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Contents

0 Executive summary

The ICES Working Group for the Assessment of Demersal Stocks in the North Sea and Skagerrak (WGNSSK) met at ICES Headquarters in Copenhagen, Denmark, during 5-11 May 2010. There were 24 participants from 9 countries. The main terms of reference for the Working Group were: to Produce a first draft of the advice on the fish stocks and fisheries under considerations, to update, quality check and report relevant data for the working group, to produce an overview of the sampling activities on a national basis to update the description of major regulatory changes and comment on the potential effects of such changes, to update the assessment of the stocks and to set MSY reference points (F_{MSY} and MSY $B_{trigger}$) The group also met by correspondence in September 2010 to carry out assessments of the sandeel in the North Sea and the second of the biannual assessments of the North Sea Pout; and by correspondence in October of 2010 to provide update forecasts for stocks with survey information collected after the May meeting.

0.1 Working procedures

A number of issues were encountered by the WG to meet its objectives as a result of

1) The addition of new ToRs of primary importance, without any additional time available to the WG for its May meeting. In particular, the process of providing new reference points for the MSY framework as well as the requested changes to the format of advice sheets were experienced to be highly time-consuming by the WG members.

2) Data quality issues arising from

    a. the scheduling of the meeting in May imposing severe stress at some national laboratories as a result of the concentration of the majority of ICES assessment working groups into May

    b. the timing of the meeting being close to the date at which survey information from the IBTS quarter 1 survey was first complete

    c. a number of important sources of data, including both commercial tuning series and scientific surveys, having no estimates for 2009

    d. sometimes severe inconsistencies in the stock trends coming out of the various sources of information.

3) The requirement for update advice in September after the autumn surveys

The point raised in a) was the main issue encountered by the WG. The 7 days duration of the WG meeting (which had been scheduled in September 2009, prior to the addition of the ToR related to MSY) is considered appropriate by the WG to address the more routine ToRs dealing with stock assessment and draft advice. However, providing relevant MSY reference points building on a sound a thorough scientific analysis required considerable time during the WG meeting, in spite of significant amount of work performed by a number of WG members prior to the meeting. This is due to the high level of uncertainty and variability linked to the estimation and interpretation of long-term yield, which leads to necessary discussions about the number of arbitrary choices that must be made.

While the WG generally supports the transition of ICES advice to the MSY framework, it is also strongly concerned by the very short time frame that has been allocated to its testing prior actual implementation in the advice. It is the opinion of the WG that a thorough and generic review of the outcomes of the various assessment EGs should take place in order to adjust for potential inconsistencies and gaps between stocks, before than this framework can serve as the basis for advice. The WG wishes to underline that the estimates provided this year during the May meeting are considered as preliminary estimates and are likely to be revised during future meetings.

With regards to the point raised in b), considerable effort was made by the WG this year to provide the data in due time ahead of the meeting, and improve the quantity and quality of data being included in the InterCatch database. Much effort was also done by the various labs to provide their IBTS estimates to ICES secretariat, timely for the WG. However, a number of data issues still remained; These are described in the relevant parts of the report.

As in previous years, the system of benchmark/update assessments could not be entirely followed by the WG. Various changes in data availability and/or consistency raised important issues for the assessment of a number of stocks, leading to some hindrance to produce an updated advice draft during the May meeting

As previously, stock annexes for where available were included in the main report within Appendix 3. The stock annexes will be updated each time that the stock is analysed within a benchmark review.

0.2 State of the stocks

The yields for stocks of **Nephrops** are fairly stable from year to year. Reported landings for FU 3 (Skagerrak) and FU 4 (Kattegat) have averaged 2500t and 1500t respectively since 2000 with relatively little variation. There are no signs of overexploitation in IIIa and given the apparent stability of the stock, the current levels of exploitation appear to be sustainable.

FU 7 (Fladen, 13300 t), FU 8 (Firth of Forth, 2600 t) and landings from outside the FUs (2367t) were all at their highest recorded landings TV surveys for FUs 7, 8 and 9 all decreased in 2009 following several years of increases in observed abundance. The TV survey in FU6 also decreased but this stock is considered to have been in a depleted state for the last 3 years due to high levels of fishing effort. Extended effort was performed in order to provide a sound basis for Fmsy reference points, thus replacing the previous F0.1 standard approach.

The **Norway Pout** fishery has fluctuated considerably in recent years with full or partial closures in 2005, 2006, and 2007 due to very low recruitments in 2003 & 2004. The mid-year update of the Norway Pout assessment shows the stock to be well above Btrigger at the start of 2010 and projected to remain above Btrigger at the start of 2011. The first indications of the 2010 year class (from the 2010 IBTS 3rd quarter survey), is for a record **low** recruitment. For this reason, short term forecasts indicate that even in a total absence of fishing mortality in 2011 the stock will fall back below Btrigger by the start of 2012.

The **sandeel** assessment was benchmarked in September 2010. This resulted from a move in the assessment from a single region to 7 distinct regions, for which analytical assessments can be undertaken for 3 areas (covering the majority of the fishery).

The sandeel fishery targets 1 and 2 year old fish and by October there are no data upon which to gauge the size of the incoming 0-group. The DTU-Aqua dredge survey undertaken in December will provide sufficient data to estimate the 0-group in areas SA1 (Dogger) and SA2 (SE North Sea). ICES will be in a position to give advice for these areas in late January. The data for SA3 (NE North Sea) is not yet robust enough to provide a reliable estimate and in-year monitoring will probably be required in this area for a few more years and therefore final advice for this stock will be available in April 2011**.**

Assessment of **cod in Sub-area IV and Divisions IIIa and VIId** has been particularly difficult for 2009. Estimates of abundance (and consequently mortality) from the two IBTS surveys have continued to diverge to the extent that they are not considered reliable enough to provide a precise assessment of the stock status although the main trends can be estimated with some degree of certainty. Estimated spawning-stock biomass reached a low in 2006 but has subsequently increased. Fishing mortality is now estimated to have declined since 2000 (~ 0.64 in 2007). Recruitment since 2000 has been well below average. The higher levels of discarding observed since 2007 is maintaining the fishery induced mortality at a high level.

The fishing mortality for the stock of **Haddock in Subarea IV and Division IIIaN** in 2009 is close to the historical low. The decline in abundance of the dominant 1999 year-class has been offset to a certain extent by an improved 2005 year class. However, the reduction in mortality rate has not prevented a continued decline in SSB. The 2005 year-class is estimated to be quite abundant (39 000 million) and the largest since the 1999 year-class.

The assessment of **whiting in Sub-area IV and Division VIId** remains problematic in that the historic estimates of biomass derived from surveys exhibit differing trends from those based on catch data. However the recent trends are consistent and the WG accepted that assessment based on data from 1990. There have been substantial revisions in estimates of recent recruitment and, in conjunction with low fishing mortality, the stock is considered to be increasing from its recent low level. Survey estimates of the youngest ages in the recent years appear to have either underestimated the incoming recruitment or imply that mortality has effectively been zero (which is unlikely).

The assessment of **saithe in Sub-areas IV and VI and Division IIIa** was hampered by the loss of several tuning indices for the year 2009, hence it was not possible to run an update assessment. As the assessment results of saithe tend to be relatively stable between years catch option for saithe were generated using a 3 year forecast from the assessment results of ICES WGNSSK 2009. Landings of saithe in Sub-areas IV and VI and Division IIIa have been stable for several years at a level well-below the permitted TAC. Fishing mortality has now remained at or below 0.3 (Fmsy) for nine years while SSB has stabilised at around 260 kt. Recruitment is fluctuating about the mean level.

The reported landings for **sole in Subarea IV** in 2009 (13.9 kt) were almost the same as 2008 (14.0kt). SSB has fluctuated around a moderate-to-low level for several years and is currently around Bpa. Fishing mortality has been generally falling since the late 1990's and is now below Bpa. However, the updated recruitment estimate based on the latest BTS data in September suggests a high 2009 year class abundance, and hence a potential for slight TAC increase compared to the June advice.

Landings of **plaice in Subarea IV** increased slightly in 2009 but are low compared to historical levels. SSB has increased dramatically over the last three years, well above

Bpa and is currently close to the historical maximum. Fishing mortality has decreased to its lowest observed level. Recent year-class strength has been at the long-term mean.

Discrepancies between catch-at-age based analyses and survey-based analyses have still prevented the WG from providing a definitive assessment the state of **plaice in Division VIId,** in spite of significant improvements gained during the benchmark procedure in 2010. F has been stable for the last five years. The spawning stock biomass has followed a stepped decline in the last 10 years, following a peek generated by the strong 1996 year class. The current level of SSB is stable at a low level.

It has been postulated that a mismatch between the biological entity of the **Plaice** stock in **Division IIIa** and the defined management area might exist. Most catches are taken at the boundary with the North Sea where some mixing with North Sea plaice may occur, and this may undermine the quality of age-based information. Furthermore, the limited survey coverage of main fishing grounds has regularly prevented the presentation of a stock assessment. There is evidence for sustained biomass in the Kattegat and in Eastern Skagerrak, where the populations intermingle between both areas. But the status of the stock in the Southwestern Skagerrak, cannot be determined.

Landings for **sole in Division VIId** have fluctuated around a mean level for many years, and show no significant trends. Fishing mortality has been stable between 2000 and 2005 around Fpa. In the last 4 years fishing mortality has increased to values between Fpa (0.4) and Flim (0.57). The spawning stock biomass has been stable for most of the time series and SSB is presently well above Bpa. The strong 2004 and 2005 year class increased SSB to around record high level of the time series in 2008. The potentially very strong 2008 year class could even increase SSB in the future.

0.3 Environmental and ecosystem considerations

The WG was asked to summarise, when relevant, species interactions and ecosystem drivers, and ecosystem effects of fisheries. Potential updates of relevant information were done within each stock section, but no significant changes have been considered compared to the previous reports. The main adjustment so far has been the inclusion of natural mortality estimates accounting for multispecies interactions, and provided by ICEs WGSAM, in the single-stock assessment models.

Beside this, only few quantitative modifications have been made so far to assessments or forecasts to account for environmental information. As a general basis, the lack of firm understanding on causative mechanisms linking fish stocks and the environment, the poor predictability of ecosystems and the difficult coupling between environmental models and assessment models are the main reasons advocated to explain this,. The exceptions were those stocks for which recent recruitment is clearly different (in some way) to historical recruitment, in which case the recent recruitment estimates only were used to generate recruitment forecasts. Apart from this, the report is limited to comments on potentially-important ecosystem impacts.

0.4 Mixed-fisheries data collation and modelling

Since 2006, most of the analyses of mixed-fisheries interactions were undertaken outside of the WGNSSK, both within the Study Group on Simple Mixed-Fisheries Management models (ICES SGMIXMAN) which met between 2006 and 2008 (ICES, 2006-2008), and within various research projects, but each time with the demersal fisheries of the North Sea as the primary case study. This resulted of the setup of a workshop

(ICES WKMIXFISH 2009) and a adhoc group (ICES AGMIXNS 2009) which aimed at providing a draft mixed-fisheries advice for the North Sea, based on single-stock exploitation boundaries produced by WGNSSK in 2009. The results of this were presented to WGNSSK during its May meeting this year. This workshop reconvened in August 2010 as Working Group (WGMIXFISH), and the information collected by this group in terms of trends in catches and fishing effort have been summarised in the overview section. Mixed fisheries issues are also raised in management considerations for the individual stocks where appropriate.

1 General

1.1 Terms of Reference

The **Working Group on the Assessment of Demersal Stocks in the North Sea and Skagerrak** [WGNSSK] (Chaired by: Clara Ulrich*, Denmark and Ewen Bell*, UK) met at ICES HQ, 5–11 May 2010 to:

a) address generic ToRs for Fish Stock Assessment Working Groups (see table below). The Sandeel and Norway pout assessments shall be developed by correspondence;

The assessments will be carried out on the basis of the stock annex in National Laboratories, prior to the meeting. This will be coordinated as indicated in the table below.

Material and data relevant for the meeting must be available to the group no later than 14 days prior to the starting date.

WGNSSK will report by 18 May and 17 September 2010 (Sandeel/Norway pout) for the attention of ACOM. The group will report on the AGCREMP 2008 procedure on reopening of the advice before 8 October and will report on reopened advice before 29 October.

Fish Stock	Stock Name	Stock Coordinator	Assessment Coord. 1	Assessment Coord. 2	Perform assessment	Advice
cod-347d	Cod in Subarea IV, Divison VIId & Division IIIa (Skagerrak)	UK(Scotland)	UK(England)	Denmark	Y	Update
had-34	Haddock in Subarea IV (North Sea) and Division IIIa	UK(Scotland)	UK(Scotland)	UK(England)	Y	Update
nep-5	*Nephrops* in Division IVbc (Botney Gut - Silver Pit, FU 5)	Denmark	Denmark	Denmark	Y	Update
nep-6	*Nephrops* in Division IVb (Farn Deeps, FU 6)	UK(England)	UK(England)	Denmark	Y	Update
nep-7	*Nephrops* in Division IVa (Fladen Ground, FU 7)	UK(Scotland)	UK(Scotland)	Denmark	Y	Update
nep-8	*Nephrops* in Division IVb (Firth of Forth, FU8)	UK(Scotland)	UK(Scotland)	Denmark	Y	Update
nep-9	*Nephrops* in Division IVa (Moray Firth, FU9)	UK(Scotland)	UK(Scotland)	Denmark	Y	Update
nep-10	*Nephrops* in Division IVa (Noup, FU 10)	UK(Scotland)	UK(Scotland)	Denmark	Y	Update
nep-32	*Nephrops* in Division IVa (Norwegian Deeps, FU 32)	Norway	Norway	Denmark	Y	Update
nep-33	*Nephrops* in Division IVb (Off Horn Reef, FU 33)	Denmark	Denmark	Norway	Y	Update
nep-iiia	*Nephrops* in Division IIIa (Skagerak Kattegat, FU 3,4)	Denmark	Denmark	Sweden	Y	Update
nop-34	Norway Pout in Subarea IV and Division IIIa	Denmark	Denmark	Norway	Y	Update
ple-eche	Plaice in Division VIId (Eastern Channel)	France	France	Belgium	Y	Update

ple-kask	Plaice in Division IIIa (Skagerrak - Kattegat)	Denmark	Denmark	Sweden	Y	Same advice as last year
ple-nsea	Plaice Subarea IV (North Sea)	Netherlands	Netherlands	Belgium	Y	Update
sai-3a46	Saithe in Subarea IV (North Sea) Division IIIa West (Skagerrak) and Subarea VI (West of Scotland and Rockall)	Norway	Norway	Germany	Y	Update
san-nsea	Sandeel in Subarea IV excluding the Shetland area	Denmark	Denmark	Norway	Y	Update
san-shet	Sandeel in Division IVa North of 59° N and West of 0 ° E – (Shetland area)	UK/ Denmark			N	Catch statistics only
san-kask	Sandeel in Division IIIa (Skagerrak – Kattegatt	DK			N	Catch statistics only
san-scow	Sandeel in Division VIa	DK			N	Catch statistics only
sol-eche	Sole in Division VIId (Eastern Channel)	Belgium	Belgium	France	Y	Update
sol-nsea	Sole in Subarea IV (North Sea)	Netherlands	Netherlands	Belgium	Y	Update
whg-47d	Whiting Subarea IV (North Sea) & Division VIId (Eastern Channel)	UK(Scotland)	UK(Scotland)	UK(England)	Y	Update
whg-kask	Whiting in Division IIIa (Skagerrak - Kattegat)	Sweden	Sweden	Denmark	N	Catch statistics only

The generic ToRs applying to assessment Expert Groups were the following :

The working group should focus on:

ToRs a) to h) for stocks that will have advice,

ToRs b) to f) and h) for stocks with same advice as last year.

ToRs b) to c) and f) for stocks with no advice.

a) Produce a first draft of the advice on the fish stocks and fisheries under considerations and the regional overview according to ACOM guidelines.

b) Update, quality check and report relevant data for the working group:

    b) Load fisheries data on effort and catches (landings, discards, bycatch, including estimates of misreporting when appropriate) in the INTERCATCH database by fisheries/fleets. Data should be provided to the data coordinators at deadlines specified in the ToRs of the individual groups. Data submitted after the deadlines can be incorporated in the assessments at the discretion of the Expert Group chair;

    c) Abundance survey results;

    d) Environmental drivers.

    e) Propose specific actions to be taken to improve the quality of the data (including improvements in data collection).

c) Produce an overview of the sampling activities on a national basis based on the INTERCATCH database);

d) In cooperation with the Secretariat, update the description of major regulatory changes (technical measures, TACs, effort control and management plans) and comment on the potential effects of such changes including the effects of newly agreed management and recovery plans.

e) For each stock update the assessment by applying the agreed assessment method (analytical, forecast or trends indicators) as described in the stock annex. If no stock annex is available this should be prepared prior to the meeting.

f) Produce a brief report of the work carried out by the Working Group. This report should summarise for the stocks and fisheries where the item is relevant:

Input data (including information from the fishing industry and NGO that is pertinent to the assessments and projections);

f) Where misreporting of catches is significant, provide qualitative and where possible quantitative information and describe the methods used to obtain the information;

g) Stock status and 2011 catch options;

h) Historical performance of the assessment and brief description of quality issues with the assessment;

i) Mixed fisheries overview and considerations;

j) Species interaction effects and ecosystem drivers;

k) Ecosystem effects of fisheries;

l) Effects of regulatory changes on the assessment or projections;

g) Where appropriate, check for the need to reopen the advice in autumn based on the new survey information and the guidelines in AGCREFA

h) Set MSY reference points (F_{MSY} and MSY $B_{trigger}$) according to the ICES MSY framework and following the guidelines developed by WKFRAME.

1.2 InterCatch

The InterCatch database has historically not been widely used by the WGNSSK. In particular for the stocks including discards estimates, a repeated concern has been the incapacity of InterCatch to raise discards data to sampling strata with missing data (e.g. countries not providing discards estimates, where estimates must then be approximated externally based on landings figures). In 2009, only one stock was using InterCatch up to the final level, and some data sets were also uploaded into the database for some other stocks, but not used for generating assessment data.

During the 2010 meeting, a specific effort was made to try improving the coverage of the data uploaded in InterCatch, through short workshops dedicated to particular stocks in order to identify the potential issues in the use of InterCatch. It has though not been possible to spend much time actually uploading new data during the meeting itself because of time pressure, but it is expected that further follow-up will take place intersessionally and improvements will be achieved by 2011. The actual level of InterCatch use by stock is described within each stock section.

1.3 MSY reference points

The WGNSSK spent a considerable share of its May meeting addressing this ToR, which was added after decision on the 7-days duration of the meeting. Important work had been prepared by some WG members in advance of the meeting, in order to provide generic exploratory and estimation tools to the group (see below). Many preliminary analyses could be performed using these tools on a variety of stocks, and improving the scripts available alongside.

The WG considered there to be fundamental differences between the PA framework, which worked out limits reference points largely based on observed historical data, and the MSY framework, which builds on fuzzier potential future targets. There is thus more inherent uncertainty in Fmsy than in Fpa. However, the limited duration of the WG meeting did not allow sufficient analyses of the preliminary results obtained. As underlined during ICES WKFRAME, and as experienced by the WG members, the MSY reference points estimates are highly dependent of the underlying hypotheses. In a single-stock context, Fmsy estimates are mostly sensitive to:

- The form of the Stock-Recruitment relationships chosen, and the choice of the fitting algorithm and software,
- The number of years used for averaging the weight-at-age and selectivity-at-age values in a deterministic approach, or for estimating the variability around these in a stochastic context.

Because of this inherent uncertainty, the WG does not consider that the results included in the stock sections are definitive. In particular, the priority has been towards the estimation of Fmsy, and little time has been left to the estimation of MSY Btrigger. Therefore, it is inevitable that revisions will occur before the next WG meeting if further work takes place intersessionally and that some changes may be substantial. It is the WG opinion that 1-2 additional meeting days would have allowed more appropriate analyses and adequate discussion of the results obtained, and would have lead to more robust estimates in the first place.

Four different approaches were developed by WG members, largely developed around ICES WKFRAME and further used and developed during the WGNSSK meeting. The first three deal with stocks for which age-based information exist, and present many similarities in their standard combinations of YPR, SRR and SPR relationships. The fourth one is an approach specifically developed for Nephrops stocks ahead of the WG meeting.

It is to be noted that the approaches 1, 2 and 4 were later used by the WGCSE, which met after WGNSSK. The four approaches are briefly summarised below :

1.3.1 Estimating Fmsy using AD model builder

(Further information available from Jose DeOliveira, Timothy Earl, Chris Darby)

AD Model Builder (admb-project.org) is a highly efficient, freely available software for implementing non-linear statistical models. One of the principal advantages of this software is the ability to carry out automatic differentiation which speeds up the convergence of any model fit and calculates the derivatives as accurately as if the analytical derivatives were implemented. It also produces several different estimates of the uncertainties of model parameters and selected derived quantities.

During ICES WKFRAME, a suite of programmes in AD model builder was developed, in order to estimate Fmsy and some components of its uncertainty from the outputs of a standard ICES stock assessment, and in particular the ICES *.sum and *.sen files. The suite is described in details in ICES WKFRAME (2010), Case Study 2.

This suite of programs was successfully tested and used for a number of stocks during WGNSSK meeting, and served as the primary tool for providing final Fmsy estimates.

1.3.2 Estimating Fmsy using FLR

(Further information available from Clara Ulrich, John Simmonds, Jan-Jaap Poos)

A number of R scripts using the FLR framework (www.flr-project.org) were developed ahead and during ICES WKFRAME 2010 (Case Studies 3 and 6). These scripts were later merged into a single generic R-FLR program (Finding Fmsy with FLR_v4.r), in order to explore and compare various methods for estimating Fmsy using a single FLStock object as input. As no adequate documentation is to be found in ICES WKFRAME (2010), this script is briefly summarised here. The script investigates the following steps:

- Fitting and comparing various Stock Recruitment Relationships with FLSR,
- Estimating usual deterministic biological Reference Points (Fmax, F0.1, Fspr30%, Fmsy) using these SRR and the standard equilibrium equations from the FLBRP package,
- Exploring the variability in time of these reference points, using the default 3-years average for weight-at-age and selectivity-at-age or using a longer time span for averaging
- Fitting stochastic SRR, either through bootstrapping of the variance-covariance matrix of the parameters of the SRR (if positive), or alternatively using boostrapping og jaknifing of the observations
- Estimating stochastic BRP using equilibrium equations as above (Analytical estimation of Fmsy)
- Estimating maximum yield out of long-term projections of the stock under various levels of fishing mortality (Empirical estimation of Fmsy)

This flexible script was tested and further developed on a number of stocks during WGNSSK, and served mostly as a valuable exploratory tool for understanding the importance of the choices around input parameters (cf figure 1.3.1).

1.3.3 Estimating Fmsy using a stand-alone R script

(Further information available from Coby Needle)

An alternative R script was also developed around ICES WKFRAME 2010 (Case Study 5), using a analytical combination of fitted stock-recruit, yield-per-recruit and SSB-per-recruit curves. This script was used during WGNSSK for estimating Fmsy for the haddock stock, and is thus described in section 13.7

1.3.4 Estimating Fmsy for Nephrops

(Further information available from Ewen Bell and Helen Dobby)

The different *Nephrops* stocks (Functional Units, FUs) for which ICES delivers advice cover a wide range of fisheries including single, twin, triple and even quadruple trawls, creeling (potting), with activity covering inshore and offshore grounds. The timing of these fisheries varies, which due to the different emergence patterns of the different sexes due to moulting and egg-brooding, leads to very different relative exploitation rates (between the sexes) in different FUs. Local ecosystem type is also highly variable with a range of *Nephrops* densities, different composition and density of organisms competing for space as well as different assemblages of predators. Ground types also cover a wide range including large contiguous sediment beds, fragmented patches of suitable sediment in rocky areas, shallow sea-lochs and patches of mud on relatively deep shelf-edges. Given these differences in fishery and ecology it is inevitable that estimates of the exploitation rate leading to long term MSY will vary between the FUs, the difficulty for scientists is how to estimate these rates given the inherent difficulty in assessing crustacean stocks, for which no practical method routine of age determination is available. Some assessments take the observed length frequency data and slice it into age-classes according to the Von-Bertalanffy growth parameters. These numbers at age are then taken forward into standard stock-assessment packages. This practice was ceased in 2005 within this Group due to concerns over both the reliability of reported landings in some FUs (particularly the UK fisheries) and the use of the 'pseudo' age-structured data in an age-based assessment was deemed untenable. As a result of this, no dynamic population model is fitted to the data and consequently there are no estimates of spawning stock and recruitment which are fundamental to the determination of F_{msy} and proxies for F_{msy} must therefore be sought. ICES WKFRAME (ICES 2010) made several recommendations for defining F_{msy} proxies where no direct estimation of F_{msy} was possible (i.e. for stocks for which there is no analytic assessment, but length- or age-structured catch data are available). The suggested approach focussed on per-recruit analysis with the following guidelines:

- Use input parameters which reflects the current situation (selection and discard ogive, maturity and weight at age/length)
- If there is clear peak at low F in the YPR analysis and no evidence of recruitment dependence on biomass, then F_{max} may be an appropriate proxy.
- Where F_{max}, is undefined then $F_{0.1}$ might be considered as a 'lower bound' to the range of F suitable for F_{msy}, as it is assumed to be low risk.
- Spawning biomass per recruit analysis should be routinely evaluated in addition to YPR. There is not a single level of % SPR that is optimal for all stocks and the proposal for F_{msy} should include some consideration of life history. Studies by Clark (1991, 1993) concluded that F35% and higher were robust proxies for F_{msy}, considering uncertainty in stock-recruitment functions and or recruitment variability.
- Conduct a sensitivity analysis to the input parameters and consider the variability of estimates over time.

WKFRAME also emphasized that given the substantial amount of data exploration and sensitivity analysis that would be required in defining appropriate F_{msy} proxies, the process was likely to be iterative and that ICES and its clients should be willing to work with recursively updated targets.

Within the North Sea, Skagerrak and Kattegat areas, assessment of *Nephrops* stocks falls into three categories, those with TV surveys, those monitored by LPUE / mean size and those with only landing information. Only for those stocks with TV surveys is the catch advice determined by an exploitation rate, advice for the other stocks is based on changes to landings. For those stocks with a TV survey, the Harvest Rates (removals divided by abundance as estimated by the TV survey) associated with fishing at $F_{0.1}$ and F_{max} were estimated at the 2009 benchmark meeting WKNEPH (ICES

2009). In response to the recommendations of WKFRAME, estimates of $F_{35\%SpR}$ and the corresponding Harvest Rate have also been determined and these estimates typically lie between the estimates of $F_{0.1}$ and F_{max}. Suggestions for a TV-abundance based proxy for $B_{trigger}$ have been made on the basis of the lowest observed TV-abundance (median survey value) *unless* the stock has shown signs of stress at a higher TV-abundance in which case this value becomes $B_{trigger}$.

The remaining challenge is determining which F_{msy} proxy is appropriate for which stock and this becomes an exercise in expert judgement based upon knowledge of the fishery and the ecosystem. The implications for exploitation rate can vary considerably depending upon which proxy is chosen ($F_{0.1}$, $F_{35\%SpR}$ or F_{max}). Given that there is often a distinct difference in the exploitation rate between the two sexes (males>females) it is usually impossible to simultaneously achieve the target fishing mortality on both sexes (i.e. the stock cannot be fished such that both the male and female YPRs are maximised simultaneously). Different F_{msy} proxies are therefore obtained by conducting male, female or a combined sex per-recruit analysis. The following text-table shows the F-multipliers required to achieve various F_{msy} proxies for the sexes of a typical *Nephrops* stock (FU 8 in this example), the Harvest Rates which correspond to those F multipliers and the resulting level of spawner-per-recruit expressed as a percentage of the virgin level.

			Fbar(20-40 mm)		HR (%)	SPR (%)		
		Fmult	Male	Female		Male	Female	Combined
$F_{0.1}$	Male	0.2	0.13	0.06	7.47	42.33	64.50	51.72
	Female	0.43	0.29	0.13	14.23	22.96	44.80	32.21
	Combined	0.24	0.16	0.07	8.75	37.29	60.04	46.92
F_{max}	Male	0.36	0.24	0.11	12.31	26.94	49.50	36.49
	Female	0.81	0.54	0.24	23.38	12.11	28.95	19.24
	Combined	0.46	0.31	0.14	15.03	21.55	43.02	30.64
$F_{35\%SpR}$	Male	0.27	0.18	0.08	9.67	34.13	57.04	43.83
	Female	0.63	0.42	0.19	19.28	15.79	34.96	23.91
	Combined	0.39	0.26	0.12	13.15	25.10	47.38	34.53

The yield per-recruit and spawner per-recruit plots for this stock are shown in figure 1.3.2, emphasising the disparity in f-multipliers required to achieve F_{max}. The general tradition in fisheries science is to concentrate on the mortality on females because in a freely distributing population, one male should be able to fertilise several females and therefore a higher exploitation rate on males should not affect spawning potential. *Nephrops* are slightly different in that the adults have a fairly limited range of movement (100's of metres) and therefore very low densities of males could result in sperm limitation. Ensuring that the fishing mortality target on males is not exceeded will usually result in an under-utilisation of the females, but due to the faster growth rate of males the under-utilisation of total yield is not likely to be large. The alternative, of trying to achieve F_{msy} on females, carries a potentially serious risk to the production of future recruits and may result in very high exploitation of males. The Working Group suggested that a combined sex F_{msy} proxy should be considered appropriate *provided* that the resulting percentage of virgin spawner per-recruit for males does not fall below 20%. In such a case the male F_{msy} proxy should be chosen in preference to the combined proxy.

In cases where recruitment rates are typically low and/or highly variable then a more cautious F_{msy} proxy would be appropriate as the stock may have reduced resilience to periods of poor recruitment and in this case $F_{0.1}$ is recommended. Conversely where recruitment rates are considered to be regularly high and the stock appears to have supported a harvest rate at or above F_{max}, (or in the case of a short TV time series a particular landing level) without showing signs of recruitment overfishing, then F_{max} is recommended. In all other cases F35%SpR should deliver high long term yield with a low probability of recruitment overfishing and is recommended as the "default" value.

In order to assist communication of the decision process the following bullet list is suggested as a standard checklist for describing the rationale behind the choice of a particular F_{msy}.

- Describe the absolute density. Is it high (i.e. >1 per m^2), medium (i.e. 1.0 – 0.2 per m^2) or low (i.e. <0.2 per m^2)
- Variability in density. Is there large interannual variability, spatial complexity?
- Understanding of biological parameters. Is the growth rate particularly fast or slow, high or low estimates of natural mortality?
- Fishery timing & operation. Is there a strong seasonal pattern leading to different exploitation rates on the sexes, does this pattern vary much between years?
- Observed Harvest Rate or landings compared to stock status. Is the harvest rate consistently around or above F_{max}? Have landings been stable? Have the indicators of stock status shown signs of difficulty?

Accompanying this text should be a table listing the F_{msy} proxies F_{max}, $F_{35\%SpR}$ and $F_{0.1}$ for males and females, the Harvest Rates they correspond to along with the implied %spawner per recruit for males and females.

Following changes to UK legislation in 2006 the reliability of UK landings data is considered to have significantly improved (representing ~80% of the landings). Provided that this is both true and continues into the future, assessment scientists will eventually have data which could be used to parameterise dynamic stock assessment models which in turn will enable estimation of F_{msy} directly rather than have to rely upon proxies thereof. Until this point the decision of which F_{msy} proxy is suitable for which FU will inherently be a subjective process but the process outlined above should provide sufficient justification to support the decision.

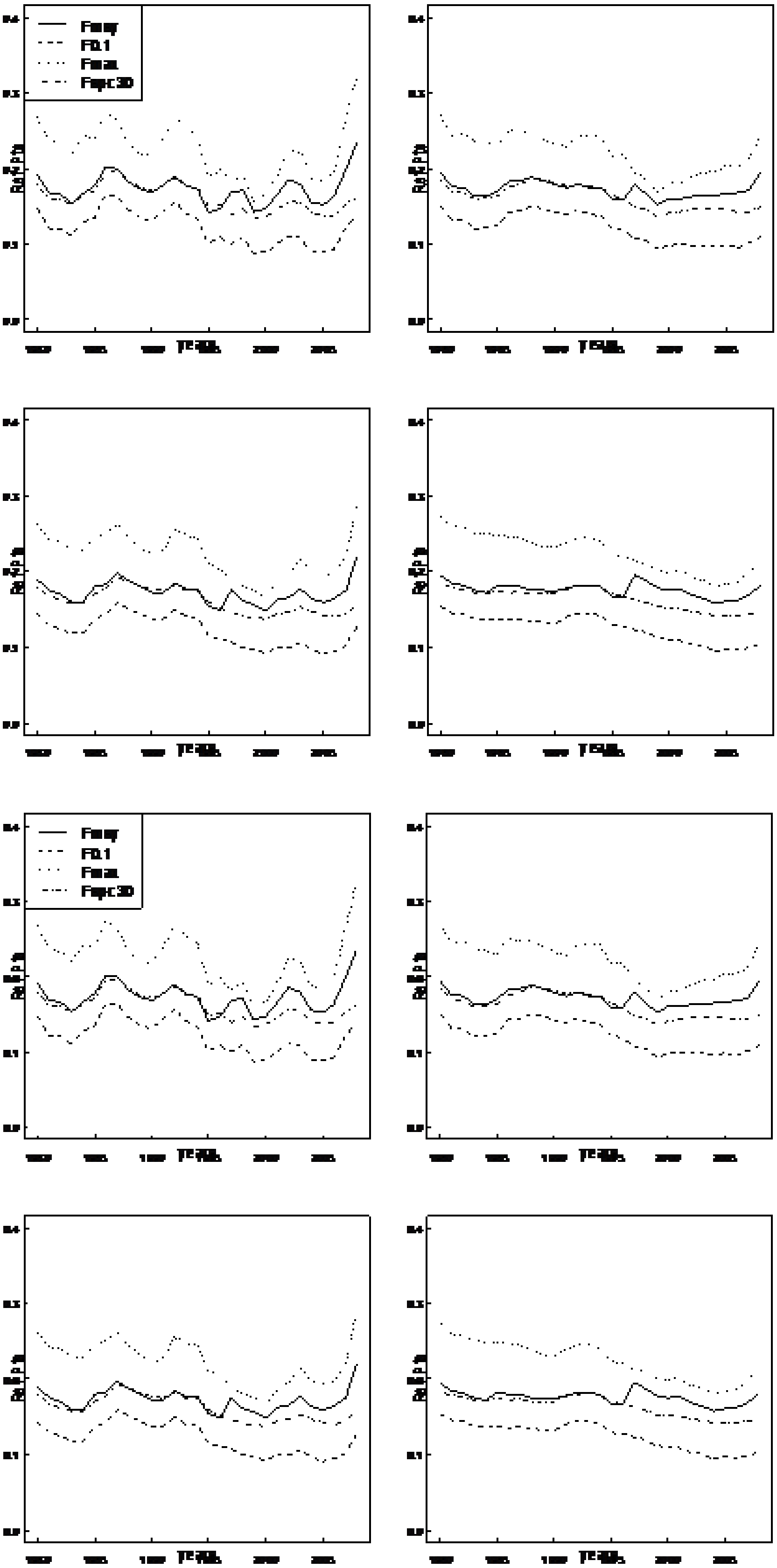

Figure 1.3.1. Example of variability in time of standard Biological Reference Points using 3-years average for input parameters (Top left), 4-years average (Bottom left), 5-years average (Top right) and 10-years average (Bottom right) for saithe, using a Beverton-Holt Stock Recruitment relationships.

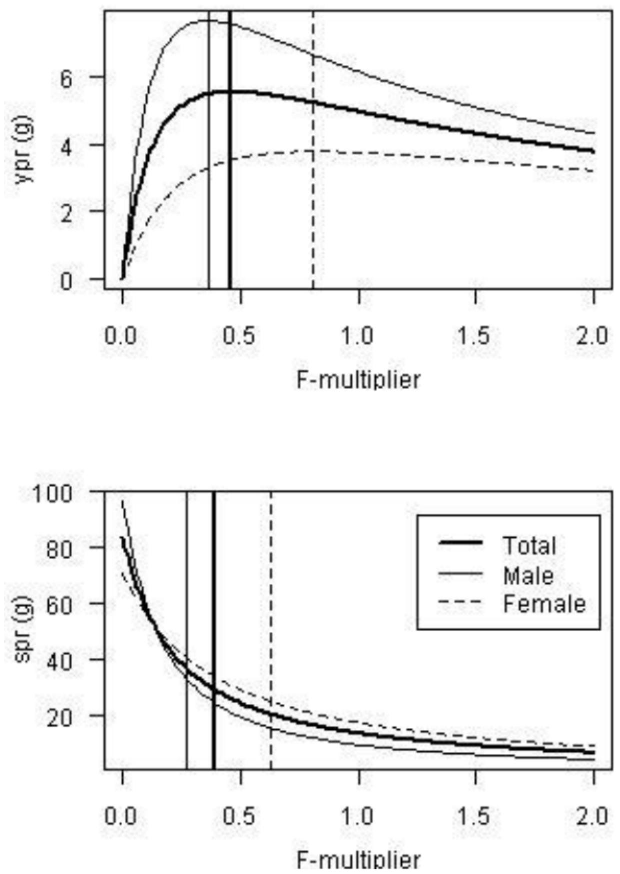

Figure 1.3.2. Yield-per-recruit and spawning stock biomass-per recruit for males, females (dotted line) and combined (bold) with F_{max} and $F_{35\%spr}$ reference points.

2 Overview

The overview section was not updated in the 2009 WGNSSK report.

Some parts of the overview for the 2008 WGNSSK report were updated in 2010, with additional insights from other EGs.

2.1 Stocks in the North Sea (Subarea IV)

2.1.1 Introduction

The demersal fisheries in the North Sea can be categorised as a) human consumption fisheries, and b) industrial fisheries which land the majority of their catch for reduction purposes. Demersal human consumption fisheries usually either target a mixture of roundfish species (cod, haddock, whiting), a mixture of flatfish species (plaice and sole) with a by-catch of roundfish, or *Nephrops* with a bycatch of roundfish and flatfish. A fishery directed at saithe exists along the shelf edge. Landings used by the WG for each North Sea stock are summarised in Table 2.1.1.

The industrial fisheries which used to dominate the North Sea catch in weight have become much less prominent. Human consumption landings have steadily declined over the last 30 years, with an intermediate high in the early 80's. The landings of the industrial fisheries show the largest annual variations, resulting from variable recruitment and the short life span of the main target species. The total demersal landings from the North Sea reached over 2 million t in 1974, and have been around 1.5 million t in the 1990s.

For some stocks, the North Sea assessment area may also cover other regions adjacent to ICES Sub-area IV. Thus, combined assessments were made for cod including IIIaN (Skagerrak) and VIId, for haddock and Norway pout including IIIa, for whiting including VIId, and for saithe including IIIa and VI. Advice for the sandeel stocks at the Shetland Islands and in IIIa is provided separately by ICES, and there are no analytic assessments for them. The state of *Nephrops* stocks are evaluated on the basis of discrete Functional Units (FU) on which estimates of appropriate removals are founded. Quota management for *Nephrops* is still carried out at the Sub-Area and Division level, however.

Biological interactions are not dynamically incorporated in the assessments or the forecasts for the North Sea stocks. However, average values of natural mortalities estimated by multispecies assessments for cod, haddock, whiting and sandeel are incorporated in the assessments of these species, and exploratory runs using updated natural mortality estimates are presented for some stocks.

Gear types vary between fisheries. Human consumption fisheries use otter trawls, pair trawls, *Nephrops* trawls, seines, gill nets, or beam trawls, while industrial fisheries use small meshed otter trawls. Trends in reported effort in the major fleets fishing in the North Sea are described annually by the STECF[1]; Quantitative description of the main fleets and fisheries and their recent trends was also summarised in the ICES WG report on Mixed Fisheries Advice for the North Sea (ICES WGMIXFISH 2010),

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1 Scientific, Technical and Economic Committee for Fisheries (STECF) Report of the SG-MOS-09-05 Working Group on Fishing Effort Regime Edited by Nick Bailey & Hans-Joachim Rätz 28 september – 2 october 2009, Ispra, Italy.

largely based on the data collected for STECF SGMOS 10-05 for the evaluation of effort management, with additional data provided for some countries. The main trends are summarised below:

Some discards data were available for some of the fleet segments. French data are missing for 2009 in these tables.

The data distinguish between two basic concepts, the Fleet (or fleet segment), and the Métier. Their definition has evolved with time, but the most recent official definitions are those from the CEC's Data Collection Framework (DCF, Reg. (EC) No 949/2008), which we adopt here*:*

- ***A Fleet segment*** is a group of vessels with the same length class and predominant fishing gear during the year. Vessels may have different fishing activities during the reference period, but might be classified in only one fleet segment.
- ***A Métier*** is a group of fishing operations targeting a similar (assemblage of) species, using similar gear, during the same period of the year and/or within the same area and which are characterized by a similar exploitation pattern.

Fleets and métiers were defined to match with the available economic data and the cod long term management plan. WGMIXFISH defined 27 national fleets from nine countries. These fleets engaged in one to five different métiers each, resulting in 73 combinations of country*fleet*métier catching cod, haddock, whiting, saithe, plaice, sole and Nephrops.

ICES WGMIXFISH produced a number of synthetic figures describing main trends, between 2003 and 2009, of effort by fleet in absolute levels (Figure 2.1.2.1) and relative trends (Figure 2.1.2.2), effort share by fleet (Figure 2.1.2.3) and landings by fleet and stock (Figure 2.1.2.4). Data are also summarized by main metier and stock in the table 2.1.2.4.

The total effort (expressed in KW*days at sea) for these 27 fleets decreased by 25% between 2003 and 2009, with largest decreases between 2006 and 2008, but less that 2% decrease between 2008 and 2009.

2.1.2 Main management regulations

The near-collapse of the North Sea cod stock in the beginning of the 2000s led to the introduction of effort restrictions alongside TACs as a management measure within EU fisheries. There has also been an increasing use of single-species multi-annual management plans, partly in relation to cod recovery, but also more generally. These management frames can be summarised as such :

2.1.2.1 Effort limitations

For vessels registered in EU member states, effort restrictions in terms of days at sea were introduced in 2003 and subsequently revised annually (Table 2.1.2.1). Initially days at sea allowances were defined by calendar month. From 2006 the limit was defined on an annual basis. The maximum number of days a fishing vessel could be absent from port varied according to gear type, mesh size (where applicable) and region. A complex system of 'special conditions' (SPECONs) developed upon request from the Member States, whereby vessels could qualify for extra days at sea if special conditions (specified in the Annexes) were met. The evolution of the number of gear categories and special conditions used in these regulations are given in Table 2.1.2.2, illustrating the trend towards increasingly detailed micromanagement that has taken place until 2008. A detailed description of these categories as well as the corresponding days at sea can be found in STECF (2008).

In 2008 the system was radically redesigned. For 2009, a total effort limit (measured in kW days) was set and divided up between the various nation's fleet effort categories. The baselines assigned in 2009 were based on track record per fleet effort category averaged over 2004-2006 or 2005-2007 depending on national preference. Table 2.1.2.3 lists the new fleet effort categories and shows how they map to the previous gear groups. The effort allocations available by nation and gear are given in Appendix 1A of Annex IIa of Council Regulation 43/2009. In relation to this, some member states have implemented real-time closure schemes. The closures apply to areas with high cod catch rates with the intention that closing these will lead to an overall reduction in the catchability of cod.

In addition to the restrictions on effort, a number of other measures have been introduced during 2009 to help ensure that the cod quota is not exceeded. For instance, if a nation's uptake of its cod quota reaches 90% on or before 15 November 2009, this will trigger a requirement for that nation's vessels to use highly selective gears (Regulation 43/2009, Annexe III, para. 5a). This is associated with a ban on high-grading (Regulation 43/2009, Annexe III, para. 5c).

2.1.2.2 Stock-based management plans

Cod, saithe, haddock, plaice and sole are now subject to multi-annual management plans (the latter two, being EU plans, not EU-Norway agreements) . These plans all consist of harvest rules to derive annual TACs depending on the state of the stock relative to biomass reference points and target fishing mortality. The harvest rules also impose constraints on the annual percentage change in TAC. These plans have been discussed, evaluated and adopted on a stock-by-stock basis, involving different timing, procedures, stakeholders and scientists involved, and have never been evaluated in an integrated mixed-fisheries approach (ICES WKMIXFISH 2009). The technical basis of the individual management plans is detailed in the relevant stock section.

2.1.3 Additional Technical measures

The national management measures with regard to the implementation of the available quota in the fisheries differ between species and countries. The industrial fisheries are subject to regulations for the by-catches of other species (e.g. herring, whiting, haddock, cod). Quotas for these fisheries have only recently been introduced. Technical measures relevant to each stock are listed in each stock section – for convenience, the recent history of technical measures in the area as a whole is also summarised here.

Until 2001, the technical measures applicable to the North Sea demersal stocks in EU waters were laid down in the Council Regulation (EC) No 850/98. Additional technical measures have been established in 2001 by the Commission Regulation (EC) No 2056/2001, for the recovery of the stocks of cod in the North Sea and to the west of Scotland. In 2001, an emergency measure was enforced by the Commission to enhance cod spawning (Commission Regulation EC No 259/2001).

2.1.3.1 Minimum landing size

"Undersized marine organisms must not be retained on board or be transhipped, landed, transported, stored, sold, displayed or offered for sale, but must be discarded immediately to the sea" (EC 850/98). Minimum landing sizes in the North Sea are the same as in all European waters (except in Skagerrak and Kattegat, where minimum sizes are slightly smaller for fin fish and larger for *Nephrops*). The value for demersal stocks is shown below.

Species	MLS
Cod	35 cm
Haddock	30 cm
Saithe	35 cm
Whiting	27 cm
Sole	24 cm
Plaice	27 cm
Nephrops	24mm (carapace length)

2.1.3.2 Minimum mesh size

Regulations on mesh sizes are more complex than those on landing sizes, as they differ depending on gears used, target species and fishing areas. Many other accompanying measures are implemented simultaneously with mesh sizes. They include regulations on gear dimensions (e.g. number of meshes on the circumference), square-meshed panels, and netting material. The most relevant mesh size regulations of EC No 2056/2001 are presented below.

Towed nets excluding beam trawls

Since January 2002, the minimum mesh size for towed nets fishing for human consumption demersal species in the North Sea is 120 mm. There are however many derogations to this general rule, and the most important are given below:

- ***Nephrops* fishing.** It is possible to use a mesh size in range 70-99 mm, provided catches retained on board consist of at least 30% of *Nephrops*. However, the net needs to be equipped with a 80 mm square-meshed panel if a mesh size of 70-99 mm is to be used in the North Sea and if a mesh size of 70-89 mm is to be used in the Skagerrak and Kattegatt the codend has to be square meshed.
- **Saithe fishing.** It is possible to use a mesh size range of 110-119 mm, provided catches consist of at least 70% of saithe and less than 3% of cod. This exception however does not apply to Norwegian waters, where the minimum mesh size for all human consumption fishing is 120 mm. Since January 2002 Norwegian trawlers (human consumption) have had a minimum mesh size of 120 mm in EU-waters. However, since August 2004 they have been allowed to use down to 110 mm mesh size in EU-waters (but minimum mesh size is still 120 mm in Norwegian waters).
- **Fishing for other stocks.** It is possible to use a mesh size range of 100-119 mm, provided the net is equipped with a square-meshed panel of at least 90 mm mesh size and the catch composition retained on board consists of no more than 3 % of cod.
- **2002 exemption.** In 2002 only, it was possible to use a mesh size range of 110-119 mm, provided catches retained on board consist of at least 50% of a mixture of haddock, whiting, plaice sole, lemon sole, skates and anglerfish, and no more than 25% of cod.

Beam trawls

- **Northern North Sea.** It is prohibited to use any beam trawl of mesh size range 32 to 119 mm in that part of ICES Sub-area IV to the north of 56° 00' N. However, it is permitted to use any beam trawl of mesh size range 100 to 119 mm within the area enclosed by the east coast of the United Kingdom between 55° 00' N and 56° 00' N and by straight lines sequentially joining the following geographical coordinates: a point on the east coast of the United Kingdom at 55° 00' N, 55° 00' N 05° 00' E, 56° 00' N 05° 00' E, a point on the east coast of the United Kingdom at 56° 00' N, provided that the catches taken within this area with such a fishing gear and retained on board consist of no more than 5 % of cod.
- **Southern North Sea.** It is possible to fish for sole south of 56° N with 80-99 mm meshes in the cod end, provided that at least 40 % of the catch is sole, and no more than 5 % of the catch is composed of cod, haddock and saithe.

Combined nets

It is prohibited to simultaneously carry on board beam trawls of more than two of the mesh size ranges 32 to 99 mm, 100 to 119 mm and equal to or greater than 120 mm.

Fixed gears

The minimum mesh size of fixed gears is of 140 mm when targeting cod, that is when the proportion of cod catches retained exceeds 30% of total catches.

2.1.3.3 Closed areas

Twelve mile zone

Beam trawling is not allowed in a 12 nm wide zone along the British coast, except for vessel having an engine power not exceeding 221 kW and an overall length of 24 m maximum. In the 12 mile zone extending from the French coast at 51°N to Hirtshals in Denmark trawling is not allowed to vessels over 8m overall length. However, otter trawling is allowed to vessels of maximum 221 kW and 24 m overall length, provided that catches of plaice and sole do not exceed 5% of the total catch. Beam trawling is only allowed to vessels included in a list that has been drawn up for the purposes. The number of vessels on this list is bound to a maximum, but the vessels on it may be replaced by other ones, provided that their engine power does not exceed 221 kW and their overall length is 24 m maximum. Vessels on the list are allowed to fish within the twelve miles zone with beam trawls having an aggregate width of 9 m maximum. To this rule there is a further derogation for vessels having shrimping as their main occupation. Such vessels may be included in annually revised second list and are allowed to use beam trawls exceeding 9 m total width.

Plaice box

To reduce the discarding of plaice in the nursery grounds along the continental coast of the North Sea, an area between 53°N and 57°N has been closed to fishing for trawlers with engine power of more than 221 kw (300 hp) in the second and third quarter since 1989, and for the whole year since 1995. Beare et al. (2010) conducted a thorough analysis of the potential effect of the plaice box on the stock of plaice, and concluded that no significant effect, neither positive nor negative, could be related to the implementation of the plaice box.

Cod box

An emergency measure to enhance cod spawning in the North Sea was enforced in January 2001. The EU and Norway agreed on a temporary closure of the demersal fishery in the main spawning grounds from February 15 until 30 April 2001.

Sandeel box

In the light of studies linking low sandeel availability to poor breeding success of kittiwake, ICES advised in 2000 for a closure of the sandeel fisheries in the Firth of Forth area east of Scotland. All commercial fishing was excluded, except for a maximum of 10 boat days in each of May and June for stock monitoring purposes. The closure was initially designated to last for three years but has been repeatedly extended and remains in force. The level of effort of the monitoring fishery was increased in 2006.

Cod protection area in the North Sea

The cod protection area defined in Council Regulation (EC) No 2287/2003 Annex IV was intended to enhance the TAC uptake of haddock in the North Sea while preventing cod by-catches. It regulated fishing of haddock of licensed vessels for a maximum of 3 months under the conditions that there was no fishing inside or transiting the cod protection area, that cod did not contribute more than 5 % to the total catch retained on board, that no transhipment of fish at sea occurred, that trawl gear of less than 100 mm mesh size was carried on board or deployed, and that a number of special landing regulations were complied with. It was discontinued at the end of 2004.

2.1.4 Environmental considerations

The WG considers that although it is clear that the North Sea ecosystem is undergoing change and this will affect fish stocks, the causal mechanisms linking the environment with fish stock dynamics are not yet clearly-enough understood for such information to be used as part of fisheries management advice.

2.1.5 Human consumption fisheries

2.1.5.1 Data

Estimates of discarding rates provided by a number of countries through observer sampling programme were used in the assessments of cod, haddock, whiting and some *Nephrops* FUs in the North Sea, to raise landings to catch. A combination of observed and reconstructed discard rates was used in the North Sea plaice assessment. Other discard sampling programmes have been in place in recent years, but have not been used in the assessments yet because of short time-series or because of collation problems. In general, some discarding occurs in most human-consumption fisheries, particularly when strong year classes are approaching the minimum landing size.

For a number of years there have been indications that substantial under-reporting of roundfish and flatfish landings is likely to have occurred. Anecdotal evidence for this is particularly strong for cod during 2001–2003, when the agreed TAC implied a reduction in effort of more than 50% which the WG suggests probably did not occur. In the absence of information from the industry on the likely scale of this under-reporting, the WG has used a modified assessment method for North Sea cod (Section 14) which estimates unallocated removals on the basis of research-vessel survey data. Such removals may be due to reporting problems, unrecorded discards, changes in natural mortality, or changes in survey catchability, and cannot be interpreted as representing mis- or underreporting. Increased enforcement of regulations (and measures such as the UK Buyers and Sellers Regulation) means that mis- or underreporting is considered to be less now than previously.

Several research-vessel survey indices are available for most species, and were used both to calibrate population estimates from catch-at-age analyses, and in exploratory analyses based on survey data only. Commercial CPUE series were available for a number of fleets and stocks, but for various reasons few of them could be used for assessment purposes (although they are presented and discussed in full for each stock). The use of commercial CPUE indices is being phased out where possible.

Bycatches in the industrial fisheries were significant in the past for haddock, whiting and saithe, but these have reduced considerably in recent years.

2.1.5.2 Stock impressions

In the North Sea all stocks of roundfish and flatfish species have at some time been exposed to high levels of fishing mortality for a long period. For most of these stocks their lowest observed spawning stock size has been seen in recent years. This has resulted from excessive fishing effort, possibly combined with an effect of a climatic phase which is unfavourable to recruitment. For a number of years, ICES has recommended significant and sustained reductions in fishing mortality on some of the stocks. In order to achieve this, significant reductions in fishing effort are required. In recent years, estimated fishing mortality has declined in most stocks for which analytic assessments are available.

Assessment of cod in Sub-area IV and Divisions IIIa and VIId has been particularly difficult for 2009. Estimates of abundance (and consequently mortality) from the two IBTS surveys have continued to diverge to the extent that they are not considered reliable enough to provide a definitive assessment. Catches of **cod** in have increased in the last couple of years after having been at historic low levels for several years. Estimated spawning-stock biomass reached a low in 2006 but has subsequently increased. Fishing mortality is now estimated to have declined since 2000 (~ 0.64 in 2007). Recruitment of the 2000-2004 year classes was poor the 2005 year class is stronger but still below the long-term average. Subsequent recruitment levels are below the long term average. Recent reductions in realised fishing mortality should enable biomass to increase in the short-term. The higher levels of discarding observed since 2007 is maintaining the fishery induced mortality at a high level.

Haddock fishing mortality in 2009 is close to the historical low. The decline in abundance of the dominant 1999 year class has been offset to a certain extent by an improved 2005 year class. However, the reduction in mortality rate has not prevented a continued decline in SSB. The 2005 year class is estimated to be quite abundant (39 000 million) and the largest since the 1999 year class. There are indications that the 2009 year class is also reasonably abundant (20,000 million).

The assessment of **whiting** in Sub-area IV and Division VIId remains problematic in that the historic estimates of biomass derived from surveys exhibit differing trends from those based on catch data. However the recent trends are consistent and the WG accepted that assessment based on data from 1990. There have been substantial revisions in estimates of recent recruitment and, in conjunction with low fishing mortality, the stock is considered to be increasing from its recent low level. Survey estimates of the youngest ages in the recent years appear to have either underestimated the incoming recruitment or imply that mortality has effectively been zero (which is unlikely).

The saithe assessment was hampered by the loss of several tuning indices, hence it was not possible to run an update assessment. As the assessment results of saithe tend to be relatively stable between years catch option for saithe were generated using a 3 year forecast from the assessment results of ICES 2009 (WGNSSK). Landings of **saithe** in Sub-areas IV and VI and Division IIIa have been stable for several years at a level well-below the permitted TAC. Fishing mortality has now remained at or below 0.3 for nine years while SSB has stabilised at around 260 kt. Recruitment is fluctuating about the mean level.

The reported landings for **sole** in Subarea IV in 2009 (13.9 kt) were almost the same as 2008 (14.0kt). SSB has fluctuated around a moderate-to-low level for several years and is currently around Bpa. Fishing mortality has been generally falling since the late 1990’s and is now below Bpa.

Landings of plaice in Subarea IV increased slightly in 2009 but are low compared to historical levels. SSB has increased dramatically over the last three years, well above Bpa and is currently close to the historical maximum. Fishing mortality has decreased to its lowest observed level. Recent year class strength has been at the long-term mean.

The yields for stocks of Nephrops are fairly stable from year to year. Reported landings for FU 3 (Skagerrak) and FU 4 (Kattegat) have averaged 2500t and 1500t respectively since 2000 with relatively little variation. There are no signs of overexploitation in IIIa and given the apparent stability of the stock, the current levels of exploitation appear to be sustainable.

FU 7 (Fladen, 13300 t), FU 8 (Firth of Forth, 2600 t) and landings from outside the FUs (2367t) were all at their highest recorded landings TV surveys for FUs 7, 8 and 9 all decreased in 2009 following several years of increases in observed abundance. The TV survey in FU6 also decreased but this stock is considered to have been in a depleted state for the last 3 years due to high levels of fishing effort.

2.1.6 Industrial fisheries

Sandeel in area IV underwent the benchmark process in September, resulting in a move away from a single area assessment to regional assessments (7 sandeel areas, SAs). The majority of the stock biomasses are contained within SAs 1, 2 and 3 covering the central and southern North Sea and analytical assessments are possible in these areas. The 2009 year class appears to be large and widespread across these areas resulting in stock increases. The other SAs have much more limited fishery information and hence analytical assessments were not possible, however the state of the stocks is considered to be much lower in the northern North Sea, particularly in the Viking bank area.

The Norway Pout fishery has fluctuated considerably in recent years with full or partial closures in 2005, 2006, and 2007. Fishing mortality has declined since the 1980s but the stock was in a poor state in 2005 & 2006 due to very low recruitments in 2003 & 2004. SSB at the start of 2010 (259kt) is estimated to be well above Bpa (150kt), but the 2010 year class is estimated to be the lowest on record, so the prognosis for a fishery in 2011 is poor.

The overview of industrial fisheries is displayed on Tables 2.1.6.1 to 2.1.6.4.

2.2 Stocks in the Skagerrak and Kattegat (Division IIIa)

This section has not been updated in 2010. For the most recent overview see Report of the Working Group on the Assessment of Demersal Stocks in the North Sea and Skagerrak (WGNSSK) 2008 CM 2008\ACOM:09, section 2. Catches of the Danish industrial fisheries are presented in Table 2.2.1.

In addition, recent trends in European effort and landings can also be found in STECF - SGMOS report (2009)[1]

There hasn't been major improvements in the basic issues undermining the assessment of Plaice in IIIa.

Some Underwater TV Survey have now been conducted for the assessment of Nephrops FU 3 and 4, but the results haven't been included in the assessment yet.

2.3 Stocks in the Eastern Channel (Division VIId)

This section has not been updated in 2010. For the most recent overview see Report of the Working Group on the Assessment of Demersal Stocks in the North Sea and Skagerrak (WGNSSK) 2008 CM 2008\ACOM:09, section 2.

In addition, recent trends in European effort and landings can also be found in STECF - SGMOS report (2009).

The stock of Plaice in VIId was benchmarked this year (ICES WKFLAT 2010), leading to significant improvements in a number of areas. However, the validity of the assessment is still undermined by the structural issues of stock discrimination and migration, leading to significant mixing with plaice in VIIe and in the North Sea.

2.4 Industrial fisheries in Division VIa

This section has not been updated in 2010. For the most recent overview see Report of the Working Group on the Assessment of Demersal Stocks in the North Sea and Skagerrak (WGNSSK) 2008 CM 2008\ACOM:09, section 2.

2.4.1 Input from The ICES – FAO Working Group on Fishing Technology & Fish Behaviour (WGFTFB)

The WGFTFB provides every year fishery development information specific to the various assessment Expert Groups, based on annual questionnaires to a number of FTFB members. The main outcomes from the 2009 WGFTFB report to WGNSSK are :

Annex 7: FTFB Report to WGNSSK

FTFB report to WGNSSK

This report outlines a number of technical issues relating to fishing technology that may impact on fishing mortality and more general ecological impacts. This includes information recent changes in commercial fleet behaviour that may influence commercial CPUE estimates; identification of recent technological advances (creep); eco-

1 Scientific, Technical and Economic Committee for Fisheries (STECF) Report of the SG-MOS-09-05 Working Group on Fishing Effort Regime Edited by Nick Bailey & Hans-Joachim Rätz 28 september – 2 october 2009, Ispra, Italy.Available at http://fishnet.jrc.it/web/stecf

system effects; and the development of new fisheries in the North Sea, Skagerrak and Kattegat.

It should be noted that the information contained in this report does not cover fully all fleets engaged in North Sea fisheries; information was obtained from Scotland, France, Belgium, Netherlands, Sweden and Norway. Only very limited information was received from the UK-England and Wales or Denmark.

Fleet dynamics

- All countries have reported very low prices for fish and shellfish. Indications that prices for some species have dropped by as much as 50% on 2007 levels. Many vessels have tied up because of low prices in 2009. This is compared to 2008 when vessels tied up because of high fuel prices. Traditional Spanish and French markets are particularly depressed. Imports and the world recession are the main reasons given (All countries: Implications: Low prices leading to reduced effort).
- In 2008 due to the days and fuel used steaming to Rockall many Scottish vessels which would have targeted these grounds instead targeted west coast or North Sea grounds. A few vessels made single trips to Rockall but the returns were poor and therefore proved a disincentive to other vessels making the long journey. From 1st February 2009, however, many of these Scottish vessels have now reverted back to the Rockall grounds which has now become attractive due to the steaming and fishing time not counting against days at sea days at and because fuel costs have reduced. These vessels are targeting haddock, anglerfish and megrim, however, this could lead to a quick uptake of Rockall quotas. (Scotland: Implications: Shift of effort from Rockall (VIb) to IVa (North Sea) and vice versa and quick uptake of quotas).
- Up to 3-4 Scottish vessels have also moved from the North Sea and west of Scotland to Area VIIb-k in 2008 and 2009. These vessels are all large vessels 24m+ and are targeting *Nephrops* at the Porcupine Bank and Labadie Banks. This is thought motivated by the fact that there area no days at sea limitations in VIIb-k (Scotland: Implications: Shift of effort into VIIb-k)
- Due to the new by-catch limits (30%) introduced from February 2009 as part of the new technical measures in Area VIa, the west coast grounds, inside the 200m line, are effectively closed to Scottish vessels, with whitefish vessels fishing outside the 200m line or shifting to North Sea grounds. The effort shift associated with this is expected to be large. (Scotland: Implications: Shift in effort from VIa inside the French Line to Area VIa and IVa).
- The codend mesh size for smaller vessels (< 15m) on west coast grounds has increased from 100mm to 110mm. As a result some (> 20 Scottish vessels) of those which targeted megrim have moved to other areas, particularly the North Sea as these vessels are too small to target Rockall. (Scotland: Implications: Shift of effort from Area VIa into other areas).
- The new regulations in Area VIa have also affected Scottish Seine net vessels, which are now on a one net rule and have to use the whitefish codend mesh size of 120mm. This has effectively closed the fishery for these vessels and forced them to tie up or shift into the North Sea. (Scotland: Implications: Shift of effort from Area VIa to other areas).

