BTS-Solea and BTS-Belgica.

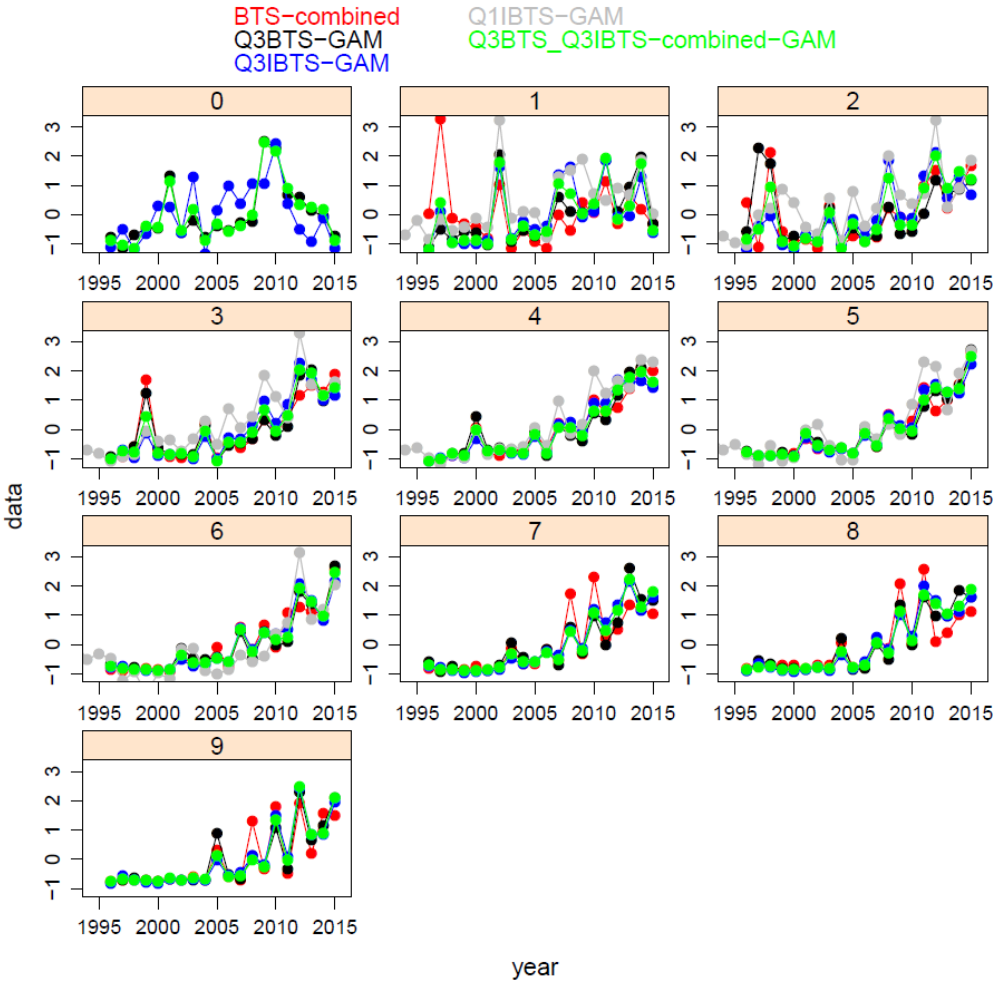

Figure 2. Comparing the currently used combined BTS index (RV Isis & RV Tridens) with the different indices estimated applying the GAM model approach by Berg *et al.* (2014).

All GAM indices follow well the trends of the currently used combined BTS survey index by age groups. Only for the older age groups (≥age7) the trends are somewhat smoother. Based on the discussion in the group it was agreed to substitute the old BTS combined index and to perform trial runs in order to test the alternative GAM survey indices in the assessment model.

Different combinations of new and old survey indices were tested. The survey residuals and retrospective patterns were evaluated in order to find the best settings for the final assessment. For all different cases, no strong residual patterns were detected. In comparison to the base run, which is the run most similar to the WGNSSK 2016 final assessment, the best combination of indices was the inclusion of the SNS time-series (SNS1 and SNS2) and all new indices: combined Q3BTS_new, Q3 IBTS and the Q1IBTS (for all details see WD 2). In a first trial the use of these indices resulted in the best retrospective patterns for SSB, R and F (Mohn’s Rho). The exclusion of the SNS time-series resulted in a very good Rho for SSB but the Rho for F was the lowest compared to the all other runs. Finally, it was concluded that the model run including all indices showed the best overall results with respect to the retrospective runs. This run resulted in a lower SSB and a slightly higher F.

4.6.2.2 Catch and effort series

No new information was presented at the benchmark meeting.

4.6.3 Weights, growth, maturity, natural mortality

4.6.3.1 Weights and growth

No new information was presented at the benchmark meeting.

4.6.3.2 Maturity

The maturity ogive is an important population attribute and it is used for estimating SSB in the stock assessment. For North Sea plaice, a fixed maturity ogive was employed in the assessment model (Table 4.6.3.1). Grift *et al.* (2003) showed that the age and length at maturation have decreased over the past half century. With the observed biological growth curve changes in plaice since 2000 and the substantial increase of SSB, it is interesting to gain more insight into the maturity ogive for North Sea plaice (areas 4 and 3.a) and to investigate its impact on SSB. In WGNSSK 2005, a preliminary estimation of maturity ogive was conducted using Dutch landing data and no change were made thereafter to Table 1.

A more population representative NS-IBTS Q1 survey data were originally dedicated to estimate maturity ogive. However, due to the short time-series and inconsistencies among participating countries, NS-IBTS data were eventually not taken into account in the benchmark (WD 3). Instead, Dutch commercial landings (1957–2015) were used to estimate the plaice maturity ogive in the North Sea, following three steps (WD 3):

1) Maturity ogive at given age *a*, length *l* and year *y*, i.e. $f_{s,a,y}(l)$, was estimated using a glm model for each sex (s={female, male}):

$$\text{logit}[P(y_i = 1)] = \alpha + \beta_1 \cdot Year_i + \beta_2 \cdot Age_i + \beta_3 \cdot length_i, \text{ per sex} \qquad (1)$$

2) The mean maturity of $f_{s,a,y}(l)$, given length distribution per age year sex $LF_{s,a,y}(l)$, is defined as:

$$E[f_{s,a,y}(l)] = \int LF_{s,a,y}(l)\, f_{s,a,y}(l)\, dl \qquad (2)$$

A mean length-at-age for Q1 per year, i.e. $\bar{l}_{a,y}$, was estimated from BTS survey data (WD 3 Table 2, Figure 14): A growth curve (von Bertalanffy, 1938) was estimated from BTS survey Q3 data, and extrapolated into the mean length at Q1. Since survey samples are less length selective than Dutch landing, the estimated mean length from the BTS is less likely to be biased and serves well as a population mean. The estimated mean maturity rate at-age *a,* year *y*, sex *s* was then approximated as $f_{s,a,y}(l)$ at $l = \bar{l}_{a,y}$ (i.e. first order approximate mean from Taylor series).

3) Assuming equal proportion of sex per age, the final maturity-at-age was estimated as:

$$E[f_{s,a,y}(l)] \approx f_{\text{female},a,y}(l = \bar{l}_{a,y})/2 + f_{\text{male},a,y}(l = \bar{l}_{a,y})/2 \qquad (3)$$

Note that both approximations and assumptions were employed to obtain formula (2) from (3), e.g. the mean maturity is not computed from the product between $LF_{s,a,y}(l)$ and $f_{s,a,y}(l)$, but $f_{s,a,y}(l)$ at mean value of $LF_{s,a,y}(l)$; a sex-independent mean length $\bar{l}_{a,y}$ is applied to sex-specific maturity $f_{s,a,y}(l)$. However, this is the "best" we can approximate, given the available biological length–age sex samples.

Dutch landing samples in 1988 were excluded due to too few samples. Additionally, samples in 2002 were excluded due to the confusion in maturity staging. The final estimated maturity ogive for age 2–4 are illustrated in Figure 4.6.3.1 and Table 4.6.3.2.

Due to the lack of BTS samples to provide length–age distributions, maturity ogive for 1957–1984 cannot be directly estimated using the method above. On the other hand, the estimated stock weight-at-age for Q1 is available since 1957. Therefore, the time-trend of mean weight was used as a proxy for the time-trend of mean length. The comparison between mean weight in the missing years (1957–1984) vs. known years (1985–2015) was used to derive the imputation strategy for the missing years. A constant mean size-at-age as well as maturity-at-age length were observed since 1957 till 1980, whereas both variables show a changing trend after 1980, i.e. negative trend of mean size and a positive trend of maturity-at-age length for female (WD 3, Figures 13 and 18). Both observations suggest that the maturity ogive in 1957–1984 can be imputed using the ogive in 1985. The ogives in year 1988 and 2002 were reconstructed using the average of adjacent years.

The reconstructed maturity ogive was tested in the final assessment model (Figure 4.6.3.3). However, given the very limited effect that these maturity ogives had on the reconstructed SSB, the benchmark decided to keep the current time-invarying maturity ogive.

4.6.3.3 Natural mortality

The current estimate for natural mortality (M) is assumed to be 0.1 year-1 for all ages and years (Table 4.6.3.1). This is based on Beverton (1963), who estimated from the survival of plaice cohorts in the North Sea during the Second World War, see also WD 1. The natural mortality of plaice males was estimated to be 0.14 year-1 while the natural mortality for females was estimated to be 0.08 year 1. Gislason *et al*. (2010) state a second potential source of information for plaice: an estimate of 0.2 year-1 from Siddeek (1989). However, the experiments of Siddeek actually resulted in a wide range of M estimates, ranging between 0.085–0.204, for males and females. It should be noted that these experiments were not done in the North Sea, but in the Irish Sea.

So far, a list of natural mortality estimators have been proposed and a recent overview has been given in Kenchington T J, 2014. Gislason's First estimator (Gislason *et al*., 2010) on natural mortality rate (M) at-length was explored as the first attempt: $\ln(M) = 0.55 - 1.61\ln(L) + 1.44\ln(L_\infty) + \ln(K)$, due to its regression property and ability to estimate M-at-size. The estimator requires estimation of von Bertalanffy (von Bertalanffy L., 1938) growth parameters L_∞ and K (WD 1). However, the estimated mortality rate turned to be substantially higher than the estimated values in Beverton (1963) (Table 4.6.3.3). This could due to the high uncertainties from the formula derived from their original regression output, or the uncertainties from the estimated growth parameters. Similar pessimistic findings were also found in other stocks (e.g. plaice 7.d). Therefore, Gislason's estimator is not adopted in the benchmark.

Hoenig's Tmax-based estimator (Hoenig, 1983) on total mortality rate (Z) was tried in the benchmark. Since the various versions of the estimator differ little when considering their uncertainties, we used the approximated formula Z ≈ 4.3/ Tmax for simplicity. Both the Dutch landing data and survey age samples were collected to estimate Tmax and Z. Their age distributions are illustrated in Figure 2. The estimated Tmax are 38 year and 31 year from landing and survey, respectively, resulting in the estimated Z of 4.3/38=0.11 and 4.3/31=0.14. The updated mortality does not deviate substantially from the current values in stock assessment (Beverton, 1963). Therefore, no update of natural mortality is needed.

4.6.4 Assessment models

A number of assessment runs were done using different formulations of a smoother-based age-structured stock assessment, based on Aarts and Poos (2009). The assessments were based on combinations of surveys, and methods for combining survey information (WD 4). The current assessment uses discards data from 2000 onwards: The discards time-series used in the assessment includes Dutch, Danish, German and UK discards observations for 2000–2015. To reconstruct the number of plaice discards at-age before 2000, catch numbers-at-age data were reconstructed in 2005 based on a model-based analysis of growth, selectivity of the 80 mm beam trawl gear, and the availability of undersized plaice on the fishing grounds. This reconstruction was done in 2004 (van Keeken *et al.*, 2004). The benchmark decided to continue this procedure.

The assessment is similar in structure to that in Aarts and Poos (2009), but the F-at-age matrix is generated using a tensor spline (with a design matrix taken from mgcv (Wood, 2006)). The number of knots in this tensor spline are controlled by means of a vector of length 2, one for the knots in the age dimension, and one for the number of knots in the year dimension of the assessment. Rather than using the discards and landings-at-age as separate data sources as in Aarts and Poos (2009), the final assessment uses the catches (the sum of landings and discards) as data and the basis for the likelihood fitting. After fitting the catches, landings and discards in the model fit are separated using the observed proportionality between landings and discards.

The final model used the following data and settings (see also WD 4):

Stock	North Sea and Skagerrak combined
Catch-at-age	Landings + (reconstructed) discards based on NL, DK + UK + DE fleets and BE (since 2012)
Fleets (years; ages)	BTS-Isis-early 1985–1995; 1–8 BTS-combined 1996–now; 1–9 SNS1 1982–1999; 1–6 SNS2 2000–now (excl. 2003); 1–6 IBTS Q1 2007–now; 1–7 IBTS Q3 1997–now; 1–9
Plus group	10
Catchability independent of ages for ages >=	6
Age at which the catchability for the F-at-age reaches a plateau >=	9
F tensor spline age knots	6

F tensor spline year knots	26

Results of this assessment are given in Figures 4.6.4.1–4.6.4. Comparisons to the current assessment show that the final assessment outcomes are fairly consistent with the current assessment (in terms of F, SSB, and R). Moreover, the assessment shows low Mohn's Rho values for retrospectives up to five years in the past. Given the structure of the model, the delta method can now be used to estimate uncertainty on F, SSB, and R.

4.7 Appropriate reference points (MSY)

4.7.1 Reference points prior to benchmark

The existing reference points are listed in the current ICES advice:

Framework	Reference point	Value	Technical basis	Source
MSY approach	MSY $B_{trigger}$	230 000 t	Default to value of B_{pa}	
	F_{MSY}	0.19	Combined stock	ICES (2014)
Precautionary approach	B_{lim}	160 000 t	B_{loss} = 160 000 t, the lowest observed biomass in 1997 as assessed in 2004	ICES (2004)
	B_{pa}	230 000 t	1.44 × B_{lim}	ICES (2004)
	F_{lim}	0.63	The F that in equilibrium will maintain the stock above B_{lim} with a 50% probability	ICES (2016a)
	F_{pa}	0.45	$F_{pa} = F_{lim} \times \exp(-1.645\sigma_F)$; $\sigma_F = 0.20$	ICES (2016a)
Management plan	SSB_{MP}	230 000 t	Stage one: Article 2	EU management plan (EU, 2007)
	F_{MP}	0.30	Stage two: Article 4.2 – F_{MSY} constrained to F ≥0.3	EU management plan (EU, 2007)

4.7.2 Source of data

Data used for the reference point estimation were derived from the final assessment as defined in Section 4.6.4. The SSB and R pairs can be found in assessment summary Table 4.7.2.1. The fishing mortalities-at-age can be found in Table 4.7.2.2. Weights-at-age for the stock, landings, discards and catches have not changed and can be found in the ICES, WGNSSK 2016 report.

4.7.3 Stock–recruitment relationship and new B_{lim} and B_{pa} reference points

The stock–recruit fits for a pure segmented regression and for a mixture of stock–recruitment relationships are shown in Figures 4.7.3.1 and 4.7.3.2, respectively. The SR scatter for North Sea plaice shows no clear patterns with both high and low recruitments found across the whole range of observed SSB. There is a single outlier (1985 year class) near the middle of the observed SSB range.

In the Eqsim method, the segmented regression estimates a breakpoint in the data at 207 287 tonnes. This is just above the B_{loss} of 202 100 tonnes observed in 1997. This

207 288 is thus the proposed B_{lim} reference point. Using the default multiplier (of 1.4) to calculate B_{pa} from B_{lim}, results in a B_{pa} reference point of 290 203 tonnes.

4.7.4 Methods and settings used to determine ranges for F_{MSY}

The Eqsim methods were applied to estimate the remainder of the reference points. Runs with and without $MSYB_{trigger}$ were done for the Eqsim method. The total (catch) F was optimised for maximum landings. The EQ sim runs were based on the S–R fits in Section 4.7.3. For each run, 3000 draws were taken from the S–R results.

First, an EQ sim run was done to estimate F_{lim}. This was done using the segmented regression fit to the S–R data and the following settings:

- bio.years = c(2006, 2015), bio.const = FALSE
- sel.years = c(2006, 2015), sel.const = FALSE
- F_{cv}=0, F_{phi}=0
- $B_{trigger}$ = 0, B_{lim}=B_{lim}, B_{pa}=NA

The resulting reference points table is given in Table 4.7.4.1. The resulting F_{lim} estimate is 0.516 $year^{-1}$. Using the default multiplier (of $^1/_{1.4}$) between F_{lim} and F_{pa} results in a corresponding F_{pa} estimate of 0.369 $year^{-1}$.

In order to get the initial F_{MSY} and $F_{0.5}$ estimates, a run was done with all S–R relationships and the following settings:

- bio.years = c(2006,2015), bio.const = FALSE
- sel.years = c(2006,2015), sel.const = FALSE
- F_{cv}=0.212, F_{phi}=0.423, # WKMSYREF4 defaults
- $B_{trigger}$ = 0, B_{lim}=B_{lim}, B_{pa}=B_{pa}

The resulting reference points table is given in Table 4.7.4.2, and summarized in Figures 4.7.4.1 and 4.7.4.2. The resulting median F_{MSY} estimate is 0.210 $year^{-1}$ and the resulting $F_{0.5}$ is 0.425 $year^{-1}$.

Next, a run was done to determine the $B_{trigger}$. The settings for this were

- bio.years = c(2006, 2015), bio.const = FALSE,
- sel.years = c(2006, 2015), sel.const = FALSE,
- F_{cv}=0, F_{phi}=0
- $B_{trigger}$ = 0,B_{lim}=B_{lim},B_{pa}=B_{pa}

The estimates of this trigger were 793 905 tonnes. This is larger than the current $B_{trigger}$, larger than B_{pa}, and larger than the 5%ile of the most recent SSB estimate in the model (based on SSB_{2015}/1.4= 564 599). Because the SSB has climbed so steeply in recent years, and the effects in terms of density-dependent growth and mortality cannot (yet) be evaluated, the benchmark decided to propose a trigger that is based on historic observations, from the time period when fishing mortality was substantially lower, and abundances high: the peak in abundance of 481.5 thousand tonnes in the first ten years of the assessment. This $B_{trigger}$ means a substantial increase compared to the current $B_{trigger}$, and is substantially higher than B_{pa}. The next benchmark can then revaluate the trigger, once the population processes and dynamics that govern the stock when fishing at F around F_{MSY} have been evaluated.

4.7.5 Final Eqsim run

To evaluate the reference points when enforcing a $B_{trigger}$ a final EQSIM run was done with the following settings.

- bio.years = c(2011,2015), bio.const = FALSE
- sel.years = c(2011,2015), sel.const = FALSE
- F_{cv}=0.212, F_{phi}=0.423, # WKMSYREF4 defaults
- $B_{trigger}$ = 481 500, B_{lim}=B_{lim}, B_{pa}=B_{pa}

The results of this run are summarized in Table 4.7.5.1 and Figures 4.7.5.1 and 4.7.5.2.

4.7.6 Sensitivity runs

A sensitivity test was carried out using fewer years for average selectivity and weights-at-age (5vs.10 years). This was done because there has been a significant shift in the gears used by the Dutch 80 mm beam trawl fleet in recent years and because of observed changes in growth historically. However, the F_{MSY} range using a shorter selectivity period does not differ substantially from the range using the ten year selectivity period (see Tables 4.7.6.1 and 4.7.6.2 and Figures 4.7.6.1 and 4.7.6.2).

4.7.7 Proposed MSY reference points

Reference point	Value
F_{MSY} without $B^{trigger}$	0.21
F_{MSY} lower without $B^{trigger}$	0.15
F_{MSY} upper without $B^{trigger}$	0.30
$F_{P.05}$ (5% risk to B_{lim} without $B^{trigger}$)	0.43
F_{MSY} with $B_{trigger}$	0.21
F_{MSY} lower with $B_{trigger}$	0.15
F_{MSY} upper with $B_{trigger}$	0.30
$F_{P.05}$ (5% risk to B_{lim} with $B_{trigger}$)	0.77
MSY	104 113 t
Median SSB at F_{MSY}	1 104 120 t
Median SSB lower precautionary (median at F_{MSY} upper precautionary)	690 328 t
Median SSB upper (median at F_{MSY} lower)	1 616 173 t

4.8 Future research and data requirements

Biological data must be collected from the NS-IBTS surveys (e.g. age, maturity stages). This species is not currently a mandatory species for these surveys. A request was made to the IBTSWG to collect biological information on this species (i.e. add it to the mandatory species list).

4.9 References

Aarts, G., and Poos, J. J. 2009. Comprehensive discard reconstruction and abundance estimation using flexible selectivity functions. ICES Journal of Marine Science, 66: 763–771.

Agresti, A. 2010. Analysis of Ordinal Categorical Data. Wiley Series in Probability and Statistics. Wiley.

Beverton, R.J.H. 1963. Maturation, growth and mortality of clupeid and engraulid stocks in relation to fishing. Rapports et Proces-Verbaux des Réunions Conseil Internationale pour l'Exploration de la Mer 154, 44–67.

Grift, R.E., Rijnsdorp, A. D., *et al*. 2003. Fisheries-induced trends in reaction norms for maturation in North Sea plaice. Marine Ecology Progress series, Vol. 257: 247–257.

Grift, R. E., M. Heino, A. D., *et al*. 2007. Three dimensional maturation reaction norms for North Sea plaice. Marine Ecology Progress Series 334:213–224.

Rijnsdorp, A. D. 1989. Maturation of male and female North Sea plaice (*Pleuronectes platessa* L.) J. Cons. Int. Explor. Mer, 46: 35–51.

Hoenig, J.M. 1983. Empirical use of longevity data to estimate mortality rates. Fishery Bulletin 82, 898–903.

ICES. 2015a. WKPLE. Report of the Benchmark Workshop on Plaice. ICES CM 2015/ACOM 33.

ICES. 2015b. WGNSSK. Report of the Working Group on the Assessment of Demersal Stocks in the North Sea and Skagerrak. ICES CM 2015/ACOM:13.

Rijnsdorp, A. D., van Damme, C. J. G., and Witthames, P. R. 2010. Implications of fisheries-induced changes in stock structure and reproductive potential for stock recovery of a sex-dimorphic species, North Sea plaice. ICES Journal of Marine Science, 67: 1931–1938.

Gislason, H., Daan, N., Rice, J.C. and Pope, J.G. 2010. Size, growth, temperature and natural mortality of marine fish. Fish and Fisheries 11, 149–158.

Kenchington T. J. 2014. Natural mortality estimators for information-limited fisheries. Fish and Fisheries, 15: 533–562.

von Bertalanffy, L. 1938. A quantitative theory of organic growth. Hum. Biol. 10: 181–213.

4.10 Tables

Table 4.6.3.1. North Sea plaice maturity ogive and natural mortality (ICES, WGNSSK 2016).

Age	1	2	3	4	5	6	7	8	9	10
Maturity	0	0.5	0.5	1	1	1	1	1	1	1
Natural mortality	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1

Table 4.6.3.2. Estimated maturity ogive at-age 2–4 per year. Ogive in 1985 was used for 1957–1984.

Year	age1	age2	age3	age4
1957–1984	*0*	*0.45*	*0.50*	*0.66*
1985	0	0.45	0.50	0.66
1986	0	0.29	0.52	0.64
1987	0	0.39	0.49	0.70
1988	*0*	*0.39*	*0.50*	*0.67*
1989	0	0.39	0.50	0.63
1990	0	0.42	0.52	0.70
1991	0	0.43	0.52	0.66
1992	0	0.39	0.55	0.73
1993	0	0.42	0.53	0.79
1994	0	0.48	0.59	0.80
1995	0	0.47	0.71	0.85
1996	0	0.47	0.59	0.85
1997	0	0.47	0.65	0.83
1998	0	0.43	0.56	0.74
1999	0	0.45	0.55	0.74
2000	0	0.46	0.61	0.79
2001	0	0.48	0.61	0.79
2002	*0*	*0.49*	*0.70*	*0.85*
2003	0	0.49	0.78	0.90
2004	0	0.46	0.68	0.90
2005	0	0.59	0.87	0.96
2006	0	0.50	0.74	0.90
2007	0	0.57	0.81	0.94
2008	0	0.63	0.90	0.96
2009	0	0.51	0.82	0.92
2010	0	0.47	0.62	0.85
2011	0	0.51	0.65	0.84
2012	0	0.46	0.58	0.74
2013	0	0.50	0.66	0.85
2014	0	0.49	0.70	0.84
2015	0	0.48	0.64	0.78

Table 4.6.3.3. Estimated M values using Gislason (2010), and Linf and K per cohort.

age										
year	1	2	3	4	5	6	7	8	9	10
1985	1.119	0.739	0.485	0.400	0.319	0.246	0.201	0.201	0.186	0.746
1986	1.138	0.632	0.572	0.445	0.337	0.313	0.264	0.251	0.185	0.158
1987	1.267	0.728	0.505	0.417	0.342	0.326	0.298	0.227	0.196	0.161
1988	1.289	0.721	0.555	0.404	0.388	0.301	0.275	0.195	0.199	0.146
1989	1.279	0.713	0.479	0.459	0.463	0.314	0.262	0.259	0.260	0.176
1990	1.310	0.739	0.539	0.438	0.336	0.288	0.299	0.266	0.268	0.214
1991	1.167	0.724	0.561	0.426	0.379	0.327	0.308	0.421	0.225	0.218
1992	1.317	0.743	0.536	0.450	0.379	0.403	0.328	0.290	0.275	0.227
1993	1.451	0.805	0.591	0.469	0.360	0.322	0.312	0.273	0.216	0.261
1994	1.337	0.886	0.555	0.531	0.383	0.339	0.300	0.419	0.238	0.200
1995	1.367	0.755	0.573	0.396	0.335	0.353	0.373	0.313	0.307	0.217
1996	1.332	0.807	0.537	0.477	0.366	0.324	0.313	0.335	0.265	0.222
1997	1.119	0.775	0.574	0.457	0.459	0.349	0.291	0.305	0.312	0.218
1998	1.152	0.836	0.733	0.548	0.436	0.378	0.317	0.258	0.313	0.239
1999	1.331	0.900	0.635	0.529	0.453	0.367	0.353	0.294	0.253	0.241
2000	1.357	0.849	0.656	0.527	0.531	0.423	0.546	0.349	0.274	0.260
2001	1.420	0.874	0.617	0.543	0.455	0.443	0.369	0.392	0.314	0.258
2002	1.260	0.952	0.670	0.518	0.468	0.387	0.463	0.364	0.349	0.455
2003	1.166	0.887	0.724	0.624	0.491	0.455	0.398	0.535	0.456	0.263
2004	1.301	0.854	0.674	0.644	0.573	0.453	0.516	0.350	0.552	0.385
2005	1.264	0.911	0.654	0.582	0.535	0.555	0.427	0.414	0.406	0.395
2006	1.333	0.936	0.676	0.599	0.531	0.578	0.516	0.443	0.418	0.364
2007	1.341	0.961	0.702	0.628	0.530	0.532	0.553	0.550	0.387	0.429
2008	1.294	0.935	0.706	0.576	0.533	0.433	0.476	0.592	0.461	0.445
2009	1.211	0.877	0.743	0.648	0.546	0.484	0.469	0.462	0.543	0.457
2010	1.430	0.910	0.697	0.622	0.590	0.537	0.468	0.419	0.476	0.561
2011	1.439	1.062	0.704	0.599	0.585	0.594	0.500	0.473	0.442	0.402
2012	1.661	0.996	0.845	0.607	0.571	0.555	0.545	0.428	0.483	0.431
2013	1.442	1.144	0.774	0.712	0.600	0.555	0.544	0.505	0.550	0.450
2014	1.516	1.012	0.919	0.660	0.670	0.557	0.511	0.493	0.587	0.440
2015	1.984	1.161	0.830	0.837	0.652	0.635	0.501	0.549	0.553	0.505
2016	1.825	1.244	0.911	0.728	0.794	0.605	0.659	0.495	0.465	0.573

Table 4.7.2.1. Outcomes of final assessment results relevant to reference points estimation.

YEAR	SSB	F(2-6)	R
	('000 T)	(YEAR-1)	(MILLIONS)
1957	342.1	0.242	474.8
1958	355.2	0.280	710.4
1959	361.8	0.313	876.9
1960	379.2	0.324	785.8
1961	390.1	0.323	882.6
1962	481.5	0.336	614.5
1963	439.5	0.370	614.4
1964	430.1	0.396	2434.7
1965	383.3	0.386	669.4
1966	405.5	0.362	579.8
1967	472.6	0.350	422.4
1968	455.9	0.352	416.3
1969	402.3	0.358	672.5
1970	372.6	0.364	674.9
1971	363.6	0.378	436.7
1972	364.3	0.410	364.5
1973	298.8	0.445	1351.8
1974	297.0	0.461	1090.4
1975	306.2	0.460	807.6
1976	331.0	0.456	683.0
1977	325.5	0.459	1014.0
1978	321.0	0.476	869.3
1979	301.1	0.508	917.4
1980	323.0	0.541	1089.5
1981	294.2	0.552	1014.2
1982	284.8	0.540	1926.2
1983	336.2	0.516	1348.8
1984	364.3	0.501	1285.2
1985	397.8	0.522	1824.9
1986	419.5	0.592	4387.1
1987	478.1	0.654	1927.9
1988	418.7	0.635	1706.3
1989	442.5	0.585	1243.0
1990	401.4	0.583	1127.1
1991	367.5	0.633	992.1
1992	311.0	0.651	812.3
1993	271.7	0.597	523.1
1994	230.3	0.563	608.5
1995	226.5	0.611	1022.2
1996	207.3	0.708	927.9
1997	202.1	0.749	2324.0

YEAR	SSB	F(2-6)	R
	('000 T)	(YEAR-1)	(MILLIONS)
1998	231.2	0.713	826.4
1999	223.3	0.666	733.2
2000	232.9	0.634	851.7
2001	225.8	0.615	584.0
2002	207.3	0.597	1749.7
2003	236.0	0.564	587.1
2004	227.6	0.500	1268.0
2005	246.1	0.418	825.6
2006	270.7	0.347	863.6
2007	279.4	0.295	1418.7
2008	360.3	0.255	1131.5
2009	441.6	0.223	1021.4
2010	537.7	0.204	1412.9
2011	556.7	0.202	1701.0
2012	600.5	0.208	1276.3
2013	695.9	0.207	1482.8
2014	817.0	0.192	2015.0
2015	790.4	0.173	835.6

Table 4.7.2.2. Fishing mortalities-at-age estimates resulting from final assessment as used for reference points estimation.

AGE										
YEAR	1	2	3	4	5	6	7	8	9	10
1957	0.095	0.168	0.262	0.312	0.257	0.210	0.224	0.227	0.197	0.197
1958	0.112	0.214	0.313	0.328	0.293	0.253	0.229	0.224	0.231	0.231
1959	0.128	0.254	0.354	0.341	0.324	0.292	0.235	0.221	0.249	0.249
1960	0.136	0.262	0.360	0.349	0.339	0.310	0.244	0.218	0.231	0.231
1961	0.131	0.250	0.352	0.354	0.343	0.316	0.259	0.219	0.200	0.200
1962	0.113	0.252	0.373	0.364	0.353	0.338	0.284	0.232	0.193	0.193
1963	0.091	0.273	0.438	0.381	0.375	0.383	0.315	0.255	0.219	0.219
1964	0.074	0.282	0.490	0.400	0.394	0.414	0.331	0.272	0.252	0.252
1965	0.067	0.256	0.469	0.411	0.397	0.396	0.316	0.268	0.260	0.260
1966	0.072	0.232	0.418	0.406	0.388	0.364	0.295	0.254	0.246	0.246
1967	0.095	0.243	0.388	0.381	0.377	0.360	0.292	0.245	0.226	0.226
1968	0.139	0.283	0.382	0.352	0.366	0.377	0.308	0.248	0.215	0.215
1969	0.185	0.320	0.385	0.339	0.359	0.388	0.329	0.268	0.229	0.229
1970	0.206	0.331	0.391	0.352	0.361	0.383	0.346	0.302	0.269	0.269
1971	0.202	0.327	0.408	0.391	0.384	0.383	0.357	0.330	0.311	0.311
1972	0.189	0.323	0.438	0.453	0.434	0.403	0.361	0.335	0.326	0.326
1973	0.190	0.332	0.471	0.513	0.485	0.426	0.366	0.337	0.333	0.333
1974	0.226	0.361	0.490	0.530	0.494	0.432	0.382	0.360	0.360	0.360
1975	0.297	0.402	0.489	0.510	0.474	0.426	0.397	0.388	0.391	0.391
1976	0.365	0.426	0.473	0.488	0.467	0.429	0.395	0.379	0.378	0.378
1977	0.386	0.426	0.461	0.482	0.483	0.445	0.378	0.339	0.326	0.326
1978	0.355	0.432	0.483	0.496	0.501	0.466	0.381	0.320	0.288	0.288
1979	0.295	0.460	0.561	0.531	0.506	0.481	0.417	0.347	0.286	0.286
1980	0.247	0.487	0.652	0.577	0.508	0.481	0.451	0.388	0.308	0.308
1981	0.230	0.480	0.680	0.621	0.518	0.460	0.434	0.393	0.335	0.335
1982	0.238	0.449	0.642	0.643	0.531	0.432	0.387	0.365	0.351	0.351
1983	0.260	0.421	0.582	0.628	0.532	0.417	0.356	0.336	0.337	0.337
1984	0.286	0.412	0.539	0.592	0.531	0.432	0.361	0.325	0.309	0.309
1985	0.308	0.433	0.541	0.579	0.561	0.497	0.410	0.347	0.308	0.308
1986	0.316	0.482	0.600	0.612	0.642	0.625	0.503	0.406	0.351	0.351
1987	0.295	0.511	0.662	0.656	0.712	0.730	0.582	0.463	0.400	0.400
1988	0.245	0.472	0.660	0.667	0.693	0.685	0.562	0.459	0.397	0.397
1989	0.205	0.419	0.621	0.645	0.639	0.600	0.503	0.424	0.372	0.372
1990	0.204	0.423	0.609	0.609	0.641	0.635	0.503	0.415	0.385	0.385
1991	0.233	0.473	0.624	0.581	0.699	0.787	0.575	0.452	0.443	0.443
1992	0.250	0.476	0.615	0.585	0.726	0.854	0.661	0.525	0.493	0.493
1993	0.221	0.400	0.570	0.628	0.673	0.714	0.699	0.612	0.494	0.494
1994	0.175	0.351	0.570	0.673	0.622	0.601	0.694	0.659	0.486	0.486
1995	0.136	0.396	0.687	0.680	0.640	0.654	0.670	0.616	0.510	0.510
1996	0.117	0.490	0.864	0.680	0.706	0.800	0.648	0.544	0.532	0.532
1997	0.122	0.505	0.903	0.732	0.765	0.842	0.646	0.518	0.494	0.494

AGE										
YEAR	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
1998	0.144	0.428	0.779	0.820	0.790	0.747	0.644	0.527	0.423	0.423
1999	0.160	0.368	0.664	0.837	0.787	0.672	0.600	0.504	0.393	0.393
2000	0.154	0.364	0.627	0.741	0.761	0.678	0.519	0.433	0.410	0.410
2001	0.150	0.399	0.639	0.633	0.704	0.699	0.478	0.374	0.378	0.378
2002	0.170	0.454	0.671	0.578	0.615	0.667	0.513	0.357	0.256	0.256
2003	0.204	0.494	0.679	0.548	0.523	0.578	0.537	0.341	0.161	0.161
2004	0.220	0.471	0.620	0.503	0.447	0.457	0.428	0.279	0.133	0.133
2005	0.208	0.406	0.522	0.438	0.381	0.344	0.277	0.198	0.131	0.131
2006	0.188	0.355	0.444	0.365	0.308	0.263	0.196	0.141	0.102	0.102
2007	0.172	0.329	0.397	0.300	0.238	0.211	0.174	0.111	0.057	0.057
2008	0.161	0.297	0.352	0.261	0.193	0.172	0.161	0.093	0.034	0.034
2009	0.153	0.245	0.297	0.252	0.178	0.142	0.132	0.081	0.031	0.031
2010	0.140	0.199	0.255	0.256	0.183	0.126	0.103	0.070	0.036	0.036
2011	0.118	0.179	0.242	0.256	0.199	0.132	0.088	0.058	0.038	0.038
2012	0.098	0.179	0.248	0.247	0.214	0.151	0.083	0.049	0.033	0.033
2013	0.094	0.182	0.249	0.233	0.211	0.158	0.085	0.047	0.029	0.029
2014	0.112	0.183	0.233	0.221	0.186	0.140	0.090	0.051	0.027	0.027
2015	0.148	0.181	0.210	0.208	0.154	0.113	0.098	0.061	0.027	0.027

Table 4.7.4.1. EQSIM results for estimating F_{lim} reference point. The value of the reference point is highlighted in dark grey.

	F05	F10	F50	Median	Mean	Med	Mean	Med	Mean
				MSY	MSY	LOWER	LOWER	UPPER	UPPER
catF	0.451	0.466	0.516	NA	0.28	NA	NA	NA	NA
lanF	NA	NA	NA	0.201	0.20	0.143	0.144	0.292	0.294
catch	135 650	131 766	104 385	NA	151 162	NA	NA	NA	NA
landings	NA	NA	NA	106 543	106 426	101 231	105 780	101 179	105 738
catB	327 478	301 919	206 132	NA	773 657	NA	NA	NA	NA
lanB	NA	NA	NA	1194321	1 207 457	1 694 019	NA	726 209	NA

Table 4.7.4.2. EQSIM results for estimating initial F_{MSY} and F_{05} reference point (without $B_{trigger}$). The values of the references point are highlighted in dark grey.

	F05	F10	F50	Median	Mean	Med	Mean	Med	Mean
				MSY	MSY	Lower	Lower	Upper	Upper
catF	0.427	0.445	0.509	NA	0.26	NA	NA	NA	NA
lanF	NA	NA	NA	0.21	0.20	0.146	0.145	0.295	0.291
catch	134 223	130 241	104 517	NA	14 883	NA	NA	NA	NA
landings	NA	NA	NA	103 926	103 819	98 766	105 632	98 735	105 558
catB	353 741	321 278	206 631	NA	841 130	NA	NA	NA	NA
lanB	NA	NA	NA	1 105 904	1 171 689	1 613 102	NA	696 743	NA

Table 4.7.5.1. EQSIM results when using $B_{trigger}$.

	F05	F10	F50	Median	Mean	Med	Mean	Med	Mean
				MSY	MSY	Lower	Lower	Upper	Upper
catF	0.769	0.846	1.187	NA	0.26	NA	NA	NA	NA
lanF	NA	NA	NA	0.21	0.20	0.145	0.144	0.298	0.29
catch	125 523	122 569	108 860	NA	149 072	NA	NA	NA	NA
landings	NA	NA	NA	104 113	103 956	98913	105 673	98 905	105 751
catB	287 384	268 277	207 269	NA	840 472	NA	NA	NA	NA
lanB	NA	NA	NA	1 104 120	1 169 758	1 616 172	NA	690 328	NA

Table 4.7.6.1. Sensitivity run (2011–2015) EQSIM results for estimating initial F_{MSY} and F_{05} reference point (without $B_{trigger}$). The values of the references point are highlighted in dark grey.

	F05	F10	F50	Median	Mean	Med	Mean	Med	Mean
				MSY	MSY	Lower	Lower	Upper	Upper
catF	0.425	0.442	0.502	NA	0.26	NA	NA	NA	NA
lanF	NA	NA	NA	0.21	0.20	0.146	0.145	0.294	0.289
catch	124 464	120 679	97 527	NA	139 453	NA	NA	NA	NA
landings	NA	NA	NA	97 532	97 404	92 613	98 742	92 618	98 753
catB	344 217	313 696	206 956	NA	813 215	NA	NA	NA	NA
lanB	NA	NA	NA	1 067 618	1 130 621	1 551 989	NA	677 122	NA

Table 4.7.6.2. Sensitivity run (2011–2015) EQSIM results with $B_{trigger}$.

	F05	F10	F50	Median MSY	Mean MSY	Med Lower	Mean Lower	Med Upper	Mean Upper
catF	0.8	0.87	1.174	NA	0.26	NA	NA	NA	NA
lanF	NA	NA	NA	0.208	0.20	0.145	0.145	0.294	0.289
catch	116223	113721	102191	NA	139436	NA	NA	NA	NA
landings	NA	NA	NA	97649	97539	92748	98922	92841	98925
catB	276993	260727	207293	NA	816038	NA	NA	NA	NA
lanB	NA	NA	NA	1085168	1134230	1561934	NA	681513	NA

4.11 Figures

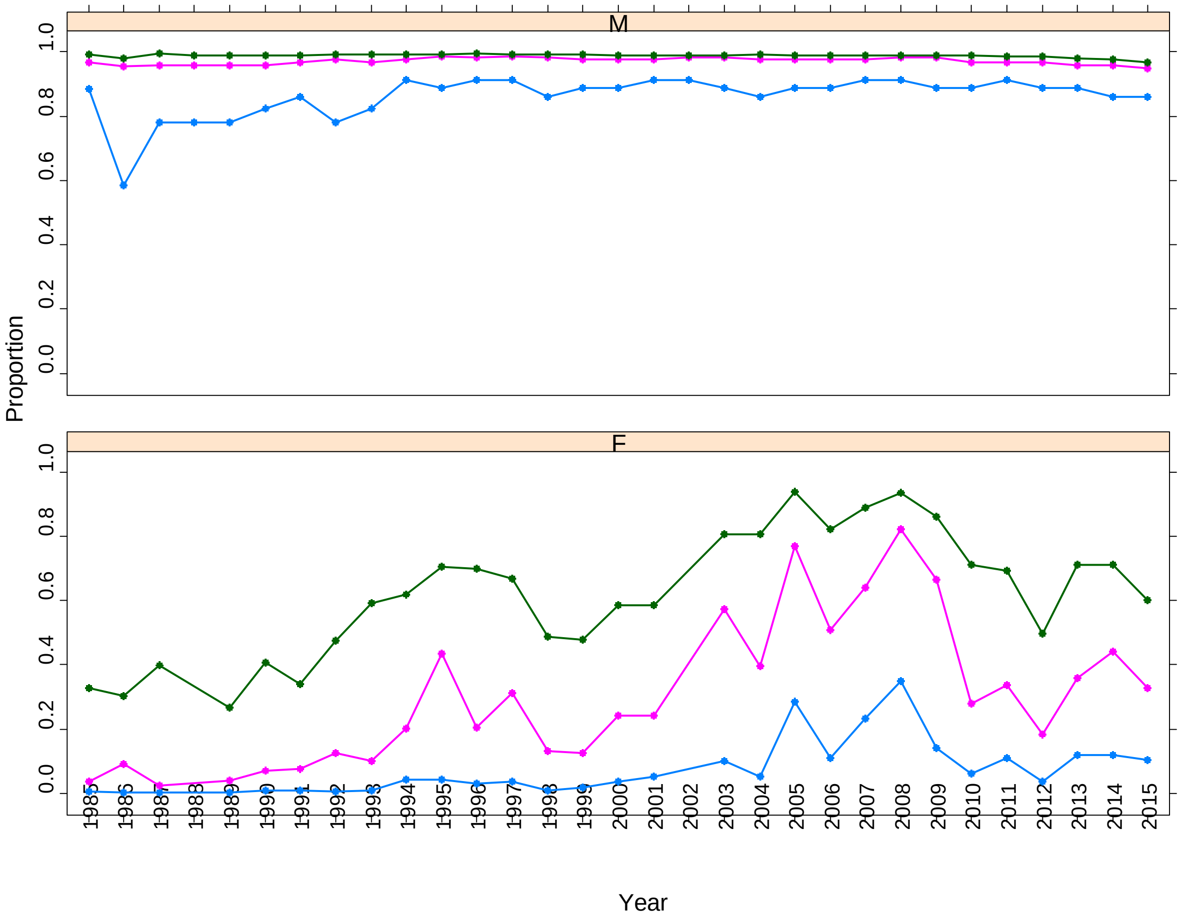

Figure 4.6.3.1. Estimated maturity ogive by sex per year for age 2–4. Maturity model was derived from Dutch landing while the mean length-at-age was derived from the BTS survey, with equal sex proportion at given assumption.

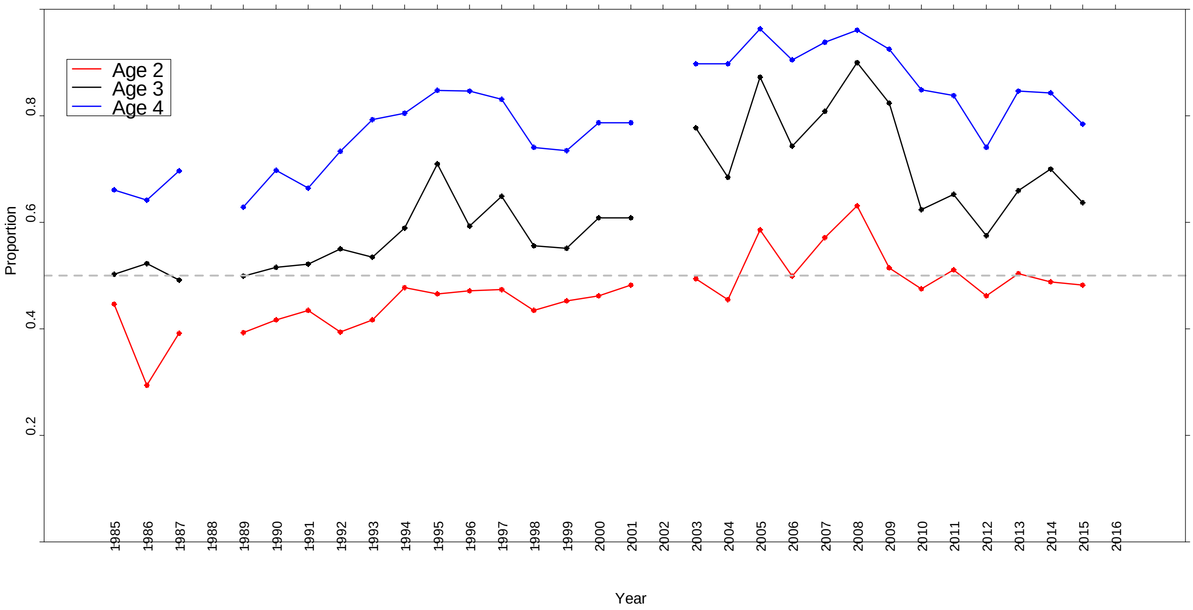

Figure 4.6.3.2. Estimated maturity ogive per year for age 2–4. Maturity model was derived from Dutch landing while the mean length-at-age was derived from the BTS survey, with equal sex proportion at given assumption.

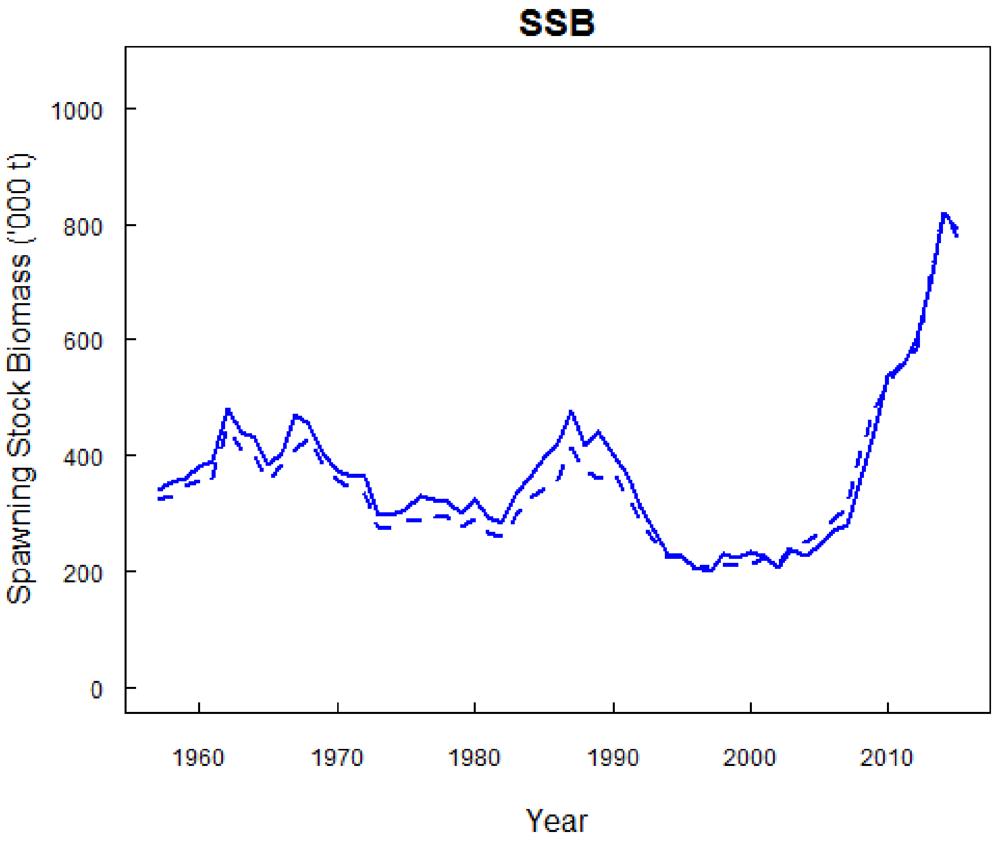

Figure 4.6.3.3. Estimated SSB using the fixed maturity ogive in Table 4.3.6.1 (drawn line) and using the time-varying maturity as estimated in Table 4.3.6.2 (dashed line).

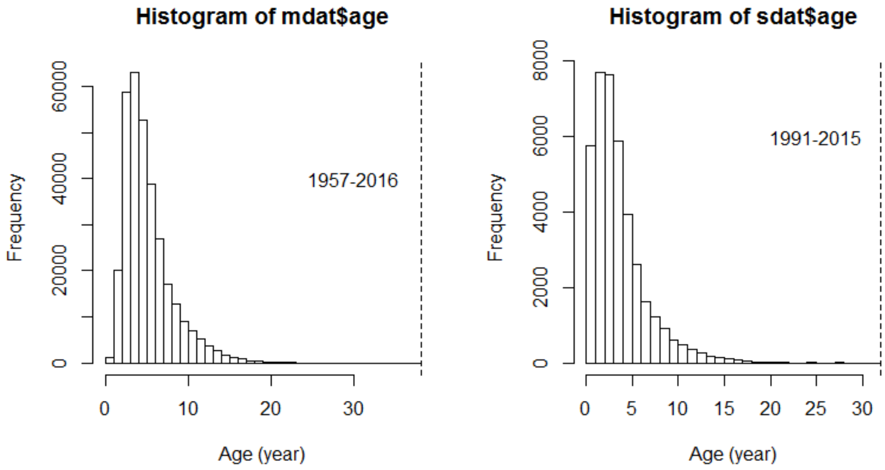

Figure 4.6.3.4 Histograms of ages in Dutch market sampling program samples (left panel) and survey age samples (right panel). Timespan for samples in top right of each panel. Max observed ages are indicated by vertical dashed line (38 years for market samples and 31 years for survey age samples). Estimated M values based on these would be (4.3/38=) 0.11 and (4.3/31=) 0.14 for market samples and survey samples, respectively.

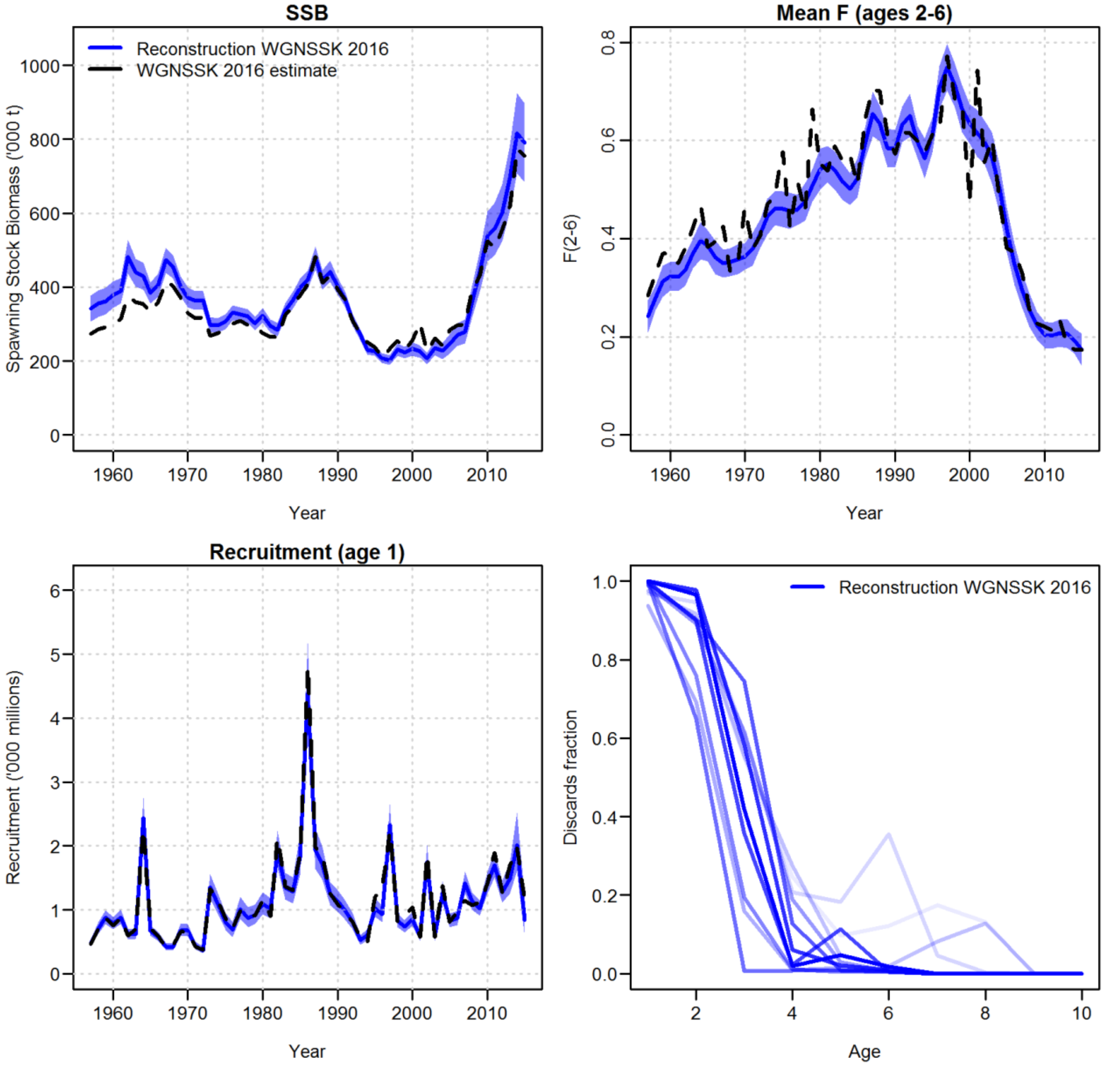

Figure 4.6.4.1. Summary plot of final assessment runs including the WGNSSK 2016 estimates.

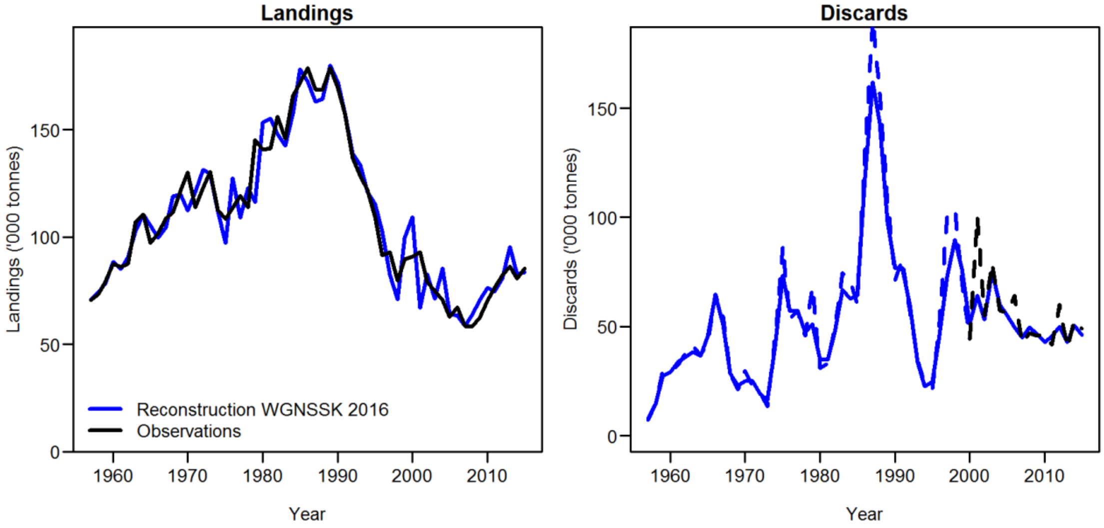

Figure 4.6.4.2. Landings and discards estimates of assessment runs including the WGNSSK 2016 estimates.

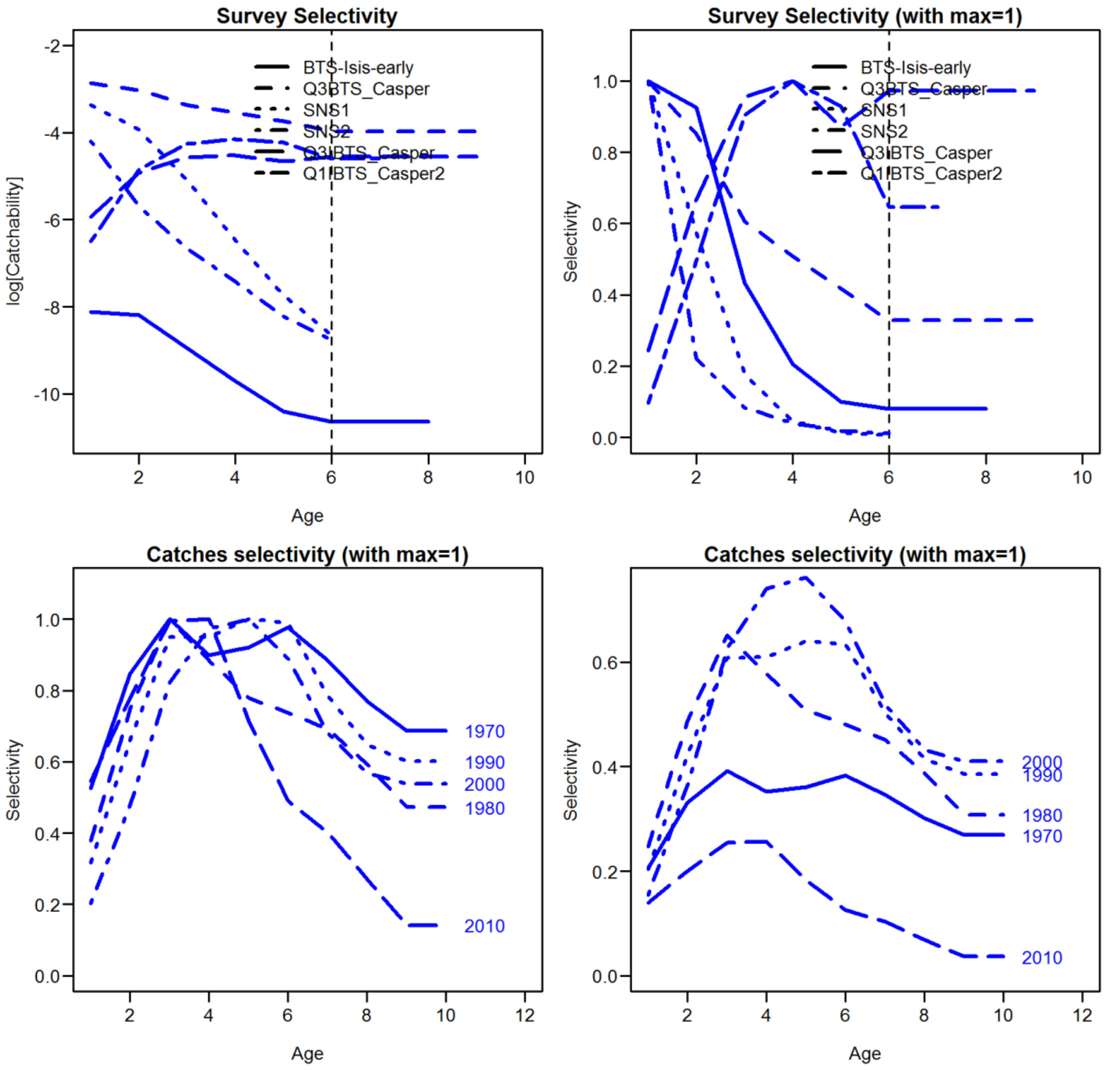

Figure 4.6.4.3. Survey selectivities (top panels) and selectivities catches (lower panels) for final assessment runs.

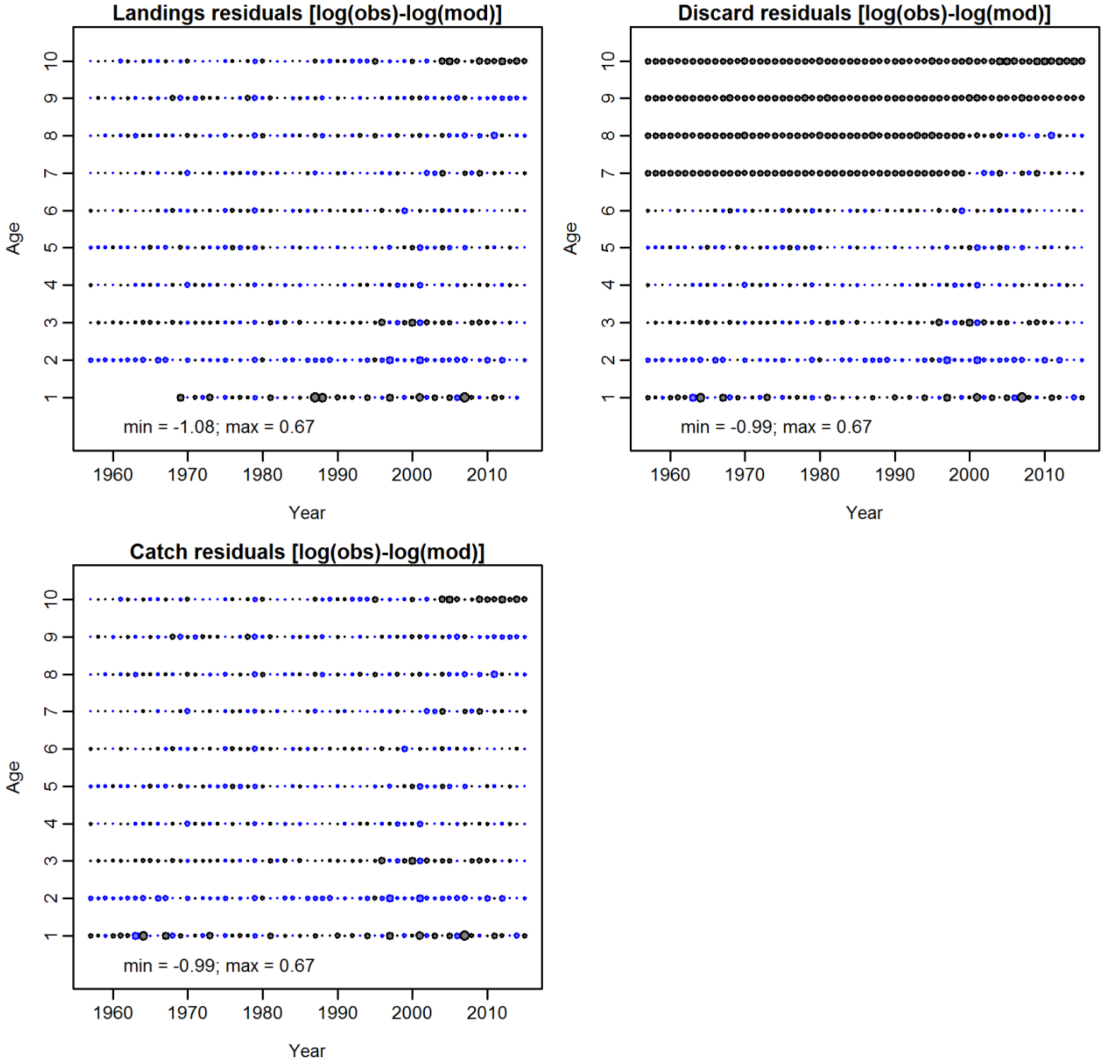

Figure 4.6.4.4. Landings residuals (left panel) and discards residuals (right panel). Blue bubbles positive residuals (observations greater than model), and black bubbles indicate negative residuals (observations less than model).

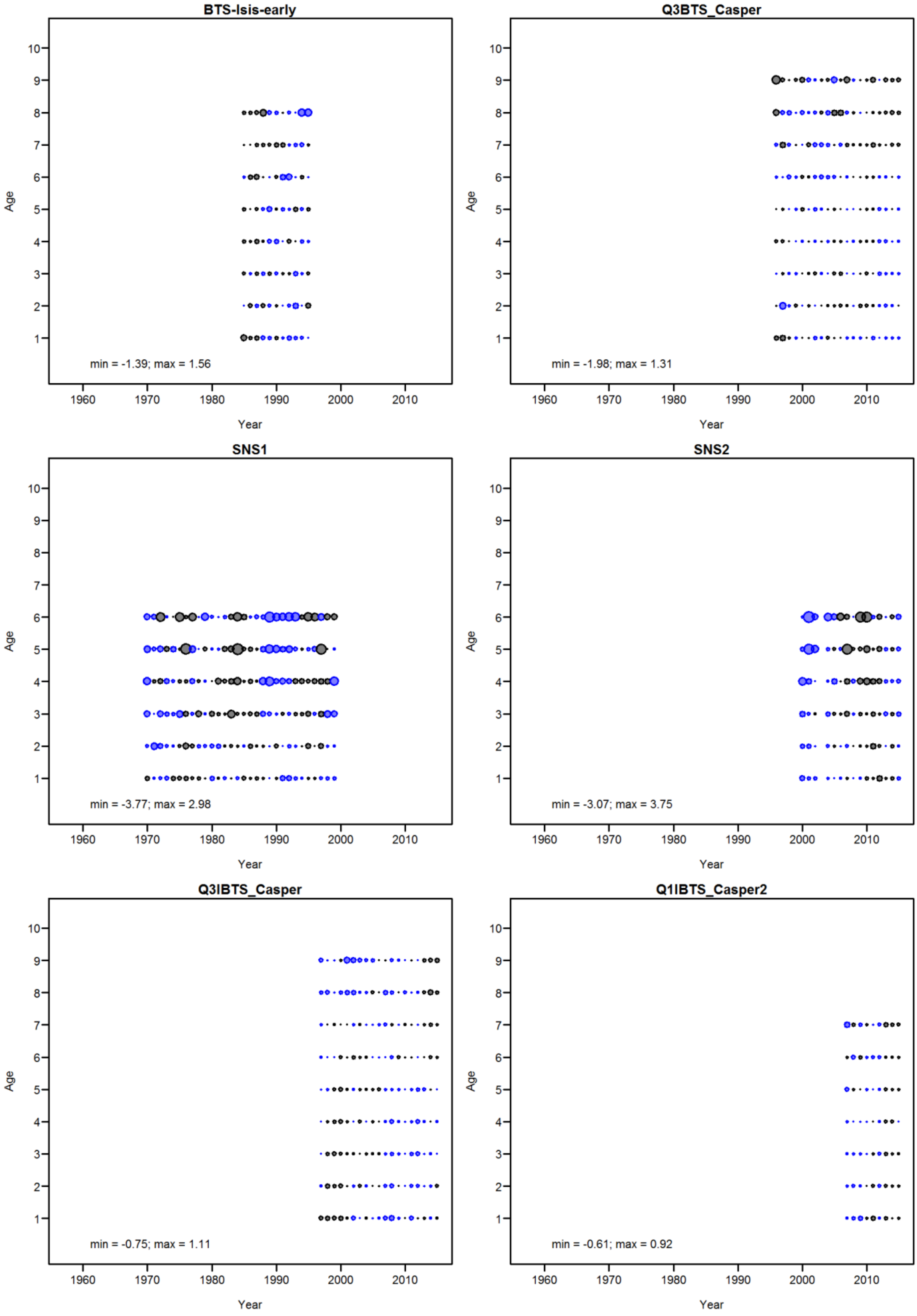

Figure 4.6.4.5. Survey residuals for final assessment model. Blue bubbles indicate positive residuals (observations greater than model), and black bubbles indicate negative residuals (observations less than model).

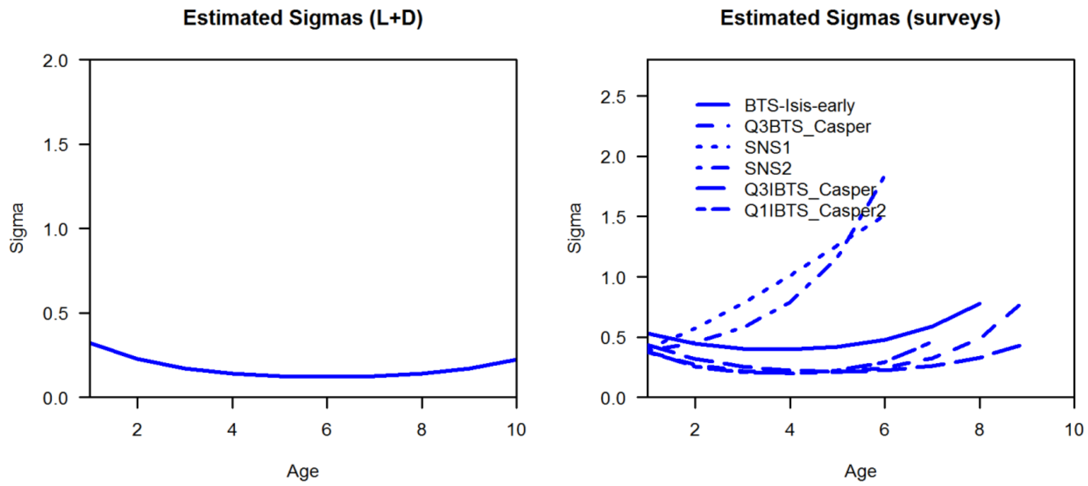

Figure 4.6.4.6. Estimated age-dependent sigmas for the different likelihood components.

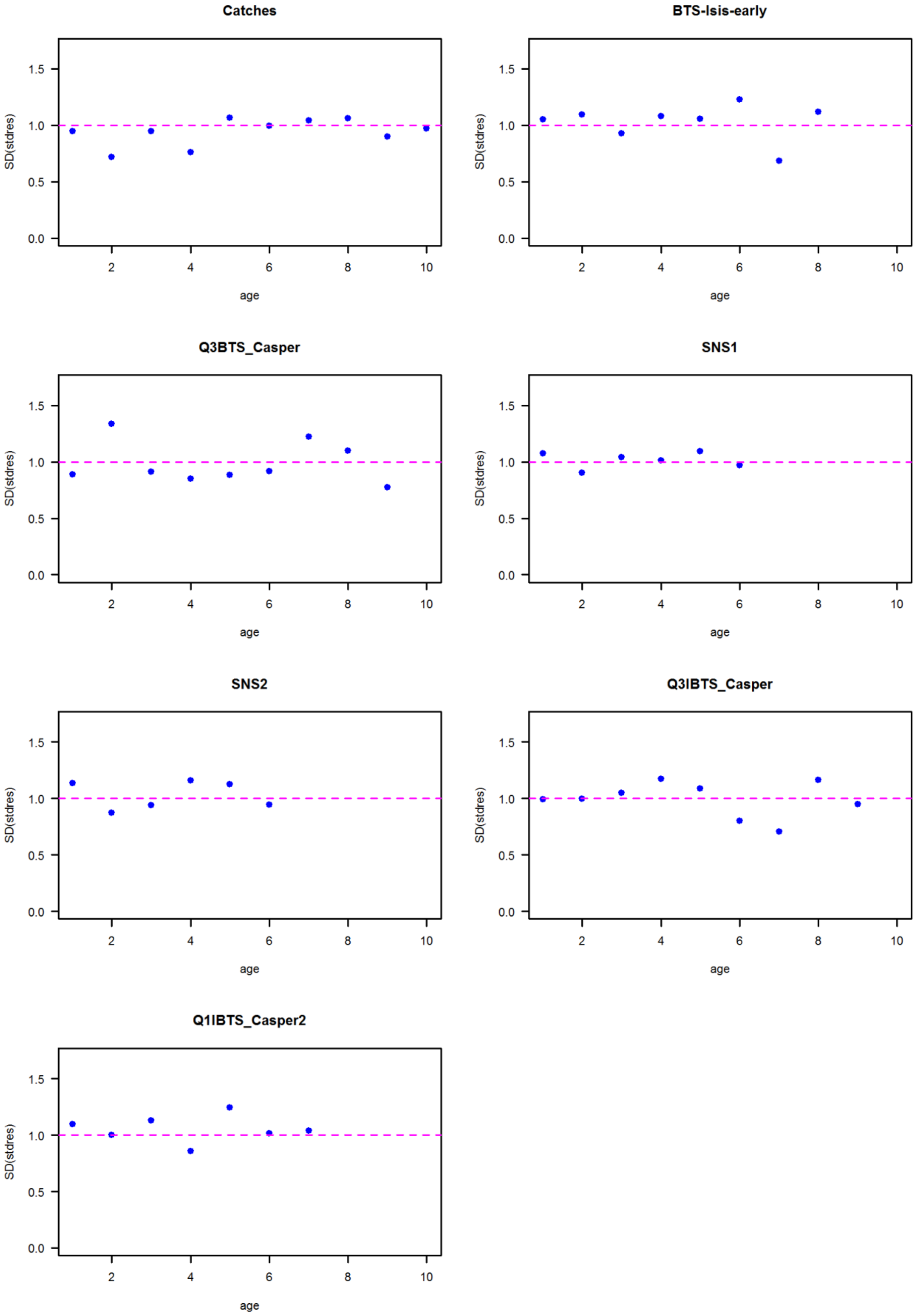

Figure 4.6.4.7. SDs of standardized residuals (for discards estimates from WGNSSK 2016 assessment).

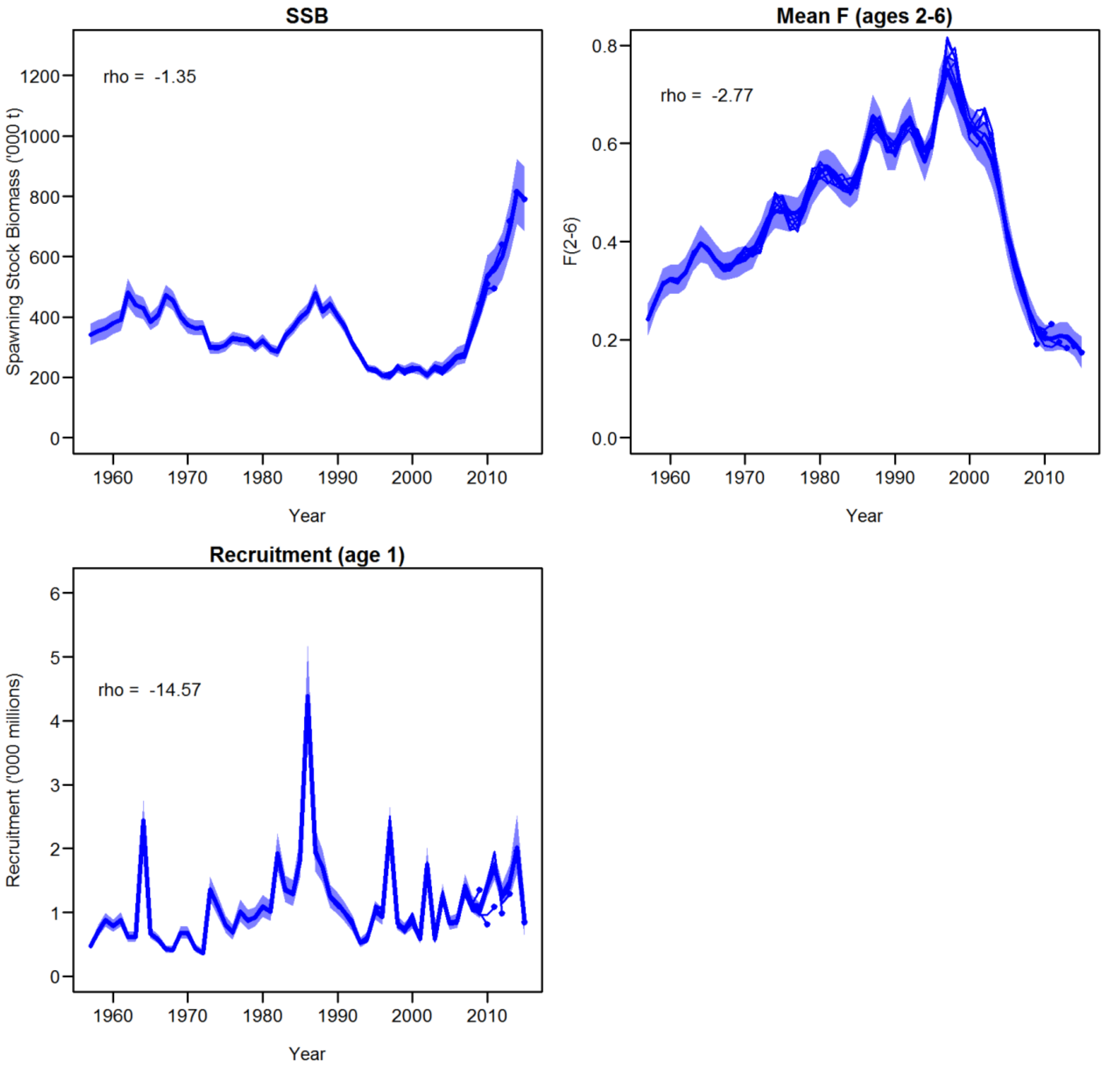

Figure 4.6.4.8. Retro (for discards estimates from WGNSSK 2016 assessment).

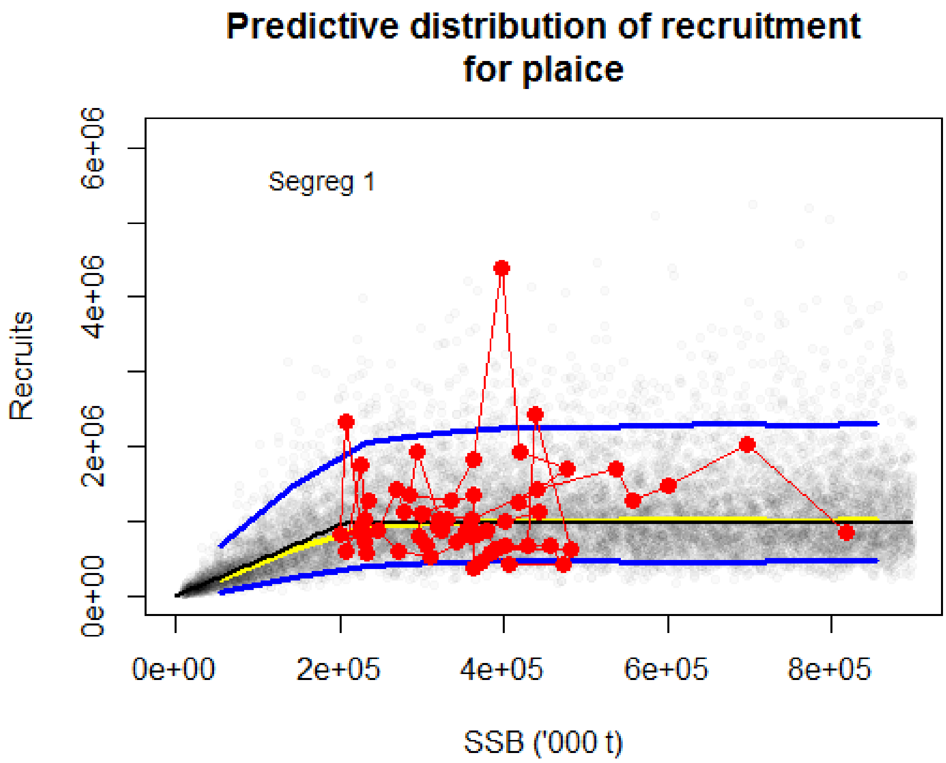

Figure 4.7.3.1. Segmented regression for to plaice S-R data using EQSIM.

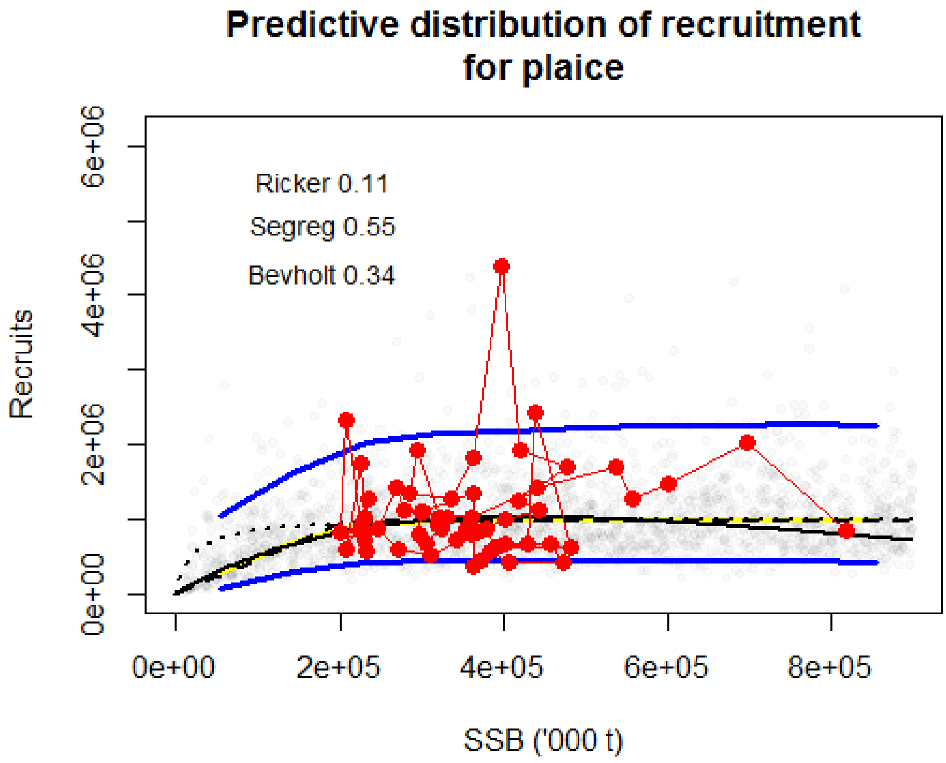

Figure 4.7.3.1. Ricker, segmented regression, and Beverton & Holt fits for to plaice S–R data using EQSIM.

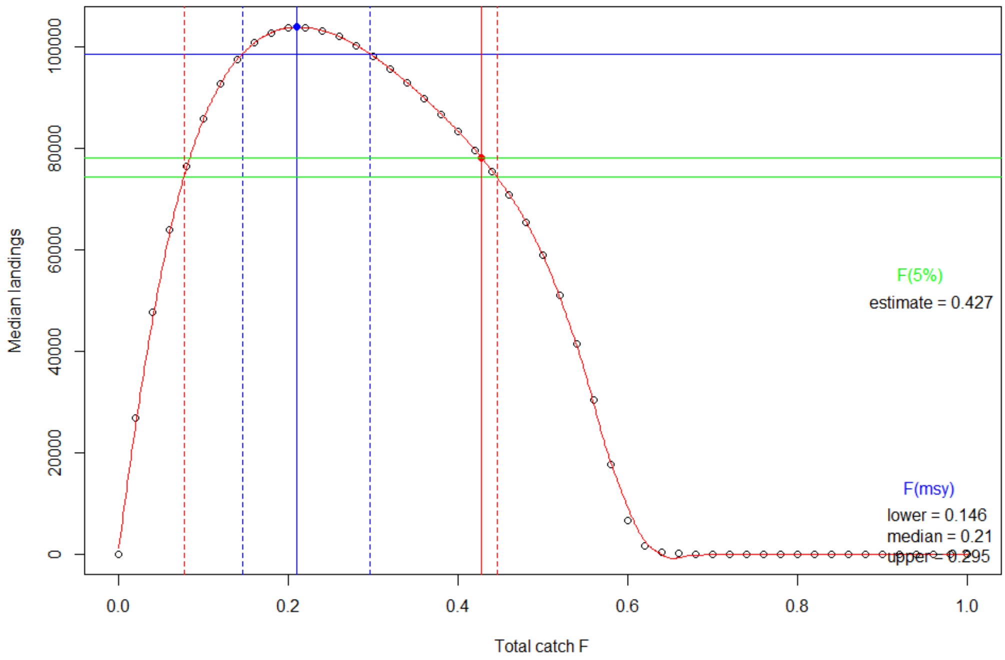

Figure 4.7.4.1. EQSIM yield curve results for the "initial" estimates for F_{MSY} (without $B_{trigger}$).

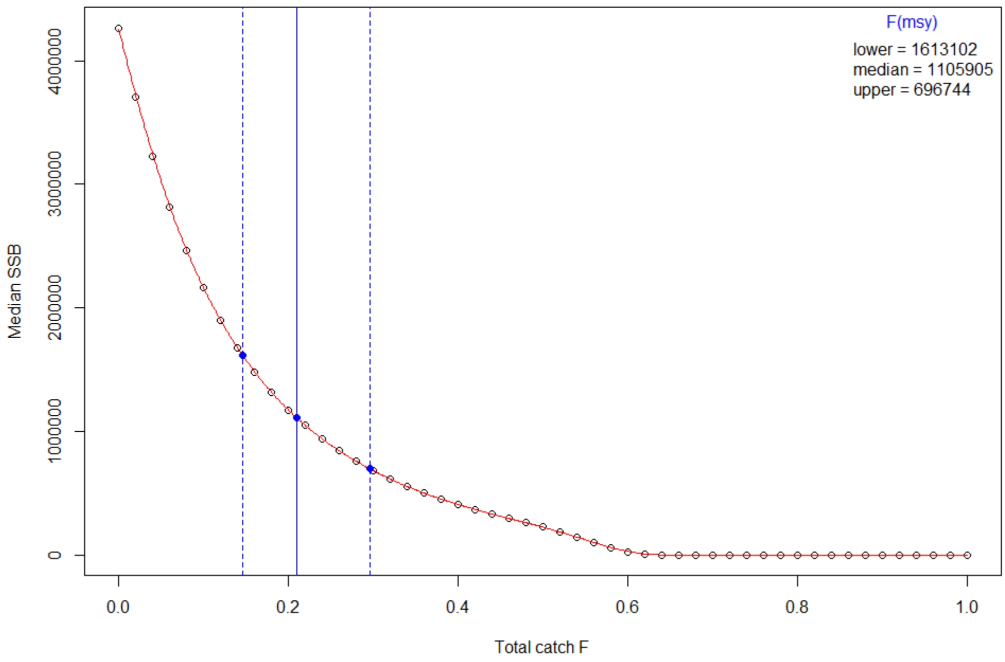

Figure 4.7.4.2. EQSIM SSB curve results for the "initial" estimates for F_{MSY} (without $B_{trigger}$).

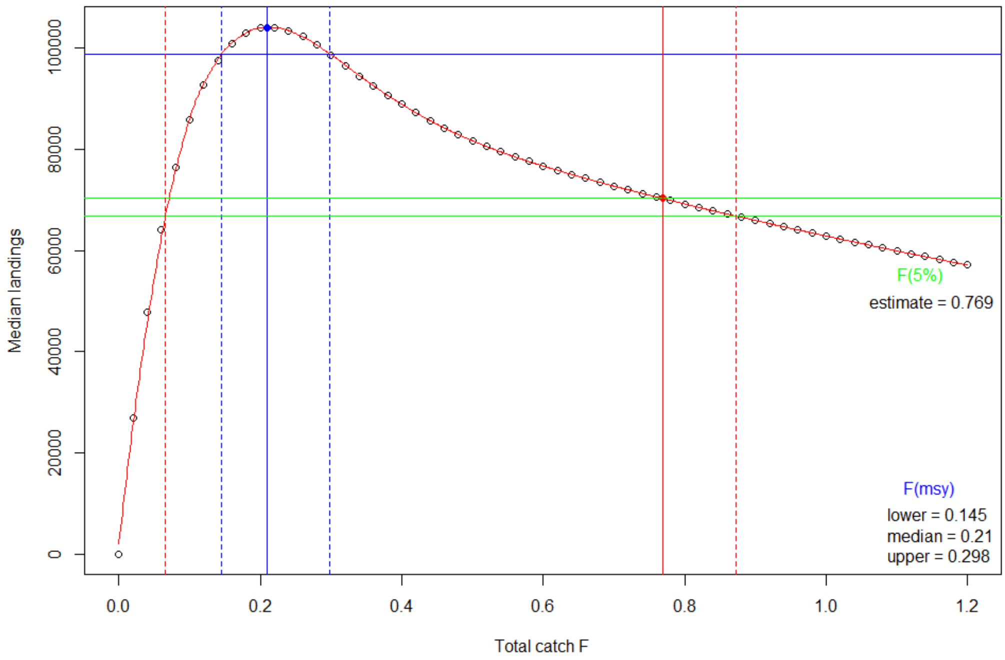

Figure 4.7.5.1. EQSIM yield curve results with $B_{trigger}$.

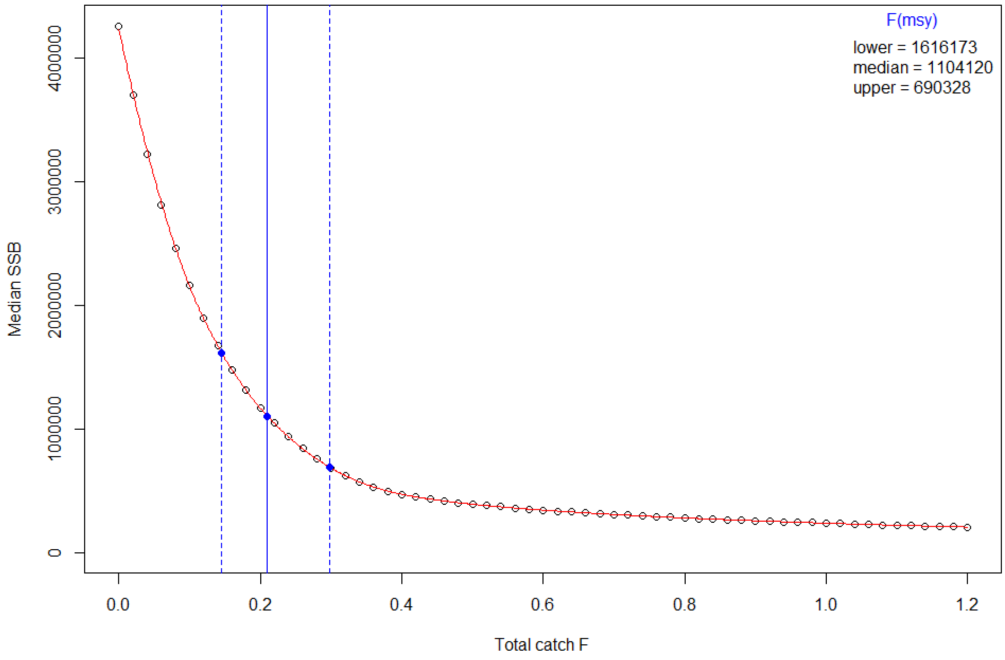

Figure 4.7.5.2. EQSIM SSB curve results with $B_{trigger}$.

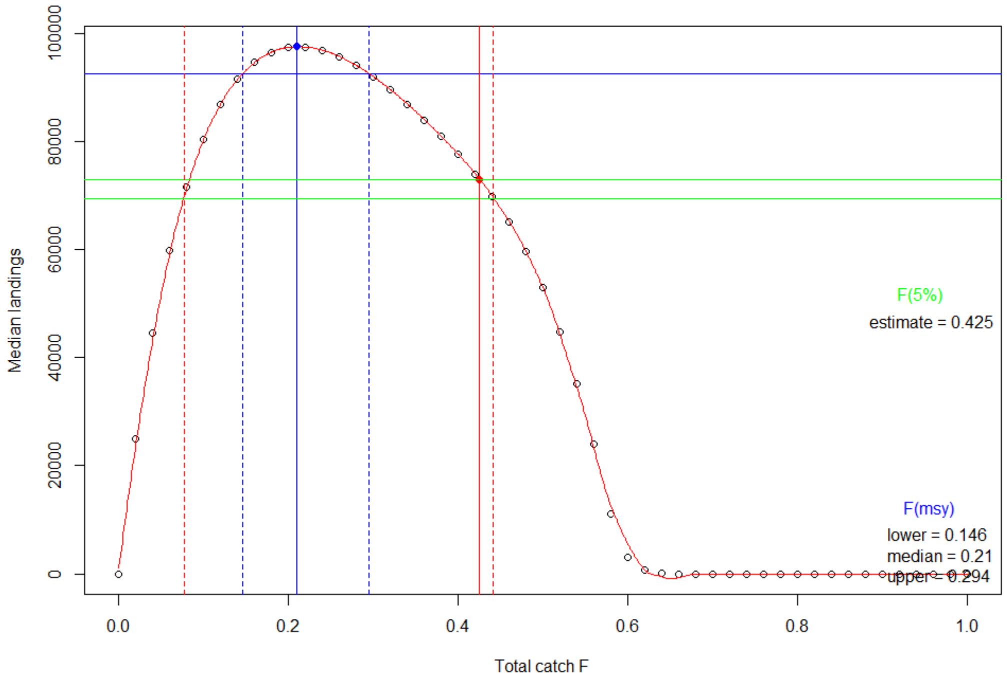

Figure 4.7.6.1. Sensitivity run (years 2011–2015) EQSIM yield curve results for the "initial" estimates for F_{MSY} (without $B_{trigger}$).

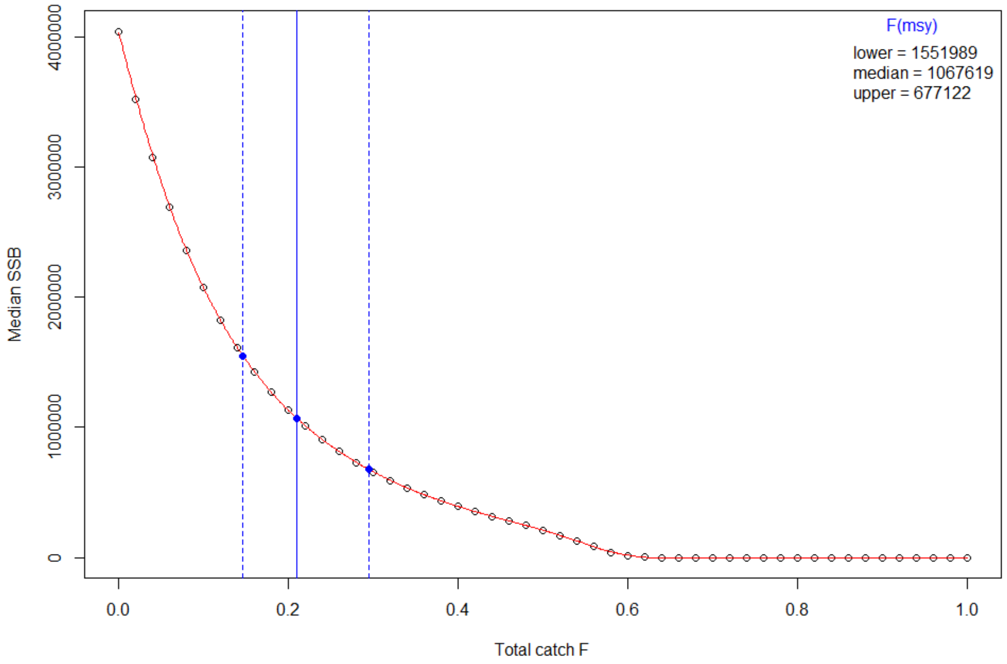

Figure 4.7.6.2. Sensitivity run (years 2011–2015) EQSIM SSB curve results for the "initial" estimates for F_{MSY} (without $B_{trigger}$).

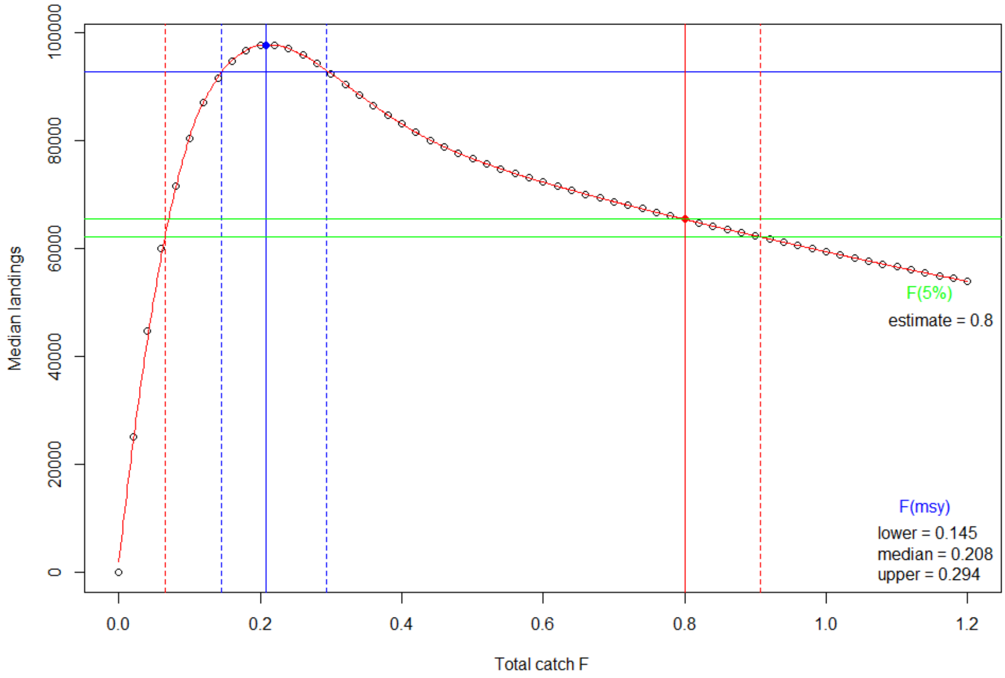

Figure 4.7.6.3. Sensitivity run (years 2011–2015) EQSIM yield curve results with $B_{trigger}$.

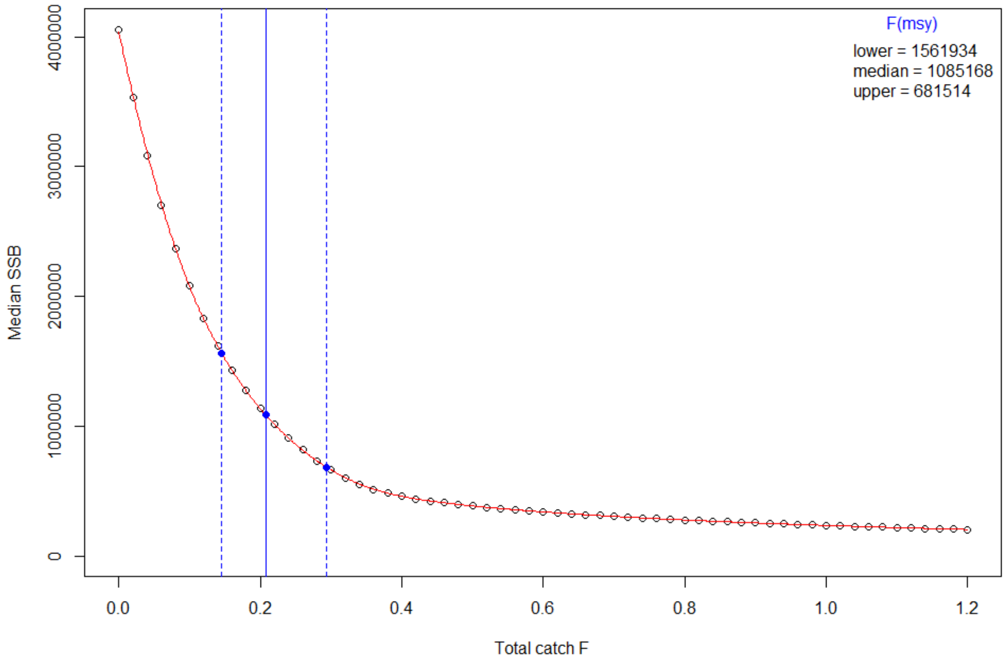

Figure 4.7.6.4. Sensitivity run (years 2011–2015) EQSIM SSB curve with $B_{trigger}$.

5 Sole in 7.d

This section relates to the sole stock in the eastern English Channel (Division 7.d).

5.1 Stock ID and substock structure

Information available through the Cefas long-term tagging programme and new information collected in recent research projects (B-Fishconnect and SMAC) were reviewed and summarised in the working document on stock identify (WD 1). A brief summary of that working document is provided in the following paragraphs.

Stock ID

Genetic analyses using outlier Single Nucleotide Polymorphisms (SNP) revealed that sole in area 7.e is genetically distinct from 7.d while 7.d sole shows a pattern of isolation by distance (gradual change in genetic diversity) with the North Sea sole.

The tagging information showed that 91% of sole in the North Sea and 72% in 7.d remained resident. The remaining 9% of the North Sea sole were found in 7.d (7%) and in 7.e (2%). 20% of the sole released in 7.d had moved west into the neighbouring area 7.e (and 1% beyond 7.e). 7% moved into the North Sea. The extent of movement between 7.d and 7.e increased closer to the boundary between the two areas. However, the abundance of sole in the western part of 7.d is much lower than in the eastern area and this movement across the management boundary, although significant, might represent a relatively small number of fish.

Substock structure

Three regions are distinguished within area 7.d that are associated with low connectivity for larvae and juveniles: a) along the English coast, b) in the Bay of Seine, and c) along the coast of northern France. Limited exchange of larvae or juveniles occurs between these three areas, with the exception of the northern side of the region 'coast of northern France', where exchange with the North Sea was observed due to the strong hydrodynamics.

Less information is available for adults, but a similar low exchange rate was suggested by tagging studies performed by Cefas.

5.2 Issue list

The issue list is taken from Annex 6 of ICES, WGNSSK (2016). The 'Comments' column indicates whether the issue was handled during this benchmark and, if yes, where it can be found.

Issue	Problem/Aim	Work needed/possible direction of solution	Data needed to be able to do this: are these available / where should these come from?	Comments
Tuning series	As the UK Young Fish Survey (YFS) stopped in 2006, the French YFS and the UK(E&W)-BTS-Q3 are the two remaining fishery-independent sources of information on age 1. There is however doubt around to what extent the BTS, that fishes with a mesh size of 40 mm in the codend, catches 1 year old sole in a quantitative way (BTS tuning series used in other assessments often start at age 2). Furthermore , the French YFS is probably not providing the correct recruitment estimates as it only covers part of VIId (potential impact on forecast).	Analysis : test runs with UK(E&W)-BTS-Q3 for ages 2 and older only. New data : Long term : UK to consider picking up the YFS in VIId again, or FRA to consider extending the French YFS into UK waters. Short term : FRA/UK to check for other data sources that could inform WKNSEA 2017 on the strength of incoming year classes (especially ages 1–2), so it can be evaluated to what extent these data correspond to the views presented by the French YFS.	Data are delivered annually by Cefas. If the UK-YFS is reinstated, this will not lead to a time-series that will already be useful at the time of WKNSEA 2017. FRA and UK	See Section 5.6.2 and WD 2 on tuning series
Discards	Discards are not included in the assessment.	BEL, FRA and UK to compose time-series of raised discard data (as long as possible).	Data available from Belgian, French and English discard sampling programmes.	See Section 5.6.1 and WD 3 on preparation of Catch data.
	FRA and UK upload quarterly discard data for all sampled métiers to Intercatch, whereas Belgium only uploads annual estimates. As Belgium only samples the métier TBB_DEF_70-99, a métier with a high	Belgium to compute quarterly discard estimates for sol-eche (TBB_DEF_70-99) based on the available data (some countries have a	Data available in Belgium (ILVO), but need to be processed differently and delivered so the impact on the assessment can be evaluated. Not relevant to	Belgium stated that it was not possible to provide an age distribution for TBB_DEF_70-99 for all quarters, because commercial sampling in the third quarter is limited. The main reason is that all sea

Issue	Problem/Aim	Work needed/possible direction of solution	Data needed to be able to do this: are these available / where should these come from?	Comments
	share in the total effort/landings of sol-eche and that is generally characterised by high discard rates and discard patterns that can be very different compared to the other métiers that are predominant in the FRA and UK sampling programmes, it would be desirable to also obtain quarterly discard estimates from Belgium for this métier.	comparable sampling level, but deliver quarterly data with a low qualitative self-evaluation, where Belgium chooses to only compute annual estimates with a higher self-evaluation)	WKNSEA 2017.	going observers are involved in survey sampling (DYFS and BTS).
Biological Parameters	A knife-edged maturity ogive, with full maturation from age 3 onwards is used in the assessment. No new data have been explored for a long time.	Investigate all available trawl survey maturity data to come up with a maturity ogive that is supported by recent data.	Data available in DATRAS.	See sSction 5.6.3 and WD 4 on biological parameters
Assessment method	The current XSA behaves well, but when discard time-series get included as input data, other models need to be tested: AAP, potentially SAM.	Carry out comparative runs using different models.		See sSction 5.6.3.4 and WD 5 on assessment models
Biological Reference Points	Revision of reference points. Preliminary analyses during WGNSSK 2014 already suggested that a revision of F_{MSY} could be considered. No B_{lim} is identified and F_{bar} is calculated on other ages than F_{MSY} is.	Computation of potential new reference points.	Data available from assessment.	See Section 5.8

5.3 Scorecard on data quality

A scorecard was not used for this benchmark.

5.4 Multispecies and mixed fisheries issues

No new information was presented at the benchmark meeting.

5.5 Ecosystem drivers

No new information was presented at the benchmark meeting.

5.6 Stock assessment

5.6.1 Catch: quality, misreporting, discards

InterCatch was used for estimation of numbers and weights-at-age in the catch.

Discard raising was performed on a gear level regardless of season or country. More information on which groups were distinguished, can be found in the working document on the preparation of catch data (WD 3). The weighting factor for raising the discards was 'Landings CATON'. Discard ratios varied between 0.001 and 0.47 over the matched landings–discard strata. High ratios were not included in the raising as they were assumed not to be representative. Higher ratios generally came from the French OTB_DEF_70-99 strata.

Two allocation schemes were explored to allocate ages when age distributions had to be borrowed from other métiers: 1) allocating ages manually and 2) using the autoallocation option in InterCatch. Landings and discards were handled separately; samples from landings were used only for landings and vice versa. More information on these two allocation schemes can be found in the working document on the preparation of catch data (WD 3). The weighting factor used was 'Mean Weight weighted by numbers-at-age'. In general, both allocation schemes resulted in quite similar outcomes, especially for the landings. For discards, less sampled strata were available, which resulted in larger differences between the allocation schemes. Especially for the older data, a lot of métiers have only samples in one quarter. Therefore, the save solution is to make the allocations based on several strata (manual allocation scheme) instead of one (automatic allocation scheme).

Numbers-at-age and mean weights-at-age were compared for landings between the 2016 assessment input and the output of the manual allocation scheme. Especially age 1 and the older ages, which are landed less frequently, and the earlier data years (2003–2007) showed the largest differences (>40%). Several reasons were identified to contribute to this difference: 1) More data were provided for this benchmark; 2) some data were adapted as they appeared to be wrong; 3) some unusual allocations were made during the previous assessment, e.g. using landings for age allocation of discards and *vice versa*.

No major issues were identified by the external reviewers concerning the preparation of the catch data during the WKNSEA 2017 benchmark. Therefore, the catch data were used as such as input for the assessment runs.

5.6.2 Surveys

5.6.2.1 Research surveys

The Eastern English Channel sole stock was assessed during the WGNSSK 2016 using 3 survey indices: UK (E&W) BTS (1989–2015), UK YFS (1987–2006) and French YFS (1987–2015). The latter specifically focus on age 0 and 1.

5.6.2.2 Catch and effort series

The working document on tuning series (WD 2) explores whether sufficient information on age 1 was available with the current survey tuning indices, considering the fact that the French YFS survey does not cover the complete 7.d area and the UK_YFS survey was last performed in 2006. It was concluded that no strong arguments to further revise this issue were available. Therefore, the survey tuning indices were retained in their current form in the assessment.

5.6.3 Weights, growth, maturity, natural mortality

5.6.3.1 Weights and growth

Analysing the available data on biological parameters revealed a pattern of decreasing mean lengths and weights at a specific age for sole 7.d from 2004–2015, especially for the younger ages. More information is provided in the working document on biological parameters (WD 4, Section 2).

Stock weights-at-age were obtained by calculating the quarter 2 catch weights in InterCatch. In the WGNSSK 2016 assessment, the Belgian yearly data for the TBB_DEF_70-99 métier were not included for this calculation. Belgium stated that it was not possible to provide a qualitative age distribution for all quarters of this métier, because sampling in area 7.d is limited in some quarters. However, for the years 2006–2007 and 2012–2015, quarter 2 mean catch weights could be obtained and were used to calculate stock weights.

5.6.3.2 Maturity

For sole in the Eastern English Channel (7.d), a knife-edged maturity ogive is used, which assumes full maturation from age 3 onwards. Some investigation revealed that this ogive was adopted from the North Sea sole stock, which seemed to be deduced from market sampling of North Sea plaice. Investigating the available maturity data were therefore appropriate and necessary.

Maturity data were available from Belgian, French and UK commercial fisheries and from the French IBTS. Unfortunately, the IBTS survey dataset contained only 126 samples (1 sample is maturity scored in 1 fish), which is quite limited. The UK commercial dataset was the largest with 9092 samples and represented a continuous time-series (2004–2015) for both males and females, which was not the case for the other datasets. In general, more data on females were available than on males. The reason for this was not further investigated during this benchmark. All datasets were combined, which resulted in 15 191 maturity records. More information on the available datasets can be found in the working document on biological parameters (WD 4, Section 1).

A Generalized Linear Model (GLM) was used to estimate the proportion of mature fish at age for females and males separately. The age plus group consisted of age 10 and older. The model with lowest AIC was retained: Maturity ~ Age + Length + Year

+ Country (for both males and females). The probability of maturity given sex, age and length was converted to the probability of maturity-at-age per country.

When looking into the data for males prior to 2008, an odd decline in maturity was observed. As only UK data were provided for males prior to 2008, no comparison with other datasets was possible to verify the accuracy of the data. During the benchmark, it was decided to explore a model (Maturity ~ age+length+country+year) without those data. Two important conclusions were drawn from the model output: 1) almost no variation over the years and, 2) almost no variation over the different countries was observed. Therefore, it was decided that both country and year should no longer be included in the model. Maturity-at-age was estimated per sex without the use of age–length keys and the maturity-at-age for both sexes was combined assuming a 50:50 sex ratio. No extra information was available to refute this sex ratio.

The obtained ogive was comprehensively discussed because in particular the proportion of mature sole at age 2 was much higher (74%) than in the currently used ogive (knife-edged: 0% mature at age 2). Two important issues were pointed out: a) the majority of the data originated from commercial datasets including fewer fish of age 2 (less caught commercially, especially during more recent years) and b) the only survey information included, are the 126 samples of the IBTS survey, which is not targeting sole and covers only a part of division 7.d.

Consequently, the ogive could give the wrong idea on the maturity-at-age 2. Therefore, based on the advice of the experts present at the benchmark, the proportion of mature sole was determined using the ratio of mature samples vs. all samples at age 2. The dataset used for this reasoning was the UK dataset, being the largest. The obtained value reflecting the mature fish at age 2 is 0.53 (=97/182 records). This more or less complied with the proportion of mature fish in the IBTS dataset (=12/25 records = 0.48). This reasoning led to the following maturity ogive:

Age	2	3	4	5	6	7	8	9	10
Maturity	0.53	0.92	0.96	0.97	0.97	0.97	0.97	0.99	0.98

Due to the large variation in the dataset to construct this ogive, full maturation was never reached (never 100%). The maturity rate started to plateau from age 5–6 onwards. The effect of setting full maturation at age 5 or 6 on the SSB was investigated in the assessment working document (WD 4, Section 1). Based on this analysis and expert judgement, it was decided to move forward with the maturity ogive as presented below.

Age	0	1	2	3	4	5	6	7	8	9	10 (+)
Maturity	0.00	0.00	0.53	0.92	0.96	0.97	1.00	1.00	1.00	1.00	1.00

5.6.3.3 Natural mortality

No new information was presented at the benchmark meeting.

5.6.3.4 Assessment models

Three different assessment models were tested during the benchmark: XSA, AAP and SAM. Especially the XSA model, which was also used for the WGNSSK 2016 assessment, was extensively investigated. For the SAM and AAP model, only exploratory runs were conducted. Detailed information on the different assessment models and runs can be found in the assessment working document (WD 5).

In the working document on tuning series (WD 2), the Belgian commercial tuning series was investigated and modified and a new French commercial tuning series was explored. Both commercial tuning series were included in several exploratory assessment runs.

XSA

During the WKNSEA 2017 benchmark, it was decided to use the settings of run 13 in future assessments (WD 5). Run 13 uses the new catch data (including the raised discards for all available data years) and stock weights. Besides higher catches from 2003 onwards, this resulted in a higher SSB (especially in 2003) and more recruits. The F_{bar} remained around the same average as for the baserun (i.e. WGNSSK 2016 assessment), except for a substantial decrease in the most recent years.

Several runs exploring the different tuning fleets were performed. In run 13, the Belgian index from 1986–2015 (BE_CBT_1986_2015) is replaced by a new one including only the years 2004–2015. Also the new French commercial otter trawl series was included (2002–2015) for the first time (WD 2). This resulted in a significant increase of the SSB for the whole time-series and a substantial decrease of the F_{bar}, especially in the most recent years. Additionally, the number of recruits are estimated to be higher over the whole time-series. Furthermore, all commercial tuning series included in run 13 were trimmed from age 3–8 to avoid underestimating age 2 and because of the poor internal consistency for ages 9 and 10. This further enhanced the effects on SSB and F_{bar}. Including the new maturity ogive resulted in an even further increase and decrease respectively.

Compared to the baserun, the small retrospective pattern in F (with overestimation in 2012 and 2013) is no longer present. The patterns for the recruits and SSB are comparable.

The effect on future stock advice is described in Section 5.7 Short-term projections.

AAP

The model reasonably reproduced the landings time-series and produced an estimation of discards for the period 1982–2003. The discard ratio-at-age used by the model matches almost perfectly the average discard ratio over the 2004–2015 period.

Two scenarios were tested using the AAP model. The first one included four tuning series (BE CBT new (2004–2015), UK CBT, FR OTB and UK BTS) and the second one included one extra tuning series (BE CBT old (1986–2003)). These scenarios produced similar results. The only differences are situated in the first part of the time-series (before 1990), where F fluctuates more in scenario 1 due to the absence of the old BE index (1986–2003).

With the same catch data and indices, the AAP model produces a less optimistic assessment than the XSA model. More specifically, the SSB shows a similar increasing trend, but with lower absolute values. The same is observed for F, but in the last two years F increases unlike the XSA model (WD 5).

SAM

The WGNSSK 2016 XSA assessment could not entirely be replicated using the SAM model, as it did not converge when the Q plateau was set at age 7. Nevertheless, several scenarios were run for exploratory purposes using the revised 2003–2015 data and adding new/adjusted tuning series and/or the new maturity ogive one at a time (WD 5). The output of these scenarios were used to verify whether the trends in SSB, F, and recruitment were similar to comparable XSA output, to explore the effect of scaling cpue to exploitable stock biomass instead of using the age information twice (once for cpue, once for disaggregating catch information by age), and to explore the effect of including autocorrelation structure in the survey indices following the method of Berg and Nielsen (2016). Because of this, the failure of several of the models to converge, and the inability to set the Q plateau to age 7 to replicate the WGNSSK 2016 assessment exactly, they do not warrant further discussion.

Comparing XSA, AAP and SAM

When comparing a similar scenario of the SAM model (scenario 5) with XSA run 13, the trends generally concur, but absolute values differ, with the XSA run 13 estimating SSB higher and F_{bar} lower. Although the YFS tuning series were not included in the AAP scenarios, the first scenario of the AAP model concurs more with scenario 5 of the SAM model than with run 13 of the XSA model. However, as both AAP and SAM did not allow the same flexibility in settings and data input as the XSA model did, the latter was used to move forward for future assessments.

5.7 Short-term projections

The long-term GM_{82-12} recruitment (29.7 million) was assumed for the 2015 and subsequent year classes. Population numbers at the start of 2016, estimated for ages 2 and older, were taken from the XSA output. Fishing mortality was set as the mean over the last three years not scaled to 2015 (0.28). Weights-at-age in the catch and in the stock are averages for the years 2013–2015. It was decided to use a TAC constraint for the intermediate year (2016) as recent landings have been close to the TAC. Assuming a TAC constraint for 2016 of 3258 t, implies a total catch of 3258 t.

Estimates of year-class strength used for prediction can be summarised as follows:

Year class	At age in 2016	XSA	GM	Source
2013	3	31 577		XSA
2014	2	24 832		XSA
2015	1	-	29 752	GM 1982–2012
2016 & 2017	recruits	-	29 752	GM 1982–2012

Intermediate year assumptions can be summarised as follows:

Variable	Value	Notes
F ages 3–7 (2016)	0.21	TAC constraint
SSB (2017)	20 578	Short-term forecast (STF), tonnes
R_{age1}(2016–2017)	29 752	Geometric mean (GM, excluding 2013–2015), thousands
Total catch (2016)	3258	STF, tonnes
Commercial landings (2016)	2846	STF, tonnes
Discards (2016)	409	STF, tonnes

5.8 Appropriate reference points (MSY)

5.8.1 Reference points prior to benchmark

Framework	Reference point	Value	Technical basis
MSY approach	MSY $B_{trigger}$	8000 t	B_{pa}
	F_{MSY}	0.3	Stochastic simulations assuming a smooth hockey-stick relationship. Calculations based on ages 3–8.
Precautionary approach	B_{lim}	Not defined.	Poor biological basis for definition.
	B_{pa}	8000 t	This is the lowest observed biomass at which there is no indication of impaired recruitment. Smoothed B_{loss}
	F_{lim}	0.55	F_{loss}, but poorly defined; analogy to North Sea and setting of 1.4 F_{pa} = 0.55. This is a fishing mortality at or above which the stock has shown continued decline.
	F_{pa}	0.4	Between F_{med} and the 5th percentile of F_{loss}; SSB >B_{pa} and probability (SSB_{mt}< B_{pa}), 10%: 0.4.
Management plan*	SSB_{MGT}	8000 t	B_{pa}
	F_{MGT}	Not defined.	

5.8.2 Source of data

Data used in the MSY analyses were taken from the FLStock object created from the benchmark model.

5.8.3 Stock-recruitment relationship and new B_{lim} and B_{pa} reference points

The interval analysis was based on a segmented regression, where the inflection point was set to **B_{lim}** (**13 751** tonnes; Figure 5.8.3.1 left panel). The time period for the interval analysis was truncated by removing the last three years (2013–2015) to avoid evaluating the recent upward trend in recruitment (WD 5). The stock–recruitment relationship was evaluated as type 2, showing a stock with a wide dynamic range of SSB. Whether recruitment is or has been impaired was less clear. Using the type 2 stock with segmented regression showed the most conservative stock–recruitment relationship when SSB is low (Figure 5.8.3.1 right panel). This was preferred considering the already large increase in SSB uncovered by the new assessment recipe and considering the evidence on decreasing body size at age (weight and length) over time (WD 4). **B_{pa}** was estimated to be **19 251** tonnes, from the equation $B_{pa} = B_{lim} * 1.4$, as for the alternate equation of $B_{pa} = B_{lim} * \exp(1.645 * \sigma)$, σ was not available.

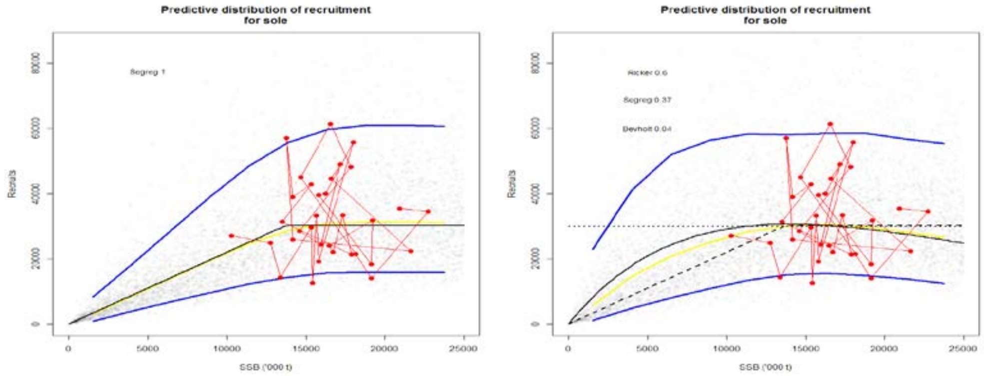

Figure 5.8.3.1. Left panel: Stock–recruitment relationship for sole in area 7.d, based on segmented regression over the truncated time period (removing 2013–2015), where the inflection point was set to B_{lim}. Right panel: Stock–recruitment relationship showing the estimation of the three regression models (Ricker: full black line; Beverton & Holt: dotted line; segmented regression: dashed line; the yellow line represents the best fit over the three models).

5.8.4 Methods and settings used to determine ranges for F_{MSY}

All analyses were conducted with Eqsim to estimate the remainder of the reference points, using the S–R fit from Section 5.8.3 (segmented regression).

F_{lim} was estimated at **0.36** (stochastic projection) using the last ten years of data (2006–2015) (see table below). **F_{pa}** was estimated to be **0.26** from the equation $F_{pa} = F_{lim}/1.4$.

	F05	F10	F50	medianMSY	meanMSY	Medlower	Meanlower	Medupper	Meanupper
catF	0.301	0.313	0.359	NA	0.28	NA	NA	NA	NA
lanF	NA	NA	NA	0.288	0.26	0.18	0.17	0.332	0.315
catch	4877.026	4833.969	4233.555	NA	4892.507	NA	NA	NA	NA
landings	NA	NA	NA	4605.495	4526.252	4302.958	4438.886	4311.312	4439.496
catB	19204.196	18260.033	13735.059	NA	20947.254	NA	NA	NA	NA
lanB	NA	NA	NA	20 503.273	22 720.237	32 638.5	NA	16 595.467	NA

For the remaining runs, the last five years of data (2011–2015) were used. During the last ten years mean weight-at-age decreased (WD 4), therefore, instead of the last ten years (default), the last five years were selected.

The assessment error in the advisory year (F_{CV}) and the autocorrelation (F_{phi}) were set to values agreed at WKMSYREF4 for stocks where these uncertainties cannot be estimated (ICES, WKMSYREF4 2016). These values, which are normally derived by comparing F values from the latest assessment with forecasted F values in year-1, could not be estimated for sole in the Eastern English Channel because the input data and age range for F_{bar} were changed during the benchmark.

Data and parameters	Settings	Comments
Recruitment model	Segmented regression, where the inflection point is set to B_{lim}	The stock–recruitment relationship showed a stock with a wide dynamic range of SSB (type 2).
SSB–recruitment data	Truncated time-series by removing the last three years (2013–2015)	The last three years were removed to avoid evaluating the recent upward trend in recruitment.
Exclusion of extreme values (option extreme.trim)	No	
Mean weights and proportion mature; natural mortality	2011–2015	During the last ten years mean weight-at-age decreased (see WD on biological parameters), therefore, instead of the last ten years (default), the last five years were selected.
Exploitation pattern	2011–2015	Over the last ten years, less sole with age 2 were caught, probably as a result of the decreasing mean weight and length-at-age. Therefore, instead of the last ten years (default), the last five years were selected.
Assessment error in the advisory year. CV of F	0.212	Default value for stocks where these uncertainties cannot be estimated
Autocorrelation in assessment error in the advisory year	0.423	Default value for stocks where these uncertainties cannot be estimated.

The initial F_{MSY} and $F_{0.5}$ were estimated by Eqsim without $MSYB_{trigger}$. This resulted in a median F_{MSY} of 0.27. The upper bound of the F_{MSY} range, giving at least 95% of the maximum yield, was estimated at 0.32 and the lower bound at 0.20. Because the F_{MSY} value is larger than F_{pa}, it needs to be restricted to F_{pa} (0.26, where F_{pa} was estimated as F_{lim}/1.4). The median of the SSB estimates at F_{MSY} was 21 825. The results of the Eqsim simulations are shown in the table below and in Figures 5.8.5.1, 5.8.5.2 and 5.8.5.3.

	F05	F10	F50	medianMSY	meanMSY	Medlower	Meanlower	Medupper	Meanupper
catF	0.286	0.301	0.348	NA	0.28	NA	NA	NA	NA
lanF	NA	NA	NA	0.271	0.28	0.195	0.196	0.322	0.313
catch	4502.767	4474.386	3752.876	NA	4511.935	NA	NA	NA	NA
landings	NA	NA	NA	4184.803	4153.492	3948.522	4121.684	3954.148	4118.718
catB	20 332.507	18 974.571	13 566.02	NA	20 918.552	NA	NA	NA	NA
lanB	NA	NA	NA	21 825.246	20 918.552	30 641.62	NA	16 955.049	NA

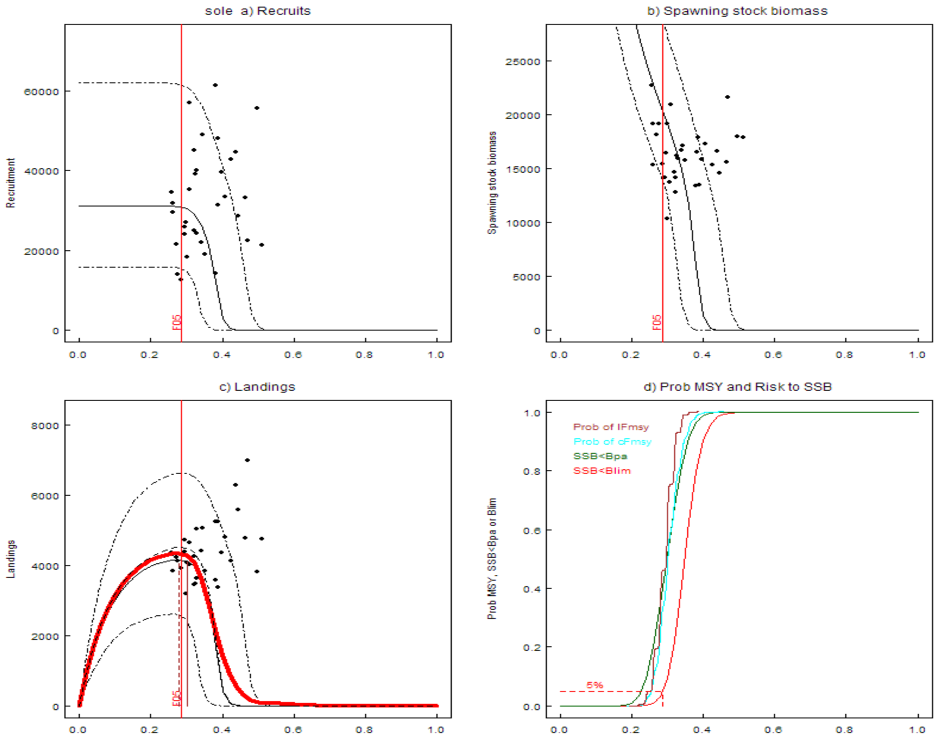

Figure 5.8.5.1. Eqsim results for sole in area 7.d (no trim, no $B_{trigger}$, segmented regression with the inflection point set as B_{lim}). Panels a–c: historic values (dots), median (solid black line), and 90% intervals (dotted black lines) for recruitment, SSB, and landings for exploitation at fixed values of F. Panel c also shows mean landings (red solid line). Panel d shows the probability of SSB<B_{lim} (red), SSB<B_{pa} (green), and the cumulative distribution of F_{MSY} based on yield as landings (brown) and catch (cyan).

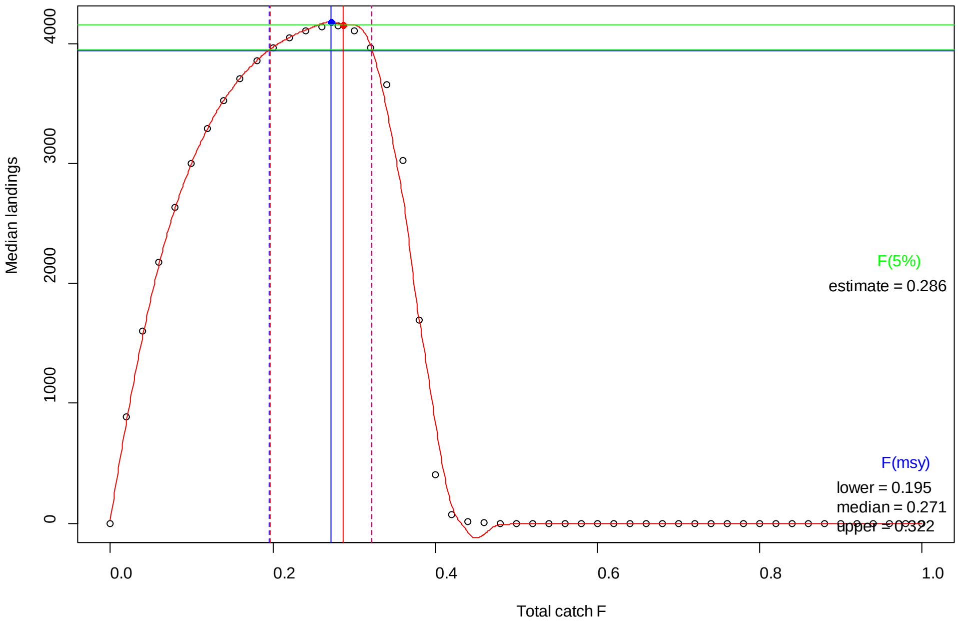

Figure 5.8.5.2. Median landing yield curve with estimated reference points for sole in area 7.d, with a fixed F exploitation from F = 0 to 1.0 (no $B_{trigger}$). Blue lines: F_{MSY} estimate (solid) and range at 95% of maximum yield (dotted lines), with the upper bound restricted to F_{pa}. Green lines: F(5%) estimate (solid).

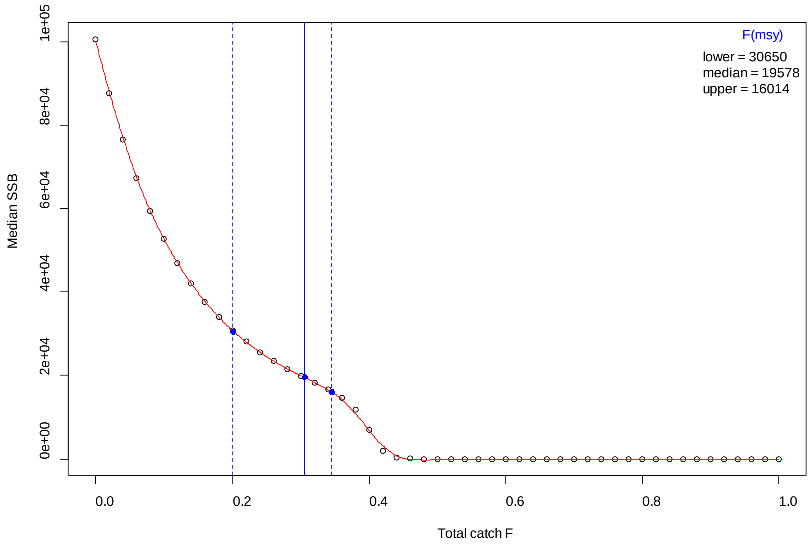

Figure 5.8.5.3. Median SSB with estimated reference points for sole in area 7.d, with a fixed F exploitation (no $B_{trigger}$). Blue lines show the location of F_{MSY} (solid) with the (dotted) lower and upper 95% F_{MSY} bound.

The next run was done to determine the $B_{trigger}$. The estimate (18 393 tonnes) was lower than B_{pa}. This is not possible. Moreover, as the sole 7.d stock has not been fished at F_{MSY} for five or more years, $MSYB_{trigger}$ should be set to B_{pa} (=19 251 tonnes).

5.8.5 Final Eqsim run

To evaluate the reference points when enforcing a $B_{trigger}$, a final Eqsim run was performed. When applying the ICES MSY harvest control rule with a $B_{trigger}$ of 19 251 tonnes, median F_{MSY} increased to 0.30 with a lower bound of the range at 0.20 and an upper bound at 0.41. The $F_{0.5}$ value also increased to 0.35. As this $F_{0.5}$ value is larger than F_{MSY}, F_{MSY} stays at the value initially calculated. F_{MSY} cannot be larger than F_{pa}, and thus it was set to F_{pa} = 0.26 (see Section 5.8.4).

The results of the Eqsim simulations are shown in the table below and in Figures 5.8.5.4, 5.8.5.5 and 5.8.5.6.

	F05	F10	F50	medianMSY	meanMSY	Medlower	Meanlower	Medupper	Meanupper
catF	0.348	0.377	0.497	NA	0.3	NA	NA	NA	NA
lanF	NA	NA	NA	0.297	0.3	0.203	0.2	0.409	0.417
catch	4508.47	4452.3	4040.511	NA	4540.737	NA	NA	NA	NA
landings	NA	NA	NA	4172.562	4173.751	3969.087	4131.845	3965.784	4131.934
catB	17 855.445	16 860.713	13751.464	NA	20 094.99	NA	NA	NA	NA
lanB	NA	NA	NA	20 254.563	20 094.99	29 445.47	NA	15 883.533	NA

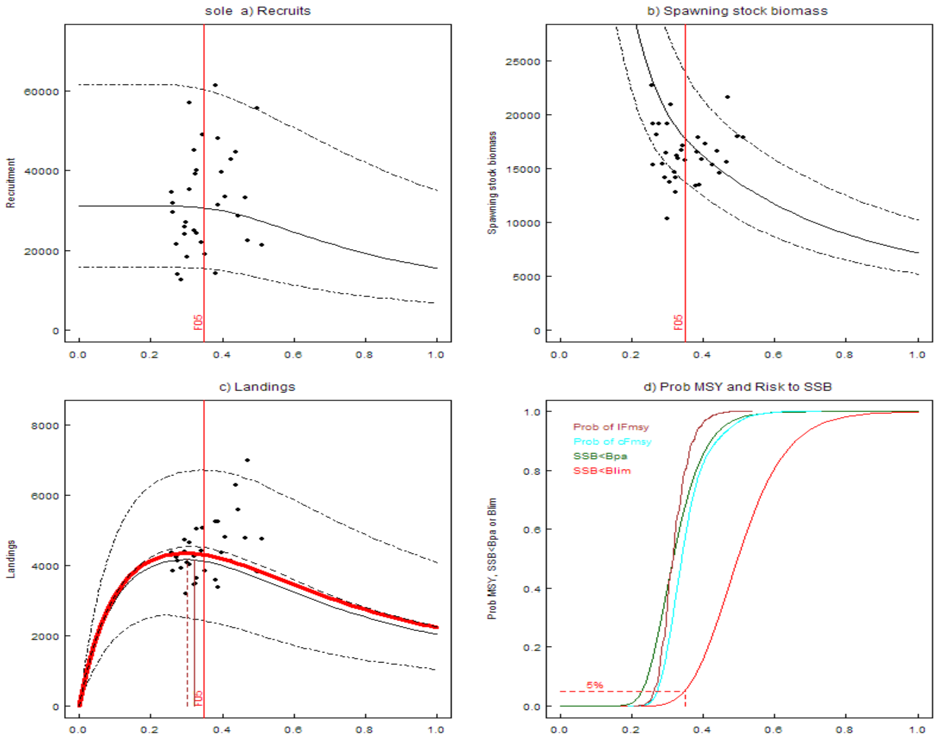

Figure 5.8.5.4. Eqsim results for sole in area 7.d (no trim, with $B_{trigger}$, segmented regression with the inflection point set as B_{lim}). Panels a–c: historic values (dots), median (solid black line), and 90% intervals (dotted black lines) for recruitment, SSB, and landings for exploitation at fixed values of F. Panel c also shows mean landings (red solid line). Panel d shows the probability of SSB<B_{lim} (red), SSB<B_{pa} (green), and the cumulative distribution of F_{MSY} based on yield as landings (brown) and catch (cyan).

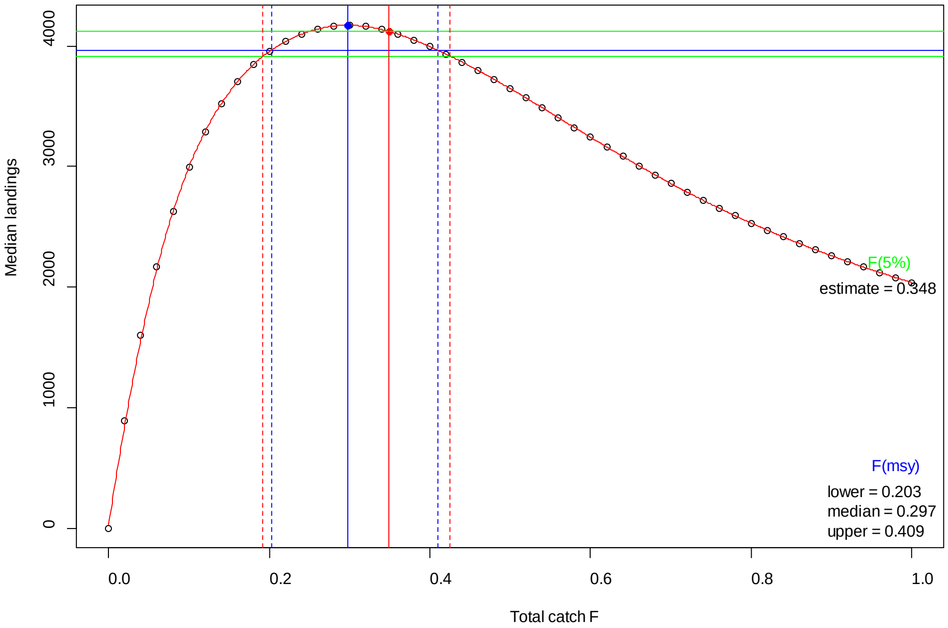

Figure 5.8.5.5. Median landing yield curve with estimated reference points when applying the ICES MSY harvest control rule with a $B_{trigger}$ at 19 729 tonnes for sole in subareas 7.d, with a fixed F exploitation from F = 0 to 1.0. Blue lines: F_{MSY} estimate (solid) and range at 95% of maximum yield (dotted). Green lines: F(5%) estimate (solid).

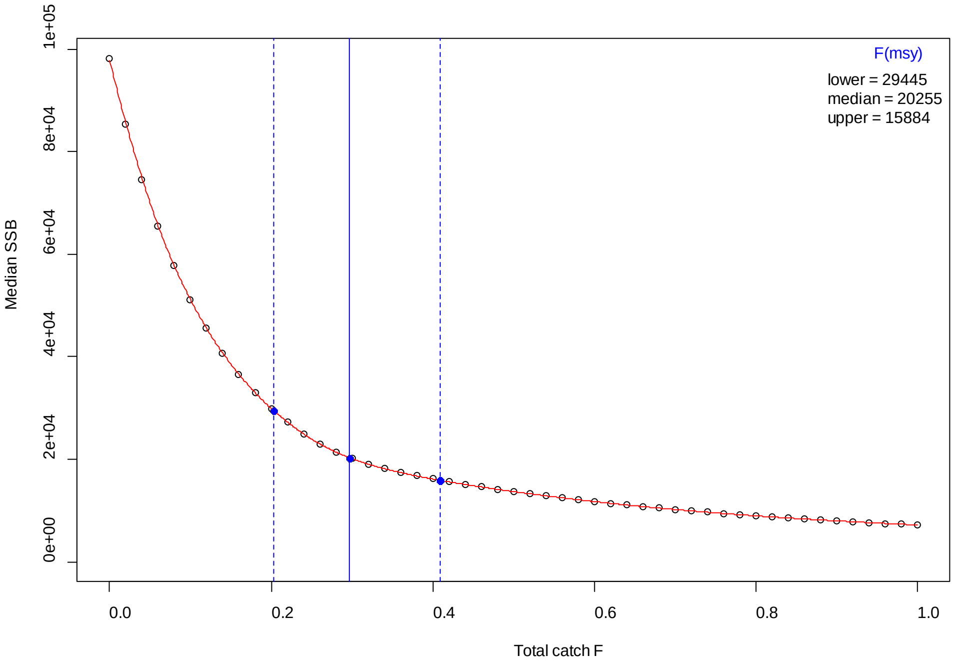

Figure 5.8.5.6. Median SSB with estimated reference points when applying the ICES MSY harvest control rule with a $B_{trigger}$ at 19 729 tonnes for sole in subareas 7.d. Blue lines show the location of F_{MSY} (solid) with the (dotted) lower and upper 95% F_{MSY} bound.

5.8.6 Sensitivity runs

No sensitivity runs were performed during the benchmark.

5.8.7 Proposed MSY reference points

Reference point	Value
B_{lim}	13 751
$B_{pa\ (1.4)}$	19 251
$B_{trigger}$	19 251
F_{lim}	0.359
$F_{pa\ (1.4)}$	0.256
F_{MSY} without $B_{trigger}$	0.271
F_{MSY} lower without $B_{trigger}$	0.195
F_{MSY} upper without $B_{trigger}$	0.322
New $F_{P.05}$ (5% risk to B_{lim} without $B_{trigger}$)	0.286
F_{MSY} upper precautionary without $B_{trigger}$	0.256
$F_{P.05}$ (5% risk to B_{lim} with $B_{trigger}$)	0.348
F_{MSY} with $B_{trigger}$	0.297
F_{MSY} lower with $B_{trigger}$	0.203
F_{MSY} upper with $B_{trigger}$	0.409
F_{MSY} upper precautionary with $B_{trigger}$	0.256
MSY (without HCR)	4185
Median SSB at F_{MSY} (without HCR)	21 825
Median SSB lower precautionary (median at F_{MSY} upper precautionary; without HCR)	/
Median SSB upper (median at F_{MSY} lower; without HCR)	30 642

5.9 Future research and data requirements

The following were noted as needing further exploration:

- Alternate rates of natural mortality need to be investigated,
- Trends and reasons for the decreasing body size (both weight and length) as mentioned in the working document on biological parameters should be further investigated;
- Other assessment models, such as SAM or AAP, should be further investigated to verify why certain settings did not allow the models to converge;
- The Belgian sampling design is under revision as part of the new National Programme. One of the goals is to be able to upload quarterly instead of yearly distributions;
- A more coherent maturity dataset is needed covering a long time period and including both male and female records. Furthermore, it should be investigated why more female than male data were available. Is there a skewed sex ratio? Do males and females occupy different spatial areas? Is the maturity scoring method not sufficient for one of the sexes;
- Explore the possibility of updating the BE-CBT tuning data from 1986–2003. Similar to the more recent data (2004–2015), this update includes a recalculation based only on data from the large fleet segment (HP >221 kW).

The standardisation of the nominal log transformed catch rates is performed using a generalised linear model, including horse power (HP) as a continuous linear variable and year and month as factors.

5.10 References

Berg, C.W. and A. Nielsen. 2016. Accounting for correlated observations in an age-based state–space assessment model. ICES J Mar Sci. doi: 10.1093/icesjms/fsw046.

ICES. 2016. Report of the Working Group on the Assessment of Demersal Stocks in the North Sea and Skagerrak (WGNSSK), 26 April–5 May 2016. ICES CM 2016/ACOM:14.

ICES. 2016. Report of the Workshop to consider F_{MSY} ranges for stocks in ICES categories 1 and 2 in Western Waters (WKMSYREF4), 13–16 October 2015, Brest, France. ICES CM 2015/ACOM:58. 187 pp.

6 External Reviewers' Report

Elizabeth Brooks, Nathan Taylor, and John Wiedenmann served as the external experts for the WKNSEA benchmark of Plaice 3.a4 and Sole 7.d, reviewing the data compilation and modelling methods from February 5–9th, 2017 at a meeting attended by the assessment analysts for each stock. Over the course of the meeting, the assessment teams were asked by the review panel to conduct a number of additional data exploration and assessment model runs, and the teams responded very well to each request, and are to be commended for their efforts.

A majority of the meeting time was devoted to data analysis, rather than reviewing the assessment model, diagnostics, and projections. While we feel that the time spent on data definitely led to much improved inputs to the assessment model this year, and it checked the box for research recommendations made at previous benchmarks, it would have been better if more time were available to review the assessment model and the basis for advice. In future, it would be ideal if the data decisions were final by the time of the benchmark review. However, we recognize that benchmarks are an incremental process of improvement, and require a lot of time and coordination between the scientists from many countries. Perhaps the timeline for the data workshop and data analysis is too compressed to expect the work to be completed before the benchmark review.

6.1 Plaice 3.a4

6.1.1 Major issues addressed at the benchmark

The primary issues addressed at the benchmark for plaice were biological analyses into time-varying maturity- and natural mortality-at-age, inclusion of new fisheries-independent indices, and estimation of historical discards within a new assessment model (developed by Aarts and Poos (2009); herein called the AAP model).

Biological analyses - Working documents were presented for analyses of maturity and natural mortality. The current estimate of natural mortality (*M*) is based on work by Beverton (1964) and the value (0.11) reflects an average of estimates for males and females during the Second World War when fishing effort was minimal. The assessment team explored using the Gislason *et al*. (2010) equation using time-varying estimates of *k* and L_∞ from the von-Bertalanffy growth model to generate time- and age-varying estimates of *M*. The reviewers felt this was a useful exploration, however the resulting estimates of M were unbelievable, implying cumulative survival of <6% after age 3. Follow-up analyses that considered a time- and age-invariant M estimate based on maximum age using Hoenig's 1983 method produced an estimate of 0.11, which was identical with the current value. Analyses of *M* considering the 95th percentile of the total distribution of ages resulted in unrealistic estimates of *M* (and a maximum age of 12). There do not appear to be any additional data sources that could help inform on current estimates of *M*. Therefore, lacking evidence to change the current estimate, we recommend that the current value of *M*=0.11 be maintained. If new data or models emerge, they should be brought forward at future benchmarks.

Maturity was exhaustively considered for plaice, primarily due to concerns over observed changes in growth over time. The assessment team estimated time-varying maturity for plaice using samples only from Dutch commercial landings due to the shorter time-series of fisheries-independent maturity samples. The analysis showed a general increase in the proportion mature fish at younger ages, although with a subsequent decrease since 2010. Questions were raised about whether or not to include the time-varying maturity estimates in the model, and how to deal with earlier years (pre-1988) where no estimates were available. Because recruitments in the assessment model are freely estimated, changes in the maturity ogive would not impact abundance estimates, but would impact spawning biomass estimates. The reviewers felt that sensitivity runs should be done to determine the impact of different maturity ogives. Ultimately, there was minimal difference between runs, so the assessment team moved forward with the assessment model using a fixed maturity ogive, and the review team agreed with this approach.

6.1.1.1 Indices of abundance

The assessment team conducted a thorough analysis regarding the creation of standardized indices of abundance from surveys, and the impact that inclusion / exclusion of certain indices had on assessment results. Part of the focus was with regard to inclusion of new beam trawl survey (BTS) data, specifically the German (SOLEA) data source, and whether or not to this survey could be combined with the existing BTS survey from the ISIS and TRIDENS vessels or if it should be used as a separate tuning index. The assessment team used the delta-GAM model of Berg *et al*. (2014) to create the combined index, and the resulting combined index showed good internal consistencies and nearly identical temporal trends at age to the original combined index. The assessment team also explored the use of International Bottom-trawl Survey data (IBTS) to expand the spatial coverage of survey estimates for plaice. Again, the GAM model of Berg *et al*. (2014) was used in the creation of indices for quarters 1 and 3 (Q1 and Q3), and it was also used to explore a combined IBTS and BTS index for Q3 from 1996–2015. The assessment team decided to use the combined BTS index and to include the IBTS Q1 and Q3 indices in the assessment (in addition to the previously used sole net survey (SNS) and BTS survey index from earlier years without the German data), and the reviewers agreed. Additional survey data from different countries are available, but these data were not available in DATRAS at the time of the assessment. As these data become available, the analyses done for the current assessment should be repeated to determine their suitability for inclusion in the assessment model.

Assessment models - Multiple runs from AAP were presented and compared to WKNSSK 2016, the previous XSA model results, with motivation to move to the AAP model. The AAP model offers additional flexibility over the XSA model, including the ability to estimate historical discards, as opposed to fitting the model to reconstructed estimates. However, runs that estimated historical discards resulted in no discards early in the time-series, so it was agreed to stick with the reconstructed estimates of discards. Run 15 was proposed as the new assessment model for plaice. This model used the following surveys: BTS-Isis early, BTS combined new (spatial GAM), SNS1 ages 1–6, SNS2 ages 1–6, IBTSQ1 and IBTSQ3. Initial model runs attempted to estimate time-varying selectivity for the discard estimates, but obtained poor fits in the most recent years of the time-series, with consistent overestimation of discards in recent years. Run 15 treated the discards as observations, rather than estimating them, and fit to the ratio of observed discards/(total catch). This provided an improvement in the model predicted discards, and the assessment team and reviewers agreed that this was the best model to proceed with. Going forward, we suggest exploring additional flexibility in modelling the discard selectivity.

Reference points - Application of the MSY software followed the prescribed steps. While the estimated F_{MSY} (0.21) was similar to the previous estimate (0.19), and B_{pa} was similar (290 000 for this benchmark compared to the previous estimate of 230 000), there was a doubling of $B_{trigger}$ (previously set equal to B_{pa} of 230 000 for 2016) because the stock has been fished below F_{MSY} for five years and the 5th percentile of B_{MSY} (804 000) is greater than the B_{pa} estimated from this assessment (290 000). Because of these two conditions, the new proposal for $B_{trigger}$ is to use the 5th percentile of the most recent SSB estimate, divided by 1.4, resulting in a new $B_{trigger}$ of 565 000. While the aim of the MSY reference point algorithm is to gradually transition between reference points, a doubling of $B_{trigger}$ from one year to the next seems rather abrupt; although the value of 565 000 is less abrupt than jumping to 804 000. Considering the decline in recent weights-at-age, which has been most pronounced, we suggest exploring a five year average of recent ogives (weights-at-age, maturity-at-age, and selectivity-at-age). A ten year average of these ogives is expected to be higher than the most recent values, and could impact the reference point calculations.

Basis for advice - Model Run 15 was proposed and accepted as the new assessment model for plaice. This model used the following surveys: BTS-Isis early, BTS combined new (spatial GAM), SNS1 ages 1–6, SNS2 ages 1–6, IBTSQ1 and IBTSQ3, as well as a fixed maturity ogive with $M = 0.11$ across years and age classes.

Recommendations for future work - The following recommendations are ordered by priority.

1) Objective criteria for including/excluding survey and commercial indices of abundance. This could include consideration of length of the time-series, amount of spatial coverage, consistent statistical sampling design (for surveys), ability to identify targeting and/or consideration of whether trips catching no plaice can be identified as targeted trips, and others. These criteria should be applied to new survey or other data as they become available (e.g. not all countries had survey data uploaded into DATRAS), and similar analyses should be conducted to create standardized indices when data are deemed appropriate to inclusion in the assessment. Plots of internal consistency and ability to track cohorts were helpful and should continue to be used in future evaluations.

2) Investigate reasons for the observed pattern between maturity data collected in RA8 and RA2–7. If indeed RA8 has delayed maturation compared to the other areas, then the maturity ogive should incorporate these data so that it is reflective of the entire population, and so that the corresponding reference points are appropriate.

3) Time-varying biological parameters. A lot of effort was spent exploring models that allowed for time varying maturity and mortality. Part of the motivation for this was the observed changes in mean length-at-age, particularly at older ages. To better understand the mean length trend, we recommend examining whether the sex ratio has changed such that the proportion of males has increased. As males are smaller at size, an increasing proportion of males could explain the decreasing mean length-at-age. In addition, it will be important to consider that any apparent changes in time-varying biological parameters can be as a result of fishing and sampling regimes. Consider that the probability of being observed at length and age is the product of multiple processes: the probability of being alive at age is given by the history of total mortality experienced by a given co-

hort, the probability of being observed at length in a given year is given by the probability of being alive at length (given the history of size-selective fishing) and the probability of being captured at length/age during a given sampling event. Accordingly, being able to disentangle sampling and fishing effects from 'true' changes in mean life-history parameters is potentially very challenging.

6.2 Sole 7d

6.2.1 Major issues addressed at the benchmark

The primary issues addressed at the benchmark for sole were biological analysis considering time-varying maturity, as well as some discussion of stock structure, standardization and inclusion of French and Belgian fishery-dependent indices of abundance, and reestimation of landings and raising of discard estimates.

6.2.1.1 Biological analyses

The analysis of maturity was discussed extensively at the meeting. As was the case for plaice, the reviewers participated with the rest of the working group in making the decisions about the analysis of maturity data. There was an observed pattern between maturity data collected in RA8 and RA2–7. A set of analysis considering time-varying maturity was done: however the time-varying changes estimated in this ogive were small. The biggest change between the maturity ogive used before this benchmark and the ogives presented at this review was the estimate of maturity for fish at age 2: historically this was assumed to be zero whereas in this year maturity-at-age 2 was given by raw proportions mature observed in the data from England. We agreed with the decisions made about the maturity analyses that were done at the meeting. The final working paper should document the decisions made and the final maturity ogives being input into the assessment model.

A summary of results from previous tagging studies, as well preliminary results from ongoing tagging studies, suggests some connectivity between the sole stock in 7.d with 7.e to the west and also with the North Sea. Hypotheses were presented for three distinct subregions within 7.d, corresponding to nursery areas with no/minimal juvenile exchange, however adult movement between these subareas is unknown. Differences in otolith microchemistry support the hypothesis of distinct nursery areas. Genetic analyses did not demonstrate differentiation in this area. Overall, there appears to be no firm evidence to propose alternative stock structure, and we agree that maintaining current stock boundaries is the best decision. Ongoing work, specifically the tagging studies and further otolith microchemistry work, may provide a clearer picture of exchanges between stock areas and should be reviewed at a future benchmark when those results are available.

6.2.1.2 Indices of abundance

In contrast to plaice, limited fishery-independent data were available for sole in 7.d, so the discussion focused on standardization and inclusion of fisheries-dependent landings per unit of effort (lpue) estimates in the assessment. The reviewers had concerns over inclusion of the lpue estimates, including issues related to hyper-depletion or hyper-stability in the index, as well as concerns about how commercial age composition data would be used twice in the creation of datasets that are treated as independent in the model. In other words, the age composition data in the commercial landings is used to create age-specific indices of lpue, such that the cohort signals in the landings age composition data will match up with the survey estimates, potentially creating biases in the model fitting. Despite these concerns, the assessment team and reviewers agreed that the limited survey data for sole (BTS Q3 for multiple age classes from England, and young fish surveys from England and France), particularly of older age classes, justified the inclusion of lpue data. For the fishery-dependent data, the focus was on the Belgian beam trawl fleet, and the impact of vessel horsepower on the lpue, and on the French otter trawl fleet, and whether or not to include all vessels and all mesh sizes over a 16 year timespan, all vessels with a fixed mesh size, or only those vessels that had fished all years. For the Belgian fleet, additional factors beyond horsepower were considered in a GLM, including year, quarter and statistical area (rectangle). All factors were significant, but inclusion of the rectangle covariate resulted in two less years of data. The difference between lpue at age was negligible whether or not rectangle was included in the model, so the group agreed that excluding rectangle to obtain two additional years of data was the preferred approach. For the French index, the limited number of boats that fished the entire time-series was concerning, as was the spatial distribution of the effort of these vessels, so it was decided to include all vessels with the standard mesh size in the calculation of the lpue index. In addition to these fleets, a UK beam trawl index was also presented, but no discussion occurred on the methods used in the calculation of this index or any caveats associated with it.

Reestimation of Landings and Discards - Reestimation of landings for this benchmark were explored with a manual specification of groupings for age allocation. Manual specification was compared to the automatic allocation in InterCatch. While both options showed substantial differences at the youngest and oldest ages, it was felt that this was a result of revisions/corrections to the database as well as improvements in the specification of groupings. Comparing just the automatic and manual allocations on the current data did not reveal great differences for the landings. Discard raising and age allocation were also explored with manual and automatic schemes. Greater differences were observed between the manual and automatic allocation groupings for discards than for landings. It was felt that the automatic allocation schemes were not sufficiently flexible, so the manual specification was the preferred option, particularly for the discards. We appreciated the work to explore the different allocation schemes, and agree that the current capability of the automatic allocation as described is limited, and we therefore support the decision to use manual allocation of landings and discards.

Assessment models - Given the time required to evaluate analyses of maturity and indices, it was decided to proceed with the XSA as the assessment model since time would not be adequate to conduct and evaluate multiple runs with alternative models. A stepwise presentation of one update at a time, compared to the 2016 base run was extremely helpful in evaluating which of the updated inputs (catch, indices) produced a difference. The largest difference was due to the new treatment of the Belgian commercial index. Previously, this was a continuous index that used all vessels in all horsepower classes, with horsepower calibrated by a single relationship. It has been recommended to re-evaluate horsepower standardization since 2009 (WKFLAT 2009), particularly since it was recognized that many vessels in the horsepower class reporting 216–225 HP were clearly underreporting their HP, and these vessels represented 44% of vessels and 66% of discards. The new standardization that omitted these vessels is an improvement and likely removes the bias from misreported HP, however, this was only carried out for years 2004–present. A run with the old Belgian commercial index from 1986–2003 was included with the new 2004–

present index. The resulting XSA run estimated that q for the new index was ⅓ the q values of the old index. This result did not seem reasonable. Furthermore, given the recognized bias in the old index, it was decided that the index with the old HP calibration from 1986–2003 should not be included.

Reference points - It is not clear how much latitude there is for reviewers to comment on the reference point estimation procedure. We assume that the tool used for estimating reference points has been validated through a separate ICES process but the process introduces a significant amount of subjectivity to the process in particular for decisions about which stock–recruit curve to fit, and in classifying which one of the six recruitment 'types' apply to the given stock. For sole, it is not clear that there is enough contrast in the data to estimate stock–recruitment parameters at all: the stock appears to have been fluctuating around a nearly constant level.

Basis for advice - The final XSA assessment run included only the new Belgian HP standardization, in addition to a new French commercial index. The resulting SSB and F trends generally followed the same trends as the 2016 benchmark, but SSB was shifted to higher abundance and F was shifted to lower values, especially in the most recent years.

Recommendations for future work - The following recommendations are ordered by priority.

1) Objective criteria for including/excluding survey and commercial indices of abundance. This could include consideration of length of the time-series, amount and consistency of spatial coverage, consistent statistical sampling design (for surveys), ability to identify targeting and/or consideration of whether trips catching no plaice can be identified as targeted trips, and others. Plots of internal consistency and ability to track cohorts were helpful and should continue to be used in future evaluations.

2) The reviewers expressed some concern that maturity estimates were derived from commercial landings, which could introduce bias. If there are no other data to rely on, then that is the best available. If fisheries-independent data are available, we would encourage developing it for analysis.

3) If possible, we encourage work to identify HP estimates for the Belgian index; this would allow incorporation of more years of data into that index.

4) As much of the review time for sole was devoted to data issues, there was less time to review assessment modelling. At future benchmarks, we would encourage exploration of alternative modelling platforms (e.g. SAM) that would allow an exploration of the sensitivity of the model to uncertainty in commercial catch-at-age information being used in the indices.

5) Greater flexibility for specifying multiple allocation schemes in InterCatch was noted as a software feature that would make it feasible to compare sensitivity of landings and discards to different grouping schemes. If practicable, we encourage development of additional flexibility within InterCatch.

Annex 1: List of participants

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Annex 2: Stock Annexes

The table below provides an overview of the WGNSSK Stock Annex updated at WKNSEA. Stock Annexes for other stocks are available on the ICES website Library under the Publication Type "Stock Annexes". Use the search facility to find a particular Stock Annex, refining your search in the left-hand column to include the *year, ecoregion, species,* and *acronym* of the relevant ICES expert group.

STOCK ID	STOCK NAME	LAST UPDATED	LINK
ple.27.420	Plaice (*Pleuronectes platessa*) in Subarea 4 (North Sea) and Subdivision 20 (Skagerrak)	February 2017	ple.27.420
sol.27.7d	Sole (*Solea solea*) in Division 7.d (eastern English Channel)	February 2017	sol.27.7d

Annex 3: Plaice working documents

The following working documents on plaice were presented at WKNSEA 2017 and are found below:

8 Working document 1: natural mortality plaice in 3a and 4

8.1 Table of contents

8.2 Introduction

The current estimate for natural mortality (*M*) is assumed to be 0.1 year^{-1} for all ages and years. This is based on Beverton (1964), who estimated from the survival of plaice cohorts in the North Sea during the second world war. The natural mortality of plaice males was estimated to be 0.14 year^{-1} while the natural mortality for females was estimated to be 0.08 year^{-1}. Gislason *et al.* (2010) state a second potential source of information for plaice (Table 1): an estimate of 0.2 year^{-1} from Siddeek (1989). However, the experiments of Siddeek actually resulted in a wide range of *M* estimates, ranging between 0.085 – 0.204, for males and females. It should be noted that these experiments were not done in the North Sea, but in the Irish Sea.

The information collected in Gislason et al. (2010)n was used to derive an empirical formula for forecasting *M*: $\ln(M) = 0.55 - 1.61\ln(L) + 1.44\ln(L\infty) + \ln(K)$. This formula could be used as a third alternative for our current *M* assumption.

8.3 Alternative sources for L∞ and K (van Walraven et al 2010)

Estimated in van Walraven et al. (2010) where one of objectives are to estimate changes in Von Bertalanffy (VB) growth parameters in males and females between three time periods: I — 1900s (female maturation and male and female growth), II — 1980s and III — 2000s. Data was selected for the different periods as follows: “For period I, the mean length at age reported by Herwig (1908) was used for the ages 1–4. For the older age groups, mean length at age were reported by Masterman (1911) and Wallace (1914). Averages were weighted by the number of observations per area and 0.5 was added to the age to account for sampling throughout the year. For period II and III, the survey data of ages ≤6 and commercial data of ages ≥6 were merged because the commercial data is biased towards larger sizes due to the minimal mesh and landing size regulations. To account for the length stratification of the sampling, observations were weighted by their relative frequency in the population.”

Results (Table 2) indicated that ”The growth curves of both male and female plaice showed a gradual decrease in the L∞ since the 1900s, whereas the slope of the curves in the origin or K, the velocity to reach L∞, increased between period I and period II (Fig. 4). For females, the estimated L∞ decreased from 90 cm in period I to 53 cm in period II to 48 cm in period III, whereas K increased from 0.087 to 0.200 and 0.232 (Table 4). For the males, the L∞ decreased from 51.3 to 41.2 cm and 32.6 cm, whereas K increased from 0.155 to 0.281 and 0.393 in period I, period II and period III, respectively.”

8.4 Alternative sources for L∞ and K (BTS)

The lengths, L∞ and K can also be estimated using data from BTS ISIS and or Tridens (for ages 1-10) (see Tables 3-6, and Figure 1). Given the lengths-at-age, L∞ and K can be estimated. Because the These are in Q3, so, added +0.5 to age. A simple estimate of L∞

and K using nonlinear regression (assuming normally distributed residuals) yields estimates for L∞ and K of 39.14, 0.35 respectively (figure 2). This model has a nll of 1638.174, with 3 df. However, the model with fixed Linf and K does not accommodate for the changes in growth that have been observed: the model underestimates the length for older ages at the beginning of the time series, and overestimates it for the recent part of the time series.

Two alternative models can be formulated to estimate the changes in L∞ and K over time: a model where these are assumed to be linearly changing over time for the cohorts, and a model where Linf and K are estimated by cohort. Results for the model with a linearly changing L∞ and K are given in Figure 3. The results suggest a decreasing L∞, with decreasing K. This model has a substantially reduced nll of 1429.5 (5 df)).

The model where L∞ and K are estimated by cohort gives similar results (Figure 4), with the exception of the start and end of the time series: this is because there is limited information on growth in those cohorts.

8.5 Using Gislason equation for estimating M-at-age matrix (from BTS data)

The models that allow for changing Linf and K were used to calculate M, using lengths-at-age, and estimated Linf and K values. The results are in tables 7 and 8.

All code can be found in appendix A

8.6 Figures

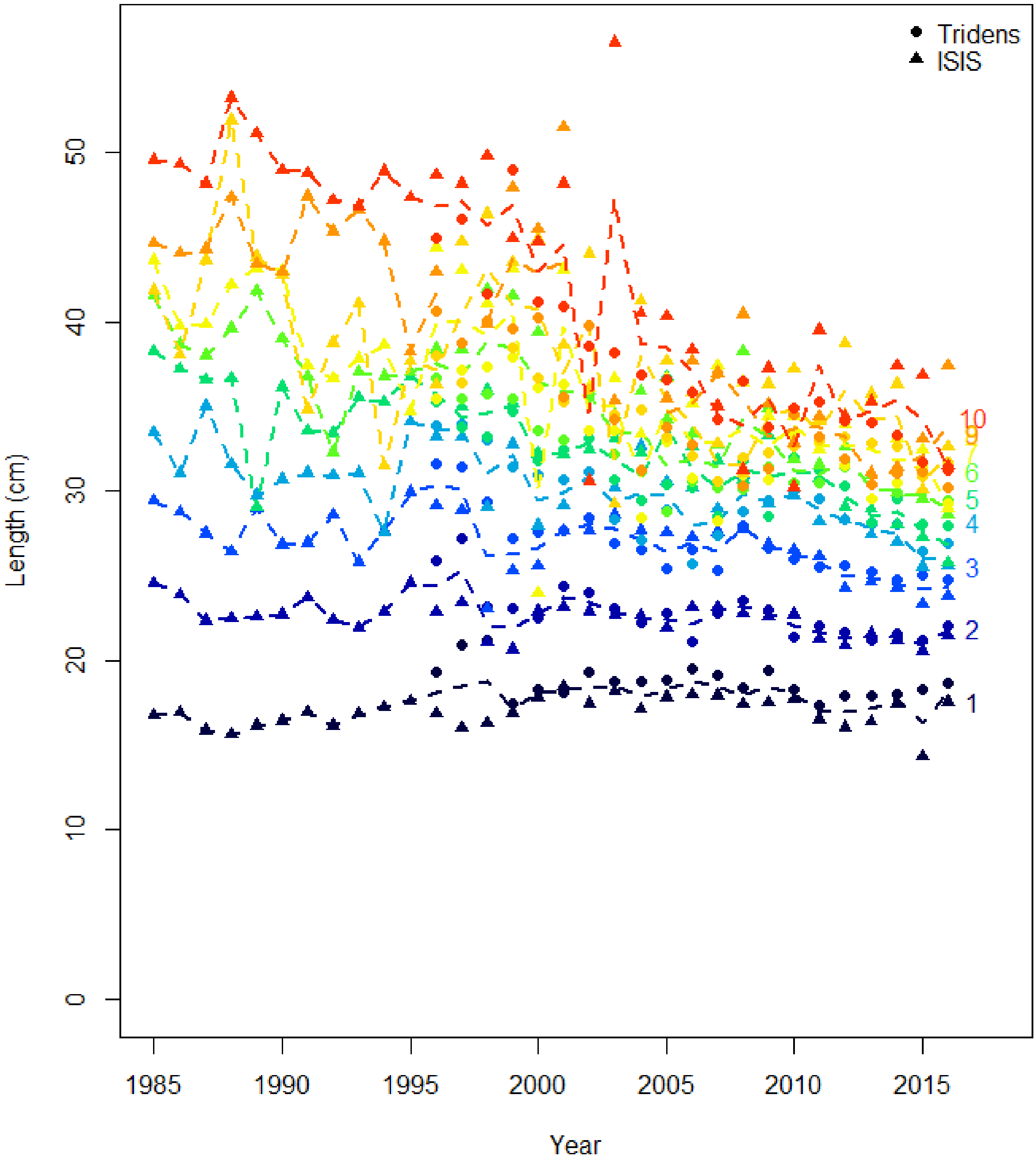


Fig 1. Estimated mean lengths from BTS, including means (dashed lines)

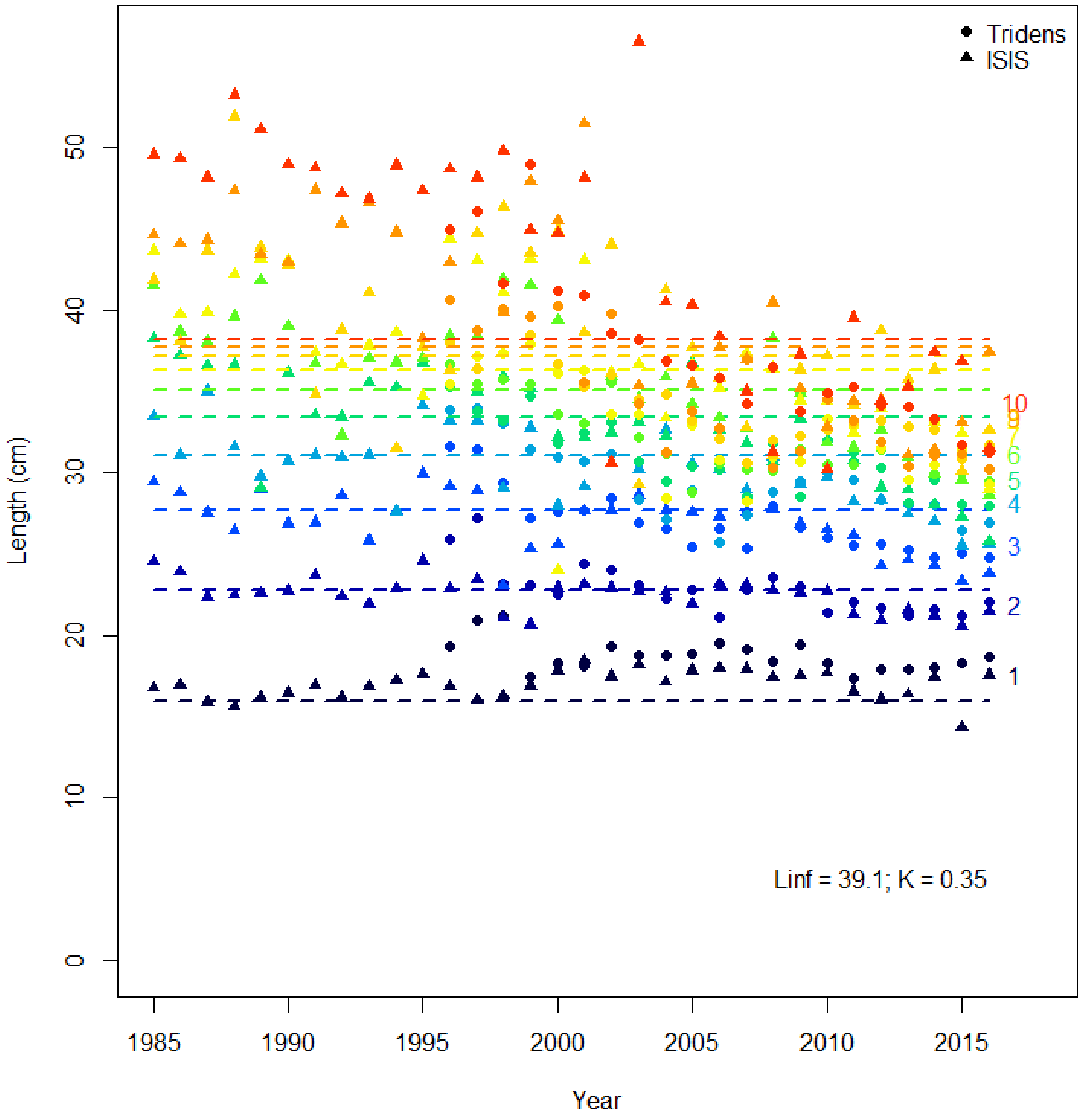


Fig 2. Estimated mean lengths from BTS, using a VBLG growth curve (dashed lines) with fixed Linf and K.

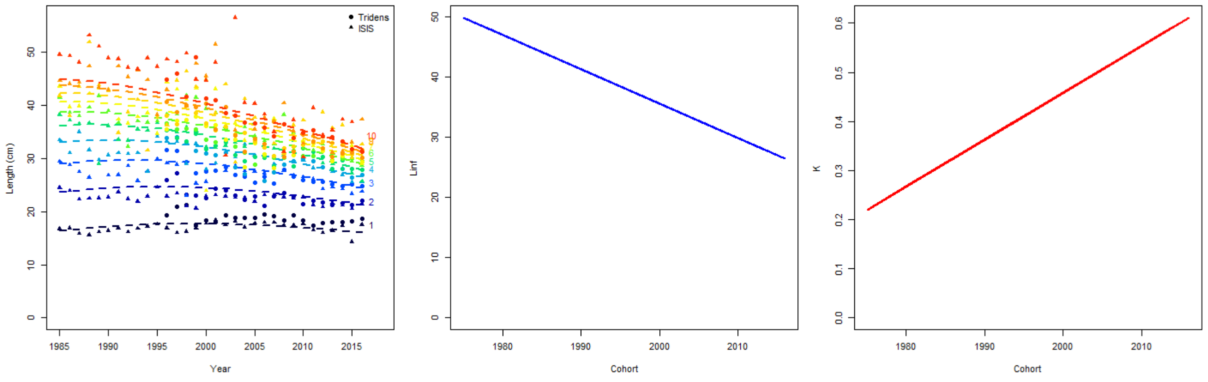


Fig 3. Allowing for a linear trend for Linf and K over time (results in estimates of decreasing Linf, with decreasing K. This model has a substantially reduced nll of 1429.5 (5 df)).

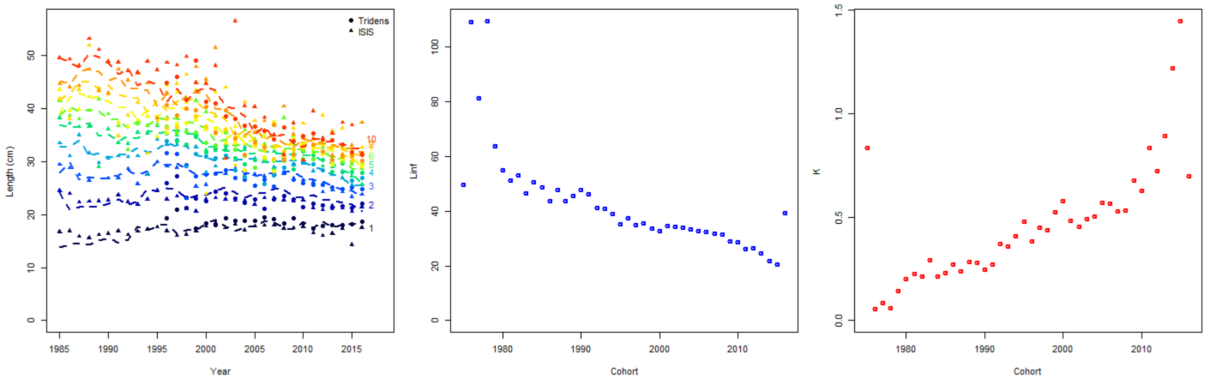


Fig 3. Allowing for Linf and K estimates per cohort (results in estimates of decreasing Linf, with decreasing K (Figure xxxx). This model has a reduced nll of 1358.5 (85 df)). The first and last observations are uncertain because of limited information on growth for those cohorts.

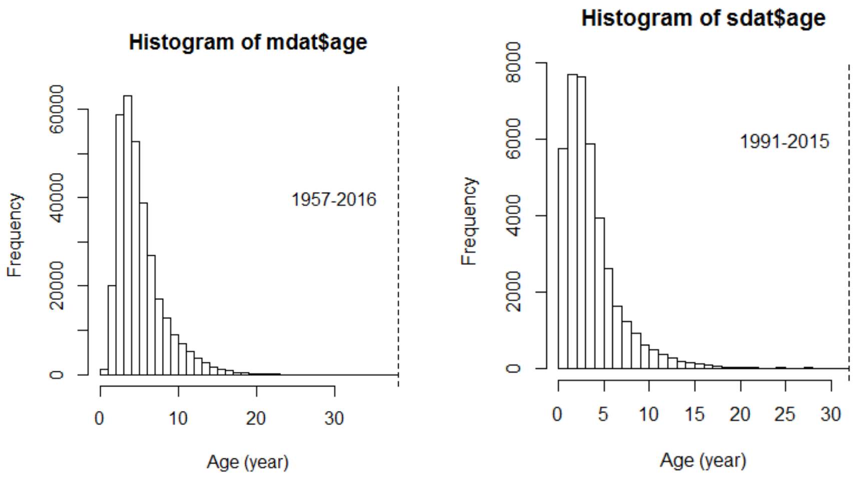


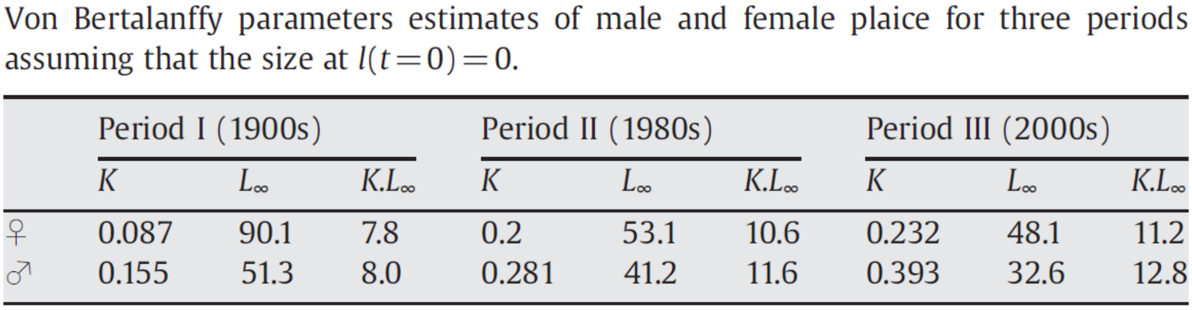
Fig 4. Histograms of ages in Dutch market sampling program samples (left panel) and survey age samples. Time span for samples in top right of each panel. Max observed ages are indicated by vertical dashed line (38 years for market samples and 31 years for survey age samples). Estimated M values based on these would be (4.3/38=) 0.11 and (4.3/31=) 0.14 for market samples and survey samples, respectively.

8.7 Tables

Table 1. Natural mortality (M, y-1), sex (S, M: male; F: female; C: combined), source of *M* estimate, average annual ambient temperature (τ, °C), body length of fish for which *M* was estimated (L, cm), von Bertalanffy growth parameters (L∞ (cm) and K(y-1)) and source of von Bertalanffy growth parameters. Data for plaice, taken from Gislason *et al.* (2010).

M	Sex	Source of M	τ	L	L∞	K	Source of L∞ and K
0.20	C	Siddeek(1989)	12	36.3	46	0.26	Basimi & Grove(1985)
0.14	M	Beverton(1964)	7	31.2	45	0.15	Beverton & Holt(1959)
0.08	F	Beverton(1964)	7	40.5	70	0.08	Beverton & Holt(1959)

Table 2 (from van Walraven et al. 2010)



Von Bertalanffy parameters estimates of male and female plaice for three periods assuming that the size at $l(t=0)=0$.

	Period I (1900s)			Period II (1980s)			Period III (2000s)		
	K	L_∞	$K.L_\infty$	K	L_∞	$K.L_\infty$	K	L_∞	$K.L_\infty$
♀	0.087	90.1	7.8	0.2	53.1	10.6	0.232	48.1	11.2
♂	0.155	51.3	8.0	0.281	41.2	11.6	0.393	32.6	12.8

Table 3. Average length (cm) by age estimates from BTS ISIS survey (for sexes combined)

Year	Age								
	1	2	3	4	5	6	7	8	9	10
1985	16.8	24.5	29.4	33.4	38.3	41.5	43.6	41.9	44.6	49.6
1986	16.9	23.9	28.8	31.1	37.2	38.7	39.7	38.1	44.1	49.3
1987	15.9	22.3	27.5	35.0	36.6	38.0	39.9	43.6	44.3	48.1
1988	15.6	22.5	26.4	31.6	36.6	39.6	42.2	51.9	47.4	53.2
1989	16.2	22.6	29.0	29.7	29.0	41.8	43.2	43.8	43.4	51.1
1990	16.4	22.7	26.8	30.7	36.1	39.0	43.1	42.8	42.9	49.0
1991	16.9	23.7	26.9	31.1	33.5	36.7	37.4	34.8	47.4	48.8
1992	16.2	22.4	28.6	30.9	33.4	32.3	36.7	38.8	45.3	47.2
1993	16.8	21.9	25.8	31.1	35.5	37.0	37.8	41.1	46.6	46.8
1994	17.2	22.9	27.7	27.6	35.2	36.8	38.6	31.5	44.8	48.9
1995	17.6	24.6	30.0	34.1	36.7	37.0	34.7	37.7	38.3	47.3
1996	16.9	22.9	29.2	33.2	36.3	38.4	44.4	36.3	42.9	48.6
1997	16.0	23.4	28.9	33.2	35.0	38.3	43.0	44.7		48.2
1998	16.3	21.1	23.1	29.1	35.9	41.9	41.1	46.4	39.8	49.8
1999	16.9	20.7	25.3	32.7	35.2	41.5	43.2	43.5	47.9	44.9
2000	17.8	22.9	25.6	28.0	32.2	39.4	24.0	44.9	45.5	44.7
2001	18.5	23.1	27.7	29.1	32.1	38.6	43.1	38.6	51.5	48.1
2002	17.5	22.9	27.7	30.6	32.5	35.9	36.1	44.0		30.6
2003	18.2	22.7	28.6	30.2	33.1	34.5	36.7	29.3	35.3	56.5
2004	17.1	22.7	27.7	32.7	32.3	35.9	33.4	41.2		40.5
2005	17.8	21.9	27.6	30.6	36.7	34.2	36.7	37.7	35.5	40.3
2006	18.0	23.1	27.3	30.2	32.7	33.4	35.1	35.8	37.7	38.3
2007	17.9	23.2	27.6	29.0	31.8	32.7	37.4	32.8	37.0	35.0
2008	17.4	22.8	27.8	31.0	30.6	38.3	36.4	31.0	40.5	31.3
2009	17.5	22.6	26.8	29.3	33.3	34.9	34.5	36.3	35.2	37.2
2010	17.7	22.7	26.5	29.7	30.2	31.9	34.4	37.2	32.8	30.2
2011	16.5	21.3	26.1	28.2	30.7	31.5	32.4	34.2	34.4	39.5
2012	16.1	20.9	24.3	28.3	29.1	32.7	33.9	38.7	34.5	34.4
2013	16.4	21.6	24.6	27.5	29.0	30.9	35.4	35.8	31.1	35.3
2014	17.4	21.2	24.3	27.0	28.0	29.9	33.1	36.3	31.4	37.4
2015	14.3	20.6	23.3	25.5	27.3	29.6	32.5	30.1	33.1	36.8
2016	17.5	21.5	23.8	25.6	25.7	28.6	29.0	32.6	37.4	31.5

Table 4. Average length (cm) by age estimates from BTS Tridens survey (for sexes combined)

Year	Age									
	1	2	3	4	5	6	7	8	9	10
1996	19.3	25.9	31.6	33.9	35.3	36.7	35.5	38.0	40.6	44.9
1997	20.9	27.2	31.5	34.0	33.8	35.5	37.1	36.4	38.8	46.1
1998	21.2	23.2	29.3	33.0	33.2	35.7	37.3	40.0	40.1	41.6
1999	17.4	23.1	27.2	31.4	34.7	35.5	37.9	38.5	39.6	49.0
2000	18.3	22.5	27.6	30.9	31.9	33.6	36.2	36.7	40.3	41.2
2001	18.1	24.4	27.7	30.7	32.4	33.0	36.3	35.3	35.6	40.9
2002	19.3	24.0	28.4	31.2	33.1	35.5	33.6	36.0	39.7	38.6
2003	18.8	23.1	27.0	28.3	30.7	32.2	33.6	34.5	34.3	38.2
2004	18.8	22.2	26.6	27.1	29.5	31.2	28.4	34.8	31.2	36.9
2005	18.9	22.8	25.4	28.9	30.4	28.8	32.9	33.2	33.8	36.6
2006	19.5	21.1	26.6	25.7	30.2	30.5	30.8	32.1	32.8	35.8
2007	19.1	22.8	25.3	27.4	28.5	30.2	28.2	30.5	37.0	34.3
2008	18.4	23.6	27.9	28.8	31.9	30.2	31.0	32.0	30.3	36.5
2009	19.4	23.0	26.6	29.4	28.5	31.4	30.7	32.3	31.3	33.8
2010	18.3	21.4	26.0	30.0	32.0	30.5	33.3	32.6	34.6	34.9
2011	17.3	22.0	25.6	29.5	31.3	30.5	32.8	33.1	33.2	35.3
2012	17.9	21.7	25.6	28.4	30.4	31.4	31.5	33.2	32.0	34.2
2013	18.0	21.2	25.2	28.0	28.1	29.6	29.5	32.8	30.4	34.1
2014	18.0	21.6	24.7	28.0	29.6	29.9	30.5	32.6	31.0	33.3
2015	18.3	21.2	25.1	26.4	28.1	30.0	31.4	30.9	31.2	31.7
2016	18.6	22.1	24.8	26.9	27.9	29.4	29.3	31.7	30.2	31.3

Table 5. Standard errors (cm) of lengths estimated in BTS ISIS

Year	Age									
	1	2	3	4	5	6	7	8	9	10
1985	1.7	1.8	1.7	1.9	1.8	1.6	1.9	3.6	1.6	3.7
1986	1.5	2.0	2.0	2.1	1.6	2.6	2.4	1.6	3.2	3.8
1987	1.6	1.9	2.9	2.3	2.8	2.2	1.6	5.0	3.5	3.4
1988	1.1	1.3	1.8	2.1	2.5	4.4	0.8	0.5	3.4	4.1
1989	1.7	2.5	2.0	2.2	4.4	2.7	4.2	2.1	4.3	1.8
1990	1.7	2.3	1.5	1.3	1.9	1.6	1.2	3.2	4.2	5.4
1991	1.5	1.9	2.5	2.3	2.1	2.4	2.1	2.4	2.2	3.2
1992	2.0	2.2	1.6	2.3	2.4	3.9	6.6	4.4	1.3	3.2
1993	1.7	2.0	2.1	1.6	2.2	1.6	3.9	3.2	1.7	2.4
1994	1.9	2.5	1.6	3.8	1.8	2.1	2.3	8.5	2.8	2.0
1995	2.2	1.9	1.1	2.4	2.3	2.4	5.0	5.3	1.9	2.4
1996	1.7	2.0	2.1	2.1	2.6	2.4	1.2	5.8	0.8	5.1
1997	1.5	2.9	2.5	1.6	3.6	2.2	2.8	7.3		0.9
1998	1.1	1.5	3.5	5.7	3.0	0.8	0.5	1.9	2.6	5.8
1999	1.0	1.6	1.5	2.4	2.7	1.7	3.2	0.0	0.5	1.2
2000	1.3	1.4	1.9	3.1	3.9	3.9	5.6	2.4	0.0	4.0
2001	1.6	1.4	1.6	1.4	1.8	2.7	1.1	2.1	0.0	2.4
2002	1.2	1.9	1.2	1.4	1.6	1.9	1.7	6.3		6.3
2003	2.4	1.0	1.6	1.5	2.1	3.0	3.0	1.6	10.1	0.0
2004	1.5	2.8	1.5	1.8	2.4	4.5	3.1	6.0		0.0
2005	1.2	1.5	1.6	1.5	2.7	2.6	3.5	4.1	3.5	2.9
2006	1.7	1.7	1.5	1.9	1.8	2.1	2.6	0.9	3.5	4.8
2007	1.2	1.8	1.7	2.1	2.1	2.9	4.5	5.5	3.5	5.8
2008	1.2	1.6	0.9	1.7	2.1	2.1	4.6	5.3	7.1	2.9
2009	1.4	1.5	2.0	2.9	2.3	2.1	2.1	3.4	6.9	5.3
2010	1.1	1.2	2.1	2.1	5.4	3.3	2.3	0.7	3.2	6.9
2011	1.1	1.2	1.4	1.9	1.5	3.3	3.3	2.8	3.3	6.6
2012	1.7	1.0	1.4	2.3	3.0	2.6	3.2	4.4	4.2	3.7
2013	1.6	1.4	1.0	1.8	1.8	1.9	3.4	4.0	6.4	2.5
2014	1.0	1.3	0.7	1.4	1.6	2.8	3.7	3.5	5.8	3.7
2015	3.1	1.3	1.6	1.9	1.8	2.0	2.7	2.3	3.6	4.9
2016	1.0	1.3	1.2	1.8	2.0	2.6	2.5	4.4	3.0	4.7

Table 6. Standard errors (cm) for lengths BTS TRI

Year	**Age**									
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
1996	1.0	1.9	1.9	2.4	3.2	3.5	2.5	3.4	2.5	4.0
1997	1.2	2.5	1.6	2.6	2.9	3.1	2.6	2.9	2.8	5.6
1998	2.3	1.9	3.6	3.9	3.8	4.7	3.9	5.5	3.2	4.1
1999	1.7	2.1	2.4	3.5	3.1	3.5	4.2	3.7	4.2	3.7
2000	0.9	2.6	2.3	2.2	3.4	3.1	3.7	5.2	3.9	7.6
2001	1.4	1.9	2.3	2.1	2.5	2.8	4.0	3.3	3.9	4.1
2002	1.4	1.6	2.9	2.3	2.6	2.6	3.3	3.3	5.3	5.2
2003	0.8	2.1	3.7	3.8	3.9	3.2	3.7	2.9	3.2	7.0
2004	1.2	2.9	2.7	4.0	3.3	4.7	5.2	5.0	4.3	3.8
2005	1.1	1.9	3.0	3.3	4.6	3.8	2.9	4.1	3.5	3.6
2006	2.3	3.0	3.2	3.5	3.4	3.9	3.3	3.9	3.3	4.5
2007	1.3	2.9	3.6	4.1	4.6	3.7	5.3	2.4	5.3	3.5
2008	0.7	1.7	2.3	3.7	3.4	4.9	3.8	3.5	5.1	3.9
2009	1.7	2.5	3.4	4.2	4.5	4.6	3.8	5.2	4.8	4.4
2010	0.6	2.8	3.5	4.0	4.7	5.6	5.8	4.4	4.5	6.4
2011	0.8	1.9	2.4	2.3	2.8	4.0	3.7	4.6	5.1	4.3
2012	0.9	1.5	2.3	2.4	3.0	3.9	4.4	5.8	5.3	4.6
2013	1.2	1.7	1.7	2.4	3.0	3.3	3.9	3.5	4.7	3.8
2014	0.8	1.6	2.2	2.3	2.2	2.7	2.6	3.6	3.1	3.8
2015	2.2	1.6	1.4	1.8	2.8	3.1	3.0	3.3	4.2	3.9
2016	1.2	2.0	1.9	2.3	2.7	3.2	3.9	3.1	3.5	4.6

Table 7. Estimated M values using Gislason (2010), and Linf and K as sloping function of cohort

	age									
year	1	2	3	4	5	6	7	8	9	10
1985	1.345	0.720	0.530	0.424	0.336	0.289	0.261	0.273	0.240	0.198
1986	1.342	0.760	0.557	0.485	0.357	0.330	0.310	0.325	0.252	0.205
1987	1.509	0.859	0.607	0.406	0.373	0.345	0.314	0.267	0.255	0.218
1988	1.561	0.858	0.655	0.486	0.378	0.328	0.292	0.205	0.234	0.190
1989	1.492	0.863	0.570	0.542	0.557	0.306	0.286	0.274	0.274	0.207
1990	1.465	0.862	0.653	0.521	0.396	0.346	0.291	0.290	0.284	0.226
1991	1.404	0.809	0.655	0.515	0.451	0.386	0.371	0.410	0.246	0.231
1992	1.521	0.894	0.599	0.525	0.458	0.480	0.387	0.349	0.268	0.248
1993	1.432	0.930	0.712	0.525	0.420	0.389	0.372	0.322	0.260	0.254
1994	1.383	0.875	0.641	0.639	0.428	0.396	0.363	0.499	0.280	0.240
1995	1.342	0.781	0.566	0.457	0.403	0.395	0.435	0.378	0.365	0.256
1996	1.288	0.793	0.556	0.471	0.423	0.390	0.350	0.390	0.320	0.264
1997	1.247	0.749	0.564	0.472	0.453	0.403	0.351	0.341	0.364	0.264
1998	1.217	0.932	0.709	0.538	0.451	0.373	0.366	0.311	0.350	0.279
1999	1.403	0.950	0.708	0.512	0.445	0.380	0.348	0.340	0.304	0.270
2000	1.289	0.895	0.693	0.588	0.513	0.415	0.565	0.345	0.316	0.313
2001	1.263	0.830	0.650	0.574	0.508	0.429	0.362	0.406	0.310	0.298
2002	1.248	0.847	0.636	0.546	0.495	0.431	0.447	0.358	0.361	0.449
2003	1.233	0.878	0.644	0.593	0.517	0.481	0.443	0.517	0.448	0.272
2004	1.289	0.903	0.667	0.573	0.544	0.477	0.545	0.390	0.534	0.378
2005	1.237	0.902	0.691	0.576	0.475	0.527	0.450	0.437	0.453	0.382
2006	1.187	0.916	0.670	0.634	0.526	0.514	0.490	0.467	0.441	0.406
2007	1.203	0.855	0.687	0.622	0.561	0.526	0.492	0.523	0.407	0.453
2008	1.263	0.839	0.628	0.564	0.528	0.458	0.471	0.527	0.437	0.469
2009	1.191	0.856	0.666	0.577	0.535	0.480	0.496	0.458	0.483	0.434
2010	1.229	0.895	0.680	0.558	0.525	0.526	0.464	0.443	0.471	0.499
2011	1.341	0.913	0.693	0.584	0.525	0.529	0.489	0.469	0.467	0.398
2012	1.323	0.928	0.727	0.597	0.558	0.498	0.485	0.419	0.478	0.456
2013	1.283	0.911	0.721	0.612	0.590	0.542	0.488	0.449	0.539	0.446
2014	1.207	0.901	0.732	0.615	0.576	0.548	0.499	0.442	0.523	0.431
2015	1.361	0.925	0.738	0.666	0.608	0.546	0.493	0.536	0.496	0.449
2016	1.135	0.853	0.725	0.648	0.633	0.564	0.566	0.487	0.454	0.514

Table 8. Estimated M values using Gislason (2010), and Linf and K per cohort

age										
year	1	2	3	4	5	6	7	8	9	10
1985	1.119	0.739	0.485	0.400	0.319	0.246	0.201	0.201	0.186	0.746
1986	1.138	0.632	0.572	0.445	0.337	0.313	0.264	0.251	0.185	0.158
1987	1.267	0.728	0.505	0.417	0.342	0.326	0.298	0.227	0.196	0.161
1988	1.289	0.721	0.555	0.404	0.388	0.301	0.275	0.195	0.199	0.146
1989	1.279	0.713	0.479	0.459	0.463	0.314	0.262	0.259	0.260	0.176
1990	1.310	0.739	0.539	0.438	0.336	0.288	0.299	0.266	0.268	0.214
1991	1.167	0.724	0.561	0.426	0.379	0.327	0.308	0.421	0.225	0.218
1992	1.317	0.743	0.536	0.450	0.379	0.403	0.328	0.290	0.275	0.227
1993	1.451	0.805	0.591	0.469	0.360	0.322	0.312	0.273	0.216	0.261
1994	1.337	0.886	0.555	0.531	0.383	0.339	0.300	0.419	0.238	0.200
1995	1.367	0.755	0.573	0.396	0.335	0.353	0.373	0.313	0.307	0.217
1996	1.332	0.807	0.537	0.477	0.366	0.324	0.313	0.335	0.265	0.222
1997	1.119	0.775	0.574	0.457	0.459	0.349	0.291	0.305	0.312	0.218
1998	1.152	0.836	0.733	0.548	0.436	0.378	0.317	0.258	0.313	0.239
1999	1.331	0.900	0.635	0.529	0.453	0.367	0.353	0.294	0.253	0.241
2000	1.357	0.849	0.656	0.527	0.531	0.423	0.546	0.349	0.274	0.260
2001	1.420	0.874	0.617	0.543	0.455	0.443	0.369	0.392	0.314	0.258
2002	1.260	0.952	0.670	0.518	0.468	0.387	0.463	0.364	0.349	0.455
2003	1.166	0.887	0.724	0.624	0.491	0.455	0.398	0.535	0.456	0.263
2004	1.301	0.854	0.674	0.644	0.573	0.453	0.516	0.350	0.552	0.385
2005	1.264	0.911	0.654	0.582	0.535	0.555	0.427	0.414	0.406	0.395
2006	1.333	0.936	0.676	0.599	0.531	0.578	0.516	0.443	0.418	0.364
2007	1.341	0.961	0.702	0.628	0.530	0.532	0.553	0.550	0.387	0.429
2008	1.294	0.935	0.706	0.576	0.533	0.433	0.476	0.592	0.461	0.445
2009	1.211	0.877	0.743	0.648	0.546	0.484	0.469	0.462	0.543	0.457
2010	1.430	0.910	0.697	0.622	0.590	0.537	0.468	0.419	0.476	0.561
2011	1.439	1.062	0.704	0.599	0.585	0.594	0.500	0.473	0.442	0.402
2012	1.661	0.996	0.845	0.607	0.571	0.555	0.545	0.428	0.483	0.431
2013	1.442	1.144	0.774	0.712	0.600	0.555	0.544	0.505	0.550	0.450
2014	1.516	1.012	0.919	0.660	0.670	0.557	0.511	0.493	0.587	0.440
2015	1.984	1.161	0.830	0.837	0.652	0.635	0.501	0.549	0.553	0.505
2016	1.825	1.244	0.911	0.728	0.794	0.605	0.659	0.495	0.465	0.573

8.8 References

Basimi, R.A., and Grove, D.J. (1985) Studies on feeding, growth and production of a recruited inshore population of Pleuronectes platessa (L.) at East Anglesey, North Wales. Journal of Fish Biology 27, 765-783.

Beverton, R.J.H. (1964) Differential catchability of male and female plaice in the North Sea and its effect on estimates of stock abundance. Rapport et Procès-verbaux des Réunions Conseil Permanent International pour l' Exploration de la Mer 155, 103-112.

Beverton, R.J.H., and Holt, S.J. (1959) A review of the lifespans and mortality rates of fish in nature, and their relation to growth and other physiological characteristics. CIBA Foundation Colloquia on Ageing 5, 142-180.

Siddeek, M.S.M. (1989). The estimation of natural mortality in Irish Sea plaice, *Pleuronectes platessa* L., using tagging methods. Journal of Fish Biology 35, 145-154.

van Walraven, L., Mollet, F.M., van Damme, C.J.G., Rijnsdorp, A.D. (2010) Fisheries-induced evolution in growth, maturation and reproductive investment of the sexually dimorphic North Sea plaice (Pleuronectes platessa L.) Journal of Sea Research 64, 85-93.

8.9 Appendix A: R code

```
library(gplots)

ldat <- read.csv("w:/IMARES/Data/ICES-
WG/WKNSEA/2017/PLE4/WD_natmor_including_from_bts_ple4/bts_index_and_lengths.csv",na.strings = ".")
ldat$cohort <- ldat$year - ldat$age

cols <- rich.colors(10)
par(mfcol=c(1,1), mar=c(4.5,4.1,2.1,1.1))

plot(x=ldat[ldat$age==1,]$year,y=ldat[ldat$age==1,]$mean_len, xlim=c(min(ldat$year), 2018),
ylim=c(0,max(ldat$mean_len,na.rm=T)),pch=16+(ldat[ldat$age==1,]$ship=="Isis"), col=cols[1],xlab="Year",
ylab="Length (cm)")
for(aa in 1:10){
  points(x=ldat[ldat$age==aa,]$year,y=ldat[ldat$age==aa,]$mean_len,
  pch=16+(ldat[ldat$age==1,]$ship=="Isis"), col=cols[aa])
  text(x=2017,y=mean(ldat[ldat$age==aa & ldat$year > 2006 ,]$mean_len), aa, col=cols[aa] )
  lines(x=aggregate(ldat[ldat$age==aa  ,]$mean_len,by=list("year" =ldat[ldat$age==aa  ,]$year),
  "mean")$year,y=aggregate(ldat[ldat$age==aa  ,]$mean_len,by=list("year" =ldat[ldat$age==aa  ,]$year),
  "mean")$x, col=cols[aa], lty=2, lwd=2 )
}
legend("topright", c( "Tridens", "ISIS"), pch=c(16,17), bty="n")

#################################################################
# Estimate Linf and K (assuming L0=0) fixed in time
#################################################################

nll <- function(parms){
 EL <<- parms[1] * (1- exp(-parms[2]* (ldat$age +0.5)))
 nll <- -sum(dnorm(ldat$mean_len,EL,exp(parms[3]), TRUE), na.rm=T)
 return (nll)
}

parms <- c(40,0.55, -1)
print(res <- optim(parms, nll, method="BFGS", control=list("maxit"=10000)))

ldat$EL <- EL

plot(x=ldat[ldat$age==1,]$year,y=ldat[ldat$age==1,]$mean_len, xlim=c(min(ldat$year), 2018),
ylim=c(0,max(ldat$mean_len,na.rm=T)),pch=16+(ldat[ldat$age==1,]$ship=="Isis"), col=cols[1],xlab="Year",
ylab="Length (cm)")
for(aa in 1:10){
  points(x=ldat[ldat$age==aa,]$year,y=ldat[ldat$age==aa,]$mean_len,
  pch=16+(ldat[ldat$age==1,]$ship=="Isis"), col=cols[aa])
  text(x=2017,y=mean(ldat[ldat$age==aa & ldat$year > 2006 ,]$mean_len), aa, col=cols[aa] )
  lines(x=ldat[ldat$age==aa  ,]$year,y=ldat[ldat$age==aa  ,]$EL, col=cols[aa], lty=2, lwd=2 )
}
text(x=2012,y=5, paste0("Linf = ",round(res$par[1],1),"; K = ", round(res$par[2],3)), col="black" )

legend("topright", c( "Tridens", "ISIS"), pch=c(16,17), bty="n")

#################################################################
# Estimate Linf (with slope) and K (with slope) (assuming L0=0) fixed in time
#################################################################

nll <- function(parms){
  EL <<- (parms[1] + parms[2]*ldat$cohort) * (1- exp(-(parms[3] + parms[4]/2000 *ldat$cohort )*(ldat$age
+ 0.5)))
  nll <- -sum(dnorm(ldat$mean_len,EL,exp(parms[5]), TRUE), na.rm=T)
  return (nll)
}

parms <- c(832.55,-0.396,0.3, 0.00001, 1.197)
print(res <- optim(parms, nll, method="BFGS", control=list("maxit"=10000)))

ldat$EL <- EL

par(mfcol=c(1,3), mar=c(4.5,4.1,2.1,1.1))

plot(x=ldat[ldat$age==1,]$year,y=ldat[ldat$age==1,]$mean_len, xlim=c(min(ldat$year), 2018),
ylim=c(0,max(ldat$mean_len,na.rm=T)),pch=16+(ldat[ldat$age==1,]$ship=="Isis"), col=cols[1],xlab="Year",
ylab="Length (cm)")
for(aa in 1:10){
  points(x=ldat[ldat$age==aa,]$year,y=ldat[ldat$age==aa,]$mean_len,
  pch=16+(ldat[ldat$age==1,]$ship=="Isis"), col=cols[aa])
  text(x=2017,y=mean(ldat[ldat$age==aa & ldat$year > 2006 ,]$mean_len), aa, col=cols[aa] )
  lines(x=ldat[ldat$age==aa  ,]$year,y=ldat[ldat$age==aa  ,]$EL, col=cols[aa], lty=2, lwd=2 )
}
legend("topright", c( "Tridens", "ISIS"), pch=c(16,17), bty="n")

#################################################################
# plot estimated K and Linf over time
#################################################################
ldat$Linf <- res$par[1] + res$par[2]*ldat$cohort
```

```
ldat$K    <- res$par[3] + res$par[4]/2000 *ldat$cohort
plot(x=ldat$cohort, y=ldat$Linf, ylim=c(0,max(ldat$Linf)), type="l", lwd=2, col= "blue", xlab="Cohort",
ylab="Linf")
plot(x=ldat$cohort, y=ldat$K, lwd=2, col= "red",ylim=c(0,max(ldat$K)), type="l", xlab="Cohort", ylab="K")

##############################################################
# Estimate M   (from sloping Linf  and K ) (assuming L0=0)
##############################################################

Mres <- aggregate(cbind(Linf,K,mean_len)~year+ age, data=ldat, FUN="mean")
Mres$M <-  round(exp(0.55 -  1.61 *log(Mres$mean_len) + 1.44 *log(Mres$Linf) + log(Mres$K)),3)

reshape(Mres[,c("age","year","M")],
        timevar = "age",
        idvar = c("year"),
        direction = "wide")

##############################################################
# Estimate Linf (for each cohort) and K (for each cohort) (assuming L0=0)
##############################################################

nll <- function(parms){
 EL <<- parms[paste("Linf",ldat$cohort)] * (1- exp(-( parms[paste("K",ldat$cohort)] )*(ldat$age +0.5)))
 nll <- -sum(dnorm(ldat$mean_len,EL,exp(parms["logsigma"]), TRUE), na.rm=T)
 return (nll)
}

parms <- c(rep(40,length(unique(ldat$cohort))), rep(0.3,length(unique(ldat$cohort))), 1.197)
names(parms) <-  c(paste("Linf",unique(ldat$cohort)),paste("K",unique(ldat$cohort)),"logsigma")
print(res <- optim(parms, nll, method="BFGS", control=list("maxit"=10000)))

ldat$EL <- EL

plot(x=ldat[ldat$age==1,]$year,y=ldat[ldat$age==1,]$mean_len, xlim=c(min(ldat$year), 2018),
ylim=c(0,max(ldat$mean_len,na.rm=T)),pch=16+(ldat[ldat$age==1,]$ship=="Isis"), col=cols[1],xlab="Year",
ylab="Length (cm)")
for(aa in 1:10){
 points(x=ldat[ldat$age==aa,]$year,y=ldat[ldat$age==aa,]$mean_len,
 pch=16+(ldat[ldat$age==1,]$ship=="Isis"), col=cols[aa])
 text(x=2017,y=mean(ldat[ldat$age==aa & ldat$year > 2006 ,]$mean_len), aa, col=cols[aa] )
 lines(x=ldat[ldat$age==aa  ,]$year,y=ldat[ldat$age==aa  ,]$EL, col=cols[aa], lty=2, lwd=2 )
}
legend("topright", c( "Tridens", "ISIS"), pch=c(16,17), bty="n")

ldat$Linf <- res$par[paste("Linf",ldat$cohort)]
ldat$K    <- res$par[paste("K",ldat$cohort)]
plot(x=ldat$cohort, y=ldat$Linf, ylim=c(0,max(ldat$Linf)), type="p", lwd=2, col= "blue", xlab="Cohort",
ylab="Linf")
plot(x=ldat$cohort, y=ldat$K, lwd=2, col= "red",ylim=c(0,max(ldat$K)), type="p", xlab="Cohort", ylab="K")

################################################################
# Estimate M   (fromLinf for each cohort slope and K for each cohort) (assuming L0=0)
##############################################################

Mres <- aggregate(cbind(Linf,K,mean_len)~year+ age, data=ldat, FUN="mean")
Mres$M <-  round(exp(0.55 -  1.61 *log(Mres$mean_len) + 1.44 *log(Mres$Linf) + log(Mres$K)),3)

reshape(Mres[,c("age","year","M")],
     timevar = "age",
     idvar = c("year"),
     direction = "wide")
```

Working Document 2: Survey indices available for plaice in area 4 and 3a

Introduction

Several survey time series exist which might be useful for the North Sea plaice stock assessment model to be used as tuning indices. The two most important surveys for demersal fish species in the North Sea area are the Beam Trawl Surveys (BTS, 3rd Quarter) and the International Bottom Trawl Survey (IBTS, 1st and 3rd Quarter).

Historically the North Sea plaice stock was assessed as a single stock unit in area IV. For this stock unit the longest and most appropriate index time series come from the RV Isis beam trawl survey covering the south eastern North Sea (1985-today, Figure 1). Since 1996 the beam trawl survey with RV Tridens was started covering the more northern and western areas of the North Sea up to 58.5°N (Figure 1). Besides these two survey indices a third Dutch survey index from the Sole Net Survey (SNS), a coastal survey covering the German Bight and especially designed for sole, were used as tuning indices for the plaice assessment. Since 2013 the RV Isis and the RV Tridens indices were combined and used as a single survey index (ICES WKFLAT 2009; ICES WGNSSK, 2013). Recently, problems occurred with the Sole Net Survey index showing strong residual patterns (ICES WGNSSK, 2015). This problem was solved by dividing this index into two time periods. Besides the Dutch survey time series there exist also a Belgian, U.K. and a German beam trawl survey data. The Belgian and U.K. beam trawl surveys cover additional parts of area IVc and IVb. The German beam trawl survey started to survey the area west of Jutland since 1994 (Area IVb). This survey overlaps with some of the area covered by RV Isis and RV Tridens but it also adds some areas to the survey area. However, the latter surveys were not used for the plaice assessment until today. There are mainly two reasons for this: (i) The beam trawl surveys are not fully standardized between nations and different gears and riggings are in use. Further, the spatial overlap differs and there is only limited overlap to directly compare between hauls of different surveys in area IV. Therefore the creation of a single survey index might not be straightforward. (ii) The Belgian and German data are only available for the more recent years via the DATRAS data portal and/or became just recently available.

The formerly separated plaice stocks of area IV (North Sea) and IIIaN (Skagerrak) were combined and assessed as a single stock unit since 2015 (WGNSSK, 2015; WKPLE, 2015). The beam trawl surveys do not provide any information for area IIIaN, but the International Bottom Trawl Survey (IBTS, Figure 2) covers area IV and IIIaN in a standardized way in quarter 1 (since 1983) and quarter 3 (since 1991). However, plaice was historically not one of the main target species of these surveys and biological data (age, weight) were not taken in a consistent way in area IV before 2007. But in recent years plaice was sampled more regularly and consistent on the IBTS (Q1 and Q3). Further, in general there is a good coverage of sampling for area IIIa for most years of the time series. Therefore, the IBTS is potentially a suitable survey for the estimation of an abundance index covering the North Sea and the Skagerrak (Ulrich et al., 2017). However, it should be investigated if it is suitable to borrow age-length-keys for that cases were data gaps occur, especially when only data from area IIIa are available, or if there is a substantial difference in plaice growth patterns between area IV and IIIa.

The purpose of this working document is to:

- Evaluate the use of German beam trawl survey data and construct an age based abundance index from these data. Compare this index with the existing indices (Dutch RV Isis, Dutch RV Tridens, combined Dutch).

Evaluate the combination of ISIS, TRIDENS (Dutch beam trawl) and SOLEA (German beam trawl) survey data applying a GAM modelling approach (Berg et al., 2014) in order to construct a single beam trawl survey index covering most of area IVb and IVc.

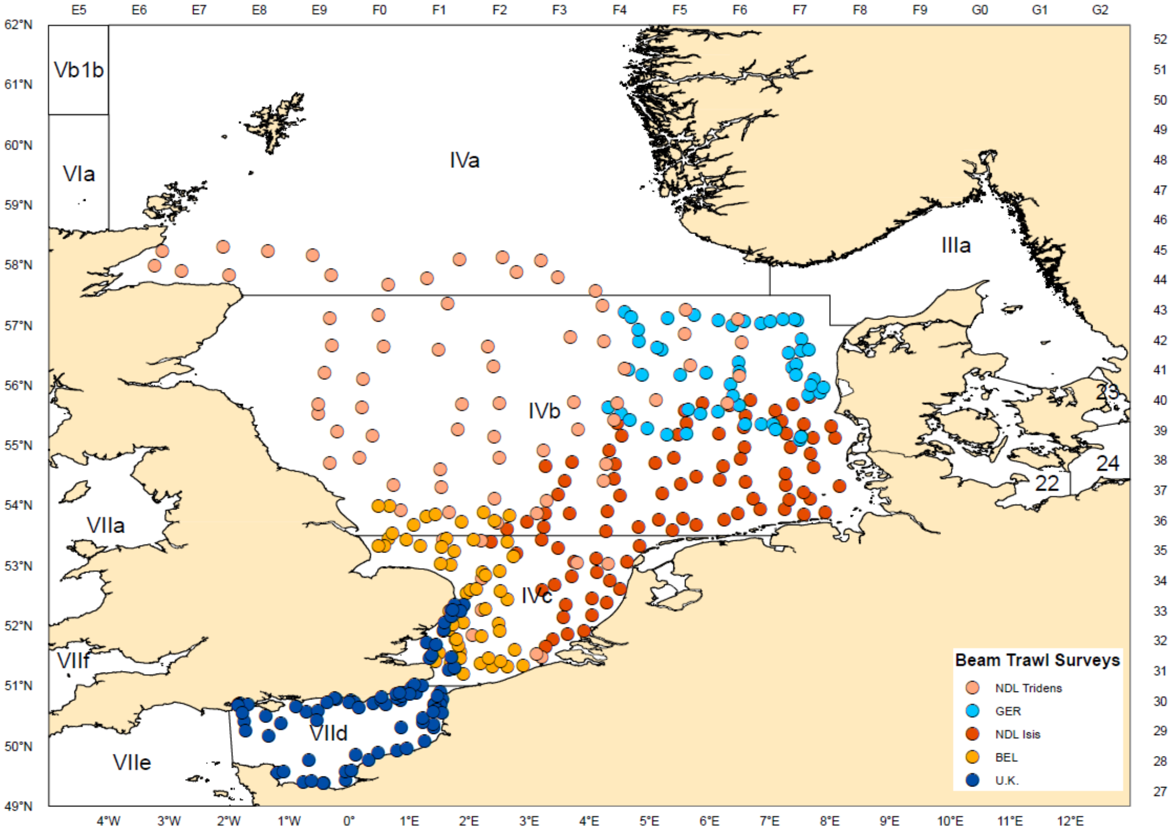


Figure 1: Spatial coverage of the different off shore beam trawl surveys in the North Sea (3^{rd} Quarter). Displayed are exemplarily the realized stations from 2012.

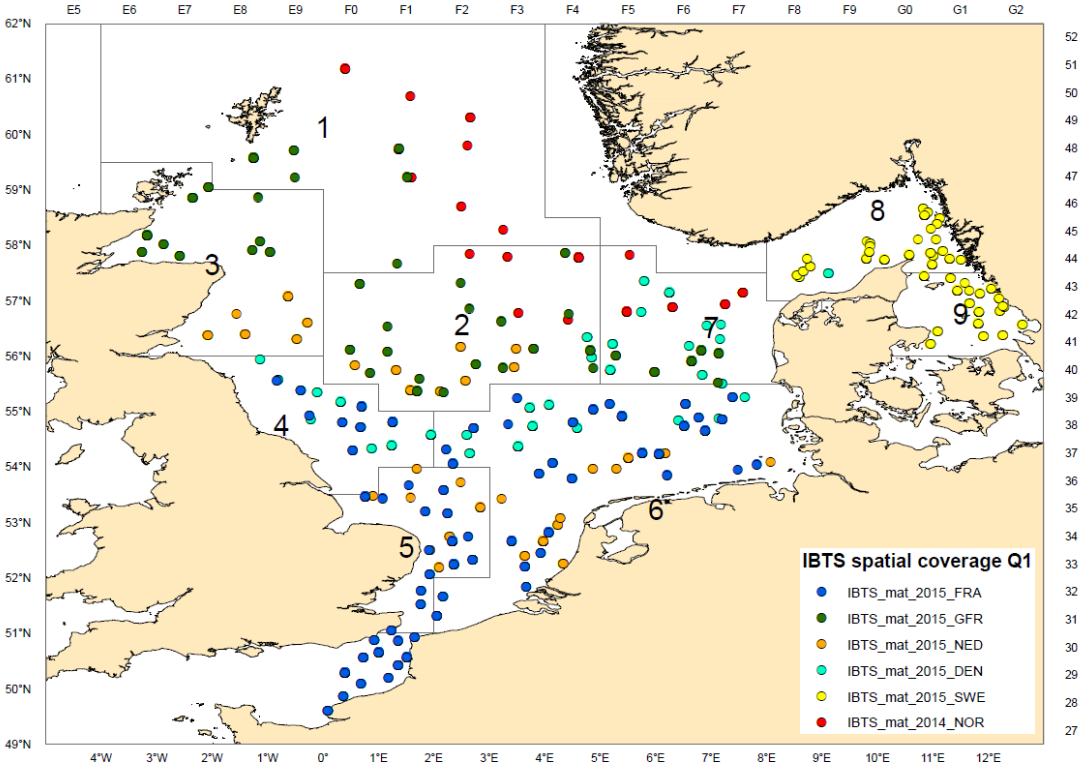


Figure 2: Spatial coverage of the IBTS (1st quarter) and stratification by roundfish areas. Displayed are stations from 2015 where plaice age and maturity data were collected.

Currently used tuning indices for plaice in area IV and IIIaN

The following part is taken from the most recent report of the Working Group on the Assessments of Demersal Stocks in the North Sea and Skagerrak (WGNSSK, ICES, 2016):

“Three survey indices are used as tuning indices, as decided during an Inter Benchmark Protocol, in March 2013 (Miller and Coers 2013). For some additional explanation, see also the WGNSSK report of 2013 (ICES 2013). This year, the SNS survey was split into two timeseries.

Table 8.2.10 and Figure 8.2.5 show the index values for the years that they are used in the assessment:

Beam Trawl Survey combined for RV Tridens and ISIS (BTS-combined); (1996–2015)

Beam Trawl Survey RV Isis (BTS–Isis) for the older part of the time series; (1985–1995)

Sole Net Survey 1 (SNS1); (1982–1999)

Sole Net Survey 2 (SNS2); (2000–2015)

Of the BTS-combined survey index, ages 1–9 are used for tuning the North Sea plaice assessment. Of the BTS-Isis older survey index, ages 1–8 are used. And of the Sole Net Survey (SNS1 & SNS2) ages 1–3 are used in the assessment, while the 0-group index is used in the RCT3 analysis for recent recruitment estimates. The internal consistency of the survey indices used for tuning appears relatively high for the Beam trawl surveys, but low for the SNS surveys (Figures 8.2.6–8.2.8).

Since 2011 there is an annual survey of plaice and sole using commercial vessels and gears (Reijden *et al.* 2016). This survey takes place in the same season as the BTS surveys. Length structured catch per unit effort estimates and age-length keys are collected during this survey.

An additional survey index is used for recruitment estimates in the RCT3 analysis (Table 8.5.1):

Demersal Fish Survey (DFS) age-0

Several commercial LPUE series consisting of an effort series and landings-at-age series are available for usage as tuning fleets. These include time series for the Dutch beam trawl fleet and the UK beam trawl fleet (excluding all flag vessels). Because WKFLAT 2009 recommended to exclude LPUE series from the final assessment run upon which management advice is based, they have not been included in the assessment."

The German beam trawl index for plaice

Data from the German beam trawl survey (3rd quarter) are available in the DATRAS data portal for the years 2002-2005 and 2007 – 2016. Data from the earlier years are available at the national institute but have to be further checked for consistency and errors before an upload into DATRAS would make sense. The age based index estimated with the German data shows in general a quite good internal consistency for most of the age classes (Figure 3). Compared to the existing tuning time series the German index displays similar trends for the single age classes (Figure 4), only for the older age classes (≥7 yrs) larger discrepancies are visible. The use of this index as an additional separate tuning index in the assessment model will be tested.

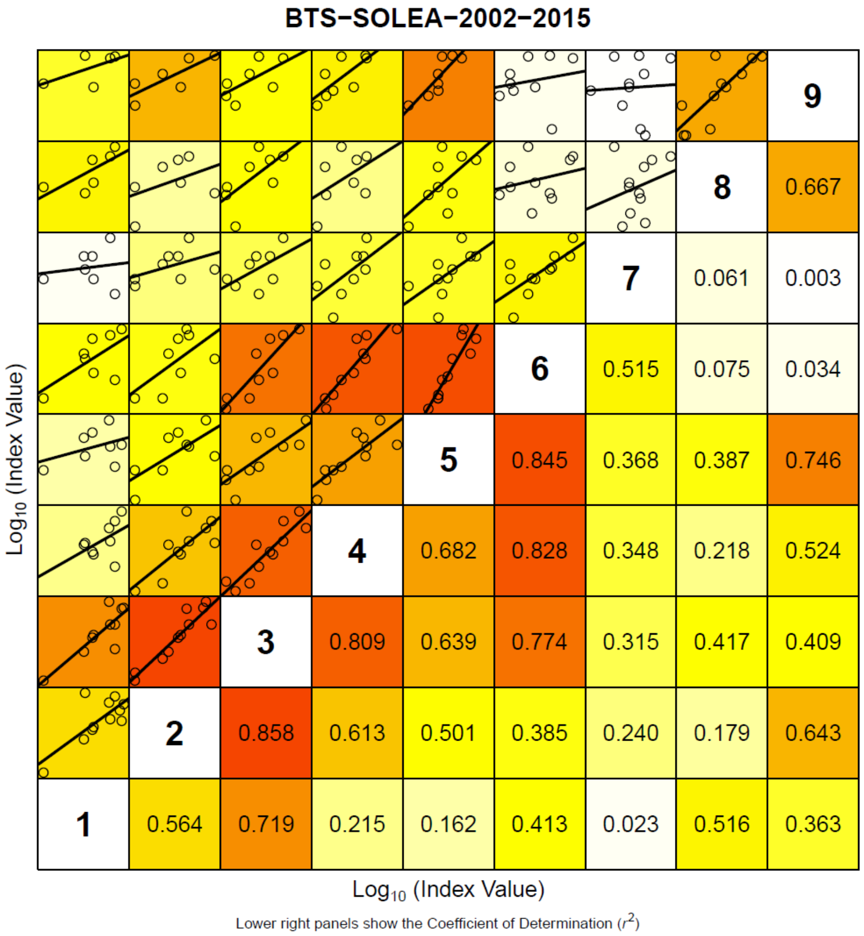


Figure 3: Internal consistency plot for the German beam trawl index for plaice 2002-2015.

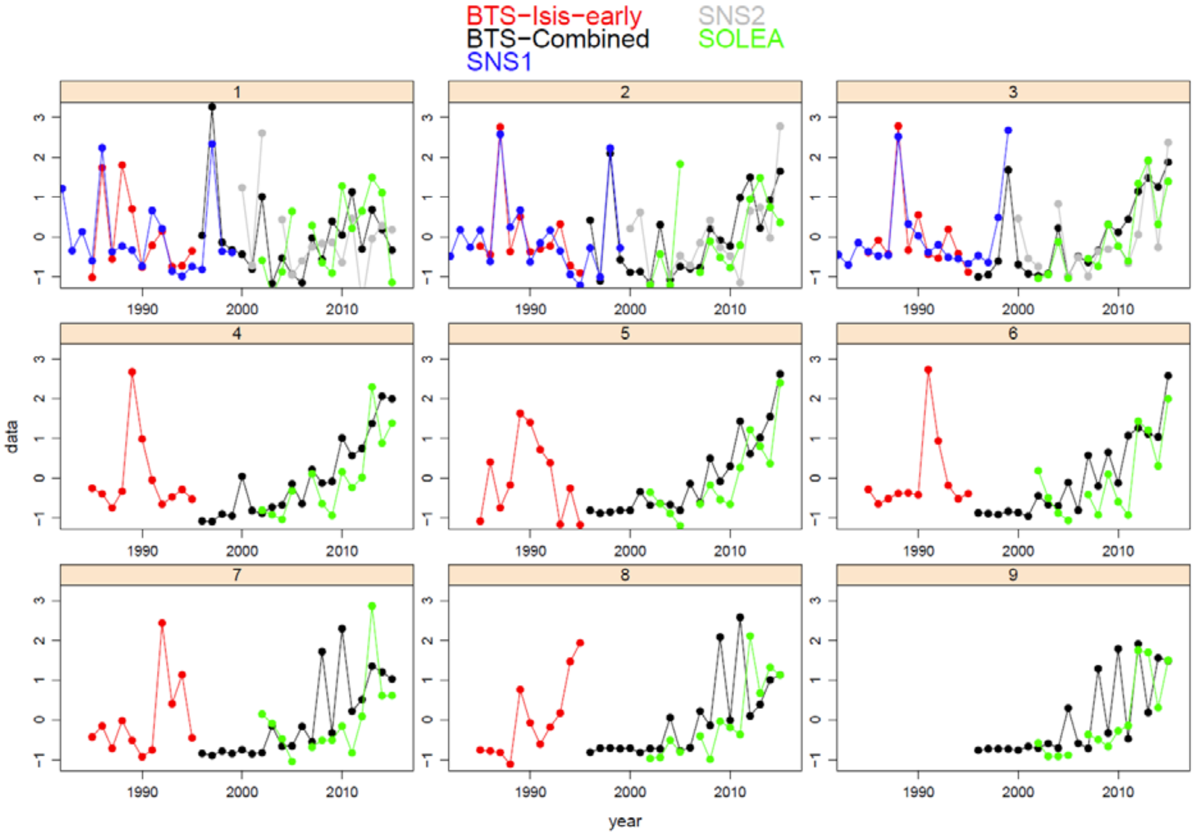


Figure 4: The currently used tuning indices by age groups compared to the German (SOLEA, green) beam trawl index.

Combined BTS indices

Since 2013 a combined beam trawl survey index is used in the North Sea plaice assessment (ICES WKFLAT 2009; ICES WGNSSK 2013) combining data from the RV Isis and the RV Tridens survey. Before that, both surveys were used as separate time series. The internal consistency of this combined index is in general high for all age groups (Figure 5). However, there is still information from other beam trawl surveys which is not included into the assessment but could potentially be useful because the spatial coverage would be increased and for some areas information from more hauls would be included. Figure 6 displays the internal consistency of a combined index created with the GAM model approach by Berg et al. (2014) using the same data as for the currently used combined index (RV Isis and RV Tridens). The internal consistency of this index is not as high as for the old combined index (Figure 5). However, the internal consistency of a combined BTS taking into account also the German time series (2002 – 2015) is higher compared to the time series using only the Dutch BTS data (Figure 7 and Figure 8). The trends of both indices are similar with some smoother trends for the older age groups (i.e. age 7 and age 8) for the GAM index (Figure 9). The use of the combined GAM index in the assessment model will be tested.

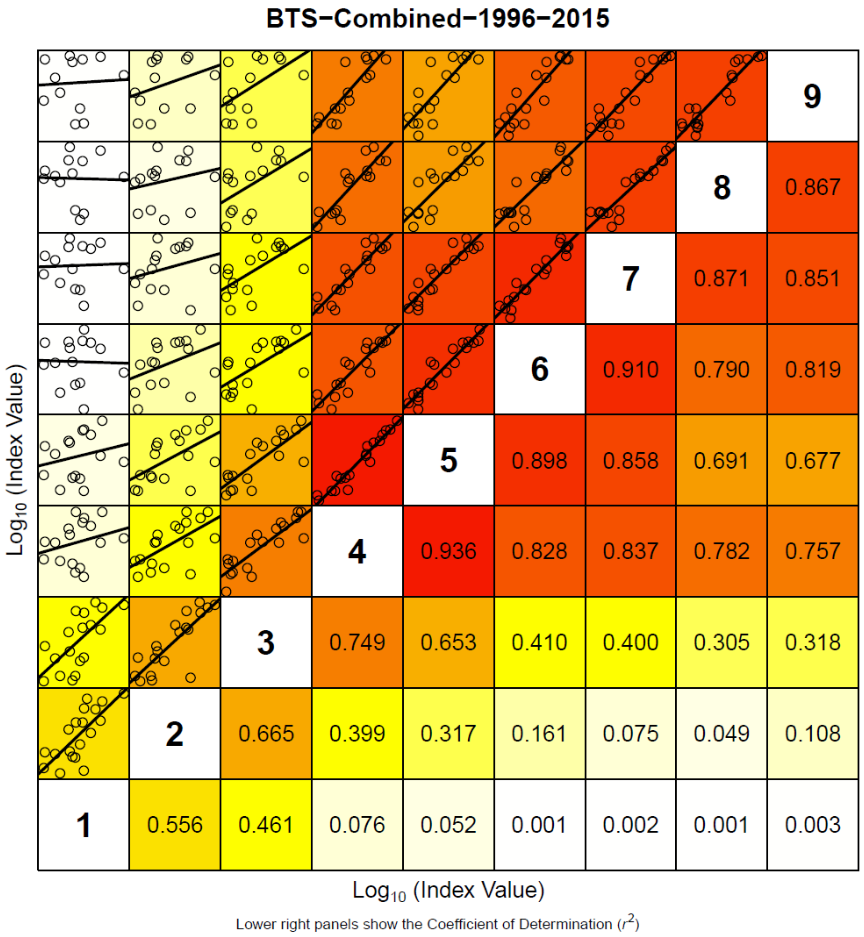


Figure 5: Internal consistency plot of the combined Dutch BTS survey index (RV Isis, RV Tridens) as it is used currently in the plaice assessment model (ICES WGNSSK, 2016).

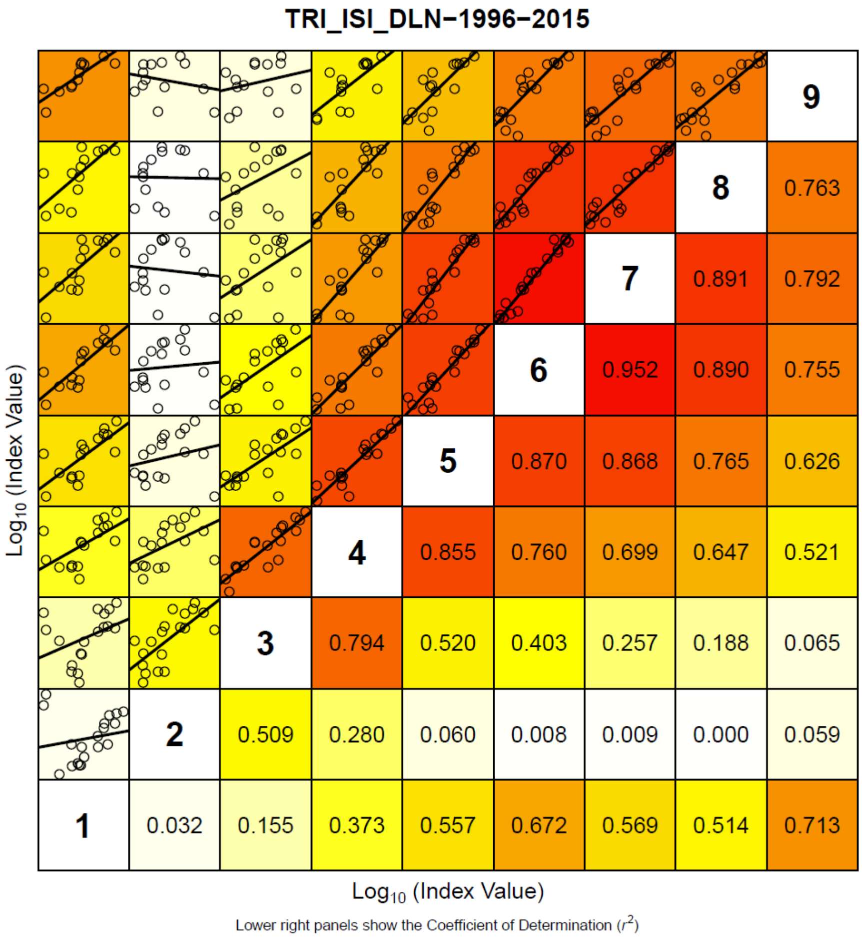


Figure 6: Internal consistency plot of the combined Dutch BTS survey index (RV Isis, RV Tridens) obtained by the GAM modelling approach (Berg et al., 2014).

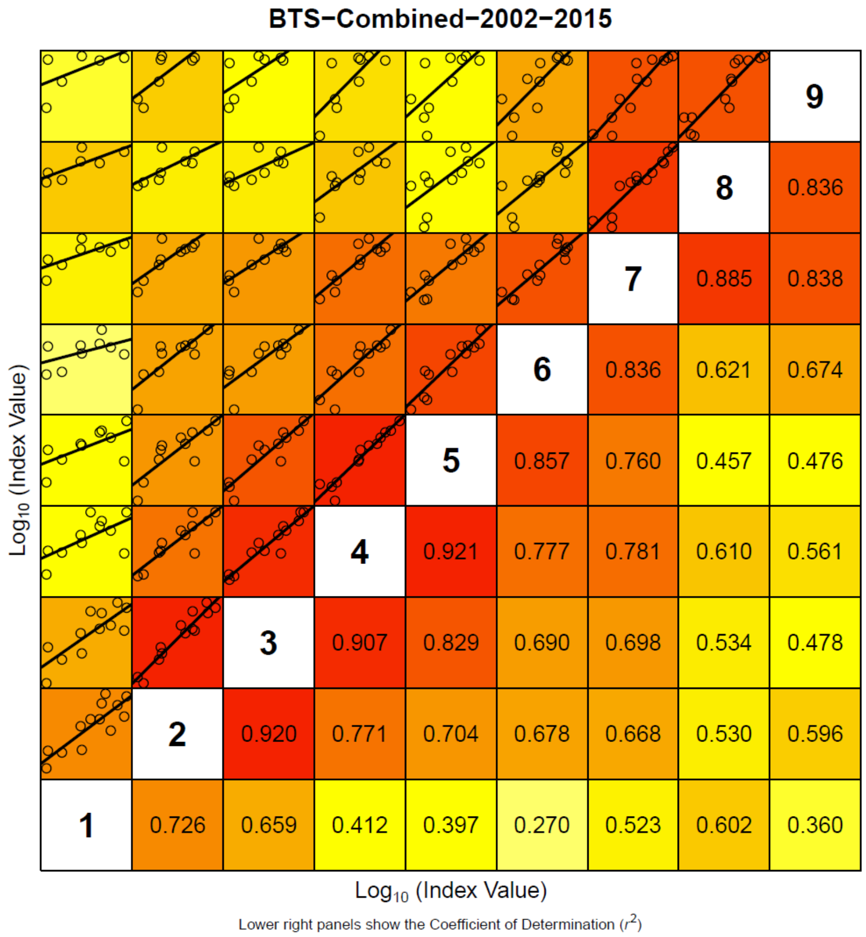


Figure 7: Internal consistency plot of Dutch BTS survey indices (RV Isisi, RV Tridens) for a shorter time period.

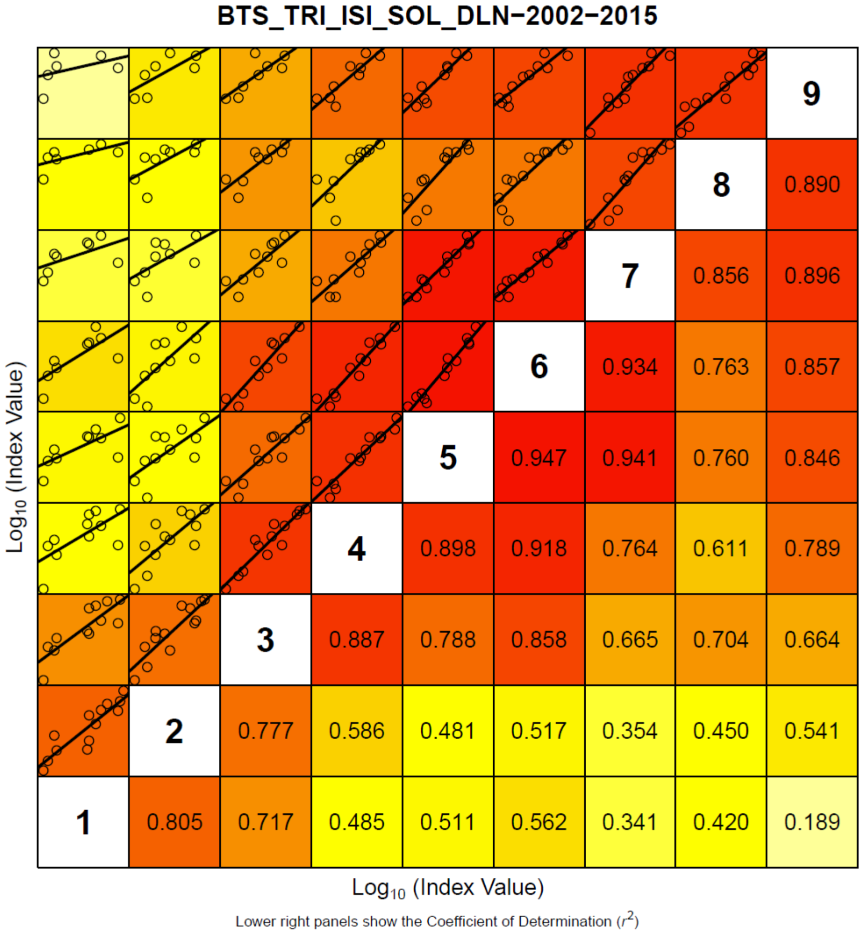


Figure 8: Internal consistency plot of a new combined BTS survey index applying a GAM model approach and taking into account data from RV Isis, RV Tridens, and RV Solea.

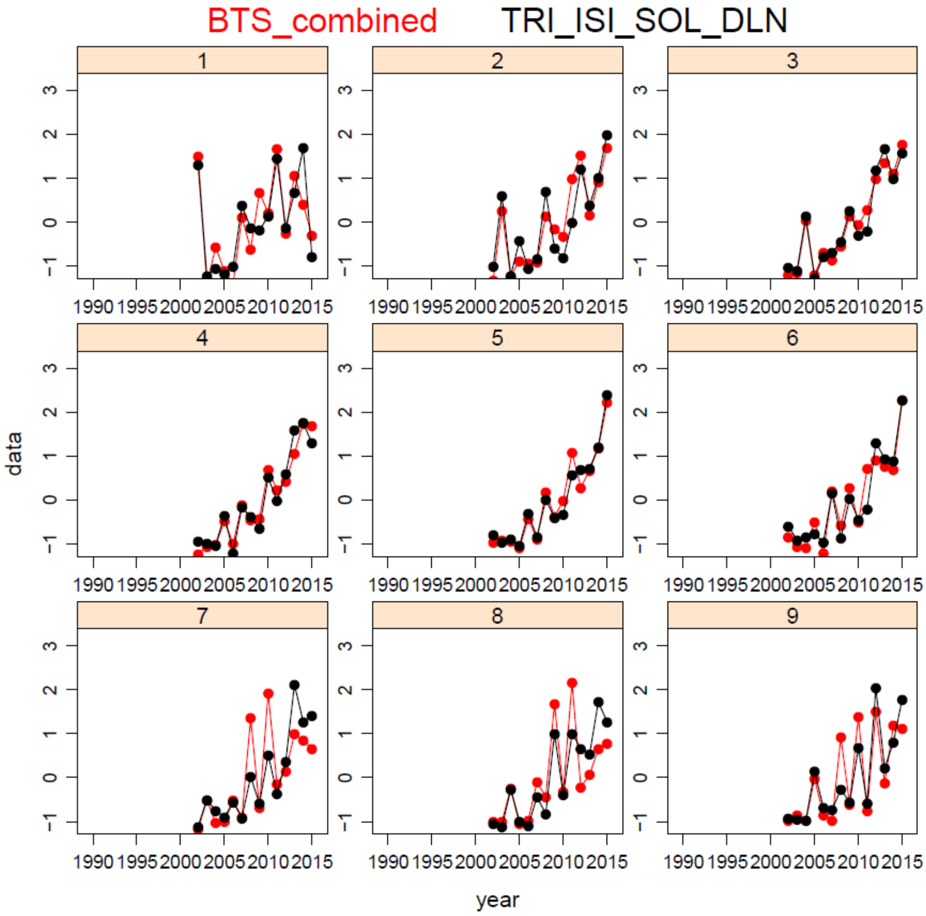


Figure 9: Comparison between the currently used combined BTS (red lines and dots) and the new combined BTS index (black lines and sots) for the years 2002-2015.

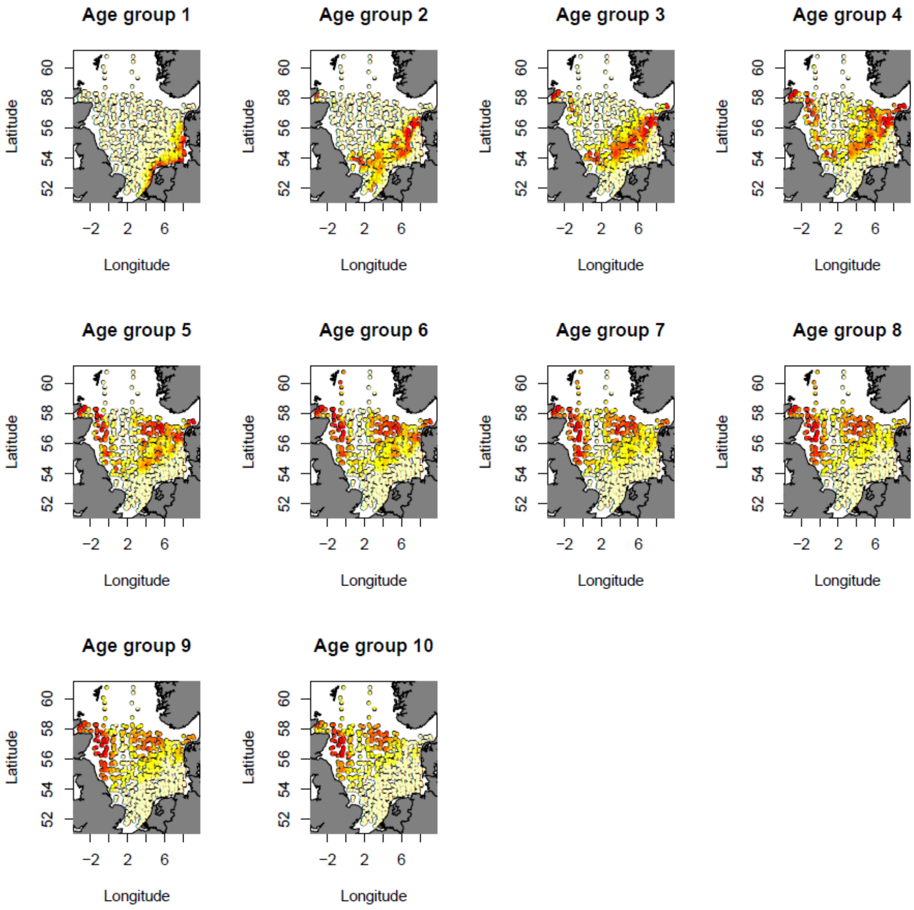


Figure 10: Spatial distribution of plaice age groups obtained by the combined GAM index 2002-2015.

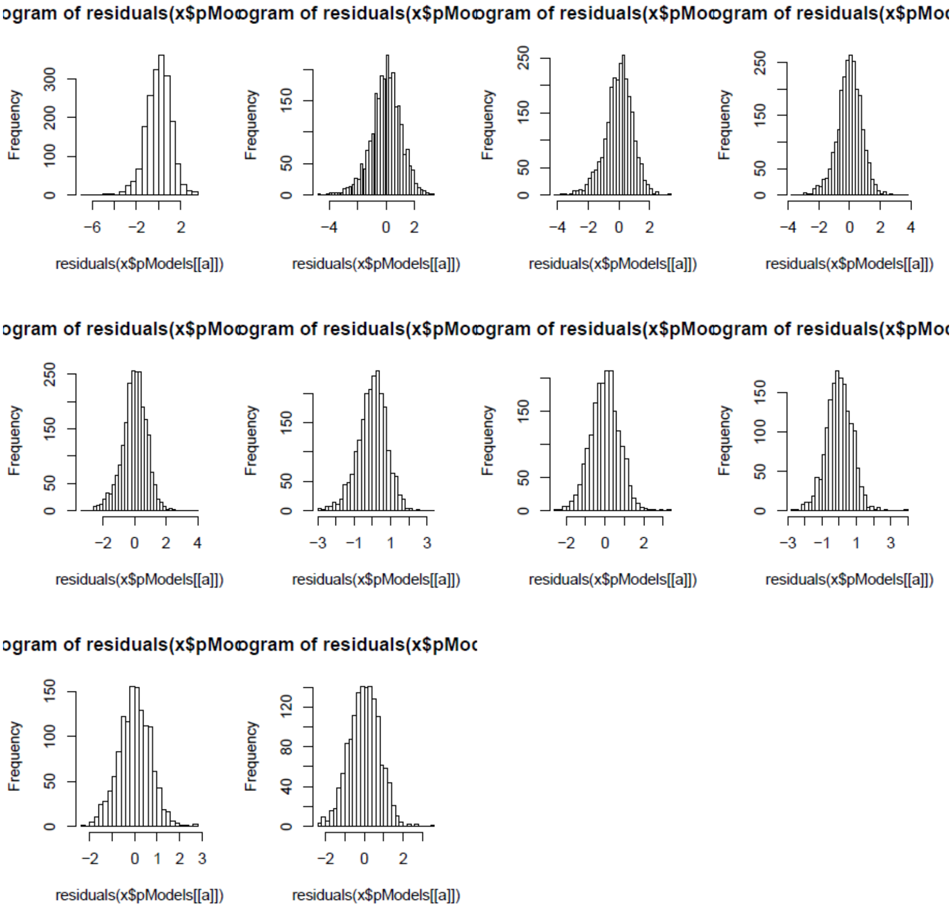


Figure 11: Residual distribution of the GAM index 2002-2015 by age group.

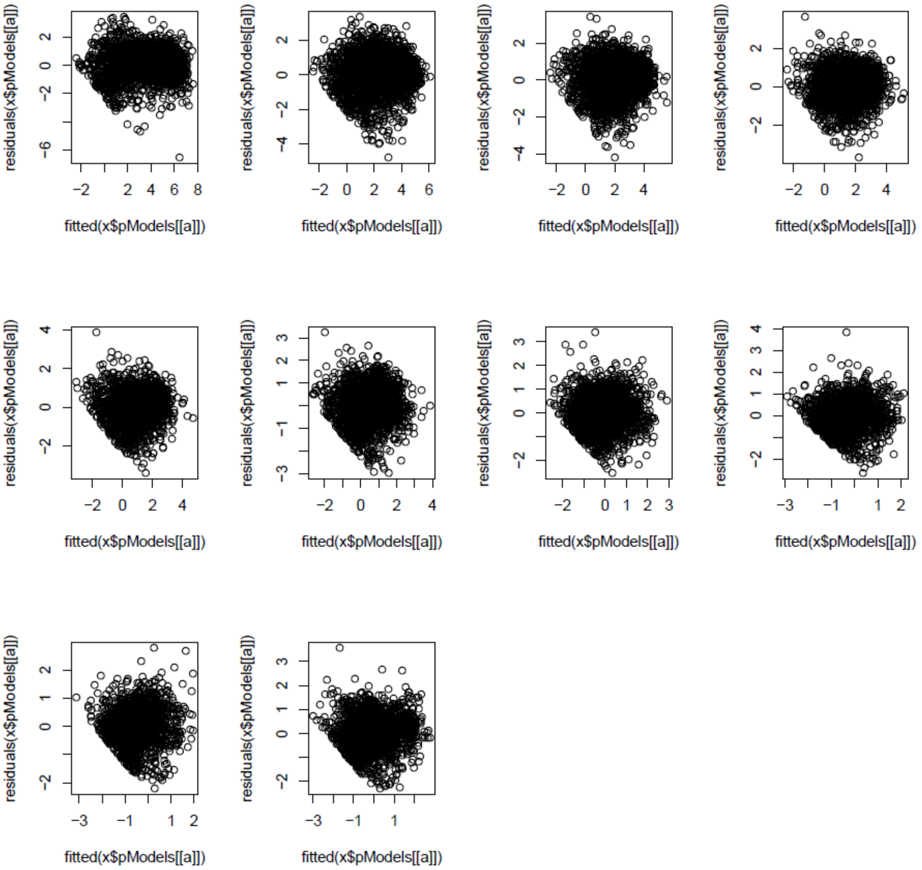


Figure 11: Residuals plotted against fitted values of the combined GAM index 2002 – 2015 by each age group.

IBTS index for plaice

Data from both IBTS surveys were used to estimate age based indices for plaice covering area IV and IIIa (Figure 13, Ulrich et al., 2017). The indices were calculated by applying the standard ICES methods (IBTS manual). The IBTS otolith sampling is stratified by the so called round fish areas (Figure 2). If age length keys are not available for one round fish area, then data from neighboring round fish areas are borrowed and applied to estimate the age based indices. An overview of the available age data from the IBTS per year, quarter and country and per year, quarter, and round fish area is given by Table 1 and Table 2, respectively. Table 1 shows that only Sweden collected plaice data for the whole time series during the 1st quarter IBTS and for most of the years during the 3rd quarter IBTS (since 1997). Denmark started to collect plaice data in 2002 (3rd quarter), and since 2003 regularly during both quarters. Also England collected quite a lot of data during the 3rd quarter survey since the beginning of the time series but with some gaps. Table 2 displays the coverage per round fish area for both surveys. For a number of years there are only data from round fish area 8 and 9 collected during the 1st quarter IBTS (1991, 1995-2000,2002). For the 3rd quarter IBTS there is in general a good sampling coverage of round fish areas since 1997. For the earlier years (1991-1996) there are no data for round fish areas 8 and 9. Further, there are obviously data gaps for the years 1995 and 2000 for the 3rd quarter IBTS with no data at all.

Growth curves for plaice separated by sex and comparing between round fish areas 2-7 and round fish area 8 show only slight differences (Figure 14). However, it still has to be tested if differences in growth between areas and years exist and if the borrowing of age length keys from different areas and/or years is suitable for calculating the IBTS indices, especially for the 1st quarter with less overall sampling coverage.

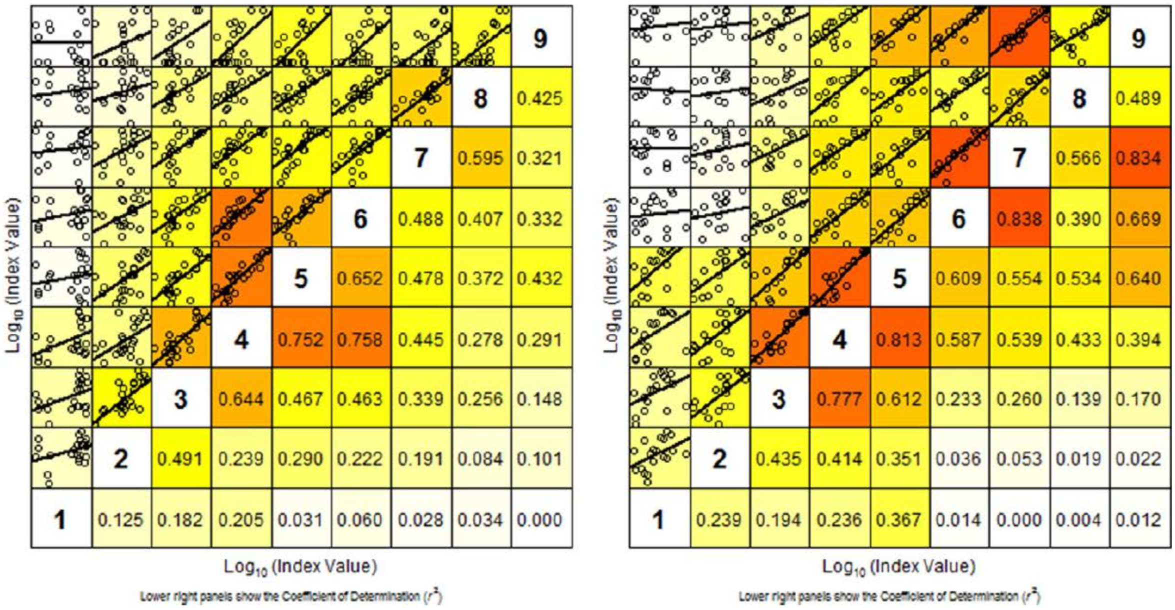


Figure 13: Internal consistency plot of IBTS first (left panel) and third (right panel) quarter for the combined North Sea and Skagerrak area (from Ulrich et al., 2017).

Table 1: Available plaice age readings per year, country and quarter from the IBTS.

	Quarter 1							Quarter 3			
	DEN	ENG	FRA	GFR	NED	NOR	SWE	DEN	ENG	GFR	SWE
1991							252		1001		
1992	273		337			74	514		363		
1993			511			25	687		259		
1994			343				662		265		
1995							696				
1996							733		309		
1997							958		533		563
1998							654		342		928
1999							1516		453		726
2000							1142				
2001		515					624		699		470
2002							607	544			457
2003	353						630	227			462
2004	327						709	432	698		611
2005	273						810	542	664		657
2006	446						756	755	820		750

2007	491			295	233		1050	807	899		748
2008	475				389		918	948	1226		768
2009	430		998		459		615	967	959		763
2010	589		1362	305	403	73	754		1057		682
2011	597		1284	296	402	51	512	866	1019		680
2012	571		907	619	419		729	896	1202	434	835
2013	576		819	322	342		624	905	1054	109	637
2014	658		807	309	649	14	653	864		307	810
2015	668		1019	320	454		821	695	1242	250	731
2016	646		388	225	380		676	600	3	212	446

Table 2: Available plaice age readings per year, roundfish area and quarter from the IBTS.

	Roundfish Area (Quarter 1)									**Roundfish Area (Quarter 3)**								
Year	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
1991								152	100	84	140	175	74	158	213	157		
1992	12	31		128	35	256	204	258	274	16	37	54	22	25	145	64		
1993	9			60	27	324	100	442	261	15	24	47	23	29	102	19		
1994				39	4	184	116	323	339	27	13	62	38	9	81	35		
1995								358	338									
1996								224	509	34	18	76	9	20	119	33		
1997								343	615	12	45	63	25	47	228	113	357	206
1998								343	311	9	12	37	12	14	140	118	494	434
1999								546	970	12	17	40	9	33	220	122	304	422
2000								573	569									
2001		7		39	51	418		274	350	26	46	171	20	47	244	145	196	274
2002								261	346		41	78	98	73	119	135	217	240
2003				90		155	108	271	359		21	11	65	2	68	60	218	244
2004				48		144	135	307	402	55	114	204	69	103	361	224	336	275
2005						142	131	434	376	63	143	148	70	138	370	215	441	275
2006				88		211	147	349	407	56	123	196	82	175	492	357	451	318
2007	58	7	106	103	33	505	207	528	489	85	176	196	126	235	514	274	515	300
2008		43	17	93	112	433	166	434	426	80	290	265	192	294	595	458	426	268
2009		71	60	126	480	787	363	269	346	48	195	250	99	261	566	430	475	285
2010	75	121	235	419	573	785	524	327	372	48	88	236	41	91	374	179	382	275
2011	97	164	231	354	528	773	483	216	296	59	249	257	171	335	478	336	430	250
2012	141	241	264	334	510	657	369	391	338	83	348	294	164	309	790	544	490	345
2013	40	189	122	164	534	677	320	340	284	87	337	308	184	288	442	422	394	243
2014	11	239	178	196	645	795	338	334	354	5	160	44	137	142	412	241	519	321
2015	33	241	254	215	646	742	298	466	387	85	355	329	99	194	647	411	446	352
2016	2	134	151	142	243	608	340	243	452	10	54	13	49	107	378	171	275	204

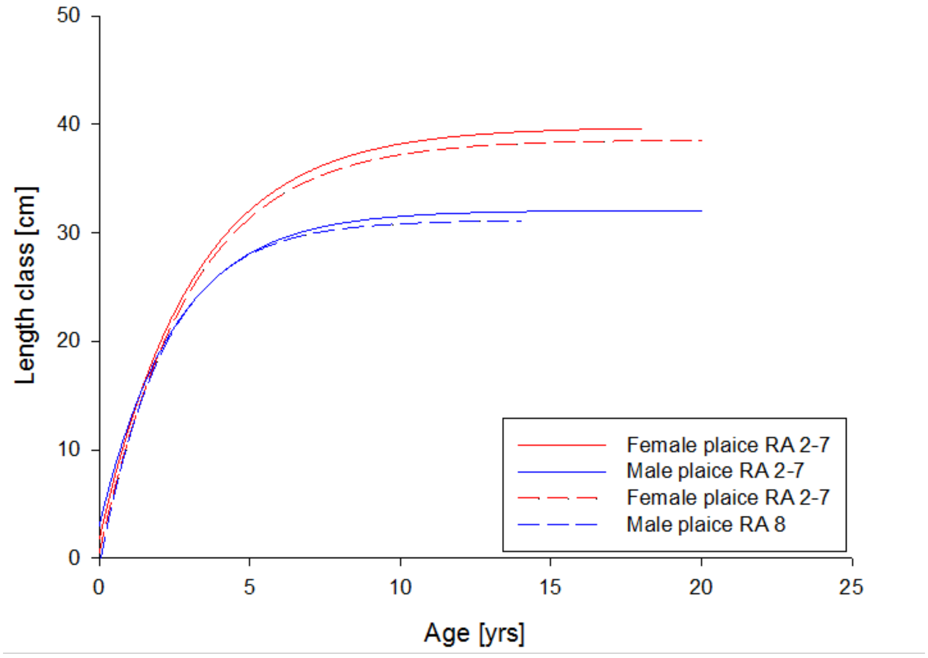


Figure 14: Sex separated plaice growth curves 2007-2015 for round fish area 2-7 and round fish area 8.

References

Berg, C., Nielsen, A., Christensen, K., 2014. Evaluation of alternative age-based methods for estimating relative abundance from survey data in relation to assessment models. Fisheries Research 151: 91-99.

ICES 2016, WGNSSK. Report of the Working Group on the Assessment of Demersal Stocks in the North Sea and Skagerrak. ICES CM 2016/ACOM:13.

ICES 2015, WGNSSK. Report of the Working Group on the Assessment of Demersal Stocks in the North Sea and Skagerrak. ICES CM 2015/ACOM:13.

ICES 2013, WGNSSK. Report of the Working Group on the Assessment of Demersal Stocks in the North Sea and Skagerrak. ICES CM 2013/ACOM:13.

ICES 2015, WKPLE. Report of the Benchmark Workshop on Plaice. ICES CM 2015/ACOM 33.

ICES 2009, WKFLAT. Report of the Benchmark and Data Compilation Workshop for Flatfish. ICES CM 2009/ACOM:31.

Ulrich, C., Hemmer-Hansen, J., Boje, J., Christensen, A., Hüssy, K., Sun, H.,Worsøe Clausen, L. 2017. Variability and connectivity of plaice populations from the Eastern North Sea to the Baltic Sea, part II. Biological evidence of population mixing. Journal of Sea Research 120: 13–23.

8 Working document 3: maturation plaice in 3a and 4

8.1 Table of contents

8.2 Introduction

The proportion of mature fish at age, often called the maturity ogive, is an important population attribute and it is used for estimating SSB in the stock assessment. For North Sea plaice, a fixed maturity ogive was employed in the current assessment model (Table 1). With the observed biological growth curve changes in plaice since 2010 and the large SSB, it is interesting to gain more insight into the maturity ogive for North Sea plaice (areas IV and IIIa) and to investigate its impact on SSB.

Table 1. North Sea plaice maturity ogive (ICES WGNSSK, 2016)

Age	1	2	3	4	5	6	7	8	9	10
maturity	0	0.5	0.5	1	1	1	1	1	1	1

8.3 Data

Three data sources were initially being considered: 1) NS-IBTS Q1 survey data, with available plaice age readings from 1991 to 2016; 2) Dutch commercial Q1 landing data, 1957-2015; 3) Dutch commercial Q1 discards data, 1999-2016. Given the extra-long time series, we expect to use Dutch commercial samples to provide the maturity ogive estimate for early years. The pre-processing and quality check of the data are presented in Appendix 1.

8.4 Dichotomous maturity definition:

We need to have a dichotomous maturity definition. So we merged the old 4scale/6scale scoring into the following 2 scales:

1. Immature: including *juvenile/immature*

2. Mature: including *maturing, spawning, spent,* and *resting/skip of spawning*
3. NA: including *abnormal*

8.5 Analysis

8.5.1 Why a model based method

An estimate of proportion of mature fishes at age (i.e. maturity@age) is required to be updated as the input of the stock assessment model. We could estimate maturity@age by simple averaging the yearly age samples, or apply statistical models. Applying statistical models gives the following advantages:

1. Age (maturity) sample is not a simple random sample of the fish population. In NS-IBTS, age samples are stratified by length (i.e. age n fishes per length class). In Dutch commercial sampling, age samples are stratified by size classes. Therefore, a simple average at age would give a biased estimate.
2. Model based estimation helps to adjust other factors (than age) that are associated with maturity, especially if these factors were not originally considered in the sampling design, for instance length, country, area.
3. Model based estimation helps to explain the mechanism of maturity changes with respect to other factors.

8.5.2 Data exploration and selection of covariates

Several covariates were first explored before including them in a full maturity model (Appendix 2).

- Due to biological reasons, maturity model is sex-specific (Rijnsdorp, 1989; Grift *et.al*, 2003; Rijnsdorp *et.al*, 2010)
- Since samples are stratified by length, length is included as a covariate. Additionally, after adjusting age, length shows a strong correlation with maturity ogive. Including length could also disentangle the gear effect where different gears catch fishes with different length ranges (now the maturity is estimated at given length, independent of what gear it is from).
- Country and area effect. In NS-IBTS, every country is sampling at specific areas, country could be a confounding factor with area. Therefore, to explore the country effect, we selected subset of NS-IBTS data of the same year and area, and applied a GLM to investigate the country effect. Similarly, to explore the area effect, we selected a subset of NS-IBTS data of the same year and same country, and applied a GLM to investigate the area effect (Appendix 2).Results show that RA8 exhibits a different maturity ogive than RA2-7 for fishes at same age, length and year. Additionally, countries score maturity differently for fishes at the same age and length, coming from the same year and area.
- The maturity score was also compared between Dutch NS-IBTS, Dutch landings and Dutch discards, on matched year, subarea (RA, rectangle) at given age and length. Unfortunately, inconsistencies were found among the three data sources. Dutch discards samples yield a strangely higher maturity ogive than NS-IBTS at shorter length. The discards samples were scored by two trained external fishermen. This could cause the observed high maturity ogive. As a result, we decide to exclude the discard samples from the following analysis. On the other hand, Dutch landing samples yield an overall lower maturity ogive than NS-IBTS. It is a strange finding since both samples were staged by the same observer. Possible explanation are 1) staging variability from very fresh samples (survey) and fresh samples (auction); 2) selectivity difference of immature/mature fishes between NS-IBTS and commercial beam trawler; 3) different time coverage, as the IBTS samples in the 2nd part of Q1, while the landings will also comprise of samples taken in January. Due to the unexplained observations, landing samples were not included in the following analysis.

8.5.3 Maturity model

Final decisions on data:

- Age plus group = 10 for both RA2-7 and RA8
- Exclude RA1, RA9, RA10; RA2-RA7 considered to be consistent; model RA8 separately
- Exclude NOR data(few samples)
- Covariates are: year, age, length and country (if multiple), model separately for RA8, RA2-7 and sex
- Do not use Dutch discards and landing samples
- Select data year 2010-2016 for area 2-7, data year 1991-2016 for area 8

8.5.3.1 RA8 1991–2016, country SWE

A GLM (or GAM) is applied per area (RA8 vs. RA2-7) and per sex, including covariates year, length, age, country and possible interactions (year-length, year-age, area-length, etc). The best fitted model with the minimum AIC was then selected. The best fitted model for RA8 is:

Area RA8:

glm(maturity ~ Year + length + Age, family=binomial, data=dat) , per sex (1)

or gam(maturity ~ s(Year) + length + Age, family=binomial, data=dat) , per sex

All terms were statistically significant at significance level 0.05. Due to the large sample size, a subtle difference among the levels of the covariates could lead to a “significant” result. Therefore, it is more interesting to check the actual maturity ogive differences estimated by the model, and to see whether it is biologically meaningful. Results are given in Figures 1-5.

8.5.3.2 RA2–7 2010–2016, country NED, DEN, GFR, FRA

The best fitted model for RA2-7 is:

Area RA2-7:

glm(maturity ~ Year + length + Age + Country, family=binomial, data=dat), per sex (2)

or gam(maturity ~ s(Year) + length + Age + Country, family=binomial, data=dat) , per sex

8.5.4 Methods in estimating maturity at age:

The maturity model estimates the probability of mature, given sex (=s), age (=a) and length (=l) of the fish, defined as Prob(M=1 |A=*a*, L=*l*, S=*s*), where M, A, L and S refer to maturity, age, length and sex.

The final output we need to estimate is Prob(M=1 |A=*a*)=Prob(M=1,Sex=Female |A=*a*)+ Prob(M=1,Sex=Male |A=*a*).

$$\begin{aligned}\mathrm{Prob}(M=1\,|A=a) &= \sum_{s=\{female,male\}}\sum_{l=lmin}^{lmax}\mathrm{Prob}(M=1\,|A=a,L=l,S=s)\cdot\mathrm{Prob}(L=l,S=s\,|A=a)\\ &= \sum_{s=\{female,male\}}\sum_{l=lmin}^{lmax}\mathrm{Prob}(M=1,L=l,S=s\,|A=a,)\end{aligned} \tag{3}$$

Therefore, to estimate $\mathrm{Prob}(M=1\,|A=a)$, we need to estimate the probability of length(=l) per sex, at given age, $\mathrm{Prob}(L=l,S=s\,|A=a)$. This probability can be derived from two terms as seen in (4) below, the left term is the probability of length(=l) at given age(=a) and the right term is the probability of sex(=s) at given length(=l):

$$\mathrm{Prob}(L=l,S=s\,|A=a)=\mathrm{Prob}(L=l\,|A=a)\cdot\mathrm{Prob}(S=\mathrm{s}\,|L=l) \tag{4}$$

The left term $\mathrm{Prob}(L=l\,|A=a)$ can be seen as an “inverse” version of the age-length key $\mathrm{Prob}(A=a\,|\,L=l)$, converted using the length-frequency distribution $\mathrm{Prob}(L=l)$ as weight:

$$\mathrm{Prob}(L=l\,|A=a)=\frac{\mathrm{Prob}(L=l,A=a)}{\mathrm{Prob}(A=a)}=\frac{\mathrm{Prob}(A=a\,|\,L=l)\cdot\mathrm{Prob}(L=l)}{\mathrm{Prob}(A=a)}$$

Based on Equations (3), (4), (5), we still need to estimate the following three probabilities to obtain $\mathrm{Prob}(\mathrm{M}=1\,|A=a)$.

- $\mathrm{Prob}(L=l)$: probability of length l. This is the length-frequency distribution. If possible, this should be estimated based on the simple random length samples per haul.
- $\mathrm{Prob}(A=a\,|\,L=l)$: probability of age at given length l. This is the age-length key and should be estimated from the age samples.

- $\mathrm{Prob}(S = \mathrm{s} \mid L = l)$: probability of female or male at given length l. This should be ideally estimated from the length samples due to its large sample size. However, if sex reading is not given for length samples, we could use age samples to estimate this value.

Table 1. summarizes the data and methods we used to estimate these 4 probabilities. Note that for estimating age-length key, we applied a continuation-logit model (Agresti, 2010), where the logit of the continuation ratio is modeled as a linear combination of the covariates:

$$\text{continuation ratio} = \mathrm{Prob}(A = a \mid A \geq a)$$

$$\mathrm{logit}[\mathrm{Prob}(A = a \mid A \geq a)] = \alpha_a + \beta' \boldsymbol{x}, \qquad a = Amin, Amax - 1$$

Similar to the maturity model, the ALK is estimated sepaogively per area. However, we do not differentiate by sex. The included covariates are year, length and country (if multiple). The best model was selected through minimum AIC.

Table 1. Summary of data and methods used to estimate the 4 key probabilities.

Step	Data	Output	Output definition	Method
1	Length-sample	Length-frequency distribution	$\mathrm{Prob}(L = l)$	Simple average
2	Age-sample	Sex ogive per length	$\mathrm{Prob}(\mathrm{S} = \mathrm{s} \mid L = l)$	Simple average
3	Age-sample	Age-length key	$\mathrm{Prob}(\mathrm{A} = a \mid L = l)$:	Continuation-logit model (Agresti, 2010)
4	Age-sample	Maturity ogive at given age, length, sex	$\mathrm{Prob}(M = 1 \mid \mathrm{A} = a, L = l, S = s)$,	GLM model

8.5.5 Result maturity at age:

The estimated maturity ogive at age for area RA8 and RA2-7 are illustrated in Figure 10-12. Note that the illustrated year variability is a combination of the sex-specific year indices as shown in Figure 2 and 4 (Figure 7.9 for area 2-7). RA8 has a relatively longer time series. The data in 1991 exhibits an unreasonably low maturity ogive at high ages and should be excluded.

8.5.6 Discussions/conclusions on the Maturity ogive estimated from NS-IBTS data

8.5.6.1 Exclude round fish area 8 (IIIaN) from NS-IBTS

Although provided with a longer time series, the Swedish samples in RA8 shows a large annual variability and shows a substantially low maturity ogive as compared to area IV (RA2-7) in the same period of 2010 onwards (compare Figure 11 and 12). Similar discrepancies have been picked up in other stocks and WGs. It’s unknown whether it is caused by any sampling flaw or the actual biological differences. Therefore, maturity ogive from RA8 is not used and only maturity from IV will be estimated. Recommendations will be given to NS-IBTS group to further investigate the discrepancies.

8.5.6.2 Concerns in change of maturity staging

The maturity staging categories have changed several times over the history (ref WKMSSPDF, WKMSTB). It is possible that the change of staging system leads to the change of maturity ogive, especially if the change is larger than biological characteristics and coincide with time when the system is changing, as we see in Figure 2. Also the country differences.

8.5.6.3 Exclude the short time-series of area IV (RA2-7) from NS-IBTS; use Dutch landing data to provide a longer time series estimate

8.5.7 Maturity ogive estimation using Dutch landings

A longer time series (1985-2015) of maturity ogive was estimated from the Dutch commercial landing, following 3 steps:

1) Maturity ogive, i.e. $f_{s,a,y}(l)$, at given age a, length l and year y was estimated using a glm model for each sex (s={female, male}).

   glm (maturity ~ Year + length + Age, family=binomial, data=dat), per sex (6)

   The estimated year coefficients are illustrated in Figure 13.

2) A mean length at age, i.e. $\bar{l}_{a,y}$, for Q1 per year was estimated from BTS survey data (Table 2, Figure 14): A growth curve (ref) was estimated from BTS survey Q3 data, and extrapolated into the mean length at Q1. Since survey samples are less length selective than Dutch landing, the estimated mean length from the BTS is less likely to be biased and serves well as a population mean. The estimated mean proportion of maturity at age a, year y, sex s was then approximated as $f_{s,a,y}(l)$ at $l = \bar{l}_{a,y}$.
3) Assuming equal proportion of sex per age, the final maturity at age was estimated as $f_{\text{female},a,y}(l = \bar{l}_{a,y})/2 + f_{\text{male},a,y}(l = \bar{l}_{a,y})/2$

Dutch landing samples in 1988 were excluded due to too few samples. Additionally, samples in 2002 were excluded due to the confusion in maturity staging. The final estimated maturity ogive for age 2-4 are illustrated in Figure 16 and Table 3. A previous maturity study in WGNSSK05 using also Dutch landing data showed similar magnitude of maturity within the overlapping period (1985-2002), comparing Figure 16 and 17.

Due to the lack of BTS samples to provide length-age distributions, maturity ogive for 1957-1984 can not be directly estimated using the method above. On the other hand, the estimated mean weight at age for Q1 is available since 1957. Therefore, to check how we can reconstruct the maturity ogive in this period, we used the time trend of mean weight (Figure 18) as a proxy for the time trend of mean length (Figure 14). The comparison between mean weight in the missing years (1957-1984) versus known years (1985-2015) was used to derive the imputation strategy for the missing years. Figure implies a constant size at age in the early years and a negative trend since 1980. Figure 13 implies a constant maturity rate at given length age in the early years and a positive trend since 1980. Both observations imply that the maturity ogive in 1957-1984 can be imputed using the ogive in 1980.

Table 2. Mean length at age 2-4 in Q1 from 1985-2016, estimated using BTS Q3 survey data.

Year	Age 2	Age 3	Age 4
1985	21	25	31
1986	18	27	30
1987	18	24	32
1988	18	24	29
1989	18	24	29
1990	19	24	29
1991	20	25	29
1992	18	26	30
1993	19	25	31
1994	22	26	30
1995	21	28	30
1996	22	27	32
1997	22	28	31
1998	20	27	31
1999	21	26	30
2000	21	26	29
2001	22	26	29
2002	22	27	29
2003	21	27	29
2004	20	26	30
2005	21	26	29
2006	21	26	29
2007	22	26	29

2008	22	27	29
2009	21	27	29
2010	21	25	29
2011	22	25	28
2012	21	25	28
2013	21	24	27
2014	20	24	26
2015	20	23	25
2016	20	23	25

Table 3. Estimated maturity ogive at age 2-4 per year.

Year	Age2	Age3	Age4
1985	0.45	0.50	0.66
1986	0.29	0.52	0.64
1987	0.39	0.49	0.70
1988	-	-	-
1989	0.39	0.50	0.63
1990	0.42	0.52	0.70
1991	0.43	0.52	0.66
1992	0.39	0.55	0.73
1993	0.42	0.53	0.79
1994	0.48	0.59	0.80
1995	0.47	0.71	0.85
1996	0.47	0.59	0.85
1997	0.47	0.65	0.83
1998	0.43	0.56	0.74
1999	0.45	0.55	0.74
2000	0.46	0.61	0.79
2001	0.48	0.61	0.79
2002	-	-	-
2003	0.49	0.78	0.90
2004	0.46	0.68	0.90
2005	0.59	0.87	0.96
2006	0.50	0.74	0.90
2007	0.57	0.81	0.94
2008	0.63	0.90	0.96
2009	0.51	0.82	0.92
2010	0.47	0.62	0.85
2011	0.51	0.65	0.84
2012	0.46	0.58	0.74
2013	0.50	0.66	0.85
2014	0.49	0.70	0.84
2015	0.48	0.64	0.78

8.6 References

Grift, R.E., Rijnsdorp, A. D., et.al. 2003. Fisheries-induced trends in reaction norms for maturation in North Sea plaice. Marine Ecology Progress series, Vol. 257: 247-257.

Rijnsdorp, A. D., 1989. Maturation of male and female North Sea plaice (Pleuronectes platessa L.) J. Cons. Int. Explor. Mer, 46: 35-51.

Rijnsdorp, A. D., van Damme, C. J. G., and Witthames, P. R. 2010. Implications of fisheries-induced changes in stock structure and reproductive potential for stock recovery of a sex-dimorphic species, North Sea plaice. – ICES Journal of Marine Science, 67: 1931–1938.

Agresti, A., 2010. Analysis of Ordinal Categorical Data. Wiley Series in Probability and Statistics. Wiley.

8.7 Figures

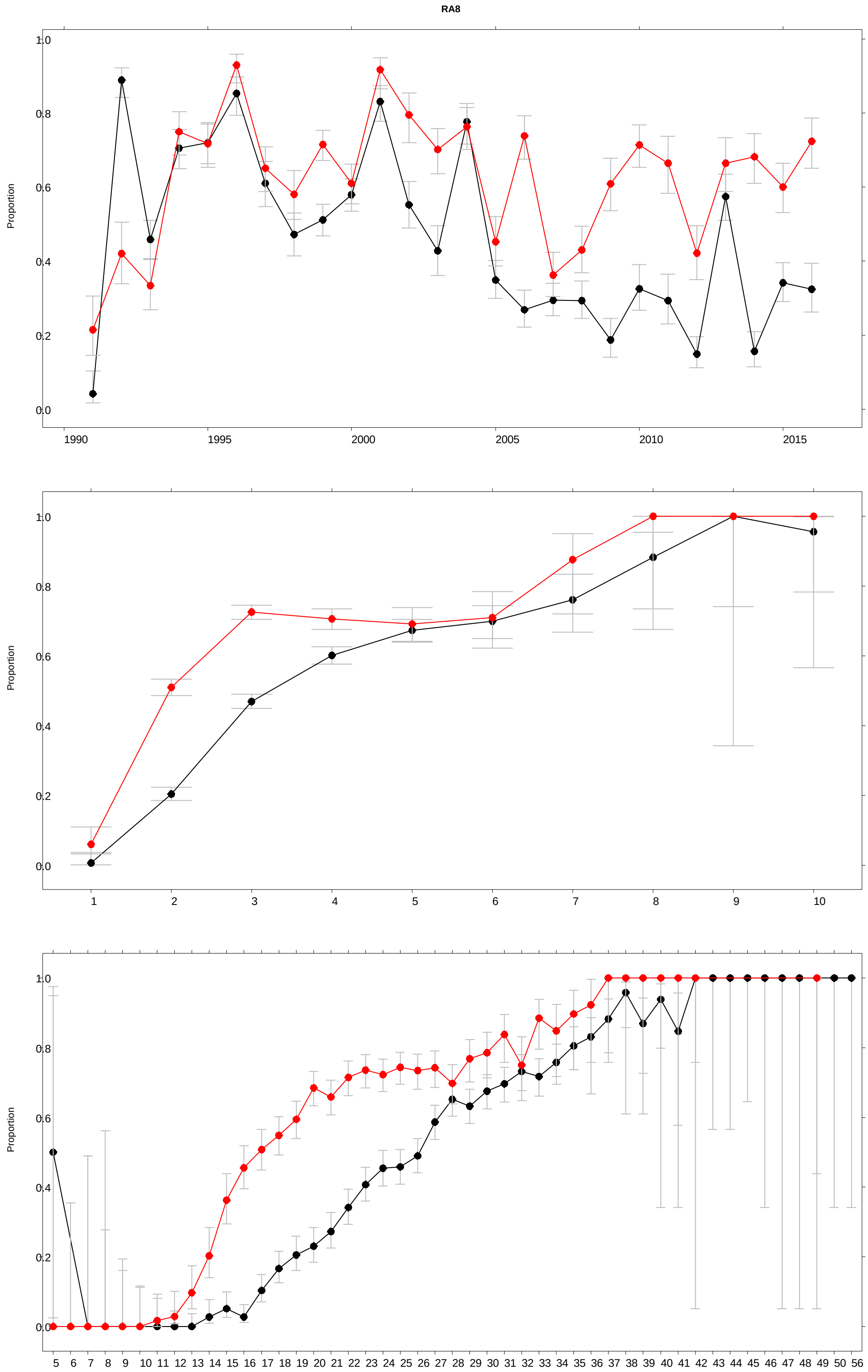


Figure 1 : Maturity ogive computed from raw data of RA8. (a) by year, (b) by age and (c) by length. male (red), female (black).

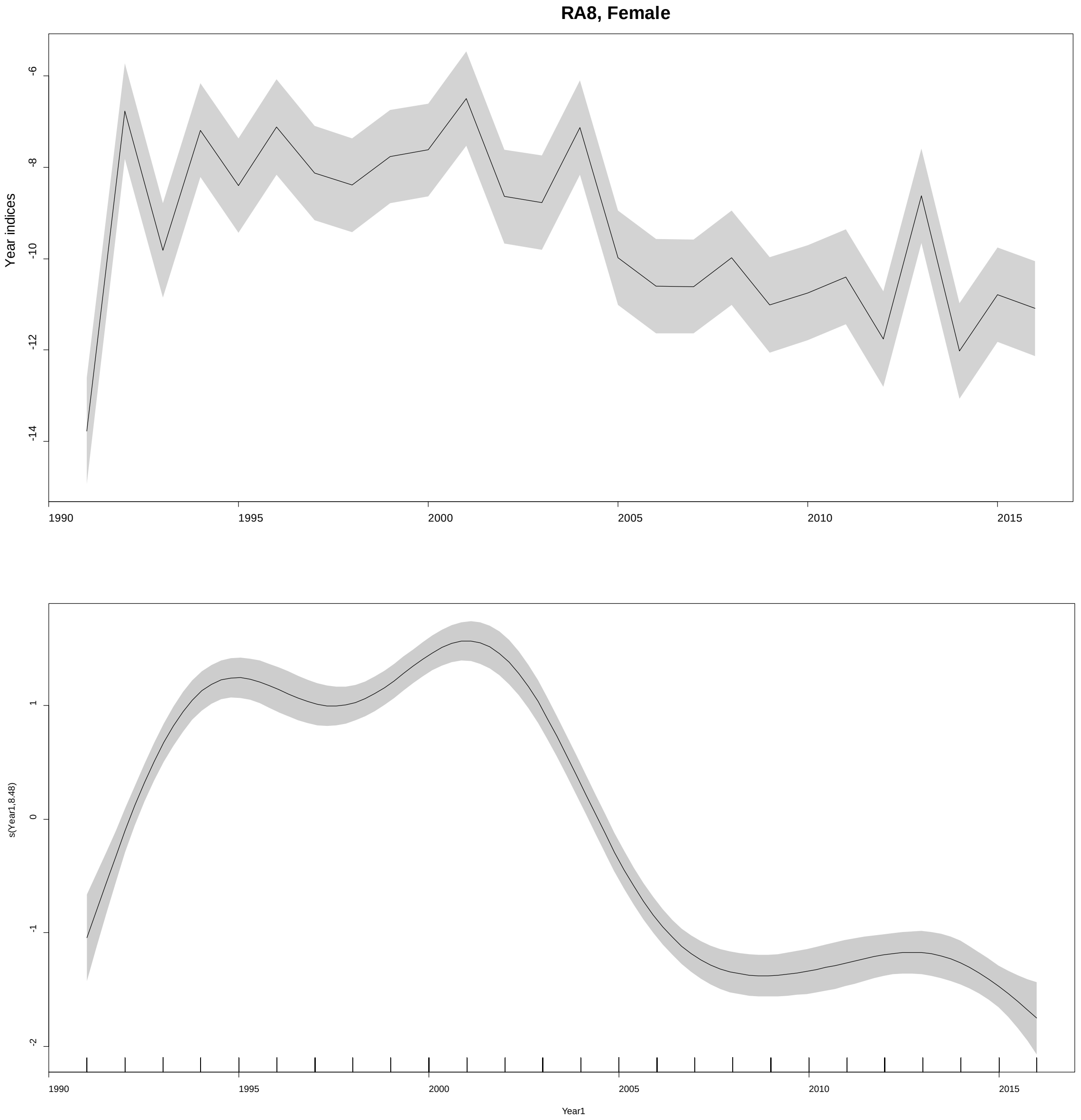


Figure 2 : Estimated year indices of the best fitted maturity model (1) for **female RA8**. (top panel) GLM, (bottom panel) GAM.

