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Contents

Executive summary

Stock identification issues were examined for three of the four stocks: based on larval drift, otolith characteristics, genetics, and tagging studies the Skagerrak stock was evaluated to have strong connectivity to the North Sea plaice stock. North Sea plaice are having extensive feeding migrations into Skagerrak. The likely magnitude of the stock mix was considered sufficient to recommend and approve that plaice in the North Sea and Skagerrak are combined and assessed as one stock although some stock components in Skagerrak are considered resident. Given the size of the fishery in Skagerrak (about one tenth of the North Sea) the addition of catches from Skagerrak to the North Sea assessment has little impact on the combined assessment. For the combined North Sea and Skagerrak stock, future attempts should be made to include the IBTS data since it seemed to improve the quality compared to the IBTS data which excluded the Skagerrak region. In addition monitoring the Skagerrak proportion should be a high priority for the North Sea stock assessment and advice. This should be done to avoid local depletion of the resident stock.

The stock entity of plaice in Subdivisions 21-23 and in Subdivisions 24-32 is less well defined and available studies are inconclusive. WKPLE reviewed arguments to include 21-23 and 24-32 in one stock and had not sufficient arguments to suggest a deviation from the present perception of two stocks, the Kattegat-Belt stock (SD21-23) and the Baltic stock (SD24-32). Examination of a combined 21-23 and 24-32 assessment was initiated but further work is required.

The stock assessment for the Eastern Channel plaice stock in Division VIId was improved with regard to input and assessment method. Discard estimates from 2006–2013 are considered representative for the historic period and are included in the assessment. The commercial cpue series from the Belgian beam trawler fleet was rejected as tuning fleet because of poor performance to track cohorts and concerns on changes in fishing practices over time. Natural mortality by age group was estimated and included in the analytical assessment. The previous accepted assessment model, XSA, was rejected as a category 1 assessment model due to the lack of account of discards. A statistical catch-at-age model including discard information, Aarts and Poos (2009), was approved as the assessment model for this stock. Relevant future work should include sensitivity estimates to the strong assumption of 90% discard rates for age-1 over time since this appears to be the cause of the high amount of discards. The impact of size-based discards instead of the Aarts and Poos assumption that it can be adequately tracked by age should also be considered.

Previous assessments of the plaice stock in Kattegat and the Belts (SD 21-23) were qualitative and data limited stock approach were used for catch advice (category 3.2 stock). This benchmark reviewed and re-estimated a number of input parameters to the assessment. Four surveys (NS-IBTS(SD21) 1st and 3rd quarter, BITS(SD21-23) 1st and 4th quarter) were combined by use of a standardization into two survey indices (1st quarter and 3rd–4th quarter). This reduced much of the noise in their performance to track cohorts. Also likely noise in individual weights in stock and in maturity was reduced by assuming a fixed age pattern for all years. Ageing difficulties is recognized to be one of the main causes for the noise in input data. Based on the two combined surveys an analytical age based assessment, SAM, was accepted and the stock is therefore now assigned a category 1 stock. Future research should consider activi-

ties involved in improving the efficiency and standardization of fishery data collection particularly on discards. Evaluation of length-specific survey indices highlighted the potential benefit of models that could fit to length compositions directly. Further, modelling approaches should explore possibilities to allow incorporation of historical catch time-series. Since the sampling protocols have changed in recent years the assessment model should be developed so that variable (by year) catch estimation uncertainty can be accounted for.

Small and dispersed landings of plaice in the Baltic (Subdivision 24-32) prevent proper sampling and result in a noisy catch-at-age matrix. In addition high and variable discard rates from fisheries targeting other species in the Baltic, i.e. discards without any landings, impeded accurate discard estimates in the Baltic. Basis for stock status continues therefore to be surveys conducted in 1st and 4th quarter. SAM modelling with the surveys provides SSB estimates with high uncertainty but acceptable for a trend based assessment. The computed SSB is considered for use in an indicative assessment with DLS approach to base advice upon. Future research should consider methods to improve discard estimates to deal with discards with zero landings. Also landings estimates should be refined to ensure plaice and no other species are included. Given the relative lack of stock id studies for this area continued work should explore stock structure and potential for a combined 21-23 and 24-31 assessment. Considering the large proportion of discards and small landings more flexible modelling platforms should be evaluated to deal with size-based discards and variable observations errors over time.

WKPLE was not able to explore and define reference points for the Kattegat and Baltic stocks due to time constraints. The recent protocols on estimation procedures developed by WKMSYREF3 and WKLIFE4 both for stocks with a full analytical assessment and for data limited stocks is expected to serve as appropriate objective guidelines to derive on reference point estimates prior to the 2015 working group meetings of WGBFAS.

Generic for all stock considered at WKPLE was concluded that given the high uncertainty in mix between areas and degree of connectivity continued work on stock identification should be conducted in order to be able to better quantify the migrations/drift. Therefore explorations of alternative models that incorporate spatial issues and capture length based dynamics (discards, selectivity, ageing problems, migrations, drift) are also recommended.

1 Introduction

Within the Working Group on the Assessment of Demersal Stocks in the North Sea and Skagerrak (WGNSSK) and the Baltic Fisheries Assessment Working Group (WGBFAS) a number of common problems have recently been identified for plaice stocks and their assessments including population dynamics and technical assessment issues. Based on a number of stock identification studies the Workshop on the Evaluation of Plaice Stocks (WKPESTO) in 2012 focused on the Skagerrak plaice stock and its relation to neighbouring stocks especially the North Sea plaice. This previous work formed the basis and objective for this benchmark along with generic improvement of stock assessment and incorporation of discard in the assessments. The current assessment of the Eastern Channel plaice stock in Division VIId is currently violated by high immigration of spawning plaice from both the North Sea and the Western Channel in spawning season. Similarly the Skagerrak plaice population is highly influenced by plaice from the North Sea. Population structure in Kattegat, the Danish Belts and the Baltic (Subdivisions 21-32) is also poorly known and the present stock boundary separating Kattegat and the Belts (Subdivisions 21-23) and the Baltic (Subdivisions 24-32) needs to be examined. Comprehensive new research on the relation between plaice in Skagerrak the adjacent areas (North Sea and Kattegat) and to a lesser degree for the Belts and Baltic were presented and evaluated on this benchmark. This information provided the benchmark workshop with adequate information to decide on revised stock boundaries.

A generic request to include discard estimates into stock assessments and advice formed a major work issue. With the exception of fisheries other than beam trawl in Skagerrak, high discard rates are common in all the areas considered in this benchmark. High discard rates in combination with few landings in fisheries targeting other species impeded accurate discard estimates in the Baltic. For the remaining areas discard was estimated and included in stock assessments.

Skagerrak, Kattegat and the Belts are in many ways transition areas between the North Sea and the Baltic. The coverage of surveys in this area reflects this as many of them are only partly covering this transition area, but mainly designed to cover either the North Sea or the Baltic with various extensions into Skagerrak, Kattegat and the Belts. This has led to various problems in appropriate use of survey indices as stock indicators for stocks that are only partly covered by more surveys.

The Data Compilation Workshop (DCWK) took place 15-17 December 2014 and the Benchmark Workshop on plaice (WKPLE) was held 23-27 February 2015. The terms of reference for the benchmark are provided in Annex 1.

2 Description of the Benchmark Process

A data compilation workshop was held mid December 2014 approximately 2 months prior to the benchmark mainly in order to solve stock identification issues among the IIIa and Baltic stocks, and subsequent data compilation issues related to decision on this subject. The workshop went satisfactory and there was consensus of keeping the three of the four stocks as of last year with respect to affinity. Thus the meeting served well as a platform to discuss and agree on the various issues raised by the stock leaders and to continue data compilation and assessment preparation to the benchmark meeting.

The pre-benchmark meeting review procedure was hampered by late submission of documents to the benchmark meeting. External reviewers were therefore put in a difficult position and under time pressure from the start of benchmark meeting. Further, shortly before the meeting, the stock leader for the Eastern Channel plaice stock had to cancel attendance to the meeting. Therefore further communication between the benchmark group and the Eastern Channel plaice stock leader was by mail correspondence and WebEx's during the workshop.

Due to hard and constructive work by all participants during the benchmark, especially stock leaders and reviewers and with support from the ICES Secretariat, the benchmark process under the meeting was successful, taking into account the difficulties that were foreseen prior to the meeting. Required and valuable decisions were thus taken for all stocks and offline/remote work for the Eastern Channel plaice also ensured progress for this stock. However, due to time constraints little effort was put into report writing and editing during the meeting, but this task was completed after 1-2 weeks.

The three external reviewers stated the following on the procedure:

"The Panel of the External Experts evaluated the data and modelling approaches used for assessments of plaice stocks in Kattegat-Belt (SD21-23), the Baltic (SD24-32) and the Eastern Channel (Division VIId) and made recommendations regarding stock annexes for these stocks. The Panel also examined available stock structure information for plaice in the Skagerrak in relation to neighbouring areas. The Panel did not consider stock annex topics, such as "ecosystem drivers", that did not explicitly inform an analytical portion of the assessment. For the stocks evaluated, the assessments generally show increasing stock trends, with fishing mortality rates at acceptable levels.

Assessment working documents distributed prior to the benchmark meeting were rather limited, which constrained the review process somewhat. However, the hard work of stock leaders during the benchmark week helped to ensure that suitable stock annexes were developed. The Panel made general recommendations that apply to all stocks and assessments reviewed and also provided stock-specific recommendations." Stock specific recommendations are to be found at end of each stock section.

3 Plaice in Eastern Channel Division VIId

3.1 Stock ID and substock structure

It has been demonstrated that plaice from the southern North Sea and from Western Channel migrate into the Eastern Channel for spawning in January and February, and return back to their home ground relatively quickly after spawning. From the Eastern Channel perspective, accounting for such behaviour would imply removing a proportion of catches from quarter 1 in the input files. However, while the existence of these important migrations is an acknowledged fact, their extent and year-to-year variability are more difficult to quantify precisely. During the Benchmark Workshop on Flatfish (WKFLAT, ICES 2010), tagging studies results were analysed, and it was estimated that on average 15% of the Eastern Channel plaice stock in quarter 1 are individuals from Western Channel, and 50% of individuals are from the Southern North Sea. As a result, the assessment has been run with 65% of catches removed from VIId quarter 1, for all ages and years. The removal of 65% of the catches was done on the true values of quarterly age structure of the catch-at-age matrix from 2000 to 2008 based on the data available during WKFLAT (ICES 2010). For the previous years, the catch-at-age values for the first quarter were computed using the average percentage of catches from the first quarter over the period 2000 to 2008 and the annual catch-at-age structure of the landing. The landings values were adjusted accordingly. During the WKFLAT Benchmark, only the Belgian tuning-series of quarterly age structure was available, so only this tuning-series was modified by removing the same percentage of catches from the series

In addition to the likely variability of these spawning migrations, the processing of Q1 catches raise a number of issues. First, the analysis uses the proportion of plaice in VIId which come from neighbouring sectors, rather than a proportion of individuals from VIIe and a proportion of individuals from IV which move into VIId, but the tagging results do not permit such calculation. Second, the Q1 catch age structure is actually a mix of spawners coming from VIIe and IV and the whole population from VIId. Spawners only should be removed, not the whole age structure. Finally, if stocks are different, the length-age and weight at age might be different.

In the absence of new tagging data (to our knowledge), only limited work has been done on these aspects.

3.2 Issue list

The evaluation of the status of the stock is based on an XSA assessment using one commercial CPUE index, and three survey indices. The commercial tuning-series are the Belgian Beam Trawlers, the survey indices are the UK Beam Trawl Survey (designed for catching plaice and sole), the French Groundfish Survey and the International Young fish Survey. The International Young Fish survey (combination of UK and French YFS survey, on the basis of the carrying capacity of the respective habitats), was stopped in 2006 because of the cessation of the UK YFS, which is a cause of concern for the estimation of recruitment.

Lack of discarding information also adds to the uncertainty. Routine discard sampling began in 2003 following the introduction of the EU Data Collection Regulations and indicates percentages of discards up to 50% in number, depending on the trip and on fishing practices. However, up to now, the time-series of discards was not considered long enough to be used in an analytical assessment (ICES Advice, 2009).

The assessment settings used in the most recent years (since the last benchmark WKFLAT) were as follows:

YEARS OF ASSESSMENT		2010 to 2014	
Assessment model		XSA	
Assessment software		FLR library	
Fleets			
BE Beam Trawlers	Age range Year range		2–6 1981–2013
Survey			
UK Beam Trawl Survey	Age range Year range		4–6 1988–2007
FR Groundfish Survey	Age range Year range		2–3 1988–2007
Intern'l Young Fish Survey	Age range Year range		1 1987–2007
Catch/Landings			
Age range	1–7+		
Landings data:		1980–2013	
Discards data		None	
Model settings			
Fbar:	3–6		
Time-series weights:	None		None
Power model for ages:	No		No
Catchability plateau:	Age 5		Age 5
Survivor est. shrunk towards the mean F:	5 years/3 ages		5 years/3 ages
S.e. of mean (F- shrinkage):	1.0		1.0
Min. s.e. of population estimates:	0.3		0.3
Prior weighting:	No		No

According to the current assessment (Figure 3.1, SPALY on new data submitted for WKPLE), the spawning-stock biomass of plaice in VIId has been increasing over the last 10 years after of period a relative stability. The retrospective results show a strong pattern on recruitment, and the tuning series residuals suggest contradictory influence on the assessment from the nineties.

3.3 Stock Assessments

3.3.1 Catch – quality, misreporting, discards

The landings are mainly taken by three countries, France, Belgium and England (Figure 3.2 upper panel). Quarterly catch numbers and weights were available for a range of years depending on country; see text table below. Levels of sampling prior to 1985 were poor and these data are considered to be less reliable. In 2001 international landings covered by market sampling schemes represented the majority of the total landings. New landings data (submitted for the WKPLE benchmark) are slightly higher than old ones, and larger proportion of older individuals particularly for years between 2003 and 2007(Figure 3.2).

COUNTRY	NUMBERS	WEIGHTS-AT-AGE
Belgium	1981–present	1986–present
France	1989–present	1989–present
UK	1980–present	1989–present

Discards data time-series have been uploaded in Intercatch by UK, Belgium, Netherlands and France for WKPLE (See Appendix 1). From 2006, the « discard coverage », i.e. the proportion of landings for which we have discards data exceeds 60% (Figure 3.3). Discard data for the 2006–2013 is used to derive total discards by use of the intercatch discard raising procedure with the default option based on the landings. The correlation between discards and landings vary quite a lot from year to year (Figure 3.5), and other correlations have been explored but with no major improvements (example Figure 3.4).

From 2006 to 2013, most of the discards are aged 2 or 3 (Figure 3.6, bubble plot).

The discard ratio decreases with age (Figure 3.6), and the discard ratio at age tends to increase for ages 1, 2 and 3. Possible explanations include changes in discarding practices due to the increased abundance of small individuals, or due to increased highgrading, or variations in length-at-age of the population.

The weights at age do not appear to follow marked trends for landings nor discards (calculated with ALKs) (Figure 3.7). The length-at-age on the other hand, averaged on the French samplings (surveys and landings, untransformed data) suggest a slightly decreasing length for age 1 (Figure 3.8).

3.3.1.1 Accounting for spawning migrations from VIIe and IV

Tagging studies and WKFLAT (ICES 2010) have shown that a large amount of fish caught in the Eastern Channel during the first quarter were fish coming from the North Sea and Western Channel to spawn. It was estimated that 65 per cent of the first quarter catches in the Eastern Channel were coming from these areas (50% from the North Sea and 15% from the Western Channel) and it was decided to remove these catches from the catch matrix and reallocate then to the corresponding stocks.

However, this removal was done on the total catch (landing matrix) and not only on the mature component of the population. This was addressed during WKPLE and the impact of removing only mature fish (based on the maturity ogive) is presented in Figure 3.9 to Figure 3.13.

Removals(age i) = Catch (age i)*maturity (age i)*0.65

3.3.2 Surveys and commercial tuning series

BE CBT. One commercial fleet has been used in tuning, i.e. the Belgian Beam Trawlers. Only trips where sole and/or plaice have been caught are accounted for. The effort is corrected for engine power. The current XSA assessment uses the ages 2 to 6 (Figure 3.14).

UK BTS. A dedicated 4 m beam trawl survey for plaice and sole has been carried out by England in July using the RV Corystes since 1988. The survey covers the whole of VIId and is a depth stratified survey with most samples allocated to the shallower inshore stations where the abundance of sole is highest. This survey shows the best internal consistency by far (Figure 3.15). In the current XSA assessment, only ages 4 to 6 were used.

FR GFS. A third survey is the French otter trawl groundfish survey (FR GFS) in October. Prior to 2002, the abundance indices were calculated by splitting the survey area into five zones, calculating a separate index for each zone, and then averaging to obtain the final GFS index. This procedure was not thought to be entirely satisfactory, as the level of sampling was inconsistent across geographical strata. A new procedure was developed based on raising abundance indices to the level of ICES rectangles, then by averaging those to calculate the final abundance index. Although there are only minor differences between the two indices, the revised method was used in 2002 and subsequently. In the current XSA assessment, only the ages 2 and 3 were used (Figure 3.16).

IN YFS. Inshore small boat surveys using 2 m beam trawls were undertaken along the English coast and in a restricted area of the Baie de Somme on the French coast in September. In 2002, The English and French Young Fish Surveys were combined into an International Young Fish Survey. The dataset was revised for the period back to 1987. The two surveys operate with the same gear (beam trawl) during the same period (September) in two different nursery areas. Previous analysis (Riou *et al.*, 2001) has demonstrated that asynchronous spawning occurs for flatfish in Division VIId. Therefore both surveys were combined based on weighting of the individual index with the area nursery surface sampled. Taking into account the low, medium, and high potential area of recruitment, the French YFS got a weight index of 55% and the English YFS of 45%. The UK Young Fish Survey ceased in 2006, disrupting the ability to derive an International YFS.

FR NRS. French component of the IN YFS.

3.3.2.1 Comparisons of tuning indices (Figure 3.17)

<u>Age 1:</u> Four surveys tuning series are fully selective for age 1. Data from the recruitment surveys (IN YFS and FR NRS) tend to suggest a decrease in age 1 abundances, while the UK BTS suggest the opposite trend.

<u>Age 2 and older:</u> During the previous benchmark, the divergences observed between the commercial fleet series and the surveys (UK and FR) were discussed. It was suggested that they resulted from a different perception of the adult stock size: the surveys would have a full view of the age structure of the stock, whereas the information coming from the commercial series is truncated due to the discarding behaviour. For the sake of consistency, as the discards were not included in the assessment at this stage, it was decided to remove the ages 1, 2 and 3 from the UK BTS (the most discarded ones). The resulting retrospective pattern showed a net improvement. The same was not necessary on the FR CGFS, because of a lesser weight in the assessment (due to a lower internal consistency). It was suggested that the full age range of the surveys should be reintegrated once the discards are included in the assessment.

During the Data Compilation Workshop prior to WKPLE, the validity of such a long time-series as the Belgian commercial tuning series was discussed. Even if it is corrected for engine power, it was argued that fishing practices and fishing zones might have evolved. It was then suggested to try to cut the time-series and use only the most recent years. A removal of the age 2 (not fully fished) was also suggested.

<u>Comparison with or without the 65% removal</u>

The proportion of the Q1 landings to the total landings in the Belgian Beam trawlers fleet is used to calculate the 65% of catch to remove from the abundance time-series.

As this proportion varies in time, the correlation between the BE and BE-65% are not equal to 1 (**Error! Reference source not found.**).

No other commercial fleet tuning series will be reinvestigated. Prior to the previous benchmark WKFLAT, 2 of them were used (FR otter trawlers and UK Beam trawls) and it was argued during WKFLAT that "the 3 commercial tuning-series correspond to more than 60% of the overall catches, which leads to some circularity in the assessment. Moreover, most of the tuning series display long-term trends in catchability."

Owing to poor performance to track cohorts and concerns on changes in fishing practices over time, the commercial cpue series from the Belgian beam trawler fleet was rejected as tuning fleet.

3.3.3 Biological data

Maturity ogive: assumes that 15% of age 2.53% of age 3 and 96% of age 4 are mature and 100% for ages 5 and older (WKFLAT, 2010).

Weights-at-age: prior to 2001, stock weights were calculated from a smoothed curve of the catch weights interpolated to the 1 January. From 2001, second quarter catch weights were used as stock weights in order to be consistent with North Sea plaice. The database was revised back to 1990.

Both the proportion of natural mortality before spawning (M_{prop}) and the proportion of fishing mortality before spawning (F_{prop}) are set to 0.

Until now, natural mortality was assumed constant at 0.1 for all age classes. Alternative natural mortality values have been investigated for WKPLE, using three different methods: Jensen's second estimator, Gislason's first estimator, and Peterson and Wroblewski estimator, selected on the basis of Kenchington's review (2014).

Jensen's second estimator is based on the estimation of the von Bertalanffy K (Figure 3.19 and table below).

Linf	K	T0
47.97	0.2329	-1.836

Based on this estimation, Jensen's second estimator of M would be M= 0.35 (Jensen, 1996).

Gislason's first estimator, based on length:

$$M(l) = 1.73l^{-1.61} \times L\infty^{1.44} \times K$$

gives for the mean observed length-at-age the curve plotted in Figure 3.20, and consequently the mortality values listed in the table below.

age	meanLength	M_Gislason
0	14.08	1.501
1	22.93	0.6851
2	28.47	0.4834
3	31.66	0.4073
4	34.59	0.3533
5	37.59	0.3091
6	40.23	0.2771
7	43.51	0.2442
8	45.06	0.2308
9	46.49	0.2195
10	46.08	0.2227
11	50	0.1952
12	47.56	0.2116
13	53.55	0.1748
14	53	0.1777
17	56	0.1627

Finally, Peterson and Wroblewski's estimator, based on weight:

$$M(w) = 1.28 \times w^{-0.25}$$

gives for the mean observed weight at age the curve plotted in, and consequently the mortality values listed in the table below.

age	meanWt	M_Peterson
0	31.79	0.5391
1	172.8	0.3531
2	279	0.3132
3	369.1	0.292
4	470.1	0.2749
5	592.7	0.2594
6	716.8	0.2474
7	912.6	0.2329
8	1013	0.2269
9	1141	0.2202
10	1049	0.2249
11	1441	0.2077
12	1346	0.2113
13	1745	0.198
14	1403	0.2091
17	1628	0.2015

Figure 3.22 summarizes the values from the three methods.

3.3.4 Assessment models

3.3.4.1 Art and Poos's statistical catch-at-age model

A revisited version of Art and Poos catch-at-age model (2009) has been run to provide discards estimates for the years prior to 2006. In summary, the model takes a design matrix for a tensor spline that will describe the F matrix. The dimension of that design matrix is defined by the parameters in the model (see table below). It assumes that the F-at age is constant after a given age, which is a parameter to the model. It assumes that the q-at-age for the indices is a smooth function of age, using a spline smoother. The number of knots is a parameter to the model. Also, q-at-age is constant after a given age, which is a parameter to the model. It assumes that the discards fraction of the catch is a logistic curve, described by two parameters. This curve is constant over time. The sigma values in the log-likelihood are 3 parameter polynomials of the form (a + b*age + c*age^2), one for each datasource. Finally, recruitment is estimated as a single parameter per year.

Model parameters	code	Values
Age from which F is constant	qplat.Fmatrix	6
Dimension of the F matrix	Fage.knots	4
	Ftime.knots	14
	Wtime.knots	5
Age from which q is constant	qplat.surveys	5

<u>Scenario 1 (100% catch-at-age, 3 tuning series, Peterson's natural mortality)</u>

In this first scenario, we used the catch-at-age matrix corresponding to the total population (without correcting it for spawning migrations), the 3 multi-age tuning series (UK BTS, FR GFS and BE CBT), and the natural mortality-at-age calculated with Peterson's method (see section 3.3.3)

The model reproduces correctly the observed landings (Figure 3.23), although it tends to overestimate them from 2010–2014, when the discards are underestimated. In general, according to the retrospective results, the model tends to underestimate F. Only one survey covering the age 1 is considered, the recruitment surveys (with only age 1, i.e. IN YFS and FR NRS) cannot be included in the model at this stage. The retrospective pattern observed in the recruitment might be due to the highly variable abundance of age 1 as observed by the UK BTS.

The high volumes of discards produced in 1990–1995 and around 2000 are essentially age 1, and appear to be due to a combination of a very high discard ratio for age 1 (such as fitted on existing data 2006–2013), the relatively high observed landings (therefore high predicted catches), and high predicted age 1 abundance (Figure 3.24). The F mortality and as part of it the $F_{discard}$ mortality fluctuate through time, but the discard ratio at age is fixed.

A second scenario was run to check whether these massive discards event might be due to the influence of the commercial tuning fleet. The settings were the same (Peterson's mortality and 100% of catches and discards), but we now only use the 2 surveys as tuning series.

<u>Scenario 2 (100% catch-at-age, 2 tuning series, Peterson's natural mortality)</u>

The estimatedvs.observed landings and discards results are unchanged, but the retrospective results are improved on F and SSB. Similar retro patterns remain on the recruitment, associated with the fluctuations of the abundance of age 1 as suggested by the UK BTS survey (Figure 3.25).

The estimated discards are almost the same, with an identical dynamics of F through time (Figure 3.26).

The overestimation of landings in the last 3 years is due to the ages 2 and 3. Discards are correctly estimated for ages 1 and 2 but are largely underestimated for ages 3 and 4 (Figure 3.27).

It was then decided to include 2 surveys only, as the retrospective results were improved compared to the previous scenario, but to run an additional scenario with a catch-at-age matrix accounting for spawning migrations in the new method described in section 3.3.1.

<u>Scenario 3 (catch-at-age corrected for spawning migrations, 2 surveys, Peterson's natural mortality)</u>

No changes in the performance of the model are noted (Figure 3.28 to Figure 3.31). In particular, the changes in the catch-at-age matrix do not alter our results in landings and discards at age (vs observations). This scenario was judged the most satisfactory.

For comparison, two other scenarios were run and presented here.

<u>Scenario 4 (catch-at-age corrected for spawning migrations, 2 surveys, old natural mortality)</u>

First, the same scenario but with the natural mortality rate that was used before, i.e. 0.1. The results are displayed in Figure 3.32 and Figure 3.33.

<u>Scenario 5 (catch-at-age corrected for spawning migrations *in the old way*, 2 surveys, Peterson's natural mortality)</u>

Then, the same scenario as scenario 3, but with the catch-at-age matrix corrected for spawning migrations in the old way, i.e. 65% of the Q1 whole age structure and not only the mature individuals being removed). The results are displayed in Figure 3.34 and 3.35.

3.3.4.2 XSA

The XSA model was run, using the discard time-series estimated from the Art and Poos model from 1980 to 2005 (scenario 3), and the observed discards from 2006 to 2013, and using Peterson's natural mortality.

Several combinations of the available tuning indices and their age ranges were tested, and only results from the best two are shown here.

<u>XSA Scenario 1</u>

In this one we use the 5 indices with the following age ranges:

BE CBT: ages 4 to 6 (the most discarded ages were removed)

UK BTS: age 1 to 6

FR GFS: ages 2 to 4 (the ages with the best internal consistency)

IN YFS and FR NRS: age 1.

The results still show significant patterns in the retrospective (Figure 3.36), particularly in the recruitment and F_{bar}, and heavily trended survey residuals.

XSA Scenario 2

In this one we use 4 indices with the following age ranges:

UK BTS: age 1 to 6

FR GFS: ages 2 to 4 (the ages with the best internal consistency)

IN YFS and FR NRS: age 1.

We remove the Belgian commercial tuning series, just as we did with Art and Poos' model. The retrospective patterns are greatly improved, for F in particular (Figure 3.37), but we still have quite conflicting influences from the different surveys.

3.3.4.3 A4a statistical catch-at-age model

An assessment of Eastern Channel Plaice was carried out using a4a modelling framework (Jardim *et al.*, 2015). This framework relies on the specification of three log-linear submodels, one each for fishing mortality, survey catchability and recruitment. The catchability and stock recruitment submodel was a year effect model with independently varying recruitment and age effect for catchability. The fishing mortality submodel investigated was a year and age effect. Results shown in Figure 3.38 to Log residuals show the same patterns already observed in XSA with a trend for the surveys (UK BTS and FR GFS) that have negative residuals at the beginning of the time-series and positive values at the end of the period (Figure 3.39).

Figure 3.44,

The model reconstructs the catch quite well in general excepted for the years where it has trouble estimating the catch-at-age (i.e. 2000 or 2001, Figure 3.40).

The retrospective analysis shows the same retrospective pattern already seen in the XSA assessment (Figure 3.43).

3.3.4.4 Conclusion on assessment models

The inclusion of discards data and the testing of different combinations of tuning series (and age range in them) did not solve the issues associated with the use of the XSA method. The a4a assessment in its specification did neither improve the assessment. In both cases, the inclusion of discards estimated from the Aart and Poos model in other models was not considered satisfactory by the benchmark panel. The results obtained with the Art and Poos model on the other hand were judged acceptable, although the panel recommended further explorations of the high estimated discard volumes in the 1990s and early 2000s. The scenario 3, i.e. the catch-at-age matrix corrected for spawning migrations in the new way, 2 surveys and Peterson's mortality was selected. The Belgian Beam trawl tuning was therefore rejected as input to this assessment.

3.4 Appropriate Reference Points (MSY)

3.4.1 Methods used

Eqsim with additional WKMSYREF3 code was used to produce median yield and F estimates (see methods section 3.4.4)

3.4.2 Current reference points

Table 3.1 Summary table of current stock reference points.

Reference point	Value	Technical basis
Current FMSY	0.25	Computed with Eqsim based on the 2014 assessment during WKMSYREF3 (ICES, 2014).
Current Blim	Not defined	
Current Bpa	Not defined	
Current MSYBtrigger	Not defined	

3.4.3 Settings

Table 3.2 Model and data selection settings

Data and parameters	Setting	Comments
S/R - Relationship	Segmented regression, Beverton and Holt and Ricker	With automatic weighting (eqsr_fit)
SSB-recruitment data	Year classes 1980–2013	
Blim suggestion	8958 t	Hockey stick breakpoint
Exclusion of extreme values for (option extreme.trim)	No trimming	
Mean weights and proportion mature	2006–2013	Observations on discards weight at age and in the stock are available from 2006 onwards only
Exploitation pattern	2004–2013	
Assessment error in the advisory year. CV of F	0.25	
Autocorrelation in assessment error in the advisory year	0.30	

3.4.4 Results

3.4.4.1 Stock recruitment relation

The full available period (1980–2013) was used for stock–recruit modelling.

The stock recruitment fit, using the three models (Ricker, B&H and segmented regression), did not result in much weight to the Ricker model (8%). The segmented regression model and the Beverton and Holt model on the other hand obtained 26% and 66% of the weighting, respectively (Figure 3.45). We used the three stock–recruitment relationships (with the weighting mentioned previously) and a B_{lim} of 8958 t (defined as the breaking point of the segmented regression SRR, Figure 3.46) to calculate F_{MSY} and F_{MSY} F-ranges.

The assessment error in the advisory year was set to 0.25 (F_{cv}) and the autocorrelation in assessment error in the advisory year was set to 0.30 (F_{phi}).

3.4.4.2 Eqsim scenarios

There were no extreme values excluded from the simulations (No Trim). The year range assumed for selectivity was set to 2004–2013 as recommended in the section 3.1.2 of the WKMSYREF3 report (ICES, 2014), as no apparent trend were seen over this period for selectivity and stock/catch weights. The year range 2006–2013 was used for the biological parameters, as discards weight at age were only available from 2006 (section 3.3.1).

Two scenarios are presented, without or with $B_{trigger}$, with in the second case $B_{trigger}$ = 1.4*B_{lim}.

3.4.5 Proposed reference points

The 3 Stock–recruitment relationships (with automatic weighting) model, with a Blim of 8958 t (defined from the segmented regression model) was used (no trim, not excluding years).

Table 3.3 Summary table of proposed stock reference points from Eqsim

Stock – Plaice VIId	without $B_{trigger}$	with $B_{trigger}$
Reference point	Value	Value
F_{MSY} (median)	0.30	0.31
F_{MSY} lower	0.20	0.21
F_{MSY} upper	0.43	0.43
New FP.05 (5% risk to B_{lim} without $B_{trigger}$)	0.52	0.60
F_{MSY} upper precautionary with note of whether conditional	0.43	0.43
MSY	7517 t	7551
Median SSB at F_{MSY}	34 570 t	33 607
Median SSB lower precautionary (median at F_{MSY} upper precautionary)	50814 t	50 346
Median SSB upper (median at F_{MSY} lower)	21 487 t	21 563

The Eqsim summary plots for Plaice VIId are presented in Figure 3.47 and 3.48. The estimated yield curve for Plaice VIId is presented in Figure 3.49 and 3.50. And finally median SSB for Plaice VIId over a range of target F values are presented in Figure 3.51 and 3.52.

3.5 Future Research and data requirements

Recruitment: Include the recruitment surveys in the Art and Poos' model, plus potential additional data or research on recruitment.

Validate the model findings with high discards volumes in the nineties and early 2000’s: look for data, ask fishers, compare with the situation in the North Sea.

Explore further potential changes in size at age and consider using a size-structure model, if length/weigth at age evolution is demonstrated.

3.6 External reviewer report

A high priority for this stock for the benchmark was to develop an approach that would appropriately account for discard amounts since previous attempts of incorporating discard information had failed due to the limited discard data available. Several alternative models were presented at the benchmark, including the FLR implementation of the Aart and Poos (2009) model, a4a and XSA. The Panel appreciated the efforts of exploring an XSA-based assessment, but in order to include discard estimation in the XSA model, the total catch composition was taken from the Aarts and Poos model, which was considered a complicated and unnecessary step. Therefore, the Panel recommended the Aarts and Poos model from the alternatives presented.

Documentation distributed prior to the benchmark meeting was inadequate. The Panel would have preferred to have adequate documentation prior to the meeting and the stock assessor physically present for the discussions, for the most efficient review process. However, the WebEx presentations and e-mail exchange during the benchmark week helped considerably to ensure that a suitable stock annex will be forthcoming.

3.6.1 Issues addressed at the benchmark

Data on discard rates by age are available during recent years (from 2006 forward) and these rates were used to extrapolate discard information to the historical period. The Panel was concerned with substantial historical discard amount. For example, the data indicated that in the recent period only 10% of the harvested age-1 plaice were landed, and 90% discarded. Using these recent data, the model greatly inflated the discards of age-1 plaice in historical years when even small amounts of age-1 plaice were landed. The Panel was also concerned with poor fit of the model to recent discards-at-age data (especially for age 3) but agreed that this poor fit is likely due to the fact that the Aarts and Poos model uses age-specific discard functions when the actual discarding is a size-based process.

Originally, the assessment included the Belgium beam trawler fleet cpue data as a tuning index for this stock. The Panel concluded that there was little justification to use this index in the assessment, because of its poor performance in tracking cohorts and concerns over changes in fishing practices over time. Survey index data for the Eastern Channel stock suggest that due to a recent strong 2010 year class the spawning biomass projections are increasing, which is consistent with the nearby plaice stocks. Some "year-effects" were apparent in the survey data (e.g. 2010), which can be probably be resolved by using models that separate the overall catch rate per survey operation (expanded appropriately to obtain an index) from the composition of the size and age classes within the survey operations.

The Panel noted that it is unlikely that the choice for natural mortality (M) of 0.1 across all ages is unlikely for a stock that has very few fish much older than age 6 or so. Several alternative natural mortality models based on biological traits were presented and the Panel recommended using the Peterson vector of M at age for the assessment. The maturity vector was assumed to be 15% at age 2.53% at age 3.96% age 4, and 100% for ages 5 and older. The Panel recommended further evaluation of this vector and comparison with plaice stocks from other regions (i.e. North Sea and Baltic).

3.6.2 Use of final stock annex as basis for providing advice

The Panel agreed that the stock annex is adequate for providing scientific advice and should include the following recommendations:

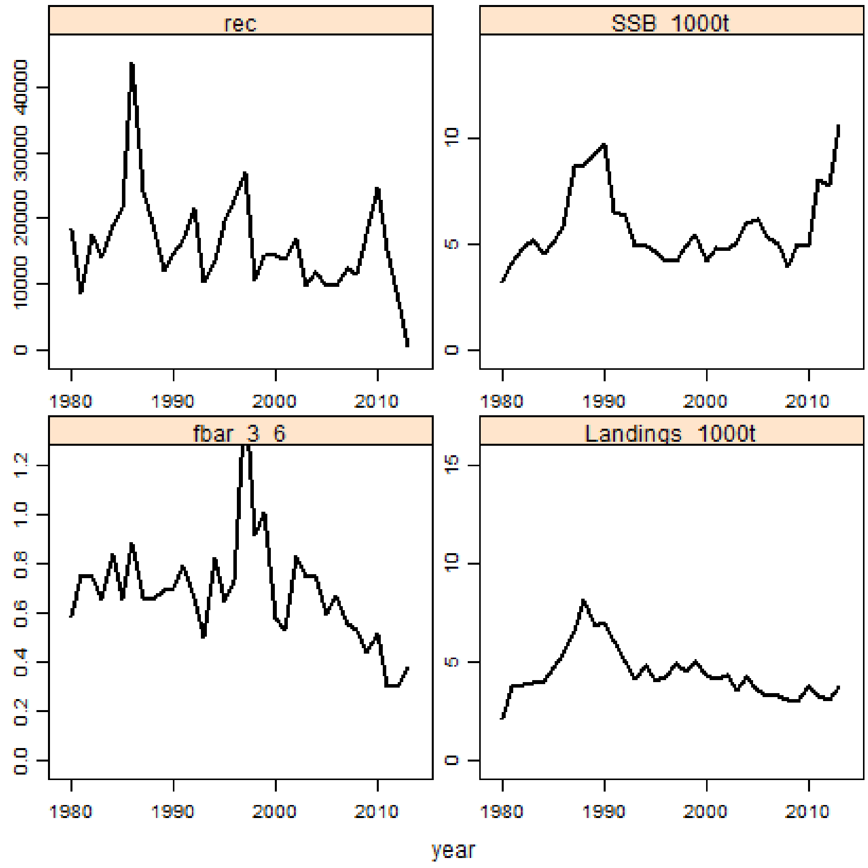
1) Use the Aarts and Poos (2009) model for catch-at-age;
2) Use new age-specific M calculated based on Peterson model;
3) Exclude the cpue series from the Belgian beam trawler fleet;
4) Exclude 65% of mature fish from the catch matrix due to observed migration of mature fish between Channel and the North Sea (originally, 65% from the all ages was excluded);

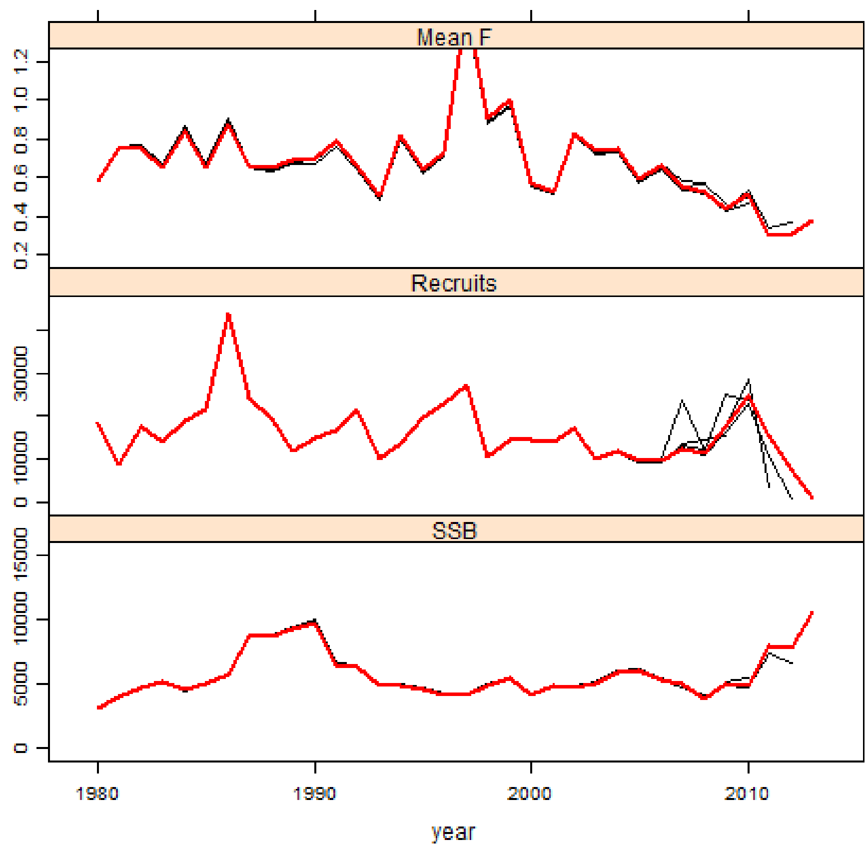
3.6.3 Recommendations for future work

Prior to the next benchmark, the Panel recommends to:

5) Develop a model that can provide sensitivity analysis to the assumption of 90% discard rates for age-1;

6) Consider the impact of using size-based discards instead of the age-based discards in the Aarts and Poos model;
7) Investigate whether historical patterns in fishing practices can inform assumptions about historical discards (and evaluate whether discard rates relative to landings may have changed);
8) Continue analysing movement patterns and connectivity of Eastern Channel stock with plaice in the North Sea with the goal of developing spatially-explicit modelling approaches.


rec
SSB 1000t
fbar 3 6
Landings 1000t
year


Mean F
Recruits
SSB
year

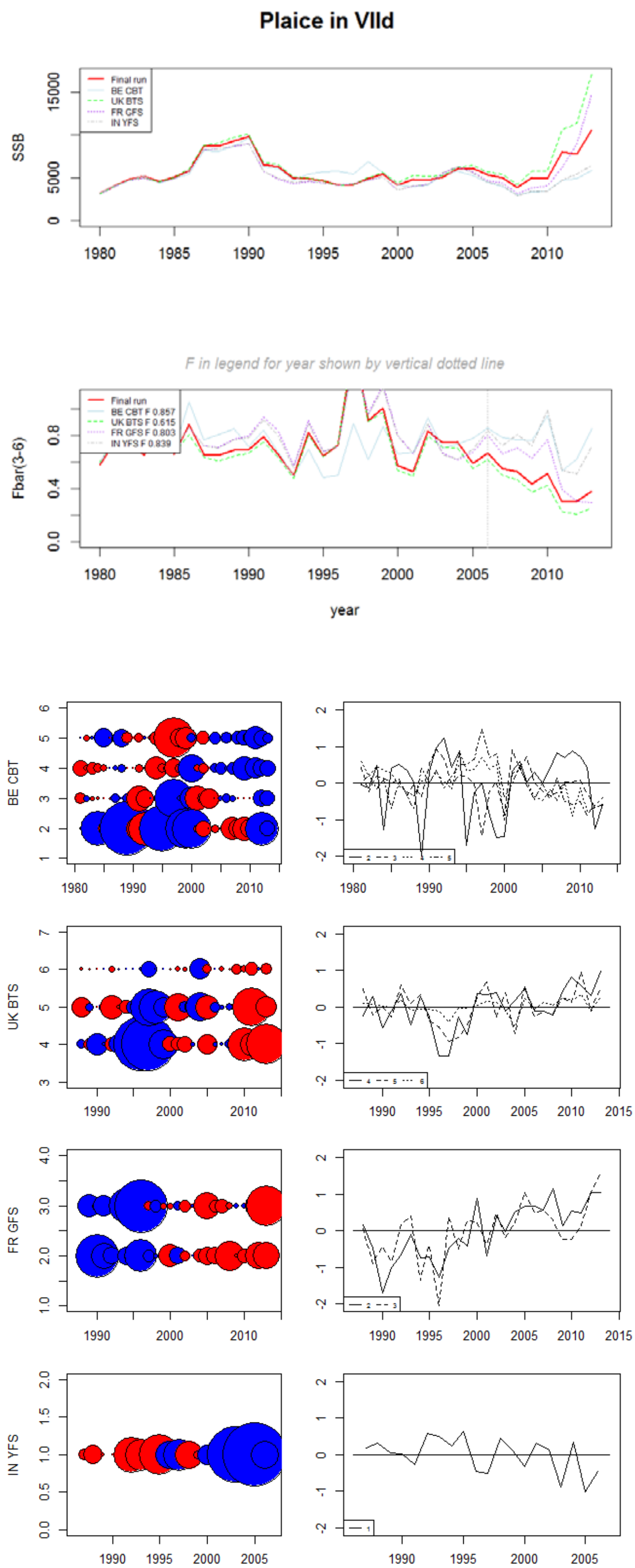
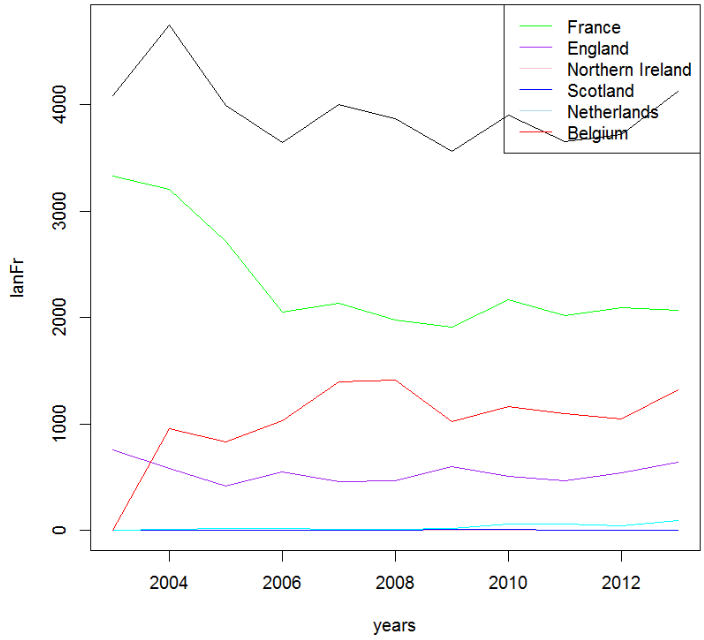
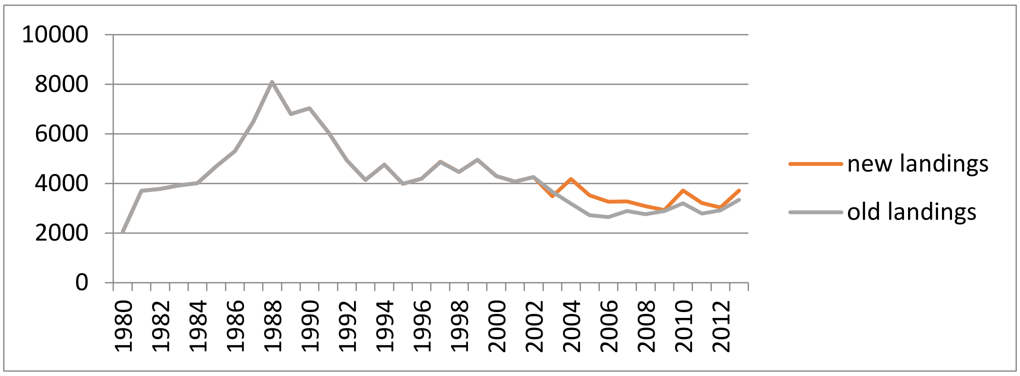


Figure 3.1: XSA assessment (SPALY: Same Procedure as Last Year), on the data newly submitted on Intercatch, i.e. for WKPLE





Year	1	2	3	4	5	6	7	8	9	10
2003	0.00	0.77	0.43	1.11	1.28	1.35	2.44	3.05	1.25	1.59
2004	0.84	0.57	1.15	1.31	1.75	2.16	1.59	2.43	4.05	2.52
2005	0.27	0.87	0.70	1.45	1.62	2.01	1.49	1.66	3.99	4.12
2006	0.34	1.04	1.22	1.49	1.76	1.23	1.74	1.49	2.72	2.49
2007	0.67	1.04	1.00	1.06	0.97	1.26	1.26	2.09	4.17	2.01
2008	0.81	1.03	1.19	1.18	1.33	1.17	1.12	1.00	1.59	1.70
2009	1.04	0.93	0.84	0.79	0.94	0.85	0.98	0.82	0.91	0.59
2010	0.89	1.03	1.21	1.19	1.44	1.22	1.06	1.70	0.92	0.77
2011	1.36	1.18	1.17	1.06	0.79	1.22	1.69	1.37	1.09	0.93
2012	0.99	1.23	1.00	0.99	0.95	0.94	0.91	1.01	0.73	1.00
2013	0.93	1.04	1.08	1.15	1.17	1.19	1.21	1.27	1.18	1.25

new canum/old canum: ratios between the numbers of fish per age class in the data newly submitted to IC, and the numbers of fish per age class previously used (before WKPLE).

Figure 3.2: New landings data submitted on Intercatch for WKPLE.

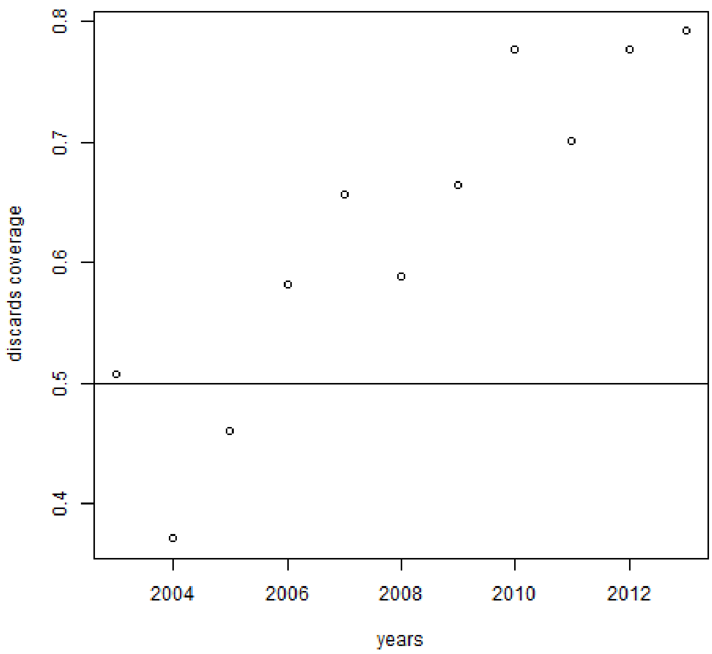


Figure 3.3: Proportion of the total landings for which we have discards data.

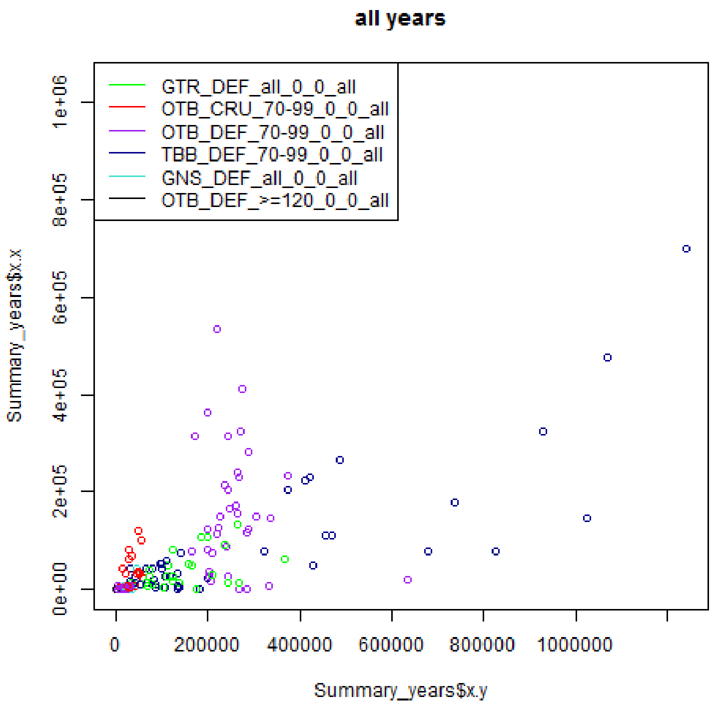
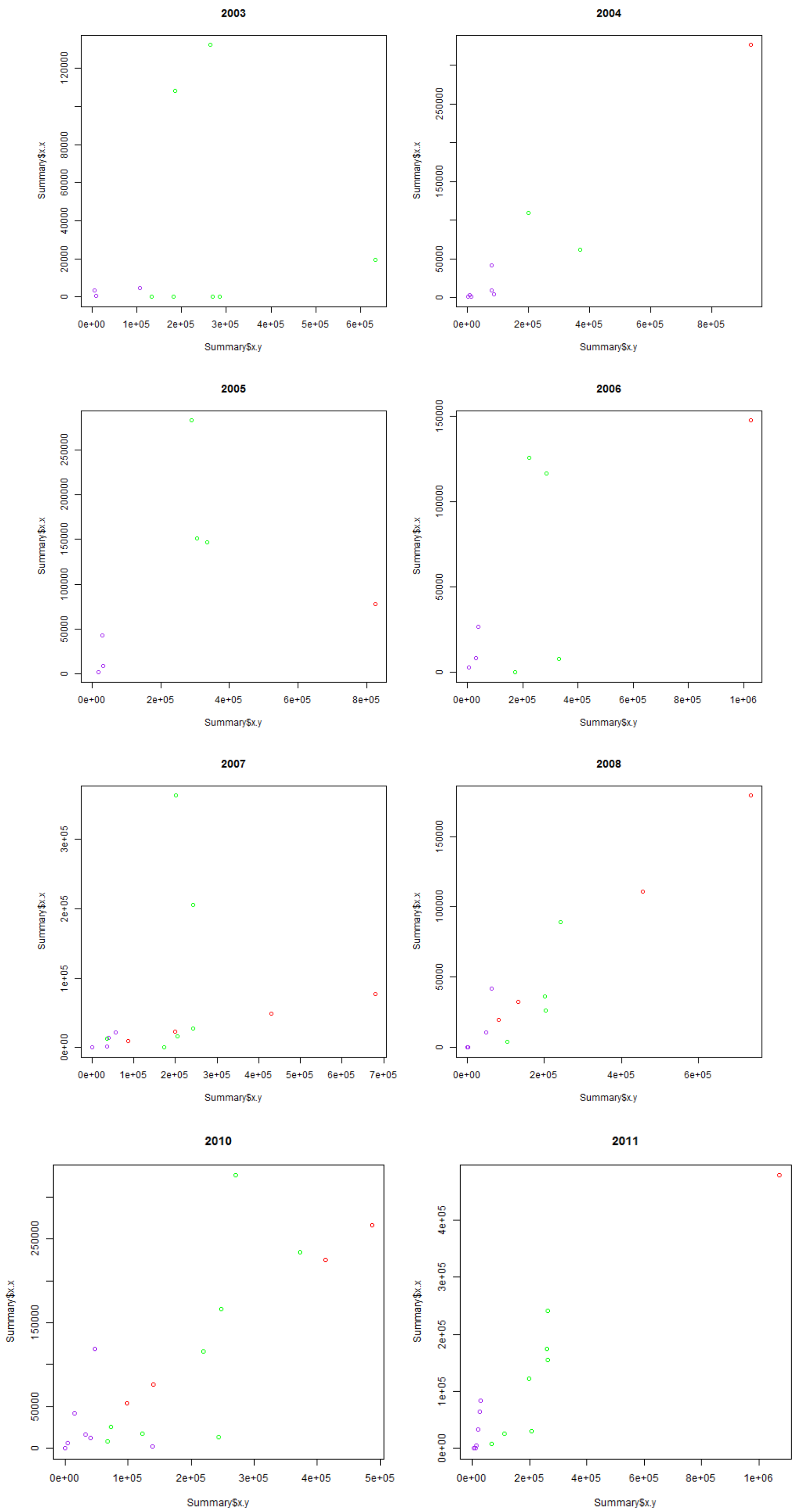


Figure 3.4: Discards vs. Landings per fleets, all years and countries considered.


2003
2004
2005
2006
2007
2008
2010
2011
Summary$x.x
Summary$x.y

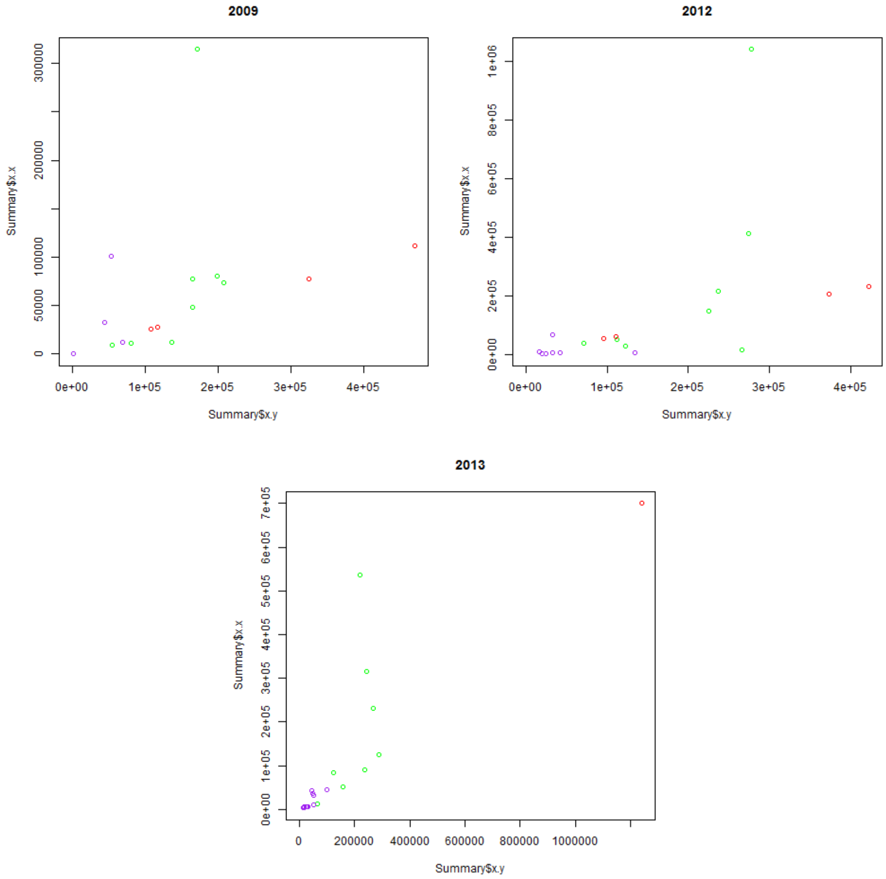
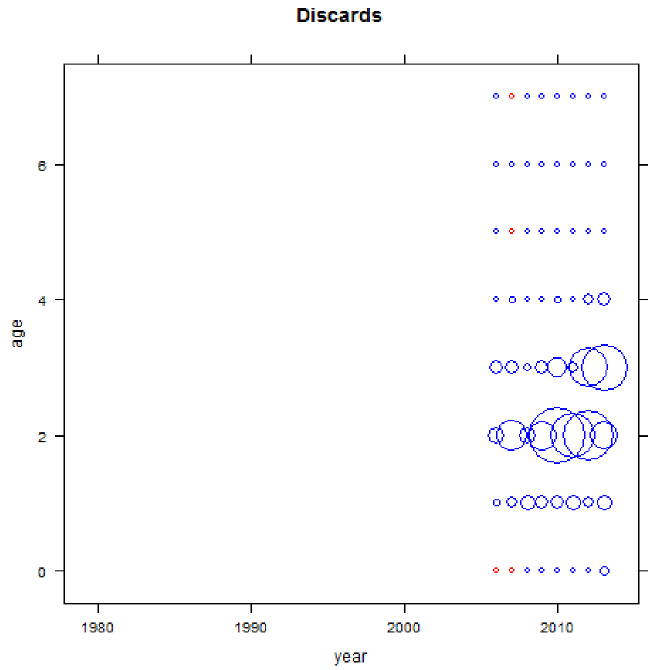
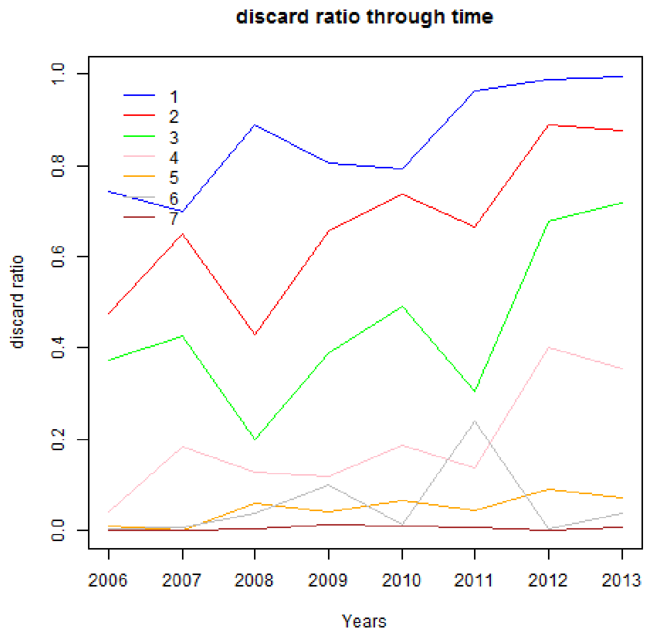


Figure 3.5: Discards vs. Landings per year, all countries and fishing fleets considered.


Discards
age
0
2
4
6
year
1980
1990
2000
2010


discard ratio through time
discard ratio
0.0
0.2
0.4
0.6
0.8
1.0
1
2
3
4
5
6
7
Years
2006
2007
2008
2009
2010
2011
2012
2013

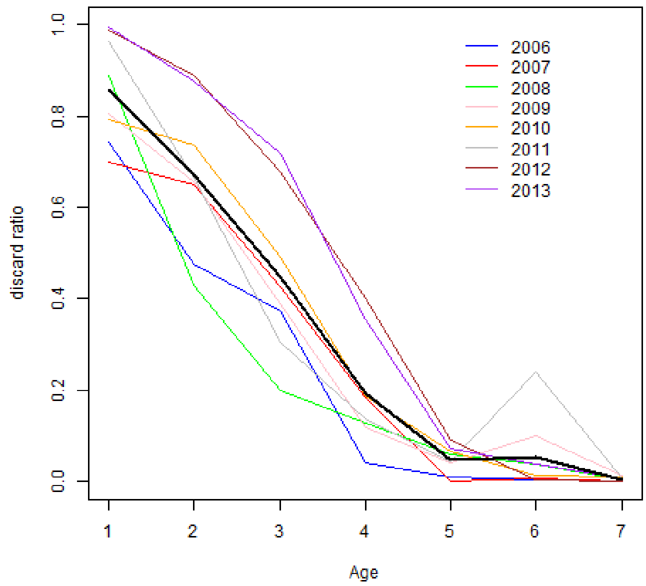


Figure 3.6: Exploration of discards data uploaded in Intercatch for WKPLE.

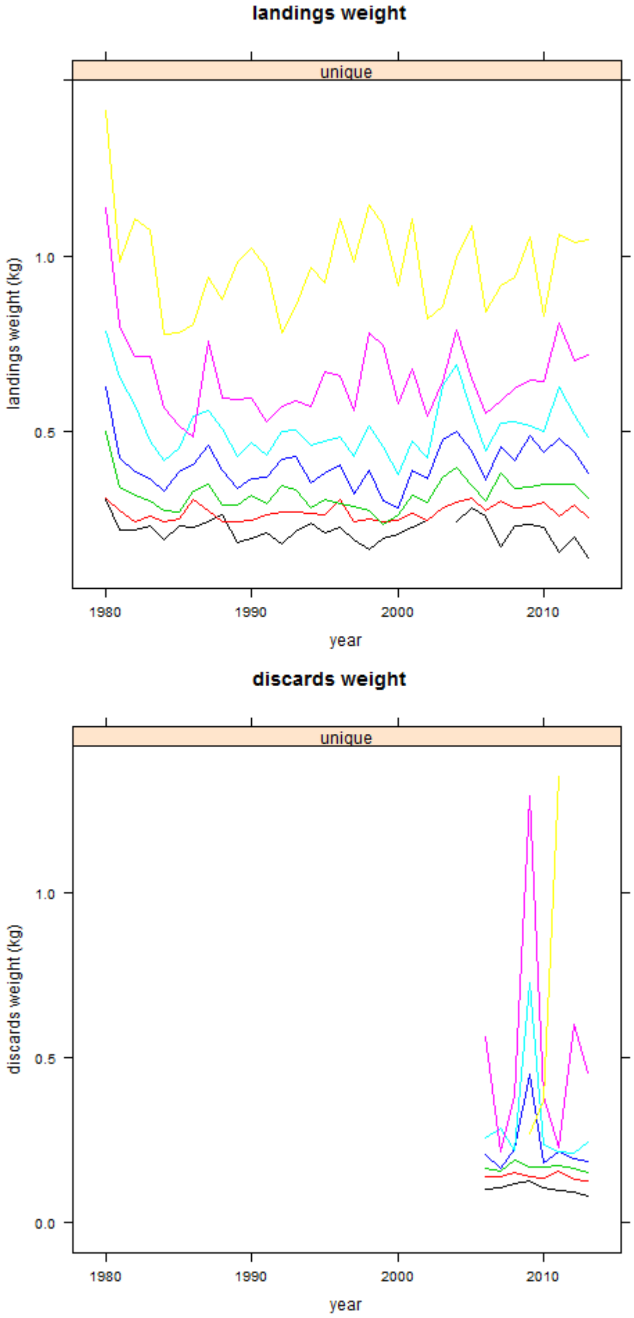


Figure 3.7: Weight at age for landings and discards for all countries (calculated with ALKs)

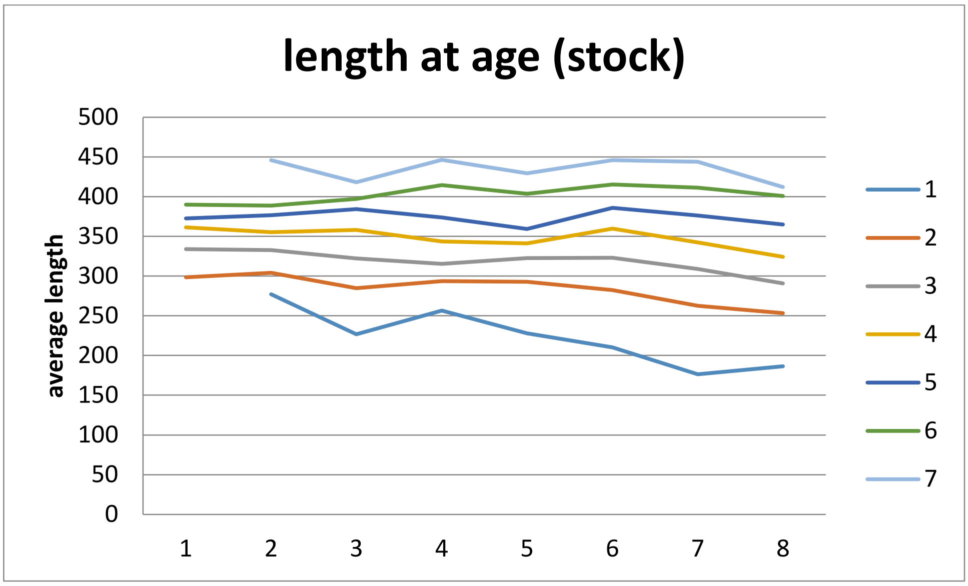


Figure 3.8: Average Length-at-age (untransformed) of French samplings (surveys plus landings).