- There has been a decommissioning scheme in France that has removed a number of 24m+ whitefish vessels that targeted mixed demersal species including cod in VIIb-k and the fisheries in VIId. The actual amount of GT and KW that has been removed but is reported to be significant (France: Implications: Reductions in demersal fleet).
- Since 2008, 24 boats out of 320 boats were decommissioned from the Dutch beam trawl fleet (7.5% reduction). A number of these vessels have been subsequently using passive licences. There is a tendency to opt for smaller multi-purpose vessels replacing the conventional beam trawler (Dutch: Implications: Reduction in effort in the beam trawl sector).
- There has been decommissioning of Swedish Baltic/Kattegat cod trawlers during 2008/20009 both old and newer vessels have been removed from the fleet - 10% in numbers, 15% in capacity. This has been driven by low quotas for cod, new days at sea regs and low prices (Sweden: Implications: Reduced fleet numbers).
- The Belgian fishing fleet numbered 102 fishing vessels in the beginning of 2008 and has now been reduced in 2009 to 98 active vessels due to 4 vessels going bankrupt (Belgium: Implications: Reduction in fleet size).
- There are 3 French vessels and approximately 10 Dutch vessels (with a further 3 under construction) that have switched to Scottish seining. These vessels are around 24m+/650hp-1200hp. The French vessels have reportedly been targeting whiting in particular but also cod and non-quota species in Area VIIb-k (mainly VIIg) for the 1st and 2nd quarter of 2009. These vessels, along with the Dutch vessels are also working in VIId and IVb for non-quota species such as red mullet, squid and gurnard. They are fishing with ~50mm diameter seine rope and are hauling the last two coils of the "ring" at 5 knots compared to 1-1.5 knots by Scottish and Irish seiners. These vessels can complete up to 8-10 rings in a day compared to 5 or 6 by Scottish and Irish vessels. This represents a considerable increase in effort in this fishery. (France and Netherlands: Implications: Increased effort in VIIb-k whitefish fisheries).
- Fewer Belgium beam trawlers have fished in the ICES-zone VIII (Gulf of Gascogne) in 2008 and 2009, mainly due to high fuel costs in 2008 and a lack of quota. The vessels have tended to stay in the North Sea (Belgium: Implications: Shift of effort from VIII to IV).
- Two Belgium beam trawlers converted to scallop dredging in 2008, although 1 of these vessels has since reverted back to beam trawling due crew problems (Belgium: Implications: Shift from beam trawling to scallop dredging).
- In 2007 there were more or less as many Belgium beam trawlers changing between flatfish and shrimp beam trawl fisheries as in 2006. However, due to reduced landings in 2007 landings of brown shrimp (*Crangon crangon*), effort was reduced quite significantly. In the second half of 2008, the landings of shrimp have increased again and effort by beam trawlers has increased in this fishery (Belgium; Implications: Fluctuating effort in the *Crangon* fishery).
- In the Dutch fleet the gradual shift from beam trawling on flatfish to twin trawling on other species e.g. gurnards, and *Nephrops*, etc. has continued in 2008 and 2009. A number of beam trawlers decided to shift to other tech-

niques such as outrigging or Scottish seining in the British Channel (VIId). The recent drop in fish prices, however, has caused a temporary halt in the use of alternative lower drag gears. Some went back to normal beam trawling to catch remaining sole quota in 2008 e.g. the vessels using outriggers (Netherlands: Implications: Shifts in effort from beam trawling).

- In Belgium there up to 3 vessels now using trammel nets for sole, pots for cuttlefish, Handlining for bass and tangle nets for turbot, mainly in IVc, VIIe and VIIf. There is considerable interest in Belgium for diversifying into these gears although there is an issue with days at sea as Belgium as only a very small allocation for static nets. Fishermen in the Netherlands are also considering shifting to these gears (Belgium: Implications: Diversification into static gears).
- Following introduction of the new days at regime ~70 Swedish vessels have received exemption in the Kattegat for using grids in the *Nephrops* fishery. This device reduces cod catches to almost zero levels (Sweden: Implications: Reduced cod catch).
- In the first quarter of 2008, the number of Swedish vessels fishing (and effort deployed) in the Kattegatt decreased due to an increased effort cost (2.5 days at sea per effort day deployed). This effort was mainly been reallocated to the Skagerrak or the Baltic Sea. Vessels without the possibility to change area mainly targeted *Nephrops* using grid-equipped trawls (i.e. a gear with effort limitation). (Sweden: Implications: Shifts in effort among areas and fleets).
- There has been a gradual shift towards *Nephrops* and *Pandalus* fisheries from traditional demersal fish during the last years. This shift is due to lowered quotas per vessel for cod (Area IIIa) (Sweden: Implications: Shift away from cod fisheries).
- Several larger French trawlers using mesh size range 70-99mm have moved further north in the North sea (south east of Scotland in Area IVb) because of the low abundance of whiting in VIId, and also to reduce fuel consumption by increasing the duration of their individual trip (from 2 days long to 4 or 5 days long) (France: Implications: Shift in an effort from VIId to IVb).
- French trawlers using 70-99 mm fishing in VIId and IVb have increasingly targeted red mullet, sea bass and squids to offset lower catches of cod, whiting and plaice). Other vessels including Dutch and Belgium beam trawlers and Dutch seiners are also targeting these species at high effort levels (France: Implications: Targeting of different non-quota species).
- There has been a significant decrease in effort in the North Sea in 2008/2009 by Northern Irish vessels. Many vessels stayed in the Irish Sea due to high fuel prices and also in 2009 due to uncertainty about the days at sea allocations. (Northern Ireland Implications: Increased effort in VIIa).

Technology Creep

- 3 Scottish seiners are now fitted with seine power reels that allow them to haul without using a seine winch. This considerably increases the efficiency of the operation and allows an extra haul per day. These vessels are currently working in the North Sea but this could spread to the west of Scotland at a later date. Most of the French seiners working in VIIb-k are also using this system (Scotland ad France: Implications: Improved efficiency in seine net fisheries).

- Some Dutch vessels started using the SumWing construction replacing conventional beam trawls with trawl shoes. A comparative fishing experiment showed no effect on target and non-target species and an 11% lower fuel consumption. The new design was first used on even grounds in the Northern North Sea, and trials on harder grounds are foreseen in the near future. Tests are being done with hydro-dynamical stimulation (HydroRig) and replacement of beam trawls by Outrigger nets. These are to be continued in 2009. Five beam trawlers will be converted to fishing with pulse trawls. The first one has currently started testing the system and it maybe combined with the SumWing technology (Netherlands: Implications: More efficient beam trawls).
- In 2009 more and more Belgium beam trawlers are using roller gear instead of the standard trawl shoes to reduce fuel consumption. About 3 vessels are also investigating the Dutch SumWing beam trawl to reduce fuel consumption as well. It is expected that this initiative will lead to gear modifications used in beam trawls, depending on legislation changes (Belgium: Implications: Adoption of fuel efficient gear).
- Belgium beam trawlers and French trawlers are increasingly being equipped with 3D mapping sonar which has opened up new areas to fishing close to wrecks and areas of hard ground (Belgium and France: Implications: Increased access to unfished areas).
- The move by Belgium beam trawlers to use R-nets and chain matrices rather than with V-nets, using tickler chains has continued in 2008 and 2009. Fishing speed for beam trawls with R-nets is generally lower and following the high fuel prices in 2008, fewer beam trawlers now use the V-nets. The impact of this change on benthos and discarding has not been assessed but is anticipated to have reduced (Belgium: Implications: Unknown).

Technical Conservation Measures

- For vessels in the new Scottish Conservation Credit Scheme the minimum SMP mesh sizes for *Nephrops* vessels from 1 Feb 2009 are 120mm @ 12-15m for west of Scotland grounds (VIa) and 110mm in North Sea grounds (IVa). The use of this gear is now mandatory under the Conservation Credit Scheme. It has been estimated that the 120mm SMP gives a 30% increase in L50 of haddock, whiting and saithe. Smaller increases in L50 of (perhaps 10%) for cod are likely but only if the panel is put close to the codend (Scotland: Implications: Improved selectivity).
- Offshore *Nephrops* vessels are making up their days from a combination of *Nephrops* and whitefish but using the same 100mm codend to for both in the North Sea. The reason for this is down to the uncertainty at the start of each fishing trip on how the fish by-catch (>35% of the catch must be *Nephrops*) will work out. Therefore vessels leave port with 100mm codends with lifting bags rigged. If fish are the main component then the rearmost meshes attaching the bag to the codend are cut (i.e. removing the lifting bag) and the vessel is now targeting fish for the trip,
- For Scottish vessels in the Scottish Conservation Credit Scheme the minimum SMP mesh sizes for *Nephrops* vessels from 1 Feb 2009 are 120mm @

12-15m for west of Scotland grounds and 110mm in North Sea grounds. The impact of this unknown but it is expected to improve the selectivity for haddock and whiting but only slightly for small cod (Scotland: Implications: Improved selectivity).

- There have been a number of attempts in Scotland to develop cod avoidance gears that maintain catches of haddock and whiting as well as other species such as monkfish, megrim and lemon sole. These trials have looked at incorporating large mesh panels (800mm) into the belly sheets of standard trawl designs. The results are still being analysed but indicate that cod catches can be reduced but not eliminated (Scotland: Implications: Low cod impact gears).
- Scottish seine net vessels are now restricted to a one net rule and have to use the whitefish mesh size of 120mm. This has created difficulties for these vessels with a result many are considering changing over to pair seine gear were the impact is lessened (Scotland: Implications: Improved selectivity of seine net vessels).
- The use of Bycatch Reduction Panels (BRP) in the lower sheet of beam trawls is studied on FRV "Tridens", with voluntary uptake by several Dutch beam trawlers. Some twin-trawlers are also using a similar BRP in the top sheet. Indications are that plaice discards can be dropped by 20% (Netherlands: Implications: Voluntary use of TCMs and reduced discarding).
- The producers' organisation In Belgium has set up a working group of ship owners to test gear modifications to beam trawls. The testing is partial funded nationally and partially voluntary testing. Gear modifications tested include a square mesh panel in the upper-aft of the trawl and bigger diamond meshes in the top panel. Both modifications have been tested in the Central North Sea in 2009 to reduce the by-catch of unwanted roundfish, particularly whiting and cod. Beam trawler (1200hp) fishing in the Irish Sea is using a combination of T90-codend, benthos release panel, big meshes in the top panel and roller gear. These modifications have been tested in 2006 on a project scale and are now used by the same vessel on voluntary basis (Belgium: Implications: Voluntary adoption of TCMs).
- In Norway there has been extensive testing by industry of pelagic and semipelagic trawling for saithe in the North Sea. Three trawlers have been involved in 2008-2009. Until 2008, only demersal trawl was used. It is expected that the number of vessels using this technique will increase in 2009. During semipelagic trawling the doors are off the seabed and the opening (27 by 70 m) of the new trawls are approximately 20 times the size of commercial twin trawls for gadoids. According to information from the fishermen the fuel/kg saithe caught, are reduced. Another reason for trying this technique is the focus on the impact of trawl doors on the seabed (Norway: Implications: Unknown).
- Altogether ~140-150 Swedish *Nephrops* vessels are now either fishing with the grid or intend to start fishing with it due to days at sea exemptions (Sweden: Implications: Widespread uptake of selective gear).
- A new closed area regime was introduced in the Kattegat in 2009 to protect Kattegat cod. Among other measures four different zones for gear usage were introduced whereby both the Swedish grid and a Danish SELTRA-trawl (>300 mm SMP in the cod-end top panel) are mandatory in a large

part of the area. The driver for this is access to otherwise closed areas (the Kattegatt closure, Swedish coastal waters). Exclusion from the kW-day system for Swedish vessels using the *Nephrops* grid and square mesh codend (Sweden and Denmark: Implications: Access to areas for use with selective gears).

Ecosystem Effects

- All countries report that the increase in the cod quota for the North Sea in 2009 does not adequately reflect the amount of fish in the stock currently. The result predicted is discarding of cod and this has been strongly signalled to the Commission by the NSRAC (All countries: Implications: Discarding of cod).
- There is anecdotal evidence in Scotland that the real-time closures are being more widely respected by Scottish vessels with the number of closures in operation increasing to over 55 between January and May 2009. There has been no assessment of the impact of these closures but as the numbers of small cod in the North Sea has increased it is hoped these closures will protect this part of the stock (Scotland: Implications: Real-time closures).
- There are problems in the UK with the uptake of the whiting, saithe and cod quotas. The whiting quota was almost 50% taken by April 2009, with the saithe and cod quotas around 40% caught. It is anticipated this will lead to further discarding of these species later in the year. The fishermen claim whiting particularly are very abundant in the North Sea this year (UK: Implications: Increased discarding).
- There has not been a major shift in mesh size categories (anecdotal information) although some of the Belgian beam trawler fleet have been fishing with trawl nets of 150mm mesh size instead of 120mm in the belly of the net during the summer of 2007 and 2008. These changes are especially prevalent on fishing grounds with a lot of weed, hydrozoans and bryozoans, namely ICES subarea IVb and VIIg (Belgium: Implications: Reduced benthic impact).
- Five beam trawlers will be converted to fishing with pulse trawls. The first one has currently started testing the system (Netherlands: Implications: Unknown).
- The beam trawl fleet in both Netherlands and Belgium are feeling the increased pressure of the market not wanting to buy fish caught with beam trawls due to the bad reputation. This incentive is stimulating research on selective nets and ways of diminishing impact. Initiatives have been taken to promote fish products from ecosystem friendly methods, e.g. outriggers. In the UK the Seafish Responsible Fishing Scheme is being used in a similar way but up to 300 UK vessels to promote their catch. These initiatives are likely to continue over the next few years (All Countries: Implications: Better public perception).
- The Dutch beam trawl fleet are voluntarily using longitudinal release holes and benthic release panels made of square mesh in the lower panel of the trawl, which open when nets fill with benthos. Research is being carried out with the industry to optimise a Benthic Release Panel for the Dutch beam trawling segment. This work is continuing in 2009 (Netherlands: Implications: Reduced impact on benthos).

- Poor prices for *Nephrops* are affecting all fleets targeting this species. Prices have dropped up to 40% from 2007/2008 levels for both whole, tails and frozen *Nephrops*. Despite low prices effort has remained high on this species as many fishermen face have few options (All countries: Implications: Increased effort in *Nephrops* fisheries).

Development of New Fisheries

- As indicated 3 French vessels and up to 10 Dutch have been converted to seining. These vessels are targeting mixed demersal species in VIIb-k (most effort in VIIg) and also species such as red mullet, gurnard and squid in VIId and IVb. These vessels are much more powerful than seine net vessels in Ireland and Scotland as they are converted vessels (beam trawlers, whitefish trawlers and one tuna purse seiner) (France and Netherlands: Implications: Targeted fishery on non-quota species).
- Passive fishing methods have been tested in ICES subarea IVc by Belgium vessels, mainly due to less of a restriction in kw days. There were also limited experimental trials for gill net fisheries in ICES subarea VIIf and with pots for cuttlefish in 2009 (Belgium: Implications: New fisheries with passive gears).
- The Belgium fleet have been experimenting with outrigger trawls as an alternative to beam trawls since 2006. Currently there are 5 vessels using this gear mainly in VIIf, VIIg and IVc. The catch composition with this gear is different than with beam trawls with reduced sole catches but increased ray catches (up to 50% by weight) and also *Nephrops* in certain areas. Catches of plaice are similar and overall levels of discards seem to be reduced by around 20% compared to standard beam trawls (Belgium: Implications: Use of outrigger trawl).

Table 2.1.1. Human consumption landings, discards and industrial bycatch landings of assessed species from the North Sea management area (in tonnes), as used by the WG in assessments.

	Cod, IIIa, IV, VIId		Haddock, IIIa & IV			Whg IV, VIId			Saithe IIIa, IV, VI	Plaice IV		Sole IV	Norway Pout IIIa, IV	Sandeel IV
	Landings	*Discards*	Landings	*Discards*	Industrial by-catch	Landings	Discards	Industrial by-catch	Landings	Landings	*Discards*	Landings		
1985	214.6	*31.5*	164.1	*85.2*	6				220.9	159.8	*60.5*	24.2	205.1	621.8
1986	204.1	*139.1*	168.2	*52.2*	2.6				198.6	165.3	*130.0*	18.2	174.3	847.8
1987	216.2	*27.8*	110.3	*59.1*	4.4				167.5	153.7	*190.5*	17.4	149.3	824.6
1988	184.2	*10.7*	107.0	*62.1*	4				135.2	154.5	*156.4*	21.6	109.3	892.8
1989	139.9	*62.1*	78.4	*25.7*	2.4				108.9	169.8	*107.8*	21.8	166.4	1039.1
1990	125.3	*27*	53.8	*32.6*	2.6	49.0	*54.5*	51.3	103.8	156.2	*71.2*	35.1	163.3	591.3
1991	102.5	*18.6*	47.7	*40.2*	5.4	56.2	*33.6*	39.8	108.0	148.0	*80.9*	33.5	186.6	842.8
1992	114	*36.9*	72.8	*47.9*	10.9	55.0	*30.6*	25.0	99.7	125.2	*57.0*	29.3	296.8	854.9
1993	121.7	*21.9*	82.2	*79.6*	10.7	54.8	*43.0*	20.7	111.5	117.1	*35.0*	31.5	183.1	579.2
1994	110.6	*99.6*	82.1	*65.4*	3.6	52.3	*33.1*	17.5	109.6	110.4	*23.8*	33.0	182.0	785.5
1995	136.1	*32.2*	77.5	*57.4*	7.7	49.2	*30.3*	27.4	121.8	98.4	*21.8*	30.5	236.8	917.9
1996	126.3	*14.3*	79.1	*72.5*	5	43.9	*28.2*	5.1	115.0	81.7	*52.0*	22.7	163.8	776.9
1997	124.2	*33.6*	82.6	*52.1*	6.7	38.6	*17.2*	6.2	107.3	83.0	*100.1*	14.9	169.7	1137.8
1998	146	*40.5*	81.1	*45.2*	5.1	31.5	*12.7*	3.5	106.1	71.5	*103.8*	20.9	57.7	1004.4
1999	96.2	*14.2*	65.6	*42.6*	3.8	33.7	*23.5*	5.0	110.7	80.7	*71.0*	23.5	94.5	735.1
2000	71.4	*13.7*	47.6	*48.8*	8.1	32.7	*23.2*	9.2	91.3	81.1	*44.3*	22.5	184.4	699.1
2001	49.7	*13.9*	40.9	*118.2*	7.9	28.2	*16.5*	0.9	95.0	82.0	*100.3*	19.9	65.6	861.6
2002	54.9	*5.7*	58.3	*45.9*	3.7	22.0	*17.5*	7.3	115.4	70.2	*54.4*	16.9	80.0	810.7
2003	30.9	*6.4*	42.0	*23.7*	1.2	16.8	*26.1*	2.7	105.6	66.5	*77.8*	17.9	27.1	325.6
2004	28.2	*5.8*	48.7	*15.6*	0.5	14.2	*18.1*	1.2	104.2	61.4	*54.5*	17.1	13.5	361.5
2005	28.7	*6.3*	48.4	*8.6*	0.2	17.7	*10.3*	0.9	124.5	55.7	*53.9*	16.4	1.9	172.1
2006	26.6	*8.1*	37.6	*17.9*	0.5	20.8	*14.0*	2.2	125.7	57.9	*61.8*	12.6	46.6	287.9
2007	24.4	*23.6*	30.9	*28.7*	0.05	20.7	*5.2*	1.2	101.2	49.7	*39.4*	14.6	5.7	206.3
2008	26.8	*21.8*	30.2	*13.2*	0.2	19.9	*8.5*	1.0	119.3	48.9	*45.9*	14.1	36.1	335.2
2009	30.8	*14.6*	32.8	*10.5*	0.05	21.7	*5.1*	1.4	112.5	55.0	*45.2*	14.0	54.5	347.7

Table 2.1.2.1, Council regulations introducing and modifying fishing effort (days at sea) allowances in EU fisheries.

Year of application	Regulation
2003	(EC) No 2341/2002–Annex XVII
2004	(EC) No 2287/2003–Annex V
2005	(EC) No 27/2005–Annex IVa
2006	(EC) No 51/2006–Annex IIa
2007	(EC) No 41/2007–Annex IIa
2008	(EC) No 40/2008–Annex IIa
2009	(EC) No 43/2009–Annex IIa

Table 2.1.2.2. Overview over the number of regulated gear categories and corresponding special conditions by year.

Gear type	Cat./Specon	2003	2004	2005	2006	2007	2008	2009
Demersal Traws, seines, towed gears	Categories	3	3	3	5	5	5	3
	Special Con.	-	2	4	15	17	17	-
Beam trawl	Categories	1	1	1	4	4	4	2
	Special Con.	-	-	1	5	5	5	-
Static demersal nets	Categories	1	1	1	-	-	-	-
	Special Con.	-	2	2	-	-	-	-
Gillnets	Categories	-	-	-	2	4	4	1
	Special Con.	-	-	-	1	1	1	-
Trammel	Categories	-	-	-	1	1	1	1
	Special Con.	-	-	-	1	1	1	-
Longlines	Categories	1	1	1	1	1	1	1
	Special Con.	-	-	-	-	-	-	-
Total		6	10	13	35	39	39	8

Table 2.1.2.3; Gear categories used in effort management in 2009 (regulations 1342/2008 and 43/2009)

Mesh size ranges used in Gillnet categories changed in 2007. The most recent categorisation is given here.

Gear group (2006-2008)	Code	Gear group 2009
Demersal trawls, seines or similar towed gears of mesh size ≥120 mm except beam trawls;	4av	TR1
Demersal trawls, seines or similar towed gears of mesh size 100 mm to 119 mm except beam trawls;	4aiv	TR1
Demersal trawls, seines or similar towed gears of mesh size between 90 mm to 99 mm except beam trawls;	4aiii	TR2
Demersal trawls, seines or similar towed gears of mesh size between 70 mm to 89 mm except beam trawls;	4aii	TR2
Demersal trawls, seines or similar towed gears of mesh size between 16 mm to 31 mm except beam trawls.	4ai	TR3
Beam trawls with mesh sizes equal to or larger than 120mm	4biv	BT1
Beam trawls with mesh sizes equal to or larger than 80 mm and less than 90mm	4bi	BT2
Beam trawls with mesh sizes equal to or larger than 90 mm and less than 100mm	4bii	BT2
Beam trawls with mesh sizes equal to or larger than 100 mm and less than 120mm	4biii	BT2
Gillnets & entangling nets with mesh size less than 110mm	4ci	GN
Gillnets & entangling nets with mesh size greater than or equal to 110mm and less than 150mm	4cii	GN
Gillnets & entangling nets with mesh size greater than or equal to 150mm and less than 220mm	4ciii	GN
Gillnets & entangling nets with mesh size greater than or equal to 220mm	4civ	GN
Trammel Nets	4d	GT
Longlines	4e	LL

Table 2.1.2.4. Overview of the landings by main regulated gear for the main stocks. Area IV. Source WGMIXFISH 2010.

metier	stock	2003	2004	2005	2006	2007	2008	2009
BT1	Cod	765	1349	1456	1085	746	371	234
	Haddock	361	367	176	98	155	71	42
	Nephrops	3	1	0	0	0	0	0
	Plaice	7030	5503	5124	6697	5243	2997	2683
	Saithe	29	25	28	15	19	7	2
	Sole	115	96	52	52	29	26	8
	Whiting	15	7	4	6	3	1	1
BT1 Total		8318	7348	6840	7953	6195	3473	2970
BT2	Cod	2167	1462	1442	1352	1264	1504	1934
	Haddock	245	159	69	19	22	23	11
	Nephrops	270	248	294	223	330	73	70
	Plaice	36075	35637	31773	27134	27581	23420	26896
	Saithe	3	8	1	1	1	0	0
	Sole	13761	14568	12517	9267	11284	9988	10238
	Whiting	651	605	598	582	418	400	411
BT2 Total		53172	52687	46694	38578	40900	35408	39560
GN1	Cod	2697	3675	3402	3170	2062	2319	2482
	Haddock	160	153	94	72	53	47	31
	Nephrops	1	0	0	0	0	2	1
	Plaice	3980	2507	2343	2467	1086	1069	1281
	Saithe	81	69	64	44	26	28	43
	Sole	795	920	981	811	667	864	873
	Whiting	36	34	17	31	15	6	16
GN1 Total		7750	7358	6901	6595	3909	4335	4727
GT1	Cod	245	239	219	206	143	217	297
	Haddock	3	4	2	1	1	1	1
	Nephrops	0	0	0	0	0	0	0
	Plaice	659	821	1152	1102	633	385	839
	Saithe	4	1	1	1	0	1	2
	Sole	714	700	785	703	562	813	838
	Whiting	12	4	4	5	3	3	8
GT1 Total		1637	1769	2163	2018	1342	1420	1985
LL1	Cod	467	271	188	274	231	387	311
	Haddock	72	24	26	68	10	12	14
	Nephrops	15	18	14	19	18	23	26
	Plaice	1	10	1	2	1	0	0
	Saithe	16	20	4	19	2	4	8
	Sole	1	1	1	0	0	0	1
	Whiting	2	4	2	2	3	3	4
LL1 Total		574	348	236	384	265	429	364
TR1	Cod	12085	10793	12179	11344	10709	11868	15444
	Haddock	35358	41044	41711	31378	26459	26225	26972
	Nephrops	1708	1331	2052	1981	1803	1608	1386
	Plaice	6968	7389	6559	9602	7532	12185	12602
	Saithe	81446	79520	90916	90112	70894	92533	86319
	Sole	25	20	14	17	24	47	41
	Whiting	5058	4449	5441	7714	8491	7851	6714
TR1 Total		142648	144546	158872	152148	125912	152317	149478
TR2	Cod	2109	1582	1570	1410	1529	1625	1561
	Haddock	4273	4230	4478	3509	2808	2889	3414
	Nephrops	13294	16453	18941	21243	21463	19535	22022
	Plaice	6090	5625	4552	4275	4005	4584	3960
	Saithe	648	626	597	372	716	547	384
	Sole	281	250	218	236	316	493	434
	Whiting	4582	3807	4153	6792	6950	4786	4567
TR2 Total		31277	32573	34509	37837	37787	34459	36342
TR3	Cod	35	16	24	27	8	57	4
	Haddock	125	72	31	266	8	175	35
	Nephrops	12	15	5	20	11	0	10
	Plaice	32	8	16	25	6	0	1
	Saithe	286	254	159	114	49	17	0
	Sole	0	0	0	0	0	0	0
	Whiting	938	391	352	1610	296	116	180
TR3 Total		1428	756	587	2062	378	365	230

Table 2.1.6.1. Species composition in the Danish and Norwegian small-meshed fisheries in the North Sea (thousand tonnes). Data provided by WG members. The "other" category is sub-divided by species in Table 2.1.6.2.

Year	Sandeel	Sprat	Herring	Norway pout	Blue whiting	Haddock	Whiting	Saithe	Other	Total
1974	525	314	-	736	62	48	130	42		1857
1975	428	641	-	560	42	41	86	38		1836
1976	488	622	12	435	36	48	150	67		1858
1977	786	304	10	390	38	35	106	6		1675
1978	787	378	8	270	100	11	55	3		1612
1979	578	380	15	320	64	16	59	2		1434
1980	729	323	7	471	76	22	46	-		1674
1981	569	209	84	236	62	17	67	1		1245
1982	611	153	153	360	118	19	33	5	24	1476
1983	537	88	155	423	118	13	24	1	42	1401
1984	669	77	35	355	79	10	19	6	48	1298
1985	622	50	63	197	73	6	15	8	66	1100
1986	848	16	40	174	37	3	18	1	33	1170
1987	825	33	47	147	30	4	16	4	73	1179
1988	893	87	179	102	28	4	49	1	45	1388
1989	1039	63	146	162	28	2	36	1	59	1536
1990	591	71	115	140	22	3	50	8	40	1040
1991	843	110	131	155	28	5	38	1	38	1349
1992	854	214	128	252	45	11	27	-	30	1561
1993	578	153	102	174	17	11	20	1	27	1083
1994	769	281	40	172	11	5	10	-	19	1307
1995	911	278	66	181	64	8	27	1	15	1551
1996	761	81	39	122	93	5	5	0	13	1119
1997	1091	99	15	126	46	7	7	3	21	1416
1998	956	131	16	72	72	5	3	3	24	1283
1999	678	166	23	97	89	4	5	2	40	1103
2000	655	191	24	176	98	8	8	6	21	1187
2001	810	156	21	59	76	6	7	3	14	1152
2002	804	142	26	73	107	4	8	8	15	1186
2003	303	175	16	18	139	1	3	8	18	681
2004	324	193	19	12	107	1	2	7	29	692
2005	172	207	23	1	101	0	1	6	13	524
2006	256	107	13	48	82	0	2	7	15	530
2007	196	75	7	5	48	0	1	3	9	349
2008	241	61	9	30	0	0	1	0	2	344
2009	286	118	10	18	0	0	1	0	0	433
Avg 75-09	639	187	53	202	62	11	32	8	28	1260

Table 2.1.6.2 Sum of Danish and Norwegian North Sea by-catch (tonnes) landed for industrial reduction in the small-meshed fisheries by year and species (excluding Saithe, haddock and whiting accounted for in Table 2.1.6.1).

Species	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
Gadus morhua	544	710	1092	1404	2988	2948	570	1044	1052	876
Scomber scombrus	4	534	2663	6414	8013	5212	7466	4631	4386	3576
Trachurus trachurus	22789	16658	7391	18104	22723	14918	5704	6651	6169	4886
Trigla sp.	0	888[2]	4534	5394	9391	2598	5622	4209	1593	1139
Limanda limanda	187	3209	4632	3781	7743	4706	5578	3986	4871	528
Argentina spp.	8714	5210	3033	1918	778	2801	3434	2024	2874	2209
Hippoglossoides platessoides	59	718	1173	946	2160	1673	1024	1694	1428	529
Pleuronectes platessa	34	119	109	372	582	566	1305	218	128	143
Merluccius merluccius[4]	349	165	261	242	290	429	28	359	109	10
Trisopterus minutus	0	68[3]	0	5	48	121	79	111	36	0
Molva molva[3]	51	1	40	39	37	13	65	10	28	0
Glyptocephalus cynoglossus	236	132	341	44	255	251	1439	195	246	40
Gadiculus argenteus[3]	1210	729	3043	2494	741	476	801	0	0	0
Others	31715	3853	3604	3670	3528	3154	4444	4553	4106	5141
Total	65892	32994	72724	44827	59277	39866	37559	29685	27026	19077

Species	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Gadus morhua	955	366	1688	1281	532	383	192	29	49	44
Scomber scombrus	2331	2019	3153	1934	2728	2443	1749	1260	2549	6515
Trachurus trachurus	2746	2369	3332	2576	5116	5312	1159	2338	5791	10272
Trigla sp.	2091	897	2618	1015	2566	1343	2293	1071	847	1101
Limanda limanda	1028	1065	2662	6620	4317	441	1441	321	596	386
Argentina spp.	292	3101	2604	5205	3580	333	397		1376	786
Hippoglossoides platessoides	617	339	1411	2229	1272	493	431	112	208	174
Pleuronectes platessa	33	90	73	91	88	64	56	51	28	1
Merluccius merluccius[4]	0	3625	2364	33	211	231	167	6	301	423
Trisopterus minutus	9	30	181	261	922	518	0	196	5	91
Molva molva[3]	0	0	31	31	125	19	49	0	42	169
Glyptocephalus cynoglossus	0	97	394	860	437	154	246	58	437	286
Gadiculus argenteus[3]	0	7	248	248	387	532	942	459	993	1550
Others	5158	50	749	5405	17931	8927	301	2226	4888	6953
Total	15260	14055	21508	27787	40211	21192	12523	8127	20115	28750

Species	2005	2006	2007	2008*2	2009*2
Gadus morhua	22	72	119	46	76
Scomber scombrus	2195	2313	466	592	257
Trachurus trachurus	5226	1390	608	38	47
Trigla sp.	597	1849	278	838	1934
Limanda limanda	287	839	76	0	0
Argentina spp.	1348	2025	1382	0	13
Hippoglossoides platessoides	61	302	30	17	15
Pleuronectes platessa	38	10	0	0	1
Merluccius merluccius[4]	254	597	494	0	0
Trisopterus minutus	0	0	0	0	0
Molva molva[3]	34	131	15	0	0
Glyptocephalus cynoglossus	87	68	43	0	0
Gadiculus argenteus[3]	909	1926	3955	0	0
Others	1964	3295	1682	767	604
Total	13022	14815	9146	2298	2947

[1]DK cod and mackerel included. [2]Only DK catches. [3]N catches. DK catches in "Others". [4]Until 1995 N catches only. DK catches in "Others".

Table 2.1.6.3. Danish by-catch landings of cod, haddock and saithe in 1994–2006 from small-meshed fisheries in the North Sea. Landings (tonnes) used for reduction.

Cod	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Sandeel fishery	70	79	288	375	202	51	56	7	12	5	10	2	1		5	70
Sprat fishery	493	174	23	40	11	7	4	4		11	3	16	4	18		1
Norway pout fishery	201	680	4	242	161	11		81	3	3	1		19		41	5
Blue whiting fishery			24	37	20	28			14				0			
"Others" fishery	14	23	2	94	6	4	1	4	1	2	1		0			
Total	778	956	341	789	400	101	61	97	30	21	16	18	24	18	46	76

Haddock	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Sandeel fishery	528	534	1,600	524	202	364	1,226	1,557	220	103	33		97	20	5	
Sprat fishery	685	1,097	18	11	6	62	66	223	27	15		4	25	6	10	3
Norway pout fishery	1,399	4,766	1,774	1,454	251	318	1,734	1,252	1,545	16	57		243		183	49
Blue whiting fishery	10		153	205	66	195	258	218	133	59	16	13				
"Others" fishery	71	349	77	137	218	117	40	42	183	96	10					
Total	2,693	6,745	3,622	2,331	744	1,055	3,324	3,292	2,108	289	116	18	364	27	198	52

Whiting	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Sandeel fishery	1,392	3,322	1,909	2,143	902	2,121	1,539	2,761	1,397	444	653	261	274	326	619	913
Sprat fishery	4,352	10,386	784	107	673	1,088	2,107	1,700	2,238	1,105	333	545	343	900	380	307
Norway pout fishery	3,121	7,291	1,373	2,235	178	331	2,935	1,559	1,675	265	232		1536		17	125
Blue whiting fishery			126	113	83	169	71	217	123	30			0			0
"Others" fishery	187	4,422	22	173	112	116	89	184	127	63		19	1			1
Total	9,053	25,422	4,214	4,771	1,948	3,825	6,740	6,420	5,560	1,907	1,218	825	2154	1226	1,016	1,346

Saithe	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Sandeel fishery			40	0		28		1		30	14					
Sprat fishery	11	297	0	0				3				7		5		
Norway pout fishery	135	490	84	209			116	22	246				14			
Blue whiting fishery	0		20	80	11	8	2	84	72	17	51	7	27	1		
"Others" fishery	0	542		40	1	4	2	7	109	69						
Total	146	1,329	144	329	12	40	120	117	427	116	65	14	41	6	0	0

All species	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Sandeel fishery	611,554	644,473	622,211	761,963	624,925	514,047	551,008	637,518	628,205	274,854	291,445	150,426	254,210	145845	243,655	292,990
Sprat fishery	314,970	344,309	107,243	103,523	145,978	171,757	208,641	170,862	167,472	194,210	200,907	234,251	120,033	82807	71,562	122,345
Norway pout fishery	111,208	140,550	76,390	104,499	33,515	29,361	135,196	47,788	54,980	9,020	8,980		38,943		29,942	19,094
Blue whiting fishery	419		34,857	13,181	46,052	51,060	34,129	26,038	27,052	21,320	20,295		2037	3137		
"Others" fishery	19,480	48,936	8,882	14,554	17,893	26,945	7,433	10,554	8,503	6,184	10,298	6,944	137	2110		1,029
Total	1,057,632	1,178,268	849,584	997,719	868,363	793,169	936,408	892,760	886,212	505,588	531,925	408488	415361	233900	345,159	435,458

Table 2.1.6.4. Quarterly Danish by-catch landings of cod, haddock and saithe in 2009 from small-meshed fisheries in the North Sea. Landings (tonnes) used for reduction purposes.

Cod	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Total
Sandeel fishery		5			5
Blue whiting fishry					0
Sprat fishery					0
Norway pout fishery			41		41
"Others" fishery					0
Total	0	5	41	0	46

Haddock	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Total
Sandeel fishery		5			5
Blue whiting fishry					0
Sprat fishery				10	10
Norway pout fishery			110	74	184
"Others" fishery					0
Total	0	5	110	84	199

Whiting	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Total
Sandeel fishery		619			619
Blue whiting fishery					0
Sprat fishery			315	65	380
Norway pout fishery	17				17
"Others" fishery					0
Total	17	619	315	65	1,016

Saithe	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Total
Sandeel fishery					0
Blue whiting fishery					0
Sprat fishery					0
Norway pout fishery					0
"Others" fishery					0
Total	0	0	0	0	0

Table 2.2.1 Catches in tonnes of the most important target and by-catch species in the Danish industrial fisheres in Division IIIa, 1989-2009

	Species											
Year	Blue whg	Haddock	Herring	N. pout	Other fish	Saithe	Sandeels	Sprat	Whiting	Cod	Plaice	Total
1989	8,635	363	52,378	5,484	6,276	25	18,185	3,941	11,690	829	305	108,111
1990	10,133	1,970	51,015	27,329	13,436	104	15,792	2,325	17,875	820	270	141,070
1991	9,849	2,275	44,241	38,662	11,061	124	23,848	6,424	14,440	1,406	238	152,567
1992	18,698	4,253	65,950	45,095	11,145	128	39,130	3,787	10,677	1,355	210	200,429
1993	32,052	2,630	70,637	7,773	8,267	346	44,804	1,728	5,568	665	315	174,785
1994	11,640	2,179	29,974	6,598	6,358	3	54,901	57,776	5,391	844	156	175,818
1995	10,353	2,162	34,064	50,338	6,089	290	12,143	42,048	9,112	1,054	67	167,719
1996	14,638	2,926	26,194	36,228	7,651	84	53,427	10,326	2,668	911	232	155,285
1997	4,279	687	6,331	31,610	3,389	104	81,542	11,618	914	250	79	140,804
1998	6,619	314	5,055	14,673	5,385	8	10,713	11,241	847	140	9	55,005
1999	3,897	424	9,079	7,496	4,416	37	11,650	17,251	1,199	115	18	55,581
2000	4,217	759	8,901	9,631	4,063	0	16,582	12,722	1,164	99	34	58,173
2001	2,955	260	9,834	7,541	4,130	3	21,966	21,734	1,611	74	35	70,143
2002	6,455	69	14,768	3,299	5,301	0	27,901	13,569	1,430	60	9	72,862
2003	7,315	82	6,296	5,130	9,817	4	12,330	10,970	654	50	16	52,665
2004	4,274	25	5,637	344	10,614	23	15,162	14,948	1,120	44	18	52,208
2005	283	68	6,570	8	12,887	0	4,223	31,857	907	22	12	56,837
2006	995	17	3,074	117	4,066	0	4,435	7,675	290	48	4	20,721
2007	313	31	2,089	2	551	0	22,679	7,155	227	5	2	33,055
2008	119	3	2,169	125	79	0	12,756	5,005	286	11	3	20,556
2009	0	15	3,125	3	175	0	7,002	5,087	173	1	5	15,586
Average 1989-2009	7,511	1,024	21,780	14,166	6,436	61	24,341	14,247	4,202	419	97	102,307

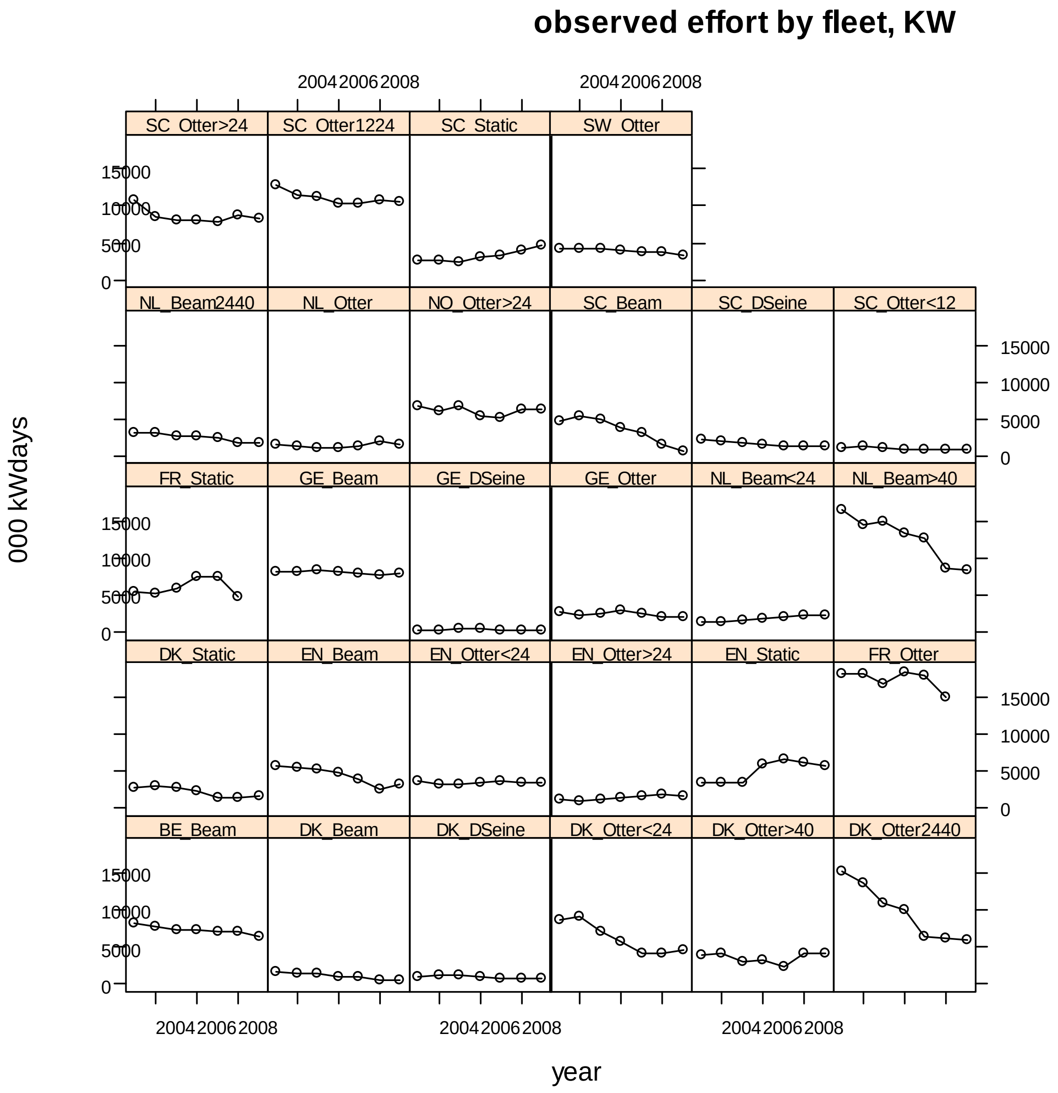

Figure 2.1.2.1 – Effort by fleet and year for the North Sea demersal fleets, in '000 KWdays. Data for French fleets from 2009 was not available and the data point is omitted. Source : ICES WGMIXFISH, 2010.

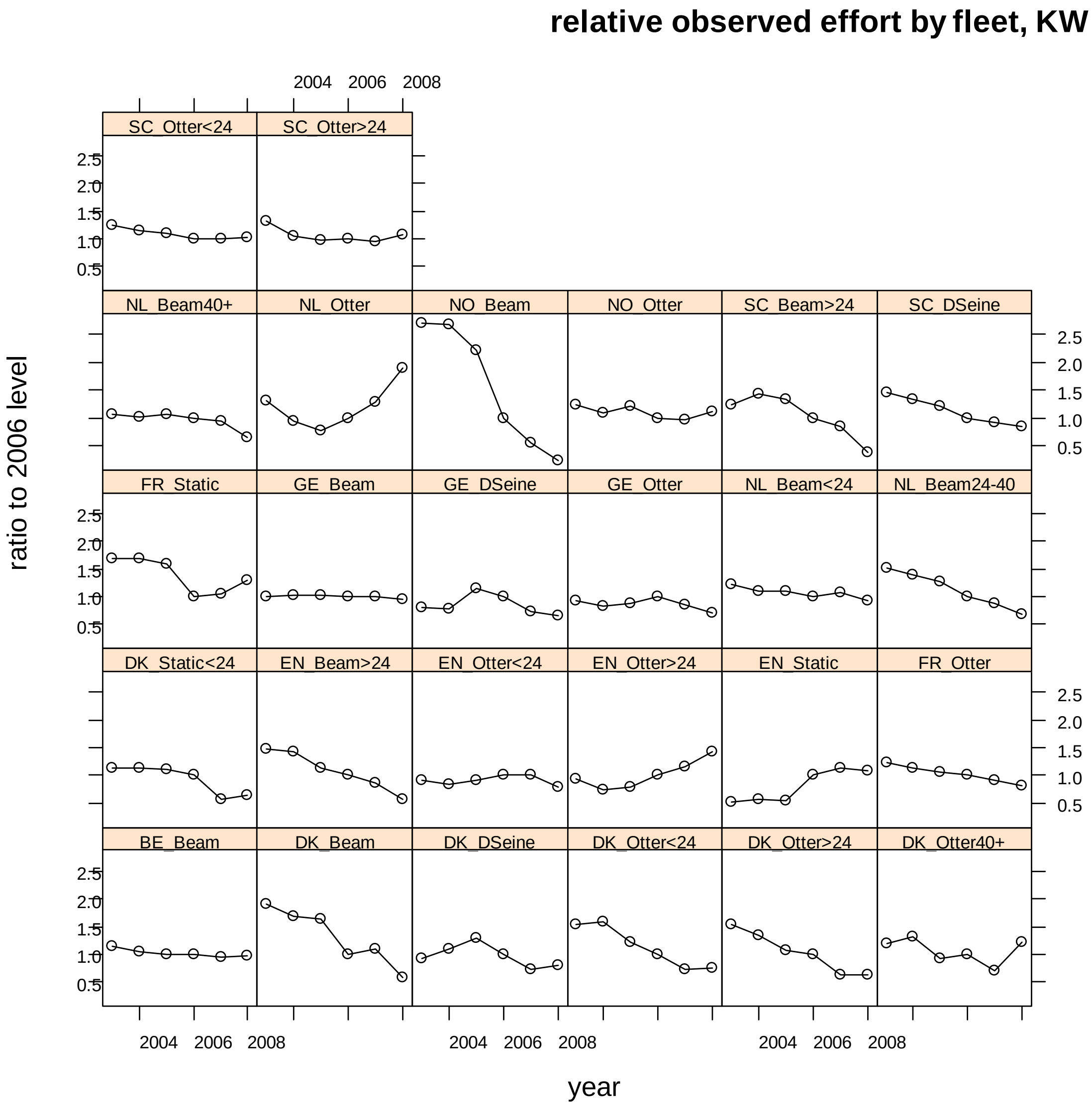

Figure 2.1.2.2 – Relative trends in effort (KW Days) for selected fleets and year for the North Sea demersal fleets (French data omitted in 2009) – source : ICES WGMIXFISH, 2010.

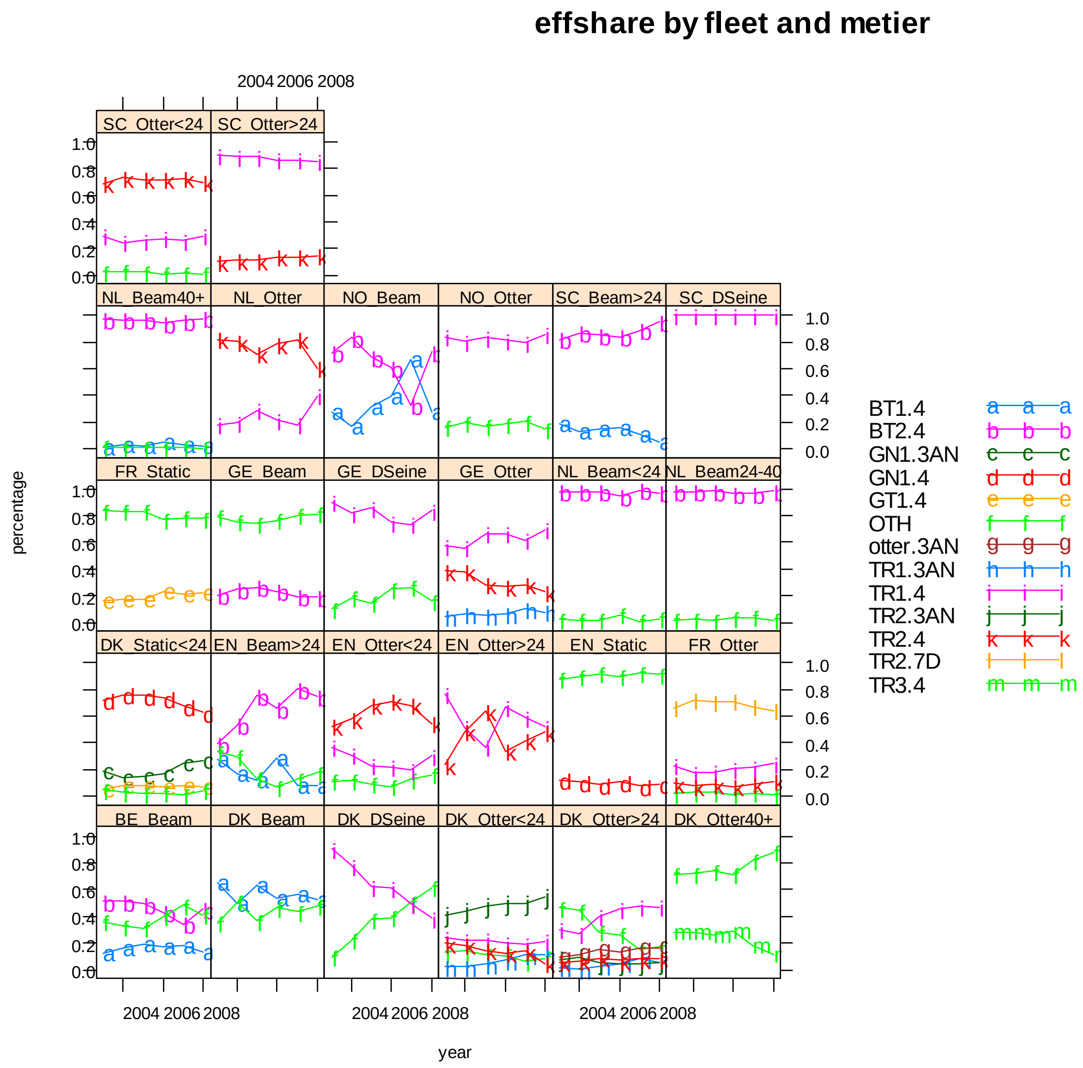

Figure 2.1.2.3 – Effort share (in proportion) by métier for each fleet. source : ICES WGMIXFISH, 2010.

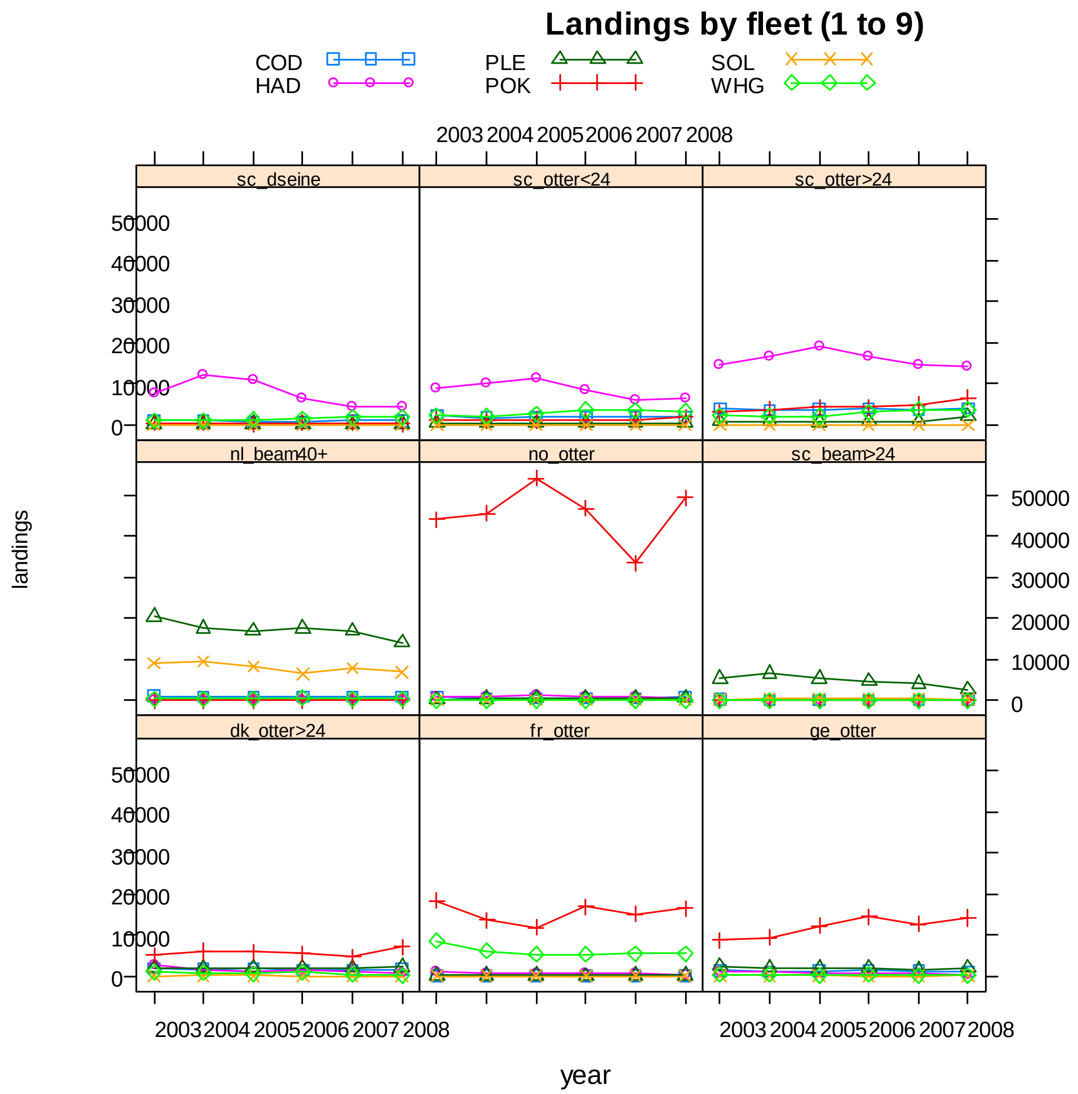

Figure 2.1.2.4. Landings by fleet, stock and year. Fleets are shown in decreasing groups of total landings and with different scales

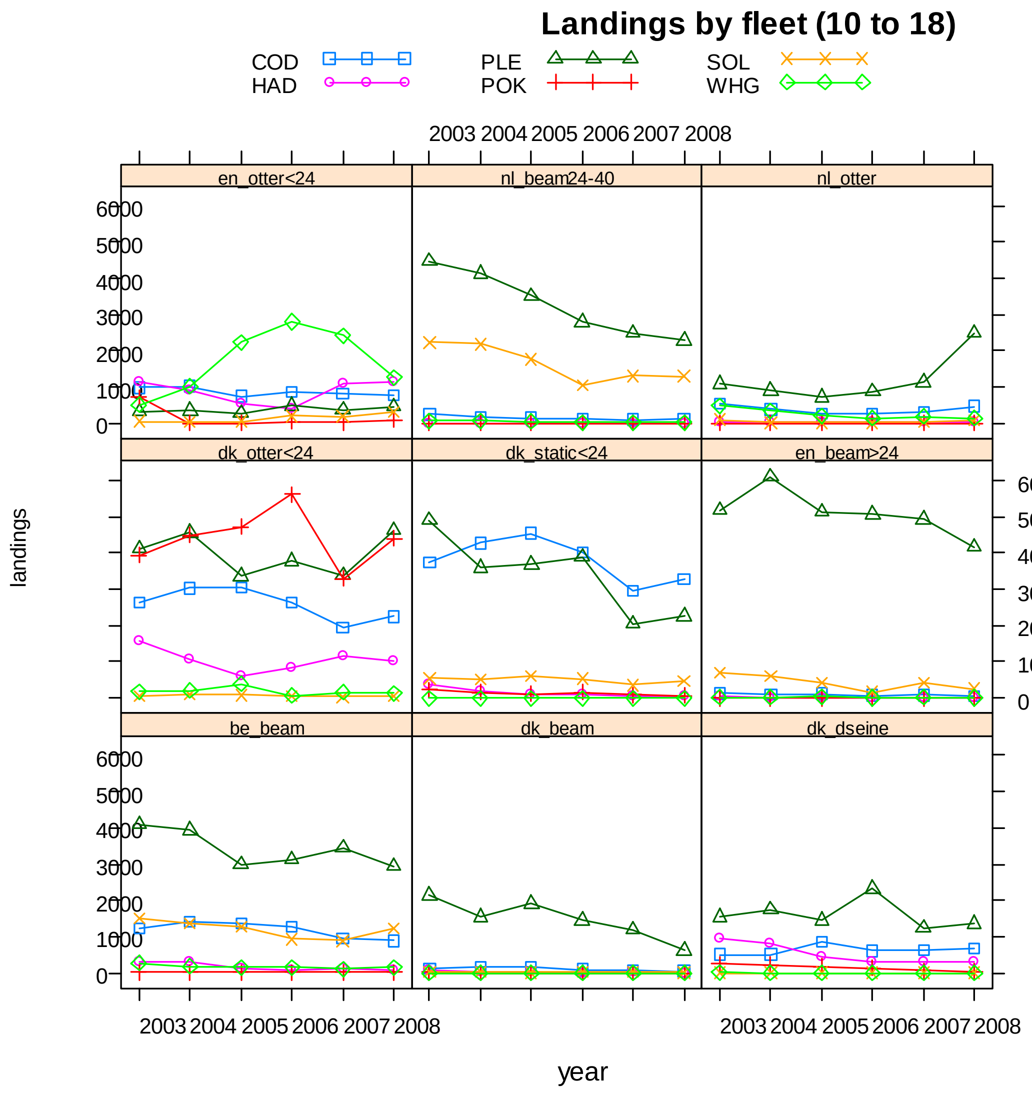

Figure 2.1.2.4 (ctd)

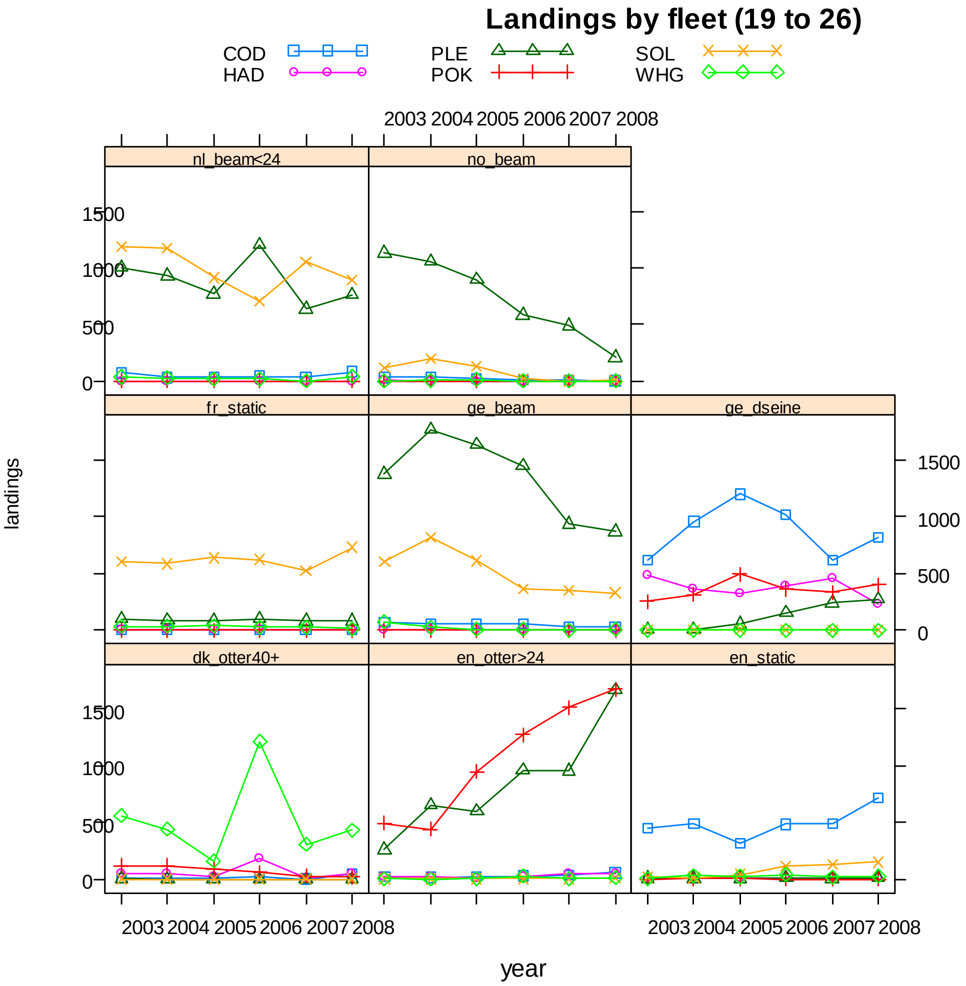

Figure 2.1.2.4. (Ctd)

3 *Nephrops* in Subareas IIIa and IV

3.1 General comments relating to all *Nephrops* stocks

3.1.1 Introduction

Nephrops stocks have previously been identified by WGNEPH on the basis of population distribution and characteristics, and established as separate Functional Units. The Functional Units (FU) are defined by the groupings of ICES statistical rectangles given in Table 3.1.1 and illustrated in Figure 3.1.1. The statistical rectangles making up each FU encompass the distribution of mud sediment on which *Nephrops* live. There are two FUs in Division IIIa and eight FUs in Subarea IV. It is important to note that additional catches of *Nephrops* are also taken from smaller, isolated pockets of mud distributed throughout the ICES divisions. In recent years some of these areas have contributed significant landings despite their small size (eg Devils Hole). Management of *Nephrops* currently operates at the ICES Subarea/Division level.

Functional Units were previously aggregated by WGNEPH into a series of nominal Management Areas (MA) intended to provide a pragmatic solution for more localised management. In 2008 the Working Group agreed that this process had served no useful purpose and should be discontinued.

MSY estimation for *Nephrops* stocks is complicated by the absence of an age-based analytical assessment. The process for determining suitable F_{msy} proxies for *Nephrops* stocks can be found in section 1.3.4.

The presentation of data and text relating to the Division IIIa FUs can be found as follows: Skagerrak (FU3) in Section 3.2.2; Kattegat (FU4) in Section 3.2.3; Divison IIIa overall in Section 3.2.3. The presentation of data and assessments for the Division IV FUs can be found as follows: Botney Gut – Silver Pit (FU 5) in Section 3.3.1; Farn Deeps (FU 6) in Section 3.3.2; Fladen (FU 7) in Section 3.3.3; Firth of Forth (FU 8) in Section 3.3.4; Moray Firth (FU 9) in Section 3.3.5; Noup (FU 10) in Section 3.3.6; Norwegian Deeps (FU 32) in Section 3.3.7; Off Horn Reef (FU 33) in Section 3.3.8; Other areas of Subarea IV in Section 3.3.9.

Overall landings for Divisions IIIa and IV reported to the WG are summarised by Functional Unit in Table 3.1.2 and Figure 3.1.2.

3.2 *Nephrops* in Subarea IIIa

3.2.1 General

Official landings supplied to ICES for Division IIIa are shown in Table 3.2.1.1. Supplied by ICES staff Division IIIa includes FU 3 and 4, which are assessed together. Total *Nephrops* landings by FU and country are shown in Table 3.2.1.2 and Table 3.2.1.3.

FU 3 and FU 4 have for many years, mainly on basis on historical differences in the local fisheries, been maintained as separate stock units. The minor differences observed between the two areas in for instance size distributions may well have been due to area based differences in selectivity of fishing gear. However, for many years the trends both in fisheries data (LPUE) and size data have been very similar and do not indicate any significant differences between the two areas. Consequently, in the assessments and advice the two FUs have always been merged. Therefore, the WG suggests and recommends that both assessment data and assessments for these two FUs formally are merged into a single FU, comprising both Skagerrak and Kattegat (ICES Division IIIa).

Ecosystem aspects

Nephrops lives in burrows in suitable muddy sediments and is characterised by being omnivorous and emerge out of the burrows to feed. It can, however, also sustain itself as a suspension feeder (in the burrows) (Loo *et al*., 1993). This ability may contribute to maintaining a high production of this species in IIIa, due to increased organic production.