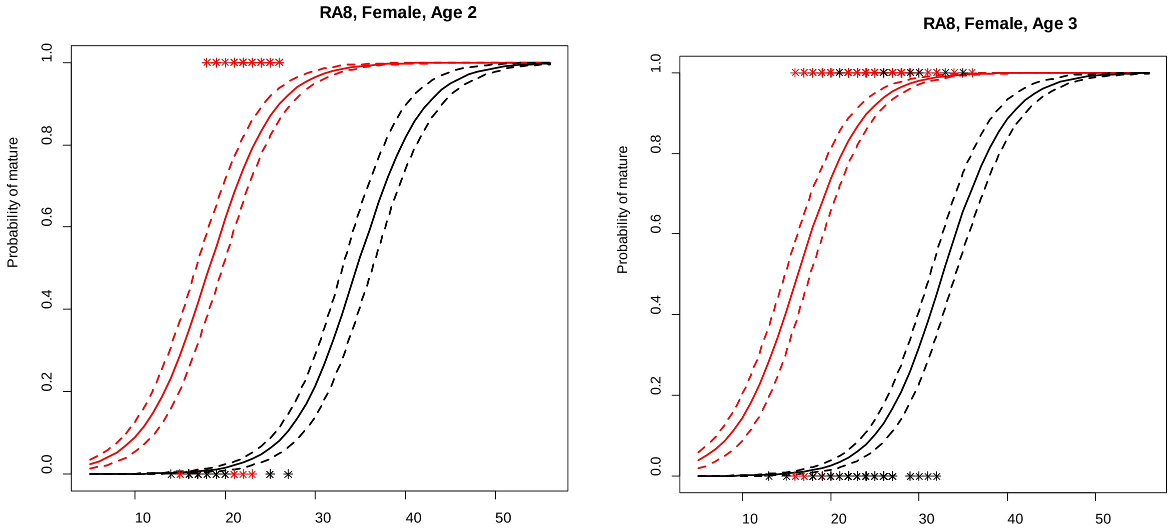


Figure 3: Comparing the fitted maturity ogive between 2001 and 2016 at given length for female age 2 and 3. red: 2001; black:2016

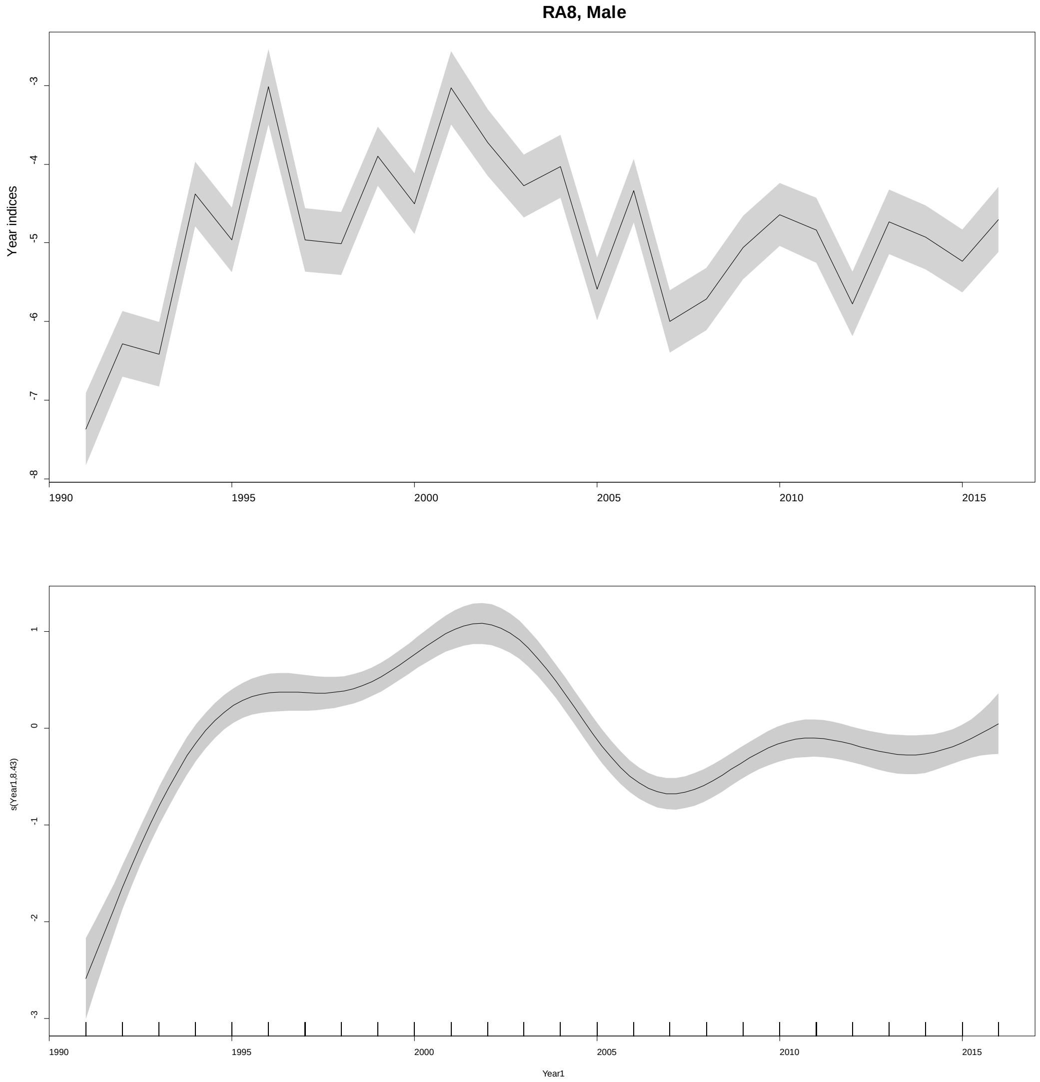


Figure 4 : Estimated year indices of the best fitted maturity model (1) for **male RA8**. (top panel) GLM, (bottom panel) GAM.

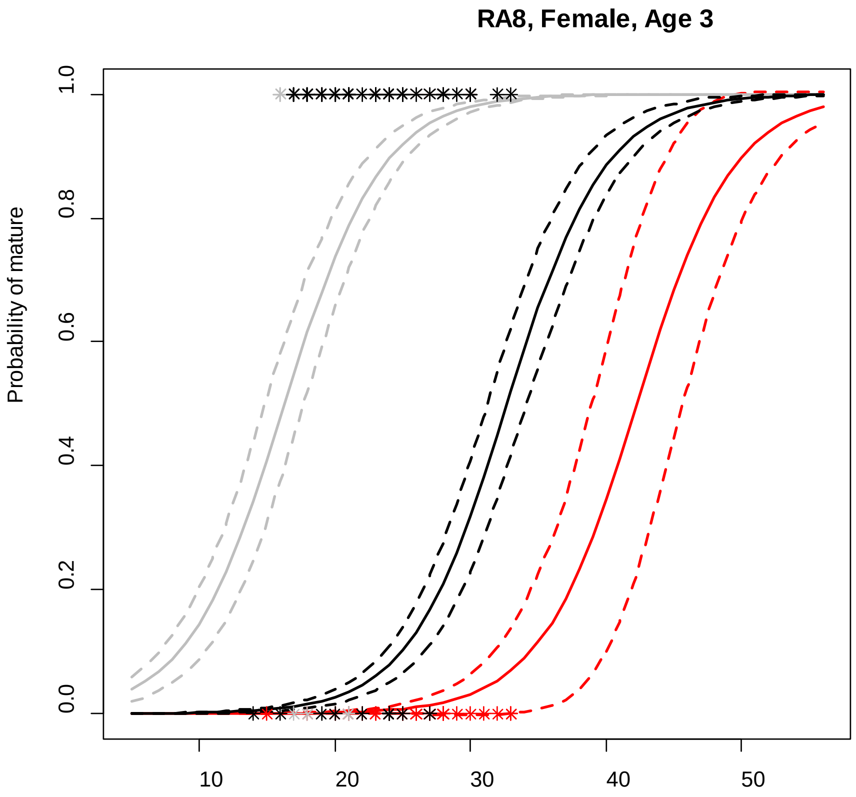


Figure 5: Comparing the fitted maturity ogive between 1991, 2001 and 2016 at given length for male age 3. red: 1991; gray: 2001, black:2016

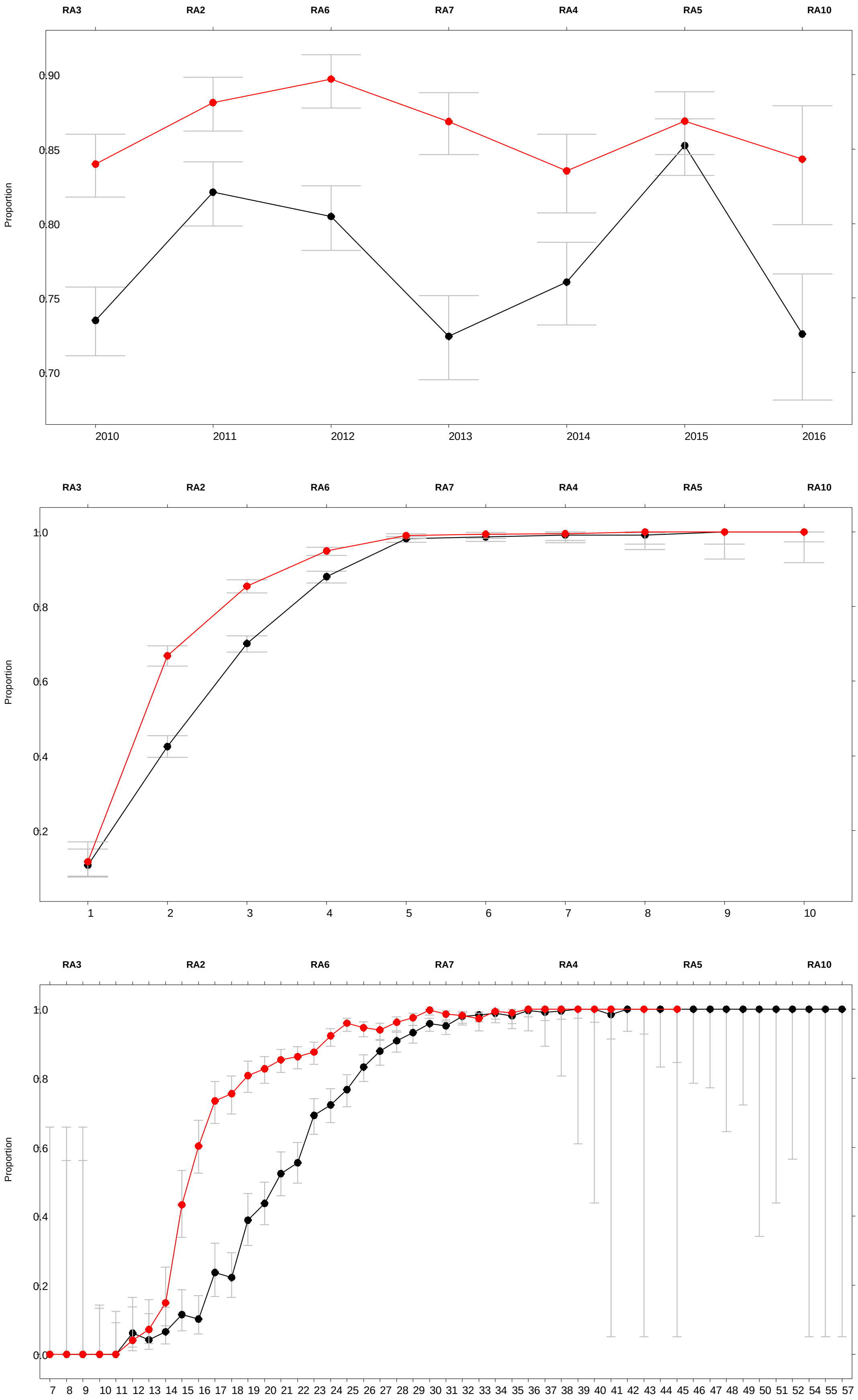
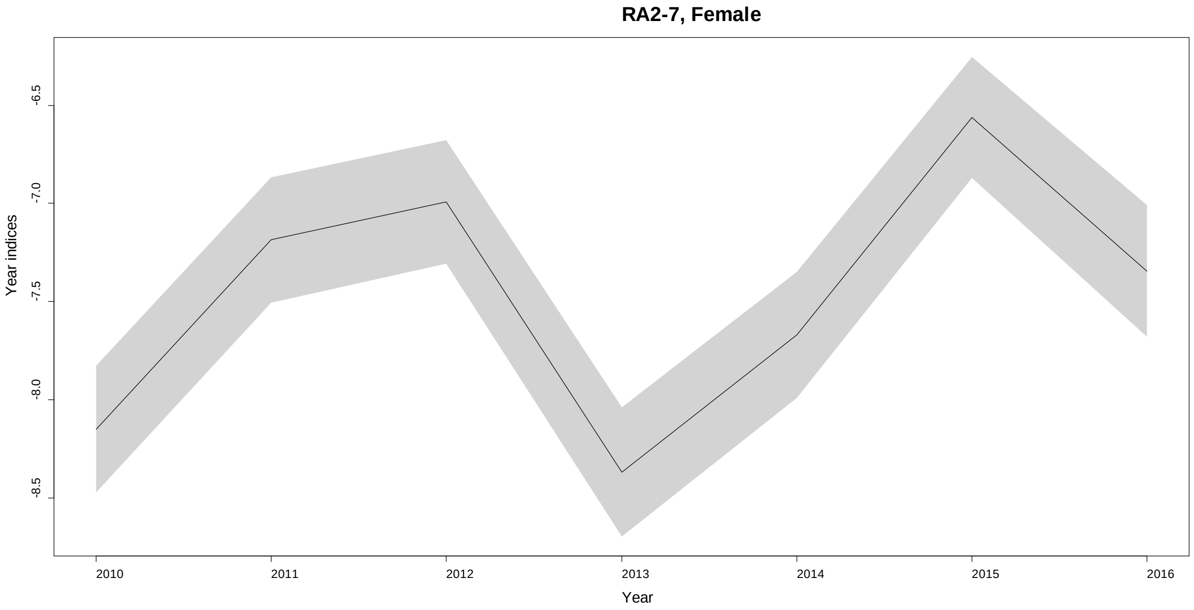
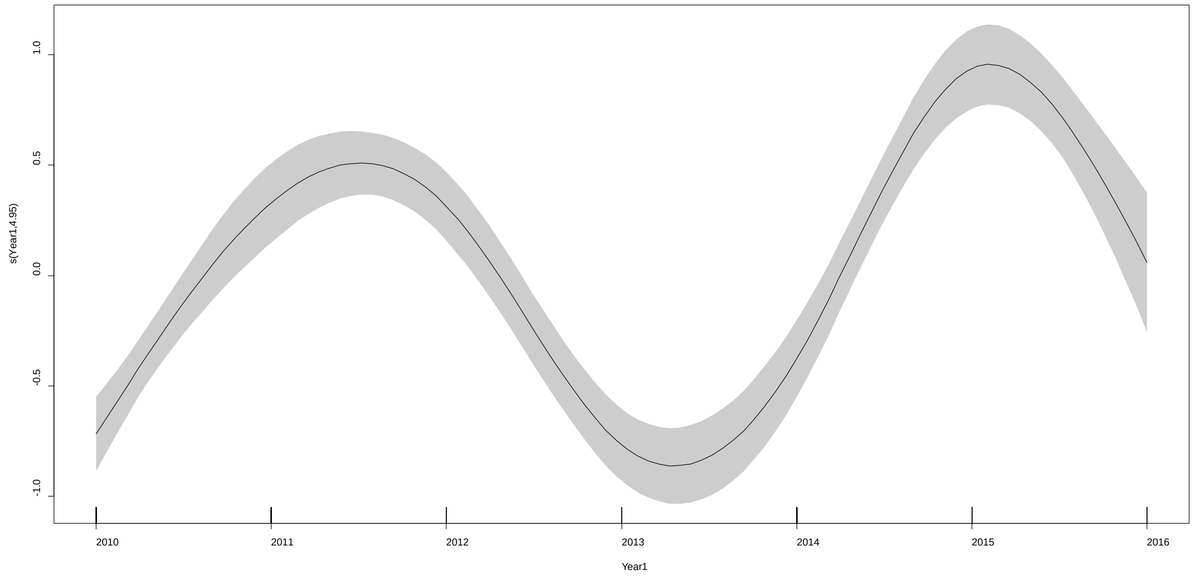


Figure 6 : Maturity ogive computed from raw data of RA2-7. (a) by Year, (b) by age and (c) by length. male (red), female(black).



(a)



(b)

Figure 7 : Estimated year indices of the best fitted maturity model (2) for **female RA2-7**. (a) GLM, (b) GAM.

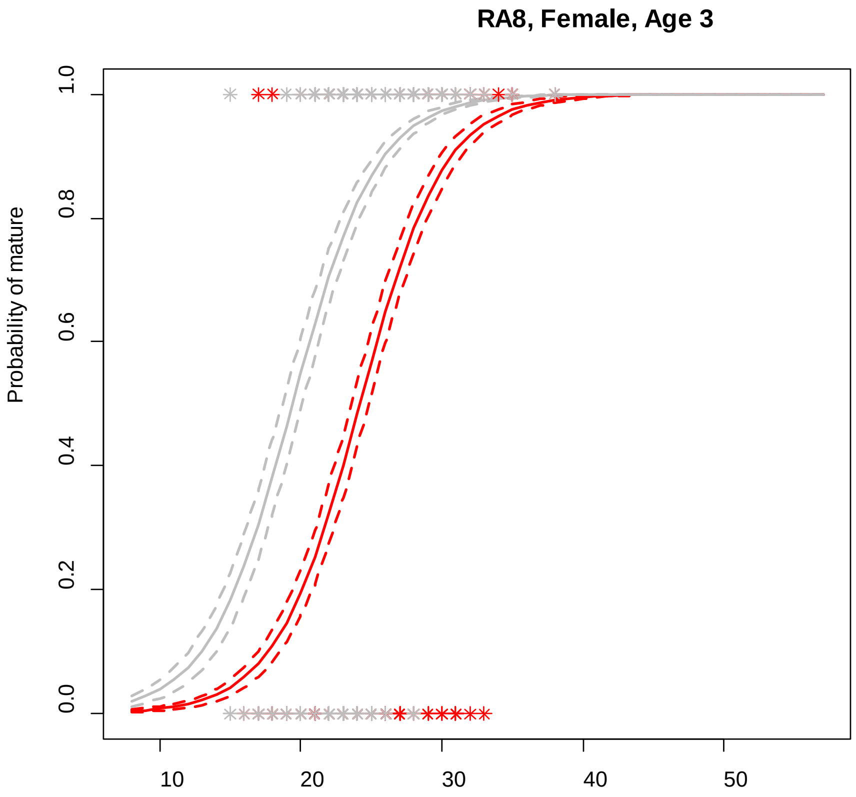


Figure 8: Comparing the fitted maturity ogive between 2013 and 2015 at given length for female age 3. red: 2013; gray: 2015, black:2016

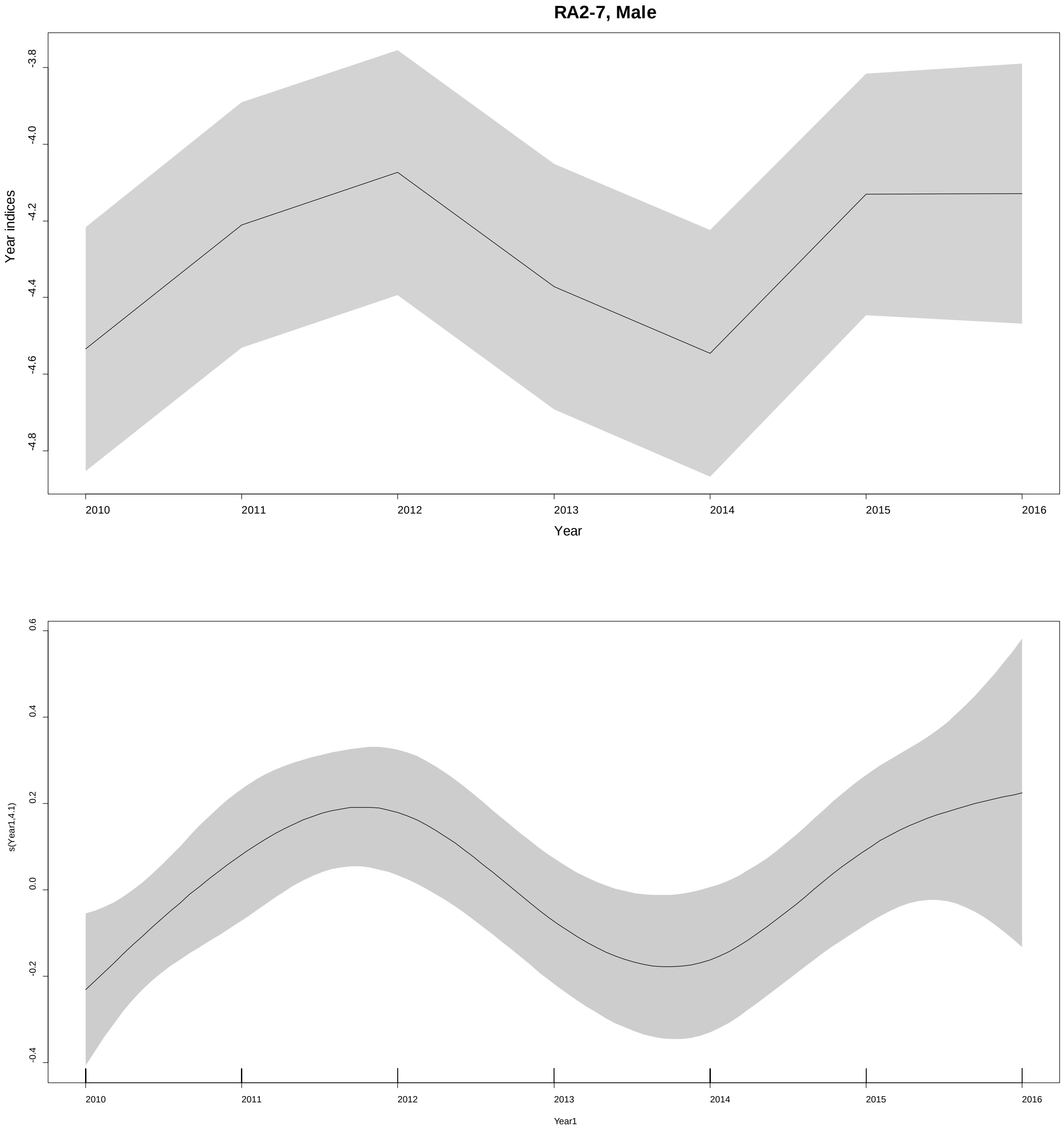


Figure 9 : Estimated year indices of the best fitted maturity model (2) for **male RA2-7**. (a) GLM, (b) GAM.

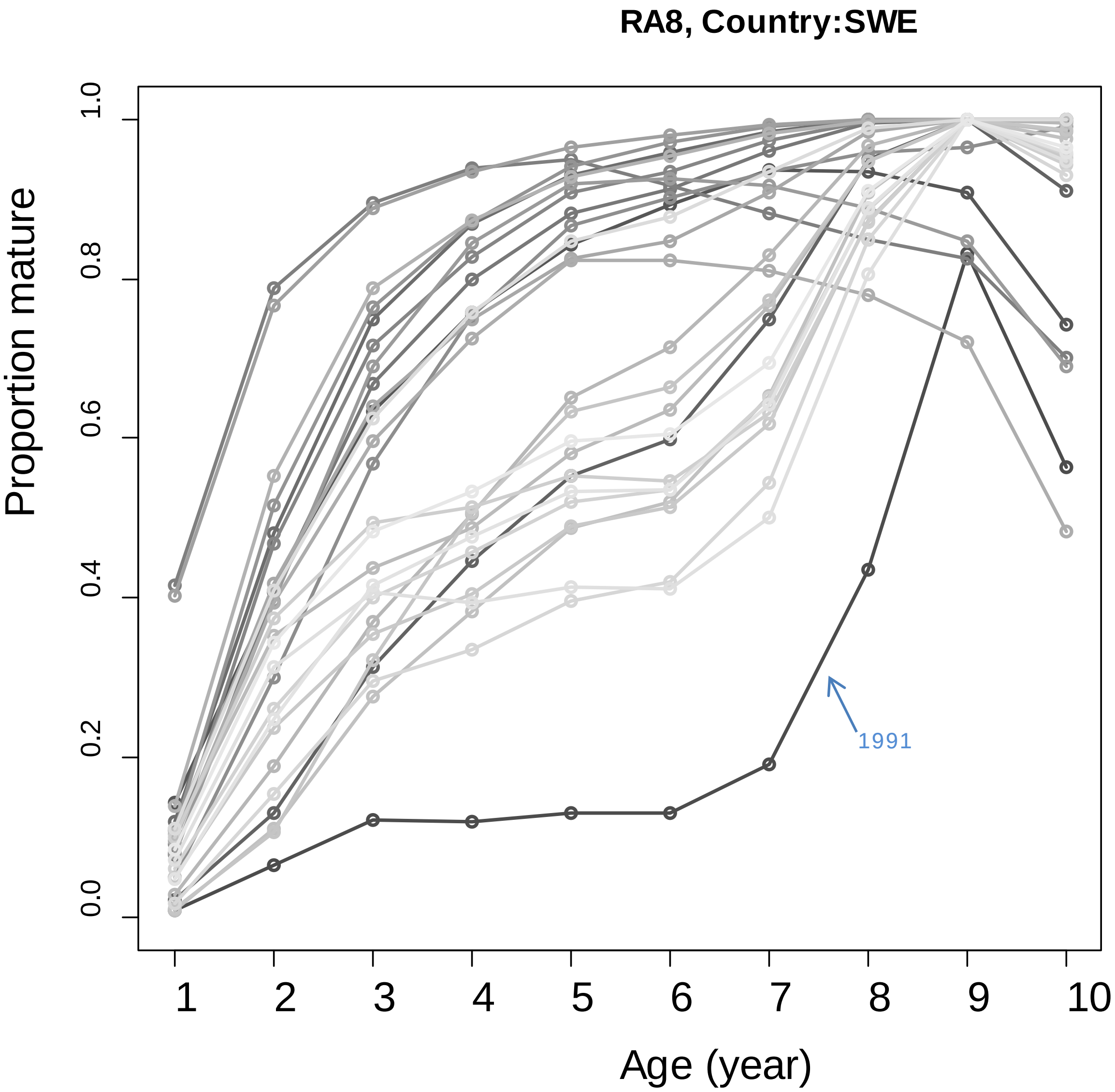


Figure 10. estimated proportion of mature fishes per age for area RA8. Each line indicates a year (1991-2016) with earlier years in darker black and recent years in lighter gray colors.

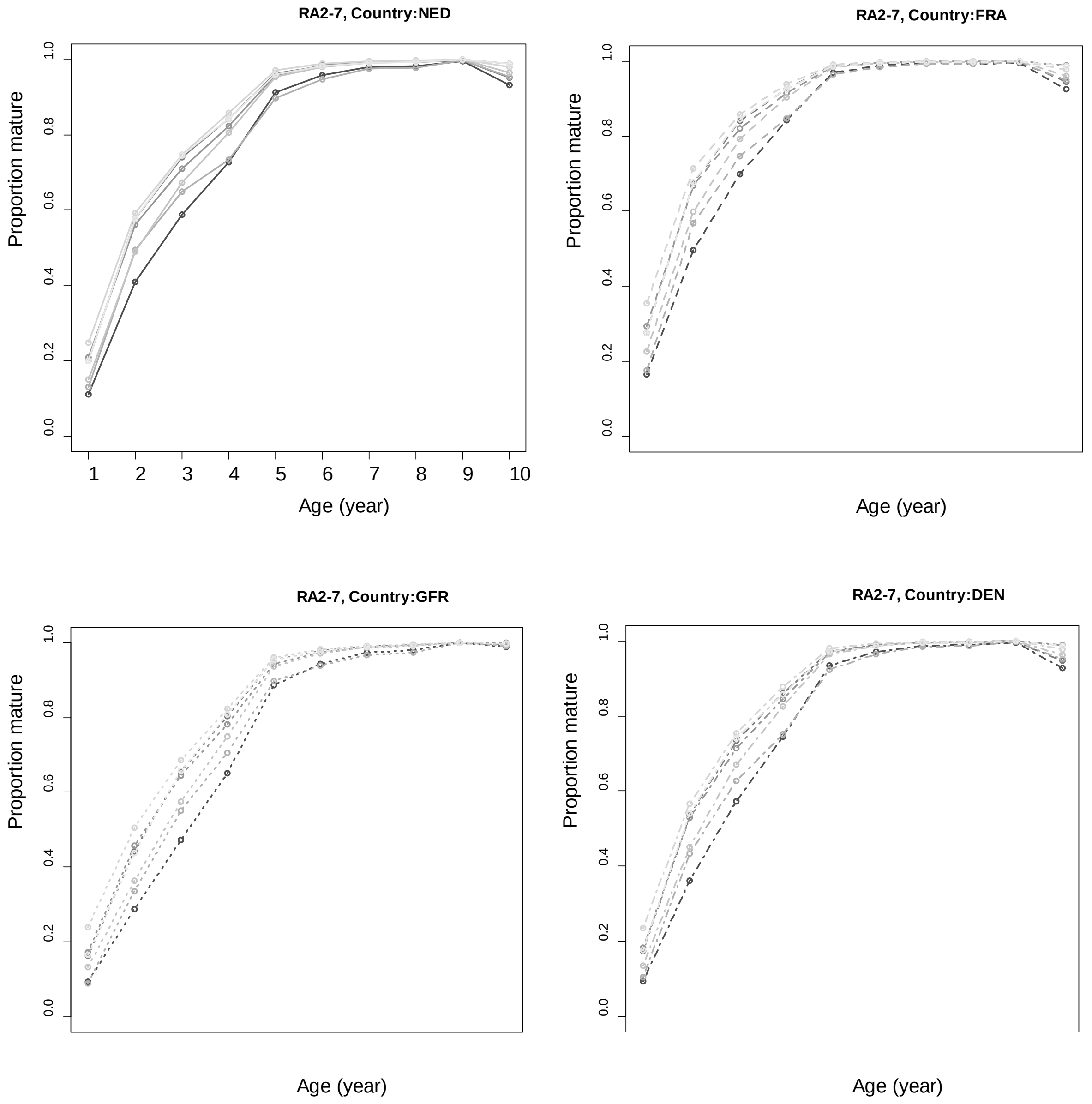


Figure 11. estimated proportion of mature fishes per age for area RA2-7. Each line indicates a year (2010-2016) with earlier years in darker black and recent years in lighter gray colors.

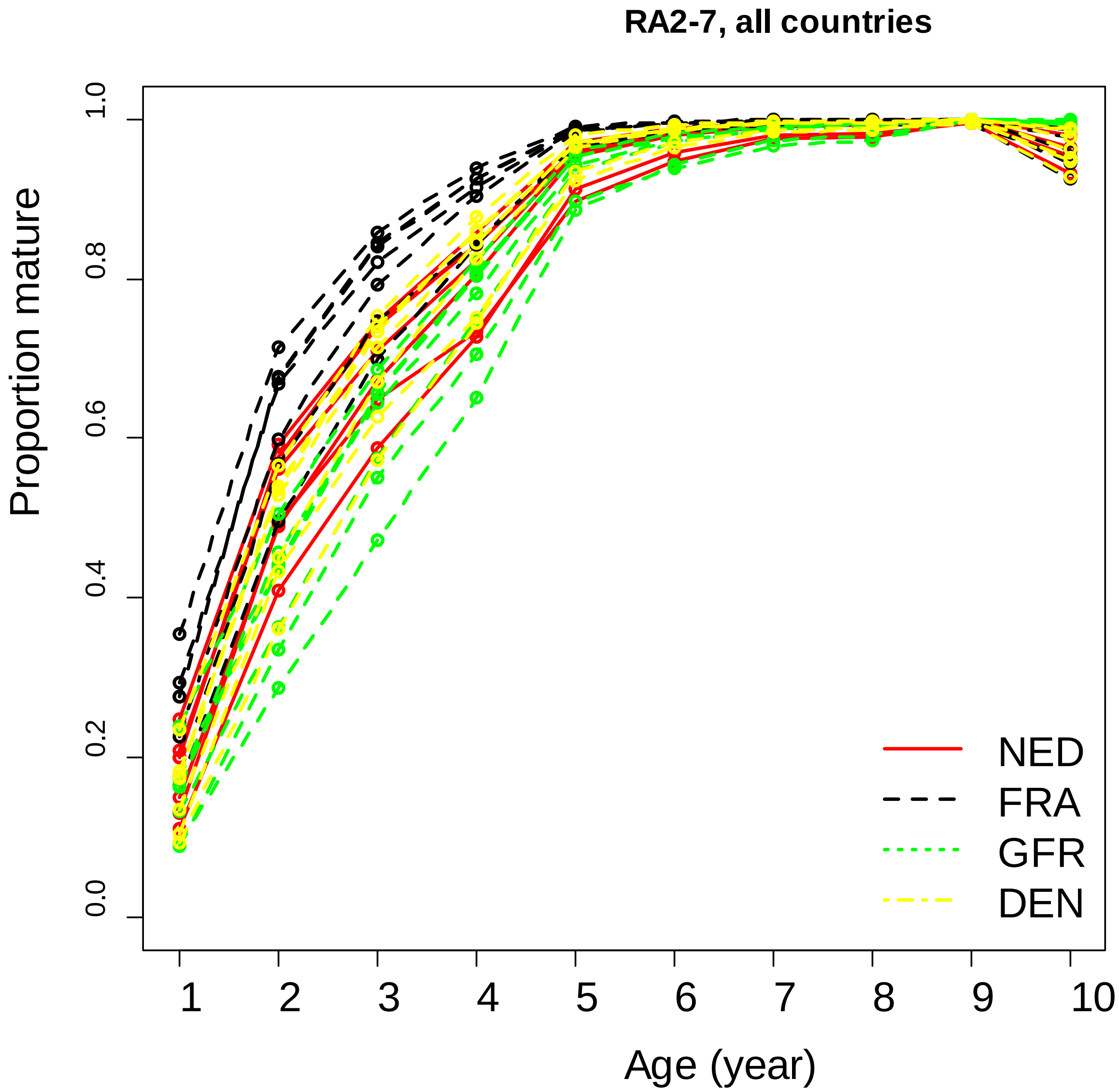


Figure 12. estimated proportion of mature fishes by different countries per age for area RA2-7.

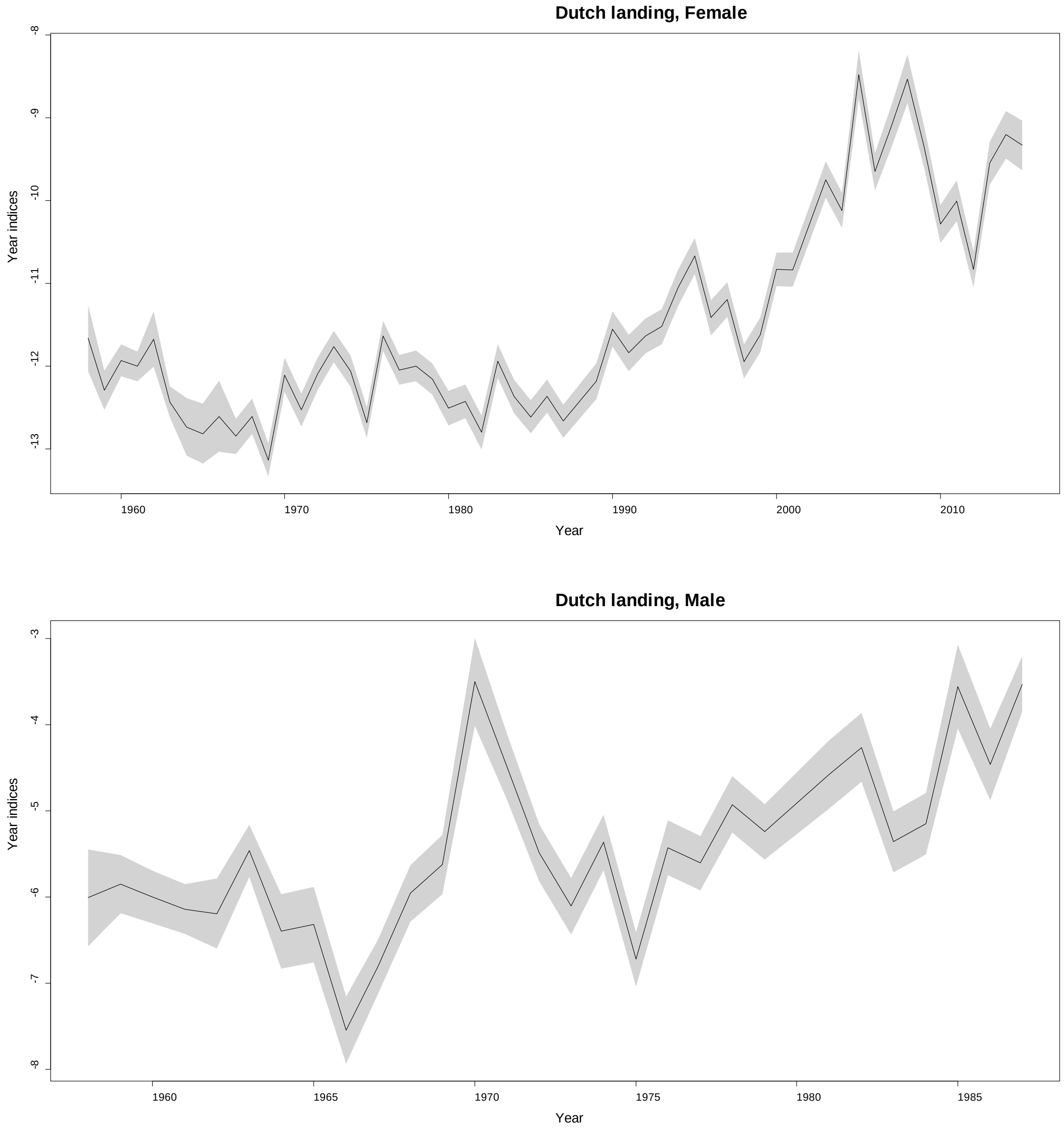


Figure 13. Estimated year coefficients in the model (6) for female and male, using Dutch landings.

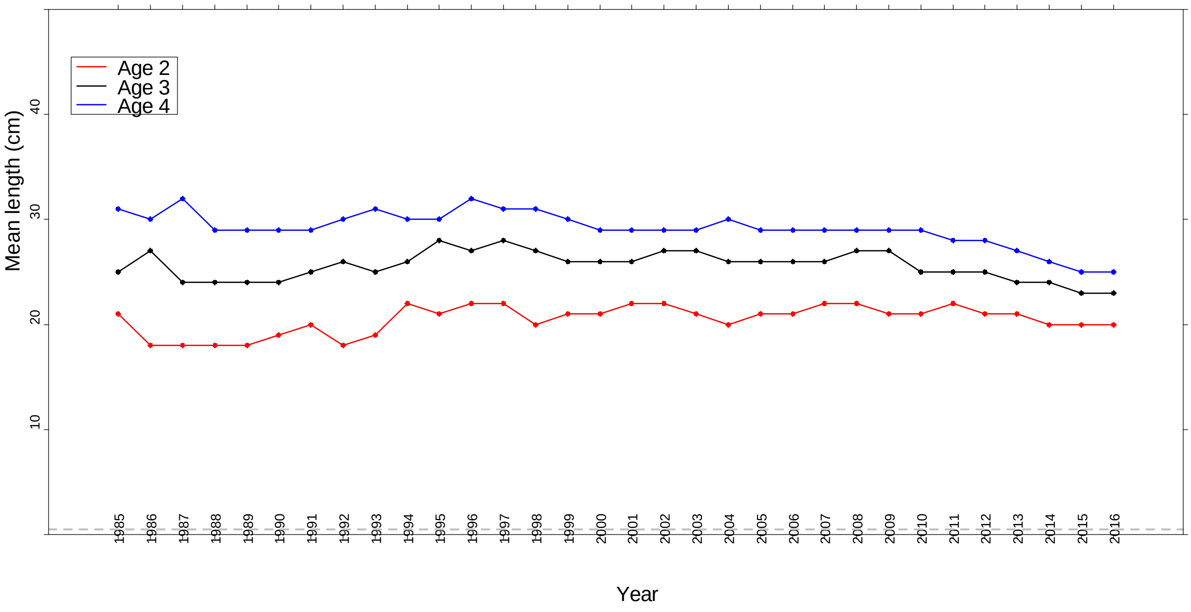


Figure 14. Mean length at age 2-4 in Q1 from 1985-2016, estimated using BTS Q3 survey data.

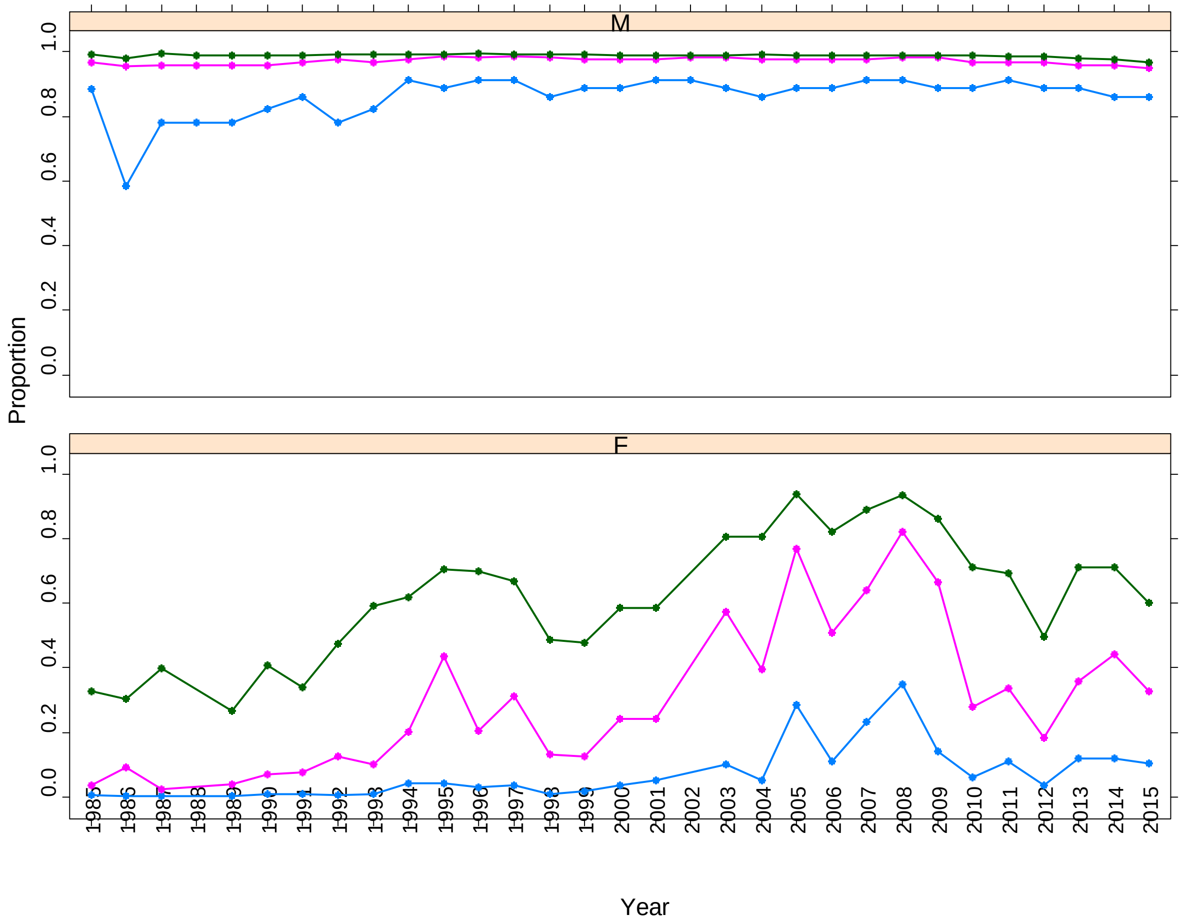


Figure 15. Estimated maturity ogive by sex per year for age 2-4. Maturity model was derived from Dutch landing while the mean length at age was derived from the BTS survey, with equal sex proportion at given assumption.

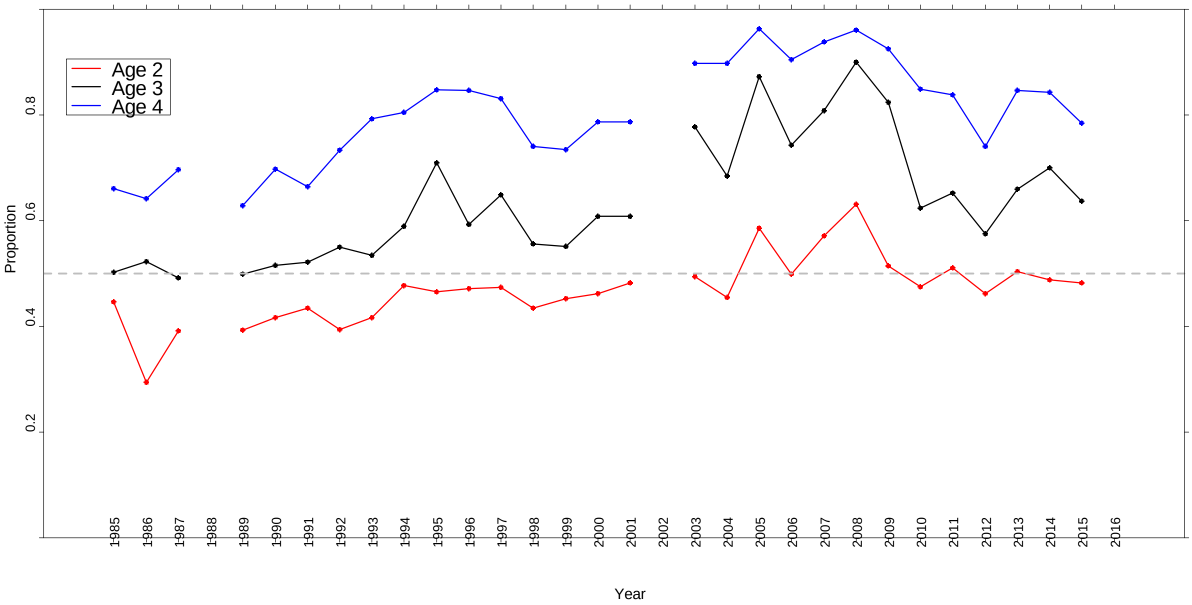


Figure 16. Estimated maturity ogive per year for age 2-4. Maturity model was derived from Dutch landing while the mean length at age was derived from the BTS survey, with equal sex proportion at given assumption.

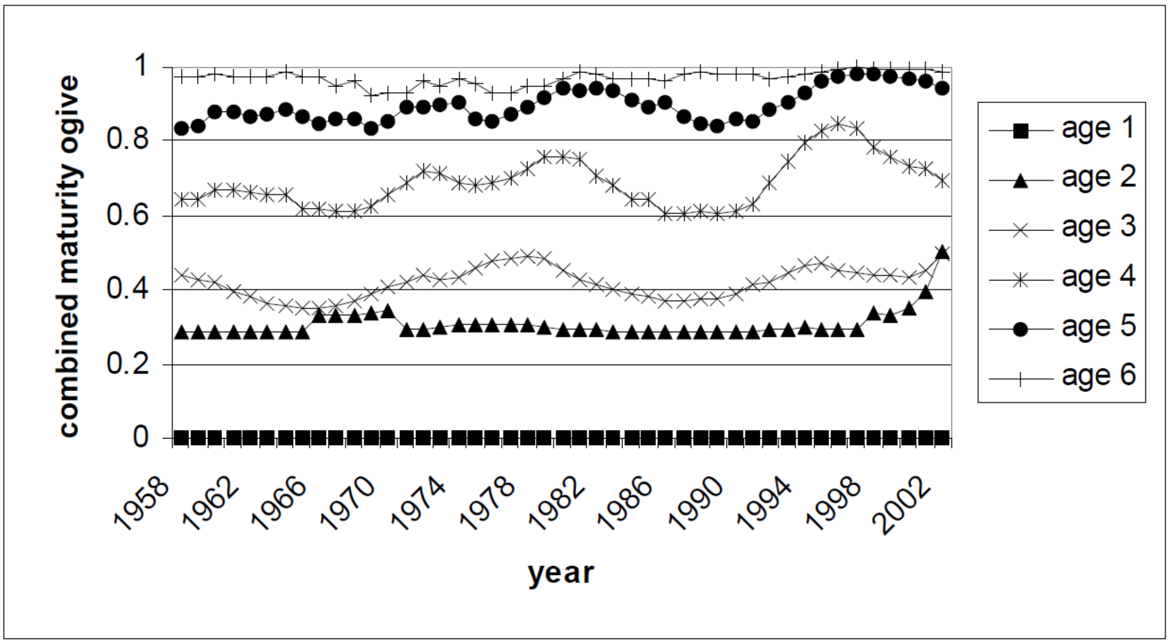


Figure 17. Maturity at age for North Sea plaice (taken from ICES WGNSSK 2005).

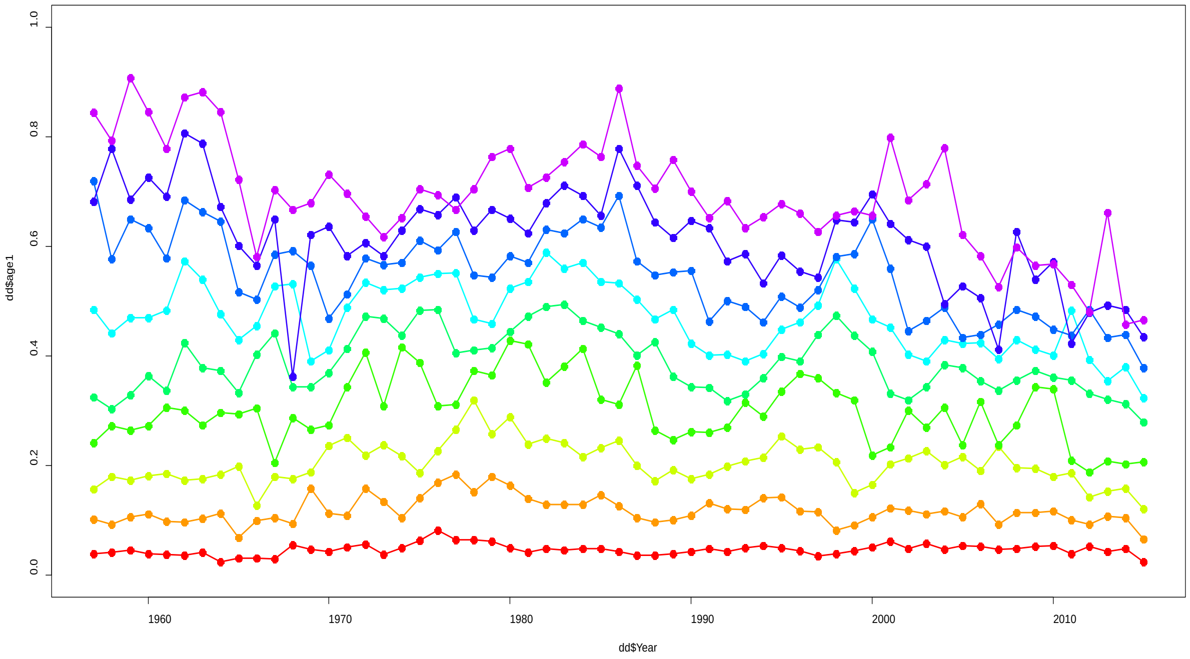


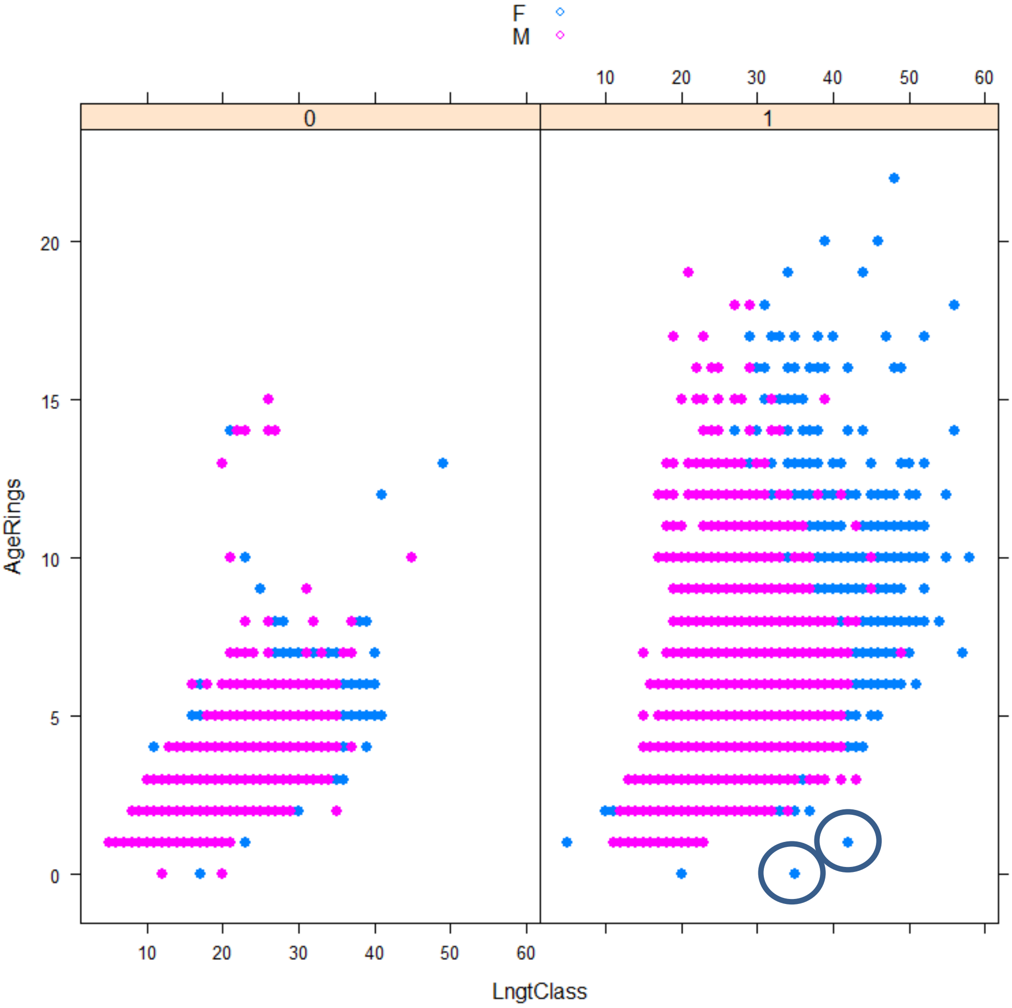
Figure 18. Estimated mean weight at age in Q1 (age1: red; age 9: purple).

8.8 Appendix A

8.8.1 Quality check and pre-processing of data:

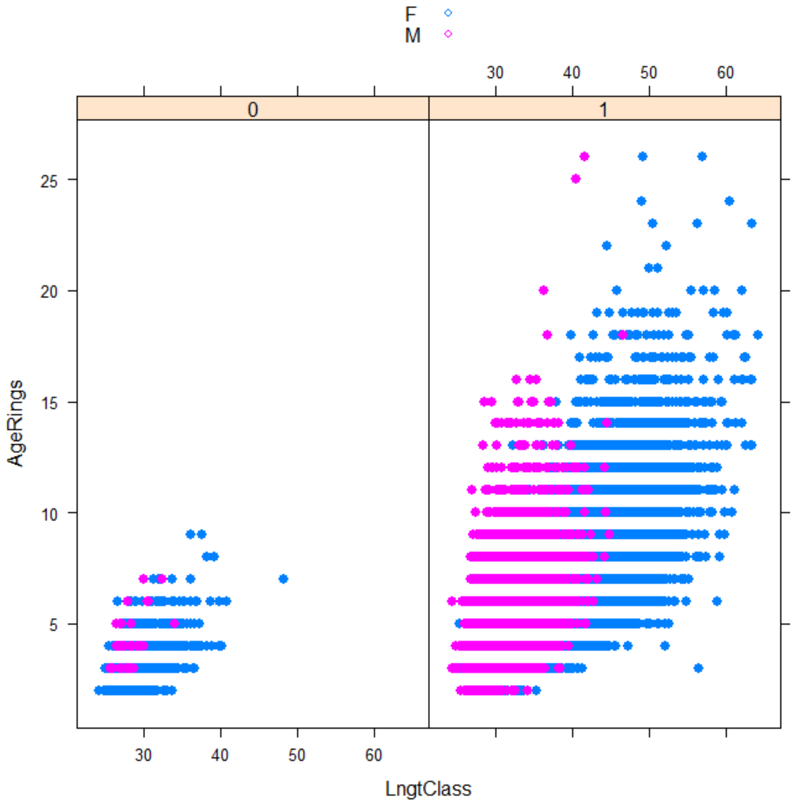
8.8.1.1 NS-IBTS Q1:

- Data available in 1991-2016
- Number of fishes per row (CANoAtLngt) is not always 1. -> geneogive duplicate fish samples
- Longitude and latitude locations are converted into round fish areas RA1-RA10. Area RA9-and RA10 are excluded.
- Maturity of samples with "-9" or "U" sex are assigned as NA. Samples with missing values in age, length, sex, maturity, area_code are excluded.
- Problem in 1991 data, all samples are immature. So we exclude data year 1991.
- The last digit of length measurement is in cm.
- Delete samples with age 0 (too few)
- Exclude 2 outliers e.g. long length with very young age but mature (figure below)



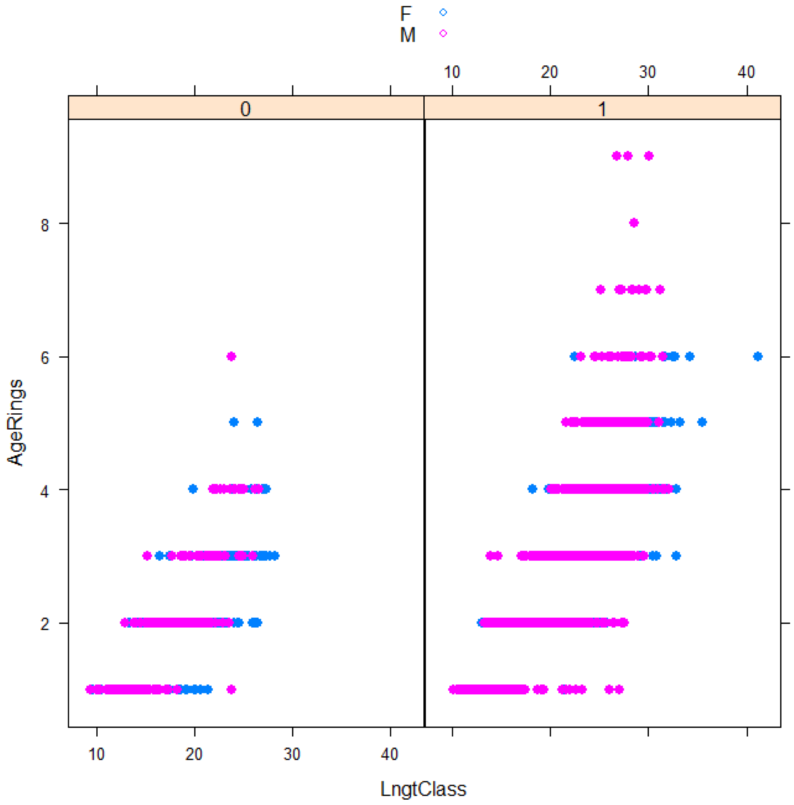
8.8.1.2 Dutch Q1 landing:

- Data available in 1958-2015
- Longitude and latitude locations are converted into flat fish areas RA1-RA10.
- Maturity of samples with "-9" or "U" sex are assigned as NA. Samples with missing values in age, length, sex, maturity, area_code are excluded. Area RA9-and RA10 are excluded.
- The last digit of length measurement is in mm.
- Neither NS-IBTS or discards data have data in 1958-1990. Therefore, exclude data year 1958-1990.



8.8.1.3 Dutch Q1 discards:

- Data available in 2000, 2001, 2003, 2009-2016
- Longitude and latitude locations are converted into flat fish areas RA1-RA10. Area RA9-and RA10 are excluded.
- Maturity of samples with "-9" or "U" sex are assigned as NA. Samples with missing values in age, length, sex, maturity, area_code are excluded.
- The last digit of length measurement is in mm.



8.9 Appendix B

8.9.1 Data summary and exploration

8.9.1.1 Country (observer) effect?

Country is not independent of year, neither of area:

- RA1 is only sampled by GFR, mainly since 2010.
- RA2 is sampled mainly by GFR and NED since 2010, FRA in 2010-2011, DEN 2013-2015
- RA3 is sampled mainly by GFR and NED since 2010
- RA4 is sampled mainly by DEN since 2003, FRA since 2009
- RA5 is sampled mainly by FRA since 2009, NED since 2007
- RA6 is sampled mainly by DEN since 2003, FRA since 2009, NED since 2007
- RA7 is sampled mainly by DEN since 2003, FRA in 2009-2011, GFR since 2012
- RA8 is only sampled by SWE
- ENG only sampled in 2001 mainly in RA6
- NOR has few samples in RA7 and RA2 in recent years

Table 1. number of maturity staged fishes in NS-IBTS per country per year in RA2-8

year	DEN	FRA	GFR	NED	SWE
1991	0	0	0	0	198
1992	0	0	0	0	385
1993	0	0	0	0	567
1994	0	0	0	0	551
1995	0	0	0	0	481
1996	0	0	0	0	366
1997	0	0	0	0	494
1998	0	0	0	0	549
1999	0	0	0	0	1034
2000	0	0	0	0	805
2001	0	0	0	0	407
2002	0	0	0	0	395
2003	357	0	0	0	436
2004	261	0	0	0	445
2005	279	0	0	0	548
2006	451	0	0	0	518
2007	442	0	236	227	678
2008	488	0	0	319	559
2009	432	818	0	410	393
2010	569	1177	234	402	461
2011	553	1090	207	353	314
2012	572	742	477	356	448
2013	567	608	282	263	399
2014	643	561	308	0	411
2015	613	692	288	463	518
2016	0	330	231	116	360

Table 2. number of maturity staged fishes in NS-IBTS per country per area

Country	RA2	RA3	RA4	RA5	RA6	RA7	RA8
DEN	261	0	1203	0	2446	2250	67
FRA	90	15	1035	1572	2617	689	0
GFR	439	1057	0	0	196	571	0
NED	402	451	0	656	1400	0	0
SWE	0	0	0	0	0	0	12720

To explore the country effect and adjust the possible area differences (see table 2), we selected female NS-IBTS data in each sub area in 2010-2016 (with some exclusion) and apply a GLM with country, year, age, length as covariates.

glm(maturity ~ Year + length + Age + Country, family=binomial, data=dat), for each matched subarea+year data

RA2: GFR vs. NED

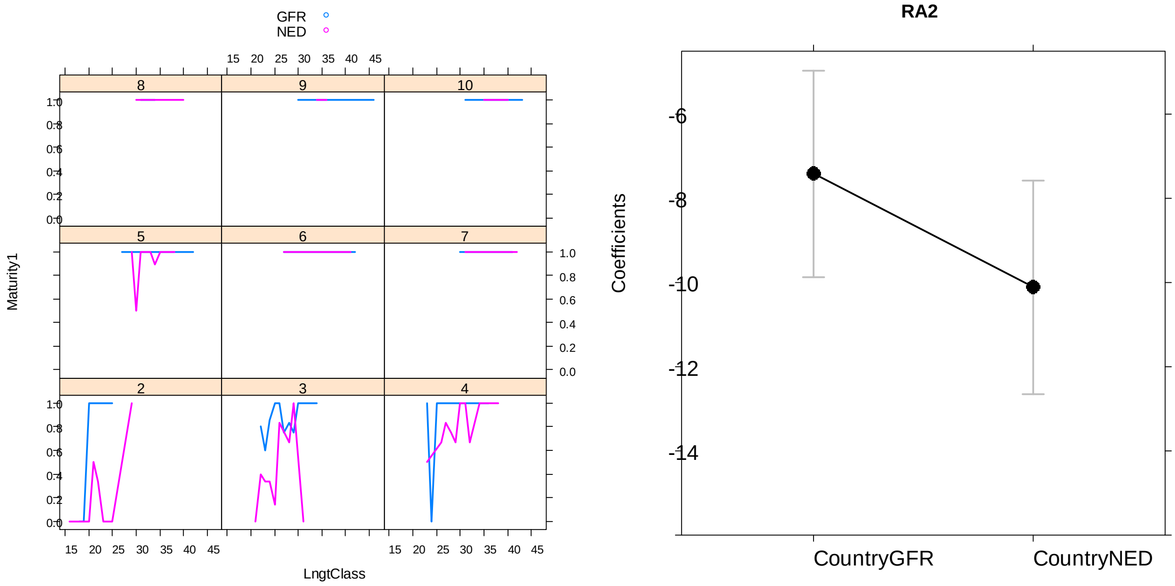


Figure B1. Left: maturity ogive from raw data; right: estimated country coefficient from the model

RA3: GFR vs. NED

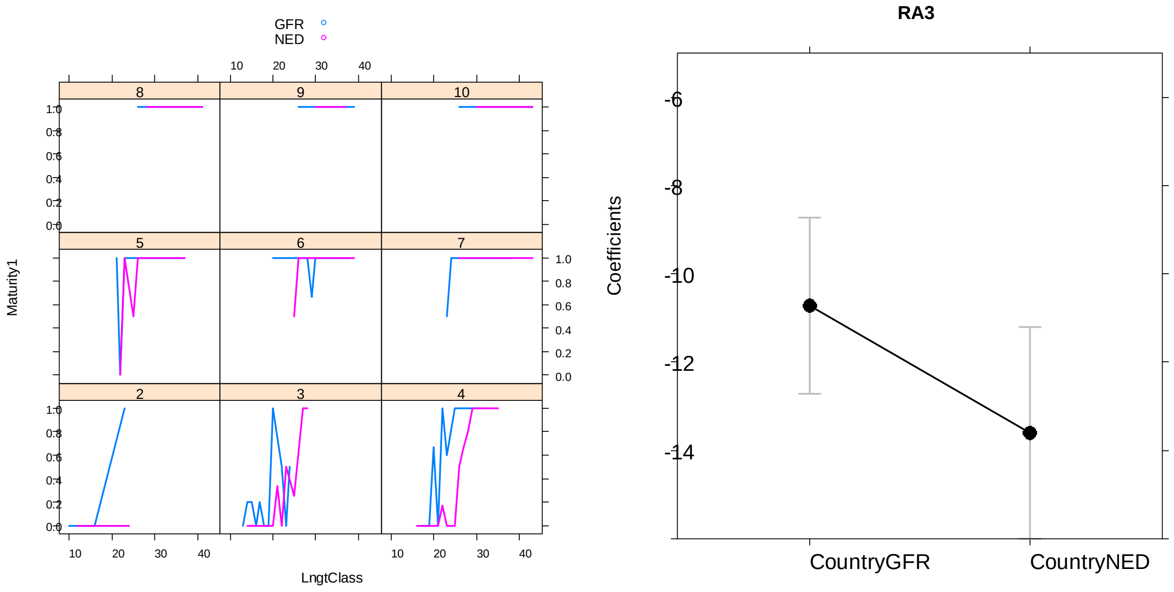


Figure B2. Left: maturity ogive from raw data; right: estimated country coefficient from the model

RA4: DEN vs. FRA

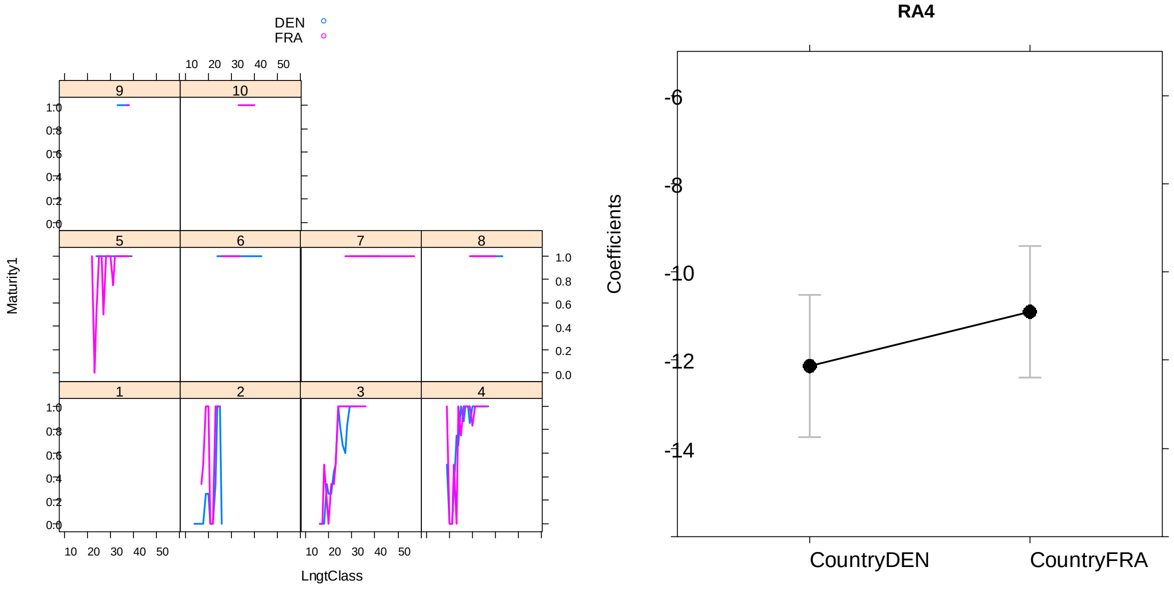


Figure B3. Left: maturity ogive from raw data; right: estimated country coefficient from the model

RA5: FRA vs. NED

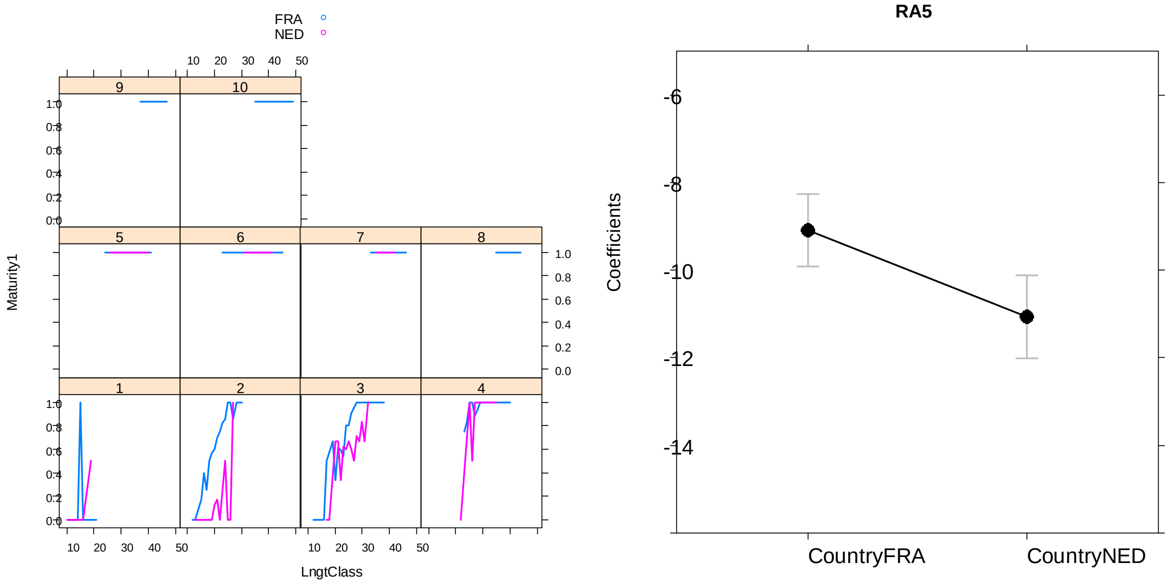


Figure B4. Left: maturity ogive from raw data; right: estimated country coefficient from the model

RA6: DEN vs. FRA vs. NED

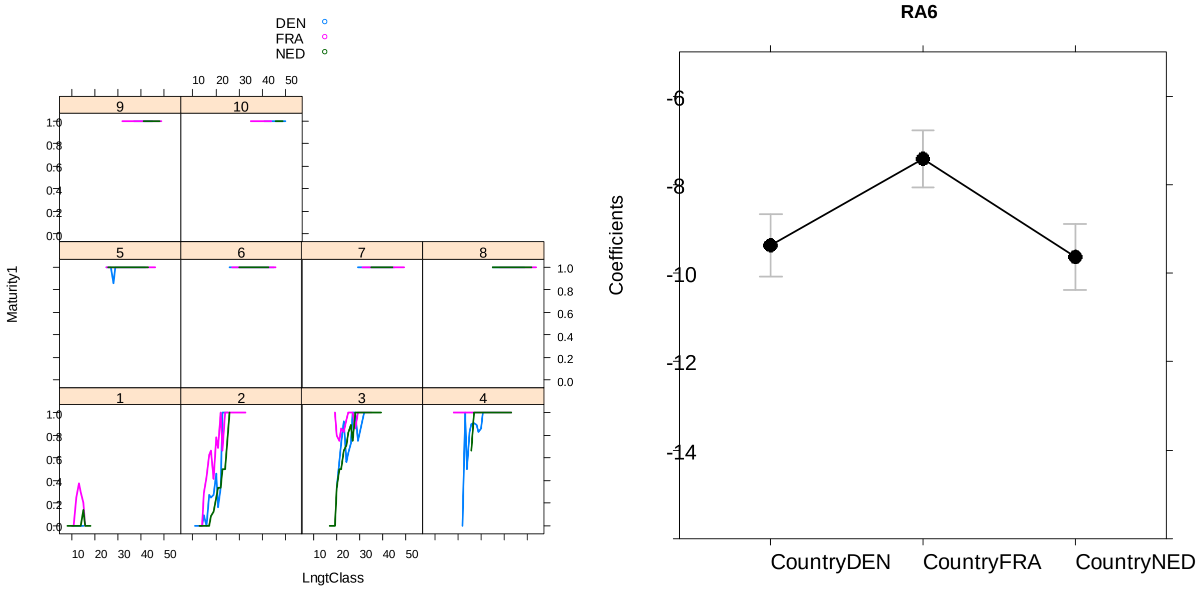


Figure B5. Left: maturity ogive from raw data; right: estimated country coefficient from the model

RA7: DEN vs. GFR

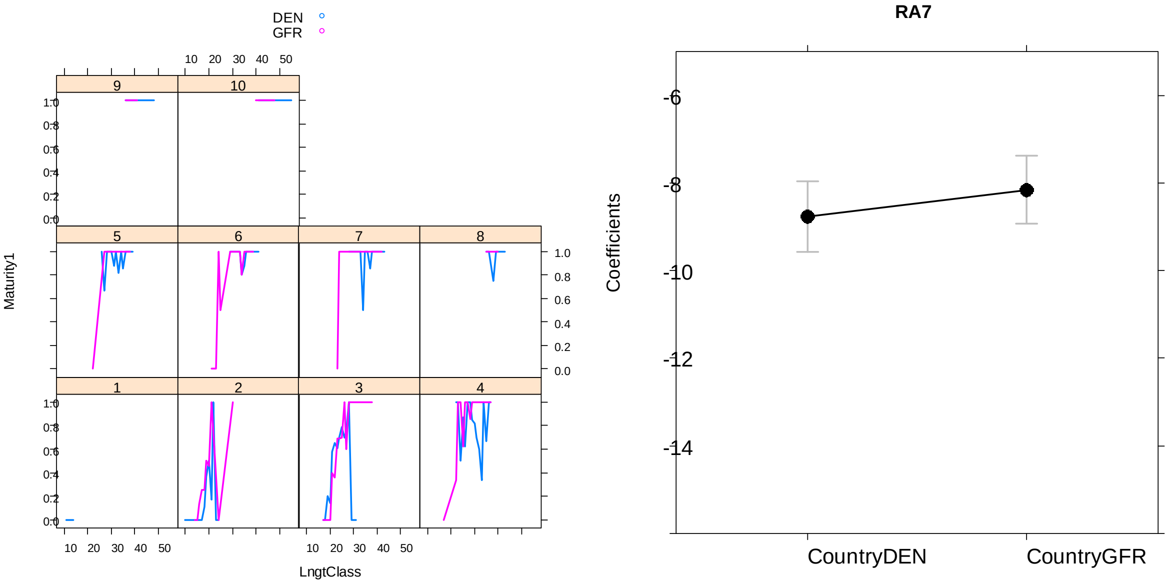


Figure B6. Left: maturity ogive from raw data; right: estimated country coefficient from the model

Country factor showed statistically significant effect in all models, implying observer effect:

GFR>NED; FRA>DEN; FRA>NED; DEN comparable to NED

8.9.1.2 Area effect

Does plaice maturity differ by area? The NS-IBTS data is not independent distributed between area and country, neither independent between year and area. Therefore, subsets (NS-IBTS, female, year>2010, age<=6) are selected to check such effect. The proportion of mature per length and agering from the raw data for area RA1, RA3 and RA8 are shown below. RA1 is only sampled by GFR and has very few samples; the observed higher maturity ogive could be due to the country effect, or due to different biological characteristics (e.g. large size). RA8 is mainly and consistently sampled by SWE since 1991. An average much lower maturity is observed in this area. This is most likely due to a different biological characteristics for plaice in this area.

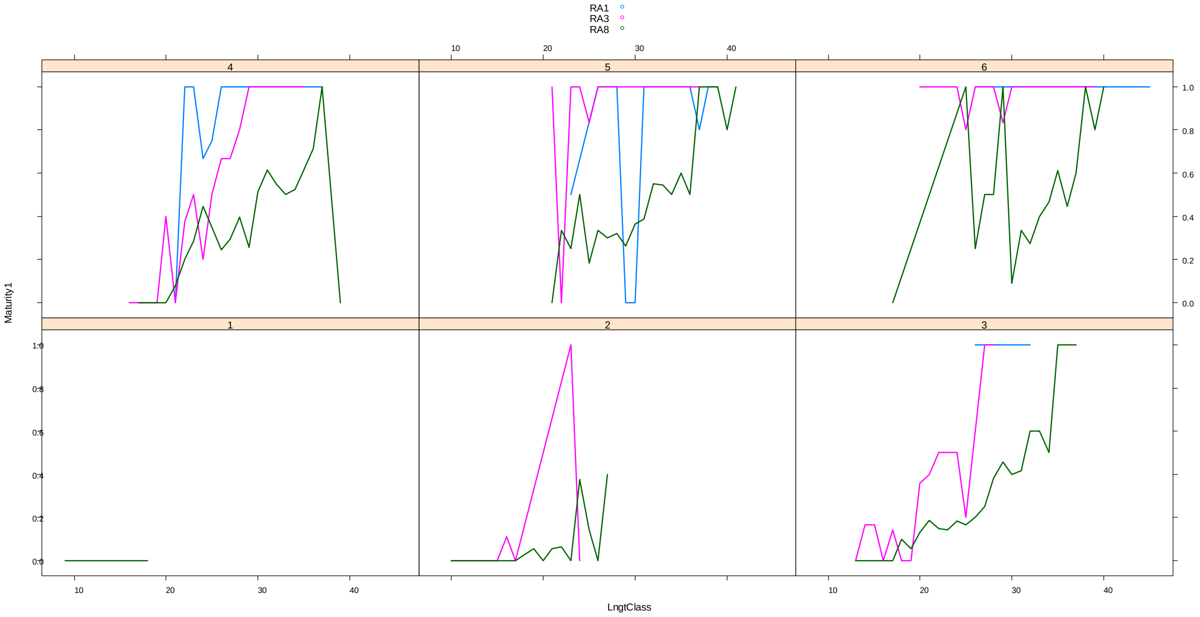


Figure B7. Area effects

To check the area effect among RA2-7, we selected NS-IBTS, female, year>2010, and applied a GLM with covariates year, age, length.

glm(maturity ~ Year + length + Age + Area + country, family=binomial, data=dat), for each matched subarea+year data

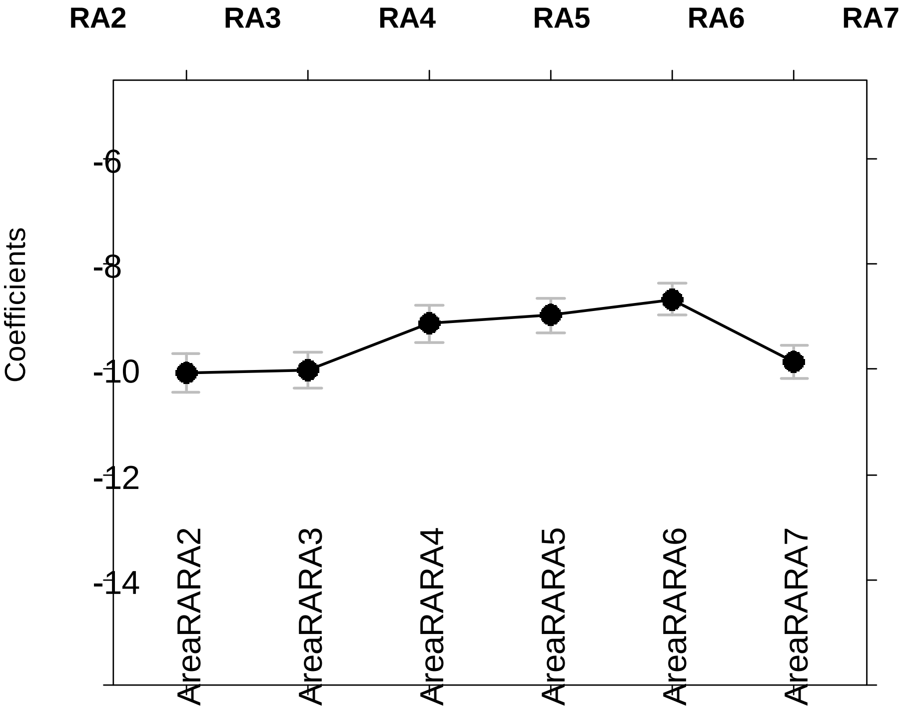


Figure B8. Model output with input from all areas 2-7, adjusted by country

Area 2-7show relatively homogeneous maturity ogive, therefore, we do not need to differentiate them. As a result, we decide to exclude RA1 data, and model RA8 separately from RA2-7.

8.9.1.3 Data type :

8.9.1.3.1 Overview:

Sufficient Dutch discards samples were obtained since 2010, while Dutch landing samples were available since 1957.

Table 3. number of maturity staged fishes sampled per year per data type

Year	NED-NS-IBTS	NED-landing	NED-discards
1991	0	1496	0
1992	0	1614	0
1993	0	1553	0
1994	0	1619	0
1995	0	1366	0
1996	0	1546	0
1997	0	1593	0
1998	0	1606	0
1999	0	1391	0
2000	0	1492	97
2001	0	1552	54
2002	0	2628	0
2003	0	1847	25

2004	0	1303	0
2005	0	1439	0
2006	0	1555	0
2007	227	1484	0
2008	319	1370	0
2009	410	1318	32
2010	402	1320	646
2011	353	1320	106
2012	356	1316	1081
2013	263	1320	632
2014	0	1320	407
2015	463	1317	499
2016	116	0	323

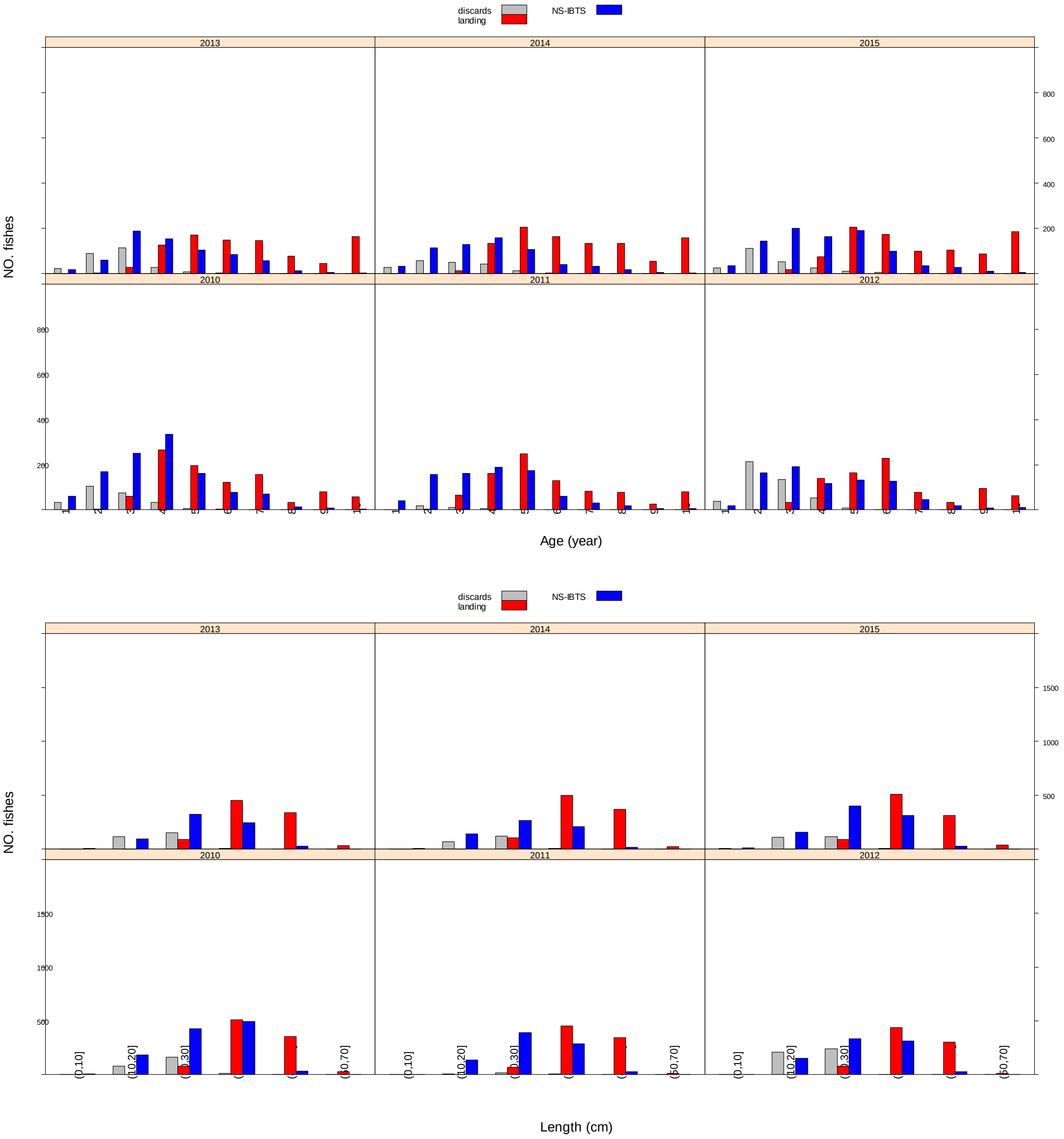


Figure B9. Number of sampled fishes per data type per year by (top panels) age and (bottom panels) length

Discards data are mainly in age 1-4, length 10-30. Landing data are mainly age>=3, length>=30.

8.9.1.3.2 Dutch NS-IBTS vs. Dutch landing

To compare Dutch landing samples against Dutch NS-IBTS while adjusting other factors, we selected the following subset: Dutch samples, female, RAarea 2, 5, 6, year 2010, 2011, 2012, 2013,2015, age>=3. (No Dutch IBTS data in 2014, Dutch landing data are from RA2,5,6,7, no Dutch IBTS data in RA7).

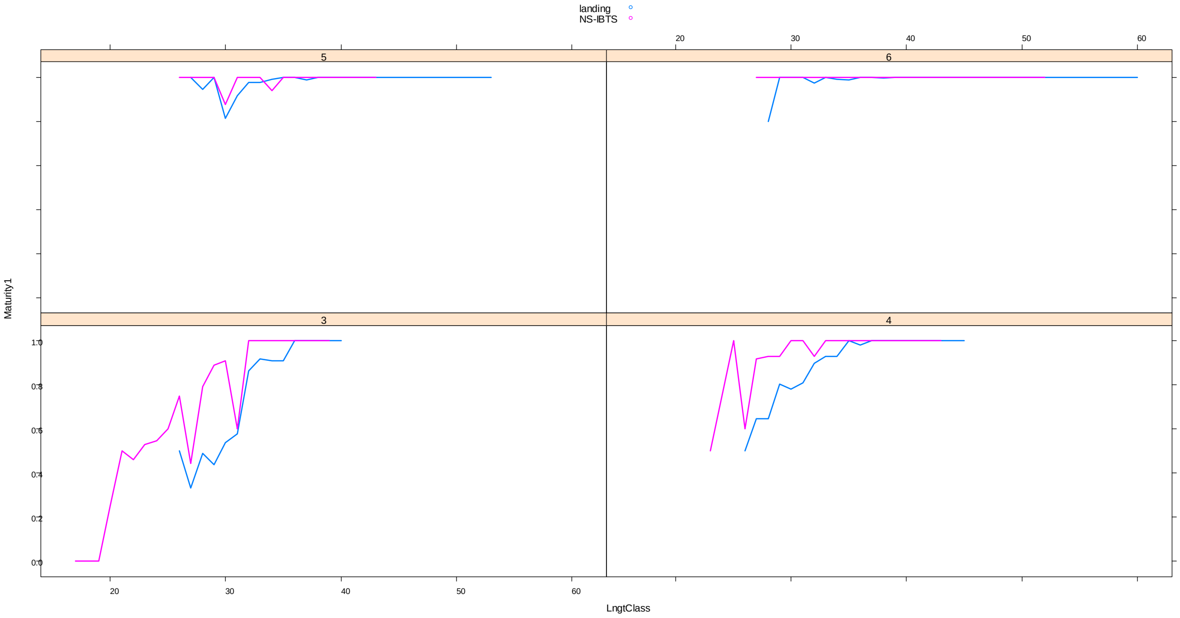


Figure B10. Propotion of mature at given length (x-axis) per age class 3-6 (panel), calculated from raw data. Plus age=6 (age>6 is categorized as 6).

Several models were applied including interactions (year-length, year-age, type-area, area-length, area-age). The best fitted model (minimum AIC) is:

glm(maturity ~ type + AreaRA (or ICESrectangle) + Year + LngtClass + AgeRings, family=binomial, data=dat)

All terms were statistically significant p<0.001 at significance level 0.05. Due to the large sample size (n=4980), a subtle difference among the levels of the covariates could lead to a “significant” result. Therefore, it is more interesting to check the actual maturity ogive differences estimated by the model, and to see whether it is biologically interesting.

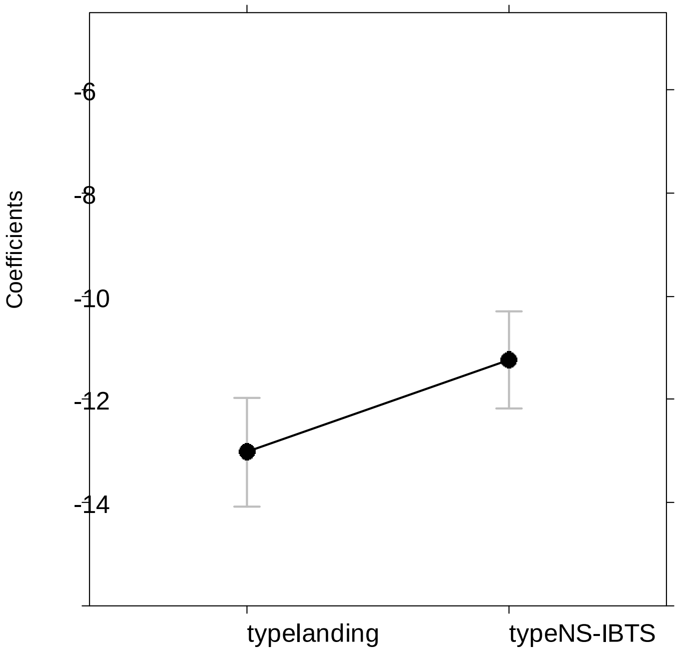


Figure B11. estimated coefficients for data type.

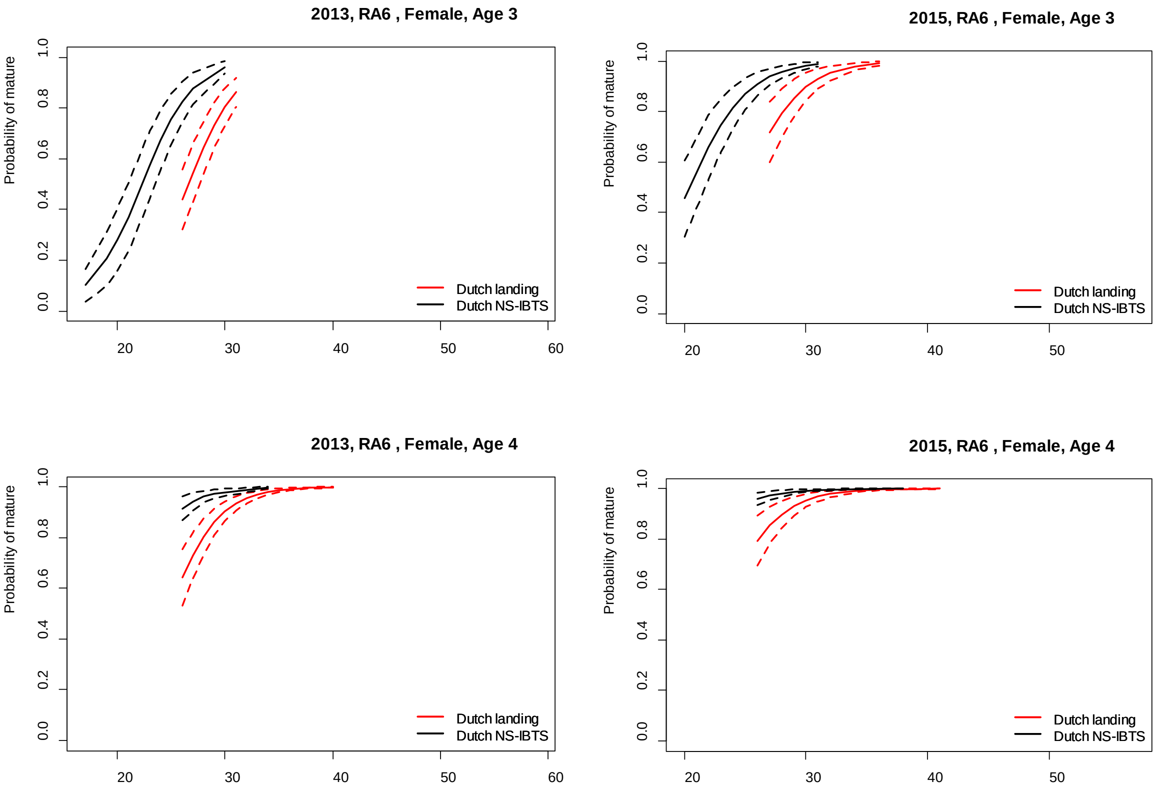


Figure B12. Fitted maturity ogive at given length, age, area, sex. The plotted length range is the same as the range from the raw data.

The fitted maturity ogive curves imply a higher maturity ogive from landing samples, especially around length 30cm at age 3. It is strange to obtain such result, since the Dutch samples were measured by the same observer. Possible explanation are 1) staging variability from very fresh samples (survey) and fresh samples (auction); 2) Perhaps it is related to the difference in behaviour of immature and mature plaice during the spawning period. During their migrations to the spawning grounds, plaice use tidal transport and leave the seafloor and swim in midwater. As the vertical net opening of the IBTS is wider than the beam trawl, this may cause a bias in the fish sampled. This is quite farfetched as the time spend in midwater relative to the spawning period will be (very) small; 3) Another possibility is that the differences may be due to subtle changes in the maturity composition of the population in time. As the IBTS takes it samples in the 2nd part of Q1, the landings will also comprise of samples taken in January. I have never checked whether this affects the maturity ogive. It does influence the maturity stages found in the samples.

8.9.1.3.3 Dutch NS-IBTS vs. Dutch discards

To compare Dutch discards samples against Dutch NS-IBTS while adjusting other factors, we selected the following subset: Dutch samples, female, RA area 6, year 2010-2016 excluding 2014, age 1-4.

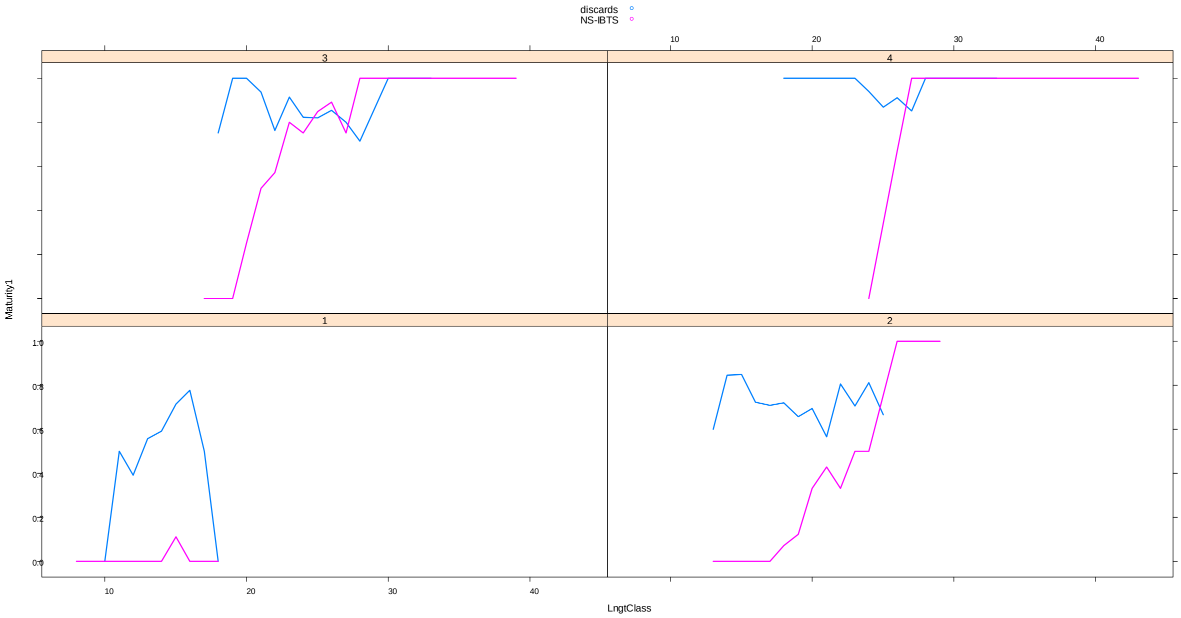


Figure B13. Propotion of mature at given length (x-axis) per age class 1-5 (panel), calculated from raw data.

It seems that when the length is larger than 25cm, both data type yield similar maturity ogive. When length is <25cm, the Dutch discard samples have a much higher maturity ogive. This implies that a length-data_type interaction might exist.

Several models were applied including interactions (year-length, year-age, type-length, type-age). The best fitted model (minimum AIC) is:

glm(maturity ~ type * LngtClass + Year + AgeRings, family=binomial, data=dat)

All terms were statistically significant at significance level 0.05. Due to the large sample size (n=1348), a subtle difference among the levels of the covariates could lead to a “significant” result. Therefore, it is more interesting to check the actual maturity ogive differences estimated by the model, and to see whether it is biologically interesting.

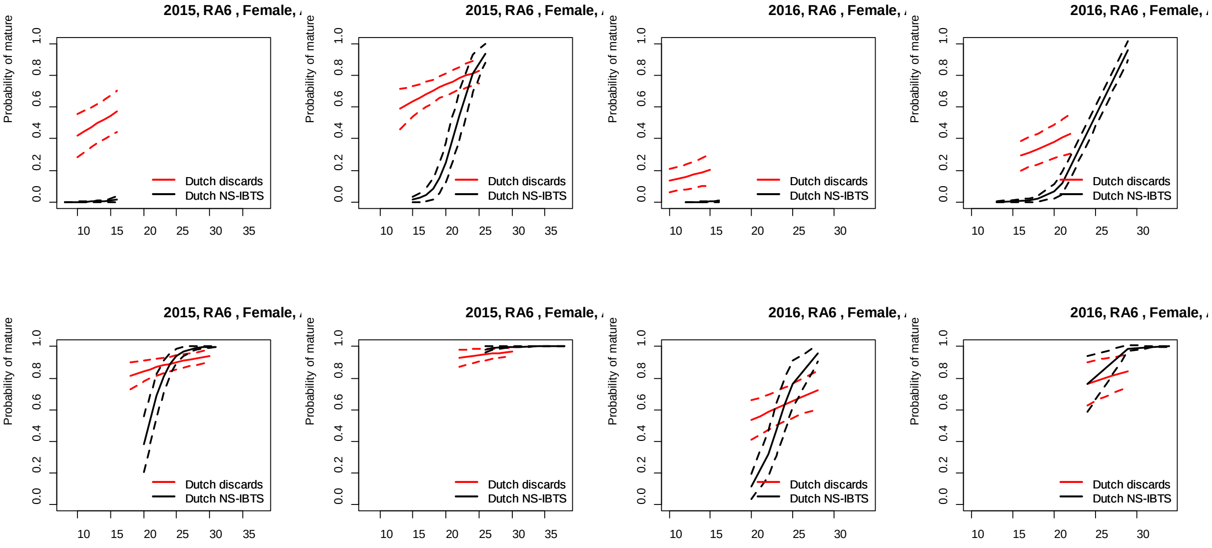


Figure B14. Fitted maturity ogive at given length, age, area, sex. The plotted length range is the same as the range from the raw data.

Discards samples have a strangely extremely high maturity ogive at short length. This is due to the high proportion (66%) of “spent” (=score 64) in the samples. The discard samples in NED was scored by two trained external fishermen. This could cause the observed high maturity ogive. As a result, we decide to exclude the discards samples.

8 Working document 4: assessment plaice in 3a and 4

8.1 Table of contents

8.2 Introduction

This working document describes the exploratory assessment runs done for plaice in 3a and 4. The first part of the document describes the generic model formulation of the model, including the settings. The next section describes the data that was initially available. Those data were extended with the combined BTS and IBTS datasets during the explorations. The final section contains all the runs with different model settings and model formulations, including the results.

The current assessment uses discards data from 2000 onwards: The discards time series used in the assessment includes Dutch, Danish, German and UK discards observations for 2000–2015. To reconstruct the number of plaice discards at age before 2000, catch numbers at age data was reconstructed in 2005 based on a model-based analysis of growth, selectivity of the 80-mm beam trawl gear, and the availability of undersized plaice on the fishing grounds. This reconstruction was done in 2004 (van Keeken et al. 2004). Since, novel methods have been developed to estimate discards in stock assessments (Aarts and Poos, 2009). This assessment also has the benefit of being able to estimate uncertainty in SSB, fishing mortality and recruitment.

8.3 Model formulation preliminary assessment runs

The assessment presented here is similar in structure to that in Aarts and Poos (2009), but the F-at-age matrix is generated using a tensor spline (with a design matrix taken from mgcv (Wood, 2006)). The number of knots in this tensor spline are controlled by means of a vector of length 2, one for the knots in the age dimension, and one for the number of knots in the year dimension of the assessment . As a starting point, the assessment is run with a discards selectivity curve that is fixed over time, described by a two parameter inverse logit function:

$$d_{a,t} = 1/\ (1 + \exp(\ \mathrm{dcf}(1) * (a + \mathrm{dcf}(2))) \qquad [1]$$

Here, dcf(1) and dcf(2) are the two parameters needed to estimate this discards fraction as a function of age, fixed over the years. The tuning indices are described using a basis spline, the amount of knots of which can be set in the control object. Because the catchability–at-age vectors for all tuning indices are treated as splines, the age range for the SNS indices in this assessment is extended from 1-3 to 1-7.

A first run with low number of knots in the year direction is given below. Results are presented for the case in which the discards estimates by van Keeken et al. 2004 are treated as observations (as is done in the current assessment), and for the case in which the discards prior to 2000 are estimated from the survey and landings information.

Numbers at age are modelled along each cohort using

$$N_{a,t} = N_{a-1,t-1}\, e^{-Z_{a-1,t-1}} \qquad [2]$$

where $N_{a,t}$ are the numbers at age *a* at time *t*, and $Z_{a,t}$ the total mortality, which is composed of the instantaneous natural mortality rate $M_{a,t}$ and the fishing mortality rate $F_{a,t}$. Fishing mortality $F_{a,t}$ is calculated by matrix multiplication of a design matrix $\boldsymbol{X}$ and β, a vector of the model's coefficients. The length of β is the product of *Fage.knots, Ftime.knots* (see settings). In order to ensure that $F_{a,t}$ remains positive for any value of β, $\boldsymbol{X}\,\beta$ is exponentiated in the model.

The expected catch $C_{a,t}$ for age *a* and year *t* is calculated from

$$C_{a,t} = \frac{F_{a,t}}{Z_{a,t}} N_{a,t}(1 - e^{-Z_{a,t}})$$

The catch consist of discards $D_{a,t}$ and landings $L_{a,t}$. An age-dependent fraction $d_{a,t}$ of the catch is discarded (see eq [1]) and

$$D_{a,t} = d_{a,t}C_{a,t}$$

$$L_{a,t} = \left(1 - d_{a,t}\right)C_{a,t}$$

The population size $N_{a,t}$ represents the population size on 1 January of year *t*. Survey indices often take place later in the year, and the population size may be reduced considerably by fishing and natural mortality. The catch of survey $U_{a,t}$ can be calculated as

$$U_{a,t} = q_a N_{a,t} e^{-\kappa Z_{a,t}}$$

where $e^{-\kappa Z_{a,t}}$ term corrects for the reduction in population size because of fishing and natural mortality, and κ is the timing of each survey expressed as a fraction of a year. The age dependent catchability of the survey is the inverse logit of a smooth function of age, constructed using b-spline basis functions.

The available datasets for parameter estimation are (i) landings-at-age, (ii) discards-at-age, and (iii) tuning series from surveys. The data are assumed to be lognormally distributed, with means and age-specific standard deviations predicted by the model. Zero values were replaced by half of the lowest value observed in the dataset where each occurred. This approach guards against zeros in the likelihood function by taking account of the scale of the data. The total log-likelihood is the sum of the log likelihood components for the landings-at-age, discards-at-age and tuning series.

8.4 Settings

A number of assessment settings are available in the model. These are described below

pGrp. This setting defines the interpretation of the final age in the landings-at-age and discards-at-age matrix. If set to True (1), then these are plusgroups, and the final age in the model will be evaluated to be a plusgroup. Eq [2] is extended to accomodate for this plusgroup:

$$N_{a^+,t} = N_{a^+-1,t-1}\, e^{-Z_{a^+-1,t-1}} + pGrp\, N_{a^+,t-1}\, e^{-Z_{a^+,-1t}}$$

N(t+1,nages) = N(t,nages-1) * S(t,nages-1) + pGrp * (N(t,nages) * S(t,nages))

In which N (t,a) are the numbers at age, and S(a,t) is the survival (defined as exp(-(F(a,t)+M(a,t))). The plusgroup is used only for a=nages.

qplat.surveys Defines the age at which the catchability for the surveys reaches a plateau. For ages below qplat.surveys the catchability is estimated to be a value between 0 and 1, using a basis spline with a number of knots being equal to Fage.knots): exp(log_sel_cofU(s)*bs1)/ 1+exp(log_sel_cofU(s)*bs1). log_sel_cofU being a matrix of dimensions number of surveys, Fage.knots. bs 1 being the basis spline matrix.

qplat.Fmatrix. Defines the age at which the catchability for the F-at-age reaches a plateau. For ages below qplat.Fmatrix the F ate age matrix (F(a,t)) is estimated using a tensor spline design matrix (taken from mgcv in R. The dimensions of this matrix are defined by Fage.knots, Ftime.knots and the number of years in the F-at-age matrix and *qplat.Fmatrix.*

Fage.knots, Ftime.knots No. of knots for age dim of F-at-age matrix (&survey catchabilities), and year dim of F-at-age matrix. Total degrees of freedom used by the tensor spline is product of *Fage.knots, Ftime.knots.*

dsel.time phase in which the time varying discards curve is estimated in an extension of Eq. [2]:

$d_{a,t}$ = 1/(1+exp((dcf(1)+dct(1)*t + dct(2)*t*t)*(a+dcf(2)+dct(3)*t+dct(4)*t*t)) [3]

If a time varying discards function is thus estimated, this requires 4 additional parameters. If a time-varying discards curve is estimated, the starting year for this function can be set, so that all years prior to this year have a time-invarying curve, and the time varying part only starts at *dsel.startyr.* The discards selectivity prior to t *dsel.startyr* is equal to the discards selection in *dsel.startyr.* It should be noted that all years (also those prior to *dsel.startyr* areused in the estimation routines.

8.5 Data availability

Apart from the settings of the assessment, the starting year of the assessment can be chosen. The age structured landings information is available since 1957, but the first age structured survey information is available since 1970. The first age structured discards observations are available since 2000, but a reconstruction was done in the period 1957-1999, described in (van Keeken et al. 2004)

The current assessment uses four age structured index series: SNS1, SNS2, BTS-Isis early, and BTS combined. SNS1 and SN2 are the SNS survey that started in 1970 and that has been held annualy since, split in two time series. This was done of problems with auto-correlated survey residuals. This autocorrelation is likely the result from changes in the spatial distribution of plaice (van Keeken et al. 2007; Poos et al. 2013), but alternatively could result from the shift in using historically reconstructed discards estimates (prior to 2000) to the discards observations).

8.6 Runs

A number of assessment runs were done, mimicking the XSA (see table below)

Stock	North Sea and Skagerrak combined
Catch at age	Landings + (reconstructed) discards based on NL, DK + UK + DE fleets and BE (since 2012)
Fleets (years; ages)	BTS-Isis-early 1985–1995; 1–8 BTS-combined 1996–2015; 1–9 SNS1 1982–1999; 1–3 SNS2 2000-2015 (excl. 2003); 1–3
Plus group	10
First tuning year	1982
Last data year	2015
Time series weights	No taper
Catchability dependent on stock size for age <	1
Catchability independent of ages for ages >=	6
Survivor estimates shrunk towards the mean F	5 years / 5 years
s.e. of the mean for shrinkage	2.0
Minimum standard error for population estimates	0.3
Prior weighting	Not applied

The runs below using the AAP model are described in the subsquent sections. For each run, results are presented using the historic discards estimates as data in the assessment, as well as results that omit the discards reconstructions, and only use the direct observations (2000-2015). A set of relevant results are also available for comparison in table 1.

Early on in the exploratory assessment runs, a full replacement of discards estimates of the current reconstruction by estimates from the assessment model was envisaged. However, during the preliminary runs, it became clear that if a time-varying discards selectivity was to be estimated, a lack of survey information in the early part of the assessment prevented estimation of discards prior to approx. 1975. Then, because the original discards reconstruction by van Keeken et al. (2004) was going to be used, it was decided to treat the sum of discards-at-ag and landings-at-age as a single source of information, rather than estimating discards-at-age and landings-at-age separately.

First a base run was done, with settings mimicking the XSA settings (apart from qplat. surveys, see text). This first run assumes a time unvarying age dependent discards fraction. The results of the exploratory runs for settings are summarized in Table 1.

The second run has a time varying discards fraction at age. One of the problems is clearly that if the discards reconstruction is used as input then the assessment works well. If the discards reconstruction is omitted and the discards are estimated in the model, then the discards estimate prior to 1975 become unrealistically small. The reason for this is that there is no survey information available that connects the current discards estimates with the period for which discards have to be estimated.

Run 3 tries to solve this problem by running the assessment from 1970 onwards, but the problem for the assessments where the historic discards have to be estimate still occurs, with the model estimating unrealistically low discards estimates for the first years of the assessment.

In Run 4 the starting year was set back to 1957. If we decide to use the historic reconstruction also in the new assessment, then the question becomes how many degrees of freedom to use in the assessment. What if we increase from 26 to 30? What happens to nll, the rho estimates, and the results in terms of F,R, and SSB?

Run 5 is to test if the autocorrelation in the SNS (if we combine SNS1 and SNS2) disappears if we estimate the historic discards in the assessment. Potentially, cutting the series in two that was decided historically was a mistake, if the autocorrelation comes from the way the discards were reconstructed. However, the autocorrelation in the SNS residuals is present also if the AAP model estimates the discards.

Run 6 was equal to run2, but the q plateau for the surveys was set to age 6, This is more in line with the current XSA settings. This setting implies that the catchability in the SNS for ages six and seven do not decrease, which is not completely true (see earlier runs).

In run 7, age 7 is removed from the SNS series (so that it now spans ages 1:6, and the zero discards-at-age for the older ages in the original reconstruction are removed (and set to NA). Those would now be estimated. The latter change to the model removes part of the “hump shaped” sigma estimates in the log-likelihood component for the discards-at-age: the assumed zeros get replaced by a small constant, but the difference between that constant and the modelled discards estimates for those ages are large when compared on a log-scale (as is done in the model)

Run 8 is equal to run 7, with the exception that the BTS indices now come from the the GAM model approach by Berg et al. (2014). The creation of these indices is described in more detail in the working document on the combination of the indices. This combined BTS index contains more survey information on plaice (mainly because it includes information from the German BTS that fishes in an area that is not covered by BTS ISIS or BTS Tridens). For a summary of the runs with the different new indices, see Table 2.

Run 9 is equal to run 8, with the exception that the IBTS Q3 indices are now included. These IBTS Q3 indices also come from the GAM model approach by Berg et al. (2014), and are available from 1997 onwards. For more information on this time series see the working document on the surveys.

Run 10 is equal to run 9, with the exception that the IBTS Q1 indices are now included. These IBTS Q1 indices also come from the GAM model approach by Berg et al. (2014), and are available from 2007 onwards. For more information on this time series see the working document on the surveys.

Run 11 is equal to run 10, with the exception that the IBTS Q3 indices are now removed. This can thus be seen as a ”leave-one-out run” of the assessment with all survey information as in run 10. Note that run 9 can likewise be seen as a ”leave-one-out run”, but then for IBTS Q1.

Run 12 is equal to run 10, but the q plateau for the surveys was set to age 7 and the number of knots for year dimension in the tensor spline was reduced to 22. This was done to evaluate if there is a trend in catchability between ages 6 and 7, and to see the effect of reducing the . The results there was no such trend.

Run 13 is equal to run 12, but the plateau is set to 6 and the discards selection pattern is assumed to be constant in the period 1957-2000, and time varying in the subsequent years. This model setting was chosen to try and improve the discards estimates in the most recent part of the assessment.

Run 14 is equal to run 13, but the number of knots for year dimension in the tensor spline was increased to 26.

In run 15, the structure of the model is altered so that the sum of discards-at-ag and landings-at-age as a single source of information, rather than estimating discards-at-age and landings-at-age separately. After the estimation of the catches-at age in the likelihood function the discards-at-age and landings-at-age are estimated using the estimated catches-at-age and the proportionality of discards-at-age and landings-at-age in the observations. This procedure results in discards-at-age and landings-at-age that follow the observations closer, probably leading to less variability in the forecasts needed for advice. The settings for this run were selected from a larger number of runs using this model structure, summarized in table 3.

8.6.1 Run 1 (base run)

This run mimicks the XSA in terms of starting year, surveys used, qplat.Fmatrix. One difference is the qplat.surveys, which is set to 7 here (rather than age 6 in the XSA).

The final settings are thus:

Startyear data	1957
Indices	BTS early ages 1-8 BTS combined ages 1-9 SNS1 ages 1-7 SNS2 ages 1-7
pGrp: TRUE	The final age of Landings-at-age and discards-at-age matrix are plusgroups
qplat.surveys: 7	Age at which the catchability for the surveys reaches a plateau
qplat.Fmatrix: 9	Age at which the catchability for the F-at-age reaches a plateau
Fage.knots: 6	No. of knots for age dim of F-at-age matrix (&survey catchabilities)
Ftime.knots: 26	No. of knots for year dim of F-at-age matrix
dsel.time: -1	constant discards selectivity over years
dsel.startyr: 1957	start year of the time-varying discards selectivity curve (if applicable)

The results of this run are in Figures 1-11.

8.6.2 Run 2 (estimate time varying discarding selectivity)

Startyear data	1957
Indices	BTS early ages 1-8 BTS combined ages 1-9 SNS1 ages 1-7 SNS2 ages 1-7
pGrp: TRUE	The final age of Landings-at-age and discards-at-age matrix are plusgroups
qplat.surveys: 7	Age at which the catchability for the surveys reaches a plateau

qplat.Fmatrix: 9	Age at which the catchability for the F-at-age reaches a plateau
Fage.knots: 6	No. of knots for age dim of F-at-age matrix (&survey catchabilities)
Ftime.knots: 26	No. of knots for year dim of F-at-age matrix
dsel.time: 2	estimate discards selectivity over years (in phase 2)
dsel.startyr: 1957	start year of the time-varying discards selectivity curve (if applicable)

The results of this run are in Figures 12:22

8.6.3 Run 3 (Preliminary assessment runs from 1970)

Startyear data	1970
Indices	BTS early ages 1-8
	BTS combined ages 1-9
	SNS1 ages 1-7
	SNS2 ages 1-7

pGrp: TRUE	The final age of Landings-at-age and discards-at-age matrix are plusgroups
qplat.surveys: 7	Age at which the catchability for the surveys reaches a plateau
qplat.Fmatrix: 9	Age at which the catchability for the F-at-age reaches a plateau
Fage.knots: 6	No. of knots for age dim of F-at-age matrix (&survey catchabilities)
Ftime.knots: 26	No. of knots for year dim of F-at-age matrix
dsel.time: -1	constant discards selectivity over years

The results of this run are in Figures 23:33

8.6.4 Run 4 (time varying discard selectivity, higher number of time knots tensor F at age)

Startyear data	1957
Indices	BTS early ages 1-8
	BTS combined ages 1-9
	SNS1 ages 1-7
	SNS2 ages 1-7

pGrp: TRUE	The final age of Landings-at-age and discards-at-age matrix are plusgroups
qplat.surveys: 7	Age at which the catchability for the surveys reaches a plateau
qplat.Fmatrix: 9	Age at which the catchability for the F-at-age reaches a plateau
Fage.knots: 6	No. of knots for age dim of F-at-age matrix (&survey catchabilities)
Ftime.knots: 30	No. of knots for year dim of F-at-age matrix
dsel.time: 2	estimate discards selectivity over years (in phase 2)
dsel.startyr: 1957	start year of the time-varying discards selectivity curve (if applicable)

The results of this run are in Figures 34:44

8.6.5 Run 5 (settings equal to run 4, but with SNS1 and SNS2 combined)

Startyear data	1957
Indices	BTS early ages 1-8
	BTS combined ages 1-9
	SNS combined ages 1-7

pGrp: TRUE	The final age of Landings-at-age and discards-at-age matrix are plusgroups
qplat.surveys: 7	Age at which the catchability for the surveys reaches a plateau
qplat.Fmatrix: 9	Age at which the catchability for the F-at-age reaches a plateau
Fage.knots: 6	No. of knots for age dim of F-at-age matrix (&survey catchabilities)
Ftime.knots: 30	No. of knots for year dim of F-at-age matrix
dsel.time: 2	estimate discards selectivity over years (in phase 2)

dsel.startyr: 1957	start year of the time-varying discards selectivity curve (if applicable)

The results of this run are in Figures 45:55

8.6.6 Run 6 (equal to run2, but with q plateau for survey at age 6, like current XSA)

Startyear data	1957
Indices	BTS early ages 1-8 BTS combined ages 1-9 SNS1 ages 1-7 SNS2 ages 1-7
pGrp: TRUE	The final age of Landings-at-age and discards-at-age matrix are plusgroups
qplat.surveys: 6	Age at which the catchability for the surveys reaches a plateau
qplat.Fmatrix: 9	Age at which the catchability for the F-at-age reaches a plateau
Fage.knots: 6	No. of knots for age dim of F-at-age matrix (&survey catchabilities)
Ftime.knots: 26	No. of knots for year dim of F-at-age matrix
dsel.time: 2	estimate discards selectivity over years (in phase 2)
dsel.startyr: 1957	start year of the time-varying discards selectivity curve (if applicable)

The results of this run are in Figures 56:66

8.6.7 Run 7 (equal to run6, but SNS ages 1:6, and removing the zero assumed discards in the historic part)

This run was done because now q plateau is at age 6, and SNS has clearly decreasing catchability there. Also, the strong ”hump-shape” in the discards sigmas is likely because these are inflated around age seven, where all discards are assumed to be zero.

Startyear data	1957
Indices	BTS early ages 1-8 BTS combined ages 1-9 SNS1 ages 1-6 SNS2 ages 1-6
pGrp: TRUE	The final age of Landings-at-age and discards-at-age matrix are plusgroups
qplat.surveys: 6	Age at which the catchability for the surveys reaches a plateau
qplat.Fmatrix: 9	Age at which the catchability for the F-at-age reaches a plateau
Fage.knots: 6	No. of knots for age dim of F-at-age matrix (&survey catchabilities)
Ftime.knots: 26	No. of knots for year dim of F-at-age matrix
dsel.time: 2	estimate discards selectivity over years (in phase 2)
dsel.startyr: 1957	start year of the time-varying discards selectivity curve (if applicable)

The results of this run are in Figures 67:77

8.6.8 Run 8 (equal to run7, BTS combined now from DATRAS)

This run was done because now q plateau is at age 6, and SNS has clearly decreasing catchability there. Also, the strong ”hump-shape” in the discards sigmas is likely because these are inflated around age seven, where all discards are assumed to be zero.

Startyear data	1957
Indices	BTS early ages 1-8 BTS combined new ages 1-9 SNS1 ages 1-6 SNS2 ages 1-6
pGrp: TRUE	The final age of Landings-at-age and discards-at-age matrix are plusgroups

qplat.surveys: 6	Age at which the catchability for the surveys reaches a plateau
qplat.Fmatrix: 9	Age at which the catchability for the F-at-age reaches a plateau
Fage.knots: 6	No. of knots for age dim of F-at-age matrix (&survey catchabilities)
Ftime.knots: 26	No. of knots for year dim of F-at-age matrix
dsel.time: 2	estimate discards selectivity over years (in phase 2)
dsel.startyr: 1957	start year of the time-varying discards selectivity curve (if applicable)

The results of this run are in Figures 78:88

8.6.9 Run 9 (Inclusion of only IBTS Q3)

This run was done because now q plateau is at age 6, and SNS has clearly decreasing catchability there. Also, the strong ”hump-shape” in the discards sigmas is likely because these are inflated around age seven, where all discards are assumed to be zero.

Startyear data	1957
Indices	BTS early ages 1-8
	BTS combined new ages 1-9
	SNS1 ages 1-6
	SNS2 ages 1-6
	IBTS Q3 ages 1-9

pGrp: TRUE	The final age of Landings-at-age and discards-at-age matrix are plusgroups
qplat.surveys: 6	Age at which the catchability for the surveys reaches a plateau
qplat.Fmatrix: 9	Age at which the catchability for the F-at-age reaches a plateau
Fage.knots: 6	No. of knots for age dim of F-at-age matrix (&survey catchabilities)
Ftime.knots: 26	No. of knots for year dim of F-at-age matrix
dsel.time: 2	estimate discards selectivity over years (in phase 2)

The results of this run are in Figures 89:99

8.6.10 Run 10 (Inclusion of IBTS Q3 & IBTS Q1)

This run was done because now q plateau is at age 6, and SNS has clearly decreasing catchability there. Also, the strong ”hump-shape” in the discards sigmas is likely because these are inflated around age seven, where all discards are assumed to be zero.

Startyear data	1957
Indices	BTS early ages 1-8
	BTS combined new ages 1-9
	SNS1 ages 1-6
	SNS2 ages 1-6
	IBTS Q3 ages 1-9
	IBTS Q1 ages 1-9

pGrp: TRUE	The final age of Landings-at-age and discards-at-age matrix are plusgroups
qplat.surveys: 6	Age at which the catchability for the surveys reaches a plateau
qplat.Fmatrix: 9	Age at which the catchability for the F-at-age reaches a plateau
Fage.knots: 6	No. of knots for age dim of F-at-age matrix (&survey catchabilities)
Ftime.knots: 26	No. of knots for year dim of F-at-age matrix
dsel.time: 2	estimate discards selectivity over years (in phase 2)
dsel.startyr: 1957	start year of the time-varying discards selectivity curve (if applicable)

The results of this run are in Figures 100:107

8.6.11 Run 11 (Inclusion of only IBTS Q1)

This run was done because now q plateau is at age 6, and SNS has clearly decreasing catchability there. Also, the strong ”hump-shape” in the discards sigmas is likely because these are inflated around age seven, where all discards are assumed to be zero.

Startyear data	1957
Indices	BTS early ages 1-8 BTS combined new ages 1-9 SNS1 ages 1-6 SNS2 ages 1-6 IBTS Q1 ages 1-9

pGrp: TRUE	The final age of Landings-at-age and discards-at-age matrix are plusgroups
qplat.surveys: 6	Age at which the catchability for the surveys reaches a plateau
qplat.Fmatrix: 9	Age at which the catchability for the F-at-age reaches a plateau
Fage.knots: 6	No. of knots for age dim of F-at-age matrix (&survey catchabilities)
Ftime.knots: 26	No. of knots for year dim of F-at-age matrix
dsel.time: 2	estimate discards selectivity over years (in phase 2)
dsel.startyr: 1957	start year of the time-varying discards selectivity curve (if applicable)

The results of this run are in Figures 100:115

8.6.12 Run 12 (equal to run 10, but q plateau set to age 7, and Ftime.knots to 22)

This run was done because now q plateau is at age 6, and SNS has clearly decreasing catchability there. Also, the strong ”hump-shape” in the discards sigmas is likely because these are inflated around age seven, where all discards are assumed to be zero.

Startyear data	1957
Indices	BTS early ages 1-8 BTS combined new ages 1-9 SNS1 ages 1-6 SNS2 ages 1-6 IBTS Q3 ages 1-9 IBTS Q1 ages 1-9

pGrp: TRUE	The final age of Landings-at-age and discards-at-age matrix are plusgroups
qplat.surveys: 7	Age at which the catchability for the surveys reaches a plateau
qplat.Fmatrix: 9	Age at which the catchability for the F-at-age reaches a plateau
Fage.knots: 6	No. of knots for age dim of F-at-age matrix (&survey catchabilities)
Ftime.knots: 22	No. of knots for year dim of F-at-age matrix
dsel.time: 2	estimate discards selectivity over years (in phase 2)
dsel.startyr: 1957	start year of the time-varying discards selectivity curve (if applicable)

The results of this run are in Figures 116:123

8.6.13 Run 13 (starting time varying discard selectivity in 2000)

This run was done to see if starting time varying discards later in the time series improves the estimation of landings and discards in the most recent part of the time series.

Startyear data	1957
Indices	BTS early ages 1-8 BTS combined new ages 1-9 SNS1 ages 1-6 SNS2 ages 1-6

	IBTS Q3 ages 1-9
	IBTS Q1 ages 1-9

pGrp: TRUE	The final age of Landings-at-age and discards-at-age matrix are plusgroups
qplat.surveys: 6	Age at which the catchability for the surveys reaches a plateau
qplat.Fmatrix: 9	Age at which the catchability for the F-at-age reaches a plateau
Fage.knots: 6	No. of knots for age dim of F-at-age matrix (&survey catchabilities)
Ftime.knots: 22	No. of knots for year dim of F-at-age matrix
dsel.time: 2	estimate discards selectivity over years (in phase 2)
dsel.startyr: 2000	start year of the time-varying discards selectivity curve (if applicable)

The results of this run are in Figures 124:125

8.6.14 Run 14 (equal to 13, but increase of knots for tensor F-at age)

This run was done to see if starting time varying discards later in the time series improves the estimation of landings and discards in the most recent part of the time series.

Startyear data	1957
Indices	BTS early ages 1-8
	BTS combined new ages 1-9
	SNS1 ages 1-6
	SNS2 ages 1-6
	IBTS Q3 ages 1-9
	IBTS Q1 ages 1-9

pGrp: TRUE	The final age of Landings-at-age and discards-at-age matrix are plusgroups
qplat.surveys: 6	Age at which the catchability for the surveys reaches a plateau
qplat.Fmatrix: 9	Age at which the catchability for the F-at-age reaches a plateau
Fage.knots: 6	No. of knots for age dim of F-at-age matrix (&survey catchabilities)
Ftime.knots: 26	No. of knots for year dim of F-at-age matrix
dsel.time: 2	estimate discards selectivity over years (in phase 2)
dsel.startyr: 2000	start year of the time-varying discards selectivity curve (if applicable)

The results of this run are in Figures 126:127

8.6.15 Run 15 (using catches-at-age combined in likelihood, final run)

In run 15, the structure of the model is altered so that the sum of discards-at-ag and landings-at-age as a single source of information, rather than estimating discards-at-age and landings-at-age separately. After the estimation of the catches-at age in the likelihood function the discards-at-age and landings-at-age are estimated using the estimated catches-at-age and the proportionality of discards-at-age and landings-at-age in the observations. This procedure results in discards-at-age and landings-at-age that follow the observations closer, probably leading to less variability in the forecasts needed for advice. The settings for this run were selected from a larger number of runs using this model structure, summarized

Startyear data	1957
Indices	BTS early ages 1-8
	BTS combined new ages 1-9
	SNS1 ages 1-6
	SNS2 ages 1-6
	IBTS Q3 ages 1-9
	IBTS Q1 ages 1-9

pGrp: TRUE	The final age of Landings-at-age and discards-at-age matrix are plusgroups
qplat.surveys: 6	Age at which the catchability for the surveys reaches a plateau
qplat.Fmatrix: 9	Age at which the catchability for the F-at-age reaches a plateau
Fage.knots: 6	No. of knots for age dim of F-at-age matrix (&survey catchabilities)

Ftime.knots: 26 No. of knots for year dim of F-at-age matrix

The results of this run are in Figures 128:135

References

Aarts G., and Poos J. J. 2009. Comprehensive discard reconstruction and abundance estimation using flexible selectivity functions. – ICES Journal of Marine Science, 66: 763–771.

Poos J.J., Aarts G. Vandemaele S., Willems W., Bolle L.J., van Helmond A.T.M. (2013) Estimating spatial and temporal variability of juvenile North Sea plaice from opportunistic data. Journal of Sea Research 75 118–128

van Keeken, O., Pastoors M. and Rijnsdorp A.D. 2004. Reconstructing the numbers of plaice discarded in the demersal fisheries since 1957. Working document for the ICES Working Group on the Assessments of Demersal stocks in the North Sea and Skagerrak. 12 pp.

van Keeken O.A., van Hoppe M., Grift R.E. and Rijnsdorp A.D. 2007. Changes in the spatial distribution of North Sea plaice (Pleuronectes platessa) and implications for fisheries management. Journal of Sea Research 57 187–197.

Wood, S.N. (2006) Generalized Additive Models: An Introduction with R. Chapman and Hall/CRC.

Figures Run 1 (1957-2015, 7, 9, 6, 26, -1, BTS-Isis early, BTS combined, SNS1, SNS2)

8.7 Figures

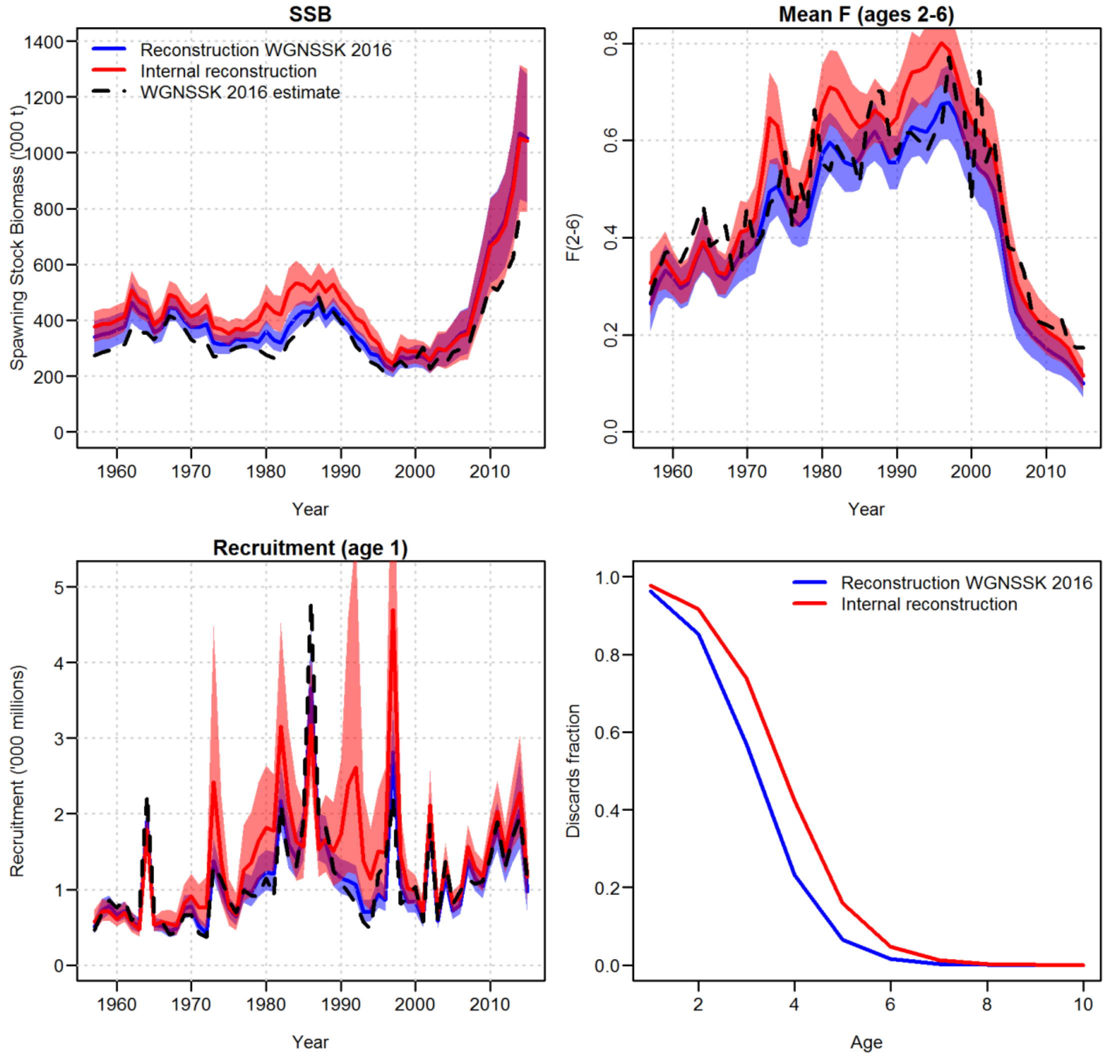


Figure 1. Run 1: Summary plot of first assessment runs, with and without internal discards reconstruction, including the WGNSSK 2016 estimates.

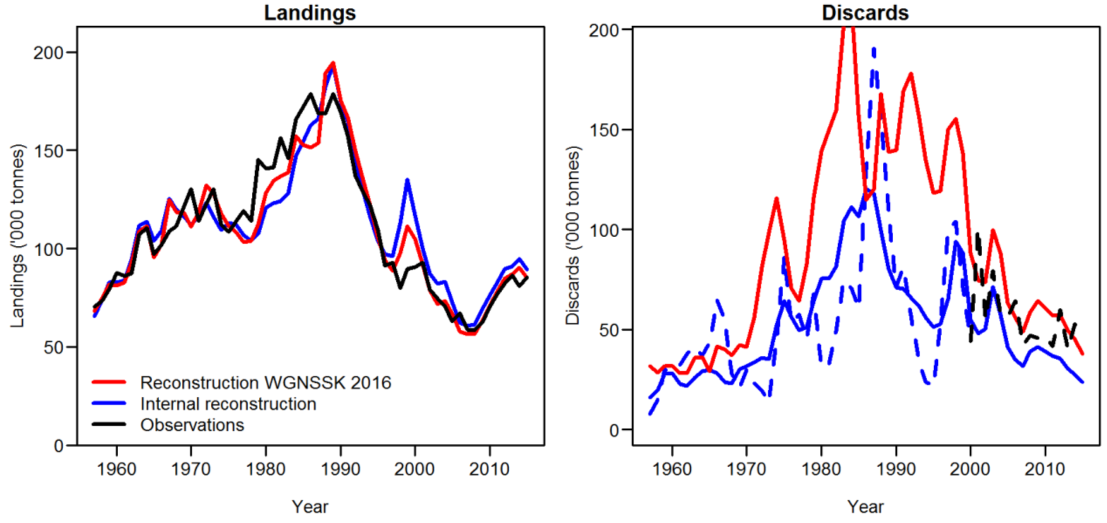


Figure 2. Run 1: Landings and discards estimates of first assessment runs, with and without internal discards reconstruction, including the WGNSSK 2016 estimates.

Figures Run 1 (1957-2015, 7, 9, 6, 26, -1, BTS-Isis early, BTS combined, SNS1, SNS2)

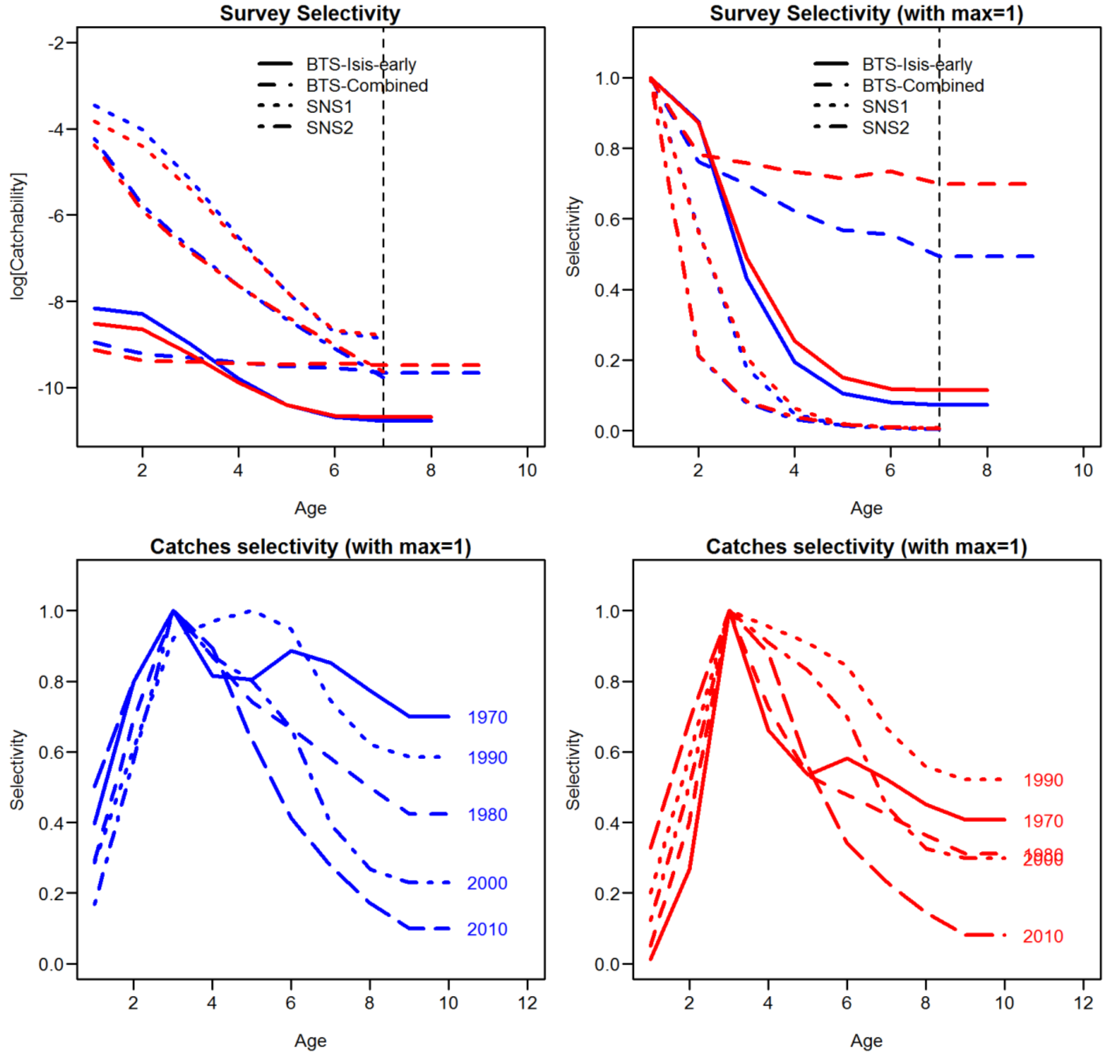


Figure 3: Run 1: survey selectivities (top panels) and selectivities catches (lower panels). Blue lines indicate the assessment that uses the WGNSSK 2016 reconstruction, red lines indicate the assessment where internal estimation is done.

Figures Run 1 (1957-2015, 7, 9, 6, 26, -1, BTS-Isis early, BTS combined, SNS1, SNS2)

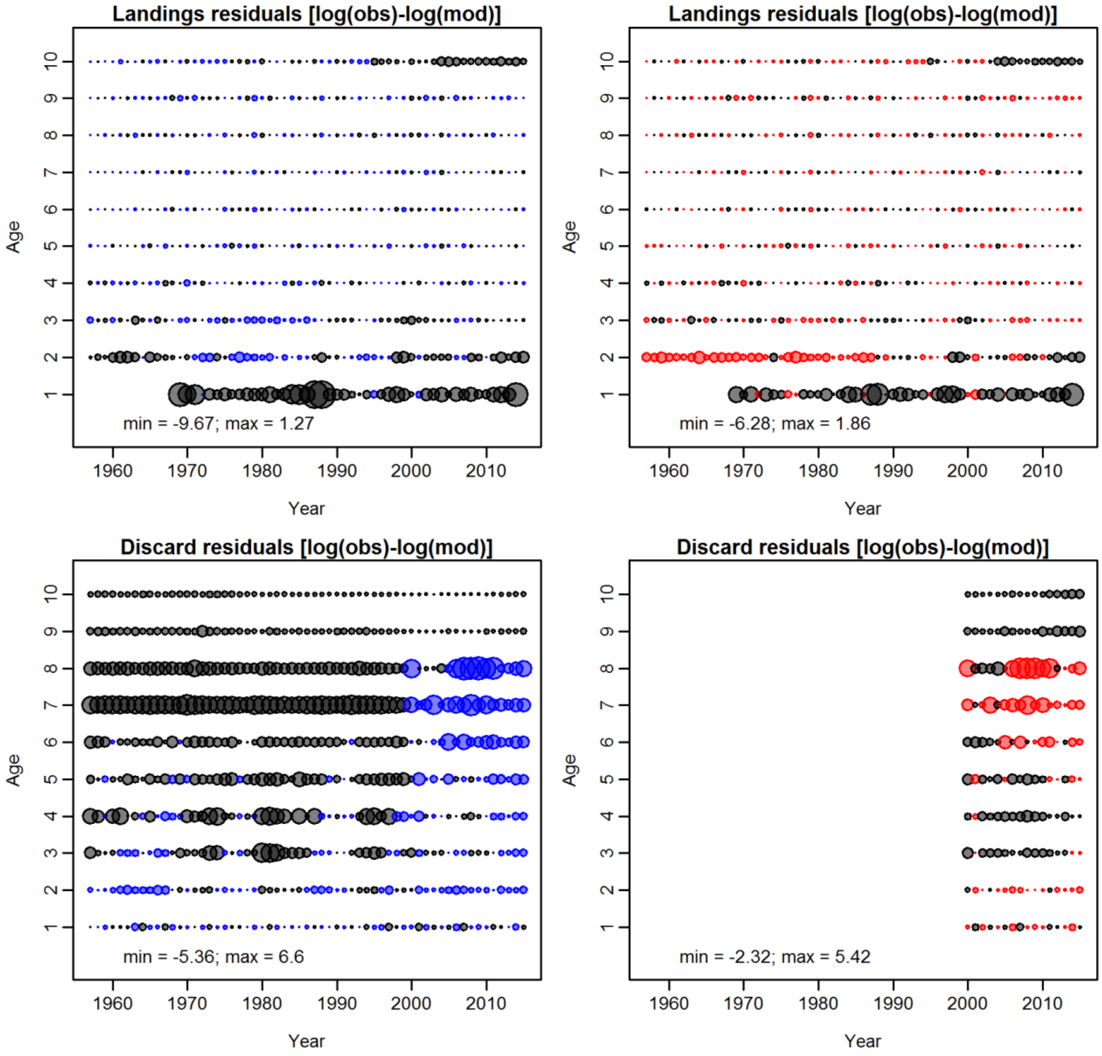


Figure 4: Run 1: Landings residuals (top panels) and discards residuals (lower panels). Blue/red bubbles positive residuals (observations greater than model), and black bubbles indicate negative residuals (observations less than model). Left panels indicate assessment with WGNSSK 2016 being used (blue colors for positive residuals), right panels indicate assessment where discards are estimated internally (red colors for positive residuals).

Figures Run 1 (1957-2015, 7, 9, 6, 26, -1, BTS-Isis early, BTS combined, SNS1, SNS2)

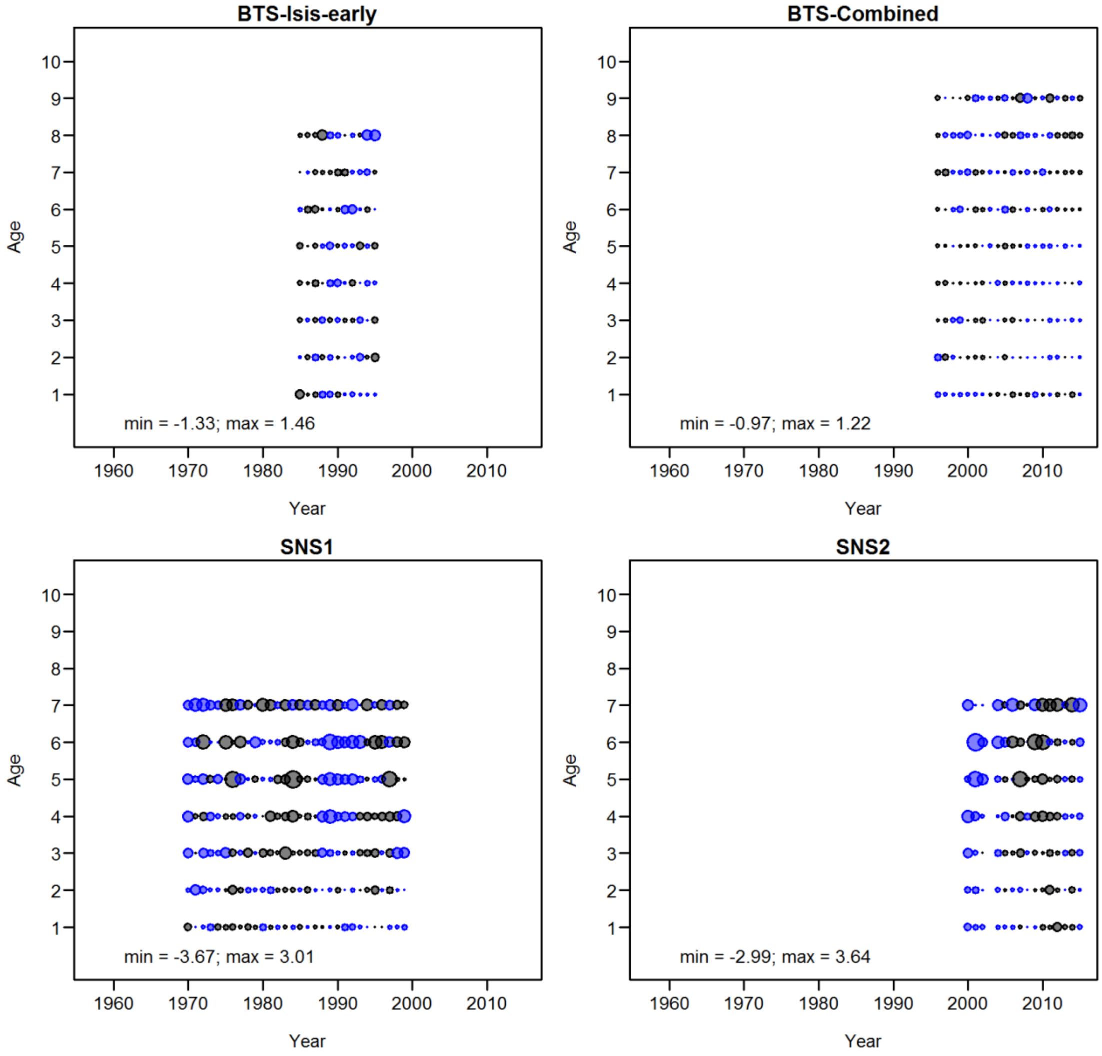


Figure 5: Run 1: Survey residuals for model using WGNSSK 2016 discards reconstruction. Blue bubbles indicate positive residuals (observations greater than model), and black bubbles indicate negative residuals (observations less than model).

Figures Run 1 (1957-2015, 7, 9, 6, 26, -1, BTS-Isis early, BTS combined, SNS1, SNS2)

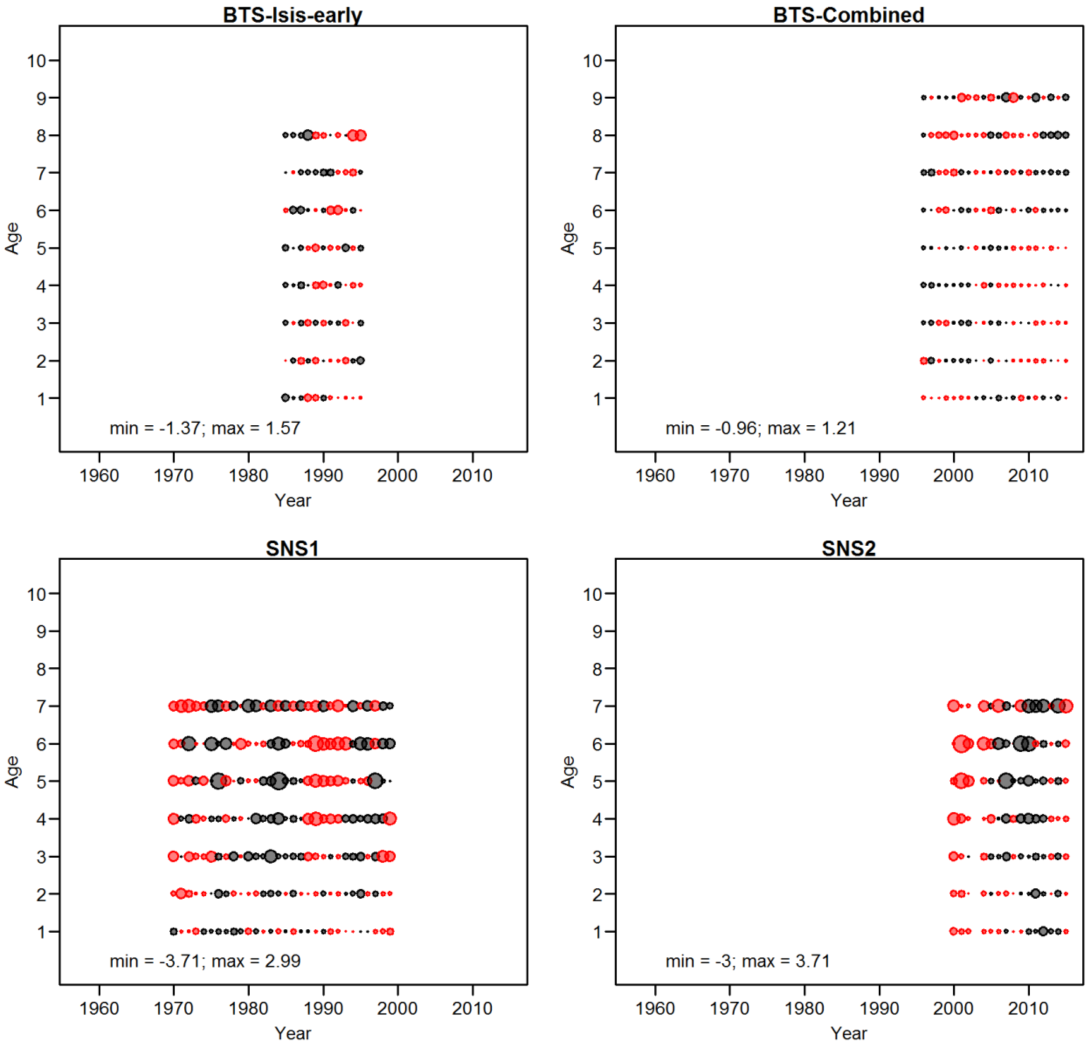


Figure 6: Run 1: Survey residuals for internally reconstructed discards. Red bubbles indicate positive residuals (observations greater than model), and black bubbles indicate negative residuals (observations less than model).

Figures Run 1 (1957-2015, 7, 9, 6, 26, -1, BTS-Isis early, BTS combined, SNS1, SNS2)

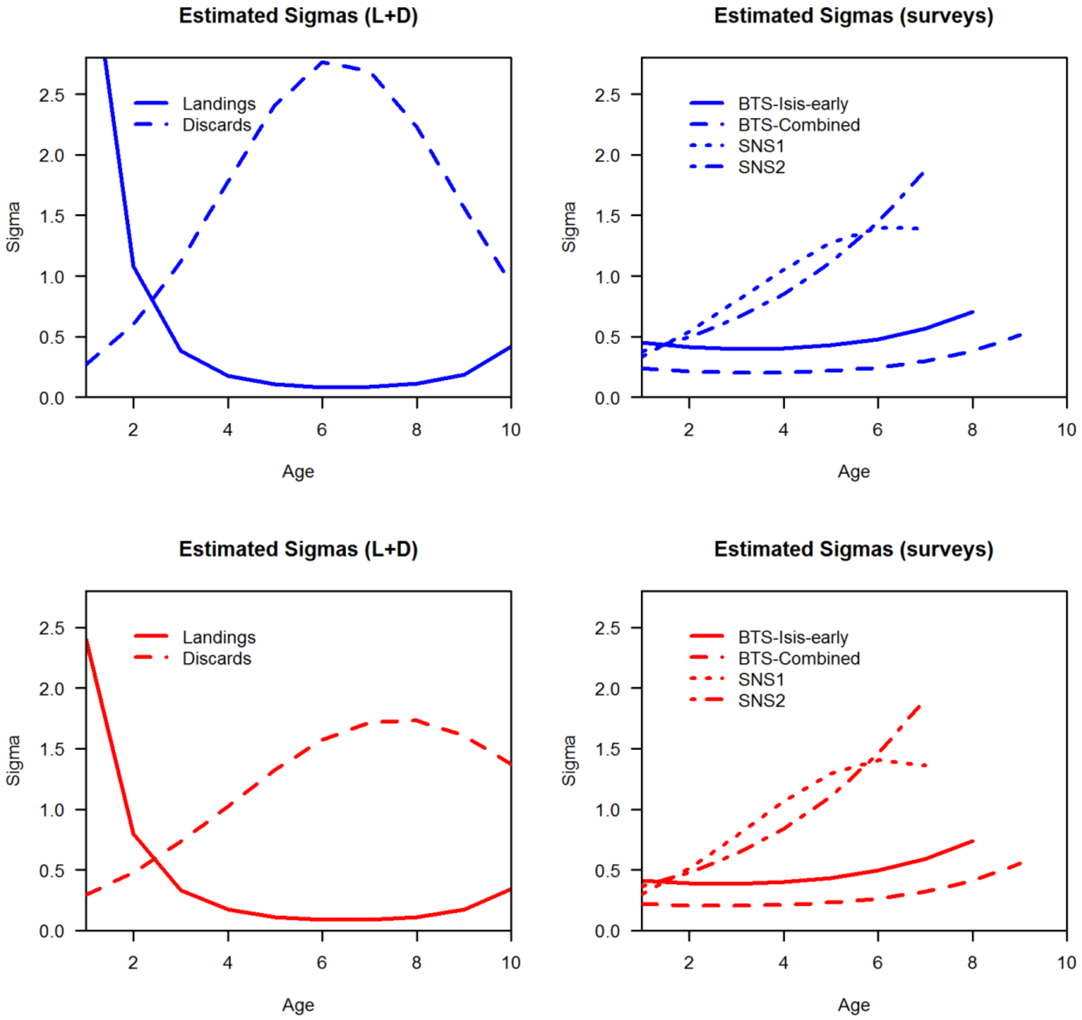


Figure 7: Run 1: Estimated age-dependent sigmas for the different likelihood components.

Figures Run 1 (1957-2015, 7, 9, 6, 26, -1, BTS-Isis early, BTS combined, SNS1, SNS2)

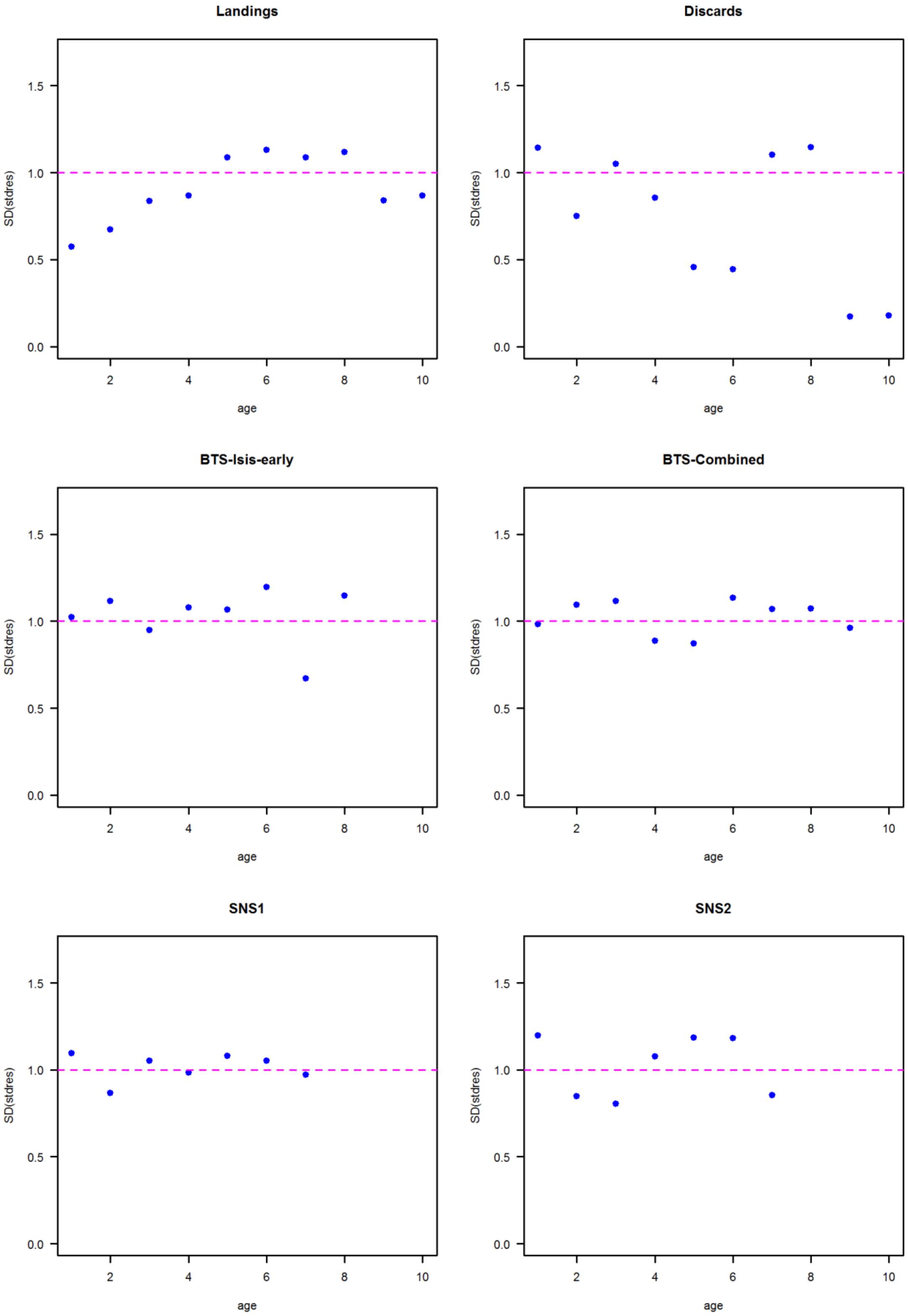


Figure 8: Run 1: SDs of standardized residuals (for discards estimates from WGNSSK 2016 assessment).

Figures Run 1 (1957-2015, 7, 9, 6, 26, -1, BTS-Isis early, BTS combined, SNS1, SNS2)

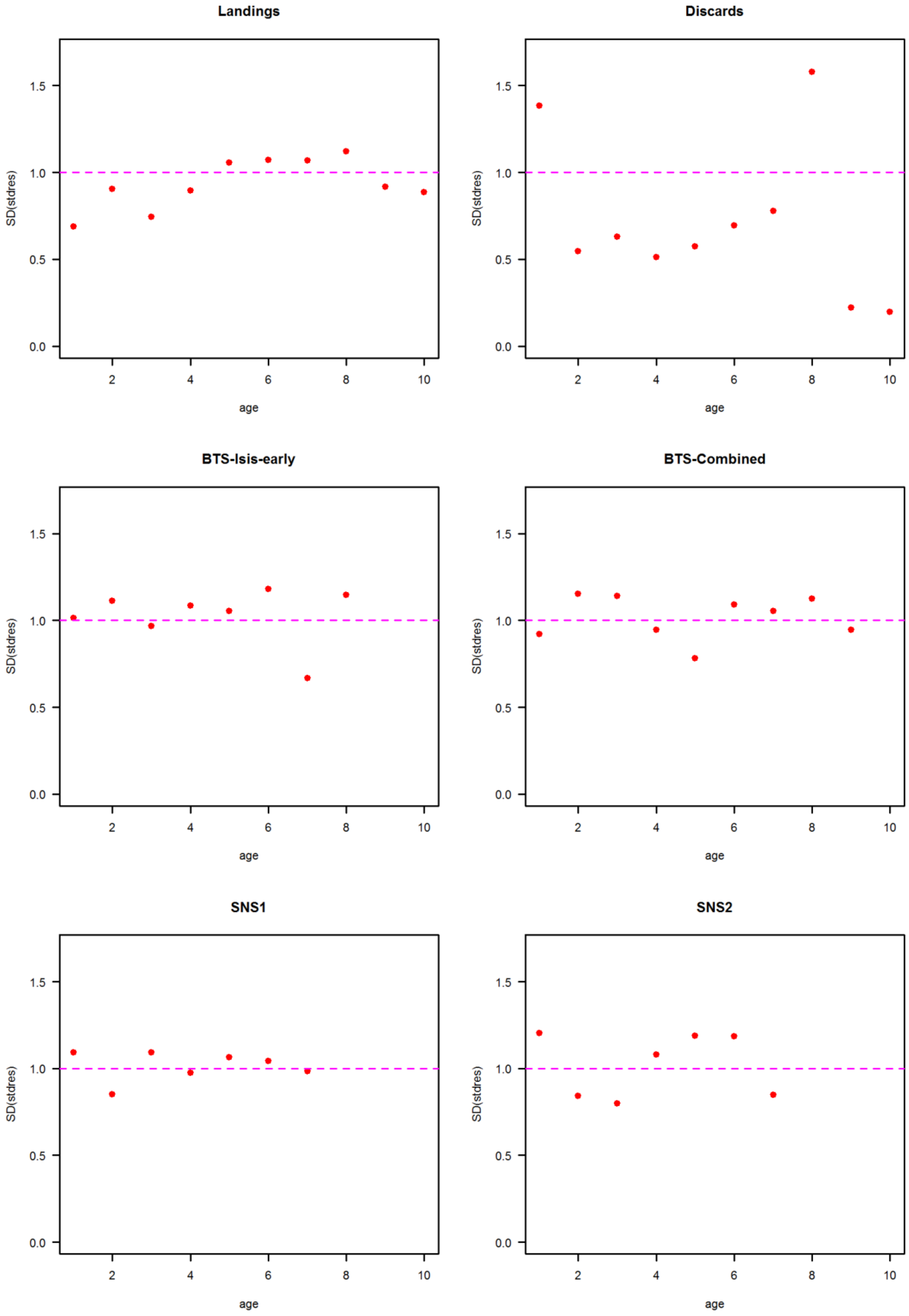


Figure 9: Run 1: SDs of standardized residuals (for internally estimated discards assessment).

Figures Run 1 (1957-2015, 7, 9, 6, 26, -1, BTS-Isis early, BTS combined, SNS1, SNS2)

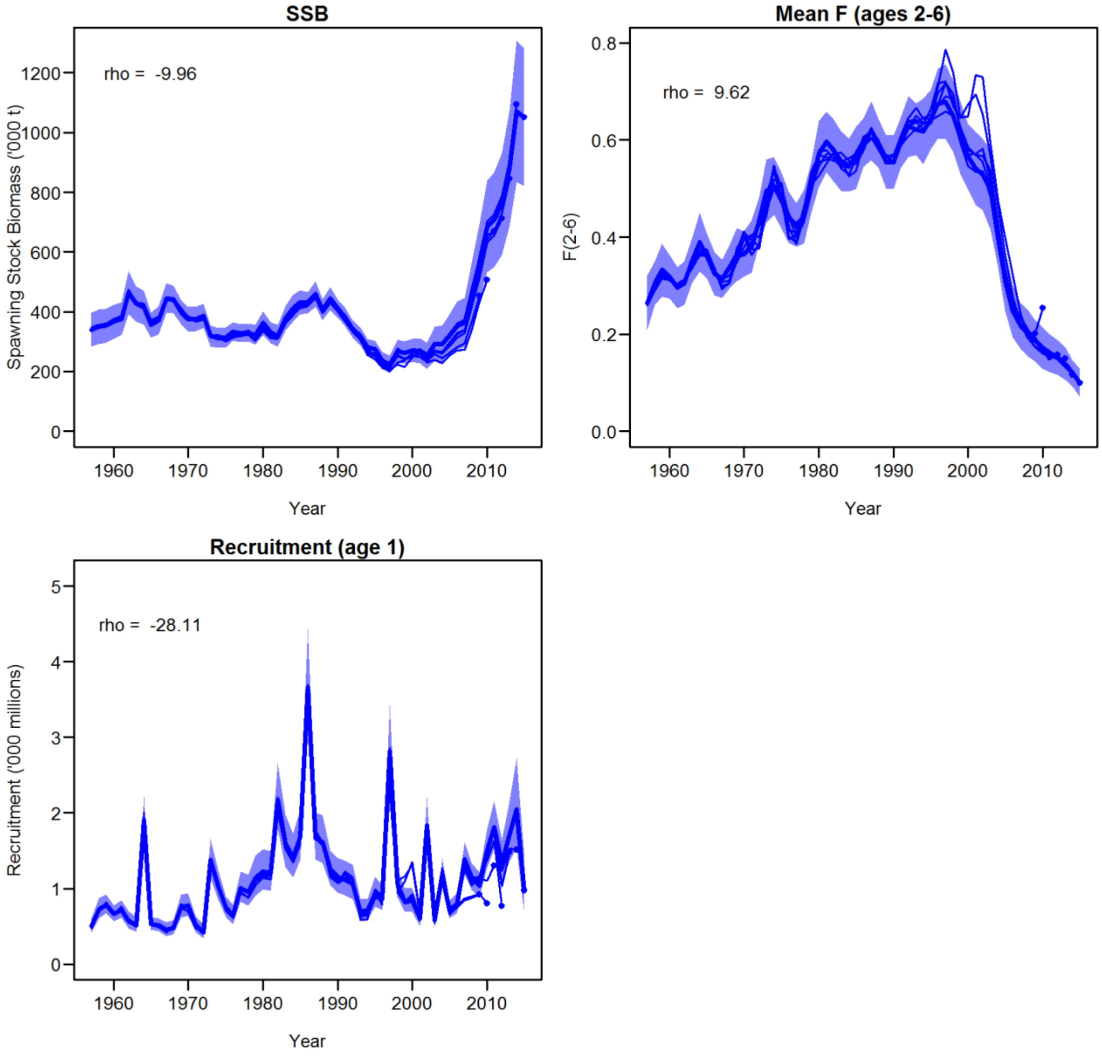


Figure 10. Run 1: Retro (for discards estimates from WGNSSK 2016 assessment).

Figures Run 1 (1957-2015, 7, 9, 6, 26, -1, BTS-Isis early, BTS combined, SNS1, SNS2)

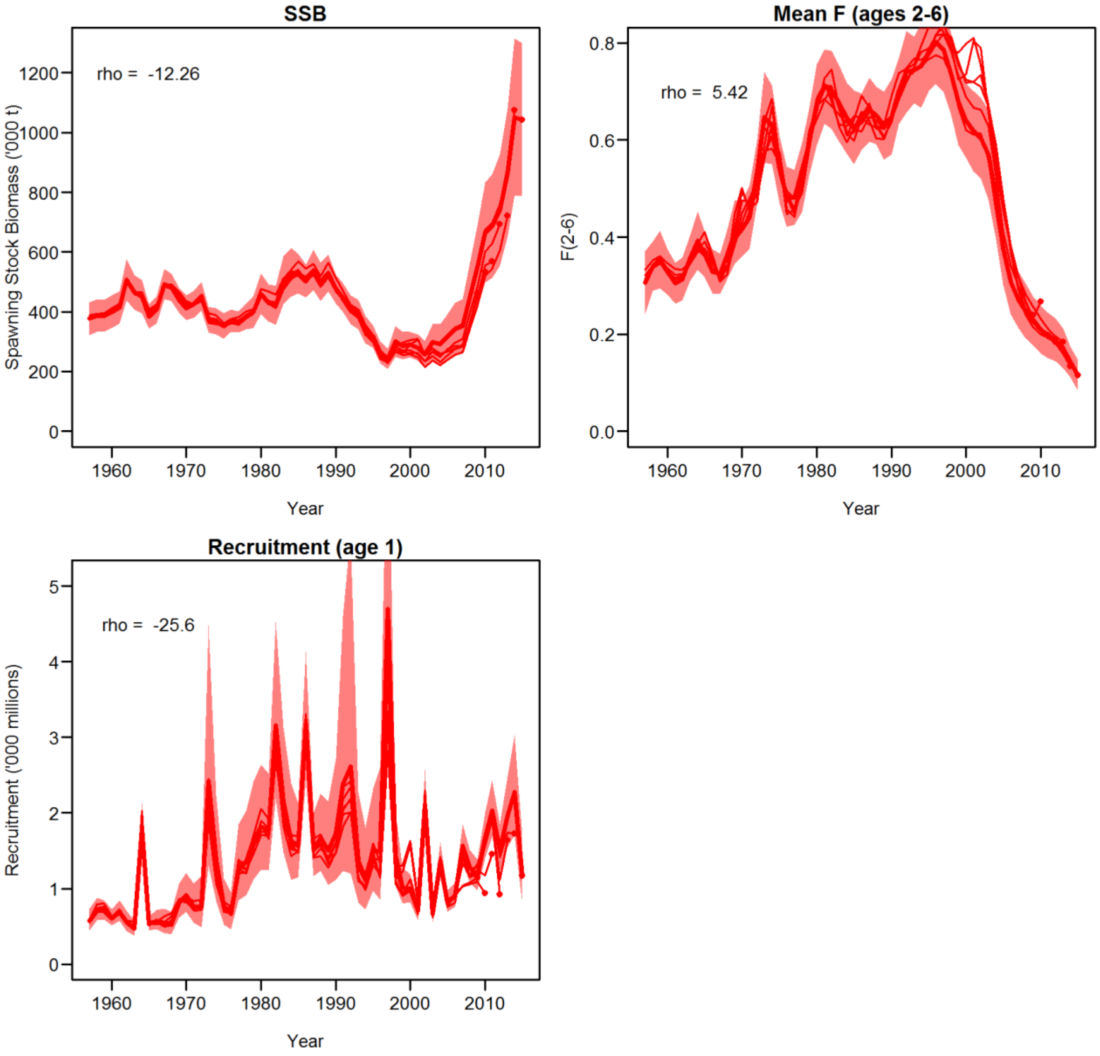


Figure 11. Run 1: Retro (for internally estimated discards assessment).

Figures run 2 (1957-2015, 7, 9, 6, 26, 2, BTS-Isis early, BTS combined, SNS1, SNS2)

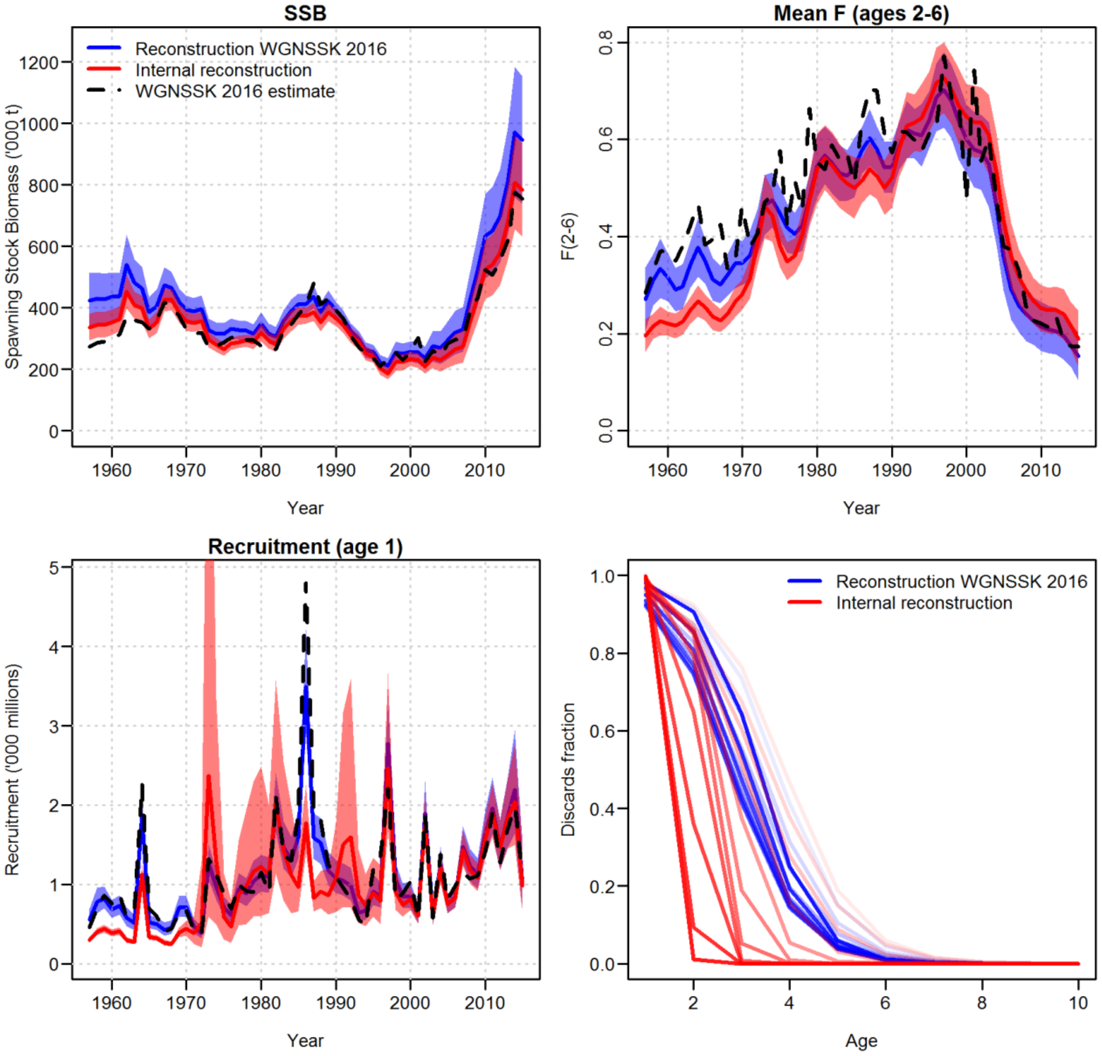


Figure 12. Run 2: Summary plot of assessment runs, with and without internal discards reconstruction, including the WGNSSK 2016 estimates. Allows for time varying discard selectivity

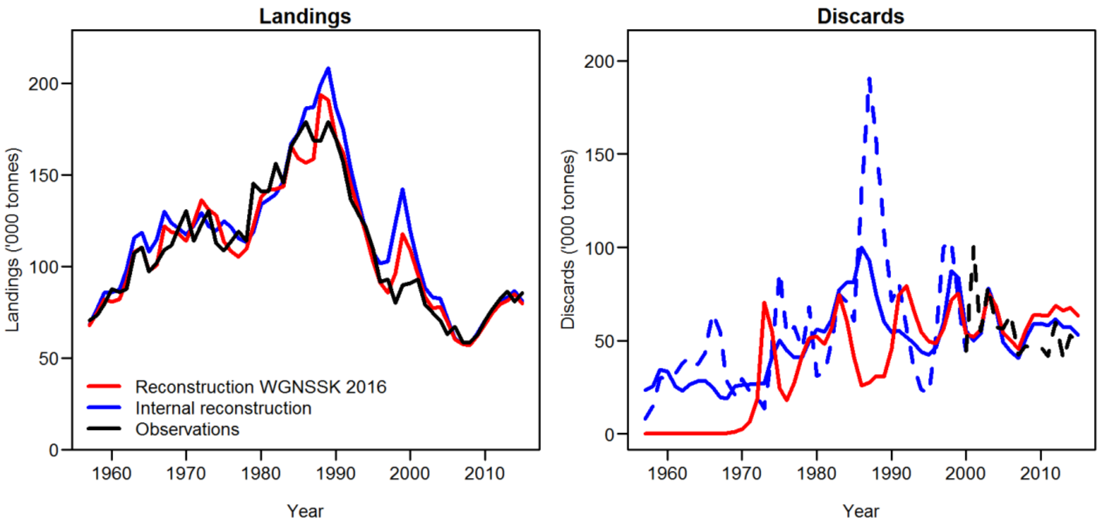


Figure 13. Run 2: Landings and discards estimates of first assessment runs, with and without internal discards reconstruction, including the WGNSSK 2016 estimates.

Figures run 2 (1957-2015, 7, 9, 6, 26, 2, BTS-Isis early, BTS combined, SNS1, SNS2)

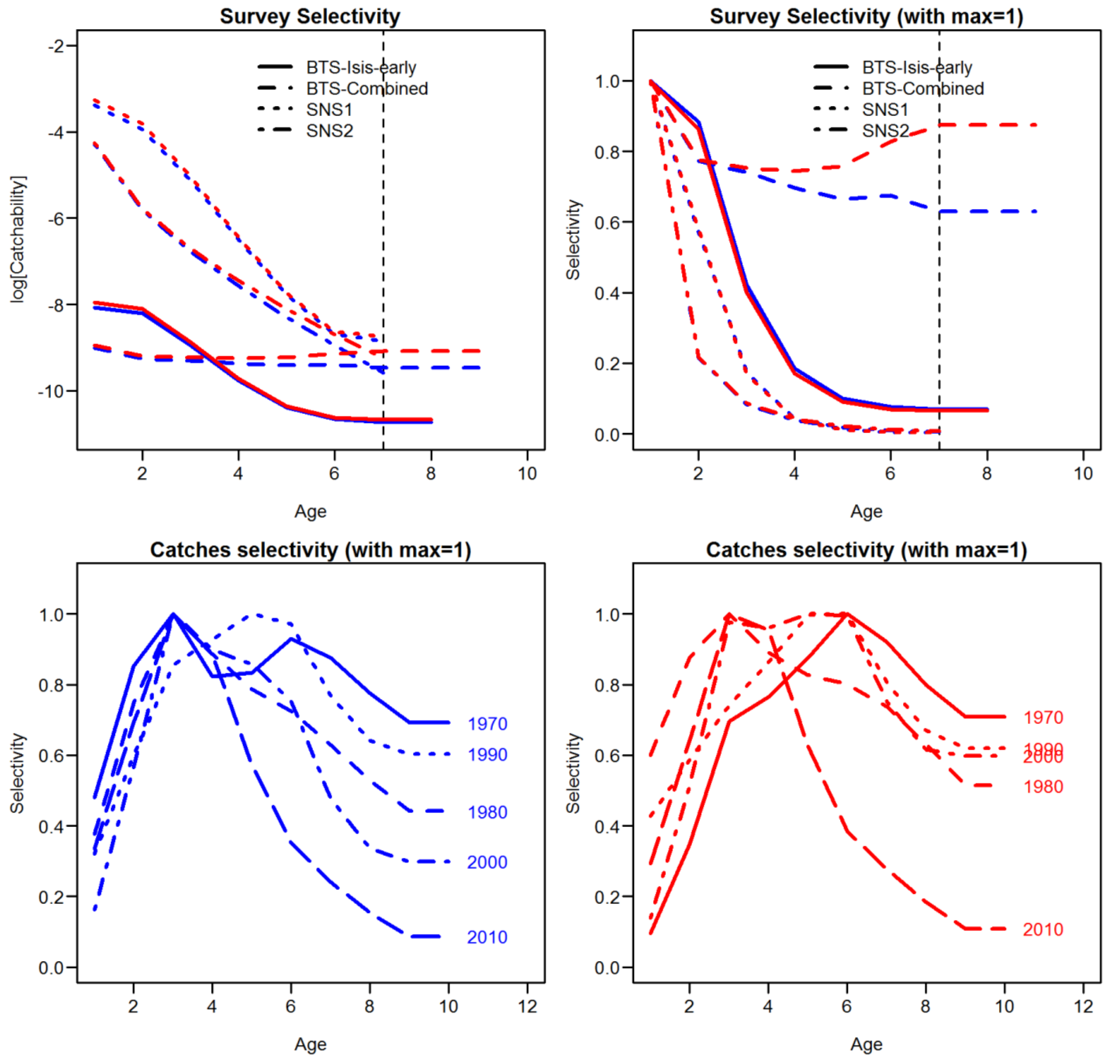


Figure 14. Run 2: survey selectivities (top panels) and selectivities catches (lower panels). Blue lines indicate the assessment that uses the WGNSSK 2016 reconstruction, red lines indicate the assessment where internal estimation is done.

Figures run 2 (1957-2015, 7, 9, 6, 26, 2, BTS-Isis early, BTS combined, SNS1, SNS2)

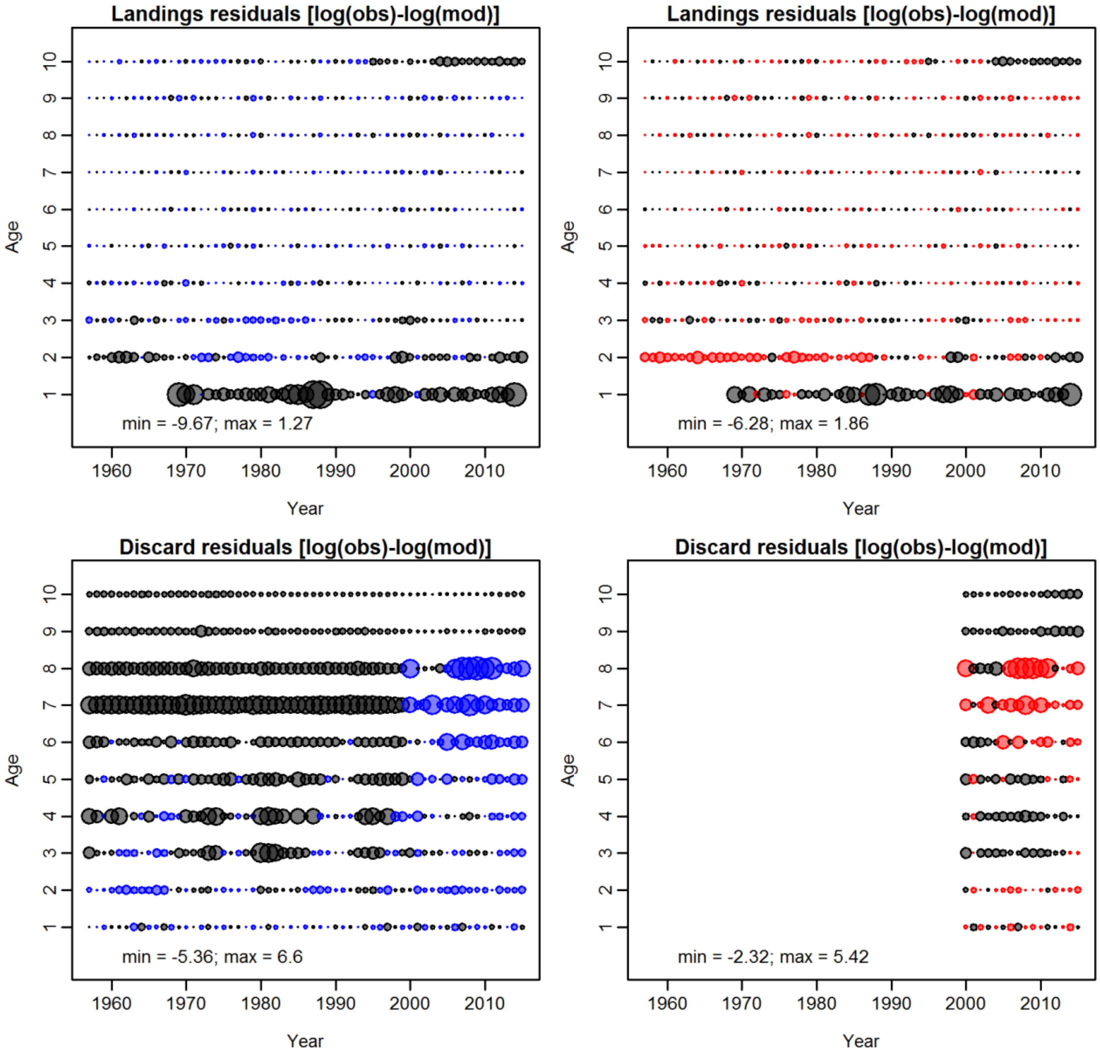


Figure 15. Run 2: Landings residuals (top panels) and discards residuals (lower panels). Blue/red bubbles positive residuals (observations greater than model), and black bubbles indicate negative residuals (observations less than model). Left panels indicate assessment with WGNSSK 2016 being used (blue colors for positive residuals), right panels indicate assessment where discards are estimated internally (red colors for positive residuals).

Figures run 2 (1957-2015, 7, 9, 6, 26, 2, BTS-Isis early, BTS combined, SNS1, SNS2)

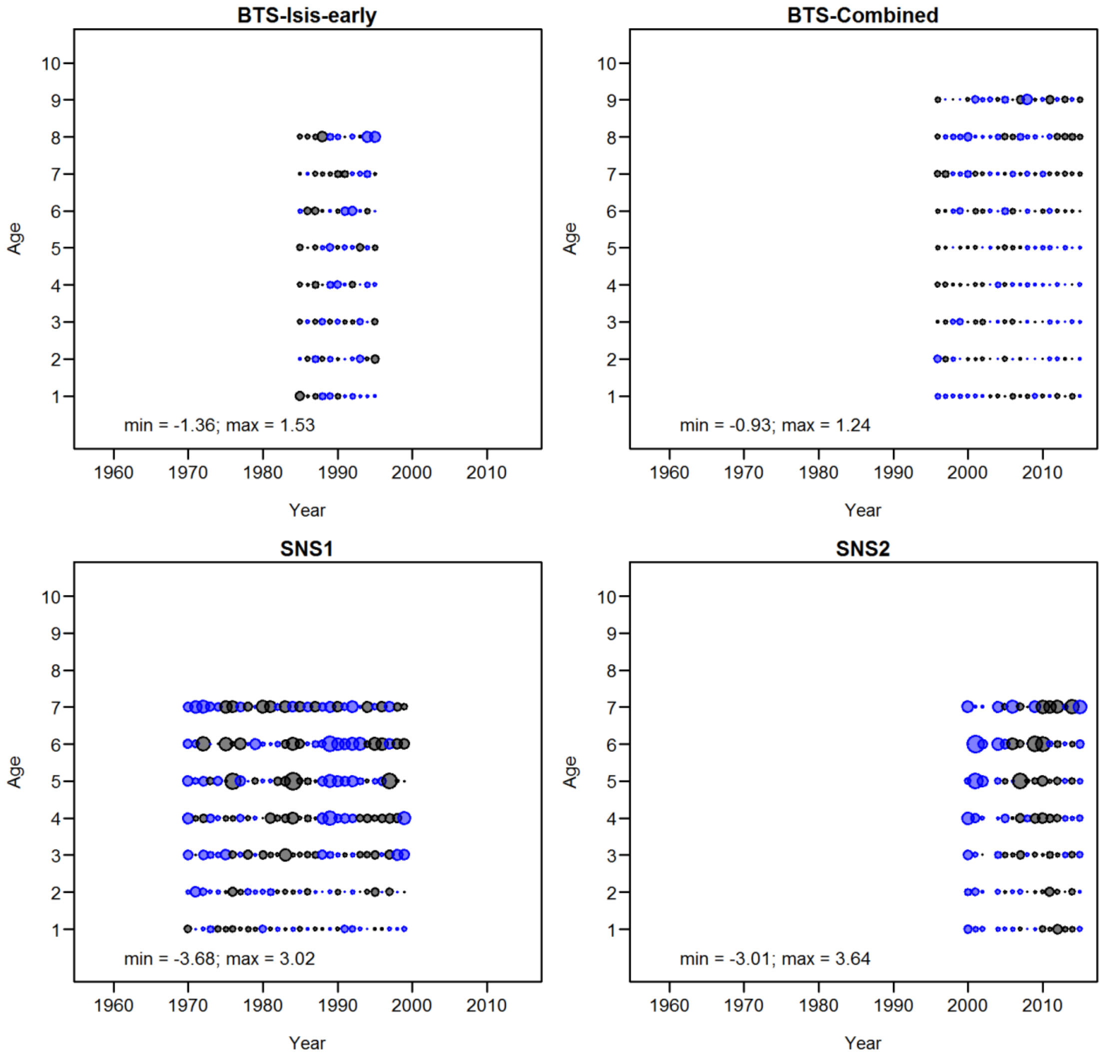


Figure 16. Run 2: Survey residuals for model using WGNSSK 2016 discards reconstruction. Blue bubbles indicate positive residuals (observations greater than model), and black bubbles indicate negative residuals (observations less than model).

Figures run 2 (1957-2015, 7, 9, 6, 26, 2, BTS-Isis early, BTS combined, SNS1, SNS2)

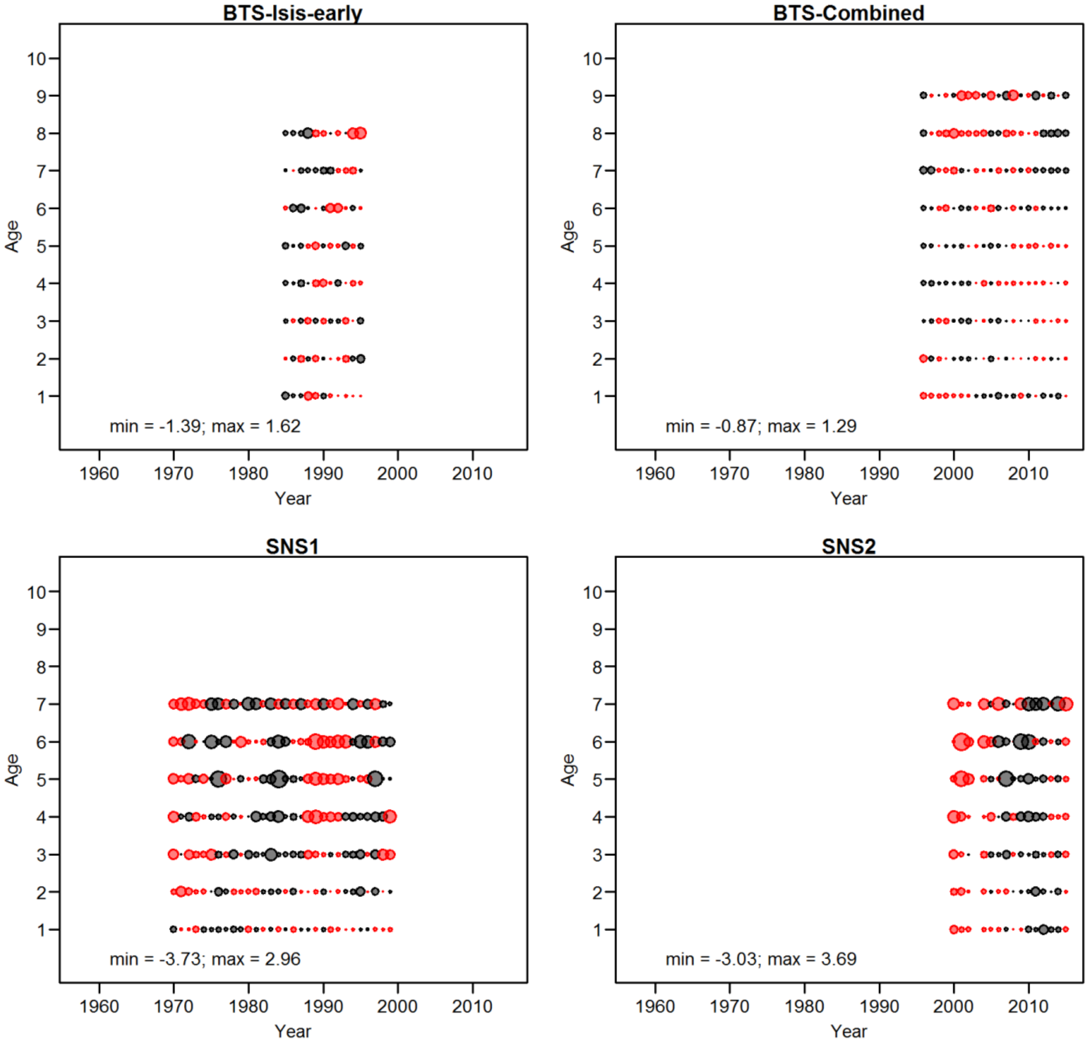


Figure 17. Run 2: Survey residuals for internally reconstructed discards. Red bubbles indicate positive residuals (observations greater than model), and black bubbles indicate negative residuals (observations less than model).

Figures run 2 (1957-2015, 7, 9, 6, 26, 2, BTS-Isis early, BTS combined, SNS1, SNS2)

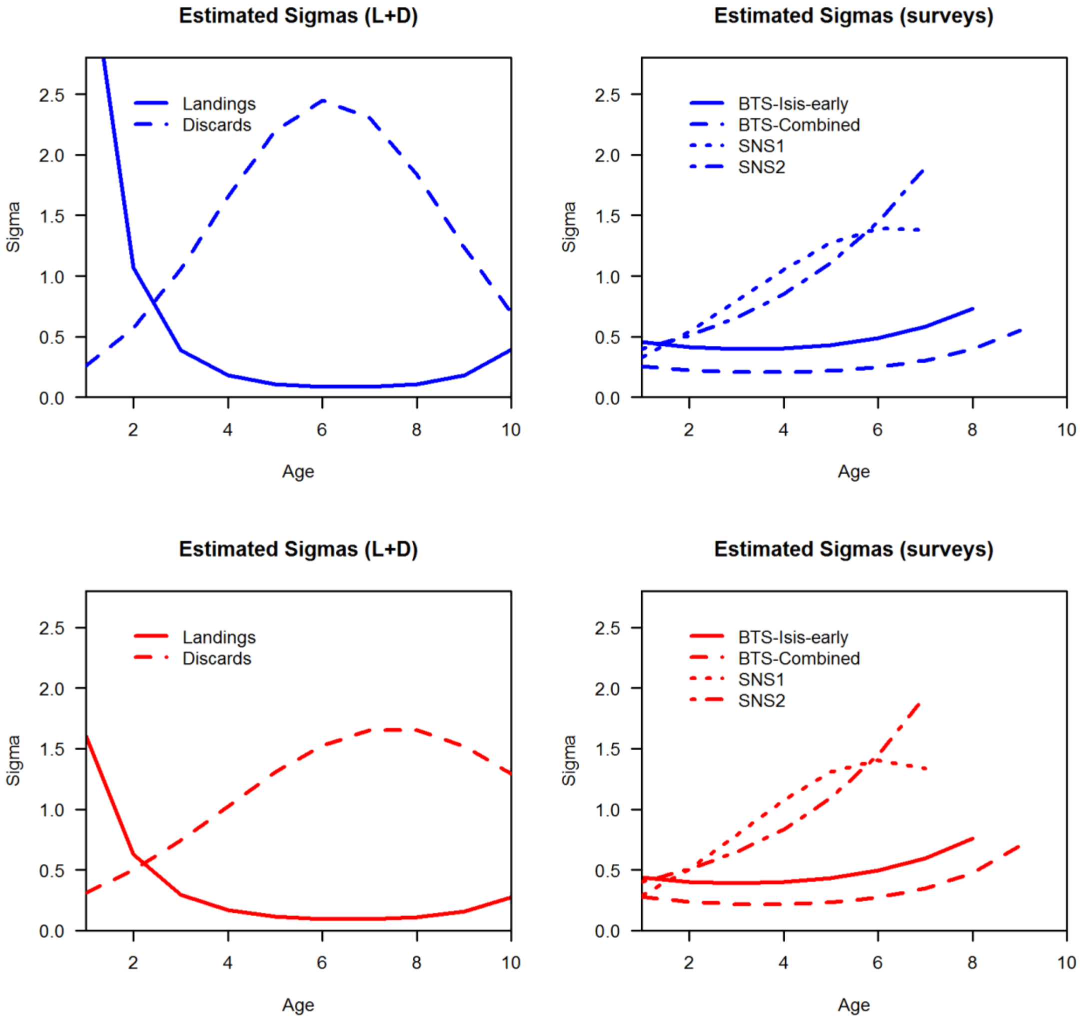


Figure 18. Run 2: Estimated age-dependent sigmas for the different likelihood components.

Figures run 2 (1957-2015, 7, 9, 6, 26, 2, BTS-Isis early, BTS combined, SNS1, SNS2)

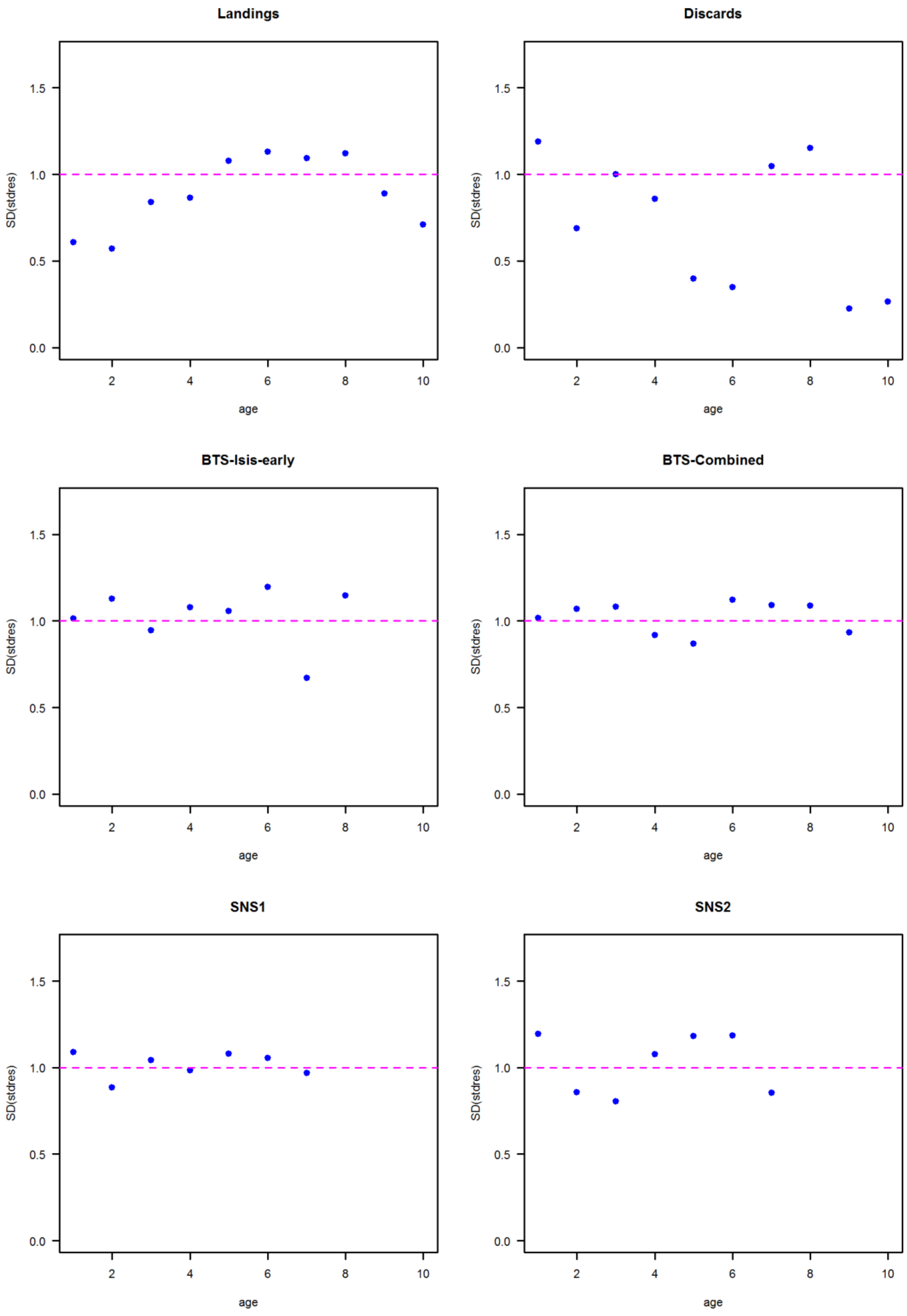


Figure 19. Run 2: SDs of standardized residuals (for discards estimates from WGNSSK 2016 assessment).

Figures run 2 (1957-2015, 7, 9, 6, 26, 2, BTS-Isis early, BTS combined, SNS1, SNS2)

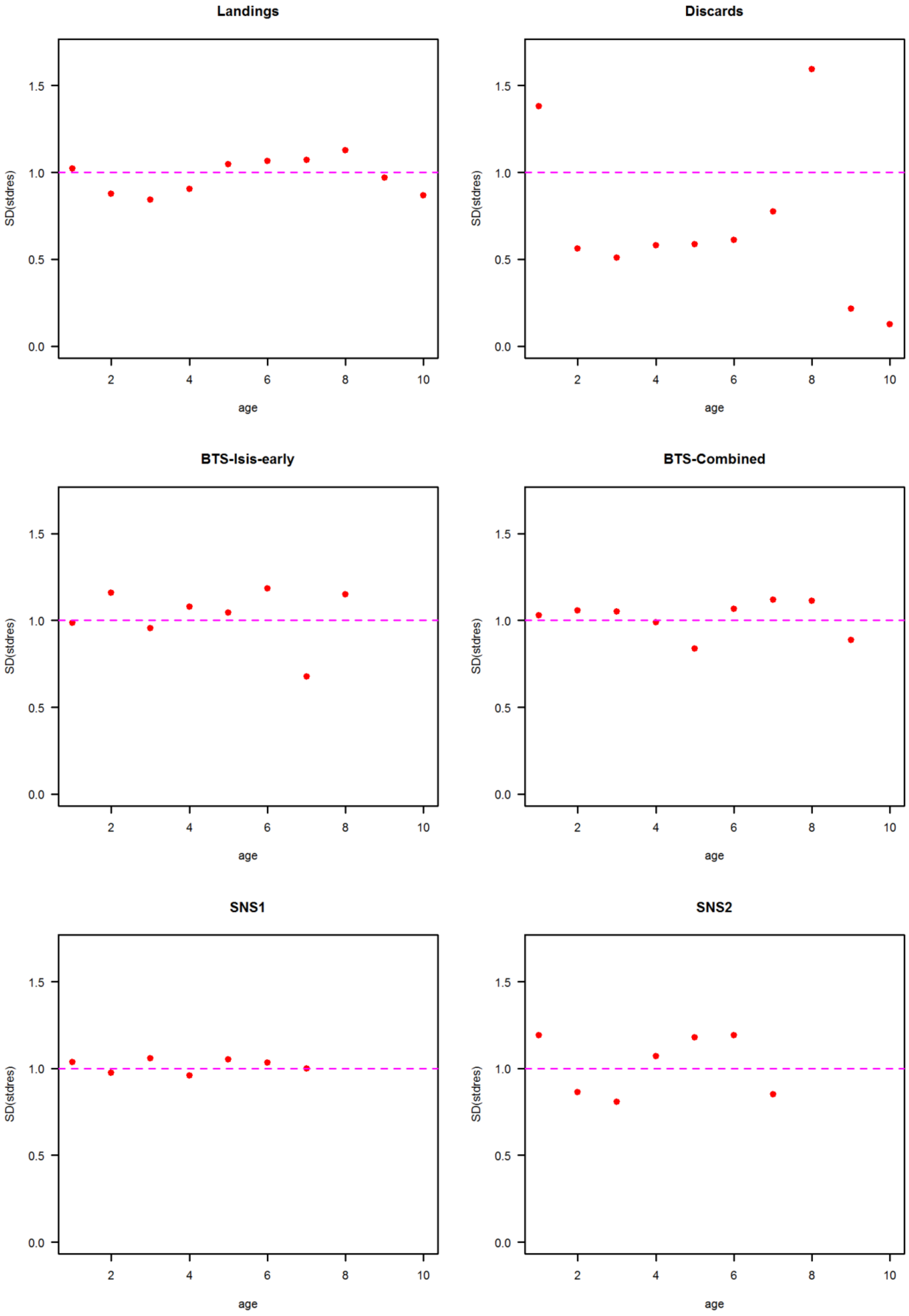


Figure 20. Run 2: SDs of standardized residuals (for internally estimated discards assessment).

Figures run 2 (1957-2015, 7, 9, 6, 26, 2, BTS-Isis early, BTS combined, SNS1, SNS2)

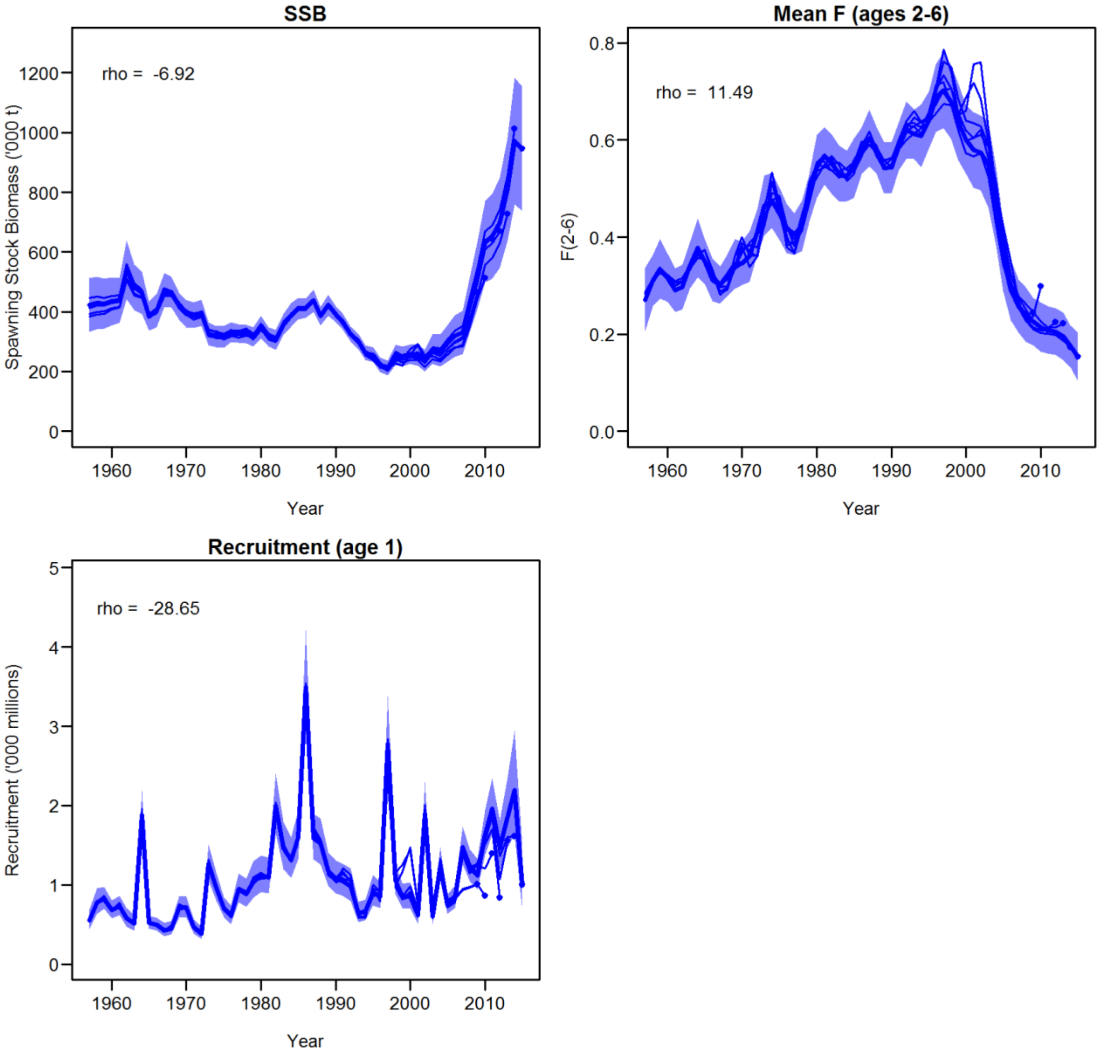


Figure 21. Run 2: Retro (for discards estimates from WGNSSK 2016 assessment).

Figures run 2 (1957-2015, 7, 9, 6, 26, 2, BTS-Isis early, BTS combined, SNS1, SNS2)

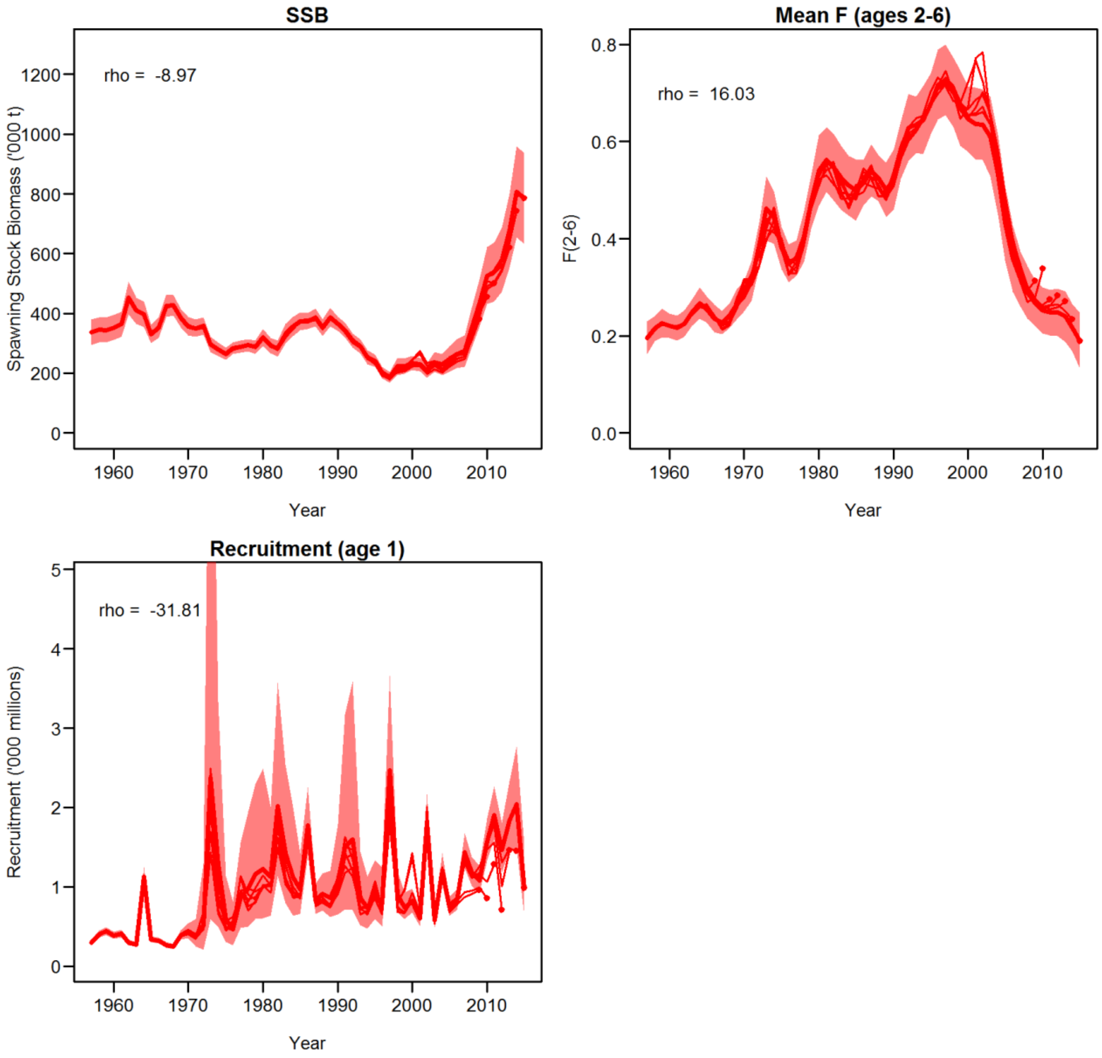


Figure 22. Run 2: Retro (for internally estimated discards assessment).

Figures run 3 (1970-2015, 7, 9, 6, 26, 2, BTS-Isis early, BTS combined, SNS1, SNS2)

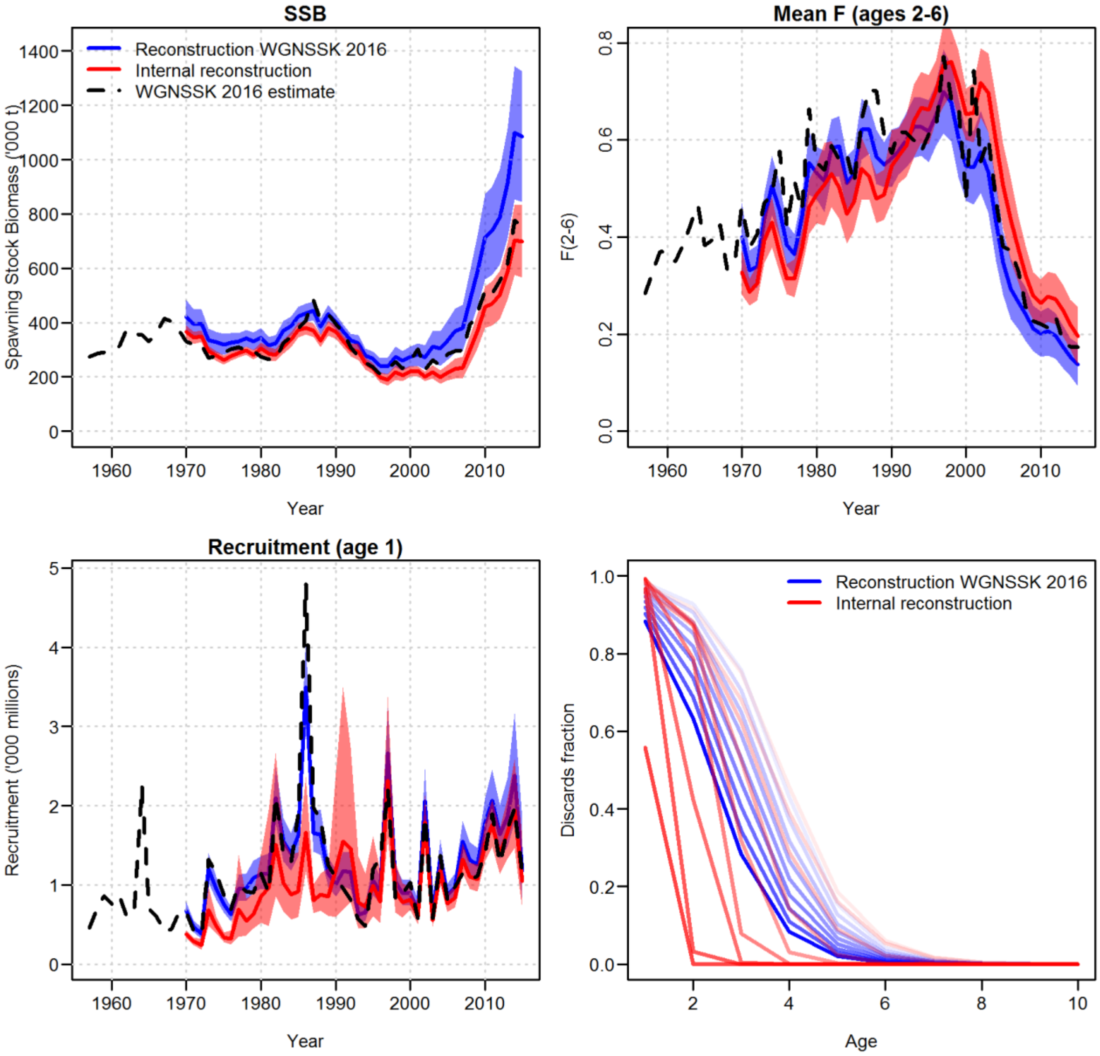


Figure 23. Run 3: Summary plot of assessment runs, with and without internal discards reconstruction, including the WGNSSK 2016 estimates. Allows for time varying discard selectivity, but starting in 1970

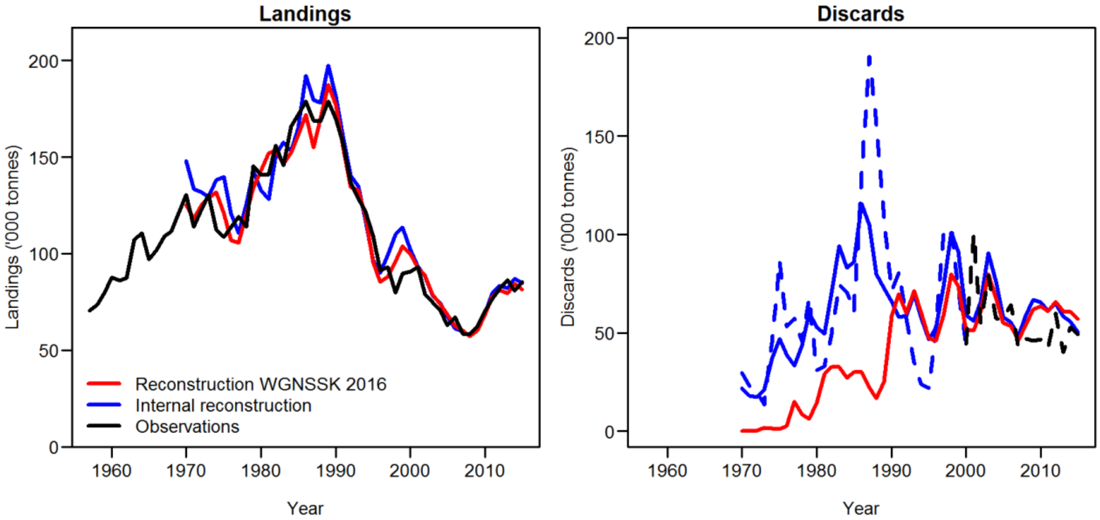


Figure 24. Run 3: Landings and discards estimates of first assessment runs, with and without internal discards reconstruction, including the WGNSSK 2016 estimates.

Figures run 3 (1970-2015, 7, 9, 6, 26, 2, BTS-Isis early, BTS combined, SNS1, SNS2)

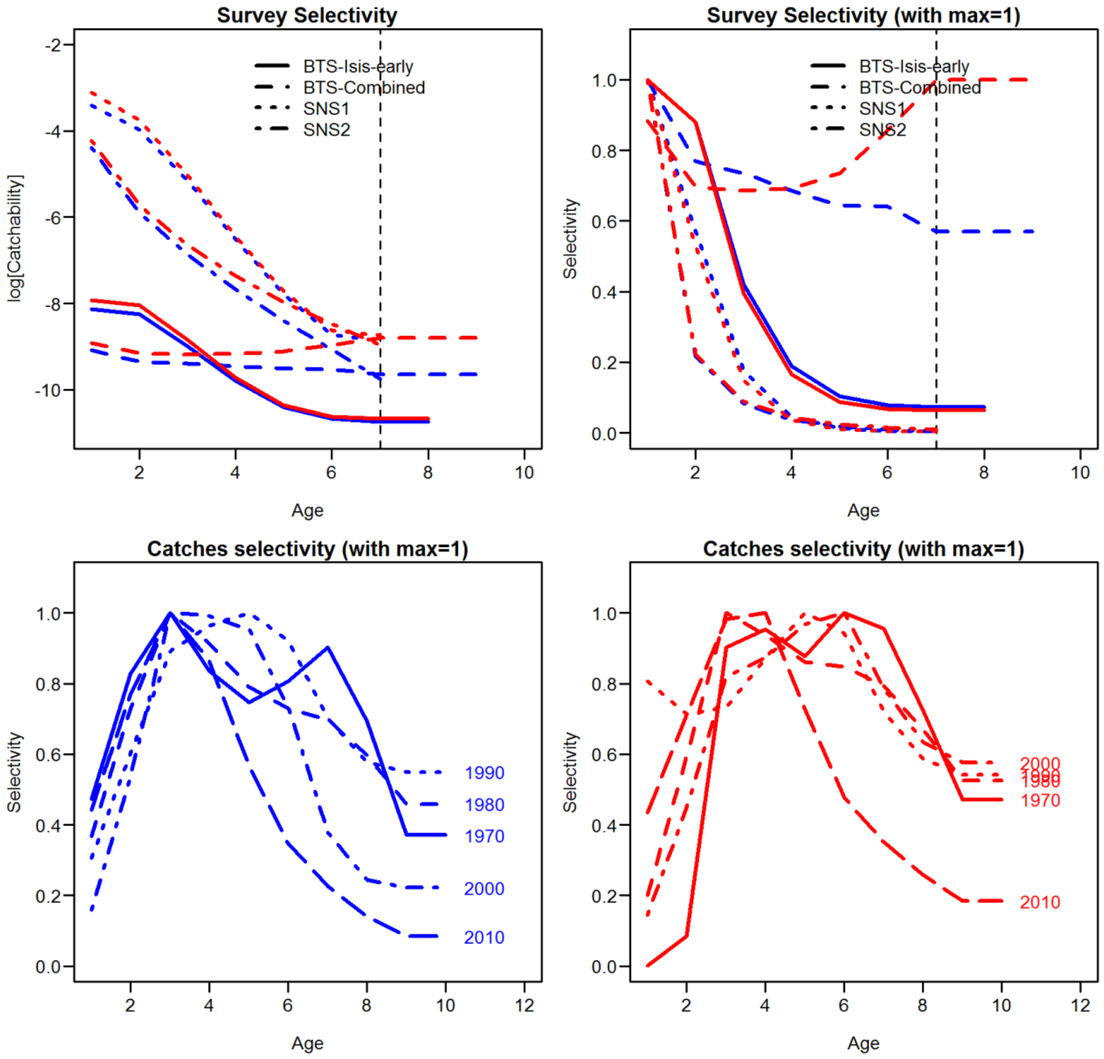


Figure 25. Run 3: survey selectivities (top panels) and selectivities catches (lower panels). Blue lines indicate the assessment that uses the WGNSSK 2016 reconstruction, red lines indicate the assessment where internal estimation is done.

Figures run 3 (1970-2015, 7, 9, 6, 26, 2, BTS-Isis early, BTS combined, SNS1, SNS2)

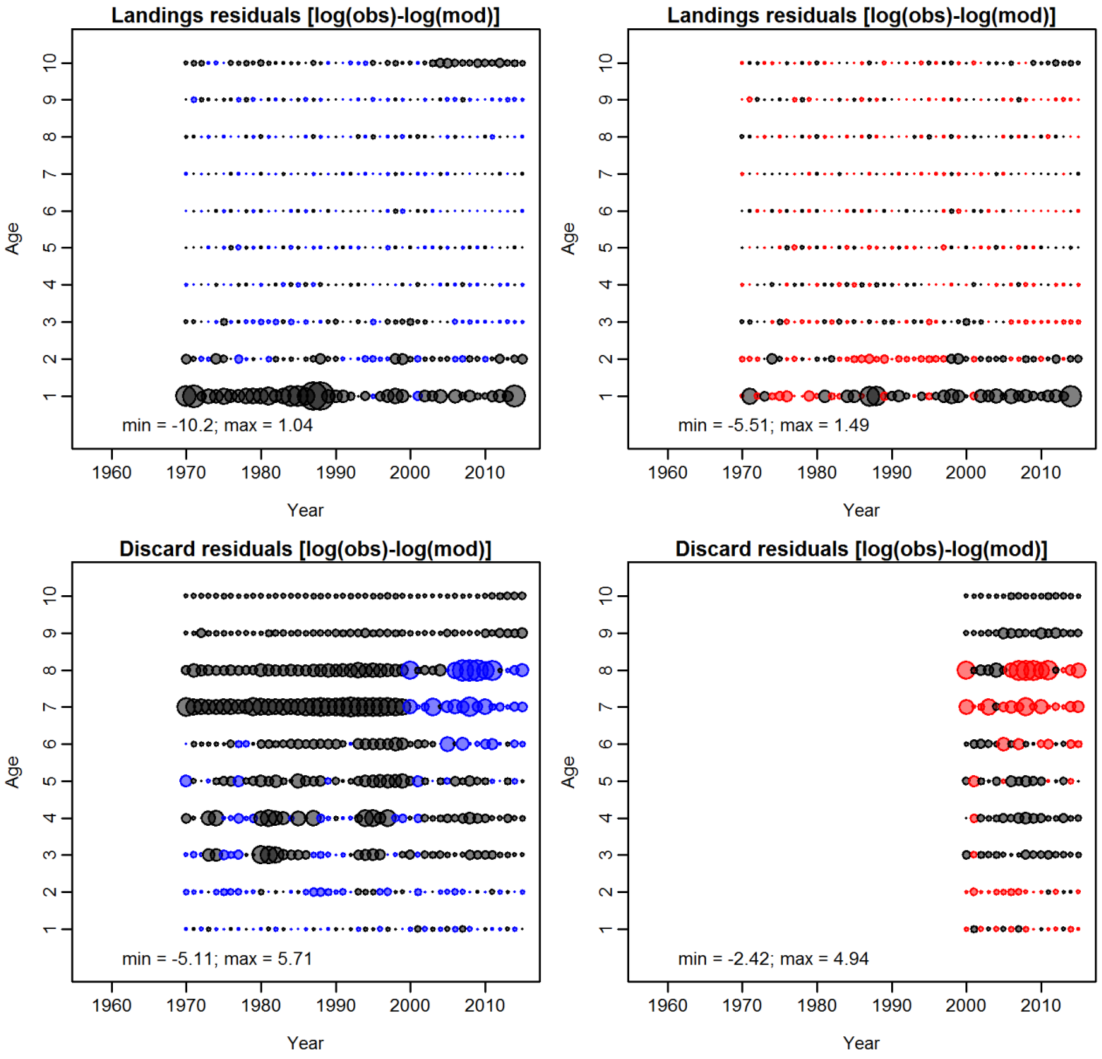


Figure 26. Run 3: Landings residuals (top panels) and discards residuals (lower panels). Blue/red bubbles positive residuals (observations greater than model), and black bubbles indicate negative residuals (observations less than model). Left panels indicate assessment with WGNSSK 2016 being used (blue colors for positive residuals), right panels indicate assessment where discards are estimated internally (red colors for positive residuals).

Figures run 3 (1970-2015, 7, 9, 6, 26, 2, BTS-Isis early, BTS combined, SNS1, SNS2)

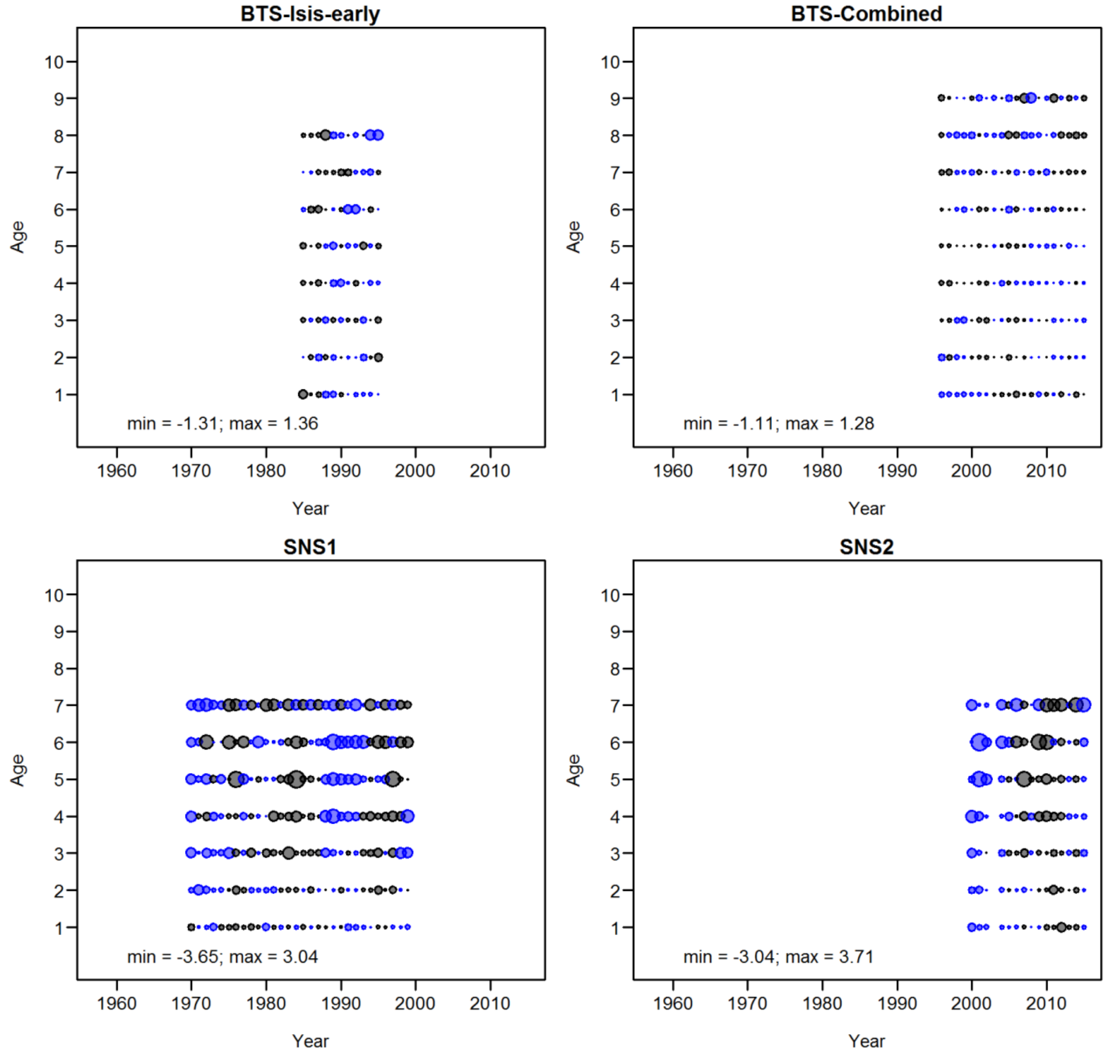


Figure 27. Run 3: Survey residuals for model using WGNSSK 2016 discards reconstruction. Blue bubbles indicate positive residuals (observations greater than model), and black bubbles indicate negative residuals (observations less than model).

Figures run 3 (1970-2015, 7, 9, 6, 26, 2, BTS-Isis early, BTS combined, SNS1, SNS2)

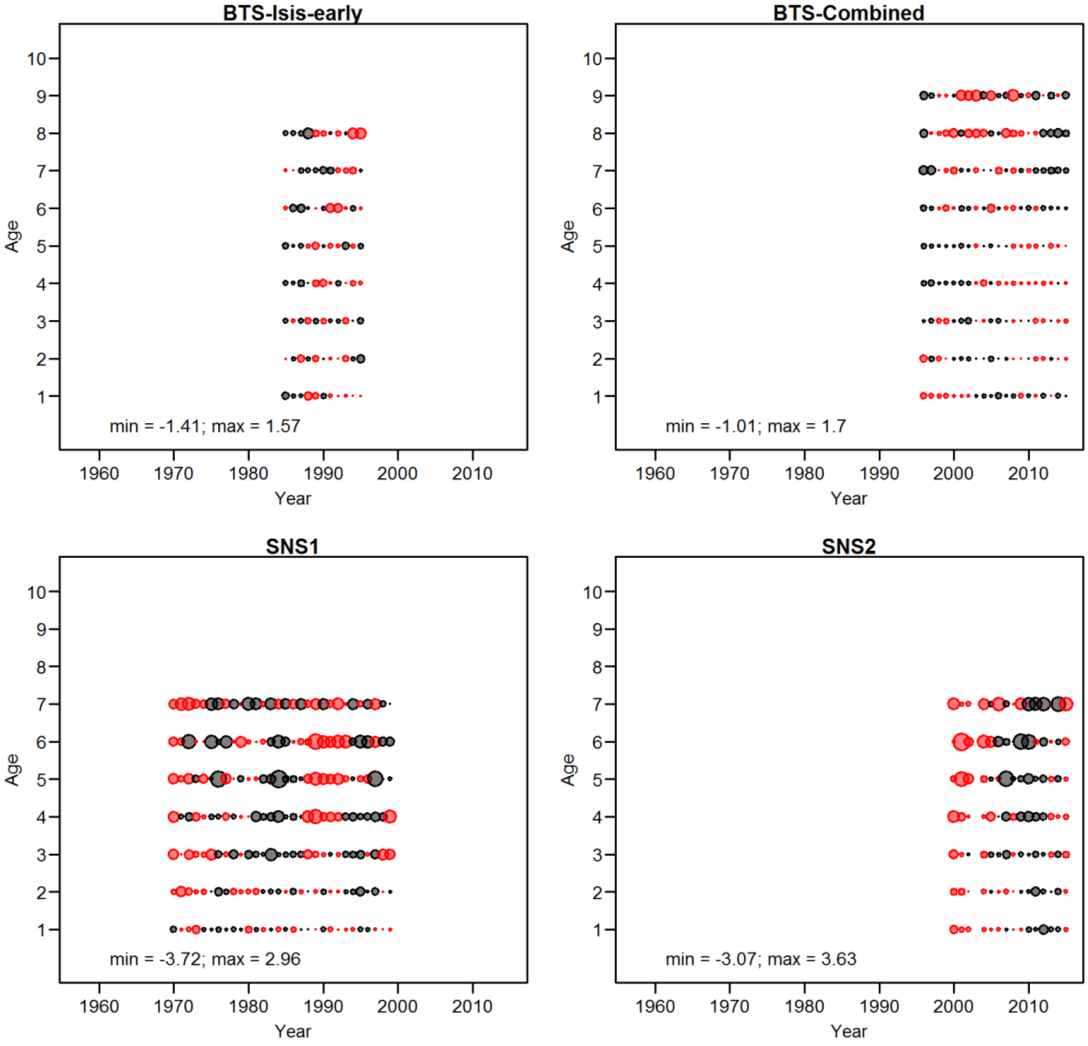


Figure 28. Run 3: Survey residuals for internally reconstructed discards. Red bubbles indicate positive residuals (observations greater than model), and black bubbles indicate negative residuals (observations less than model).

Figures run 3 (1970-2015, 7, 9, 6, 26, 2, BTS-Isis early, BTS combined, SNS1, SNS2)

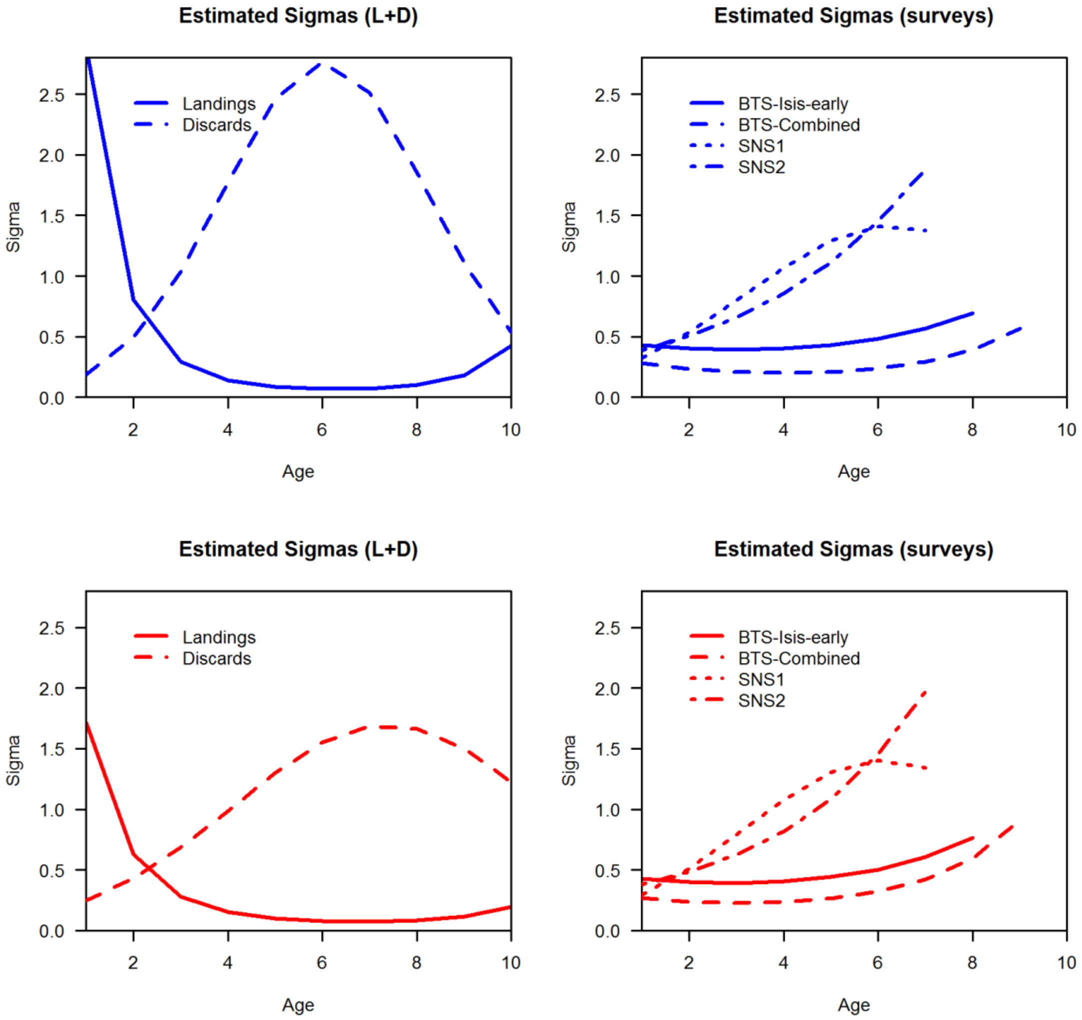


Figure 29. Run 3: Estimated age-dependent sigmas for the different likelihood components.

Figures run 3 (1970-2015, 7, 9, 6, 26, 2, BTS-Isis early, BTS combined, SNS1, SNS2)

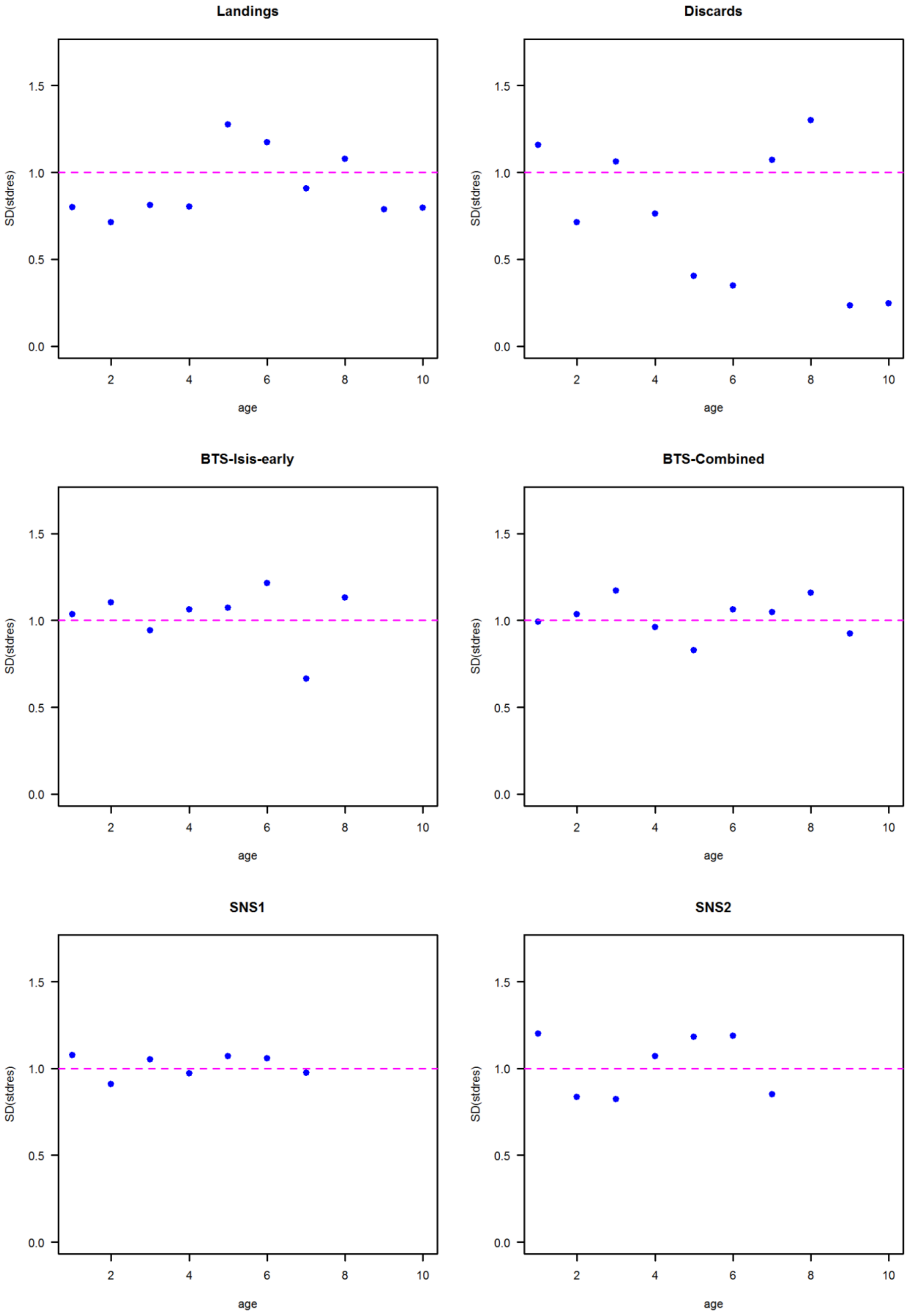


Figure 30. Run 3: SDs of standardized residuals (for discards estimates from WGNSSK 2016 assessment).

Figures run 3 (1970-2015, 7, 9, 6, 26, 2, BTS-Isis early, BTS combined, SNS1, SNS2)

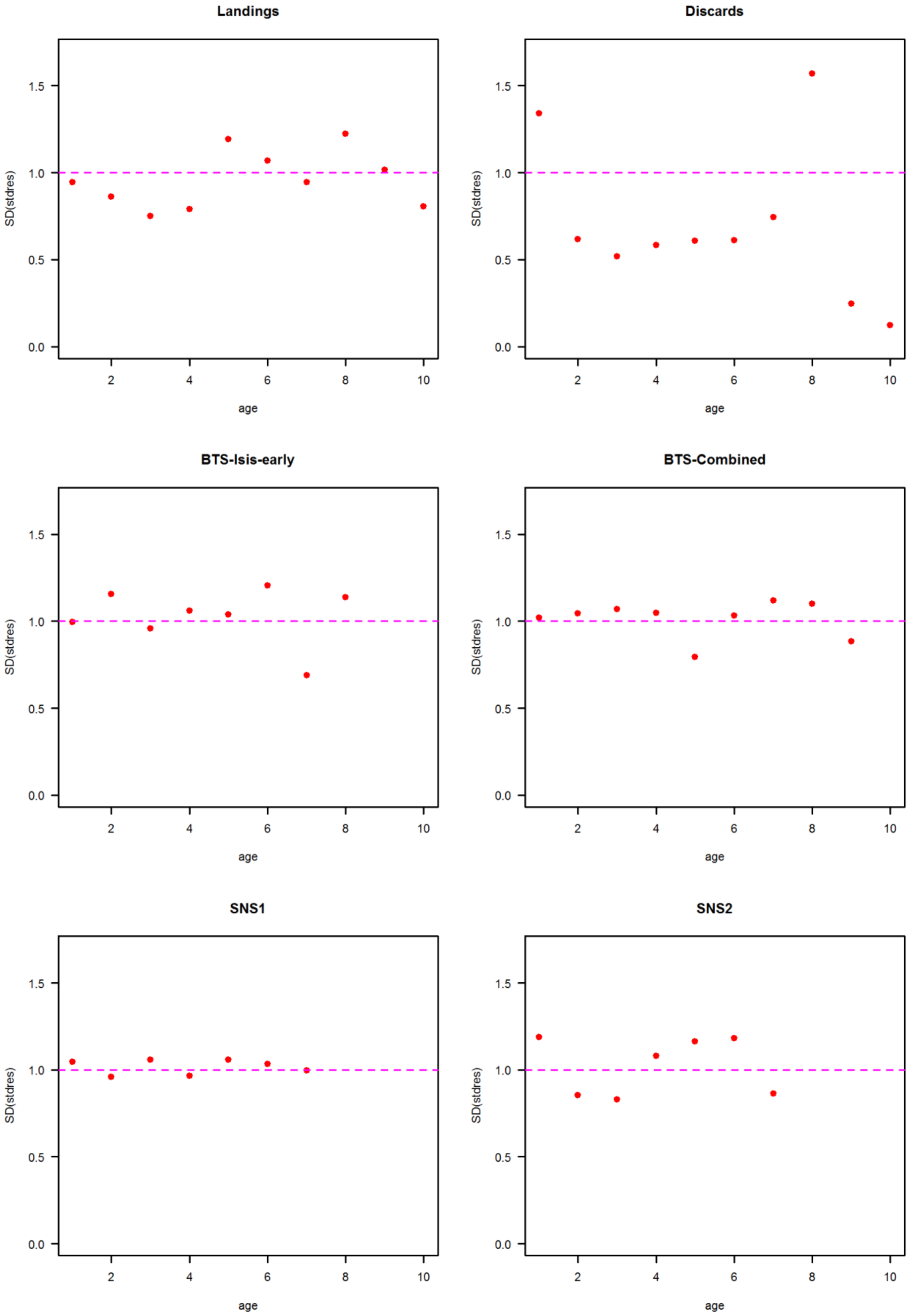


Figure 31. Run 3: SDs of standardized residuals (for internally estimated discards assessment).

Figures run 3 (1970-2015, 7, 9, 6, 26, 2, BTS-Isis early, BTS combined, SNS1, SNS2)

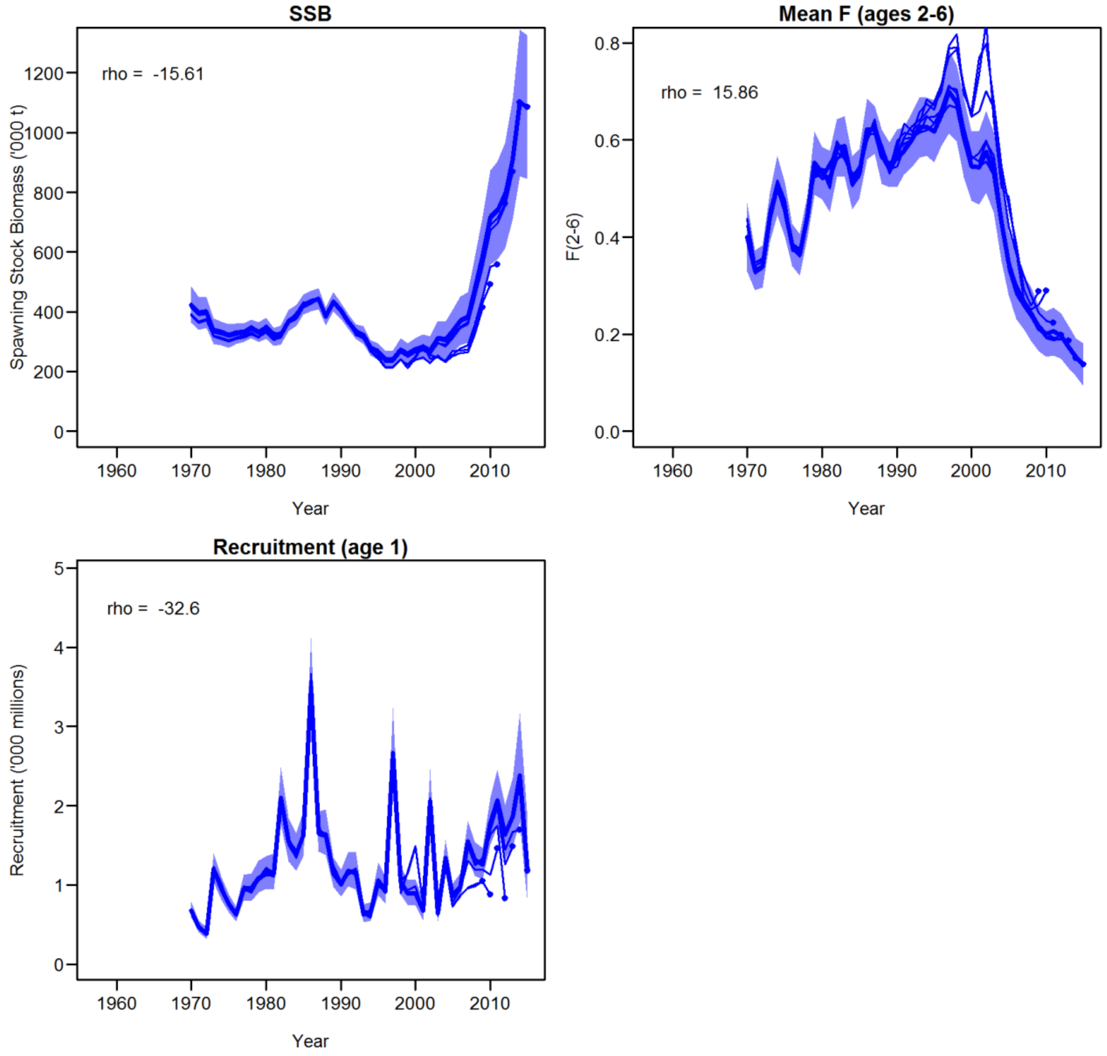


Figure 32. Run 3: Retro (for discards estimates from WGNSSK 2016 assessment).

Figures run 3 (1970-2015, 7, 9, 6, 26, 2, BTS-Isis early, BTS combined, SNS1, SNS2)

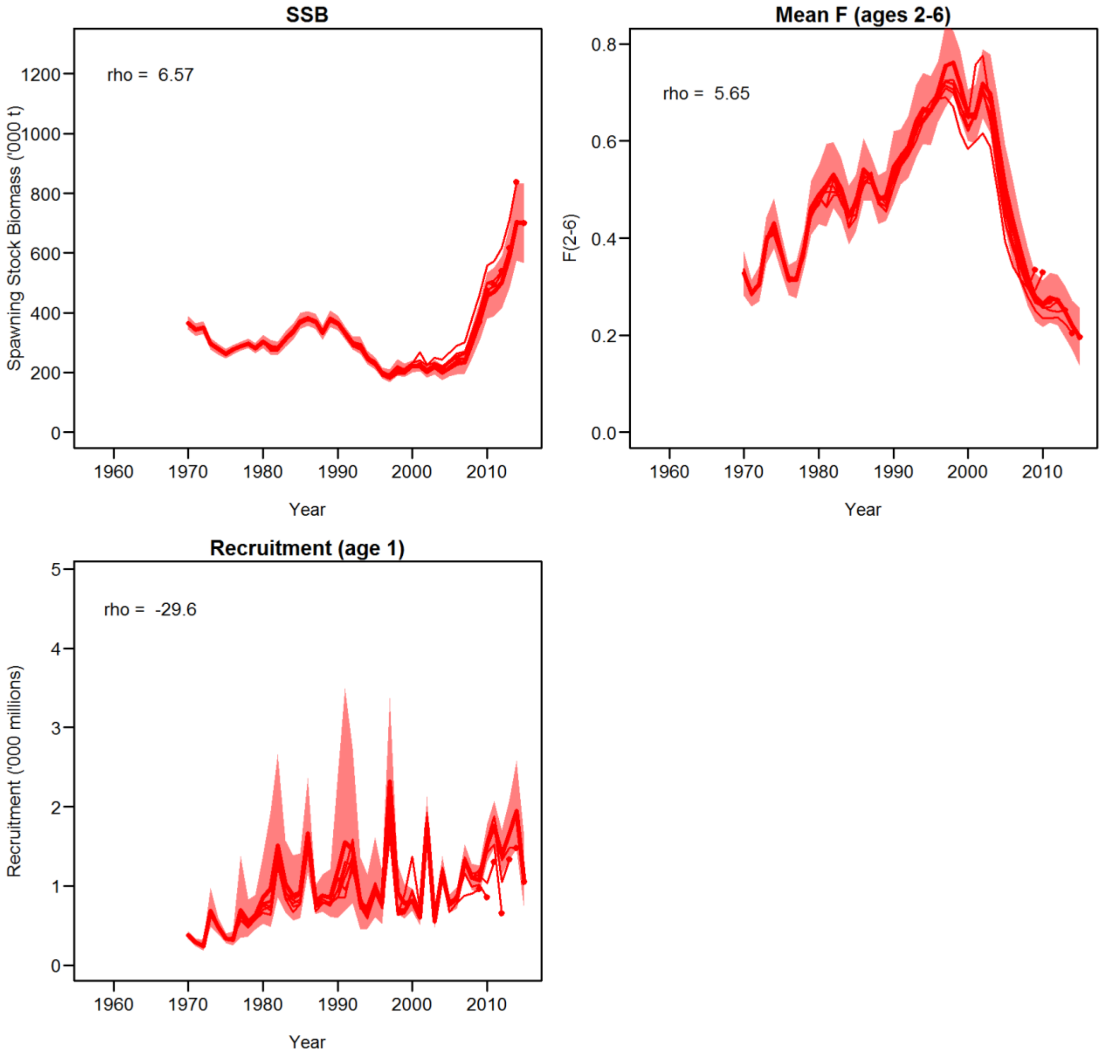


Figure 33. Run 3: Retro (for internally estimated discards assessment).

Figures run 4 (1957-2015, 7, 9, 6, 30, 2, BTS-Isis early, BTS combined, SNS1, SNS2)

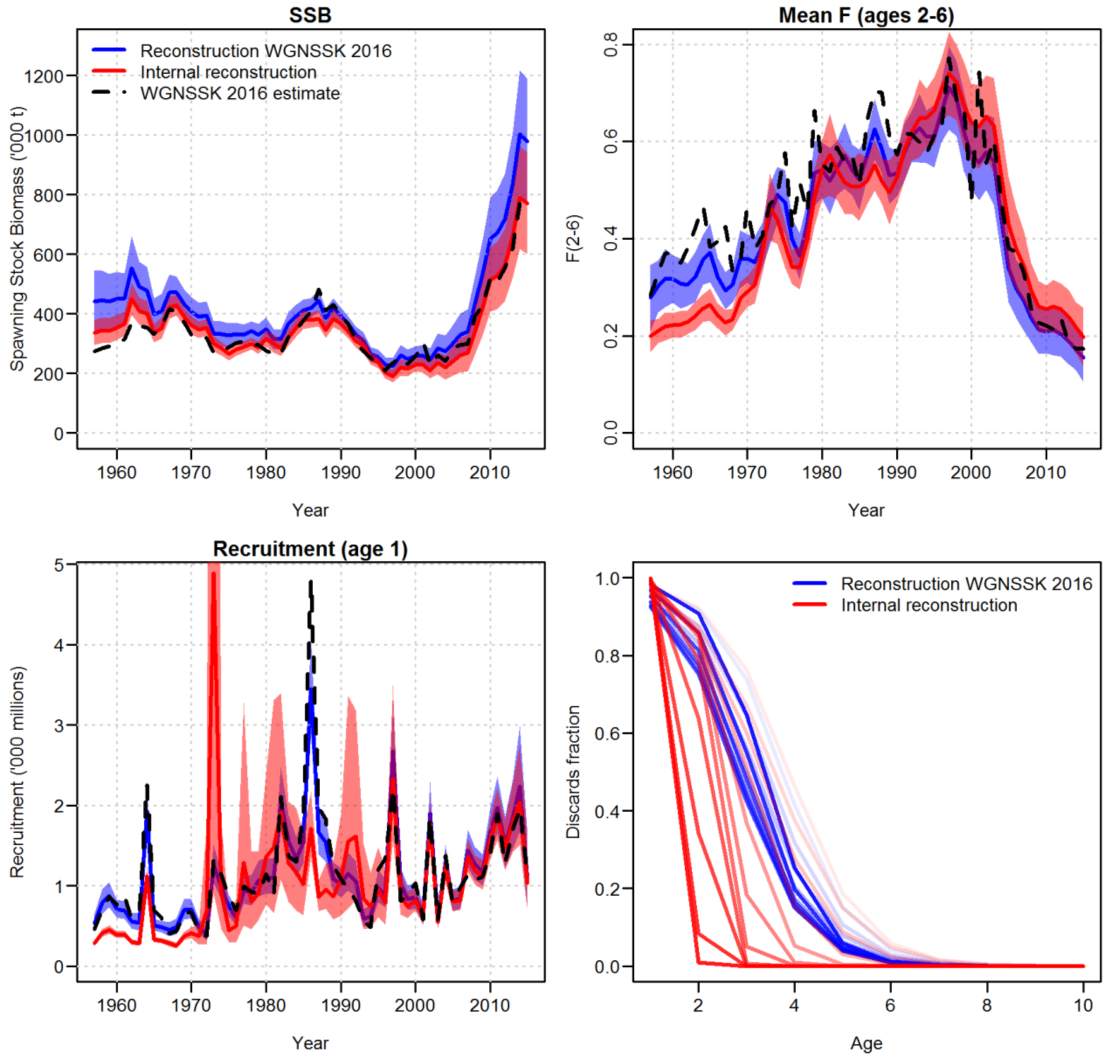


Figure 34. Run 4: Summary plot of assessment runs, with and without internal discards reconstruction, including the WGNSSK 2016 estimates.

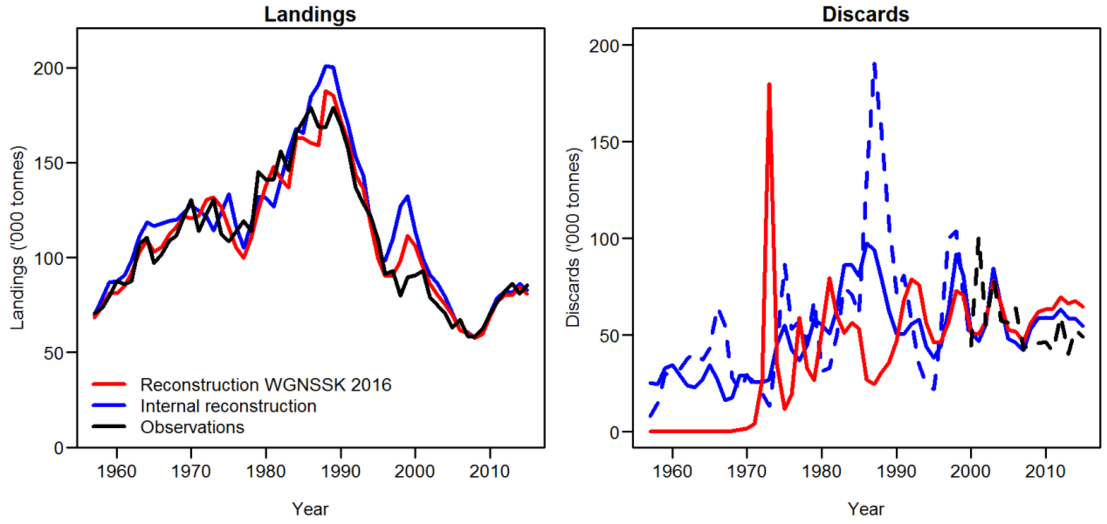


Figure 35. Run 4: Landings and discards estimates of first assessment runs, with and without internal discards reconstruction, including the WGNSSK 2016 estimates.

Figures run 4 (1957-2015, 7, 9, 6, 30, 2, BTS-Isis early, BTS combined, SNS1, SNS2)

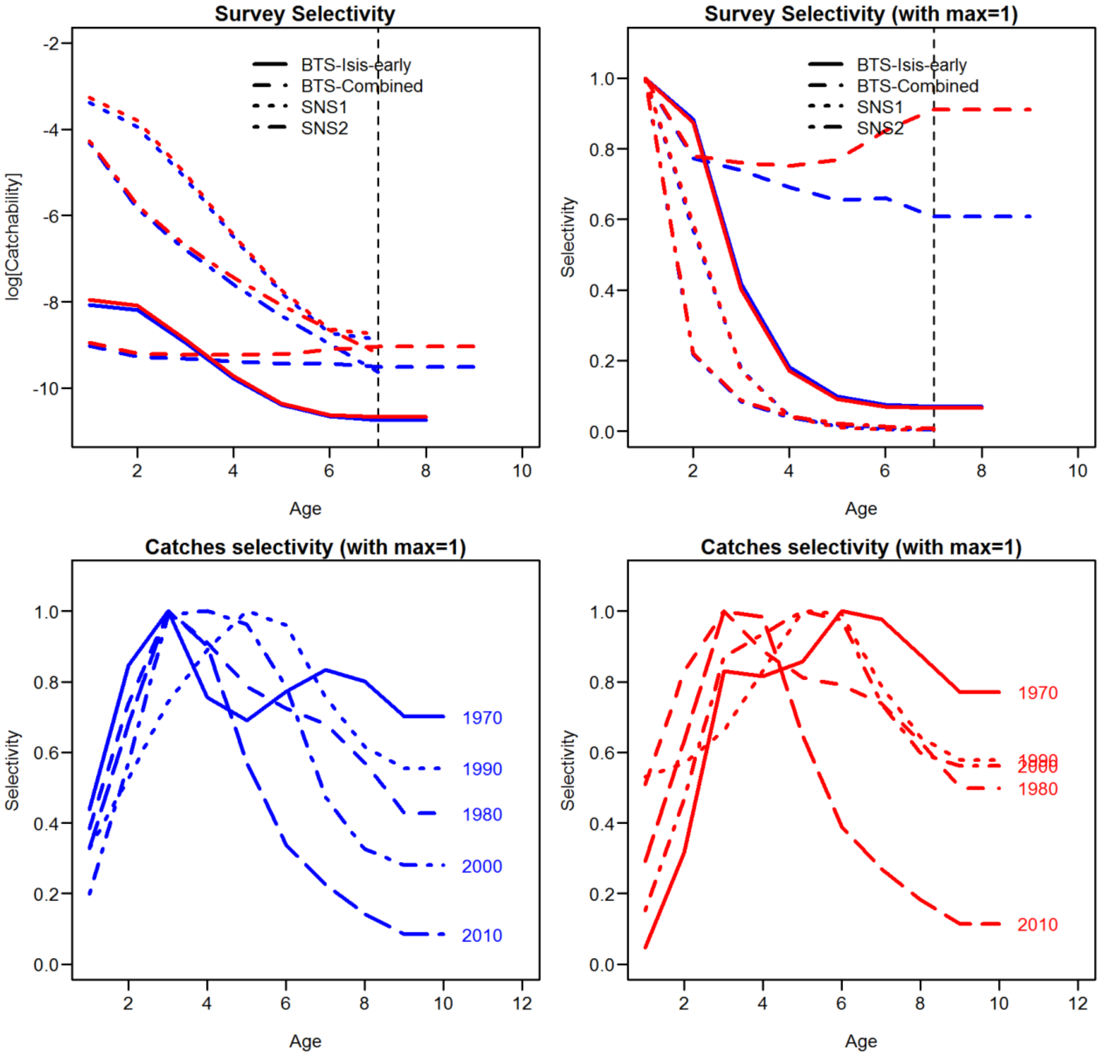


Figure 36. Run 4: survey selectivities (top panels) and selectivities catches (lower panels). Blue lines indicate the assessment that uses the WGNSSK 2016 reconstruction, red lines indicate the assessment where internal estimation is done.

Figures run 4 (1957-2015, 7, 9, 6, 30, 2, BTS-Isis early, BTS combined, SNS1, SNS2)

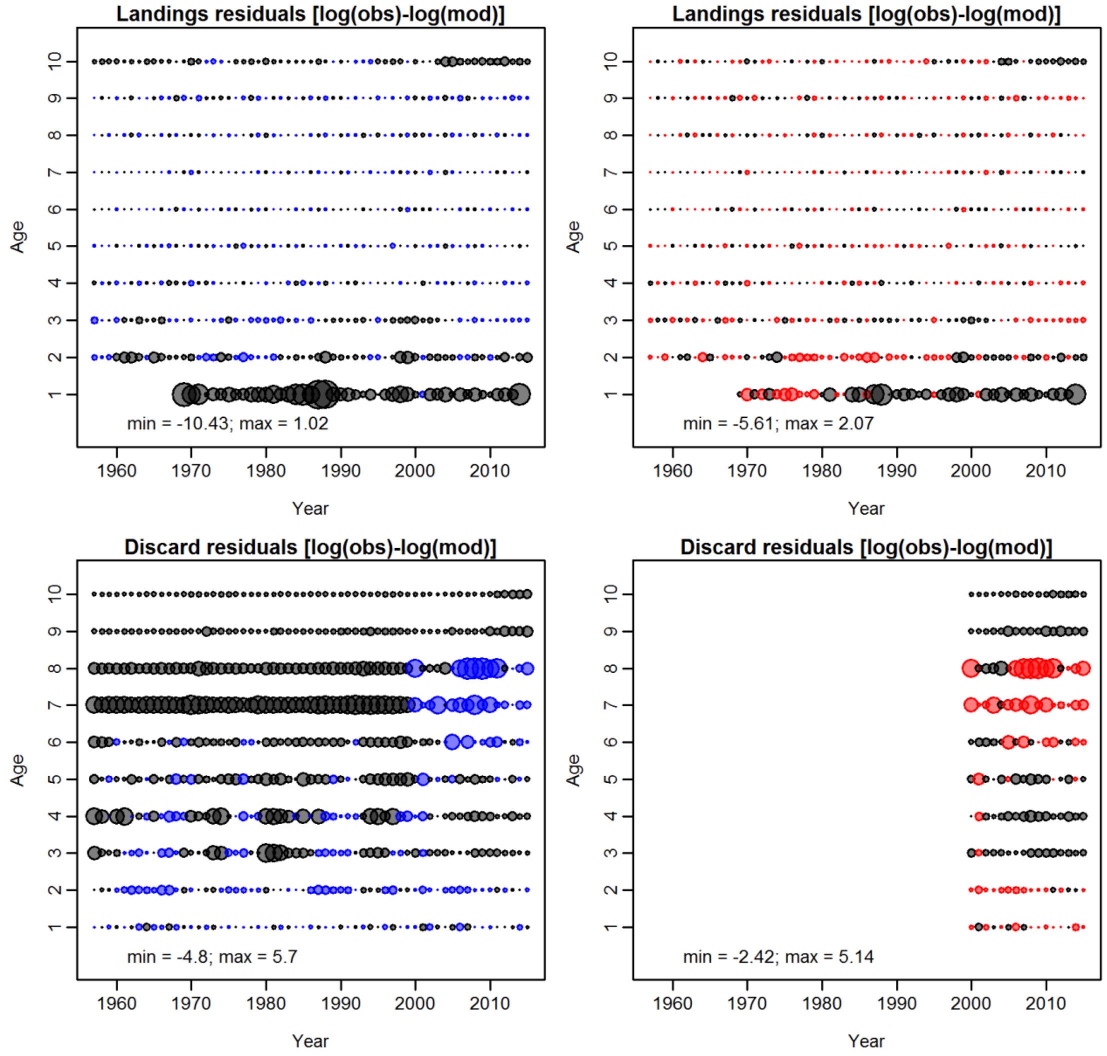


Figure 37. Run 4: Landings residuals (top panels) and discards residuals (lower panels). Blue/red bubbles positive residuals (observations greater than model), and black bubbles indicate negative residuals (observations less than model). Left panels indicate assessment with WGNSSK 2016 being used (blue colors for positive residuals), right panels indicate assessment where discards are estimated internally (red colors for positive residuals).

Figures run 4 (1957-2015, 7, 9, 6, 30, 2, BTS-Isis early, BTS combined, SNS1, SNS2)

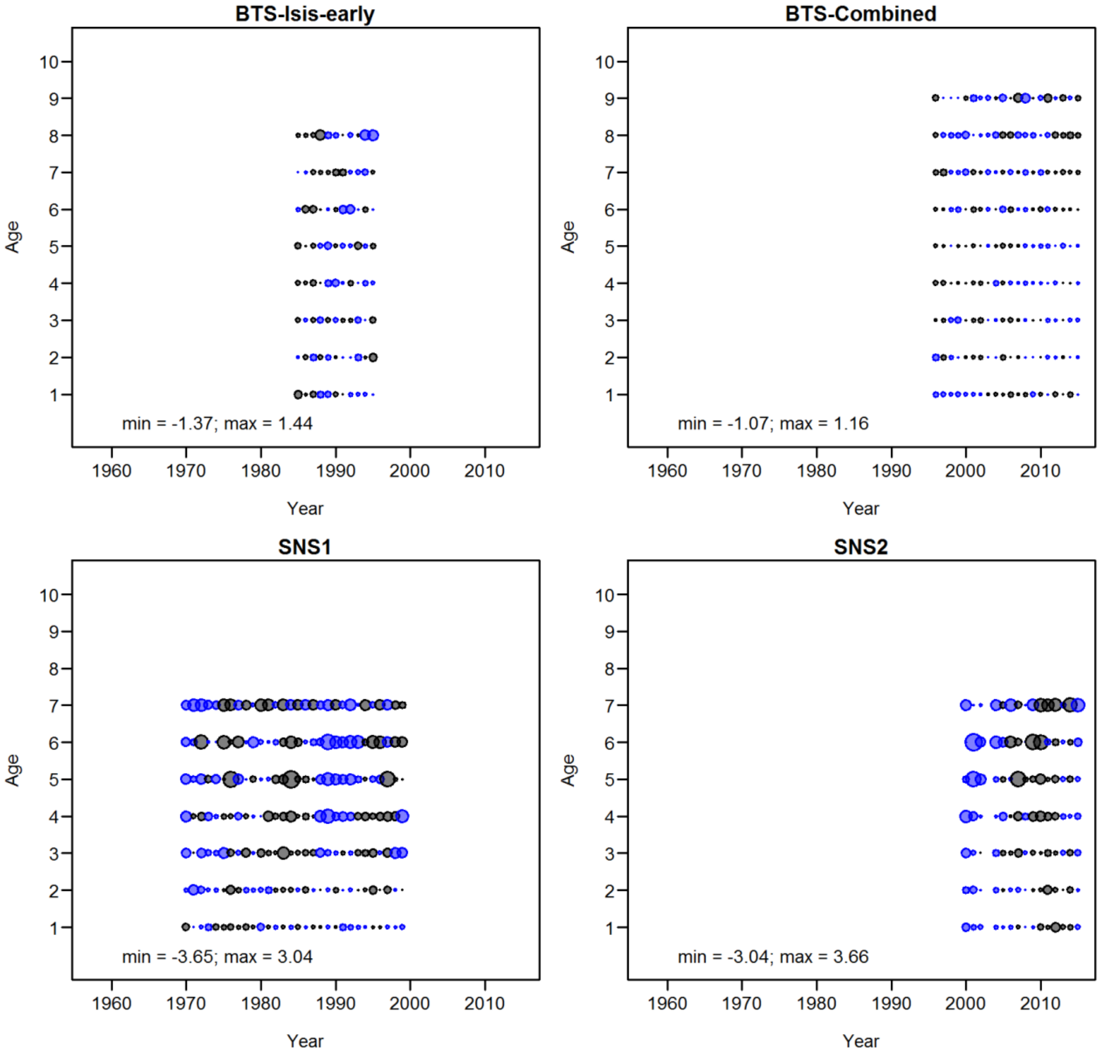


Figure 38. Run 4: Survey residuals for model using WGNSSK 2016 discards reconstruction. Blue bubbles indicate positive residuals (observations greater than model), and black bubbles indicate negative residuals (observations less than model).

Figures run 4 (1957-2015, 7, 9, 6, 30, 2, BTS-Isis early, BTS combined, SNS1, SNS2)

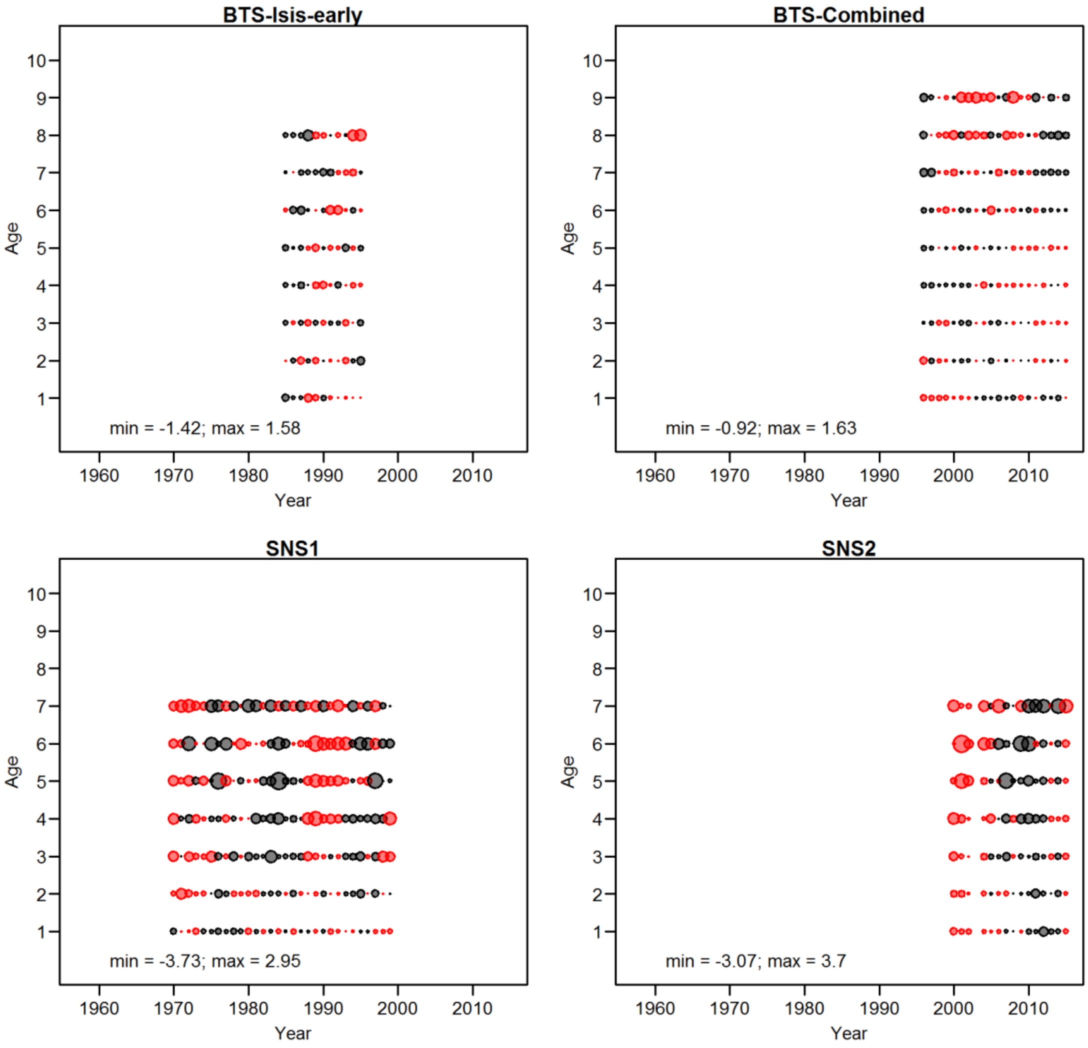


Figure 39. Run 4: Survey residuals for internally recosntructed discards. Red bubbles indicate positive residuals (observations greater than model), and black bubbles indicate negative residuals (observations less than model).

Figures run 4 (1957-2015, 7, 9, 6, 30, 2, BTS-Isis early, BTS combined, SNS1, SNS2)

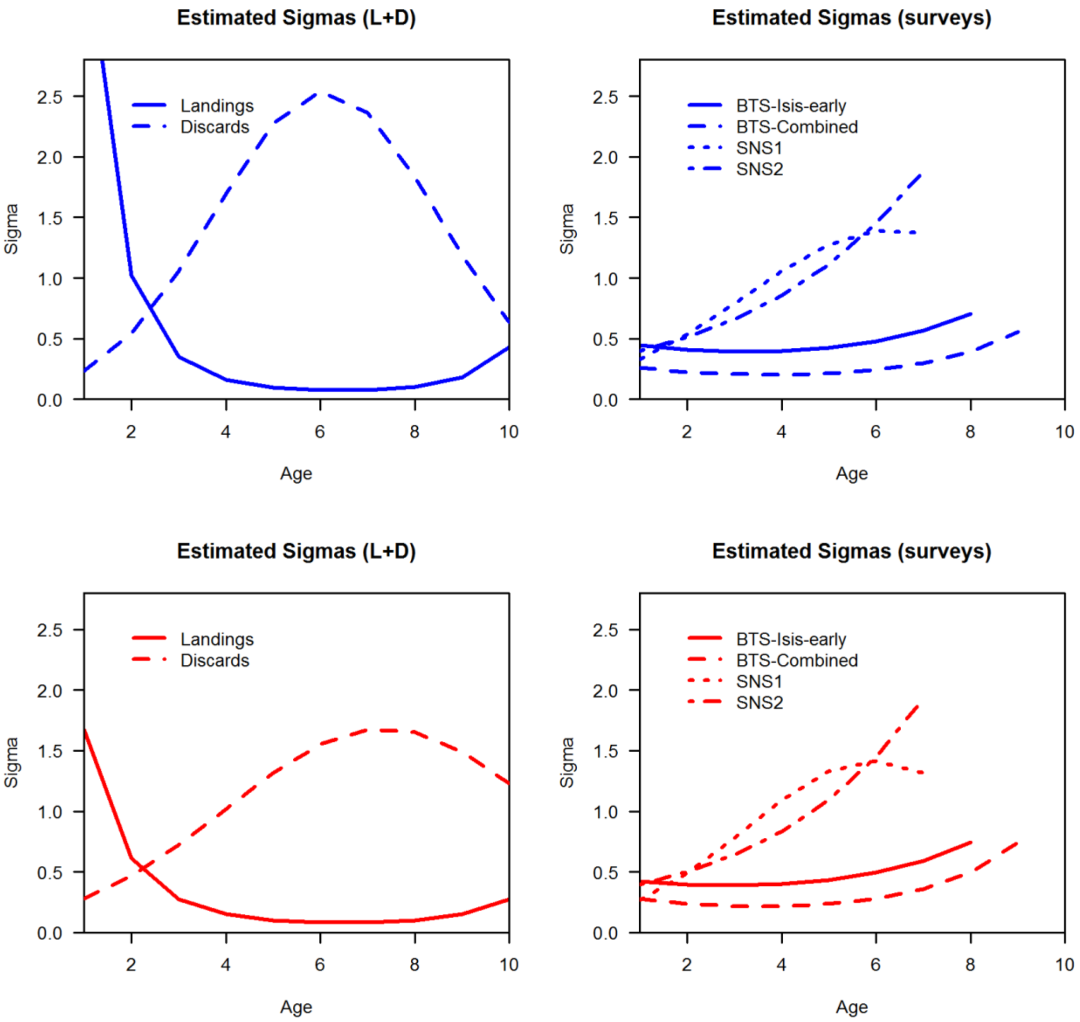


Figure 40. Run 4: Estimated age-dependent sigmas for the different likelihood components.