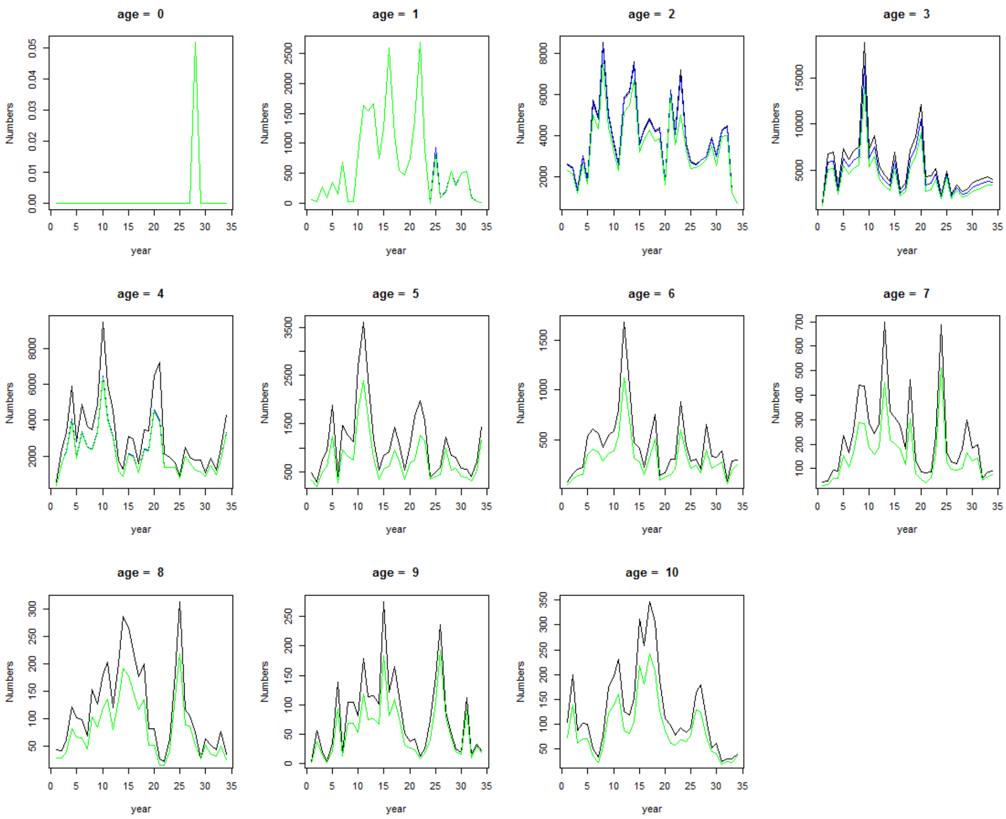


Figure 3.9: Landings numbers-at-age (black line: Total langing matrix, green line: removing 65% of the first quarter catches for all ages, blue line: removing 65% of the landings based on the mature fish) blue and green line overlay after age 5 where maturity is 100%

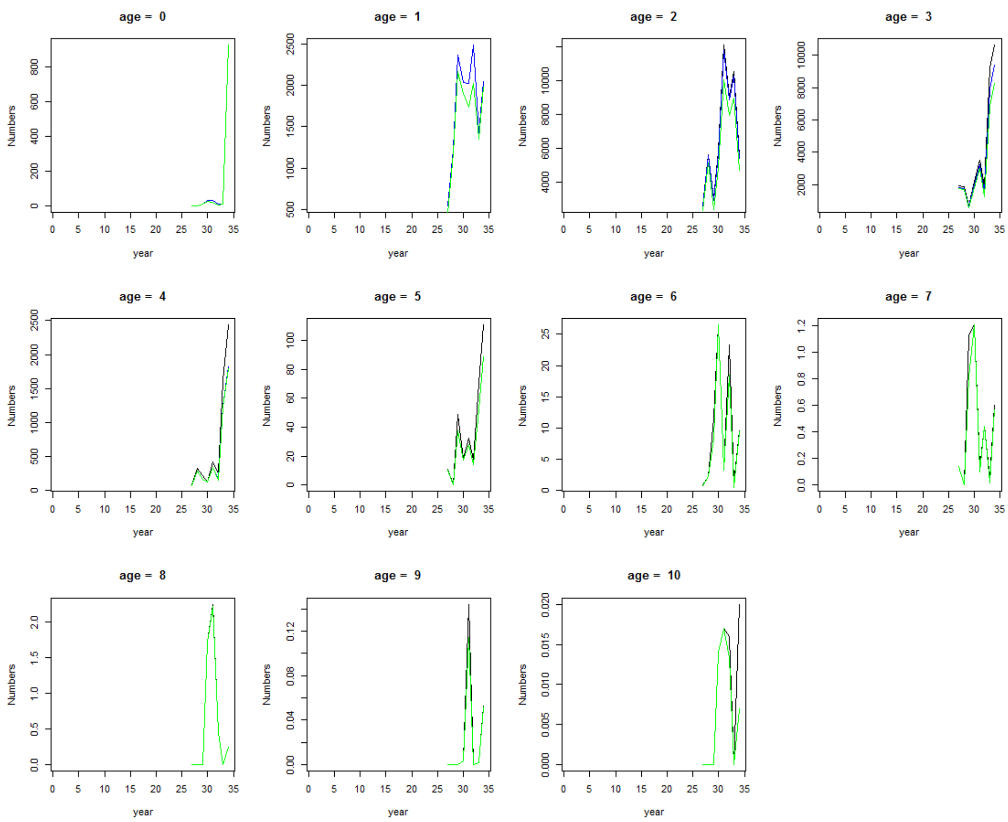


Figure 3.10: Discards numbers-at-age (black line: Total langing matrix, green line: removing 65% of the first quarter catches for all ages, blue line: removing 65% of the landings based on the mature fish) blue and green line overlay after age 5 where maturity is 100%

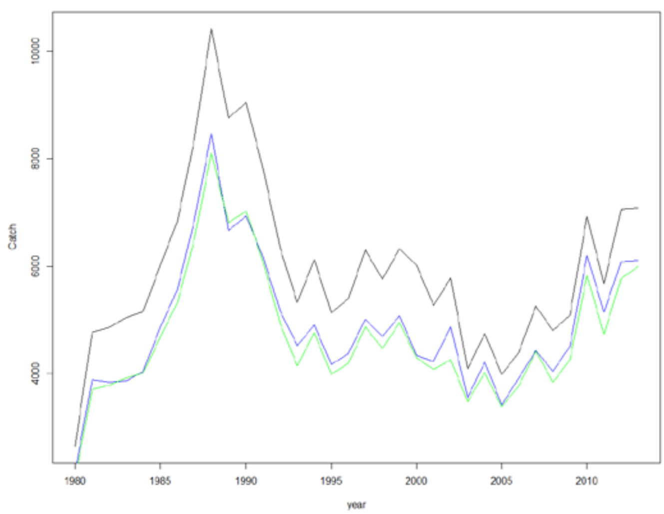


Figure 3.11: Total catch (black line), catch with 65% removal (green line), catch with 65% removal on mature fish (blue line)

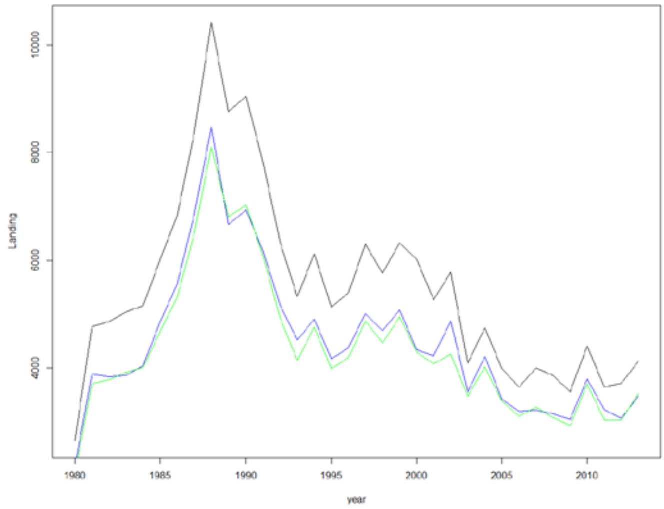


Figure 3.12: Total landings (black line), landings with 65% removal (green line), landings with 65% removal on mature fish (blue line)

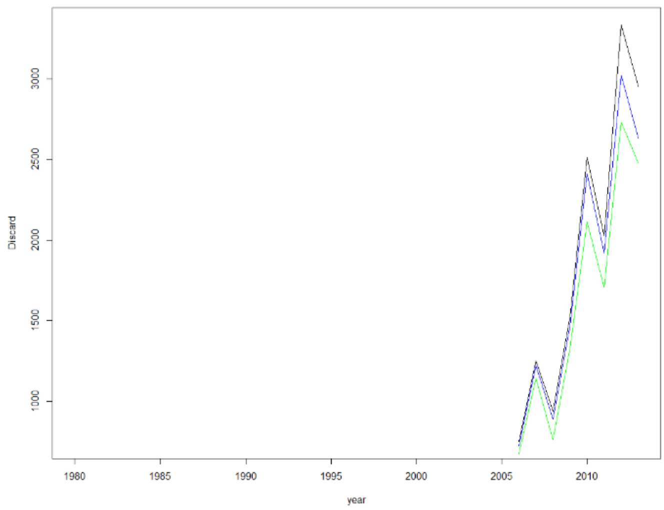
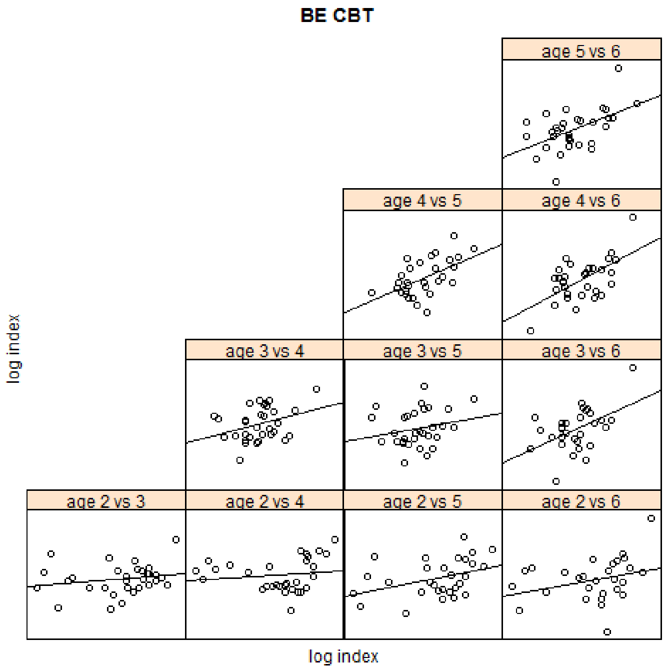
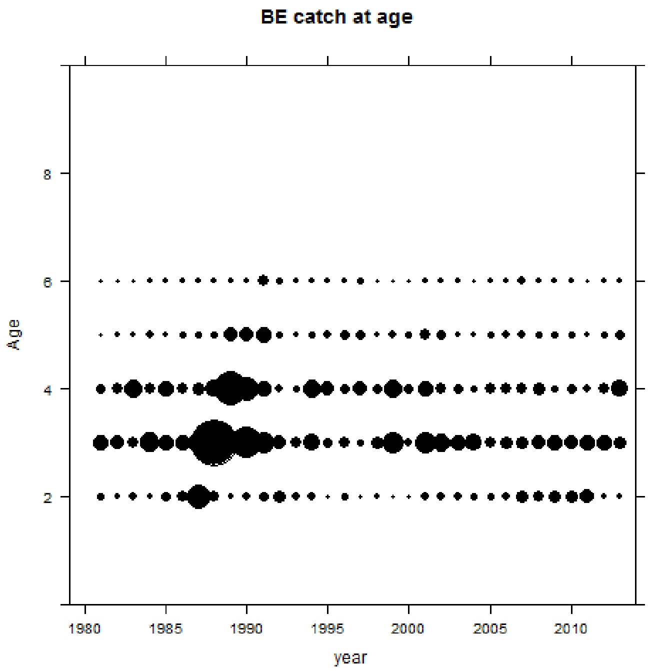


Figure 3.13: Total discards (black line), discards with 65% removal (green line), discards with 65% removal on mature fish (blue line)


BE CBT
age 5 vs 6
age 4 vs 5
age 4 vs 6
age 3 vs 4
age 3 vs 5
age 3 vs 6
age 2 vs 3
age 2 vs 4
age 2 vs 5
age 2 vs 6
log index
log index


BE catch at age
Age
year
1980
1985
1990
1995
2000
2005
2010
2
4
6
8

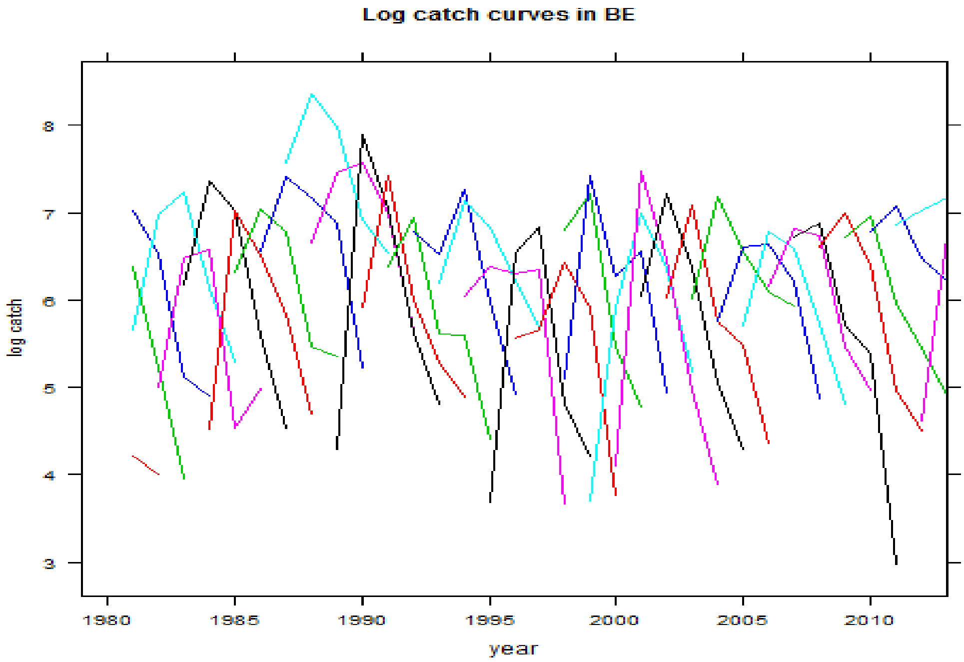
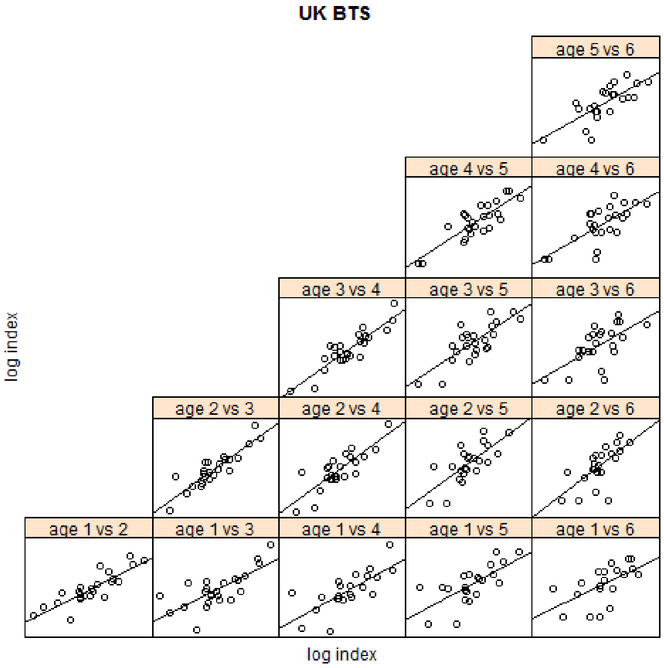
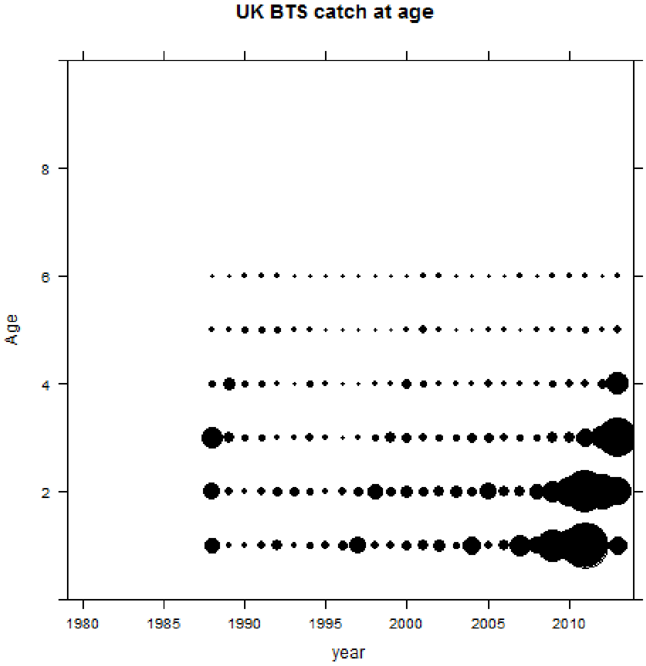


Figure 3.14: Exploration of data from the BE CBT tuning series


UK BTS
age 5 vs 6
age 4 vs 5
age 4 vs 6
age 3 vs 4
age 3 vs 5
age 3 vs 6
age 2 vs 3
age 2 vs 4
age 2 vs 5
age 2 vs 6
age 1 vs 2
age 1 vs 3
age 1 vs 4
age 1 vs 5
age 1 vs 6
log index
log index


UK BTS catch at age
Age
8
6
4
2
1980
1985
1990
1995
2000
2005
2010
year

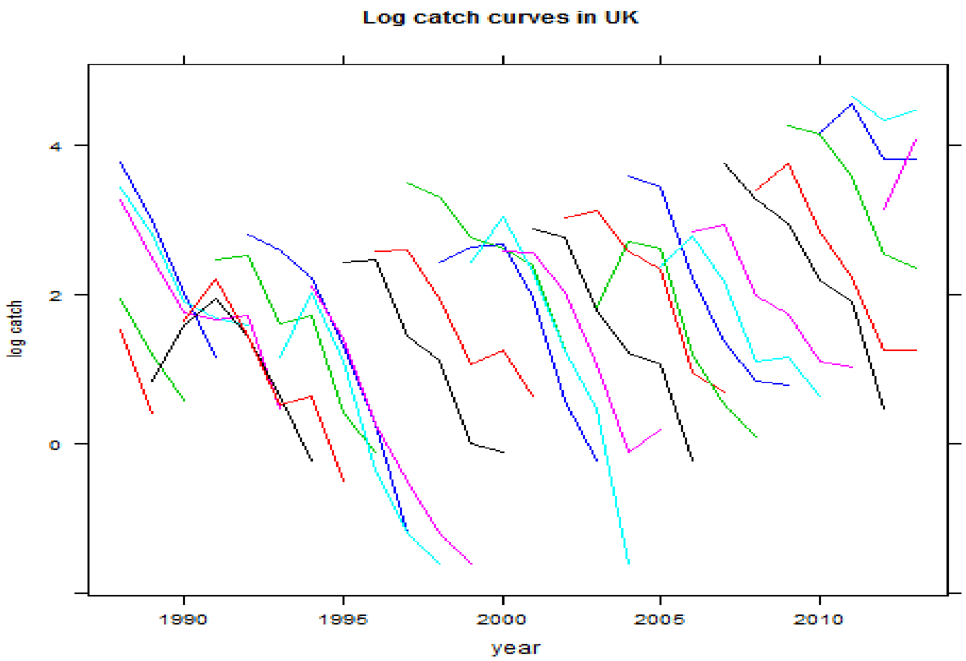
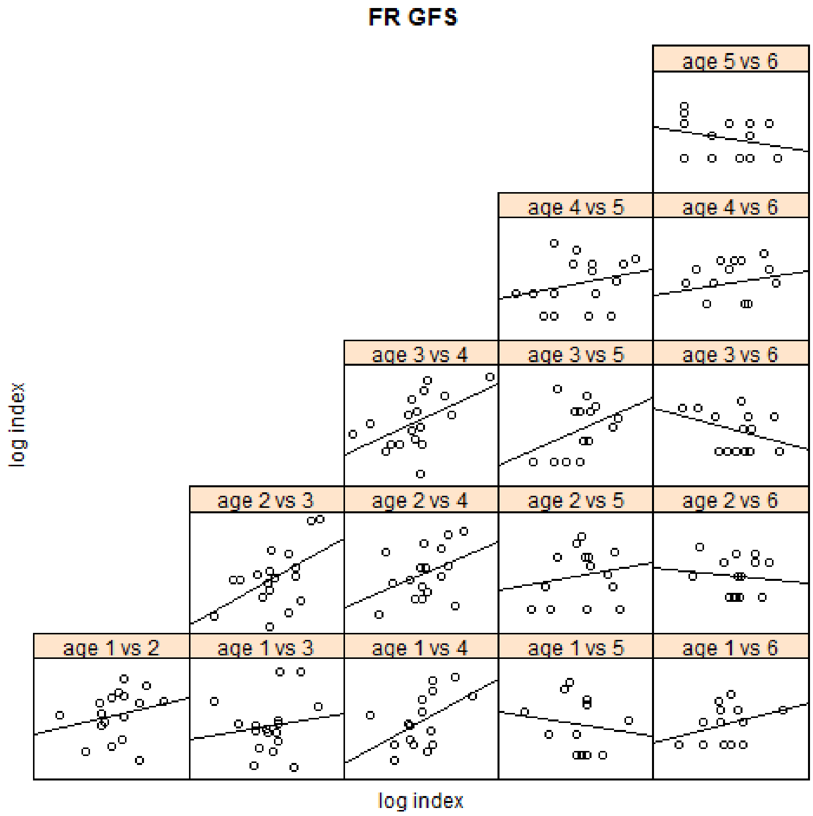
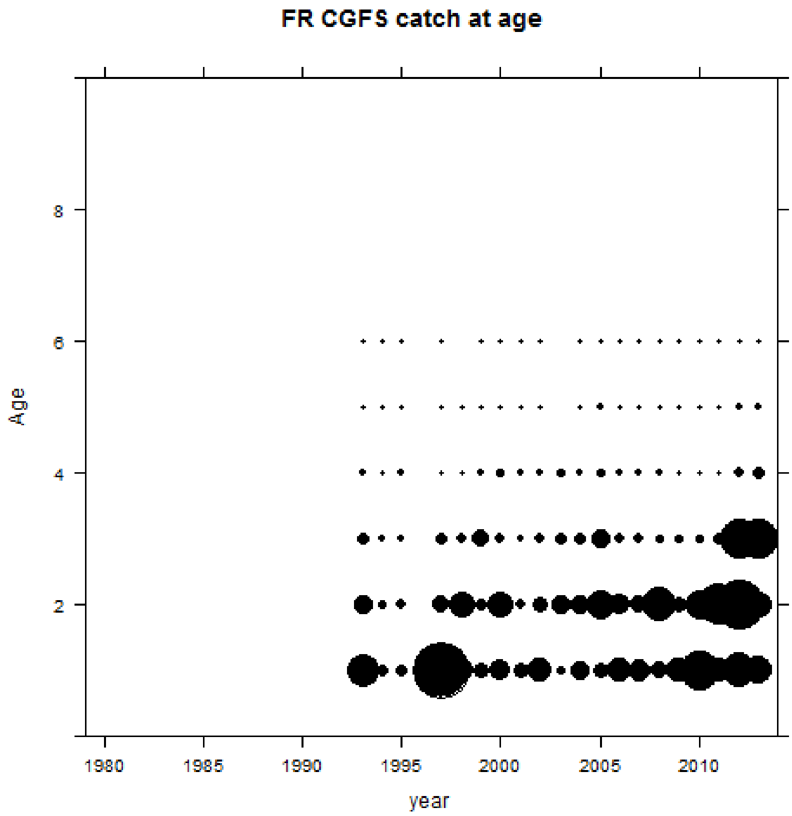


Figure 3.15: Exploration of data from the UK BTS survey


FR GFS
age 5 vs 6
age 4 vs 5
age 4 vs 6
age 3 vs 4
age 3 vs 5
age 3 vs 6
age 2 vs 3
age 2 vs 4
age 2 vs 5
age 2 vs 6
age 1 vs 2
age 1 vs 3
age 1 vs 4
age 1 vs 5
age 1 vs 6
log index
log index


FR CGFS catch at age
Age
2
4
6
8
1980
1985
1990
1995
2000
2005
2010
year

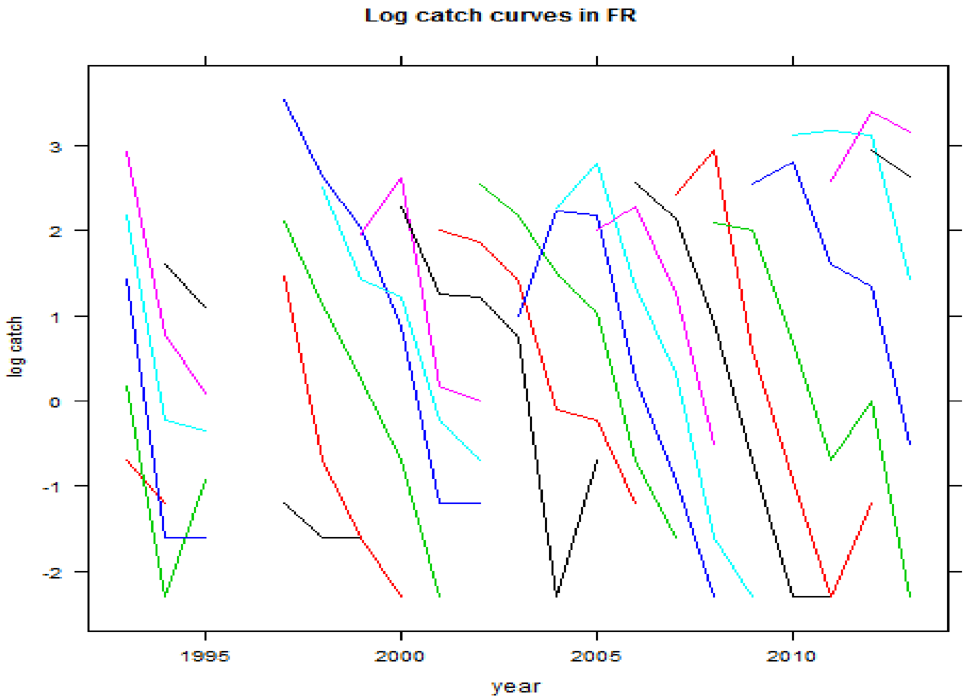


Figure 3.16: Exploration of data from the FR GFS survey

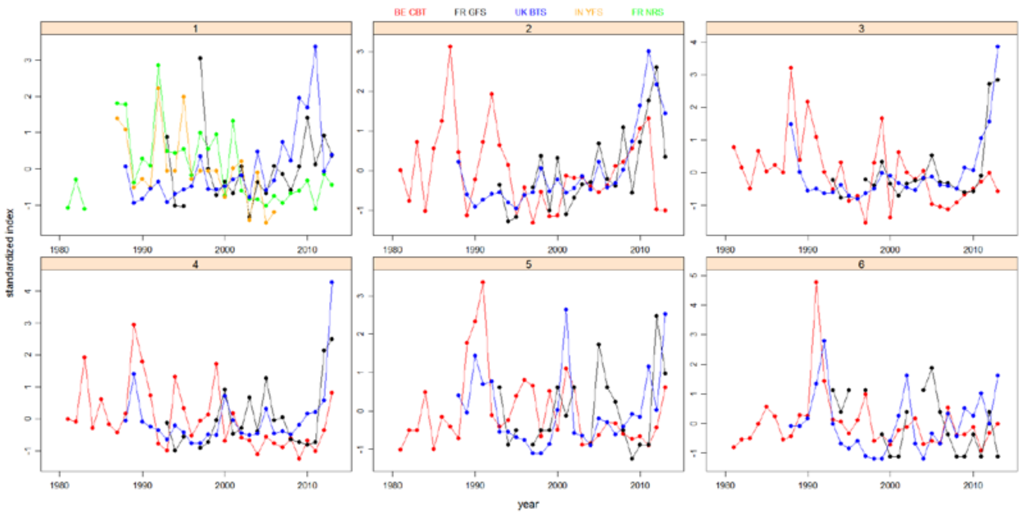


Figure 3.17: Catch-at-age indices trends per age

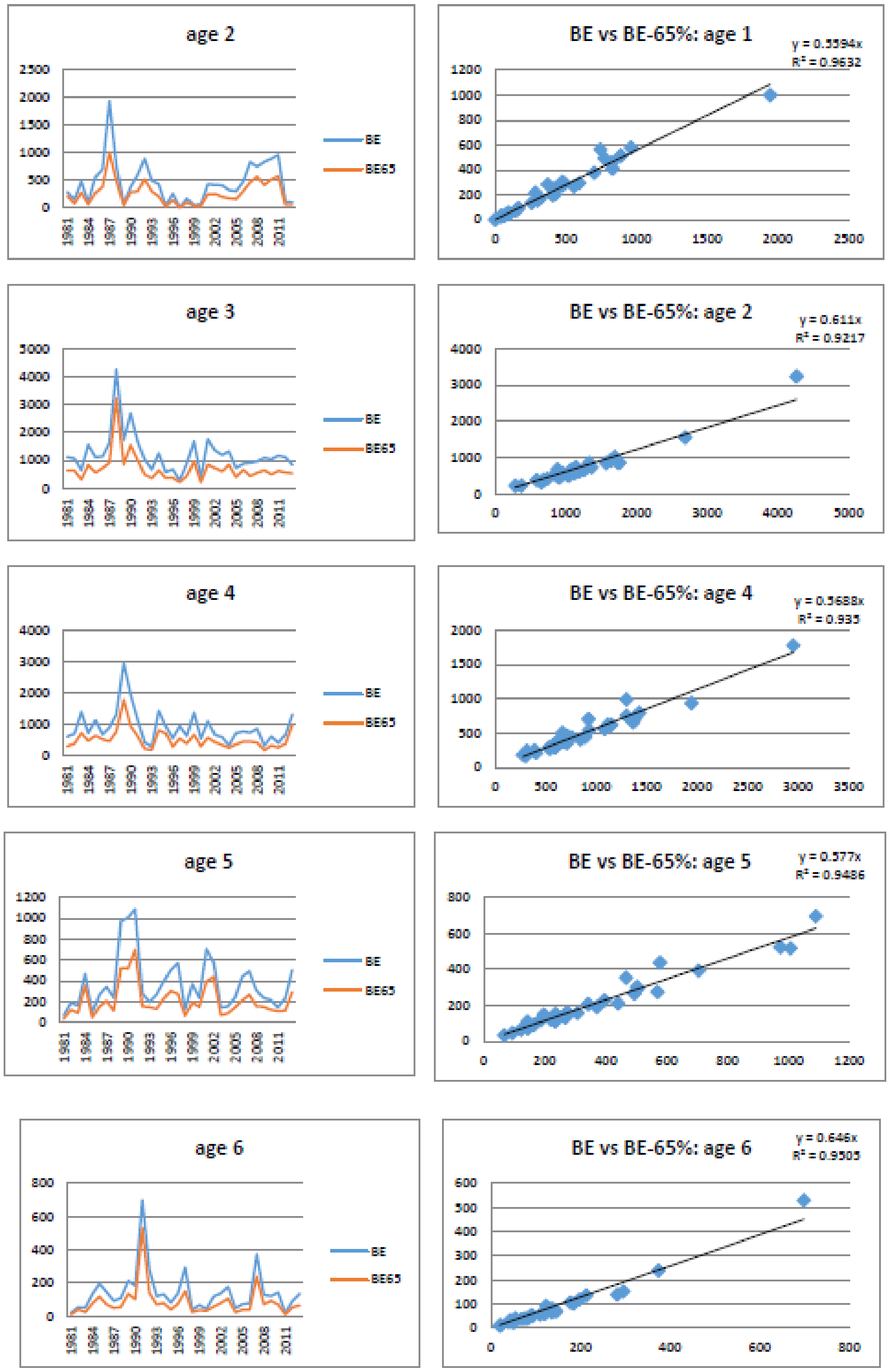


Figure 3.18: Comparison of BE CBT data with and without the removal of 65% of Q1 catches.

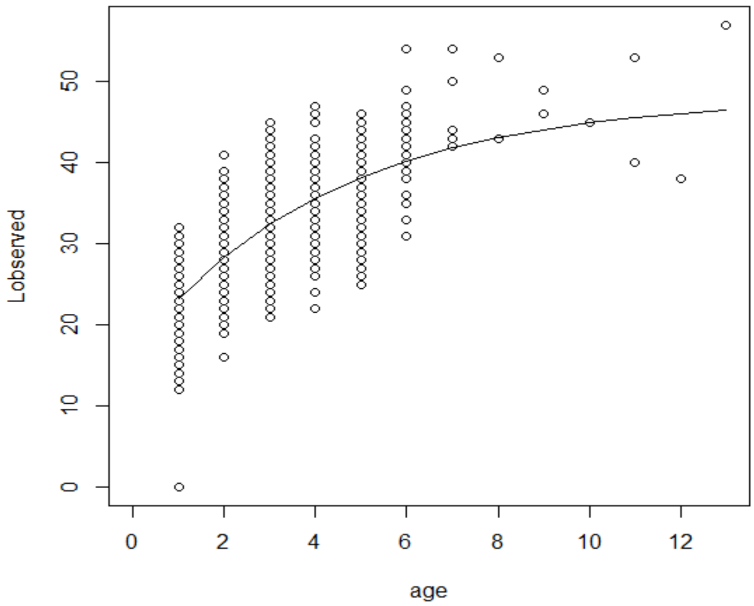


Figure 3.19: Observed Length-at-age and fitted von Bertalanffy growth curve for Jensen's mortality estimation method

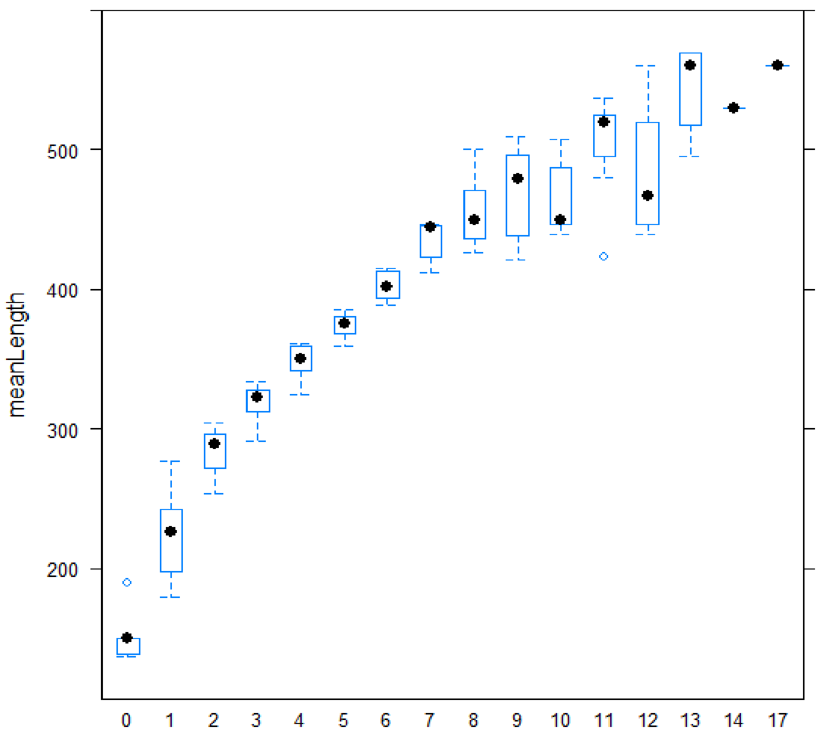


Figure 3.20: Length-at-age curve based on Gislason's first estimator.

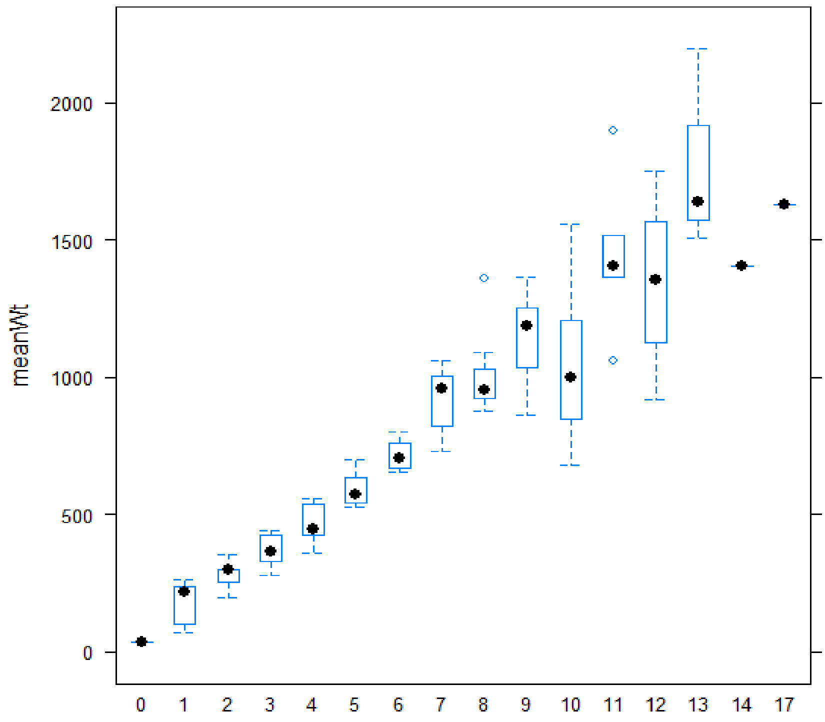


Figure 3.21: Observed mean weight at age based on Peterson and Wroblewski's method.

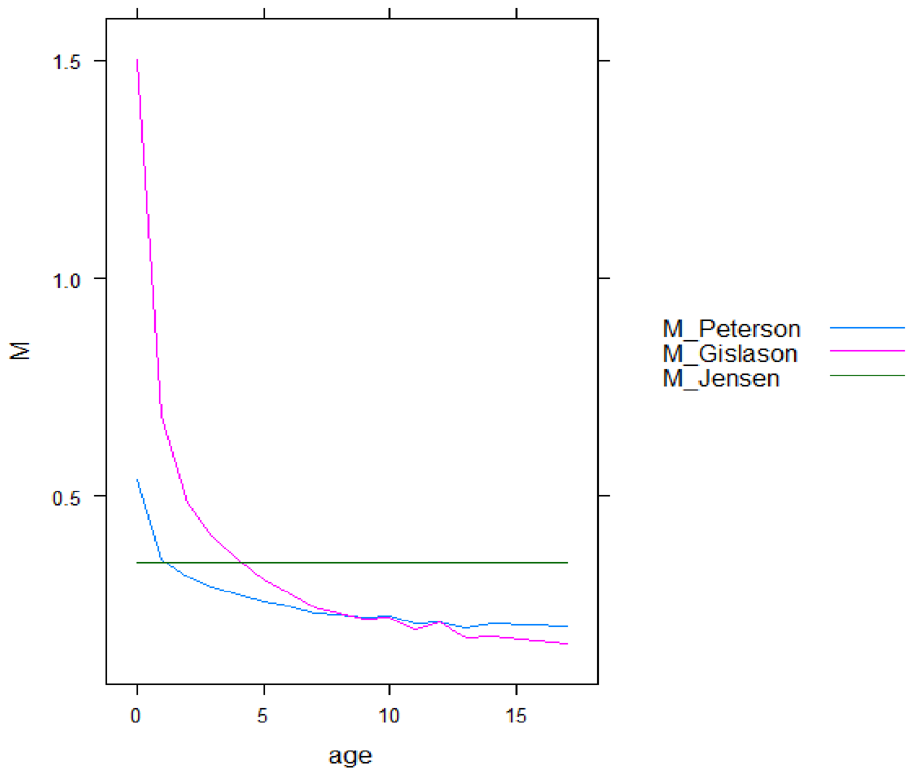
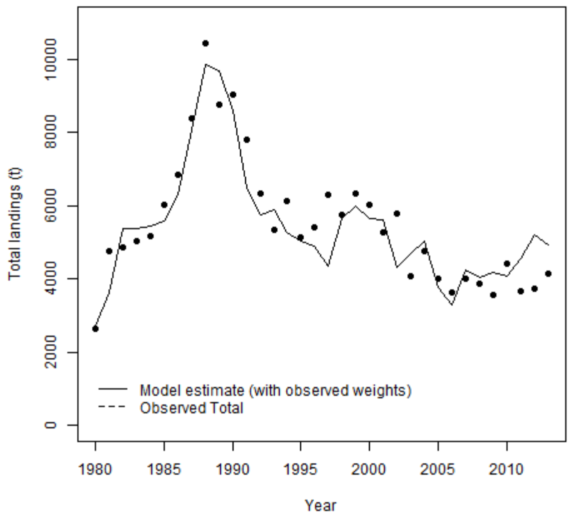
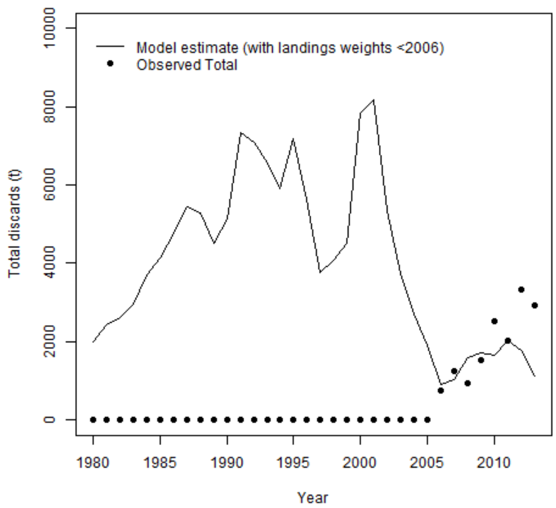


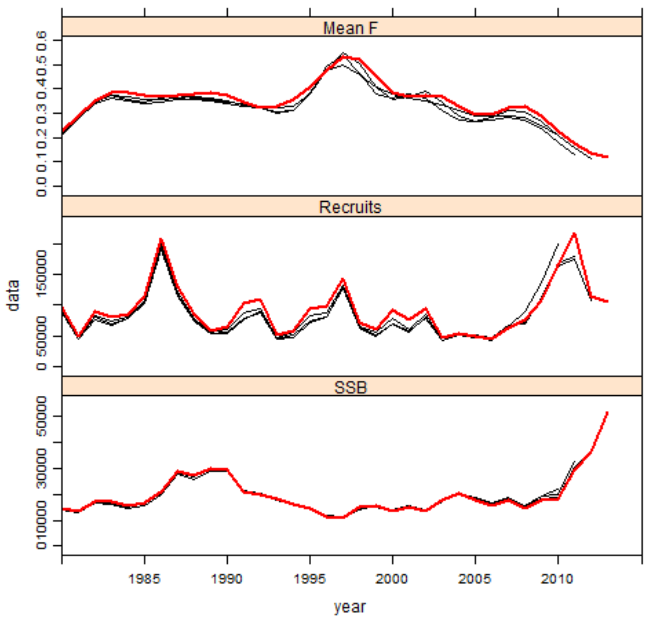
Figure 3.22: Comparison of natural mortality values estimated with the three methods.



Total landings (t)
0
2000
4000
6000
8000
10000
Model estimate (with observed weights)
Observed Total
1980
1985
1990
1995
2000
2005
2010
Year



Total discards (t)
0
2000
4000
6000
8000
10000
Model estimate (with landings weights <2006)
Observed Total
1980
1985
1990
1995
2000
2005
2010
Year



Mean F
Recruits
SSB
data
0.0 0.1 0.2 0.3 0.4 0.5 0.6
0 50000 150000
0 10000 30000 50000
1985
1990
1995
2000
2005
2010
year

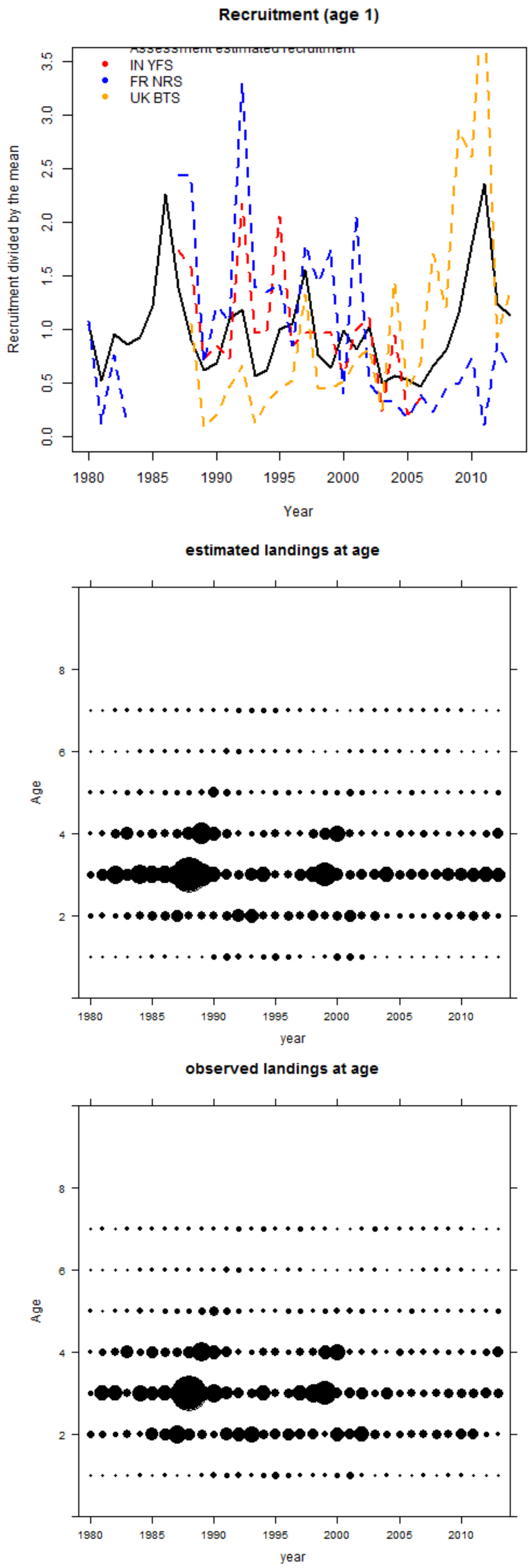
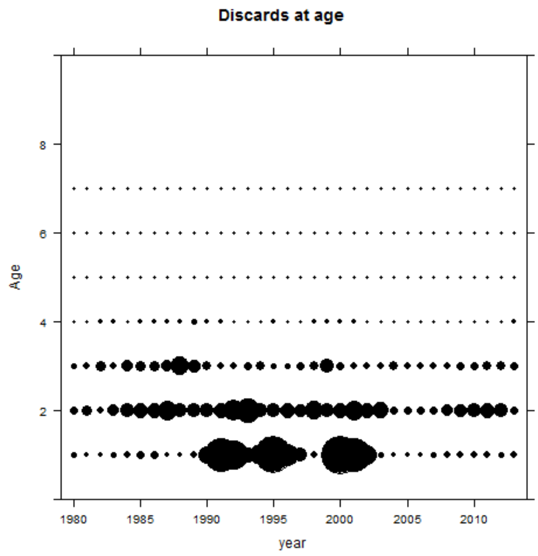
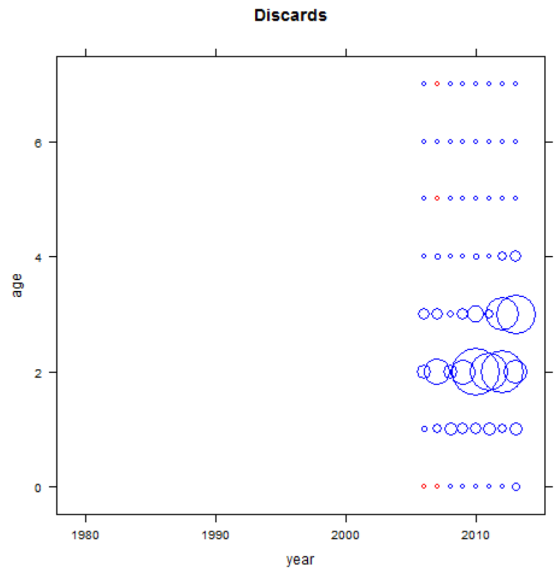
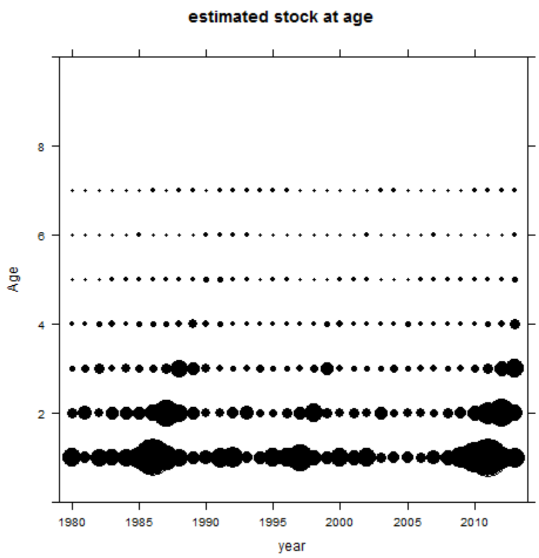


Figure 3.23: Results from Art and Poos model for the scenario 1 (total population, 3 tuning series, Peterson's mortality)


Discards at age
Age
year
1980
1985
1990
1995
2000
2005
2010
2
4
6
8


Discards
age
year
1980
1990
2000
2010
0
2
4
6


estimated stock at age
Age
year
1980
1985
1990
1995
2000
2005
2010
2
4
6
8

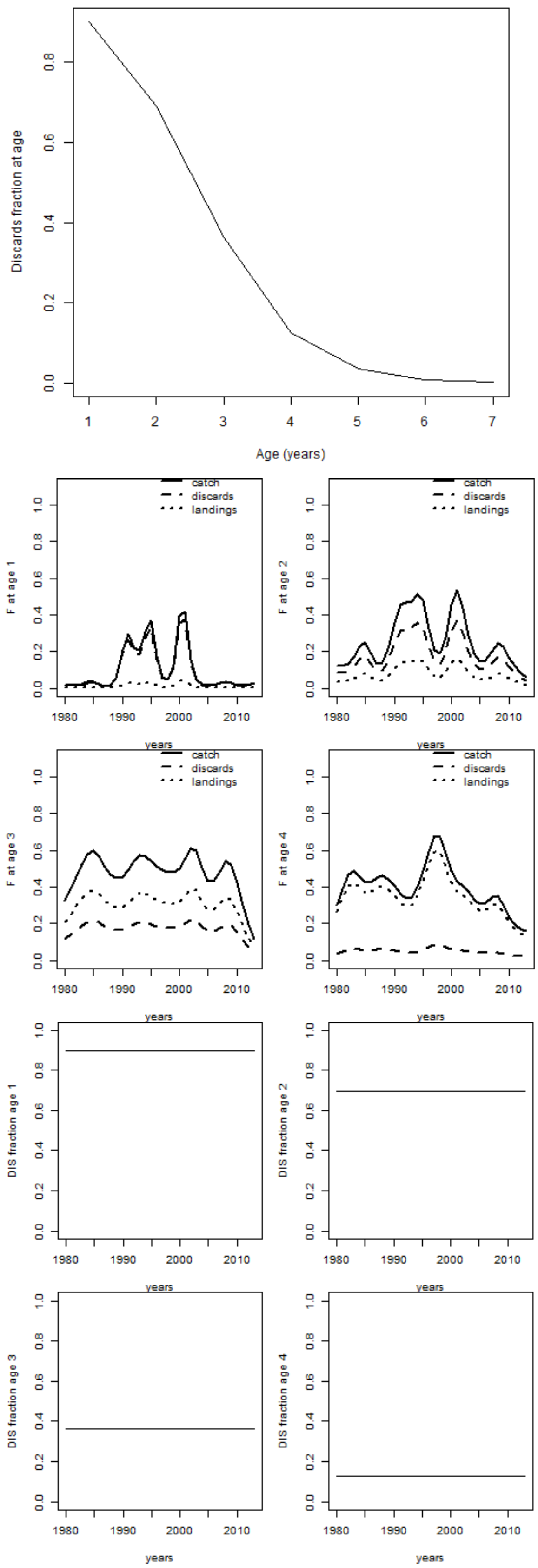
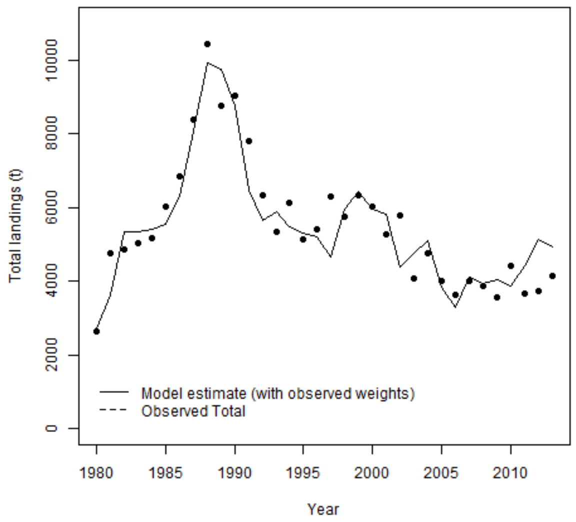
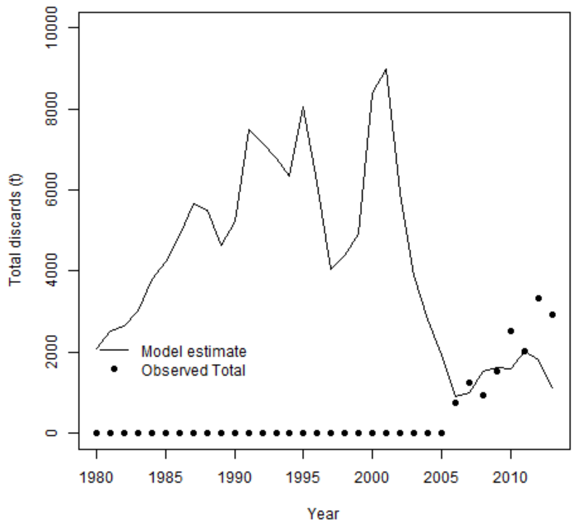
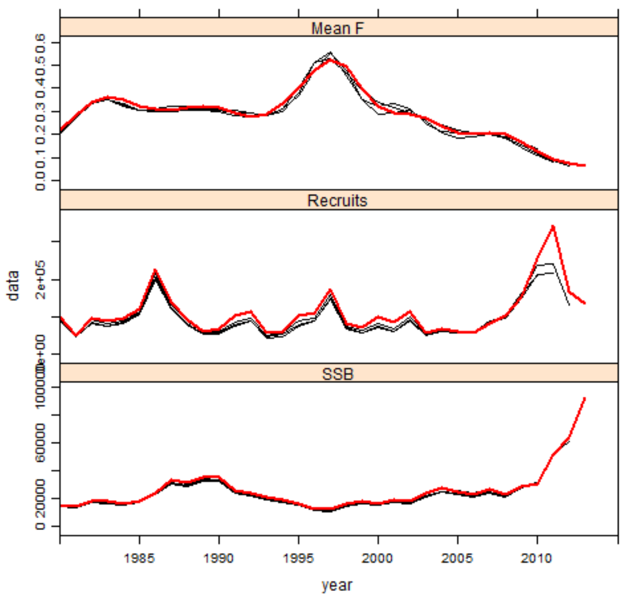


Figure 3.24: Results from Art and Poos model for the scenario 1 cont.


Total landings (t)
0
2000
4000
6000
8000
10000
Model estimate (with observed weights)
Observed Total
1980
1985
1990
1995
2000
2005
2010
Year


Total discards (t)
0
2000
4000
6000
8000
10000
Model estimate
Observed Total
1980
1985
1990
1995
2000
2005
2010
Year


Mean F
Recruits
SSB
data
year
1985
1990
1995
2000
2005
2010

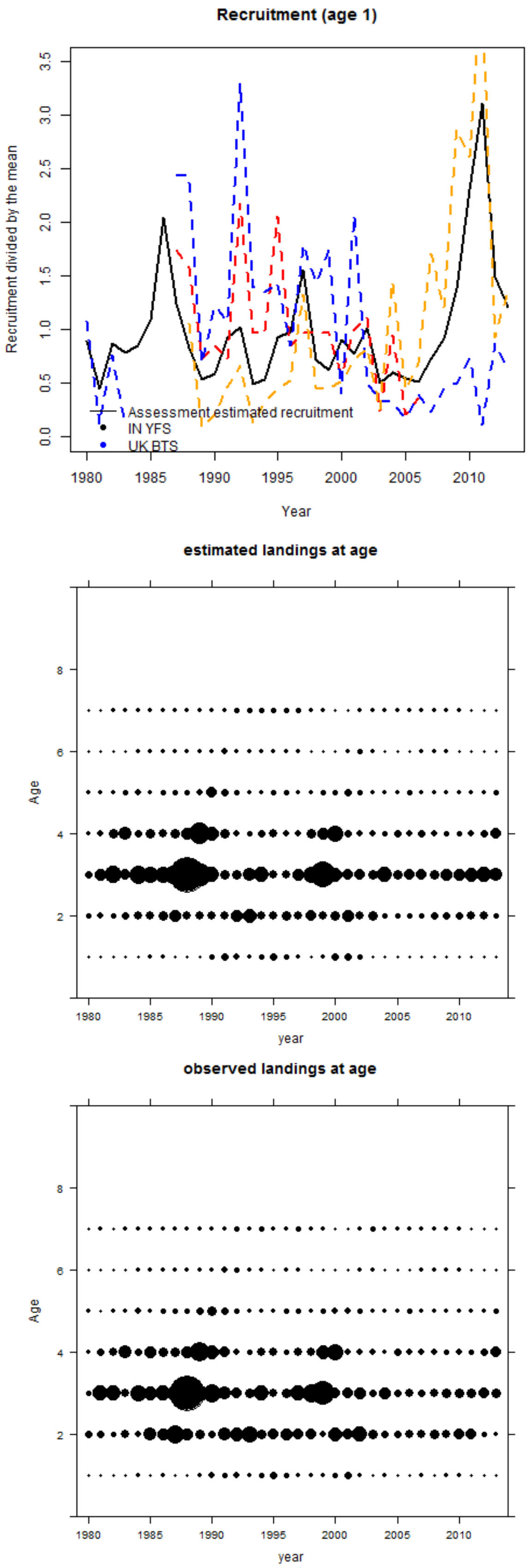
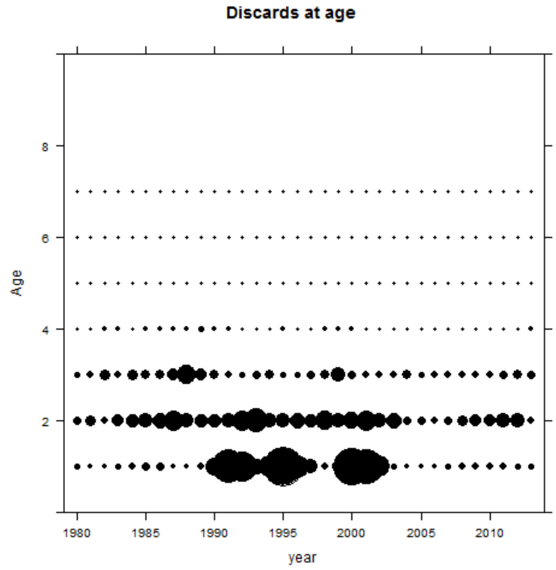
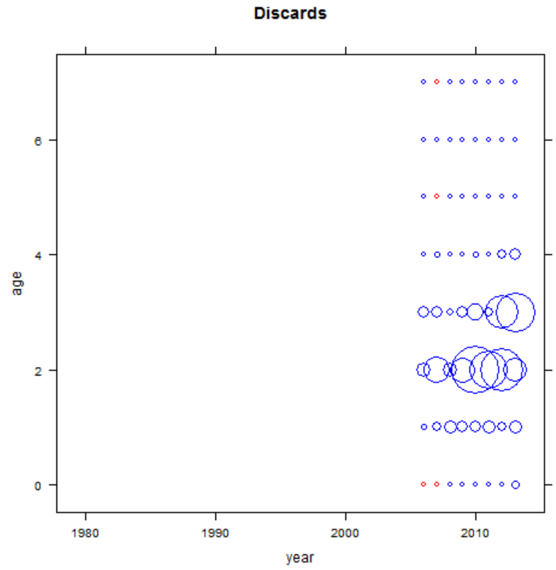
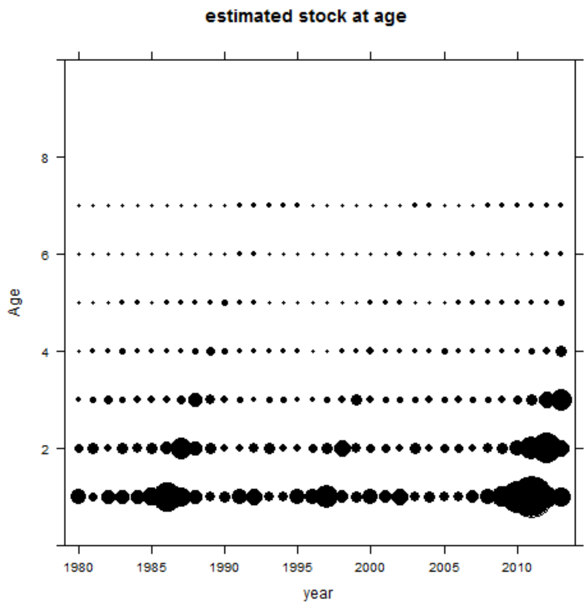


Figure 3.25: Results from Art and Poos model for the scenario 2 (total population, 2 tuning series, Peterson's mortality)


Discards at age
Age
year
1980
1985
1990
1995
2000
2005
2010
2
4
6
8


Discards
age
year
1980
1990
2000
2010
0
2
4
6


estimated stock at age
Age
year
1980
1985
1990
1995
2000
2005
2010
2
4
6
8

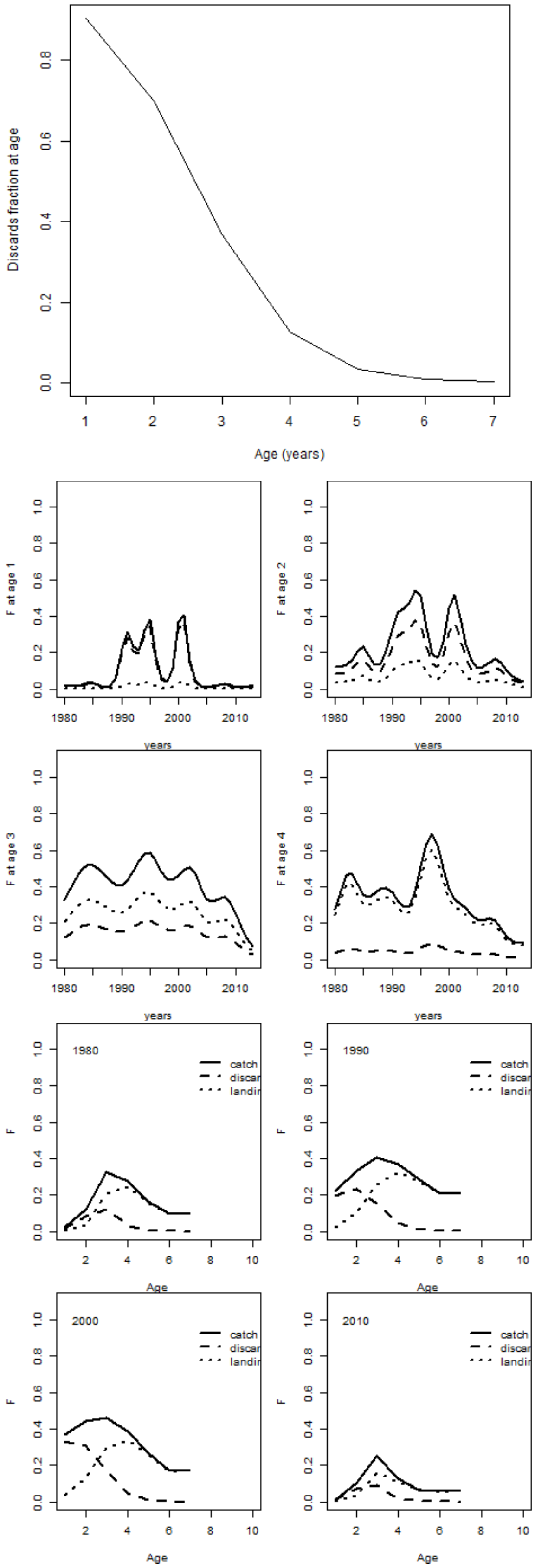


Figure 3.26: Results from Art and Poos model for the scenario 2 cont.