Severe depletion in oxygen content in the water can force the animals out of their burrows, thus temporarily increasing the trawl catchability of this species during such environmental changes (Bagge *et al*. 1979). A specially severe case was observed in the end of the 1980s in the southern part of IIIa in late summer, where initially unusually high catch rates of *Nephrops* were observed. Eventually the increasing amount of dead specimens in the catches lead to the conclusion of severe oxygen deficiency in especially the southern part of IIIa (Kattegat) in late 1988 (Bagge *et al*., 1990).

No information is available on the extent to which larval mixing occurs between *Nephrops* stocks, but the similarity in stock indicator trends between FU 3 and 4 for both Denmark and Sweden indicates that recruitment has been similar in both areas. These observations suggest they may be related to environmental influences.

Functional units and their fisheries.

See stock annex

ICES Advice

The most recent advice for *Nephrops* in IIIa was given in 2008. ICES concluded that:

'*Due to uncertainty in the available data ICES is not able to reliably forecast catch. There are no signs of decline in the stocks and therefore current levels of exploitation and effort appear to be sustainable.'*

No specific catch levels were recommended, but ICES gave the following comments:

The fishing effort on Nephrops has decreased since 2002 and is currently at a low level. In recent years, lpue has shown an increasing trend but this is not necessarily an indication of increase in stock abundance. There are no signs of overexploitation in Division IIIa.

ICES currently advises no catches for cod in Division IIIa, which is a significant bycatch species in the Nephrops fisheries. The current effort regulation (limiting days at sea for gears not using selective sorting grids) may increase the incentives to use sorting grids. This may reduce by-catch of cod.'

Management for FU 3 and FU 4

The 2009 and 2010 TAC for *Nephrops* in ICES area IIIa was set to 5170 tonnes, i.e. unchanged since 2006. The minimum landings size for *Nephrops* in area IIIa is still 40mm carapace length. This high MLS for IIIa is maintained following advice from the industry. However, this leads to a high discard rate and at present 75% of the catch (N) in IIIa consists of undersized individuals (Figure 3.2.1.1). It is expected that ongoing experimental work on improved selectivity of the gear eventually will reduce the amounts of discards.

Days at sea limits restrict *Nephrops* trawlers to 19 days per month when using 90mm mesh with no square mesh panel, and 22 days with a square mesh panel. New gear regulations imply that it is mandatory to use a 35 mm species selective grid and 8 m of 70 mm full square mesh codend and extension piece when trawling for *Nephrops* in Swedish national waters. As Sweden has bilateral agreements with Denmark and Norway to fish inside the 12 nm limit, the regulations cover only waters exclusively fished by Swedish vessels (inside 3 nm in Kattegat and 4 nm in Skagerrak). Since 2006, days at sea is unlimited for this species selective trawl (Council Regulation 51/2006). The changes in the national Danish regulation system from 2007 are described earlier in this section.

3.2.2 The Skagerrak (FU3)

3.2.2.1 Data available

Landings

Denmark, Sweden and Norway exploit this FU. Denmark and Sweden dominate this fishery, with 61 % and 33 % by weight of the landings in 2008. Landings by the Swedish creel fishery represent 13-18 % of the total Swedish *Nephrops* landings from the Skagerrak in the period 1991 to 2002 and has increased to 29% in 2008 (Table 3.2.2.1)

In the early 1980s, total *Nephrops* landings from the Skagerrak increased from around 1000 t to just over 2670 t. Since then they have been fluctuating around a mean of 2500 t (Figure 3.2.2.1)).

Length compositions

For the Skagerrak, size distributions of both the landings and discards are available from both Denmark and Sweden for 1991-2008. Of these, the Swedish data series can be considered as being the most complete, since sampling took place regularly throughout the time period and usually covered the whole year. In earlier years the Swedish discard samples were obtained by agreement with selected fishermen, and this might tempt fishermen to bias the samples. However, the reliability of the catch samplings is cross-checked by special discard sampling projects in both the Skagerrak and the Kattegat. In recent years the Swedish *Nephrops* sampling is carried out by onboard observers in both Skagerrak and Kattegat. Geographically, the samples from the Swedish fishery mainly cover the north-eastern part of the Skagerrak.

In 1991, a biological sampling programme of the Danish *Nephrops* fishery was started on board the fishing vessels, in order to also cover the discards in this fishery. Due to its high cost and the lack of manpower, Danish sampling intensity in the early years was in general not satisfactory, and seasonal variations were not often adequately covered. Due to increasing lack of resources the Danish at sea sampling in Skagerrak was at unsatisfactory low level in 2007 and 2008, and for these years the length composition data for Skagerrak are based on Swedish samples only. The Norwegian *Nephrops* fishery is small and has not been sampled. Trends in mean size in catch and landings are shown in Figure 3.2.2.1. Mean sizes in landings, in both sexes are fluctuating without trend while there is a slightly decreasing trend for discards.

Maturity and natural mortality

Data on size at maturity for males and females were presented at the ICES Workshop on *Nephrops* Stocks in January 2006 (ICES WKNEPH, 2006), see also stock annex. Since no estimates of SSB have been made, these data were not used in this year’s analysis of these stocks.

Catch, effort and research vessel data

Effort data for the Swedish fleet are available from logbooks for 1978-2009 (Figure 3.2.2.1 and Table 3.2.2.3). In recent years the twin trawlers have shifted to target both fish and *Nephrops*, and this shift has resulted in a decreasing trend in LPUE from 1998 to 2005 for this gear (Table 3.2.2.3). In the most recent years LPUEs have increased for both gear types. The long term trend in LPUEs (an increase from 1992 to 1998, a decrease from 1999 to 2001 and a subsequent increase in the last 6 years) is similar in the Swedish and Danish fisheries. Total Swedish trawl effort shows a decreasing trend since 1992. From 2004 onwards total Swedish trawl effort has been estimated from LPUEs from the grid single trawl (targeting only *Nephrops*) and total trawl landings.

Danish effort Figures for the Skagerrak (Table 3.2.2.4 and Figure 3.2.2.1) were estimated from logbook data. For the whole period, it is assumed that effort is exerted mainly by vessels using twin trawls. The overall trend in effort for the Danish fleet is similar to that in the Swedish fishery. After having been at a relatively low level in 1994-97, effort did increase again in the next five years followed by a decrease in recent six years. Also the trend in LPUE is similar to that in the Swedish single trawl fishery, however with a much more marked increase in the Danish LPUE for 2007 and 2008. This high LPUE level is likely to be a consequence of the national (Danish) management system introduced in 2007.

It has not been possible to incorporate 'technological creeping' in a further evaluation of the Danish effort data. However, use of twin trawls has been widespread for many years. Since 2008 the Danish logbook data have been analysed in various ways to elucidate the effect of factors likely to influence the effort/LPUE, e.g. vessel size (GLM to standardise LPUE regarding vessel size, Figure 3.2.2.3).

Note, that the trends in the resulting LPUE are very similar. However, this may merely reflect that vessels catching *Nephrops* in this area are very similar with respect to e.g. size and HP.

3.2.3 The Kattegat (FU4)

3.2.3.1 Data available

Catch

Both Denmark and Sweden have *Nephrops* directed fisheries in the Kattegat. In 2009, Denmark accounted for about 74 % of total landings, while Sweden took remaining 26 % (Table 3.2.3.1). Minor landings are taken by Germany.

After the low that was observed in 1994, total *Nephrops* landings from the Kattegat increased again until 1998. Since then, they have fluctuated around 1500 t. However, landings increased markedly in 2008 to more than 2000 t, the highest observed landings since 1984 (Figure 3.2.3.1). Total landings decreased slightly in 2009 compared to 2008.

Length compositions

For Kattegat, size distributions of both the landings and discards are available from Sweden for 1990-1992 and 2004-2009, and from Denmark for 1992-2009. The at-sea-sampling intensity has generally increased since 1999. The Danish sampling intensity was low in 2007 and 2008, but was normalised in 2009. Information on mean size is shown in Figure 3.2.3.1 and table 3.2.3.5. Notice, that except for small mean sizes from1993 to 1996 all categories have been fluctuating without trend the last 13 years.

Maturity and natural mortality

Data on size at maturity for males and females were presented at the ICES Workshop on *Nephrops* Stocks in January 2006 (ICES WKNEPH, 2006), see also stock annex. Since no estimates of SSB has been made, these data were not used in this year's analysis of these stocks.

Catch, effort and research vessel data

Swedish total effort, converted to single trawl effort, has been relatively stable over the period 1978-90. An increase is noted in 1993 and 1994, followed by a decrease to 1996, and a stabilisation at intermediate levels in recent years (Figure 3.2.3.1 and Table 3.2.3.1)). Figures for total Danish effort are based on logbook records since 1987. Danish effort increased during 1995 to 2001, but since then it has been showing a decreasing trend until 2007. In 2008 and 2009 the recorded effort was on the same level (Figure 3.2.3.1 and Table 3.2.3.4).

It has not been possible to incorporate 'technological creeping' in a further evaluation of the Danish effort data. However, use of twin trawls has been widespread for many years. Since 2008 the Danish logbook data have been analysed in various ways to elucidate the effect of factors likely to influence the effort/LPUE, e.g. essel size (GLM to standardise LPUE regarding vessel size, (Figure 3.2.3.2):

Notice, that the trends in the resulting LPUE (relative indices) are very similar. However, this may merely reflect that vessels catching *Nephrops* in this area are very similar with respect to e.g. size and HP.

3.2.4 Combined assessment (FU 3 & 4)

Reviews of last year's assessment

In the last review of this assessment (2008) it was stated that:

> *"…a proper updated segmentation and standardization should be encouraged for the main fleets involved in this fishery, mainly for Danish (~65%) and Swedish (~30%), in order to understand in a coherent, comparable and relative way trends of the whole time series".*
>
> *"…the assumption that commercial information reflects exploitation and abundance should be considered with caution, though all is indicating that there are no special problems with these FUs."*
>
> *"…The RG supports the Danish initiative (2006 and 2007) for carrying out underwater TV (UWTV) surveys in larger areas and it is desirable that Sweden should be joined to this initiative."*

3.2.4.1 Exploratory assessment

An ongoing Danish underwater TV survey started in 2007. In 2007 and 2008 the survey could be considered as being in a trial phase, where the technical routines were steadily improving. Preliminary estimates of stock abundance for Kattegat based on the 2007 and 2008 data have been made. The coverage of the Danish UWTV survey in 2009 was extended, but there was no coverage of Skagerrak. In 2009 a similar Swedish UWTV survey started, but due to technical problems no data were collected. Preliminary estimates of standing stock sizes based on the Danish survey data in 2007 and 2008 indicate low H.R.s. As from 2010 both Denmark and Sweden are expected to provide UWTV survey data. Sweden should cover mainly the eastern parts of IIIa while Denmark is to cover the western part

A number of factors are suspected to contribute with bias to the indices from the TV surveys: Edge effect, detection rate, species identification, occupancy. These uncertainties are described in details in the reports of WKNEPHTV (2007), and WKNEPHBID (2009). However, apart from the problem of biased indices there is also the problem of raising from index, e.g. numbers/sqm to total stock. In Div. IIIa the distribution of *Nephrops* is limited to soft bottom areas, but as densities vary within this type of bottom, stratification of the sampling localities is necessary in order to provide uncertainty estimates of the indices. The survey design has been based on the maps of the sea bed for the Kattegat provided by GEUS (Danish Geological Institute) and for IIIa combined Danish and Swedish VMS data for the recent years (2008 and 2009), see Figure 3.2.4.1. As the VMS data (point densities) probably reflects the fishable *Nephrops* stock best, this has been used as basis for a (preliminary) estimate of the 2009 standing stock in IIIa (N and Biomass), which in this case is based indices from Kattegat only, see Table 3.2.4.1. Notice the significant difference in densities between the northern and southern Kattegat. Table 3.2.4.2. gives the estimates of standing stock based on the average density and the low density. Applying the average density estimate with the catch (N) for 2009 would imply a H.R. of approximately 10%.

However, due to above mentioned uncertainties as well as the lack of survey data for Skagerrak the 2010 WGNSSK considered these stock estimates too uncertain to base the 2010 ICES advice on this stock on. The main issues to be further elucidated are:

- Which of several estimates of total area will reflect the distribution of the fishable stock best.
- Survey designs with optimal stratification incorporating both the Danish and Swedish surveys.

Further analyses of the 2007-2009 data together with the data from both the Danish and Swedish surveys in 2010 as well as the VMS data for IIIa are expected to reduce these problems. The UW survey data are therefore expected to be the basis for assessment in 2011.

3.2.4.2 2010 Assessment.

The assessment of the state of the *Nephrops* stocks in the Skagerrak and Kattegat area is based on the patterns in fluctuations of total combined LPUE by Denmark and Sweden during the period 1990-2009 and the patterns in fluctuations of discards in the fisheries as estimated from the catch samples for the same period.

Combined relative effort declined slightly over the period 1990 to 2009 (Figure 3.2.4.2) while combined relative LPUE has increased over the last 8 years (at around 4% per year) and is at present at the highest level (Figure 3.2.4.3) although technical creep may be responsible for some of this increase. The Danish LPUEs have been adjusted to the Swedish level since 2007 in order compensate a sudden change in LPUE level caused by a change in the Danish management system (WGNSSK Report, 2008). Changes in LPUE may reflect changes in stock size, catchability but also consequences of changes in management system. High LPUEs attributable to sudden changes in catchability (caused by e.g. poor oxygen conditions) are generally of short duration.

Since the abundance of *Nephrops* discards (mainly small specimens below minimum landing size) may also be regarded as an index of recruitment, they can be used to further explain the current developments in the stocks. The large amounts of discards in the periods 1993-95 and 1999-2000 reflect strong recruitment during these years (Figure 3.2.44). The high levels of recruitment in 1993-95 are believed to have significantly contributed to the high LPUE in 1998-99. The high amount of discards observed in 2007, 2008 and 2009 would then indicate high recruitment in these years.

Conclusions drawn from these indicator analyses

The combined logbook recorded effort has decreased since 2002 and is currently at a low level while LPUE shows an increasing trend in recent years (Figures 3.2.4.3 and 3.2.4.4). Mean sizes are fluctuating without trend. There are no signs of overexploitation in IIIa.

The conclusion form this indicator based assessment is that that the stock is increasing.

According to the EU's policy paper these stocks would be classified as a Category 8 stocks (due to the analysis through LPUE trend). The rule set employed by the EU compares the most recent 2 years with the preceding 3 years with a maximum TAC change of 15%. The combined LPUE Figures for area IIIa *Nephrops* show a 11.7% increase which would be translated into an 11.7% TAC increase.

3.2.4.3 Biological reference points

No biological reference points are used for this stock.

3.2.4.4 Quality of the assessment

Perceptions of the stock are based on Swedish and Danish LPUE data. The TAC is not thought to be restrictive for the fleets exploiting this stock, but no information is available on technological creep in the fishery. Swedish *Nephrops* directed single trawl LPUE and Danish *Nephrops* directed twin trawl LPUE are weighted and used as combined LPUE in the trend analysis.

3.2.4.5 Status of the Stock

This assessment for Div. IIIa does not provide a sufficient basis to formulate catch options based on various effort levels. Instead, given the apparent stability of the stocks, the WG concludes that current levels of exploitation appear to be sustainable.

3.2.5 Division IIIa *Nephrops* Management Considerations

The observed trends in effort, LPUE and discards are similar for FU 3 and FU 4. Our present knowledge on the biological characteristics of the *Nephrops* stocks in these two areas does not indicate obvious differences, and therefore the two FUs are treated as one single 'stock' in the assessment.

The combined logbook recorded effort has decreased since 2002 and is currently at a low level while LPUE shows an increasing trend in recent years (Figures 3.2.4.3 and 3.2.4.4). Mean sizes are fluctuating without trend. There are no signs of overexploitation in IIIa.

Given the apparent stability of the stock, the WG concludes that current levels of exploitation appear to be sustainable.

The high amount of discards observed in 2007, 2008 and 2009 could indicate high recruitment in these years.

The WG encourages the work on size selectivity in *Nephrops* trawls to reduce the large amount of discarded undersized *Nephrops* in IIIa.

Mixed fishery aspects

Cod and sole are significant by-catch species in these fisheries in IIIa, and even if data on catch including discards of the by-catch gradually become available, they have not yet been used in the management. The WG has for many years recommended the use of species selective grids in the fisheries targeting *Nephrops* as legislated for Swedish national waters. The current effort regulation (days at sea) in IIIa may increase the incentives to use the sorting grid as this gear is not subject to the otherwise restrictive effort limitations in force.

3.3 *Nephrops* in Subarea IV

Division IV contains eight FUs 5, 6, 7, 8, 9, 10, 32, and 33. Management is applied at the scale of ICES Division through the use of a TAC and an effort regime.

Management at ICES Subarea Level

The 2009 EC TAC for *Nephrops* in ICES Subarea IIa and IV was 24837 tonnes in EC waters (plus 1210 tonnes in Norwegian waters). For 2010, this has been reduced to 24688 tonnes in EC waters and 1200 tonnes in Norwegian waters.

The minimum landings size (MLS) for *Nephrops* in Subarea IV (EC) is 25mm carapace length. Denmark, Sweden and Norway apply a national MLS of 40mm.

Days-at-sea regulations and recently introduced effort allocation schemes (kW*day) have reduced opportunities for directed whitefish fishing. STECF 2008 stated that the overall effort (kW*days) by demersal trawls, seines and beam trawls shows a substantial reduction since 2002. However, there have also been substantial changes in the usage of the different mesh size categories by the demersal trawls. In particular there has been a sharp reduction in usage of gears with a mesh size of between 100mm and 119mm (targeting whitefish), and a subsequent general increase in effort by vessels using smaller mesh sizes (targeting *Nephrops* for instance).

UK legislation (SI 2001/649, SSI 2000/227) requires at least a 90 mm square mesh panel in trawls from 80 to 119mm, where the rear of the panel should be not more than 15 m from the cod-line. The length of the panel must be 3 m if the engine power of the vessel exceeds 112 kW, otherwise a 2 m panel may be used. Under UK legislation, when fishing for *Nephrops,* the cod-end, extension and any square mesh panel must be constructed of single twine, of a thickness not exceeding 4 mm for mesh sizes 70-99 mm, while EU legislation restricts twine thickness to a maximum of 8 mm single or 6 mm double.

Under EU legislation, a maximum of 120 meshes round the cod-end circumference is permissible for all mesh sizes less than 90 mm. For this mesh size range, an additional panel must also be inserted at the rear of the headline of the trawl. UK legislation also prohibits twin or multiple rig trawling with a diamond cod end mesh smaller that 100 mm in the North Sea south of 57°30′N.

Official catch statistics for Subarea IV are presented in Table 3.3.1. The preliminary officially reported landings in 2009 are almost 24,000 tonnes which is around 2,000 tonnes greater than in 2008. Minor updates have been made to landings in previous years. No official landings are available from Denmark for 2009. Landings from other rectangles not associated with Functional Units increased significantly in 2009 to their highest observed level.

Table 3.1.2 shows landings by FU as reported to the WG. It also shows that a small but significant proportion of the landings from Subarea IV come from outside the defined *Nephrops* FUs. Figure 3.1.2 shows the distribution of landings by rectangle and FU. Data at the rectangle level were not readily available from Denmark, Netherlands, Belgium and Sweden, so the level of landings from the eastern North Sea (FUs 5 and 33) and area IIIa are underrepresented. The red circles show landings from rectangles not assigned to a FU. The large concentration of red circles in the eastern North Sea are the Devil's Hole.

The trends observed in the 2009 Fishers' North Sea stock survey for *Nephrops* are discussed in the Quality of Assessment sections.

3.3.1 Botney Gut (FU5)

3.3.1.1 Data Available

Landings.

Table 3.3.1.1 shows the landings from this FU. For many years total landings have been at a level of 1000 t. Up to 1995, the Belgian fleet took more than 75% of the international *Nephrops* landings from this FU/stock, but since then, the Belgian landings have declined drastically, and since 2006 there has been no directed Belgian *Nephrops* fishery. Danish landings have been at low levels in recent years. Peak landings were in 2001-2002 with around 1200 t. In the most recent years UK, Netherlands and Germany have accounted for most of the landings from this FU. In 2009 total landings amounted to around 700 t.

Discards.

Discard data were available for the Belgian *Nephrops* fleet for the period 2002 - 2005. Since 2006, because of no directed fisheries, there has been no data collection from the Belgian *Nephrops* landings. No discard data are available from the other fisheries.

Length compositions

Danish sampling of landed *Nephrops* has taken place 2005-2007, mainly as a compensation for inadequate at-sea-sampling. In 2009 data on length composition in the Dutch catches are available, see Figure. 3.3.1.1

Data on mean sizes of male and female *Nephrops* in the Belgian landings (1991- 2005) are shown in Table 3.3.1.2 and Figure 3.3.1.2. The mean sizes of males show evidence of an overall downward trend, while mean sizes of females seem to be stable, Figure 3.3.1.2 shows a time series of landing length compositions. There is little evidence in these of a notable change in sizes and the maximum sizes have remained quite constant during this period.

Natural mortality, maturity at age and other biological parameters

In previous analytical assessments (see e.g. WGNEPH, 2003), natural mortality was assumed to be 0.3 for males of all ages and in all years. Natural mortality was assumed to be 0.3 for immature females, and 0.2 for mature females. Discard survival was assumed to be 0.25 for both males and females (after Gueguen & Charuau, 1975, and Redant & Polet, 1994).

Growth parameters are as follows:

Males: $L\infty$ = 62mm CL, k = 0.165.

Immature females: $L\infty$ = 62mm CL, k = 0.165.

Mature females: $L\infty$ = 60mm CL, k = 0.080, Size at 50% maturity = 27mm CL.

Growth parameters have been assumed to be similar to those of Scottish *Nephrops* stocks with similar overall size distributions of the landings (see e.g. WGNEPH, 2003). Female size at 50% maturity was taken from Redant (1994).

Commercial catch-effort data and research vessel surveys

Effort and LPUE Figures are available for Belgian *Nephrops* specialist trawlers (1985-2005), the Dutch fleet (all vessels catching *Nephrops* for the period 2000-2009 and the Danish bottom trawlers with mesh size > 70 mm (1996-2009), Table 3.3.1.3 and Figure 3.3.1.1.

The effort of the Belgian *Nephrops* fleet has shown an almost continuous decrease since the all times high in the early 1990s. In 2005, effort was at the lowest level in the time series No data are available for the 2006-2007

The effort of the Dutch (*Nephrops*) fleet was at a high level in 2000-05between 7900 and 9800 days at sea annually. Since then they have declined to a level of 5000-6000 days. The time series of corresponding LPUE shows a peak in 2005. Danish *Nephrops* effort in the Botney Gut was always low but has fluctuated drastically in recent years. Considering the time series and the data from the Netherlands, it is most likely, the very high LPUE Figure in 2008 may reflect either some misreporting or sudden increasing efficiency due to the FKA agreement for fishing industry described in Section 3.2.1.2.

There are no fishery-independent survey data for FU 5.

3.3.1.2 Status of stock

The shortage of information on this stock in the recent years makes an evaluation of stock condition difficult. The Dutch LPUEs have been declining since 2005, and it is unlikely that the single high value of the Danish LPUE in 2008 reflects increase in stock abundance. Considering the declining Dutch LPUEs and lack of other more substantial data gives rise for concern about the status of this stock.

Management considerations for FU 5.

The North Sea TAC is not thought to be restrictive for the fleets exploiting this stock, Considering the recent trend in LPUE and technological creep of the gear, the exploitation of this stock should monitored closely.

3.3.2 Farn Deeps (FU6)

3.3.2.1 Fishery in 2008 & 2009

Since the beginning of the time-series, the UK fleet has accounted for virtually all landings from the Farn Deeps (Table 3.3.2.1). In 2009 total landings were 2,711 tonnes, a large increase on the low 2008 value (1,218t) but below the levels of both 2006 and

2007 (Figure 3.3.2.1). The introduction of the buyers and sellers legislation in 2006 precludes direct comparison with previous years because the resulting improvement in reporting levels has created a discontinuity in the data. Effort in 2009 increased following the sharp decrease observed in 2008 but the overall the general trend of declining effort since the early 1990s has continued (although again the change in legislation in 2006 complicates the interpretation of any trends). Effort trends in terms of KW hours are further complicated by moves towards multi-rig fishing gears which generally have a higher fishing power. The proportion of landings by multi-rig gears (mainly twin riggers) had risen steadily through time but fell slightly in 2009 from the peak in 2008 (Figure 3.3.2.2). Historically the fishery is prosecuted by a combination of local English boats (smaller vessels undertaking day-trips) and larger vessels from Scotland with occasional influxes of effort by Northern Irish vessels. The number of vessels in the fishery from Scotland and Northern Ireland had decreased in 2008 but increased again in 2009 albeit not to the levels seen in 2006 and 2007.

The Farn Deeps fishery is essentially a winter fishery commencing in September and running through to March, hence the 2009 fishery comprised the end of the 2008-2009 fishery and the start of the 2009-2010 fishery. The quarterly pattern of effort continued relatively unchanged in 2009, the 2nd and 3rd quarters remained at similar levels to previous years whilst the 1st and 4th quarter effort increased over the low 2008 levels. (Figure 3.3.2.3).

3.3.2.2 ICES Advice in 2009

The last assessment of *Nephrops* in FU6 was in 2009.

ICES advises on the basis of exploitation boundaries in relation to high long term yield and low risk of depletion of production potential that the Harvest Rate for Nephrops fisheries should not exceed F2008. This corresponds to landings of no more than 1 210 t for the Farn Deeps stock.Management

Management is at the ICES Subarea level as described at the beginning of Section 3.3.

3.3.2.3 Assessment

Review of the 2009 assessment.

May 2009:

"The RG agrees with the view of the EG in that this stock is showing serious declines in the recent past. Signals from the TV survey and fishery dependant data suggest a downward trend, although the TV survey from 2008 suggests that this has stabilized but LPUE and catch data continues to show a downward trend. Although trends in fishery dependant data (LPUE) as an indicator of stock trends are not used in the final assessment, the EG are encouraged to incorporate the estimates of twin trawl usage into the effort estimates. Sangster and Breen (1998)1 observed an increase in Nephrops catches of 420% when using twin-rigged gear in comparison to a single net."

The LPUE by single and twin rig is now given in Figure3.3.2.3 where twin rig catch rates are about double the single rig rates for vessels targeting *Nephrops* (i.e. >=25% landings by weight of *Nephrops*).

Data available

Catch, effort and research vessel data

Three types of sampling occur on this stock, landings sampling, catch sampling and discard sampling providing information on size distribution and sex ratio. The sampling intensity is considered to be generally good although concerns regarding the sampling levels of tail (as opposed to whole) landings has resulted in the catch and landings distributions being estimated from the monthly catch samples, supplemented by the discard sampling.

Two different procedures have been used to estimate discards with a change in method in 2002. These are described in detail in the Stock Annex.

LPUE had remained relatively stable between 1993-2000, at a relatively high level around 26 $kg.hour^{-1}$ (Table 3.3.2.2 & Figure 3.3.2.1). Since 2000 annual LPUE has sharply increased to its highest value in the series in 2006. LPUE in 2009 increased from the low level observed in 2008 to just above the 2007 level. The introduction of the buyers and sellers legislation in 2006 precludes comparison with previous years.

The harvest rate (removals in numbers divided by the TV abundance fluctuates considerably but the 2009 level was moderately high (19.34%).

Males generally predominate in the landings, averaging about 70% (range 64%-79%) by biomass in the period 1992-2005. There was an anomaly in the 2006-2007 fishery with a predominance of females. This anomaly corrected itself in the 2007-2008 fishery but the 2008-2009 season again showed a higher than expected level of females, albeit not as marked as the 2006-2007 season (Figure 3.3.2.4).

Effort is generally highest in the 1st and 4th quarter of the year in this fishery (Figure 3.3.2.4) with landings correspondingly highest in these quarters. In both 2008 and 2009 effort was down on recent levels. The reduced number of larger vessels in 2008 may have a disproportional negative impact on CPUE measures in that the larger vessels are likely to have a higher efficiency. With the exception of quarter 2 which always has low LPUE there was an continual increase for females since quarter 1 2008 with quite a hike in rates in the 4th quarter to well above average levels increase in LPUE over the 2008 levels. For males the LPUE in quarters 1-3 was at the same level as in 2008 but quarter 4 showed a sharp increase although the absolute level remains within the recently observed range.

Trends in the mean lengths for the <35mm categories (Figure 3.3.2.1) are used to infer possible changes to recruitment. Changes to the raising procedure in 2000 and 2002 confound comparison with years prior to 2002, but clear upward trends can be seen for both sexes between 2002 and 2007 implying a trend towards lower recruitments. There was a reduction in mean length in 2005 which corresponded with the high abundance index in 2006. The mean length of all catch components appear to have remained fairly constant in between 2007 and 2009.

The length frequency distribution (Figure 3.3.2.5) shows an broadening of the dominant lengths for females as well as more distinct modality than normal in 2009. Although the mean size of females did not appreciably change, the distribution was flattened out with a fairly flat distribution between 26 and 38mm, all of which should be mature. The proportion of both males and females in the ~24mm category is lower than the 2008 level indicating lower recruitment.

Analysis of individual vessel records indicates an increase in directed *Nephrops* fishing since around 2000. Restrictions on both quota and effort for directed finfish fishing over the last eight years will have restricted the more casual effort on *Nephrops*. Further research is needed to better define directed fishing effort and thereby improve on this series.

Underwater TV surveys of the Farn Deeps grounds have been conducted at least once in each year from 1996 onwards. The most consistent series, and the one used in the assessment is the autumn survey which coincides with the start of the winter fishery. A time series of indices is given in Figure 3.3.2.6 and table 3.3.2.4. Figure 3.3.2.7 shows the distribution of stations and relative density in the most recent 8 TV surveys. The TV survey in 2009 was hampered by a period of poor weather and low visibility which coincided with the surveying of the areas traditionally associated with the highest densities (fishing vessels were working this area at the time of survey and consequently disturbing the sediment). The abundance estimate for 2009 was 778, 19% down on the 2008 estimate.

Discard survival is set to zero for this FU in contrast to the 25% used in many other FUs. This is due to the practice of catch sorting and tailing whilst steaming back to port when the vessel passes over ground not suitable for *Nephrops* habitation.

Natural mortality, maturity at age and other biological parameters

Biological parameter values are included in the Stock Annex.

Exploratory analyses of RV data

A comprehensive review of the use of underwater TV surveys for *Nephrops* stock assessment was undertaken by WKNeph (ICES 2009). This covered the range of potential biases resulting from factors including edge effects, species mis-identification, burrow occupancy. Cumulative bias factors were estimated for each FU and for FU6 the bias correction factor is 1.2 meaning that the TV estimate is likely to overestimate absolute abundance of *Nephrops* by 20%. Estimates of mean burrow density and the resulting bias-corrected abundance estimates (with confidence estimates) are given in table 3.3.2.4. The confidence estimates presented are a product of the within-strata variance which only partially takes into account the spatial structure of the data. Analyses which take spatial structuring of the counts into account (such as geostatistical methods) have been carried out for other FUs and indicate that uncertainty in the estimates of abundance from these underwater TV surveys is potentially overestimated.

In order to estimate the potential impact of the missing TV stations, the 2008 data were re-worked using only those stations which were sampled in 2009 and the resulting abundance in 2008 was reduced by ~9%. This suggests that the decrease observed in 2009 may partially be due to enforced changes to the survey distribution.

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Nephrops in FU6 continues to be in a depleted state. The stock abundance as estimated by the TV survey in 2009 was the lowest observed in the time series although other features also point to major concerns regarding the ability of the stock to sustain itself. The mean size of females did not appreciably change but the distribution was flattened out with a fairly flat distribution between 26 and 38mm, all of which should be mature. The markedly increased CPUE of females in the 4th quarter of 2009 when they should be remaining in their burrows for egg-brooding and therefore less vulnerable to fishing indicates that fertilisation success had been low (as also suspected in 2006-2007) and therefore the increased LPUE was on mature females. Recruitment is again expected to be impaired in the immediate future.

3.3.2.4 Historic stock trends.

The time series of TV surveys is short compared to the IBTS (8 consecutive years) but estimates that the stock has fluctuated between ~800 and 1700 million individuals with the three most recent estimates being at the bottom of this range, finishing at 778 million.

Estimates of historic harvest ratio (the proportion of the stock which is removed) range from 6.84% to 25.47% (Table 3.3.2.5). The harvest ratio jumped from around 12% in 2004-2005 to 25.5% in 2006 when the new reporting legislation came in.

3.3.2.5 MSY considerations

Considerations for setting Harvest Ratios associated with proxies for F_{msy} for *Nephrops* are described in section 2.????.

- Average density in the stock is at a medium level, above the level of the FU 7 but below that of FU 8.
- Density has varied through time but does not appear to undergo large scale interannual fluctuations. Spatially there is a good degree of consistency in the pattern of high and low density between the years.
- Estimated growth rates are at a moderate level although the data supporting them are quite old. Natural mortality estimates are standard.
- The fishery in the Farn Deeps is a winter fishery (October – March) with typically male dominated catches. The intra-annual pattern of sex ratios in the catches has changed in 2006 and 2009 but this is an apparently temporary biological phenomenon rather than a change of season and is therefore the expectation is for a continuation of heavier exploitation on males in future years.
- Although the time series of observed harvest rates is relatively short, there has been a fair degree of fluctuation (7-25%). The observed harvest rate is, of course, confounded by the change in reporting levels considered to have occurred around 2006. The average harvest rate since 2006 is 17% which is well above the F_{max} level for males. The stock has shown signs of stress and decreasing abundance concurrent with this observed harvest rate.

		Fbar 20-40mm		Harvest Rate	% Virgin Spawner per Recruit	
		Female	Male		Female	Male
F0.1	Comb	0.06	0.17	8.2%	63.0%	38.6%
F0.1	Female	0.12	0.33	14.2%	45.6%	22.2%
F0.1	Male	0.05	0.15	7.1%	67.1%	43.5%
F35%	Comb	0.11	0.30	12.9%	48.9%	24.8%
F35%	Female	0.18	0.50	19.4%	35.0%	14.8%
F35%	Male	0.07	0.20	9.3%	59.5%	34.8%
Fmax	Comb	0.11	0.30	13.2%	48.3%	24.3%
Fmax	Female	0.19	0.51	19.9%	34.3%	14.4%
Fmax	Male	0.09	0.24	10.9%	54.6%	29.9%

The default Harvest Rate suggested for *Nephrops* is the combined sex F35%SpR. The effects of sperm limitation appear to have been a factor in the recent development of this stock however at the harvest rate associated with combined sex F35%SpR (12.9%) the SpR for males is over the 20% threshold.

WGNSSK suggests the bias adjusted TV abundance as observed in 2007 (i.e. the first year when the stock was considered to be depleted in the recent series) should become a proxy for $B_{trigger}$ ($B_{trigger}$ = 968 million). As the stock is currently estimated to be below $B_{trigger}$, the ICES F_{msy} transition framework dictates that the recommended F for 2010 be a combination of the current F and the F_{msy} (or proxy thereof). As *Nephrops* are advised on the basis of Harvest Rates, the transition calculations will be determined on these rates assuming linearity between Harvest Rate and F. Owing to the TV index being below the proxy for $B_{trigger}$, according to the MSY Transition scheme the advised Harvest Rates should be adjusted by the ratio between the TV2009 and $B_{trigger}$.

The formulation is therefore

$$HR_{2011} = \left((\overline{HR}_{2007-2009} \times 0.8) + (HR_{MSY} \times 0.2) \right) \times \left(\frac{TV_{2009}}{[illegible]} \right)$$

3.3.2.6 Short term forecasts.

Catch and landing predictions for 2011 are given in the text table below. This assumes that the bias corrected survey index made in October 2009 is relevant to the stock status for 2011. Discard rates and mean weight in the landings are the mean of the last three years.

Discard rate = 28.4%, mean weight in retained portion (2007-2009)=25.0g

	Harvest ratio	Bias corrected survey index	Retained number	Landings
	0%	778	0	0
	2%		16	279
	4%		31	557
	6%		47	836
Male F0.1	7.10%		55	989
	8%		62	1114
Combined F0.1	8.20%		64	1142
Male F35%SpR	9.3%		72	1295
Male Fmax	10.9%		85	1518
Combined F35%Spr	12.9%		100	1796
Combined Fmax	13.2%		103	1838
Female F0.1	14.2%		110	1978
Transition framework	14.4%		112	2005
Female F35%SpR	19.4%		151	2702
Female Fmax	19.9%		155	2771

3.3.2.7 BRPs

Suggestions for proxies of biological reference points are shown in the catch option table.

3.3.2.8 Quality of assessment

Changes to the legislation regarding the reporting of catches in 2006 means that the levels of reported landings from this point forward are considered to better reflect the true landings and hence effort input into this fishery. This does mean that comparison of LPUE with previous years is inadvisable and the independence of the final assessment from these data is likely to continue for some time.

The length and sex compositions arising from the land-based catch sampling programme are considered to be representative of the fishery. Estimates of discarded and retained length frequencies arising from the discard sampling programme are also considered robust since 2002.

The TV survey in this area has a high density of survey stations compared to other TV surveys and the abundance estimates are generally considered robust. There is greater uncertainty in the index for 2009 due to the absence of stations in the higher density areas which may result in an over-estimate of the magnitude of the decline.

The most recent North Sea Stock Survey was carried out in mid 2009. 10 of the 13 respondents thought that abundance of *Nephrops* in Area 4 (Farn Deeps is the only FU in this area) was more or much more than in 2008 which agrees with the increase in LPUE observed in 2009. The time series for Area 4 indicates an increasing trend until 2007, a decline in 2008 and an increase again in 2009.

Without suitable controls on the movement of effort between Functional Units there is nothing to prevent the effort in 2011 returning to levels observed prior to 2008 most of which were above the F35%SprR level and indeed above the level of Fmax. Prior to the introduction of "Buyers and Sellers" legislation in 2006 reporting rates are considered to have been low and hence the estimated Harvest Ratios prior to 2006 are also likely to have been underestimated.

3.3.2.9 Status of stock

The TV survey, fishery data and length frequency data all point to the stock continuing to be in a depleted state. The increase in female exploitation suggests that recruitment in the near future is likely to be low as a lower proportion of females were brooding eggs.

3.3.2.10 Management considerations

The WG, ACFM and STECF have repeatedly advised that management should be at a smaller scale than the ICES Division level and management at the Functional Unit level could provide the controls to ensure that catch opportunities and effort were compatible and in line with the scale of the resource.

Increases in abundance in other FUs (i.e. Firth of Forth and the Fladen grounds) are likely to translate to increases in TAC, increasing the risk of higher effort being deployed in this FU. The high cost of fuel combined with the relative coastal proximity of this ground may result in it attracting additional fishing effort which would be inadvisable given the current low level of the stock.

3.3.3 Fladen Ground (FU7)

3.3.3.1 Ecosystem aspects

Information on ecosystem aspects can now be found in the Stock Annex.

3.3.3.2 The Fishery in 2008 and 2009

The *Nephrops* fishery at Fladen is the largest in the North Sea and is mainly prosecuted by UK (Scotland) vessels, with Denmark the only other nation taking a significant amount of landings (Table 3.3.3.1).

No major changes have been reported in the Scottish fishery in 2009. Over 100 vessels continue to participate in the fishery which takes a mixed catch consisting of haddock, whiting, cod, anglerfish and megrim as well as *Nephrops*. Changes to more selective gear which are required under the Scottish Conservation Credits scheme (CCS; see Section 13.1.4) are likely to reduce bycatch (and therefore) discards of whitefish. The majority of these vessels (80%) fish out of Fraserburgh. Six new *Nephrops* vessels in the 20-25 m size category joined the fleet in 2008 and in addition a number of vessels have installed freezer capabilities enabling longer trip to be carried out. However, a number of vessels have also left the Scottish fleet and are now registered in England to avoid the ban on multiple-rig (>2) trawling. Other developments that may have mitigated effort increases (due to new vessels) to some extent, are the number of larger boats taking up oil guard vessel duties. Further general information on the fishery can be found in the Stock Annex.

3.3.3.3 ICES advice in 2009

The ICES conclusions in 2009 in relation to State of the Stock were as follows:

'UWTV observations indicate that the stock is fluctuating without obvious trend with estimates for the last 2 years increasing to the highest abundance in the series. Considering the UWTV result alongside the indications of stable or slightly increasing mean sizes in the length compositions of catches (of individuals >35mm carapace length) suggests that the stock is being exploited sustainably. The decline in mean length of smaller individuals in the catch may be indicative of recent good recruitment.'

The ICES advice for 2009 (Single-stock exploitation boundaries) was as follows:

Exploitation boundaries in relation to precautionary considerations

'ICES advises on the basis of exploitation boundaries in relation to high long term yield and low risk of depletion of production potential that the Harvest Rate for *Nephrops* fisheries should not exceed $F_{0.1}$. This corresponds to landings of no more than 16,419t for the Fladen Ground.'

3.3.3.4 Management

Management is at the ICES Subarea level as described at the beginning of Section 3.3.

3.3.3.5 Assessment

Review of the 2009 assessment

'The RG agrees with the EG view of the stock status and notes the valid concerns regarding the inherent problems of managing this stock as part of a wider North Sea TAC.'

The RG also raised a number of issues regarding incomplete coverage of the stock distribution by the survey and the likely poor quality of the Scottish effort data. These issues are addressed in the relevant sections later in the report.

Approach in 2010

The assessment and provision of advice through the use of the UWTV survey data and other commercial fishery data follows the process defined by the benchmark WG and described in Section 3.1 of last year's WG report.

3.3.3.6 Data available

Commercial catch and effort data

Landings from this fishery are predominantly reported from Scotland, with small contributions from Denmark and others, and are presented in Table 3.3.3.1 and Figure 3.3.3.1, together with a breakdown by gear type. Total international landings (as reported to the WG) in 2009 were over 13,300 tonnes (approximately 1000 tonnes greater than the 2008 total), consisting of 13,200 tonnes landed by Scotland and 130 tonnes landed by Denmark. Approximately 25 % of the Scottish landings are taken by twin rig vessels.

Given the concerns about the previously presented Scottish effort data (due to non-mandatory recording of hours fished in recent years) and following recommendations made by the RG, effort data in terms of days absent were presented to the WG. These data (not illustrated) gave unrealistically high values of LPUE (2,000-3,000 kg/day). On investigation, it appears that the in-house Marine Scotland Science database holds an incomplete record of days absent for the Fladen (and Noup) when compared to the official data held in the database populated by Marine Scotland Compliance. Although Scottish LPUE data are not considered further for the Fladen, the effort data may still provide a good indication of seasonal trends. Figure 3.3.3.2 suggests effort is generally greatest in quarters 2 and 3.

Danish LPUE data are presented in Figure 3.3.3.1 and Table 3.3.3.2. These show an increase in the mid-2000s, with values remaining high in 2009.

Males consistently make the largest contribution to the landings, although the sex ratio does seem to vary. This is likely to be due to the varying seasonal pattern in the fishery and associated relative catchability (due to different burrow emergence behaviour) of male and female *Nephrops* (Figure 3.3.3.2).

Discarding of undersized and unwanted *Nephrops* occurs in this fishery, and quarterly discard sampling has been conducted on the Scottish *Nephrops* trawler fleet since 2000. Discarding rates average around 10 % by number in this FU and in 2009 are about average: 10 % by number and 4 % by weight.

Following the implementation of new procedures for raising the Scottish commercial data in 2010, a number of issues came to light regarding previous raising procedures. This has resulted in a revision to the Fladen 2006-2008 discard estimates (absolute values although not mean sizes) provided to the 2009 WG and the discard rate now appears more stable from year to year.

It is likely that some *Nephrops* survive the discarding process, an estimate of 25 % survival is assumed for this FU in order to calculate removals (landings + dead discards) from the population.

Intercatch

Intercatch has not been used for this FU. The option of automatically generating Intercatch input from national databases will be explored following the WG.

Length compositions

Length compositions of landings and discards are obtained during monthly market sampling and quarterly on-board observer sampling respectively. Levels of sampling have increased since 2000 and are shown in Section 2.2.4.XX. Although assessments based on detailed catch data analysis are not presently possible, examination of length compositions can provide a preliminary indication of exploitation effects.

Figure 3.3.3.3 shows a series of annual length frequency distributions for the period 2000 to 2009. Catch (removals) length compositions are shown for each sex with the mean catch and landings lengths shown in relation to MLS (25 mm) and 35 mm. In both sexes the mean sizes have been fairly stable over time and examination of the tails of the distributions above 35 mm shows no evidence of reductions in relative numbers of larger animals.

The observation of relatively stable length compositions is further confirmed in the series of mean sizes of larger *Nephrops* (>35 mm) in the landings shown in Figure 3.3.3.1 and Table 3.3.3.3. This parameter might be expected to reduce in size if over-exploitation were taking place but there is no evidence of this. The mean size of smaller animals (<35 mm) in the catch (and landings) is also quite stable through time although in 2009 there has been a clear increase which may be associated with lower recruitment than previous years.

Mean weights in the landings through time are shown in Figure 3.3.3.4 and Table 3.3.3.4 and these also show no systematic changes over the time series.

Natural mortality, maturity at age and other biological parameters

Biological parameter values are included in the Stock Annex.

Research vessel data

TV surveys using a stratified random design are available for FU 7 since 1992 (missing survey in 1996). Underwater television surveys of *Nephrops* burrow number and distribution, reduce the problems associated with traditional trawl surveys that arise from variability in burrow emergence of *Nephrops*.

The numbers of valid stations used in the final analysis in each year are shown in Table 3.3.3.5. On average, about 65 stations have been considered valid each year. Data are raised to a stock area of 28153 km^2 based on the stratification (by sediment type). General analysis methods for underwater TV survey data are similar for each of the Scottish surveys, and are described in more detail in the Stock Annex.

The RG noted that the UWTV survey did not cover the stock distribution. The survey stations are randomly distributed within strata and therefore the actual location of the survey stations varies from year to year and in some years, particular regions of the main part of the ground may not be surveyed. There is an additional small patch of mud to the north of the ground which is not surveyed and therefore the estimated abundance is likely to be slightly underestimated by the UWTV survey.

3.3.3.7 Data analyses

Exploratory analyses of survey data

Table 3.3.3.6 shows the basic analysis for the three most recent TV surveys conducted in FU 7. The table includes estimates of abundance and variability in each of the strata adopted in the stratified random approach. The ground has a range of mud types from soft silty clays to coarser sandy muds, the latter predominate. Most of the variance in the survey is associated with this coarse sediment which surrounds the main centres of abundance.

Figure 3.3.3.5 shows the distribution of stations in recent TV surveys (2004-2009), with the size of the symbol reflecting the *Nephrops* burrow density. Abundance is generally higher in the soft and intermediate sediments located to the centre and south east of the ground but in 2007, high densities were also widely recorded in the coarser sediment of the ground. Table 3.3.3.5 and Figure 3.3.3.6 show the time series estimated abundance for the TV surveys, with 95% confidence intervals on annual estimates.

A revised time series of UWTV abundance estimates (corrected for changes in the camera field of view which had previously gone unnoticed) was presented at WGNSSK in 2009 and compared with the 'old' time series. This 'old' time series is not included in the WG report this year.

The use of the UWTV surveys for *Nephrops* in the provision of advice was extensively reviewed by WKNEPH (ICES, 2009). A number of potential biases were highlighted including those due to edge effects, species burrow mis-identification and burrow occupancy. The cumulative bias correction factor estimated for FU7 was 1.35 meaning that the TV survey is likely to overestimate *Nephrops* abundance by 35 %.

Final assessment

The underwater TV survey is again presented as the best available information on the Fladen Ground *Nephrops* stock. This survey provides a fishery independent estimate of *Nephrops* abundance. At present it is not possible to extract any length or age structure information from the survey, and it therefore only provides information on abundance over the area of the survey.

The 2009 TV survey data presented at this meeting shows that the abundance, although still one of the highest in the time period has fallen by around 25 % since 2008. .

3.3.3.8 Historical Stock trends

The TV survey estimates of abundance for *Nephrops* in the Fladen suggest that the population has been generally increasing (although fluctuating) over a period of 15 years. The decrease observed in 2009 follows the two highest estimates in 2007 and 2008. The bias adjusted abundance estimates from 2003-2009 are shown in Table 3.3.3.8. The current stock size is estimated to be 5500 million individuals.

Table 3.3.3.7 also shows the estimated harvest ratios over this period. These range from 4-9% over this period and are all below $F_{0.1}$. (It is unlikely that prior to 2006, the estimated harvest ratios are representative of actual harvest ratios due to under-reporting of landings).

3.3.3.9 Recruitment estimates

Recruitment estimates from surveys are not available for this FU. However, the increase in mean size of small animals <35 mm (i.e a lower proportion of small animals in this component of the catch) may be indicative of lower recent recruitment.

3.3.3.10 MSY considerations

A number of potential F_{msy} proxies are obtained from the per-recruit analysis for *Nephrops* and these are discussed further in Section 2 of this report. The analysis assumes the same input parameters (exploitation, discard ogive and biological parameters) as used at the benchmark meeting in 2009. The complete range of the per-recruit F_{msy} proxies is given in the table below and the process for choosing an appropriate F_{msy} proxy is described in Section 2.

For this FU, the absolute density observed on the UWTV survey is low (average of just over 0.2 m^{-2}) suggesting the stock may have low productivity. In addition, the expansion of the fishery in this area is a relatively recent phenomenon and as a result the population has not been well-studied and biological parameters are considered particularly uncertain. Furthermore, historical harvest ratios in this FU have been below that equivalent to fishing at $F_{0.1}$. For these reasons, it is suggested that a more conservative proxy is chosen for F_{msy} such as $F_{0.1(T)}$.

		Fbar(20-40 mm)		HR (%)	SPR (%)		
		M	F		M	F	T
$F_{0.1}$	M	0.14	0.10	9.4	41.7	48.9	44.7
	F	0.19	0.14	11.7	34.5	41.9	37.6
	T	0.16	0.11	10.2	39.1	46.3	42.1
F_{max}	M	0.27	0.19	15.4	25.8	33.1	28.9
	F	0.40	0.29	20.9	17.6	24.2	20.3
	T	0.30	0.22	17.0	23.1	30.2	26.0
$F_{35\%SpR}$	M	0.19	0.14	11.7	34.5	41.9	37.6
	F	0.25	0.18	14.8	27.1	34.5	30.1
	T	0.21	0.15	12.7	31.7	39.1	34.8

All F_{msy} proxy harvest rate values are considered preliminary and may be modified following further data exploration and analysis.

The $B_{trigger}$ point for this FU (bias adjusted lowest observed UWTV abundance) is calculated as 2767 million individuals.

3.3.3.11 Short-term forecasts

A landings prediction for 2011 was made for the Fladen Ground (FU7) using the approach agreed at the Benchmark Workshop and outlined in the introductory section to last year's report (Section 3.1). The table below shows landings predictions at various harvest ratios, including a selection of those equivalent to the per-recruit reference points discussed in Section 2 of this report and the harvest ratio in 2009 using the input parameters agreed at WKNEPH (ICES 2009). The landings prediction for 2011 at the F_{msy} proxy harvest ratio is 13276 tonnes. There is no transition stage as the current harvest ratio is actually below that equivalent to F_{msy}.

The inputs to the landings forecast were as follows:

Mean weight in landings (07-09) = 27.67 g

Discard rate (by number) = 13.8 % (as calculated at WKBENCH)

Survey bias = 1.35.

F_{sq} = average harvest ratio over 2007-2009 = 7.3 %

	Harvest rate	Survey Index (adjusted)	Implied fishery	
			Retained number	Landings (tonnes)
F_{msy}	10.2%	5457	480	13276
	0.0%	5457	0	0
	5.0%	5457	235	6508
F_{sq}	7.3%	5457	345	9545
F_{2009}	9.0%	5457	423	11714
$F_{0.1(M)}$	9.4%	5457	441	12196
	10.0%	5457	470	13016
$F_{0.1(T)}$	10.2%	5457	480	13276
$F_{35\%SPR(M)}$	11.7%	5457	550	15229
$F_{35\%SPR(T)}$	12.7%	5457	599	16582
	15.0%	5457	706	19524
$F_{max\ (M)}$	15.4%	5457	724	20044
$F_{max\ (T)}$	17.0%	5457	798	22075
	20.0%	5457	941	26032

$F_{0.1(M,T)}$: Harvest ratio equivalent to fishing at a level associated with 10 % of the slope at the origin on the male or combined sex YPR curve.

$F_{35\%SPR(M,T)}$: Harvest ratio equivalent to fishing at a rate which results in male or combined SPR equal to 35% of the unfished level.

$F_{max\ (M,\ T)}$: Harvest ratio equivalent to fishing at a rate which maximises the male or combined YPR.

A discussion of F_{msy} reference points for *Nephrops* is provided in Section 3.1.

3.3.3.12 Biological Reference points

Biological reference points have not been defined for this stock.

3.3.3.13 Quality of assessment

The length and sex composition of the landings data is considered to be well sampled. Discard sampling has been conducted on a quarterly basis for Scottish *Nephrops* trawlers in this fishery since 2000, and is considered to represent the fishery adequately.

The quality of landings (and catch) data is likely to have improved in recent years but because of concerns over the accuracy of earlier years, the final assessment adopted is independent of official statistics.

Underwater TV surveys have been conducted for this stock since 1992, with a continuous annual series available since 1997. The number of valid stations in the survey has remained relatively stable throughout the time period. Confidence intervals are relatively small.

The UWTV survey is conducted over the main part of the ground, representing an area of around 28 200 km^2 of suitable mud substrate (the largest ground in Europe). The Fladen Ground Functional Unit contains several patches of mud to the north of the ground which are fished, bringing the overall area of substrate to 30 633 km^2. This area is not surveyed but would add to the abundance estimate. The absolute abundance estimate for this ground is therefore likely to be underestimated by the current methodology.

NSCFP stock survey suggests that moderate or high amounts of recruits are apparent in Area 1 (which Fladen FU lies largely within) compared to 2008. The time series of perceived abundance in Area 1 increases to 2009.

3.3.3.14 Status of the stock

The perception of the state of the stock has not changed substantially since the assessment in 2009. The UWTV abundance is still at a high level relative to the historical time series although there has been a 25 % reduction in 2009 from the 2008 value. The stable mean sizes in the length compositions of catches (of individuals >35mm CL) over a long period of time suggests that the stock is being exploited sustainably. The increase in mean length of smaller individuals in the catch may be indicative of recent lower recruitment. The estimated harvest ratio in 2009 (removals/TV abundance) is lower than $F_{0.1}$.

3.3.3.15 Management considerations

The WG, ACOM and STECF have repeatedly advised that management should be at a smaller scale than the ICES Division level and management at the Functional Unit level could provide the controls to ensure that catch opportunities and effort were compatible and in line with the scale of the resource.

Nephrops fisheries have a bycatch of cod. In 2005, high abundance of 0 group cod was recorded in Scottish surveys near to this ground. This year class of cod has subsequently contributed to slightly improved cod stock biomass and efforts are being made to avoid the capture of cod so that the stock can build further. The Scottish industry operates under the Conservation Credits Scheme and has implemented improved selectivity measures in gears which target *Nephrops* and real time closures with a view to reducing unwanted by-catch of cod and other species.

3.3.4 Firth of Forth (FU 8)

3.3.4.1 Ecosystem aspects

Information on ecosystem aspects can now be found in the Stock Annex.

3.3.4.1.1 The Fishery in 2008 and 2009

The *Nephrops* fishery in the Firth of Forth is dominated by UK (Scotland) vessels with low landings reported by other UK nations (Table 3.3.4.1). In recent years the number of Scottish vessels regularly fishing this FU has been around 40 although this varies seasonally as vessels move around the UK with fluctuating catch rates. The fishery continues to be characterised by catches of small *Nephrops* which often leads to high discard rates. Although the whitefish by-catch is typically low, anecdotal information suggests increasing cod by-catch in recent years. There is also a small amount of landings by creel vessels in this area, although typically the main target species of these vessels are crabs and lobsters.

Further general information on the fishery can be found in the Stock Annex.

3.3.4.2 Advice in 2009

The ICES conclusions in 2009 in relation to State of the Stock were as follows:

'The evidence from the UWTV survey suggests that the population has been at a relatively high level since 2003. The UWTV survey information, taken together with information showing stable mean sizes, suggest that the stock is being exploited sustainably.'

The ICES advice for 2009 (Single-stock exploitation boundaries) was as follows:

Exploitation boundaries in relation to precautionary considerations

'ICES advises on the basis of exploitation boundaries in relation to high long term yield and low risk of depletion of production potential that the Harvest Rate for *Nephrops* fisheries should not exceed F_{max}. This corresponds to landings of no more than 1,567 tonnes for the Firth of Forth stock.'

3.3.4.3 Management

Management is at the ICES Subarea level as described at the beginning of Section 3.3.

3.3.4.4 Assessment

Review of the 2009 assessment

'The RG agrees with the EG view of the stock status and notes the valid concerns regarding the inherent problems of managing this stock as part of a wider North Sea TAC.'

The RG also raised a number of issues regarding areas outside the FU which may be suitable habitat for *Nephrops* and the likely poor quality of the Scottish effort data. These issues are addressed in the relevant sections later in the report.

Approach in 2010

The assessment and provision of advice through the use of the UWTV survey data and other commercial fishery data follows the process defined by the benchmark WG and described in Section 3.1.

Data available

Commercial catch and effort data

Landings from this fishery are predominantly reported from Scotland, with very small contributions from England, and are presented in Table 3.3.4.1, together with a breakdown by gear type (See also Table 3.3.4.2). Reported landings have increased dramatically since 2003 (although this may have been due to increased reporting as well as increased actual landings) and the value for 2009 of over 2,600 tonnes is the highest in the available time series.

Given the concerns about the previously presented Scottish effort data (due to non-mandatory recording of hours fished in recent years) and following recommendations made by the RG, effort data in terms of days absent were presented to the WG.

Reported effort by Scottish *Nephrops* trawlers has remained relatively stable since 2005 (Table 3.3.4.2 and Figure 3.3.4.1). Scottish *Nephrops* trawler LPUE was relatively stable in the late 1980's and early 1990's, but increased markedly in the past 10 years.

Males consistently make the largest contribution to the landings (Figure 3.3.4.2), although the sex ratio does vary. The proportion of females in the landings in 2008 was somewhat higher than in other years. This may be due to the change in seasonal effort distribution with greatest effort in the 3rd quarter in 2008 when females are likely to be more available to the fishery (compared with a more evenly distributed seasonal effort pattern in 2007).

Discarding of undersize and unwanted *Nephrops* occurs in this fishery, and quarterly discard sampling has been conducted on the Scottish *Nephrops* trawler fleet since 1990. Discarding rates in this FU over the last 5 years have varied between 25 and 50 % of the catch by number (34 % by number and 14 % by weight in 2009). Discard rates are higher in this stock than the more northerly North Sea FUs for which Scottish discard estimates are also available. This could arise from the fact that the use of larger meshed nets is not so prevalent in this fishery (80 mm is more common).

Following the implementation of new procedures for raising the Scottish commercial data in 2010, a number of issues came to light regarding previous raising procedures. This has resulted in minor revisions to 2006-2008 discard estimates for this FU (absolute values but not mean sizes) provided to the 2009 WG.

It is likely that some *Nephrops* survive the discarding process, an estimate of 25% survival is assumed in order to calculate removals (landings + dead discards) from the population.

Intercatch

Intercatch has not been used for this FU. The option of automatically generating Intercatch input from national databases will be explored following the WG.

Length compositions

Length compositions of landings and discards are obtained during monthly market sampling and quarterly on-board observer sampling respectively. Levels of sampling are shown in Table 2.2.XX. Although assessments based on detailed catch data analysis are not presently possible, examination of length compositions may provide an indication of exploitation effects.

Figure 3.3.4.3 shows a series of annual length frequency distributions for the period 2000 to 2009. Catch (removals) are shown for each sex with the mean catch and landings lengths shown in relation to MLS and 35mm. There is little evidence of change in the mean size of either sex over time and examination of the tails of the distributions above 35mm shows no evidence of reductions in relative numbers of larger animals.

The observation of relatively stable length compositions is further confirmed in the series of mean sizes of larger *Nephrops* (>35 mm) in the landings shown in Figure 3.3.4.1 and Table 3.3.4.3. This parameter might be expected to reduce in size if over-exploitation were taking place but over the last 15 years has in fact been quite stable and increased very slightly in more recent years. The mean size in the catch in the < 35 mm category (Figure 3.3.4.1) shows a reduction in recent years. Such a trend could be associated with increased recruitment in recent years..

Mean weight in the landings is shown in Figure 3.3.3.3 and Table 3.3.3.5 and this also shows no systematic changes over the time series.

Natural mortality, maturity at age and other biological parameters

Biological parameter values are included in the Stock Annex.

Research vessel data

TV surveys using a stratified random design are available for FU 8 since 1993 (missing surveys in 1995 and 1997). Underwater television surveys of *Nephrops* burrow number and distribution, reduce the problems associated with traditional trawl surveys that arise from variability in burrow emergence of *Nephrops*.

The numbers of valid stations used in the final analysis in each year are shown in Table 3.3.4.4. On average, about 40 stations have been considered valid each year. In 2009, there were 47 valid stations. Abundance data are raised to a stock area of 915 km^2. General analysis methods for underwater TV survey data are similar for each of the Scottish surveys, and are described in the Stock Annex.

The RG noted a further non-surveyed area of sediment illustrated just north of the Firth of Forth FU. There is a small Nephrops fishery in this area (off Arbroath), but the area is only surveyed on an irregular basis and therefore is not included in any estimates of abundance.

Data analyses

Exploratory analyses of survey data

Table 3.3.4.5 shows the basic analysis for the three most recent TV surveys conducted in FU 8. The table includes estimates of abundance and variability in each of the strata adopted in the stratified random approach. The ground is predominantly of coarser muddy sand. Depending on the year, high variance in the survey is associated with different strata and there is no clear distributional or sedimentary pattern in this area. Densities observed in this FU are typically higher than those of the more northerly FUs in the North Sea.

Figure 3.3.4.4 shows the distribution of stations in TV surveys, with the size of the symbol reflecting the *Nephrops* burrow density. Abundance is generally higher towards the central part of the ground and around the Isle of May. In recent years higher densities have been recorded over quite wide areas. Table 3.3.4.4 and Figure 3.3.4.5 show the time series of estimated abundance for the TV surveys, with 95% confidence intervals on annual estimates. The use of the UWTV surveys for *Nephrops* in the provision of advice was extensively reviewed by WKNEPH (ICES, 2009). A number of potential biases were highlighted including those due to edge effects, species burrow mis-identification and burrow occupancy. The cumulative bias correction factor estimated for FU 8 was 1.18 meaning that the TV survey is likely to overestimate *Nephrops* abundance by 18 %.

Final assessment

The underwater TV survey is again presented as the best available information on the Firth of Forth *Nephrops* stock. This survey provides a fishery independent estimate of *Nephrops* abundance. At present it is not possible to extract any length or age structure information from the survey, and it therefore only provides information on abundance over the area of the survey.

The 2009 TV survey data presented at this meeting shows that abundance has fallen by just over 15 % (though not a statistically significant decline) from the highest observed level in 2008.

The mean size of individuals < 35 mm in the catch show slight decrease in recent years.

3.3.4.5 Historic Stock trends

The TV survey estimate of abundance for *Nephrops* in the Firth of Forth suggests that the population decreased between 1993 and 1998 and then began a steady increase up to 2003. Abundance is estimated to have fluctuated without trend in the years since then. The bias adjusted abundance estimates form 2003-2008 (the period over which the survey estimates have been revised) is shown in Table 3.3.4.6. The stock is currently estimated to consist of 732 million individuals.

Table 3.3.4.6 also shows the estimated harvest ratios over this period. These range from 12-26 % over this period. (Estimated harvest ratios prior to 2006 may not be representative of actual harvest ratios due to under-reporting of landings before the introduction of 'Buyers and Sellers' legislation). These estimated harvest rates are significantly above the estimated value at $F_{max.}$

3.3.4.6 Recruitment estimates

Survey recruitment estimates are not available for this stock.