Figures run 4 (1957-2015, 7, 9, 6, 30, 2, BTS-Isis early, BTS combined, SNS1, SNS2)

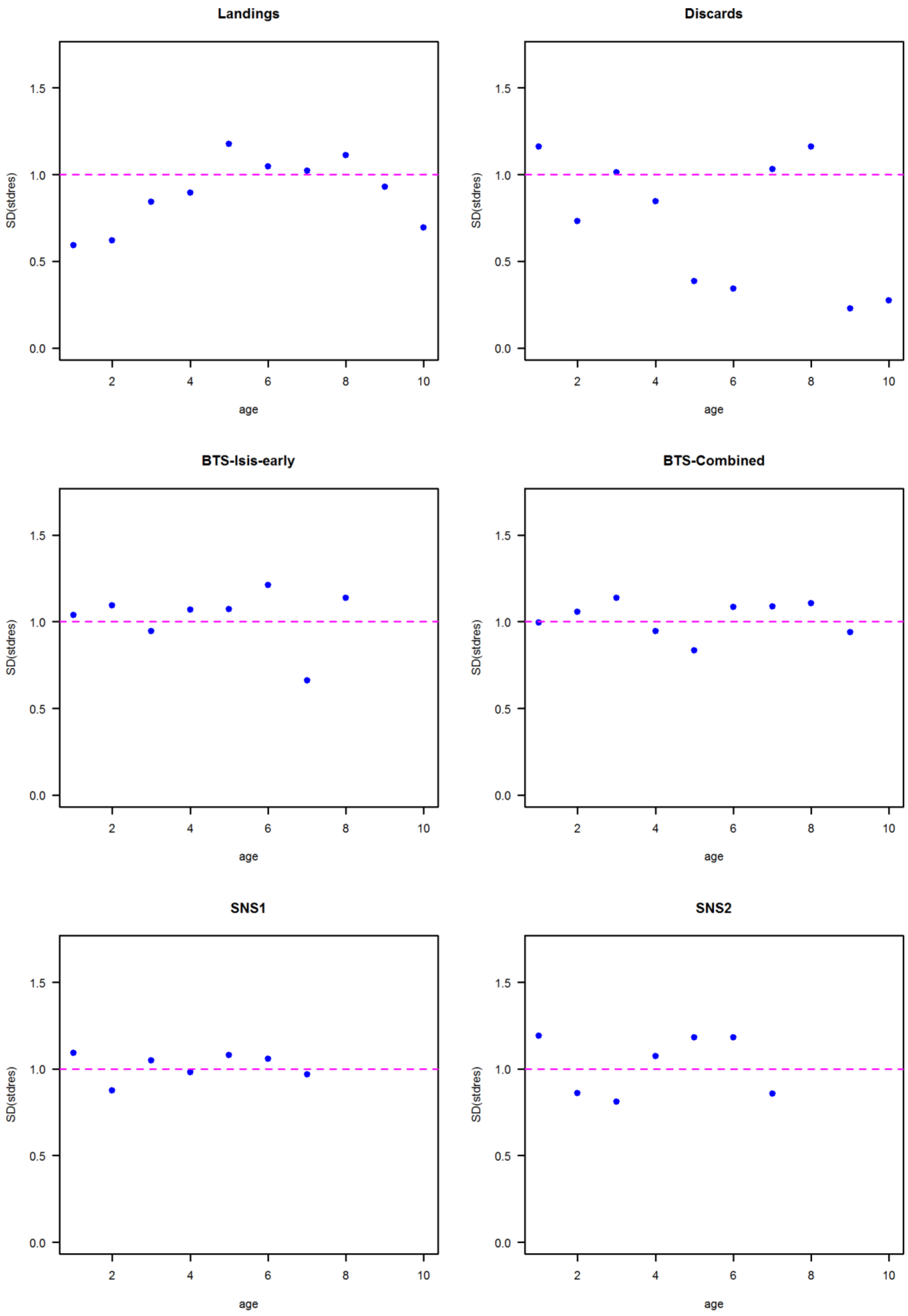


Figure 41. Run 4: SDs of standardized residuals (for discards estimates from WGNSSK 2016 assessment).

Figures run 4 (1957-2015, 7, 9, 6, 30, 2, BTS-Isis early, BTS combined, SNS1, SNS2)

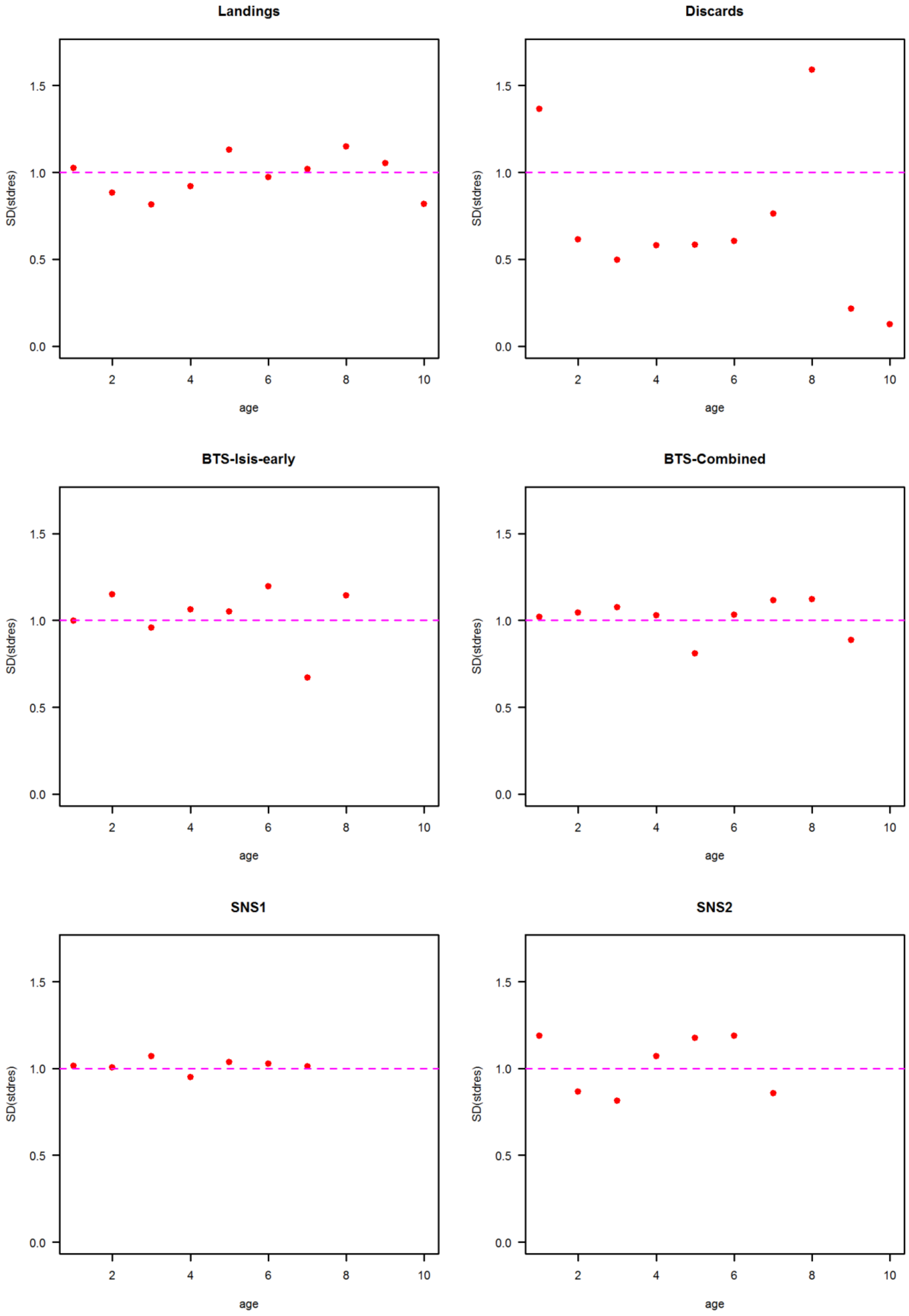


Figure 42. Run 4: SDs of standardized residuals (for internally estimated discards assessment).

Figures run 4 (1957-2015, 7, 9, 6, 30, 2, BTS-Isis early, BTS combined, SNS1, SNS2)

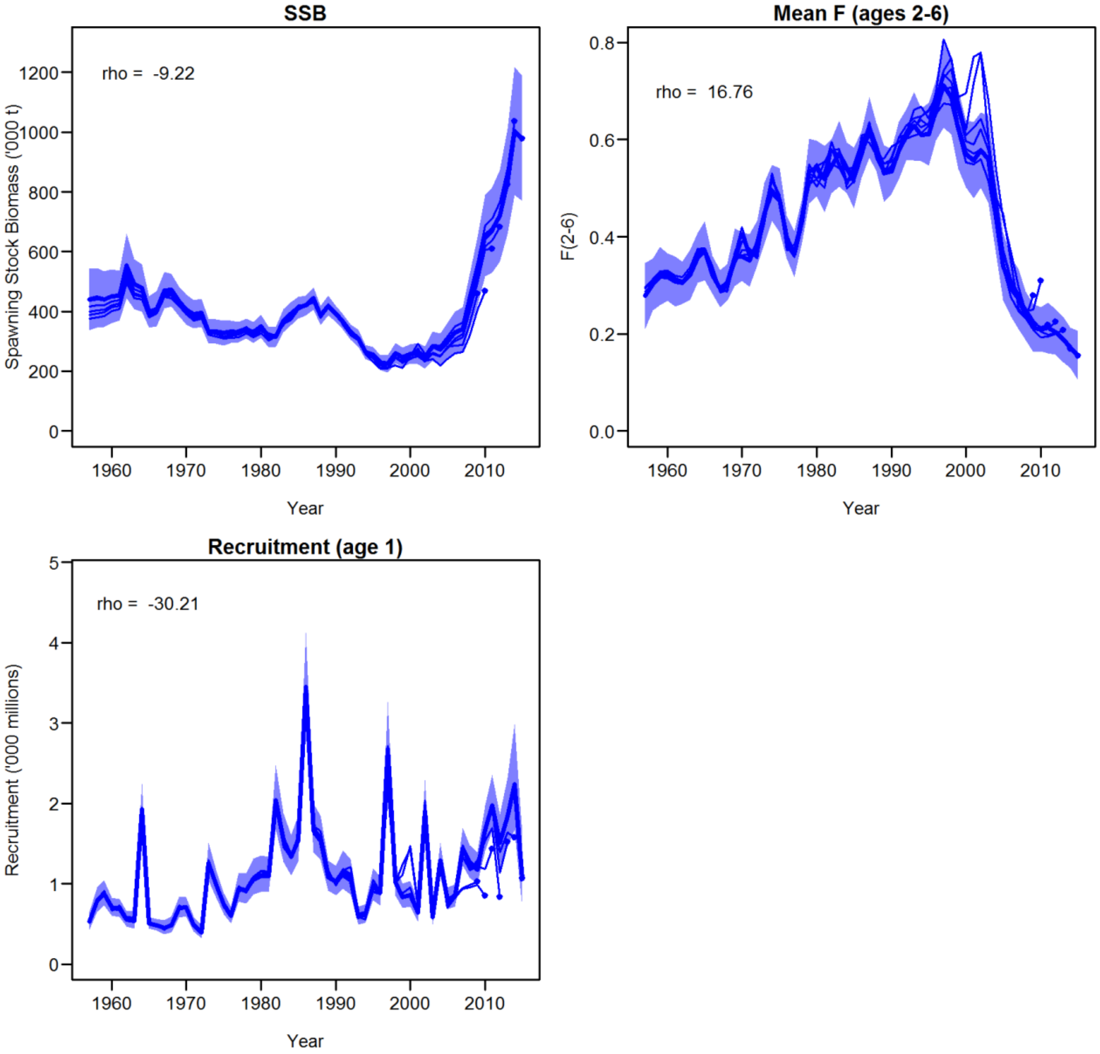


Figure 43. Run 4: Retro (for discards estimates from WGNSSK 2016 assessment).

Figures run 4 (1957-2015, 7, 9, 6, 30, 2, BTS-Isis early, BTS combined, SNS1, SNS2)

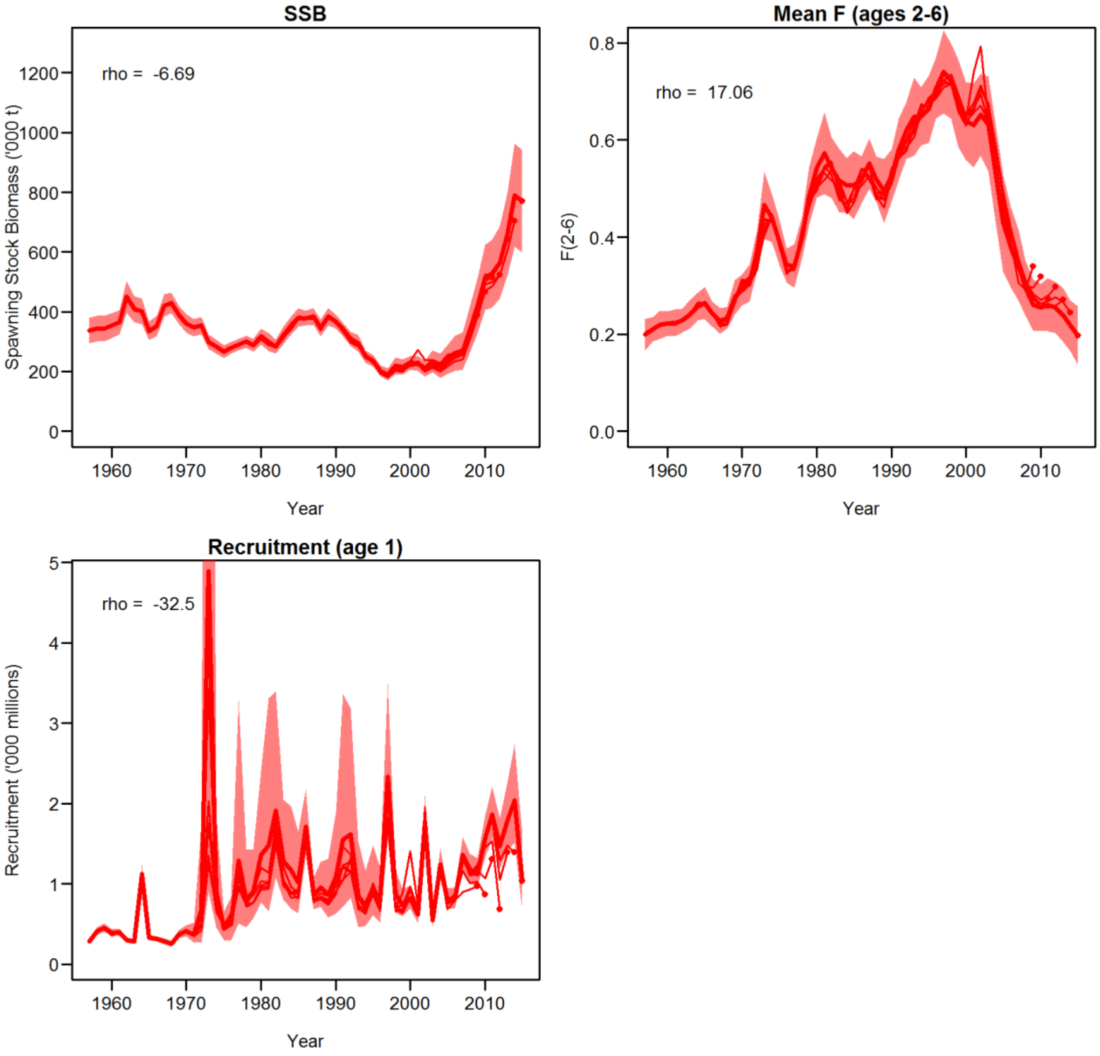


Figure 44. Run 4: Retro (for internally estimated discards assessment).

Figures run 5 (1957-2015, 7, 9, 6, 30, 2, BTS-Isis early, BTS combined, Combined SNS)

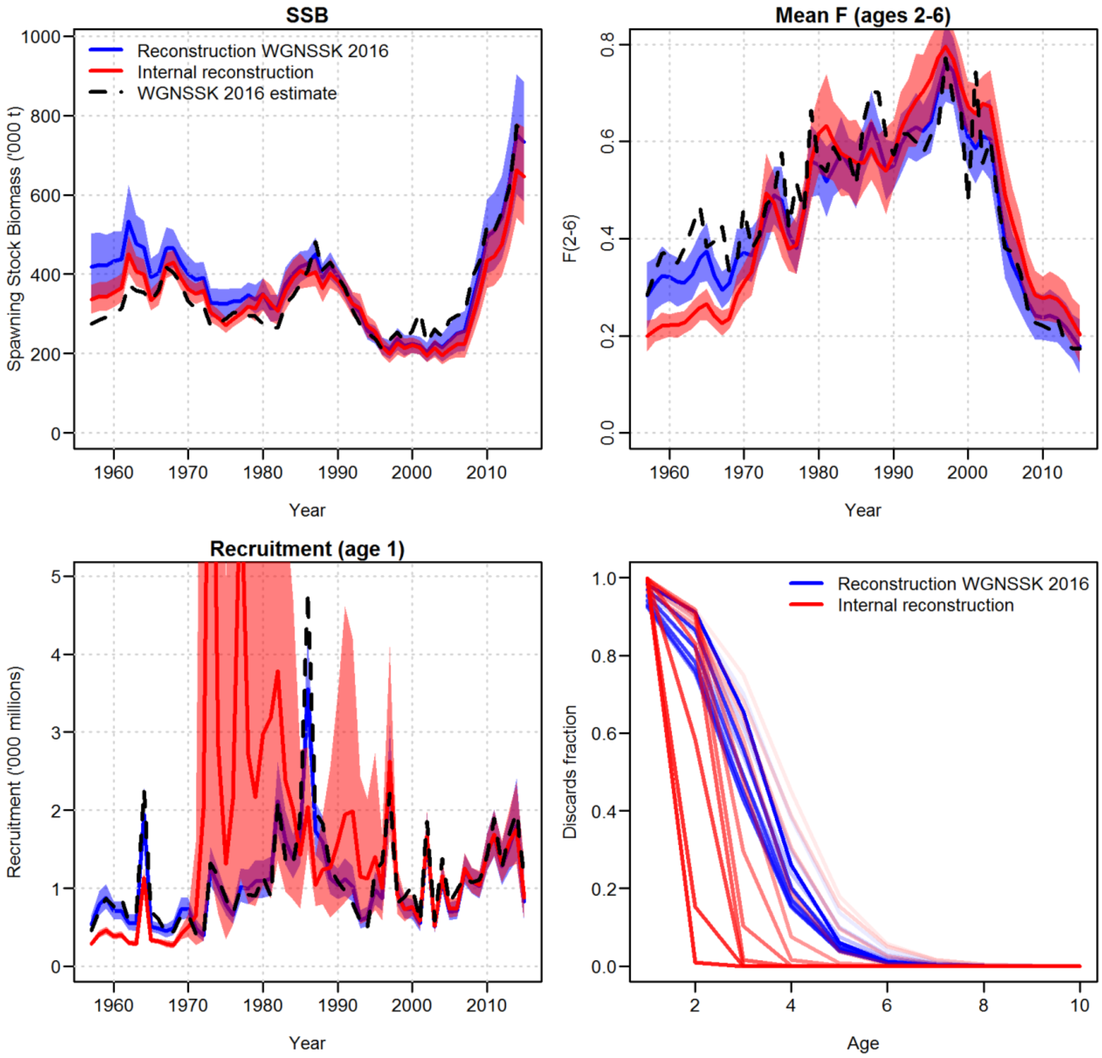


Figure 45. Run 5: Summary plot of assessment runs, with and without internal discards reconstruction, including the WGNSSK 2016 estimates.

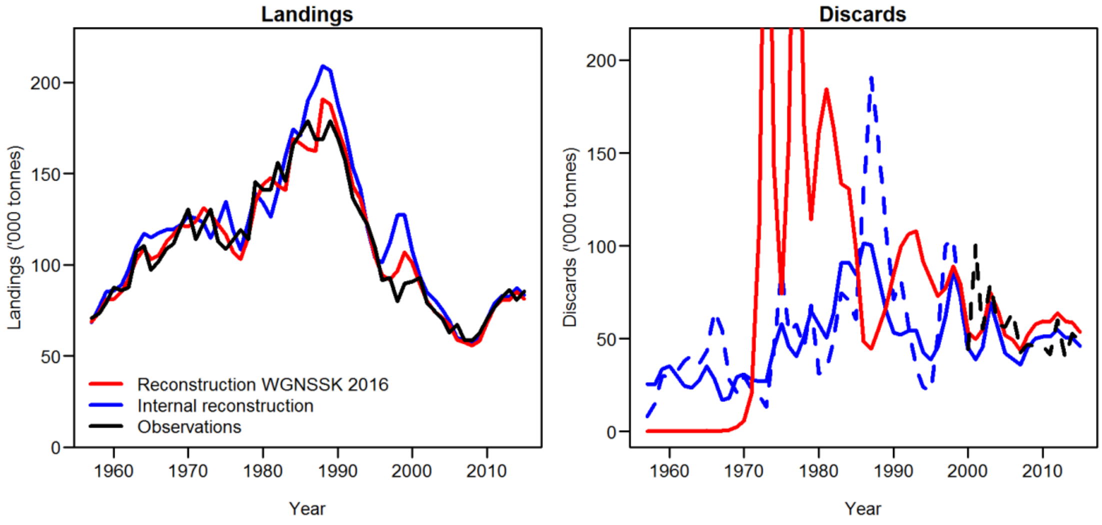


Figure 46. Run 5: Landings and discards estimates of first assessment runs, with and without internal discards reconstruction, including the WGNSSK 2016 estimates.

Figures run 5 (1957-2015, 7, 9, 6, 30, 2, BTS-Isis early, BTS combined, Combined SNS)

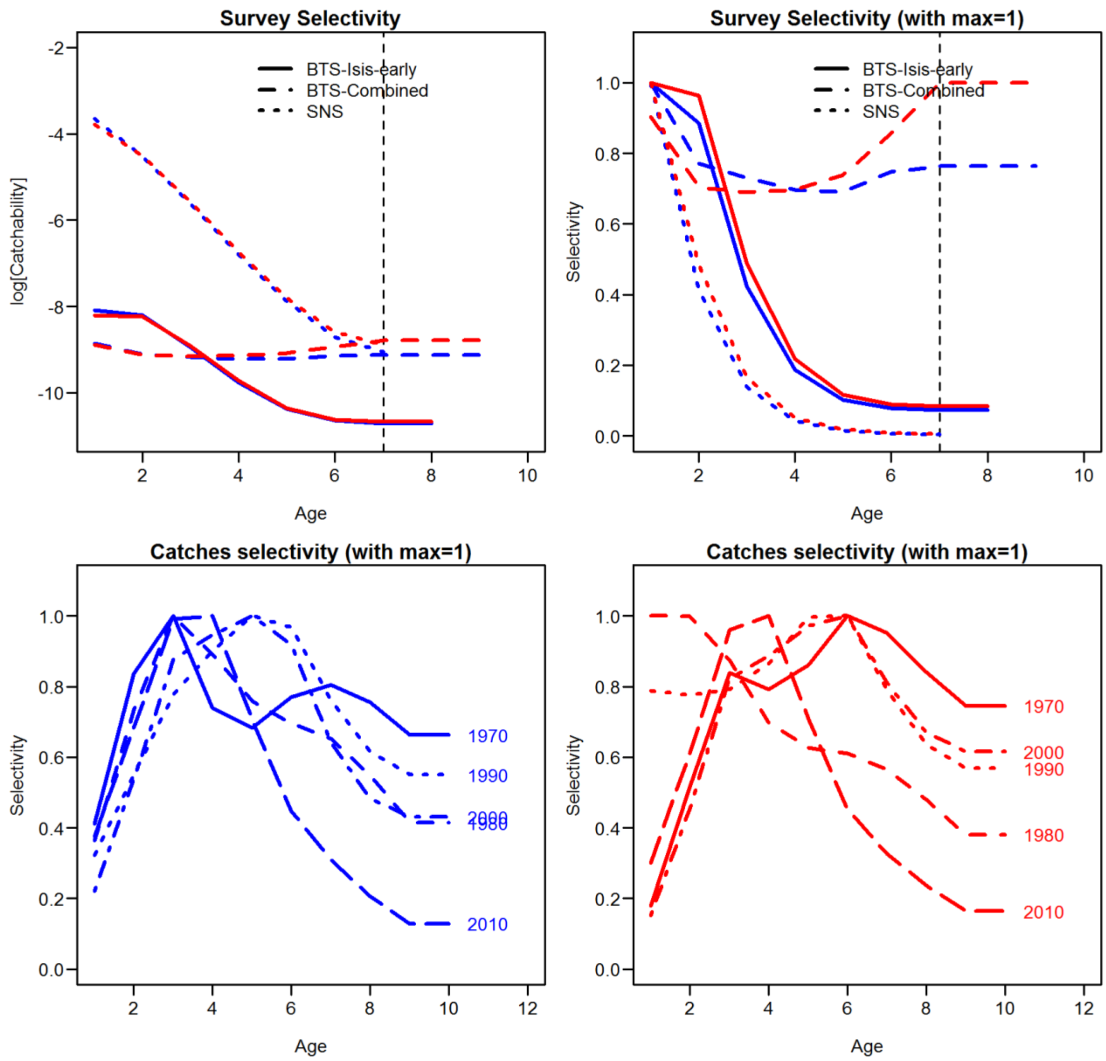


Figure 47. Run 5: survey selectivities (top panels) and selectivities catches (lower panels). Blue lines indicate the assessment that uses the WGNSSK 2016 reconstruction, red lines indicate the assessment where internal estimation is done.

Figures run 5 (1957-2015, 7, 9, 6, 30, 2, BTS-Isis early, BTS combined, Combined SNS)

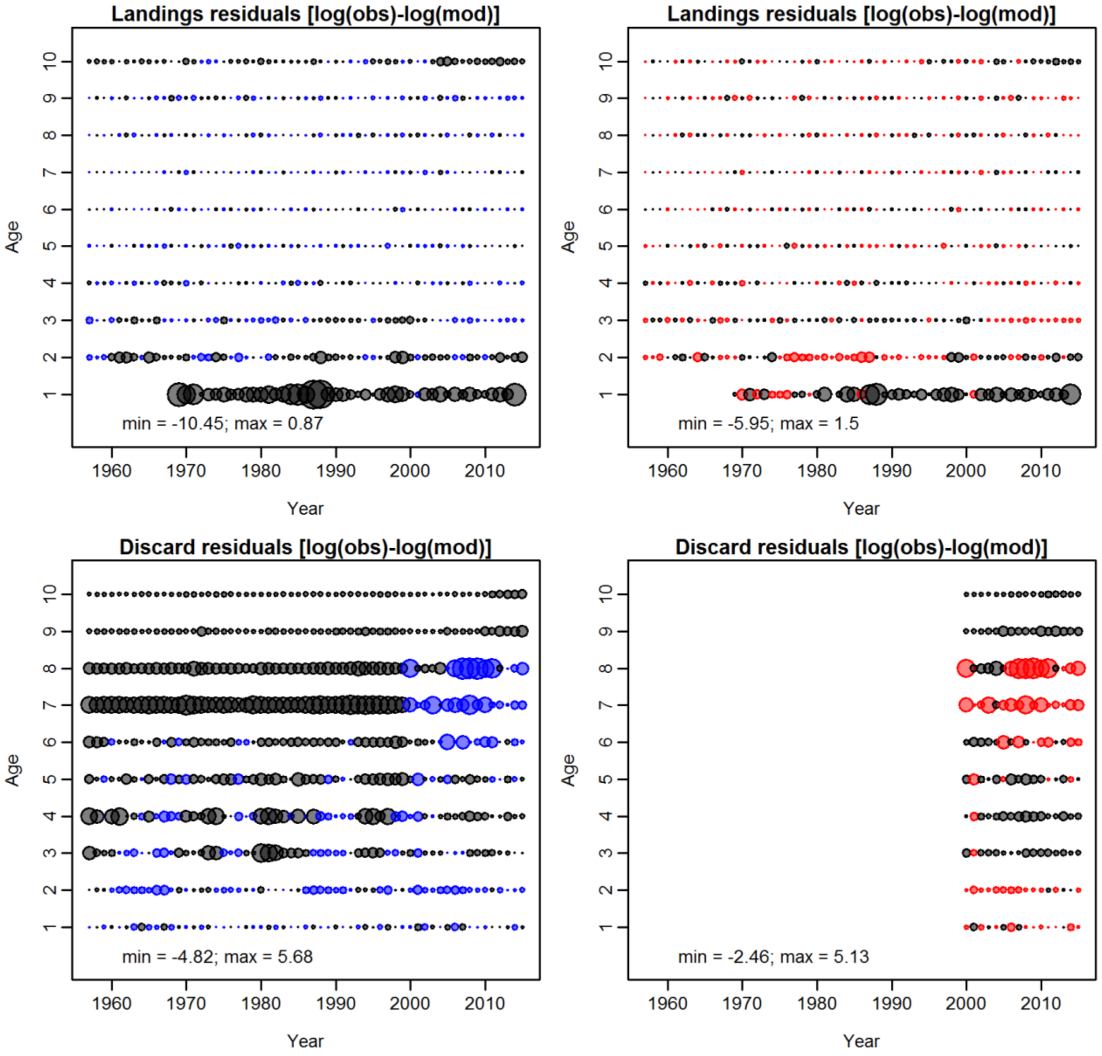


Figure 48. Run 5: Landings residuals (top panels) and discards residuals (lower panels). Blue/red bubbles positive residuals (observations greater than model), and black bubbles indicate negative residuals (observations less than model). Left panels indicate assessment with WGNSSK 2016 being used (blue colors for positive residuals), right panels indicate assessment where discards are estimated internally (red colors for positive residuals).

Figures run 5 (1957-2015, 7, 9, 6, 30, 2, BTS-Isis early, BTS combined, Combined SNS)

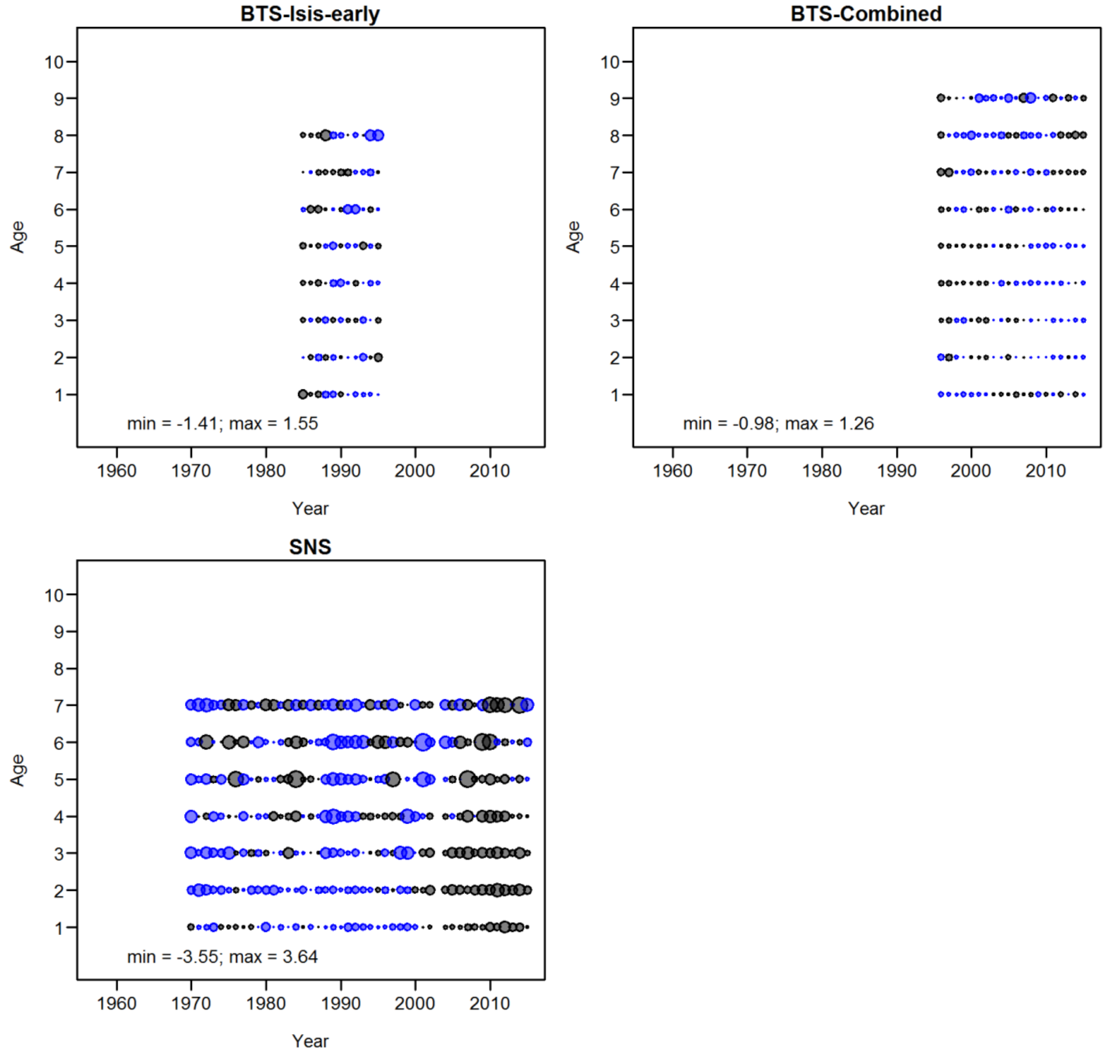


Figure 49. Run 5: Survey residuals for model using WGNSSK 2016 discards reconstruction. Blue bubbles indicate positive residuals (observations greater than model), and black bubbles indicate negative residuals (observations less than model).

Figures run 5 (1957-2015, 7, 9, 6, 30, 2, BTS-Isis early, BTS combined, Combined SNS)

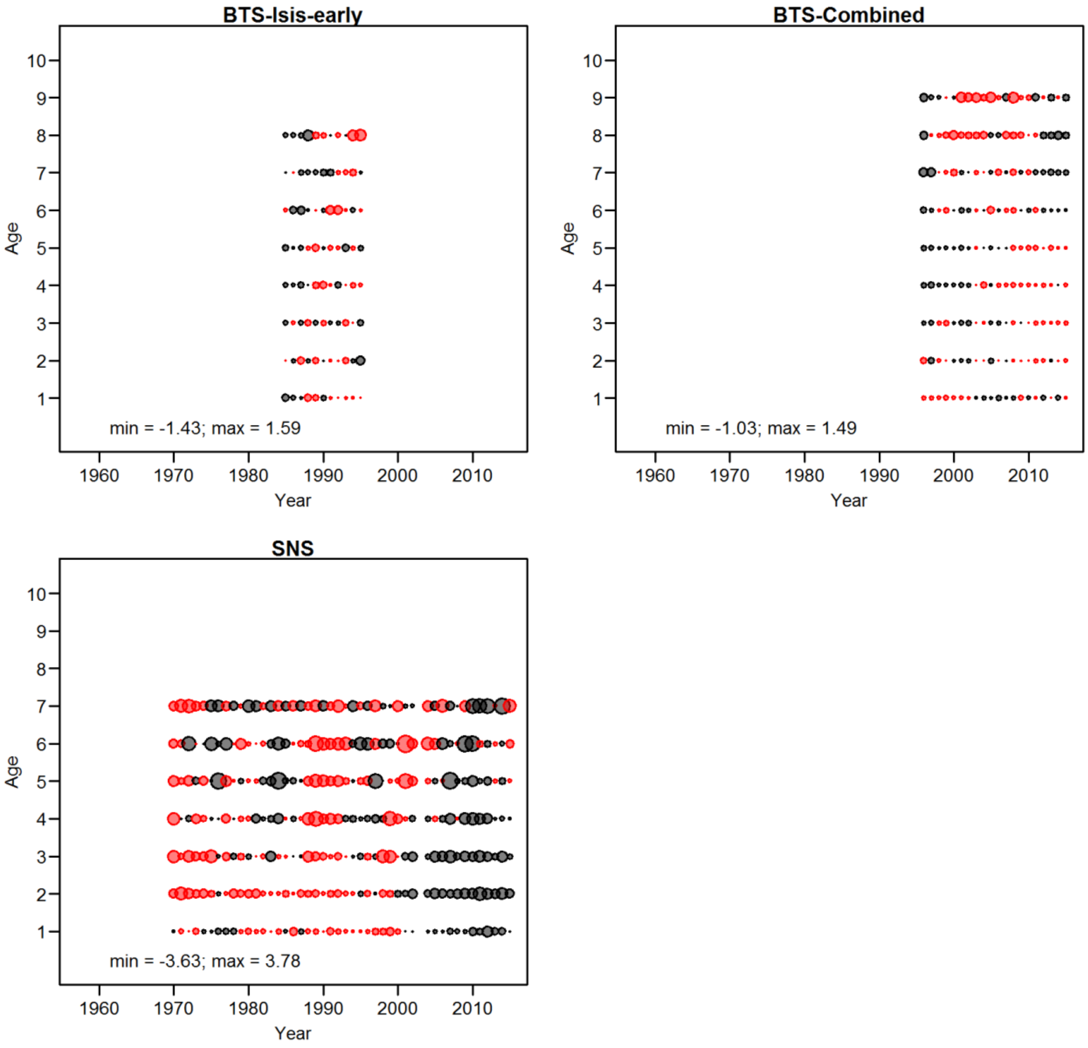


Figure 50. Run 5: Survey residuals for internally recosntructed discards. Red bubbles indicate positive residuals (observations greater than model), and black bubbles indicate negative residuals (observations less than model).

Figures run 5 (1957-2015, 7, 9, 6, 30, 2, BTS-Isis early, BTS combined, Combined SNS)

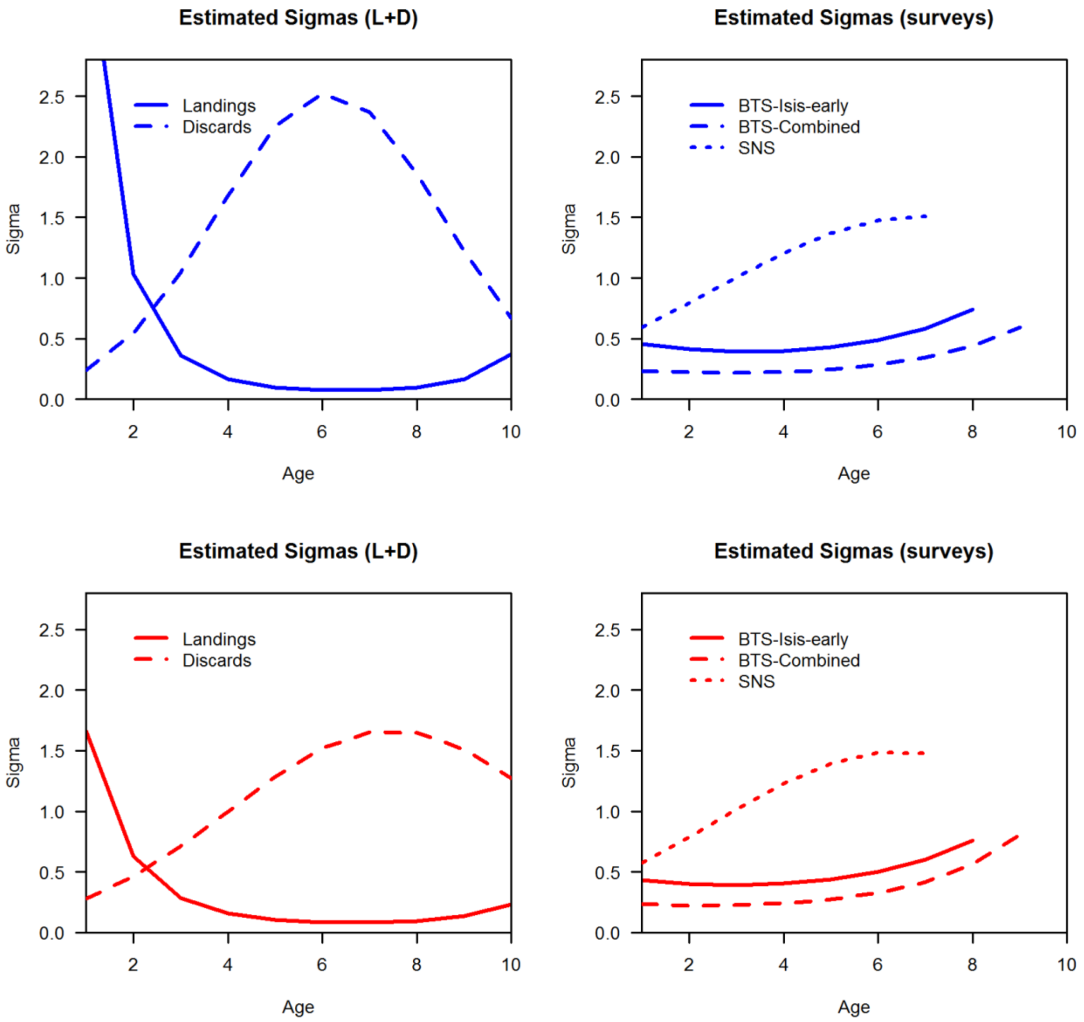


Figure 51. Run 5: Estimated age-dependent sigmas for the different likelihood components.

Figures run 5 (1957-2015, 7, 9, 6, 30, 2, BTS-Isis early, BTS combined, Combined SNS)

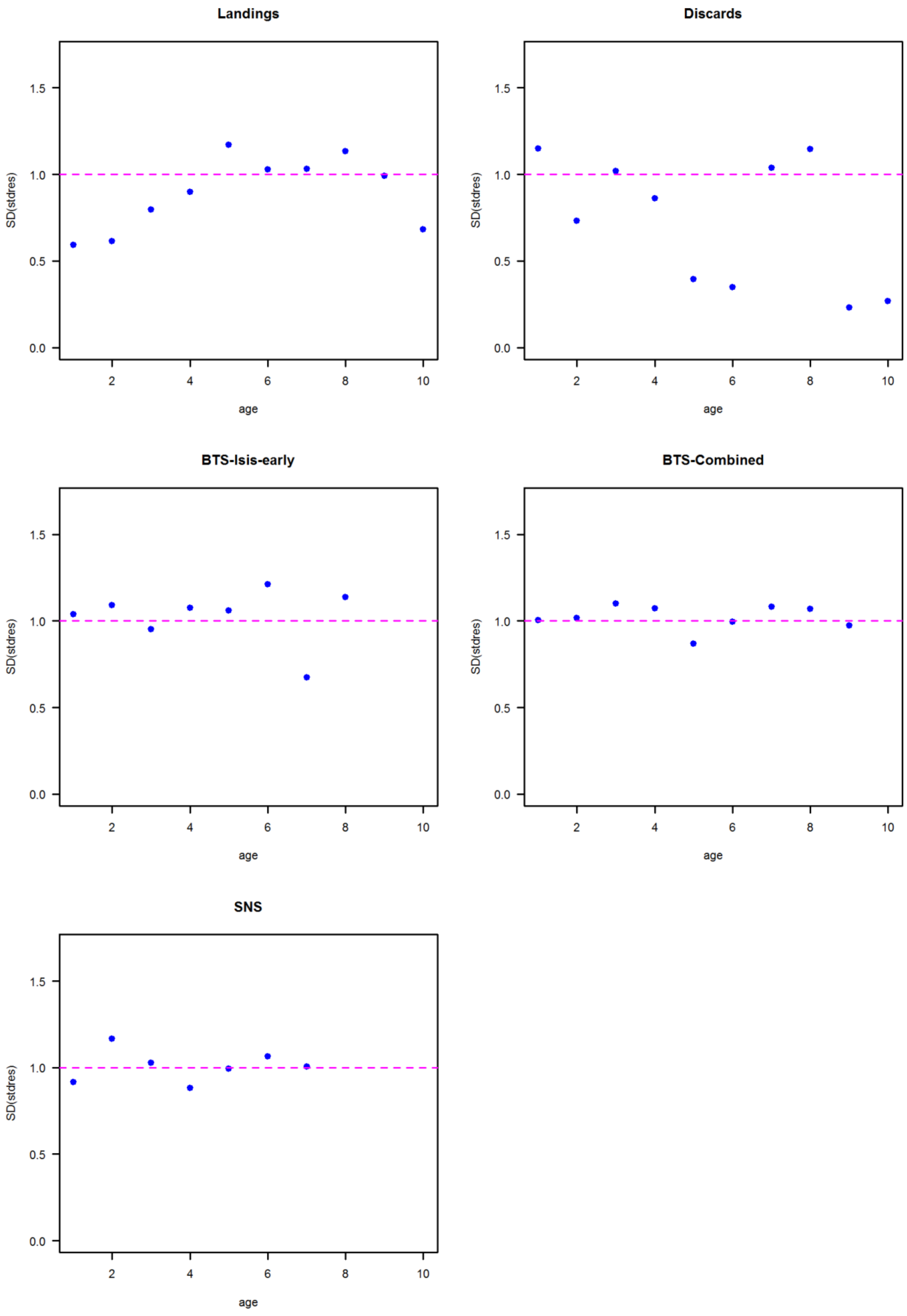


Figure 52. Run 5: SDs of standardized residuals (for discards estimates from WGNSSK 2016 assessment).

Figures run 5 (1957-2015, 7, 9, 6, 30, 2, BTS-Isis early, BTS combined, Combined SNS)

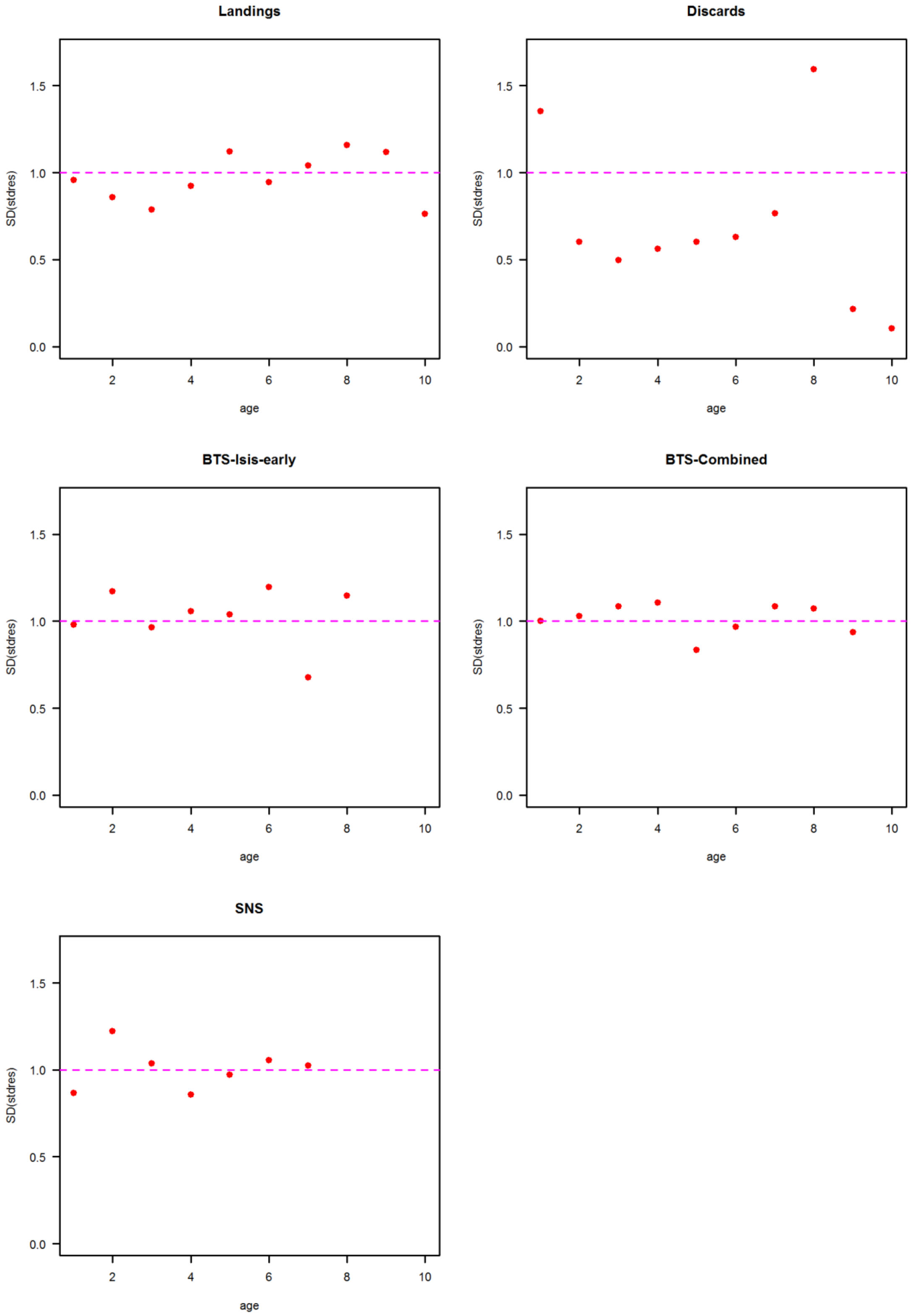


Figure 53. Run 5: SDs of standardized residuals (for internally estimated discards assessment).

Figures run 5 (1957-2015, 7, 9, 6, 30, 2, BTS-Isis early, BTS combined, Combined SNS)

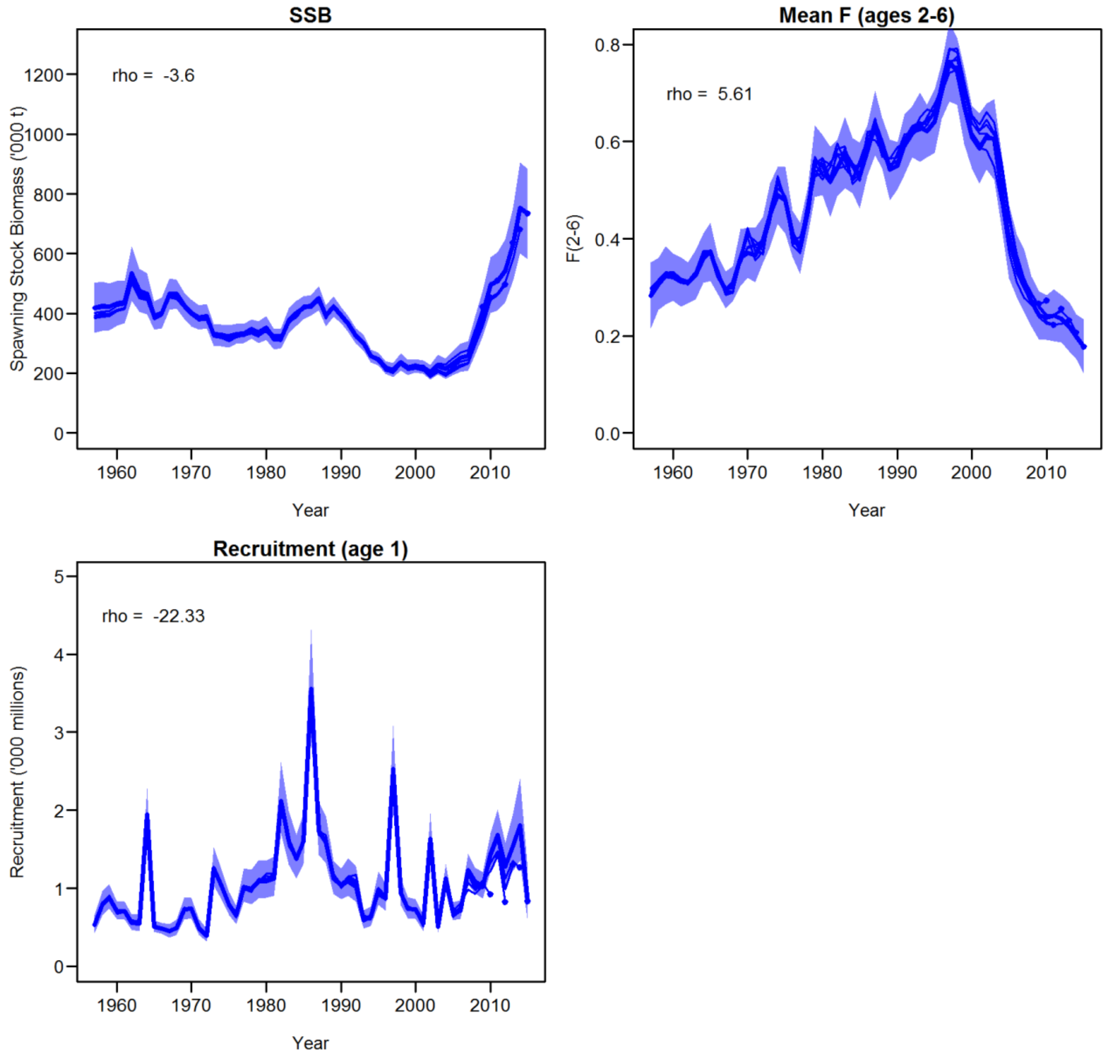


Figure 54. Run 5: Retro (for discards estimates from WGNSSK 2016 assessment).

Figures run 5 (1957-2015, 7, 9, 6, 30, 2, BTS-Isis early, BTS combined, Combined SNS)

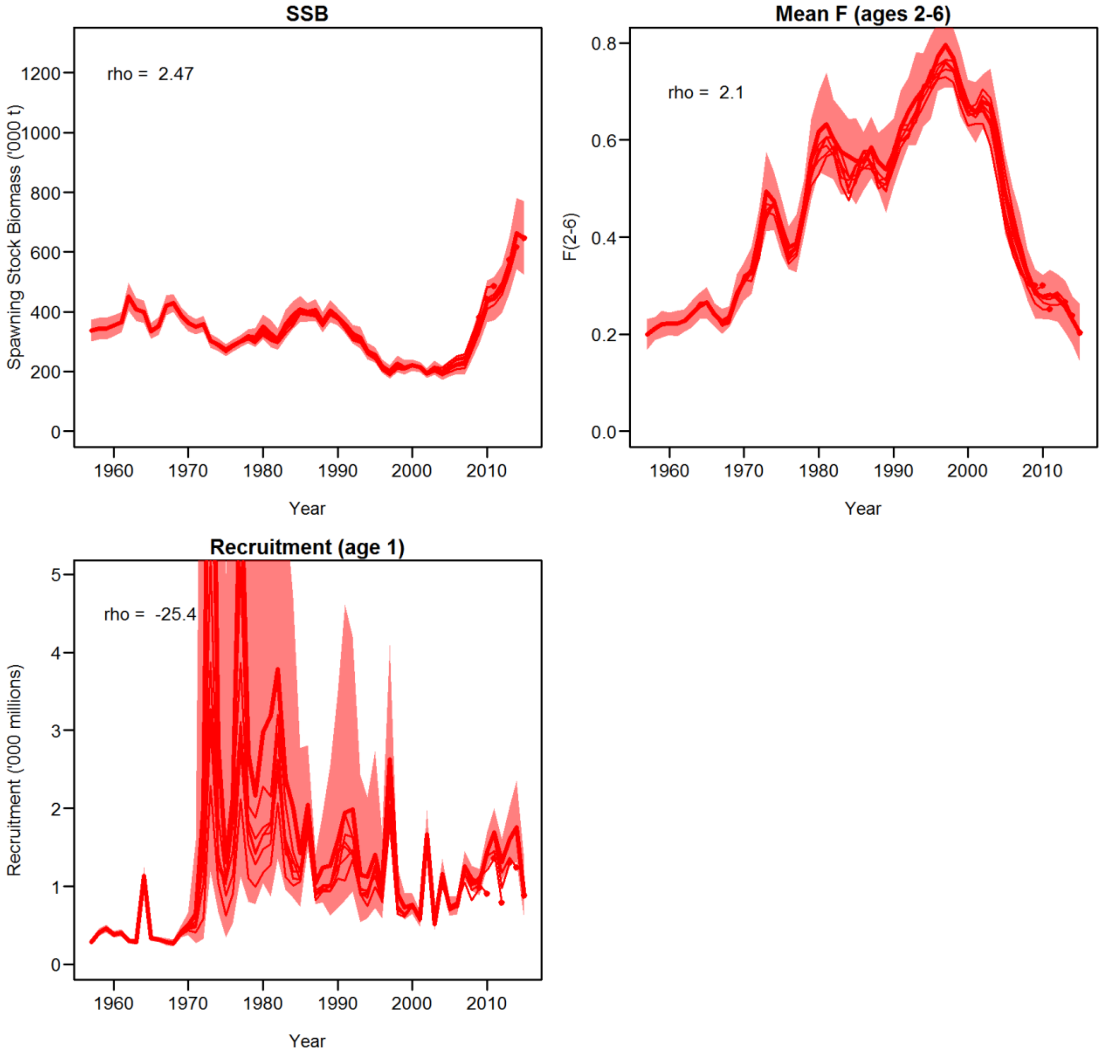


Figure 55. Run 5: Retro (for internally estimated discards assessment).

Figures run 6 (1957-2015, 6, 9, 6, 26, 2, BTS-Isis early, BTS combined, SNS1, SNS2)

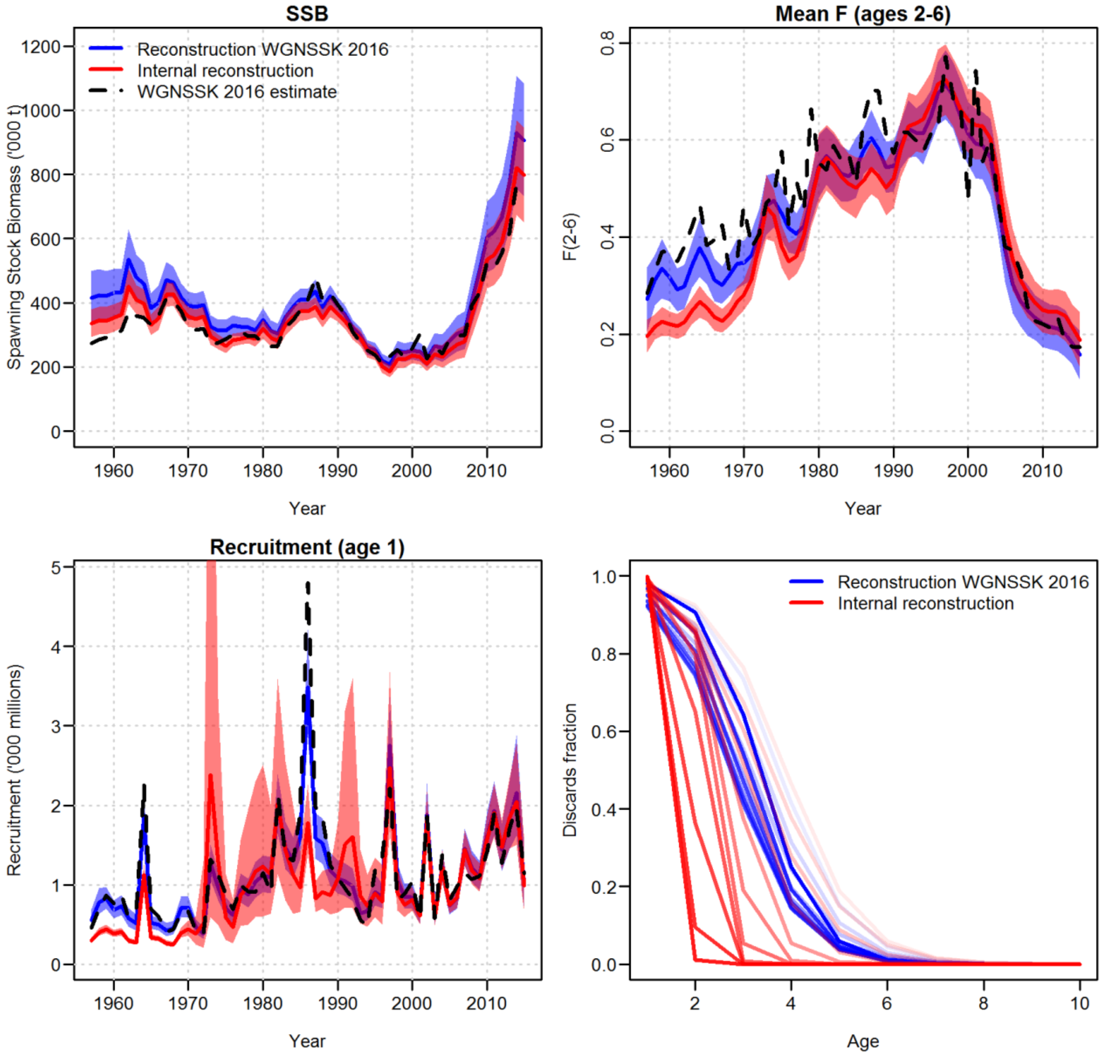


Figure 56. Run 6: Summary plot of assessment runs, with and without internal discards reconstruction, including the WGNSSK 2016 estimates.

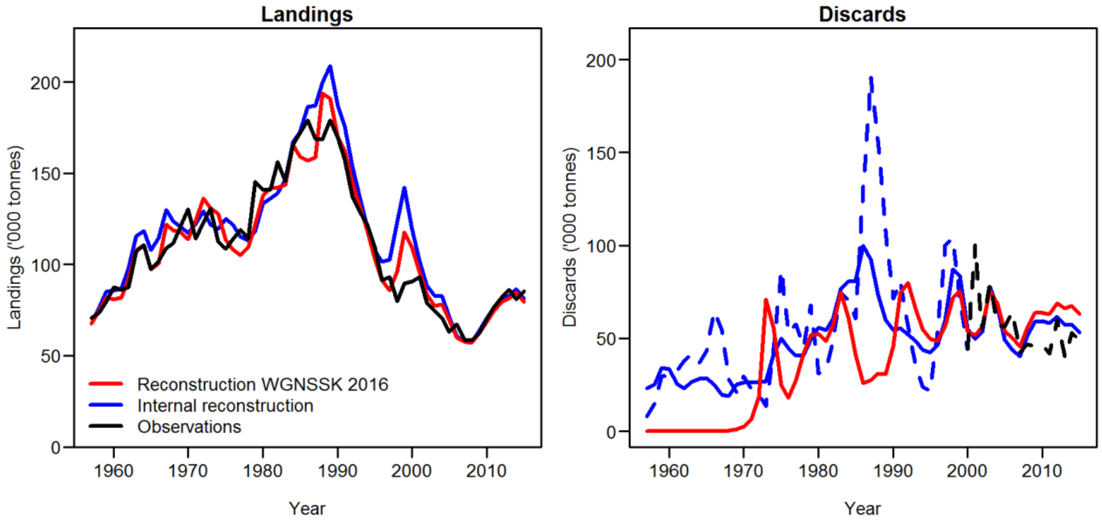


Figure 57. Run 6: Landings and discards estimates of first assessment runs, with and without internal discards reconstruction, including the WGNSSK 2016 estimates.

Figures run 6 (1957-2015, 6, 9, 6, 26, 2, BTS-Isis early, BTS combined, SNS1, SNS2)

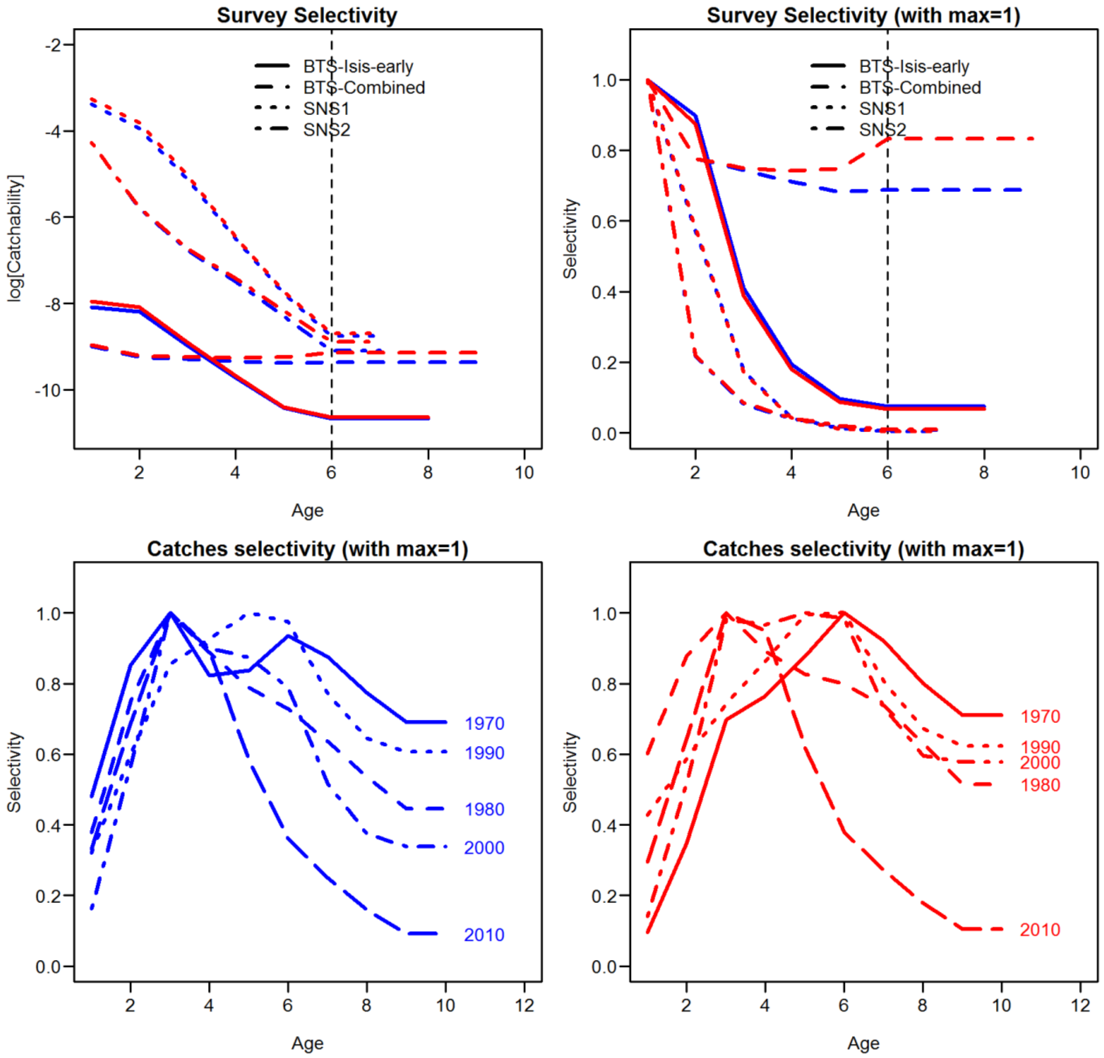


Figure 58. Run 6: survey selectivities (top panels) and selectivities catches (lower panels). Blue lines indicate the assessment that uses the WGNSSK 2016 reconstruction, red lines indicate the assessment where internal estimation is done.

Figures run 6 (1957-2015, 6, 9, 6, 26, 2, BTS-Isis early, BTS combined, SNS1, SNS2)

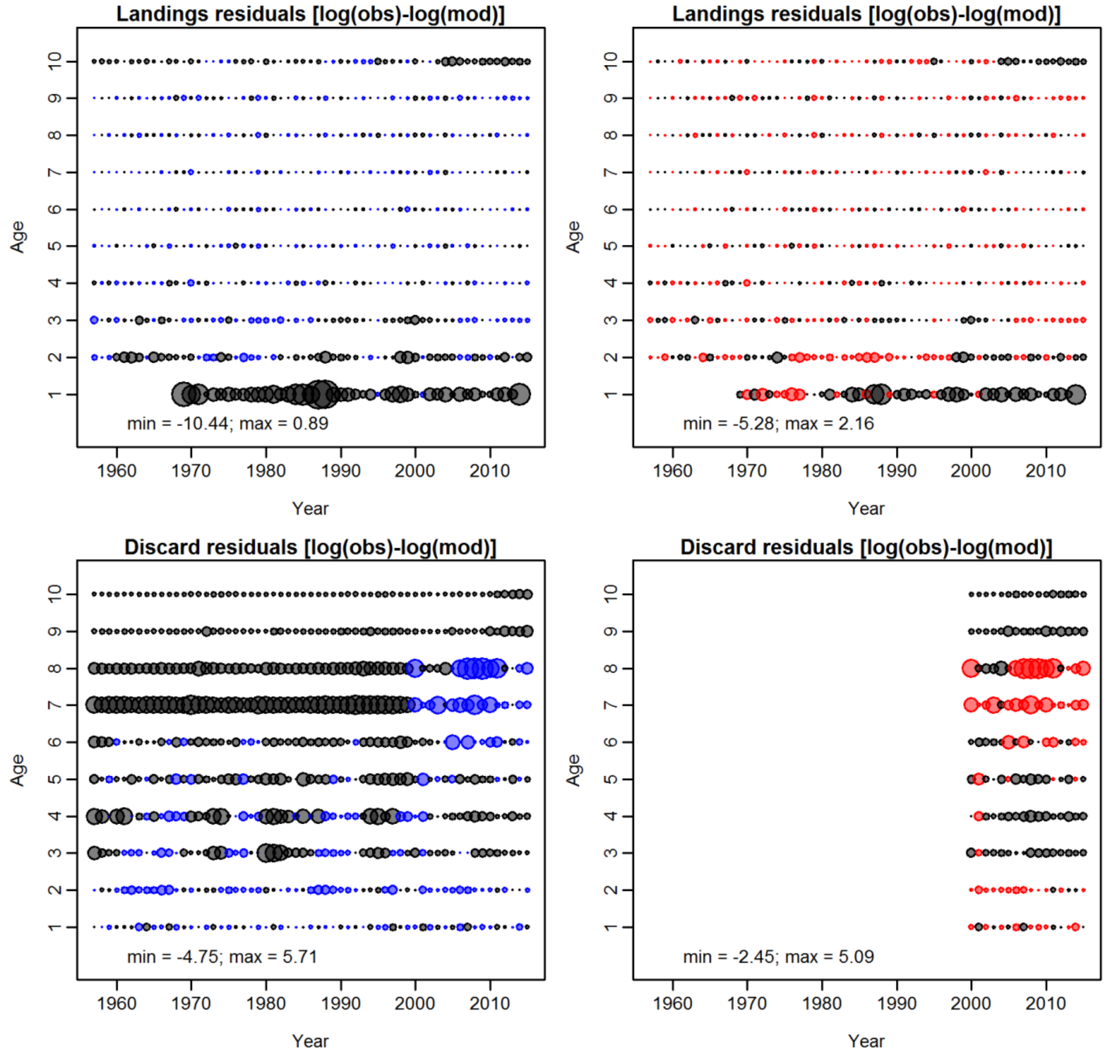
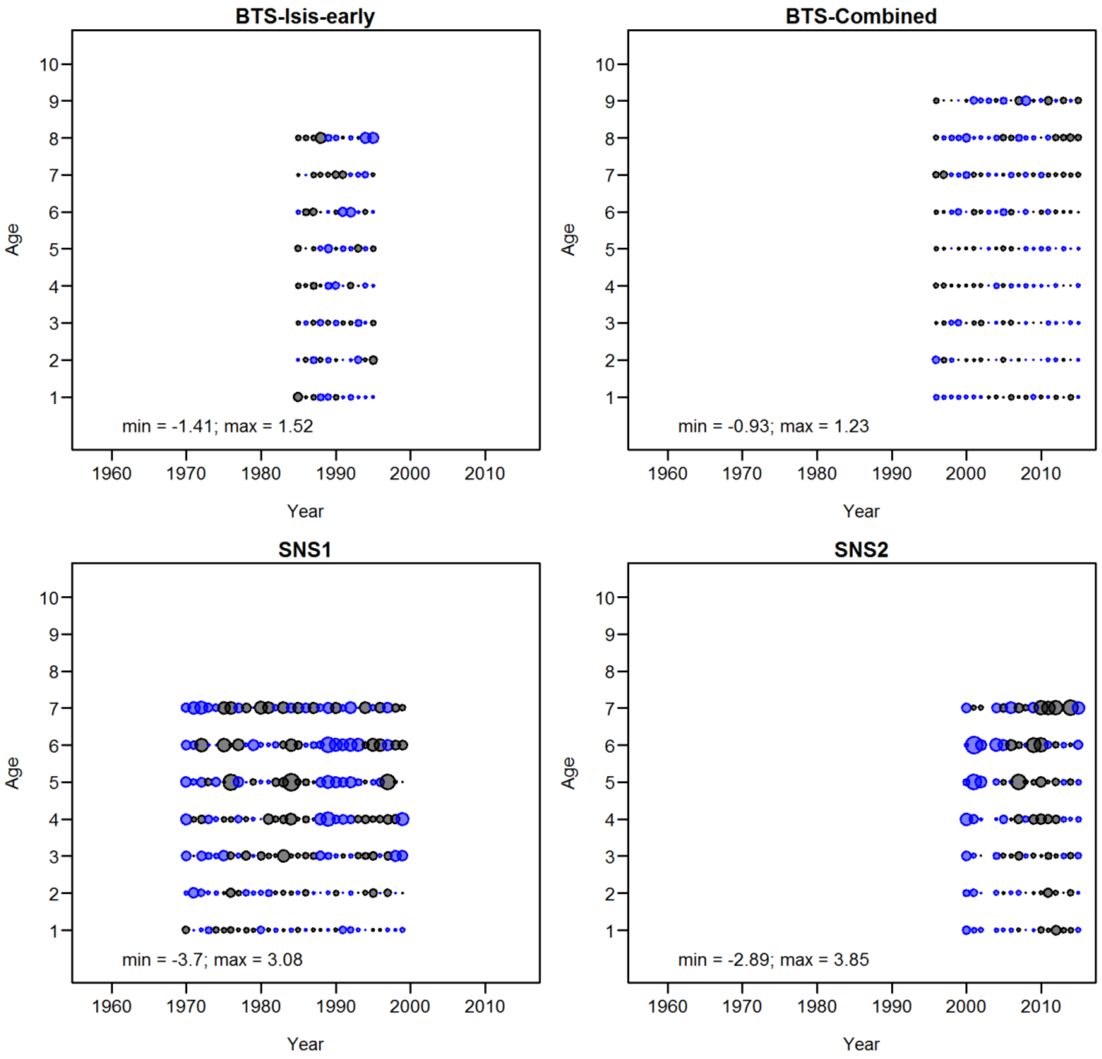


Figure 59. Run 6: Landings residuals (top panels) and discards residuals (lower panels). Blue/red bubbles positive residuals (observations greater than model), and black bubbles indicate negative residuals (observations less than model). Left panels indicate assessment with WGNSSK 2016 being used (blue colors for positive residuals), right panels indicate assessment where discards are estimated internally (red colors for positive residuals).

Figures run 6 (1957-2015, 6, 9, 6, 26, 2, BTS-Isis early, BTS combined, SNS1, SNS2)



BTS-Isis-early

BTS-Combined

SNS1

SNS2

Figure 60. Run 6: Survey residuals for model using WGNSSK 2016 discards reconstruction. Blue bubbles indicate positive residuals (observations greater than model), and black bubbles indicate negative residuals (observations less than model).

Figures run 6 (1957-2015, 6, 9, 6, 26, 2, BTS-Isis early, BTS combined, SNS1, SNS2)

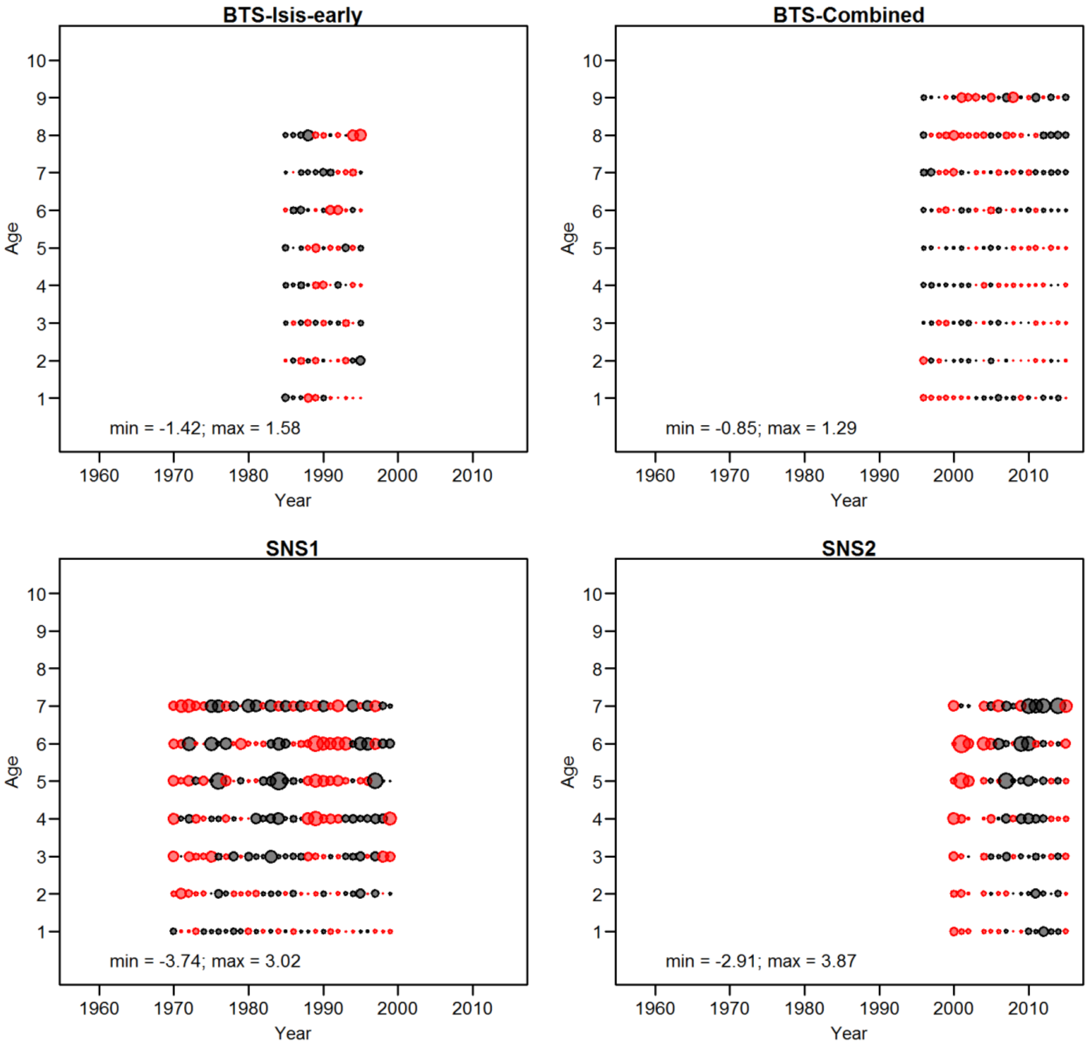


Figure 61. Run 6: Survey residuals for internally reconstructed discards. Red bubbles indicate positive residuals (observations greater than model), and black bubbles indicate negative residuals (observations less than model).

Figures run 6 (1957-2015, 6, 9, 6, 26, 2, BTS-Isis early, BTS combined, SNS1, SNS2)

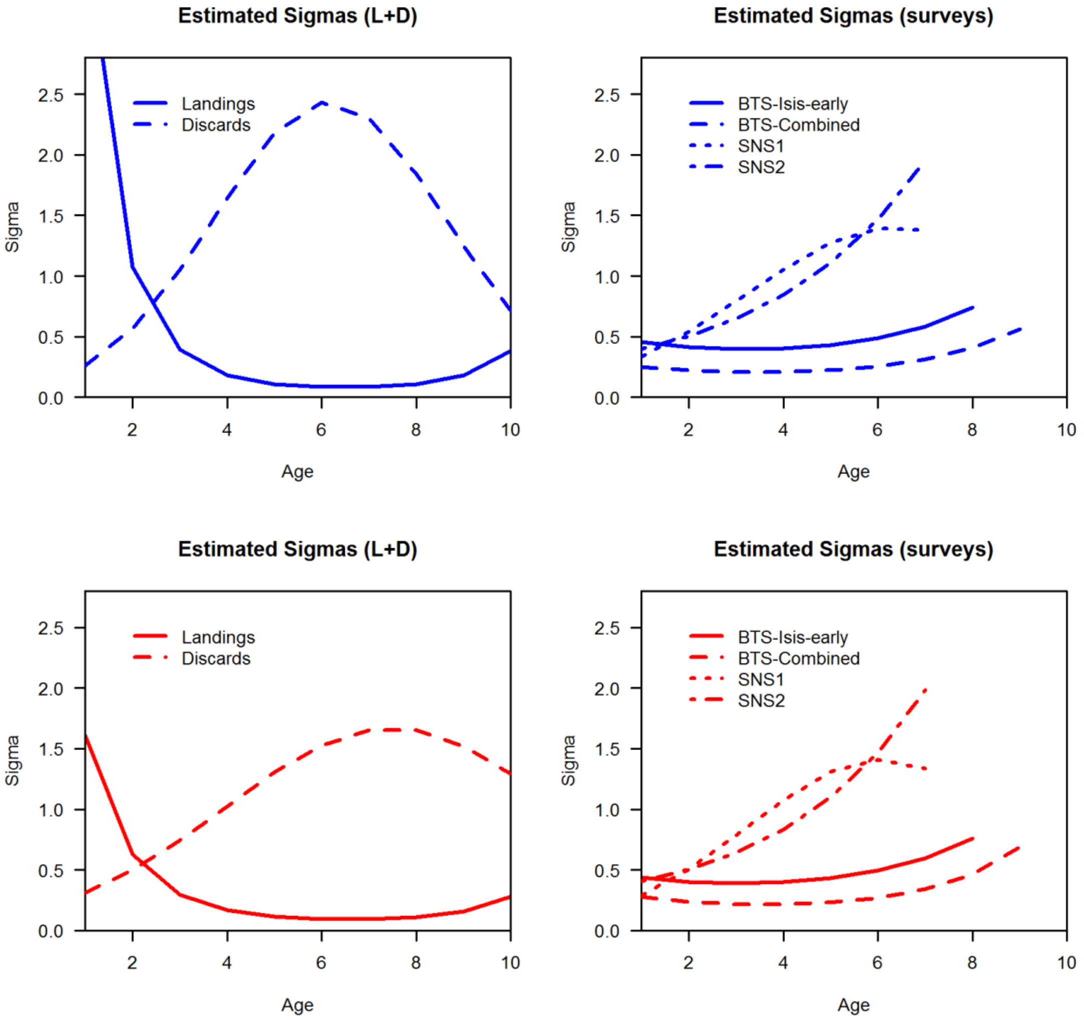


Figure 62. Run 6: Estimated age-dependent sigmas for the different likelihood components.

Figures run 6 (1957-2015, 6, 9, 6, 26, 2, BTS-Isis early, BTS combined, SNS1, SNS2)

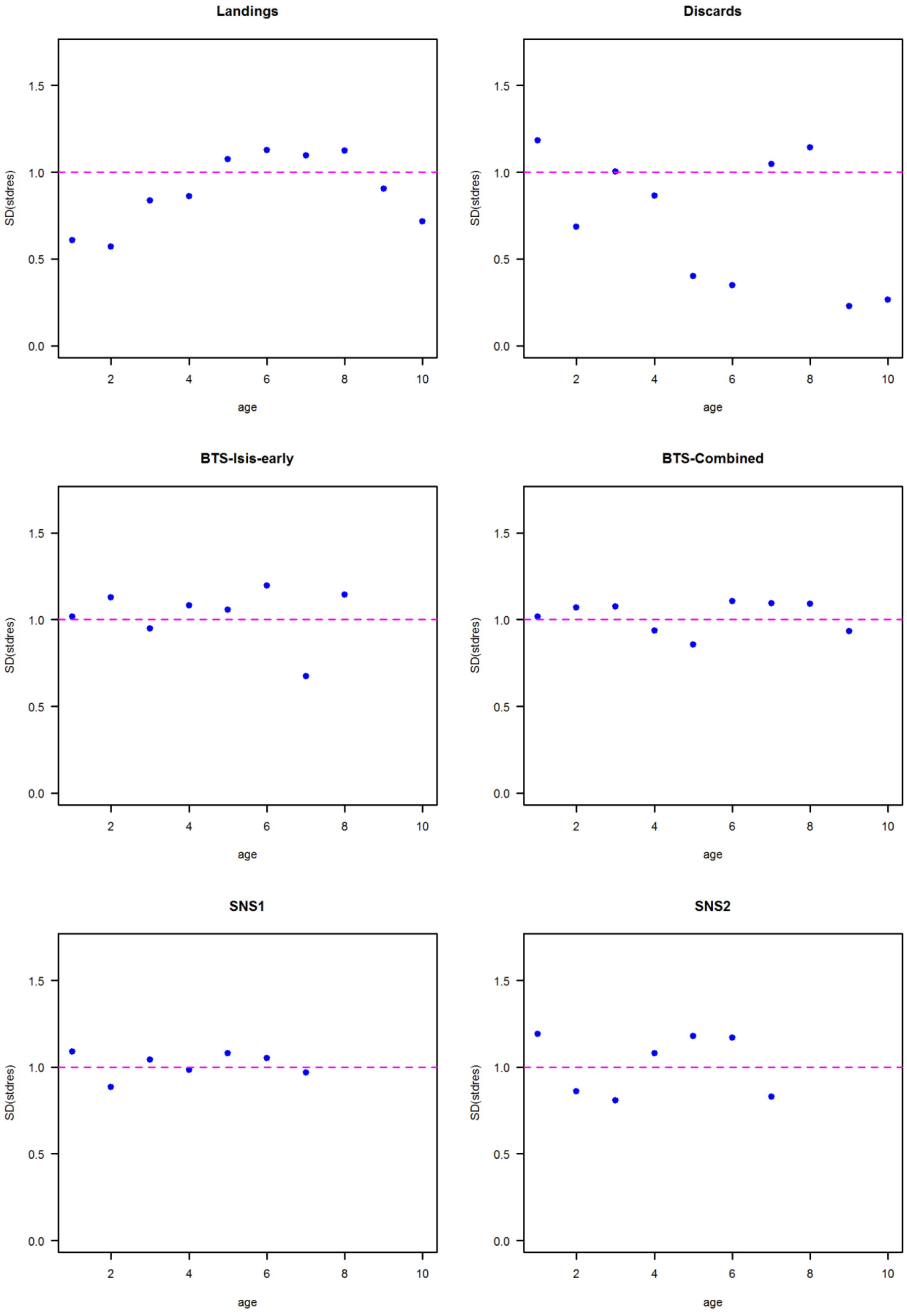


Figure 63. Run 6: SDs of standardized residuals (for discards estimates from WGNSSK 2016 assessment).

Figures run 6 (1957-2015, 6, 9, 6, 26, 2, BTS-Isis early, BTS combined, SNS1, SNS2)

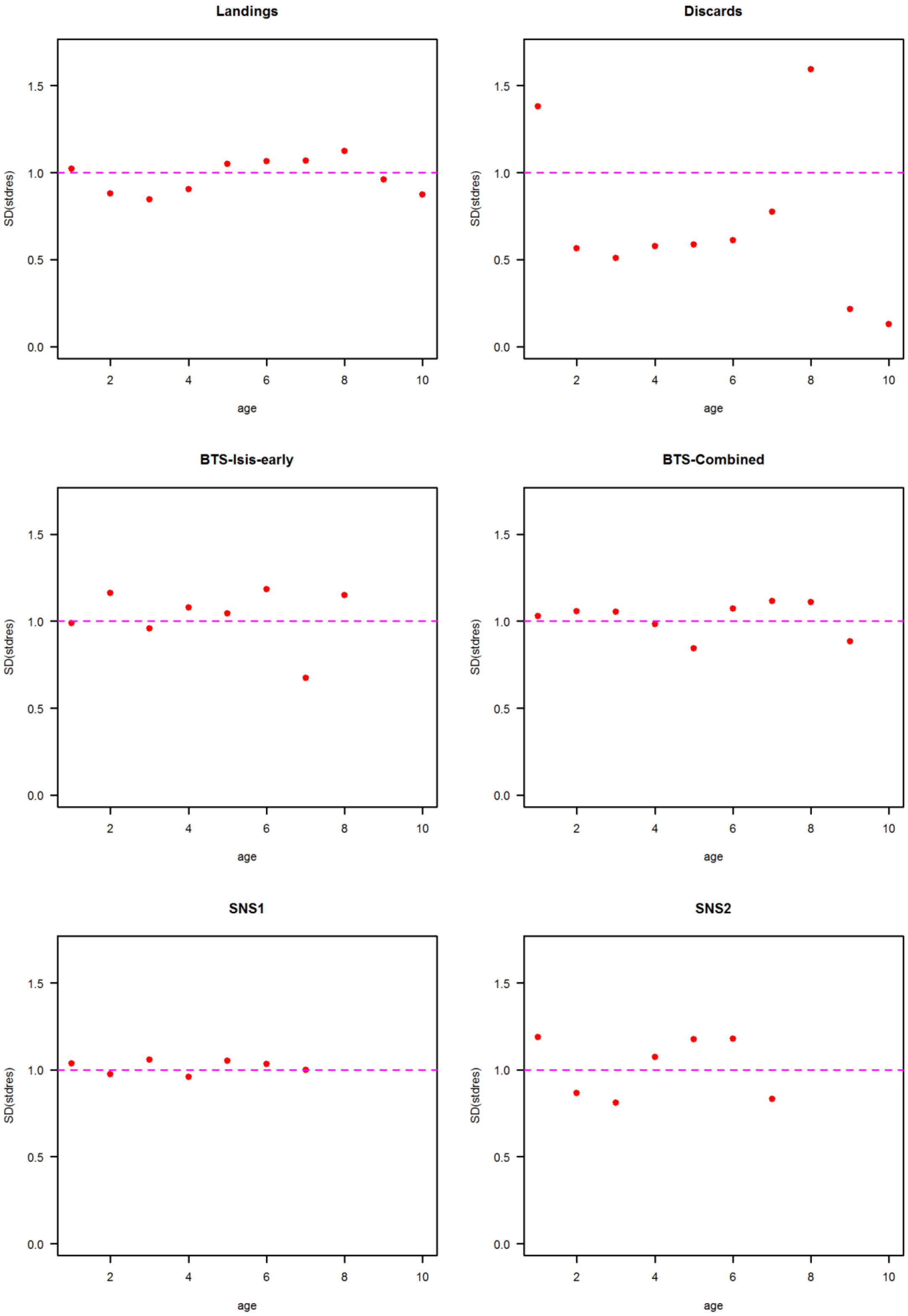


Figure 64. Run 6: SDs of standardized residuals (for internally estimated discards assessment).

Figures run 6 (1957-2015, 6, 9, 6, 26, 2, BTS-Isis early, BTS combined, SNS1, SNS2)

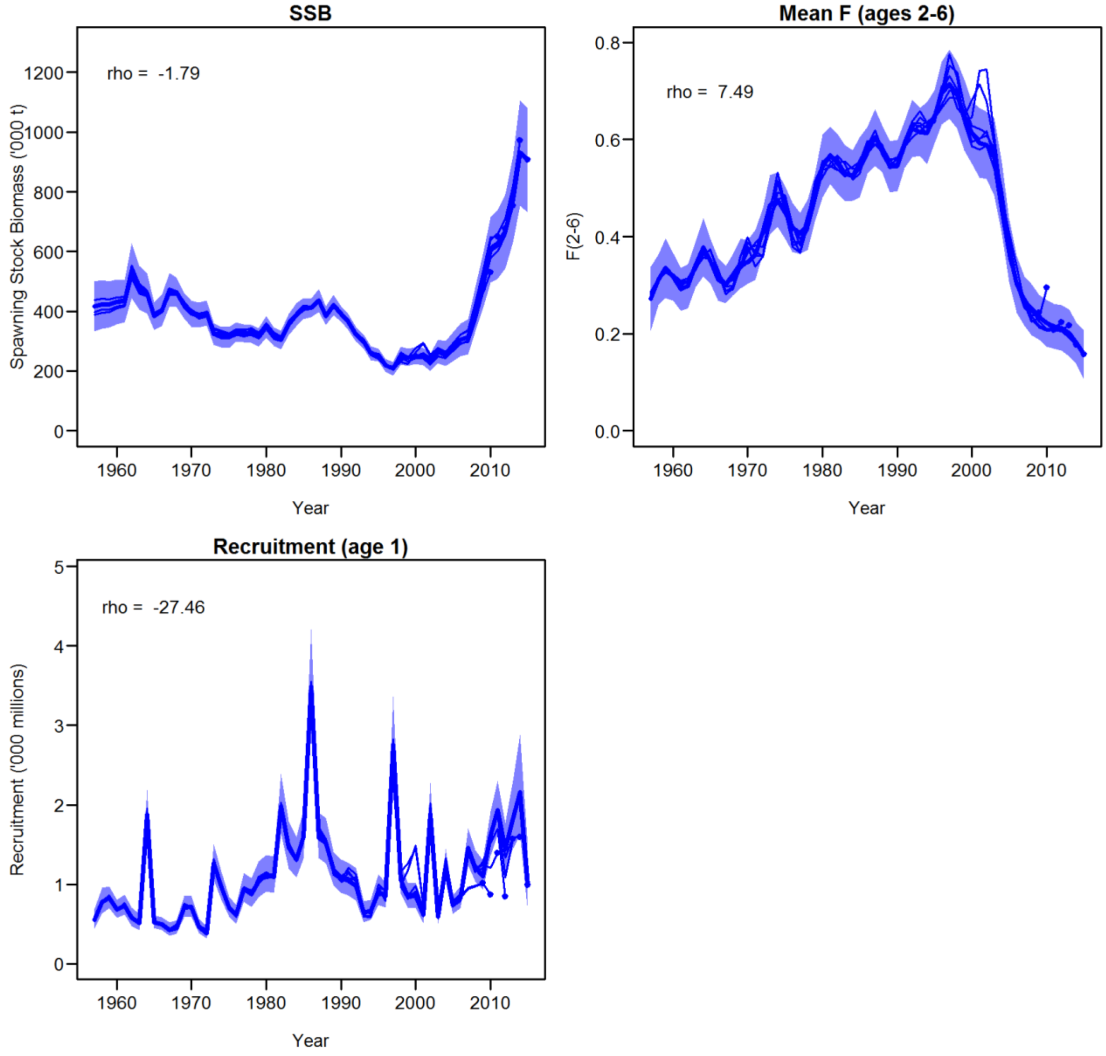


Figure 65. Run 6: Retro (for discards estimates from WGNSSK 2016 assessment).

Figures run 6 (1957-2015, 6, 9, 6, 26, 2, BTS-Isis early, BTS combined, SNS1, SNS2)

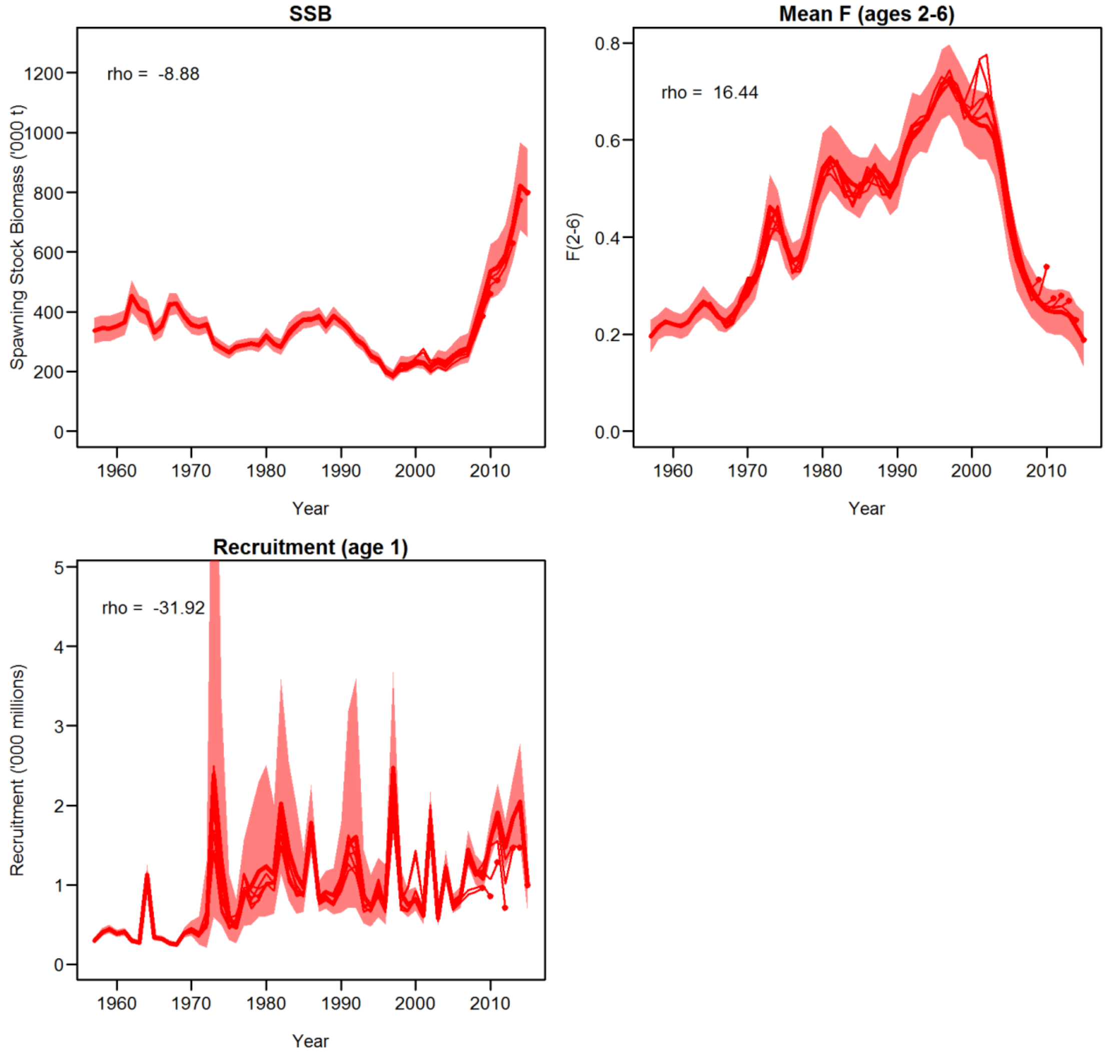


Figure 66. Run 6: Retro (for internally estimated discards assessment).

Figures run 7 (1957-2015, 6, 9, 6, 26, 2, BTS-Isis early, BTS combined, SNS1 ages 1-6, SNS2 ages 1-6, removed historic discards estimates above age 7 that were assumed zero)

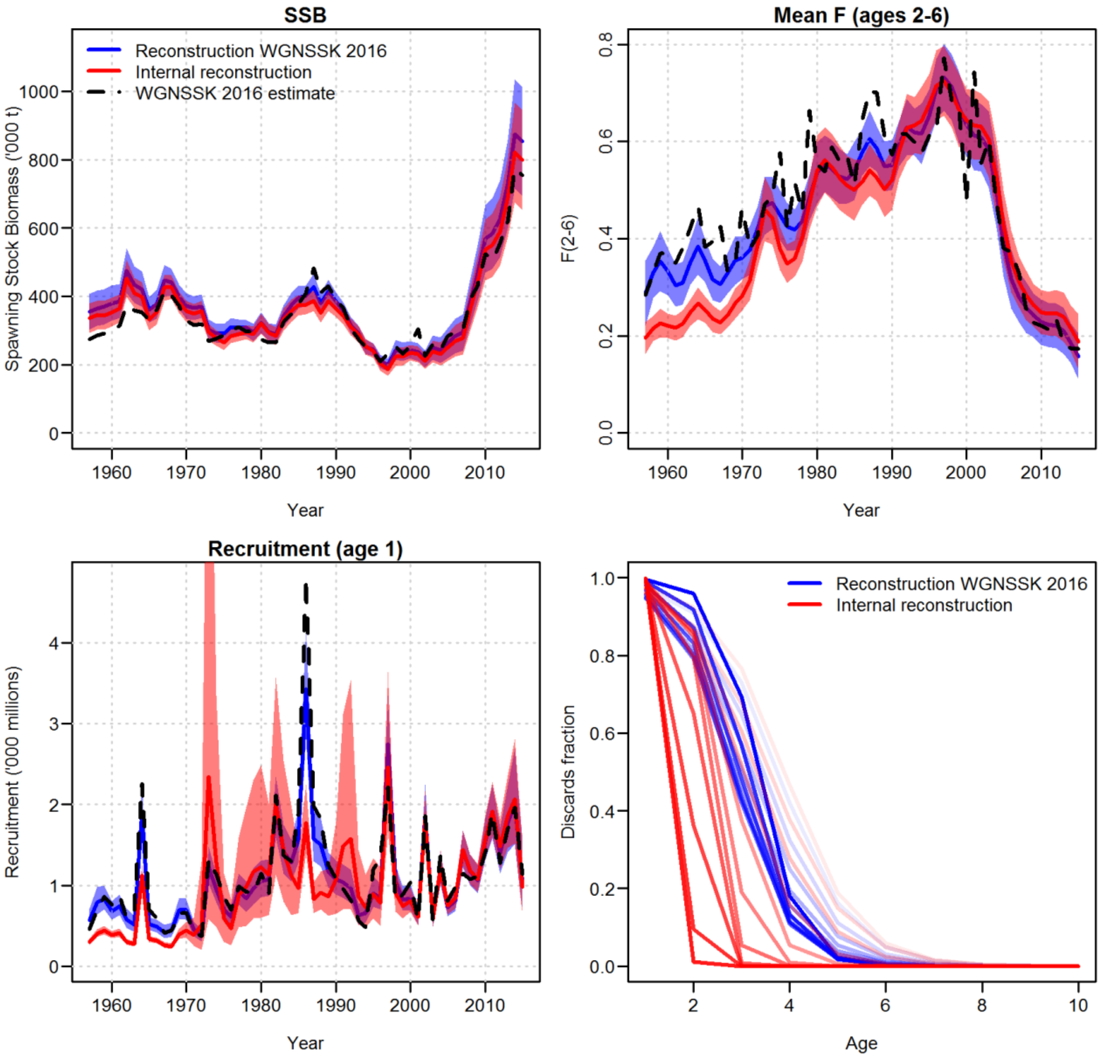


Figure 67. Run 7: Summary plot of assessment runs, with and without internal discards reconstruction, including the WGNSSK 2016 estimates.

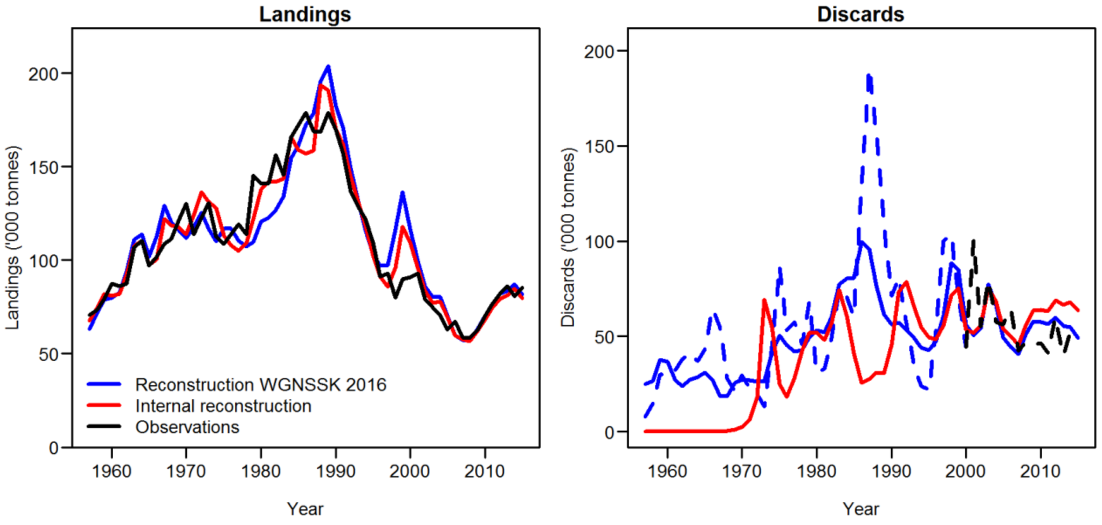


Figure 68. Run 7: Landings and discards estimates of first assessment runs, with and without internal discards reconstruction, including the WGNSSK 2016 estimates.

Figures run 7 (1957-2015, 6, 9, 6, 26, 2, BTS-Isis early, BTS combined, SNS1 ages 1-6, SNS2 ages 1-6, removed historic discards estimates above age 7 that were assumed zero)

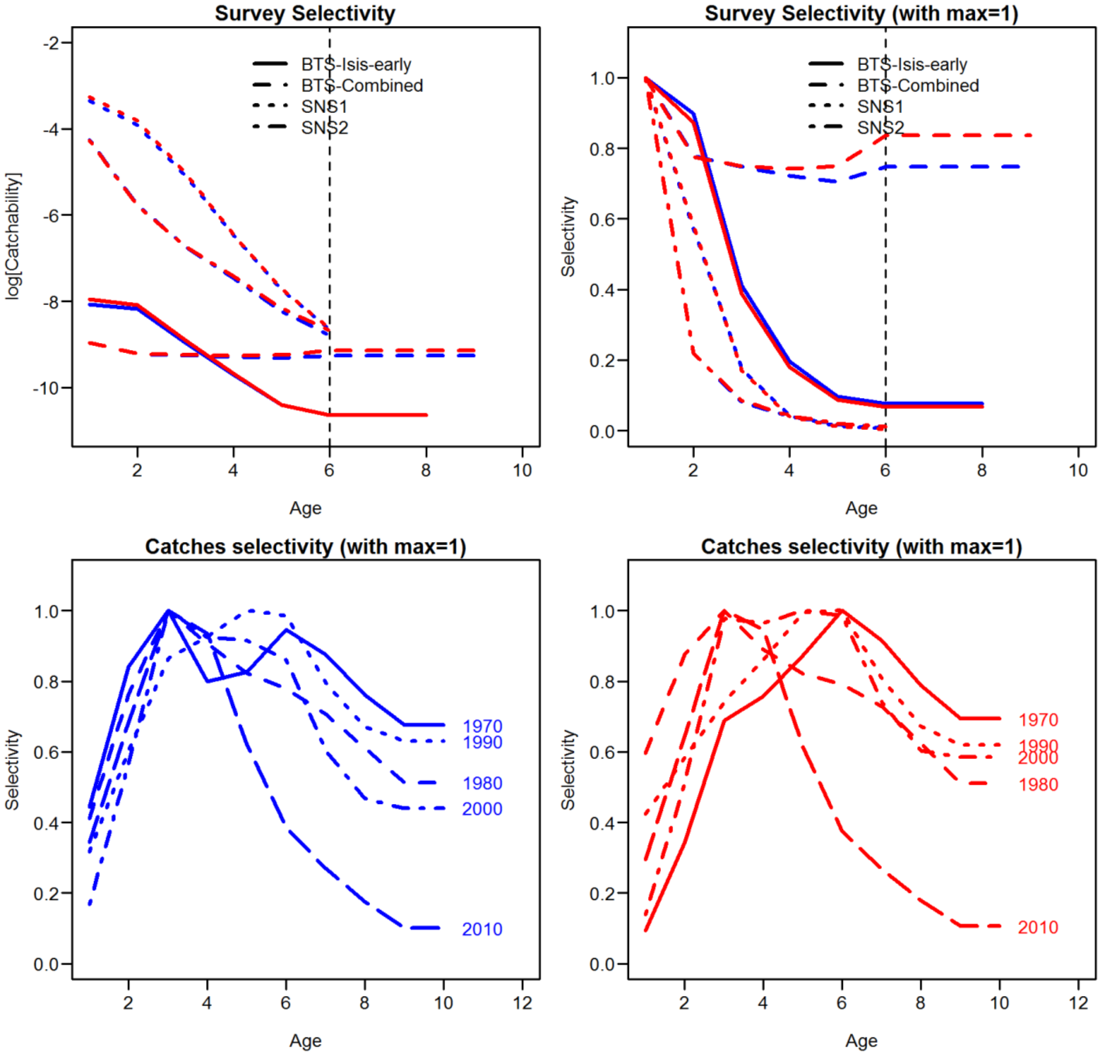


Figure 69. Run 7: survey selectivities (top panels) and selectivities catches (lower panels). Blue lines indicate the assessment that uses the WGNSSK 2016 reconstruction, red lines indicate the assessment where internal estimation is done.

Figures run 7 (1957-2015, 6, 9, 6, 26, 2, BTS-Isis early, BTS combined, SNS1 ages 1-6, SNS2 ages 1-6, removed historic discards estimates above age 7 that were assumed zero)

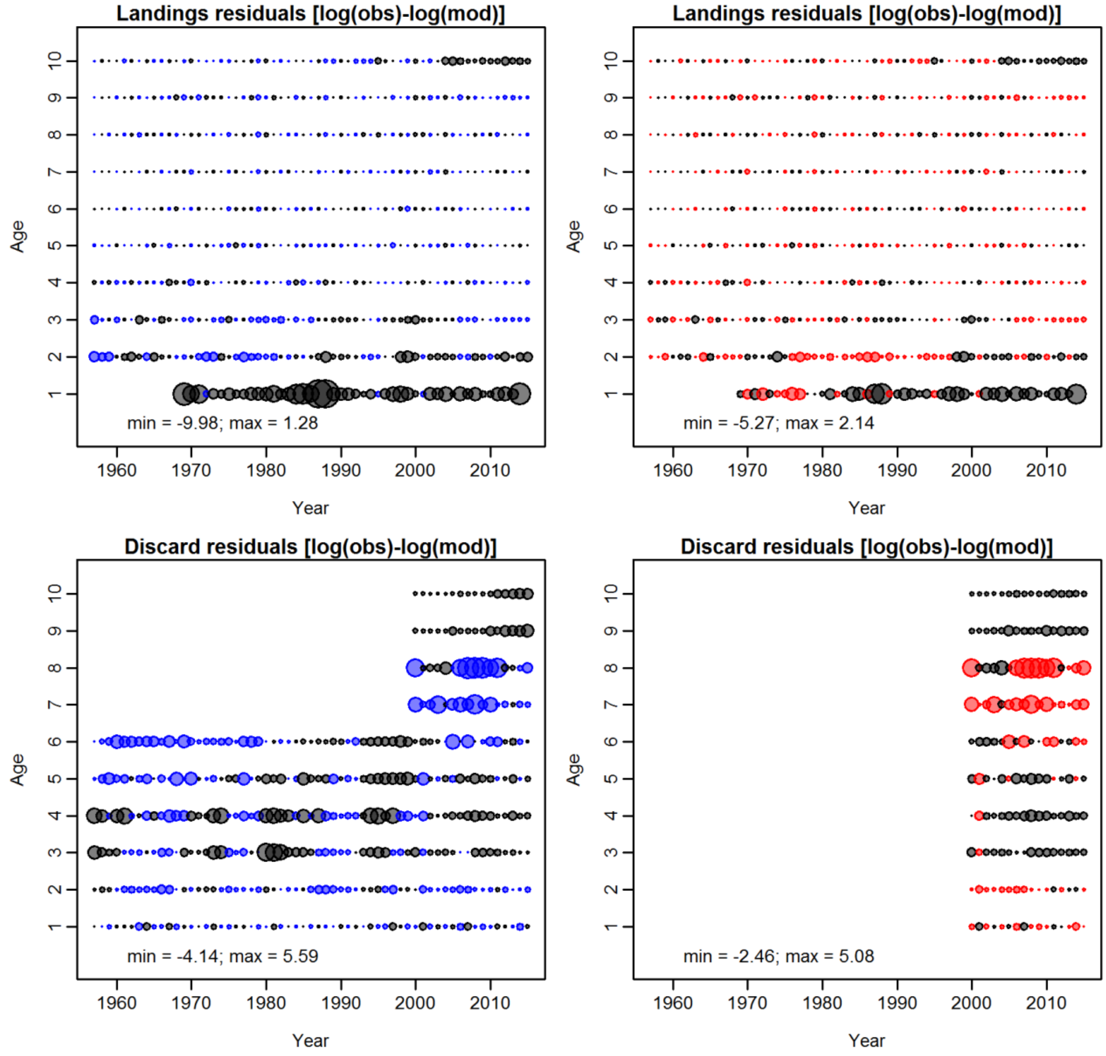


Figure 70. Run 7: Landings residuals (top panels) and discards residuals (lower panels). Blue/red bubbles positive residuals (observations greater than model), and black bubbles indicate negative residuals (observations less than model). Left panels indicate assessment with WGNSSK 2016 being used (blue colors for positive residuals), right panels indicate assessment where discards are estimated internally (red colors for positive residuals).

Figures run 7 (1957-2015, 6, 9, 6, 26, 2, BTS-Isis early, BTS combined, SNS1 ages 1-6, SNS2 ages 1-6, removed historic discards estimates above age 7 that were assumed zero)

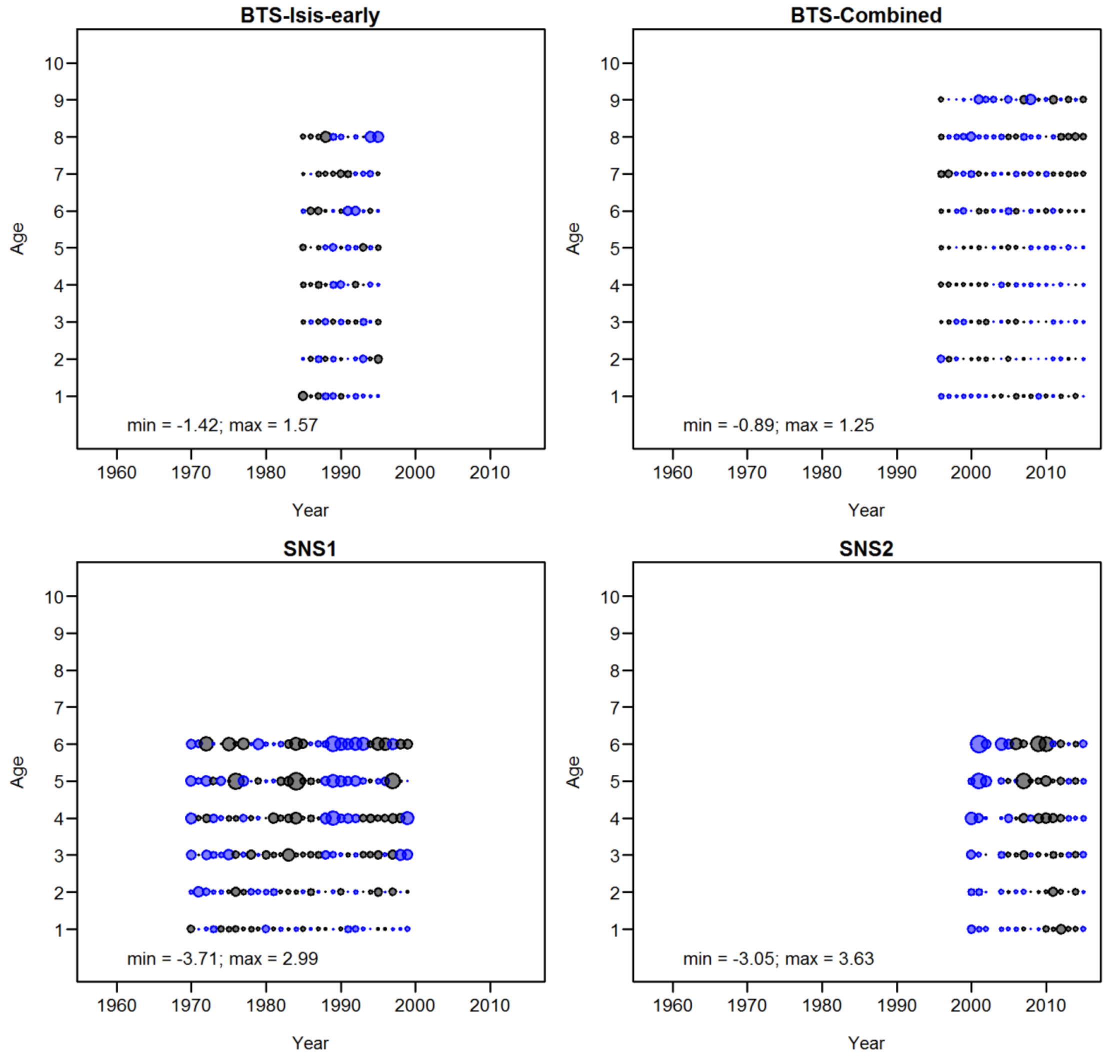


Figure 71. Run 7: Survey residuals for model using WGNSSK 2016 discards reconstruction. Blue bubbles indicate positive residuals (observations greater than model), and black bubbles indicate negative residuals (observations less than model).

Figures run 7 (1957-2015, 6, 9, 6, 26, 2, BTS-Isis early, BTS combined, SNS1 ages 1-6, SNS2 ages 1-6, removed historic discards estimates above age 7 that were assumed zero)

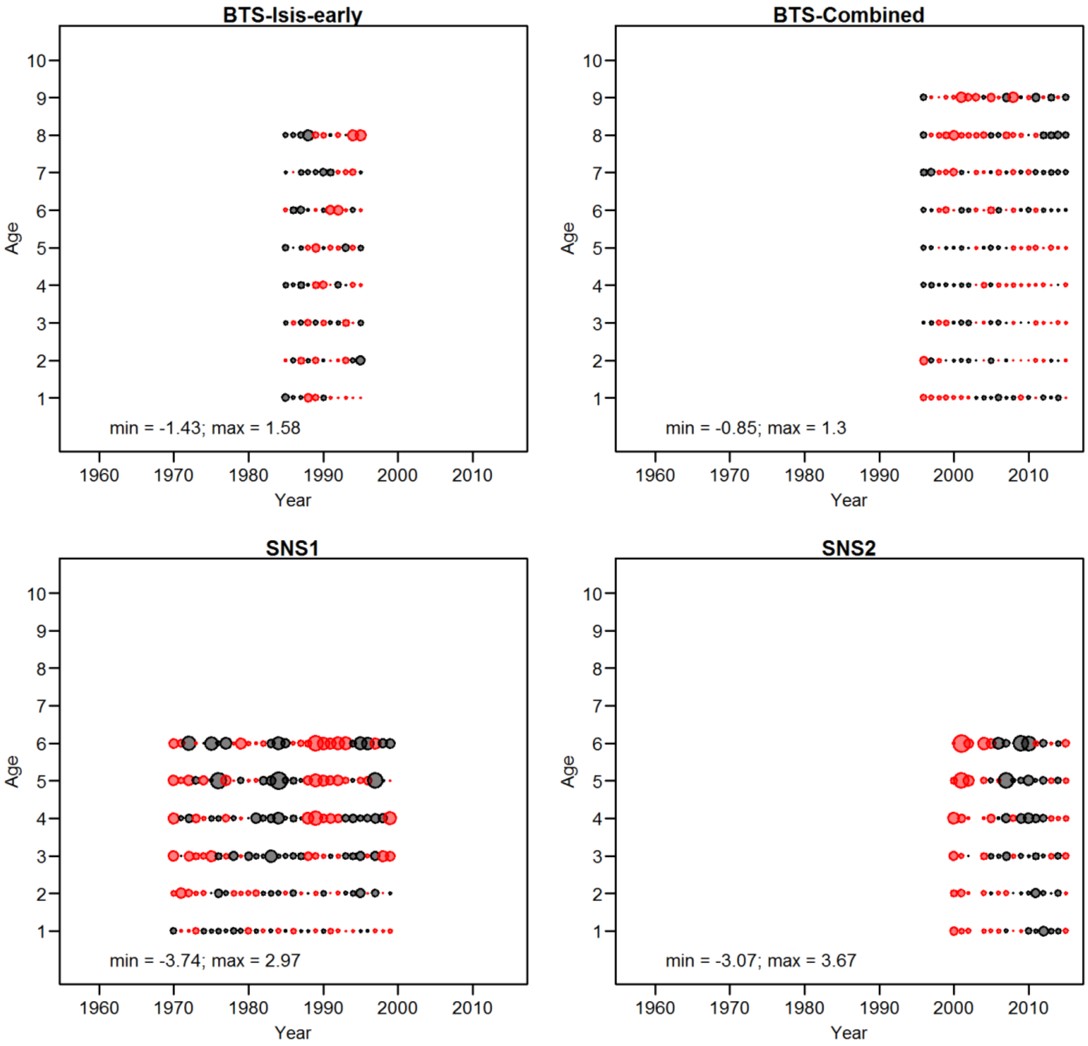


Figure 72. Run 7: Survey residuals for internally reconstructed discards. Red bubbles indicate positive residuals (observations greater than model), and black bubbles indicate negative residuals (observations less than model).

Figures run 7 (1957-2015, 6, 9, 6, 26, 2, BTS-Isis early, BTS combined, SNS1 ages 1-6, SNS2 ages 1-6, removed historic discards estimates above age 7 that were assumed zero)

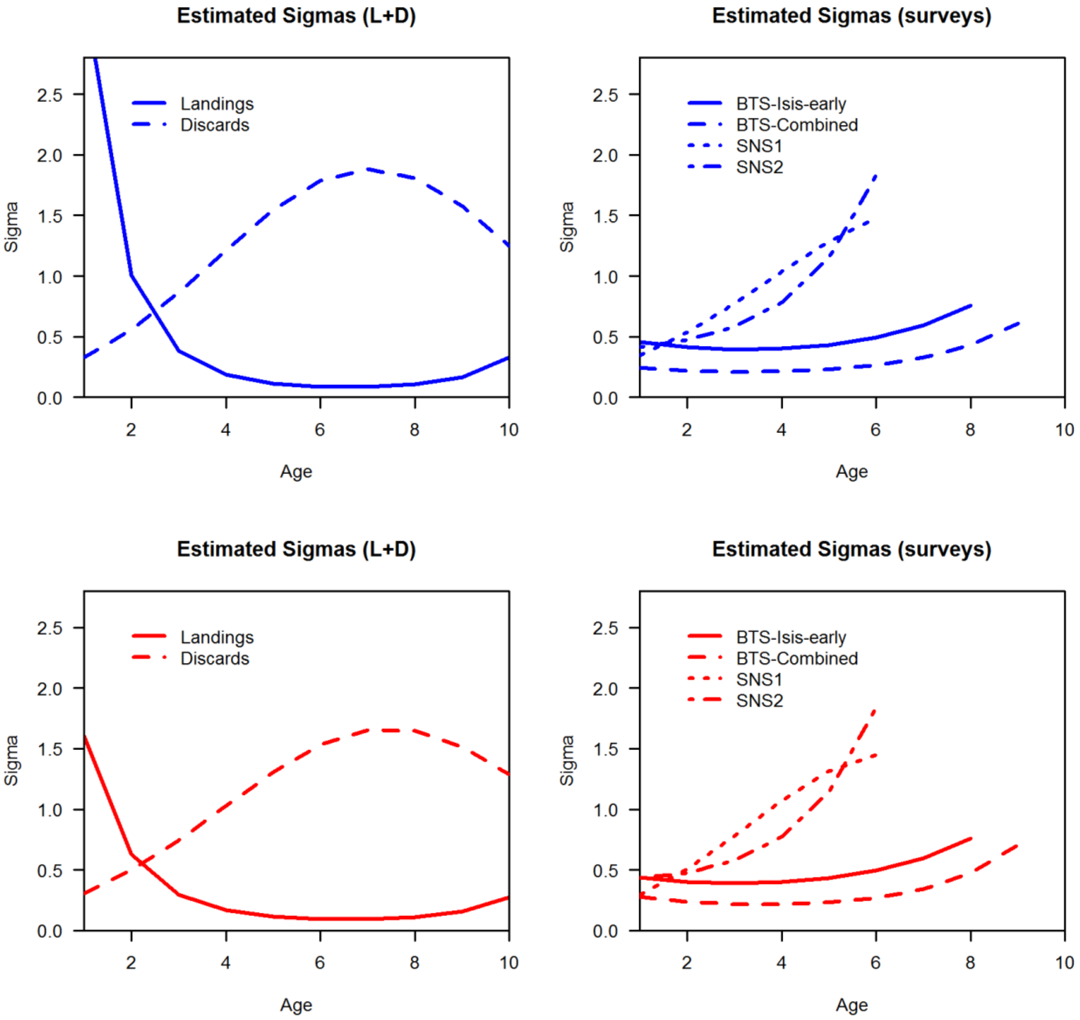


Figure 73. Run 7: Estimated age-dependent sigmas for the different likelihood components.

Figures run 7 (1957-2015, 6, 9, 6, 26, 2, BTS-Isis early, BTS combined, SNS1 ages 1-6, SNS2 ages 1-6, removed historic discards estimates above age 7 that were assumed zero)

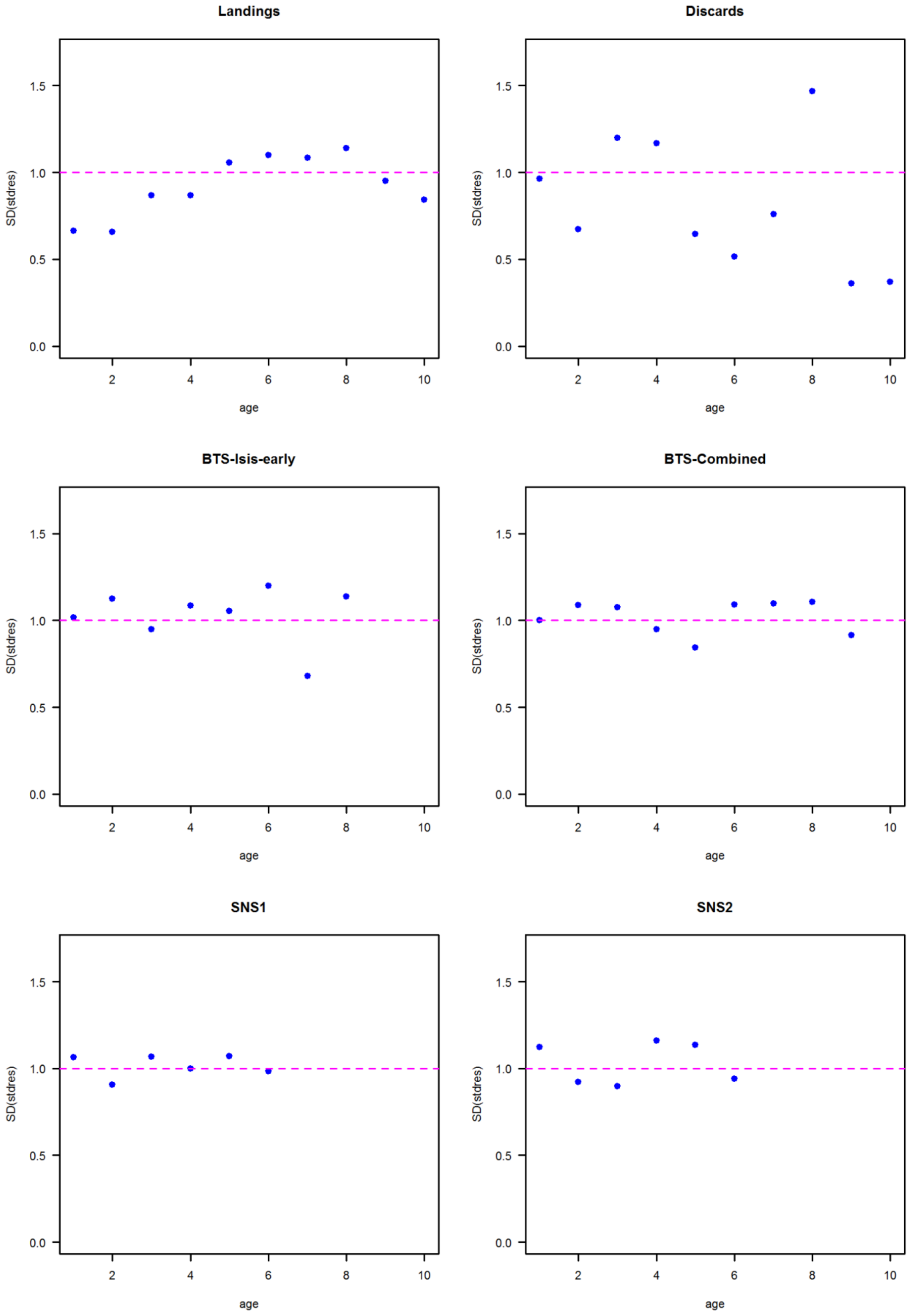


Figure 74. Run 7: SDs of standardized residuals (for discards estimates from WGNSSK 2016 assessment).

Figures run 7 (1957-2015, 6, 9, 6, 26, 2, BTS-Isis early, BTS combined, SNS1 ages 1-6, SNS2 ages 1-6, removed historic discards estimates above age 7 that were assumed zero)

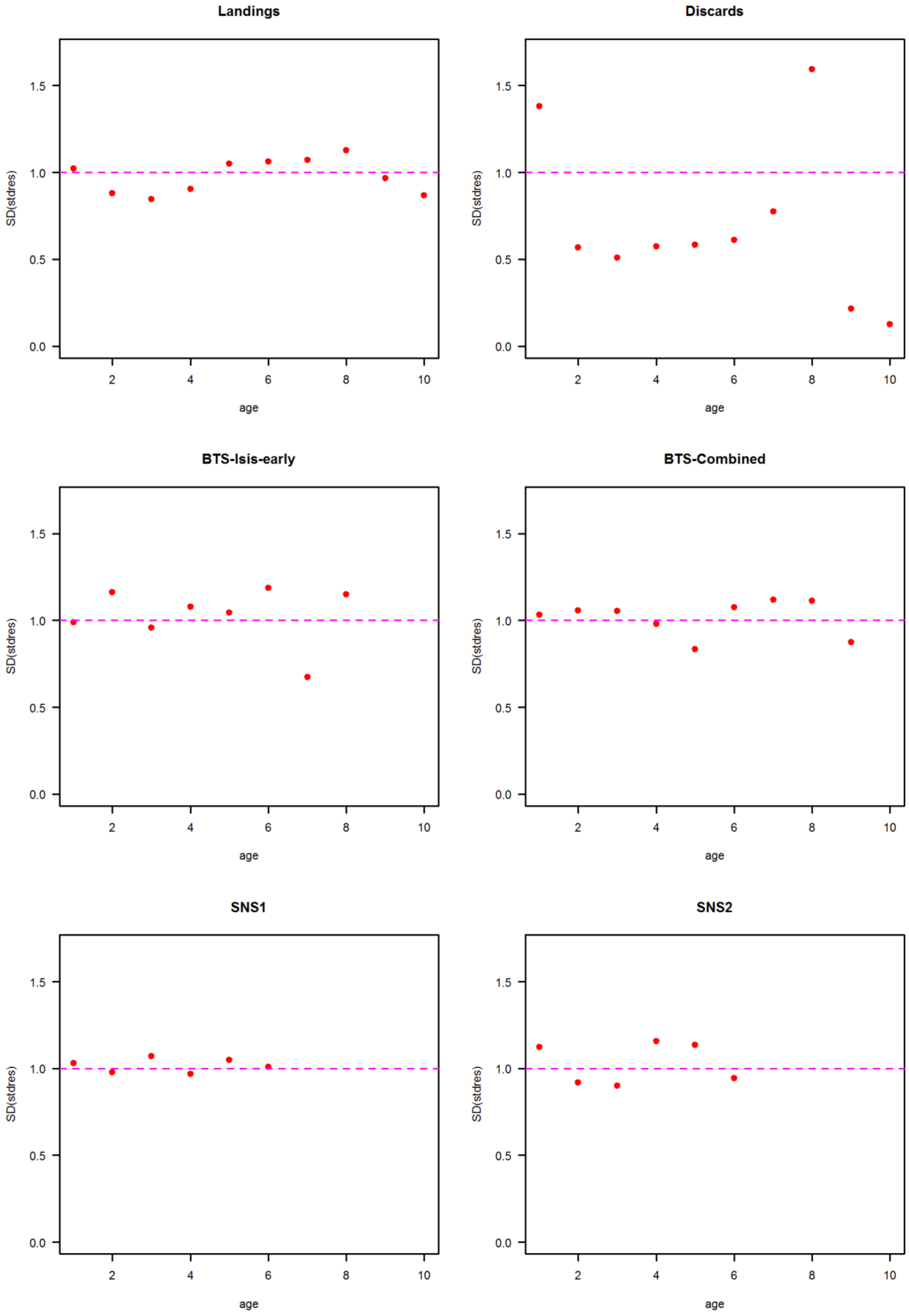


Figure 75. Run 7: SDs of standardized residuals (for internally estimated discards assessment).

Figures run 7 (1957-2015, 6, 9, 6, 26, 2, BTS-Isis early, BTS combined, SNS1 ages 1-6, SNS2 ages 1-6, removed historic discards estimates above age 7 that were assumed zero)

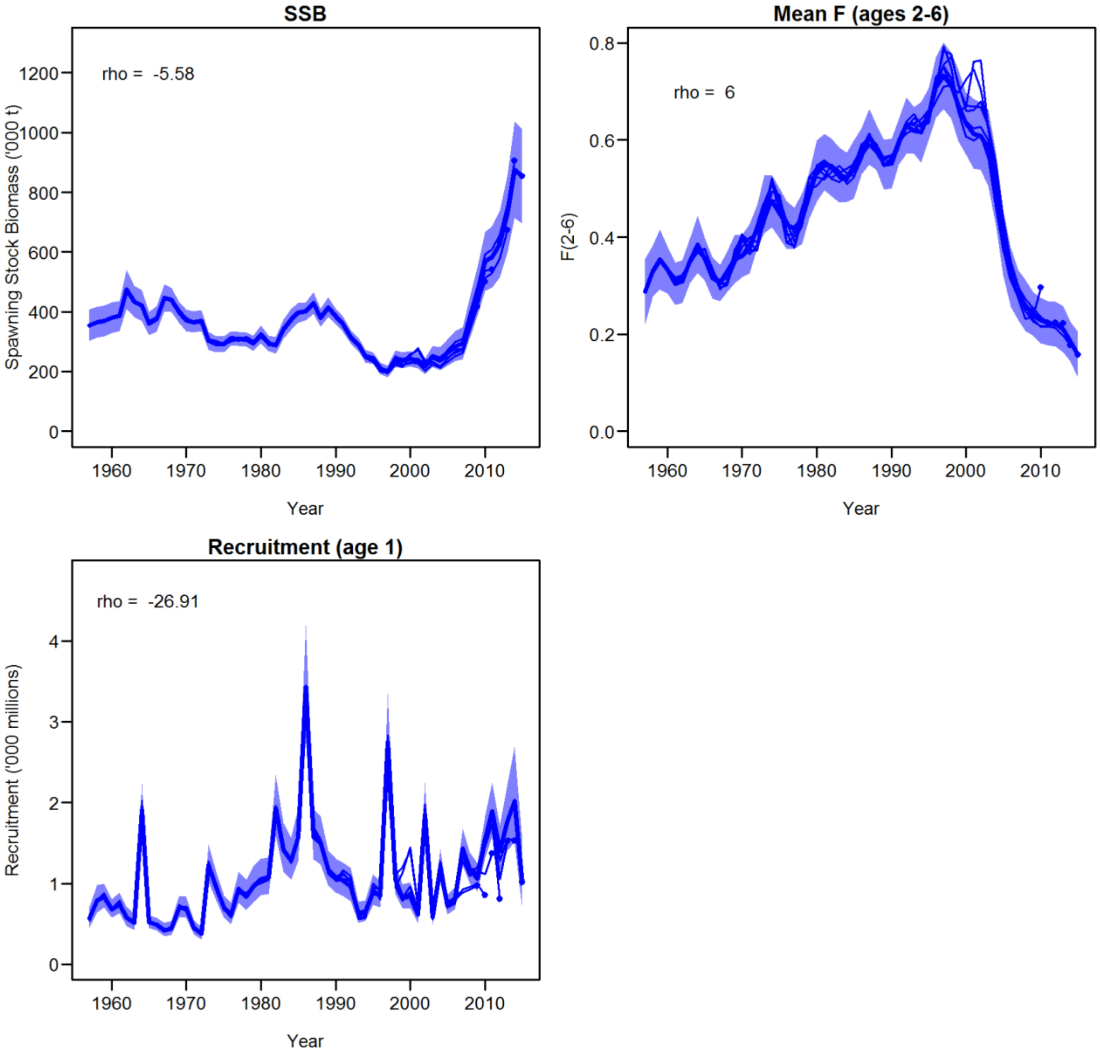


Figure 76. Run 7: Retro (for discards estimates from WGNSSK 2016 assessment).

Figures run 7 (1957-2015, 6, 9, 6, 26, 2, BTS-Isis early, BTS combined, SNS1 ages 1-6, SNS2 ages 1-6, removed historic discards estimates above age 7 that were assumed zero)

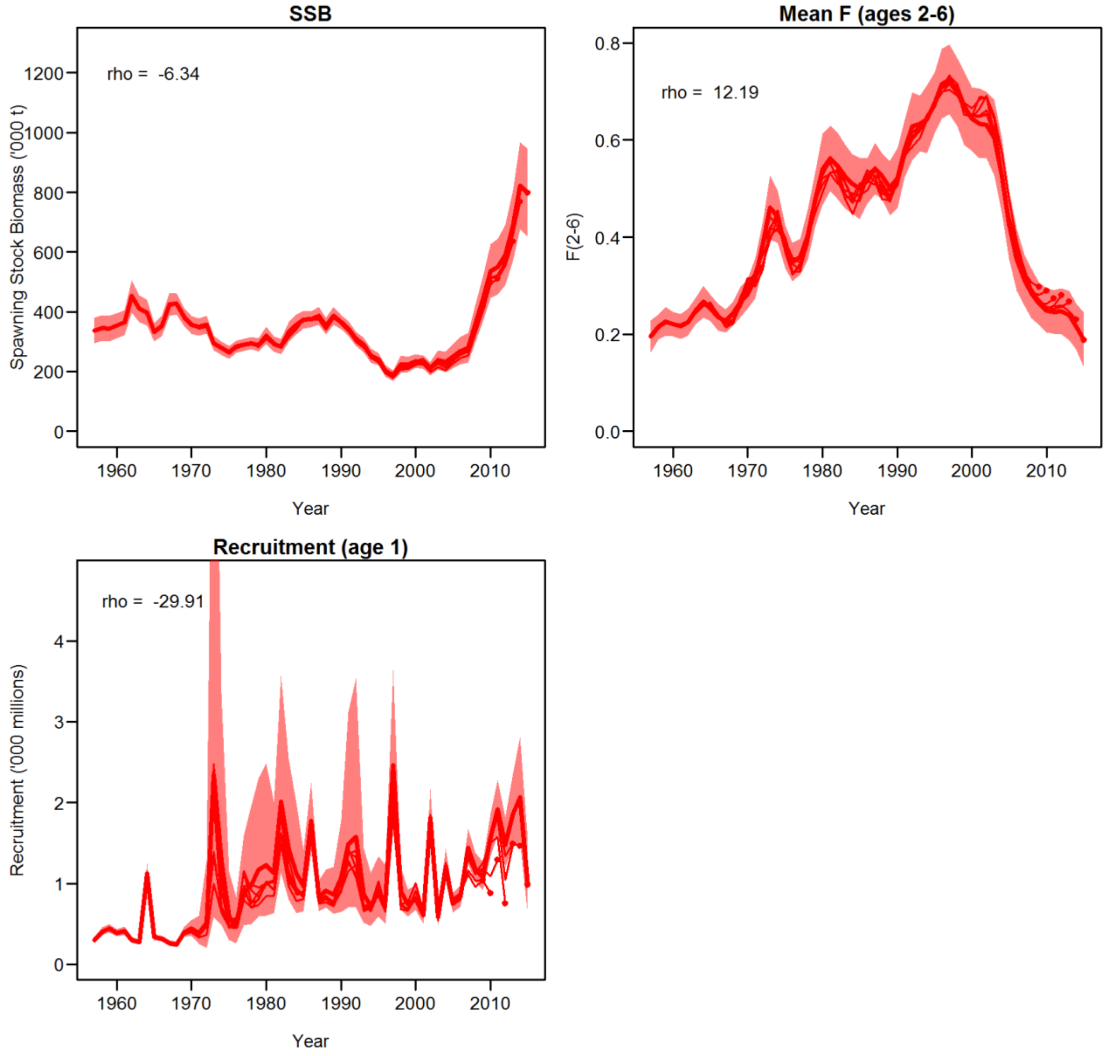


Figure 77. Run 7: Retro (for internally estimated discards assessment).

Figures run 8 (1957-2015, 6, 9, 6, 26, 2, BTS-Isis early, BTS combined new, SNS1 ages 1-6, SNS2 ages 1-6, removed historic discards estimates above age 7 that were assumed zero)

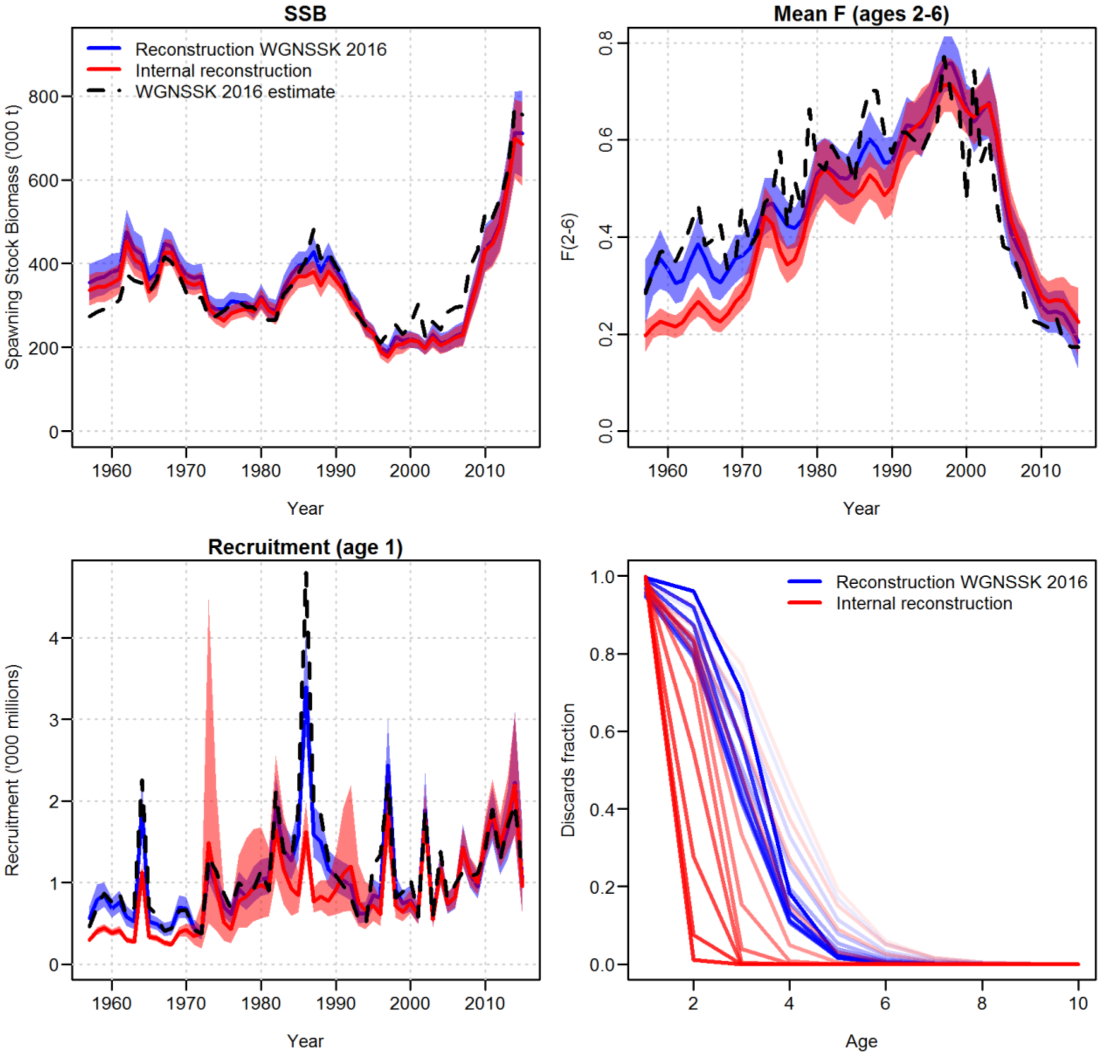


Figure 78. Run 8: Summary plot of assessment runs, with and without internal discards reconstruction, including the WGNSSK 2016 estimates.

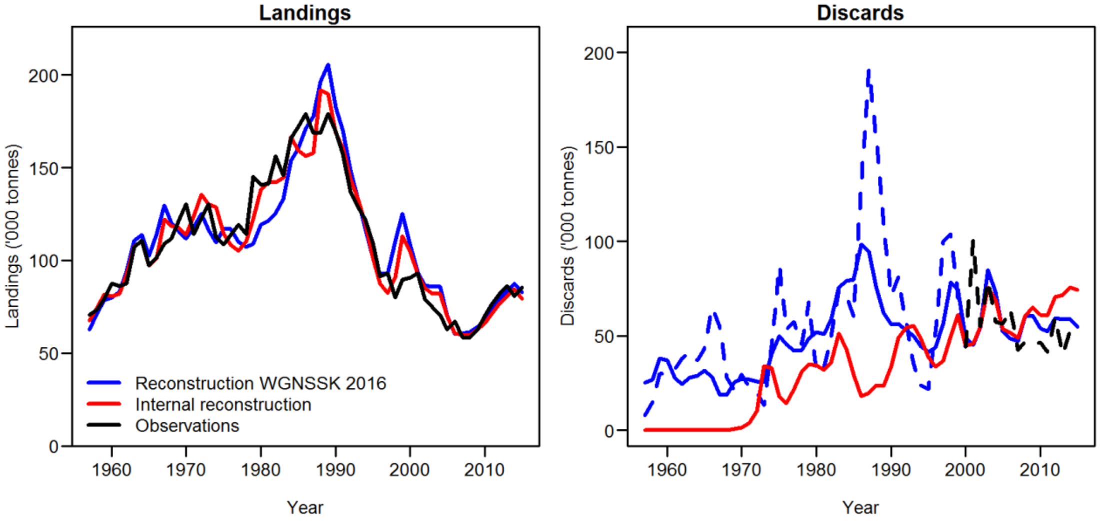


Figure 79. Run 8: Landings and discards estimates of first assessment runs, with and without internal discards reconstruction, including the WGNSSK 2016 estimates.

Figures run 8 (1957-2015, 6, 9, 6, 26, 2, BTS-Isis early, BTS combined new, SNS1 ages 1-6, SNS2 ages 1-6, removed historic discards estimates above age 7 that were assumed zero)

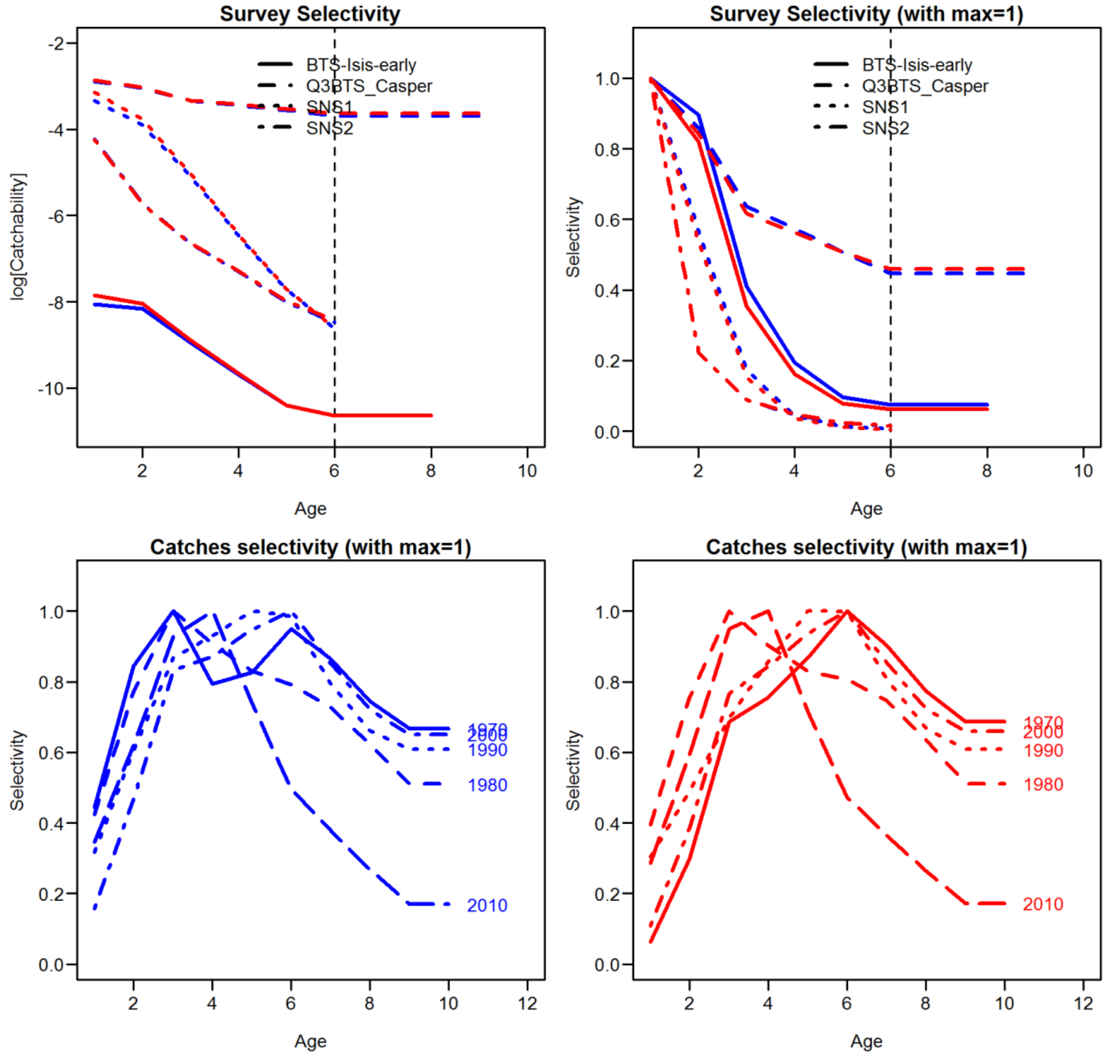


Figure 80. Run 8: survey selectivities (top panels) and selectivities catches (lower panels). Blue lines indicate the assessment that uses the WGNSSK 2016 reconstruction, red lines indicate the assessment where internal estimation is done.

Figures run 8 (1957-2015, 6, 9, 6, 26, 2, BTS-Isis early, BTS combined new, SNS1 ages 1-6, SNS2 ages 1-6, removed historic discards estimates above age 7 that were assumed zero)

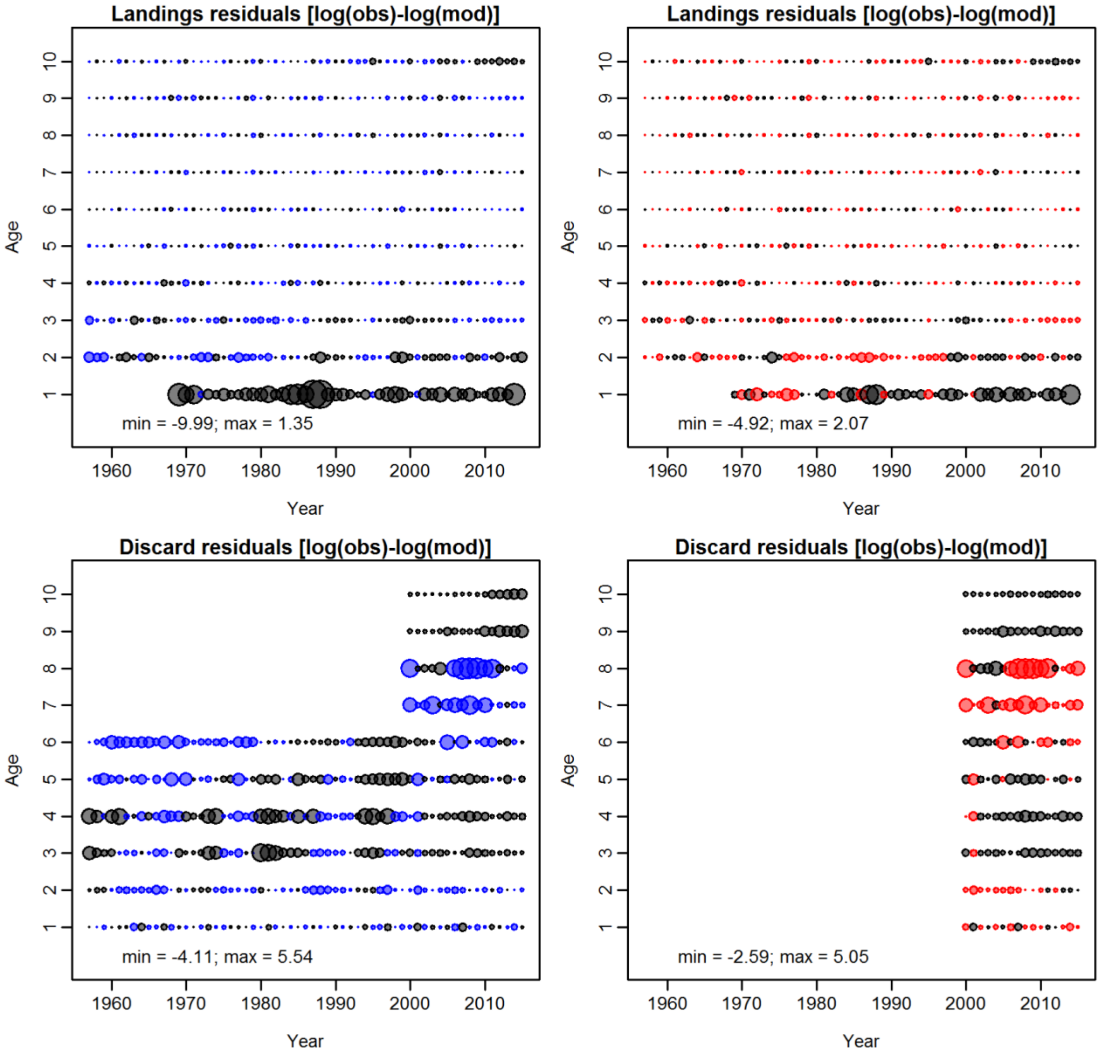


Figure 81. Run 8: Landings residuals (top panels) and discards residuals (lower panels). Blue/red bubbles positive residuals (observations greater than model), and black bubbles indicate negative residuals (observations less than model). Left panels indicate assessment with WGNSSK 2016 being used (blue colors for positive residuals), right panels indicate assessment where discards are estimated internally (red colors for positive residuals).

Figures run 8 (1957-2015, 6, 9, 6, 26, 2, BTS-Isis early, BTS combined new, SNS1 ages 1-6, SNS2 ages 1-6, removed historic discards estimates above age 7 that were assumed zero)

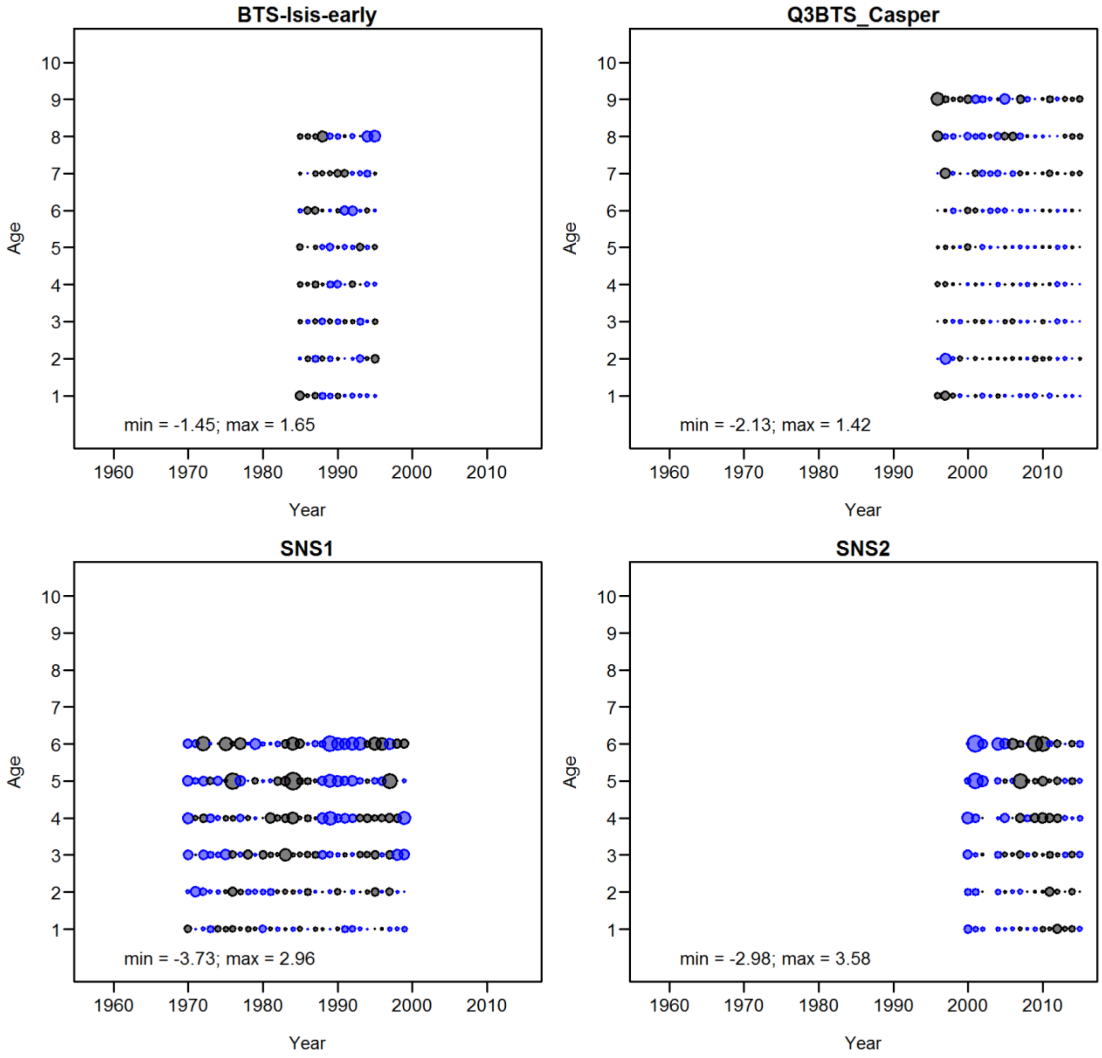


Figure 82. Run 8: Survey residuals for model using WGNSSK 2016 discards reconstruction. Blue bubbles indicate positive residuals (observations greater than model), and black bubbles indicate negative residuals (observations less than model).

Figures run 8 (1957-2015, 6, 9, 6, 26, 2, BTS-Isis early, BTS combined new, SNS1 ages 1-6, SNS2 ages 1-6, removed historic discards estimates above age 7 that were assumed zero)

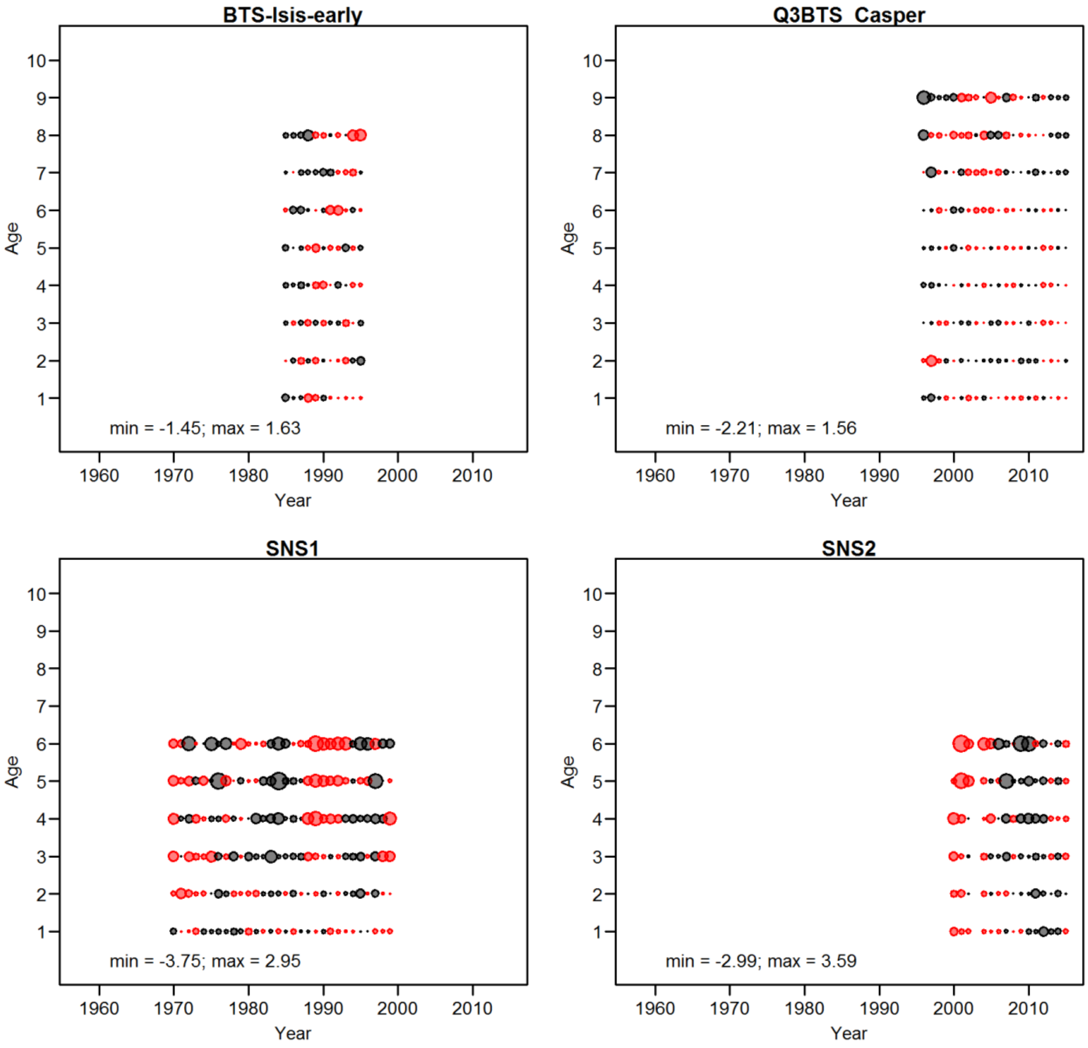


Figure 83. Run 8: Survey residuals for internally reconstructed discards. Red bubbles indicate positive residuals (observations greater than model), and black bubbles indicate negative residuals (observations less than model).

Figures run 8 (1957-2015, 6, 9, 6, 26, 2, BTS-Isis early, BTS combined new, SNS1 ages 1-6, SNS2 ages 1-6, removed historic discards estimates above age 7 that were assumed zero)

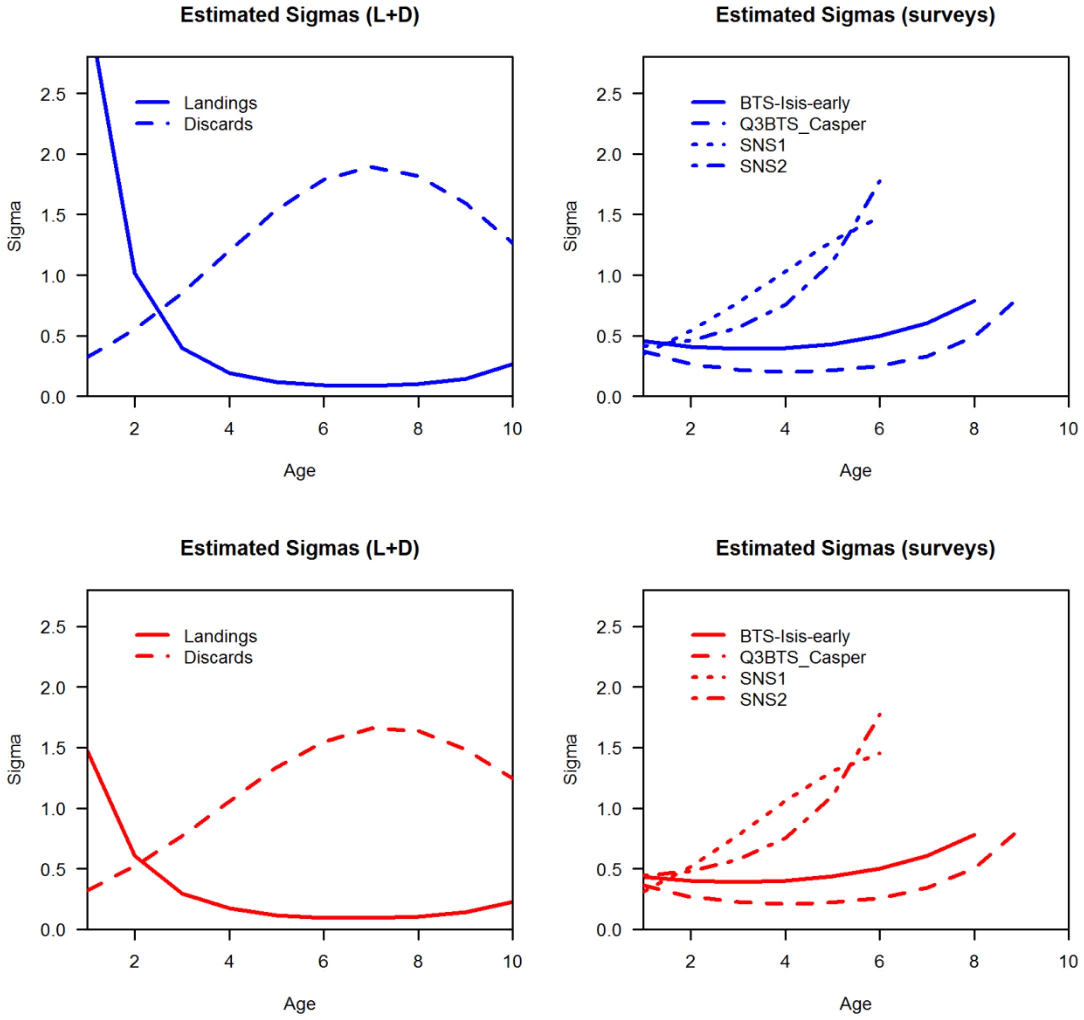


Figure 84. Run 8: Estimated age-dependent sigmas for the different likelihood components.

Figures run 8 (1957-2015, 6, 9, 6, 26, 2, BTS-Isis early, BTS combined new, SNS1 ages 1-6, SNS2 ages 1-6, removed historic discards estimates above age 7 that were assumed zero)

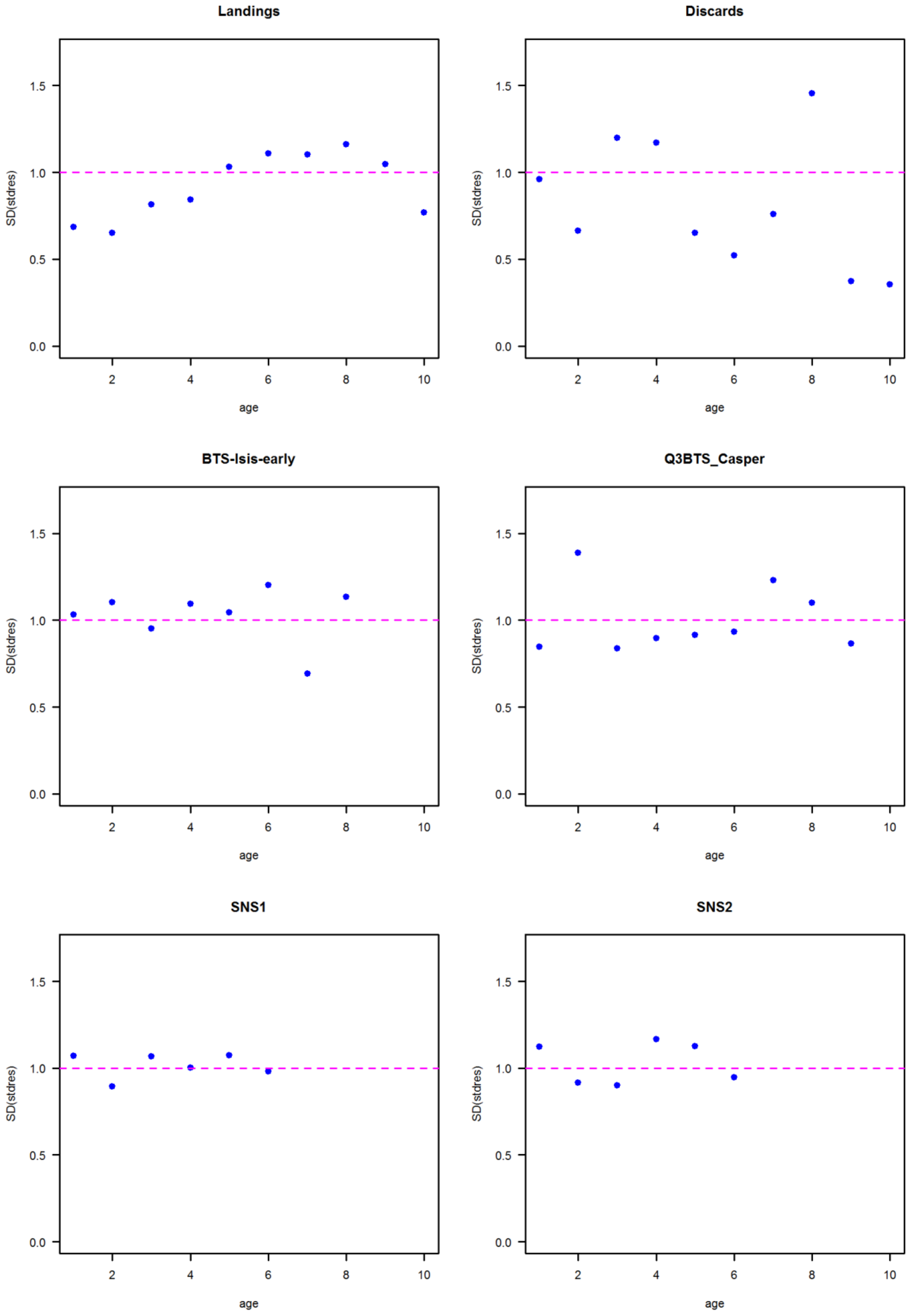


Figure 85. Run 8: SDs of standardized residuals (for discards estimates from WGNSSK 2016 assessment).

Figures run 8 (1957-2015, 6, 9, 6, 26, 2, BTS-Isis early, BTS combined new, SNS1 ages 1-6, SNS2 ages 1-6, removed historic discards estimates above age 7 that were assumed zero)

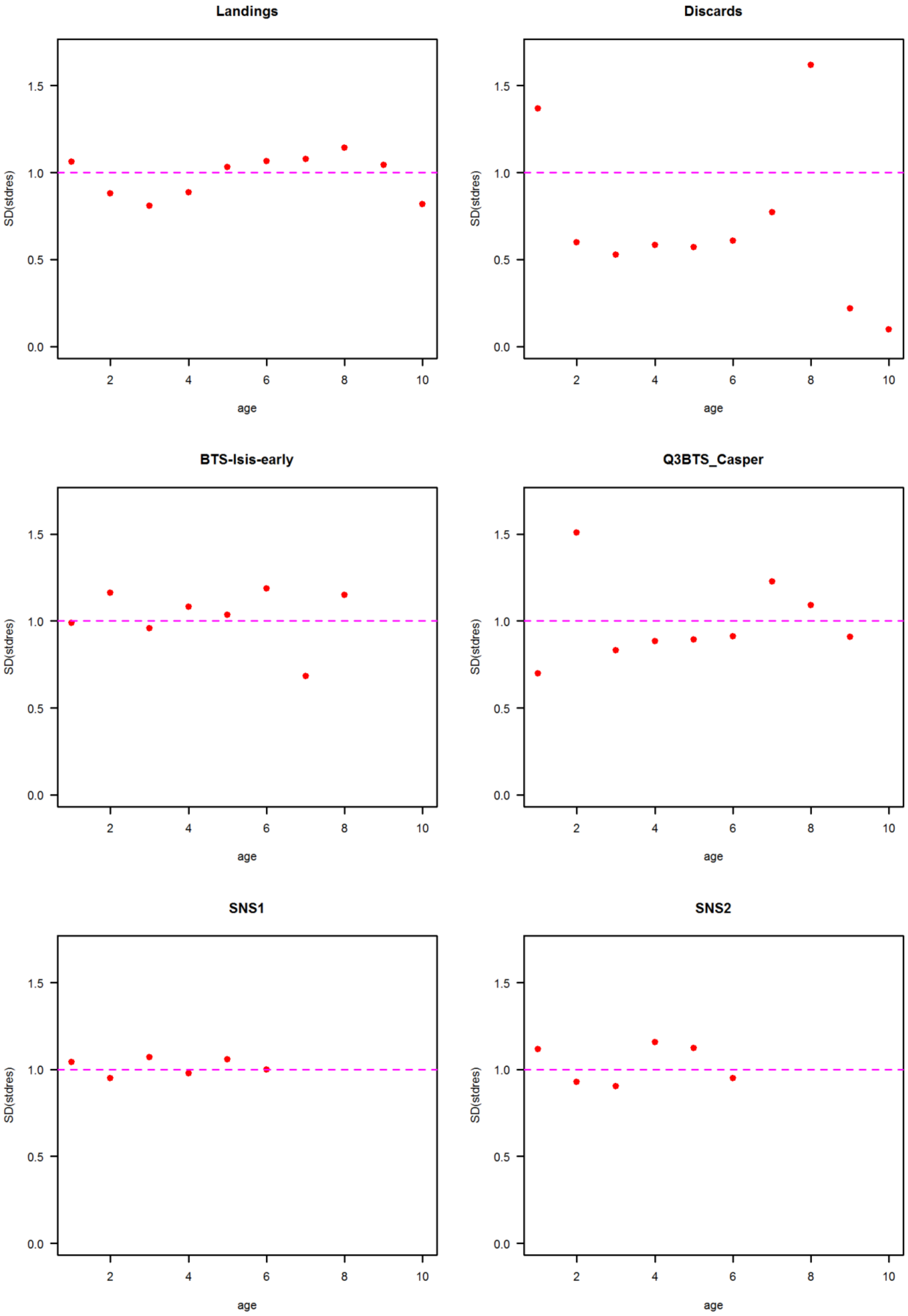


Figure 86. Run 8: SDs of standardized residuals (for internally estimated discards assessment).

Figures run 8 (1957-2015, 6, 9, 6, 26, 2, BTS-Isis early, BTS combined new, SNS1 ages 1-6, SNS2 ages 1-6, removed historic discards estimates above age 7 that were assumed zero)

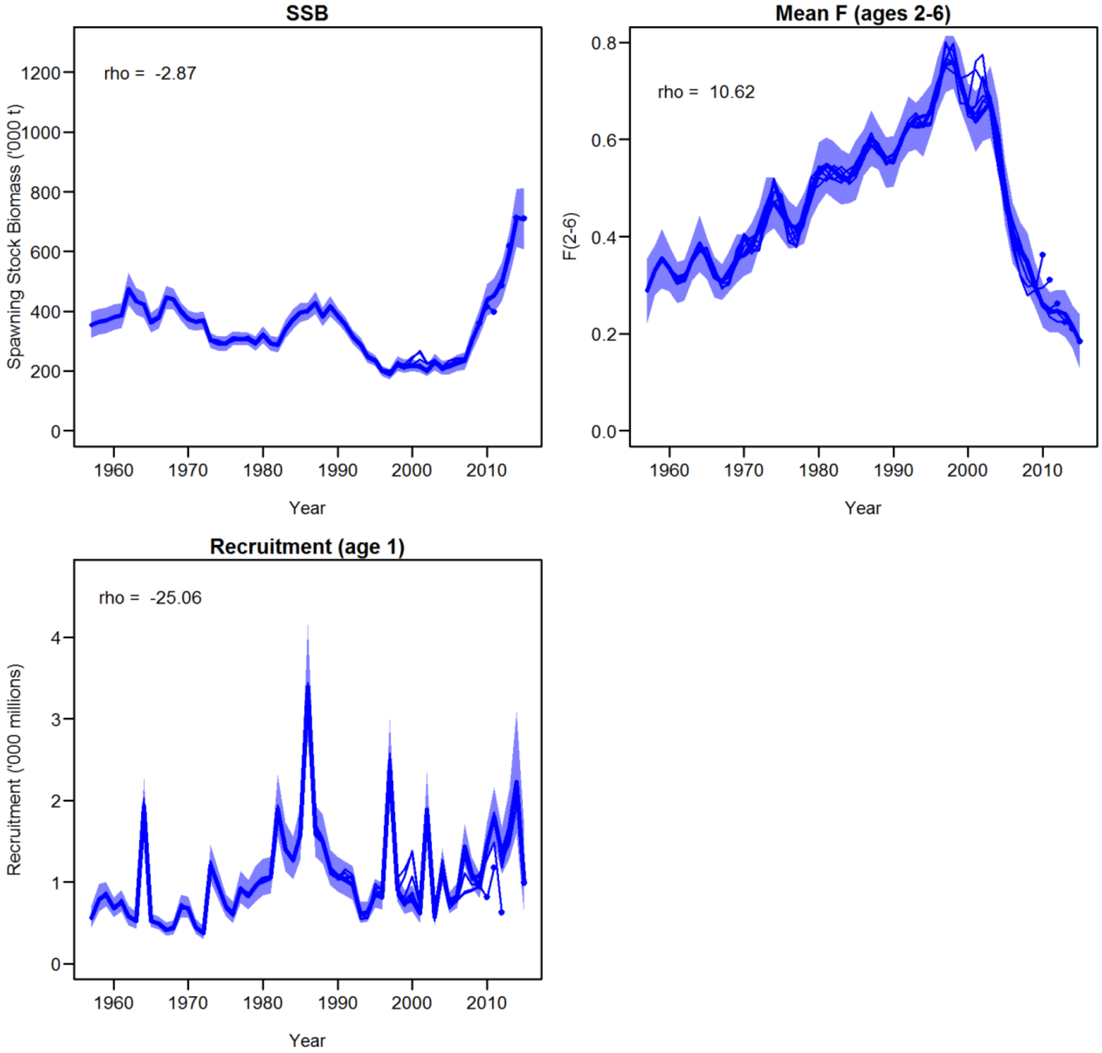


Figure 87. Run 8: Retro (for discards estimates from WGNSSK 2016 assessment).

Figures run 8 (1957-2015, 6, 9, 6, 26, 2, BTS-Isis early, BTS combined new, SNS1 ages 1-6, SNS2 ages 1-6, removed historic discards estimates above age 7 that were assumed zero)

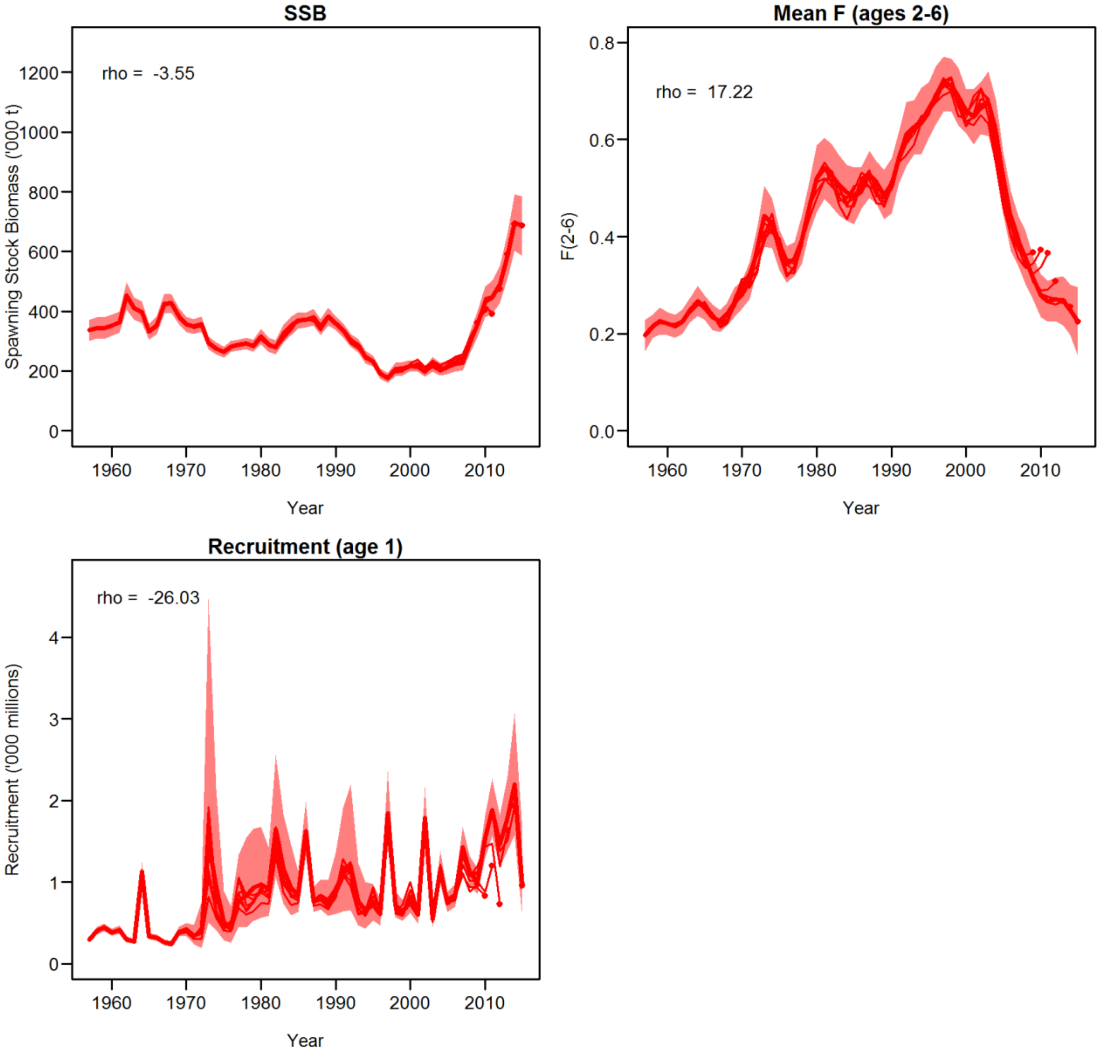


Figure 88. Run 8: Retro (for internally estimated discards assessment).

Figures run 9 (1957-2015, 6, 9, 6, 26, 2, BTS-Isis early, BTS combined new, SNS1 ages 1-6, SNS2 ages 1-6, IBTS Q3, removed historic discards estimates above age 7 that were assumed zero)

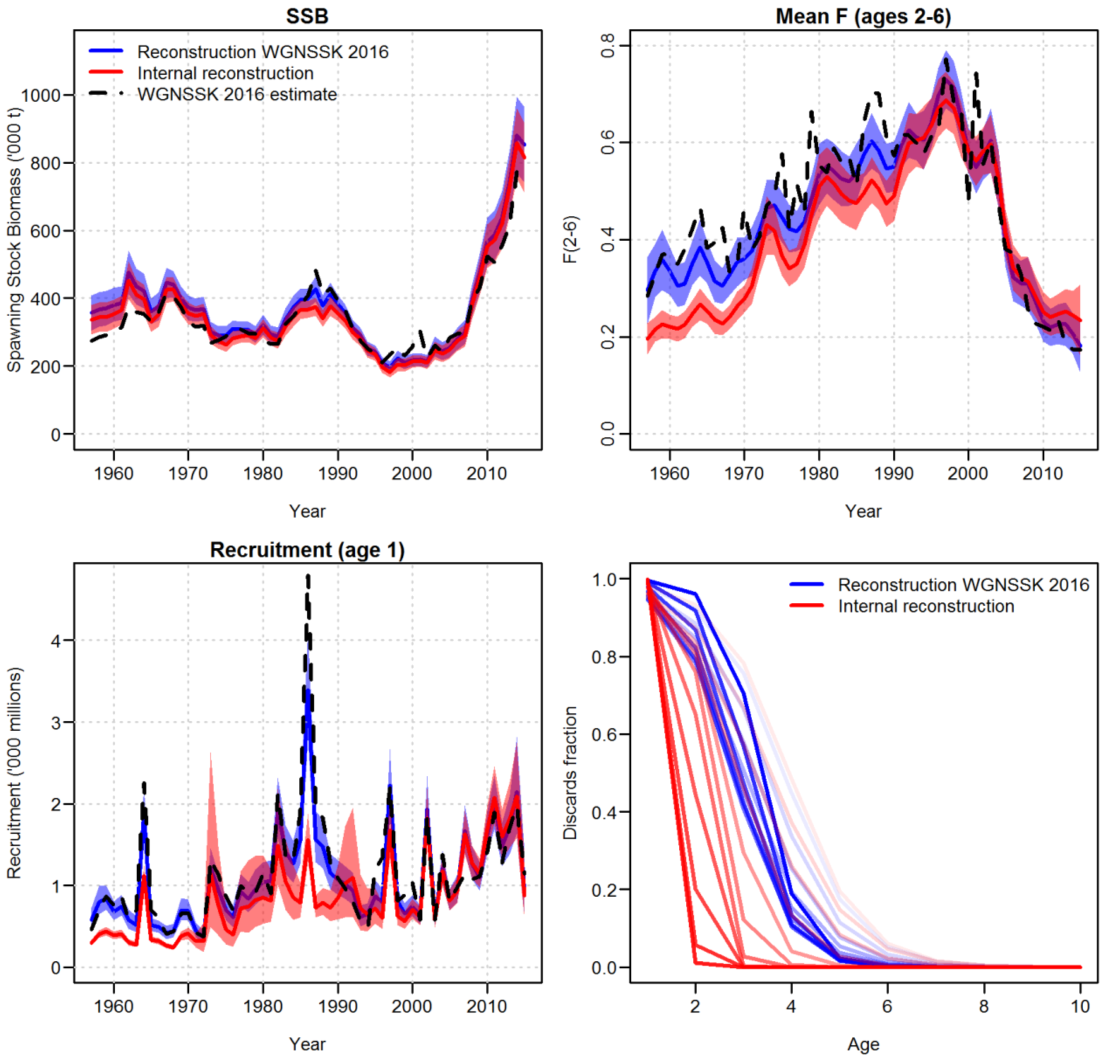


Figure 89. Run 9: Summary plot of assessment runs, with and without internal discards reconstruction, including the WGNSSK 2016 estimates.

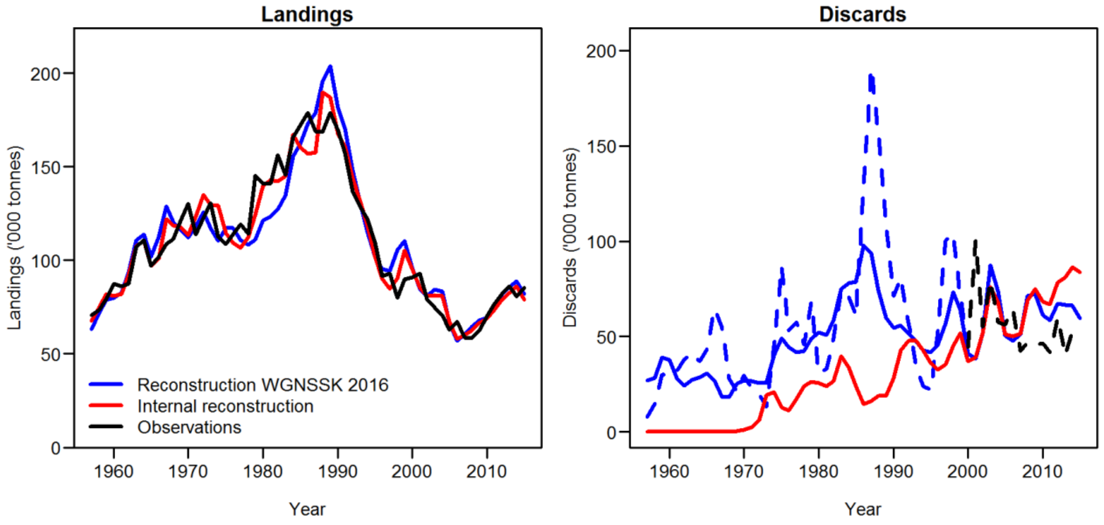


Figure 90. Run 9: Landings and discards estimates of first assessment runs, with and without internal discards reconstruction, including the WGNSSK 2016 estimates.

Figures run 9 (1957-2015, 6, 9, 6, 26, 2, BTS-Isis early, BTS combined new, SNS1 ages 1-6, SNS2 ages 1-6, IBTS Q3, removed historic discards estimates above age 7 that were assumed zero)

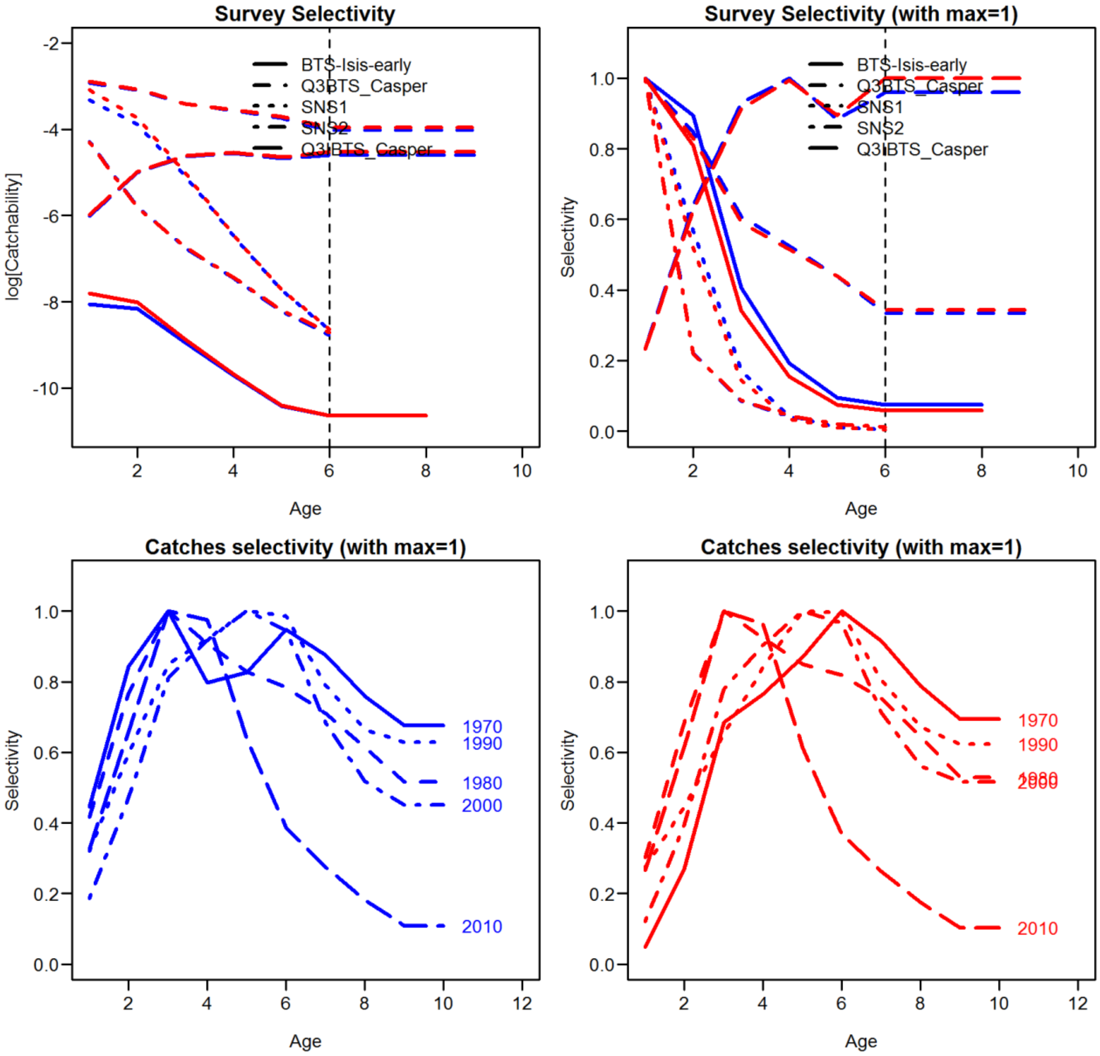


Figure 91. Run 9: survey selectivities (top panels) and selectivities catches (lower panels). Blue lines indicate the assessment that uses the WGNSSK 2016 reconstruction, red lines indicate the assessment where internal estimation is done.

Figures run 9 (1957-2015, 6, 9, 6, 26, 2, BTS-Isis early, BTS combined new, SNS1 ages 1-6, SNS2 ages 1-6, IBTS Q3, removed historic discards estimates above age 7 that were assumed zero)

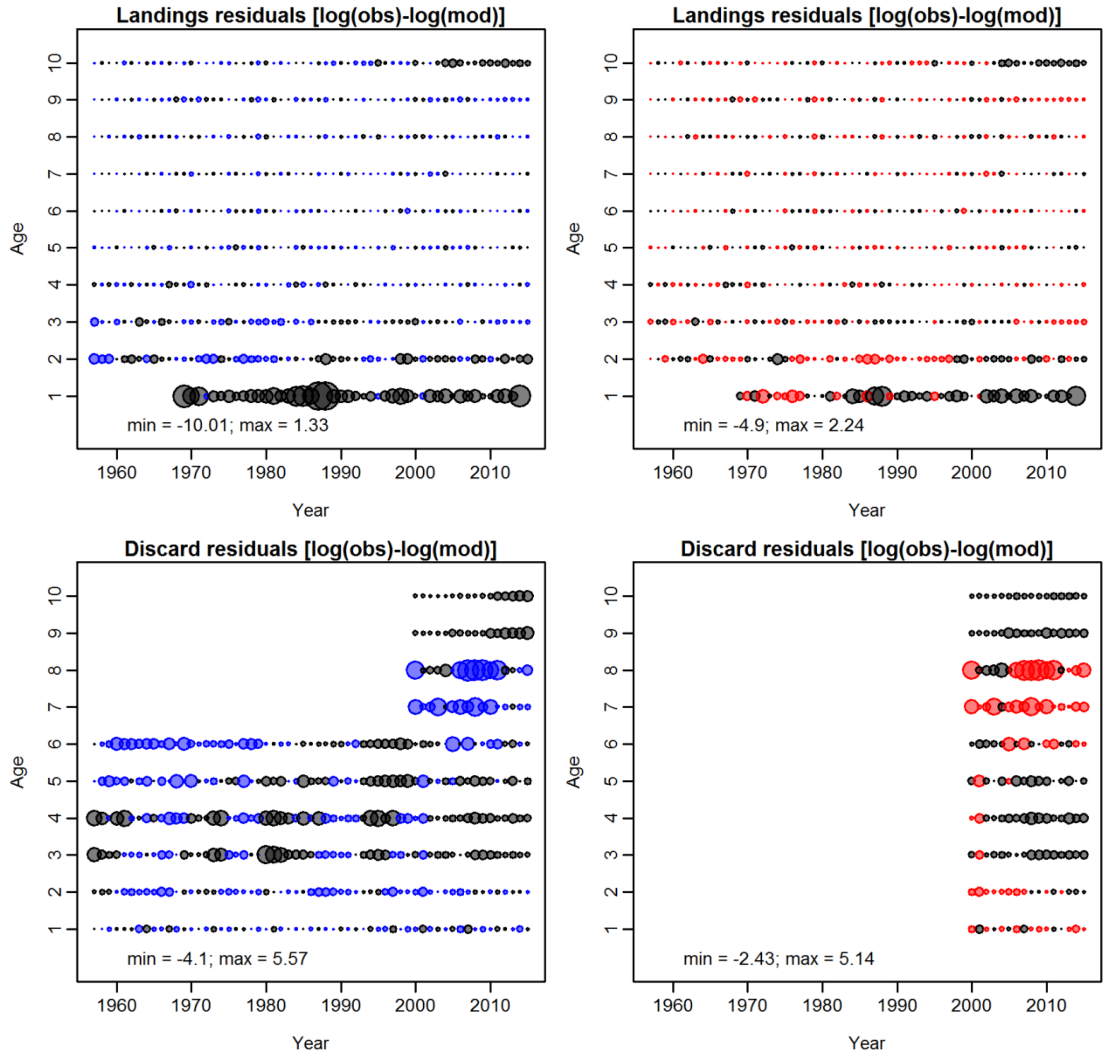


Figure 92. Run 9: Landings residuals (top panels) and discards residuals (lower panels). Blue/red bubbles positive residuals (observations greater than model), and black bubbles indicate negative residuals (observations less than model). Left panels indicate assessment with WGNSSK 2016 being used (blue colors for positive residuals), right panels indicate assessment where discards are estimated internally (red colors for positive residuals).

Figures run 9 (1957-2015, 6, 9, 6, 26, 2, BTS-Isis early, BTS combined new, SNS1 ages 1-6, SNS2 ages 1-6, IBTS Q3, removed historic discards estimates above age 7 that were assumed zero)

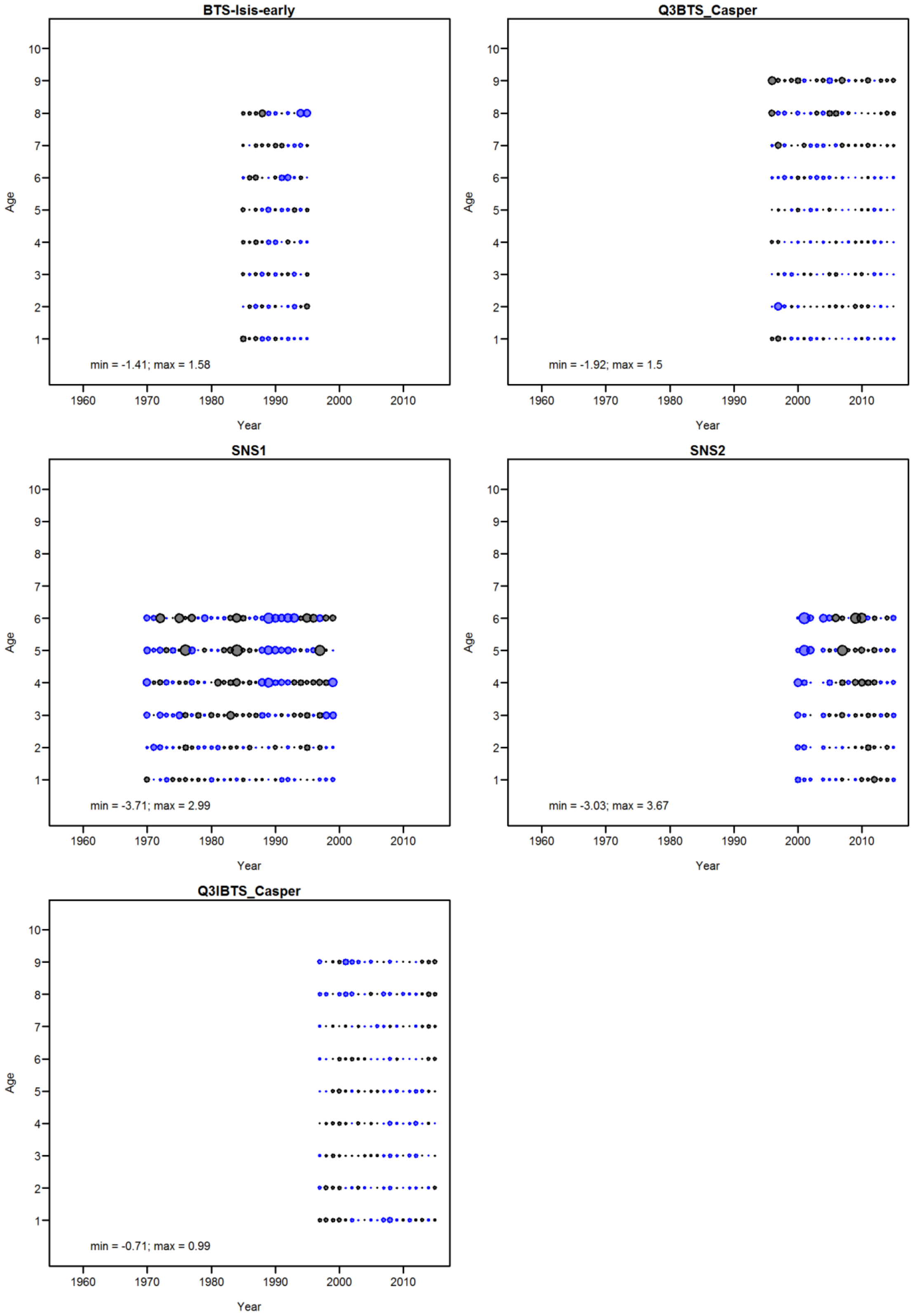


Figure 93. Run 9: Survey residuals for model using WGNSSK 2016 discards reconstruction. Blue bubbles indicate positive residuals (observations greater than model), and black bubbles indicate negative residuals (observations less than model).

Figures run 9 (1957-2015, 6, 9, 6, 26, 2, BTS-Isis early, BTS combined new, SNS1 ages 1-6, SNS2 ages 1-6, IBTS Q3, removed historic discards estimates above age 7 that were assumed zero)

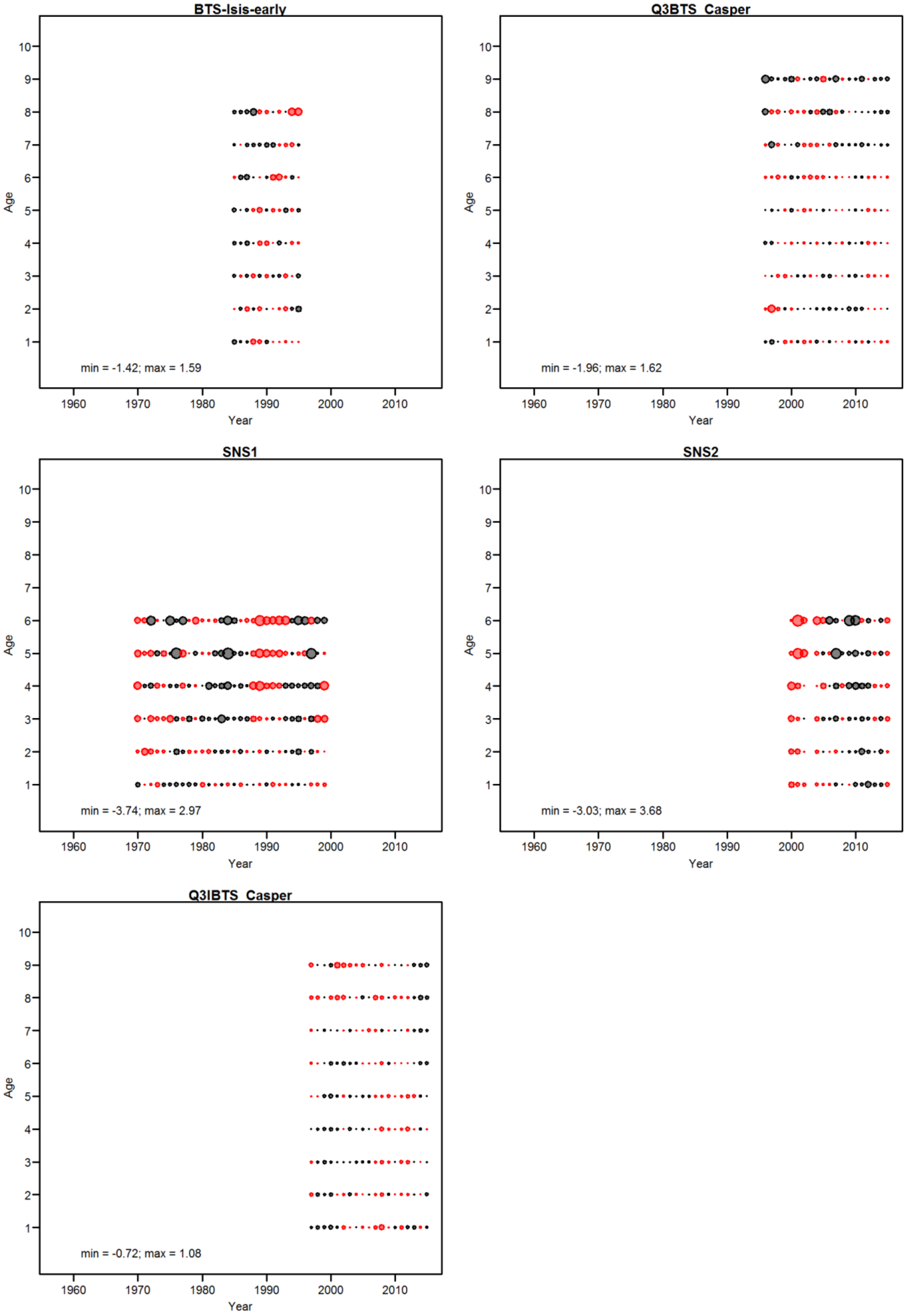


Figure 94. Run 9: Survey residuals for internally reconstructed discards. Red bubbles indicate positive residuals (observations greater than model), and black bubbles indicate negative residuals (observations less than model).

Figures run 9 (1957-2015, 6, 9, 6, 26, 2, BTS-Isis early, BTS combined new, SNS1 ages 1-6, SNS2 ages 1-6, IBTS Q3, removed historic discards estimates above age 7 that were assumed zero)

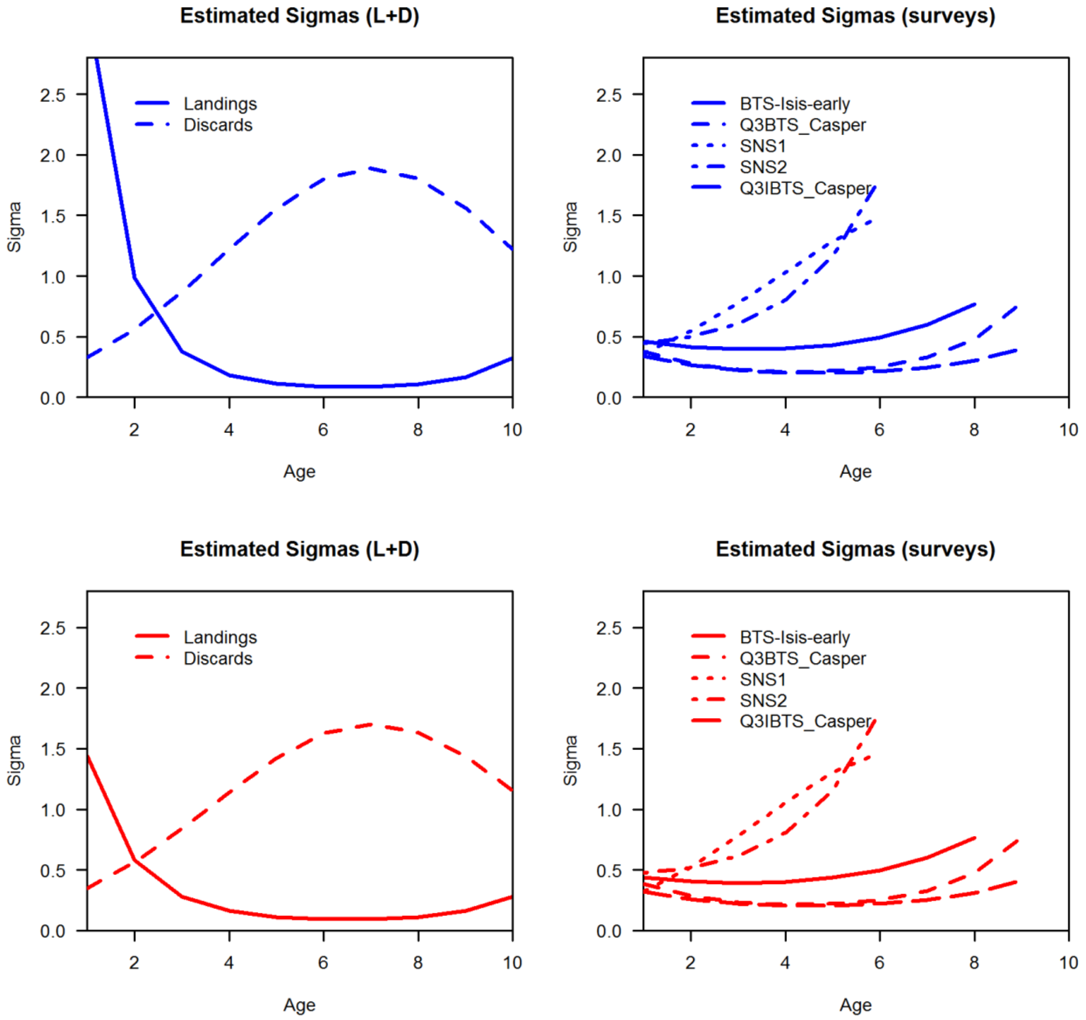


Figure 95. Run 9: Estimated age-dependent sigmas for the different likelihood components.

Figures run 9 (1957-2015, 6, 9, 6, 26, 2, BTS-Isis early, BTS combined new, SNS1 ages 1-6, SNS2 ages 1-6, IBTS Q3, removed historic discards estimates above age 7 that were assumed zero)

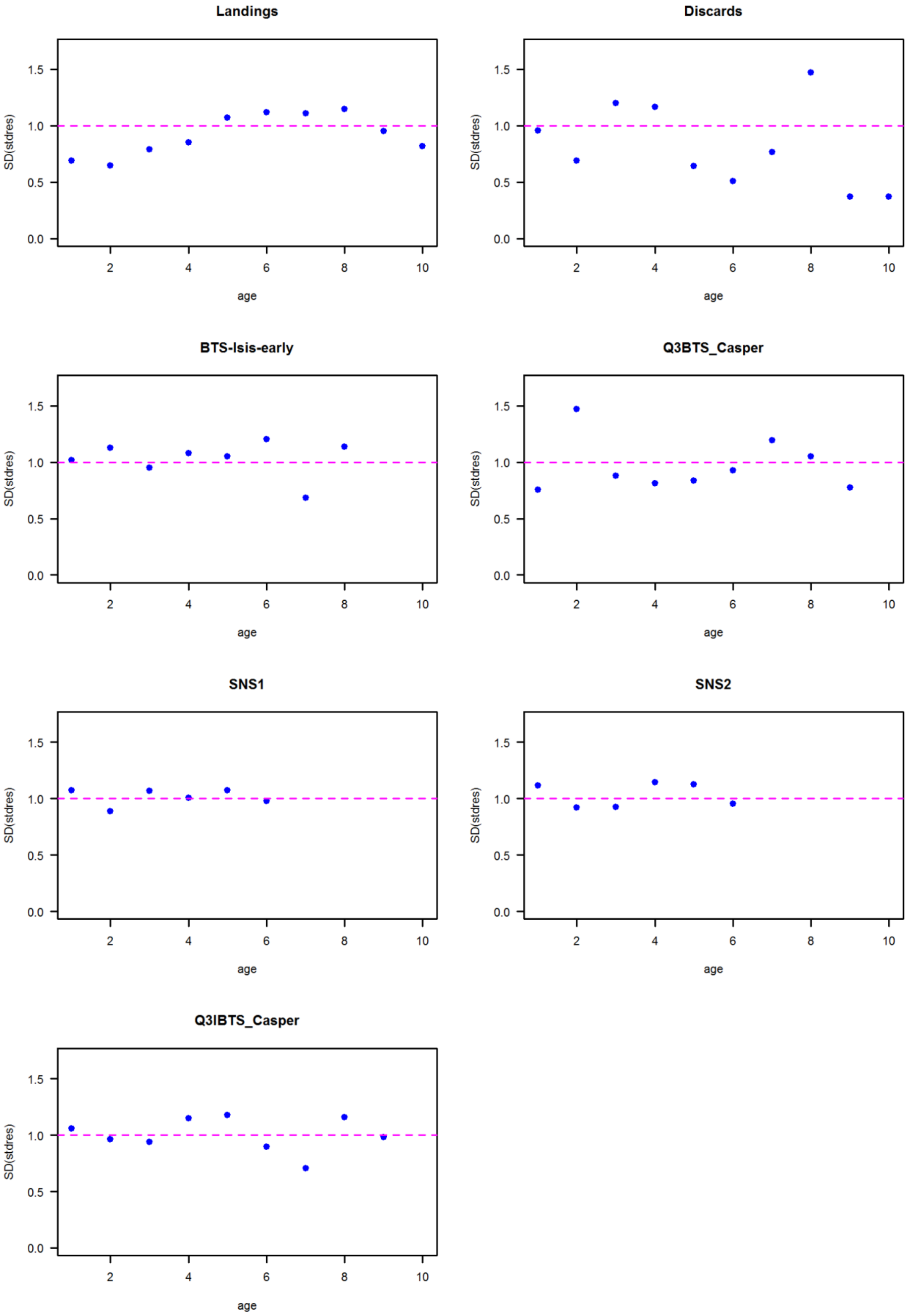


Figure 96. Run 9: SDs of standardized residuals (for discards estimates from WGNSSK 2016 assessment).

Figures run 9 (1957-2015, 6, 9, 6, 26, 2, BTS-Isis early, BTS combined new, SNS1 ages 1-6, SNS2 ages 1-6, IBTS Q3, removed historic discards estimates above age 7 that were assumed zero)

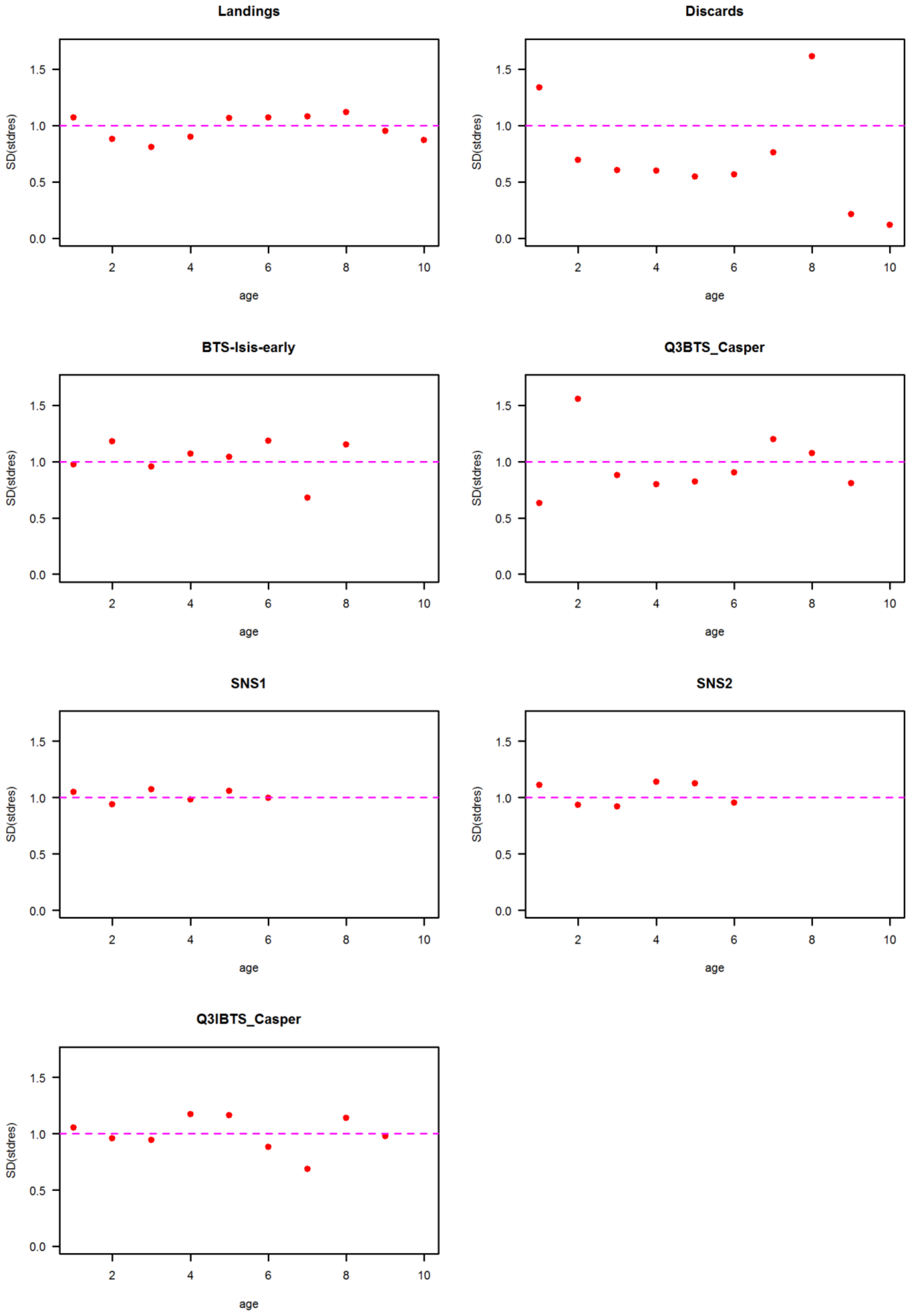


Figure 97. Run 9: SDs of standardized residuals (for internally estimated discards assessment).

Figures run 9 (1957-2015, 6, 9, 6, 26, 2, BTS-Isis early, BTS combined new, SNS1 ages 1-6, SNS2 ages 1-6, IBTS Q3, removed historic discards estimates above age 7 that were assumed zero)

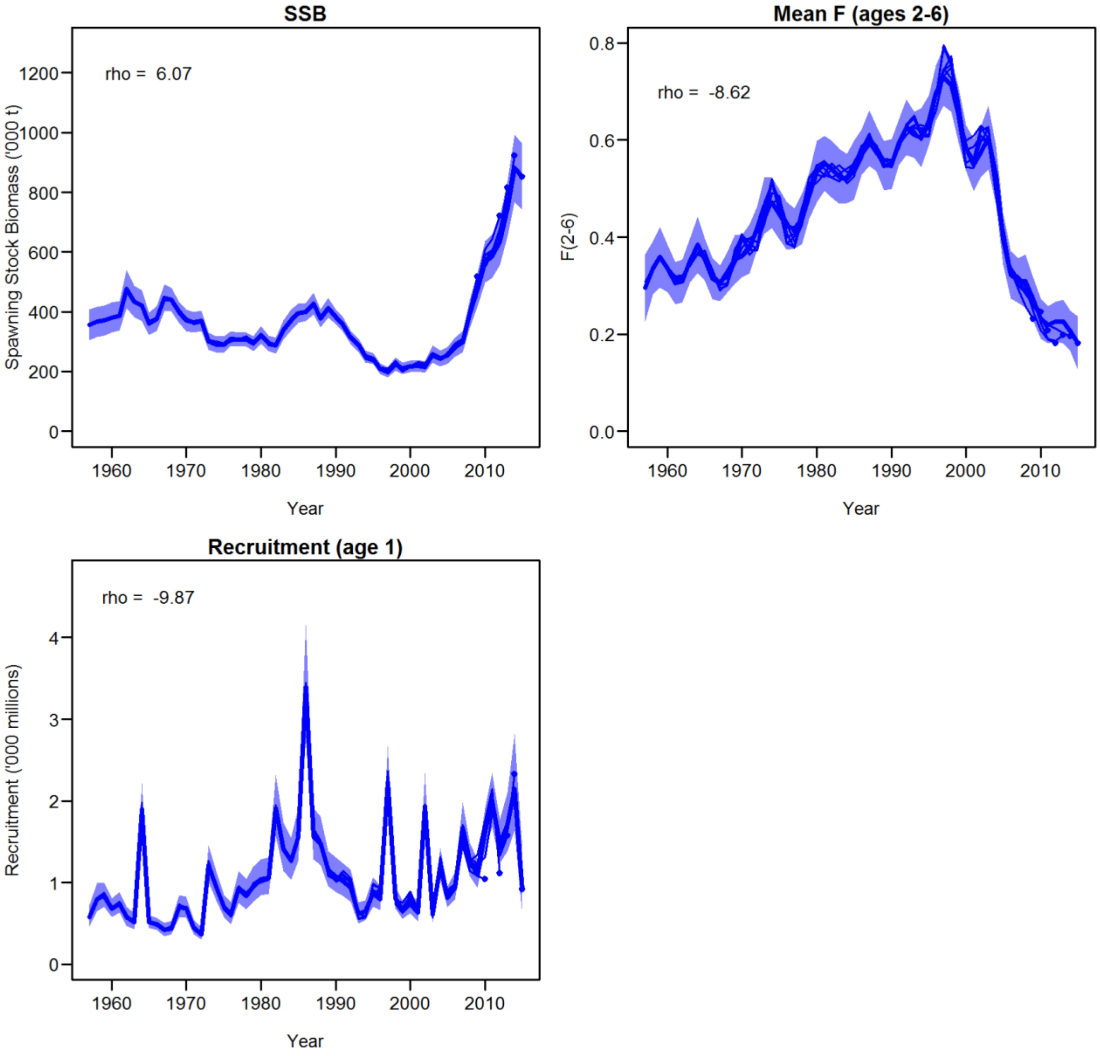


Figure 98. Run 9: Retro (for discards estimates from WGNSSK 2016 assessment).

Figures run 9 (1957-2015, 6, 9, 6, 26, 2, BTS-Isis early, BTS combined new, SNS1 ages 1-6, SNS2 ages 1-6, IBTS Q3, removed historic discards estimates above age 7 that were assumed zero)

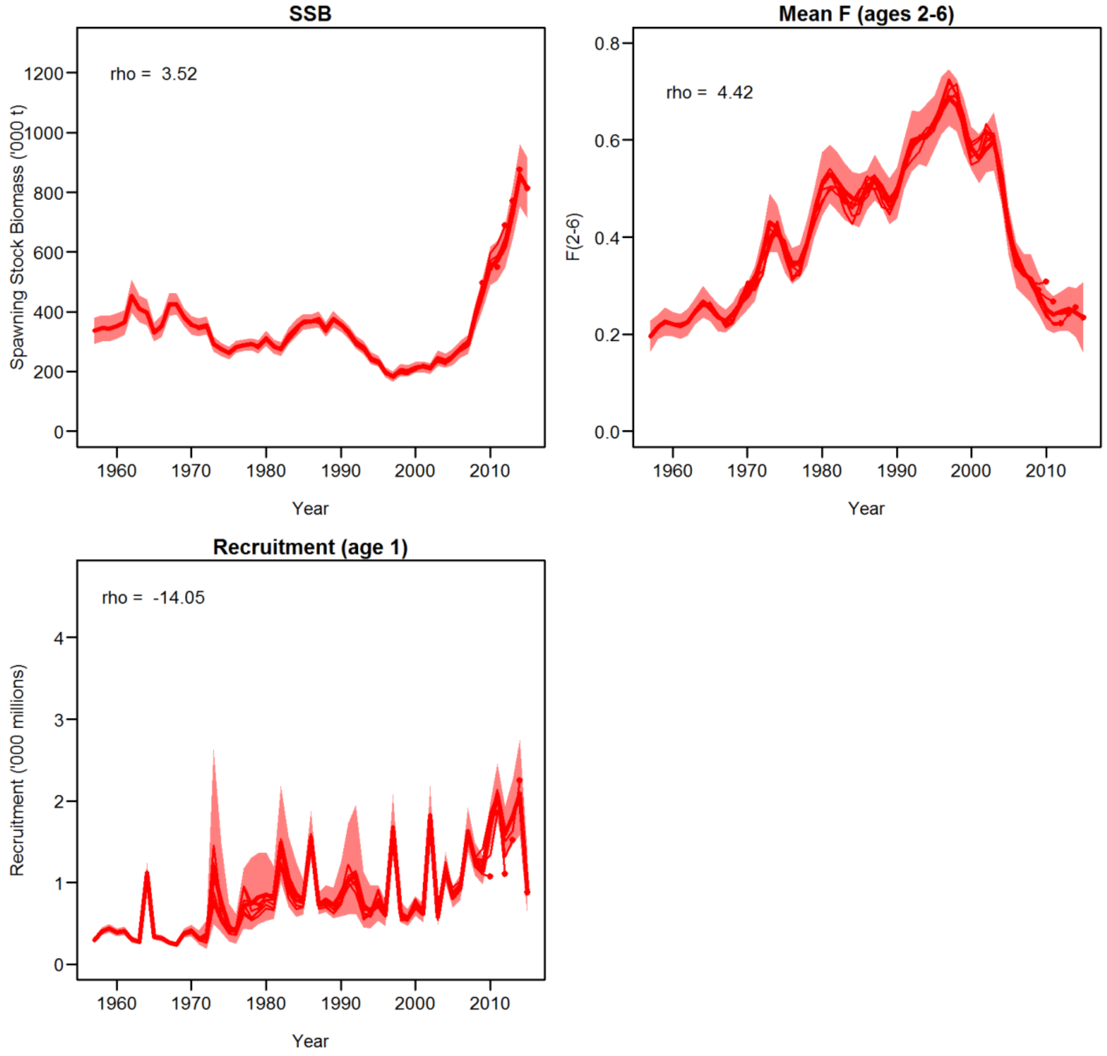


Figure 99. Run 9: Retro (for internally estimated discards assessment).

Figures run 10 (1957-2015, 6, 9, 6, 26, 2, BTS-Isis early, BTS combined new, SNS1 ages 1-6, SNS2 ages 1-6, IBTS Q3, IBTSQ1, removed historic discards estimates above age 7 that were assumed zero)

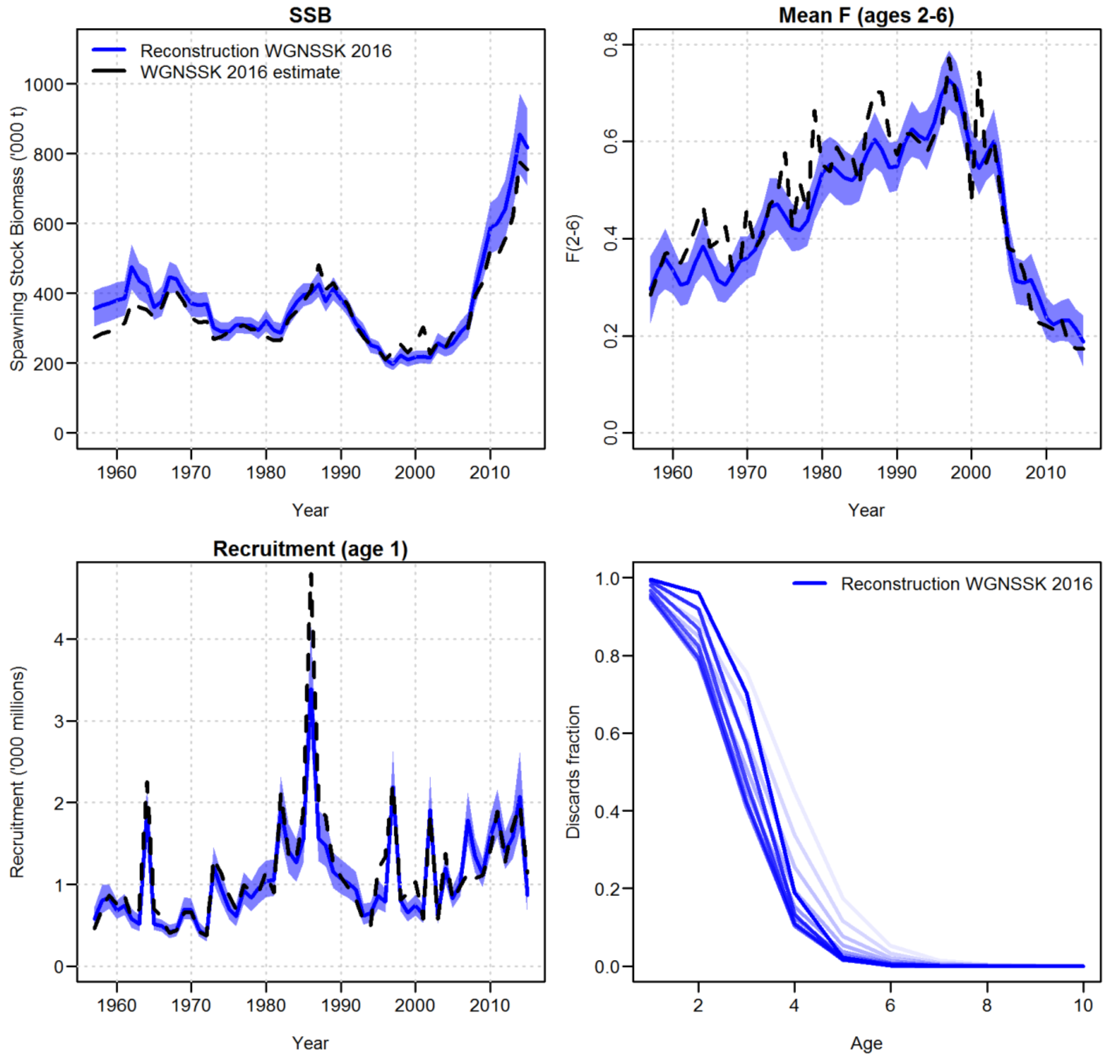


Figure 100. Run 10: Summary plot of assessment runs, without internal discards reconstruction, including the WGNSSK 2016 estimates.

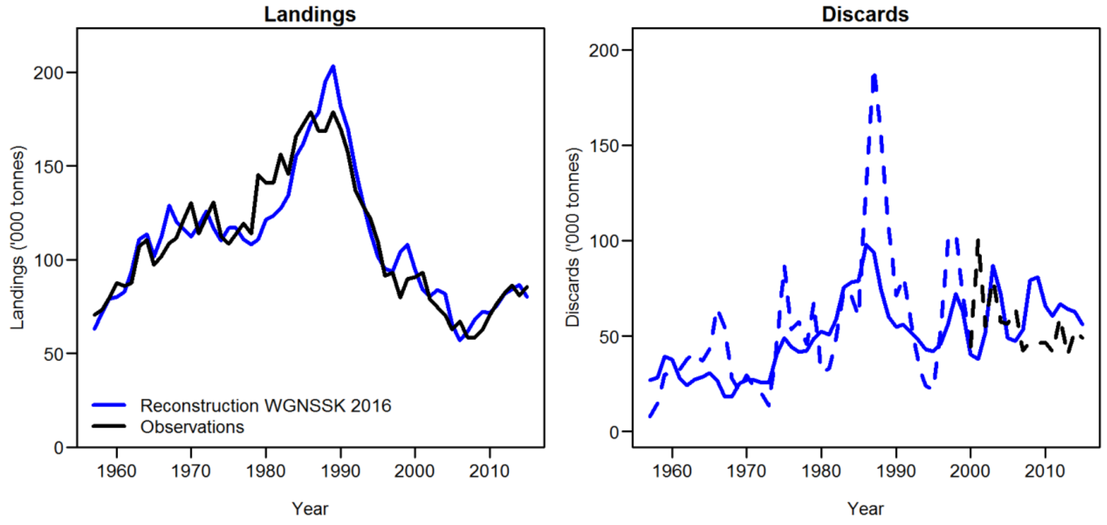


Figure 101. Run 10: Landings and discards estimates of first assessment runs, without internal discards reconstruction, including the WGNSSK 2016 estimates.

Figures run 10 (1957-2015, 6, 9, 6, 26, 2, BTS-Isis early, BTS combined new, SNS1 ages 1-6, SNS2 ages 1-6, IBTS Q3, IBTSQ1, removed historic discards estimates above age 7 that were assumed zero)

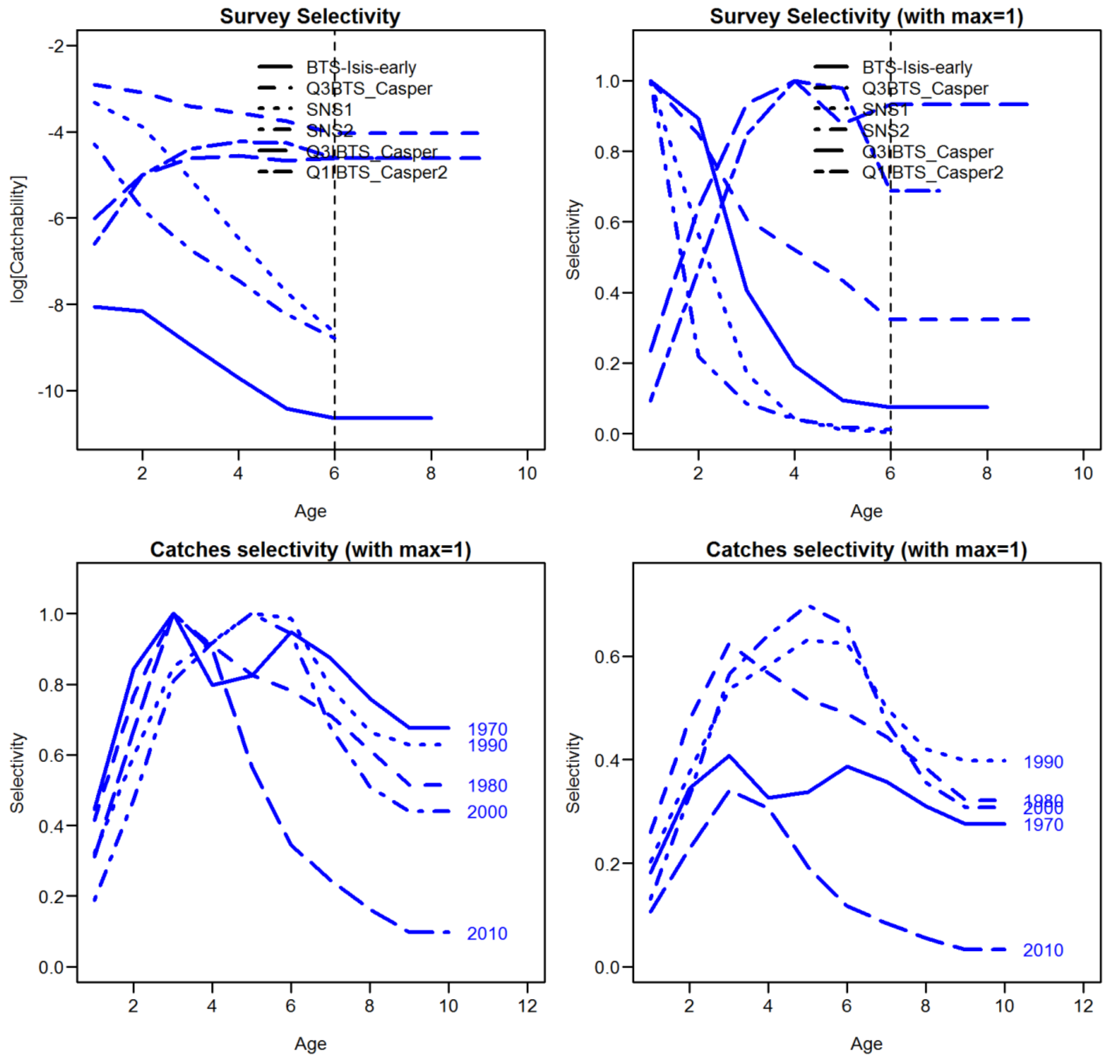
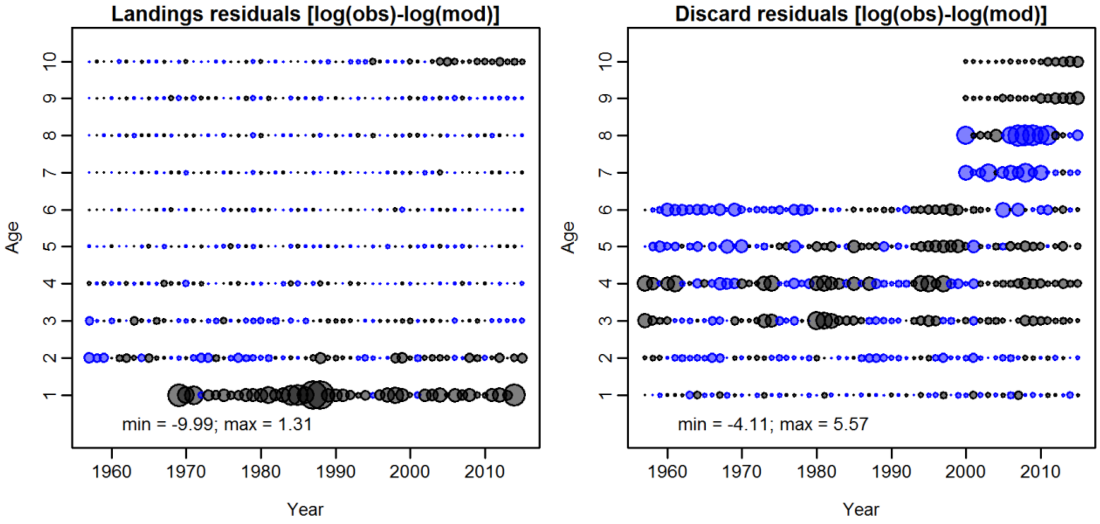


Figure 102. Run 10: survey selectivities (top panels) and selectivities catches (lower panels). Blue lines indicate the assessment that uses the WGNSSK 2016 reconstruction.

Figures run 10 (1957-2015, 6, 9, 6, 26, 2, BTS-Isis early, BTS combined new, SNS1 ages 1-6, SNS2 ages 1-6, IBTS Q3, IBTSQ1, removed historic discards estimates above age 7 that were assumed zero)


Landings residuals [log(obs)-log(mod)]

Discard residuals [log(obs)-log(mod)]

Figure 103. Run 10: Landings residuals (left panel) and discards residuals (right panel). Blue bubbles positive residuals (observations greater than model), and black bubbles indicate negative residuals (observations less than model). Assessment with WGNSSK 2016 discards estimates being used.

Figures run 10 (1957-2015, 6, 9, 6, 26, 2, BTS-Isis early, BTS combined new, SNS1 ages 1-6, SNS2 ages 1-6, IBTS Q3, IBTSQ1, removed historic discards estimates above age 7 that were assumed zero)

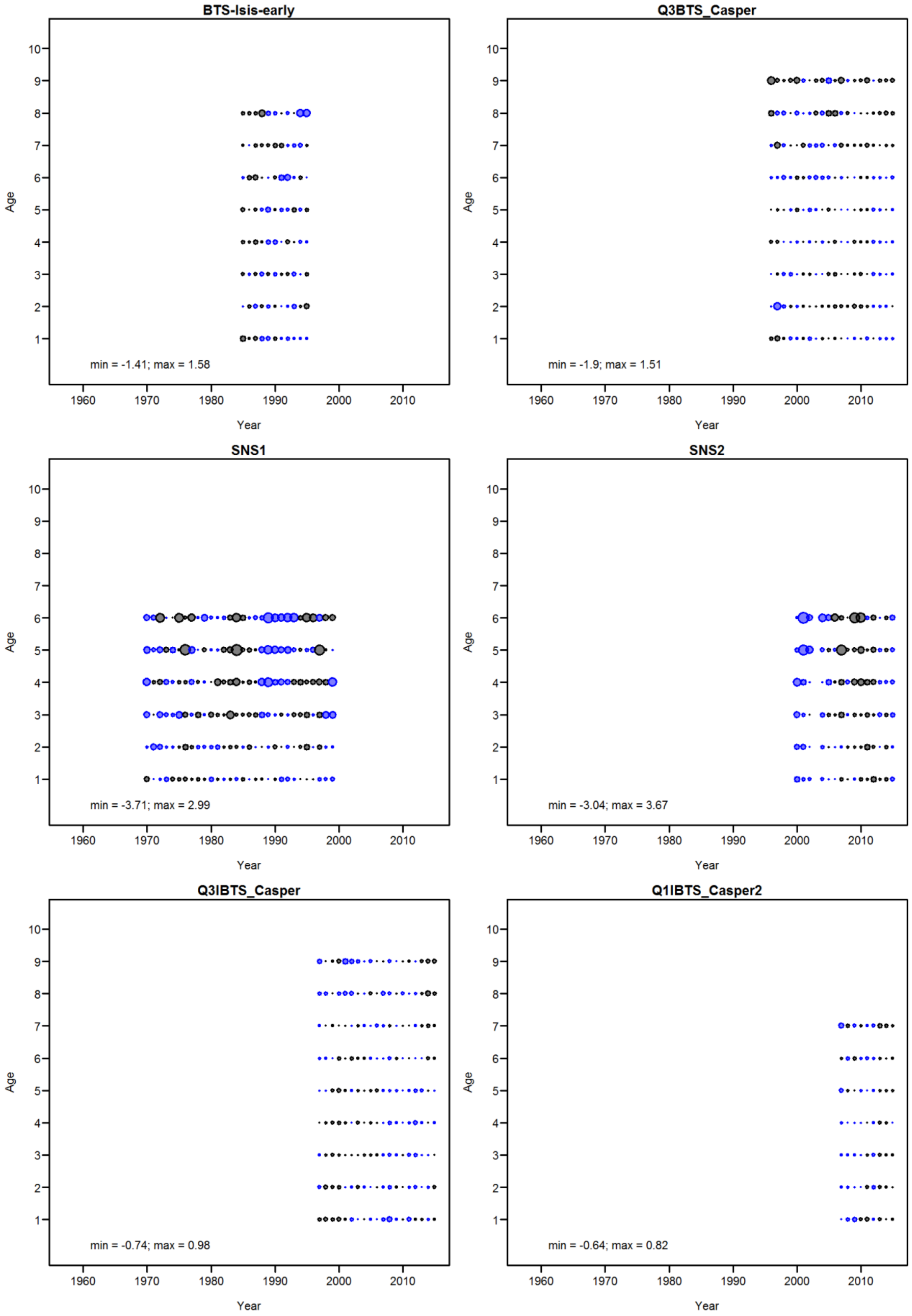


Figure 104. Run 10: Survey residuals for model using WGNSSK 2016 discards reconstruction. Blue bubbles indicate positive residuals (observations greater than model), and black bubbles indicate negative residuals (observations less than model).

Figures run 10 (1957-2015, 6, 9, 6, 26, 2, BTS-Isis early, BTS combined new, SNS1 ages 1-6, SNS2 ages 1-6, IBTS Q3, IBTSQ1, removed historic discards estimates above age 7 that were assumed zero)

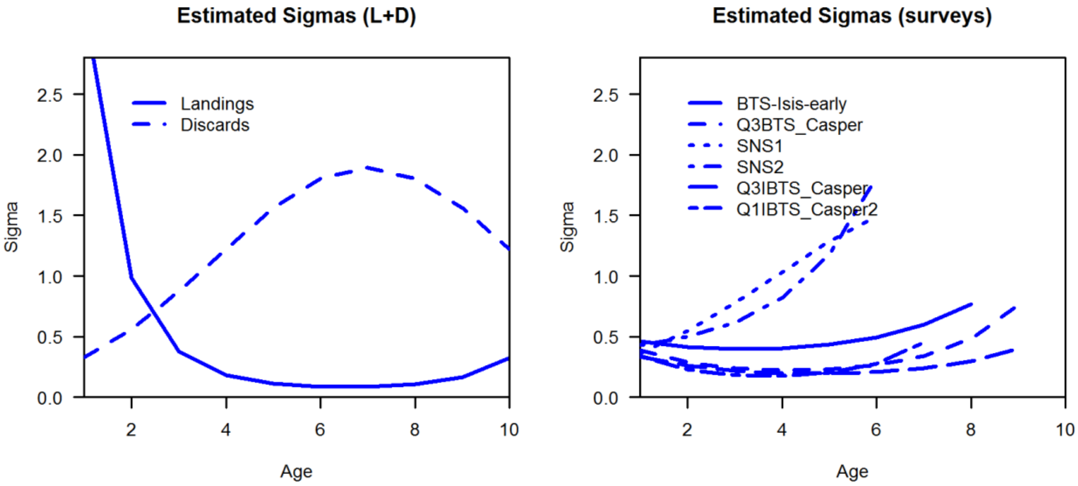


Figure 105. Run 10: Estimated age-dependent sigmas for the different likelihood components.

Figures run 10 (1957-2015, 6, 9, 6, 26, 2, BTS-Isis early, BTS combined new, SNS1 ages 1-6, SNS2 ages 1-6, IBTS Q3, IBTSQ1, removed historic discards estimates above age 7 that were assumed zero)

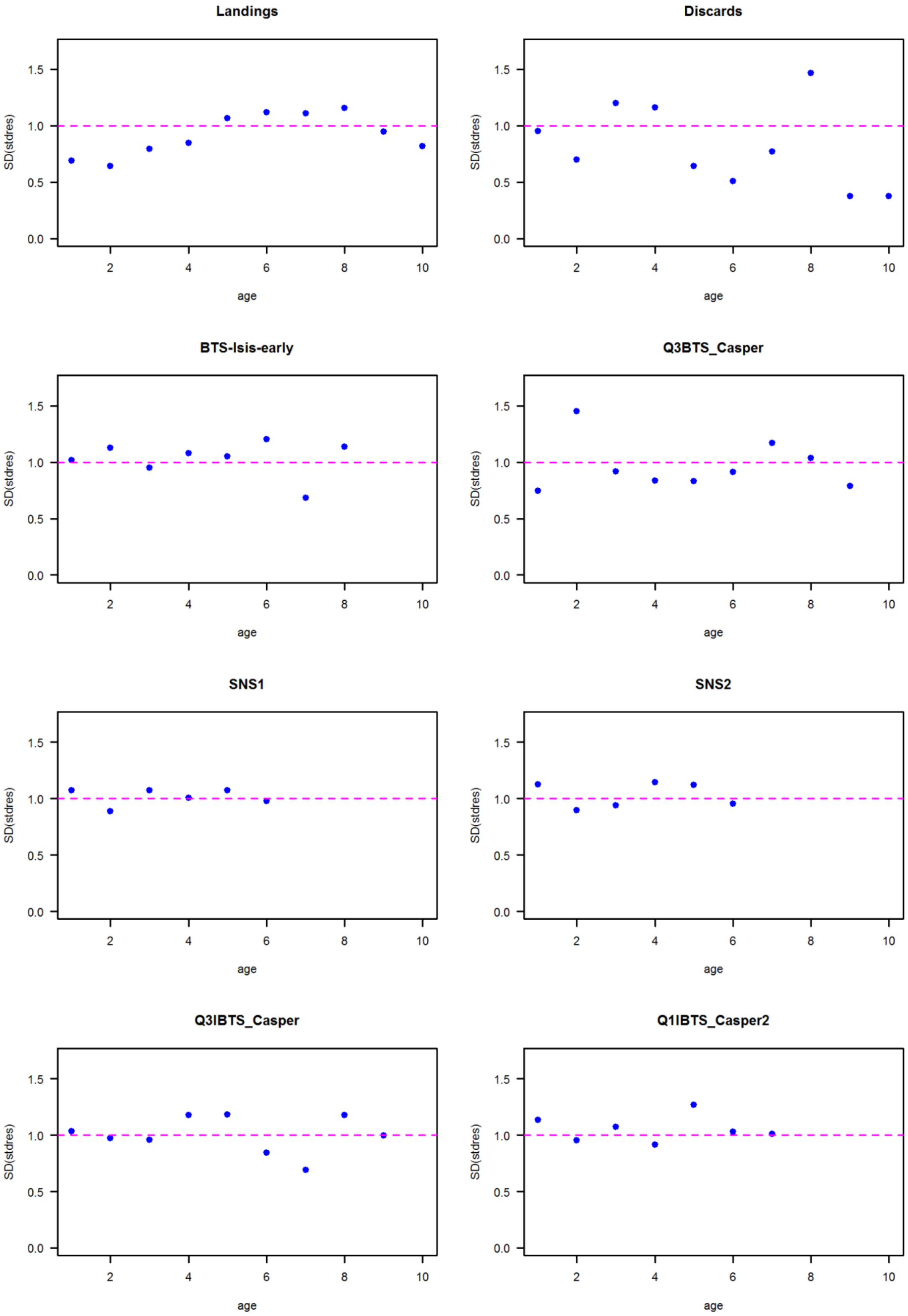
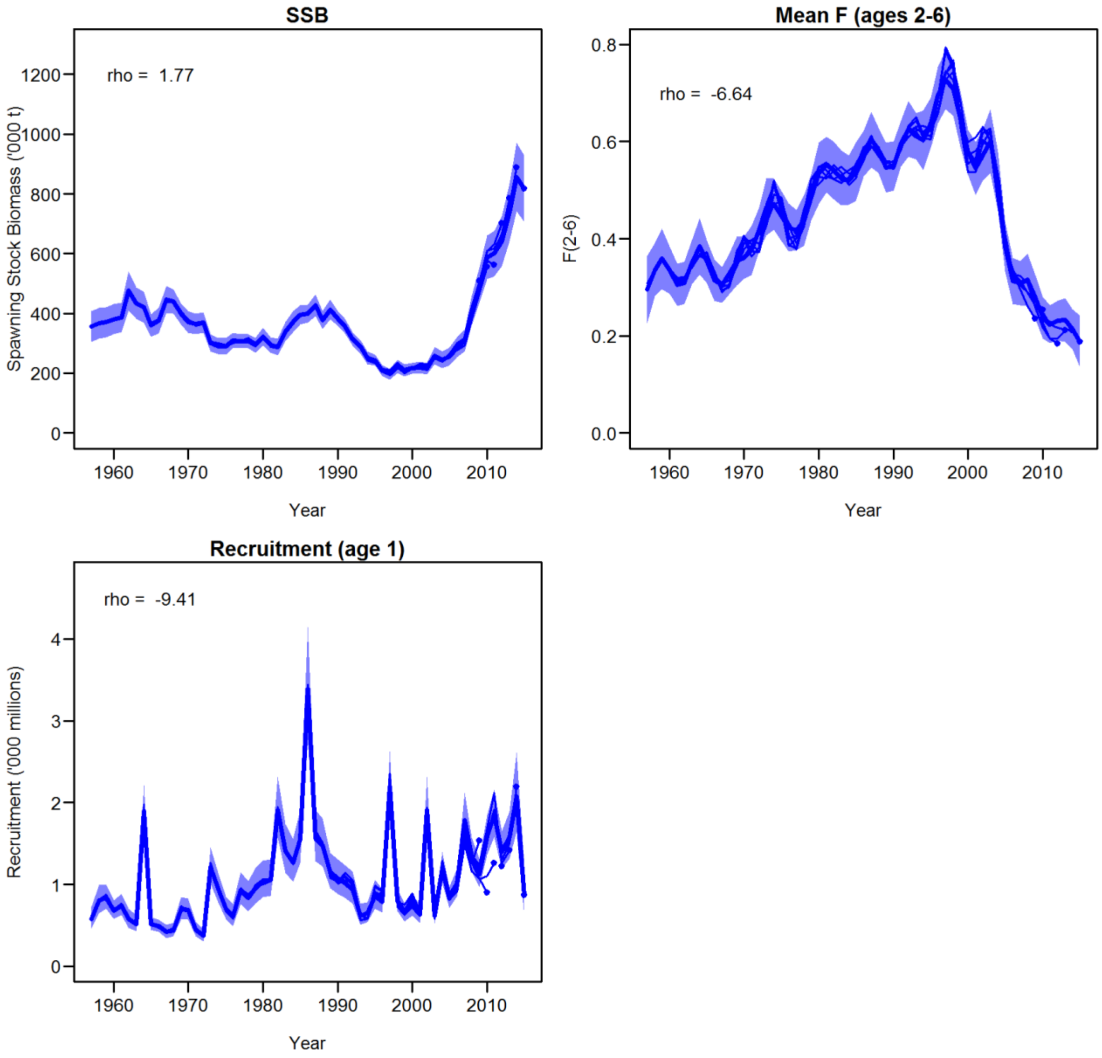


Figure 106. Run 10: SDs of standardized residuals (for discards estimates from WGNSSK 2016 assessment).

Figures run 10 (1957-2015, 6, 9, 6, 26, 2, BTS-Isis early, BTS combined new, SNS1 ages 1-6, SNS2 ages 1-6, IBTS Q3, IBTSQ1, removed historic discards estimates above age 7 that were assumed zero)


SSB

Mean F (ages 2-6)

Recruitment (age 1)

Figure 107. Run 10: Retro (for discards estimates from WGNSSK 2016 assessment).

Figures run 11 (1957-2015, 6, 9, 6, 26, 2, BTS-Isis early, BTS combined new, SNS1 ages 1-6, SNS2 ages 1-6, IBTSQ1, removed historic discards estimates above age 7 that were assumed zero)

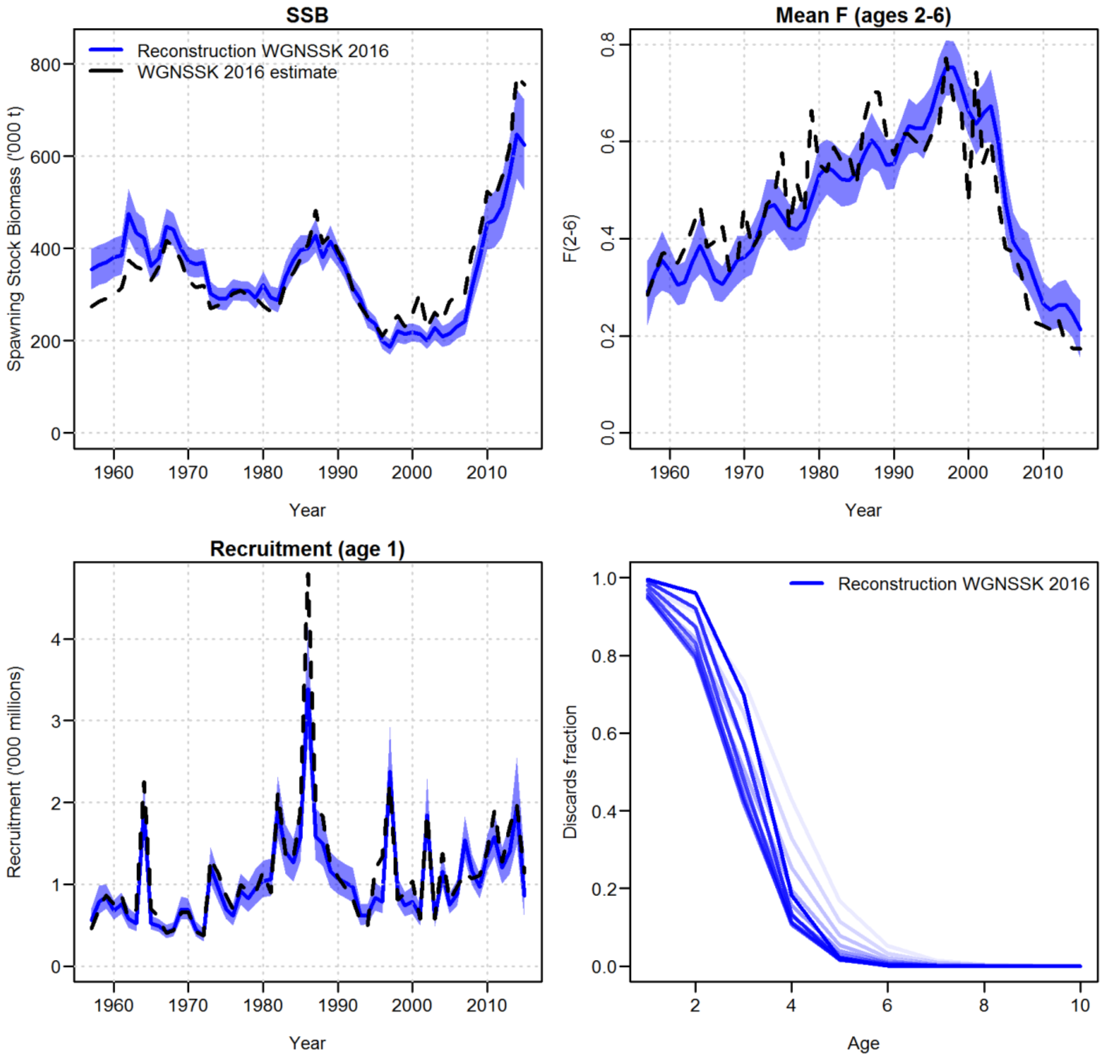


Figure 108. Run 11: Summary plot of assessment runs, without internal discards reconstruction, including the WGNSSK 2016 estimates.

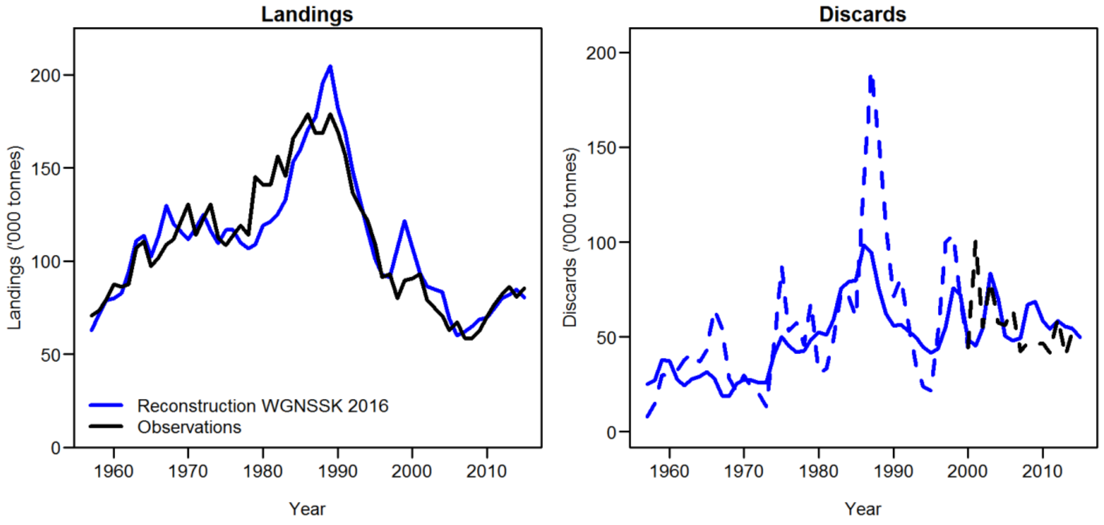


Figure 109. Run 11: Landings and discards estimates of first assessment runs, without internal discards reconstruction, including the WGNSSK 2016 estimates.

Figures run 11 (1957-2015, 6, 9, 6, 26, 2, BTS-Isis early, BTS combined new, SNS1 ages 1-6, SNS2 ages 1-6, IBTSQ1, removed historic discards estimates above age 7 that were assumed zero)

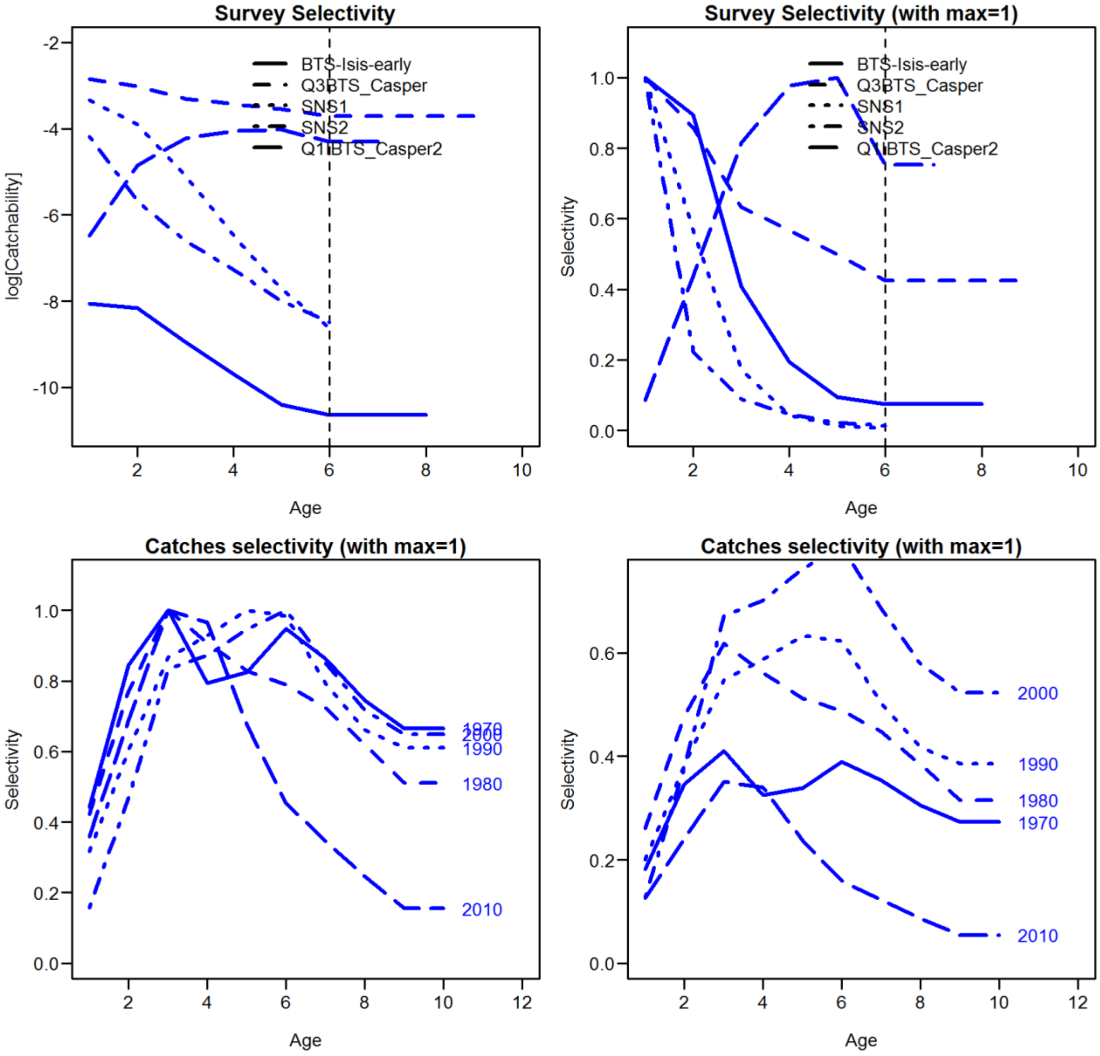


Figure 110. Run 11: survey selectivities (top panels) and selectivities catches (lower panels). Blue lines indicate the assessment that uses the WGNSSK 2016 reconstruction.

Figures run 11 (1957-2015, 6, 9, 6, 26, 2, BTS-Isis early, BTS combined new, SNS1 ages 1-6, SNS2 ages 1-6, IBTSQ1, removed historic discards estimates above age 7 that were assumed zero)

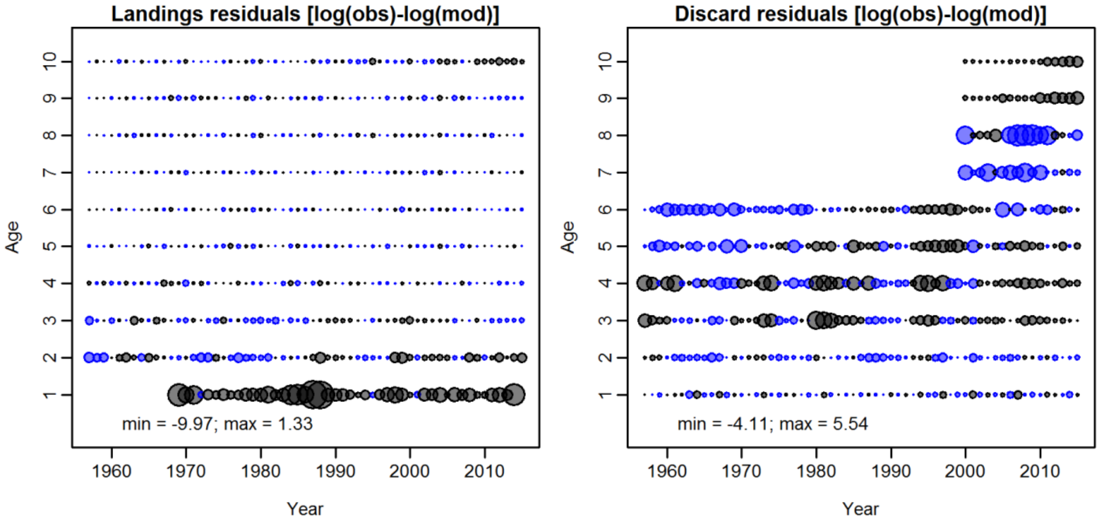


Figure 111. Run 11: Landings residuals (left panel) and discards residuals (right panel). Blue bubbles positive residuals (observations greater than model), and black bubbles indicate negative residuals (observations less than model). Assessment with WGNSSK 2016 discards estimates being used.

Figures run 11 (1957-2015, 6, 9, 6, 26, 2, BTS-Isis early, BTS combined new, SNS1 ages 1-6, SNS2 ages 1-6, IBTSQ1, removed historic discards estimates above age 7 that were assumed zero)

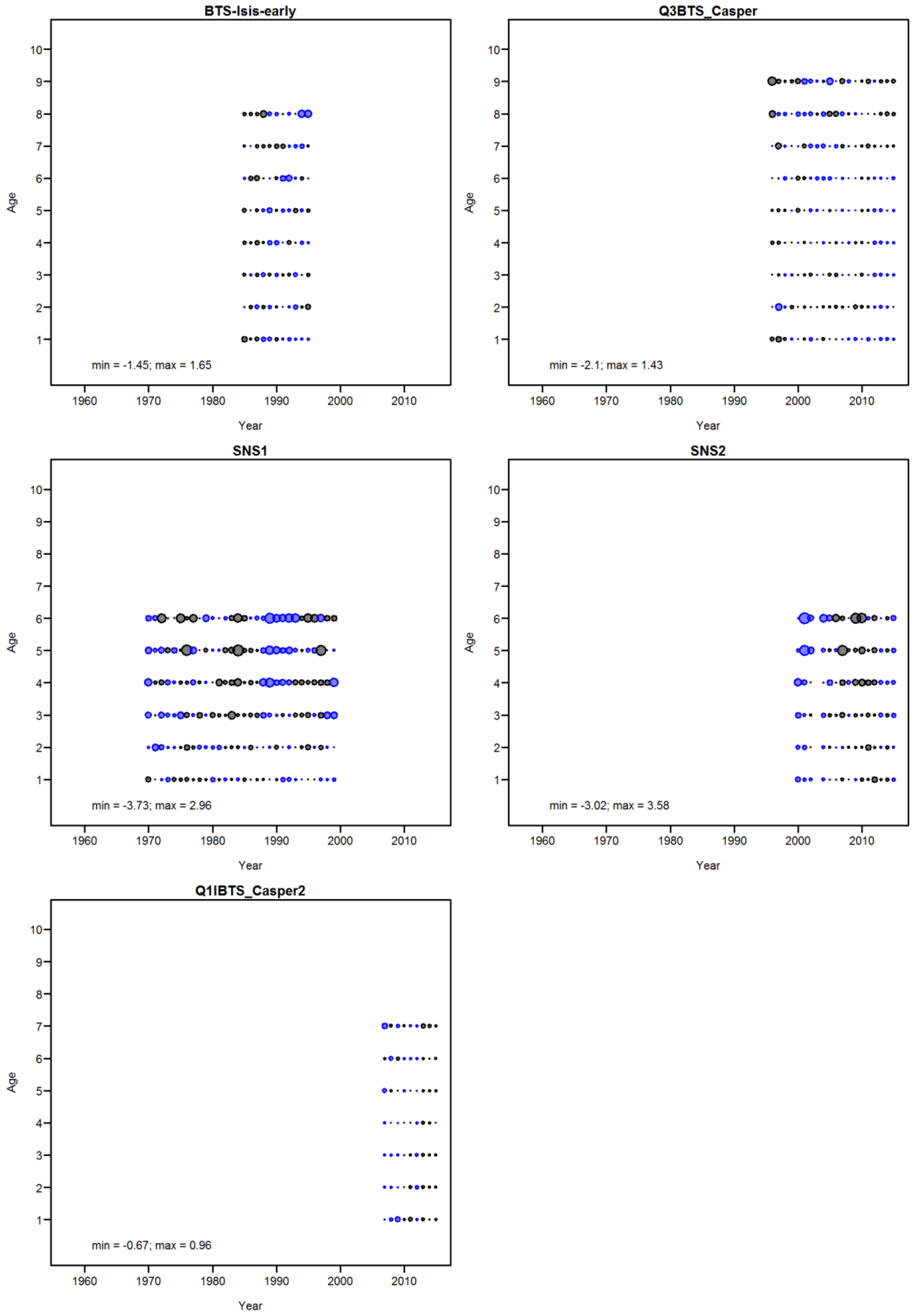


Figure 112. Run 11: Survey residuals for model using WGNSSK 2016 discards reconstruction. Blue bubbles indicate positive residuals (observations greater than model), and black bubbles indicate negative residuals (observations less than model).

Figures run 11 (1957-2015, 6, 9, 6, 26, 2, BTS-Isis early, BTS combined new, SNS1 ages 1-6, SNS2 ages 1-6, IBTSQ1, removed historic discards estimates above age 7 that were assumed zero)

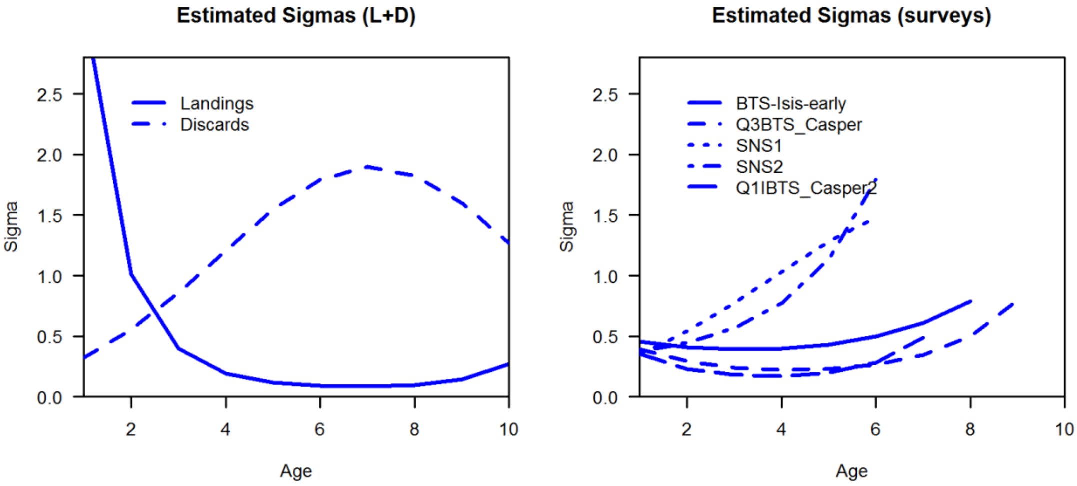


Figure 73. Run 113: Estimated age-dependent sigmas for the different likelihood components.

Figures run 11 (1957-2015, 6, 9, 6, 26, 2, BTS-Isis early, BTS combined new, SNS1 ages 1-6, SNS2 ages 1-6, IBTSQ1, removed historic discards estimates above age 7 that were assumed zero)

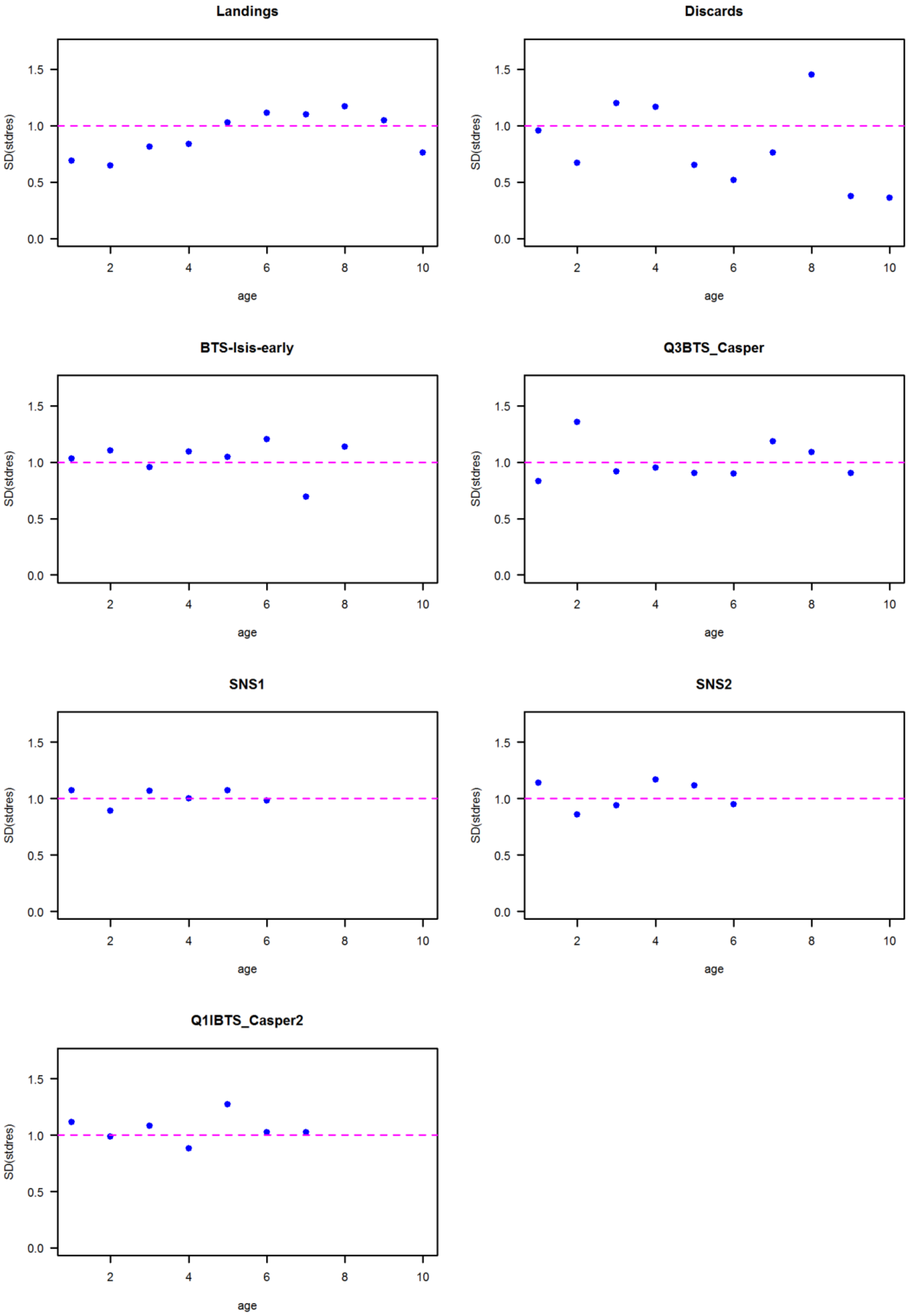


Figure 114. Run 11: SDs of standardized residuals (for discards estimates from WGNSSK 2016 assessment).

Figures run 11 (1957-2015, 6, 9, 6, 26, 2, BTS-Isis early, BTS combined new, SNS1 ages 1-6, SNS2 ages 1-6, IBTSQ1, removed historic discards estimates above age 7 that were assumed zero)

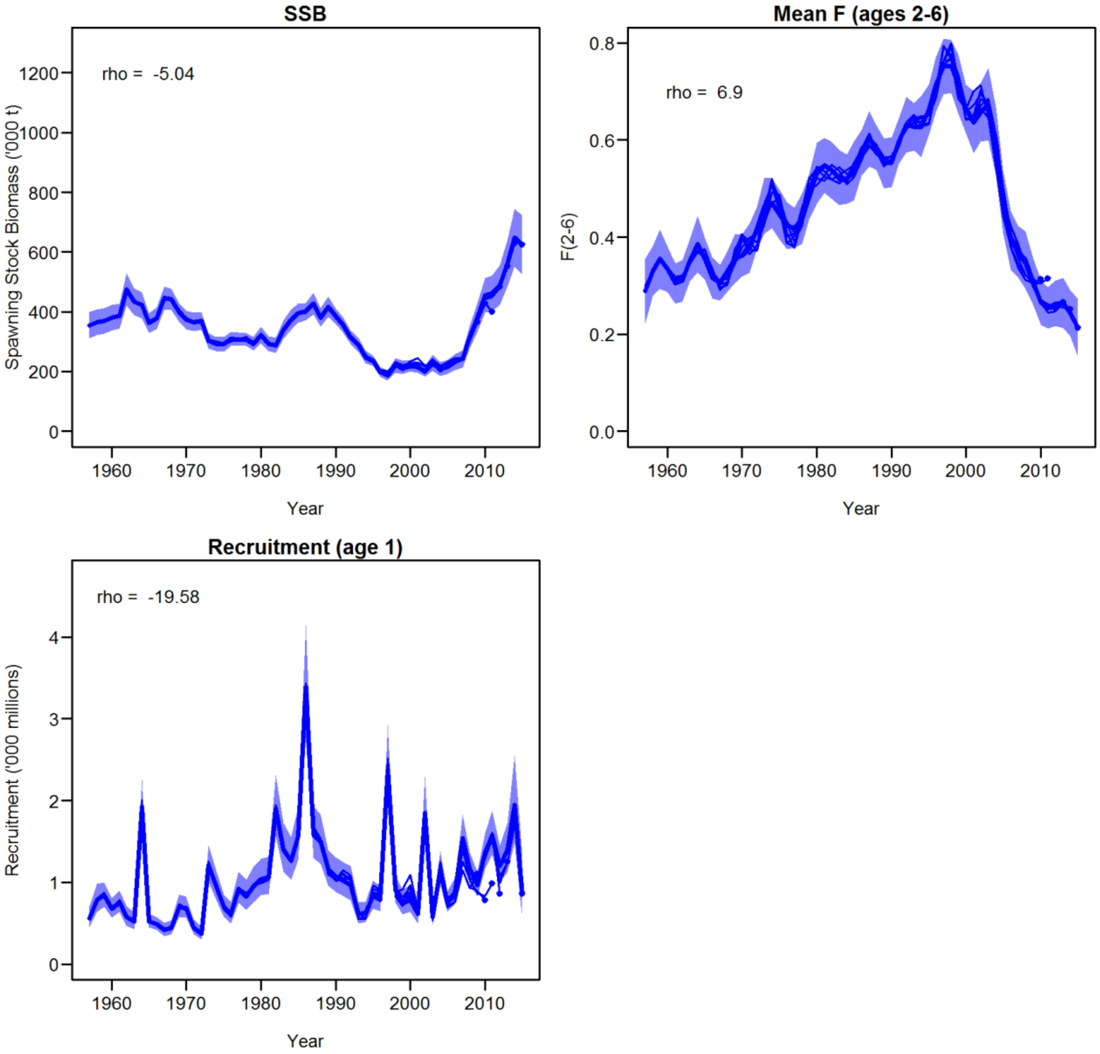


Figure 115. Run 11: Retro (for discards estimates from WGNSSK 2016 assessment).

Figures run 12 (1957-2015, 7, 9, 6, 22, 2, BTS-Isis early, BTS combined new, SNS1 ages 1-6, SNS2 ages 1-6, IBTSQ1, IBTSQ3, removed historic discards estimates above age 7 that were assumed zero)

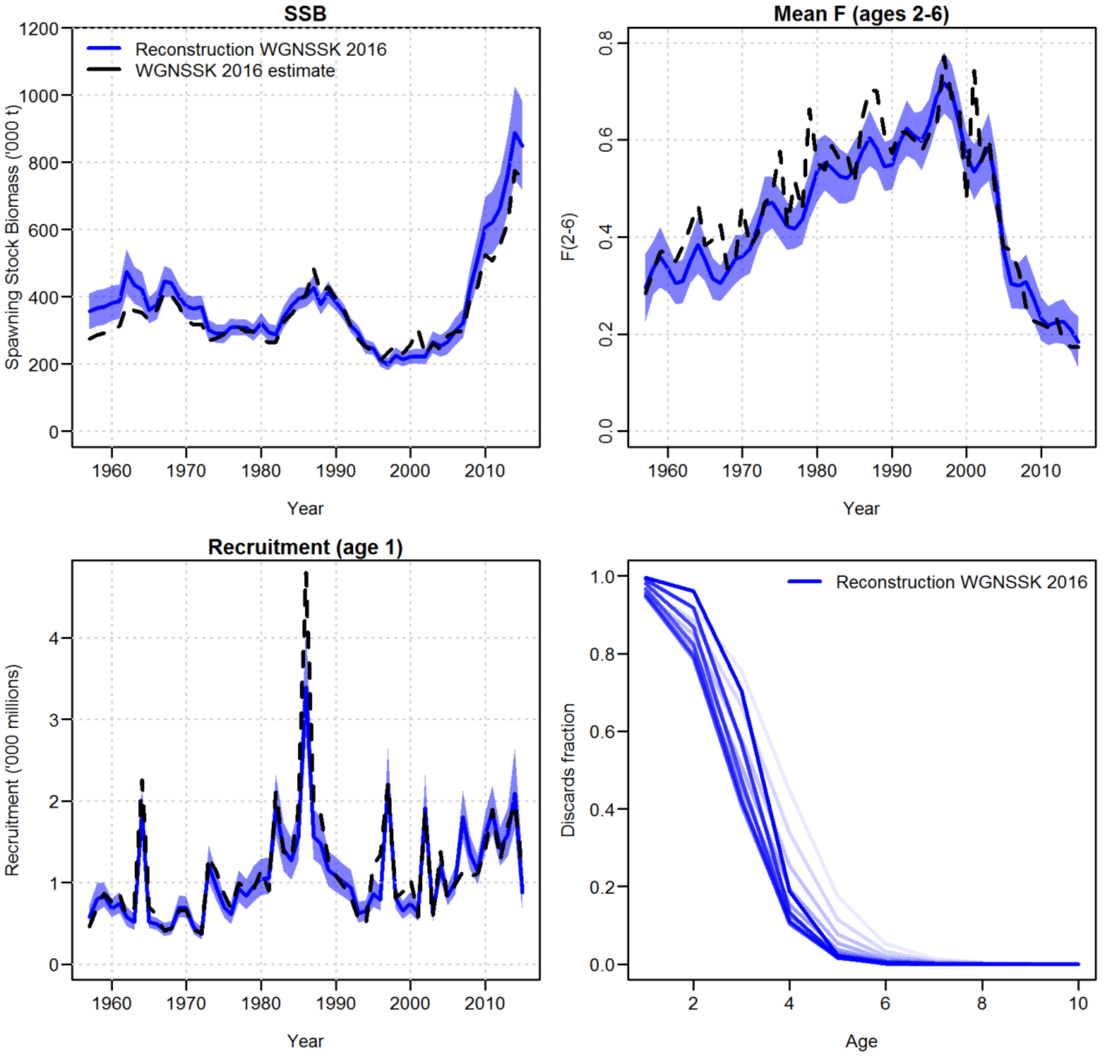


Figure 116. Run 12: Summary plot of assessment runs, without internal discards reconstruction, including the WGNSSK 2016 estimates.

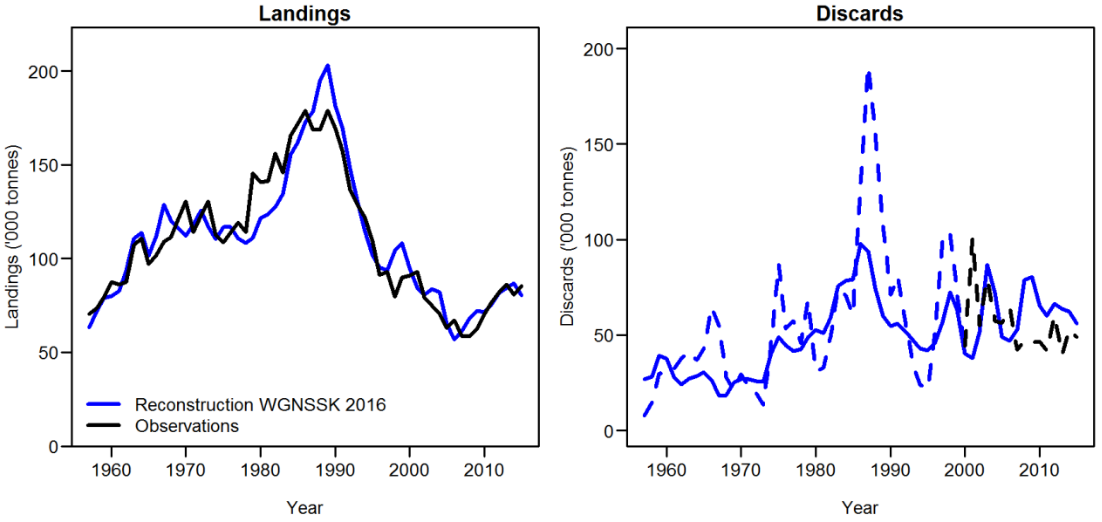


Figure 117. Run 12: Landings and discards estimates of first assessment runs, without internal discards reconstruction, including the WGNSSK 2016 estimates.