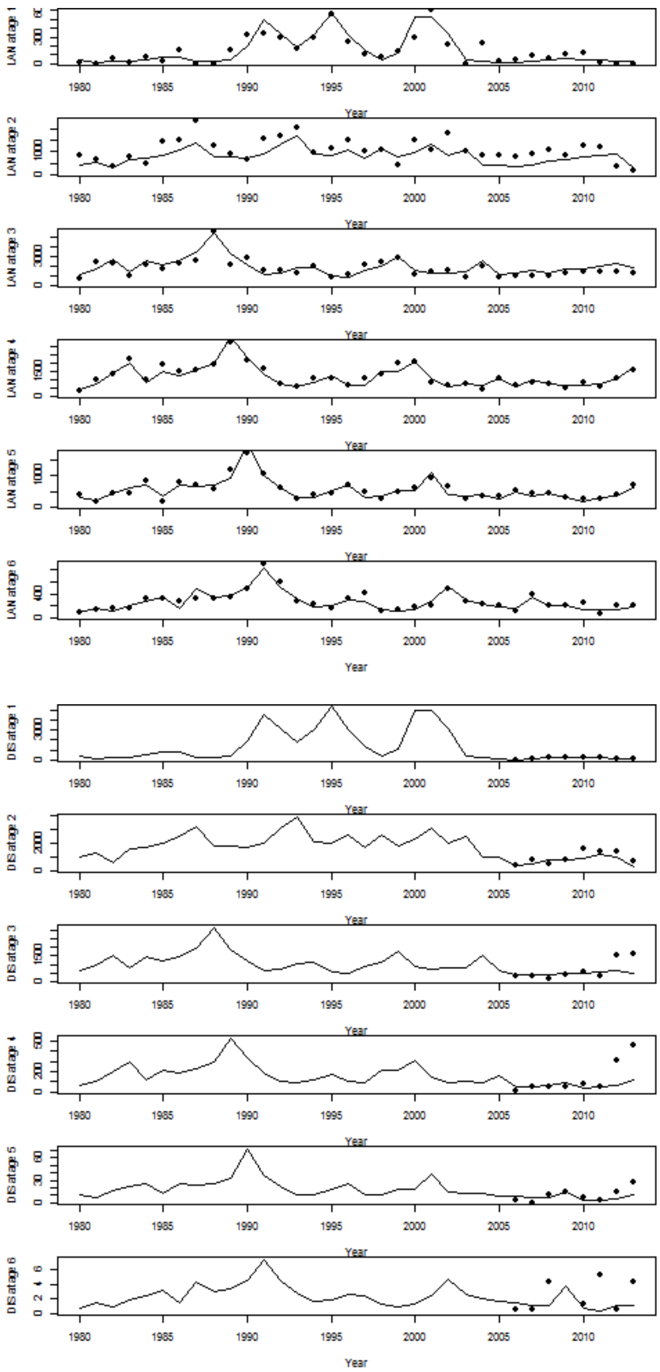
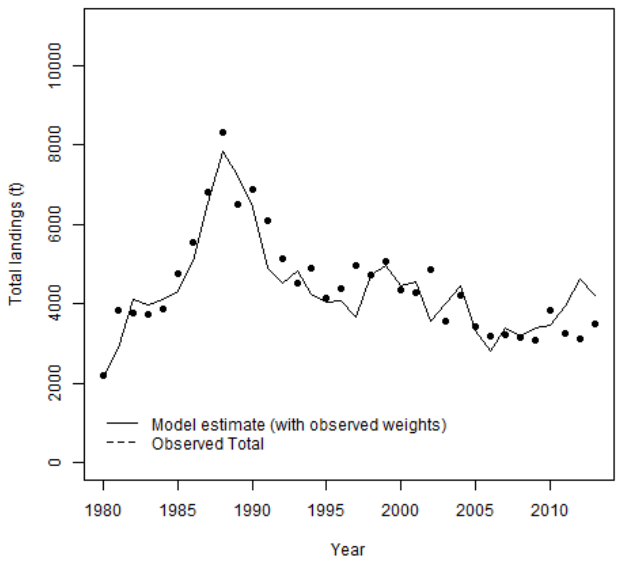
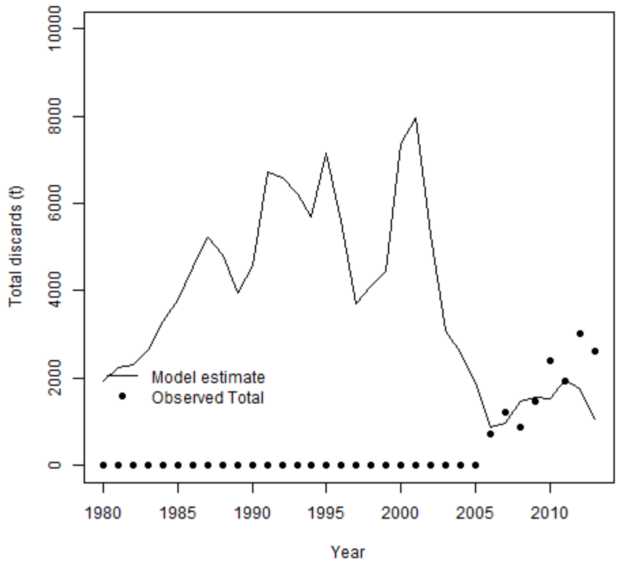
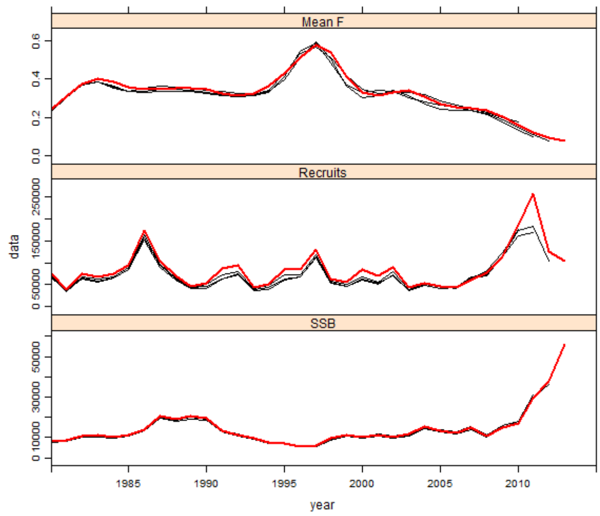


Figure 3.27: Results from Art and Poos model for the scenario 2 cont. Landings at age and discards at age: observed vs. estimated


Total landings (t)
Model estimate (with observed weights)
Observed Total
Year


Total discards (t)
Model estimate
Observed Total
Year


Mean F
Recruits
SSB
data
year

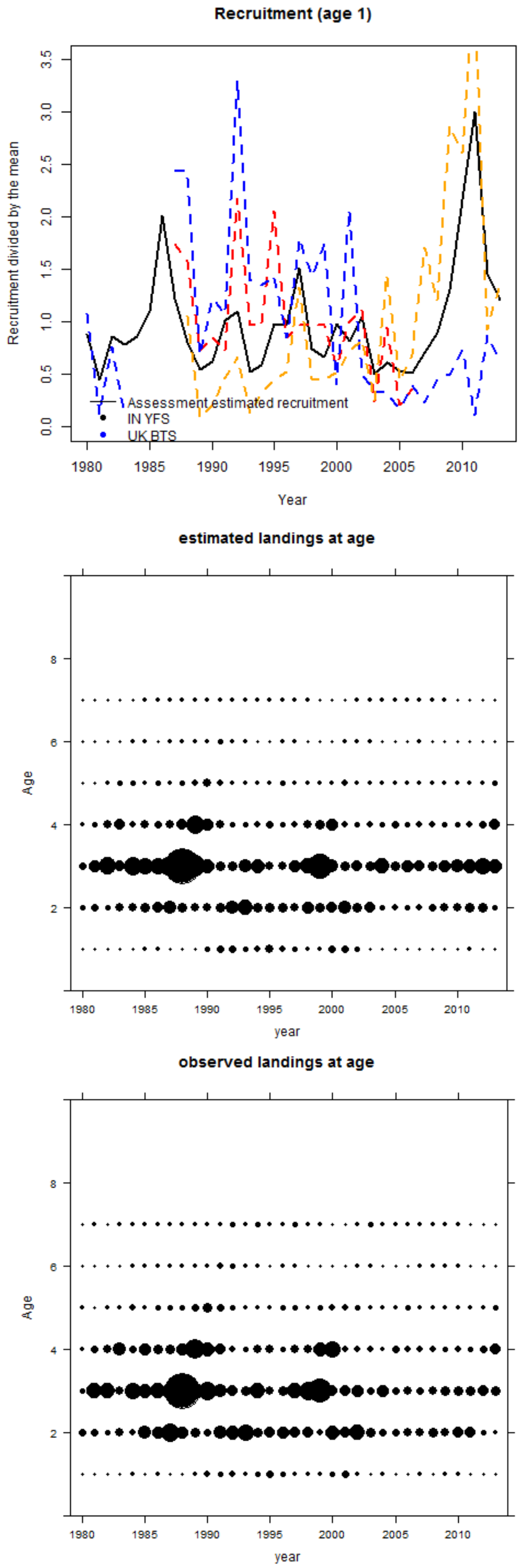
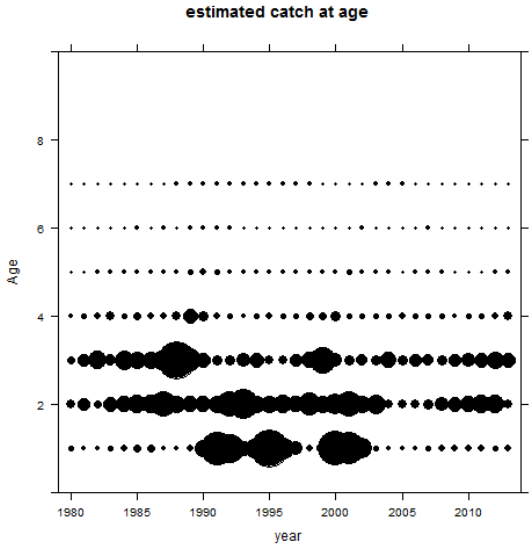
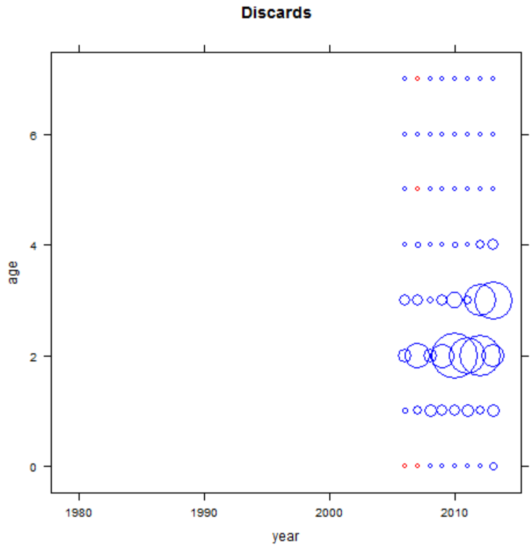
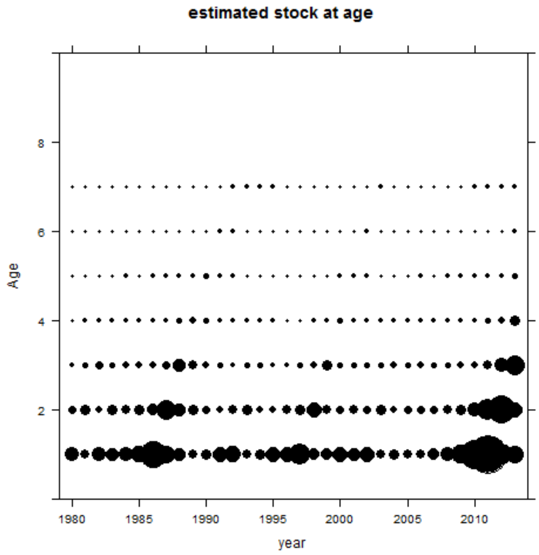


Figure 3.28: Results from Art and Poos model for the scenario 3 (7D population calculated with the new method, 2 tuning series, Peterson's mortality)


estimated catch at age
Age
year
1980
1985
1990
1995
2000
2005
2010
8
6
4
2


Discards
age
year
1980
1990
2000
2010
6
4
2
0


estimated stock at age
Age
year
1980
1985
1990
1995
2000
2005
2010
8
6
4
2

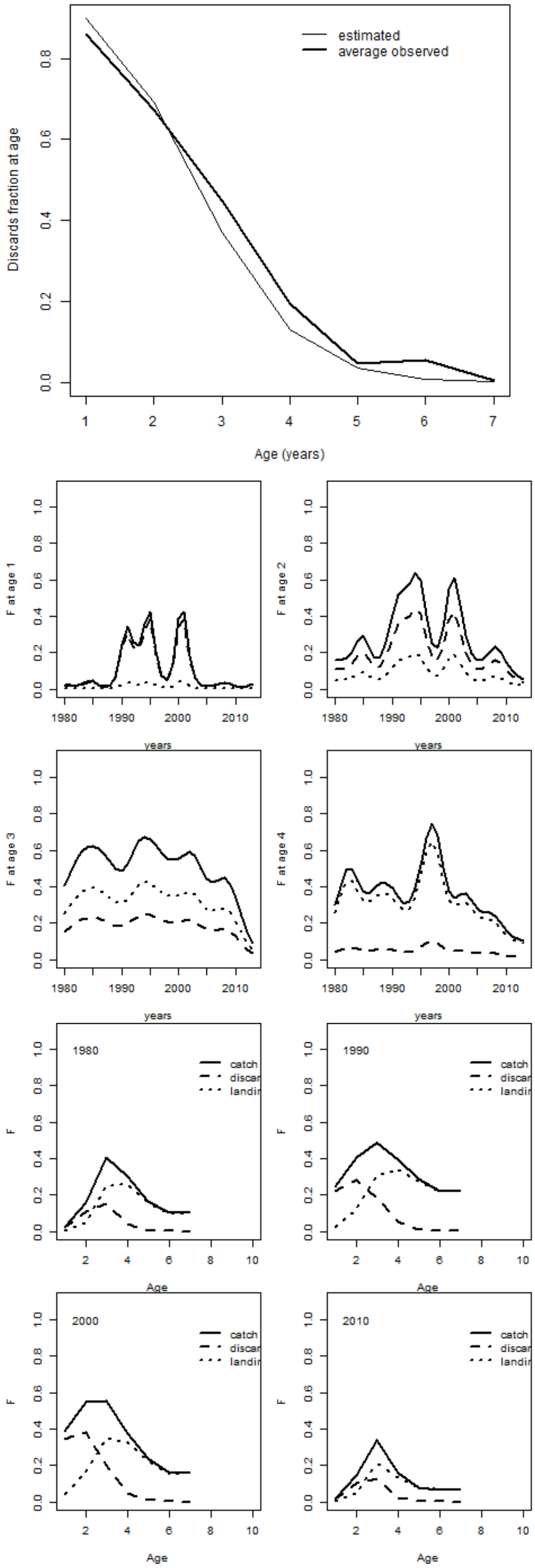
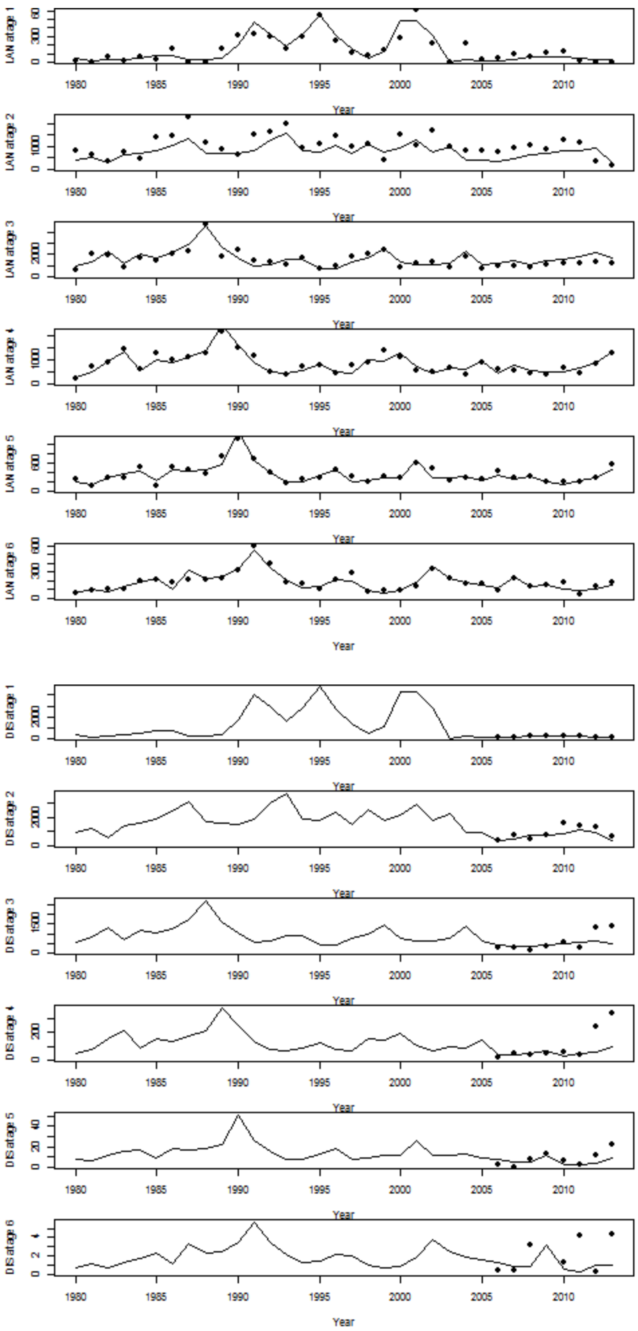


Figure 3.29: Results from Art and Poos model for the scenario 3 cont.


LAN at age 1
LAN at age 2
LAN at age 3
LAN at age 4
LAN at age 5
LAN at age 6
DIS at age 1
DIS at age 2
DIS at age 3
DIS at age 4
DIS at age 5
DIS at age 6
Year

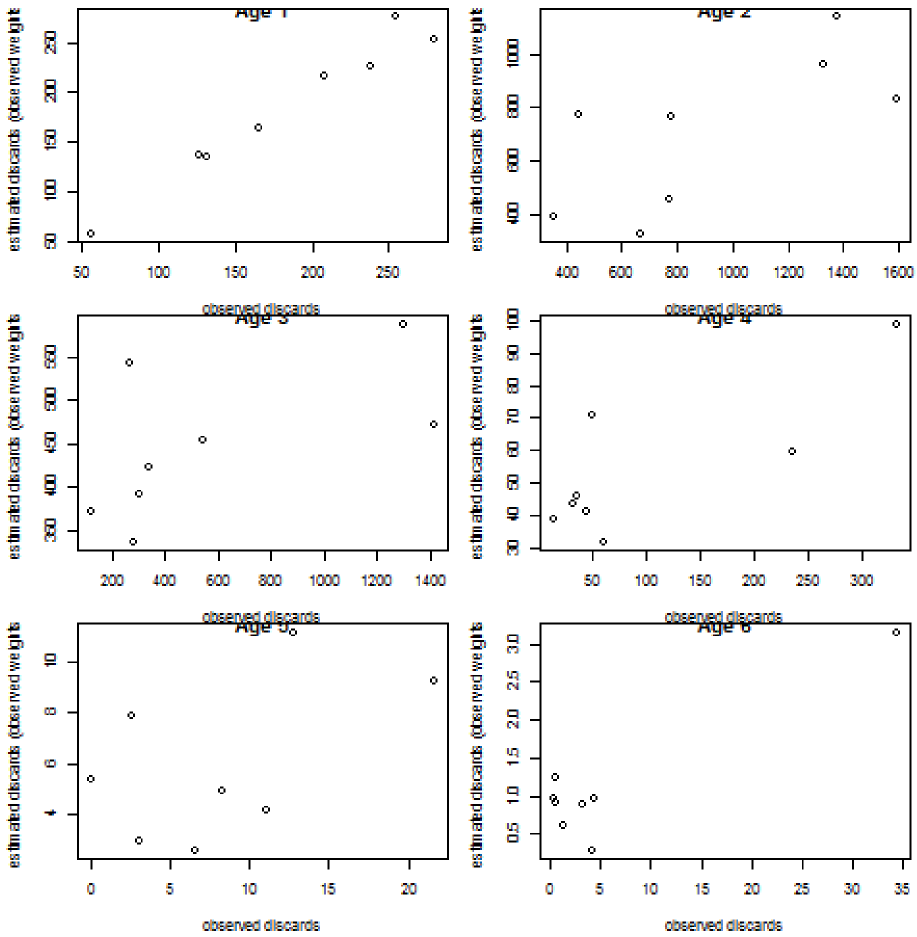


Figure 3.30: Results from Art and Poos model for the scenario 3 cont. Landings at age and discards at age: observed vs. estimated (top), and estimated discards vs. observed discards (bottom)

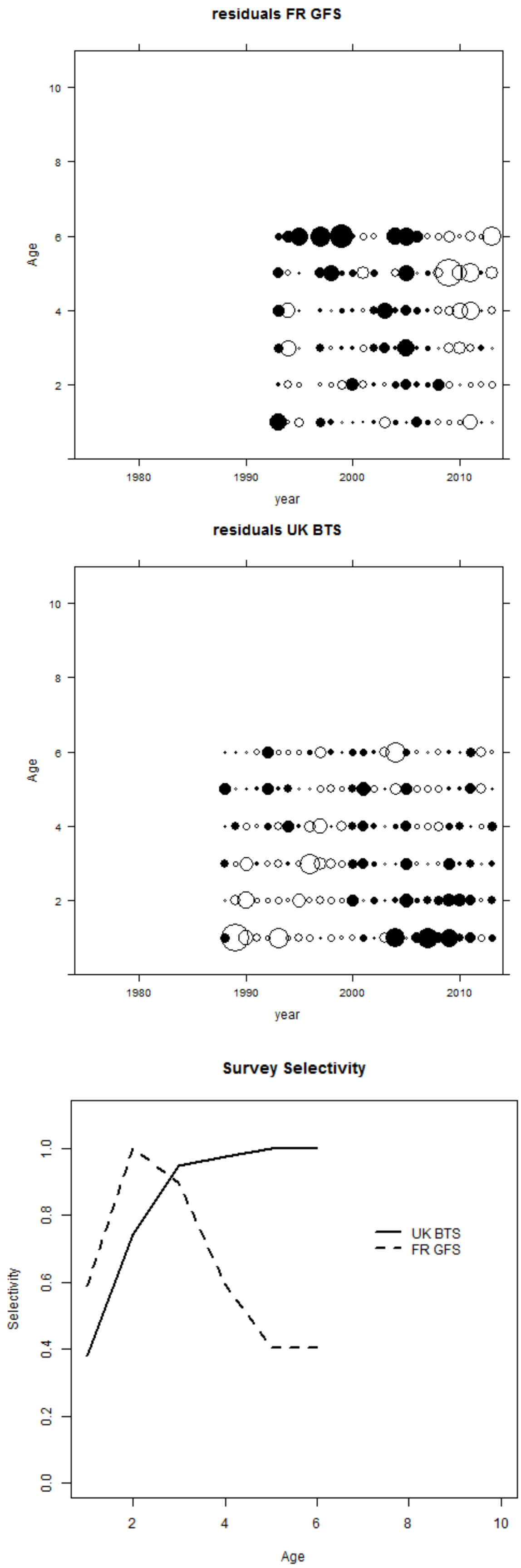
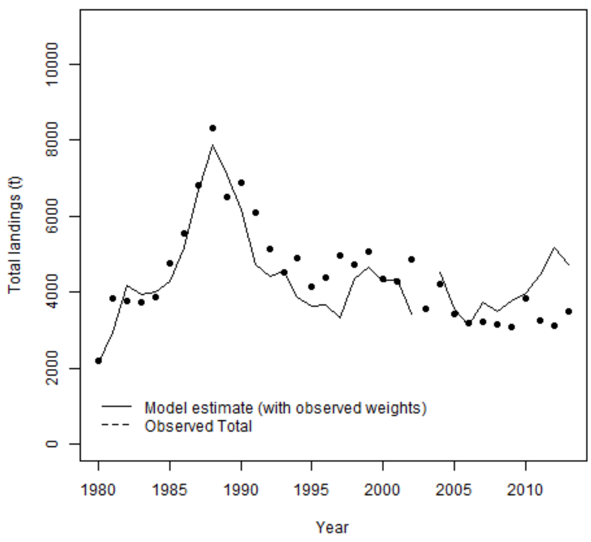
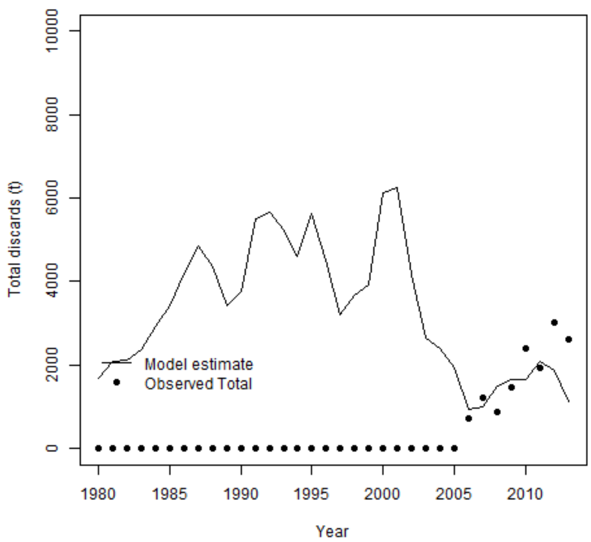
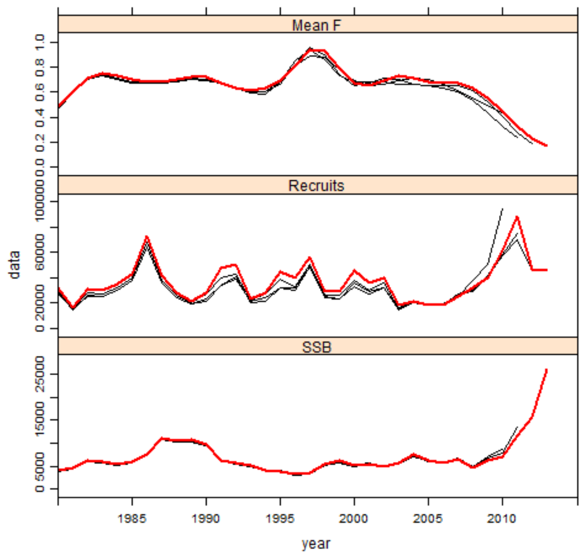


Figure 3.31: Results from Art and Poos model for the scenario 3 cont. Survey residuals and selectivity.


Total landings (t)
Model estimate (with observed weights)
Observed Total
Year


Total discards (t)
Model estimate
Observed Total
Year


Mean F
Recruits
SSB
data
year

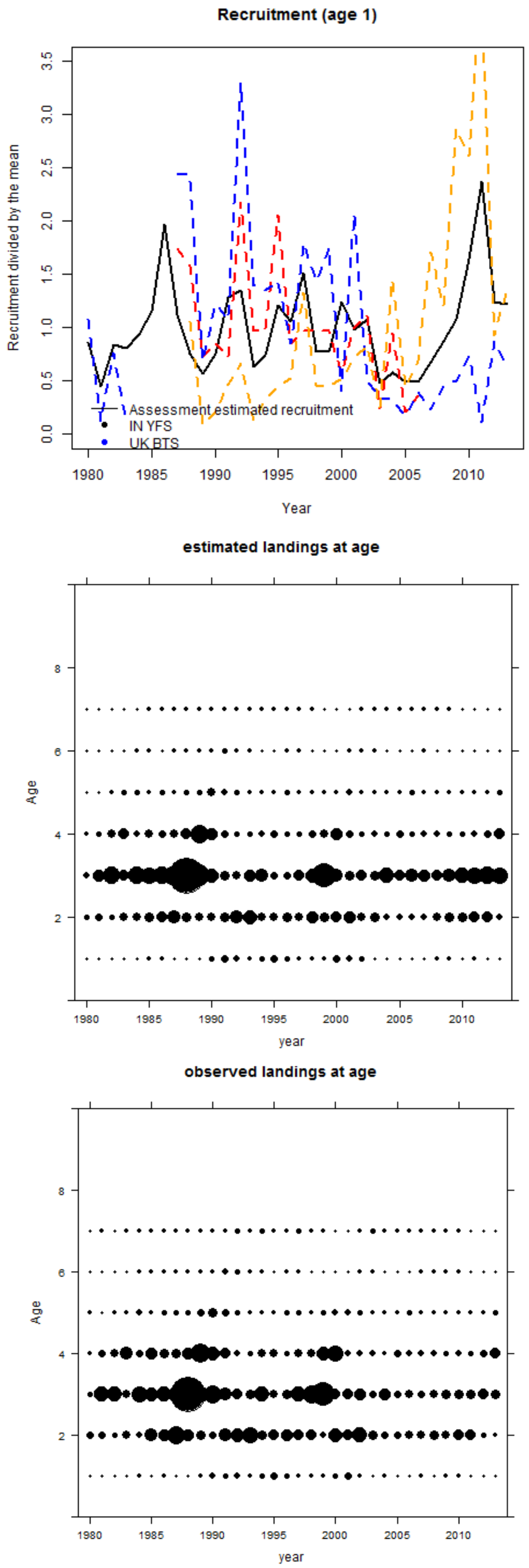
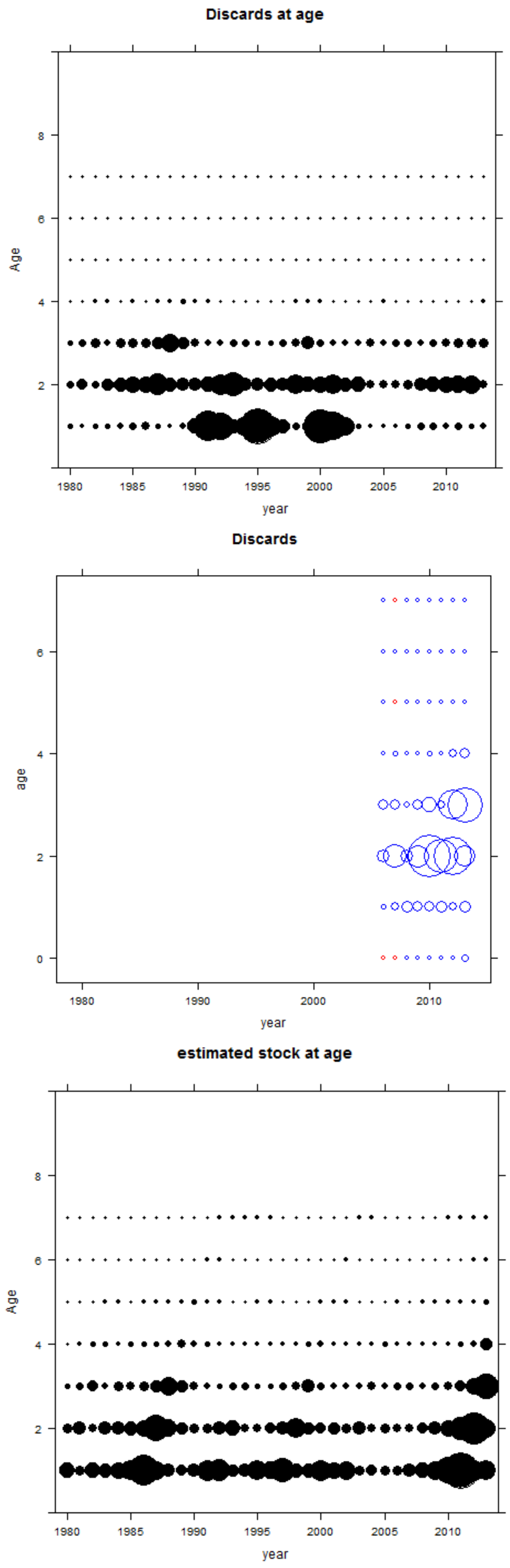


Figure 3.32: Results from Art and Poos model for the scenario 4 (7D population calculated with the new method, 2 tuning series, old natural mortality, i.e. 0.1)


Discards at age
Age
year
Discards
age
year
estimated stock at age
Age
year

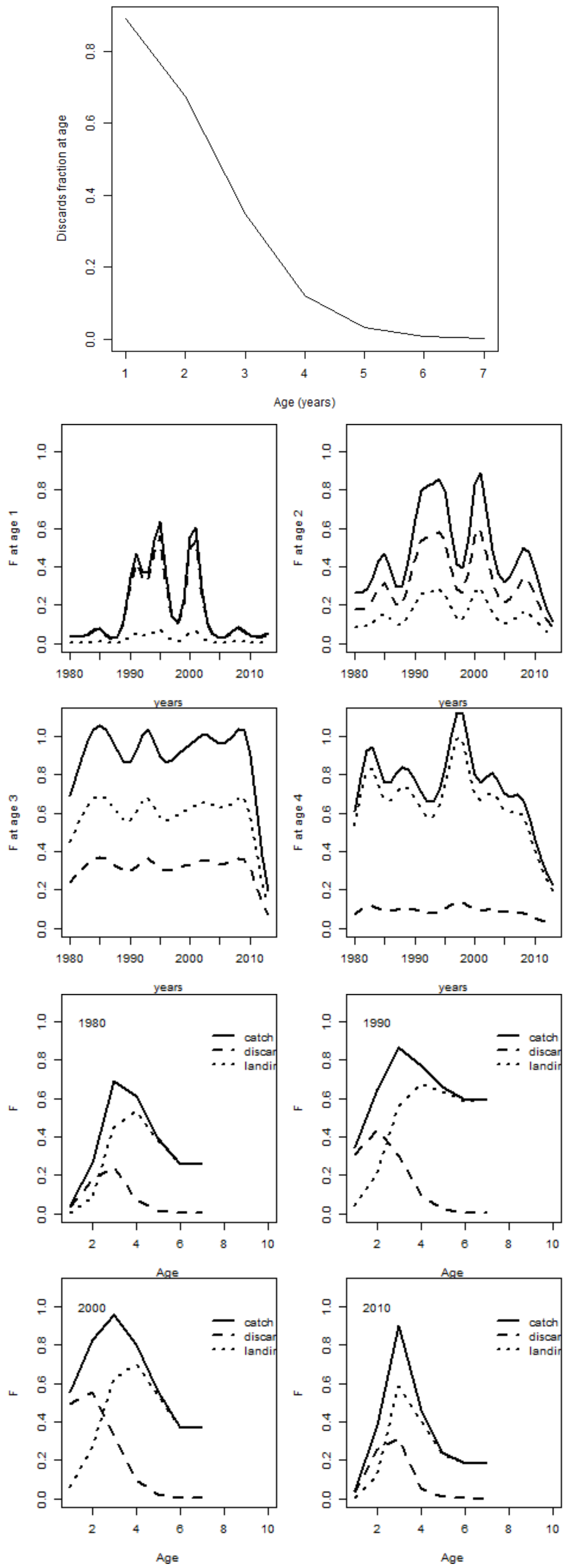
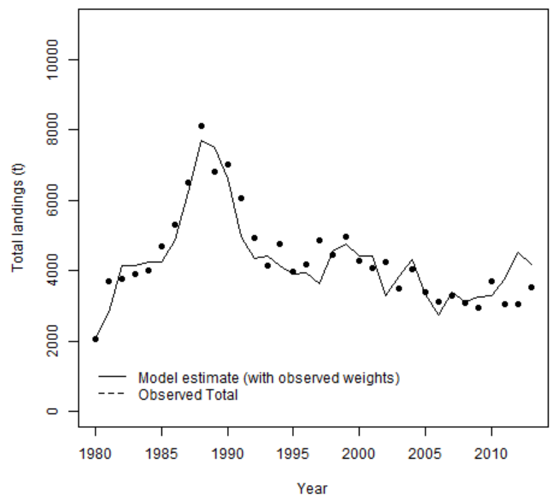
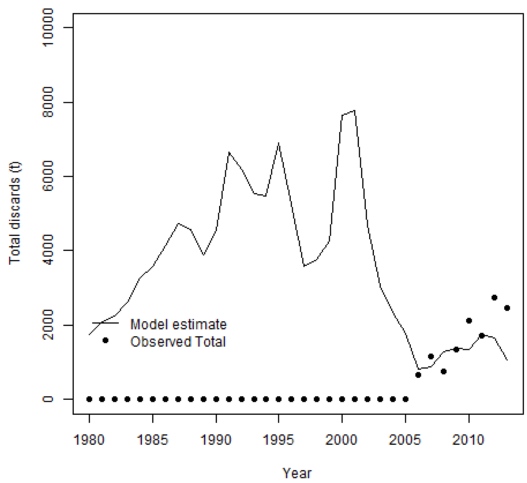
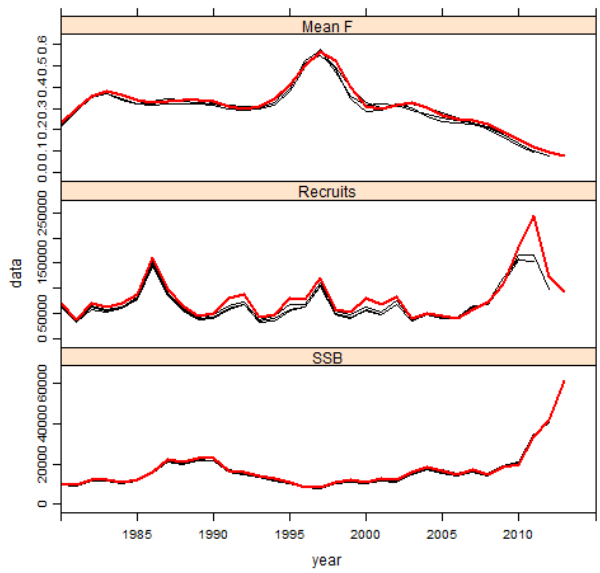


Figure 3.33: Results from Art and Poos model for the scenario 4 cont.


Total landings (t)
Model estimate (with observed weights)
Observed Total
Year


Total discards (t)
Model estimate
Observed Total
Year


Mean F
Recruits
SSB
data
year

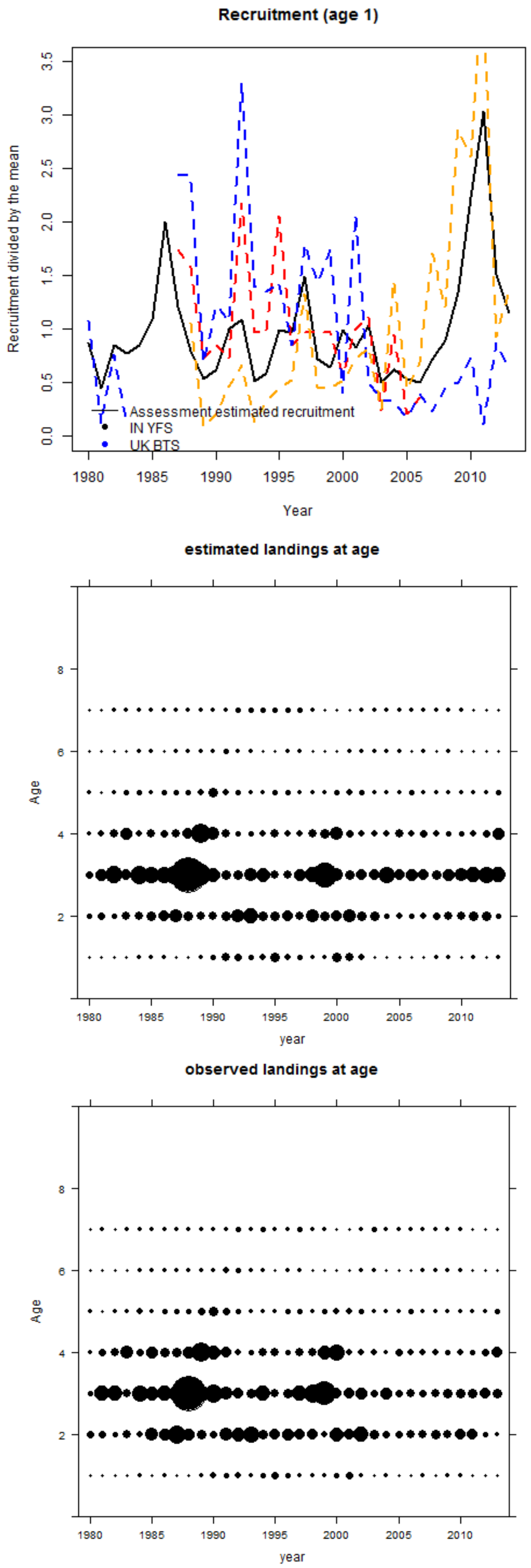
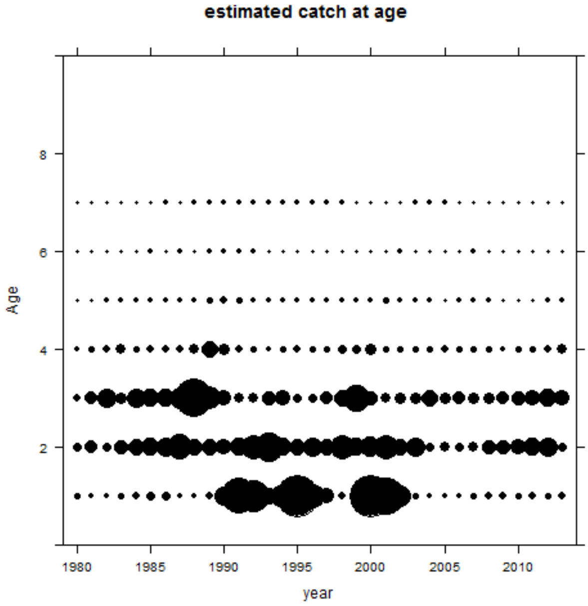
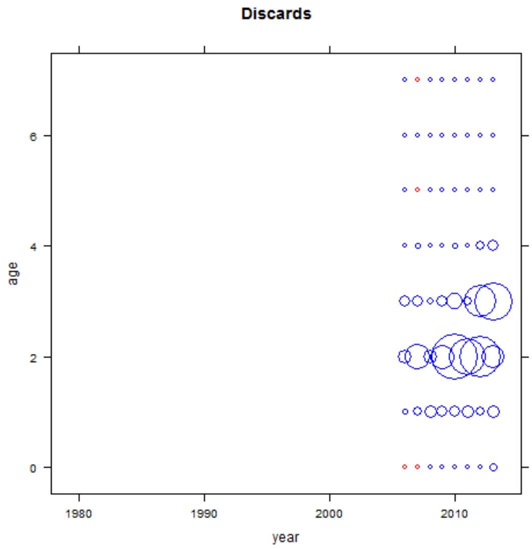
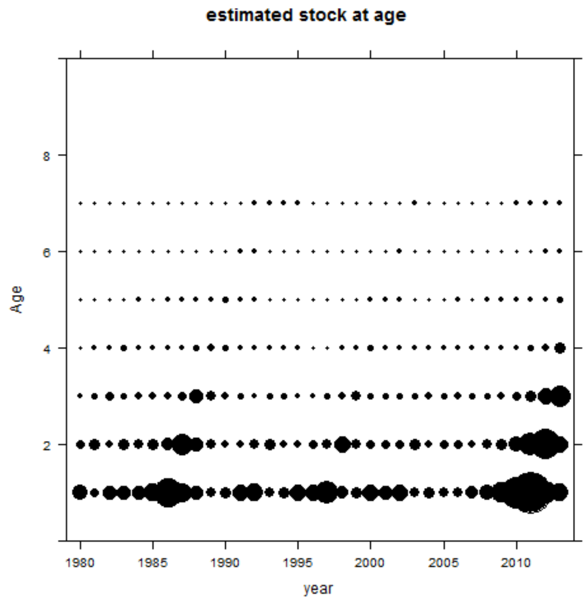


Figure 3.34: Results from Art and Poos model for the scenario 5 (7D population calculated with the old method, 2 tuning series, Peterson's mortality)


estimated catch at age
Age
year
1980
1985
1990
1995
2000
2005
2010


Discards
age
year
1980
1990
2000
2010


estimated stock at age
Age
year
1980
1985
1990
1995
2000
2005
2010

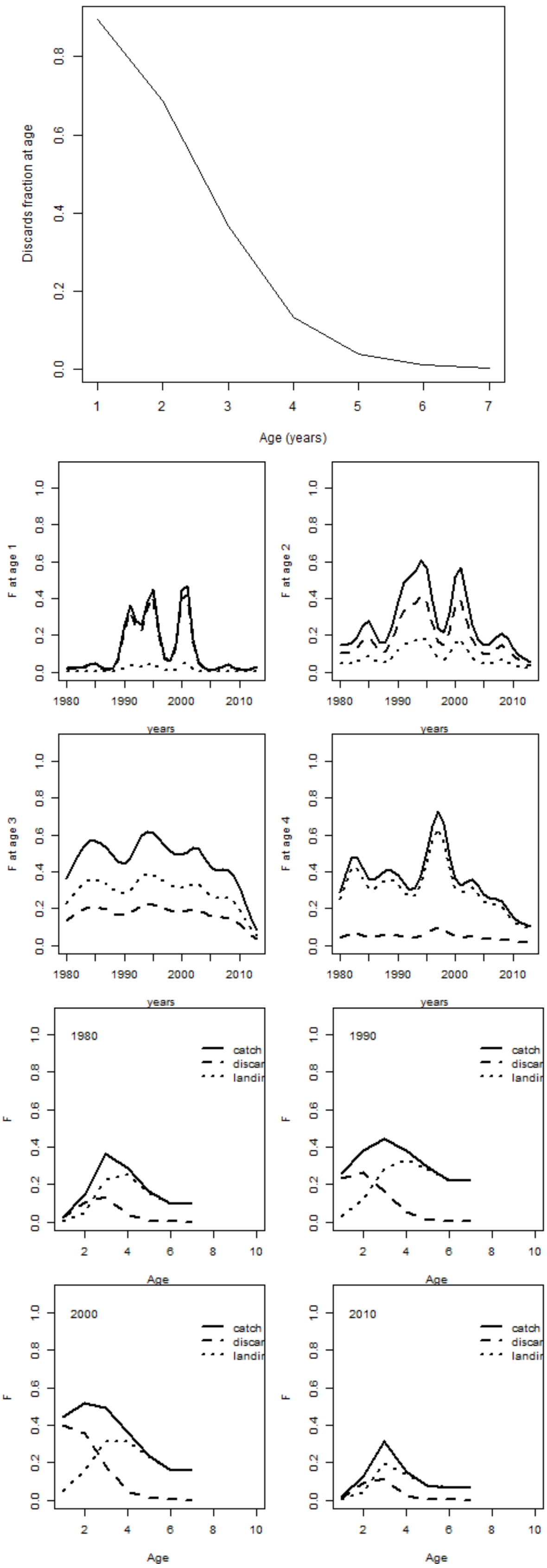
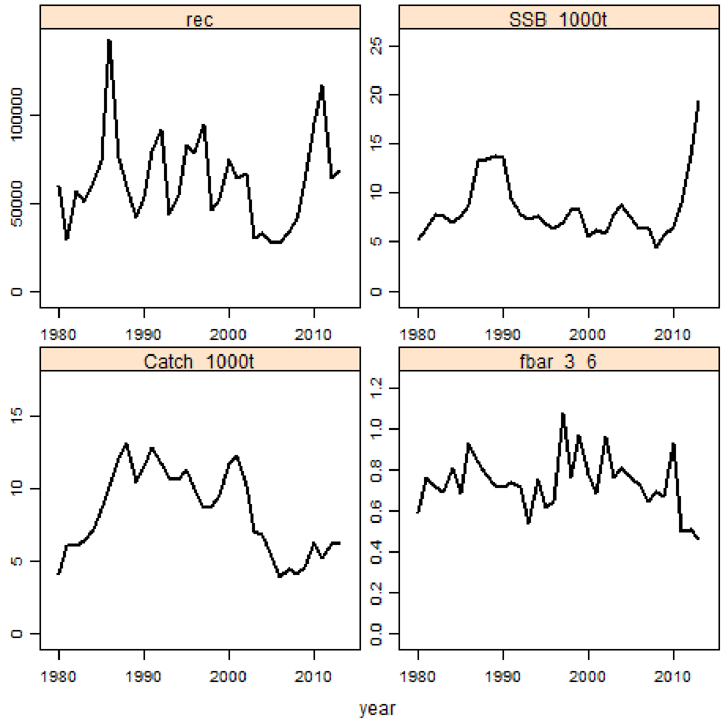
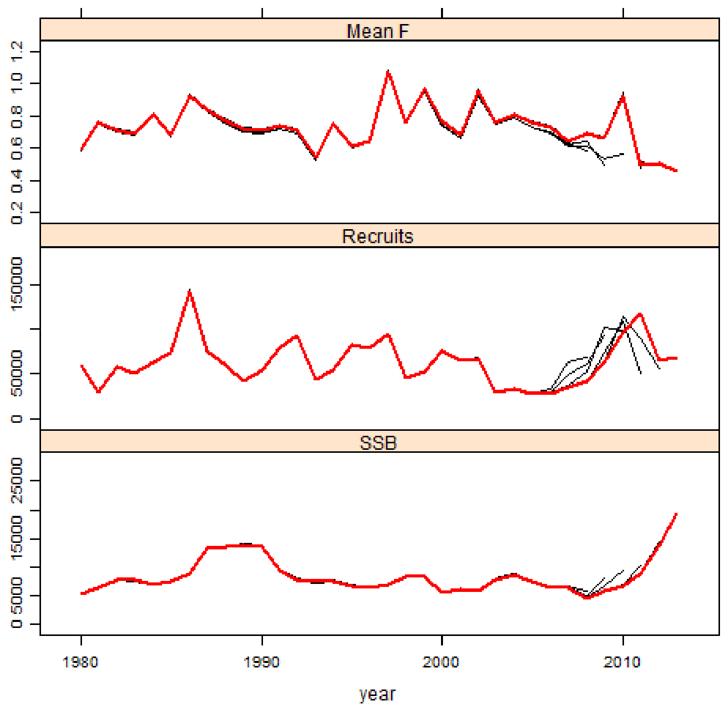


Figure 3.35: Results from Art and Poos model for the scenario 5 cont.


rec
SSB 1000t
Catch 1000t
fbar 3 6
year


Mean F
Recruits
SSB
year

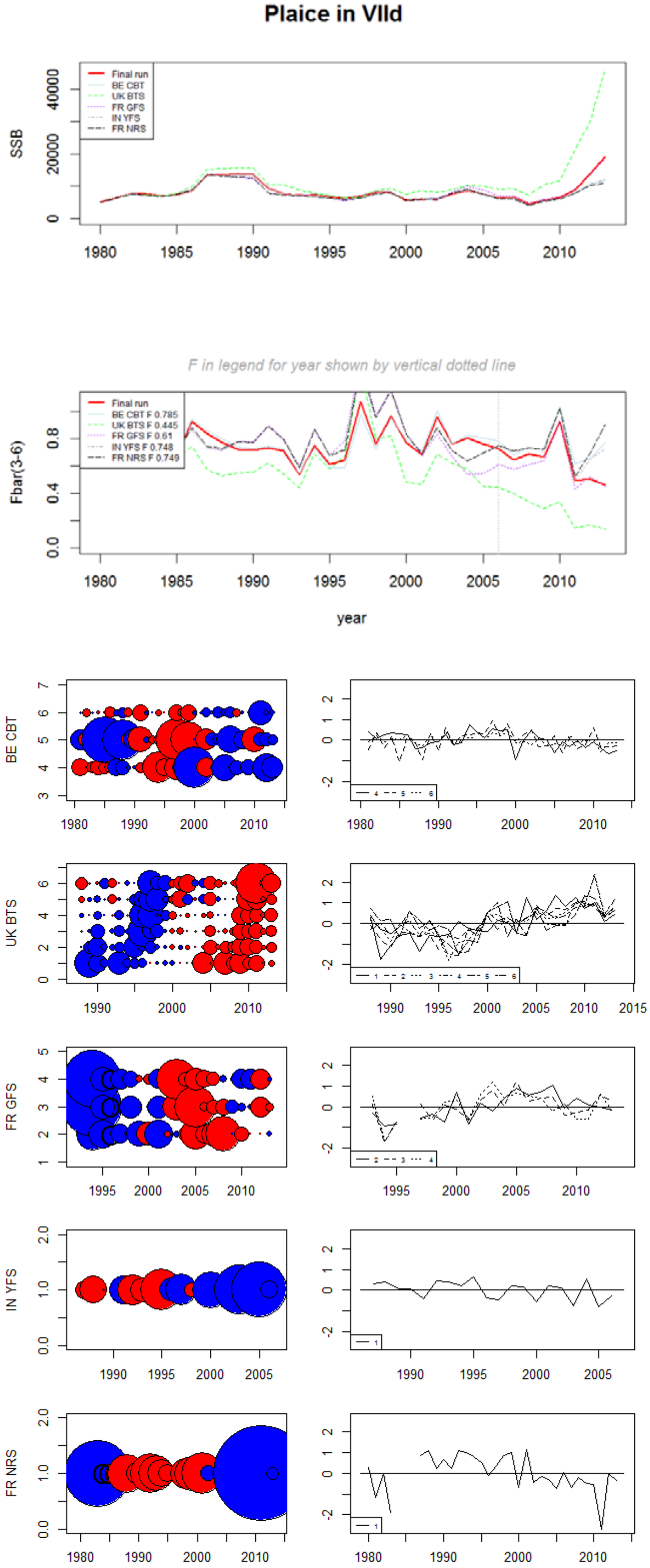
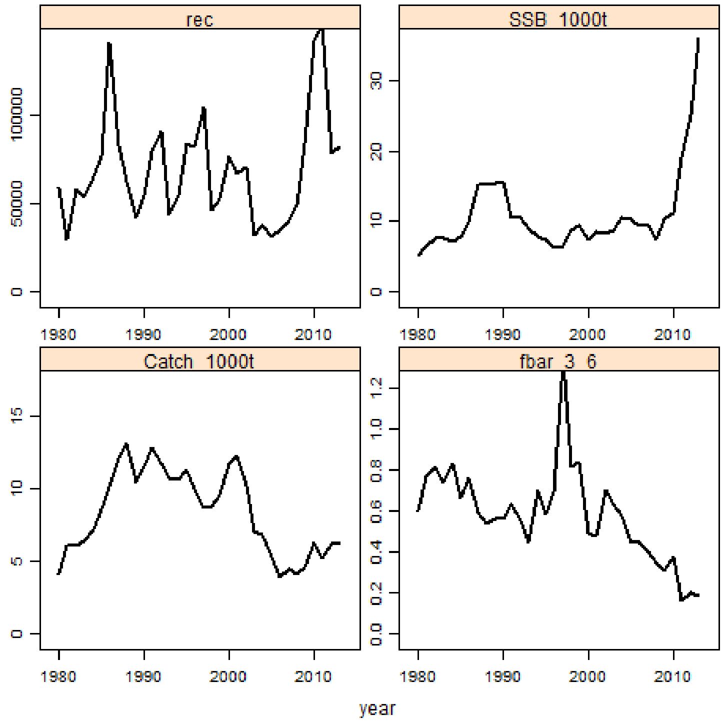
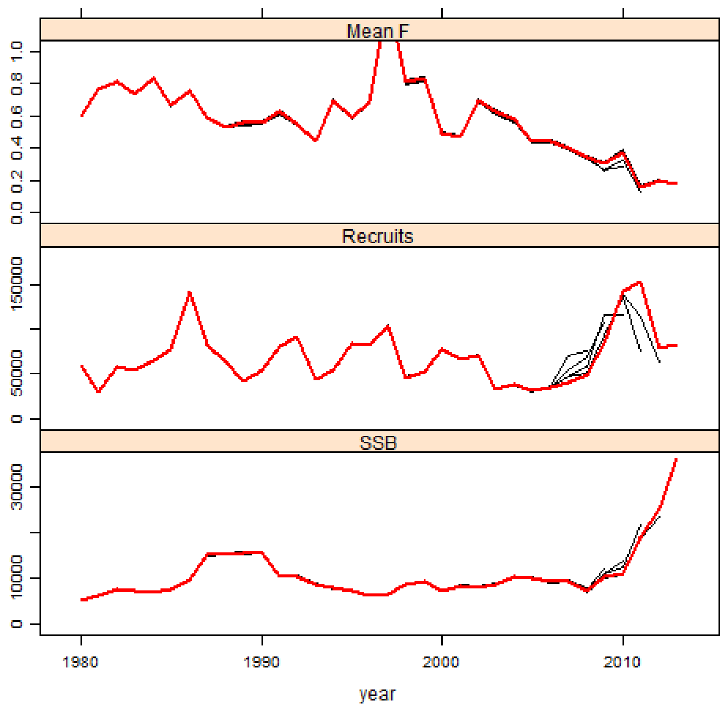


Figure 3.36: Results from the XSA: Scenario 1 (7D population corrected in the new way, Peterson's mortality, 5 tuning series).


rec
SSB 1000t
Catch 1000t
fbar 3 6
year


Mean F
Recruits
SSB
year

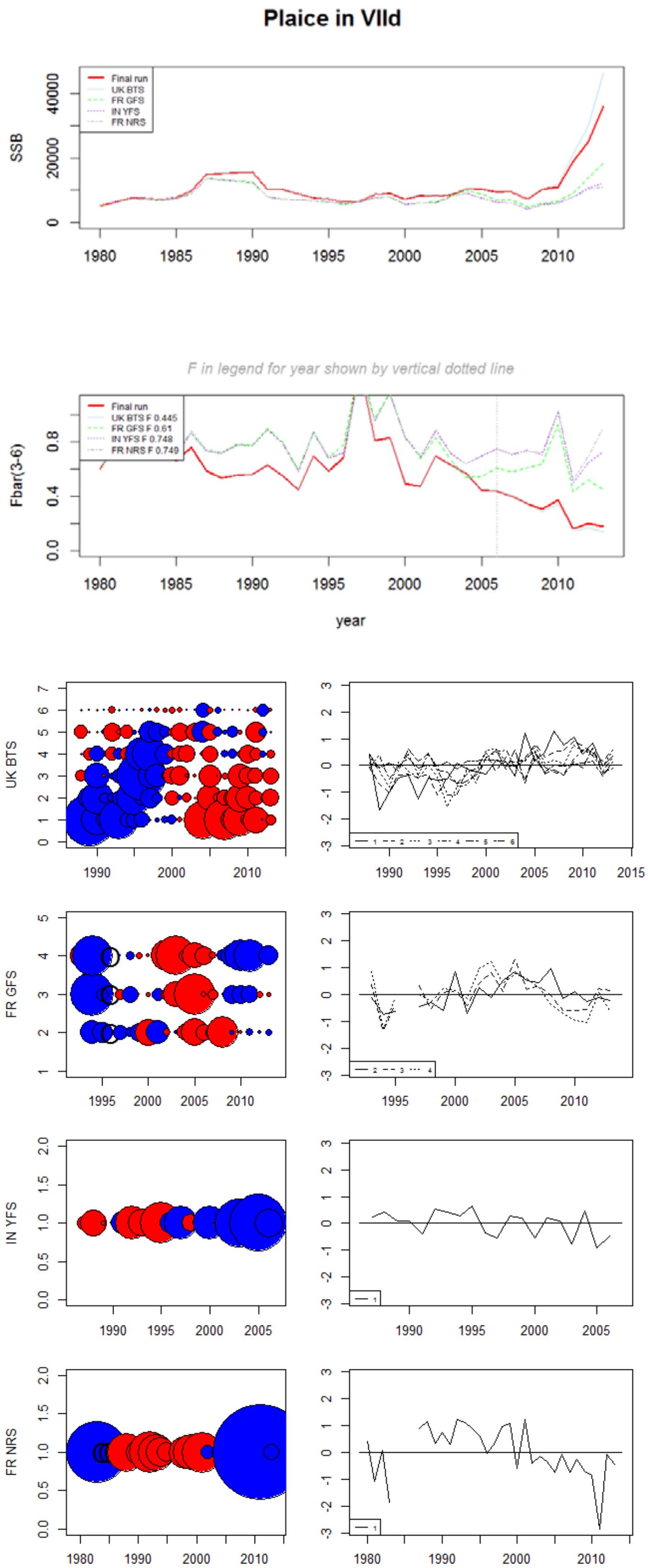


Figure 3.37: Results from the XSA: Scenario 2 (7D population corrected in the new way, Peterson's mortality, 4 tuning series).

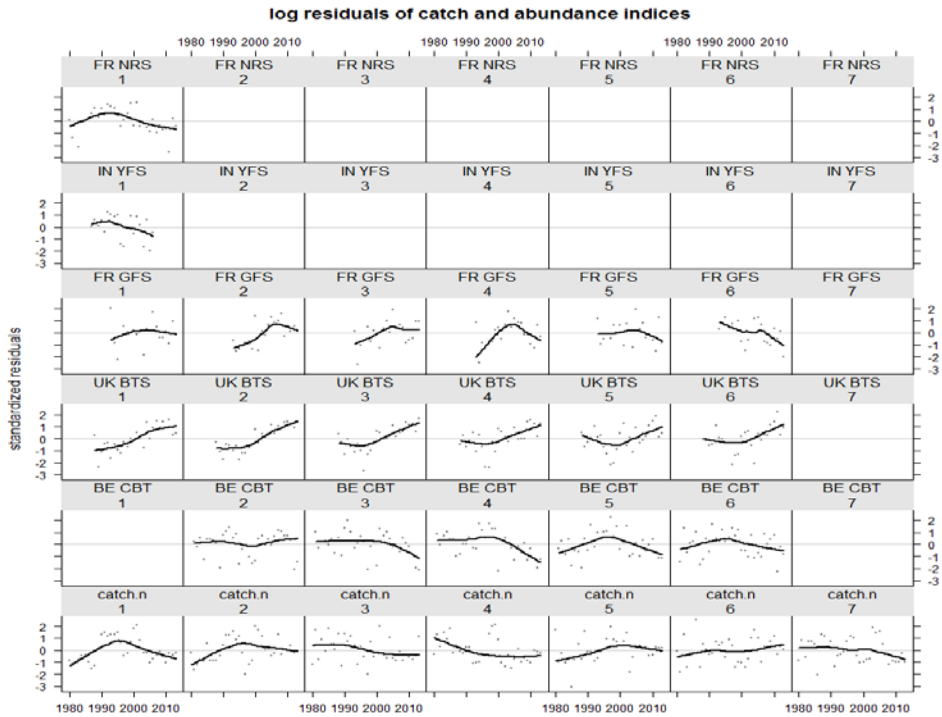


Figure 3.38: a4a model outputs - residuals

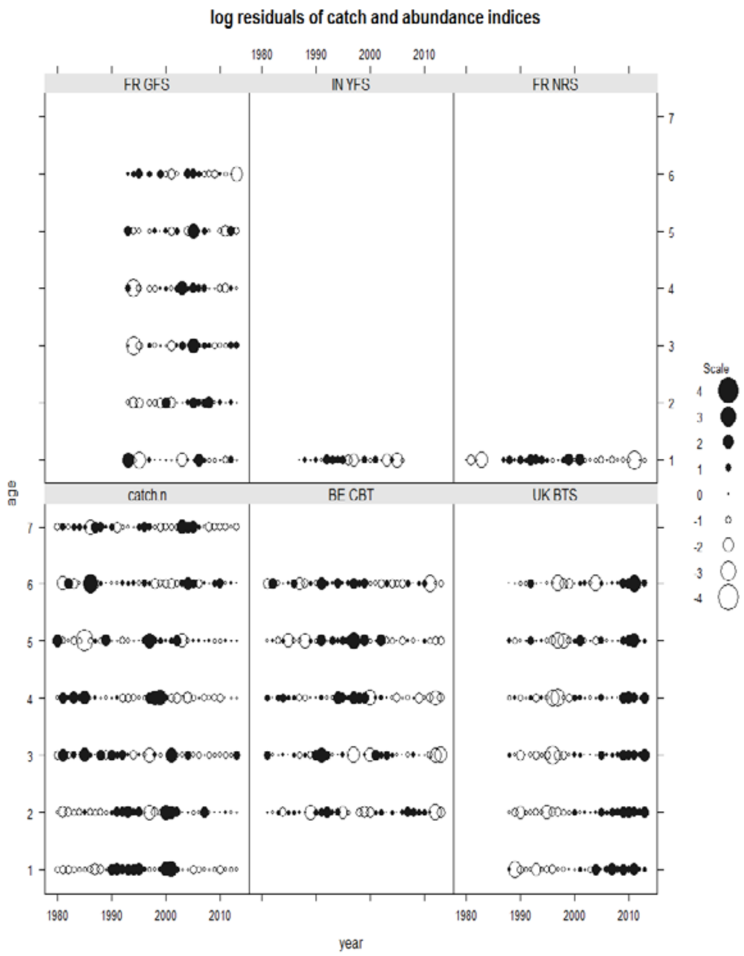


Figure 3.39: a4a model outputs – residuals cont.