3.3.4.7 MSY considerations

A number of potential F_{msy} proxies are obtained from the per-recruit analysis for *Nephrops* and these are discussed further in Section 2 of this report. The analysis assumes the same input parameters (exploitation, discard ogive and biological parameters) as used at the benchmark meeting in 2009. The complete range of the per-recruit F_{msy} proxies is given in the table below and the process for choosing an appropriate F_{msy} proxy is described in Section 2.

For this FU, the absolute density observed on the UWTV survey is relatively high (average of ~ 0.8 m^{-2}). Harvest ratios (which are likely to have been underestimated prior to 2006) has been well above F_{max} and in addition there is a long time series of relatively stable landings (average reported landings ~ 2000 tonnes, well above those predicted by currently fishing at F_{max}) suggesting a productive stock. For these reasons, it is suggested that $F_{max(T)}$ is chosen as the F_{msy} proxy.

		Fbar(20-40 mm)		HR (%)	SPR (%)		
		M	F		M	F	T
$F_{0.1}$	M	0.13	0.06	7.5	42.3	64.5	51.7
	F	0.29	0.13	14.2	23.0	44.8	32.2
	T	0.16	0.07	8.7	37.3	60.0	46.9
F_{max}	M	0.24	0.11	12.3	26.9	49.5	36.5
	F	0.54	0.24	23.4	12.1	29.0	19.2
	T	0.31	0.14	15.0	21.6	43.0	30.6
$F_{35\%SpR}$	M	0.18	0.08	9.7	34.1	57.0	43.8
	F	0.42	0.19	19.3	15.8	35.0	23.9
	T	0.26	0.12	13.1	25.1	47.4	34.5

All F_{msy} proxy harvest rate values are considered preliminary and may be modified following further data exploration and analysis.

The $B_{trigger}$ point for this FU (bias adjusted lowest observed UWTV abundance) is calculated as 292 million individuals.

3.3.4.8 Short-term forecasts

A landings prediction for 2011 was made for the Firth of Forth (FU8) using the approach agreed at the Benchmark Workshop and outlined in the introductory section to this chapter (Section 3.1). The table below shows landings predictions at various harvest ratios, including a selection of those equivalent to the per-recruit reference points discussed in Section 2 of this report and the harvest ratio in 2009 using the input parameters agreed at WKNEPH (ICES 2009). The landings prediction for 2011 at the F_{msy} proxy harvest ratio is 1379 tonnes. The F_{msy} transition stage harvest ratio results in a landings option of 1992 tonnes.

The inputs to the landings forecast were as follows:

Mean weight in landings (07-09) = 19.20 g

Discard rate (by number) = 34.6 %

Survey bias = 1.18

F_{sq} = average harvest ratio of 2007-2009 = 23.3%

F_{msy} transition (21.7 %) is calculated from 0.2 x Fmsy + 0.8 x F_{sq}

	Harvest rate	Survey Index (adjusted)	Implied fishery	
			Retained number	Landings (tonnes)
F_{msy}	15.0%	732	72	1379
F_{msy} transition	21.7%	732	104	1992
No catch	0.0%	732	0	0
	5.0%	732	24	460
$F_{0.1(M)}$	7.5%	732	36	690
$F_{0.1(T)}$	8.8%	732	42	809
$F_{35\%SPR(M)}$	9.7%	732	46	892
	10.0%	732	48	919
$F_{max(M)}$	12.3%	732	59	1131
$F_{35\%SPR(T)}$	13.2%	732	63	1209
$F_{max(T)}$	15.0%	732	72	1379
	20.0%	732	96	1839
F_{sq}	23.3%	732	112	2145

$F_{0.1(M,T)}$: Harvest ratio equivalent to fishing at a level associated with 10 % of the slope at the origin on the male or combined sex YPR curve.

$F_{35\%SPR(M,T)}$: Harvest ratio equivalent to fishing at a rate which results in male or combined SPR equal to 35% of the unfished level.

$F_{max\ (M,,\ T)}$: Harvest ratio equivalent to fishing at a rate which maximises the male or combined YPR.

A discussion of F_{msy} reference points for *Nephrops* is provided in Section 3.1.

3.3.4.9 Biological Reference points

Biological reference points have not been defined for this stock.

3.3.4.10 Quality of assessment

The length and sex composition of the landings data is considered to be well sampled. Discard sampling has been conducted on a quarterly basis for Scottish *Nephrops* trawlers in this fishery since 1990, and is considered to represent the fishery adequately.

There are concerns over the accuracy of historical landings (pre 2006) and because of this the final assessment adopted is independent of officially reported data.

UWTV surveys have been conducted for this stock since 1993, with a continual annual series available since 1998.

The Fishers' North Sea stock survey area containing the Firth of Forth had only 4 respondents. The time series of perceived abundance for this area show an increase up to 2008 and then a decline. However, given that there is more than one FU within this NSCFP area, it is not clear as to whether the replies were actually related to the Firth of Forth *Nephrops*.

3.3.4.11 Status of the stock

The evidence from the TV survey suggests that the population has been at a relatively high level since 2003 and the decline of 15 % observed in 2009 is not significant. The TV survey information, taken together with information showing stable mean sizes, suggest that the stock does not show signs of overexploitation. The calculated harvest ratio in 2009 (dead removals/TV abundance) is above F_{max}.

3.3.4.12 Management considerations

The WG, ACOM and STECF have repeatedly advised that management should be at a smaller scale than the ICES Division level. Management at the Functional Unit level could provide the controls to ensure that catch opportunities and effort were compatible and in line with the scale of the resource.

Nephrops discard rates in this Functional Unit are high and there is a need to reduce these and to improve the exploitation pattern. An additional reason for suggesting improved selectivity in this area relates to bycatch. It is important that efforts are made to ensure that other fish are not taken as unwanted bycatch in this fishery which uses 80mm mesh. Larger square mesh panels implemented as part of the Scottish Conservation Credits scheme should help to im-prove the exploitation pattern for some species such as haddock and whiting and small cod.

Although the persistently high estimated harvest rates do not appear to have adversely affected the stock, they are estimated to be equivalent to fishing at a rate greater than F_{max} and therefore it would be unwise to allow effort to increase in this FU.

3.3.5 Moray Firth (FU 9)

3.3.5.1 Ecosystem aspects

Information on ecosystem aspects can now be found in the Stock Annex.

3.3.5.2 The Fishery in 2008 and 2009

The Moray Firth *Nephrops* fishery is essentially a Scottish fishery with only occasional landings made by vessels from elsewhere in the UK (Table 3.3.5.1). The general situation in 2008 and 2009 is similar to previous years with the vessels targeting this fishery typically conducting day trips from the nearby ports along the Moray Firth coast. Occasionally larger vessels fish the outer Moray Firth grounds on their way to/from the Fladen or in times of poor weather. A squid fishery appeared in the summer and a number of vessels switched effort to this fishery during the second half of the year.

Further general information on the fishery can be found in the Stock Annex.

3.3.5.3 Advice in 2009

The ICES conclusions in 2009 in relation to State of the Stock were as follows:

'The evidence from the UWTV survey suggests that the population is stable, but at a lower level than that evident from 2003-2005. The UWTV survey information, taken together with information showing stable mean sizes, suggest that the stock is being exploited sustainably.'

The ICES advice for 2009 (Single-stock exploitation boundaries) was as follows:

Exploitation boundaries in relation to precautionary considerations

'ICES advises on the basis of exploitation boundaries in relation to high long term yield and low risk of depletion of production potential that the Harvest Rate for *Nephrops* fisheries should not exceed F_{2008}. This corresponds to landings of no more than 1,372 tonnes for the Moray Firth stock.'

3.3.5.4 Management

Management is at the ICES Subarea level as described at the beginning of Section 3.3.

3.3.5.5 Assessment

Review of the 2009 assessment

'The RG agrees with the EG view of the stock status and notes the valid concerns regarding the inherent problems of managing this stock as part of a wider North Sea TAC.'

The RG also raised a number of issues regarding changing discard rates in this FU and the likely poor quality of the Scottish effort data. These issues are addressed in the relevant sections later in the report.

Approach in 2010

The assessment and provision of advice through the use of the UWTV survey data and other commercial fishery data follows the process defined by the benchmark WG and is described in Section 3.1.

Data available

Commercial catch and effort data

Landings from this fishery are predominantly reported from Scotland, with very small contributions from England, and are presented in Table 3.3.5.1, together with a breakdown by gear type (See also Table 3.3.5.2). Total landings (as reported to the WG) in 2009 were just over 1,000 tonnes, a 30 % reduction on the 2008 landings. Following a number of years of increasing reported landings (which may have been due to increased reporting as well as increased actual landings), the landings have fallen by over 40 % in a two year period. The long term landings trends are shown in Figure 3.3.5.1.

Given the concerns about the previously presented Scottish effort data (due to non-mandatory recording of hours fished in recent years) and following recommendations made by the RG, effort data in terms of days absent were presented to the WG.

Reported effort by Scottish *Nephrops* trawlers has fallen steadily over the past 10 years (Table 3.3.5.2 and Figure 3.3.5.1). Scottish *Nephrops* trawler LPUE was relatively stable in the late 1980's and early 1990's, but increased markedly in the past 10 years. (The early part of this increase (approx 2000-2005) coincides with an increase in UWTV abundance.)

Males consistently make the largest contribution to the landings (Figure 3.3.5.2), although in 2009, the proportion of females is considerably higher than in the recent past. Although this may be due to a change in the seasonal pattern in the fishery to a time when females are particularly available, increased female catchability has also been associated with stocks which are in a poor state (females may remain more active as they have been unable to mate due to lack of males in the population).

Discarding of undersize and unwanted *Nephrops* occurs in this fishery, and quarterly discard sampling has been conducted on the Scottish *Nephrops* trawler fleet since 1990. Discarding rates in this FU appear to be highly variable with rates of between 8 and 35 % of the catch in recent years. In 2009, the discard rate is 8 % by number and under 3 % by weight. The RG suggested that there had been a systematic decline in discards suggesting reduced recruitment. Discards rates were consistently higher in the past and now appear to be generally lower but with occasional high annual levels which may be associated with occasional high recruitments (e.g. 2004).

Following the implementation of new procedures for raising the Scottish commercial data in 2010, a number of issues came to light regarding previous raising procedures. This has resulted in revisions to 2006-2008 discard estimates for this FU (absolute values but not mean sizes) provided to the 2009 WG.

It is likely that some *Nephrops* survive the discarding process, an estimate of 25% survival is assumed in order to calculate removals (landings + dead discards) from the population.

Intercatch

Intercatch has not been used for this FU. The option of automatically generating Intercatch input from national databases will be explored following the WG.

Length compositions

Length compositions of landings and discards are obtained during monthly market sampling and quarterly on-board observer sampling respectively. Levels of sampling are shown in Table 2.2.XX. Although assessments based on detailed catch analysis are not presently possible, examination of length compositions may provide an indication of exploitation effects.

Figure 3.3.5.3 shows a series of annual length frequency distributions for the period 2000 to 2008. Catch (removals) are shown for each sex with the mean catch and landings lengths shown in relation to MLS and 35mm. There is little evidence of change in the mean size of either sex over time and examination of the tails of the distributions above 35mm shows no evidence of reductions in relative numbers of larger animals. Occasional large year classes can be observed in these length frequency data (2002). This is consistent with the occasional high discard rates observed for this FU.

The observation of relatively stable length compositions is further confirmed in the series of mean sizes of larger *Nephrops* (>35mm) in the landings shown in Figure 3.3.5.1 and Table 3.3.5.3. This parameter might be expected to reduce in size if over-exploitation were taking place but over the last 15 years has in fact been quite stable.

Mean weight in the landings is shown in Figure 3.3.3.3 and Table 3.3.3.5 and this also shows no systematic changes over the time series.

Natural mortality, maturity at age and other biological parameters

Biological parameter values are included in the Stock Annex.

Research vessel data

TV surveys using a stratified random design are available for FU 9 since 1993 (missing survey in 1995). Underwater television surveys of *Nephrops* burrow number and distribution, reduce the problems associated with traditional trawl surveys that arise from variability in burrow emergence of *Nephrops*.

The numbers of valid stations used in the final analysis in each year are shown in Table 3.3.5.4. On average, about 40 stations have been considered valid each year. Abundance data are raised to a stock area of 2195 km^2. General analysis methods for underwater TV survey data are similar for each of the Scottish surveys, and are described in the Stock Annex.

Data analyses

Exploratory analyses of survey data

Table 3.3.5.5 shows the basic analysis for the three most recent TV surveys conducted in FU 9. The table includes estimates of abundance and variability in each of the strata adopted in the stratified random approach. The ground is predominantly of coarser muddy sand and typically, most off the variance in the survey is associated with a patchy area of this sediment to the west of the FU. The densities typically observed in this FU are lower than those observed in FU 8.

Figure 3.3.5.4 shows the distribution of stations in TV surveys, with the size of the symbol reflecting the *Nephrops* burrow density. The abundance appears to be highest at the western and eastern ends of the FU, with lower densities in the more central area. Table 3.3.5.4 and Figure 3.3.5.5 show the time series of estimated abundance for the TV surveys, with 95% confidence intervals on annual estimates. With the exception of 2003, the confidence intervals have been fairly stable in this survey.

The use of the UWTV surveys for *Nephrops* in the provision of advice was extensively reviewed by WKNEPH (ICES, 2009). A number of potential biases were highlighted including those due to edge effects, species burrow mis-identification and burrow occupancy. The cumulative bias correction factor estimated for FU 9 was 1.21 meaning that the TV survey is likely to overestimate *Nephrops* abundance by 21 %.

Final assessment

The underwater TV survey is again presented as the best available information on the Moray Firth *Nephrops* stock. This survey provides a fishery independent estimate of *Nephrops* abundance. At present it is not possible to extract any length or age structure information from the survey, and it therefore only provides information on abundance over the area of the survey.

The 2009 TV survey data presented at this meeting shows that abundance remains at a similar level to that estimated for 2008 (around a 14 % reduction in number, but not statistically significant).

The mean size of individuals > 35 mm (males and females) remains relatively stable.

3.3.5.6 Historic Stock trends

The TV survey estimate of abundance for *Nephrops* in the Moray Firth suggests that the population increased between 1997 and 2003 but has fallen to a fairly stable lower level since 2006. The bias adjusted abundance estimates from 2003-2009 are shown in Table 3.3.5.6. The stock is currently estimated to consist of 415 million individuals.

Table 3.3.5.6 also shows the estimated harvest ratios over this period. These range from 7-20 % over this period. (Estimated harvest ratios prior to 2006 may not be representative of actual harvest ratios due to under-reporting of landings before the introduction of 'Buyers and Sellers' legislation).

3.3.5.7 Recruitment estimates

Survey recruitment estimates are not available for this stock, although the length frequency distributions and highly variable discard rates suggest that this FU may be characterised by occasional large year classes.

3.3.5.8 MSY considerations

A number of potential F_{msy} proxies are obtained from the per-recruit analysis for *Nephrops* and these are discussed further in Section 2 of this report. The analysis assumes the same input parameters (exploitation, discard ogive and biological parameters) as used at the benchmark meeting in 2009. The complete range of the per-recruit F_{msy} proxies is given in the table below and the process for choosing an appropriate F_{msy} proxy is described in Section 2.

Moderate absolute densities are generally observed on the UWTV survey of this FU. Harvest ratios (which are likely to have been underestimated prior to 2006) appear to have been above $F_{35\%SPR}$ and in addition there is a long time series of relatively stable landings (average reported landings ~ 1500 tonnes, above those predicted by currently fishing at $F_{35\%SPR}$). For these reasons, it is suggested that $F_{35\%SPR(T)}$ is chosen as the F_{msy} proxy.

		Fbar(20-40 mm) M	F	HR (%)	SPR (%) M	F	T
$F_{0.1}$	M	0.17	0.1	7.9	39.8	64.1	49.4
	F	0.43	0.2	17.1	17.4	39.5	26.1
	T	0.21	0.1	9.5	34.0	58.8	43.7
F_{max}	M	0.32	0.1	13.6	23.4	47.4	32.9
	F	1.10	0.4	33.1	6.2	18.7	11.1
	T	0.45	0.2	17.9	16.5	38.1	25.0
$F_{35\%SpR}$	M	0.21	0.1	9.5	34.0	58.8	43.7
	F	0.51	0.2	19.7	14.4	34.8	22.4
	T	0.29	0.1	12.7	25.2	49.5	34.7

All F_{msy} proxy harvest rate values are considered preliminary and may be modified following further data exploration and analysis.

The $B_{trigger}$ point for this FU (bias adjusted lowest observed UWTV abundance) is calculated as 262 million individuals.

3.3.5.9 Short-term forecasts

A landings prediction for 2010 was made for the Moray Firth (FU9) using the approach agreed at the Benchmark Workshop and outlined in the introductory section to this chapter (Section 3.1). The table below shows landings predictions at various harvest ratios, including a selection of those equivalent to the per-recruit reference points discussed in Section 2 of this report and the harvest ratio in 2009 using the input parameters agreed at WKNEPH (ICES 2009). The landings prediction for 2011 at the F_{msy} proxy harvest ratio is 1171 tonnes. The F_{msy} transition stage harvest ratio results in a landings option of 1264 tonnes.

The inputs to the landings forecast were as follows:

Mean weight in landings (07-09) = 23.93 g

Discard rate (by number) = 7.4 %

Survey bias = 1.21

F_{sq} = average harvest ratio of 2007-2009 = 14 %

F_{msy} transition (13.7 %) is calculated from 0.2 x F_{msy} + 0.8 x F_{sq}

	Harvest rate	Survey Index (adjusted)	Implied fishery Retained number	Landings (tonnes)
F_{msy}	12.7%	415	49	1171
F_{msy} transition	13.7%	415	53	1264
	0.0%	415	0	0
	5.0%	415	19	460
$F_{0.1(M)}$	7.9%	415	30	726
$F_{0.1(T)}$/$F_{35\%SPR(M)}$	9.5%	415	36	873
	10.0%	415	38	919
$F_{35\%SPR(T)}$	12.7%	415	49	1171
$F_{max(M)}$	13.6%	415	52	1250
F_{sq}	14.0%	415	54	1287
	15.0%	415	58	1379
$F_{max(T)}$	17.9%	415	69	1641
	20.0%	415	77	1839

$F_{0.1(M, T)}$: Harvest ratio equivalent to fishing at a level associated with 10 % of the slope at the origin on the combined sex YPR curve.

$F_{35\%SPR(M,T)}$: Harvest ratio equivalent to fishing at a rate which results in male SPR equal to 35% of the unfished level.

$F_{max (M, T)}$: Harvest ratio equivalent to fishing at a rate which maximises the male YPR.

A discussion of F_{msy} reference points for *Nephrops* is provided in Section 3.1.

3.3.5.10 Biological Reference points

Biological reference points have not been defined for this stock.

3.3.5.11 Quality of assessment

The length and sex composition of the landings data is considered to be well sampled. Discard sampling has been conducted on a quarterly basis for Scottish *Nephrops* trawlers in this fishery since 1990, and is considered to represent the fishery adequately.

There are concerns over the accuracy of landings and effort data and because of this the final assessment adopted is independent of official statistics.

UWTV surveys have been conducted for this stock since 1993, with a continual annual series available since 1998. Confidence intervals around the abundance estimates are greater during years when abundance estimates have been slightly higher.

The Fishers' North Sea stock survey does not include specific information for the Moray Firth. The time series of perceived abundance for this area show an increase up to 2008 and then a decline. However, given that there is more than one FU within this survey area, it is not clear as to whether the replies were actually related to the Moray Firth *Nephrops*.

3.3.5.12 Status of the stock

The evidence from the TV survey suggests that the population is stable, but at a lower level than that evident from 2003-2005. There is no evidence from the mean size information to suggest overexploitation of the FU although the current low discard rate suggests that recruitment may be lower than it has been previously. There has also been an apparent increase in female catchability which when observed in other FUs has been associated with the stock having been overexploited.

The calculated harvest ratio in 2009 (removals/TV abundance) is above $F_{35\%SpR}$ but below F_{max}.

3.3.5.13 Management considerations

The WG, ACOM and STECF have repeatedly advised that management should be at a smaller scale than the ICES Division level. Management at the Functional Unit level could provide the controls to ensure that catch opportunities and effort were compatible and in line with the scale of the resource.

There is a by-catch of other species in the Moray Firth area. It is important that efforts are made to ensure that unwanted by-catch is kept to a minimum in this fishery. Current efforts to reduce discards and unwanted by-catches of cod under the Scottish Conservation credits scheme, include the implementation of larger meshed square mesh panels and real time closures to avoid cod.

The estimated harvest rates have generally been greater than $F_{35\%SpR}$ and although the abundance (as estimated by the TV survey) does not appear to have been adversely affected by this, it would be unwise to allow effort to increase in this FU.

3.3.6 Noup (FU 10)

3.3.6.1 Ecosystem aspects

Information on ecosystem aspects can now be found in the Stock Annex.

3.3.6.2 The Fishery in 2008 and 2009

The Noup supports a relatively small fishery with only 3-4 boats fishing regularly. The landings data as reported to the WG are shown in Table 3.3.6.1. No new information is available for 2008 and 2009.

Further general information on the fishery can be found in the Stock Annex.

3.3.6.3 Advice in 2009

The advice provided in 2008 was biennial and valid for 2009 and 2010.

The ICES conclusions in 2008 in relation to State of the Stock were as follows:

'The lpue indicator is increasing and mean length in the catches is stable. Current levels of exploitation appear to be sustainable.'

The ICES advice for 2008 (Single-stock exploitation boundaries) was as follows:

Exploitation boundaries in relation to precautionary considerations

'Given the apparent stability of the stock, current levels of exploitation and effort appear to be sustainable. ICES maintains the previous advice (based on the average landings 2003–2005) for the Noup fishery, i.e. less than 240 t. This amount is almost identical to the long-term average for the time-series.'

3.3.6.4 Management

Management is at the ICES Subarea level as described at the beginning of Section 3.3.

3.3.6.5 Assessment

There is no assessment of this FU.

Data available

Commercial catch and effort data

Landings from this fishery are reported only from Scotland and are presented in Table 3.3.6.1 and Figure 3.3.6.1, together with a breakdown by gear type. Total landings (as reported to the WG) in 2009 were 89 tonnes, a reduction of almost 50 % since 2008.

Given the concerns about the previously presented Scottish effort data (due to non-mandatory recording of hours fished in recent years) and following recommendations made by the RG, effort data in terms of days absent were presented to the WG. These data (not illustrated) gave unrealistically high values of LPUE (2,000-3,000 kg/day). On investigation, it appears that the in-house Marine Scotland Science database holds an incomplete record of days absent for the Noup (and Fladen) when compared to the official data held in the database populated by Marine Scotland Compliance. The data are not considered further in this section.,

Length compositions

Levels of market sampling are low and discard sampling is not available. Mean sizes in the landings in previous years are shown in Figure 3.3.6.1 and Table 3.3.6.2 (based on only 2 samples in 2009)

Natural mortality, maturity at age and other biological parameters

No data available.

Research vessel data

An underwater TV survey of this FU has been conducted sporadically (1994, 1999, 2006 and 2007). A density distribution map of these surveys is shown in Figure 3.3.6.2 and results shown in Table 3.3.6.3.

Data analyses

No assessment has been presented in 2010.

3.3.6.6 Historical stock trends

Total landings for this FU have fallen to below 100 tonnes which is < 1% of the total landings from the North Sea.

No UWTV survey has been conducted in this FU in recent years.

3.3.6.7 Recruitment estimates

There are no recruitment estimates for this FU.

3.3.6.8 Short-term Forecasts

No short-term forecasts are presented for this FU.

3.3.6.9 Status of the stock

The current state of the stock is unknown.

3.3.6.10 Management considerations

The WG, ACOM and STECF have repeatedly advised that management should be at a smaller scale than the ICES Division level. Management at the Functional Unit level could provide the controls to ensure that catch opportunities and effort were compatible and in line with the scale of the resource.

There is a by-catch of other species in the Noup area. It is important that efforts are made to ensure that unwanted by-catch is kept to a minimum in this fishery. Current efforts to reduce discards and unwanted by-catches of cod under the Scottish Conservation credits scheme, include the implementation of larger meshed square mesh panels and real time closures to avoid cod.

3.3.7 Norwegian Deep (FU 32)

3.3.7.1 General

3.3.7.1.1 Ecosystem aspects.

See stock annex.

3.3.7.1.2 Norwegian Deep (FU 32) fisheries

See stock annex.

3.3.7.1.3 Advice in 2008

In 2008 ICES noted for this stock that:

- *"International landings from the Norwegian Deep increased from less than 20 t in the mid-1980s to 1,190 t in 2001, the highest Figure so far. Since then landings have declined and total landings in 2007 amounted to 755 t, mainly due to a reduction of Danish landings."*
- *"Perceptions of this stock (FU 32) are based on Danish LPUE data."*
- *"The overall picture is that of a stable LPUE fluctuating around a mean of 200 kg/day. The trend in Danish LPUE Figures does not indicate any decline in stock abundance."*
- *"Recent trends in overall size distribution in the catches indicate that the Nephrops stock in the Norwegian Deep is not over-exploited."*
- *"However, the effect of technological creep on the effective effort of the fishery is not known."*

The WG concluded that the level of exploitation on this stock is sustainable. No specific advice for this stock was given, and no TAC was suggested for 2008 or 2009. It was noted that recent average landings have been approximately 1,000 t (average landings 2002-2007).

3.3.7.1.4 Management

The EU fisheries in FU 32 take place mainly in the Norwegian zone of the North Sea. The EU fisheries are managed by a separate TAC for this area. For 2008 and 2009 the agreed TAC for EU vessels was respectively 1300 and 1200 t. There are no quotas for the Norwegian fishery.

3.3.7.2 Assessment

3.3.7.2.1 Data available

Catch

Catch data for this year's assessment have not been uploaded using InterCatch. The different *Nephrops* fleet were not agreed upon before this year's WG meeting.

Dutch landings from FU 32 are incorporated in the report for the first time this year. International landings from the Norwegian Deep increased from less than 20 t in the mid-1980s to 1,190 t in 2001, the highest Figure so far (Table 3.3.7.1, Figure 3.3.7.1). Since then landings have declined and total landings in 2009 amounted to only 477 t, due to a reduction of Danish landings. This is the lowest Figure since 1994. Danish vessels used to take 80-90 % of total landings, but in 2009 this percentage decreased to 69 %. Norwegian landings increased from 2007 to 2008-2009 by around 45 %.

Length composition

The average size of *Nephrops* as recorded from Danish landings (100-120 mm mesh size) showed a decreasing trend for both males and females in the period 2000-2006, but increased again in 2007 (Figure 3.3.7.1). Average sizes in catches (for both sexes) also increased in 2007. There are no sex specific Danish size data for FU 32 for 2008 and 2009. The size distributions in the Danish catches (100-120 mm mesh size) from 2002 to 2009 do not show any conspicuous changes (Figure 3.3.7.2). Size data from Norwegian coast guard inspections of Danish and Norwegian trawlers are available for 2006-2009. (Figure 3.3.7.3.). The Danish and Norwegian length distributions for 2008-2009 are very similar (Figure 3.3.7.4). Figure 3.3.7.5 shows a time series of length compositions for this stock. There is little evidence of notable change in sizes, and maximum sizes have remained quite constant.

Since 2003 the Danish at-sea-sampling programme has provided data for discard estimates. However, the samples have not covered all quarters. There were no discards data for 2008.

Natural mortality, maturity at age and other biological parameters

No data available.

Catch, effort and research vessel data

Effort and LPUE Figures for the period 1989-2009 are available from Danish logbooks (Table 3.3.7.2, Figure 3.3.7.1). Available logbook data from Norwegian *Nephrops* trawlers cover only a small proportion of the landings (15-40%) in 2001-2005 and are lacking for 2006-2008. The working group considers them unsuitable for any LPUE analysis. In the beginning of the 1990s vessel size increased in the Danish fleet fishing in the Norwegian Deep. This increase and more directed fisheries for *Nephrops* in areas with hitherto low exploitation levels are probably partly responsible for the observed increase in the Danish LPUEs in those years (Table 3.3.7.2, Figure 3.3.7.1). A similar development has been occurring in the Norwegian fleet. Since 1994 the Danish LPUEs have fluctuated around 200 kg day^{-1}. Some of the fluctuations may be caused by fishing vessels locally switching between roundfish and *Nephrops* due to changes in management regulations in the Norwegian zone. The Danish effort increased from 2004 to 2006, but showed a strong decline in 2007 and has since continued decreasing. This decline corresponds to large declines in landings.

It has not been possible to incorporate 'technological creeping' in the evaluation of the effort data. However, use of twin trawls has been widespread for many years. Figure 3.3.7.1 shows the GLM standardised LPUE (regarding vessel size) from the Danish logbook data. Note that the trends in the non-standardised and the standardised LPUE values (relative indices) are very similar. However, this may merely reflect that vessels catching *Nephrops* in this area are very similar with respect to e.g. size and HP.

3.3.7.2.2 Data analysis

Review of last year's assessment

The last assessment of this stock was in 2008. The Review Group (RG) noted:

"It is clear that for this stock there is a lack of basic information. Danish vessels caught recently around 90% of total landings with doubts about its quality, so first it should be necessary to carry out a better segmentation and later a proper standardisation for these fleets. There is a lack of information from Norwegian vessels. From this point of view is quite difficult to know the representation of commercial Figures in relation to this stock.

Based on Danish LPUE data the perception of the stock does not indicate any clear decline in abundance but even so the RG is uncomfortable with this EG views. It is evident that under these circumstances (the data) is inadequate to provide any sound advice"

Exploratory analysis of catch data

There was no age based analysis carried out

Exploratory analysis of survey data

The only survey data for this stock are catches of *Nephrops* during the annual Norwegian shrimp trawl survey. These catches are too sparse to be useful for exploratory analysis.

Final assessment

No age based numerical assessment is presented for this stock. The state of the stock was judged on the basis of basic fishery data.

3.3.7.2.3 Historic stock trends

The slight increase in mean size in the catches and landings from 2006 to 2007 in females and from 2005 to 2007 in males could indicate a lower exploitation pressure in recent years and coincides well with the decreasing landings in the same time period. The Danish LPUE decreased from 2005 to 2006, increased in 2007, and then decreased again in 2008 and 2009. The overall picture is that of a stable LPUE fluctuating around a mean of 200 kg/day. Thus the stock seems to be stable and shows no sign of overexploitation.

3.3.7.2.4 Recruitment estimates

There are no recruitment estimates for this stock.

3.3.7.2.5 Forecasts

There were no forecasts for this stock.

3.3.7.2.6 Biological reference points

No reference points are defined for this stock.

3.3.7.2.7 Quality of assessment

The data available for this stock remains limited.

3.3.7.2.8 Status of stock

Perceptions of this stock (FU 32) are based on Danish LPUE data. The trend in these LPUE Figures does not indicate any decline in stock abundance. However, the effect of technological creep on the effective effort of the fishery is not known. Recent trends in overall size distribution in the catches also indicate that the *Nephrops* stock in FU 32 is not over-exploited. The WG concludes that the level of exploitation on this stock is sustainable. The WG therefore advises that catches should remain at the present level. Historic average annual landings have been approximately 1000 t (2002-2007), while recent average landings are 575 t (2008-2009).

3.3.7.3 Management considerations

For 2006-2008 the agreed catch for EU vessels was 1300 t, while this decreased to 1200 t in 2009. The WG considers that the stock should be monitored more closely. The Norwegian logbook system should be improved. Sampling of Norwegian commercial catches from this area should be intensified. Also the sampling of the Danish vessels should be intensified so as to again provide sex specific sampling of catches and landings.

3.3.8 Off Horns Reef (FU 33)

3.3.8.1.1 Data available

Catch

The landings from FU 33 were marginal for many years. However, from 1993 to 2004, Danish landings increased considerably, from 159 to 1,097 t (Figure 3.3.8.1). In this period Denmark dominated this fishery. The other countries reporting landings from the area are Belgium, Netherlands and the UK. In recent years total landings increased to above1400 t. Since 2004 Danish landings have gradually decreased, and in 2008 fell to less than 400 t. During the same period landings from Netherlands increased. In 2009 total landings from this FU amounted to 1163 t (Table 3.3.8.1), of which the Netherlands accounted for around 500 t. The other countries contributed with less than 300 t.

Length compositions

Length (CL) distributions of the Danish catches 2001 to 2005 and 2009 are shown in Figure 3.3.8.2. Notice, that except for 2005 they are rather similar. Figure 3.4.5.3 gives the development of the mean size of the catches and landings by sex. The drop in mean CL in 2005 reflect increased numbers around 30 mm CL in the catch and could indicate a large recruitment that year, see also Figure. 3.3.8.1

In the period 2001-2005, and in 2009 the Danish at-sea-sampling programme has provided data for discard estimates. However, the samples do not cover all quarters.

Natural mortality, maturity at age and other biological parameters

No data available

Catch, effort and research vessel data

Table 3.3.8.1 and Figure 3.3.8.1 show the development in Danish effort and LPUE. Notice that the 10-fold increase in fishing effort from 1996 to 2004 seems to correspond to the increase in landings during the same period. It appears that LPUEs have been rather stable from 1998 to 2005, fluctuating around 200 kg per day. However, in 2007 LPUE increased markedly and was more than 400 kg per day both in 2008 and 2009. This increase in LPUE could reflect increase in gear efficiency (technological creep).

3.3.8.1.2 Data analysis

Reviews of the 2008 assessment (FU 5 and FU33)

'Due to that the only information available for both FUs comes from the fishery, the quality (and quantity) should be qualified in a deeper way and ideally better segmented and standardised for the most important countries involved currently in this fishery.

It is obvious that this fishery should be monitored more closely; due to this is a valuable fishery with combined landings for both FU of more than 2,000 t per year. '

Exploratory analyses of catch data

No catch at age analysis has been carried out for this stock.

Exploratory analyses of survey

No survey data were available

3.3.8.1.3 Historic stock trends

3.3.8.1.4 Historic stock trends

The available data do not provide any clear signals on stock development:

LPUE for 2009 has remained at the high 2008 level. However, as the increase in previous years also could reflect technological creep and since only Danish effort data are available, these data should be considered cautiously as stock indicators.

The size distribution in the 2009 catches is similar to those in 2001-04. The generally smaller individuals in the 2005 catches could reflect a high recruitment that year. The decrease in mean size could indicate either high recruitment or a decline in stock reflected by fewer large individuals.

Recruitment estimates: There are no recruitment estimates, but fluctuations in discards may reflect corresponding fluctuations in recruitment.

Forecasts: Forecasts were not performed.

Biological reference points: There are no reference points defined for this stock.

Perceptions of the stock are based on Danish LPUE data and size composition in Danish catches. As stated above, comparing the size distribution in the 2005 catches with those in the 2001-2004 catches as well as the 2009 catches could indicate a high recruitment in 2005. This interpretation of the 2005 catches is supported by the increase in LPUEs in 2006, 2007 and 2008. The development in 2009 then suggests that the contribution of the 2005 recruitment to the stock now has faded and LPUE may therefore decline in coming years.

Management considerations for FU 33.

The North Sea TAC is not thought to be restrictive for the fleets exploiting this stock, Considering the recent trend in LPUE and the technological creep of the gear, the exploitation of this stock should monitored closely.

Table 3.1.2 Summary of Nephrops landings from the ICES area, by Functional Unit , 1991-2008.

Year	FU 3	FU 4	FU 5	FU 6	FU 7	FU 8	FU 9	FU 10	FU 32	FU 33	Other	Total
1981				1073	373	1006	1416	36			76	3980
1982				2524	422	1195	1120	19			157	5437
1983				2078	693	1724	940	15			101	5551
1984				1479	646	2134	1170	111			88	5628
1985				2027	1148	1969	2081	22			139	7386
1986				2015	1543	2263	2143	68			204	8236
1987				2191	1696	1674	1991	44			195	7791
1988				2495	1573	2528	1959	76			364	8995
1989				3098	2299	1886	2576	84			233	10176
1990				2498	2537	1930	2038	217			222	9442
1991	2924	1304	862	2063	4220	1404	1519	196			560	16356
1992	1893	1012	612	1473	3338	1757	1591	188			401	13277
1993	2288	924	721	3030	3521	2369	1808	376	339	160	434	15970
1994	1981	893	503	3683	4566	1850	1538	495	755	137	703	17104
1995	2429	998	869	2569	6442	1763	1297	280	489	164	844	18144
1996	2695	1285	679	2482	5220	1688	1451	344	952	77	808	17681
1997	2612	1594	1149	2189	6171	2194	1446	316	760	276	662	19369
1998	3248	1808	1111	2177	5138	2145	1032	254	836	350	694	18793
1999	3194	1755	1244	2391	6505	2205	1008	279	1119	724	988	21412
2000	2894	1816	1121	2178	5580	1785	1541	275	1084	597	900	19771
2001	2282	1774	1443	2574	5545	1528	1403	177	1190	791	1268	19975
2002	2977	1471	1231	1953	7234	1340	1118	401	1170	861	1383	21139
2003	2126	1641	1144	2245	6305	1126	1079	337	1089	929	1390	19411
2004	2312	1653	1070	2152	8733	1658	1335	228	922	1268	1224	22555
2005	2546	1488	1058	3094	10685	1990	1605	165	1089	1050	1120	25890
2006	2392	1280	986	4858	10789	2458	1803	133	1028	1288	1249	28264
2007	2771	1741	1311	2966	11910	2652	1842	155	755	1467	1637	29207
2008	2851	2025	695	1213	12240	2450	1514	173	675	1444	1673	26953
2009*	3004	1842	719	2711	13327	2663	1066	89	477	1163	2367	29428

*** Provisional**

Table 3.3.1. Nominal landings (tonnes) of *Nephrops* in Sub-area IV, 1987 – 2008, as officially reported to ICES.

	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
Belgium	638	679	344	437	500	574	610	427	384	418	304	410	185
Denmark	7	50	323	479	409	508	743	880	581	691	1128	1182	1315
Faeroe Islands	-	-	-	0	0	0	0	0	0	1	3	12	0
France	-	-	-	7	0	0	0	0	0	0	0	0	0
Germany	.	.	.	0	0	0	0	2	2	16	24	16	69
Germany (Fed. Rep.)	5	4	5	1	2	1	2	0	0	0	0	0	0
Ireland	-	-	-	0	0	0	0	0	0	0	0	0	0
Netherlands	-	-	-	0	0	0	9	3	134	131	159	254	423
Norway	1	1	1	2	17	17	46	117	125	107	171	74	83
Sweden	-	1	-	0	0	0	0	4	0	1	1	1	0
UK (Eng + Wales + NI)	.	.	.	0	0	2938	2332	1955	1451	2983	3613	2530	2462
UK (Eng + Wales)	1477	2052	2002	2173	2397	0	0	0	0	0	0	0	-
UK (Scotland)	4158	5369	6190	5304	6527	7065	6871	7501	6898	8250	8850	10018	8981
UK	-	-	-	-	-	-	-	-	-	-	-	-	-
Total	6286	8156	8865	8403	9852	11103	10613	10889	9575	12598	14253	14497	13518

	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009*
Belgium	311	238	350	252	283	284	229	213	180	214	205	200	277
Denmark	1309	1440	1963	1747	1935	2154	2128	2244	2339	2024	1408	1078	
Faeroe Islands	1	1	1	0	-	-	-	-	-	-	-	-	-
France	0	0	0	0	-	-	-	-	-	-	-	-	-
Germany	64	58	104	79	140	125	50	50	109	288	602	266	410
Germany (Fed. Rep.)	0	0	0	0	-	-	-	-	-	-	-	-	-
Ireland	0	0	0	0	-	-	1	2	-	-	-	-	-
Netherlands	627	695	662	572	851	966	940	918	1019	982	1147	737	1053
Norway	64	93	144	147	115	130	100	93	132	96	99	143	139
Sweden	1	3	4	37	26	14	1	1	3	1	5	26	2
UK (Eng + Wales + NI)	2206	2094	2431	2210	2691	1964	2295	2241	3236	4924	3295	1679	
UK (Eng + Wales)	-	-	-	-	-	-	-	-	-	-	-	-	-
UK (Scotland)	10466	8980	10715	9834	9681	11045	10094	12912	10565	16165	17930	17960	-
UK	-	-	-	-	-	-	-	-		-	-	-	21942
Total	15049	13602	16374	14878	15722	16682	15838	18674	17583	24694	24691	22089	23823

* Landings data for 2009 are preliminary.

Table 3.2.1.2. - Division IIIa: Total Nephrops landings (tonnes) by Functional Unit, 1991-2009.

Year	FU 3	FU 4	Total
1991	2924	1304	4228
1992	1893	1012	2905
1993	2288	924	3212
1994	1981	893	2874
1995	2429	998	3427
1996	2695	1285	3980
1997	2612	1594	4206
1998	3248	1808	5056
1999	3194	1755	4949
2000	2894	1816	4710
2001	2282	1774	4056
2002	2977	1471	4448
2003	2126	1641	3767
2004	2312	1653	3965
2005	2546	1488	4034
2006	2392	1280	3672
2007	2771	1741	4512
2008	2851	2025	4876
2009	3004	1842	4846

Table 3.2.1.3. - Division IIIa: Total Nephrops landings (tonnes) by country, 1991-2009.

Year	Denmark	Norway	Sweden	Germany	Total
1991	2824	185	1219		4228
1992	2052	104	749		2905
1993	2250	103	859		3212
1994	2049	62	763		2874
1995	2419	90	918		3427
1996	2844	102	1034		3980
1997	2959	117	1130		4206
1998	3541	184	1319	12	5056
1999	3486	214	1243	6	4949
2000	3325	181	1197	7	4710
2001	2880	138	1037	1	4056
2002	3293	116	1032	7	4448
2003	2757	99	898	13	3767
2004	2955	95	903	12	3965
2005	2901	83	1048	2	4034
2006	2432	91	1143	6	3672
2007	2887	145	1467	13	4512
2008	3174	158	1509	19	4860
2009	3372	128	1331	15	4846

Table 3.2.2.1. Nephrops in Skagerrak (FU 3): Landings (tonnes) by country, 1991-2009.

Year	Denmark	Norway			Sweden			Total
		Trawl	Creel	Sub-total	Trawl	Creel	Sub-total	
1991	1639	185	0	185	949	151	1100	2924
1992	1151	104	0	104	524	114	638	1893
1993	1485	101	2	103	577	123	700	2288
1994	1298	62	0	62	531	90	621	1981
1995	1569	90	0	90	659	111	770	2429
1996	1772	102	0	102	708	113	821	2695
1997	1687	117	0	117	690	118	808	2612
1998	2055	184	0	184	864	145	1009	3248
1999	2070	214	0	214	793	117	910	3194
2000	1877	181	0	181	689	147	836	2894
2001	1416	125	13	138	594	134	728	2282
2002	2053	99	17	116	658	150	808	2977
2003	1421	90	9	99	471	135	606	2126
2004	1595	85	10	95	449	173	622	2312
2005	1727	71	12	83	538	198	736	2546
2006	1516	80	11	91	583	201	784	2391
2007	1664	127	18	145	709	253	962	2771
2008	1745	124	34	158	675	273	948	2851
2009	2012	101	27	128	605	260	864	3004

Table 3.2.2.3. Nephrops Skagerrak (FU 3): Catches and landings (tonnes), effort ('000 hours trawling), CPUE and LPUE (kg/hour trawling) of Swedish Nephrops trawlers, 1991-2009. (*Include only Nephrops trawls with grid and square mesh codend).

Single trawl					
Year	Catches	Landings	Effort	CPUE	LPUE
1991	676	401	71.4	9.5	5.6
1992	360	231	73.7	4.9	3.1
1993	614	279	72.6	8.4	3.8
1994	441	246	60.1	7.3	4.1
1995	501	336	60.8	7.8	5.2
1996	754	488	51.1	14.8	9.6
1997	643	437	44.4	14.4	9.8
1998	794	557	49.7	16.0	11.2
1999	605	386	34.5	17.5	9.3
2000	486	329	32.7	14.9	10.9
2001	446	236	26.2	17.0	10.4
2002	503	301	29.4	17.1	8.8
2003	310	254	21.5	13.9	11.4
2004*	474	257	20.1	23.6	13.4
2005*	760	339	29.7	25.6	12.7
2006*	839	401	37.5	22.4	12.2
2007*	894	314	24.1	37.0	13.0
2008*	605	264	20.0	30.3	13.2
2009*	482	285	19.6	24.5	14.5

Twin trawl					
Year	Catches	Landings	Effort	CPUE	LPUE
1991	740	439	39.5	18.7	11.1
1992	370	238	34.1	10.9	7.0
1993	568	258	35.9	15.8	7.2
1994	444	248	34.1	13.1	7.3
1995	403	270	32.9	12.2	8.2
1996	187	121	13.0	14.4	9.3
1997	219	149	17.5	12.5	8.5
1998	254	178	16.7	15.2	10.6
1999	382	244	27.6	13.8	8.8
2000	349	237	31.3	11.1	10.1
2001	470	249	33.7	14.0	7.4
2002	392	244	33.3	11.8	7.1
2003	168	138	22.5	7.5	6.1
2004	217	118	21.7	10.0	5.4
2005	263	117	22.1	11.9	5.3
2006	253	121	19.6	12.9	6.2
2007*	248	87	5.4	45.6	16.0
2008*	139	61	3.4	41.3	18.0
2009*	211	125	7.1	29.5	17.5

Table 3.2.2.4. Nephrops Skagerrak (FU 3): Logbook recorded effort (days fishing) and LPUE (kg/day) for bottom trawlers catching Nephrops with codend mesh sizes of 70 mm or above, and estimated total effort by Danish trawlers, 1991-2009.

Year	Logbook data		Estimated total effort
	Effort	LPUE	
1991	17136	73	22158
1992	12183	70	16239
1993	11073	105	14068
1994	10655	110	11958
1995	10494	132	11935
1996	11885	138	12793
1997	11791	140	12075
1998	12501	155	13038
1999	13686	139	14787
2000	14802	120	15663
2001	14244	100	13976
2002	16386	123	16750
2003	10645	121	11802
2004	11987	122	12996
2005	10682	144	12003
2006	9638	141	10737
2007	7598	212	7877
2008	7785	216	8058
2009	8394	236	8535

Table 3.2.1.5. - Skagerrak (FU 3): Mean sizes (mm CL) of male and female Nephrops in catches of Danish and Swedish combined, 1991-2009.

Year	**Catches**					
	Undersized		**Full sized**		**All**	
	Males	Females	Males	Females	Males	Females
1991	30.2	30.9	41.2	42.7	30.9	29.8
1992	33.3	32.3	43.3	44.7	33.3	32.2
1993	33.0	31.5	42.0	43.6	33.0	31.5
1994	31.7	29.6	41.7	43.6	31.7	29.6
1995	30.0	28.5	41.6	41.3	32.9	29.8
1996	33.2	31.9	42.9	44.0	37.6	37.0
1997	35.8	34.5	44.6	44.1	39.8	39.1
1998	34.8	34.4	46.1	43.9	40.7	37.3
1999	34.6	33.9	44.9	43.8	39.3	36.1
2000	30.6	30.5	45.6	45.0	32.5	34.1
2001	33.6	33.6	45.5	43.6	37.3	36.4
2002	33.9	33.7	44.0	42.5	37.2	37.3
2003	33.5	32.6	43.2	43.4	38.0	36.7
2004	34.3	33.4	44.6	45.2	38.7	36.6
2005	33.5	32.4	43.7	43.0	36.4	35.3
2006	33.2	32.9	44.7	42.7	37.1	36.1
2007	32.6	31.9	44.4	42.4	34.9	33.5
2008	33.6	32.3	44.0	42.7	36.5	34.5
2009	35.0	33.8	45.3	42.8	39.8	35.9

Table 3.2.3.1. Nephrops Kattegat (FU 4): Landings (tonnes) by country, 1991-2009.

Year	Denmark	Sweden		Sub-total	Germany	Total
		Trawl	Creel			
1991	1185	119	0	119	0	1304
1992	901	111	0	111	0	1012
1993	765	159	0	159	0	924
1994	751	142	0	142	0	893
1995	850	148	0	148	0	998
1996	1072	213	0	213	0	1285
1997	1272	319	3	322	0	1594
1998	1486	306	4	310	12	1808
1999	1416	329	4	333	6	1755
2000	1448	357	4	361	7	1816
2001	1464	304	6	309	1	1774
2002	1240	219	5	224	7	1471
2003	1336	287	5	292	13	1641
2004	1360	270	11	281	12	1653
2005	1175	303	8	311	2	1488
2006	916	347	11	358	6	1280
2007	1223	491	15	505	13	1741
2008	1429	561	16	577	19	2025
2009	1360	450	16	467	15	1842

Table 3.2.3.3. - Kattegat (FU 4): Catches and landings (tonnes), effort ('000 hours trawling), CPUE and LPUE (kg/hour trawling) of Swedish Nephrops trawlers, 1991-2009 (*Include only Nephrops trawls with grid and square mesh codend).

Single trawl					
Year	Catches	Landings	Effort	CPUE	LPUE
1991	66	39	10.3	6.4	3.7
1992	44	28	11.6	3.8	2.4
1993	128	58	14.9	8.6	3.9
1994	95	53	16.2	5.7	3.2
1995	79	53	9.6	7.8	5.5
1996	207	134	13.7	15.1	9.8
1997	269	183	18.0	15.0	10.2
1998	181	127	13.1	13.8	9.7
1999	146	93	8.1	17.9	11.4
2000	114	77	8.5	13.4	9.1
2001	117	62	7.6	15.4	8.2
2002	42	25	3.7	11.2	6.7
2003	49	40	4.6	10.7	8.7
2004	70	44	4.3	16.2	10.1
2005	147	100	12.3	11.9	8.1
2006	234	154	15.1	15.5	10.2
2007*	107	51	4.1	25.7	12.3
2008*	121	57	4.4	27.6	13.0
2009*	157	81	5.1	30.9	16.1

Twin trawl					
Year	Catches	Landings	Effort	CPUE	LPUE
1991	93	55	8.8	10.6	6.2
1992	101	65	14.2	7.1	4.6
1993	187	85	17.8	10.6	4.8
1994	138	77	14.2	9.7	5.4
1995	125	84	11.0	12.2	7.7
1996	97	63	7.5	13.0	8.4
1997	183	124	12.7	14.3	9.7
1998	215	151	15.0	14.4	10.1
1999	306	195	20.1	15.2	9.7
2000	330	224	24.5	13.5	9.1
2001	353	187	25.1	14.1	7.4
2002	256	153	23.2	11.0	6.6
2003	222	181	24.8	9	7.3
2004	253	158	16.5	15.4	9.6
2005	198	135	15.3	12.9	8.8
2006	183	121	12.7	14.4	9.5
2007*	112	54	3.6	30.9	14.8
2008*	164	78	4.8	34.1	16.1
2009*	309	161	11.0	28.2	14.6

Table 3.2.3.4. Nephrops Kattegat (FU 4): Logbook recorded effort (days fishing) and LPUE (kg/day) for bottom trawlers catching Nephrops with codend mesh sizes of 70 mm or above, and estimated total effort by Danish trawlers, 1991-2009.

Year	Logbook data		Estimated total effort
	Effort	LPUE	
1991	13494	69	17175
1992	12126	65	13627
1993	8815	75	10195
1994	9403	77	9802
1995	9039	91	9357
1996	9872	96	11209
1997	10028	112	11348
1998	10388	122	12144
1999	11434	109	13019
2000	12845	100	14448
2001	13017	93	15870
2002	11571	88	13772
2003	11768	103	13015
2004	11122	115	11669
2005	9286	127	9286
2006	8080	113	7998
2007	7165	162	7588
2008	7911	170	8428
2009	8323	167	8159

Table 3.2.3.5. Nephrops Kattegat (FU 4): Mean sizes (mm CL) of male and female Nephrops in discards, landings and catches, 1991-2009. Since 2005 based on combined Danish and Swedish data.

Year	**Catches**					
	Discards		**Landings**		**All**	
	Males	Females	Males	Females	Males	Females
1991	30.7	31.1	42.4	42.5	32.5	32.9
1992	33.0	30.3	44.4	43.2	36.7	34.9
1993	30.5	29.3	42.3	43.1	31.3	30.1
1994	29.7	28.3	40.8	40.2	31.2	28.9
1995	30.8	30.5	42.4	42.0	33.7	33.2
1996	32.7	31.3	42.0	44.0	36.7	37.3
1997	33.6	33.2	45.0	44.5	37.1	35.0
1998	34.2	33.2	45.6	44.1	41.3	36.8
1999	32.9	33.8	45.3	40.9	37.8	34.9
2000	35.1	35.2	45.7	42.1	40.4	36.9
2001	32.2	33.0	44.1	41.9	35.9	36.5
2002	34.4	33.3	44.4	43.8	37.2	36.2
2003	33.0	33.2	43.5	42.2	37.1	36.0
2004	34.7	34.2	45.1	43.2	39.9	37.5
2005	33.5	33.9	45.8	43.1	38.7	38.7
2006	33.2	33.6	45.1	42.8	37.9	37.4
2007	33.9	33.2	44.8	43.5	37.2	35.5
2008	32.6	32.4	44.0	43.9	37.5	35.9
2009	33.8	33.1	44.7	44.1	36.8	35.2

Table 3.2.4.1 FU3&4: Results from the 2008 and 2009 UWTV surveys

(Hauls à 10 min.)	n hauls	nos/m2	grams/m2
N. Kattegat	23	0.31	11.06
S. Kattegat	19	0.15	5.32
average / sq m	**42**	**0.24**	**8.46**

Table 3.2.4.2 FU3&4, Estimate of abundance.

Bottom type	sq km	N_(mill.)	tons
Area, VMS	**13015**	**3107.1**	**110136**

Table 3.3.1.1 FU5 Botney Gut. Landings by country

	Belgium	Denmark	Netherl.	Germany	UK	Total **
1991	682	176	na		4	***862***
1992	571	22	na		19	***612***
1993	694	20	na		7	***721***
1994	494	0	na		9	***503***
1995	641	77	148		3	***869***
1996	266	41	317		55	***679***
1997	486	67	540		56	***1149***
1998	372	88	584	39	28	***1111***
1999	436	53	538	59	158	***1244***
2000	366	83	402	52	218	***1121***
2001	353	145	553	114	278	***1443***
2002	281	94	617	88	151	***1231***
2003	265	36	661	24	158	***1144***
2004	171	39	646	16	198	***1070***
2005	109	87	654	51	198	***1099***
2006	77	24	444	99	330	***974***
2007	75	3	464	201	551	***1294***
2008	49	29	268	108	486	***939***
2009*	52	3	288	94	283	***719***

* provisional na = not available

** Totals for 1991-94 exclusive of landings by the Netherlands

Table 3.3.1.2 FU5 Botney Gut. Mean sizes by sex in the Belgian landings 1991-2005

	Landings	
	Males	Females
1991	40.8	41.3
1992	40.9	40.9
1993	41.0	40.9
1994	40.3	40.6
1995	40.7	39.8
1996	41.3	39.4
1997	41.2	39.0
1998	41.0	39.2
1999	40.9	39.5
2000	40.8	39.9
2001	40.3	39.7
2002	39.7	39.3
2003	40.5	39.3
2004	40.1	39.9
2005	40.2	39.5

Table 3.3.1.1 FU5 Botney Gut. Effort and LPUE figures are available for Belgian *Nephrops* specialist trawlers (1985-2005), the Dutch fleet (all vessels catching *Nephrops* for the period 2000-2009 and the Danish bottom trawlers with mesh size > 70 mm (1996-2009),

	Belgium (1)				Netherlands (2)			Denmark (3)		
	Landings	Effort	LPUE		Landings	Effort	LPUE	Landings	Effort	LPUE
	tons	'000 hrs	kg/hour		tons	days at sea	kg/day	tons	days at sea	kg/day
1991	566	74.0	7.7							
1992	525	74.5	7.0							
1993	672	58.3	11.5							
1994	453	35.5	12.7							
1995	559	32.5	17.2							
1996	245	30.1	8.1					34	132	261.0
1997	399	31.8	12.5					24	59	412.0
1998	309	28.6	10.8					78	174	447.0
1999	322	31.8	10.1					44	107	408.0
2000	174	21.8	8.0		402	7936	50.7	76	247	306.0
2001	195	21.5	9.1		553	9797	56.5	78	283	275.0
2002	144	15.8	9.1		617	8999	68.6	47	200	237.0
2003	118	6.2	19.3		661	9043	73.1	33	132	247.3
2004	106	5.7	18.8		646	8676	74.5	36	149	241.9
2005	69	2.9	23.9		654	7912	82.7	87	297	290.9
2006	no data	no data	no data	no data	444	6849	64.8	24	66	365.6
2007	no data	no data	no data	no data	464	6922	67.0	3	13	253.6
2008	no data	no data	no data	no data	268	5020	53.3	29	41	777.0
2009*	no data	no data	no data	no data	288	5909	48.7	3	9	323.9

* provisional na = not available

(1) Vessels directed towards Nephrops at least 10 months per year

(2) All vessels operating in FU 5, regardless of directedness towards Nephrops

(3) Logbook records from vessels operating in FU 5, with mesh size >=70 mm with Nephrops in catches

Table 3.3.2.1 FU6 Farn Deeps. Landings by country

Year	UK England & N. Ireland	UK Scotland	Sub total	Other countries**	Total
1981	1006	67	1073	0	1073
1982	2443	81	2524	0	2524
1983	2073	5	2078	0	2078
1984	1471	8	1479	0	1479
1985	2009	18	2027	0	2027
1986	1987	28	2015	0	2015
1987	2158	33	2191	0	2191
1988	2390	105	2495	0	2495
1989	2930	168	3098	0	3098
1990	2306	192	2498	0	2498
1991	1884	179	2063	0	2063
1992	1403	60	1463	10	1473
1993	2941	89	3030	0	3030
1994	3530	153	3683	0	3683
1995	2478	90	2568	1	2569
1996	2386	96	2482	1	2483
1997	2109	80	2189	0	2189
1998	2029	147	2176	1	2177
1999	2197	194	2391	0	2391
2000	1947	231	2178	0	2178
2001	2319	255	2574	0	2574
2002	1739	215	1954	0	1954
2003	2031	214	2245	0	2245
2004	1952	201	2153	0	2153
2005	2936	158	3094	0	3094
2006	4430	434	4864	39	4903
2007	2525	437	2962	4	2966
2008	974	244	1218	0	1218
2009	2297	414	2711	0	2711

* provisional   na = not available

** Other countries includes Ne, Be and Dk

Table 3.3.2.1 FU6 Farn Deeps. LPUE by UK targetted *Nephrops* trawlers.

Year	Catches	Landings	Effort	CPUE	LPUE
1985	2546	1906	70.8	35.9	26.9
1986	2541	1902	72.1	35.2	26.4
1987	2773	2075	80.1	34.6	25.9
1988	3187	2385	98.8	32.2	24.1
1989	3754	2809	122.4	30.7	23
1990	2980	2230	103.5	28.8	21.5
1991	2384	1784	107.2	22.2	16.7
1992	1729	1294	58.2	29.7	22.2
1993	3756	2811	106.7	35.2	26.3
1994	4612	3451	152.5	30.2	22.6
1995	3192	2388	96.8	33	24.7
1996	3031	2268	87.3	34.7	26
1997	2508	1877	75.7	33.2	24.8
1998	2531	1894	62.7	40.4	30.2
1999	2888	2161	86.2	33.5	25.1
2000	3409	1863	74.2	46	25.1
2001	4024	2096	88.8	45.3	23.6
2002	2222	1605	65.8	33.7	24.4
2003	2576	1975	79.6	32.4	24.8
2004	2239	1824	65.5	34.2	27.8
2005	3059	2498	78.7	38.9	31.8
2006	4307	3547	93.7	46	37.9
2007	2205	1914	78.3	28.2	24.5
2008	979	838	44.9	21.8	18.6
2009*	na	na	na	na	na

* provisional na = not available

Table 3.3.2.3 FU6 Farn Deeps. Mean sizes in the catches and landings by sex

	Catches		**Landings**	
Year	Males	Females	Males	Females
1985	30.1	28.5	35.4	33.8
1986	31.7	30.2	35.3	33.7
1987	28.6	27	35.3	33.3
1988	28.7	27.3	35	33.9
1989	29	28.2	32.4	31.9
1990	27.1	27.4	31.8	31.3
1991	28.9	27.1	33.5	33.1
1992	30.8	29	33	31.9
1993	32.1	28.7	33.4	30.1
1994	30.5	27.7	33.8	30.5
1995	28.4	27.4	33.8	31.6
1996	29.8	28.2	34.5	32.1
1997	29.9	29.6	33.5	32.1
1998	30	28.9	34.9	33.7
1999	29.6	27.5	35.1	33.6
2000	27.3	26.8	31.1	31.3
2001	26.3	26.4	30.6	31.3
2002	28.4	26.8	31.2	29.8
2003	29.3	27.2	31.9	30.6
2004	30.4	28.0	32.5	30.9
2005	29.9	29.4	32.2	32.2
2006	29.0	30.3	31.4	32.4
2007	31.2	30.5	33.3	32.5
2008	31.1	30.3	33.0	32.7
2009*	30.4	30.9	32.4	33.1

* provisional   na = not available

Table 3.3.2.4 FU6 Farn Deeps. Results of the UWTV survey

Year	Stations	Season	Mean density	Bias-corrected Abundance	95% confidence interval
			burrows/m²	millions	millions
1996	71	Spring	0.53	1459	100
	-	Autumn	No survey		
1997	105	Spring	0.53	1494	139
	87	Autumn	0.55	1500	125
1998	78	Spring	0.25	662	48
	91	Autumn	0.39	1090	89
1999	95	Spring	0.29	829	78
	-	Autumn	No survey		
2000	98	Spring	0.33	927	67
	-	Autumn	No survey		
2001	-	Spring	No survey		
	180	Autumn	0.67	1685	67
2002	180	Spring	0.54	1390	93
	37	Autumn	0.39	1048	112
2003	-	Spring	No survey		
	958	Autumn	0.39	1085	90
2004	-	Spring	No survey		
	76	Autumn	0.51	1377	101
2005	-	Spring	No survey		
	105	Autumn	0.59	1657	148
2006	-	Spring	No survey		
	105	Autumn*	0.44	1244	114
2007	-	Spring	No survey		
	105	Autumn*	0.34	958	114
2008	-	Spring	No survey		
	95	Autumn*	0.34	965	112
2009		Spring	No survey		
	76	Autumn*	0.3	778	133

Table 3.3.2.5 FU6 Farn Deeps. History of the UWTV survey and resulting estimate of the harvest rate

Year	Bias corrected TV abundance index	Landings (t)	Discard rate	Mean Weight (g)	N removed	Observed Harvest Rate
2001	1685	2574	66.40%	20.67	370	21.98%
2002	1048	1953	45.00%	20.53	173	16.54%
2003	1085	2245	41.30%	22.27	171	15.80%
2004	1377	2152	33.90%	23.58	138	10.03%
2005	1657	3094	33.90%	23.74	197	11.90%
2006	1244	4858	31.40%	22.55	317	25.47%
2007	968	2966	26.10%	25.00	160	16.58%
2008	965	1213	28.00%	25.41	66	6.84%
2009	778	2711	31.10%	24.60	150	19.34%

Table 3.3.3.1 *Nephrops*, Fladen (FU 7), Nominal Landings (tonnes) of *Nephrops*, 1981-2009, as reported to the WG.

Year	Denmark	UK Scotland			Other countries **	Total
		Nephrops trawl	Other trawl	Sub-total		
1981	0	304	69	373	0	373
1982	0	382	40	422	0	422
1983	0	548	145	693	0	693
1984	0	549	97	646	0	646
1985	7	1016	125	1141	0	1148
1986	50	1398	95	1493	0	1543
1987	323	1024	349	1373	0	1696
1988	81	1306	186	1492	0	1573
1989	165	1719	415	2134	0	2299
1990	236	1703	598	2301	0	2537
1991	424	3024	769	3793	3	4220
1992	359	1794	1179	2973	6	3338
1993	224	2033	1233	3266	31	3521
1994	390	1817	2356	4173	3	4566
1995	439	3569	2428	5997	6	6442
1996	286	2338	2592	4930	4	5220
1997	235	2713	3221	5934	2	6171
1998	173	2291	2672	4963	2	5138
1999	96	2860	3549	6409	0	6505
2000	103	2915	2546	5461	16	5580
2001	64	3539	1936	5475	6	5545
2002	173	4513	2546	7059	2	7234
2003	82	4175	2033	6208	15	6305
2004	136	7274	1319	8593	4	8733
2005	321	8849	1514	10363	1	10685
2006	283	9396	1101	10497	9	10789
2007	119	11055	733	11788	3	11910
2008	133	11432	667	12099	8	12240
2009*	130	12696	491	13187	10	13327

* provisional na = not available

** Other countries includes Belgium, Norway and UK England

Table 3.3.3.2 *Nephrops*, Fladen (FU 7): Logbook recorded effort (days fishing) and LPUE (kg/day) for bottom trawlers catching Nephrops with codend mesh sizes of 70 mm or above, and estimated total effort by Danish trawlers, 1991-2009.