Figures run 12 (1957-2015, 7, 9, 6, 22, 2, BTS-Isis early, BTS combined new, SNS1 ages 1-6, SNS2 ages 1-6, IBTSQ1, IBTSQ3, removed historic discards estimates above age 7 that were assumed zero)

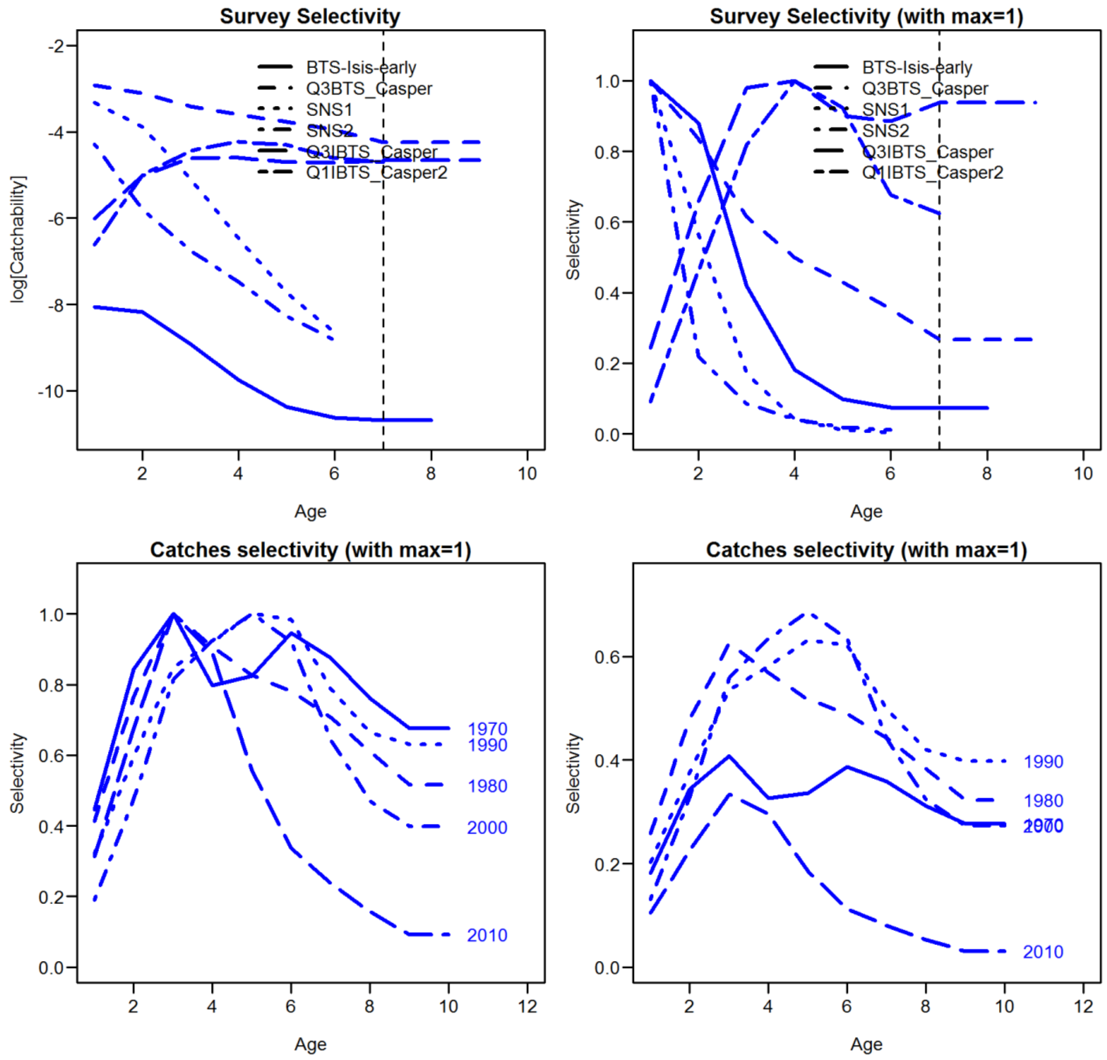


Figure 118. Run 12: survey selectivities (top panels) and selectivities catches (lower panels). Blue lines indicate the assessment that uses the WGNSSK 2016 reconstruction.

Figures run 12 (1957-2015, 7, 9, 6, 22, 2, BTS-Isis early, BTS combined new, SNS1 ages 1-6, SNS2 ages 1-6, IBTSQ1, IBTSQ3, removed historic discards estimates above age 7 that were assumed zero)

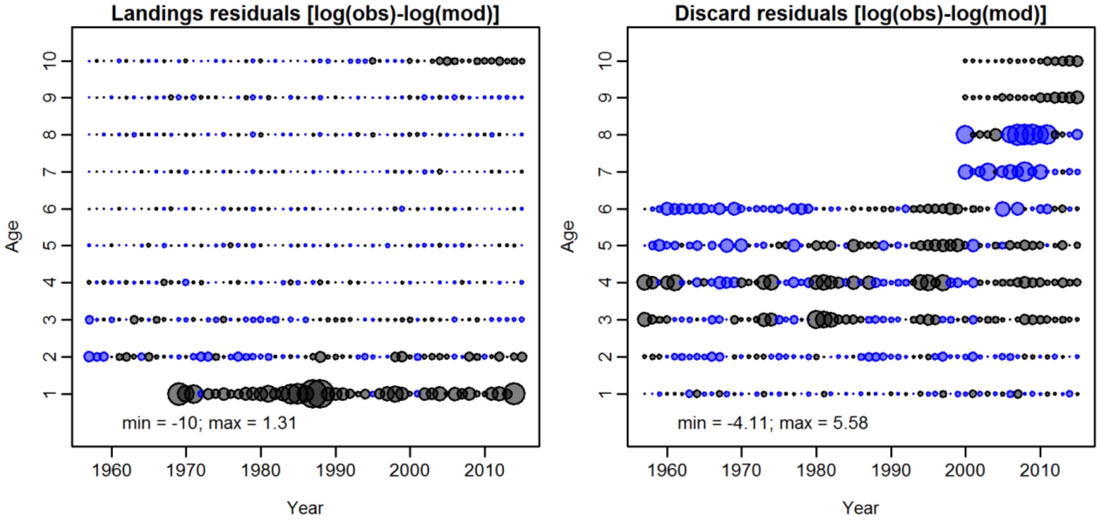


Figure 119. Run 12: Landings residuals (left panel) and discards residuals (right panel). Blue bubbles positive residuals (observations greater than model), and black bubbles indicate negative residuals (observations less than model). Assessment with WGNSSK 2016 discards estimates being used.

Figures run 12 (1957-2015, 7, 9, 6, 22, 2, BTS-Isis early, BTS combined new, SNS1 ages 1-6, SNS2 ages 1-6, IBTSQ1, IBTSQ3, removed historic discards estimates above age 7 that were assumed zero)

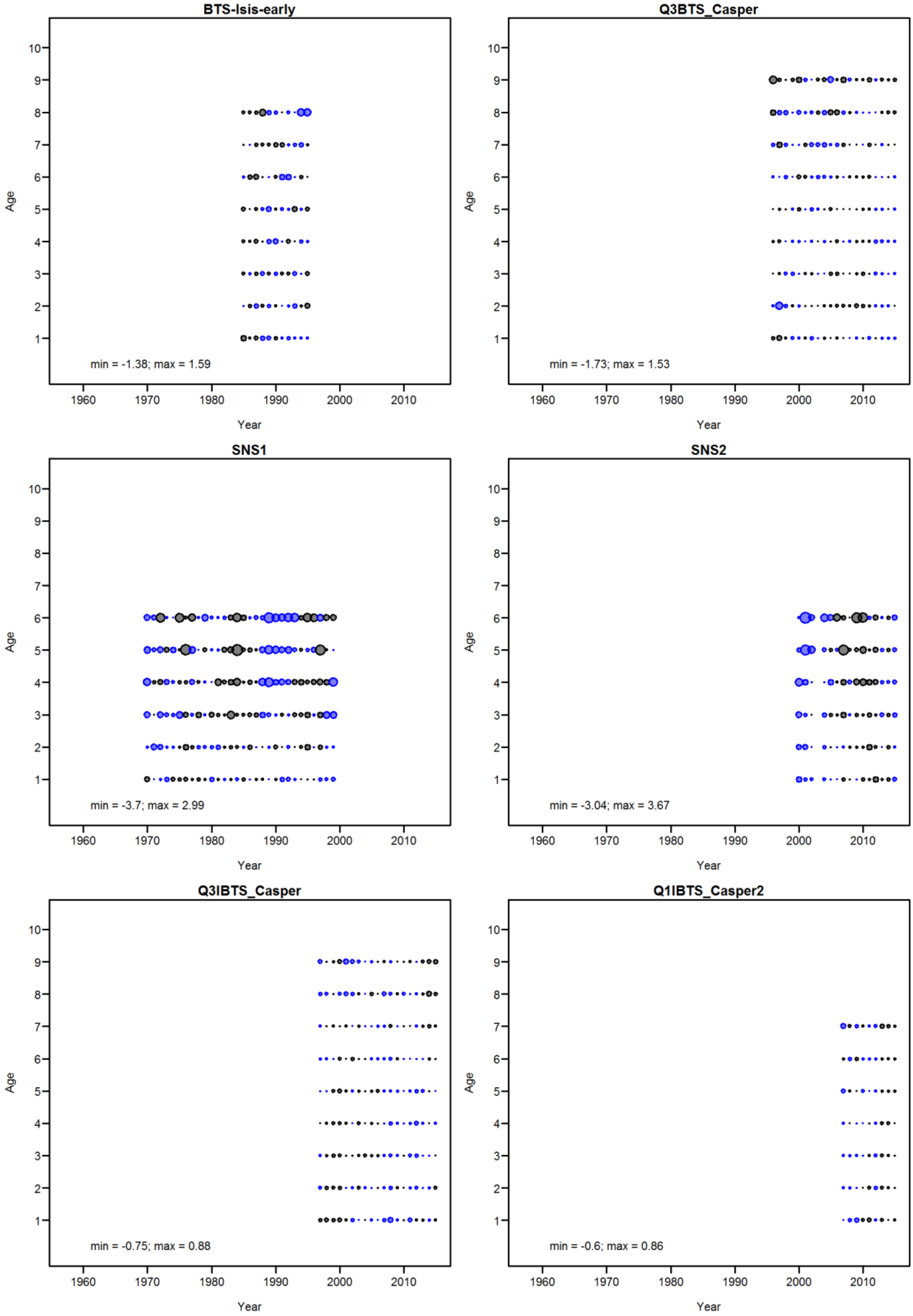


Figure 120. Run 12: Survey residuals for model using WGNSSK 2016 discards reconstruction. Blue bubbles indicate positive residuals (observations greater than model), and black bubbles indicate negative residuals (observations less than model).

Figures run 12 (1957-2015, 7, 9, 6, 22, 2, BTS-Isis early, BTS combined new, SNS1 ages 1-6, SNS2 ages 1-6, IBTSQ1, IBTSQ3, removed historic discards estimates above age 7 that were assumed zero)

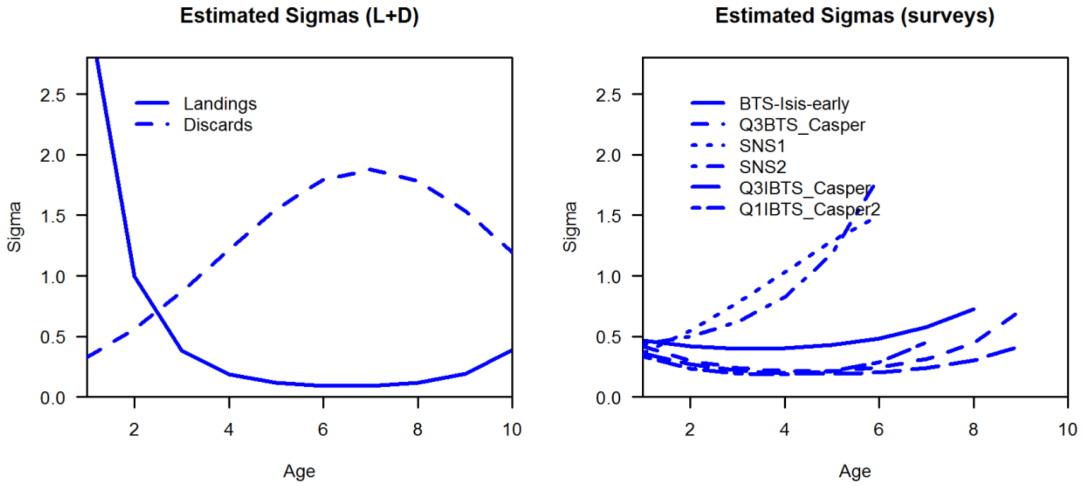


Figure 121. Run 12: Estimated age-dependent sigmas for the different likelihood components.

Figures run 12 (1957-2015, 7, 9, 6, 22, 2, BTS-Isis early, BTS combined new, SNS1 ages 1-6, SNS2 ages 1-6, IBTSQ1, IBTSQ3, removed historic discards estimates above age 7 that were assumed zero)

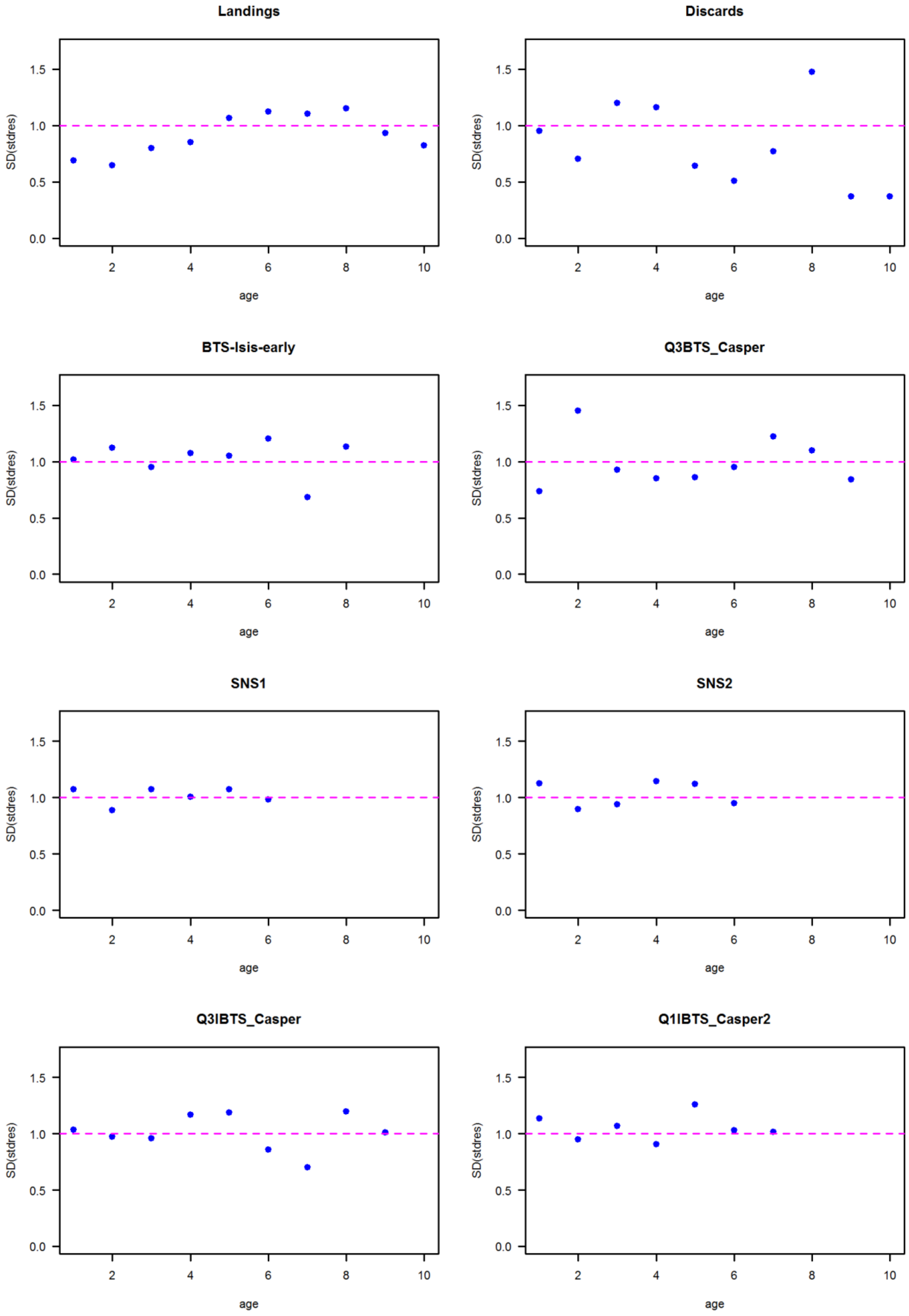


Figure 122. Run 12: SDs of standardized residuals (for discards estimates from WGNSSK 2016 assessment).

Figures run 12 (1957-2015, 7, 9, 6, 22, 2, BTS-Isis early, BTS combined new, SNS1 ages 1-6, SNS2 ages 1-6, IBTSQ1, IBTSQ3, removed historic discards estimates above age 7 that were assumed zero)

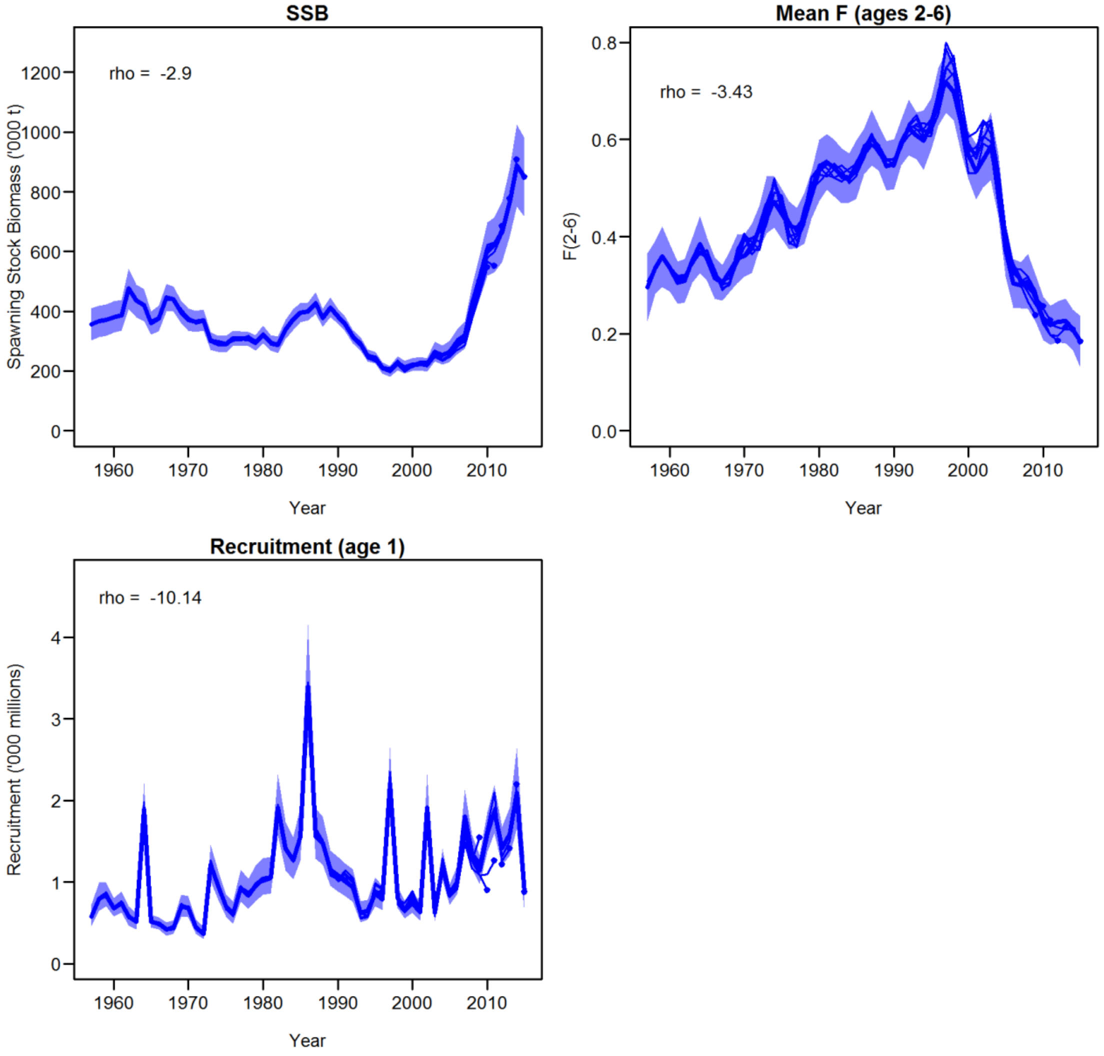


Figure 123. Run 12: Retro (for discards estimates from WGNSSK 2016 assessment).

Figures run 13 (1957-2015, 6, 9, 6, 22, 2, BTS-Isis early, BTS combined new, SNS1 ages 1-6, SNS2 ages 1-6, IBTSQ1, IBTSQ3, starting time variant discards at year 43 (2000))

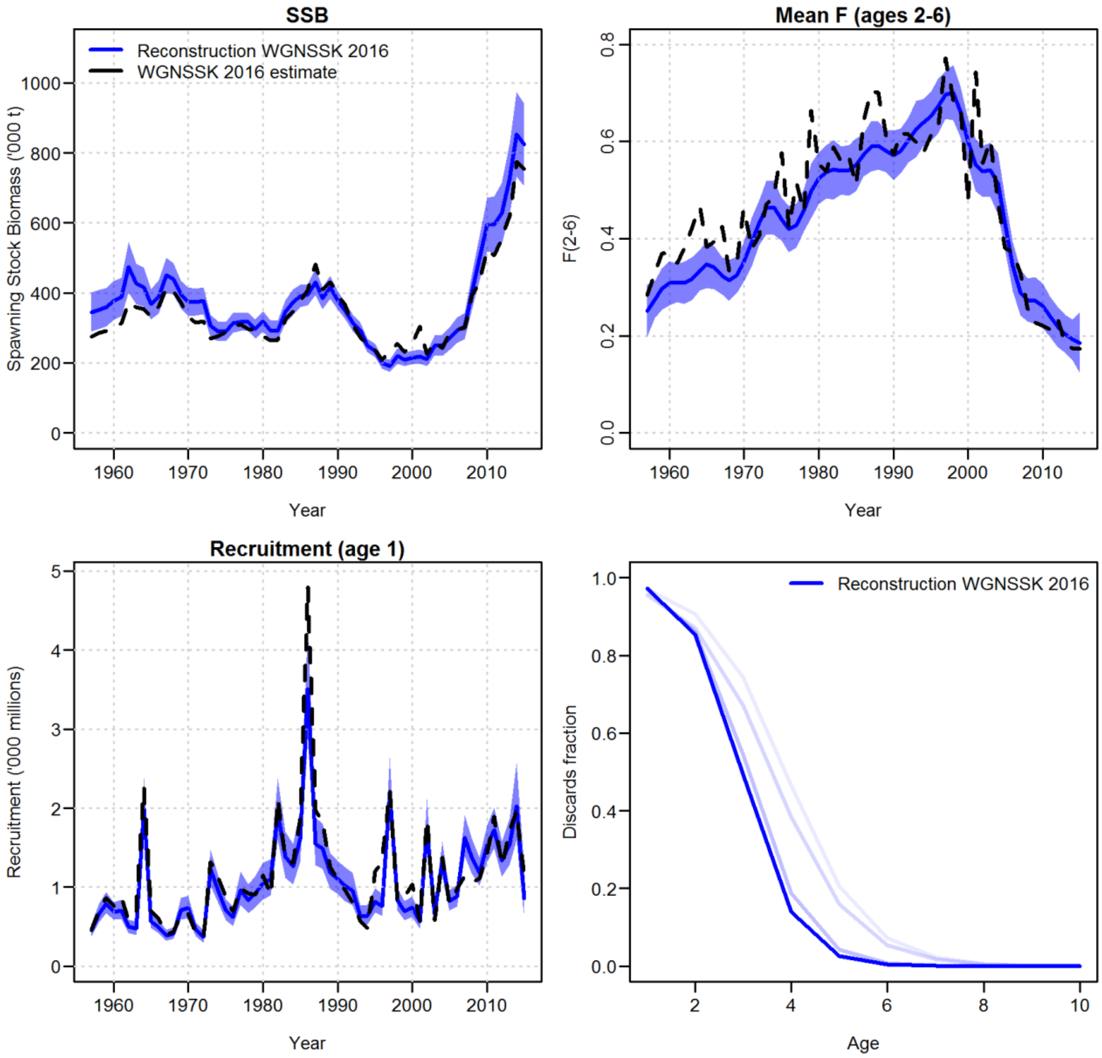


Figure 124. Run 13: Summary plot of assessment runs, without internal discards reconstruction, including the WGNSSK 2016 estimates.

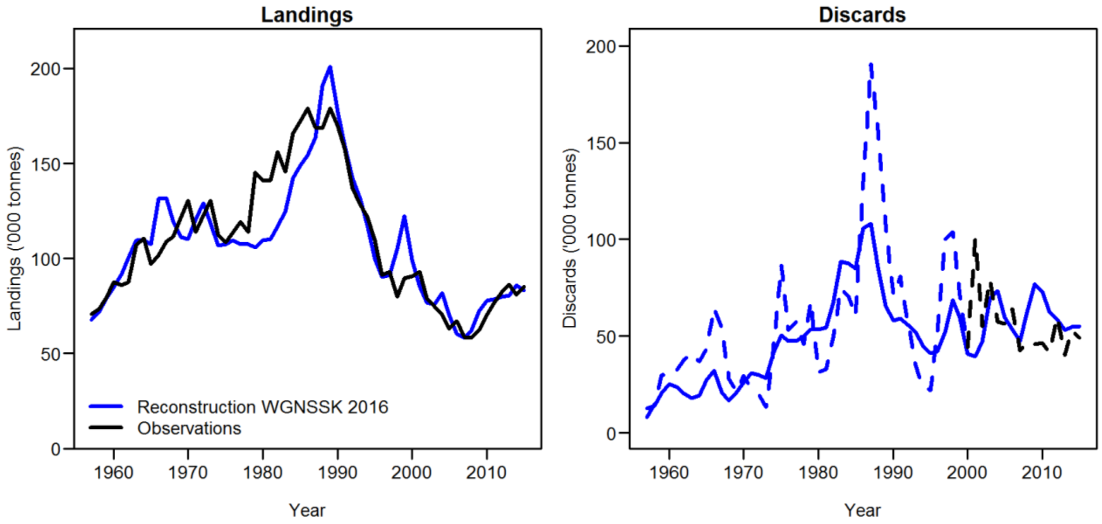


Figure 125. Run 13: Landings and discards estimates of first assessment runs, without internal discards reconstruction, including the WGNSSK 2016 estimates.

Figures run 15 (1957-2015, 6, 9, 6, 26, 2, BTS-Isis early, BTS combined new, SNS1 ages 1-6, SNS2 ages 1-6, IBTSQ1, IBTSQ3, simplified assessment)

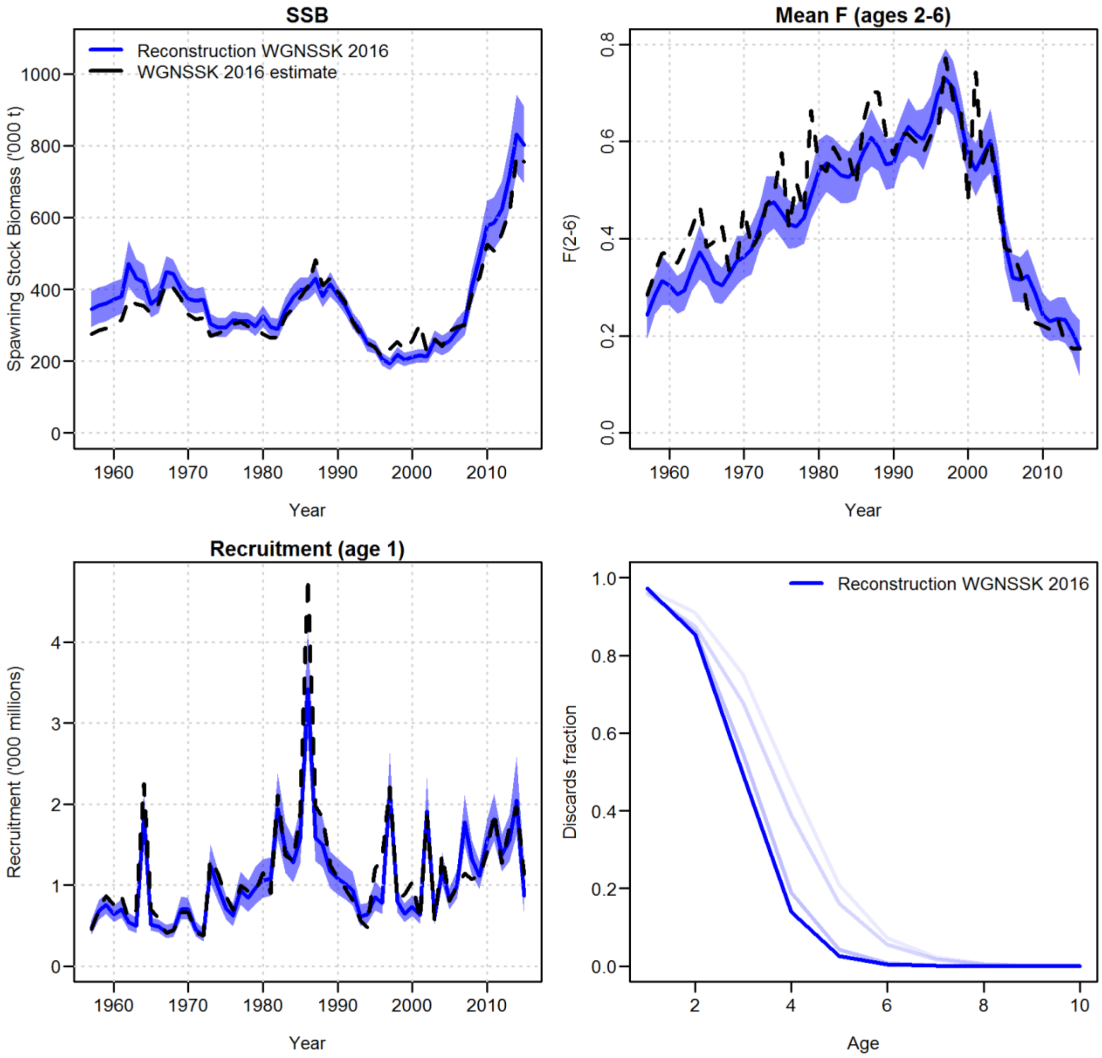


Figure 126. Run 14: Summary plot of assessment runs, without internal discards reconstruction, including the WGNSSK 2016 estimates.

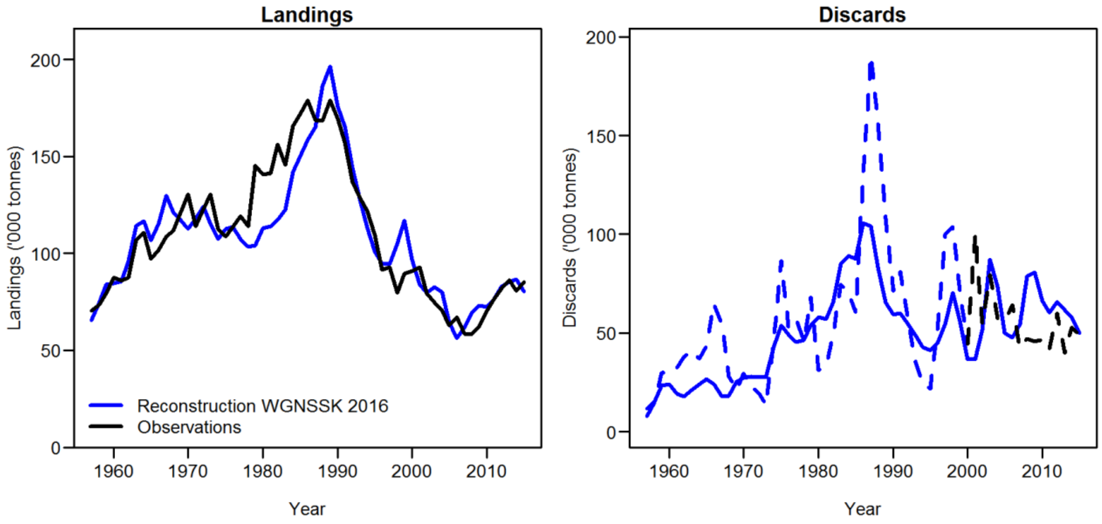


Figure 127. Run 14: Landings and discards estimates of first assessment runs, without internal discards reconstruction, including the WGNSSK 2016 estimates.

Figures run 15 (1957-2015, 6, 9, 6, 26, 2, BTS-Isis early, BTS combined new, SNS1 ages 1-6, SNS2 ages 1-6, IBTSQ1, IBTSQ3, simplified assessment)

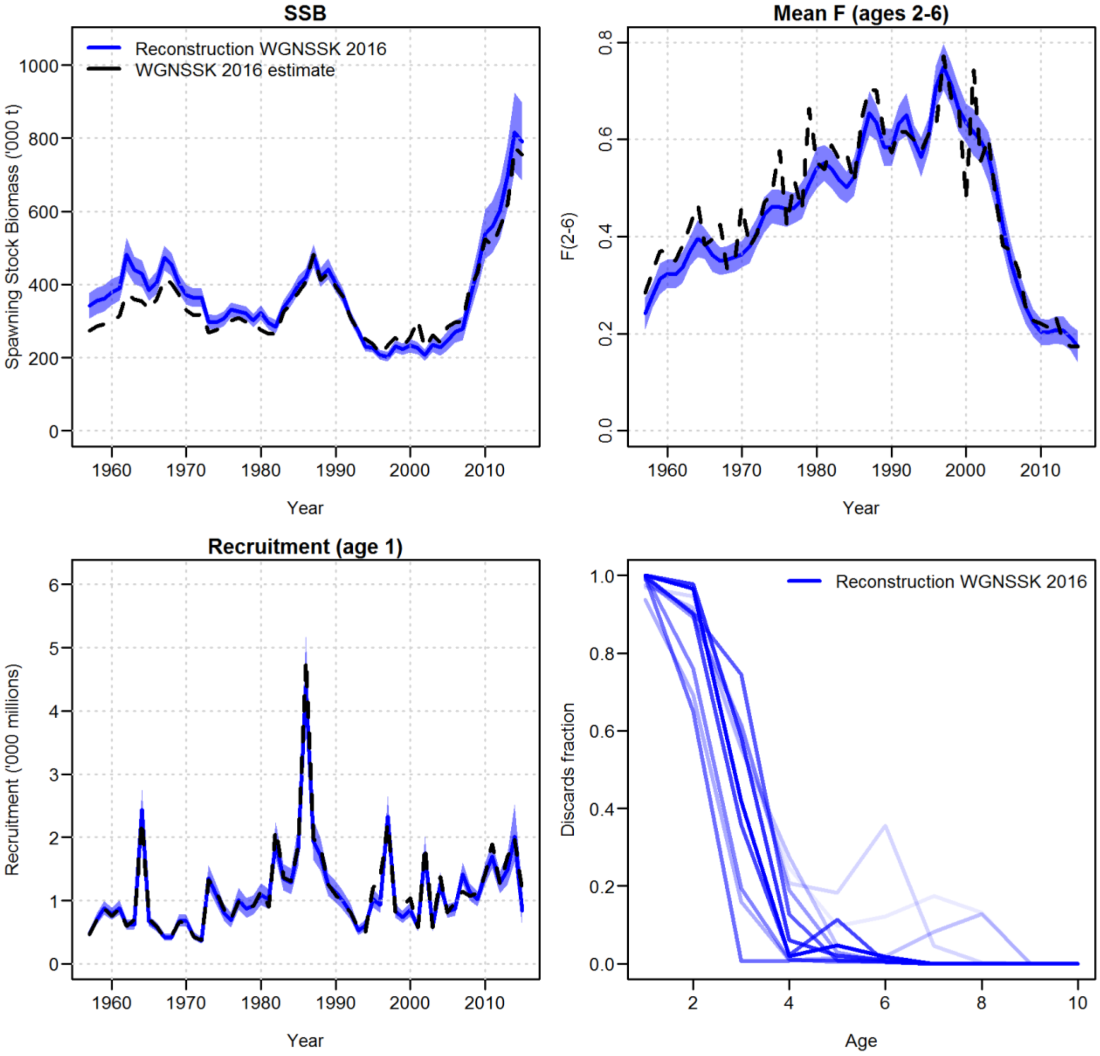


Figure 128. Run 15: Summary plot of assessment runs, without internal discards reconstruction, including the WGNSSK 2016 estimates.

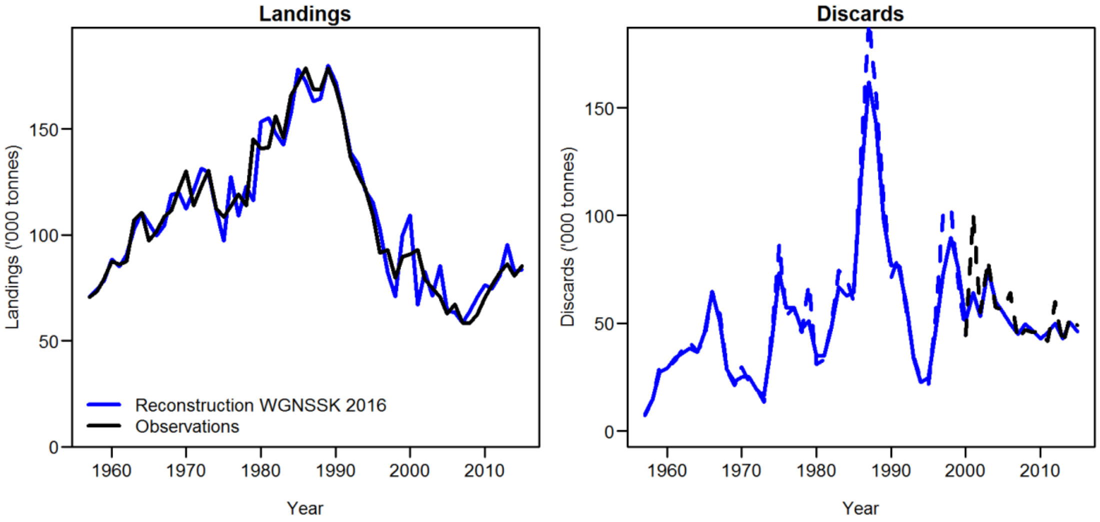


Figure 129. Run 15: Landings and discards estimates of first assessment runs, without internal discards reconstruction, including the WGNSSK 2016 estimates.

Figures run 15 (1957-2015, 6, 9, 6, 26, 2, BTS-Isis early, BTS combined new, SNS1 ages 1-6, SNS2 ages 1-6, IBTSQ1, IBTSQ3, simplified assessment)

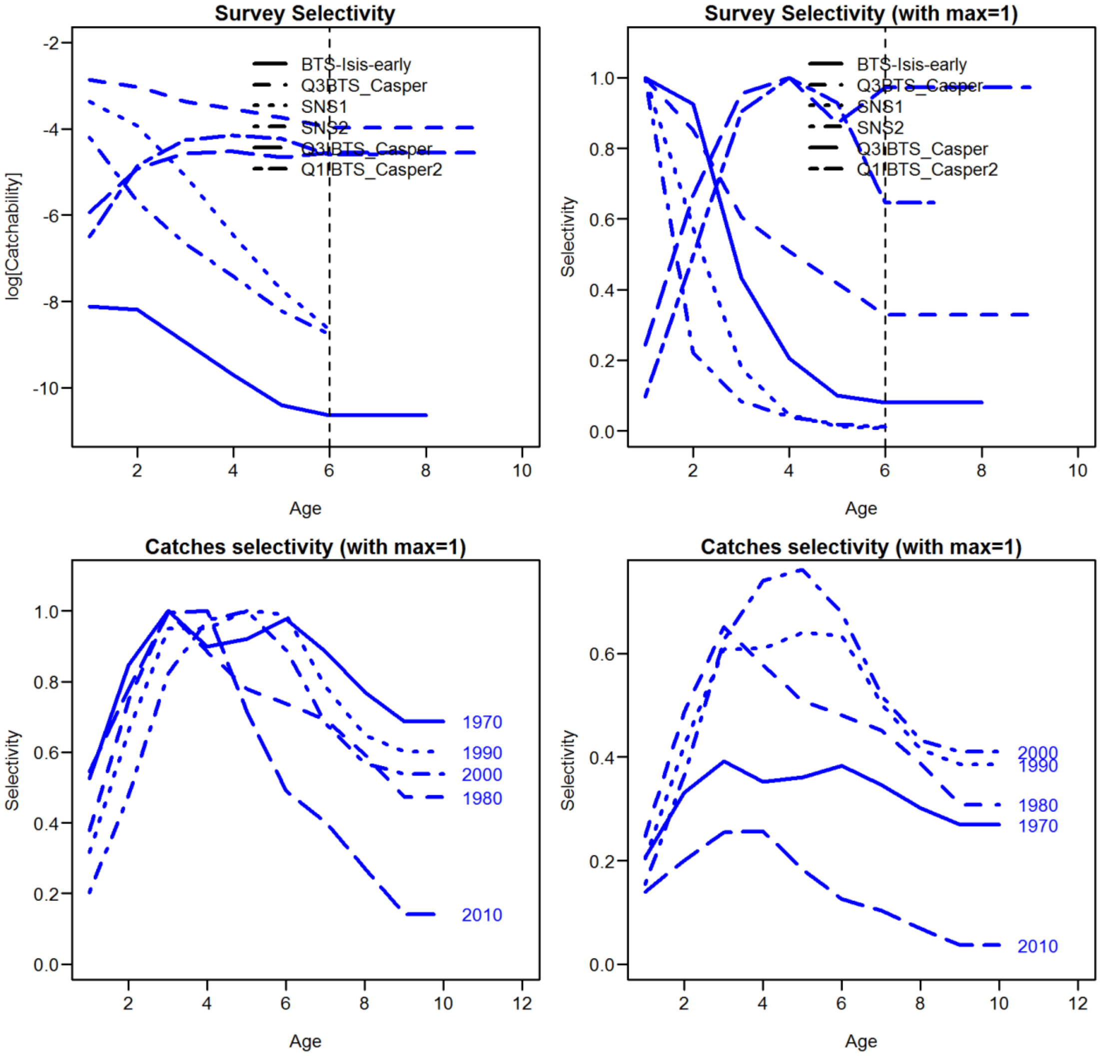


Figure 130. Run 13: survey selectivities (top panels) and selectivities catches (lower panels). Blue lines indicate the assessment that uses the WGNSSK 2016 reconstruction.

Figures run 15 (1957-2015, 6, 9, 6, 26, 2, BTS-Isis early, BTS combined new, SNS1 ages 1-6, SNS2 ages 1-6, IBTSQ1, IBTSQ3, simplified assessment)

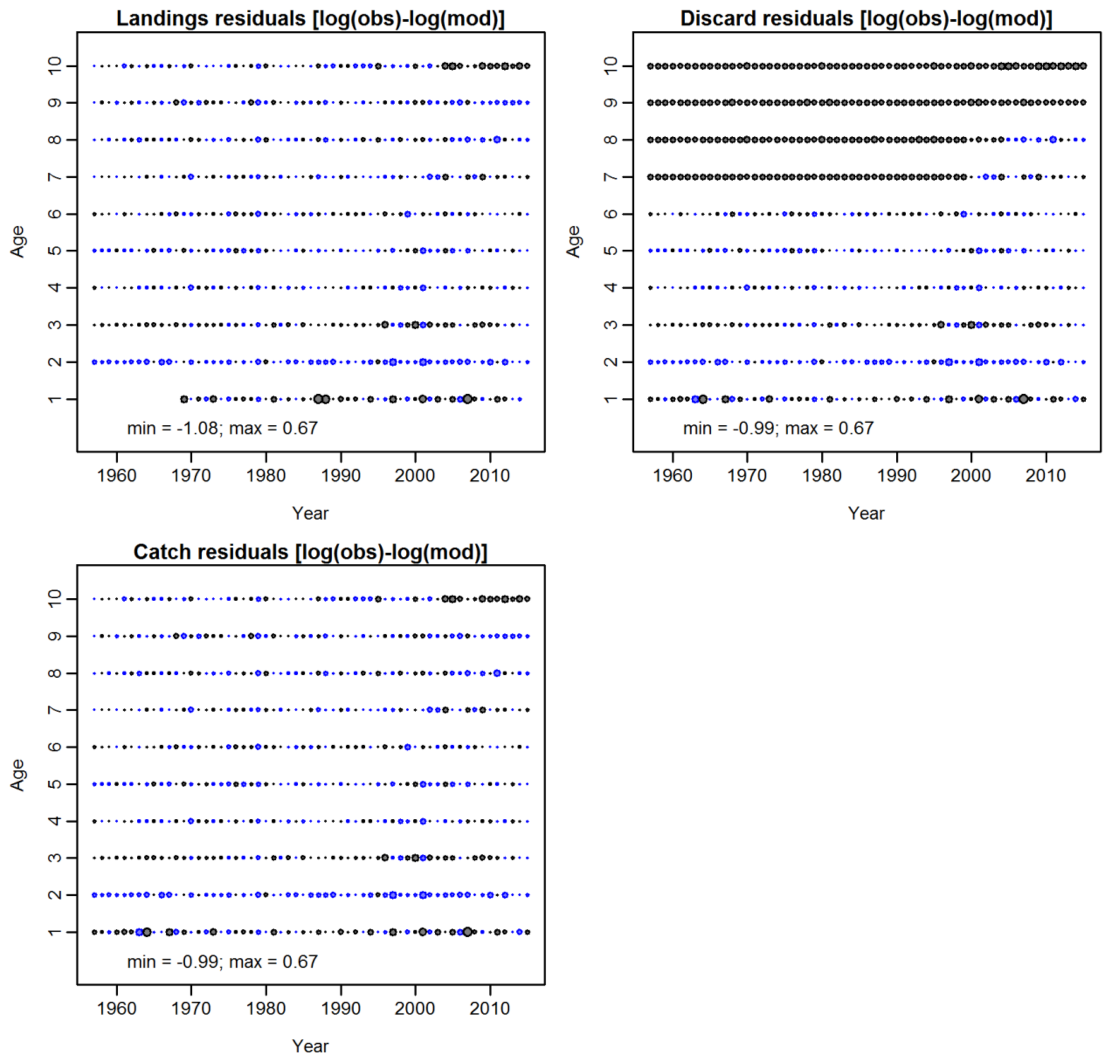


Figure 131. Run 15: Landings residuals (left panel) and discards residuals (right panel). Blue bubbles positive residuals (observations greater than model), and black bubbles indicate negative residuals (observations less than model). Assessment with WGNSSK 2016 discards estimates being used.

Figures run 15 (1957-2015, 6, 9, 6, 26, 2, BTS-Isis early, BTS combined new, SNS1 ages 1-6, SNS2 ages 1-6, IBTSQ1, IBTSQ3, simplified assessment)

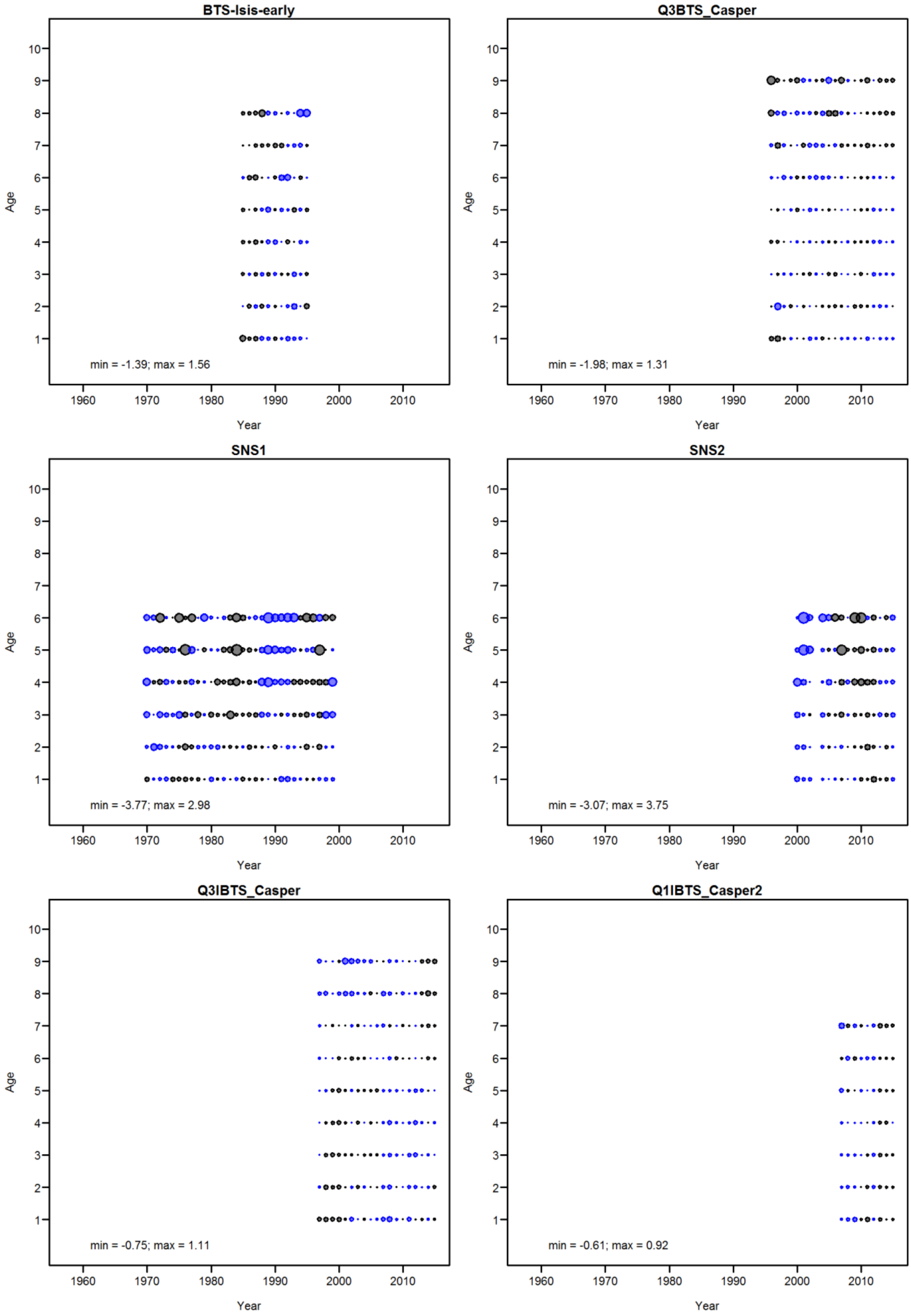


Figure 132. Run 15: Survey residuals for model using WGNSSK 2016 discards reconstruction. Blue bubbles indicate positive residuals (observations greater than model), and black bubbles indicate negative residuals (observations less than model).

Figures run 15 (1957-2015, 6, 9, 6, 26, 2, BTS-Isis early, BTS combined new, SNS1 ages 1-6, SNS2 ages 1-6, IBTSQ1, IBTSQ3, simplified assessment)

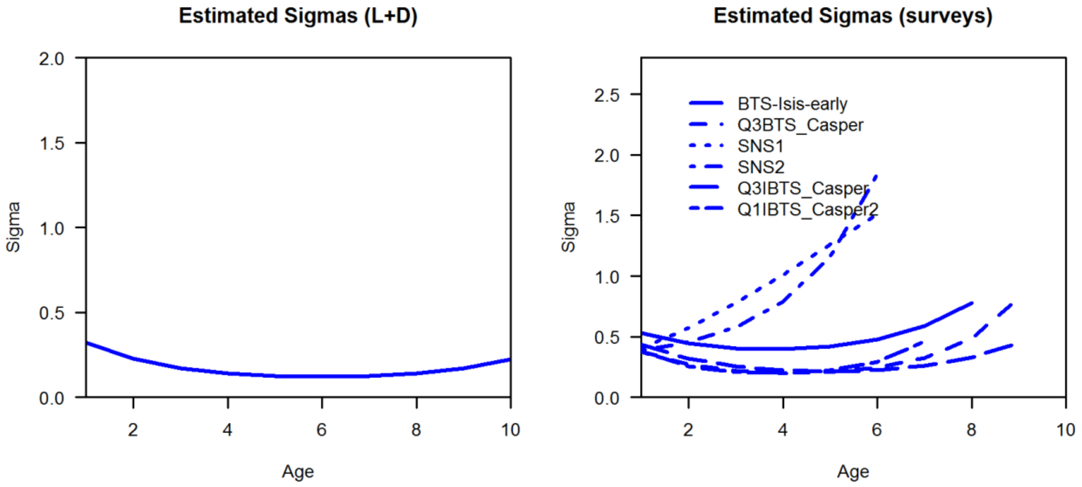


Figure 133. Run 15: Estimated age-dependent sigmas for the different likelihood components.

Figures run 15 (1957-2015, 6, 9, 6, 26, 2, BTS-Isis early, BTS combined new, SNS1 ages 1-6, SNS2 ages 1-6, IBTSQ1, IBTSQ3, simplified assessment)

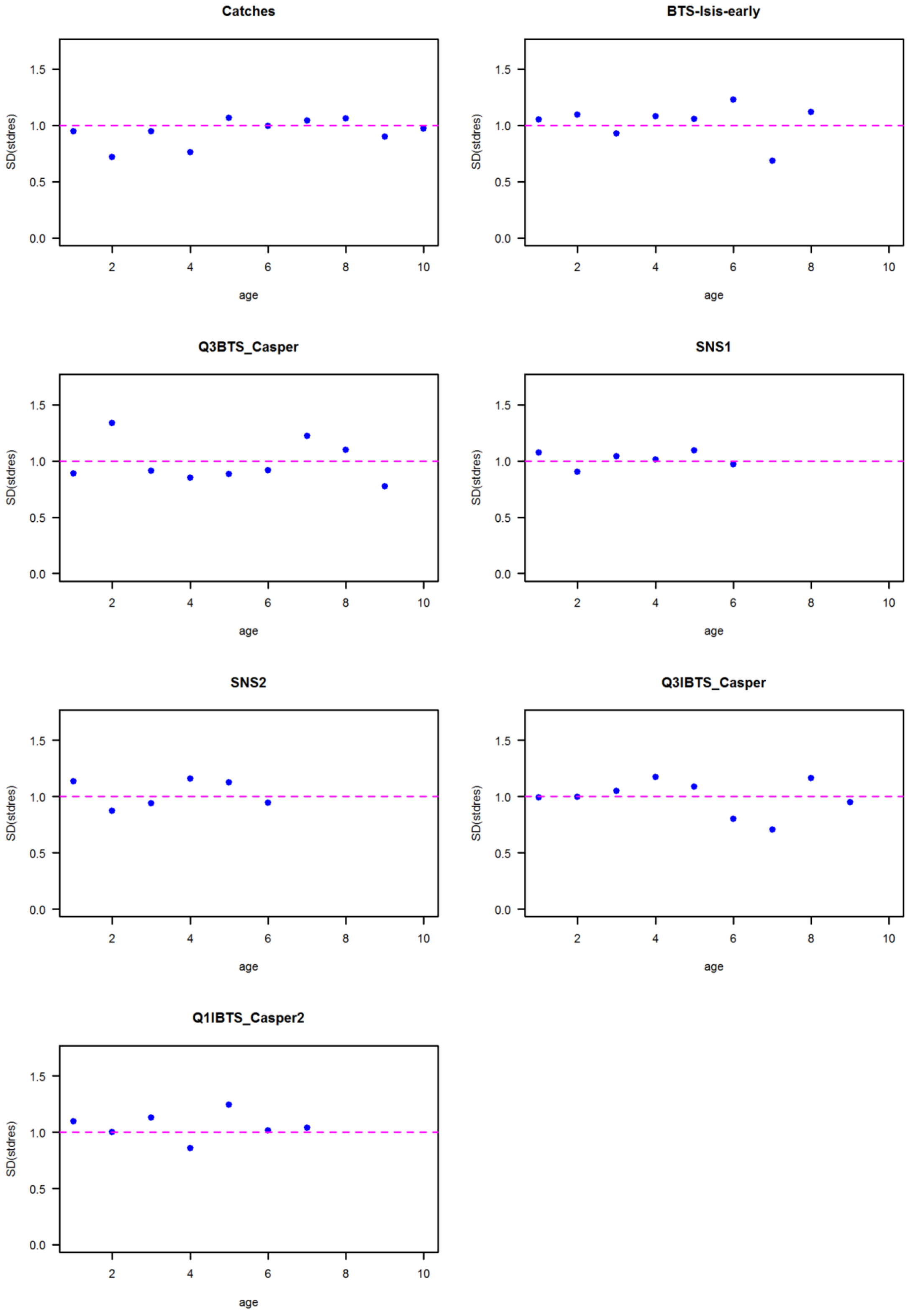


Figure 134. Run 15: SDs of standardized residuals (for discards estimates from WGNSSK 2016 assessment).

Figures run 15 (1957-2015, 6, 9, 6, 26, 2, BTS-Isis early, BTS combined new, SNS1 ages 1-6, SNS2 ages 1-6, IBTSQ1, IBTSQ3, simplified assessment)

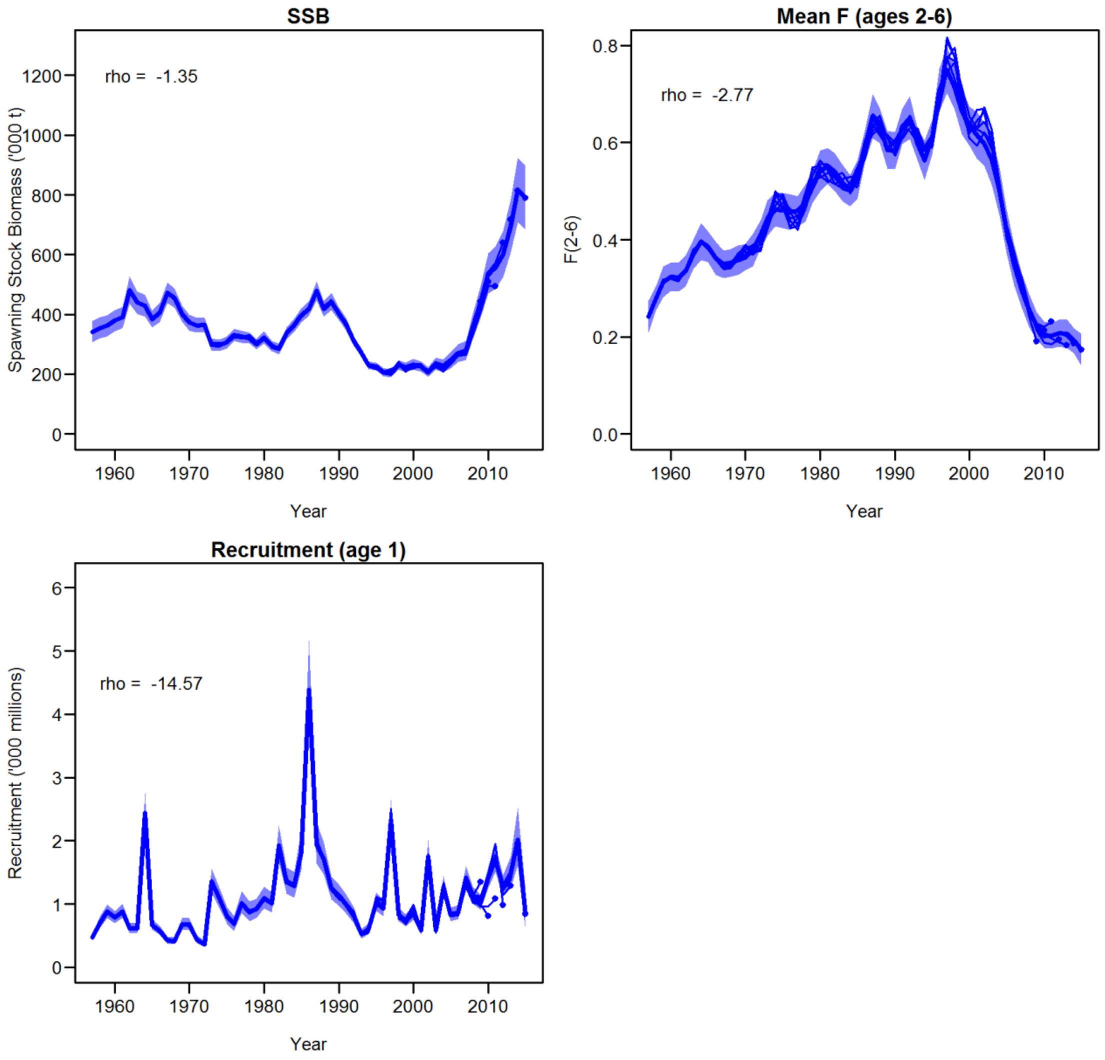


Figure 135. Run 15: Retro (for discards estimates from WGNSSK 2016 assessment).

8.8 Tables

Table 1. Summary of exploratory runs with different model settings (associated with runs 1-7)

reconstruct	startyr		Nll comp	Nll comp	Nll comp	Nll comp	Nll comp	Nll comp	Sum nll	df	SSB 2015	F 2015	Rho SSB	Rho F	Rho R
BTS-Isis-early BTS-Combined SNS1 SNS2															
Orig	1957	6 9 6 26 2 1	53.7	933.5	59.9	25.0	267.8	133.3	1473.2	272	907	0.16	-1.7	7.5	-27.5
Orig	1957	6 9 6 30 2 1	18.5	925.0	58.4	24.4	266.9	133.4	1426.6	296	931	0.16	-4.1	12.4	-29.0
Orig	1957	7 9 6 26 -1 1	60.9	1010.1	58.6	17.2	268.2	131.8	1546.8	268	1051	0.10	-10.0	9.6	-28.1
Orig	1957	7 9 6 26 2 1	56.5	932.7	59.7	22.6	267.8	133.1	1472.4	272	946	0.15	-6.9	11.5	-28.7
Orig	1957	7 9 6 26 2 25	67.2	931.7	58.9	18.9	267.2	132.5	1476.4	272	1064	0.13	-9.5	6.4	-29.8
Orig	1957	7 9 6 28 -1 1	33.5	1009.8	56.3	17.3	267.7	132.4	1517.0	280	1151	0.09	-18.4	20.0	-30.7
Orig	1957	7 9 6 28 2 1	29.9	932.8	57.5	22.0	267.1	133.9	1443.2	284	1049	0.15	-15.9	21.5	-31.3
Orig	1957	7 9 6 28 2 25	39.7	930.2	56.7	19.1	266.2	133.0	1444.9	284	1188	0.12	-18.8	16.4	-32.7
Orig	1957	7 9 6 30 -1 1	26.0	1002.4	56.8	16.5	267.4	131.9	1501.0	292	1077	0.10	-12.4	14.8	-29.5
Orig	1957	7 9 6 30 2 1	21.6	924.0	58.1	21.7	266.9	133.2	1425.5	296	979	0.15	-9.2	16.8	-30.2
Orig	1957	7 9 6 30 2 25	32.2	921.7	57.4	18.2	265.8	132.4	1427.7	296	1103	0.12	-11.7	10.9	-31.3
Orig	1970	7 9 6 26 2 1	-37.5	706.2	57.6	22.9	268.4	132.7	1150.3	259	1085	0.14	-15.6	15.9	-32.6
Intern	1957	6 9 6 26 2 1	-64.1	230.7	59.6	40.2	262.8	133.3	662.5	272	797	0.19	-8.8	16.4	-31.9
Intern	1957	6 9 6 30 2 1	-100.0	226.7	58.6	42.1	259.0	132.8	619.2	296	794	0.19	-8.3	19.0	-32.9
Intern	1957	7 9 6 26 -1 1	-5.1	233.0	58.1	22.6	263.8	130.2	702.6	268	1043	0.11	-12.3	5.4	-25.6
Intern	1957	7 9 6 26 2 1	-65.7	230.7	59.8	41.7	262.8	132.8	662.1	272	785	0.19	-9.0	16.0	-31.8
Intern	1957	7 9 6 26 2 25	-63.0	231.5	60.6	38.2	260.3	131.5	659.1	272	793	0.17	-8.5	8.6	-31.1
Intern	1957	7 9 6 28 -1 1	-28.5	232.0	56.5	19.4	264.3	130.6	674.3	280	1165	0.11	-22.7	16.0	-28.9
Intern	1957	7 9 6 28 2 1	-112.3	230.7	59.2	59.0	262.6	132.1	631.3	284	714	0.21	0.6	9.9	-30.1
Intern	1957	7 9 6 28 2 25	-109.4	231.0	60.0	56.4	260.4	130.9	629.3	284	719	0.19	1.6	2.9	-29.5
Intern	1957	7 9 6 30 -1 1	-38.5	229.3	56.5	20.8	261.8	130.2	660.1	292	1081	0.12	-14.3	9.9	-27.1
Intern	1957	7 9 6 30 2 1	-103.3	226.6	58.9	45.4	259.0	132.2	618.8	296	771	0.20	-6.7	17.1	-32.5
Intern	1957	7 9 6 30 2 25	-101.0	227.5	59.3	42.6	256.4	130.9	615.7	296	777	0.18	-6.6	11.0	-32.1
Intern	1970	7 9 6 26 2 1	-125.4	222.3	60.1	63.4	263.9	130.6	614.9	259	699	0.20	6.6	5.7	-29.6
BTS-Isis-early BTS-Combined SNS															
Orig	1957	7 9 6 26 2 25	52.3	938.6	60.8	31.7		470.4	1553.8	263	762	0.15	-1.3	-2.9	-19.4
Orig	1957	7 9 6 30 2 1	8.0	928.5	59.8	35.2		471.9	1503.4	287	733	0.18	-3.6	5.6	-22.3
Orig	1957	7 9 6 30 2 25	17.7	928.7	59.3	30.6		470.9	1507.2	287	793	0.15	-4.5	-0.1	-21.6
Orig	1970	6 9 6 26 2 1	-53.3	710.1	59.7	41.2		474.5	1232.2	250	746	0.17	2.5	-4.4	-22.7
Orig	1970	7 9 6 26 2 1	-67.7	711.8	60.5	56.7		470.2	1231.5	250	658	0.19	13.0	-10.7	-19.9
Orig	1970	7 9 6 30 2 1	-90.9	705.6	60.7	65.7		469.1	1210.2	274	629	0.20	14.8	-11.0	-18.7
Intern	1957	7 9 6 26 2 25	-72.0	233.2	62.0	44.8		470.5	738.5	263	683	0.19	1.7	-7.1	-16.2
Intern	1957	7 9 6 30 2 1	-112.6	226.1	60.0	56.3		471.5	701.3	287	647	0.20	2.5	2.1	-25.4
Intern	1957	7 9 6 30 2 25	-113.5	229.2	60.4	53.0		468.6	697.7	287	655	0.20	4.9	-5.4	-18.5
Intern	1970	6 9 6 26 2 1	-111.6	228.4	60.0	61.9		439.1	677.8	250	764	0.16	19.5	-23.7	-3.6
Intern	1970	7 9 6 26 2 1	-115.3	228.3	60.3	65.3		437.9	676.5	250	738	0.16	22.6	-25.0	-2.8
intern	1970	7 9 6 30 2 1	-138.0	225.1	60.2	70.7		438.9	656.9	274	718	0.17	22.0	-24.2	-2.1

Tables

Table 2. Summary of exploratory runs with the model including different new survey indices (associated with runs 8-14).

Model structure			Sum nll								Nll components	df	SSB 2015	F2015	Rho SSB	Rho R	Rho F	Indices					
6	26	1	1026.0	31.0	585.7	60.4	29.2	217.4	102.4			272	854	0.157	-5.58	-26.91	6.00	BTS-Isis-early	BTS-Comb	SNS1	SNS2		
6	22	1	1059.9	64.4	583.8	59.5	32.1	217.5	102.6			248	862	0.158	-2.69	-26.43	-1.94	BTS-Isis-early	BTS-Comb	SNS1	SNS2		
6	26	1	1027.7	16.1	584.2	61.0	48.3	217.8	100.3			272	710	0.184	-2.87	-25.06	10.62	BTS-Isis-early	Q3BTS_all	SNS1	SNS2		
6	22	1	1059.1	48.3	582.3	60.8	49.2	218.0	100.5			248	719	0.190	-4.11	-24.69	4.16	BTS-Isis-early	Q3BTS_all	SNS1	SNS2		
6	22	1	1059.1	48.3	582.3	60.8	49.2	218.0	100.5			248	719	0.190	-4.11	-24.69	4.16	BTS-Isis-early	Q3BTS_all	SNS1	SNS2		
6	26	1	1060.4	25.1	587.7	60.9	49.1	219.7	105.6	12.2		281	852	0.181	6.07	-9.87	-8.62	BTS-Isis-early	Q3BTS_all	SNS1	SNS2	Q3IBTS	
6	26	1	1066.9	25.6	588.8	61.0	55.2	219.8	105.7	8.3	2.5	290	818	0.188	1.77	-9.41	-6.64	BTS-Isis-early	Q3BTS_all	SNS1	SNS2	Q3IBTS	Q1IBTS
6	26	1	1038.3	14.0	585.4	61.1	57.8	217.9	99.1	3.1		281	624	0.213	-5.04	-19.58	6.90	BTS-Isis-early	Q3BTS_all	SNS1	SNS2		Q1IBTS
6	22	1	1105.8	61.2	585.7	60.0	55.3	219.6	105.7	14.3	4.2	266	844	0.197	-1.23	-10.96	-4.65	BTS-Isis-early	Q3BTS_all	SNS1	SNS2	Q3IBTS	Q1IBTS
6	22	1	1071.6	47.9	583.1	60.7	57.5	218.0	99.1	5.3		257	636	0.219	-6.12	-21.89	6.28	BTS-Isis-early	Q3BTS_all	SNS1	SNS2		Q1IBTS
6	22	1	775.9	61.8	583.2	61.6	58.2	7.0	4.1			248	887	0.199	0.82	1.75	-7.05	BTS-Isis-early	Q3BTS_all			Q3IBTS	Q1IBTS
6	26	1	716.1	11.5	581.5	62.9	56.8	3.4				263	660	0.211	-2.18	-4.01	2.50	BTS-Isis-early	Q3BTS_all				Q1IBTS
7	22	1	1070.3	50.4	583.3	60.8	53.0	217.9	99.5	5.4		257	668	0.212	-9.59	-24.11	7.37	BTS-Isis-early	Q3BTS_all	SNS1	SNS2		Q1IBTS
7	26	1	1037.3	15.8	585.6	61.2	54.2	217.9	99.4	3.2		281	646	0.208	-8.09	-22.37	11.10	BTS-Isis-early	Q3BTS_all	SNS1	SNS2		Q1IBTS
7	26	1	1061.2	28.0	588.9	61.0	49.5	219.9	105.9	5.5	2.6	290	848	0.183	-2.90	-10.14	-3.43	BTS-Isis-early	Q3BTS_all	SNS1	SNS2	Q3IBTS	Q1IBTS
7	22	1	1099.6	64.5	585.7	59.9	49.1	219.6	106.2	10.5	4.1	266	904	0.189	-8.74	-12.53	1.14	BTS-Isis-early	Q3BTS_all	SNS1	SNS2	Q3IBTS	Q1IBTS
6	26	33	1067.2	32.7	580.6	61.0	54.4	219.7	105.3	10.8	2.7	290	829	0.184	1.74	-9.82	-7.69	BTS-Isis-early	Q3BTS_all	SNS1	SNS2	Q3IBTS	Q1IBTS
6	26	43	1075.2	38.3	582.5	61.1	55.9	220.2	105.3	10.2	1.7	290	801	0.173	1.77	-10.98	-18.06	BTS-Isis-early	Q3BTS_all	SNS1	SNS2	Q3IBTS	Q1IBTS
6	22	43	1114.0	74.0	579.1	60.1	55.6	219.9	105.3	16.4	3.6	266	823	0.186	-0.77	-12.10	-15.57	BTS-Isis-early	Q3BTS_all	SNS1	SNS2	Q3IBTS	Q1IBTS

Table 3. Summary of runs with the model where catches are used in the likelihood function rather than landings and discards (associated with run 15). Dark grey row indicates final run.

Model structure		Sum nll							Nll components	df	SSB 2015	F2015	Rho SSB	Rho R	Rho F	Indices					
6	22	290.27	-186.02	61.30	48.68	222.58	102.05	34.02	7.67	257	798	0.176	-0.91	-13.69	-4.37	BTS-Isis-early	Q3BTS_all	SNS1	SNS2	Q3IBTS	Q1IBTS
6	26	259.39	-214.62	62.66	47.57	223.48	101.41	30.90	8.00	281	790	0.173	-1.35	-14.57	-2.77	BTS-Isis-early	Q3BTS_all	SNS1	SNS2	Q3IBTS	Q1IBTS
6	26	206.49	-245.86	63.07	60.58	222.76	96.76	9.18		272	606	0.207	-1.85	-21.77	6.95	BTS-Isis-early	Q3BTS_all	SNS1	SNS2		Q1IBTS
6	26	247.47	-217.08	62.68	41.91	223.42	101.76	34.77		272	827	0.159	3.22	-16.86	-7.37	BTS-Isis-early	Q3BTS_all	SNS1	SNS2	Q3IBTS	

Survey Index Calculations for Plaice in the North Sea/Skagerrak from BTS and NS-IBTS data

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1 Summary

This documents describes a model for trawl catches of Plaice for the purpose of deriving survey indices by age using combined data from the NS-IBTS and BTS surveys in quarter 3. Also, an index using the NS-IBTS data from quarter 1 is estimated. This requires borrowing of age data from other years and areas since there are many years with no age data for Q1. This also facilitates the computation of external consistencies.

All the surveys considered seem useful for estimating age based abundance indices for plaice, given that they all give consistent estimates of increasing abundances since around 2005 and it is possible to follow cohorts within and between all surveys (based on rather high internal and external consistencies). It is possible to extend the Q1 index back to 1983 by extrapolating ALKs from other years/areas, and this does not seem to affect the internal consistencies. While Q3 IBTS and the combined BTS survey both provide rather good indices, combining BTS and IBTS yields even better consistencies than either of two in isolation. The choice of survey index model (constant or time-varying spatial effect, cutoff value k, Gamma or log-normal) has some effect also, but mostly on the younger age groups, and does not seem crucial.

2 ALKs

Spatially varying age length keys are estimated using the methodology described in [1]. Numbers-at-age are then calculated using the observed numbers-at-length and the estimated ALKs. This methodology was found to give internal consistency in survey indices for haddock when compared to current standard approach of estimating ALKs that are constant within “Roundfish” (RF) areas in [1]. It avoids ad-hoc borrowing of samples from neighbour RF areas, when certain age groups are missing, and it provides an objective fill-in procedure for missing length groups also. The methodology has been implemented in the DATRAS package with full source code available [3]

In the Q1 IBTS there are no age samples before 1991, and only from some Roundfish areas in the period from 1991–2006. This means that the Q1 survey series cannot be estimated before 2006 without using age samples from other years/areas.

The following model model for the continuation ratio logits is tried

$$\operatorname{logit}(\pi_{ay}) = \alpha_a + A_{a,y} + (\beta_a + B_{a,y})l_i + s_a(lon_i, lat_i)$$

where $\pi_a = P(Y = a|Y \geq a)$, i denotes the ith fish, l denotes the length of the fish, (lon, lat) the geographical coordinates where the haul was taken (longitude and latitude), and $A_{a,y}$ and $B_{a,y}$ are random yearly deviations in the intercept and slope (normal iid random effects). This model assumes a time-invariant spatial effect, and is able to predict an ALK in case of partly or completely missing age data.

	1	2	3	4	5	6	7	8
1991	0	0	0	0	0	0	0	156
1992	0	0	0	128	35	329	191	256
1993	0	0	0	60	27	324	100	447
1994	0	0	0	39	4	184	116	354
1995	0	0	0	0	0	0	0	362
1996	0	0	0	0	0	0	0	235
1997	0	0	0	0	0	0	0	317
1998	0	0	0	0	0	0	0	345
1999	0	0	0	0	0	0	0	563
2000	0	0	0	0	0	0	0	539
2001	0	7	0	39	51	419	0	278
2002	0	0	0	0	0	0	0	260
2003	0	0	0	91	0	158	108	274
2004	1	6	0	48	0	144	184	314
2005	0	10	0	0	0	142	138	444
2006	1	12	0	89	0	212	157	331
2007	2	7	106	106	22	512	212	524
2008	0	44	17	93	68	438	212	450
2009	4	91	61	128	253	794	490	272
2010	25	121	235	419	395	787	526	332
2011	82	169	230	354	291	776	497	216
2012	56	425	264	335	281	659	615	372
2013	33	202	121	164	288	677	365	340
2014	5	261	199	197	332	808	391	314
2015	24	242	255	216	332	749	302	446
2016	5	194	154	144	179	623	452	300

Table 1: Number of age samples by year and Roundfish area in IBTS Q1. There are no age-samples available before 1991.

	BTS	NS-IBTS
1990	143	0
1991	163	989
1992	4	362
1993	0	260
1994	0	261
1995	120	0
1996	588	304
1997	643	903
1998	871	822
1999	914	767
2000	1426	0
2001	1840	875
2002	3129	762
2003	3085	607
2004	2529	1554
2005	2414	1621
2006	1999	1989
2007	4021	2078
2008	2806	2503
2009	3231	2244
2010	4079	1379
2011	5064	2360
2012	5008	2931
2013	5124	2533
2014	3577	3019
2015	2987	2619
2016	2226	2772

Table 2: Number of age samples by year and survey (excluding BT4S and ABD gears) Q3

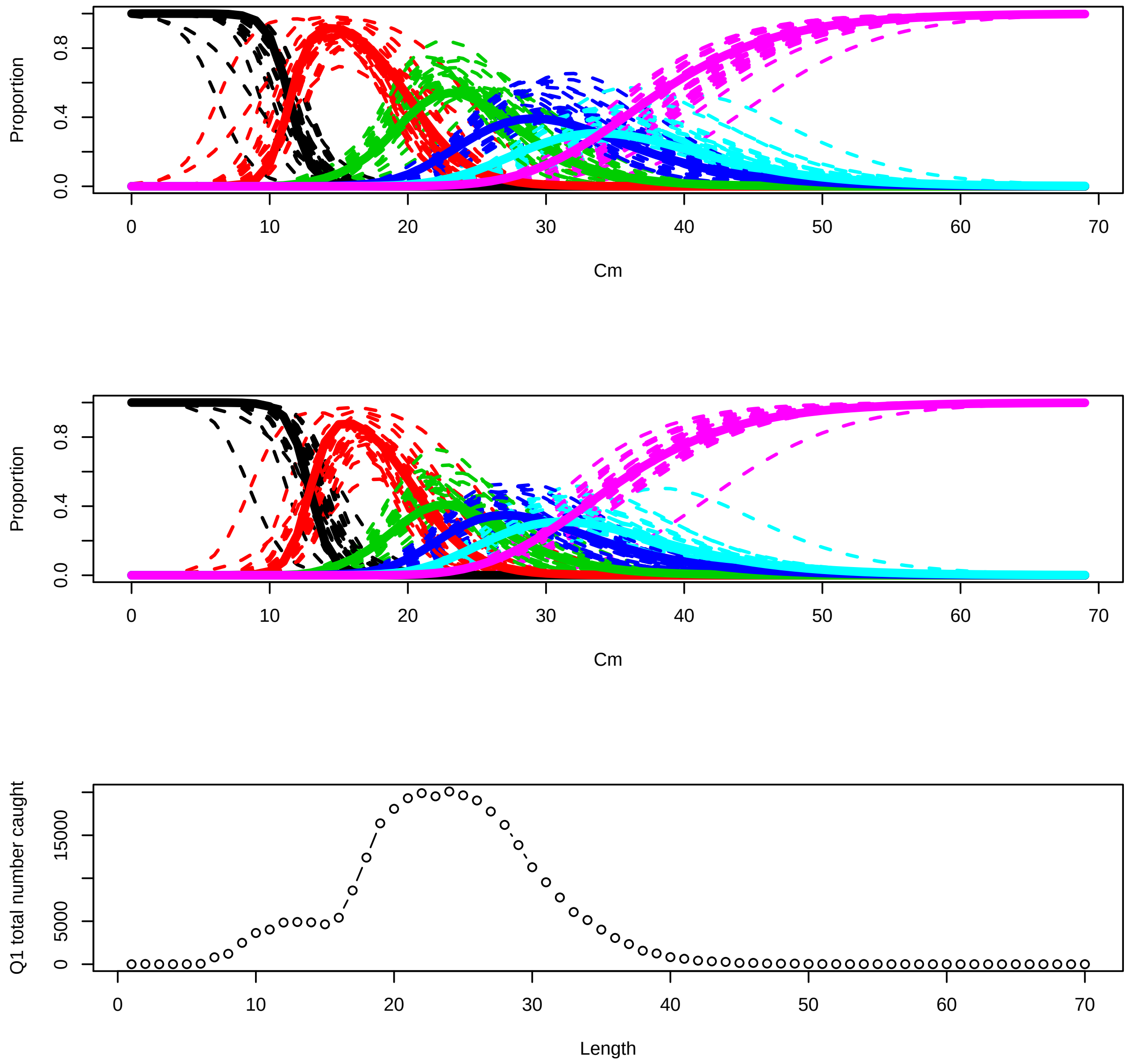


Figure 1: Q1 estimated age-length keys. Top: ALKs in different years in 44G0 (IIIa), Middle: ALKs in different years in 38F6. Bottom: Length distribution (all years). Fat solid lines in two top plots indicate the ALKs used in years with no age samples.

3 Index Areas

The precision of survey indices is likely to drop if large areas with nearly zero densities are included. Therefore the North-Eastern part of the North Sea has been excluded from the index calculations. This was done for both Q1 and Q3 data.

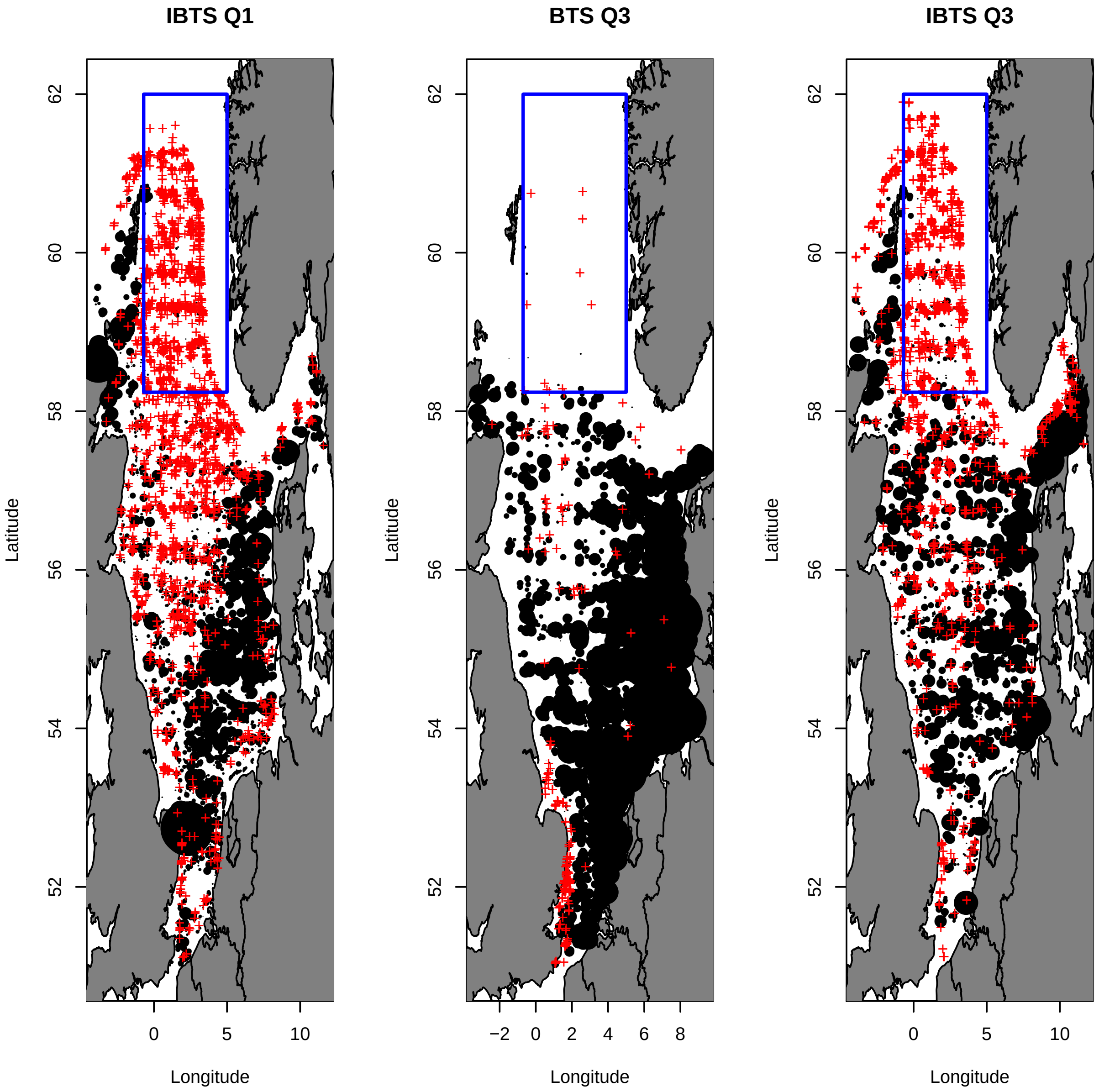


Figure 2: All hauls in the three Q3 surveys considered, sizes of bubbles are proportional to total catch weight. Red crosses represent zero catch hauls. The blue rectangle indicate excluded hauls.

4 Gear effects Q3

Four gear types have been used in the BTS (BT8,BT4A,BT7, and BT4S). BT4S has only been used in one year (2015) and slightly later in the year compared to the other gear types, so these are removed from the data. The number of hauls and in particular the number of age samples is significantly smaller prior to 1996, hence only data from 1996 and onwards are included in the analyses. While NS-IBTS Q3 data are available from 1991 and onwards, we consider only data from 1996 and onwards as for the BTS, and only the GOV gear.

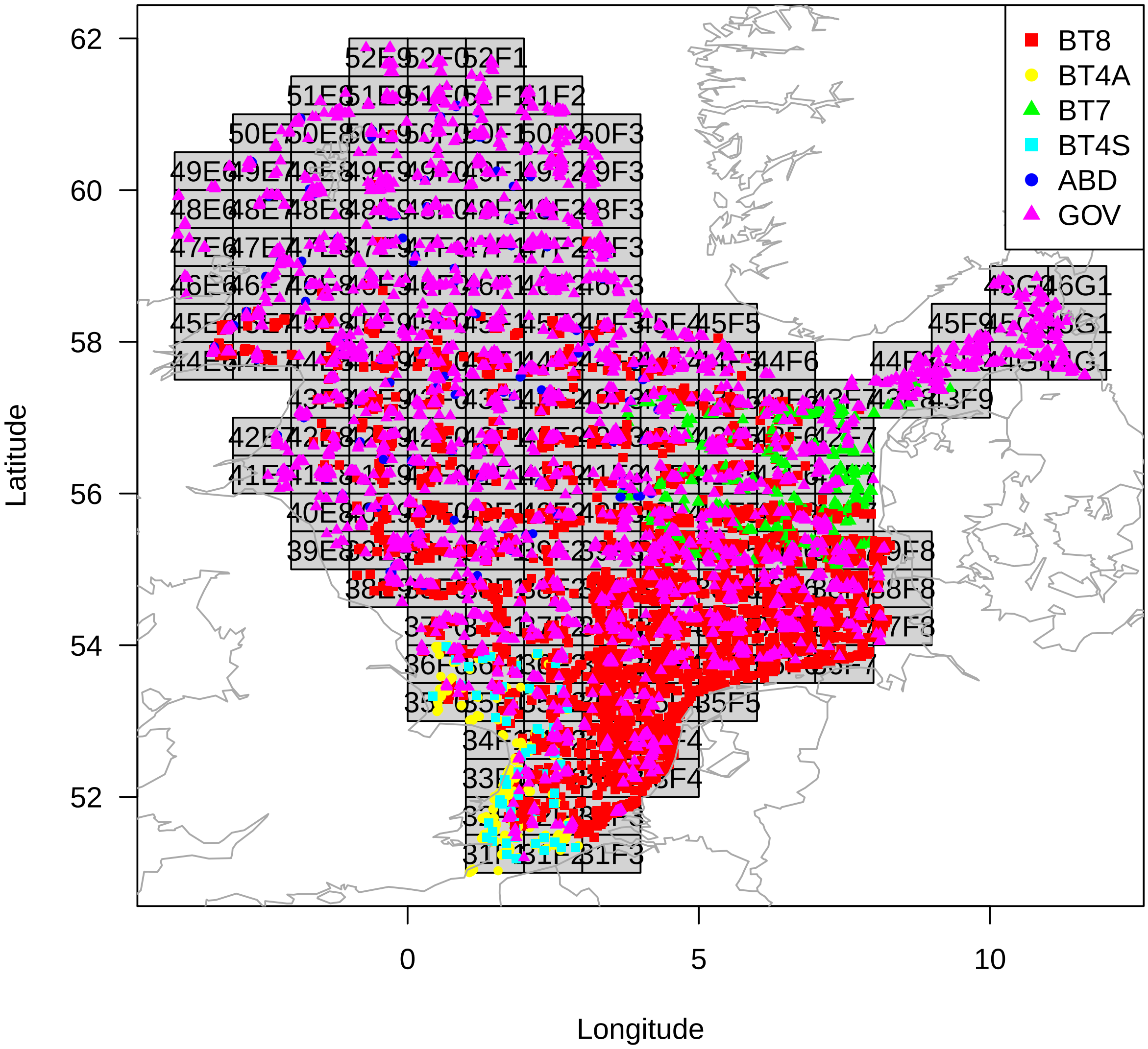


Figure 3: Distribution of hauls by gear type, BTS and IBTS Q3 combined.

	BT8	BT4A	BT7	BT4S
1990	94	22	0	0
1991	98	16	0	0
1992	97	4	0	0
1993	100	5	0	0
1994	91	7	0	0
1995	87	31	0	0
1996	129	29	0	0
1997	126	19	0	0
1998	121	18	0	0
1999	157	17	0	0
2000	159	16	0	0
2001	141	16	0	0
2002	154	15	52	0
2003	157	20	51	0
2004	156	50	53	0
2005	162	11	45	0
2006	150	20	0	0
2007	150	35	47	0
2008	138	20	44	0
2009	147	29	56	0
2010	112	88	54	0
2011	133	70	55	0
2012	160	73	53	0
2013	147	78	63	0
2014	124	78	30	0
2015	155	19	63	57
2016	157	0	0	0

Table 3: Number of hauls by gear and year BTS Q3

5 Survey Indices

Survey indices by age and area are calculated using the methodology described in [2], although we consider a broader class of equations describing the observed abundance in each haul. While [2] considered a time-invariant spatial effect and a data set consisting almost exclusively of 30 min hauls, the following model classes contains a space-time smoother, which allows for smooth changes in the spatial distribution of each age group over time, as well as haul duration effect.

In quarter 1, we only consider hauls taken with the GOV gear, so gear effects need not be included. The following equation describes the maximal model considered for both the presence-absence and the positive parts of the model:

$$\begin{aligned} g(\mu_i) =& \text{Year(i)} + f_1(\text{Year}_i, \text{lon}_i, \text{lat}_i) && (1) \\ & + f_2(\text{depth}_i) + \log(\text{HaulDur}_i) && (2) \end{aligned}$$

	GOV	DHT	GRT	ABD
1991	91	65	69	0
1992	232	0	0	60
1993	217	0	0	61
1994	182	0	0	62
1995	123	0	0	61
1996	196	0	0	59
1997	135	0	0	61
1998	217	0	0	0
1999	277	0	0	0
2000	252	0	0	0
2001	252	0	0	0
2002	249	0	0	0
2003	243	0	0	0
2004	261	0	0	0
2005	246	0	0	0
2006	247	0	0	0
2007	231	0	0	0
2008	240	0	0	0
2009	223	0	0	0
2010	229	0	0	0
2011	242	0	0	0
2012	238	0	0	0
2013	231	0	0	0
2014	241	0	0	0
2015	254	0	0	0
2016	280	0	0	0

Table 4: Number of hauls by gear and year NS-IBTS Q3

An offset is used for the effect of haul duration ($HaulDur$), i.e. the coefficient is not estimated but taken to be 1. f_1 is a 3-dimensional tensor product spline (a 2D thin-plate spline for space × a 1D cubic spline for time), f_2 is a 1-dimensional thin plate spline for the effect of bottom depth. The function g is the link function, which is taken to be the logit function for the binomial model. The positive part of the delta-distribution is assumed to be either Gamma (with log link) or lognormal distributed. Each combination of quarter age group are estimated separately. The fitted models are then used to sum the expected catches over a fine grid by year and age to obtain the survey index. Nuisance variables such as time-of-day and haul duration are corrected for in this process. For simplicity no vessel effects were considered here.

The whole procedure consists of the following steps:

1. Apply spatial ALK
2. Fit model for catch-at-age by age and quarter

3. Select grid of haul positions
4. Predict abundance on grid by year (using reference vessel, time-of-day etc).
5. Sum of grid points = index
6. Approximate the full multivariate distribution of the index (optional)

The 6. step above was explored in for other species than cod in [2], where it was found that survey indices for neighbouring age-classes in the same year can be highly correlated, and that failing to account for these correlations led to significantly different assessments, and was much more important than accounting for time-varying CVs within age groups.

The following six models are considered:

1. Delta-Lognormal distribution with stationary spatial field ($f_1(\text{lon}_i, \text{lat}_i)$) [SI]
2. Same as 1. but using cutoff $k = 0.5$ instead of $k = 0.01$. [SI.ac]
3. Same as 1. but using a Delta-Gamma distribution. [SI.g]
4. Same as 1. but using a Delta-Gamma distribution and $k = 0.5$. [SI.g.ac]
5. Delta-Lognormal distribution with non-stationary spatial field ($f_1(\text{Year}_i, \text{lon}_i, \text{lat}_i)$) [SI.ns]
6. Stratified mean method (standard ICES approach). [SMM]

6 Results

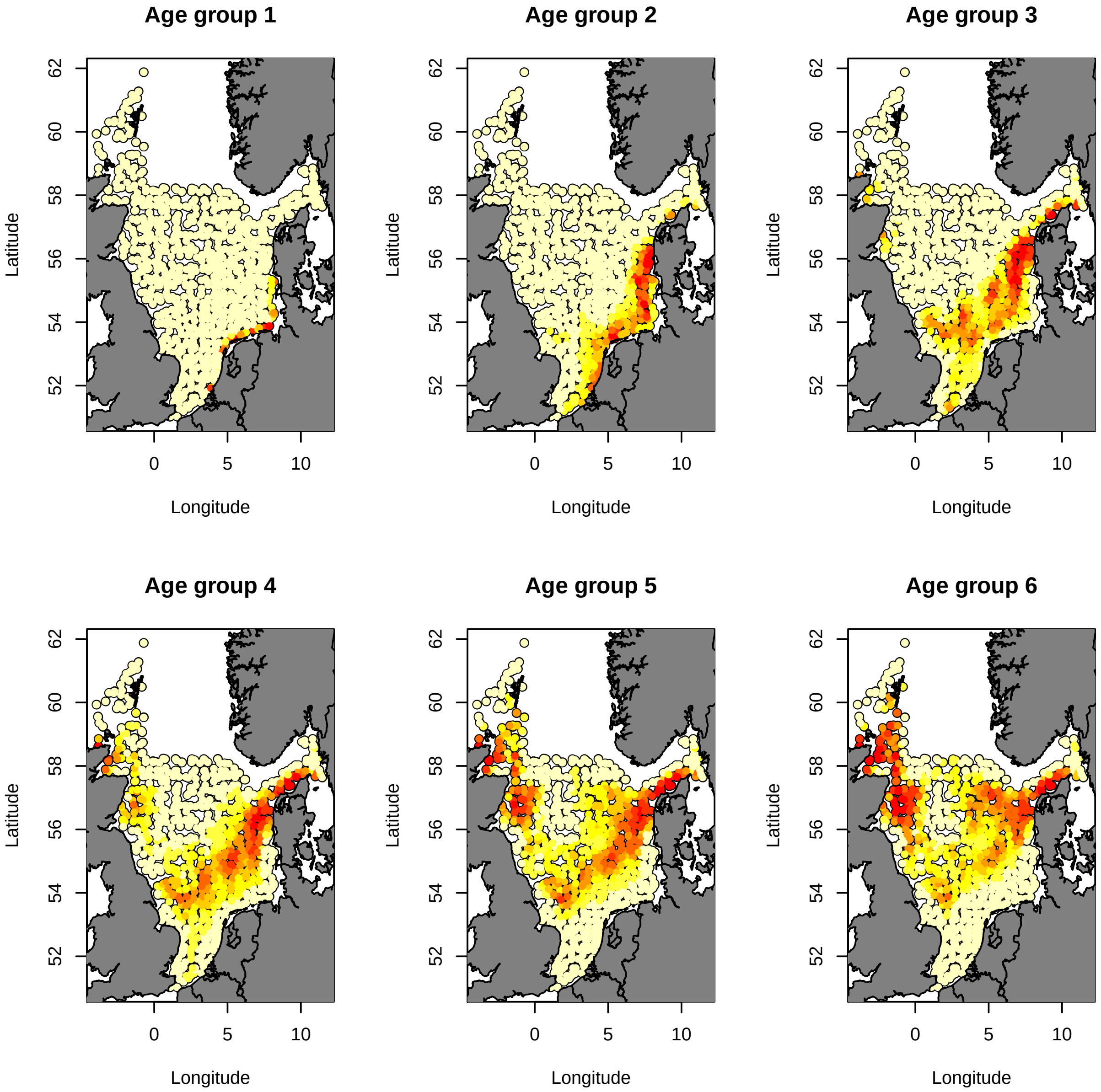


Figure 4: Estimated stock concentration plot Q3 (stationary model [SI.ac], combined data). Note, that age group 1 is age 0, 2 is 1, etc.

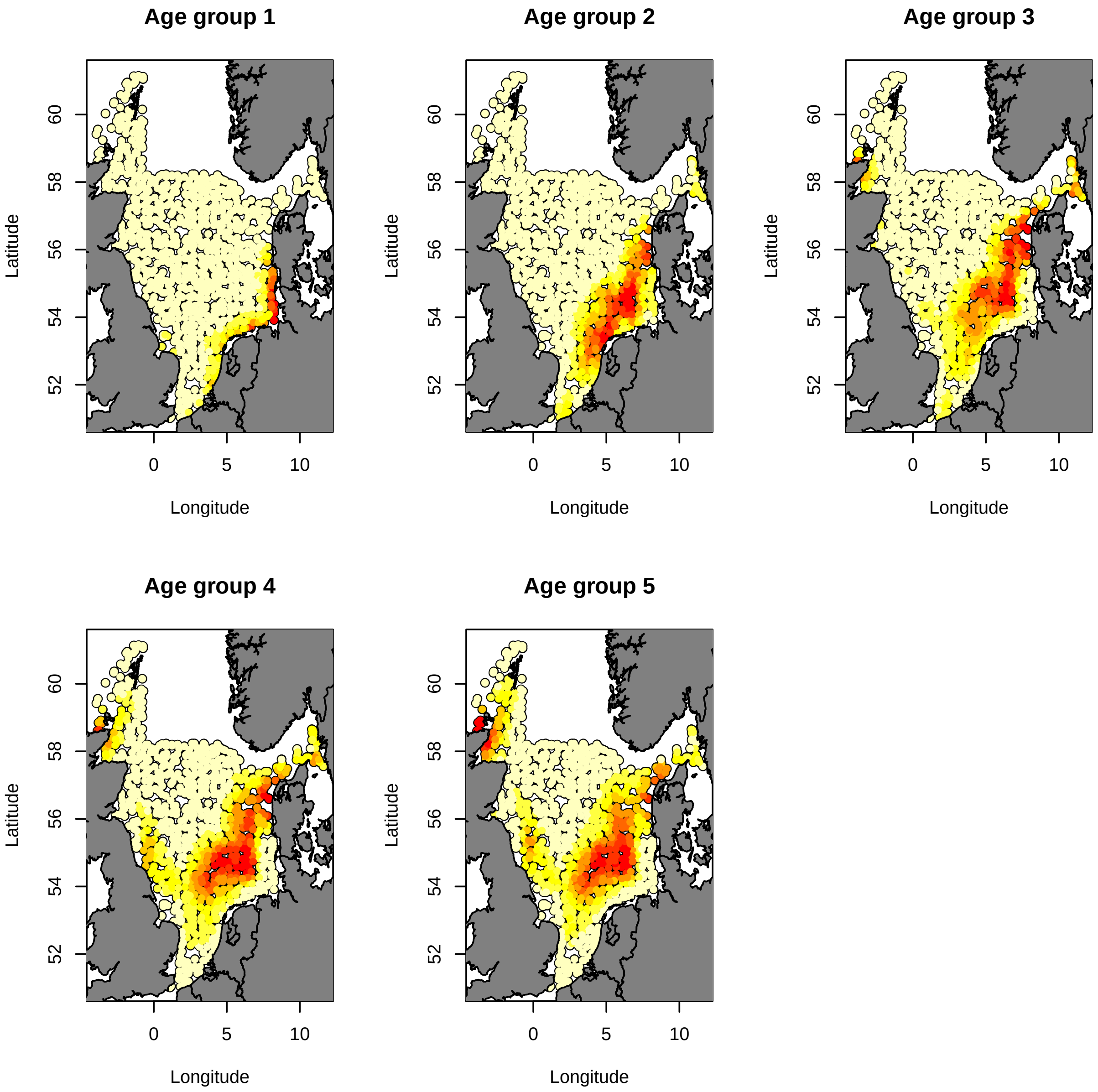


Figure 5: Estimated stock concentration plot Q1 (stationary model [SI]).

7 Conclusion

All the surveys considered seem useful for estimating age based abundance indices for plaice, given that they all give consistent estimates of increasing abundances since around 2005 and it is possible to follow cohorts within and between all surveys (based on rather high internal and external consistencies). It is possible to extend the Q1 index back to 1983 by extrapolating ALKs from other years/areas, and this does not seem to affect the internal consistencies. While Q3 IBTS and

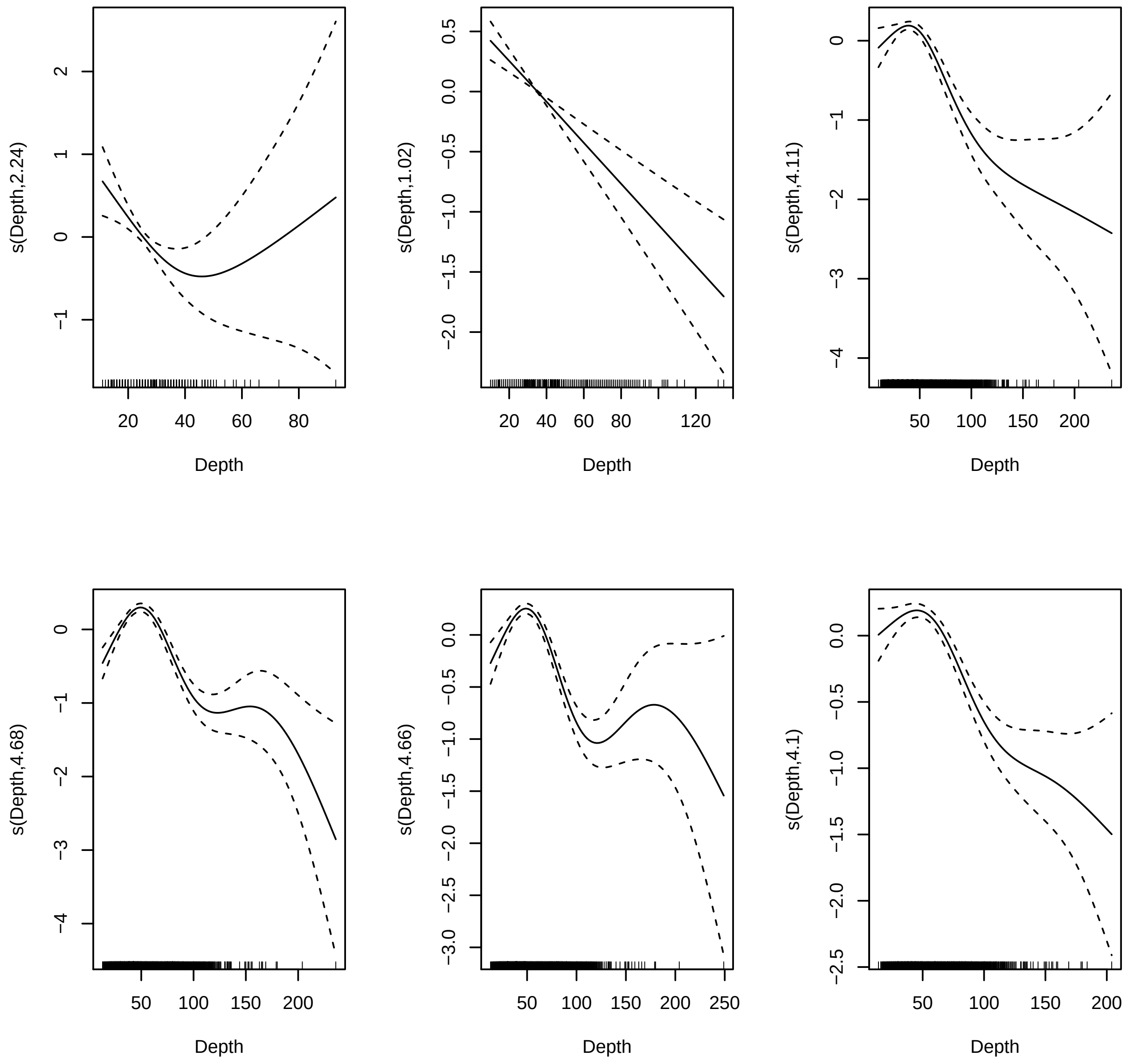


Figure 6: Estimated depth effect Q3 by age (stationary model [SI.ac], combined data).

the combined BTS survey both provide rather good indices, combining BTS and IBTS yields even better consistencies than either of two in isolation. The choice of survey index model (constant or time-varying spatial effect, cutoff value k, Gamma or log-normal) has some effect also, but mostly on the younger age groups, and does not seem crucial.

8 Appendix

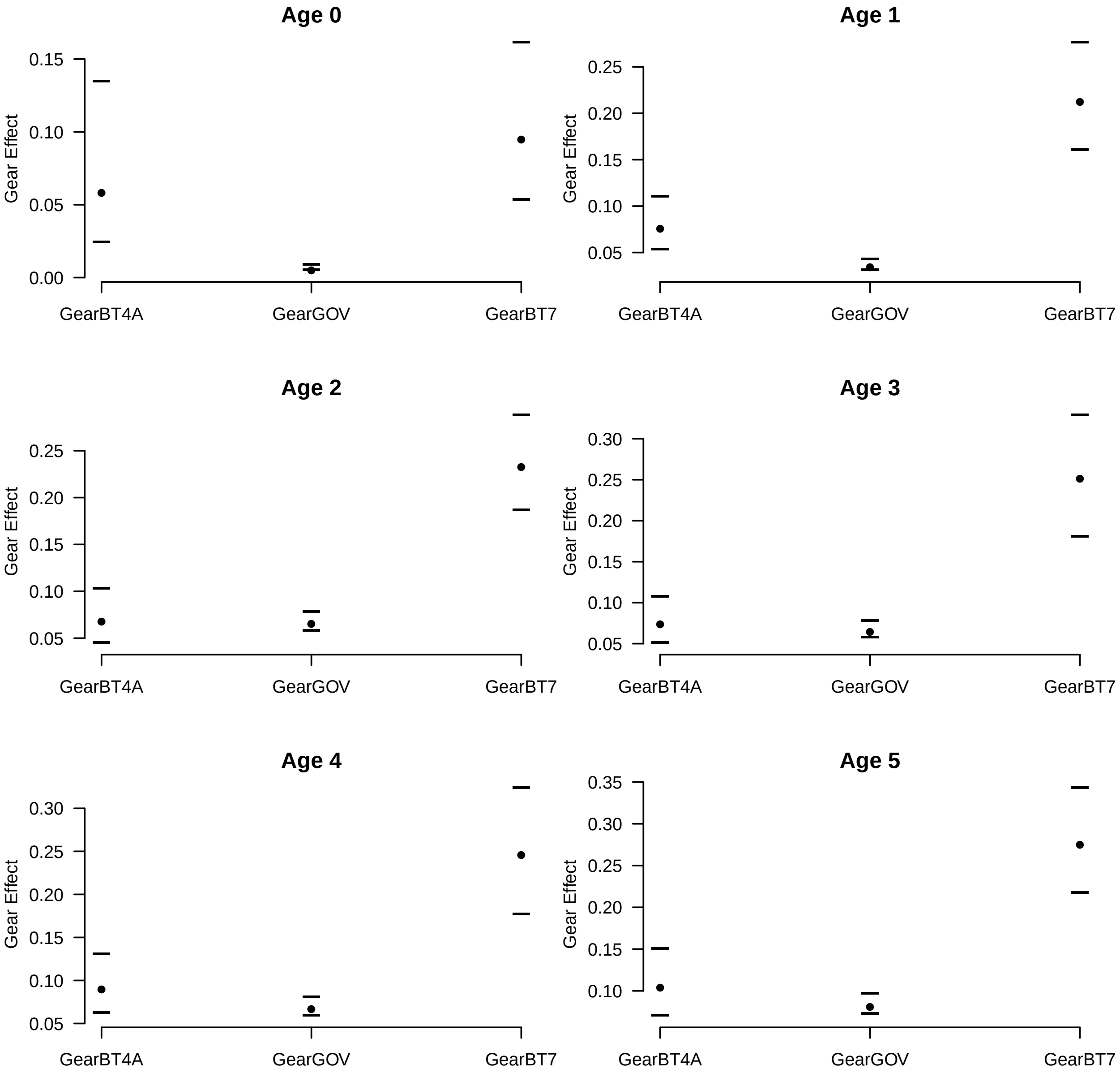


Figure 7: Estimated gear effect Q3 by age (stationary model [SI.ac], combined data). Estimates are multiplicative relative to the BT8 gear (BT8 = 1.0)

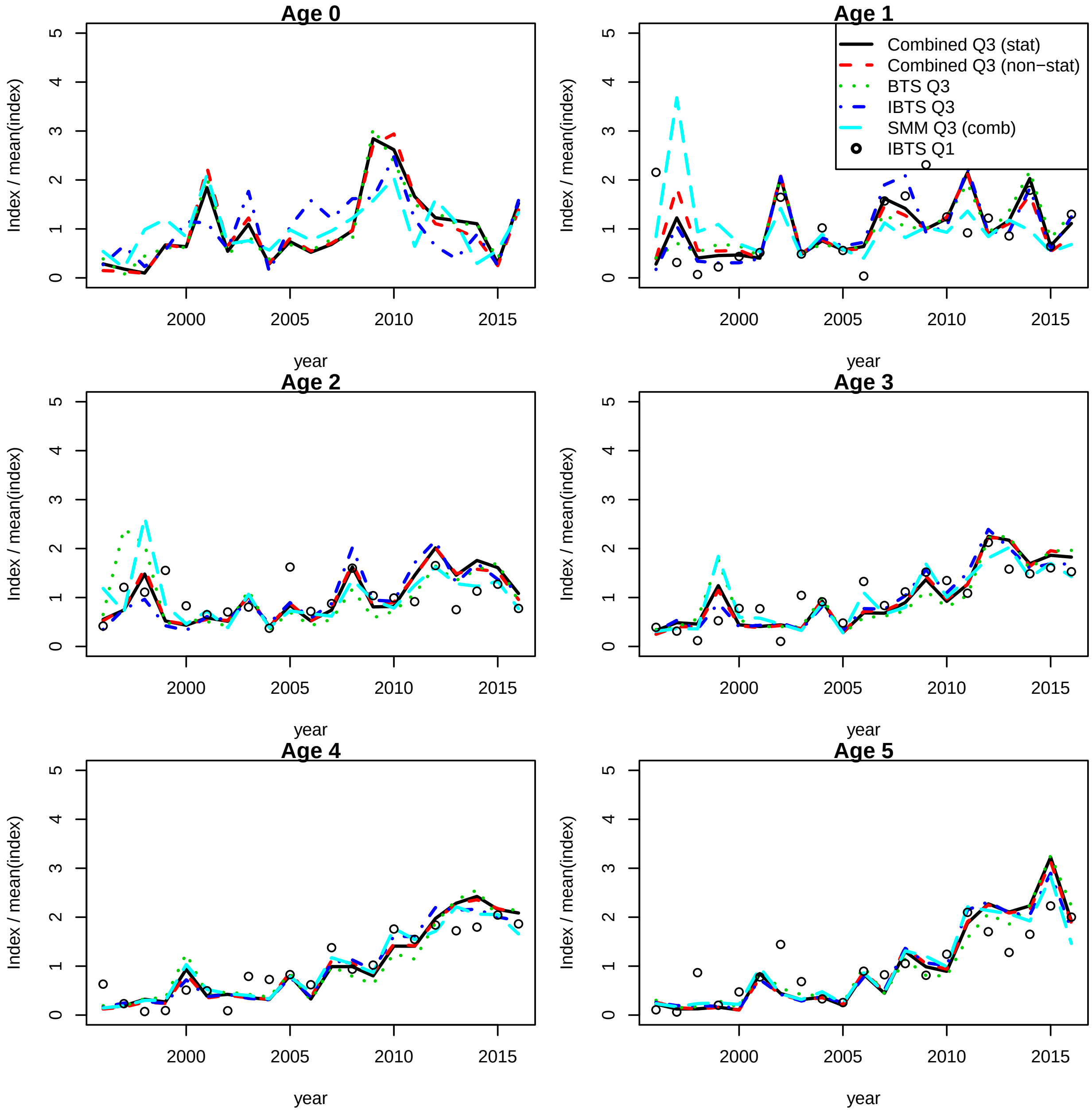


Figure 8: Comparison of indices

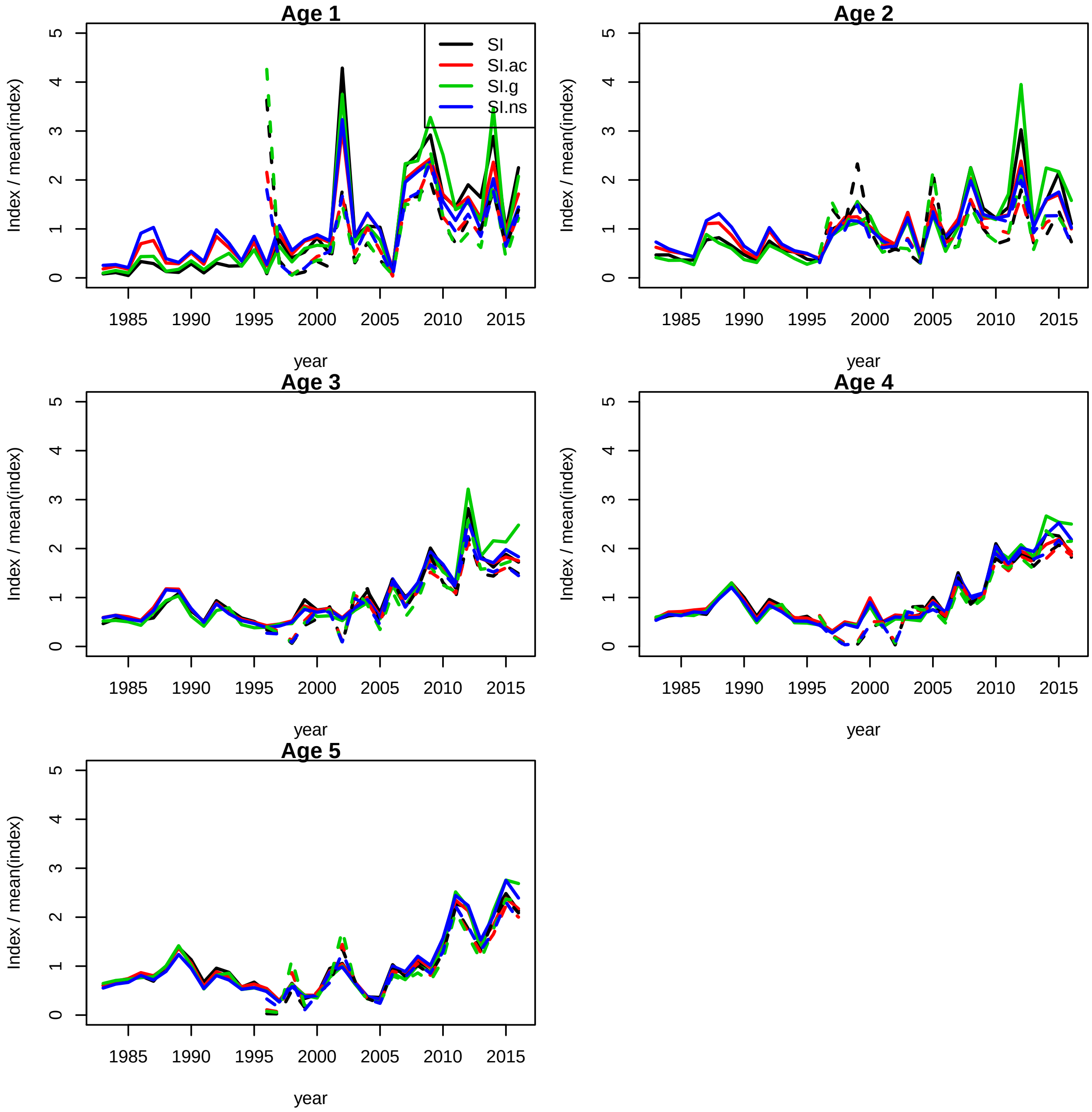


Figure 9: Comparison of indices Q1 (solid: 1983-2016, dashed: 1996-2016).

	EC	IC	mean
SI	0.513	0.683	0.598
SI.ac	0.580	0.711	0.646
SI.g	0.527	0.659	0.593
SI.g.ac	0.577	0.688	0.633
SI.ns	0.616	0.717	0.667
SMM	0.576	0.656	0.616

Table 5: Mean (over all data sets and ages) internal and external consistencies by model/method Q3

	IC	EC	mean
IBTS Q1	0.426		
BTS	0.723	0.528	0.625
IBTS Q3	0.740	0.577	0.658
Combined	0.801	0.590	0.696

Table 6: Mean (over all methods and ages) internal and external consistencies by data set Q3

	SI	SI.ac	SI.g	SI.g.ac	SI.ns
1996:2016	0.346	0.427	0.397	0.453	0.535
1983:2016	0.788	0.777	0.788	0.774	0.776
1983:2016 first ten	0.523	0.544	0.537	0.597	0.566
1983:2016 last ten	0.490	0.461	0.444	0.450	0.489

Table 7: Mean (over ages) internal consistencies Q1

	Age 1	Age 2	Age 3	Age 4	Age 5
1983	383.76	3793.84	3438.17	2524.74	1663.31
1984	508.99	3813.31	4162.91	2863.08	1900.27
1985	226.32	2957.33	4051.65	2986.77	1920.80
1986	1566.66	2950.75	3961.78	3138.45	2191.44
1987	1374.25	6289.18	4296.19	3005.55	1894.97
1988	607.78	6658.77	6615.87	4598.33	2733.93
1989	524.75	5340.51	7968.69	5948.88	3793.03
1990	1340.50	3844.31	5337.58	4590.28	3095.67
1991	476.55	2824.74	3804.63	2825.12	1850.22
1992	1414.03	6101.84	6898.29	4398.85	2624.53
1993	1132.57	4588.55	5591.63	3817.17	2390.49
1994	1158.78	4278.64	4297.55	2604.66	1569.90
1995	3489.51	3088.35	3768.78	2825.67	1844.68
1996	399.61	2747.53	2766.65	1995.10	1313.04
1997	3651.84	8073.56	3317.00	1346.52	753.12
1998	1925.52	9141.36	3717.59	2213.06	1778.34
1999	2464.15	12529.31	7038.07	1933.01	924.78
2000	3832.84	10154.21	5491.75	4399.06	1139.11
2001	2327.64	5814.73	5729.17	2301.87	2609.52
2002	20141.46	4702.44	4115.74	2765.17	2894.36
2003	3934.48	10837.97	5856.71	2713.60	1799.30
2004	4969.17	3527.68	8344.87	2985.44	1023.83
2005	4862.43	12051.91	5119.50	4594.62	986.02
2006	660.94	6088.42	10110.70	3045.17	2820.04
2007	10698.93	9128.76	7482.78	6901.96	2160.49
2008	11904.61	18262.38	8948.11	4108.29	2935.89
2009	13720.36	11513.26	14815.69	4848.62	2398.25
2010	7913.92	9930.95	11763.72	9622.82	3949.67
2011	6817.13	11680.80	8807.90	7640.22	6229.74
2012	8938.19	24543.20	20752.27	8669.97	6016.17
2013	7723.93	9305.75	13621.24	8080.15	3698.47
2014	13580.09	12766.60	11948.75	10529.04	5621.53
2015	4555.93	17462.11	13862.64	10344.41	6803.96
2016	10577.97	8949.78	12687.58	8635.27	5837.65

Table 8: Q1 index

	Age 0	Age 1	Age 2	Age 3	Age 4	Age 5
1996	825.85	1925.39	4504.48	1996.58	479.93	411.60
1997	521.75	8400.02	6070.42	2967.15	641.91	229.78
1998	283.93	2783.28	12067.62	2797.27	1096.45	235.62
1999	1946.14	3123.53	4251.33	7587.74	911.63	295.75
2000	1843.12	3196.27	3535.48	2700.45	3174.92	194.49
2001	5333.38	2749.96	4780.28	2498.66	1317.96	1552.09
2002	1571.51	14093.88	4201.40	2695.26	1439.21	810.77
2003	3172.07	3260.83	8455.07	2222.69	1218.07	580.74
2004	827.20	5194.00	3300.93	5673.29	1079.84	668.55
2005	2144.92	3917.75	6846.71	1721.33	2732.79	363.04
2006	1513.01	4391.97	4268.89	4190.78	1116.28	1523.99
2007	1979.11	11091.27	6046.94	4153.75	3363.96	818.82
2008	2791.85	9724.47	13252.62	5479.19	3362.58	2382.72
2009	8227.02	6844.43	6598.25	8347.46	2720.54	1809.45
2010	7576.85	8292.53	6676.90	5624.95	4784.85	1640.16
2011	4806.81	14743.89	11841.70	7743.87	4777.32	3447.27
2012	3553.75	6136.74	16431.37	13735.33	6703.35	4170.45
2013	3381.70	8045.18	11871.85	13252.70	7761.07	3862.50
2014	3200.17	13908.59	14331.95	10323.49	8233.45	4095.17
2015	865.00	4499.39	13143.36	11371.50	7332.96	5917.66
2016	4409.71	7622.82	8831.65	11151.87	7083.35	3523.64

Table 9: Q3 index (combined)

References

[1] Casper W Berg and Kasper Kristensen. Spatial age-length key modelling using continuation ratio logits. *Fisheries Research*, 129:119–126, 2012.

[2] Casper W Berg, Anders Nielsen, and Kasper Kristensen. Evaluation of alternative age-based methods for estimating relative abundance from survey data in relation to assessment models. *Fisheries Research*, 151:91–99, 2014.

[3] Kasper Kristensen and Casper W. Berg. Datras package for r. `http://rforge.net/DATRAS/`, 2012.

Annex 4: Sole working documents

The following working documents on sole were presented at WKNSEA 2017 and are found below:

Working document 1: Stock identity of Sole (*Solea solea* L.) in the Eastern English Channel (ICES division VIId)

Marie Savina-Rolland (Ifremer), Filip Volckaert (KULeuven), Etienne Rivot (Agrocampus Ouest), Olivier Le Pape (Agrocampus Ouest), Elodie Réveillac (Agrocampus Ouest)

Sole in the eastern English Channel (VIId) is considered to be a stock separated from the larger North Sea stock (IV) to the east and the smaller geographically-separated stock to the west in VIIe (western Englisch Channel).

This document reviews the existing knowledge about the VIId sole stock identity, as well as the current research activity (B-Fishconnect and SMAC projects).

1. Connectivity between ICES area VIId and nearby VIIe and IVc

Genetics

Cuveliers et al. (2012) showed genetic differences at a large spatial scale along a latitudinal gradient from the Skagerrak/Kattegat to the Bay of Biscay using neutral microsatellite markers and a mitochondrial marker. However, at a smaller spatial scale, within the North Sea Ecoregion, subpopulations seemed genetically homogeneous. This is probably due to a high level of gene flow and/or the high effective population size preventing strong effects of genetic drift. Moreover, a remarkably high genetic stability was found from the 1950s up to present (Cuveliers et al., 2011). This all confirms previous enquiries (Exadactylos, 2001) about the lack of genetic structure based on neutral genetic markers.

Diopere et al. (submitted) prepared a study based on outlier Single Nucleotide Polymorphisms (SNP) at a high level of resolution. This method revealed that area VIIe is distinct from VIId while VIId shows a pattern of isolation by distance (gradual change in genetic diversity) with the North Sea sole. Southern North Sea sole appeared more similar to eastern Channel sole.

Otoliths

Significant differences in the elemental composition of juvenile sole otoliths have been detected among nursery grounds in the southern North Sea (Cuveliers et al., 2010). Even though some interannual variability in otolith chemistry was observed in some nurseries, spatial differences among nurseries override the temporal variability. These results constitute a firm basis for future investigations on nursery area contributions and quality, adult dispersal history and applications of population traceability.

This method aims now at being complementarily applied in the Eastern Channel to (1) produce an atlas of microchemical signatures of coastal nurseries in VIId enabling to (2) trace back the origin and exchanges of adult soles in VIId and IV (Collaboration Smac – B-Fishconnect).

Tagging studies

The CEFAS report by Burt and Millner (2008) summarizes the results of the CEFAS intensive tagging program carried out on flatfish in the Eastern Channel and the North Sea between 1955 and 2004 (Figure 1).

Overall, 91% of sole in the North Sea and 72% in VIId remained resident. The remaining 9% of the North Sea were found in VIId (7%) and in VIIe (2%). 20% of the sole released in VIId had moved west into the neighbouring area VIIe (and 1% beyond VIIe), but more noticeably so in autumn and winter (31% in Q4 – Q1 vs 15% in Q2-Q3). 7% moved into the North Sea.

The extent of movement between VIId and VIIe increases closer to the boundary between the two areas. However, the abundance of sole in the western part of VIId is much lower than in the eastern area and this movement across the management boundary, although significant, might represent a relatively small number of fish.

Within this CEFAS tagging program, the number of fish tagged off the French coast was considerably lower than the number of fish tagged off the English coast (Figure 1, based on a recent analysis of the UK tagging program).

As part of the SMAC project, further analysis are ongoing using (1) the CEFAS tagging database, focussing on tagging done in VIIe, and (2) additional tagging data from IFREMER (1976-1980). A new tagging program is also being set-up as part of the SMAC project (using passive Petersen tags), which aims at tagging another 5000 soles between 2016 and 2018.

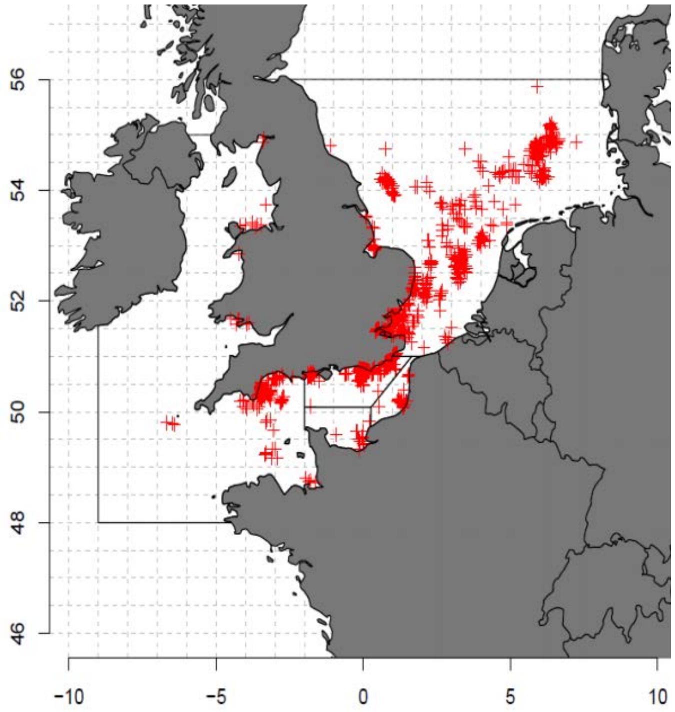


Figure 1 : Release points of the soles tagged by CEFAS (Figure based on the CEFAS database, Burt and Millner, 2008)

2. Connectivity within VIId

Recent studies (Rochette et al., 2013; Archambault et al., 2016) suggest a distinct spatial structure for sole in the Eastern Channel with three regions associated with low connectivity for larvae and juveniles: along the English coast, in the Bay of Seine, and along the coast of northern France (Figure 2, area 2, 1 and 3 respectively). Coastal spawning areas (Eastwood et al., 2001) feed adjacent nurseries and no significant exchanges between those three areas was found as a result of a relatively short larval stage (less than 2 months) and limited transport (Grioche et al., 2000; Rochette et al., 2012). The only exception is found at the northern side of the coast of northern France (“Pas de Calais”, northern side of region 3 in Figure 2), where the hydrodynamics lead to exchanges between region 3 and the southern North Sea (Savina et al., 2010; Savina et al., 2016).

Once settled, juvenile movements are very limited (Coggan and Dando, 1988; Riou et al., 2001), and very low exchange rates are observed during this juvenile stage (Le Pape et Cognez, 2015).

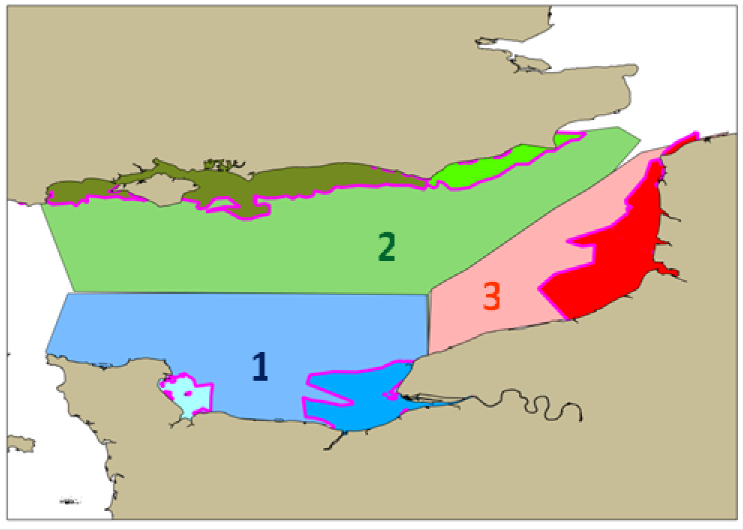


Figure 2 : Regions characterised by low connectivity for larvae and juveniles in the Eastern Channel, nurseries indicated in purple.

The connectivity induced by adult movements and its impact on the population structure is less documented compared to larvae and juveniles. Analyses of the tagging studies performed by CEFAS between 1955 and 2007 (Kotthaus, 1963; Burt et Millner, 2008) seem to show limited movements between the three regions (Figure 2 and Figure 3). These preliminary results will be further analysed using other existing data sources and the results of the currently-ongoing tagging experiment (see section 1.3).

Additionally, otolith microchemistry (see section 1.2), as well as otolith shape will be used to identify homogeneous entities.

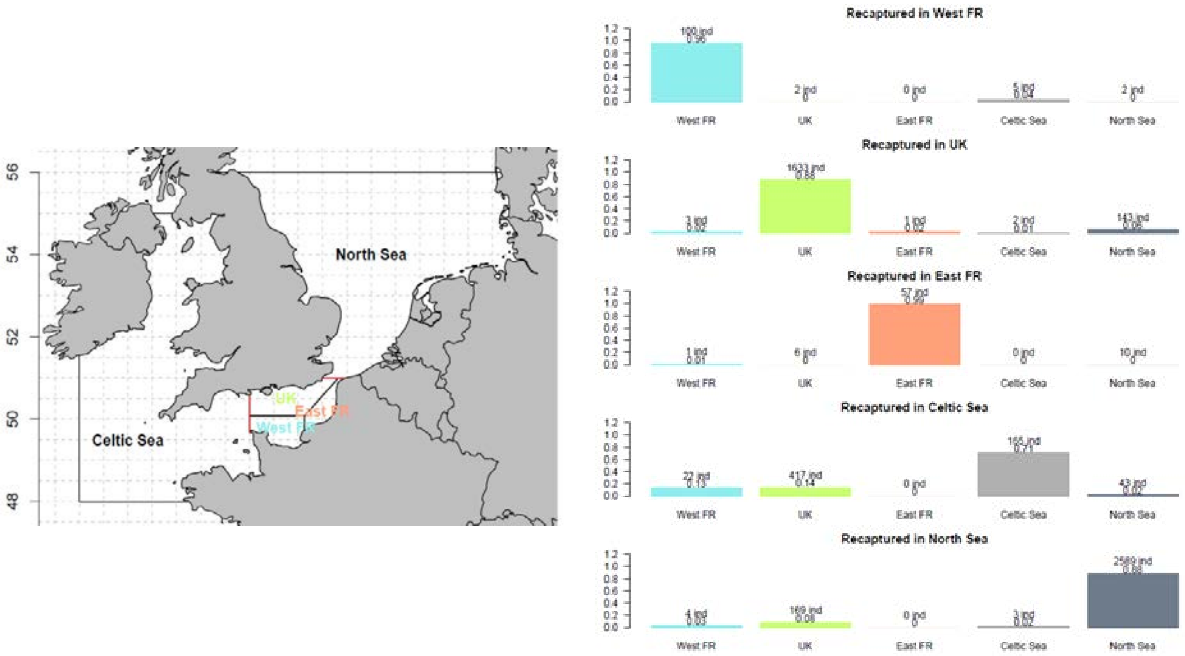


Figure 3 : Origin of the sole caught in each spatial unit (Figure based on the CEFAS database; Burt and Millner, 2008). For example: from the tagged sole recaptured in the 'East FR' area, 57 (the majority, 99%) had been released in that area. A minority came from neighbouring areas: 1 individual from 'West FR' (1%), 6 individuals from 'UK' (<1%) and 10 from the North Sea (<1%), percentages are the ratio of tagged soled recovered in the area X and released in Y over the total amount of tags released in Y.

3. References

Archambault b., Le Pape O., Baullier L., Vermard Y., Rivot E. (2016) Adults mediated connectivity affects inferences on population dynamics and stock assessment of exploited marine populations. *Fisheries Research,* 181 : 198-213.

Burt, G.J. and Millner, R.S. 2008. Movements of Sole in the Southern North Sea and Eastern English Channel from Tagging Studies (1955–2004). Lowestoft: CEFAS, 44 pp.

Coggan, R.A. and Dando, P.R. 1988. Movements of juvenile Dover sole, Solea solea (L.), in the Tamar Estuary, Southwestern England. J. Fish Biol. 33:177–184.

Cuveliers EL, Geffen AJ, Guelinckx J, Raeymaekers JAM, Skadal J, Volckaert FAM, Maes GE, 2010. Microchemical variation in juvenile Solea solea otoliths as a powerful tool for studying connectivity in the North Sea. Mar. Ecol. Prog. Ser. 401:211-220.

Cuveliers, E. L.; Volckaert, F. A. M.; Rijnsdorp, A. D.; et al., 2011. Temporal genetic stability and high effective population size despite fisheries induced life history trait evolution in the North Sea. Molecular Ecology 20(17): 3555-3568.

Cuveliers E, Larmuseau M, Hellemans B, Verherstraeten S, Volckaert F, Maes G. 2012. Multi-marker estimate of genetic connectivity of sole (Solea solea) in the North-East Atlantic Ocean. Marine Biology159(6):1239-53.

Eastwood PD, Meaden GJ, Grioche A. 2001. Modelling spatial variations in spawning habitat suitability for the sole Solea solea using regression quantiles and GIS procedures. Marine Ecology Progress Series 224:251-266.

Exadactylos, A; Thorpe, JP, 2001. Allozyme variation and genetic inter-relationships between seven flatfish species (Pleuronectiformes). Zoological journal of the linnean society, 132(4): 487-499.

Grioche A., Harlay X., Koubbi P. Fraga Lago L. 2000. Vertical migrations of fish larvae: Eulerian and Lagrangian observations in the Eastern English Channel. J. Plankton Res. 22 (10): 1813-1828.

Kotthaus, A. (1963) Tagging experiments with the North Sea sole (*Solea solea*) in 1959 and 1960. Spec. Publ. Int. Commn.NW. Atlantic Fish 4:123–129.

Le Pape O., Cognez, N. (2015). The range of juvenile movements of estuarine and coastal nursery dependent flatfishes: estimation from a meta-analytical approach. Journal of Sea research 107(1): 43-55.

Riou P., Le Pape O., Rogers S. (2001). Relative contributions of different sole and plaice nurseries to the adult population in the Eastern Channel: application of a combined method using Generalized Linear Models and a Geographic Information System. Aquatic Living Resources, 14: 125-135.

Rochette S, Le Pape, O, Vigneau, J, Rivot, E, 2013. A hierarchical bayesian model for embedding larval drift and habitat models in integrated life cycles for exploited fish. Ecological Applications 23(7): 1659-1676.

Savina M, Lacroix G, Ruddick K. 2010. Modelling the transport of common sole larvae in the Southern North Sea: Influence of hydrodynamics and larval vertical movements. J Mar Sys;81:86-98.

Savina M., Lunghi M., Archambault B., Baulier L., Huret M., Le Pape O. (2016) Sole larval supply to coastal nurseries: interannual variability and connectivity at interregional and interpopulation scale. *Journal of Sea research* 111 : 1-16.

4. Current projects

B-Fish-Connect

The B-FishConnect project aims at disentangling the physical and biological factors influencing dispersal and recruitment in North Sea flatfish. It makes use of population dynamics, ecology, combined hydrodynamical-IBM models, genomics, otolith microchemistry and GIS to analyse data. Four commercially important flatfish species of the North Sea are targeted: sole, plaice, turbot and brill.

Partners:

- University of Leuven – Laboratory of Biodiversity and Evolutionary Genomics (coordinator)
  Contact: Dr. Filip Volckaert (email: filip.volckaert@bio.kuleuven.be)
- Royal Belgian Institute of Natural Sciences - Operational Directorate Natural Environment
- Institute for Agriculture and Fisheries Research – Fisheries Biology
- IMARES Wageningen UR

SMAC

The Smac project focuses on the Eastern Channel sole, and aims at increasing the knowledge of the ecology and exploitation of this stock in order to improve its management. The work is distributed in 3 axes: spatial structure and connectivity (a multi approach integrating genetics, mark-recapture, analysis of growth and density patterns, otoliths morphometry and microchemistry), recruitment dynamics, and selectivity and fishing strategies.

Science Partners

- Ifremer (coordinator)
  Contact: Dr Marie Savina-Rolland (email: Marie.Savina.Rolland@ifremer.fr)
- Agrocampus Ouest
- UMR Borea

With the technical support of CEFAS and ILVO.

Working document 2: Tuning series for Sole (*Solea solea* L.) in the Eastern English Channel (ICES division VIId)

Sofie Nimmegeers, Bart Vanelslander, Youen Vermard, Marie Savina-Roland, Chun Chen, Jennifer Devine, Lies Vansteenbrugge and others

1. Introduction

Currently, 2 commercial (BE_CBT_1986-2015 and UK(E&W)_CBT_1986-2015) and 3 survey (UK(E&W)_BTS_1989-2015, UK_YFS_1987-2006, FR_YFS_1987-2015) tuning series are used in the assessment (WGNSSK 2016 assessment, see working document on assessment models).

Three issues concerning the tuning series are covered in this working document. First, it was investigated whether sufficient information on age 1 was available, considering the fact that the French YFS survey does not cover the complete VIId area and the UK_YFS survey was last performed in 2006. Second, the Belgian tuning series was investigated as since the review of this series during WKFLAT 2009, the suggestions made by WKFLAT 2009 were not implemented. Third, a new French tuning series was constructed and investigated, which includes CPUEs from the French otter trawl fleet targeting sole seasonally and mainly along the French coast.

2. Investigating survey indices covering age 1

As the UK YFS ended in 2006, the question was raised whether sufficient information on age 1 was available, considering the fact that the French YFS survey does not cover the complete VIId area.

When evaluating the internal consistency plots for the UK BTS for age 1, the correlation (R^2) is low, but similar to that for age 2 (0.442 and 0.443 respectively; Figure 2.1).

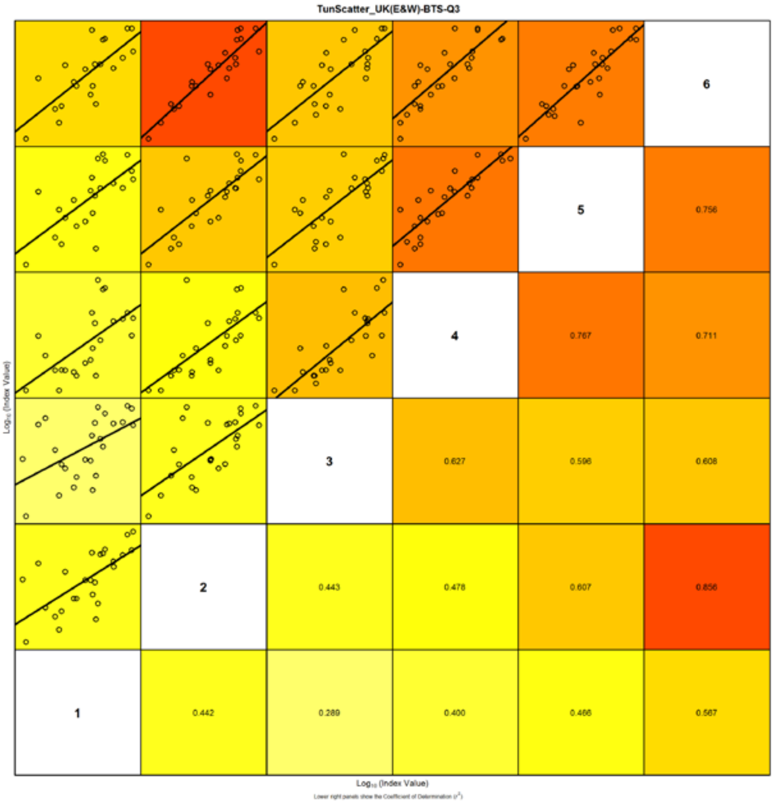


Figure 2.1: Internal consistency plot of the UK(E&W)_BTS_Q3 tuning series for 7.d sole

Additionally, the standardized indices by age of the survey tuning series for age 1 line up well. Especially when comparing the ongoing UK(E&W) BTS and the UK YFS tuning series ended in 2006 (Figure 2.2).

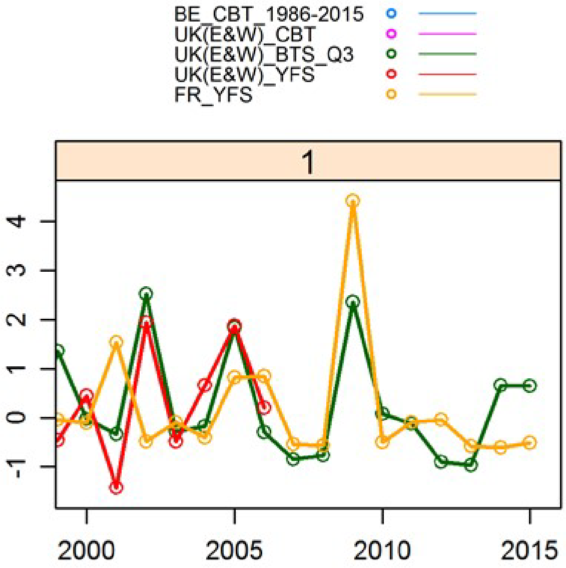


Figure 2.2: Standardised indices by age of the tuning series for 7d sole.

Therefore, it was concluded that there are no strong arguments to further revise the survey tuning indices and retain them in their current form in the assessment.

3. Investigating the Belgian commercial tuning series

Objective

The BE-CBT (Belgian commercial beam trawl) tuning series is included in the current assessment (1986-2015). The effort is corrected for horse power, based on a study carried out by IMARES and CEFAS in the mid 90’s (applicable to sole and plaice effort in the beam trawls fisheries). At WKFLAT 2009 the objective was to investigate a more realistic conversion factor for horse-power (HP) to convert nominal fishing effort to effective effort. Suggestions made by WKFLAT 2009 were not implemented in the following assessments. Therefore, an update of the BE-CBT tuning series has been put forward as a task for the WKNSEA2017.

Available data sources

Landings data: the logbooks contain the estimated weight for all species caught, grouped by ICES Statistical Rectangle and by day. The sales notes contain information on the quantities auctioned by market category for all species landed. These two data sources are merged to obtain the landings by area and market category. As the retained catches from the logbooks are estimated weights, the landed weights are derived from the quantities recorded in the sales notes.

Effort data: the logbooks provide information on the hours spent fishing per day and per ICES Statistical Rectangle.

The landings of sole and effort data from beam trawlers (métier: TBB_DEF_70-99) active in ICES Division 7d were combined to calculate the catch rate of sole from 2003 onwards. Additional information on year, month, fleet segment and horsepower (kW) is provided. The Belgian beam trawl fleet consists of a small fleet segment (Eurocutter and coastal vessels; HP ≤ 221 kW) and a large fleet segment (HP > 221 kW). On average 53% of the fishing hours In ICES Division 7d can be attributed to the large fleet segment.

Data sets

Dataset 1- original data (2003-2015)

Belgium catch rates as kilograms of sole per hour per trip from 2003 to 2015.

	Number of trips	
Year	Small fleet segment	Large fleet segment
2003	712	485
2004	681	489
2005	645	380
2006	625	487
2007	504	543
2008	487	444
2009	543	413
2010	630	295
2011	578	300
2012	365	266
2013	280	278
2014	356	364
2015	377	339

	Fishing hours	
Year	Small fleet segment	Large fleet segment
2003	48426	45746
2004	39027	34106
2005	36038	29356
2006	35302	47329
2007	29613	54008
2008	29208	41808
2009	26967	34049
2010	34952	27061
2011	32941	26921
2012	20991	21645
2013	18737	25163
2014	23347	34131
2015	22129	32620

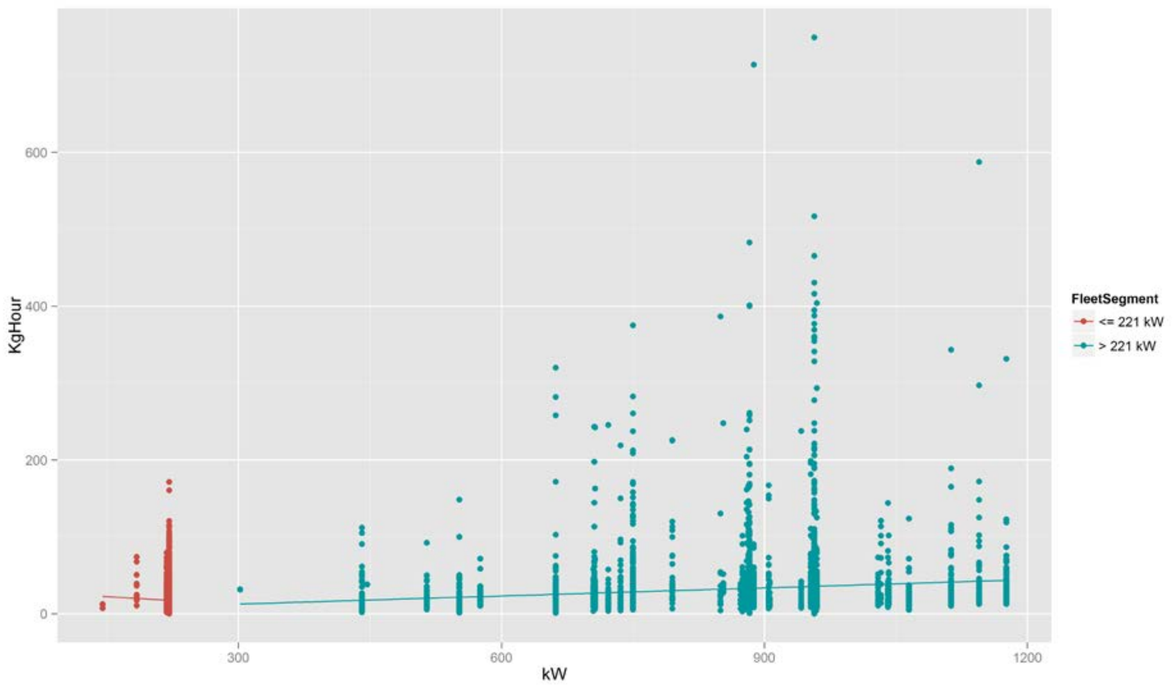


Figure 3.1. Nominal sole catch rate (Kg/h per trip) against HP (kW) by vessels grouped into class <= 221 kW (red) and all other vessels (class > 221 Kw (blue)). Linear fit for CPUE vs HP.

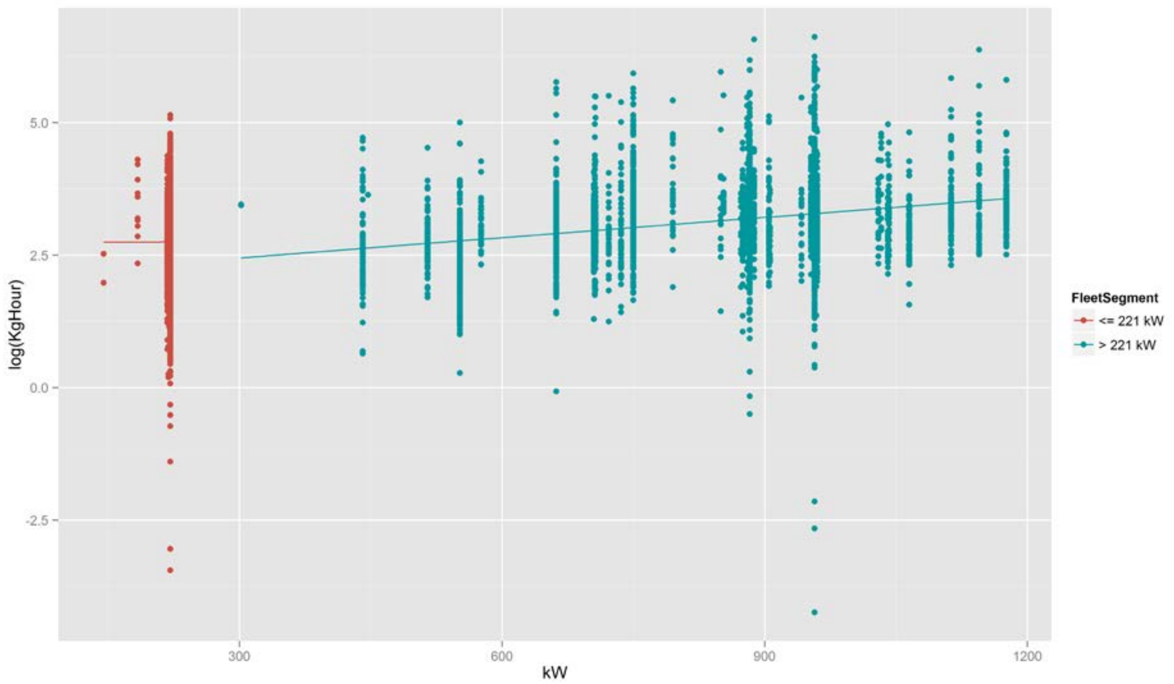


Figure 3.2. Nominal log transformed sole catch rate (log Kg/h per trip) against HP (kW) by vessels grouped into class <= 221 kW (red) and all other vessels (class > 221 Kw (blue)). Linear fit for log CPUE vs HP.

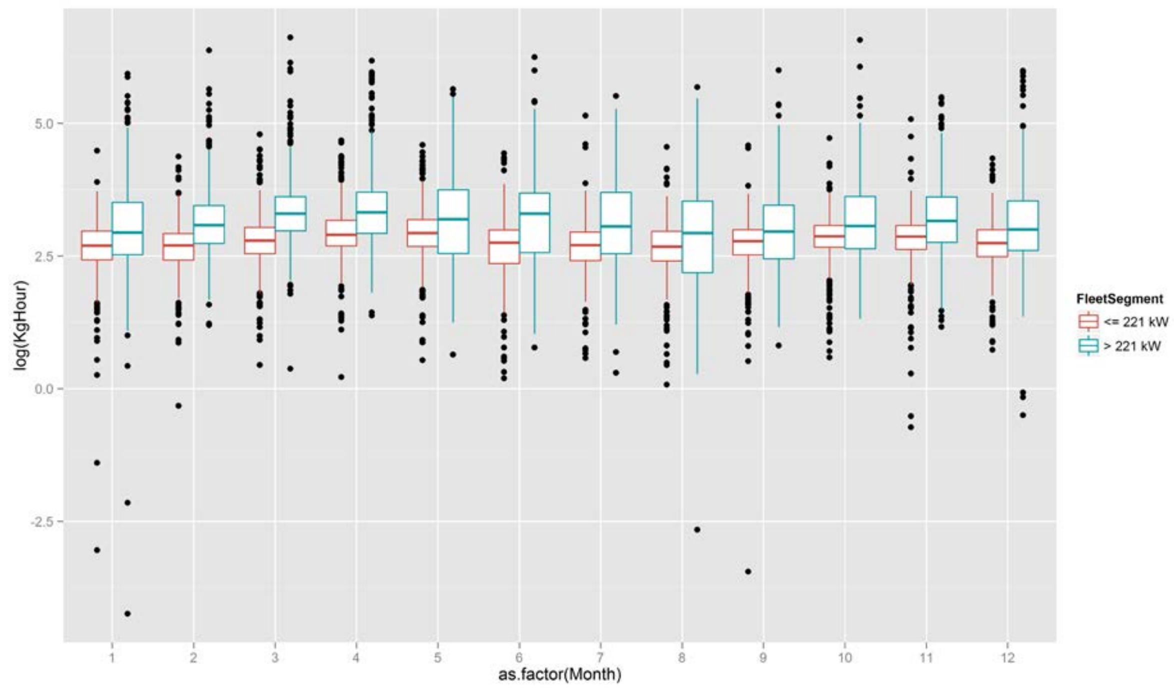


Figure 3.3. Nominal log transformed catch rates of sole (Kg/h per trip) by month and vessel class.

Dataset 2 (2003-2015)

The group of vessels with HP ≤ 221kW is likely a group that is misreporting HP. Therefore it was suggested to only take into account the vessels of the large fleet segment. Furthermore we selected only the rectangles with at least one trip in each year for the period (2006-2015). We couldn't apply this selection for the years 2003-2005, because we only have the catches by rectangle from 2006 onwards.

Year	Number of trips
2003	485
2004	489
2005	380
2006	485
2007	542
2008	444
2009	413
2010	294
2011	300
2012	266
2013	278
2014	364
2015	338

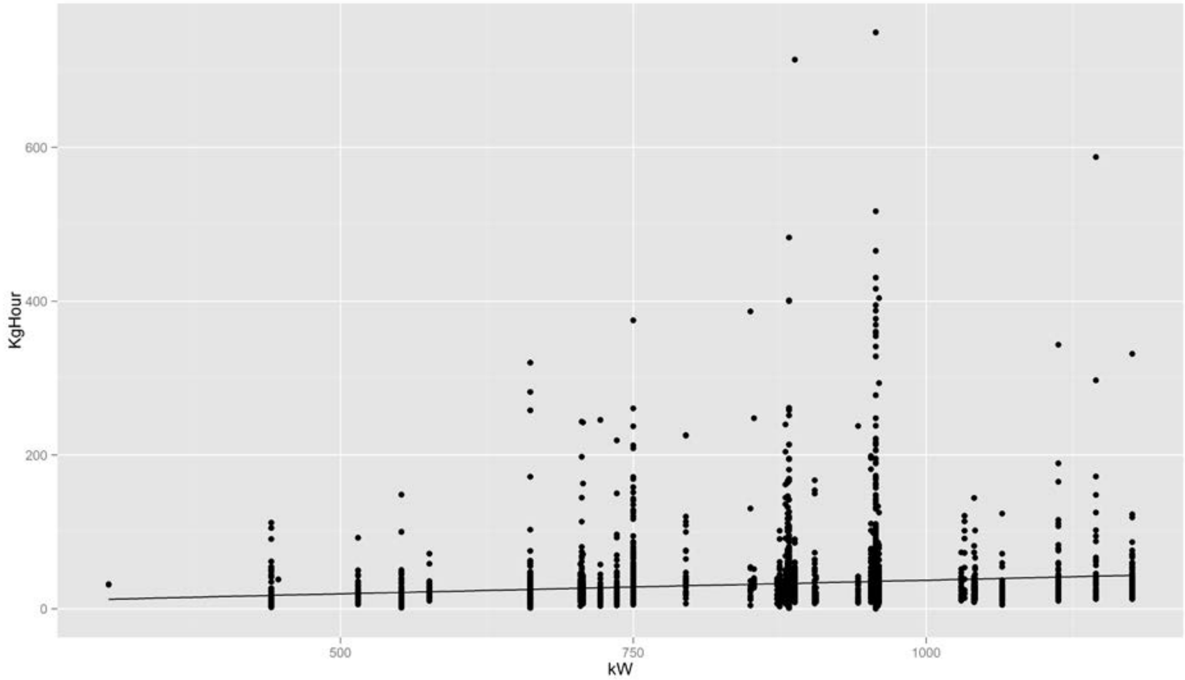


Figure 3.4. Nominal sole catch rate (Kg/h per trip) against HP (kW)) of trips with HP >221 kW and catches in the selected rectangles. Linear fit for CPUE vs HP.

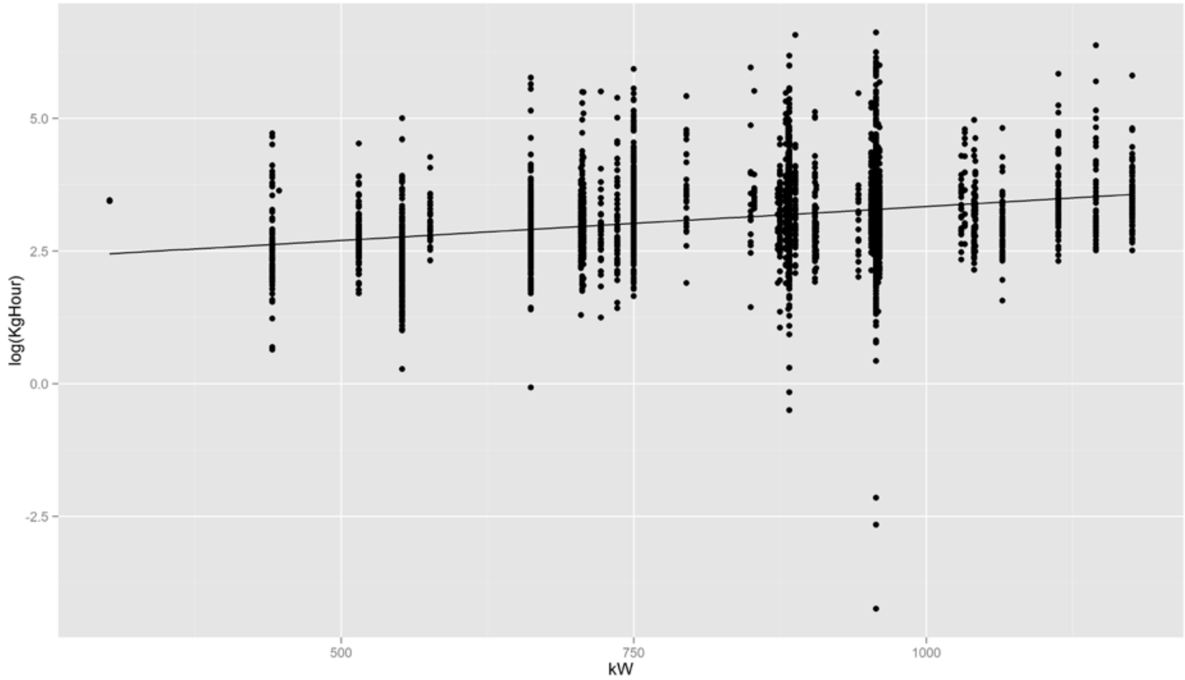


Figure 3.5. Nominal log transformed sole catch rate (log Kg/h per trip) against HP (kW) of trips with HP >221 kW and catches in the selected rectangles. Linear fit for CPUE vs HP.

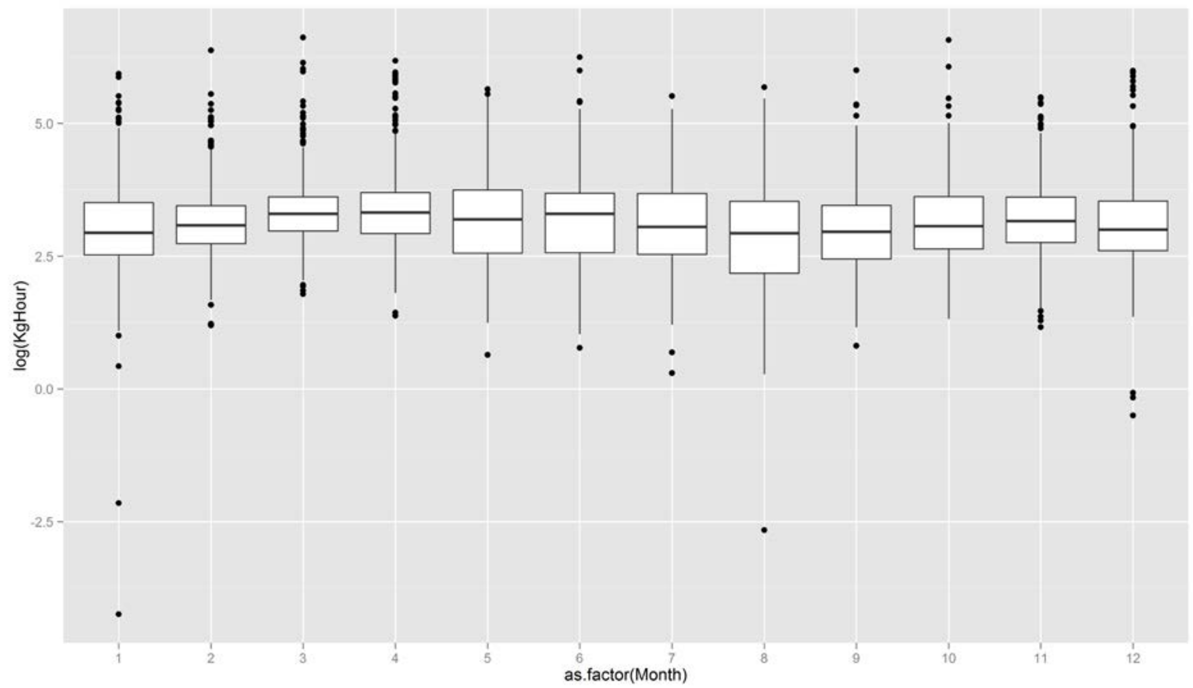


Figure 3.6. Nominal log transformed catch rates of sole (Kg/h per trip) by month of trips with HP >221 kW and catches in the selected rectangles.

Identification of outliers – at sea sampling

To have an idea on the common catch rates of sole, we calculated the catch rates of sole (Kg/h) based on the data from the Belgian beam trawl at sea sampling program performed by ILVO scientific observers at sea (2003-2015) in ICES division 7d. An average catch rate of 18.8 kg/h (min 2 kg/h and max 52 kg/h) per trip was found, although per haul occasionally higher values were registered.

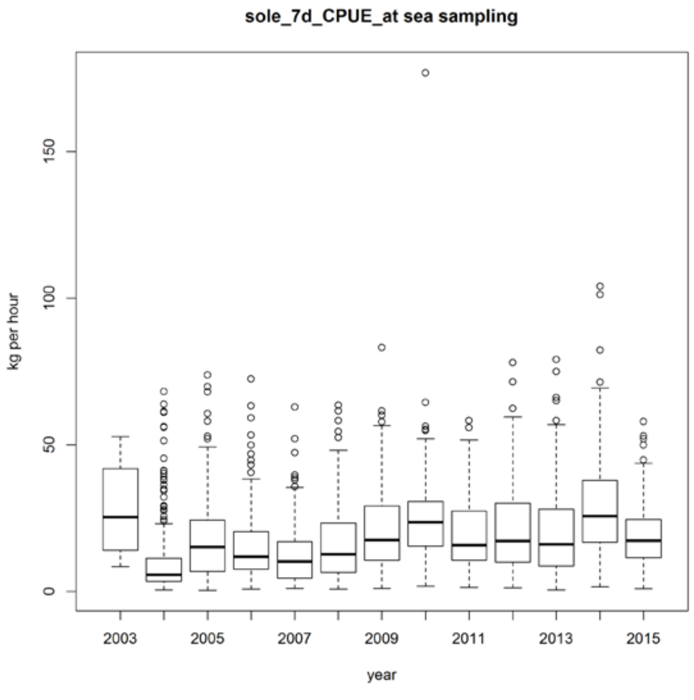


Figure 3.7. Catch rates of sole (Kg/h per trip) by haul from Belgian beam trawl at sea sampling program performed by ILVO scientific observers at sea.

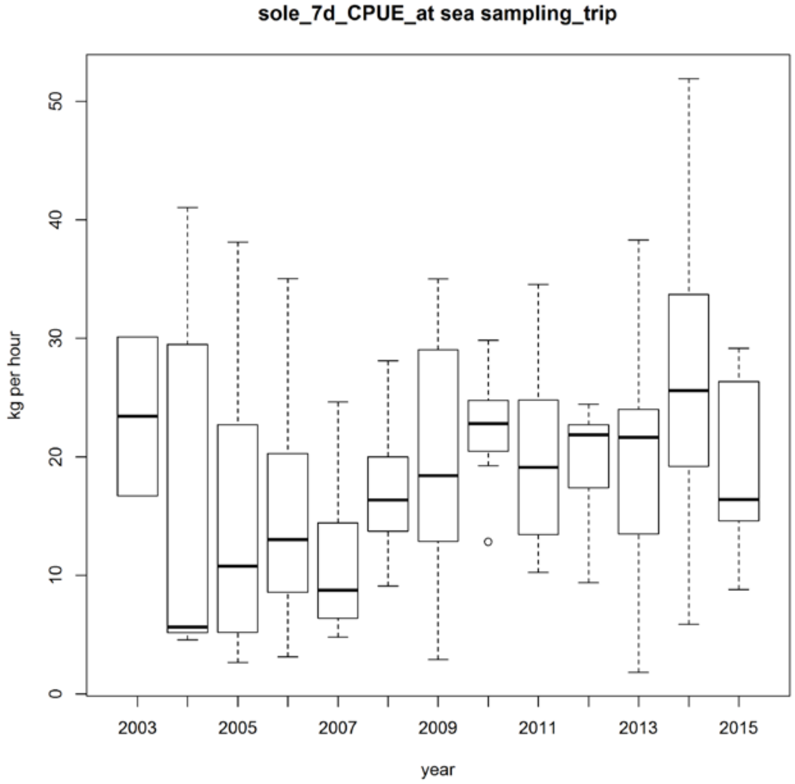


Figure 3.8. Catch rates of sole (Kg/h per trip) by trip from Belgian beam trawl at sea sampling program performed by ILVO scientific observers at sea.

Identification of outliers – misreporting catches

A plot of catch rate against fishing hours clearly shows that for low fishing hours a lot of extremely high catch rates were calculated. This is likely due to the fact that catches are misreported. Therefore it was decided to exclude the catch rates with fishing hours lower than 25.

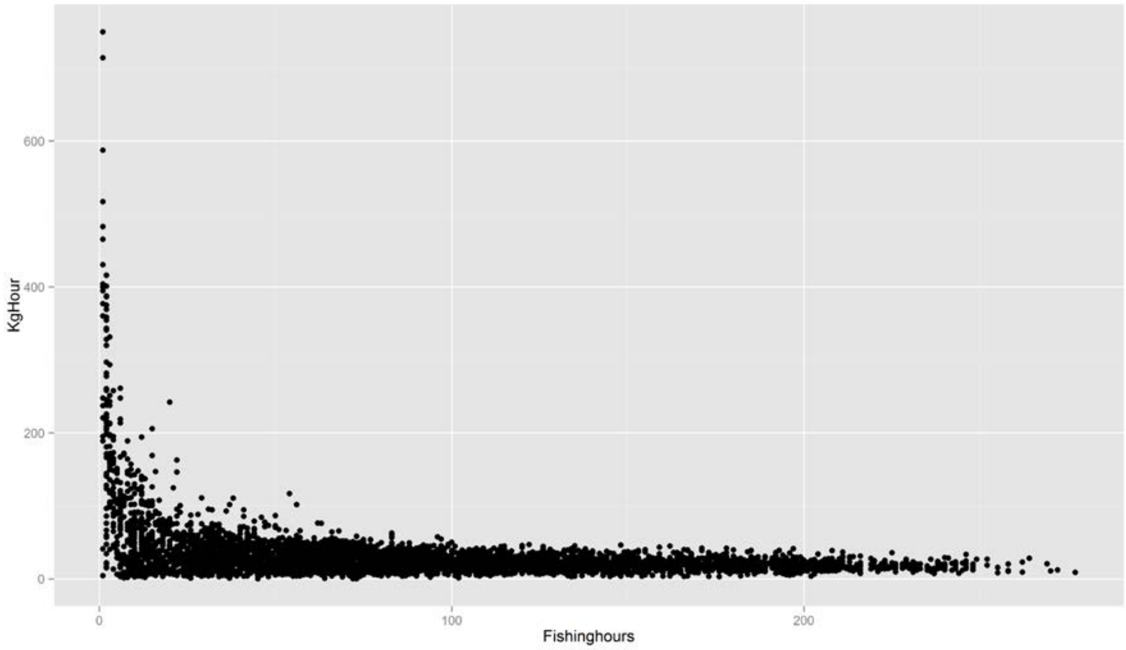


Figure 3.9. Catch rate of sole (Kg/h per trip) against fishing hours

Dataset 3 (2003-2015)

From dataset 2 we only selected the trips with fishing hours >25 and a catch rate > 1.

Year	Number of trips fishing hours >25	Number of trips fishing hours >25 and CPUE>1
2003	423	423
2004	372	371
2005	310	307
2006	427	427
2007	464	464
2008	398	397
2009	361	361
2010	258	258
2011	266	266
2012	221	221
2013	239	239
2014	331	331
2015	305	304

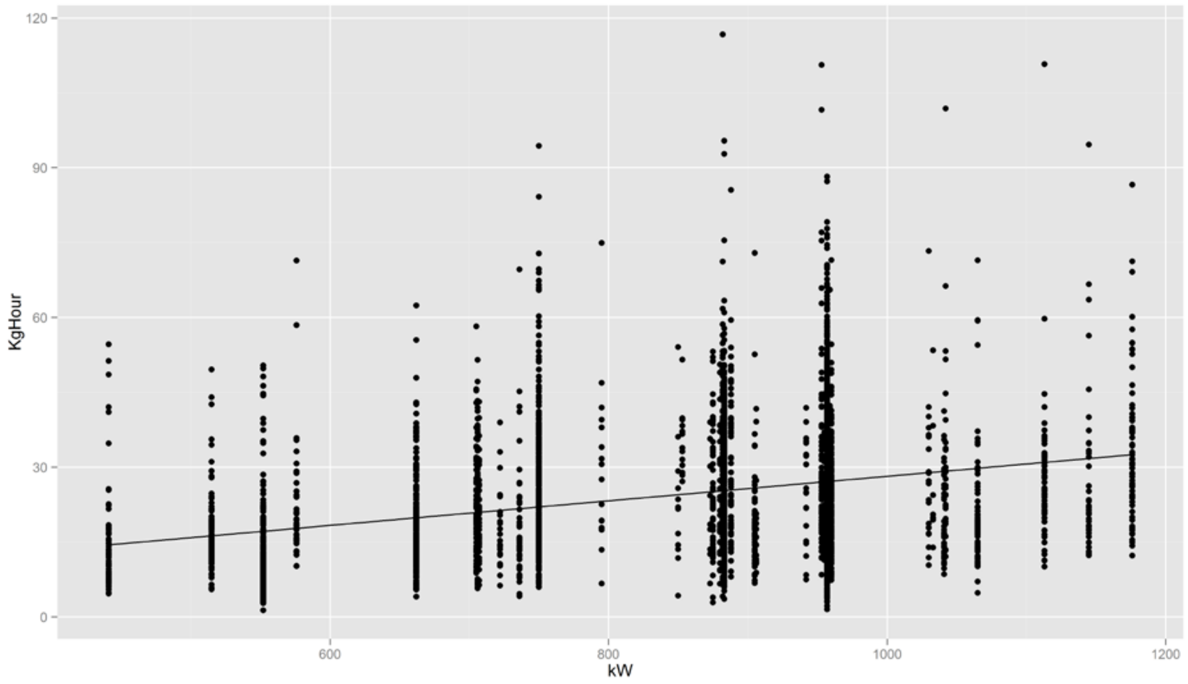


Figure 3.10. Nominal sole catch rate (Kg/h per trip) against HP (kW)) of trips with HP >221 kW, catches in the selected rectangles, fishing hours >25 and a catch rate >1. Linear fit for CPUE vs HP.

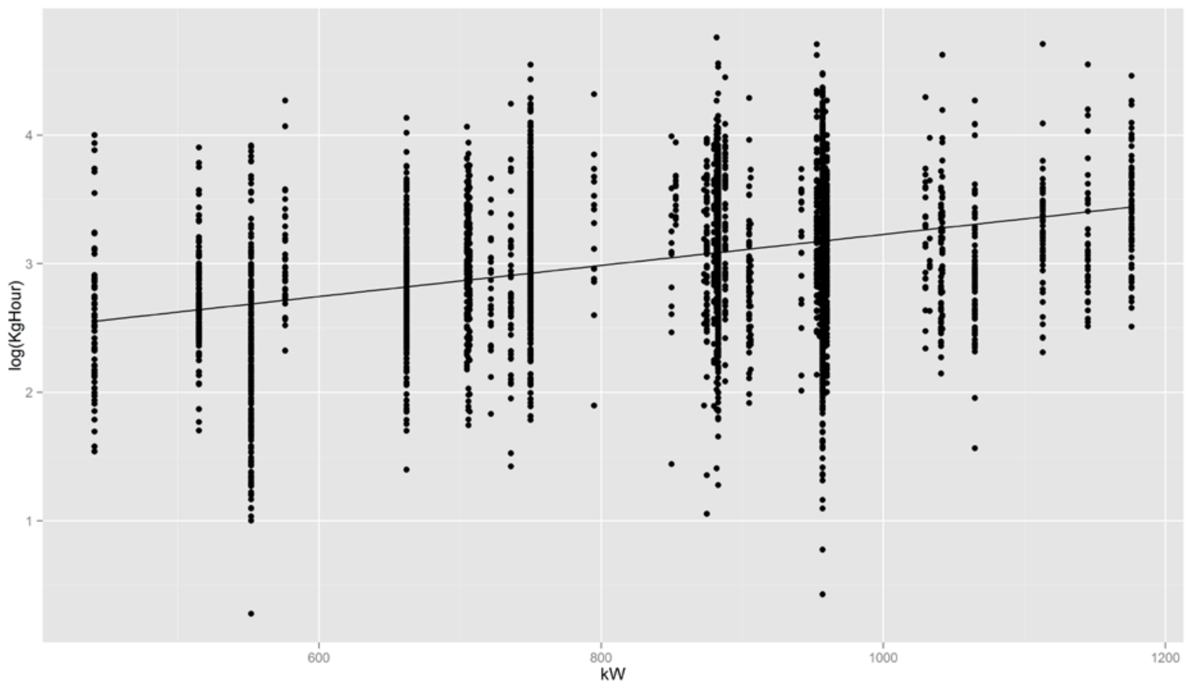


Figure 3.11. Nominal log transformed sole catch rate (log Kg/h per trip) against HP (kW) of trips with HP >221 kW and catches in the selected rectangles, fishing hours >25 and a catch rate >1. Linear fit for CPUE vs HP.

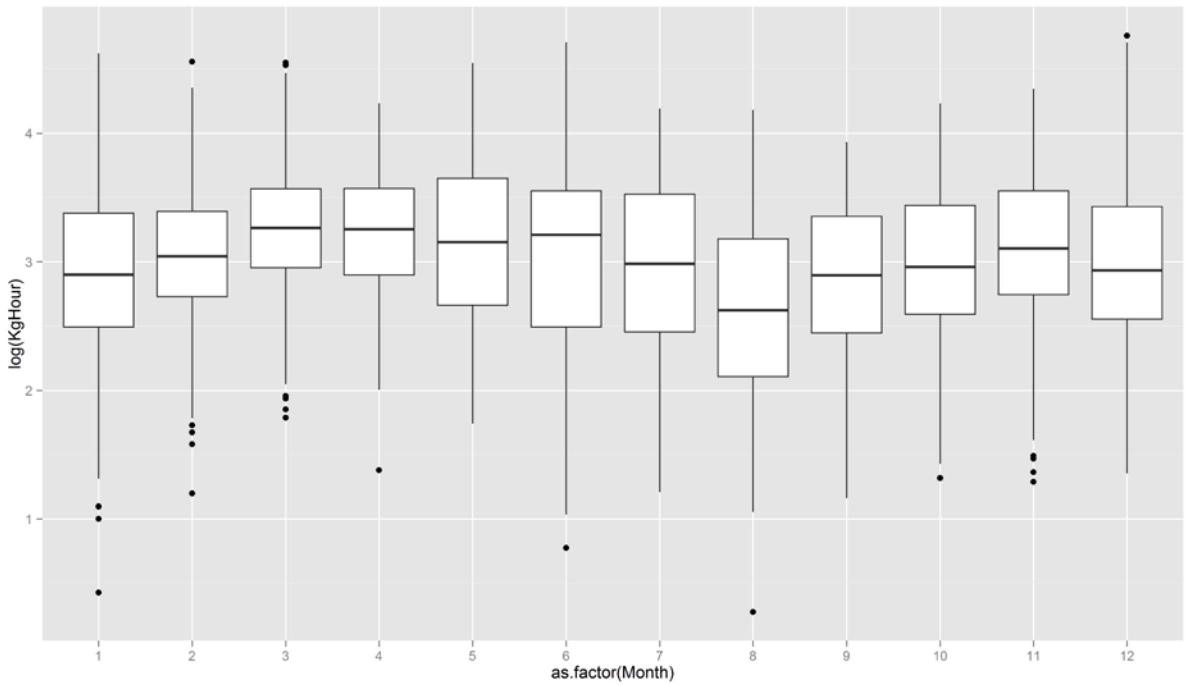


Figure 3.12. Nominal log transformed catch rates of sole (Kg/h per trip) by month of trips with HP >221 kW and catches in the selected rectangles, fishing hours >25 and a catch rate >1.

Dataset 4 (2006-2015)

As for dataset 2, we only selected the vessels with HP>221kW and the rectangles with at least one trip in each year for the period (2006-2015). In dataset 2, the catch rates were calculated on trip level, whereas in dataset 4, we aggregated the data by trip and rectangle. We added information on quarter and we grouped the horsepower information into 21 different kW classes (original dataset contains 33 different kW values).

Year	Number of trips
2006	485
2007	542
2008	444
2009	413
2010	294
2011	300
2012	266
2013	278
2014	364
2015	338

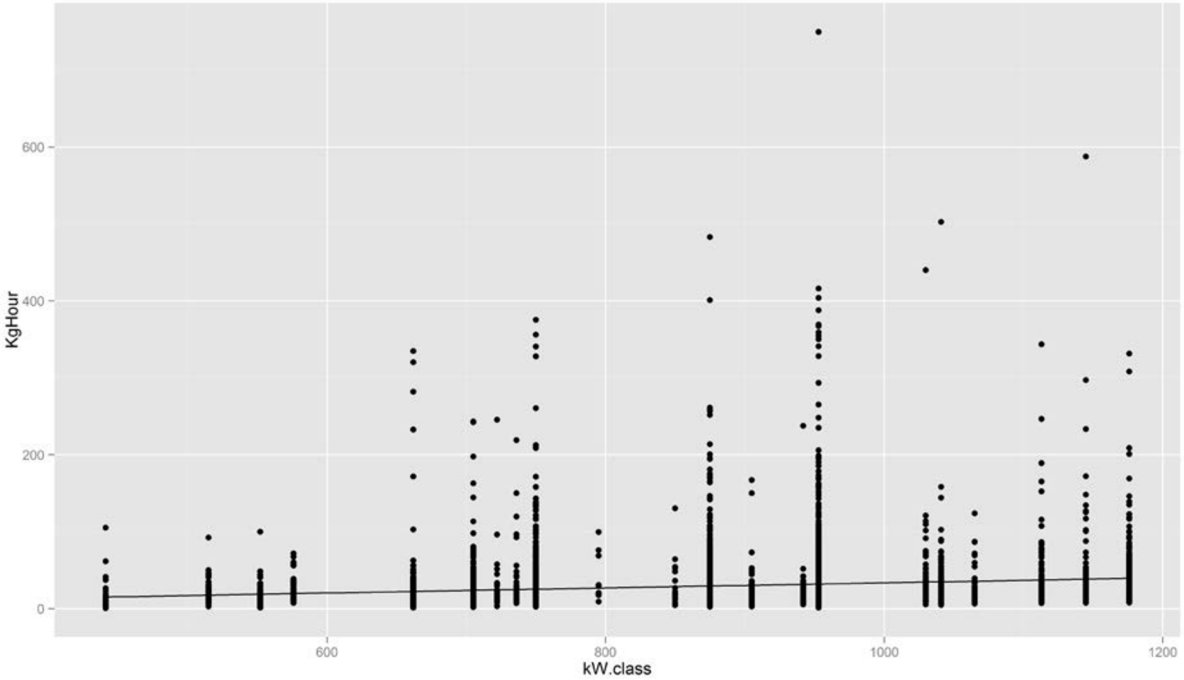


Figure 3.13. Nominal sole catch rate (Kg/h per trip + rectangle) against HP class (kW class)) of trips with HP >221 kW and catches in the selected rectangles. Linear fit for CPUE vs HP class.

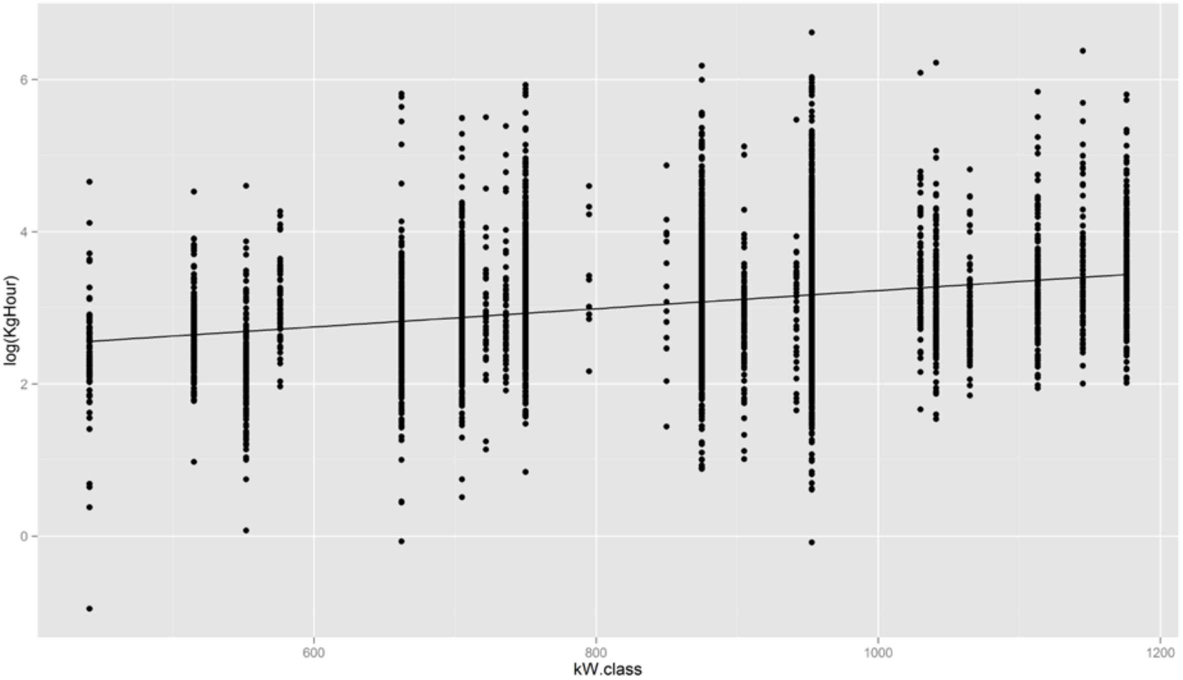


Figure 3.14. Nominal log transformed sole catch rate (log Kg/h per trip + rectangle) against HP class (kW class) of trips with HP >221 kW and catches in the selected rectangles. Linear fit for CPUE vs HP class.

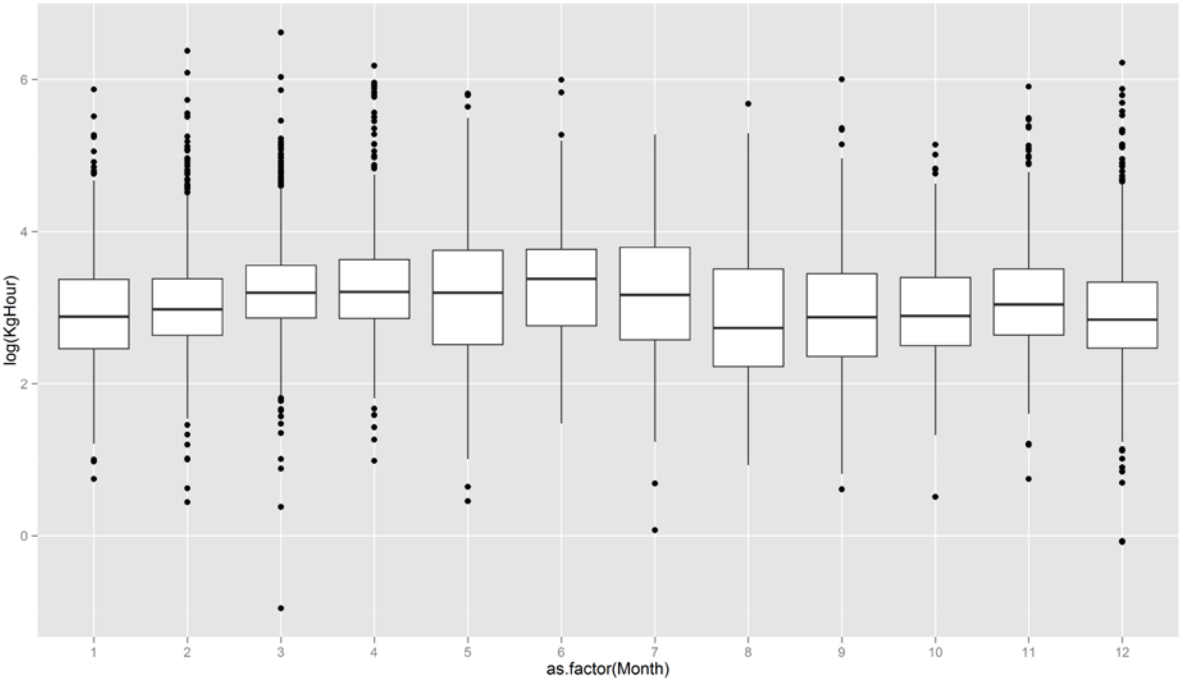


Figure 3.15. Nominal log transformed catch rates of sole (Kg/h per trip + rectangle) by month of trips with HP >221 kW and catches in the selected rectangles.

Dataset 5 (2006-2015)

From dataset 4 we only selected the records with fishing hours >25 and a catch rate > 1.

Year	Number of trips fishing hours >25	Number of trips fishing hours >25 and CPUE>1
2006	411	411
2007	448	448
2008	377	377
2009	345	345
2010	253	253
2011	253	253
2012	213	213
2013	226	226
2014	322	322
2015	299	298

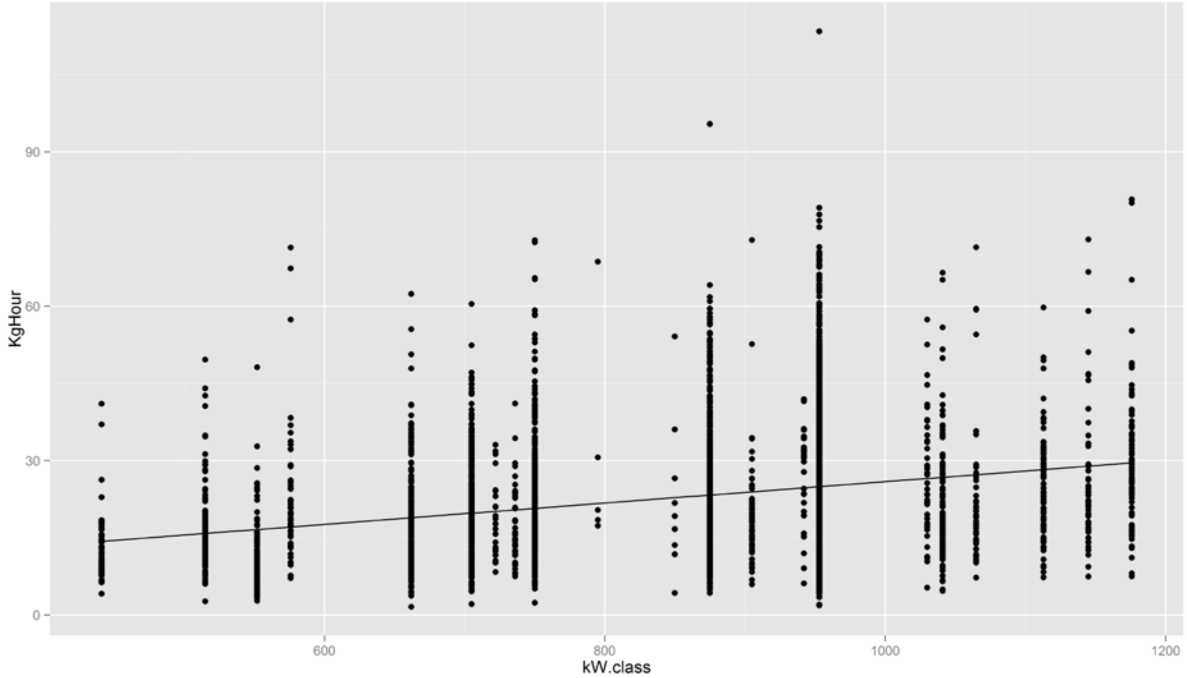


Figure 3.16. Nominal sole catch rate (Kg/h per trip + rectangle) against HP class (kW class)) of trips with HP >221 kW, catches in the selected rectangles, fishing hours >25 and a catch rate >1. Linear fit for CPUE vs HP class.

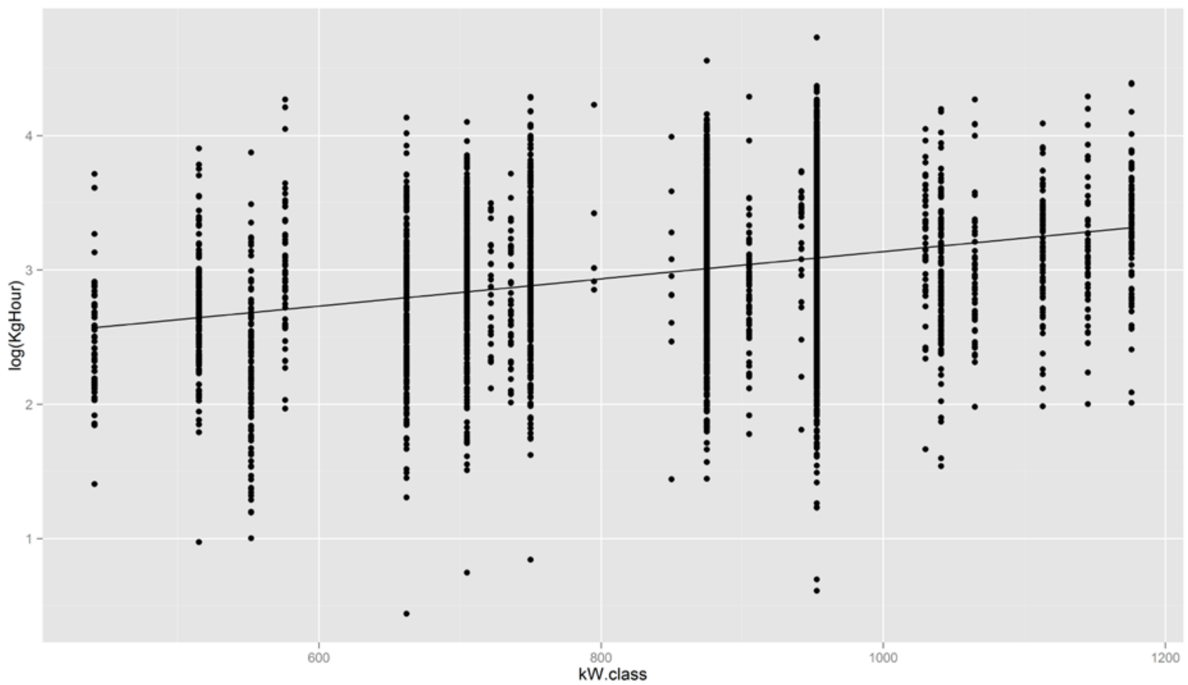


Figure 3.17. Nominal log transformed sole catch rate (log Kg/h per trip + rectangle) against HP class (kW class) of trips with HP >221 kW and catches in the selected rectangles, fishing hours >25 and a catch rate >1. Linear fit for CPUE vs HP class.

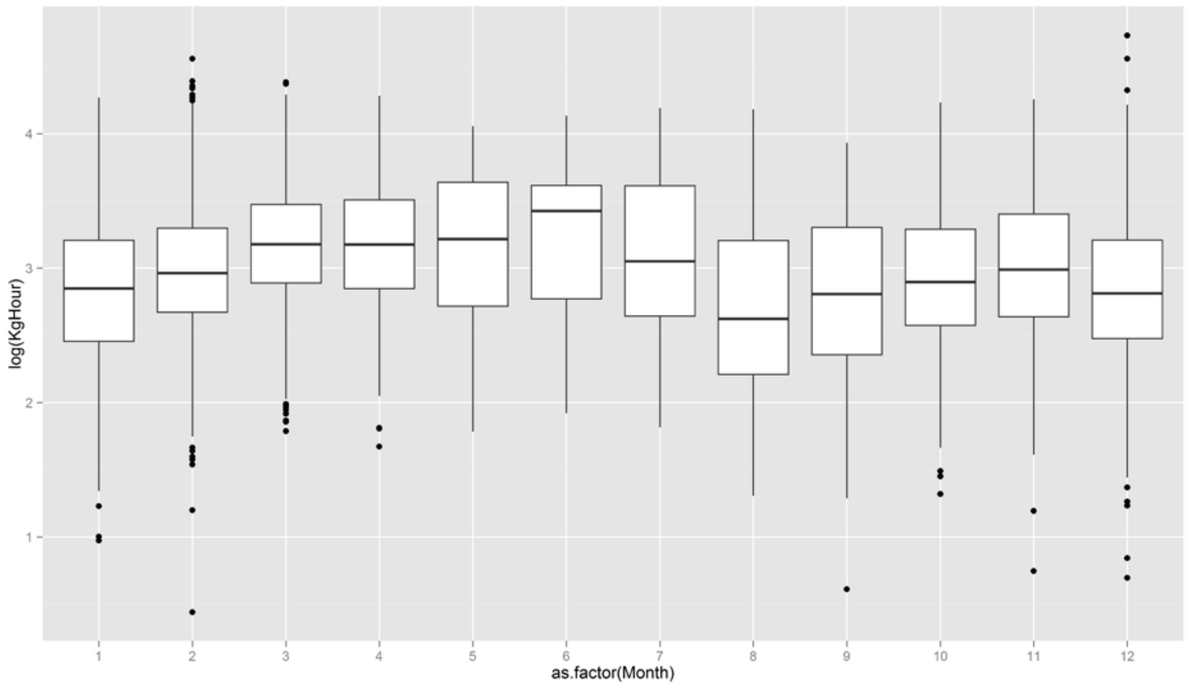


Figure 3.18. Nominal log transformed catch rates of sole (Kg/h per trip + rectangle) by month of trips with HP >221 kW and catches in the selected rectangles, fishing hours >25 and a catch rate >1.

Dataset 6 (2006-2015)

As for dataset 4, we only selected the vessels with HP>221kW and only the rectangles with at least one trip in each year for the period (2006-2015). We aggregated the data by trip and rectangle. We added information on quarter and we grouped the horsepower information into 5 different kW classes. We only selected the records with fishing hours >25 and a catch rate > 1.

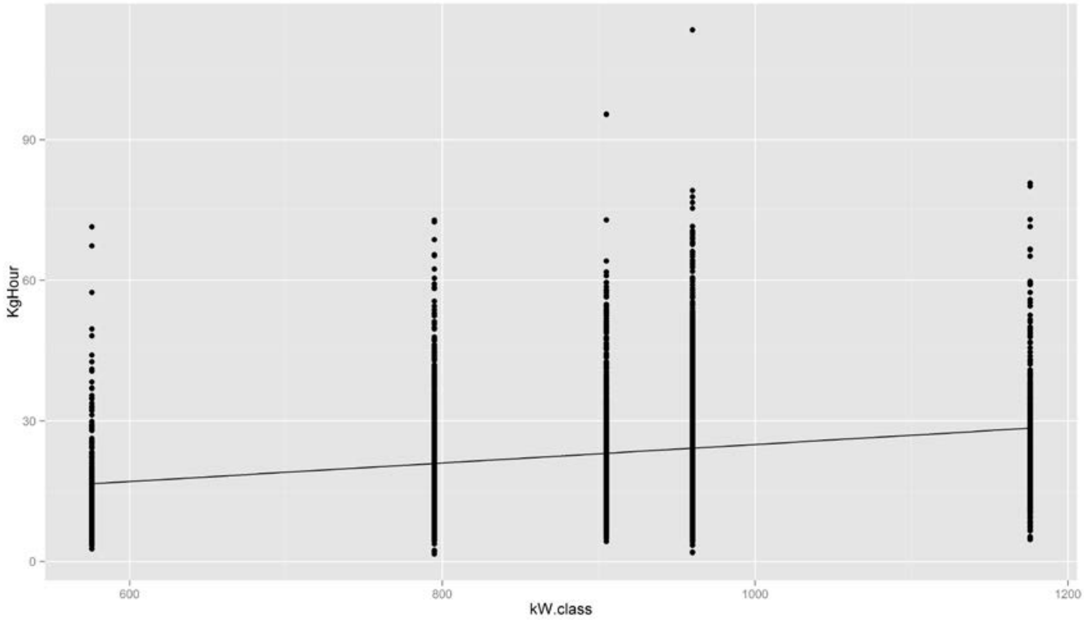


Figure 3.19. Nominal sole catch rate (Kg/h per trip + rectangle) against HP class (kW class)) of trips with HP >221 kW, catches in the selected rectangles, fishing hours >25 and a catch rate >1. Linear fit for CPUE vs HP class.

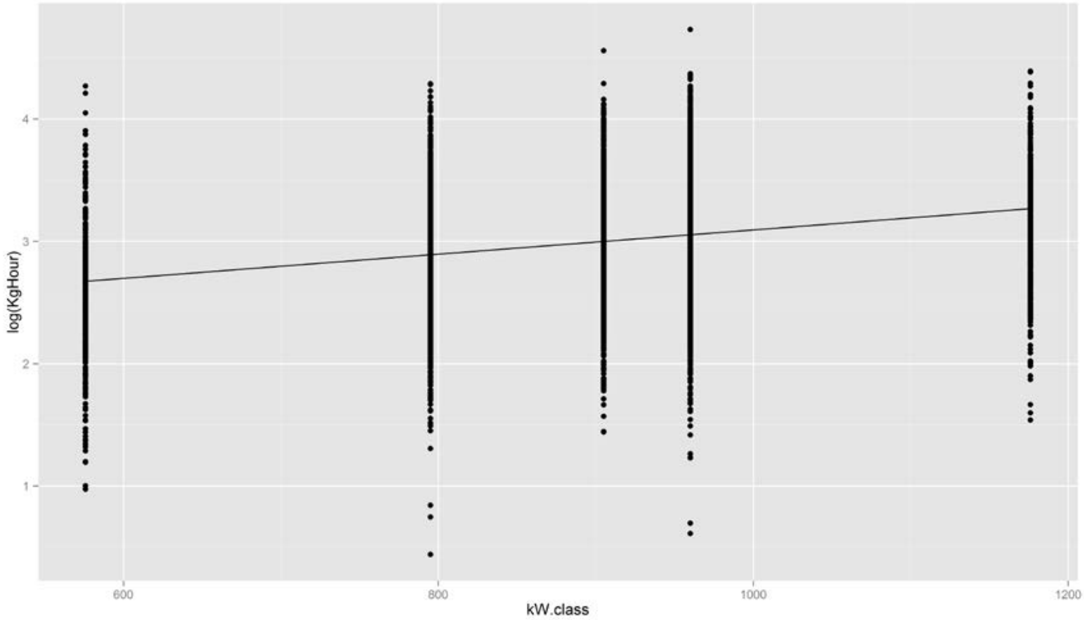


Figure 3.20. Nominal log transformed sole catch rate (log Kg/h per trip + rectangle) against HP class (kW class) of trips with HP >221 kW and catches in the selected rectangles, fishing hours >25 and a catch rate >1. Linear fit for CPUE vs HP class.

Dataset 7 (2006-2015)

As for dataset 4, we only selected the vessels with HP>221kW and only the rectangles with at least one trip in each year for the period (2006-2015). We aggregated the data by trip and rectangle. We added information on quarter and we grouped the horsepower information into 7 different kW classes. We only selected the records with fishing hours >25 and a catch rate > 1.

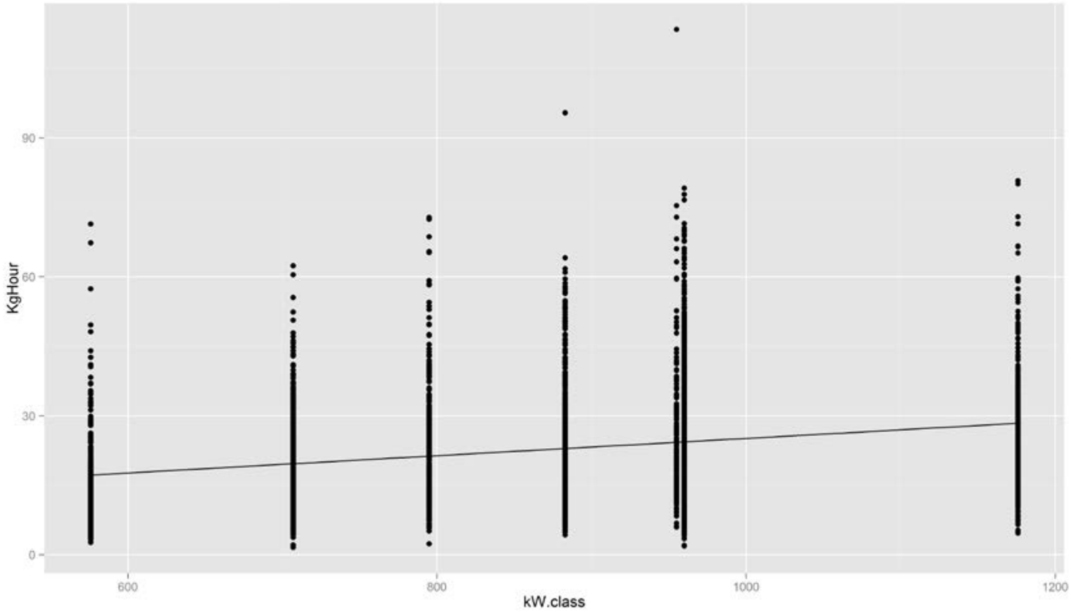


Figure 3.21. Nominal sole catch rate (Kg/h per trip + rectangle) against HP class (kW class)) of trips with HP >221 kW, catches in the selected rectangles, fishing hours >25 and a catch rate >1. Linear fit for CPUE vs HP class.

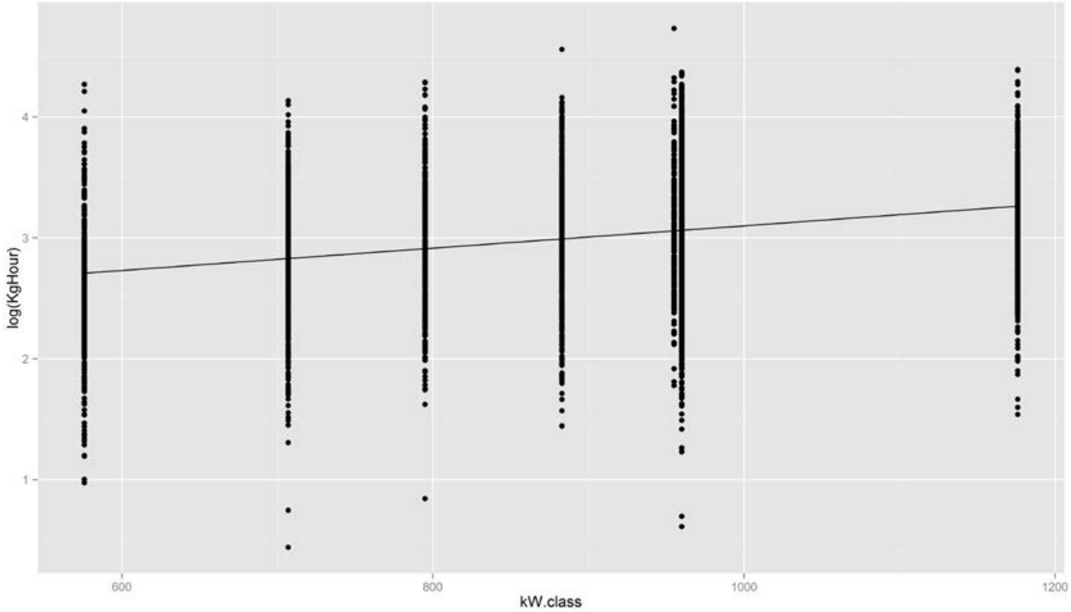


Figure 3.22. Nominal log transformed sole catch rate (log Kg/h per trip + rectangle) against HP class (kW class) of trips with HP >221 kW and catches in the selected rectangles, fishing hours >25 and a catch rate >1. Linear fit for CPUE vs HP class.

Dataset 8 (2006-2015)

As for dataset 4, we only selected the vessels with HP>221kW and only the rectangles with at least one trip in each year for the period (2006-2015). We aggregated the data by trip and rectangle. We added information on quarter and the horsepower information is not grouped into kW classes. We only selected the records with fishing hours >25 and a catch rate > 1.

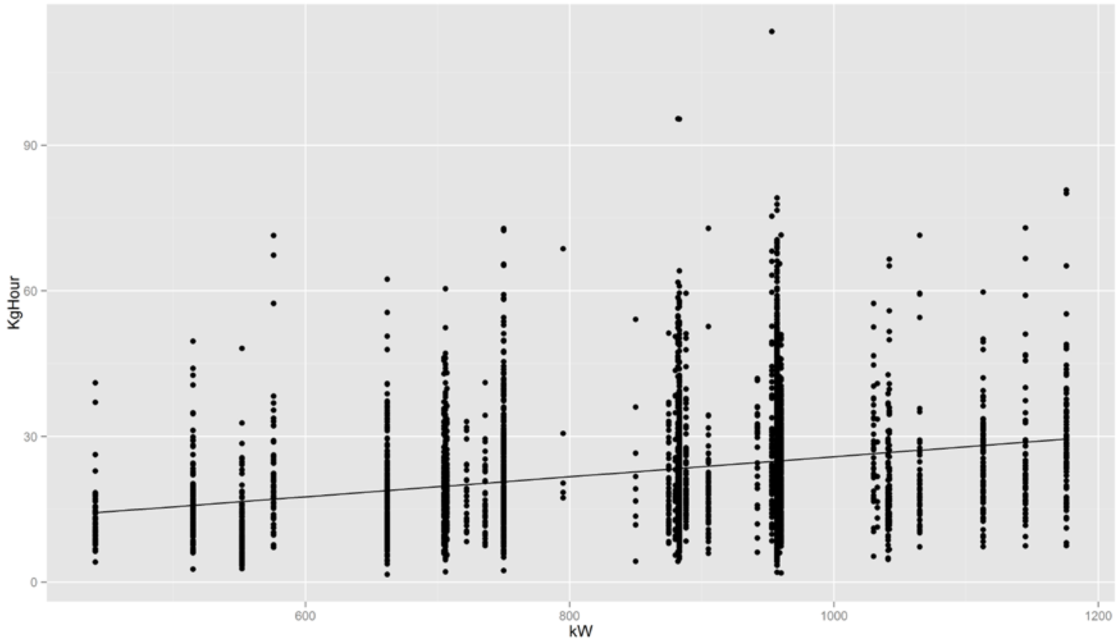


Figure 3.23. Nominal sole catch rate (Kg/h per trip + rectangle) against HP class (kW class)) of trips with HP >221 kW, catches in the selected rectangles, fishing hours >25 and a catch rate >1. Linear fit for CPUE vs HP class.

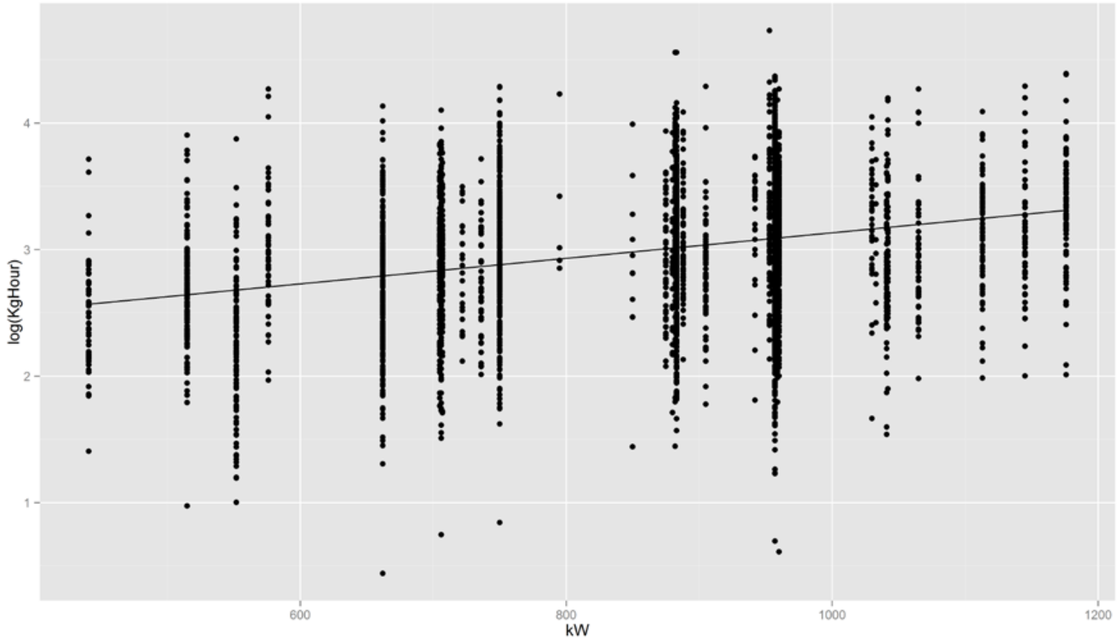


Figure 3.24. Nominal log transformed sole catch rate (log Kg/h per trip + rectangle) against HP class (kW class) of trips with HP >221 kW and catches in the selected rectangles, fishing hours >25 and a catch rate >1. Linear fit for CPUE vs HP class.

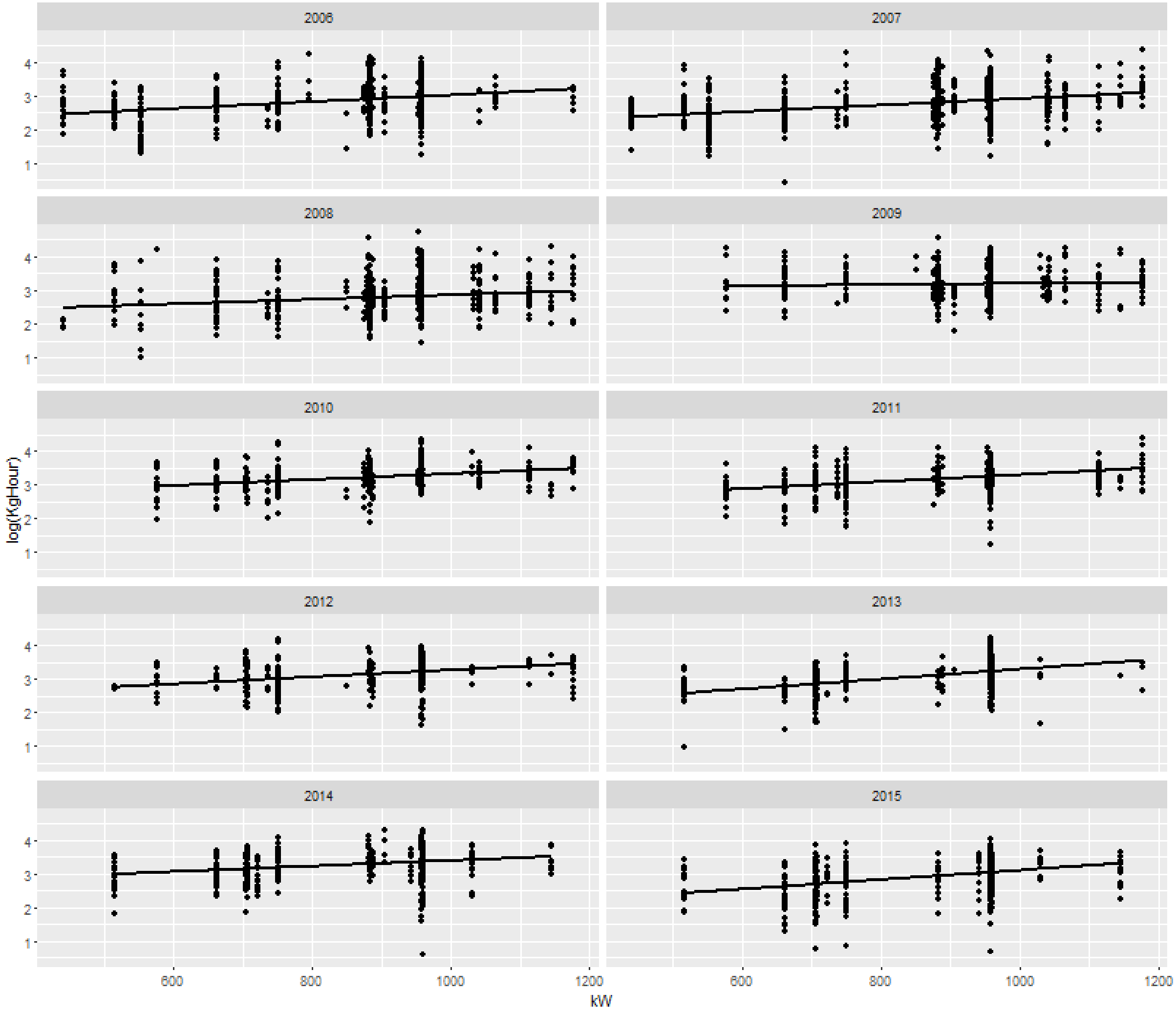


Figure 3.25. Nominal log transformed sole catch rate (log Kg/h per trip + rectangle) per year against HP class (kW class) of trips with HP >221 kW and catches in the selected rectangles, fishing hours >25 and a catch rate >1. Linear fit for CPUE vs HP class.

Model estimation

The standardization of the nominal log transformed catch rates was performed using a generalized linear model.

Generalized linear model (GLM) - dataset 2

A generalized linear model was applied, including year, month and HP factors. Year and month were treated as class factors, while HP was included as a continuous linear variable.

```
Call:

glm(formula = log(KgHour) ~ factor(Year) + factor(Month) + kW, data = weight)

Deviance Residuals:

    Min       1Q   Median       3Q      Max

-7.3334  -0.3946  -0.0535   0.3420   3.4016

Coefficients:

                   Estimate Std. Error t value Pr(>|t|)

(Intercept)          1.977e+00  6.660e-02  29.688  < 2e-16 ***
factor(Year)2004  1.506e-01  4.411e-02   3.414 0.000646 ***
factor(Year)2005 -4.713e-02  4.717e-02  -0.999 0.317777
factor(Year)2006 -1.354e-01  4.422e-02  -3.061 0.002215 **
factor(Year)2007 -1.669e-01  4.306e-02  -3.876 0.000108 ***
factor(Year)2008 -2.026e-01  4.554e-02  -4.449 8.81e-06 ***
factor(Year)2009  1.661e-01  4.648e-02   3.574 0.000355 ***
factor(Year)2010  1.068e-01  5.116e-02   2.088 0.036869 *
factor(Year)2011  8.081e-02  5.063e-02   1.596 0.110492
factor(Year)2012  1.206e-01  5.260e-02   2.293 0.021871 *
factor(Year)2013  1.822e-03  5.182e-02   0.035 0.971957
factor(Year)2014  1.361e-01  4.782e-02   2.845 0.004458 **
factor(Year)2015 -1.387e-01  4.885e-02  -2.840 0.004534 **
factor(Month)2    8.756e-02  3.520e-02   2.488 0.012888 *
factor(Month)3    2.857e-01  3.448e-02   8.288  < 2e-16 ***
factor(Month)4    3.802e-01  4.177e-02   9.102  < 2e-16 ***
factor(Month)5    1.561e-01  6.052e-02   2.579 0.009940 **
factor(Month)6    1.327e-01  8.054e-02   1.648 0.099369 .
factor(Month)7    9.842e-02  7.736e-02   1.272 0.203358
factor(Month)8   -4.793e-02  6.211e-02  -0.772 0.440331
factor(Month)9   -2.371e-02  5.823e-02  -0.407 0.683848
factor(Month)10   1.613e-01  4.912e-02   3.284 0.001032 **
factor(Month)11   1.772e-01  4.148e-02   4.273 1.97e-05 ***
factor(Month)12   6.330e-02  3.768e-02   1.680 0.092971 .
kW                1.214e-03  6.403e-05  18.961  < 2e-16 ***
---

Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

(Dispersion parameter for gaussian family taken to be 0.4731023)
```

Null deviance: 2756.3 on 5078 degrees of freedom

Residual deviance: 2391.1 on 5054 degrees of freedom

AIC: 10639

Number of Fisher Scoring iterations: 2

Start: AIC=10639.17

log(KgHour) ~ factor(Year) + factor(Month) + kW

```
                Df Deviance   AIC
<none>               2391.1 10639
- factor(Month) 11   2468.5 10779
- factor(Year)  12   2478.3 10797
- kW             1   2561.1 10986
```

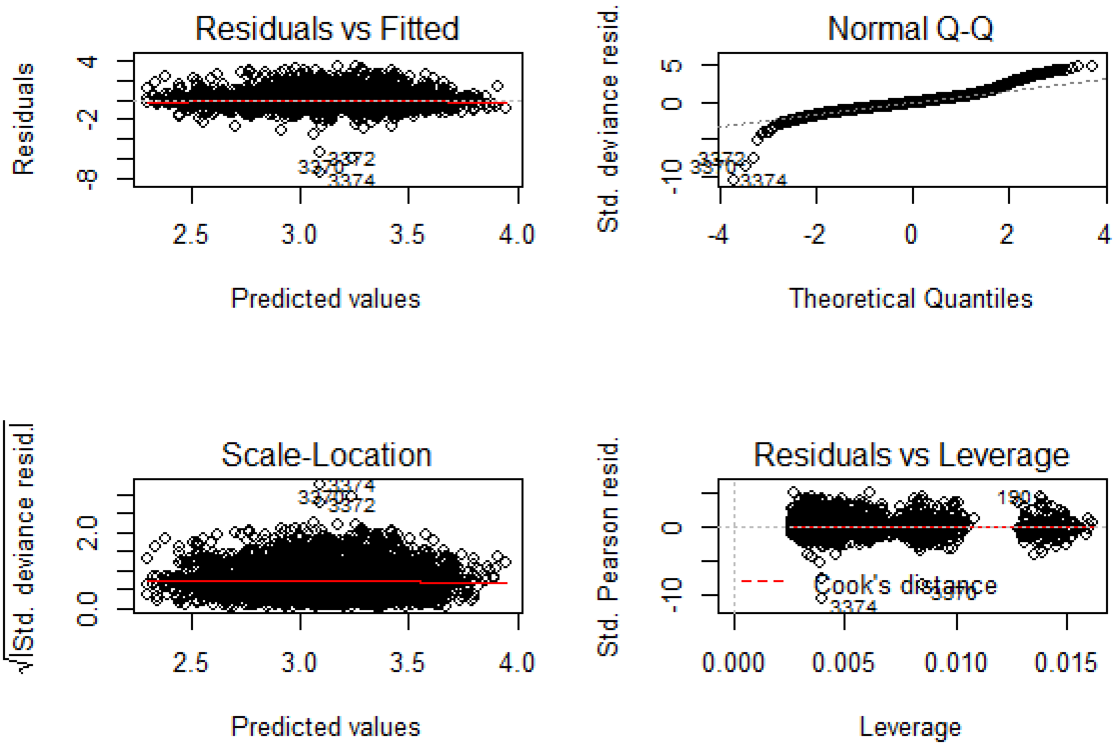


Figure 3.26. Residual plots- GLM-dataset 2

Generalized linear model (GLM) - dataset 3

A generalized linear model was applied, including year, month and HP factors. Year and month were treated as class factors, while HP was included as a continuous linear variable.

Call:

glm(formula = log(KgHour) ~ factor(Year) + factor(Month) + kW, data = weight_outlier_visuren2)

Deviance Residuals:

```
    Min       1Q   Median       3Q      Max
-2.62818  -0.31855  -0.00317   0.33890   1.96139


Coefficients:
                        Estimate Std. Error t value Pr(>|t|)
(Intercept)           2.001e+00  5.166e-02  38.736  < 2e-16 ***
factor(Year)2004  4.186e-03  3.557e-02   0.118 0.906309
factor(Year)2005 -4.630e-02  3.754e-02  -1.233 0.217555
factor(Year)2006 -1.523e-01  3.429e-02  -4.443 9.11e-06 ***
factor(Year)2007 -2.440e-01  3.367e-02  -7.246 5.06e-13 ***
factor(Year)2008 -2.282e-01  3.520e-02  -6.482 1.01e-10 ***
factor(Year)2009  1.589e-01  3.608e-02   4.404 1.09e-05 ***
factor(Year)2010  1.390e-01  3.973e-02   3.498 0.000473 ***
factor(Year)2011  1.272e-01  3.919e-02   3.247 0.001177 **
factor(Year)2012  1.176e-01  4.158e-02   2.828 0.004702 **
factor(Year)2013  6.452e-02  4.048e-02   1.594 0.111085
factor(Year)2014  2.012e-01  3.673e-02   5.478 4.55e-08 ***
factor(Year)2015 -1.199e-01  3.765e-02  -3.184 0.001463 **
factor(Month)2    1.192e-01  2.717e-02   4.388 1.17e-05 ***
factor(Month)3    3.067e-01  2.664e-02  11.512  < 2e-16 ***
factor(Month)4    2.748e-01  3.393e-02   8.101 7.04e-16 ***
factor(Month)5    1.418e-01  5.041e-02   2.813 0.004937 **
factor(Month)6   -5.103e-03  7.054e-02  -0.072 0.942337
factor(Month)7   -3.133e-02  6.640e-02  -0.472 0.637036
factor(Month)8   -2.341e-01  5.149e-02  -4.547 5.59e-06 ***
factor(Month)9   -3.896e-02  4.634e-02  -0.841 0.400523
factor(Month)10   7.278e-02  3.922e-02   1.856 0.063542 .
factor(Month)11   1.789e-01  3.210e-02   5.572 2.67e-08 ***
factor(Month)12   5.791e-02  2.945e-02   1.966 0.049358 *
kW              1.097e-03  4.943e-05  22.191  < 2e-16 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

(Dispersion parameter for gaussian family taken to be 0.2491426)

Null deviance: 1411.1  on 4369  degrees of freedom

Residual deviance: 1082.5  on 4345  degrees of freedom
```

AIC: 6355.3

```
Number of Fisher Scoring iterations: 2
```

Start: AIC=6355.33

```
log(KgHour) ~ factor(Year) + factor(Month) + kW
```

```
               Df Deviance    AIC
<none>              1082.5 6355.3
- factor(Month) 11   1154.0 6612.8
- factor(Year)  12   1179.2 6705.0
- kW             1   1205.2 6822.5
```

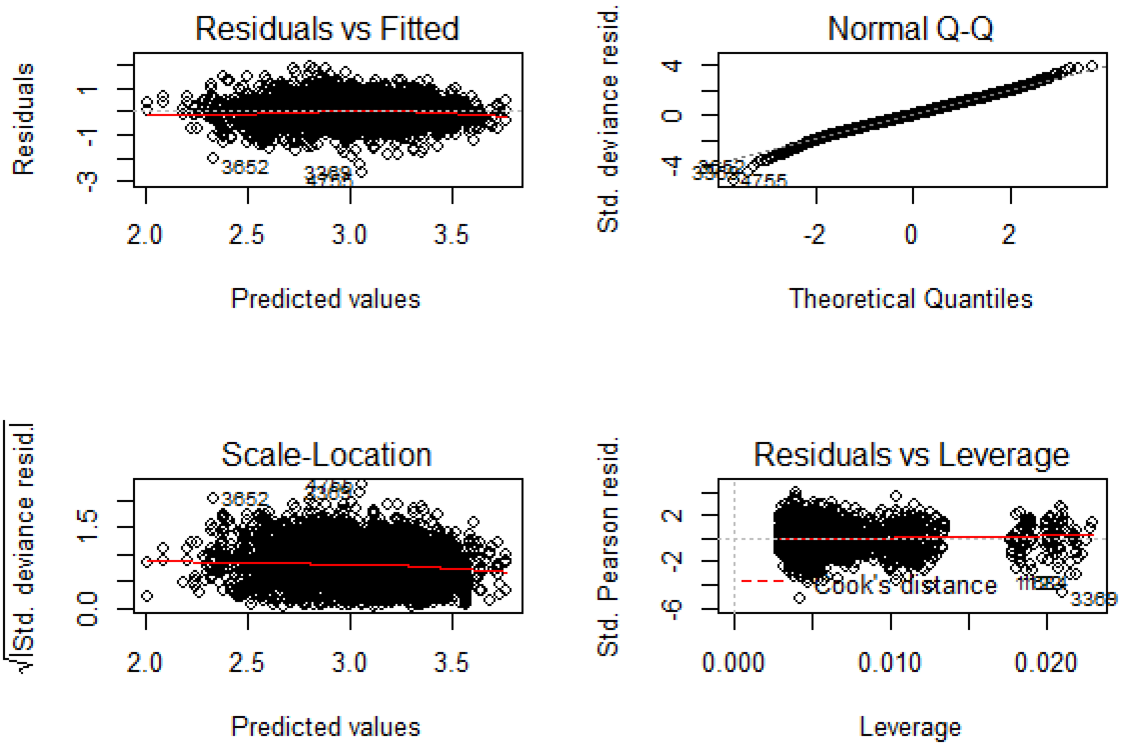


Figure 3.27. Residual plots- GLM-dataset 3

Generalized linear model (GLM) - dataset 4

A generalized linear model was applied, including year, quarter, rectangle and HPclass as factors.

Call:

glm(formula = log(KgHour) ~ factor(Year) + factor(Quarter) + factor(IcesStatisticalRectangle) + factor(kW.class), data = weight)

Deviance Residuals:

```
    Min      1Q   Median      3Q     Max
-3.3516  -0.3946  -0.0381   0.3585   3.5524
```

Coefficients:

```
                          Estimate Std. Error t value Pr(>|t|)
(Intercept)               2.525018   0.078861  32.019  < 2e-16 ***
```

```
factor(Year)2007                -0.045067   0.030157  -1.494 0.135111
factor(Year)2008                -0.089970   0.032144  -2.799 0.005141 **
factor(Year)2009                 0.267277   0.033725   7.925 2.64e-15 ***
factor(Year)2010                 0.237106   0.037171   6.379 1.90e-10 ***
factor(Year)2011                 0.149565   0.036727   4.072 4.71e-05 ***
factor(Year)2012                 0.148383   0.038545   3.850 0.000119 ***
factor(Year)2013                -0.006060   0.038572  -0.157 0.875163
factor(Year)2014                 0.201097   0.035968   5.591 2.35e-08 ***
factor(Year)2015                -0.096375   0.036623  -2.632 0.008518 **
factor(Quarter)2                 0.197029   0.026932   7.316 2.86e-13 ***
factor(Quarter)3                -0.026062   0.034307  -0.760 0.447480
factor(Quarter)4                -0.034843   0.020239  -1.722 0.085200 .
factor(IcesStatisticalRectangle)29E8  0.467106   0.051520   9.066  < 2e-16 ***
factor(IcesStatisticalRectangle)29E9 -0.058123   0.027271  -2.131 0.033103 *
factor(IcesStatisticalRectangle)29F0 -0.164168   0.031119  -5.275 1.37e-07 ***
factor(IcesStatisticalRectangle)29F1 -0.127162   0.062986  -2.019 0.043537 *
factor(IcesStatisticalRectangle)30E9 -0.191803   0.034433  -5.570 2.64e-08 ***
factor(IcesStatisticalRectangle)30F0 -0.128484   0.028407  -4.523 6.20e-06 ***
factor(IcesStatisticalRectangle)30F1 -0.004372   0.033439  -0.131 0.895982
factor(kW.class)515              0.224125   0.090399   2.479 0.013189 *
factor(kW.class)552             -0.155526   0.087358  -1.780 0.075067 .
factor(kW.class)576              0.373061   0.109916   3.394 0.000693 ***
factor(kW.class)662              0.278589   0.081431   3.421 0.000627 ***
factor(kW.class)705              0.469970   0.082140   5.722 1.10e-08 ***
factor(kW.class)722              0.417556   0.126524   3.300 0.000971 ***
factor(kW.class)736              0.447834   0.110168   4.065 4.86e-05 ***
factor(kW.class)750              0.595083   0.079997   7.439 1.14e-13 ***
factor(kW.class)795              1.009429   0.231267   4.365 1.29e-05 ***
factor(kW.class)850              0.519328   0.176178   2.948 0.003212 **
factor(kW.class)875              0.549584   0.076657   7.169 8.33e-13 ***
factor(kW.class)905              0.315569   0.096183   3.281 0.001040 **
factor(kW.class)942              0.535753   0.127914   4.188 2.85e-05 ***
factor(kW.class)953              0.645202   0.075648   8.529  < 2e-16 ***
factor(kW.class)1030             0.840308   0.110740   7.588 3.68e-14 ***
factor(kW.class)1041             0.544862   0.090007   6.054 1.49e-09 ***
factor(kW.class)1065             0.522463   0.100890   5.179 2.30e-07 ***
factor(kW.class)1113             0.785499   0.092242   8.516  < 2e-16 ***
factor(kW.class)1145             0.883039   0.103301   8.548  < 2e-16 ***
factor(kW.class)1176             0.849943   0.089025   9.547  < 2e-16 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1


(Dispersion parameter for gaussian family taken to be 0.4297864)

Null deviance: 3506.1  on 6823  degrees of freedom

Residual deviance: 2915.7  on 6784  degrees of freedom
```

AIC: 13645

Number of Fisher Scoring iterations: 2

Start: AIC=13644.91

log(KgHour) ~ factor(Year) + factor(Quarter) + factor(IcesStatisticalRectangle) + factor(kW.class)

```
                                 Df Deviance   AIC
<none>                                2915.7 13645
- factor(Quarter)                 3   2944.3 13706
- factor(IcesStatisticalRectangle) 7   2999.5 13824
- factor(Year)                    9   3028.1 13885
- factor(kW.class)               20   3141.3 14114
```

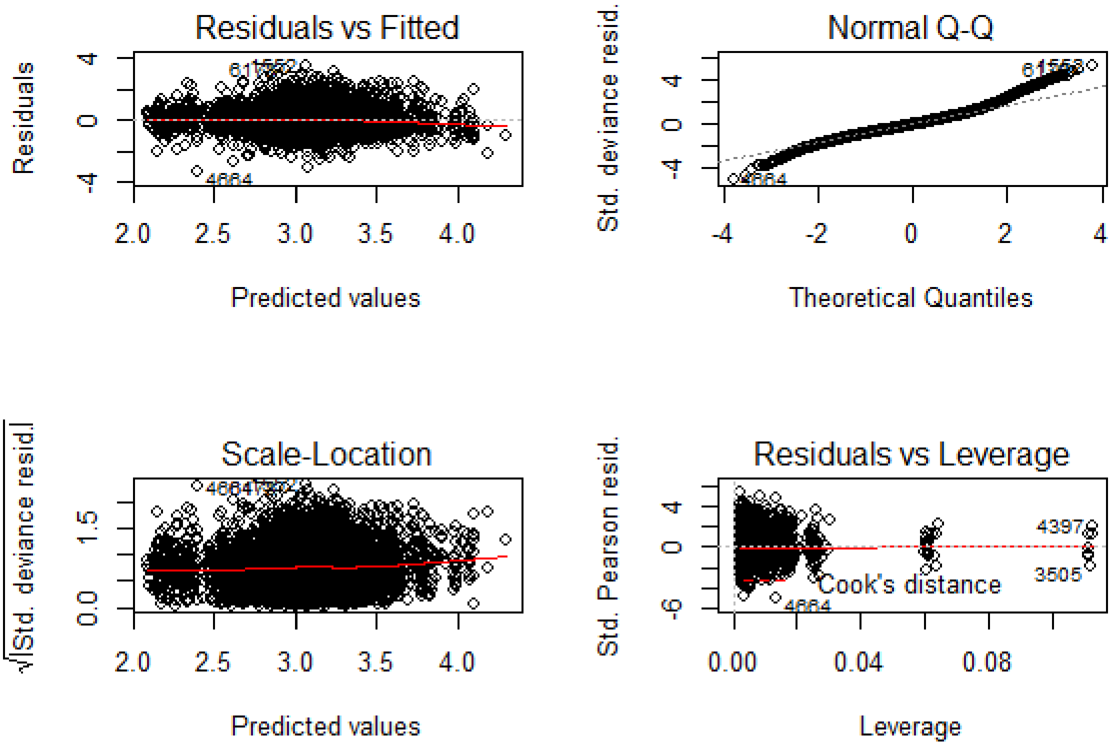


Figure 3.28. Residual plots- GLM-dataset 4

Generalized linear model (GLM) - dataset 5

A generalized linear model was applied, including year, quarter, rectangle and HPclass as factors.

Call:

glm(formula = log(KgHour) ~ factor(Year) + factor(Quarter) + factor(IcesStatisticalRectangle) + factor(kW.class), data = weight_outlier_visuren2)

Deviance Residuals:

```
     Min       1Q   Median       3Q      Max

-2.55441  -0.29876  -0.00025   0.30653   1.92819

Coefficients:

                                   Estimate Std. Error t value Pr(>|t|)

(Intercept)                         2.663049   0.068145  39.079  < 2e-16 ***
factor(Year)2007                   -0.058882   0.027635  -2.131 0.033170 *
factor(Year)2008                   -0.094373   0.029135  -3.239 0.001208 **
factor(Year)2009                    0.272285   0.030725   8.862  < 2e-16 ***
factor(Year)2010                    0.331733   0.033691   9.846  < 2e-16 ***
factor(Year)2011                    0.269481   0.033762   7.982 1.84e-15 ***
factor(Year)2012                    0.243286   0.035982   6.761 1.55e-11 ***
factor(Year)2013                    0.171024   0.035553   4.810 1.56e-06 ***
factor(Year)2014                    0.378741   0.032452  11.671  < 2e-16 ***
factor(Year)2015                    0.013777   0.033084   0.416 0.677118
factor(Quarter)2                    0.122290   0.026124   4.681 2.94e-06 ***
factor(Quarter)3                   -0.155403   0.031479  -4.937 8.25e-07 ***
factor(Quarter)4                   -0.090590   0.019359  -4.680 2.96e-06 ***
factor(IcesStatisticalRectangle)29E8  0.139163   0.071182   1.955 0.050644 .
factor(IcesStatisticalRectangle)29E9 -0.086027   0.024184  -3.557 0.000379 ***
factor(IcesStatisticalRectangle)29F0 -0.107635   0.028598  -3.764 0.000170 ***
factor(IcesStatisticalRectangle)29F1  0.049243   0.056799   0.867 0.386005
factor(IcesStatisticalRectangle)30E9 -0.153423   0.032456  -4.727 2.35e-06 ***
factor(IcesStatisticalRectangle)30F0 -0.076171   0.026351  -2.891 0.003864 **
factor(IcesStatisticalRectangle)30F1 -0.003987   0.034405  -0.116 0.907758
factor(kW.class)515                  0.037887   0.076884   0.493 0.622192
factor(kW.class)552                 -0.240678   0.076293  -3.155 0.001618 **
factor(kW.class)576                  0.111580   0.091762   1.216 0.224059
factor(kW.class)662                  0.092115   0.070055   1.315 0.188617
factor(kW.class)705                  0.168933   0.071497   2.363 0.018181 *
factor(kW.class)722                  0.071800   0.116323   0.617 0.537104
factor(kW.class)736                  0.029226   0.096737   0.302 0.762576
factor(kW.class)750                  0.239301   0.069826   3.427 0.000616 ***
factor(kW.class)795                  0.704824   0.221912   3.176 0.001503 **
factor(kW.class)850                  0.264285   0.157295   1.680 0.092995 .
factor(kW.class)875                  0.325022   0.066208   4.909 9.49e-07 ***
factor(kW.class)905                  0.216345   0.085530   2.529 0.011459 *
factor(kW.class)942                  0.438415   0.114020   3.845 0.000122 ***
factor(kW.class)953                  0.432420   0.065271   6.625 3.90e-11 ***
factor(kW.class)1030                  0.384569   0.097373   3.949 7.96e-05 ***
factor(kW.class)1041                  0.283787   0.077418   3.666 0.000250 ***
factor(kW.class)1065                  0.376854   0.089077   4.231 2.38e-05 ***
factor(kW.class)1113                  0.438748   0.083744   5.239 1.69e-07 ***
factor(kW.class)1145                  0.426470   0.092046   4.633 3.71e-06 ***
factor(kW.class)1176                  0.540703   0.083294   6.492 9.47e-11 ***
---
```

Signif. codes: 0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

(Dispersion parameter for gaussian family taken to be 0.2247659)

Null deviance: 1270.48 on 4318 degrees of freedom

Residual deviance: 961.77 on 4279 degrees of freedom

AIC: 5851.7

Number of Fisher Scoring iterations: 2

Start: AIC=5851.65

log(KgHour) ~ factor(Year) + factor(Quarter) + factor(IcesStatisticalRectangle) + factor(kW.class)

```
                                  Df Deviance    AIC
<none>                                 961.77 5851.7
- factor(IcesStatisticalRectangle)  7   973.18 5888.6
- factor(Quarter)                   3   978.21 5918.8
- factor(kW.class)                 20  1068.04 6264.3
- factor(Year)                      9  1071.12 6298.7
```

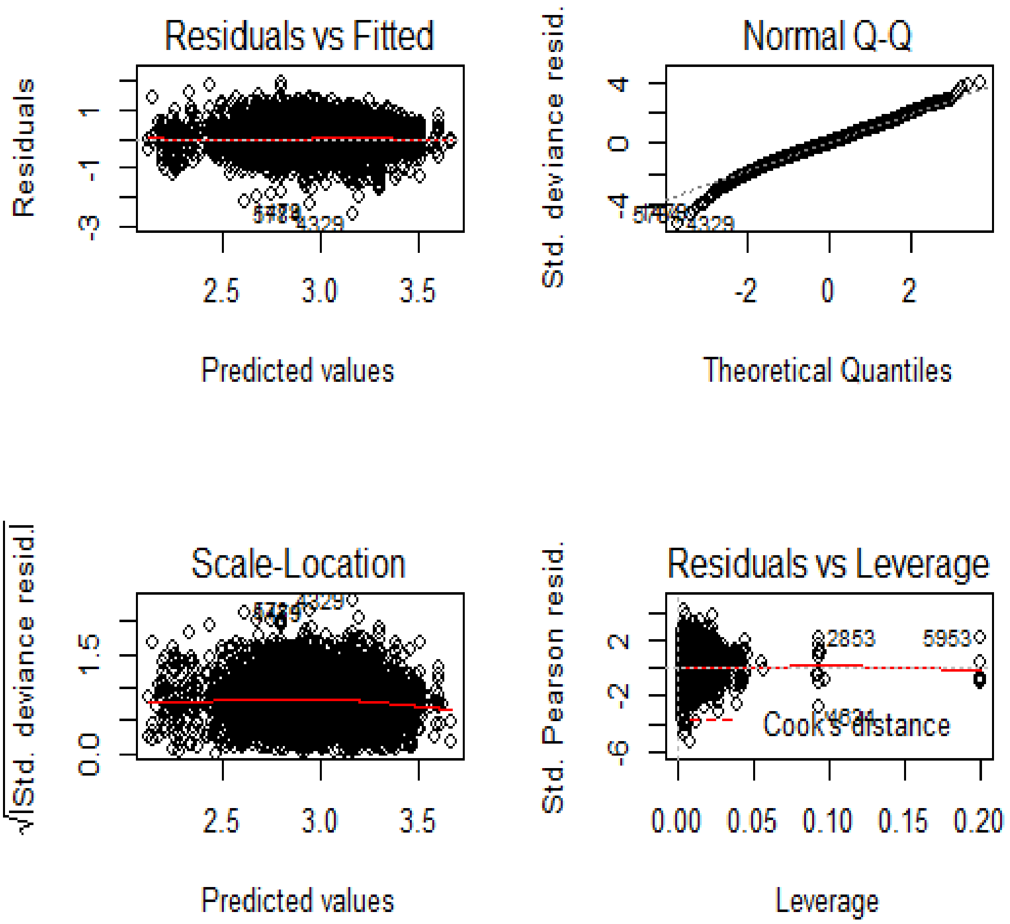


Figure 3.29. Residual plots- GLM-dataset 5

Generalized linear model (GLM) - dataset 6

A generalized linear model was applied, including year, quarter, rectangle and HPclass as factors.

```
Call:

glm(formula = log(KgHour) ~ -1 + factor(Year) + factor(Quarter) + factor(IcesStatisticalRectangle) +
factor(kW.class), data = weight_outlier_visuren3)


Deviance Residuals:

    Min       1Q   Median       3Q      Max

-2.54515  -0.30308   0.00125   0.30615   1.94843

Coefficients:

                                   Estimate Std. Error t value Pr(>|t|)

factor(Year)2006                  2.611300   0.036408  71.723  < 2e-16 ***
factor(Year)2007                  2.537990   0.034863  72.798  < 2e-16 ***
factor(Year)2008                  2.516212   0.038038  66.150  < 2e-16 ***
factor(Year)2009                  2.892218   0.039767  72.729  < 2e-16 ***
factor(Year)2010                  2.964728   0.041383  71.642  < 2e-16 ***
factor(Year)2011                  2.910095   0.041221  70.598  < 2e-16 ***
factor(Year)2012                  2.888223   0.042708  67.627  < 2e-16 ***
factor(Year)2013                  2.806970   0.041783  67.180  < 2e-16 ***
factor(Year)2014                  3.006479   0.039984  75.192  < 2e-16 ***
factor(Year)2015                  2.642875   0.039928  66.191  < 2e-16 ***
factor(Quarter)2                  0.119789   0.026232   4.567 5.10e-06 ***
factor(Quarter)3                 -0.157440   0.031474  -5.002 5.89e-07 ***
factor(Quarter)4                 -0.089013   0.019279  -4.617 4.00e-06 ***
factor(IcesStatisticalRectangle)29E8  0.167389   0.070763   2.365 0.018051 *
factor(IcesStatisticalRectangle)29E9 -0.086178   0.024161  -3.567 0.000365 ***
factor(IcesStatisticalRectangle)29F0 -0.103432   0.028530  -3.625 0.000292 ***
factor(IcesStatisticalRectangle)29F1  0.065482   0.056764   1.154 0.248742
factor(IcesStatisticalRectangle)30E9 -0.166225   0.032231  -5.157 2.62e-07 ***
factor(IcesStatisticalRectangle)30F0 -0.080888   0.026156  -3.093 0.001997 **
factor(IcesStatisticalRectangle)30F1  0.009077   0.034151   0.266 0.790412
factor(kW.class)795               0.202464   0.030589   6.619 4.07e-11 ***
factor(kW.class)905               0.361368   0.030601  11.809  < 2e-16 ***
factor(kW.class)960               0.473312   0.028608  16.545  < 2e-16 ***
factor(kW.class)1176               0.445174   0.034987  12.724  < 2e-16 ***
---

Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

(Dispersion parameter for gaussian family taken to be 0.2277008)

Null deviance: 39981.48  on 4319  degrees of freedom

Residual deviance:   977.98  on 4295  degrees of freedom
```

AIC: 5891.8

Number of Fisher Scoring iterations: 2

Start: AIC=5891.8

log(KgHour) ~ -1 + factor(Year) + factor(Quarter) + factor(IcesStatisticalRectangle) + factor(kW.class)

```
                                  Df Deviance     AIC
<none>                                 977.98  5891.8
- factor(IcesStatisticalRectangle)  7   992.08  5939.6
- factor(Quarter)                   3   994.33  5957.5
- factor(kW.class)                  4  1068.04  6264.3
- factor(Year)                     10  2708.97 10272.2
```

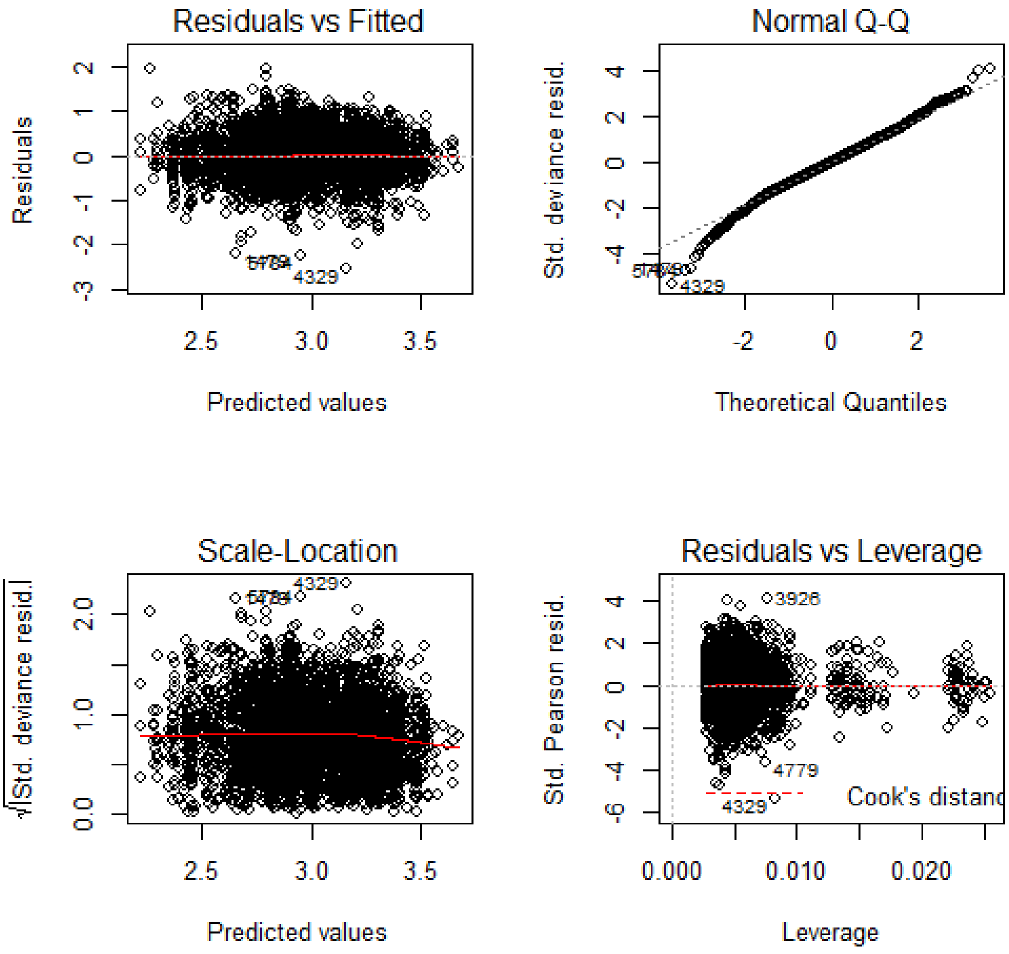


Figure 3.30. Residual plots- GLM-dataset 6

Generalized linear model (GLM) - dataset 7

A generalized linear model was applied, including year, quarter, rectangle and HPclass as factors.

Call:

```
glm(formula = log(KgHour) ~ -1 + factor(Year) + factor(Quarter) + factor(IcesStatisticalRectangle) +
factor(kW.class), data = weight_outlier_visuren4)

Deviance Residuals:

    Min       1Q   Median       3Q      Max

-2.55013  -0.30560   0.00311   0.30869   2.00703


Coefficients:

                                 Estimate Std. Error t value Pr(>|t|)

factor(Year)2006                  2.60409    0.03652  71.304  < 2e-16 ***
factor(Year)2007                  2.53404    0.03495  72.497  < 2e-16 ***
factor(Year)2008                  2.51039    0.03818  65.745  < 2e-16 ***
factor(Year)2009                  2.88705    0.03990  72.356  < 2e-16 ***
factor(Year)2010                  2.95979    0.04150  71.328  < 2e-16 ***
factor(Year)2011                  2.90705    0.04136  70.278  < 2e-16 ***
factor(Year)2012                  2.88149    0.04284  67.260  < 2e-16 ***
factor(Year)2013                  2.80974    0.04184  67.151  < 2e-16 ***
factor(Year)2014                  3.00697    0.04007  75.043  < 2e-16 ***
factor(Year)2015                  2.64811    0.03997  66.244  < 2e-16 ***
factor(Quarter)2                  0.12118    0.02625   4.616 4.04e-06 ***
factor(Quarter)3                 -0.15640    0.03151  -4.963 7.19e-07 ***
factor(Quarter)4                 -0.08694    0.01928  -4.510 6.65e-06 ***
factor(IcesStatisticalRectangle)29E8  0.17238    0.07083   2.434 0.014986 *
factor(IcesStatisticalRectangle)29E9 -0.08374    0.02425  -3.454 0.000558 ***
factor(IcesStatisticalRectangle)29F0 -0.10420    0.02857  -3.648 0.000268 ***
factor(IcesStatisticalRectangle)29F1  0.06629    0.05700   1.163 0.244936
factor(IcesStatisticalRectangle)30E9 -0.15597    0.03252  -4.796 1.67e-06 ***
factor(IcesStatisticalRectangle)30F0 -0.07524    0.02636  -2.854 0.004335 **
factor(IcesStatisticalRectangle)30F1  0.01279    0.03427   0.373 0.708946
factor(kW.class)707                 0.16632    0.03326   5.001 5.92e-07 ***
factor(kW.class)795                 0.24724    0.03545   6.975 3.53e-12 ***
factor(kW.class)883                 0.37654    0.03152  11.947  < 2e-16 ***
factor(kW.class)955                 0.40479    0.03948  10.253  < 2e-16 ***
factor(kW.class)960                 0.46650    0.02882  16.189  < 2e-16 ***
factor(kW.class)1176                 0.44533    0.03502  12.718  < 2e-16 ***
---

Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1


(Dispersion parameter for gaussian family taken to be 0.2280295)

Null deviance: 39981.48  on 4319  degrees of freedom

Residual deviance:   978.93  on 4293  degrees of freedom

AIC: 5900
```

Number of Fisher Scoring iterations: 2

Start: AIC=5900.02

log(KgHour) ~ -1 + factor(Year) + factor(Quarter) + factor(IcesStatisticalRectangle) + factor(kW.class)

```
                                  Df Deviance     AIC
<none>                                 978.93  5900.0
- factor(IcesStatisticalRectangle)  7   992.41  5945.1
- factor(Quarter)                   3   995.15  5965.0
- factor(kW.class)                  6  1068.04  6264.3
- factor(Year)                     10  2699.25 10260.6
```

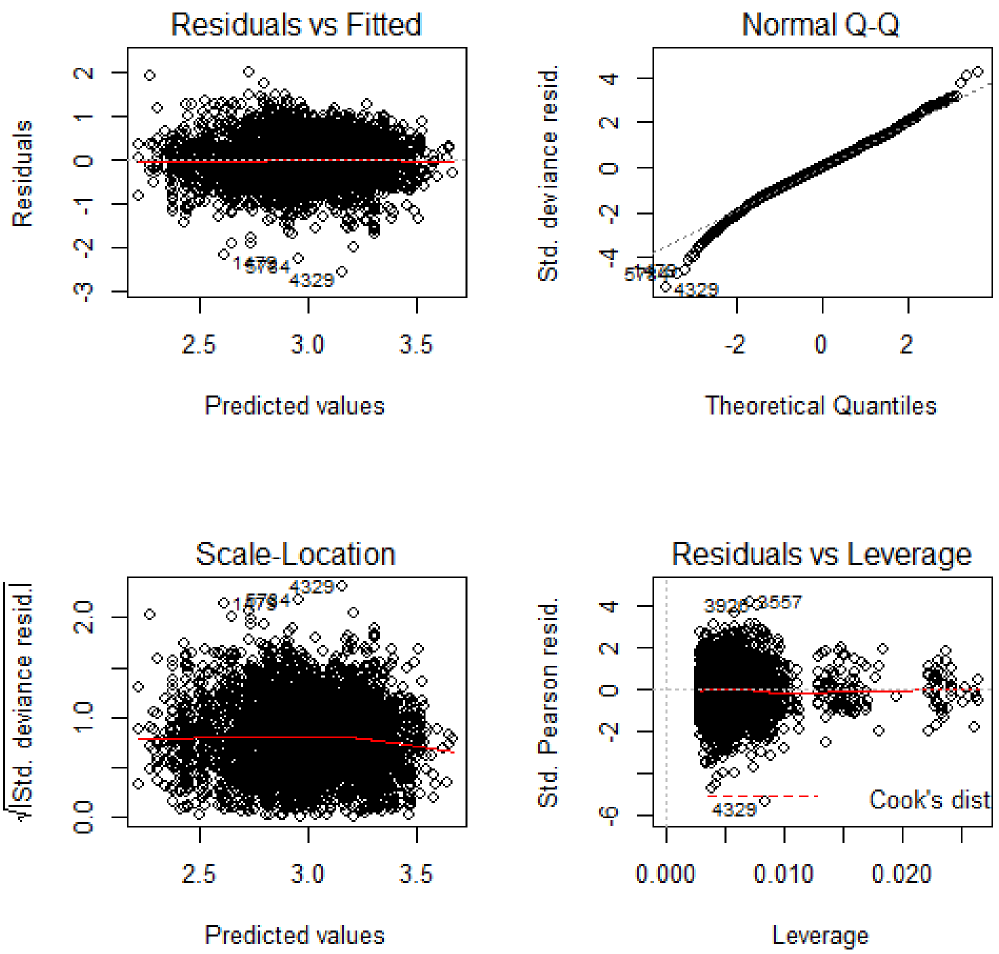


Figure 3.31. Residual plots- GLM-dataset 7

Generalized linear model (GLM) - dataset 8

A generalized linear model was applied, including year, quarter and rectangle as class factors, while HP was included as a continuous linear variable.

Call:

```
glm(formula = log(KgHour) ~ -1 + factor(Year) + factor(Quarter) + factor(IcesStatisticalRectangle) +
kW, data = weight_outlier_visuren2)

Deviance Residuals:

    Min       1Q   Median       3Q      Max

-2.52174  -0.30026  -0.00268   0.31022   1.99189

Coefficients:

                                    Estimate Std. Error t value Pr(>|t|)

factor(Year)2006                   2.164e+00  4.885e-02  44.295  < 2e-16 ***
factor(Year)2007                   2.083e+00  4.849e-02  42.956  < 2e-16 ***
factor(Year)2008                   2.058e+00  5.108e-02  40.297  < 2e-16 ***
factor(Year)2009                   2.433e+00  5.270e-02  46.161  < 2e-16 ***
factor(Year)2010                   2.503e+00  5.315e-02  47.099  < 2e-16 ***
factor(Year)2011                   2.450e+00  5.255e-02  46.611  < 2e-16 ***
factor(Year)2012                   2.433e+00  5.362e-02  45.376  < 2e-16 ***
factor(Year)2013                   2.365e+00  5.139e-02  46.023  < 2e-16 ***
factor(Year)2014                   2.566e+00  5.069e-02  50.616  < 2e-16 ***
factor(Year)2015                   2.202e+00  5.015e-02  43.900  < 2e-16 ***
factor(Quarter)2                   1.247e-01  2.624e-02   4.753 2.07e-06 ***
factor(Quarter)3                  -1.538e-01  3.152e-02  -4.878 1.11e-06 ***
factor(Quarter)4                  -8.945e-02  1.917e-02  -4.666 3.17e-06 ***
factor(IcesStatisticalRectangle)29E8  1.468e-01  7.095e-02   2.069 0.038561 *
factor(IcesStatisticalRectangle)29E9 -8.695e-02  2.420e-02  -3.592 0.000331 ***
factor(IcesStatisticalRectangle)29F0 -1.056e-01  2.858e-02  -3.694 0.000224 ***
factor(IcesStatisticalRectangle)29F1  6.686e-02  5.680e-02   1.177 0.239253
factor(IcesStatisticalRectangle)30E9 -1.617e-01  3.226e-02  -5.013 5.58e-07 ***
factor(IcesStatisticalRectangle)30F0 -6.597e-02  2.597e-02  -2.540 0.011118 *
factor(IcesStatisticalRectangle)30F1  1.183e-02  3.418e-02   0.346 0.729160
kW                                    9.190e-04  4.797e-05  19.158  < 2e-16 ***
---

Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1


(Dispersion parameter for gaussian family taken to be 0.228945)

Null deviance: 39981.48  on 4319  degrees of freedom

Residual deviance:   984.01  on 4298  degrees of freedom
```

AIC: 5912.4

```
Number of Fisher Scoring iterations: 2
```

Start: AIC=5912.35

```
log(KgHour) ~ -1 + factor(Year) + factor(Quarter) + factor(IcesStatisticalRectangle) + kW
```

```
                                  Df Deviance    AIC
<none>                                 984.01 5912.4
- factor(IcesStatisticalRectangle)  7   997.52 5957.3
- factor(Quarter)                   3  1000.94 5980.1
- kW                                1  1068.04 6264.3
- factor(Year)                     10  1689.36 8226.7
```

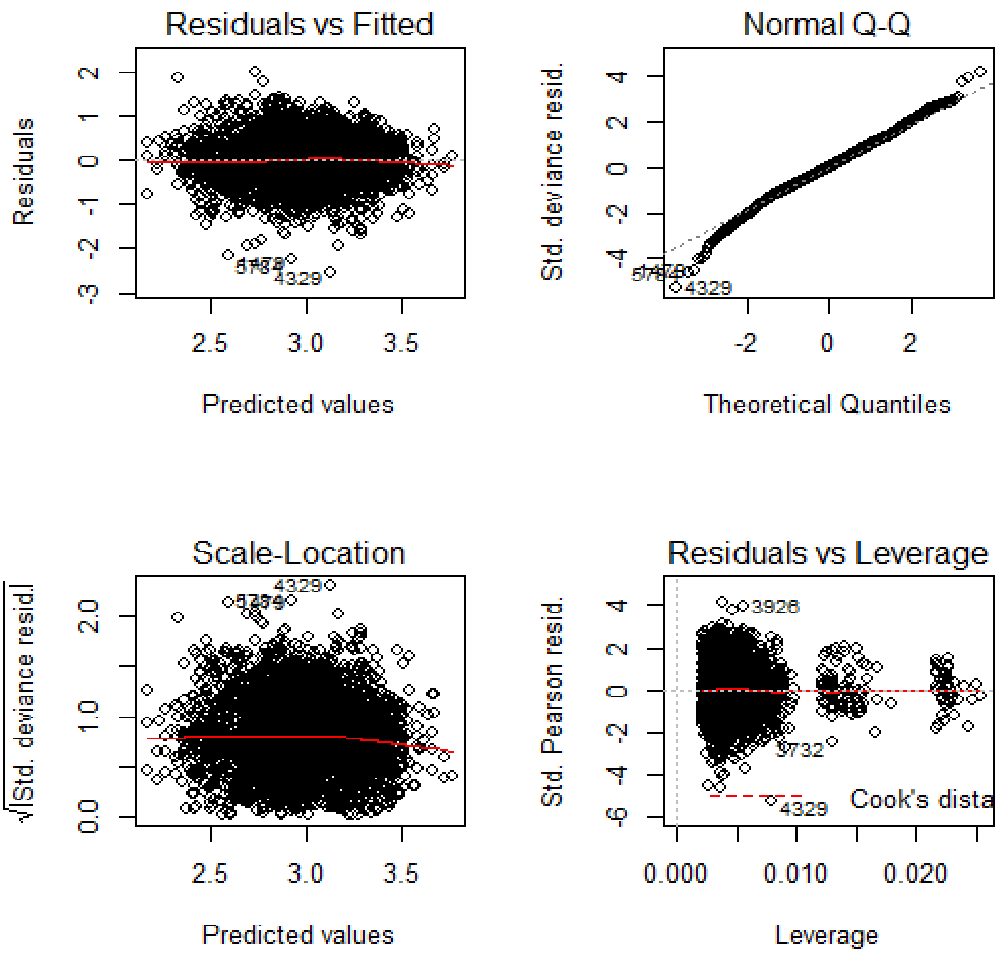


Figure 3.32. Residual plots- GLM-dataset 8

Single term deletions

Model:

log(KgHour) ~ -1 + factor(Year) + factor(Quarter) + factor(IcesStatisticalRectangle) + kW

	Df	Deviance	AIC	scaled dev.	Pr(>Chi)
<none>		984.01	5912.4		
factor(Year)	10	1689.36	8226.7	2334.30	< 2.2e-16 ***
factor(Quarter)	3	1000.94	5980.1	73.70	6.878e-16 ***
factor(IcesStatisticalRectangle)	7	997.52	5957.3	58.93	2.473e-10 ***
kW	1	1068.04	6264.3	353.93	< 2.2e-16 ***

```
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1
```

Generalized linear model (GLM) - dataset 6 - interaction

A generalized linear model was applied, including year, quarter, rectangle and HPclass as factors. An interaction of HPclass and rectangle was included in the model.

```
Call:

glm(formula = log(KgHour) ~ -1 + factor(Year) + factor(Quarter) + factor(IcesStatisticalRectangle) + factor(kW.class) + factor(kW.class) * factor(IcesStatisticalRectangle), data = weight_outlier_visuren2)

Deviance Residuals:

    Min       1Q   Median       3Q      Max

-2.43396  -0.29538   0.00293   0.29558   2.01073

Coefficients: (1 not defined because of singularities)

                                                         Estimate Std. Error t value Pr(>|t|)

factor(Year)2006                                     2.69545    0.07897  34.132  < 2e-16 ***
factor(Year)2007                                     2.61875    0.07846  33.377  < 2e-16 ***
factor(Year)2008                                     2.59956    0.07986  32.553  < 2e-16 ***
factor(Year)2009                                     2.96545    0.08053  36.822  < 2e-16 ***
factor(Year)2010                                     3.03132    0.08099  37.426  < 2e-16 ***
factor(Year)2011                                     2.98187    0.08182  36.445  < 2e-16 ***
factor(Year)2012                                     2.95272    0.08257  35.759  < 2e-16 ***
factor(Year)2013                                     2.86851    0.08164  35.135  < 2e-16 ***
factor(Year)2014                                     3.07666    0.08109  37.943  < 2e-16 ***
factor(Year)2015                                     2.70897    0.08111  33.400  < 2e-16 ***
factor(Quarter)2                                     0.10517    0.02608   4.033 5.60e-05 ***
factor(Quarter)3                                    -0.15107    0.03137  -4.815 1.52e-06 ***
factor(Quarter)4                                    -0.08193    0.01929  -4.247 2.21e-05 ***
factor(IcesStatisticalRectangle)29E8                 0.35169    0.14487   2.428 0.015240 *
factor(IcesStatisticalRectangle)29E9                -0.16607    0.09466  -1.754 0.079458 .
factor(IcesStatisticalRectangle)29F0                -0.09141    0.09552  -0.957 0.338628
factor(IcesStatisticalRectangle)29F1                -0.03164    0.13626  -0.232 0.816387
factor(IcesStatisticalRectangle)30E9                -0.20666    0.11018  -1.876 0.060761 .
factor(IcesStatisticalRectangle)30F0                -0.34298    0.09243  -3.711 0.000209 ***
factor(IcesStatisticalRectangle)30F1                 0.07411    0.10622   0.698 0.485370
factor(kW.class)795                                  0.17478    0.08600   2.032 0.042174 *
factor(kW.class)905                                  0.26563    0.08615   3.083 0.002059 **
factor(kW.class)960                                  0.38674    0.08455   4.574 4.92e-06 ***
factor(kW.class)1176                                 0.31688    0.09857   3.215 0.001315 **
factor(IcesStatisticalRectangle)29E8:factor(kW.class)795  -1.04098    0.49678  -2.095 0.036191 *
factor(IcesStatisticalRectangle)29E9:factor(kW.class)795   0.10552    0.10624   0.993 0.320667
factor(IcesStatisticalRectangle)29F0:factor(kW.class)795  -0.03574    0.10849  -0.329 0.741872
factor(IcesStatisticalRectangle)29F1:factor(kW.class)795   0.05594    0.17203   0.325 0.745066
factor(IcesStatisticalRectangle)30E9:factor(kW.class)795   0.04972    0.12262   0.405 0.685166
```

```
factor(IcesStatisticalRectangle)30F0:factor(kW.class)795   0.05094    0.10567   0.482 0.629826
factor(IcesStatisticalRectangle)30F1:factor(kW.class)795  -0.18751    0.12388  -1.514 0.130175
factor(IcesStatisticalRectangle)29E8:factor(kW.class)905  -0.12672    0.21749  -0.583 0.560168
factor(IcesStatisticalRectangle)29E9:factor(kW.class)905   0.10692    0.10637   1.005 0.314839
factor(IcesStatisticalRectangle)29F0:factor(kW.class)905   0.04619    0.11096   0.416 0.677241
factor(IcesStatisticalRectangle)29F1:factor(kW.class)905   0.05428    0.15937   0.341 0.733413
factor(IcesStatisticalRectangle)30E9:factor(kW.class)905   0.07902    0.13518   0.585 0.558865
factor(IcesStatisticalRectangle)30F0:factor(kW.class)905   0.26777    0.10676   2.508 0.012172 *
factor(IcesStatisticalRectangle)30F1:factor(kW.class)905  -0.08107    0.12765  -0.635 0.525398
factor(IcesStatisticalRectangle)29E8:factor(kW.class)960  -0.21017    0.17446  -1.205 0.228380
factor(IcesStatisticalRectangle)29E9:factor(kW.class)960   0.05418    0.10335   0.524 0.600095
factor(IcesStatisticalRectangle)29F0:factor(kW.class)960  -0.09263    0.10765  -0.860 0.389569
factor(IcesStatisticalRectangle)29F1:factor(kW.class)960   0.45619    0.22699   2.010 0.044518 *
factor(IcesStatisticalRectangle)30E9:factor(kW.class)960  -0.06073    0.12345  -0.492 0.622797
factor(IcesStatisticalRectangle)30F0:factor(kW.class)960   0.36387    0.10046   3.622 0.000296 ***
factor(IcesStatisticalRectangle)30F1:factor(kW.class)960  -0.08504    0.11970  -0.710 0.477465
factor(IcesStatisticalRectangle)29E8:factor(kW.class)1176       NA         NA      NA       NA
factor(IcesStatisticalRectangle)29E9:factor(kW.class)1176  0.12540    0.11896   1.054 0.291887
factor(IcesStatisticalRectangle)29F0:factor(kW.class)1176  0.04252    0.13268   0.320 0.748646
factor(IcesStatisticalRectangle)29F1:factor(kW.class)1176 -0.13031    0.36636  -0.356 0.722083
factor(IcesStatisticalRectangle)30E9:factor(kW.class)1176  0.13946    0.14343   0.972 0.330958
factor(IcesStatisticalRectangle)30F0:factor(kW.class)1176  0.26289    0.12165   2.161 0.030751 *
factor(IcesStatisticalRectangle)30F1:factor(kW.class)1176  0.15354    0.14994   1.024 0.305895
---
```

Signif. codes: 0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

(Dispersion parameter for gaussian family taken to be 0.2235272)

Null deviance: 39981.48 on 4319 degrees of freedom
Residual deviance: 954.01 on 4268 degrees of freedom

AIC: 5838.7

Number of Fisher Scoring iterations: 2

Start: AIC=5838.67

log(KgHour) ~ -1 + factor(Year) + factor(Quarter) + factor(IcesStatisticalRectangle) + factor(kW.class) + factor(kW.class) * factor(IcesStatisticalRectangle)

```
                                                     Df Deviance    AIC
<none>                                                    954.01 5838.7
- factor(IcesStatisticalRectangle):factor(kW.class) 27    977.98 5891.8
- factor(Quarter)                                     3   967.55 5893.5
- factor(Year)                                       10  1360.24 7350.8
```

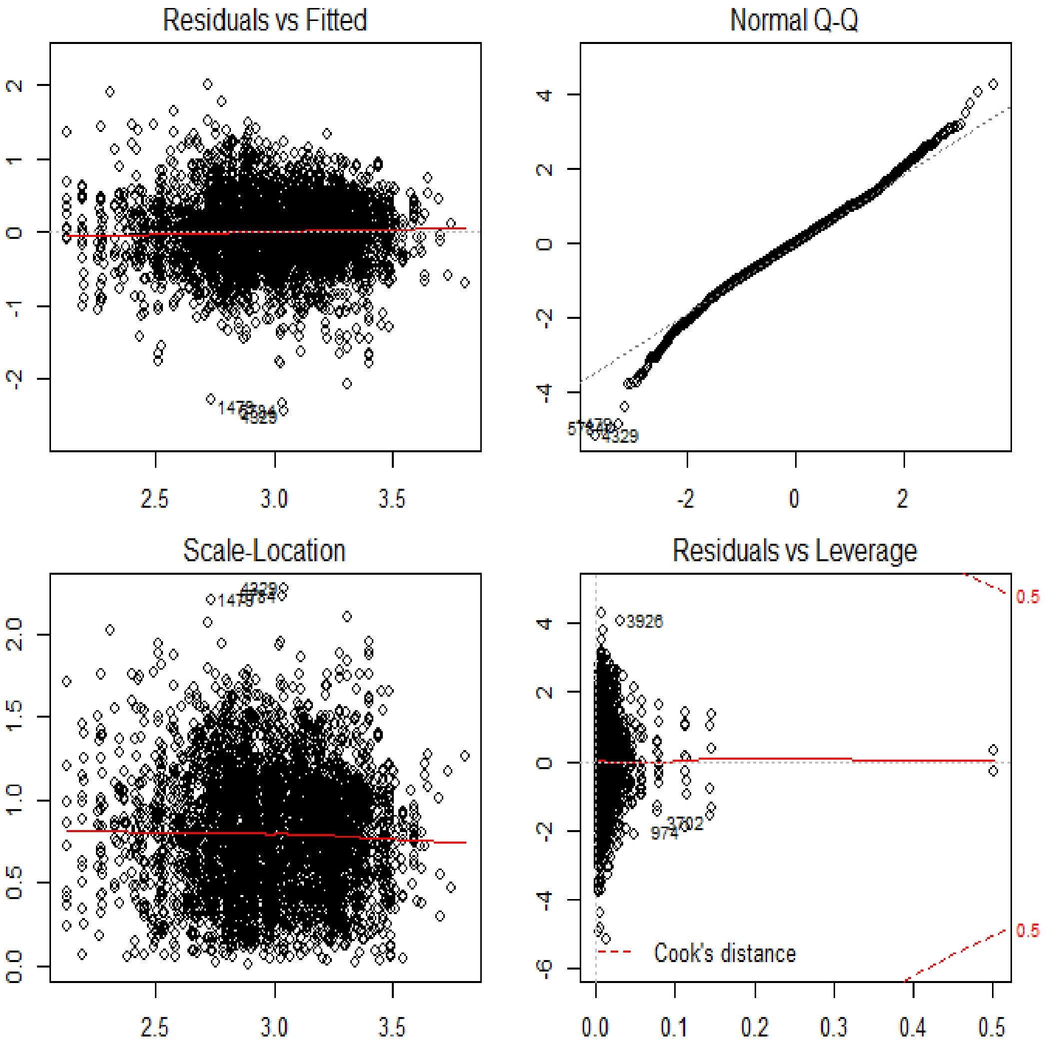


Figure 3.33. Residual plots- GLM-dataset 6 – interaction

Generalized linear model (GLM) - dataset 8 - predictions

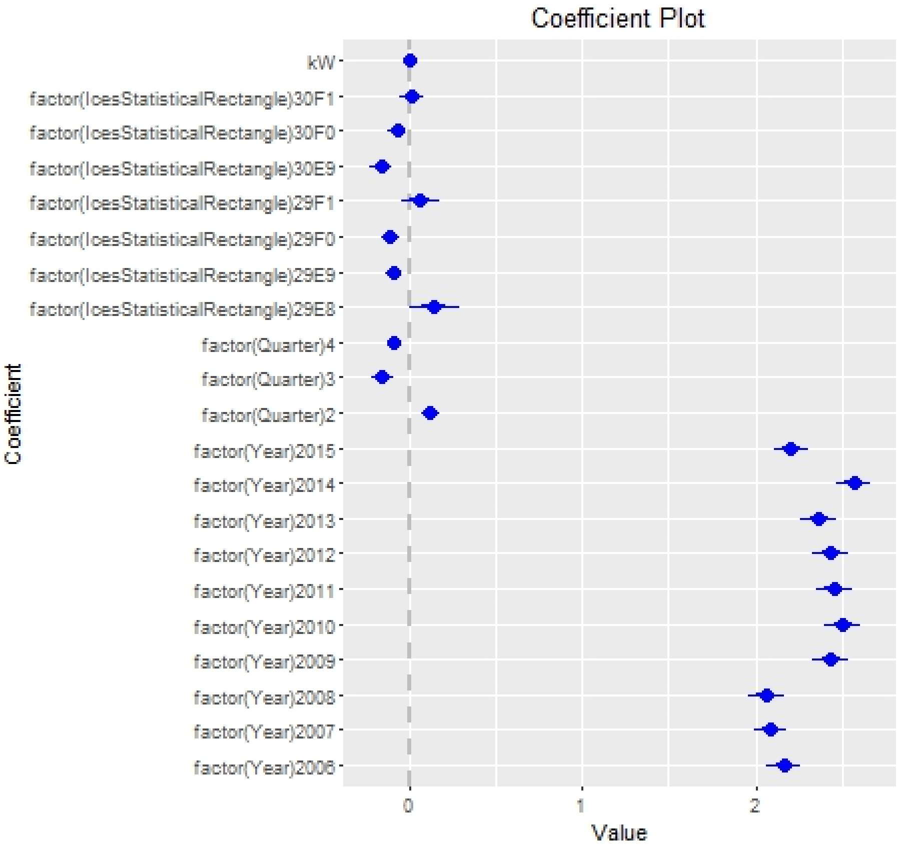
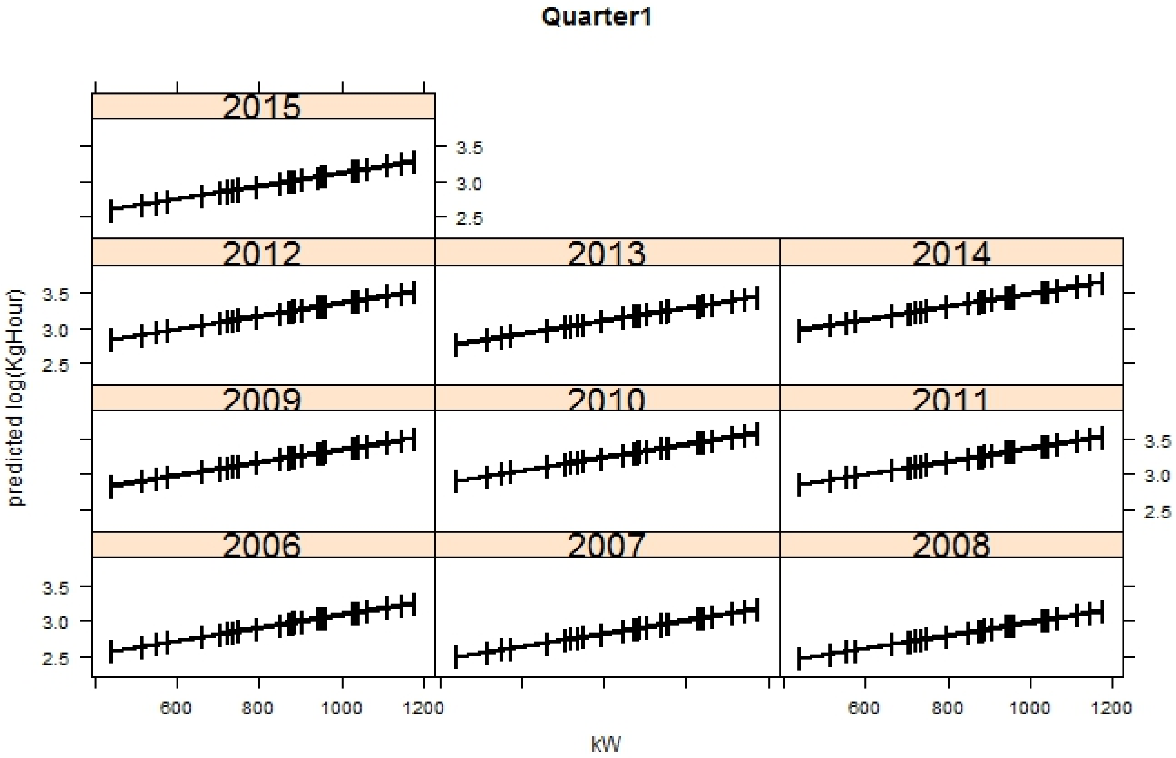
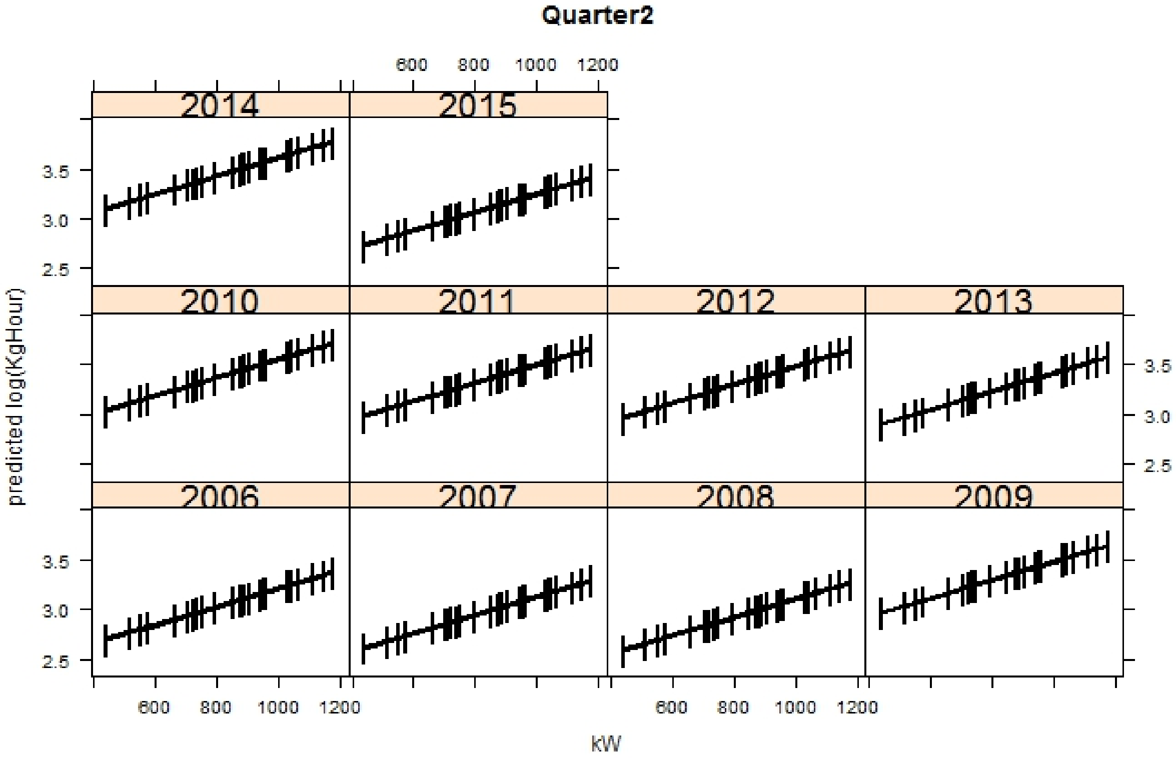


Figure 3.34. Estimated coefficients from the model (GLM-dataset 8)

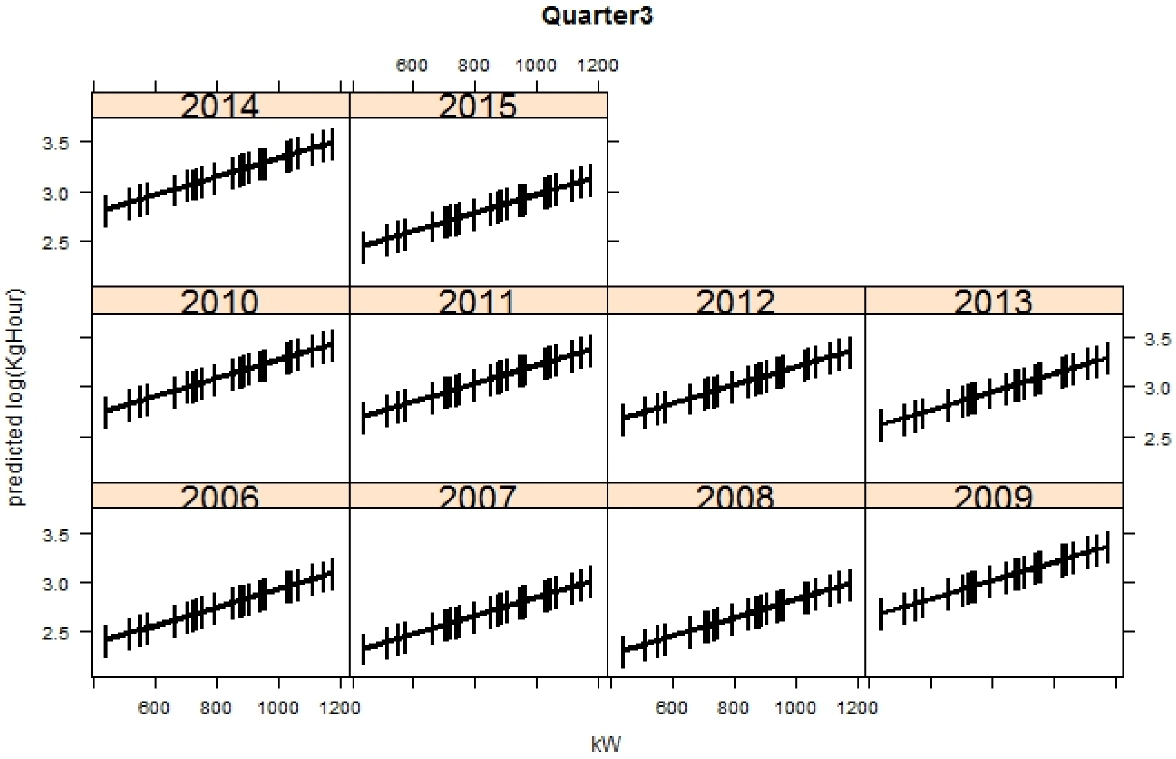
(a)


Quarter1
2015
2012
2013
2014
2009
2010
2011
2006
2007
2008
3.5
3.0
2.5
predicted log(KgHour)
600
800
1000
1200
kW

(b)


Quarter2
2014
2015
2010
2011
2012
2013
2006
2007
2008
2009
3.5
3.0
2.5
predicted log(KgHour)
600
800
1000
1200
kW

(c)



(d)

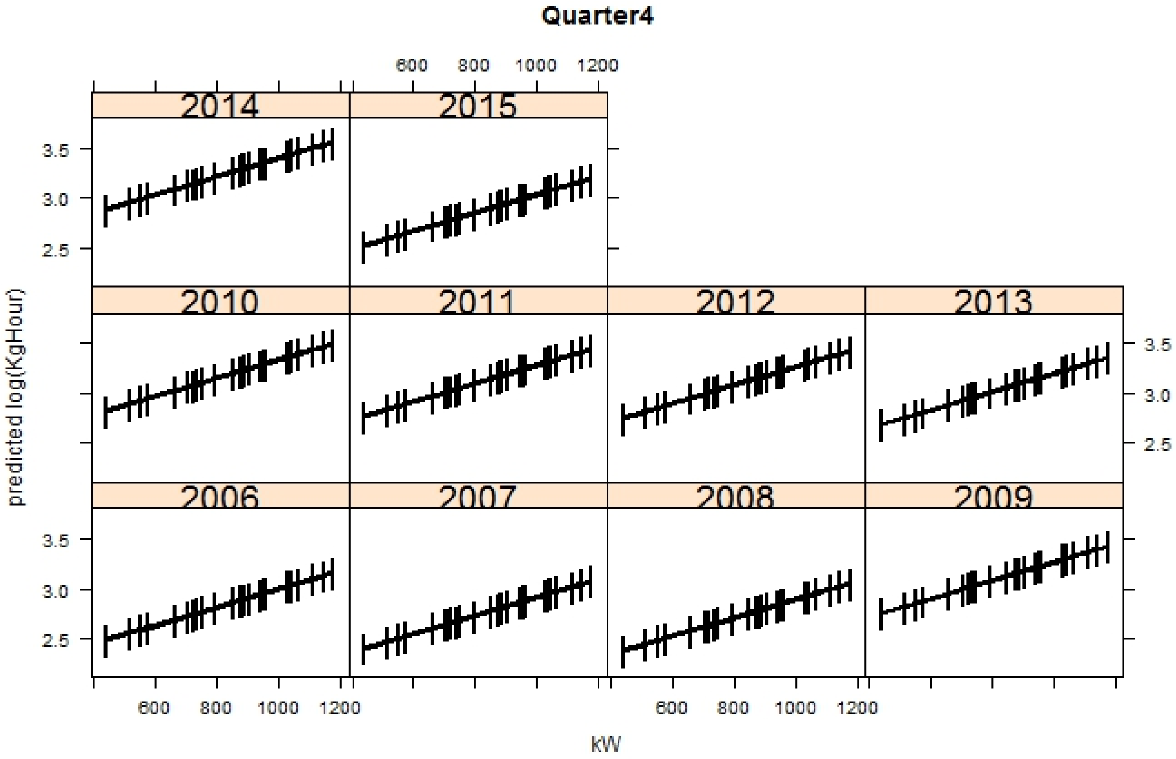
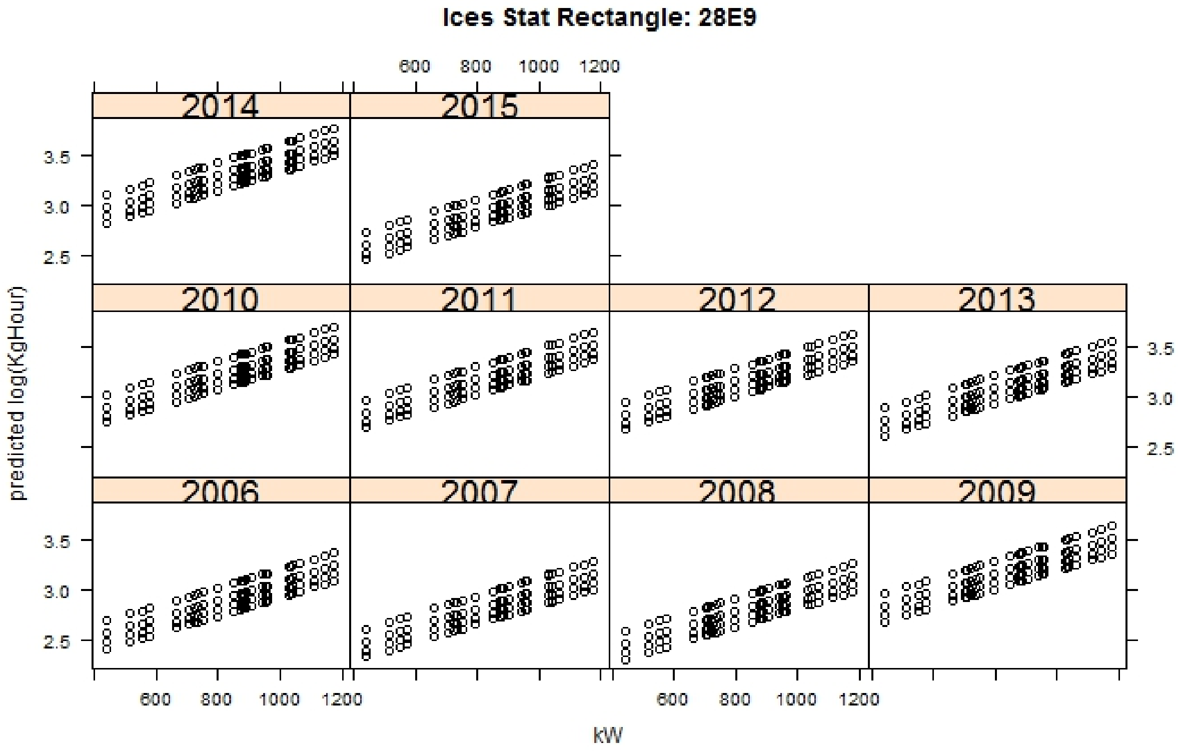
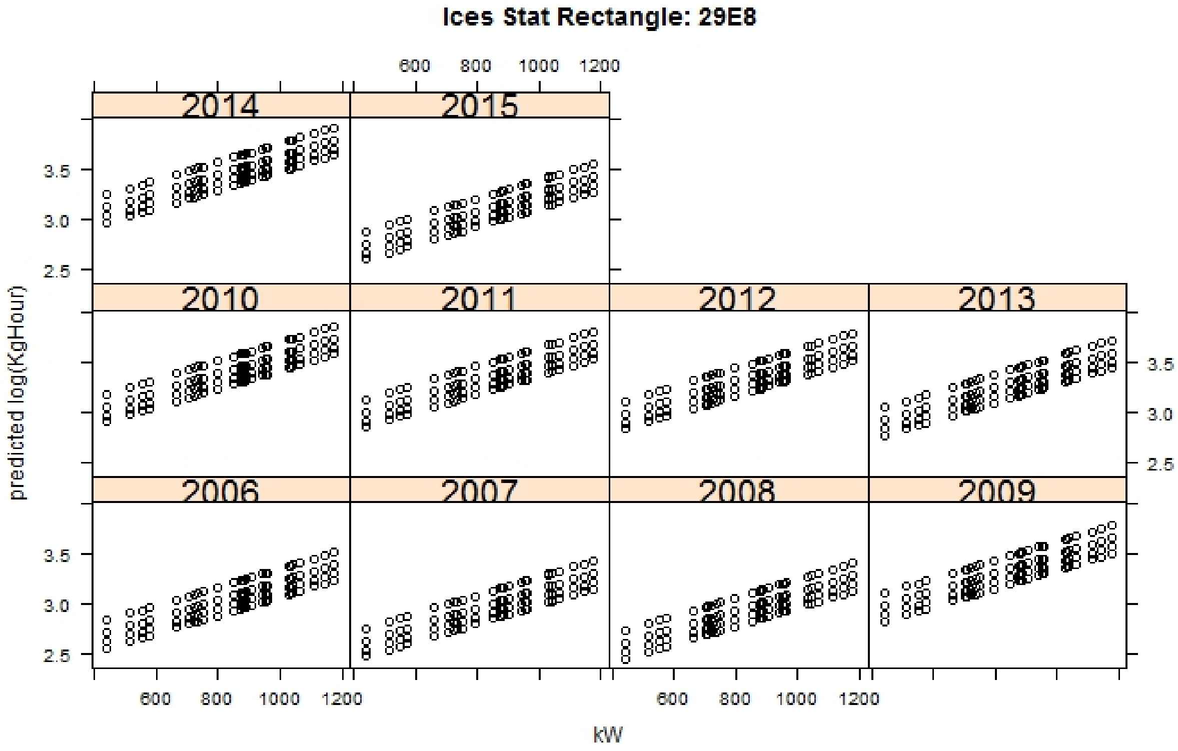


Figure 3.35. Estimated log catch rates (log(Kg/h) per trip + rectangle) against HP (kW) for (a) quarter 1, (b) quarter 2, (c) quarter 3 and (d) quarter4.