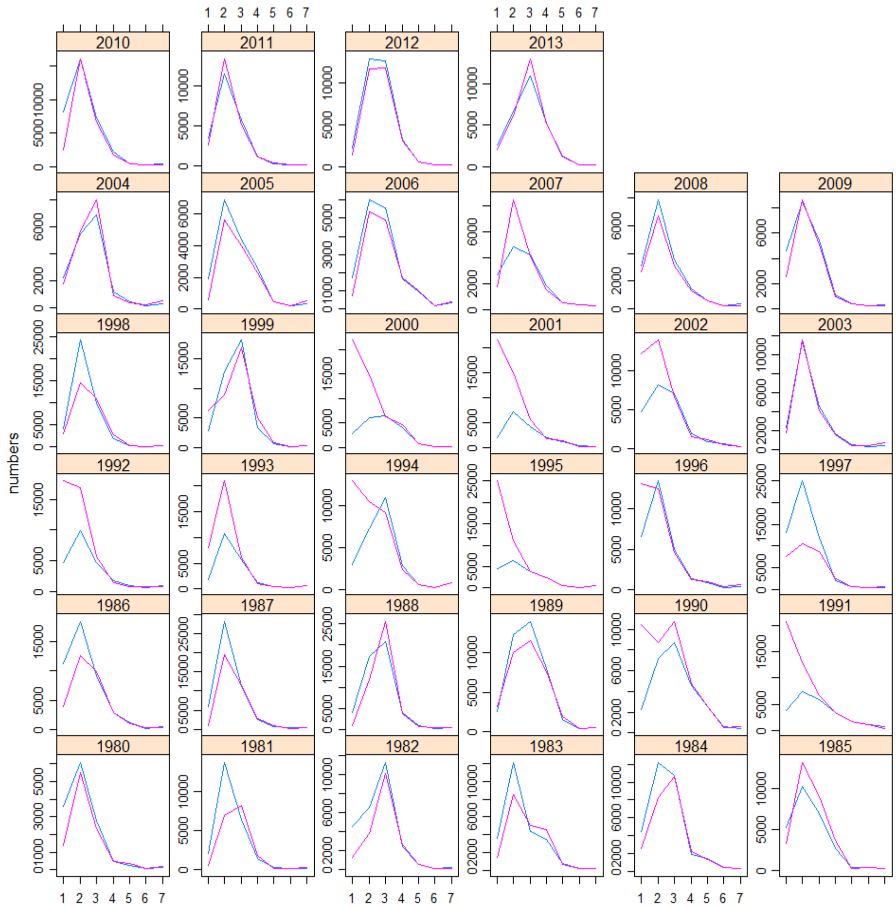


Figure 3.40: a4a assessment - Observed (pink) and estimated (blue) catch numbers

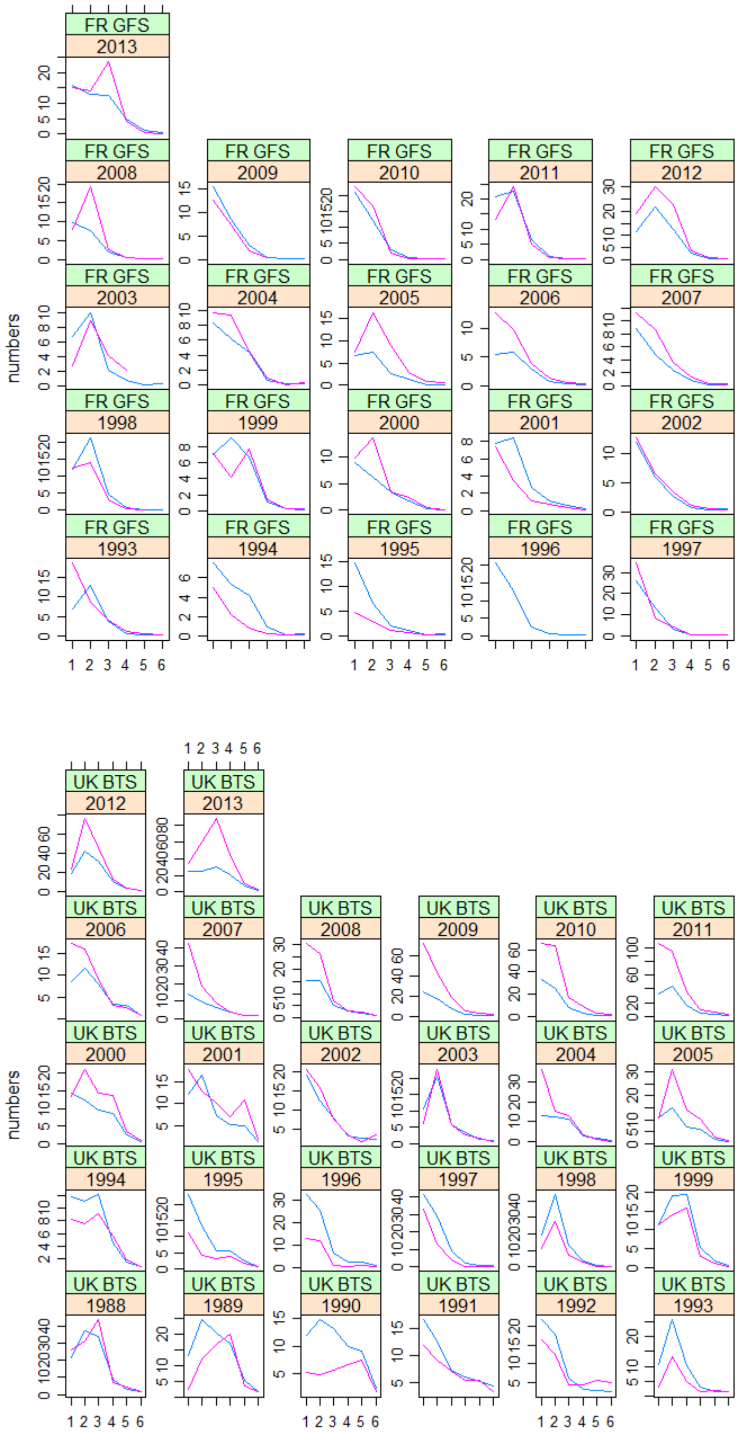


Figure 3.41: a4a assessment - Observed (pink) and estimated (blue) catch numbers in the indices

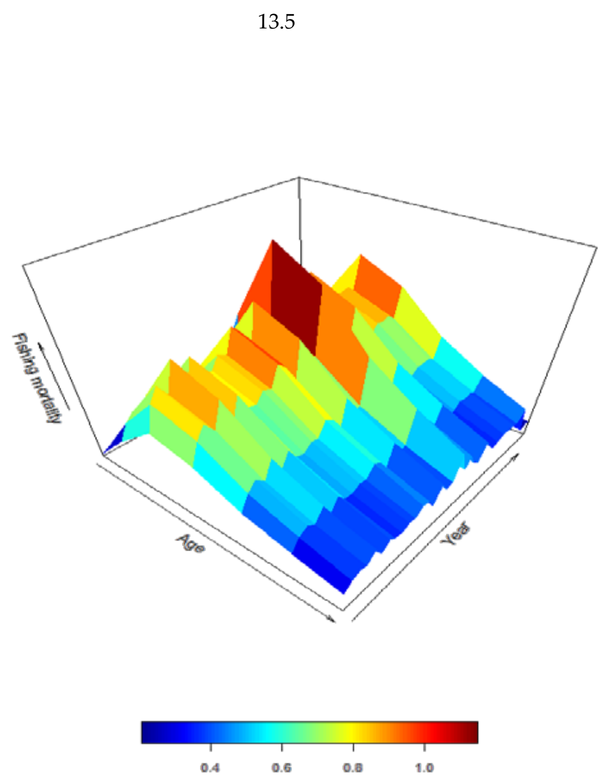


Figure 3.42: a4a assessment - Fishing mortality-at-age

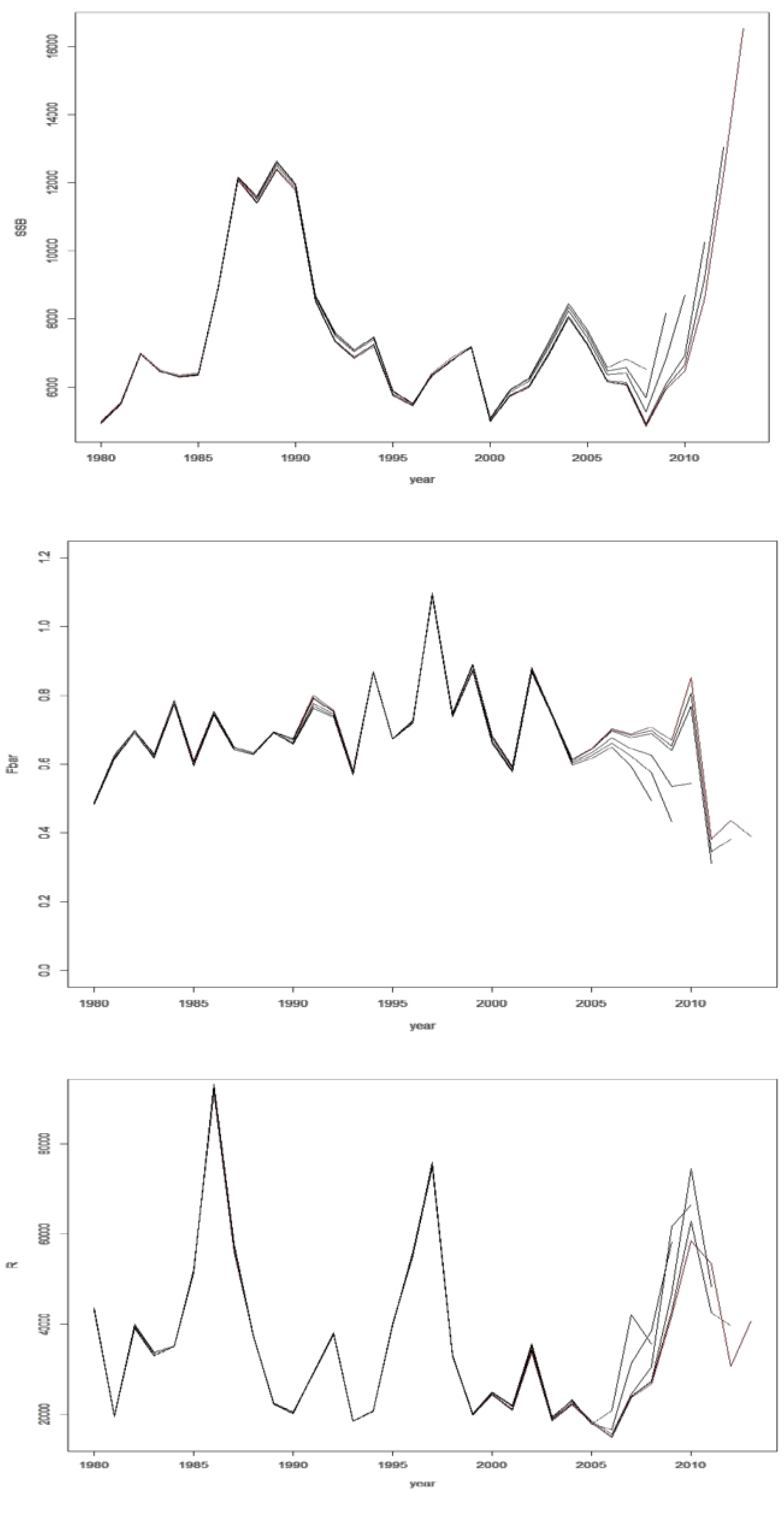


Figure 3.43: a4a assessment - Retrospective patterns in SSB (top panel), F_{bar} (middle panel) and R

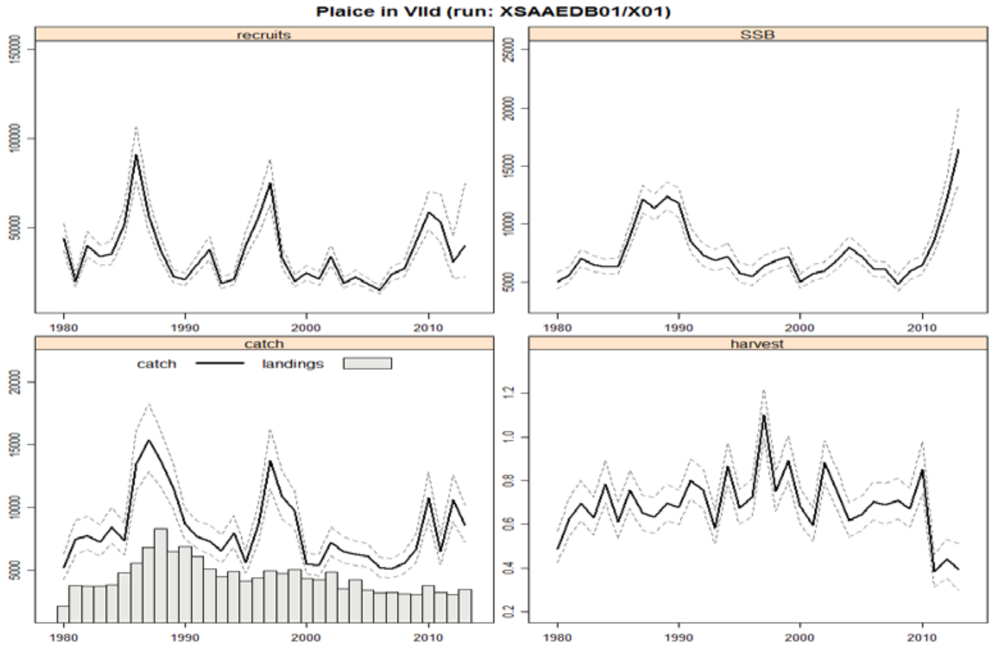


Figure 3.44: a4a assessment - Standard plot using the constant natural mortalities (=0.1) and 65% removal of catches of mature fish in the first quarter. Reconstructed discards, results of the Aart and Poos model were included for the period 1980–2005. 2006–2013 discards value is the estimated discards from InterCatch.

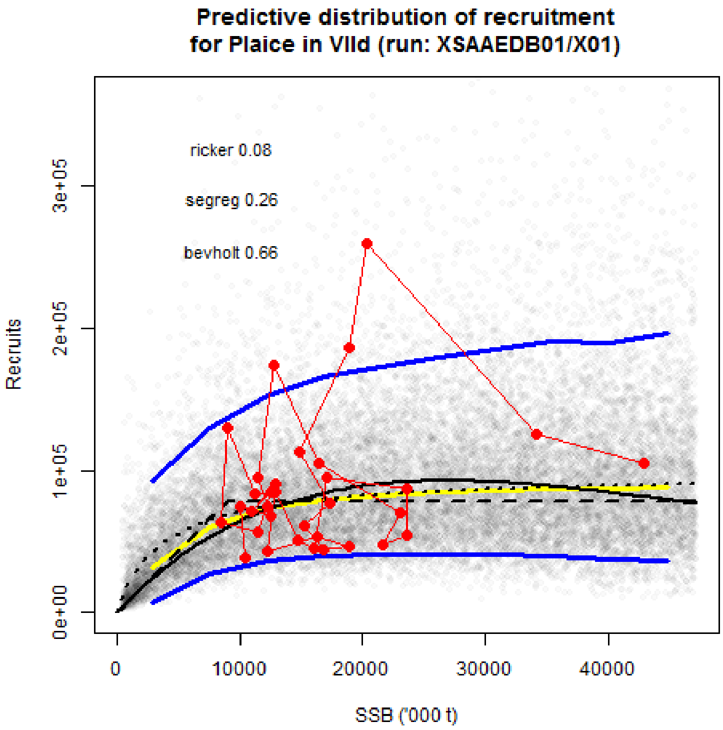


Figure 3.45. Eqsim summary of recruitment models (Ricker, Beverton and Holt and segmented regression for Plaice VIId.

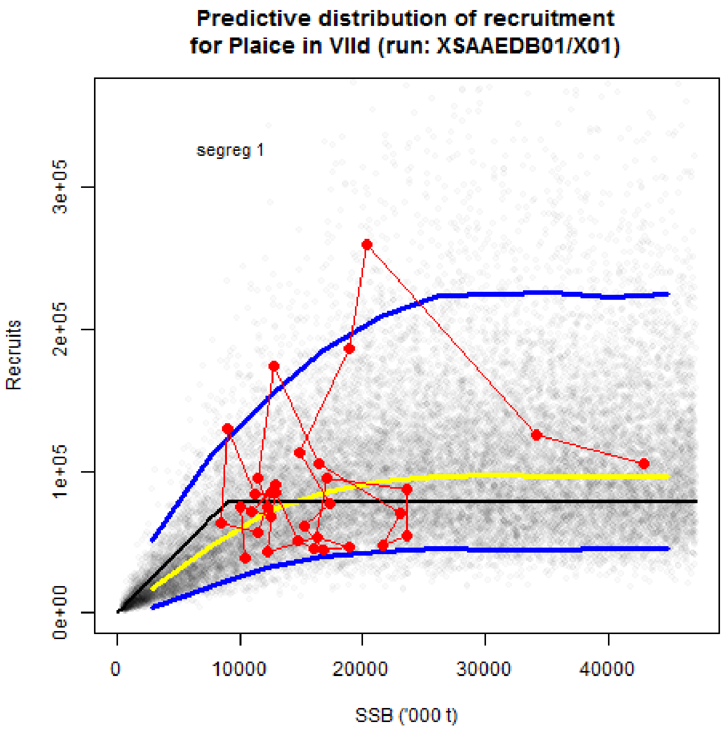


Figure 3.46. Eqsim summary of recruitment model (segmented regression) for Plaice VIId (used for analysis).

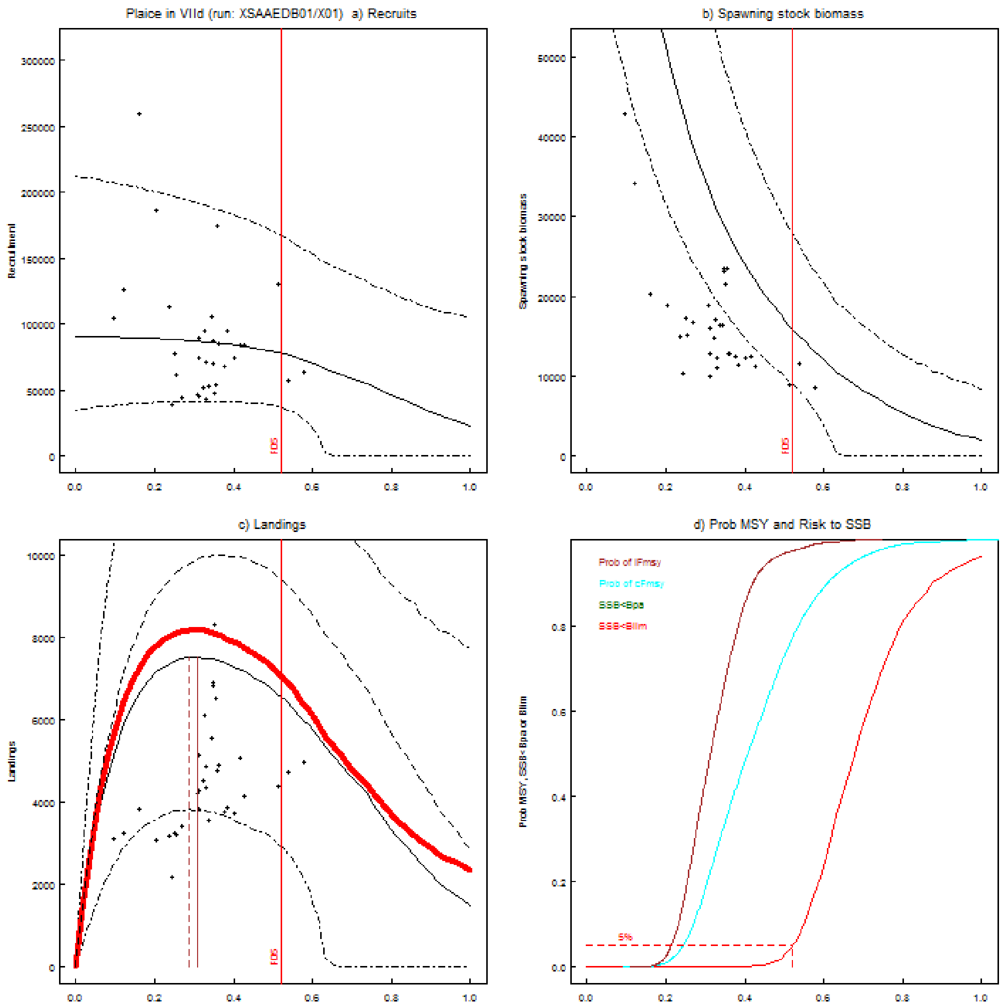


Figure 3.47. Eqsim summary plot for Plaice VIId (no trim, no excluding years, no $B_{trigger}$).

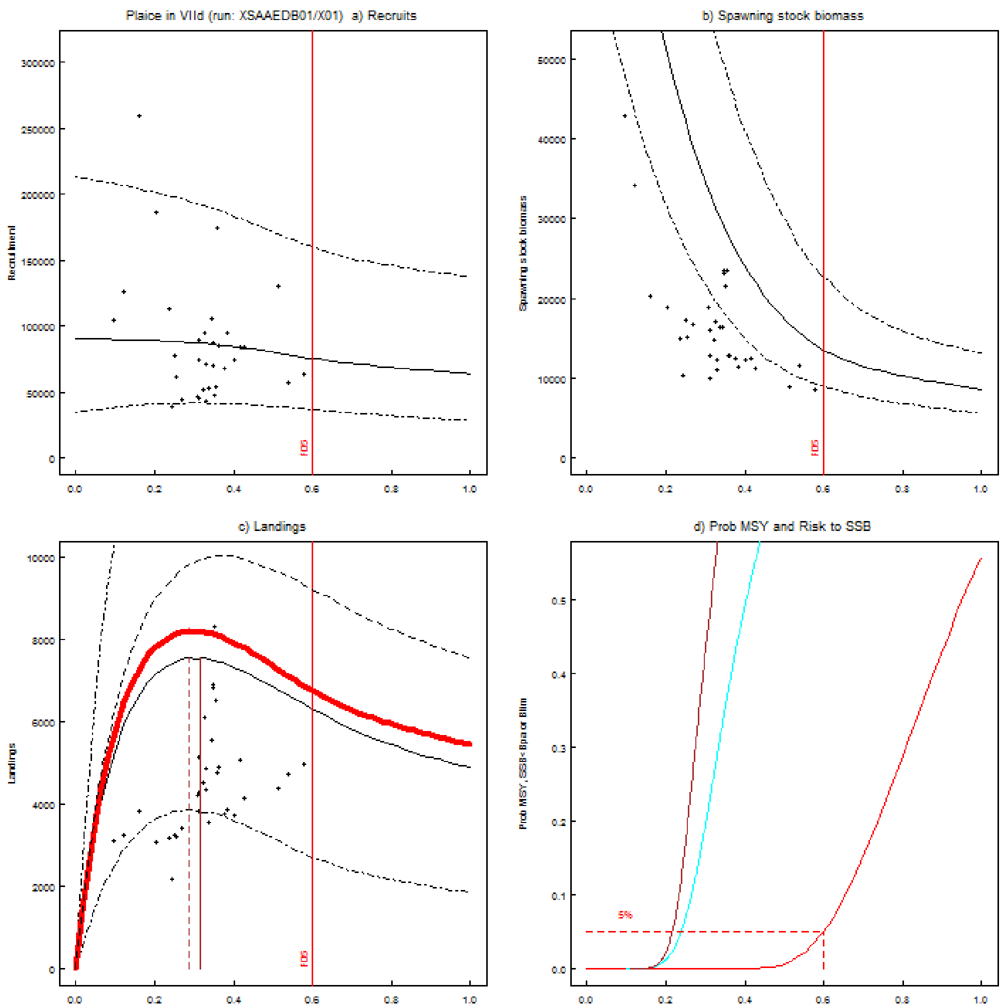


Figure 3.48. Eqsim summary plot for Plaice VIId with $B_{trigger}$ = 1.4*B_{lim} (no trim, no excluding years).

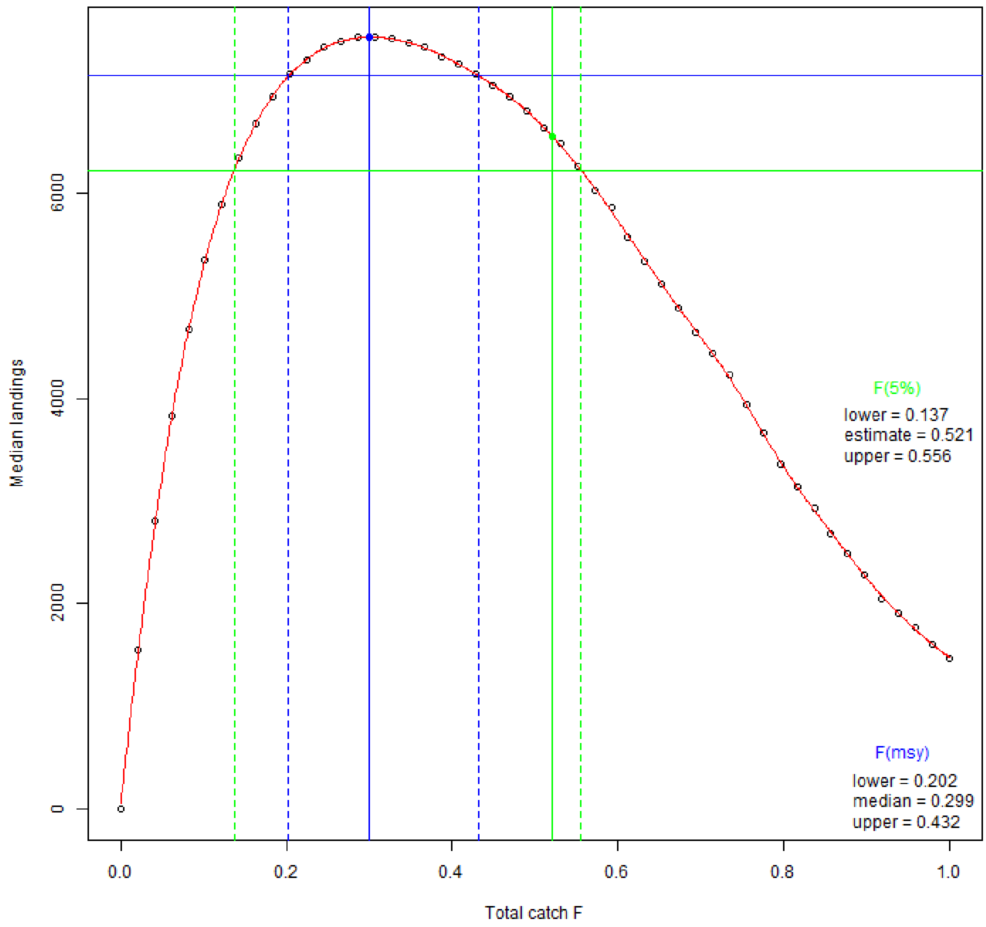


Figure 3.49. Plaice in Div. VIId Eqsim median landings yield curve with estimated reference points. Blue lines: F(MSY) estimate (solid) and range at 95% of maximum yield (dotted). Green lines: F(5%) estimate (solid) and range at 95% of yield implied by F(5%) (dotted). No $B_{trigger}$

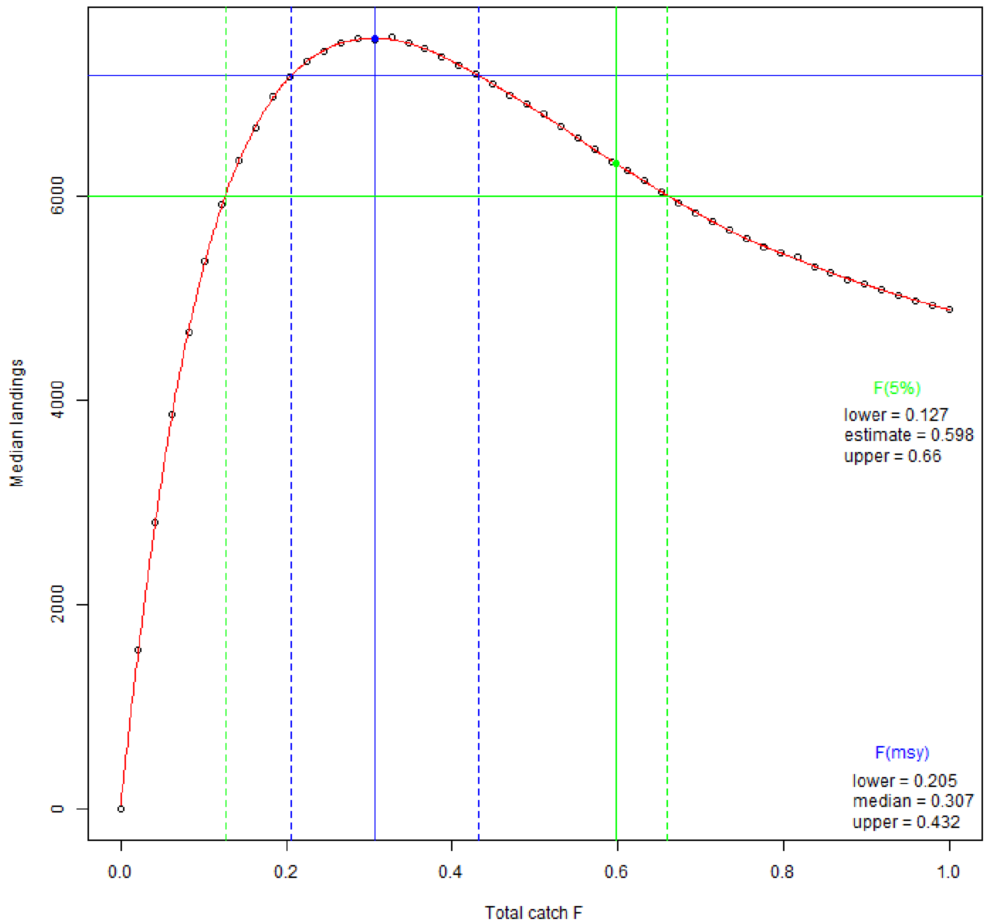


Figure 3.50. Plaice in Div. VIId Eqsim median landings yield curve with estimated reference points. Blue lines: F(MSY) estimate (solid) and range at 95% of maximum yield (dotted). Green lines: F(5%) estimate (solid) and range at 95% of yield implied by F(5%) (dotted). $B_{trigger} = 1.4 * B_{lim}$

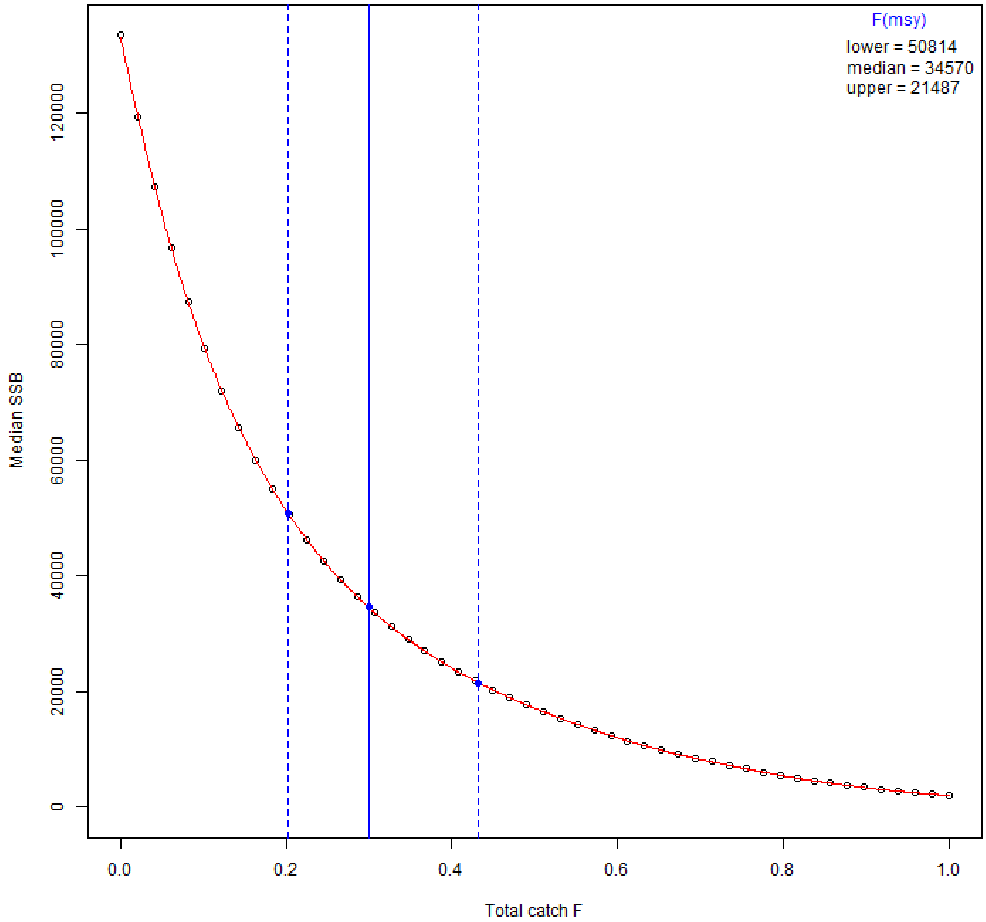


Figure 3.51. Plaice in Div. VIId Eqsim median SSB for Plaice VIId over a range of target F values. Blue lines show location of F(MSY) (solid) with 95% yield range (dotted).. No $B_{trigger}$

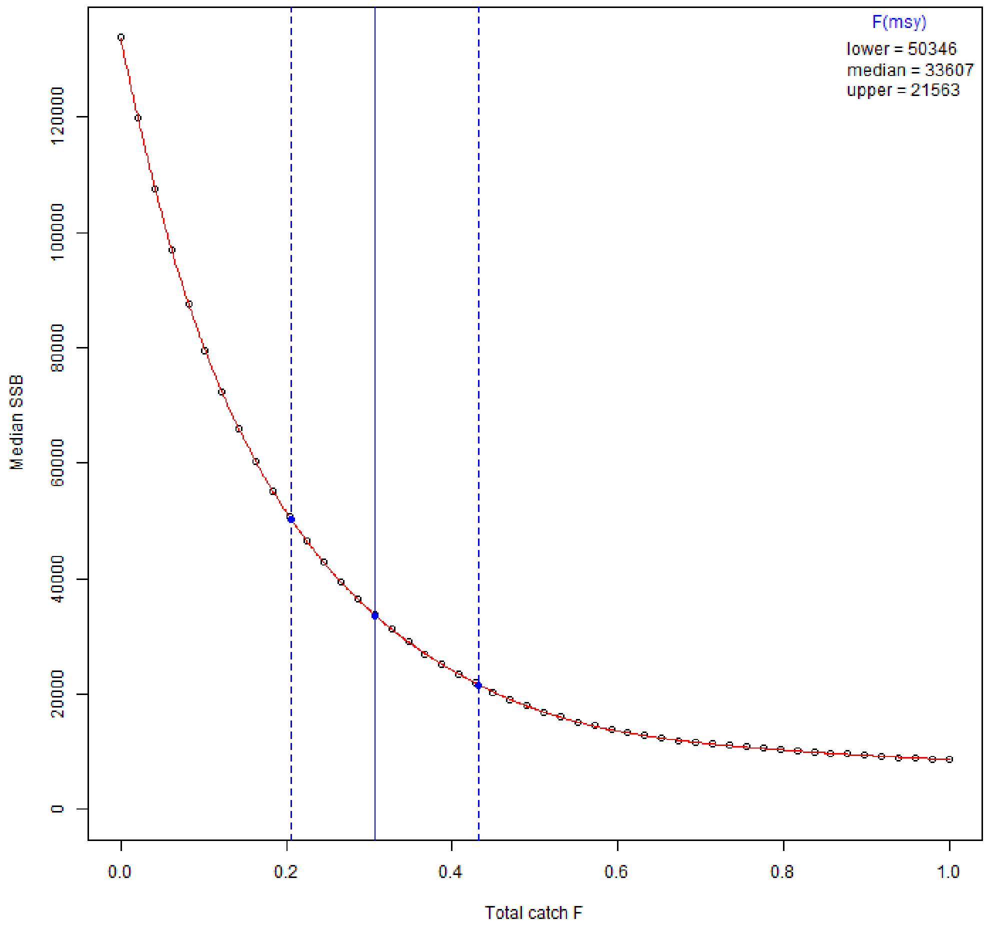


Figure 3.52. Plaice in Div. VIId Eqsim median SSB for Plaice VIId over a range of target F values. Blue lines show location of F(MSY) (solid) with 95% yield range (dotted).. $B_{trigger}$ = 1.4*B_{lim}

3.7 Appendix 1. Discards data per strata (Yellow cells: landings but no discards data, Red cells: Landings with associated discards data

Country	Season	2003 -1	2003 -2	2003 -3	2003 -4	2004 -1	2004 -2	2004 -3	2004 -4	2004 -all	2005 -1	2005 -2	2005 -3	2005 -4	2005 -all	2006 -1	2006 -2	2006 -3	2006 -4	2006 -all	2007 -1	2007 -2	2007 -3	2007 -4
UK (England)	TBB_DEF_70-99_0_0_all																							
UK (England)	GNS_DEF_all_0_0_all																							
UK (England)	GTR_DEF_all_0_0_all																							
UK (England)	MIS_MIS_0_0_0_HC																							
UK (England)	OTB_CRU_70-99_0_0_all																							
UK (England)	OTB_CRU_16-31_0_0_all																							
UK (England)	LLS_FIF_0_0_0_all																							
UK (England)	OTB_DEF_>=120_0_0_all																							
UK (England)	SSC_DEF_>=120_0_0_all																							
UK(North Ir)	GNS_DEF_100-119_0_0_all																							
UK(Scotland)	OTB_CRU_70-99_0_0_all																							
UK(Scotland)	TBB_DEF_70-99_0_0_all																							
UK(Scotland)	MIS_MIS_0_0_0_HC																							

Country	Season	2003 -1	2003 -2	2003 -3	2003 -4	2004 -1	2004 -2	2004 -3	2004 -4	2004 -all	2005 -1	2005 -2	2005 -3	2005 -4	2005 -all	2006 -1	2006 -2	2006 -3	2006 -4	2006 -all	2007 -1	2007 -2	2007 -3	2007 -4
Netherlands	OTB_DEF_70-99_0_0_all																							
Netherlands	OTB_DEF_>=120_0_0_all																							
Netherlands	SSC_DEF_70-99_0_0_all																							
Netherlands	PTB_DEF_70-99_0_0_all																							
Netherlands	TBB_DEF_70-99_0_0_all																							
Netherlands	DRB_MOL_0_0_0_all																							
Netherlands	MIS_MIS_0_0_0_HC																							
Netherlands	FPO_CRU_0_0_0_all																							
Netherlands	SDN_DEF_70-99_0_0_all																							
Netherlands	SSC_DEF_100-119_0_0_all																							
Netherlands	SDN_DEF_>=120_0_0_all																							
Belgium	GNS_DEF_all_0_0_all																							
Belgium	OTB_CRU_70-99_0_0_all																							
Belgium	TBB_CRU_16-31_0_0_all																							

Country	Season	2003 -1	2003 -2	2003 -3	2003 -4	2004 -1	2004 -2	2004 -3	2004 -4	2004 -all	2005 -1	2005 -2	2005 -3	2005 -4	2005 -all	2006 -1	2006 -2	2006 -3	2006 -4	2006 -all	2007 -1	2007 -2	2007 -3	2007 -4
Belgium	TBB_DEF_70-99_0_0_all																							
Belgium	MIS_MIS_0_0_0_HC																							
Belgium	GTR_DEF_all_0_0_all																							
Belgium	TBB_DEF_>=120_0_0_all																							
Belgium	SSC_DEF_>=120_0_0_all																							
France	GNS_DEF_120-219_0_0_all																							
France	GNS_DEF_90-99_0_0_all																							
France	GTR_DEF_all_0_0_all																							
France	MIS_MIS_0_0_0_HC																							
France	OTB_DEF_70-99_0_0_all																							
France	OTB_SPF_70-99_0_0_all																							
France	TBB_DEF_70-99_0_0_all																							
France	FPO_CRU_0_0_0_all																							
France	OTB_DEF_100-119_0_0_all																							

Country	Season	2003 –1	2003 –2	2003 –3	2003 –4	2004 –1	2004 –2	2004 –3	2004 –4	2004 –all	2005 –1	2005 –2	2005 –3	2005 –4	2005 –all	2006 –1	2006 –2	2006 –3	2006 –4	2006 –all	2007 –1	2007 –2	2007 –3	2007 –4
France	SDN_DEF_>=120_0_0_all																							
France	OTB_CRU_32-69_0_0_all																							
France	SDN_all_0_0_all																							

Country	Season	2008-1	2008-2	2008-3	2008-4	2009-1	2009-2	2009-3	2009-4	2010-1	2010-2	2010-3	2010-4	2011-1	2011-2	2011-3	2011-4	2011-all	2012-1	2012-2	2012-3	2012-4	2013-1	2013-2	2013-3	2013-4	2013-all
UK (England)	TBB_DEF_70-99_0_0_all																										
UK (England)	GNS_DEF_all_0_0_all																										
UK (England)	GTR_DEF_all_0_0_all																										
UK (England)	MIS_MIS_0_0_HC																										
UK (England)	OTB_CRU_70-99_0_0_all																										
UK (England)	OTB_CRU_16-31_0_0_all																										
UK (England)	LLS_FIF_0_0_0_all																										
UK (England)	OTB_DEF_>=120_0_0_all																										
UK (England)	SSC_DEF_>=120_0_0_all																										
UK(North Ir)	GNS_DEF_100-119_0_0_al																										

Country	Season	2008-1	2008-2	2008-3	2008-4	2009-1	2009-2	2009-3	2009-4	2010-1	2010-2	2010-3	2010-4	2011-1	2011-2	2011-3	2011-4	2011-all	2012-1	2012-2	2012-3	2012-4	2013-1	2013-2	2013-3	2013-4	2013-all
UK(Scotland)	OTB_CRU_70-99_0_0_all																										
UK(Scotland)	TBB_DEF_70-99_0_0_all																										
UK(Scotland)	MIS_MIS_0_0_0_HC																										
Netherlands	OTB_DEF_70-99_0_0_all																										
Netherlands	OTB_DEF_>=120_0_0_all																										
Netherlands	SSC_DEF_70-99_0_0_all																										
Netherlands	PTB_DEF_70-99_0_0_all																										
Netherlands	TBB_DEF_70-99_0_0_all																										
Netherlands	DRB_MOL_0_0_0_all																										
Netherlands	MIS_MIS_0_0_0_HC																										

Country	Season	2008-1	2008-2	2008-3	2008-4	2009-1	2009-2	2009-3	2009-4	2010-1	2010-2	2010-3	2010-4	2011-1	2011-2	2011-3	2011-4	2011-all	2012-1	2012-2	2012-3	2012-4	2013-1	2013-2	2013-3	2013-4	2013-all
Netherlands	FPO_CRU_0_0_0_all																										
Netherlands	SDN_DEF_70-99_0_0_all																										
Netherlands	SSC_DEF_100-119_0_0_all																										
Netherlands	SDN_DEF_>=120_0_0_all																										
Belgium	GNS_DEF_all_0_0_all																										
Belgium	OTB_CRU_70-99_0_0_all																										
Belgium	TBB_CRU_16-31_0_0_all																										
Belgium	TBB_DEF_70-99_0_0_all																										
Belgium	MIS_MIS_0_0_0_HC																										
Belgium	GTR_DEF_all_0_0_all																										

Country	Season	2008-1	2008-2	2008-3	2008-4	2009-1	2009-2	2009-3	2009-4	2010-1	2010-2	2010-3	2010-4	2011-1	2011-2	2011-3	2011-4	2011-all	2012-1	2012-2	2012-3	2012-4	2013-1	2013-2	2013-3	2013-4	2013-all
Belgium	TBB_DEF_>=120_0_0_all																										
Belgium	SSC_DEF_>=120_0_0_all																										
France	GNS_DEF_120-219_0_0_all																										
France	GNS_DEF_90-99_0_0_all																										
France	GTR_DEF_all_0_0_all																										
France	MIS_MIS_0_0_0_HC																										
France	OTB_DEF_70-99_0_0_all																										
France	OTB_SPF_70-99_0_0_all																										
France	TBB_DEF_70-99_0_0_all																										
France	FPO_CRU_0_0_0_all																										

Country	Season	2008-1	2008-2	2008-3	2008-4	2009-1	2009-2	2009-3	2009-4	2010-1	2010-2	2010-3	2010-4	2011-1	2011-2	2011-3	2011-4	2011-all	2012-1	2012-2	2012-3	2012-4	2013-1	2013-2	2013-3	2013-4	2013-all
France	OTB_DEF_100-119_0_0_al																										
France	SDN_DEF_>=120_0_0_all																										
France	OTB_CRU_32-69_0_0_all																										
France	SDN_all_0_0_all																										

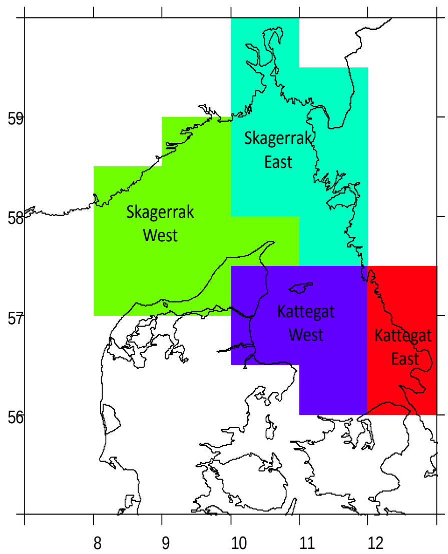
4 Stock Plaice in Skagerrak

Extensive analyses and figures are presented in the Working Documents presented to WKPLE, and only a summary of those is reported here.

4.1 Stock ID and substock structure

The issue of the stock ID for plaice in Skagerrak has been a long-lasting story, which has triggered many discussions over time. Until 2002, the stock was assessed together with Kattegat (plaice IIIa stock) in a standard analytical way. In 2002, the assessment was considered to be too unreliable to form the basis of advice, and was rejected. The various data entering the assessment were scrutinized over the years, and in 2012, it was concluded that the primary issue hampering assessment was that the stock ID was inappropriate (ICES WKPESTO 2012, Ulrich *et al.*, 2013). On the basis of literature review and of the analysis of a range of biological data readily available at that time, Skagerrak and Kattegat were split, being considered to belong to different stock units. It was also hypothesized that Skagerrak (mainly the Western part) was likely strongly linked with the North Sea through mixing and/or migration, but the amount of mixing could not be quantified nor fully ascertained. On the basis of the results achieved at that time, ICES advice for Skagerrak plaice became based on a mixture of combined North Sea-Skagerrak assessment and IBTS Q1 indices for Skagerrak. (Figure 4.1).

With the following areas defined as West and East:



However, issues with this approach soon appeared, regarding mainly the uncertainty of the IBTS index (red bars in the Figure 4.1). In parallel, and following up on the recommendations by ICES WKPESTO, a national Danish research project on plaice stock ID (financed by the Danish Ministry of Food, Fisheries and Agriculture and the European Fisheries Fund) was launched over 2013–2014, with the aim of quantifying the mixing of populations in Danish waters (Hemmer-Hansen *et al.*, 2015). New biological data were collected and gathered, following (and further developing) state-of-the-art methodologies for stock ID, including:

- Establishment of new baselines of genetic markers for plaice and robust assignment of individual fish to genetic populations

- Hydrogeographical modelling of eggs and larvae drift from spawning areas to nurseries
- Differences in individual growth patterns from otolith back tracking information
- Further analyses of historical tagging data

The results of these various analyses are presented in details in Ulrich *et al.*, (#WD2 – with few updates presented directly to WKPLE but not included in WD2), and can be summarized as follows (results detailed for the Skagerrak only – the results concerning the other stocks are reported in the relevant sections of this report):

- **From genetic data**: New Single Nucleotide Polymorphisms (SNPs) markers were identified, allowing the establishment of new genetic baselines for plaice in the region. These corroborated major genetic differentiation between the North Sea in the one hand and the Eastern and Western Baltic in the other hand. The markers indicated that genetic populations in the Skagerrak and in the Kattegat were not very different from each other, and were half-way in between these two extremes. The population assignment of 118 fish from the various areas at spawning time showed that approximately half of the fish caught in Western Skagerrak had a North Sea genetic print (Figure 4.2a).
- **From drift modelling**: Eggs and larvae from North Sea Dogger Bank do likely not drift into Skagerrak and beyond. The inflow from North Sea German Bight is likely very variable from year to year, but it is possible that some North Sea juveniles can settle along the Skagerrak and Kattegat coastline (Figure 4.2b). The eggs and larvae spawned in Skagerrak had similar modelled drift pattern into the various nurseries as those spawned in German Bight, i.e. along the Skagerrak and Kattegat coastline . Finally, those spawned in Kattegat will primarily stay within Kattegat and settled along the Danish and Swedish coast. There is generally only little drift from Kattegat into 24-25
- **From otolith growth back-calculation**: Most fish analysed were taken during spawning season. There are significant differences in growth between Skagerrak and Kattegat, but not within either of the areas. Differences in growth between Eastern North Sea and Western Skagerrak do exist but are weak, and are mainly driven by a difference in slope rather than intercept within the growth curve. This is interpreted as that fish in both areas may originate in the same population (or mix of populations not isolated from each other) but would have experienced different growth conditions (Figure 3.2c).
- **From tagging data**: There is globally a high residency of fish, with most of them being recaptured in the area where they were released (N Sea, Skagerrak W, Skagerrak E, Kattegat sound and Belts). However, important migrations were observed between the North Sea and the Skagerrak, with fish migrating into Skagerrak during summer and returning into the North Sea during spawning (Figure 4.2d).

b)

In addition to this, new studies were performed to investigate further the approach agreed in 2012, which uses IBTS Q1 as an index of local abundance (Ulrich, #WD3). In 2013 and 2014, concerns were raised on the very large confidence intervals of the Skagerrak West and Skagerrak East indices. WKPLE investigated these further, and it became clear that the indices are based on very few hauls, with high variability of average cpue per haul. In addition, an additional haul was performed in 2014 in the more shallow waters (less than 30 m deep) and yielded the highest cpue of the time-series (Figure 4.3). Until more hauls are taken in shallow waters it is impossible to disentangle the effect of depth from the random effect of a single outlier haul; nevertheless, this observation raised concerns that IBTS was not covering well the distribution area of plaice in Skagerrak during spawning season.

In WD#3, a number of plots and maps were then produced to investigate the relevance of IBTS as an abundance index for plaice. Data were explored both for Q1 and Q3, and both for Skagerrak, the North Sea and for the combined Skagerrak and North Sea. Alternative area definitions in Skagerrak were also explored, to see if calculating indices on fewer hauls restricted on the main plaice fishing areas would improve them. But no obvious improvements were observed and all hauls in Skagerrak were retained in the following analyses.

IBTS data were also compared to fisheries data, and the seasonal patterns of the fishery were investigated in more details. It became obvious that the fishery is very much a summer fishery, with little fishing activity occurring during the spawning season (Figure 4.4).

With regards to the issue of stock ID, the conclusions from #WD3 can be summarized as follows:

- Plaice densities in Q1 in Skagerrak are patchy and relatively low, as shown by IBTS and fishery data. There are many hauls with zero catch of plaice, especially below 50 m deep. The average density in IBTS Q1 has fluctuated over the years without trends.
- The inter-annual consistency of IBTS Q1 in Skagerrak is poor, with poor tracking of cohorts potentially spawning in Skagerrak (Figure 4.5). This can result from IBTS hauls being outside Q1 plaice distribution, but this can also indicate that the evidence of a permanent population is blurred. Ultimately, IBTS Q1 in Skagerrak cannot be considered a very reliable index for assessment and advice.
- IBTS Q3 in Skagerrak is more internally consistent, and the high densities are well matched with the commercial data. It indicates higher densities of plaice during summer feeding season.
- There are some (although weak) correlations between recruitment in the North Sea and summer abundance in Skagerrak (IBTS Q3) at adult ages in numbers-at-age, and also between cpue in Skagerrak during summer and cpue in the North Sea (both summer and spring, Figure 4.6).
- The internal consistency of IBTS in the North Sea is globally good. During summer season (Q3), this consistency is further improved when including Skagerrak.

Finally, trial assessments were made to explore the validity of assessing Skagerrak as a stand-alone stock (see #WD 9 and section 4.6.4 below), but the results obtained were uncertain and very sensitive to how the assumptions of mixing and inflow from the North Sea were modelled in the assessment. This underlined that it is unlikely that Skagerrak plaice could be assessed and managed as a single stock with current data, neither as a category 1 stock with full assessment nor as a survey-based trends category 3 stock.

Conclusion on stock ID. Major progresses have been achieved this year with regards to the understanding of plaice stock ID in the Skagerrak. The results presented at WKPLE 2015 support the qualitative conclusions made in 2012, but they also provide a much better picture of the quantitative and seasonal patterns.

There is still agreement that there is a resident plaice population in Skagerrak, with a distinct genetic print. However, this population is importantly mixed with the North Sea population, also during spawning season, indicating that the North Sea population extends beyond the North Sea boundary. Eggs and juveniles in the area could have drifted from both Skagerrak and North Sea spawning grounds. Globally, the population density during spawning in Skagerrak is not very well tracked, but the information currently available does not point out towards major trends in plaice density over the period. Fishing on spawning aggregations is limited in the area.

During summer, there is likely an important inflow from the North Sea population, entering Skagerrak to feed. This inflow has increased over the recent years, consistently with the increase of abundance of the North Sea stock. By far the largest part of the fishery occurs in this period, and in the most westerly part of the Skagerrak close to the North Sea border. Therefore, much (and likely most) of the commercial catches recorded for Skagerrak may belong to the North Sea component, although the geographical patterns of mixing with the local Skagerrak component is not known in detail at present.

In terms of stock assessment, WKPLE considered therefore that most catches in Skagerrak should in principle be allocated to the North Sea assessment, and that there is thus only limited scope for a stock assessment of the Skagerrak population alone. This, added to the fact that the data currently available do not allow a precise separation and monitoring of this local component, and that the fishery is limited in the inner Skagerrak, points towards that a combined stock assessment for North Sea + Skagerrak is the most appropriate option for stock assessment.

In terms of management, the fact that local components most likely exist and mix with the larger North Sea components during seasons with intense fishery, Skagerrak plaice will still necessitate the development and implementation of tools to monitor population mixing in order to avoid local depletion.

In the short term, WKPLE has produced a number of commercial and surveys time-series that can be easily updated every year, providing a useful monitoring of the fisheries trends in Skagerrak. This routine scrutiny should potentially be able to detect if any alarming event of importance would occur that would indicate a departure from the current situation and an increased risk of local depletion (e.g. drop in cpue in Q1, decoupling of trends between North Sea and Skagerrak during Q3, shift of the fishery inside Skagerrak), that would lead to reconsider the need for area-specific management measures.

In the medium-term, there are many actions that should be undertaken to improve the monitoring of the local component in Skagerrak. It would be useful to perform additional genetic assignments of a larger sample of individuals in different locations and seasons, to refine the knowledge of the spatio-temporal variability of mixing. Also, the genetic baselines should be coupled with the otolith growth baselines to identify if the genetic print aligns with the differences in growth, which would open for broader and cost-effective monitoring means. Finally, the survey coverage in Skagerrak should be improved or intensified, in order to cover better the putative distribution areas in the shallower waters.

4.2 Issues list

7 issues had been listed for plaice in Skagerrak that needed to be addressed.

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?	External expertise needed at benchmark type of expertise / proposed names
(New) data to be Considered and/or quantified	Stock definition is poorly defined, uncertain level of mixing with the North Sea	Some work is ongoing at DTU Aqua on collecting/analysing new dataon genetics, tagging studies and otolith microstructure	New information available by 2014	DTU Aqua participants to EFF project (Clara Ulrich, Jacob Hemmer-Hansen, Karin Hussy, Jesper Boje, Henrik Degel) plus relevant experts on plaice ecology in IMARES, SLU Aqua and TI.
Tuning series	This stock is linked to the North Sea and time-series must be considered over the the combined area	Define appropriate tuning series . Use IIBTS for the entire area IV-IIIa	National data sources/DATRAS	Clara Ulrich, Vaishav Soni
Catch-at-age data	Separation of catches coming from North Sea stock vs. Skagerrak stock	If a baseline can be established from otoliths and genetics		DTU Aqua participants to EFF project
Discards	The time-series of discards was common to Skagerrak and Kattegat	Historical discards estimates must be splitted by area	InterCatch, historic assessment reports and data	Clara Ulrich, Henrik Degel
Biological Parameters	There is uncertainty on growth and otolith reading	Need some work in collaboration with the plaice 21-23 benchmark on age reading and growth estimation	DATRAS; survey data	Plaice age readers from DTU Aqua and SLU Aqua
Assessment method	This stock cannot be assessed alone but together with the North Sea plaice	Define the appropriate assessment methode		David Miller, Clara Ulrich.
Biological Reference Points	Revision of reference points will be needed	Generation of new reference points after the final assessment.	Stock assessment outputs	David Miller, Clara Ulrich.

* The issue 1 has been addressed, and is dealt in section 1 above, and in #WDs 2 and 3. New data have been collected and analysed.

* The issue 2 (tuning series) has been addressed in sections 1 and 4 and in #WD3, but this will have to be finalized during a benchmark for the combined North Sea-Skagerrak stock

* The issue 3 (catch-at-age data) could not be addressed, since the genetic data collected do not allow yet a full and routine separation of the catch. But new monitoring of this may be established in future.

* The issue 4 (discards at age) was partly addressed, see section 4 and #WD8

* The issue 5 (biological parameters) is not relevant anymore, as this concerns the Kattegat more than the Skagerrak

* The issues 6 and 7 (assessment and biological reference points) will have to be finalized during a benchmark for the combined North Sea-Skagerrak stock (see also #WDs 8 and 9).

4.3 Multispecies and mixed fisheries issues

There are no major multispecies and/or mixed fisheries issues to be considered specifically for plaice in Skagerrak. Predator–prey interactions for flatfish are very limited, and plaice is not included in the multispecies analyses in the North Sea.

In terms of mixed-fisheries, the main part of the catches is taken in a targeted fishery using Danish seines, trawls and gillnets above 120 mm mesh size. (Figure 4.7). Discards ratios are quite low compared to other plaice stocks in the region, since there is only limited catch of juveniles due the absence of sole in this area (unlike the North Sea) and since the flesh quality is good for markets due to saline waters in the Skagerrak (unlike the Baltic).

4.4 Stock Assessment

4.4.1 Catch – quality, misreporting, discards

For the benchmark, a data call was issued for catch data since 2002 to be uploaded in InterCatch and raised according to the procedures established by WGNSSK in 2013–2014. All data were uploaded by Member States in due time. However, an issue in the Danish data was discovered shortly before WKPLE, preventing the work to be finalized (see also the details in #WD8): It was spotted that the revised age distribution looked quite different from the initial time-series regarding old ages, with the 10+ group being absent in many years whereas it was present before. After checking with the Danish data provider (Kirsten Birch Håkansson, DTU Aqua), it was realized that market categories 1 (0.6 kg/fish and over) and 2 (0.4 to 0.6 kg/fish) had been merged together. This is normally done if these categories are insufficiently landed and thus poorly sampled. It was however considered after checking that this should not have been the case for plaice in Skagerrak, since category 1 represents 5 to 10% of the landed weight. This error was quickly resolved in the Danish raw data; however, there wasn't enough time left before the benchmark to re-run all the InterCatch procedures (as it takes around 1 hour to process, check and document the entire flow for one data year), so it was decided not to upload the corrected data now but wait to after the benchmark. The time-series will be corrected in April before the next WGNSSK.

Beside this issue, no major problems arose during the compilation of catch-at-age data. There is generally good information available on discard ratio and age distribution (Table 4.1). The estimated discards ratios have varied between 10 and 30% in weight, depending on the presence or not of Dutch beam trawlers in Skagerrak over the years.

All together, these catches represent only a minor part of the combined North Sea-Skagerrak assessment, and the effects of this revision and the inclusion of the discard time-series in the assessment will be very limited.

4.4.2 Surveys

Major progresses have been achieved in WKPLE regarding potential tuning series for the combined North-Sea-Skagerrak assessment. At present, North Sea plaice assessment is tuned with two North Sea beam surveys, the Beam Trawl Survey (BTS, which is split into two periods) and the coastal SNS survey. None of these two cover the Skagerrak, and they are also not entirely consistent with each other. It was therefore explored whether the Bottom-trawl survey (IBTS) could be a potential tuning survey for the combined assessment, also considering that it covers both areas. Bottom-trawl surveys are usually not considered well suited for flatfish; however, plaice is caught by most commercial gears including trawls, and is so abundant in the North Sea that cpue is high in IBTS (see Figure 3.8, and Figure 3.6 above).

IBTS indices mainly considered both using the standard approach as performed by the ICES data centre (#WD3) and the smoothed GAM approach developed by Berg *et al.*, (2014). (#WD3b) was also trialled, but the work on this could not be finalized in time and was only briefly explored.

The decision to incorporate IBTS Q1 and Q3 as new tuning indices for the combined assessment will be discussed further in WGNSSK 2015, but the decision will have to formally pass through a benchmark or inter benchmark protocol.

4.4.3 Weights, maturities, growth

No changes here. The revised weight at age from the new InterCatch raising will be incorporated into the combined assessment estimates.

4.4.4 Assessment model

Exploratory combined assessments with and without IBTS were performed for the benchmark, exploring both the standard XSA (#WD8), SURBA (#WD3) and a4a (#WD9, also available at https://fishreg.jrc.ec.europa.eu/documents/75108/188503/2014-a4asrp-ns.pdf). In particular, the a4a exploratory runs were performed during a workshop in early December 2014, before the work on stock ID was finished and before the data compilation workshop. Some trials were run to fit a4a on the Skagerrak data alone or within a combined North Sea-Skagerrak assessment. Ideas to incorporate North Sea summer migrations into the Skagerrak assessment by e.g. including a time effect in IBTS Q3 were also explored. The results demonstrated that the assessment of Skagerrak as an isolated stock was very uncertain and not very robust. Completely opposite trends could be obtained with equally good model fit when varying catchability assumptions. This showed how difficult it would be to provide sensible assessment and advice for the Skagerrak if not combined with the North Sea. These results further supported the later conclusions from WKPLE on stock ID.

Assessment of the combined North Sea and Skagerrak plaice is therefore recommended to be conducted at WGNSSK 2015 by including Skagerrak catches in the present assessment approach for the NS stock. Further decisions of additional tuning indices for the Skagerrak plaice to be included in this assessment will have to be formally taken through a benchmark or inter benchmark protocol.

4.5 Short-term projections

Not performed – will be considered in future benchmark for the combined stock.

4.6 Appropriate Reference Points (MSY)

Not performed – will be considered in future benchmark for the combined stock. Given the predominant size of the North Sea catches in the combined assessment, it is assumed that the inclusion of Skagerrak in the current North Sea plaice assessment will not affect the MSY values as estimated by WKMSYREF3.

4.7 Future Research and data requirements

In the short term, the most important requirement is to finalize the setup of the combined North Sea-Skagerrak assessment, through a benchmark or inter-benchmark. While the inclusion of Skagerrak catches into the North Sea assessment will not significantly affect the perception of the North Sea stock, WKPLE has suggested other aspects that would need to be investigated further in a benchmark. The possible inclusion of IBTS as a tuning fleet is the most important feature, but other aspects including the analysis of the SNS survey and the estimates of natural mortality-at-age (e.g. as done for the Eastern Channel plaice) have been mentioned. It is then suggested that WGNSSK makes a plan for the benchmarking of the combined assessment.

In the longer term, there is still scope for a better characterization and monitoring of the local population in Skagerrak, to prevent risks of local depletion. As mentioned above in section 4.1, it would be useful to pursue one step further the work on population assignment through genetic and otoliths analyses. Also, the survey coverage in Skagerrak should be improved or intensified, in order to cover better the putative distribution areas in the shallower waters. Finally, some work should be done to include the overview of the small-scale fisheries (without VMS) fishing on coastal areas into the monitoring of CPUE trends in Skagerrak.

4.8 External Reviewers report

The Panel was presented with an extensive review of studies that evaluate plaice stock structure in Skagerrak and adjacent regions. These studies included genetic and larval drift analyses, otolith back-calculations, and tagging studies. Based on the evidence presented, the Panel agreed that the Skagerrak plaice has strong connectivity to the North Sea stock, and the likely magnitude of the stock mixing is sufficient to recommend that plaice in the North Sea and Skagerrak be combined into one stock for assessment. Given the size of the fishery in Skagerrak (approximately 10% of the fishery in the North Sea), it is most likely that the addition catches from Skagerrak to the North Sea assessment will have little impact on the assessment output.

4.8.1 Use of final stock annex as basis for providing advice

The Panel agreed that it is appropriate to assess the plaice in Skagerrak as one unit stock with the North Sea plaice, given this new information on plaice stock structure,. Therefore, an assessment annex specific to the plaice stock in Skagerrak alone is no longer relevant. The Panel recommended continuing monitoring of the Skagerrak portion of the stock to avoid local depletion of the resident Skagerrak plaice.

4.8.2 Recommendations for future work

For the combined North Sea and Skagerrak assessment, the Panel recommended including the Skagerrak IBTS survey data when estimating the survey abundance index, since it was demonstrated that inclusion of Skagerrak data to the North Sea IBTS survey dataset improves the quality (internal consistency) of the survey index. The Panel also recommended dropping the large tow from 2014 IBTS survey in Skagerrak, because it came from a new depth stratum (not previously covered by the survey) and statistical approaches to account for this change are currently inadequate. When shallow waters are better covered by the survey through a longer time-series it may be appropriate to include the observation in the index.

Table 4.1: Summary of data provided to InterCatch and compiled by the time of the WKPLE meeting. Weight given in tonnes.

	previous landings	revised landings	revision	discards provided to IC	total discards after raising	discards ratio	share of landings with discards provided	share of landings with age information provided	Danish discards ratio provided to IC	Swedish discards ratio provided to IC
	t	t	%	t	t	%			%	%
2002	6671	7084	6%	517	574	7%	0.89	0.96	6%	37%
2003	6656	7098	7%	748	1437	17%	0.51	0.72	11%	37%
2004	7513	8011	7%	1761	2873	26%	0.59	0.75	20%	30%
2005	5690	6084	7%	1200			0.62	0.77	19%	13%
2006	7855	8361	6%	1309	2243	21%	0.53	0.78	14%	35%
2007	7406	7626	3%	1714	2862	27%	0.55	0.74	21%	36%
2008	7607	8292	9%	811	1043	11%	0.72	0.86	7%	50%
2009	6035	6500	8%	520			0.87	0.9	7%	53%

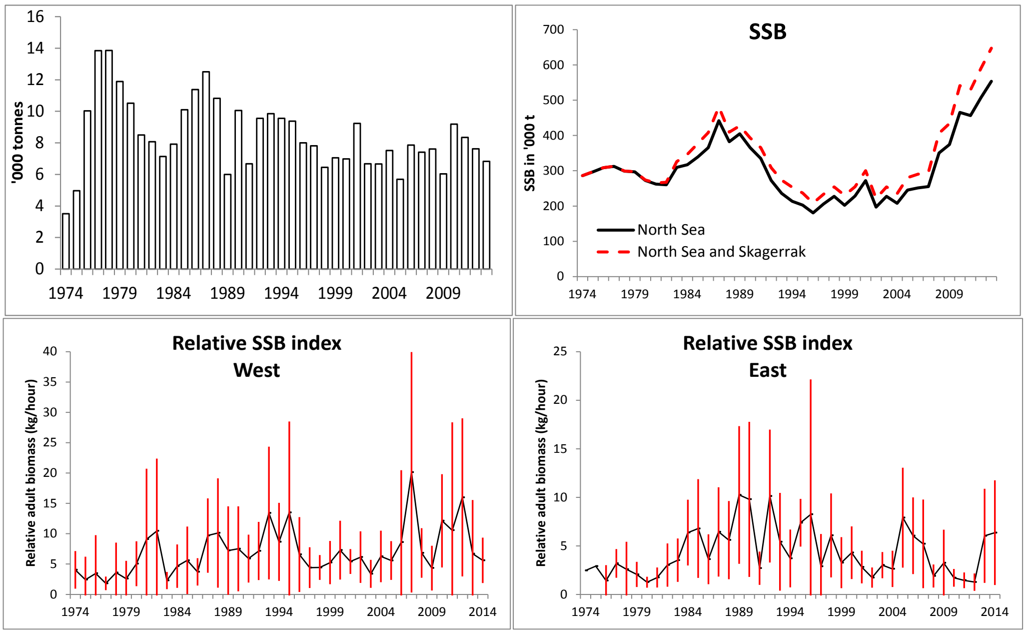
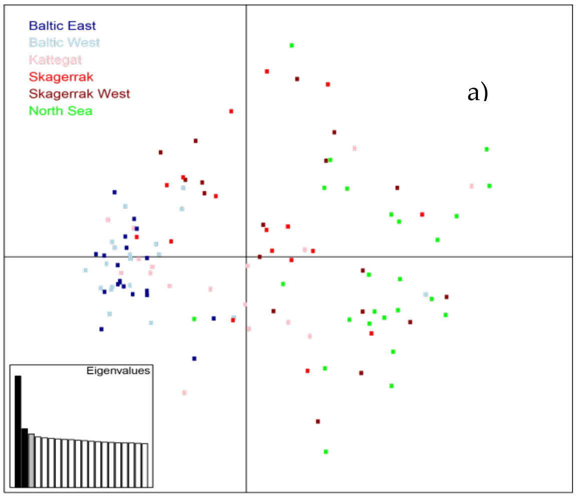
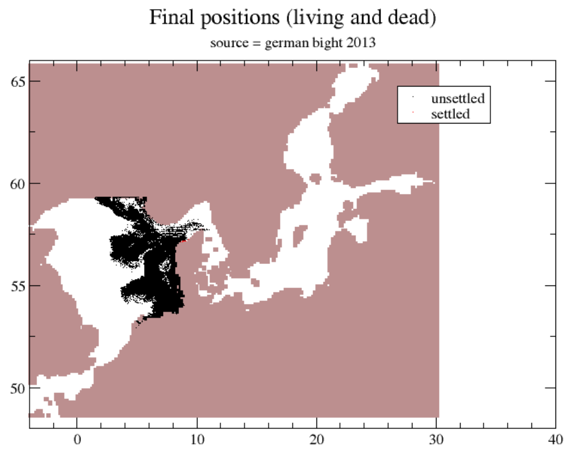


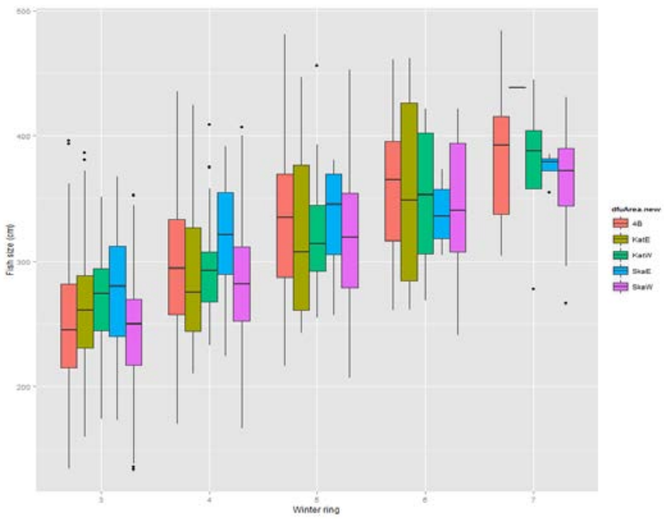
Figure 4.1 Plaice in Subdivision 20 (Skagerrak). Top: ICES landings (in thousand tonnes) in Skagerrak and SSB for the North Sea stock, with and without the Skagerrak landings data included in the assessment. Below: Trends in the adult-stock biomass index (fish above 25 cm, in g/hour) in the Western and Eastern Skagerrak (IBTS Q1). Red bars : 1 standard deviation (From ICES advice 2014)


Baltic East
Baltic West
Kattegat
Skagerrak
Skagerrak West
North Sea
a)
Eigenvalues

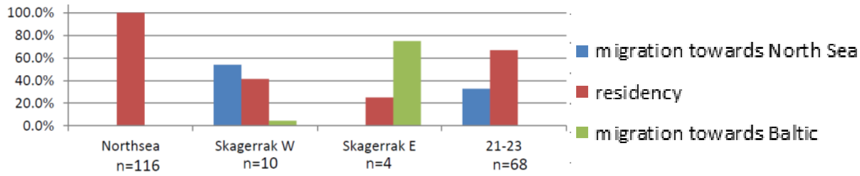
a)


Final positions (living and dead)
source = german bight 2013
unsettled
settled
65
60
55
50
0
10
20
30
40

b)


Fish size (cm)
Winter ring
dfuArea.new
4B
KatE
KatW
SkaE
SkaW
3
4
5
6
7

c)



d)

Figure 4.2: example of the outcomes of stock ID analysis in WD#2. a): Principle component analysis of 118 plaice individuals based on analysis of 5.605 SNP markers. b) Final modelled position of particles released in German Bight during spawning season, for 2013. c) Boxplot of fish size (cm) in relation to age for the different WKPESTO areas (females only), based on otolith growth back calculation. Colours represent different areas. d) Proportion of seasonal movement towards the North Sea, the Baltic or residency. The graph is based on fish >28 cm released in July-November (feeding season) and recaptured in January-April (spawning season.