Year	Logbook data	
	Effort	LPUE
1991	3115	116
1992	2289	130
1993	820	130
1994	1209	251
1995	841	343
1996	568	254
1997	395	349
1998	268	165
1999	197	251
2000	292	170
2001	213	181
2002	335	368
2003	194	308
2004	290	461
2005	607	482
2006	576	450
2007	274	426
2008	241	512
2009	282	512

Table 3.3.3.3 *Nephrops*, Fladen (FU 7): Mean sizes (CL mm) above and below 35 mm of male and female *Nephrops* in Scottish catches and landings, 1993-2009.

Year	Catches		Landings			
	< 35 mm CL		< 35 mm CL		> 35 mm CL	
	Males	Females	Males	Females	Males	Females
1993	na	na	30.4	29.6	38.7	38.2
1994	na	na	30.0	28.9	39.2	37.8
1995	na	na	30.6	29.8	39.9	38.1
1996	na	na	30.4	29.1	40.6	38.8
1997	na	na	30.2	29.1	40.9	38.8
1998	na	na	30.8	29.4	40.7	38.4
1999	na	na	30.9	29.6	40.5	38.5
2000	30.7	30.1	31.2	30.5	41.3	38.7
2001	30.1	29.4	30.7	29.7	39.6	38
2002	30.6	30	31.3	30.7	39.5	38.3
2003	30.9	29.8	31.2	30.1	40	38.1
2004	30.8	29.9	31.1	30.2	40.1	38.7
2005	30.9	30	31.2	30.1	40.1	38.2
2006	30.1	29.5	30.8	30	40.7	38.2
2007	29.8	29.2	30.4	29.5	40.8	38.8
2008	29.7	28.6	29.8	28.7	41.8	39.1
2009*	30.7	29.5	31.2	29.9	39.7	38.7

* provisional, na = not available

Table 3.3.3.4. Nephrops, FUs 7-9. Mean weight (g) in the landings.

Year	Fladen	Firth of Forth	Moray Firth
1990	31.59	20.29	20.05
1991	26.50	20.03	18.53
1992	29.61	20.96	23.49
1993	25.38	24.30	23.42
1994	23.72	19.51	22.25
1995	27.51	19.55	20.59
1996	29.82	20.81	21.40
1997	32.08	18.87	20.43
1998	31.37	18.23	20.47
1999	30.55	20.05	21.79
2000	36.35	21.83	25.44
2001	25.10	21.22	24.18
2002	27.93	19.62	27.68
2003	30.15	22.31	23.32
2004	30.98	22.45	27.57
2005	29.05	22.33	23.84
2006	29.25	21.43	22.34
2007	26.63	20.97	23.04
2008	28.18	17.23	25.29
2009	28.20	19.41	23.46
Mean (07-09)	27.67	19.20	23.93

Table 3.3.3.5. *Nephrops*, Fladen (FU 7): Results of the 1992-2009 TV surveys (not bias-adjusted).

Year	Stations	Abundance	Mean density	95% confidence interval
		millions	burrows/m^2	millions
1992	69	4942	0.17	508
1993	74	6007	0.21	768
1994	59	8329	0.3	1099
1995	61	6733	0.24	1209
1996	No survey			
1997	56	3736	0.13	689
1998	60	5181	0.18	968
1999	62	5597	0.2	876
2000	68	4898	0.17	663
2001	50	6725	0.23	1310
2002	54	8217	0.29	1022
2003	55	7488	0.27	1452
2004	52	7729	0.27	1391
2005	72	5839	0.21	894
2006	69	6564	0.23	836
2007	82	9473	0.34	986
2008	74	9936	0.35	1375
2009	59	7367	0.26	1042

Table 3.3.3.6. *Nephrops*, Fladen Ground (FU 7):Summary of TV results for most recent 3 years (2007-2009) showing strata surveyed, numbers of stations in each strata, mean density and observed variance, overall abundance and variance raised to stratum area. Proportion indicates relative amounts of overall raised variance attributable to each stratum.

Stratum (ranges of % silt clay)	Area (km^2)	Number of Stations	Mean burrow density (no./m^2)	Observed variance	Abundance (millions)	Stratum variance	Proportion of total variance
2007 TV survey							
>80	3248	12	0.52	0	1686	2517	0.010
55<80	4967	17	0.43	0.02	2136	21856	0.090
40<55	4304	17	0.36	0.02	1534	24566	0.101
<40	15634	36	0.26	0.03	4117	194102	0.799
Total	28153	82			9473	243041	1
2008 TV survey							
>80	3248	12	0.68	0	2209	4028	0.008
55<80	4967	18	0.32	0.04	1589	50866	0.107
40<55	4304	17	0.60	0.04	2562	38458	0.081
<40	15634	27	0.22	0.04	3497	380988	0.803
Total	28153	74			9857	474340	1
2009 TV survey							
>80	3248	10	0.622	0.013	2020	14039	0.052
55<80	4967	13	0.318	0.039	1582	74914	0.276
40<55	4304	18	0.394	0.049	1697	50394	0.186
<40	15634	18	0.132	0.010	2067	132204	0.487
Total	28153	59			7366	271551	1

Table 3.3.3.7 *Nephrops*, Fladen (FU 7): Adjusted TV survey abundance, landings, total discard rate (proportion by number) and estimated harvest ratio 2003-2009.

	Adjusted abundance (millions)	Landings (tonnes)	Discard rate	Harvest ratio
2003	5547	6305	0.10	0.04
2004	5725	8733	0.11	0.05
2005	4325	10685	0.11	0.09
2006	4862	10789	0.13	0.08
2007	7017	11910	0.11	0.07
2008	7360	12240	0.04	0.06
2009	5457	13197	0.10	0.09

Table 3.3.4.1 *Nephrops*, Firth of Forth (FU 8), Nominal Landings (tonnes) of *Nephrops*, 1981-2009, as reported to the WG.

Year	UK Scotland				UK England	Total **
	Nephrops trawl	Other trawl	Creel	Sub-total		
1981	945	61	0	1006	0	1006
1982	1138	57	0	1195	0	1195
1983	1681	43	0	1724	0	1724
1984	2078	56	0	2134	0	2134
1985	1908	61	0	1969	0	1969
1986	2204	59	0	2263	0	2263
1987	1582	92	0	1674	0	1674
1988	2455	73	0	2528	0	2528
1989	1833	52	0	1885	1	1886
1990	1901	28	0	1929	1	1930
1991	1359	45	0	1404	0	1404
1992	1714	43	0	1757	0	1757
1993	2349	18	0	2367	2	2369
1994	1827	17	0	1844	6	1850
1995	1708	53	0	1761	2	1763
1996	1621	66	1	1688	0	1688
1997	2137	55	0	2192	2	2194
1998	2105	38	0	2143	2	2145
1999	2192	9	1	2202	3	2205
2000	1775	9	0	1784	1	1785
2001	1484	35	0	1519	9	1528
2002	1302	31	1	1334	6	1340
2003	1115	8	0	1123	3	1126
2004	1651	4	0	1655	3	1658
2005	1973	0	6	1979	11	1990
2006	2437	4	12	2453	5	2458
2007	2628	9	8	2645	7	2652
2008	2435	3	7	2445	5	2450
2009*	2628	0	26	2654	9	2663

* provisional   na = not available

** There are no landings by other countries from this FU

Table 3.3.4.2 ***Nephrops*****, Firth of Forth (FU 8): Landings (tonnes), effort (days absent) and LPUE (kg/day) of Scottish** ***Nephrops*** **trawlers, 1981-2009 (data for all** ***Nephrops*** **gears combined, and for single and multirigs separately).**

Year	**All *Nephrops* gears combined**			**Single rig**			**Multirig**		
	Landings	Effort	LPUE	Landings	Effort	LPUE	Landings	Effort	LPUE
1981	946	5.1	185.5	946	5.1	185.5	0	0	NA
1982	1135	6.2	183.1	1135	6.2	183.1	0	0	NA
1983	1681	7.2	233.5	1681	7.2	233.5	0	0	NA
1984	2078	10.0	207.8	2078	10.0	207.8	0	0	NA
1985	1908	8.7	219.3	1908	8.7	219.3	0	0	NA
1986	2204	9.1	242.2	2204	9.1	242.2	0	0	NA
1987	1582	7.7	205.5	1582	7.7	205.5	0	0	NA
1988	2455	11.4	215.4	2455	11.4	215.4	0	0	NA
1989	1833	10.6	172.9	1833	10.6	172.9	0	0	NA
1990	1900	9.7	195.9	1900	9.7	195.9	0	0	NA
1991	1361	8.5	160.1	1233	7.9	156.1	128	0.6	213.3
1992	1715	9.1	188.5	1513	8.0	189.1	202	1.1	183.6
1993	2349	11.3	207.9	2340	11.2	208.9	9	0.0	NA
1994	1827	10.5	174.0	1827	10.5	174.0	0	0.0	NA
1995	1708	9.7	176.1	1708	9.7	176.1	0	0.0	NA
1996	1621	8	202.6	1621	8.0	202.6	0	0.0	NA
1997	2137	14.1	151.6	2137	14.1	151.6	0	0.0	NA
1998	2105	11.7	179.9	2105	11.7	179.9	0	0.0	NA
1999	2193	13.5	162.4	2193	13.5	162.4	0	0.0	NA
2000	1775	13.2	134.5	1761	13.1	134.4	14	0.1	140.0
2001	1483	14.6	101.6	1464	14.5	101.0	19	0.1	190.0
2002	1302	12.6	103.3	1286	12.5	102.9	16	0.1	160.0
2003	1116	9.6	116.2	1083	9.4	115.2	33	0.1	330.0
2004	1651	10.8	152.9	1633	10.8	151.2	18	0.0	NA
2005	1972	9.4	209.8	1969	9.4	209.5	3	0.0	NA
2006	2406	8.8	273.4	2401	8.7	276.0	5	0.0	NA
2007	2627	8.5	309.1	2606	8.4	310.2	21	0.0	NA
2008	2435	8.3	293.4	2405	8.3	289.8	30	0.1	300.0
2009	2628	7.9	332.7	2578	7.8	330.5	50	0.1	500.0

Table 3.3.4.3 *Nephrops*, Firth of Forth (FU 8): Mean sizes (CL mm) above and below 35 mm of male and female *Nephrops* in Scottish catches and landings, 1991-2009.

Year	Catches		Landings			
	< 35 mm CL		< 35 mm CL		> 35 mm CL	
	Males	Females	Males	Females	Males	Females
1981	na	na	31.5	31.0	39.7	38.7
1982	na	na	30.4	30.1	40.0	39.1
1983	na	na	31.1	30.8	40.2	38.7
1984	na	na	30.3	29.7	39.4	38.4
1985	na	na	30.6	29.9	39.4	38.2
1986	na	na	29.7	29.2	39.1	38.5
1987	na	na	29.9	29.6	39.1	38.2
1988	na	na	28.5	28.5	39.1	39.0
1989	na	na	29.2	28.9	38.7	38.9
1990	28.3	27.2	29.8	28.6	38.3	38.8
1991	28.7	27.5	29.8	28.7	38.3	38.7
1992	29.5	27.9	30.2	28.7	38.1	38.7
1993	28.7	28.0	30.3	29.5	39.0	38.6
1994	25.7	25.1	29.1	28.5	38.8	37.8
1995	27.9	27.1	29.4	28.9	38.7	37.9
1996	28.0	27.4	29.8	28.8	38.6	38.6
1997	27.2	27.0	29.2	28.7	38.8	38.2
1998	27.7	26.4	29.0	27.9	38.5	38.4
1999	27.2	26.5	29.6	28.8	38.0	37.9
2000	28.5	27.2	30.6	29.8	38.2	38.3
2001	28.1	27.0	30.6	29.2	38.0	37.9
2002	27.1	26.3	29.8	29.3	38.3	37.9
2003	27.2	25.4	30.2	29.1	38.1	38.0
2004	28.6	27.8	30.7	30.0	38.4	37.6
2005	27.6	26.9	30.3	30.0	38.7	38.2
2006	27.3	27.0	29.8	29.9	38.7	37.8
2007	29.2	28.3	29.8	28.6	39.1	38.6
2008	27.7	27.2	28.1	26.9	39.4	37.9
2009*	27.5	26.2	29.7	28.5	38.3	38.0
	* provisional na = not available					

Table 3.3.4.4. *Nephrops*, Firth of Forth (FU 8): Results of the 1993-2009 TV surveys.

Year	Stations	Mean density	Abundance	95% confidence interval
		burrows/m²	millions	millions
1993	37	0.72	655	167
1994	30	0.58	529	92
1995	no survey			
1996	27	0.48	443	104
1997	no survey			
1998	32	0.38	345	95
1999	49	0.60	546	92
2000	53	0.57	523	83
2001	46	0.54	494	93
2002	41	0.66	600	140
2003	36	0.99	905	163
2004	37	0.81	743	166
2005	54	0.92	838	169
2006	43	1.07	976	148
2007	49	0.90	816	156
2008	38	1.14	1040	350
2009	47	0.94	864	168

Table 3.3.4.5. *Nephrops*, Firth of Forth (FU 8):Summary of TV results for most recent 3 years (2007-2009) showing strata surveyed, numbers of stations in each strata, mean density and observed variance, overall abundance and variance raised to stratum area. Proportion indicates relative amounts of overall raised variance attributable to each stratum.

Stratum	Area (km²)	Number of Stations	Mean burrow density (no./m²)	Observed variance	Abundance (millions)	Stratum variance	Proportion of total variance
2007 TV survey							
M & SM	171	10	0.99	0.69	168	1998	0.329
MS(west)	139	8	0.58	0.24	81	577	0.095
MS(mid)	211	12	1.18	0.45	248	1676	0.276
MS(east)	395	19	0.81	0.22	319	1817	0.299
Total	915	49			816	6069	1
2008 TV survey							
M & SM	171	3	0.92	1.67	156	24333	0.793
MS(west)	139	9	1.04	0.82	144	1757	0.057
MS(mid)	211	11	1.69	0.47	355	1898	0.062
MS(east)	395	15	0.97	0.26	384	2685	0.088
Total	915	38			1040	30673	1
2009 TV survey							
M & SM	171	9	1.178	0.657	201	2123	0.301
MS(west)	139	9	0.842	0.628	117	1346	0.191
MS(mid)	211	13	1.318	0.348	278	1189	0.169
MS(east)	395	14	0.679	0.215	268	2397	0.340
Total	915	45			864	7055	1

Table 3.3.4.6 *Nephrops*, Firth of Forth (FU 8): Adjusted TV survey abundance, landings, total discard rate (proportion by number) and estimated harvest ratio 2003-2009.

	Adjusted abundance (millions)	Landings (tonnes)	Discard rate	Harvest ratio
2003	767	1126	0.54	0.12
2004	630	1658	0.35	0.16
2005	710	1990	0.42	0.19
2006	827	2458	0.55	0.26
2007	692	2652	0.25	0.23
2008	881	2450	0.29	0.21
2009	732	2663	0.34	0.26

Table 3.3.5.1 ***Nephrops*****, Moray Firth (FU 9), Nominal Landings (tonnes) of** ***Nephrops*****, 1981-2009, as reported to the WG.**

Year	UK Scotland				UK England	Total **
	Nephrops trawl	Other trawl	Creel	Sub-total		
1981	1298	118	0	1416	0	1416
1982	1034	86	0	1120	0	1120
1983	850	90	0	940	0	940
1984	960	210	0	1170	0	1170
1985	1908	173	0	2081	0	2081
1986	1933	210	0	2143	0	2143
1987	1723	268	0	1991	0	1991
1988	1638	321	0	1959	0	1959
1989	2101	475	0	2576	0	2576
1990	1698	340	0	2038	0	2038
1991	1285	234	0	1519	0	1519
1992	1285	306	0	1591	0	1591
1993	1505	303	0	1808	0	1808
1994	1178	360	0	1538	0	1538
1995	967	330	0	1297	0	1297
1996	1084	364	1	1449	2	1451
1997	1102	343	0	1445	1	1446
1998	739	289	4	1032	0	1032
1999	813	193	2	1008	0	1008
2000	1344	194	3	1541	0	1541
2001	1188	213	2	1403	0	1403
2002	884	232	2	1118	0	1118
2003	874	194	11	1079	0	1079
2004	1223	103	9	1335	0	1335
2005	1526	64	12	1602	3	1605
2006	1718	73	11	1802	1	1803
2007	1816	17	7	1840	2	1842
2008	1443	67	4	1514	0	1514
2009	1042	22	2	1066	0	1066

* provisional na = not available

** There are no landings by other countries from this FU

Table 3.3.5.2 *Nephrops*, Moray Firth (FU 9): Landings (tonnes), effort (days) and LPUE (kg/day) of Scottish *Nephrops* trawlers, 1981-2009 (data for all *Nephrops* gears combined, and for single and multirigs separately).

Year	All *Nephrops* gears combined			Single rig			Multirig		
	Landings	Effort	LPUE	Landings	Effort	LPUE	Landings	Effort	LPUE
1981	1298	3.9	332.8	1298	3.9	332.8	0.0	0.0	NA
1982	1034	3.2	323.1	1034	3.2	323.1	0.0	0.0	NA
1983	850	2.8	303.6	850	2.8	303.6	0.0	0.0	NA
1984	960	3.3	290.9	960	3.3	290.9	0.0	0.0	NA
1985	1908	5.2	366.9	1908	5.2	366.9	0.0	0.0	NA
1986	1933	5.4	358.0	1933	5.4	358.0	0.0	0.0	NA
1987	1723	6.5	265.1	1723	6.5	265.1	0.0	0.0	NA
1988	1638	6.0	273.0	1638	6.0	273.0	0.0	0.0	NA
1989	2101	6.2	338.9	2101	6.2	338.9	0.0	0.0	NA
1990	1698	5.0	339.6	1698	5.0	339.6	0.0	0.0	NA
1991	1285	4.1	313.4	571	2.6	219.6	714	1.6	446.2
1992	1285	3.7	347.3	622	2.6	239.2	663	1.2	552.5
1993	1505	4.2	358.3	783	2.8	279.6	722	1.4	515.7
1994	1178	4.1	287.3	1023	3.7	276.5	155	0.4	387.5
1995	967	2.9	333.4	857	2.6	329.6	110	0.3	366.7
1996	1084	3.3	328.5	1057	3.2	330.3	27	0.1	270.0
1997	1102	5.5	200.4	960	5.1	188.2	142	0.4	355.0
1998	739	3.9	189.5	576	3.4	169.4	163	0.5	326.0
1999	813	4.5	180.7	699	4.1	170.5	114	0.3	380.0
2000	1344	6.4	210.0	1068	5.6	190.7	276	0.8	345.0
2001	1188	5.7	208.4	913	4.9	186.3	275	0.8	343.8
2002	884	5.7	155.1	650	5.1	127.5	234	0.6	390.0
2003	874	4.1	213.2	738	3.8	194.2	136	0.3	453.3
2004	1223	4.7	260.2	1100	4.5	244.4	123	0.2	615.0
2005	1526	4.2	363.3	1309	3.9	335.6	217	0.2	1085.0
2006	1718	3.8	452.1	1477	3.5	422.0	241	0.2	1205.0
2007	1818	3.8	478.4	1503	3.5	429.4	315	0.3	1050.0
2008	1444	2.9	497.9	1126	2.6	433.1	318	0.3	1060.0
2009	1042	2.5	416.8	813	2.3	353.5	229	0.2	1145.0

Table 3.3.5.3 *Nephrops*, Moray Firth (FU 9): Mean sizes (CL mm) above and below 35 mm of male and female *Nephrops* in Scottish catches and landings, 1991-2009.

Year	**Catches**		**Landings**			
	< 35 mm CL		**< 35 mm CL**		**=> 35 mm CL**	
	Males	Females	Males	Females	Males	Females
1981	na	na	30.5	28.2	39.1	37.7
1982	na	na	30.2	29.0	40.0	37.9
1983	na	na	29.9	29.1	40.6	38.3
1984	na	na	29.7	29.3	39.4	38.1
1985	na	na	28.9	28.7	38.7	37.8
1986	na	na	28.7	27.8	39.1	38.4
1987	na	na	29.0	28.3	39.4	38.6
1988	na	na	29.1	28.7	38.9	38.4
1989	na	na	29.8	28.8	40.1	39.4
1990	28.0	27.5	30.3	29.1	38.4	38.7
1991	28.3	27.4	30.1	28.6	38.2	38.2
1992	29.4	28.6	31.0	30.5	38.3	38.0
1993	29.8	29.9	31.3	30.9	38.6	37.7
1994	28.9	30.1	30.8	31.0	39.4	37.5
1995	25.8	25.0	29.9	29.3	39.1	38.0
1996	29.3	28.4	30.6	29.7	38.5	38.0
1997	28.5	27.9	29.5	28.9	38.8	38.2
1998	28.7	28.2	30.1	29.3	38.8	38.2
1999	29.5	28.8	30.4	29.7	38.9	37.6
2000	29.8	29.1	31.5	30.6	39.2	38.3
2001	30.0	29.2	30.9	30.2	39.5	37.9
2002	27.2	27.0	31.2	30.9	41.0	38.7
2003	29.3	29.2	30.3	30.1	39.8	38.0
2004	29.3	28.4	31.3	30.8	39.0	39.2
2005	30.0	28.7	31.0	29.6	39.2	38.5
2006	29.7	28.9	30.6	29.6	39.3	38.6
2007	30.1	28.8	30.3	29.0	39.4	38.6
2008	29.3	27.7	30.2	28.2	39.8	40.2
2009*	29.7	28.9	30.7	29.3	39.6	38.5

* provisional na = not available

Table 3.3.5.4 *Nephrops*, Moray Firth (FU 9): Results of the 1993-2009 TV surveys.

Year	Stations	Mean density	Abundance	95% confidence interval
		burrows/m²	millions	millions
1993	31	0.19	418	94
1994	29	0.39	850	213
1995	no survey			
1996	27	0.26	563	109
1997	34	0.14	317	66
1998	31	0.18	391	115
1999	52	0.22	484	105
2000	44	0.21	467	118
2001	45	0.19	417	135
2002	31	0.29	630	146
2003	32	0.40	883	380
2004	42	0.35	757	225
2005	42	0.48	1052	239
2006	50	0.25	539	150
2007	40	0.29	642	189
2008	45	0.26	579	183
2009	50	0.23	502	169

Table 3.3.5.5 ***Nephrops*****, Moray Firth (FU 8):Summary of TV results for most recent 3 years (2007-2009) showing strata surveyed, numbers of stations in each strata, mean density and observed variance, overall abundance and variance raised to stratum area. Proportion indicates relative amounts of overall raised variance attributable to each stratum.**

Stratum	Area (km^2)	Number of Stations	Mean burrow density (no./m^2)	Observed variance	Abundance (millions)	Stratum variance	Proportion of total variance
2007 TV survey							
M & SM	169	3	0.45	0.11	76	1006	0.112
MS(west)	682	13	0.29	0.12	195	4263	0.475
MS(mid)	698	11	0.24	0.01	166	460	0.051
MS(east)	646	13	0.32	0.10	205	3248	0.362
Total	2195	40			642	8977	1
2008 TV survey							
M & SM	169	2	0.35	0.08	58	1200	0.144
MS(west)	682	16	0.35	0.17	239	5023	0.603
MS(mid)	698	13	0.20	0.01	141	413	0.050
MS(east)	646	14	0.22	0.06	141	1699	0.204
Total	2195	45			579	8335	1
2009 TV survey							
M & SM	169	8	0.46	0.13	78	459	0.064
MS(west)	682	15	0.24	0.14	164	4206	0.590
MS(mid)	698	15	0.19	0.04	135	1145	0.161
MS(east)	646	12	0.19	0.04	125	1315	0.185
Total	2195	50			502	7125	1

Table 3.3.5.6 *Nephrops*, Moray Firth (FU 8): Adjusted TV survey abundance, landings, discard rate (proportion by number) and estimated harvest ratio 2003-2009.

year	Adjusted abundance	Landings (tonnes)	Discard rate	Harvest ratio
2003	730	1079	0.14	0.07
2004	626	1335	0.33	0.11
2005	869	1605	0.15	0.09
2006	445	1803	0.13	0.20
2007	531	1842	0.08	0.16
2008	481	1514	0.11	0.14
2009	415	1066	0.08	0.12

Table 3.3.6.1 *Nephrops*, Noup (FU 10), Nominal Landings (tonnes) of *Nephrops*, 1981-2009, as reported to the WG.

Year	Nephrops Trawl	Other trawl	Creel	Sub Total	Other UK	Total
1997	184	130	0	314	0	314
1998	183	71	0	254	0	254
1999	211	68	0	279	0	279
2000	196	79	0	275	0	275
2001	88	88	0	176	0	176
2002	244	157	0	401	0	401
2003	258	79	0	337	0	337
2004	174	53	0	227	0	227
2005	81	84	0	165	0	165
2006	44	89	0	133	0	133
2007	47	108	0	155	0	155
2008	75	98	0	173	0	173
2009	24	65	0	89	0	89

Table 3.3.6.2 *Nephrops*, Noup (FU 10): Mean sizes (CL mm) above and below 35 mm of male and female *Nephrops* in landings, 1997-2009.

Year	**Landings**			
	< 35 mm CL		**=> 35 mm CL**	
	Males	Females	Males	Females
1997	29.7	28.3	40.4	38.2
1998	30.4	29.8	38.8	38.6
1999	30.4	30.1	39.2	37.8
2000	31.8	30.1	38.2	39.1
2001	31.4	29.5	38.7	37.9
2002	30.8	29.9	39.7	38.5
2003	29.3	30.4	39.9	38.5
2004	31.4	30	40.2	38.8
2005	31	29.3	39.3	38.4
2006	30.8	30.2	40.4	38.7
2007	30.7	29.4	40.2	38.7
2008	31.9	30.6	40.3	39.3
2009*	33.2	33.2	42.6	42.7
* provisional				

Table 3.3.6.3 *Nephrops*, Noup (FU 10): Results of the 1994, 1999, 2006 & 2007 TV surveys.

Year	Stations	Mean density	Abundance	95% confidence interval
		burrows/m²	millions	millions
1994	10	0.63	250	90
1995	no survey			
1996	no survey			
1997	no survey			
1998	no survey			
1999	10	0.30	120	42
2000	no survey			
2001	no survey			
2002	no survey			
2003	no survey			
2004	no survey			
2005	2	poor visibility, limited survey - see text		
2006	7	0.18	73.7	47.1
2007	9	0.15	60	25

Table 3.3.7.1 Nephrops Norwegian Deep (FU 32): Landings (tonnes) by country, 1993-2009.

Year	Denmark	Norway			Sweden	UK	Netherlands	Total
		Trawl	Creel	Sub-total				
1993	220	102	1	103		16		339
1994	584	161	0	161		10		755
1995	418	68	1	69		2		489
1996	868	73	1	74		10		952
1997	689	56	8	64		7		760
1998	743	88	1	89		4		836
1999	972	119	15	134		13		1119
2000	871	143	0	143	37	33		1084
2001	1026	72	13	85	26	53		1190
2002	1043	42	21	63	13	52		1171
2003	996	68	11	79	1	14		1090
2004	835	72	8	80	1	6		922
2005	979	89	13	102	2	6		1089
2006	939	62	19	81	1	6	5	1032
2007	652	77	20	97	5	1		755
2008	505	112	30	142	24	4		675
2009*	331	107	31	138	2	6		477

* provisional na = not available

Table 3.3.7.2 Nephrops Norwegian Deep (FU 32): Danish effort (days) and LPUE, 1993-2009

Year	Effort	LPUE
1993	1317	121
1994	2126	208
1995	1792	198
1996	3139	235
1997	3189	218
1998	2707	214
1999	3710	226
2000	3986	192
2001	5372	166
2002	4968	188
2003	5273	177
2004	3488	216
2005	3919	234
2006	4796	196
2007	2878	226
2008	2301	220
2009	1694	195

Table 5.7.12. - Off Horns Reef (FU 33): Landings (tonnes) by country, 1993-2009.

	Belgium	Denmark	Germany	Netherl.	UK	Total **
1993	0	159		na	1	160
1994	0	137		na	0	137
1995	3	158		3	1	164
1996	1	74		2	0	77
1997	0	274		2	0	276
1998	4	333	8	12	1	350
1999	22	683	14	12	6	724
2000	13	537	12	39	9	597
2001	52	667	11	61	+	791
2002	21	772	13	51	4	861
2003	15	842	4	67	1	929
2004	37	1097	24	109	1	1268
2005	16	803	31	191	9	1050
2006	97	710	151	314	15	1288
2007	118	610	201	496	42	1467
2008	130	362	160	386	58	1096
2009*	121	231	150	491	170	1163

* provisional na = not available

** Totals for 1993-94 exclusive of landings by the Netherlands

Table 5.7.13. - Off Horns Reef (FU 33): Logbook recorded effort (days fishing) and LPUE (kg/day) for bottom trawlers catching Nephrops with codend mesh sizes of 70 mm or above, and estimated total effort by Danish trawlers, 1993-2009.

	Logbook data		Estimated total effort
	Effort	LPUE	
1993	975	170	971
1994	739	165	830
1995	724	194	816
1996	370	157	471
1997	925	161	1702
1998	1442	208	1601
1999	2323	252	2710
2000	2286	209	2569
2001	2818	191	3489
2002	3214	207	3734
2003	3640	212	3973
2004	4306	234	4694
2005	2524	285	2776
2006	2062	308	2288
2007	1609	337	1818
2008	755	448	805
2009*	543	443	515

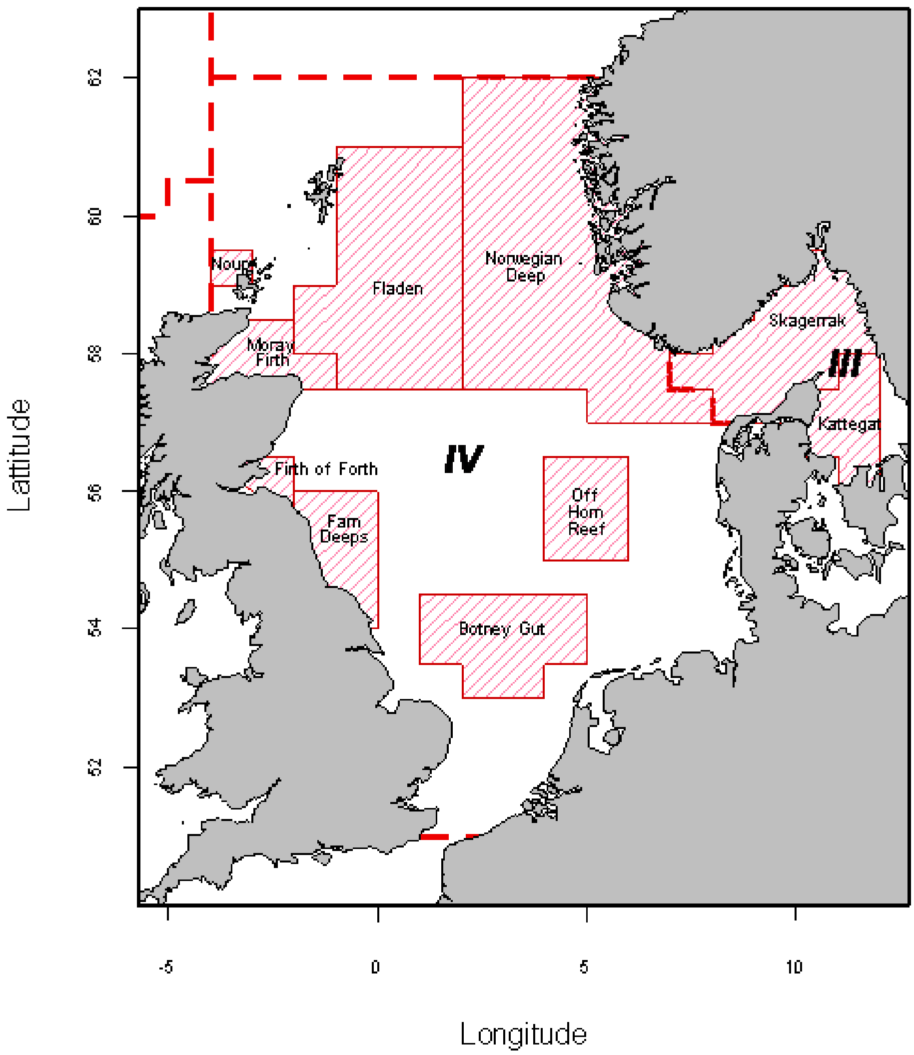
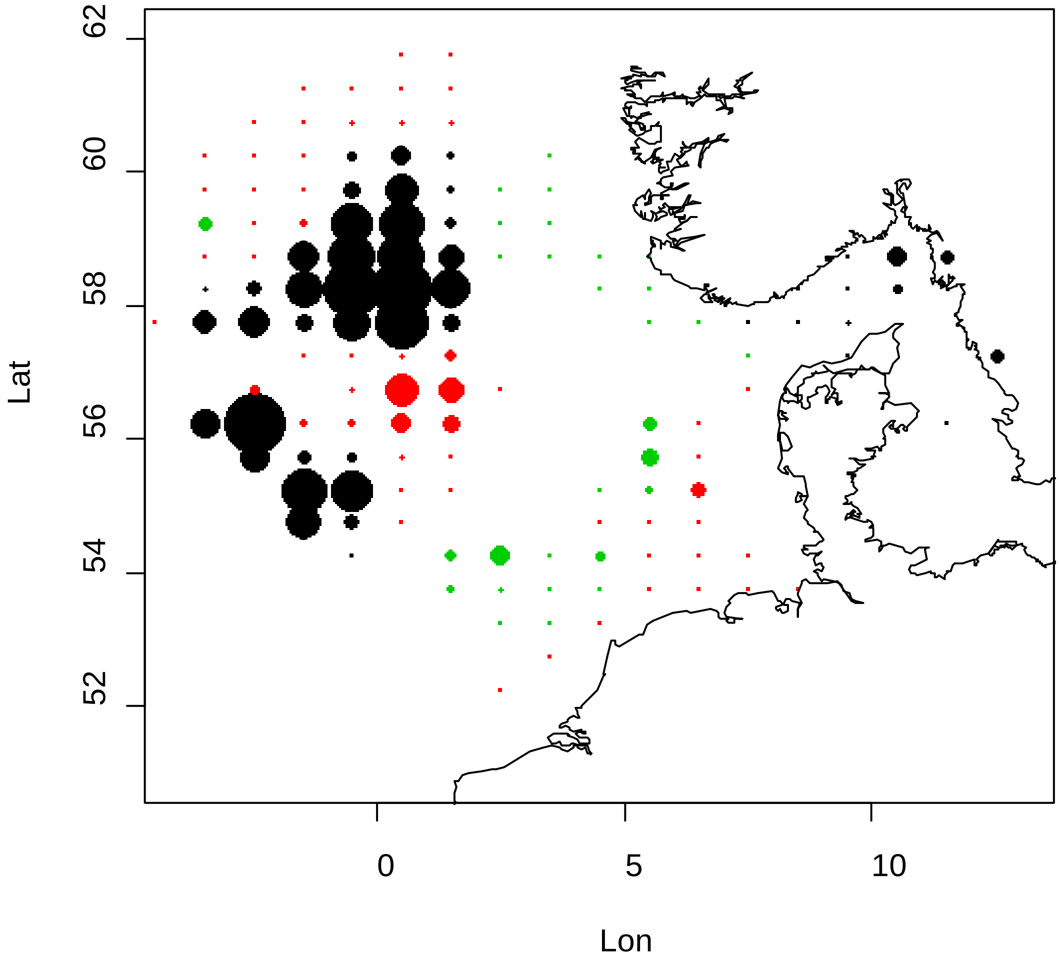


Figure 3.1.1 Functional Units in the North Sea and Skagerrak/Kattegat region.


62
60
58
56
54
52
Lat
0
5
10
Lon

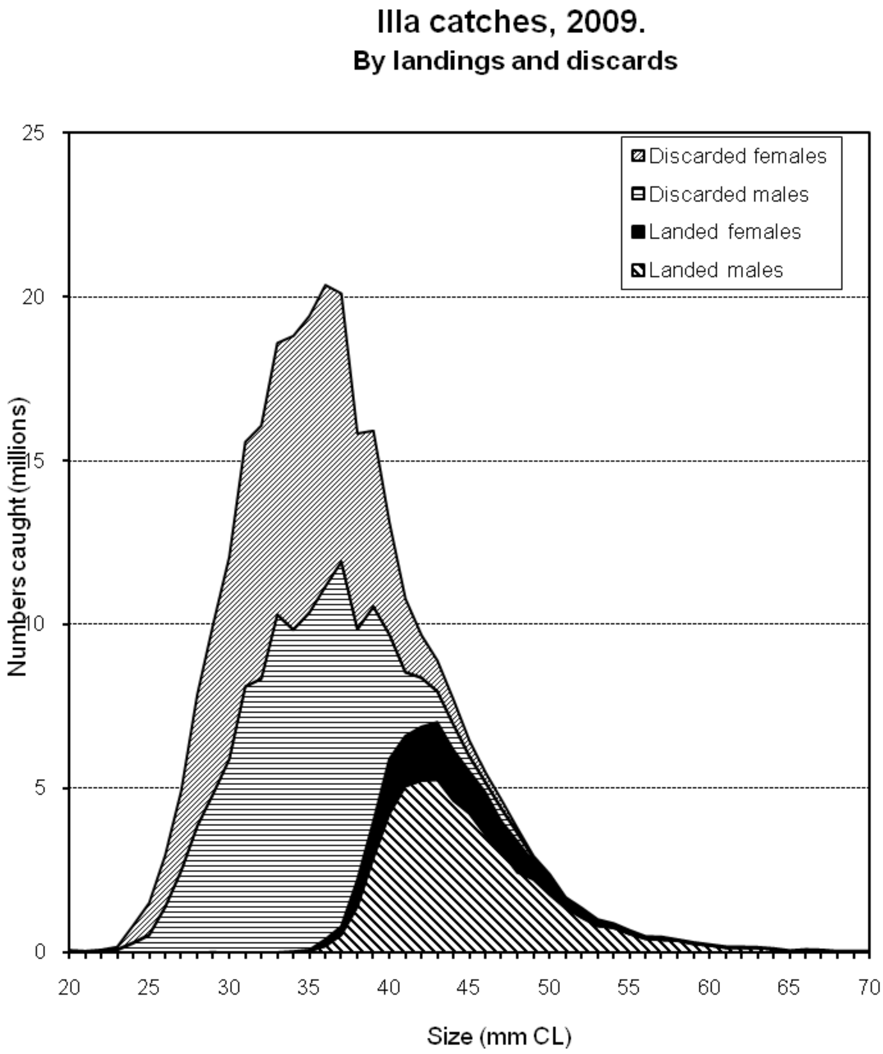


Figure 3.2.1.1. - Skagerrak (FU 3) and Kattegat (FU4): Length frequency distributions of Nephrops catches, split by catch fraction (landings and discards) and sex. Data for Denmark and Sweden combined for 2009.

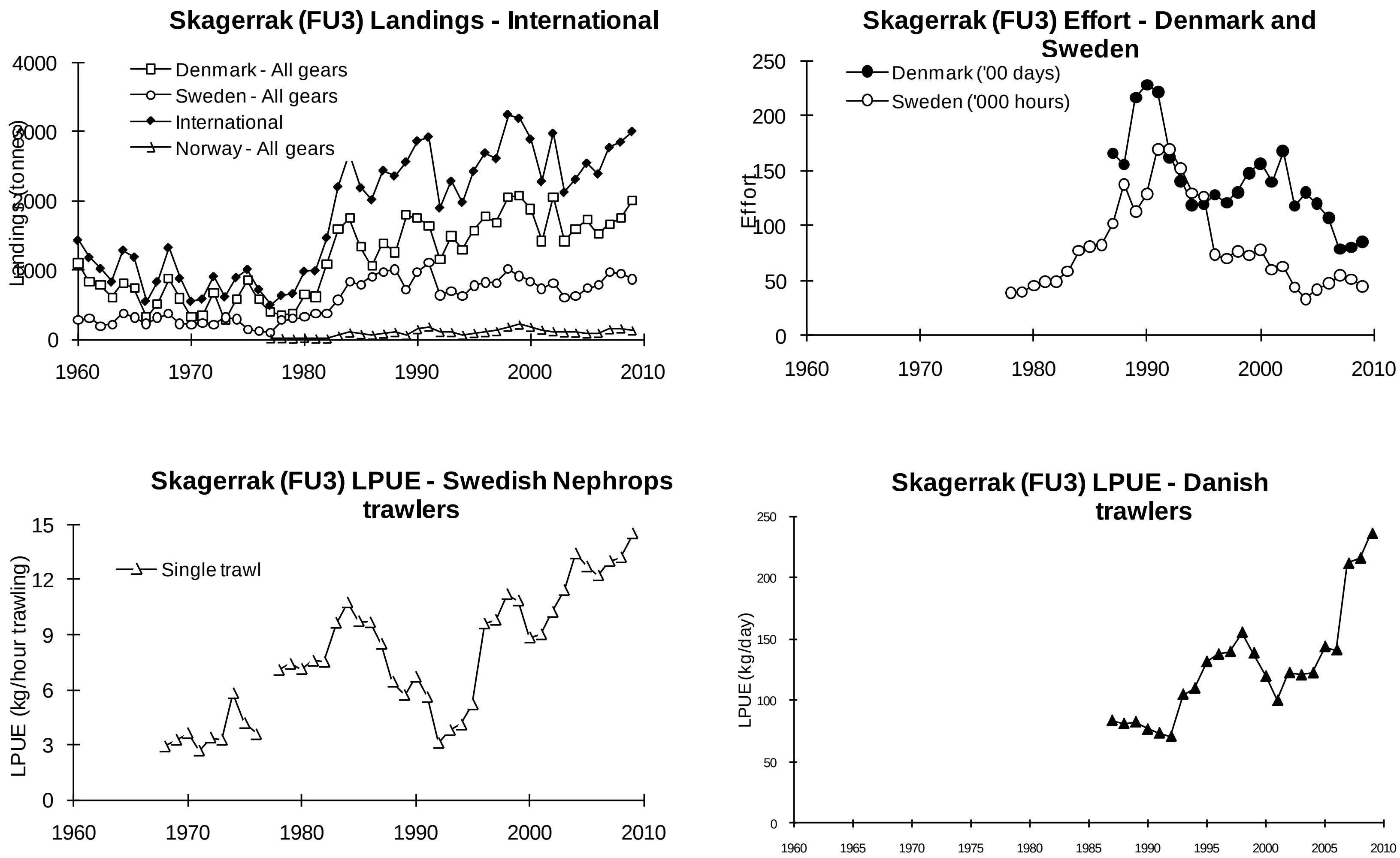


Figure 3.2.2.1. Nephrops Skagerrak (FU 3): Long-term trends in landings, effort, LPUEs, and mean sizes of Nephrops.

Fig. 3.2.2.3. FU3 (Skagerrak): Danish LPUE based on logbook data.

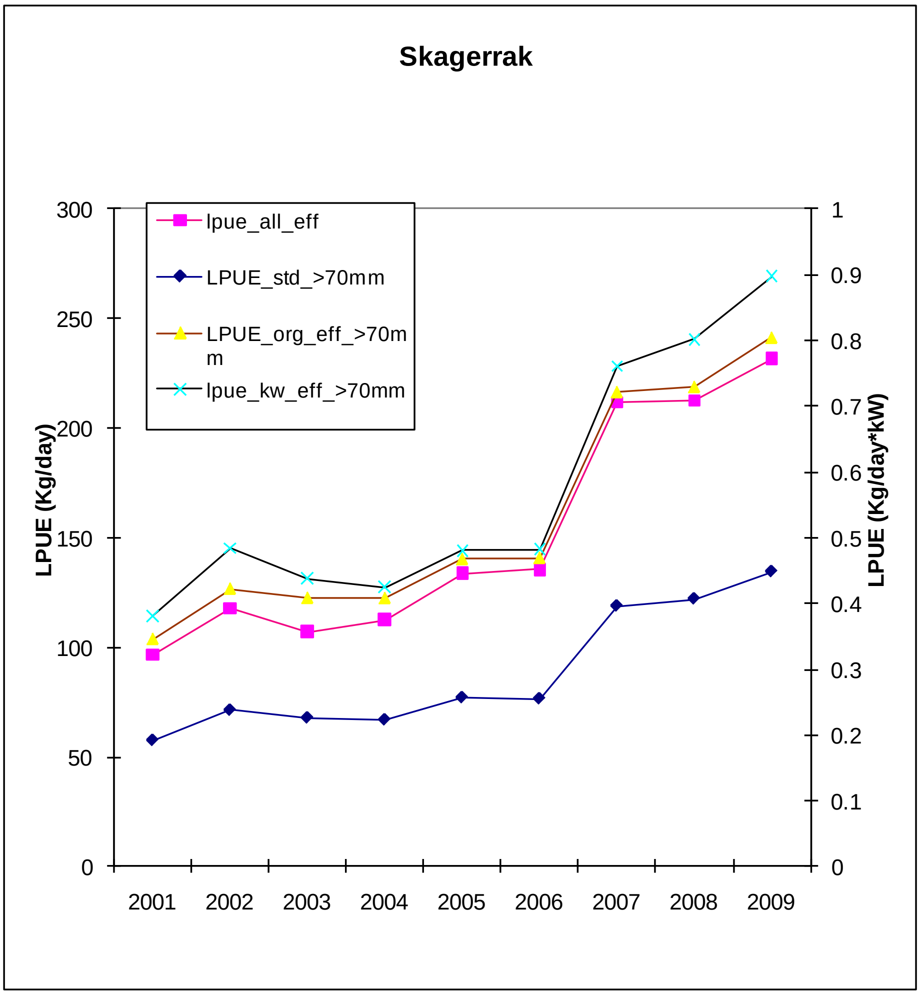
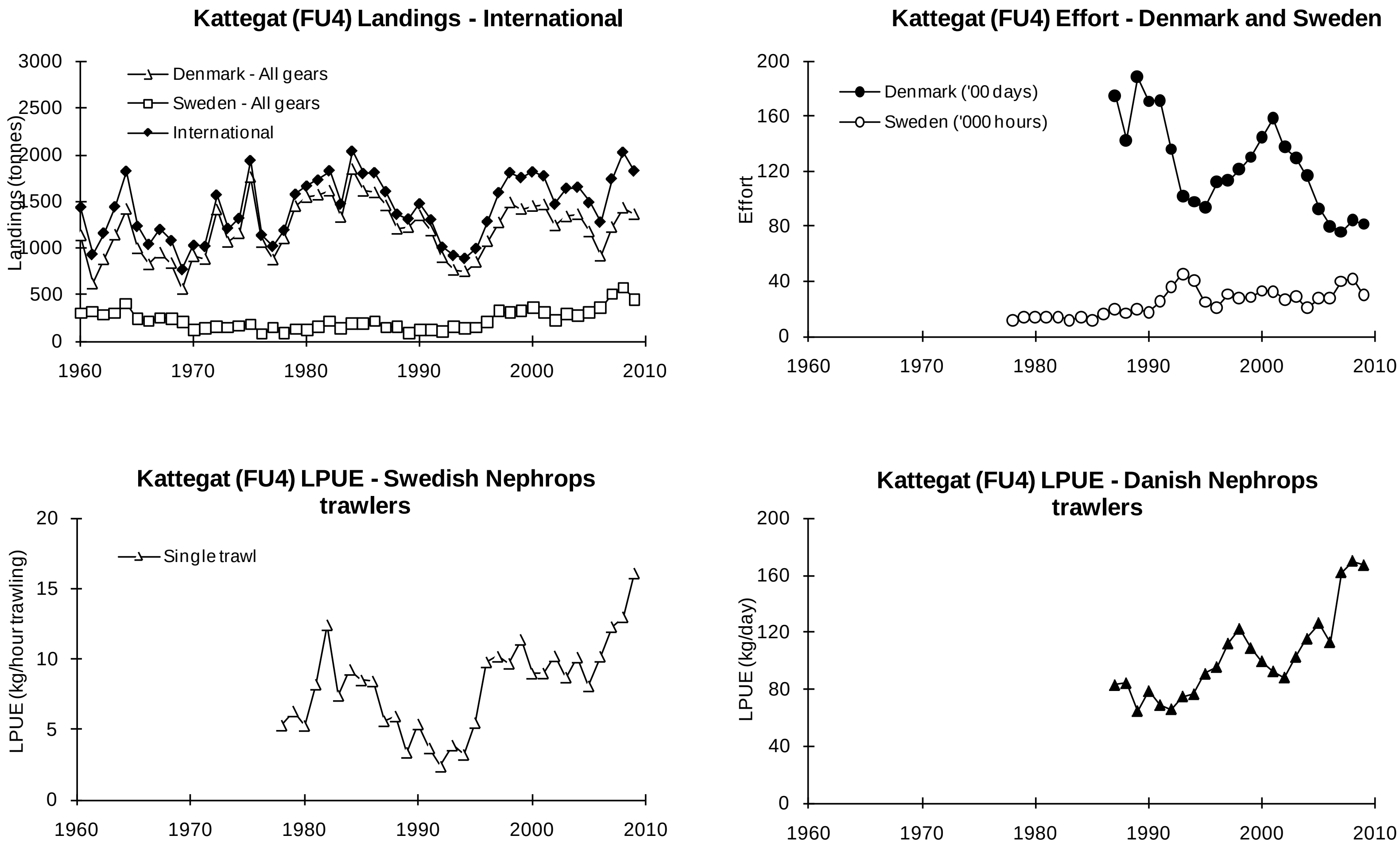


Figure 3.2.3.1. Nephrops Kattegat (FU 4): Long-term trends in landings, effort, LPUEs, and mean sizes of .



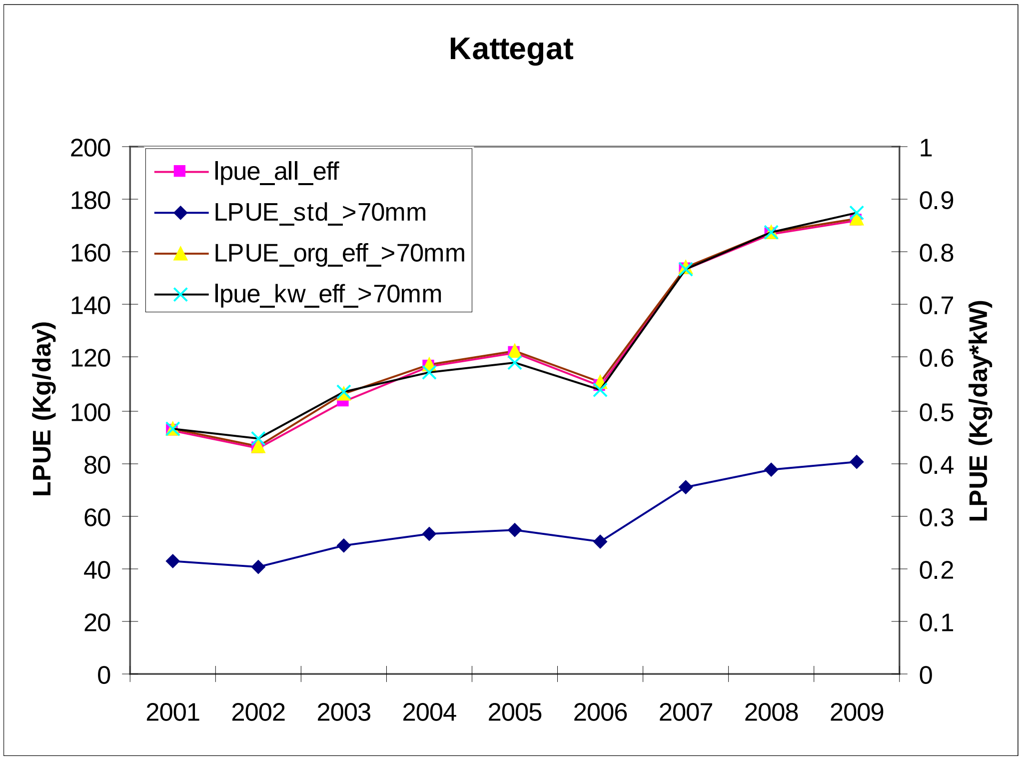


Figure 3.2.3.2 FU4 (Kattegat): Danish LPUE based on logbook data.

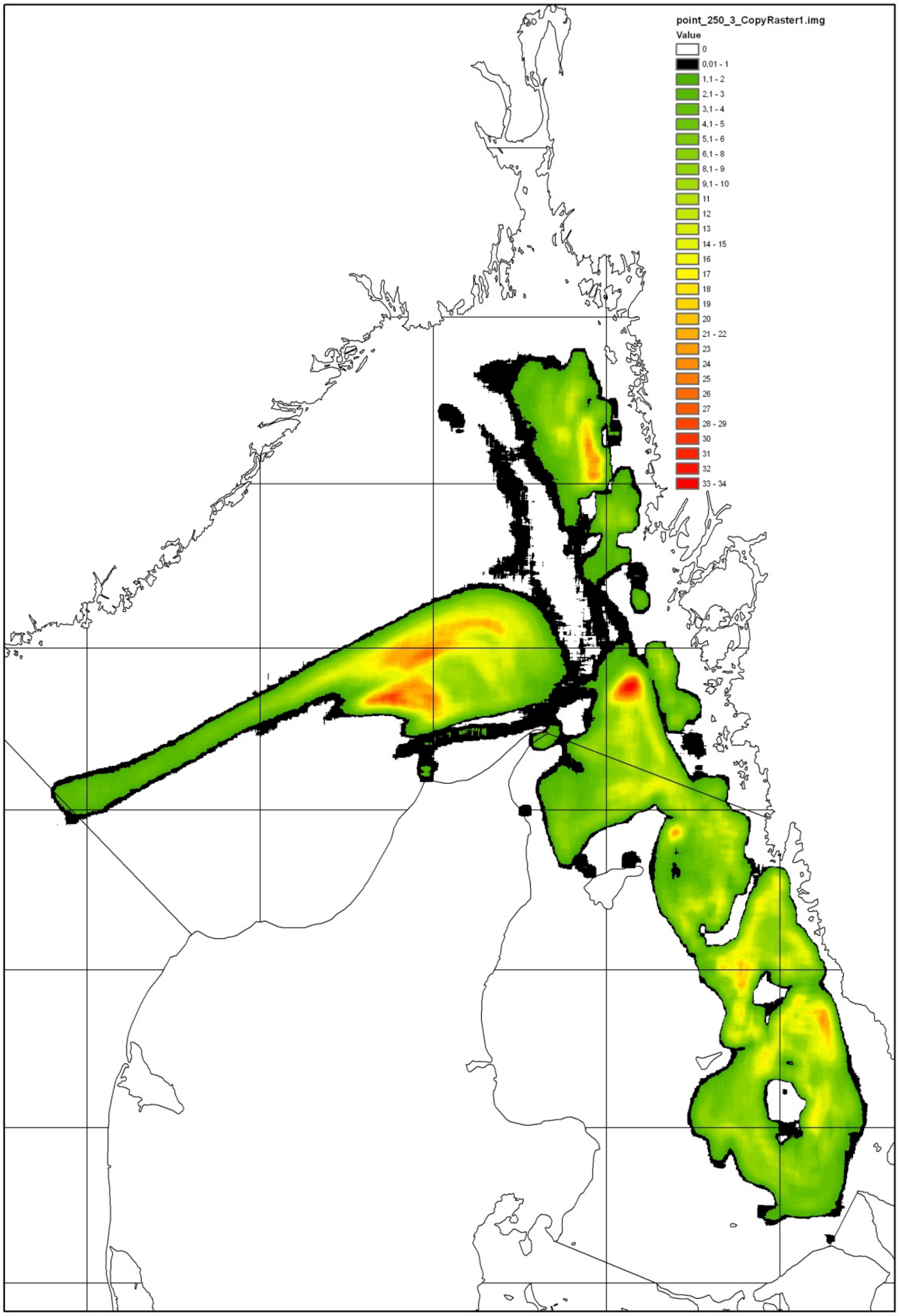


Figure 3.2.4.1 Distribution of Nephrops in IIIa based on Danish and Swedish VMS data

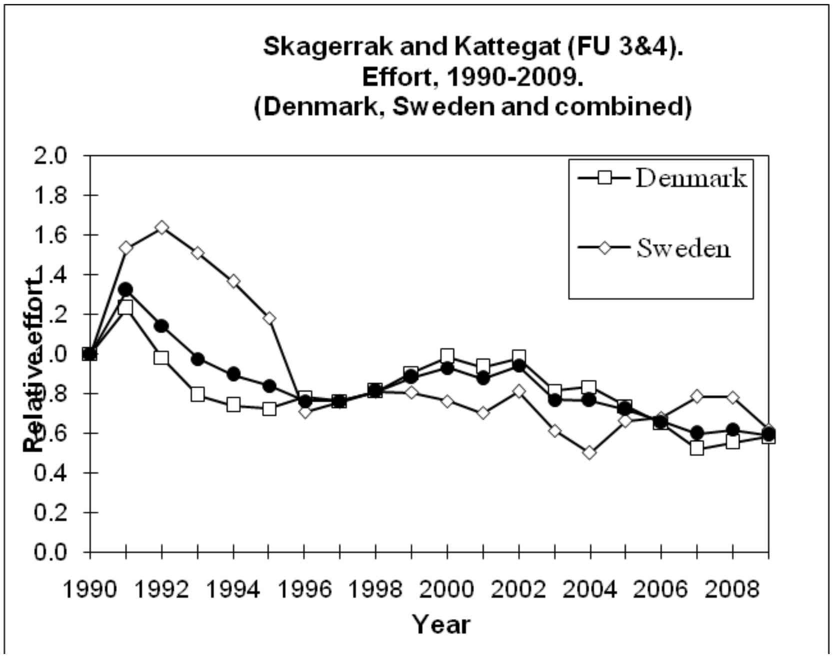


Figure 3.2.4.2

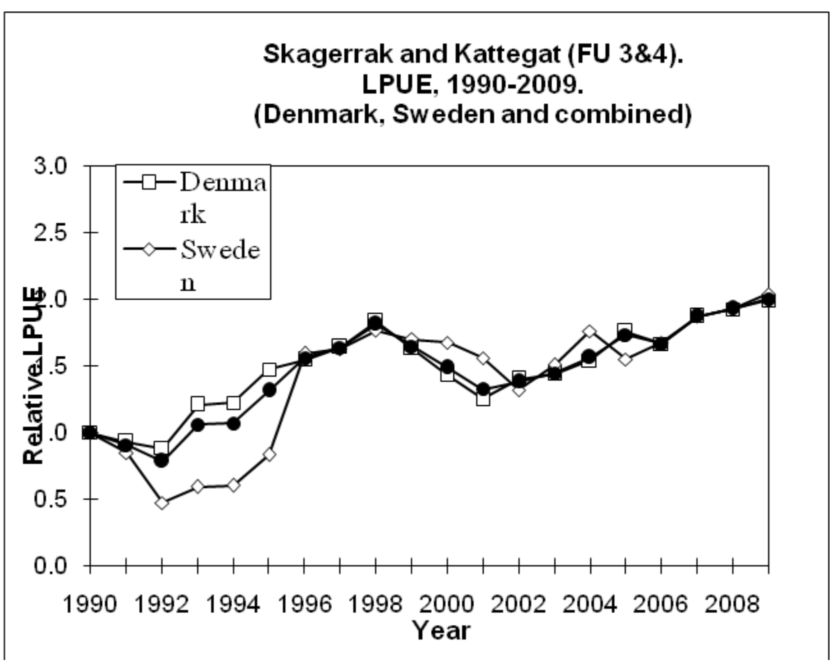


Figure 3.2.4.3

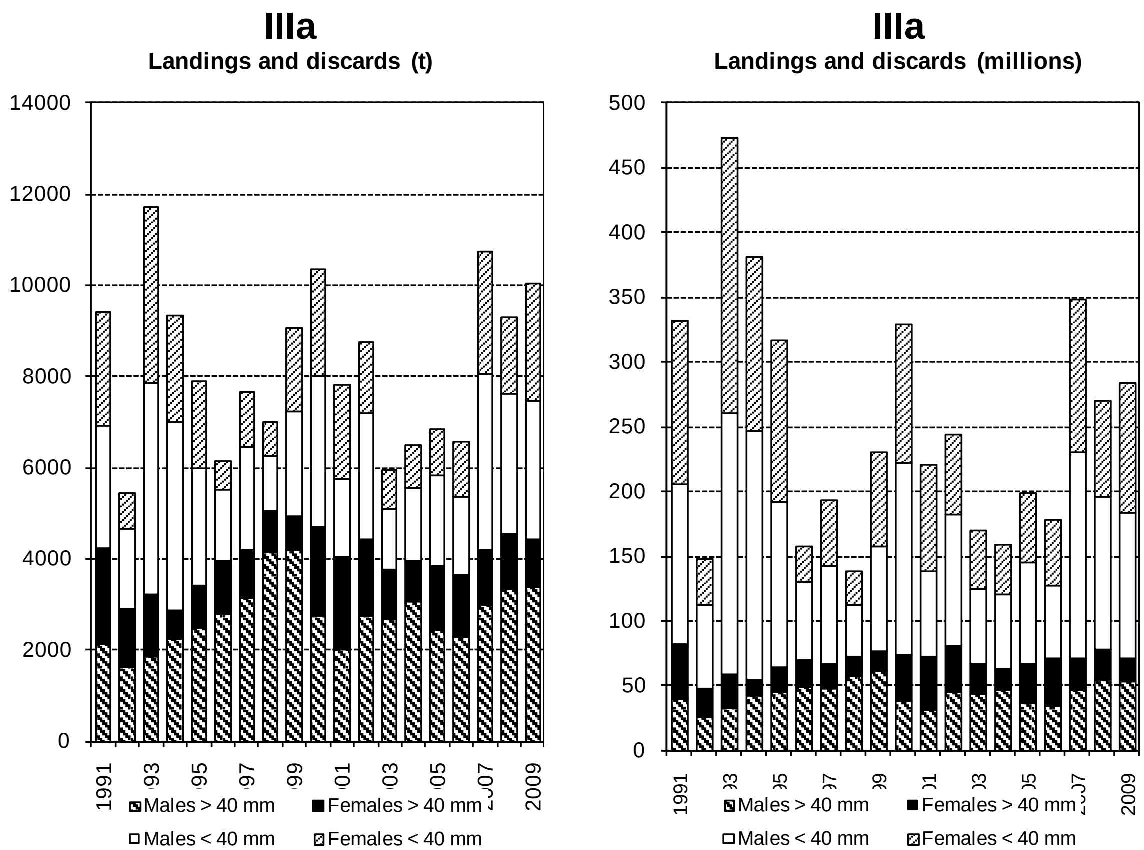


Figure 3.2.4.4. Nephrops Division IIIa : Composition of Nephrops catches by trawl, split by catch fraction (landings and discards) and by sex, 1991-2008.