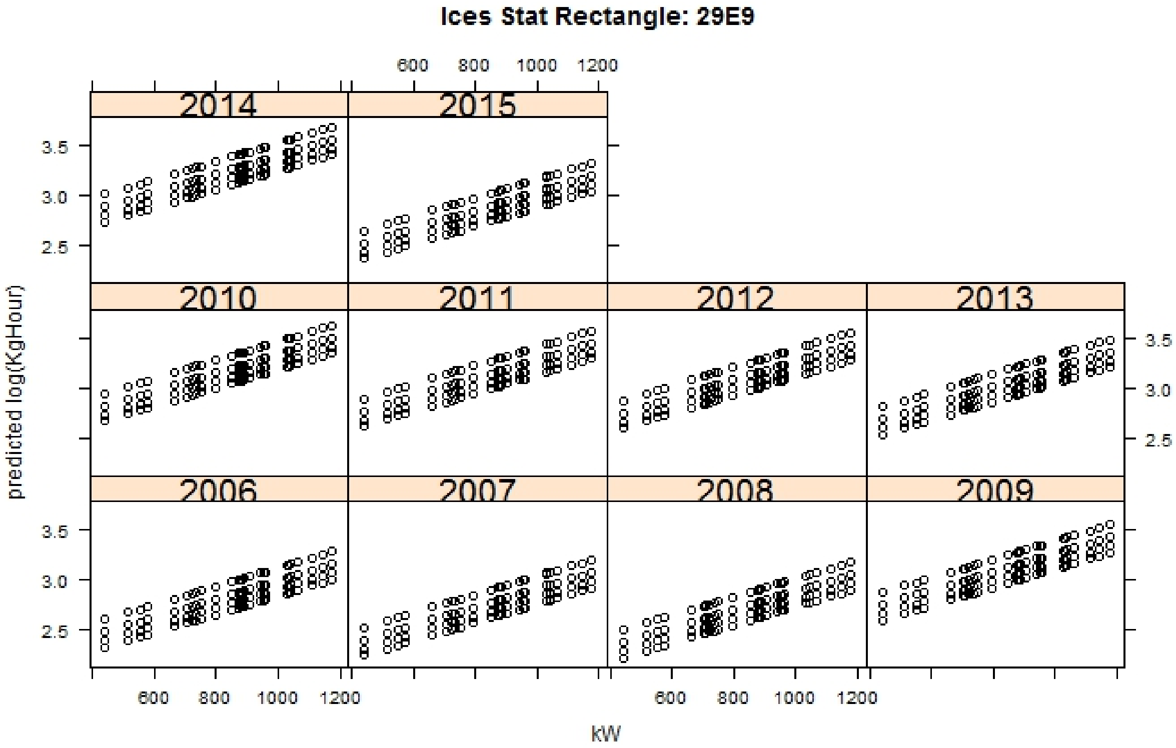
(a)


Ices Stat Rectangle: 28E9
2014
2015
2010
2011
2012
2013
2006
2007
2008
2009
predicted log(KgHour)
kW
2.5
3.0
3.5
600
800
1000
1200

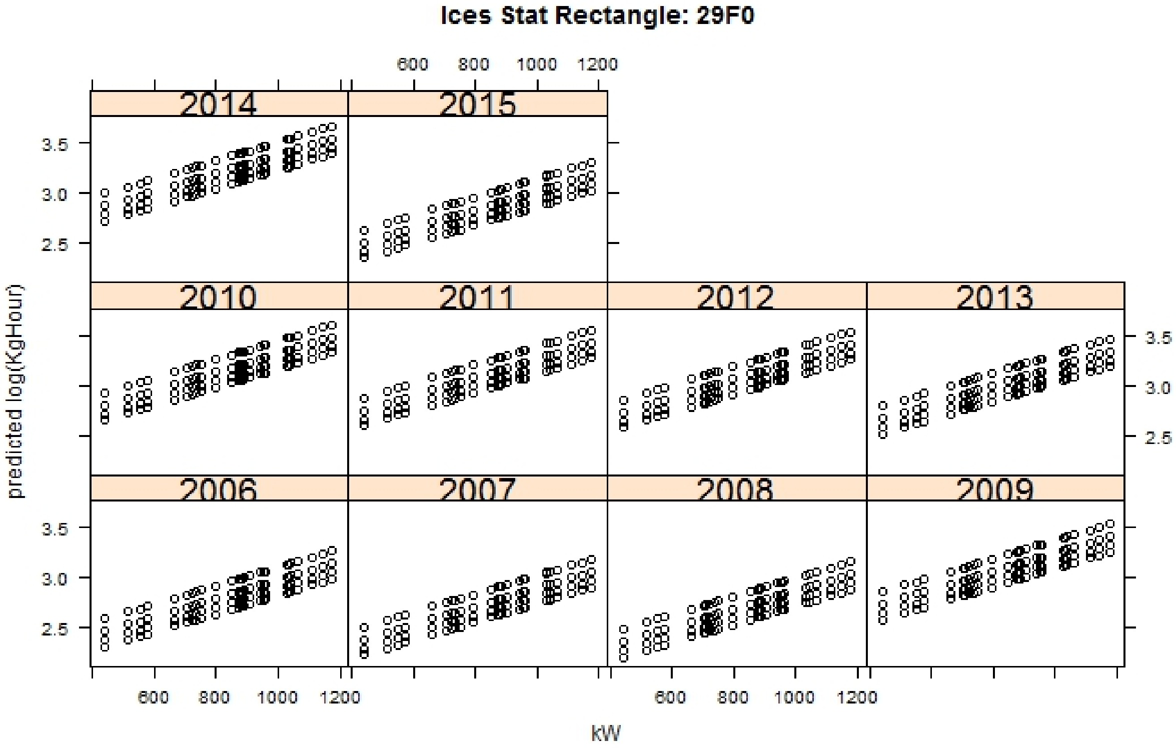
(b)


Ices Stat Rectangle: 29E8
2014
2015
2010
2011
2012
2013
2006
2007
2008
2009
predicted log(KgHour)
kW
2.5
3.0
3.5
600
800
1000
1200

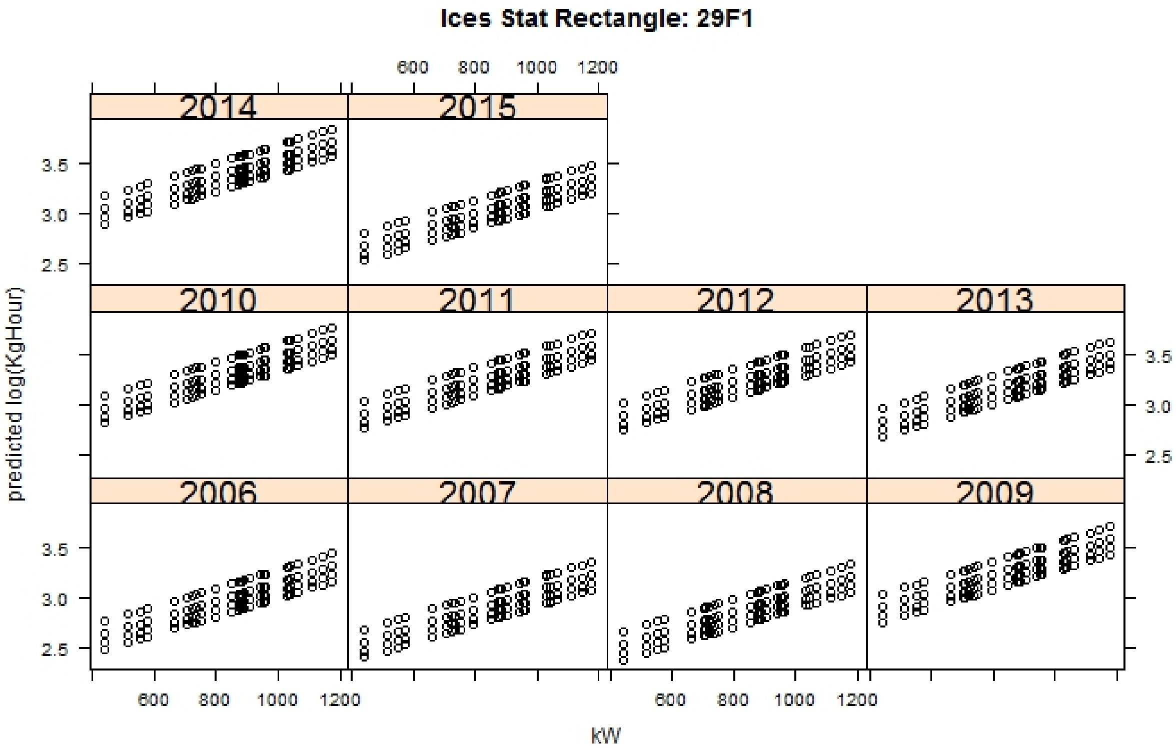
(c)


Ices Stat Rectangle: 29E9
2014
2015
2010
2011
2012
2013
2006
2007
2008
2009
predicted log(KgHour)
kW
600
800
1000
1200
2.5
3.0
3.5

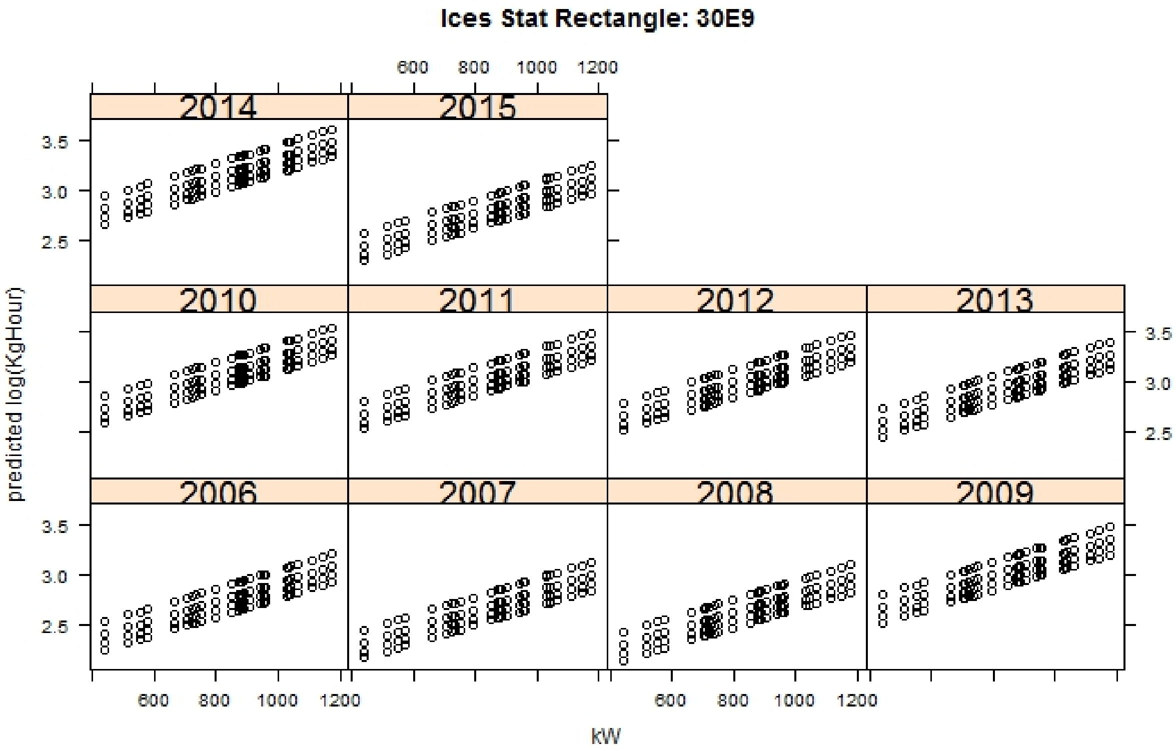
(d)


Ices Stat Rectangle: 29F0
2014
2015
2010
2011
2012
2013
2006
2007
2008
2009
predicted log(KgHour)
kW
600
800
1000
1200
2.5
3.0
3.5

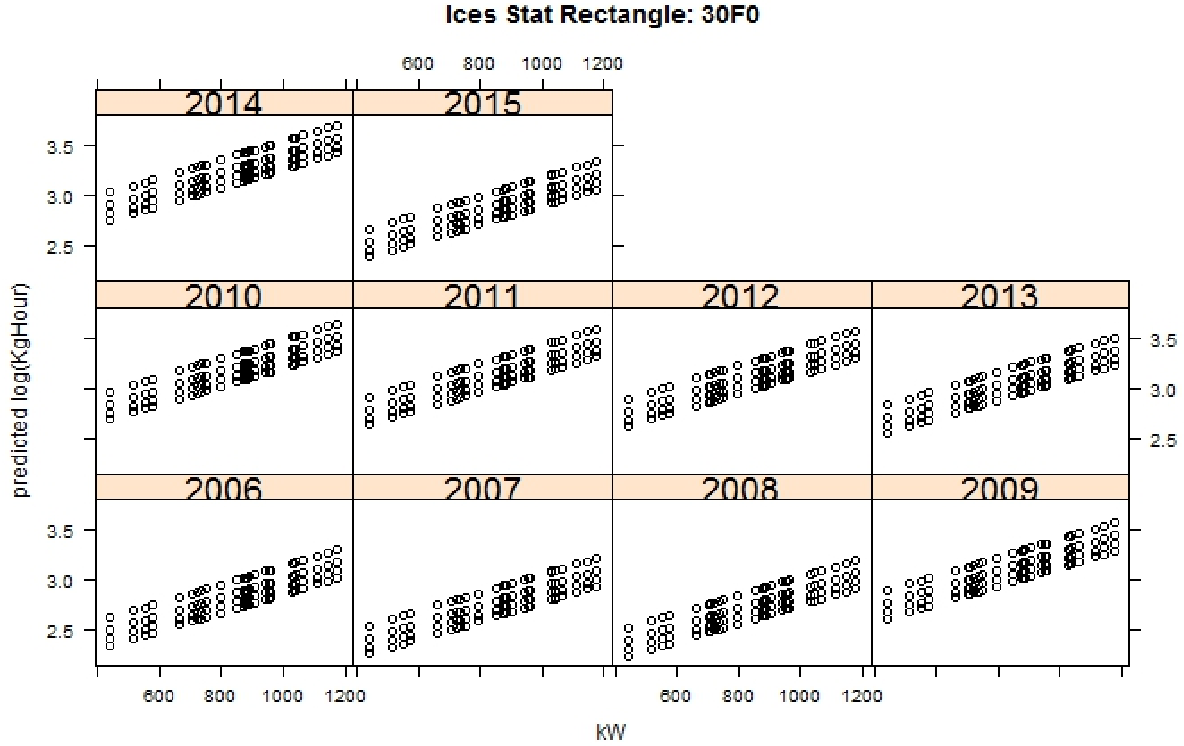
(e)


Ices Stat Rectangle: 29F1
2014
2015
2010
2011
2012
2013
2006
2007
2008
2009
predicted log(KgHour)
kW
600
800
1000
1200
2.5
3.0
3.5

(f)


Ices Stat Rectangle: 30E9
2014
2015
2010
2011
2012
2013
2006
2007
2008
2009
predicted log(KgHour)
kW
600
800
1000
1200
2.5
3.0
3.5

(g)



(h)

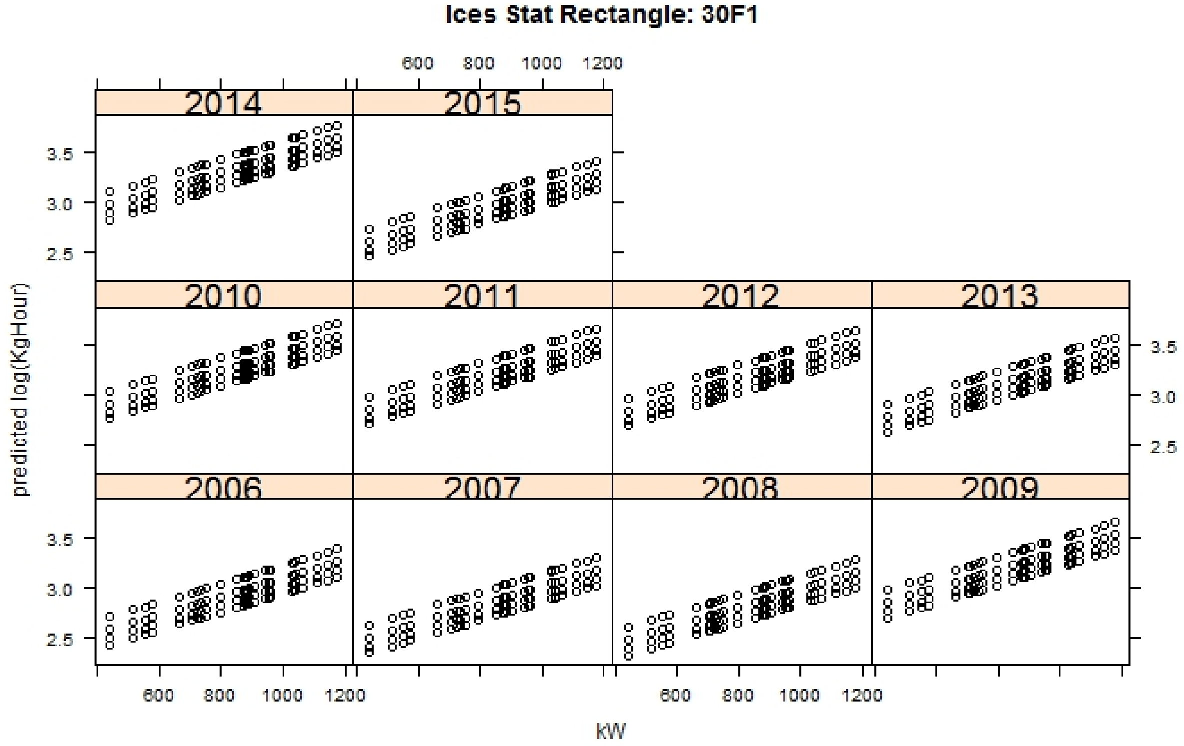
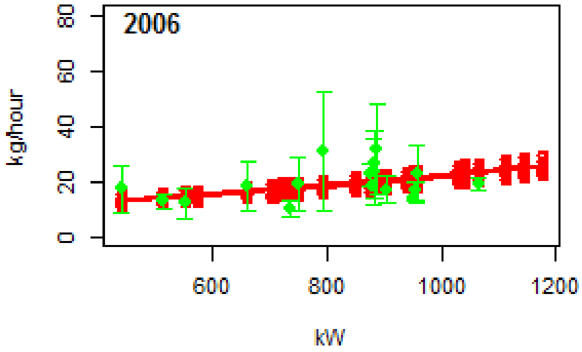
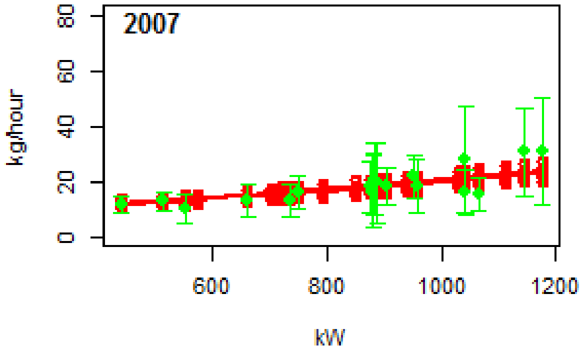
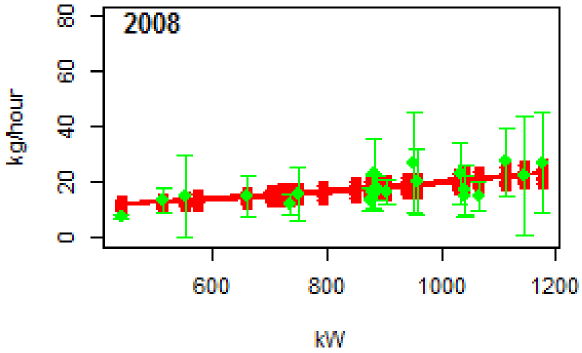
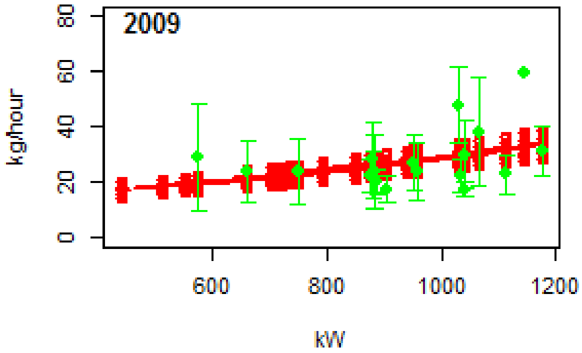


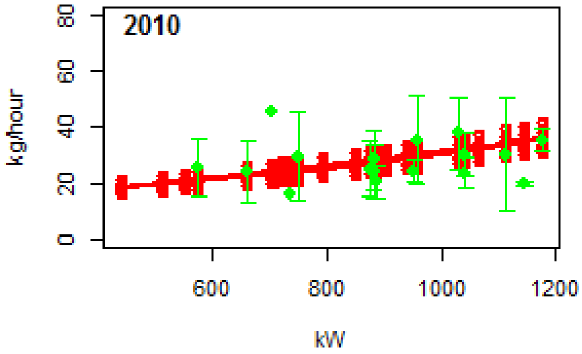
Figure 3.36. Estimated log catch rate (log(Kg/h) per trip + rectangle) against HP (kW) for (a) rectangle 28E9, (b) rectangle 29E8, (c) rectangle 29E9, (d) rectangle 29F0, (e) rectangle 29F1, (f) rectangle 30E9, (g) rectangle 30F0 and (h) rectangle 30F1.

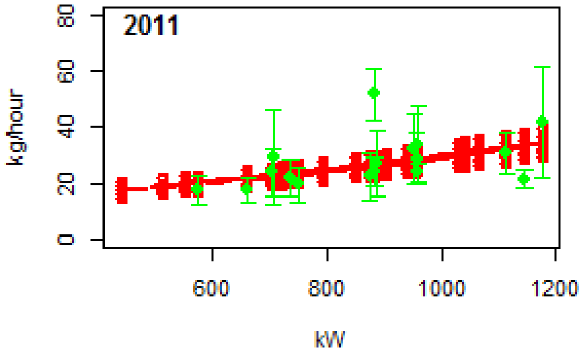

2006
kg/hour
0
20
40
60
80
600
800
1000
1200
kW


2007
kg/hour
0
20
40
60
80
600
800
1000
1200
kW


2008
kg/hour
0
20
40
60
80
600
800
1000
1200
kW


2009
kg/hour
0
20
40
60
80
600
800
1000
1200
kW


2010
kg/hour
0
20
40
60
80
600
800
1000
1200
kW


2011
kg/hour
0
20
40
60
80
600
800
1000
1200
kW

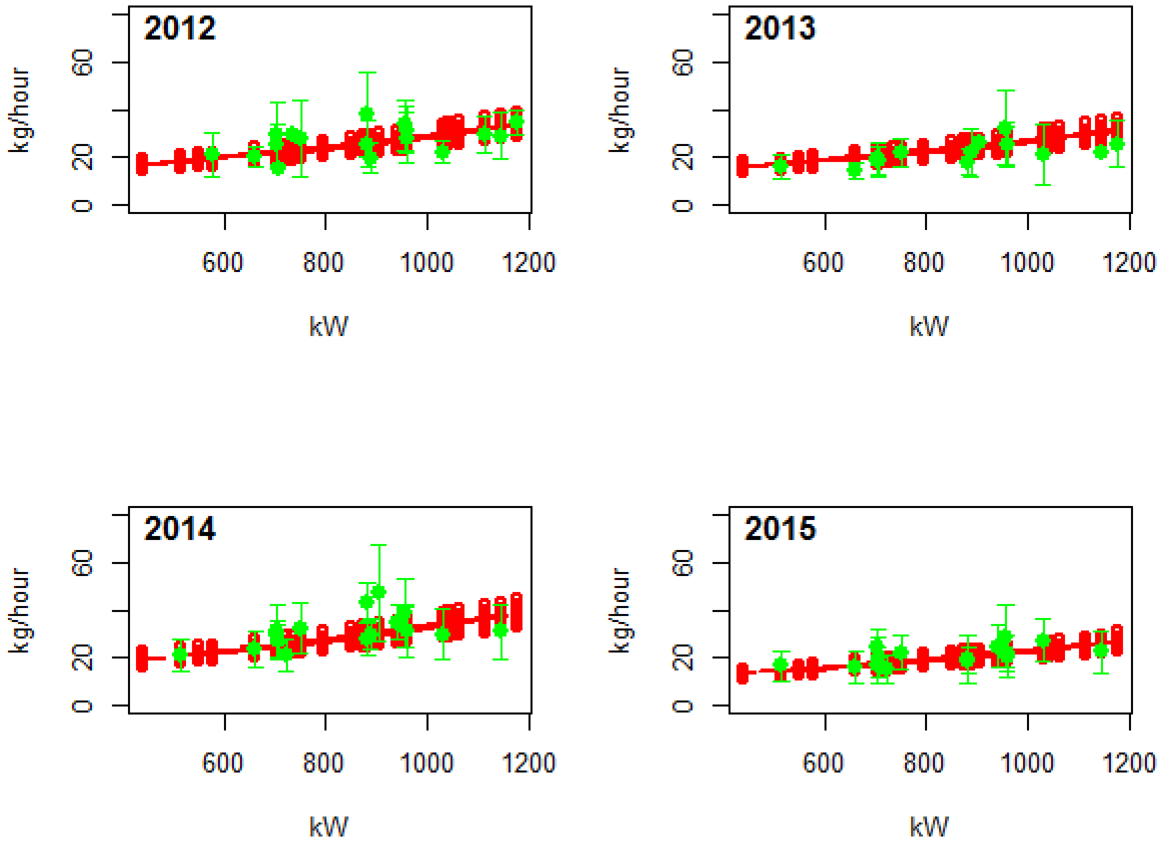
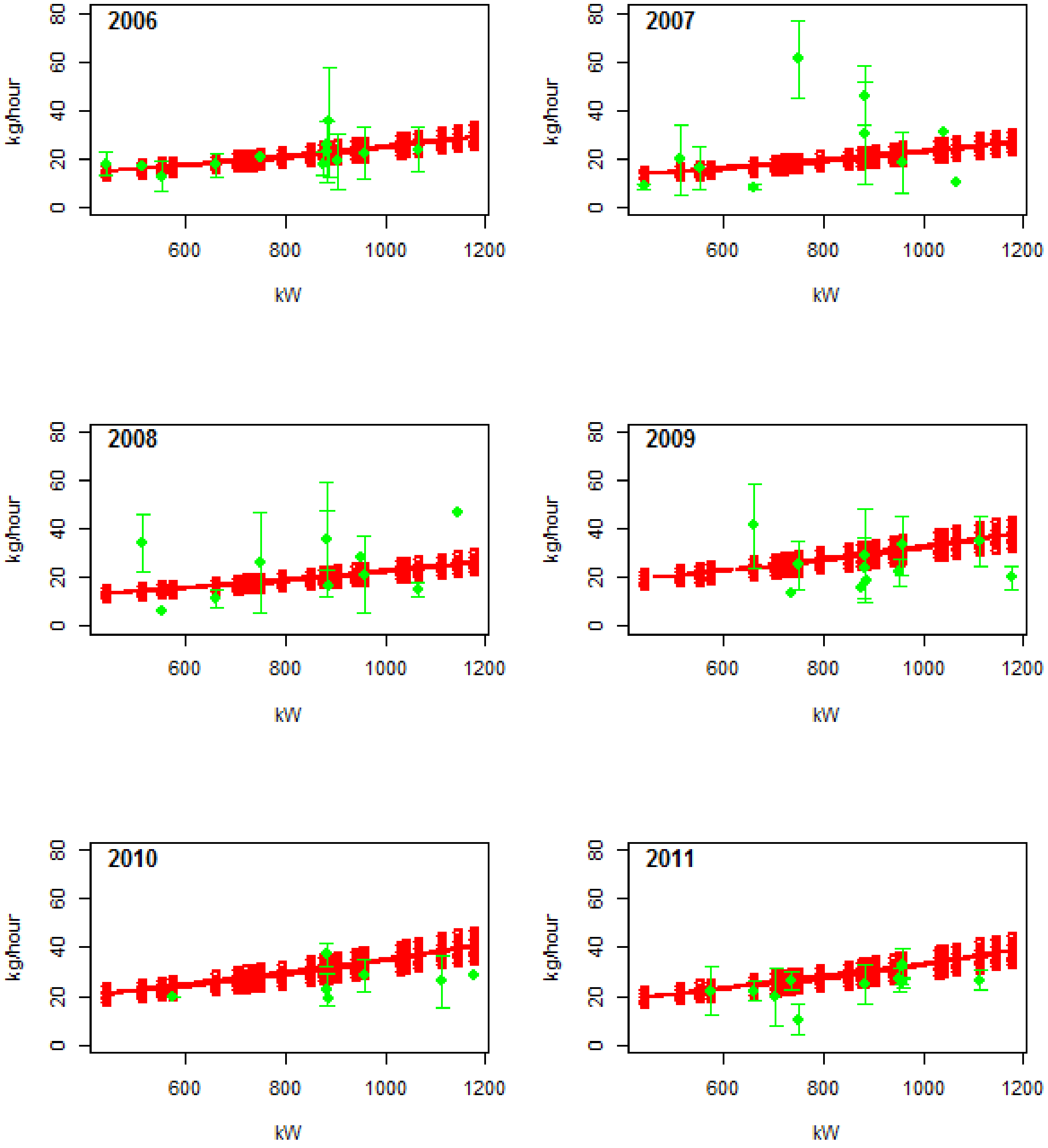


Figure 3.37. The predicted catch rates (red) versus the nominal ones (green) ((Kg/h) per trip + rectangle) against HP (kW) by year for quarter 1.


2006
2007
2008
2009
2010
2011
kg/hour
0
20
40
60
80
kW
600
800
1000
1200

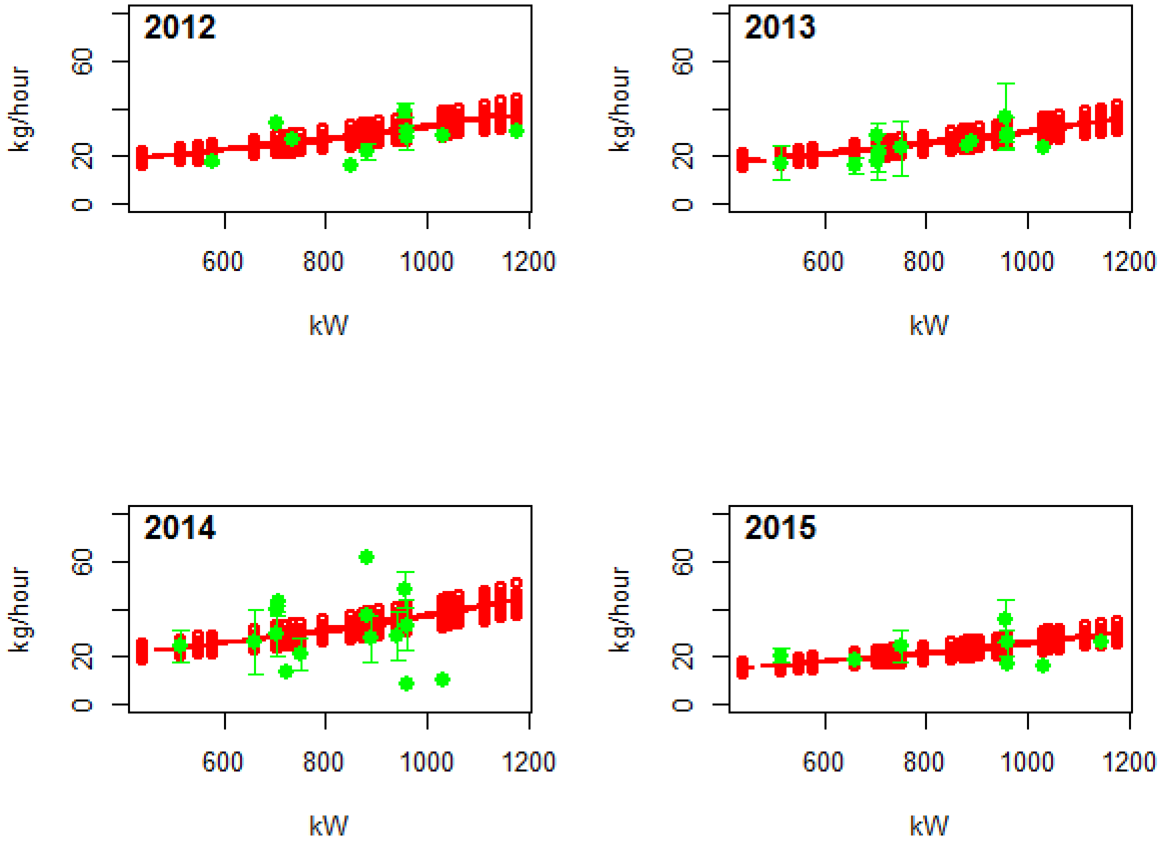
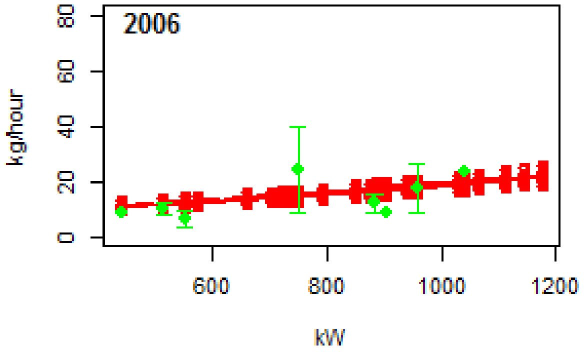
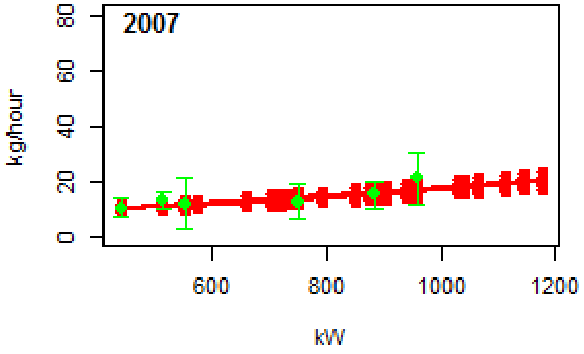
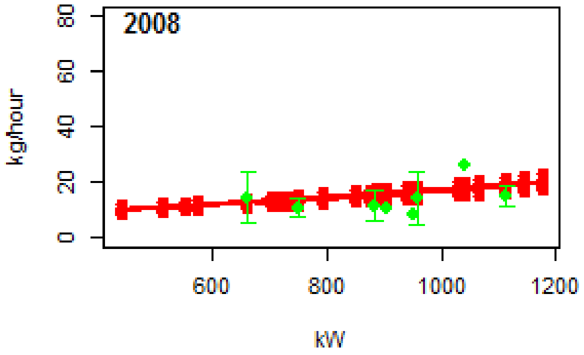
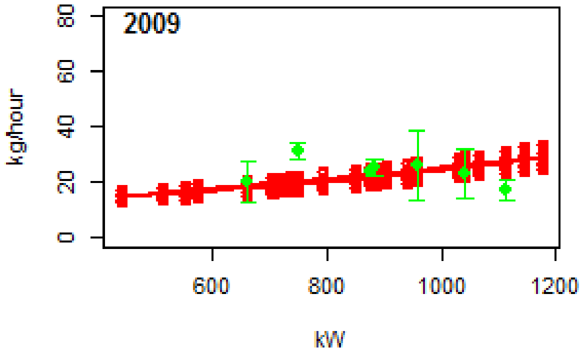


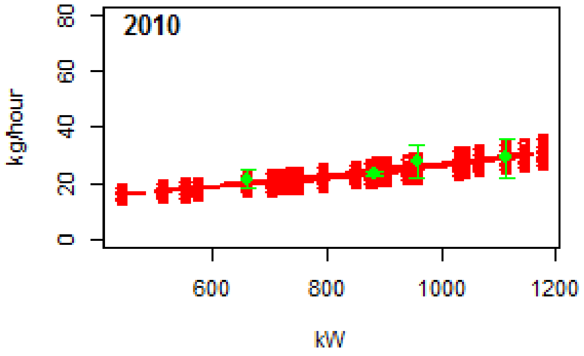
Figure 3.38. The predicted catch rates (red) versus the nominal ones (green) ((Kg/h) per trip + rectangle) against HP (kW) by year for quarter 2.

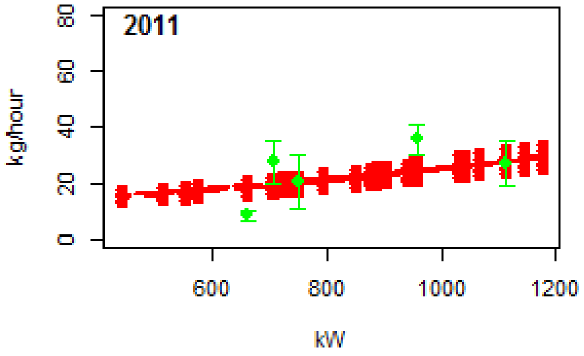

2006
kg/hour
0
20
40
60
80
600
800
1000
1200
kW


2007
kg/hour
0
20
40
60
80
600
800
1000
1200
kW


2008
kg/hour
0
20
40
60
80
600
800
1000
1200
kW


2009
kg/hour
0
20
40
60
80
600
800
1000
1200
kW


2010
kg/hour
0
20
40
60
80
600
800
1000
1200
kW


2011
kg/hour
0
20
40
60
80
600
800
1000
1200
kW

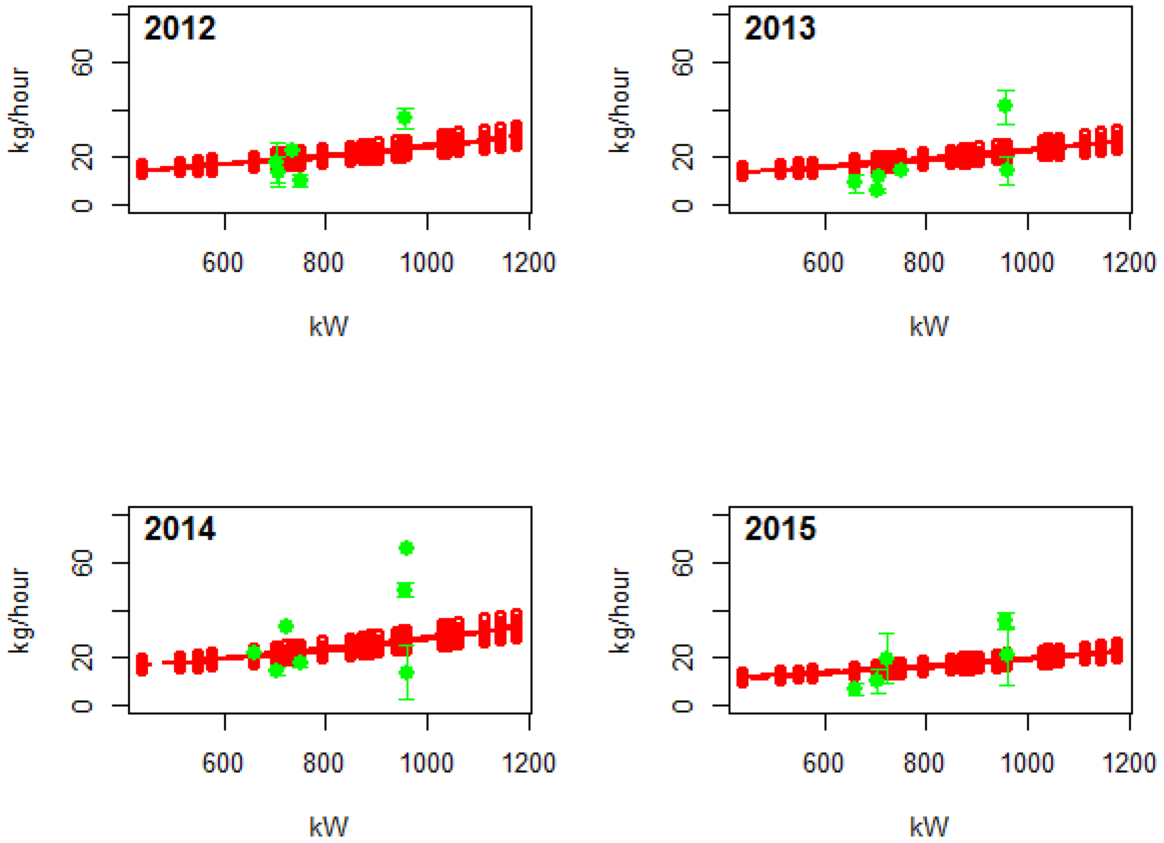
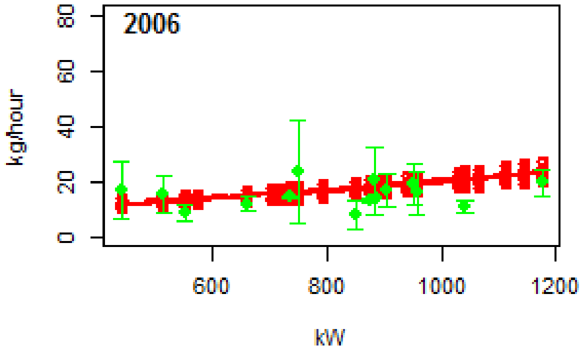
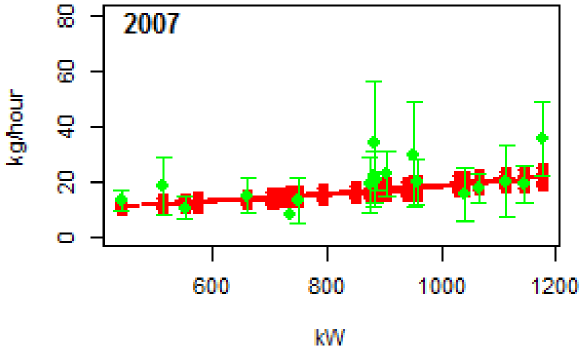
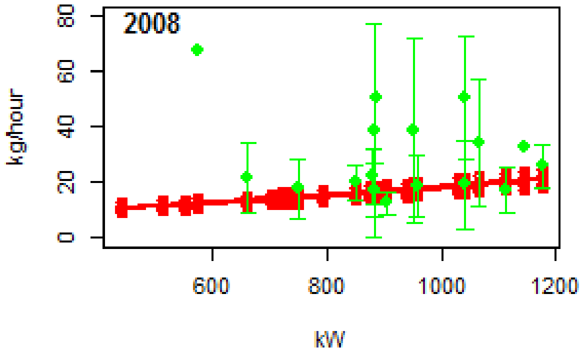
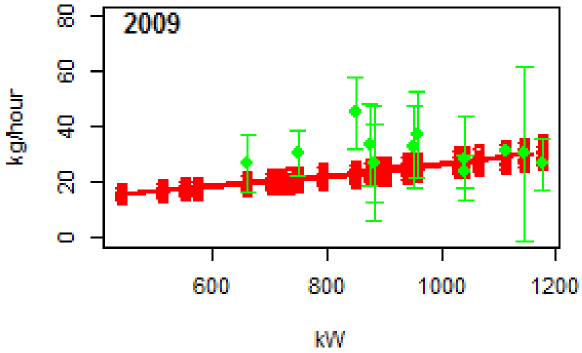


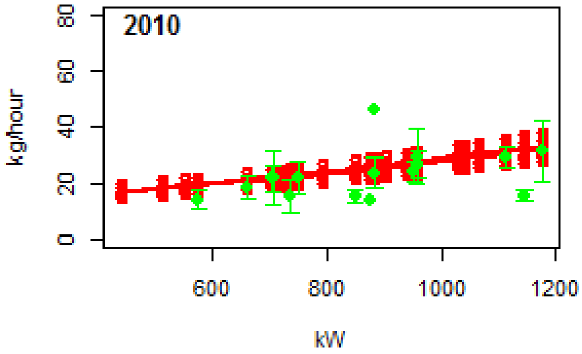
Figure 3.39. The predicted catch rates (red) versus the nominal ones (green) ((Kg/h) per trip + rectangle) against HP (kW) by year for quarter 3.

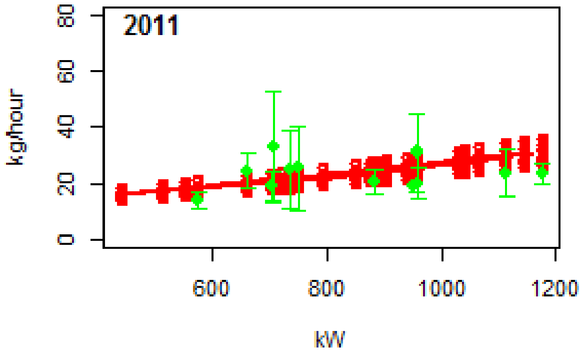

2006
kg/hour
0
20
40
60
80
600
800
1000
1200
kW


2007
kg/hour
0
20
40
60
80
600
800
1000
1200
kW


2008
kg/hour
0
20
40
60
80
600
800
1000
1200
kW


2009
kg/hour
0
20
40
60
80
600
800
1000
1200
kW


2010
kg/hour
0
20
40
60
80
600
800
1000
1200
kW


2011
kg/hour
0
20
40
60
80
600
800
1000
1200
kW

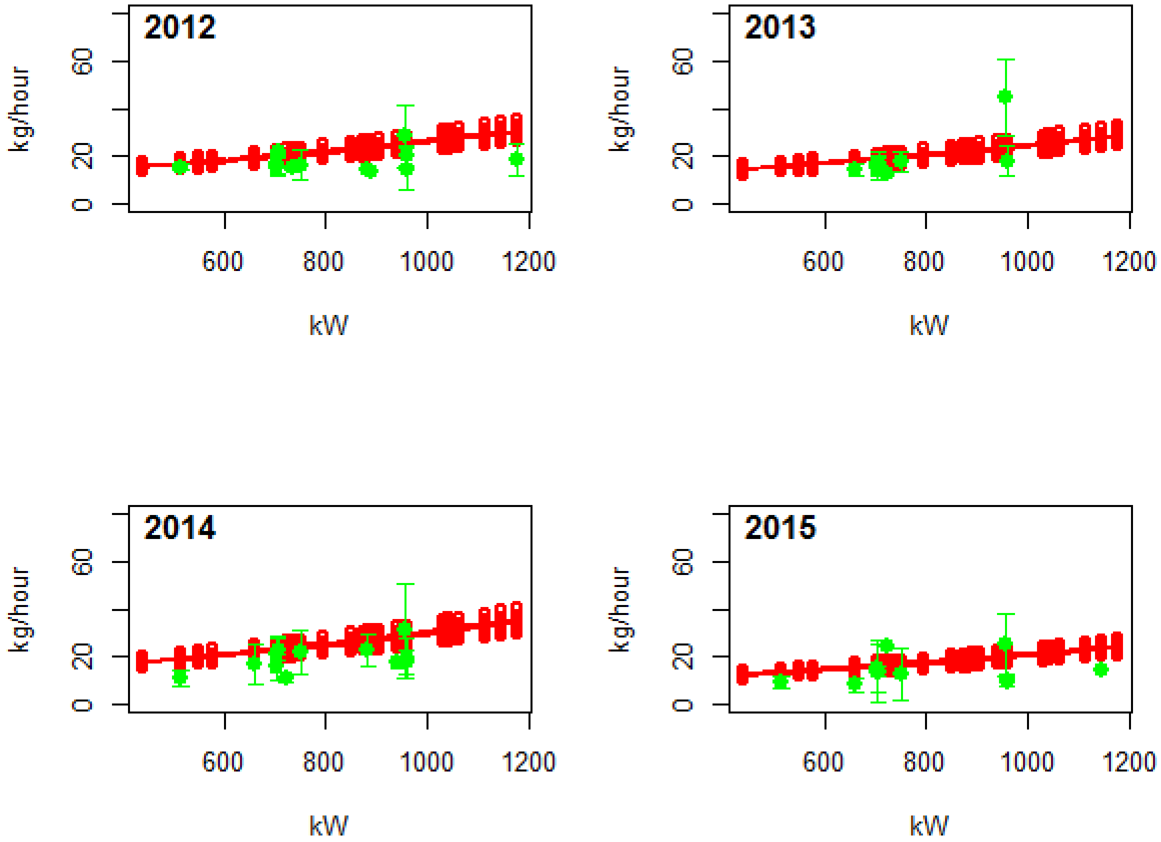


Figure 3.40. The predicted catch rates (red) versus the nominal ones (green) ((Kg/h) per trip + rectangle) against HP (kW) by year for quarter 4.

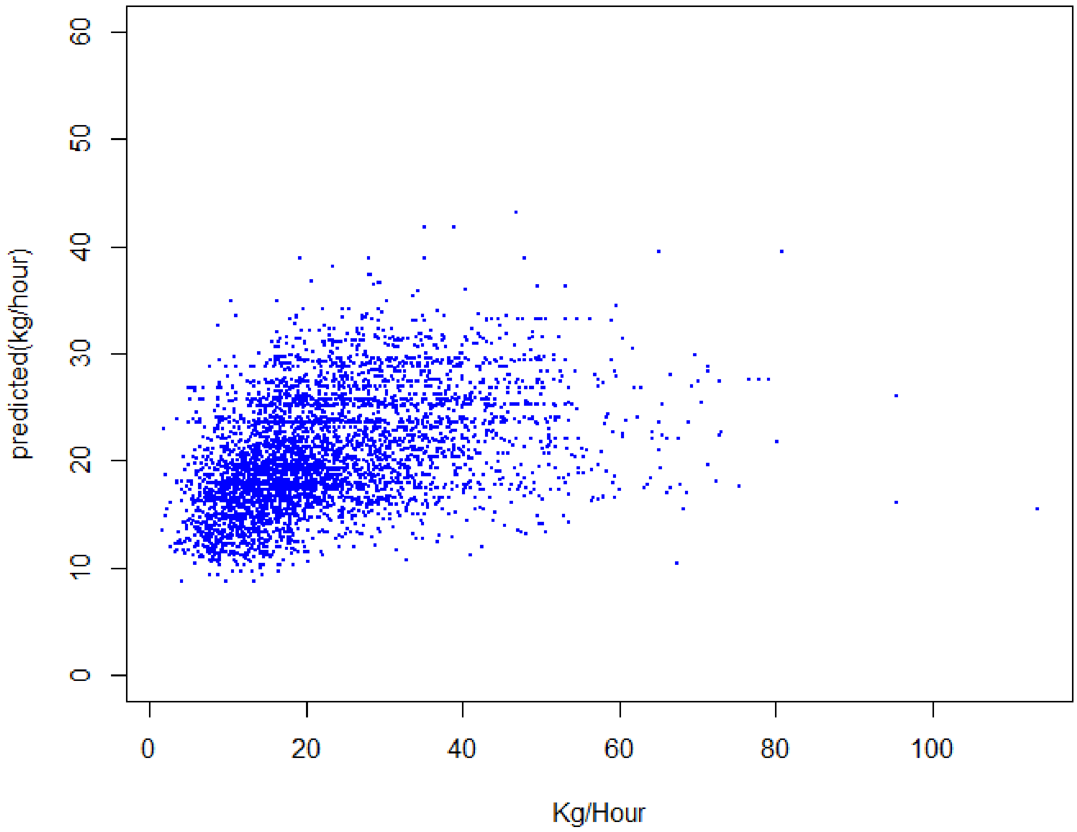


Figure 3.41. The predicted catch rates versus the nominal ones ((Kg/h) per trip + rectangle).

Conclusions before presentation at the WKNSEA

The plot of log transformed catch rates against kW clearly shows an increasing trend (figure 3.11). To retain this linear correlation between horsepower and the mean catch rate, it was suggested to move forward with the outcome of the GLM with HP included as a continuous linear variable (GLM – dataset 8). This linear trend is persistent over all the years (2006-2015), although less pronounced in 2008 and 2009 (figure 3.25). Sole catch rates are slightly different by month (figure 3.18), indicating a seasonality effect. Spatial differences were accounted for by aggregating the data by trip and rectangle. Year, quarter and rectangle were included in the model as factors. The difference in AIC value between the GLM's whereby only the HP information is treated differently, is very limited (5852-5912).

The model fit indicated that all factors were significant (see single term deletions) and showed a small residual variability. Figures 3.37-3.41 show the predicted catch rates versus the nominal ones, the model predicted lower catch rates for the higher catch rates (>40kg/hour, figure 3.41).

The predicted catch rates by year, quarter, rectangle and horsepower were divided by the corresponding total catch to obtain the standardized effort values. The sum of those effort values by year was matched with the age distribution to obtain the BE-CBT tuning series. As the standardization of the effort is solely based on data from the large fleet segment (HP > 221 kW), only length and age samples from the large fleet segment were raised to obtain the corresponding numbers at age distribution.

Further explorations at the WKNSEA

As we only have the catches by rectangle from 2006 onwards, the aggregation of the data by trip and rectangle, forces us to skip the data from 2004 and 2005. To have a longer time series, we were asked to explore the outcome of the model applied on the data aggregated by trip. This dataset (dataset 9) is identical to dataset 3 except for the addition of the quarter information and the exclusion of the 2003 data. The 2003 data were skipped because the corresponding numbers at age distribution is only available from 2004 onwards. In the glm, year and quarter were treated as class factors, while HP was included as a continuous linear variable.

```
Call:

glm(formula = log(KgHour) ~ -1 + factor(Year) + factor(Quarter) + kW, data = weight_outlier_visuren3)

Deviance Residuals:

    Min       1Q    Median       3Q       Max

-2.78028  -0.31902  -0.00587   0.34556   1.94071

Coefficients:

                        Estimate   Std. Error    t value Pr(>|t|)

factor(Year)2004  2.177e+00   5.258e-02    41.404    < 2e-16 ***

factor(Year)2005  2.111e+00   5.394e-02    39.142    < 2e-16 ***

factor(Year)2006  2.025e+00   5.152e-02    39.307    < 2e-16 ***

factor(Year)2007  1.937e+00   5.172e-02    37.442    < 2e-16 ***

factor(Year)2008  1.954e+00   5.514e-02    35.435    < 2e-16 ***

factor(Year)2009  2.343e+00   5.665e-02    41.358    < 2e-16 ***

factor(Year)2010  2.333e+00   5.855e-02    39.851    < 2e-16 ***

factor(Year)2011  2.308e+00   5.708e-02    40.431    < 2e-16 ***

factor(Year)2012  2.311e+00   5.881e-02    39.295    < 2e-16 ***

factor(Year)2013  2.244e+00   5.674e-02    39.539    < 2e-16 ***

factor(Year)2014  2.390e+00   5.444e-02    43.898    < 2e-16 ***

factor(Year)2015  2.063e+00   5.468e-02    37.729    < 2e-16 ***

factor(Quarter)2  9.648e-02    2.636e-02    3.661     0.000255 ***

factor(Quarter)3 -2.351e-01    3.259e-02   -7.213     6.53e-13 ***

factor(Quarter)4 -8.450e-02   1.905e-02   -4.435     9.46e-06 ***

kW                    1.077e-03    5.318e-05    20.245    < 2e-16 ***

---

Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1
```

(Dispersion parameter for gaussian family taken to be 0.2597388)

Null deviance: 38219.4 on 3946 degrees of freedom

Residual deviance: 1020.8 on 3930 degrees of freedom

AIC: 5896.7

Number of Fisher Scoring iterations: 2

```
Start:  AIC=5896.71
log(KgHour) ~ -1 + factor(Year) + factor(Quarter) + kW

                   Df Deviance    AIC
<none>                  1020.8 5896.7
- factor(Quarter)  3    1044.7 5982.2
- kW               1    1127.2 6286.2
- factor(Year)    12    1639.0 7741.2
```

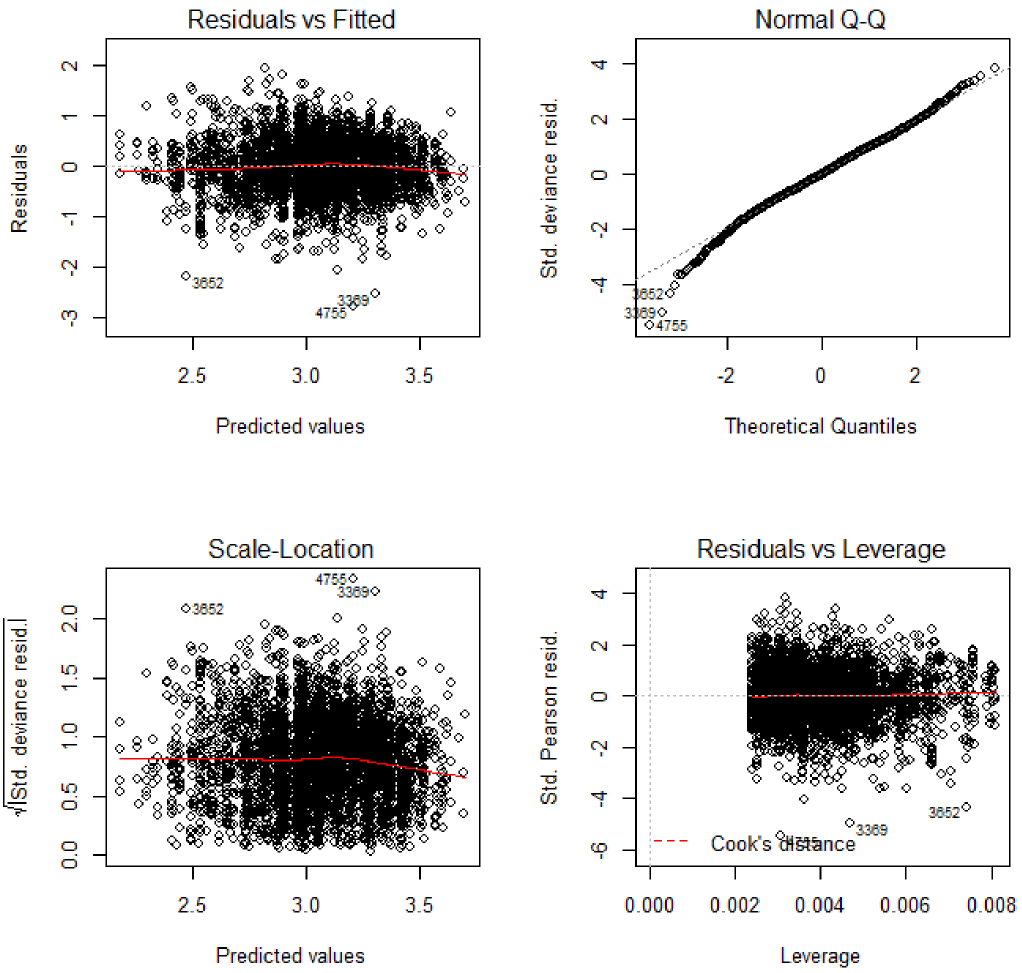


Figure 3.42. Residual plots- GLM-dataset 9

Generalized linear model (GLM) - dataset 9 - predictions

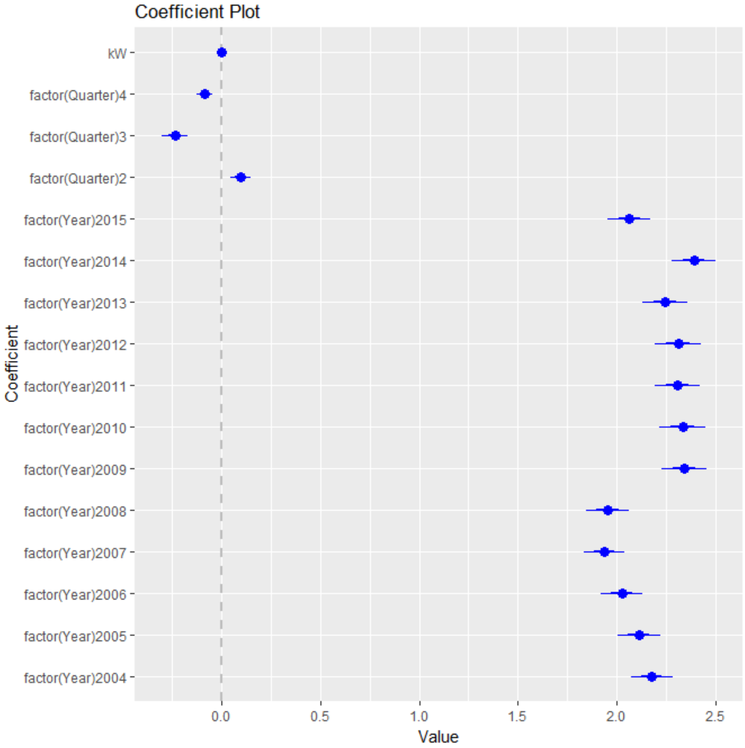
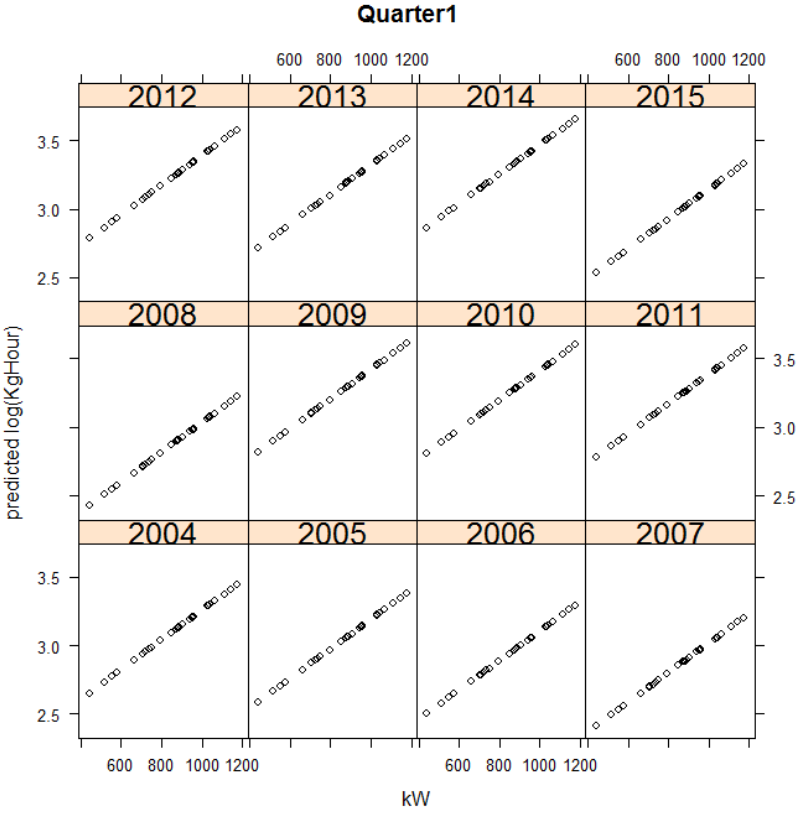
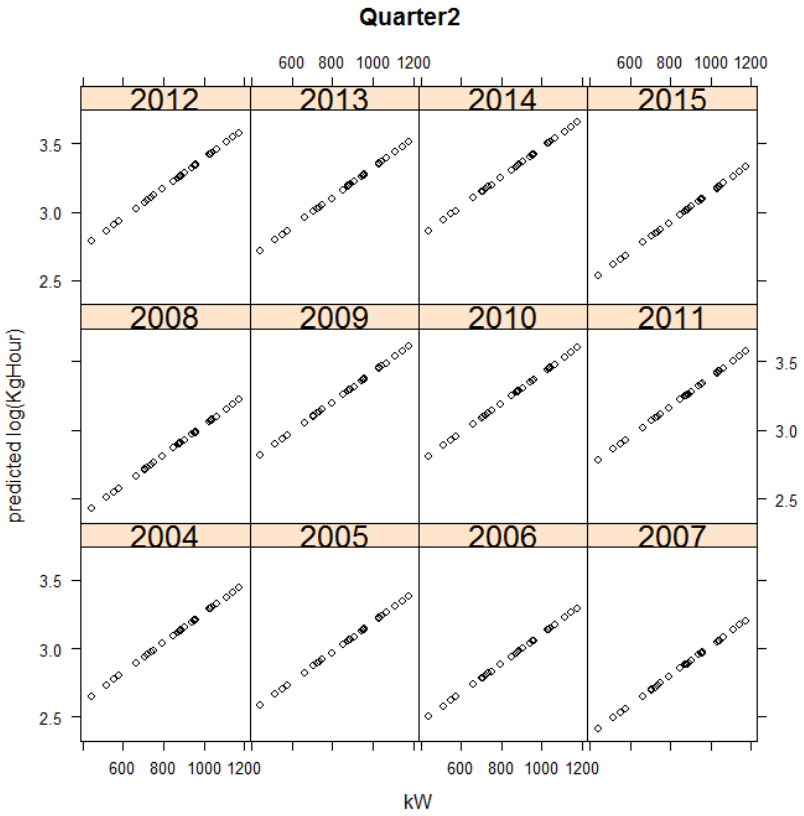


Figure 3.43. Estimated coefficients from the model (GLM-dataset 9)

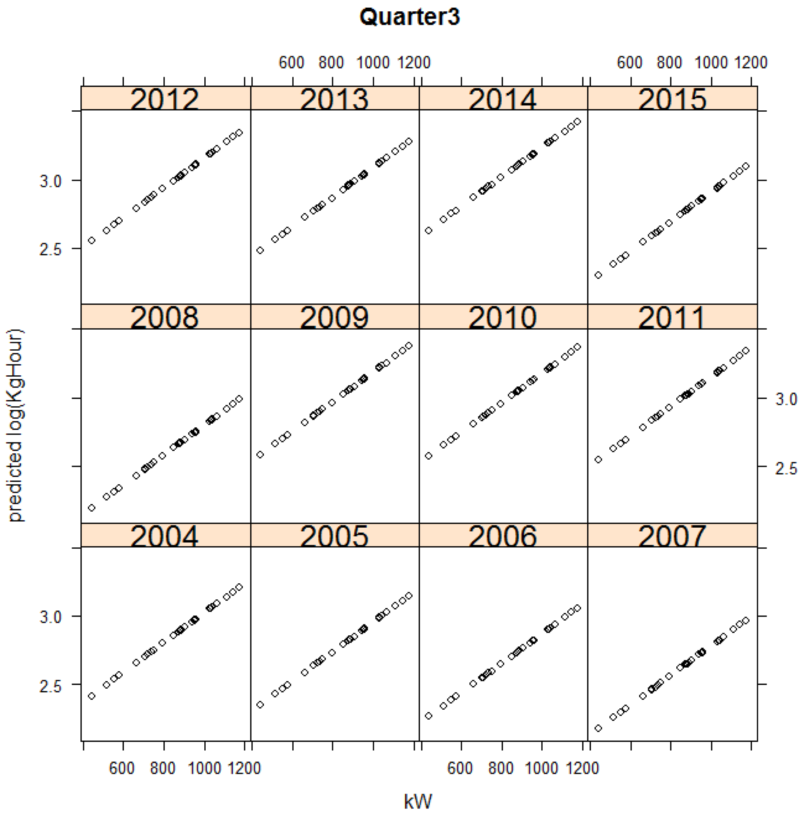
(a)



(b)


Quarter2
2012
2013
2014
2015
2008
2009
2010
2011
2004
2005
2006
2007
3.5
3.0
2.5
600 800 1000 1200
predicted log(KgHour)
kW

(c)


Quarter3
2012
2013
2014
2015
2008
2009
2010
2011
2004
2005
2006
2007
3.0
2.5
600 800 1000 1200
predicted log(KgHour)
kW

(d)

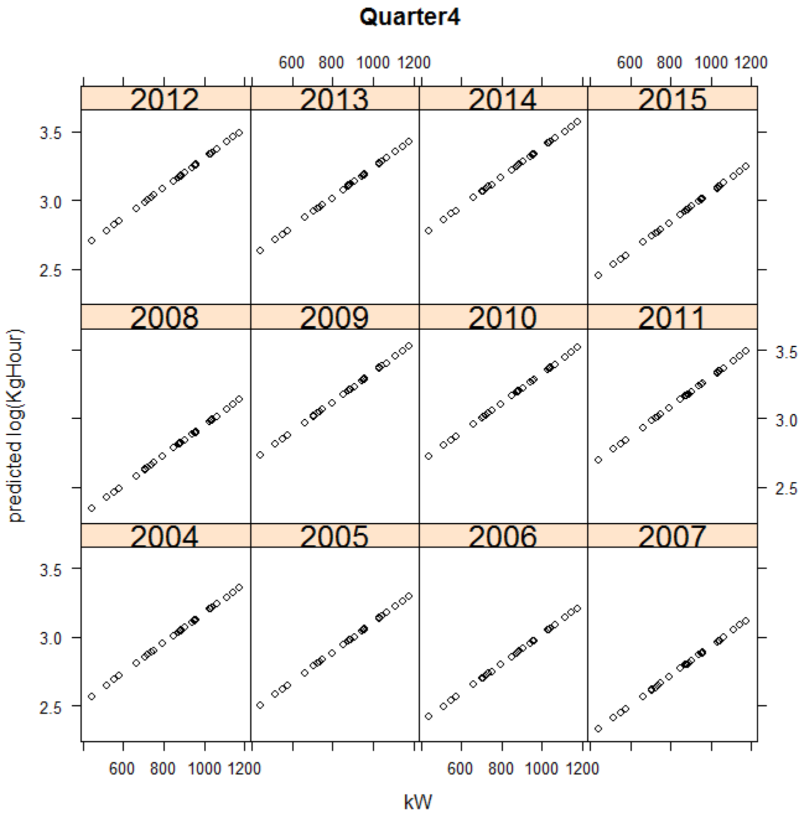
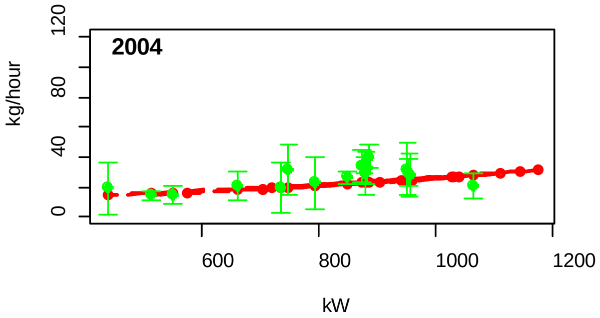
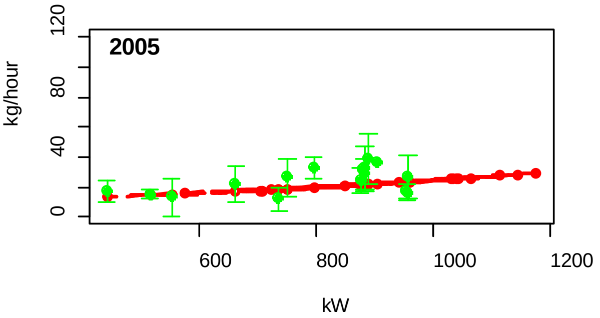
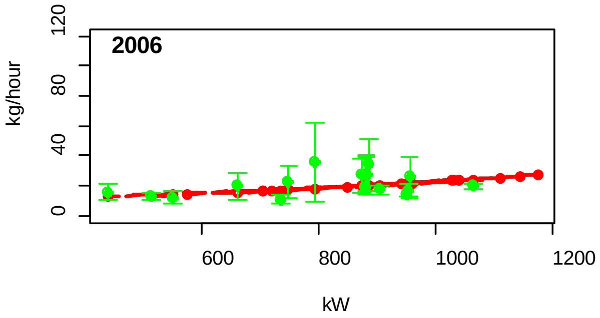
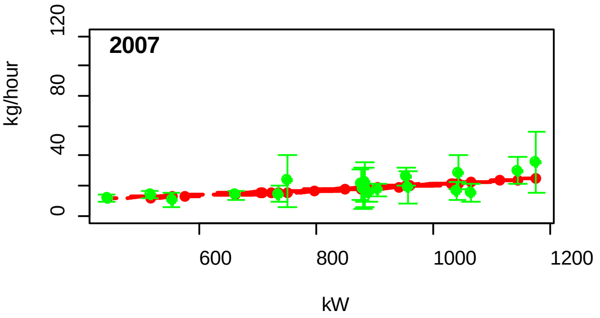


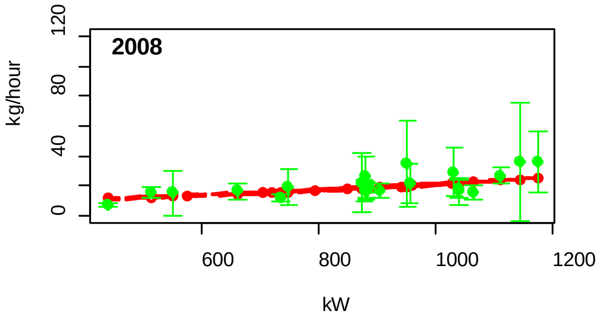
Figure 3.44. Estimated log catch rates (log(Kg/h) per trip) against HP (kW) for (a) quarter 1, (b) quarter 2, (c) quarter 3 and (d) quarter4.

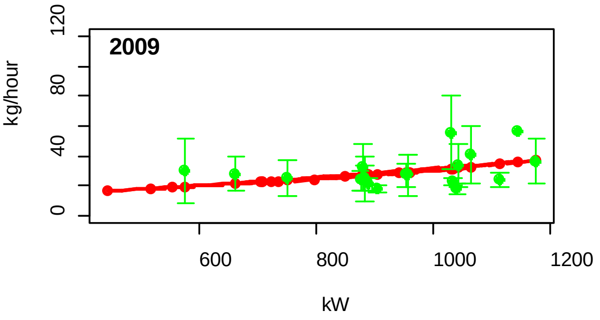

2004
kg/hour
0
40
80
120
600
800
1000
1200
kW


2005
kg/hour
0
40
80
120
600
800
1000
1200
kW


2006
kg/hour
0
40
80
120
600
800
1000
1200
kW


2007
kg/hour
0
40
80
120
600
800
1000
1200
kW


2008
kg/hour
0
40
80
120
600
800
1000
1200
kW


2009
kg/hour
0
40
80
120
600
800
1000
1200
kW

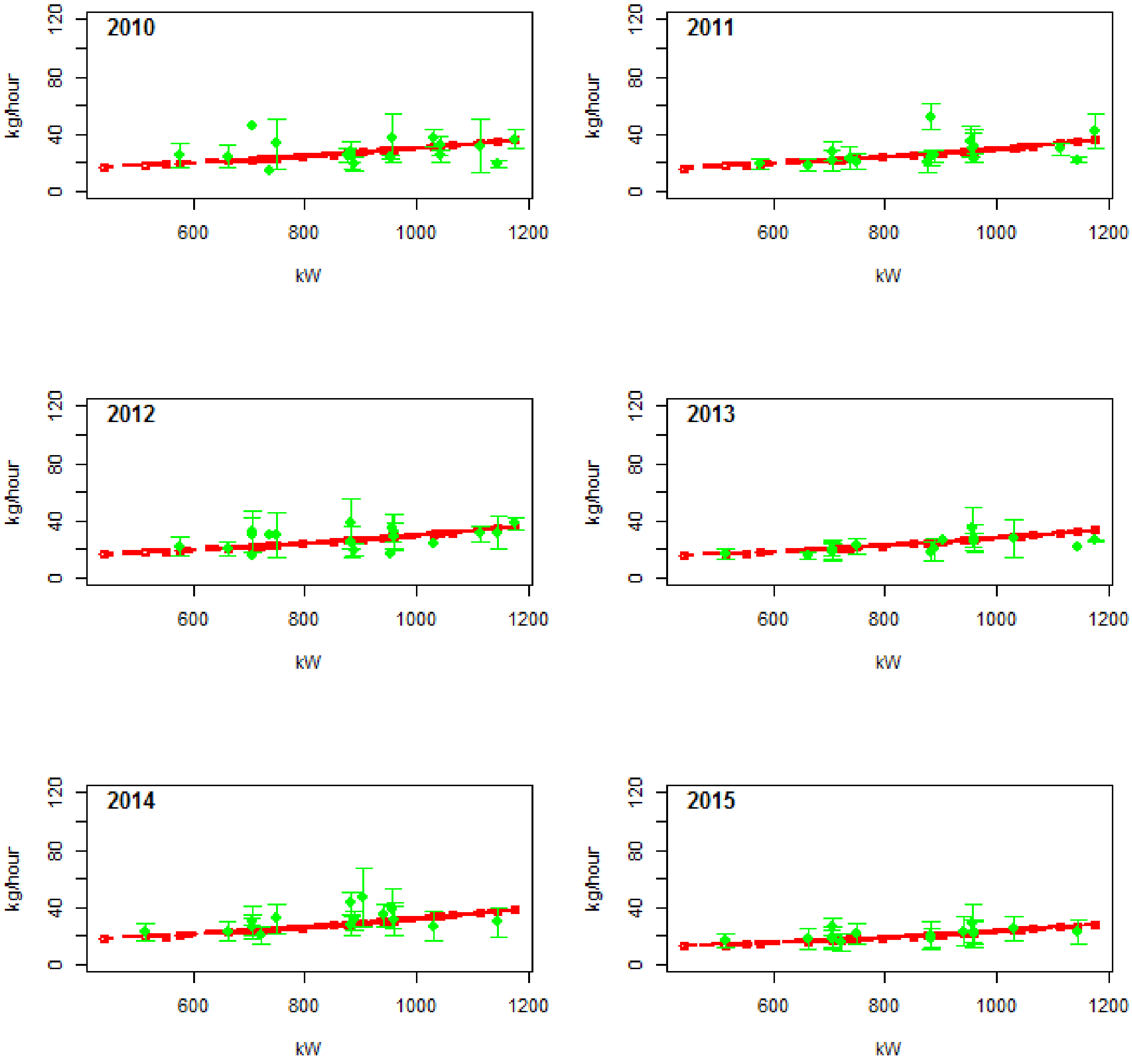
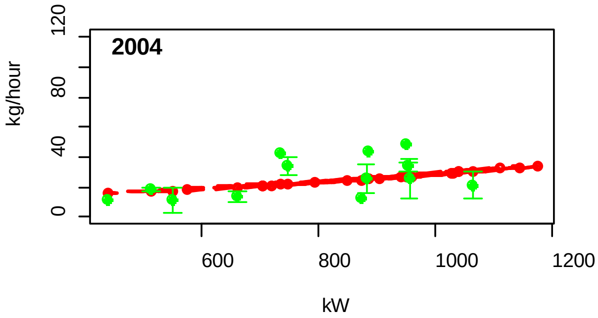
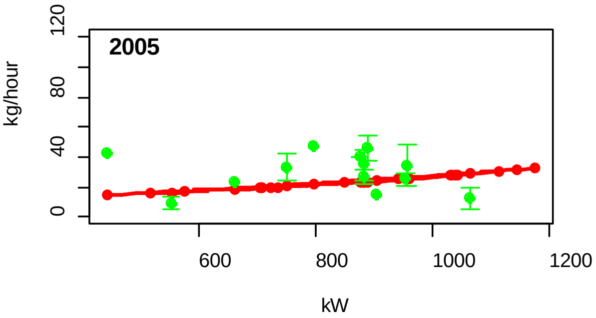
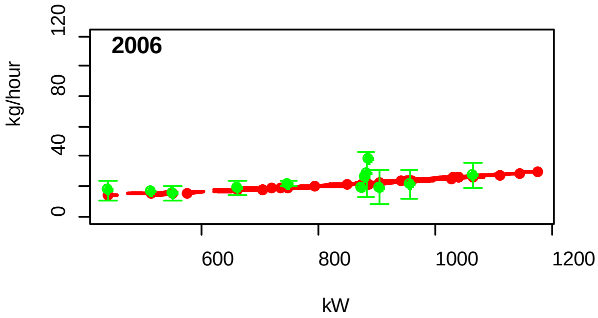
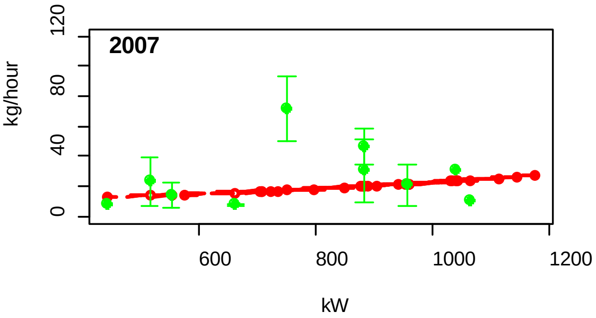


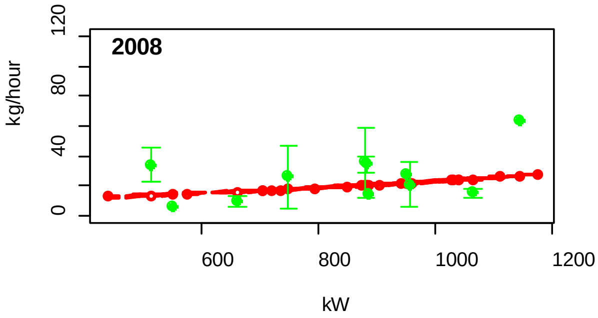
Figure 3.45. The predicted catch rates (red) versus the nominal ones (green) ((Kg/h) per trip) against HP (kW) by year for quarter 1.

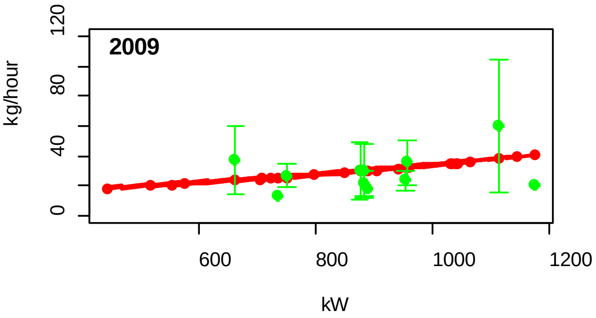

2004
120
80
40
0
kg/hour
600
800
1000
1200
kW


2005
120
80
40
0
kg/hour
600
800
1000
1200
kW


2006
120
80
40
0
kg/hour
600
800
1000
1200
kW


2007
120
80
40
0
kg/hour
600
800
1000
1200
kW


2008
120
80
40
0
kg/hour
600
800
1000
1200
kW


2009
120
80
40
0
kg/hour
600
800
1000
1200
kW

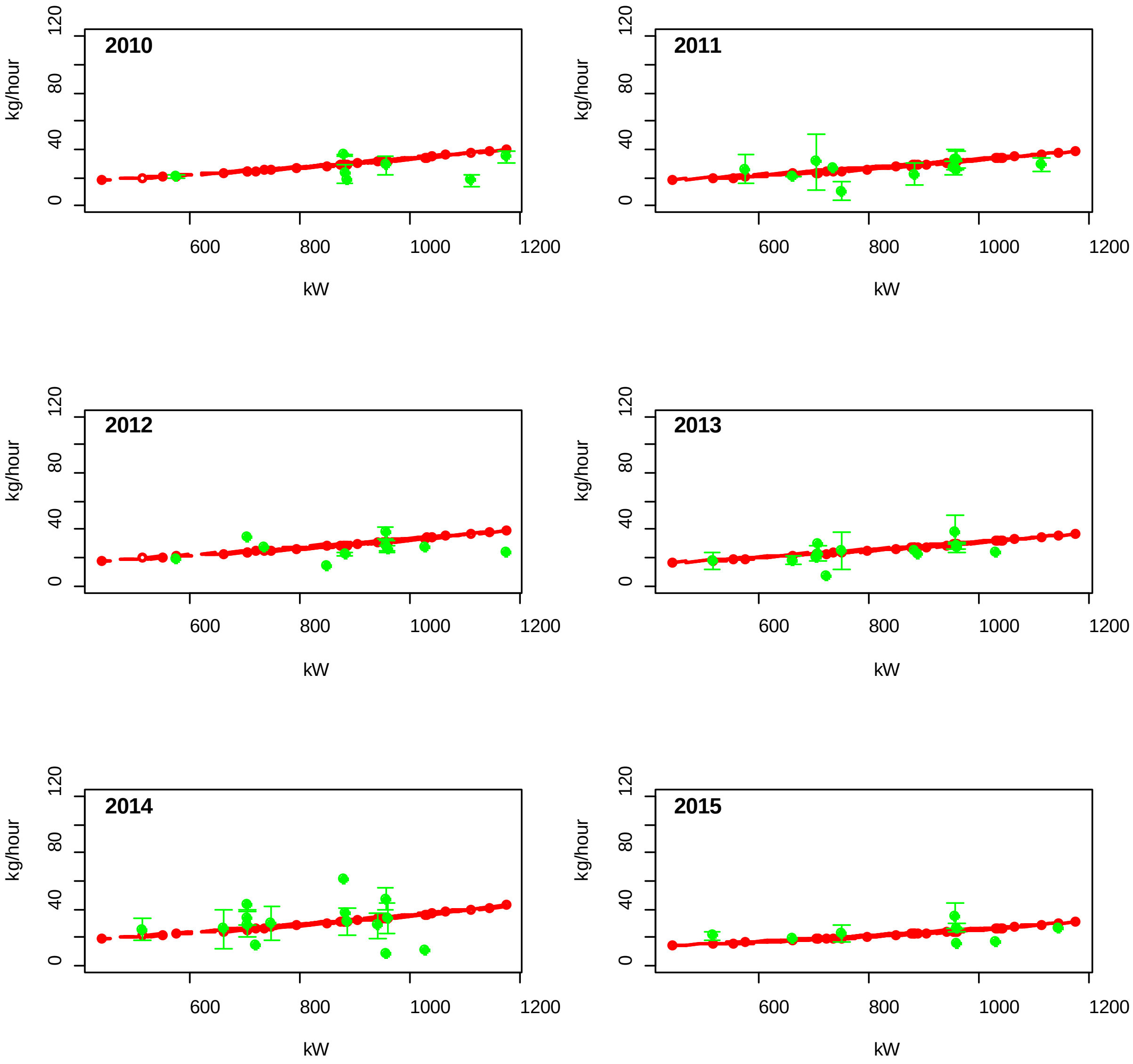
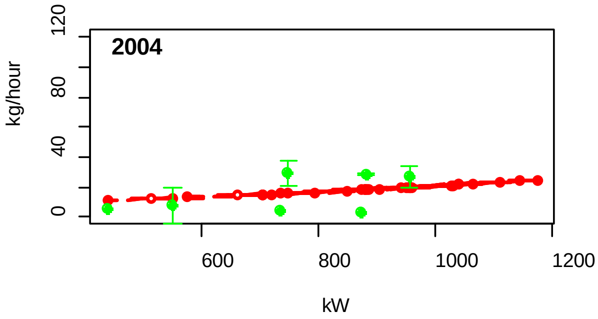
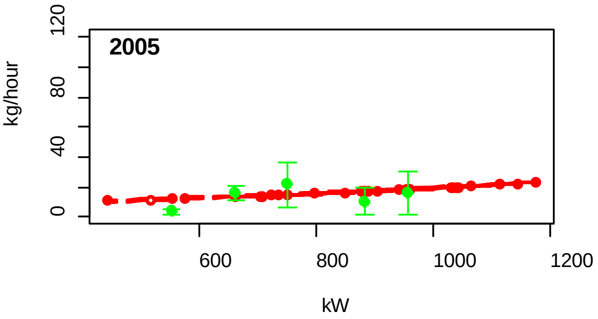
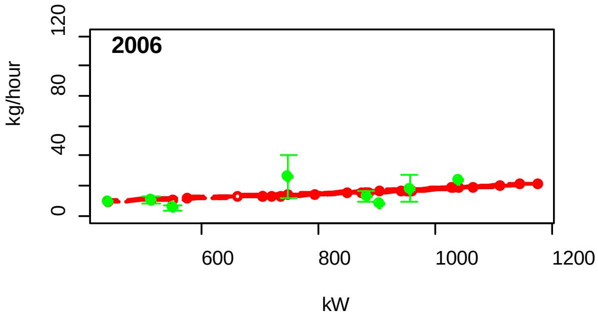
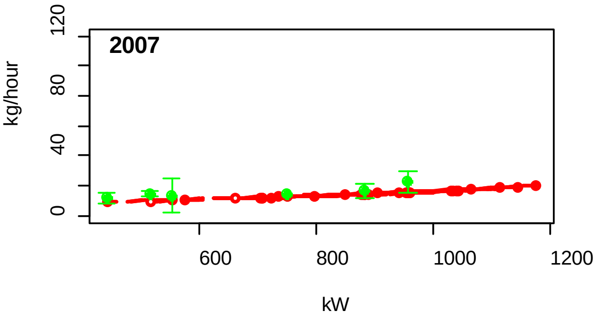


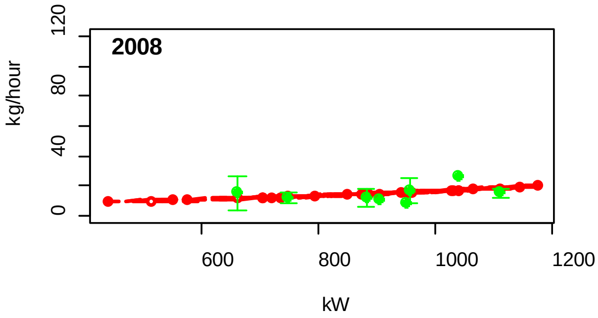
Figure 3.46. The predicted catch rates (red) versus the nominal ones (green) ((Kg/h) per trip) against HP (kW) by year for quarter 2.

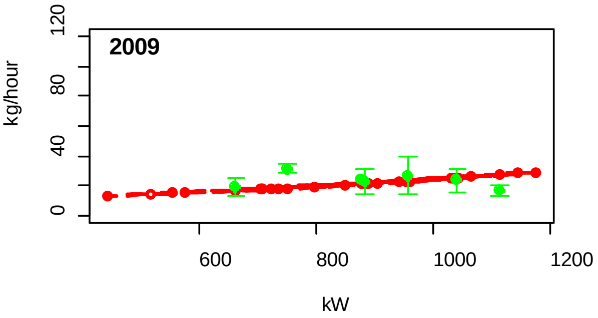

2004
kg/hour
0
40
80
120
600
800
1000
1200
kW


2005
kg/hour
0
40
80
120
600
800
1000
1200
kW


2006
kg/hour
0
40
80
120
600
800
1000
1200
kW


2007
kg/hour
0
40
80
120
600
800
1000
1200
kW


2008
kg/hour
0
40
80
120
600
800
1000
1200
kW


2009
kg/hour
0
40
80
120
600
800
1000
1200
kW

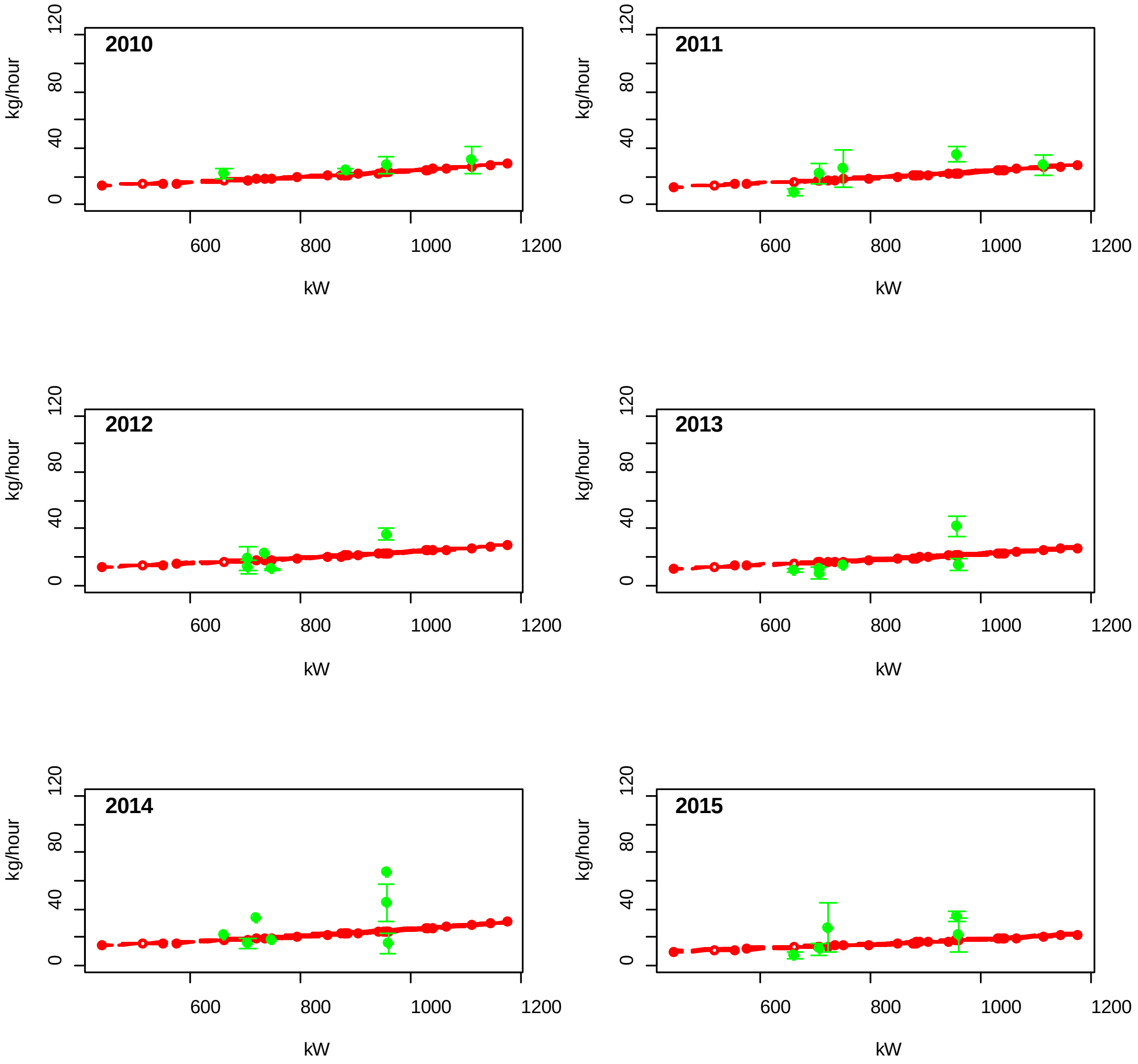
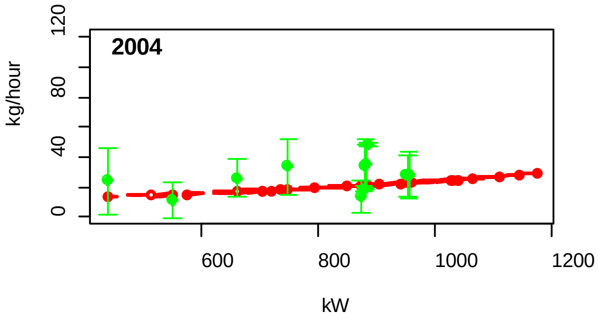
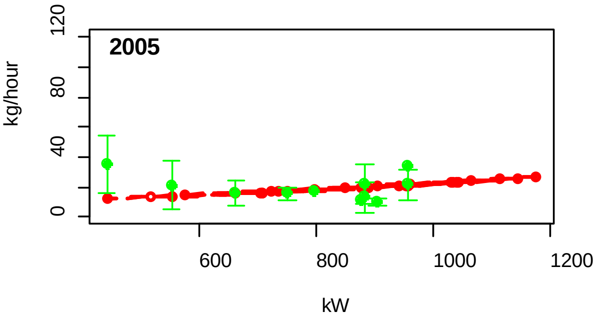
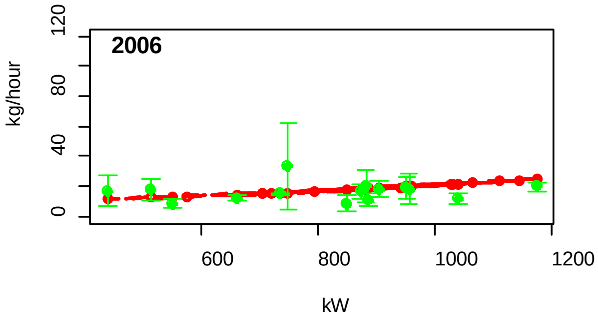
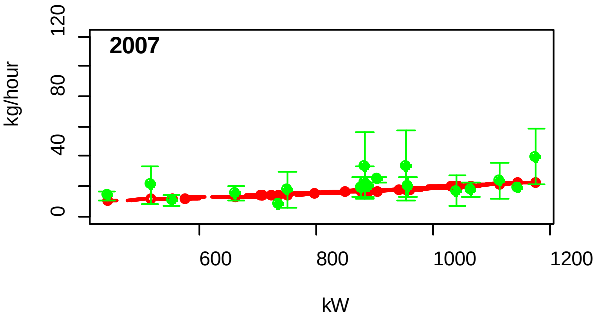


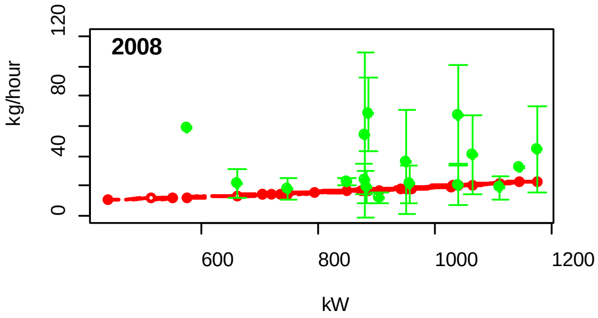
Figure 3.47. The predicted catch rates (red) versus the nominal ones (green) ((Kg/h) per trip) against HP (kW) by year for quarter 3.

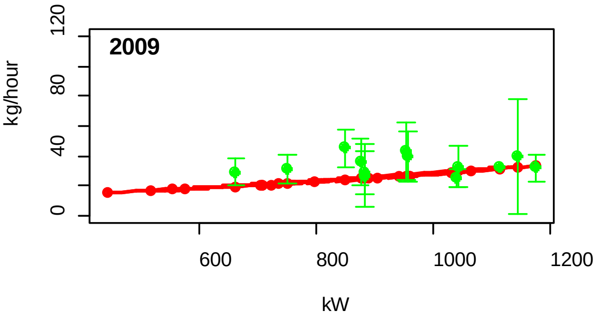

2004
kg/hour
0
40
80
120
600
800
1000
1200
kW


2005
kg/hour
0
40
80
120
600
800
1000
1200
kW


2006
kg/hour
0
40
80
120
600
800
1000
1200
kW


2007
kg/hour
0
40
80
120
600
800
1000
1200
kW


2008
kg/hour
0
40
80
120
600
800
1000
1200
kW


2009
kg/hour
0
40
80
120
600
800
1000
1200
kW

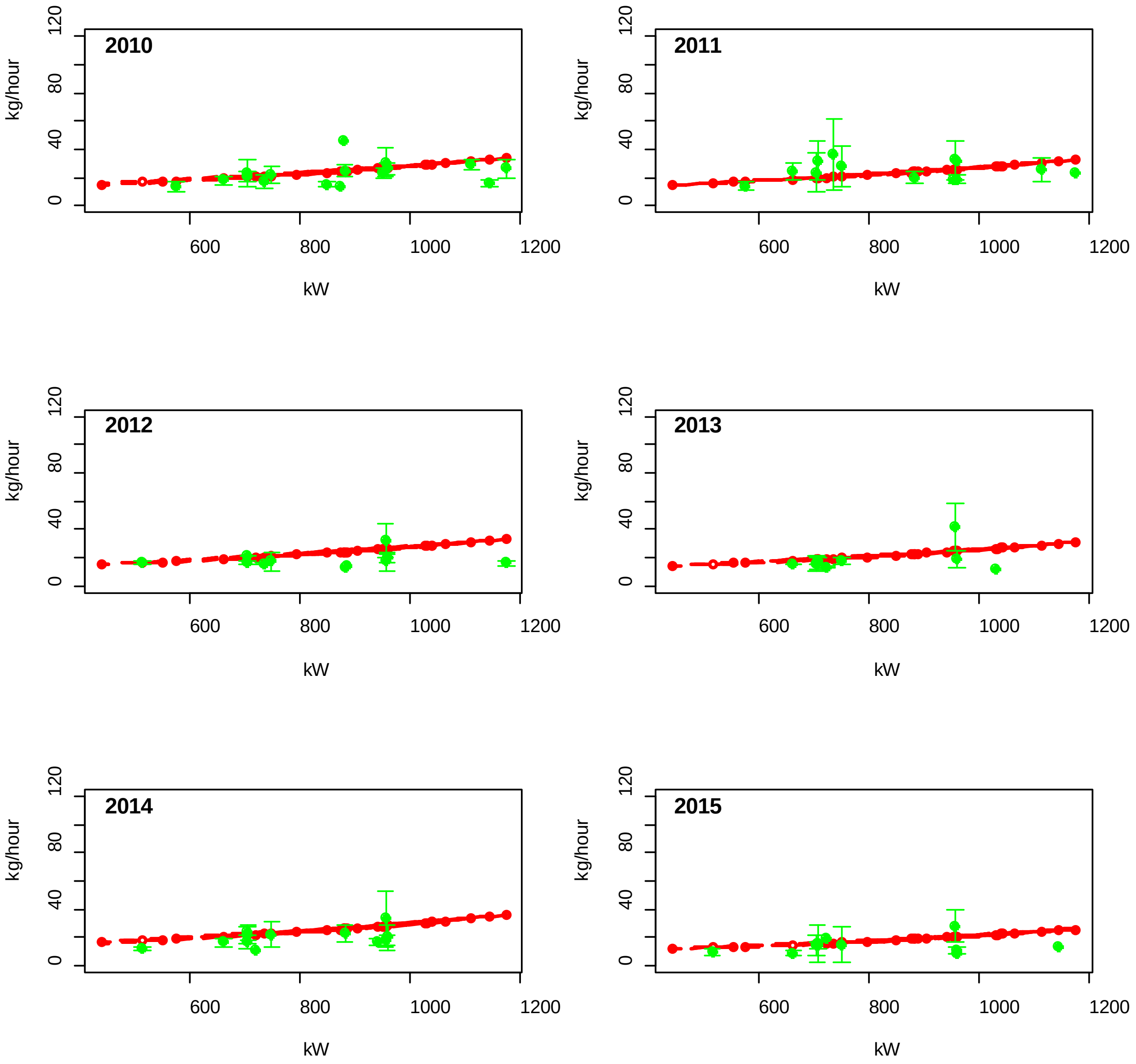


Figure 3.48. The predicted catch rates (red) versus the nominal ones (green) ((Kg/h) per trip) against HP (kW) by year for quarter 4.

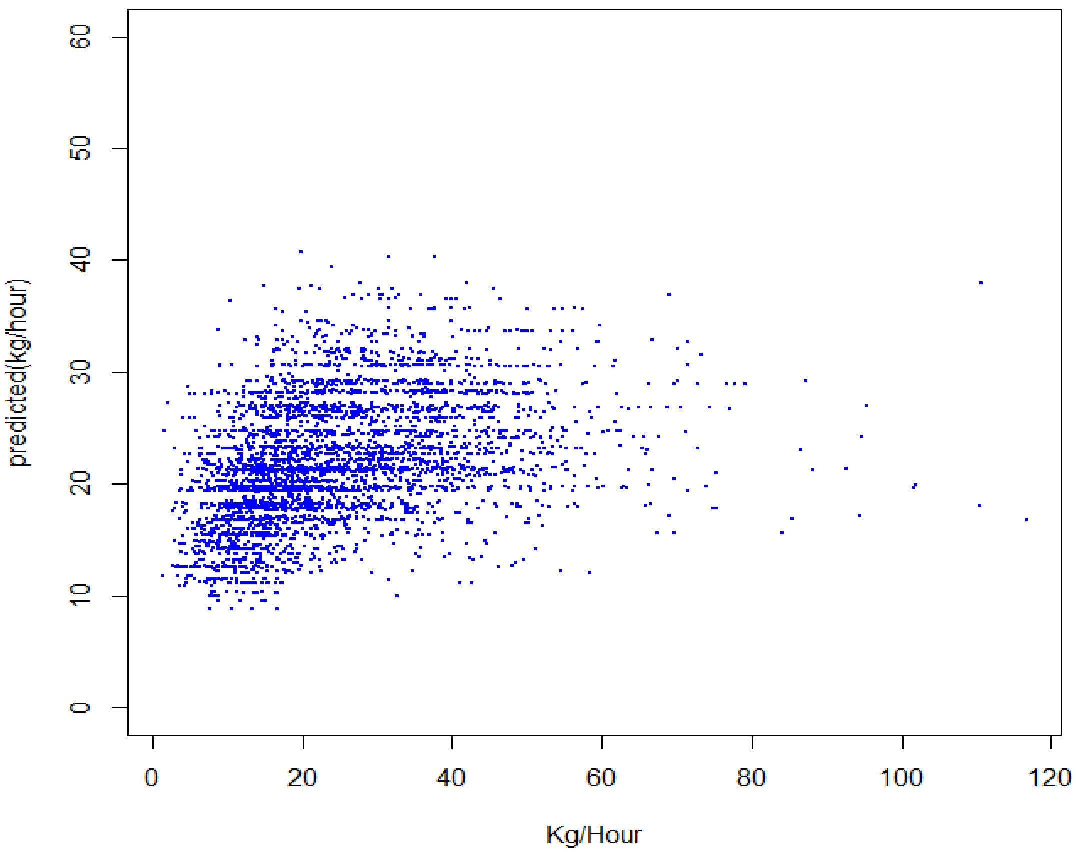


Figure 3.49. The predicted catch rates versus the nominal ones ((Kg/h) per trip).

<u>Comparison of the estimated year coefficients from the GLM on dataset 8 and the GLM on dataset 9</u>

Figure 3.50. Estimated year coefficients from the GLM on dataset 8 (blue) and the GLM on dataset 9 (red)

Comparison of the Belgian commercial tuning series with standardized effort from model output on dataset 8 (from 2006) and dataset 9 (from 2004).

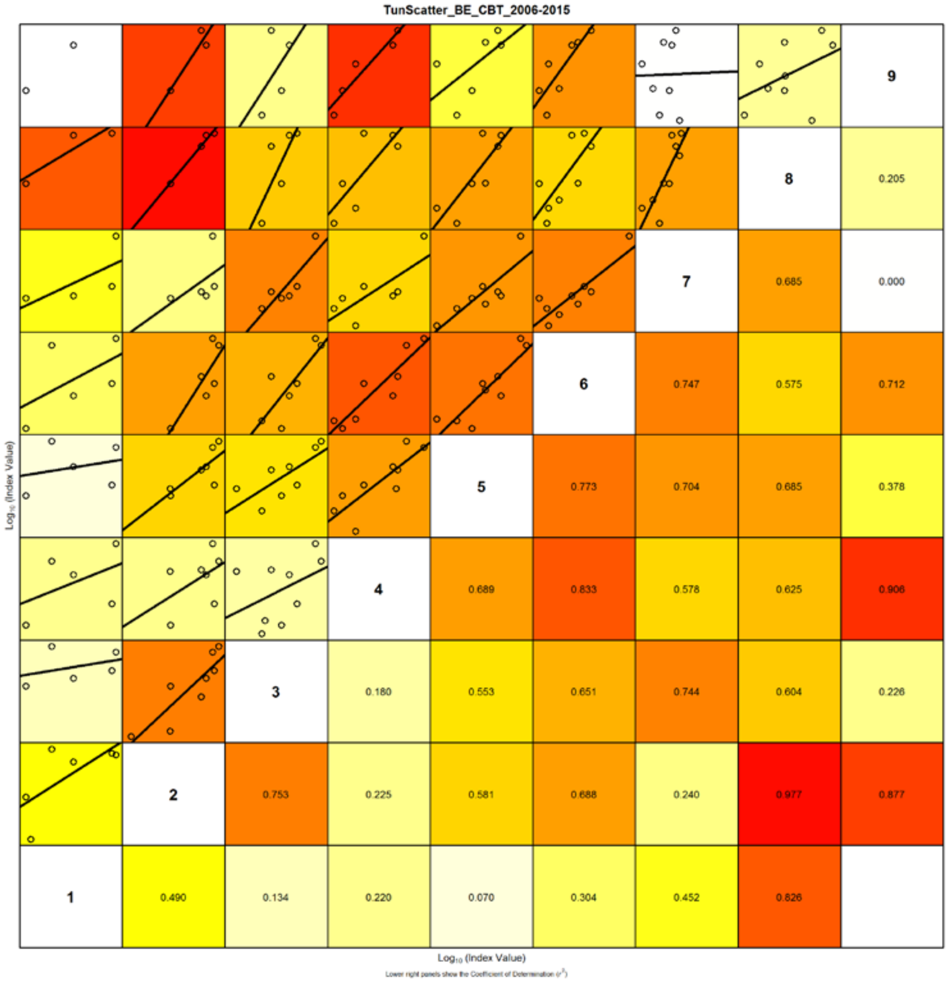


Figure 3.51. Internal consistency plot of the BE_CBT_**2006**-2015 tuning series for 7.d sole (dataset 8).

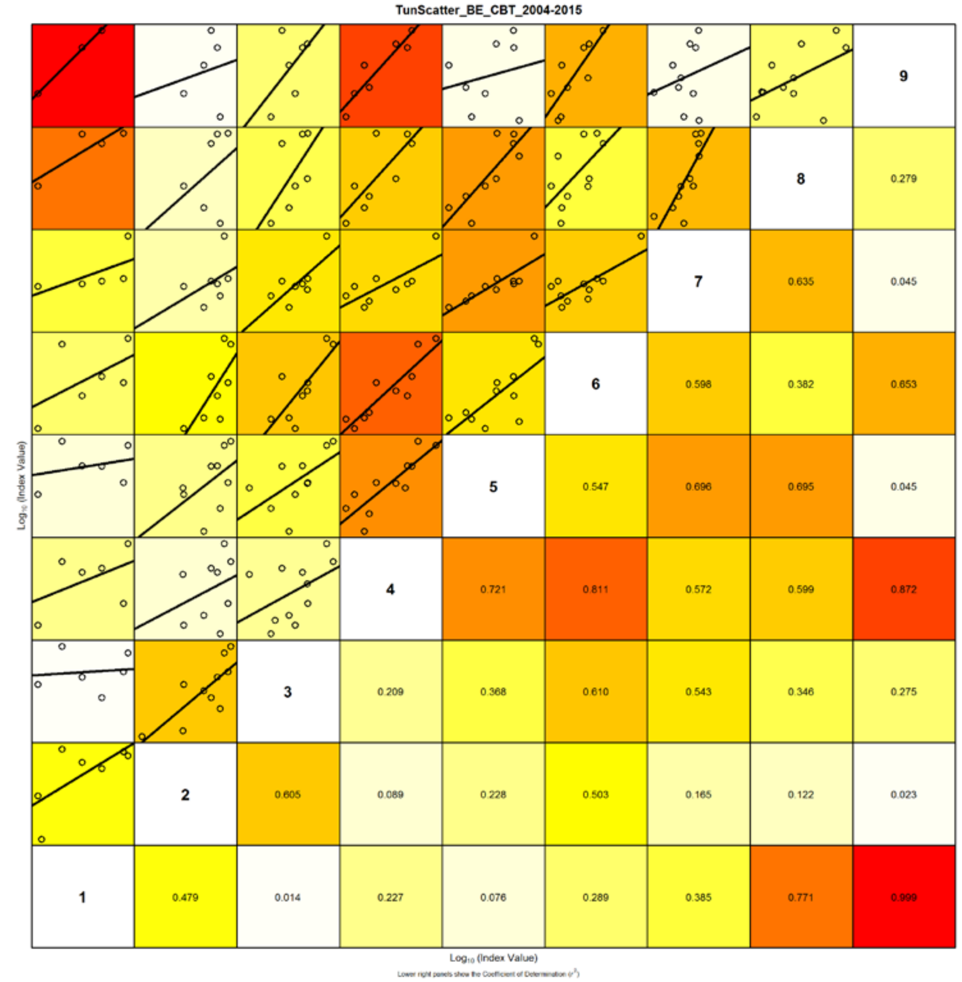


Figure 3.52. Internal consistency plot of the BE_CBT_**2004**-2015 tuning series for 7.d sole (dataset 9).

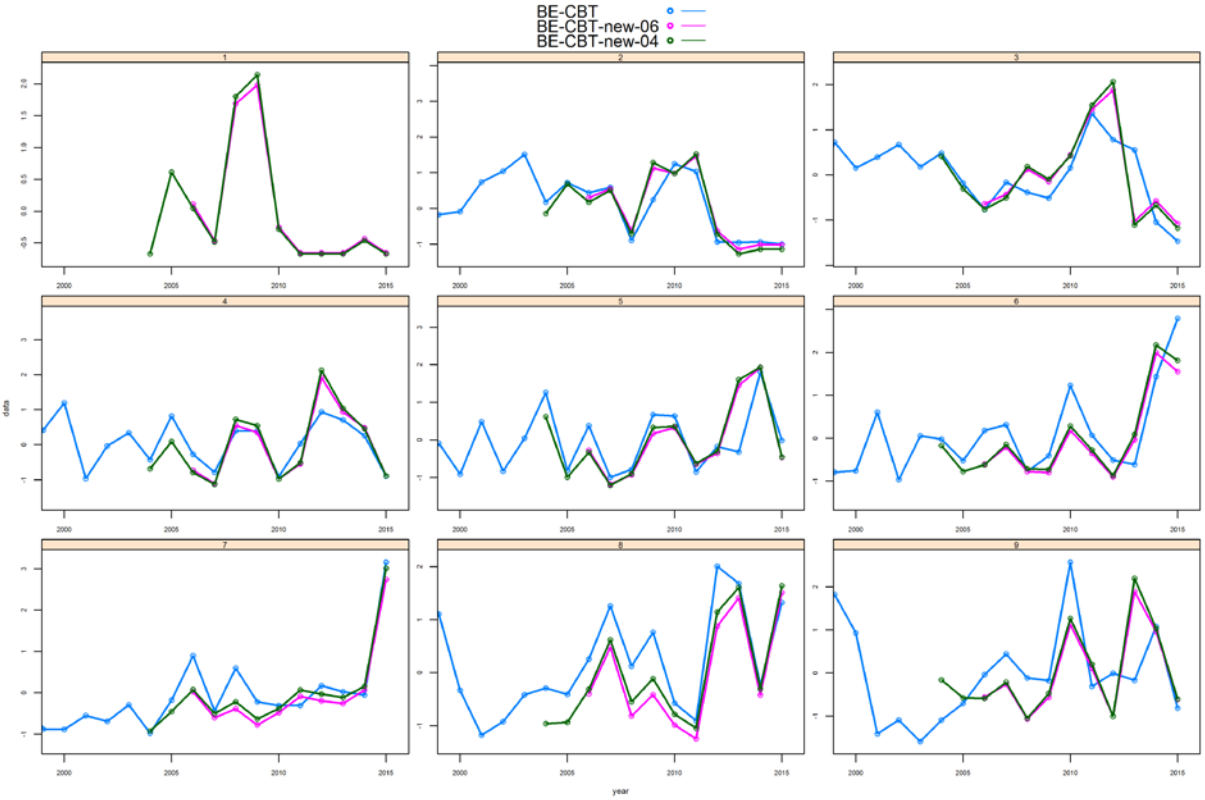


Figure 3.53. Standardized indices by age of the BE_CBT_1986-2015 (blue), the BE_CBT_2004-2015 (green) and the BE_CBT_2006-2015 (pink) tuning series for 7.d sole.

Conclusions at the WKNSEA benchmark

The differences between the estimated year coefficients from the GLM on dataset 8 (aggregation by trip and rectangle, 2006-2015) and the GLM on dataset 9 (aggregation by trip, 2004-2015) are very small (figure 3.50). Therefore, the addition of 2 extra years of data is more beneficial than including spatial variation. Moreover, the internal consistency of the BE_CBT_2004-2015 tuning series (figure 3.52) is very similar to the one of the BE_CBT_2006-2015 tuning series (figure 3.51). Additionally, the similarity plot (figure 3.53) shows that both tuning series indicate the same higher and lower year classes by age. Finally, with the original tuning series from 2004 until 2015, there is an overall similarity. At the WKNSEA benchmark, it was decide to go forward with the **BE_CBT_2004-2015 tuning series** (dataset 9) and explore the inclusion of this tuning series in the assessment.

4. Investigating a new French commercial tuning series

Objective

The Eastern Channel Sole stock is currently assessed using 3 survey indices: UK(E&W)_BTS, UK (E&W)_YFS, and FR_YFS; and 2 commercial indices: BE_CBT and UK(E&W)_CBT. However, these fleets cover mainly the middle of the Channel and the English coast and they are present in the EEC only a part of the year.

This document reviews the data available from the French otter trawl fleet which targets sole seasonally and mainly along the French coast and is an attempt to create a CPUEs time series from it.

Data analysis

Mesh sizes used

Trawlers fishing for sole use mesh sizes of approximately 80 mm. However, in the logbooks, mesh sizes can be missing or misreported. Table 4.1 shows the data available in the logbooks and how mesh sizes have been reported in the past without filtering on the landings.

Table 4.1: Number of trips per métier (continued below)

	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
	0	0	0	0	0	0	0	82	0	573	471	0	0	6	0	0	0
OTB_DEF_>=120_0	0	0	0	1811	381	41	156	156	0	0	34	151	650	20	24	510	172
OTB_DEF_0_0_0	0	25866	22824	17640	22825	11574	2621	708	2232	1141	415	146	17	108	455	1394	9625
OTB_DEF_0_16_0	0	0	865	958	565	773	98	68	29	47	253	56	107	502	438	168	34
OTB_DEF_100_119_0	0	4866	4372	9426	4097	2748	1473	1411	15040	2813	7270	5670	2271	1407	293	172	132
OTB_DEF_16_31_0	0	131	81	1017	1639	1289	1242	346	395	1155	2278	2361	1782	1399	1173	1281	1345
OTB_DEF_32_69_0	0	218	335	3327	15242	22297	20787	9017	7121	5183	4885	4010	6492	5543	3066	3180	6394
OTB_DEF_70_99_0	28	78102	158583	196049	204658	263923	310952	269232	306520	280821	270328	261430	240271	254481	226311	225903	175316

Most of the trips with demersal trawls in the Eastern Channel use mesh sizes in the range of 70-99 mm. However, the mesh size reporting rate increased with time. Especially in the beginning of the time series, a lot of mesh sizes are missing: for OTB_DEF_0_0_0, around 20 000 trips have missing mesh sizes in the beginning of the 2000s.

Table 4.2 shows the same data selecting only trips that landed sole.

Table 4.2: Number of trips landing sole per métier (continued below)

	1999	2000	2001	2002	2003	2004	2005	2006
	0	0	0	0	0	0	0	19
OTB_DEF_>=120_0	0	0	0	39	38	2	16	64
OTB_DEF_0_0_0	0	2454	2399	1794	3320	1579	454	150
OTB_DEF_0_16_0	0	0	61	58	57	67	10	17
OTB_DEF_100_119_0	0	61	77	150	92	204	77	15
OTB_DEF_16_31_0	0	15	41	208	188	142	108	42
OTB_DEF_32_69_0	0	12	31	387	1188	1732	2047	1109
OTB_DEF_70_99_0	1	3738	7669	10848	11192	11471	12784	14839

	2007	2008	2009	2010	2011	2012	2013	2014	2015
	0	47	8	0	0	1	0	0	0
OTB_DEF_>=120_0	0	0	1	13	13	0	1	25	3
OTB_DEF_0_0_0	338	175	53	13	2	12	45	349	677
OTB_DEF_0_16_0	6	8	1	7	7	66	89	24	3
OTB_DEF_100_119_0	159	92	196	101	72	52	15	5	7
OTB_DEF_16_31_0	48	119	68	76	165	111	123	140	143
OTB_DEF_32_69_0	296	396	492	359	618	742	509	501	669
OTB_DEF_70_99_0	15291	13239	10780	11849	12955	15050	14474	13745	10990

The number of trips that recorded sole in their landings with missing mesh sizes (OTB_DEF_0_0_0) fluctuated in time but does not represent a significant proportion of the trips. Sole is mostly caught using *OTB_DEF_70_99_0*.

In the following sections, only trips using OTB_DEF_70_99_0 were considered to avoid the use of mis-or unreported mesh sizes in the analyses.

Vessels

In order to create a time series from commercial catches, vessels staying in the fishery during a long period are preferred, to avoid having large changes in the vessel characteristics and fishing practices.

Table 3 shows that only 31 vessels are observed during the whole time series (2000-2015) whereas about 102 vessels recorded sole landings in the EEC only during one year.

Table 3: Number of vessels landing Sole each year (without threshold)

Number of years with Sole landings	Number of vessels
1	102
2	54
3	36
4	49
5	29
6	26
7	32
8	21
9	40

10	20
11	16
12	20
13	27
14	25
15	13
16	31

In order to assess the impact of having boats entering/leaving the fishery, analyses will be conducted in the following sections with on the one hand vessels that landed sole over a period of 16 years and all vessels on the other hand.

Trends in sole landings

Eastern Channel trawlers target sole seasonally: they switch to other target species and change gear during the year. Ideally, those seasonal patterns should remain stable from one year to another, for the tuning series to be reliable.

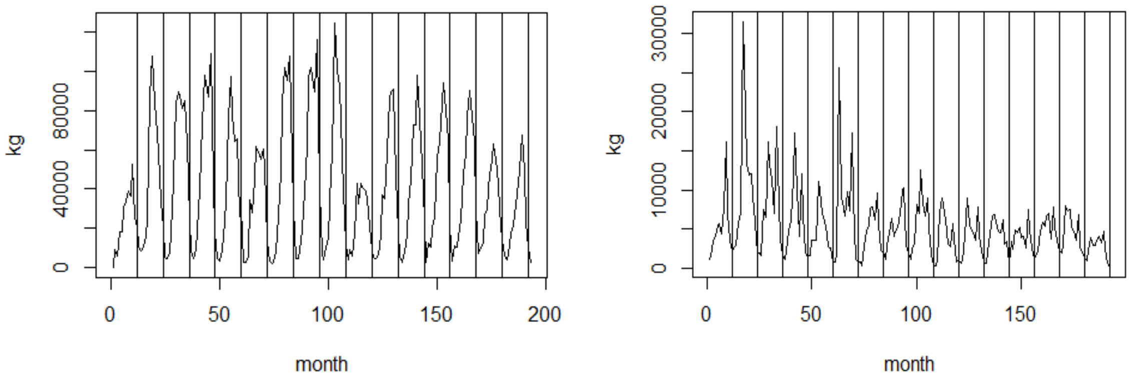


Figure 4.1: Trends in landings for the French trawler fleet. The x-axis represents the time in months and vertical black lines represents the years (January). All boats (left panel), boats present over the time series (right panel)

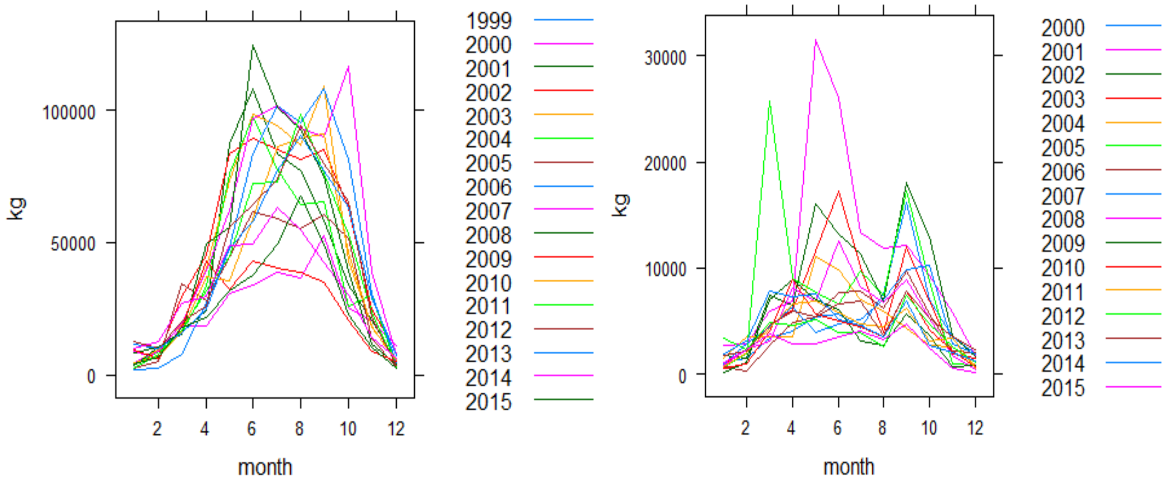


Figure 4.2: Trends in sole landings by year. All boats (left panel), boats present over the time series (right panel)

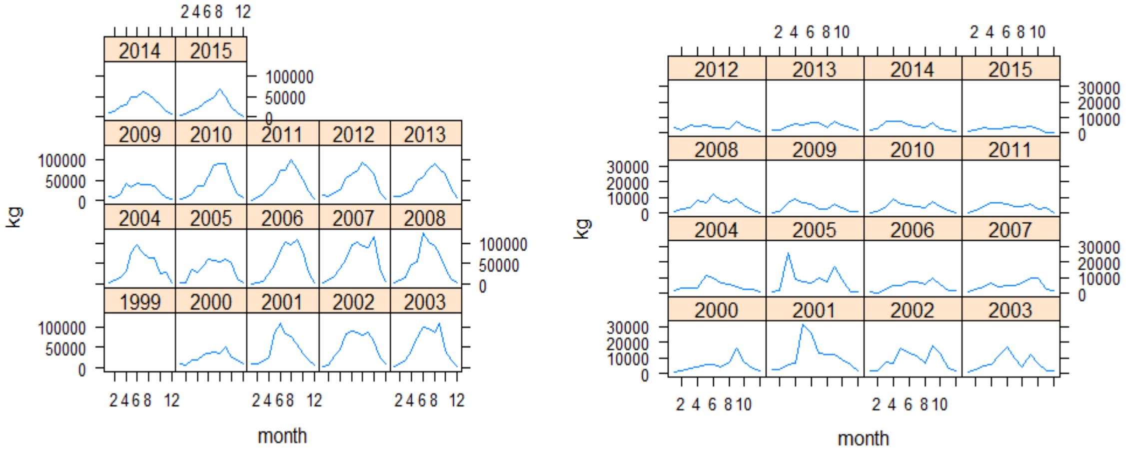


Figure 4.3: Trends in sole landings. All boats (left panel), boats present over the time series (right panel)

Landings patterns for all boats are quite consistent between years with a peak in the landings during summer/autumn (Figure 4.4 left panel). When focusing on boats present over the time series, total landings are high at the beginning of the time period (2000-2003), which might be due to an increase in reporting (Figure 4.4 right panel). The decrease during the last years follows the decrease in total landings from the Eastern Channel. This is less obvious when considering all boats, as this is probably partially compensated by new boats coming in the fishery (Figure 4.4 left panel).

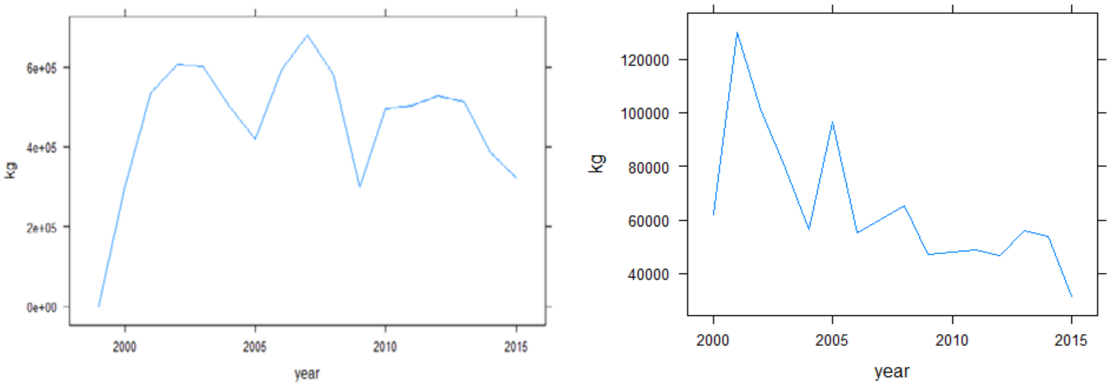


Figure 4.4: Sole landings (OTB_DEF_70_99_0). All boats (left panel), boats present over the time series (right panel)

<u>Trends in the number of boats landing sole</u>

The total number of boats increased from 2000 to 2007 and then decreased. The number of boats landing sole per month is following the landings trends per month with a peak during summer/autumn (Figure 4.5 left panel). No clear seasonal pattern appears when looking at the right panel of figure 4.5 where the focus lies on boats staying in the fisheries from 2000 onwards.

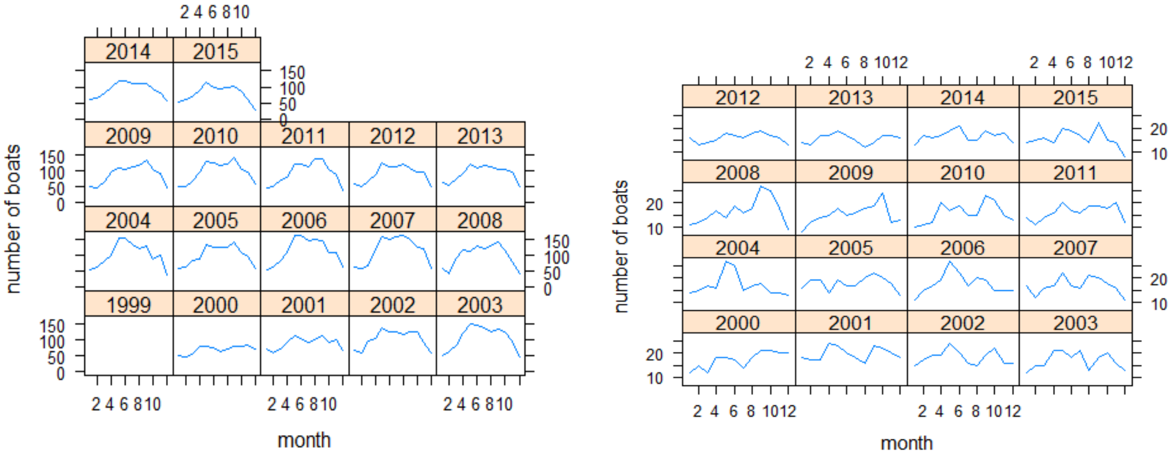


Figure 4.5: Trends in number of boats landing sole. All boats (left panel), boats present over the time series (right panel)

<u>Trends in effort (fishing hours)</u>

The fishing effort in hours increased from 2000 to 2007 and then decreased. The effort per month is following the landings trends per month with a peak during summer/autumn (Figure 4.6).

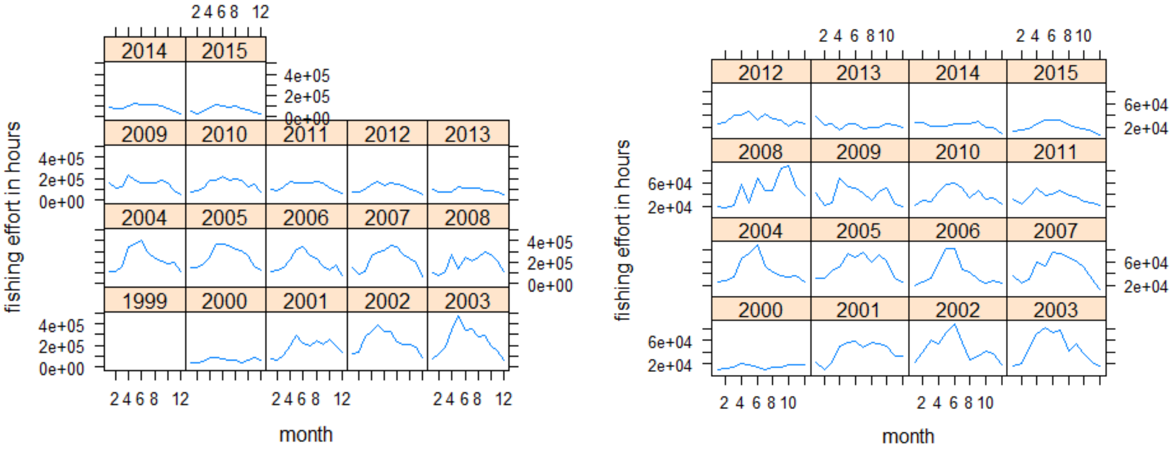


Figure 4.6: Trends in effort (fishing hours) for trawlers landing sole. All boats (left panel), boats present over the time series (right panel)

Trends in effort (kwH)

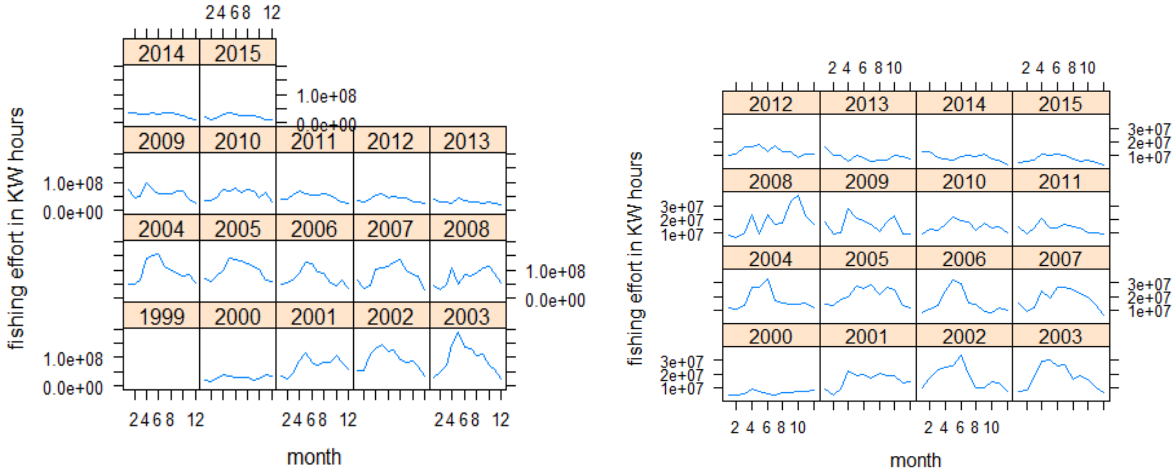
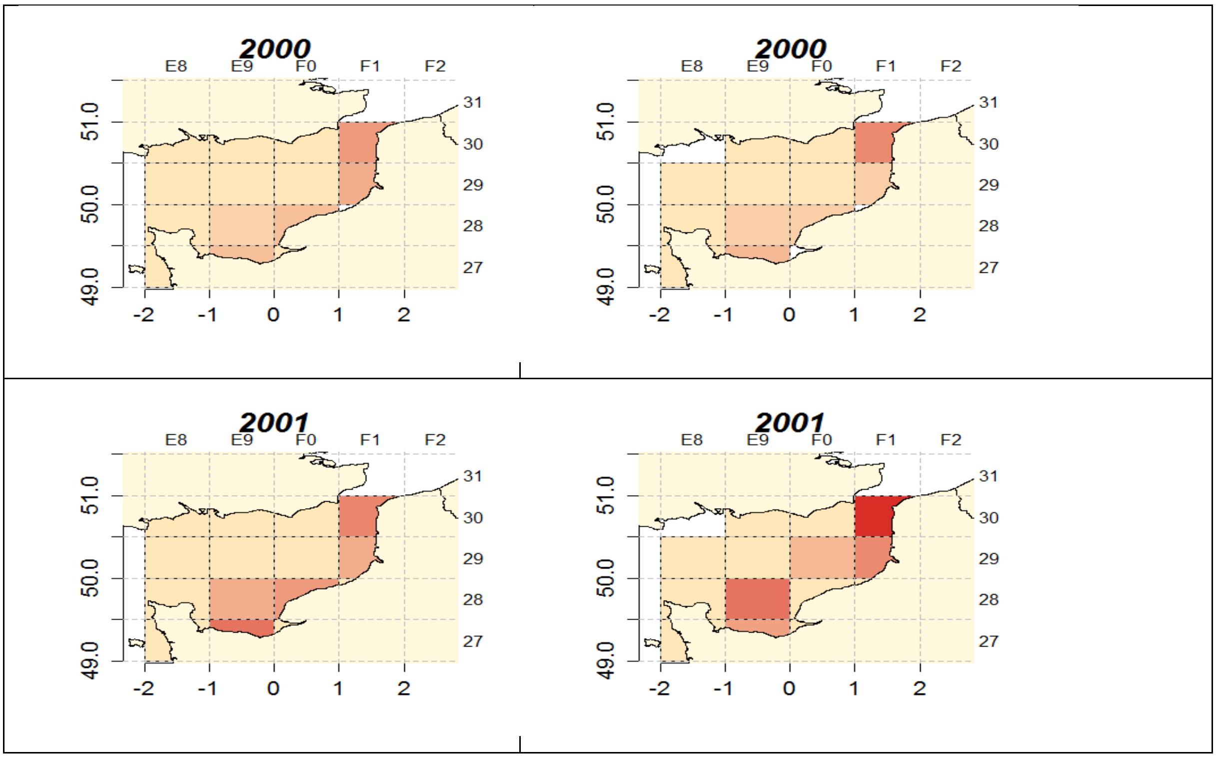
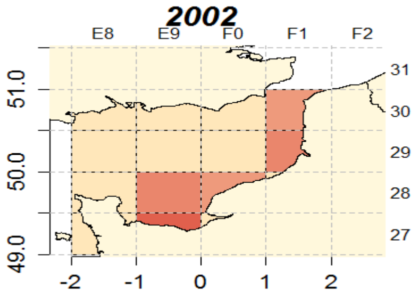


Figure 4.7 : Trends in effort (kwH) for trawlers landing sole. All boats (left panel), boats present over the time series (right panel)

Spatial plots of landings

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E8
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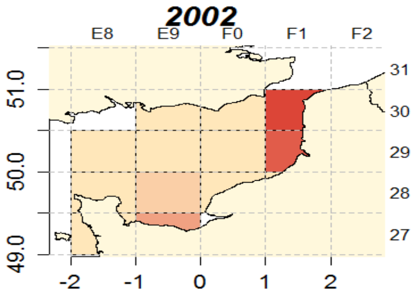
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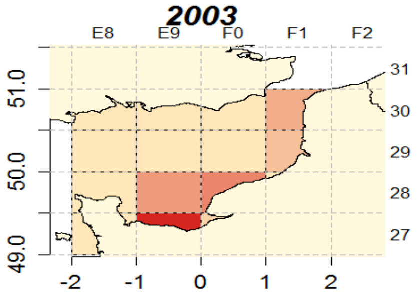
2003
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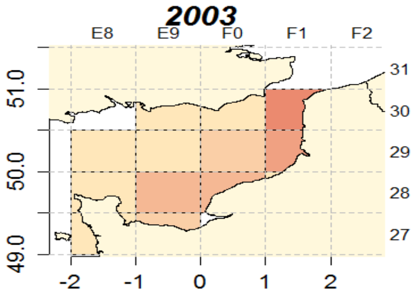
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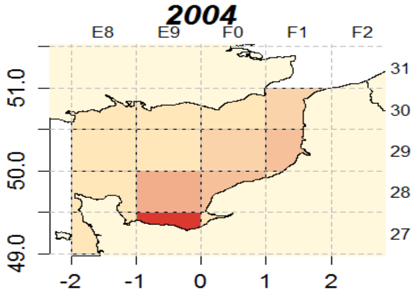
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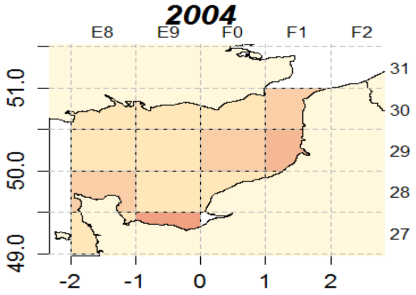
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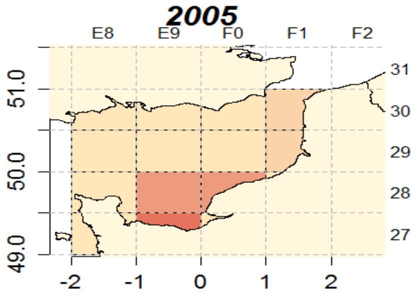
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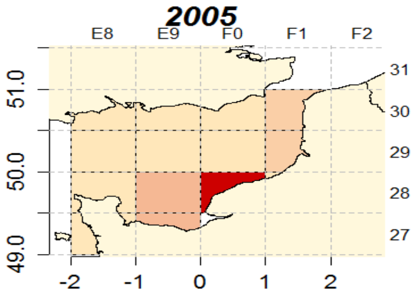
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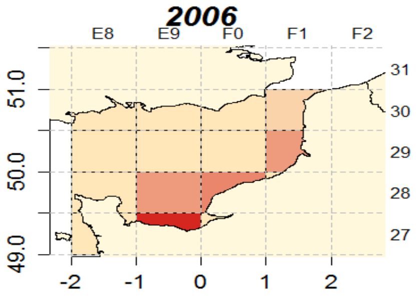
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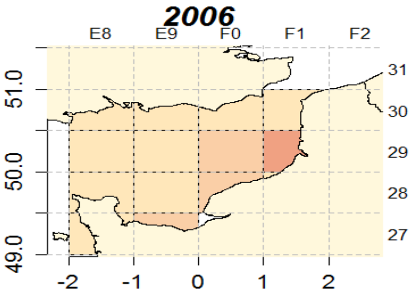
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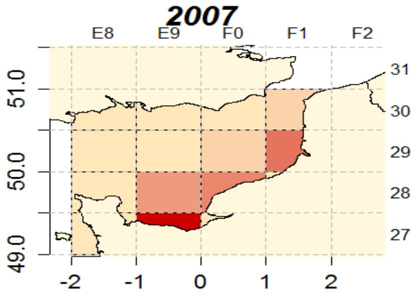
2007
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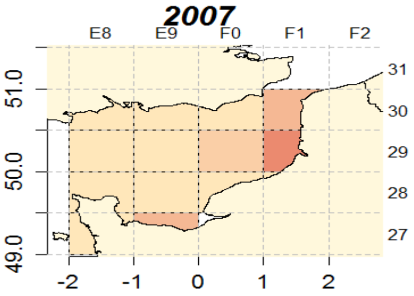
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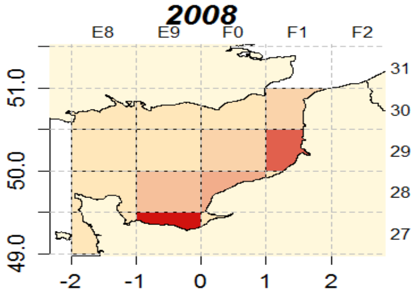
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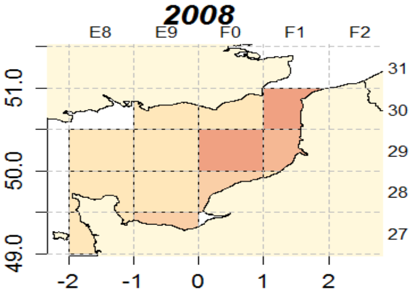
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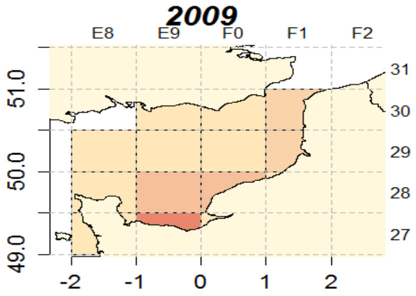
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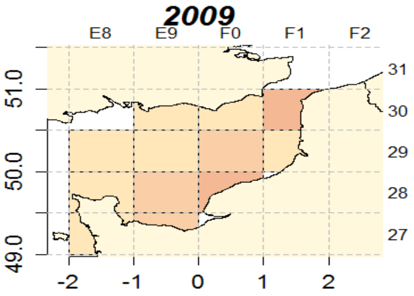
2009
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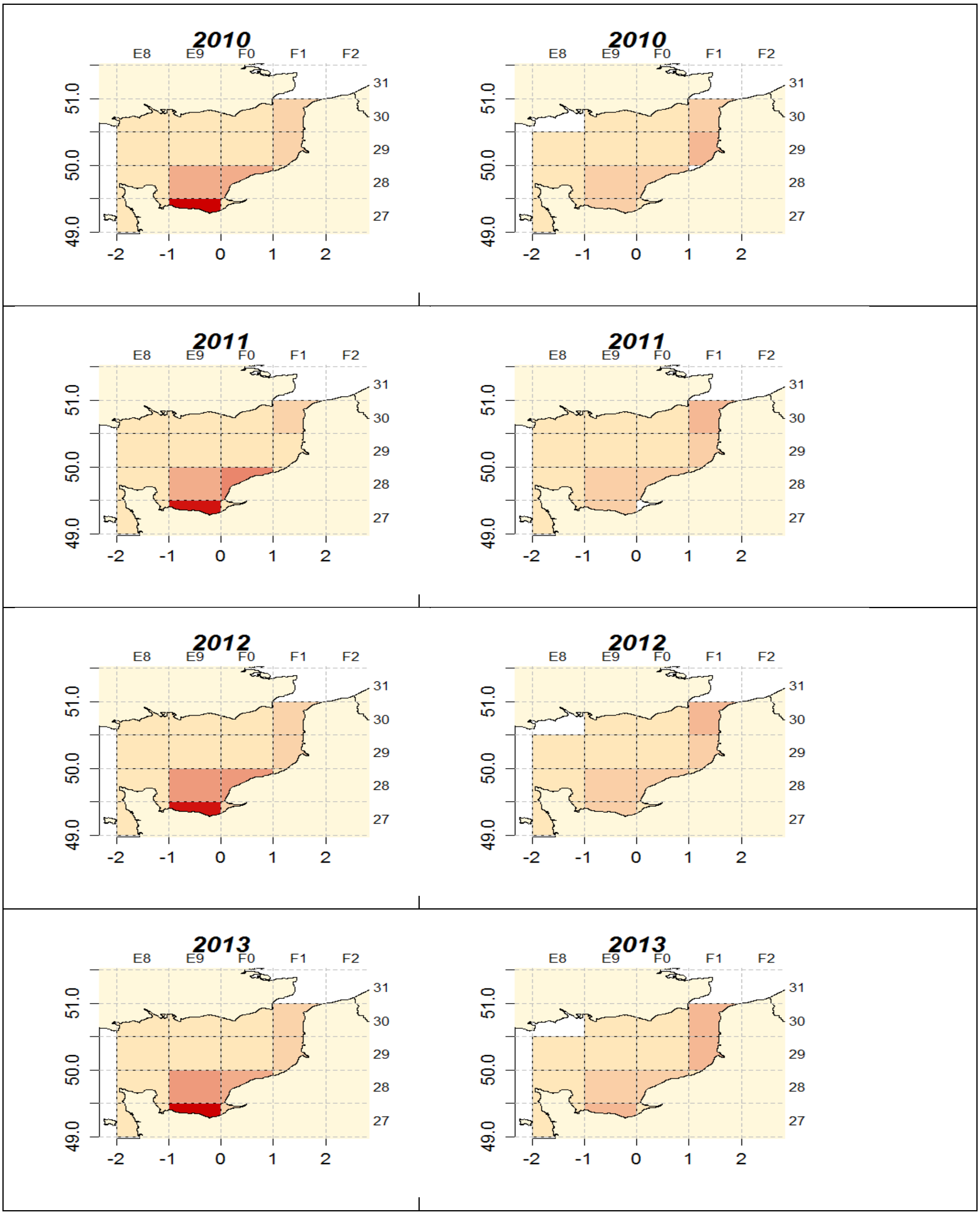
2010
2010
2011
2011
2012
2012
2013
2013
E8
E9
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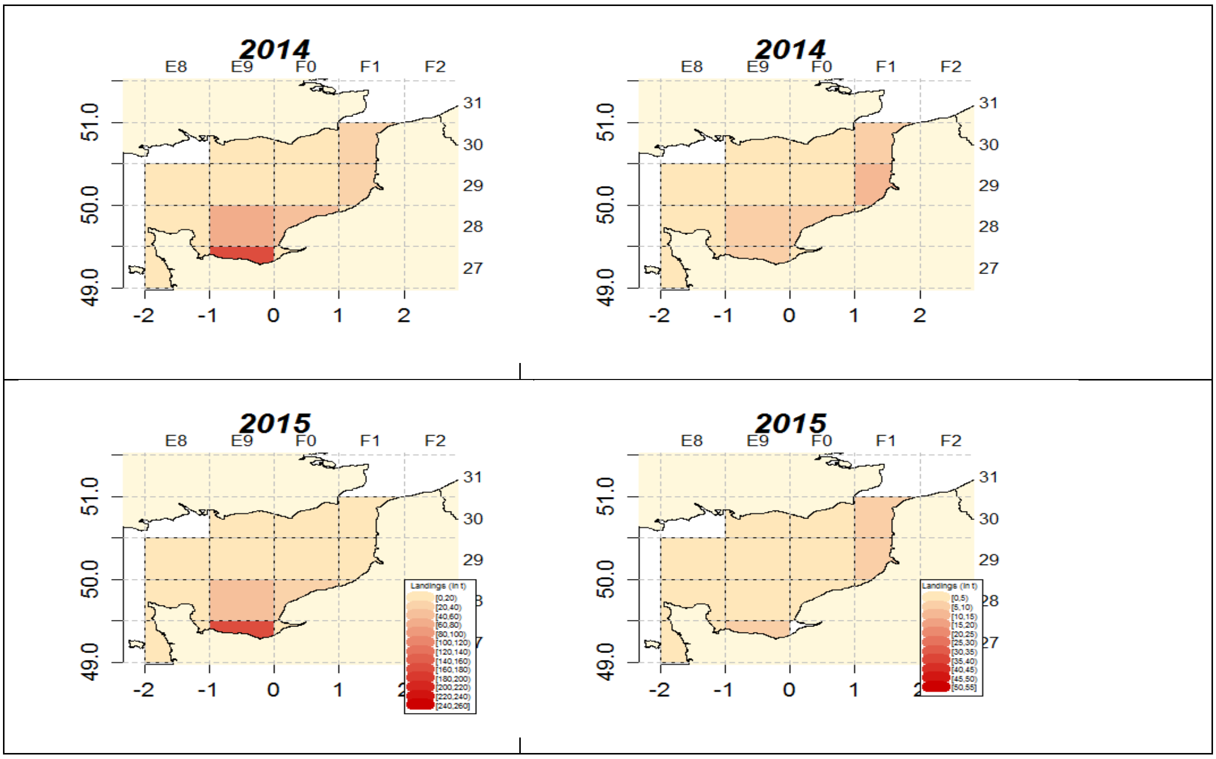


Figure 4.8: Spatial sole landings from the French otter trawl fleet. All boats (left panel), boats present over the time series (right panel)

When looking at the whole fleet, the spatial landing pattern is consistent in time. Most of the landings are made in the ICES Rectangle 27E9 in the 'Baie de Seine'. The landings in the North-East of the Eastern Channel progressively decrease from the beginning to the end of the time series. This is consistent with other observations showing the reduction in the number of trawlers fishing for sole in the northern part of the Eastern Channel.

When focusing on the 31 vessels present over the whole time series, landings are more spread over the area and no real spatial pattern appears from these distributions.

Conclusions from data analysis

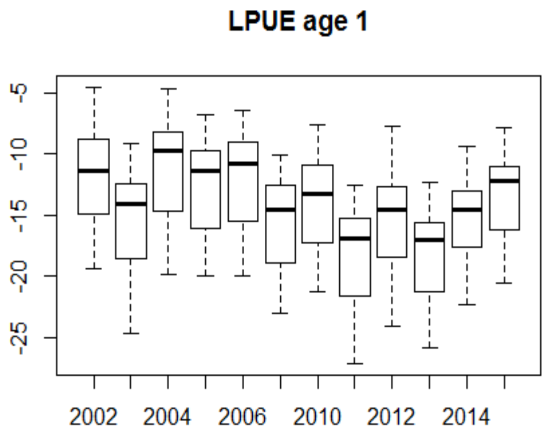
Spatial trends were observed in the time series, showing a reduction of the landings coming from the northern part of the fishing area. This is consistent with other observations showing the reduction of the number of trawlers in the main port of the north of France. It is also consistent with a general reduction in effort from 2007. Many of the boats present at the beginning of the time series stopped fishing for sole or were removed from the fisheries.

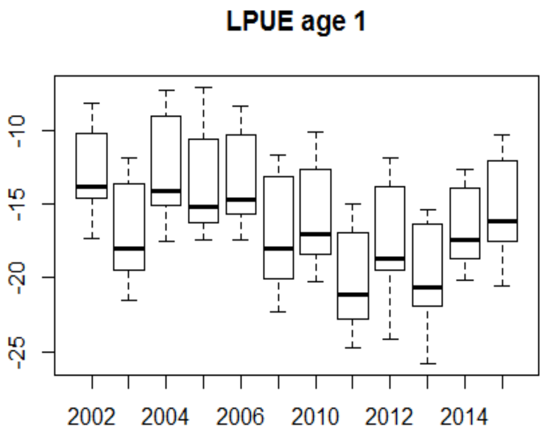
Seasonal patterns remained constant over time, showing a peak in summer.

In terms of spatial distribution, it seemed to be more consistent to use all boats to derive LPUEs. The 31 boats present over the time series seem to change their main fishing areas between years. Effort was expressed in kW to account for a potential trend in vessels size/power. LPUE was computed as landings divided by kWH (hours fished * kW). The age structures of the landings were derived from quarterly length sampling and the age length key used to produce the landings structures submitted to InterCatch.

Trends in LPUE at age

Figure 4.9 shows boxplots of LPUE per age, year and vessel.


LPUE age 1
-5
-10
-15
-20
-25
2002
2004
2006
2010
2012
2014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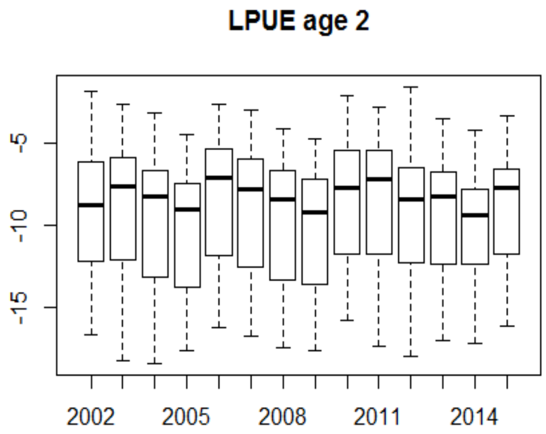
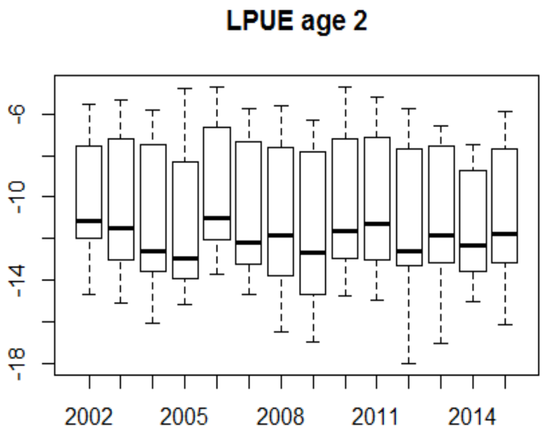
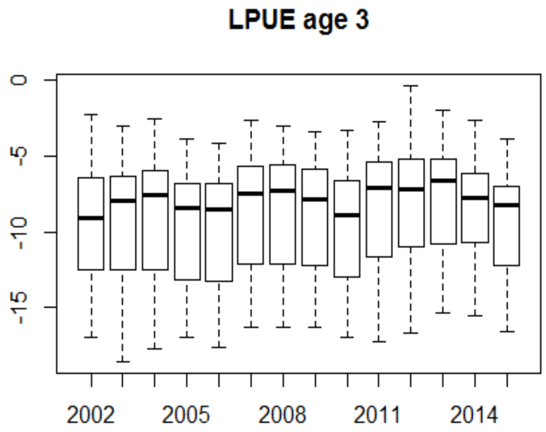
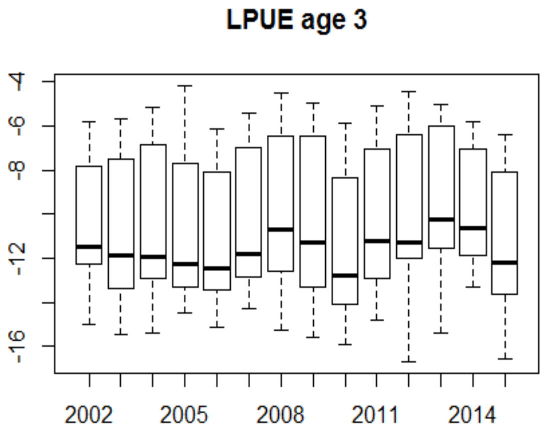
-10
-15
-20
-25
2002
2004
2006
2010
2012
2014


LPUE age 2
-5
-10
-15
2002
2005
2008
2011
2014


LPUE age 2
-6
-10
-14
-18
2002
2005
2008
2011
2014


LPUE age 3
0
-5
-10
-15
2002
2005
2008
2011
2014


LPUE age 3
-4
-6
-8
-12
-16
2002
2005
2008
2011
2014

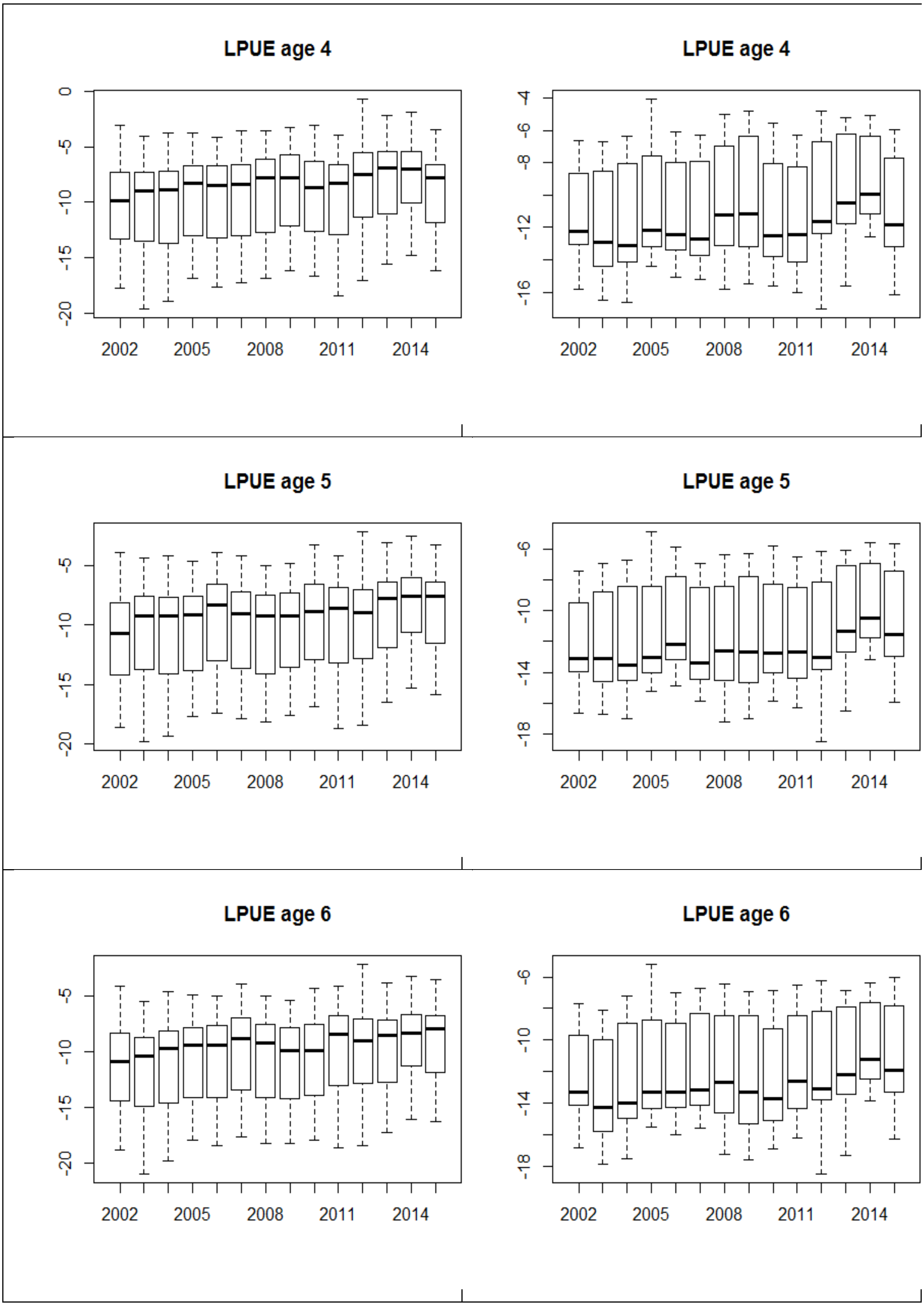
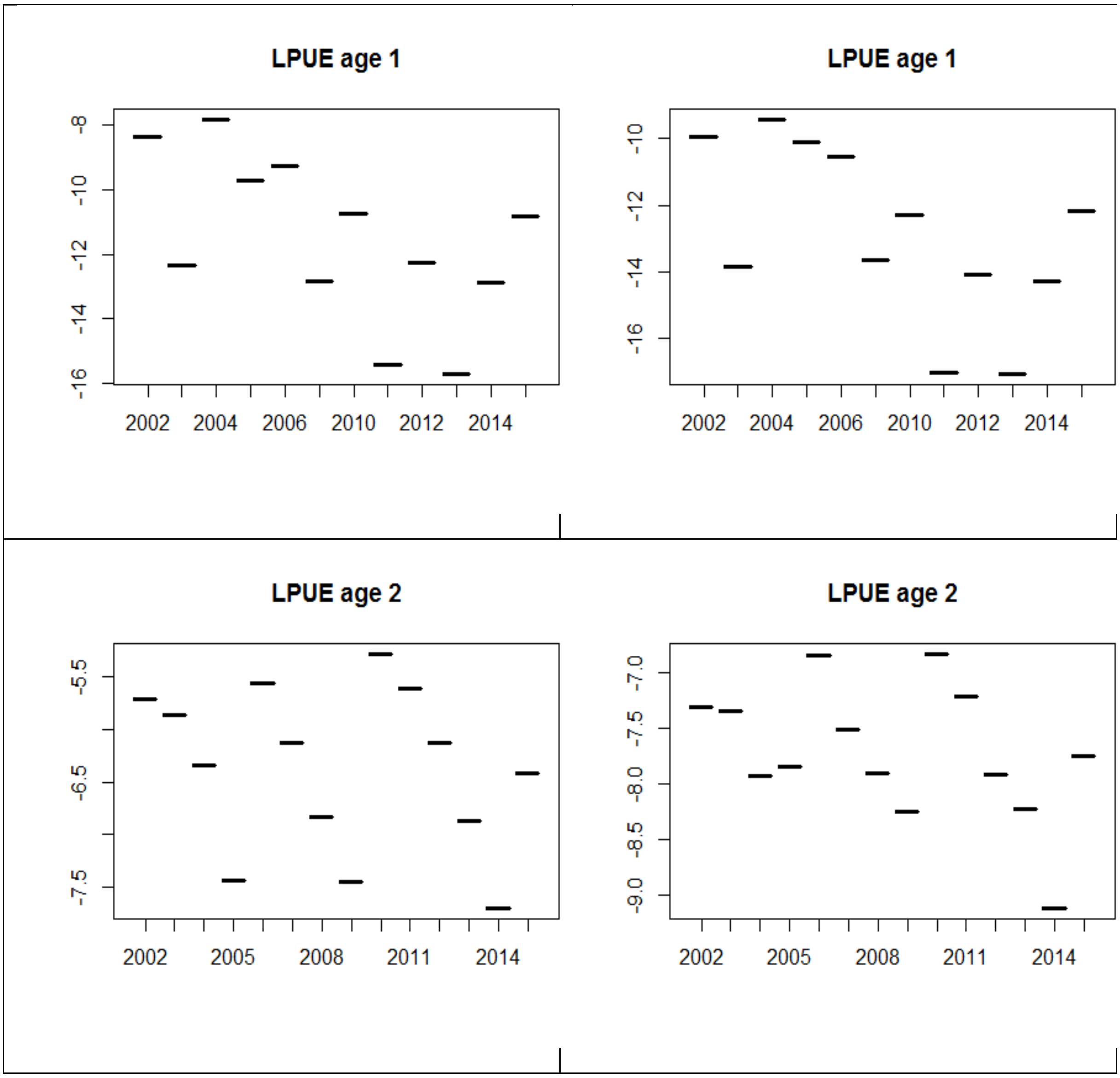
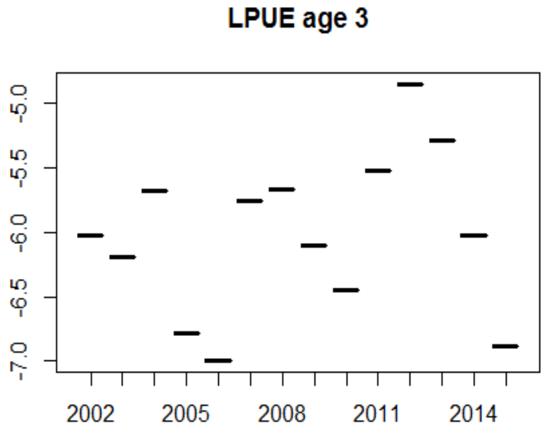


Figure 4.9: Boxplots of LPUE at age for the French otter trawl fleet. All boats (left panel), boats present over the time series (right panel)

The confidence intervals between the log(LPUE) are quite important when looking at the whole French fleet (Figure 4.9). This illustrates that there are quite some differences in the landings by boats. Inter-annual variations for age 1 are quite important and might reflect the variations in recruitment. These variations tend to smoothen with age. However, it should be noted that for age 5 and 6, an increasing trend of the LPUEs at the end of the time series is observed (Figure 4.10).

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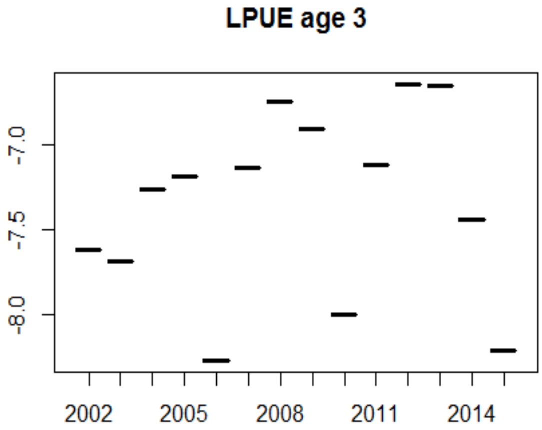
-5.0
-5.5
-6.0
-6.5
-7.0
2002
2005
2008
2011
2014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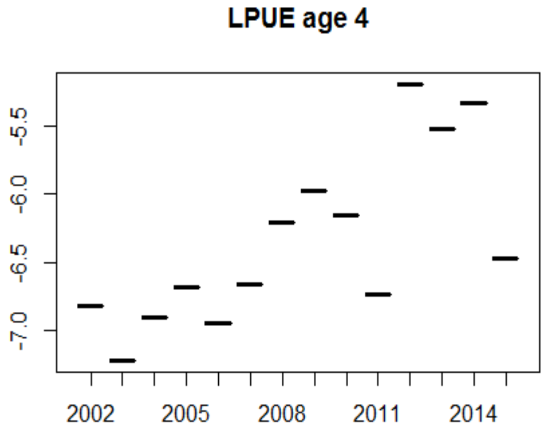
-7.5
-8.0
2002
2005
2008
2011
2014


LPUE age 4
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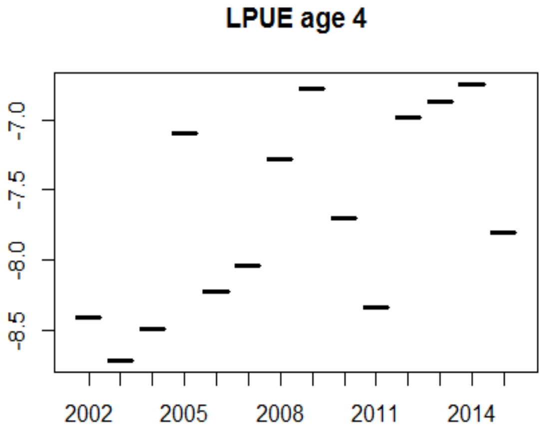
-6.0
-6.5
-7.0
2002
2005
2008
2011
2014


LPUE age 4
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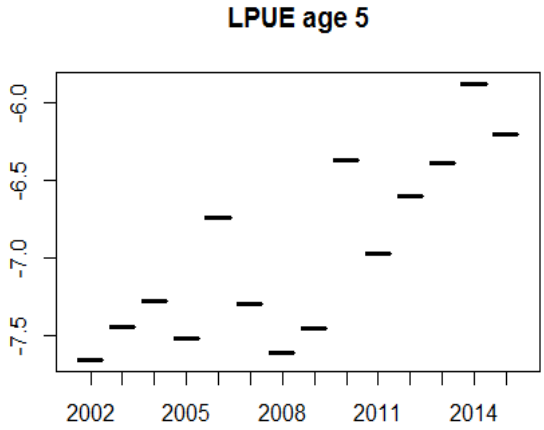
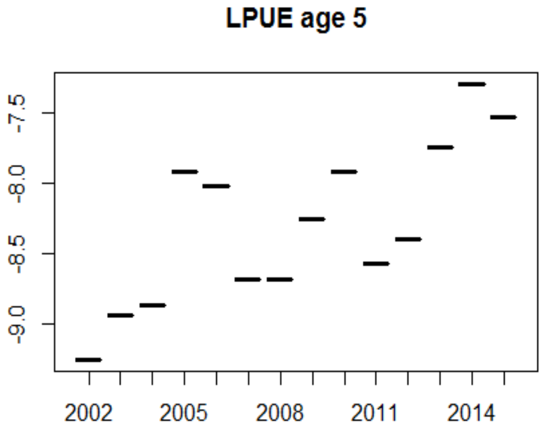
-7.5
-8.0
-8.5
2002
2005
2008
2011
2014


LPUE age 5
-6.0
-6.5
-7.0
-7.5
2002
2005
2008
2011
2014


LPUE age 5
-7.5
-8.0
-8.5
-9.0
2002
2005
2008
2011
2014

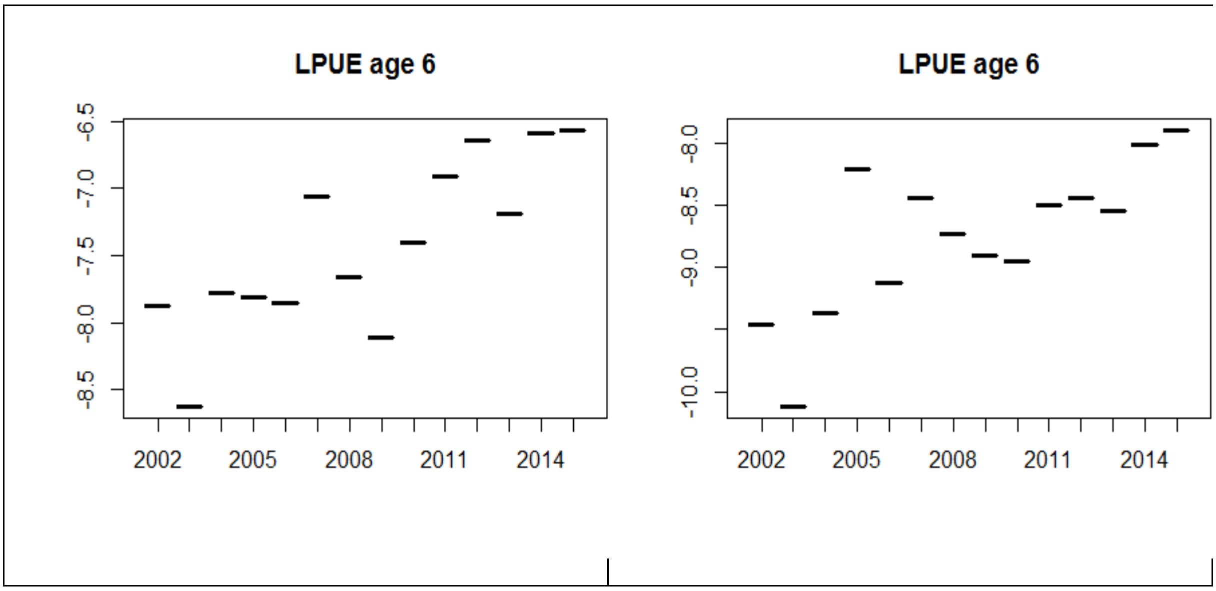


Figure 4.10: Trends in LPUE at age for the French otter trawl fleet. All boats (left panel), boats present over the time series (right panel)

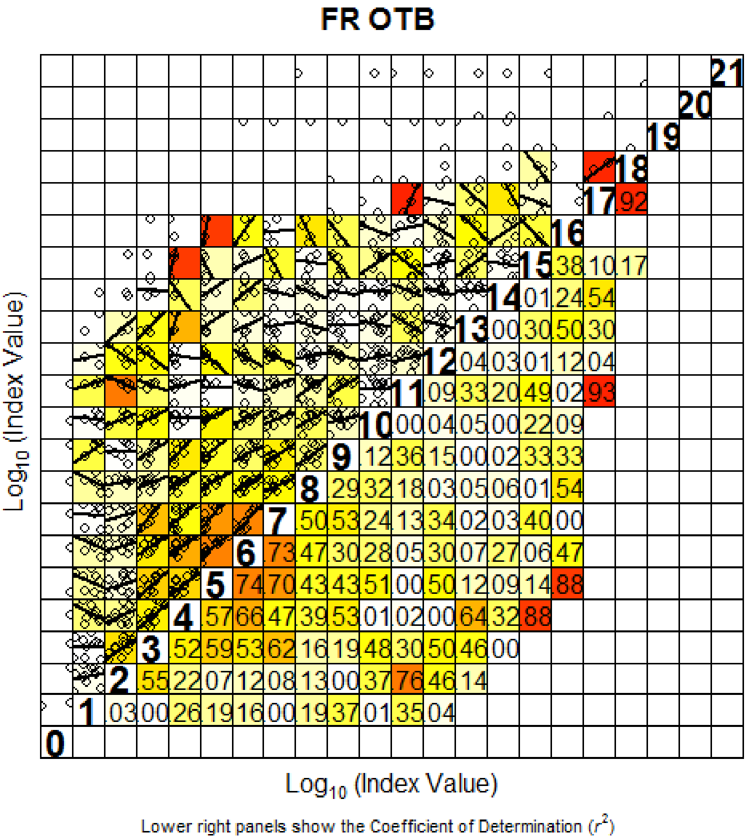


Figure 4.11: Internal consistency of the index. All boats.

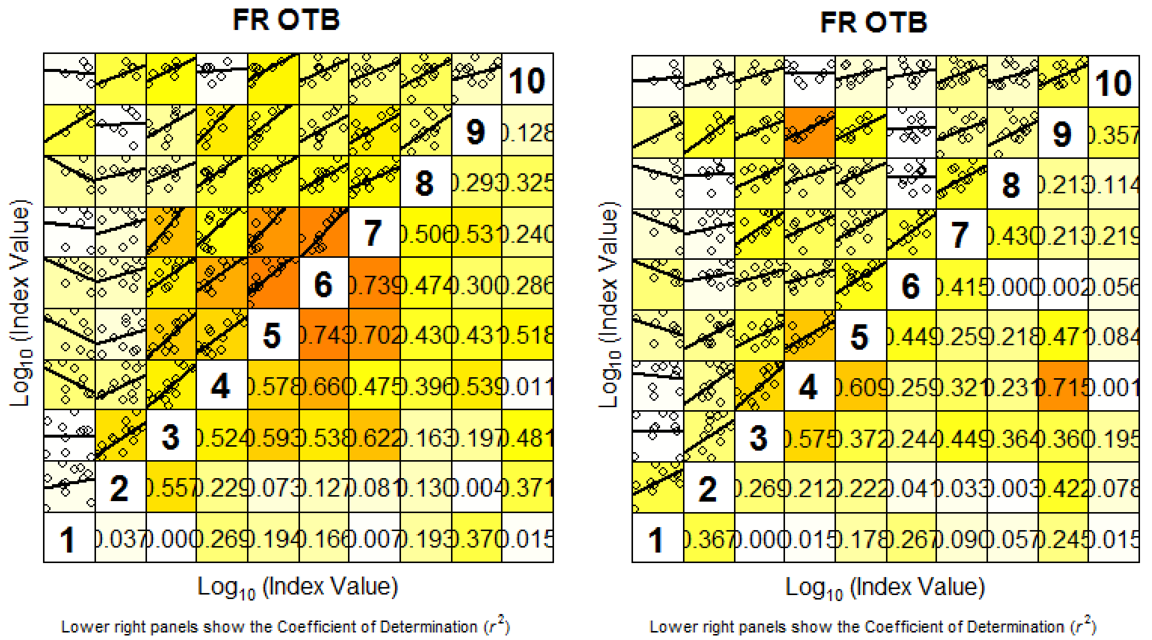


Figure 4.12: Internal consistency over age 1 to 10. All boats (left panel), boats present over the time series (right panel)

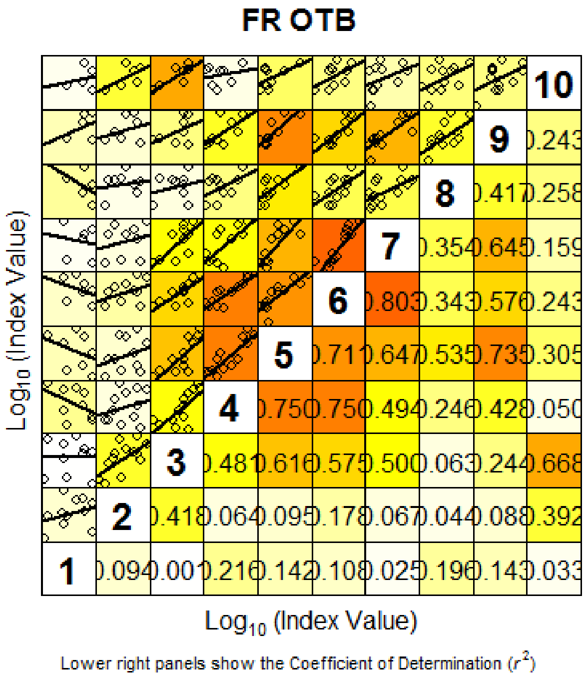


Figure 4.13: Internal consistency when keeping all gear, all boats from 2002 to 2015

Conclusion at the WKNSEA benchmark

It was decided during the benchmark to use the “all boats OTB 70-99” index. The 31 boats that remained in the fleet throughout the whole period display variable seasonal and spatial patterns in their activity. This reduces their suitability as tuning series in the assessment.

Working document 3: Preparation of Catch Data for Sole (*Solea solea* L.) in the Eastern English Channel (ICES division VIId)

Sofie Nimmegeers, Lies Vansteenbrugge, Bart Vanelslander and others

Catch data for 2003-2015

InterCatch was used for estimation of both landings and discards numbers and age compositions. Data submitters from each nation were tasked to upload data for 2003-2015 in InterCatch, disaggregated by quarter and métier (fleet). Belgium could not provide quarterly data for the TBB_DEF_70-99 métier, but uploaded data on a yearly basis[1]. Allocations of discard ratios and age compositions for unsampled strata were then performed to obtain the input data required for the assessment. Although InterCatch was previously used to estimate 2011-2015 catch data, these years were re-calculated in InterCatch following the 2016 data call; catch data for the years 2003-2010 have now been processed through InterCatch for the first time.

Raising discard data

If discards were not included for a particular métier-quarter-country-year combination, they were assumed to be unknown (non-zero) and raised. The instructions in the data call specified that if discards were 0, this had to be included in the upload to InterCatch (as a 0).

Discards on a country-quarter-métier basis were automatically matched by InterCatch to the corresponding landings. The matched discards-landings provided a landing-discard ratio estimate, which was then used for further raising (creating discard amounts) of the unmatched discards. The weighting factor for raising the discards was '*Landings CATON*' (landings catch).

Discard raising was performed on a gear level regardless of season or country. This approach was favoured over a more detailed one (e.g. using 1 or 2 quarters from 1 country to complete all other quarters of that country).

- The following groups were distinguished based on the gear:
    - TBB
    - OTB, SSC and SDN
    - GTR and GNS
- The remaining gears were combined in a REST group (including for example MIS, FPO, LLS and DRB)
- Raising within a gear group was performed when the proportion of landings for which discard weights are available, was equal or larger than 75% compared to the total landings of that group (an overview per year is provided in appendix 1, section E (Ldis_gear))
- When the threshold was not reached for a gear group, it was pooled with the rest group to raise discards based on all available information (overall).

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[1] Belgium stated that it was not possible to provide a qualitative age distribution for TBB_DEF_70-99 for all quarters, because sampling in VIId is limited in some quarters. In order to have stock weights as input for the assessment, mean catch weights for quarter 2 need to be calculated. Unfortunately, too little individual discard weights were available (38 for the whole data series). Therefore, Belgium decided to use discard weights from area IVc. These weights were also used to provide the yearly age distribution. Individual landing weights were available for the years 2006, 2007 and 2012-2015. For the other years (2004-2005 and 2008-2011), Belgian mean catch weights were not used as input for the stock weights. As this is quite unfortunate, Belgium is developing a new sampling design as part of the new DCF, which takes into account these issues.

Discard ratio's varied between 0.001 and 0.47 over the matched landings-discard strata. High ratios were not included in the raising (e.g., ratios > 0.5, but also ratios >>1). These higher ratios were not assumed to be representative for the available strata, but there is no knowledge to support that assumption. Higher ratios generally came from OTB_DEF_70-99 from France.

A sensitivity test for the raising of discards should have been completed. InterCatch currently does not support saving multiple discard raising schemes (unlike with sample allocations), which makes it a time laborious process. There was no time to complete this for the benchmark.

Age allocations

To allocate age compositions, landings and discards were handled separately; samples from landings were used only for landings and vice versa. An overview of the allocation scheme is provided in appendix 2.

When age distributions had to be borrowed from other métiers, allocations were completed using the following scenarios:

1. **By métier.** Age allocation for landings of the most important métiers (as ranked in appendix 1 section A.5) representing 75% of the total landings were performed on the métier level. For example: In 2004, TBB_DEF_70-99, GTR_DEF_90-99 and OTB_DEF_70-99 together covered 75% of the total landings. Unsampled data for each of these métiers was complemented with age data from that same métier. This scenario was only used when performing age allocations for landings.
2. **By gear group.** For the remaining unsampled data (both landings and discards), the same gear groups (TBB; OTB-SSC-SDN; GTR-GNS; REST) as used for discard raising were applied. When the threshold of 75% was reached for the proportion of landings or discards covered by age (Lage_gear and Dage_gear respectively, see appendix 1 section D), allocation of age occurred with all available information within that gear group. For example: In 2004, the proportion of landings covered by age was 96% for the gear group TBB. Age allocations for all métiers within that group (e.g. TBB_CRU_16-31, quarter 4) were performed using the available sampled TBB data, in this case only the TBB_DEF_70-99 métier.
3. **Use all (overall).** When the threshold of 75% was not reached for the proportion of landings or discards covered by age for the gear groups (appendix 1 section D), unsampled data were pooled in the REST group and ages were allocated using all sampled data (overall).

The weighting factor used with all scenarios was '*Mean Weight weighted by numbers at age'*.

Tabulating the sampled data for discards and landings was problematic. Many countries did not report the number of age and length samples, nor did they report the amount of sampled catch. Knowing how representative the samples for discards and landings were for a stratum was difficult to determine. Because allocations were weighted by *mean weight weighted by numbers at age*, missing numbers have an effect on the weighting.

Quality control

The quality of age allocations in InterCatch was verified by (1) creating a second allocation scheme using the autoallocation option in InterCatch, (2) comparing the numbers at age and (3) comparing the weight at age. Based on this quality control, a decision was made which allocation scheme to go forward with.

(1) Creating a second ‘autoallocation’ scheme

The ‘Automatic allocation’ option in InterCatch was used to create a second allocation scheme. First, CatchCategory, SeasonType, Season and fleet were selected. In a second step, only CatchCategory and fleet were selected and in a third step only CatchCategory was selected until all strata were allocated. The outcome was compared with the manual allocation schema as described above (example for 2015 in appendix 2 and 3).

In the automatic allocation scheme, ages can be allocated based on only one stratum. For example: landings from all 4 quarters of the Belgian GTR_DEF_all métier were filled with UK GTR_DEF_all quarter 3 stratum, while for the manual allocation scheme, all available age information from all GTR and GNS métiers were used to fill these 4 Belgian strata. Using only one stratum might be problematic when this information is not entirely representative, then a more general approach, such as grouping over different strata, can be more safe. On the other hand, when the information of this one stratum is accurate, it will provide a more correct allocation compared to the general approach.

In appendix 4, an detailed overview of the InterCatch output per year is provided for both discard raising and age allocation (using the script of Youen Vermard). An overview for the SOP percentage ((N@A x W@A)/CATON) from both allocation schemes is provided below:

		SOP %	
Year	allocation	landings	discards
2003	manual	92	116
	auto	92	110
2004	manual	98	100
	auto	98	100
2005	manual	97	100
	auto	97	100
2006	manual	100	100
	auto	100	100
2007	manual	99	99
	auto	98	99
2008	manual	98	99
	auto	98	99
2009	manual	92	107
	auto	91	108
2010	manual	95	107
	auto	95	108
2011	manual	96	98
	auto	96	100
2012	manual	91	112
	auto	92	112
2013	manual	96	108
	auto	97	109
2014	manual	96	108
	auto	96	109
2015	manual	96	97
	auto	96	97

(2) Comparing numbers at age

Numbers at age were compared for landings between the 2016 assessment input and the output of the new allocations schemes (Table 1).

Table 1: Differences by age for landings numbers, using (a) the manual allocation scheme and (b) the autoallocation scheme compared with the 2016 assessment input. This was not possible for discards because discard age data has not been reported prior to the benchmark data call. Differences are shaded such that darker colours highlight greater differences.

(a)

Landings Year/Age	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
2003	-94	-3	75	16	11	-10	225	7	-3	41	23	-2	-56	65	135
2004	-40	2	8	33	166	36	86	45	82	144	-6	-5	110	280	213
2005	17	-5	24	0	22	-2	-19	59	-40	-37	-8	-34	100	-56	-7
2006	-28	2	-13	-4	-7	-1	8	21	13	32	35	29	36	-28	58
2007	-81	-18	3	7	18	32	27	49	68	7	76	98	126	29	154
2008	109	-5	4	37	16	27	6	19	-4	15	-1	9	182	250	-22
2009	664	-6	8	-13	-34	-5	5	-27	9	-34	-32	-28	-17	88	-19
2010	-66	-6	-8	-12	-10	19	-6	2	-8	-20	2	51	36	418	-78
2011	#DIV/0!	0	3	-5	0	2	-3	2	-10	-5	-14	-39	-3	0	-30
2012	20	13	7	9	0	-1	-8	-13	-17	-27	-40	-61	-44	-6	-30
2013	-80	-5	1	3	1	2	-7	-7	-11	-18	3	-5	100	0	-19
2014	-28	-22	5	-3	-3	10	2	8	-2	-3	18	-12	104	4	12
2015	-24	-49	-9	3	3	1	6	7	10	7	5	8	0	5	60

(b)

Landings Year/Age	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
2003	-94	-16	57	7	10	-13	299	12	20	49	20	47	-45	175	203
2004	-47	-6	6	34	32	38	94	51	97	148	-3	-8	129	287	213
2005	8	-12	20	3	21	0	-17	62	-35	-24	-6	-26	100	-50	5
2006	-34	-2	-13	-8	-4	0	9	24	12	37	45	39	38	-31	96
2007	-73	-16	-3	4	20	31	26	43	73	7	66	105	137	29	176
2008	99	-4	4	36	14	27	7	18	-7	15	4	0	173	225	-19
2009	567	-15	3	-13	-34	-4	4	-22	7	-35	-38	-26	-27	68	7
2010	-68	-9	-9	-13	-9	21	-6	3	-7	-19	3	57	36	418	-77
2011	#DIV/0!	-2	2	-6	-1	3	-2	8	-9	-4	-2	-38	0	-11	-26
2012	20	6	11	7	4	-6	0	-9	-16	-10	-29	-57	-44	3	-17
2013	-80	-9	-2	3	3	4	-6	-3	-8	-13	3	3	111	3	-19
2014	-22	-5	17	-4	-5	8	-1	4	-5	-3	12	-14	102	11	12
2015	-19	-49	-11	1	4	0	4	5	6	8	5	6	0	32	63

Comparing the original landings numbers at age matrix with the InterCatch outcome based on the new allocation schemes, differences were identified (Table 1). Especially age 1 and the older ages (7+), which are landed less frequently, and the earlier data years (2003-2007) showed the largest differences (> 40%).

Additionally, numbers at age were compared between both allocation schemes for both landings and discards (Table 2).

Table 2: Differences by age for landings numbers between the outcome of manual allocation scheme and the autoallocation scheme for (a) the landings and (b) the discards. Differences are shaded such that darker colours highlight greater differences.

(a)

Landings Year/Age	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
2003	0	5	0	-1	0	0	0	1	-8	0	0	-29	0	2	1
2004	0	-5	0	0	-1	0	0	0	0	0	0	1	0	0	0
2005	-1	1	0	6	0	-1	0	0	0	0	0	0	0	0	-2
2006	0	-2	0	1	0	-1	0	0	0	0	0	0	0	0	1
2007	0	0	-2	0	0	0	0	0	0	0	0	0	0	0	0
2008	0	0	0	0	0	0	0	0	1	0	-5	-1	0	0	0
2009	0	1	-1	0	0	0	0	0	0	0	0	0	1	0	-1
2010	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
2011	#DIV/0!	-9	0	0	-5	0	0	3	0	0	-1	0	-1	#DIV/0!	0
2012	0	-1	1	0	13	3	-1	0	0	-1	0	0	0	-2	0
2013	0	1	-6	0	1	1	0	-1	0	0	0	-2	0	#DIV/0!	0
2014	0	-1	2	0	1	0	-1	-1	1	0	0	0	0	2	0
2015	0	0	0	-1	0	-1	0	0	0	0	0	0	#DIV/0!	6	0

(b)

Discards Year/Age	1	2	3	4	5	6	7	8	9	10+
2003	117	7	-37	-33	-50	-50	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
2004	-2	-9	-7	15	433	150	0	400	#DIV/0!	#DIV/0!
2005	2	0	0	1	0	0	0	0	#DIV/0!	#DIV/0!
2006	1	0	-1	0	0	0	#DIV/0!	0	#DIV/0!	#DIV/0!
2007	255	1	-26	33	-26	-5	50	100	#DIV/0!	#DIV/0!
2008	-2	-3	3	-1	0	54	33	0	#DIV/0!	#DIV/0!
2009	-24	0	-8	23	214	#DIV/0!	0	#DIV/0!	#DIV/0!	#DIV/0!
2010	8	5	-22	-24	-26	-9	#DIV/0!	-11	#DIV/0!	#DIV/0!
2011	76	4	-30	-32	-27	-29	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
2012	17	-1	-1	-4	-8	0	0	0	0	#DIV/0!
2013	21	3	-2	-5	-6	-9	#DIV/0!	0	#DIV/0!	#DIV/0!
2014	11	-4	-7	2	-21	-8	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
2015	2	1	-3	-5	-5	-6	0	-10	#DIV/0!	#DIV/0!

Comparing the two allocation schemes resulted for the landings in smaller differences than for the discards (Table 2). A large difference for the discards is the 255% for age 1 in 2007 originating from the 334 thousand fish after manual allocation and the 1185 thousand fish after autoallocation. The stratum mostly contributing for age 1 is the OTB_DEF_70-99 third quarter stratum from France. In the autoallocation scheme, the OTB_DEF_70-99 second quarter stratum from the UK is used to allocate the ages, while in the manual allocation an overall allocation based on 7 strata (including samples from TBB_DEF_70-99, GTR_DEF_ALL and GNS_DEF_ALL) is used. The weighting factor (the ratio of numbers over CATON) from the UK OTB_DEF_70-99 second quarter stratum resulted in a factor equal to 9, while for the overall allocation this factor equals 0.9. As discard age data are scarce for that métier of the UK, we cannot easily compare with other years to verify which weighting factor is more accurate.

(3) Comparing mean weights at age

Mean weights at age were compared for landings between the 2016 assessment input and the output of the new allocations schemes (Table 3).

Table 3: Differences by age for mean weights, using (a) the manual allocation scheme and (b) the autoallocation scheme compared with the 2016 assessment input. This was not possible for discards because discard age data has not been reported prior to the benchmark data call. Differences are shaded such that darker colours highlight greater differences.

(a)

Landings Year/Age	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
2003	16	-4	10	12	32	14	-57	8	-12	2	-4	11	22	0	-15
2004	32	8	2	4	3	12	9	8	-2	-13	13	1	4	-2	33
2005	12	2	4	8	10	14	22	7	-3	22	-16	25	-4	56	5
2006	28	4	7	5	6	5	9	4	10	18	1	-9	5	18	-4
2007	-9	-8	-2	-5	-1	-1	23	6	6	-8	8	-3	-25	23	13
2008	3	0	5	0	-39	-4	-13	-5	11	-10	-2	-24	16	-3	-8
2009	17	-5	4	1	8	-13	10	-16	-5	-19	-32	-5	-50	-4	-56
2010	-9	-2	2	0	-2	-7	-1	2	-19	5	-5	7	11	-10	-47
2011	13	-3	1	-2	0	2	-2	-4	7	-2	-6	-17	9	1	-11
2012	-73	-19	-8	-4	-8	0	-9	-9	-18	21	-24	-13	-2	-42	-35
2013	30	-9	1	0	0	-3	-3	-3	-3	5	-3	0	-26	3	-24
2014	776	17	7	6	0	-1	-3	1	1	1	-8	0	-37	-11	0
2015	5	14	1	2	2	1	-1	0	-3	-1	-1	-6	3	-2	-13

(b)

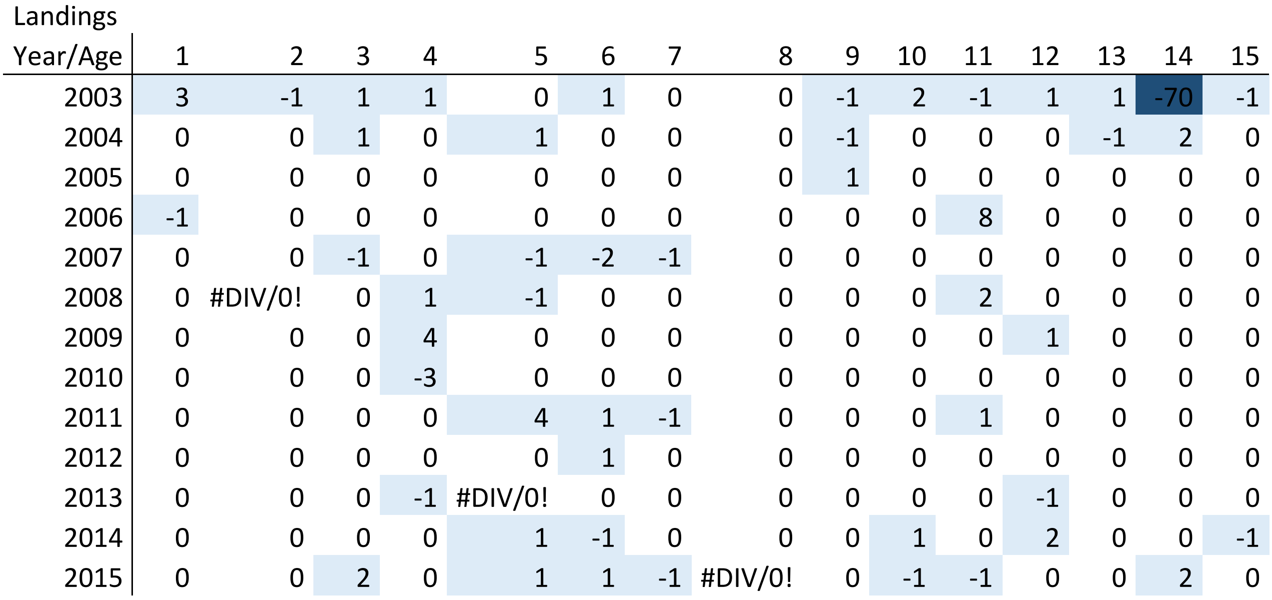
Landings Year/Age	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
2003	69	-1	17	23	45	23	-58	11	-4	5	-2	17	38	23	-1
2004	33	9	3	5	5	14	9	8	0	-14	11	0	1	-5	30
2005	12	2	5	10	11	14	22	7	-5	20	-14	20	-3	48	5
2006	-13	6	8	4	3	4	7	4	11	21	6	-8	5	15	-3
2007	-7	-7	0	-4	0	0	10	6	6	-8	8	-3	-28	29	16
2008	3	1	6	1	0	-4	-13	-5	11	-11	-6	-24	17	-4	-8
2009	17	-6	5	3	10	-10	12	-17	-6	-17	-32	-8	-50	-3	-56
2010	-8	-1	2	1	-2	-6	-1	2	-17	5	-5	6	11	-10	-50
2011	13	-3	1	-2	2	4	-1	-5	8	-2	-10	-16	11	1	-10
2012	-74	-19	-9	-5	-9	-1	-14	-10	-18	14	-25	-14	-2	-44	-39
2013	33	-8	1	0	0	-2	-2	-3	-3	5	-2	0	-25	3	-22
2014	718	15	6	5	-1	0	-2	1	2	2	-8	1	-38	-16	0
2015	6	13	2	3	3	2	0	1	-3	0	0	-6	4	-5	-14

Differences were identified when comparing the original mean weights at age matrix with the InterCatch outcome based on the new allocation schemes (Table 3). Especially age 1 and the older ages (10+), which are landed less frequently, and the earlier data years (2003-2005) showed the largest differences (> 40%).

Additionally, mean weights at age were compared between both allocation schemes for both landings and discards (Table 4).

Table 4: Differences by age for mean weights between the outcome of manual allocation scheme and the autoallocation scheme for (a) the landings and (b) the discards. Differences are shaded such that darker colours highlight greater differences.

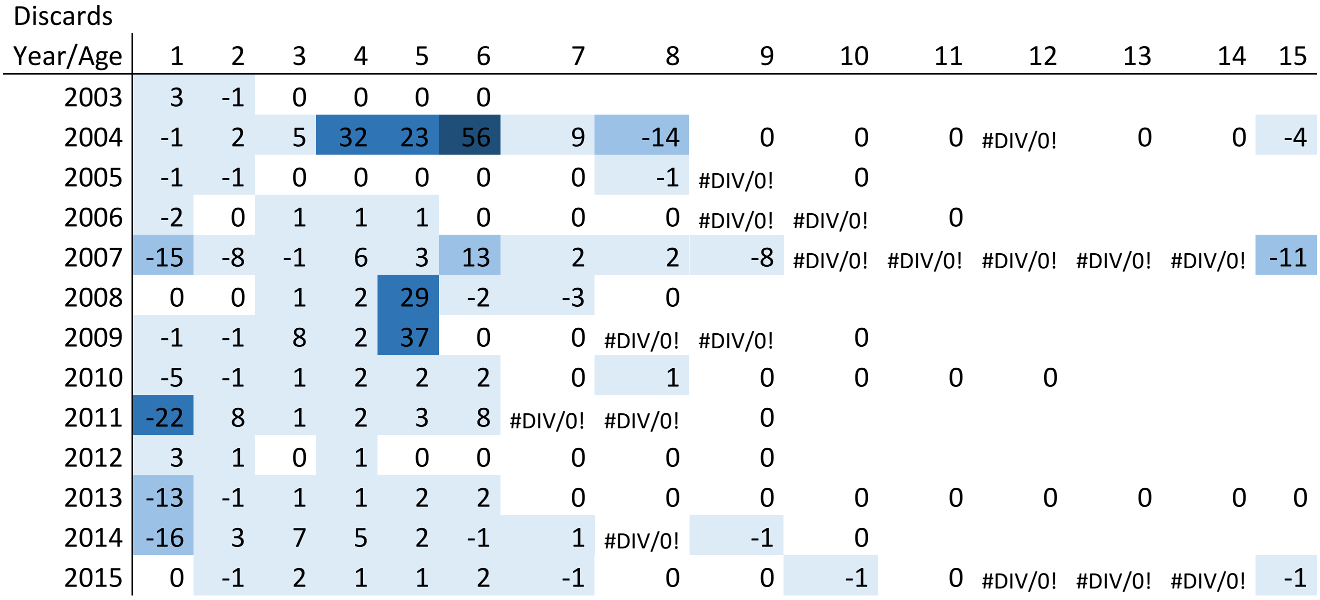
(a)



Landings

Year/Age	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
2003	3	-1	1	1	0	1	0	0	-1	2	-1	1	1	-70	-1
2004	0	0	1	0	1	0	0	0	-1	0	0	0	-1	2	0
2005	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
2006	-1	0	0	0	0	0	0	0	0	0	8	0	0	0	0
2007	0	0	-1	0	-1	-2	-1	0	0	0	0	0	0	0	0
2008	0	#DIV/0!	0	1	-1	0	0	0	0	0	2	0	0	0	0
2009	0	0	0	4	0	0	0	0	0	0	0	1	0	0	0
2010	0	0	0	-3	0	0	0	0	0	0	0	0	0	0	0
2011	0	0	0	0	4	1	-1	0	0	0	1	0	0	0	0
2012	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
2013	0	0	0	-1	#DIV/0!	0	0	0	0	0	0	-1	0	0	0
2014	0	0	0	0	1	-1	0	0	0	1	0	2	0	0	-1
2015	0	0	2	0	1	1	-1	#DIV/0!	0	-1	-1	0	0	2	0

(b)



Discards

Year/Age	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
2003	3	-1	0	0	0	0									
2004	-1	2	5	32	23	56	9	-14	0	0	0	#DIV/0!	0	0	-4
2005	-1	-1	0	0	0	0	0	-1	#DIV/0!	0					
2006	-2	0	1	1	1	0	0	0	#DIV/0!	#DIV/0!	0				
2007	-15	-8	-1	6	3	13	2	2	-8	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	-11
2008	0	0	1	2	29	-2	-3	0							
2009	-1	-1	8	2	37	0	0	#DIV/0!	#DIV/0!	0					
2010	-5	-1	1	2	2	2	0	1	0	0	0	0			
2011	-22	8	1	2	3	8	#DIV/0!	#DIV/0!	0						
2012	3	1	0	1	0	0	0	0	0						
2013	-13	-1	1	1	2	2	0	0	0	0	0	0	0	0	0
2014	-16	3	7	5	2	-1	1	#DIV/0!	-1	0					
2015	0	-1	2	1	1	2	-1	0	0	-1	0	#DIV/0!	#DIV/0!	#DIV/0!	-1

Comparing the two allocation schemes resulted for the landings in smaller differences than for the discards (Table 4), except for the landings mean weight of age 14 in 2003 (-70%). This 70% reflects the difference between the mean weight of 607 g after manual allocation, which is similar to the input value of the 2016 assessment (609 g), and the mean weight of 748 g after autoallocation. The latter being substantially higher. The stratum mostly contributing to this higher mean weight (based on CANUM) is the OTB_DEF_70-99 fourth quarter stratum from France. In the autoallocation scheme, the OTB_DEF_70-99 fourth quarter stratum from the UK (984 g for age 14 landings) is used to allocate its weights. In the manual allocation scheme, not the OTB_DEF_70-99 fourth quarter stratum from France, but the the OTB_DEF_70-99 second quarter stratum from France (588 g for age 14 landings) is mostly contributing. This latter stratum was sampled and not estimated.

The largest difference for the discards is the 56% for age 6 in 2004, originating from 196 g mean weight after manual allocation and 306 g mean weight after autoallocation. The stratum mostly contributing to this latter and higher mean weight (306 g; based on CANUM) is the GTR_DEF_all second quarter stratum from France. In the autoallocation scheme, the GTR_DEF_all fourth quarter stratum from the UK (361 g for age 6 discards) is used to allocate its weights. In the manual allocation scheme, not the GTR_DEF_all second quarter stratum from France, but the TBB_DEF_70-99 year stratum from Belgium (161 g for age 6 discards) is mostly contributing. This latter stratum was sampled and not estimated.

(4) Comparing overall tonnage

Overall tonnage estimates of landings were compared for landings between the 2016 assessment input and the output of the new allocations schemes (Table 5).

Table 5: Comparison of overall tonnage estimates of landings used in the 2016 assessment and the outcome of the allocation schemes. For discards only the outcome of the allocation schemes is presented because discards have not been estimated prior to the benchmark. Differences are shaded such that darker colours highlight greater differences.

	2016 assessment	WKNSEA 2017		
Year	landings (t)		discards (t)	dif landings
2003	5038	6977	62	38.5
2004	4826	6283	308	30.2
2005	4383	5056	319	15.4
2006	4833	5040	229	4.3
2007	5166	5588	379	8.2
2008	4517	5256	256	16.4
2009	5266	5251	360	-0.3
2010	4409	4269	438	-3.2
2011	4133	4225	477	2.2
2012	4048	4131	533	2.1
2013	4390	4372	466	-0.4
2014	4620	4655	528	0.8
2015	3441	3443	294	0.1

The largest differences were noted for the earlier data years (2003-2004) due to additional data uploaded by France on the occasion of this benchmark.

Conclusions

In general, both allocation schemes resulted in quite similar outcomes (numbers at age and mean weights at age), especially for the landings. For discards, less sampled strata were available, which resulted in larger differences between the allocation schemes. Especially for the older data, a lot of métiers have only sampled one quarter. Therefore, the save solution is to make the allocations based on several strata instead of one.

Differences between the two allocation schemes and the 2016 assessment input are larger, especially for age 1, the older ages and the earlier years. Several reasons were identified to contribute to this differences:

- More data were provided for this benchmark
- Some data were adapted as they appeared to be wrong
- Some unusual allocations were made during the previous assessment, e.g. using landings for age allocation of discards and *vice versa*.

Appendix 1: Intercatch input for discard raising and age allocation (based on script from José De Oliveira)

InterCatch input for 2003

This appendix lists 5 sections of tables (A-E) for each InterCatch year (2003-2015). It provides a detailed summary of the InterCatch input data in terms of importance by landed weight and the proportional coverage for age data and discard ratios.

Section A: Importance by landed weight (Lwt / sum(Lwt))

1. Proportion of landings by area and season

```
L_AS*100

##             1       2        3        4
## 27.7.d 28.1063 21.1528 27.64624 23.09466
```

2. Proportion of landings by métier and country

```
format(data.frame(L_FC*100),scientific=3,digit=1)

##                         Belgium France UK..England.
## DRB_all_0_0_all              NA   3.42           NA
## FPO_CRU_0_0_0_all            NA     NA      0.03168
## GNS_DEF_100-119_0_0_all      NA   0.63           NA
## GNS_DEF_90-99_0_0_all        NA   1.86           NA
## GNS_DEF_all_0_0_all        0.25     NA      3.11363
## GTR_DEF_100-119_0_0_all      NA   2.85           NA
## GTR_DEF_120-219_0_0_all      NA   0.76           NA
## GTR_DEF_90-99_0_0_all        NA  24.09           NA
## GTR_DEF_all_0_0_all          NA   6.54      1.05391
## LLS_DEF_0_0_0_all            NA   0.03           NA
## LLS_FIF_0_0_0_all            NA     NA      0.00004
## MIS_MIS_0_0_0_HC             NA   0.04      0.02936
## OTB_CRU_16-31_0_0_all        NA     NA      0.65802
## OTB_CRU_70-99_0_0_all      0.02     NA      0.00090
## OTB_DEF_>=120_0_0_all        NA     NA      0.00496
## OTB_DEF_70-99_0_0_all        NA  13.68      0.69265
## TBB_CRU_16-31_0_0_all        NA     NA      0.00107
## TBB_DEF_>=120_0_0_all        NA     NA      0.01657
## TBB_DEF_70-99_0_0_all     23.49   6.38     10.34910
```

3. Proportion of landings by country

```
apply(L_FC*100,2,function(x) sum(x,na.rm=T))

##      Belgium       France UK (England)
##     23.75423     60.29389     15.95188
```

4. Proportion of landings by fleet and area

```
format(data.frame(L_FA*100),scientific=4,digit=1)

##                          X27.7.d
## DRB_all_0_0_all          3.42087
## FPO_CRU_0_0_0_all        0.03168
## GNS_DEF_100-119_0_0_all  0.63310
## GNS_DEF_90-99_0_0_all    1.86394
## GNS_DEF_all_0_0_all      3.36137
## GTR_DEF_100-119_0_0_all  2.85333
## GTR_DEF_120-219_0_0_all  0.75945
## GTR_DEF_90-99_0_0_all   24.08950
## GTR_DEF_all_0_0_all      7.59882
## LLS_DEF_0_0_0_all        0.03436
## LLS_FIF_0_0_0_all        0.00004
## MIS_MIS_0_0_0_HC         0.07085
## OTB_CRU_16-31_0_0_all    0.65802
## OTB_CRU_70-99_0_0_all    0.02053
## OTB_DEF_>=120_0_0_all    0.00496
## OTB_DEF_70-99_0_0_all   14.36856
## TBB_CRU_16-31_0_0_all    0.00107
## TBB_DEF_>=120_0_0_all    0.01657
## TBB_DEF_70-99_0_0_all   40.21299
```

5. Proportion of landings by métier, ranked from largest to smallest, together with cumulative sum

```
L_F1<-L_F
L_F1$rank_Total<-L_F1$rank_Total*100
L_F1<-L_F1[rev(order(L_F1$rank_Total)),]
L_F1$cum<-cumsum(L_F1$rank_Total)
format(L_F1,scientific=4,digit=1)

##                         rank_Total                   Fleet cum
## TBB_DEF_70-99_0_0_all     40.21299   TBB_DEF_70-99_0_0_all  40
## GTR_DEF_90-99_0_0_all     24.08950   GTR_DEF_90-99_0_0_all  64
## OTB_DEF_70-99_0_0_all     14.36856   OTB_DEF_70-99_0_0_all  79
## GTR_DEF_all_0_0_all        7.59882     GTR_DEF_all_0_0_all  86
## DRB_all_0_0_all            3.42087         DRB_all_0_0_all  90
## GNS_DEF_all_0_0_all        3.36137     GNS_DEF_all_0_0_all  93
## GTR_DEF_100-119_0_0_all    2.85333 GTR_DEF_100-119_0_0_all  96
## GNS_DEF_90-99_0_0_all      1.86394   GNS_DEF_90-99_0_0_all  98
## GTR_DEF_120-219_0_0_all    0.75945 GTR_DEF_120-219_0_0_all  99
## OTB_CRU_16-31_0_0_all      0.65802   OTB_CRU_16-31_0_0_all  99
## GNS_DEF_100-119_0_0_all    0.63310 GNS_DEF_100-119_0_0_all 100
## MIS_MIS_0_0_0_HC           0.07085        MIS_MIS_0_0_0_HC 100
## LLS_DEF_0_0_0_all          0.03436       LLS_DEF_0_0_0_all 100
## FPO_CRU_0_0_0_all          0.03168       FPO_CRU_0_0_0_all 100
## OTB_CRU_70-99_0_0_all      0.02053   OTB_CRU_70-99_0_0_all 100
## TBB_DEF_>=120_0_0_all      0.01657   TBB_DEF_>=120_0_0_all 100
## OTB_DEF_>=120_0_0_all      0.00496   OTB_DEF_>=120_0_0_all 100
## TBB_CRU_16-31_0_0_all      0.00107   TBB_CRU_16-31_0_0_all 100
## LLS_FIF_0_0_0_all          0.00004       LLS_FIF_0_0_0_all 100
```

Section B: Age coverage

1. Total proportion of the landings/sampled discards that is covered for age composition

```
Lage_A_tot #(Lwt !Lagesamp / sum(Lwt))

## [1] 0.5968668

Dage_A_tot #(Dwt !Dagesamp / sum(Dwt))

## [1] 1
```

2. Proportion of landings/sampled discards by area and season that is covered for age composition

```
Lage_AS

##                 1         2       3         4
## 27.7.d 0.5483495 0.7066975 0.76696 0.3517007

Dage_AS

##        3
## 27.7.d 1
```

3. Proportion of landings/sampled discards in each métier-country stratum that is covered for age composition

```
Lage_FC

##                         Belgium    France UK (England)
## DRB_all_0_0_all              NA 0.2022599           NA
## FPO_CRU_0_0_0_all            NA        NA   0.00000000
## GNS_DEF_100-119_0_0_all      NA 0.0000000           NA
## GNS_DEF_90-99_0_0_all        NA 0.0000000           NA
## GNS_DEF_all_0_0_all           0        NA   0.18975092
## GTR_DEF_100-119_0_0_all      NA 0.6977009           NA
## GTR_DEF_120-219_0_0_all      NA 0.3751138           NA
## GTR_DEF_90-99_0_0_all        NA 1.0000000           NA
## GTR_DEF_all_0_0_all          NA 1.0000000   0.00000000
## LLS_DEF_0_0_0_all            NA 0.0000000           NA
## LLS_FIF_0_0_0_all            NA        NA   0.00000000
## MIS_MIS_0_0_0_HC             NA 0.7439662   0.02626568
## OTB_CRU_16-31_0_0_all        NA        NA   0.08984677
## OTB_CRU_70-99_0_0_all         0        NA   0.00000000
## OTB_DEF_>=120_0_0_all        NA        NA   0.87265377
## OTB_DEF_70-99_0_0_all        NA 0.8594086   1.00000000
## TBB_CRU_16-31_0_0_all        NA        NA   0.00000000
## TBB_DEF_>=120_0_0_all        NA        NA   0.00000000
## TBB_DEF_70-99_0_0_all         0 1.0000000   0.63541054
```

```
Dage_FC #note: proportions shown prior to discard raising

##                          Belgium France UK (England)
## DRB_all_0_0_all               NA    NaN           NA
## FPO_CRU_0_0_0_all             NA     NA          NaN
## GNS_DEF_100-119_0_0_all       NA    NaN           NA
## GNS_DEF_90-99_0_0_all         NA    NaN           NA
## GNS_DEF_all_0_0_all          NaN     NA          NaN
## GTR_DEF_100-119_0_0_all       NA      1           NA
## GTR_DEF_120-219_0_0_all       NA    NaN           NA
## GTR_DEF_90-99_0_0_all         NA    NaN           NA
## GTR_DEF_all_0_0_all           NA    NaN          NaN
## LLS_DEF_0_0_0_all             NA    NaN           NA
## LLS_FIF_0_0_0_all             NA     NA          NaN
## MIS_MIS_0_0_0_HC              NA    NaN          NaN
## OTB_CRU_16-31_0_0_all         NA     NA          NaN
## OTB_CRU_70-99_0_0_all        NaN     NA          NaN
## OTB_DEF_>=120_0_0_all         NA     NA          NaN
## OTB_DEF_70-99_0_0_all         NA    NaN          NaN
## TBB_CRU_16-31_0_0_all         NA     NA          NaN
## TBB_DEF_>=120_0_0_all         NA     NA          NaN
## TBB_DEF_70-99_0_0_all        NaN    NaN            1
```

Section C: Discard ratio coverage (Lwt !Dwt / sum(Lwt))

1. Total proportion of the landings for which discard weights are available

```
Ldis_A_tot

## [1] 0.03933879
```

2. Proportion of landings for which discard weights are available by area and season

```
Ldis_AS

##        1 2         3 4
## 27.7.d 0 0 0.1422934 0
```

3. Proportion of landings for which discard weights are available in each métier-country stratum

```
Ldis_FC

##                          Belgium    France UK (England)
## DRB_all_0_0_all               NA 0.0000000           NA
## FPO_CRU_0_0_0_all             NA        NA    0.0000000
## GNS_DEF_100-119_0_0_all       NA 0.0000000           NA
## GNS_DEF_90-99_0_0_all         NA 0.0000000           NA
## GNS_DEF_all_0_0_all            0        NA    0.0000000
## GTR_DEF_100-119_0_0_all       NA 0.3559446           NA
## GTR_DEF_120-219_0_0_all       NA 0.0000000           NA
## GTR_DEF_90-99_0_0_all         NA 0.0000000           NA
## GTR_DEF_all_0_0_all           NA 0.0000000    0.0000000
## LLS_DEF_0_0_0_all             NA 0.0000000           NA
## LLS_FIF_0_0_0_all             NA        NA    0.0000000
## MIS_MIS_0_0_0_HC              NA 0.0000000    0.0000000
## OTB_CRU_16-31_0_0_all         NA        NA    0.0000000
## OTB_CRU_70-99_0_0_all          0        NA    0.0000000
## OTB_DEF_>=120_0_0_all         NA        NA    0.0000000
## OTB_DEF_70-99_0_0_all         NA 0.0000000    0.0000000
## TBB_CRU_16-31_0_0_all         NA        NA    0.0000000
## TBB_DEF_>=120_0_0_all         NA        NA    0.0000000
## TBB_DEF_70-99_0_0_all          0 0.0000000    0.2819813
```

Section D: Landings age coverage ranked by landed weights

This section shows the proportion of landings covered for age composition, in total (Lage_tot), by métier and for the larger gear groups (Lage_gear). The métiers are ranked by landed weight, so it is easy to check whether the most important métiers have reasonable age coverage for landings. Additionally, the proportion of landings for which discard age coverage is available is presented for the larger gear groups (Dage_gear).

```
Lage_tot<-sum(Lage_AS*L_AS,na.rm=T)/sum(L_AS,na.rm=T)
#(Lage_AS = Lwt !Lagesamp / sum(Lwt); L_AS = Lwt / sum(Lwt))
Lage_tot

## [1] 0.5968668
```

```
format(Lage_F_Tot,scientific=4,digit=1) #ranking by L_AS; total by Lage_AS

##                        Fleet Total rank_Total
## 19   TBB_DEF_70-99_0_0_all  0.32  0.4021299
## 8    GTR_DEF_90-99_0_0_all  1.00  0.2408950
## 16   OTB_DEF_70-99_0_0_all  0.87  0.1436856
## 9      GTR_DEF_all_0_0_all  0.86  0.0759882
## 1          DRB_all_0_0_all  0.20  0.0342087
## 5      GNS_DEF_all_0_0_all  0.18  0.0336137
## 6  GTR_DEF_100-119_0_0_all  0.70  0.0285333
## 4    GNS_DEF_90-99_0_0_all  0.00  0.0186394
## 7  GTR_DEF_120-219_0_0_all  0.38  0.0075945
## 13   OTB_CRU_16-31_0_0_all  0.09  0.0065802
## 3  GNS_DEF_100-119_0_0_all  0.00  0.0063310
## 12         MIS_MIS_0_0_0_HC  0.45  0.0007085
## 10        LLS_DEF_0_0_0_all  0.00  0.0003436
## 2         FPO_CRU_0_0_0_all  0.00  0.0003168
## 14   OTB_CRU_70-99_0_0_all  0.00  0.0002053
## 18   TBB_DEF_>=120_0_0_all  0.00  0.0001657
## 15   OTB_DEF_>=120_0_0_all  0.87  0.0000496
## 17   TBB_CRU_16-31_0_0_all  0.00  0.0000107
## 11        LLS_FIF_0_0_0_all  0.00  0.0000004

Lage_gear

##       GTR       OTB      REST       TBB 
## 0.8139279 0.8310683 0.2033696 0.3219677

Dage_gear

##        GTR        OTB       REST        TBB 
## 0.02467538 0.00000000 0.00000000 0.07253807
```

Section E: Discard ratio coverage ranked by landed weight

This section shows the proportion of landings for which discard weights are available, in total (Ldis_tot), by métier and for the larger gear groups (Ldis_gear). The métiers are ranked by landed weight, so it is easy to check whether the most important métiers have reasonable discard ratio coverage.

```
Ldis_tot<-sum(Ldis_AS*L_AS,na.rm=T)/sum(L_AS,na.rm=T)
#(Ldis_AS = Lwt !Dwt / sum(Lwt); L_AS = Lwt / sum(Lwt)
Ldis_tot

## [1] 0.03933879

format(Ldis_F_Tot,scientific=4,digit=1) #ranking by L_AS; total by Ldis_AS

##                        Fleet Total rank_Total
## 19   TBB_DEF_70-99_0_0_all  0.07  0.4021299
## 8    GTR_DEF_90-99_0_0_all  0.00  0.2408950
## 16   OTB_DEF_70-99_0_0_all  0.00  0.1436856
## 9      GTR_DEF_all_0_0_all  0.00  0.0759882
## 1          DRB_all_0_0_all  0.00  0.0342087
## 5      GNS_DEF_all_0_0_all  0.00  0.0336137
## 6  GTR_DEF_100-119_0_0_all  0.36  0.0285333
## 4    GNS_DEF_90-99_0_0_all  0.00  0.0186394
## 7  GTR_DEF_120-219_0_0_all  0.00  0.0075945
## 13   OTB_CRU_16-31_0_0_all  0.00  0.0065802
## 3  GNS_DEF_100-119_0_0_all  0.00  0.0063310
## 12         MIS_MIS_0_0_0_HC  0.00  0.0007085
## 10        LLS_DEF_0_0_0_all  0.00  0.0003436
## 2         FPO_CRU_0_0_0_all  0.00  0.0003168
## 14   OTB_CRU_70-99_0_0_all  0.00  0.0002053
## 18   TBB_DEF_>=120_0_0_all  0.00  0.0001657
## 15   OTB_DEF_>=120_0_0_all  0.00  0.0000496
## 17   TBB_CRU_16-31_0_0_all  0.00  0.0000107
## 11        LLS_FIF_0_0_0_all  0.00  0.0000004

Ldis_gear

##        GTR        OTB       REST        TBB 
## 0.02467538 0.00000000 0.00000000 0.07253807
```

InterCatch input for 2004

This appendix lists 5 sections of tables (A-E) for each InterCatch year (2003-2015). It provides a detailed summary of the InterCatch input data in terms of importance by landed weight and the proportional coverage for age data and discard ratios.

Section A: Importance by landed weight (Lwt / sum(Lwt))

1. Proportion of landings by area and season

```
L_AS*100

##               1        2        3        4     2004
## 27.7.d 14.37151 23.21702 22.36385 17.23835 22.80927
```

2. Proportion of landings by métier and country

```
format(data.frame(L_FC*100),scientific=3,digit=1)

##                         Belgium France Netherlands UK..England.
## DRB_all_0_0_all              NA  4.659          NA           NA
## FPO_CRU_0_0_0_all            NA     NA          NA        7e-03
## GNS_DEF_100-119_0_0_all      NA  0.185          NA           NA
## GNS_DEF_90-99_0_0_all        NA  1.201          NA           NA
## GNS_DEF_all_0_0_all         0.3     NA          NA        4e+00
## GTR_DEF_100-119_0_0_all      NA  2.874          NA           NA
## GTR_DEF_120-219_0_0_all      NA  0.611          NA           NA
## GTR_DEF_90-99_0_0_all        NA 22.531          NA           NA
## GTR_DEF_all_0_0_all          NA  8.246          NA        5e-01
## LLS_DEF_0_0_0_all            NA  0.007          NA           NA
## LLS_FIF_0_0_0_all            NA     NA          NA        6e-06
## MIS_MIS_0_0_0_HC             NA  0.104      0.0016        5e-01
## OTB_CRU_16-31_0_0_all        NA     NA          NA        1e+00
## OTB_CRU_70-99_0_0_all       0.3     NA          NA        3e-04
## OTB_DEF_>=120_0_0_all        NA     NA          NA        1e-05
## OTB_DEF_70-99_0_0_all        NA 12.413      0.0007        4e-01
## TBB_CRU_16-31_0_0_all        NA     NA          NA        5e-02
## TBB_DEF_70-99_0_0_all      22.8  5.601      0.0032        1e+01
```

3. Proportion of landings by country

```
apply(L_FC*100,2,function(x) sum(x,na.rm=T))

##      Belgium       France  Netherlands UK (England)
## 23.401299790 58.431874465  0.005490924 18.161334821
```

4. Proportion of landings by fleet and area

```
format(data.frame(L_FA*100),scientific=4,digit=1)

##                           X27.7.d
## DRB_all_0_0_all          4.659433
## FPO_CRU_0_0_0_all        0.007393
## GNS_DEF_100-119_0_0_all  0.185018
## GNS_DEF_90-99_0_0_all    1.201403
## GNS_DEF_all_0_0_all      4.603331
## GTR_DEF_100-119_0_0_all  2.874029
## GTR_DEF_120-219_0_0_all  0.610635
## GTR_DEF_90-99_0_0_all   22.530987
## GTR_DEF_all_0_0_all      8.780588
## LLS_DEF_0_0_0_all        0.006584
## LLS_FIF_0_0_0_all        0.000006
## MIS_MIS_0_0_0_HC         0.588050
## OTB_CRU_16-31_0_0_all    0.996047
## OTB_CRU_70-99_0_0_all    0.292749
## OTB_DEF_>=120_0_0_all    0.000010
## OTB_DEF_70-99_0_0_all   12.849536
## TBB_CRU_16-31_0_0_all    0.048210
## TBB_DEF_70-99_0_0_all   39.765991
```

5. Proportion of landings by métier, ranked from largest to smallest, together with cumulative sum

```
L_F1<-L_F
L_F1$rank_Total<-L_F1$rank_Total*100
L_F1<-L_F1[rev(order(L_F1$rank_Total)),]
```

```
L_F1$cum<-cumsum(L_F1$rank_Total)
format(L_F1,scientific=4,digit=1)

##                          rank_Total                   Fleet cum
## TBB_DEF_70-99_0_0_all    39.765991   TBB_DEF_70-99_0_0_all  40
## GTR_DEF_90-99_0_0_all    22.530987   GTR_DEF_90-99_0_0_all  62
## OTB_DEF_70-99_0_0_all    12.849536   OTB_DEF_70-99_0_0_all  75
## GTR_DEF_all_0_0_all       8.780588     GTR_DEF_all_0_0_all  84
## DRB_all_0_0_all           4.659433         DRB_all_0_0_all  89
## GNS_DEF_all_0_0_all       4.603331     GNS_DEF_all_0_0_all  93
## GTR_DEF_100-119_0_0_all   2.874029 GTR_DEF_100-119_0_0_all  96
## GNS_DEF_90-99_0_0_all     1.201403   GNS_DEF_90-99_0_0_all  97
## OTB_CRU_16-31_0_0_all     0.996047   OTB_CRU_16-31_0_0_all  98
## GTR_DEF_120-219_0_0_all   0.610635 GTR_DEF_120-219_0_0_all  99
## MIS_MIS_0_0_0_HC          0.588050        MIS_MIS_0_0_0_HC  99
## OTB_CRU_70-99_0_0_all     0.292749   OTB_CRU_70-99_0_0_all 100
## GNS_DEF_100-119_0_0_all   0.185018 GNS_DEF_100-119_0_0_all 100
## TBB_CRU_16-31_0_0_all     0.048210   TBB_CRU_16-31_0_0_all 100
## FPO_CRU_0_0_0_all         0.007393       FPO_CRU_0_0_0_all 100
## LLS_DEF_0_0_0_all         0.006584       LLS_DEF_0_0_0_all 100
## OTB_DEF_>=120_0_0_all     0.000010   OTB_DEF_>=120_0_0_all 100
## LLS_FIF_0_0_0_all         0.000006       LLS_FIF_0_0_0_all 100
```

Section B: Age coverage

1. Total proportion of the landings/sampled discards that is covered for age composition

```
Lage_A_tot #(Lwt !Lagesamp / sum(Lwt))

## [1] 0.8186457

Dage_A_tot #(Dwt !Dagesamp / sum(Dwt))

## [1] 0.5867881
```

2. Proportion of landings/sampled discards by area and season that is covered for age composition

```
Lage_AS

##                 1         2         3         4 2004
## 27.7.d 0.4787666 0.9544346 0.8758152 0.6049871    1

Dage_AS

##                 2         3 4 2004
## 27.7.d 0.2021087 0.2091242 1    1
```

3. Proportion of landings/sampled discards in each métier-country stratum that is covered for age composition

```
Lage_FC

##                         Belgium    France Netherlands UK (England)
## DRB_all_0_0_all              NA 0.5379741          NA           NA
## FPO_CRU_0_0_0_all            NA        NA          NA    0.0861141
## GNS_DEF_100-119_0_0_all      NA 0.0000000          NA           NA
## GNS_DEF_90-99_0_0_all        NA 0.0000000          NA           NA
## GNS_DEF_all_0_0_all           0        NA          NA    0.8357576
## GTR_DEF_100-119_0_0_all      NA 0.8973717          NA           NA
## GTR_DEF_120-219_0_0_all      NA 0.0000000          NA           NA
## GTR_DEF_90-99_0_0_all        NA 0.7744211          NA           NA
## GTR_DEF_all_0_0_all          NA 0.7858531          NA    0.0000000
## LLS_DEF_0_0_0_all            NA 0.0000000          NA           NA
## LLS_FIF_0_0_0_all            NA        NA          NA    0.0000000
## MIS_MIS_0_0_0_HC             NA 0.5893825           0    0.0000000
## OTB_CRU_16-31_0_0_all        NA        NA          NA    0.0000000
## OTB_CRU_70-99_0_0_all         0        NA          NA    0.0000000
## OTB_DEF_>=120_0_0_all        NA        NA          NA    0.0000000
## OTB_DEF_70-99_0_0_all        NA 0.8626505           0    0.8580133
## TBB_CRU_16-31_0_0_all        NA        NA          NA    0.0000000
## TBB_DEF_70-99_0_0_all         1 0.7048846           0    1.0000000

Dage_FC #note: proportions shown prior to discard raising

##                         Belgium France Netherlands UK (England)
## DRB_all_0_0_all              NA    NaN          NA           NA
## FPO_CRU_0_0_0_all            NA     NA          NA          NaN
```

```
## GNS_DEF_100-119_0_0_all      NA    NaN          NA           NA
## GNS_DEF_90-99_0_0_all        NA    NaN          NA           NA
## GNS_DEF_all_0_0_all         NaN     NA          NA          NaN
## GTR_DEF_100-119_0_0_all      NA    NaN          NA           NA
## GTR_DEF_120-219_0_0_all      NA    NaN          NA           NA
## GTR_DEF_90-99_0_0_all        NA    NaN          NA           NA
## GTR_DEF_all_0_0_all          NA    NaN          NA            1
## LLS_DEF_0_0_0_all            NA    NaN          NA           NA
## LLS_FIF_0_0_0_all            NA     NA          NA          NaN
## MIS_MIS_0_0_0_HC             NA    NaN         NaN            1
## OTB_CRU_16-31_0_0_all        NA     NA          NA          NaN
## OTB_CRU_70-99_0_0_all       NaN     NA          NA          NaN
## OTB_DEF_>=120_0_0_all        NA     NA          NA          NaN
## OTB_DEF_70-99_0_0_all        NA      0         NaN          NaN
## TBB_CRU_16-31_0_0_all        NA     NA          NA          NaN
## TBB_DEF_70-99_0_0_all         1    NaN         NaN            1
```

Section C: Discard ratio coverage (Lwt !Dwt / sum(Lwt))

1. Total proportion of the landings for which discard weights are available

```
Ldis_A_tot

## [1] 0.4187467
```

2. Proportion of landings for which discard weights are available by area and season

```
Ldis_AS

##        1         2         3         4 2004
## 27.7.d 0 0.2978729 0.3731438 0.2207142    1
```

3. Proportion of landings for which discard weights are available in each métier-country stratum

```
Ldis_FC

##                         Belgium    France Netherlands UK (England)
## DRB_all_0_0_all              NA 0.0000000          NA           NA
## FPO_CRU_0_0_0_all            NA        NA          NA  0.000000000
## GNS_DEF_100-119_0_0_all      NA 0.0000000          NA           NA
## GNS_DEF_90-99_0_0_all        NA 0.0000000          NA           NA
## GNS_DEF_all_0_0_all           0        NA          NA  0.000000000
## GTR_DEF_100-119_0_0_all      NA 0.0000000          NA           NA
## GTR_DEF_120-219_0_0_all      NA 0.0000000          NA           NA
## GTR_DEF_90-99_0_0_all        NA 0.0000000          NA           NA
## GTR_DEF_all_0_0_all          NA 0.0000000          NA  0.224480503
## LLS_DEF_0_0_0_all            NA 0.0000000          NA           NA
## LLS_FIF_0_0_0_all            NA        NA          NA  0.000000000
## MIS_MIS_0_0_0_HC             NA 0.0000000           0  0.004561575
## OTB_CRU_16-31_0_0_all        NA        NA          NA  0.000000000
## OTB_CRU_70-99_0_0_all         0        NA          NA  0.000000000
## OTB_DEF_>=120_0_0_all        NA        NA          NA  0.000000000
## OTB_DEF_70-99_0_0_all        NA 0.8020338           0  0.000000000
## TBB_CRU_16-31_0_0_all        NA        NA          NA  0.000000000
## TBB_DEF_70-99_0_0_all         1 0.0000000           0  0.791680634
```

Section D: Landings age coverage ranked by landed weights

This section shows the proportion of landings covered for age composition, in total (Lage_tot), by métier and for the larger gear groups (Lage_gear). The métiers are ranked by landed weight, so it is easy to check whether the most important métiers have reasonable age coverage for landings. Additionally, the proportion of landings for which discard age coverage is available is presented for the larger gear groups (Dage_gear).

```
Lage_tot<-sum(Lage_AS*L_AS,na.rm=T)/sum(L_AS,na.rm=T)
#(Lage_AS = Lwt !Lagesamp / sum(Lwt); L_AS = Lwt / sum(Lwt))
Lage_tot

## [1] 0.8186457

format(Lage_F_Tot,scientific=4,digit=1) #ranking by L_AS; total by Lage_AS

##                      Fleet Total rank_Total
## 18   TBB_DEF_70-99_0_0_all  0.96      4e-01
## 8    GTR_DEF_90-99_0_0_all  0.77      2e-01
## 16   OTB_DEF_70-99_0_0_all  0.86      1e-01
```

```
## 9      GTR_DEF_all_0_0_all  0.74      9e-02
## 1          DRB_all_0_0_all  0.54      5e-02
## 5      GNS_DEF_all_0_0_all  0.78      5e-02
## 6  GTR_DEF_100-119_0_0_all  0.90      3e-02
## 4    GNS_DEF_90-99_0_0_all  0.00      1e-02
## 13   OTB_CRU_16-31_0_0_all  0.00      1e-02
## 7  GTR_DEF_120-219_0_0_all  0.00      6e-03
## 12        MIS_MIS_0_0_0_HC  0.10      6e-03
## 14   OTB_CRU_70-99_0_0_all  0.00      3e-03
## 3  GNS_DEF_100-119_0_0_all  0.00      2e-03
## 17   TBB_CRU_16-31_0_0_all  0.00      5e-04
## 2        FPO_CRU_0_0_0_all  0.09      7e-05
## 10       LLS_DEF_0_0_0_all  0.00      7e-05
## 15   OTB_DEF_>=120_0_0_all  0.00      1e-07
## 11       LLS_FIF_0_0_0_all  0.00      6e-08

Lage_gear

##       GTR       OTB      REST       TBB
## 0.7381071 0.7838275 0.4881401 0.9571910

Dage_gear

##          GTR          OTB         REST          TBB
## 0.0029432737 0.0000000000 0.0004186543 0.7986260533
```

Section E: Discard ratio coverage ranked by landed weight

This section shows the proportion of landings for which discard weights are available, in total (Ldis_tot), by métier and for the larger gear groups (Ldis_gear). The métiers are ranked by landed weight, so it is easy to check whether the most important métiers have reasonable discard ratio coverage.

```
Ldis_tot<-sum(Ldis_AS*L_AS,na.rm=T)/sum(L_AS,na.rm=T)
#(Ldis_AS = Lwt !Dwt / sum(Lwt); L_AS = Lwt / sum(Lwt)
Ldis_tot

## [1] 0.4187467

format(Ldis_F_Tot,scientific=4,digit=1) #ranking by L_AS; total by Ldis_AS

##                       Fleet Total rank_Total
## 18   TBB_DEF_70-99_0_0_all 0.800      4e-01
## 8    GTR_DEF_90-99_0_0_all 0.000      2e-01
## 16   OTB_DEF_70-99_0_0_all 0.775      1e-01
## 9      GTR_DEF_all_0_0_all 0.014      9e-02
## 1          DRB_all_0_0_all 0.000      5e-02
## 5      GNS_DEF_all_0_0_all 0.000      5e-02
## 6  GTR_DEF_100-119_0_0_all 0.000      3e-02
## 4    GNS_DEF_90-99_0_0_all 0.000      1e-02
## 13   OTB_CRU_16-31_0_0_all 0.000      1e-02
## 7  GTR_DEF_120-219_0_0_all 0.000      6e-03
## 12        MIS_MIS_0_0_0_HC 0.004      6e-03
## 14   OTB_CRU_70-99_0_0_all 0.000      3e-03
## 3  GNS_DEF_100-119_0_0_all 0.000      2e-03
## 17   TBB_CRU_16-31_0_0_all 0.000      5e-04
## 2        FPO_CRU_0_0_0_all 0.000      7e-05
## 10       LLS_DEF_0_0_0_all 0.000      7e-05
## 15   OTB_DEF_>=120_0_0_all 0.000      1e-07
## 11       LLS_FIF_0_0_0_all 0.000      6e-08

Ldis_gear

##          GTR          OTB         REST          TBB
## 0.0029432737 0.7041677337 0.0004186543 0.7986260533
```

InterCatch input for 2005

This appendix lists 5 sections of tables (A-E) for each InterCatch year (2003-2015). It provides a detailed summary of the InterCatch input data in terms of importance by landed weight and the proportional coverage for age data and discard ratios.

Section A: Importance by landed weight (Lwt / sum(Lwt))

1. Proportion of landings by area and season

```
L_AS*100

##                1        2        3        4     2005
## 27.7.d 15.88785 25.99401 20.02343 14.54427 23.55044
```

2. Proportion of landings by métier and country

```
format(data.frame(L_FC*100),scientific=3,digit=1)

##                          Belgium France Netherlands UK..England.
## DRB_all_0_0_all               NA   6.65          NA           NA
## FPO_CRU_0_0_0_all             NA     NA          NA       0.0064
## GNS_DEF_100-119_0_0_all       NA   0.11          NA           NA
## GNS_DEF_90-99_0_0_all         NA   0.26          NA           NA
## GNS_DEF_all_0_0_all         0.38     NA          NA       3.5961
## GTR_DEF_100-119_0_0_all       NA   4.38          NA           NA
## GTR_DEF_120-219_0_0_all       NA   1.10          NA           NA
## GTR_DEF_90-99_0_0_all         NA  29.67          NA           NA
## GTR_DEF_all_0_0_all           NA   7.18          NA       0.2836
## LLS_DEF_0_0_0_all             NA   0.04          NA           NA
## LLS_FIF_0_0_0_all             NA     NA          NA       0.0006
## MIS_MIS_0_0_0_HC            0.03   0.07          NA       0.0909
## OTB_CRU_16-31_0_0_all         NA     NA          NA       0.4444
## OTB_CRU_70-99_0_0_all       0.17     NA          NA       0.0013
## OTB_DEF_>=120_0_0_all         NA     NA          NA       0.0003
## OTB_DEF_70-99_0_0_all         NA  11.61      0.0009       0.4972
## TBB_CRU_16-31_0_0_all       0.07     NA          NA       0.0039
## TBB_DEF_>=120_0_0_all         NA     NA          NA       0.0331
## TBB_DEF_70-99_0_0_all      23.55   3.47          NA       6.2876
```

3. Proportion of landings by country

```
apply(L_FC*100,2,function(x) sum(x,na.rm=T))

##      Belgium       France  Netherlands UK (England)
## 2.420027e+01 6.455338e+01 9.296318e-04 1.124541e+01
```

4. Proportion of landings by fleet and area

```
format(data.frame(L_FA*100),scientific=4,digit=1)

##                          X27.7.d
## DRB_all_0_0_all           6.6489
## FPO_CRU_0_0_0_all         0.0064
## GNS_DEF_100-119_0_0_all   0.1129
## GNS_DEF_90-99_0_0_all     0.2595
## GNS_DEF_all_0_0_all       3.9761
## GTR_DEF_100-119_0_0_all   4.3829
## GTR_DEF_120-219_0_0_all   1.1032
## GTR_DEF_90-99_0_0_all    29.6668
## GTR_DEF_all_0_0_all       7.4677
## LLS_DEF_0_0_0_all         0.0433
## LLS_FIF_0_0_0_all         0.0006
## MIS_MIS_0_0_0_HC          0.1923
## OTB_CRU_16-31_0_0_all     0.4444
## OTB_CRU_70-99_0_0_all     0.1740
## OTB_DEF_>=120_0_0_all     0.0003
## OTB_DEF_70-99_0_0_all    12.1101
## TBB_CRU_16-31_0_0_all     0.0728
## TBB_DEF_>=120_0_0_all     0.0331
## TBB_DEF_70-99_0_0_all    33.3047
```

5. Proportion of landings by métier, ranked from largest to smallest, together with cumulative sum

```
L_F1<-L_F
L_F1$rank_Total<-L_F1$rank_Total*100
```

```
L_F1<-L_F1[rev(order(L_F1$rank_Total)),]
L_F1$cum<-cumsum(L_F1$rank_Total)
format(L_F1,scientific=4,digit=1)

##                         rank_Total                   Fleet cum
## TBB_DEF_70-99_0_0_all      33.3047   TBB_DEF_70-99_0_0_all  33
## GTR_DEF_90-99_0_0_all      29.6668   GTR_DEF_90-99_0_0_all  63
## OTB_DEF_70-99_0_0_all      12.1101   OTB_DEF_70-99_0_0_all  75
## GTR_DEF_all_0_0_all         7.4677     GTR_DEF_all_0_0_all  83
## DRB_all_0_0_all             6.6489         DRB_all_0_0_all  89
## GTR_DEF_100-119_0_0_all     4.3829 GTR_DEF_100-119_0_0_all  94
## GNS_DEF_all_0_0_all         3.9761     GNS_DEF_all_0_0_all  98
## GTR_DEF_120-219_0_0_all     1.1032 GTR_DEF_120-219_0_0_all  99
## OTB_CRU_16-31_0_0_all       0.4444   OTB_CRU_16-31_0_0_all  99
## GNS_DEF_90-99_0_0_all       0.2595   GNS_DEF_90-99_0_0_all  99
## MIS_MIS_0_0_0_HC            0.1923        MIS_MIS_0_0_0_HC 100
## OTB_CRU_70-99_0_0_all       0.1740   OTB_CRU_70-99_0_0_all 100
## GNS_DEF_100-119_0_0_all     0.1129 GNS_DEF_100-119_0_0_all 100
## TBB_CRU_16-31_0_0_all       0.0728   TBB_CRU_16-31_0_0_all 100
## LLS_DEF_0_0_0_all           0.0433       LLS_DEF_0_0_0_all 100
## TBB_DEF_>=120_0_0_all       0.0331   TBB_DEF_>=120_0_0_all 100
## FPO_CRU_0_0_0_all           0.0064       FPO_CRU_0_0_0_all 100
## LLS_FIF_0_0_0_all           0.0006       LLS_FIF_0_0_0_all 100
## OTB_DEF_>=120_0_0_all       0.0003   OTB_DEF_>=120_0_0_all 100
```

Section B: Age coverage

1. Total proportion of the landings/sampled discards that is covered for age composition

```
Lage_A_tot #(Lwt !Lagesamp / sum(Lwt))

## [1] 0.8376969

Dage_A_tot #(Dwt !Dagesamp / sum(Dwt))

## [1] 0.7858638
```

2. Proportion of landings/sampled discards by area and season that is covered for age composition

```
Lage_AS

##                1         2         3         4 2005
## 27.7.d 0.6224199 0.8477873 0.7761313 0.8767804    1

Dage_AS

##        1         2 3 2005
## 27.7.d 1 0.6260657 0    1
```

3. Proportion of landings/sampled discards in each métier-country stratum that is covered for age composition

```
Lage_FC

##                         Belgium    France Netherlands UK (England)
## DRB_all_0_0_all              NA 0.5892833          NA           NA
## FPO_CRU_0_0_0_all            NA        NA          NA    0.0000000
## GNS_DEF_100-119_0_0_all      NA 0.0000000          NA           NA
## GNS_DEF_90-99_0_0_all        NA 0.0000000          NA           NA
## GNS_DEF_all_0_0_all           0        NA          NA    0.3506011
## GTR_DEF_100-119_0_0_all      NA 0.9306905          NA           NA
## GTR_DEF_120-219_0_0_all      NA 0.0000000          NA           NA
## GTR_DEF_90-99_0_0_all        NA 1.0000000          NA           NA
## GTR_DEF_all_0_0_all          NA 0.6195297          NA    0.0000000
## LLS_DEF_0_0_0_all            NA 0.0000000          NA           NA
## LLS_FIF_0_0_0_all            NA        NA          NA    0.0000000
## MIS_MIS_0_0_0_HC              0 0.2086304          NA    0.0000000
## OTB_CRU_16-31_0_0_all        NA        NA          NA    0.0000000
## OTB_CRU_70-99_0_0_all         0        NA          NA    0.0000000
## OTB_DEF_>=120_0_0_all        NA        NA          NA    0.0000000
## OTB_DEF_70-99_0_0_all        NA 0.9119591           0    1.0000000
## TBB_CRU_16-31_0_0_all         0        NA          NA    0.0000000
## TBB_DEF_>=120_0_0_all        NA        NA          NA    0.0000000
## TBB_DEF_70-99_0_0_all         1 0.4567138          NA    0.6613306

Dage_FC #note: proportions shown prior to discard raising
```

```
##                         Belgium France Netherlands UK (England)
## DRB_all_0_0_all              NA    NaN          NA           NA
## FPO_CRU_0_0_0_all            NA     NA          NA          NaN
## GNS_DEF_100-119_0_0_all      NA    NaN          NA           NA
## GNS_DEF_90-99_0_0_all        NA    NaN          NA           NA
## GNS_DEF_all_0_0_all         NaN     NA          NA          NaN
## GTR_DEF_100-119_0_0_all      NA      0          NA           NA
## GTR_DEF_120-219_0_0_all      NA    NaN          NA           NA
## GTR_DEF_90-99_0_0_all        NA    NaN          NA           NA
## GTR_DEF_all_0_0_all          NA    NaN          NA          NaN
## LLS_DEF_0_0_0_all            NA    NaN          NA           NA
## LLS_FIF_0_0_0_all            NA     NA          NA          NaN
## MIS_MIS_0_0_0_HC            NaN    NaN          NA          NaN
## OTB_CRU_16-31_0_0_all        NA     NA          NA          NaN
## OTB_CRU_70-99_0_0_all       NaN     NA          NA          NaN
## OTB_DEF_>=120_0_0_all        NA     NA          NA          NaN
## OTB_DEF_70-99_0_0_all        NA      0         NaN          NaN
## TBB_CRU_16-31_0_0_all       NaN     NA          NA          NaN
## TBB_DEF_>=120_0_0_all        NA     NA          NA          NaN
## TBB_DEF_70-99_0_0_all         1    NaN          NA            1
```

Section C: Discard ratio coverage (Lwt !Dwt / sum(Lwt))

1. Total proportion of the landings for which discard weights are available

```
Ldis_A_tot

## [1] 0.3366546
```

2. Proportion of landings for which discard weights are available by area and season

```
Ldis_AS

##               1          2         3 4 2005
## 27.7.d 0.154601 0.09782517 0.2554947 0    1
```

3. Proportion of landings for which discard weights are available in each métier-country stratum

```
Ldis_FC

##                         Belgium    France Netherlands UK (England)
## DRB_all_0_0_all              NA 0.0000000          NA           NA
## FPO_CRU_0_0_0_all            NA        NA          NA    0.0000000
## GNS_DEF_100-119_0_0_all      NA 0.0000000          NA           NA
## GNS_DEF_90-99_0_0_all        NA 0.0000000          NA           NA
## GNS_DEF_all_0_0_all           0        NA          NA    0.0000000
## GTR_DEF_100-119_0_0_all      NA 0.3652055          NA           NA
## GTR_DEF_120-219_0_0_all      NA 0.0000000          NA           NA
## GTR_DEF_90-99_0_0_all        NA 0.0000000          NA           NA
## GTR_DEF_all_0_0_all          NA 0.0000000          NA    0.0000000
## LLS_DEF_0_0_0_all            NA 0.0000000          NA           NA
## LLS_FIF_0_0_0_all            NA        NA          NA    0.0000000
## MIS_MIS_0_0_0_HC              0 0.0000000          NA    0.0000000
## OTB_CRU_16-31_0_0_all        NA        NA          NA    0.0000000
## OTB_CRU_70-99_0_0_all         0        NA          NA    0.0000000
## OTB_DEF_>=120_0_0_all        NA        NA          NA    0.0000000
## OTB_DEF_70-99_0_0_all        NA 0.4405696           0    0.0000000
## TBB_CRU_16-31_0_0_all         0        NA          NA    0.0000000
## TBB_DEF_>=120_0_0_all        NA        NA          NA    0.0000000
## TBB_DEF_70-99_0_0_all         1 0.0000000          NA    0.5405022
```

Section D: Landings age coverage ranked by landed weights

This section shows the proportion of landings covered for age composition, in total (Lage_tot), by métier and for the larger gear groups (Lage_gear). The métiers are ranked by landed weight, so it is easy to check whether the most important métiers have reasonable age coverage for landings. Additionally, the proportion of landings for which discard age coverage is available is presented for the larger gear groups (Dage_gear).

```
Lage_tot<-sum(Lage_AS*L_AS,na.rm=T)/sum(L_AS,na.rm=T)
#(Lage_AS = Lwt !Lagesamp / sum(Lwt); L_AS = Lwt / sum(Lwt))
Lage_tot

## [1] 0.8376969

format(Lage_F_Tot,scientific=4,digit=1) #ranking by L_AS; total by Lage_AS
```

```
##                      Fleet Total rank_Total
## 19   TBB_DEF_70-99_0_0_all  0.88   0.333047
## 8    GTR_DEF_90-99_0_0_all  1.00   0.296668
## 16   OTB_DEF_70-99_0_0_all  0.92   0.121101
## 9      GTR_DEF_all_0_0_all  0.60   0.074677
## 1          DRB_all_0_0_all  0.59   0.066489
## 6  GTR_DEF_100-119_0_0_all  0.93   0.043829
## 5      GNS_DEF_all_0_0_all  0.32   0.039761
## 7  GTR_DEF_120-219_0_0_all  0.00   0.011032
## 13   OTB_CRU_16-31_0_0_all  0.00   0.004444
## 4    GNS_DEF_90-99_0_0_all  0.00   0.002595
## 12         MIS_MIS_0_0_0_HC  0.08   0.001923
## 14   OTB_CRU_70-99_0_0_all  0.00   0.001740
## 3  GNS_DEF_100-119_0_0_all  0.00   0.001129
## 17   TBB_CRU_16-31_0_0_all  0.00   0.000728
## 10        LLS_DEF_0_0_0_all  0.00   0.000433
## 18   TBB_DEF_>=120_0_0_all  0.00   0.000331
## 2         FPO_CRU_0_0_0_all  0.00   0.000064
## 11        LLS_FIF_0_0_0_all  0.00   0.000006
## 15   OTB_DEF_>=120_0_0_all  0.00   0.000003

Lage_gear

##       GTR       OTB      REST       TBB
## 0.8400743 0.8710034 0.5707614 0.8767250

Dage_gear

##       GTR       OTB      REST       TBB
## 0.0000000 0.0000000 0.0000000 0.8065983
```

Section E: Discard ratio coverage ranked by landed weight

This section shows the proportion of landings for which discard weights are available, in total (Ldis_tot), by métier and for the larger gear groups (Ldis_gear). The métiers are ranked by landed weight, so it is easy to check whether the most important métiers have reasonable discard ratio coverage.

```
Ldis_tot<-sum(Ldis_AS*L_AS,na.rm=T)/sum(L_AS,na.rm=T)
#(Ldis_AS = Lwt !Dwt / sum(Lwt); L_AS = Lwt / sum(Lwt)
Ldis_tot

## [1] 0.3366546

format(Ldis_F_Tot,scientific=4,digit=1) #ranking by L_AS; total by Ldis_AS

##                      Fleet Total rank_Total
## 19   TBB_DEF_70-99_0_0_all   0.8   0.333047
## 8    GTR_DEF_90-99_0_0_all   0.0   0.296668
## 16   OTB_DEF_70-99_0_0_all   0.4   0.121101
## 9      GTR_DEF_all_0_0_all   0.0   0.074677
## 1          DRB_all_0_0_all   0.0   0.066489
## 6  GTR_DEF_100-119_0_0_all   0.4   0.043829
## 5      GNS_DEF_all_0_0_all   0.0   0.039761
## 7  GTR_DEF_120-219_0_0_all   0.0   0.011032
## 13   OTB_CRU_16-31_0_0_all   0.0   0.004444
## 4    GNS_DEF_90-99_0_0_all   0.0   0.002595
## 12         MIS_MIS_0_0_0_HC   0.0   0.001923
## 14   OTB_CRU_70-99_0_0_all   0.0   0.001740
## 3  GNS_DEF_100-119_0_0_all   0.0   0.001129
## 17   TBB_CRU_16-31_0_0_all   0.0   0.000728
## 10        LLS_DEF_0_0_0_all   0.0   0.000433
## 18   TBB_DEF_>=120_0_0_all   0.0   0.000331
## 2         FPO_CRU_0_0_0_all   0.0   0.000064
## 11        LLS_FIF_0_0_0_all   0.0   0.000006
## 15   OTB_DEF_>=120_0_0_all   0.0   0.000003

Ldis_gear

##        GTR        OTB       REST        TBB
## 0.03407926 0.40191187 0.00000000 0.80659832
```

InterCatch input for 2006

This appendix lists 5 sections of tables (A-E) for each InterCatch year (2003-2015). It provides a detailed summary of the InterCatch input data in terms of importance by landed weight and the proportional coverage for age data and discard ratios.

Section A: Importance by landed weight (Lwt / sum(Lwt))

1. Proportion of landings by area and season

```
L_AS*100

##                1        2        3        4    2006
## 27.7.d 8.962959 24.38247 23.72916 13.28382 29.6416
```

2. Proportion of landings by métier and country

```
format(data.frame(L_FC*100),scientific=3,digit=1)

##                         Belgium France Netherlands UK..England.
## DRB_all_0_0_all              NA  4.263          NA           NA
## FPO_CRU_0_0_0_all            NA     NA          NA       0.0083
## GNS_DEF_100-119_0_0_all      NA  0.206          NA           NA
## GNS_DEF_90-99_0_0_all        NA  0.106          NA           NA
## GNS_DEF_all_0_0_all         0.5     NA          NA       5.8774
## GTR_DEF_100-119_0_0_all      NA  3.205          NA           NA
## GTR_DEF_120-219_0_0_all      NA  0.781          NA           NA
## GTR_DEF_90-99_0_0_all        NA 27.210          NA           NA
## GTR_DEF_all_0_0_all          NA  3.045          NA       0.0369
## LLS_DEF_0_0_0_all            NA  0.006          NA           NA
## LLS_FIF_0_0_0_all            NA     NA          NA       0.0113
## MIS_MIS_0_0_0_HC             NA  0.126       0.005       0.0427
## OTB_CRU_16-31_0_0_all        NA     NA          NA       0.0134
## OTB_CRU_32-69_0_0_all        NA     NA          NA       0.0006
## OTB_CRU_70-99_0_0_all       0.2     NA          NA       0.0021
## OTB_DEF_>=120_0_0_all        NA     NA          NA       0.1242
## OTB_DEF_70-99_0_0_all        NA 14.266       0.008       1.9704
## TBB_DEF_70-99_0_0_all      29.6  3.359       0.009       4.9607
```

3. Proportion of landings by country

```
apply(L_FC*100,2,function(x) sum(x,na.rm=T))

##      Belgium       France  Netherlands UK (England)
##   30.3583282   56.5722910    0.0213487   13.0480321
```

4. Proportion of landings by fleet and area

```
format(data.frame(L_FA*100),scientific=4,digit=1)

##                         X27.7.d
## DRB_all_0_0_all          4.2633
## FPO_CRU_0_0_0_all        0.0083
## GNS_DEF_100-119_0_0_all  0.2059
## GNS_DEF_90-99_0_0_all    0.1056
## GNS_DEF_all_0_0_all      6.3506
## GTR_DEF_100-119_0_0_all  3.2049
## GTR_DEF_120-219_0_0_all  0.7808
## GTR_DEF_90-99_0_0_all   27.2104
## GTR_DEF_all_0_0_all      3.0817
## LLS_DEF_0_0_0_all        0.0059
## LLS_FIF_0_0_0_all        0.0113
## MIS_MIS_0_0_0_HC         0.1734
## OTB_CRU_16-31_0_0_all    0.0134
## OTB_CRU_32-69_0_0_all    0.0006
## OTB_CRU_70-99_0_0_all    0.2457
## OTB_DEF_>=120_0_0_all    0.1242
## OTB_DEF_70-99_0_0_all   16.2437
## TBB_DEF_70-99_0_0_all   37.9704
```

5. Proportion of landings by métier, ranked from largest to smallest, together with cumulative sum

```
L_F1<-L_F
L_F1$rank_Total<-L_F1$rank_Total*100
L_F1<-L_F1[rev(order(L_F1$rank_Total)),]
```

```
L_F1$cum<-cumsum(L_F1$rank_Total)
format(L_F1,scientific=4,digit=1)

##                         rank_Total                   Fleet cum
## TBB_DEF_70-99_0_0_all      37.9704   TBB_DEF_70-99_0_0_all  38
## GTR_DEF_90-99_0_0_all      27.2104   GTR_DEF_90-99_0_0_all  65
## OTB_DEF_70-99_0_0_all      16.2437   OTB_DEF_70-99_0_0_all  81
## GNS_DEF_all_0_0_all         6.3506     GNS_DEF_all_0_0_all  88
## DRB_all_0_0_all             4.2633         DRB_all_0_0_all  92
## GTR_DEF_100-119_0_0_all     3.2049 GTR_DEF_100-119_0_0_all  95
## GTR_DEF_all_0_0_all         3.0817     GTR_DEF_all_0_0_all  98
## GTR_DEF_120-219_0_0_all     0.7808 GTR_DEF_120-219_0_0_all  99
## OTB_CRU_70-99_0_0_all       0.2457   OTB_CRU_70-99_0_0_all  99
## GNS_DEF_100-119_0_0_all     0.2059 GNS_DEF_100-119_0_0_all 100
## MIS_MIS_0_0_0_HC            0.1734        MIS_MIS_0_0_0_HC 100
## OTB_DEF_>=120_0_0_all       0.1242   OTB_DEF_>=120_0_0_all 100
## GNS_DEF_90-99_0_0_all       0.1056   GNS_DEF_90-99_0_0_all 100
## OTB_CRU_16-31_0_0_all       0.0134   OTB_CRU_16-31_0_0_all 100
## LLS_FIF_0_0_0_all           0.0113       LLS_FIF_0_0_0_all 100
## FPO_CRU_0_0_0_all           0.0083       FPO_CRU_0_0_0_all 100
## LLS_DEF_0_0_0_all           0.0059       LLS_DEF_0_0_0_all 100
## OTB_CRU_32-69_0_0_all       0.0006   OTB_CRU_32-69_0_0_all 100
```

Section B: Age coverage

1. Total proportion of the landings/sampled discards that is covered for age composition

```
Lage_A_tot #(Lwt !Lagesamp / sum(Lwt))

## [1] 0.7763097

Dage_A_tot #(Dwt !Dagesamp / sum(Dwt))

## [1] 1
```

2. Proportion of landings/sampled discards by area and season that is covered for age composition

```
Lage_AS

##                 1         2         3         4 2006
## 27.7.d 0.4859094 0.8237705 0.7327201 0.4638571    1

Dage_AS

##        1 2 2006
## 27.7.d 1 1    1
```

3. Proportion of landings/sampled discards in each métier-country stratum that is covered for age composition

```
Lage_FC

##                         Belgium     France Netherlands UK (England)
## DRB_all_0_0_all              NA 0.10375445          NA           NA
## FPO_CRU_0_0_0_all            NA         NA          NA   0.00000000
## GNS_DEF_100-119_0_0_all      NA 0.00000000          NA           NA
## GNS_DEF_90-99_0_0_all        NA 0.00000000          NA           NA
## GNS_DEF_all_0_0_all           0         NA          NA   0.65863980
## GTR_DEF_100-119_0_0_all      NA 0.76846958          NA           NA
## GTR_DEF_120-219_0_0_all      NA 0.09519884          NA           NA
## GTR_DEF_90-99_0_0_all        NA 1.00000000          NA           NA
## GTR_DEF_all_0_0_all          NA 0.38504511          NA   0.00000000
## LLS_DEF_0_0_0_all            NA 0.00000000          NA           NA
## LLS_FIF_0_0_0_all            NA         NA          NA   0.00000000
## MIS_MIS_0_0_0_HC             NA 0.46418504           0   0.00000000
## OTB_CRU_16-31_0_0_all        NA         NA          NA   0.00000000
## OTB_CRU_32-69_0_0_all        NA         NA          NA   0.00000000
## OTB_CRU_70-99_0_0_all         0         NA          NA   0.00000000
## OTB_DEF_>=120_0_0_all        NA         NA          NA   0.05013336
## OTB_DEF_70-99_0_0_all        NA 0.77679351           0   0.31876986
## TBB_DEF_70-99_0_0_all         1 0.00000000           0   0.19791078

Dage_FC #note: proportions shown prior to discard raising

##                         Belgium France Netherlands UK (England)
## DRB_all_0_0_all              NA    NaN          NA           NA
## FPO_CRU_0_0_0_all            NA     NA          NA          NaN
```

```
## GNS_DEF_100-119_0_0_all       NA    NaN          NA           NA
## GNS_DEF_90-99_0_0_all         NA    NaN          NA           NA
## GNS_DEF_all_0_0_all          NaN     NA          NA          NaN
## GTR_DEF_100-119_0_0_all       NA    NaN          NA           NA
## GTR_DEF_120-219_0_0_all       NA    NaN          NA           NA
## GTR_DEF_90-99_0_0_all         NA    NaN          NA           NA
## GTR_DEF_all_0_0_all           NA    NaN          NA          NaN
## LLS_DEF_0_0_0_all             NA    NaN          NA           NA
## LLS_FIF_0_0_0_all             NA     NA          NA          NaN
## MIS_MIS_0_0_0_HC              NA    NaN         NaN          NaN
## OTB_CRU_16-31_0_0_all         NA     NA          NA          NaN
## OTB_CRU_32-69_0_0_all         NA     NA          NA          NaN
## OTB_CRU_70-99_0_0_all        NaN     NA          NA          NaN
## OTB_DEF_>=120_0_0_all         NA     NA          NA          NaN
## OTB_DEF_70-99_0_0_all         NA    NaN         NaN          NaN
## TBB_DEF_70-99_0_0_all          1    NaN         NaN            1
```

Section C: Discard ratio coverage (Lwt !Dwt / sum(Lwt))

1. Total proportion of the landings for which discard weights are available

```
Ldis_A_tot

## [1] 0.3290959
```

2. Proportion of landings for which discard weights are available by area and season

```
Ldis_AS

##                 1          2 3 4 2006
## 27.7.d 0.2550729 0.04026591 0 0    1
```

3. Proportion of landings for which discard weights are available in each métier-country stratum

```
Ldis_FC

##                         Belgium France Netherlands UK (England)
## DRB_all_0_0_all              NA      0          NA           NA
## FPO_CRU_0_0_0_all            NA     NA          NA    0.0000000
## GNS_DEF_100-119_0_0_all      NA      0          NA           NA
## GNS_DEF_90-99_0_0_all        NA      0          NA           NA
## GNS_DEF_all_0_0_all           0     NA          NA    0.0000000
## GTR_DEF_100-119_0_0_all      NA      0          NA           NA
## GTR_DEF_120-219_0_0_all      NA      0          NA           NA
## GTR_DEF_90-99_0_0_all        NA      0          NA           NA
## GTR_DEF_all_0_0_all          NA      0          NA    0.0000000
## LLS_DEF_0_0_0_all            NA      0          NA           NA
## LLS_FIF_0_0_0_all            NA     NA          NA    0.0000000
## MIS_MIS_0_0_0_HC             NA      0           0    0.0000000
## OTB_CRU_16-31_0_0_all        NA     NA          NA    0.0000000
## OTB_CRU_32-69_0_0_all        NA     NA          NA    0.0000000
## OTB_CRU_70-99_0_0_all         0     NA          NA    0.0000000
## OTB_DEF_>=120_0_0_all        NA     NA          NA    0.0000000
## OTB_DEF_70-99_0_0_all        NA      0           0    0.0000000
## TBB_DEF_70-99_0_0_all         1      0           0    0.6587718
```

Section D: Landings age coverage ranked by landed weights

This section shows the proportion of landings covered for age composition, in total (Lage_tot), by métier and for the larger gear groups (Lage_gear). The métiers are ranked by landed weight, so it is easy to check whether the most important métiers have reasonable age coverage for landings. Additionally, the proportion of landings for which discard age coverage is available is presented for the larger gear groups (Dage_gear).

```
Lage_tot<-sum(Lage_AS*L_AS,na.rm=T)/sum(L_AS,na.rm=T)
#(Lage_AS = Lwt !Lagesamp / sum(Lwt); L_AS = Lwt / sum(Lwt))
Lage_tot

## [1] 0.7763097

format(Lage_F_Tot,scientific=4,digit=1) #ranking by L_AS; total by Lage_AS

##                       Fleet Total rank_Total
## 18   TBB_DEF_70-99_0_0_all  0.81   0.379704
## 8    GTR_DEF_90-99_0_0_all  1.00   0.272104
## 17   OTB_DEF_70-99_0_0_all  0.72   0.162437
```

```
## 5      GNS_DEF_all_0_0_all  0.61   0.063506
## 1          DRB_all_0_0_all  0.10   0.042633
## 6  GTR_DEF_100-119_0_0_all  0.77   0.032049
## 9      GTR_DEF_all_0_0_all  0.38   0.030817
## 7  GTR_DEF_120-219_0_0_all  0.10   0.007808
## 15   OTB_CRU_70-99_0_0_all  0.00   0.002457
## 3  GNS_DEF_100-119_0_0_all  0.00   0.002059
## 12        MIS_MIS_0_0_0_HC  0.34   0.001734
## 16   OTB_DEF_>=120_0_0_all  0.05   0.001242
## 4    GNS_DEF_90-99_0_0_all  0.00   0.001056
## 13   OTB_CRU_16-31_0_0_all  0.00   0.000134
## 11       LLS_FIF_0_0_0_all  0.00   0.000113
## 2        FPO_CRU_0_0_0_all  0.00   0.000083
## 10       LLS_DEF_0_0_0_all  0.00   0.000059
## 14   OTB_CRU_32-69_0_0_all  0.00   0.000006

Lage_gear

##       GTR       OTB      REST       TBB
## 0.8498100 0.7046016 0.1122128 0.8065075

Dage_gear

##       GTR       OTB      REST       TBB
## 0.0000000 0.0000000 0.0000000 0.8667178
```

Section E: Discard ratio coverage ranked by landed weight

This section shows the proportion of landings for which discard weights are available, in total (Ldis_tot), by métier and for the larger gear groups (Ldis_gear). The métiers are ranked by landed weight, so it is easy to check whether the most important métiers have reasonable discard ratio coverage.

```
Ldis_tot<-sum(Ldis_AS*L_AS,na.rm=T)/sum(L_AS,na.rm=T)
#(Ldis_AS = Lwt !Dwt / sum(Lwt); L_AS = Lwt / sum(Lwt)
Ldis_tot

## [1] 0.3290959

format(Ldis_F_Tot,scientific=4,digit=1) #ranking by L_AS; total by Ldis_AS

##                       Fleet Total rank_Total
## 18   TBB_DEF_70-99_0_0_all   0.9   0.379704
## 8    GTR_DEF_90-99_0_0_all   0.0   0.272104
## 17   OTB_DEF_70-99_0_0_all   0.0   0.162437
## 5      GNS_DEF_all_0_0_all   0.0   0.063506
## 1          DRB_all_0_0_all   0.0   0.042633
## 6  GTR_DEF_100-119_0_0_all   0.0   0.032049
## 9      GTR_DEF_all_0_0_all   0.0   0.030817
## 7  GTR_DEF_120-219_0_0_all   0.0   0.007808
## 15   OTB_CRU_70-99_0_0_all   0.0   0.002457
## 3  GNS_DEF_100-119_0_0_all   0.0   0.002059
## 12        MIS_MIS_0_0_0_HC   0.0   0.001734
## 16   OTB_DEF_>=120_0_0_all   0.0   0.001242
## 4    GNS_DEF_90-99_0_0_all   0.0   0.001056
## 13   OTB_CRU_16-31_0_0_all   0.0   0.000134
## 11       LLS_FIF_0_0_0_all   0.0   0.000113
## 2        FPO_CRU_0_0_0_all   0.0   0.000083
## 10       LLS_DEF_0_0_0_all   0.0   0.000059
## 14   OTB_CRU_32-69_0_0_all   0.0   0.000006

Ldis_gear

##       GTR       OTB      REST       TBB
## 0.0000000 0.0000000 0.0000000 0.8667178
```

InterCatch input for 2007

This appendix lists 5 sections of tables (A-E) for each InterCatch year (2003-2015). It provides a detailed summary of the InterCatch input data in terms of importance by landed weight and the proportional coverage for age data and discard ratios.