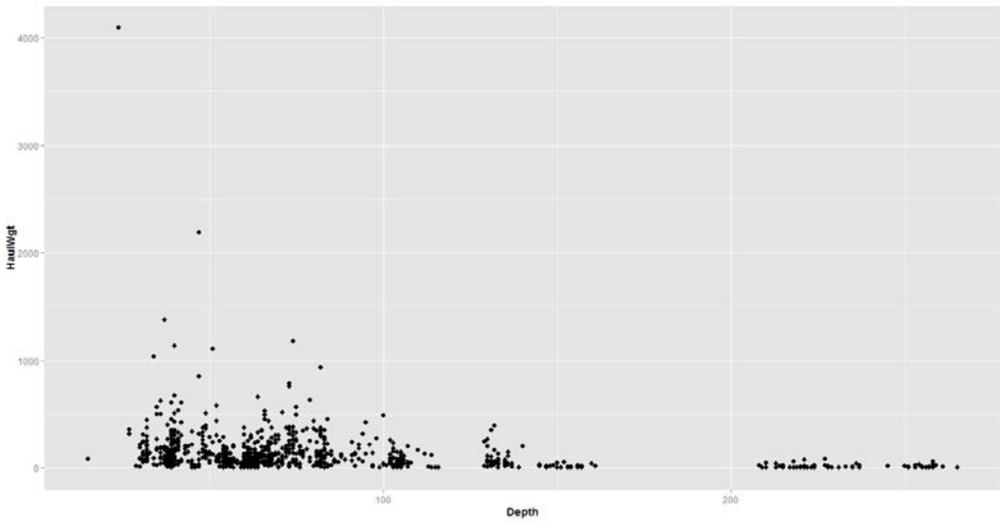


Figure 4.3: Haul weight (tonnes) by depth (m), IBTS Q1 1991-2014.

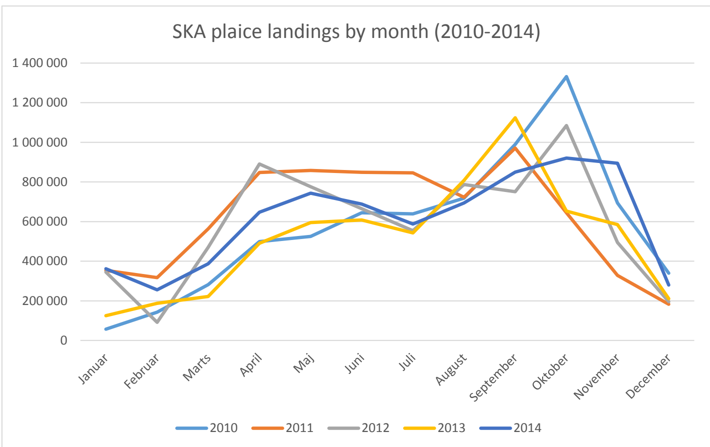
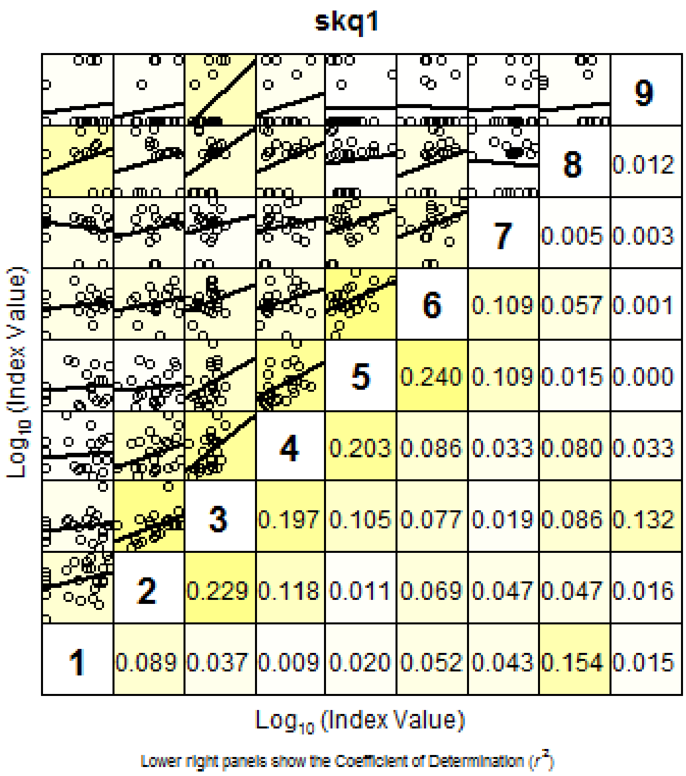


Figure 4.4: Monthly distribution of Danish plaice landings (kilograms) in Skagerrak



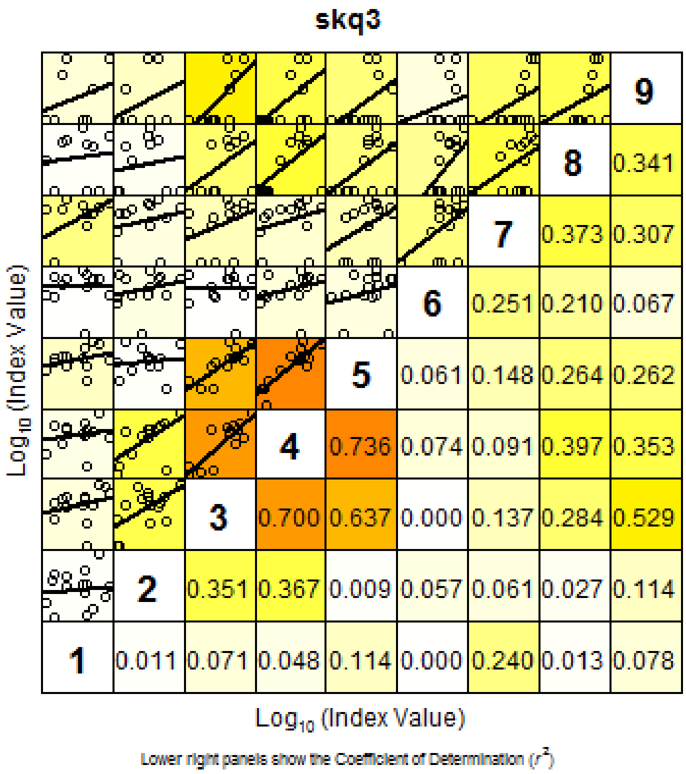


Figure 4.5: internal consistency of IBTS Q1 and Q3 in Skagerrak

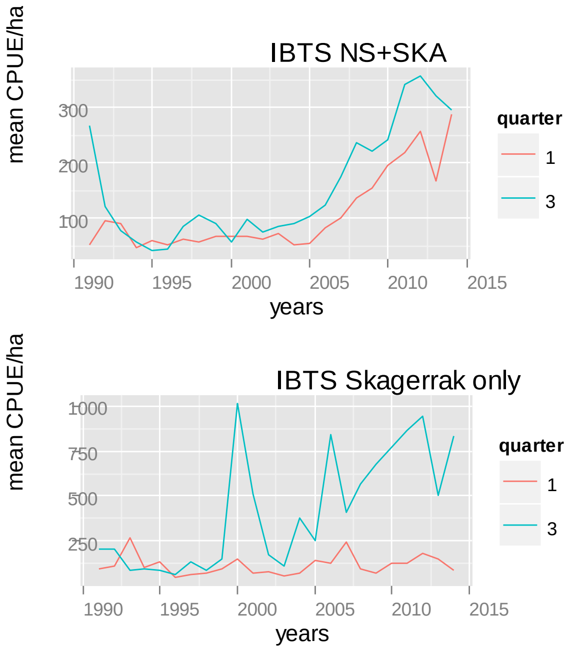


Figure 4.6: IBTS cpue index

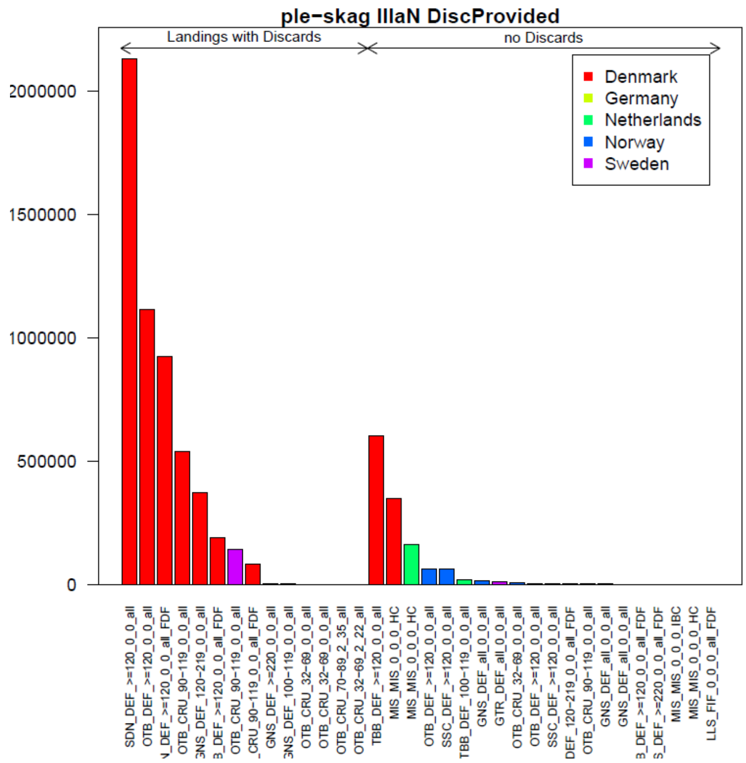


Figure 4.7: 2013 Plaice Skagerrak landings by country and métier, ordered by total tonnage and whether there is discard estimation available or not. Intercatch data in kg.

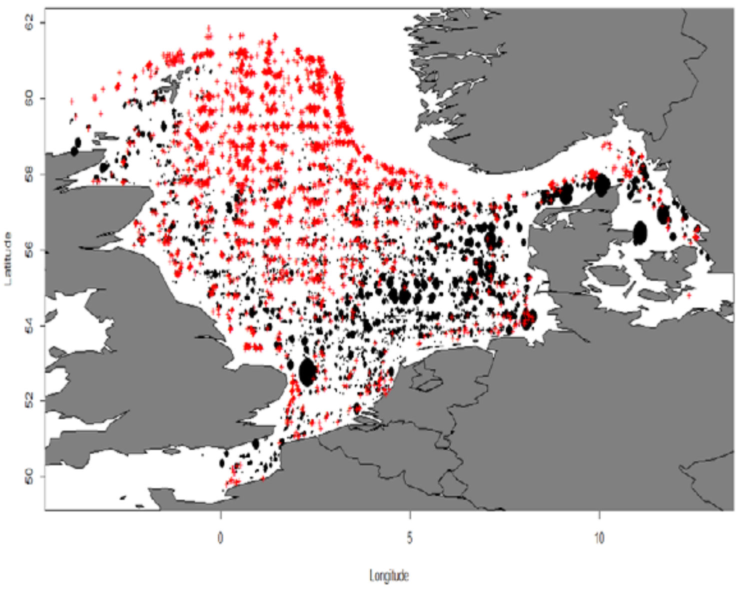
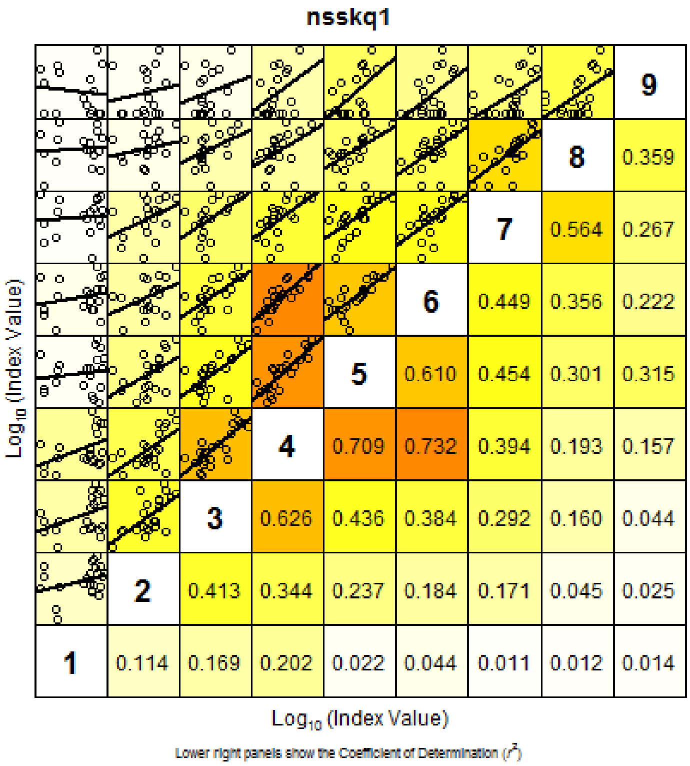


Figure 4.8: All hauls in IBTS Q1, sizes of bubbles are proportional to total catch weight. Red crosses represent zero haul.



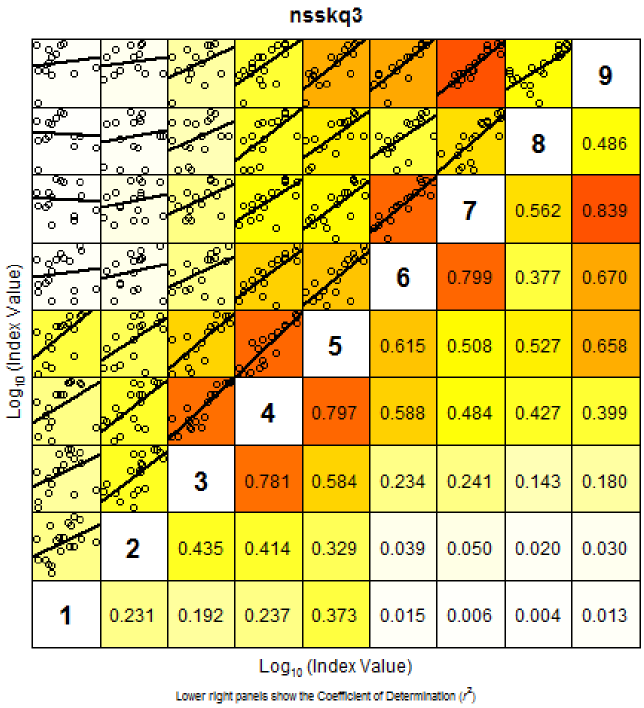


Figure 4.9: Internal consistency of IBTS Q1 and Q3 in North Sea and Skagerrak

5 Stock Subdivision 21-23 Kattegat and the Danish Belt area

5.1 Stock ID and substock structure

Plaice in Kattegat and Western Baltic Sea was until 2002 included in the Skagerrak-Kattegat (IIIa) plaice stock but consistent problems to conduct a qualified analytical assessment to base the biological advice on lead to a suggestion for revision of this and the surrounding stocks by the WKPESTO in 2012 (ICES WKPESTO 2012). Here it was suggested to recognize Kattegat together with the Belt area and Western Baltic (Subdivisions 21, 22 and 23) as an independent stock. The stock was named PLE21-23. The suggestion was built on readily literature and information from historical tagging. The split between Skagerrak and Kattegat was rather well documented but the border to Subdivision 24 was less conclusive. The suggestion was confirmed by the ICES SIMWG and an ICES biological advice based on a category 3 stock assessment (survey-based assessments for indicating of trends), supported by a SAM run for SSB input, was provided for the PLE21-23. In order to resolve and determine the stock ID problem and to identify appropriate assessment methods, it was agreed to benchmark the PLE21-23 stock in 2014 but this was later postponed to be done in 2015 (WKPLE) together with the rest of the relevant plaice stocks. Previous to the WKPLE the stock ID issue was evaluated again now including the new information from growth investigations, drift modelling of egg and larval movements and genetic provided by a national Danish research project on plaice stock ID (financed by the Danish Ministry of Food, Fisheries and Agriculture and the European Fisheries Fund) was launched over 2013-2014, with the aim of quantifying the mixing of populations in Danish waters. For a detailed description of the research project see the section under the Skagerrak plaice stock and a German paper looking at survey information. The recommendation from SIMWG was to keep the stock definition as it was as these new information shows very little exchange between Kattegat and Skagerrak and did not provide conclusive evidence of extensive exchange between Subdivision 22 and 24. The WKPLE has endorsed this recommendation but recommends that the border between PLE21-23 and PLE24-32 is further investigated in future.

5.2 Issue list

A list of relevant issues was developed for each plaice stock based on input from stock leaders and discussions during the data WK. The list for PLE21-23 is given below as it appeared after the data WK in December 2014.

Stock	**....PLE 21-23...................**	
Stock coordinator	Name: Henrik Degel	Email: hd@aqua.dtu.dk
Stock assessor	Name: Henrik Degel	Email:
Data contact	Name: Henrik Degel	Email:

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?**	**External expertise needed at benchmark type of expertise / proposed names**
(New) data to be Considered and/or quantified[1]	Additional M - predator relations			
	Prey relations	New stomach data available ?		Marie Storr-Paulsen
	Ecosystem drivers			
	Other ecosystem parameters that may need to be explored?			
Tuning series	4 surveys (2 IBTS and 2 BITS)	At present IBTS is combined in IIIA – need to be split	Data is available	Henrik Degel (DATRAS indices by SD) **Status: on-going.**
Discards	Discard is high but not used	Discard should be included	Data is available (2000 – present) Denmark and Sweden	Request to be sent to Sweden, Germany and Denmark. (Inter catch) back to 2000 Henrik D. **Status: Data compiled and available (2002-2013)**
Biological Parameters related to stock	Sex ratio from survey Maturity ogive Stock weight by sex	Stock related data should be in DATRAS and	Rainer (Germany)	Request to Sweden, Denmark and Germany check DATRAS flatfish **Status: ???? (contact Rainer)**
Catch information	Danish Biological information is applied to German and Swedish landings for data before 2010.	CANUM, WECA and CATON should be in InterCatch for as many years back as possible from all countries.	Sweden, Germany and Denmark	**Status: Done**
Assessment method	**SAM**	Configuration		Henrik D. **Status. Will be done previous to benchmark**
Biological Reference Points	Same as for the North Sea (B trigger)	Fmsy / Bpa / Blim		Henrik D **Status. Will be done previous to benchmark**

5.3 Multispecies and mixed fisheries issues

Plaice are seldom considered as a target species by the fishery, but caught as bycatch in mixed trawl fisheries targeting mainly cod or *Nephrops*. The biggest landings of plaice occur in 1st quarter SD 22 in connection with the cod fishery and in 3rd quarter in SD 21 in connection with the *Nephrops* fishery. Because plaice is considered as a bycatch species, the discard pattern, as observed in the observer program, is very fluctuating dependent on the actual market conditions for plaice (price), the quota situation for cod and local or individual discard traditions. As a consequence the Danish discard raising is based on effort (trips).

5.4 Stock Assessment

5.4.1 Catch – quality, misreporting, discards

Landing statistics from Germany, Sweden and Denmark is available back to 1972. Landings decreased from around 15 000 tonnes in the seventies to a rather stable level (2000–4000 tonnes) in the last thirty years. In recent years the landings from SD 21 has decreased (from 2000 t to 300 t) while the landings from SD 22 since mid-nineties has been stable/slightly increasing (around 1500 t). The landings from SD 23 have all years been insignificant compared to the other areas (Table 5.1).

Denmark has in the whole period been dominating the catches with landing around 96% of the total landings in 1992 gradually decreasing to 76% in 2013 caused by the increasing landings by Germany (buying quotas from Sweden and Denmark).

The quality of the landing statistics is believed to be good as it builds on log-book/sales slip information and misreporting is not believed to be an issue because quota regulation never has been limiting the fishery, except for Germany in recent years. However, this not believed to have influenced the reliability of the landings significantly.

Discard information have been compiled in InterCatch for the period 2002 to 2013 based on the EU data call in connection with the benchmark (Figure 5.1). It has not been possible to request pre-DCF-data in connection with the data call. The discard estimates is based on observer trips covering the important fisheries (otter trawl and Danish seines). The coverage I rather good as most significant strata (year, country, SD, quarter, fishery) are covered. The data are stratified on Active gears (trawls and seines) and Passive gears (gillnets). The Danish Discard raising is done outside InterCatch based on effort (number of trips) as no correlation between landed amount of plaice, all species landed or fishing days and the amount of discard of plaice could be demonstrated (WD 4). The Swedish and German discard is based on tonnes of landings of plaice (method used by InterCatch). All burrowing of data for strata without or with insufficient sampling is done inside InterCatch.

Additional rules applied for discard estimation

All un-sampled passive gear discards strata are assumed to have zero discard.

Germany uses in 2010 and 2013 the fleet groups "All" and "MIS_MIS_0_0_0_HC" in SD21. In all cases where extrapolation has been made for fleet = "All" (2010) and "MIS_MIS_0_0_0_HC" (2013), the source has been a mix of all relevant sources (same SD, Q, catch category). Manual weighting has been used in order to put equal total weighting to Passive and Active. The fleets "All" and "MIS_MIS_0_0_0_HC" only constitute a very small percentage of the total stock catches in the two years.

Additional rules applied for allocation of biological information (landing and discard)

SWE 2005 SD23 Passive discard: no source data exists. DEN 2005 SD23 Active discard is used.

For SD23: SD21 has always been used as source data if needed

If more than one source is used for discard estimation, manual equal weight is used.

The total discard per year was estimated to 4000 tonnes in 2002 decreasing to around 1300 tonnes in 2004 already and then being more a less stable around that level the rest of the period up to 2013 (Table 5.2). The overall discard percentage (all SDs) has been app. 45% in all years (31-56%).

5.5 Surveys

All available survey series were recalculated previous to the WGPLE in order to cover only the stock area. This area is not a standard option in DATRAS and has to be done manually. Four surveys are available covering the stock area (SD21, SD22 and SD 23) or part of it.

NS-IBTS 1st quarter. The dataseries includes all hauls from the survey in SD 21. All hauls carried out by Sweden using RV Argos (1991–2011) or RV Dana (2012–2014). The dataseries is available from 1991–2014. The survey mostly overs the eastern part of SD 21 (Figure 5.2a). Approx.25 hauls per year.

NS-IBTS 3rd quarter. The dataseries includes all hauls from the survey in SD 21. All hauls carried out by Sweden using RV Argos (1998–2010) or RV Dana (2011–2014). The dataseries is available from 1998–2014. The survey mostly overs the eastern part of SD 21 (Figure 5.2b). Approx.25 hauls per year.

BITS 1st quarter. The dataseries includes all hauls from the survey in SD 21, SD 22 and SD 23. All hauls carried out by Germany using RV Solea or by Denmark using RV Havfisken. The dataseries is available from 1998–2014 and covers the complete stock area. Standard gear introduced in 2000. cpue for years before 2000 are adjusted to common standard. Approx. 55 hauls per year.

BITS 4th quarter. The dataseries includes all hauls from the survey in SD 21, SD 22 and SD 23. All hauls carried out by Germany using RV Solea or by Denmark using RV Havfisken. The dataseries is available from 1999–2014 and covers the complete stock area. Standard gear introduced in 2000. cpue for years before 2000 are adjusted to common standard. Approx. 55 hauls per year.

The spatial coverage of the surveys are shown in Figure 5.2a and 5.2b.

The Internal consistencies for all four surveys are in general not good (Figure 5.3-6) and may be coursed by some difficulties interpreting the age by reading the otolith. Particularly the Danish age readings show some inconsistency across the four readers involved in the reading of plaice otoliths in the survey year period (Figure 5.7). The Danish number of hauls is app. 50 out of the total of 55 hauls per year per BITS survey. Particularly the most resent reader reading all plaice otoliths from 2011 and on shows deviant length age relationship compared to particularly Swedish readers. For a more detailed analysis of the inconsistencies of the age readings, see WD4. Only Sweden reads otoliths from the NS-IBTS (one reader) and these surveys show slightly better internal consistency.

Alternatively, the two 1st quarter surveys and the two second-half-of-the-year surveys were combined using the smoothed GAM approach developed by Casper berg (#WD3b). Only the age up to 5 was included due to small numbers for age class 6 and 7 particularly in the start of the series.

The internal consistencies of the combined surveys are not good either (Figures 5.8 and 5.9).

The external consistency plots between Combined 1st quarter and Combined 3rd, 4th quarter for each age class are given in Figure 5.10 and show acceptable consistency for age class 4 and 5.

5.6 Weights, maturities, growth, naturel mortality

The mean weight in landings, discards and catches by age were extracted from InterCatch for each individual year. The stock mean weights by age were calculated from the two first quarter surveys for each individual year. BITS data only exists for the period 2008 to 2014 and NS-IBTS only for the period 2003 to 2014. Therefore, the BITS series is extended backwards to 2003 based on the average of 2008 to 2012. The common mean weight in the stock is then calculated as the mean of the two surveys. The common series is finally extended backwards to 1999 based on the average of 2003 to 2007. Mean weight at age in the stock is given in Figure 5.11. The fluctuating stock mean weights of the older age classes is caused by the small number of individuals caught at the surveys and the extremely high variability of weight for these age classes. The constant mean weight is shown in figure 5.12 and compared with the North Sea

The maturity ogives per year (running mean of three years) are shown in figure 5.13. The mean ogive is shown in figure 5.15. The data are calculated from 1st quarter surveys of NS-IBTS and BITS.

The naturel mortality is in line with the North Sea plaice stock set to constant 0.1 for all age classes except age 1, which is set to 0.2. The reason for the low mortality is the lack of observed plaice in stomachs of potential predators.

5.7 Assessment model

The State based Assessment Model SAM is used for the assessment. All input data settings and other details can be seen on: stockassessment.org

In the initial SAM run (run 1) below) maturity, mean weight at age in stock, mean weight at age in catch (landing, discard) was allowed to wary each year and each survey was used as an individual tuning fleet. The SAM residual output showed serious patterns for all surveys probably due to very different spatial coverage of the NS-IBTS and BITS surveys (Figures 5.2 and 5.3). Combining of the 1st quarter surveys using smoothed GAM approach (#WD3b) and the combining of the 3rd quarter NS-IBTS with the 4th quarter BITS (run 2)) did very much improve the residuals, which now showed no obvious pattern. The age groups included in the surveys were reduced to 1-5 as zero index values were observed for the older age groups particularly in the early years of the tuning series. The coupling of catchability was therefore for age group 4-5 only. It was at a later state decided to keep run 3 as the "base run" and therefore the rest of the runs are compared this run.

If no coupling of the survey catchability was made (run 4), the assessment fit was to a vide extent influenced by the noisy surveys and the confidence limits were extended considerable. In order to look into the range of coupling of the SAM estimated catchabilities were plotter for various couplings (Figure 5.16). The rather curved occurrence of the lines suggests that only minor coupling of the older age classes should be an option. The bended occurrence could be explained by the fact that the research vessel carrying out the Danish part of the BITS survey is just at its power limit and often has problems maintaining the recommended trawling speed (3 knots). This might allow the bigger individuals to out speed the trawl and escape. An additional run was made coupling catchability 3-5 (run 5). Based on the curved catchability curve and the model fit (table 5.3) the group decided to stick to the coupling of age group 4-5 only in both tuning fleets.

If the maturity-at-age or the mean weights at age (landing, discard, catch, and stock) are kept constant it has no influence on the model fit, as these values in the model only is used to estimate SSB.

The following 3 runs examine the effect of constant mean weights compared to the base run (run 3).

The effects of constant mean weights (and maturity) are further analyses in the external experts section under this stock.

Setting natural maturity to average (1999–2014) does not change the perception of the state of the stock. The curve was smoothed and the 2014 value does not change at all (run 6). The group found no trend in the maturity over time and considering the variability of the data, the group recommends therefore that constant values are used for the maturity-at-age model input.

Run 7 and 8 explore the consequence for SSB when mean weights at ages are constant over time compared to if they vary individually by year. Constant mean weights smoothed the curves and had only minor effects on the estimated SSB. Therefore the group recommends keeping the individual mean weights in the commercial catches but use constant values for stock mean weights as no trends are observed and no good reason for the variability of the data can be given.

Run 9 was made in order to be able to explore the difference in the base run setup using the four surveys individually as tuning fleets or using the 2 combined survey fleets. The results are clearly affected of the conflicting signals in the four surveys (Figure 5.3) resulting in substantial enlargement of the confidence intervals and a poor model fit (Table 5.3). The residual plots again show very problematic pattern. The run support the decision to combine the surveys.

Finally, it was explored to which extent it would affect the assessment if catches from Subdivision 24-32 (insignificant catches registered for DS>26) was included (run 10).. Only the tuning fleets and CANUM was updated. The data for SD 24-26 as described in the section for PLE24-32. For tuning only BITS SD 21-26 1st and 4th quarter were included (new area and depth weighted indices were calculated) and CANUM from SD 21 to 26 were summed. Otherwise, the settings for base run (run 3) were kept. The inclusion of SD 24-32 lead to decreased model fit (Table 5.3) but the result is in agreement with the trends in the individual assessments for the two stocks, which is not surprising as both stocks show rather similar trends in the assessment outputs.

Each run is summarized below.

Common for all runs:

<u>Commercial catches</u>

Age group 0 has been excluded in input because mean weights of age 0 is highly inconsistent and is seldom even in discards.

Age group 7 has been recalculated to be +group. This is done in the model script (input data still have age10 as +group)

Landings (tonnes) are available from all countries back to 1972 but not used in the assessments. Discards (CANUM, WECA) are only available back to 2002. Discards 1999–2001 are calculated as the plain average of 2002–2005 (5 years). Landing (CANUM and WECA) are available back to 1999.

F_{bar}= 3-5.

Additional options for each individual run are as follows (for each scenario is shown SSB, Fbar, Recruits and residuals for catches and for each fleet):

1) PLE21_23_Benchmark_2015

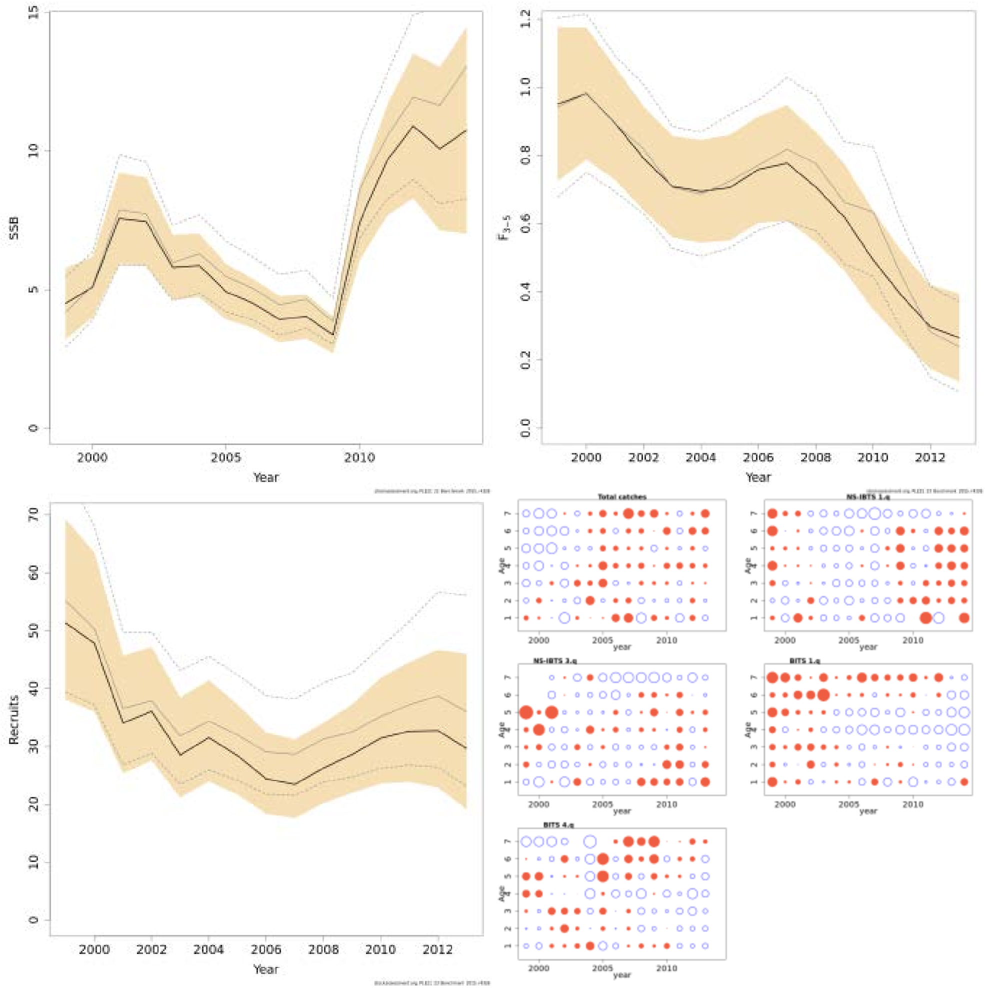
   a) Each of the four survey used as individual tuning fleet;

   b) Age 7 as plus group in all surveys;

   c) Coupling of catchability of age 4-7 for all surveys;

   d) Annually mean weight at age in stock;

   e) Annually maturity ogive (running mean of 3 years).



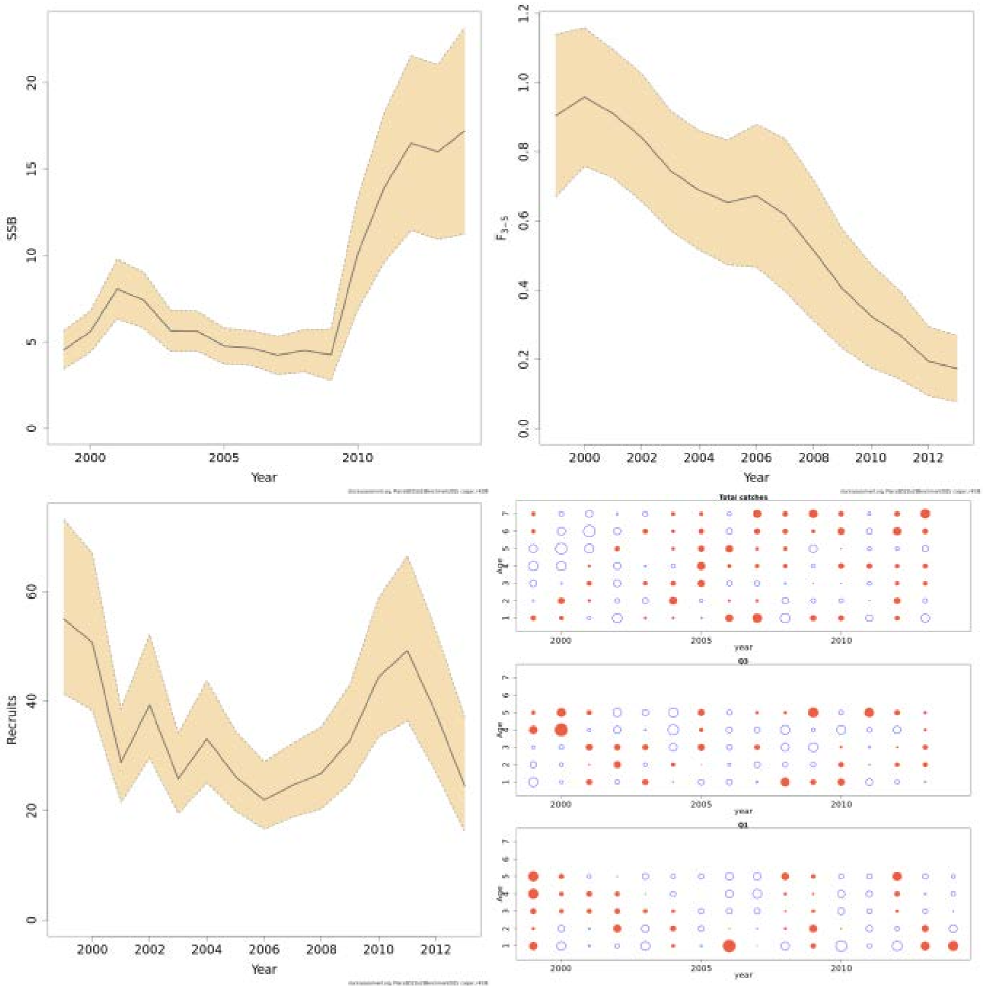
2) PLE21_23_Benchmark_2015_Version3

Same as 1) except:

a) The two 1st quarter surveys and the two 2nd half of the year survey combined;

b) Only up to age5 included in the tuning fleets;

c) Coupling of catchability of age 4-5 for both tuning fleets.

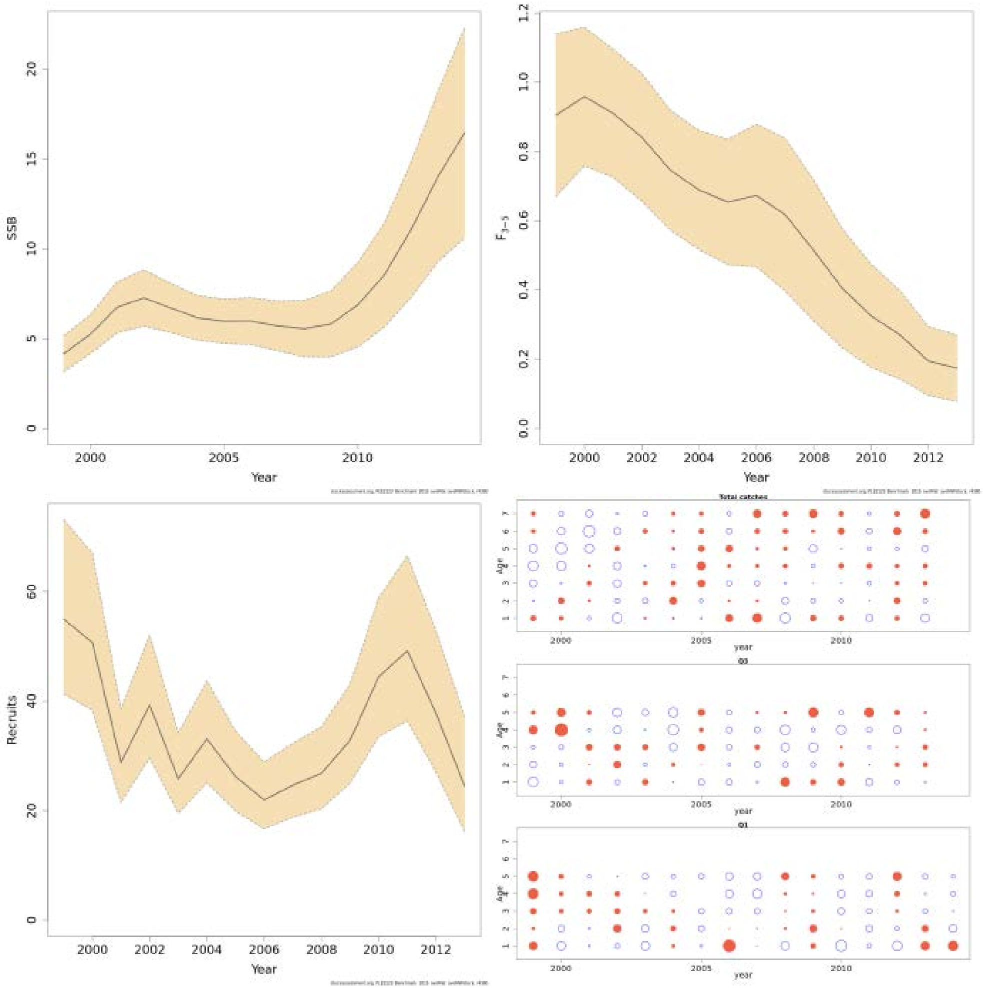


3) PLE2123_Benchnark_2015_aveMat_aveMWstock (base run)

Same as 2) except:

a) constant maturity and

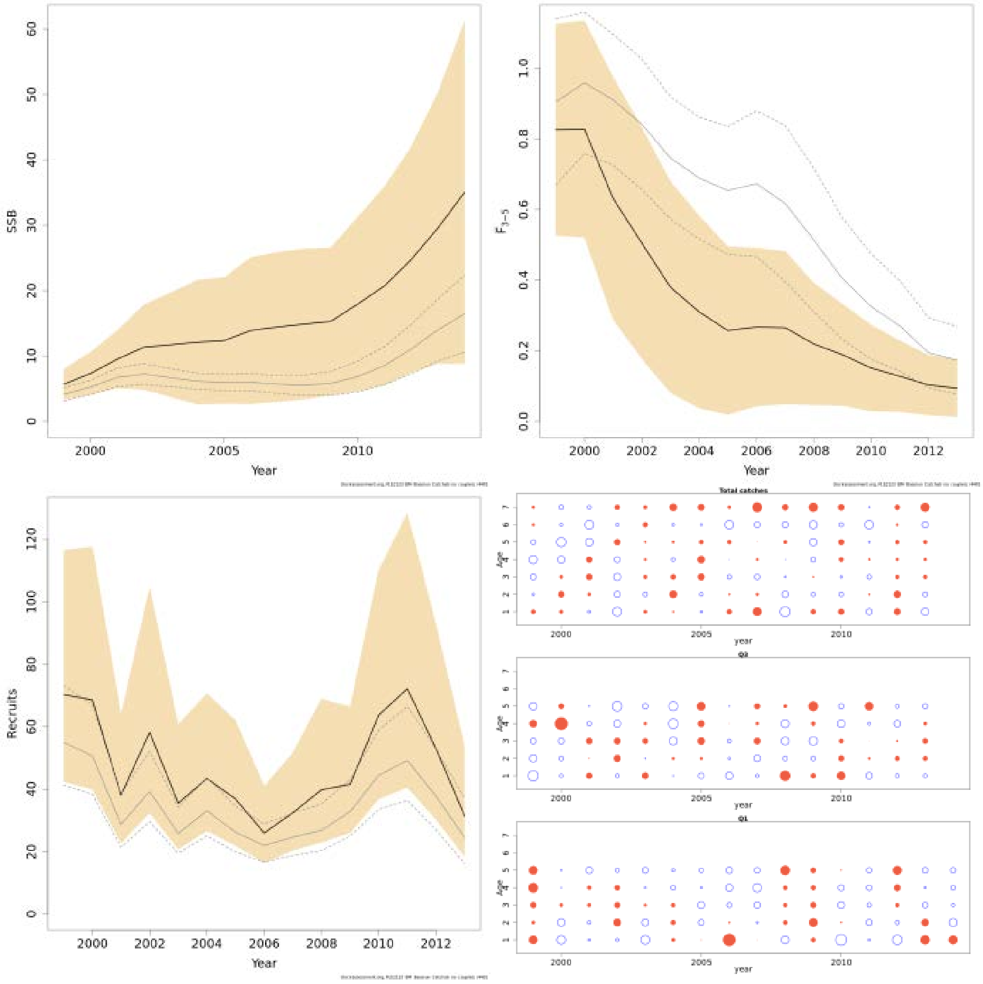
b) constant mean weight at age in stock



4) PLE2123_BM_Baserun_Catchab_no_coupled (exploratory)

Same as 3) except:

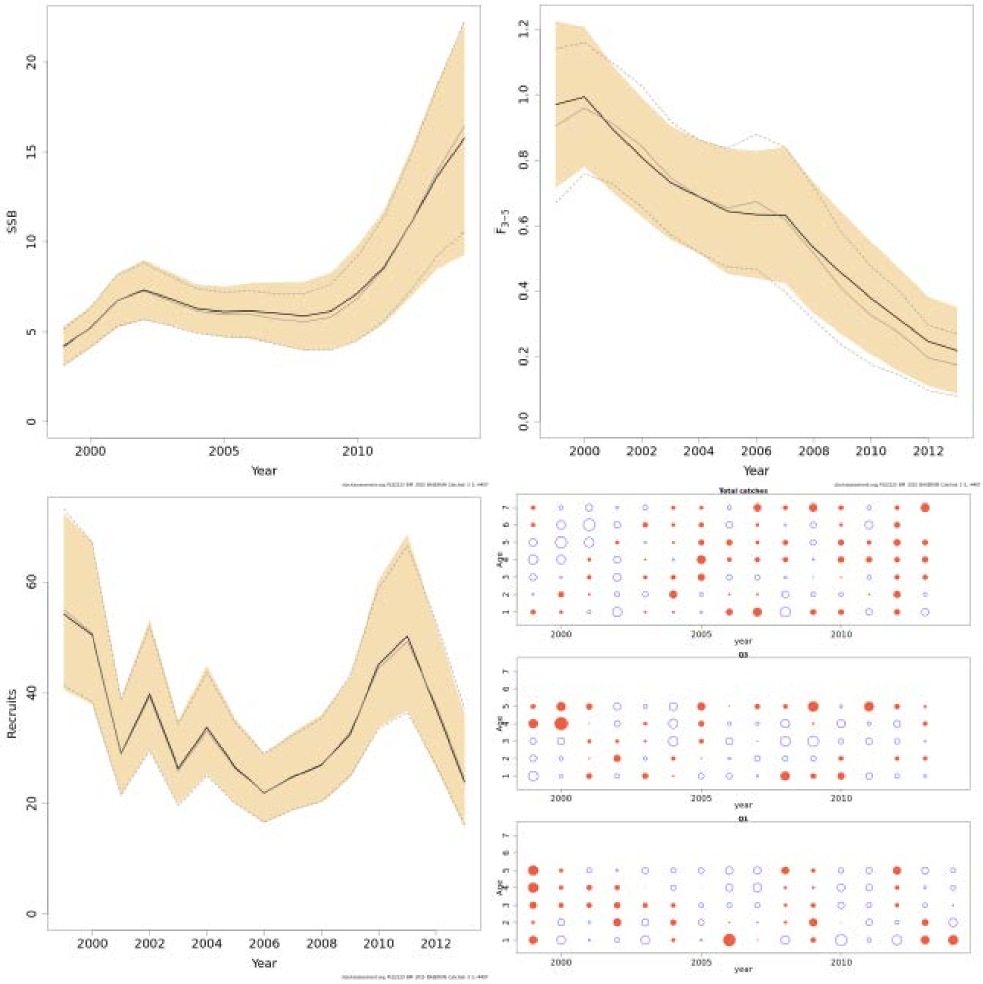
a) But no coupling of cathability for any age classes



5) PLE2123_BM_2015_BASERUN_Catchab_3_5 (exploratory)

Same as 3) except:

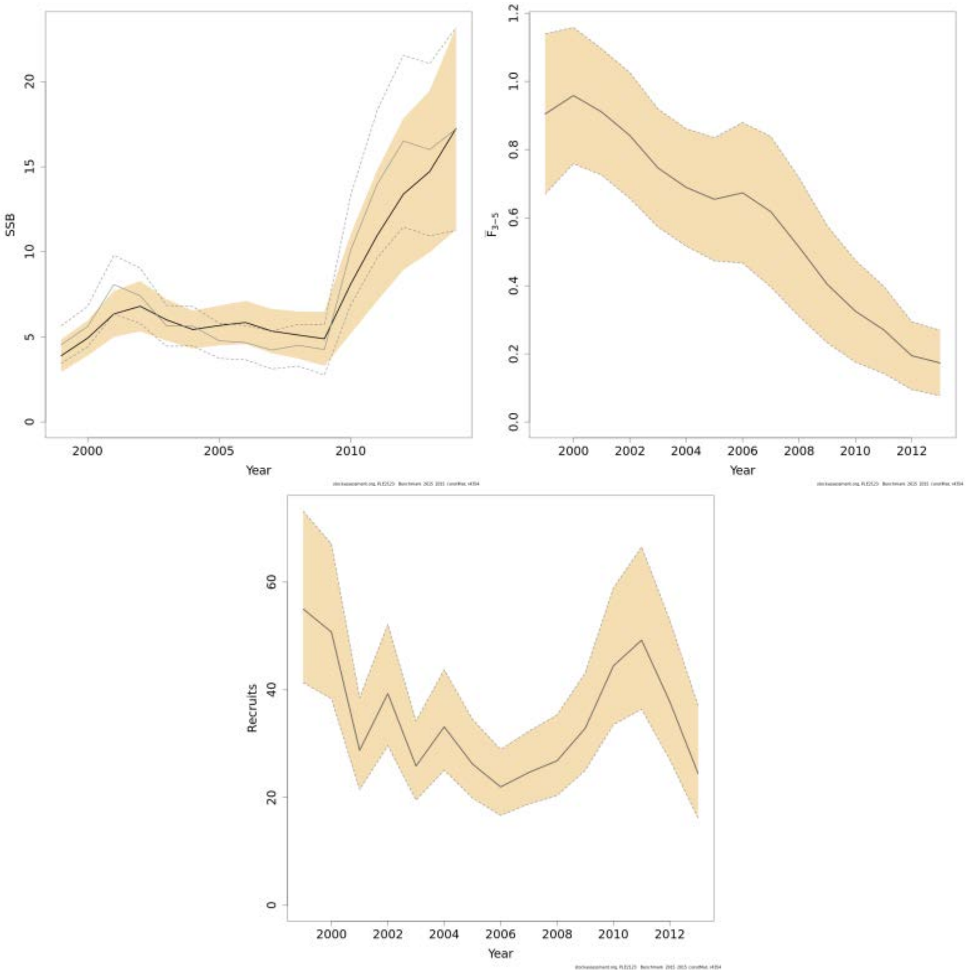
a) Coupling of catchability of age 3-5 for both tuning fleets



6) PLE2123__Benchmark_2015_2015_constMat (exploratory)

Same as 3) except:

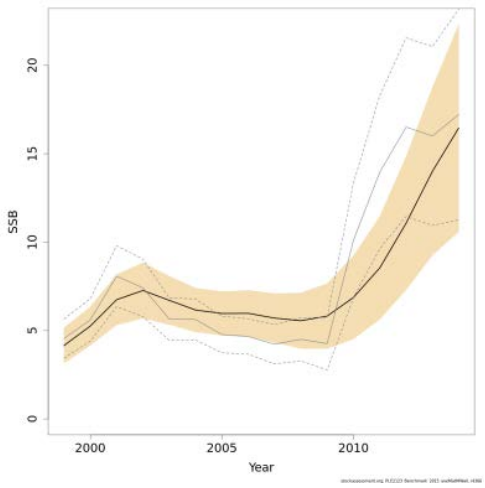
a) Year specific mean weight at age in stock



7) PLE2123_Benchmark_2015_aveMatMWall (exploratory)

Same as 3) except:

a) Constant mean weight at age in landings, discard and catch

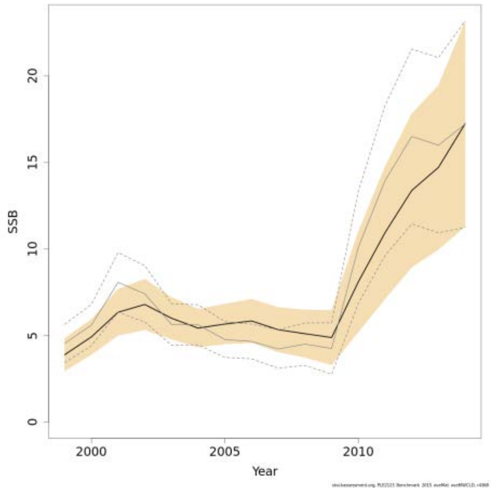


9) PLE2123_Benchmark_2015_aveMat_aveMWCLD (exploratory)

Same as 3) except:

a) Constant mean weight at age in catch, landings and discard

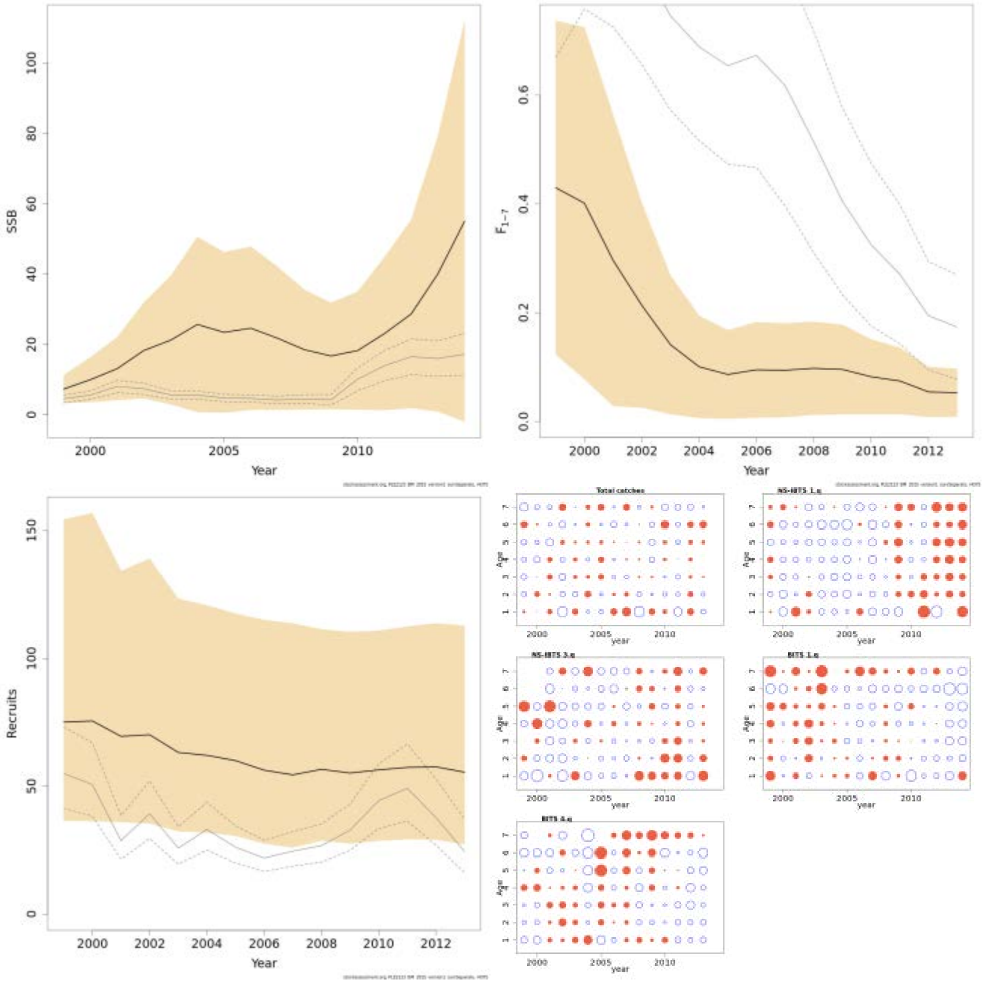
b) Individual mean weight at age in stock



10) PLE2123_BM_2015_version1_survSeparate (exploratory)

Same as 3) except:

a) Each of the four survey used as individual tuning fleet.



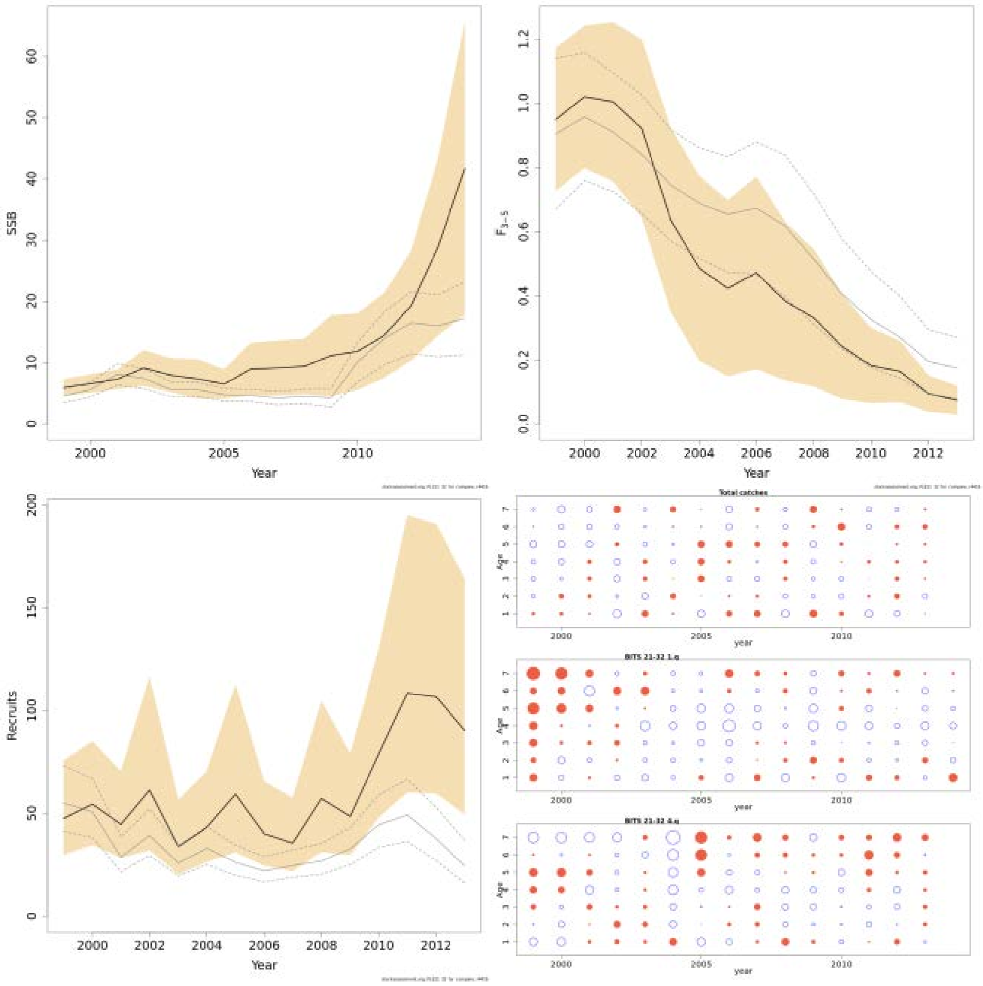
Furthermore, a run was made to investigate the effect on the assessment if SD 24-32 (PLE24-32) were included

11) PLE21_32_for_compare (exploratory)

Same as 3) except:

a) Commercial catches for SD 24 to 32 were included

b) Only BITS tuning fleets were included now extended to coverer SD 21-26.



In order to investigate if survey based assessment methods would lead to similar perception about the state of the stock a SURBA run was made based on the four individual surveys available and otherwise on the same input data as the SAM base run. The result of the SURBA run is given in Figure 5.17 and supports to a wide extent the result of the SAM run with increasing SSB, decreasing or constant Z and varying recruitment around the same mean value throughout the whole time-series.

5.8 Appropriate Reference Points (MSY)

MSY reference points will be defined intersessionally but prior to WGBFAS in mid-April 2015 and in accordance with WKMSYREF3 guidelines.

5.9 Future Research and data requirements

The assessment will probably gain in quality if the time-series were extended backwards. The discard rate is rather constant in the available dataseries (2002–2013) and it might be possible to obtain landing CANUMs and landing MW at age further back in time. The discard data previous to 2002 might be modelled based on effort data and other information about the historical fishing pattern. As Denmark is the dominating country fishing on the stock, even only Danish figures would probably significantly improve the assessment.

There are presumably some age reading issues across countries and probably also internally for particularly Danish age readings. These issues should be clarified and solved by cooperation between Sweden, Germany and Denmark.

It should be clarified to which extent inhomogeneous size distribution pattern or inconsistency in age reading in SD 21 can explain the conflicting indices trends in the surveys. Particularly the NS-IBTS and the BITS shows inconsistent signals.

5.10 External Reviewers Report

The SAM (Stock Assessment Model) approach was used to assess plaice stock in this area. The group discussed at length the issue of plaice stock structure in this and adjacent regions and whether plaice in Kattegat-Belt (SD21-23) and in Baltic (SD24-32) should be treated as one stock. The Stock Identification Method Working Group (SIMWG) that met in December 2014 concluded that the perception of plaice in Subdivisions 21-32 as a single stock unit is not well supported by the available information. The Panel agreed to follow the SIMWG recommendation to treat place in areas 21-23 and 24-32 as separate stocks for this benchmark, but also initiated exploration of combining these two stocks for assessment purposes. Exploratory runs were conducted by the stock leader and evaluated by the group with commercial catches from Kattegat-Belt and Baltic stocks combined. The group also evaluated an exploratory run with the survey index that was calculated using data collected from both stocks. This work was recommended to fully understand the model performance and outputs of the combined assessment.

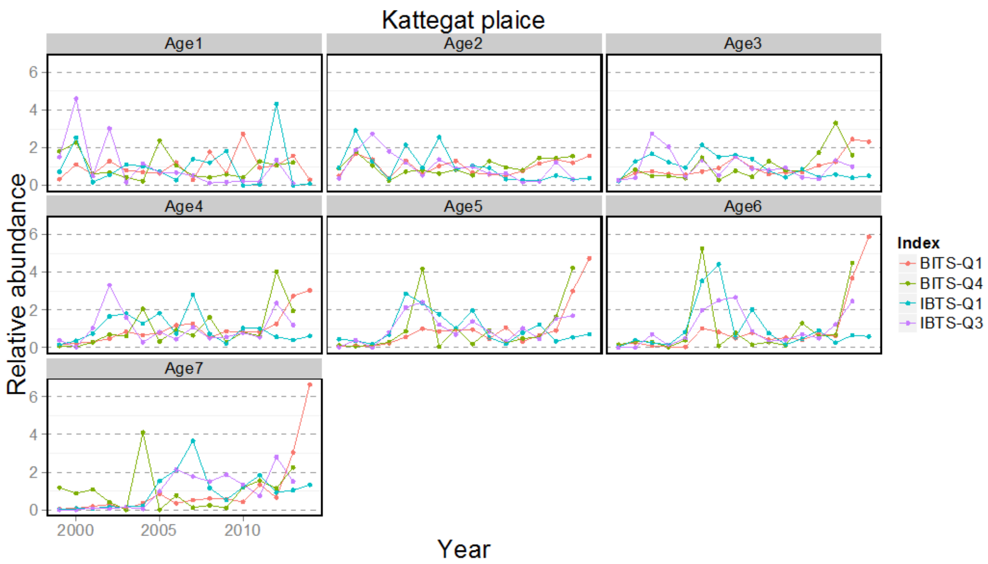
During the benchmark week the stock leader conducted a number of runs that allow detailed exploration of models with alternative age-specific schedules (constant and time-varying) and different configurations of survey indices. The stock leader also calculated exploratory diagnostics for survey data using the SURBA software and empirical evaluation of length-based indices that exhibited more consistency over years and sizes than age-based indices. This work highlighted the potential benefit of models that are able to incorporate length composition data directly.

5.10.1 Issues addressed at the benchmark

The catch-at-age data were obtained from the InterCatch database, where the data are stratified by region, area and length. The group discussed how representative biological samples of the trip-level data that inform InterCatch estimates are, since it is unclear how samples are being collected (i.e. all could be from a single haul or there could be individual hauls from multiple trips).

The landings time-series by age go back to 1999, while discard data were available from 2002 forward. The stock leader estimated discards for the years with no discard data by using average discard to landing ratio by region and quarter, extrapolated to the total number of trips. Discards were generally higher in the 1st quarter and have shown a recent increase, most likely due to an increase in cod catches in SD22. But overall, the discards relative to the landings were relatively stable and represented about 50% of the total catch. The Panel also noted that VMS and logbook data can be evaluated for effort calculations, which may help improve discard estimations.

Research surveys conducted in this region include the BITS that is split between countries and the IBTS conducted by Sweden. The BITS 1st quarter started in 1992 and BITS 4th in 1998, while the IBTS, conducted in the 3rd and 4th quarters, was initiated in 1991. The stock leader provided assessment results from a run that include age-specific indices from ages 1 through 7 for both the IBTS and the BITS, and from a run when the survey indices were combined ("casperized") following the Casper Berg *et al.*, (2014) method. The ability of individual survey indices to track cohorts (as indicated by the index internal consistency plots) was limited; the consistency among individual surveys was also questionable (see Figure a below). Combining the survey indices as described in Berg *et al.*, (2014) improved the observation error apparent in individual indices, and, therefore, the Panel recommended the combined survey index for use in the assessment. The Panel noted that future application of this approach will change the entire time-series of inputs each time a new year of data are added to the survey dataset.



A=IBTS Q1 B=BITS Q1 C=IBTS Q3 D=BITS Q4

	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7
A-B	-0.13	0.37	-0.22	-0.07	-0.03	0.02	0.19
C-D	0.46	-0.10	0.04	0.35	0.68	0.54	-0.21
A-C	0.38	0.50	0.48	0.32	0.72	0.55	0.59
A-D	0.13	0.07	-0.28	-0.12	0.21	0.32	-0.23
B-C	-0.08	0.39	0.13	0.16	0.48	0.59	0.32
B-D	-0.22	0.60	0.44	0.46	0.73	0.70	0.29

Figure a. Normalized age-specific indices correlation among them for place stock in Kattegat-Belt (SD21-23) by survey and quarter.

Age determination appears to be a concern with this stock, and it is unknown whether patterns observed in catch-at-age variability and variability of weight and maturity estimates reflect environmental conditions and/or originate because of different protocols used by different labs and countries to determine fish age.

In the initial SAM assessment model run, all demographic schedules were allowed to vary over time. To examine the relative effect on SSB, a series of runs (cases) was conducted that included:

Case	Numbers-at-age	Maturity-at-age	Stock weight at age
Const	Fixed at mean values	Set to average	Set to average
Var_mat	Fixed at mean values	Vary	Set to average
Var_wt	Fixed at mean values	Set to average	Vary
Var_N	Set to estimated values	Set to average	Set to average
All_Var	Set to estimated values	Vary	Vary

Results of these runs based on tables at www.stockassessment.org and normalized by the case where all age-specific values were held constant over time are shown in Figure b below. It is evident that the demographic schedules play a large role in variability of the spawning-stock biomass and should be carefully considered when providing advice for reference points and status determination. The case when maturity and stock weight-at-age were set to average (and not allowed to vary over time) was agreed to be the most reasonable for this assessment, because the time-varying maturity and stock weights-at-age appeared to be driven by noise that affected the trends in spawning-stock biomass.

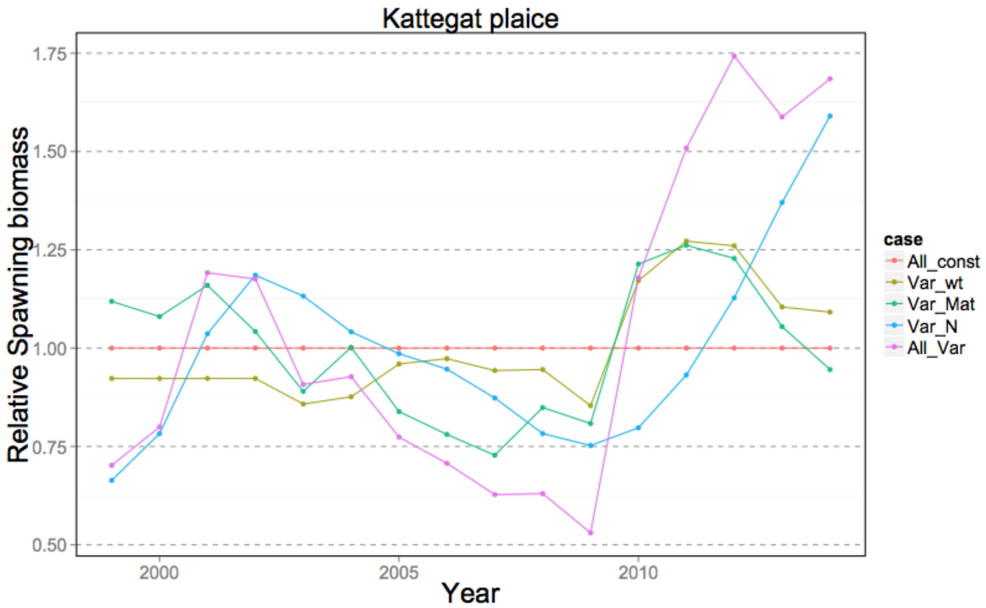


Figure b. Simple comparison of static vs. time varying age specific component effects on relative spawning biomass (normalized to the constant, time invariant time-series "All_const" case).