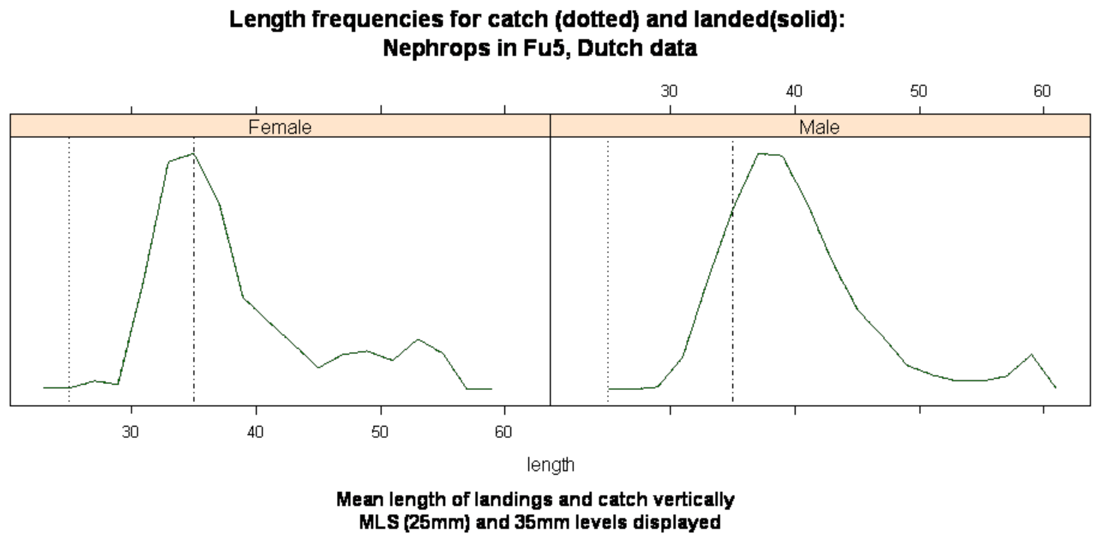


Figure 3.3.1.1. Size distribution in Dutch landings, 2009

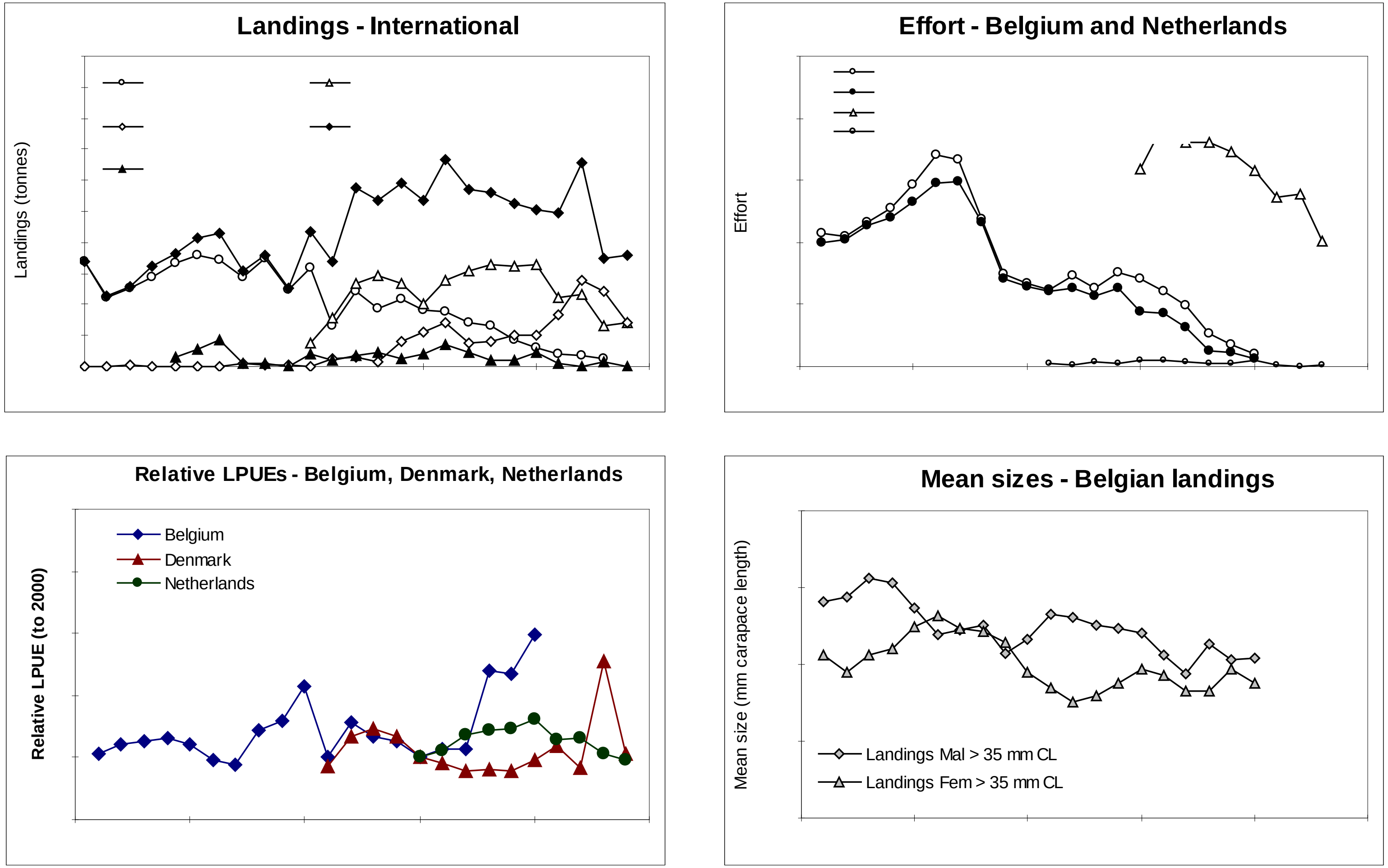


Figure. 3.3.1.2 Botney Gut - Silver Pit (FU 5): Long-term trends in landings, effort, CPUEs and/or LPUEs, and mean sizes of Nephrops.

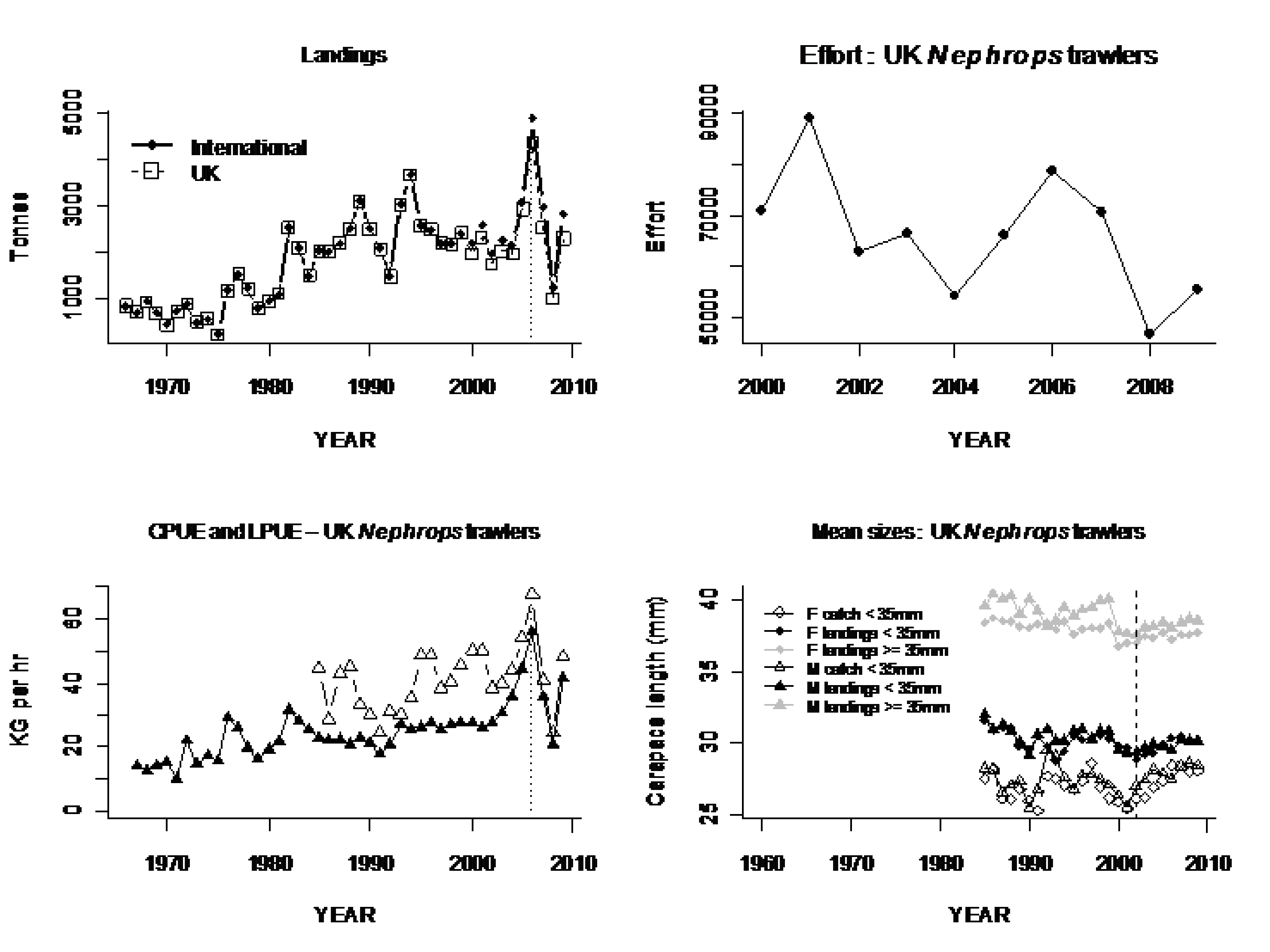


Figure 3.3.2.1 ***Nephrops*****, Farn Deeps (FU 6), Long term landings, effort, LPUE and mean sizes.**

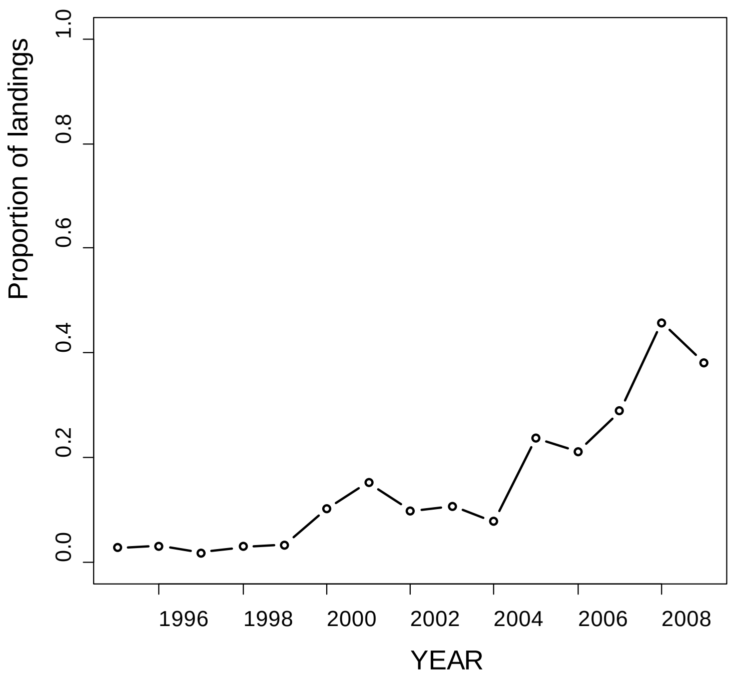


Figure 3.3.2.2. Nephrops, Farn Deeps (FU 6). Proportion of landings by multi-rigged (2-4 rigs) vessels.

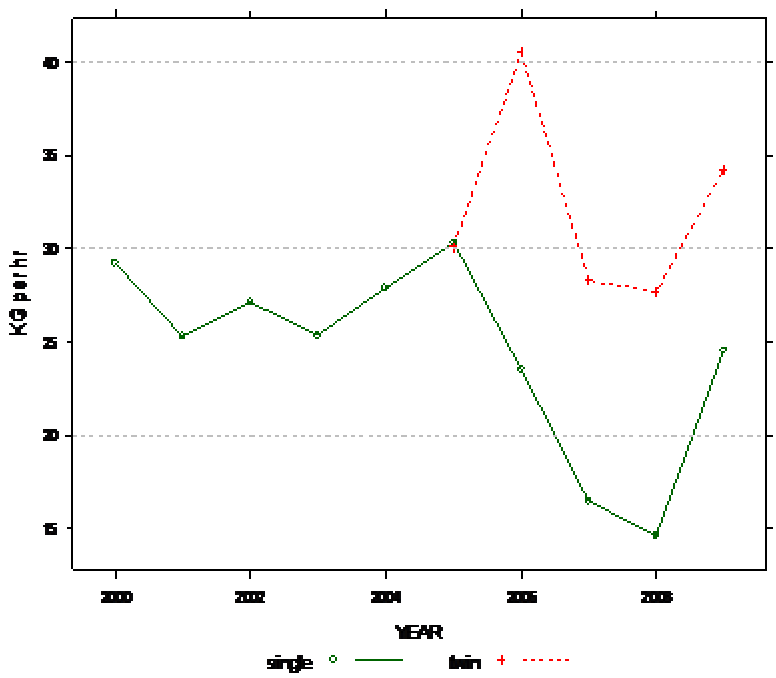


Figure 3.3.2.3 *Nephrops*, Farn Deeps (FU 6), LPUE by gear type.

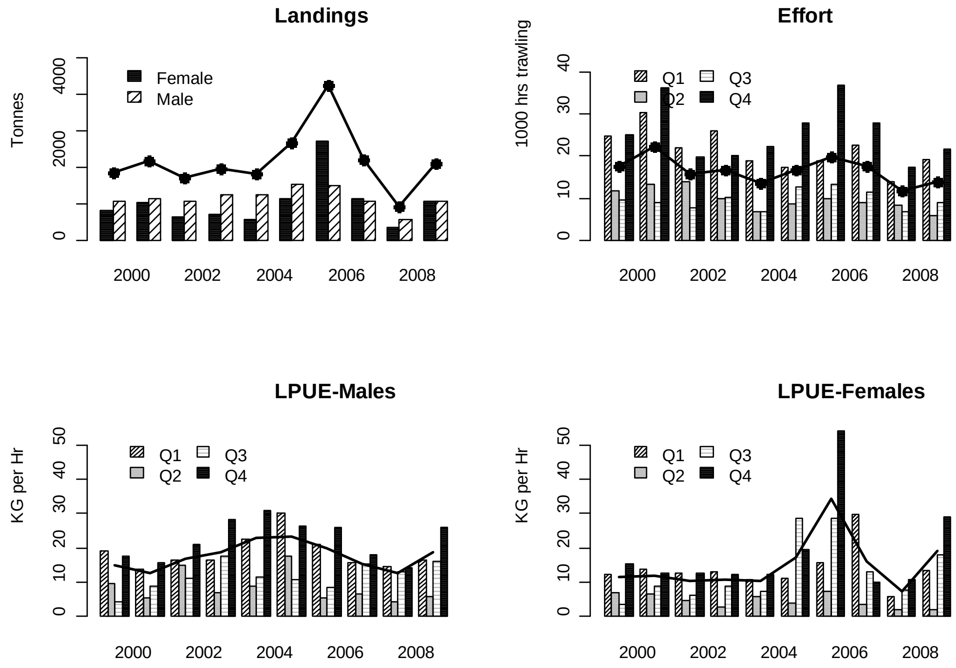


Figure 3.3.2.4 ***Nephrops*****, Farn Deeps (FU 6), Landings, effort and LPUEs by quarter and sex.**

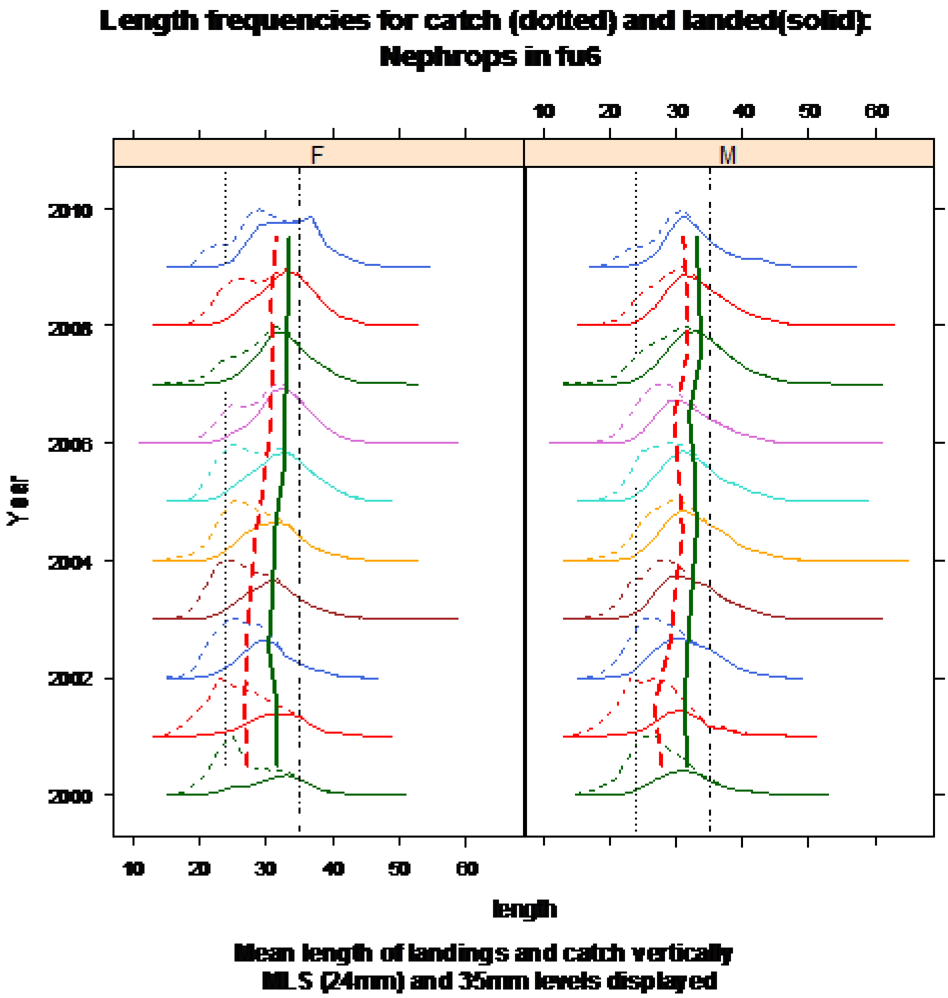


Figure 3.3.2.5 ***Nephrops*** **Farn Deeps (FU 6). Length composition of catch of males (right) and females left from 2000 (bottom) to 2009 (top). Mean sizes of catch and landings are displayed vertically.**

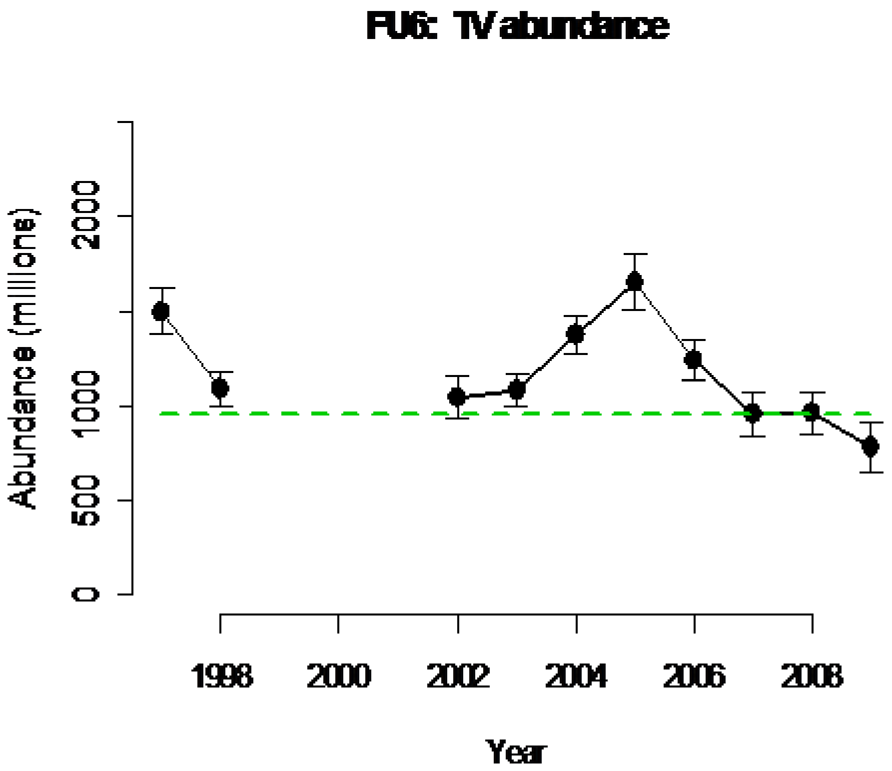


Figure 3.3.2.6 ***Nephrops*****, Farn Deeps (FU 6), Time series of TV survey abundance estimates (not bias adjusted), with 95% confidence intervals, 1997 – 2008. The green dashed line shows the proxy for $B_{trigger}$.**

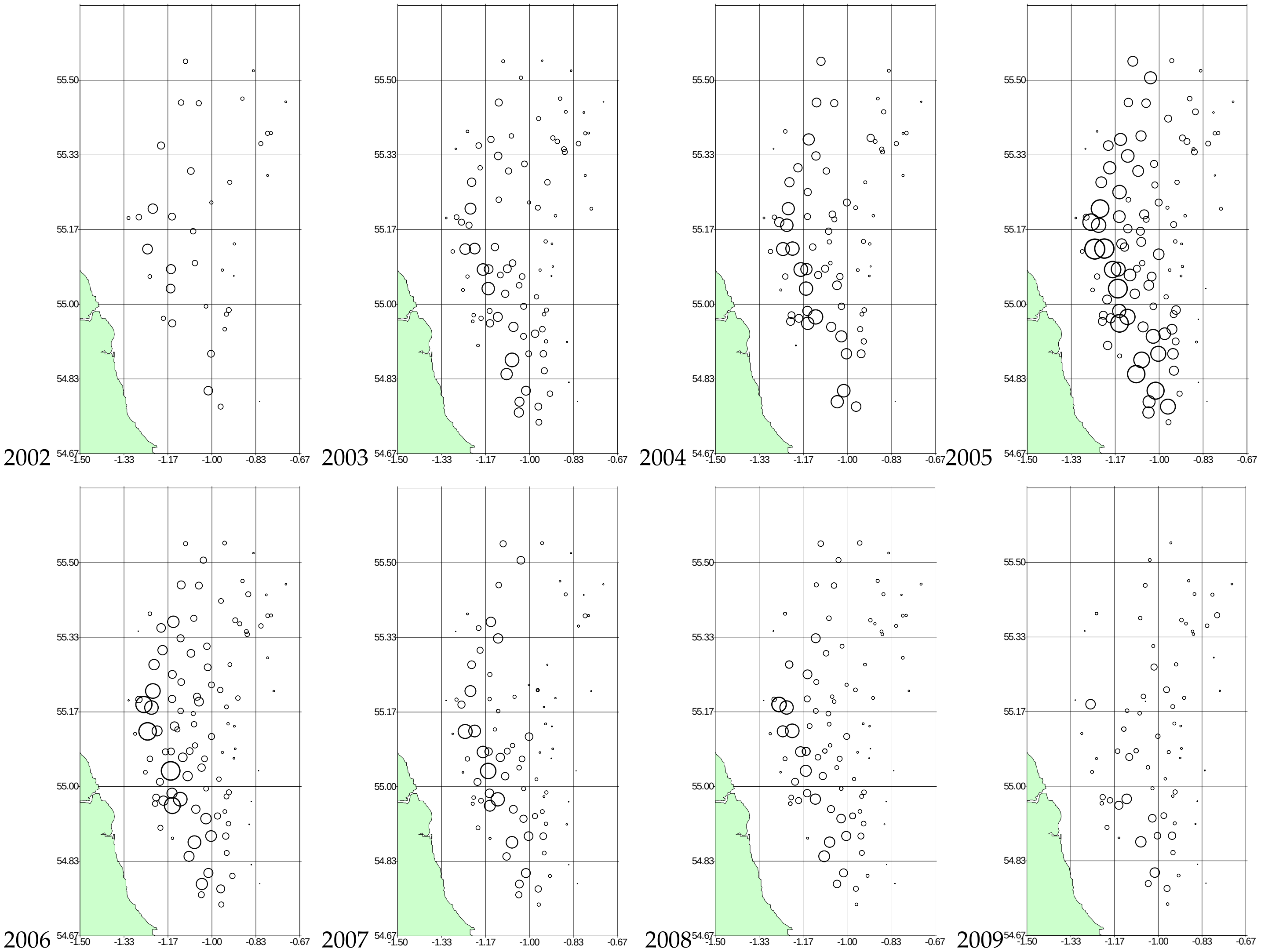


Figure 3.3.2.7. Nephrops Farn Deeps (FU6) - Station distribution and relative burrow density, from Autumn surveys 1998 – 2008.

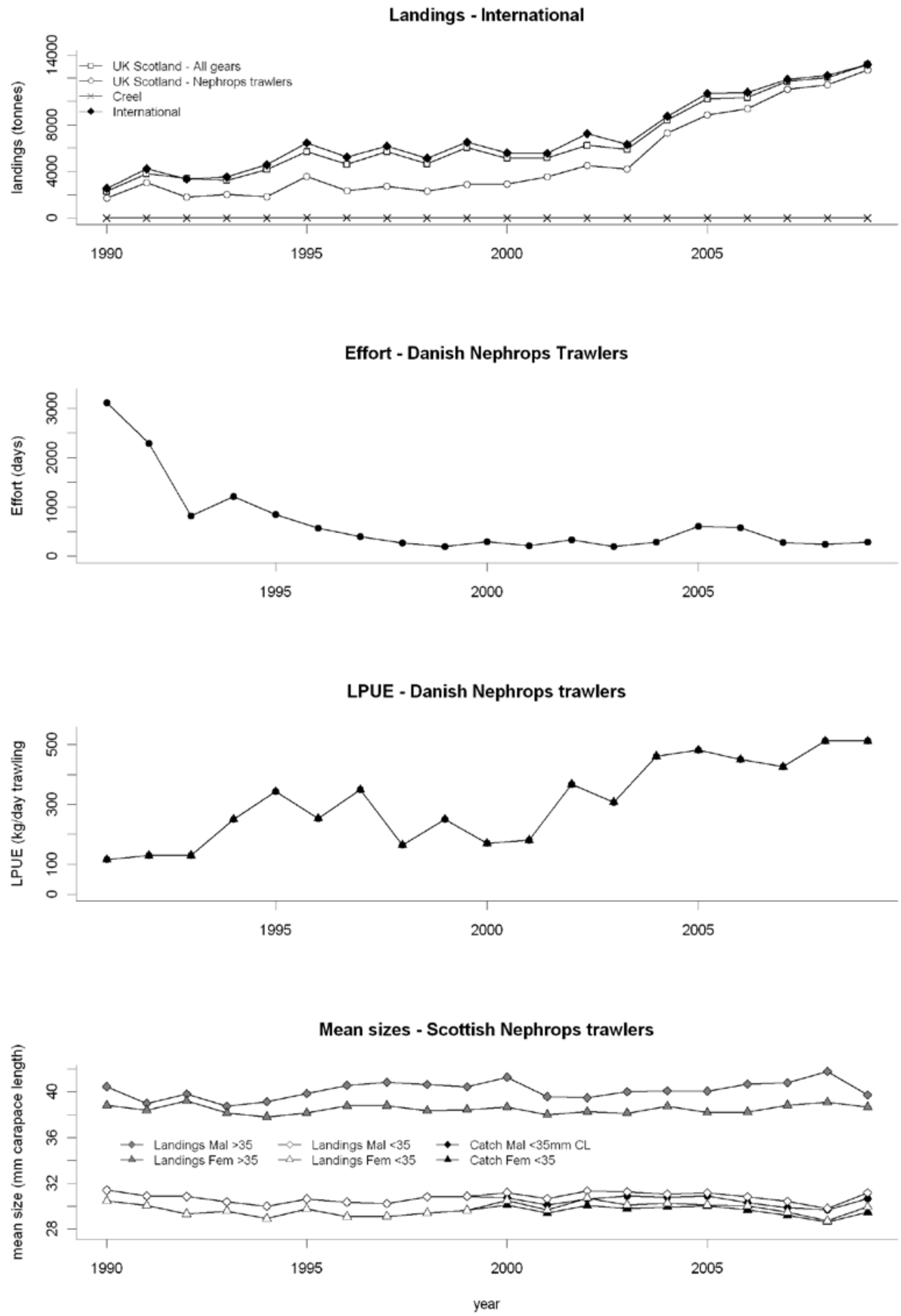


Figure 3.3.3.1 ***Nephrops*****, Fladen (FU 7), Long term landings, effort, LPUE and mean sizes.**

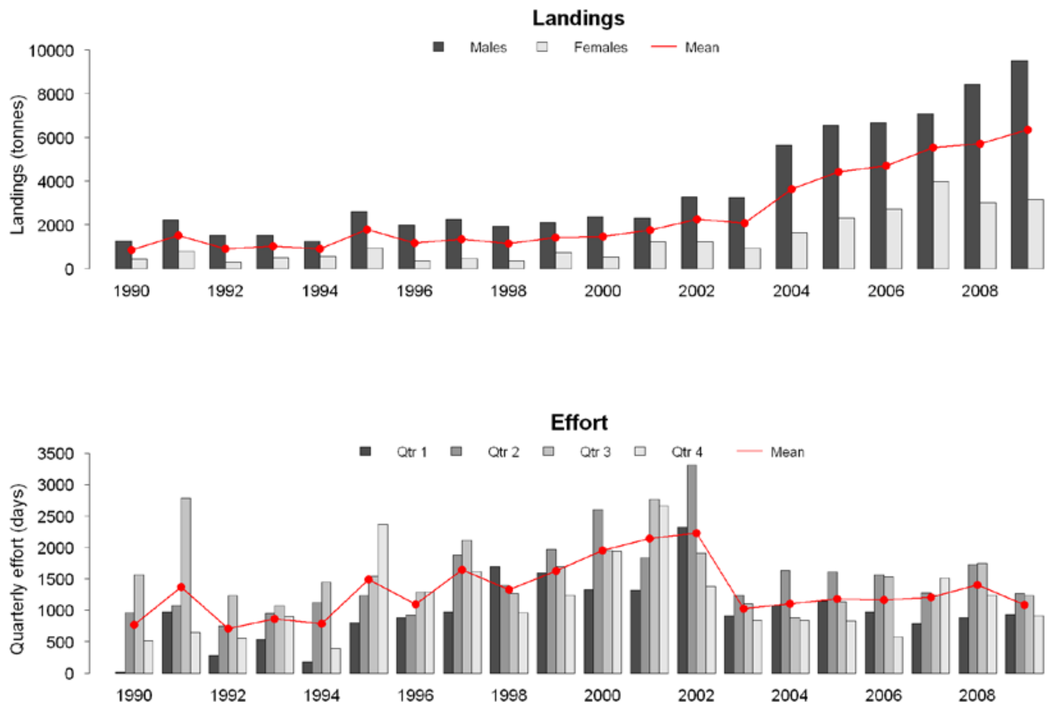


Figure 3.3.3.2 ***Nephrops*****, Fladen (FU 7), Landings by sex and effort by quarter from Scottish** ***Nephrops*** **trawlers.**

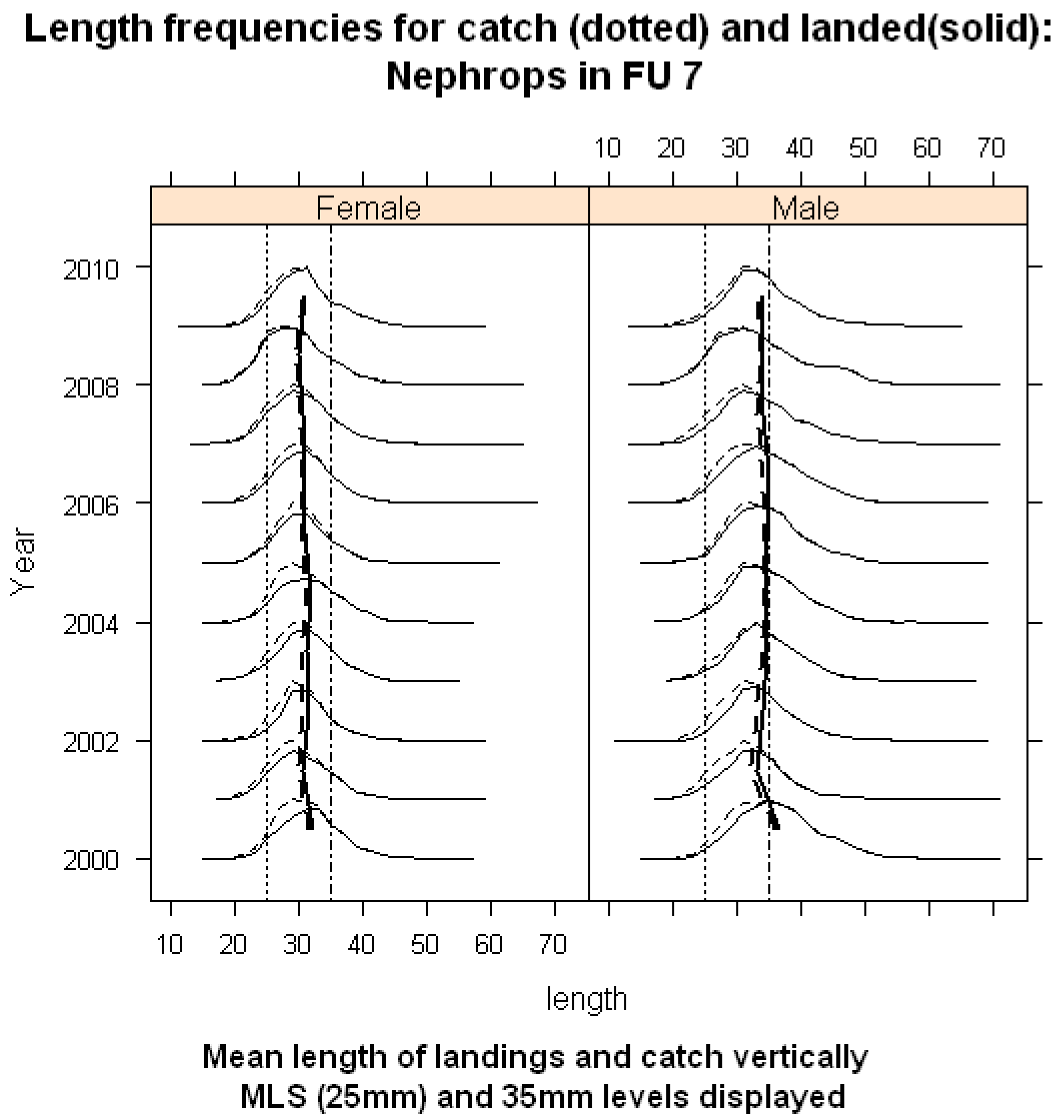


Figure 3.3.3.3. ***Nephrops*** **Fladen Ground (FU 7)Length composition of catch of males (right) and females left from 2000 (bottom) to 2009 (top). Mean sizes of catch and landings are displayed vertically.**

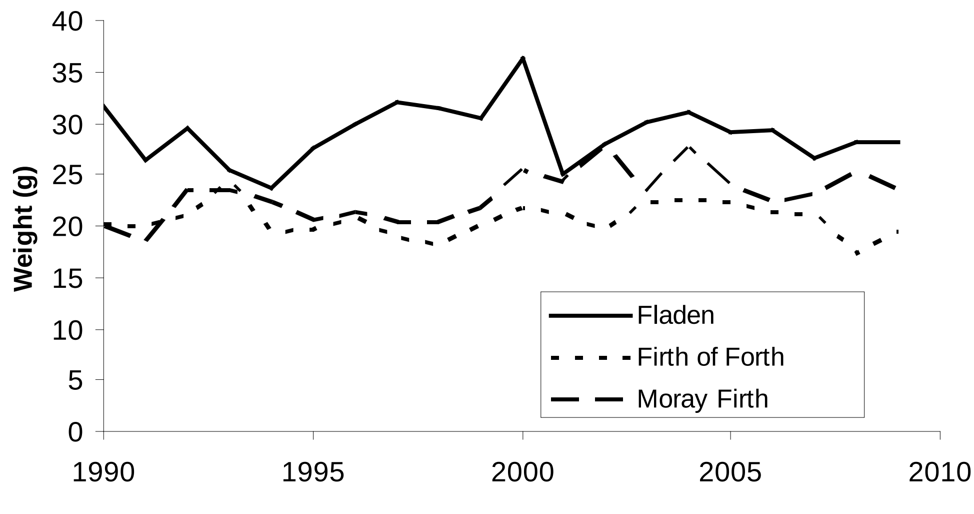


Figure 3.3.3.4 *Nephrops*, (FUs 7-9), individual mean weight in the landings from 1990-2009 (from Scottish market sampling data).

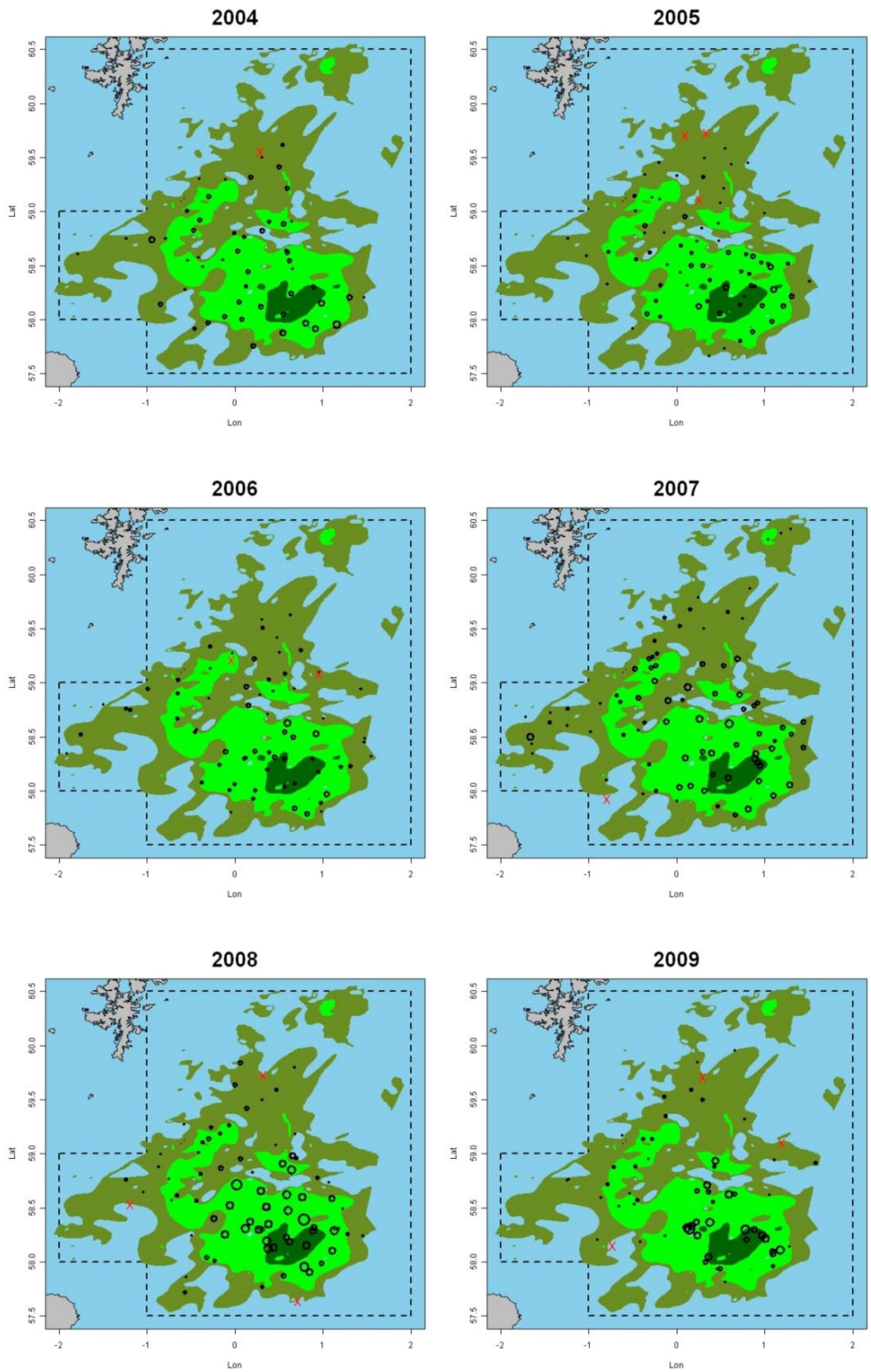


Figure 3.3.3.5 Nephrops, Fladen (FU 7). TV survey distribution and relative density (2004-2009). Green and brown areas represent areas of suitable sediment for Nephrops. Density proportional to circle radius. Red crosses represent zero observations.

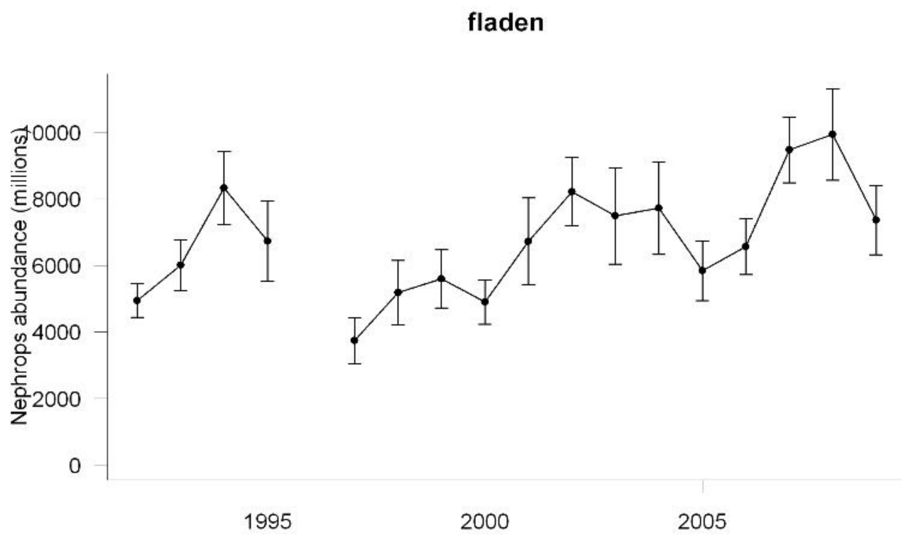


Figure 3.3.3.6 *Nephrops*, Fladen (FU 7), Time series of TV survey abundance estimates (not bias adjusted), with 95% confidence intervals, 1992 – 2009.

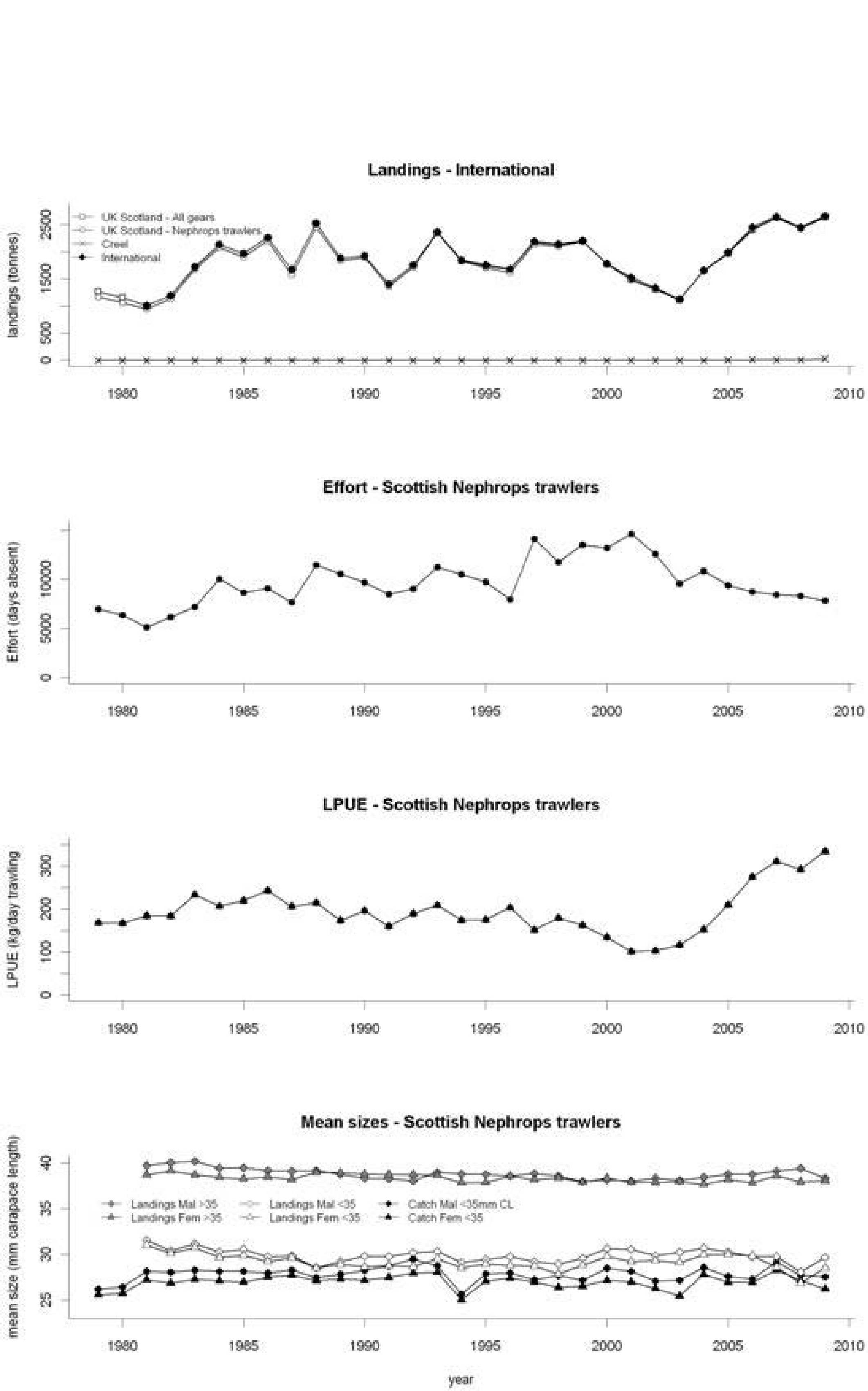


Figure 3.3.4.1 ***Nephrops*****, Firth of Forth (FU 8), Long term landings, effort, LPUE and mean sizes.**

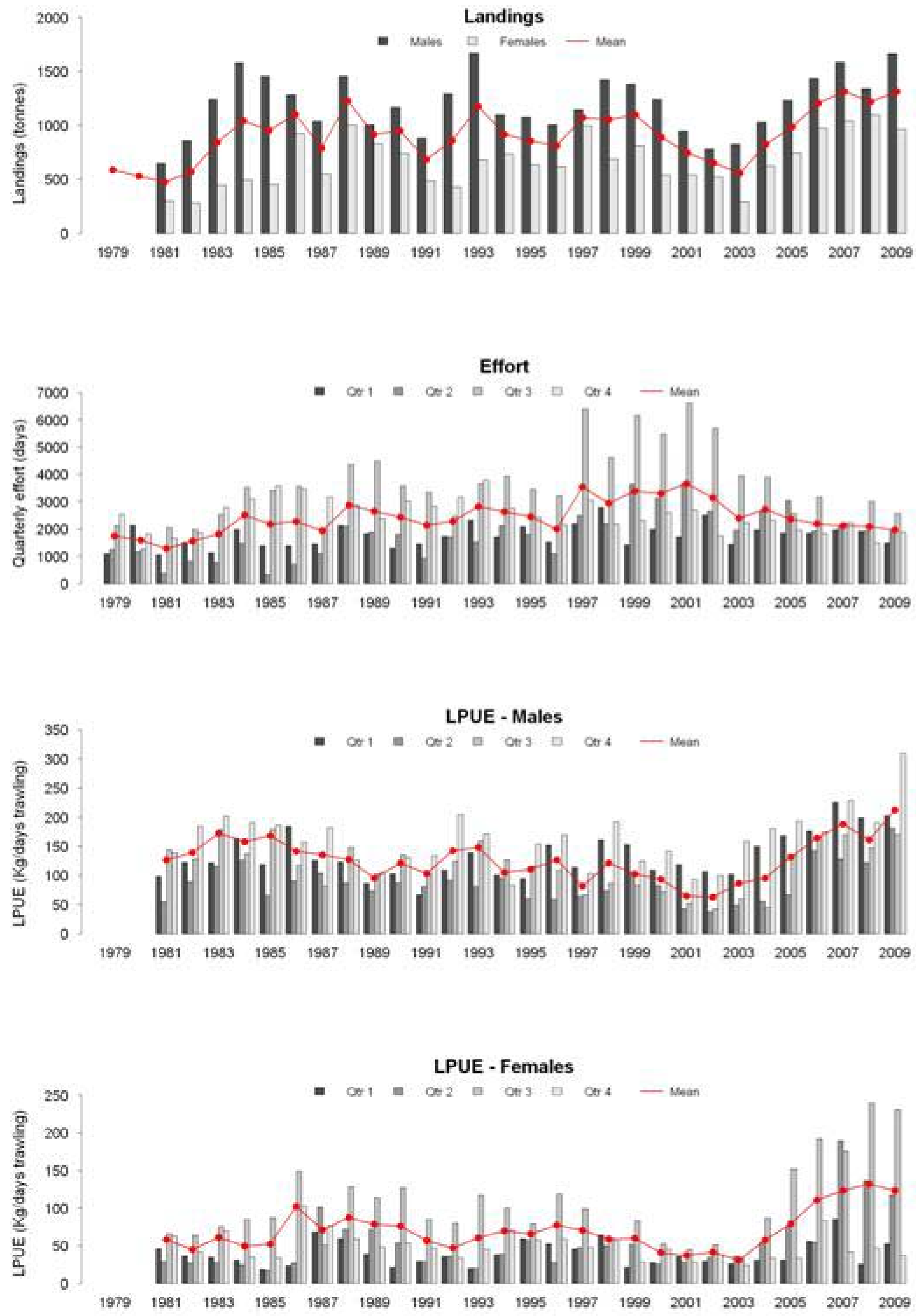


Figure 3.3.4.2 *Nephrops*, Firth of Forth (FU 8), Landings, effort and LPUEs by quarter and sex from Scottish *Nephrops* trawlers.

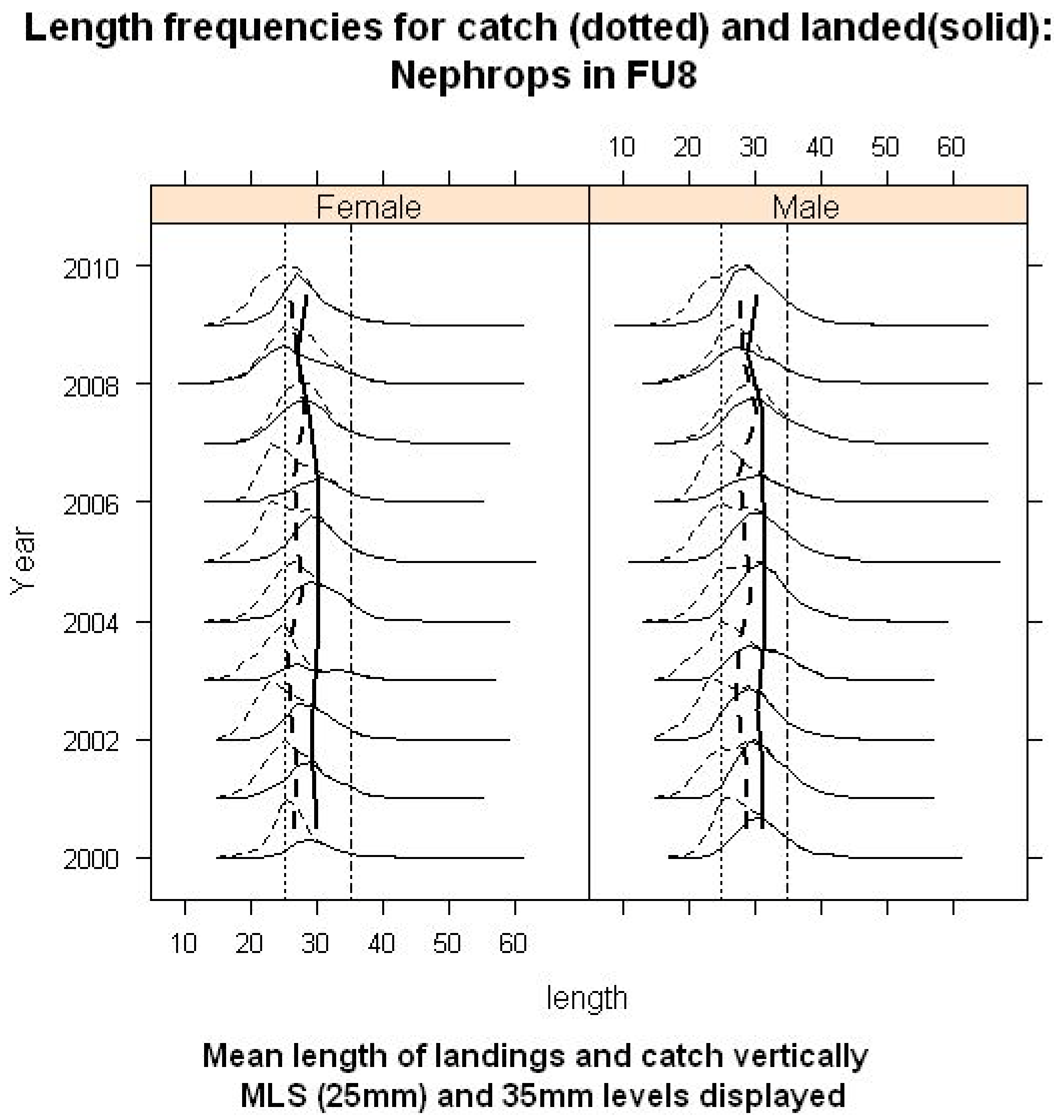


Figure 3.3.4.3 ***Nephrops*** **Firth of Forth (FU 8)Length composition of catch of males (right) and females left from 2000 (bottom) to 2009 (top). Mean sizes of catch and landings are displayed vertically.**

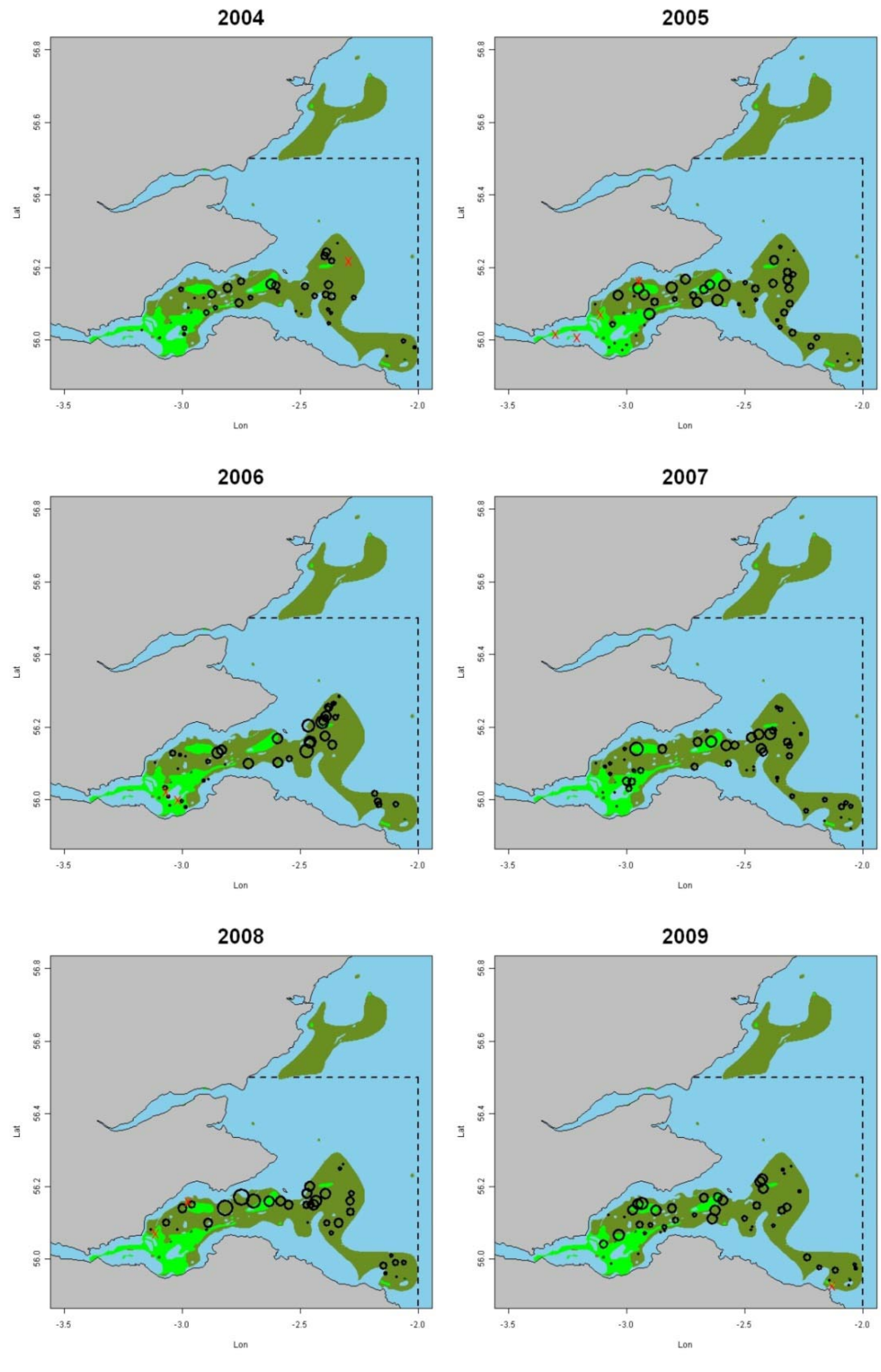


Figure 3.3.4.4 *Nephrops*, Firth of Forth (FU 8). TV survey distribution and relative density (2004-2009). Green and brown areas represent areas of suitable sediment for *Nephrops*. Density proportional to circle radius. Red crosses represent zero observations.

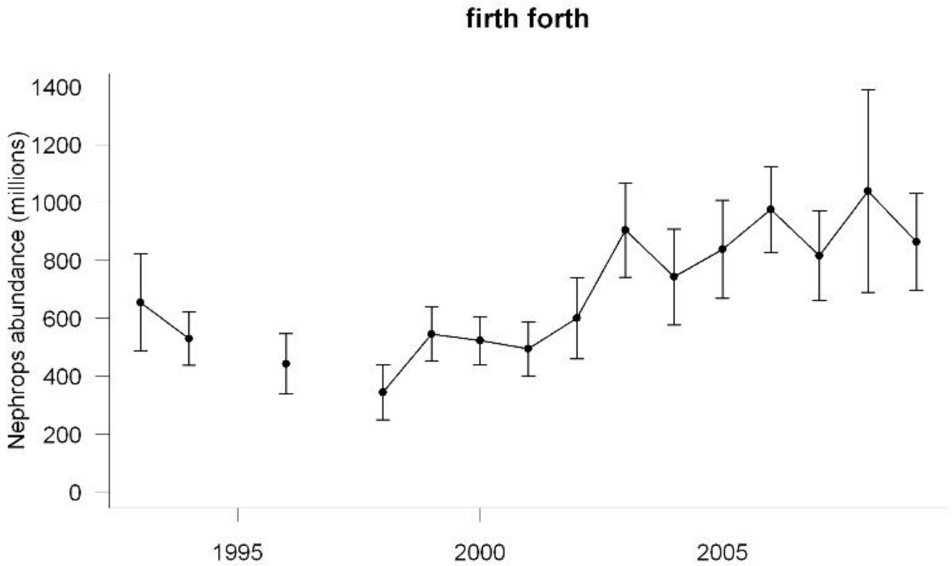


Figure 3.3.4.5 ***Nephrops*****, Firth of Forth (FU 8), Time series of TV survey abundance estimates, with 95% confidence intervals, 1995 – 2009.**

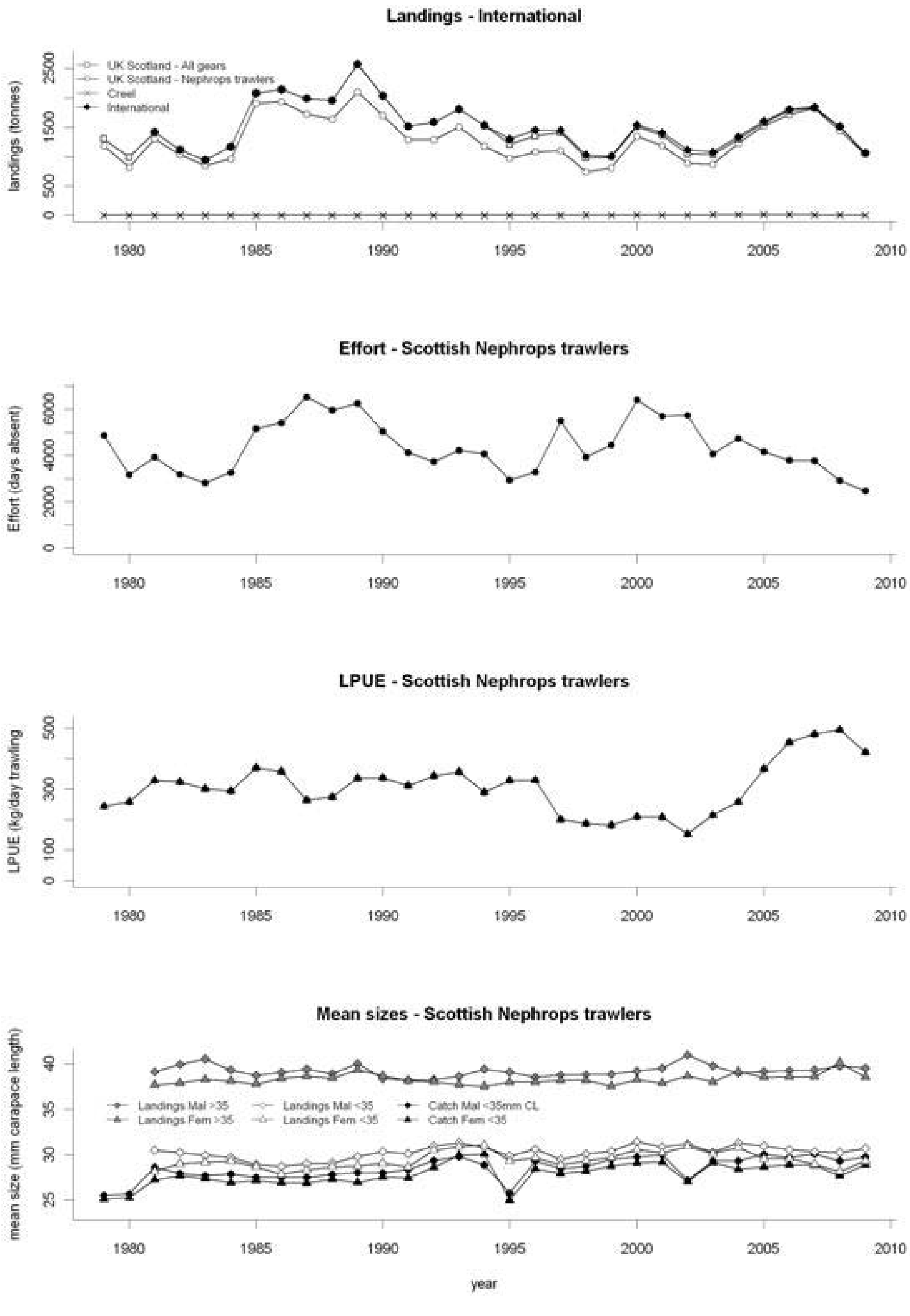


Figure 3.3.5.1 ***Nephrops*****, Moray Firth (FU 9), Long term landings, effort, LPUE and mean sizes.**

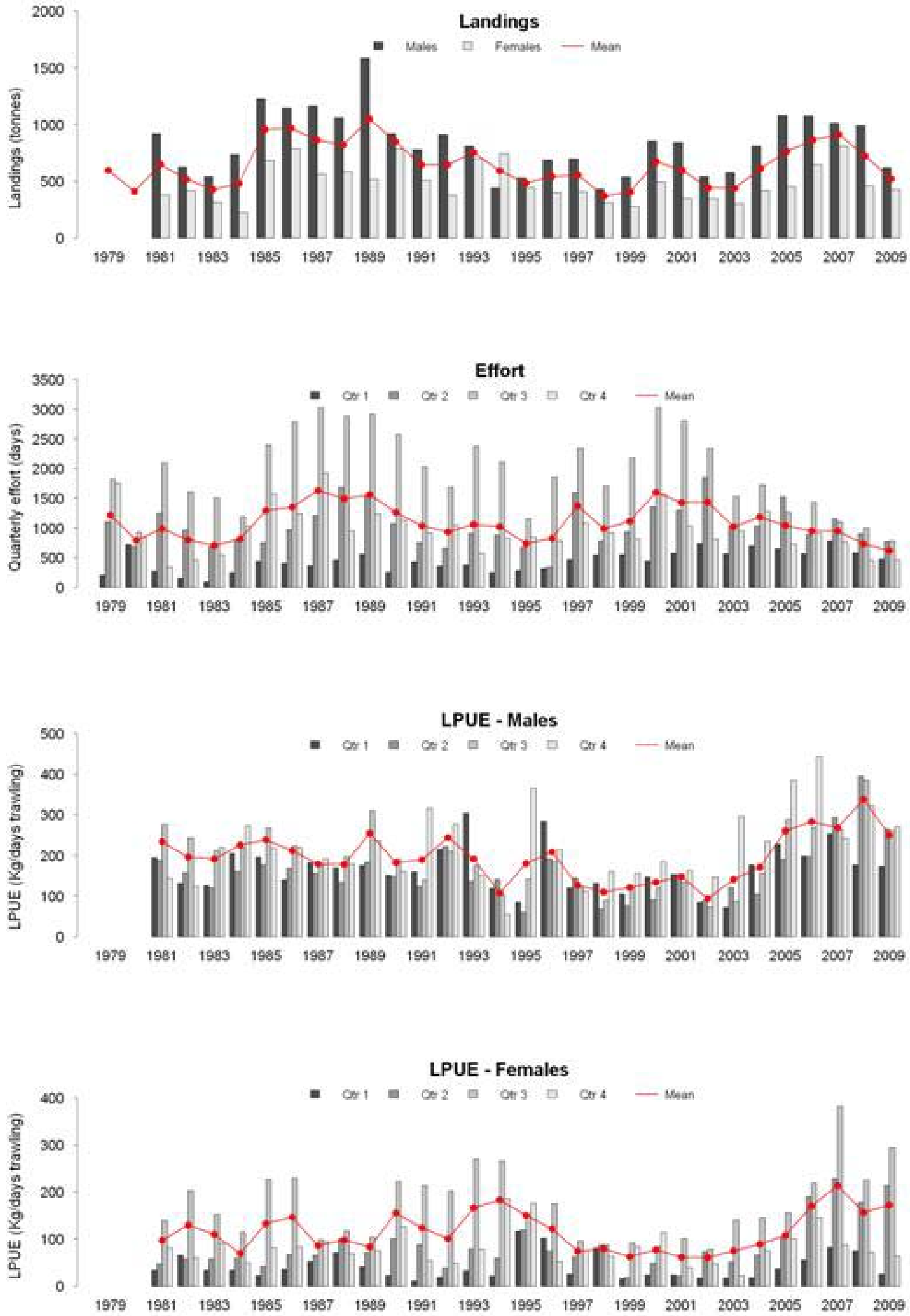


Figure 3.3.5.2 *Nephrops*, Moray Firth (FU 9), Landings, effort and LPUEs by quarter and sex from Scottish *Nephrops* trawlers.