Section A: Importance by landed weight (Lwt / sum(Lwt))

1. Proportion of landings by area and season

```
L_AS*100

##                1        2        3        4   2007
## 27.7.d 10.33618 17.89004 24.96892 20.48186 26.323
```

2. Proportion of landings by métier and country

```
format(data.frame(L_FC*100),scientific=3,digit=1)

##                         Belgium France Netherlands UK..England.
## DRB_all_0_0_all              NA  4.155          NA           NA
## FPO_CRU_0_0_0_all            NA     NA          NA        0.039
## GNS_DEF_100-119_0_0_all      NA  0.126          NA           NA
## GNS_DEF_90-99_0_0_all        NA  0.149          NA           NA
## GNS_DEF_all_0_0_all          NA     NA          NA        7.453
## GTR_DEF_100-119_0_0_all      NA  2.532          NA           NA
## GTR_DEF_120-219_0_0_all      NA  1.093          NA           NA
## GTR_DEF_90-99_0_0_all        NA 30.426          NA           NA
## GTR_DEF_all_0_0_all       0.603  3.333          NA        0.071
## LLS_DEF_0_0_0_all            NA  0.008          NA           NA
## LLS_FIF_0_0_0_all            NA     NA          NA        0.004
## MIS_MIS_0_0_0_HC          0.001  0.085       0.016        0.103
## OTB_CRU_16-31_0_0_all        NA     NA          NA        0.003
## OTB_CRU_70-99_0_0_all     0.092     NA          NA        0.001
## OTB_DEF_>=120_0_0_all        NA     NA          NA        0.282
## OTB_DEF_70-99_0_0_all        NA 13.810       0.004        2.108
## TBB_CRU_16-31_0_0_all        NA     NA          NA        0.024
## TBB_DEF_>=120_0_0_all        NA     NA          NA        0.019
## TBB_DEF_70-99_0_0_all    26.323  2.875          NA        4.261
```

3. Proportion of landings by country

```
apply(L_FC*100,2,function(x) sum(x,na.rm=T))

##      Belgium       France  Netherlands UK (England)
##  27.01960692  58.59225723   0.01982938  14.36830647
```

4. Proportion of landings by fleet and area

```
format(data.frame(L_FA*100),scientific=4,digit=1)

##                         X27.7.d
## DRB_all_0_0_all           4.155
## FPO_CRU_0_0_0_all         0.039
## GNS_DEF_100-119_0_0_all   0.126
## GNS_DEF_90-99_0_0_all     0.149
## GNS_DEF_all_0_0_all       7.453
## GTR_DEF_100-119_0_0_all   2.532
## GTR_DEF_120-219_0_0_all   1.093
## GTR_DEF_90-99_0_0_all    30.426
## GTR_DEF_all_0_0_all       4.008
## LLS_DEF_0_0_0_all         0.008
## LLS_FIF_0_0_0_all         0.004
## MIS_MIS_0_0_0_HC          0.205
## OTB_CRU_16-31_0_0_all     0.003
## OTB_CRU_70-99_0_0_all     0.093
## OTB_DEF_>=120_0_0_all     0.282
## OTB_DEF_70-99_0_0_all    15.922
## TBB_CRU_16-31_0_0_all     0.024
## TBB_DEF_>=120_0_0_all     0.019
## TBB_DEF_70-99_0_0_all    33.459
```

5. Proportion of landings by métier, ranked from largest to smallest, together with cumulative sum

```
L_F1<-L_F
L_F1$rank_Total<-L_F1$rank_Total*100
```

```
L_F1<-L_F1[rev(order(L_F1$rank_Total)),]
L_F1$cum<-cumsum(L_F1$rank_Total)
format(L_F1,scientific=4,digit=1)

##                          rank_Total                   Fleet cum
## TBB_DEF_70-99_0_0_all       33.459   TBB_DEF_70-99_0_0_all  33
## GTR_DEF_90-99_0_0_all       30.426   GTR_DEF_90-99_0_0_all  64
## OTB_DEF_70-99_0_0_all       15.922   OTB_DEF_70-99_0_0_all  80
## GNS_DEF_all_0_0_all          7.453     GNS_DEF_all_0_0_all  87
## DRB_all_0_0_all              4.155         DRB_all_0_0_all  91
## GTR_DEF_all_0_0_all          4.008     GTR_DEF_all_0_0_all  95
## GTR_DEF_100-119_0_0_all      2.532 GTR_DEF_100-119_0_0_all  98
## GTR_DEF_120-219_0_0_all      1.093 GTR_DEF_120-219_0_0_all  99
## OTB_DEF_>=120_0_0_all        0.282   OTB_DEF_>=120_0_0_all  99
## MIS_MIS_0_0_0_HC             0.205        MIS_MIS_0_0_0_HC 100
## GNS_DEF_90-99_0_0_all        0.149   GNS_DEF_90-99_0_0_all 100
## GNS_DEF_100-119_0_0_all      0.126 GNS_DEF_100-119_0_0_all 100
## OTB_CRU_70-99_0_0_all        0.093   OTB_CRU_70-99_0_0_all 100
## FPO_CRU_0_0_0_all            0.039       FPO_CRU_0_0_0_all 100
## TBB_CRU_16-31_0_0_all        0.024   TBB_CRU_16-31_0_0_all 100
## TBB_DEF_>=120_0_0_all        0.019   TBB_DEF_>=120_0_0_all 100
## LLS_DEF_0_0_0_all            0.008       LLS_DEF_0_0_0_all 100
## LLS_FIF_0_0_0_all            0.004       LLS_FIF_0_0_0_all 100
## OTB_CRU_16-31_0_0_all        0.003   OTB_CRU_16-31_0_0_all 100
```

Section B: Age coverage

1. Total proportion of the landings/sampled discards that is covered for age composition

```
Lage_A_tot #(Lwt !Lagesamp / sum(Lwt))

## [1] 0.7205318

Dage_A_tot #(Dwt !Dagesamp / sum(Dwt))

## [1] 0.4857003
```

2. Proportion of landings/sampled discards by area and season that is covered for age composition

```
Lage_AS

##                 1        2         3         4 2007
## 27.7.d 0.6861858 0.836447 0.8651513 0.1011468    1

Dage_AS

##        1         2         3         4 2007
## 27.7.d 1 0.2486642 0.2430372 0.2603375    1
```

3. Proportion of landings/sampled discards in each métier-country stratum that is covered for age composition

```
Lage_FC

##                         Belgium    France Netherlands UK (England)
## DRB_all_0_0_all              NA 0.3166216          NA           NA
## FPO_CRU_0_0_0_all            NA        NA          NA    0.0000000
## GNS_DEF_100-119_0_0_all      NA 0.0000000          NA           NA
## GNS_DEF_90-99_0_0_all        NA 0.0000000          NA           NA
## GNS_DEF_all_0_0_all          NA        NA          NA    1.0000000
## GTR_DEF_100-119_0_0_all      NA 0.6529253          NA           NA
## GTR_DEF_120-219_0_0_all      NA 0.2000349          NA           NA
## GTR_DEF_90-99_0_0_all        NA 0.6913371          NA           NA
## GTR_DEF_all_0_0_all           0 0.1812054          NA    0.0000000
## LLS_DEF_0_0_0_all            NA 0.0000000          NA           NA
## LLS_FIF_0_0_0_all            NA        NA          NA    0.0000000
## MIS_MIS_0_0_0_HC              0 0.6316237           0    0.0000000
## OTB_CRU_16-31_0_0_all        NA        NA          NA    0.0000000
## OTB_CRU_70-99_0_0_all         0        NA          NA    0.0000000
## OTB_DEF_>=120_0_0_all        NA        NA          NA    1.0000000
## OTB_DEF_70-99_0_0_all        NA 0.7183455           0    1.0000000
## TBB_CRU_16-31_0_0_all        NA        NA          NA    0.0000000
## TBB_DEF_>=120_0_0_all        NA        NA          NA    0.0000000
## TBB_DEF_70-99_0_0_all         1 0.0000000          NA    0.2551474

Dage_FC #note: proportions shown prior to discard raising
```

```
##                         Belgium France Netherlands UK (England)
## DRB_all_0_0_all              NA    NaN          NA           NA
## FPO_CRU_0_0_0_all            NA     NA          NA          NaN
## GNS_DEF_100-119_0_0_all      NA    NaN          NA           NA
## GNS_DEF_90-99_0_0_all        NA    NaN          NA           NA
## GNS_DEF_all_0_0_all          NA     NA          NA            1
## GTR_DEF_100-119_0_0_all      NA    NaN          NA           NA
## GTR_DEF_120-219_0_0_all      NA    NaN          NA           NA
## GTR_DEF_90-99_0_0_all        NA    NaN          NA           NA
## GTR_DEF_all_0_0_all         NaN    NaN          NA            1
## LLS_DEF_0_0_0_all            NA    NaN          NA           NA
## LLS_FIF_0_0_0_all            NA     NA          NA          NaN
## MIS_MIS_0_0_0_HC            NaN    NaN         NaN          NaN
## OTB_CRU_16-31_0_0_all        NA     NA          NA          NaN
## OTB_CRU_70-99_0_0_all       NaN     NA          NA          NaN
## OTB_DEF_>=120_0_0_all        NA     NA          NA          NaN
## OTB_DEF_70-99_0_0_all        NA      0         NaN            1
## TBB_CRU_16-31_0_0_all        NA     NA          NA          NaN
## TBB_DEF_>=120_0_0_all        NA     NA          NA          NaN
## TBB_DEF_70-99_0_0_all         1    NaN          NA            1
```

Section C: Discard ratio coverage (Lwt !Dwt / sum(Lwt))

1. Total proportion of the landings for which discard weights are available

```
Ldis_A_tot

## [1] 0.4667503
```

2. Proportion of landings for which discard weights are available by area and season

```
Ldis_AS

##                    1         2         3         4 2007
## 27.7.d 0.0005968297 0.3695808 0.3675932 0.2224233    1
```

3. Proportion of landings for which discard weights are available in each métier-country stratum

```
Ldis_FC

##                         Belgium   France Netherlands UK (England)
## DRB_all_0_0_all              NA 0.000000          NA           NA
## FPO_CRU_0_0_0_all            NA       NA          NA    0.0000000
## GNS_DEF_100-119_0_0_all      NA 0.000000          NA           NA
## GNS_DEF_90-99_0_0_all        NA 0.000000          NA           NA
## GNS_DEF_all_0_0_all          NA       NA          NA    0.6945943
## GTR_DEF_100-119_0_0_all      NA 0.000000          NA           NA
## GTR_DEF_120-219_0_0_all      NA 0.000000          NA           NA
## GTR_DEF_90-99_0_0_all        NA 0.000000          NA           NA
## GTR_DEF_all_0_0_all           0 0.000000          NA    0.2859361
## LLS_DEF_0_0_0_all            NA 0.000000          NA           NA
## LLS_FIF_0_0_0_all            NA       NA          NA    0.0000000
## MIS_MIS_0_0_0_HC              0 0.000000           0    0.0000000
## OTB_CRU_16-31_0_0_all        NA       NA          NA    0.0000000
## OTB_CRU_70-99_0_0_all         0       NA          NA    0.0000000
## OTB_DEF_>=120_0_0_all        NA       NA          NA    0.0000000
## OTB_DEF_70-99_0_0_all        NA 0.947538           0    0.3220729
## TBB_CRU_16-31_0_0_all        NA       NA          NA    0.0000000
## TBB_DEF_>=120_0_0_all        NA       NA          NA    0.0000000
## TBB_DEF_70-99_0_0_all         1 0.000000          NA    0.3263305
```

Section D: Landings age coverage ranked by landed weights

This section shows the proportion of landings covered for age composition, in total (Lage_tot), by métier and for the larger gear groups (Lage_gear). The métiers are ranked by landed weight, so it is easy to check whether the most important métiers have reasonable age coverage for landings. Additionally, the proportion of landings for which discard age coverage is available is presented for the larger gear groups (Dage_gear).

```
Lage_tot<-sum(Lage_AS*L_AS,na.rm=T)/sum(L_AS,na.rm=T)
#(Lage_AS = Lwt !Lagesamp / sum(Lwt); L_AS = Lwt / sum(Lwt))
Lage_tot

## [1] 0.7205318

format(Lage_F_Tot,scientific=4,digit=1) #ranking by L_AS; total by Lage_AS
```

```
##                       Fleet Total rank_Total
## 19   TBB_DEF_70-99_0_0_all   0.8    0.33459
## 8    GTR_DEF_90-99_0_0_all   0.7    0.30426
## 16   OTB_DEF_70-99_0_0_all   0.8    0.15922
## 5      GNS_DEF_all_0_0_all   1.0    0.07453
## 1          DRB_all_0_0_all   0.3    0.04155
## 9      GTR_DEF_all_0_0_all   0.2    0.04008
## 6  GTR_DEF_100-119_0_0_all   0.7    0.02532
## 7  GTR_DEF_120-219_0_0_all   0.2    0.01093
## 15   OTB_DEF_>=120_0_0_all   1.0    0.00282
## 12        MIS_MIS_0_0_0_HC   0.3    0.00205
## 4    GNS_DEF_90-99_0_0_all   0.0    0.00149
## 3  GNS_DEF_100-119_0_0_all   0.0    0.00126
## 14   OTB_CRU_70-99_0_0_all   0.0    0.00093
## 2        FPO_CRU_0_0_0_all   0.0    0.00039
## 17   TBB_CRU_16-31_0_0_all   0.0    0.00024
## 18   TBB_DEF_>=120_0_0_all   0.0    0.00019
## 10       LLS_DEF_0_0_0_all   0.0    0.00008
## 11       LLS_FIF_0_0_0_all   0.0    0.00004
## 13   OTB_CRU_16-31_0_0_all   0.0    0.00003
```

```
Lage_gear
```

```
##       GTR       OTB      REST       TBB
## 0.6762418 0.7552029 0.3104716 0.8181820
```

```
Dage_gear
```

```
##        GTR        OTB       REST        TBB
## 0.11350771 0.04164821 0.00000000 0.82723583
```

Section E: Discard ratio coverage ranked by landed weight

This section shows the proportion of landings for which discard weights are available, in total (Ldis_tot), by métier and for the larger gear groups (Ldis_gear). The métiers are ranked by landed weight, so it is easy to check whether the most important métiers have reasonable discard ratio coverage.

```
Ldis_tot<-sum(Ldis_AS*L_AS,na.rm=T)/sum(L_AS,na.rm=T)
#(Ldis_AS = Lwt !Dwt / sum(Lwt); L_AS = Lwt / sum(Lwt)
Ldis_tot
```

```
## [1] 0.4667503
```

```
format(Ldis_F_Tot,scientific=4,digit=1) #ranking by L_AS; total by Ldis_AS
```

```
##                       Fleet Total rank_Total
## 19   TBB_DEF_70-99_0_0_all 0.828    0.33459
## 8    GTR_DEF_90-99_0_0_all 0.000    0.30426
## 16   OTB_DEF_70-99_0_0_all 0.864    0.15922
## 5      GNS_DEF_all_0_0_all 0.695    0.07453
## 1          DRB_all_0_0_all 0.000    0.04155
## 9      GTR_DEF_all_0_0_all 0.005    0.04008
## 6  GTR_DEF_100-119_0_0_all 0.000    0.02532
## 7  GTR_DEF_120-219_0_0_all 0.000    0.01093
## 15   OTB_DEF_>=120_0_0_all 0.000    0.00282
## 12        MIS_MIS_0_0_0_HC 0.000    0.00205
## 4    GNS_DEF_90-99_0_0_all 0.000    0.00149
## 3  GNS_DEF_100-119_0_0_all 0.000    0.00126
## 14   OTB_CRU_70-99_0_0_all 0.000    0.00093
## 2        FPO_CRU_0_0_0_all 0.000    0.00039
## 17   TBB_CRU_16-31_0_0_all 0.000    0.00024
## 18   TBB_DEF_>=120_0_0_all 0.000    0.00019
## 10       LLS_DEF_0_0_0_all 0.000    0.00008
## 11       LLS_FIF_0_0_0_all 0.000    0.00004
## 13   OTB_CRU_16-31_0_0_all 0.000    0.00003
```

```
Ldis_gear
```

```
##       GTR       OTB      REST       TBB
## 0.1135077 0.8444074 0.0000000 0.8272358
```

InterCatch input for 2008

This appendix lists 5 sections of tables (A-E) for each InterCatch year (2003-2015). It provides a detailed summary of the InterCatch input data in terms of importance by landed weight and the proportional coverage for age data and discard ratios.

Section A: Importance by landed weight (Lwt / sum(Lwt))

1. Proportion of landings by area and season

```
L_AS*100

##               1        2        3        4     2008
## 27.7.d 11.42941 23.49516 25.41457 14.76102 24.89984
```

2. Proportion of landings by métier and country

```
format(data.frame(L_FC*100),scientific=3,digit=1)

##                         Belgium France Netherlands UK..England.
## DRB_all_0_0_all              NA  3.824          NA           NA
## FPO_CRU_0_0_0_all            NA     NA          NA       0.2540
## GNS_DEF_100-119_0_0_all      NA  0.212          NA           NA
## GNS_DEF_90-99_0_0_all        NA  0.142          NA           NA
## GNS_DEF_all_0_0_all       0.114     NA          NA       5.6573
## GTR_DEF_100-119_0_0_all      NA  3.477          NA           NA
## GTR_DEF_120-219_0_0_all      NA  1.372          NA           NA
## GTR_DEF_90-99_0_0_all        NA 30.588          NA           NA
## GTR_DEF_all_0_0_all       0.269  3.166          NA       0.2609
## LLS_DEF_0_0_0_all            NA  0.008          NA           NA
## LLS_FIF_0_0_0_all            NA     NA          NA       0.0521
## MIS_MIS_0_0_0_HC          0.003  0.173          NA       0.0708
## OTB_CRU_16-31_0_0_all        NA     NA          NA       0.0013
## OTB_CRU_32-69_0_0_all        NA     NA          NA       0.0001
## OTB_CRU_70-99_0_0_all     0.212     NA          NA       0.0003
## OTB_DEF_>=120_0_0_all        NA     NA          NA       1.3860
## OTB_DEF_70-99_0_0_all        NA 13.340      0.0028       0.8834
## SDN_DEF_70-99_0_0_all        NA     NA      0.0004           NA
## TBB_CRU_16-31_0_0_all     0.023     NA          NA           NA
## TBB_DEF_>=120_0_0_all     0.069     NA          NA           NA
## TBB_DEF_70-99_0_0_all    24.900  4.334          NA       5.2058
##                         UK.Scotland.
## DRB_all_0_0_all                   NA
## FPO_CRU_0_0_0_all                 NA
## GNS_DEF_100-119_0_0_all           NA
## GNS_DEF_90-99_0_0_all             NA
## GNS_DEF_all_0_0_all               NA
## GTR_DEF_100-119_0_0_all           NA
## GTR_DEF_120-219_0_0_all           NA
## GTR_DEF_90-99_0_0_all             NA
## GTR_DEF_all_0_0_all               NA
## LLS_DEF_0_0_0_all                 NA
## LLS_FIF_0_0_0_all                 NA
## MIS_MIS_0_0_0_HC                  NA
## OTB_CRU_16-31_0_0_all             NA
## OTB_CRU_32-69_0_0_all             NA
## OTB_CRU_70-99_0_0_all         0.0003
## OTB_DEF_>=120_0_0_all         0.0000
## OTB_DEF_70-99_0_0_all             NA
## SDN_DEF_70-99_0_0_all             NA
## TBB_CRU_16-31_0_0_all             NA
## TBB_DEF_>=120_0_0_all             NA
## TBB_DEF_70-99_0_0_all             NA
```

3. Proportion of landings by country

```
apply(L_FC*100,2,function(x) sum(x,na.rm=T))

##      Belgium       France  Netherlands UK (England) UK(Scotland)
## 2.558929e+01 6.063510e+01 3.177288e-03 1.377209e+01 3.424622e-04
```

4. Proportion of landings by fleet and area

```
format(data.frame(L_FA*100),scientific=4,digit=1)
```

```
##                          X27.7.d
## DRB_all_0_0_all           3.8236
## FPO_CRU_0_0_0_all         0.2540
## GNS_DEF_100-119_0_0_all   0.2125
## GNS_DEF_90-99_0_0_all     0.1423
## GNS_DEF_all_0_0_all       5.7713
## GTR_DEF_100-119_0_0_all   3.4772
## GTR_DEF_120-219_0_0_all   1.3716
## GTR_DEF_90-99_0_0_all    30.5882
## GTR_DEF_all_0_0_all       3.6954
## LLS_DEF_0_0_0_all         0.0075
## LLS_FIF_0_0_0_all         0.0521
## MIS_MIS_0_0_0_HC          0.2463
## OTB_CRU_16-31_0_0_all     0.0013
## OTB_CRU_32-69_0_0_all     0.0001
## OTB_CRU_70-99_0_0_all     0.2131
## OTB_DEF_>=120_0_0_all     1.3860
## OTB_DEF_70-99_0_0_all    14.2259
## SDN_DEF_70-99_0_0_all     0.0004
## TBB_CRU_16-31_0_0_all     0.0226
## TBB_DEF_>=120_0_0_all     0.0691
## TBB_DEF_70-99_0_0_all    34.4393
```

5. Proportion of landings by métier, ranked from largest to smallest, together with cumulative sum

```
L_F1<-L_F
L_F1$rank_Total<-L_F1$rank_Total*100
L_F1<-L_F1[rev(order(L_F1$rank_Total)),]
L_F1$cum<-cumsum(L_F1$rank_Total)
format(L_F1,scientific=4,digit=1)

##                          rank_Total                   Fleet cum
## TBB_DEF_70-99_0_0_all      34.4393   TBB_DEF_70-99_0_0_all  34
## GTR_DEF_90-99_0_0_all      30.5882   GTR_DEF_90-99_0_0_all  65
## OTB_DEF_70-99_0_0_all      14.2259   OTB_DEF_70-99_0_0_all  79
## GNS_DEF_all_0_0_all         5.7713     GNS_DEF_all_0_0_all  85
## DRB_all_0_0_all             3.8236         DRB_all_0_0_all  89
## GTR_DEF_all_0_0_all         3.6954     GTR_DEF_all_0_0_all  93
## GTR_DEF_100-119_0_0_all     3.4772 GTR_DEF_100-119_0_0_all  96
## OTB_DEF_>=120_0_0_all       1.3860   OTB_DEF_>=120_0_0_all  97
## GTR_DEF_120-219_0_0_all     1.3716 GTR_DEF_120-219_0_0_all  99
## FPO_CRU_0_0_0_all           0.2540       FPO_CRU_0_0_0_all  99
## MIS_MIS_0_0_0_HC            0.2463        MIS_MIS_0_0_0_HC  99
## OTB_CRU_70-99_0_0_all       0.2131   OTB_CRU_70-99_0_0_all  99
## GNS_DEF_100-119_0_0_all     0.2125 GNS_DEF_100-119_0_0_all 100
## GNS_DEF_90-99_0_0_all       0.1423   GNS_DEF_90-99_0_0_all 100
## TBB_DEF_>=120_0_0_all       0.0691   TBB_DEF_>=120_0_0_all 100
## LLS_FIF_0_0_0_all           0.0521       LLS_FIF_0_0_0_all 100
## TBB_CRU_16-31_0_0_all       0.0226   TBB_CRU_16-31_0_0_all 100
## LLS_DEF_0_0_0_all           0.0075       LLS_DEF_0_0_0_all 100
## OTB_CRU_16-31_0_0_all       0.0013   OTB_CRU_16-31_0_0_all 100
## SDN_DEF_70-99_0_0_all       0.0004   SDN_DEF_70-99_0_0_all 100
## OTB_CRU_32-69_0_0_all       0.0001   OTB_CRU_32-69_0_0_all 100
```

Section B: Age coverage

1. Total proportion of the landings/sampled discards that is covered for age composition

```
Lage_A_tot #(Lwt !Lagesamp / sum(Lwt))

## [1] 0.8045518

Dage_A_tot #(Dwt !Dagesamp / sum(Dwt))

## [1] 0.987832
```

2. Proportion of landings/sampled discards by area and season that is covered for age composition

```
Lage_AS

##                1         2         3         4 2008
## 27.7.d 0.6207669 0.7358278 0.8423026 0.6615527    1

Dage_AS
```

```
##                  2        4 2008
## 27.7.d 0.01677349 0.984766    1
```

3. Proportion of landings/sampled discards in each métier-country stratum that is covered for age composition

```
Lage_FC

##                          Belgium     France Netherlands UK (England)
## DRB_all_0_0_all               NA 0.29707754          NA           NA
## FPO_CRU_0_0_0_all             NA         NA          NA    0.0000000
## GNS_DEF_100-119_0_0_all       NA 0.05171469          NA           NA
## GNS_DEF_90-99_0_0_all         NA 0.00000000          NA           NA
## GNS_DEF_all_0_0_all            0         NA          NA    1.0000000
## GTR_DEF_100-119_0_0_all       NA 0.39044355          NA           NA
## GTR_DEF_120-219_0_0_all       NA 0.00000000          NA           NA
## GTR_DEF_90-99_0_0_all         NA 1.00000000          NA           NA
## GTR_DEF_all_0_0_all            0 0.54990603          NA    0.0000000
## LLS_DEF_0_0_0_all             NA 0.00000000          NA           NA
## LLS_FIF_0_0_0_all             NA         NA          NA    0.0000000
## MIS_MIS_0_0_0_HC               0 0.00000000          NA    0.0000000
## OTB_CRU_16-31_0_0_all         NA         NA          NA    0.0000000
## OTB_CRU_32-69_0_0_all         NA         NA          NA    0.0000000
## OTB_CRU_70-99_0_0_all          0         NA          NA    0.0000000
## OTB_DEF_>=120_0_0_all         NA         NA          NA    1.0000000
## OTB_DEF_70-99_0_0_all         NA 0.94497210           0    0.3197772
## SDN_DEF_70-99_0_0_all         NA         NA           0           NA
## TBB_CRU_16-31_0_0_all          0         NA          NA           NA
## TBB_DEF_>=120_0_0_all          0         NA          NA           NA
## TBB_DEF_70-99_0_0_all          1 0.00000000          NA    0.1517735
##                          UK(Scotland)
## DRB_all_0_0_all                    NA
## FPO_CRU_0_0_0_all                  NA
## GNS_DEF_100-119_0_0_all            NA
## GNS_DEF_90-99_0_0_all              NA
## GNS_DEF_all_0_0_all                NA
## GTR_DEF_100-119_0_0_all            NA
## GTR_DEF_120-219_0_0_all            NA
## GTR_DEF_90-99_0_0_all              NA
## GTR_DEF_all_0_0_all                NA
## LLS_DEF_0_0_0_all                  NA
## LLS_FIF_0_0_0_all                  NA
## MIS_MIS_0_0_0_HC                   NA
## OTB_CRU_16-31_0_0_all              NA
## OTB_CRU_32-69_0_0_all              NA
## OTB_CRU_70-99_0_0_all               0
## OTB_DEF_>=120_0_0_all             NaN
## OTB_DEF_70-99_0_0_all              NA
## SDN_DEF_70-99_0_0_all              NA
## TBB_CRU_16-31_0_0_all              NA
## TBB_DEF_>=120_0_0_all              NA
## TBB_DEF_70-99_0_0_all              NA
```

```
Dage_FC #note: proportions shown prior to discard raising

##                          Belgium France Netherlands UK (England)
## DRB_all_0_0_all               NA    NaN          NA           NA
## FPO_CRU_0_0_0_all             NA     NA          NA          NaN
## GNS_DEF_100-119_0_0_all       NA    NaN          NA           NA
## GNS_DEF_90-99_0_0_all         NA    NaN          NA           NA
## GNS_DEF_all_0_0_all          NaN     NA          NA          NaN
## GTR_DEF_100-119_0_0_all       NA    NaN          NA           NA
## GTR_DEF_120-219_0_0_all       NA    NaN          NA           NA
## GTR_DEF_90-99_0_0_all         NA    NaN          NA           NA
## GTR_DEF_all_0_0_all          NaN    NaN          NA            1
## LLS_DEF_0_0_0_all             NA    NaN          NA           NA
## LLS_FIF_0_0_0_all             NA     NA          NA          NaN
## MIS_MIS_0_0_0_HC             NaN    NaN          NA          NaN
## OTB_CRU_16-31_0_0_all         NA     NA          NA          NaN
## OTB_CRU_32-69_0_0_all         NA     NA          NA          NaN
## OTB_CRU_70-99_0_0_all        NaN     NA          NA          NaN
## OTB_DEF_>=120_0_0_all         NA     NA          NA          NaN
## OTB_DEF_70-99_0_0_all         NA      0         NaN          NaN
## SDN_DEF_70-99_0_0_all         NA     NA         NaN           NA
## TBB_CRU_16-31_0_0_all        NaN     NA          NA           NA
## TBB_DEF_>=120_0_0_all        NaN     NA          NA           NA
```

```
## TBB_DEF_70-99_0_0_all         1    NaN          NA            1
##                         UK(Scotland)
## DRB_all_0_0_all                   NA
## FPO_CRU_0_0_0_all                 NA
## GNS_DEF_100-119_0_0_all           NA
## GNS_DEF_90-99_0_0_all             NA
## GNS_DEF_all_0_0_all               NA
## GTR_DEF_100-119_0_0_all           NA
## GTR_DEF_120-219_0_0_all           NA
## GTR_DEF_90-99_0_0_all             NA
## GTR_DEF_all_0_0_all               NA
## LLS_DEF_0_0_0_all                 NA
## LLS_FIF_0_0_0_all                 NA
## MIS_MIS_0_0_0_HC                  NA
## OTB_CRU_16-31_0_0_all             NA
## OTB_CRU_32-69_0_0_all             NA
## OTB_CRU_70-99_0_0_all            NaN
## OTB_DEF_>=120_0_0_all            NaN
## OTB_DEF_70-99_0_0_all             NA
## SDN_DEF_70-99_0_0_all             NA
## TBB_CRU_16-31_0_0_all             NA
## TBB_DEF_>=120_0_0_all             NA
## TBB_DEF_70-99_0_0_all             NA
```

Section C: Discard ratio coverage (Lwt !Dwt / sum(Lwt))

1. Total proportion of the landings for which discard weights are available

```
Ldis_A_tot

## [1] 0.3286221
```

2. Proportion of landings for which discard weights are available by area and season

```
Ldis_AS

##        1         2 3         4 2008
## 27.7.d 0 0.2183866 0 0.1918123    1
```

3. Proportion of landings for which discard weights are available in each métier-country stratum

```
Ldis_FC

##                         Belgium    France Netherlands UK (England)
## DRB_all_0_0_all              NA 0.0000000          NA           NA
## FPO_CRU_0_0_0_all            NA        NA          NA    0.0000000
## GNS_DEF_100-119_0_0_all      NA 0.0000000          NA           NA
## GNS_DEF_90-99_0_0_all        NA 0.0000000          NA           NA
## GNS_DEF_all_0_0_all           0        NA          NA    0.0000000
## GTR_DEF_100-119_0_0_all      NA 0.0000000          NA           NA
## GTR_DEF_120-219_0_0_all      NA 0.0000000          NA           NA
## GTR_DEF_90-99_0_0_all        NA 0.0000000          NA           NA
## GTR_DEF_all_0_0_all           0 0.0000000          NA    0.5519396
## LLS_DEF_0_0_0_all            NA 0.0000000          NA           NA
## LLS_FIF_0_0_0_all            NA        NA          NA    0.0000000
## MIS_MIS_0_0_0_HC              0 0.0000000          NA    0.0000000
## OTB_CRU_16-31_0_0_all        NA        NA          NA    0.0000000
## OTB_CRU_32-69_0_0_all        NA        NA          NA    0.0000000
## OTB_CRU_70-99_0_0_all         0        NA          NA    0.0000000
## OTB_DEF_>=120_0_0_all        NA        NA          NA    0.0000000
## OTB_DEF_70-99_0_0_all        NA 0.4806623           0    0.0000000
## SDN_DEF_70-99_0_0_all        NA        NA           0           NA
## TBB_CRU_16-31_0_0_all         0        NA          NA           NA
## TBB_DEF_>=120_0_0_all         0        NA          NA           NA
## TBB_DEF_70-99_0_0_all         1 0.0000000          NA    0.2701742
##                         UK(Scotland)
## DRB_all_0_0_all                   NA
## FPO_CRU_0_0_0_all                 NA
## GNS_DEF_100-119_0_0_all           NA
## GNS_DEF_90-99_0_0_all             NA
## GNS_DEF_all_0_0_all               NA
## GTR_DEF_100-119_0_0_all           NA
## GTR_DEF_120-219_0_0_all           NA
## GTR_DEF_90-99_0_0_all             NA
## GTR_DEF_all_0_0_all               NA
## LLS_DEF_0_0_0_all                 NA
```

```
## LLS_FIF_0_0_0_all                  NA
## MIS_MIS_0_0_0_HC                   NA
## OTB_CRU_16-31_0_0_all              NA
## OTB_CRU_32-69_0_0_all              NA
## OTB_CRU_70-99_0_0_all               0
## OTB_DEF_>=120_0_0_all             NaN
## OTB_DEF_70-99_0_0_all              NA
## SDN_DEF_70-99_0_0_all              NA
## TBB_CRU_16-31_0_0_all              NA
## TBB_DEF_>=120_0_0_all              NA
## TBB_DEF_70-99_0_0_all              NA
```

Section D: Landings age coverage ranked by landed weights

This section shows the proportion of landings covered for age composition, in total (Lage_tot), by métier and for the larger gear groups (Lage_gear). The métiers are ranked by landed weight, so it is easy to check whether the most important métiers have reasonable age coverage for landings. Additionally, the proportion of landings for which discard age coverage is available is presented for the larger gear groups (Dage_gear).

```
Lage_tot<-sum(Lage_AS*L_AS,na.rm=T)/sum(L_AS,na.rm=T)
#(Lage_AS = Lwt !Lagesamp / sum(Lwt); L_AS = Lwt / sum(Lwt))
Lage_tot

## [1] 0.8045518

format(Lage_F_Tot,scientific=4,digit=1) #ranking by L_AS; total by Lage_AS

##                       Fleet Total  rank_Total
## 21   TBB_DEF_70-99_0_0_all  0.75   0.344393
## 8    GTR_DEF_90-99_0_0_all  1.00   0.305882
## 17   OTB_DEF_70-99_0_0_all  0.91   0.142259
## 5      GNS_DEF_all_0_0_all  0.98   0.057713
## 1          DRB_all_0_0_all  0.30   0.038236
## 9      GTR_DEF_all_0_0_all  0.47   0.036954
## 6  GTR_DEF_100-119_0_0_all  0.39   0.034772
## 16   OTB_DEF_>=120_0_0_all  1.00   0.013860
## 7  GTR_DEF_120-219_0_0_all  0.00   0.013716
## 2        FPO_CRU_0_0_0_all  0.00   0.002540
## 12        MIS_MIS_0_0_0_HC  0.00   0.002463
## 15   OTB_CRU_70-99_0_0_all  0.00   0.002131
## 3  GNS_DEF_100-119_0_0_all  0.05   0.002125
## 4    GNS_DEF_90-99_0_0_all  0.00   0.001423
## 20   TBB_DEF_>=120_0_0_all  0.00   0.000691
## 11       LLS_FIF_0_0_0_all  0.00   0.000521
## 19   TBB_CRU_16-31_0_0_all  0.00   0.000226
## 10       LLS_DEF_0_0_0_all  0.00   0.000075
## 13   OTB_CRU_16-31_0_0_all  0.00   0.000013
## 18   SDN_DEF_70-99_0_0_all  0.00   0.000004
## 14   OTB_CRU_32-69_0_0_all  0.00   0.000001

Lage_gear

##       GTR       OTB      REST       TBB
## 0.8695629 0.9018982 0.2591276 0.7439665

Dage_gear

##        GTR        OTB       REST        TBB
## 0.00318196 0.00000000 0.00000000 0.76181638
```

Section E: Discard ratio coverage ranked by landed weight

This section shows the proportion of landings for which discard weights are available, in total (Ldis_tot), by métier and for the larger gear groups (Ldis_gear). The métiers are ranked by landed weight, so it is easy to check whether the most important métiers have reasonable discard ratio coverage.

```
Ldis_tot<-sum(Ldis_AS*L_AS,na.rm=T)/sum(L_AS,na.rm=T)
#(Ldis_AS = Lwt !Dwt / sum(Lwt); L_AS = Lwt / sum(Lwt)
Ldis_tot

## [1] 0.3286221
```

```
format(Ldis_F_Tot,scientific=4,digit=1) #ranking by L_AS; total by Ldis_AS

##                       Fleet Total rank_Total
## 21   TBB_DEF_70-99_0_0_all  0.76   0.344393
## 8    GTR_DEF_90-99_0_0_all  0.00   0.305882
## 17   OTB_DEF_70-99_0_0_all  0.45   0.142259
## 5      GNS_DEF_all_0_0_all  0.00   0.057713
## 1          DRB_all_0_0_all  0.00   0.038236
## 9      GTR_DEF_all_0_0_all  0.04   0.036954
## 6  GTR_DEF_100-119_0_0_all  0.00   0.034772
## 16   OTB_DEF_>=120_0_0_all  0.00   0.013860
## 7  GTR_DEF_120-219_0_0_all  0.00   0.013716
## 2        FPO_CRU_0_0_0_all  0.00   0.002540
## 12        MIS_MIS_0_0_0_HC  0.00   0.002463
## 15   OTB_CRU_70-99_0_0_all  0.00   0.002131
## 3  GNS_DEF_100-119_0_0_all  0.00   0.002125
## 4    GNS_DEF_90-99_0_0_all  0.00   0.001423
## 20   TBB_DEF_>=120_0_0_all  0.00   0.000691
## 11       LLS_FIF_0_0_0_all  0.00   0.000521
## 19   TBB_CRU_16-31_0_0_all  0.00   0.000226
## 10       LLS_DEF_0_0_0_all  0.00   0.000075
## 13   OTB_CRU_16-31_0_0_all  0.00   0.000013
## 18   SDN_DEF_70-99_0_0_all  0.00   0.000004
## 14   OTB_CRU_32-69_0_0_all  0.00   0.000001

Ldis_gear

##        GTR        OTB       REST        TBB
## 0.00318196 0.40512922 0.00000000 0.76181638
```

InterCatch input for 2009

This appendix lists 5 sections of tables (A-E) for each InterCatch year (2003-2015). It provides a detailed summary of the InterCatch input data in terms of importance by landed weight and the proportional coverage for age data and discard ratios.

Section A: Importance by landed weight (Lwt / sum(Lwt))

1. Proportion of landings by area and season

```
L_AS*100

##               1        2        3       4     2009
## 27.7.d 23.84377 24.56181 14.61954 10.1629 26.81197
```

2. Proportion of landings by métier and country

```
format(data.frame(L_FC*100),scientific=3,digit=1)

##                         Belgium France Netherlands UK..England.
## DRB_all_0_0_all              NA   7.31          NA           NA
## FPO_CRU_0_0_0_all            NA     NA          NA      0.09326
## GNS_DEF_100-119_0_0_all      NA   0.02          NA           NA
## GNS_DEF_90-99_0_0_all        NA   0.21          NA           NA
## GNS_DEF_all_0_0_all        0.26     NA          NA      7.38169
## GTR_DEF_100-119_0_0_all      NA   6.87          NA           NA
## GTR_DEF_120-219_0_0_all      NA   1.13          NA           NA
## GTR_DEF_90-99_0_0_all        NA  26.97          NA           NA
## GTR_DEF_all_0_0_all        0.08   1.19          NA      0.48486
## LLS_DEF_0_0_0_all            NA   0.01          NA           NA
## LLS_FIF_0_0_0_all            NA     NA          NA      0.04179
## MIS_MIS_0_0_0_HC           0.03   0.13          NA      0.07359
## OTB_CRU_16-31_0_0_all        NA     NA          NA      0.00057
## OTB_CRU_70-99_0_0_all      0.64     NA          NA      0.00003
## OTB_DEF_>=120_0_0_all        NA     NA          NA      1.33391
## OTB_DEF_70-99_0_0_all        NA   9.03       0.003      1.39321
## TBB_CRU_16-31_0_0_all      0.01     NA          NA           NA
## TBB_DEF_70-99_0_0_all     26.81   4.73       0.005      3.76106
##                         UK.Northern.Ireland. UK.Scotland.
## DRB_all_0_0_all                           NA           NA
## FPO_CRU_0_0_0_all                         NA           NA
## GNS_DEF_100-119_0_0_all                0.003           NA
## GNS_DEF_90-99_0_0_all                     NA           NA
## GNS_DEF_all_0_0_all                       NA           NA
## GTR_DEF_100-119_0_0_all                   NA           NA
## GTR_DEF_120-219_0_0_all                   NA           NA
## GTR_DEF_90-99_0_0_all                     NA           NA
## GTR_DEF_all_0_0_all                       NA           NA
## LLS_DEF_0_0_0_all                         NA           NA
## LLS_FIF_0_0_0_all                         NA           NA
## MIS_MIS_0_0_0_HC                          NA           NA
## OTB_CRU_16-31_0_0_all                     NA           NA
## OTB_CRU_70-99_0_0_all                     NA       0.0031
## OTB_DEF_>=120_0_0_all                     NA           NA
## OTB_DEF_70-99_0_0_all                     NA           NA
## TBB_CRU_16-31_0_0_all                     NA           NA
## TBB_DEF_70-99_0_0_all                     NA       0.0004
```

3. Proportion of landings by country

```
apply(L_FC*100,2,function(x) sum(x,na.rm=T))

##              Belgium               France          Netherlands
##         27.835502726         57.586527722          0.007350781
##         UK (England) UK(Northern Ireland)         UK(Scotland)
##         14.563972599          0.003065999          0.003580173
```

4. Proportion of landings by fleet and area

```
format(data.frame(L_FA*100),scientific=4,digit=1)

##                         X27.7.d
## DRB_all_0_0_all          7.3069
## FPO_CRU_0_0_0_all        0.0933
## GNS_DEF_100-119_0_0_all  0.0219
## GNS_DEF_90-99_0_0_all    0.2125
```

```
## GNS_DEF_all_0_0_all      7.6440
## GTR_DEF_100-119_0_0_all  6.8676
## GTR_DEF_120-219_0_0_all  1.1323
## GTR_DEF_90-99_0_0_all   26.9658
## GTR_DEF_all_0_0_all      1.7489
## LLS_DEF_0_0_0_all        0.0120
## LLS_FIF_0_0_0_all        0.0418
## MIS_MIS_0_0_0_HC         0.2349
## OTB_CRU_16-31_0_0_all    0.0006
## OTB_CRU_70-99_0_0_all    0.6414
## OTB_DEF_>=120_0_0_all    1.3339
## OTB_DEF_70-99_0_0_all   10.4243
## TBB_CRU_16-31_0_0_all    0.0123
## TBB_DEF_70-99_0_0_all   35.3056
```

5. Proportion of landings by métier, ranked from largest to smallest, together with cumulative sum

```
L_F1<-L_F
L_F1$rank_Total<-L_F1$rank_Total*100
L_F1<-L_F1[rev(order(L_F1$rank_Total)),]
L_F1$cum<-cumsum(L_F1$rank_Total)
format(L_F1,scientific=4,digit=1)

##                         rank_Total                   Fleet cum
## TBB_DEF_70-99_0_0_all      35.3056   TBB_DEF_70-99_0_0_all  35
## GTR_DEF_90-99_0_0_all      26.9658   GTR_DEF_90-99_0_0_all  62
## OTB_DEF_70-99_0_0_all      10.4243   OTB_DEF_70-99_0_0_all  73
## GNS_DEF_all_0_0_all         7.6440     GNS_DEF_all_0_0_all  80
## DRB_all_0_0_all             7.3069         DRB_all_0_0_all  88
## GTR_DEF_100-119_0_0_all     6.8676 GTR_DEF_100-119_0_0_all  95
## GTR_DEF_all_0_0_all         1.7489     GTR_DEF_all_0_0_all  96
## OTB_DEF_>=120_0_0_all       1.3339   OTB_DEF_>=120_0_0_all  98
## GTR_DEF_120-219_0_0_all     1.1323 GTR_DEF_120-219_0_0_all  99
## OTB_CRU_70-99_0_0_all       0.6414   OTB_CRU_70-99_0_0_all  99
## MIS_MIS_0_0_0_HC            0.2349        MIS_MIS_0_0_0_HC 100
## GNS_DEF_90-99_0_0_all       0.2125   GNS_DEF_90-99_0_0_all 100
## FPO_CRU_0_0_0_all           0.0933       FPO_CRU_0_0_0_all 100
## LLS_FIF_0_0_0_all           0.0418       LLS_FIF_0_0_0_all 100
## GNS_DEF_100-119_0_0_all     0.0219 GNS_DEF_100-119_0_0_all 100
## TBB_CRU_16-31_0_0_all       0.0123   TBB_CRU_16-31_0_0_all 100
## LLS_DEF_0_0_0_all           0.0120       LLS_DEF_0_0_0_all 100
## OTB_CRU_16-31_0_0_all       0.0006   OTB_CRU_16-31_0_0_all 100
```

Section B: Age coverage

1. Total proportion of the landings/sampled discards that is covered for age composition

```
Lage_A_tot #(Lwt !Lagesamp / sum(Lwt))

## [1] 0.7890419

Dage_A_tot #(Dwt !Dagesamp / sum(Dwt))

## [1] 0.6546309
```

2. Proportion of landings/sampled discards by area and season that is covered for age composition

```
Lage_AS

##                 1         2         3         4 2009
## 27.7.d 0.6517112 0.7538957 0.7618714 0.6787144    1

Dage_AS

##                  1          2         3         4 2009
## 27.7.d 0.02093534 0.01159468 0.9926101 0.2709315    1
```

3. Proportion of landings/sampled discards in each métier-country stratum that is covered for age composition

```
Lage_FC

##                         Belgium     France Netherlands UK (England)
## DRB_all_0_0_all              NA 0.39072877          NA           NA
## FPO_CRU_0_0_0_all            NA         NA          NA   0.00000000
## GNS_DEF_100-119_0_0_all      NA 0.00000000          NA           NA
## GNS_DEF_90-99_0_0_all        NA 0.06810453          NA           NA
```

```
## GNS_DEF_all_0_0_all           0         NA          NA   1.00000000
## GTR_DEF_100-119_0_0_all      NA 0.28019732          NA           NA
## GTR_DEF_120-219_0_0_all      NA 0.24134349          NA           NA
## GTR_DEF_90-99_0_0_all        NA 1.00000000          NA           NA
## GTR_DEF_all_0_0_all           0 0.32251689          NA   0.00000000
## LLS_DEF_0_0_0_all            NA 0.00000000          NA           NA
## LLS_FIF_0_0_0_all            NA         NA          NA   0.00000000
## MIS_MIS_0_0_0_HC              0 0.51969263          NA   0.05478353
## OTB_CRU_16-31_0_0_all        NA         NA          NA   0.00000000
## OTB_CRU_70-99_0_0_all         0         NA          NA   0.00000000
## OTB_DEF_>=120_0_0_all        NA         NA          NA   0.00000000
## OTB_DEF_70-99_0_0_all        NA 1.00000000           0   0.00000000
## TBB_CRU_16-31_0_0_all         0         NA          NA           NA
## TBB_DEF_70-99_0_0_all         1 0.67607044           0   0.00000000
##                         UK(Northern Ireland) UK(Scotland)
## DRB_all_0_0_all                           NA           NA
## FPO_CRU_0_0_0_all                         NA           NA
## GNS_DEF_100-119_0_0_all                    0           NA
## GNS_DEF_90-99_0_0_all                     NA           NA
## GNS_DEF_all_0_0_all                       NA           NA
## GTR_DEF_100-119_0_0_all                   NA           NA
## GTR_DEF_120-219_0_0_all                   NA           NA
## GTR_DEF_90-99_0_0_all                     NA           NA
## GTR_DEF_all_0_0_all                       NA           NA
## LLS_DEF_0_0_0_all                         NA           NA
## LLS_FIF_0_0_0_all                         NA           NA
## MIS_MIS_0_0_0_HC                          NA           NA
## OTB_CRU_16-31_0_0_all                     NA           NA
## OTB_CRU_70-99_0_0_all                     NA            0
## OTB_DEF_>=120_0_0_all                     NA           NA
## OTB_DEF_70-99_0_0_all                     NA           NA
## TBB_CRU_16-31_0_0_all                     NA           NA
## TBB_DEF_70-99_0_0_all                     NA            0
```

```
Dage_FC #note: proportions shown prior to discard raising
```

```
##                         Belgium    France Netherlands UK (England)
## DRB_all_0_0_all              NA       NaN          NA           NA
## FPO_CRU_0_0_0_all            NA        NA          NA          NaN
## GNS_DEF_100-119_0_0_all      NA       NaN          NA           NA
## GNS_DEF_90-99_0_0_all        NA 0.0000000          NA           NA
## GNS_DEF_all_0_0_all         NaN        NA          NA          NaN
## GTR_DEF_100-119_0_0_all      NA 0.0000000          NA           NA
## GTR_DEF_120-219_0_0_all      NA       NaN          NA           NA
## GTR_DEF_90-99_0_0_all        NA 0.2577103          NA           NA
## GTR_DEF_all_0_0_all         NaN       NaN          NA            1
## LLS_DEF_0_0_0_all            NA       NaN          NA           NA
## LLS_FIF_0_0_0_all            NA        NA          NA          NaN
## MIS_MIS_0_0_0_HC            NaN       NaN          NA          NaN
## OTB_CRU_16-31_0_0_all        NA        NA          NA          NaN
## OTB_CRU_70-99_0_0_all       NaN        NA          NA          NaN
## OTB_DEF_>=120_0_0_all        NA        NA          NA          NaN
## OTB_DEF_70-99_0_0_all        NA 0.4569733         NaN            1
## TBB_CRU_16-31_0_0_all       NaN        NA          NA           NA
## TBB_DEF_70-99_0_0_all         1       NaN         NaN            1
##                         UK(Northern Ireland) UK(Scotland)
## DRB_all_0_0_all                           NA           NA
## FPO_CRU_0_0_0_all                         NA           NA
## GNS_DEF_100-119_0_0_all                  NaN           NA
## GNS_DEF_90-99_0_0_all                     NA           NA
## GNS_DEF_all_0_0_all                       NA           NA
## GTR_DEF_100-119_0_0_all                   NA           NA
## GTR_DEF_120-219_0_0_all                   NA           NA
## GTR_DEF_90-99_0_0_all                     NA           NA
## GTR_DEF_all_0_0_all                       NA           NA
## LLS_DEF_0_0_0_all                         NA           NA
## LLS_FIF_0_0_0_all                         NA           NA
## MIS_MIS_0_0_0_HC                          NA           NA
## OTB_CRU_16-31_0_0_all                     NA           NA
## OTB_CRU_70-99_0_0_all                     NA          NaN
## OTB_DEF_>=120_0_0_all                     NA           NA
## OTB_DEF_70-99_0_0_all                     NA           NA
## TBB_CRU_16-31_0_0_all                     NA           NA
## TBB_DEF_70-99_0_0_all                     NA          NaN
```

Section C: Discard ratio coverage (Lwt !Dwt / sum(Lwt))

1. Total proportion of the landings for which discard weights are available

```
Ldis_A_tot

## [1] 0.6565916
```

2. Proportion of landings for which discard weights are available by area and season

```
Ldis_AS

##                 1         2         3         4 2009
## 27.7.d 0.4684751 0.5236364 0.5771399 0.6275767    1
```

3. Proportion of landings for which discard weights are available in each métier-country stratum

```
Ldis_FC

##                         Belgium     France Netherlands UK (England)
## DRB_all_0_0_all              NA 0.00000000          NA           NA
## FPO_CRU_0_0_0_all            NA         NA          NA    0.0000000
## GNS_DEF_100-119_0_0_all      NA 0.00000000          NA           NA
## GNS_DEF_90-99_0_0_all        NA 0.06810453          NA           NA
## GNS_DEF_all_0_0_all           0         NA          NA    0.0000000
## GTR_DEF_100-119_0_0_all      NA 0.12030015          NA           NA
## GTR_DEF_120-219_0_0_all      NA 0.00000000          NA           NA
## GTR_DEF_90-99_0_0_all        NA 1.00000000          NA           NA
## GTR_DEF_all_0_0_all           0 0.00000000          NA    0.3584045
## LLS_DEF_0_0_0_all            NA 0.00000000          NA           NA
## LLS_FIF_0_0_0_all            NA         NA          NA    0.0000000
## MIS_MIS_0_0_0_HC              0 0.00000000          NA    0.0000000
## OTB_CRU_16-31_0_0_all        NA         NA          NA    0.0000000
## OTB_CRU_70-99_0_0_all         0         NA          NA    0.0000000
## OTB_DEF_>=120_0_0_all        NA         NA          NA    0.0000000
## OTB_DEF_70-99_0_0_all        NA 1.00000000           0    0.6025503
## TBB_CRU_16-31_0_0_all         0         NA          NA           NA
## TBB_DEF_70-99_0_0_all         1 0.00000000           0    0.2656011
##                         UK(Northern Ireland) UK(Scotland)
## DRB_all_0_0_all                           NA           NA
## FPO_CRU_0_0_0_all                         NA           NA
## GNS_DEF_100-119_0_0_all                    0           NA
## GNS_DEF_90-99_0_0_all                     NA           NA
## GNS_DEF_all_0_0_all                       NA           NA
## GTR_DEF_100-119_0_0_all                   NA           NA
## GTR_DEF_120-219_0_0_all                   NA           NA
## GTR_DEF_90-99_0_0_all                     NA           NA
## GTR_DEF_all_0_0_all                       NA           NA
## LLS_DEF_0_0_0_all                         NA           NA
## LLS_FIF_0_0_0_all                         NA           NA
## MIS_MIS_0_0_0_HC                          NA           NA
## OTB_CRU_16-31_0_0_all                     NA           NA
## OTB_CRU_70-99_0_0_all                     NA            0
## OTB_DEF_>=120_0_0_all                     NA           NA
## OTB_DEF_70-99_0_0_all                     NA           NA
## TBB_CRU_16-31_0_0_all                     NA           NA
## TBB_DEF_70-99_0_0_all                     NA            0
```

Section D: Landings age coverage ranked by landed weights

This section shows the proportion of landings covered for age composition, in total (Lage_tot), by métier and for the larger gear groups (Lage_gear). The métiers are ranked by landed weight, so it is easy to check whether the most important métiers have reasonable age coverage for landings. Additionally, the proportion of landings for which discard age coverage is available is presented for the larger gear groups (Dage_gear).

```
Lage_tot<-sum(Lage_AS*L_AS,na.rm=T)/sum(L_AS,na.rm=T)
#(Lage_AS = Lwt !Lagesamp / sum(Lwt); L_AS = Lwt / sum(Lwt))
Lage_tot

## [1] 0.7890419

format(Lage_F_Tot,scientific=4,digit=1) #ranking by L_AS; total by Lage_AS

##                       Fleet Total rank_Total
## 18   TBB_DEF_70-99_0_0_all  0.85   0.353056
```

```
## 8    GTR_DEF_90-99_0_0_all  1.00   0.269658
## 16   OTB_DEF_70-99_0_0_all  0.87   0.104243
## 5      GNS_DEF_all_0_0_all  0.97   0.076440
## 1          DRB_all_0_0_all  0.39   0.073069
## 6  GTR_DEF_100-119_0_0_all  0.28   0.068676
## 9      GTR_DEF_all_0_0_all  0.22   0.017489
## 15   OTB_DEF_>=120_0_0_all  0.00   0.013339
## 7  GTR_DEF_120-219_0_0_all  0.24   0.011323
## 14   OTB_CRU_70-99_0_0_all  0.00   0.006414
## 12        MIS_MIS_0_0_0_HC  0.30   0.002349
## 4    GNS_DEF_90-99_0_0_all  0.07   0.002125
## 2        FPO_CRU_0_0_0_all  0.00   0.000933
## 11       LLS_FIF_0_0_0_all  0.00   0.000418
## 3  GNS_DEF_100-119_0_0_all  0.00   0.000219
## 17   TBB_CRU_16-31_0_0_all  0.00   0.000123
## 10       LLS_DEF_0_0_0_all  0.00   0.000120
## 13   OTB_CRU_16-31_0_0_all  0.00   0.000006

Lage_gear

##       GTR       OTB      REST       TBB
## 0.8284410 0.7280928 0.3804238 0.8496532

Dage_gear

##       GTR       OTB      REST       TBB
## 0.2363103 0.2894237 0.0000000 0.7874434
```

Section E: Discard ratio coverage ranked by landed weight

This section shows the proportion of landings for which discard weights are available, in total (Ldis_tot), by métier and for the larger gear groups (Ldis_gear). The métiers are ranked by landed weight, so it is easy to check whether the most important métiers have reasonable discard ratio coverage.

```
Ldis_tot<-sum(Ldis_AS*L_AS,na.rm=T)/sum(L_AS,na.rm=T)
#(Ldis_AS = Lwt !Dwt / sum(Lwt); L_AS = Lwt / sum(Lwt)
Ldis_tot

## [1] 0.6565916

format(Ldis_F_Tot,scientific=4,digit=1) #ranking by L_AS; total by Ldis_AS

##                       Fleet Total rank_Total
## 18   TBB_DEF_70-99_0_0_all  0.79   0.353056
## 8    GTR_DEF_90-99_0_0_all  1.00   0.269658
## 16   OTB_DEF_70-99_0_0_all  0.95   0.104243
## 5      GNS_DEF_all_0_0_all  0.00   0.076440
## 1          DRB_all_0_0_all  0.00   0.073069
## 6  GTR_DEF_100-119_0_0_all  0.12   0.068676
## 9      GTR_DEF_all_0_0_all  0.10   0.017489
## 15   OTB_DEF_>=120_0_0_all  0.00   0.013339
## 7  GTR_DEF_120-219_0_0_all  0.00   0.011323
## 14   OTB_CRU_70-99_0_0_all  0.00   0.006414
## 12        MIS_MIS_0_0_0_HC  0.00   0.002349
## 4    GNS_DEF_90-99_0_0_all  0.07   0.002125
## 2        FPO_CRU_0_0_0_all  0.00   0.000933
## 11       LLS_FIF_0_0_0_all  0.00   0.000418
## 3  GNS_DEF_100-119_0_0_all  0.00   0.000219
## 17   TBB_CRU_16-31_0_0_all  0.00   0.000123
## 10       LLS_DEF_0_0_0_all  0.00   0.000120
## 13   OTB_CRU_16-31_0_0_all  0.00   0.000006

Ldis_gear

##       GTR       OTB      REST       TBB
## 0.6274595 0.7957917 0.0000000 0.7874434
```

InterCatch input for 2010

This appendix lists 5 sections of tables (A-E) for each InterCatch year (2003-2015). It provides a detailed summary of the InterCatch input data in terms of importance by landed weight and the proportional coverage for age data and discard ratios.

Section A: Importance by landed weight (Lwt / sum(Lwt))

1. Proportion of landings by area and season

```
L_AS*100

##              1        2        3        4     2010
## 27.7.d 18.3292 21.21318 20.48057 10.25061 29.72644
```

2. Proportion of landings by métier and country

```
format(data.frame(L_FC*100),scientific=3,digit=1)

##                           Belgium France Netherlands UK..England.
## DRB_all_0_0_all                NA  4.864          NA           NA
## FPO_CRU_0_0_0_all              NA     NA          NA        0.064
## GNS_DEF_100-119_0_0_all        NA  0.020          NA           NA
## GNS_DEF_90-99_0_0_all          NA  0.048          NA           NA
## GNS_DEF_all_0_0_all       0.14960     NA          NA        8.137
## GTR_DEF_100-119_0_0_all        NA  2.977          NA           NA
## GTR_DEF_120-219_0_0_all        NA  1.569          NA           NA
## GTR_DEF_90-99_0_0_all          NA 25.531          NA           NA
## GTR_DEF_all_0_0_all       0.24473  1.135          NA        0.992
## LLS_DEF_0_0_0_all              NA  0.009          NA           NA
## LLS_FIF_0_0_0_all              NA     NA          NA        0.005
## MIS_MIS_0_0_0_HC          0.01427  0.177          NA        0.484
## OTB_CRU_16-31_0_0_all          NA     NA          NA        0.004
## OTB_CRU_70-99_0_0_all     0.42467     NA          NA        0.004
## OTB_DEF_>=120_0_0_all          NA     NA          NA        1.016
## OTB_DEF_70-99_0_0_all          NA 13.615       0.002        1.741
## SSC_DEF_70-99_0_0_all     0.00007     NA          NA           NA
## TBB_CRU_16-31_0_0_all          NA     NA          NA        0.002
## TBB_DEF_70-99_0_0_all    29.72644  3.534          NA        3.512
##                          UK.Scotland.
## DRB_all_0_0_all                    NA
## FPO_CRU_0_0_0_all                  NA
## GNS_DEF_100-119_0_0_all            NA
## GNS_DEF_90-99_0_0_all              NA
## GNS_DEF_all_0_0_all                NA
## GTR_DEF_100-119_0_0_all            NA
## GTR_DEF_120-219_0_0_all            NA
## GTR_DEF_90-99_0_0_all              NA
## GTR_DEF_all_0_0_all                NA
## LLS_DEF_0_0_0_all                  NA
## LLS_FIF_0_0_0_all                  NA
## MIS_MIS_0_0_0_HC                   NA
## OTB_CRU_16-31_0_0_all              NA
## OTB_CRU_70-99_0_0_all         0.00002
## OTB_DEF_>=120_0_0_all              NA
## OTB_DEF_70-99_0_0_all              NA
## SSC_DEF_70-99_0_0_all              NA
## TBB_CRU_16-31_0_0_all              NA
## TBB_DEF_70-99_0_0_all              NA
```

3. Proportion of landings by country

```
apply(L_FC*100,2,function(x) sum(x,na.rm=T))

##      Belgium       France  Netherlands UK (England) UK(Scotland)
## 3.055978e+01 5.347743e+01 2.038090e-03 1.596072e+01 2.342633e-05
```

4. Proportion of landings by fleet and area

```
format(data.frame(L_FA*100),scientific=4,digit=1)

##                           X27.7.d
## DRB_all_0_0_all           4.86401
## FPO_CRU_0_0_0_all         0.06406
## GNS_DEF_100-119_0_0_all   0.01964
## GNS_DEF_90-99_0_0_all     0.04763
```

```
## GNS_DEF_all_0_0_all      8.28655
## GTR_DEF_100-119_0_0_all  2.97718
## GTR_DEF_120-219_0_0_all  1.56872
## GTR_DEF_90-99_0_0_all   25.53067
## GTR_DEF_all_0_0_all      2.37167
## LLS_DEF_0_0_0_all        0.00937
## LLS_FIF_0_0_0_all        0.00456
## MIS_MIS_0_0_0_HC         0.67550
## OTB_CRU_16-31_0_0_all    0.00380
## OTB_CRU_70-99_0_0_all    0.42875
## OTB_DEF_>=120_0_0_all    1.01570
## OTB_DEF_70-99_0_0_all   15.35815
## SSC_DEF_70-99_0_0_all    0.00007
## TBB_CRU_16-31_0_0_all    0.00163
## TBB_DEF_70-99_0_0_all   36.77234
```

5. Proportion of landings by métier, ranked from largest to smallest, together with cumulative sum

```
L_F1<-L_F
L_F1$rank_Total<-L_F1$rank_Total*100
L_F1<-L_F1[rev(order(L_F1$rank_Total)),]
L_F1$cum<-cumsum(L_F1$rank_Total)
format(L_F1,scientific=4,digit=1)

##                         rank_Total                   Fleet cum
## TBB_DEF_70-99_0_0_all     36.77234   TBB_DEF_70-99_0_0_all  37
## GTR_DEF_90-99_0_0_all     25.53067   GTR_DEF_90-99_0_0_all  62
## OTB_DEF_70-99_0_0_all     15.35815   OTB_DEF_70-99_0_0_all  78
## GNS_DEF_all_0_0_all        8.28655     GNS_DEF_all_0_0_all  86
## DRB_all_0_0_all            4.86401         DRB_all_0_0_all  91
## GTR_DEF_100-119_0_0_all    2.97718 GTR_DEF_100-119_0_0_all  94
## GTR_DEF_all_0_0_all        2.37167     GTR_DEF_all_0_0_all  96
## GTR_DEF_120-219_0_0_all    1.56872 GTR_DEF_120-219_0_0_all  98
## OTB_DEF_>=120_0_0_all      1.01570   OTB_DEF_>=120_0_0_all  99
## MIS_MIS_0_0_0_HC           0.67550        MIS_MIS_0_0_0_HC  99
## OTB_CRU_70-99_0_0_all      0.42875   OTB_CRU_70-99_0_0_all 100
## FPO_CRU_0_0_0_all          0.06406       FPO_CRU_0_0_0_all 100
## GNS_DEF_90-99_0_0_all      0.04763   GNS_DEF_90-99_0_0_all 100
## GNS_DEF_100-119_0_0_all    0.01964 GNS_DEF_100-119_0_0_all 100
## LLS_DEF_0_0_0_all          0.00937       LLS_DEF_0_0_0_all 100
## LLS_FIF_0_0_0_all          0.00456       LLS_FIF_0_0_0_all 100
## OTB_CRU_16-31_0_0_all      0.00380   OTB_CRU_16-31_0_0_all 100
## TBB_CRU_16-31_0_0_all      0.00163   TBB_CRU_16-31_0_0_all 100
## SSC_DEF_70-99_0_0_all      0.00007   SSC_DEF_70-99_0_0_all 100
```

Section B: Age coverage

1. Total proportion of the landings/sampled discards that is covered for age composition

```
Lage_A_tot #(Lwt !Lagesamp / sum(Lwt))

## [1] 0.7910655

Dage_A_tot #(Dwt !Dagesamp / sum(Dwt))

## [1] 0.7995202
```

2. Proportion of landings/sampled discards by area and season that is covered for age composition

```
Lage_AS

##                1         2         3         4 2010
## 27.7.d 0.819202 0.6717243 0.6884592 0.5868279    1

Dage_AS

##        1         2         3         4 2010
## 27.7.d 1 0.1043692 0.9965665 0.2520408    1
```

3. Proportion of landings/sampled discards in each métier-country stratum that is covered for age composition

```
Lage_FC

##                         Belgium     France Netherlands UK (England)
## DRB_all_0_0_all              NA 0.00000000          NA           NA
## FPO_CRU_0_0_0_all            NA         NA          NA  0.000000000
```

```
## GNS_DEF_100-119_0_0_all      NA 0.00000000          NA           NA
## GNS_DEF_90-99_0_0_all        NA 0.00000000          NA           NA
## GNS_DEF_all_0_0_all           0         NA          NA  1.000000000
## GTR_DEF_100-119_0_0_all      NA 0.08738842          NA           NA
## GTR_DEF_120-219_0_0_all      NA 0.26484490          NA           NA
## GTR_DEF_90-99_0_0_all        NA 1.00000000          NA           NA
## GTR_DEF_all_0_0_all           0 0.00000000          NA  0.000000000
## LLS_DEF_0_0_0_all            NA 0.00000000          NA           NA
## LLS_FIF_0_0_0_all            NA         NA          NA  0.000000000
## MIS_MIS_0_0_0_HC              0 0.00000000          NA  0.003824989
## OTB_CRU_16-31_0_0_all        NA         NA          NA  0.000000000
## OTB_CRU_70-99_0_0_all         0         NA          NA  0.000000000
## OTB_DEF_>=120_0_0_all        NA         NA          NA  0.000000000
## OTB_DEF_70-99_0_0_all        NA 1.00000000           0  0.000000000
## SSC_DEF_70-99_0_0_all         0         NA          NA           NA
## TBB_CRU_16-31_0_0_all        NA         NA          NA  0.000000000
## TBB_DEF_70-99_0_0_all         1 0.40190544          NA  0.000000000
##                         UK(Scotland)
## DRB_all_0_0_all                    NA
## FPO_CRU_0_0_0_all                  NA
## GNS_DEF_100-119_0_0_all            NA
## GNS_DEF_90-99_0_0_all              NA
## GNS_DEF_all_0_0_all                NA
## GTR_DEF_100-119_0_0_all            NA
## GTR_DEF_120-219_0_0_all            NA
## GTR_DEF_90-99_0_0_all              NA
## GTR_DEF_all_0_0_all                NA
## LLS_DEF_0_0_0_all                  NA
## LLS_FIF_0_0_0_all                  NA
## MIS_MIS_0_0_0_HC                   NA
## OTB_CRU_16-31_0_0_all              NA
## OTB_CRU_70-99_0_0_all               0
## OTB_DEF_>=120_0_0_all              NA
## OTB_DEF_70-99_0_0_all              NA
## SSC_DEF_70-99_0_0_all              NA
## TBB_CRU_16-31_0_0_all              NA
## TBB_DEF_70-99_0_0_all              NA
```

```
Dage_FC #note: proportions shown prior to discard raising
```

```
##                         Belgium    France Netherlands UK (England)
## DRB_all_0_0_all              NA       NaN          NA           NA
## FPO_CRU_0_0_0_all            NA        NA          NA          NaN
## GNS_DEF_100-119_0_0_all      NA       NaN          NA           NA
## GNS_DEF_90-99_0_0_all        NA       NaN          NA           NA
## GNS_DEF_all_0_0_all         NaN        NA          NA            1
## GTR_DEF_100-119_0_0_all      NA       NaN          NA           NA
## GTR_DEF_120-219_0_0_all      NA 0.0000000          NA           NA
## GTR_DEF_90-99_0_0_all        NA 0.3530415          NA           NA
## GTR_DEF_all_0_0_all         NaN       NaN          NA            1
## LLS_DEF_0_0_0_all            NA       NaN          NA           NA
## LLS_FIF_0_0_0_all            NA        NA          NA          NaN
## MIS_MIS_0_0_0_HC            NaN       NaN          NA          NaN
## OTB_CRU_16-31_0_0_all        NA        NA          NA          NaN
## OTB_CRU_70-99_0_0_all       NaN        NA          NA          NaN
## OTB_DEF_>=120_0_0_all        NA        NA          NA          NaN
## OTB_DEF_70-99_0_0_all        NA 0.6241327         NaN            1
## SSC_DEF_70-99_0_0_all       NaN        NA          NA           NA
## TBB_CRU_16-31_0_0_all        NA        NA          NA          NaN
## TBB_DEF_70-99_0_0_all         1       NaN          NA            1
##                         UK(Scotland)
## DRB_all_0_0_all                    NA
## FPO_CRU_0_0_0_all                  NA
## GNS_DEF_100-119_0_0_all            NA
## GNS_DEF_90-99_0_0_all              NA
## GNS_DEF_all_0_0_all                NA
## GTR_DEF_100-119_0_0_all            NA
## GTR_DEF_120-219_0_0_all            NA
## GTR_DEF_90-99_0_0_all              NA
## GTR_DEF_all_0_0_all                NA
## LLS_DEF_0_0_0_all                  NA
## LLS_FIF_0_0_0_all                  NA
## MIS_MIS_0_0_0_HC                   NA
## OTB_CRU_16-31_0_0_all              NA
```

```
## OTB_CRU_70-99_0_0_all            NaN
## OTB_DEF_>=120_0_0_all             NA
## OTB_DEF_70-99_0_0_all             NA
## SSC_DEF_70-99_0_0_all             NA
## TBB_CRU_16-31_0_0_all             NA
## TBB_DEF_70-99_0_0_all             NA
```

Section C: Discard ratio coverage (Lwt !Dwt / sum(Lwt))

1. Total proportion of the landings for which discard weights are available

```
Ldis_A_tot

## [1] 0.7626024
```

2. Proportion of landings for which discard weights are available by area and season

```
Ldis_AS

##                 1        2         3        4 2010
## 27.7.d 0.6793945 0.583186 0.7557904 0.607846    1
```

3. Proportion of landings for which discard weights are available in each métier-country stratum

```
Ldis_FC

##                         Belgium   France Netherlands UK (England)
## DRB_all_0_0_all              NA 0.000000          NA           NA
## FPO_CRU_0_0_0_all            NA       NA          NA    0.0000000
## GNS_DEF_100-119_0_0_all      NA 0.000000          NA           NA
## GNS_DEF_90-99_0_0_all        NA 0.000000          NA           NA
## GNS_DEF_all_0_0_all           0       NA          NA    0.3674359
## GTR_DEF_100-119_0_0_all      NA 0.000000          NA           NA
## GTR_DEF_120-219_0_0_all      NA 0.398282          NA           NA
## GTR_DEF_90-99_0_0_all        NA 1.000000          NA           NA
## GTR_DEF_all_0_0_all           0 0.000000          NA    0.2767122
## LLS_DEF_0_0_0_all            NA 0.000000          NA           NA
## LLS_FIF_0_0_0_all            NA       NA          NA    0.0000000
## MIS_MIS_0_0_0_HC              0 0.000000          NA    0.0000000
## OTB_CRU_16-31_0_0_all        NA       NA          NA    0.0000000
## OTB_CRU_70-99_0_0_all         0       NA          NA    0.0000000
## OTB_DEF_>=120_0_0_all        NA       NA          NA    0.0000000
## OTB_DEF_70-99_0_0_all        NA 1.000000           0    0.3039984
## SSC_DEF_70-99_0_0_all         0       NA          NA           NA
## TBB_CRU_16-31_0_0_all        NA       NA          NA    0.0000000
## TBB_DEF_70-99_0_0_all         1 0.000000          NA    0.8456339
##                         UK(Scotland)
## DRB_all_0_0_all                   NA
## FPO_CRU_0_0_0_all                 NA
## GNS_DEF_100-119_0_0_all           NA
## GNS_DEF_90-99_0_0_all             NA
## GNS_DEF_all_0_0_all               NA
## GTR_DEF_100-119_0_0_all           NA
## GTR_DEF_120-219_0_0_all           NA
## GTR_DEF_90-99_0_0_all             NA
## GTR_DEF_all_0_0_all               NA
## LLS_DEF_0_0_0_all                 NA
## LLS_FIF_0_0_0_all                 NA
## MIS_MIS_0_0_0_HC                  NA
## OTB_CRU_16-31_0_0_all             NA
## OTB_CRU_70-99_0_0_all              0
## OTB_DEF_>=120_0_0_all             NA
## OTB_DEF_70-99_0_0_all             NA
## SSC_DEF_70-99_0_0_all             NA
## TBB_CRU_16-31_0_0_all             NA
## TBB_DEF_70-99_0_0_all             NA
```

Section D: Landings age coverage ranked by landed weights

This section shows the proportion of landings covered for age composition, in total (Lage_tot), by métier and for the larger gear groups (Lage_gear). The métiers are ranked by landed weight, so it is easy to check whether the most important métiers have reasonable age coverage for landings. Additionally, the proportion of landings for which discard age coverage is available is presented for the larger gear groups (Dage_gear).

```
Lage_tot<-sum(Lage_AS*L_AS,na.rm=T)/sum(L_AS,na.rm=T)
#(Lage_AS = Lwt !Lagesamp / sum(Lwt); L_AS = Lwt / sum(Lwt))
Lage_tot

## [1] 0.7910655

format(Lage_F_Tot,scientific=4,digit=1) #ranking by L_AS; total by Lage_AS

##                       Fleet Total rank_Total
## 19   TBB_DEF_70-99_0_0_all 0.847  0.3677234
## 8    GTR_DEF_90-99_0_0_all 1.000  0.2553067
## 16   OTB_DEF_70-99_0_0_all 0.886  0.1535815
## 5      GNS_DEF_all_0_0_all 0.982  0.0828655
## 1          DRB_all_0_0_all 0.000  0.0486401
## 6  GTR_DEF_100-119_0_0_all 0.087  0.0297718
## 9      GTR_DEF_all_0_0_all 0.000  0.0237167
## 7  GTR_DEF_120-219_0_0_all 0.265  0.0156872
## 15   OTB_DEF_>=120_0_0_all 0.000  0.0101570
## 12         MIS_MIS_0_0_0_HC 0.003  0.0067550
## 14   OTB_CRU_70-99_0_0_all 0.000  0.0042875
## 2        FPO_CRU_0_0_0_all 0.000  0.0006406
## 4    GNS_DEF_90-99_0_0_all 0.000  0.0004763
## 3  GNS_DEF_100-119_0_0_all 0.000  0.0001964
## 10       LLS_DEF_0_0_0_all 0.000  0.0000937
## 11       LLS_FIF_0_0_0_all 0.000  0.0000456
## 13   OTB_CRU_16-31_0_0_all 0.000  0.0000380
## 18   TBB_CRU_16-31_0_0_all 0.000  0.0000163
## 17   SSC_DEF_70-99_0_0_all 0.000  0.0000007

Lage_gear

##          GTR          OTB          REST          TBB
## 0.8417040964 0.8100880245 0.0003298659 0.8469771951

Dage_gear

##       GTR       OTB      REST       TBB
## 0.3674821 0.5139120 0.0000000 0.8891166
```

Section E: Discard ratio coverage ranked by landed weight

This section shows the proportion of landings for which discard weights are available, in total (Ldis_tot), by métier and for the larger gear groups (Ldis_gear). The métiers are ranked by landed weight, so it is easy to check whether the most important métiers have reasonable discard ratio coverage.

```
Ldis_tot<-sum(Ldis_AS*L_AS,na.rm=T)/sum(L_AS,na.rm=T)
#(Ldis_AS = Lwt !Dwt / sum(Lwt); L_AS = Lwt / sum(Lwt)
Ldis_tot
## [1] 0.7626024
format(Ldis_F_Tot,scientific=4,digit=1) #ranking by L_AS; total by Ldis_AS
##                       Fleet Total rank_Total
## 19   TBB_DEF_70-99_0_0_all   0.9  0.3677234
## 8    GTR_DEF_90-99_0_0_all   1.0  0.2553067
## 16   OTB_DEF_70-99_0_0_all   0.9  0.1535815
## 5      GNS_DEF_all_0_0_all   0.4  0.0828655
## 1          DRB_all_0_0_all   0.0  0.0486401
## 6  GTR_DEF_100-119_0_0_all   0.0  0.0297718
## 9      GTR_DEF_all_0_0_all   0.1  0.0237167
## 7  GTR_DEF_120-219_0_0_all   0.4  0.0156872
## 15   OTB_DEF_>=120_0_0_all   0.0  0.0101570
## 12         MIS_MIS_0_0_0_HC   0.0  0.0067550
## 14   OTB_CRU_70-99_0_0_all   0.0  0.0042875
## 2        FPO_CRU_0_0_0_all   0.0  0.0006406
## 4    GNS_DEF_90-99_0_0_all   0.0  0.0004763
## 3  GNS_DEF_100-119_0_0_all   0.0  0.0001964
## 10       LLS_DEF_0_0_0_all   0.0  0.0000937
## 11       LLS_FIF_0_0_0_all   0.0  0.0000456
## 13   OTB_CRU_16-31_0_0_all   0.0  0.0000380
## 18   TBB_CRU_16-31_0_0_all   0.0  0.0000163
## 17   SSC_DEF_70-99_0_0_all   0.0  0.0000007
Ldis_gear
##       GTR       OTB      REST       TBB
## 0.7210369 0.8415865 0.0000000 0.8891166
```

InterCatch input for 2011

This appendix lists 5 sections of tables (A-E) for each InterCatch year (2003-2015). It provides a detailed summary of the InterCatch input data in terms of importance by landed weight and the proportional coverage for age data and discard ratios.

Section A: Importance by landed weight (Lwt / sum(Lwt))

1. Proportion of landings by area and season

```
L_AS*100

##               1        2        3        4     2011
## 27.7.d 19.32886 19.45257 20.67008 12.68051 27.86798
```

2. Proportion of landings by métier and country

```
format(data.frame(L_FC*100),scientific=3,digit=1)

##                          Belgium France Netherlands UK..England.
## DRB_all_0_0_all               NA  3.339          NA           NA
## FPO_CRU_0_0_0_all             NA     NA          NA       0.1433
## GNS_DEF_100-119_0_0_all       NA  0.050          NA           NA
## GNS_DEF_90-99_0_0_all         NA  0.085          NA           NA
## GNS_DEF_all_0_0_all           NA     NA          NA       7.3320
## GTR_DEF_100-119_0_0_all       NA  3.495          NA           NA
## GTR_DEF_120-219_0_0_all       NA  1.571          NA           NA
## GTR_DEF_90-99_0_0_all         NA 27.612          NA           NA
## GTR_DEF_all_0_0_all         0.84  1.165          NA       3.1716
## LLS_DEF_0_0_0_all             NA  0.001          NA           NA
## LLS_FIF_0_0_0_all             NA     NA          NA       0.0188
## MIS_MIS_0_0_0_HC            0.03  0.247       0.003       0.2730
## OTB_CRU_16-31_0_0_all         NA     NA          NA       0.0004
## OTB_CRU_70-99_0_0_all       0.18     NA          NA       0.0197
## OTB_DEF_>=120_0_0_all         NA     NA          NA       0.8777
## OTB_DEF_70-99_0_0_all         NA 13.446          NA       2.4632
## SSC_DEF_>=120_0_0_all         NA     NA          NA       0.0015
## SSC_DEF_70-99_0_0_all       0.02     NA          NA           NA
## TBB_CRU_16-31_0_0_all         NA     NA          NA       0.0004
## TBB_DEF_70-99_0_0_all      27.87  3.493          NA       2.2517
```

3. Proportion of landings by country

```
apply(L_FC*100,2,function(x) sum(x,na.rm=T))

##      Belgium       France  Netherlands UK (England)
## 28.941021797 54.503199418  0.002532541 16.553246245
```

4. Proportion of landings by fleet and area

```
format(data.frame(L_FA*100),scientific=4,digit=1)

##                          X27.7.d
## DRB_all_0_0_all           3.3388
## FPO_CRU_0_0_0_all         0.1433
## GNS_DEF_100-119_0_0_all   0.0497
## GNS_DEF_90-99_0_0_all     0.0853
## GNS_DEF_all_0_0_all       7.3320
## GTR_DEF_100-119_0_0_all   3.4947
## GTR_DEF_120-219_0_0_all   1.5709
## GTR_DEF_90-99_0_0_all    27.6118
## GTR_DEF_all_0_0_all       5.1798
## LLS_DEF_0_0_0_all         0.0015
## LLS_FIF_0_0_0_all         0.0188
## MIS_MIS_0_0_0_HC          0.5505
## OTB_CRU_16-31_0_0_all     0.0004
## OTB_CRU_70-99_0_0_all     0.1967
## OTB_DEF_>=120_0_0_all     0.8777
## OTB_DEF_70-99_0_0_all    15.9092
## SSC_DEF_>=120_0_0_all     0.0015
## SSC_DEF_70-99_0_0_all     0.0247
## TBB_CRU_16-31_0_0_all     0.0004
## TBB_DEF_70-99_0_0_all    33.6124
```

5. Proportion of landings by métier, ranked from largest to smallest, together with cumulative sum

```
L_F1<-L_F
L_F1$rank_Total<-L_F1$rank_Total*100
L_F1<-L_F1[rev(order(L_F1$rank_Total)),]
L_F1$cum<-cumsum(L_F1$rank_Total)
format(L_F1,scientific=4,digit=1)

##                         rank_Total                   Fleet cum
## TBB_DEF_70-99_0_0_all      33.6124   TBB_DEF_70-99_0_0_all  34
## GTR_DEF_90-99_0_0_all      27.6118   GTR_DEF_90-99_0_0_all  61
## OTB_DEF_70-99_0_0_all      15.9092   OTB_DEF_70-99_0_0_all  77
## GNS_DEF_all_0_0_all         7.3320     GNS_DEF_all_0_0_all  84
## GTR_DEF_all_0_0_all         5.1798     GTR_DEF_all_0_0_all  90
## GTR_DEF_100-119_0_0_all     3.4947 GTR_DEF_100-119_0_0_all  93
## DRB_all_0_0_all             3.3388         DRB_all_0_0_all  96
## GTR_DEF_120-219_0_0_all     1.5709 GTR_DEF_120-219_0_0_all  98
## OTB_DEF_>=120_0_0_all       0.8777   OTB_DEF_>=120_0_0_all  99
## MIS_MIS_0_0_0_HC            0.5505        MIS_MIS_0_0_0_HC  99
## OTB_CRU_70-99_0_0_all       0.1967   OTB_CRU_70-99_0_0_all 100
## FPO_CRU_0_0_0_all           0.1433       FPO_CRU_0_0_0_all 100
## GNS_DEF_90-99_0_0_all       0.0853   GNS_DEF_90-99_0_0_all 100
## GNS_DEF_100-119_0_0_all     0.0497 GNS_DEF_100-119_0_0_all 100
## SSC_DEF_70-99_0_0_all       0.0247   SSC_DEF_70-99_0_0_all 100
## LLS_FIF_0_0_0_all           0.0188       LLS_FIF_0_0_0_all 100
## SSC_DEF_>=120_0_0_all       0.0015   SSC_DEF_>=120_0_0_all 100
## LLS_DEF_0_0_0_all           0.0015       LLS_DEF_0_0_0_all 100
## TBB_CRU_16-31_0_0_all       0.0004   TBB_CRU_16-31_0_0_all 100
## OTB_CRU_16-31_0_0_all       0.0004   OTB_CRU_16-31_0_0_all 100
```

Section B: Age coverage

1. Total proportion of the landings/sampled discards that is covered for age composition

```
Lage_A_tot #(Lwt !Lagesamp / sum(Lwt))

## [1] 0.7932616

Dage_A_tot #(Dwt !Dagesamp / sum(Dwt))

## [1] 0.6950096
```

2. Proportion of landings/sampled discards by area and season that is covered for age composition

```
Lage_AS

##                 1         2         3         4 2011
## 27.7.d 0.7889757 0.6873656 0.6857274 0.6831831    1

Dage_AS

##                 1         2         3         4 2011
## 27.7.d 0.5888802 0.9987193 0.1924394 0.1443697    1
```

3. Proportion of landings/sampled discards in each métier-country stratum that is covered for age composition

```
Lage_FC

##                         Belgium    France Netherlands UK (England)
## DRB_all_0_0_all              NA 0.3077977          NA           NA
## FPO_CRU_0_0_0_all            NA        NA          NA    0.0000000
## GNS_DEF_100-119_0_0_all      NA 0.0000000          NA           NA
## GNS_DEF_90-99_0_0_all        NA 0.0000000          NA           NA
## GNS_DEF_all_0_0_all          NA        NA          NA    1.0000000
## GTR_DEF_100-119_0_0_all      NA 0.5195439          NA           NA
## GTR_DEF_120-219_0_0_all      NA 0.0000000          NA           NA
## GTR_DEF_90-99_0_0_all        NA 1.0000000          NA           NA
## GTR_DEF_all_0_0_all           0 0.0000000          NA    0.0000000
## LLS_DEF_0_0_0_all            NA 0.0000000          NA           NA
## LLS_FIF_0_0_0_all            NA        NA          NA    0.0000000
## MIS_MIS_0_0_0_HC              0 0.0000000           0    0.8248444
## OTB_CRU_16-31_0_0_all        NA        NA          NA    0.0000000
## OTB_CRU_70-99_0_0_all         0        NA          NA    0.0000000
## OTB_DEF_>=120_0_0_all        NA        NA          NA    0.0000000
## OTB_DEF_70-99_0_0_all        NA 1.0000000          NA    0.0000000
## SSC_DEF_>=120_0_0_all        NA        NA          NA    0.0000000
## SSC_DEF_70-99_0_0_all         0        NA          NA           NA
```

```
## TBB_CRU_16-31_0_0_all        NA        NA           NA    0.0000000
## TBB_DEF_70-99_0_0_all         1 0.0000000           NA    0.0000000
```

```
Dage_FC #note: proportions shown prior to discard raising
```

```
##                         Belgium  France Netherlands UK (England)
## DRB_all_0_0_all              NA     NaN          NA           NA
## FPO_CRU_0_0_0_all            NA      NA          NA          NaN
## GNS_DEF_100-119_0_0_all      NA     NaN          NA           NA
## GNS_DEF_90-99_0_0_all        NA     NaN          NA           NA
## GNS_DEF_all_0_0_all          NA      NA          NA            1
## GTR_DEF_100-119_0_0_all      NA 0.00000          NA           NA
## GTR_DEF_120-219_0_0_all      NA 0.00000          NA           NA
## GTR_DEF_90-99_0_0_all        NA 1.00000          NA           NA
## GTR_DEF_all_0_0_all         NaN     NaN          NA            1
## LLS_DEF_0_0_0_all            NA     NaN          NA           NA
## LLS_FIF_0_0_0_all            NA      NA          NA          NaN
## MIS_MIS_0_0_0_HC            NaN     NaN         NaN            1
## OTB_CRU_16-31_0_0_all        NA      NA          NA          NaN
## OTB_CRU_70-99_0_0_all       NaN      NA          NA          NaN
## OTB_DEF_>=120_0_0_all        NA      NA          NA          NaN
## OTB_DEF_70-99_0_0_all        NA 0.53125          NA            1
## SSC_DEF_>=120_0_0_all        NA      NA          NA          NaN
## SSC_DEF_70-99_0_0_all       NaN      NA          NA           NA
## TBB_CRU_16-31_0_0_all        NA      NA          NA          NaN
## TBB_DEF_70-99_0_0_all         1     NaN          NA            1
```

Section C: Discard ratio coverage (Lwt !Dwt / sum(Lwt))

1. Total proportion of the landings for which discard weights are available

```
Ldis_A_tot

## [1] 0.651785
```

2. Proportion of landings for which discard weights are available by area and season

```
Ldis_AS

##                  1        2         3        4 2011
## 27.7.d 0.07690282 0.564629 0.7334173 0.763439    1
```

3. Proportion of landings for which discard weights are available in each métier-country stratum

```
Ldis_FC

##                         Belgium    France Netherlands UK (England)
## DRB_all_0_0_all              NA 0.0000000          NA           NA
## FPO_CRU_0_0_0_all            NA        NA          NA    0.0000000
## GNS_DEF_100-119_0_0_all      NA 0.0000000          NA           NA
## GNS_DEF_90-99_0_0_all        NA 0.0000000          NA           NA
## GNS_DEF_all_0_0_all          NA        NA          NA    0.4628343
## GTR_DEF_100-119_0_0_all      NA 0.3406550          NA           NA
## GTR_DEF_120-219_0_0_all      NA 0.2159227          NA           NA
## GTR_DEF_90-99_0_0_all        NA 0.5721911          NA           NA
## GTR_DEF_all_0_0_all           0 0.0000000          NA    0.2517577
## LLS_DEF_0_0_0_all            NA 0.0000000          NA           NA
## LLS_FIF_0_0_0_all            NA        NA          NA    0.0000000
## MIS_MIS_0_0_0_HC              0 0.0000000           0    0.2197596
## OTB_CRU_16-31_0_0_all        NA        NA          NA    0.0000000
## OTB_CRU_70-99_0_0_all         0        NA          NA    0.0000000
## OTB_DEF_>=120_0_0_all        NA        NA          NA    0.0000000
## OTB_DEF_70-99_0_0_all        NA 1.0000000          NA    0.7301784
## SSC_DEF_>=120_0_0_all        NA        NA          NA    0.0000000
## SSC_DEF_70-99_0_0_all         0        NA          NA           NA
## TBB_CRU_16-31_0_0_all        NA        NA          NA    0.0000000
## TBB_DEF_70-99_0_0_all         1 0.0000000          NA    0.2154452
```

Section D: Landings age coverage ranked by landed weights

This section shows the proportion of landings covered for age composition, in total (Lage_tot), by métier and for the larger gear groups (Lage_gear). The métiers are ranked by landed weight, so it is easy to check whether the most important métiers have reasonable age coverage for landings. Additionally, the proportion of landings for which discard age coverage is available is presented for the larger gear groups (Dage_gear).

```
Lage_tot<-sum(Lage_AS*L_AS,na.rm=T)/sum(L_AS,na.rm=T)
#(Lage_AS = Lwt !Lagesamp / sum(Lwt); L_AS = Lwt / sum(Lwt))
Lage_tot
## [1] 0.7932616

format(Lage_F_Tot,scientific=4,digit=1) #ranking by L_AS; total by Lage_AS
##                       Fleet Total rank_Total
## 20   TBB_DEF_70-99_0_0_all   0.8   0.336124
## 8    GTR_DEF_90-99_0_0_all   1.0   0.276118
## 16   OTB_DEF_70-99_0_0_all   0.8   0.159092
## 5      GNS_DEF_all_0_0_all   1.0   0.073320
## 9      GTR_DEF_all_0_0_all   0.0   0.051798
## 6  GTR_DEF_100-119_0_0_all   0.5   0.034947
## 1          DRB_all_0_0_all   0.3   0.033388
## 7  GTR_DEF_120-219_0_0_all   0.0   0.015709
## 15   OTB_DEF_>=120_0_0_all   0.0   0.008777
## 12        MIS_MIS_0_0_0_HC   0.4   0.005505
## 14   OTB_CRU_70-99_0_0_all   0.0   0.001967
## 2        FPO_CRU_0_0_0_all   0.0   0.001433
## 4    GNS_DEF_90-99_0_0_all   0.0   0.000853
## 3  GNS_DEF_100-119_0_0_all   0.0   0.000497
## 18   SSC_DEF_70-99_0_0_all   0.0   0.000247
## 11       LLS_FIF_0_0_0_all   0.0   0.000188
## 17   SSC_DEF_>=120_0_0_all   0.0   0.000015
## 10       LLS_DEF_0_0_0_all   0.0   0.000015
## 19   TBB_CRU_16-31_0_0_all   0.0   0.000004
## 13   OTB_CRU_16-31_0_0_all   0.0   0.000004

Lage_gear
##       GTR       OTB      REST       TBB
## 0.8110315 0.7904656 0.3091262 0.8290881

Dage_gear
##        GTR        OTB       REST        TBB
## 0.44107000 0.33545825 0.01480125 0.84352074
```

Section E: Discard ratio coverage ranked by landed weight

This section shows the proportion of landings for which discard weights are available, in total (Ldis_tot), by métier and for the larger gear groups (Ldis_gear). The métiers are ranked by landed weight, so it is easy to check whether the most important métiers have reasonable discard ratio coverage.

```
Ldis_tot<-sum(Ldis_AS*L_AS,na.rm=T)/sum(L_AS,na.rm=T)
#(Ldis_AS = Lwt !Dwt / sum(Lwt); L_AS = Lwt / sum(Lwt)
Ldis_tot
## [1] 0.651785

format(Ldis_F_Tot,scientific=4,digit=1) #ranking by L_AS; total by Ldis_AS
##                       Fleet Total rank_Total
## 20   TBB_DEF_70-99_0_0_all   0.8   0.336124
## 8    GTR_DEF_90-99_0_0_all   0.6   0.276118
## 16   OTB_DEF_70-99_0_0_all   1.0   0.159092
## 5      GNS_DEF_all_0_0_all   0.5   0.073320
## 9      GTR_DEF_all_0_0_all   0.2   0.051798
## 6  GTR_DEF_100-119_0_0_all   0.3   0.034947
## 1          DRB_all_0_0_all   0.0   0.033388
## 7  GTR_DEF_120-219_0_0_all   0.2   0.015709
## 15   OTB_DEF_>=120_0_0_all   0.0   0.008777
## 12        MIS_MIS_0_0_0_HC   0.1   0.005505
## 14   OTB_CRU_70-99_0_0_all   0.0   0.001967
## 2        FPO_CRU_0_0_0_all   0.0   0.001433
## 4    GNS_DEF_90-99_0_0_all   0.0   0.000853
## 3  GNS_DEF_100-119_0_0_all   0.0   0.000497
## 18   SSC_DEF_70-99_0_0_all   0.0   0.000247
## 11       LLS_FIF_0_0_0_all   0.0   0.000188
## 17   SSC_DEF_>=120_0_0_all   0.0   0.000015
## 10       LLS_DEF_0_0_0_all   0.0   0.000015
## 19   TBB_CRU_16-31_0_0_all   0.0   0.000004
## 13   OTB_CRU_16-31_0_0_all   0.0   0.000004

Ldis_gear
##        GTR        OTB       REST        TBB
## 0.47481981 0.89620292 0.01480125 0.84352074
```

InterCatch input for 2012

This appendix lists 5 sections of tables (A-E) for each InterCatch year (2003-2015). It provides a detailed summary of the InterCatch input data in terms of importance by landed weight and the proportional coverage for age data and discard ratios.

Section A: Importance by landed weight (Lwt / sum(Lwt))

1. Proportion of landings by area and season

```
L_AS*100

##               1        2        3        4     2012
## 27.7.d 23.22743 21.46867 22.96887 10.71969 21.61534
```

2. Proportion of landings by métier and country

```
format(data.frame(L_FC*100),scientific=3,digit=1)

##                           Belgium  France Netherlands UK..England.
## DRB_all_0_0_all                NA  4.1264          NA           NA
## FPO_CRU_0_0_0_all              NA      NA          NA       0.0129
## GNS_DEF_100-119_0_0_all        NA  0.0486          NA           NA
## GNS_DEF_90-99_0_0_all          NA  0.0881          NA           NA
## GNS_DEF_all_0_0_all            NA      NA          NA       4.4956
## GTR_DEF_100-119_0_0_all        NA  3.4051          NA           NA
## GTR_DEF_120-219_0_0_all        NA  1.5883          NA           NA
## GTR_DEF_90-99_0_0_all          NA 34.3578          NA           NA
## GTR_DEF_all_0_0_all        0.8205  0.6963          NA       4.7273
## LLS_DEF_0_0_0_all              NA  0.0003          NA           NA
## LLS_FIF_0_0_0_all              NA      NA          NA       0.0028
## MIS_MIS_0_0_0_HC           0.0270  0.1969       0.001       0.1351
## OTB_CRU_16-31_0_0_all          NA      NA          NA       0.0016
## OTB_CRU_32-69_0_0_all          NA      NA          NA       0.0016
## OTB_CRU_70-99_0_0_all      0.3077      NA          NA       0.0256
## OTB_DEF_>=120_0_0_all          NA      NA          NA       1.5196
## OTB_DEF_70-99_0_0_all          NA 14.9515          NA       1.6335
## OTM_SPF_32-69_0_0_all          NA      NA          NA       0.0009
## SSC_DEF_>=120_0_0_all          NA      NA          NA       0.0011
## SSC_DEF_70-99_0_0_all      0.0003      NA          NA           NA
## SSC_DEF_70-99_0_0_all_FDF      NA      NA       0.001           NA
## SSC_DEF_All_0_0_All            NA      NA          NA       0.0011
## TBB_DEF_70-99_0_0_all     21.6153  2.4812       0.005       2.7228
```

3. Proportion of landings by country

```
apply(L_FC*100,2,function(x) sum(x,na.rm=T))

##      Belgium       France  Netherlands UK (England) 
## 22.770817057 61.940495928  0.007092966 15.281594050 
```

4. Proportion of landings by fleet and area

```
format(data.frame(L_FA*100),scientific=4,digit=1)

##                           X27.7.d
## DRB_all_0_0_all            4.1264
## FPO_CRU_0_0_0_all          0.0129
## GNS_DEF_100-119_0_0_all    0.0486
## GNS_DEF_90-99_0_0_all      0.0881
## GNS_DEF_all_0_0_all        4.4956
## GTR_DEF_100-119_0_0_all    3.4051
## GTR_DEF_120-219_0_0_all    1.5883
## GTR_DEF_90-99_0_0_all     34.3578
## GTR_DEF_all_0_0_all        6.2441
## LLS_DEF_0_0_0_all          0.0003
## LLS_FIF_0_0_0_all          0.0028
## MIS_MIS_0_0_0_HC           0.3600
## OTB_CRU_16-31_0_0_all      0.0016
## OTB_CRU_32-69_0_0_all      0.0016
## OTB_CRU_70-99_0_0_all      0.3333
## OTB_DEF_>=120_0_0_all      1.5196
## OTB_DEF_70-99_0_0_all     16.5850
## OTM_SPF_32-69_0_0_all      0.0009
## SSC_DEF_>=120_0_0_all      0.0011
## SSC_DEF_70-99_0_0_all      0.0003
```

```
## SSC_DEF_70-99_0_0_all_FDF  0.0010
## SSC_DEF_All_0_0_All        0.0011
## TBB_DEF_70-99_0_0_all     26.8244
```

5. Proportion of landings by métier, ranked from largest to smallest, together with cumulative sum

```
L_F1<-L_F
L_F1$rank_Total<-L_F1$rank_Total*100
L_F1<-L_F1[rev(order(L_F1$rank_Total)),]
L_F1$cum<-cumsum(L_F1$rank_Total)
format(L_F1,scientific=4,digit=1)

##                           rank_Total                     Fleet cum
## GTR_DEF_90-99_0_0_all        34.3578     GTR_DEF_90-99_0_0_all  34
## TBB_DEF_70-99_0_0_all        26.8244     TBB_DEF_70-99_0_0_all  61
## OTB_DEF_70-99_0_0_all        16.5850     OTB_DEF_70-99_0_0_all  78
## GTR_DEF_all_0_0_all           6.2441       GTR_DEF_all_0_0_all  84
## GNS_DEF_all_0_0_all           4.4956       GNS_DEF_all_0_0_all  89
## DRB_all_0_0_all               4.1264           DRB_all_0_0_all  93
## GTR_DEF_100-119_0_0_all       3.4051   GTR_DEF_100-119_0_0_all  96
## GTR_DEF_120-219_0_0_all       1.5883   GTR_DEF_120-219_0_0_all  98
## OTB_DEF_>=120_0_0_all         1.5196     OTB_DEF_>=120_0_0_all  99
## MIS_MIS_0_0_0_HC              0.3600          MIS_MIS_0_0_0_HC 100
## OTB_CRU_70-99_0_0_all         0.3333     OTB_CRU_70-99_0_0_all 100
## GNS_DEF_90-99_0_0_all         0.0881     GNS_DEF_90-99_0_0_all 100
## GNS_DEF_100-119_0_0_all       0.0486   GNS_DEF_100-119_0_0_all 100
## FPO_CRU_0_0_0_all             0.0129         FPO_CRU_0_0_0_all 100
## LLS_FIF_0_0_0_all             0.0028         LLS_FIF_0_0_0_all 100
## OTB_CRU_32-69_0_0_all         0.0016     OTB_CRU_32-69_0_0_all 100
## OTB_CRU_16-31_0_0_all         0.0016     OTB_CRU_16-31_0_0_all 100
## SSC_DEF_All_0_0_All           0.0011       SSC_DEF_All_0_0_All 100
## SSC_DEF_>=120_0_0_all         0.0011     SSC_DEF_>=120_0_0_all 100
## SSC_DEF_70-99_0_0_all_FDF     0.0010 SSC_DEF_70-99_0_0_all_FDF 100
## OTM_SPF_32-69_0_0_all         0.0009     OTM_SPF_32-69_0_0_all 100
## LLS_DEF_0_0_0_all             0.0003         LLS_DEF_0_0_0_all 100
## SSC_DEF_70-99_0_0_all         0.0003     SSC_DEF_70-99_0_0_all 100
```

Section B: Age coverage

1. Total proportion of the landings/sampled discards that is covered for age composition

```
Lage_A_tot #(Lwt !Lagesamp / sum(Lwt))

## [1] 0.832983

Dage_A_tot #(Dwt !Dagesamp / sum(Dwt))

## [1] 0.9828908
```

2. Proportion of landings/sampled discards by area and season that is covered for age composition

```
Lage_AS

##                 1         2         3         4 2012
## 27.7.d 0.8380877 0.7879658 0.7608068 0.7299549    1

Dage_AS

##                 1         2         3        4 2012
## 27.7.d 0.7286563 0.9978558 0.9992106 0.103091    1
```

3. Proportion of landings/sampled discards in each métier-country stratum that is covered for age composition

```
Lage_FC

##                           Belgium   France Netherlands UK (England)
## DRB_all_0_0_all                NA 0.000000          NA           NA
## FPO_CRU_0_0_0_all              NA       NA          NA    0.0000000
## GNS_DEF_100-119_0_0_all        NA 0.000000          NA           NA
## GNS_DEF_90-99_0_0_all          NA 0.000000          NA           NA
## GNS_DEF_all_0_0_all            NA       NA          NA    1.0000000
## GTR_DEF_100-119_0_0_all        NA 1.000000          NA           NA
## GTR_DEF_120-219_0_0_all        NA 0.811965          NA           NA
## GTR_DEF_90-99_0_0_all          NA 1.000000          NA           NA
## GTR_DEF_all_0_0_all             0 0.000000          NA    0.2060422
## LLS_DEF_0_0_0_all              NA 0.000000          NA           NA
```

```
## LLS_FIF_0_0_0_all              NA       NA          NA    0.0000000
## MIS_MIS_0_0_0_HC                0 0.000000           0    0.0000000
## OTB_CRU_16-31_0_0_all          NA       NA          NA    0.0000000
## OTB_CRU_32-69_0_0_all          NA       NA          NA    0.0000000
## OTB_CRU_70-99_0_0_all           0       NA          NA    0.0000000
## OTB_DEF_>=120_0_0_all          NA       NA          NA    0.3788927
## OTB_DEF_70-99_0_0_all          NA 1.000000          NA    1.0000000
## OTM_SPF_32-69_0_0_all          NA       NA          NA    0.0000000
## SSC_DEF_>=120_0_0_all          NA       NA          NA    0.0000000
## SSC_DEF_70-99_0_0_all           0       NA          NA           NA
## SSC_DEF_70-99_0_0_all_FDF      NA       NA           0           NA
## SSC_DEF_All_0_0_All            NA       NA          NA    0.0000000
## TBB_DEF_70-99_0_0_all           1 0.000000           0    0.0000000
```

```
Dage_FC #note: proportions shown prior to discard raising
```

```
##                           Belgium    France Netherlands UK (England)
## DRB_all_0_0_all                NA       NaN          NA           NA
## FPO_CRU_0_0_0_all              NA        NA          NA          NaN
## GNS_DEF_100-119_0_0_all        NA       NaN          NA           NA
## GNS_DEF_90-99_0_0_all          NA       NaN          NA           NA
## GNS_DEF_all_0_0_all            NA        NA          NA          NaN
## GTR_DEF_100-119_0_0_all        NA 0.0000000          NA           NA
## GTR_DEF_120-219_0_0_all        NA 0.0000000          NA           NA
## GTR_DEF_90-99_0_0_all          NA 0.9300896          NA           NA
## GTR_DEF_all_0_0_all           NaN       NaN          NA            1
## LLS_DEF_0_0_0_all              NA       NaN          NA           NA
## LLS_FIF_0_0_0_all              NA        NA          NA          NaN
## MIS_MIS_0_0_0_HC              NaN       NaN         NaN            1
## OTB_CRU_16-31_0_0_all          NA        NA          NA          NaN
## OTB_CRU_32-69_0_0_all          NA        NA          NA          NaN
## OTB_CRU_70-99_0_0_all         NaN        NA          NA            1
## OTB_DEF_>=120_0_0_all          NA        NA          NA          NaN
## OTB_DEF_70-99_0_0_all          NA 0.9848736          NA            1
## OTM_SPF_32-69_0_0_all          NA        NA          NA          NaN
## SSC_DEF_>=120_0_0_all          NA        NA          NA          NaN
## SSC_DEF_70-99_0_0_all         NaN        NA          NA           NA
## SSC_DEF_70-99_0_0_all_FDF      NA        NA         NaN           NA
## SSC_DEF_All_0_0_All            NA        NA          NA          NaN
## TBB_DEF_70-99_0_0_all           1       NaN         NaN            1
```

Section C: Discard ratio coverage (Lwt !Dwt / sum(Lwt))

1. Total proportion of the landings for which discard weights are available

```
Ldis_A_tot

## [1] 0.7747872
```

2. Proportion of landings for which discard weights are available by area and season

```
Ldis_AS

##                 1         2         3         4 2012
## 27.7.d 0.7498557 0.6962726 0.7021283 0.6876146    1
```

3. Proportion of landings for which discard weights are available in each métier-country stratum

```
Ldis_FC

##                           Belgium   France Netherlands UK (England)
## DRB_all_0_0_all                NA 0.000000          NA           NA
## FPO_CRU_0_0_0_all              NA       NA          NA  0.000000000
## GNS_DEF_100-119_0_0_all        NA 0.000000          NA           NA
## GNS_DEF_90-99_0_0_all          NA 0.000000          NA           NA
## GNS_DEF_all_0_0_all            NA       NA          NA  0.000000000
## GTR_DEF_100-119_0_0_all        NA 1.000000          NA           NA
## GTR_DEF_120-219_0_0_all        NA 0.811965          NA           NA
## GTR_DEF_90-99_0_0_all          NA 1.000000          NA           NA
## GTR_DEF_all_0_0_all             0 0.000000          NA  0.081244591
## LLS_DEF_0_0_0_all              NA 0.000000          NA           NA
## LLS_FIF_0_0_0_all              NA       NA          NA  0.000000000
## MIS_MIS_0_0_0_HC                0 0.000000           0  0.859497912
## OTB_CRU_16-31_0_0_all          NA       NA          NA  0.000000000
## OTB_CRU_32-69_0_0_all          NA       NA          NA  0.000000000
## OTB_CRU_70-99_0_0_all           0       NA          NA  0.006332703
```

```
## OTB_DEF_>=120_0_0_all          NA       NA          NA  0.000000000
## OTB_DEF_70-99_0_0_all          NA 1.000000          NA  0.265933499
## OTM_SPF_32-69_0_0_all          NA       NA          NA  0.000000000
## SSC_DEF_>=120_0_0_all          NA       NA          NA  0.000000000
## SSC_DEF_70-99_0_0_all           0       NA          NA           NA
## SSC_DEF_70-99_0_0_all_FDF      NA       NA           0           NA
## SSC_DEF_All_0_0_All            NA       NA          NA  0.000000000
## TBB_DEF_70-99_0_0_all           1 0.000000           0  0.339566663
```

Section D: Landings age coverage ranked by landed weights

This section shows the proportion of landings covered for age composition, in total (Lage_tot), by métier and for the larger gear groups (Lage_gear). The métiers are ranked by landed weight, so it is easy to check whether the most important métiers have reasonable age coverage for landings. Additionally, the proportion of landings for which discard age coverage is available is presented for the larger gear groups (Dage_gear).

```
Lage_tot<-sum(Lage_AS*L_AS,na.rm=T)/sum(L_AS,na.rm=T)
#(Lage_AS = Lwt !Lagesamp / sum(Lwt); L_AS = Lwt / sum(Lwt))
Lage_tot

## [1] 0.832983

format(Lage_F_Tot,scientific=4,digit=1) #ranking by L_AS; total by Lage_AS

##                         Fleet Total rank_Total
## 8      GTR_DEF_90-99_0_0_all   1.0   0.343578
## 23     TBB_DEF_70-99_0_0_all   0.8   0.268244
## 17     OTB_DEF_70-99_0_0_all   1.0   0.165850
## 9        GTR_DEF_all_0_0_all   0.2   0.062441
## 5        GNS_DEF_all_0_0_all   1.0   0.044956
## 1            DRB_all_0_0_all   0.0   0.041264
## 6    GTR_DEF_100-119_0_0_all   1.0   0.034051
## 7    GTR_DEF_120-219_0_0_all   0.8   0.015883
## 16     OTB_DEF_>=120_0_0_all   0.4   0.015196
## 12          MIS_MIS_0_0_0_HC   0.0   0.003600
## 15     OTB_CRU_70-99_0_0_all   0.0   0.003333
## 4      GNS_DEF_90-99_0_0_all   0.0   0.000881
## 3    GNS_DEF_100-119_0_0_all   0.0   0.000486
## 2          FPO_CRU_0_0_0_all   0.0   0.000129
## 11         LLS_FIF_0_0_0_all   0.0   0.000028
## 14     OTB_CRU_32-69_0_0_all   0.0   0.000016
## 13     OTB_CRU_16-31_0_0_all   0.0   0.000016
## 22       SSC_DEF_All_0_0_All   0.0   0.000011
## 19     SSC_DEF_>=120_0_0_all   0.0   0.000011
## 21 SSC_DEF_70-99_0_0_all_FDF   0.0   0.000010
## 18     OTM_SPF_32-69_0_0_all   0.0   0.000009
## 10         LLS_DEF_0_0_0_all   0.0   0.000003
## 20     SSC_DEF_70-99_0_0_all   0.0   0.000003

Lage_gear

##       GTR       OTB      REST       TBB
## 0.8864080 0.9303471 0.0000000 0.8058080

Dage_gear

##        GTR        OTB       REST        TBB
## 0.62327544 0.63715995 0.02579014 0.84027587
```

Section E: Discard ratio coverage ranked by landed weight

This section shows the proportion of landings for which discard weights are available, in total (Ldis_tot), by métier and for the larger gear groups (Ldis_gear). The métiers are ranked by landed weight, so it is easy to check whether the most important métiers have reasonable discard ratio coverage.

```
Ldis_tot<-sum(Ldis_AS*L_AS,na.rm=T)/sum(L_AS,na.rm=T)
#(Ldis_AS = Lwt !Dwt / sum(Lwt); L_AS = Lwt / sum(Lwt)
Ldis_tot

## [1] 0.7747872

format(Ldis_F_Tot,scientific=4,digit=1) #ranking by L_AS; total by Ldis_AS
```

```
##                        Fleet  Total rank_Total
## 8      GTR_DEF_90-99_0_0_all 1.0000   0.343578
## 23     TBB_DEF_70-99_0_0_all 0.8403   0.268244
## 17     OTB_DEF_70-99_0_0_all 0.9277   0.165850
## 9        GTR_DEF_all_0_0_all 0.0615   0.062441
## 5        GNS_DEF_all_0_0_all 0.0000   0.044956
## 1            DRB_all_0_0_all 0.0000   0.041264
## 6    GTR_DEF_100-119_0_0_all 1.0000   0.034051
## 7    GTR_DEF_120-219_0_0_all 0.8120   0.015883
## 16     OTB_DEF_>=120_0_0_all 0.0000   0.015196
## 12           MIS_MIS_0_0_0_HC 0.3226   0.003600
## 15     OTB_CRU_70-99_0_0_all 0.0005   0.003333
## 4      GNS_DEF_90-99_0_0_all 0.0000   0.000881
## 3    GNS_DEF_100-119_0_0_all 0.0000   0.000486
## 2          FPO_CRU_0_0_0_all 0.0000   0.000129
## 11         LLS_FIF_0_0_0_all 0.0000   0.000028
## 14     OTB_CRU_32-69_0_0_all 0.0000   0.000016
## 13     OTB_CRU_16-31_0_0_all 0.0000   0.000016
## 22       SSC_DEF_All_0_0_All 0.0000   0.000011
## 19     SSC_DEF_>=120_0_0_all 0.0000   0.000011
## 21 SSC_DEF_70-99_0_0_all_FDF 0.0000   0.000010
## 18     OTM_SPF_32-69_0_0_all 0.0000   0.000009
## 10         LLS_DEF_0_0_0_all 0.0000   0.000003
## 20     SSC_DEF_70-99_0_0_all 0.0000   0.000003
```

```
Ldis_gear
```

```
##        GTR        OTB       REST        TBB
## 0.78515758 0.83413347 0.02579014 0.84027587
```

InterCatch input for 2013

This appendix lists 5 sections of tables (A-E) for each InterCatch year (2003-2015). It provides a detailed summary of the InterCatch input data in terms of importance by landed weight and the proportional coverage for age data and discard ratios.

Section A: Importance by landed weight (Lwt / sum(Lwt))

1. Proportion of landings by area and season

```
L_AS*100

##                1        2        3        4     2013
## 27.7.d 15.18175 27.13518 26.27457 10.60514 20.80335
```

2. Proportion of landings by métier and country

```
format(data.frame(L_FC*100),scientific=3,digit=1)

##                           Belgium France UK..England.
## DRB_all_0_0_all                NA  5.916           NA
## FPO_CRU_0_0_0_all              NA     NA        0.011
## GNS_DEF_100-119_0_0_all        NA  0.048           NA
## GNS_DEF_90-99_0_0_all          NA  0.040           NA
## GNS_DEF_all_0_0_all            NA     NA        4.460
## GTR_DEF_100-119_0_0_all        NA  3.372           NA
## GTR_DEF_120-219_0_0_all        NA  1.339           NA
## GTR_DEF_90-99_0_0_all          NA 37.720           NA
## GTR_DEF_all_0_0_all        0.5585  0.758        3.640
## LLS_DEF_0_0_0_all              NA  0.003           NA
## LLS_FIF_0_0_0_all              NA     NA        0.008
## MIS_MIS_0_0_0_HC           0.0171  0.244        0.100
## OTB_CRU_70-99_0_0_all      0.0247     NA        0.054
## OTB_DEF_>=120_0_0_all          NA     NA        1.699
## OTB_DEF_70-99_0_0_all          NA 13.391        1.535
## SSC_DEF_>=120_0_0_all          NA     NA        0.004
## SSC_DEF_70-99_0_0_all      0.0003     NA           NA
## TBB_CRU_16-31_0_0_all          NA     NA        0.013
## TBB_DEF_>=120_0_0_all      0.3253     NA           NA
## TBB_DEF_70-99_0_0_all     20.8033  1.596        2.320
```

3. Proportion of landings by country

```
apply(L_FC*100,2,function(x) sum(x,na.rm=T))

##      Belgium       France UK (England)
##     21.72917     64.42718     13.84365
```

4. Proportion of landings by fleet and area

```
format(data.frame(L_FA*100),scientific=4,digit=1)

##                           X27.7.d
## DRB_all_0_0_all            5.9163
## FPO_CRU_0_0_0_all          0.0112
## GNS_DEF_100-119_0_0_all    0.0481
## GNS_DEF_90-99_0_0_all      0.0399
## GNS_DEF_all_0_0_all        4.4605
## GTR_DEF_100-119_0_0_all    3.3721
## GTR_DEF_120-219_0_0_all    1.3388
## GTR_DEF_90-99_0_0_all     37.7199
## GTR_DEF_all_0_0_all        4.9565
## LLS_DEF_0_0_0_all          0.0025
## LLS_FIF_0_0_0_all          0.0077
## MIS_MIS_0_0_0_HC           0.3615
## OTB_CRU_70-99_0_0_all      0.0785
## OTB_DEF_>=120_0_0_all      1.6990
## OTB_DEF_70-99_0_0_all     14.9259
## SSC_DEF_>=120_0_0_all      0.0037
## SSC_DEF_70-99_0_0_all      0.0003
## TBB_CRU_16-31_0_0_all      0.0128
## TBB_DEF_>=120_0_0_all      0.3253
## TBB_DEF_70-99_0_0_all     24.7194
```

5. Proportion of landings by métier, ranked from largest to smallest, together with cumulative sum

```
L_F1<-L_F
L_F1$rank_Total<-L_F1$rank_Total*100
L_F1<-L_F1[rev(order(L_F1$rank_Total)),]
L_F1$cum<-cumsum(L_F1$rank_Total)
format(L_F1,scientific=4,digit=1)

##                         rank_Total                   Fleet cum
## GTR_DEF_90-99_0_0_all      37.7199   GTR_DEF_90-99_0_0_all  38
## TBB_DEF_70-99_0_0_all      24.7194   TBB_DEF_70-99_0_0_all  62
## OTB_DEF_70-99_0_0_all      14.9259   OTB_DEF_70-99_0_0_all  77
## DRB_all_0_0_all             5.9163         DRB_all_0_0_all  83
## GTR_DEF_all_0_0_all         4.9565     GTR_DEF_all_0_0_all  88
## GNS_DEF_all_0_0_all         4.4605     GNS_DEF_all_0_0_all  93
## GTR_DEF_100-119_0_0_all     3.3721 GTR_DEF_100-119_0_0_all  96
## OTB_DEF_>=120_0_0_all       1.6990   OTB_DEF_>=120_0_0_all  98
## GTR_DEF_120-219_0_0_all     1.3388 GTR_DEF_120-219_0_0_all  99
## MIS_MIS_0_0_0_HC            0.3615        MIS_MIS_0_0_0_HC  99
## TBB_DEF_>=120_0_0_all       0.3253   TBB_DEF_>=120_0_0_all 100
## OTB_CRU_70-99_0_0_all       0.0785   OTB_CRU_70-99_0_0_all 100
## GNS_DEF_100-119_0_0_all     0.0481 GNS_DEF_100-119_0_0_all 100
## GNS_DEF_90-99_0_0_all       0.0399   GNS_DEF_90-99_0_0_all 100
## TBB_CRU_16-31_0_0_all       0.0128   TBB_CRU_16-31_0_0_all 100
## FPO_CRU_0_0_0_all           0.0112       FPO_CRU_0_0_0_all 100
## LLS_FIF_0_0_0_all           0.0077       LLS_FIF_0_0_0_all 100
## SSC_DEF_>=120_0_0_all       0.0037   SSC_DEF_>=120_0_0_all 100
## LLS_DEF_0_0_0_all           0.0025       LLS_DEF_0_0_0_all 100
## SSC_DEF_70-99_0_0_all       0.0003   SSC_DEF_70-99_0_0_all 100
```

Section B: Age coverage

1. Total proportion of the landings/sampled discards that is covered for age composition

```
Lage_A_tot #(Lwt !Lagesamp / sum(Lwt))

## [1] 0.8216608

Dage_A_tot #(Dwt !Dagesamp / sum(Dwt))

## [1] 0.953351
```

2. Proportion of landings/sampled discards by area and season that is covered for age composition

```
Lage_AS

##               1         2         3         4 2013
## 27.7.d 0.749436 0.8046486 0.7826411 0.7154199    1

Dage_AS

##                 1         2         3 4 2013
## 27.7.d 0.05311596 0.6078941 0.9998465 1    1
```

3. Proportion of landings/sampled discards in each métier-country stratum that is covered for age composition

```
Lage_FC

##                         Belgium    France UK (England)
## DRB_all_0_0_all              NA 0.0000000           NA
## FPO_CRU_0_0_0_all            NA        NA    0.0000000
## GNS_DEF_100-119_0_0_all      NA 0.0000000           NA
## GNS_DEF_90-99_0_0_all        NA 0.5362611           NA
## GNS_DEF_all_0_0_all          NA        NA    1.0000000
## GTR_DEF_100-119_0_0_all      NA 0.8184446           NA
## GTR_DEF_120-219_0_0_all      NA 0.6080366           NA
## GTR_DEF_90-99_0_0_all        NA 1.0000000           NA
## GTR_DEF_all_0_0_all           0 0.0000000    0.0000000
## LLS_DEF_0_0_0_all            NA 0.0000000           NA
## LLS_FIF_0_0_0_all            NA        NA    0.0000000
## MIS_MIS_0_0_0_HC              0 0.6403684    0.0000000
## OTB_CRU_70-99_0_0_all         0        NA    0.0000000
## OTB_DEF_>=120_0_0_all        NA        NA    0.0000000
## OTB_DEF_70-99_0_0_all        NA 0.9257115    1.0000000
## SSC_DEF_>=120_0_0_all        NA        NA    0.0000000
## SSC_DEF_70-99_0_0_all         0        NA           NA
## TBB_CRU_16-31_0_0_all        NA        NA    0.0000000
```

```
## TBB_DEF_>=120_0_0_all         0        NA           NA
## TBB_DEF_70-99_0_0_all         1 0.6653675    0.1885784
```

```
Dage_FC #note: proportions shown prior to discard raising
```

```
##                         Belgium    France UK (England)
## DRB_all_0_0_all               NA       NaN           NA
## FPO_CRU_0_0_0_all             NA        NA          NaN
## GNS_DEF_100-119_0_0_all       NA       NaN           NA
## GNS_DEF_90-99_0_0_all         NA       NaN           NA
## GNS_DEF_all_0_0_all           NA        NA            1
## GTR_DEF_100-119_0_0_all       NA 0.0000000           NA
## GTR_DEF_120-219_0_0_all       NA       NaN           NA
## GTR_DEF_90-99_0_0_all         NA 0.9443642           NA
## GTR_DEF_all_0_0_all          NaN       NaN            1
## LLS_DEF_0_0_0_all             NA       NaN           NA
## LLS_FIF_0_0_0_all             NA        NA          NaN
## MIS_MIS_0_0_0_HC             NaN       NaN          NaN
## OTB_CRU_70-99_0_0_all        NaN        NA          NaN
## OTB_DEF_>=120_0_0_all         NA        NA          NaN
## OTB_DEF_70-99_0_0_all         NA 0.9343390          NaN
## SSC_DEF_>=120_0_0_all         NA        NA          NaN
## SSC_DEF_70-99_0_0_all        NaN        NA           NA
## TBB_CRU_16-31_0_0_all         NA        NA          NaN
## TBB_DEF_>=120_0_0_all        NaN        NA           NA
## TBB_DEF_70-99_0_0_all          1       NaN            1
```

Section C: Discard ratio coverage (Lwt !Dwt / sum(Lwt))

1. Total proportion of the landings for which discard weights are available

```
Ldis_A_tot

## [1] 0.8214241
```

2. Proportion of landings for which discard weights are available by area and season

```
Ldis_AS

##                 1         2         3         4 2013
## 27.7.d 0.7493263 0.7809749 0.8209956 0.6788946    1
```

3. Proportion of landings for which discard weights are available in each métier-country stratum

```
Ldis_FC

##                         Belgium    France UK (England)
## DRB_all_0_0_all               NA 0.0000000           NA
## FPO_CRU_0_0_0_all             NA        NA    0.0000000
## GNS_DEF_100-119_0_0_all       NA 0.0000000           NA
## GNS_DEF_90-99_0_0_all         NA 0.0000000           NA
## GNS_DEF_all_0_0_all           NA        NA    0.8177689
## GTR_DEF_100-119_0_0_all       NA 0.6675051           NA
## GTR_DEF_120-219_0_0_all       NA 0.0000000           NA
## GTR_DEF_90-99_0_0_all         NA 1.0000000           NA
## GTR_DEF_all_0_0_all            0 0.0000000    1.0000000
## LLS_DEF_0_0_0_all             NA 0.0000000           NA
## LLS_FIF_0_0_0_all             NA        NA    0.0000000
## MIS_MIS_0_0_0_HC               0 0.0000000    0.0000000
## OTB_CRU_70-99_0_0_all          0        NA    0.0000000
## OTB_DEF_>=120_0_0_all         NA        NA    0.0000000
## OTB_DEF_70-99_0_0_all         NA 1.0000000    0.0000000
## SSC_DEF_>=120_0_0_all         NA        NA    0.0000000
## SSC_DEF_70-99_0_0_all          0        NA           NA
## TBB_CRU_16-31_0_0_all         NA        NA    0.0000000
## TBB_DEF_>=120_0_0_all          0        NA           NA
## TBB_DEF_70-99_0_0_all          1 0.0000000    0.2973940
```

Section D: Landings age coverage ranked by landed weights

This section shows the proportion of landings covered for age composition, in total (Lage_tot), by métier and for the larger gear groups (Lage_gear). The métiers are ranked by landed weight, so it is easy to check whether the most important métiers have reasonable age coverage for landings. Additionally, the proportion of landings for which discard age coverage is available is presented for the larger gear groups (Dage_gear).

```
Lage_tot<-sum(Lage_AS*L_AS,na.rm=T)/sum(L_AS,na.rm=T)
#(Lage_AS = Lwt !Lagesamp / sum(Lwt); L_AS = Lwt / sum(Lwt))
Lage_tot
## [1] 0.8216608

format(Lage_F_Tot,scientific=4,digit=1) #ranking by L_AS; total by Lage_AS
##                        Fleet Total rank_Total
## 8    GTR_DEF_90-99_0_0_all   1.0   0.377199
## 20   TBB_DEF_70-99_0_0_all   0.9   0.247194
## 15   OTB_DEF_70-99_0_0_all   0.9   0.149259
## 1          DRB_all_0_0_all   0.0   0.059163
## 9      GTR_DEF_all_0_0_all   0.0   0.049565
## 5      GNS_DEF_all_0_0_all   1.0   0.044605
## 6  GTR_DEF_100-119_0_0_all   0.8   0.033721
## 14   OTB_DEF_>=120_0_0_all   0.0   0.016990
## 7  GTR_DEF_120-219_0_0_all   0.6   0.013388
## 12        MIS_MIS_0_0_0_HC   0.4   0.003615
## 19   TBB_DEF_>=120_0_0_all   0.0   0.003253
## 13   OTB_CRU_70-99_0_0_all   0.0   0.000785
## 3  GNS_DEF_100-119_0_0_all   0.0   0.000481
## 4    GNS_DEF_90-99_0_0_all   0.5   0.000399
## 18   TBB_CRU_16-31_0_0_all   0.0   0.000128
## 2        FPO_CRU_0_0_0_all   0.0   0.000112
## 11       LLS_FIF_0_0_0_all   0.0   0.000077
## 16   SSC_DEF_>=120_0_0_all   0.0   0.000037
## 10       LLS_DEF_0_0_0_all   0.0   0.000025
## 17   SSC_DEF_70-99_0_0_all   0.0   0.000003

Lage_gear
##        GTR        OTB       REST        TBB
## 0.88138995 0.83382728 0.02484963 0.89006047

Dage_gear
##       GTR       OTB      REST       TBB
## 0.6779189 0.5345933 0.0000000 0.8577637
```

Section E: Discard ratio coverage ranked by landed weight

This section shows the proportion of landings for which discard weights are available, in total (Ldis_tot), by métier and for the larger gear groups (Ldis_gear). The métiers are ranked by landed weight, so it is easy to check whether the most important métiers have reasonable discard ratio coverage.

```
Ldis_tot<-sum(Ldis_AS*L_AS,na.rm=T)/sum(L_AS,na.rm=T)
#(Ldis_AS = Lwt !Dwt / sum(Lwt); L_AS = Lwt / sum(Lwt)
Ldis_tot
## [1] 0.8214241

format(Ldis_F_Tot,scientific=4,digit=1) #ranking by L_AS; total by Ldis_AS
##                        Fleet Total rank_Total
## 8    GTR_DEF_90-99_0_0_all   1.0   0.377199
## 20   TBB_DEF_70-99_0_0_all   0.9   0.247194
## 15   OTB_DEF_70-99_0_0_all   0.9   0.149259
## 1          DRB_all_0_0_all   0.0   0.059163
## 9      GTR_DEF_all_0_0_all   0.7   0.049565
## 5      GNS_DEF_all_0_0_all   0.8   0.044605
## 6  GTR_DEF_100-119_0_0_all   0.7   0.033721
## 14   OTB_DEF_>=120_0_0_all   0.0   0.016990
## 7  GTR_DEF_120-219_0_0_all   0.0   0.013388
## 12        MIS_MIS_0_0_0_HC   0.0   0.003615
## 19   TBB_DEF_>=120_0_0_all   0.0   0.003253
## 13   OTB_CRU_70-99_0_0_all   0.0   0.000785
## 3  GNS_DEF_100-119_0_0_all   0.0   0.000481
## 4    GNS_DEF_90-99_0_0_all   0.0   0.000399
## 18   TBB_CRU_16-31_0_0_all   0.0   0.000128
## 2        FPO_CRU_0_0_0_all   0.0   0.000112
## 11       LLS_FIF_0_0_0_all   0.0   0.000077
## 16   SSC_DEF_>=120_0_0_all   0.0   0.000037
## 10       LLS_DEF_0_0_0_all   0.0   0.000025
## 17   SSC_DEF_70-99_0_0_all   0.0   0.000003

Ldis_gear
##       GTR       OTB      REST       TBB
## 0.9099320 0.8014937 0.0000000 0.8577637
```

InterCatch input for 2014

This appendix lists 5 sections of tables (A-E) for each InterCatch year (2003-2015). It provides a detailed summary of the InterCatch input data in terms of importance by landed weight and the proportional coverage for age data and discard ratios.

Section A: Importance by landed weight (Lwt / sum(Lwt))

1. Proportion of landings by area and season

```
L_AS*100

##               1        2        3        4     2014
## 27.7.d 16.75236 21.57997 21.17769 9.674328 30.81565
```

2. Proportion of landings by métier and country

```
format(data.frame(L_FC*100),scientific=3,digit=1)

##                          Belgium  France Netherlands UK..England.
## DRB_all_0_0_all               NA  4.7080          NA           NA
## DRB_MOL_0_0_0_all             NA      NA          NA      0.17065
## FPO_CRU_0_0_0_all             NA      NA          NA      0.01404
## GNS_DEF_100-119_0_0_all       NA  0.0680          NA           NA
## GNS_DEF_90-99_0_0_all         NA  0.0142          NA           NA
## GNS_DEF_all_0_0_all           NA      NA          NA      5.06447
## GTR_DEF_100-119_0_0_all       NA  4.0070          NA           NA
## GTR_DEF_120-219_0_0_all       NA  0.6985          NA           NA
## GTR_DEF_90-99_0_0_all         NA 30.6989          NA           NA
## GTR_DEF_all_0_0_all      1.04881  1.8074          NA      3.60034
## LLS_DEF_0_0_0_all             NA  0.0008          NA           NA
## LLS_FIF_0_0_0_all             NA      NA          NA      0.00635
## MIS_MIS_0_0_0_HC         0.04795  0.1581          NA      0.17052
## OTB_CRU_70-99_0_0_all    0.15972      NA          NA      0.00008
## OTB_DEF_>=120_0_0_all         NA      NA          NA      0.86760
## OTB_DEF_70-99_0_0_all         NA 10.5067          NA      1.55772
## SSC_DEF_>=120_0_0_all         NA      NA          NA      0.00903
## SSC_DEF_70-99_0_0_all    0.00002      NA      0.0005           NA
## SSC_DEF_All_0_0_All           NA      NA          NA      0.00903
## TBB_DEF_>=120_0_0_all         NA      NA          NA      0.06379
## TBB_DEF_70-99_0_0_all   30.81565  1.1427          NA      2.58287
##                         UK.Scotland.
## DRB_all_0_0_all                   NA
## DRB_MOL_0_0_0_all                 NA
## FPO_CRU_0_0_0_all                 NA
## GNS_DEF_100-119_0_0_all           NA
## GNS_DEF_90-99_0_0_all             NA
## GNS_DEF_all_0_0_all               NA
## GTR_DEF_100-119_0_0_all           NA
## GTR_DEF_120-219_0_0_all           NA
## GTR_DEF_90-99_0_0_all             NA
## GTR_DEF_all_0_0_all               NA
## LLS_DEF_0_0_0_all                 NA
## LLS_FIF_0_0_0_all                 NA
## MIS_MIS_0_0_0_HC              0.0004
## OTB_CRU_70-99_0_0_all             NA
## OTB_DEF_>=120_0_0_all             NA
## OTB_DEF_70-99_0_0_all             NA
## SSC_DEF_>=120_0_0_all             NA
## SSC_DEF_70-99_0_0_all             NA
## SSC_DEF_All_0_0_All               NA
## TBB_DEF_>=120_0_0_all             NA
## TBB_DEF_70-99_0_0_all             NA
```

3. Proportion of landings by country

```
apply(L_FC*100,2,function(x) sum(x,na.rm=T))

##      Belgium       France  Netherlands UK (England) UK(Scotland)
## 3.207216e+01 5.381041e+01 4.940936e-04 1.411651e+01 4.296466e-04
```

4. Proportion of landings by fleet and area

```
format(data.frame(L_FA*100),scientific=4,digit=1)
```

```
##                         X27.7.d
## DRB_all_0_0_all          4.7080
## DRB_MOL_0_0_0_all        0.1706
## FPO_CRU_0_0_0_all        0.0140
## GNS_DEF_100-119_0_0_all  0.0680
## GNS_DEF_90-99_0_0_all    0.0142
## GNS_DEF_all_0_0_all      5.0645
## GTR_DEF_100-119_0_0_all  4.0070
## GTR_DEF_120-219_0_0_all  0.6985
## GTR_DEF_90-99_0_0_all   30.6989
## GTR_DEF_all_0_0_all      6.4566
## LLS_DEF_0_0_0_all        0.0008
## LLS_FIF_0_0_0_all        0.0064
## MIS_MIS_0_0_0_HC         0.3770
## OTB_CRU_70-99_0_0_all    0.1598
## OTB_DEF_>=120_0_0_all    0.8676
## OTB_DEF_70-99_0_0_all   12.0645
## SSC_DEF_>=120_0_0_all    0.0090
## SSC_DEF_70-99_0_0_all    0.0005
## SSC_DEF_All_0_0_All      0.0090
## TBB_DEF_>=120_0_0_all    0.0638
## TBB_DEF_70-99_0_0_all   34.5413
```

5. Proportion of landings by métier, ranked from largest to smallest, together with cumulative sum

```
L_F1<-L_F
L_F1$rank_Total<-L_F1$rank_Total*100
L_F1<-L_F1[rev(order(L_F1$rank_Total)),]
L_F1$cum<-cumsum(L_F1$rank_Total)
format(L_F1,scientific=4,digit=1)

##                         rank_Total                   Fleet cum
## TBB_DEF_70-99_0_0_all      34.5413   TBB_DEF_70-99_0_0_all  35
## GTR_DEF_90-99_0_0_all      30.6989   GTR_DEF_90-99_0_0_all  65
## OTB_DEF_70-99_0_0_all      12.0645   OTB_DEF_70-99_0_0_all  77
## GTR_DEF_all_0_0_all         6.4566     GTR_DEF_all_0_0_all  84
## GNS_DEF_all_0_0_all         5.0645     GNS_DEF_all_0_0_all  89
## DRB_all_0_0_all             4.7080         DRB_all_0_0_all  94
## GTR_DEF_100-119_0_0_all     4.0070 GTR_DEF_100-119_0_0_all  98
## OTB_DEF_>=120_0_0_all       0.8676   OTB_DEF_>=120_0_0_all  98
## GTR_DEF_120-219_0_0_all     0.6985 GTR_DEF_120-219_0_0_all  99
## MIS_MIS_0_0_0_HC            0.3770        MIS_MIS_0_0_0_HC  99
## DRB_MOL_0_0_0_all           0.1706       DRB_MOL_0_0_0_all 100
## OTB_CRU_70-99_0_0_all       0.1598   OTB_CRU_70-99_0_0_all 100
## GNS_DEF_100-119_0_0_all     0.0680 GNS_DEF_100-119_0_0_all 100
## TBB_DEF_>=120_0_0_all       0.0638   TBB_DEF_>=120_0_0_all 100
## GNS_DEF_90-99_0_0_all       0.0142   GNS_DEF_90-99_0_0_all 100
## FPO_CRU_0_0_0_all           0.0140       FPO_CRU_0_0_0_all 100
## SSC_DEF_All_0_0_All         0.0090     SSC_DEF_All_0_0_All 100
## SSC_DEF_>=120_0_0_all       0.0090   SSC_DEF_>=120_0_0_all 100
## LLS_FIF_0_0_0_all           0.0064       LLS_FIF_0_0_0_all 100
## LLS_DEF_0_0_0_all           0.0008       LLS_DEF_0_0_0_all 100
## SSC_DEF_70-99_0_0_all       0.0005   SSC_DEF_70-99_0_0_all 100
```

Section B: Age coverage

1. Total proportion of the landings/sampled discards that is covered for age composition

```
Lage_A_tot #(Lwt !Lagesamp / sum(Lwt))

## [1] 0.8331006

Dage_A_tot #(Dwt !Dagesamp / sum(Dwt))

## [1] 0.7640221
```

2. Proportion of landings/sampled discards by area and season that is covered for age composition

```
Lage_AS

##               1         2         3        4 2014
## 27.7.d 0.772417 0.7573669 0.8067151 0.633251    1

Dage_AS
```

```
##                1         2         3           4 2014
## 27.7.d 0.7036247 0.3735288 0.9941813 0.005774305    1
```

3. Proportion of landings/sampled discards in each métier-country stratum that is covered for age composition

```
Lage_FC

##                         Belgium    France Netherlands UK (England)
## DRB_all_0_0_all              NA 0.2102570          NA           NA
## DRB_MOL_0_0_0_all            NA        NA          NA            0
## FPO_CRU_0_0_0_all            NA        NA          NA            0
## GNS_DEF_100-119_0_0_all      NA 0.0000000          NA           NA
## GNS_DEF_90-99_0_0_all        NA 0.3893697          NA           NA
## GNS_DEF_all_0_0_all          NA        NA          NA            1
## GTR_DEF_100-119_0_0_all      NA 0.8119498          NA           NA
## GTR_DEF_120-219_0_0_all      NA 0.0000000          NA           NA
## GTR_DEF_90-99_0_0_all        NA 1.0000000          NA           NA
## GTR_DEF_all_0_0_all           0 0.0000000          NA            0
## LLS_DEF_0_0_0_all            NA 0.0000000          NA           NA
## LLS_FIF_0_0_0_all            NA        NA          NA            0
## MIS_MIS_0_0_0_HC              0 0.0000000          NA            0
## OTB_CRU_70-99_0_0_all         0        NA          NA            0
## OTB_DEF_>=120_0_0_all        NA        NA          NA            0
## OTB_DEF_70-99_0_0_all        NA 1.0000000          NA            1
## SSC_DEF_>=120_0_0_all        NA        NA          NA            0
## SSC_DEF_70-99_0_0_all         0        NA           0           NA
## SSC_DEF_All_0_0_All          NA        NA          NA            0
## TBB_DEF_>=120_0_0_all        NA        NA          NA            0
## TBB_DEF_70-99_0_0_all         1 0.3654547          NA            0
##                         UK(Scotland)
## DRB_all_0_0_all                   NA
## DRB_MOL_0_0_0_all                 NA
## FPO_CRU_0_0_0_all                 NA
## GNS_DEF_100-119_0_0_all           NA
## GNS_DEF_90-99_0_0_all             NA
## GNS_DEF_all_0_0_all               NA
## GTR_DEF_100-119_0_0_all           NA
## GTR_DEF_120-219_0_0_all           NA
## GTR_DEF_90-99_0_0_all             NA
## GTR_DEF_all_0_0_all               NA
## LLS_DEF_0_0_0_all                 NA
## LLS_FIF_0_0_0_all                 NA
## MIS_MIS_0_0_0_HC                   0
## OTB_CRU_70-99_0_0_all             NA
## OTB_DEF_>=120_0_0_all             NA
## OTB_DEF_70-99_0_0_all             NA
## SSC_DEF_>=120_0_0_all             NA
## SSC_DEF_70-99_0_0_all             NA
## SSC_DEF_All_0_0_All               NA
## TBB_DEF_>=120_0_0_all             NA
## TBB_DEF_70-99_0_0_all             NA
```

```
Dage_FC #note: proportions shown prior to discard raising

##                         Belgium    France Netherlands UK (England)
## DRB_all_0_0_all              NA       NaN          NA           NA
## DRB_MOL_0_0_0_all            NA        NA          NA          NaN
## FPO_CRU_0_0_0_all            NA        NA          NA          NaN
## GNS_DEF_100-119_0_0_all      NA       NaN          NA           NA
## GNS_DEF_90-99_0_0_all        NA       NaN          NA           NA
## GNS_DEF_all_0_0_all          NA        NA          NA            1
## GTR_DEF_100-119_0_0_all      NA 0.0000000          NA           NA
## GTR_DEF_120-219_0_0_all      NA       NaN          NA           NA
## GTR_DEF_90-99_0_0_all        NA 0.8529639          NA           NA
## GTR_DEF_all_0_0_all         NaN       NaN          NA            1
## LLS_DEF_0_0_0_all            NA       NaN          NA           NA
## LLS_FIF_0_0_0_all            NA        NA          NA          NaN
## MIS_MIS_0_0_0_HC            NaN       NaN          NA          NaN
## OTB_CRU_70-99_0_0_all       NaN        NA          NA          NaN
## OTB_DEF_>=120_0_0_all        NA        NA          NA          NaN
## OTB_DEF_70-99_0_0_all        NA 0.6621656          NA          NaN
## SSC_DEF_>=120_0_0_all        NA        NA          NA          NaN
## SSC_DEF_70-99_0_0_all       NaN        NA         NaN           NA
## SSC_DEF_All_0_0_All          NA        NA          NA          NaN
## TBB_DEF_>=120_0_0_all        NA        NA          NA          NaN
```

```
## TBB_DEF_70-99_0_0_all          1       NaN          NA            1
##                         UK(Scotland)
## DRB_all_0_0_all                   NA
## DRB_MOL_0_0_0_all                 NA
## FPO_CRU_0_0_0_all                 NA
## GNS_DEF_100-119_0_0_all           NA
## GNS_DEF_90-99_0_0_all             NA
## GNS_DEF_all_0_0_all               NA
## GTR_DEF_100-119_0_0_all           NA
## GTR_DEF_120-219_0_0_all           NA
## GTR_DEF_90-99_0_0_all             NA
## GTR_DEF_all_0_0_all               NA
## LLS_DEF_0_0_0_all                 NA
## LLS_FIF_0_0_0_all                 NA
## MIS_MIS_0_0_0_HC                 NaN
## OTB_CRU_70-99_0_0_all             NA
## OTB_DEF_>=120_0_0_all             NA
## OTB_DEF_70-99_0_0_all             NA
## SSC_DEF_>=120_0_0_all             NA
## SSC_DEF_70-99_0_0_all             NA
## SSC_DEF_All_0_0_All               NA
## TBB_DEF_>=120_0_0_all             NA
## TBB_DEF_70-99_0_0_all             NA
```

Section C: Discard ratio coverage (Lwt !Dwt / sum(Lwt))

1. Total proportion of the landings for which discard weights are available

```
Ldis_A_tot

## [1] 0.8315863
```

2. Proportion of landings for which discard weights are available by area and season

```
Ldis_AS

##                 1         2         3         4 2014
## 27.7.d 0.7241053 0.7912937 0.7968859 0.6470949    1
```

3. Proportion of landings for which discard weights are available in each métier-country stratum

```
Ldis_FC

##                         Belgium    France Netherlands UK (England)
## DRB_all_0_0_all              NA 0.0000000          NA           NA
## DRB_MOL_0_0_0_all            NA        NA          NA    0.0000000
## FPO_CRU_0_0_0_all            NA        NA          NA    0.0000000
## GNS_DEF_100-119_0_0_all      NA 0.0000000          NA           NA
## GNS_DEF_90-99_0_0_all        NA 0.0000000          NA           NA
## GNS_DEF_all_0_0_all          NA        NA          NA    0.9318427
## GTR_DEF_100-119_0_0_all      NA 0.6519569          NA           NA
## GTR_DEF_120-219_0_0_all      NA 0.0000000          NA           NA
## GTR_DEF_90-99_0_0_all        NA 1.0000000          NA           NA
## GTR_DEF_all_0_0_all           0 0.0000000          NA    0.8629576
## LLS_DEF_0_0_0_all            NA 0.0000000          NA           NA
## LLS_FIF_0_0_0_all            NA        NA          NA    0.0000000
## MIS_MIS_0_0_0_HC              0 0.0000000          NA    0.0000000
## OTB_CRU_70-99_0_0_all         0        NA          NA    0.0000000
## OTB_DEF_>=120_0_0_all        NA        NA          NA    0.0000000
## OTB_DEF_70-99_0_0_all        NA 1.0000000          NA    0.0000000
## SSC_DEF_>=120_0_0_all        NA        NA          NA    0.0000000
## SSC_DEF_70-99_0_0_all         0        NA           0           NA
## SSC_DEF_All_0_0_All          NA        NA          NA    0.0000000
## TBB_DEF_>=120_0_0_all        NA        NA          NA    0.0000000
## TBB_DEF_70-99_0_0_all         1 0.0000000          NA    0.2704911
##                         UK(Scotland)
## DRB_all_0_0_all                   NA
## DRB_MOL_0_0_0_all                 NA
## FPO_CRU_0_0_0_all                 NA
## GNS_DEF_100-119_0_0_all           NA
## GNS_DEF_90-99_0_0_all             NA
## GNS_DEF_all_0_0_all               NA
## GTR_DEF_100-119_0_0_all           NA
## GTR_DEF_120-219_0_0_all           NA
## GTR_DEF_90-99_0_0_all             NA
## GTR_DEF_all_0_0_all               NA
```

```
## LLS_DEF_0_0_0_all                 NA
## LLS_FIF_0_0_0_all                 NA
## MIS_MIS_0_0_0_HC                   0
## OTB_CRU_70-99_0_0_all             NA
## OTB_DEF_>=120_0_0_all             NA
## OTB_DEF_70-99_0_0_all             NA
## SSC_DEF_>=120_0_0_all             NA
## SSC_DEF_70-99_0_0_all             NA
## SSC_DEF_All_0_0_All               NA
## TBB_DEF_>=120_0_0_all             NA
## TBB_DEF_70-99_0_0_all             NA
```

Section D: Landings age coverage ranked by landed weights

This section shows the proportion of landings covered for age composition, in total (Lage_tot), by métier and for the larger gear groups (Lage_gear). The métiers are ranked by landed weight, so it is easy to check whether the most important métiers have reasonable age coverage for landings. Additionally, the proportion of landings for which discard age coverage is available is presented for the larger gear groups (Dage_gear).

```
Lage_tot<-sum(Lage_AS*L_AS,na.rm=T)/sum(L_AS,na.rm=T)
#(Lage_AS = Lwt !Lagesamp / sum(Lwt); L_AS = Lwt / sum(Lwt))
Lage_tot

## [1] 0.8331006

format(Lage_F_Tot,scientific=4,digit=1) #ranking by L_AS; total by Lage_AS

##                       Fleet Total rank_Total
## 21   TBB_DEF_70-99_0_0_all   0.9   0.345413
## 9    GTR_DEF_90-99_0_0_all   1.0   0.306989
## 16   OTB_DEF_70-99_0_0_all   1.0   0.120645
## 10     GTR_DEF_all_0_0_all   0.0   0.064566
## 6      GNS_DEF_all_0_0_all   1.0   0.050645
## 1          DRB_all_0_0_all   0.2   0.047080
## 7  GTR_DEF_100-119_0_0_all   0.8   0.040070
## 15   OTB_DEF_>=120_0_0_all   0.0   0.008676
## 8  GTR_DEF_120-219_0_0_all   0.0   0.006985
## 13        MIS_MIS_0_0_0_HC   0.0   0.003770
## 2          DRB_MOL_0_0_all   0.0   0.001706
## 14   OTB_CRU_70-99_0_0_all   0.0   0.001598
## 4  GNS_DEF_100-119_0_0_all   0.0   0.000680
## 20   TBB_DEF_>=120_0_0_all   0.0   0.000638
## 5    GNS_DEF_90-99_0_0_all   0.4   0.000142
## 3          FPO_CRU_0_0_all   0.0   0.000140
## 19     SSC_DEF_All_0_0_All   0.0   0.000090
## 17   SSC_DEF_>=120_0_0_all   0.0   0.000090
## 12         LLS_FIF_0_0_all   0.0   0.000064
## 11         LLS_DEF_0_0_all   0.0   0.000008
## 18   SSC_DEF_70-99_0_0_all   0.0   0.000005

Lage_gear

##       GTR       OTB      REST       TBB
## 0.8301285 0.9202176 0.1875912 0.9025639

Dage_gear

##       GTR       OTB      REST       TBB
## 0.6030847 0.3442339 0.0000000 0.9106849
```

Section E: Discard ratio coverage ranked by landed weight

This section shows the proportion of landings for which discard weights are available, in total (Ldis_tot), by métier and for the larger gear groups (Ldis_gear). The métiers are ranked by landed weight, so it is easy to check whether the most important métiers have reasonable discard ratio coverage.

```
Ldis_tot<-sum(Ldis_AS*L_AS,na.rm=T)/sum(L_AS,na.rm=T)
#(Ldis_AS = Lwt !Dwt / sum(Lwt); L_AS = Lwt / sum(Lwt)
Ldis_tot

## [1] 0.8315863
```

```
format(Ldis_F_Tot,scientific=4,digit=1) #ranking by L_AS; total by Ldis_AS

##                       Fleet Total rank_Total
## 21   TBB_DEF_70-99_0_0_all   0.9   0.345413
## 9    GTR_DEF_90-99_0_0_all   1.0   0.306989
## 16   OTB_DEF_70-99_0_0_all   0.9   0.120645
## 10     GTR_DEF_all_0_0_all   0.5   0.064566
## 6      GNS_DEF_all_0_0_all   0.9   0.050645
## 1          DRB_all_0_0_all   0.0   0.047080
## 7  GTR_DEF_100-119_0_0_all   0.7   0.040070
## 15   OTB_DEF_>=120_0_0_all   0.0   0.008676
## 8  GTR_DEF_120-219_0_0_all   0.0   0.006985
## 13         MIS_MIS_0_0_0_HC   0.0   0.003770
## 2        DRB_MOL_0_0_0_all   0.0   0.001706
## 14   OTB_CRU_70-99_0_0_all   0.0   0.001598
## 4  GNS_DEF_100-119_0_0_all   0.0   0.000680
## 20   TBB_DEF_>=120_0_0_all   0.0   0.000638
## 5    GNS_DEF_90-99_0_0_all   0.0   0.000142
## 3        FPO_CRU_0_0_0_all   0.0   0.000140
## 19     SSC_DEF_All_0_0_All   0.0   0.000090
## 17   SSC_DEF_>=120_0_0_all   0.0   0.000090
## 12       LLS_FIF_0_0_0_all   0.0   0.000064
## 11       LLS_DEF_0_0_0_all   0.0   0.000008
## 18   SSC_DEF_70-99_0_0_all   0.0   0.000005

Ldis_gear

##       GTR       OTB      REST       TBB
## 0.8751243 0.8014025 0.0000000 0.9106849
```

InterCatch input for 2015

This appendix lists 5 sections of tables (A-E) for each InterCatch year (2003-2015). It provides a detailed summary of the InterCatch input data in terms of importance by landed weight and the proportional coverage for age data and discard ratios.

Section A: Importance by landed weight (Lwt / sum(Lwt))

1. Proportion of landings by area and season

```
L_AS*100

##               1        2        3        4     2015
## 27.7.d 22.62361 21.03905 18.25077 7.927419 30.15915
```

2. Proportion of landings by métier and country

```
format(data.frame(L_FC*100),scientific=3,digit=1)

##                          Belgium   France UK..England.
## DRB_all_0_0_all               NA  5.48759           NA
## FPO_CRU_0_0_0_all             NA       NA        0.020
## GNS_DEF_100-119_0_0_all       NA  0.04936           NA
## GNS_DEF_90-99_0_0_all         NA  0.01303           NA
## GNS_DEF_all_0_0_all           NA       NA        5.521
## GTR_DEF_100-119_0_0_all       NA  4.49441           NA
## GTR_DEF_120-219_0_0_all       NA  0.71494           NA
## GTR_DEF_90-99_0_0_all         NA 30.15634           NA
## GTR_DEF_all_0_0_all        0.216  0.45240        4.108
## LLS_DEF_0_0_0_all             NA  0.00003           NA
## LLS_FIF_0_0_0_all             NA       NA        0.007
## MIS_MIS_0_0_0_HC           0.008  0.15276        0.063
## OTB_CRU_70-99_0_0_all      0.092       NA        0.031
## OTB_DEF_>=120_0_0_all         NA       NA        0.673
## OTB_DEF_70-99_0_0_all         NA 12.76021        1.067
## SSC_DEF_>=120_0_0_all         NA       NA        0.004
## SSC_DEF_70-99_0_0_all      0.002       NA           NA
## TBB_CRU_16-31_0_0_all         NA       NA        0.003
## TBB_DEF_70-99_0_0_all     30.159  1.64628        2.101
```

3. Proportion of landings by country

```
apply(L_FC*100,2,function(x) sum(x,na.rm=T))

##      Belgium       France UK (England)
##     30.47662     55.92736     13.59602
```

4. Proportion of landings by fleet and area

```
format(data.frame(L_FA*100),scientific=4,digit=1)

##                           X27.7.d
## DRB_all_0_0_all           5.48759
## FPO_CRU_0_0_0_all         0.01994
## GNS_DEF_100-119_0_0_all   0.04936
## GNS_DEF_90-99_0_0_all     0.01303
## GNS_DEF_all_0_0_all       5.52078
## GTR_DEF_100-119_0_0_all   4.49441
## GTR_DEF_120-219_0_0_all   0.71494
## GTR_DEF_90-99_0_0_all    30.15634
## GTR_DEF_all_0_0_all       4.77655
## LLS_DEF_0_0_0_all         0.00003
## LLS_FIF_0_0_0_all         0.00663
## MIS_MIS_0_0_0_HC          0.22392
## OTB_CRU_70-99_0_0_all     0.12226
## OTB_DEF_>=120_0_0_all     0.67277
## OTB_DEF_70-99_0_0_all    13.82688
## SSC_DEF_>=120_0_0_all     0.00366
## SSC_DEF_70-99_0_0_all     0.00151
## TBB_CRU_16-31_0_0_all     0.00342
## TBB_DEF_70-99_0_0_all    33.90596
```

5. Proportion of landings by métier, ranked from largest to smallest, together with cumulative sum

```
L_F1<-L_F
L_F1$rank_Total<-L_F1$rank_Total*100
```

```
L_F1<-L_F1[rev(order(L_F1$rank_Total)),]
L_F1$cum<-cumsum(L_F1$rank_Total)
format(L_F1,scientific=4,digit=1)

##                          rank_Total                   Fleet cum
## TBB_DEF_70-99_0_0_all     33.90596   TBB_DEF_70-99_0_0_all  34
## GTR_DEF_90-99_0_0_all     30.15634   GTR_DEF_90-99_0_0_all  64
## OTB_DEF_70-99_0_0_all     13.82688   OTB_DEF_70-99_0_0_all  78
## GNS_DEF_all_0_0_all        5.52078     GNS_DEF_all_0_0_all  83
## DRB_all_0_0_all            5.48759         DRB_all_0_0_all  89
## GTR_DEF_all_0_0_all        4.77655     GTR_DEF_all_0_0_all  94
## GTR_DEF_100-119_0_0_all    4.49441 GTR_DEF_100-119_0_0_all  98
## GTR_DEF_120-219_0_0_all    0.71494 GTR_DEF_120-219_0_0_all  99
## OTB_DEF_>=120_0_0_all      0.67277   OTB_DEF_>=120_0_0_all 100
## MIS_MIS_0_0_0_HC           0.22392        MIS_MIS_0_0_0_HC 100
## OTB_CRU_70-99_0_0_all      0.12226   OTB_CRU_70-99_0_0_all 100
## GNS_DEF_100-119_0_0_all    0.04936 GNS_DEF_100-119_0_0_all 100
## FPO_CRU_0_0_0_all          0.01994       FPO_CRU_0_0_0_all 100
## GNS_DEF_90-99_0_0_all      0.01303   GNS_DEF_90-99_0_0_all 100
## LLS_FIF_0_0_0_all          0.00663       LLS_FIF_0_0_0_all 100
## SSC_DEF_>=120_0_0_all      0.00366   SSC_DEF_>=120_0_0_all 100
## TBB_CRU_16-31_0_0_all      0.00342   TBB_CRU_16-31_0_0_all 100
## SSC_DEF_70-99_0_0_all      0.00151   SSC_DEF_70-99_0_0_all 100
## LLS_DEF_0_0_0_all          0.00003       LLS_DEF_0_0_0_all 100
```

Section B: Age coverage

1. Total proportion of the landings/sampled discards that is covered for age composition

```
Lage_A_tot #(Lwt !Lagesamp / sum(Lwt))

## [1] 0.8769721

Dage_A_tot #(Dwt !Dagesamp / sum(Dwt))

## [1] 0.9493753
```

2. Proportion of landings/sampled discards by area and season that is covered for age composition

```
Lage_AS

##                 1         2         3         4 2015
## 27.7.d 0.8398477 0.7470733 0.8893574 0.8311034    1

Dage_AS

##                 1         2         3         4 2015
## 27.7.d 0.1840325 0.9958688 0.9933751 0.6120184    1
```

3. Proportion of landings/sampled discards in each métier-country stratum that is covered for age composition

```
Lage_FC

##                          Belgium    France UK (England)
## DRB_all_0_0_all              NA 0.0000000           NA
## FPO_CRU_0_0_0_all            NA        NA    0.0000000
## GNS_DEF_100-119_0_0_all      NA 0.0000000           NA
## GNS_DEF_90-99_0_0_all        NA 0.0000000           NA
## GNS_DEF_all_0_0_all          NA        NA    1.0000000
## GTR_DEF_100-119_0_0_all      NA 1.0000000           NA
## GTR_DEF_120-219_0_0_all      NA 0.1919487           NA
## GTR_DEF_90-99_0_0_all        NA 1.0000000           NA
## GTR_DEF_all_0_0_all           0 0.0000000    0.2451302
## LLS_DEF_0_0_0_all            NA 0.0000000           NA
## LLS_FIF_0_0_0_all            NA        NA    0.0000000
## MIS_MIS_0_0_0_HC              0 0.0000000    0.0000000
## OTB_CRU_70-99_0_0_all         0        NA    0.0000000
## OTB_DEF_>=120_0_0_all        NA        NA    0.9550300
## OTB_DEF_70-99_0_0_all        NA 1.0000000    1.0000000
## SSC_DEF_>=120_0_0_all        NA        NA    0.0000000
## SSC_DEF_70-99_0_0_all         0        NA           NA
## TBB_CRU_16-31_0_0_all        NA        NA    0.0000000
## TBB_DEF_70-99_0_0_all         1 0.6497278    0.3253141

Dage_FC #note: proportions shown prior to discard raising
```

```
##                         Belgium    France UK (England)
## DRB_all_0_0_all              NA       NaN           NA
## FPO_CRU_0_0_0_all            NA        NA          NaN
## GNS_DEF_100-119_0_0_all      NA       NaN           NA
## GNS_DEF_90-99_0_0_all        NA       NaN           NA
## GNS_DEF_all_0_0_all          NA        NA            1
## GTR_DEF_100-119_0_0_all      NA 0.0000000           NA
## GTR_DEF_120-219_0_0_all      NA 0.0000000           NA
## GTR_DEF_90-99_0_0_all        NA 0.8484761           NA
## GTR_DEF_all_0_0_all         NaN       NaN            1
## LLS_DEF_0_0_0_all            NA       NaN           NA
## LLS_FIF_0_0_0_all            NA        NA          NaN
## MIS_MIS_0_0_0_HC            NaN       NaN          NaN
## OTB_CRU_70-99_0_0_all       NaN        NA          NaN
## OTB_DEF_>=120_0_0_all        NA        NA          NaN
## OTB_DEF_70-99_0_0_all        NA 0.9224386          NaN
## SSC_DEF_>=120_0_0_all        NA        NA          NaN
## SSC_DEF_70-99_0_0_all       NaN        NA           NA
## TBB_CRU_16-31_0_0_all        NA        NA          NaN
## TBB_DEF_70-99_0_0_all         1       NaN          NaN
```

Section C: Discard ratio coverage (Lwt !Dwt / sum(Lwt))

1. Total proportion of the landings for which discard weights are available

```
Ldis_A_tot

## [1] 0.8595535
```

2. Proportion of landings for which discard weights are available by area and season

```
Ldis_AS

##                1         2         3         4 2015
## 27.7.d 0.7885385 0.8414965 0.8498375 0.5981948    1
```

3. Proportion of landings for which discard weights are available in each métier-country stratum

```
Ldis_FC

##                         Belgium    France UK (England)
## DRB_all_0_0_all              NA 0.0000000           NA
## FPO_CRU_0_0_0_all            NA        NA    0.0000000
## GNS_DEF_100-119_0_0_all      NA 0.0000000           NA
## GNS_DEF_90-99_0_0_all        NA 0.0000000           NA
## GNS_DEF_all_0_0_all          NA        NA    0.8481194
## GTR_DEF_100-119_0_0_all      NA 0.8374721           NA
## GTR_DEF_120-219_0_0_all      NA 0.4555154           NA
## GTR_DEF_90-99_0_0_all        NA 1.0000000           NA
## GTR_DEF_all_0_0_all           0 0.0000000    1.0000000
## LLS_DEF_0_0_0_all            NA 0.0000000           NA
## LLS_FIF_0_0_0_all            NA        NA    0.0000000
## MIS_MIS_0_0_0_HC              0 0.0000000    0.0000000
## OTB_CRU_70-99_0_0_all         0        NA    0.0000000
## OTB_DEF_>=120_0_0_all        NA        NA    0.0000000
## OTB_DEF_70-99_0_0_all        NA 1.0000000    0.0000000
## SSC_DEF_>=120_0_0_all        NA        NA    0.0000000
## SSC_DEF_70-99_0_0_all         0        NA           NA
## TBB_CRU_16-31_0_0_all        NA        NA    0.0000000
## TBB_DEF_70-99_0_0_all         1 0.0000000    0.0000000
```

Section D: Landings age coverage ranked by landed weights

This section shows the proportion of landings covered for age composition, in total (Lage_tot), by métier and for the larger gear groups (Lage_gear). The métiers are ranked by landed weight, so it is easy to check whether the most important métiers have reasonable age coverage for landings. Additionally, the proportion of landings for which discard age coverage is available is presented for the larger gear groups (Dage_gear).

```
Lage_tot<-sum(Lage_AS*L_AS,na.rm=T)/sum(L_AS,na.rm=T)
#(Lage_AS = Lwt !Lagesamp / sum(Lwt); L_AS = Lwt / sum(Lwt))
Lage_tot

## [1] 0.8769721

format(Lage_F_Tot,scientific=4,digit=1) #ranking by L_AS; total by Lage_AS
```

```
##                      Fleet Total rank_Total
## 19   TBB_DEF_70-99_0_0_all   0.9  0.3390596
## 8    GTR_DEF_90-99_0_0_all   1.0  0.3015634
## 15   OTB_DEF_70-99_0_0_all   1.0  0.1382688
## 5      GNS_DEF_all_0_0_all   1.0  0.0552078
## 1          DRB_all_0_0_all   0.0  0.0548759
## 9      GTR_DEF_all_0_0_all   0.2  0.0477655
## 6  GTR_DEF_100-119_0_0_all   1.0  0.0449441
## 7  GTR_DEF_120-219_0_0_all   0.2  0.0071494
## 14   OTB_DEF_>=120_0_0_all   1.0  0.0067277
## 12         MIS_MIS_0_0_0_HC   0.0  0.0022392
## 13   OTB_CRU_70-99_0_0_all   0.0  0.0012226
## 3  GNS_DEF_100-119_0_0_all   0.0  0.0004936
## 2        FPO_CRU_0_0_0_all   0.0  0.0001994
## 4    GNS_DEF_90-99_0_0_all   0.0  0.0001303
## 11       LLS_FIF_0_0_0_all   0.0  0.0000663
## 16   SSC_DEF_>=120_0_0_all   0.0  0.0000366
## 18   TBB_CRU_16-31_0_0_all   0.0  0.0000342
## 17   SSC_DEF_70-99_0_0_all   0.0  0.0000151
## 10       LLS_DEF_0_0_0_all   0.0  0.0000003

Lage_gear

##       GTR       OTB      REST       TBB
## 0.9035610 0.9892193 0.0000000 0.9410999

Dage_gear

##       GTR       OTB      REST       TBB
## 0.4701201 0.6929450 0.0000000 0.8894042
```

Section E: Discard ratio coverage ranked by landed weight

This section shows the proportion of landings for which discard weights are available, in total (Ldis_tot), by métier and for the larger gear groups (Ldis_gear). The métiers are ranked by landed weight, so it is easy to check whether the most important métiers have reasonable discard ratio coverage.

```
Ldis_tot<-sum(Ldis_AS*L_AS,na.rm=T)/sum(L_AS,na.rm=T)
#(Ldis_AS = Lwt !Dwt / sum(Lwt); L_AS = Lwt / sum(Lwt)
Ldis_tot

## [1] 0.8595535

format(Ldis_F_Tot,scientific=4,digit=1) #ranking by L_AS; total by Ldis_AS

##                      Fleet Total rank_Total
## 19   TBB_DEF_70-99_0_0_all   0.9  0.3390596
## 8    GTR_DEF_90-99_0_0_all   1.0  0.3015634
## 15   OTB_DEF_70-99_0_0_all   0.9  0.1382688
## 5      GNS_DEF_all_0_0_all   0.8  0.0552078
## 1          DRB_all_0_0_all   0.0  0.0548759
## 9      GTR_DEF_all_0_0_all   0.9  0.0477655
## 6  GTR_DEF_100-119_0_0_all   0.8  0.0449441
## 7  GTR_DEF_120-219_0_0_all   0.5  0.0071494
## 14   OTB_DEF_>=120_0_0_all   0.0  0.0067277
## 12         MIS_MIS_0_0_0_HC   0.0  0.0022392
## 13   OTB_CRU_70-99_0_0_all   0.0  0.0012226
## 3  GNS_DEF_100-119_0_0_all   0.0  0.0004936
## 2        FPO_CRU_0_0_0_all   0.0  0.0001994
## 4    GNS_DEF_90-99_0_0_all   0.0  0.0001303
## 11       LLS_FIF_0_0_0_all   0.0  0.0000663
## 16   SSC_DEF_>=120_0_0_all   0.0  0.0000366
## 18   TBB_CRU_16-31_0_0_all   0.0  0.0000342
## 17   SSC_DEF_70-99_0_0_all   0.0  0.0000151
## 10       LLS_DEF_0_0_0_all   0.0  0.0000003

Ldis_gear

##       GTR       OTB      REST       TBB
## 0.9411833 0.8723687 0.0000000 0.8894042
```

Appendix 2: Overview age allocations using manual allocation scheme

Allocation scheme for landings 2015 as an example

	BE_27.7.d_TBB_DEF_70-99_0_0_all_2015_L	FR_27.7.d_GTR_DEF_100-119_0_0_all_1_L	FR_27.7.d_GTR_DEF_100-119_0_0_all_2_L	FR_27.7.d_GTR_DEF_100-119_0_0_all_3_L	FR_27.7.d_GTR_DEF_100-119_0_0_all_4_L	FR_27.7.d_GTR_DEF_120-219_0_0_all_4_L	FR_27.7.d_GTR_DEF_90-99_0_0_all_1_L	FR_27.7.d_GTR_DEF_90-99_0_0_all_2_L	FR_27.7.d_GTR_DEF_90-99_0_0_all_3_L	FR_27.7.d_GTR_DEF_90-99_0_0_all_4_L	FR_27.7.d_OTB_DEF_70-99_0_0_all_1_L	FR_27.7.d_OTB_DEF_70-99_0_0_all_2_L	FR_27.7.d_OTB_DEF_70-99_0_0_all_3_L	FR_27.7.d_OTB_DEF_70-99_0_0_all_4_L	FR_27.7.d_TBB_DEF_70-99_0_0_all_1_L	FR_27.7.d_TBB_DEF_70-99_0_0_all_4_L	UKE_27.7.d_GNS_DEF_all_0_0_all_1_L	UKE_27.7.d_GNS_DEF_all_0_0_all_2_L	UKE_27.7.d_GNS_DEF_all_0_0_all_3_L	UKE_27.7.d_GNS_DEF_all_0_0_all_4_L	UKE_27.7.d_GTR_DEF_all_0_0_all_3_L	UKE_27.7.d_OTB_DEF_>=120_0_0_all_2_L	UKE_27.7.d_OTB_DEF_>=120_0_0_all_3_L	UKE_27.7.d_OTB_DEF_>=120_0_0_all_4_L	UKE_27.7.d_OTB_DEF_70-99_0_0_all_1_L	UKE_27.7.d_OTB_DEF_70-99_0_0_all_2_L	UKE_27.7.d_OTB_DEF_70-99_0_0_all_3_L	UKE_27.7.d_OTB_DEF_70-99_0_0_all_4_L	UKE_27.7.d_TBB_DEF_70-99_0_0_all_4_L	Grand Total
BE_27.7.d_GTR_DEF_all_0_0_all_1_L		1	1	1	1	1	1	1	1	1							1	1	1	1	1									14
BE_27.7.d_GTR_DEF_all_0_0_all_2_L		1	1	1	1	1	1	1	1	1							1	1	1	1	1									14
BE_27.7.d_GTR_DEF_all_0_0_all_3_L		1	1	1	1	1	1	1	1	1							1	1	1	1	1									14
BE_27.7.d_GTR_DEF_all_0_0_all_4_L		1	1	1	1	1	1	1	1	1							1	1	1	1	1									14
BE_27.7.d_MIS_MIS_0_0_0_HC_1_L	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	29
BE_27.7.d_MIS_MIS_0_0_0_HC_2_L	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	29
BE_27.7.d_MIS_MIS_0_0_0_HC_4_L	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	29
BE_27.7.d_OTB_CRU_70-99_0_0_all_1_L											1	1	1	1								1	1	1	1	1	1	1		11
BE_27.7.d_OTB_CRU_70-99_0_0_all_2_L											1	1	1	1								1	1	1	1	1	1	1		11
BE_27.7.d_OTB_CRU_70-99_0_0_all_4_L											1	1	1	1								1	1	1	1	1	1	1		11
BE_27.7.d_SSC_DEF_70-99_0_0_all_1_L											1	1	1	1								1	1	1	1	1	1	1		11
BE_27.7.d_SSC_DEF_70-99_0_0_all_2_L											1	1	1	1								1	1	1	1	1	1	1		11
BE_27.7.d_SSC_DEF_70-99_0_0_all_3_L											1	1	1	1								1	1	1	1	1	1	1		11
BE_27.7.d_SSC_DEF_70-99_0_0_all_4_L											1	1	1	1								1	1	1	1	1	1	1		11
FR_27.7.d_DRB_all_0_0_all_1_L	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	29
FR_27.7.d_DRB_all_0_0_all_2_L	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	29

FR_27.7.d_DRB_all_0_0_all_3_L	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	29
FR_27.7.d_DRB_all_0_0_all_4_L	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	29
FR_27.7.d_GNS_DEF_100-119_0_0_all_1_L		1	1	1	1	1	1	1	1	1							1	1	1	1	1									14
FR_27.7.d_GNS_DEF_100-119_0_0_all_2_L		1	1	1	1	1	1	1	1	1							1	1	1	1	1									14
FR_27.7.d_GNS_DEF_100-119_0_0_all_3_L		1	1	1	1	1	1	1	1	1							1	1	1	1	1									14
FR_27.7.d_GNS_DEF_100-119_0_0_all_4_L		1	1	1	1	1	1	1	1	1							1	1	1	1	1									14
FR_27.7.d_GNS_DEF_90-99_0_0_all_1_L		1	1	1	1	1	1	1	1	1							1	1	1	1	1									14
FR_27.7.d_GNS_DEF_90-99_0_0_all_2_L		1	1	1	1	1	1	1	1	1							1	1	1	1	1									14
FR_27.7.d_GNS_DEF_90-99_0_0_all_3_L		1	1	1	1	1	1	1	1	1							1	1	1	1	1									14
FR_27.7.d_GNS_DEF_90-99_0_0_all_4_L		1	1	1	1	1	1	1	1	1							1	1	1	1	1									14
FR_27.7.d_GTR_DEF_120-219_0_0_all_1_L		1	1	1	1	1	1	1	1	1							1	1	1	1	1									14
FR_27.7.d_GTR_DEF_120-219_0_0_all_2_L		1	1	1	1	1	1	1	1	1							1	1	1	1	1									14
FR_27.7.d_GTR_DEF_120-219_0_0_all_3_L		1	1	1	1	1	1	1	1	1							1	1	1	1	1									14
FR_27.7.d_GTR_DEF_all_0_0_all_1_L		1	1	1	1	1	1	1	1	1							1	1	1	1	1									14
FR_27.7.d_GTR_DEF_all_0_0_all_2_L		1	1	1	1	1	1	1	1	1							1	1	1	1	1									14
FR_27.7.d_GTR_DEF_all_0_0_all_3_L		1	1	1	1	1	1	1	1	1							1	1	1	1	1									14
FR_27.7.d_GTR_DEF_all_0_0_all_4_L		1	1	1	1	1	1	1	1	1							1	1	1	1	1									14
FR_27.7.d_LLS_DEF_0_0_0_all_2_L	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	29
FR_27.7.d_MIS_MIS_0_0_0_HC_1_L	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	29
FR_27.7.d_MIS_MIS_0_0_0_HC_2_L	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	29
FR_27.7.d_MIS_MIS_0_0_0_HC_3_L	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	29
FR_27.7.d_MIS_MIS_0_0_0_HC_4_L	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	29
FR_27.7.d_TBB_DEF_70-99_0_0_all_2_L	1														1	1													1	4
FR_27.7.d_TBB_DEF_70-99_0_0_all_3_L	1														1	1													1	4
UKE_27.7.d_FPO_CRU_0_0_0_all_1_L	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	29
UKE_27.7.d_FPO_CRU_0_0_0_all_2_L	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	29
UKE_27.7.d_FPO_CRU_0_0_0_all_3_L	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	29
UKE_27.7.d_FPO_CRU_0_0_0_all_4_L	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	29
UKE_27.7.d_GTR_DEF_all_0_0_all_1_L		1	1	1	1	1	1	1	1	1							1	1	1	1	1									14
UKE_27.7.d_GTR_DEF_all_0_0_all_2_L		1	1	1	1	1	1	1	1	1							1	1	1	1	1									14
UKE_27.7.d_GTR_DEF_all_0_0_all_4_L		1	1	1	1	1	1	1	1	1							1	1	1	1	1									14

UKE_27.7.d_LLS_FIF_0_0_0_all_2_L	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	29
UKE_27.7.d_LLS_FIF_0_0_0_all_3_L	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	29
UKE_27.7.d_LLS_FIF_0_0_0_all_4_L	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	29
UKE_27.7.d_MIS_MIS_0_0_0_HC_1_L	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	29
UKE_27.7.d_MIS_MIS_0_0_0_HC_2_L	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	29
UKE_27.7.d_MIS_MIS_0_0_0_HC_3_L	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	29
UKE_27.7.d_MIS_MIS_0_0_0_HC_4_L	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	29
UKE_27.7.d_OTB_CRU_70-99_0_0_all_1_L											1	1	1	1								1	1	1	1	1	1	1		11
UKE_27.7.d_OTB_CRU_70-99_0_0_all_2_L											1	1	1	1								1	1	1	1	1	1	1		11
UKE_27.7.d_OTB_CRU_70-99_0_0_all_3_L											1	1	1	1								1	1	1	1	1	1	1		11
UKE_27.7.d_OTB_CRU_70-99_0_0_all_4_L											1	1	1	1								1	1	1	1	1	1	1		11
UKE_27.7.d_OTB_DEF_>=120_0_0_all_1_L											1	1	1	1								1	1	1	1	1	1	1		11
UKE_27.7.d_SSC_DEF_>=120_0_0_all_1_L											1	1	1	1								1	1	1	1	1	1	1		11
UKE_27.7.d_SSC_DEF_>=120_0_0_all_2_L											1	1	1	1								1	1	1	1	1	1	1		11
UKE_27.7.d_SSC_DEF_>=120_0_0_all_4_L											1	1	1	1								1	1	1	1	1	1	1		11
UKE_27.7.d_TBB_CRU_16-31_0_0_all_2_L	1														1	1													1	4
UKE_27.7.d_TBB_DEF_70-99_0_0_all_1_L	1														1	1													1	4
UKE_27.7.d_TBB_DEF_70-99_0_0_all_2_L	1														1	1													1	4
UKE_27.7.d_TBB_DEF_70-99_0_0_all_3_L	1														1	1													1	4
Grand Total	**29**	**45**	**45**	**45**	**45**	**45**	**45**	**45**	**45**	**45**	**38**	**38**	**38**	**38**	**29**	**29**	**45**	**45**	**45**	**45**	**45**	**38**	**38**	**38**	**38**	**38**	**38**	**38**	**29**	**1164**

Appendix 3: Overview age allocations using autoallocation scheme

Autoallocation scheme for landings 2015 as an example

	BE_27.7.d_TBB_DEF_70-99_0_0_all_2015_L	FR_27.7.d_GTR_DEF_100-119_0_0_all_1_L	FR_27.7.d_GTR_DEF_100-119_0_0_all_2_L	FR_27.7.d_GTR_DEF_100-119_0_0_all_3_L	FR_27.7.d_GTR_DEF_100-119_0_0_all_4_L	FR_27.7.d_GTR_DEF_120-219_0_0_all_4_L	FR_27.7.d_GTR_DEF_90-99_0_0_all_1_L	FR_27.7.d_GTR_DEF_90-99_0_0_all_2_L	FR_27.7.d_GTR_DEF_90-99_0_0_all_3_L	FR_27.7.d_GTR_DEF_90-99_0_0_all_4_L	FR_27.7.d_OTB_DEF_70-99_0_0_all_1_L	FR_27.7.d_OTB_DEF_70-99_0_0_all_2_L	FR_27.7.d_OTB_DEF_70-99_0_0_all_3_L	FR_27.7.d_OTB_DEF_70-99_0_0_all_4_L	FR_27.7.d_TBB_DEF_70-99_0_0_all_1_L	FR_27.7.d_TBB_DEF_70-99_0_0_all_4_L	UKE_27.7.d_GNS_DEF_all_0_0_all_1_L	UKE_27.7.d_GNS_DEF_all_0_0_all_2_L	UKE_27.7.d_GNS_DEF_all_0_0_all_3_L	UKE_27.7.d_GNS_DEF_all_0_0_all_4_L	UKE_27.7.d_GTR_DEF_all_0_0_all_3_L	UKE_27.7.d_OTB_DEF_>=120_0_0_all_2_L	UKE_27.7.d_OTB_DEF_>=120_0_0_all_3_L	UKE_27.7.d_OTB_DEF_>=120_0_0_all_4_L	UKE_27.7.d_OTB_DEF_70-99_0_0_all_1_L	UKE_27.7.d_OTB_DEF_70-99_0_0_all_2_L	UKE_27.7.d_OTB_DEF_70-99_0_0_all_3_L	UKE_27.7.d_OTB_DEF_70-99_0_0_all_4_L	UKE_27.7.d_TBB_DEF_70-99_0_0_all_4_L	Grand Total
BE_27.7.d_GTR_DEF_all_0_0_all_1_L																					1									1
BE_27.7.d_GTR_DEF_all_0_0_all_2_L																					1									1
BE_27.7.d_GTR_DEF_all_0_0_all_3_L																					1									1
BE_27.7.d_GTR_DEF_all_0_0_all_4_L																					1									1
BE_27.7.d_MIS_MIS_0_0_0_HC_1_L	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	29
BE_27.7.d_MIS_MIS_0_0_0_HC_2_L	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	29
BE_27.7.d_MIS_MIS_0_0_0_HC_4_L	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	29
BE_27.7.d_OTB_CRU_70-99_0_0_all_1_L	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	29
BE_27.7.d_OTB_CRU_70-99_0_0_all_2_L	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	29
BE_27.7.d_OTB_CRU_70-99_0_0_all_4_L	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	29
BE_27.7.d_SSC_DEF_70-99_0_0_all_1_L	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	29
BE_27.7.d_SSC_DEF_70-99_0_0_all_2_L	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	29
BE_27.7.d_SSC_DEF_70-99_0_0_all_3_L	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	29
BE_27.7.d_SSC_DEF_70-99_0_0_all_4_L	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	29

FR_27.7.d_DRB_all_0_0_all_1_L	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	29
FR_27.7.d_DRB_all_0_0_all_2_L	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	29
FR_27.7.d_DRB_all_0_0_all_3_L	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	29
FR_27.7.d_DRB_all_0_0_all_4_L	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	29
FR_27.7.d_GNS_DEF_100-119_0_0_all_1_L	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	29
FR_27.7.d_GNS_DEF_100-119_0_0_all_2_L	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	29
FR_27.7.d_GNS_DEF_100-119_0_0_all_3_L	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	29
FR_27.7.d_GNS_DEF_100-119_0_0_all_4_L	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	29
FR_27.7.d_GNS_DEF_90-99_0_0_all_1_L	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	29
FR_27.7.d_GNS_DEF_90-99_0_0_all_2_L	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	29
FR_27.7.d_GNS_DEF_90-99_0_0_all_3_L	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	29
FR_27.7.d_GNS_DEF_90-99_0_0_all_4_L	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	29
FR_27.7.d_GTR_DEF_120-219_0_0_all_1_L						1																								1
FR_27.7.d_GTR_DEF_120-219_0_0_all_2_L						1																								1
FR_27.7.d_GTR_DEF_120-219_0_0_all_3_L						1																								1
FR_27.7.d_GTR_DEF_all_0_0_all_1_L																					1									1
FR_27.7.d_GTR_DEF_all_0_0_all_2_L																					1									1
FR_27.7.d_GTR_DEF_all_0_0_all_3_L																					1									1
FR_27.7.d_GTR_DEF_all_0_0_all_4_L																					1									1
FR_27.7.d_LLS_DEF_0_0_0_all_2_L	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	29
FR_27.7.d_MIS_MIS_0_0_0_HC_1_L	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	29
FR_27.7.d_MIS_MIS_0_0_0_HC_2_L	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	29
FR_27.7.d_MIS_MIS_0_0_0_HC_3_L	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	29
FR_27.7.d_MIS_MIS_0_0_0_HC_4_L	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	29
FR_27.7.d_TBB_DEF_70-99_0_0_all_2_L	1														1	1													1	4
FR_27.7.d_TBB_DEF_70-99_0_0_all_3_L	1														1	1													1	4
UKE_27.7.d_FPO_CRU_0_0_0_all_1_L	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	29
UKE_27.7.d_FPO_CRU_0_0_0_all_2_L	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	29
UKE_27.7.d_FPO_CRU_0_0_0_all_3_L	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	29
UKE_27.7.d_FPO_CRU_0_0_0_all_4_L	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	29
UKE_27.7.d_GTR_DEF_all_0_0_all_1_L																					1									1

UKE_27.7.d_GTR_DEF_all_0_0_all_2_L																					1									1
UKE_27.7.d_GTR_DEF_all_0_0_all_4_L																					1									1
UKE_27.7.d_LLS_FIF_0_0_0_all_2_L	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	29
UKE_27.7.d_LLS_FIF_0_0_0_all_3_L	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	29
UKE_27.7.d_LLS_FIF_0_0_0_all_4_L	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	29
UKE_27.7.d_MIS_MIS_0_0_0_HC_1_L	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	29
UKE_27.7.d_MIS_MIS_0_0_0_HC_2_L	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	29
UKE_27.7.d_MIS_MIS_0_0_0_HC_3_L	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	29
UKE_27.7.d_MIS_MIS_0_0_0_HC_4_L	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	29
UKE_27.7.d_OTB_CRU_70-99_0_0_all_1_L	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	29
UKE_27.7.d_OTB_CRU_70-99_0_0_all_2_L	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	29
UKE_27.7.d_OTB_CRU_70-99_0_0_all_3_L	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	29
UKE_27.7.d_OTB_CRU_70-99_0_0_all_4_L	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	29
UKE_27.7.d_OTB_DEF_>=120_0_0_all_1_L																						1	1	1						3
UKE_27.7.d_SSC_DEF_>=120_0_0_all_1_L	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	29
UKE_27.7.d_SSC_DEF_>=120_0_0_all_2_L	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	29
UKE_27.7.d_SSC_DEF_>=120_0_0_all_4_L	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	29
UKE_27.7.d_TBB_CRU_16-31_0_0_all_2_L	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	29
UKE_27.7.d_TBB_DEF_70-99_0_0_all_1_L															1															1
UKE_27.7.d_TBB_DEF_70-99_0_0_all_2_L	1														1	1													1	4
UKE_27.7.d_TBB_DEF_70-99_0_0_all_3_L	1														1	1													1	4
Grand Total	**50**	**46**	**46**	**46**	**46**	**49**	**46**	**46**	**46**	**46**	**46**	**46**	**46**	**46**	**51**	**50**	**46**	**46**	**46**	**46**	**57**	**47**	**47**	**47**	**46**	**46**	**46**	**46**	**50**	**1368**

Appendix 4: Intercatch output after discard raising and age allocation (based on script from Youen Vermard)

InterCatch output for 2003

This document uses Table 2 from CatchAndSampleDataTables.txt from the InterCatch outputs to describe the raising procedures that were made. In the following tables, CATON=WECA*CANUM/1000000 (in tonnes)

Raised discards

In InterCatch, the first step consists in raising the discards volumes for strata with landings and no discards associated. These discards are called in the following table 'Raised_Discards'. The data called 'Imported_Data' are landings or discards volumes imported into InterCatch with or without length/age structure.

The proportion of Landings with Discards associated (same strata) is **4 percent**.

The volumes (and associated proportion) of landings and discards imported (Imported_Data) or raised (Raised_Discards) are described in the following table.

Table 1a: Summary of the imported/Raised data for manual allocation

CatchCategory	RaisedOrImported	CATON	perc
Discards	Raised_Discards	69.43	96
Discards	Imported_Data	2.846	4
Landings	Imported_Data	6470	100

Table 1b: Summary of the imported/Raised data for autoallocation

CatchCategory	RaisedOrImported	CATON	perc
Discards	Raised_Discards	65.68	96
Discards	Imported_Data	2.846	4
Landings	Imported_Data	6436	100

Length/Age distribution

For the imported landings/discards and the raised discards without age distribution, the length or age distribution is then computed using the defined allocation scheme. *Sampled_distribution* means that the data (ladings or discards) were input with age/length distribution. *Estimated_distribution* means that the imported/raised volumes were estimated using the allocation scheme.

Table 2a: Summary of the imported/Raised/SampledOrEstimated data for manual allocation

CatchCategory	RaisedOrImported	SampledOrEstimated	CATON	perc
Landings	Imported_Data	Sampled_Distribution	3844	59
Landings	Imported_Data	Estimated_Distribution	2627	41
Discards	Raised_Discards	Estimated_Distribution	69.43	96
Discards	Imported_Data	Sampled_Distribution	2.846	4

Table 2b: Summary of the imported/Raised/SampledOrEstimated data for autoallocation

CatchCategory	RaisedOrImported	SampledOrEstimated	CATON	perc
Landings	Imported_Data	Sampled_Distribution	3844	60
Landings	Imported_Data	Estimated_Distribution	2592	40
Discards	Raised_Discards	Estimated_Distribution	65.68	96
Discards	Imported_Data	Sampled_Distribution	2.846	4

Impact of the raising on the age/length structure

Once the samples imported or raised are identified, it is possible to check the impact of the allocation scheme on the mean age/length of the final age/length distribution of the stock. The following figures compare the mean age (computed as the weighted mean of the age per stratum ("CatchCategory",'RaisedOrImported',"SampledOrEstimated","Country","Area","Season","Fleet","Sex") of the estimated strata compared to the imported ones and the final distribution. Each individual included in the boxplot corresponds to the weighted mean age of a stratum.

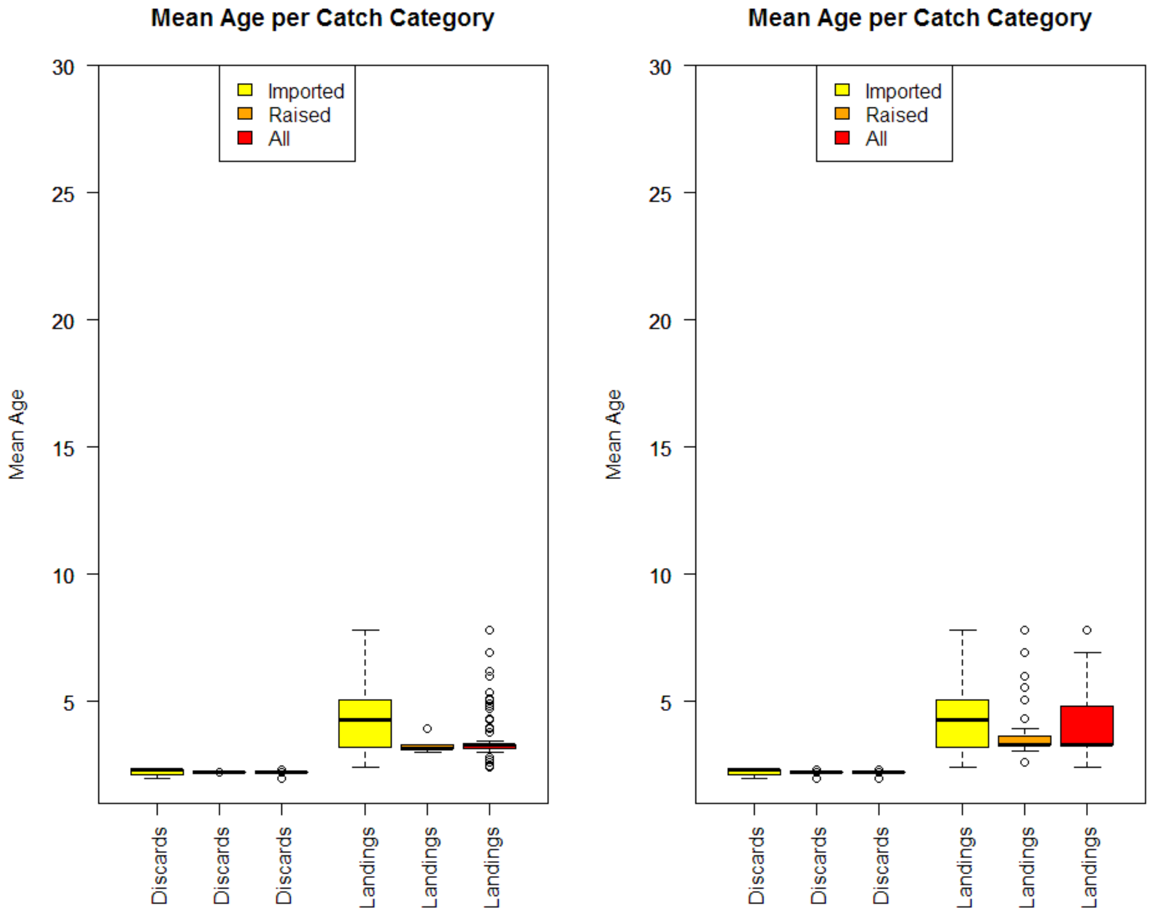


Figure 1: Mean Age per catch category (left: manual allocation; right: autoallocation)

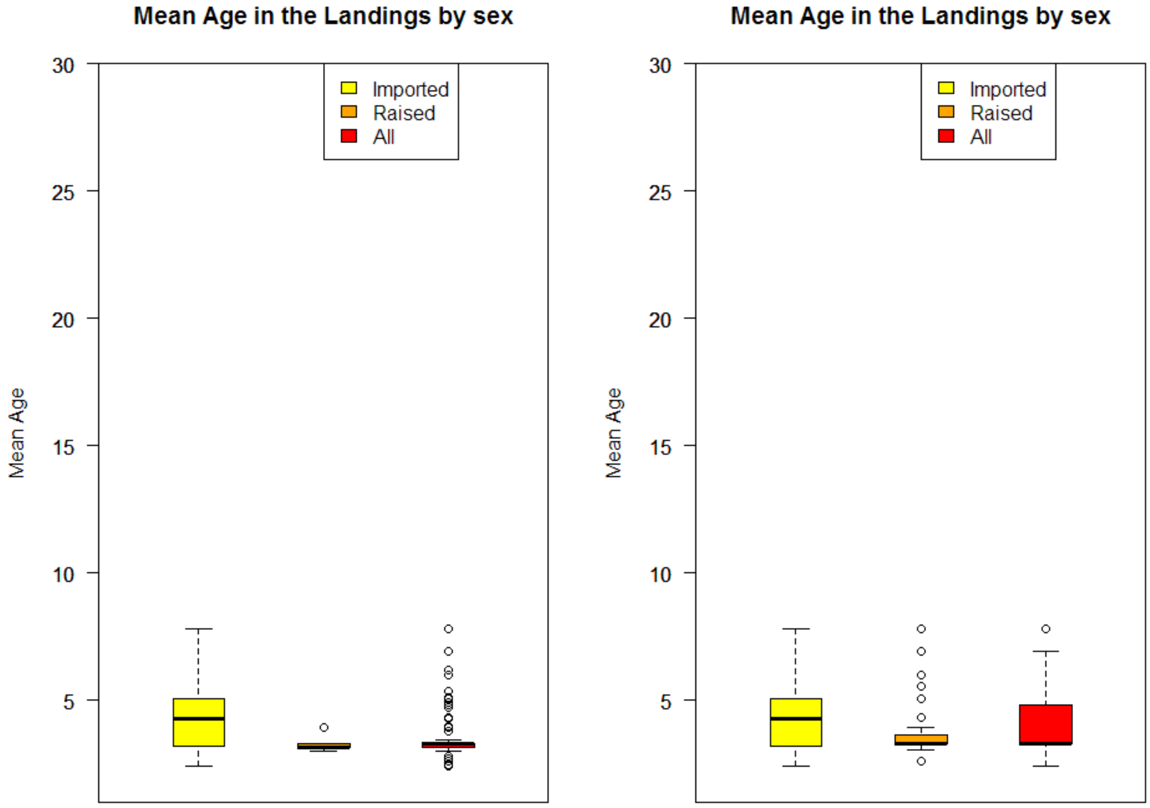


Figure 2: Mean Age in the Landings by sex (left: manual allocation; right: autoallocation)

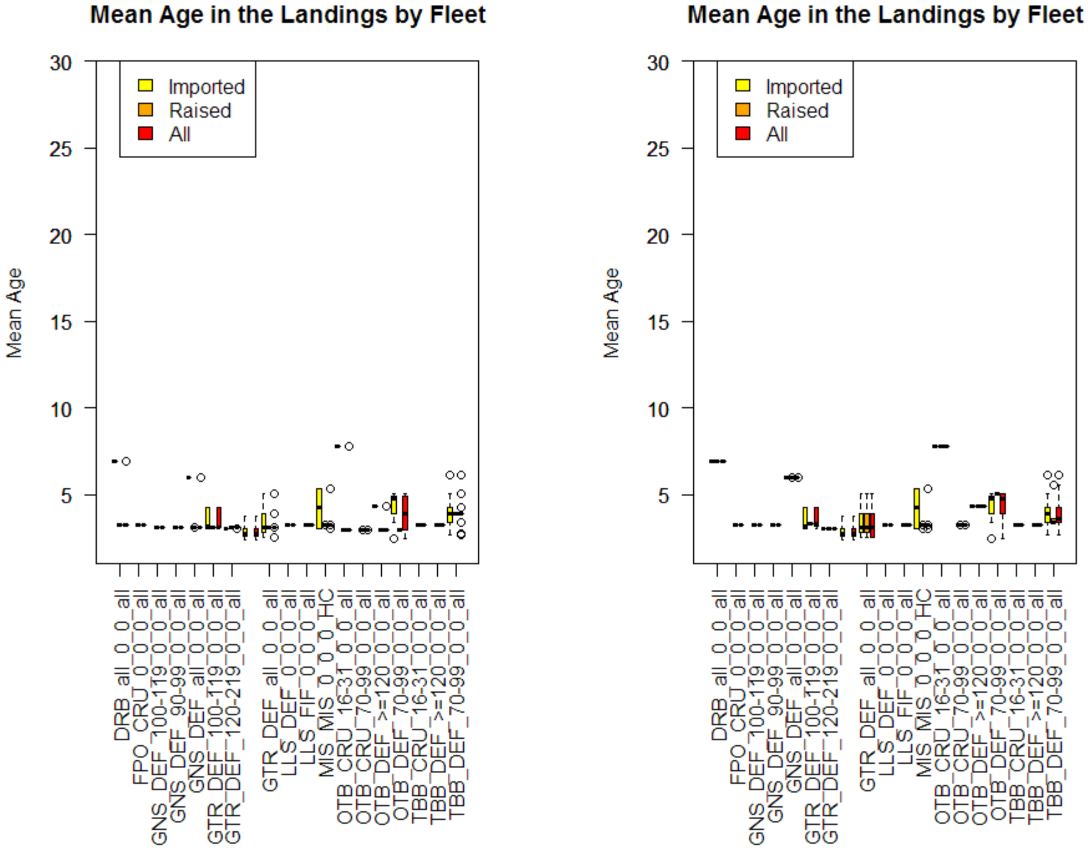


Figure 3: Mean Age in the Landings by Fleet (left: manual allocation; right: autoallocation)

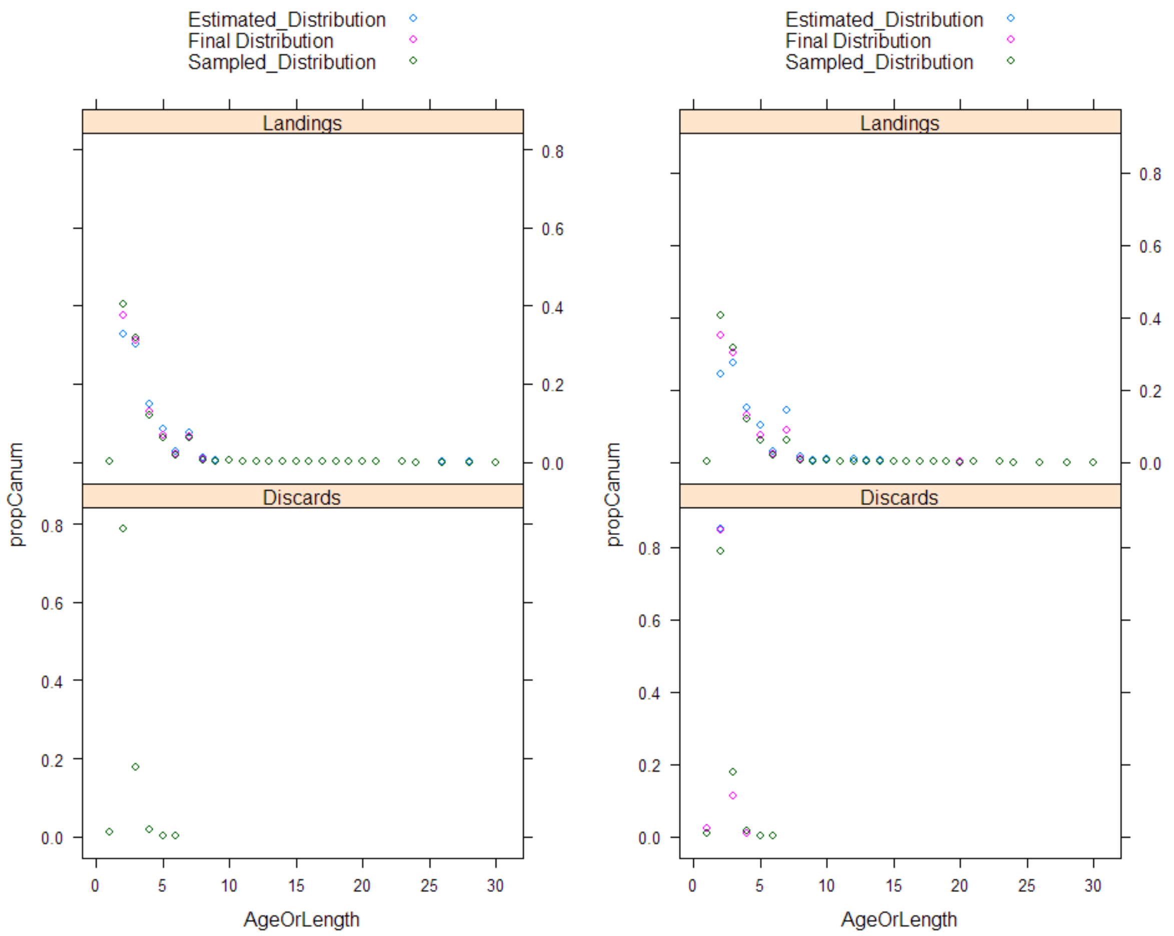


Figure 4: The percentage of each age for the sampled strata, estimated and the final age structure for the landing and discard fractions (left: manual allocation; right: autoallocation)

Impact of the raising on the mean weight

The CatchAndSampleData also provide the weight at age per stratum for the Sampled/Estimated strata. One should also check the sampled/estimated and resulting weight at age.

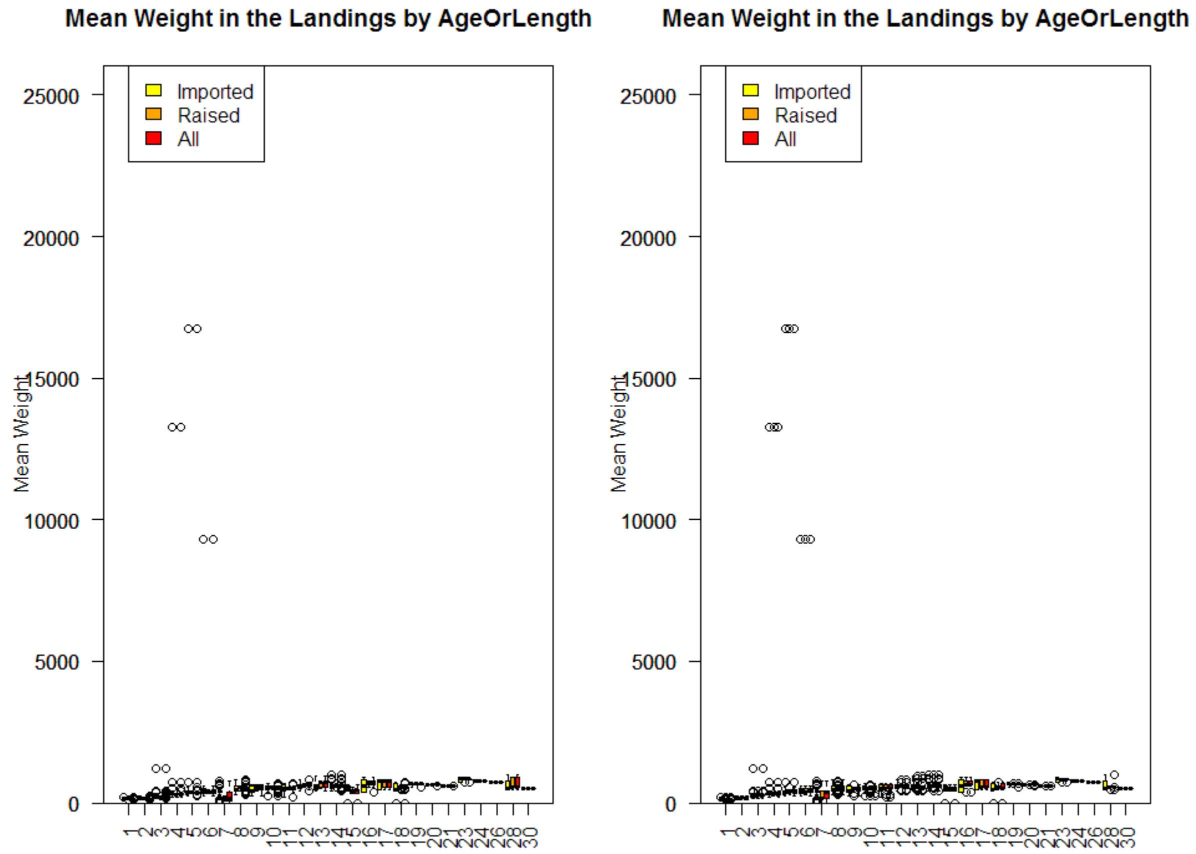


Figure 5: Each boxplot represents the distribution of the weight at age for the different strata (left: manual allocation; right: autoallocation)

Table 3a: Samples that are higher or lower than the average weigth at age +/- 3*standard deviation (outliers) for manual allocation

Table continues below

Country	Fleet	CatchCategory	WECA	AverageWtSize
France	DRB_all_0_0_all	Landings	9308	494.2
France	DRB_all_0_0_all	Landings	26024	516.7
France	DRB_all_0_0_all	Landings	13263	442.9
France	DRB_all_0_0_all	Landings	16727	544.6
France	OTB_DEF_70-99_0_0_all	Landings	241	166.7
UK (England)	OTB_DEF_>=120_0_0_all	Landings	312.1	525.9
France	GTR_DEF_90-99_0_0_all	Landings	0	502.7
France	GTR_DEF_90-99_0_0_all	Landings	0	433.9
France	MIS_MIS_0_0_0_HC	Landings	212	492.7
France	TBB_DEF_70-99_0_0_all	Landings	212	492.7
UK (England)	MIS_MIS_0_0_0_HC	Landings	379.6	698.6
UK (England)	MIS_MIS_0_0_0_HC	Landings	408.3	620.1
UK (England)	OTB_DEF_70-99_0_0_all	Landings	610.1	629.8

UK (England)	OTB_DEF_70-99_0_0_all	Landings	610.1	586.3
UK (England)	OTB_DEF_70-99_0_0_all	Landings	566.6	674.1
UK (England)	TBB_DEF_70-99_0_0_all	Landings	382.1	698.6
UK (England)	TBB_DEF_70-99_0_0_all	Landings	411.3	620.1
France	GTR_DEF_120-219_0_0_all	Landings	257.5	166.7
France	GTR_DEF_90-99_0_0_all	Landings	800	523
France	TBB_DEF_70-99_0_0_all	Landings	224.4	525.9
UK (England)	OTB_CRU_16-31_0_0_all	Landings	871.1	624.2
UK (England)	OTB_CRU_16-31_0_0_all	Landings	209.6	133.9
UK (England)	OTB_DEF_70-99_0_0_all	Landings	743.9	502.7
UK (England)	OTB_DEF_70-99_0_0_all	Landings	760.6	231
UK (England)	OTB_DEF_70-99_0_0_all	Landings	787.1	523
UK (England)	OTB_DEF_70-99_0_0_all	Landings	826.8	620.1
UK (England)	OTB_DEF_70-99_0_0_all	Landings	983.7	624.2

AgeOrLength	Area
6	27.7.d
3	27.7.d
4	27.7.d
5	27.7.d
2	27.7.d
10	27.7.d
18	27.7.d
15	27.7.d
11	27.7.d
11	27.7.d
16	27.7.d
12	27.7.d
20	27.7.d
21	27.7.d
19	27.7.d
16	27.7.d
12	27.7.d
2	27.7.d
8	27.7.d
10	27.7.d
14	27.7.d
1	27.7.d
18	27.7.d
7	27.7.d
8	27.7.d
12	27.7.d
14	27.7.d

Table 3b: Samples that are higher or lower than the average weigth at age +/- 3*standard deviation (outliers) for autoallocation

Table continues below

Country	Fleet	CatchCategory	WECA	AverageWtSize
UK (England)	OTB_CRU_16-31_0_0_all	Landings	209.6	136.3
France	DRB_all_0_0_all	Landings	26024	1369
France	DRB_all_0_0_all	Landings	13263	887.5
France	DRB_all_0_0_all	Landings	16727	1090
France	DRB_all_0_0_all	Landings	9308	810.8
UK (England)	OTB_CRU_16-31_0_0_all	Landings	209.6	136.3
Belgium	TBB_DEF_70-99_0_0_all	Landings	727.6	833.2
France	DRB_all_0_0_all	Landings	26024	1369
France	DRB_all_0_0_all	Landings	13263	887.5
France	DRB_all_0_0_all	Landings	16727	1090
France	DRB_all_0_0_all	Landings	9308	810.8
UK (England)	OTB_CRU_16-31_0_0_all	Landings	209.6	136.3
France	DRB_all_0_0_all	Landings	26024	1369
France	DRB_all_0_0_all	Landings	13263	887.5
France	DRB_all_0_0_all	Landings	16727	1090
France	DRB_all_0_0_all	Landings	9308	810.8
France	DRB_all_0_0_all	Landings	26024	1369
France	DRB_all_0_0_all	Landings	13263	887.5
France	DRB_all_0_0_all	Landings	16727	1090
France	DRB_all_0_0_all	Landings	9308	810.8
France	GTR_DEF_90-99_0_0_all	Landings	0	501.3
France	GTR_DEF_90-99_0_0_all	Landings	0	543.4
UK (England)	OTB_DEF_70-99_0_0_all	Landings	566.6	676.2
UK (England)	OTB_DEF_70-99_0_0_all	Landings	610.1	629.9
UK (England)	OTB_DEF_70-99_0_0_all	Landings	610.1	586.5
UK (England)	OTB_DEF_70-99_0_0_all	Landings	727.6	833.2
UK (England)	OTB_DEF_70-99_0_0_all	Landings	1012	563.3
UK (England)	TBB_DEF_70-99_0_0_all	Landings	727.6	833.2
UK (England)	OTB_CRU_16-31_0_0_all	Landings	209.6	136.3

AgeOrLength	Area
1	27.7.d
3	27.7.d
4	27.7.d
5	27.7.d
6	27.7.d
1	27.7.d
23	27.7.d
3	27.7.d
4	27.7.d
5	27.7.d
6	27.7.d
1	27.7.d
3	27.7.d
4	27.7.d

5	27.7.d
6	27.7.d
3	27.7.d
4	27.7.d
5	27.7.d
6	27.7.d
15	27.7.d
18	27.7.d
19	27.7.d
20	27.7.d
21	27.7.d
23	27.7.d
28	27.7.d
23	27.7.d
1	27.7.d

InterCatch output for 2004

This document uses Table 2 from CatchAndSampleDataTables.txt from the InterCatch outputs to describe the raising procedures that were made. In the following tables, CATON=WECA*CANUM/1000000 (in tonnes)

Raised discards

In InterCatch, the first step consists in raising the discards volumes for strata with landings and no discards associated. These discards are called in the following table 'Raised_Discards'. The data called 'Imported_Data' are landings or discards volumes imported into InterCatch with or without length/age structure.

The proportion of Landings with Discards associated (same strata) is **43 percent**.

The volumes (and associated proportion) of landings and discards imported (Imported_Data) or raised (Raised_Discards) are described in the following table.

Table 1a: Summary of the imported/Raised data for manual allocation

CatchCategory	RaisedOrImported	CATON	perc
Discards	Raised_Discards	176.7	57
Discards	Imported_Data	131.6	43
Landings	Imported_Data	6190	100

Table 1b: Summary of the imported/Raised data for autoallocation

CatchCategory	RaisedOrImported	CATON	perc
Discards	Raised_Discards	176.7	57
Discards	Imported_Data	131.6	43
Landings	Imported_Data	6184	100

Length/Age distribution

For the imported landings/discards and the raised discards without age distribution, the length or age distribution is then computed using the defined allocation scheme. *Sampled_distribution* means that the data (ladings or discards) were input with age/length distribution. *Estimated_distribution* means that the imported/raised volumes were estimated using the allocation scheme.

Table 2a: Summary of the imported/Raised/SampledOrEstimated data for manual allocation

CatchCategory	RaisedOrImported	SampledOrEstimated	CATON	perc
Landings	Imported_Data	Sampled_Distribution	5070	82
Landings	Imported_Data	Estimated_Distribution	1120	18
Discards	Raised_Discards	Estimated_Distribution	176.7	57
Discards	Imported_Data	Sampled_Distribution	77.25	25
Discards	Imported_Data	Estimated_Distribution	54.4	18

Table 2b: Summary of the imported/Raised/SampledOrEstimated data for autoallocation

CatchCategory	RaisedOrImported	SampledOrEstimated	CATON	perc
Landings	Imported_Data	Sampled_Distribution	5070	82
Landings	Imported_Data	Estimated_Distribution	1114	18
Discards	Raised_Discards	Estimated_Distribution	176.7	57
Discards	Imported_Data	Sampled_Distribution	77.25	25
Discards	Imported_Data	Estimated_Distribution	54.4	18

Impact of the raising on the age/length structure

Once the samples imported or raised are identified, it is possible to check the impact of the allocation scheme on the mean age/length of the final age/length distribution of the stock. The following figures compare the mean age (computed as the weighted mean of the age per stratum ("CatchCategory",'RaisedOrImported','SampledOrEstimated","Country","Area","Season","Fleet","Sex") of the estimated

strata compared to the imported ones and the final distribution. Each individual included in the boxplot corresponds to the weighted mean age of a stratum.

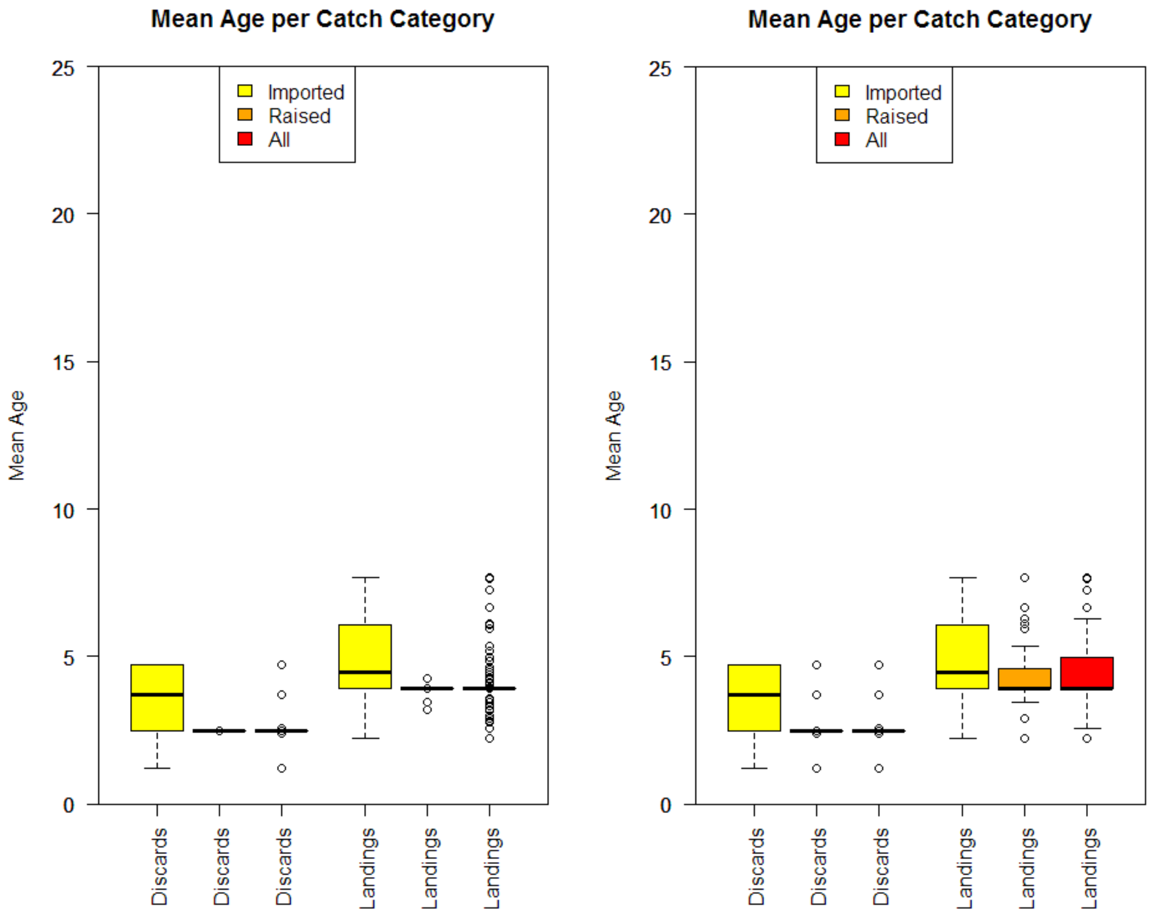


Figure 1: Mean Age per catch category (left: manual allocation; right: autoallocation)

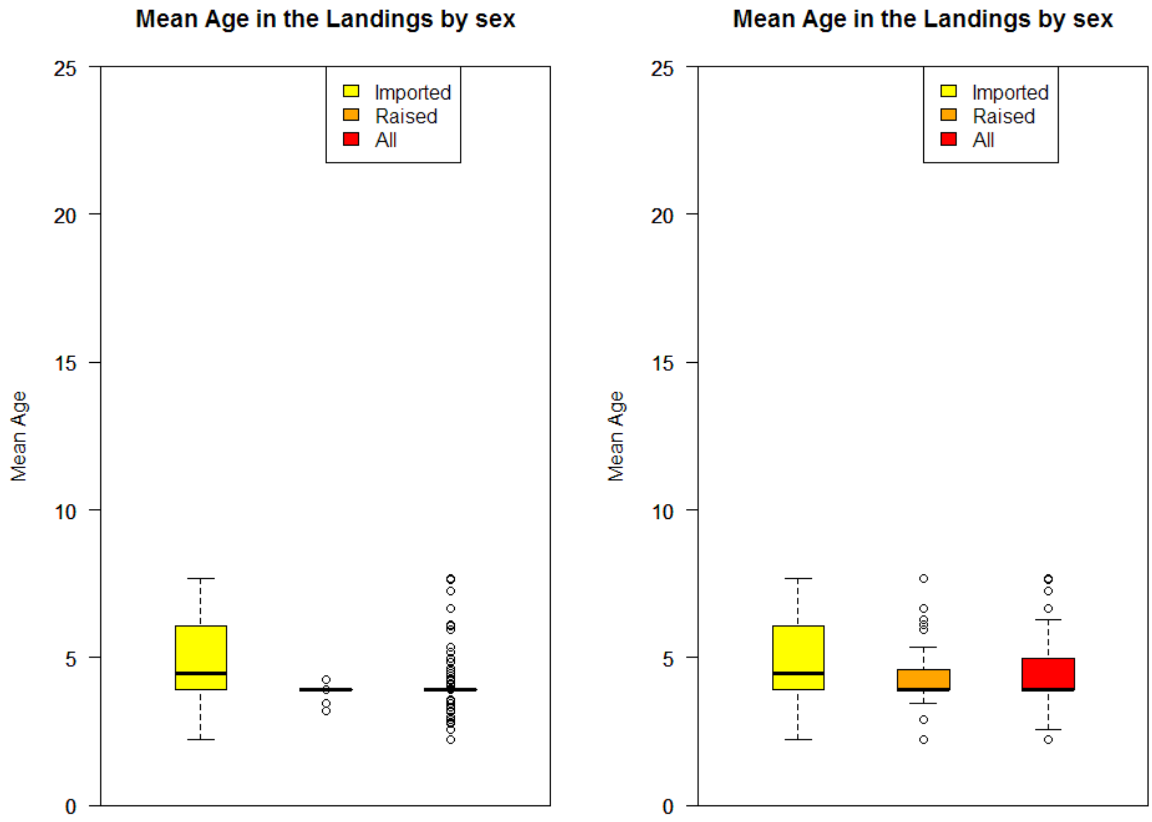


Figure 2: Mean Age in the Landings by sex (left: manual allocation; right: autoallocation)

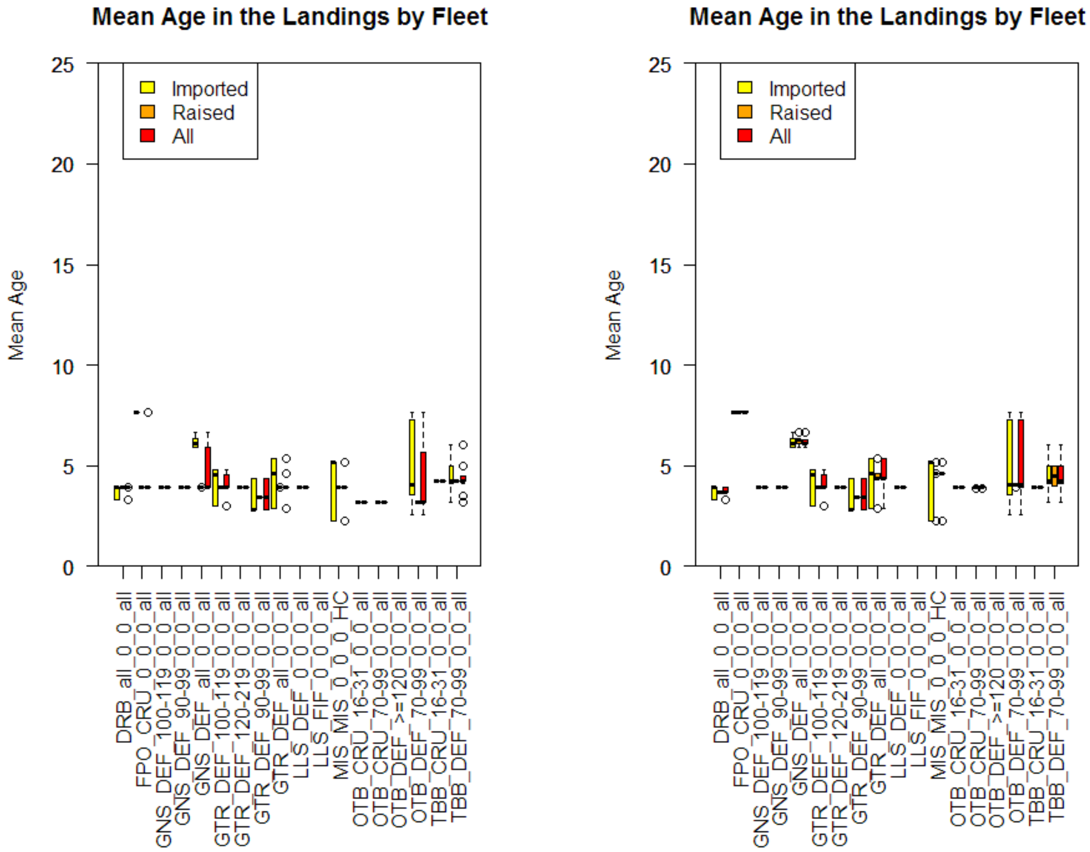


Figure 3: Mean Age in the Landings by Fleet (left: manual allocation; right: autoallocation)

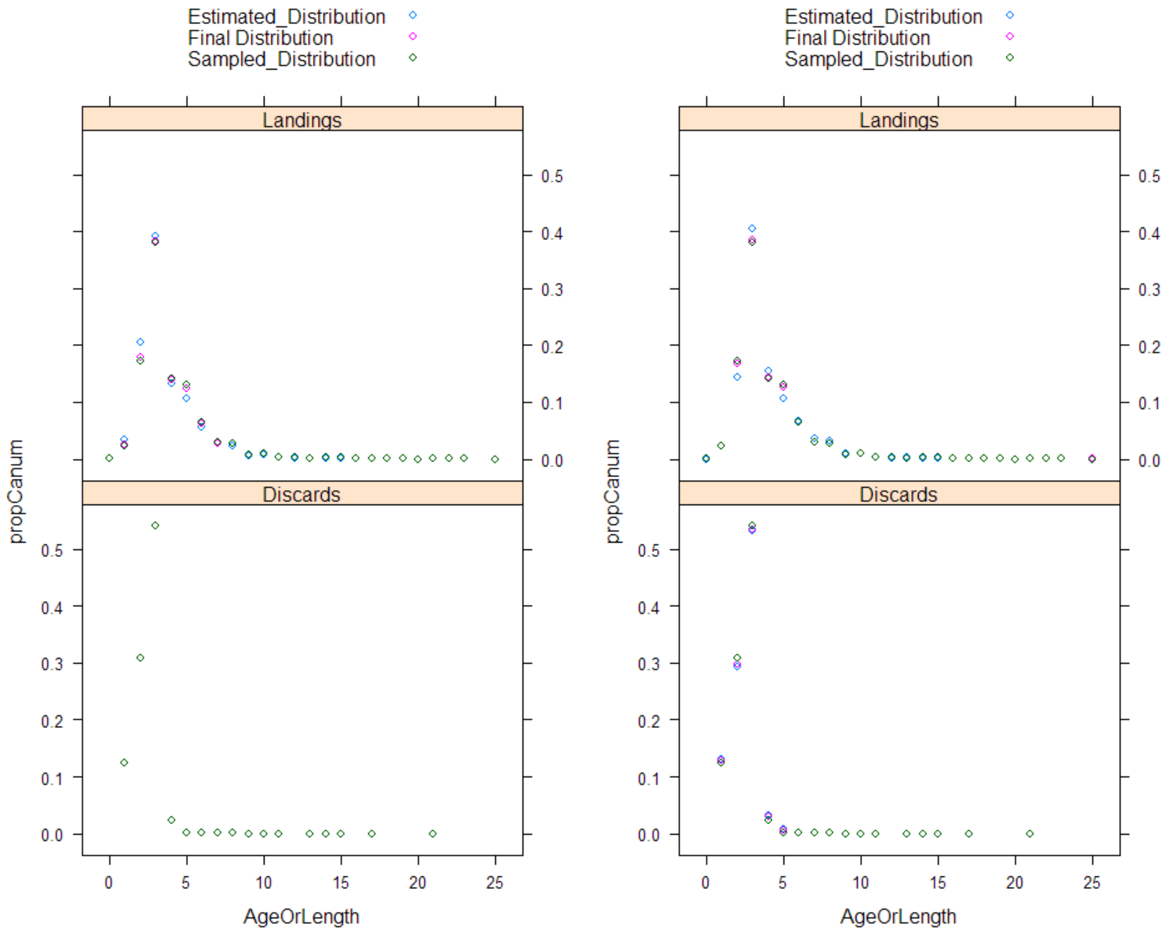


Figure 4: The percentage of each age for the sampled strata, estimated and the final age structure for the landing and discard fractions (left: manual allocation; right: autoallocation)

Impact of the raising on the mean weight

The CatchAndSampleData also provide the weight at age per stratum for the Sampled/Estimated strata. One should also check the sampled/estimated and resulting weight at age.

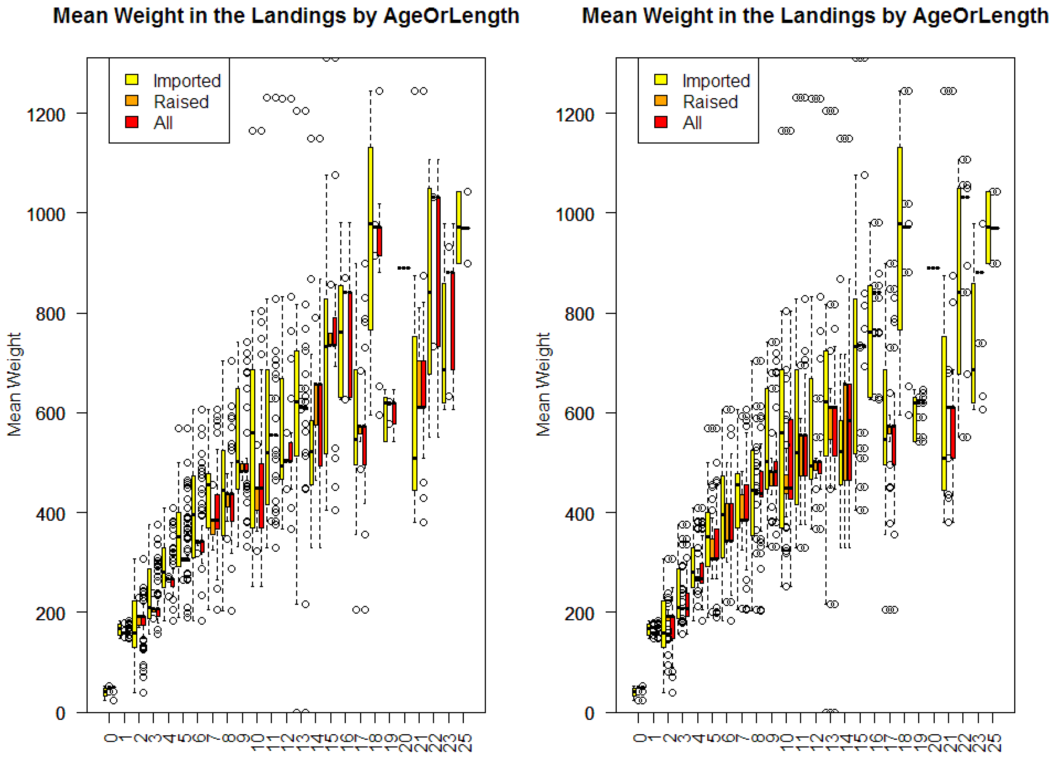


Figure 5: Each boxplot represents the distribution of the weight at age for the different strata (left: manual allocation; right: autoallocation)

Table 3a: Samples that are higher or lower than the average weigth at age +/- 3*standard deviation (outliers) for manual allocation

Table continues below

Country	Fleet	CatchCategory	WECA	AverageWtSize
France	GTR_DEF_100-119_0_0_all	Landings	39.07	180.8
UK (England)	GNS_DEF_all_0_0_all	Landings	569.6	317.1
UK (England)	GNS_DEF_all_0_0_all	Landings	605.4	357.9
UK (England)	GNS_DEF_all_0_0_all	Landings	704.6	433.5
UK (England)	TBB_DEF_70-99_0_0_all	Landings	404.9	759.9
UK (England)	TBB_DEF_70-99_0_0_all	Landings	899.2	970.5
France	DRB_all_0_0_all	Landings	202.4	433.5
France	GTR_DEF_100-119_0_0_all	Landings	0	607.5
France	MIS_MIS_0_0_0_HC	Landings	206.2	562.8
France	MIS_MIS_0_0_0_HC	Landings	215.4	607.5
UK (England)	FPO_CRU_0_0_0_all	Landings	1245	956.9
UK (England)	FPO_CRU_0_0_0_all	Landings	1245	658.1
UK (England)	FPO_CRU_0_0_0_all	Landings	1229	529.2
UK (England)	FPO_CRU_0_0_0_all	Landings	1204	607.5
UK (England)	FPO_CRU_0_0_0_all	Landings	1310	759.9
UK (England)	FPO_CRU_0_0_0_all	Landings	1150	604.1
UK (England)	FPO_CRU_0_0_0_all	Landings	740.8	500

UK (England)	FPO_CRU_0_0_0_all	Landings	1166	472.5
UK (England)	FPO_CRU_0_0_0_all	Landings	1231	560.7
UK (England)	GNS_DEF_all_0_0_all	Landings	347.4	214.5
UK (England)	OTB_DEF_70-99_0_0_all	Landings	1245	956.9
France	GTR_DEF_100-119_0_0_all	Landings	23.11	49.42
France	GTR_DEF_90-99_0_0_all	Landings	720	500
France	TBB_DEF_70-99_0_0_all	Landings	720	500
UK (England)	GNS_DEF_all_0_0_all	Landings	898.5	562.8
UK (England)	GNS_DEF_all_0_0_all	Landings	335.7	214.5
UK (England)	OTB_DEF_70-99_0_0_all	Landings	568.1	357.9
UK (England)	OTB_DEF_70-99_0_0_all	Landings	499.6	317.1
UK (England)	OTB_DEF_70-99_0_0_all	Landings	652.4	956.9
UK (England)	TBB_DEF_70-99_0_0_all	Landings	595.3	956.9
UK (England)	OTB_DEF_70-99_0_0_all	Landings	408.4	270.9
UK (England)	OTB_DEF_70-99_0_0_all	Landings	375.2	214.5
UK (England)	OTB_DEF_70-99_0_0_all	Landings	307.5	180.8
UK (England)	TBB_DEF_70-99_0_0_all	Landings	1043	970.5

AgeOrLength	Area
2	27.7.d
5	27.7.d
6	27.7.d
8	27.7.d
15	27.7.d
25	27.7.d
8	27.7.d
13	27.7.d
17	27.7.d
13	27.7.d
18	27.7.d
21	27.7.d
12	27.7.d
13	27.7.d
15	27.7.d
14	27.7.d
9	27.7.d
10	27.7.d
11	27.7.d
3	27.7.d
18	27.7.d
0	27.7.d
9	27.7.d
9	27.7.d
17	27.7.d
3	27.7.d
6	27.7.d
5	27.7.d
18	27.7.d
18	27.7.d

4	27.7.d
3	27.7.d
2	27.7.d
25	27.7.d

Table 3b: Samples that are higher or lower than the average weigth at age +/- 3*standard deviation (outliers) for autoallocation

Table continues below

Country	Fleet	CatchCategory	WECA	AverageWtSize
Belgium	GNS_DEF_all_0_0_all	Landings	569.6	336.9
UK (England)	FPO_CRU_0_0_0_all	Landings	1166	511.9
UK (England)	FPO_CRU_0_0_0_all	Landings	1231	563.7
UK (England)	FPO_CRU_0_0_0_all	Landings	1229	543.3
UK (England)	FPO_CRU_0_0_0_all	Landings	1150	587.2
UK (England)	FPO_CRU_0_0_0_all	Landings	1166	511.9
UK (England)	FPO_CRU_0_0_0_all	Landings	1231	563.7
UK (England)	FPO_CRU_0_0_0_all	Landings	1229	543.3
UK (England)	FPO_CRU_0_0_0_all	Landings	1150	587.2
France	GTR_DEF_100-119_0_0_all	Landings	23.11	47.7
UK (England)	FPO_CRU_0_0_0_all	Landings	1166	511.9
UK (England)	FPO_CRU_0_0_0_all	Landings	1231	563.7
UK (England)	FPO_CRU_0_0_0_all	Landings	1229	543.3
UK (England)	FPO_CRU_0_0_0_all	Landings	1150	587.2
UK (England)	GNS_DEF_all_0_0_all	Landings	569.6	336.9
UK (England)	FPO_CRU_0_0_0_all	Landings	1229	543.3
UK (England)	FPO_CRU_0_0_0_all	Landings	1150	587.2
UK (England)	FPO_CRU_0_0_0_all	Landings	1166	511.9
UK (England)	FPO_CRU_0_0_0_all	Landings	1231	563.7
France	GTR_DEF_100-119_0_0_all	Landings	23.11	47.7
UK (England)	TBB_DEF_70-99_0_0_all	Landings	606.7	851.9
UK (England)	TBB_DEF_70-99_0_0_all	Landings	595.3	981.8

AgeOrLength	Area
5	27.7.d
10	27.7.d
11	27.7.d
12	27.7.d
14	27.7.d
10	27.7.d
11	27.7.d
12	27.7.d
14	27.7.d
0	27.7.d
10	27.7.d
11	27.7.d
12	27.7.d
14	27.7.d
5	27.7.d
12	27.7.d

14	27.7.d
10	27.7.d
11	27.7.d
0	27.7.d
23	27.7.d
18	27.7.d

InterCatch output for 2005

This document uses Table 2 from CatchAndSampleDataTables.txt from the InterCatch outputs to describe the raising procedures that were made. In the following tables, CATON=WECA*CANUM/1000000 (in tonnes)

Raised discards

In InterCatch, the first step consists in raising the discards volumes for strata with landings and no discards associated. These discards are called in the following table 'Raised_Discards'. The data called 'Imported_Data' are landings or discards volumes imported into InterCatch with or without length/age structure.

The proportion of Landings with Discards associated (same strata) is **35 percent** (manual) and **34 percent** (autoallocation).

The volumes (and associated proportion) of landings and discards imported (Imported_Data) or raised (Raised_Discards) are described in the following table.

Table 1a: Summary of the imported/Raised data for manual allocation

CatchCategory	RaisedOrImported	CATON	perc
Discards	Raised_Discards	212	66
Discards	Imported_Data	107.8	34
Landings	Imported_Data	4912	100

Table 1b: Summary of the imported/Raised data for autoallocation

CatchCategory	RaisedOrImported	CATON	perc
Discards	Raised_Discards	212	66
Discards	Imported_Data	107.8	34
Landings	Imported_Data	4947	100

Length/Age distribution

For the imported landings/discards and the raised discards without age distribution, the length or age distribution is then computed using the defined allocation scheme. *Sampled_distribution* means that the data (ladings or discards) were input with age/length distribution. *Estimated_distribution* means that the imported/raised volumes were estimated using the allocation scheme.

Table 2a: Summary of the imported/Raised/SampledOrEstimated data for manual allocation

CatchCategory	RaisedOrImported	SampledOrEstimated	CATON	perc
Landings	Imported_Data	Sampled_Distribution	4120	84
Landings	Imported_Data	Estimated_Distribution	791.9	16
Discards	Raised_Discards	Estimated_Distribution	212	66
Discards	Imported_Data	Sampled_Distribution	84.71	26
Discards	Imported_Data	Estimated_Distribution	23.08	7

Table 2b: Summary of the imported/Raised/SampledOrEstimated data for autoallocation

CatchCategory	RaisedOrImported	SampledOrEstimated	CATON	perc
Landings	Imported_Data	Sampled_Distribution	4120	83
Landings	Imported_Data	Estimated_Distribution	826.5	17
Discards	Raised_Discards	Estimated_Distribution	212	66
Discards	Imported_Data	Sampled_Distribution	84.71	26
Discards	Imported_Data	Estimated_Distribution	23.08	7

Impact of the raising on the age/length structure

Once the samples imported or raised are identified, it is possible to check the impact of the allocation scheme on the mean age/length of the final age/length distribution of the stock. The following figures compare the mean age (computed as the

weighted mean of the age per stratum ("CatchCategory",'RaisedOrImported',"SampledOrEstimated","Country","Area","Season","Fleet","Sex") of the estimated strata compared to the imported ones and the final distribution. Each individual included in the boxplot corresponds to the weighted mean age of a stratum.

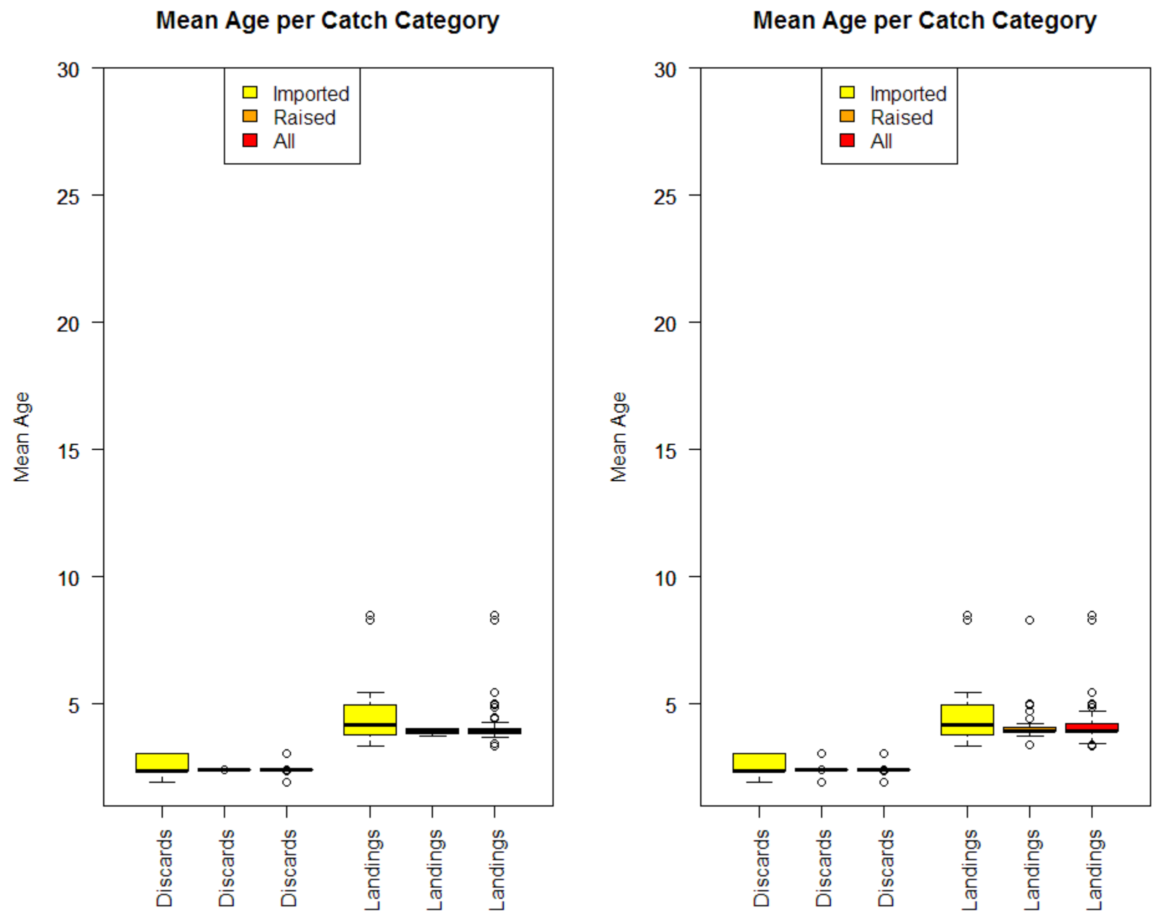


Figure 1: Mean Age per catch category (left: manual allocation; right: autoallocation)

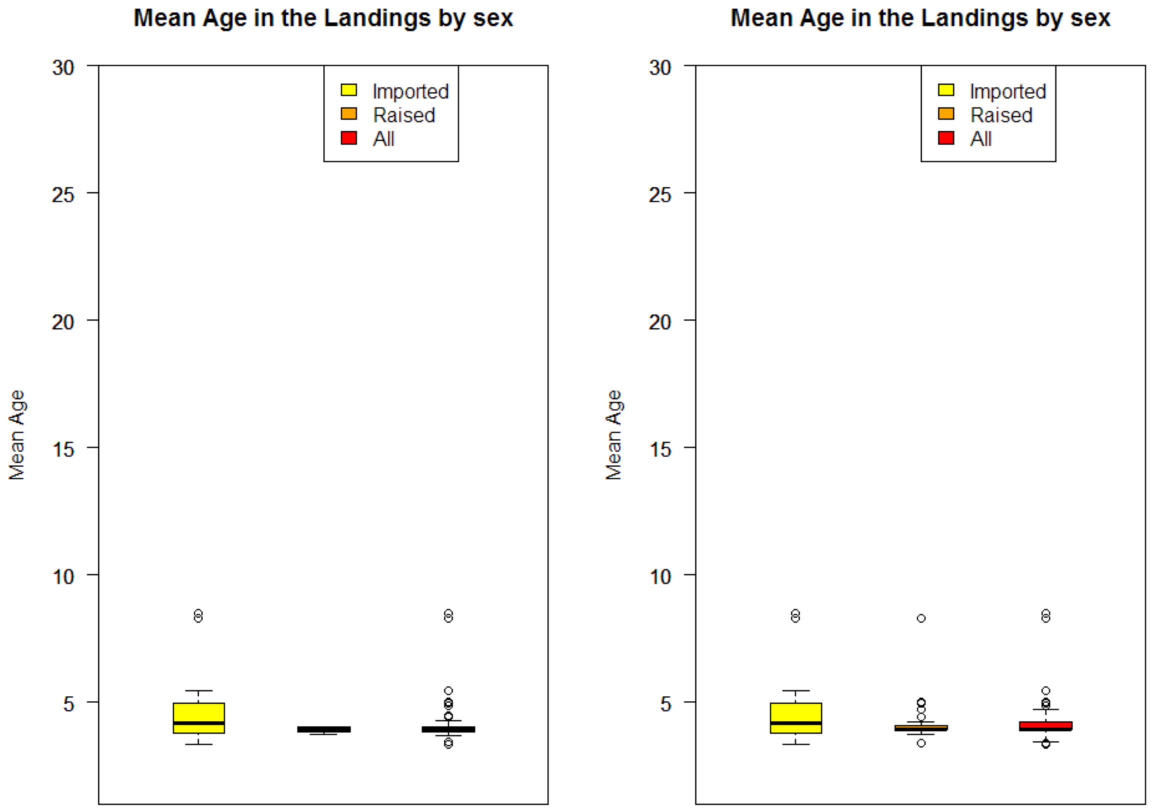


Figure 2: Mean Age in the Landings by sex (left: manual allocation; right: autoallocation)

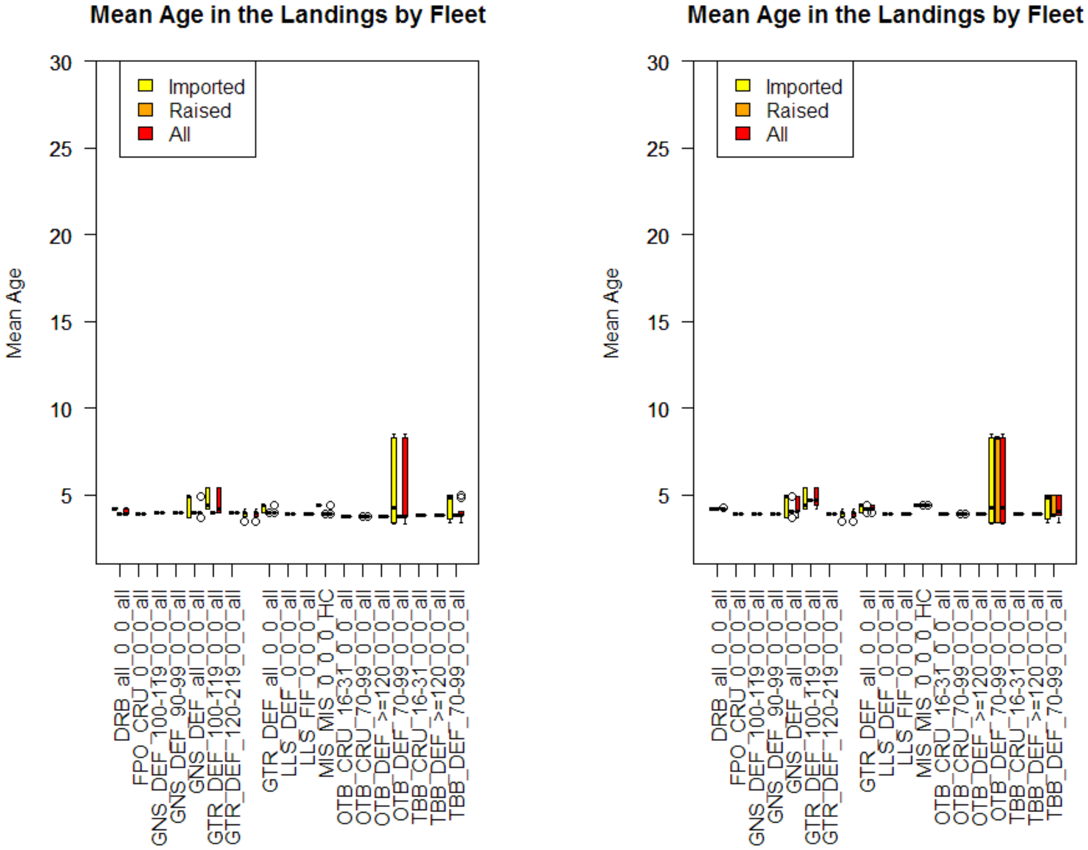


Figure 3: Mean Age in the Landings by Fleet (left: manual allocation; right: autoallocation)

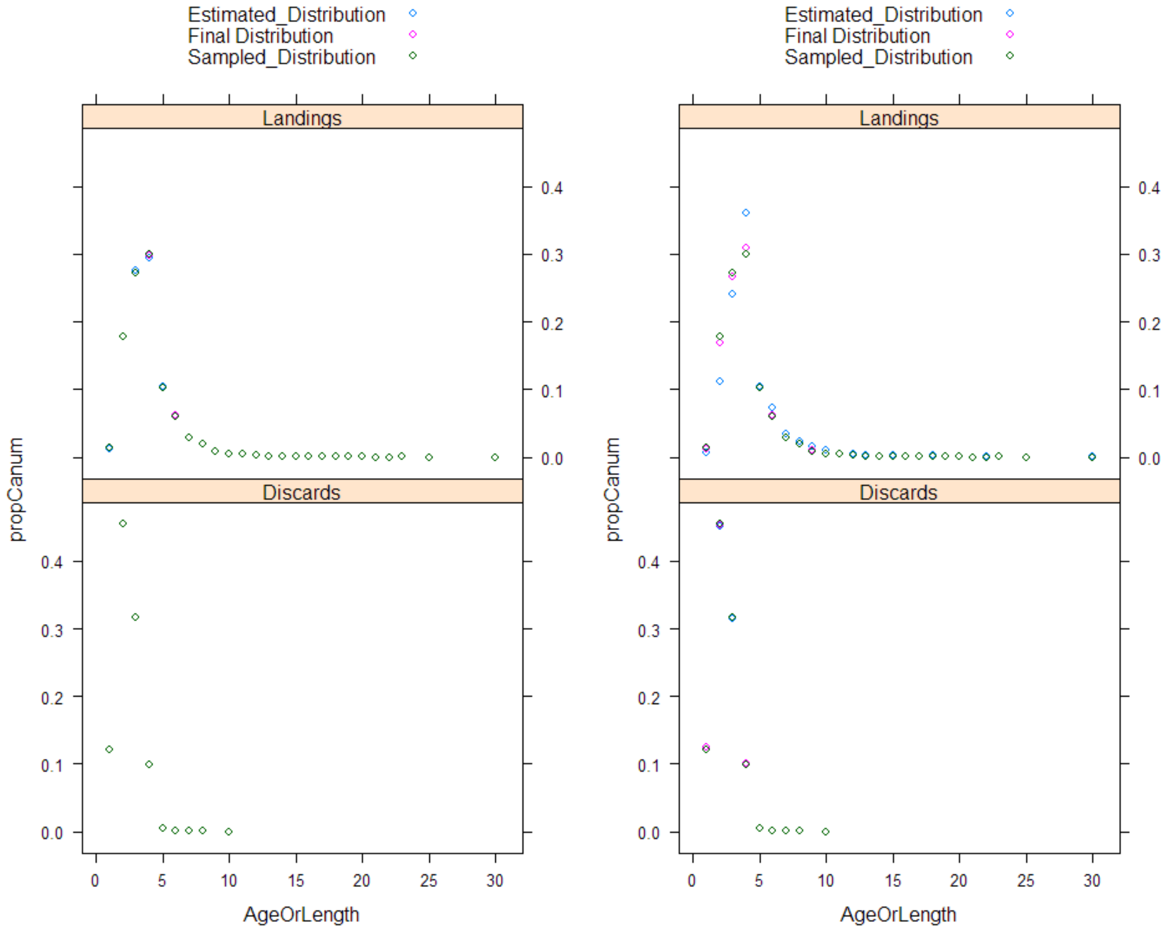


Figure 4: The percentage of each age for the sampled strata, estimated and the final age structure for the landing and discard fractions (left: manual allocation; right: autoallocation)

Impact of the raising on the mean weight

The CatchAndSampleData also provide the weight at age per stratum for the Sampled/Estimated strata. One should also check the sampled/estimated and resulting weight at age.

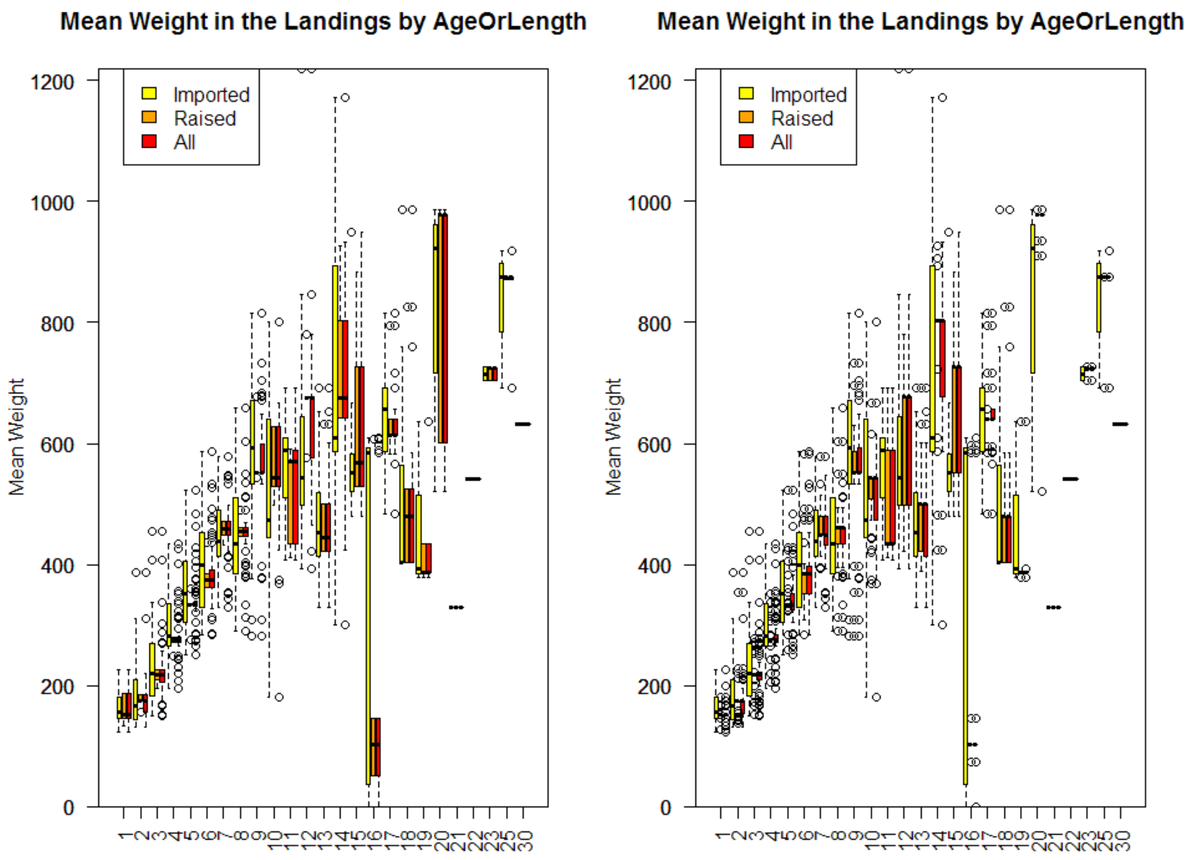


Figure 5: Each boxplot represents the distribution of the weight at age for the different strata (left: manual allocation; right: autoallocation)

Table 3a: Samples that are higher or lower than the average weigth at age +/- 3*standard deviation (outliers) for manual allocation

Table continues below

Country	Fleet	CatchCategory	WECA	AverageWtSize
UK (England)	GNS_DEF_all_0_0_all	Landings	308.5	573.3
UK (England)	OTB_DEF_70-99_0_0_all	Landings	522.8	334.8
UK (England)	OTB_DEF_70-99_0_0_all	Landings	602.2	454.5
UK (England)	OTB_DEF_70-99_0_0_all	Landings	635.5	404.3
France	DRB_all_0_0_all	Landings	329.7	454.6
France	DRB_all_0_0_all	Landings	281	573.3
France	MIS_MIS_0_0_0_HC	Landings	578.3	454.6
UK (England)	OTB_DEF_70-99_0_0_all	Landings	658.5	454.5
Belgium	TBB_DEF_70-99_0_0_all	Landings	1219	655.9
Belgium	TBB_DEF_70-99_0_0_all	Landings	1172	725.3
UK (England)	OTB_DEF_70-99_0_0_all	Landings	343.3	454.6
UK (England)	OTB_DEF_70-99_0_0_all	Landings	180.1	554
UK (England)	OTB_DEF_70-99_0_0_all	Landings	299.9	725.3
France	DRB_all_0_0_all	Landings	387.1	177

France	DRB_all_0_0_all	Landings	454.7	221.5
France	DRB_all_0_0_all	Landings	425.8	278.2
France	GTR_DEF_100-119_0_0_all	Landings	310.8	177
France	GTR_DEF_100-119_0_0_all	Landings	407.1	221.5
France	GTR_DEF_100-119_0_0_all	Landings	401.8	278.2
France	OTB_DEF_70-99_0_0_all	Landings	586.2	386.1
UK (England)	GNS_DEF_all_0_0_all	Landings	311.9	454.5
UK (England)	OTB_DEF_70-99_0_0_all	Landings	289.8	454.5
UK (England)	OTB_DEF_70-99_0_0_all	Landings	692.1	871
UK (England)	TBB_DEF_70-99_0_0_all	Landings	433.8	278.2
UK (England)	TBB_DEF_70-99_0_0_all	Landings	482.7	334.8
UK (England)	TBB_DEF_70-99_0_0_all	Landings	533.6	386.1
UK (England)	TBB_DEF_70-99_0_0_all	Landings	987.1	506.5

AgeOrLength	Area
9	27.7.d
5	27.7.d
8	27.7.d
19	27.7.d
7	27.7.d
9	27.7.d
7	27.7.d
8	27.7.d
12	27.7.d
14	27.7.d
7	27.7.d
10	27.7.d
14	27.7.d
2	27.7.d
3	27.7.d
4	27.7.d
2	27.7.d
3	27.7.d
4	27.7.d
6	27.7.d
8	27.7.d
8	27.7.d
25	27.7.d
4	27.7.d
5	27.7.d
6	27.7.d
18	27.7.d

Table 3b: Samples that are higher or lower than the average weigth at age +/- 3*standard deviation (outliers) for autoallocation

Table continues below

Country	Fleet	CatchCategory	WECA	AverageWtSize
France	DRB_all_0_0_all	Landings	353.4	178.7
France	OTB_DEF_70-99_0_0_all	Landings	522.8	342.3

France	OTB_DEF_70-99_0_0_all	Landings	635.5	397.5
France	OTB_DEF_70-99_0_0_all	Landings	703.3	723.3
France	TBB_DEF_70-99_0_0_all	Landings	825.3	486.1
UK (England)	TBB_DEF_70-99_0_0_all	Landings	825.3	486.1
France	DRB_all_0_0_all	Landings	353.4	178.7
Netherlands	OTB_DEF_70-99_0_0_all	Landings	582.2	381
Netherlands	OTB_DEF_70-99_0_0_all	Landings	692.1	867.4
France	GTR_DEF_90-99_0_0_all	Landings	800.7	519.6
UK (England)	OTB_DEF_70-99_0_0_all	Landings	522.8	342.3
UK (England)	OTB_DEF_70-99_0_0_all	Landings	635.5	397.5
UK (England)	OTB_DEF_70-99_0_0_all	Landings	703.3	723.3
UK (England)	OTB_DEF_70-99_0_0_all	Landings	658.5	449.1
UK (England)	OTB_DEF_70-99_0_0_all	Landings	520.9	962.9
Belgium	TBB_DEF_70-99_0_0_all	Landings	1219	613.2
UK (England)	OTB_DEF_70-99_0_0_all	Landings	180.1	519.6
France	DRB_all_0_0_all	Landings	387.1	178.7
France	DRB_all_0_0_all	Landings	454.7	223.4
France	DRB_all_0_0_all	Landings	425.8	283.6
France	GTR_DEF_100-119_0_0_all	Landings	226.1	155.2
France	GTR_DEF_100-119_0_0_all	Landings	310.8	178.7
France	GTR_DEF_100-119_0_0_all	Landings	407.1	223.4
France	GTR_DEF_100-119_0_0_all	Landings	401.8	283.6
France	OTB_DEF_70-99_0_0_all	Landings	586.2	381
UK (England)	OTB_DEF_70-99_0_0_all	Landings	692.1	867.4
UK (England)	TBB_DEF_70-99_0_0_all	Landings	433.8	283.6
UK (England)	TBB_DEF_70-99_0_0_all	Landings	987.1	486.1

AgeOrLength	Area
2	27.7.d
5	27.7.d
19	27.7.d
23	27.7.d
18	27.7.d
18	27.7.d
2	27.7.d
6	27.7.d
25	27.7.d
10	27.7.d
5	27.7.d
19	27.7.d
23	27.7.d
8	27.7.d
20	27.7.d
12	27.7.d
10	27.7.d
2	27.7.d
3	27.7.d
4	27.7.d

1	27.7.d
2	27.7.d
3	27.7.d
4	27.7.d
6	27.7.d
25	27.7.d
4	27.7.d
18	27.7.d

InterCatch output for 2006

This document uses Table 2 from CatchAndSampleDataTables.txt from the InterCatch outputs to describe the raising procedures that were made. In the following tables, CATON=WECA*CANUM/1000000 (in tonnes)

Raised discards

In InterCatch, the first step consists in raising the discards volumes for strata with landings and no discards associated. These discards are called in the following table 'Raised_Discards'. The data called 'Imported_Data' are landings or discards volumes imported into InterCatch with or without length/age structure.

The proportion of Landings with Discards associated (same strata) is **33 percent**.

The volumes (and associated proportion) of landings and discards imported (Imported_Data) or raised (Raised_Discards) are described in the following table.

Table 1a: Summary of the imported/Raised data for manual allocation

CatchCategory	RaisedOrImported	CATON	perc
Discards	Raised_Discards	154.1	67
Discards	Imported_Data	75.64	33
Landings	Imported_Data	5049	100

Table 1b: Summary of the imported/Raised data for autoallocation

CatchCategory	RaisedOrImported	CATON	perc
Discards	Raised_Discards	154.1	67
Discards	Imported_Data	75.64	33
Landings	Imported_Data	5048	100

Length/Age distribution

For the imported landings/discards and the raised discards without age distribution, the length or age distribution is then computed using the defined allocation scheme. *Sampled_distribution* means that the data (ladings or discards) were input with age/length distribution. *Estimated_distribution* means that the imported/raised volumes were estimated using the allocation scheme.

Table 2a: Summary of the imported/Raised/SampledOrEstimated data for manual allocation

CatchCategory	RaisedOrImported	SampledOrEstimated	CATON	perc
Landings	Imported_Data	Sampled_Distribution	3920	78
Landings	Imported_Data	Estimated_Distribution	1128	22
Discards	Raised_Discards	Estimated_Distribution	154.1	67
Discards	Imported_Data	Sampled_Distribution	75.64	33

Table 2b: Summary of the imported/Raised/SampledOrEstimated data for autoallocation

CatchCategory	RaisedOrImported	SampledOrEstimated	CATON	perc
Landings	Imported_Data	Sampled_Distribution	3920	78
Landings	Imported_Data	Estimated_Distribution	1128	22
Discards	Raised_Discards	Estimated_Distribution	154.1	67
Discards	Imported_Data	Sampled_Distribution	75.64	33

Impact of the raising on the age/length structure

Once the samples imported or raised are identified, it is possible to check the impact of the allocation scheme on the mean age/length of the final age/length distribution of the stock. The following figures compare the mean age (computed as the weighted mean of the age per stratum ("CatchCategory",'RaisedOrImported","SampledOrEstimated","Country","Area","Season","Fleet","Sex") of the estimated

strata compared to the imported ones and the final distribution. Each individual included in the boxplot corresponds to the weighted mean age of a stratum.

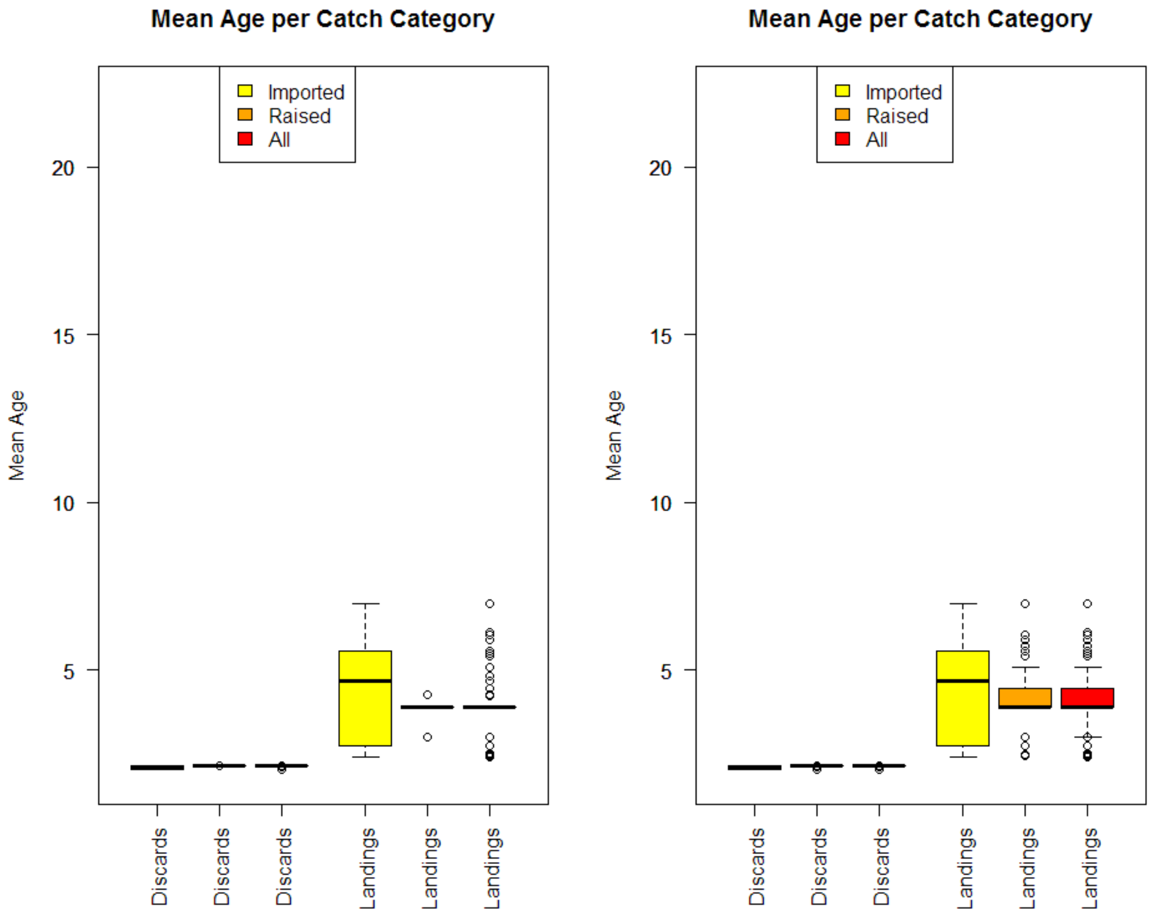


Figure 1: Mean Age per catch category (left: manual allocation; right: autoallocation)

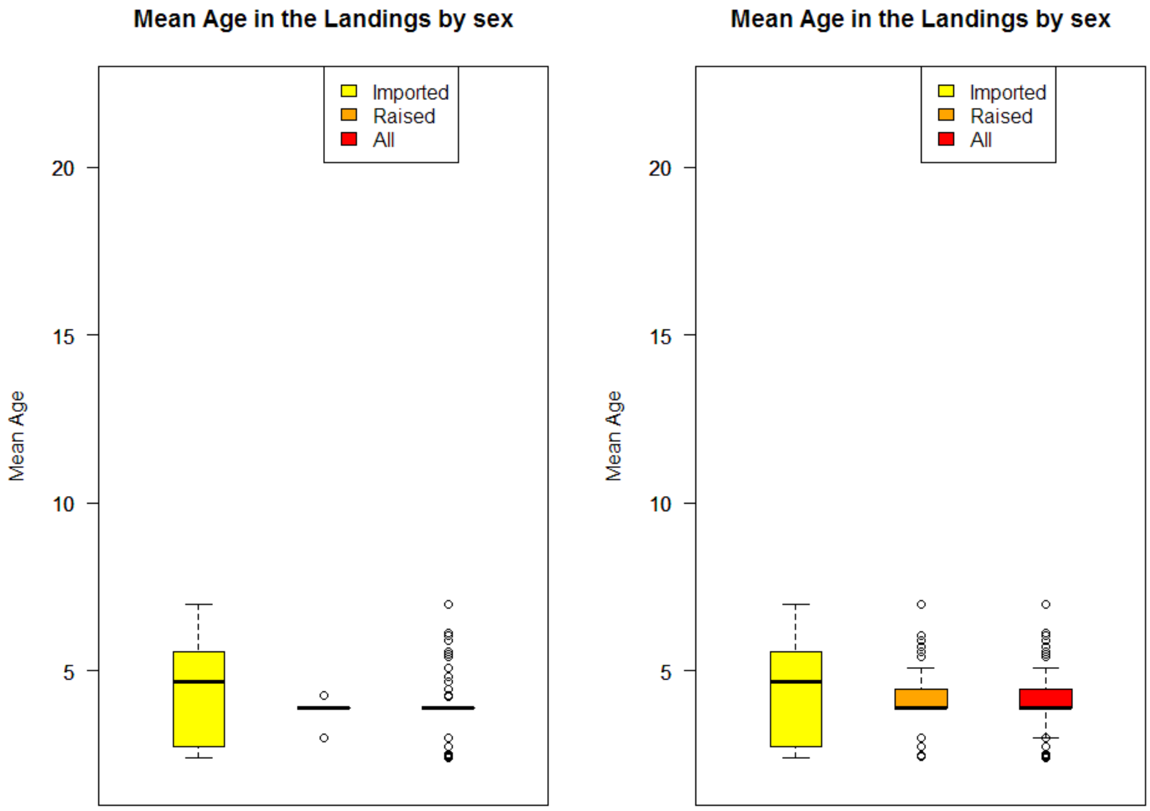


Figure 2: Mean Age in the Landings by sex (left: manual allocation; right: autoallocation)

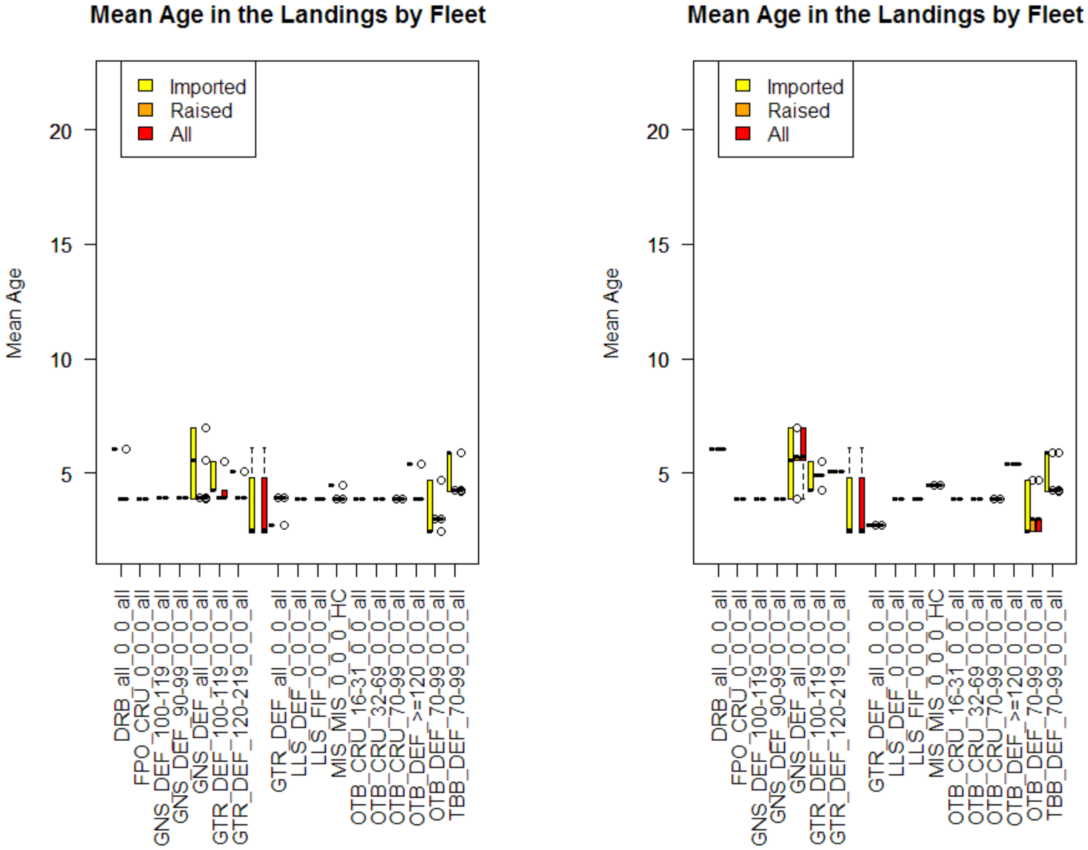


Figure 3: Mean Age in the Landings by Fleet (left: manual allocation; right: autoallocation)

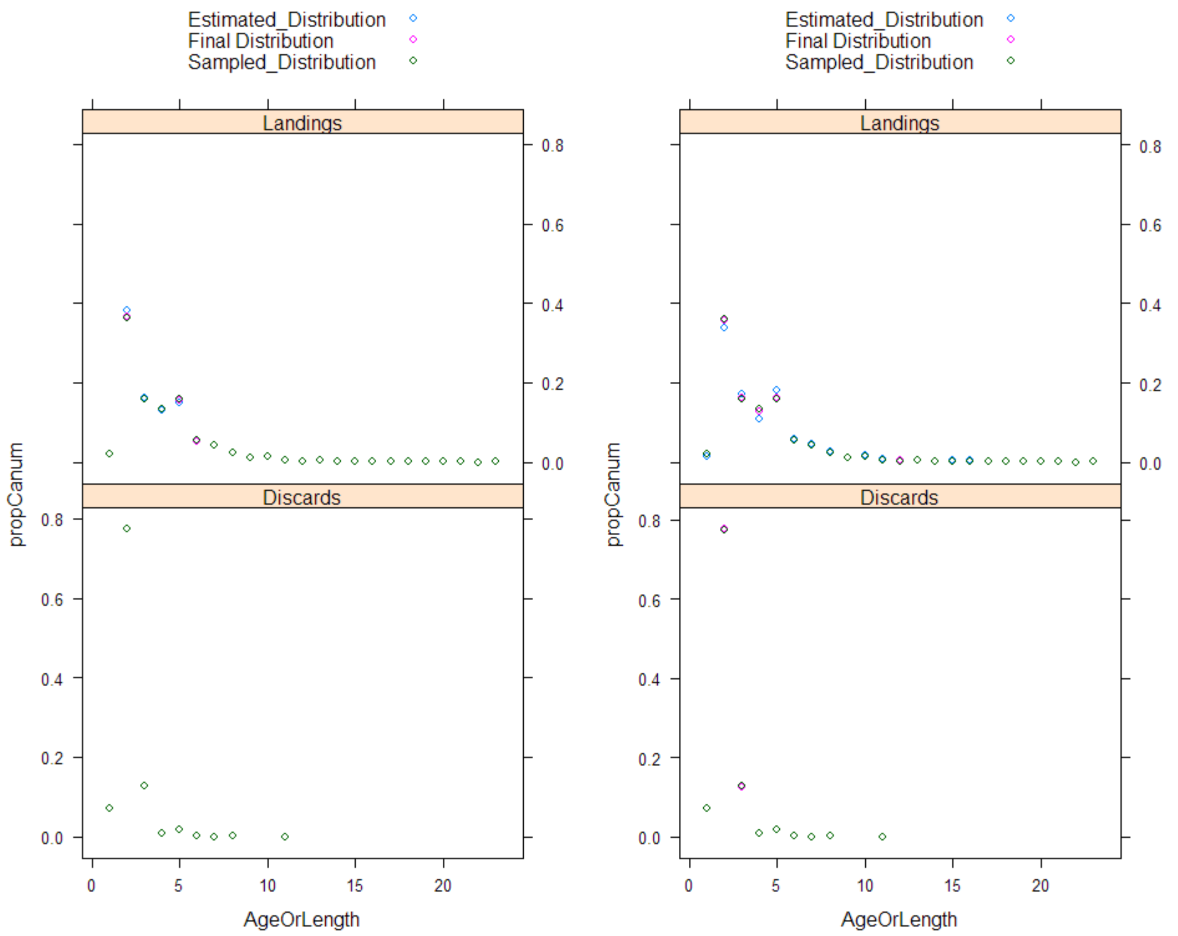


Figure 4: The percentage of each age for the sampled strata, estimated and the final age structure for the landing and discard fractions (left: manual allocation; right: autoallocation)

Impact of the raising on the mean weight

The CatchAndSampleData also provide the weight at age per stratum for the Sampled/Estimated strata. One should also check the sampled/estimated and resulting weight at age.