Alternative settings for the SAM catchability parameters were explored which included having a separate catchability for every age, assuming equal catchabilities for ages 4 and 5, and assuming equal catchabilities for ages 3, 4 and 5. The alternative sensitivity runs gave similar results, and the Panel agreed that using the coupled catchabilities for ages 4 and 5 was reasonable compromise among catchability options for this assessment.

5.10.2 Use of final stock annex as basis for providing advice

The Panel agreed that the stock annex is adequate for providing scientific advice (stock category 1) and should include the following recommendations:

- Use SAM approach for the assessment that is configured to include:
  - the average maturity ogive for the modelled period;
  - the average mean weight at age for the stock;
  - the combined ("casperized") survey IBTS and BITS age-specific indices using the method of Casper Berg *et al.*, (2014);
  - coupled catchabilities for age 4 and 5.

5.10.3 Recommendations for future work

Future research prior to the next benchmark should consider the following:

- Explore extending the model further back, to at least the beginning of the survey time-series. The current assessment model starts in 1999 when landings-at-age data are first available.
- Continue to improve approaches for discard estimation, specifically support activities involved in improving the efficiency and standardization of fishery data collection (e.g. that of the Baltic working group).
- Evaluate models where length data can be used directly due to issues related to variability of age determination which may be affecting the age indices.
- Explore a modelling platform that allows incorporation of historical catch time-series (in biomass or numbers) not by age, to allow the use of available catch data back to 1903. At a minimum, the model should extend back to the period when the surveys began (1991) as this may improve estimates of catchability.
- A new survey vessel will be used for the BITS and it is unclear whether the protocols of past surveys will need to be compared, and whether the ability to account for vessel changes within the assessment model will be needed.
- Develop a model so that variable (by year) catch estimation uncertainty can be accounted for, because the sampling protocols have changed (improved in recent years). Currently the SAM model specifies a single observation-error term over time.

Table 5.1 official landings by country and Subdivision as given in WGBFAS report 2014.

	DNK				GER			SWE				
Year	SD 21	SD 22	SD 23	DNK Total	SD 21	SD 22	GER Total	SD 21	SD 22	SD 23	SWE Total	Total
1972	15 504	2726		18 230	77	154	231	348			348	18 809
1973	10 021	2399		12 420	48	165	213	231			231	12 864
1974	11 401	3440		14 841	52	202	254	255			255	15 350
1975	10 158	2814		12 972	39	313	352	296			296	13 620
1976	9487	3328		12 815	32	313	345	177			177	13 337
1977	11 611	3452		15 063	32	353	385	300			300	15 748
1978	12 685	3848		16 533	100	379	479	312			312	17 324
1979	9721	3554		13 275	38	205	243	333			333	13 851
1980	5582	2216		7798	40	89	129	313			313	8240
1981	3803	1193		4996	42	80	122	256			256	5374
1982	2717	716		3433	19	45	64	238			238	3735
1983	3280	901		4181	36	42	78	334			334	4593
1984	3252	803		4055	31	30	61	388			388	4504
1985	2979	648		3627	4	94	98	403			403	4128
1986	2470	570		3040	2	59	61	202			202	3303
1987	2846	414		3260	3	18	21	307			307	3588
1988	1820	234		2054	0	10	10	210			210	2274
1989	1609	167		1776	0	7	7	135			135	1918
1990	1830	236		2066	2	9	11	202			202	2279
1991	1737	328		2065	19	15	34	265			265	2364
1992	2068	316		2384	101	11	112	208			208	2704

Year	DNK			DNK Total	GER		GER Total	SWE			SWE Total	Total
	SD 21	SD 22	SD 23		SD 21	SD 22		SD 21	SD 22	SD 23		
1993	1294	171		1465	0	16	16	175		2	177	1658
1994	1547	355		1902	0	1	1	227		6	233	2136
1995	1254	601	64	1919	0	75	75	133		12	145	2139
1996	2337	859	81	3277	0	43	43	205	1	13	219	3539
1997	2198	902		3100	25	51	76	255		13	268	3444
1998	1786	642		2428	10	213	223	185		13	198	2849
1999	1510	1456		2966	20	244	264	161	1	13	175	3405
2000	1644	1932		3576	10	140	150	184		26	210	3936
2001	2069	1627		3696		58	58	260		39	299	4053
2002	1806	1759		3565	26	46	72	198		42	240	3877
2003	2037	1024		3061	6	35	41	253	0	26	279	3381
2004	1395	911		2306	77	60	137	137		35	172	2615
2005	1104	908	145	2157	47	51	98	100		35	135	2390
2006	1355	600	166	2121	20	46	66	175		39	214	2401
2007	1198	894	193	2285	10	63	73	172		69	241	2599
2008	866	750	116	1732	6	92	98	136	0	45	181	2011
2009	570	633	139	1342	5	194	199	84	0	42	126	1667
2010	428	748	57	1233	3	221	224	66	0	17	83	1540
2011	328	851	46	1225	0	310	310	40		11	51	1586
2012	196	1189	54	1439	0	365	365	30	7	12	49	1853
2013	232	1253	14	1499	0	319	319	60	0	76	136	1954
Total	153 735	54 368	1075	209 178	982	5236	6218	8949	9	586	9544	224 940

Table 5.2. Landing, discard and discard percentage for the total stock. Discrepancies between table 5.1 and 5.2 is due to national updates in connection with the benchmark data call.

Year	Discard	Landing	Catch	Discard %
2002	4357	3939	8296	53
2003	2004	3618	5623	36
2004	1369	2766	4135	33
2005	1197	2354	3551	34
2006	1770	2580	4350	41
2007	1191	2691	3882	31
2008	1902	2028	3930	48
2009	1448	1635	3083	47
2010	1489	1570	3059	49
2011	2045	1584	3629	56
2012	1351	1845	3196	42
2013	1638	1956	3593	46

Table 5.3 Likelihood values for each run to be compared with the base run (run 3)

Run	Model	Negative log likelihood	Number of parameters	Degrees of freedom	P value
1	Current	658.5	25		
2	Current	654.97	24	1	1
3	Base	202.23	15		
4	Current	201.35	16		
5	Current	209.85	12	3	0.0016
6	Current	202.23	15		
7	Current	202.23	15		
8	Current	202.23	15		
9	Current	632.87	32		
10	Current	316.66	15		

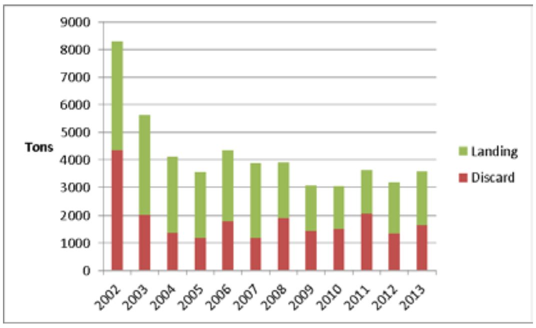


Figure 5.1: Catches series

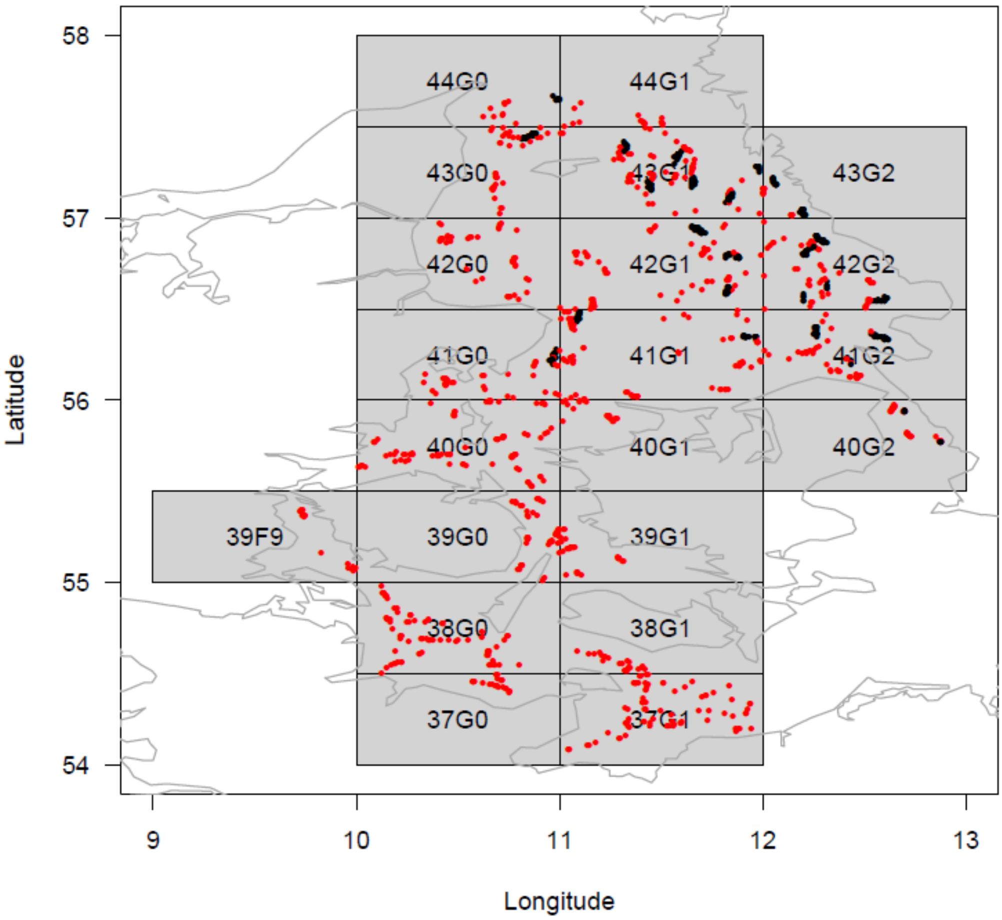


Figure 5.2a: Spatial distribution of hauls in first quarter (all years). Red dots: BITS, Black dots: NS_IBTS.

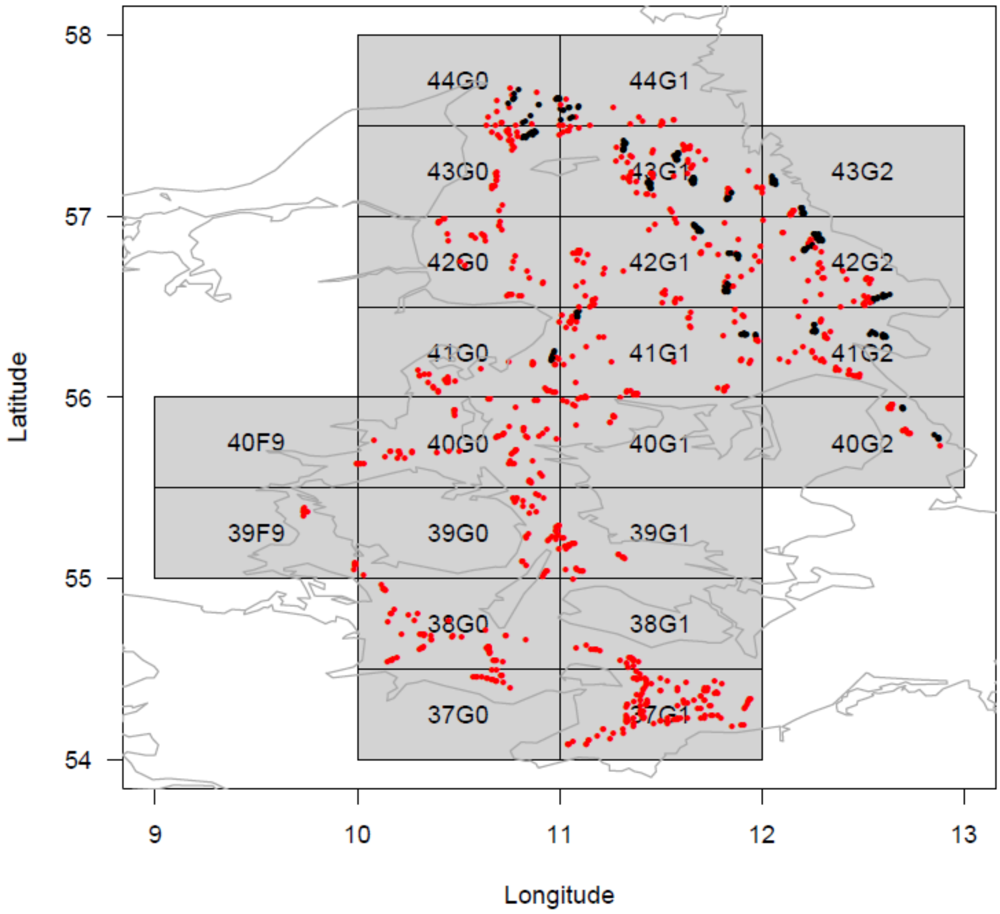


Figure 5.2b: Spatial distribution of hauls in third and fourth quarter (all years). Red dots: BITS, black dots: NS_IBTS.

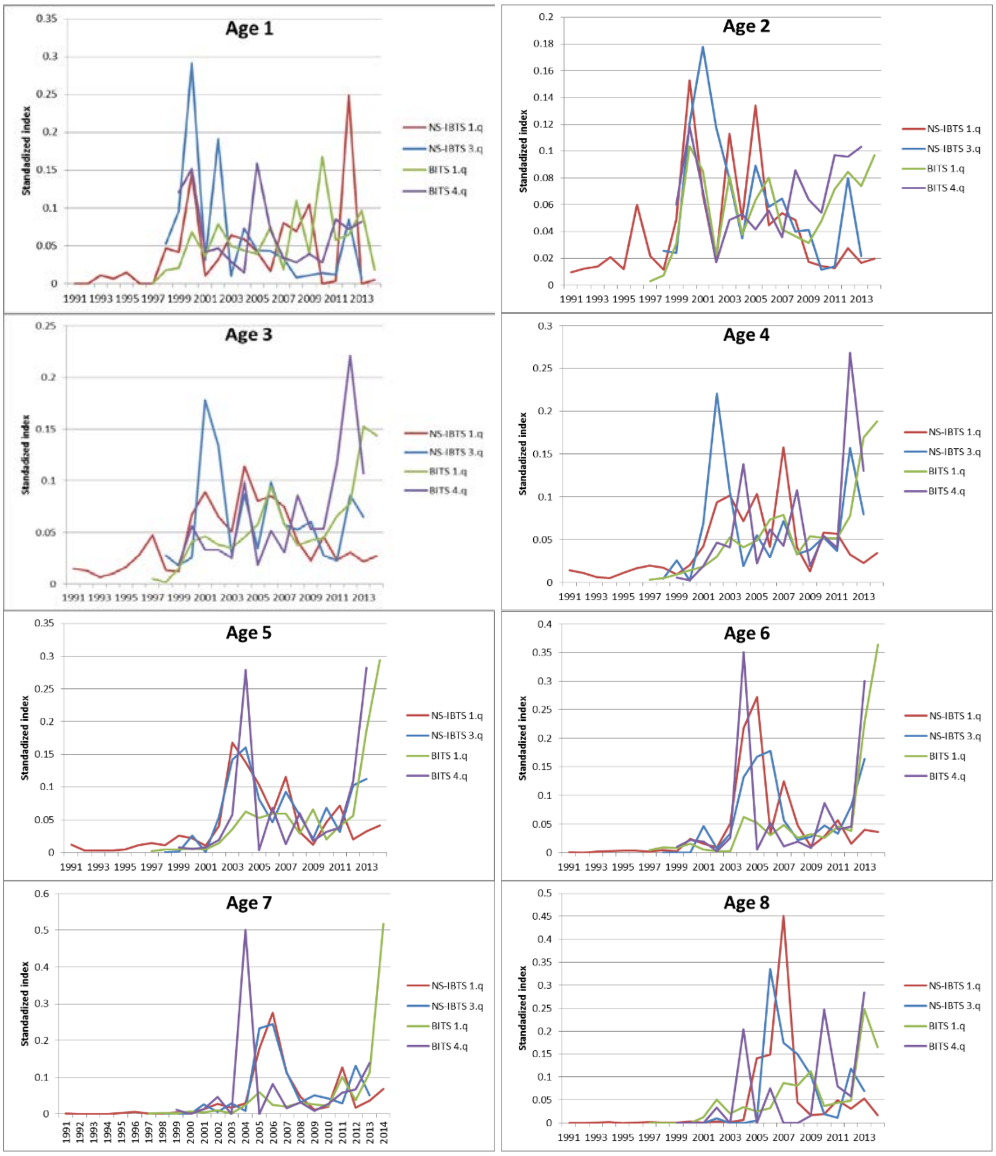


Figure 5.3: Standardized index value by survey for each year class.

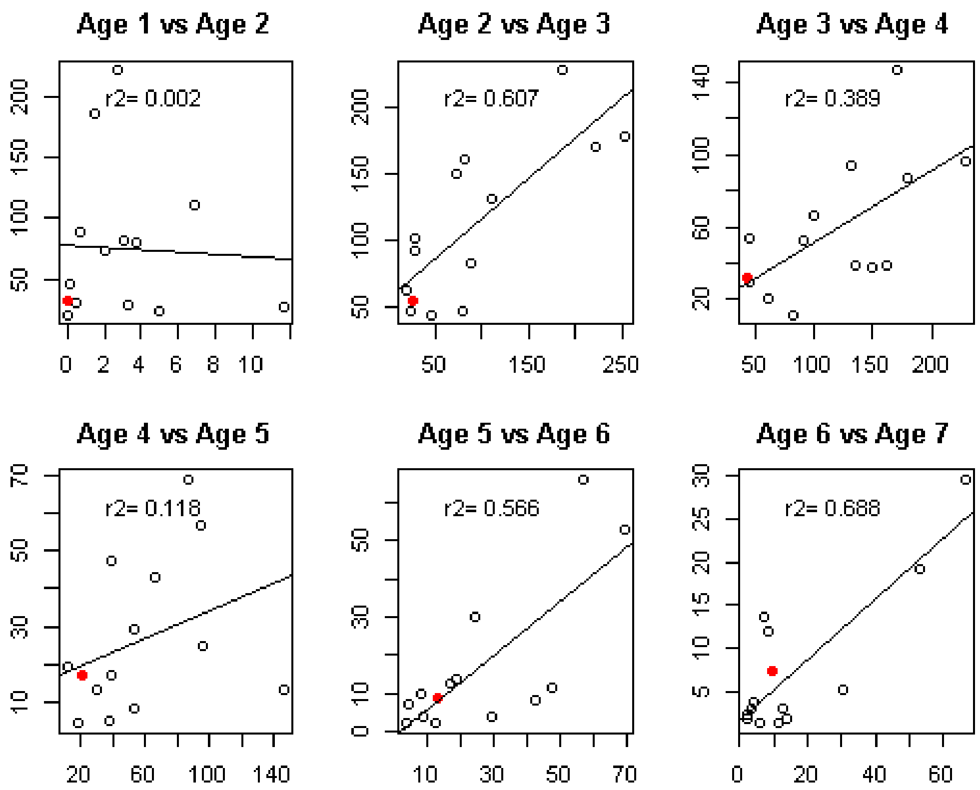


Figure 5.4: Internal consistency plots of NS-IBTS (SD 21) quarter 1

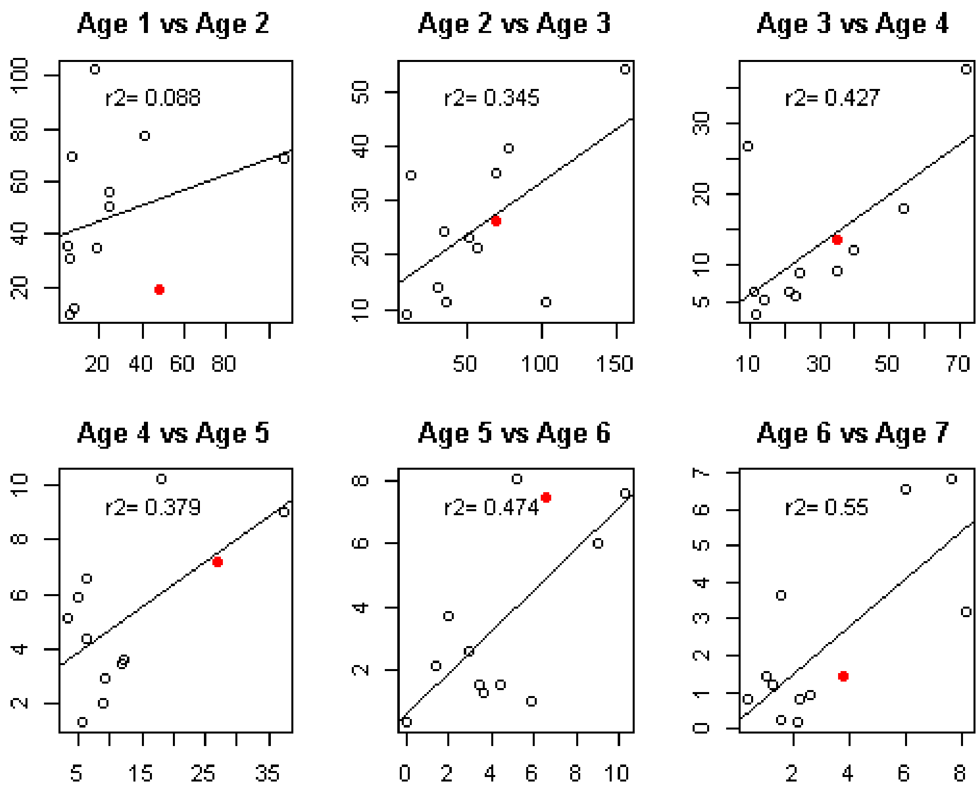


Figure 5.5: Internal consistency plots of NS-IBTS (SD 21) quarter 3

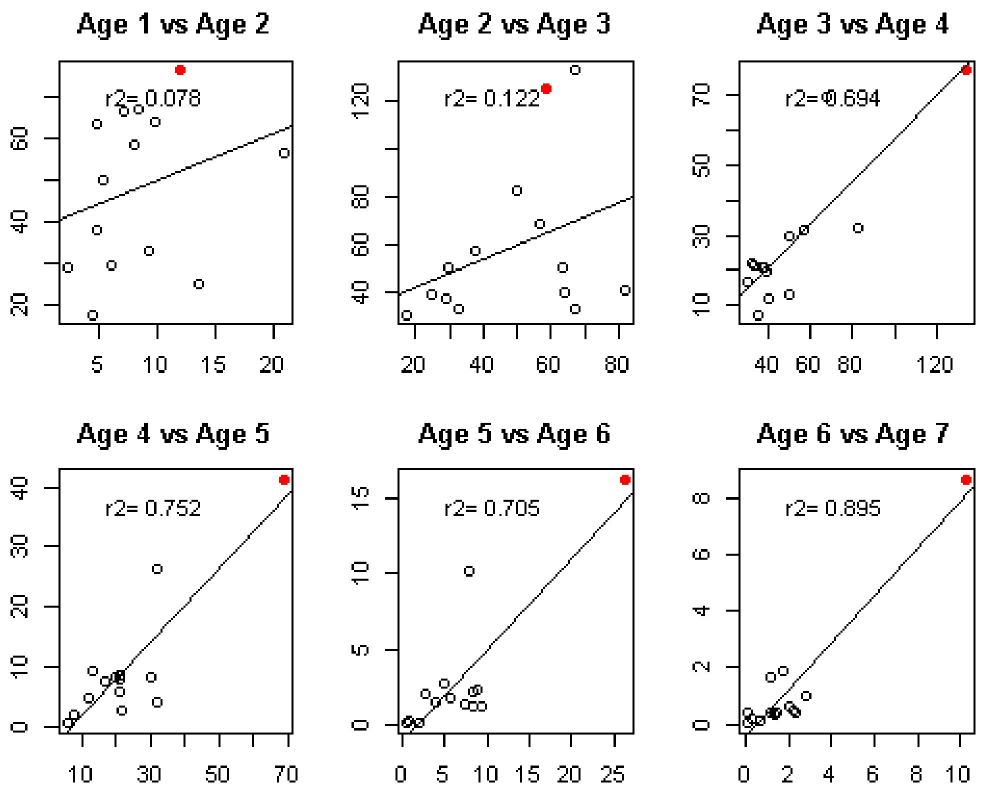


Figure 5.6: Internal consistency plots of BITS (SD 21-23) quarter 1.

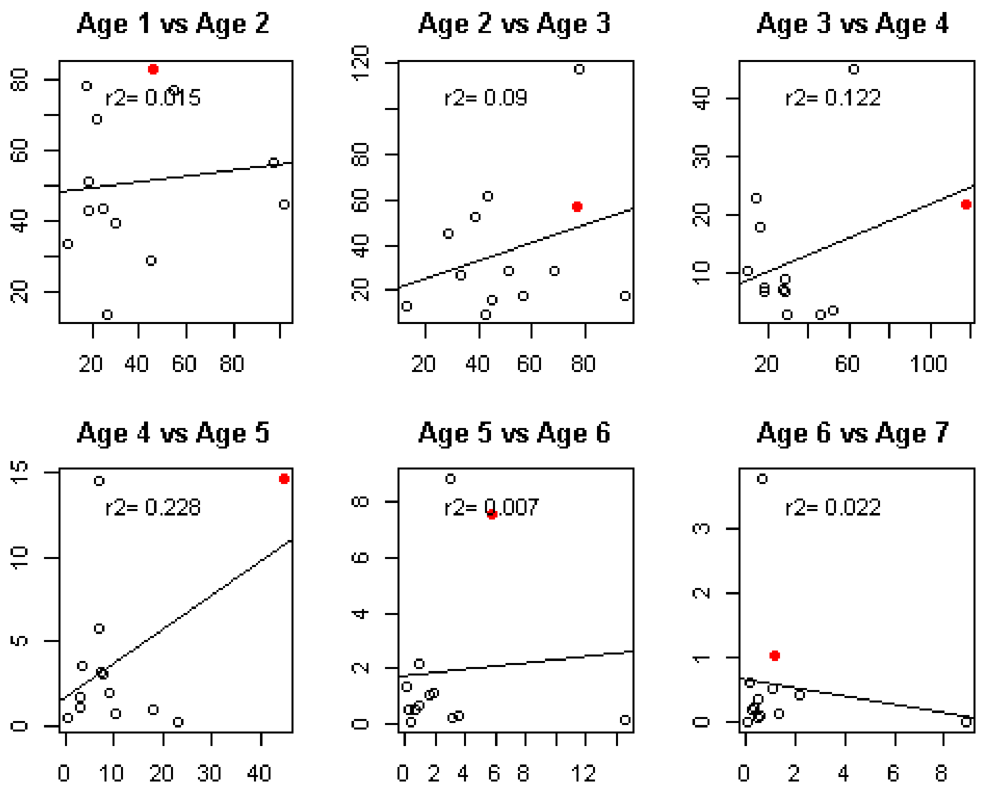


Figure 5.7: Internal consistency plots of BITS (SD 21-23) quarter 4.

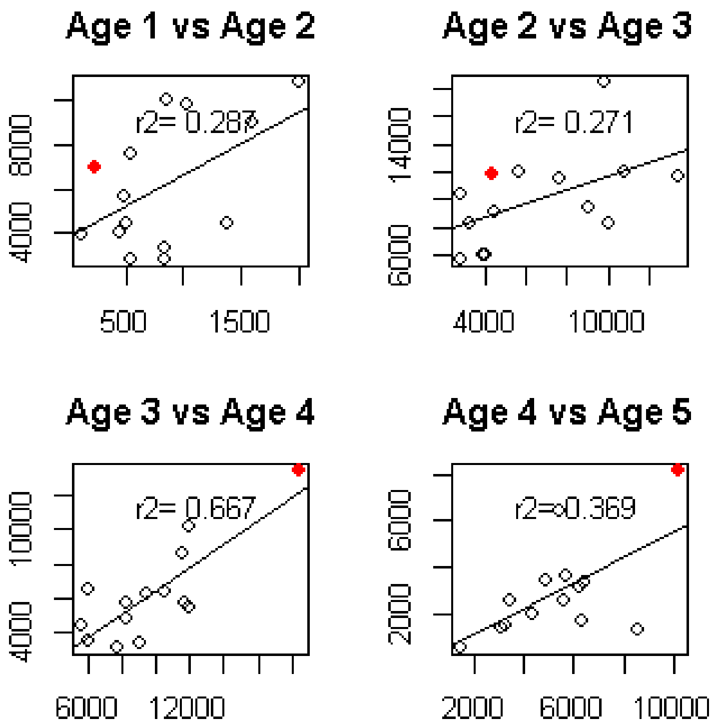


Figure 5.8: Internal consistency plots of Combined 1st quarter

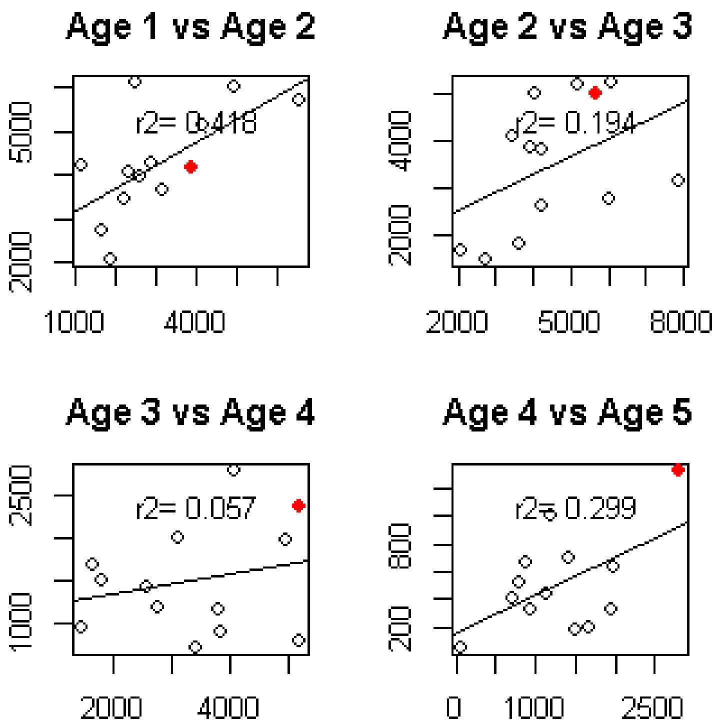


Figure 5.9: Internal consistency plots of Combined 3-4 quarter

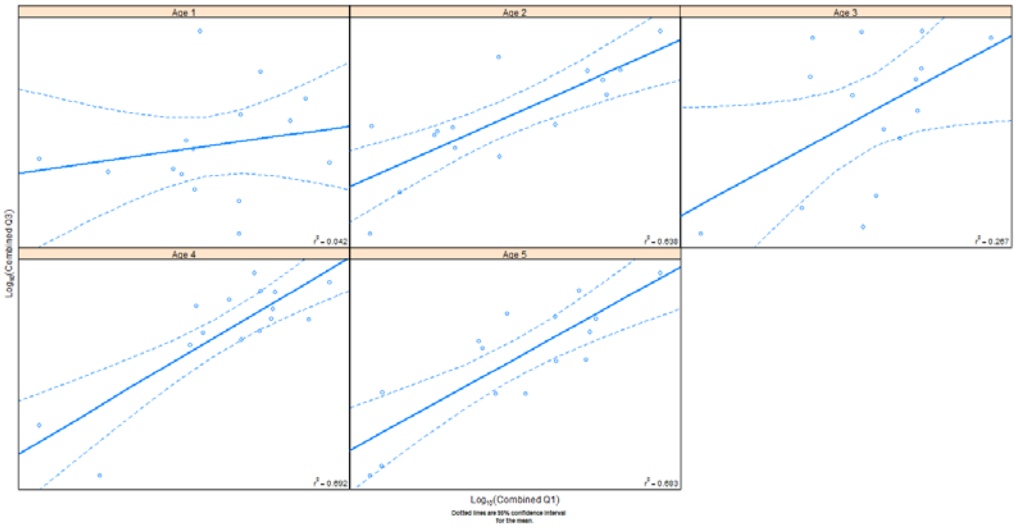


Figure 5.10: External consistence between combined 1q and combined 3_4 q.

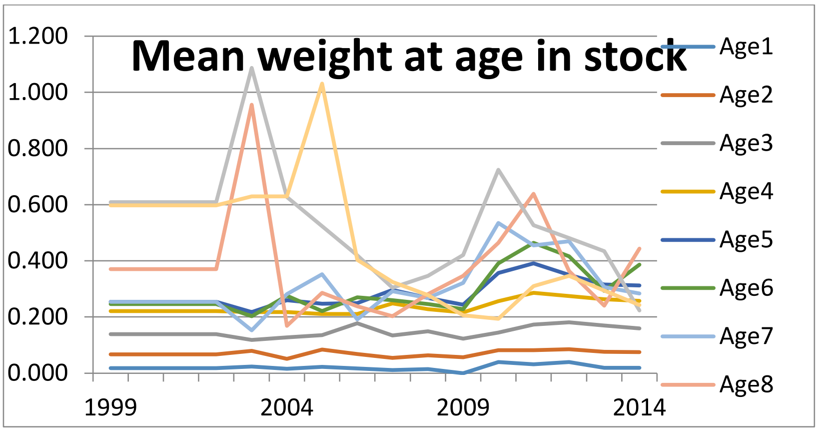


Figure 5.11: Mean weight at age in stock.

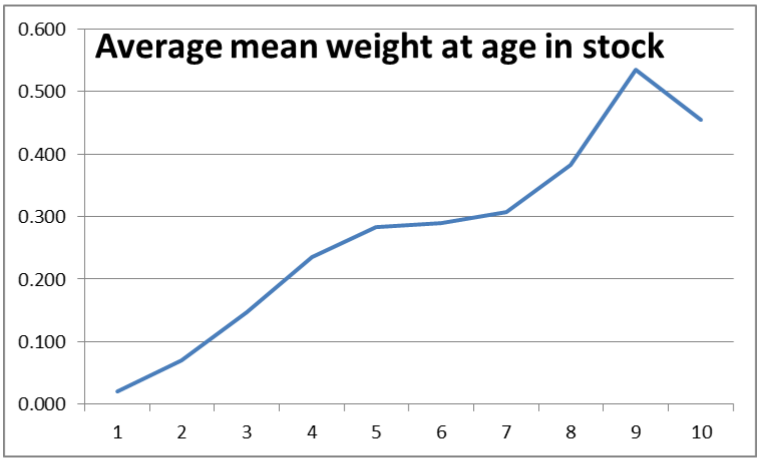


Figure 5.12: Constant mean weight at age in stock (average of 2002-2014).

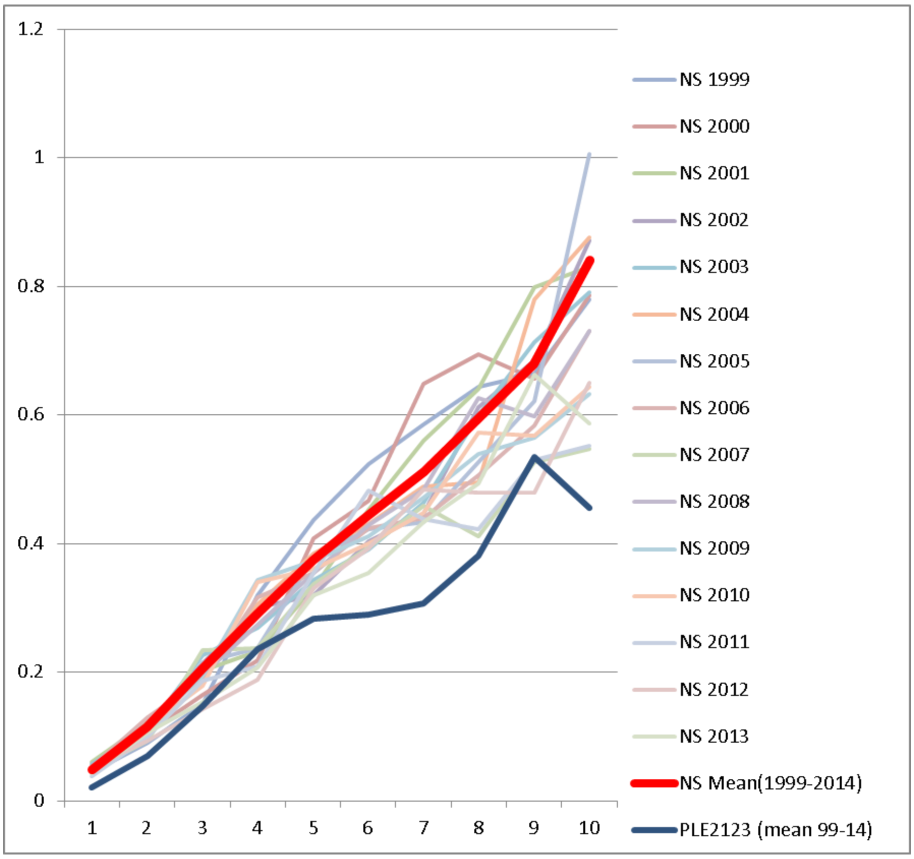


Figure 5.13: Mean weight in stock compared to values for North Sea plaice.

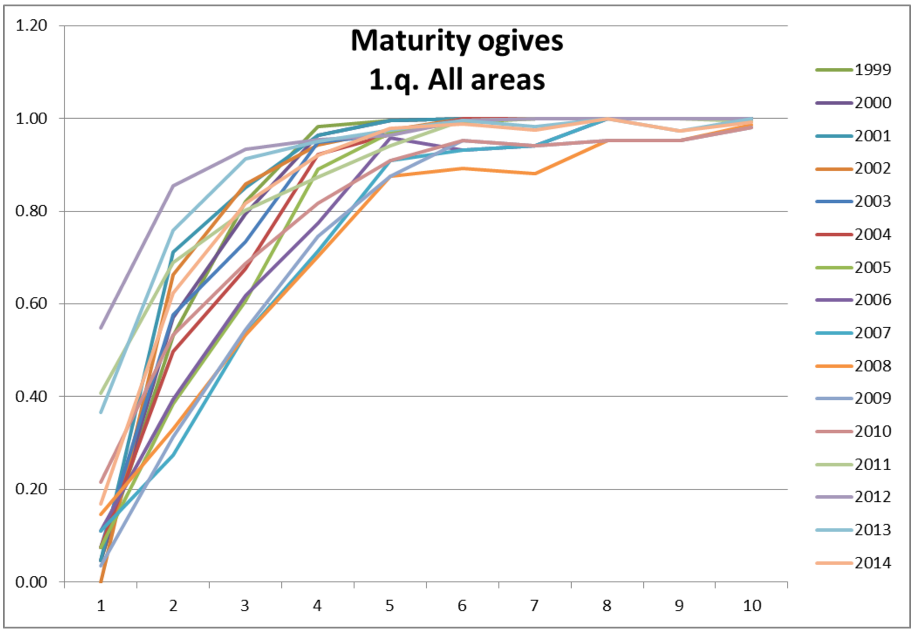


Figure 5.14: Year specific maturity ogives based on both 1st quarter surveys.

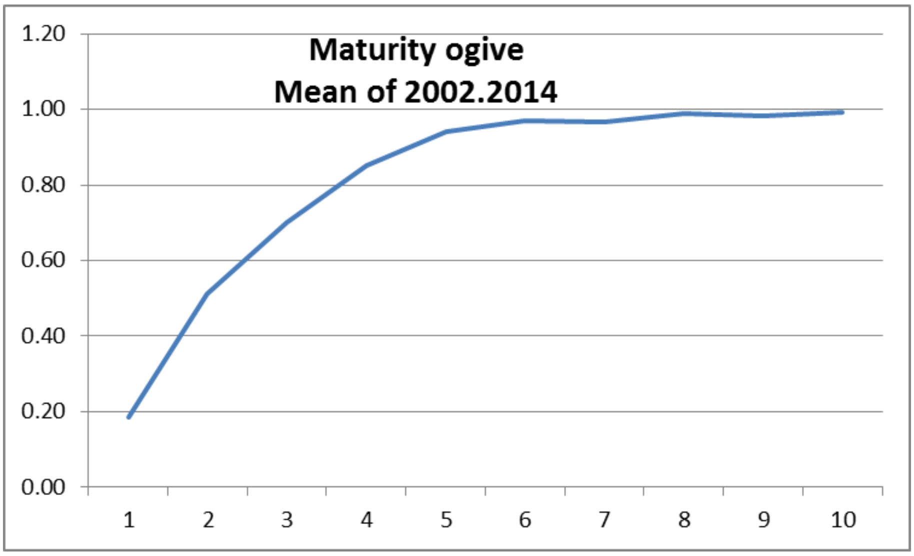


Figure 5.15: Constant maturity ogives based on average of 2002–2014.

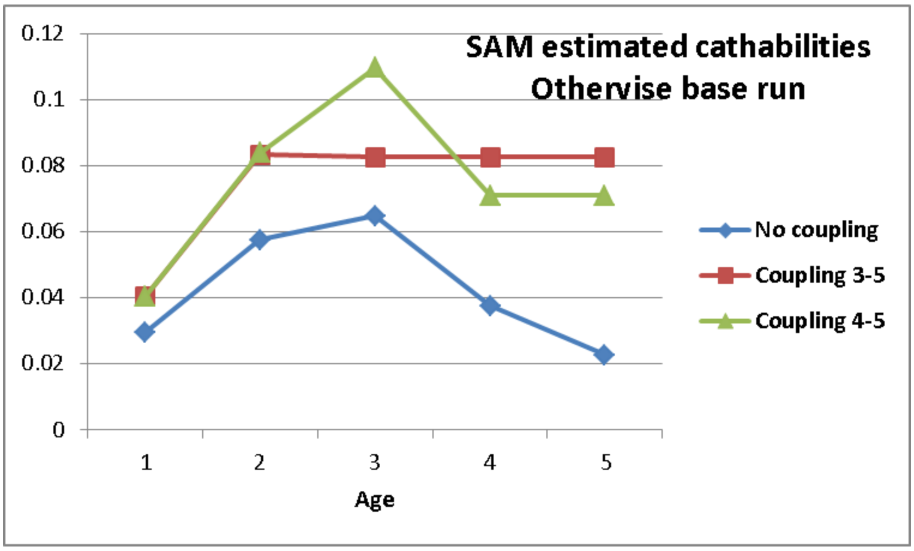


Figure 5.16: Catchability curves from individual SAM run exploring coupling (same for both tuning fleets).

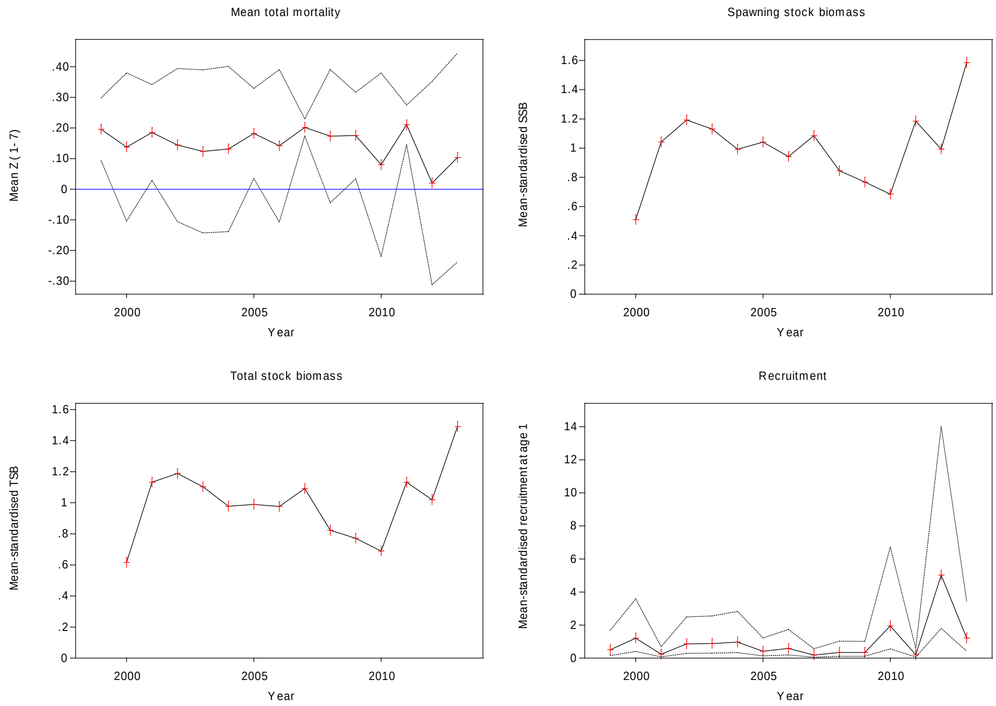


Figure 5.17: Summary output from Surba based on same data input as SAM base run except that each of the four available surveys is used individually as tuning fleet.

6 Eastern Baltic Sea plaice PLE-2432

Plaice is mainly caught in the area of Arkona and Bornholm basin (SD 24 and SD 25). ICES Subdivision 24 is the main fishing area with Denmark and Germany being the main fishing countries. Subdivision 25 is the second most important fishing area. Denmark, Sweden and Poland are the main fishing countries there. Minor catches occur in Gdańsk basin (SD 26). Marginal catches of plaice in other SD are found occasionally in some years, but were usually lower than 1 ton/year. Plaice are caught by trawlers and gillnetters mostly. Active gears provide most of the landings in SD 24 (ca. 65%) and SD 25 (ca. 77%), whereas landings from passive gears are low. However, in SD 26, passive gears provide ca. 75% of total plaice landings. Only a few occasional landings from trawl-fisheries took place in SD 26. Discard in the commercial fisheries can be high and seems to vary greatly between countries, quarters, areas and gears.

6.1 Stock ID and substock structure

The stock ID was discussed at WKPLE and a description assigned to Eastern Baltic plaice is provided in section 5.1 (SD21-23, Kattegat and Belt plaice). Based on available data no conclusive decisions could be made for Eastern Baltic plaice and therefore the stock is still considered a stock unit for assessment purposes.

No.	WD	Method	Results	Supports
1	1	Survey distribution	- Mixing of smaller plaice in SD21-25 - Large fluctuations in CPUE - Also times of spatial separation	H0 > H1
2	1	Survey Index	- Very Similar trends between SD21-23 and SD24+	H0
3	1	Length-weight-rel.	- Weight in plaice SD24 > SD22	H1
4	1	Age-length-rel.	- No sign. diff. bet. females in SD22/24 - Similar growth functions	H0
5	1	Egg buoyancy	- Egg density potentials do not differ between SD - Salinity requirements for eggs suggest only one stock (oxygen req. unknown)	H0
6	1	Maturity	-SD21: slightly lower L50 as in the Baltic -Annual maturity cycle in SD22 resembles SD24 (but not SD25)	H0/H1
7	2	Egg & larvae drift	-doesn't account for Baltic (focus on WKPESTO areas)	---
8	2	Growth charact.	-otolith ring structures: -no sign. difference in SD24/25 -Sign. difference in SD22/24	H1
9	2	Adult migration	-very low recaptures bet. SD22/24 -Low numbers of recaptures, some did indeed migrate	H1 > H0
10	2	Genetics	-Genotyping suggests genetic differences -low sample size in the Baltic -SD22/23 not covered	H1 > H0

6.2 Issue list

A list of relevant issues was developed for each plaice stock based on input from stock leaders and discussions during the data WK. The list for PLE2432 is given below as it appeared after the data WK in December 2014.

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?
Stock identification	Reasons for separation of PLE 2432 as suggested by WKPESTO (2012) are unclear. Lack of scientific evidence of a separation of PLE 2432 from PLE 2123	- Assess life-history data such as recruitment, maturity, growth rates, movements and mixing, environmental conditions and reproductive success, Salinity – hydrographical condition etc.	- Life-history data are needed (only partly available, e.g. through BITS-data; however, there is a lack of recent tagging experiments; studies on reproductive success do not provide evidence from SD22) - Genetic analyses - Otolith microchemistry – (Denmark - Henrik) Genetic structure (Denmark – before October) Henrik Degel BITS survey analysis – growth, recruitment, maturity (Rainer) Hydro-salinity (Litterateur study – Sven)
Tuning series	cpue, only available from BIT-Survey		
Discards	- Low landings, high and unknown Discards (with a poor sampling-coverage) and few biological data . - Discard-estimates from submitting countries seem unreliable (e.g. raising discard on one landed box of plaice in SD26, resulting in 57 and 518 Tonnes! of Discards).	a.) improvement of data for catch and discard. (b.) improvement of biological data, e.g. better sampling-coverage in space and time and increased number of measured and aged fish c.)Alternatively, merging with the larger stock-unit (PLE-2123) to be considered.	- improved biological sampling data from commercial fisheries (partly solved by data call 2 and Henrik …..) - better information discard rates from submitting countries ALK comparison between the SD 2123 and SD 2425 (Rainer)
Biological Parameters	Few data from commercial sampling (see table below)	See above	--
Assessment method	Survey-based (Cat. 3.2.1 following manual on DLS)	See above	--
Biological Reference Points	none	--	--

6.3 Scorecard on data quality

A score card on data quality has been developed by WKPICS3 (ICES, 2015) and was presented at WGBFAS in 2014. However, this has so far only been done for Baltic cod.

The score card aims to gives an overview on both, sample quality and sample coverage, e.g. by comparing unique vessels sampled, total number of trips and the rejection rate achieved by contacting fishers.

6.4 Multispecies and mixed fisheries issues

Plaice in the Eastern Baltic Sea is mainly a bycatch species in a cod-directed fisheries or part of mixed-flatfish fisheries. There is no information on a plaice-directed fishery taking place.

6.5 Stock Assessment

6.5.1 Catch – quality, misreporting, discards

Plaice is mainly caught in SD24 and SD25. Both subdivisons account for more than 99% of the landings. However, discards also appear where no landings took place, esp. in SD25 many strata in active and passive fisheries have no landings attached. However, fisheries took place suggesting that 100% discard appeared. Recent years show a better covering in reported discards (Figure 6.1). Misreporting happened in all landing countries, before 2004, Polish landings were reported as "flatfish", in a mix with flounder and dab. Also in other countries misreporting was observed in the past, where flounder and dab were landed as plaice and even cod was landed as flatfish (due to quota limitations in the 70's). No reliable data on the quantity of those misreporting are available.

The *to-be-filled-strata* for discards without attached landings results in a database problem. No information or estimations were given by the national data submitter on how to fill these discard strata. The ICES database InterCatch (IC) is so far not able to allow the assignment of discards to strata without landings (only ratios). IC also does not allow using discard ratios from different years or average values. When creating unknown discards to estimate total catch, this is essential.

To test for the influence these empty strata might have, discard ratios were borrowed with two methods, both in IC and manually.

Based on discussions in Data Compilation Workshop, following approach was used in the IC discard raising procedure. When filling the gaps, where no discard information was available, the process was done stepwise:

a) same country, same fleet, same Subdivision (+/- one quarter);
b) same fleet, same Subdivision, same quarter (country with similar discard pattern);
c) same fleet, same subdivision, similar country (+/- one quarter);
d) same country, same fleet, same quarter, different subdivision.

The manual estimation of discards was done on the IC output, only data uploaded to the database were included in the procedure. Since discards in plaice fisheries are highly variable, the average of the last years (were the sampling coverage and hence the discard estimations improved) was taken.

a) a.) average value of the last three to five years from the same country, fleet, Subdivision and quarter;
b) b.) increase the number of years covered;
c) c.) +/- one quarter.

In case where zero-landings (but discards) appeared, an average weight was applied, using the same procedures as described in steps a.-c., only using the actual weight this time.

In subdivisions were no discard information were available while landings are low (<0.1 tonnes per quarter), a default value of 0.025 tonnes (SD26) and 0.01 tonnes (SD27+) was applied to strata with zero landings.

The two raising methods resulted in different discards for the subdivisions and hence influenced the raising of the biological data.

SD24 is the area with the best coverage, both in discard estimations and biological sampling. Additionally, there are landings in most strata, reducing the amount of needed discard estimations without landings. The influence of the different methods is therefore rather low, the discard ratios show only slight differences (Figure 6.2), but are generally higher when using the average ratios (manual method), esp. in the years 2006-2008, the amount of discard doubles. SD25 is the second-most important fishing ground for plaice but shows a less sufficient sampling and discard estimation. Many zero-landing strata occur. Since IC assigns only a ratio, leading to "zero discards" in these strata. Assigning discards manually (zero landing strata) and by average values leads to a much higher discards component in the catch (Figure 6.2).

The differences are even more prominent in the remaining subdivisions, where almost no landings occur, but discards take place regularly. However, the amount of landings and discards are very low, accounting for ca. 1% of the catch for this stock and were therefore not taken into account.

6.5.2 Surveys

The data of the Baltic International Trawl Survey (BITS) from 2001 onwards were used to evaluate the current stock structure of Baltic plaice. Since 2001 standardized gear types TV3 #930 (TVL) and TV3 #520 (TVS) have been used by al countries which participate in the BITS. Survey-cpue from 2000 and backwards can't be compared directly, although the difference in catchability between the gear types is quite small. The positions of the hauls have been allocated based on a standard method since 2002. The allocation of the stations by ICES Subdivision and depth layer depends on the area of the depth layers and the 5-years running mean of the density of cod age group 1+ in quarter 1 (ICES 2008, WGBIFS) because cod is more important for the commercial use.

The procedures for analysing the hauls are given in the BITS manual (ICES, 2014: WGBIFS). The data are uploaded to the ICES database DATRAS where the source data and different catch per hour estimates by length and age are provided.

The cpue index for plaice in BAL24-BAL26 (no plaice were caught in BITS in BAL27+) shows an increasing trend, which is in accordance with the landing pattern, the increase is stronger in BAL24 then in the other subdivisions.

The index is calculated by weighing the cpue per age, survey and area with depth-stratum and by all depth strata per year, cruise and area together. The trend in the index is similar to the pure cpue trends.

6.5.3 Weights, maturities, growth

The sampling for the Eastern plaice stock (PLE-2432) concentrates on SD24 and SD25 where >99% of catches (Landings and Discards) are taken. Beside length measurements, the individual weight, maturity, age and length of plaice is recorded both in commercial fishery samples and scientific surveys. The main countries involved in the biological sampling are Denmark, Poland and Germany. All three countries sample biological information; Sweden only samples length distributions despite the fact that plaice is a quota species and belongs to DCF species group 1 (No Swedish sampling data were used during the analyses and assessment, since no usable data format was submitted or uploaded to InterCatch despite the data call for the data compilation workshop in December, Figure 6.7).

However, there is a severe imbalance between sampling and catches of PLE-2432 (Table 6.1). In 2013, only 56% of the landings originated from SD24 but 89% of the samples from the landings fraction took place in SD24 (“L-sampling”). In SD25, 43% of the catches were covered by only 11% of the samples. 66% of the discard samples originated from SD25 (“D-sampling”) while only 50% of the discards came from this subdivision. Sampling intensity increased in recent years (Figure 6.4). However, the coverage is still scattered and not all samples show a data quality that allows direct use or reasonable borrowing (for “hole-filling” of unsampled strata). Data borrowing among strata took place in 2011 and 2012 for Danish data, the original stratum is not known.

The estimation of discard was often done based on just one trip in the respective stratum (e.g. I Swedish data, which was stated by the data submitter in the comment section of IC), leading to a highgrade of unreliability, since discards differ even between hauls.

Overall, the sampling coverage is poor, esp. in the years 2002 to 2005. The following years show an increasing coverage in age-samples and length-distribution in both landed and discarded fractions. But still, 50-70% of the strata is not sampled or lack reliable/usable data. PLE-2432 is still categorized as a data limited stock (DLS).

CANUM was calculated, again using both methods (in IC and manual) to see the influence of different methods. Although the trends are similar, the scaling in biomass and SSB changes.

Age groups 2-4 are the most present in the catch and the fisheries. For an exploratory assessment, the F_{bar} was set to 2-5 to cover these ages. The numbers-at-age increased in recent years, which is in accordance to increasing landings and an increasing cpue-Index (BITS).

6.5.4 Assessment model

Previously, PLE-2432 was assessed as *Data Limited Stock* (DLS), and categorized as *category 3*, where only trends in survey indices were used to give a catch advice. This catch advice however did not include discard estimations. In 2014, a trend in fisheries effort was added to the advice.

Given the low amount of age data and the short period covered, a sufficient internal consistency was found for both survey indices (quarter 1 and quarter 4 BITS) and for the catch-matrix (see Figure. 6.7).

WKPLE decided that both discard estimations and biological data are not sufficient to classify PLE-2432 as a category 1 stock (i.e. analytical assessment with a forecast). Different exploratory assessments (SAM, SURBA) suggest however that a category 3 assessment, using trends in SSB is acceptable for this stock.

A full overview of the exploratory SAM using different data is given in WD 5 and accessible at www.stockassessment.org

6.6 Future Research and data requirements

To improve the exploratory assessment and hence the quality of the advice, more discard estimations are required by national data submitters. Additionally, more flexible tools need to be developed for InterCatch, allowing the allocation of discards also to strata with no landings attached (discard only) and extrapolation across years (to allow reasonable borrowing in years without sufficient estimations). Data handling, such as allocation and hole-filling should take place in the database to allow comprehension of the methods used.

The sampling of biological data needs further enhancement, esp. in SD 25, where the number of age readings and length measurements is in no relation to the landings. The discarded fraction need a better sampling coverage. Although all landing countries are obliged to submit biological data, not all available information was uploaded by every country. To improve the quality of the assessment, this is however mandatory.

To improve the exploratory SAM, a maturity ogive for the Eastern Baltic Sea should be calculated. Natural mortality values should be verified, the index values of BITS should be verified as well to minimize residuals.

6.7 External Reviewers Report

As with the Kattegat-Belt stock, the group discussed the plaice stock structure issue in the area and whether plaice in Baltic (SD24-32) represent a separate stock or is a part of a stock that includes SD21–32. The stock leader presented an overview of available information on stock ID (including results of genetic analysis and tagging data, as well as modelled egg and larval distributions, and growth characteristics) and demonstrated that at present there are no strong arguments that would help to resolve this issue. Again, the Panel agreed to follow SIMWG recommendation to separate place in areas 21-23 and 24-32 for this benchmark, but also conducted exploratory runs for the combined assessment for Kattegat-Belt and Baltic stocks. Further work was recommended to fully understand model performance and outputs of the combined assessment.

6.7.1 Issues addressed at the benchmark

The commercial catch data for the assessment were extracted from the InterCatch database. The InterCatch is currently unable to provide discard estimates when no landings are reported. Therefore, when discarding occurs without any landings (within an area-time stratum), InterCatch total catch estimates are biased low. The stock leader performed manual calculations and demonstrated that this is an issue for plaice in the Baltic. The Panel agreed that work should be done to account for all the discard information in a systematic and repeatable way (perhaps through application of effort data). An issue was also brought up that some of the landings records, specifically for the Polish fleet, are most likely flounder, and not plaice.

Survey trends of plaice biomass appear stable, and survey internal consistency plots are reasonable. The stock leader initially suggested using landings advice based on the survey index and trends in commercial effort for management advice. An analytical assessment was originally ruled out due to concern about having only limited amount of biological data from commercial fisheries. However, during the benchmark, an implementation of the SAM approach was explored. Upon review, the model produced reasonable results that were consistent with stock survey trends. The SAM output for the stock was associated with a substantial degree of uncertainty, which is primarily because the SAM framework treats observation error as constant over time, while catch-at-age data for this stock vary.

6.7.2 Use of final stock annex as basis for providing advice

The Panel agreed that the stock annex is adequate for providing scientific advice and should include the following recommendations:

1) Treat Baltic plaice (SD24-32) as an individual stock until more information on stock structure of plaice in Kattegat, Belt and the Baltic is available, and further progress is achieved in developing a combined assessment for these areas.
2) Use the SAM approach to estimate time-series of the stock biomass. The significant amount of uncertainty in assessment results is considered appropriate given the quality of the data and the specifics of SAM approach.
3) Assume that the stock weight and maturity parameters are constant over time.

6.7.3 Recommendations for future work

Future research prior to the next benchmark should consider to:

1) Improve (ideally in InterCatch) discard estimates to deal with discards with zero landings, perhaps with effort data.
2) Refine landings estimates to make sure they include only plaice and no other species.
3) Continue to explore stock structure and with the goal of developing an assessment for Kattegat, Belt and the Baltic areas combined.
4) Explore using a more flexible modelling platform to deal with size-based discards and variable observations errors over time.

Table 1: Sampling intensity (share on landings/discard and share of the total sampling in % per SD) 2013 for the Eastern plaice-stock PLE-2432.

	Landings	L-sampling	Discards	D-sampling
SD24	56,5%	89%	49,9%	33%
SD25	42,8%	11%	49,5%	66%
SD26	0,67%	<0,1%	0,60%	<0,1%
SD27	0,04%	n.a.	0,04%	n.a.