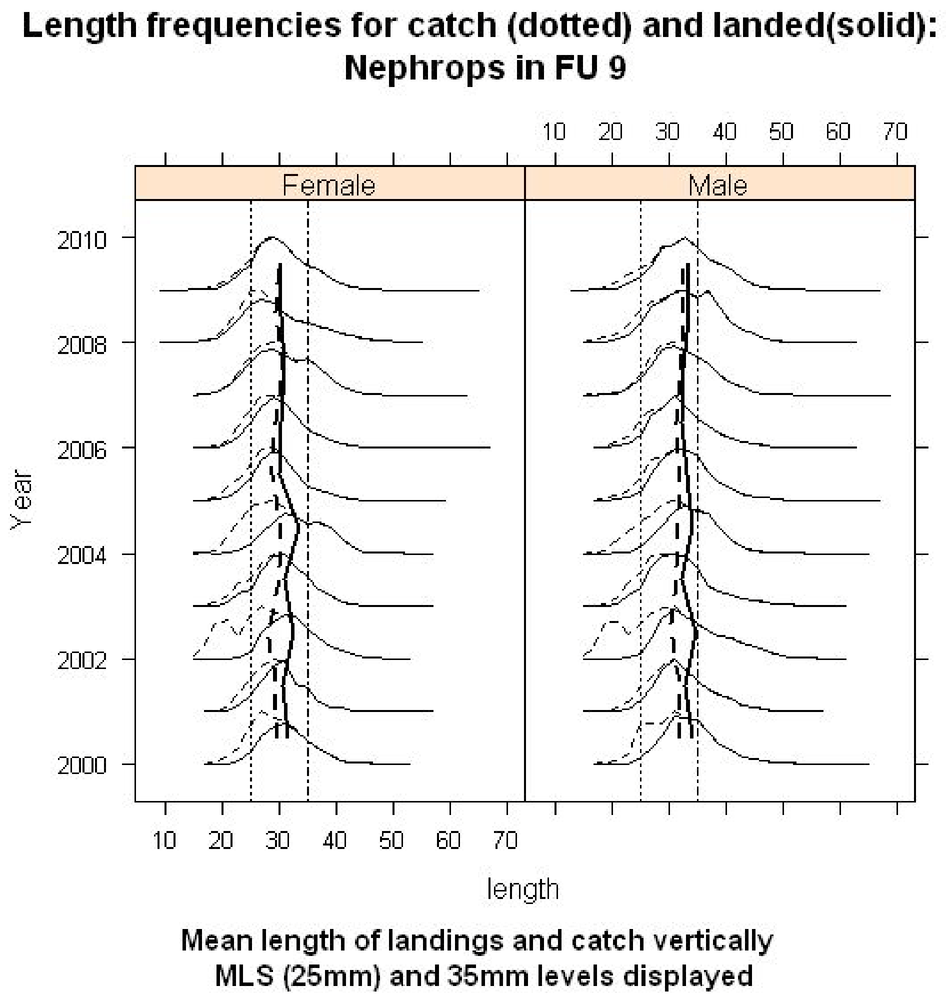


Figure 3.3.5.3 ***Nephrops*** **Moray Firth (FU 9) Length composition of catch of males (right) and females left from 2000 (bottom) to 2009 (top). Mean sizes of catch and landings are displayed vertically.**

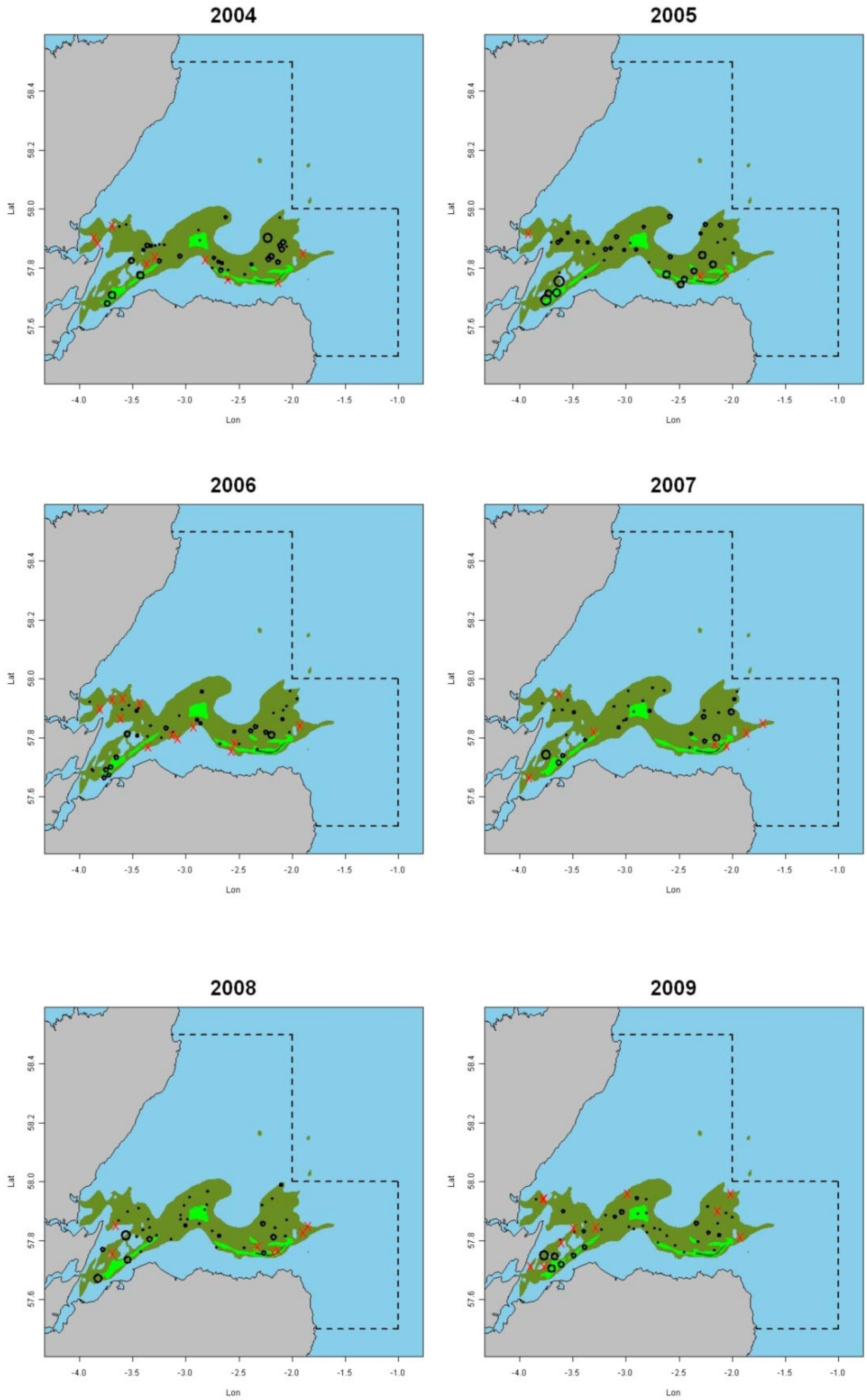


Figure 3.3.5.4 ***Nephrops*****, Moray Firth (FU 9). TV survey distribution and relative density (2003-2008). Green and brown areas represent areas of suitable sediment for *Nephrops*. Density proportional to circle radius. Red crosses represent zero observations.**

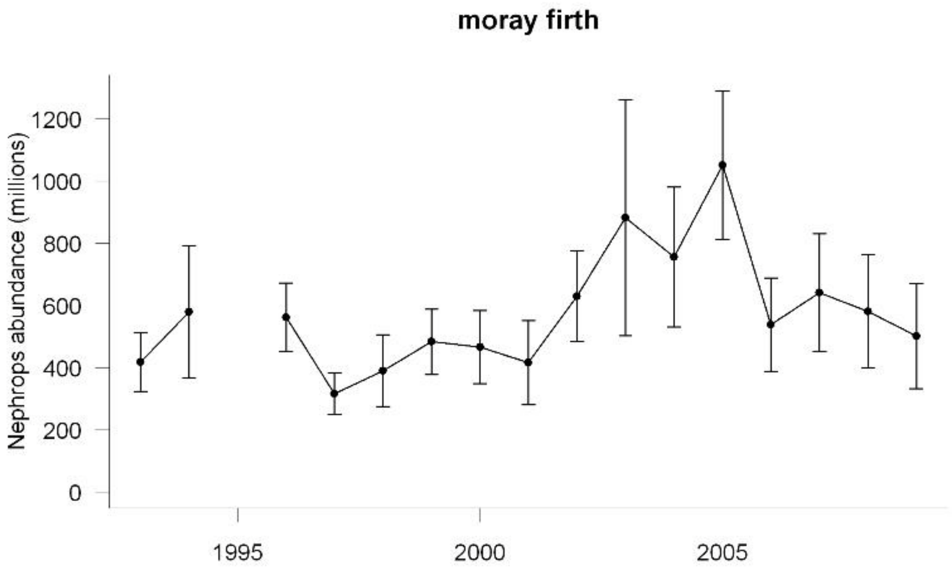
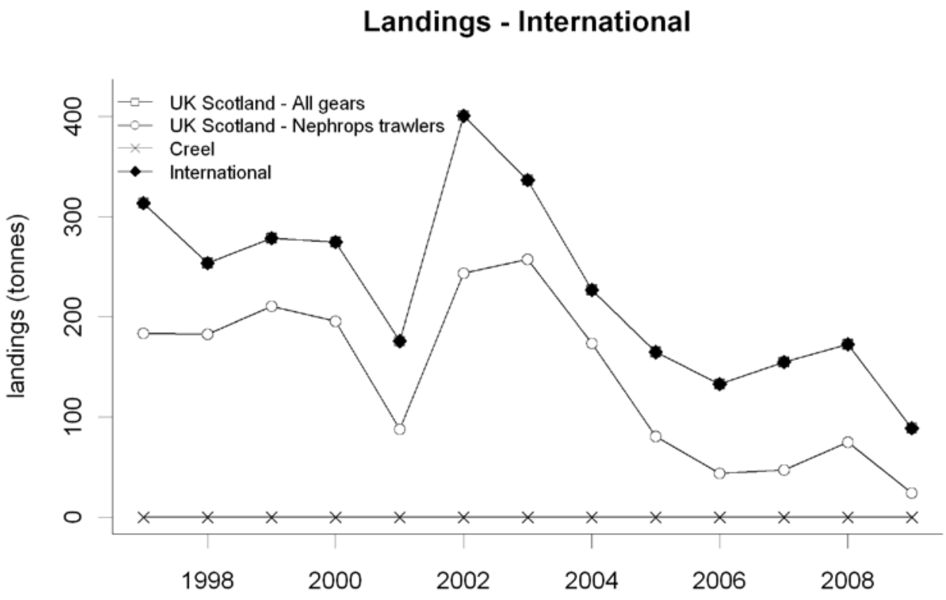


Figure 3.3.5.5 ***Nephrops*****, Moray Firth (FU 9), Time series of TV survey abundance estimates, with 95% confidence intervals, 1993 – 2009.**



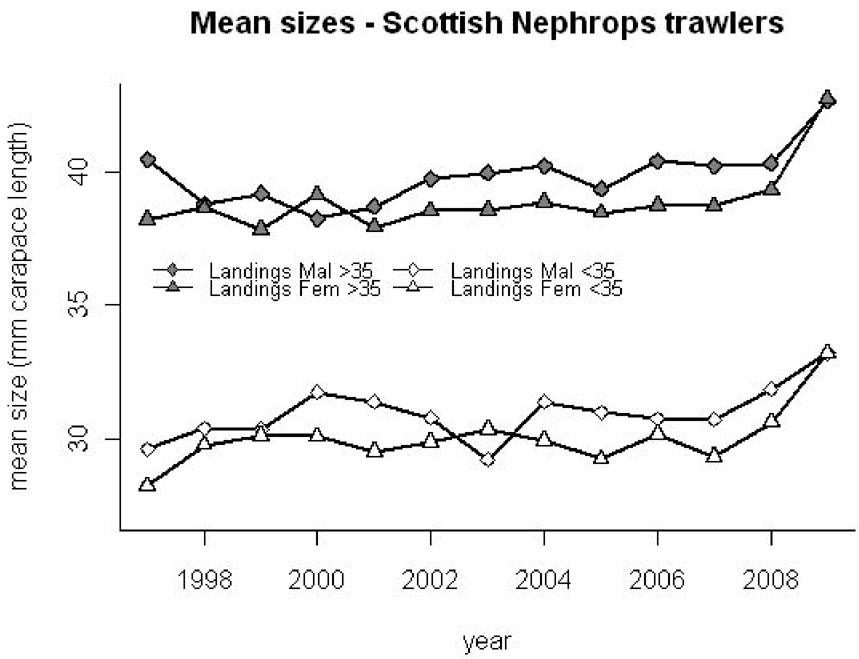


Figure 3.3.6.1 ***Nephrops*****, Noup (FU 10), Long term landings and mean sizes.**

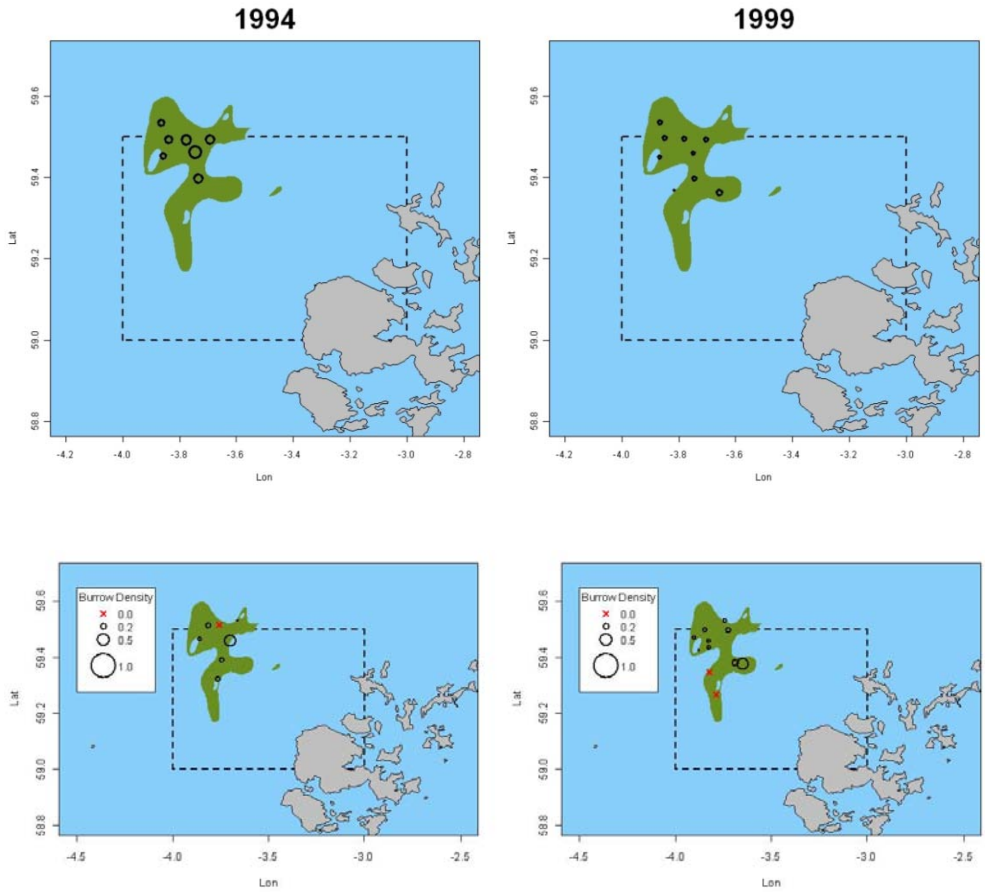
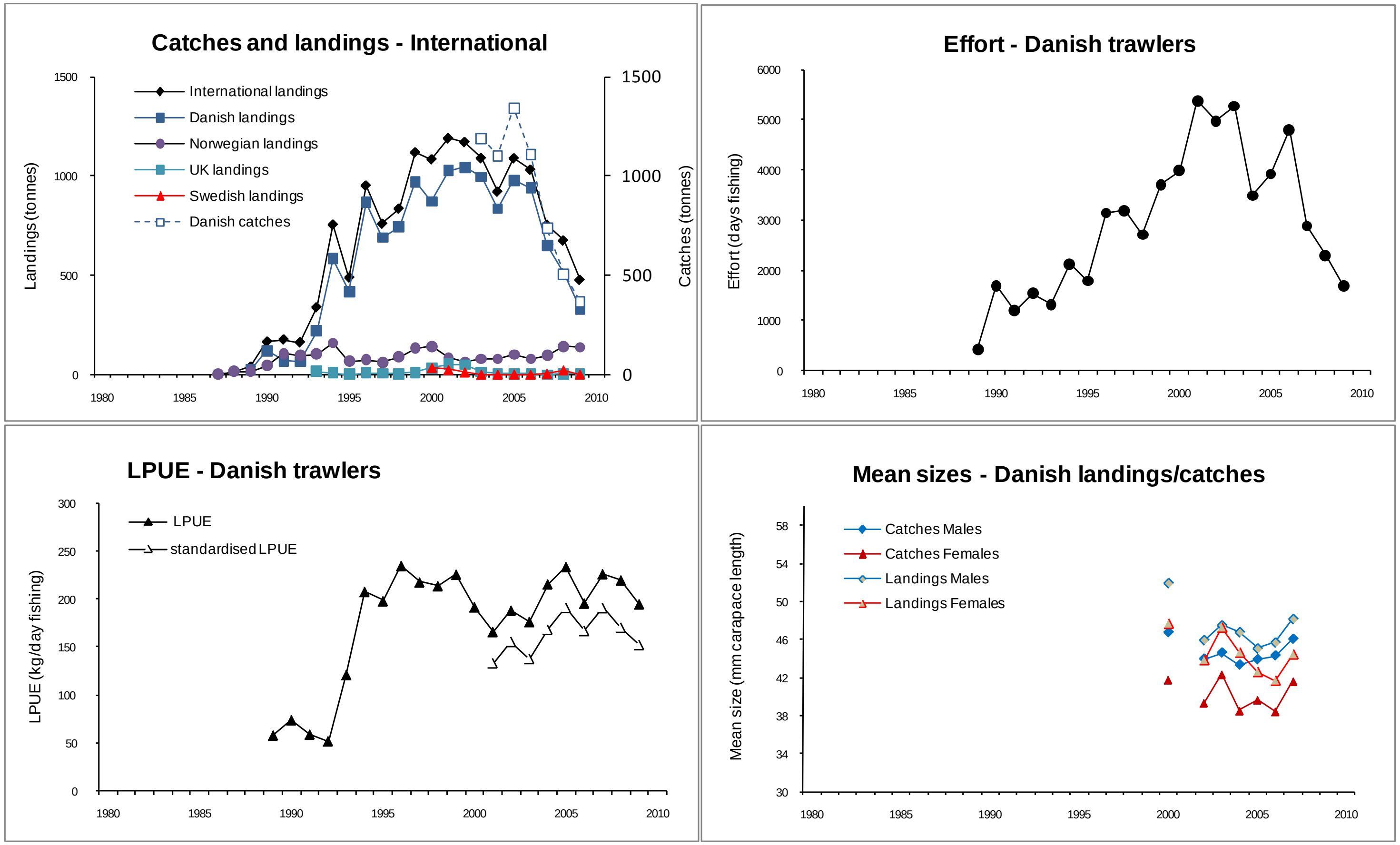


Figure 3.3.6.2 ***Nephrops*****, Noup (FU 10). TV survey distribution and relative density (1994, 1999, 2006, 2007). Green and brown areas represent areas of suitable sediment for *Nephrops*. Density proportional to circle radius. Red crosses represent zero observations.**

Figure 3.3.7.1 ***Nephrops*** **Norwegian Deep (FU 32): Long-term trends in landings, effort, CPUEs and/or LPUEs, and mean sizes of *Nephrops*.**



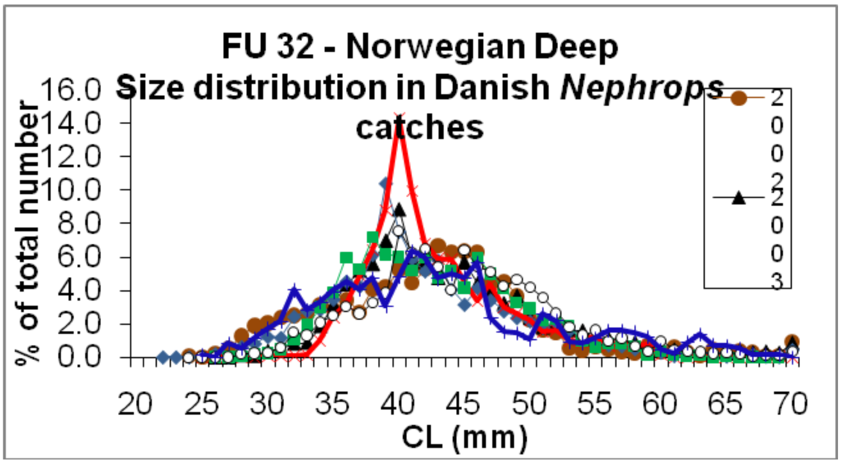


Figure 3.3.7.2. ***Nephrops*** **Norwegian Deep (FU 32): LFDs from Danish Nephrops/finfish trawlers in FU 32.**

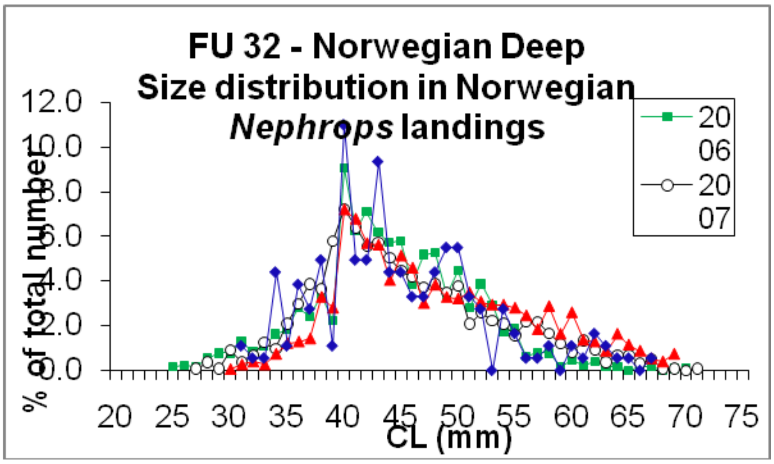


Figure 3.3.7.3. ***Nephrops*** **Norwegian Deep (FU 32): LFDs from Norwegian Nephrops/finfish trawlers in FU 32 (using 100 mm mesh trawls).**

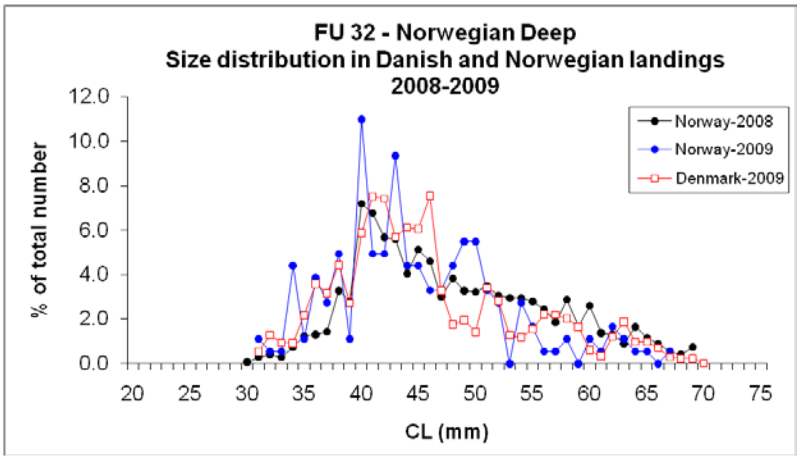


Figure 3.3.7.4. ***Nephrops*** **Norwegian Deep (FU 32): LFDs from Norwegian and Danish trawlers 2008-2009**

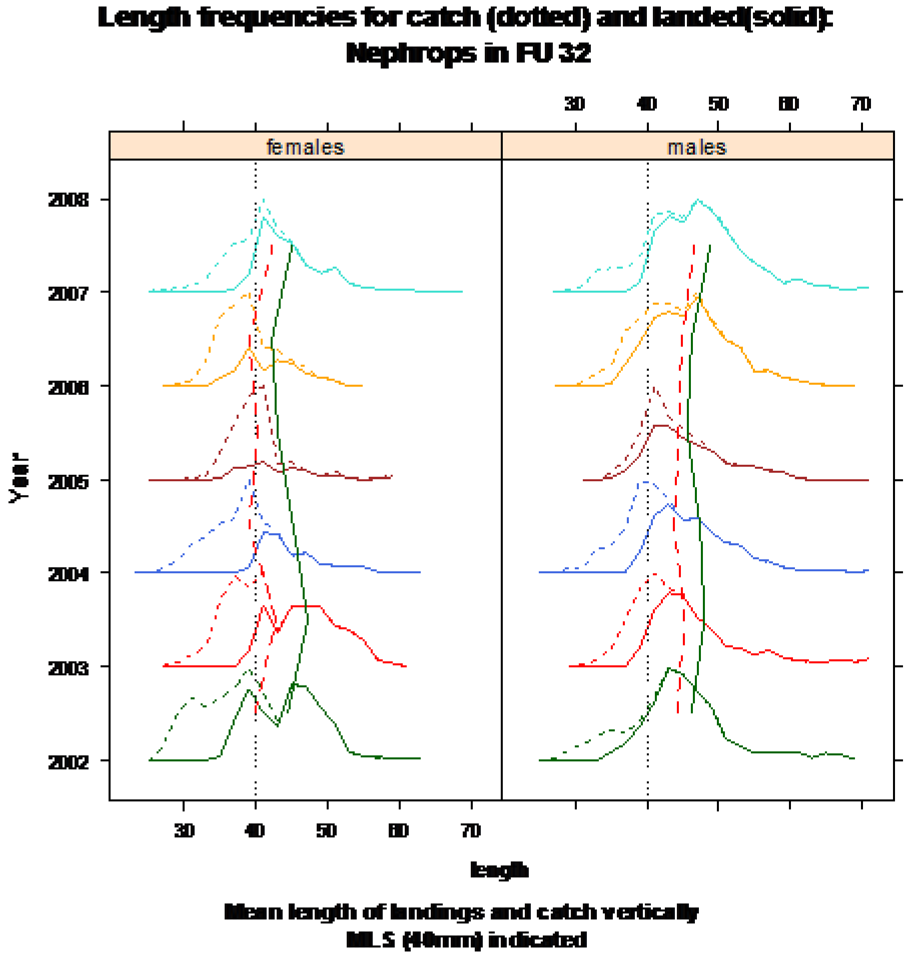


Figure 3.3.7.5 ***Nephrops*** **Norwegian Deep (FU 32): Length composition of catch (dotted) and landed (solid) of males (right) and females (left) from 2002 (bottom) to 2007 (top). Mean sizes of catch and landings (using same line types) is shown in relation to MLS. Sex-specific data are not available for 2008 or 2009.**

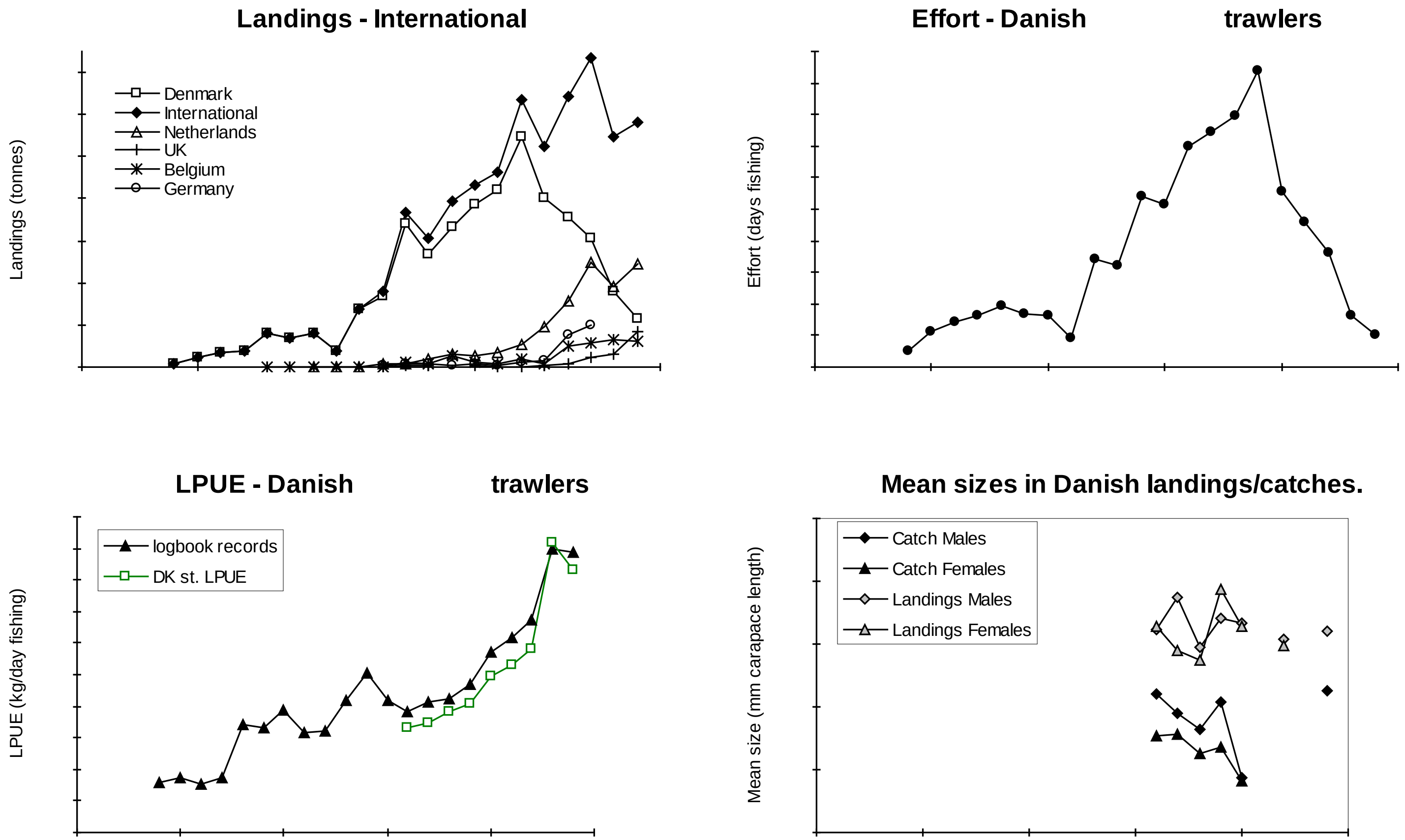


Figure 3.3.8.1 ***Nephrops*** **Off Horn Reef (FU 33): Long-term trends in landings, effort, CPUEs and/or LPUEs, and mean sizes of** ***Nephrops*****.**

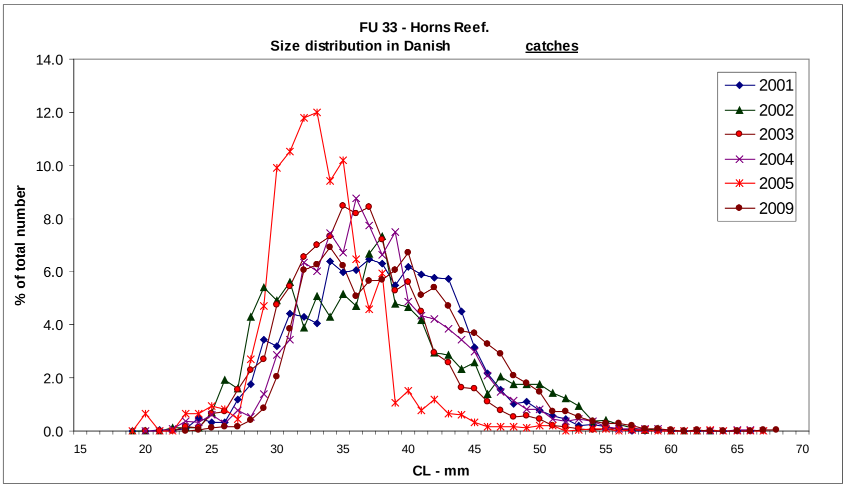


Figure 3.3.8.2. ***Nephrops*** **Off Horn Reef size distributions of Danish catches.**

4 Sandeel in IV (WGNSSK Sep. 2010)

For assessment purposes, the European continental shelf has since 1995 been divided into four regions: Division IIIa (Skagerrak), Division IV (the North Sea excl Shetland Islands), Division Vb2 (Shetland Islands), and Division VIa (west of Scotland). Only the stock in Division IV is assessed in this report.

Before 1995 two independent sandeel assessments were made: One for the northern North Sea and one for the southern North Sea. In 1995, and it was decided to amalgamate the two stocks into a single stock unit The Shetland sandeel stock was assessed separately. ICES assessments used these stock definitions from 1995 to 2009.

Larval drift models and studies on growth differences have indicated that the assumption of a single stock unit is invalid and that the total stock is divided in several sub-populations. Based on this information ICES (ICES CM 2009\ACOM:51) suggested that the North Sea should be divided into seven sandeel assessment areas as indicated in Figure 4.1.1. On this basis the benchmark assessment (ICES 2010, (WKSAN 2010)) decided to make area specific assessments from 2010 onwards.

In 2010 the SMS-effort model was used for the first time to estimate fishing mortalities and stock numbers at age by half year, using data from 1983 to 2010. This model assumes that fishing mortality is proportional to fishing effort.

Further information on the stock areas and assessment model can be found in the Stock Annex and in the benchmark report (WGSAN, 2010).

4.1 General

4.1.1 Ecosystem aspects

Sandeels in the North Sea can be divided into a number of reproductively isolated sub-populations (see the Stock Annex). A decline in the sandeel population in recent years concurrent with a marked change in distribution has increased the concern about local depletion, of which there has been some evidence (ICES WGNSSK 2006b, ICES AGSAN 2008b).

Local depletion of sandeel aggregations at a distance less than 100 km from seabird colonies may affect some species of birds, especially black-legged kittiwake and sandwich tern, whereas the more mobile marine mammals and fish may be less vulnerable to local sandeel depletion.

The stock annex contains a comprehensive description of ecosystem aspects.

4.1.2 Fisheries

General information about the sandeel fishery can be found in the Stock Annex.

The size distribution of the Danish fleet has changed through time, with a clear tendency towards fewer and larger vessels (ICES WGNSSK 2006b). In 2009 only 84 Danish vessels participated in the North Sea sandeel fishery, compared to more than 200 vessels in 2004.

The same tendency was seen for the Norwegian vessels fishing sandeels until 2005. In 2006 only 6 Norwegian vessels were allowed to participate in an experimental sandeel fishery in the Norwegian EEZ compared to 53 in 2002. However, the number of Norwegian fishing vessels participating in the sandeel fishery has increased to 42 in

2008. From 2002 to 2008 also the average GRT per trip in the Norwegian fleet increased from 269 to 507 t.

The rapid changes of the structure of the fleet that have occurred in recent years may introduce more uncertainty in the assessment, as the fishing pattern and efficiency of the "new" fleet may differ from the previous fleet.

The sandeel fishery in 2010 was opened 1st of April. As in the most recent years the main fishery took place in the in the Dogger Bank area and grounds north east of Dogger Bank.

4.1.3 ICES Advice

ICES advised that, the fishery in 2010 should be allowed only if analysis of data from the in-year monitoring programme indicated that the stock could be rebuilt to $\mathbf{B}_{pa}$ by 2011.

Subsequently, based on results from the in-year monitoring programme ICES recommended that the catches in 2010 should not exceed 253 000t.

ICES noted that the management of sandeel fisheries should try to prevent depletion of local aggregations, particularly in areas where predators congregate.

ICES recommended that future management should take into account the spatial structure of sandeels.

4.1.4 Management

TAC

The guidelines for setting TAC and quotas regarding sandeels in 2010 are given by the Council Regulation (EC) No. 23/2010.

However, considering the uncertainty of the Sandeel assessment, the late onset of the fishery, and the high catch rates obtained by the end of the monitoring period total TAC in the EU share of the North Sea was set at 400 000 tons.

Closed periods

Since 2004 the fishery in the Norwegian EEZ opened April 1 and closed again June 23.

Since 2005 Danish vessels have not been allowed to fish sandeels before 31st of March. In 2010 sandeel fishery in the EU zone was opened on the 1st of April and closed 1t of August.

Closed areas

The Norwegian EEZ was closed to fishery in 2009.

In the light of studies linking low sandeel availability to poor breeding success of kittiwake, there has been a moratorium on sandeel fisheries on Firth of Forth area along the U.K. coast since 2000., except for a limited fishery in May and June for stock monitoring purposes

4.1.5 Catch

Landing and trends in landings

Landings statistics for Division IV are given in by country in Table 4.1.1. Landing statistics and effort by assessment area are given in Tables 4.1.2 to 4.1.7. Figure 4.1.1 shows the areas for which catches are tabulated.

The sandeel fishery developed during the 1970s, and landings peaked in 1997 and 1998 with more than 1 million tons. Since 1983 the total landings have fluctuated between 1.2 million tons (1997) and 180 000 tons (2005) with an overall average at 686 000 tons (Figure 4.1.3). There was a significant decrease in landings in 2003. The average landings of the period 1983 to 2002 was 835 000 tons whereas the average landings of the period 2003 to 2010 was 313 000 tons. Total landings in 2010 were 395 000 t.

Spatial distribution of landings

Yearly landings for the period 1995–2009 distributed by ICES rectangle are shown in Figure 4.1.2. Since 2008 the Dogger Bank area remained the main fishing area. However, the number of fishing grounds fished in the Dogger Bank area has increased and the fishery has expanded into the central North Sea north east of the Dogger Bank area. In 2006 there was only a limited monitoring fishery in the Norwegian EEZ and in the southern North Sea the fishery was concentrated at the fishing grounds in the Dogger Bank area in both 2006 and 2007.

Figure 4.1.3 shows the landings by area. There are large differences in the regional patterns of the landings. Areas 1 and 3 have always been the most important with regard to sandeel landings. In average, together these two areas have contributed 84% of the total sandeel landings in the period 1983 to 2010. However, there has been a significant shift in the relative contribution of the two areas over the period. Up to 2002 area 1 and 3 contributed 47 and 36% respectively whereas their contributions were 65 and 20% in the period 2003 to 2010. In Area-3 landings in the Norwegian EEZ have been have declined since 2006 due to national regulation of the fishery.

The third most important area for the sandeel fishery is area 2. In the period 2003 to 2009 landings from this area contributed 12% of the total landings in average. The contribution of area 2 over the entire period is 9% in average.

Area 4 has contributed about 6% of the total landings since 1994 but there has been a few outstanding years with particular high landings (1994, 1996 and 2003 contributing 19, 17 and 20% of the total landings respectively). In the periods 1994 to 2002 and 2003 to 2009 the average contributions from area 4 was 8 and 3% respectively.

Several banks in the Norwegian EEZ have not provided landings for the last 8-12 years (Figure 4.4). These fishing banks are considered commercially depleted, i.e. the concentrations are too low to provide a profitable fishery. For several years after 2001 almost all landings from the Norwegian EEZ came from the Vestbank area (Figure 4.1.5).

Some of the more southerly banks were repopulated by new recruitment in 2006, but commercially depleted again in 2007 or 2008; Inner Shoal East and Outer Shoal were commercially depleted in 2007, and English Klondyke, which was closed after the RTM fishery in 2007, was commercially depleted in 2008. The main concentrations of sandeel in the Norwegian EEZ are again found in the Vestbank area (Figure 4.1.6). There are high concentrations on Inner Shoal West too, but this is a very small fishing ground. In the Vestbank area and Inner Shoal West there are natural refuges that prevent the fleet from depleting the local sandeel stocks.

Most of the fishing grounds in the Norwegian EEZ were commercially depleted during a period when the assessment suggested that SSB was well above Bpa. In addition, evidence from 2007 and 2008 suggests that fishing grounds can be commercially depleted within a few weeks without marked decreases in CPUE in tonnes (AGSAN 2009).

4.2 Sandeel in Area-1

4.2.1 Catch data

Total catch weight by year for area 1 is given in Tables 4.1.2-4.1.4. Catch numbers at age by half-year is given in Table 4.2.1.

In 2010 the proportion of 1-group in the catch was more than 90% (Figure 4.2.1). Such high proportion has been observed in other years as well.

4.2.2 Weight at age

The methods applied to compile age-length-weight keys and mean weights at age in the catches and in the stock are described in the Stock Annex.

The mean weights at age observed in the catch are given in Table 4.2.2 by half year. It is assumed that the mean weights in the sea are the same as in the catch. The time series of mean weight in the catch and in the stock is shown in Figure 4.2.2. From 2004 there is an increasing trend in mean weights for all age groups except for age group 0.

4.2.3 Maturity

Maturity estimates from 2005 onwards are obtained from the Danish dredge survey as described in the stock annex.

For 1983 to 2004 are applied the means of the period 2005-2010 (Table 4.2.3)

4.2.4 Natural mortality

As described in the Stock Annex values of natural mortality are obtained from a multispecies model where predation mortality is estimated (ICES, 2008).

Text table: Values for natural mortality by age and half year used in the assessments.

Age	First half year	Second half year
0		0.96
1	0.46	0.58
2	0.44	0.42
3	0.31	0.37
4+	0.28	0.36

4.2.5 Effort and research vessel data

Trends in overall effort and CPUE

The Tables 4.1.5-4.1.7 and Figure 4.2.3 show the trends in the international effort over years measured as number of fishing days standardised to a 200 GRT vessel. The standardisation includes just the effect of vessel size, and does not take changes in efficiency into account. Total international standardized effort peeked in 2001 (10500 days), and declined thereafter to the all time lowest (1776 days) in 2007. In the period 2005 to 2010 effort has been fluctuating around a mean of 3200 days. The average CPUE in the period 1994 to 2002 was 60 tons/day. In 2003 the CPUE declined to the all time lowest at 24 tons/day. Since 2004 the CPUE has increased and reached the all time highest (100 tons/day) in 2010.

Tuning series used in the assessments

No commercial tuning series are used in the present assessment.

In 2010, for the first time, a time series of stratified catch rates from a dredge survey was used to calibrate the assessment.

The internal consistency, i.e. the ability of the survey to follow cohorts, was evaluated by plotting catch rates of an age group in a given year versus the catch rates of the next age group in the following year. The internal consistency plot (Figure 4.2.4) shows a high consistency for age 0 and age 1.

Details about the dredge survey and the consistency analysis are given in the Stock Annex and the benchmark report (WKSAN, 2010).

4.2.6 Data analysis

Based on the results from the Benchmark assessment (WKSAN ,2010) the SMS-effort model was used to estimate fishing mortalities and stock numbers at age by half year, using data from 1983 to 2010. In the SMS model it is assumed that fishing mortality is proportional to fishing effort. For details about the SMS model and model settings, see the Stock Annex.

The diagnostics output from SMS are shown in Table 4.2.4. The seasonal effect on the relation between effort and F ("F, Season effect" in the table) is as expected rather constant over the three year ranges used, showing a stable relationship between effort and F for the full assessment period. The "age catchability" ("F, age effect" in the table) shows a change in the fishery where the fishery was mainly targeting the age 2+ sandeel in the beginning of the period, to a fishery mainly targeting age 1 and age 2 in the most recent years.

The CV of the dredge survey (Table 4.2.4) is low (0.26) for age 0 and medium (0.46) for age 1, showing a high consistency between the results from the dredge survey and the overall model results. The residual plot (Figure 4.2.5) shows no clear bias for this relatively short time series.

The model CV of catch at age is low (0.254) for age 1 and age 2 in the first half of the year and medium or high for the remaining ages and season combinations. The residual plots for catch at age (Figure 4.2.6) confirm that the fits is generally poor except for age 1 and 2 in the first half year. There is a cluster of negative residuals (observed catch is less than model catch) for age 4+ in most recent years, but for age 1 – age 3 there is no obvious bias in first half year catches in most recent years.

The CV of the fitted Stock recruitment relationship (table 4.2.4) is very high (0.77) which is also indicated by the stock recruitment plot (Figure 4.2.7). If recruitment in 1987 is excluded from the plot, there is no clear relationship between SSB and recruitment.

The retrospective analysis (Figure 4.2.8) shows a very consistent assessment results from one year to the next. This is probably due to the assumed relation ship between effort and F, which is rather insensitive to removal of a few years. However, it should be noted that the very short time series (2004-2009) of the dredge survey is actually too short to make a proper retrospective analysis.

Uncertainties of the estimated SSB, F and recruitment (Figure 4.2.9) are in general small, which gives relatively narrow 95% confidence limits (Figure 4.2.10). The confidence limits of SSB show that SSB has been above Blim since 2007 with a high probability.

The plot of standardised fishing effort and estimated F (Figure 4.2.11) show a clear relation between effort and F as specified by the model. As the model assumes a different efficiency and catchability for the three periods 1983-1988, 1989-1998 and 1999-2010, the relation between effort and F varies between these periods. It is clearly seen that an effort unit in 1983 gives a smaller F than one in the most recent years. This is due to technical creeping, i.e. a standard 200 GT vessel has become more efficient over time.

4.2.7 Final assessment

The output from the assessment is presented in Tables 4.2.5 (fishing mortality at age by half year), 4.2.6 (fishing mortality at age by year), 4.2.7 (stock numbers at age) and 4.2.8 (Stock summary).

4.2.8 Historic Stock Trends

The stock summary (Figure 4.2.12 and Table 4.2.8) shows that SSB have been at or below B_{lim} from 2000 to 2003 and again in 2005 and 2006. Since 2007 SSB has been above B_{pa}. $F_{(1-2)}$ is estimated to have been below the long time average since 2005.

4.2.9 Recruitment estimates

As no recruitment estimates from surveys are available until the results from the dredge survey in December become available, recruitment estimated in the assessments are based on commercial catch-at-age data exclusively. This estimate is too uncertain to be used in a forecast and the number has been removed from the summary table (Table 4.2.8).

4.2.10 Short-term forecasts

No recruitment estimates from surveys are available until data from the dredge survey in December become available. To provide an early prognosis for the relationship between recruitment in 2010 (age 1 in 2011) and TAC in 2011 a preliminary forecast is made based on assumptions of recruitment.

Input

Input to the short term forecast is given in Table 4.2.9. Stock numbers in the TAC year are taken from the assessment for age 2 and older. Recruitment in the second half year is the geometric mean of the recruitment 1983-2009 (222 billion at age 0). Age 1 is variable and various levels of long term recruitment are used in forecast. The exploitation pattern and Fsq is taken from the assessment values in 2010. As the SMS-model assumes a fixed exploitation pattern since 1999, the choice of year is not critical for. Mean weight at age in the catch and in the sea is the average value for the years 2008-2010. Proportion mature in 2011 is copied from the 2010 values (this will be updated by observations from the dredge survey in the January forecast). For 2012 the long term average proportion mature is applied. Natural mortality is the fixed M applied in the assessment.

The Stock annex gives more details about the forecast methodology.

Prognosis for 2011

Due to the large 2009 year-class, the preliminary prognosis for 2012 (Table 4.2.10) shows that a TAC of more than 200000 tonnes 2011 is possible given a low recruitment and the use of B $MSY_{trigger}$ at 215000 tonnes.

4.2.11 Stochastic short-term forecast.

Stochastic short term forecast will be provided in the January update of the assessment.

4.2.12 Biological reference points

B_{lim} is set at 160 000 tons and Bpa at 200 000 tons. B $MSY_{trigger}$ is set at Bpa.

Further information about biological reference points for sandeels in IV can be found in the Stock Annex.

4.2.13 Quality of the assessment

The quality of the present assessment is considered much improved compared to the combined assessment for whole North Sea previously presented by ICES. This is mainly due to the fact that the present division of stock assessment areas better reflects the actual spatial stock structure and dynamic of sandeel. Addition of fishery independent data from the dredge survey has also improved the quality of the assessment. Application of the new statistical assessment model SMS-effort has removed the retrospective bias in F and SSB for the most recent years. This is probably due to the robust model assumption of fishing mortality being proportional to fishing effort. This assumption in combination with the available data, give rather narrow confidence limits for the model estimates of F, SSB and recruitment.

The model uses effort as basis for the calculation of F. The total international effort is derived from Danish CPUE and total international landings. Danish catches are by far the weightiest in the area, but effort by the individual countries would improve the quality of the assessment.

4.2.14 Status of the Stock

The stock has recovered from the low levels of SSB estimated for 2000-2006, due to recent recruitments around the long term mean and a decrease in F from around 1.0 in the period 1999-2004 to around 0.5 since 2005. Recruitment in 2009 is estimated to be twice the long term mean. SSB has been above Bpa since 2007.

4.2.15 Management Considerations

A management plan needs to be developed. The ICES approach for MSY based management of a short-lived species as sandeel is the so-called escapement strategy, i.e. to maintain SSB above MSY $B_{trigger}$ after the fishery has taken place. With the present MSY $B_{trigger}$ at Bpa (215 000 tonnes) the preliminary forecast (Table 4.2.10) indicates that F is allowed to increase several times in case of an average recruitment. However, talking the historical F and stock development into account an F value above 0.6

is probably not recommendable. As effort is assumed proportional to F, an upper effort limit should be defined on the basis of the effort applied in the most recent years.

4.3 Sandeel in Area-2

4.3.1 Catch data

Total catch weight by year for area 2 is given in Tables 4.1.2-4.1.4. Catch numbers at age by half-year is given in Table 4.3.1.

In 2010 the proportion of 1-group in the catch was more than 80% (Figure 4.2.1). Such high proportion has been observed in other years as well.

4.3.2 Weight at age

The methods applied to compile age-length-weight keys and mean weights at age in the catches and in the stock are described in the Stock Annex.

The mean weights at age observed in the catch are given in Table 4.3.2 by half year. It is assumed that the mean weights in the sea are the same as in the catch. The time series of mean weight in the catch and in the stock is shown in Figure 4.3.2. From 2000 there is a general decrease in 1st half-year mean weights for all age.

4.3.3 Maturity

The dredge survey does not cover Area-2. Therefore means of the maturity estimates from Area-1 in the period 2005-2010 are used for the entire time series in Area-2.

The Danish dredge survey is described in the stock annex.

4.3.4 Natural mortality

As described in the Stock Annex values of natural mortality are obtained from a multispecies model where predation mortality is estimated (ICES, 2008).

Text table: Values for natural mortality by age and half year used in the assessments.

Age	First half year	Second half year
0		0.96
1	0.46	0.58
2	0.44	0.42
3	0.31	0.37
4+	0.28	0.36

4.3.5 Effort and research vessel data

Trends in overall effort and CPUE

Tables 4.1.5-4.1.7 and Figure 4.3.3 show the trends in the international effort over years measured as number of fishing days standardised to a 200 GRT vessel. The standardisation includes just the effect of vessel size, and does not take changes in efficiency into account.

Total international standardized effort has shown a clear drop from 13240 days in 1985 136 days in 2007. In 2010 the effort was 519 days. The CPUE increased from 1983 (36 tons/day) to 1994 (57 tons/day). Since 2004 the CPUE has increased and reached the all time highest (59 tons/day) in 2010.

Tuning series used in the assessments

No commercial tuning series are used in the present assessment.

The dredge survey does not cover Area-2. However, as there is a strong correlation between recruitments in Area-1 and Area-2 (Figure 4.3.4) the catch rate indices of age group 0 from Area-1 was used to calibrate the assessment of Area-2.

Details about the dredge survey and the consistency analysis are given in the Stock Annex and the benchmark report (WKSAN, 2010).

4.3.6 Data analysis

The diagnostics output from SMS-effort are shown in Table 4.3.4. The seasonal effect on the relation between effort and F ("F, Season effect" in the table) is as expected rather constant over the two year ranges used, showing a stable relationship between effort and F for the full assessment period. The "age catchability" ("F, age effect" in the table) and the "Exploitation pattern" show that the exploitation in the second year is highest for the most recent period 1999-2010.

The CV of the dredge survey (Table 4.3.4) is medium (0.36) for age 0 indicating a high consistency between the results from the dredge survey and the overall model results. The residual plot (Figure 4.3.5) shows no clear bias for this relatively short time series.

The model CV of catch at age 1 and 2 is medium (0.433) in the first half of the year and high for the remaining ages and season combinations. The residual plots for catch at age (Figure 4.3.6) confirm that the fits is generally poor except for age 1 and 2 in the first half year. There is a clusters of positive and negative and residuals for age 1 in the first half-year.

The CV of the fitted Stock recruitment relationship (table 4.3.4) is very high (0.993) which is also indicated by the stock recruitment plot (Figure 4.3.7).

The retrospective analysis (Figure 4.3.8) shows a reasonable consistent assessment results from one year to the next. This is probably due to the assumed relationship between effort and F, which is rather insensitive to removal of a few years. However, it should be noted that the very short time series (2004-2009) of the dredge survey is actually too short to make a proper retrospective analysis.

Uncertainties of the estimated SSB, F and recruitment (Figure 4.3.9) are in general medium to high, which gives rather wide confidence limits (Figure 4.3.10).

The plot of standardised fishing effort and estimated F (Figure 4.3.11) show a clear relation between effort and F as specified by the model. As the model assumes a different efficiency and catchability for the two periods 1983-1998, 1998-2010, the relation between effort and F varies between these periods. It is seen that an effort unit prior to 1998 gives a smaller F than one in the most recent years. This indicates of technical creep, i.e. a standard 200 GT vessel has become more efficient over time.

4.3.7 Final assessment

The output from the assessment is presented in Tables 4.3.5 (fishing mortality at age by half year), 4.3.6 (fishing mortality at age by year), 4.3.7 (stock numbers at age) and 4.3.8 (Stock summary).

4.3.8 Historic Stock Trends

The stock summary (Figure 4.3.12 and Table 4.3.8) show that recruitment has been highly variable but without a clear trend fro the whole time series. SSB has decreased considerably from 1999 to 2002 where SSB was below Blim. From 2004 SSB has increased and SSB was just below Bpa in 2010 and clearly above Bpa in 2010. $F_{(1-2)}$ is estimated to have been below the long time average since 2005.

4.3.9 Recruitment estimates

As no recruitment estimates from surveys are available until the results from the dredge survey in December become available, recruitment estimated in the assessments are based on commercial catch-at-age data exclusively. This estimate is too uncertain to be used in a forecast and the number has been removed from the summary table (Table 4.3.8).

4.3.10 Short-term forecasts

No recruitment estimates from surveys are available until data from the dredge survey in December become available. To provide an early prognosis for the relationship between recruitment in 2010 (age 1 in 2011) and TAC in 2011 a preliminary forecast is made based on assumptions of recruitment.

Input

Input to the short term forecast is given in Table 4.3.9. Stock numbers for age 2 and older in the TAC year are taken from the assessment. Recruitment in the second half year is the geometric mean of the recruitment 1983-2009 (44.499 billion at age 0). Age 1 is variable and various levels of long term recruitment are used in forecast. The exploitation pattern and Fsq is taken from the assessment values in 2010. As the SMS-model assumes a fixed exploitation pattern since 1999, the choice of year is not critical for. Mean weight at age in the catch and in the sea is the average value for the years 2008-2010. Proportion mature in 2011 is copied from the 2010 values (this will be updated by observations from the dredge survey in the January forecast). For 2012 the long term average proportion mature is applied. Natural mortality is the fixed M applied in the assessment.

The Stock annex gives more details about the forecast methodology.

Prognosis for 2011

Due to the large 2009 year-class, the preliminary prognosis for 2011 (Table 4.3.10) shows that a TAC of more than 52 000 tonnes is possible given a low recruitment and the use of B $MSY_{trigger}$ at 100 000 tonnes.

4.3.11 Stochastic short-term forecast.

Stochastic short term forecast will be provided in the January update of the assessment.

4.3.12 Biological reference points

B_{lim} is set at 70 000 tons and Bpa at 100 000 tons. B $MSY_{trigger}$ is set at Bpa.

Further information about biological reference points can be found in the Stock Annex.

4.3.13 Quality of the assessment

The quality of the present assessment is considered much improved compared to the combined assessment for whole North Sea previously presented by ICES. This is mainly due to the fact that the present division of stock assessment areas better reflects the actual spatial stock structure and dynamic of sandeel. Addition of fishery independent data from the dredge survey has also improved the quality of the assessment although it would be preferable to have area specific survey data. Application of the new statistical assessment model SMS-effort has removed the retrospective bias in F and SSB for the most recent years. This is probably due to the robust model assumption of fishing mortality being proportional to fishing effort. This assumption in combination with the available data, give reasonable confidence limits for the model estimates of F, SSB and recruitment.

There is no fishery independent data from area 2. The present use of data from the dredge survey in area 1 improves the quality of the assessment, but a real survey covering the main fishing banks in area 2 should be established as soon as possible.

The model uses effort as basis for the calculation of F. The total international effort is derived from Danish CPUE and total international landings. Danish catches are by far the weightiest in the area, but effort by the individual countries would improve the quality of the assessment.

4.3.14 Status of the Stock

Due to low value of F (around 0.1) since 2007 and the strong 2009 year class, SSB in 2010 is around twice as high as Bpa.

4.3.15 Management Considerations

A management plan needs to be developed. The ICES approach for MSY based management of a short-lived species as sandeel is the so-called escapement strategy, i.e. to maintain SSB above MSY $B_{trigger}$ after the fishery has taken place. With the present MSY $B_{trigger}$ at Bpa (100 000 tonnes) the preliminary forecast (Table 4.3.10) indicates that F is allowed to increase several times in case of an average recruitment. However, talking the historical F and stock development into account an F value above 0.4-0.5 is probably not recommendable. Such F ceiling can be expressed as an effort ceiling for management usage as effort is assumed proportional to F.

4.4 Sandeel in Area-3

4.4.1 Catch data

Total catch weight by year for area 3 is given in Tables 4.1.2-4.1.4. Catch numbers at age by half-year is given in Table 4.4.1.

In 2010 the proportion of 1-group in the catch was around 80%, and age 2 and age 3 with around 10% each (Figure 4.4.1). The proportion of 0-groups in the catch has been very low since 2004.

Section 4.1.5 gives a detailed description of landings by fishing banks in the northern part of Area-3.

4.4.2 Weight at age

The methods applied to compile age-length-weight keys and mean weights at age in the catches and in the stock are described in the Stock Annex.

The mean weights at age observed in the catch are given in Table 4.4.2 by half year. It is assumed that the mean weights in the sea are the same as in the catch. The time series of mean weight in the catch and in the stock is shown in Figure 4.4.2. The mean weights of age 4 have been very variable over the full time series.

4.4.3 Maturity

Maturity estimates from 2005 onwards are obtained from the Danish dredge survey as described in the stock annex.

For 1983 to 2004 are applied the means of the period 2005-2010 (Table 4.4.3)

4.4.4 Natural mortality

As described in the Stock Annex values of natural mortality are obtained from a multispecies model where predation mortality is estimated (ICES, 2008).

Text table: Values for natural mortality by age and half year used in the assessments.

Age	First half year	Second half year
0		0.96
1	0.46	0.58
2	0.44	0.42
3	0.31	0.37
4+	0.28	0.36

4.4.5 Effort and research vessel data

Trends in overall effort and CPUE

Tables 4.1.5-4.1.7 and Figure 4.4.3 show the trends in the international effort over years measured as number of fishing days standardised to a 200 GRT vessel. The standardisation includes just the effect of vessel size, and does not take changes in efficiency into account. Total international standardized effort peeked in 1998 (12176 days), and declined thereafter to less than 2000 days since 2005. CPUE has fluctuated without a clear trend over the full time series, with minimum CPUE in 2003.

Tuning series used in the assessments

No commercial tuning series are used in the present assessment.

In 2010, for the first time, a time series of stratified catch rates from a dredge survey was used to calibrate the assessment.

The internal consistency, i.e. the ability of the survey to follow cohorts, was evaluated by plotting catch rates of an age group in a given year versus the catch rates of the next age group in the following year. The internal consistency plot (Figure 4.4.4) shows a high consistency for age 0 and medium consistency for age 1.

Details about the dredge survey and the consistency analysis are given in the Stock Annex and the benchmark report (WKSAN, 2010).

4.4.6 Data analysis

The diagnostics output from SMS-effort model are shown in Table 4.4.4. The seasonal effect on the relation between effort and F ("F, Season effect" in the table) is quite different over the three year ranges used. One effort unit applied in the first half year in the period 1989-1998 produces more than twice the fishing mortality in the second half year (ratio between 1.251 and 0.500). Right now this cannot be explained. The "age catchability" ("F, age effect" in the table) shows a change in the fishery where the fishery was mainly targeting the age 2+ sandeel in the beginning of the period, to a fishery mainly targeting age 1 and age 2 in the most recent years.

The CV of the dredge survey (Table 4.4.4) is low (0.37) for age 0 and high (1.04) for age 1, showing a medium consistency between the results from the dredge survey and the overall model results. Catchability for the ages has been combined, as the independent estimates were not statistical different. The residual plot (Figure 4.4.5) shows no clear bias for this relatively short time series.