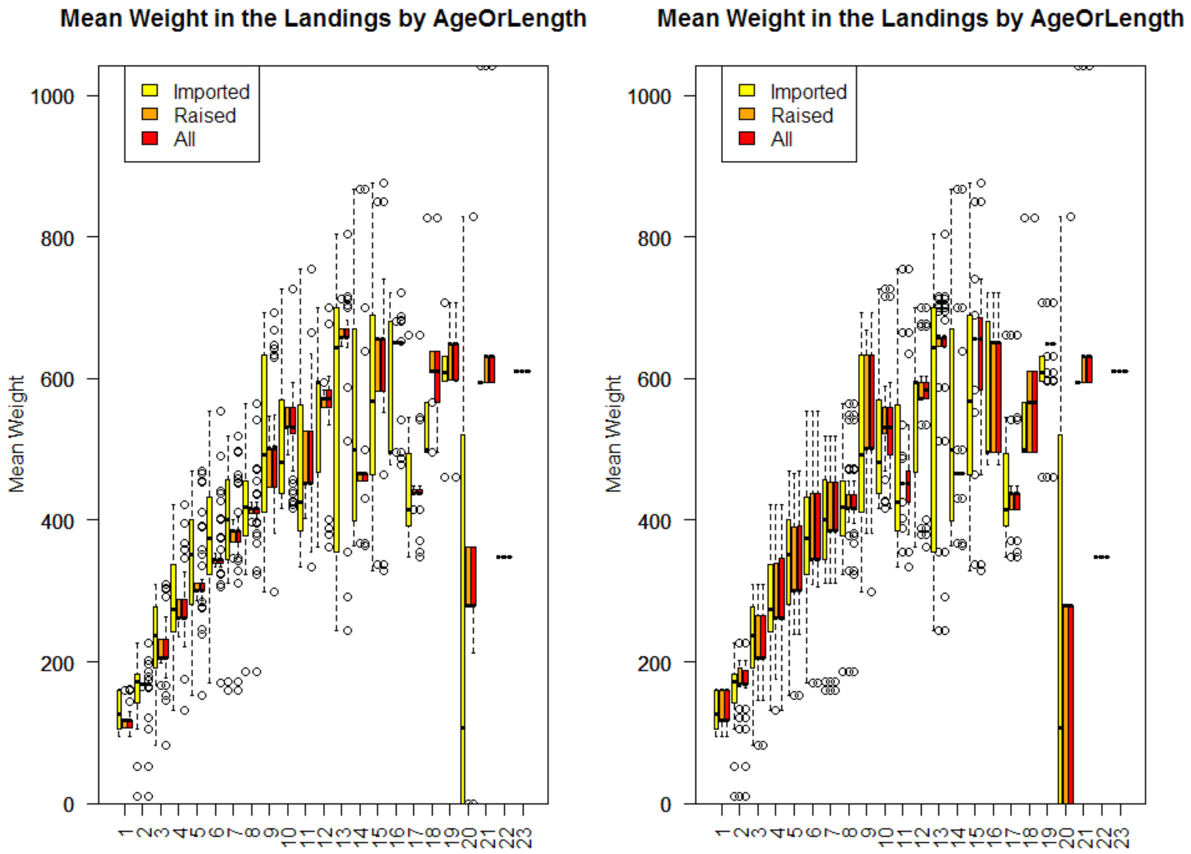


Figure 5: Each boxplot represents the distribution of the weight at age for the different strata (left: manual allocation; right: autoallocation)

Table 3a: Samples that are higher or lower than the average weigth at age +/- 3*standard deviation (outliers) for manual allocation

Table continues below

Country	Fleet	CatchCategory	WECA	AverageWtSize
France	DRB_all_0_0_all	Landings	665.5	476.3
France	GTR_DEF_120-219_0_0_all	Landings	152.4	311.8
France	GTR_DEF_120-219_0_0_all	Landings	170.9	348.9
France	GTR_DEF_120-219_0_0_all	Landings	172.4	379.2
France	GTR_DEF_120-219_0_0_all	Landings	186.3	413.1
France	GTR_DEF_120-219_0_0_all	Landings	380	567.2
France	GTR_DEF_90-99_0_0_all	Landings	400.2	567.2
France	GTR_DEF_90-99_0_0_all	Landings	826.8	597.5
UK (England)	GNS_DEF_all_0_0_all	Landings	387.9	567.2
UK (England)	GNS_DEF_all_0_0_all	Landings	354.6	648.9
UK (England)	GNS_DEF_all_0_0_all	Landings	541.5	439.1
UK (England)	GNS_DEF_all_0_0_all	Landings	460.4	634.2
France	GTR_DEF_100-119_0_0_all	Landings	52.11	166.8
France	OTB_DEF_70-99_0_0_all	Landings	9.64	166.8

France	OTB_DEF_70-99_0_0_all	Landings	82.26	214
UK (England)	GNS_DEF_all_0_0_all	Landings	131.6	272.6
UK (England)	GNS_DEF_all_0_0_all	Landings	553.5	348.9
UK (England)	GNS_DEF_all_0_0_all	Landings	565.3	413.1
UK (England)	GNS_DEF_all_0_0_all	Landings	726.3	529.4
UK (England)	GNS_DEF_all_0_0_all	Landings	754.1	476.3
UK (England)	GNS_DEF_all_0_0_all	Landings	661.7	439.1
France	GTR_DEF_100-119_0_0_all	Landings	468.7	311.8
France	GTR_DEF_90-99_0_0_all	Landings	694	493.8
France	GTR_DEF_90-99_0_0_all	Landings	829	280.2
France	GTR_DEF_all_0_0_all	Landings	454	311.8
France	MIS_MIS_0_0_0_HC	Landings	396.3	272.6
France	MIS_MIS_0_0_0_HC	Landings	465.8	311.8
France	MIS_MIS_0_0_0_HC	Landings	519	379.2
France	MIS_MIS_0_0_0_HC	Landings	541.4	413.1
UK (England)	OTB_DEF_>=120_0_0_all	Landings	422.4	272.6
UK (England)	OTB_DEF_>=120_0_0_all	Landings	456.1	311.8
UK (England)	OTB_DEF_>=120_0_0_all	Landings	490.3	348.9
France	GTR_DEF_90-99_0_0_all	Landings	298.8	493.8
France	GTR_DEF_90-99_0_0_all	Landings	362.8	567.2
France	GTR_DEF_90-99_0_0_all	Landings	292	648.9
France	GTR_DEF_90-99_0_0_all	Landings	545	439.1
UK (England)	GNS_DEF_all_0_0_all	Landings	244.9	648.9
UK (England)	OTB_DEF_70-99_0_0_all	Landings	160.4	379.2
UK (England)	OTB_DEF_70-99_0_0_all	Landings	244.9	648.9

AgeOrLength	Area
11	27.7.d
5	27.7.d
6	27.7.d
7	27.7.d
8	27.7.d
12	27.7.d
12	27.7.d
18	27.7.d
12	27.7.d
13	27.7.d
17	27.7.d
19	27.7.d
2	27.7.d
2	27.7.d
3	27.7.d
4	27.7.d
6	27.7.d
8	27.7.d
10	27.7.d
11	27.7.d
17	27.7.d

5	27.7.d
9	27.7.d
20	27.7.d
5	27.7.d
4	27.7.d
5	27.7.d
7	27.7.d
8	27.7.d
4	27.7.d
5	27.7.d
6	27.7.d
9	27.7.d
12	27.7.d
13	27.7.d
17	27.7.d
13	27.7.d
7	27.7.d
13	27.7.d

Table 3b: Samples that are higher or lower than the average weigth at age +/- 3*standard deviation (outliers) for autoallocation

Table continues below

Country	Fleet	CatchCategory	WECA	AverageWtSize
Belgium	GNS_DEF_all_0_0_all	Landings	460.4	644.7
Belgium	GNS_DEF_all_0_0_all	Landings	726.3	530.4
Belgium	GNS_DEF_all_0_0_all	Landings	754.1	468
Belgium	GNS_DEF_all_0_0_all	Landings	661.7	437.2
France	GTR_DEF_120-219_0_0_all	Landings	186.3	426.2
UK (England)	OTB_DEF_70-99_0_0_all	Landings	9.64	172.4
Belgium	GNS_DEF_all_0_0_all	Landings	661.1	437.2
France	GTR_DEF_120-219_0_0_all	Landings	186.3	426.2
UK (England)	GNS_DEF_all_0_0_all	Landings	661.1	437.2
France	GTR_DEF_120-219_0_0_all	Landings	186.3	426.2
France	GTR_DEF_120-219_0_0_all	Landings	186.3	426.2
France	GTR_DEF_90-99_0_0_all	Landings	826.8	557.8
UK (England)	GNS_DEF_all_0_0_all	Landings	460.4	644.7
France	GTR_DEF_100-119_0_0_all	Landings	52.11	172.4
France	OTB_DEF_70-99_0_0_all	Landings	9.64	172.4
UK (England)	GNS_DEF_all_0_0_all	Landings	726.3	530.4
UK (England)	GNS_DEF_all_0_0_all	Landings	754.1	468
UK (England)	GNS_DEF_all_0_0_all	Landings	661.7	437.2
France	GTR_DEF_90-99_0_0_all	Landings	829	208.1
France	GTR_DEF_90-99_0_0_all	Landings	362.8	570.1

AgeOrLength	Area
19	27.7.d
10	27.7.d
11	27.7.d
17	27.7.d

8	27.7.d
2	27.7.d
17	27.7.d
8	27.7.d
17	27.7.d
8	27.7.d
8	27.7.d
18	27.7.d
19	27.7.d
2	27.7.d
2	27.7.d
10	27.7.d
11	27.7.d
17	27.7.d
20	27.7.d
12	27.7.d

InterCatch output for 2007

This document uses Table 2 from CatchAndSampleDataTables.txt from the InterCatch outputs to describe the raising procedures that were made. In the following tables, CATON=WECA*CANUM/1000000 (in tonnes)

Raised discards

In InterCatch, the first step consists in raising the discards volumes for strata with landings and no discards associated. These discards are called in the following table 'Raised_Discards'. The data called 'Imported_Data' are landings or discards volumes imported into InterCatch with or without length/age structure.

The proportion of Landings with Discards associated (same strata) is **47 percent**.

The volumes (and associated proportion) of landings and discards imported (Imported_Data) or raised (Raised_Discards) are described in the following table.

Table 1a: Summary of the imported/Raised data for manual allocation

CatchCategory	RaisedOrImported	CATON	perc
Discards	Raised_Discards	200.9	53
Discards	Imported_Data	177.7	47
Landings	Imported_Data	5533	100

Table 1b: Summary of the imported/Raised data for autoallocation

CatchCategory	RaisedOrImported	CATON	perc
Discards	Raised_Discards	200.9	53
Discards	Imported_Data	177.8	47
Landings	Imported_Data	5501	100

Length/Age distribution

For the imported landings/discards and the raised discards without age distribution, the length or age distribution is then computed using the defined allocation scheme. *Sampled_distribution* means that the data (ladings or discards) were input with age/length distribution. *Estimated_distribution* means that the imported/raised volumes were estimated using the allocation scheme.

Table 2a: Summary of the imported/Raised/SampledOrEstimated data for manual allocation

CatchCategory	RaisedOrImported	SampledOrEstimated	CATON	perc
Landings	Imported_Data	Sampled_Distribution	3989	72
Landings	Imported_Data	Estimated_Distribution	1544	28
Discards	Raised_Discards	Estimated_Distribution	200.9	53
Discards	Imported_Data	Estimated_Distribution	91.41	24
Discards	Imported_Data	Sampled_Distribution	86.32	23

Table 2b: Summary of the imported/Raised/SampledOrEstimated data for autoallocation

CatchCategory	RaisedOrImported	SampledOrEstimated	CATON	perc
Landings	Imported_Data	Sampled_Distribution	3989	73
Landings	Imported_Data	Estimated_Distribution	1513	27
Discards	Raised_Discards	Estimated_Distribution	200.9	53
Discards	Imported_Data	Estimated_Distribution	91.46	24
Discards	Imported_Data	Sampled_Distribution	86.32	23

Impact of the raising on the age/length structure

Once the samples imported or raised are identified, it is possible to check the impact of the allocation scheme on the mean age/length of the final age/length distribution of the stock. The following figures compare the mean age (computed as the

weighted mean of the age per stratum ("CatchCategory",'RaisedOrImported',"SampledOrEstimated","Country","Area","Season","Fleet","Sex") of the estimated strata compared to the imported ones and the final distribution. Each individual included in the boxplot corresponds to the weighted mean age of a stratum.

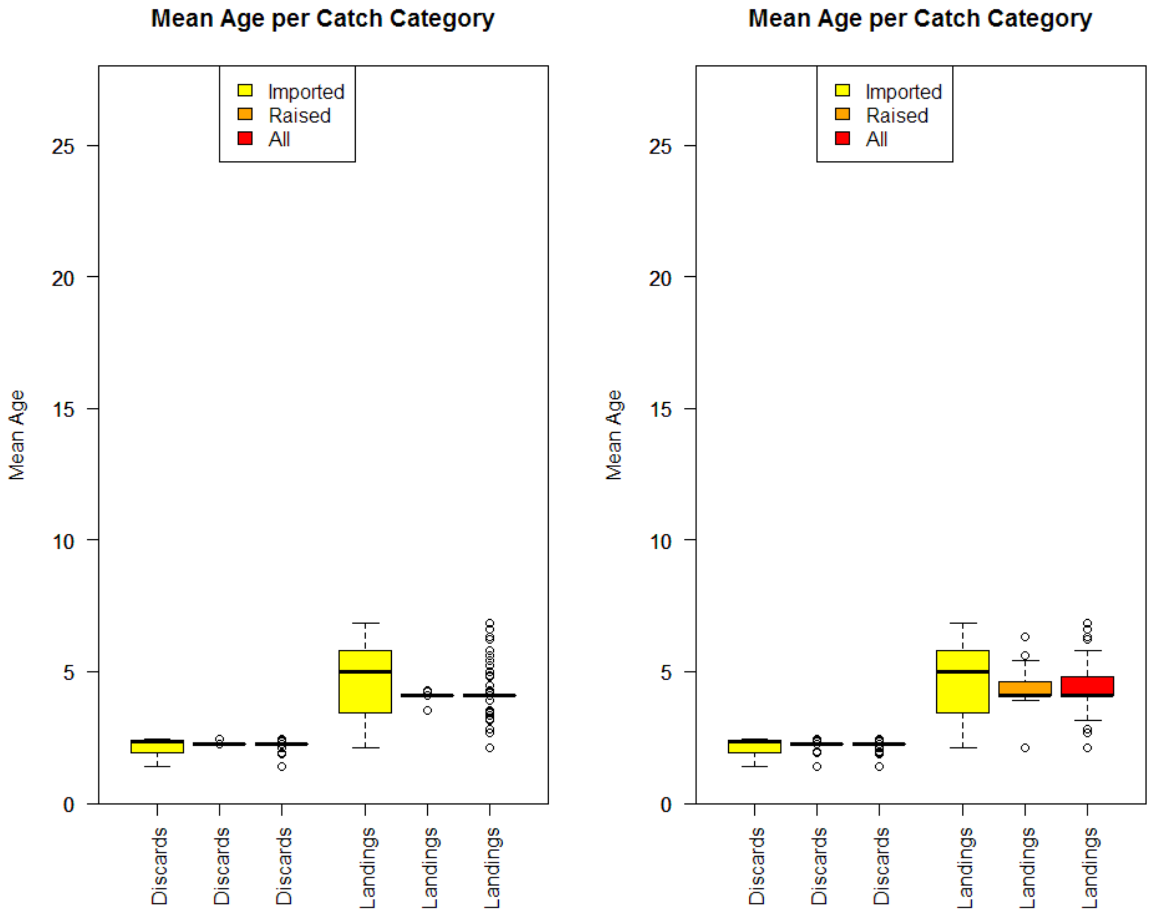


Figure 1: Mean Age per catch category (left: manual allocation; right: autoallocation)

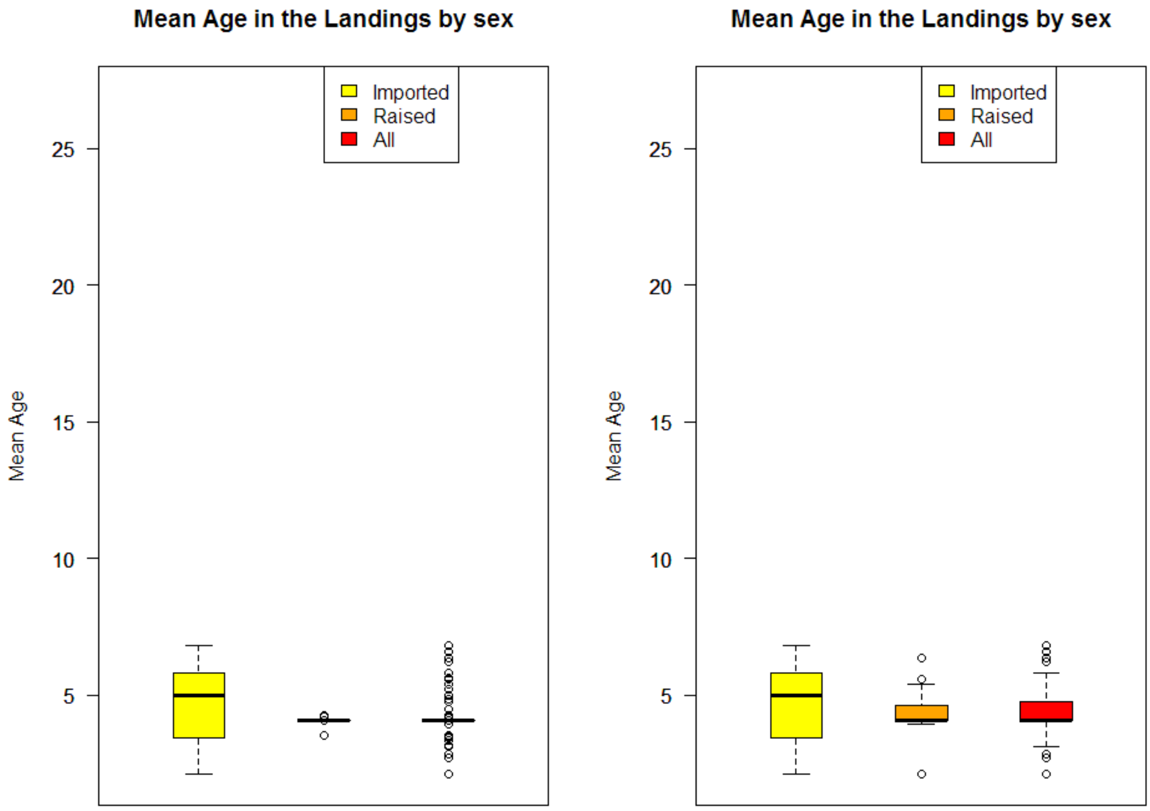


Figure 2: Mean Age in the Landings by sex (left: manual allocation; right: autoallocation)

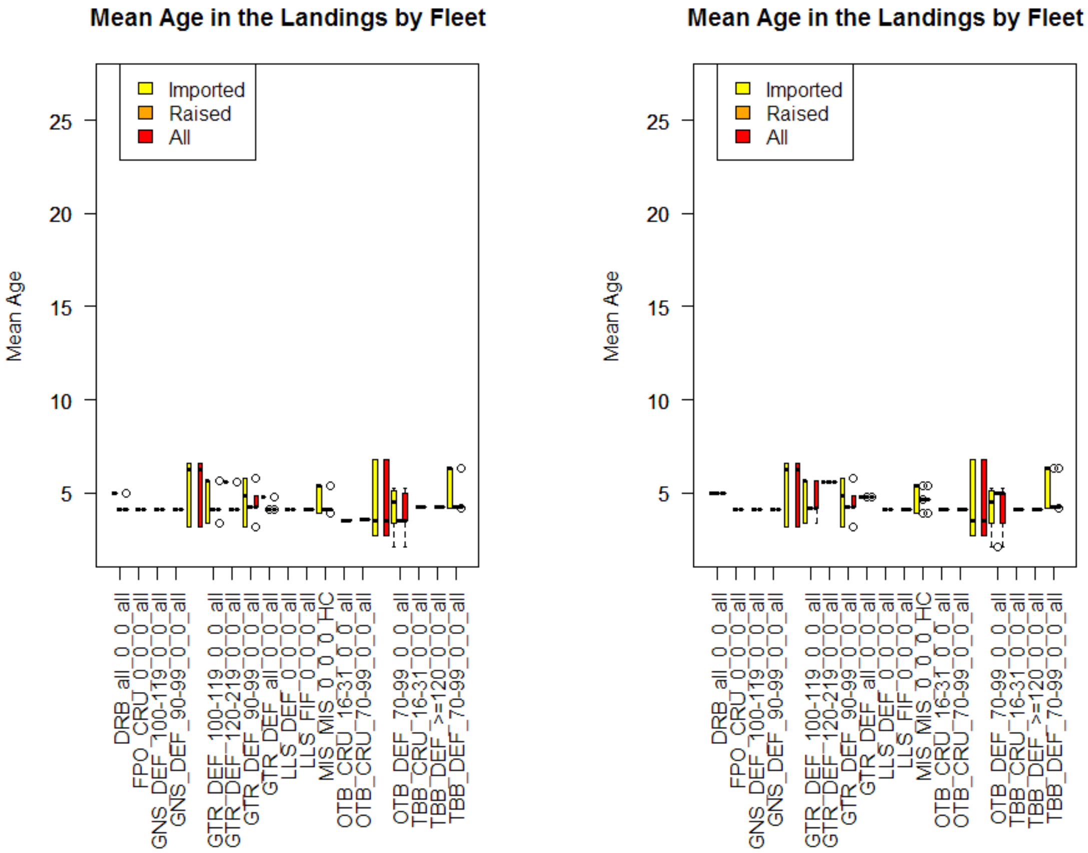


Figure 3: Mean Age in the Landings by Fleet (left: manual allocation; right: autoallocation)

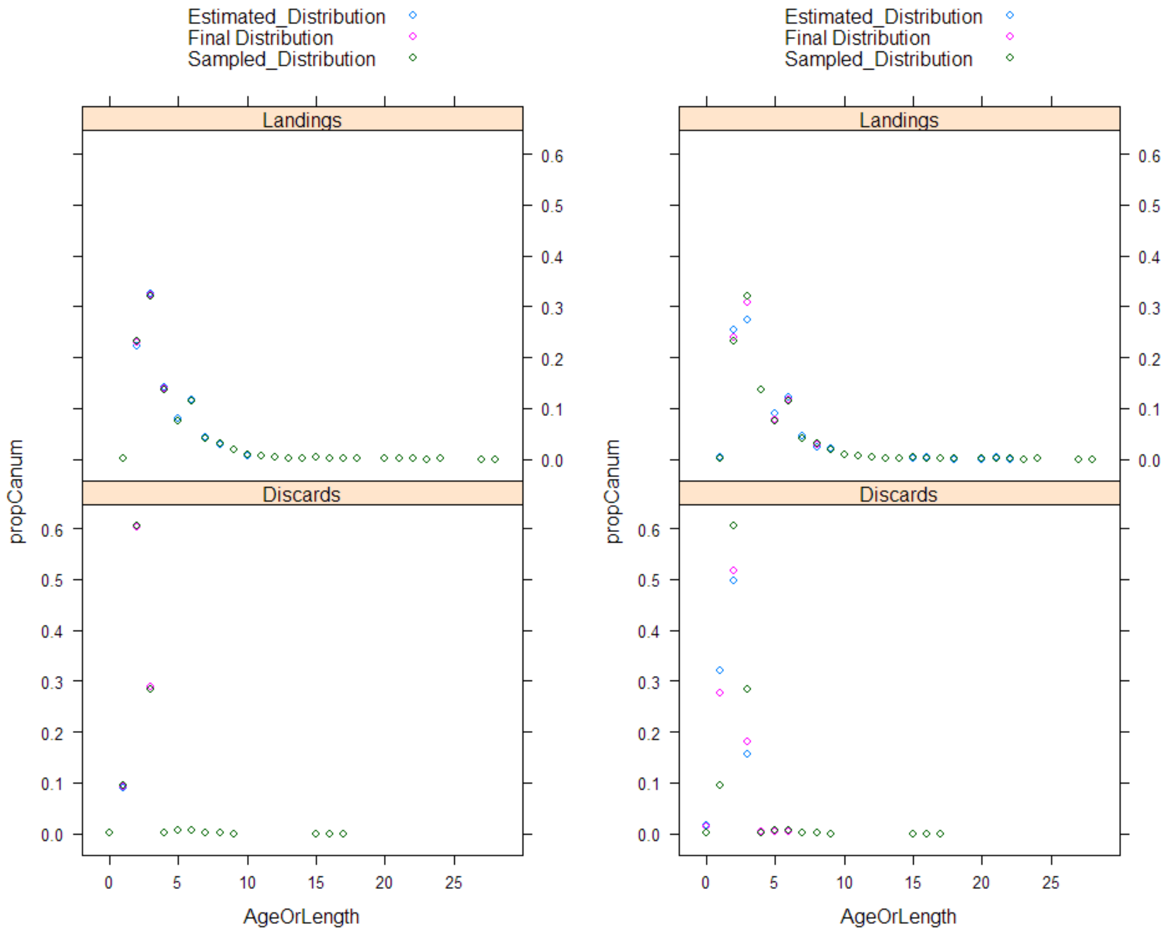


Figure 4: The percentage of each age for the sampled strata, estimated and the final age structure for the landing and discard fractions (left: manual allocation; right: autoallocation)

Impact of the raising on the mean weight

The CatchAndSampleData also provide the weight at age per stratum for the Sampled/Estimated strata. One should also check the sampled/estimated and resulting weight at age.

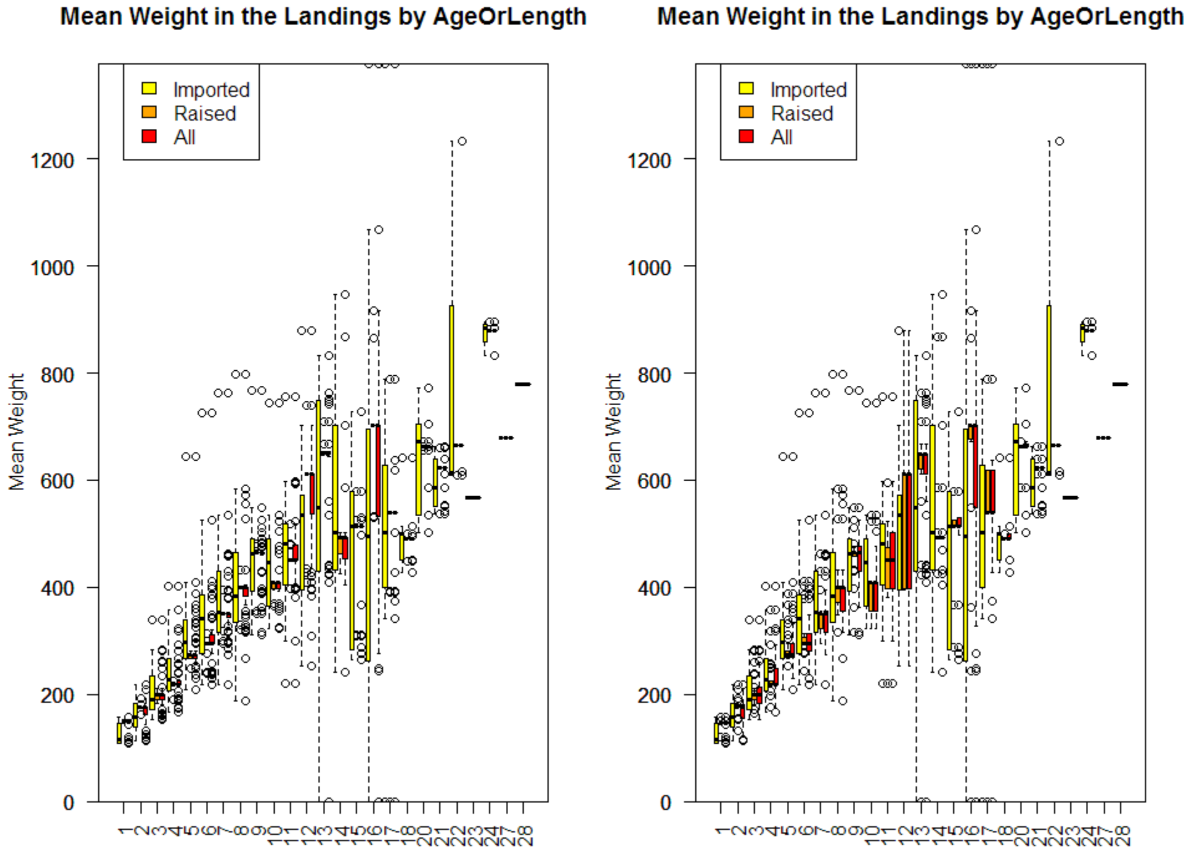


Figure 5: Each boxplot represents the distribution of the weight at age for the different strata (left: manual allocation; right: autoallocation)

Table 3a: Samples that are higher or lower than the average weigth at age +/- 3*standard deviation (outliers) for manual allocation

Table continues below

Country	Fleet	CatchCategory	WECA	AverageWtSize
France	GTR_DEF_90-99_0_0_all	Landings	0	542.3
France	GTR_DEF_90-99_0_0_all	Landings	536.7	624.5
France	GTR_DEF_120-219_0_0_all	Landings	1377	663.6
France	GTR_DEF_120-219_0_0_all	Landings	1377	542.3
France	GTR_DEF_90-99_0_0_all	Landings	0	663.6
France	GTR_DEF_90-99_0_0_all	Landings	0	542.3
UK (England)	GNS_DEF_all_0_0_all	Landings	743.9	409.6
UK (England)	GNS_DEF_all_0_0_all	Landings	947.2	489.6
UK (England)	GNS_DEF_all_0_0_all	Landings	773.3	660
UK (England)	GNS_DEF_all_0_0_all	Landings	1233	662.4
UK (England)	TBB_DEF_70-99_0_0_all	Landings	867.8	489.6
France	OTB_DEF_70-99_0_0_all	Landings	115.8	170.4
UK (England)	GNS_DEF_all_0_0_all	Landings	107.7	145.2
UK (England)	GNS_DEF_all_0_0_all	Landings	114.3	170.4

UK (England)	OTB_DEF_>=120_0_0_all	Landings	107.7	145.2
UK (England)	OTB_DEF_70-99_0_0_all	Landings	107.4	145.2
UK (England)	OTB_DEF_70-99_0_0_all	Landings	113.3	170.4
France	DRB_all_0_0_all	Landings	282.2	198.2
France	GTR_DEF_90-99_0_0_all	Landings	0	663.6
France	GTR_DEF_90-99_0_0_all	Landings	536.7	624.5
France	MIS_MIS_0_0_0_HC	Landings	0	639.3
France	MIS_MIS_0_0_0_HC	Landings	0	663.6
UK (England)	GNS_DEF_all_0_0_all	Landings	111	145.2
UK (England)	GNS_DEF_all_0_0_all	Landings	535.2	660
UK (England)	GNS_DEF_all_0_0_all	Landings	833.9	882.2
UK (England)	OTB_DEF_>=120_0_0_all	Landings	110.2	145.2
UK (England)	OTB_DEF_>=120_0_0_all	Landings	502.1	660
UK (England)	OTB_DEF_70-99_0_0_all	Landings	502.1	660
UK (England)	GNS_DEF_all_0_0_all	Landings	338.8	198.2
UK (England)	GNS_DEF_all_0_0_all	Landings	403	221.8
UK (England)	GNS_DEF_all_0_0_all	Landings	524.5	303.1
UK (England)	GNS_DEF_all_0_0_all	Landings	642.7	486.7
UK (England)	OTB_DEF_>=120_0_0_all	Landings	644	281.8
UK (England)	OTB_DEF_>=120_0_0_all	Landings	724.7	303.1
UK (England)	OTB_DEF_>=120_0_0_all	Landings	763.7	356.5
UK (England)	OTB_DEF_>=120_0_0_all	Landings	797.4	393.9
UK (England)	OTB_DEF_>=120_0_0_all	Landings	767.6	451.7
UK (England)	OTB_DEF_>=120_0_0_all	Landings	755.8	455.6
UK (England)	OTB_DEF_70-99_0_0_all	Landings	280.7	198.2
UK (England)	OTB_DEF_70-99_0_0_all	Landings	356.7	221.8
UK (England)	OTB_DEF_70-99_0_0_all	Landings	220.4	455.6

AgeOrLength	Area
17	27.7.d
21	27.7.d
16	27.7.d
17	27.7.d
16	27.7.d
17	27.7.d
10	27.7.d
14	27.7.d
20	27.7.d
22	27.7.d
14	27.7.d
2	27.7.d
1	27.7.d
2	27.7.d
1	27.7.d
1	27.7.d
2	27.7.d
3	27.7.d
16	27.7.d

21	27.7.d
13	27.7.d
16	27.7.d
1	27.7.d
20	27.7.d
24	27.7.d
1	27.7.d
20	27.7.d
20	27.7.d
3	27.7.d
4	27.7.d
6	27.7.d
18	27.7.d
5	27.7.d
6	27.7.d
7	27.7.d
8	27.7.d
9	27.7.d
11	27.7.d
3	27.7.d
4	27.7.d
11	27.7.d

Table 3b: Samples that are higher or lower than the average weigth at age +/- 3*standard deviation (outliers) for autoallocation

Table continues below

Country	Fleet	CatchCategory	WECA	AverageWtSize
France	TBB_DEF_70-99_0_0_all	Landings	867.8	510.2
UK (England)	MIS_MIS_0_0_0_HC	Landings	0	609
France	OTB_DEF_70-99_0_0_all	Landings	220.4	456.2
UK (England)	GNS_DEF_all_0_0_all	Landings	743.9	402.4
UK (England)	GNS_DEF_all_0_0_all	Landings	947.2	510.2
UK (England)	GNS_DEF_all_0_0_all	Landings	1233	677.7
UK (England)	TBB_DEF_70-99_0_0_all	Landings	867.8	510.2
France	MIS_MIS_0_0_0_HC	Landings	0	609
UK (England)	GNS_DEF_all_0_0_all	Landings	833.9	882.3
UK (England)	OTB_DEF_>=120_0_0_all	Landings	502.1	655.1
UK (England)	OTB_DEF_70-99_0_0_all	Landings	502.1	655.1
UK (England)	GNS_DEF_all_0_0_all	Landings	338.8	203.5
UK (England)	GNS_DEF_all_0_0_all	Landings	403	229.5
UK (England)	GNS_DEF_all_0_0_all	Landings	524.5	311.5
UK (England)	GNS_DEF_all_0_0_all	Landings	642.7	493.9
UK (England)	OTB_DEF_>=120_0_0_all	Landings	644	290.9
UK (England)	OTB_DEF_>=120_0_0_all	Landings	724.7	311.5
UK (England)	OTB_DEF_>=120_0_0_all	Landings	763.7	355.5
UK (England)	OTB_DEF_>=120_0_0_all	Landings	797.4	396.7
UK (England)	OTB_DEF_>=120_0_0_all	Landings	767.6	450
UK (England)	OTB_DEF_>=120_0_0_all	Landings	755.8	456.2

UK (England)	OTB_DEF_70-99_0_0_all	Landings	220.4	456.2

AgeOrLength	Area
14	27.7.d
13	27.7.d
11	27.7.d
10	27.7.d
14	27.7.d
22	27.7.d
14	27.7.d
13	27.7.d
24	27.7.d
20	27.7.d
20	27.7.d
3	27.7.d
4	27.7.d
6	27.7.d
18	27.7.d
5	27.7.d
6	27.7.d
7	27.7.d
8	27.7.d
9	27.7.d
11	27.7.d
11	27.7.d

InterCatch output for 2008

This document uses Table 2 from CatchAndSampleDataTables.txt from the InterCatch outputs to describe the raising procedures that were made. In the following tables, CATON=WECA*CANUM/1000000 (in tonnes)

Raised discards

In InterCatch, the first step consists in raising the discards volumes for strata with landings and no discards associated. These discards are called in the following table 'Raised_Discards'. The data called 'Imported_Data' are landings or discards volumes imported into InterCatch with or without length/age structure.

The proportion of Landings with Discards associated (same strata) is **33 percent**.

The volumes (and associated proportion) of landings and discards imported (Imported_Data) or raised (Raised_Discards) are described in the following table.

Table 1a: Summary of the imported/Raised data for manual allocation

CatchCategory	RaisedOrImported	CATON	perc
Discards	Raised_Discards	173.5	68
Discards	Imported_Data	82.61	32
Landings	Imported_Data	5179	100

Table 1b: Summary of the imported/Raised data for autoallocation

CatchCategory	RaisedOrImported	CATON	perc
Discards	Raised_Discards	173.5	68
Discards	Imported_Data	82.61	32
Landings	Imported_Data	5198	100

Length/Age distribution

For the imported landings/discards and the raised discards without age distribution, the length or age distribution is then computed using the defined allocation scheme. *Sampled_distribution* means that the data (ladings or discards) were input with age/length distribution. *Estimated_distribution* means that the imported/raised volumes were estimated using the allocation scheme.

Table 2a: Summary of the imported/Raised/SampledOrEstimated data for manual allocation

CatchCategory	RaisedOrImported	SampledOrEstimated	CATON	perc
Landings	Imported_Data	Sampled_Distribution	4165	80
Landings	Imported_Data	Estimated_Distribution	1014	20
Discards	Raised_Discards	Estimated_Distribution	173.5	68
Discards	Imported_Data	Sampled_Distribution	81.6	32
Discards	Imported_Data	Estimated_Distribution	1.004	0

Table 2b: Summary of the imported/Raised/SampledOrEstimated data for autoallocation

CatchCategory	RaisedOrImported	SampledOrEstimated	CATON	perc
Landings	Imported_Data	Sampled_Distribution	4165	80
Landings	Imported_Data	Estimated_Distribution	1033	20
Discards	Raised_Discards	Estimated_Distribution	173.5	68
Discards	Imported_Data	Sampled_Distribution	81.6	32
Discards	Imported_Data	Estimated_Distribution	1.004	0

Impact of the raising on the age/length structure

Once the samples imported or raised are identified, it is possible to check the impact of the allocation scheme on the mean age/length of the final age/length distribution of the stock. The following figures compare the mean age (computed as the

weighted mean of the age per stratum ("CatchCategory",'RaisedOrImported',"SampledOrEstimated","Country","Area","Season","Fleet","Sex") of the estimated strata compared to the imported ones and the final distribution. Each individual included in the boxplot corresponds to the weighted mean age of a stratum.

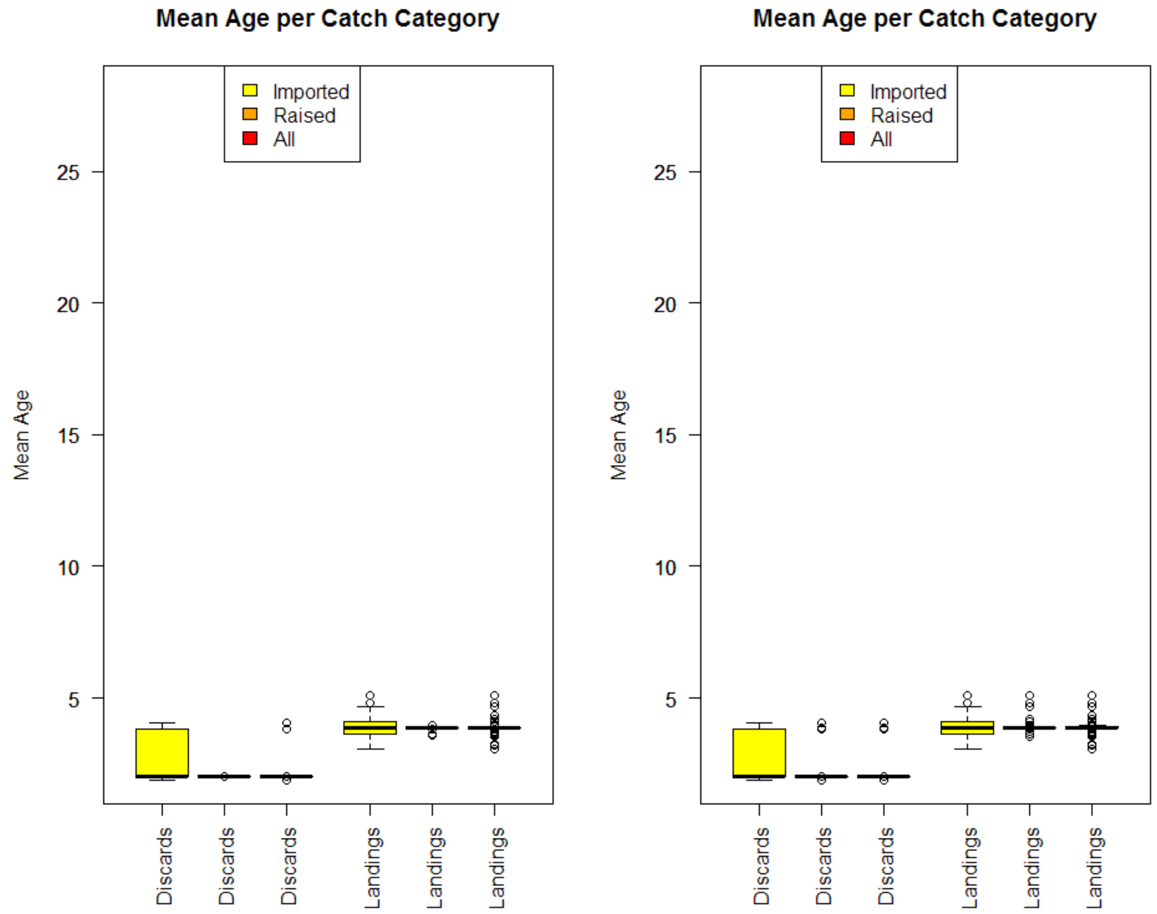


Figure 1: Mean Age per catch category (left: manual allocation; right: autoallocation)

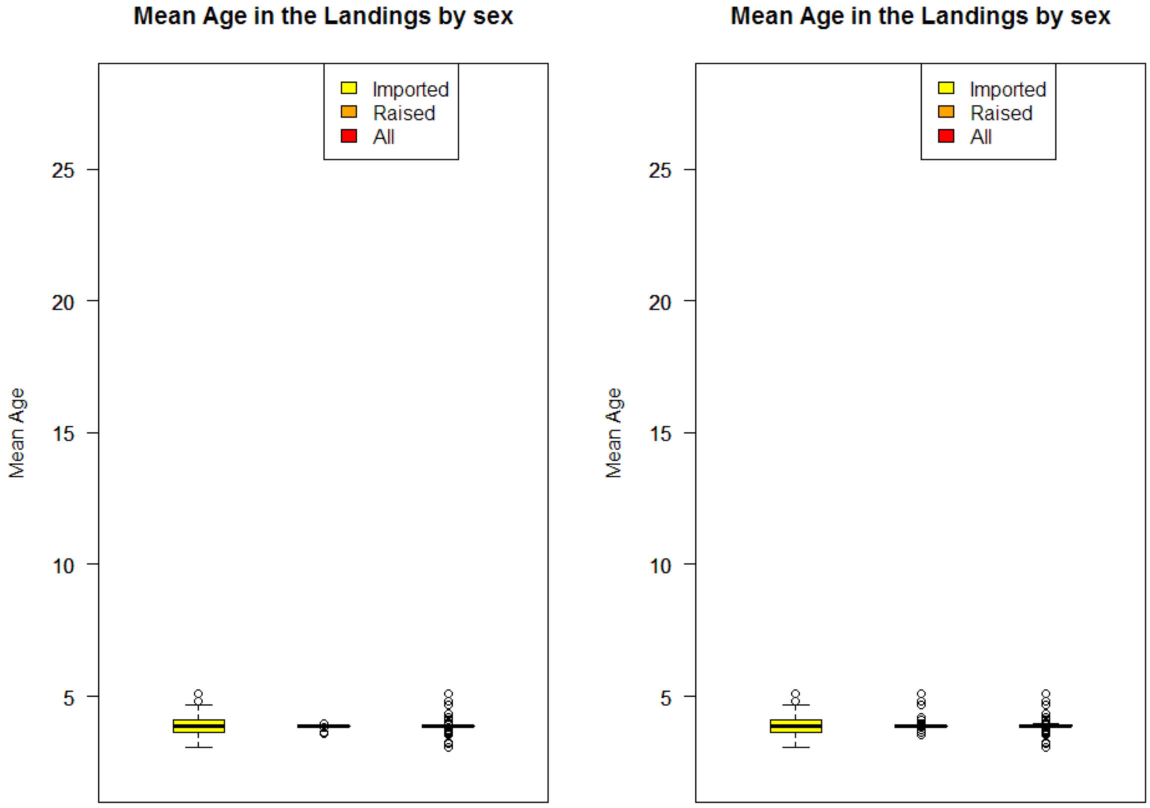


Figure 2: Mean Age in the Landings by sex (left: manual allocation; right: autoallocation)

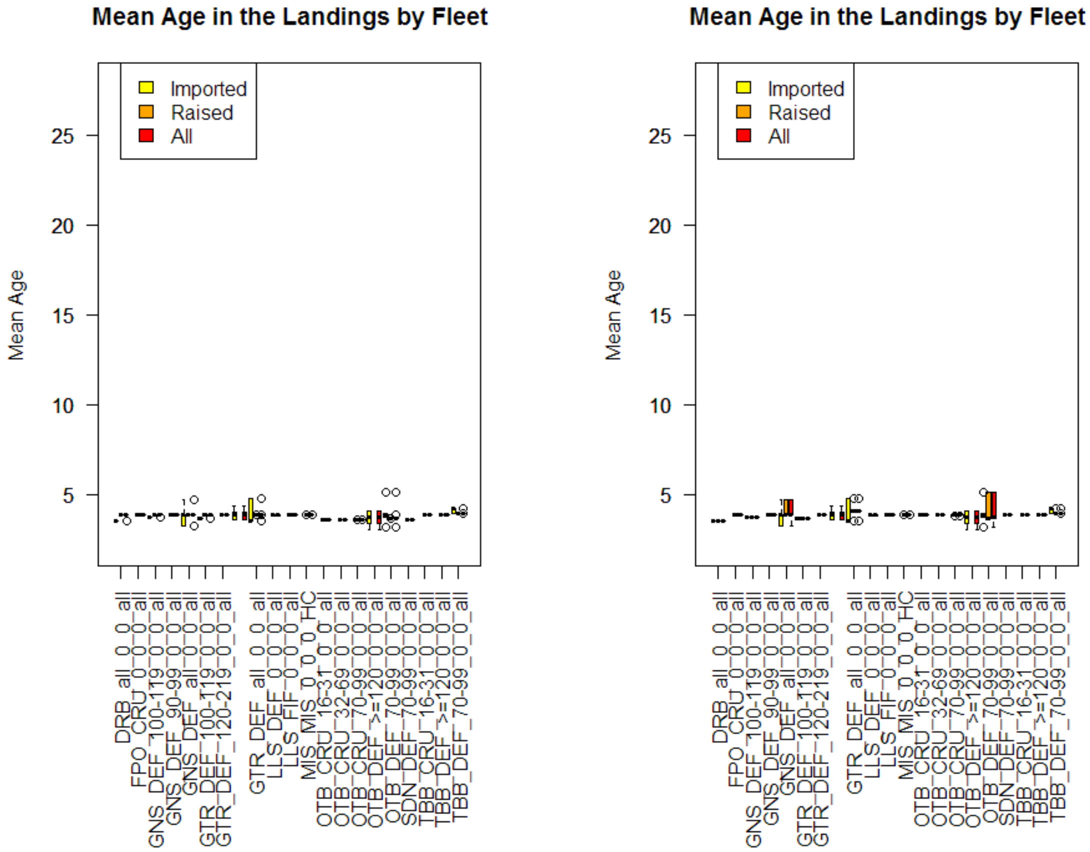


Figure 3: Mean Age in the Landings by Fleet (left: manual allocation; right: autoallocation)

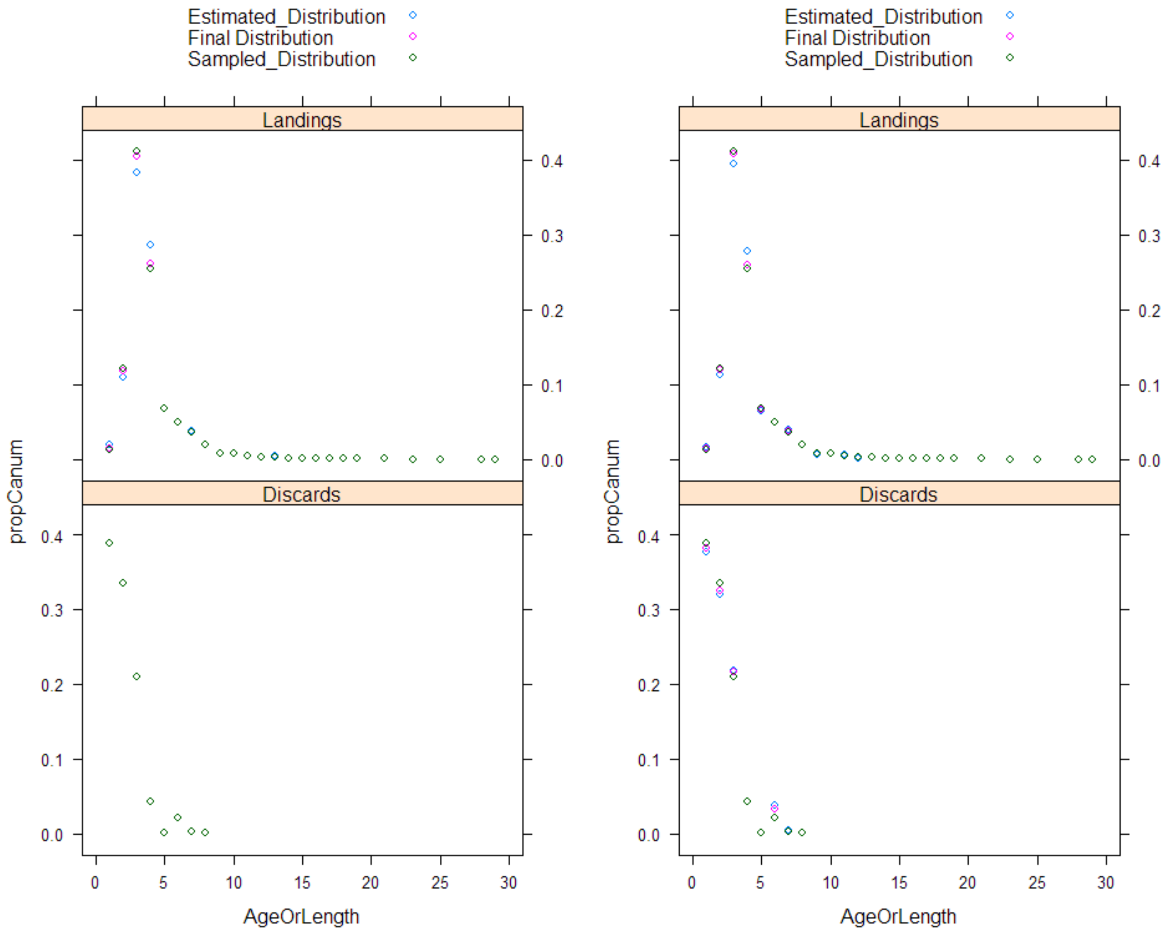


Figure 4: The percentage of each age for the sampled strata, estimated and the final age structure for the landing and discard fractions (left: manual allocation; right: autoallocation)

Impact of the raising on the mean weight

The CatchAndSampleData also provide the weight at age per stratum for the Sampled/Estimated strata. One should also check the sampled/estimated and resulting weight at age.

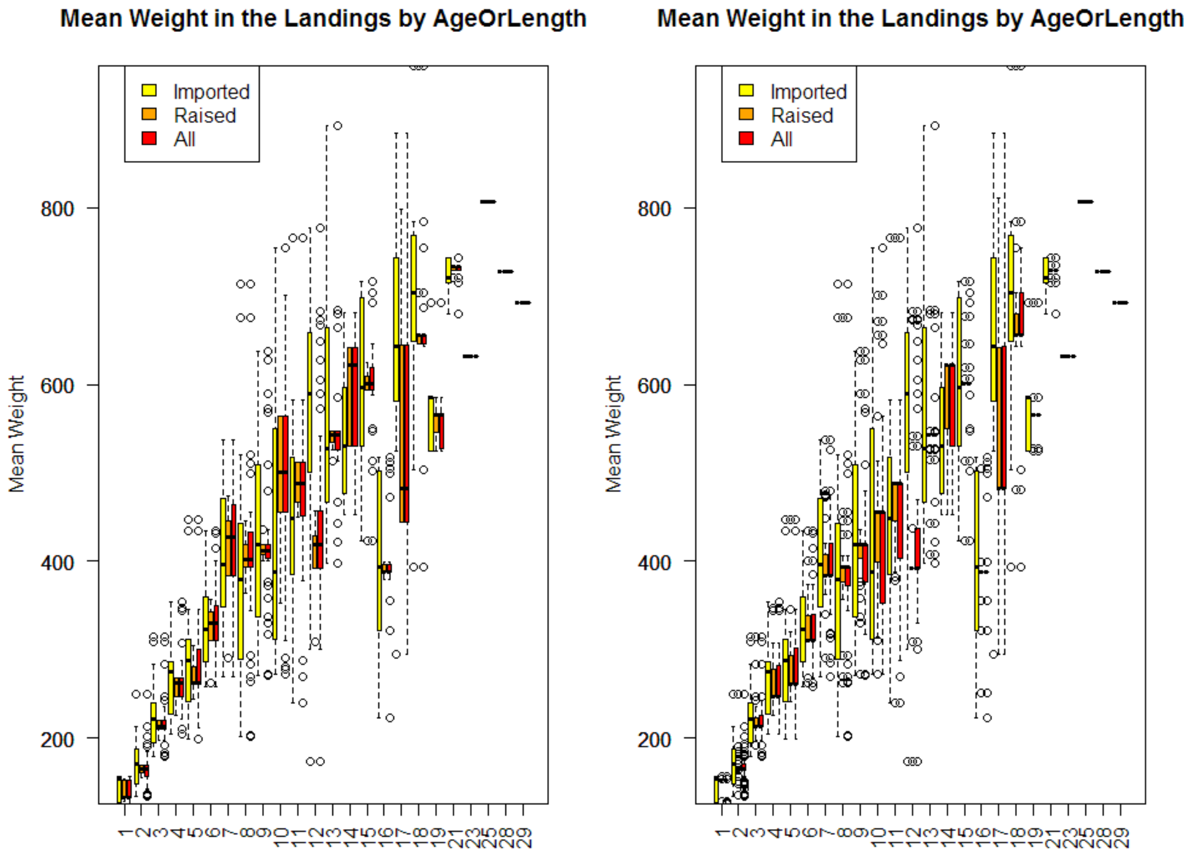


Figure 5: Each boxplot represents the distribution of the weight at age for the different strata (left: manual allocation; right: autoallocation)

Table 3a: Samples that are higher or lower than the average weigth at age +/- 3*standard deviation (outliers) for manual allocation

Table continues below

Country	Fleet	CatchCategory	WECA	AverageWtSize
UK (England)	GNS_DEF_all_0_0_all	Landings	248.9	165.2
UK (England)	GNS_DEF_all_0_0_all	Landings	637.4	416.2
UK (England)	OTB_DEF_>=120_0_0_all	Landings	288.1	478.7
UK (England)	OTB_DEF_>=120_0_0_all	Landings	680.1	730.4
UK (England)	TBB_DEF_70-99_0_0_all	Landings	627.8	416.2
UK (England)	TBB_DEF_70-99_0_0_all	Landings	239.3	478.7
France	GTR_DEF_90-99_0_0_all	Landings	893.8	542.3
France	GTR_DEF_90-99_0_0_all	Landings	518	391
UK (England)	OTB_DEF_>=120_0_0_all	Landings	201.7	401.8
UK (England)	OTB_DEF_>=120_0_0_all	Landings	511.6	391
UK (England)	OTB_DEF_70-99_0_0_all	Landings	202.6	401.8
UK (England)	OTB_DEF_70-99_0_0_all	Landings	269.8	478.7
UK (England)	GNS_DEF_all_0_0_all	Landings	223.2	391
UK (England)	OTB_DEF_>=120_0_0_all	Landings	223.2	391

UK (England)	OTB_DEF_>=120_0_0_all	Landings	393	683.3
France	OTB_DEF_70-99_0_0_all	Landings	283.4	215.7
France	OTB_DEF_70-99_0_0_all	Landings	344.6	258.4
UK (England)	GNS_DEF_all_0_0_all	Landings	315.1	215.7
UK (England)	GNS_DEF_all_0_0_all	Landings	346.6	258.4
UK (England)	GNS_DEF_all_0_0_all	Landings	446.4	273.5
UK (England)	GNS_DEF_all_0_0_all	Landings	435.1	325.5
UK (England)	GNS_DEF_all_0_0_all	Landings	676.2	401.8
UK (England)	GNS_DEF_all_0_0_all	Landings	589	416.2
UK (England)	GNS_DEF_all_0_0_all	Landings	765.7	478.7
UK (England)	GNS_DEF_all_0_0_all	Landings	692.1	559.4
UK (England)	OTB_DEF_>=120_0_0_all	Landings	213	165.2
UK (England)	OTB_DEF_>=120_0_0_all	Landings	308.9	215.7
UK (England)	OTB_DEF_>=120_0_0_all	Landings	354.6	258.4
UK (England)	OTB_DEF_>=120_0_0_all	Landings	434.3	273.5
UK (England)	OTB_DEF_>=120_0_0_all	Landings	432.2	325.5
UK (England)	OTB_DEF_>=120_0_0_all	Landings	714.3	401.8
UK (England)	OTB_DEF_>=120_0_0_all	Landings	776.9	430.1

AgeOrLength	Area
2	27.7.d
9	27.7.d
11	27.7.d
21	27.7.d
9	27.7.d
11	27.7.d
13	27.7.d
16	27.7.d
8	27.7.d
16	27.7.d
8	27.7.d
11	27.7.d
16	27.7.d
16	27.7.d
18	27.7.d
3	27.7.d
4	27.7.d
3	27.7.d
4	27.7.d
5	27.7.d
6	27.7.d
8	27.7.d
9	27.7.d
11	27.7.d
19	27.7.d
2	27.7.d
3	27.7.d
4	27.7.d

5	27.7.d
6	27.7.d
8	27.7.d
12	27.7.d

Table 3b: Samples that are higher or lower than the average weigth at age +/- 3*standard deviation (outliers) for autoallocation

Table continues below

Country	Fleet	CatchCategory	WECA	AverageWtSize
Belgium	GNS_DEF_all_0_0_all	Landings	248.9	168
Belgium	GNS_DEF_all_0_0_all	Landings	637.4	412.3
UK(Scotland)	OTB_DEF_>=120_0_0_all	Landings	128	151.7
Belgium	GNS_DEF_all_0_0_all	Landings	315.1	219.7
Belgium	GNS_DEF_all_0_0_all	Landings	446.4	277.7
Belgium	GNS_DEF_all_0_0_all	Landings	435.1	323.3
Belgium	GNS_DEF_all_0_0_all	Landings	676.2	391.2
Belgium	GNS_DEF_all_0_0_all	Landings	765.7	459.8
Belgium	GNS_DEF_all_0_0_all	Landings	692.1	568.1
UK (England)	GNS_DEF_all_0_0_all	Landings	248.9	168
UK (England)	GNS_DEF_all_0_0_all	Landings	637.4	412.3
UK (England)	OTB_DEF_>=120_0_0_all	Landings	680.1	727.9
France	GTR_DEF_90-99_0_0_all	Landings	893.8	546.8
UK (England)	GNS_DEF_all_0_0_all	Landings	125.9	151.7
UK (England)	GNS_DEF_all_0_0_all	Landings	223.2	379.9
UK (England)	OTB_DEF_>=120_0_0_all	Landings	126.5	151.7
UK (England)	OTB_DEF_>=120_0_0_all	Landings	223.2	379.9
UK (England)	GNS_DEF_all_0_0_all	Landings	315.1	219.7
UK (England)	GNS_DEF_all_0_0_all	Landings	446.4	277.7
UK (England)	GNS_DEF_all_0_0_all	Landings	435.1	323.3
UK (England)	GNS_DEF_all_0_0_all	Landings	676.2	391.2
UK (England)	GNS_DEF_all_0_0_all	Landings	765.7	459.8
UK (England)	GNS_DEF_all_0_0_all	Landings	692.1	568.1
UK (England)	OTB_DEF_>=120_0_0_all	Landings	308.9	219.7
UK (England)	OTB_DEF_>=120_0_0_all	Landings	354.6	260.4
UK (England)	OTB_DEF_>=120_0_0_all	Landings	434.3	277.7
UK (England)	OTB_DEF_>=120_0_0_all	Landings	714.3	391.2

AgeOrLength	Area
2	27.7.d
9	27.7.d
1	27.7.d
3	27.7.d
5	27.7.d
6	27.7.d
8	27.7.d
11	27.7.d
19	27.7.d
2	27.7.d
9	27.7.d

21	27.7.d
13	27.7.d
1	27.7.d
16	27.7.d
1	27.7.d
16	27.7.d
3	27.7.d
5	27.7.d
6	27.7.d
8	27.7.d
11	27.7.d
19	27.7.d
3	27.7.d
4	27.7.d
5	27.7.d
8	27.7.d

InterCatch output for 2009

This document uses Table 2 from CatchAndSampleDataTables.txt from the InterCatch outputs to describe the raising procedures that were made. In the following tables, CATON=WECA*CANUM/1000000 (in tonnes)

Raised discards

In InterCatch, the first step consists in raising the discards volumes for strata with landings and no discards associated. These discards are called in the following table 'Raised_Discards'. The data called 'Imported_Data' are landings or discards volumes imported into InterCatch with or without length/age structure.

The proportion of Landings with Discards associated (same strata) is **65 percent** (manual) and **66 percent** (autoallocation).

The volumes (and associated proportion) of landings and discards imported (Imported_Data) or raised (Raised_Discards) are described in the following table.

Table 1a: Summary of the imported/Raised data for manual allocation

CatchCategory	RaisedOrImported	CATON	perc
Discards	Raised_Discards	104.1	27
Discards	Imported_Data	284.8	73
Landings	Imported_Data	4862	100

Table 1b: Summary of the imported/Raised data for autoallocation

CatchCategory	RaisedOrImported	CATON	perc
Discards	Raised_Discards	104.2	27
Discards	Imported_Data	287.4	73
Landings	Imported_Data	4813	100

Length/Age distribution

For the imported landings/discards and the raised discards without age distribution, the length or age distribution is then computed using the defined allocation scheme. *Sampled_distribution* means that the data (ladings or discards) were input with age/length distribution. *Estimated_distribution* means that the imported/raised volumes were estimated using the allocation scheme.

Table 2a: Summary of the imported/Raised/SampledOrEstimated data for manual allocation

CatchCategory	RaisedOrImported	SampledOrEstimated	CATON	perc
Landings	Imported_Data	Sampled_Distribution	3833	79
Landings	Imported_Data	Estimated_Distribution	1029	21
Discards	Imported_Data	Sampled_Distribution	186.4	48
Discards	Raised_Discards	Estimated_Distribution	104.1	27
Discards	Imported_Data	Estimated_Distribution	98.35	25

Table 2b: Summary of the imported/Raised/SampledOrEstimated data for autoallocation

CatchCategory	RaisedOrImported	SampledOrEstimated	CATON	perc
Landings	Imported_Data	Sampled_Distribution	3833	80
Landings	Imported_Data	Estimated_Distribution	980.4	20
Discards	Imported_Data	Sampled_Distribution	186.4	48
Discards	Raised_Discards	Estimated_Distribution	104.2	27
Discards	Imported_Data	Estimated_Distribution	101	26

Impact of the raising on the age/length structure

Once the samples imported or raised are identified, it is possible to check the impact of the allocation scheme on the mean age/length of the final age/length distribution of the stock. The following figures compare the mean age (computed as the

weighted mean of the age per stratum ("CatchCategory",'RaisedOrImported',"SampledOrEstimated","Country","Area","Season","Fleet","Sex") of the estimated strata compared to the imported ones and the final distribution. Each individual included in the boxplot corresponds to the weighted mean age of a stratum.

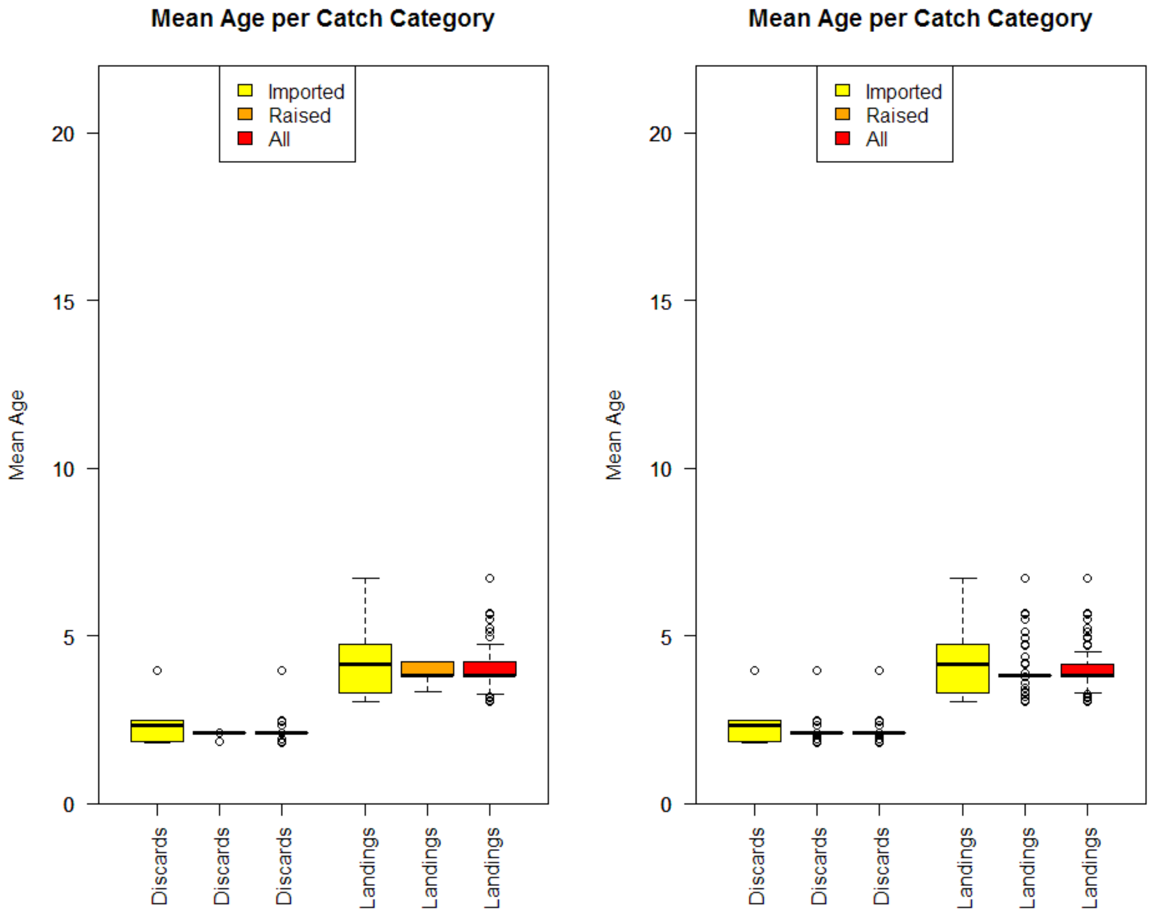


Figure 1: Mean Age per catch category (left: manual allocation; right: autoallocation)

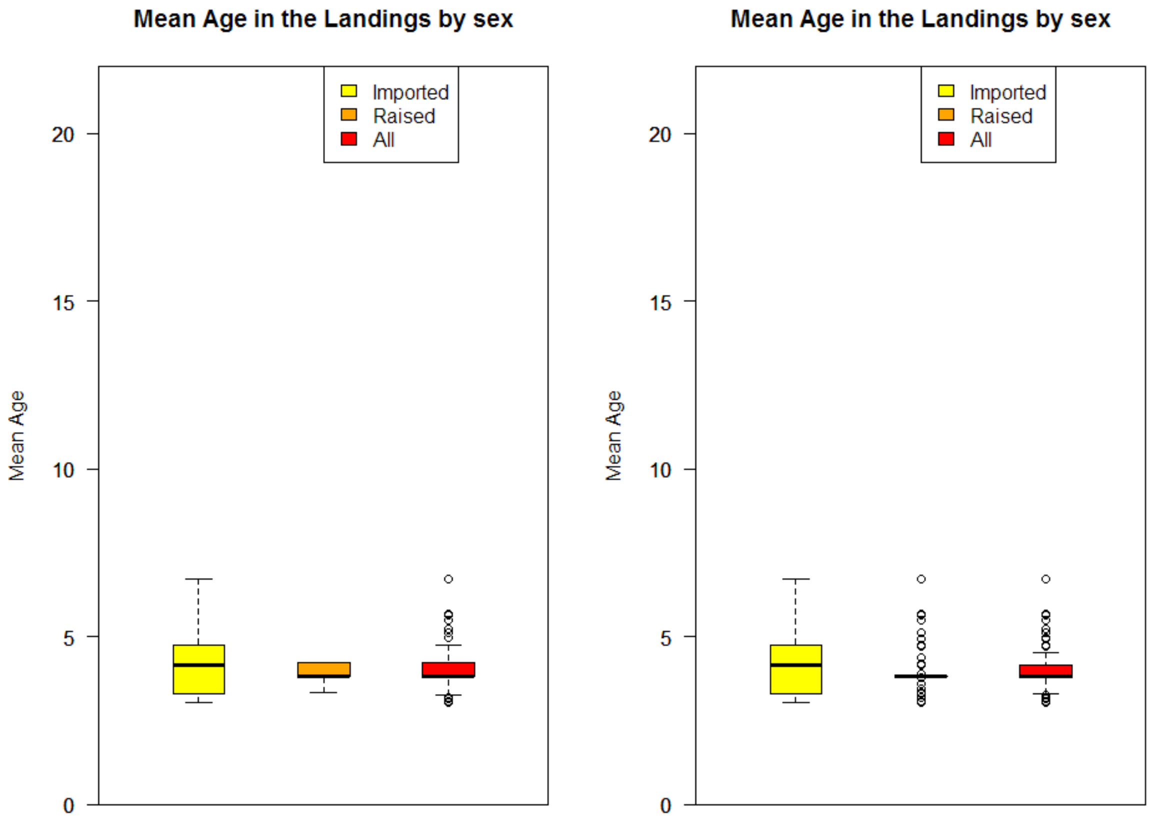


Figure 2: Mean Age in the Landings by sex (left: manual allocation; right: autoallocation)

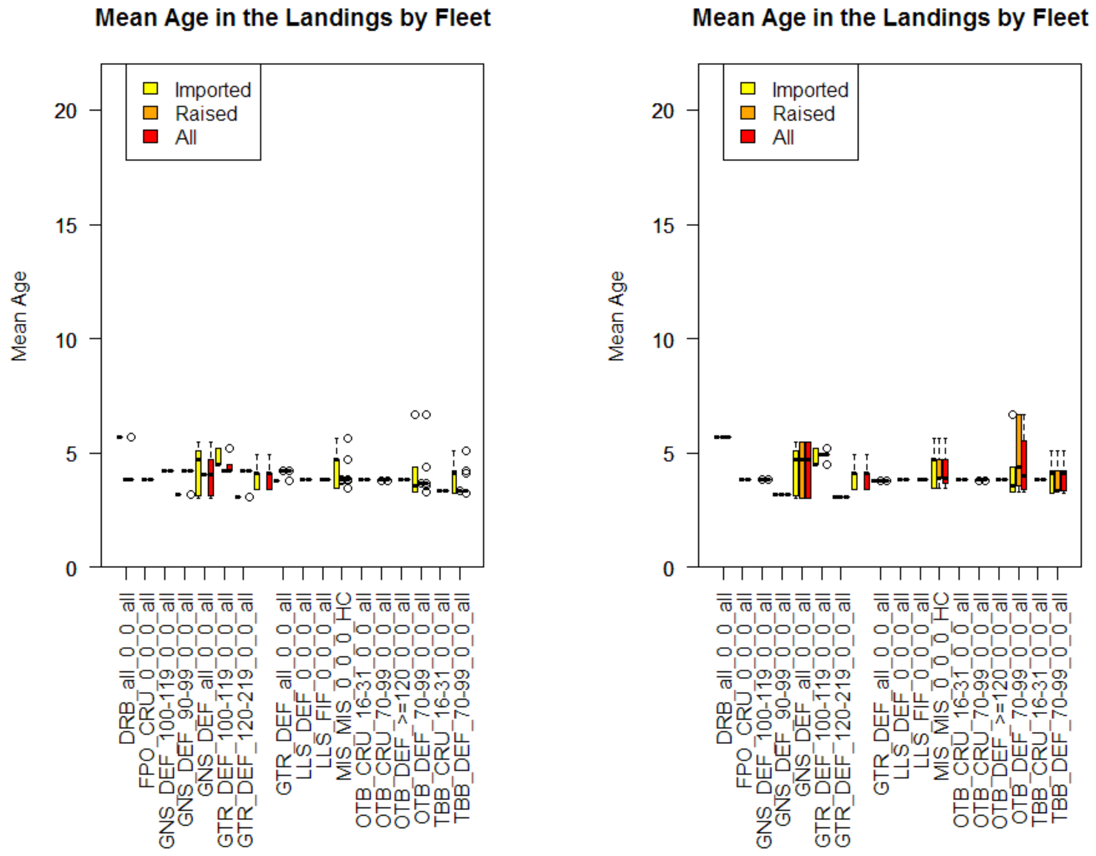


Figure 3: Mean Age in the Landings by Fleet (left: manual allocation; right: autoallocation)

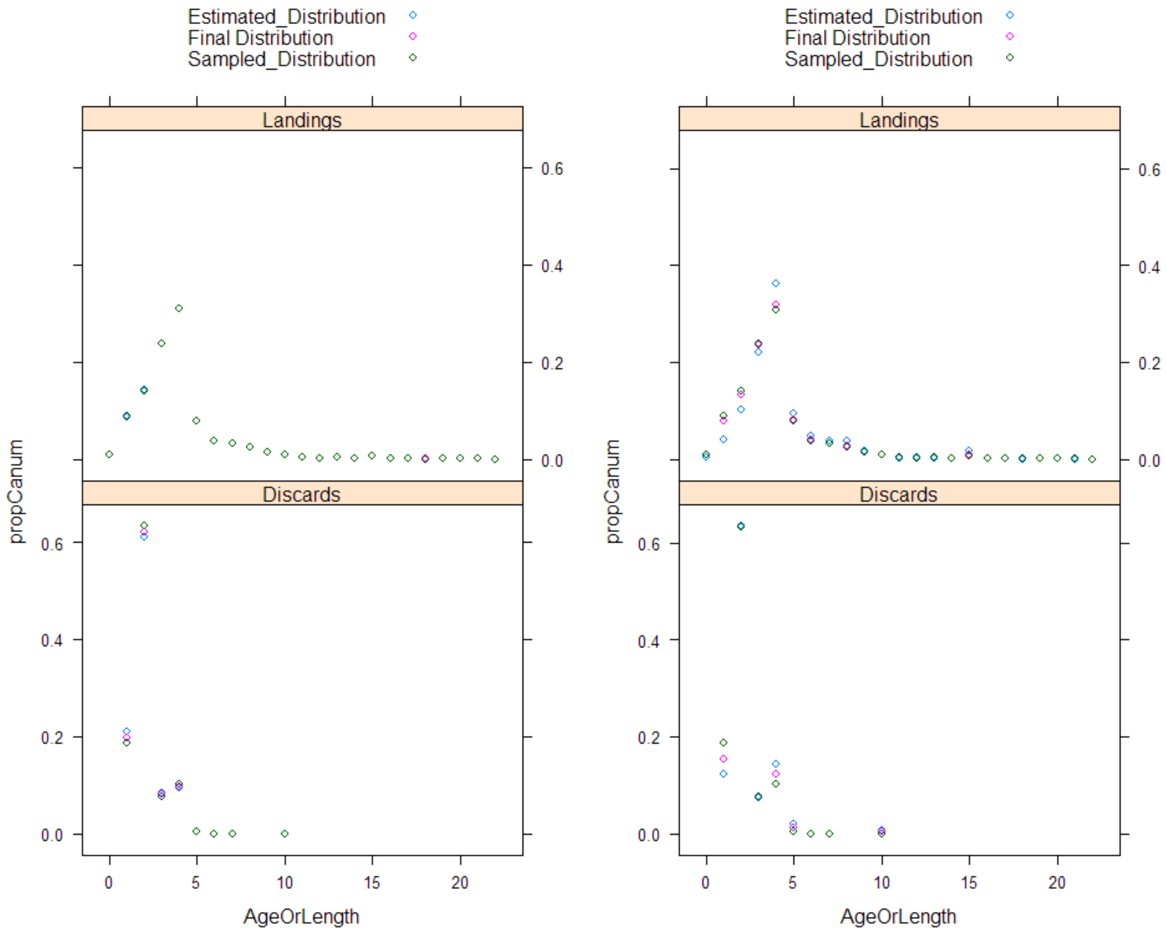


Figure 4: The percentage of each age for the sampled strata, estimated and the final age structure for the landing and discard fractions (left: manual allocation; right: autoallocation)

Impact of the raising on the mean weight

The CatchAndSampleData also provide the weight at age per stratum for the Sampled/Estimated strata. One should also check the sampled/estimated and resulting weight at age.

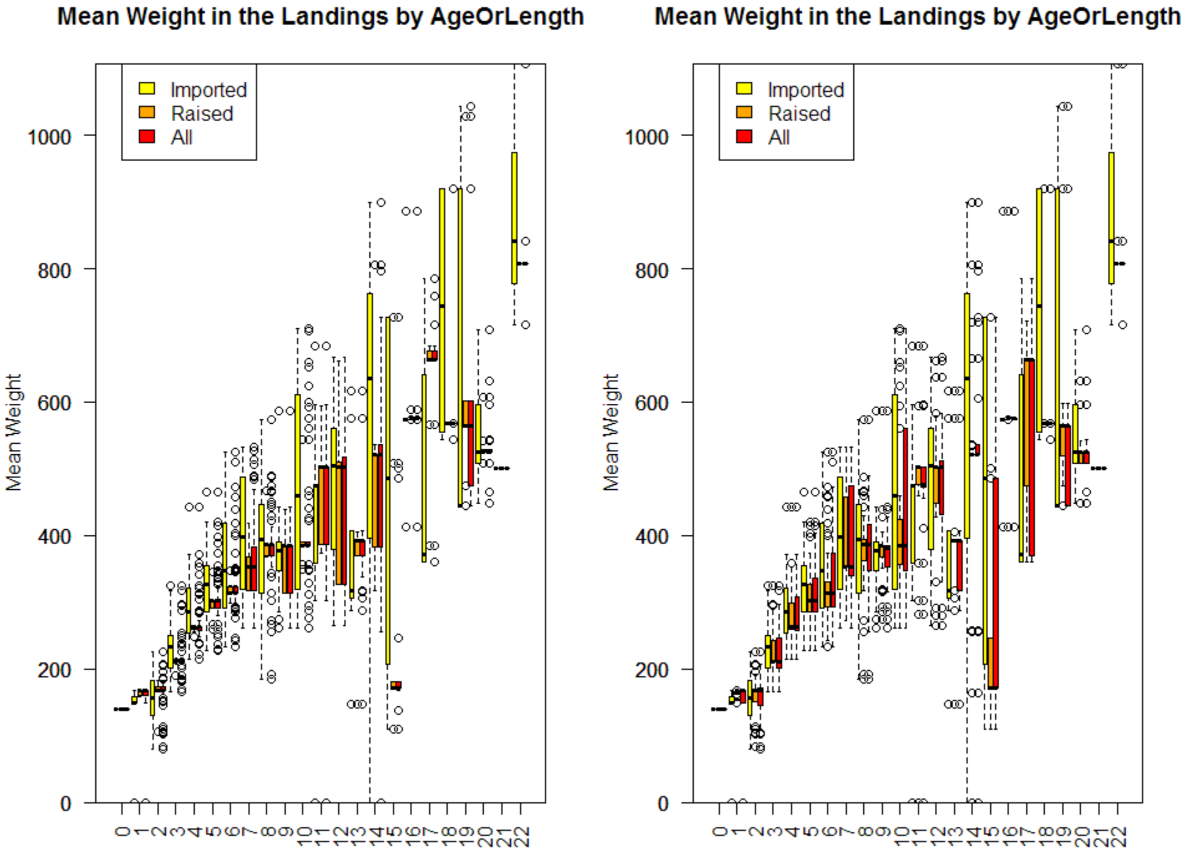


Figure 5: Each boxplot represents the distribution of the weight at age for the different strata (left: manual allocation; right: autoallocation)

Table 3a: Samples that are higher or lower than the average weigth at age +/- 3*standard deviation (outliers) for manual allocation

Table continues below

Country	Fleet	CatchCategory	WECA	AverageWtSize
Belgium	GNS_DEF_all_0_0_all	Landings	1029	576.9
Belgium	GNS_DEF_all_0_0_all	Landings	1029	576.9
Belgium	GNS_DEF_all_0_0_all	Landings	1029	576.9
France	DRB_all_0_0_all	Landings	184.8	386.4
France	GTR_DEF_90-99_0_0_all	Landings	0	160.9
France	GTR_DEF_90-99_0_0_all	Landings	80.14	163.5
France	MIS_MIS_0_0_0_HC	Landings	324.5	215.6
France	MIS_MIS_0_0_0_HC	Landings	191.8	386.4
France	OTB_DEF_70-99_0_0_all	Landings	442.3	268.4
France	OTB_DEF_70-99_0_0_all	Landings	472.3	327.5
UK (England)	GNS_DEF_all_0_0_all	Landings	617.5	363.7
UK (England)	GNS_DEF_all_0_0_all	Landings	631.5	530.5
France	GTR_DEF_90-99_0_0_all	Landings	709	530.5
France	OTB_DEF_70-99_0_0_all	Landings	706.9	414.6

France	TBB_DEF_70-99_0_0_all	Landings	82.62	163.5
France	TBB_DEF_70-99_0_0_all	Landings	709.9	414.6
UK (England)	GNS_DEF_all_0_0_all	Landings	413	577.7
UK (England)	GNS_DEF_all_0_0_all	Landings	919.1	579
UK (England)	GNS_DEF_all_0_0_all	Landings	1107	811.4
UK (England)	MIS_MIS_0_0_0_HC	Landings	919.1	579
France	GTR_DEF_100-119_0_0_all	Landings	316.7	215.6
France	GTR_DEF_100-119_0_0_all	Landings	370.9	268.4
France	GTR_DEF_100-119_0_0_all	Landings	464.9	305.2
France	GTR_DEF_100-119_0_0_all	Landings	509.9	327.5
France	GTR_DEF_90-99_0_0_all	Landings	0	461.2
France	MIS_MIS_0_0_0_HC	Landings	0	461.2
France	MIS_MIS_0_0_0_HC	Landings	0	510.3
France	TBB_DEF_70-99_0_0_all	Landings	294.7	215.6
France	TBB_DEF_70-99_0_0_all	Landings	419.9	305.2
France	TBB_DEF_70-99_0_0_all	Landings	296.5	215.6
UK (England)	GNS_DEF_all_0_0_all	Landings	358	268.4
UK (England)	GNS_DEF_all_0_0_all	Landings	526	327.5
UK (England)	GNS_DEF_all_0_0_all	Landings	574.2	386.4
UK (England)	GNS_DEF_all_0_0_all	Landings	586.7	369.7
UK (England)	GNS_DEF_all_0_0_all	Landings	886.3	577.7
UK (England)	GNS_DEF_all_0_0_all	Landings	1043	576.9

AgeOrLength	Area
19	27.7.d
19	27.7.d
19	27.7.d
8	27.7.d
1	27.7.d
2	27.7.d
3	27.7.d
8	27.7.d
4	27.7.d
6	27.7.d
13	27.7.d
20	27.7.d
20	27.7.d
10	27.7.d
2	27.7.d
10	27.7.d
16	27.7.d
18	27.7.d
22	27.7.d
18	27.7.d
3	27.7.d
4	27.7.d
5	27.7.d
6	27.7.d

11	27.7.d
11	27.7.d
14	27.7.d
3	27.7.d
5	27.7.d
3	27.7.d
4	27.7.d
6	27.7.d
8	27.7.d
9	27.7.d
16	27.7.d
19	27.7.d

Table 3b: Samples that are higher or lower than the average weigth at age +/- 3*standard deviation (outliers) for autoallocation

Table continues below

Country	Fleet	CatchCategory	WECA	AverageWtSize	AgeOrLength	Area
Netherlands	OTB_DEF_70-99_0_0_all	Landings	442.3	281.6	4	27.7.d
UK (England)	OTB_DEF_70-99_0_0_all	Landings	442.3	281.6	4	27.7.d
Belgium	GNS_DEF_all_0_0_all	Landings	1107	824.9	22	27.7.d
Belgium	MIS_MIS_0_0_0_HC	Landings	0	451.8	11	27.7.d
UK (England)	MIS_MIS_0_0_0_HC	Landings	0	451.8	11	27.7.d
Belgium	GNS_DEF_all_0_0_all	Landings	586.7	371.8	9	27.7.d
Belgium	GNS_DEF_all_0_0_all	Landings	886.3	582.1	16	27.7.d
France	GTR_DEF_90-99_0_0_all	Landings	0	158.5	1	27.7.d
France	OTB_DEF_70-99_0_0_all	Landings	442.3	281.6	4	27.7.d
France	GTR_DEF_90-99_0_0_all	Landings	709	522.1	20	27.7.d
UK (England)	GNS_DEF_all_0_0_all	Landings	1107	824.9	22	27.7.d
France	GTR_DEF_90-99_0_0_all	Landings	0	451.8	11	27.7.d
France	MIS_MIS_0_0_0_HC	Landings	0	451.8	11	27.7.d
UK (England)	GNS_DEF_all_0_0_all	Landings	586.7	371.8	9	27.7.d
UK (England)	GNS_DEF_all_0_0_all	Landings	886.3	582.1	16	27.7.d

InterCatch output for 2010

This document uses Table 2 from CatchAndSampleDataTables.txt from the InterCatch outputs to describe the raising procedures that were made. In the following tables, CATON=WECA*CANUM/1000000 (in tonnes)

Raised discards

In InterCatch, the first step consists in raising the discards volumes for strata with landings and no discards associated. These discards are called in the following table 'Raised_Discards'. The data called 'Imported_Data' are landings or discards volumes imported into InterCatch with or without length/age structure.

The proportion of Landings with Discards associated (same strata) is **76 percent** (manual) and **77 percent** (autoallocation).

The volumes (and associated proportion) of landings and discards imported (Imported_Data) or raised (Raised_Discards) are described in the following table.

Table 1a: Summary of the imported/Raised data for manual allocation

CatchCategory	RaisedOrImported	CATON	perc
Discards	Raised_Discards	128.7	27
Discards	Imported_Data	343.7	73
Landings	Imported_Data	4086	100

Table 1b: Summary of the imported/Raised data for autoallocation

CatchCategory	RaisedOrImported	CATON	perc
Discards	Raised_Discards	127.8	27
Discards	Imported_Data	347.7	73
Landings	Imported_Data	4080	100

Length/Age distribution

For the imported landings/discards and the raised discards without age distribution, the length or age distribution is then computed using the defined allocation scheme. *Sampled_distribution* means that the data (ladings or discards) were input with age/length distribution. *Estimated_distribution* means that the imported/raised volumes were estimated using the allocation scheme.

Table 2a: Summary of the imported/Raised/SampledOrEstimated data for manual allocation

CatchCategory	RaisedOrImported	SampledOrEstimated	CATON	perc
Landings	Imported_Data	Sampled_Distribution	3232	79
Landings	Imported_Data	Estimated_Distribution	854	21
Discards	Imported_Data	Sampled_Distribution	274.8	58
Discards	Raised_Discards	Estimated_Distribution	128.7	27
Discards	Imported_Data	Estimated_Distribution	68.91	15

Table 2b: Summary of the imported/Raised/SampledOrEstimated data for autoallocation

CatchCategory	RaisedOrImported	SampledOrEstimated	CATON	perc
Landings	Imported_Data	Sampled_Distribution	3232	79
Landings	Imported_Data	Estimated_Distribution	847.8	21
Discards	Imported_Data	Sampled_Distribution	274.8	58
Discards	Raised_Discards	Estimated_Distribution	127.8	27
Discards	Imported_Data	Estimated_Distribution	72.86	15

Impact of the raising on the age/length structure

Once the samples imported or raised are identified, it is possible to check the impact of the allocation scheme on the mean age/length of the final age/length distribution of the stock. The following figures compare the mean age (computed as the weighted mean of the age per stratum ("CatchCategory",'RaisedOrImported',"SampledOrEstimated","Country","Area","Season","Fleet","Sex") of the estimated

strata compared to the imported ones and the final distribution. Each individual included in the boxplot corresponds to the weighted mean age of a stratum.

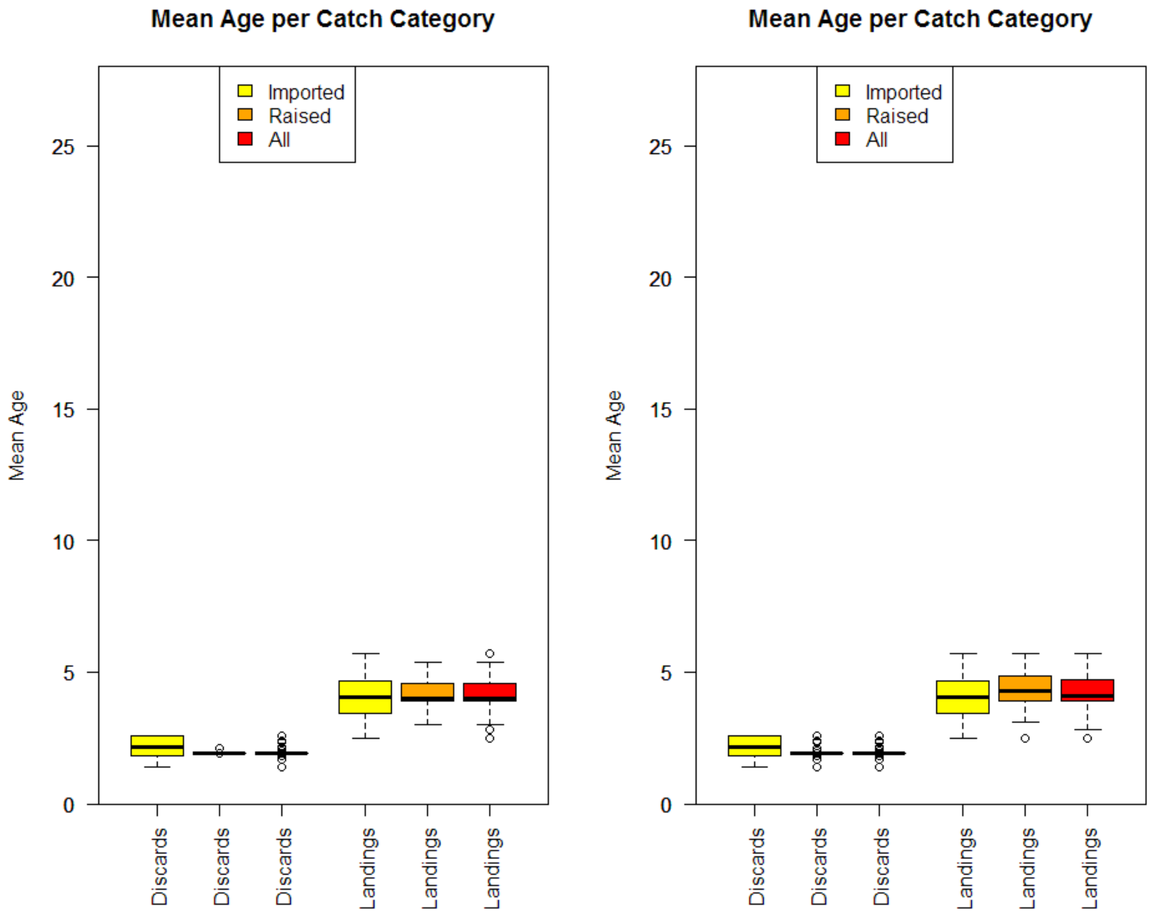


Figure 1: Mean Age per catch category (left: manual allocation; right: autoallocation)

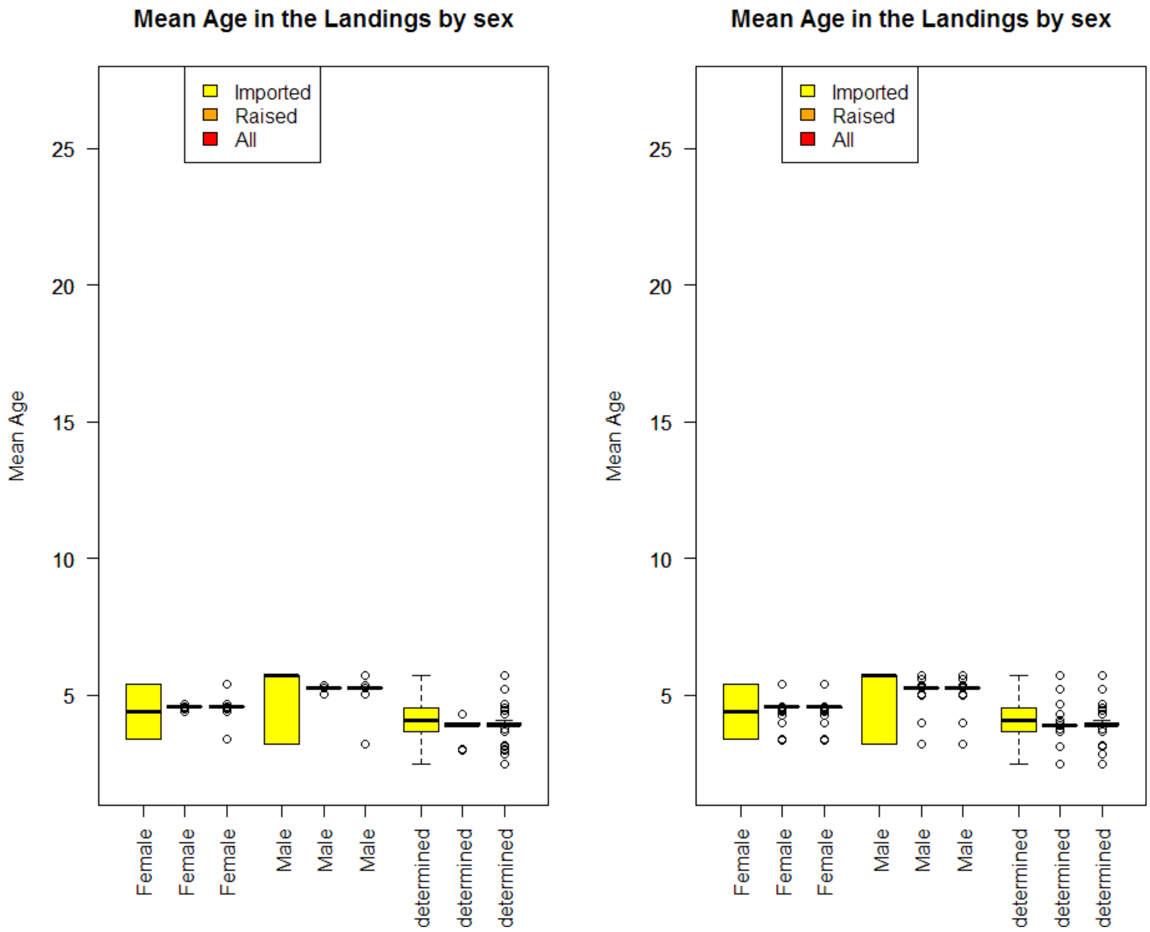


Figure 2: Mean Age in the Landings by sex (left: manual allocation; right: autoallocation)

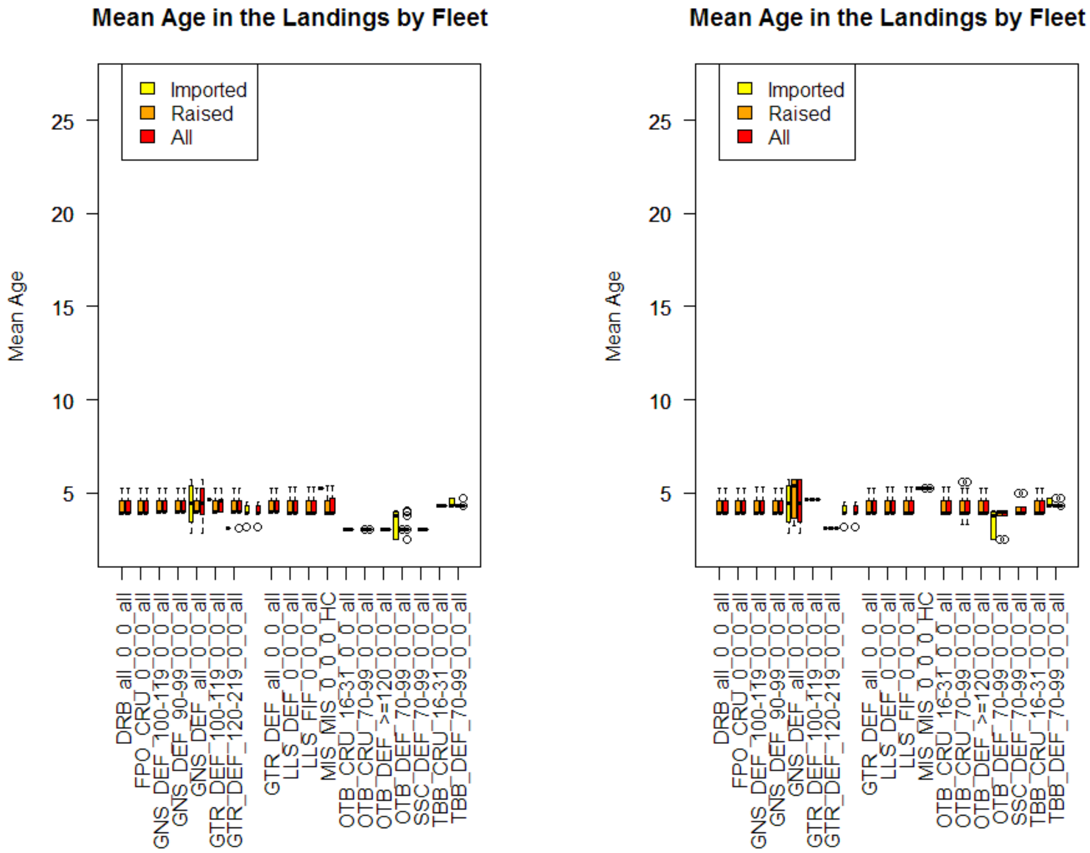


Figure 3: Mean Age in the Landings by Fleet (left: manual allocation; right: autoallocation)

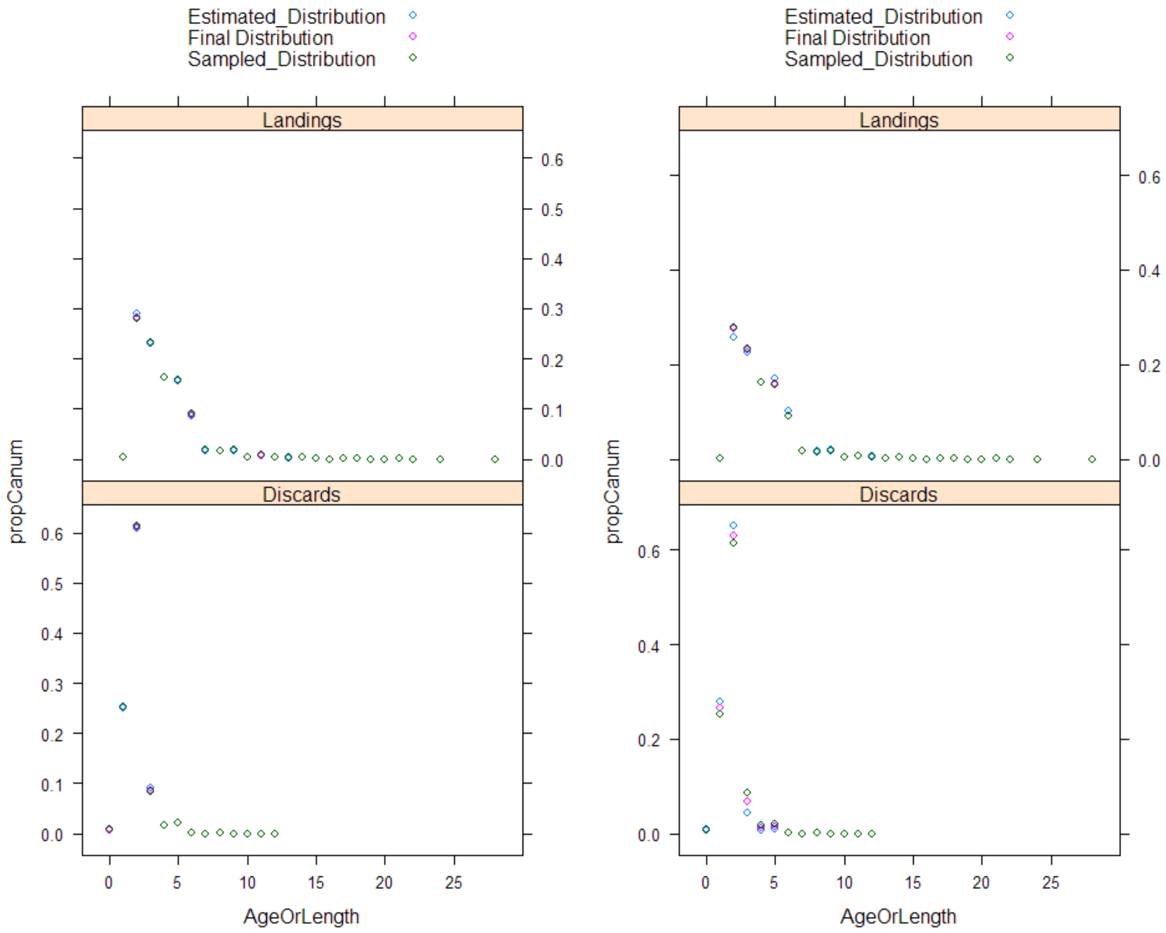


Figure 4: The percentage of each age for the sampled strata, estimated and the final age structure for the landing and discard fractions (left: manual allocation; right: autoallocation)

Impact of the raising on the mean weight

The CatchAndSampleData also provide the weight at age per stratum for the Sampled/Estimated strata. One should also check the sampled/estimated and resulting weight at age.

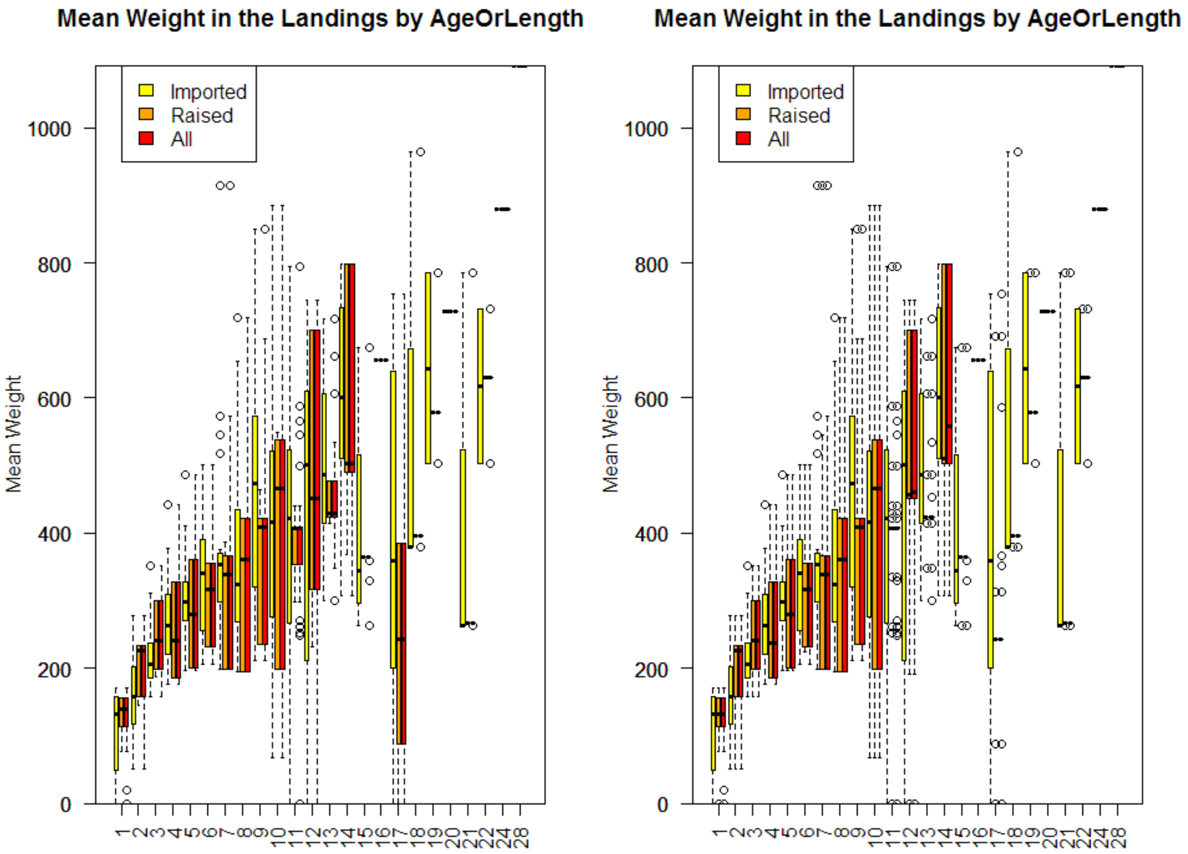


Figure 5: Each boxplot represents the distribution of the weight at age for the different strata (left: manual allocation; right: autoallocation)

Table 3a: Samples that are higher or lower than the average weigth at age +/- 3*standard deviation (outliers) for manual allocation

Table continues below

Country	Fleet	CatchCategory	WECA	AverageWtSize
France	OTB_DEF_70-99_0_0_all	Landings	50.06	194.1
UK (England)	GNS_DEF_all_0_0_all	Landings	673.8	368
UK (England)	GNS_DEF_all_0_0_all	Landings	784.6	581.4
UK (England)	GNS_DEF_all_0_0_all	Landings	784.6	275.1
UK (England)	GNS_DEF_all_0_0_all	Landings	731.1	629.3
France	OTB_DEF_70-99_0_0_all	Landings	606.2	446.7
UK (England)	GNS_DEF_all_0_0_all	Landings	716.3	446.7
France	GTR_DEF_90-99_0_0_all	Landings	754	235.9
France	GTR_DEF_90-99_0_0_all	Landings	964.4	404.8
UK (England)	GNS_DEF_all_0_0_all	Landings	502.1	629.3
France	GTR_DEF_120-219_0_0_all	Landings	0	128.9
France	GTR_DEF_120-219_0_0_all	Landings	0	381.6
France	GTR_DEF_90-99_0_0_all	Landings	20.32	128.9
France	GTR_DEF_90-99_0_0_all	Landings	654.5	336

France	OTB_DEF_70-99_0_0_all	Landings	719.5	336
France	OTB_DEF_70-99_0_0_all	Landings	686.6	366.5
UK (England)	GNS_DEF_all_0_0_all	Landings	442.2	251.3
UK (England)	GNS_DEF_all_0_0_all	Landings	485.6	283.1
UK (England)	GNS_DEF_all_0_0_all	Landings	500.7	307.7
UK (England)	GNS_DEF_all_0_0_all	Landings	662	446.7
UK (England)	GNS_DEF_all_0_0_all	Landings	915.1	314
UK (England)	GNS_DEF_all_0_0_all	Landings	850.6	366.5
UK (England)	GNS_DEF_all_0_0_all	Landings	884.8	409.9
UK (England)	GNS_DEF_all_0_0_all	Landings	793.9	381.6

AgeOrLength	Area
2	27.7.d
15	27.7.d
19	27.7.d
21	27.7.d
22	27.7.d
13	27.7.d
13	27.7.d
17	27.7.d
18	27.7.d
22	27.7.d
1	27.7.d
11	27.7.d
1	27.7.d
8	27.7.d
8	27.7.d
9	27.7.d
4	27.7.d
5	27.7.d
6	27.7.d
13	27.7.d
7	27.7.d
9	27.7.d
10	27.7.d
11	27.7.d

Table 3b: Samples that are higher or lower than the average weigth at age +/- 3*standard deviation (outliers) for autoallocation

Table continues below

Country	Fleet	CatchCategory	WECA	AverageWtSize
Belgium	GNS_DEF_all_0_0_all	Landings	673.8	355.9
Belgium	GNS_DEF_all_0_0_all	Landings	784.6	584.9
Belgium	GNS_DEF_all_0_0_all	Landings	784.6	280.7
Belgium	GNS_DEF_all_0_0_all	Landings	731.1	631.1
France	GTR_DEF_120-219_0_0_all	Landings	0	130.3
France	GTR_DEF_120-219_0_0_all	Landings	0	392.8
Netherlands	OTB_DEF_70-99_0_0_all	Landings	50.06	195.6

UK (England)	OTB_DEF_70-99_0_0_all	Landings	50.06	195.6
France	GTR_DEF_120-219_0_0_all	Landings	0	130.3
France	GTR_DEF_120-219_0_0_all	Landings	0	392.8
France	GTR_DEF_120-219_0_0_all	Landings	0	130.3
France	GTR_DEF_120-219_0_0_all	Landings	0	392.8
Belgium	GNS_DEF_all_0_0_all	Landings	442.2	253.5
Belgium	GNS_DEF_all_0_0_all	Landings	485.6	283.7
Belgium	GNS_DEF_all_0_0_all	Landings	500.7	307.2
Belgium	GNS_DEF_all_0_0_all	Landings	692.1	247.4
Belgium	GNS_DEF_all_0_0_all	Landings	662	445.4
Belgium	GNS_DEF_all_0_0_all	Landings	793.9	392.8
Belgium	GNS_DEF_all_0_0_all	Landings	915.1	316.6
Belgium	GNS_DEF_all_0_0_all	Landings	850.6	376.3
Belgium	GNS_DEF_all_0_0_all	Landings	884.8	401.6
UK (England)	OTB_DEF_70-99_0_0_all	Landings	719.5	336
France	OTB_DEF_70-99_0_0_all	Landings	50.06	195.6
UK (England)	GNS_DEF_all_0_0_all	Landings	673.8	355.9
UK (England)	GNS_DEF_all_0_0_all	Landings	784.6	584.9
UK (England)	GNS_DEF_all_0_0_all	Landings	784.6	280.7
UK (England)	GNS_DEF_all_0_0_all	Landings	731.1	631.1
UK (England)	GNS_DEF_all_0_0_all	Landings	716.3	445.4
France	GTR_DEF_90-99_0_0_all	Landings	754	247.4
France	GTR_DEF_90-99_0_0_all	Landings	964.4	400.7
UK (England)	GNS_DEF_all_0_0_all	Landings	502.1	631.1
France	GTR_DEF_120-219_0_0_all	Landings	0	130.3
France	GTR_DEF_120-219_0_0_all	Landings	0	392.8
France	GTR_DEF_90-99_0_0_all	Landings	20.32	130.3
France	GTR_DEF_90-99_0_0_all	Landings	654.5	336
France	OTB_DEF_70-99_0_0_all	Landings	719.5	336
UK (England)	GNS_DEF_all_0_0_all	Landings	692.1	247.4
UK (England)	GNS_DEF_all_0_0_all	Landings	915.1	316.6
UK (England)	GNS_DEF_all_0_0_all	Landings	850.6	376.3
UK (England)	GNS_DEF_all_0_0_all	Landings	884.8	401.6
UK (England)	GNS_DEF_all_0_0_all	Landings	793.9	392.8
UK (England)	GNS_DEF_all_0_0_all	Landings	442.2	253.5
UK (England)	GNS_DEF_all_0_0_all	Landings	485.6	283.7
UK (England)	GNS_DEF_all_0_0_all	Landings	500.7	307.2
UK (England)	GNS_DEF_all_0_0_all	Landings	662	445.4

AgeOrLength	Area
15	27.7.d
19	27.7.d
21	27.7.d
22	27.7.d
1	27.7.d
11	27.7.d
2	27.7.d
2	27.7.d

1	27.7.d
11	27.7.d
1	27.7.d
11	27.7.d
4	27.7.d
5	27.7.d
6	27.7.d
17	27.7.d
13	27.7.d
11	27.7.d
7	27.7.d
9	27.7.d
10	27.7.d
8	27.7.d
2	27.7.d
15	27.7.d
19	27.7.d
21	27.7.d
22	27.7.d
13	27.7.d
17	27.7.d
18	27.7.d
22	27.7.d
1	27.7.d
11	27.7.d
1	27.7.d
8	27.7.d
8	27.7.d
17	27.7.d
7	27.7.d
9	27.7.d
10	27.7.d
11	27.7.d
4	27.7.d
5	27.7.d
6	27.7.d
13	27.7.d

InterCatch output for 2011

This document uses Table 2 from CatchAndSampleDataTables.txt from the InterCatch outputs to describe the raising procedures that were made. In the following tables, CATON=WECA*CANUM/1000000 (in tonnes)

Raised discards

In InterCatch, the first step consists in raising the discards volumes for strata with landings and no discards associated. These discards are called in the following table 'Raised_Discards'. The data called 'Imported_Data' are landings or discards volumes imported into InterCatch with or without length/age structure.

The proportion of Landings with Discards associated (same strata) is **65 percent** (manual) and **66 percent** (autoallocation).

The volumes (and associated proportion) of landings and discards imported (Imported_Data) or raised (Raised_Discards) are described in the following table.

Table 1a: Summary of the imported/Raised data for manual allocation

CatchCategory	RaisedOrImported	CATON	perc
Discards	Raised_Discards	133.4	28
Discards	Imported_Data	335.6	72
Landings	Imported_Data	4079	100

Table 1b: Summary of the imported/Raised data for autoallocation

CatchCategory	RaisedOrImported	CATON	perc
Discards	Raised_Discards	143.1	30
Discards	Imported_Data	337.4	70
Landings	Imported_Data	4061	100

Length/Age distribution

For the imported landings/discards and the raised discards without age distribution, the length or age distribution is then computed using the defined allocation scheme. *Sampled_distribution* means that the data (ladings or discards) were input with age/length distribution. *Estimated_distribution* means that the imported/raised volumes were estimated using the allocation scheme.

Table 2a: Summary of the imported/Raised/SampledOrEstimated data for manual allocation

CatchCategory	RaisedOrImported	SampledOrEstimated	CATON	perc
Landings	Imported_Data	Sampled_Distribution	3236	79
Landings	Imported_Data	Estimated_Distribution	842.9	21
Discards	Imported_Data	Sampled_Distribution	233.2	50
Discards	Raised_Discards	Estimated_Distribution	133.4	28
Discards	Imported_Data	Estimated_Distribution	102.3	22

Table 2b: Summary of the imported/Raised/SampledOrEstimated data for autoallocation

CatchCategory	RaisedOrImported	SampledOrEstimated	CATON	perc
Landings	Imported_Data	Sampled_Distribution	3236	80
Landings	Imported_Data	Estimated_Distribution	825.5	20
Discards	Imported_Data	Sampled_Distribution	233.2	49
Discards	Raised_Discards	Estimated_Distribution	143.1	30
Discards	Imported_Data	Estimated_Distribution	104.2	22

Impact of the raising on the age/length structure

Once the samples imported or raised are identified, it is possible to check the impact of the allocation scheme on the mean age/length of the final age/length distribution of the stock. The following figures compare the mean age (computed as the

weighted mean of the age per stratum ("CatchCategory",'RaisedOrImported',"SampledOrEstimated","Country","Area","Season","Fleet","Sex") of the estimated strata compared to the imported ones and the final distribution. Each individual included in the boxplot corresponds to the weighted mean age of a stratum.

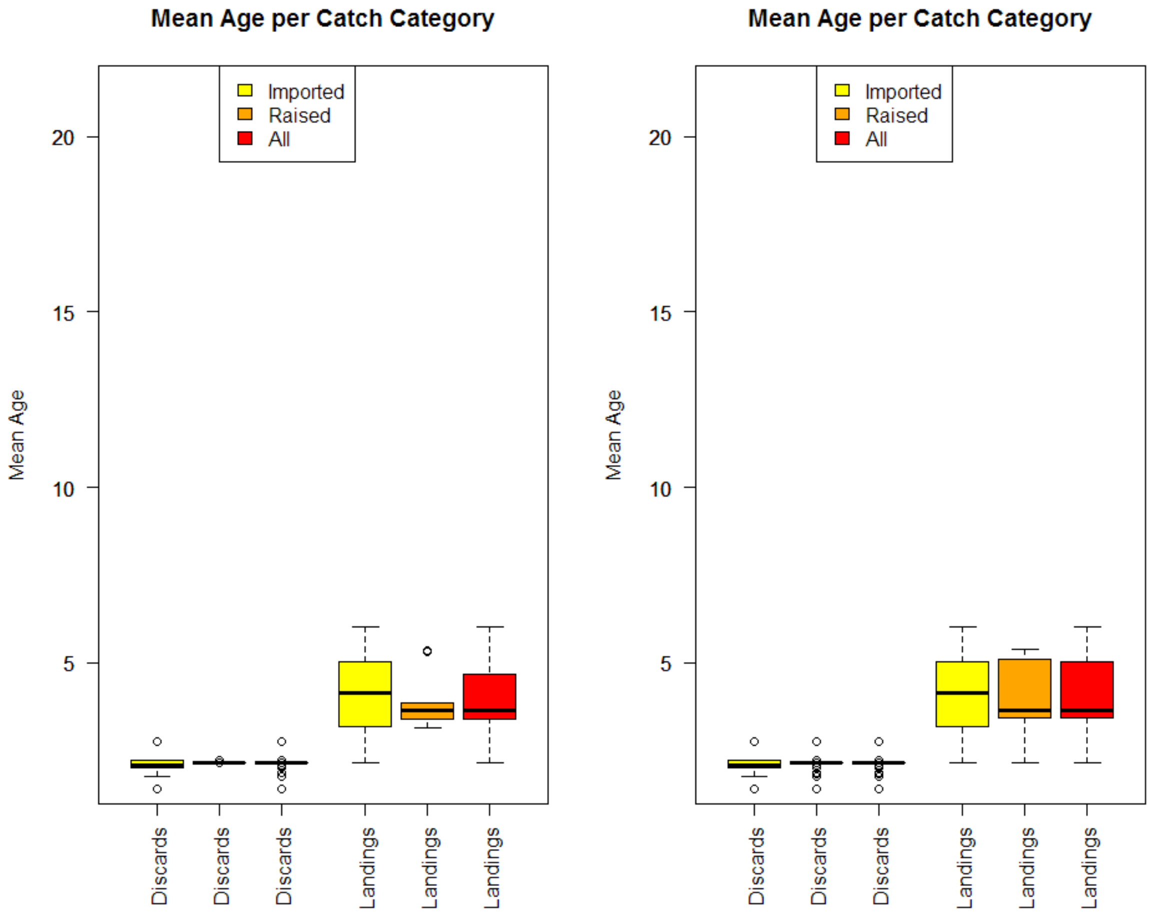


Figure 1: Mean Age per catch category (left: manual allocation; right: autoallocation)

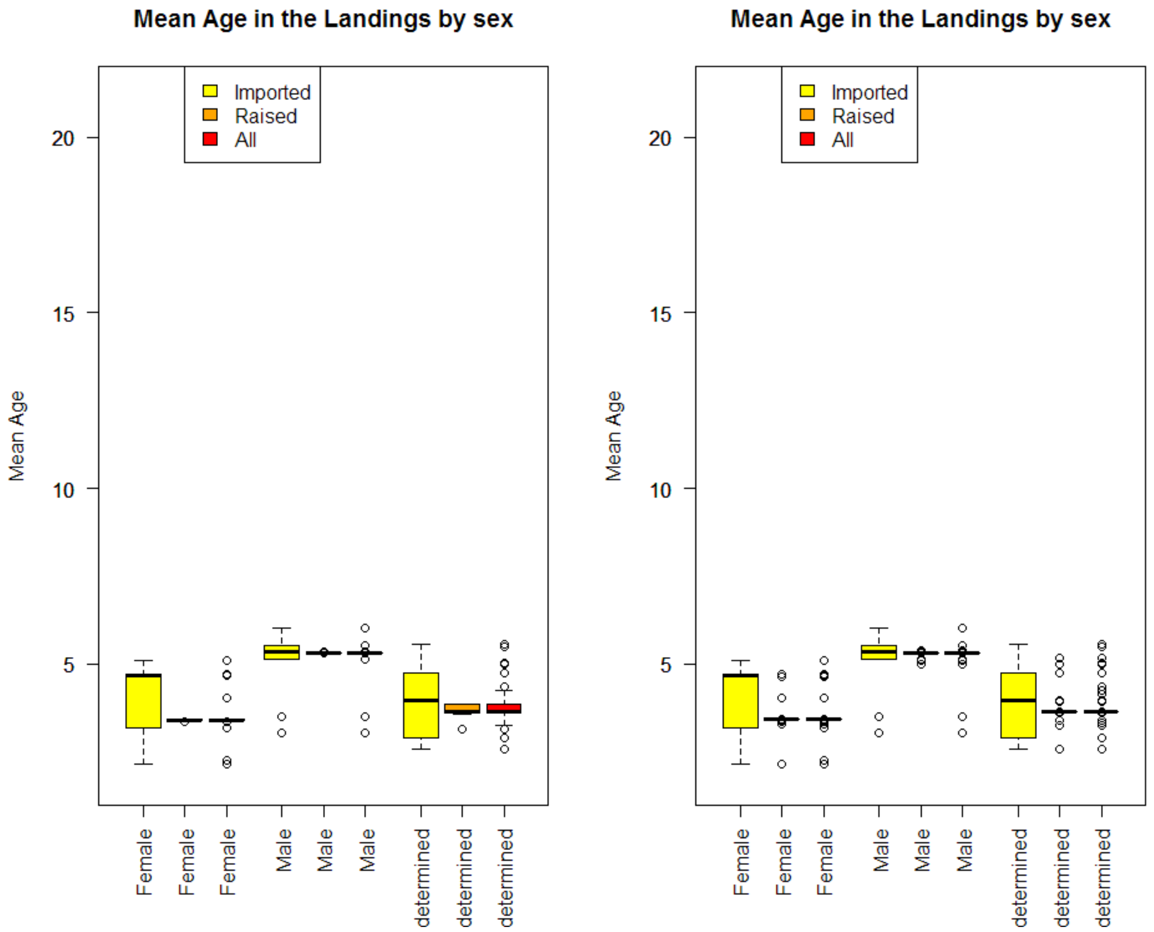


Figure 2: Mean Age in the Landings by sex (left: manual allocation; right: autoallocation)

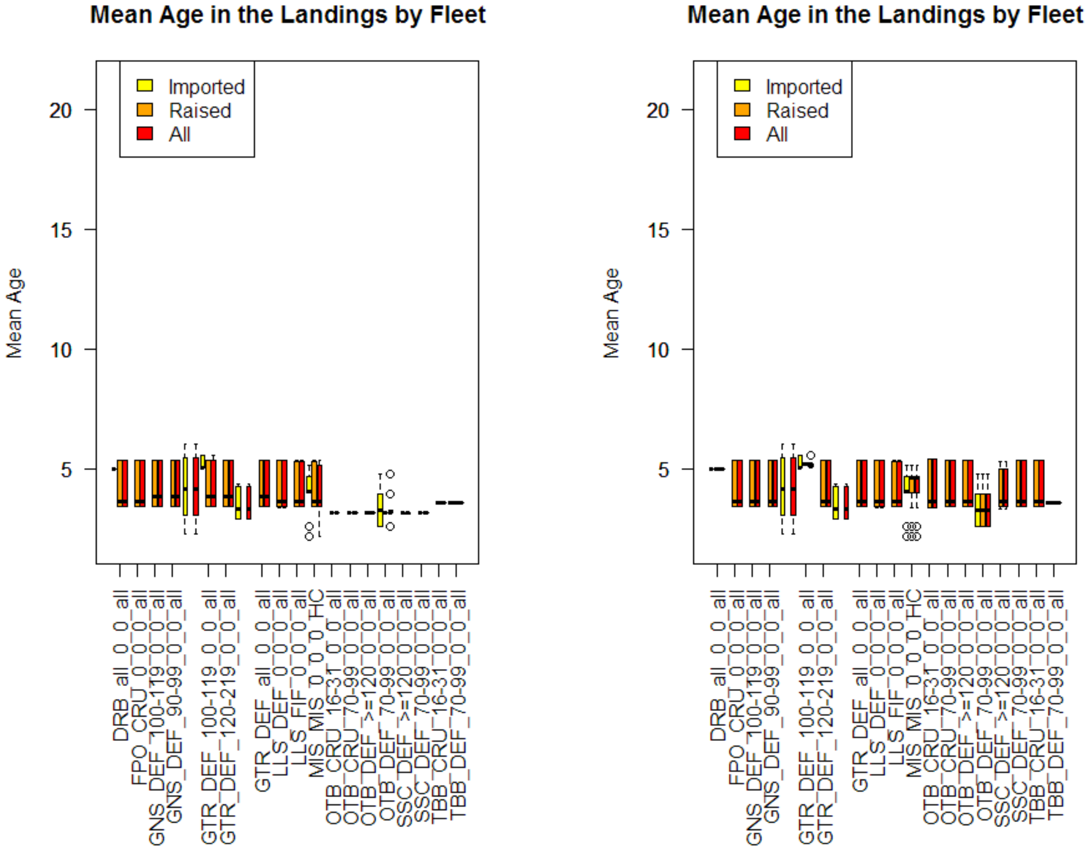


Figure 3: Mean Age in the Landings by Fleet (left: manual allocation; right: autoallocation)

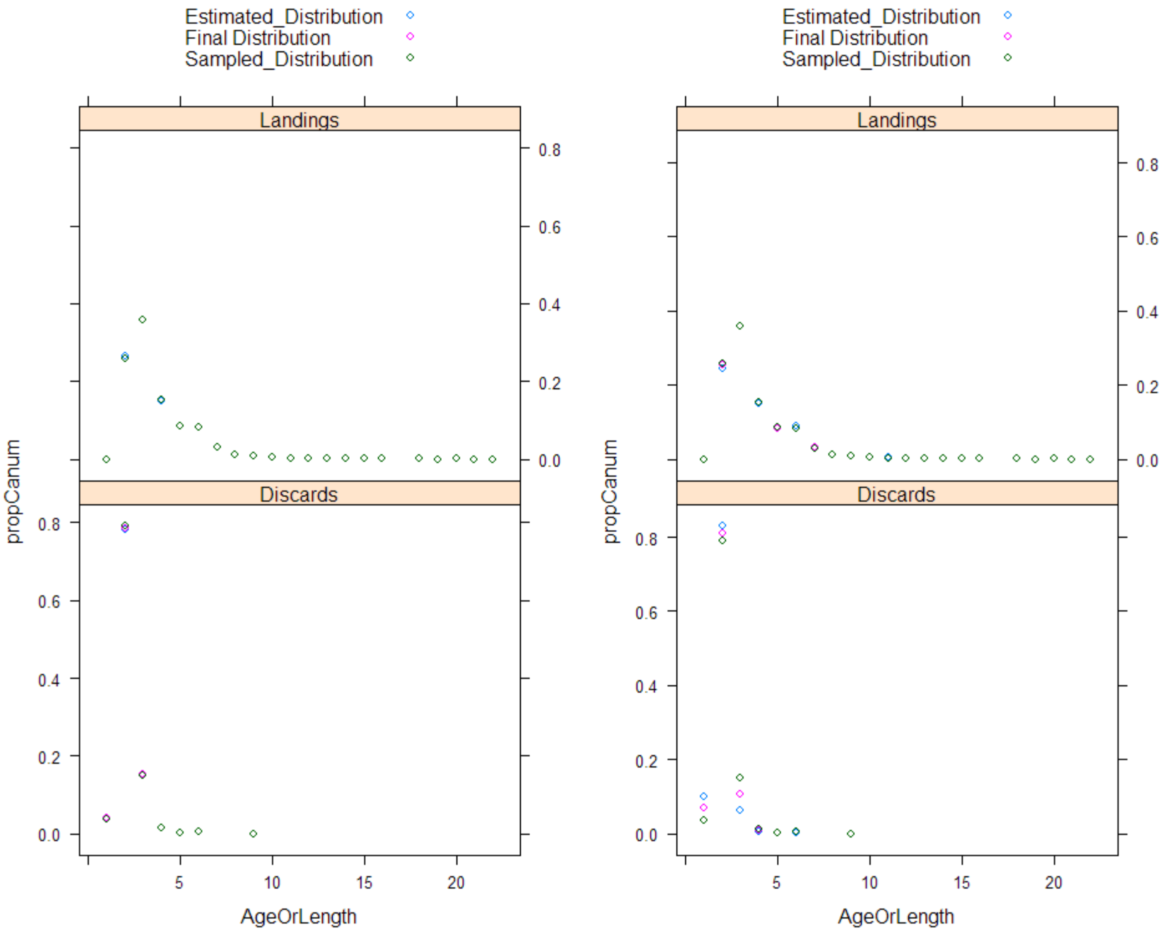


Figure 4: The percentage of each age for the sampled strata, estimated and the final age structure for the landing and discard fractions (left: manual allocation; right: autoallocation)

Impact of the raising on the mean weight

The CatchAndSampleData also provide the weight at age per stratum for the Sampled/Estimated strata. One should also check the sampled/estimated and resulting weight at age.

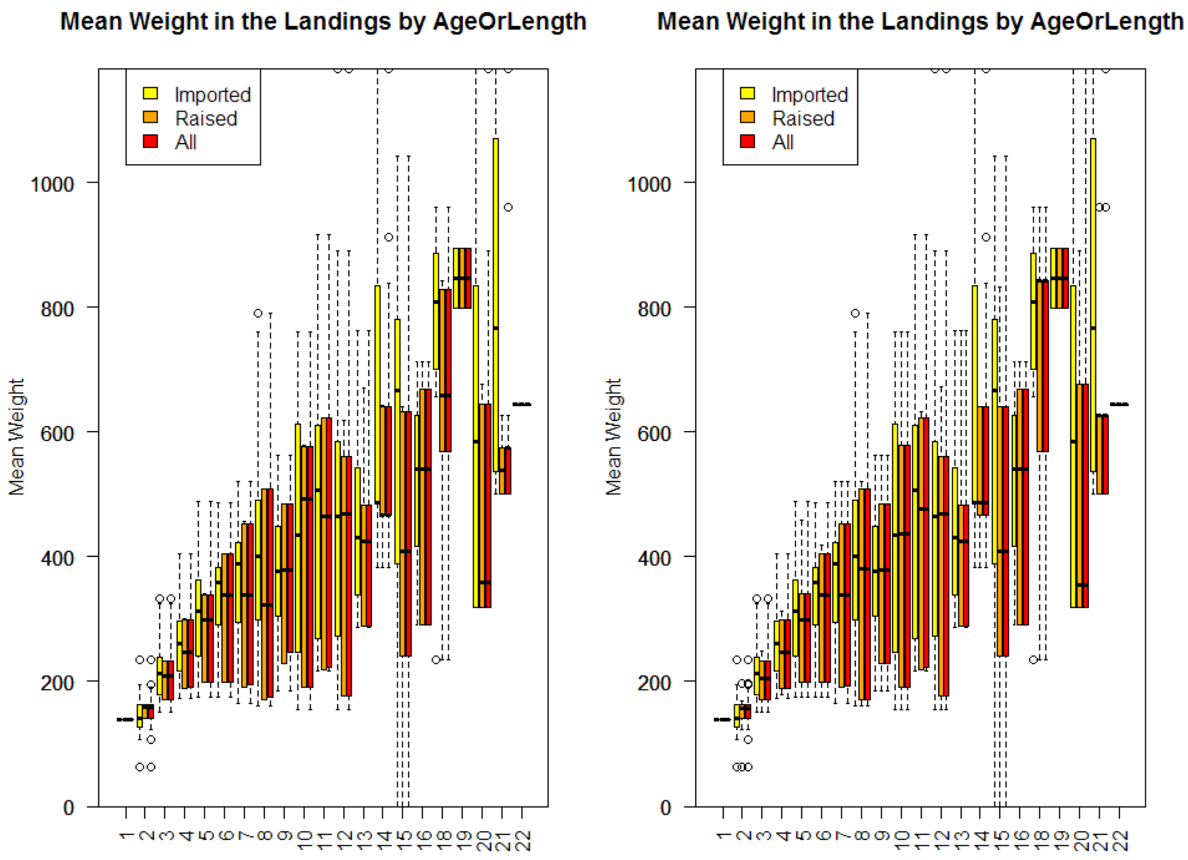


Figure 5: Each boxplot represents the distribution of the weight at age for the different strata (left: manual allocation; right: autoallocation)

Table 3a: Samples that are higher or lower than the average weigth at age +/- 3*standard deviation (outliers) for manual allocation

Table continues below

Country	Fleet	CatchCategory	WECA	AverageWtSize
UK (England)	MIS_MIS_0_0_0_HC	Landings	960.5	559.4
France	GTR_DEF_90-99_0_0_all	Landings	108	153.5
France	OTB_DEF_70-99_0_0_all	Landings	62.36	153.5
France	OTB_DEF_70-99_0_0_all	Landings	762	419.7
France	GTR_DEF_100-119_0_0_all	Landings	234.2	153.5
France	GTR_DEF_100-119_0_0_all	Landings	324.3	207.1
France	GTR_DEF_100-119_0_0_all	Landings	388.1	248.4
France	GTR_DEF_100-119_0_0_all	Landings	487.8	285.7
UK (England)	GNS_DEF_all_0_0_all	Landings	310.1	207.1
UK (England)	GNS_DEF_all_0_0_all	Landings	1181	418.2
UK (England)	GNS_DEF_all_0_0_all	Landings	1181	533.1
UK (England)	GNS_DEF_all_0_0_all	Landings	791.2	355.3
UK (England)	GNS_DEF_all_0_0_all	Landings	404.2	248.4
UK (England)	GNS_DEF_all_0_0_all	Landings	473.5	285.7

UK (England)	GNS_DEF_all_0_0_all	Landings	332.9	207.1
UK (England)	GNS_DEF_all_0_0_all	Landings	1181	453.9
UK (England)	GNS_DEF_all_0_0_all	Landings	1181	559.4

AgeOrLength	Area
21	27.7.d
2	27.7.d
2	27.7.d
13	27.7.d
2	27.7.d
3	27.7.d
4	27.7.d
5	27.7.d
3	27.7.d
12	27.7.d
14	27.7.d
8	27.7.d
4	27.7.d
5	27.7.d
3	27.7.d
20	27.7.d
21	27.7.d

Table 3b: Samples that are higher or lower than the average weigth at age +/- 3*standard deviation (outliers) for autoallocation

Table continues below

Country	Fleet	CatchCategory	WECA	AverageWtSize
UK (England)	OTB_DEF_70-99_0_0_all	Landings	62.36	151.2
UK (England)	OTB_DEF_70-99_0_0_all	Landings	762	415.8
UK (England)	OTB_DEF_70-99_0_0_all	Landings	235.4	716.6
France	GTR_DEF_90-99_0_0_all	Landings	912.4	551.9
France	OTB_DEF_70-99_0_0_all	Landings	62.36	151.2
France	OTB_DEF_70-99_0_0_all	Landings	762	415.8
France	OTB_DEF_70-99_0_0_all	Landings	235.4	716.6
France	GTR_DEF_100-119_0_0_all	Landings	234.2	151.2
France	GTR_DEF_100-119_0_0_all	Landings	324.3	203.9
France	GTR_DEF_100-119_0_0_all	Landings	388.1	245.6
UK (England)	GNS_DEF_all_0_0_all	Landings	1181	463.1
UK (England)	GNS_DEF_all_0_0_all	Landings	1181	591.6
UK (England)	GNS_DEF_all_0_0_all	Landings	1181	406.8
UK (England)	GNS_DEF_all_0_0_all	Landings	736.6	415.8
UK (England)	GNS_DEF_all_0_0_all	Landings	1181	551.9
UK (England)	GNS_DEF_all_0_0_all	Landings	791.2	360.9
UK (England)	GNS_DEF_all_0_0_all	Landings	404.2	245.6
UK (England)	GNS_DEF_all_0_0_all	Landings	332.9	203.9
UK (England)	GNS_DEF_all_0_0_all	Landings	310.1	203.9

AgeOrLength	Area
2	27.7.d
13	27.7.d

18	27.7.d
14	27.7.d
2	27.7.d
13	27.7.d
18	27.7.d
2	27.7.d
3	27.7.d
4	27.7.d
20	27.7.d
21	27.7.d
12	27.7.d
13	27.7.d
14	27.7.d
8	27.7.d
4	27.7.d
3	27.7.d
3	27.7.d

InterCatch output for 2012

This document uses Table 2 from CatchAndSampleDataTables.txt from the InterCatch outputs to describe the raising procedures that were made. In the following tables, CATON=WECA*CANUM/1000000 (in tonnes)

Raised discards

In InterCatch, the first step consists in raising the discards volumes for strata with landings and no discards associated. These discards are called in the following table 'Raised_Discards'. The data called 'Imported_Data' are landings or discards volumes imported into InterCatch with or without length/age structure.

The proportion of Landings with Discards associated (same strata) is **77 percent** (manual) and **76 percent** (autoallocation).

The volumes (and associated proportion) of landings and discards imported (Imported_Data) or raised (Raised_Discards) are described in the following table.

Table 1a: Summary of the imported/Raised data for manual allocation

CatchCategory	RaisedOrImported	CATON	perc
Discards	Raised_Discards	76.3	13
Discards	Imported_Data	525.6	87
Landings	Imported_Data	3800	100

Table 1b: Summary of the imported/Raised data for autoallocation

CatchCategory	RaisedOrImported	CATON	perc
Discards	Raised_Discards	75.9	13
Discards	Imported_Data	525.2	87
Landings	Imported_Data	3829	100

Length/Age distribution

For the imported landings/discards and the raised discards without age distribution, the length or age distribution is then computed using the defined allocation scheme. *Sampled_distribution* means that the data (ladings or discards) were input with age/length distribution. *Estimated_distribution* means that the imported/raised volumes were estimated using the allocation scheme.

Table 2a: Summary of the imported/Raised/SampledOrEstimated data for manual allocation

CatchCategory	RaisedOrImported	SampledOrEstimated	CATON	perc
Landings	Imported_Data	Sampled_Distribution	3157	83
Landings	Imported_Data	Estimated_Distribution	643	17
Discards	Imported_Data	Sampled_Distribution	516.7	86
Discards	Raised_Discards	Estimated_Distribution	76.3	13
Discards	Imported_Data	Estimated_Distribution	8.99	1

Table 2b: Summary of the imported/Raised/SampledOrEstimated data for autoallocation

CatchCategory	RaisedOrImported	SampledOrEstimated	CATON	perc
Landings	Imported_Data	Sampled_Distribution	3157	82
Landings	Imported_Data	Estimated_Distribution	671.9	18
Discards	Imported_Data	Sampled_Distribution	516.7	86
Discards	Raised_Discards	Estimated_Distribution	75.9	13
Discards	Imported_Data	Estimated_Distribution	8.51	1

Impact of the raising on the age/length structure

Once the samples imported or raised are identified, it is possible to check the impact of the allocation scheme on the mean age/length of the final age/length distribution of the stock. The following figures compare the mean age (computed as the

weighted mean of the age per stratum ("CatchCategory",'RaisedOrImported',"SampledOrEstimated","Country","Area","Season","Fleet","Sex") of the estimated strata compared to the imported ones and the final distribution. Each individual included in the boxplot corresponds to the weighted mean age of a stratum.

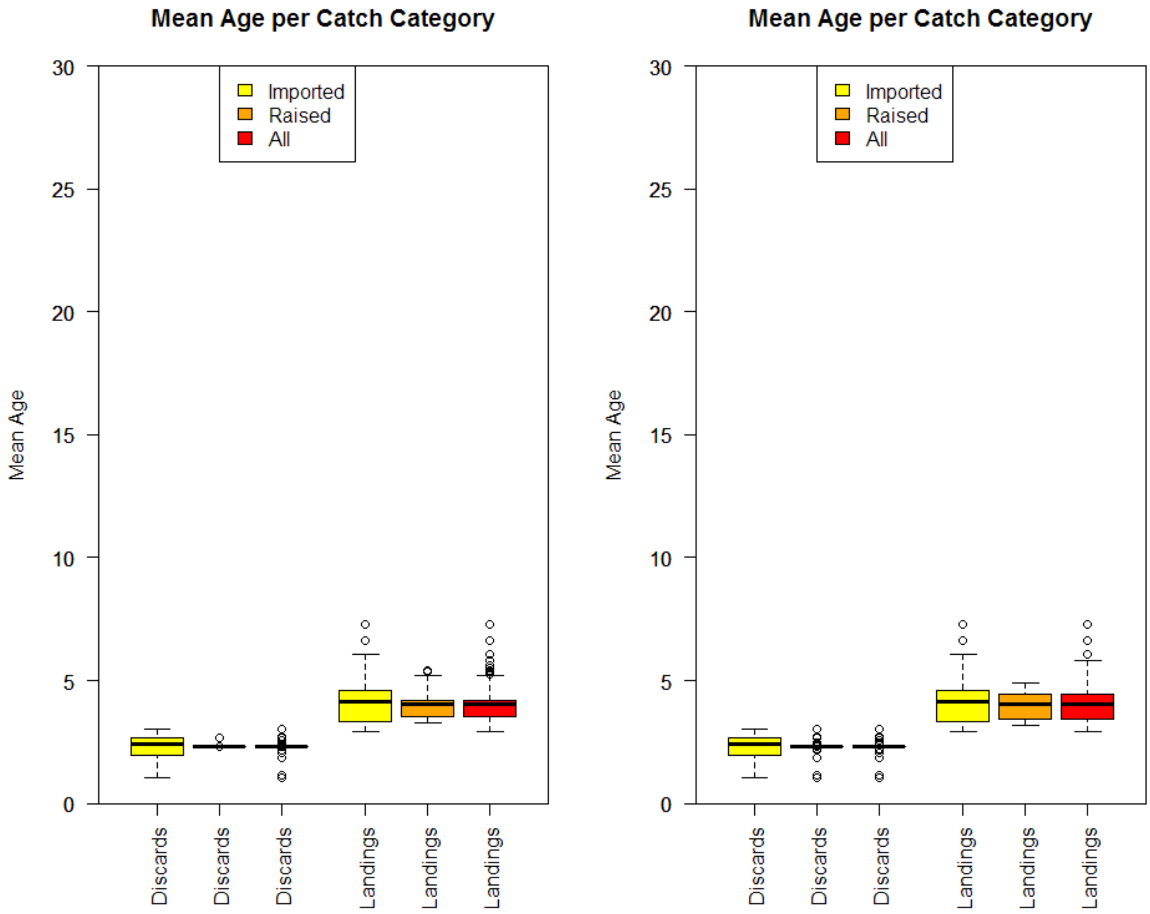


Figure 1: Mean Age per catch category (left: manual allocation; right: autoallocation)

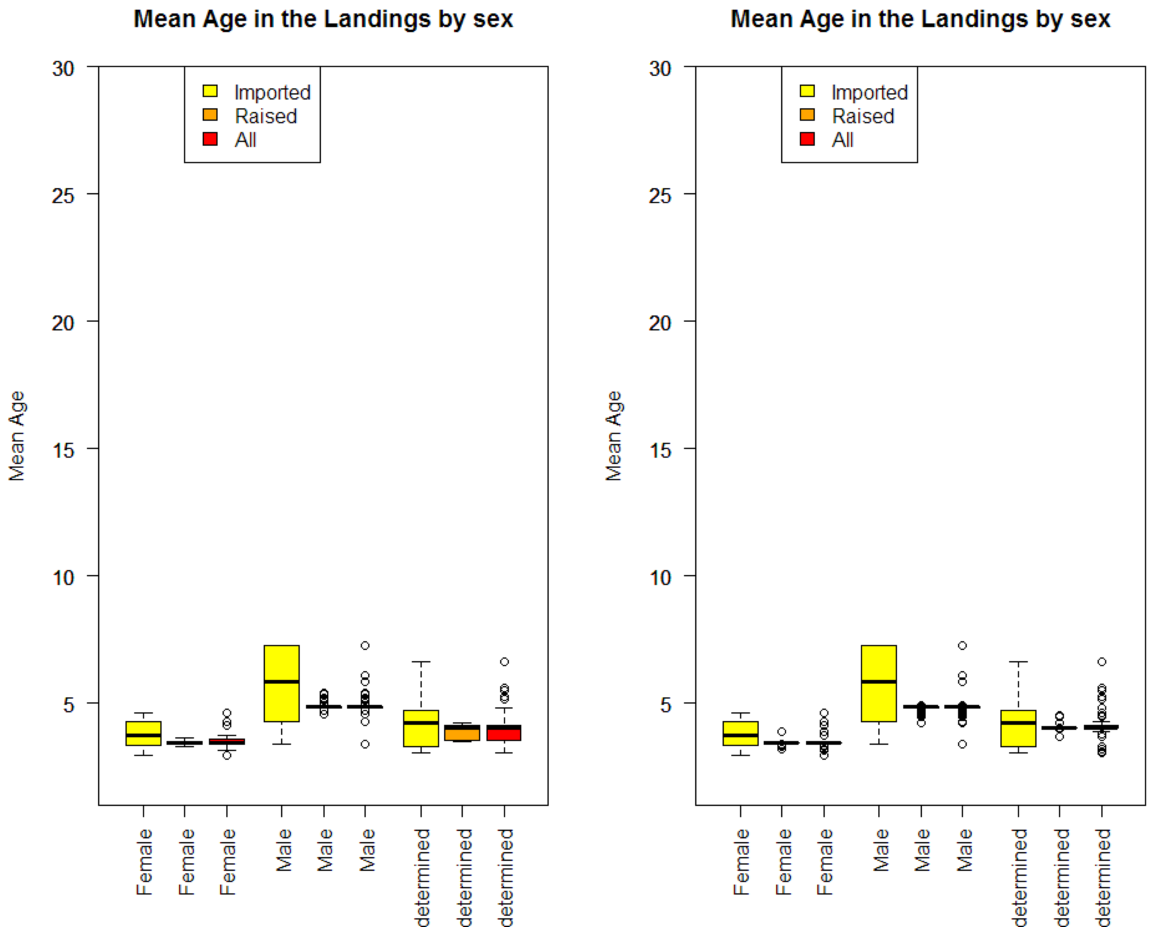


Figure 2: Mean Age in the Landings by sex (left: manual allocation; right: autoallocation)

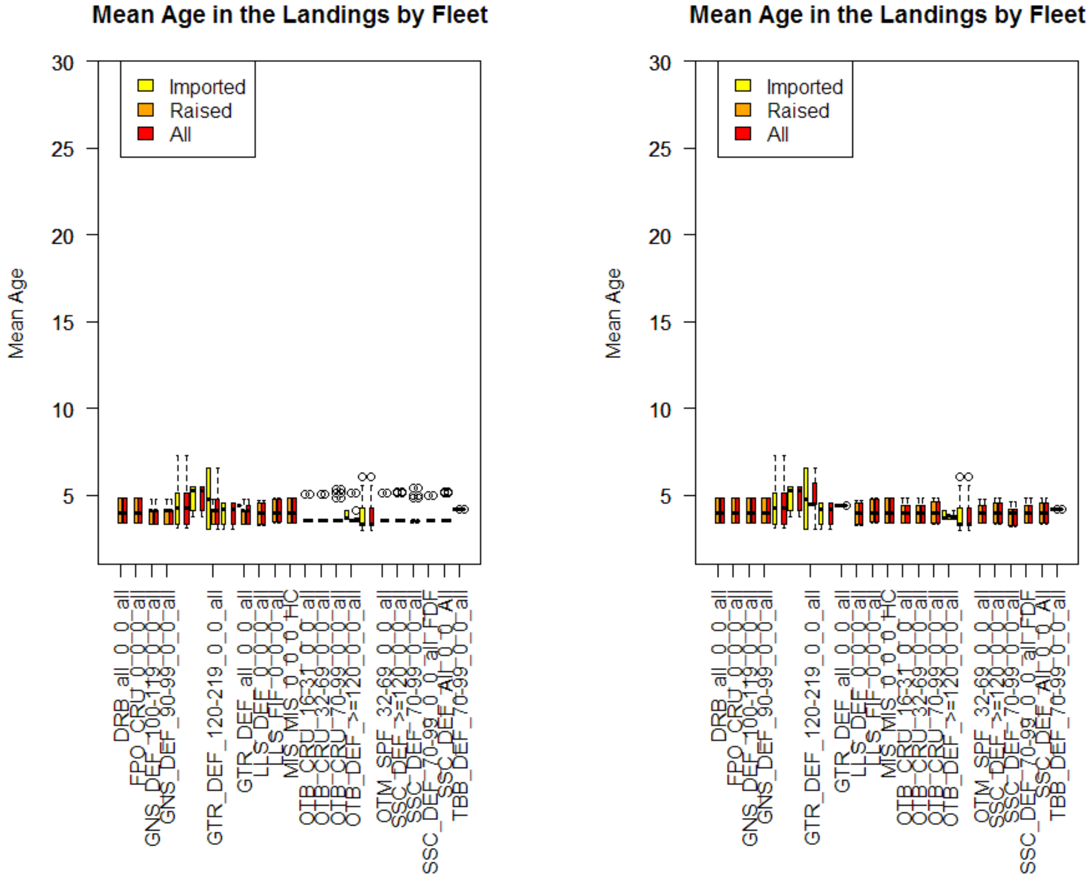


Figure 3: Mean Age in the Landings by Fleet (left: manual allocation; right: autoallocation)

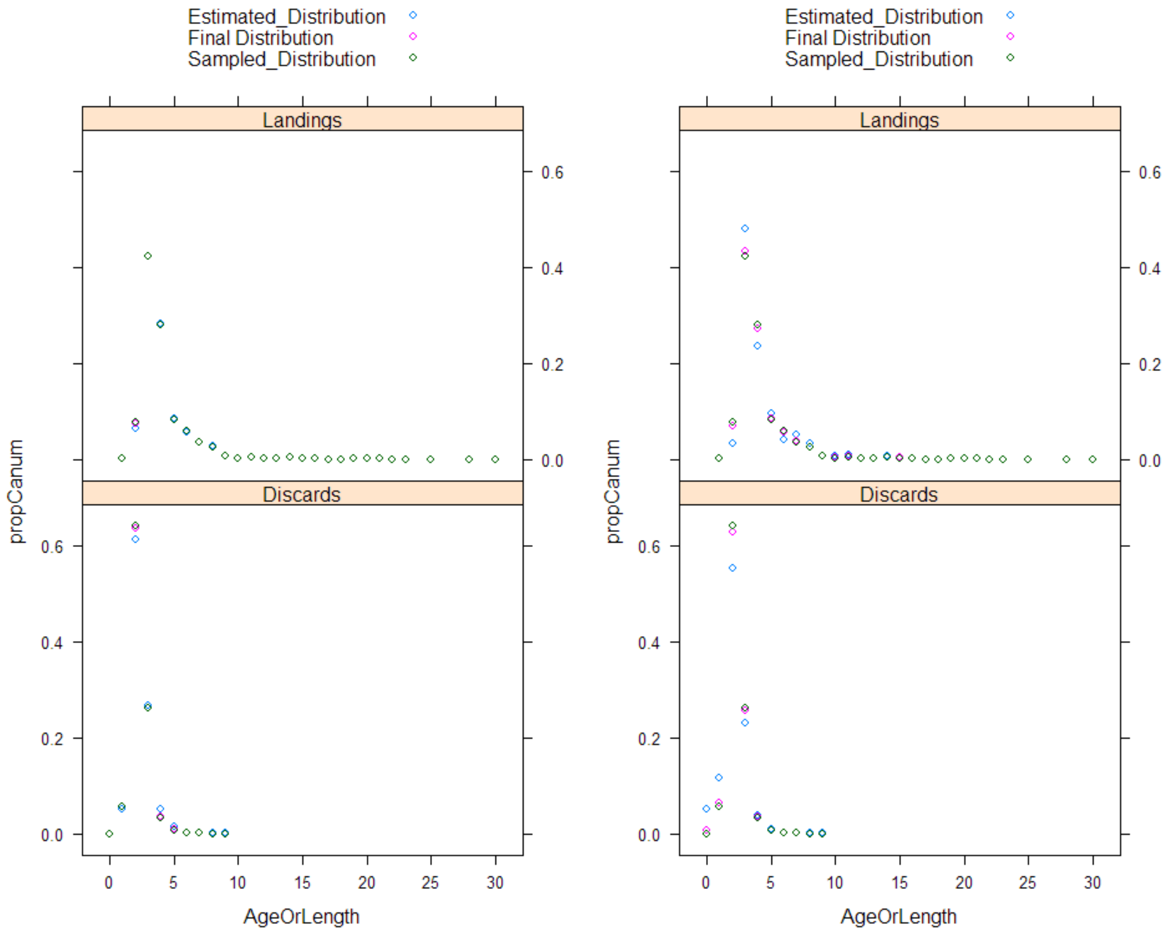


Figure 4: The percentage of each age for the sampled strata, estimated and the final age structure for the landing and discard fractions (left: manual allocation; right: autoallocation)

Impact of the raising on the mean weight

The CatchAndSampleData also provide the weight at age per stratum for the Sampled/Estimated strata. One should also check the sampled/estimated and resulting weight at age.

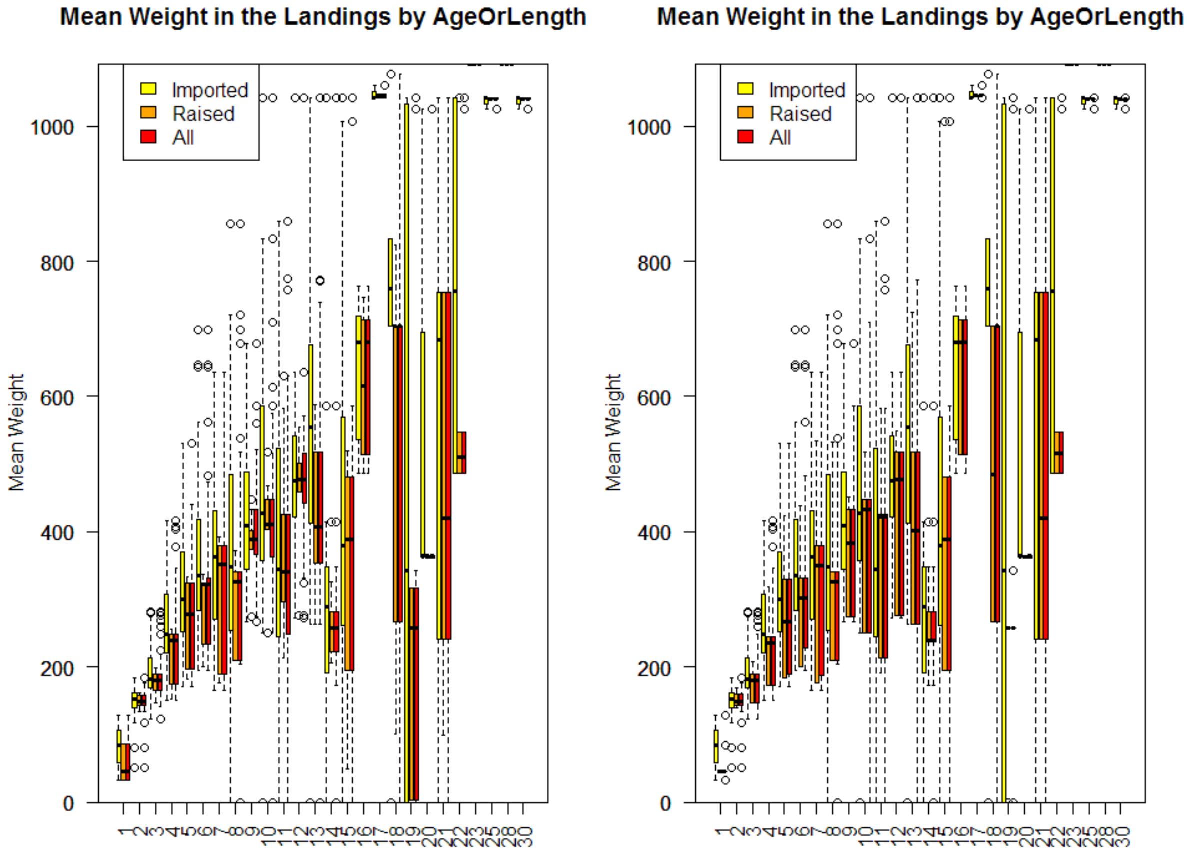


Figure 5: Each boxplot represents the distribution of the weight at age for the different strata (left: manual allocation; right: autoallocation)

Table 3a: Samples that are higher or lower than the average weigth at age +/- 3*standard deviation (outliers) for manual allocation

Table continues below

Country	Fleet	CatchCategory	WECA	AverageWtSize
France	GTR_DEF_120-219_0_0_all	Landings	417	225.2
France	GTR_DEF_120-219_0_0_all	Landings	530.8	271.6
France	GTR_DEF_120-219_0_0_all	Landings	678.7	306.9
France	GTR_DEF_120-219_0_0_all	Landings	1007	335.6
UK (England)	GNS_DEF_all_0_0_all	Landings	1025	1041
UK (England)	GNS_DEF_all_0_0_all	Landings	1025	1041
UK (England)	GNS_DEF_all_0_0_all	Landings	1060	1045
UK (England)	GNS_DEF_all_0_0_all	Landings	1025	221.6
UK (England)	GNS_DEF_all_0_0_all	Landings	1025	368.7
France	GTR_DEF_100-119_0_0_all	Landings	248.3	178
France	GTR_DEF_120-219_0_0_all	Landings	80.34	148.5
France	GTR_DEF_120-219_0_0_all	Landings	834	402
France	GTR_DEF_90-99_0_0_all	Landings	834	402
France	OTB_DEF_70-99_0_0_all	Landings	51.03	148.5

France	OTB_DEF_70-99_0_0_all	Landings	0	402
France	OTB_DEF_70-99_0_0_all	Landings	0	435.5
France	GTR_DEF_100-119_0_0_all	Landings	128.4	53.82
France	GTR_DEF_100-119_0_0_all	Landings	269.5	178
France	OTB_DEF_70-99_0_0_all	Landings	0	402
UK (England)	GNS_DEF_all_0_0_all	Landings	678	378.7
France	GTR_DEF_100-119_0_0_all	Landings	282.1	178
France	GTR_DEF_100-119_0_0_all	Landings	377	225.2
France	GTR_DEF_120-219_0_0_all	Landings	0	306.9
France	GTR_DEF_90-99_0_0_all	Landings	561.9	301.3
France	GTR_DEF_90-99_0_0_all	Landings	636.6	315.5
France	OTB_DEF_70-99_0_0_all	Landings	279.1	178
France	OTB_DEF_70-99_0_0_all	Landings	403.4	225.2
UK (England)	GNS_DEF_all_0_0_all	Landings	585.5	378.7
UK (England)	GNS_DEF_all_0_0_all	Landings	1043	402
UK (England)	GNS_DEF_all_0_0_all	Landings	1043	448.7
UK (England)	GNS_DEF_all_0_0_all	Landings	1043	435.5
UK (England)	GNS_DEF_all_0_0_all	Landings	1043	275.7
UK (England)	GNS_DEF_all_0_0_all	Landings	720.3	306.9
UK (England)	GNS_DEF_all_0_0_all	Landings	1043	221.6
UK (England)	GNS_DEF_all_0_0_all	Landings	647.5	301.3
UK (England)	GNS_DEF_all_0_0_all	Landings	259.3	178
UK (England)	GNS_DEF_all_0_0_all	Landings	275.1	178
UK (England)	GNS_DEF_all_0_0_all	Landings	407.6	225.2
UK (England)	GNS_DEF_all_0_0_all	Landings	642.7	301.3
UK (England)	GNS_DEF_all_0_0_all	Landings	855.4	306.9
UK (England)	OTB_DEF_70-99_0_0_all	Landings	699.3	301.3
UK (England)	OTB_DEF_70-99_0_0_all	Landings	698.6	306.9
UK (England)	OTB_DEF_70-99_0_0_all	Landings	1043	402
UK (England)	OTB_DEF_70-99_0_0_all	Landings	858.8	371.1
UK (England)	OTB_DEF_70-99_0_0_all	Landings	1043	448.7
UK (England)	OTB_DEF_70-99_0_0_all	Landings	1043	435.5
UK (England)	OTB_DEF_70-99_0_0_all	Landings	1043	275.7
UK (England)	OTB_DEF_70-99_0_0_all	Landings	1043	335.6
UK (England)	OTB_DEF_70-99_0_0_all	Landings	1043	221.6

AgeOrLength	Area
4	27.7.d
5	27.7.d
8	27.7.d
15	27.7.d
25	27.7.d
30	27.7.d
17	27.7.d
19	27.7.d
20	27.7.d
3	27.7.d
2	27.7.d

10	27.7.d
10	27.7.d
2	27.7.d
10	27.7.d
13	27.7.d
1	27.7.d
3	27.7.d
10	27.7.d
9	27.7.d
3	27.7.d
4	27.7.d
8	27.7.d
6	27.7.d
7	27.7.d
3	27.7.d
4	27.7.d
9	27.7.d
10	27.7.d
12	27.7.d
13	27.7.d
14	27.7.d
8	27.7.d
19	27.7.d
6	27.7.d
3	27.7.d
3	27.7.d
4	27.7.d
6	27.7.d
8	27.7.d
6	27.7.d
8	27.7.d
10	27.7.d
11	27.7.d
12	27.7.d
13	27.7.d
14	27.7.d
15	27.7.d
19	27.7.d

Table 3b: Samples that are higher or lower than the average weigth at age +/- 3*standard deviation (outliers) for autoallocation

Table continues below

Country	Fleet	CatchCategory	WECA	AverageWtSize
France	GTR_DEF_120-219_0_0_all	Landings	1007	361.5
France	GTR_DEF_120-219_0_0_all	Landings	417	225.7
France	GTR_DEF_120-219_0_0_all	Landings	530.8	267.7
France	GTR_DEF_120-219_0_0_all	Landings	678.7	307.6
France	GTR_DEF_120-219_0_0_all	Landings	1007	361.5

UK (England)	GNS_DEF_all_0_0_all	Landings	1025	529.1
UK (England)	GNS_DEF_all_0_0_all	Landings	1025	1041
UK (England)	GNS_DEF_all_0_0_all	Landings	1025	1041
UK (England)	GNS_DEF_all_0_0_all	Landings	1060	1046
UK (England)	GNS_DEF_all_0_0_all	Landings	1025	280.1
UK (England)	GNS_DEF_all_0_0_all	Landings	1025	368.6
UK (England)	OTB_DEF_70-99_0_0_all	Landings	774.2	367.6
France	GTR_DEF_100-119_0_0_all	Landings	248.3	176.1
France	GTR_DEF_120-219_0_0_all	Landings	80.34	150
France	GTR_DEF_120-219_0_0_all	Landings	834	395.3
France	GTR_DEF_90-99_0_0_all	Landings	834	395.3
France	OTB_DEF_70-99_0_0_all	Landings	51.03	150
France	OTB_DEF_70-99_0_0_all	Landings	0	395.3
France	OTB_DEF_70-99_0_0_all	Landings	0	419.5
France	GTR_DEF_100-119_0_0_all	Landings	128.4	47.35
France	GTR_DEF_100-119_0_0_all	Landings	269.5	176.1
France	GTR_DEF_90-99_0_0_all	Landings	83.79	47.35
France	OTB_DEF_70-99_0_0_all	Landings	0	395.3
UK (England)	GNS_DEF_all_0_0_all	Landings	678	370.8
France	GTR_DEF_100-119_0_0_all	Landings	282.1	176.1
France	GTR_DEF_100-119_0_0_all	Landings	377	225.7
France	GTR_DEF_120-219_0_0_all	Landings	0	307.6
France	GTR_DEF_90-99_0_0_all	Landings	561.9	292.8
France	GTR_DEF_90-99_0_0_all	Landings	636.6	308.6
France	OTB_DEF_70-99_0_0_all	Landings	279.1	176.1
France	OTB_DEF_70-99_0_0_all	Landings	403.4	225.7
UK (England)	GNS_DEF_all_0_0_all	Landings	1043	280.1
UK (England)	GNS_DEF_all_0_0_all	Landings	1043	529.1
UK (England)	GNS_DEF_all_0_0_all	Landings	585.5	370.8
UK (England)	GNS_DEF_all_0_0_all	Landings	1043	395.3
UK (England)	GNS_DEF_all_0_0_all	Landings	758.3	367.6
UK (England)	GNS_DEF_all_0_0_all	Landings	1043	436.1
UK (England)	GNS_DEF_all_0_0_all	Landings	1043	419.5
UK (England)	GNS_DEF_all_0_0_all	Landings	1043	274.2
UK (England)	GNS_DEF_all_0_0_all	Landings	720.3	307.6
UK (England)	GNS_DEF_all_0_0_all	Landings	647.5	292.8
UK (England)	GNS_DEF_all_0_0_all	Landings	259.3	176.1
UK (England)	GNS_DEF_all_0_0_all	Landings	275.1	176.1
UK (England)	GNS_DEF_all_0_0_all	Landings	407.6	225.7
UK (England)	GNS_DEF_all_0_0_all	Landings	642.7	292.8
UK (England)	GNS_DEF_all_0_0_all	Landings	855.4	307.6
UK (England)	OTB_DEF_70-99_0_0_all	Landings	699.3	292.8
UK (England)	OTB_DEF_70-99_0_0_all	Landings	1043	395.3
UK (England)	OTB_DEF_70-99_0_0_all	Landings	858.8	367.6
UK (England)	OTB_DEF_70-99_0_0_all	Landings	1043	436.1
UK (England)	OTB_DEF_70-99_0_0_all	Landings	1043	419.5
UK (England)	OTB_DEF_70-99_0_0_all	Landings	1043	274.2
UK (England)	OTB_DEF_70-99_0_0_all	Landings	1043	361.5

UK (England)	OTB_DEF_70-99_0_0_all	Landings	1043	280.1
UK (England)	OTB_DEF_70-99_0_0_all	Landings	1043	529.1
UK (England)	OTB_DEF_70-99_0_0_all	Landings	698.6	307.6

AgeOrLength	Area
15	27.7.d
4	27.7.d
5	27.7.d
8	27.7.d
15	27.7.d
22	27.7.d
25	27.7.d
30	27.7.d
17	27.7.d
19	27.7.d
20	27.7.d
11	27.7.d
3	27.7.d
2	27.7.d
10	27.7.d
10	27.7.d
2	27.7.d
10	27.7.d
13	27.7.d
1	27.7.d
3	27.7.d
1	27.7.d
10	27.7.d
9	27.7.d
3	27.7.d
4	27.7.d
8	27.7.d
6	27.7.d
7	27.7.d
3	27.7.d
4	27.7.d
19	27.7.d
22	27.7.d
9	27.7.d
10	27.7.d
11	27.7.d
12	27.7.d
13	27.7.d
14	27.7.d
8	27.7.d
6	27.7.d
3	27.7.d
3	27.7.d

4	27.7.d
6	27.7.d
8	27.7.d
6	27.7.d
10	27.7.d
11	27.7.d
12	27.7.d
13	27.7.d
14	27.7.d
15	27.7.d
19	27.7.d
22	27.7.d
8	27.7.d

InterCatch output for 2013

This document uses Table 2 from CatchAndSampleDataTables.txt from the InterCatch outputs to describe the raising procedures that were made. In the following tables, CATON=WECA*CANUM/1000000 (in tonnes)

Raised discards

In InterCatch, the first step consists in raising the discards volumes for strata with landings and no discards associated. These discards are called in the following table 'Raised_Discards'. The data called 'Imported_Data' are landings or discards volumes imported into InterCatch with or without length/age structure.

The proportion of Landings with Discards associated (same strata) is **82 percent**.

The volumes (and associated proportion) of landings and discards imported (Imported_Data) or raised (Raised_Discards) are described in the following table.

Table 1a: Summary of the imported/Raised data for manual allocation

CatchCategory	RaisedOrImported	CATON	perc
Discards	Raised_Discards	64.64	13
Discards	Imported_Data	442.5	87
Landings	Imported_Data	4241	100

Table 1b: Summary of the imported/Raised data for autoallocation

CatchCategory	RaisedOrImported	CATON	perc
Discards	Raised_Discards	65.07	13
Discards	Imported_Data	443.4	87
Landings	Imported_Data	4242	100

Length/Age distribution

For the imported landings/discards and the raised discards without age distribution, the length or age distribution is then computed using the defined allocation scheme. *Sampled_distribution* means that the data (ladings or discards) were input with age/length distribution. *Estimated_distribution* means that the imported/raised volumes were estimated using the allocation scheme.

Table 2a: Summary of the imported/Raised/SampledOrEstimated data for manual allocation

CatchCategory	RaisedOrImported	SampledOrEstimated	CATON	perc
Landings	Imported_Data	Sampled_Distribution	3486	82
Landings	Imported_Data	Estimated_Distribution	754.4	18
Discards	Imported_Data	Sampled_Distribution	421.9	83
Discards	Raised_Discards	Estimated_Distribution	64.64	13
Discards	Imported_Data	Estimated_Distribution	20.64	4

Table 2b: Summary of the imported/Raised/SampledOrEstimated data for autoallocation

CatchCategory	RaisedOrImported	SampledOrEstimated	CATON	perc
Landings	Imported_Data	Sampled_Distribution	3486	82
Landings	Imported_Data	Estimated_Distribution	756.2	18
Discards	Imported_Data	Sampled_Distribution	421.9	83
Discards	Raised_Discards	Estimated_Distribution	65.07	13
Discards	Imported_Data	Estimated_Distribution	21.45	4

Impact of the raising on the age/length structure

Once the samples imported or raised are identified, it is possible to check the impact of the allocation scheme on the mean age/length of the final age/length distribution of the stock. The following figures compare the mean age (computed as the

weighted mean of the age per stratum ("CatchCategory",'RaisedOrImported',"SampledOrEstimated","Country","Area","Season","Fleet","Sex") of the estimated strata compared to the imported ones and the final distribution. Each individual included in the boxplot corresponds to the weighted mean age of a stratum.

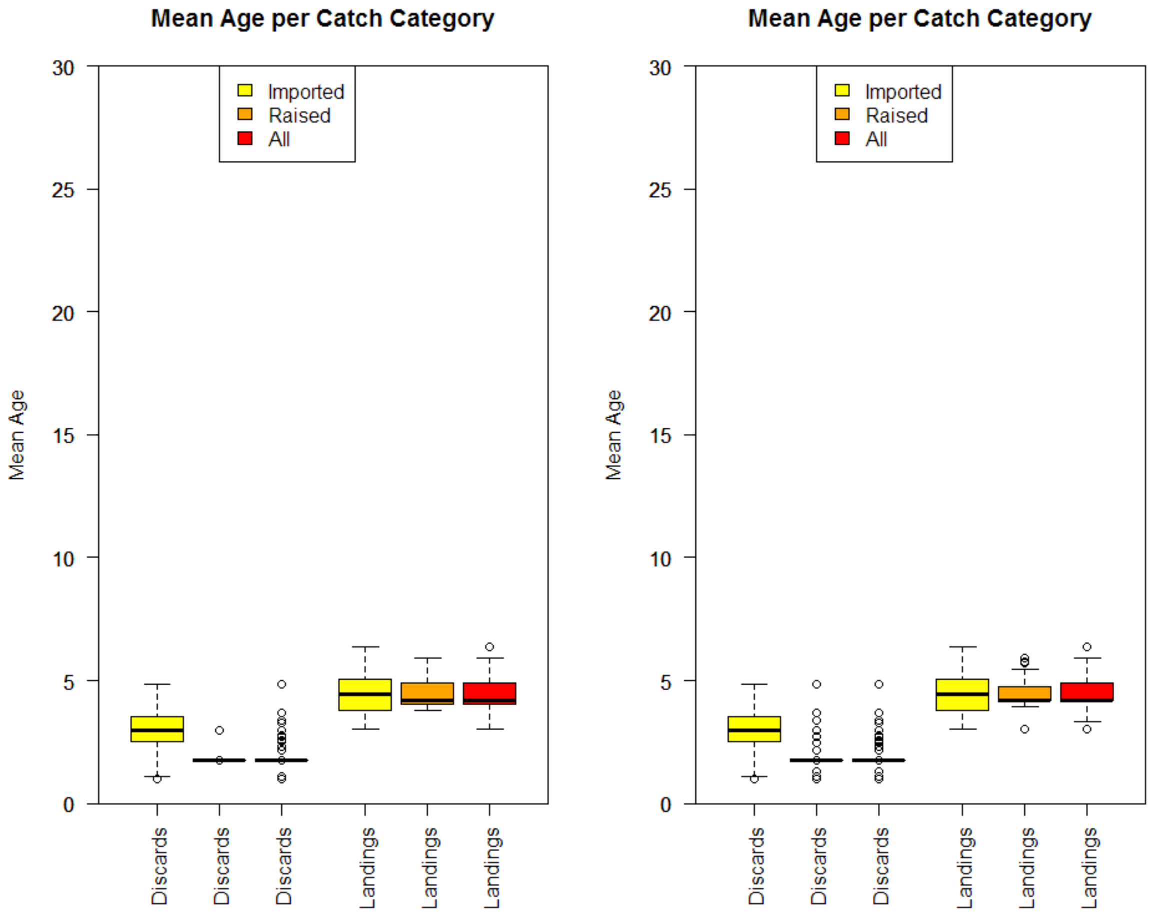


Figure 1: Mean Age per catch category (left: manual allocation; right: autoallocation)

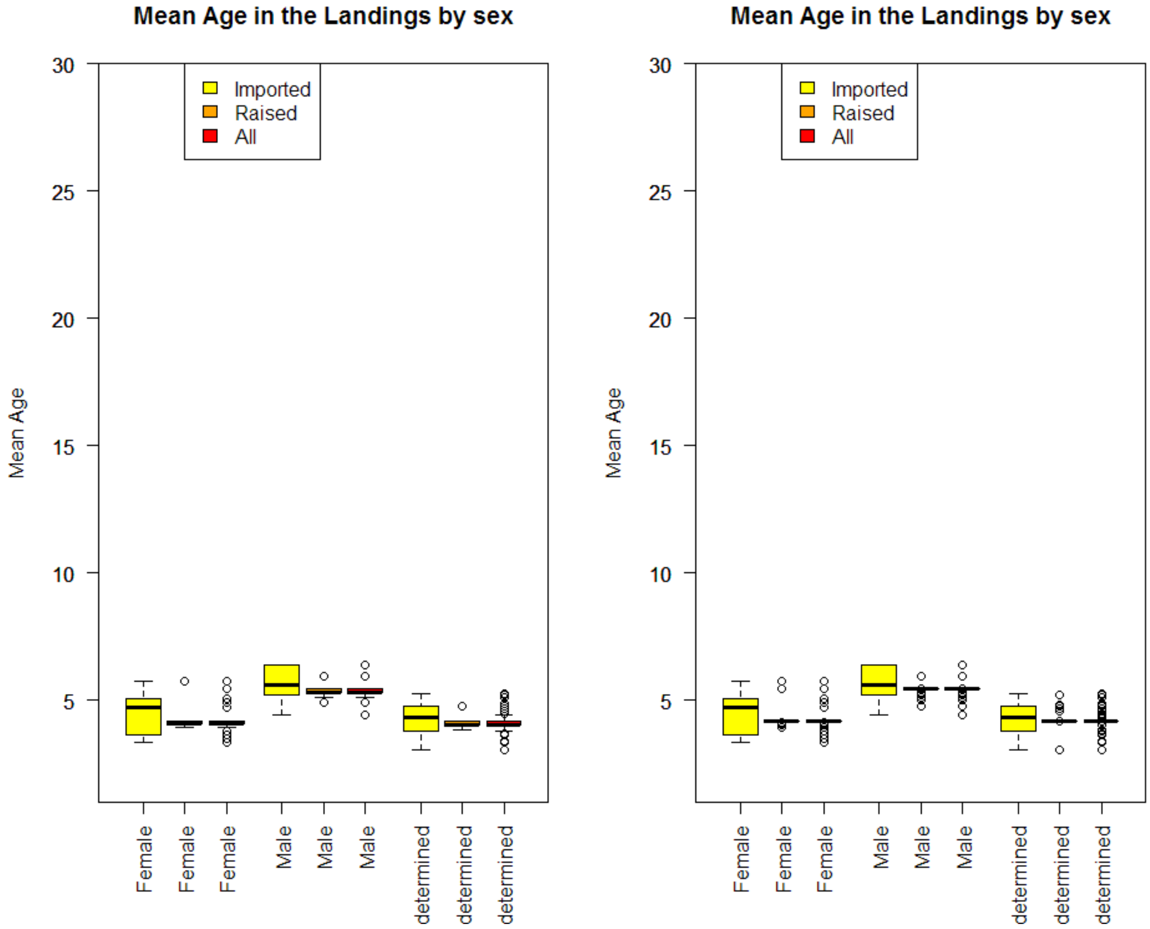


Figure 2: Mean Age in the Landings by sex (left: manual allocation; right: autoallocation)

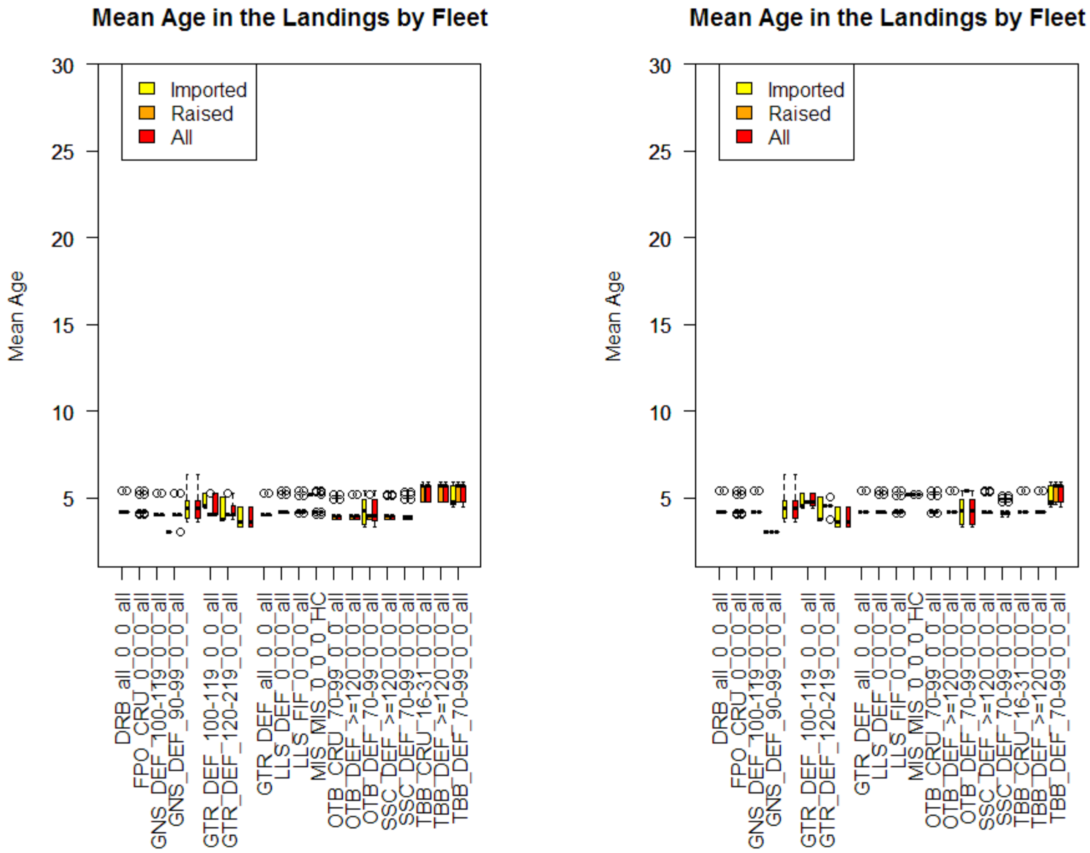


Figure 3: Mean Age in the Landings by Fleet (left: manual allocation; right: autoallocation)

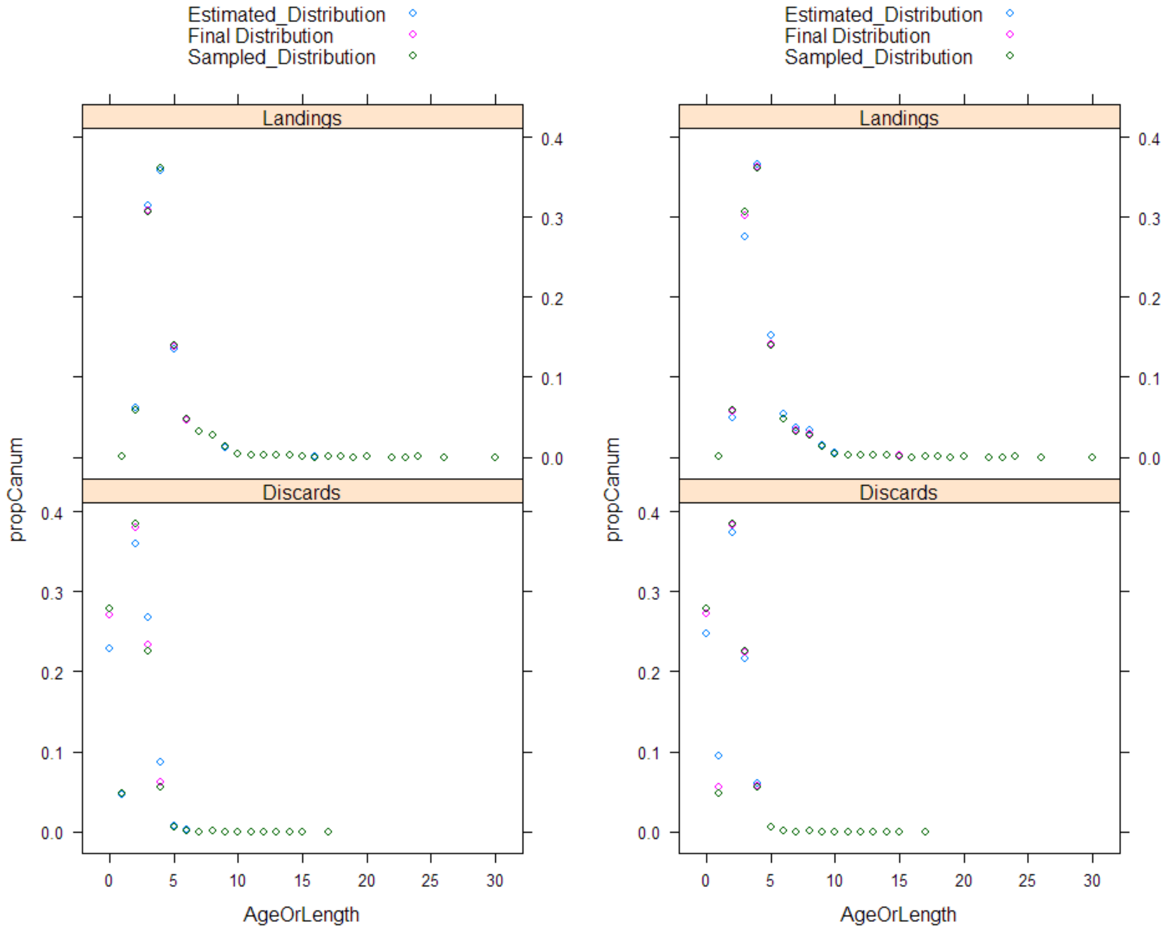


Figure 4: The percentage of each age for the sampled strata, estimated and the final age structure for the landing and discard fractions (left: manual allocation; right: autoallocation)

Impact of the raising on the mean weight

The CatchAndSampleData also provide the weight at age per stratum for the Sampled/Estimated strata. One should also check the sampled/estimated and resulting weight at age.

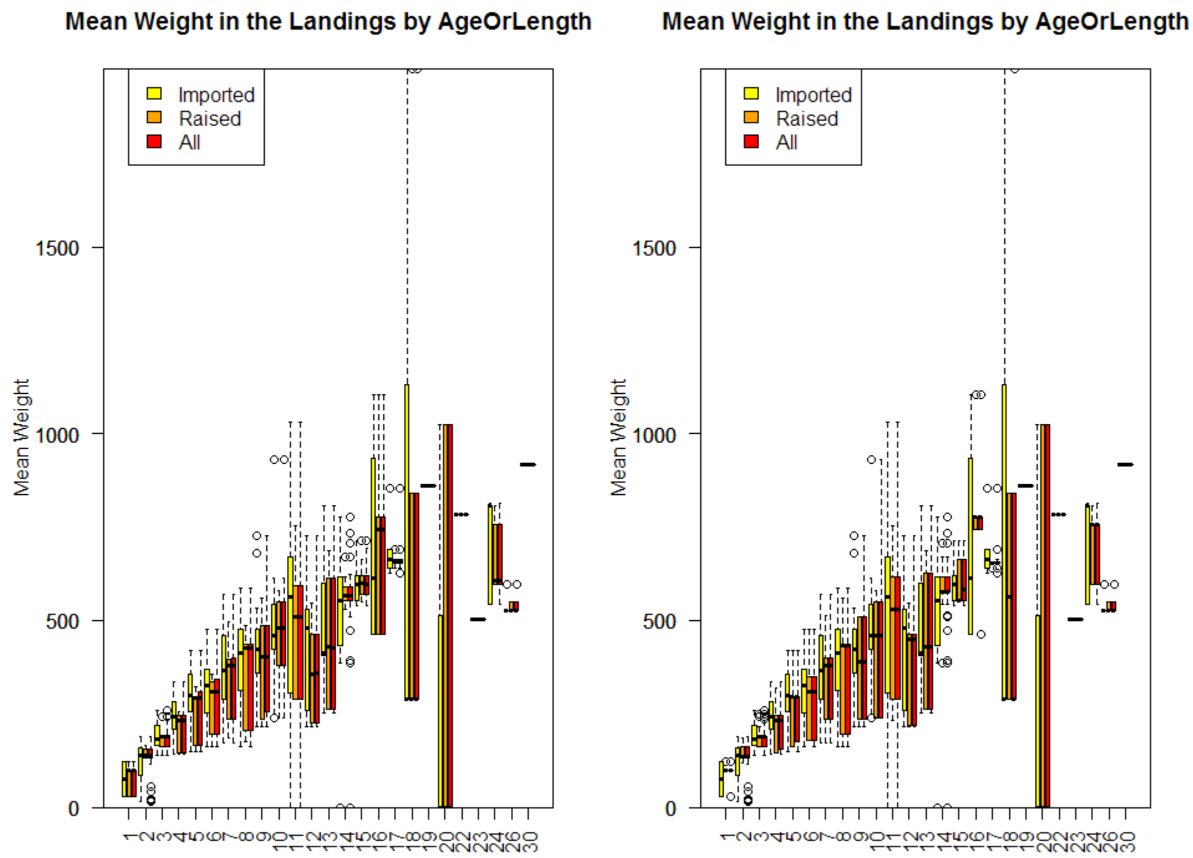


Figure 5: Each boxplot represents the distribution of the weight at age for the different strata (left: manual allocation; right: autoallocation)

Table 3a: Samples that are higher or lower than the average weigth at age +/- 3*standard deviation (outliers) for manual allocation

Table continues below

Country	Fleet	CatchCategory	WECA	AverageWtSize
UK (England)	GNS_DEF_all_0_0_all	Landings	725.9	370.1
France	GTR_DEF_100-119_0_0_all	Landings	22.01	141.4
France	GTR_DEF_90-99_0_0_all	Landings	56.1	141.4
France	OTB_DEF_70-99_0_0_all	Landings	17.02	141.4
France	TBB_DEF_70-99_0_0_all	Landings	16.66	141.4
France	GTR_DEF_100-119_0_0_all	Landings	259.4	181.3
France	GTR_DEF_90-99_0_0_all	Landings	0	477.9
France	GTR_DEF_90-99_0_0_all	Landings	0	571.9
France	OTB_DEF_70-99_0_0_all	Landings	42.66	141.4
UK (England)	GNS_DEF_all_0_0_all	Landings	930.9	440.1
UK (England)	GNS_DEF_all_0_0_all	Landings	1032	477.9
UK (England)	GNS_DEF_all_0_0_all	Landings	855.4	661.8
UK (England)	GNS_DEF_all_0_0_all	Landings	595.7	535.1

AgeOrLength	Area

12	27.7.d
2	27.7.d
2	27.7.d
2	27.7.d
2	27.7.d
3	27.7.d
11	27.7.d
14	27.7.d
2	27.7.d
10	27.7.d
11	27.7.d
17	27.7.d
26	27.7.d

Table 3b: Samples that are higher or lower than the average weigth at age +/- 3*standard deviation (outliers) for autoallocation

Table continues below

Country	Fleet	CatchCategory	WECA	AverageWtSize
France	TBB_DEF_70-99_0_0_all	Landings	1107	770
UK (England)	TBB_DEF_70-99_0_0_all	Landings	1107	770
France	TBB_DEF_70-99_0_0_all	Landings	1107	770
UK (England)	TBB_DEF_70-99_0_0_all	Landings	1107	770
France	GTR_DEF_100-119_0_0_all	Landings	22.01	141
France	GTR_DEF_90-99_0_0_all	Landings	56.1	141
France	OTB_DEF_70-99_0_0_all	Landings	17.02	141
France	TBB_DEF_70-99_0_0_all	Landings	16.66	141
UK (England)	TBB_DEF_70-99_0_0_all	Landings	1107	770
France	GTR_DEF_100-119_0_0_all	Landings	259.4	185.8
France	OTB_DEF_70-99_0_0_all	Landings	29.29	100.2
UK (England)	GNS_DEF_all_0_0_all	Landings	463.5	770
UK (England)	GNS_DEF_all_0_0_all	Landings	463.5	770
UK (England)	OTB_DEF_70-99_0_0_all	Landings	1977	570.6
France	GTR_DEF_90-99_0_0_all	Landings	0	576.4
France	OTB_DEF_70-99_0_0_all	Landings	42.66	141
UK (England)	GNS_DEF_all_0_0_all	Landings	930.9	429.1
UK (England)	GNS_DEF_all_0_0_all	Landings	1032	473.9
UK (England)	GNS_DEF_all_0_0_all	Landings	855.4	657.1
UK (England)	GNS_DEF_all_0_0_all	Landings	595.7	537.3
UK (England)	GNS_DEF_all_0_0_all	Landings	727.6	387.1

AgeOrLength	Area
16	27.7.d
16	27.7.d
16	27.7.d
16	27.7.d
2	27.7.d
2	27.7.d
2	27.7.d
2	27.7.d

16	27.7.d
3	27.7.d
1	27.7.d
16	27.7.d
16	27.7.d
18	27.7.d
14	27.7.d
2	27.7.d
10	27.7.d
11	27.7.d
17	27.7.d
26	27.7.d
9	27.7.d

InterCatch output for 2014

This document uses Table 2 from CatchAndSampleDataTables.txt from the InterCatch outputs to describe the raising procedures that were made. In the following tables, CATON=WECA*CANUM/1000000 (in tonnes)

Raised discards

In InterCatch, the first step consists in raising the discards volumes for strata with landings and no discards associated. These discards are called in the following table 'Raised_Discards'. The data called 'Imported_Data' are landings or discards volumes imported into InterCatch with or without length/age structure.

The proportion of Landings with Discards associated (same strata) is **83 percent**.

The volumes (and associated proportion) of landings and discards imported (Imported_Data) or raised (Raised_Discards) are described in the following table.

Table 1a: Summary of the imported/Raised data for manual allocation

CatchCategory	RaisedOrImported	CATON	perc
Discards	Raised_Discards	39.95	7
Discards	Imported_Data	531.4	93
Landings	Imported_Data	4475	100

Table 1b: Summary of the imported/Raised data for autoallocation

CatchCategory	RaisedOrImported	CATON	perc
Discards	Raised_Discards	40.07	7
Discards	Imported_Data	536.7	93
Landings	Imported_Data	4472	100

Length/Age distribution

For the imported landings/discards and the raised discards without age distribution, the length or age distribution is then computed using the defined allocation scheme. *Sampled_distribution* means that the data (ladings or discards) were input with age/length distribution. *Estimated_distribution* means that the imported/raised volumes were estimated using the allocation scheme.

Table 2a: Summary of the imported/Raised/SampledOrEstimated data for manual allocation

CatchCategory	RaisedOrImported	SampledOrEstimated	CATON	perc
Landings	Imported_Data	Sampled_Distribution	3732	83
Landings	Imported_Data	Estimated_Distribution	743.1	17
Discards	Imported_Data	Sampled_Distribution	406	71
Discards	Imported_Data	Estimated_Distribution	125.4	22
Discards	Raised_Discards	Estimated_Distribution	39.95	7

Table 2b: Summary of the imported/Raised/SampledOrEstimated data for autoallocation

CatchCategory	RaisedOrImported	SampledOrEstimated	CATON	perc
Landings	Imported_Data	Sampled_Distribution	3732	83
Landings	Imported_Data	Estimated_Distribution	739.9	17
Discards	Imported_Data	Sampled_Distribution	406	70
Discards	Imported_Data	Estimated_Distribution	130.7	23
Discards	Raised_Discards	Estimated_Distribution	40.07	7

Impact of the raising on the age/length structure

Once the samples imported or raised are identified, it is possible to check the impact of the allocation scheme on the mean age/length of the final age/length distribution of the stock. The following figures compare the mean age (computed as the

weighted mean of the age per stratum ("CatchCategory",'RaisedOrImported',"SampledOrEstimated","Country","Area","Season","Fleet","Sex") of the estimated strata compared to the imported ones and the final distribution. Each individual included in the boxplot corresponds to the weighted mean age of a stratum.

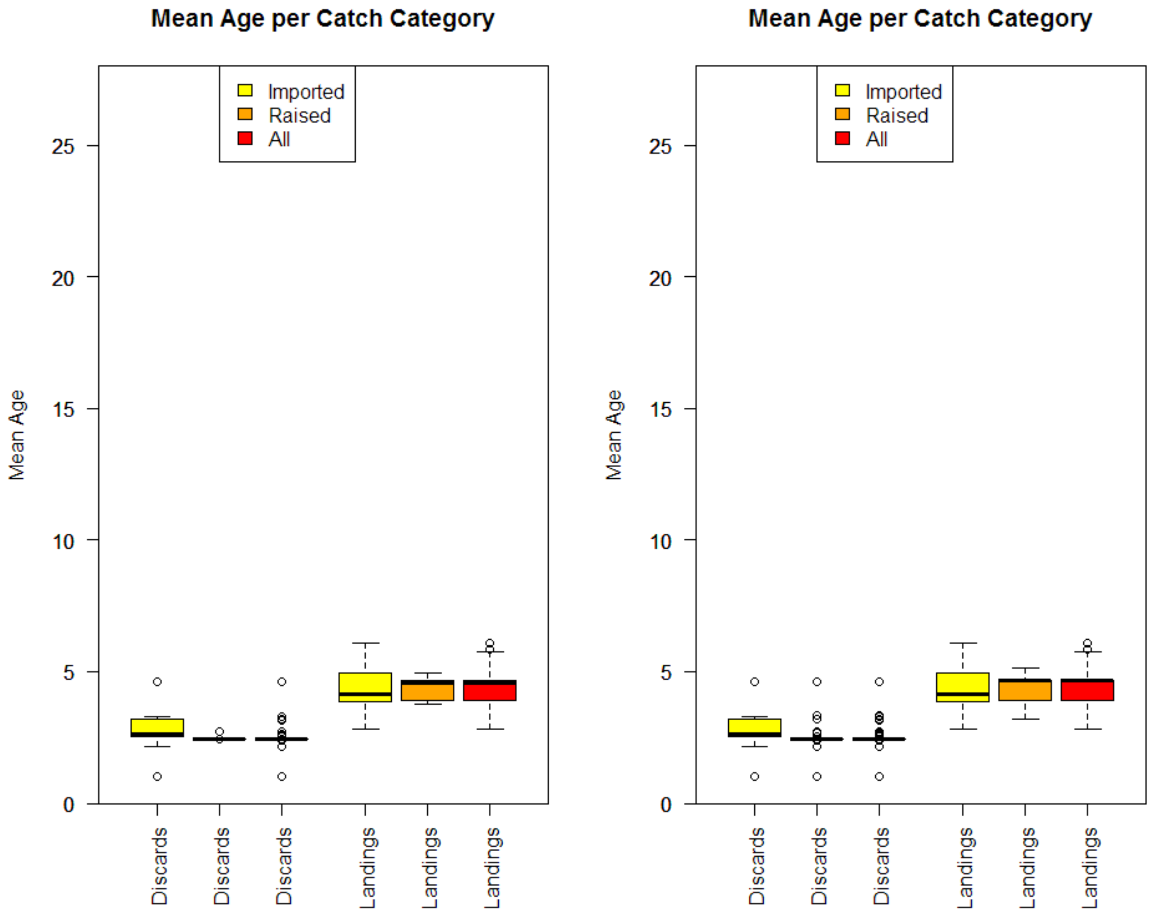


Figure 1: Mean Age per catch category (left: manual allocation; right: autoallocation)

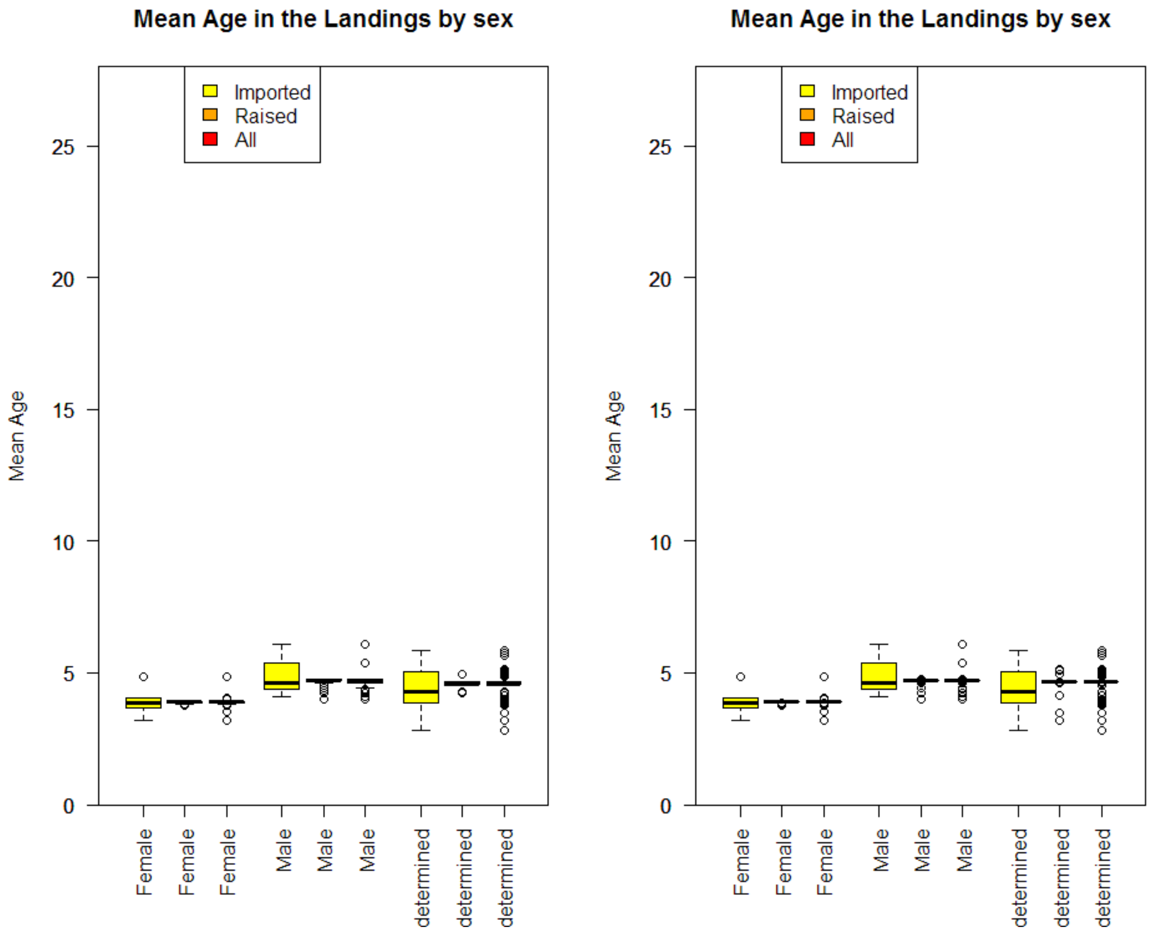


Figure 2: Mean Age in the Landings by sex (left: manual allocation; right: autoallocation)

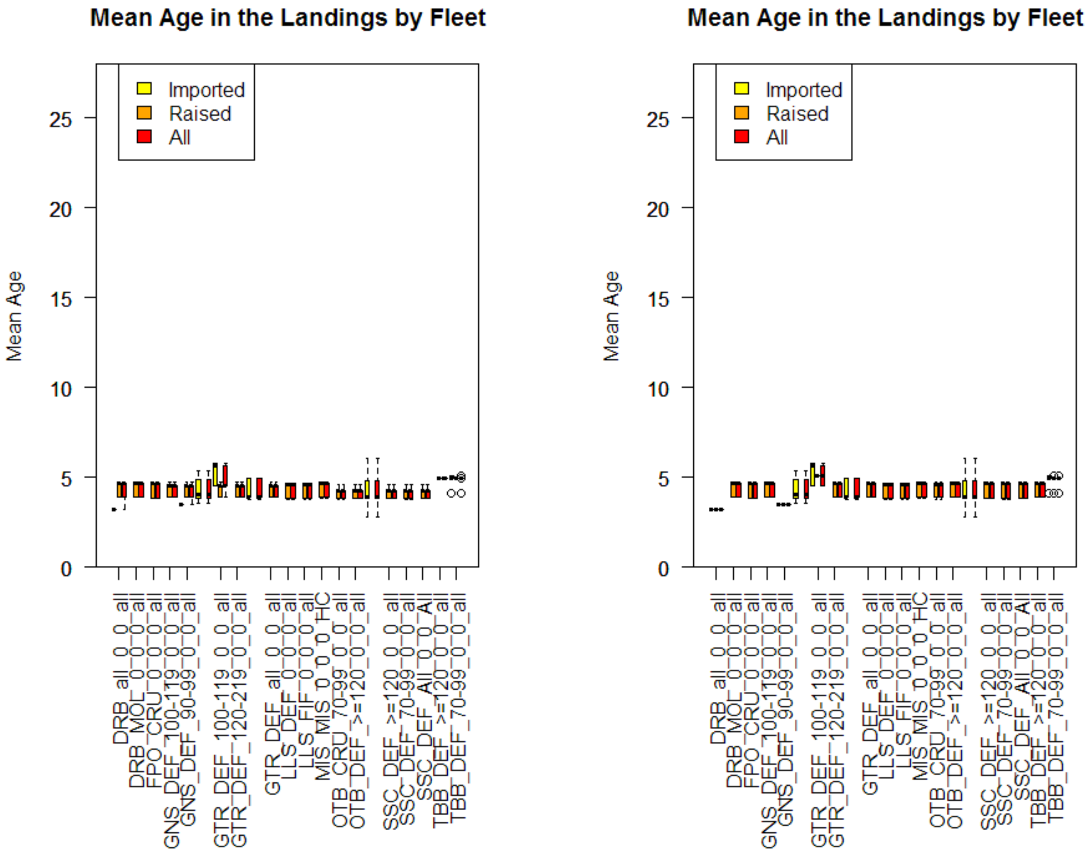


Figure 3: Mean Age in the Landings by Fleet (left: manual allocation; right: autoallocation)

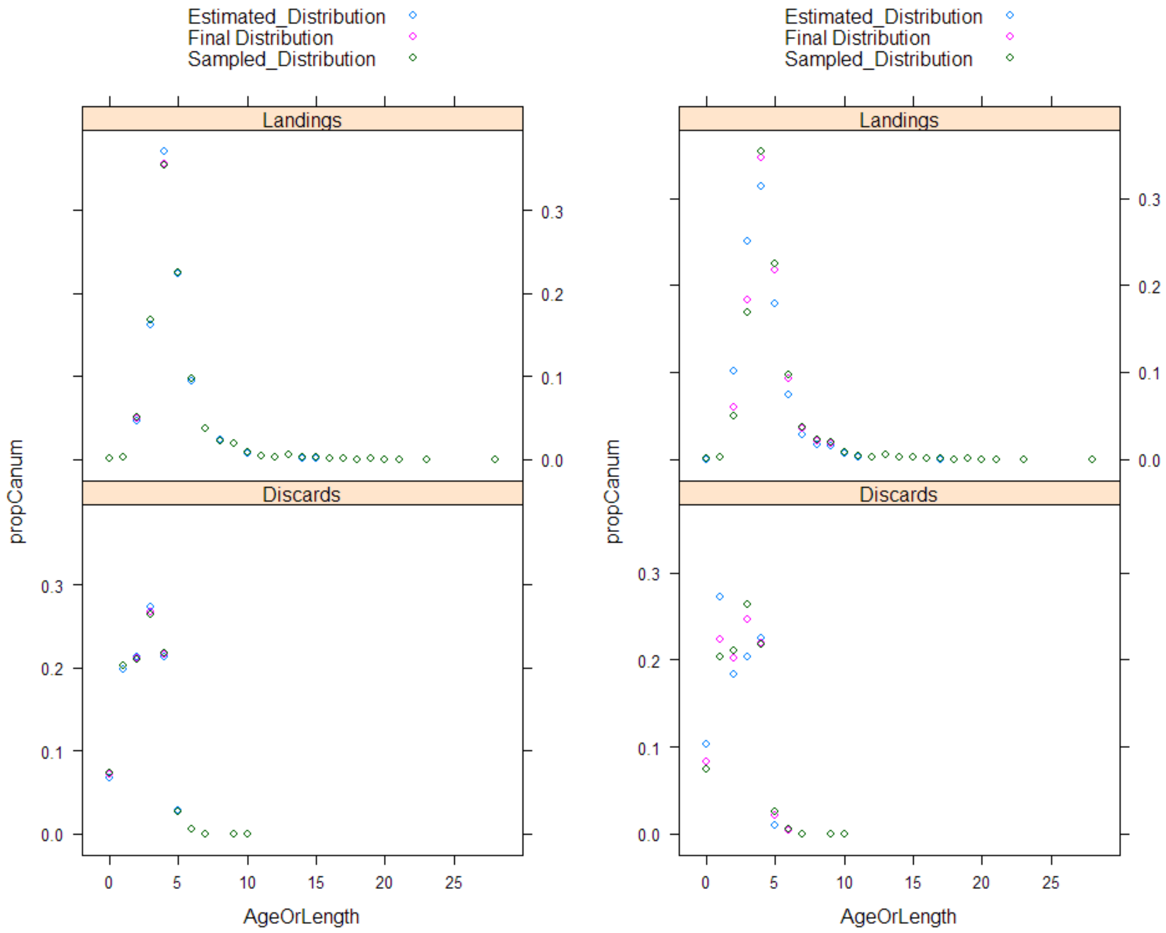


Figure 4: The percentage of each age for the sampled strata, estimated and the final age structure for the landing and discard fractions (left: manual allocation; right: autoallocation)

Impact of the raising on the mean weight

The CatchAndSampleData also provide the weight at age per stratum for the Sampled/Estimated strata. One should also check the sampled/estimated and resulting weight at age.

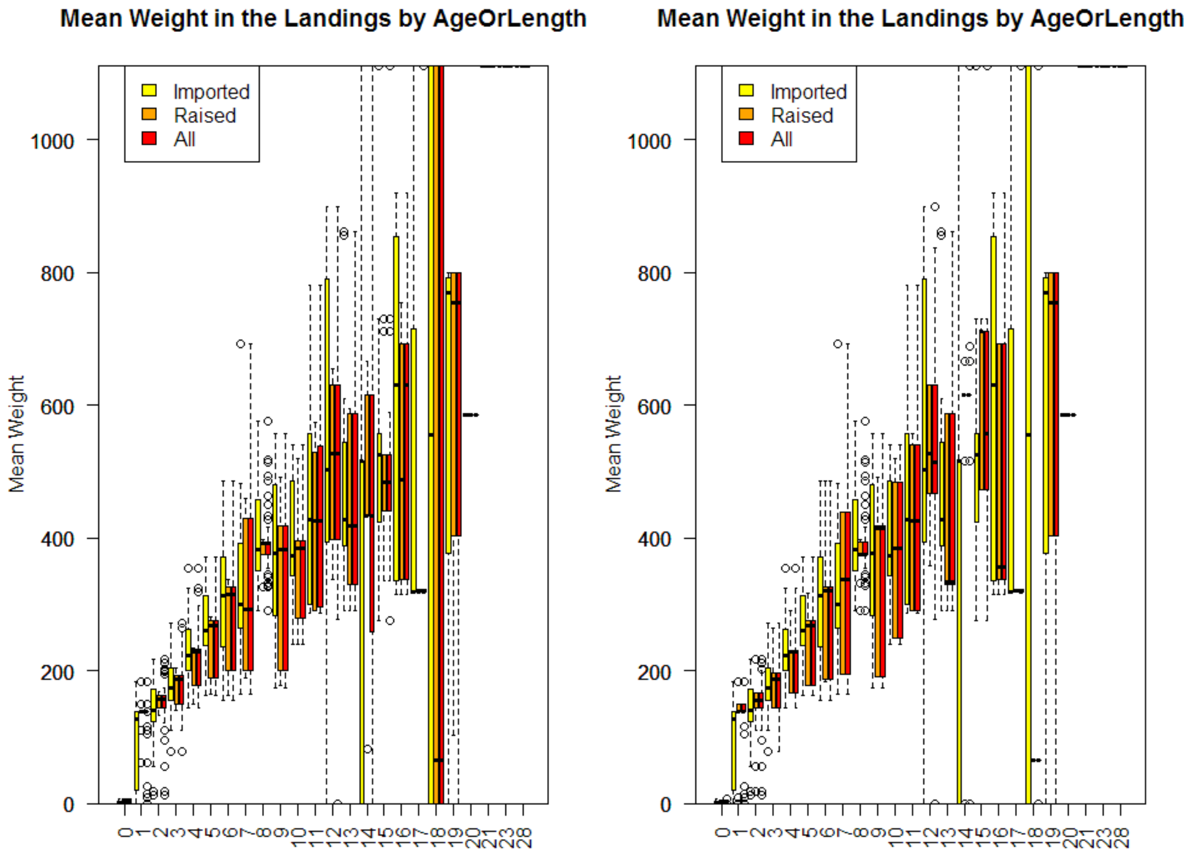


Figure 5: Each boxplot represents the distribution of the weight at age for the different strata (left: manual allocation; right: autoallocation)

Table 3a: Samples that are higher or lower than the average weigth at age +/- 3*standard deviation (outliers) for manual allocation

Table continues below

Country	Fleet	CatchCategory	WECA	AverageWtSize
France	GTR_DEF_100-119_0_0_all	Landings	78.41	177.7
France	GTR_DEF_100-119_0_0_all	Landings	324.5	211.3
France	OTB_DEF_70-99_0_0_all	Landings	516.8	383.2
France	GTR_DEF_90-99_0_0_all	Landings	56.45	153.3
France	OTB_DEF_70-99_0_0_all	Landings	12.39	153.3
France	TBB_DEF_70-99_0_0_all	Landings	18.56	153.3
France	DRB_all_0_0_all	Landings	0	127.9
France	GNS_DEF_90-99_0_0_all	Landings	56.44	153.3
France	GTR_DEF_100-119_0_0_all	Landings	8.17	127.9
France	GTR_DEF_90-99_0_0_all	Landings	14.22	127.9
France	OTB_DEF_70-99_0_0_all	Landings	24.67	127.9
France	OTB_DEF_70-99_0_0_all	Landings	0	522.9
UK (England)	GNS_DEF_all_0_0_all	Landings	512.9	383.2
France	GTR_DEF_90-99_0_0_all	Landings	576	383.2

France	OTB_DEF_70-99_0_0_all	Landings	576	383.2
France	TBB_DEF_70-99_0_0_all	Landings	216.3	153.3
France	TBB_DEF_70-99_0_0_all	Landings	263.2	177.7
UK (England)	GNS_DEF_all_0_0_all	Landings	855.4	433
UK (England)	GNS_DEF_all_0_0_all	Landings	692.1	318.1
UK (England)	GNS_DEF_all_0_0_all	Landings	317.6	211.3
UK (England)	GNS_DEF_all_0_0_all	Landings	779.7	436.3
UK (England)	GNS_DEF_all_0_0_all	Landings	271.9	177.7
UK (England)	GNS_DEF_all_0_0_all	Landings	354.1	211.3
UK (England)	GNS_DEF_all_0_0_all	Landings	860.7	433
UK (England)	GNS_DEF_all_0_0_all	Landings	1111	519.7
UK (England)	GNS_DEF_all_0_0_all	Landings	1111	325.8

AgeOrLength	Area
3	27.7.d
4	27.7.d
8	27.7.d
2	27.7.d
2	27.7.d
2	27.7.d
1	27.7.d
2	27.7.d
1	27.7.d
1	27.7.d
1	27.7.d
12	27.7.d
8	27.7.d
8	27.7.d
8	27.7.d
2	27.7.d
3	27.7.d
13	27.7.d
7	27.7.d
4	27.7.d
11	27.7.d
3	27.7.d
4	27.7.d
13	27.7.d
15	27.7.d
17	27.7.d

Table 3b: Samples that are higher or lower than the average weigth at age +/- 3*standard deviation (outliers) for autoallocation

Table continues below

Country	Fleet	CatchCategory	WECA	AverageWtSize
France	DRB_all_0_0_all	Landings	0	138.4
France	GNS_DEF_90-99_0_0_all	Landings	56.44	151.3
France	DRB_all_0_0_all	Landings	0	138.4
France	GNS_DEF_90-99_0_0_all	Landings	56.44	151.3

UK (England)	TBB_DEF_70-99_0_0_all	Landings	18.56	151.3
France	DRB_all_0_0_all	Landings	0	138.4
France	GNS_DEF_90-99_0_0_all	Landings	56.44	151.3
France	GTR_DEF_100-119_0_0_all	Landings	0	3.181
France	GTR_DEF_100-119_0_0_all	Landings	8.17	138.4
UK (England)	TBB_DEF_70-99_0_0_all	Landings	263.2	177.1
UK (England)	TBB_DEF_70-99_0_0_all	Landings	0	588.1
France	GTR_DEF_100-119_0_0_all	Landings	78.41	177.1
France	GTR_DEF_100-119_0_0_all	Landings	324.5	211.3
France	OTB_DEF_70-99_0_0_all	Landings	516.8	385.3
UK (England)	GNS_DEF_all_0_0_all	Landings	899.2	546.2
UK (England)	GNS_DEF_all_0_0_all	Landings	899.2	546.2
France	GTR_DEF_90-99_0_0_all	Landings	56.45	151.3
France	OTB_DEF_70-99_0_0_all	Landings	12.39	151.3
France	TBB_DEF_70-99_0_0_all	Landings	18.56	151.3
France	DRB_all_0_0_all	Landings	0	138.4
France	GNS_DEF_90-99_0_0_all	Landings	56.44	151.3
France	GTR_DEF_100-119_0_0_all	Landings	0	3.181
France	GTR_DEF_100-119_0_0_all	Landings	8.17	138.4
France	GTR_DEF_90-99_0_0_all	Landings	0	3.181
France	GTR_DEF_90-99_0_0_all	Landings	14.22	138.4
France	OTB_DEF_70-99_0_0_all	Landings	6.5	3.181
France	OTB_DEF_70-99_0_0_all	Landings	24.67	138.4
France	OTB_DEF_70-99_0_0_all	Landings	0	546.2
UK (England)	GNS_DEF_all_0_0_all	Landings	493	385.3
UK (England)	GNS_DEF_all_0_0_all	Landings	512.9	385.3
France	GTR_DEF_90-99_0_0_all	Landings	576	385.3
France	GTR_DEF_90-99_0_0_all	Landings	0	588.1
France	OTB_DEF_70-99_0_0_all	Landings	576	385.3
France	OTB_DEF_70-99_0_0_all	Landings	0	588.1
France	TBB_DEF_70-99_0_0_all	Landings	263.2	177.1
France	TBB_DEF_70-99_0_0_all	Landings	0	588.1
UK (England)	GNS_DEF_all_0_0_all	Landings	855.4	420.3
UK (England)	GNS_DEF_all_0_0_all	Landings	692.1	321.9
UK (England)	GNS_DEF_all_0_0_all	Landings	317.6	211.3
UK (England)	GNS_DEF_all_0_0_all	Landings	860.7	420.3
UK (England)	GNS_DEF_all_0_0_all	Landings	1111	588.1
UK (England)	GNS_DEF_all_0_0_all	Landings	1111	592.1
UK (England)	GNS_DEF_all_0_0_all	Landings	1111	325.9
UK (England)	GNS_DEF_all_0_0_all	Landings	1111	79.4
UK (England)	GNS_DEF_all_0_0_all	Landings	779.7	422.1
UK (England)	GNS_DEF_all_0_0_all	Landings	271.9	177.1
UK (England)	GNS_DEF_all_0_0_all	Landings	354.1	211.3

AgeOrLength	Area
1	27.7.d
2	27.7.d
1	27.7.d

2	27.7.d
2	27.7.d
1	27.7.d
2	27.7.d
0	27.7.d
1	27.7.d
3	27.7.d
14	27.7.d
3	27.7.d
4	27.7.d
8	27.7.d
12	27.7.d
12	27.7.d
2	27.7.d
2	27.7.d
2	27.7.d
1	27.7.d
2	27.7.d
0	27.7.d
1	27.7.d
0	27.7.d
1	27.7.d
0	27.7.d
1	27.7.d
12	27.7.d
8	27.7.d
8	27.7.d
8	27.7.d
14	27.7.d
8	27.7.d
14	27.7.d
3	27.7.d
14	27.7.d
13	27.7.d
7	27.7.d
4	27.7.d
13	27.7.d
14	27.7.d
15	27.7.d
17	27.7.d
18	27.7.d
11	27.7.d
3	27.7.d
4	27.7.d

InterCatch output for 2015

This document uses Table 2 from CatchAndSampleDataTables.txt from the InterCatch outputs to describe the raising procedures that were made. In the following tables, CATON=WECA*CANUM/1000000 (in tonnes)

Raised discards

In InterCatch, the first step consists in raising the discards volumes for strata with landings and no discards associated. These discards are called in the following table 'Raised_Discards'. The data called 'Imported_Data' are landings or discards volumes imported into InterCatch with or without length/age structure.

The proportion of Landings with Discards associated (same strata) is **86 percent**.

The volumes (and associated proportion) of landings and discards imported (Imported_Data) or raised (Raised_Discards) are described in the following table.

Table 1a: Summary of the imported/Raised data for manual allocation

CatchCategory	RaisedOrImported	CATON	perc
Discards	Raised_Discards	47.53	17
Discards	Imported_Data	239.9	83
Landings	Imported_Data	3332	100

Table 1b: Summary of the imported/Raised data for autoallocation

CatchCategory	RaisedOrImported	CATON	perc
Discards	Raised_Discards	47.17	16
Discards	Imported_Data	239.8	84
Landings	Imported_Data	3331	100

Length/Age distribution

For the imported landings/discards and the raised discards without age distribution, the length or age distribution is then computed using the defined allocation scheme. *Sampled_distribution* means that the data (ladings or discards) were input with age/length distribution. *Estimated_distribution* means that the imported/raised volumes were estimated using the allocation scheme.

Table 2a: Summary of the imported/Raised/SampledOrEstimated data for manual allocation

CatchCategory	RaisedOrImported	SampledOrEstimated	CATON	perc
Landings	Imported_Data	Sampled_Distribution	2921	88
Landings	Imported_Data	Estimated_Distribution	411	12
Discards	Imported_Data	Sampled_Distribution	227.7	79
Discards	Raised_Discards	Estimated_Distribution	47.53	17
Discards	Imported_Data	Estimated_Distribution	12.14	4

Table 2b: Summary of the imported/Raised/SampledOrEstimated data for autoallocation

CatchCategory	RaisedOrImported	SampledOrEstimated	CATON	perc
Landings	Imported_Data	Sampled_Distribution	2921	88
Landings	Imported_Data	Estimated_Distribution	410.5	12
Discards	Imported_Data	Sampled_Distribution	227.7	79
Discards	Raised_Discards	Estimated_Distribution	47.17	16
Discards	Imported_Data	Estimated_Distribution	12.12	4

Impact of the raising on the age/length structure

Once the samples imported or raised are identified, it is possible to check the impact of the allocation scheme on the mean age/length of the final age/length distribution of the stock. The following figures compare the mean age (computed as the

weighted mean of the age per stratum ("CatchCategory",'RaisedOrImported',"SampledOrEstimated","Country","Area","Season","Fleet","Sex") of the estimated strata compared to the imported ones and the final distribution. Each individual included in the boxplot corresponds to the weighted mean age of a stratum.

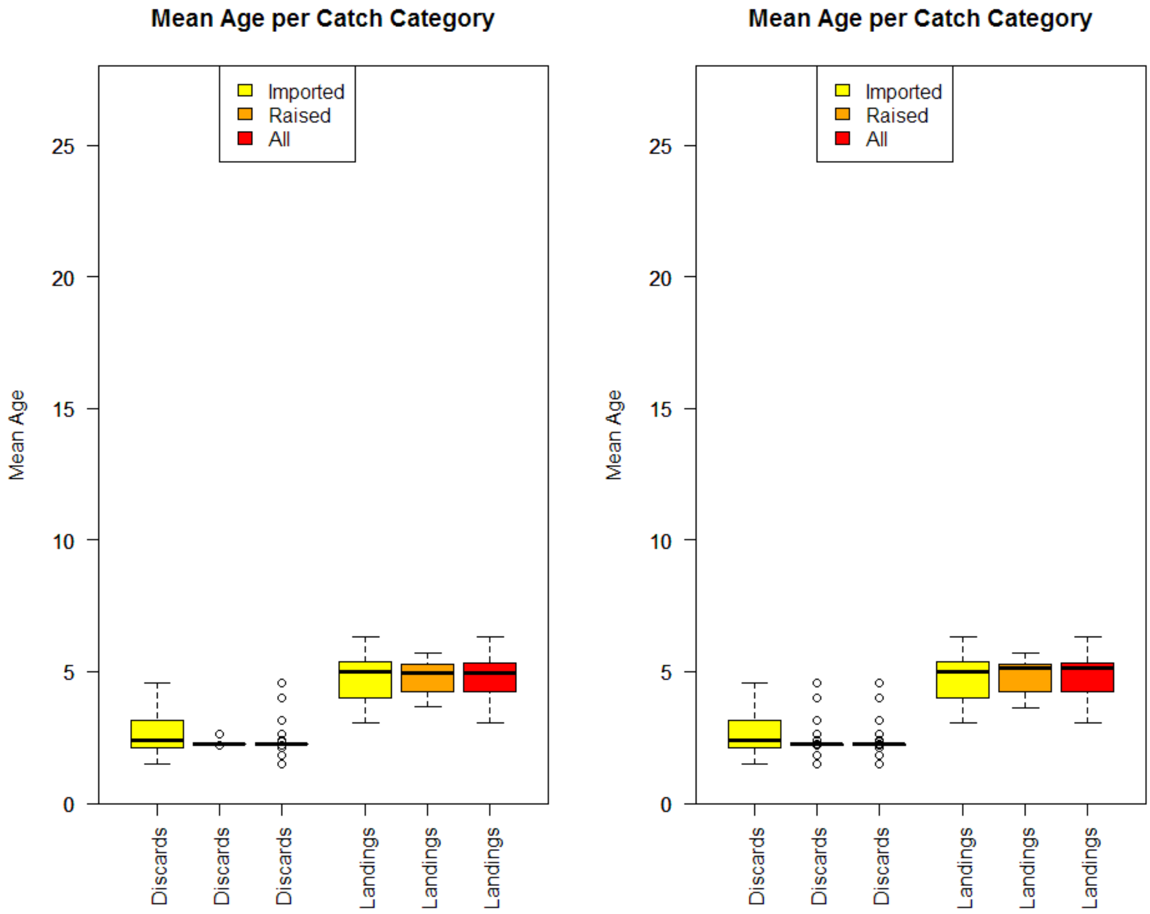


Figure 1: Mean Age per catch category (left: manual allocation; right: autoallocation)

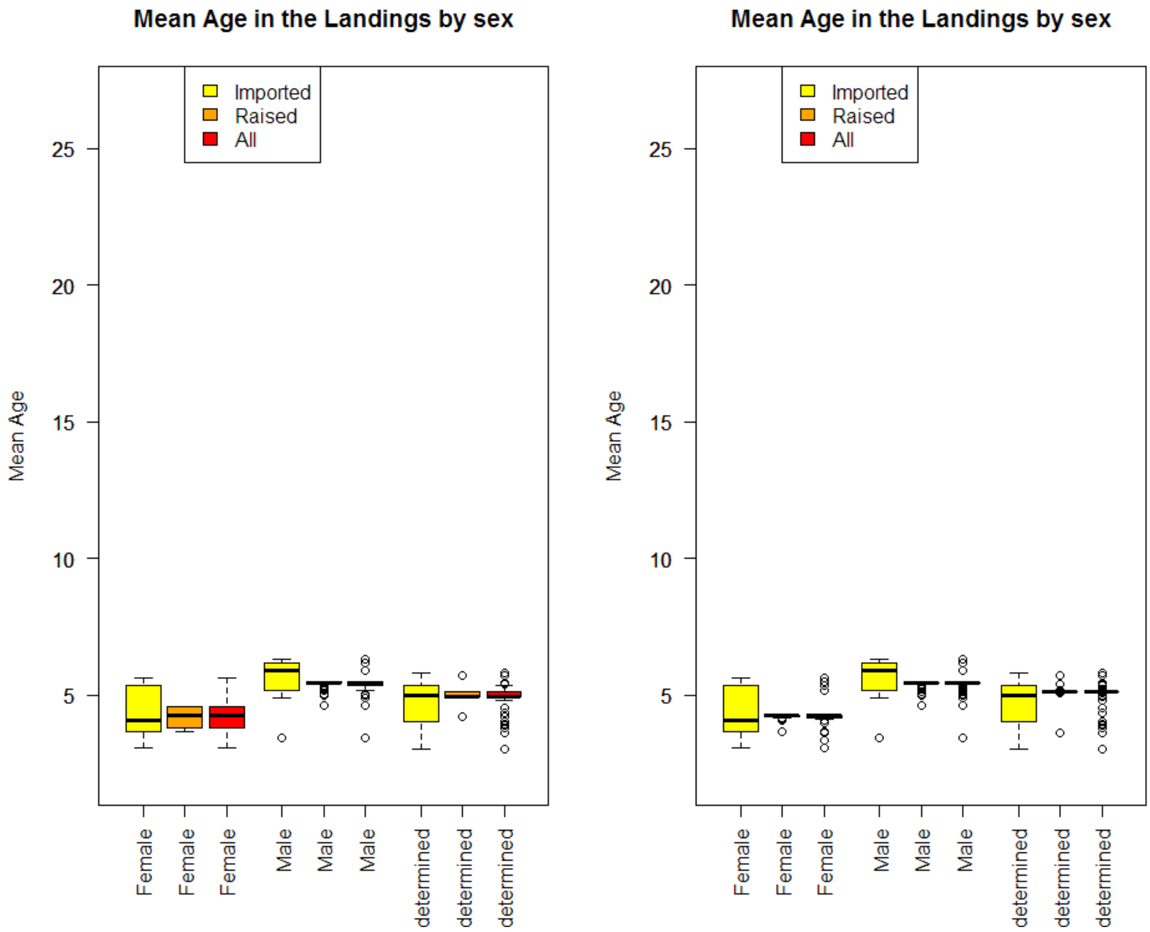


Figure 2: Mean Age in the Landings by sex (left: manual allocation; right: autoallocation)

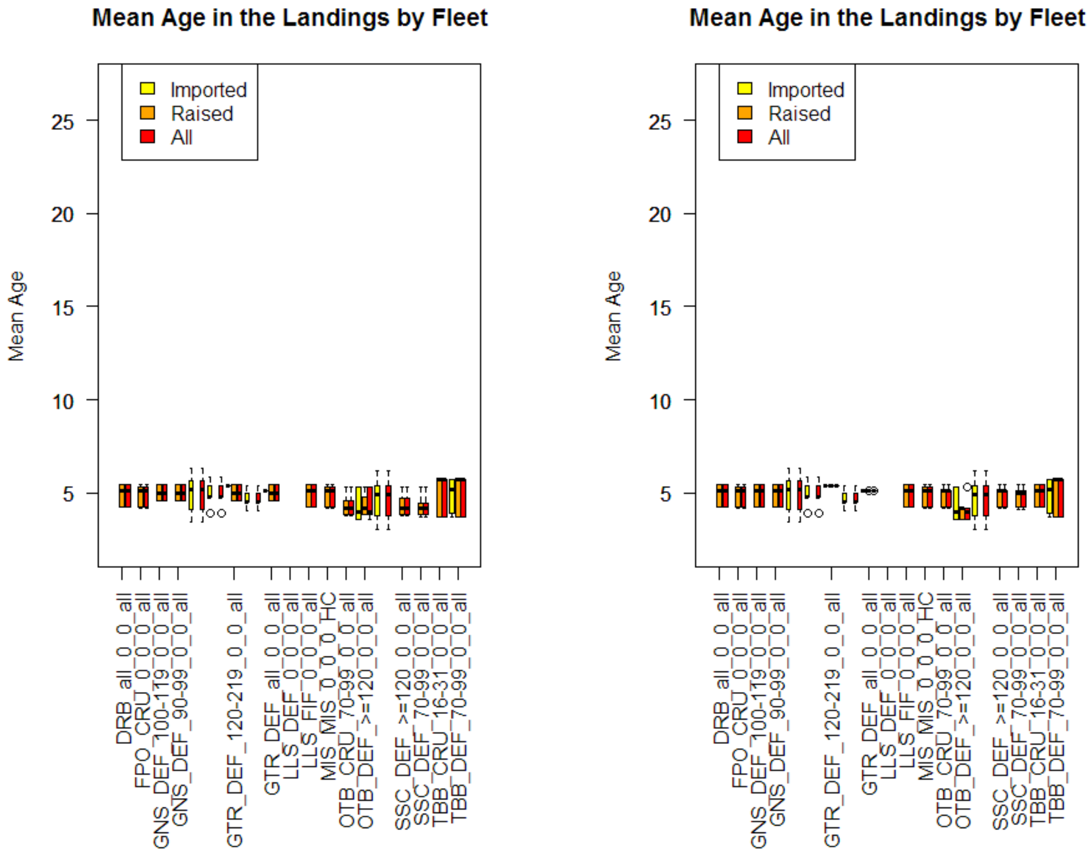


Figure 3: Mean Age in the Landings by Fleet (left: manual allocation; right: autoallocation)

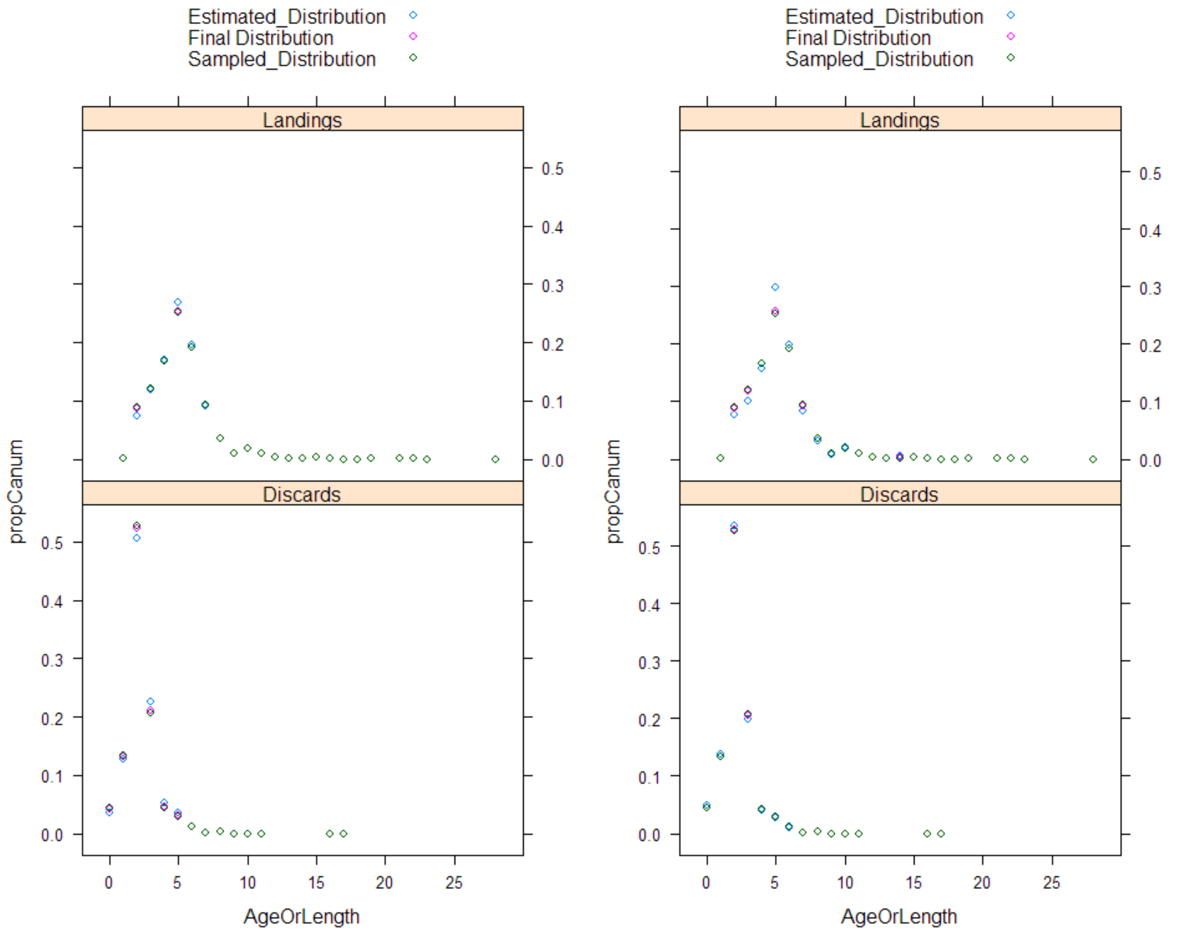


Figure 4: The percentage of each age for the sampled strata, estimated and the final age structure for the landing and discard fractions (left: manual allocation; right: autoallocation)

Impact of the raising on the mean weight

The CatchAndSampleData also provide the weight at age per stratum for the Sampled/Estimated strata. One should also check the sampled/estimated and resulting weight at age.

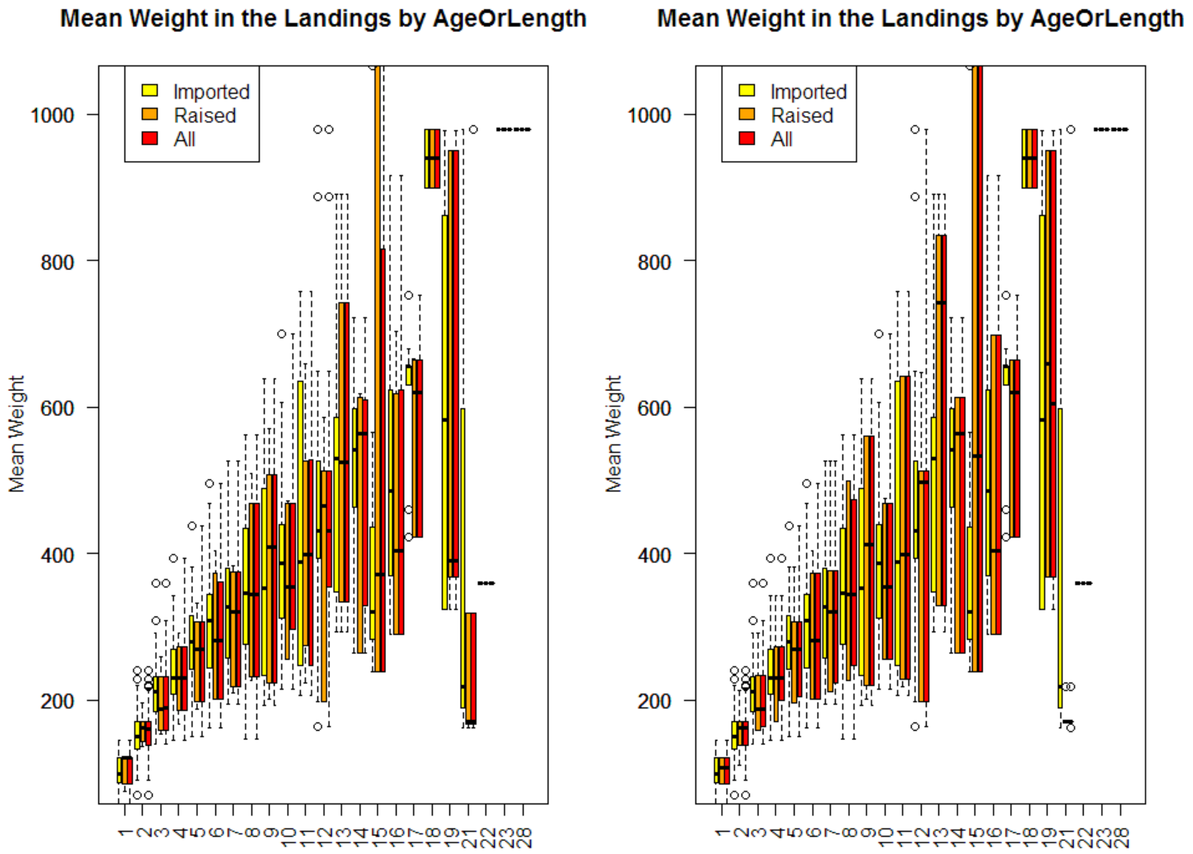


Figure 5: Each boxplot represents the distribution of the weight at age for the different strata (left: manual allocation; right: autoallocation)

Table 3a: Samples that are higher or lower than the average weigth at age +/- 3*standard deviation (outliers) for manual allocation

Table continues below

Country	Fleet	CatchCategory	WECA	AverageWtSize
UK (England)	GNS_DEF_all_0_0_all	Landings	887.1	420.8
UK (England)	OTB_DEF_70-99_0_0_all	Landings	309.3	198.3
France	GTR_DEF_90-99_0_0_all	Landings	90.95	158.2
France	OTB_DEF_70-99_0_0_all	Landings	70.94	158.2
UK (England)	GNS_DEF_all_0_0_all	Landings	979	420.8
UK (England)	GNS_DEF_all_0_0_all	Landings	979	234.1
France	GTR_DEF_100-119_0_0_all	Landings	240.1	158.2
France	GTR_DEF_120-219_0_0_all	Landings	526.3	310.6
France	GTR_DEF_90-99_0_0_all	Landings	228.1	158.2
UK (England)	GNS_DEF_all_0_0_all	Landings	359.4	198.3
UK (England)	GNS_DEF_all_0_0_all	Landings	394.6	230.1
UK (England)	GNS_DEF_all_0_0_all	Landings	437.8	262.3
UK (England)	GNS_DEF_all_0_0_all	Landings	700.3	371.7

AgeOrLength	Area

12	27.7.d
3	27.7.d
2	27.7.d
2	27.7.d
12	27.7.d
21	27.7.d
2	27.7.d
7	27.7.d
2	27.7.d
3	27.7.d
4	27.7.d
5	27.7.d
10	27.7.d

Table 3b: Samples that are higher or lower than the average weigth at age +/- 3*standard deviation (outliers) for autoallocation

Table continues below

Country	Fleet	CatchCategory	WECA	AverageWtSize	AgeOrLength	Area
UK (England)	GNS_DEF_all_0_0_all	Landings	887.1	417.8	12	27.7.d
France	OTB_DEF_70-99_0_0_all	Landings	70.94	155.5	2	27.7.d
UK (England)	GNS_DEF_all_0_0_all	Landings	979	417.8	12	27.7.d
UK (England)	GNS_DEF_all_0_0_all	Landings	979	190.2	21	27.7.d
France	GTR_DEF_100-119_0_0_all	Landings	240.1	155.5	2	27.7.d
UK (England)	GNS_DEF_all_0_0_all	Landings	359.4	205.6	3	27.7.d
UK (England)	GNS_DEF_all_0_0_all	Landings	394.6	236.8	4	27.7.d
UK (England)	GNS_DEF_all_0_0_all	Landings	437.8	269.6	5	27.7.d
UK (England)	GNS_DEF_all_0_0_all	Landings	700.3	364.4	10	27.7.d

Working document 4: Biological parameters of Sole (*Solea solea* L.) in the Eastern English Channel (ICES division VIId)

Lies Vansteenbrugge, Chun Chen, Bart Vanelslander, Jennifer Devine, Sofie Nimmegeers, Holger Haslob and others

1. Maturity

Introduction

The proportion of mature fish at age, often called the maturity ogive, is an important population characteristic and used for estimating spawning stock biomass (SSB) in the stock assessment. For sole in the Eastern English Channel, a knife-edged maturity ogive is used (Table 1). This ogive assumes full maturation from age 3 onwards. The stock annex (ICES 2016) describes that this is similar to sole in the North Sea. From the Working Group report on demersal stocks in the North Sea and Skagerrak (ICES 2002), we learned that the maturity ogive of sole in the North Sea is based on market samples of females from observations in the sixties and seventies. From the report of the Comprehensive fishery evaluation working group in 1997 (ICES 1997) we learned that these market samples originated from plaice and not from sole (Figure 1).

Table 1 Maturity ogive of Sole in the Eastern English Channel (ICES 2016)

Age	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Maturity	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1

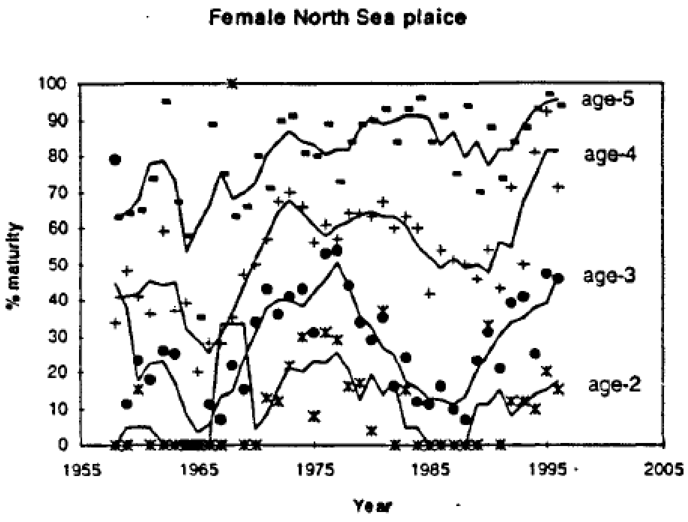

Female North Sea plaice

Figure 1 From ICES (1997): Percentage of mature females of plaice of age 2 to 5 as observed in the Dutch market sampling programme

Changes in life history traits such as age and size at first maturation were reported in several commercially exploited fish stocks (Jørgensen 1990; Rijnsdorp 1993; Mollet *et al.* 2007). Therefore, available maturity data for sole VIId were evaluated to verify whether this currently-used knife-edged maturity ogive is still applicable.

Material and methods

Available datasets

Maturity data were available from Belgian, French and UK commercial fisheries and from the French IBTS. After filtering for the correct area (7D), species (SOL) and selecting only quarter 1 and 2 (most informative to investigate maturity), some quality checks were performed, including:

- Remove missing values for Maturity and Age (AgeRings = -9)
- Remove unidentified sex (U or I) (samples with unidentified sex should have a missing value for maturity (-9) as well)
- Unify the unit of length measurements (cm/mm) to cm
- Number of fishes per row (CANoAtLngt) is not always 1. Duplicate samples were generated.
- Remove the current data year (*i.e.* 2016) for the IBTS dataset, because the commercial data sources did not provide 2016 data as the year was still ongoing.

a) IBTS maturity data

The French IBTS campaign occurs in the first quarter. Data are available for 2009 and from 2012 until 2015. This resulted in 126 maturity records. More insight in the data is provided in the table and figure below (Table 2; Figure 2).

Table 2 Overview of the available maturity data from the IBTS dataset (Q1 includes records of all sampled years)

Variable	Parameter		Number of records
Year	2009		19
	2012		48
	2013		13
	2014		29
	2015		17
Quarter	Q1		126
Sex	Male		49
	Female		77
Length Class (cm)	Min	10	1
	Max	42	1
	Mean	25	7
	Median	25	7
Age (years)	Min	1	1
	Max	13	1
	Mean	4	28
	Median	3	31
Maturity	Mature		97
	Immature		29

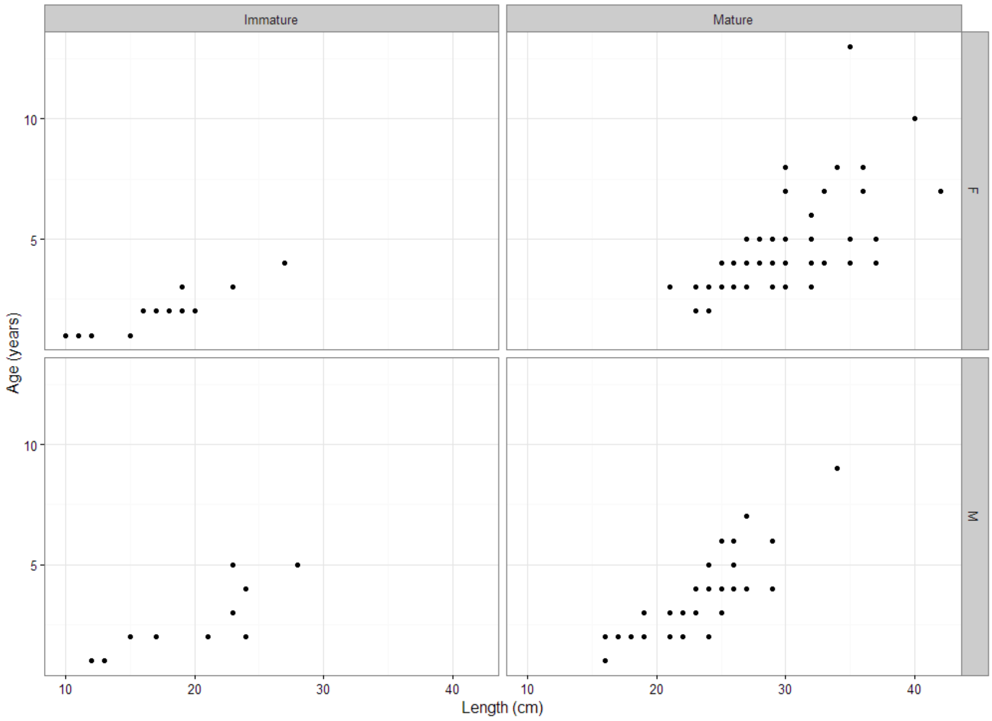


Figure 2 Age-length distribution with indication of sex and maturation level

b) French commercial maturity data

French commercial maturity data are available for the 2 selected quarters (Q1 and Q2) from 2010 until 2014 (no data from 2015 were provided). This resulted in 3391 maturity records. No age 0 and age 1 fish were collected and in 2014, no immature fish were recorded. More insight in the data is provided in the table and figure below (Table 3; Figure 3).

Table 3 Overview of the available maturity data from the French commercial dataset

Variable	Parameter		Number of records
Year	2010		715
	2011		776
	2012		380
	2013		739
	2014		781
Quarter	Q1		978
	Q2		2413
Sex	Male		979
	Female		2412
Length Class (cm)	Min	20	5
	Max	47	2
	Mean	30	308
	Median	29	262
Age (year)	Min	2	153
	Max	21	1
	Mean	5	645
	Median	4	1087
Maturity	Mature		3362

	Immature	29

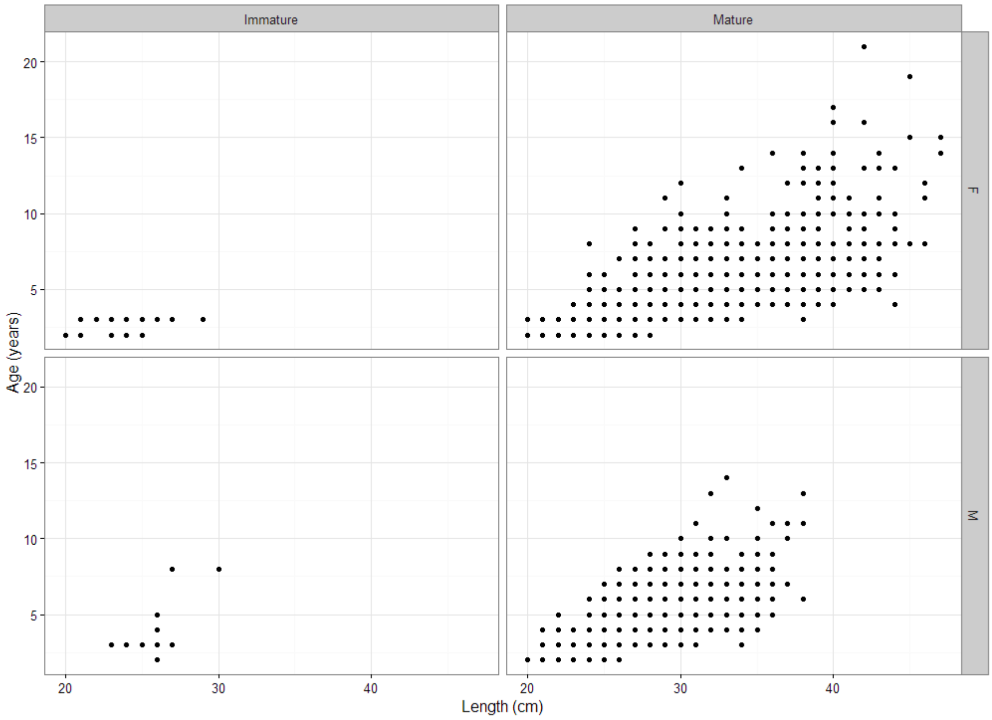


Figure 3 Age-length distribution with indication of sex and maturation level

c) Belgian commercial maturity data

Belgian commercial maturity data are available for the 2 selected quarters (Q1 and Q2) from 2004 until 2015. This resulted in 2582 maturity records. No age 0 and age 1 fish were collected and in 2008 and 2013, no immature fish were recorded. More insight in the data is provided in the table and figure below (Table 4; Figure 4).

Table 4 Overview of the available maturity data from the Belgian commercial dataset

Variable	Parameter	Number of records
Year	2004	76
	2005	148
	2006	175
	2007	179
	2008	15
	2009	59
	2010	119
	2011	231
	2012	255
	2013	252
	2014	440
	2015	633
Quarter	Q1	2089
	Q2	493

Sex	Male	560
	Female	2022
Length Class (cm)	Min 17	1
	Max 53	1
	Mean 33	117
	Median 32	122
Age (year)	Min 2	49
	Max 39	1
	Mean 6	399
	Median 5	434
Maturity	Mature	2526
	Immature	56

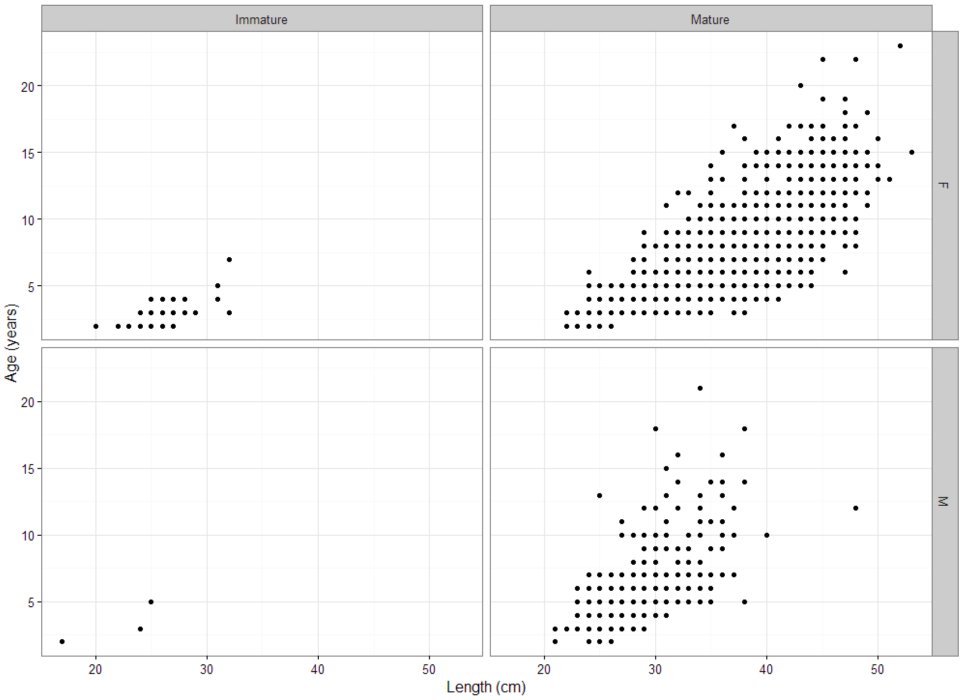


Figure 4 Age-length distribution with indication of sex and maturation level

d) UK commercial maturity data

UK commercial maturity data are available for the 2 selected quarters (Q1 and Q2) from 2004 until 2015. This resulted in 9092 maturity records. No age 0 and age 1 fish were collected. More insight in the data is provided in the table and figure below (Table 5; Figure 5).

Table 5 Overview of the available maturity data from the UK commercial dataset

Variable	Parameter	Number of records
Year	2004	573
	2005	702
	2006	732
	2007	736
	2008	776
	2009	690
	2010	631
	2011	855

	2012		794
	2013		985
	2014		709
	2015		909
Quarter	Q1		4181
	Q2		4911
Sex	Male		1341
	Female		7751
Length Class	Min	21	1
	Max	52	2
	Mean	32	595
	Median	32	595
Age	Min	2	182
	Max	30	1
	Mean	6	1254
	Median	5	1660
Maturity	Mature		8637
	Immature		455

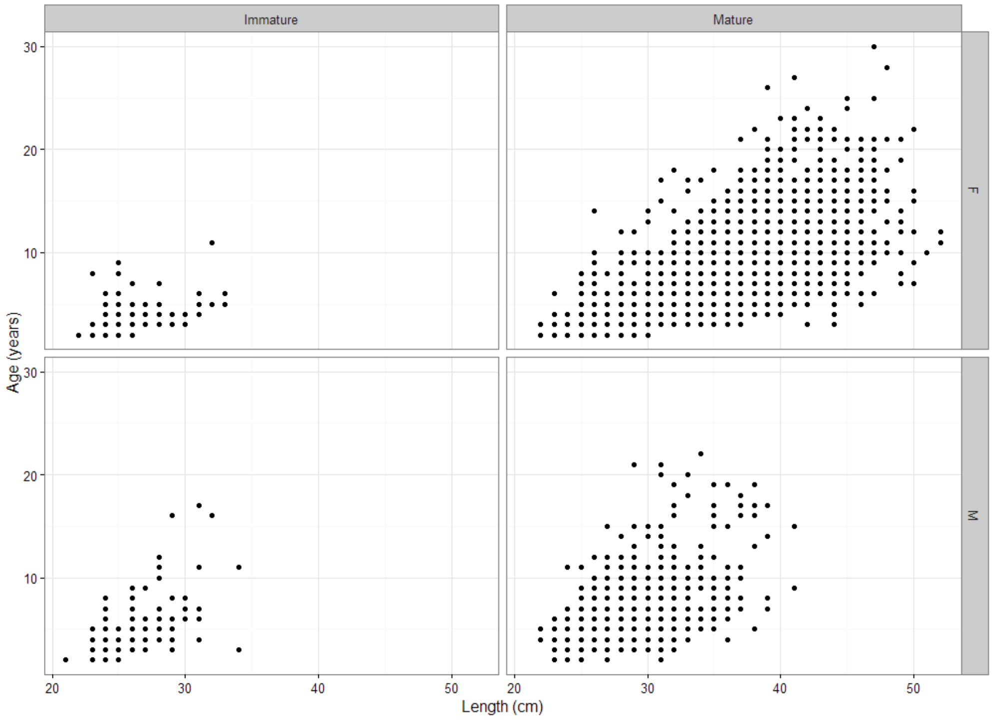


Figure 5 Age-length distribution with indication of sex and maturation level

Maturity definition

In order to obtain a dichotomous maturity definition, several stages were merged:

- Immature: stage 1 or 61 (juvenile/immature) and I (immature)
- Mature: stage M (maturing), H (hyaline), R (running), S (spent), stage 2 or 62 (maturing), 3 or 63 (spawning), 4 or 64 (spent), 5 or 65 (resting/skipped spawning)
- Stage 6 or 66 (abnormal) were not present in the datasets

Combined dataset and data exploration

The combined maturity dataset provides data from 2004 until 2015. This resulted in 15191 maturity records. More insight in the data is provided in the table and figures below (Table 6; Figure 6; Figure 7).

Table 6 Overview of the combine maturity dataset

Variable	Parameter		Number of records
Year	2004		649
	2005		850
	2006		907
	2007		915
	2008		791
	2009		768
	2010		1465
	2011		1862
	2012		1477
	2013		1989
	2014		1959
	2015		1559
Quarter	Q1		7374
	Q2		7817
Sex	Male		2929
	Female		12262
Length Class	Min	10	1
	Max	53	1
	Mean	32	918
	Median	31	1005
Age	Min	1	10
	Max	39	1
	Mean	6	2036
	Median	5	2754
Maturity	Mature		14622
	Immature		569

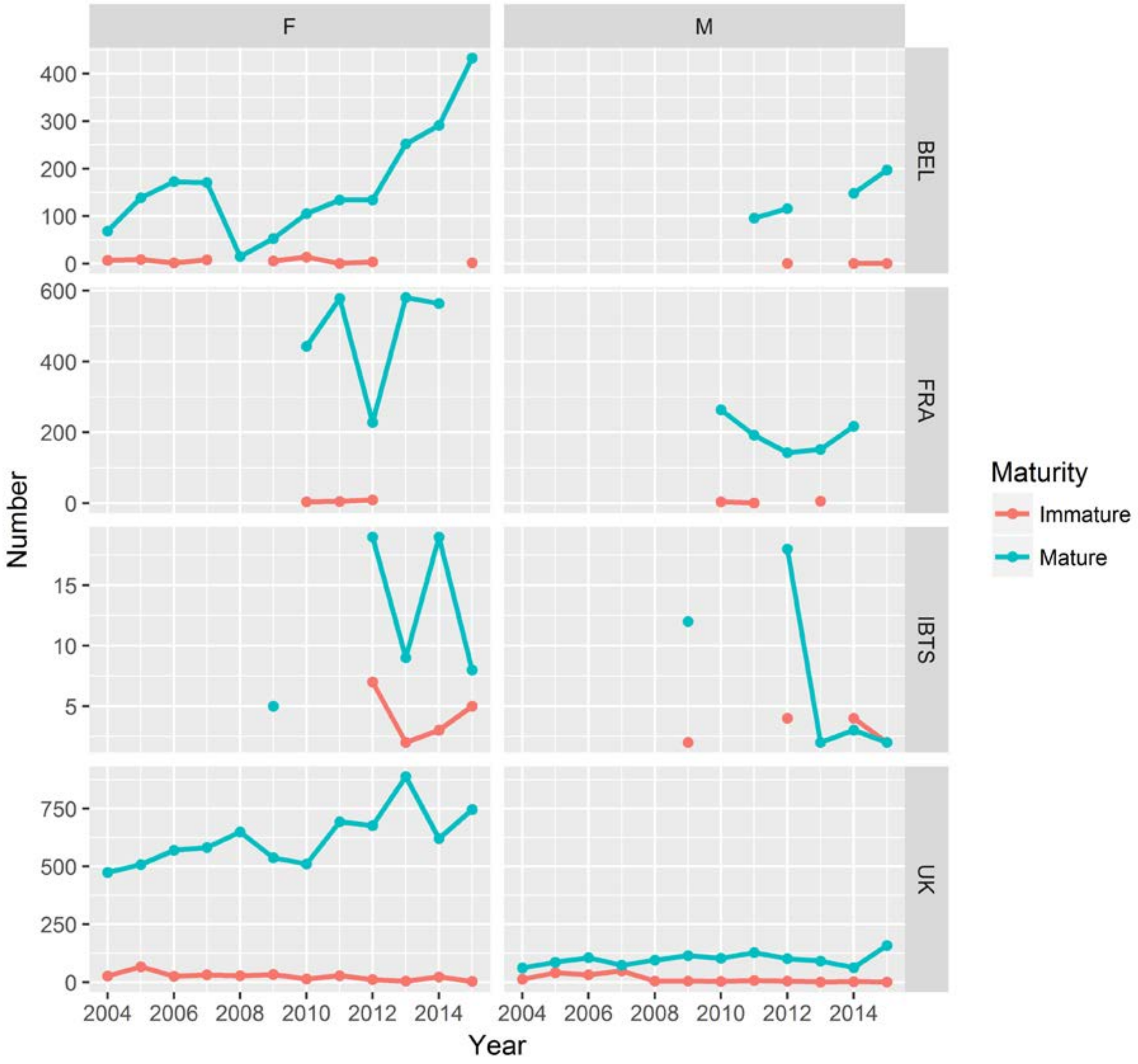


Figure 6 Number of records per sex and country with indication of maturiation level (note: different scale on y-axis)

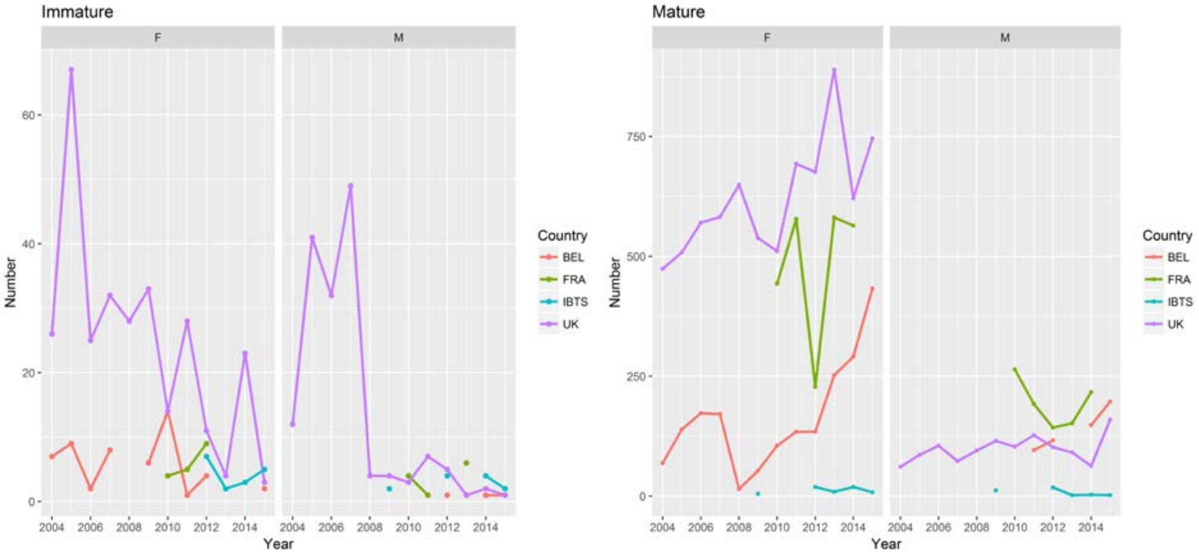


Figure 7 Number of records per sex and country (left: immature sole; right: mature sole; note different scale on y-axis)

The majority of the data originate from commercial datasets (99%), from which the UK dataset has most of the records (UK = 60%; BEL = 17%; FRA = 22%). The underrepresentation of survey data (IBTS = 1%) results in a limited number of immature records (4%).

This dataset is further explored in Appendix 1.

Analysis

An estimate of the proportion of mature fish at age (*i.e.* maturity@age) is required to be able to evaluate the maturity ogive as input for the stock assessment model. We could estimate maturity@age by simply averaging the yearly age samples, but applying statistical models has the following advantages:

- Age samples (including maturity) are not a random sample of the fish population. Protocols describe to collect x number of fish per cm-class (e.g. Belgium collects 5 fish per cm-class per statistical rectangle). This results in stratification by length. Therefore, a simple average at age would give an biased estimate.
- Model based estimation helps to adjust other factors (than age) that are associated with maturity, especially if these factors were not originally considered in the sampling design, for instance length, country and year. It can also help to explain the mechanism of maturity changes with respect to those factors.

Several covariates were first explored before including them in the final GLM maturity model.

- Sex: One model for females and one for males were used to explore maturity, as male and female sole were shown to have different growth and reproductive strategies (Bromley 2003, Haslob 2015).
- Length: Since samples are stratified by length, length is included as a covariate. Additionally, after adjusting age, length is strongly correlated with maturity. Including length could also disentangle the gear effect where different gears catch fishes with different length ranges (now the maturity is estimated at a given length, independent of what gear it is from).
- Country: Due to variation in the dimension of the data series (number of years) of the different countries, the covariate 'country' was explored using a subset of the data (Appendix 2). The subset included only years where all countries had data. For the females, 2012 to 2014 were selected. For the males, 2012 and 2014 were selected. For both subsets, 'country' needed to be retained in the GLM model as it resulted in the lowest AIC value and significant differences for maturity between countries were identified.

Results

A GLM was used to estimate the proportion of mature fish at age for females and males separately, including age, length, year and country. The age plus group consisted of age 10 and older. The best model with lowest AIC was retained.

Females

Age 1 was excluded from this dataset as it only contained 5 records.

```
> fit1e <- glm(Maturity1 ~ -1 + AgeRings + LngtClass + Year + Country, fami
ly=binomial, data=datFwhole)
> summary(fit1e)

Call:
```

```
glm(formula = Maturity1 ~ -1 + AgeRings + LngtClass + Year +
    Country, family = binomial, data = datFwhole)

Deviance Residuals:
    Min       1Q   Median       3Q      Max
-3.6191   0.0098   0.0351   0.1234   1.8629

Coefficients:
             Estimate Std. Error z value Pr(>|z|)
AgeRings2   -15.99009    0.94506 -16.920  < 2e-16 ***
AgeRings3   -14.94982    0.97540 -15.327  < 2e-16 ***
AgeRings4   -14.80004    1.03161 -14.347  < 2e-16 ***
AgeRings5   -15.00544    1.11489 -13.459  < 2e-16 ***
AgeRings6   -14.63605    1.17454 -12.461  < 2e-16 ***
AgeRings7   -15.60450    1.27924 -12.198  < 2e-16 ***
AgeRings8   -14.61868    1.28530 -11.374  < 2e-16 ***
AgeRings9   -15.61253    1.54124 -10.130  < 2e-16 ***
AgeRings10  -15.37595    1.53734 -10.002  < 2e-16 ***
LngtClass     0.63357    0.03583  17.682  < 2e-16 ***
Year2005     -1.42252    0.29015  -4.903 9.45e-07 ***
Year2006     -0.01958    0.32653  -0.060  0.95219
Year2007      0.09752    0.29610   0.329  0.74189
Year2008      0.74253    0.30803   2.411  0.01593 *
Year2009      0.48180    0.31602   1.525  0.12736
Year2010      1.27043    0.31864   3.987 6.69e-05 ***
Year2011      1.02731    0.31734   3.237  0.00121 **
Year2012      1.86993    0.31305   5.973 2.33e-09 ***
Year2013      2.93713    0.49413   5.944 2.78e-09 ***
Year2014      1.73550    0.32971   5.264 1.41e-07 ***
Year2015      3.02233    0.52242   5.785 7.24e-09 ***
CountryFRA    2.09664    0.33054   6.343 2.25e-10 ***
CountryIBTS  -0.27248    0.63545  -0.429  0.66807
CountryUK    -0.37454    0.19103  -1.961  0.04992 *
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

(Dispersion parameter for binomial family taken to be 1)

    Null deviance: 16991.8  on 12257  degrees of freedom
Residual deviance:  1769.4  on 12233  degrees of freedom
AIC: 1817.4

Number of Fisher Scoring iterations: 10
```

All included covariates had a significant effect on maturity.

```
> drop1(fit1e, test="Chisq")
Single term deletions

Model:
Maturity1 ~ -1 + AgeRings + LngtClass + Year + Country
          Df Deviance    AIC    LRT  Pr(>Chi)
<none>         1769.4 1817.4
AgeRings   9   2362.1 2392.1 592.68 < 2.2e-16 ***
LngtClass  1   2220.8 2266.8 451.38 < 2.2e-16 ***
Year      11   2076.6 2102.6 307.15 < 2.2e-16 ***
Country    3   1862.1 1904.1  92.73 < 2.2e-16 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1
```

The fitted curve was plotted with indication of the raw data at age 3 for the females (Figure 8).

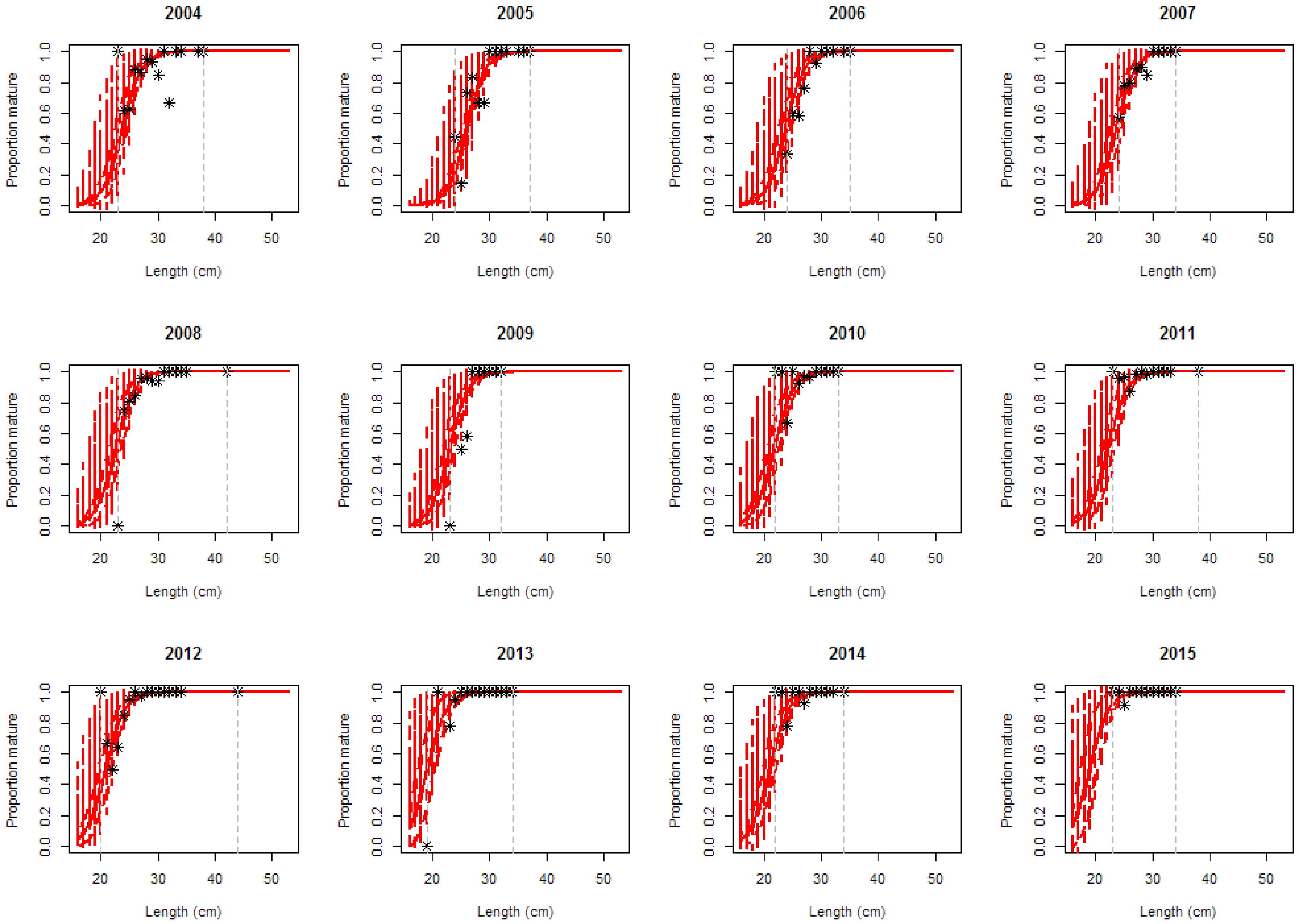


Figure 8 The fitted curve of the model was plotted for age 3 (model = full red line; red dashed lines = standard errors) with indication of the raw data (black dots; grey dashed lines = outer limits of raw data)

The fitted curve was plotted with indication of the raw data at the minimum landing size (24 cm) for the females (Figure 9).

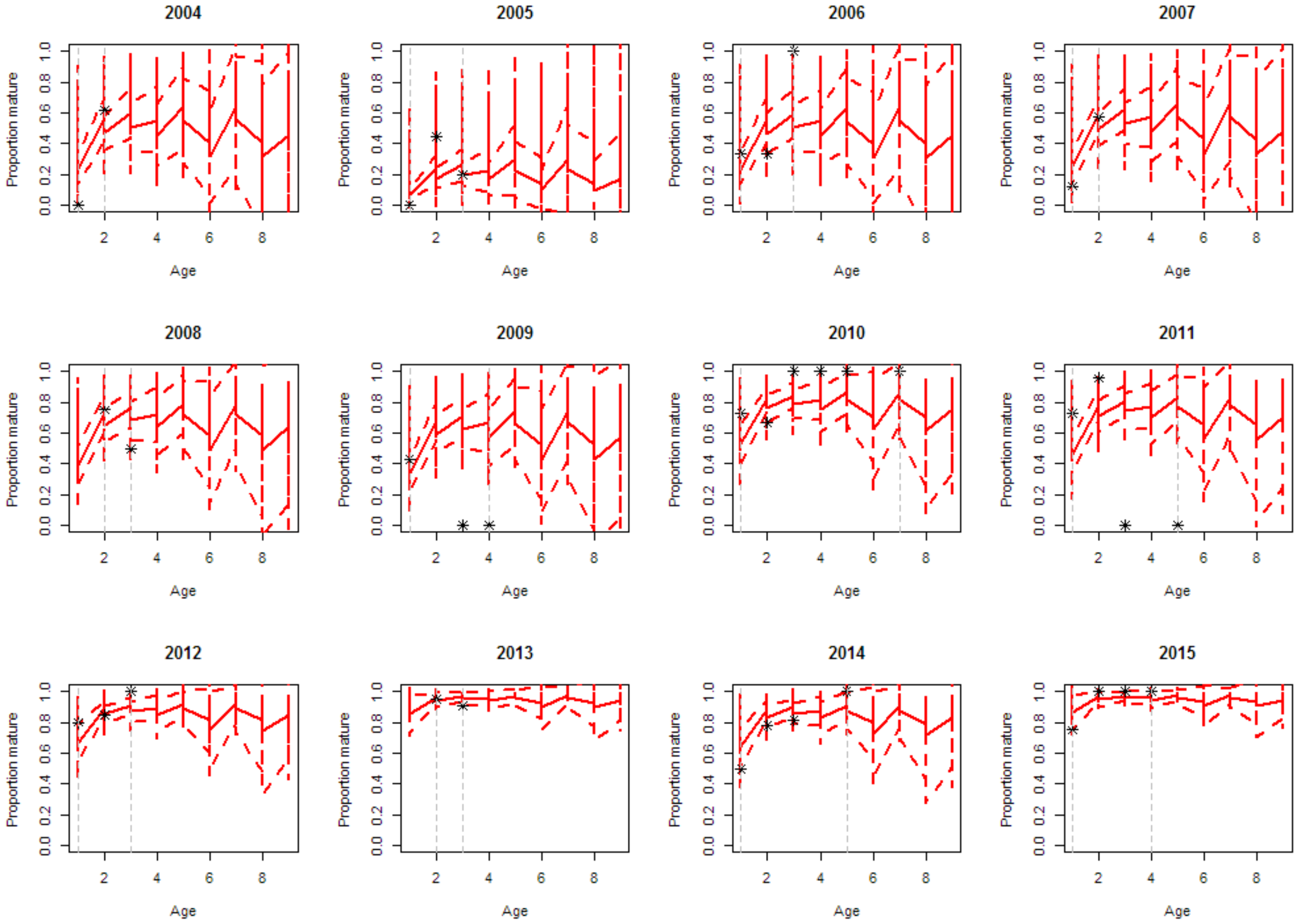


Figure 9 The fitted curve of the model was plotted for a size of 24 cm (model = full red line; red dashed lines = standard errors) with indication of raw data (black dots; outer limits of raw data)

Males

Age 1 was excluded from this dataset as it only contained 2 records.

```
> fit1e <- glm(Maturity1 ~ -1 + AgeRings + LngtClass + Country + Year, fami
ly=binomial, data=datM)
> summary(fit1e)

Call:
glm(formula = Maturity1 ~ -1 + AgeRings + LngtClass + Country + 
    Year, family = binomial, data = datM)

Deviance Residuals: 
    Min       1Q   Median       3Q      Max  
-3.3613   0.0784   0.1457   0.2528   1.6334  

Coefficients:
            Estimate Std. Error z value Pr(>|z|)    
AgeRings2   -5.69166    1.33921  -4.250 2.14e-05 ***
AgeRings3   -5.42578    1.35072  -4.017 5.90e-05 ***
AgeRings4   -5.07800    1.40169  -3.623 0.000291 ***
AgeRings5   -5.75162    1.44523  -3.980 6.90e-05 ***
AgeRings6   -5.40067    1.46299  -3.692 0.000223 ***
AgeRings7   -5.50217    1.48144  -3.714 0.000204 ***
AgeRings8   -5.52689    1.53525  -3.600 0.000318 ***
AgeRings9   -4.62114    1.67204  -2.764 0.005714 ** 
AgeRings10  -5.60378    1.58778  -3.529 0.000417 ***
LngtClass    0.31070    0.04368   7.113 1.14e-12 ***
CountryFRA  -0.43055    0.69148  -0.623 0.533516    
CountryIBTS -2.47665    0.79031  -3.134 0.001726 ** 
CountryUK   -1.57239    0.65133  -2.414 0.015773 *  
Year2005    -0.98165    0.40518  -2.423 0.015403 *  
Year2006    -0.38027    0.40607  -0.936 0.349039    
Year2007    -1.16111    0.39399  -2.947 0.003208 ** 
Year2008     1.79799    0.62006   2.900 0.003735 ** 
Year2009     2.21654    0.58257   3.805 0.000142 ***
Year2010     2.28192    0.56039   4.072 4.66e-05 ***
Year2011     2.06326    0.52554   3.926 8.64e-05 ***
Year2012     2.82340    0.61826   4.567 4.96e-06 ***
Year2013     1.96759    0.55138   3.568 0.000359 ***
Year2014     2.28844    0.57767   3.962 7.45e-05 ***
Year2015     3.12596    0.70278   4.448 8.67e-06 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

(Dispersion parameter for binomial family taken to be 1)

    Null deviance: 4053.52  on 2924  degrees of freedom
Residual deviance:  875.86  on 2900  degrees of freedom
AIC: 923.86

Number of Fisher Scoring iterations: 8
```

All included covariates had a significant effect on maturity.

```
> drop1(fit1e, test="Chisq")
Single term deletions

Model:
Maturity1 ~ -1 + AgeRings + LngtClass + Country + Year
          Df Deviance     AIC     LRT  Pr(>Chi)    
<none>          959.46  987.46                      
AgeRings   9   1134.31 1144.31 174.852 < 2.2e-16 ***
LngtClass  1   1028.84 1054.84  69.385 < 2.2e-16 ***
Country    3    987.77 1009.77  28.308  3.13e-06 ***
Year       1   1124.40 1150.40 164.945 < 2.2e-16 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1
```

The fitted curve was plotted with indication of the raw data at age 3 for the males (Figure 10).

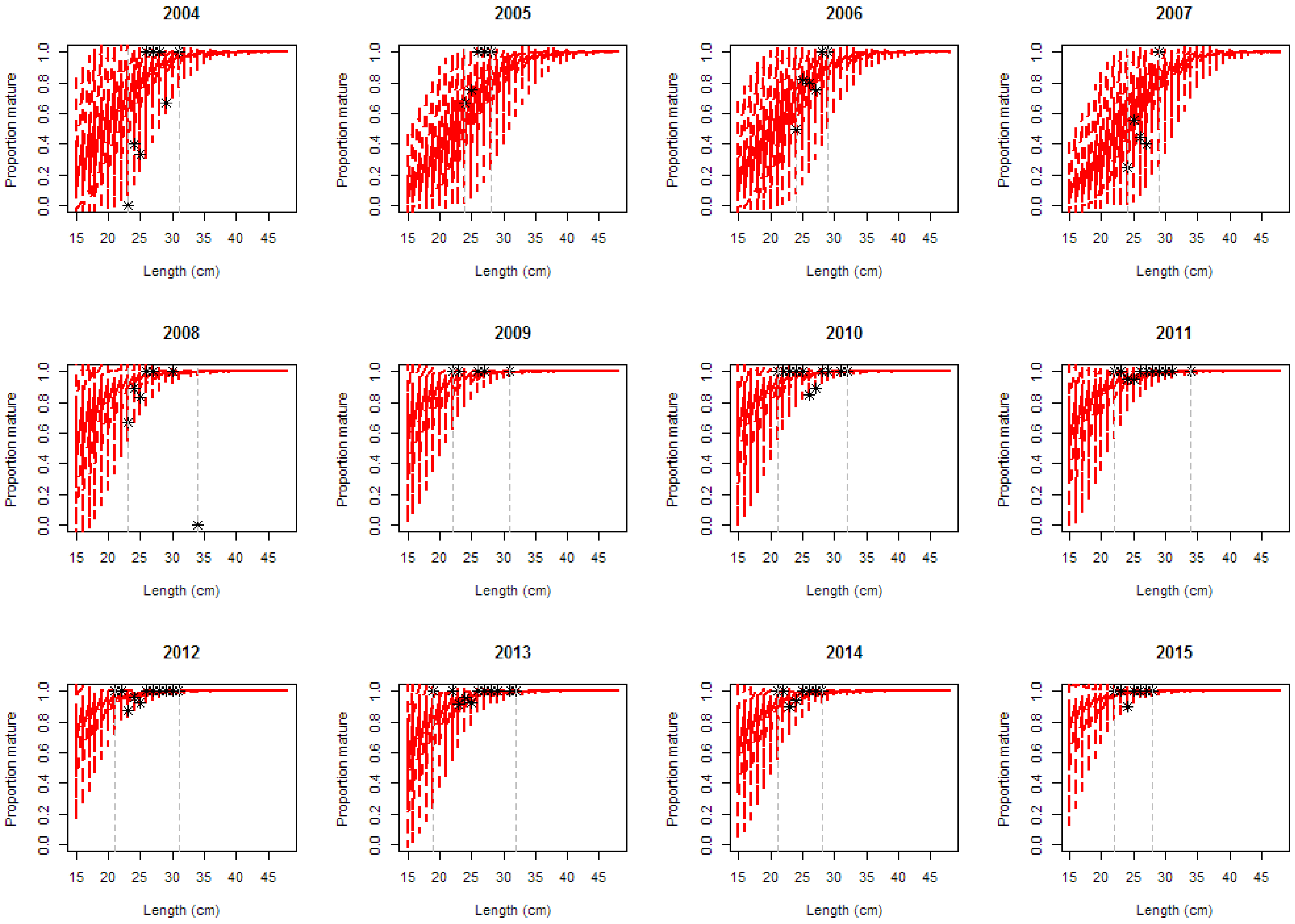


Figure 10 The fitted curve of the model was plotted for age 3 (model = full red line; red dashed lines = standard errors) with indication of the raw data (black dots; outer limits of raw data)

The fitted curve was plotted with indication of the raw data at the minimum landing size (24 cm) for the males (Figure 11).

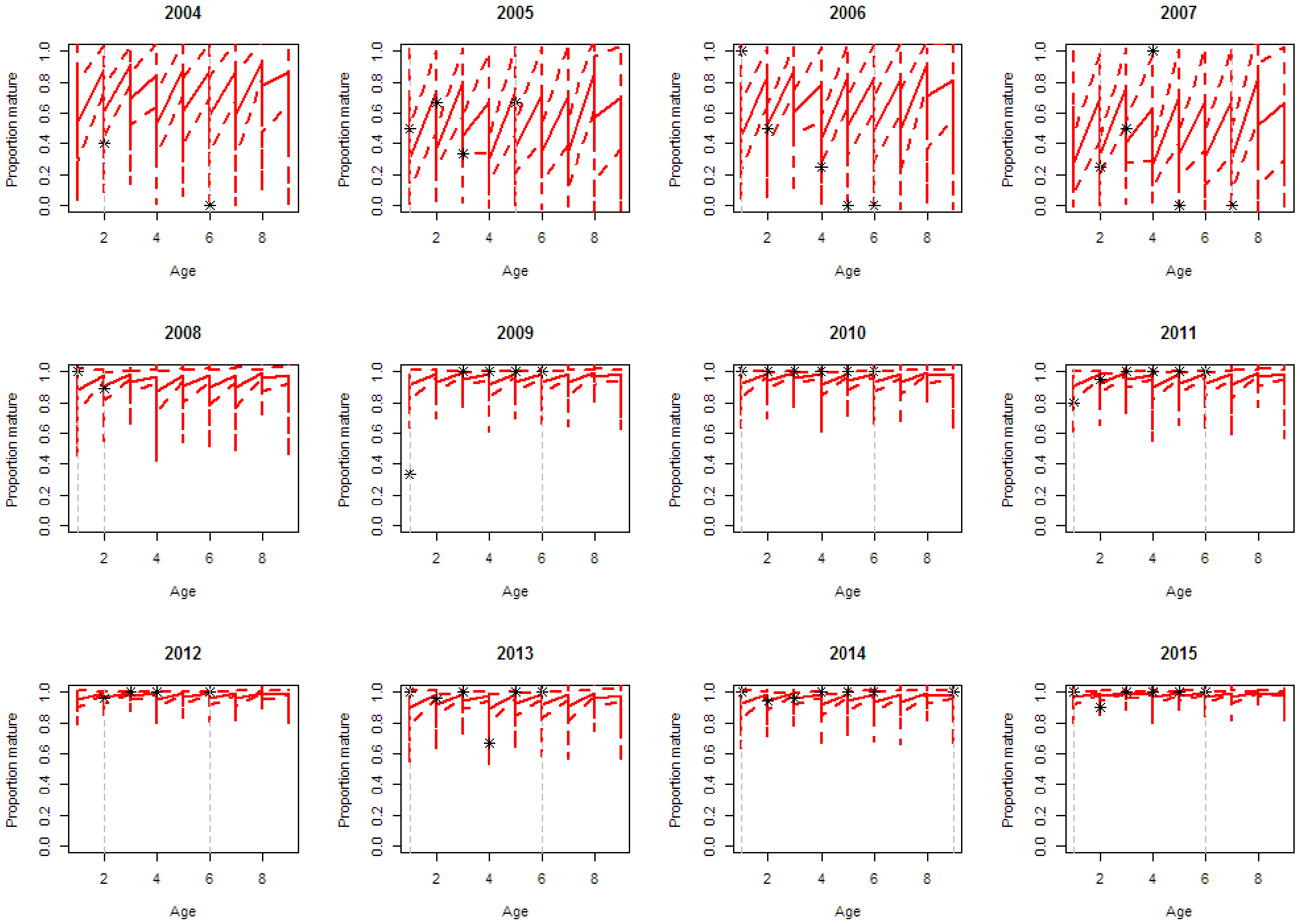


Figure 11 The fitted curve of the model was plotted for a size of 24 cm (model = full red line; red dashed lines = standard errors) with indication of raw data (black dots; outer limits of raw data)

All terms were statistically significant at significance level 0.05. Due to the large sample size, a subtle difference among the levels of the covariates could lead to a "significant" result. Therefore, it is more interesting to check the actual maturity ogive differences estimated by the model, and to see whether it is biologically meaningful (Figure 12).