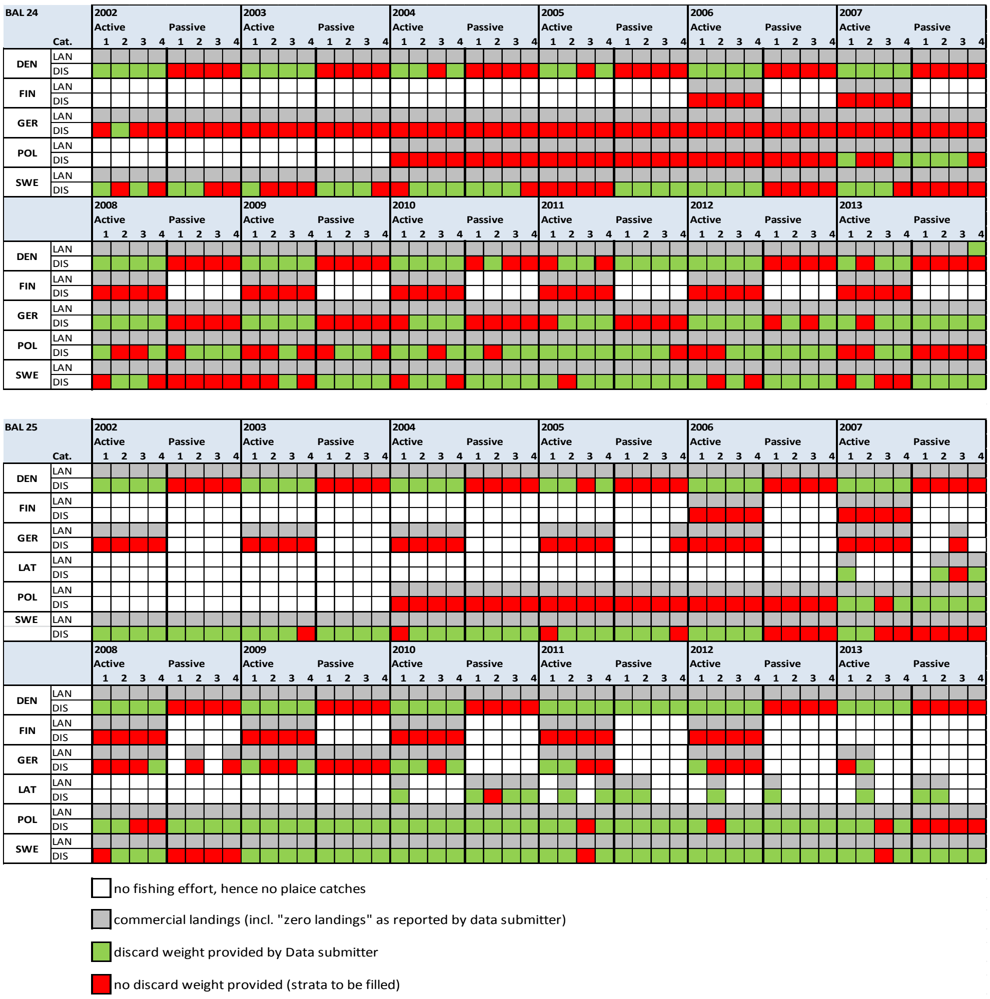


Figure 6.1: Landings and Discards in BAL24 and BAL25 per country, fishery and quarter between 2002 and 2013

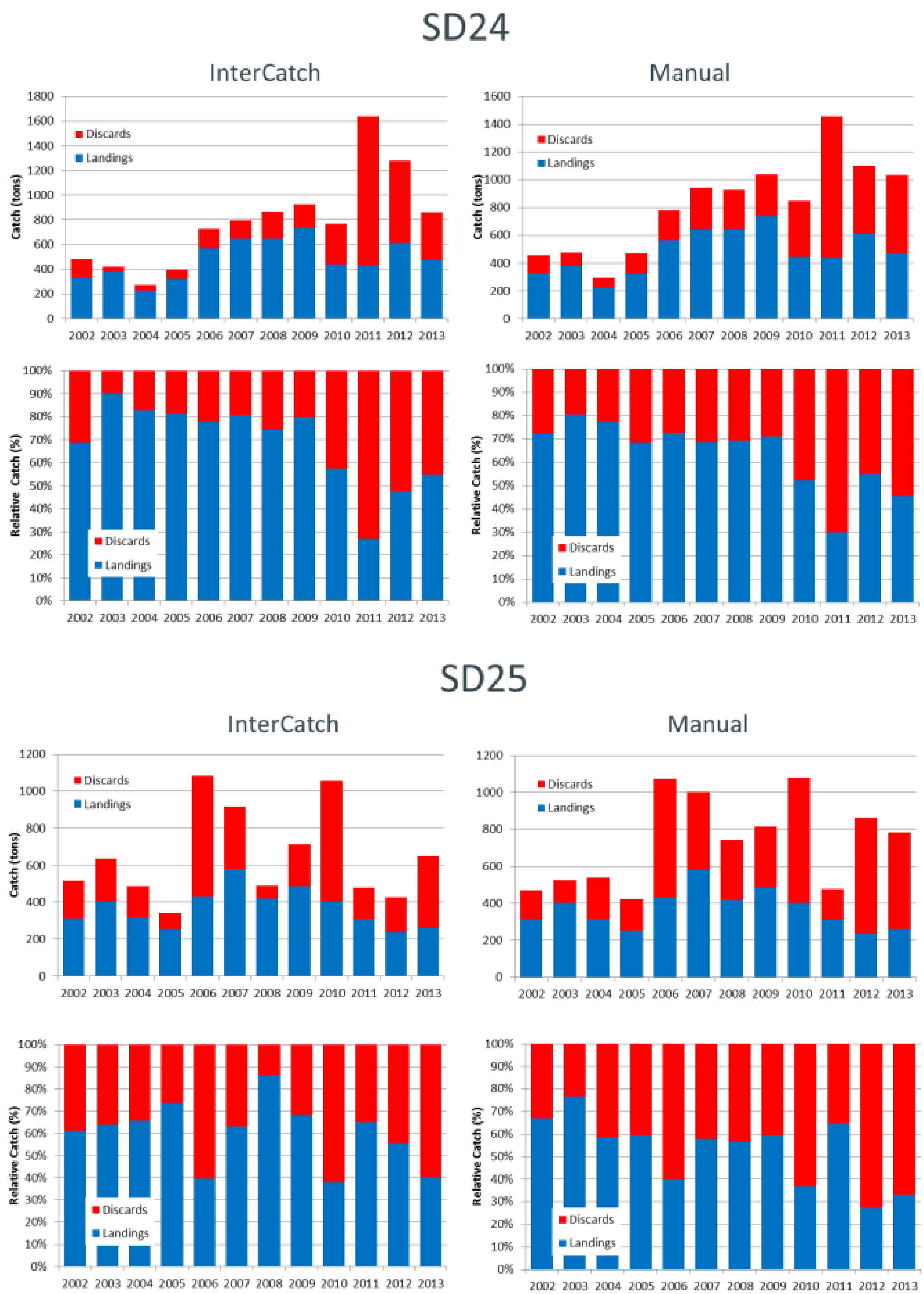


Figure 6.2: Differences in Catch composition between raising in IC (left figures) or manually (right figures) in SD24 and SD25

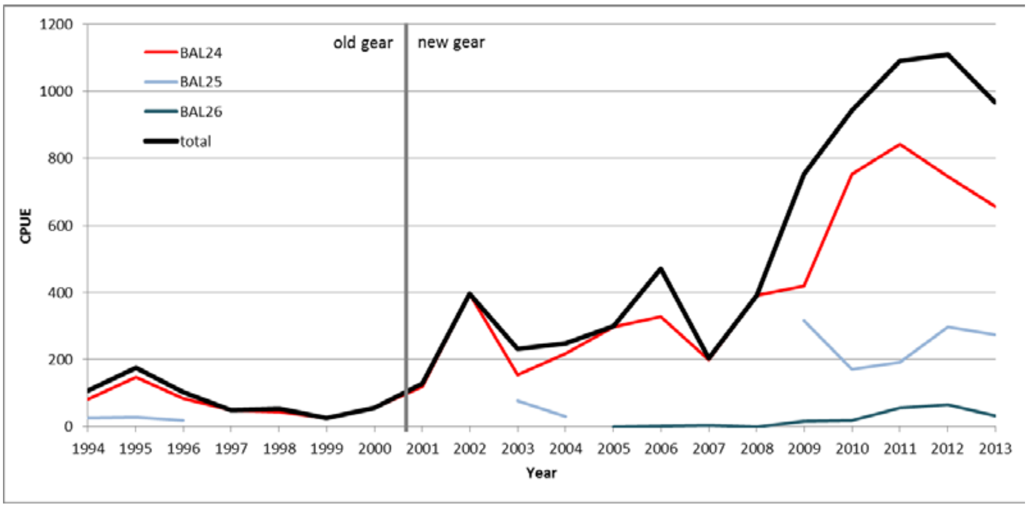


Figure 6.3: cpue (number of plaice >19 cm) caught by a standardized trawl survey in the Central and Eastern Baltic Sea (PLE-2432)

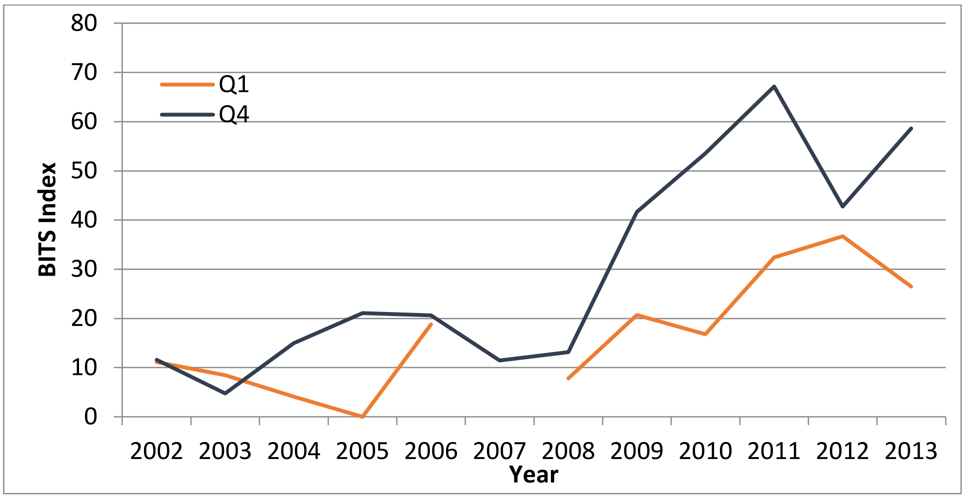


Figure 6.4: BITS Index, average value per year and survey (quarter 1 and quarter 4)

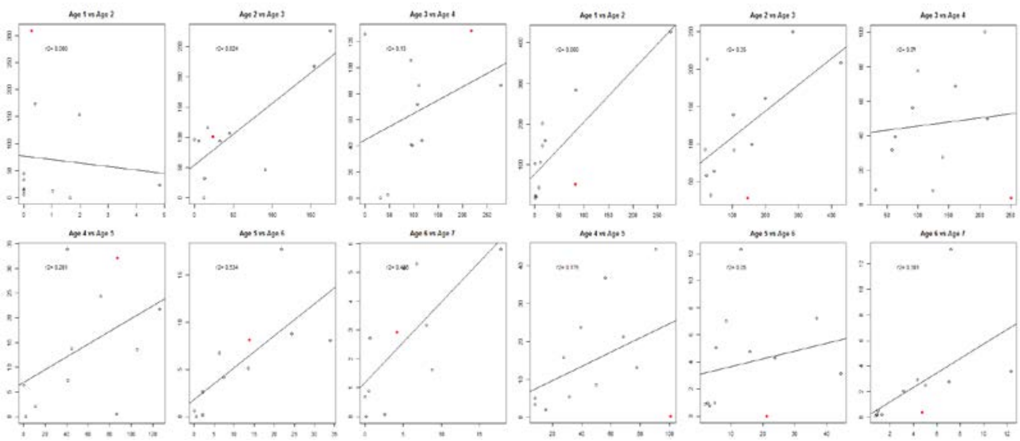


Figure 6.5: internal consistency for BITS 1st quarter (left) and 4th quarter (right)

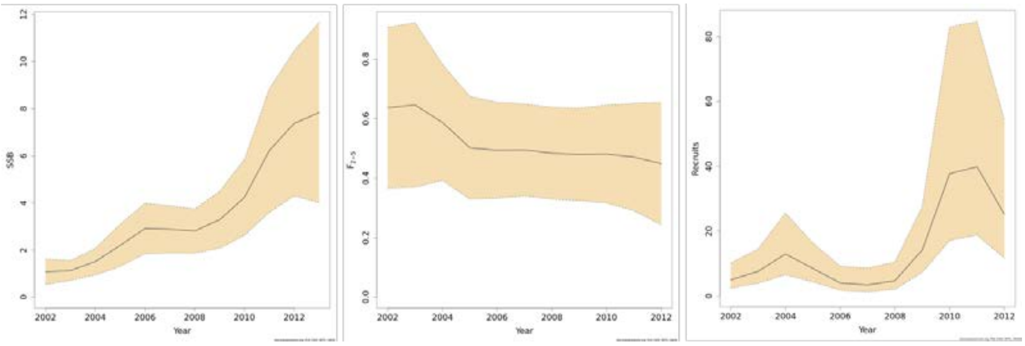
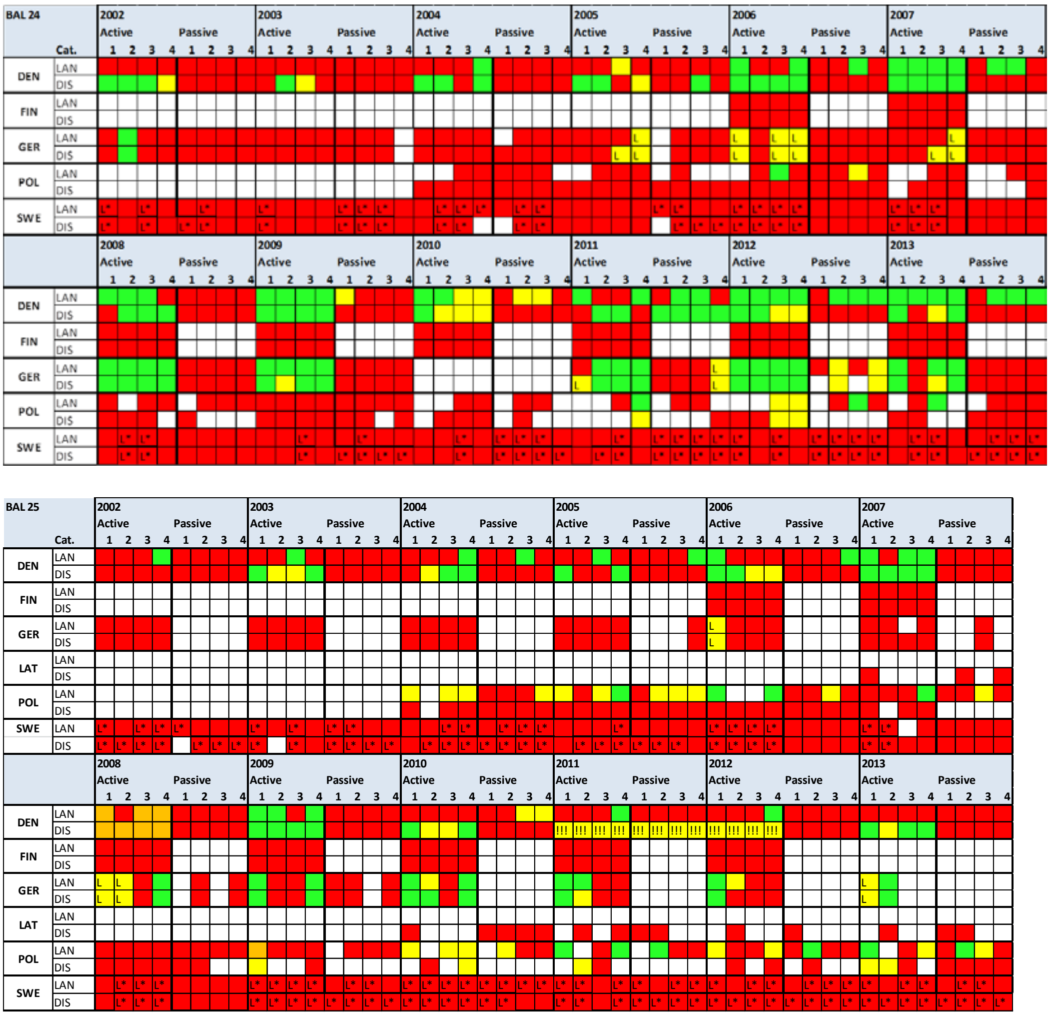


Figure 6.6: exploratory SAM for PLE-2432, using IC values (left figure: SSB, middle figure: fishing mortality, right figure: Recruits)



sufficient age data (min 20 ages)

unsufficient age data (<20) or only length data (marked by "L" in the cell)

unsampled landings/discards

L* accounts for Swedish data, where a low number of fish was measured per stratum. Additionally, raising took place but on an unknown data basis

L only Length data were taken

!!! = Copy/paste of datasets across SD and gears

Figure 6.7: data quality overview for all strata in PLE-2432. White fields don't have fisheries or a zero was provided by national Data submitter. Red fields need to be filled, yellow field show strata with a medium data quality, green field have sufficient biological data attached.

7 Conclusions

Stock identification issues were examined for three of the four stocks and the Skagerrak stock (SD 20) was evaluated to have strong connectivity to the North Sea plaice stock. The likely magnitude of the stock mix was considered sufficient to recommend and approve that plaice in the North Sea and Skagerrak can be combined and assessed as one stock. For the combined North Sea and Skagerrak stock, future attempts should be made to include the IBTS data since it seemed to improve the quality of the assessment. Monitoring the Skagerrak component should also be a high priority for the North Sea stock assessment and advice, to avoid local depletion of the resident stock.

The stock assessment for the Eastern Channel plaice stock in Division VIId was improved; discard estimates from 2006–2013 are now included in the assessment and the commercial cpue series from the Belgian beam trawler fleet was rejected as tuning fleet. Natural mortality by age group was estimated and included in the analytical assessment. A statistical catch-at-age model including discard information, Aarts and Poos (2009), was approved as the assessment model for this stock (category 1).

The assessment of plaice stock in Kattegat and the Belts (SD 21-23) was improved considerably and based on two combined surveys (1st quarter and 3rd – 4th quarter BITS and IBTS) an analytical age based assessment, SAM, was accepted. The stock is now a category 1 stock. Likely noise in individual weights in stock and in maturity was reduced by assuming a fixed age pattern for all years.

Small and dispersed landings of plaice in the Baltic (Subdivision 24-32) prevent proper sampling and result in a noisy catch-at-age matrix. In addition high discard rates from fisheries targeting other species in the Baltic impeded accurate discard estimates in the Baltic. Basis for stock status therefore continues to be surveys conducted in 1st and 4th quarter. SAM modelling provides SSB estimates with high uncertainty but considered for use in an indicative assessment with DLS approach to base advice upon (category 3.2). Future research should consider methods to improve discard estimates to deal with discards with zero landings.

Generic recommendations are provided by the external reviewers in the following section.

7.1 General recommendations

1) Explore using a more flexible modelling platform (such as Stock Synthesis) that allows to accommodate:
   a) Size-based selectivity and discard data directly, because age-based methods currently used in reviewed assessments can be biased when market categories and gear selectivity are size-based. It will also help to avoid dealing with uncertainty in age estimates when describing fishery selectivity.
   b) Fitting to length composition data for both indices and fisheries. Assessment models presented at this review are based on age-specific indices. Age-aggregated indices may be preferred (along with decomposed age- or size- composition data because they are less restrictive (e.g. observations with zeros are common and can be included). and there is enhanced flexibility to account for between-year differences in sampling efforts (for surveys and fisheries).

c) Fitting to market sized categories. Models that can incorporate the market sized categories directly could provide a robust source of currently unused information about the size composition of landings.

d) Historical time-series of catches for which detailed catch-at-age information is unavailable, to allow better understanding of historical dynamics of the stock and more suitable biological reference points. The reviewed plaice assessments were only able to accommodate years with catches-at-age, and therefore modelled periods were limited to relatively recent years.

e) Spatially disaggregated data. In many cases there were distinct fisheries in specific areas (e.g. the Skagerrak component of the North Sea stock) that remove different age classes than fisheries in other areas. Therefore, the relative allocation of catches among different areas should be evaluated for providing catch advice.

2) Develop a statistically sound and programmatic way to estimate discards. The ICES community has made considerable improvements by having the InterCatch database as a standard repository for catch statistics. However, issues remain in how regional and quarterly discard estimates are computed when landings data are missing. For example, in some areas and quarters there are known discards but no landings. A combination of estimation rules for categories of effort and landed target species could be developed as defaults to help fill in missing regions.

3) Natural mortality for most stocks (except for Division VIId) is assumed to be 0.1 across ages. Alternative assumptions (perhaps similar to those explored Eastern Channel plaice stock) should be considered.

4) Advice sheets with recommended format for all stocks should be standardized. Currently the posted ones differ substantially (e.g. the Eastern Channel stock assessment has MSY estimates and others do not; different time-series of landings are presented in different assessments).

5) Explore spatial modelling approaches for place population, given uncertainty in plaice stock structure and connectivity among areas.

8 References

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Annex 1. Terms of Reference

WKPLE – Benchmark Workshop on Plaice

2014/2/ACOM33 A **Benchmark Workshop on Plaice** (WKPLE), chaired by External Chair Vladlena Gertseva, USA and ICES Chair Jesper Boje, Denmark, and attended by three invited external experts Jim Ianelli, USA and Terrance Quinn, USA will be established and will meet at ICES HQ for a data compilation meeting 15–17 December 2014 and at ICES HQ, Denmark for a 5 day Benchmark meeting 23–27 February 2015 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, multi-species 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 about environmental drivers, including multispecies interactions, and ecosystem impacts should be integrated in the methodology

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) Evaluate the possible implications for biological reference points, when new standard analyses methods are proposed. Propose new MSY reference points taking into account the WKFRAME2, results and the introduction to the ICES advice (section 1.2), WKMSYREF3.
d) Develop recommendations for future improving of the assessment methodology and data collection;
e) As part of the evaluation:
    i) Conduct a 3 day data compilation workshop (DCWK). 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 compilation workshop consider the quality of data including discard and estimates of misreporting of landings;
    ii) Following the DCWK, produce working documents to be reviewed during the Benchmark meeting at least 7 days prior to the meeting

Stocks	Stock leader
ple-eche	Marie Savina-Rolland
ple-skag	Clara Ulrich
ple-2123	Henrik Degel
Ple-24–32	Sven Stötera

The Benchmark Workshop will report by 1 April 2015 for the attention of ACOM.

Annex 2. Participants

DCWKPLE participants

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Annex 3. Stock Annexes

Stock Annex: Plaice in Division VIId

Stock specific documentation of standard assessment procedures used by ICES.

Stock	Plaice in division VIId
Date:	March 2015
Revised by:	Marie Savina and Youen Vermard (WKPLE, 2015), and Joël Vigneau (Joel.Vigneau@ifremer.fr) and Youen Vermard (Youen.Vermard@ifremer.fr) (WKFLAT, 2010)
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A. General

A.1. Stock definition

The management area for this stock is strictly that for ICES area VIId called the eastern Channel, although the TAC area includes the smaller component of VIIe (western Channel).

Major spawning centres were found in the eastern English Channel, the Southern Bight, the central North Sea and the German Bight. Other less important local spawning centres were found in the western English Channel and off the UK coast from Flamborough Head northwards to Moray Firth (Houghton & Harding 1976, Harding & Nichols 1987 in ICES PGEGGS, 2003c). The regions of plaice spawning are generally confined within the 50-meter depth contour (Harding *et al*. 1978, in ICES PGEGGS, 2003c).

The stocks of plaice in the Channel and North Sea are known to mix greatly (Figure 1), especially during the spawning season (January-February). At this time many western Channel and North Sea plaice may be found in the eastern Channel. The comparable lack of spawning habitat in the western Channel alone suggests that this migration from VIIe to VIId during the first quarter may be of considerable importance.

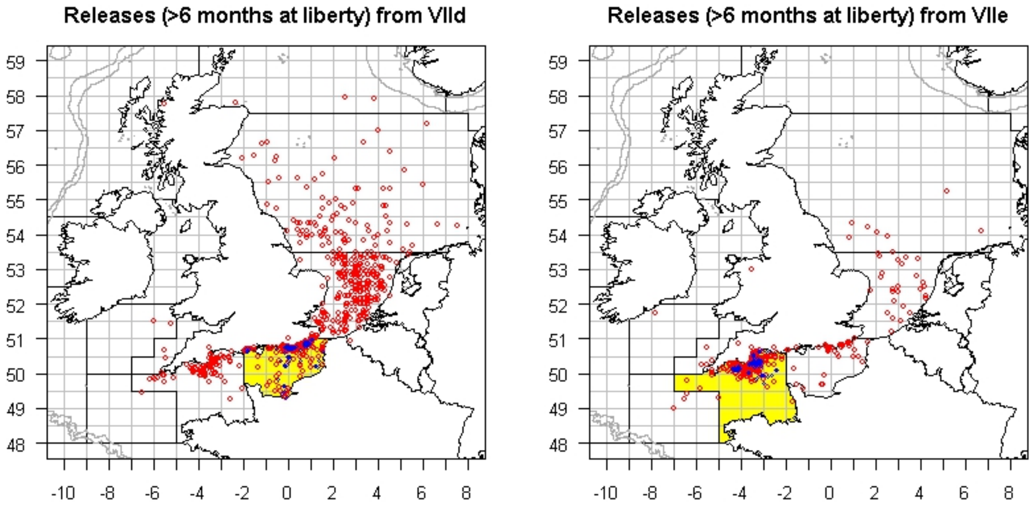

Figure 1: Locations of recaptures (red circles) after 6 or more months at liberty for tagged plaice released (blue crosses) in the English Channel: bottom left, released in the eastern (VIId) Channel and bottom right, released in western (VIIe) Channel.

From tagging experiments, it was possible to derive estimates of the proportion of fish in quarter 1 in VIId that would return, if not caught by the fishery, to VIIe and IV (Table 1). In summary, 14% of males and 9% of females would migrate to VIIe, while 52% of males and 58% of females would migrate to IV. To the nearest 5%, this suggests that 10 to 15% of the catch in Q1 in VIId should be allocated to VIIe, while between 50 and 60% of the catch in Q1 in VIId should be allocated to IV. These estimates are in agreement with previous analyses (based on the same data) reported by Pawson (1995), which suggest that 20% of the plaice spawning in VIIe and VIId spend the summer in VIIe, while 56% migrate to the North Sea. Given the assumptions involved in these calculations and the relatively small numbers of adult tags returned the estimates of movement rates are subject to great variability. The limitations of the data do not permit an estimate of annual movement probabilities. Recent studies based on data storage tags suggest that the retention rate of spawning plaice tagged in the eastern English Channel is 28%, while 62% of spawning fish tagged were recaptured in the North Sea (Kell *et al*. 2004).

Table 1: Summary of estimated movement probabilities for plaice (≥ 270mm) recaptured after 6 or more months at liberty, for data collected between 1960 and 2006.

Release Information		period			WEIGHTED BY INTN CATCH AND SSB pr(recap) after 6 or more months at liberty			
DIV	Sex	Release	Recapture	N	7A	7E	7D	4
VIIe	B	ALL		564	0.001	0.90	0.06	0.04
	M	Jan-Mar		2	0	0.74	0.26	0
	F			3	0	0.60	0.40	0
	M	Apr_Dec		180	0	0.91	0.05	0.03
	F			224	0.001	0.93	0.03	0.04
	M	Jan-Mar	Apr_Dec	17	0	0.66	0.11	0.23
	F			8	0	0.67	0.24	0.09
	M	Apr_Dec	Jan-Mar	68	0	0.83	0.12	0.05
	F			62	0	0.88	0.07	0.06
VIId	B	ALL		990	0.00	0.10	0.54	0.36
	M	Jan-Mar		31	0	0.04	0.73	0.22
	F			86	0	0.08	0.58	0.34
	M	Apr_Dec		144	0	0.10	0.76	0.14
	F			180	0	0.09	0.79	0.12
	M	Jan-Mar	Apr_Dec	144	0	0.14	0.35	0.52
	F			305	0	0.09	0.33	0.58
	M	Apr_Dec	Jan-Mar	31	0	0.20	0.57	0.23
	F			63	0	0.11	0.72	0.17
IVc	B	ALL		812	0	0.01	0.06	0.93
	M	Jan-Mar		54	0	0	0.03	0.97
	F			17	0	0	0.28	0.72
	M	Apr_Dec		172	0	0.01	0.06	0.92
	F			235	0	0.01	0.04	0.95
	M	Jan-Mar	Apr_Dec	102	0	0	0	1
	F			38	0	0	0	1
	M	Apr_Dec	Jan-Mar	54	0	0.02	0.05	0.93
	F			71	0	0.01	0.18	0.80

A.2. Fishery

Plaice is mainly caught in beam trawl and gillnet fisheries for sole or in mixed demersal fisheries using otter trawls. There is also a directed fishery during parts of the year by inshore trawlers and netters on the English and French coasts. The Belgian beam trawlers fish mainly in the 1st and 4th quarters and their area of activity covers almost the whole of VIId south of the 6 mile contour from the English coast. The second offshore fleet is mainly large otter trawlers from Boulogne, Dieppe and Fecamp. The target species of these vessels are cod, whiting, plaice, gurnards and cuttlefish and the fleet operates throughout VIId. The inshore trawlers and netters are mainly vessels <12m operating on a daily basis within 12 miles of the coast. There are a large number of these vessels (in excess of 400) operating from small ports along the French and English coast. These vessels target sole, plaice, cod and cuttlefish.

The minimum landing size for plaice is 27cm. Minimum mesh sizes for demersal gears permitted to catch plaice are 80mm for beam trawling and 100mm for otter trawlers. Fixed nets are required to use 100mm mesh since 2002 although an exemption to permit 90mm has been in force since that time.

There is widespread discarding of plaice, especially from beam trawlers. The 25 and 50% retention lengths for plaice in an 80mm beam trawl are16.4cm and 17.6cm respectively which are substantially below the MLS. Routine data on discarding is now available, and show plaice discards ratio between 20 and 60% depending on the metier. Discard survival from small otter trawlers can be in excess of 50% (Millner *et al*., 1993). In comparison discard survival from large beam trawlers has been found to be between less than 20% after a 2h haul and up to 40% for a one-hour tow (van Beek *et al* 1989).

A.3. Ecosystem aspects

Biology : Adult plaice feed essentially on annelid polychaetes, bivalve molluscs, coelenterates, crustaceans, echinoderms, and small fish. In the English Channel, spawning occurs from December to March between 20 and 40 m. depth. At the beginning, pelagic eggs float at the surface and then progressively sink into deeper waters during development. Hatching occurs 20 (5-6°C) to 30 (2-2.5°C) days after fertilization. Larvae spend about 40 days in the plankton before migrating to the bottom and moving to coastal waters when metamorphosing (10-17 mm). The fry undergo relatively fast growth during the first year (*Carpentier et al., 2005*).

Environment: This bentho-demersal species prefers living on sand but also gravel or mud bottoms, from the coast to 200 m depth. The sepcies is found from marine to brackish waters in temperate climate (*Carpentier et al., 2005*)..

Geographical distribution : Northeast Atlantic, from northern Norway and Greenland to Morocco, including the White Sea; Mediterranean and Black Seas (*Carpentier et al., 2005*)..

Vaz *et al*. (2007) used a multivariate and spatial analyses to identify and locate fish, cephalopod, and macrocrustacean species assemblages in the eastern English Channel from 1988 to 2004. Four sub-communities with varying diversity levels were identified in relation to depth, salinity, temperature, seabed shear stress, sediment type, and benthic community nature (Vaz *et al*, 2004). One Group was a coastal heterogeneous community represented by pouting, poor cod, and sole and was classified as preferential for many flatfish and gadoids. It displayed the greatest diversity and was characterized by heterogeneous sediment type (from muds to coarse sands) and various associated benthic community types, as well as by coastal hydrology and bathymetry. It was mostly near the coast, close to large river estuaries, and in areas subject to big salinity and temperature variations. Possibly resulting from this potentially heterogeneous environment (both in space and in time), this sub-community type was the most diverse.

Community evolution over time : (From Vaz *et al*., 2007). The community relationship with its environment was remarkably stable over the 17 y of observation. However, community structure changed significantly over time without any detectable trend, as did temperature and salinity. The community is so strongly structured by its environment that it may reflect interannual climate variations, although no patterns could be distinguished over the study period. The absence of any trend in the structure of the eastern English Channel fish community suggests that fishing pressure and selectivity have not altered greatly over the study period at least. However, the period considered here (1988–2004) may be insufficient to detect such a trend.

More details on biology, habitat and distribution of plaice in VIId from the Interreg 3a project CHARM II, may be found in Annex 1.

B. Data

B.1. Commercial catch

The landings are taken by three countries France (55% of combined TAC), England (29%) and Belgium (16%). Quarterly catch numbers and weights were available for a range of years depending on country; the availability is presented in the text table below. Levels of sampling prior to 1985 were poor and these data are considered to be less reliable. In 2001 international landings covered by market sampling schemes represented the majority of the total landings

Belgian commercial landings and effort information by quarter, area and gear are derived from log-books. Sampling for age and length occurs for the beam trawl fleet (main fleet operating in Belgium). Quarterly sampling of landings takes place at the auctions of Zeebrugge and Oostende (main fishing ports in Belgium). Length is measured to the cm below. Samples are raised per market category to the catches of both harbours. Quarterly otolith samples are taken throughout the length range of the landings (sexes separated). These are aged and combined to the quarterly level. The ALK is used to obtain the quarterly age distribution from the length distribution. From 2003, an on-board sampling programme is routinely carried out following the provision of the EU Regulation 1639/2001.

French commercial landings in tonnes by quarter, area and gear are derived from log-books for boats over 10m and from sales declaration forms for vessels under 10m. These self-declared production data are then linked to the auction sales in order to have a complete and precise trip description. The length measurements were done by market commercial categories and by quarter into the principal auctions of Grandcamp, Port-en-Bessin, Dieppe and Boulogne until 2008. From 2009, concurrent sampling by metier was initiated following the provisions of EU Regulation 95/2008. Otoliths samples are taken by quarter throughout the length range of the landed catch for quarters 1 to 3 and from the October GFS survey in quarter 4. These are aged and combined to the quarterly level and the age-length key thus obtained is used to transform the quarterly length compositions. The lengths not sampled during one quarter are derived from the same year in the nearest available quarter. Weight, sex and maturity at length and at age are obtained from the fish sampled for the age-length keys. The collection of discard data began in 2003 within the EU Regulation 1639/2001. This first year of collection was incomplete in terms of time coverage, therefore the use of these data should be considered only from 2005. English commercial landings in tonnes by quarter, area and gear are derived from the sales notes statistics for vessels under 12m that do not complete logbooks. For those over 12m (or >10m fishing away for more than 24h), data is taken from the EC logbooks. Effort and gear information for the vessels <10m is not routinely collected and is obtained by interview and by census. No information is collected on discarding from vessels <10m. Discarding from vessels >10m has been obtained since 2002 under the EU Data Collection Regulation. The gear group used for length measurements are beam trawl, otter trawl and net. Separate-sex length measurements are taken from each of the gear groupings by trip. Trip length samples are combined and raised to monthly totals by port and gear group. Months and ports are then combined to give quarterly total length compositions by gear group; unsampled port landings are added in at this stage. Quarterly length compositions are added to give annual totals by gear. These are for reference only, as ALK conversion takes place at the quarterly level. Otoliths samples are taken by 2cm length groups separately for each sex throughout the length range of the landed catch. These are aged and combined to the quarterly level, and include all ports, gears and months. The quarterly sex-separate age-length-keys are used to transform quarterly length compositions by gear group to quarterly age compositions.

A minimum of 24 length samples are collected per gear category per quarter. Age samples are collected by sexes separately and the target is 300 otoliths per sex per quarter. If this is not reached, the 1st and 2nd or 3rd and 4th quarters are combined.

The text table below shows which country supplies which kind of data:

COUNTRY	NUMBERS	WEIGHTS-AT-AGE
Belgium	1981-present	1986-present
France	1989- present	1989- present
UK	1980- present	1989- present

Data are uploaded in InterCatch and include quarterly numbers at age, weight at age, length at age and total landings. The files are aggregated by the stock co-ordinator to produce a FLR stock object. SOP corrections are applied to the data.

B.2. Biological

Natural mortality: Estimated with Peterson and Wroblewski's estimator, based on weight (Peterson and Wroblewski, 1984)

AGE	1	2	3	4	5	6	7
M	0.3531	0.3132	0.292	0.2749	0.2594	0.2474	0.2329

Maturity ogive: assumes that 15% of age 2, 53% of age 3 and 96% of age 4 are mature and 100% for ages 5 and older.

Weights at age: prior to 2001, stock weights were calculated from a smoothed curve of the catch weights interpolated to the 1st January. From 2001, second quarter catch weights were used as stock weights in order to be consistent with North Sea plaice. The database was revised back to 1990.

Both the proportion of natural mortality before spawning (Mprop) and the proportion of fishing mortality before spawning (Fprop) are set to 0.

B.3. Surveys

A dedicated 4m beam trawl survey for plaice and sole has been carried out by England using the RV Corystes since 1988 in July. The survey covers the whole of VIId and is a depth stratified survey with most samples allocated to the shallower inshore stations where the abundance of sole is highest. In addition, inshore small boat surveys using 2m beam trawls were undertaken along the English coast and in a restricted area of the Baie de Somme on the French coast. In 2002, The English and French Young Fish Surveys were combined into an International Young Fish Survey. The dataset was revised for the period back to 1987. The two surveys operate with the same gear (beam trawl) during the same period (September) in two different nursery areas. Previous analysis (Riou *et al*, 2001) has shown that asynchronous spawning occurs for flatfish in Division VIId. Therefore both surveys were combined based on weighting of the individual index with the area nursery surface sampled (Cf. Annex 1). Taking into account the low, medium, and high potential area of recruitment, the French YFS got a weight index of 55% and the English YFS of 45%. The UK Young Fish Survey ceased in 2006, disrupting the ability to derive an International YFS.

A third survey consists of the French otter trawl groundfish survey (FR GFS) in October. Prior to 2002, the abundance indices were calculated by splitting the survey area into five zones, calculating a separate index for each zone each zone, and then averaging to obtain the final GFS index. This procedure was not thought to be entirely satisfactory, as the level of sampling was inconsistent across geographical strata. A new procedure was developed based on raising abundance indices to the level of ICES rectangles, and then by averaging those to calculate the final abundance index. Although there are only minor differences between the two indices, the revised method was used in 2002 and subsequently.

B.4. Commercial CPUE

One commercial fleet was used in tuning: the Belgian Beam Trawlers.Only trips where sole and/or plaice have been caught is accounted for. The effort of the Belgian Beam Trawlers is corrected for engine power. This tuning series is no longer used due to concerns on changes in fishing practices over time (including discarding practices), and poor performance to track cohorts.

B.5. Other relevant data

None.

C. Historical Stock Development

Benchmark 2010

This stock was 'benchmarked' at the WKFLAT 2010 meeting where two main issues have been under review, (i) inclusion of a discards time series in the assessment and (ii) an attempt to overcome the problematic retrospective pattern. Solutions explored included making an 'allowance' for migration patterns between the two Channel plaice stocks and the southern North Sea.

The combined assessment of the two Channel plaice stocks was examined. It was agreed that this would require further investigation as the inclusion of the North Sea stock would also need to be considered. Any combining of stocks would a have a wide ranging impact on the assessment and any subsequent management.

The issue of including discard estimates was based on a working document provided to the benchmark workshop, where all on-board samples from Belgium, France and UK from 2002 to 2008 were gathered in an international dataset. An estimate of annual discards at age was produced for the period 2004 – 2008, and the flexible Statistical Catch-at-Age model developed by Aarts and Poos (2009) has been tested for reconstructing discards prior to 2004. The model did not succeed in providing reasonable and robust fit. The current discard time series was considered too short and too variable to support proper model fitting. Further work on the data and method used for estimating the 2004-2008 series of discards is necessary before inclusion in the statistical model is considered further.

The persistent retrospective pattern in the assessment without discards was largely reduced, when 65% of quarter 1 catches were removed as well as removal of younger ages (1, 2 and 3) from the survey UK BTS. The patterns in log q residuals, already shown in the previous assessment remained unchanged.

In conclusion, the proposed final settings (detailed below) improve the retrospective pattern, and take into account the acknowledged mixing between neighbouring areas, but the model is not entirely satisfactory in terms of quality of the assessment. The reasons are that the model still does not account for discards, removes younger ages from an internally consistent survey, and does not provide solutions for the patterns in log catchability residuals.

The recommendation from WKFLAT was that **this assessment was useful in determining recent trends in F and SSB, and in providing a short-term forecast and advice on relative changes in F**. However, WKFLAT did not recommend this as an analytical assessment, as it would not be useful for calculation of reference points.

Since further work on including the discard estimates, on the relevance of the commercial tuning series, and sensitivity of the assessment to the 65% adjustment to the Q1 catch at age need to be examined, the information concerning the settings of the assessment model was only valid for WGNSSK 2010.

Model used: XSA

Software used: IFAP / Lowestoft VPA suite for final assessment; FLR packages and SURBA software for exploratory analysis

Model Options chosen:

1) Tapered time weighting not applied
2) Catchability independent of stock size for all ages
3) Catchability independent of age for ages >= 7
4) Survivor estimates shrunk towards the mean F of the final 5 years or the 3 oldest ages
5) S.E. of the mean to which the estimate are shrunk = 1.0
6) Minimum standard error for population estimates derived from each fleet = 0.300
7) Prior weighting not applied
8) Input data types and characteristics:
9) Catch data available for 1980-present year. However, there was no French age compositions before 1986 and large catchability residuals were observed in the commercial data before 1986. In the final analyses only data from 1986-present were used in tuning.
10) Removal of 65% of quarter 1 catches in tonnes, catches at age and weight at age for all years

Benchmark 2015

This stock was 'benchmarked' at the WKPLE 2015 meeting where the same two main issues as during WKFLAT have been under review: the inclusion of a discards time series in the assessment and (ii) an attempt to overcome the problematic retrospective pattern.

All on-board samples from Belgium, France and UK from 2003 to 2013 had been uploaded to Intercatch prior to the benchmark. An estimate of annual discards at age was produced for the period 2006 – 13 and the flexible Statistical Catch-at-Age model developed by Aarts and Poos (2009) has been tested for reconstructing discards prior to 2006.

In addition to the Art and Poos' model, two others models were run during the benchmark. First the XSA model which has been used until 2014, as well as a model developed using the a4a modelling framework (Jardim et al. 2015). This framework relies on the specification of three log-linear submodels, one each for fishing mortality, survey catchability and recruitment. The catchability and stock recruitment submodel was a year effect model with independently varying recruitment and age effect for catchability. The fishing mortality submodel investigated was a year and age effect.

The inclusion of discards data and the testing of different combinations of tuning series (and age range in them) did not solve the issues associated with the use of the XSA method. The a4a assessment in its specification did neither improve the assessment. In both cases, the inclusion of discards estimated from the Aart and Poos model in other models was not considered satisfactory by the benchmark panel. The results obtained with the Art and Poos model on the other hand were judged acceptable, although the panel recommended further explorations of the high estimated discard volumes in the 1990s and early 2000s. The removal of 65% of Q1 catches to account for spawnig migrations) was maintained, but the calculation was changed such as only the mature age class are affected now. The scenario retained for the analytical assessment has: the catch at age matrix corrected for spawning migrations (only mature age classes), Peterson and Wroblewski's mortality, and two surveys: UK BTS and FR GFS. The Belgian Beam trawl tuning was rejected as input to this assessment.

In summary, the Art and Poos model (ADMB and R) takes a design matrix for a tensor spline that will describe the F matrix. The dimension of that design matrix is defined by the parameters in the model (see table below). It assumes that the F-at age is constant after a given age, which is a parameter to the model. It assumes that the q-at-age for the indices is a smooth function of age, using a spline smoother. The number of knots is a parameter to the model. Also, q-at-age is constant after a given age, which is a parameter to the model. It assumes that the discards fraction of the catch is a logistic curve, described by two parameters. This curve is constant over time. The sigma values in the log-likelihood are 3 parameter polynomials of the form (a + b*age + c*age^2), one for each datasource. Finally, recruitment is estimated as a single parameter per year.

MODEL PARAMETERS	CODE	VALUES
Age from which F is constant	qplat.Fmatrix	6
Dimension of the F matrix	Fage.knots	4
	Ftime.knots	14
	Wtime.knots	5
Age from which q is constant	qplat.surveys	5

Input data types and characteristics:

Type	Name	Year range	Age range	Variable from year to year Yes/No
Caton	Catch in tonnes	1980-Last yr	1-7+	No
Canum	Catch at age in numbers	1980-Last yr	1-7+	No
Weca	Weight at age in the commercial catch	1980-Last yr	1-7+	No
West	Weight at age of the spawning stock at spawning time.	1980-Last yr	1-7+	No
Mprop	Proportion of natural mortality before spawning	1980-Last yr	1-7+	No
Fprop	Proportion of fishing mortality before spawning	1980-Last yr	1-7+	No
Matprop	Proportion mature at age	1980-Last yr	1-7+	No
Natmor	Natural mortality	1980-Last yr	1-7+	No

Tuning data:

Type	Name	Year range	Age range
Tuning fleet 1	UK BeamTrawl	Excluded	
Tuning fleet 2	BE Beam Trawl	Excluded	
Tuning fleet 3	FR Otter Trawl	Excluded	
Tuning fleet 4.	UK BTS	1988 – Last yr	1-6
Tuning fleet 5	FR GFS	1988 – Last yr	1-6
Tuning fleet 6	Int YFS	Excluded	1

D. Short-Term Projection

Short term projection were done using the ICES 2012 recommendations

Model used: Age structured

Software used: FLR package

Initial stock size:

1) the survivors at age 2 and greater from the Art and Poos assessment
2) N at age 1 = to be confirmed

Maturity: same ogive as in the assessment is used for all years

F and M before spawning: Set to 0 for all ages and all years

Weight at age in the stock: average stock and catch weights over the preceding 3 years.

Weight at age in the catch: average stock and catch weights over the preceding 3 years.

Exploitation pattern: The F vector used will be the average F-at-age in the last 3 years, scaled by the Fbar (3-6) to the level of last year.

Intermediate year assumptions: all TAC used

Stock recruitment model used: None, the long term geometric mean recruitment at age 1 is used

Procedures used for splitting projected catches:

E. Medium-Term Projections

F. Long-Term Projections

G. Biological Reference Points

Previous Reference Points:

Blim = 8958 t.

Bpa = 12541 t.

STOCK – PLAICE VIID	WITHOUT BTRIGGER	WITH BTRIGGER
Reference point	Value	Value
FMSY (median)	0.30	0.31
FMSY lower	0.20	0.21
FMSY upper	0.43	0.43
New $F_{P.05}$ (5% risk to Blim without Btrigger)	0.52	0.60
FMSY upper precautionary with note of whether conditional	0.43	0.43
MSY	7517 t	7551
Median SSB at FMSY	34570 t	33607
Median SSB lower precautionary (median at FMSY upper precautionary)	50814 t	50346
Median SSB upper (median at FMSY lower)	21487 t	21563

H. Other Issues

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Appendix 1 – ELEMENTS OF BIOLOGY ON PLAICE VIId.

Excerpts from the project InterReg 3A CHARM Phase II.

Pleuronectes platessa

Linnaeus,1758

Plie commune
European plaice

Embranchement-Phylum : Chordata

Classe-Class : Actinopterygii

Ordre-Order : Pleuronectiformes

Famille-Family : Pleuronectidae

© IFREMER

Biologie - La plie commune adulte se nourrit de polychètes, de mollusques bivalves, de cœlentérés, de crustacés, d'échinodermes et de petits poissons. En Manche, la reproduction s'étale de décembre à mars sur des fonds de 20 à 40 m de profondeur, avec un pic en janvier-février. En général, les œufs flottent tout d'abord à la surface avant de s'enfoncer progressivement dans la colonne d'eau au cours du développement. L'éclosion a lieu environ 20 (à 5-6°C) à 30 jours (à 2-2.5°C) après fécondation. Les larves ont alors une vie pélagique durant une quarantaine de jours avant de se métamorphoser (lorsque 10-17 mm de longueur) et de rejoindre le fond pour migrer vers les eaux littorales. La croissance en première année est assez élevée.

Caractères démographiques - Taille maximale 100 cm ; taille commune 25-45 cm ; taille minimale de capture 22 cm sauf Skagerrak et Kattegat 27 cm (UE) ; longévité maximale 50 ans ; âge et taille à maturité 2-7 ans et 18-35 cm ; paramètres de von Bertalanffy : taille asymptotique L_{inf}=71.65 cm, taux de croissance k = 0.23 an^{-1}, âge théorique t_0 = -0.83 ; paramètres de fécondité *alpha* = 2.33 ovules.cm^{-beta} et *beta* = 3.10 (50 000 à 500 000 ovules par femelle).

Environnement - Espèce bentho-démersale vivant préférentiellement sur les fonds sableux mais aussi graveleux ou vaseux de la côte jusqu'à 200 m de profondeur, et se répartissant dans les eaux salées à saumâtres tempérées.

Répartition géographique - Atlantique nord-est, du nord de la Norvège et du Groenland au Maroc ; mer Méditerranée, dont la mer Noire.

Biology - Adult plaice essentially feed on polychaetes, bivalves, coelenterates, crustaceans, echinoderms, and small fish. In the English Channel spawning occurs from December to March at depths ranging from 20 to 40 m, with a peak in January-February. Initially, pelagic eggs generally float at the surface. They then progressively sink into deeper waters during their development. Hatching occurs around 20 (at 5-6°C) to 30 (at 2-2.5°C) days after fertilisation. Larvae spend about 40 days in the plankton before metamorphosing (when 10-17 mm in length). They then move to the bottom and migrate towards coastal waters. The fry undergoes relatively fast growth during the first year.

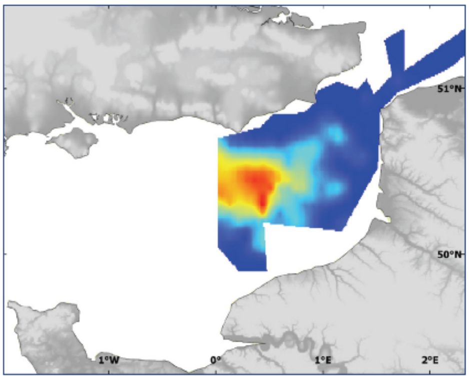
Life history parameters - Maximum length 100 cm; common length 25-45 cm; minimum landing size 22 cm except in Skaggerak and Kattegat 27 cm (EU); maximum lifespan 50 years; age and length at maturity 2-7 years and 18-35 cm; von Bertalanffy parameters: asymptotic length L_{inf} = 71.65 cm, growth rate k = 0.23 year^{-1}, theoretical age t_0 = -0.83; fecundity parameters *alpha* = 2.33 oocytes.cm^{-beta} and *beta* = 3.10 (50,000 to 500,000 oocytes per female).

Environment - This bentho-demersal species prefers to live on sand but also on gravely or muddy substrates, from the coast to 200 m in depth. The species is found in marine to brackish temperate waters.

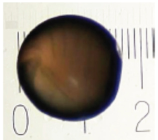
Geographical distribution - North-east Atlantic, from northern Norway and Greenland down to Morocco; Mediterranean including the Black Sea.

Œufs / Eggs - Pleuronectes platessa

Abondance en janvier (IBTS, 2007)
Abundance in January (IBTS, 2007)

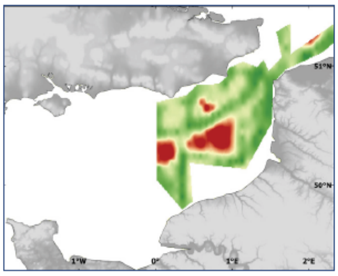


1.1
0
log (x+1),
x = nbr. ind.
/ 20 m³



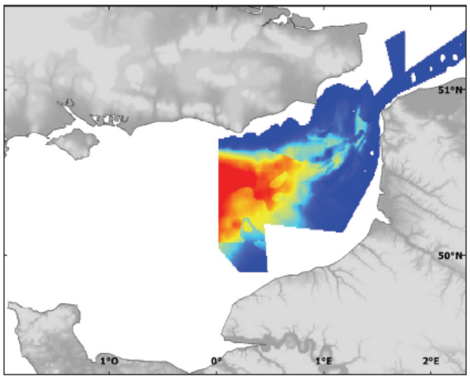
stade 1
stage 1

Erreur de krigeage
Kriging error



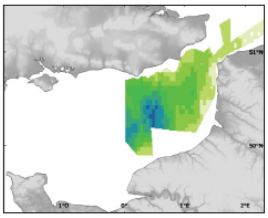
élevé/*high*
faible/*low*

Habitat préférentiel en janvier (GLM)
Preferential habitat in January (GLM)



élevé/*high*
faible/*low*

Erreur du modèle / *Model error*



1
0.6
0.4
0.3
0.25
0.2
0.15
0.1
0.05
0.01
0

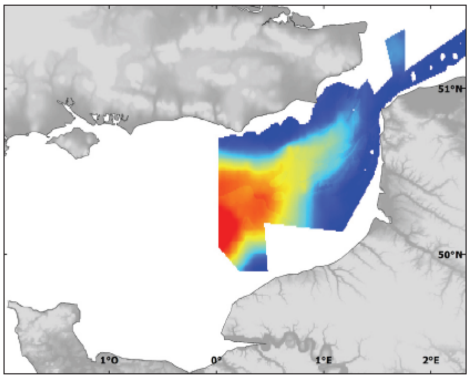
0/1 GLM

DEP	+2
STR	-
TMP	+
SAL	
CHL	+
SED	

+ GLM

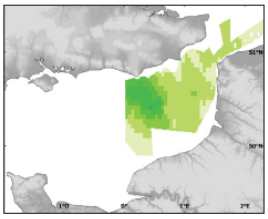
DEP	
STR	
TMP	2
SAL	
CHL	
SED	CS M - G - FS - P

Habitat potentiel en janvier (RQ)
Potential habitat in January (RQ)



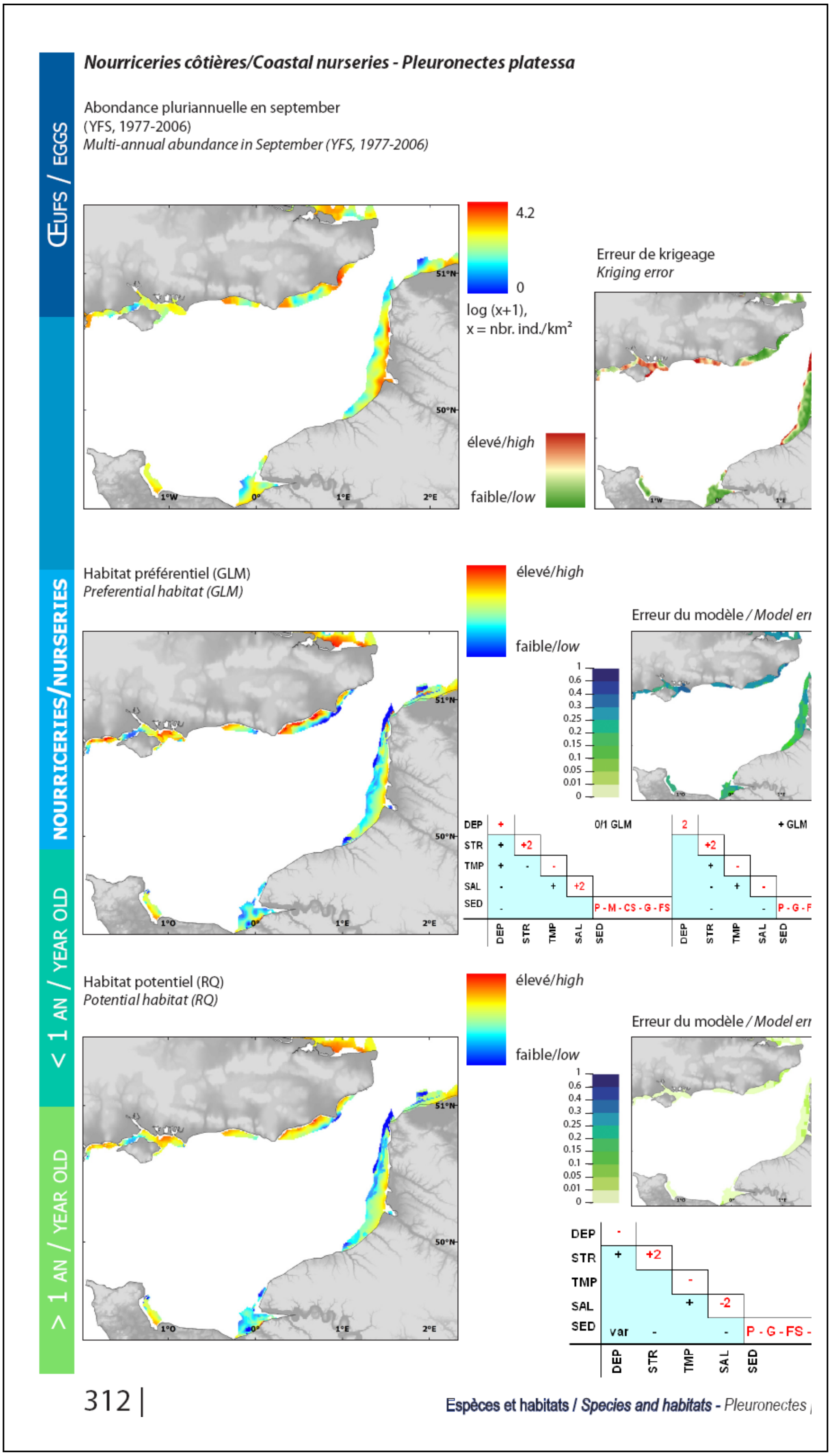
élevé/*high*
faible/*low*

Erreur du modèle / *Model error*



1
0.6
0.4
0.3
0.25
0.2
0.15
0.1
0.05
0.01
0

DEP	+2
STR	-2
TMP	-2
SAL	-2
CHL	+2
SED	CS M - FS - G - P


Nourriceries côtières/Coastal nurseries - Pleuronectes platessa
ŒUFS / EGGS
NOURRICERIES/NURSERIES
< 1 AN / YEAR OLD
> 1 AN / YEAR OLD
Abondance pluriannuelle en september
(YFS, 1977-2006)
Multi-annual abundance in September (YFS, 1977-2006)
4.2
0
log (x+1),
x = nbr. ind./km²
Erreur de krigeage
Kriging error
élevé/high
faible/low
Habitat préférentiel (GLM)
Preferential habitat (GLM)
Erreur du modèle / Model err
0/1 GLM
+ GLM
DEP
STR
TMP
SAL
SED
P - M - CS - G - FS
P - G - F
Habitat potentiel (RQ)
Potential habitat (RQ)
var
P - G - FS -
312
Espèces et habitats / Species and habitats - Pleuronectes

Pour cette espèce, les données disponibles couvrent presque l'ensemble du cycle de vie (sauf les larves) et les deux saisons pour les individus de moins et plus d'un an.

Œufs

Lors de la campagne IBTS de janvier, la plie est en pleine période de reproduction en Manche orientale. Les œufs de stade 1 récoltés alors suggèrent que les zones de frai sont situées dans les eaux centrales de la Manche orientale, dans des zones relativement profondes. Les abondances sont bien prédites par le modèle d'habitat préférentiel qui situe la zone de frai dans la partie centrale de la Manche donc dans des eaux relativement profondes mais protégées des forts courants de marées. Cependant, l'erreur du modèle est assez importante. Le modèle d'habitat potentiel montre la même zone comme favorable, avec un schéma de distribution un peu plus étendu au niveau des sédiments sableux.

Nourriceries côtières

La carte d'abondance issue des campagnes YFS (septembre) montre une répartition très côtière des individus sur presque toute la zone échantillonnée, avec toutefois des abondances plus fortes en face des baies de Somme, Canche, Authie et Rye. Les modèles d'habitats préférentiel et potentiel sont très semblables et sont en accord avec les abondances des campagnes. Ils favorisent la bande côtière et surtout le large des baies à l'exception notable de la baie de Seine. Les zones optimales pour les nourriceries sont situées dans des zones peu profondes, proches des apports d'eaux douces et froides en cette saison mais qui présentent cependant des sédiments grossiers et où les courants de marées sont relativement forts. Ces zones correspondent vraisemblablement à un front hydrologique côtier potentiellement très productif au niveau benthique.

< 1 an

Les individus de moins d'un an (< 18.0 cm) ont été séparés des autres sur la base de leur taille.

En juillet, les jeunes individus ont été échantillonnés face aux baies de Somme, Canche, Authie, autour de la presqu'île du Cotentin et un peu en baie de Seine, côté français et aux alentours de Dungeness, à l'ouest de l'île de Wight et surtout dans l'estuaire de la Tamise, coté britannique. Ces zones plutôt constantes sont plus ou moins étendues selon l'année d'étude. La carte d'habitat préférentiel n'est pas vraiment en accord avec les distributions observées. Elle favorise des zones très côtières proches des estuaires, sur les côtes française et britannique, hors dans la plupart de ces zones les abondances observées sont très faibles voire nulles. L'incertitude du modèle est plus forte sur les côtes mais très faible dans les zones centrales signifiant qu'il n'y a pratiquement aucune incertitude concernant l'absence de cette espèce à ces endroits. Le modèle d'habitat potentiel propose également des zones côtières mais qui s'étendent plus au large, ce qui est plus en accord avec les distributions observées. Le modèle d'habitat potentiel s'appuie sur de faibles température et tension de cisaillement et sur des sédiments grossiers. L'erreur est nulle sur presque toute la région sauf dans le sud-ouest de la zone étudiée où elle atteint des valeurs assez importantes.

For this species, data are available for almost the entire life cycle (except larvae), and two seasons for individuals of less and more than one year.

Eggs

The IBTS survey takes place during the reproductive period of plaice in the eastern English channel. Stage 1 eggs sampled during the survey indicate that spawning areas were located in the central eastern English channel, in relatively deep areas. Survey abundance levels were accurately predicted by the preferential habitat which showed spawning areas as being located in the central Channel, in fairly deep areas protected from strong tidal currents. Nevertheless, the model errors were high. The potential habitat model showed the same areas as favourable, though favourable habitats included sandy areas.

Coastal nurseries

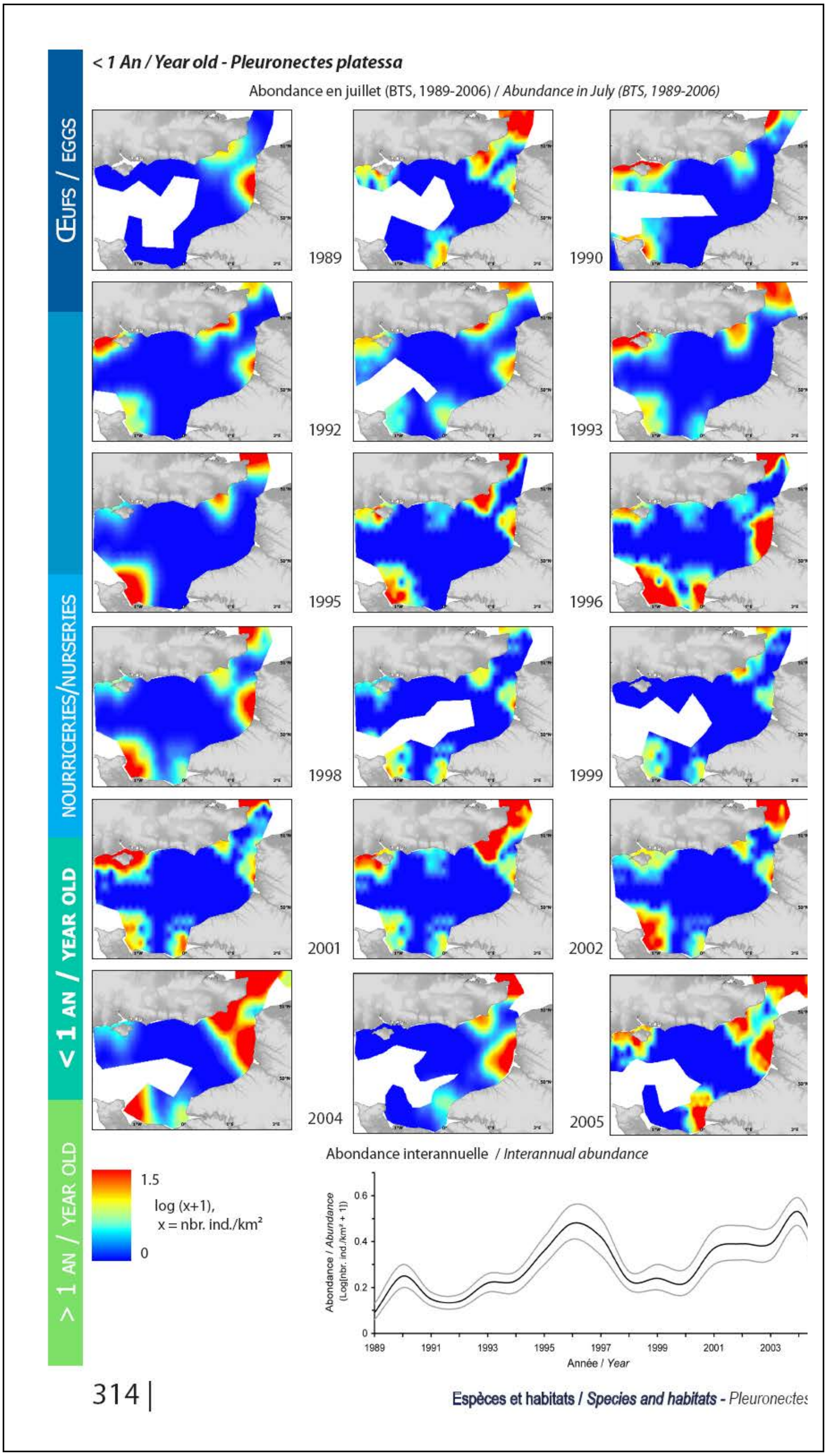
The multi-annual abundance map from the YFS surveys (September) indicates a very coastal spatial distribution of plaice across the sampled area, with some high abundance areas in front of the Bays of Somme, Canche, Authie and Rye. The potential and preferential habitat models are very similar and agree with the survey abundance levels. They both favour the coast and bays, with the exception of the Bay of Seine. Suitable sites for nurseries are located in shallow areas, close to fresh and cool seasonal water inputs. These areas are characterised by coarse sediments and strong tidal currents, i.e. corresponding to a coastal hydrological front, potentially very productive at the benthic level.

< 1 year old

Individuals of less than one year were defined as such on the basis of their length (< 18.0 cm).

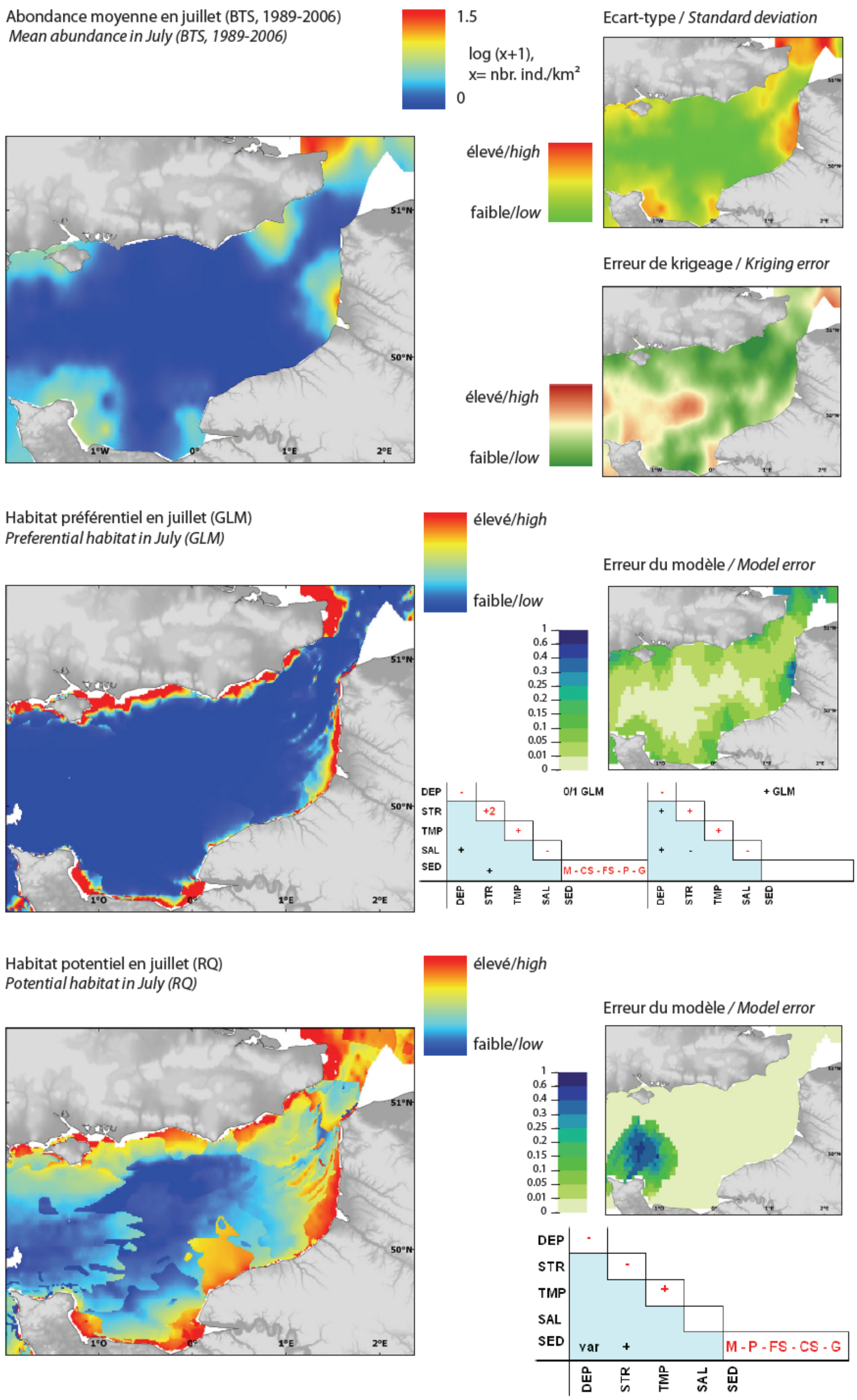
On the French side, young individuals were found off the Bays of Somme, Canche, Authie, around the Cherbourg Peninsula and a few in the Bay of Seine, in July. On the British side, they were located around Dungeness, west of the Isle of Wight and especially in the Thames estuary. The areas covered varied in size over time. The preferential habitat model did not really agree with the survey distribution. It favours very coastal zones near to estuaries on both French and British coasts but in most of these areas survey abundance levels were very low and sometimes null. The model uncertainty was higher on the coasts but very low in central areas which means that there is almost no uncertainty about the spatial extent of areas where this species is absent. The potential habitat model highlights coastal areas extending offshore as favourable, which is more coherent with survey distributions. The potential habitat model highlights areas of low temperature, weak bed shear stress and coarse sediments. The model error was almost null across the region except in the south-west, where it could reach high values.