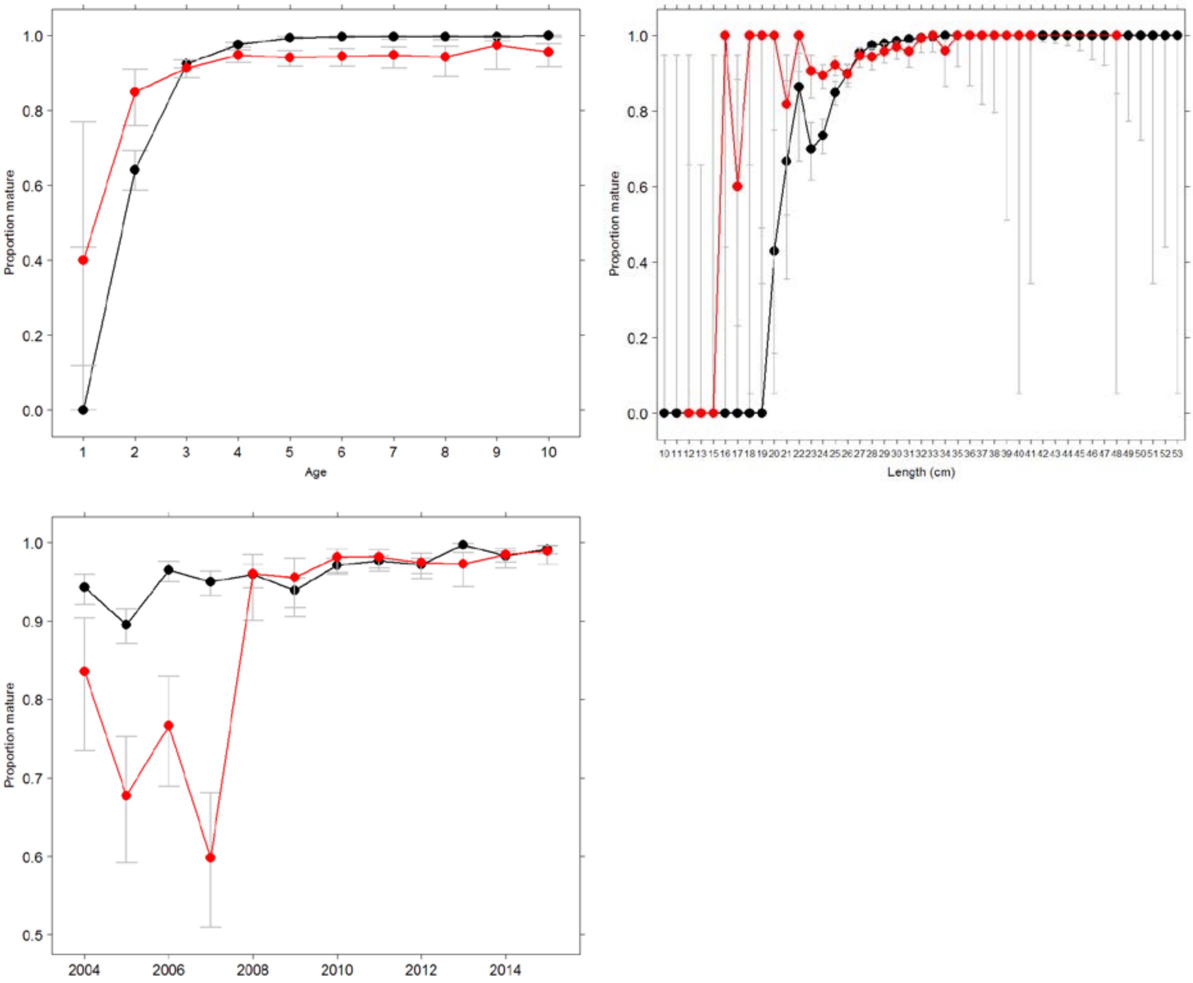


Figure 12 Maturity ogive computed from raw data by (a) age, (b) length and (c) year (red = males; black = females; error bars = 95% confidence intervals)

<u>Estimating maturity@age</u>

The same methodology as for plaice IV and IIIa was used to estimate maturity@age and is described below (working document Maturity Chun Chen).

The maturity model estimates the probability of mature, given sex (=s), age (=a) and length(=l) of the fish, defined as $\text{Prob}(\text{M} = 1\,|\text{A} = a, \text{L} = l, \text{S} = s)$, where M, A, L and S refer to maturity, age, length and sex respectively.

The final output we need to estimate is $\text{Prob}(M = 1\,|A = a) = \text{Prob}(M = 1, \text{Sex} = \text{Female}\,|A = a) + \text{Prob}(M = 1, \text{Sex} = \text{Male}\,|A = a)$.

$\text{Prob}(M = 1\,|A = a)$

$$= \sum_{s=\{female,male\}} \sum_{l=lmin}^{lmax} \text{Prob}(M = 1\,|A = a, L = l, S = s) \cdot \text{Prob}(L = l, S = s\,|A = a)$$

$$= \sum_{s=\{female,male\}} \sum_{l=lmin}^{lmax} \text{Prob}(M = 1, L = l, S = s\,|A = a,) \tag{1}$$

Therefore, to estimate $\text{Prob}(M = 1\,|A = a)$, we need to estimate the probability of length(=l) per sex, at given age, $\text{Prob}(L = l, S = s\,|A = a)$. This probability can be derived from two terms as seen in equation (2) below, the left term is the probability of length(=l) at given age(=a) and the right term is the probability of sex(=s) at given length(=l):

$$\text{Prob}(L = l, S = s\,|A = a) = \text{Prob}(L = l\,|A = a) \cdot \text{Prob}(S = \text{s}\,|L = l) \tag{2}$$

The left term$\text{Prob}(L = l\,|A = a)$ can be seen as an “inverse” version of the age-length key $\text{Prob}(A = a \mid L = l)$, converted using the length-frequency distribution $\text{Prob}(L = l)$ as weight:

$$\text{Prob}(L = l\,|A = a) = \frac{\text{Prob}(L = l, A = a)}{\text{Prob}(A = a)} = \frac{\text{Prob}(A = a \mid L = l) \cdot \text{Prob}(L = l)}{\text{Prob}(A = a)} \tag{3}$$

Based on formula (1), (2), (3), we still need to estimate the following three probabilities to obtain $\text{Prob(M} = 1\,|A = a)$.

- $\text{Prob}(L = l)$: probability of length l. This is the length-frequency distribution. If possible, this should be estimated based on the simple random length samples per haul.
- $\text{Prob}(A = a \mid L = l)$: probability of age at given length l. This is the age-length key and should be estimated from the age samples.
- $\text{Prob}(S = \text{s} \mid L = l)$: probability of female or male at given length l. This should ideally be estimated from the length samples due to its large sample size. However, if sex reading is not given for length samples, we could use age samples to estimate this value.

Table 7 summarizes the data and methods we used to estimate the 4 probabilities. Note that for estimating age-length key, we applied a continuation-logit model (Agresti, 2010), where the logit of the continuation ratio is modeled as a linear combination of the covariates:

$$\text{continuation ratio} = \text{Prob}(A = a\,|A \geq a)$$

$$\text{logit}[\text{Prob}(A = a\,|A \geq a)] = \alpha_a + \beta'\boldsymbol{x}, \qquad a = Amin, Amax - 1$$

Similar to the maturity model, the ALK is estimated separately per country. However, we do not differentiate by sex. The included covariates are year, length and country (if multiple). The best model was selected through minimum AIC.

Table 7 Summary of data and methods used to estimate the 4 key probabilities

Step	Data	Output	Output definition	Method
1	Length-sample	Length-frequency distribution	$\text{Prob}(L = l)$	Simple average

2	Age-sample	Sex ogive per length	$\text{Prob}(S = s \mid L = l)$	Simple average
3	Age-sample	Age-length key	$\text{Prob}(A = a \mid L = l)$:	Continuation-logit model (Agresti, 2010)
4	Age-sample	Maturity ogive at given age, length, sex	$\text{Prob}(M = 1 \mid A = a, L = l, S = s)$,	GLM model

The estimated maturity ogives (@age) are represented in Figure 13 and Figure 14. Note that the illustrated year variability is a combination of the sex-specific year indices as shown in Figure 8, Figure 9, Figure 10 and Figure 11.

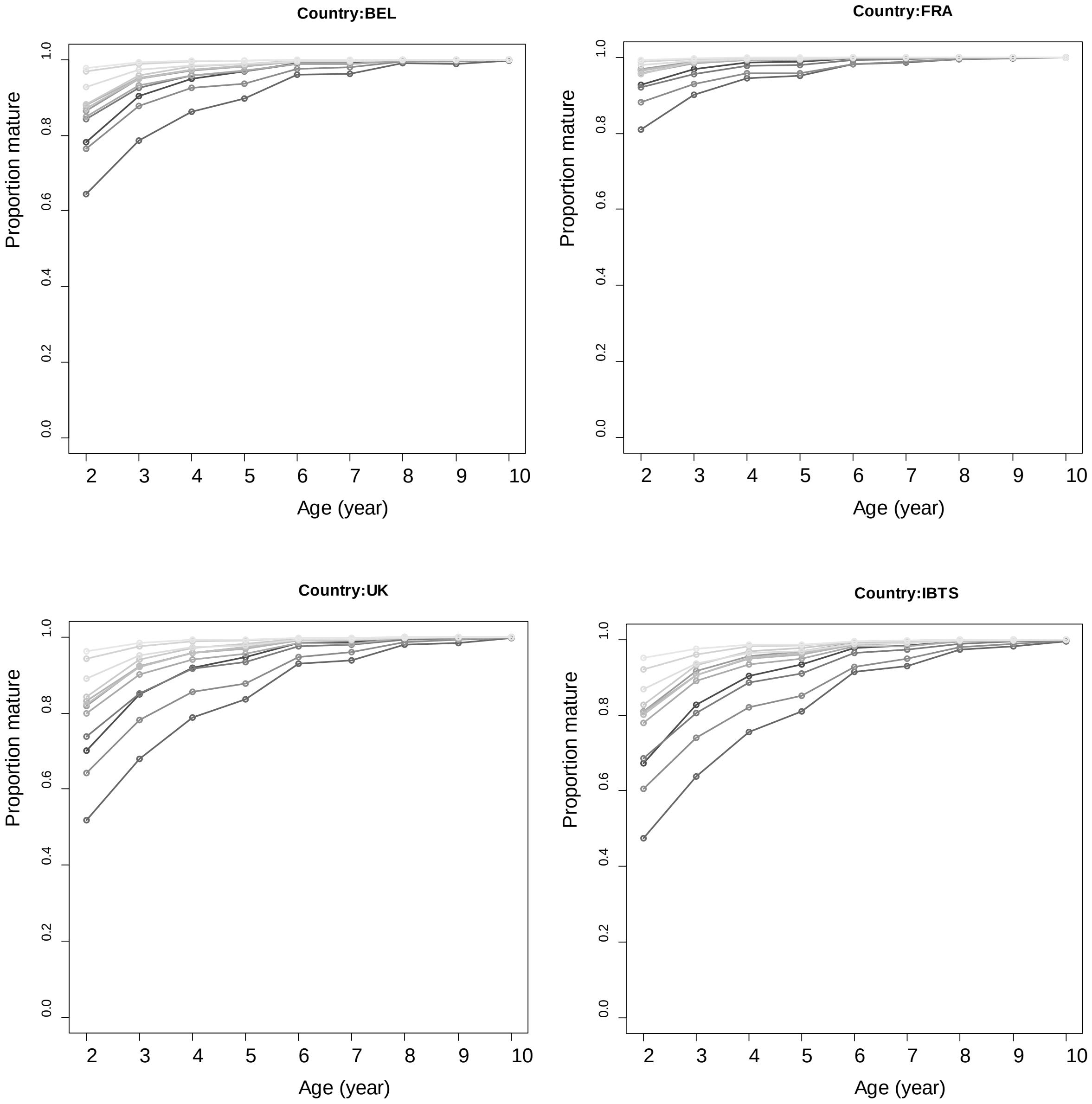


Figure 13 Estimated proportion of mature fishes per age. Each line indicates a year (2004-2015) with earlier years in darker shades and recent years in lighter shades of gray

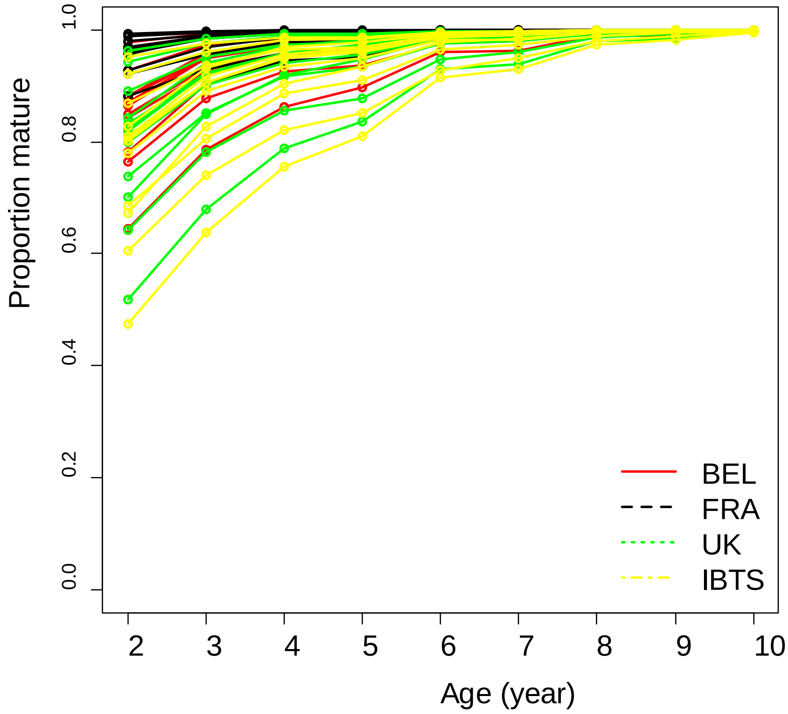
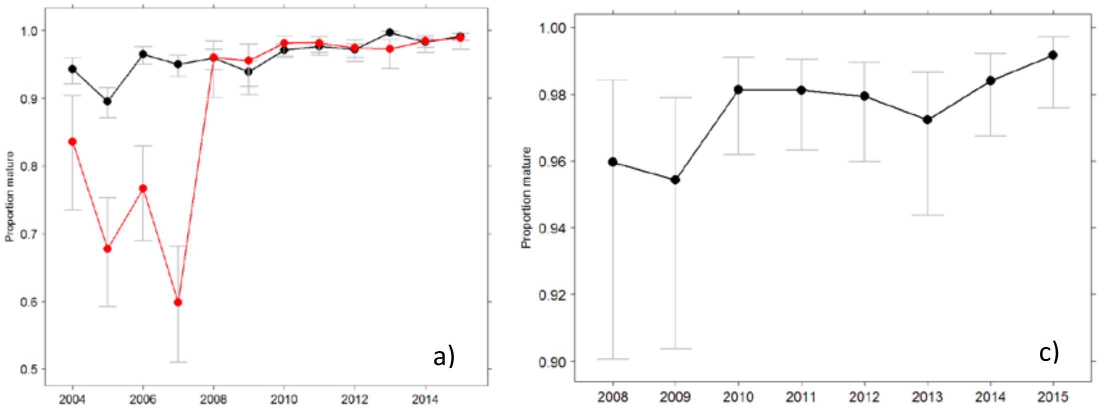


Figure 14 Estimated proportion of mature fishes by different countries per age

Data issue UK males prior to 2008

When considering the data for males prior to 2008, an odd decline in maturity is observed. As only UK data were provided for males prior to 2008, no comparison with other datasets was possible. During the benchmark (WKNSEA 2017), it was decided to explore a model (Maturity ~ age+length+country+year) without these data (Figure 15).



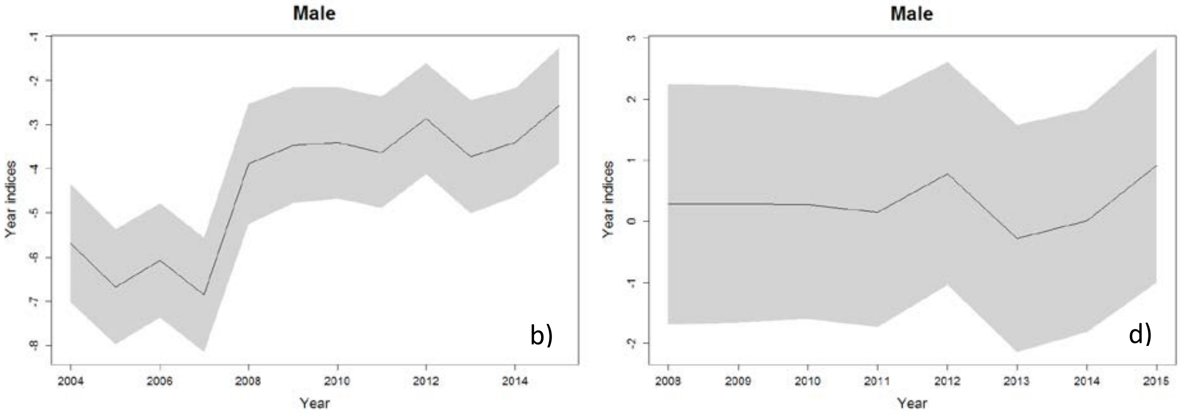


Figure 15 a) Original dataset showing raw data (females: black; males: red); b) original dataset showing model output for males; c) truncated dataset at 2008 showing raw data for males; d) truncated dataset at 2008 showing model output for males

The estimated maturity ogives (@age) using this truncated dataset for males are presented in Figure 16 (per country) and Figure 17 (overall), with Table 8 being the corresponding maturity ogive.

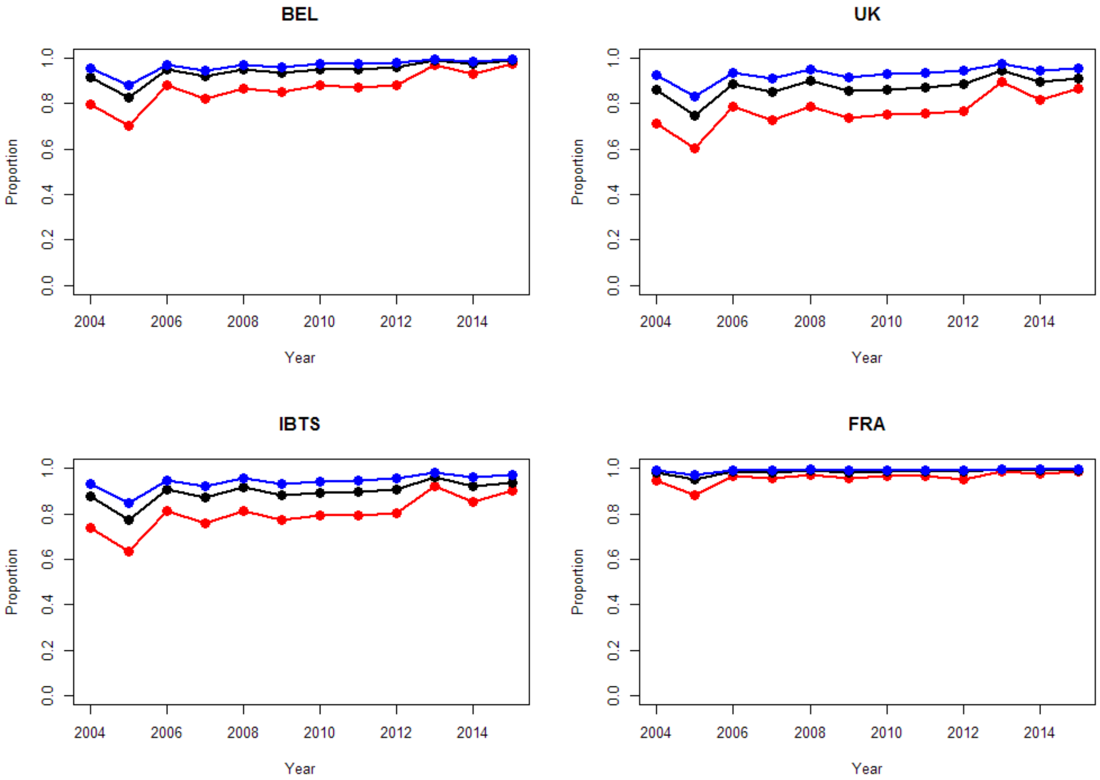


Figure 16 Estimated proportion of mature fishes per year for each country. Each line indicates an age (red = age 2, black = age 3, blue = age 4)

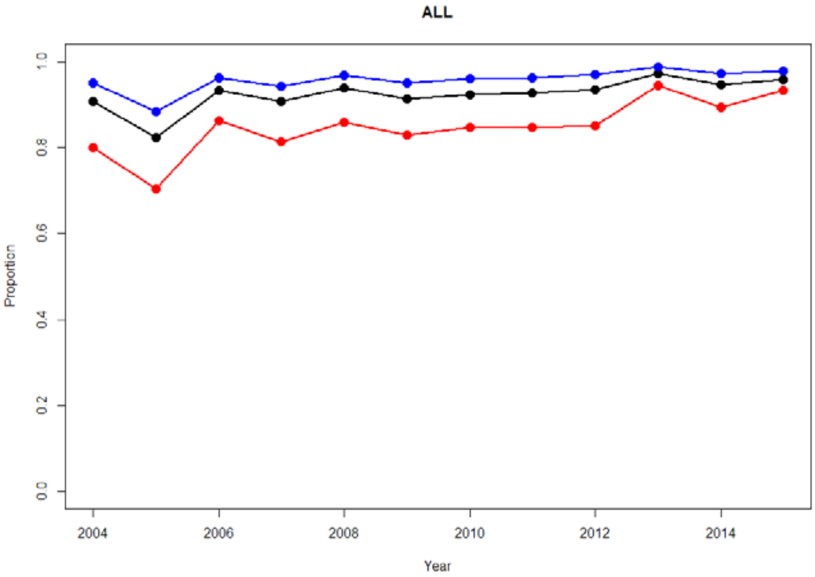


Figure 17 Estimated proportion of mature fishes for all countries per age (red = age 2; black = age 3; blue = age 4)

Table 8 Maturity ogive based on the model (Maturity ~ age+length+country+year) truncated for the males prior to 2008

Year	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
2004	0.8	0.91	0.95	0.97	0.99	0.99	1	1	1
2005	0.7	0.82	0.88	0.92	0.97	0.97	0.99	0.99	1
2006	0.86	0.93	0.96	0.97	0.99	0.99	1	1	1
2007	0.81	0.91	0.94	0.96	0.98	0.98	1	1	1
2008	0.86	0.94	0.97	0.98	0.99	0.99	1	1	1
2009	0.83	0.91	0.95	0.97	0.99	0.99	1	1	1
2010	0.85	0.92	0.96	0.97	0.99	0.99	1	1	1
2011	0.85	0.93	0.96	0.98	0.99	0.99	1	1	1
2012	0.85	0.93	0.97	0.98	0.99	0.99	1	1	1
2013	0.94	0.97	0.99	0.99	1	1	1	1	1
2014	0.89	0.95	0.97	0.98	0.99	0.99	1	1	1
2015	0.93	0.96	0.98	0.99	0.99	0.99	1	1	1

Benchmark conclusion

Two important conclusions were drawn during the WKNSEA 2017 benchmark based on this output (Figure 16; Figure 17):

- Almost no variation over the years was observed
- Almost no variation over the different countries was observed

Therefore, it was decided that both country and year should no longer be included in the model. Maturity at age was estimated per sex without the use of age-length keys and the maturity at age for both sexes was combined assuming a 50:50 sex ratio. No extra information was available to refute this sex ratio.

This resulted in the following maturity ogive, being constant over the years (Table 9):

Table 9 Resulting maturity ogive from simplified model as discussed in WKNSEA 2017

Age	2	3	4	5	6	7	8	9	10
Maturity	0.74	0.92	0.96	0.97	0.97	0.97	0.97	0.99	0.98

This ogive was comprehensively discussed because in particular the proportion of mature sole at age 2 was much higher (74%) than in the currently used ogive (knife-edged: 0% mature at age 2). Two important issues were pointed out: a) the majority of the data originated from commercial datasets including fewer fish of age 2 (less caught commercially, especially during more recent years) and b) the only survey information included, are the 126 samples of the IBTS survey, which is not targeting sole and covers only a part of division VIId.

Consequently, using Table 9 as maturity ogive, could give a wrong idea on the maturity at age 2. Therefore, based on the advice of experts present at the benchmark, the proportion of mature sole was determined using the ratio of mature records versus all records at age 2. The dataset used for this reasoning was the UK dataset, being the largest. The obtained value reflecting the mature fish at age 2 is 0.53 (=97/182 records). This more or less complied with the proportion of mature fish in the IBTS dataset (=12/25 records = 0.48). This led to the maturity ogive as presented in Table 10.

Table 10 Maturity ogive adjusted for age 2

Age	2	3	4	5	6	7	8	9	10
Maturity	0.53	0.92	0.96	0.97	0.97	0.97	0.97	0.99	0.98

Due to the large variation in the dataset to construct this ogive, full maturation was never reached (never 100%). The maturity rate started to plateau from age 5-6 onwards. The effect of setting full maturation at age 5 or 6 on the SSB was investigated in the assessment working document. Based on this analysis and expert judgement, it was decided to move forward with the maturity ogive as presented in Table 11.

Table 11 Final maturity ogive used in the new assessment

Age	0	1	2	3	4	5	6	7	8	9	10 (+)
Maturity	0.00	0.00	0.53	0.92	0.96	0.97	1.00	1.00	1.00	1.00	1.00

2. Weights and growth: decreasing body size at age

Analysing the available datasets revealed a strong pattern of decreasing mean lengths and weights at a specific age for sole VIId, especially for the younger ages (Figure 18). However, further analyses should be performed to confirm these patterns. The observed patterns could be biased. The age determinations are stratified by length, *i.e.* a fixed number of fish per length interval is collected for analyses. Therefore, the proportion of length at a given age estimated from age samples could be biased. Extra analyses should be done to compare length frequency distributions from random samples. These extra analyses are beyond the scope of the current benchmark and will be performed later on.

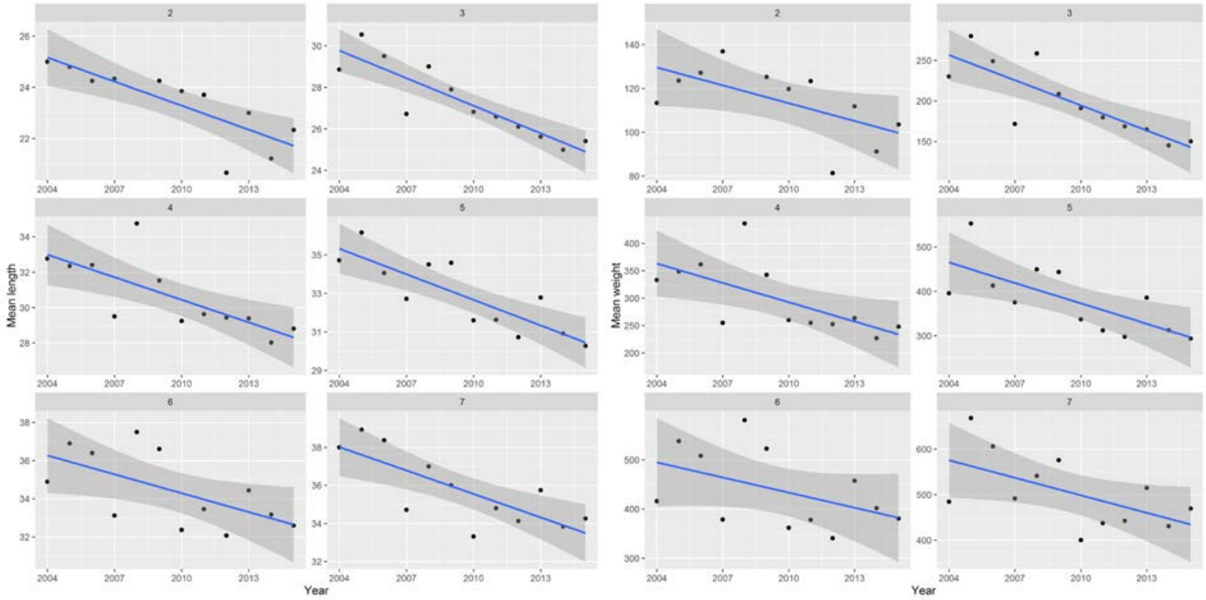


Figure 18 Left: Mean length at age from 2004-2015 for ages 2-7; Right: Mean weight at age from 2004-2015 for ages 2-7

A decrease in length and weight at age could be related to fisheries-induced evolutionary change (Mollet *et al.* 2007) or could represent a plastic response to environmental variability. Changes in nutrient availability (N, P, Si) may affect primary production and phytoplankton species composition (Finkel *et al.* 2009), which could have cascading effects on higher trophic levels. Additionally, a rise in temperature could also result in decreasing body size (Cheung *et al.* 2013).

3. References

- Bromley, P.J., 2003. The use of market sampling to generate maturity ogives and to investigate growth, sexual dimorphism and reproductive strategy in central and south-western North Sea sole (*Solea solea*, L.). ICES Journal of Marine Science 60, 52-65.
- Cheung, W.W.L., Sarmiento, J. L., Dunne, J., Frölicher, T. L., Lam, V. W. Y., Deng Palomares, M. L., Watson, R., Pauly, D., 2013. Shrinking of fishes exacerbates impacts of global ocean changes on marine ecosystems. Nature Climate Change 3, 254–258.
- Finkel, Z.V., Beardall, J., Flynn, K.J., Quigg, A., Rees, T.A.V., Raven, J.A., 2009. Phytoplankton in a changing world: cell size and elemental stoichiometry. Journal of Plankton Research 32, 119-137.
- Haslob, H., 2015. Maturity-ogives of Sole (*Solea solea* L.) in the German Bight (2007, 2008 and 2010-2012). ICES working document for WKNSEA 2015.
- Jørgensen, T., 1990. Long-term changes in age at sexual maturity of Northeast Arctic cod (*Gadus morhua* L.). J. Conseil 46, 235-248.
- Mollet, F.M., Kraak, S.B.M., Rijnsdorp, A.D., 2007. Fisheries-induced evolutionary changes in maturation reaction norms in North Sea sole *Solea solea*. Marine Ecology Progress Series 351, 189-199.
- Rijnsdorp, A.D., 1993. Fisheries as a large-scale experiment on life history evolution: disentangling phenotypic and genetic effects in changes in maturation and reproduction of North Sea plaice, *Pleuronectes platessa* L. Oecologia 96, 391-401.
- ICES, 2002. Report of the Working Group on demersal stocks in the North Sea and Skagerrak.
- ICES, 1997. Report of the Comprehensive Fishery Evaluation Working Group.
- ICES, 2016. Report of the Working Group of the North Sea and Skagerrak.

4. Appendix 1: data exploration combined dataset

The figures below provide more information on the age-length distribution with indication of maturation level and country (Figure 19) or sex (Figure 20). For a fixed age, females are usually larger than males. Females can also reach larger sizes.

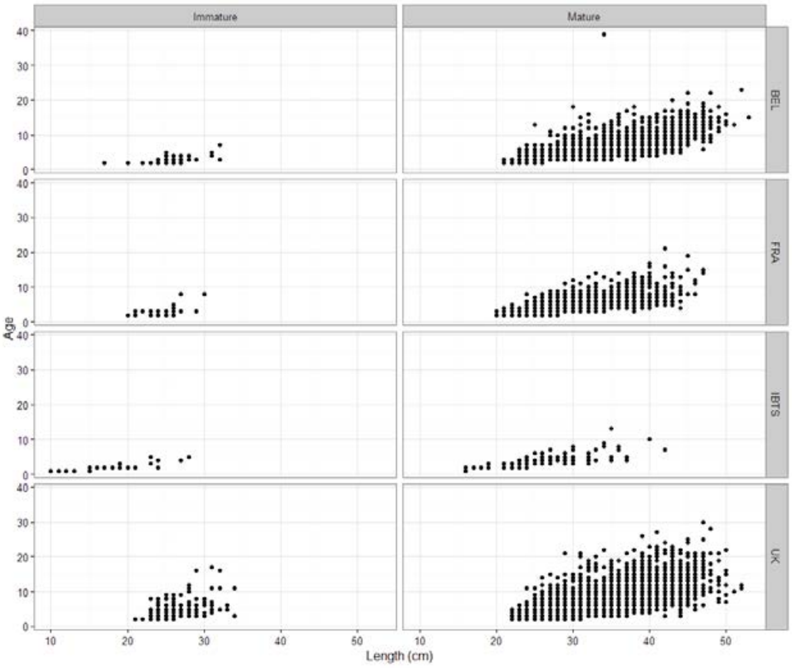


Figure 19 Age-length distribution with indication of country and maturation level

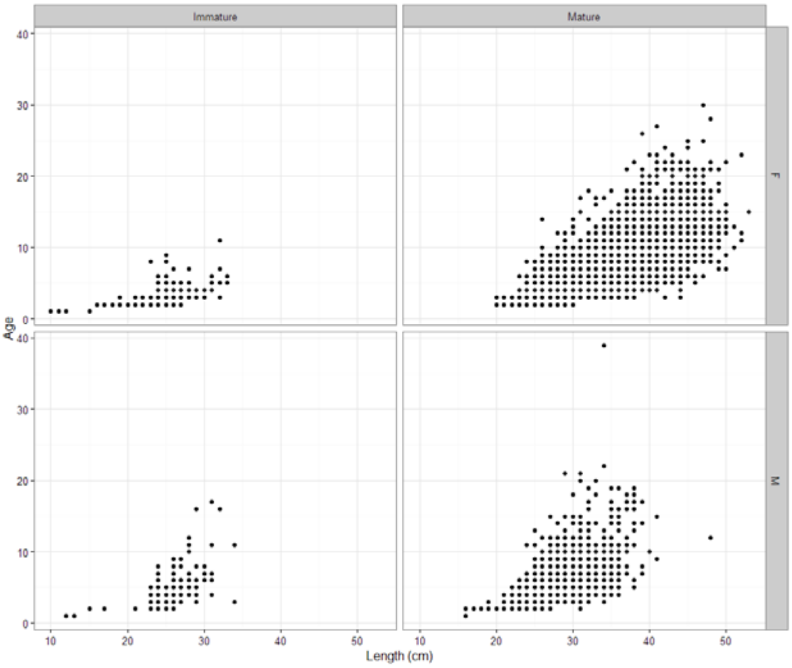


Figure 20 Age-length distribution with indication of sex and maturation level

Although quite some variation is present in the dataset, the length of mature fish varies according to sex, with males reaching maturation at larger sizes than females (Figure 21 left). At age 3, not all fish are mature (>90%; Figure 21 right). Especially for the females (representing the major part of the available records), quite some variation is present in the dataset.

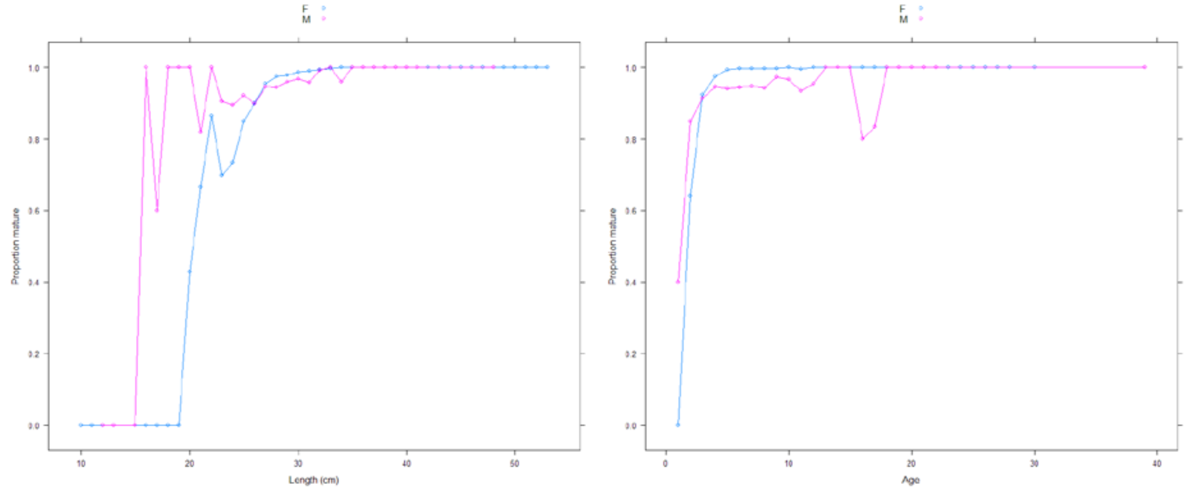


Figure 21 Proportion of mature fish for length (left) and age (right) with indication of sex

A trend towards reaching maturity at smaller sizes is clear for both males and females (Figure 22 right). This trend is not clear with age (Figure 22 right).

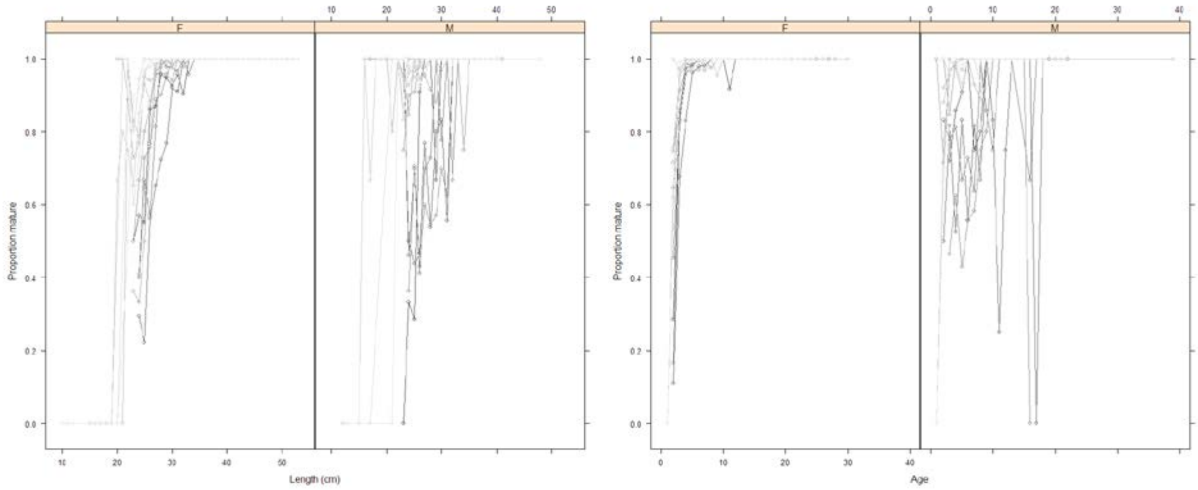


Figure 22 Proportion of mature fish for length (left) and age (right) with indication of sex; lighter shades of grey represent more recent years

Especially for the males, quite some variation is present in the dataset, resulting in an undecided trend for maturity@age (Figure 23). Immature males were recorded up to age 17. Scoring maturity macroscopically in males is quite difficult, which could result in these kind of errors. For females, some inconsistencies were also detected up to age 11.

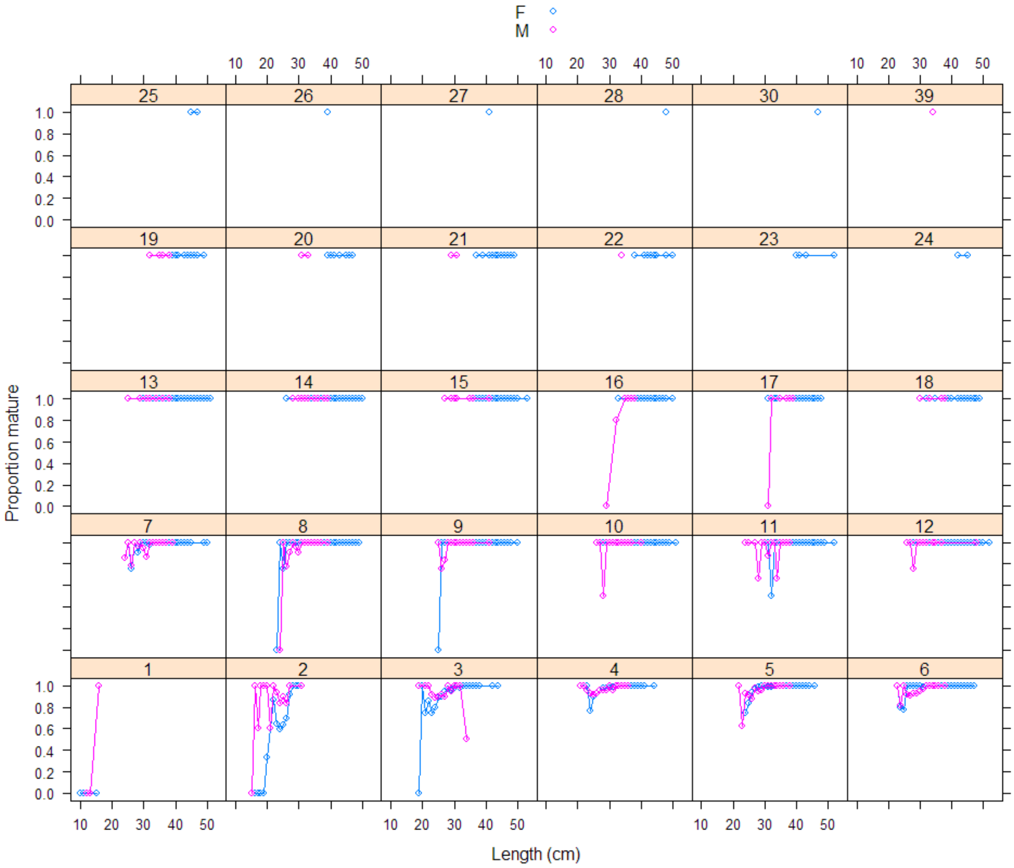


Figure 23 Proportion of mature fish for each age with indication of length and sex

5. Appendix 2: Exploring covariates

To explore the country effect, a GLM was applied to the female dataset for the years 2012 to 2014 and male dataset for the years 2012 and 2014. The model included age, length, year and country as covariates.

glm(Maturity ~ Age + Length + Year + Country, family=binomial, data=dataset)

This model was compared (both estimates and AIC) with a model without the covariate ‘Country’.

a) Females (2012-2014)

The raw data are presented in Figure 24.

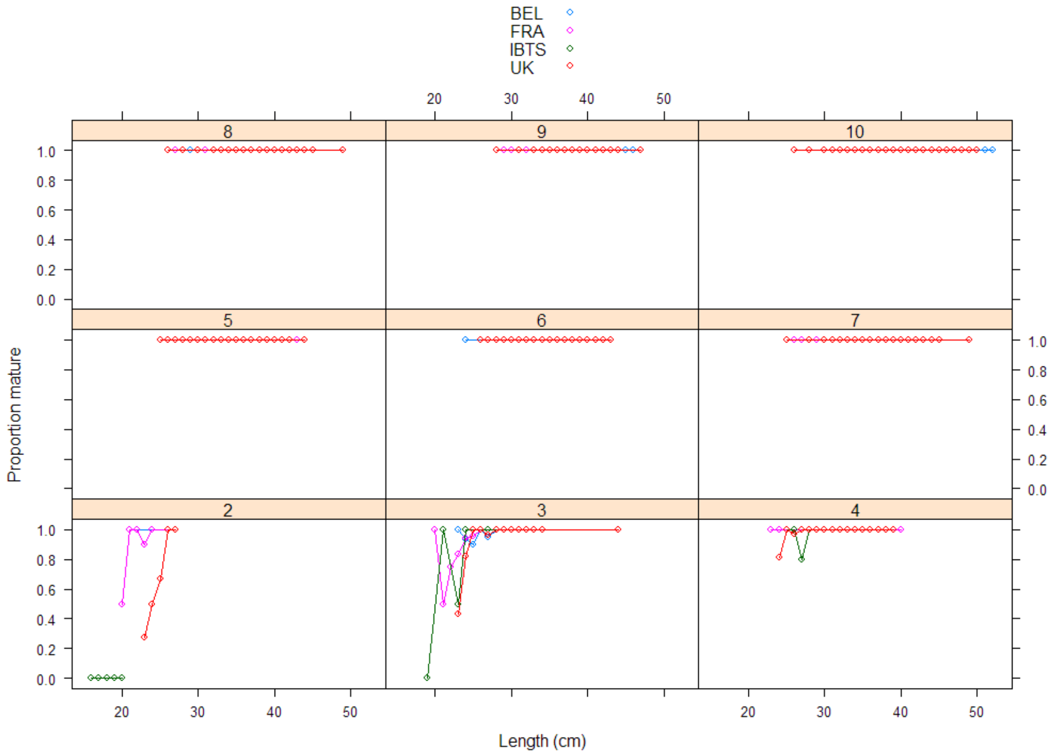


Figure 24 Maturity ogive from raw data for 2012-2014 (females)

The model and its output are listed below.

```
> fit1e <- glm(Maturity1 ~ -1 + AgeRings + LngtClass + Country + Year, fami
ly=binomial, data=datF)
> summary(fit1e)

Call:
glm(formula = Maturity1 ~ -1 + AgeRings + LngtClass + Country +
    Year, family = binomial, data = datF)

Deviance Residuals:
    Min       1Q   Median       3Q      Max
-3.2124   0.0000   0.0001   0.0460   1.6630

Coefficients:
             Estimate Std. Error z value Pr(>|z|)
AgeRings2    -20.2632     3.0307  -6.686 2.29e-11 ***
AgeRings3    -19.5358     3.1376  -6.226 4.77e-10 ***
```

```
AgeRings4    -19.0147     3.2788  -5.799 6.66e-09 ***
AgeRings5     -4.3123  1251.2284  -0.003   0.9973
AgeRings6     -4.9933  1676.6607  -0.003   0.9976
AgeRings7     -5.5747  1961.8283  -0.003   0.9977
AgeRings8     -6.6249  2186.1489  -0.003   0.9976
AgeRings9     -7.2460  2741.3941  -0.003   0.9979
AgeRings10    -7.0510  1620.1422  -0.004   0.9965
LngtClass      0.9144     0.1268   7.209 5.62e-13 ***
CountryFRA     1.1747     0.7128   1.648   0.0994 .
CountryIBTS   -0.7614     1.0241  -0.743   0.4572
CountryUK     -0.8178     0.5857  -1.396   0.1626
Year2013       0.9159     0.5383   1.702   0.0888 .
Year2014      -0.4674     0.3818  -1.224   0.2209
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

(Dispersion parameter for binomial family taken to be 1)

    Null deviance: 6023.45  on 4345  degrees of freedom
Residual deviance:  299.79  on 4330  degrees of freedom
AIC: 329.79

Number of Fisher Scoring iterations: 21
```

The coefficients for ‘country’ were plotted (Figure 25):

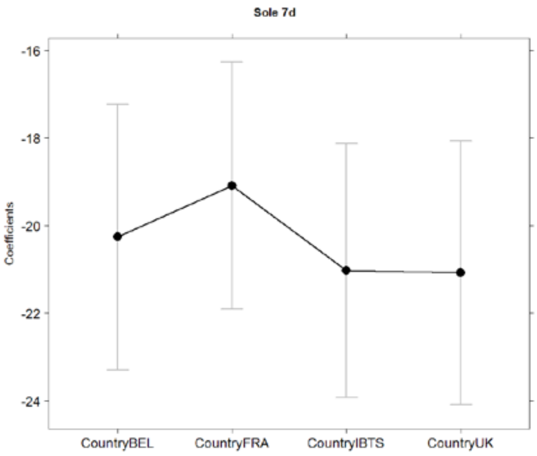


Figure 25 Estimated country coefficients from the model

The significance of the covariate ‘country’ was tested:

```
> drop1(fit1e, test="Chisq")
Single term deletions

Model:
Maturity1 ~ -1 + Country + AgeRings + LngtClass + Year
          Df Deviance    AIC    LRT Pr(>Chi)
<none>         299.79 329.79
Country    4   398.09 420.09 98.299  < 2e-16 ***
AgeRings   8   306.97 320.97  7.184  0.51689
LngtClass  1   386.56 414.56 86.768  < 2e-16 ***
Year       2   307.03 333.03  7.241  0.02677 *
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1
```

The model excluding ‘country’ as covariate is listed below, showing a higher AIC.

```
> fit1 <- glm(Maturity1 ~ -1 + AgeRings + LngtClass + Year, family=binomial
, data=datF)
```

```
> summary(fit1)

Call:
glm(formula = Maturity1 ~ -1 + AgeRings + LngtClass + Year, family = binomi
al,
    data = datF)

Deviance Residuals:
     Min        1Q    Median        3Q       Max
-3.05787   0.00000   0.00007   0.06304   1.82441

Coefficients:
            Estimate Std. Error z value Pr(>|z|)
AgeRings2   -16.4322     2.3091  -7.116 1.11e-12 ***
AgeRings3   -15.7770     2.4416  -6.462 1.04e-10 ***
AgeRings4   -14.9049     2.5821  -5.772 7.81e-09 ***
AgeRings5     0.2049  1330.7367   0.000    1.000
AgeRings6    -0.4233  1817.4837   0.000    1.000
AgeRings7    -1.2919  2216.1186  -0.001    1.000
AgeRings8    -2.0794  2367.9905  -0.001    0.999
AgeRings9    -2.4101  3009.6440  -0.001    0.999
AgeRings10   -3.0056  1827.2731  -0.002    0.999
LngtClass     0.7489     0.1002   7.476 7.67e-14 ***
Year2013      0.9048     0.5047   1.793    0.073 .
Year2014     -0.6494     0.3622  -1.793    0.073 .
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

(Dispersion parameter for binomial family taken to be 1)

    Null deviance: 6023.45  on 4345  degrees of freedom
Residual deviance:  322.64  on 4333  degrees of freedom
AIC: 346.64

Number of Fisher Scoring iterations: 21
```

For the females, the country factor showed a statistically significant effect and should be retained in the model.

b) Males (2012 and 2014)

The raw data are presented in Figure 26.

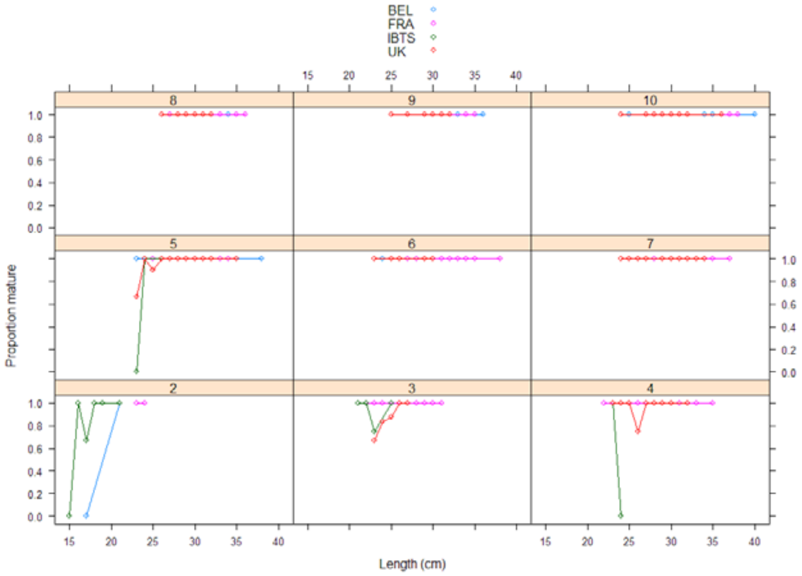


Figure 26 Maturity ogive from raw data for 2012 and 2014 (males)

The model and its output are listed below.

```
> fit1e <- glm(Maturity1 ~ -1 + AgeRings + LngtClass + Country + Year, fami
ly=binomial, data=datM1214)
> summary(fit1e)

Call:
glm(formula = Maturity1 ~ -1 + AgeRings + LngtClass + Country + 
    Year, family = binomial, data = datM1214)

Deviance Residuals: 
     Min        1Q    Median        3Q       Max  
-3.10878   0.00000   0.00003   0.09094   1.25624  

Coefficients:
             Estimate Std. Error z value Pr(>|z|)  
AgeRings2     -7.5450     4.5005  -1.676   0.0936 .
AgeRings3    -10.1607     5.7845  -1.757   0.0790 .
AgeRings4     -9.9776     6.0201  -1.657   0.0974 .
AgeRings5    -10.4193     6.0534  -1.721   0.0852 .
AgeRings6      7.0375  3778.8027   0.002   0.9985  
AgeRings7      7.4456  4414.4564   0.002   0.9987  
AgeRings8      5.8759  6031.1675   0.001   0.9992  
AgeRings9      6.8000  7586.7911   0.001   0.9993  
AgeRings10     6.7238  5422.4907   0.001   0.9990  
LngtClass      0.6097     0.2446   2.493   0.0127 *
CountryFRA    17.0068  2177.7810   0.008   0.9938  
CountryIBTS   -2.3943     1.0005  -2.393   0.0167 *
CountryUK     -2.1232     0.8829  -2.405   0.0162 *
Year2014      -0.5575     0.6676  -0.835   0.4037  
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

(Dispersion parameter for binomial family taken to be 1)

    Null deviance: 1143.693  on 825  degrees of freedom
Residual deviance:   87.972  on 811  degrees of freedom
AIC: 115.97

Number of Fisher Scoring iterations: 21
```

The coefficients for country were plotted (Figure 27):

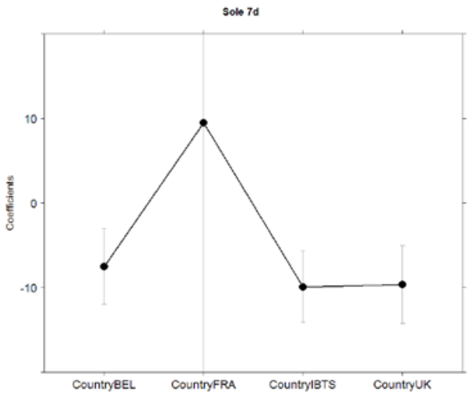


Figure 27 Estimated country coefficients from the model

The significance of the covariate ‘country’ was tested:

```
> drop1(fit1e, test="Chisq")
Single term deletions

Model:
Maturity1 ~ -1 + Country + AgeRings + LngtClass + Year
```

```
          Df Deviance    AIC    LRT  Pr(>Chi)
<none>         87.972 115.97
Country    4  120.319 140.32 32.347 1.625e-06 ***
AgeRings   8   95.403 107.40  7.431  0.490892
LngtClass  1   96.138 122.14  8.166  0.004268 **
Year       1   88.682 114.68  0.710  0.399318
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1
```

The model excluding ‘country’ as covariate is listed below, showing a higher AIC.

```
> fit1 <- glm(Maturity1 ~ -1 + AgeRings + LngtClass + Year, family=binomial
, data=datM1214)
> summary(fit1)

Call:
glm(formula = Maturity1 ~ -1 + AgeRings + LngtClass + Year, family = binomi
al,
    data = datM1214)

Deviance Residuals:
    Min       1Q   Median       3Q      Max
-3.1740   0.0000   0.0661   0.1929   1.2398

Coefficients:
            Estimate Std. Error z value Pr(>|z|)
AgeRings2   -11.6077     3.5541  -3.266 0.001091 **
AgeRings3   -13.9643     4.8025  -2.908 0.003641 **
AgeRings4   -13.5953     5.0448  -2.695 0.007041 **
AgeRings5   -15.1019     5.1101  -2.955 0.003124 **
AgeRings6     1.6137  2590.6924   0.001 0.999503
AgeRings7     1.7940  2846.6078   0.001 0.999497
AgeRings8     0.8215  3982.3660   0.000 0.999835
AgeRings9     0.3713  5060.8994   0.000 0.999941
AgeRings10    0.6839  3359.5821   0.000 0.999838
LngtClass     0.7164     0.2035   3.520 0.000432 ***
Year2014      0.3769     0.6002   0.628 0.529945
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

(Dispersion parameter for binomial family taken to be 1)

    Null deviance: 1143.69  on 825  degrees of freedom
Residual deviance:  106.54  on 814  degrees of freedom
AIC: 128.54

Number of Fisher Scoring iterations: 20
```

For the males, the country factor showed a statistically significant effect and should be retained in the model.

Working document 5: Assessment models for Sole (*Solea solea* L.) in the Eastern English Channel (ICES division VIId)

Sofie Nimmegeers, Bart Vanelslander, Marie Savina-Roland, Jan Jaap Poos, Jennifer Devine, Casper Berg, Lies Vansteenbrugge and others

1. Introduction

Three different assessment models were tested during the benchmark: XSA, AAP and SAM. Especially the XSA model, which was also the model used for the 2016 assessment, was extensively investigated. For the SAM and AAP model, only exploratory runs were conducted.

2. XSA

2016 WGNSSK-current assessment (baserun)

Data

Landings

The landings have steadily increased over the ‘70s – ‘90s, fluctuated around an average of 4815 t (range: 3832 t – 6247 t) in 2000–2014, and dropped to 3372 t in 2015. Over the last ca. 30 years, the contribution to the landings of the three main countries involved in this fishery has remained rather stable over time (~50% France, ~30% Belgium and ~20% UK).

Discards

At the WGNSSK 2015, raising of discards through InterCatch for the years 2012–2014 was done for the first time. Discard rates (based on weight data) were evaluated as reliable for Belgium, France and the UK in 2012–2015. The different métiers contributing to the fishery were not well covered for the years 2012 and 2013 (mainly for France and UK), so only the 2014 discard rate (all main métiers sampled by all countries) was used for topping up the landings advice to catch advice in 2015. Because of sufficient coverage in 2014 and 2015, the average discard rate 2014–2015 was used for the same purpose during WGNSSK 2016 (overall discard rate of 9,25%).

Catch numbers-at-age and weights-at-age in the catch

From 2011 onwards, the total international landings numbers at age and the mean landing weights at age were exported from InterCatch. The weighting algorithm for ‘Mean weight weighted by numbers at age or length‘ was applied.

Biological parameters

Natural mortality

Natural mortality is assumed constant over ages and years at 0.1.

Maturity

The maturity ogive used is knife-edged with sole regarded as fully mature at age 3 onwards (similar to the North Sea sole stock).

Weight-at-age

Prior to the 2001 WG, stock weights were calculated from a smoothed curve of the catch weights interpolated to the 1st of January. Since the 2002 WG, second quarter catch weights were used as stock weights in order to be consistent with the North Sea sole stock.

Proportion mortality before spawning

Both the proportion of natural mortality before spawning (Mprop) and the proportion of fishing mortality before spawning (Fprop) are set to 0.

Tuning series

Two commercial (both beam trawl: BE_CBT and UK(E&W)_CBT) and three survey (UK(E&W)_BTS_Q3, UK(E&W)_YFS, FR_YFS) data series are used for the calibration of the assessment of 7.d sole. The UK survey component of the Young fish survey (YFS) was last conducted in 2006.

XSA diagnostics

	2016 ASSESSMENT		
Fleets	Years	Ages	α-β
BE_CBT_1986_2015 commercial	86–15	2–10	0–1
UK(E&W)_CBT commercial	86–15	2–10	0–1
UK(E&W)_BTS survey	89–15	1–6	0.5–0.75
UK_YFS survey	87–06	1–1	0.5–0.75
FR_YFS survey	87–15	1–1	0.5–0.75
-First data year	1982		
-Last data year	2015		
-First age	1		
-Last age	11+		
-Time series weights	None		
-Model	No Power model		
-Q plateau set at age	7		
-Survivors estimates shrunk towards mean F	5 years / 5 ages		
-s.e. of the means	2.0		
-Min s.e. for pop. Estimates	0.3		
-Prior weighting	None		

Figures 2.1-2.13 present the model output for this baserun (WGNSSK 2016 – current assessment).

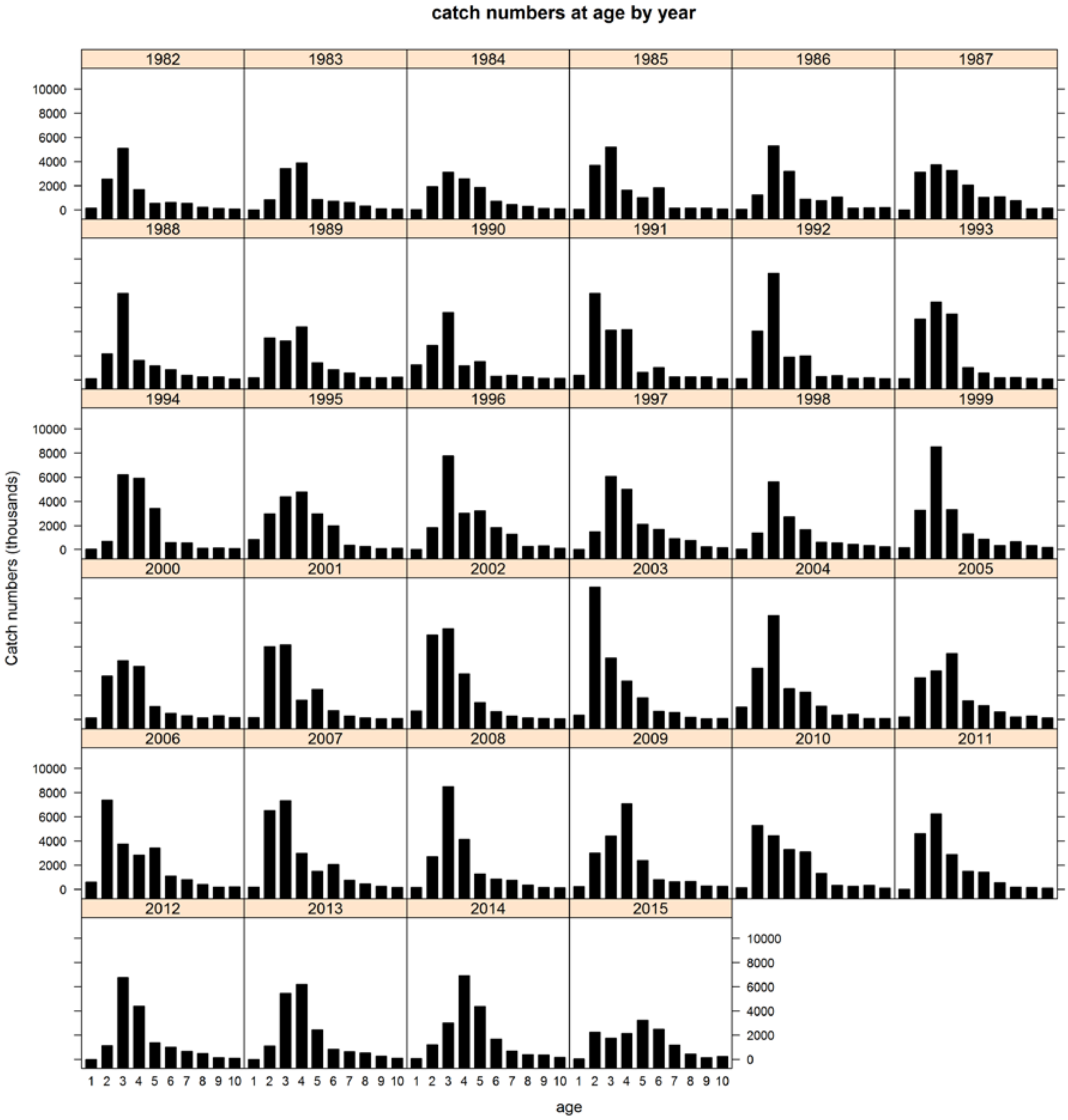


Figure 2.1. Catch numbers (landings only) at age for 7.d sole.

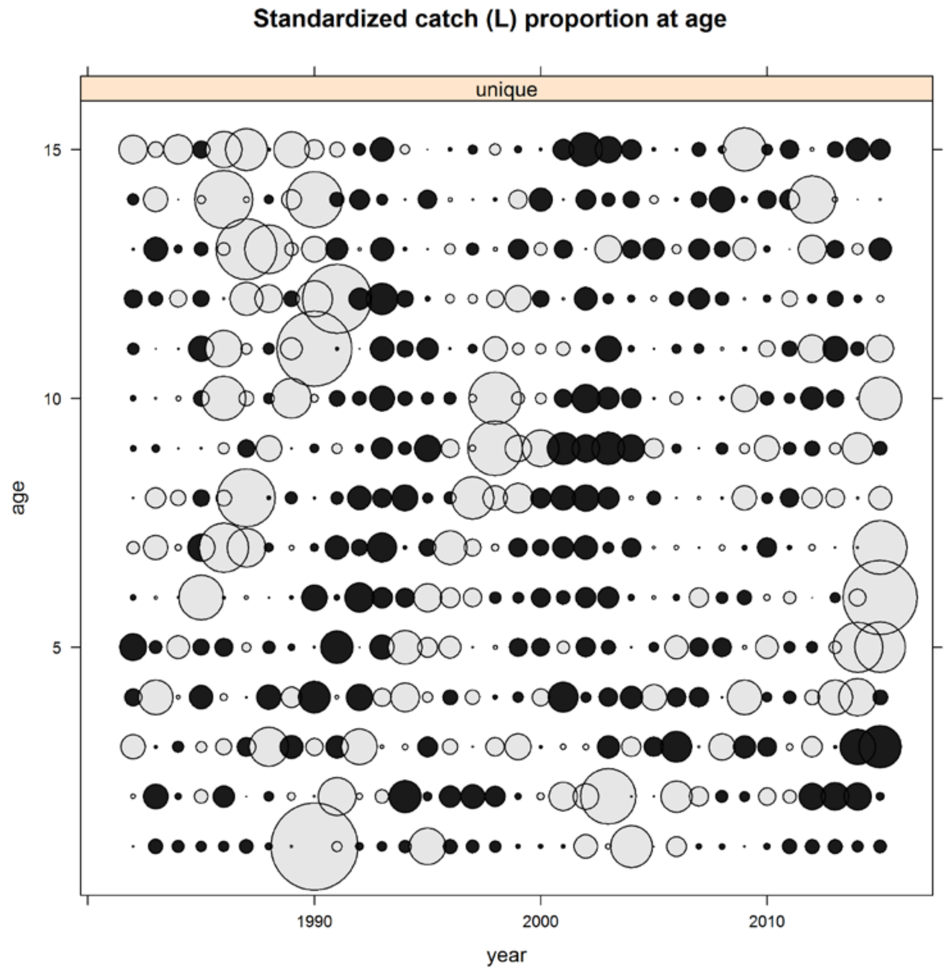


Figure 2.2. Standardized catch (landings only) proportions at age for 7.d sole.

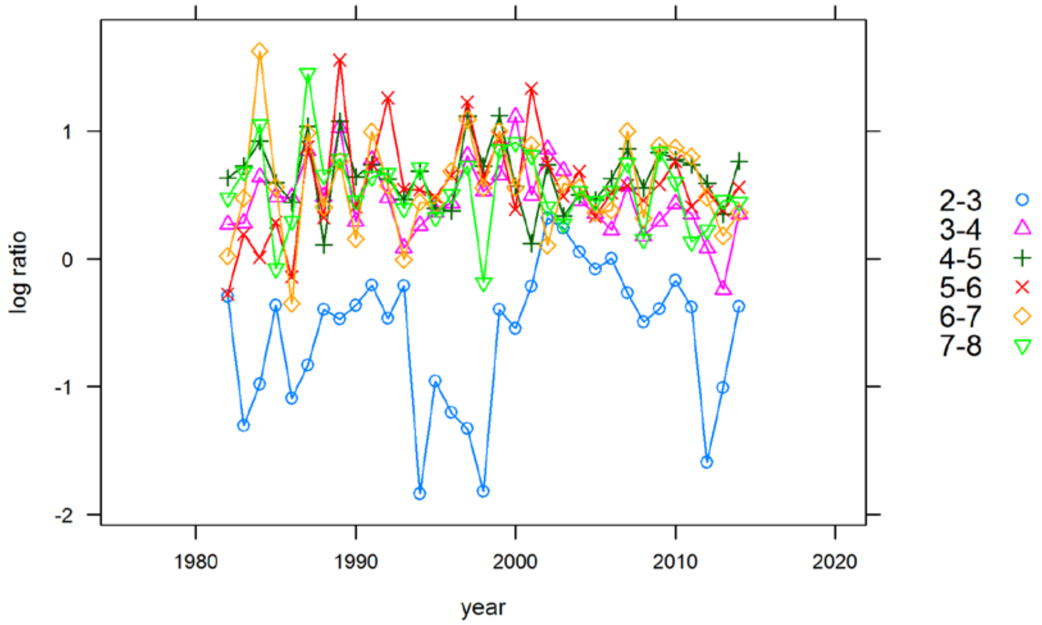


Figure 2.3. Log ratio of the catch (landings only) numbers at age for 7.d sole.

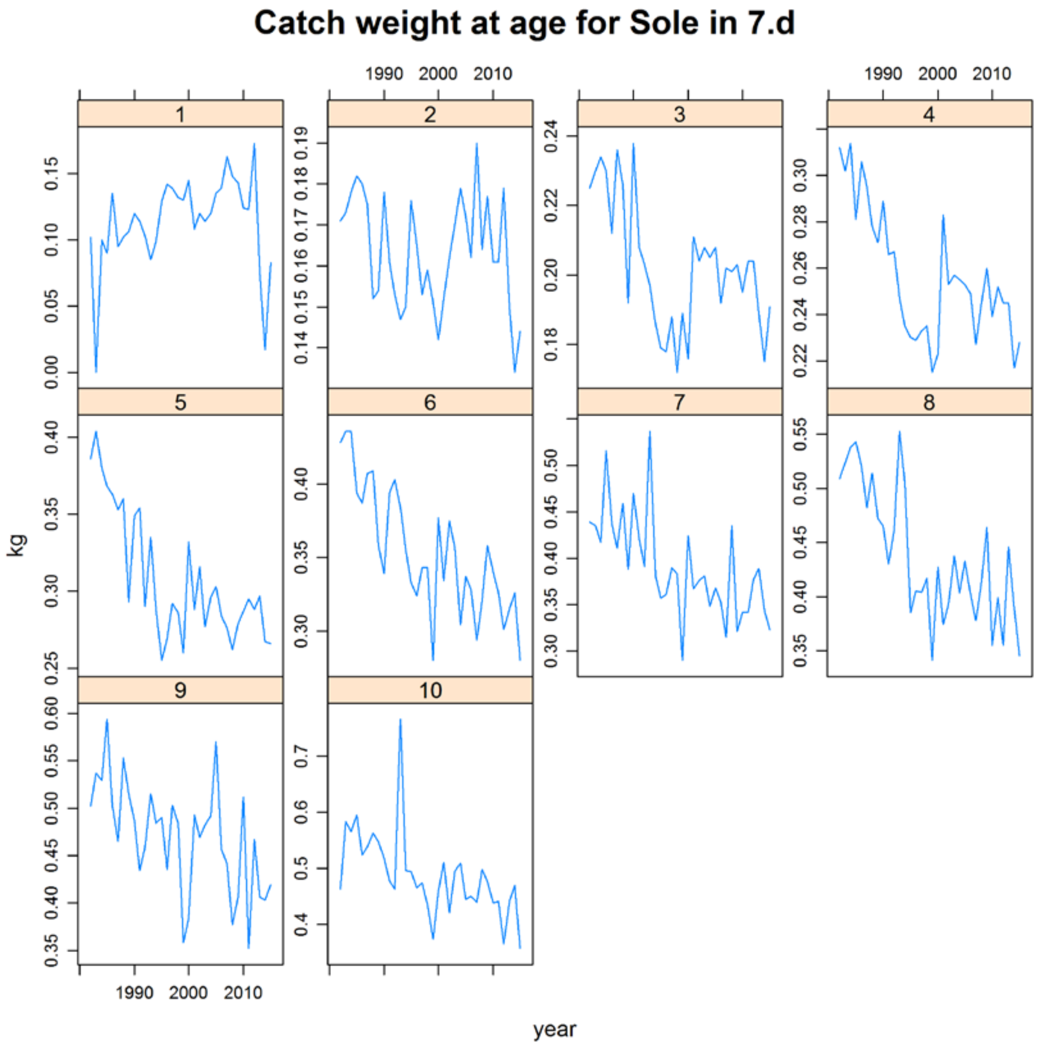


Figure 2.4. Catch (landings only) weights at age for 7.d sole.

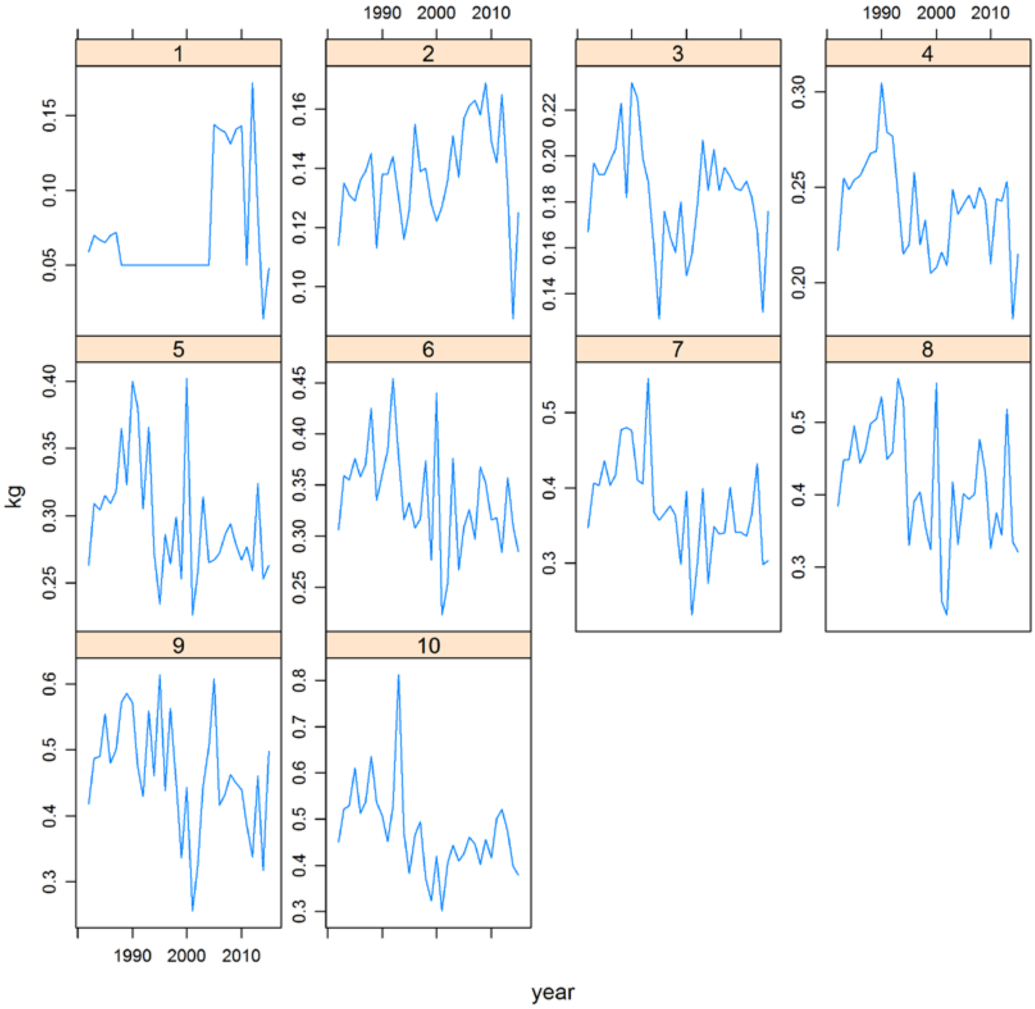


Figure 2.5. Stock weights at age for 7.d sole.

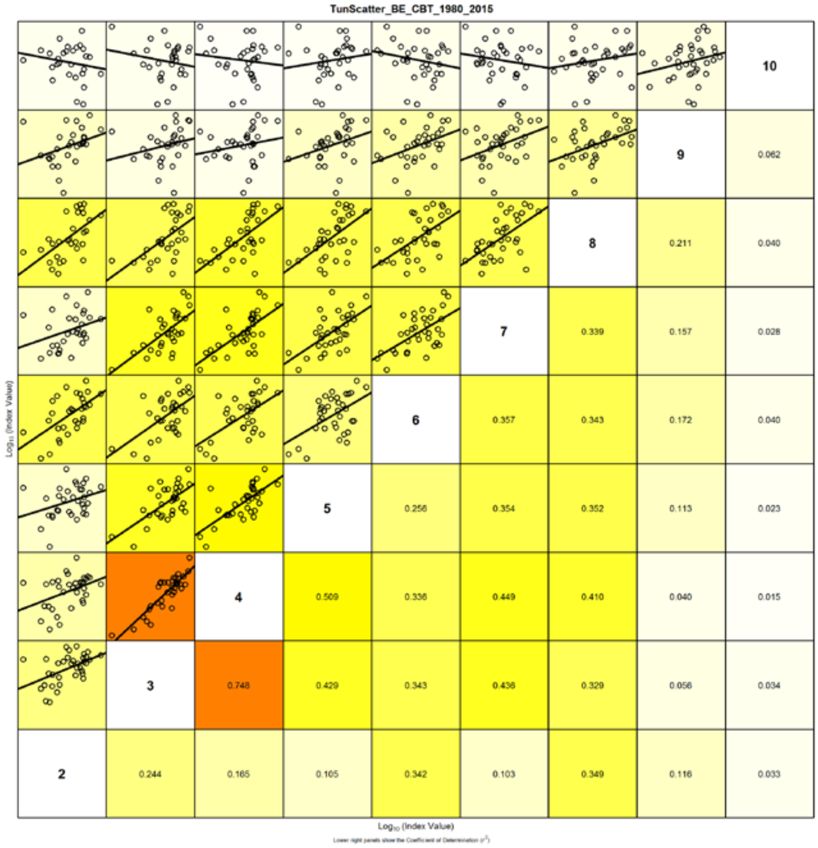


Figure 2.6. Internal consistency plot of the BE_CBT_1980-2015 tuning series for 7.d sole.

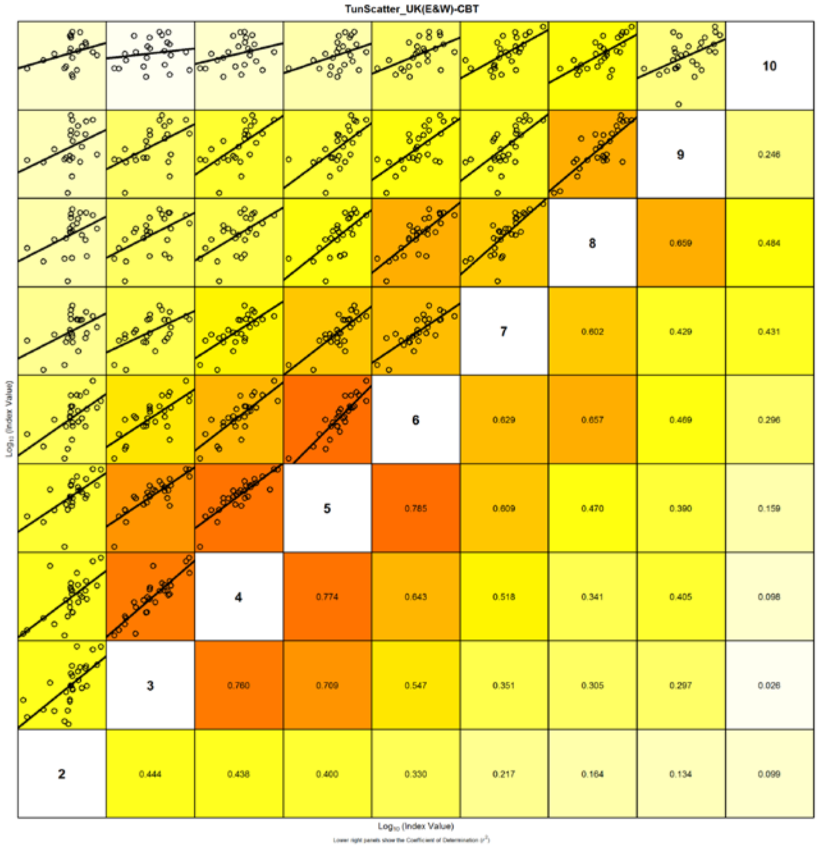


Figure 2.7. Internal consistency plot of the UK(E&W)_CBT tuning series for 7.d sole.

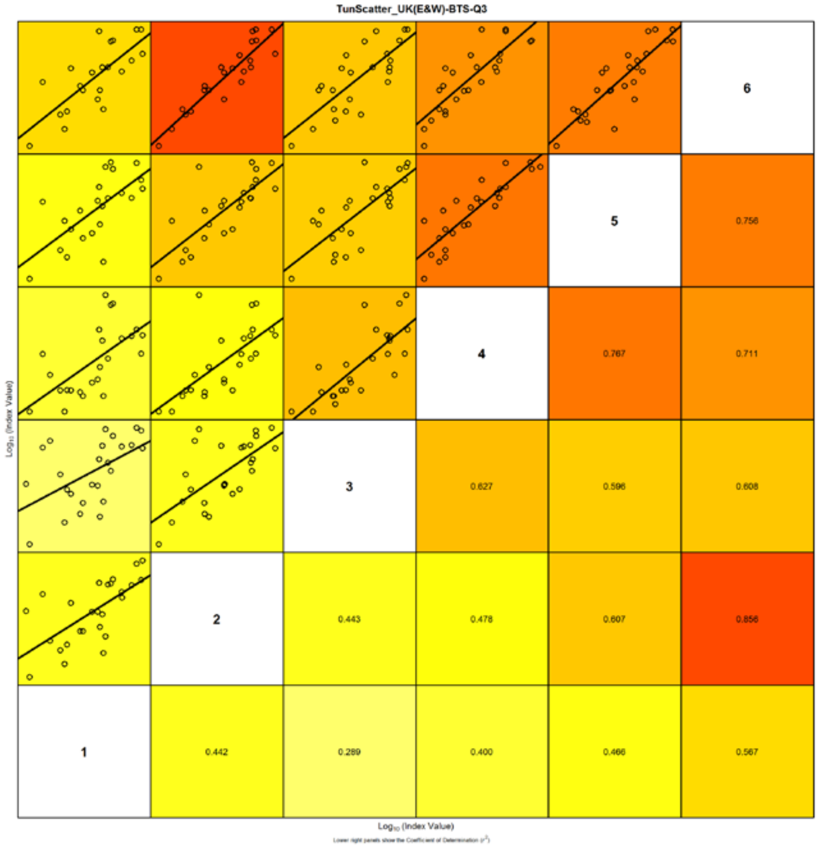


Figure 2.8. Internal consistency plot of the UK(E&W)_BTS_Q3 tuning series for 7.d sole.

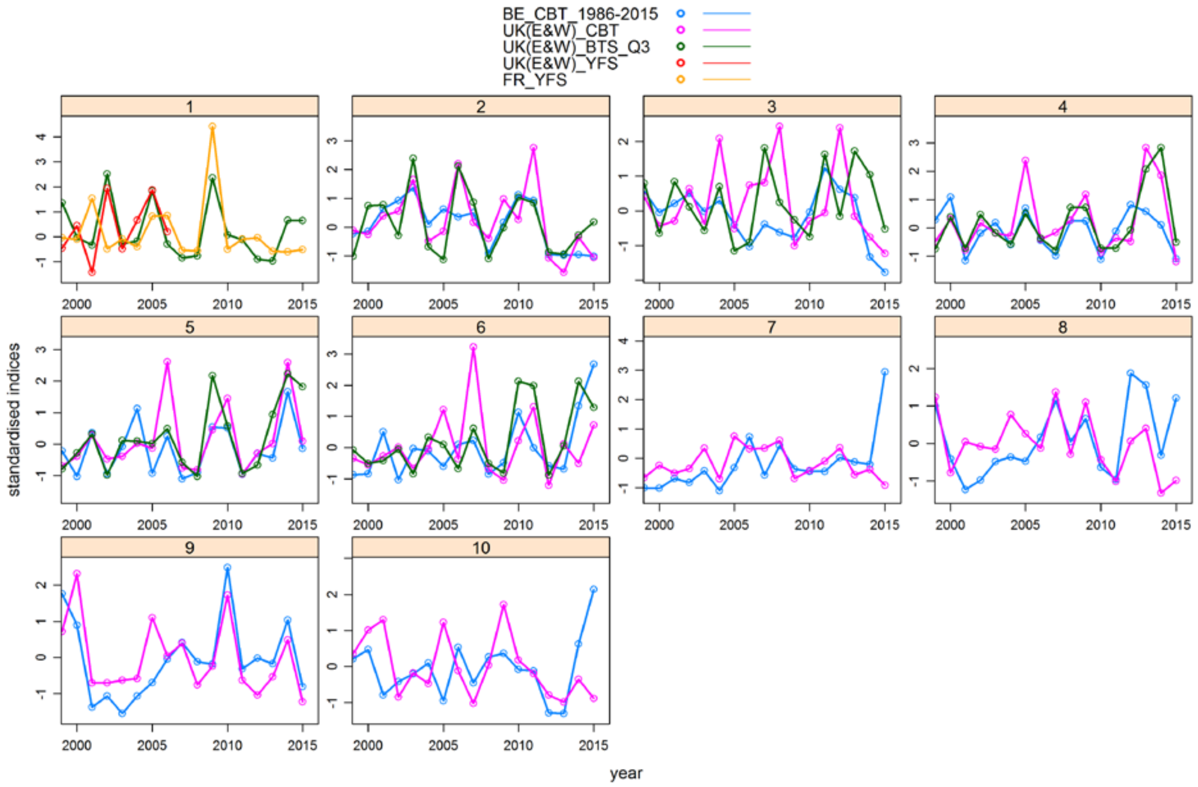


Figure 2.9. Standardized indices by age of the tuning series for 7.d sole 2016 assessment.

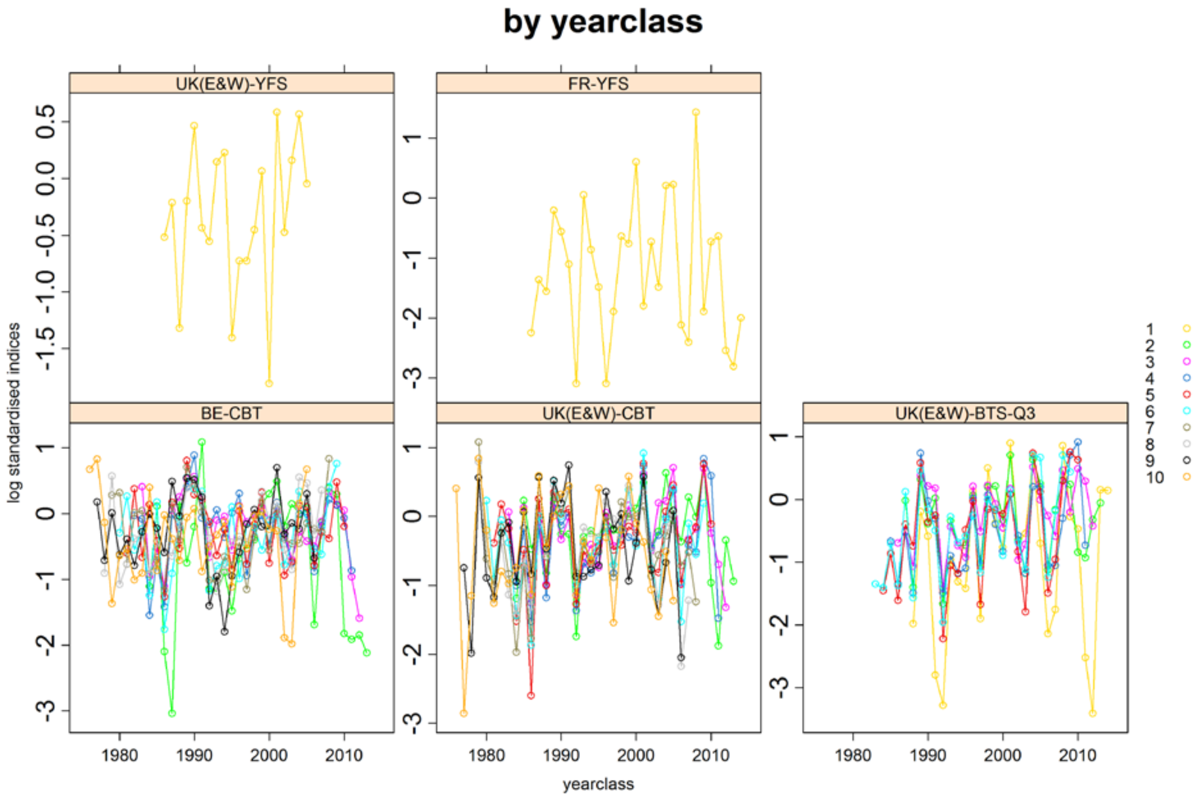


Figure 2.10. Log standardized indices by age of the tuning series for 7.d sole 2016 assessment

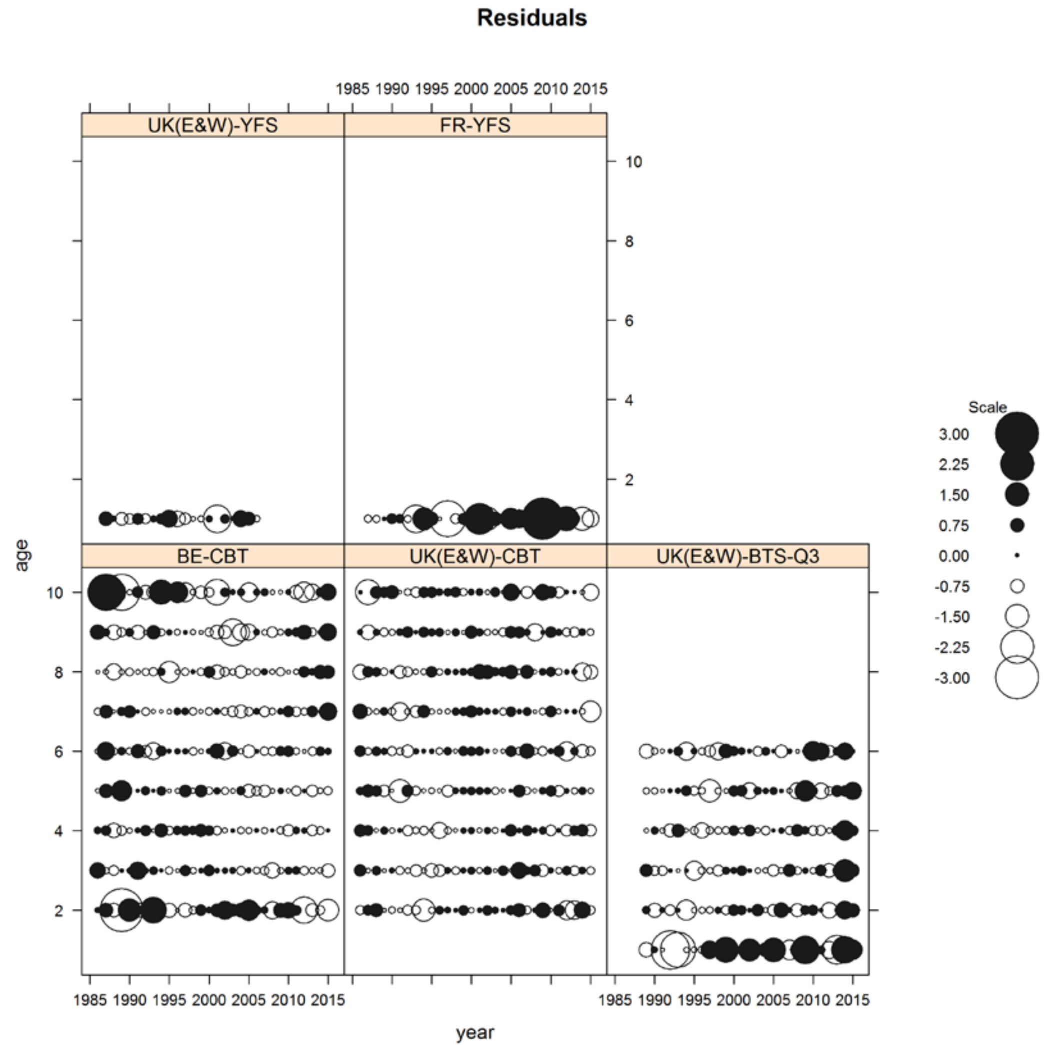


Figure 2.11. Catchability residuals for all tuning fleets used in the assessment of 7.d sole.

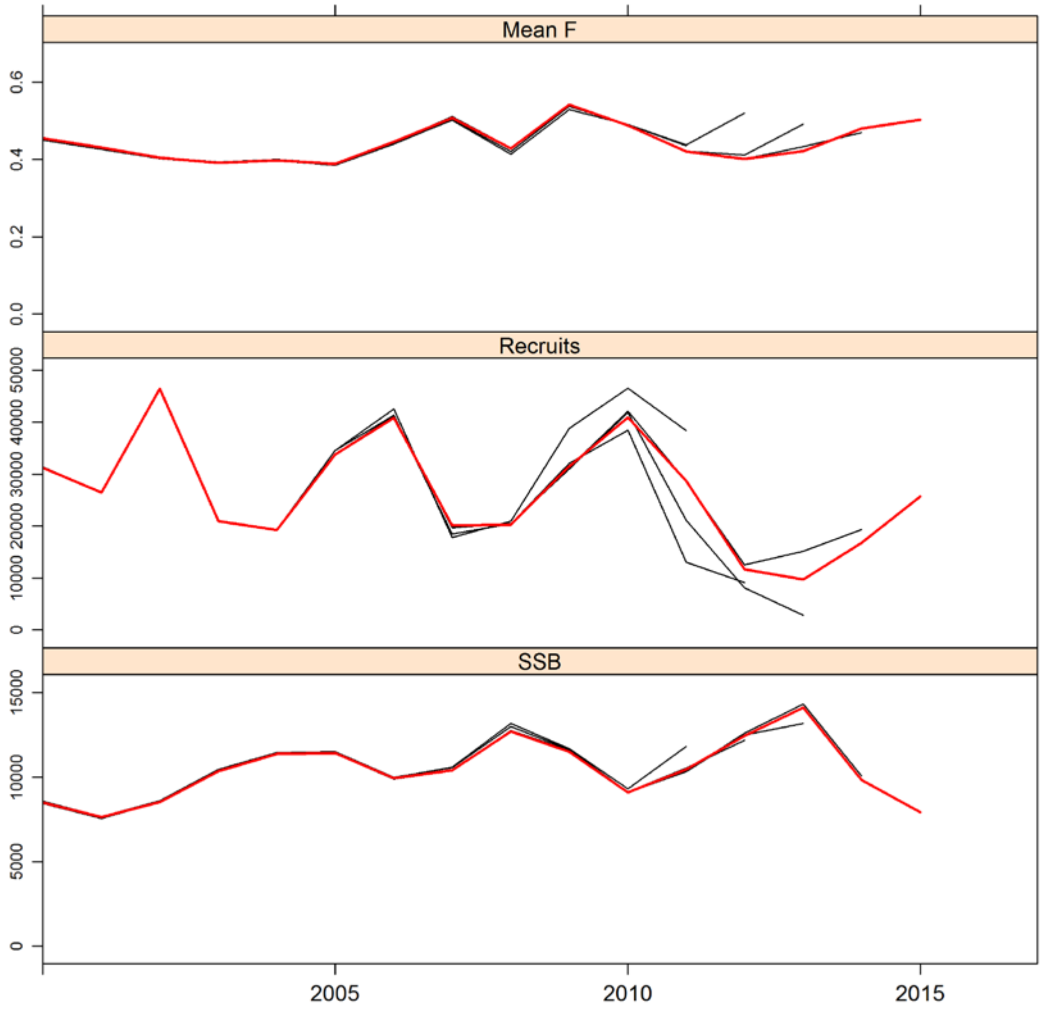


Figure 2.12. Retrospective pattern.

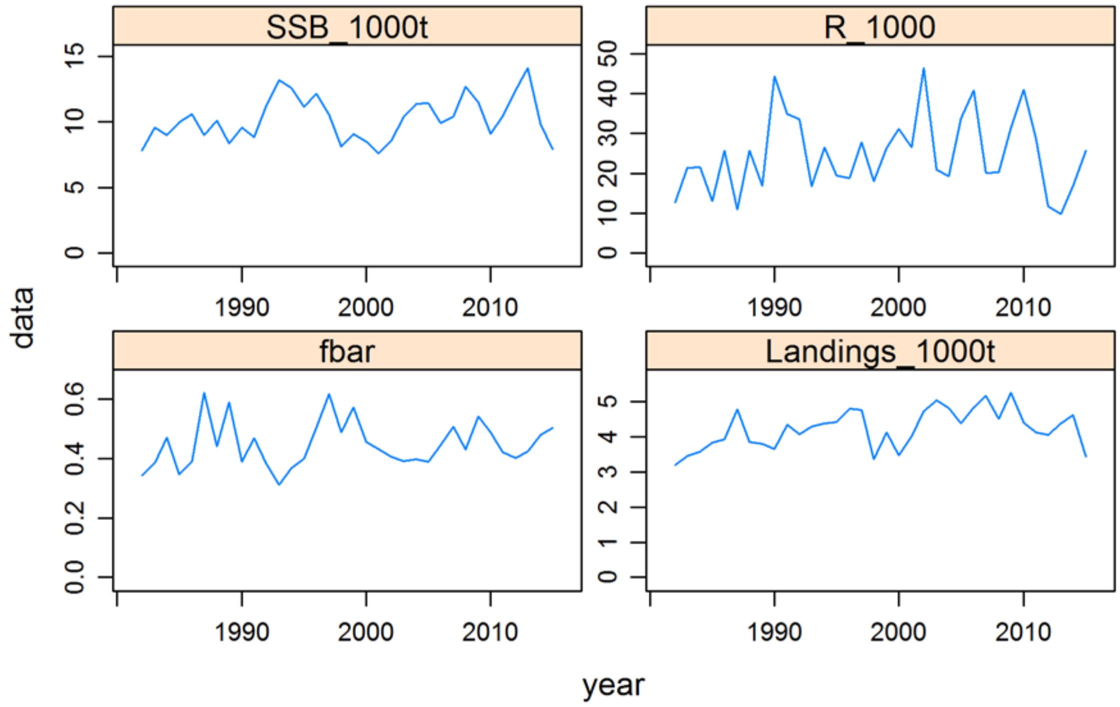


Figure 2.13. Assessment summary.

2017 WKNSEA-RUN1

Data

Data submitters from each nation were tasked to upload data for 2003-2015 in InterCatch, disaggregated by quarter and métier (fleet). Belgium could not provide quarterly data for the TBB_DEF_70-99 métier, but uploaded data on a yearly basis.

More detailed information on the preparation of the catch data is provided in the working document.

Landings

The landings have steadily increased over the ‘70s – ‘90s, fluctuated around an average of 4167 t in 1986–2002. After the increase in 2003 (6977 t), the landings dropped to 3443 t in 2015. Over the last ca 30 years, the contribution to the landings of the three main countries involved in this fishery has remained rather stable over time (~50% France, ~30% Belgium and ~20% UK).

Discards

Discard estimates (total weight) for the years 2003-2010 have now been processed through InterCatch for the first time. It was decided to exclude the estimated discard volume for 2003, because the percentage of landings with associated discards was only 4% in that year. The discard volumes for the years prior to 2004 were derived from the estimated mean weights at age and the numbers at age for those years.

Catch numbers-at-age and weights-at-age in the catch

Although InterCatch was previously used to estimate the 2011-2015 landings mean weight- and number-at-age data, these years were re-calculated in InterCatch following the 2016 benchmark data call. The landings mean weight- and number-at-age data for the years 2003-2010 and discard mean weight- and number-at-age data for the years 2003-2015 have now been processed through InterCatch for the first time. Because in 2003 the percentage of landings with associated discards is only 4%, it was decided to exclude the estimated discard mean weight- and number-at-age for that year. To estimate discards mean weights- and numbers-at-age prior to 2004, a constant ratio of discards to landings by age was applied using data from 2004-2008 (Figure 2.18). Average discards (2004-2008) to average landings (2004-2008) ratios for discard mean weight- and number-at-age were:

	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9	Age 10	Age 11	Age 12	Age 13	Age 14	Age 15
Number	1.2868	0.2963	0.1256	0.0236	0.0057	0.0100	0.0026	0.0019	0	0	0	0	0	0	0
Weight	0.5761	0.6089	0.5476	0.5476	0.5918	0.5686	0.5952	0.6527	0.4707	0.3935	0.6833	0	0.6992	0.6824	0.8134

Biological parameters

Stock-weights-at-age

In the current assessment, the Belgian yearly data for the TBB_DEF_70-99 métier were not taken into account for the calculation of the quarter 2 catch weights in InterCatch. Belgium stated that it was not possible to provide a qualitative age distribution for TBB_DEF_70-99 for all quarters, because sampling in VIId is limited in some quarters. Although for the years 2006-2007 and 2012-2015, quarter 2 mean catch weights could be obtained and were used to calculate the stock weights.

Tuning series

Same set of tuning fleets as used in the WGNSSK2016 assessment (baserun)

XSA diagnostics

Same XSA diagnostics as applied in the WGNSSK2016 assessment (baserun)

Figures 2.14-2.23 present the model output for this first run.

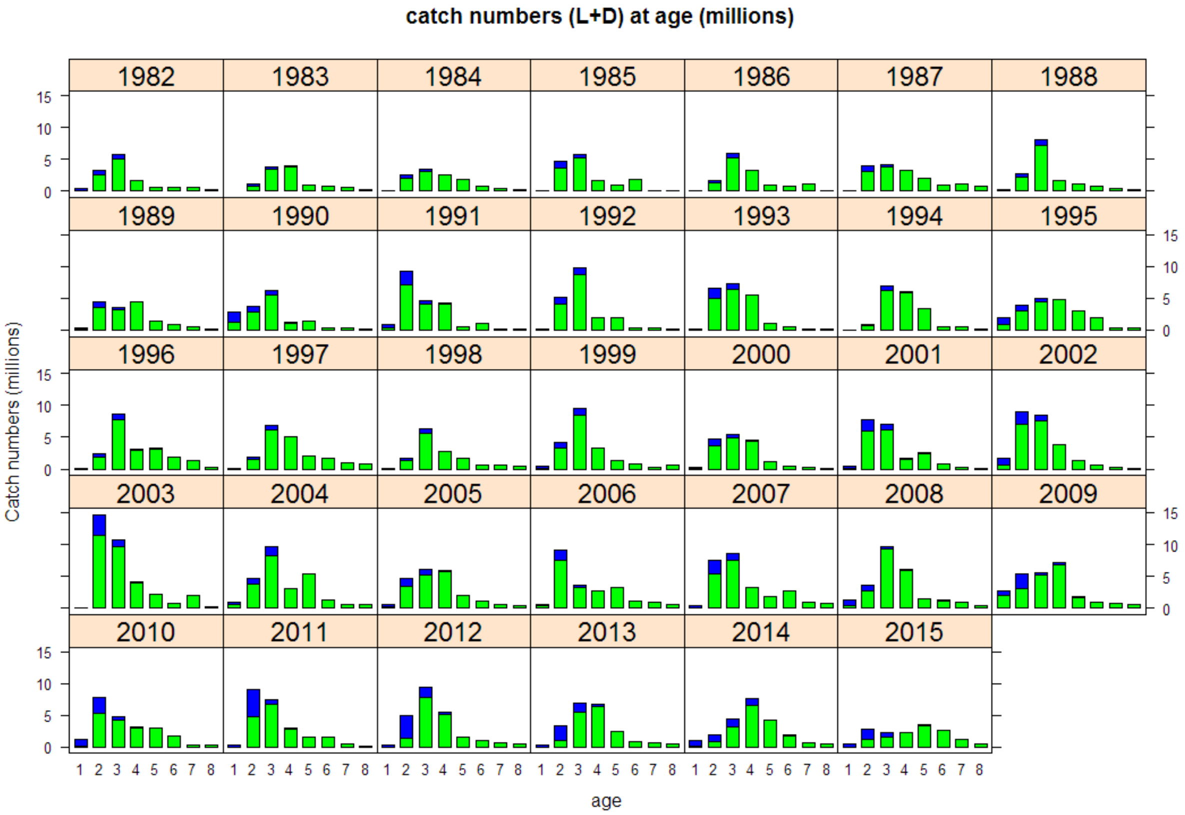


Figure 2.14. Catch numbers in millions (landings (green) and discards (blue)) at age for 7.d sole.

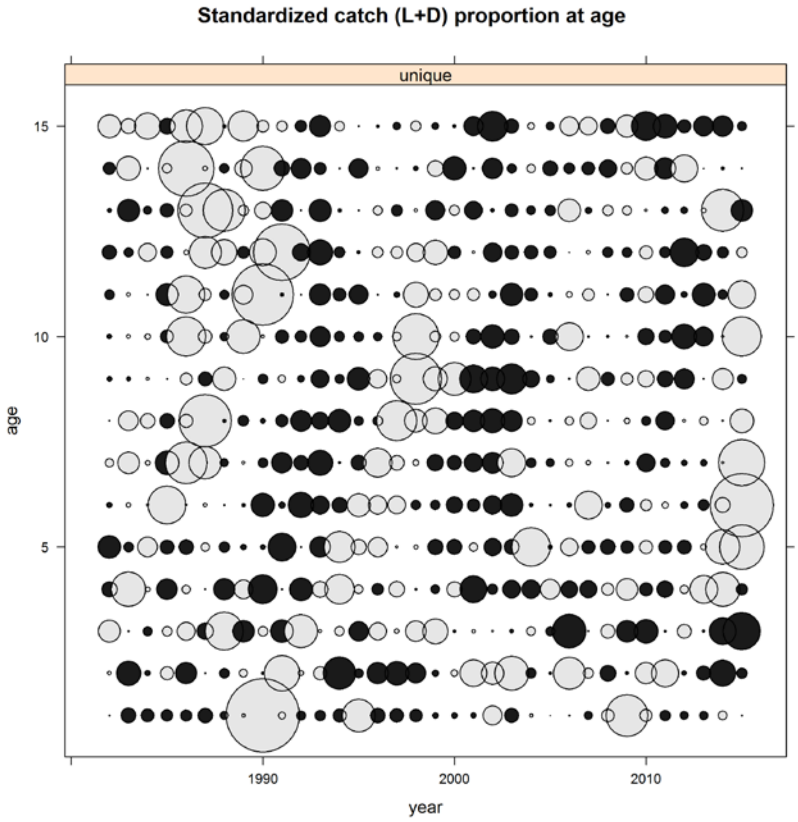


Figure 2.15. Standardized catch proportions at age for 7.d sole.

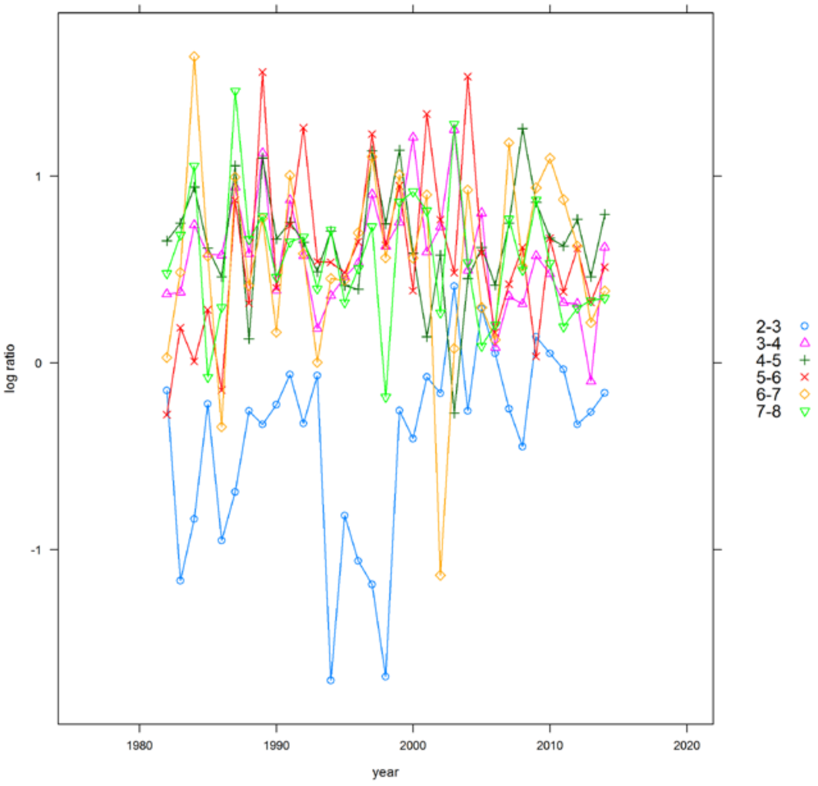


Figure 2.16. Log ratio of the catch numbers at age for 7.d sole.

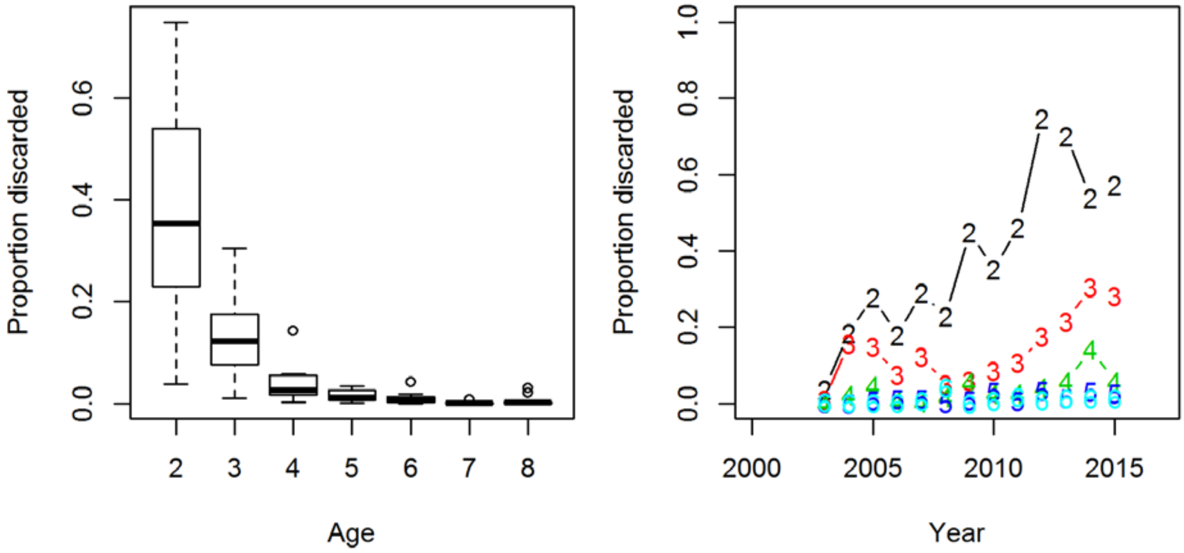


Figure 2.17. Proportion discarded (discard numbers/catch numbers) at age for 7.d sole from 2003-2015.

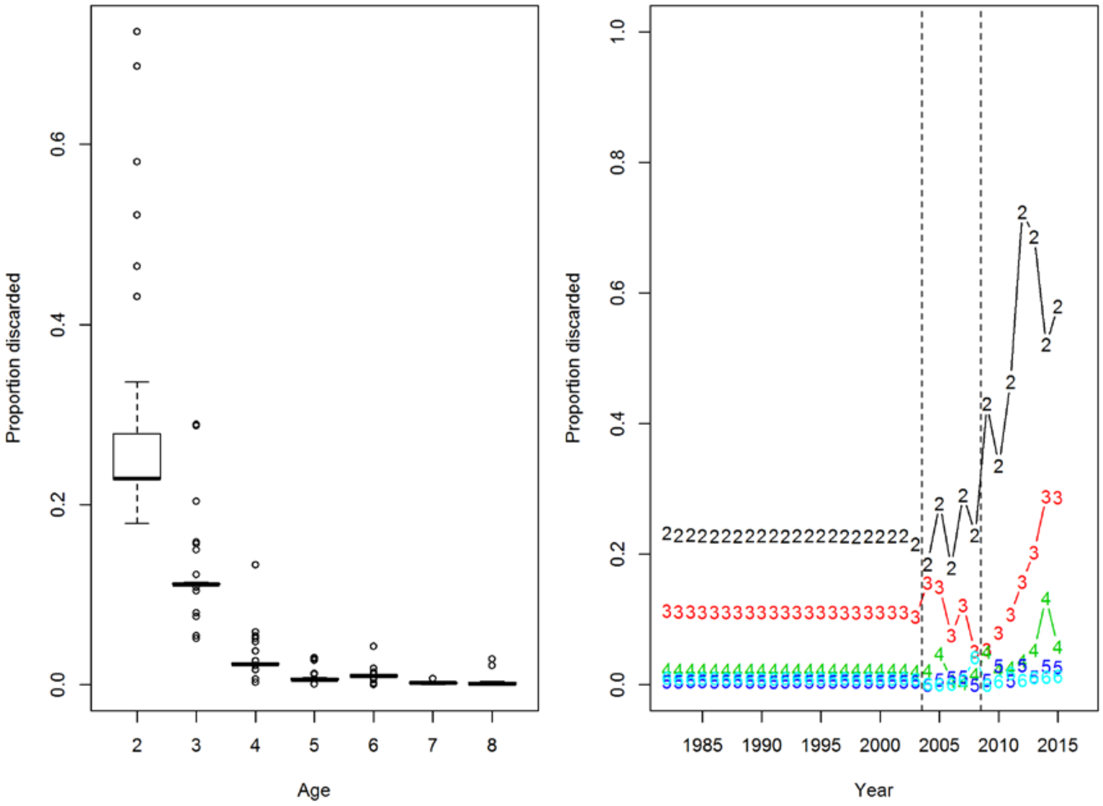


Figure 2.18. Proportion discarded (discard numbers/catch numbers) (data before 2004 are estimated based on an average ratio from 2004-2008 (indicated by dotted lines)) at age for 7.d sole.

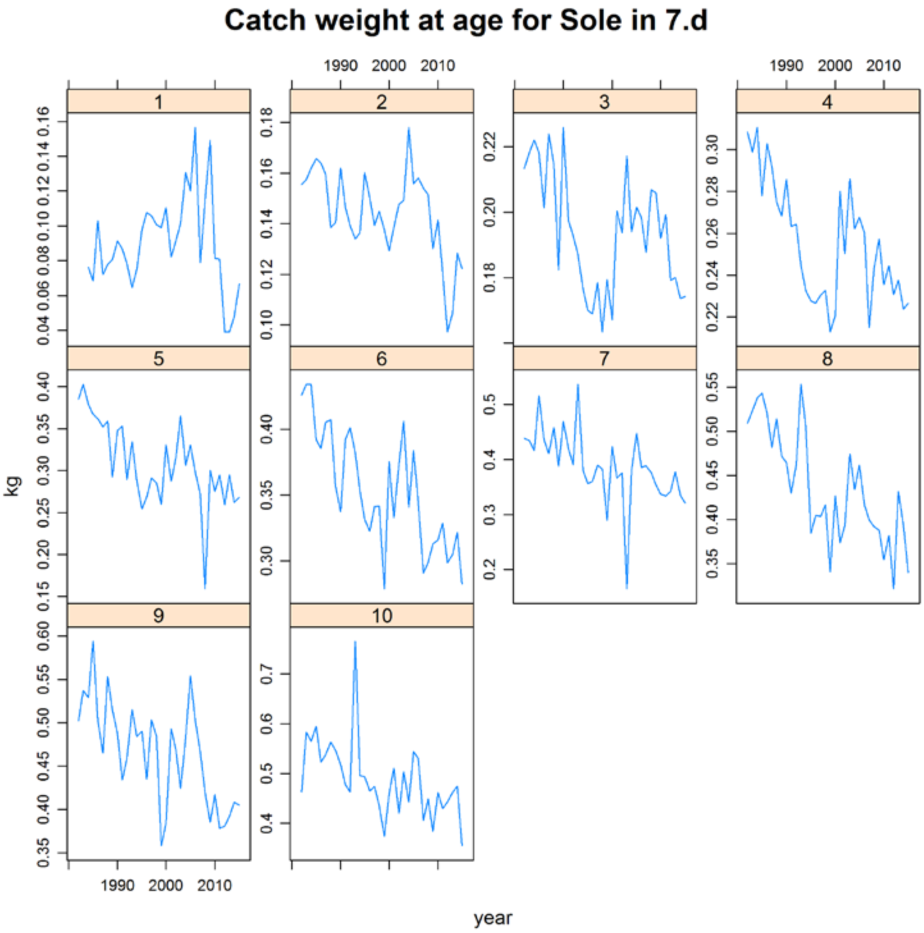


Figure 2.19. Catch weights at age for 7.d sole.

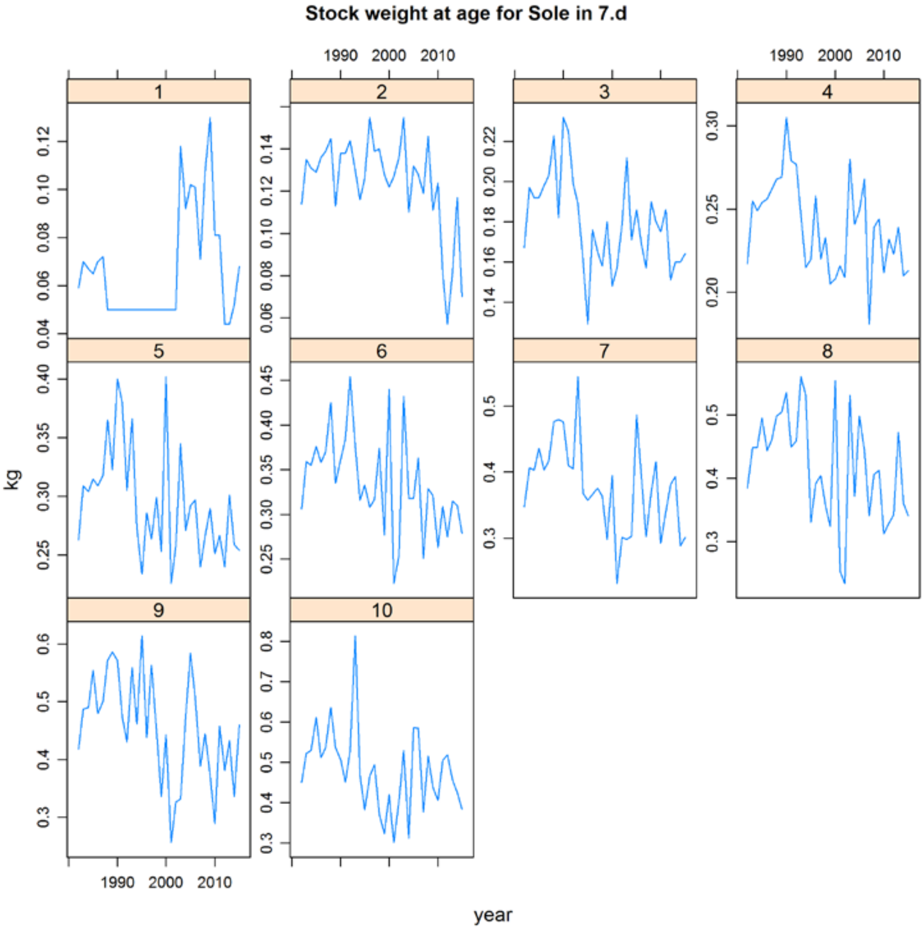


Figure 2.20. Stock weights at age for 7.d sole.

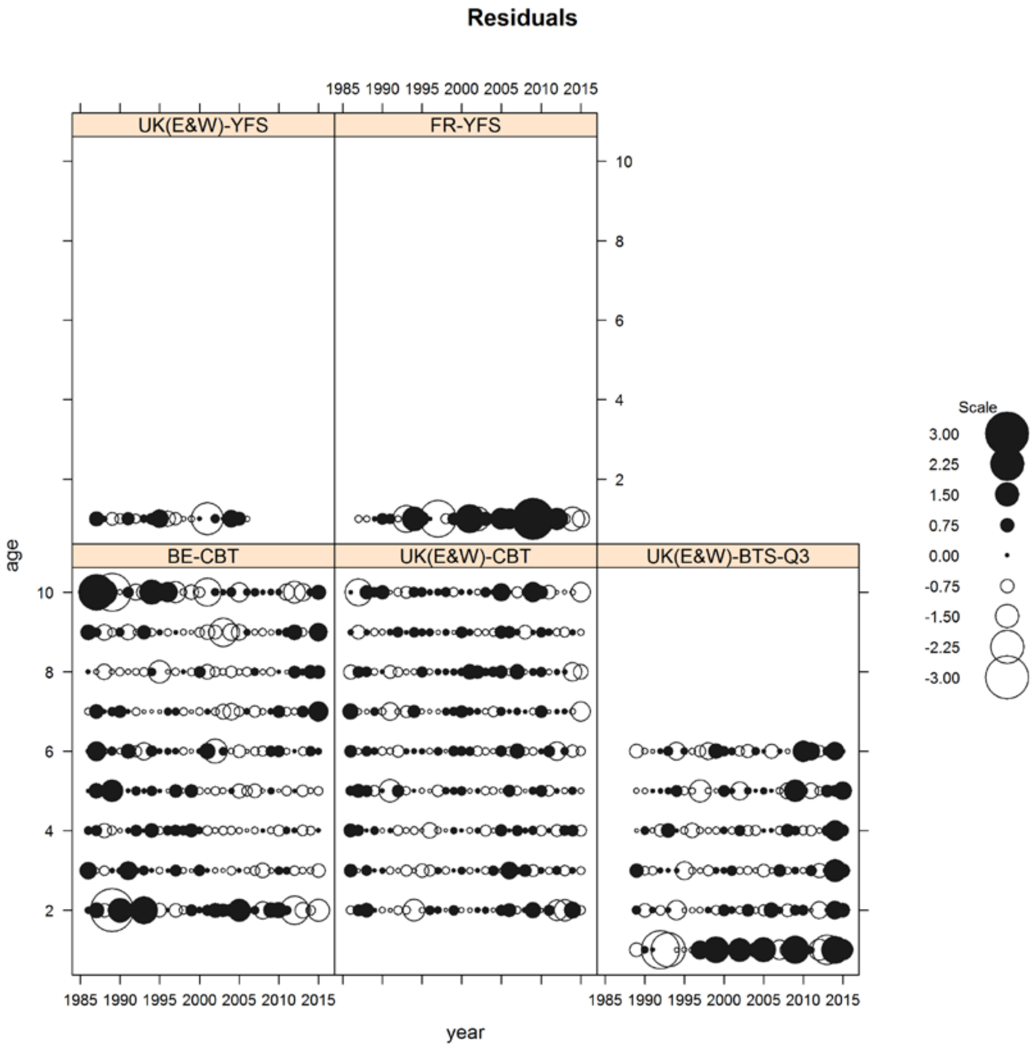


Figure 2.21. Catchability residuals for all tuning fleets used in the assessment of 7.d sole run 1.

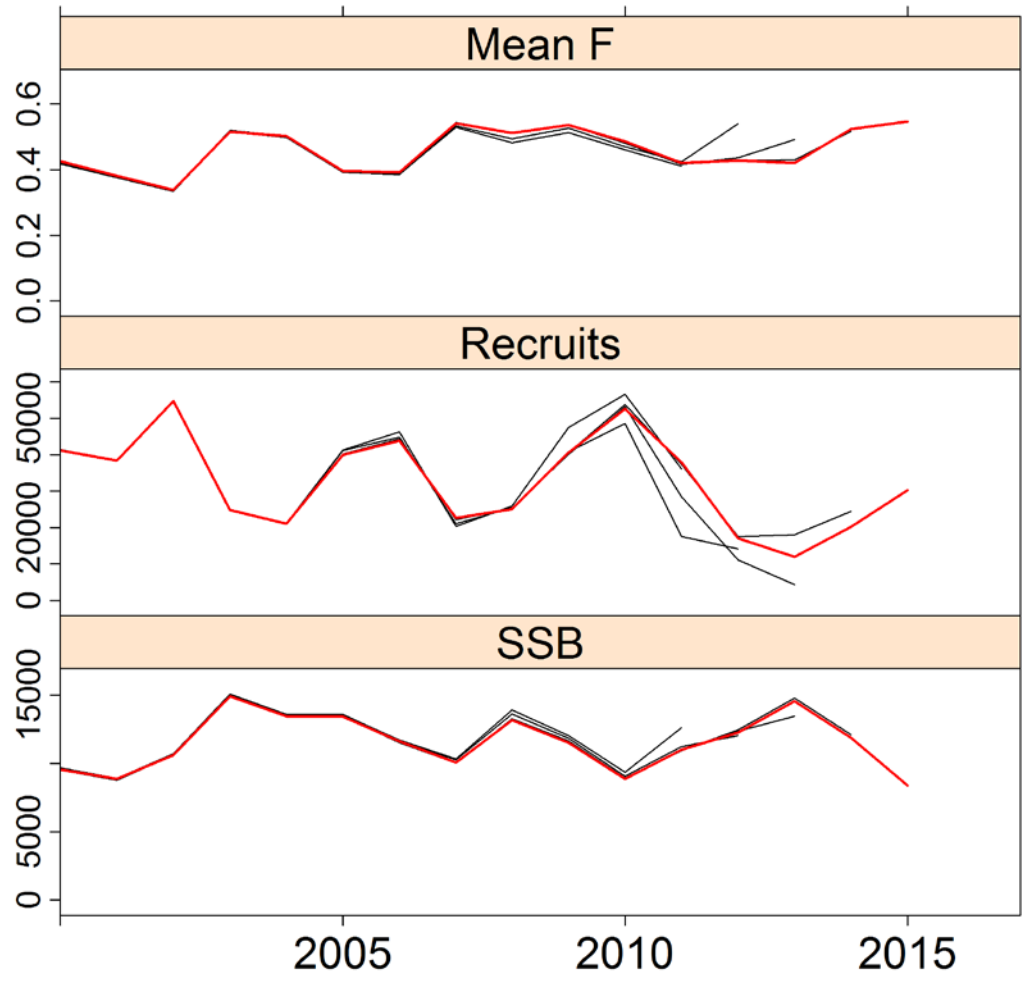


Figure 2.22. Retrospective pattern.

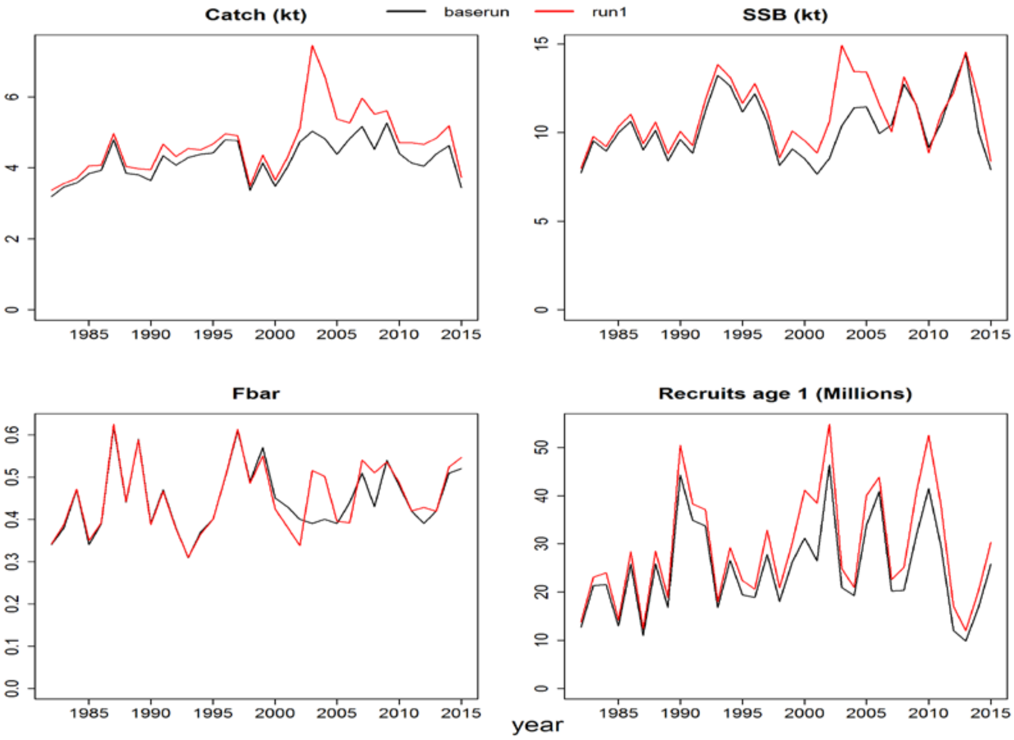


Figure 2.23. Comparison of the summary plots between the 2016 WGNSSK assessment (baserun) and the 2017 WKNSEA run1.

Differences between the baserun and run 1 can be observed for all four parameters (Figure 2.23). The catch, SSB and R curves of run 1 show an upward shift for the whole time series. Especially in the more recent years (from 2003 onwards), the catch is significantly higher including the new catch data and stock weights.

<u>2017 WKNSEA-RUN2</u>

Data

Same catch data (total weight, mean weight- and number-at-age for landings and discards) are used as in the 2017 WKNSEA-RUN1.

Biological parameters

Same biological parameters as used in the 2017 WKNSEA-RUN1.

Tuning series

In this run (run 2), three commercial (all beam trawl: BE_CBT_1980-2003 + BE_CBT_2004-2015 and UK(E&W)_CBT) and three survey (UK(E&W)_BTS_Q3, UK(E&W)_YFS, FR_YFS) data series are used for the calibration of the assessment of 7.d sole. The UK survey component of the Young fish survey (YFS) was last conducted in 2006.

The Belgian CBT tuning series used in the baserun (1986-2015) was split in 2 parts. One part (old) consisted of the CBT tuning series from 1986-2003 and the other part (new), from 2004-2015, was updated for this benchmark. This update included a re-calculation based only on data from the large fleet segment (HP > 221 kW). The standardization of the nominal log transformed catch rates was performed using a generalized linear model, including horse power (HP) as a continuous linear variable and year and month as factors. The predicted catch rates by year, quarter and horsepower were divided by the corresponding total catch to obtain the standardized effort values. The sum of those effort values by year was matched with the age distribution to obtain the BE_CBT_new tuning series. More information can be found in the working document on the horse power correction of the Belgian commercial beam trawl tuning fleet.

XSA diagnostics

	2017 WKNSEA		
Fleets	Years	Ages	α-β
BE_CBT_1986-2003 commercial	**86–03**	**2–10**	**0–1**
BE_CBT_2004-2015 commercial	**04–15**	**2–10**	**0–1**
UK(E&W)_CBT commercial	86–15	2–10	0–1
UK(E&W)_BTS survey	89–15	1–6	0.5–0.75
UK_YFS survey	87–06	1–1	0.5–0.75
FR_YFS survey	87–15	1–1	0.5–0.75
-First data year	1982		
-Last data year	2015		
-First age	1		
-Last age	11+		
Time series weights	None		
-Model	No Power model		
-Q plateau set at age	7		
-Survivors estimates shrunk towards mean F	5 years / 5 ages		
-s.e. of the means	2.0		
-Min s.e. for pop. Estimates	0.3		
-Prior weighting	None		

Figures 2.24-2.30 present the model output for this second run.

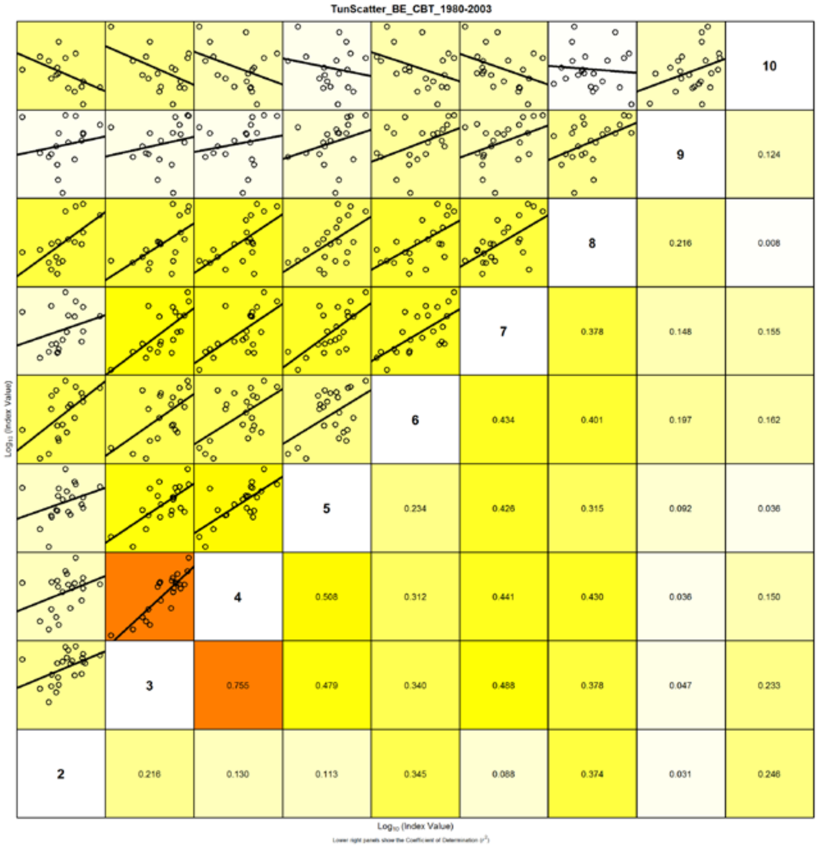


Figure 2.24. Internal consistency plot of the BE_CBT_**1980-2003** tuning series for 7.d sole.

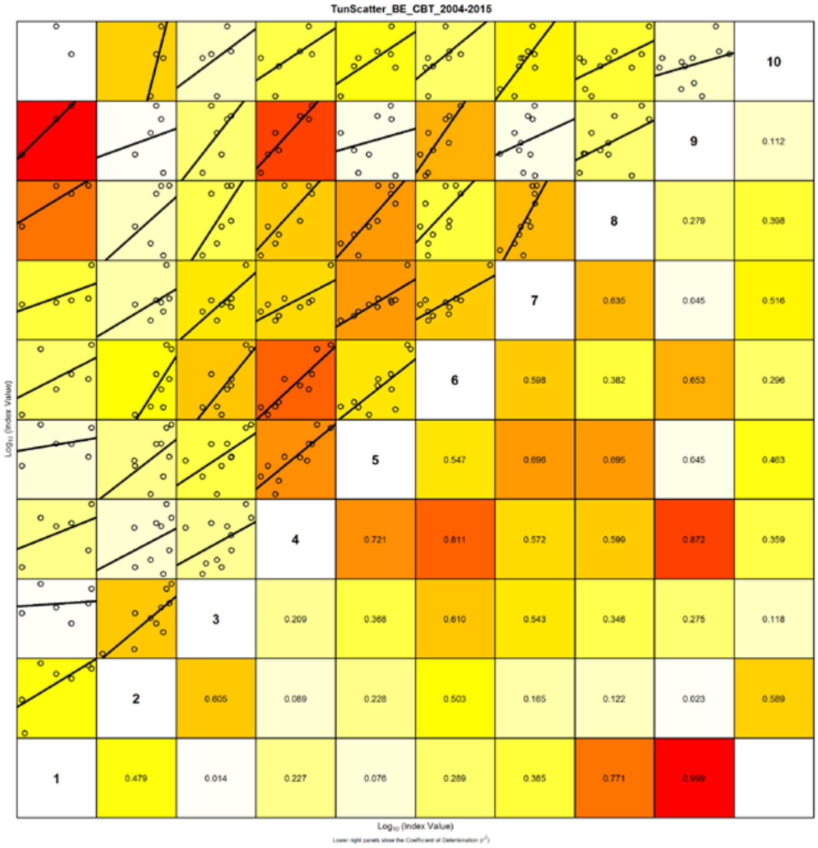


Figure 2.25. Internal consistency plot of the BE_CBT_**2004-2015** tuning series for 7.d sole.

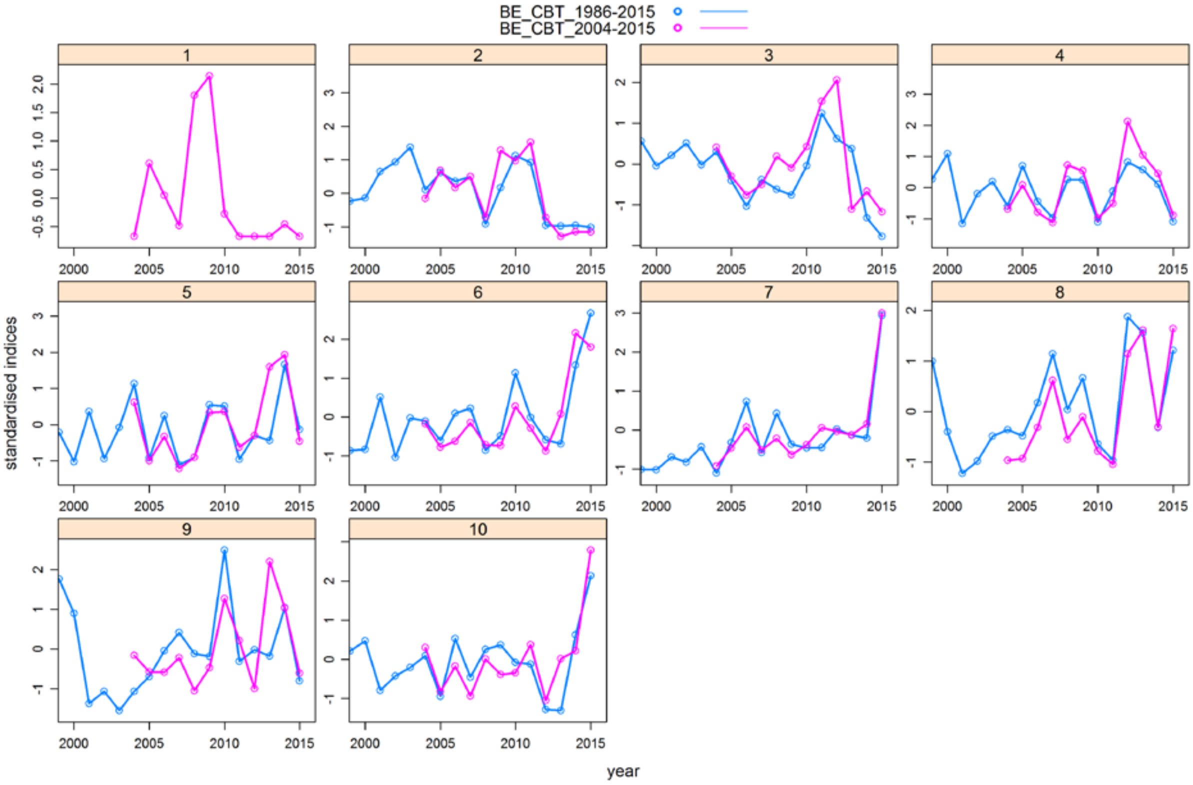


Figure 2.26. Standardized indices by age of the BE_CBT_1986-2015 and BE_CBT_2004-2015 tuning series for 7.d sole.

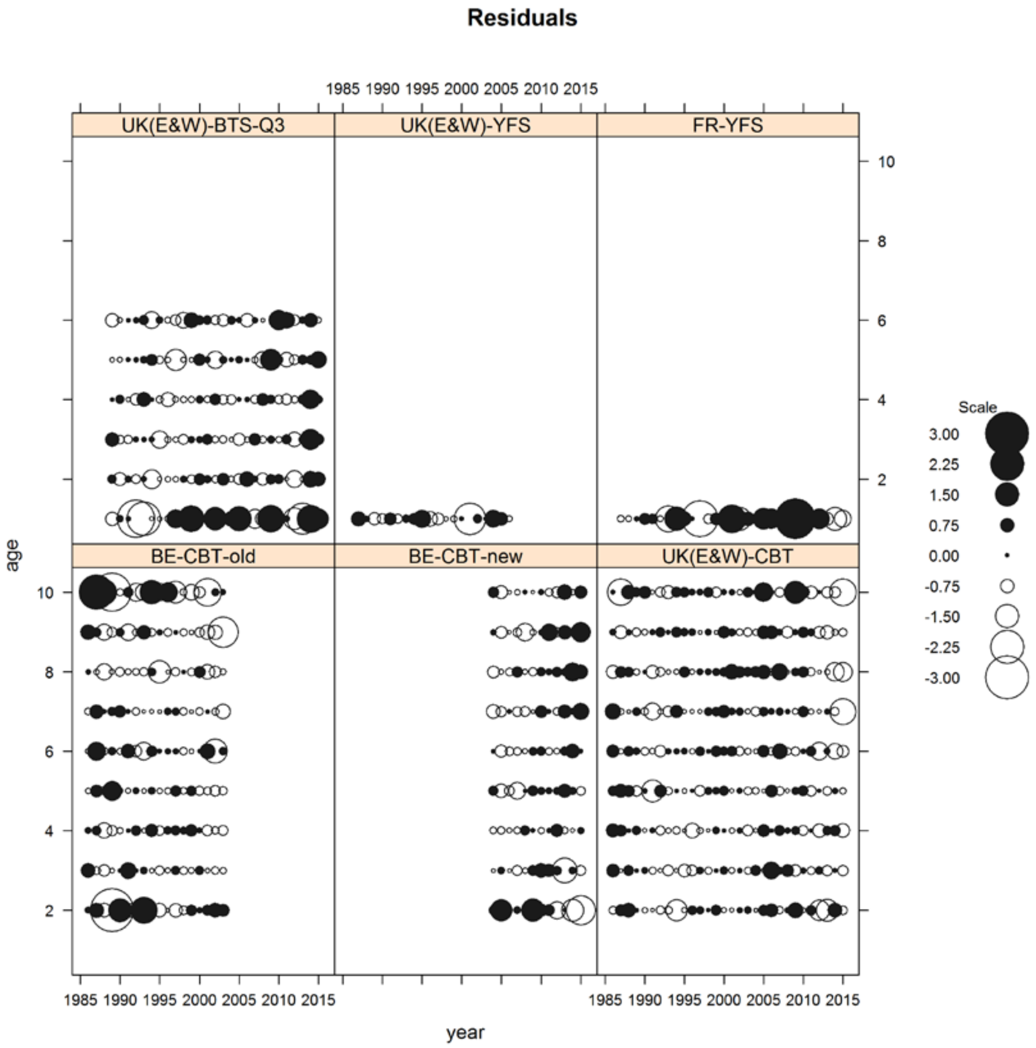


Figure 2.27. Catchability residuals for all tuning fleets used in the assessment of 7.d sole.

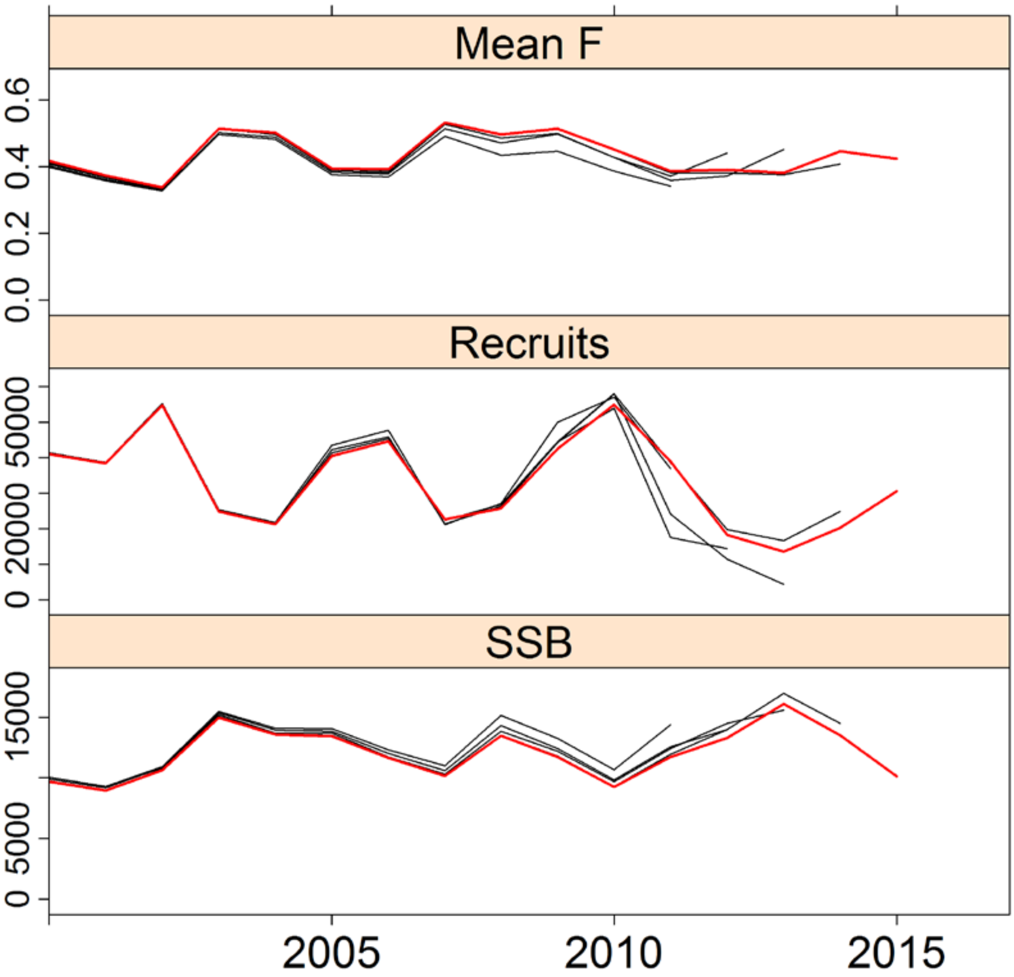


Figure 2.28. Retrospective pattern.

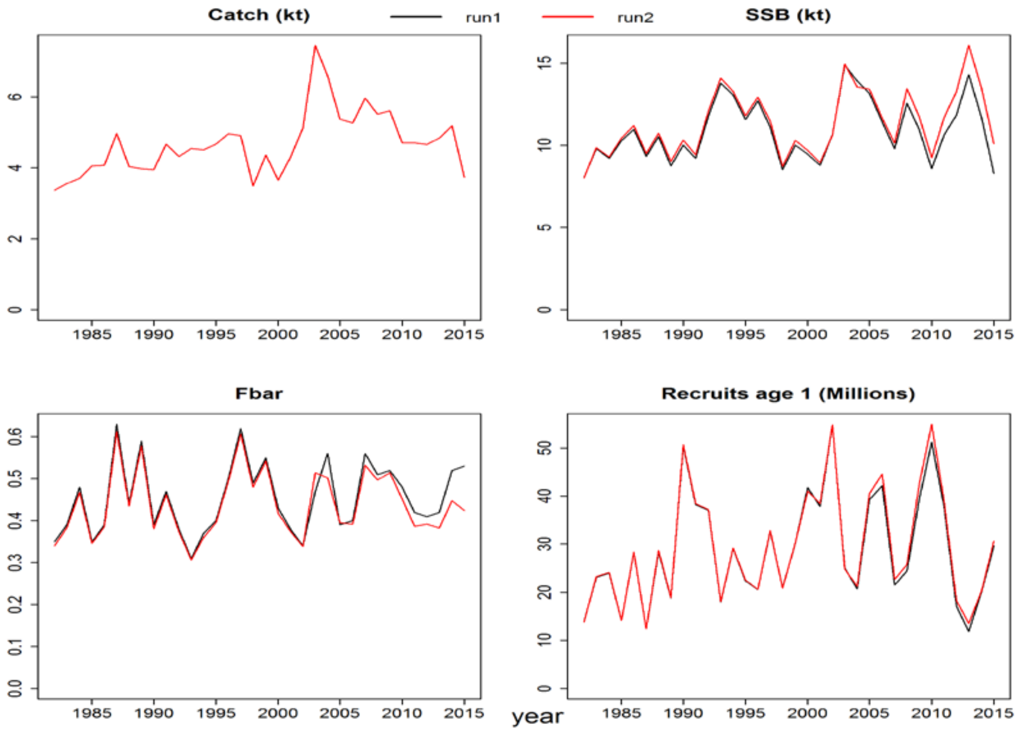


Figure 2.29. Comparison of the summary plots between the **2017 WKNSEA run1** and the **2017 WKNSEA run2**.

Modifying the Belgian commercial tuning series (*i.e.* run 2) causes the SSB to slightly increase and the F to significantly decrease in the recent years (from 2010 onwards). As described in the working document on the Belgian commercial tuning fleet, this optimized and corrected tuning series is more appropriate.

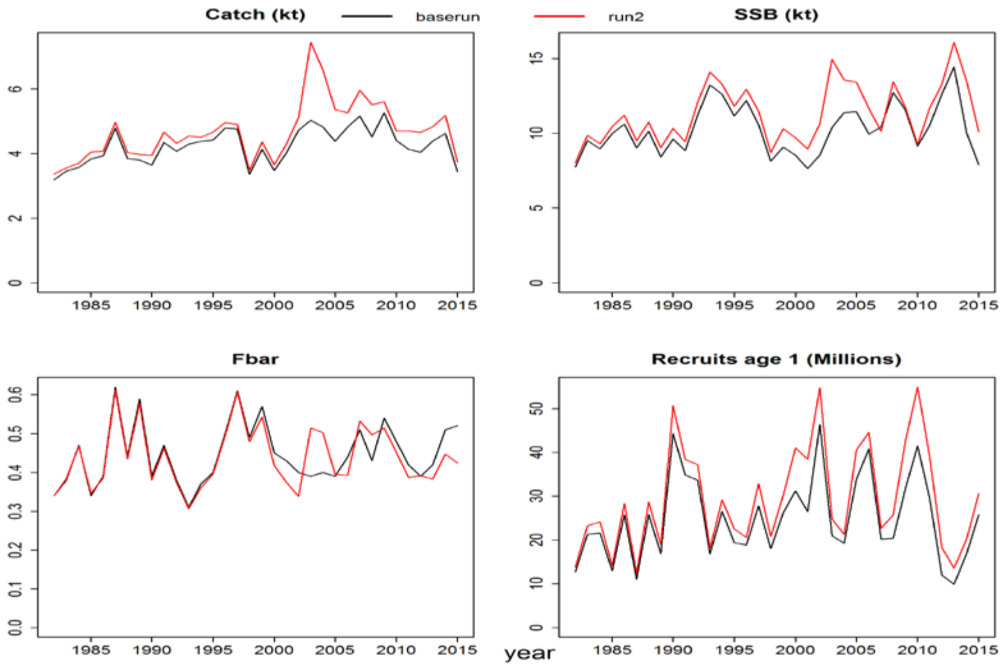


Figure 2.30. Comparison of the summary plots between the **2016 WGNSSK assessment (baserun)** and the **2017 WKNSEA run2**.

2017 WKNSEA-RUN3

Data

Same catch data (total weight, mean weight- and number-at-age for landings and discards) as used in the 2017 WKNSEA-RUN1

Biological parameters

Same biological parameters as used in the 2017 WKNSEA-RUN1.

Tuning series

In this run (run 3), three commercial (BE_CBT (1986-2015), UK(E&W)_CBT and FR_COT) and three survey (UK(E&W)_BTS_Q3, UK(E&W)_YFS, FR_YFS) data series are used for the calibration of the assessment of 7.d sole. The UK survey component of the Young fish survey (YFS) was last conducted in 2006.

A new tuning series from the French COT fleet, which targets sole seasonally and mainly along the French coast, was included for the first time. Trips were included from all demersal otter trawlers using a mesh size range of 70-99 mm (OTB_DEF_70_99_0) and targeting sole in the area during the period 2002-2015. More details on the French commercial tuning series can be found in the working document on tuning series.

XSA diagnostics

	2017 WKNSEA		
Fleets	Years	Ages	α-β
BE_CBT_1986_2015 commercial	**86–15**	**2–10**	**0–1**
FR_COT commercial	**02–15**	**2–10**	**0–1**
UK(E&W)_CBT commercial	86–15	2–10	0–1
UK(E&W)_BTS survey	89–15	1–6	0.5–0.75
UK_YFS survey	87–06	1–1	0.5–0.75
FR_YFS survey	87–15	1–1	0.5–0.75
-First data year	1982		
-Last data year	2015		
-First age -Last age	1 11+		
Time series weights	None		
-Model	No Power model		
-Q plateau set at age	7		
-Survivors estimates shrunk towards mean F	5 years / 5 ages		
-s.e. of the means	2.0		
-Min s.e. for pop. Estimates	0.3		
-Prior weighting	None		

Figures 2.31-2.35 present the model output for this third run.

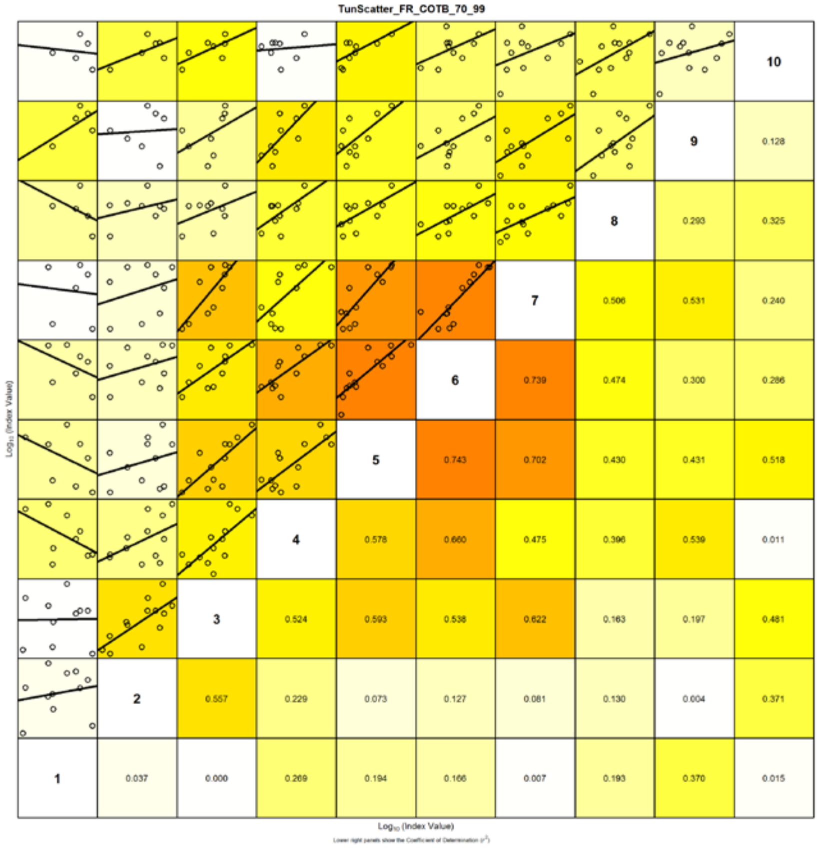


Figure 2.31. Internal consistency plot of the FR_COT tuning series for 7.d sole.

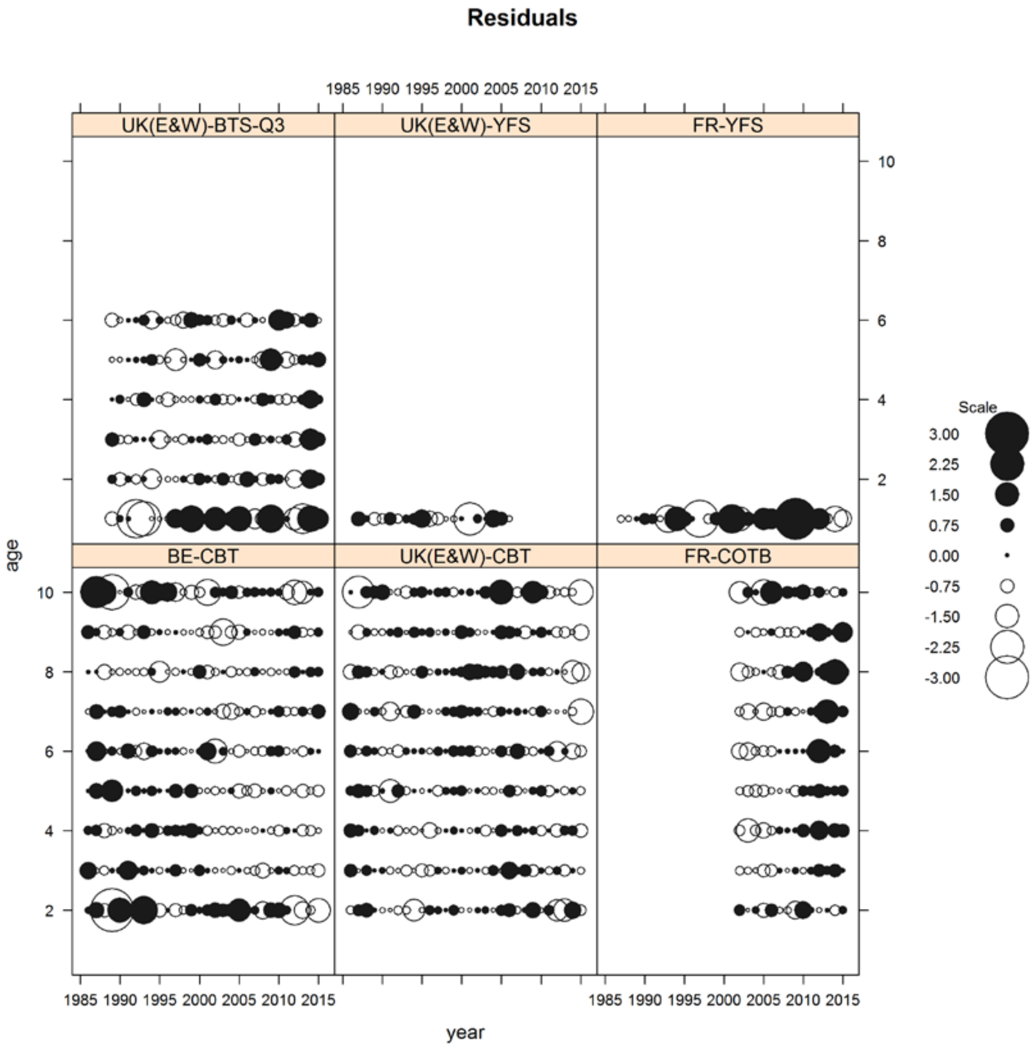


Figure 2.32. Catchability residuals for all tuning fleets used in the assessment of 7.d sole.

Figure 2.33. Retrospective pattern.

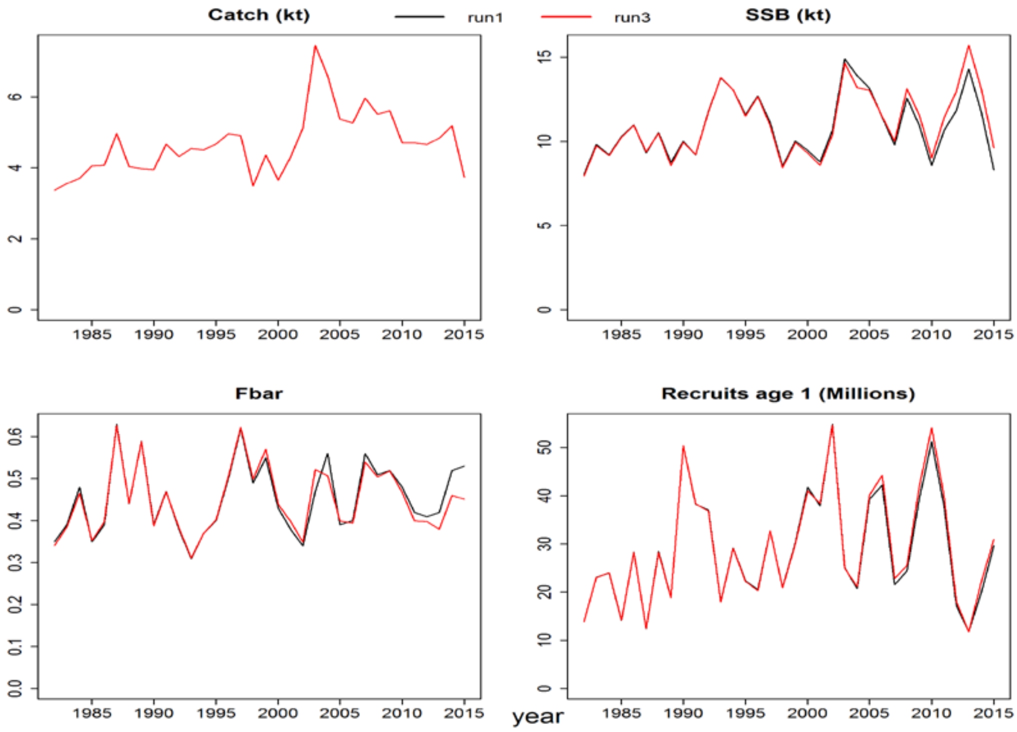


Figure 2.34. Comparison of the summary plots between the **2017 WKNSEA run1** and the **2017 WKNSEA run3**.

Little differences were identified between run 3 and run 1. Similar to the previous run (using the new Belgian commercial tuning series), the inclusion of the French commercial tuning fleet resulted in a significant decrease of the Fbar.

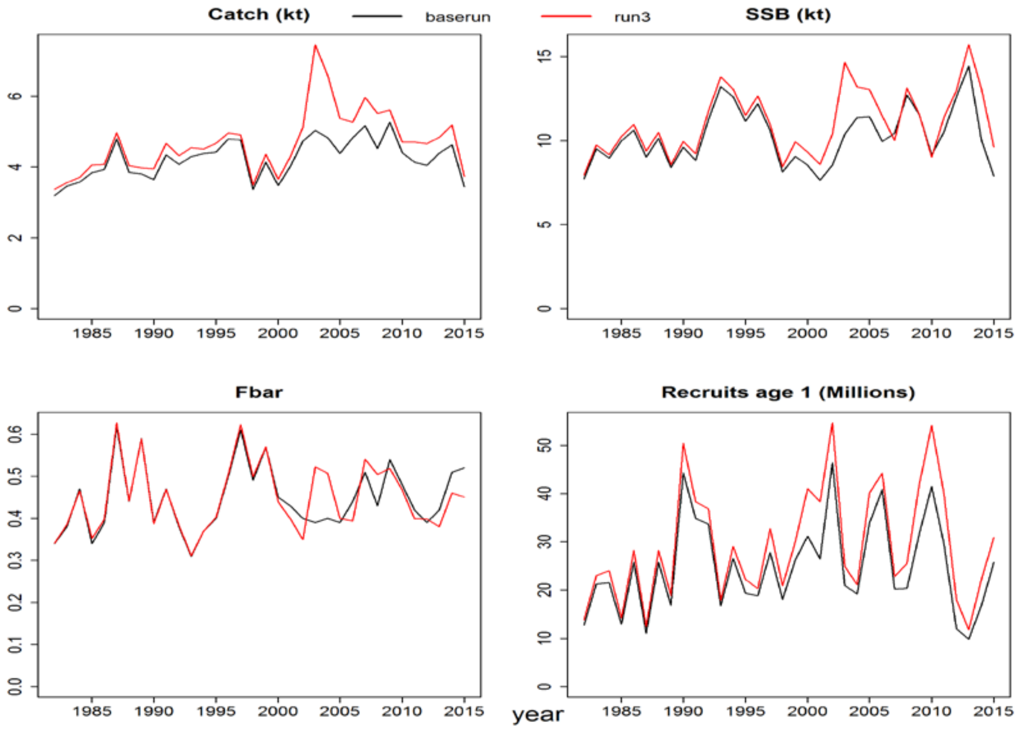


Figure 2.35. Comparison of the summary plots between the **2016 WGNSSK assessment (baserun)** and the **2017 WKNSEA run3**.

2017 WKNSEA-RUN4

Data

Same catch data (total weight, mean weight- and number-at-age for landings and discards) as used in the 2017 WKNSEA-RUN1

Biological parameters

Same biological parameters as used in the 2017 WKNSEA-RUN1.

Tuning series

In this run (run 4), four commercial (BE_CBT_1986-2003 + BE_CBT_2004-2015, UK(E&W)_CBT and FR_COT) and three survey (UK(E&W)_BTS_Q3, UK(E&W)_YFS, FR_YFS) data series are used for the calibration of the assessment of 7.d sole. The UK survey component of the Young fish survey (YFS) was last conducted in 2006.

The Belgian CBT tuning series was updated for the years 2004-2015 and therefore applied as a separate tuning series (BE_CBT_2004-2015) next to the original tuning series from 1986 to 2003 (BE_CBT_1986-2003), similar as in run 2. The French COT tuning series was also included similar as in run 3.

XSA diagnostics

		2017 WKNSEA	
Fleets	Years	Ages	α-β
BE_CBT_1986-2003 commercial	**86–03**	**2–10**	**0–1**
BE_CBT_2004-2015 commercial	**04-15**	**2–10**	**0–1**
FR_COT commercial	**02–15**	**2–10**	**0–1**
UK(E&W)_CBT commercial	86–15	2–10	0–1
UK(E&W)_BTS survey	89–15	1–6	0.5–0.75
UK_YFS survey	87–06	1–1	0.5–0.75
FR_YFS survey	87–15	1–1	0.5–0.75
-First data year	1982		
-Last data year	2015		
-First age -Last age	1 11+		
Time series weights	None		
-Model	No Power model		
-Q plateau set at age	7		
-Survivors estimates shrunk towards mean F	5 years / 5 ages		
-s.e. of the means	2.0		
-Min s.e. for pop. Estimates	0.3		
-Prior weighting	None		

Figures 2.36-2.39 present the model output for this fourth run.

Figure 2.36. Standardized indices by age of the commercial tuning series for 7.d sole.

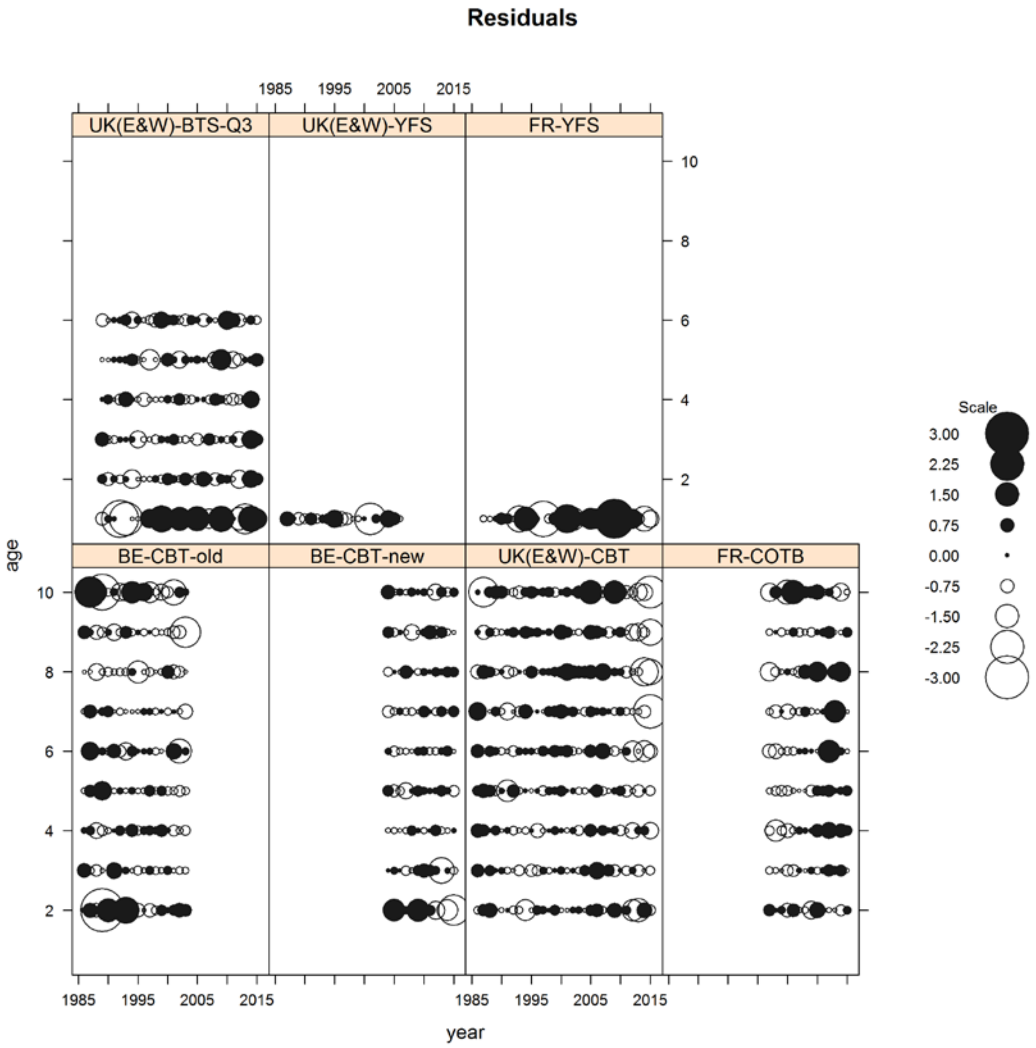


Figure 2.37. Catchability residuals for all tuning fleets used in the assessment of 7.d sole.

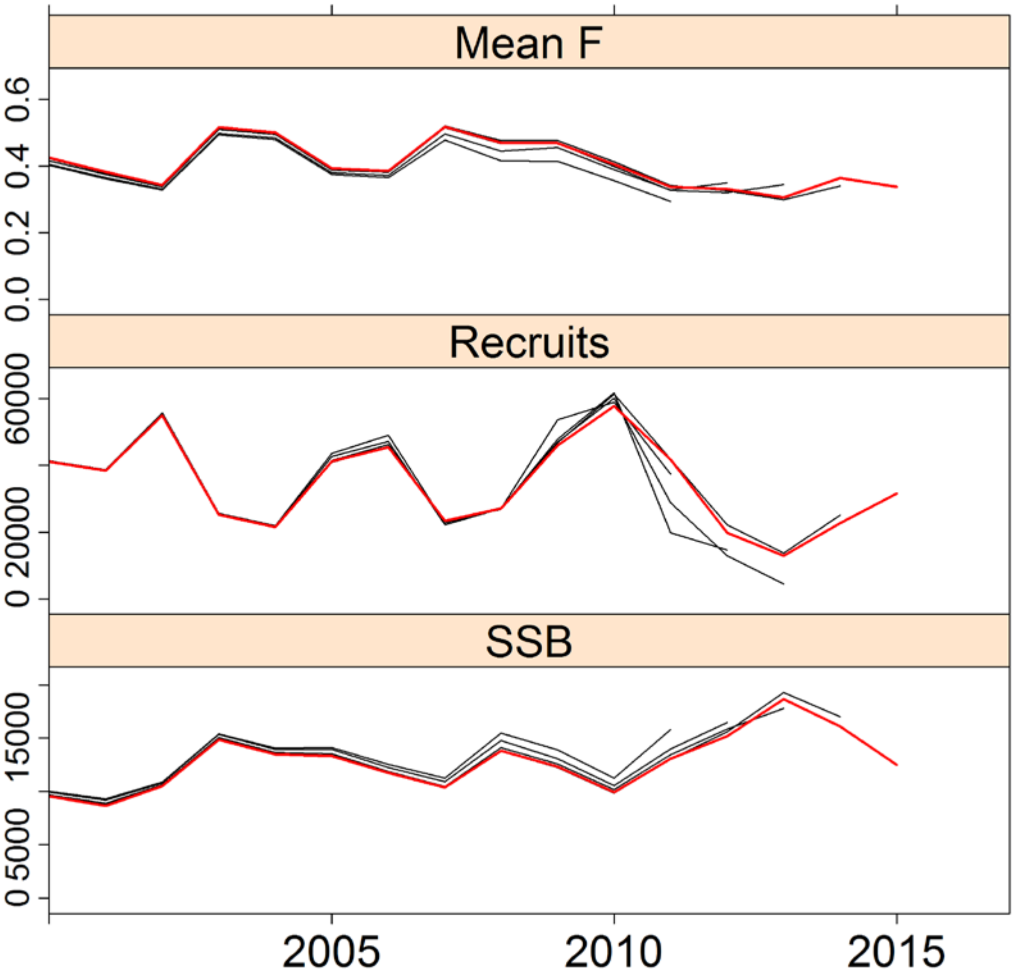


Figure 2.38. Retrospective pattern.

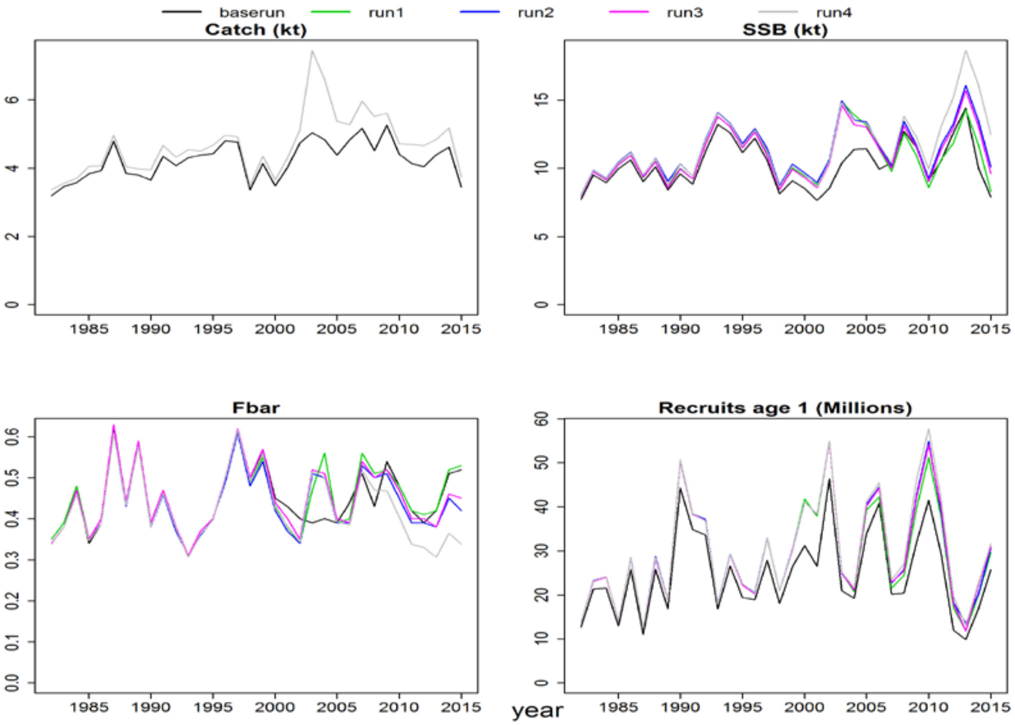


Figure 2.39. Comparison of the summary plots between the **2016 WGNSSK assessment (baserun)**, the **2017 WKNSEA run1**, the **2017 WKNSEA run2**, the **2017 WKNSEA run3** and the **2017 WKNSEA run4**.

Run 4 (including both the new Belgian CBT and French COT tuning series) shows an even higher SSB from 2010 onwards compared to run 1-3. Additionally, the lowest Fbar is observed.

2017 WKNSEA-RUN5

Data

Same catch data (total weight, mean weight- and number-at-age for landings and discards) as used in the 2017 WKNSEA-RUN1

Biological parameters

Same biological parameters as used in the 2017 WKNSEA-RUN1 except for maturity.

The new maturity ogive was obtained by estimating the maturity at age per sex using a generalized linear model (glm). Subsequently, both sexes were combined assuming a 50:50 sex ratio. As the initial maturity at age 2 was substantially different from the one used in the current knife-edged ogive (74% mature versus 0%), it was decided to lower it based on expert judgement by calculating the ratio of mature records versus all records at age 2 from the UK dataset (being the largest dataset). This resulted in a maturity value of 0.53 for age 2. More detailed information on the calculation of the maturity ogive is provided in the working document on biological parameters.

Age	0	1	2	3	4	5	6	7	8	9	10 (+)
Maturity	0.00	0.00	0.53	0.92	0.96	0.97	0.97	0.97	0.97	0.99	0.98

Due to the large variation in the dataset to construct this ogive, full maturation was never reached (never 100%), which is quite unlikely. The maturity rate started to plateau from age 5-6 onwards. Therefore, the effect on the SSB of setting full maturation at age 5 or 6 was investigated in Figure 2.40.

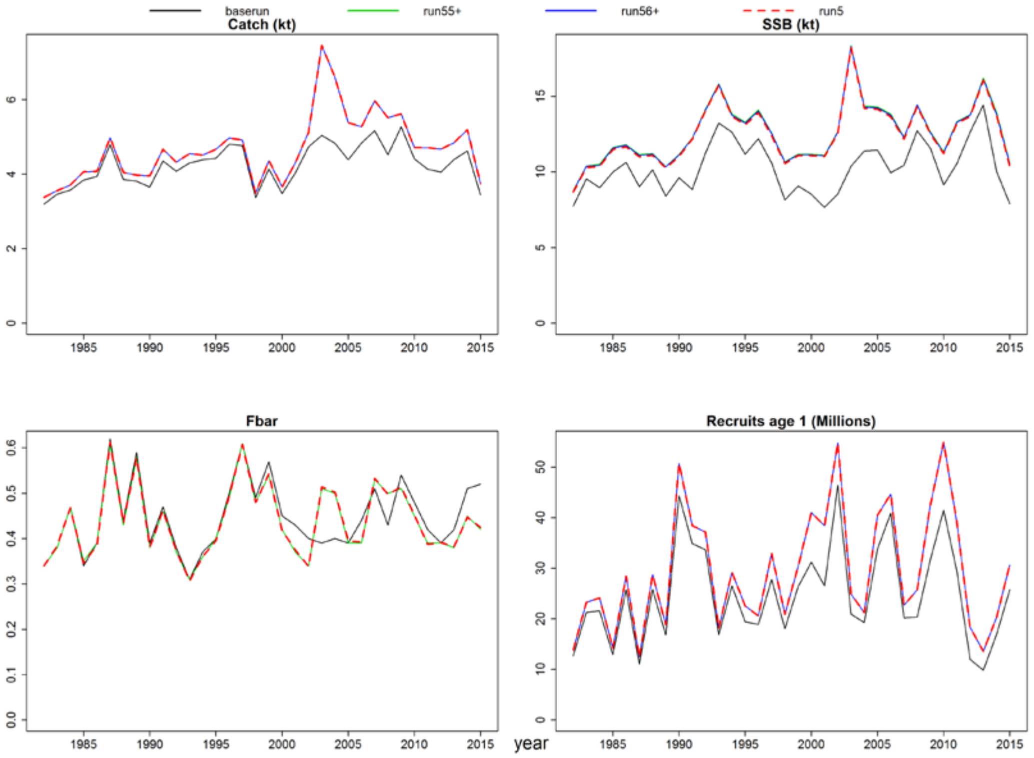


Figure 2.40. Comparison of the summary plots between the **2016 WGNSSK baserun (black line), 2017 WKNSEA run55+ (green line)** including full maturation from age 5 onwards, **2017 WKNSEA run56+ (blue line)** including full maturation from age 6 onwards and **2017 WKNSEA run5 (red dotted line)** not reaching full maturation up to age 10

As almost no difference was observed, it was decided to consider all sole 100% mature from age 6 onwards, based on expert judgement. The new maturity ogive used is presented below.

Age	0	1	2	3	4	5	6	7	8	9	10 (+)
Maturity	0.00	0.00	0.53	0.92	0.96	0.97	1.00	1.00	1.00	1.00	1.00

Tuning series

Same set of tuning fleets as used in the 2017 WKNSEA-RUN2 (*i.e.* including BE_CBT_1980-2003 + BE_CBT_2004-2015)

XSA diagnostics

Same XSA diagnostics as applied in the 2017 WKNSEA-RUN2

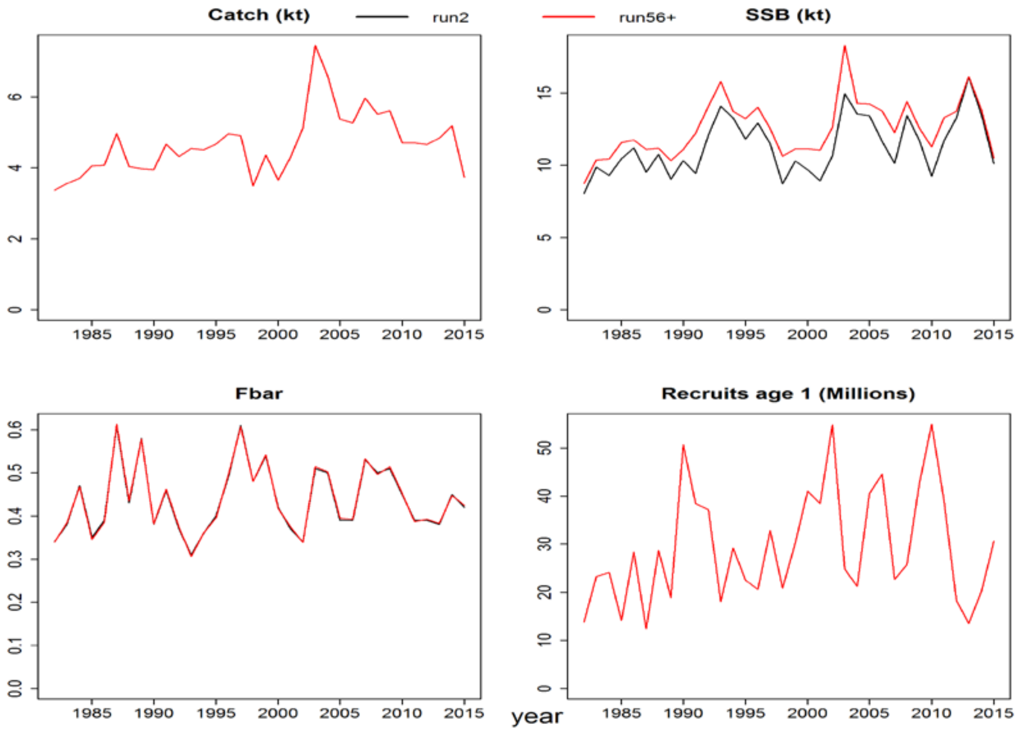


Figure 2.41. Comparison of the summary plots between the **2017 WKNSEA run2** and the **2017 WKNSEA run56+**.

The higher estimation of maturity at age 2 (0 vs. 0.53) in the new maturity ogive resulted in an upward shift of the SSB curve over the whole time series.

2017 WKNSEA-RUN6

Data

Same catch data (total weight, mean weight- and number-at-age for landings and discards) as used in the 2017 WKNSEA-RUN1.

Biological parameters

Same biological parameters as used in the 2017 WKNSEA-RUN5 (*i.e.* including the new maturity ogive)

Tuning series

Same set of tuning fleets as used in the 2017 WKNSEA-RUN3 (*i.e.* including FR-COT, but old BE-CBT)

XSA diagnostics

Same XSA diagnostics as applied in the 2017 WKNSEA-RUN3

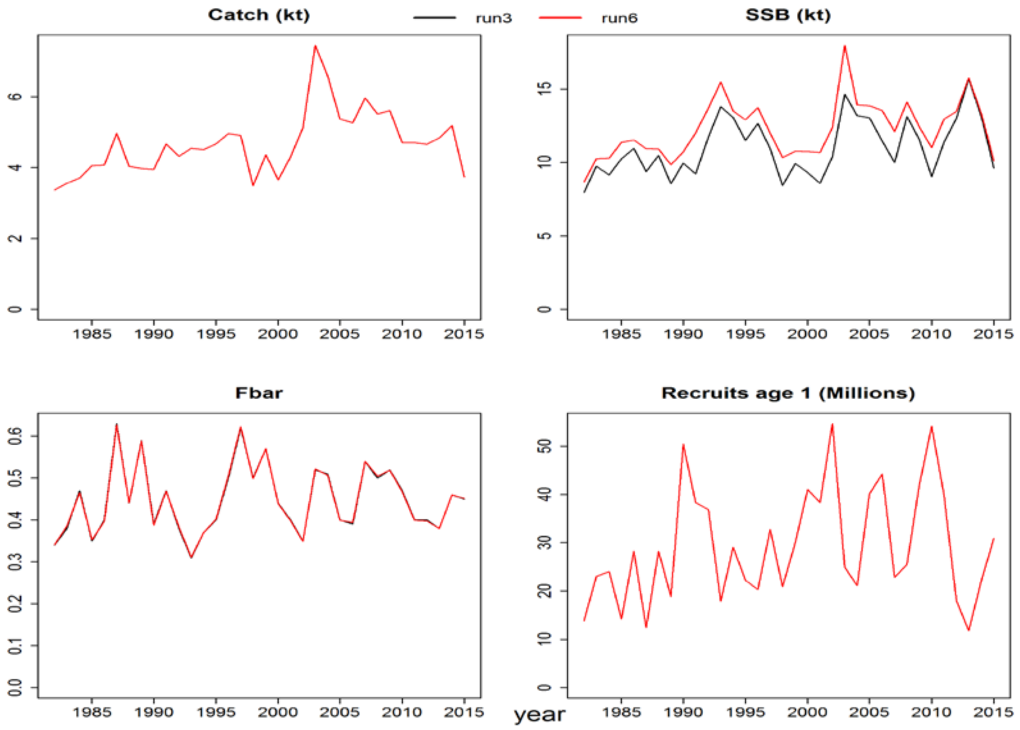


Figure 2.42. Comparison of the summary plots between the **2017 WKNSEA run3** and the **2017 WKNSEA run6**.

A similar effect (as in the previous run) of the new maturity ogive is observed in this run with the new FR-COT tuning series: a higher SSB due to the higher maturity proportion at age 2.

2017 WKNSEA-RUN7

Data

Same catch data (total weight, mean weight- and number-at-age for landings and discards) as used in the 2017 WKNSEA-RUN1

Biological parameters

Same biological parameters as used in the 2017 WKNSEA-RUN5.

Tuning series

Same set of tuning fleets as used in the 2017 WKNSEA-RUN4 (*i.e.* including both BE_CBT_1980-2003 + BE_CBT_2004-2015 and FR-COT)

XSA diagnostics

Same XSA diagnostics as applied in the 2017 WKNSEA-RUN4

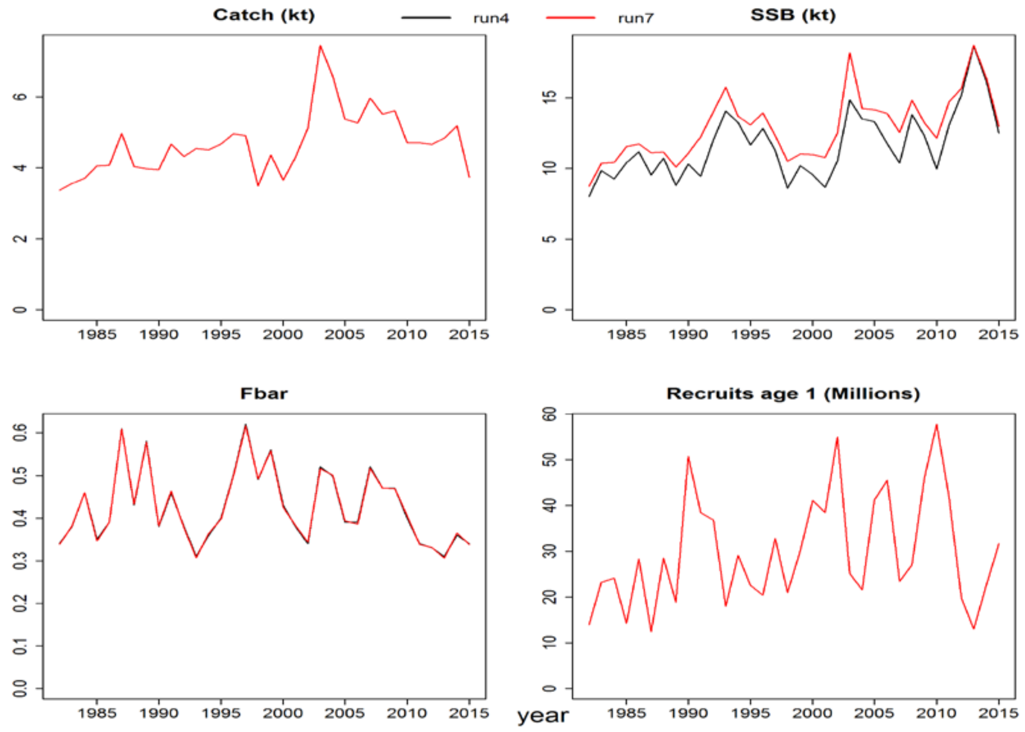


Figure 2.43. Comparison of the summary plots between the **2017 WKNSEA run4** and the **2017 WKNSEA run7**.

Including both new tuning series (i.e. BE_CBT_1980-2003 + BE_CBT_2004-2015 and FR-COT) and the new maturity ogive has a similar effect on the SSB as in run 5 and 6: a higher SSB due to the higher maturity proportion at age 2.

2017 WKNSEA-RUN8

Data

Same catch data (total weight, mean weight- and number-at-age for landings and discards) as used in the 2017 WKNSEA-RUN1

Biological parameters

Same biological parameters as used in the 2017 WKNSEA-RUN5.

Tuning series

Same set of tuning fleets as used in the 2017 WKNSEA-RUN1 (and baserun)

XSA diagnostics

Same XSA diagnostics as applied in the 2017 WKNSEA-RUN1

Figure 2.44. Comparison of the summary plots between the **2017 WKNSEA run1** and the **2017 WKNSEA run8**.

Including the new maturity ogive, but the old set of tuning series has a similar effect on the SSB as in run 5-7: a higher SSB due to the higher maturity proportion at age 2.

2017 WKNSEA-RUN9

Data

Same catch data (total weight, mean weight- and number-at-age for landings and discards) as used in the 2017 WKNSEA-RUN1

Biological parameters

Same biological parameters as used in the 2017 WKNSEA-RUN1.

Tuning series

Same set of tuning series as in RUN4 but the age range of all the commercial tuning series was trimmed to ages 3-8. Age 2 was skipped because the 2-year-old fish became less abundant in the recent landings and therefore the LPUE of the commercial fleets for this age class might be underestimated. Age 9 and 10 were skipped because the internal consistency of the commercial fleets for those older ages is rather weak (R^2 values of ages 9 to 10 are between 0.112 and 0.246, figure 2.7 (UK(E&W)_CBT,) figure 2.24 (BE_CBT_1986-2003), figure 2.25 (BE_CBT_2004-2015), figure 2.31 (FR_COT)).

XSA diagnostics

		2017 WKNSEA	
Fleets	Years	Ages	α-β
BE_CBT_1986-2003 commercial	86–03	**3–8**	0–1

BE_CBT_2004-2015 commercial	04-15	**3–8**	0–1
FR_COT commercial	02–15	**3–8**	0–1
UK(E&W)_CBT commercial	86–15	**3–8**	0–1
UK(E&W)_BTS survey	89–15	1–6	0.5–0.75
UK_YFS survey	87–06	1–1	0.5–0.75
FR_YFS survey	87–15	1–1	0.5–0.75

-First data year	1982
-Last data year	2015
-First age	1
-Last age	11+
Time series weights	None
-Model	No Power model
-Q plateau set at age	7
-Survivors estimates shrunk towards mean F	5 years / 5 ages
-s.e. of the means	2.0
-Min s.e. for pop. Estimates	0.3
-Prior weighting	None

Figures 2.45 – 2.47 present the model output for this eighth run.

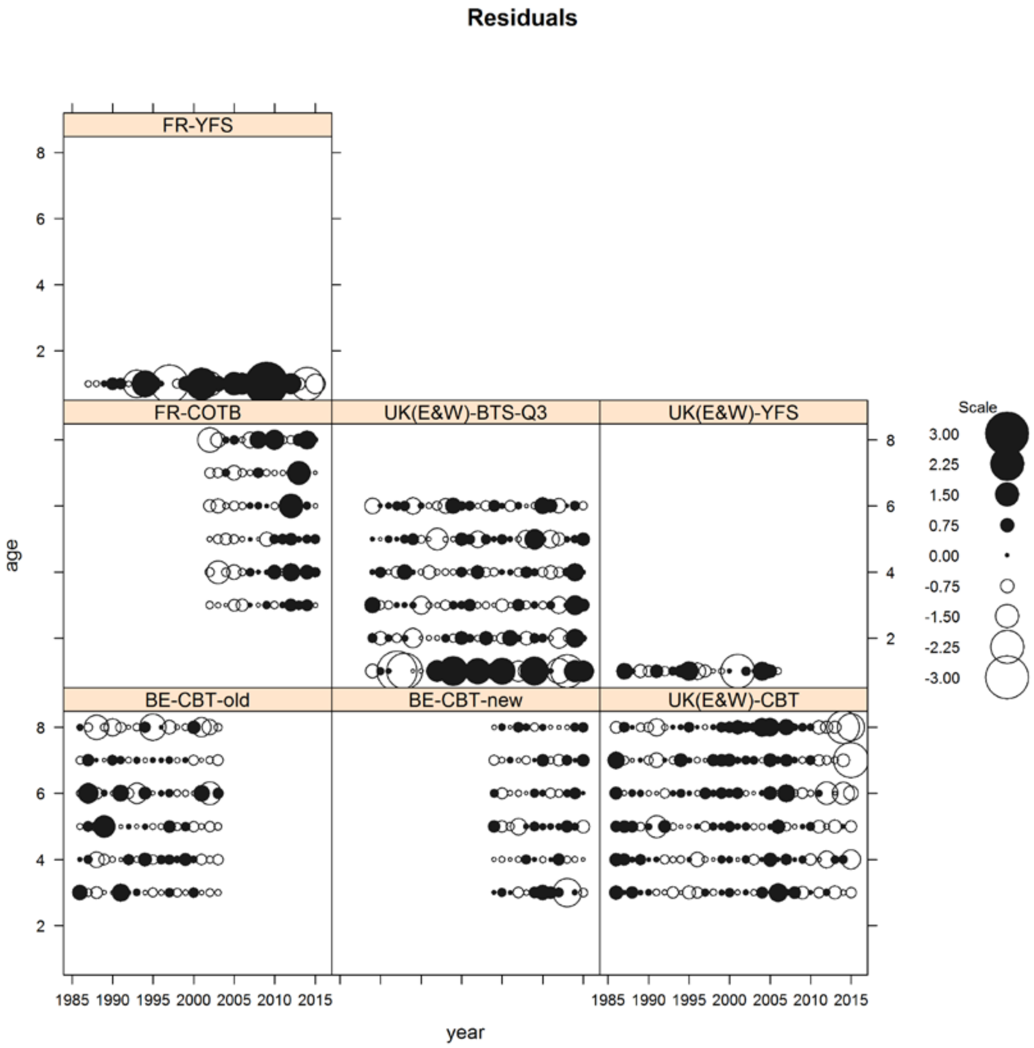


Figure 2.45. Catchability residuals for all tuning fleets used in the assessment of 7.d sole (run 8).

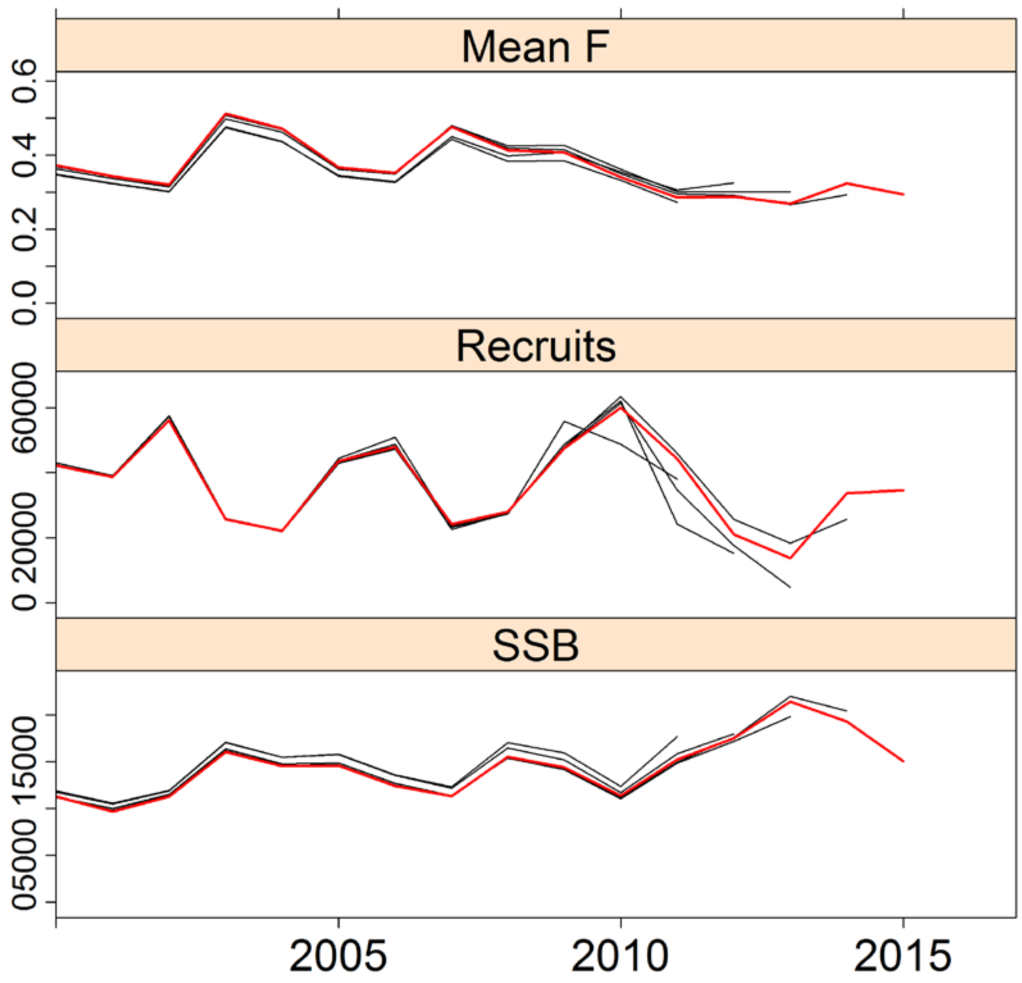


Figure 2.46. Retrospective pattern.

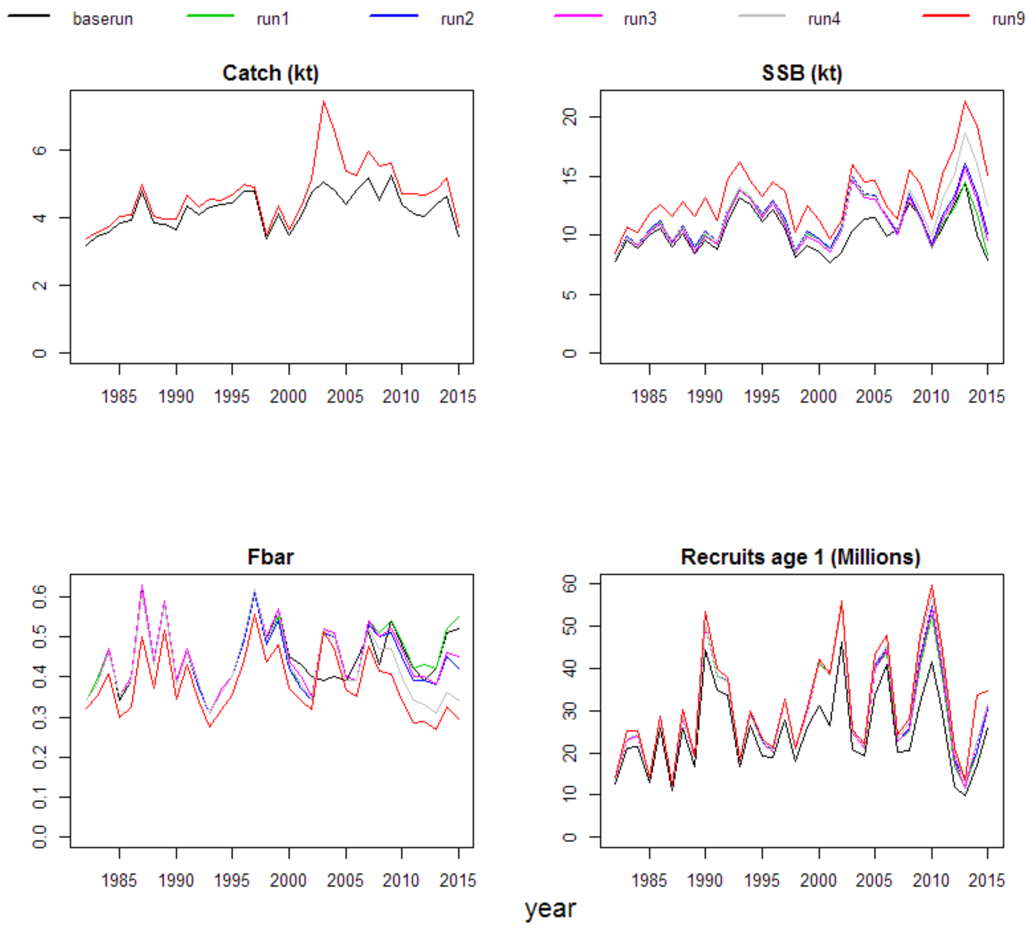


Figure 2.47. Comparison of the summary plots between the **2016 WGNSSK assessment (baserun)**, the **2017 WKNSEA run1**, the **2017 WKNSEA run2**, the **2017 WKNSEA run3**, the **2017 WKNSEA run4** and the **2017 WKNSEA run9**.

Trimming the commercial tuning series further amplifies the increase in SSB and recruits and the decrease in the Fbar, which are driven by the inclusion of the new commercial tuning series

2017 WKNSEA-RUN10

Data

Same catch data (total weight, mean weight- and number-at-age for landings and discards) as used in the 2017 WKNSEA-RUN1

Biological parameters

Same biological parameters as used in the 2017 WKNSEA-RUN1

Tuning series

No commercial tuning series, but only the three survey (UK(E&W)_BTS_Q3, UK(E&W)_YFS, FR_YFS) data series are used for the calibration of the assessment of 7.d sole. The UK survey component of the Young fish survey (YFS) was last conducted in 2006.

XSA diagnostics

	2017 WKNSEA		
Fleets	Years	Ages	α-β
UK(E&W)_BTS survey	**89–15**	**1–6**	**0.5–0.75**
UK_YFS survey	**87–06**	**1–1**	**0.5–0.75**
FR_YFS survey	**87–15**	**1–1**	**0.5–0.75**
-First data year	1982		
-Last data year	2015		
-First age -Last age	1 11+		
Time series weights	None		
-Model	No Power model		
-Q plateau set at age	7		
-Survivors estimates shrunk towards mean F	5 years / 5 ages		
-s.e. of the means	2.0		
-Min s.e. for pop. Estimates	0.3		
-Prior weighting	None		

Figures 2.48-2.50 present the model output for this tenth run.

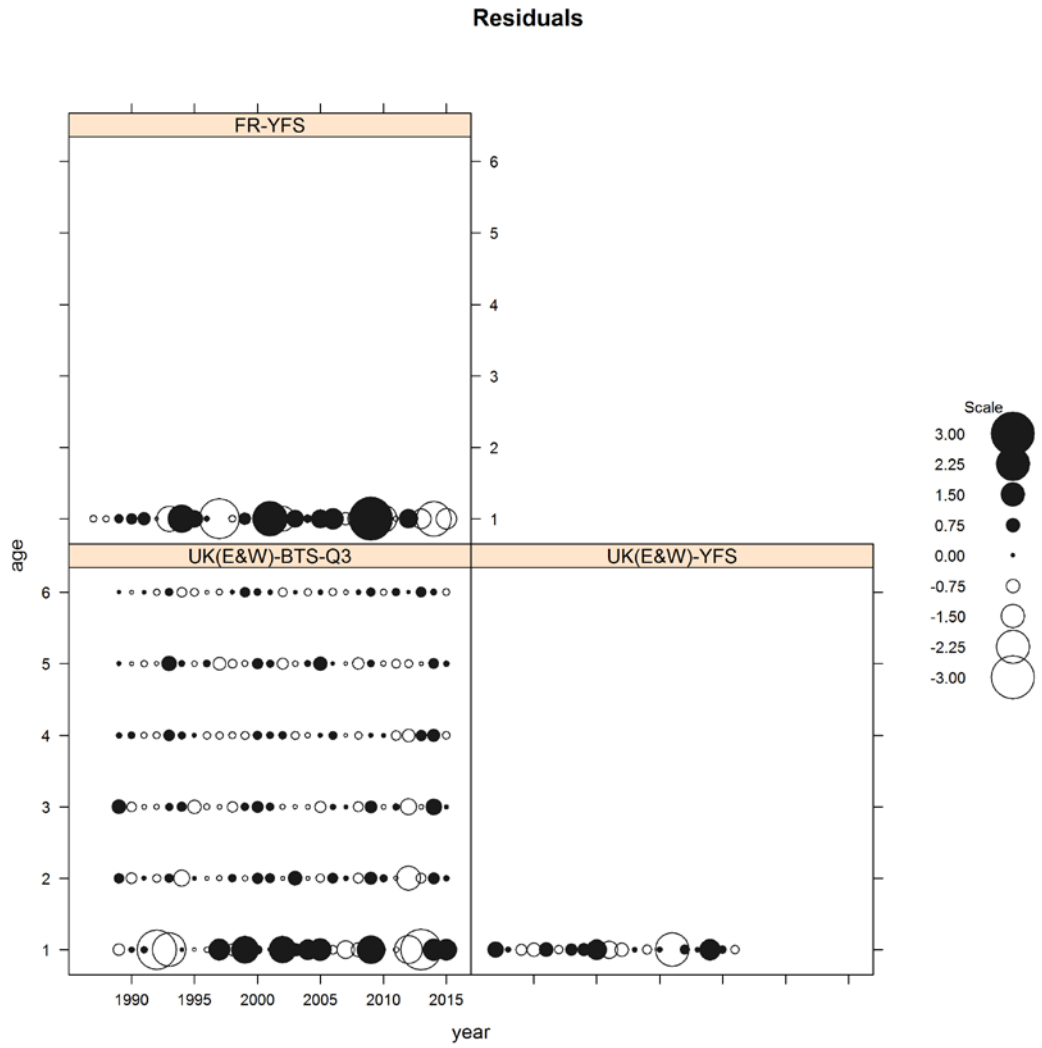


Figure 2.48. Catchability residuals for all tuning fleets used in the assessment of 7.d sole.

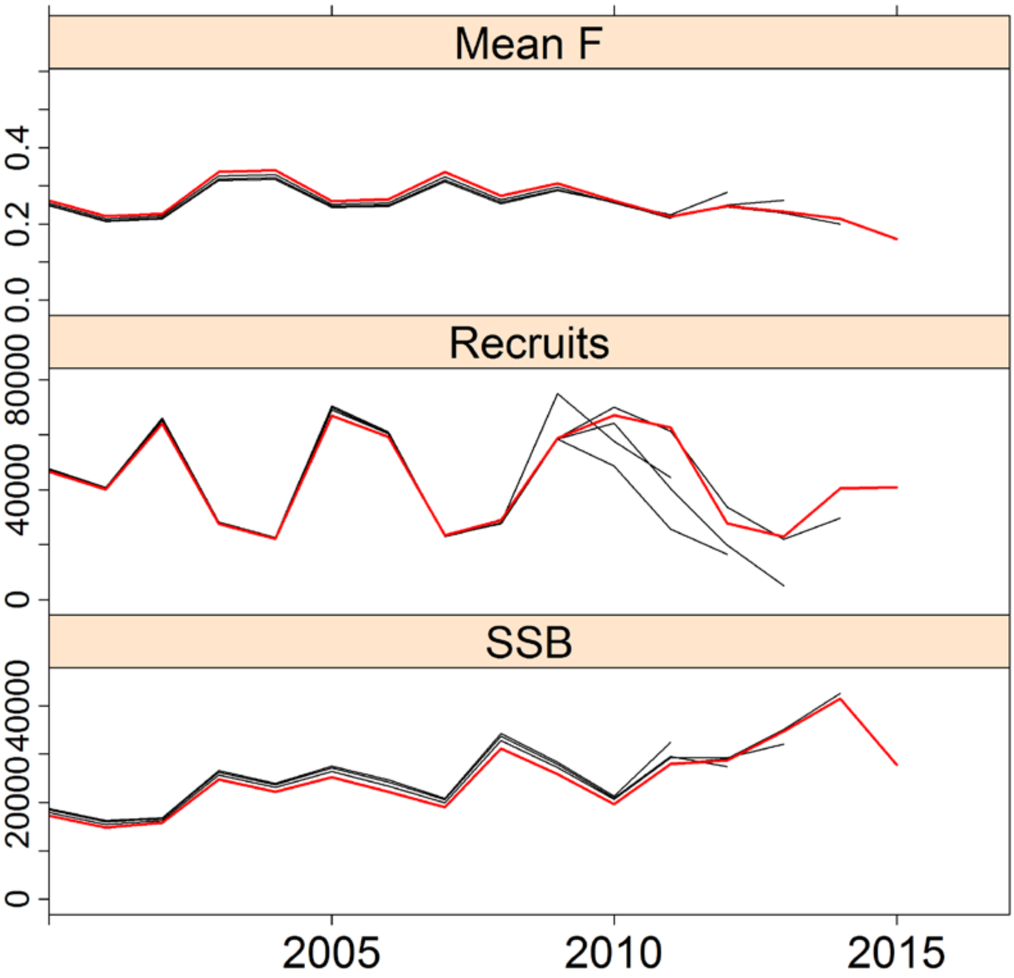


Figure 2.49. Retrospective pattern.

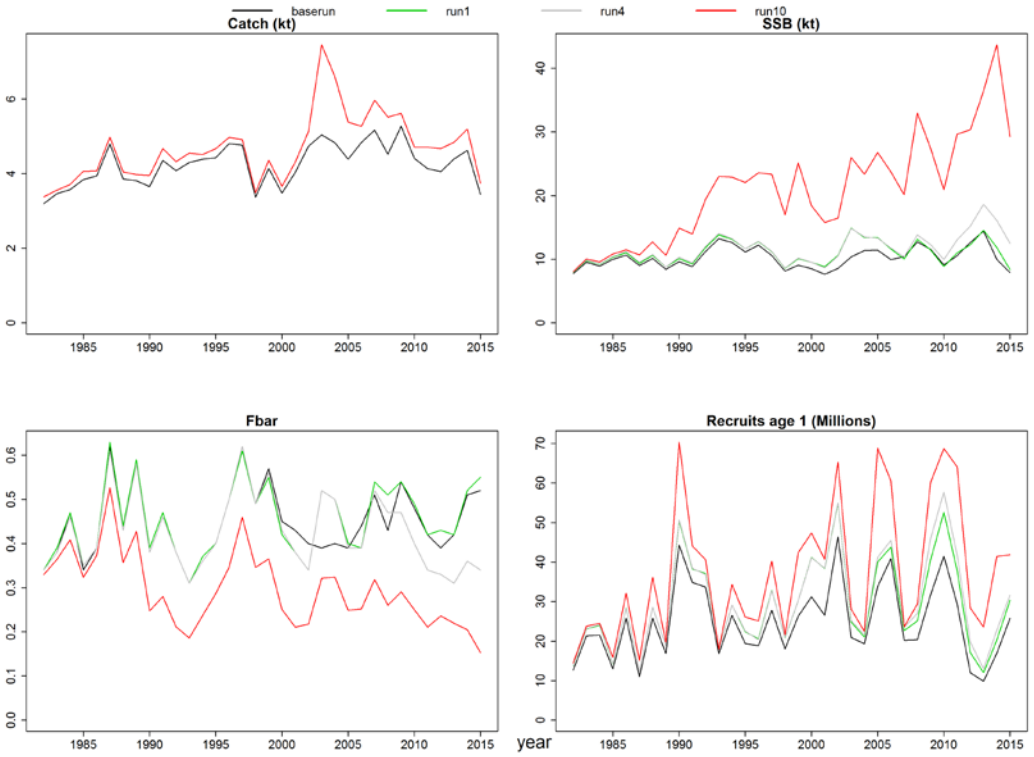


Figure 2.50. Comparison of the summary plots between the **2016 WGNSSK assessment (baserun)**, the **2017 WKNSEA run1**, the **2017 WKNSEA run4** and the **2017 WKNSEA run10**.

Only including survey tuning indices caused the SSB to strongly increase and the Fbar to strongly decrease over the whole time series.

2017 WKNSEA-RUN11

Data

Same catch data (total weight, mean weight- and number-at-age for landings and discards) as used in the 2017 WKNSEA-RUN1

Biological parameters

Same biological parameters as used in the 2017 WKNSEA-RUN1

Tuning series

Three commercial (BE_CBT_2004-2015 (=new), UK(E&W)_CBT and FR_COT) and three survey (UK(E&W)_BTS-Q3, UK(E&W)_YFS, FR_YFS) data series are used for the calibration of the assessment of 7.d sole. The UK survey component of the Young fish survey (YFS) was last conducted in 2006.

In this run, the updated Belgian CBT tuning series for the years 2004-2015 and the French COT tuning series were used. The age range of all the commercial tuning series was trimmed to ages 3-8.

XSA diagnostics

		2017 WKNSEA	
Fleets	Years	Ages	α-β
BE_CBT_2004-2015 commercial	**04-15**	**3–8**	**0–1**
FR_COT commercial	**02–15**	**3–8**	**0–1**
UK(E&W)_CBT commercial	86–15	**3–8**	0–1
UK(E&W)_BTS survey	89–15	1–6	0.5–0.75
UK_YFS survey	87–06	1–1	0.5–0.75
FR_YFS survey	87–15	1–1	0.5–0.75
-First data year	1982		
-Last data year	2015		
-First age -Last age	1 11+		
Time series weights	None		
-Model	No Power model		
-Q plateau set at age	7		
-Survivors estimates shrunk towards mean F	5 years / 5 ages		
-s.e. of the means	2.0		
-Min s.e. for pop. Estimates	0.3		
-Prior weighting	None		

Figures 2.51-2.53 present the model output for this eleventh run.

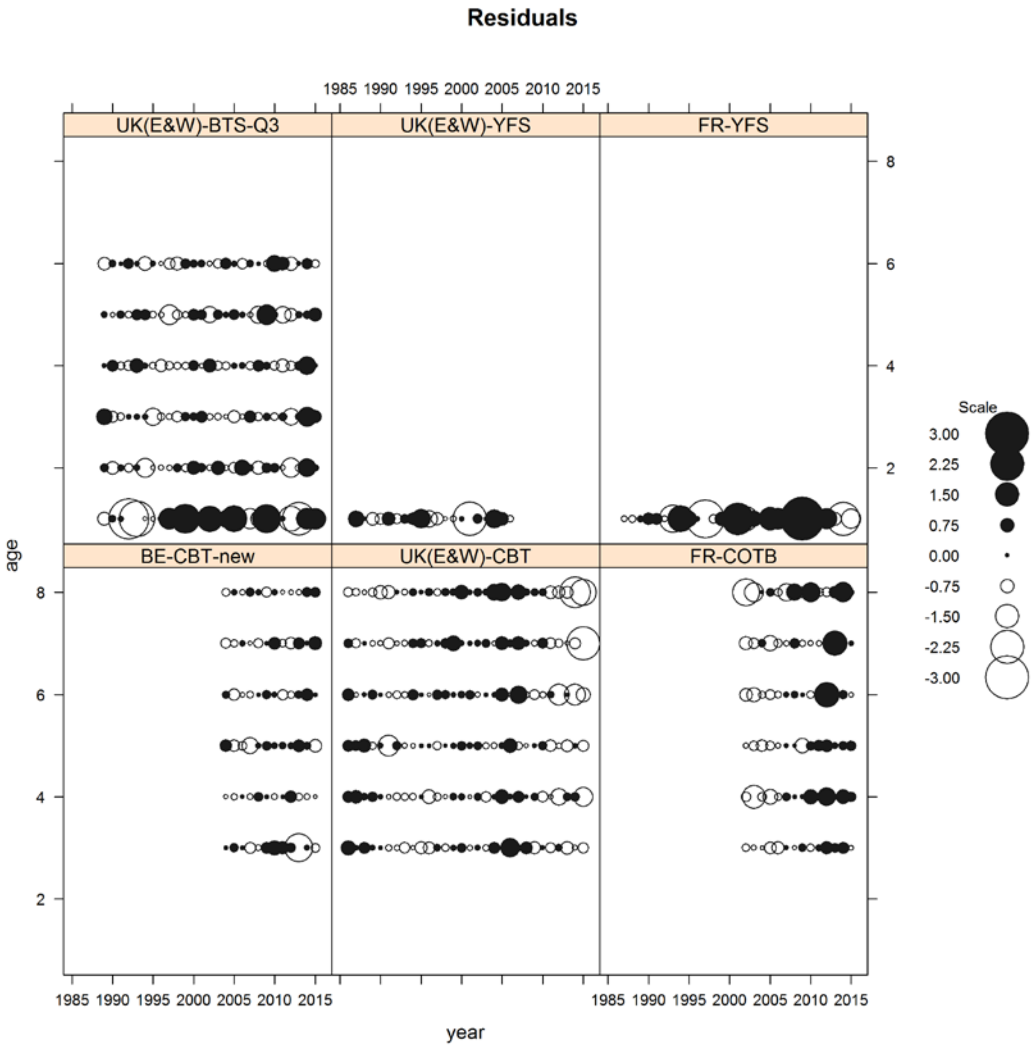


Figure 2.51. Catchability residuals for all tuning fleets used in the assessment of 7.d sole.

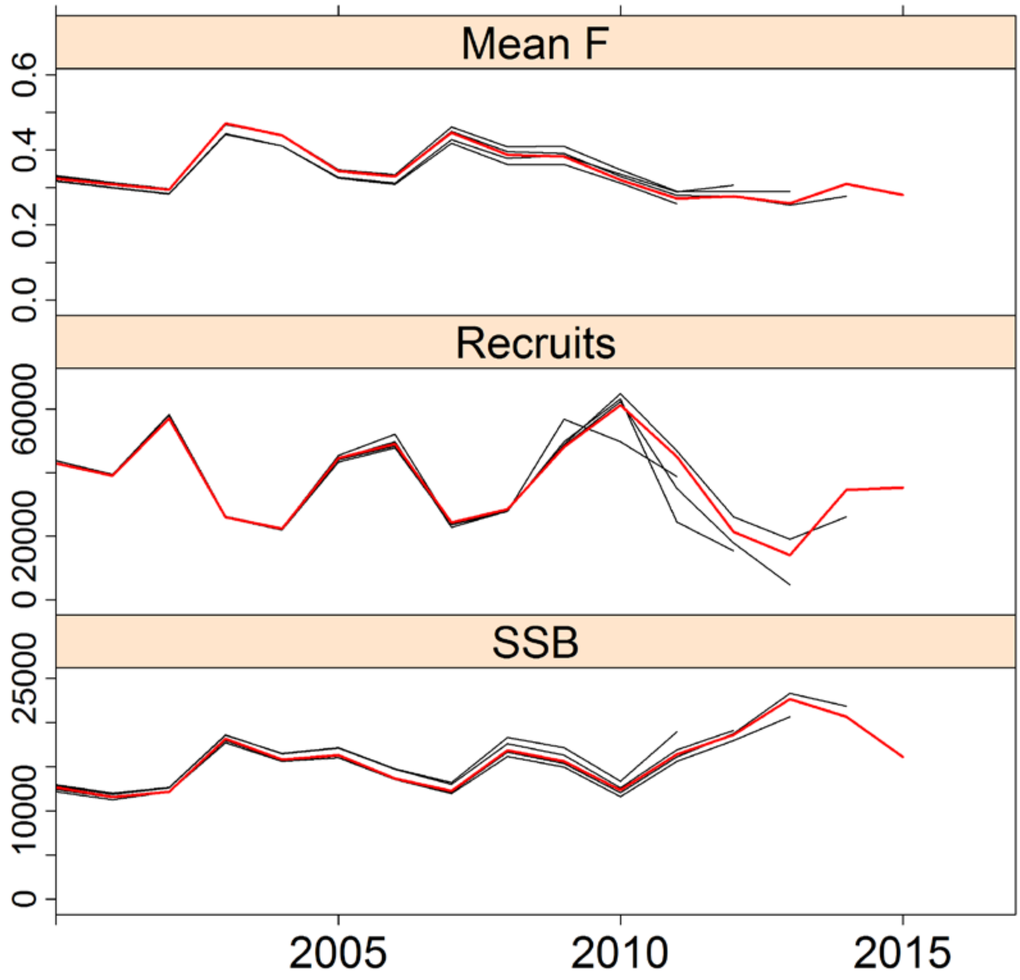


Figure 2.52. Retrospective pattern.

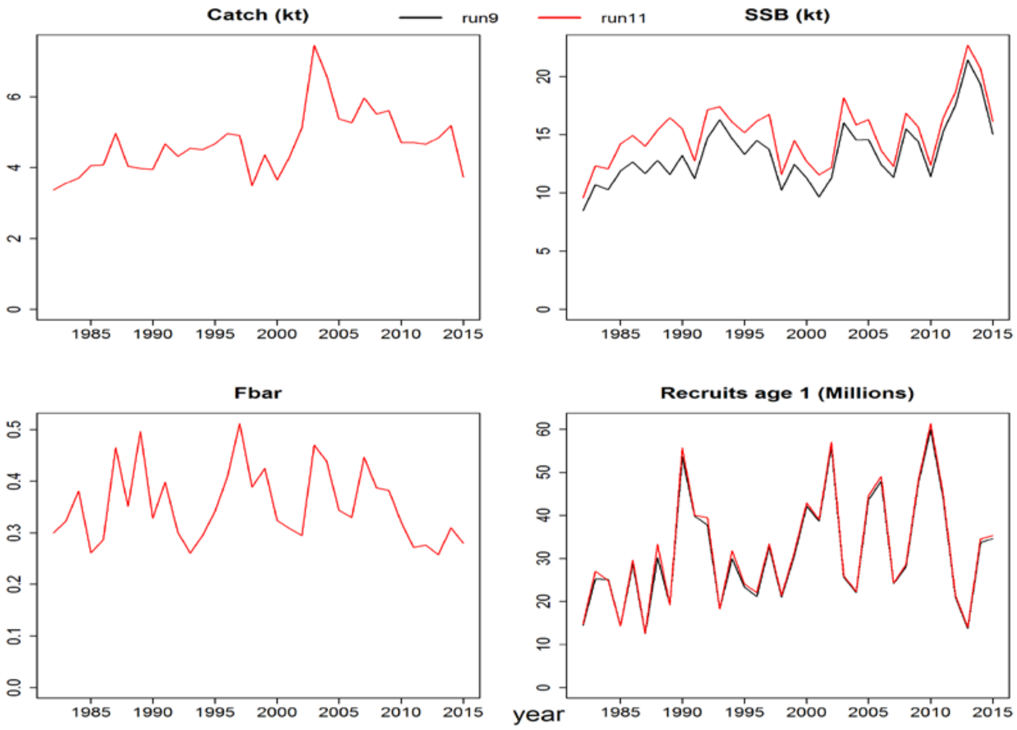


Figure 2.53. Comparison of the summary plots between the **2017 WKNSEA run9** and the **2017 WKNSEA run11**.

Excluding the BE_CBT_1980-2003 tuning fleet causes the SSB to increase from the late eighties onwards. Re-calculating this old part of the Belgian tuning series was not possible as data were not readily available. Questions on the correctness of this old tuning series were risen during the benchmark. Therefore, it was decided to move forward without this old tuning series.

2017 WKNSEA-RUN12

Data

Same catch data (total weight, mean weight- and number-at-age for landings and discards) as used in the 2017 WKNSEA-RUN1

Biological parameters

Same biological parameters as used in the 2017 WKNSEA-RUN1

Tuning series

Same set of tuning series as in RUN3 but the age range of all the commercial tuning series was trimmed to ages 3-8.

XSA diagnostics

	2017 WKNSEA		
Fleets	Years	Ages	α-β
BE_CBT_1986_2015 commercial	86–15	**3–8**	0–1
FR_COT commercial	02–15	**3–8**	0–1
UK(E&W)_CBT commercial	86–15	**3–8**	0–1

UK(E&W)_BTS survey	89–15	1–6	0.5–0.75
UK_YFS survey	87–06	1–1	0.5–0.75
FR_YFS survey	87–15	1–1	0.5–0.75
-First data year	1982		
-Last data year	2015		
-First age -Last age	1 11+		
Time series weights	None		
-Model	No Power model		
-Q plateau set at age	7		
-Survivors estimates shrunk towards mean F	5 years / 5 ages		
-s.e. of the means	2.0		
-Min s.e. for pop. Estimates	0.3		
-Prior weighting	None		

Figures 2.54-2.56 present the model output for this twelfth run.

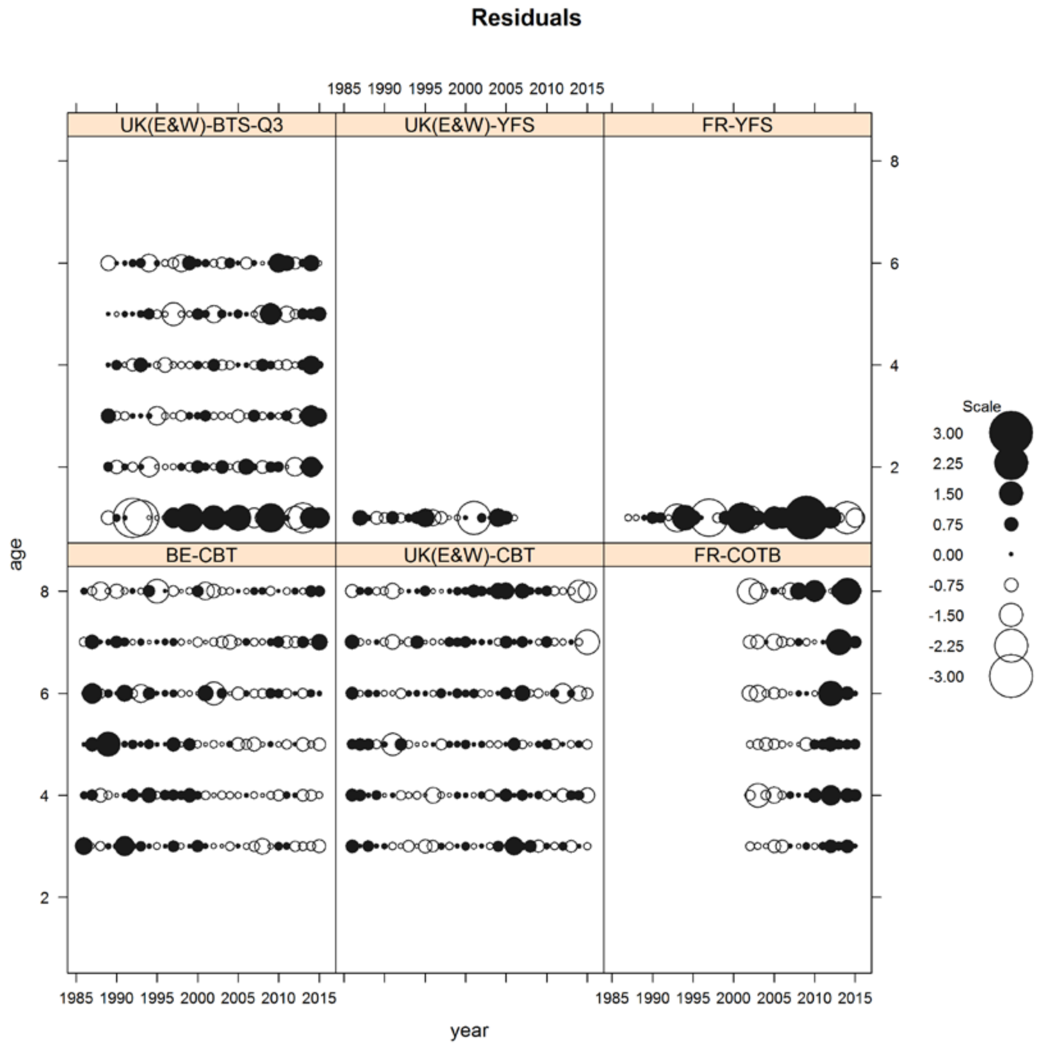


Figure 2.54. Catchability residuals for all tuning fleets used in the assessment of 7.d sole.

Figure 2.55. Retrospective pattern.

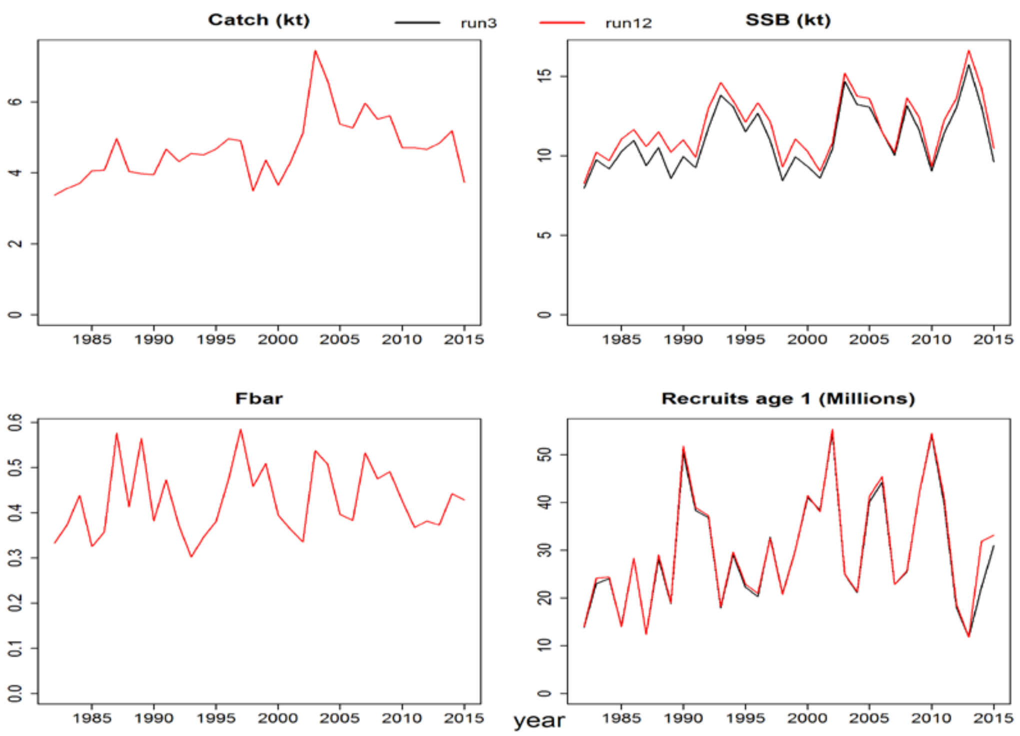


Figure 2.56. Comparison of the summary plots between the **2017 WKNSEA run3** and the **2017 WKNSEA run12**.

Trimming the commercial tuning series causes only slight differences in SSB and Fbar.

2017 WKNSEA-RUN13

Data

Same catch data (total weight, mean weight- and number-at-age for landings and discards) as used in the 2017 WKNSEA-RUN1

Biological parameters

Same biological parameters as used in the 2017 WKNSEA-RUN5

Tuning series

Same set of tuning series as in RUN11

XSA diagnostics

	2017 WKNSEA		
Fleets	Years	Ages	α-β
BE_CBT_2004-2015 commercial	**04-15**	**3–8**	**0–1**
FR_COT commercial	02–15	**3–8**	0–1
UK(E&W)_CBT commercial	86–15	**3–8**	0–1
UK(E&W)_BTS survey	89–15	1–6	0.5–0.75
UK_YFS survey	87–06	1–1	0.5–0.75
FR_YFS survey	87–15	1–1	0.5–0.75

-First data year	1982
-Last data year	2015
-First age	1
-Last age	11+
Time series weights	None
-Model	No Power model
-Q plateau set at age	7
-Survivors estimates shrunk towards mean F	5 years / 5 ages
-s.e. of the means	2.0
-Min s.e. for pop. Estimates	0.3
-Prior weighting	None

Figures 2.57-2.59 present the model output for this thirteenth run.

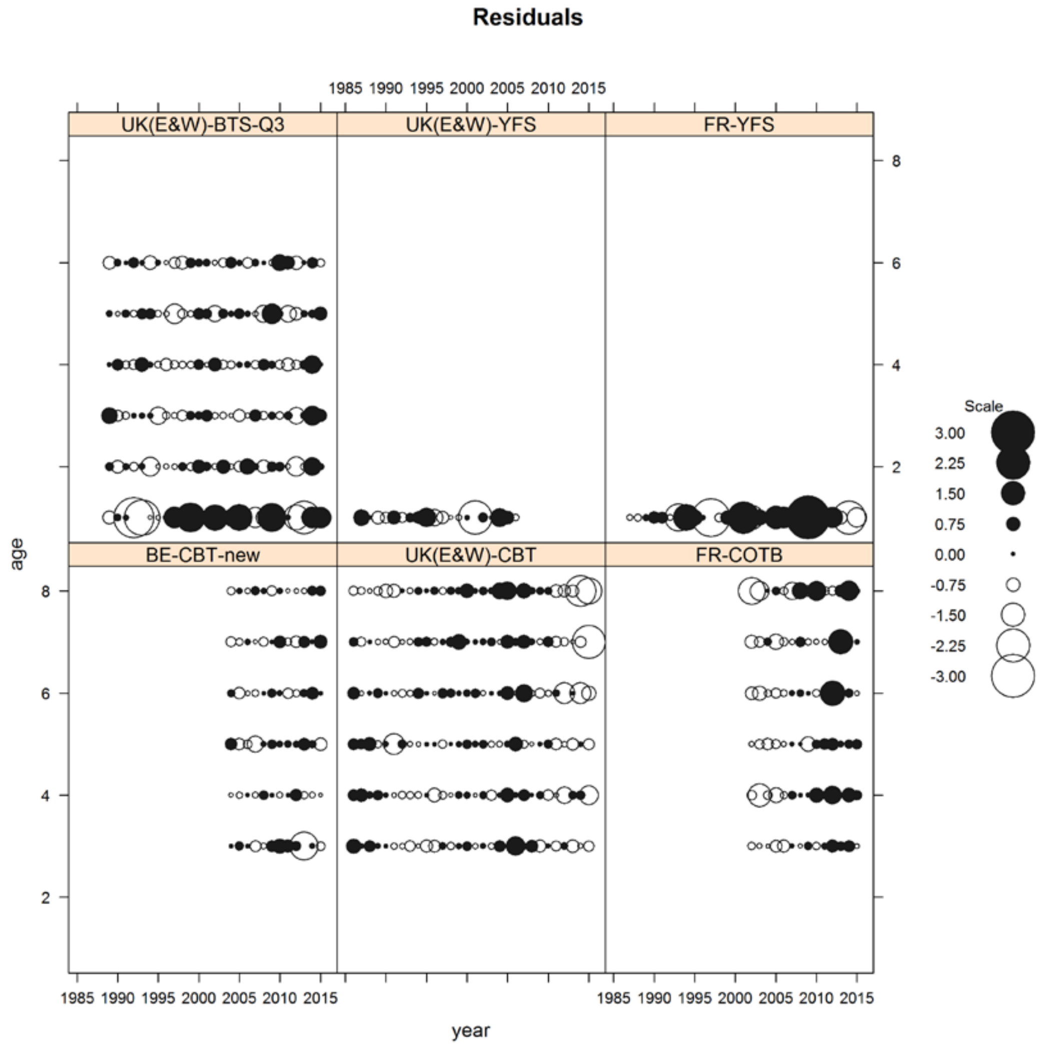


Figure 2.57. Catchability residuals for all tuning fleets used in the assessment of 7.d sole.

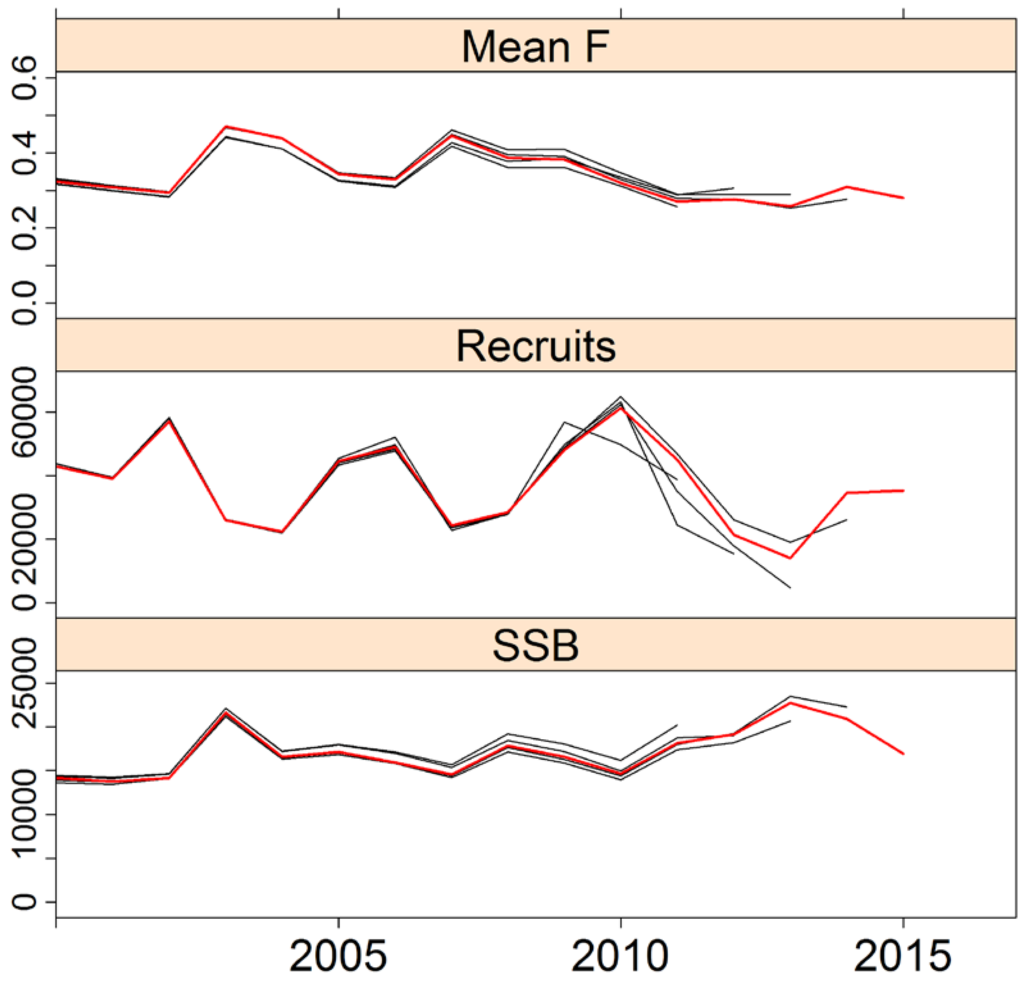


Figure 2.58. Retrospective pattern.

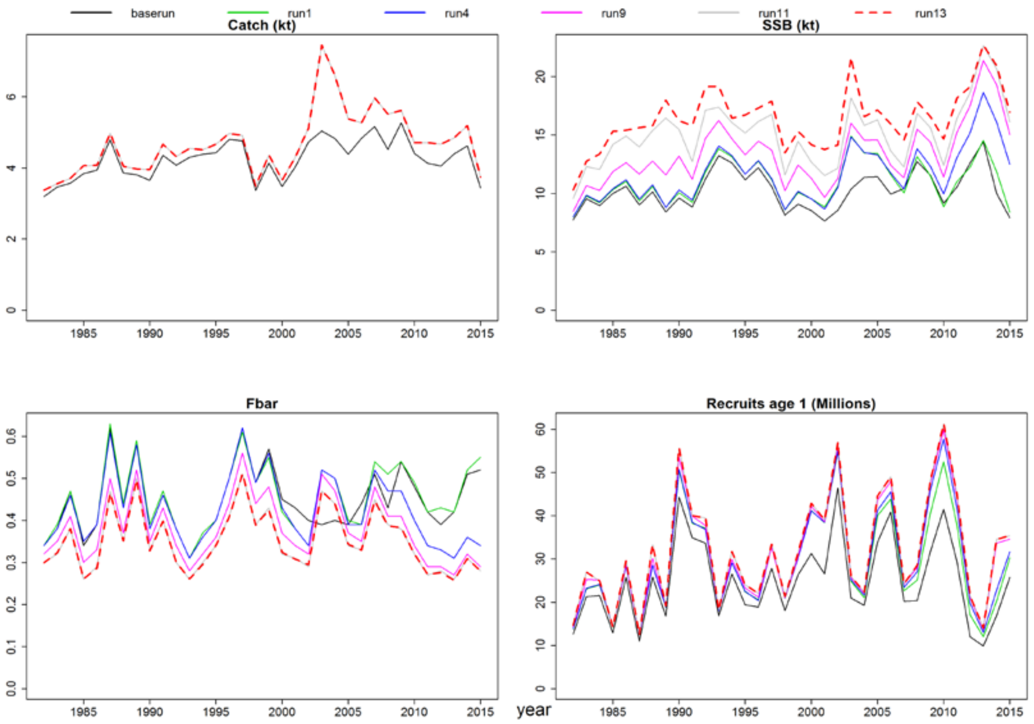


Figure 2.59. Comparison of the summary plots between the **2016 WGNSSK assessment (baserun)**, the **2017 WKNSEA run1**, the **2017 WKNSEA run4**, the **2017 WKNSEA run9**, the **2017 WKNSEA run11** and the **2017 WKNSEA run13**.

Comparing run 11 and 13 shows the effect of including the new maturity ogive.

Conclusion on XSA model runs from the benchmark

During the WKNSEA 2017 benchmark, it was decided to use the settings of run 13 in future assessments. Run 13 uses the new catch data (including the raised discards for all available data years) and stock weights. It also includes the new maturity ogive. More information on this ogive is provided in the working document on biological parameters, where it is clear that continuing to use the old one (knife-edged at age 3) was not advisable.

Several runs exploring the different tuning fleets were performed. In run 13, the Belgian index from 1986-2015 (BE_CBT_1986_2015) is replaced by a new one including only the years 2004-2015. The working document on tuning series gives more information on why it is more correct to continue with this newly calculated series. Also the French commercial otter trawl series was included (2002-2015). Considering the particular fishing behavior of the French otter trawlers in area 7d, fishing seasonally and mainly near the coasts, this tuning series provides an added value to the assessment (more information in the working document on tuning series). All commercial tuning series included in run 13 were trimmed from age 3-8 to avoid underestimating age 2 and as a consequence of poor internal consistency for ages 9 and 10 (more information see run 9).

Compared to the baserun, catches are higher from 2003 onwards. The inclusion of the new commercial tuning series (BE_CBT_2004-2015 and FR_COT) resulted in a significant increase of the SSB for the whole time series and a substantial decrease of the Fbar, especially in the most recent years. Additionally, the number of recruits are estimated to be higher over the whole time series. Those trends were further enhanced by trimming the age range of the commercial tuning series and excluding the BE_CBT_1986-2003 series.

The catchability residuals for the proposed final XSA (Figure 2.57) show some persistent effects such as the age effect for age 1 of the UK(E&W)_BTS_Q3, the UK(E&W)-YFS and the FR-YFS tuning fleets. Additionally, a year effect is observed for the UK(E&W)_BTS_Q3 series in 2014 and for the UK(E&W)_CBT series in 2015. The BE_CBT_2004-2015 series does not show any patterns or large residuals. Furthermore, there may be some indications of predominantly positive residuals in the most recent years of the FR_COT series.

Compared to the baserun, the small retrospective pattern in F (with overestimation in 2012 and 2013) is no longer present. The patterns for the recruits and SSB are comparable.

The effect on future stock advice is described in the benchmark report (forecast; section 5.7 Short term projections).

3. AAP

Model settings

A revised version of the Aarts and Poos catch-at-age model (Aarts and Poos, 2009) was used during the benchmark to assess the sole stock in the Eastern English Channel. Discards prior to 2004 are estimated directly by the model. In summary, the model takes a design matrix for a tensor spline to describe the F matrix. The dimension of that design matrix is defined by the number of knots for age and time, which are parameters in the model (see table below). Another parameter is the F-at-age, which is assumed to be constant after a given age. Furthermore, the model assumes that the q-at-age for the indices is a smooth function of age, using a spline smoother, and is also constant after a given age.

Model parameters	code	Values
Age from which F is constant	qplat.Fmatrix	7
Dimension of the F matrix	Fage.knots	5
	Ftime.knots	12
Age from which q is constant	qplat.surveys	7

The discards fraction of the catch is assumed to be a logistic curve described by two parameters. This curve is constant over time until 2008. From 2009 onwards, the observed discards-at-age ratio is used, given the observed trend in the discard-at-age ratio.

The sigma values in the log-likelihood are 3 parameter polynomials of the form (a + b*age + c*age^2), one for each data source.

Finally, recruitment is estimated as a single parameter per year.

To ensure the fitting is focused on the most important ages, the plus group has been fixed at age 8 (the model does not converge with a higher plusgroup). Only the multi-age indices can be used with this model, as it cannot handle tuning series with only 1 or 2 age classes.

Scenarios

Scenario 1 : One survey tuning series and all commercial tuning series, except the old Belgian CBT index (1986-2005)

Tuning series	Time range	Age range
BE CBT new	2004-2015	3-7
UK CBT	1986-2015	3-7
FR-OTB	2002-2015	3-7
UK BTS	1989-2015	1-6

Scenario 2 : One survey tuning series and all commercial tuning series

Tuning series	Time range	Age range
BE CBT old	1986-2003	3-7
BE CBT new	2004-2015	3-7
UK CBT	1986-2015	3-7
FR-OTB	2002-2015	3-7
UK BTS	1989-2015	1-6

Results

The model reasonably reproduced the landings time series and produced an estimation of discards for the period 1982-2003 (Figure 3.1). The discard ratio-at-age used by the model matches almost perfectly the average discard ratio over the 2004-2015 period (Figure 3.1, right panel, red and black line overlap).

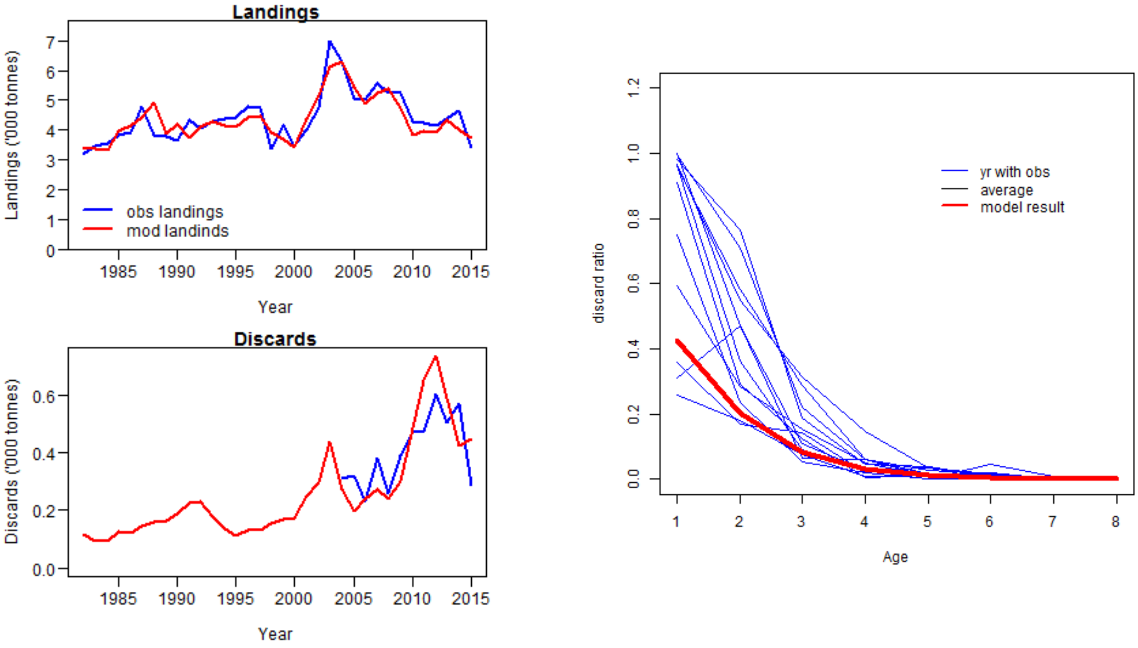


Figure 3.1 : Left panel: Historical time series of landings and discards vs landings and discards simulated by the AAP model. Right panel: Observed discards at age ratio per year (in blue), and averaged over the whole time series (2004-2015, in black), vs the discard at age ratio used in the model (in red).

In general, the residuals do not show major issues, except for the age 1 landings. They tend to be underestimated by the model (Figure 3.2).

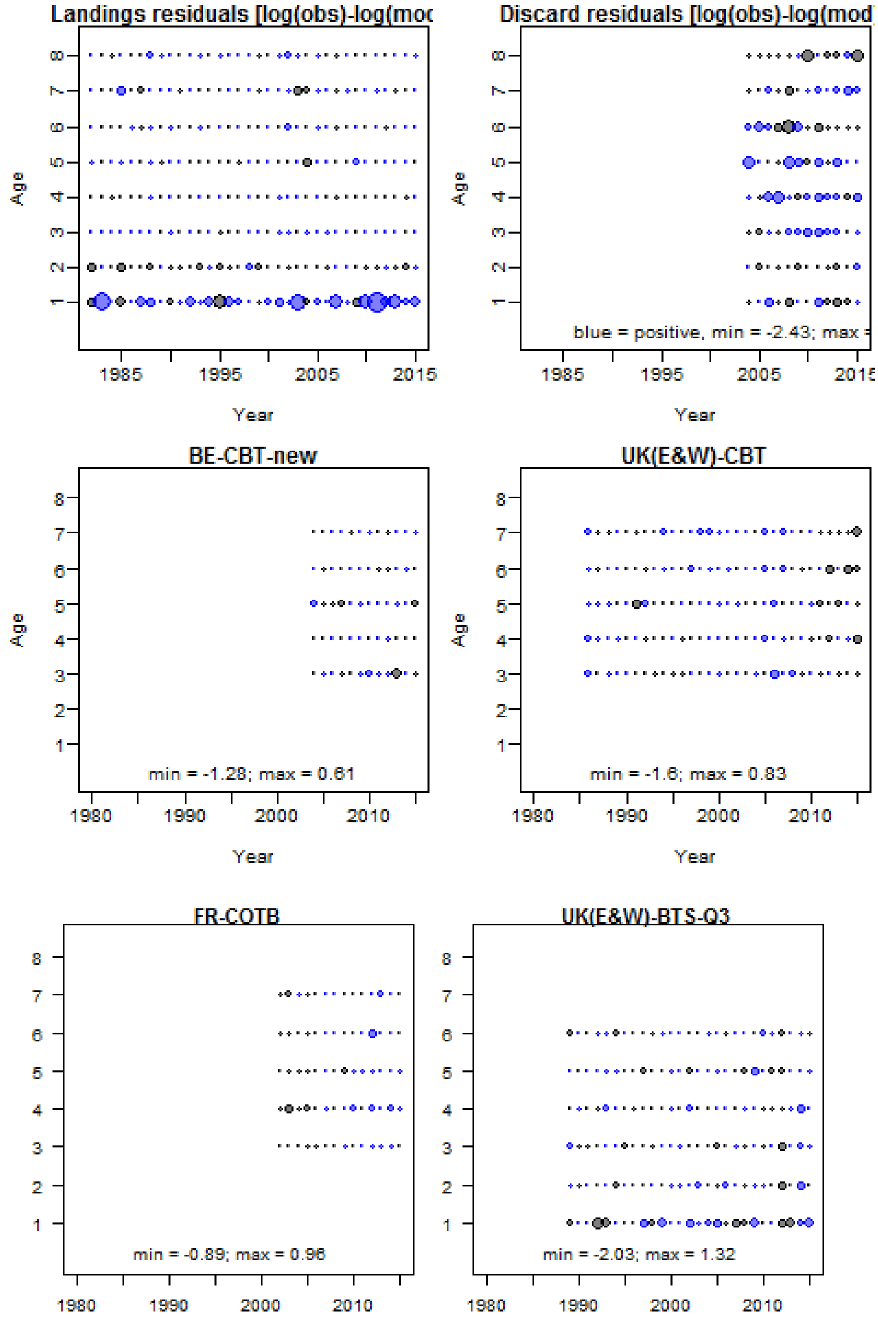


Figure 3.2: Residuals for landings, discards and all tuning indices used in the two tested scenarios.

In figure 3.3, the sigmas are plotted which provide information on how well the model is adjusted to the different sources of data available (minimization of the likelihood function). The model performs better in the youngest age classes for the discards than the landings. Then it gets better for the landings as age increases, up to age 7 (this is related to why the model works better with a relatively low plus group), and it gets worse for discards as age increase.

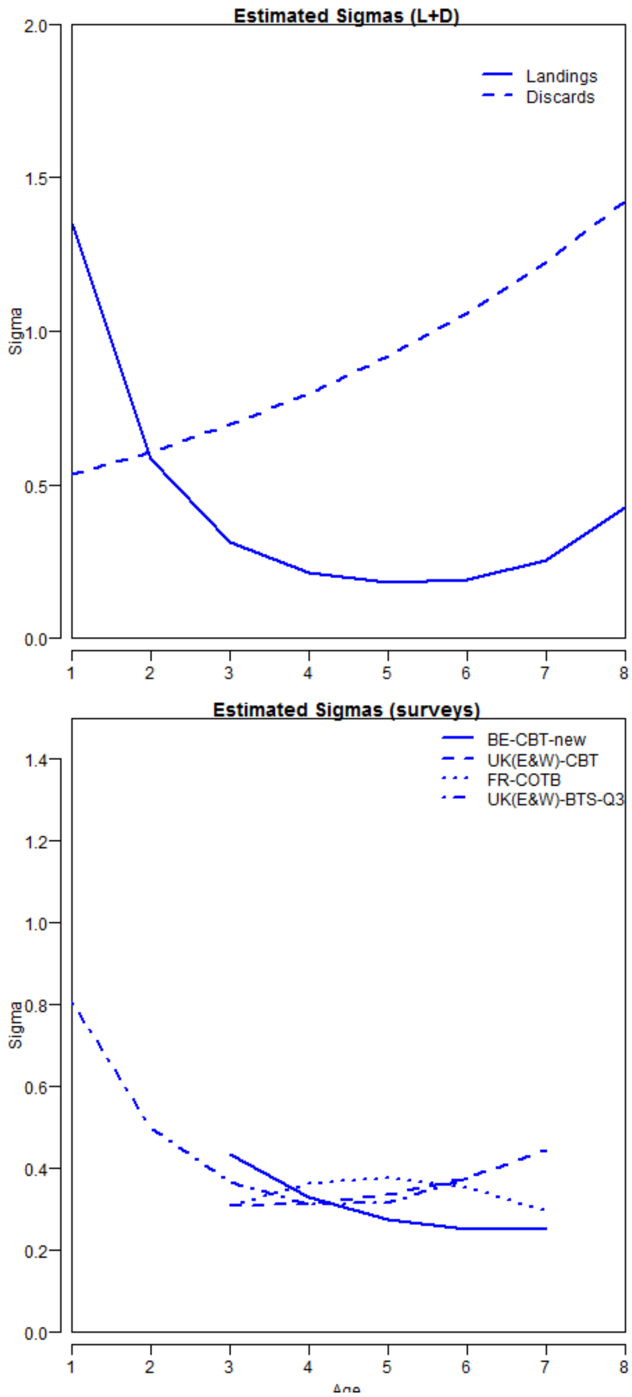


Figure 3.3: Estimated sigmas for landings, discards and all used tuning series.

Comparing the 2 scenarios

The 2 scenarios produce similar results (Figure 3.4). The only differences are situated in the first part of the time series (before 1990), where F fluctuates more in scenario 1 due to the absence of the old BE index (1986-2003).

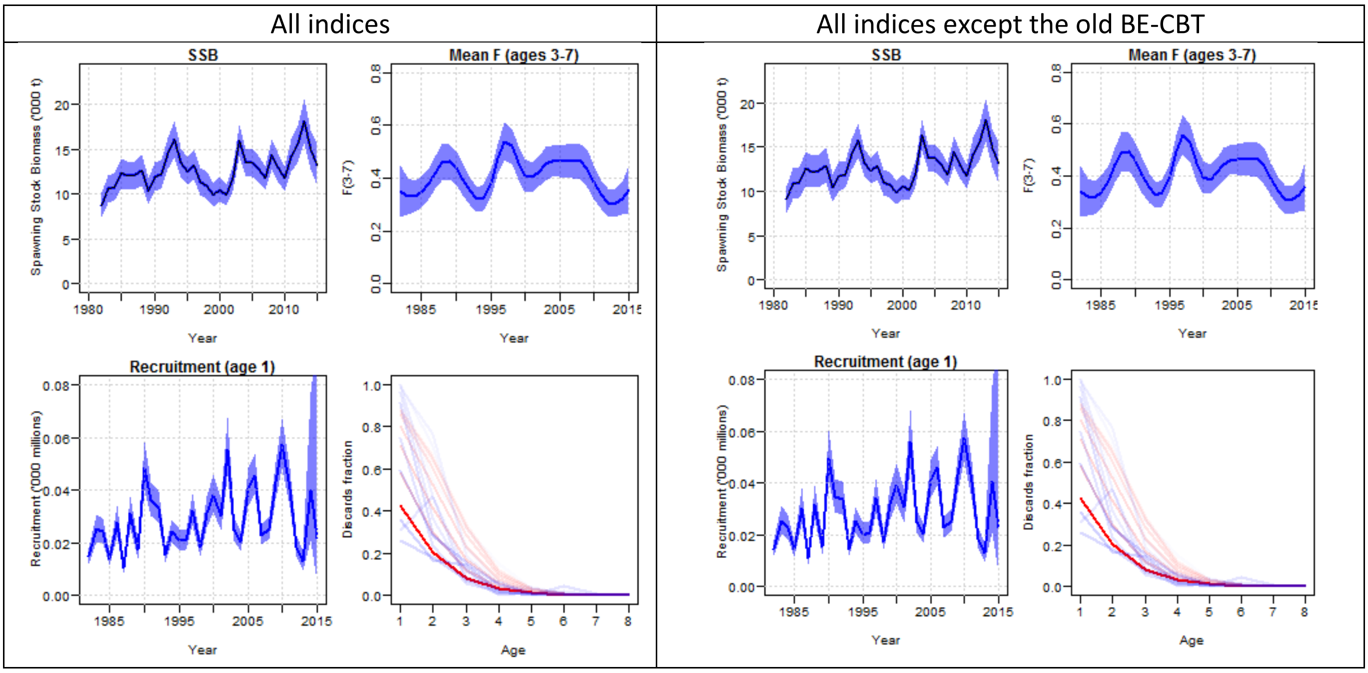


Figure 3.4: Comparison of the model output of the two tested scenarios. Scenario 2: run with all indices (left panel). Scenario 1: run with all indices except for the old Belgian index (1986-2003) (right panel).

Comparing AAP outcome with XSA outcome

With the same catch data and indices, the AAP model produces a less optimistic assessment of the sole 7d stock than the XSA model. More specifically, the SSB shows a similar increasing trend, but with lower absolute values. The same is observed for F, but in the last 2 years F increases unlike the XSA model (Figure 3.5).

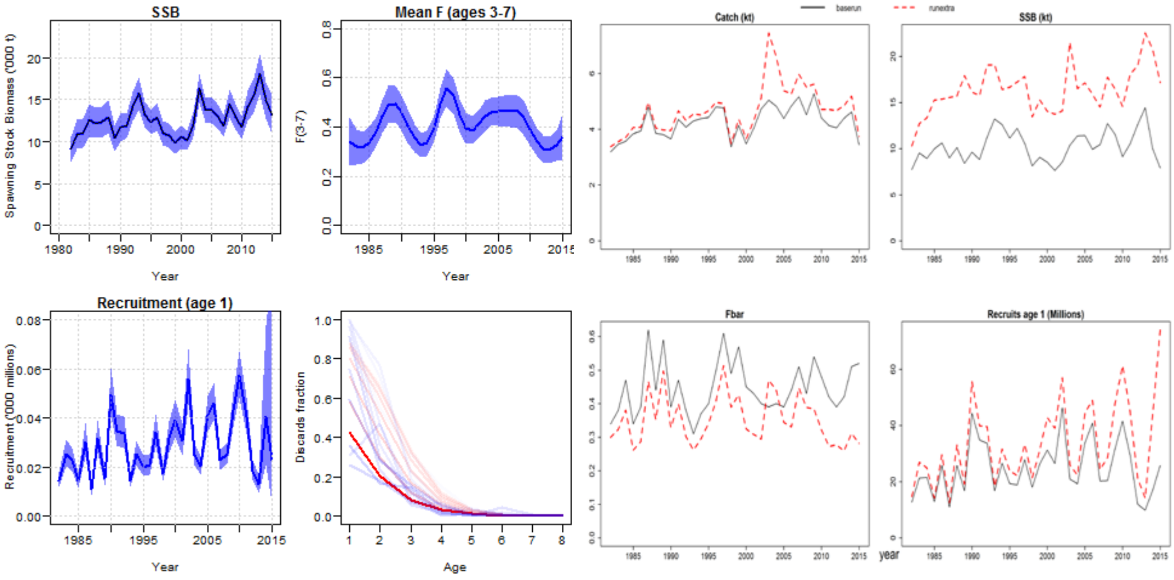


Figure 3.5: Comparing similar input between the AAP and XSA model. The AAP model produces a less optimistic assessment than the XSA model.

4. SAM

Model settings

A SAM model was set up to replicate the WGNSSK 2016 XSA assessment, but the model would not converge when the Q plateau was set at age 7. Because of this, the following settings were used to try to best replicate the WGNSSK 2016 XSA assessment (*i.e.* baserun SAM):

- 5 survey indices were used: 2 commercial beam trawl indices (BE_CBT_1986-2015 commercial and UK(E&W)_CBT commercial) and 3 research survey indices (UK(E&W)_BTS survey; UK_YFS survey and FR_YFS survey)
- Catch weights = landings weights; no discards
- Age range: 1–11+
- Max age was considered a plus group
- Fishing mortalities were a flat F from age 10, AR1 autocorrelation structure was modeled
- Catchability parameters were coupled for ages 10-11 (flat) for the commercial indices and ages 5-6 for the UK(E&W)_BTS survey
- Log N random walk variances were coupled for age 2-11, but different for age 1
- Observation variances were coupled within each tuning index (all ages)
- Catch data were not scaled to be similar for any years
- Age range for F was ages 3-7
- Natural mortality = 0.1 for all ages

Output for the baserun SAM is shown in Figures 4.1 – 4.3.

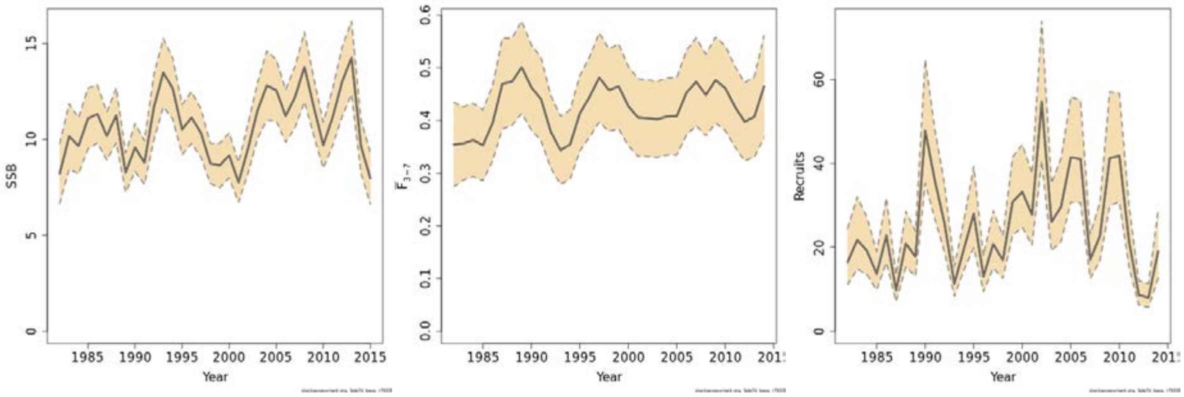


Figure 4.1. Plots of SSB, average F of ages 3-7, and recruitment for the baserun SAM.

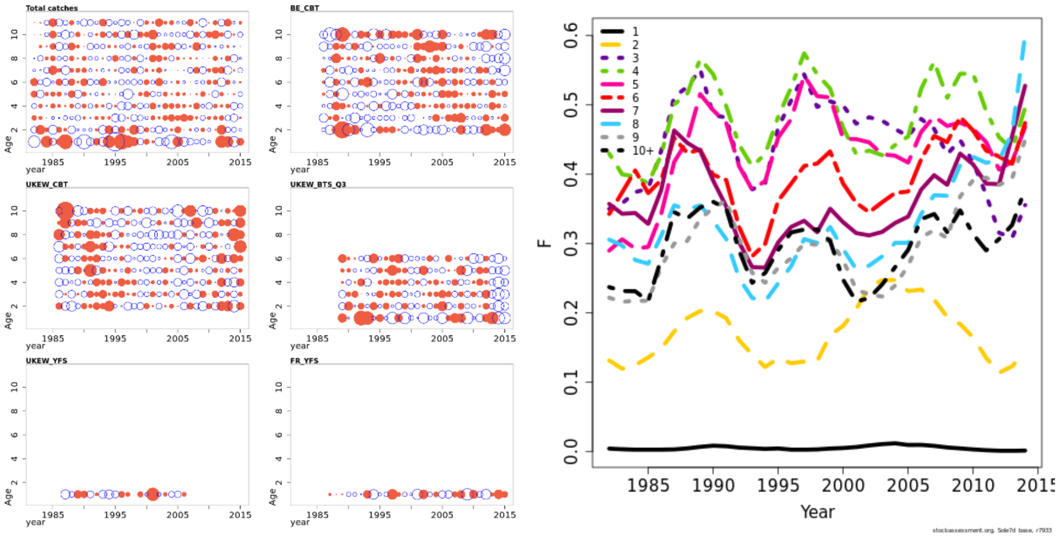


Figure 4.2. Residuals and fishing mortality at age estimated for the baserun SAM.

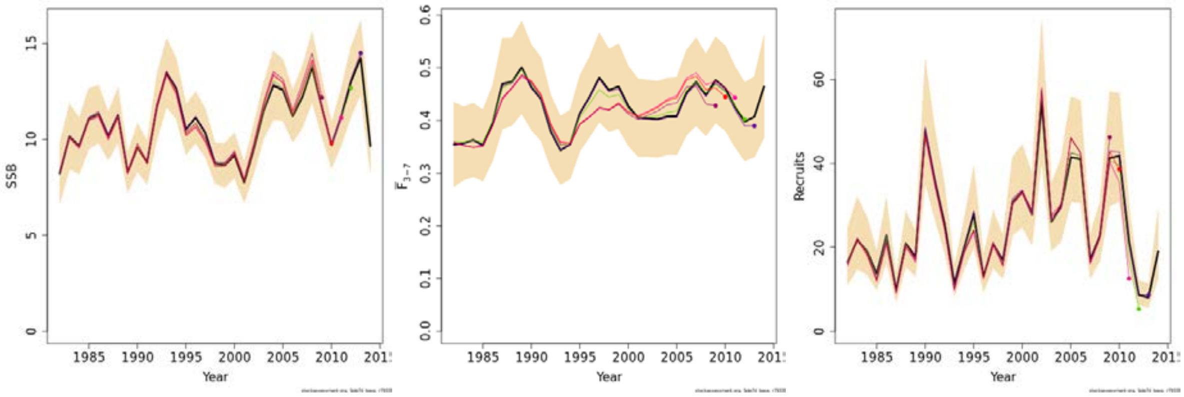


Figure 4.3. Retrospective estimates (5 years) for the baserun SAM.

Scenarios

All scenarios (1-7, see Table 4.1) were run with the revised 2003-2015 catch data as described in the working document on the preparation of catch data. New data were trialed one at a time in continuity runs to determine how changes to the data changed perceptions of the stock. New scenarios of the model consisted of scenario 1 with e.g. the BE_CBT_1986-2015 commercial tuning series replaced with the newly estimated Belgian cpue series (BE_CBT_2004-2015) (scenario 2, see Table 4.1), but leaving all other data as in scenario 1. Scenarios are outlined in Table 4.1. Changes to the input data are detailed in the working documents on biological parameters, on tuning series and on the preparation of catch data.

Table 4.1. Table of the different tested scenarios, with modifications to the input data for the baserun SAM noted. Models that failed to converge are indicated. The new Belgian cpue index is the BE_CBT_2004-2015; the new French cpue index is the FR_COT commercial. Run 5-7 include the new maturity ogive as described in the working document on biological parameters.

Scenario	Modified input data					Conversion
Baserun SAM						
1	Catch	Discards				
2	Catch	Discards	New Belgium cpue index (by age)			
3	Catch	Discards	New French cpue index (by age)			Failed
4	Catch	Discards	New Belgium cpue index (by age)	New French cpue index		
5	Catch	Discards	New Belgium cpue index (by age)	New French cpue index	Maturity	

6	Catch	Discards	New Belgium cpue index (not disaggregated by age)	New French cpue index	Maturity		
7	Catch	Discards	New Belgium cpue index (not disaggregated by age)	New French cpue index	Maturity	Autocorrelation structure	Failed

Results

Scenario 1: Revised catch data and discards

The effect of revising the catch data and incorporating discard information compared to the base model replicating the WGNSSK 2016 assessment (*i.e.* baserun SAM) are in Figure 4.4.

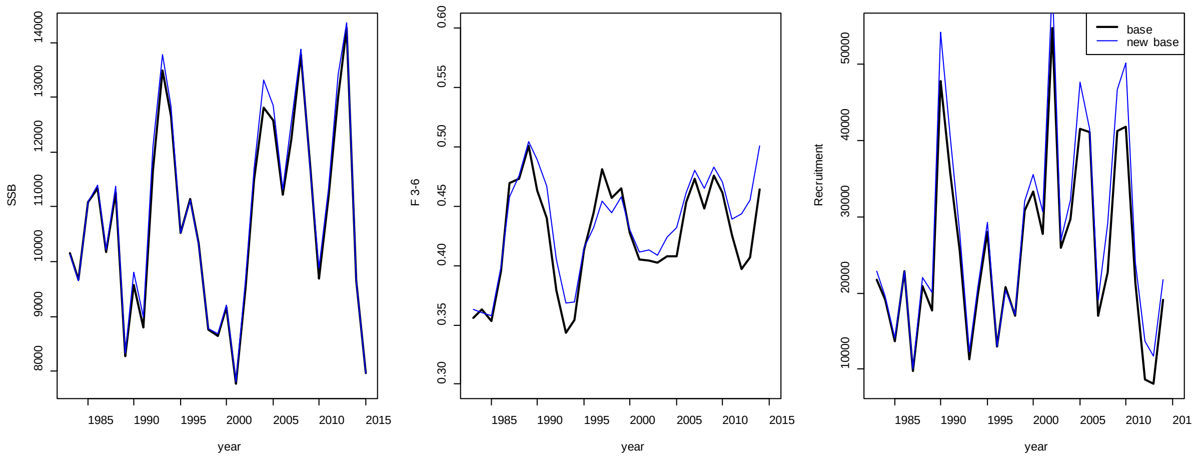


Figure 4.4. Plots of SSB, average F of ages 3-7, and recruitment. Comparing model scenarios incorporating new catch information and discards (scenario 1 (new base): blue lines) with the WGNSSK 2016 assessment output (baserun SAM: black lines).

Scenario 2: New Belgian cpue index (disaggregated by age)

Replacing the old Belgian cpue index with the modified series (using a new estimation method; BE_CBT_2004-2015) resulted in increased SSB after 2010 and lower $F_{3\text{-}7}$ (Figure 4.5, blue line).

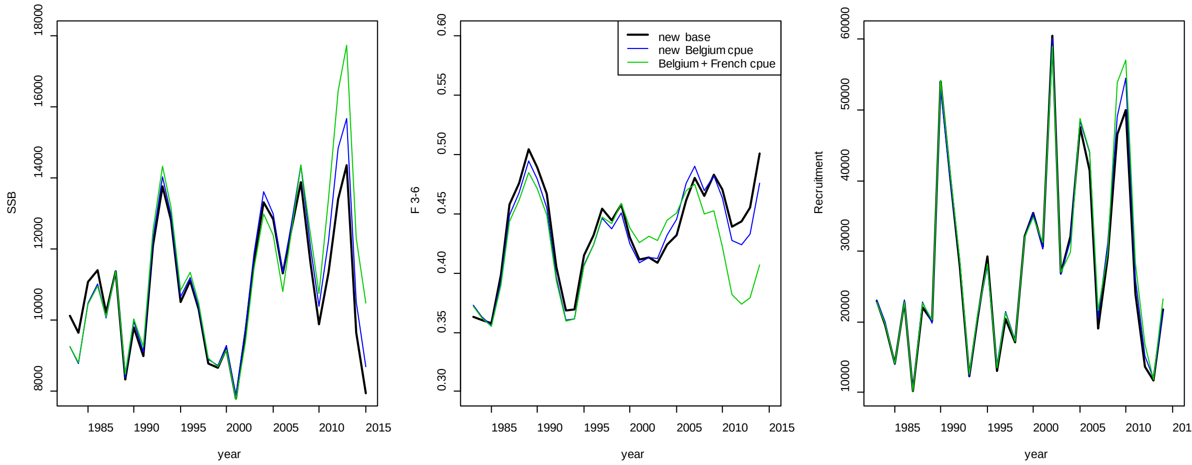


Figure 4.5. Plots of SSB, average F of ages 3-7, and recruitment. Comparing scenarios 1, 2, and 4: new catch + discard information (black lines), replacing the Belgium cpue series with new estimates (blue lines), and replacing Belgium cpue + adding new French cpue series (green lines).

Scenario 3: New French cpue index

The SAM model failed to converge when using the new base model (scenario 1) and adding the new French cpue series. It was not clear why this occurred, but a large amount of time was not spent on the model.

Scenario 4: New Belgian cpue index (disaggregated by age) + new French cpue index

Replacing the old Belgian cpue index with the modified series (using a new estimation method) and incorporating a new cpue tuning series (from French otter trawlers) resulted in increased SSB after 2010 and lower $F_{3\text{-}7}$ when compared to scenarios 1 and 2. Recruitment was fairly similar to the new base model except in 2009 and 2010 (Figure 4.5).

Scenario 5: New Belgian cpue index (disaggregated by age) + new French cpue index + new maturity ogive

This scenario resulted in the largest change in SSB and F. Incorporating the new maturity ogive appeared to have the largest effect (Figures 4.6 and 4.7).

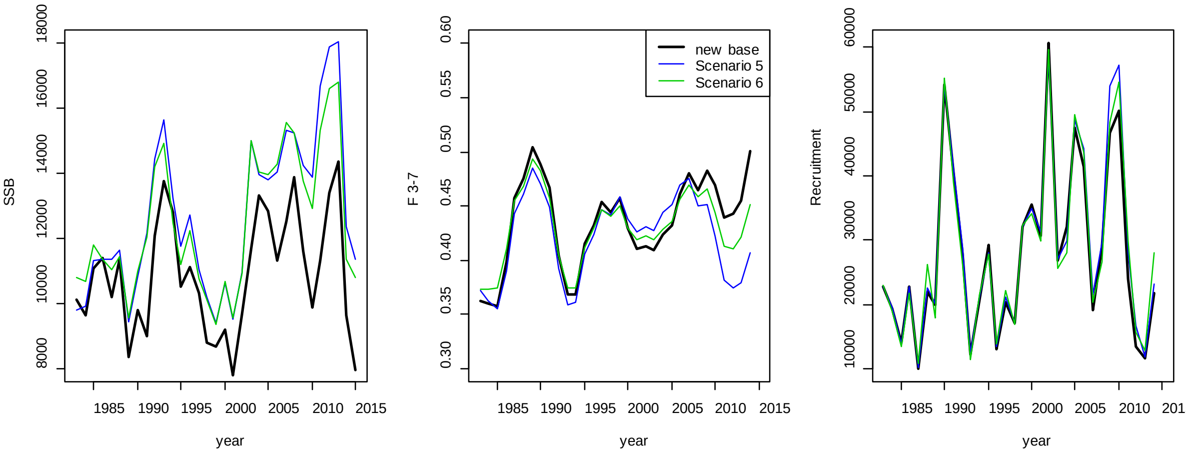


Figure 4.6. Plots of SSB, average F of ages 3-7, and recruitment. Comparing scenarios 1, 5, and 6: new catch + discard information (black lines), replacing Belgium cpue + adding new French cpue series + new maturity ogive (blue lines), and replacing Belgium cpue (not disaggregated by age) + adding new French cpue series + new maturity ogive (green lines).

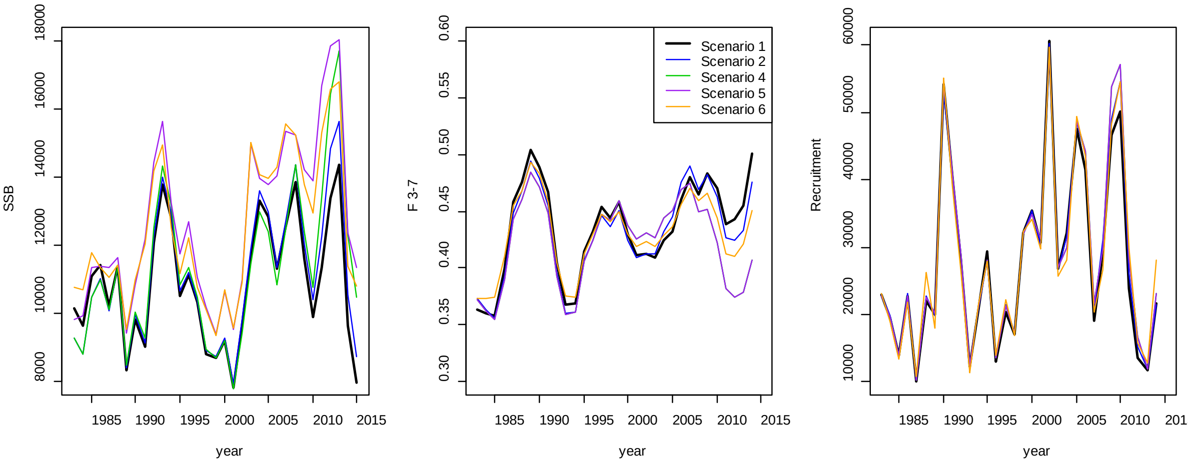


Figure 4.7. Plots of SSB, average F of ages 3-7, and recruitment. Comparing scenarios 1, 2, 4, 5, and 6.

Scenario 6: New Belgian cpue index (not disaggregated by age) + new French cpue index + new maturity ogive

This scenario had a similar effect on SSB and F as scenario 5 except after 2010. The Belgian cpue index was not disaggregated by age before being incorporated into the model, but instead cpue was scaled to exploitable stock biomass within the assessment model (Figures 4.6 and 4.7).

Scenario 7: Incorporating autocorrelation in the survey indices + data in scenario 6

Model would not converge.

Conclusions

The runs using the SAM model were mainly for exploratory purposes. They were used to verify whether the trends in SSB, F, and recruitment were similar to comparable XSA output, to explore the effect of scaling cpue to exploitable stock biomass instead of using the age information twice (once for cpue, once for disaggregating catch information by age; scenario 5 versus 6), and to explore the effect of including autocorrelation structure in the survey indices following the method of Berg and Nielsen (2016). Because of this, the failure of several of the models to converge, and the inability to set the Q plateau to age 7 to replicate the WGNSSK 2016 assessment exactly, they do not warrant further discussion.

5. Conclusion on XSA, AAP and SAM

When comparing scenario 5 of the SAM model with XSA run 13, the trends generally concur, but absolute values differ, with the XSA run 13 estimating SSB higher and Fbar lower. Although the YFS tuning series were not included in the AAP scenarios, the first scenario of the AAP model concurs more with scenario 5 of the SAM model than with run 13 of the XSA model. However, as both AAP and SAM did not allow the same flexibility in settings and data input as the XSA model did, the latter was used to move forward for the future assessments.

6. References

Berg, C.W. and A. Nielsen. 2016. Accounting for correlated observations in an age-based state-space assessment model. ICES J Mar Sci. doi: 10.1093/icesjms/fsw046.

Aarts, G. and Poos, J.J., 2009. Comprehensive discard reconstruction and abundance estimation using flexible selectivity functions. ICES Journal of Marine Sciences, 66, 763-771.

Annex 5: Recommendations

Recommendation	Adressed to
1. Plaice will be a standard species for the IBTS Q1 and Q3 surveys (to have full biological samples taken, including age information from Q1 & Q3 and stage info from Q1)	IBTSWG
2. Develope objective protocle for determining/excluding indices. This is specific to whether to include commercial lpues as current decisions are based on who attends benchmarks.	ACOM
3. Additional flexibility in InterCatch (multiple discard raising schemes)	InterCatch team
4. Sole 7.d lacks maturity data from Q1–2 (surveys, catch)	WGBEAM; WGBIOP
5. Data issues: maturity scoring of plaice and sole – country differences exist. E.g. Sweden (IBTS surveys) differs from other nations. Validity of using macroscopic determination of maturity scoring for commercial data.	IBTSWG WGBIOP