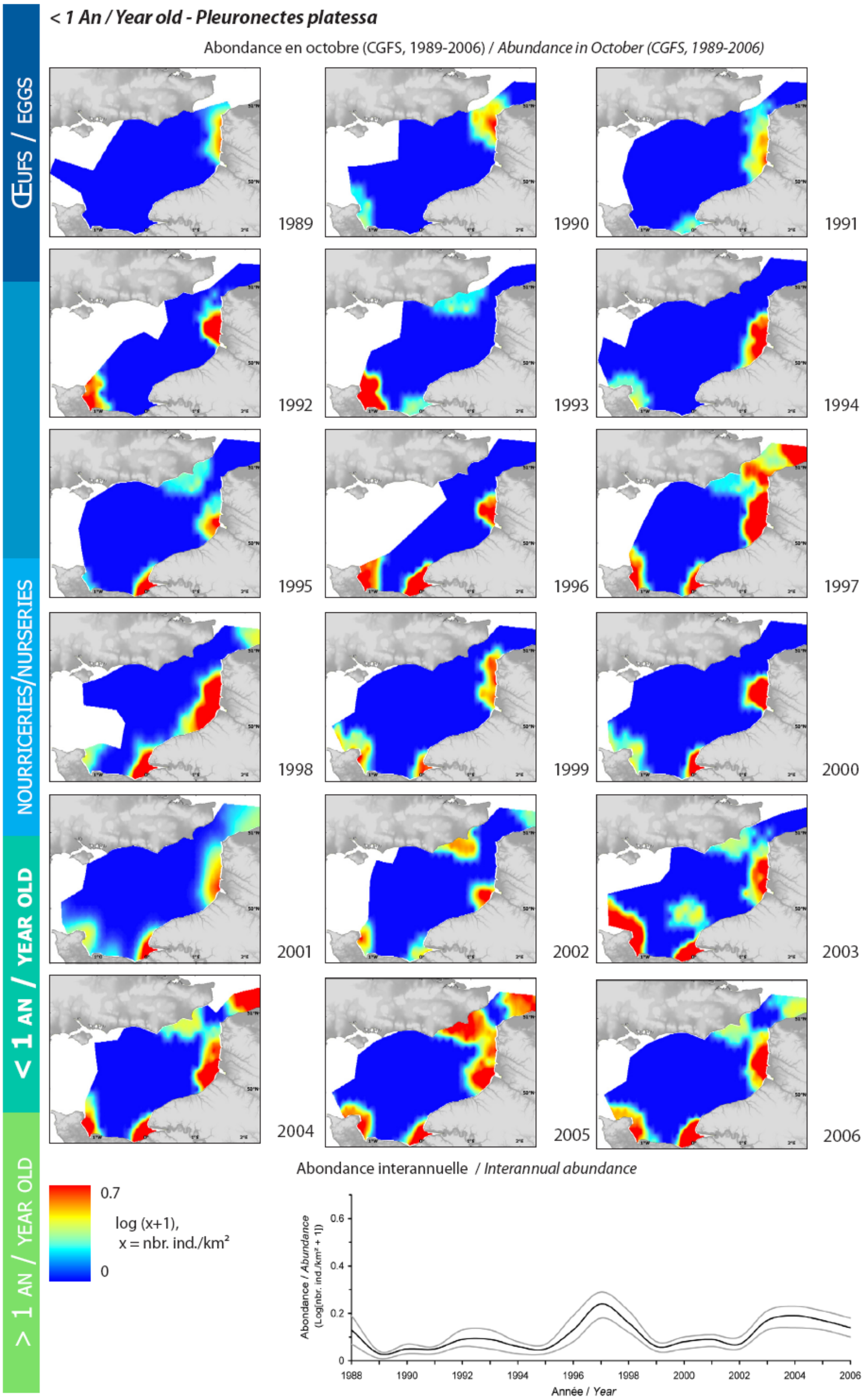
In October, the distribution of young plaice was more spatially restricted than in July, and seemed to be concentrated the Bays of Somme, Canche, Authie and Seine. Some young individuals were also found around the Cherbourg Peninsula. Occurrence areas of young plaice did not change a lot between July and October. The kriging error was more important in the north-west of the study area, where observa-



ŒUFS / EGGS
NOURRICERIES/NURSERIES
< 1 AN / YEAR OLD
> 1 AN / YEAR OLD
< 1 An / Year old - Pleuronectes platessa
Abondance en juillet (BTS, 1989-2006) / Abundance in July (BTS, 1989-2006)
1989
1990
1992
1993
1995
1996
1998
1999
2001
2002
2004
2005
1.5
log (x+1),
x = nbr. ind./km²
0
Abondance interannuelle / Interannual abundance
Abondance / Abundance
(Log[nbr. ind./km² + 1])
0.6
0.4
0.2
0
1989
1991
1993
1995
1997
1999
2001
2003
Année / Year
314 |
Espèces et habitats / Species and habitats - Pleuronectes

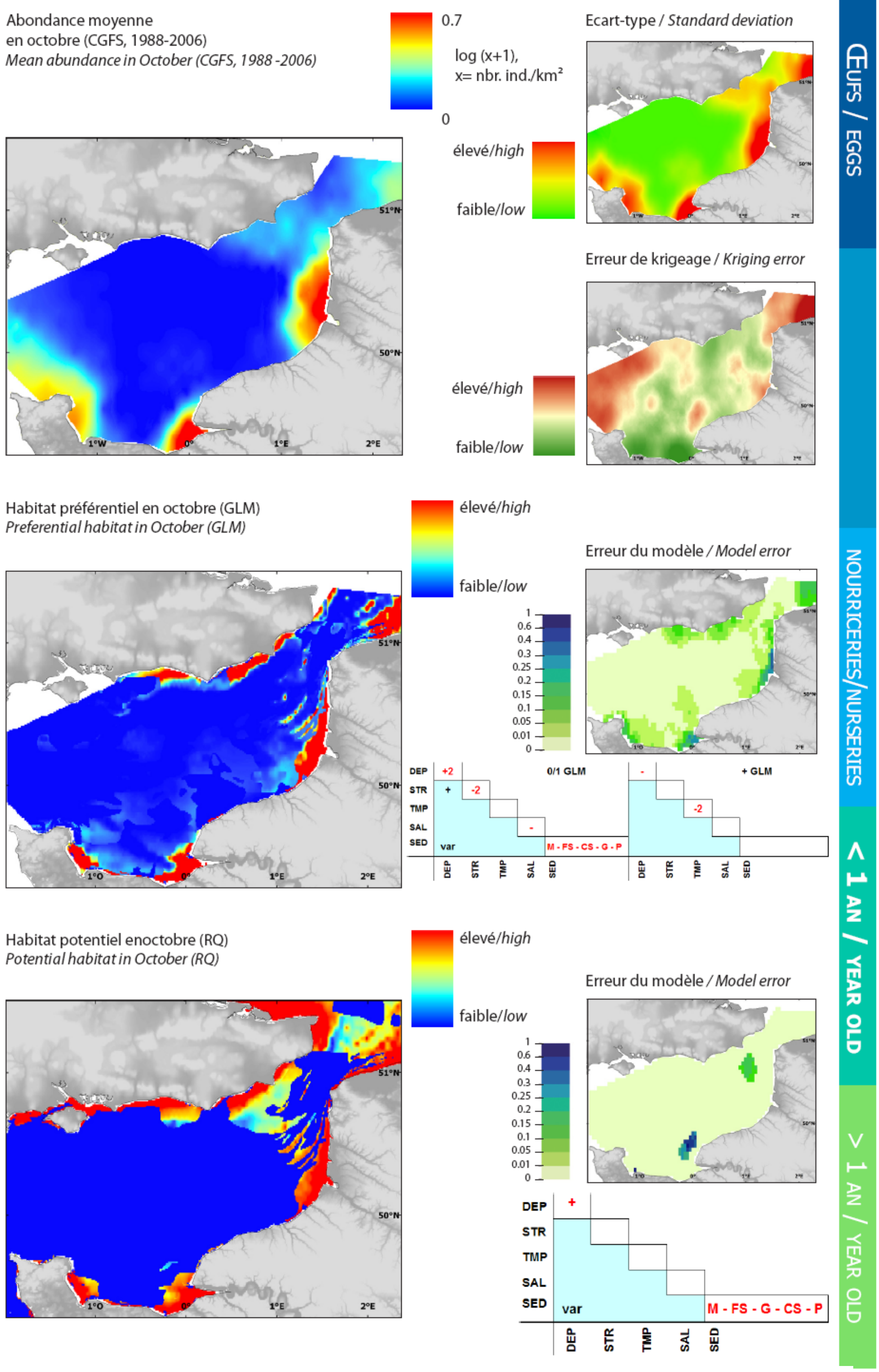
< 1 An / Year old - *Pleuronectes platessa*





Espèces et habitats / *Species and habitats* - *Pleuronectes platessa*

< 1 An / Year old - *Pleuronectes platessa*



Espèces et habitats / *Species and habitats* - *Pleuronectes platessa*

En octobre, la distribution des jeunes plies est moins étendue qu'en juillet et les individus semblent s'être concentrés au large des baies de Somme, Canche, Authie et Seine. On retrouve également des individus au niveau de la presqu'île du Cotentin. Les zones d'occurrence de la plie juvénile ne changent pas vraiment entre les deux saisons. L'erreur de krigeage est plus importante dans le nord-ouest de la zone où l'échantillonnage est plus clairsemé. Comme en juillet, le modèle d'habitat préférentiel favorise des habitats très côtiers au niveau des estuaires, ce qui ici concorde avec la distribution observée. Le modèle d'habitat potentiel se rapproche de celui de l'habitat préférentiel en allant un peu plus au large dans le détroit du Pas-de-Calais et le sud de la mer du Nord.

> 1 an

Les individus de plus d'un an (> 18.1 cm) sont échantillonnés dans les mêmes zones que les plus jeunes mais leur distribution s'étend plus au large.

En juillet, ils sont présents en forte proportion dans tout le détroit du Pas-de-Calais, dans le sud de la mer du Nord et dans les baies de Seine et des Veys. Aucun individu n'a été trouvé dans la partie centrale de la Manche orientale où les eaux sont plus profondes. Le modèle d'habitat préférentiel prédit bien la distribution observée, favorisant les zones à faibles profondeurs mais avec des courants de marées assez importants. Le modèle d'habitat potentiel est beaucoup plus optimiste, étendant les zones favorables, plus au large.

En octobre, la distribution semble se resserrer près des côtes. Beaucoup d'individus sont présents le long des côtes d'Opale ou belge et autour de Dungeness. Des zones d'abondance apparaissent également dans les baies de Seine et des Veys. L'erreur de krigeage est toujours associée aux zones où l'échantillonnage est plus épars. Les modèles d'habitats préférentiel et potentiel sont en accord avec les abondances de campagnes, toutefois l'erreur du modèle d'habitat préférentiel n'est pas négligeable. Le modèle d'habitat potentiel illustre l'affinité de cette espèce pour les fonds sableux à graveleux dans des zones de températures moyennes à faible profondeur et où les courants de marées se font ressentir.

tions were more sparse. As in July, the preferential habitat model strongly favoured coastal areas close to estuaries, which this time agrees with the survey data. The potential habitat model resembles the preferential habitat model but exhibits a more dispersed offshore spatial distribution in the Dover Strait as well as in the southern North Sea.

> 1 year old

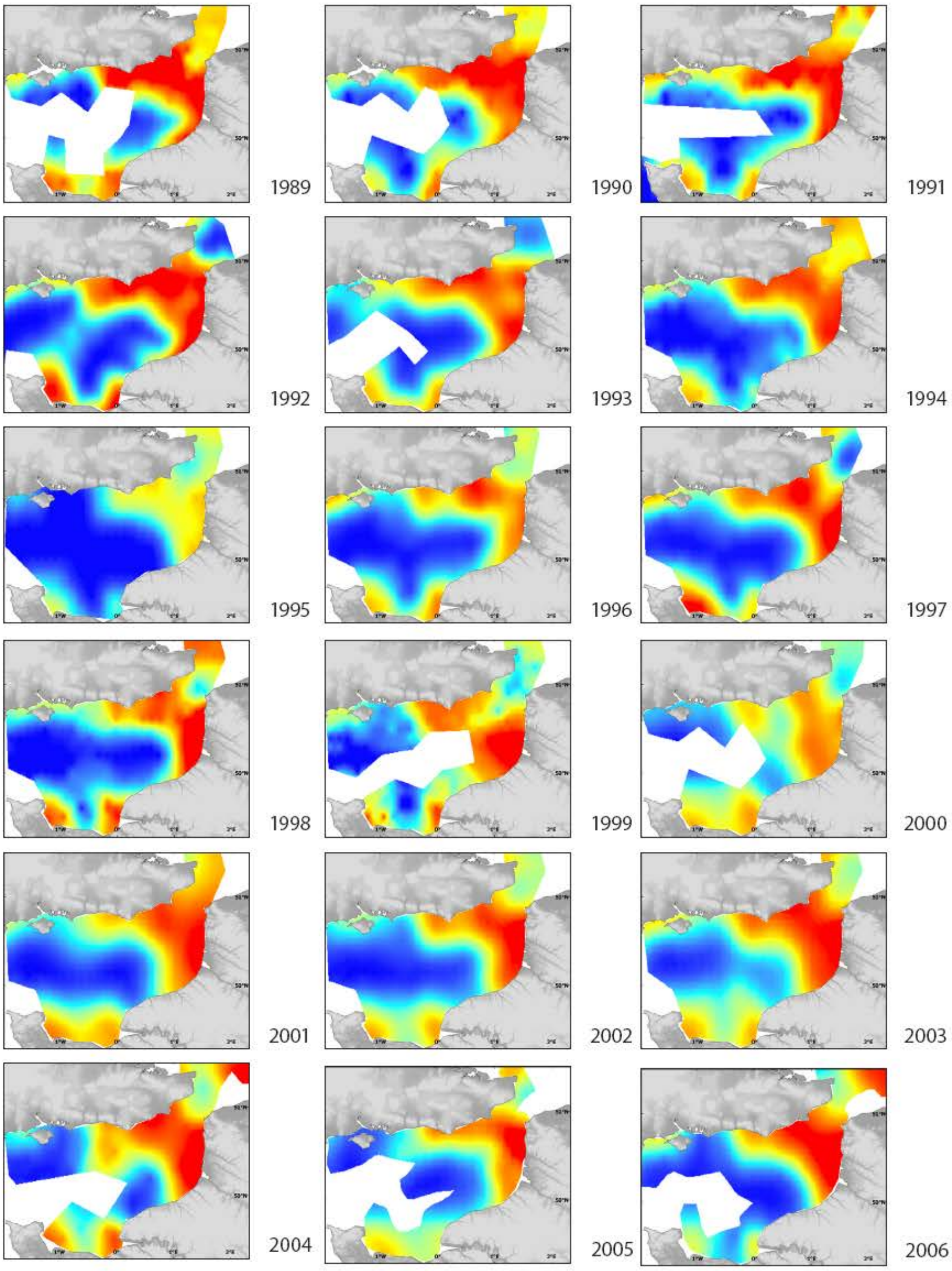
Older than one year individuals (length > 18.1 cm) were found in the same areas as younger ones but had a more offshore distribution pattern.

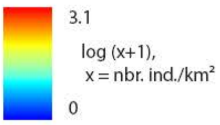
In July, high abundance levels were found in all of the Dover Strait, in the southern North Sea and in the Bays of Seine and Veys. No individual was found in the central Channel where waters are deeper. The preferential habitat model predicts the survey distribution well, favouring shallow waters with quite strong tidal currents. The potential habitat model was more optimistic, extending favourable habitats further offshore.

In October, the distribution pattern seemed to contract along the coasts. Many individuals were found along the Opale and Belgium coasts and around Dungeness. Some patches occured in the Bays of Seine and Veys. The kriging error was again associated with more sparse observations. The preferential and potential habitat models agreed with survey abundance levels though the preferential habitat model error was not negligible. The potential habitat model illustrates the affinity of this species for the sandy to gravely sediment types, shallow areas displaying average temperature conditions and where tidal currents can be strong.

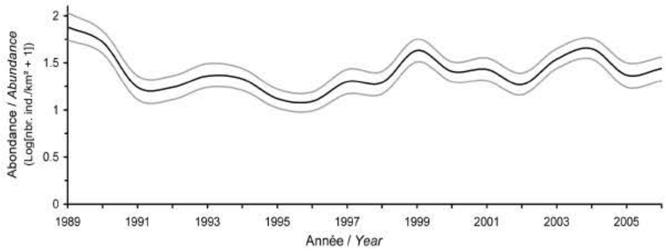
> 1 An / Year old - Pleuronectes platessa

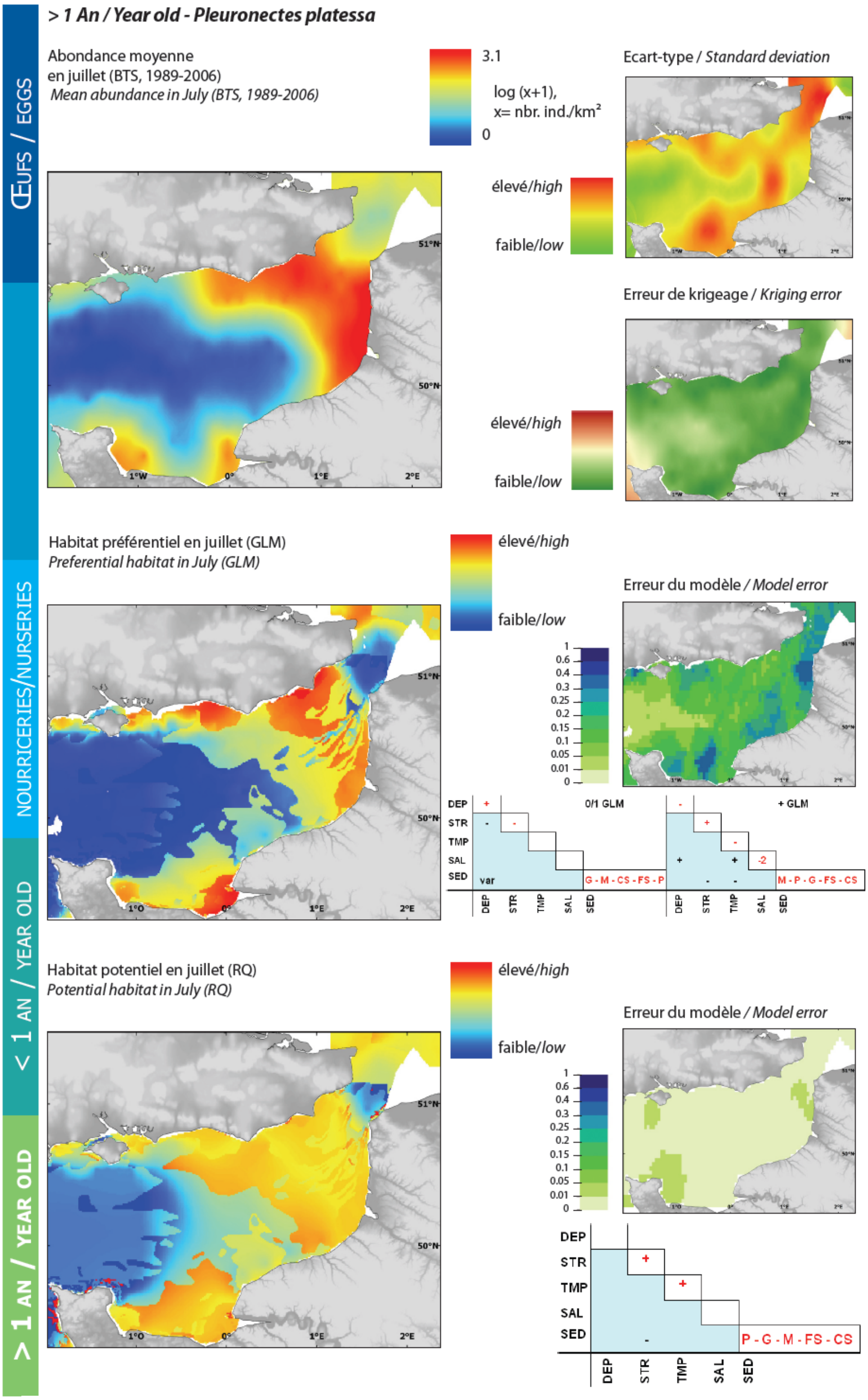
Abondance en juillet (BTS, 1989-2006) / *Abundance in July (BTS, 1989-2006)*





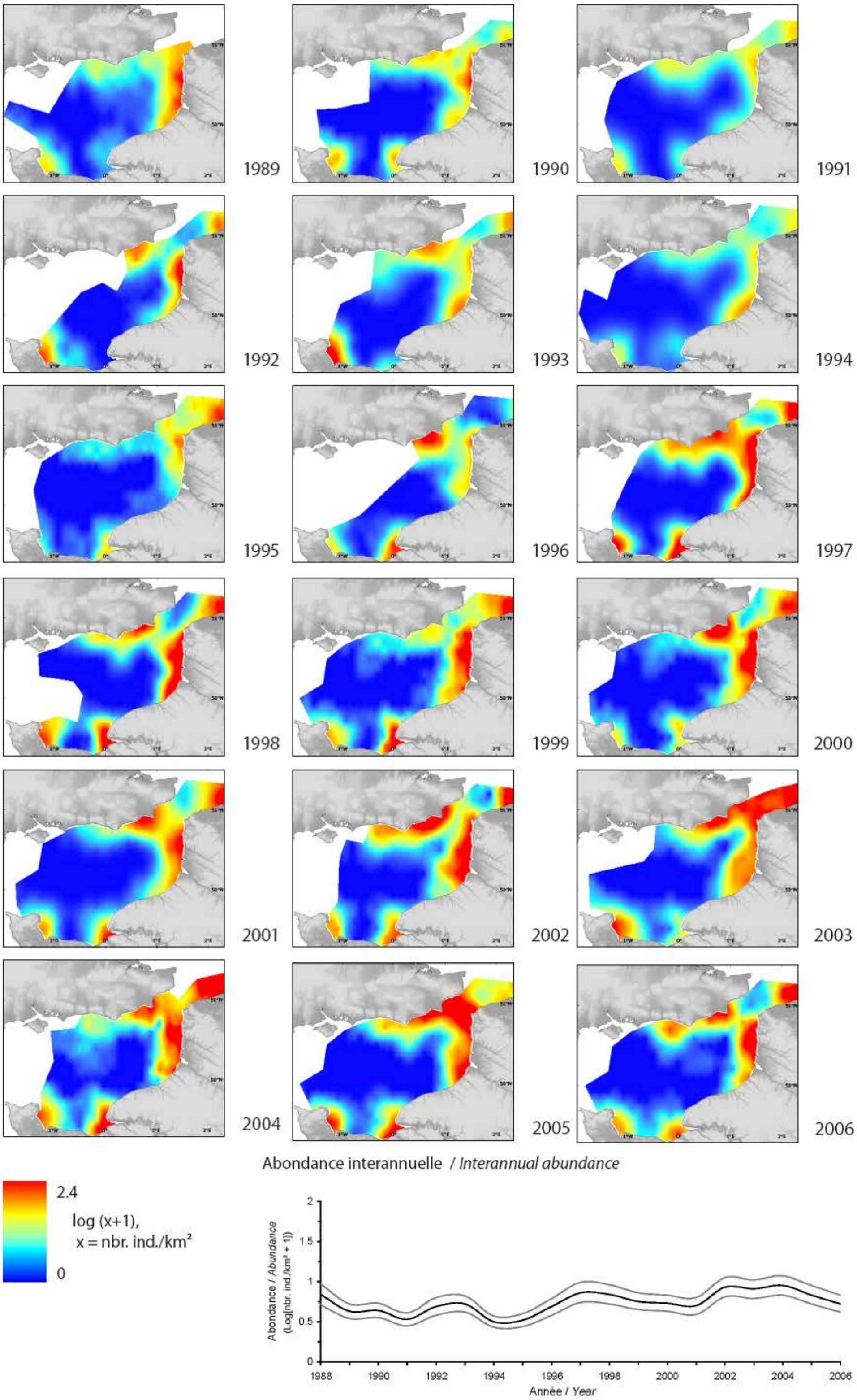
Abondance interannuelle / *Interannual abundance*



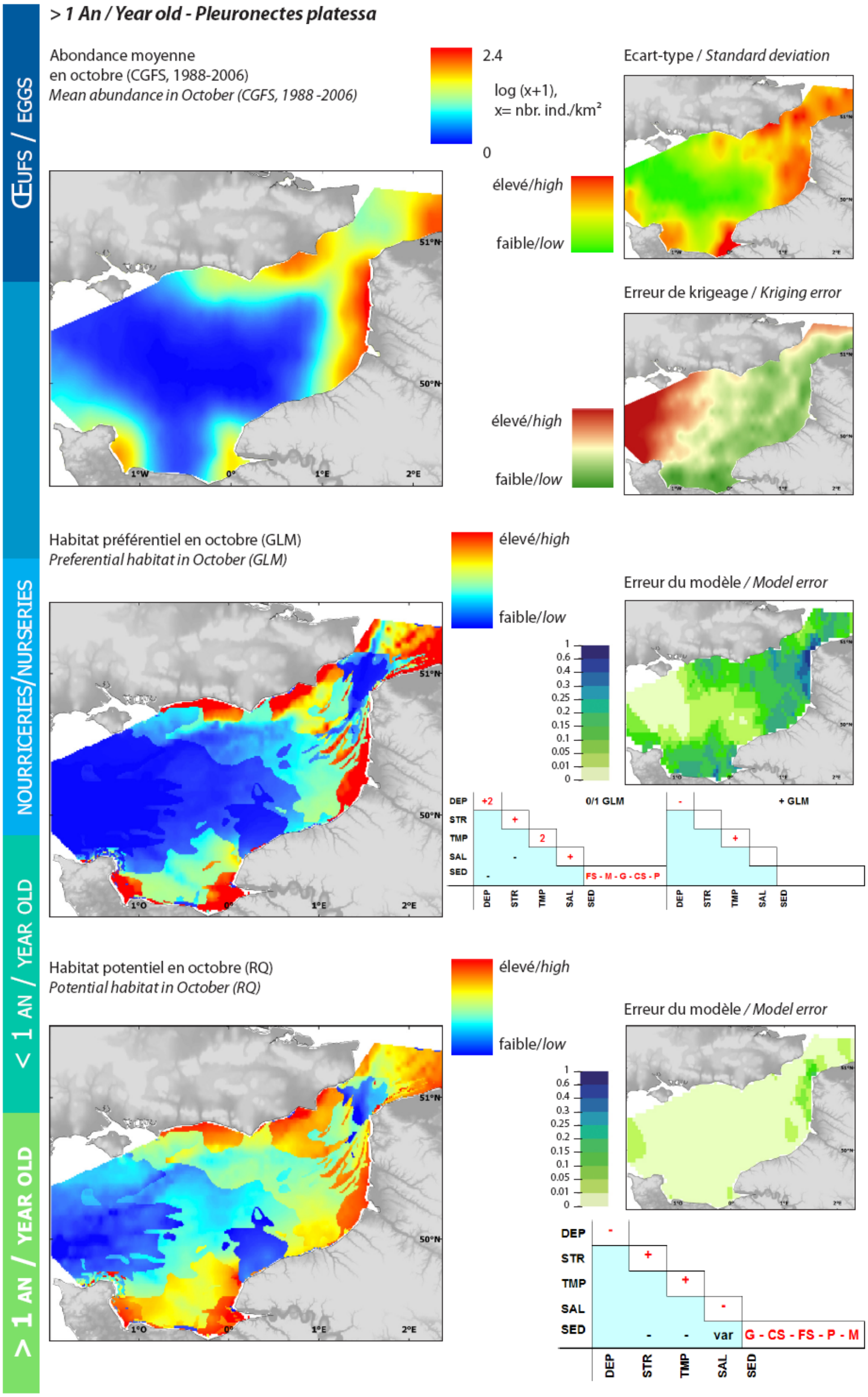

ŒUFS / EGGS
NOURRICERIES/NURSERIES
< 1 AN / YEAR OLD
> 1 AN / YEAR OLD
> 1 An / Year old - Pleuronectes platessa
Abondance moyenne en juillet (BTS, 1989-2006)
Mean abundance in July (BTS, 1989-2006)
3.1
log (x+1), x= nbr. ind./km²
0
Ecart-type / Standard deviation
élevé/high
faible/low
Erreur de krigeage / Kriging error
élevé/high
faible/low
Habitat préférentiel en juillet (GLM)
Preferential habitat in July (GLM)
élevé/high
faible/low
Erreur du modèle / Model error
1
0.6
0.4
0.3
0.25
0.2
0.15
0.1
0.05
0.01
0
0/1 GLM
+ GLM
DEP
STR
TMP
SAL
SED
var
G - M - CS - FS - P
-2
M - P - G - FS - CS
Habitat potentiel en juillet (RQ)
Potential habitat in July (RQ)
élevé/high
faible/low
Erreur du modèle / Model error
P - G - M - FS - CS
1°W
0°
1°E
2°E
50°N
51°N

> 1 An / Year old - *Pleuronectes platessa*

Abondance en octobre (CGFS, 1989-2006) / *Abundance in October (CGFS, 1989-2006)*



ŒUFS / EGGS
NOURRICERIES/NURSERIES
< 1 AN / YEAR OLD
> 1 AN / YEAR OLD



Espèces et habitats / *Species and habitats* - *Pleuronectes platessa*

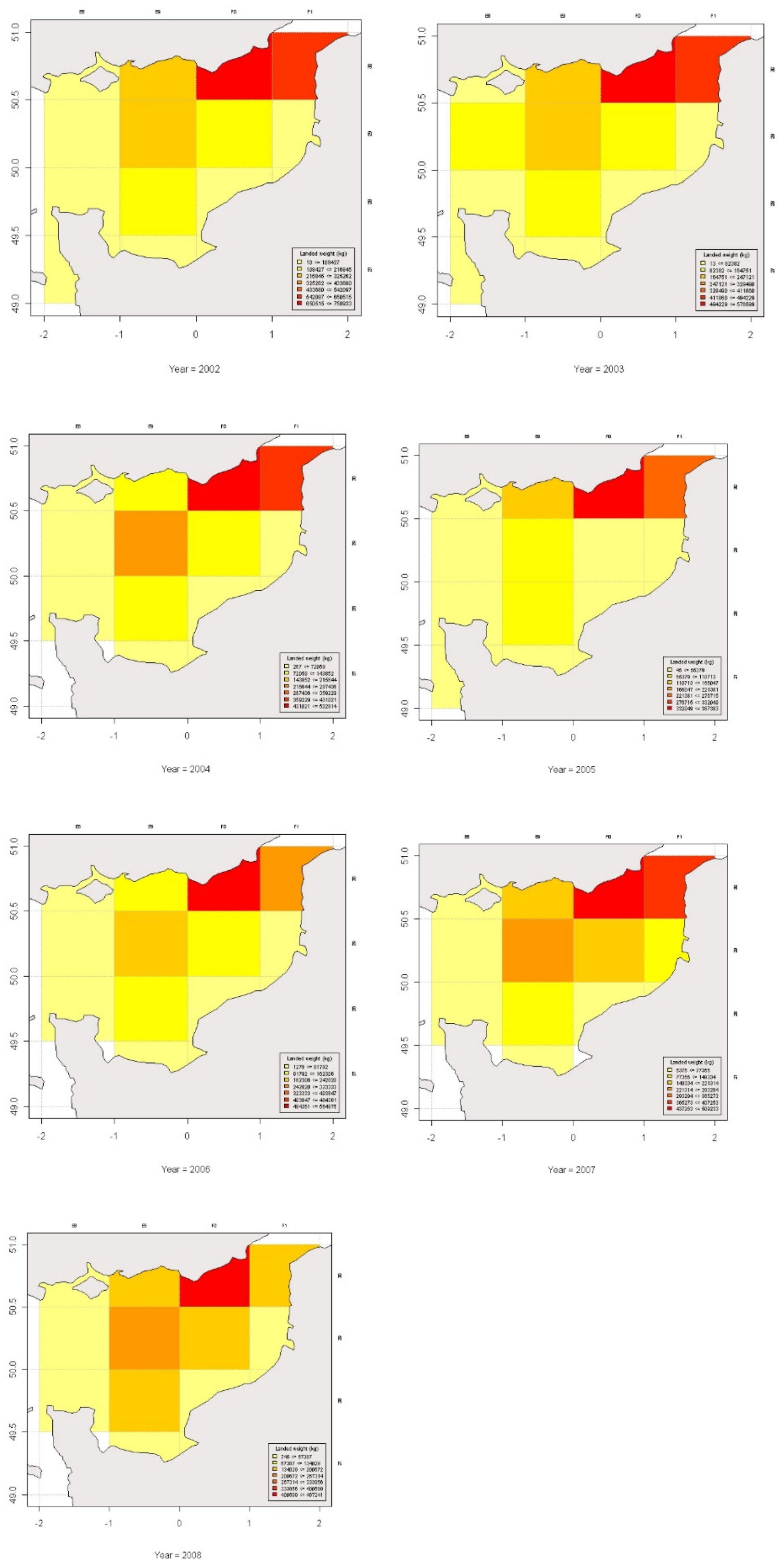


Figure. Plaice in VIId. - International landings from 2002 to 2008.

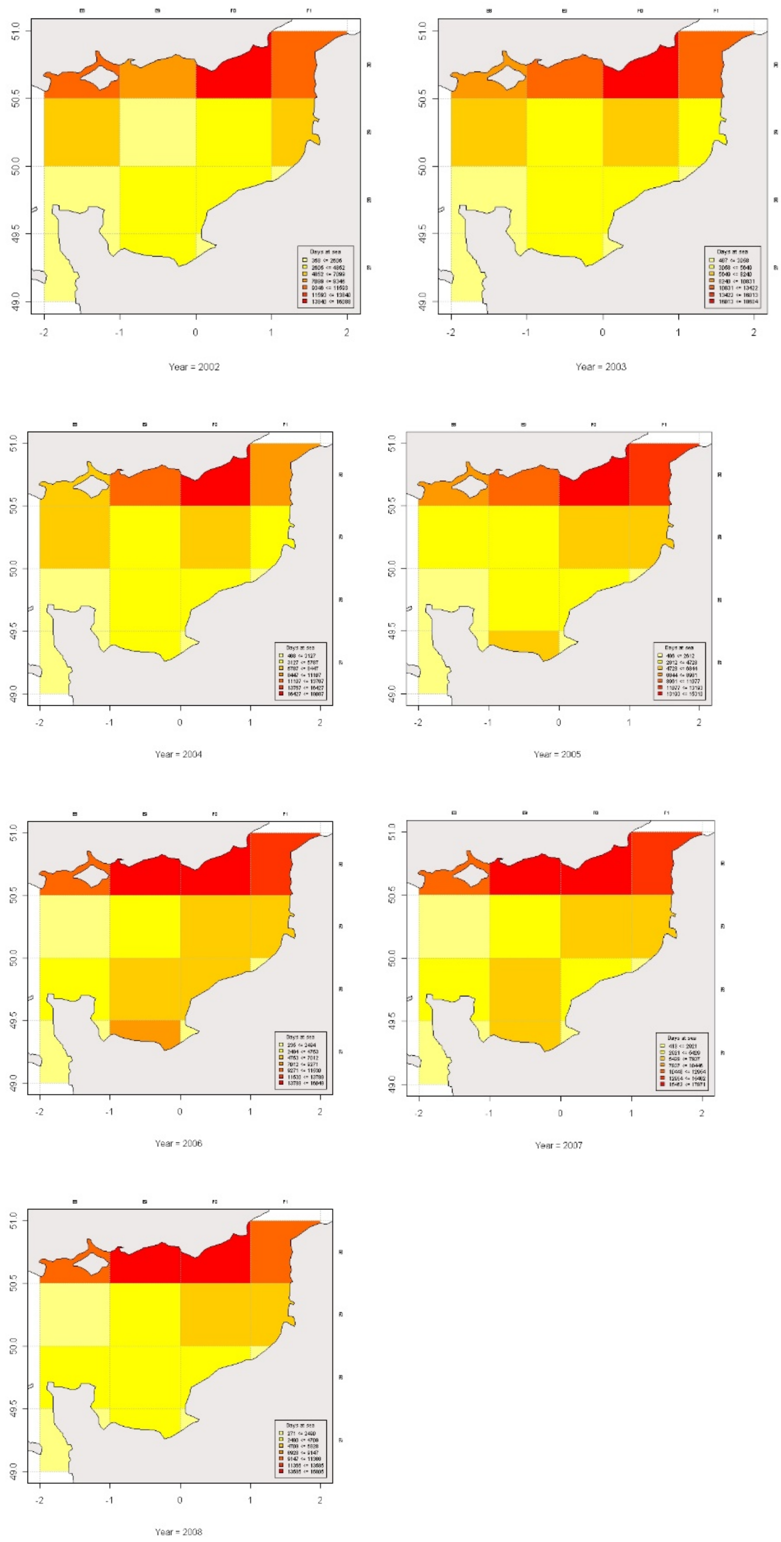


Figure Plaice in VIId - International effort in days at sea from 2002 to 2008.

Stock Annex: Plaice (*Pleuronectes platessa*) in the Eastern Baltic Sea (PLE 24–32)

Stock-specific documentation of standard assessment procedures used by the International Council for Exploration of the Sea (ICES).

Stock:	Plaice (*Pleuronectes platessa*) in the Eastern Baltic Sea (PLE 24-32)
Working group:	WGBFAS / WKPLE
Date:	March 2015
Revised by:	Sven Stötera (WKPLE)
Revisions:	
Modified paragraphs:	
Last Benchmarked:	Feburary 2015

A. General

A1. Stock definition

The Eastern Baltic plaice covers the ICES Subdivisions SD24 to SD32.

A2. Fishery

Plaice is mainly caught in the area of Arkona and Bornholm basin (SD 24 and SD 25). ICES Subdivision 24 is the main fishing area with Denmark and Germany being the main fishing countries. Subdivision 25 is the second most important fishing area. Denmark, Sweden and Poland are the main fishing countries there. Minor catches occur in Gdansk basin (SD 26). Marginal catches of plaice in other SD are found occasionally in some years, but were usually lower than 1 ton/year. The highest total landings of plaice in SD's 24 to 32 were observed at the end of the seventies (4530t in 1979) and the lowest around the period between 1990 and 1994 (80 t in 1993). Since 1995 the landings increased again and reached a moderate temporal maximum in 2003 (1281t) and again in 2009 (1226t). After 2009 the landings decreased to 748t in 2011, slightly increased in 2012 to around 848 tons and decreased to 738 tons in 2013.

Plaice are caught by trawlers and gillnetters mostly. The minimum landing size is 27 cm in 2013, active gears provide most of the landings in SD 24 (ca. 65%) and SD 25 (ca. 77%), whereas landings from passive gears are low. However, in SD 26, passive gears provided 76% of total plaice landings in 2013. Only a few occasional landings from trawl-fisheries took place in SD 26.

A2.1. General description

Countries involved: Denmark, Sweden, Poland, Germany, Finland, Latvia

A2.2 Fishery management regulations

A3. Ecosystem aspects

Plaice catches are regulated by a catch quota. This quota however, accounts for the whole Baltic Sea area. No differentiation is made between the two stocks PLE-2123 and PLE-2432.

B. Data

B.1 Commercial catch

The landing data of plaice in the Eastern Baltic (ple 24-32) according to ICES Subdivisions and countries are presented in Table 5.1. The trend and the amount of the landings of this flatfish are shown in Figure 5.3. Plaice and dab have the greatest proportions of the total landings of flatfish when excluding flounder.

B.1.1 Landings data

All countries having a fishery on PLE-2432 were asked to upload their landings, discards estimations and biological data from sampling.

B.1.1.1 Danish landings

Denmark is the main fishing country with about 600 tons landed plaice in 2013. All landings arose out of SD24 and SD25.

B.1.1.1.1 Data coverage and quality

Landings are usually sampled directly at the port ('harbour-sampling') or at sea. The sampling covers the most important fisheries, i.e. active trawling in SD24 and increased since 2007. The earlier years of the time series have a bad coverage in time and space. Recent years did not cover the trawling fleet in SD25 (only in discards).

B.1.1.2 Swedish landings

Sweden is the second-most important fishing nation for plaice in the Eastern Baltic and landed about 62 tons of plaice in 2013. All landings arose out of SD24 and SD25.

B.1.1.2.1 Data coverage and quality

Landings are usually sampled directly at the port ('harbour-sampling') or at sea. The sampling covers only length distributions, as Sweden is not sampling age of plaice. For the benchmark, these length data were not used due to missing conversion factors (age-length-keys) and a fitting format , only landings and discard estimations were used in the process.

B.1.1.3 Polish landings

Before 2004, plaice landings were not separated from other flatfishes, only a general landing of flatfish is available. Since 2004, plaice is landed as a separate species, landings in 2013 were around 50 tons.

B.1.1.3.1 Data coverage and quality

Sampling covers the 1st and 4th quarter in active fisheries in SD25 and, to a lesser extent, the passive fisheries. SD24 is only partially covered in time and space.

B.1.1.4 German landings

Germany landed about 45 tons of plaice in 2013, which was mostly caught by active trawling in SD24 and to a minor extent from SD25.

B.1.1.4.1 Data coverage and quality

Sampling of biological data started in 2008 and concentrates on the active fleet (esp. 1st and 4th quarter). Before 2008 only occasional length data and very few age data are available.

B.1.2 Discards estimates

Discard in the commercial fisheries can be high and seems to vary greatly between countries. For example the trawl-fishery targeting cod in SD 26 may have a 100% discard rate of plaice throughout the year.

However, the available data on discards are incomplete for all subdivisions. In 2013, no discard-data from the commercial fisheries of Finland, Estonia, Lithuania, Latvia and Russia were uploaded to InterCatch (although those countries have a cod-targeting trawl-fishery which may have some bycatch of plaice). The quality of the discard data cannot be assessed because countries only uploaded discard-data of strata, where landings took place. In strata no having landings assigned, usually no discard-information were given.

Sampling coverage, esp. in the passive-gear segment is low, especially on discard in SD 25 and SD 26, where only Danish data were available.

B.1.2.1 Danish data

Denmark reported discard estimates back to 2002. Discard varied between years, quarters, gears and subdivisions.

B.1.2.1.1 Data coverage and quality

Discard estimations covered most of the active fishery in SD24 and SD25, although the 3rd quarter is often missing; the passive fishery is usually not covered by estimations. Biological sampling took mostly place in the active fisheries segment, some quarter are not well covered or not sampled at all. Passive fisheries discard is usually not sampled.

B.1.2.2 Swedish data

The coverage of Swedish discards estimations increased between 2002 and 2013, covering most strata in SD24 and SD25. The estimation of discard was often done based on just one trip in the respective stratum as stated by the national data submitter in InterCatch.

B.1.2.2.1 Data coverage and quality

Discard estimations covered most of the active fishery in SD24 and SD25, although the 3rd quarter is often missing. Biological sampling took not place, only length measurements were taken, usually were also landings has been sampled.

B.1.2.3 German data

Germany started reporting discard estimations together with biological sampling in 2008, before that time, only scattered information were available.

B.1.2.3.1 Data coverage and quality

The estimated discards cover the most major fishing gears and quarter in SD24 and SD25 (active fisheries in 1st and 4th quarter) Passive fisheries are not well covered until recent years. Biological samples of discards are usually taken together with the landings-samples, the coverage is adjusted to the landings.

B.1.2.4 Polish data

Poland started reporting plaice in 2004, discard estimation were first given in 2007. Estimations were given for the most important fishing grounds and quarter, also partially covering passive gears.

B.1.2.4.1 Data coverage and quality

An estimation of discards was first given for landings in 2007, the amount and quality is increasing since then. The coverage of biological samples in the discard fraction is scattered and often lack a sufficient number of individual plaice.

B.1.2.5 Other countries data

Latvia, Estonia and Finland have <1% of the landings, but fisheries take place in the stock area. All three countries provided discard estimations for zero-landings.

B.2 Biological sampling

The sampling for the Eastern plaice stock (PLE-2432) concentrates on SD24 and SD25 where >99% of catches (Landings and Discards) are taken. The main countries involved in the biological sampling are Denmark, Poland and Germany. All three countries sample biological information such as individual age and length; Sweden only samples length distributions despite the fact that plaice is a quota species and belongs to DCF species group 1.

Overall, the sampling coverage is poor, esp. in the years 2002 to 2005. The following years show an increasing coverage in age-samples and length-distribution in both landed and discarded fractions. But still, 50-70% of the strata is not sampled or lack reliable/usable data. However, PLE-2432 is still categorized as a data limited stock (DLS).

B.2.1 Maturity

Maturity is measured in the surveys and in German biological sampling. No further information from other countries was available.

B.2.2 Natural mortality

No information on natural mortality were submitted by MS-

8.1.1 Length and age composition of landed and discarded fish in commercial fisheries

B.3 Surveys

B.3.1 Survey design and analysis

The data of the Baltic International Trawl Survey (BITS) from 2001 onwards were used to evaluate the current stock structure of Baltic plaice. Since 2001 standardized gear types TV3 #930 (TVL) and TV3 #520 (TVS) have been used by al countries which participate in the BITS. Survey-CPUE from 2000 and backwards can't be compared directly, although the difference in catchability between the gear types is quite small. The positions of the hauls have been allocated based on a standard method since 2002. The allocation of the stations by ICES subdivision and depth layer is dependent on the area of the depth layers and the 5-years running mean of the density of cod age group 1+ in quarter 1 (ICES 2008 / WGBIFS) because cod is more important for the commercial use.

The procedures for analyzing the hauls are given in the BITS manual (ICES, 2014: WGBIFS). The data are uploaded to the ICES database DATRAS where the source data and different catch per hour estimates by length and age are provided.

B.3.2. Survey data used

The data of the Baltic International Trawl Survey (BITS) from 2001 onwards were used to evaluate the current stock structure of Baltic plaice

B.4 Commercial CPUE

Commercial CPUE were no uploaded by all countries and also the format varied, so effort was not used in the assessment and only used as an indicator to determine strata with a fisheries (e.g. to borrow discards ratios and assign biological samples)

B.5 Other relevant data

C. Assessment methods and settings

C.1 Choice of stock assess model

Given the poor coverage in discard estimations and the high variability in discards, together with the poor sampling-coverage (esp. in early years of the time series), it was decided by WKPLE to keep the stock as data-limited (Cat. 3 following the ICES DLS approach).

In the last years, only the trends of the survey index were used; since 2014, the effort of the commercial fisheries is used as an additional confirmation for these trends.

C.2 Model used of basis for advice

The model used is a trend analysis, using general trends in SSB of an exploratory SAM. Commercial effort data and fishery-independent surveys might be additionally used to confirm the trends found in the assessment model.

Discards are highly variable, depending on the calculation method. The InterCatch database does not allow a borrowing of amount/ratios for strata not having a landing attached (zero-landings), causing an underestimation of discards. If using a manual way of calculation (using the average discard per country, area, gear, area and quarter), discards are higher, in some strata the amount doubles.

C.3. Assessment model configuration

Type	Name	Year range	Age range	Variable from year to year Yes/No
Caton	Catch in tonnes	2002 - 2013	1-10	Yes
Canum	Catch at age in numbers	2002 - 2013	1-10	Yes
Weca	Weight at age in the commercial catch	2002 - 2013	1-10	Yes
West	Weight at age of the spawning stock at spawning time.	2002 - 2013	1-10	Yes
Mprop	Proportion of natural mortality before spawning	2002 - 2013	1-10	No
Fprop	Proportion of fishing mortality before spawning	2002 - 2013	1-10	No
Matprop	Proportion mature at age	2002 - 2013	1-10	No
Natmor	Natural mortality	2002 - 2013	1-10	No

Age group 0 has been excluded in input because mean weights of age 0 is highly inconsistent and is seldom even in discards. Age group 10 has been recalculated to be +group.

Landings (tons) are available from all countries back to 2002. Discards (CANUM, WECA) are only available back to 2002. The majority of discard weights was extrapolated from similar strata. Landing (CANUM and WECA) are also available back to 2002.

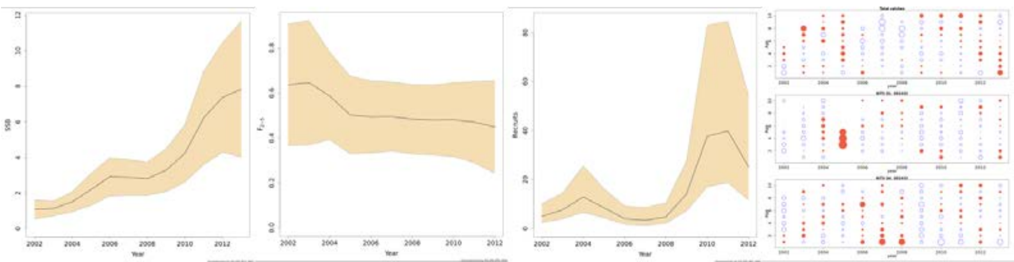
Fbar= 2-5.

Annually maturity ogive was taken from PLE-2123 (running mean of 3 years)

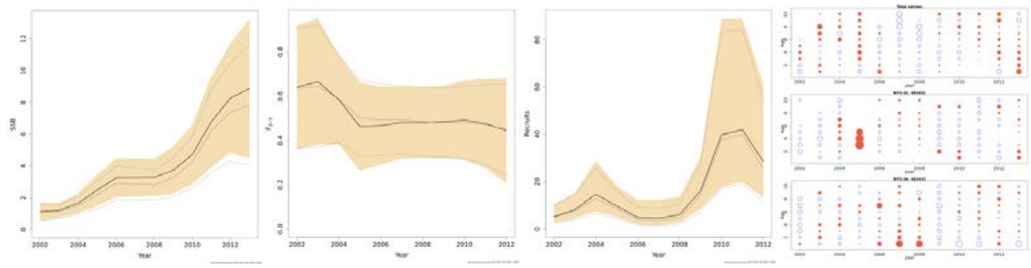
Additional options for each individual run:

Coupling of catchability of age 6-10+ for all surveys

Each of the two surveys used as individual tuning fleet



Additional runs were performed, using the manually calculated (higher) discards. Although the total amount in CANUM is higher, the influence on the SAM output is small.



D. Biological reference points

No biological reference points were set or determined during WKPLE

E. Other issues

E.1 Biology of species

YEAR (Y)	2007	2008	2009	2010	2011	2012
Assessment Model	ICA model	ICA model	ICA model	ICA model	ICA model	SAM Nielsen *et al.*, 2012
Software						
Catch data range	19-?					1947-Y
CPUE Series 1 (years)	PT-TRF9a (1977-?)					
CPUE Series 2 (years)						
Index of Biomass (years)	PT-TRC9a (1989-2006)					
Error Type	Condition on yield					
Number of bootstrap	500					
Maximum F	8.0 (y-1)					
Statistical weight B1/K	1					
Statistical weight for fisheries	1,1					
B1-ratio (starting guess)	0.5					
MSY (starting guess)	3000 t					
K (starting guess)	20 000 t					
q1 (starting guess)	1d-5					
q2 (starting guess)	1d-4					

q3 (starting guess)	
Estimated parameter	All
Min and Max allowable MSY	2000 (t) -10000 (t)
Min and Max K	5000 (t) -500000 (t)
Random Number Seed	1964185

E.2 Current fisheries

E.3 Management and advise

E.4 Others (e.g. age terminology)

Stock Annex: Plaice (*Pleuronectes platessa*) in Subdivisions 21, 22, and 23 (Kattegat, Belt Sea, Sound) (ple-2123)

Stock-specific documentation of standard assessment procedures used by the International Council for Exploration of the Sea (ICES).

Stock: Plaice (*Pleuronectes platessa*) in Subdivisions 21, 22, and 23 (Kattegat, Belt Sea, Sound) ple-2123

Working group: WGBFAS

Date: February 2015

Revised by: Henrik Degel (WGBFAS)

Revisions:

Modified paragraphs:

Last Benchmarked: WKPLE, 2015

A. General

A.1 Stock definition

WKPESTO (ICES 2012a) suggested to recognize Kattegat together with the Belt area and Western Baltic (Sub-divisions 21, 22 and 23) as an independent stock. The stock was named PLE21-23. The suggestion was built on readily literature and information from historical tagging. The split between Skagerrak and Kattegat was rather well documented but the border to Sub-division 24 was less conclusive. The suggestion was confirmed by SIMWG (ICES 2012b). Based in new information (i.e. growth investigations, drift modeling of egg and larval movements and genetics), SIMWG (ICES 2012b) recommended to keep the stock definition as it was as these new information shows very little exchange between Kattegat and Skagerrak and did not provide conclusive evidence of extensive exchange between Subdivision 22 and 24. The WKPLE (ICES 2015) has endorsed this recommendation but recommends that the border between PLE21-23 and PLE24-32 is further investigated in the future.

Spawning

The spawning occurs between late February and late March in Kattegat waters mainly at depth between 30 and 40 meters (Nielsen *et al.*, 2004). Ulmestrand (1992) showed that Kattegat were not significant spawning areas for plaice between 1990 and 1992. But Nielsen *et al.*, (2004) observed the existence of two spawning areas in Kattegat, one in the North-Eastern part and another one, of greater importance in terms of production, in the southern part. Spawning in SD 22 is not described even though spawning takes place here.

A.2 Fishery

A.2.1 General description

Plaice are seldom considered as a target species by the fishery, but caught as bycatch in mixed trawl fisheries targeting mainly cod or Nephrops. The biggest landings of plaice occur in 1st quarter SD 22 in connection with the cod fishery and in 3rd quarter in SD 21 in connection with the Nephrops fishery. Because plaice is considered as a bycatch species, the discard pattern, as observed in the observer program, is very fluctuating dependent on the actual market conditions for plaice (price), the quota situation for cod and local or individual discard traditions. As a consequence the Danish discard raising is based on effort (trips).

Countries involved: Denmark, Germany and Sweden.

A.2.2 Fishery management regulations

Implementation of a number of changes in the regulatory systems in the Kattegat between 2007 and 2008 as well as continuous reductions in the allowed days at sea to protect Kattegat cod have significantly changed the fishing patterns of the Danish and Swedish fleets.

Minimum mesh size is 90 mm for towed gears, and 100 mm for fixed gears. The minimum landing size is 27 cm. Danish fleets are prohibited to land females from January 15th to April 30th.

Kattegat (SD 21)

The fishery is dominated by Denmark, with Danish landings usually accounting for 80 to 90% of the total.

Since 1978, IIIa landings have declined from 27 000 to 9000 tonnes in the late nineties. In most years the combined TAC for the area has been largely higher than the actual landings estimates. (ICES, 2011). The TAC has been largely unrestrictive in the Kattegat (21% of TAC uptake in 2010).

Landings were previous taken year round with a predominance of the period from spring to autumn, and most catches (~80%) are linked to a targeted fishery, by Danish seiners, flatfish gillnetters. Plaice were also caught within mixed cod and *Nephrops* fishery by otter trawlers, and were as well landed as by-catch of other gillnet fisheries (Beyer *et al.*, 2011). In recent years, the prices for plaice has decreased and plaice is now to a wide extent landed as bycatch from particularly the Nephrops and sole fishery.

Figure 3.7.1. Danish and Swedish plaice landings in 2009. By ICES rectangle, all vessels included.

Implementation of a number of changes in the regulatory systems in the Kattegat between 2007 and 2008 as well as continuous reductions in the allowed days at sea to protect Kattegat cod have significantly changed the fishing patterns of the Danish and Swedish fleets.

Minimum mesh size is 90 mm for towed gears, and 100 mm for fixed gears. The minimum landing size is 27 cm. Danish fleets are prohibited to land females from January 15th to April 30th.

Belt (SD 23)

Trawl fishery is not allowed in the Belt and all landings are caught by gillnetters. The catches are insignificant compared to catches in SD 22.

Western Baltic (SD 22)

Plaice are caught by trawlers and gillnetters mostly. The minimum landing size is 25 cm. Danish fleets are prohibited to land females from January 15th to April 30th. Plaice are often landed as bycatch from the cod fishery. SD 22 has within the last years become the area where most of catches come from.

B. Data

B.1 Commercial catch

B.1.1 Landings data

Landing statistics from Germany, Sweden and Denmark is available back to 1972. Landings decreased from around 15000 tons in the seventies to a rather stable level (2000 - 4000 tons) in the last thirty years. In recent years the landings from SD 21 has decreased (from 2000 t to 300 t) while the landings from SD 22 since mid-nineties has been stable/slightly increasing (around 1500 tons). The landings from SD 23 have all years been insignificant compared to the other areas (Table 5.1).

Denmark has in the whole period been dominating the catches with landing around 96% of the total landings in 1992 gradually decreasing to 76% in 2013 caused by the increasing landings by Germany (buying quotas from Sweden and Denmark).

The quality of the landing statistics is believed to be good as it builds on logbook/sales slip information and misreporting is not believed to be an issue because quota regulation never has been limiting the fishery, except for Germany in recent years. However, this not believed to have influenced the reliability of the landings significantly.

B.1.2 Discards estimates

Discard information have been compiled in InterCatch for the period 2002 to 2013 based on the EU data call in connection with the benchmark (Figure 5.1). It has not been possible to request pre-DCF-data in connection with the data call. The discard estimates is based on observer trips covering the important fisheries (otter trawl and Danish seines). The coverage I rather good as most significant strata (year, country, SD, quarter, fishery) are covered. The data is stratified on Active gears (trawls and seines) and Passive gears (gillnets). The Danish Discard raising is done outside InterCatch based on effort (number of trips) as no correlation between landed amount of plaice, all species landed or fishing days and the amount of discard of plaice could be demonstrated (WD 4). The Swedish and German discard is based on tons of landings of plaice (method used by InterCatch). All burrowing of data for strata without or with insufficient sampling is done inside InterCatch.

Additional rules applied for discard estimation

All un-sampled passive gear discards strata are assumed to have zero discard.

Germany uses in 2010 and 2013 the fleet groups “All” and “MIS_MIS_0_0_0_HC” in SD21. In all cases where extrapolation has been made for fleet = “All” (2010) and “MIS_MIS_0_0_0_HC” (2013), the source has been a mix of all relevant sources (same SD, Q, catch category). Manual weighting has been used in order to put equal total weighting to Passive and Active. The fleets “All” and “MIS_MIS_0_0_0_HC” only constitute a very small percentage of the total stock catches in the two years.

Additional rules applied for allocation of biological information (landing and discard)

SWE 2005 SD23 Passive discard: no source data exists. DEN 2005 SD23 Active discard is used.

For SD23: SD21 has always been used as source data if needed

If more than one source is used for discard estimation, manual equal weight is used.

The total discard per year was estimated to 4000 tons in 2002 decreasing to around 1300 tons in 2004 already and then being more a less stable around that level the rest of the period up to 2013. The overall discard percentage (all SDs) has been app. 45% in all years (31-56%).

B.2 Biological sampling

B.2.1 Maturity

The maturity ogives per year (running mean of three years) are shown in figure 1. The mean ogive is shown in figure 2. The data are calculated from 1st quarter surveys of NS-IBTS and BITS.

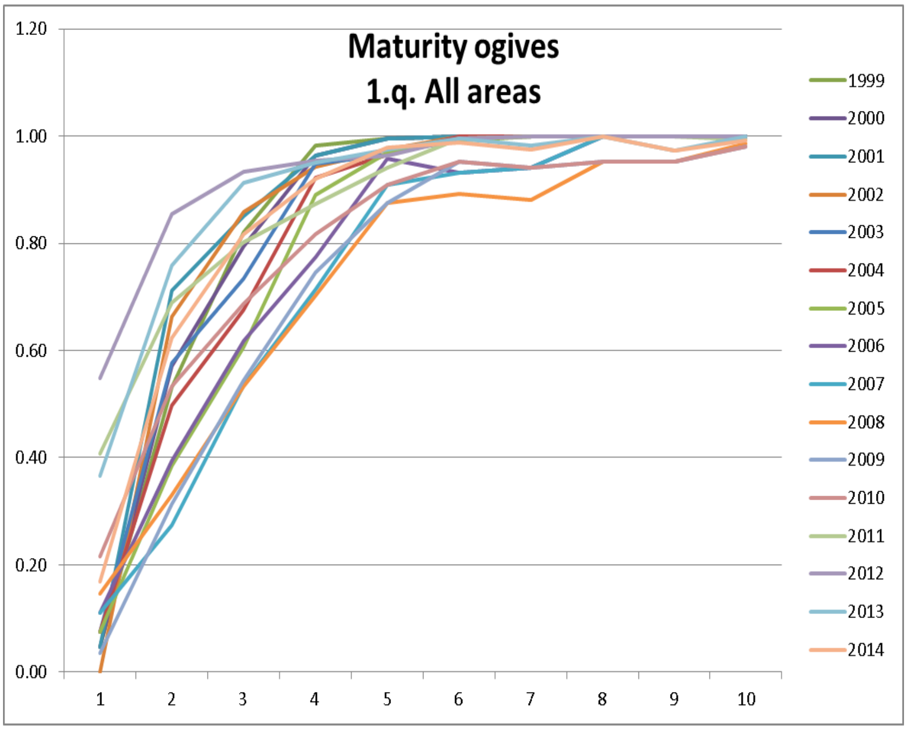


Fig. 1 Mean weight in stock compared to values for North Sea plaice.

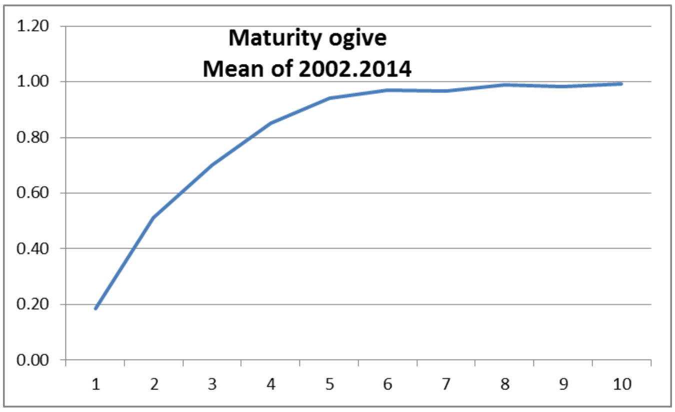


Fig. 2 Constant maturity ogive based on average of 2002-2014.

B.2.2 Natural mortality

The natural mortality is in line with the North Sea plaice stock set to constant 0.1 for all age classes except age 1, which is set to 0.2. The reason for the low mortality is the lack of observed plaice in stomachs of potential predators.

B.2.3 Length and age composition of landed and discarded fish in commercial fisheries

The mean weight in landings, discards and catches by age were extracted from InterCatch for each individual year. The stock mean weights by age were calculated from the two first quarter surveys for each individual year. BITS data only exists for the period 2008 to 2014 and NS-IBTS only for the period 2003 to 2014. Therefore, the BITS series is extended backwards to 2003 based on the average of 2008 to 2012. The common mean weight in the stock is then calculated as the mean of the two surveys. The common series is finally extended backwards to 1999 based on the average of 2003 to 2007. Mean weight at age in the stock is given in figure 3. The fluctuating stock mean weights of the older age classes is caused by the low number of individuals caught at the surveys and the extremely high variability in weight for these age classes. The constant mean weight is shown in figure 4 and compared with the North Sea

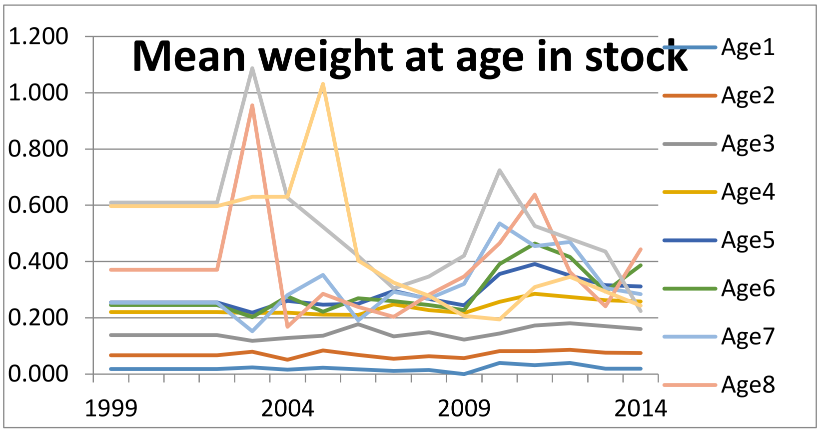


Fig. 3 Mean weight at age in stock.

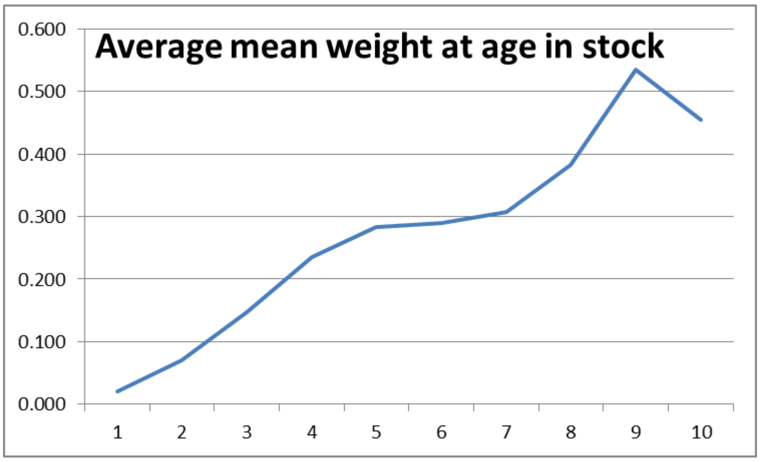


Fig. 4 Constant mean weight at age in stock (average of 2002-2014).

B.3 Surveys

All available survey series were recalculated previous to the WGPLE in order to cover only the stock area. This area is not a standard option in DATRAS and has to be done manually. Four surveys are available covering the stock area (SD21, SD22 and SD 23) or part of it.

B.3.1 Survey data used

NS-IBTS 1st quarter. The data series includes all hauls from the survey in SD 21. All hauls carried out by Sweden using RV Argos (1991-2011) or RV Dana (2012-2014). The data series is available from 1991-2014. The survey mostly overs the eastern part of SD 21 (fig 5.2a). App.25 hauls per year.

NS-IBTS 3rd quarter. The data series includes all hauls from the survey in SD 21. All hauls carried out by Sweden using RV Argos (1998-2010) or RV Dana (2011-2014). The data series is available from 1998-2014. The survey mostly overs the eastern part of SD 21 (fig 5.2b). App.25 hauls per year.

BITS 1st quarter. The data series includes all hauls from the survey in SD 21, SD 22 and SD 23. All hauls carried out by Germany using RV Solea or by Denmark using RV Havfisken. The data series is available from 1998-2014 and covers the complete stock area. Standard gear introduced in 2000. CPUE for years before 2000 are adjusted to common standard. App. 55 hauls per year.

BITS 4th quarter. The data series includes all hauls from the survey in SD 21, SD 22 and SD 23. All hauls carried out by Germany using RV Solea or by Denmark using RV Havfisken. The data series is available from 1999-2014 and covers the complete stock area. Standard gear introduced in 2000. CPUE for years before 2000 are adjusted to common standard. App. 55 hauls per year.

The two 1st quarter surveys and the two second-half-of-the-year surveys were combined using the smoothed GAM approach developed by Casper berg (#WD3b). Only the age up to 5 was included due to low numbers for age class 6 and 7 particularly in the start of the series.

B.4 Commercial CPUE

No commercial CPUE is used in this assessment.

C. Assessment methods and settings

C.1 Choice of stock assess model

Model used: State bases Assessment Model (SAM)

Software used: stockassessment.org

C.2 Model used of basis for advice

Within stockassessment.org; PLE2123_Benchnark_2015_aveMat_aveMWstock

Model options

Commercial catches

Age group 0 has been excluded in input because mean weights of age 0 is highly inconsistent and is seldom even in discards.

Age group 7 has been recalculated to be +group. This is done in the model script (input data still have age10 as +group)

Landings (tons) are available from all countries back to 1972 but not used in the assessments as SAM cannot use this information. Discards (CANUM, WECA) are only available back to 2002. Discards 1999-2001 are calculated as the plain average of 2002-2005 (5 years). Landing (CANUM and WECA) are available back to 1999.

Fbar= 3-5.

Tuning fleets

NS-IBTS 1st quarter and BITS 1st quarter combined by use of GAM-model (Berg et al. 2013).

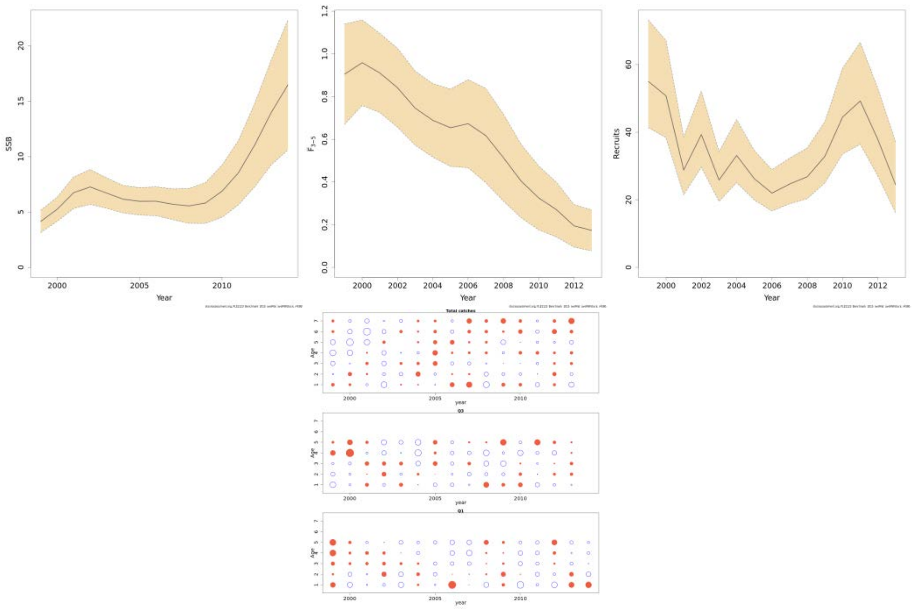
NS-IBTS 3rd quarter and BITS 4th quarter combined by use of GAM-model (Berg et al. 2013).

The tuning fleets include age class 1-5

Coupling of catchability of age 4-5 for both tuning fleets

Constant maturity and

Constant mean weight at age in stock



C.3 Assessment model configuration

TYPE	NAME	YEAR RANGE	AGE RANGE	VARIABLE FROM YEAR TO YEAR YES/NO
Caton	Catch in tonnes	1999-2014	-	Yes
Canum	Catch at age in numbers	1999-2014	1-7+	Yes
Weca	Weight at age in the commercial catch	1999-2014	1-7+	Yes
West	Weight at age of the spawning stock at spawning time.			
Mprop	Proportion of natural mortality before spawning	1999-2014	1-7+	No
Fprop	Proportion of fishing mortality before spawning	1999-2014	1-7+	No
Matprop	Proportion mature at age	1999-2014	1-7+	No
Natmor	Natural mortality	1999-2014	1-7+	No

D. Short-term prediction

Model used:

Software used: No short term prediction were made during WGPLE. This will be done during WGBFAS

Initial stock size:

Maturity:

F and M before spawning:

Weight at age in the stock:

Weight at age in the catch:

Exploitation pattern:

Intermediate year assumptions:

Stock recruitment model used:

Procedures used for splitting projected catches:

E. Biological reference points

Relevant reference points will be calculated in the upcoming WGBFAS (April 2015)

F. Other issues

F.1. Biology of species

I.1. References

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