The model CV of catch at age is high (0.468) for age 1 and age 2 in the first half of the year. For the older ages and for all ages in the second half year, the CVs are very high. The residual plots for catch at age (Figure 4.4.6) confirm that the fits is generally very poor except for age 1 and 2 in the first half year. There is a cluster of negative residuals (observed catch is less than model catch) for age 4+ in most recent years, but for age 1 – age 3 there is no obvious bias in first half year catches in most recent years.

The CV of the fitted Stock recruitment relationship (table 4.4.4) is very high (0.77) which is also indicated by the stock recruitment plot (Figure 4.4.7). The very high recruitment in 1996 is a clear outlier

The retrospective analysis (Figure 4.4.8) shows a very consistent assessment results from one year to the next. This is probably due to the assumed relationship between effort and F, which is rather insensitive to removal of a few years. However, it should be noted that the very short time series (2004-2009) of the dredge survey is actually too short to make a proper retrospective analysis.

Uncertainties of the estimated SSB, F and recruitment (Figure 4.4.9) are in general large, which gives wide confidence limits (Figure 4.4.10).

The plot of standardised fishing effort and estimated F (Figure 4.4.11) show a clear relation between effort and F as specified by the model. As the model assumes a different catchability at age for the three periods 1983-1988, 1989-1998 and 1999-2010, and as the seasonal distribution of the fishery is variable from one year to the next, the relation between effort and F varies between these periods. There is a shift in the ratio between effort and F over the full time series. In the year range 1989-1998 F is in general lower than effort on the plot, while the opposite is the case for the remaining periods. This is probably due to fact that F presented on the graph is the mean F(age1-age2) while a substantial part of the effort in 1989-1998 has been use to target the 0-group sandeel in the second half year.

4.4.7 Final assessment

The output from the assessment is presented in Tables 4.4.5 (fishing mortality at age by half year), 4.4.6 (fishing mortality at age by year), 4.4.7 (stock numbers at age) and 4.4.8 (Stock summary).

4.4.8 Historic Stock Trends

The stock summary (Figure 4.4.12 and Table 4.4.8) shows that SSB have been at or below B_{lim} from 2001 to 2007 after which it has increased. SSB in 2010 is estimated above Bpa, but drops below Bpa in 2011. $F_{(1-2)}$ is estimated to have been below the long time average since 2005. Recruitment seems to have been at a lower level since the very high recruitment in 1996.

4.4.9 Recruitment estimates

As no recruitment estimates from surveys are available until the results from the dredge survey in December become available, recruitment estimated in the assessments are based on commercial catch-at-age data exclusively. This estimate is too uncertain to be used in a forecast and the number has been removed from the summary table (Table 4.4.8).

4.4.10 Short-term forecasts

No recruitment estimates from surveys are available until data from the dredge survey in December become available. To provide an early prognosis for the relationship between recruitment in 2010 (age 1 in 2011) and TAC in 2011 a preliminary forecast is made based on assumptions of recruitment.

Input

Input to the short term forecast is given in Table 4.4.9. Stock numbers in the TAC year are taken from the assessment for age 2 and older. Recruitment in the second half year is the geometric mean of the recruitment 1983-2009 (106 billion at age 0). Age 1 is variable and various levels of long term recruitment are used in forecast. The exploitation pattern and Fsq is taken from the assessment values in 2010. As the SMS-model assumes a fixed exploitation pattern since 1999, the choice of year is not critical for. Mean weight at age in the catch and in the sea is the average value for the years 2008-2010. Proportion mature in 2011 is copied from the 2010 values (this will be updated by observations from the dredge survey in the January forecast). For 2012 the long term average proportion mature is applied. Natural mortality is the fixed M applied in the assessment.

The Stock annex gives more details about the forecast methodology.

Prognosis for 2011

An SSB below Bpa in 2011 in combination with a below average recruitment in 2009 will just bring SSB above $MSY_{trigger}$ (195 000 tonnes) in 2012, if the recruitment in 2010 is more than half of the long term recruitment. For lower recruitment there can be no landings in 2011. Recruitment in 2010 at the geometric mean will allow a TAC at 114000t in 2001, given the MSY, escapement strategy is followed.

4.4.11 Stochastic short-term forecast.

Stochastic short term forecast will be provided in the January update of the assessment.

4.4.12 Biological reference points

B_{lim} is set at 100 000 t and Bpa is estimated to 195 000 tons. B $MSY_{trigger}$ is set at Bpa. Further information about biological reference points can be found in the Stock Annex.

4.4.13 Quality of the assessment

In the assessments for the combined “North Sea sandeel stock” previously done by ICES, catches of sandeel in the Northern North Sea (mainly area 3 sandeel) have decreased far more than sandeel from the Southern North Sea (mainly area 1 sandeel). This heterogeneity is one of reason for the present assessments by area. While the quality (based on confidence limits of SSB and F) is high the quality of the area 3 assessment is low. This is partly due to quality of input to the assessment. There is no Norwegian effort data available with the right resolution. In the absence Norwegian effort has been estimated on the basis of Norwegian landings and the assumption that Danish and Norwegian CPUE are the same. Observed Norwegian effort would probably increase the quality of the assessment as the Norwegian fleet in general fish more northerly than the Danish, especially in the most recent years with limitations on the access to the Norwegian EEZ.

The dredge survey covers mainly the southern part of area 3. A northerly extension of the survey area will probably increase the quality of the survey results for assessment purpose.

Application of the new statistical assessment model SMS-effort has no retrospective bias in F and SSB for the most recent years, in contrast to the assessment for the combined North Sea stock. This is probably due to the robust model assumption of fishing mortality being proportional to fishing effort.

4.4.14 Status of the Stock

The stock has increased from the record low SSB in 2004 at half of Blim to above Bpa in 2010. SSB in 2010 is estimated to be just below Bpa in 2011. Recruitment was above the long term mean in 2006 and has been below since. F has been below the long term mean since 2004, however highly variable between years.

4.4.15 Management Considerations

A management plan needs to be developed for area 3 sandeel. Area 3 comprises both Norwegian and EU EEZ however there is no agreement between the parties on management of the stock. The EU fishery has previously been part of the Real Time Monitoring system, while the Norwegian EEZ has been managed based on a system of closed areas in combination with acoustic estimates of the stock size. Both approaches might be applicable in the future, but even though the new assessment for area 3 sandeel is considered uncertain, it might be adequate as the basis for TAC advice. Extension of the area covered by the dredge survey will probably decrease the assessment uncertainty.

4.5 Sandeel in Area-4

4.5.1 Catch data

Total catch weight by year for area 4 is given in Tables 4.1.2-4.1.4.

Catch numbers at age by half-year is given in Table 4.5.1.

4.5.2 Weight at age

The methods applied to compile age-length-weight keys and mean weights at age in the catches and in the stock are described in the Stock Annex.

The mean weights at age observed in the catch are given in Table 4.5.2 by half year. It is assumed that the mean weights in the sea are the same as in the catch. The time series of mean weight in the catch and in the stock is shown in Figure 4.5.1. The mean weights of age 4 have been very variable over the full time series.

4.5.3 Effort and research vessel data

Trends in overall effort and CPUE

Tables 4.1.5-4.1.7 and Figure 4.5.2 show the trends in the international effort over years measured as number of fishing days standardised to a 200 GRT vessel. The standardisation includes just the effect of vessel size, and does not take changes in efficiency into account. The figure also shows the development in CPUE.

Tuning series used in the assessments

Scottish dredge survey data (text table) available from Area-4 indicates a strong 2009 year class. See Stock Annex for details.

Text table. Scottish dredge survey data.

Year	Age 0	Age 1	Age 2
1999	170	143	116
2000	251	505	136
2001	48	329	251
2002	88	114	179
2003	135	-1	-1
2004	-1	-1	-1
2005	-1	-1	-1
2006	-1	-1	-1
2007	-1	-1	-1
2008	68	24	24
2009	983	164	50

4.6 Sandeel in Area-5

4.6.1 Catch data

Total catch weight by year for area 5 is given in Tables 4.1.2-4.1.4.

4.7 Sandeel in Area-6

4.7.1 Catch data

Total catch weight by year for area 6 is given in Tables 4.1.2-4.1.4.

4.8 Sandeel in Area-7

4.8.1 Catch data

Total catch weight by year for area 7 is given in Tables 4.1.2-4.1.4.

Table 4.1.1. SANDEEL in the North Sea. Landings ('000 t), 1952-2010. (Data provided by Working Group Members)

(Data provided by Working Group members.)

Year	Denmark	Germany	Faroes	Ireland	Netherlands	Norway	Sweden	UK	Lithuania	Total
1955	37.6	+	-	-	-	-	-	-	-	37.6
1956	81.9	5.3	-	-	+	1.5	-	-	-	88.7
1957	73.3	25.5	-	-	3.7	3.2	-	-	-	105.7
1958	74.4	20.2	-	-	1.5	4.8	-	-	-	100.9
1959	77.1	17.4	-	-	5.1	8.0	-	-	-	107.6
1960	100.8	7.7	-	-	+	12.1	-	-	-	120.6
1961	73.6	4.5	-	-	+	5.1	-	-	-	83.2
1962	97.4	1.4	-	-	-	10.5	-	-	-	109.3
1963	134.4	16.4	-	-	-	11.5	-	-	-	162.3
1964	104.7	12.9	-	-	-	10.4	-	-	-	128.0
1965	123.6	2.1	-	-	-	4.9	-	-	-	130.6
1966	138.5	4.4	-	-	-	0.2	-	-	-	143.1
1967	187.4	0.3	-	-	-	1.0	-	-	-	188.7
1968	193.6	+	-	-	-	0.1	-	-	-	193.7
1969	112.8	+	-	-	-	-	-	0.5	-	113.3
1970	187.8	+	-	-	-	+	-	3.6	-	191.4
1971	371.6	0.1	-	-	-	2.1	-	8.3	-	382.1
1972	329.0	+	-	-	-	18.6	8.8	2.1	-	358.5
1973	273.0	-	1.4	-	-	17.2	1.1	4.2	-	296.9
1974	424.1	-	6.4	-	-	78.6	0.2	15.5	-	524.8
1975	355.6	-	4.9	-	-	54.0	0.1	13.6	-	428.2
1976	424.7	-	-	-	-	44.2	-	18.7	-	487.6
1977	664.3	-	11.4	-	-	78.7	5.7	25.5	-	785.6
1978	647.5	-	12.1	-	-	93.5	1.2	32.5	-	786.8
1979	449.8	-	13.2	-	-	101.4	-	13.4	-	577.8
1980	542.2	-	7.2	-	-	144.8	-	34.3	-	728.5
1981	464.4	-	4.9	-	-	52.6	-	46.7	-	568.6
1982	506.9	-	4.9	-	-	46.5	0.4	52.2	-	610.9
1983	485.1	-	2.0	-	-	12.2	0.2	37.0	-	536.5
1984	596.3	-	11.3	-	-	28.3	-	32.6	-	668.5
1985	587.6	-	3.9	-	-	13.1	-	17.2	-	621.8
1986	752.5	-	1.2	-	-	82.1	-	12.0	-	847.8
1987	605.4	-	18.6	-	-	193.4	-	7.2	-	824.6
1988	686.4	-	15.5	-	-	185.1	-	5.8	-	892.8
1989	824.4	-	16.6	-	-	186.8	-	11.5	-	1039.1
1990	496.0	-	2.2	-	0.3	88.9	-	3.9	-	591.3
1991	701.4	-	11.2	-	-	128.8	-	1.2	-	842.6
1992	751.1	-	9.1	-	-	89.3	0.5	4.9	-	854.9
1993	482.2	-	-	-	-	95.5	-	1.5	-	579.2
1994	603.5	-	10.3	-	-	165.8	-	5.9	-	785.5
1995	647.8	-	-	-	-	263.4	-	6.7	-	917.9
1996	601.6	-	5.0	-	-	160.7	-	9.7	-	776.9
1997	751.9	-	11.2	-	-	350.1	-	24.6	-	1137.8
1998	617.8	-	11.0	-	+	343.3	8.5	23.8	-	1004.4
1999	500.1	-	13.2	0.4	+	187.6	22.4	11.5	-	735.1
2000	541.0	-	-	-	+	119.0	28.4	10.8	-	699.1
2001	630.8	-	-	-	-	183.0	46.5	1.3	-	861.6
2002	629.7	-	-	-	-	176.0	0.1	4.9	-	810.7
2003	274.0	-	-	-	-	29.6	21.5	0.5	-	325.6
2004	277.1	2.7	-	-	-	48.5	33.2	+	-	361.5
2005	154.8	-	-	-	-	17.3	-	-	-	172.1
2006	250.6	3.2	-	-	-	5.6	27.8	-	-	287.9
2007	144.6	1.0	2.0	-	-	51.1	6.6	1.0	-	206.3
2008	234.4	4.4	2.4	-	-	81.6	12.4	-	-	335.2
2009	285.7	12.2	2.5	-	1.8	27.4	12.1	3.6	2.0	347.4
2010	275.1	17.0	-			78.0	32.0		0.2	402.4

*** Preliminary**

+ = less than half unit.

- = no information or no catch.

Table 4.1.2. Total catch (tonnes) by area

Year	Area 1	Area 2	Area 3	Area 4	Area 5	Area 6	Area 7	All
1983	349397	74479	100330	2588	2815	0	37201	566810
1984	467664	63077	118651	2443	6103	0	33161	691098
1985	424058	96658	57835	37060	2929	0	17320	635858
1986	382912	93104	414911	12505	10517	0	14023	927973
1987	357714	53292	400402	8108	1535	0	7367	828417
1988	398221	120387	387994	1324	2450	0	4953	915330
1989	446151	109830	492999	4389	2040	909	0	1056318
1990	283148	100920	219023	3313	605	499	0	607508
1991	347102	107812	368801	41429	2532	17	0	867694
1992	564287	69848	195733	68905	4551	4277	0	907600
1993	136600	59848	296232	133197	401	4490	0	630768
1994	209631	50648	444084	159789	2765	3748	0	870666
1995	410687	60143	266720	52759	150637	1830	0	942776
1996	324561	80205	250252	162338	6176	1263	0	824796
1997	431871	102730	608164	59353	11279	2373	2068	1217839
1998	371060	68950	507269	58460	2984	936	5182	1014841
1999	428307	32117	228163	53959	140	134	4263	747083
2000	363356	52235	256250	37748	325	680	4370	714964
2001	521724	58645	253088	47828	1687	312	976	884260
2002	599585	35553	209344	12213	10	2378	521	859604
2003	150711	56262	62569	64002	44	869	261	334718
2004	206696	71426	87695	6915	0	570	0	373302
2005	103777	41447	29667	1486	0	262	0	176640
2006	238296	35392	18867	85	0	161	0	292802
2007	109363	5910	113905	11	4	661	0	229855
2008	238523	13065	94576	1201	0	472	0	347836
2009	310471	10239	34052	0	0	260	0	355022
2010	285794	30530	78067	262	0	132	0	394785
arith. mean	337917	62670	235559	36917	7590	973	4702	686327

Table 4.1.3 Total catch (tonnes) by area, first half year

Year	Area 1	Area 2	Area 3	Area 4	Area 5	Area 6	Area 7	All
1983	290179	60159	61072	2588	2815	0	37201	454014
1984	391851	44714	89171	2443	6103	0	33161	567443
1985	354907	71396	32224	36844	2929	0	17320	515619
1986	347787	70461	242720	12328	6564	0	14023	693884
1987	302494	34079	396376	7789	1535	0	7367	749639
1988	368887	104551	312107	1244	2450	0	4953	794192
1989	433511	100567	447941	4387	510	897	0	987812
1990	257760	96481	138344	2925	0	485	0	495995
1991	268214	69466	290400	17164	2532	17	0	647794
1992	520041	56894	163533	67068	4551	4270	0	816357
1993	119275	43221	209228	123199	195	4393	0	499510
1994	190869	23473	388488	148007	2763	3222	0	756821
1995	372896	25371	242186	52665	150632	1829	0	845578
1996	289986	58639	102168	45209	1827	1168	0	498997
1997	349671	52649	514991	48410	9021	2194	1654	978590
1998	353605	42984	382308	56934	2881	935	4525	844172
1999	393869	23013	101596	51769	140	21	2078	572487
2000	322880	36493	247827	37748	310	679	3805	649742
2001	356462	33526	82525	47404	1687	52	739	522395
2002	595335	20905	207937	12213	10	2378	116	838894
2003	128752	46618	27886	62533	44	816	187	266837
2004	191061	53186	68170	6893	0	569	0	319878
2005	100678	32044	28563	1486	0	262	0	163034
2006	233961	22054	15811	55	0	160	0	272040
2007	109357	5910	113905	11	4	660	0	229848
2008	235131	9752	94450	1201	0	472	0	341005
2009	292593	9873	22124	0	0	259	0	324849
2010	282020	21730	75472	262	0	132	0	379616
arith. mean	301930	45365	182126	30385	7125	924	4540	572394

Table 4.1.4. Total catch (tonnes) by area, second half year

Year	Area 1	Area 2	Area 3	Area 4	Area 5	Area 6	Area 7	All
1983	59218	14319	39258	0	0	0	0	112796
1984	75813	18363	29480	0	0	0	0	123655
1985	69151	25262	25610	216	0	0	0	120239
1986	35125	22643	172191	176	3954	0	0	234089
1987	55220	19212	4026	319	0	0	0	78778
1988	29334	15836	75888	80	0	0	0	121138
1989	12640	9263	45058	2	1530	12	0	68506
1990	25387	4439	80679	388	605	14	0	111513
1991	78888	38346	78400	24266	0	0	0	219900
1992	44245	12954	32200	1837	0	6	0	91243
1993	17325	16627	87004	9998	207	97	0	131258
1994	18762	27175	55596	11783	3	526	0	113845
1995	37791	34773	24534	94	5	1	0	97198
1996	34575	21566	148084	117129	4349	95	0	325799
1997	82201	50082	93173	10943	2258	179	414	239249
1998	17455	25966	124961	1526	102	1	657	170669
1999	34438	9104	126567	2189	0	113	2185	174596
2000	40475	15743	8423	0	15	1	565	65221
2001	165262	25118	170563	425	0	261	237	361865
2002	4250	14648	1407	0	0	0	405	20710
2003	21960	9644	34683	1468	0	53	73	67881
2004	15635	18239	19526	22	0	2	0	53424
2005	3098	9404	1104	0	0	0	0	13606
2006	4335	13339	3057	30	0	0	0	20762
2007	6	0	0	0	0	1	0	7
2008	3392	3313	126	0	0	0	0	6831
2009	17878	366	11929	0	0	0	0	30173
2010	3773	8800	2595	0	0	0	0	15168
arith. mean	35987	17305	53433	6532	465	49	162	113933

Table 4.1.5. Effort (days fishing for a standard 200 GT vessel)

Year	Area 1	Area 2	Area 3	Area 4	All
1983	8277	2089	3214	59	13639
1984	9629	1851	3436	46	14961
1985	9889	3150	2090	633	15762
1986	7318	1937	7420	278	16953
1987	5358	1133	5287	175	11953
1988	7459	2884	9311	41	19695
1989	8574	2847	11903	56	23380
1990	7853	3031	7078	51	18013
1991	6402	2216	8220	344	17181
1992	9065	1619	5011	570	16265
1993	3669	1712	8124	1327	14833
1994	3423	895	7628	1597	13543
1995	6013	1205	4977	423	12618
1996	6130	1761	6394	1453	15738
1997	5567	2245	10988	646	19447
1998	6729	1862	12176	623	21390
1999	8614	905	6705	812	17037
2000	6878	1261	5511	408	14058
2001	10547	1537	5973	664	18721
2002	8071	1187	4240	136	13635
2003	6186	2035	2781	1145	12147
2004	6985	2393	3147	213	12738
2005	2905	1112	904	84	5005
2006	4314	1015	567	2	5897
2007	1776	136	2062	1	3976
2008	2974	311	1819	8	5112
2009	4204	234	658	0	5096
2010	2837	519	2067	4	5427
arith. mean	6344	1610	5346	421	13722

Table 4.1.6 Effort (days fishing for a standard 200 GT vessel) first half year

Year	Area 1	Area 2	Area 3	Area 4	All
1983	6399	1701	2284	59	10443
1984	7461	1097	2455	46	11059
1985	7908	2307	1228	630	12074
1986	6548	1331	4657	276	12812
1987	4217	625	5156	159	10157
1988	6628	2451	7014	39	16133
1989	8186	2587	10296	56	21124
1990	7224	2926	4839	46	15034
1991	4870	1350	6567	112	12900
1992	8000	1317	4245	308	13871
1993	3195	1232	5409	1155	10992
1994	3056	408	6585	1417	11467
1995	5362	572	4467	422	10822
1996	5445	1148	2816	469	9877
1997	4127	898	8371	509	13905
1998	6205	957	7934	587	15683
1999	7543	643	2975	812	11973
2000	5961	771	5296	408	12437
2001	7694	906	2268	651	11519
2002	7893	576	4138	136	12743
2003	5348	1566	1462	1070	9447
2004	6536	1675	2362	212	10784
2005	2860	821	870	84	4636
2006	4184	624	500	2	5310
2007	1776	136	2062	1	3976
2008	2895	213	1812	8	4927
2009	3987	228	474	0	4689
2010	2733	338	1992	4	5067
arith. mean	5509	1122	3948	346	10924

Table 4.1.7. Effort (days fishing for a standard 200 GT vessel) second half year

Year	Area 1	Area 2	Area 3	Area 4	All
1983	1878	388	931	0	3196
1984	2168	754	981	0	3902
1985	1981	842	862	3	3688
1986	770	606	2763	3	4141
1987	1142	509	131	16	1797
1988	831	433	2297	2	3562
1989	389	260	1607	0	2256
1990	630	105	2239	5	2979
1991	1531	866	1652	232	4282
1992	1064	302	766	262	2394
1993	474	480	2715	172	3841
1994	367	487	1043	179	2076
1995	651	634	510	1	1797
1996	685	614	3578	984	5860
1997	1441	1347	2617	138	5542
1998	524	905	4242	36	5707
1999	1072	262	3730	0	5064
2000	917	490	215	0	1621
2001	2853	631	3705	13	7202
2002	179	611	103	0	892
2003	838	469	1318	75	2701
2004	449	718	785	2	1954
2005	45	290	33	0	369
2006	129	390	67	0	587
2007	0	0	0	0	0
2008	79	98	8	0	185
2009	217	6	184	0	407
2010	104	181	75	0	360
arith. mean	836	488	1398	76	2799

Table 4.2.1. Area-1 Sandeel. Catch at age numbers (millions) by half year

Year/Age	Age 0, 2nd half	Age 1, 1st half	Age 1, 2nd half	Age 2, 1st half	Age 2, 2nd half	Age 3, 1st half	Age 3, 2nd half	Age 4+, 1st half	Age 4+, 2nd half
1983	9738	2435	256	28479	2846	766	519	314	2
1984	0	46342	9275	1726	95	9736	567	324	43
1985	7074	6035	1140	30210	1959	1932	1331	214	177
1986	176	45968	3938	7643	217	1650	173	31	13
1987	160	4538	1670	23378	3486	1188	102	170	27
1988	688	1924	67	8158	169	14246	1353	2201	45
1989	194	61943	912	6230	85	1380	15	4601	52
1990	1398	15554	1331	12330	426	1825	63	551	19
1991	8660	16366	6827	6827	206	1001	66	344	0
1992	1451	50586	3022	8649	295	873	121	542	26
1993	1958	2054	439	5621	312	1464	178	440	52
1994	0	24171	1885	2841	137	1284	56	970	100
1995	22	37430	3776	6355	1002	747	117	293	28
1996	5096	12531	1271	14658	1232	4965	239	954	76
1997	0	38993	8912	2388	176	3641	168	726	56
1998	250	9627	466	28301	1228	2143	124	1470	70
1999	1135	45248	2880	5480	231	10130	805	613	162
2000	8399	32806	2773	3242	148	467	54	681	78
2001	59325	56332	2993	8182	414	1050	41	828	69
2002	16	83678	490	10574	90	1177	13	214	3
2003	2575	3729	412	11456	4351	852	113	210	24
2004	608	30373	2613	677	100	2224	229	453	48
2005	53	9902	326	3337	139	143	5	222	11
2006	42	32935	656	2447	64	750	28	142	12
2007	0	10429	1	4666	0	312	0	171	0
2008	8	27196	267	4057	61	1213	23	217	5
2009	1075	19242	2471	14088	313	1546	14	393	4
2010	10	38644	521	2041	17	905	1	105	0
arit. mean	3933	27393	2200	9430	707	2486	233	657	43

Table 4.2.2 Area-1 Sandeel. Individual mean weight(g) at age in the catch and in the sea

Year/Age	Age 0, 2nd half	Age 1, 1st half	Age 1, 2nd half	Age 2, 1st half	Age 2, 2nd half	Age 3, 1st half	Age 3, 2nd half	Age 4+, 1st half	Age 4+, 2nd half
1983	2.4	5.5	7.8	10.0	10.8	13.9	14.2	17.0	17.7
1984	3.4	5.5	7.5	10.1	11.6	13.8	14.2	17.0	17.7
1985	2.4	5.5	7.7	10.0	11.4	13.9	14.6	17.9	19.3
1986	2.8	5.5	7.6	10.0	11.2	13.8	14.1	16.3	18.8
1987	1.3	5.8	9.0	11.0	10.8	15.6	21.4	18.1	19.8
1988	3.0	4.0	13.2	12.5	15.5	15.5	17.1	18.7	19.6
1989	5.0	4.0	10.1	12.5	14.4	15.5	17.0	18.0	19.0
1990	2.3	4.1	10.8	12.5	14.8	15.8	18.1	19.9	21.5
1991	2.7	8.1	7.5	16.4	13.6	17.1	12.1	17.7	44.0
1992	5.3	7.4	9.5	13.7	16.6	17.6	20.0	23.0	22.6
1993	5.0	7.8	8.6	12.0	11.5	15.0	15.7	21.5	21.4
1994	3.4	6.1	8.2	9.4	18.7	13.9	24.5	22.1	27.7
1995	2.6	8.2	7.4	12.2	10.7	15.1	15.2	20.5	20.4
1996	4.4	5.9	6.9	8.8	10.9	12.5	13.8	18.9	22.0
1997	3.3	7.5	8.9	8.4	15.0	10.1	16.2	14.8	16.9
1998	3.6	6.6	7.6	9.2	10.9	12.0	13.1	13.9	15.9
1999	4.7	5.6	6.5	7.8	9.8	10.7	12.0	12.7	14.2
2000	4.1	7.0	6.2	9.5	9.4	11.8	11.2	13.9	13.6
2001	2.5	4.8	3.8	9.0	8.9	11.9	12.1	16.8	17.5
2002	4.5	6.2	7.6	7.8	9.5	10.2	11.5	14.3	15.2
2003	2.6	3.8	3.2	7.3	4.2	9.0	9.4	11.3	8.8
2004	4.2	5.4	5.4	8.5	7.4	9.4	7.5	10.9	10.1
2005	3.7	6.7	5.8	9.2	7.8	10.8	9.3	12.0	10.6
2006	3.5	6.2	5.3	10.3	8.0	12.4	9.4	13.7	11.2
2007	4.4	5.7	5.7	9.8	9.6	13.9	12.1	15.2	13.1
2008	2.5	6.5	8.7	11.3	12.6	13.8	14.5	16.5	17.6
2009	4.6	7.0	6.2	10.7	11.3	13.7	13.5	14.9	14.2
2010	2.9	6.5	7.0	12.7	11.7	14.2	13.8	17.6	16.5
arith. mean	3.5	6.0	7.5	10.4	11.4	13.3	14.2	16.6	18.1

Table 4.2.3. Sandeel in Area-1. Percent mature.

	Age				
Year	0	1	2	3	4
1983-2004	0	2	83	1	1
2005	0	6	98	100	100
2006	0	1	90	100	100
2007	0	1	94	78	100
2008	0	2	97	89	100
2009	0	0	61	73	100
2010	0	1	56	85	100
2011	0	1	56	85	100

Table 4.2.4. Area-1 Sandeel. SMS settings and statistics.

```
objective function (negative log likelihood):  16.8887
Number of parameters: 52
Maximum gradient: 7.38245e-005
Akaike information criterion (AIC):   137.777
Number of observations used in the likelihood:
                            Catch    CPUE     S/R Stomach     Sum
                             280      12      27       0     319

objective function weight:
                          Catch  CPUE   S/R
                          1.00  0.50  0.01

unweighted objective function contributions (total):
                Catch    CPUE    S/R    Stom.  Penalty     Sum
               20.2    -6.7     6.5     0.0 0.00e+000    20.0


unweighted objective function contributions (per observation):
                Catch   CPUE     S/R   Stomachs
               0.07   -0.56    0.23    0.00

F, season effect:
-----------------
age: 0
    1983-1988:   0.000 1.000
    1989-1998:   0.000 1.000
    1999-2010:   0.000 1.000
age: 1 - 4
    1983-1988:   0.494 0.500
    1989-1998:   0.470 0.500
    1999-2010:   0.410 0.500

F, age effect:
--------------
                0      1      2      3      4
1983-1988:  0.028  0.295  1.272  2.160  2.160
1989-1998:  0.056  0.852  1.381  1.470  1.470
1999-2010:  0.067  1.782  1.950  1.224  1.224


Exploitation pattern (scaled to mean F=1)
-----------------------------------------
                        0      1      2      3      4
1983-1988 season 1:  0.000  0.290  1.252  2.126  2.126
          season 2:  0.016  0.086  0.372  0.631  0.631

1989-1998 season 1:  0.000  0.726  1.178  1.253  1.253
          season 2:  0.005  0.037  0.059  0.063  0.063

1999-2010 season 1:  0.000  0.814  0.891  0.559  0.559
          season 2:  0.011  0.141  0.154  0.097  0.097
```

Table 4.2.4 (continued). Area-1 Sandeel. SMS settings and statistics.

```
sqrt(catch variance) ~ CV:
--------------------------

              season
----------------------
age        1       2

 0               1.068
 1       0.254   0.716
 2       0.254   0.716
 3       0.682   1.284
 4       0.682   1.284


Survey catchability:
--------------------           age 0    age 1
 Dredge survey 2004-2009       1.879    0.915

sqrt(Survey variance) ~ CV:
---------------------------    age 0    age 1
 Dredge survey 2004-2009        0.26     0.46

Recruit-SSB              alfa       beta      recruit s2    recruit s
Hockey stick -break.:    1427.718   1.600e+005   0.594        0.771
```

Table 4.2.5. Area-1 Sandeel. Fishing mortality at age

Year/Age	Age 0, 2nd half	Age 1, 1st half	Age 1, 2nd half	Age 2, 1st half	Age 2, 2nd half	Age 3, 1st half	Age 3, 2nd half	Age 4+, 1st half	Age 4+, 2nd half
1983	0.009	0.158	0.047	0.679	0.202	1.153	0.342	1.153	0.342
1984	0.010	0.179	0.053	0.771	0.226	1.309	0.385	1.309	0.385
1985	0.009	0.185	0.047	0.799	0.202	1.357	0.344	1.357	0.344
1986	0.003	0.152	0.018	0.653	0.078	1.109	0.132	1.109	0.132
1987	0.005	0.097	0.027	0.418	0.114	0.709	0.194	0.709	0.194
1988	0.004	0.152	0.019	0.656	0.083	1.115	0.141	1.115	0.141
1989	0.003	0.511	0.026	0.829	0.042	0.882	0.045	0.882	0.045
1990	0.006	0.452	0.042	0.732	0.068	0.780	0.072	0.780	0.072
1991	0.013	0.304	0.102	0.493	0.165	0.525	0.176	0.525	0.176
1992	0.009	0.500	0.071	0.811	0.115	0.863	0.122	0.863	0.122
1993	0.004	0.200	0.031	0.324	0.051	0.345	0.054	0.345	0.054
1994	0.003	0.191	0.024	0.310	0.040	0.330	0.042	0.330	0.042
1995	0.006	0.335	0.043	0.543	0.070	0.579	0.075	0.579	0.075
1996	0.006	0.340	0.046	0.552	0.074	0.587	0.079	0.587	0.079
1997	0.013	0.258	0.096	0.418	0.155	0.445	0.165	0.445	0.165
1998	0.005	0.388	0.035	0.629	0.057	0.669	0.060	0.669	0.060
1999	0.011	0.860	0.149	0.941	0.163	0.591	0.102	0.591	0.102
2000	0.010	0.680	0.128	0.744	0.140	0.467	0.088	0.467	0.088
2001	0.030	0.878	0.397	0.960	0.434	0.603	0.273	0.603	0.273
2002	0.002	0.900	0.025	0.985	0.027	0.618	0.017	0.618	0.017
2003	0.009	0.610	0.117	0.667	0.128	0.419	0.080	0.419	0.080
2004	0.005	0.745	0.062	0.816	0.068	0.512	0.043	0.512	0.043
2005	0.000	0.326	0.006	0.357	0.007	0.224	0.004	0.224	0.004
2006	0.001	0.477	0.018	0.522	0.020	0.328	0.012	0.328	0.012
2007	0.000	0.203	0.000	0.222	0.000	0.139	0.000	0.139	0.000
2008	0.001	0.330	0.011	0.361	0.012	0.227	0.008	0.227	0.008
2009	0.002	0.453	0.031	0.496	0.034	0.311	0.022	0.311	0.022
2010	0.001	0.312	0.014	0.341	0.016	0.214	0.010	0.214	0.010
arith. mean	0.006	0.399	0.060	0.608	0.100	0.622	0.110	0.622	0.110

Table 4.2.6. Sandeel in Area-1 : Annual Fishing mortality (F) at age

Year/Age	Age 0	Age 1	Age 2	Age 3	Age 4	Avg. 1-2
1983	0.009	0.238	0.966	1.625	1.625	0.602
1984	0.010	0.270	1.093	1.837	1.837	0.681
1985	0.009	0.274	1.106	1.853	1.853	0.690
1986	0.003	0.208	0.835	1.390	1.388	0.521
1987	0.005	0.145	0.589	0.993	0.993	0.367
1988	0.004	0.210	0.843	1.404	1.402	0.526
1989	0.003	0.665	1.007	1.058	1.055	0.836
1990	0.006	0.604	0.918	0.966	0.965	0.761
1991	0.013	0.467	0.718	0.764	0.765	0.593
1992	0.009	0.687	1.047	1.105	1.103	0.867
1993	0.004	0.280	0.427	0.451	0.450	0.353
1994	0.003	0.263	0.401	0.423	0.422	0.332
1995	0.006	0.460	0.701	0.739	0.738	0.580
1996	0.006	0.468	0.714	0.753	0.751	0.591
1997	0.013	0.404	0.623	0.664	0.664	0.514
1998	0.005	0.519	0.789	0.830	0.829	0.654
1999	0.011	1.190	1.237	0.777	0.777	1.214
2000	0.010	0.954	0.991	0.622	0.621	0.972
2001	0.030	1.414	1.483	0.939	0.940	1.448
2002	0.002	1.135	1.173	0.735	0.732	1.154
2003	0.009	0.859	0.892	0.560	0.559	0.876
2004	0.005	0.980	1.014	0.635	0.634	0.997
2005	0.000	0.419	0.431	0.267	0.267	0.425
2006	0.001	0.616	0.635	0.395	0.394	0.626
2007	0.000	0.259	0.265	0.164	0.164	0.262
2008	0.001	0.428	0.440	0.273	0.273	0.434
2009	0.002	0.597	0.616	0.384	0.383	0.607
2010	0.001	0.408	0.419	0.261	0.260	0.414
arith. mean	0.006	0.551	0.799	0.817	0.816	0.675

Table 4.2.7. Area-1 : Stock numbers (millions). Age 0 at start of 2nd half-year, age 1+ at start of 1st half-year

Year/Age	Age 0	Age 1	Age 2	Age 3	Age 4
1983	650005	17613	60739	2805	294
1984	148856	246710	5075	10656	353
1985	951797	56438	69187	792	1027
1986	154757	361242	15812	10757	172
1987	73000	59056	107760	3221	1601
1988	376861	27812	18448	26783	1003
1989	177910	143776	8280	3726	4015
1990	234808	67890	29707	1467	1586
1991	334777	89412	14647	5646	674
1992	73089	126482	21063	3211	1597
1993	306875	27726	25259	3532	922
1994	458975	117015	7778	7348	1527
1995	111329	175176	33343	2321	3122
1996	683172	42385	42405	7638	1468
1997	108749	260020	10184	9598	2386
1998	186642	41118	64515	2428	3323
1999	239241	71137	9523	13756	1438
2000	412169	90580	9163	1335	3862
2001	554488	156307	14278	1602	1558
2002	28666	206054	15446	1498	680
2003	230429	10956	28875	2375	592
2004	97942	87458	1872	5517	920
2005	269141	37325	13780	327	1883
2006	149838	103004	9461	4053	922
2007	346986	57294	22189	2329	1807
2008	113776	132858	16538	7523	1856
2009	464299	43528	33384	4818	3789
2010		177356	9476	8313	3182
2011			45239	2806	4707

Table 4.2.8. Area-1 : Estimated recruitment, total stock biomass (TBS), spawning stock biomass (SSB), landings weight (Yield) and average fishing mortality.

Year	Recruits (million)	TSB (tonnes)	SSB (tonnes)	Yield (tonnes)	Mean F ages 1-2
1983	650005	747154	548582	377381	0.602
1984	148856	1563100	222208	491891	0.681
1985	951797	1030160	608142	436271	0.690
1986	154757	2300570	323001	388901	0.521
1987	73000	1607170	1069990	360824	0.367
1988	376861	777628	628006	401603	0.526
1989	177910	814662	227815	445130	0.836
1990	234808	704655	368697	283149	0.761
1991	334777	1074350	322081	346616	0.593
1992	73089	1316230	351197	564295	0.867
1993	306875	590245	327992	135619	0.353
1994	458975	919421	210889	234961	0.332
1995	111329	1943680	465157	443219	0.580
1996	683172	745971	438292	332759	0.591
1997	108749	2158480	242898	444290	0.514
1998	186642	943295	575599	391833	0.654
1999	239241	635826	234873	449138	1.214
2000	412169	786669	154075	328592	0.972
2001	554488	919012	166567	531194	1.448
2002	28666	1433390	150829	625424	1.154
2003	230429	281254	204583	135748	0.876
2004	97942	549010	84341	214794	0.997
2005	269141	404560	165887	105035	0.425
2006	149838	796711	156787	244493	0.626
2007	346986	605378	266804	112356	0.262
2008	113776	1188990	333173	247273	0.434
2009	464299	781756	339268	335406	0.607
2010	NA	NA	252984	293734	0.414
2011		NA	444316*		
arith. mean	284040	1037775	340863	346497	0.675
geo. mean	222116				

***excl. a very small contribution from Age 1**

Table 4.2.9. Sandeel in Area-1. Input values for preliminary short term forecast

	Age 0	Age 1	Age 2	Age 3	Age 4
Stock numbers (2011)	222116	input	45239	2806	4706
Exploitation patttern 1st half		0.312	0.341	0.214	0.214
Exploitation patttern 2nd half	0.001	0.014	0.016	0.010	0.010
Weight in the stock 1st half		6.65	11.54	13.91	16.33
Weight in the catch 1st half		6.65	11.54	13.91	16.33
weight in the catch 2nd half	3.33	7.28	11.85	13.95	16.06
Proportion mature(2011)	0	0.01	0.56	1	1
Proportion mature(2012)	0	0.02	0.83	1	1
Natural mortality 1st half		0.46	0.44	0.31	0.28
Natural mortality 2nd half	0.96	0.58	0.42	0.37	0.36

Table 4.2.10. Sandeel in Area-1. Preliminary forecast for various assumptions of recruitment in 2010.

Basis: Fsq=F(2010)=0.342; Yield(2010)=294; Recruitment(2010)= input; Recruitment(2011)= geometric mean(GM) = 222 billion; SSB(2011)=409

F multiplier	Basis: Recruitment (2010)	F(2011)	Landings (2011)	SSB (2012)	%SSB change*	%TAC change**
1.467	GM* 0	0.501	202	215	-47%	-31%
1.961	GM* 0.2	0.670	296	215	-47%	1%
2.389	GM* 0.4	0.816	390	215	-48%	33%
2.765	GM* 0.6	0.944	485	215	-48%	65%
3.1	GM* 0.8	1.059	580	215	-48%	98%
3.402	GM* 1	1.162	676	215	-48%	130%

***SSB in 2012 relative to SSB in 2011**

**** TAC in 2011 relative to landings in 2010**

Table 4.3.1. Area-2 Sandeel. Catch numbers (millions) by half year

Year/Age	Age 0, 2nd half	Age 1, 1st half	Age 1, 2nd half	Age 2, 1st half	Age 2, 2nd half	Age 3, 1st half	Age 3, 2nd half	Age 4+, 1st half	Age 4+, 2nd half
1983	2417	480	66	5920	650	159	117	65	0
1984	0	5302	2237	210	24	1090	136	36	10
1985	2674	1221	426	6036	727	392	501	46	67
1986	213	9356	2429	1508	135	313	102	6	8
1987	56	512	581	2633	1213	134	36	19	9
1988	156	555	15	2332	92	4019	789	621	26
1989	127	14288	669	1399	63	342	11	1015	39
1990	351	5752	206	4669	64	691	10	209	3
1991	4202	4556	3322	1648	100	251	32	86	0
1992	458	5408	869	1136	85	122	35	76	8
1993	153	736	220	1249	531	692	185	211	43
1994	0	1849	2243	296	342	172	192	78	86
1995	0	1131	430	1009	1623	103	190	65	146
1996	90	700	538	1273	443	1555	344	280	68
1997	2	6004	6789	227	116	270	82	177	47
1998	0	32	3	2370	1459	252	115	348	161
1999	292	243	98	101	37	874	299	247	77
2000	0	1064	619	351	186	338	130	813	173
2001	2242	259	356	1157	620	147	81	473	257
2002	3	2448	1329	120	189	110	34	58	29
2003	244	136	27	3460	624	387	84	149	24
2004	0	5054	1330	409	209	626	293	120	54
2005	3	1786	459	1425	339	154	34	305	92
2006	2	1796	1014	383	118	157	56	47	23
2007	0	298	0	198	0	36	0	6	0
2008	0	985	208	148	78	66	48	9	7
2009	17	410	106	680	2	22	0	1	0
2010	1	2393	1540	137	42	360	32	58	5
arith. mean	489	2670	1005	1517	361	494	142	201	52

Table 4.3.2. Area-2 Sandeel. Individual mean weight(g) at age in the catch and in the sea

Year/Age	Age 0, 2nd half	Age 1, 1st half	Age 1, 2nd half	Age 2, 1st half	Age 2, 2nd half	Age 3, 1st half	Age 3, 2nd half	Age 4+, 1st half	Age 4+, 2nd half
1983	2.5	5.5	8.5	10.0	11.1	13.9	14.3	17.0	17.7
1984	4.0	5.5	7.6	10.3	12.3	13.8	14.2	17.0	17.7
1985	2.4	5.5	7.5	10.0	10.9	14.2	14.2	19.9	18.8
1986	2.9	5.5	7.9	10.2	12.1	14.1	14.1	16.3	18.8
1987	1.3	5.8	9.0	11.0	10.8	15.6	21.4	18.1	19.8
1988	3.0	4.1	13.2	12.5	14.6	15.5	17.0	18.7	19.3
1989	5.0	4.1	10.1	12.5	14.3	15.6	17.0	18.0	19.0
1990	2.6	4.0	11.0	12.5	15.7	15.6	19.4	19.5	23.0
1991	2.7	8.0	7.5	16.3	13.6	17.4	12.1	18.5	44.0
1992	5.3	7.1	9.5	12.8	16.6	17.9	20.0	25.5	22.6
1993	6.3	8.7	12.7	16.3	16.2	18.2	18.5	22.4	23.5
1994	4.0	7.8	7.7	14.8	14.2	19.3	18.5	20.5	19.7
1995	7.3	9.0	11.5	13.5	14.3	18.2	19.0	21.9	22.8
1996	8.2	11.8	12.7	14.8	15.9	17.6	18.1	21.6	22.5
1997	3.3	8.4	7.4	13.2	13.5	15.2	14.6	16.7	15.8
1998	4.0	9.2	6.5	13.7	14.5	16.2	17.3	18.3	18.7
1999	5.4	11.6	10.9	14.3	14.2	16.7	16.6	19.2	19.3
2000	4.0	11.1	12.0	14.7	13.9	17.3	18.7	19.8	20.5
2001	4.8	11.1	7.3	14.4	13.4	18.2	18.0	22.2	21.6
2002	3.1	7.3	8.8	12.3	14.1	15.3	16.4	18.6	18.8
2003	6.8	9.3	10.5	10.8	11.1	14.3	15.2	18.8	17.8
2004	4.2	7.7	8.6	11.7	12.0	13.7	13.8	15.7	15.7
2005	3.8	7.5	8.7	9.6	11.7	11.8	13.6	14.0	14.8
2006	3.1	8.8	11.0	10.9	11.9	13.0	13.4	14.6	14.4
2007	4.4	9.0	5.7	13.6	9.6	16.0	12.1	18.9	13.1
2008	3.1	7.6	9.4	13.5	13.2	13.9	13.8	14.6	14.6
2009	3.8	7.1	3.3	10.0	3.8	15.3	12.8	14.2	14.2
2010	2.9	6.4	5.7	11.0	9.4	11.7	13.8	13.3	16.4
arith. mean	4.1	7.7	9.0	12.5	12.8	15.5	16.0	18.4	19.5

Table 4.3.3. Area-2 Sandeel. Proportion mature at age

Year/Age	Age 1	Age 2	Age 3	Age 4
1983-2010	0.02	0.83	1	1

Table 4.3.4. Area-2 Sandeel. SMS settings and statistics.

```
objective function (negative log likelihood):  87.0541
Number of parameters: 45
Maximum gradient: 7.79502e-005
Akaike information criterion (AIC):   264.108
Number of observations used in the likelihood:
              Catch    CPUE     S/R Stomach     Sum
               280       6      27       0     313

objective function weight:
                          Catch  CPUE   S/R
                          1.00  0.25  0.01

unweighted objective function contributions (total):
              Catch    CPUE    S/R    Stom.  Penalty     Sum
               87.7    -3.1    13.3     0.0 0.00e+000    97.9


unweighted objective function contributions (per observation):
               Catch   CPUE     S/R   Stomachs
               0.31   -0.52    0.48    0.00



F, season effect:
-----------------
age: 0
    1983-1998:   0.000 1.000
    1999-2010:   0.000 1.000
age: 1 - 4
    1983-1998:   0.547 0.500
    1999-2010:   0.338 0.500

F, age effect:
--------------
                0      1      2      3      4
1983-1998:  0.020  0.283  0.694  0.662  0.662
1999-2010:  0.008  0.742  1.521  1.289  1.289


Exploitation pattern (scaled to mean F=1)
-----------------------------------------
                        0      1      2      3      4
1983-1998 season 1:  0.000  0.479  1.176  1.121  1.121
          season 2:  0.014  0.100  0.245  0.234  0.234

1999-2010 season 1:  0.000  0.409  0.839  0.711  0.711
          season 2:  0.006  0.246  0.505  0.428  0.428
```

Table 4.3.4 (continued). Area-2 Sandeel. SMS settings and statistics.

sqrt(catch variance) ~ CV:

	season	
age	1	2
0		1.690
1	0.433	0.882
2	0.433	0.882
3	1.146	1.091
4	1.146	1.091

Survey catchability:

	age 0
Dredge survey 2004-2009	8.518

sqrt(Survey variance) ~ CV:

	age 0
Dredge survey 2004-2009	0.36

Recruit-SSB	alfa	beta	recruit s2	recruit s
Hockey stick -break.:	672.720	7.000e+004	0.986	0.993

Table 4.3.5. Area-2 Sandeel. Fishing mortality at age

Year/Age	Age 0, 2nd half	Age 1, 1st half	Age 1, 2nd half	Age 2, 1st half	Age 2, 2nd half	Age 3, 1st half	Age 3, 2nd half	Age 4+, 1st half	Age 4+, 2nd half
1983	0.005	0.175	0.036	0.429	0.090	0.409	0.085	0.409	0.085
1984	0.010	0.110	0.069	0.270	0.169	0.257	0.162	0.257	0.162
1985	0.011	0.226	0.076	0.554	0.185	0.528	0.177	0.528	0.177
1986	0.008	0.129	0.054	0.316	0.132	0.301	0.125	0.301	0.125
1987	0.006	0.060	0.045	0.147	0.110	0.140	0.104	0.140	0.104
1988	0.005	0.235	0.038	0.577	0.093	0.551	0.089	0.551	0.089
1989	0.003	0.246	0.023	0.604	0.056	0.575	0.053	0.575	0.053
1990	0.001	0.279	0.009	0.684	0.022	0.652	0.021	0.652	0.021
1991	0.011	0.128	0.075	0.315	0.185	0.300	0.176	0.300	0.176
1992	0.004	0.125	0.026	0.308	0.065	0.293	0.062	0.293	0.062
1993	0.006	0.117	0.042	0.288	0.102	0.274	0.098	0.274	0.098
1994	0.006	0.039	0.042	0.095	0.104	0.091	0.099	0.091	0.099
1995	0.008	0.054	0.055	0.134	0.135	0.127	0.129	0.127	0.129
1996	0.008	0.109	0.053	0.268	0.131	0.256	0.125	0.256	0.125
1997	0.017	0.086	0.117	0.210	0.288	0.200	0.274	0.200	0.274
1998	0.011	0.091	0.079	0.224	0.193	0.213	0.184	0.213	0.184
1999	0.001	0.099	0.060	0.204	0.123	0.173	0.104	0.173	0.104
2000	0.003	0.119	0.112	0.244	0.229	0.207	0.194	0.207	0.194
2001	0.003	0.140	0.144	0.287	0.295	0.243	0.250	0.243	0.250
2002	0.003	0.089	0.140	0.182	0.286	0.155	0.242	0.155	0.242
2003	0.002	0.242	0.107	0.496	0.220	0.420	0.186	0.420	0.186
2004	0.004	0.259	0.164	0.531	0.336	0.450	0.285	0.450	0.285
2005	0.002	0.127	0.066	0.260	0.136	0.220	0.115	0.220	0.115
2006	0.002	0.096	0.089	0.198	0.183	0.167	0.155	0.167	0.155
2007	0.000	0.021	0.000	0.043	0.000	0.037	0.000	0.037	0.000
2008	0.001	0.033	0.022	0.067	0.046	0.057	0.039	0.057	0.039
2009	0.000	0.037	0.002	0.075	0.003	0.064	0.003	0.064	0.003
2010	0.001	0.052	0.041	0.107	0.085	0.091	0.072	0.091	0.072
arith. mean	0.005	0.126	0.064	0.290	0.143	0.266	0.129	0.266	0.129

Table 4.3.6. Sandeel Area-2 : Annual Fishing mortality (F) at age

Year/Age	Age 0	Age 1	Age 2	Age 3	Age 4	Avg. 1-2
1983	0.005	0.252	0.583	0.553	0.552	0.418
1984	0.010	0.195	0.457	0.440	0.442	0.326
1985	0.011	0.348	0.807	0.770	0.770	0.577
1986	0.008	0.207	0.482	0.461	0.462	0.345
1987	0.006	0.112	0.263	0.254	0.255	0.188
1988	0.005	0.330	0.759	0.719	0.718	0.545
1989	0.003	0.332	0.759	0.716	0.715	0.545
1990	0.001	0.362	0.825	0.776	0.774	0.593
1991	0.011	0.223	0.524	0.504	0.505	0.373
1992	0.004	0.181	0.419	0.397	0.397	0.300
1993	0.006	0.183	0.426	0.406	0.406	0.304
1994	0.006	0.083	0.197	0.191	0.193	0.140
1995	0.008	0.113	0.267	0.260	0.261	0.190
1996	0.008	0.182	0.425	0.408	0.408	0.304
1997	0.017	0.201	0.479	0.469	0.472	0.340
1998	0.011	0.178	0.421	0.408	0.410	0.300
1999	0.001	0.174	0.341	0.292	0.293	0.258
2000	0.003	0.240	0.474	0.409	0.411	0.357
2001	0.003	0.292	0.578	0.500	0.502	0.435
2002	0.003	0.222	0.444	0.388	0.391	0.333
2003	0.002	0.393	0.766	0.652	0.653	0.580
2004	0.004	0.459	0.901	0.771	0.773	0.680
2005	0.002	0.214	0.419	0.358	0.358	0.317
2006	0.002	0.193	0.382	0.329	0.331	0.287
2007	0.000	0.027	0.052	0.043	0.043	0.039
2008	0.001	0.060	0.117	0.101	0.101	0.089
2009	0.000	0.048	0.093	0.078	0.077	0.071
2010	0.001	0.099	0.196	0.168	0.169	0.147
arith. mean	0.005	0.211	0.459	0.422	0.423	0.335

Table 4.3.7. Sandeel Area-2 : Stock numbers (millions). Age 0 at start of 2nd half-year, age 1+ at start of 1st half-year

Year/Age	Age 0	Age 1	Age 2	Age 3	Age 4
1983	129039	4302	11979	770	51
1984	36279	49152	1231	3017	254
1985	239519	13755	14526	336	1094
1986	38183	90729	3596	2934	369
1987	18511	14509	26722	973	1097
1988	113583	7043	4618	8747	839
1989	63973	43256	1894	999	2572
1990	85091	24416	11686	415	993
1991	98407	32538	6471	2440	374
1992	32674	37277	9381	1661	890
1993	125012	12464	11321	2736	920
1994	59875	47583	3758	3243	1290
1995	20841	22788	15506	1303	1921
1996	197692	7917	7218	5013	1294
1997	3037	75121	2378	2049	2202
1998	13397	1144	21677	612	1369
1999	40849	5072	341	6046	693
2000	10791	15620	1529	104	2600
2001	108112	4121	4382	403	953
2002	6509	41260	1096	1036	431
2003	62657	2484	11603	290	506
2004	27937	23933	619	2401	226
2005	43054	10657	5542	110	641
2006	25954	16460	3105	1578	281
2007	69068	9918	4833	898	687
2008	24194	26446	3433	1959	788
2009	159724	9259	8844	1297	1279
2010	1562	61155	3150	3461	1246
2011			19684	1100	2049

Table 4.3.8. Sandeel Area-2 : Estimated recruitment, total stock biomass (TBS), spawning stock biomass (SSB), landings weight (Yield) and average fishing mortality.

Year	Recruits (million)	TSB (tonnes)	SSB (tonnes)	Yield (tonnes)	Mean F ages 1-2
1983	129039	154808	111150	80485	0.418
1984	36279	329405	61832	66320	0.326
1985	239519	247276	148355	99416	0.577
1986	38183	585890	87955	94648	0.345
1987	18511	413158	280721	53755	0.188
1988	113583	237935	199945	121389	0.545
1989	63973	264764	85230	109565	0.545
1990	85091	270710	149190	100958	0.593
1991	98407	415712	142340	107647	0.373
1992	32674	435895	157234	69824	0.300
1993	125012	363159	225951	60874	0.304
1994	59875	515762	142560	51065	0.140
1995	20841	480283	243342	62234	0.190
1996	197692	316028	206581	82871	0.304
1997	3037	728901	106639	114078	0.340
1998	13397	343308	282386	69452	0.300
1999	40849	178125	119633	33238	0.258
2000	10791	249793	75594	55001	0.357
2001	108112	137261	81753	61428	0.435
2002	6509	338957	41093	37658	0.333
2003	62657	161989	118116	57524	0.580
2004	27937	228188	46129	73063	0.680
2005	43054	142837	55987	42814	0.317
2006	25954	203394	55542	36396	0.287
2007	69068	181868	83626	6032	0.039
2008	24194	286650	81271	14300	0.089
2009	159724	192684	113073	10510	0.071
2010			93408	31478	0.147
2011			219571[1]		
arith. mean	66269	317350	131593	64429	0.335
geo. mean	44499				

[1]excl. a very small contribution from Age 1

Table 4.3.9. Sandeel in Area-2. Input values for preliminary short term forecast.

	Age 0	Age 1	Age 2	Age 3	Age 4
Stock numbers(2011)	44499	input	19684	1100	2049
Exploitation patttern 1st half	NA	0.052	0.107	0.091	0.091
Exploitation patttern 2nd half	0.001	0.041	0.085	0.072	0.072
Weight in the stock 1st half	NA	7.03	11.52	13.61	14.05
Weight in the catch 1st half	NA	7.03	11.52	13.61	14.05
weight in the catch 2nd half	3.27	6.13	8.81	13.50	15.07
Proportion mature(2011)	0	0.02	0.83	1	1
Proportion mature(2012)	0	0.02	0.83	1	1
Natural mortality 1st half	NA	0.46	0.44	0.31	0.28
Natural mortality 2nd half	0.96	0.58	0.42	0.37	0.36

Table 4.3.10. Sandeel in Area-2. Preliminary short term forecast for different assumptions about recruitment.

Basis: Fsq=F(2010)=0.143; Yield(2010)=31; Recruitment(2011)= geometric mean (GM) = 2 billion; SSB(2011)=232

F multiplier	Basis: Recruitment(2010)	F(2011)	Landings (2011)	SSB (2012)	%SSB Change*	%TAC Change**
1.792	GM* 0.0	0.256	52	100	-57%	64%
2.326	GM* 0.2	0.332	68	100	-57%	115%
2.859	GM* 0.4	0.408	84	100	-57%	167%
3.389	GM* 0.6	0.484	100	100	-57%	219%
3.916	GM* 0.8	0.559	117	100	-57%	271%
4.437	GM* 1.0	0.633	134	100	-57%	325%

***SSB in 2012 relative to SSB in 2011**

**** TAC in 2011 relative to landings in 2010**

Table 4.4.1. Area-3 Sandeel. Catch numbers (millions) by half year

Year/Age	Age 0, 2nd half	Age 1, 1st half	Age 1, 2nd half	Age 2, 1st half	Age 2, 2nd half	Age 3, 1st half	Age 3, 2nd half	Age 4+, 1st half	Age 4+, 2nd half
1983	8254	6551	315	1634	353	109	24	16	0
1984	0	11134	1740	1393	168	478	63	15	0
1985	810	792	228	1135	488	293	196	135	24
1986	9431	33296	9608	3637	640	288	10	0	1
1987	20	33853	251	14140	52	459	1	201	0
1988	13658	7108	1328	18710	363	1013	223	28	21
1989	2661	56711	3180	2248	216	3371	0	33	0
1990	13606	12170	1950	3674	409	544	61	165	18
1991	19000	32271	1339	1888	43	709	12	248	4
1992	5550	14005	124	5593	11	668	3	419	1
1993	23267	19377	1428	865	244	336	89	1652	16
1994	0	45466	2566	7918	1250	1015	165	426	24
1995	2873	28112	1055	2393	182	338	26	176	32
1996	34618	4672	8917	2860	115	411	36	360	266
1997	3214	89081	11945	4255	213	900	14	222	10
1998	31377	4292	1071	30566	845	2762	226	315	34
1999	12349	5453	2551	1584	163	2045	558	445	233
2000	0	25715	779	3617	7	584	3	633	15
2001	25320	8079	6724	1205	14	193	4	197	12
2002	0	22844	107	3706	5	719	2	183	0
2003	9231	1183	127	911	97	144	3	87	3
2004	1832	7975	1341	663	31	127	14	171	2
2005	1	3091	51	252	47	33	5	22	9
2006	0	2078	177	84	41	36	27	6	26
2007	0	14895	0	630	0	87	0	19	0
2008	0	7531	9	2201	3	469	0	77	0
2009	65	3251	1773	185	138	28	26	2	1
2010	0	6602	454	706	12	906	10	155	1
arith. mean	7755	18128	2183	4238	220	681	64	229	27

Table 4.4.2. Area-3 Sandeel. Individual mean weight(g) at age in the catch and in the sea

Year/Age	Age 0, 2nd half	Age 1, 1st half	Age 1, 2nd half	Age 2, 1st half	Age 2, 2nd half	Age 3, 1st half	Age 3, 2nd half	Age 4+, 1st half	Age 4+, 2nd half
1983	3.0	5.6	13.2	12.6	26.6	26.5	31.8	39.6	17.7
1984	4.1	5.6	13.0	12.9	27.8	17.2	34.7	22.9	17.7
1985	2.9	5.6	12.6	12.5	26.3	26.7	32.8	43.0	46.4
1986	3.0	5.6	13.1	13.0	27.5	26.7	14.1	16.3	18.8
1987	2.9	5.6	12.9	13.0	13.4	27.1	21.4	43.7	19.8
1988	3.0	5.6	13.2	13.1	27.4	26.6	27.6	34.2	40.1
1989	5.0	6.2	8.9	14.0	16.0	16.3	17.0	18.0	19.0
1990	3.0	5.6	13.1	13.0	27.0	27.1	35.0	43.8	42.5
1991	3.4	7.4	9.4	14.3	14.8	22.3	15.7	30.6	44.0
1992	5.5	5.5	12.1	10.9	18.6	18.5	20.0	29.8	22.6
1993	3.1	6.3	8.2	15.9	17.0	17.0	22.1	23.6	23.2
1994	4.1	6.3	10.6	14.3	24.2	22.2	40.0	23.0	31.6
1995	5.3	6.1	8.8	10.9	10.9	15.2	14.7	17.3	17.4
1996	3.1	8.4	6.2	14.1	17.8	27.2	20.3	39.4	30.7
1997	3.1	5.3	7.1	9.6	10.2	14.1	14.9	18.8	15.1
1998	3.3	5.2	7.2	10.4	15.4	14.1	17.6	20.8	21.3
1999	5.2	7.7	9.4	10.4	12.7	14.6	13.8	26.8	20.1
2000	4.3	7.6	10.3	11.5	13.7	17.0	17.4	22.6	17.3
2001	3.5	6.9	5.2	14.3	10.2	18.8	10.4	24.0	15.1
2002	4.1	7.1	9.7	12.8	14.3	12.9	14.8	20.4	21.3
2003	3.8	5.5	5.4	15.1	15.7	20.9	24.3	27.6	32.3
2004	5.3	6.9	7.5	9.4	12.9	14.2	16.8	14.4	11.6
2005	3.8	7.8	8.6	16.3	11.2	19.5	12.8	22.5	14.4
2006	4.1	7.0	10.3	13.1	12.6	16.9	14.4	25.6	15.9
2007	6.0	7.2	11.6	15.4	17.1	22.8	20.7	15.5	23.0
2008	4.1	6.9	9.5	15.3	12.1	22.8	15.9	26.5	13.7
2009	9.9	7.4	6.9	12.0	14.7	25.3	24.4	14.2	14.2
2010	2.9	6.3	5.7	17.5	9.4	21.0	13.8	24.7	16.4
arith. mean	4.1	6.4	9.6	13.1	17.1	20.4	20.7	26.1	23.0

Table 4.4.3. Area-3 Sandeel. Proportion mature at age

Year/Age	Age 1	Age 2	Age 3	Age 4
1983-2004	0.05	0.77	1	1
2005	0.12	0.96	1	1
2006	0.08	0.78	1	1
2007	0.02	0.80	1	1
2008	0.03	0.69	1	1
2009	0.01	0.48	1	1
2010	0.04	0.92	1	1

Table 4.4.4. Area-3 Sandeel. SMS settings and statistics.

```
objective function (negative log likelihood):  102.498
Number of parameters: 51
Maximum gradient: 5.17442e-005
Akaike information criterion (AIC):   306.997
Number of observations used in the likelihood:
                            Catch    CPUE     S/R Stomach     Sum
                             280      12      27       0     319

objective function weight:
                          Catch  CPUE   S/R
                          1.00  0.50  0.01

unweighted objective function contributions (total):
                Catch    CPUE    S/R    Stom.  Penalty     Sum
              102.1     0.6     6.3     0.0 0.00e+000   109.1


unweighted objective function contributions (per observation):
                Catch   CPUE     S/R   Stomachs
               0.36    0.05    0.23    0.00


contribution by fleet:
----------------------
Dredge survey 2004-2009     total:   0.610   mean:   0.051

F, season effect:
-----------------
age: 0
    1983-1988:   0.000 1.000
    1989-1998:   0.000 1.000
    1999-2010:   0.000 1.000
age: 1 - 4
    1983-1988:   0.802 0.500
    1989-1998:   1.242 0.500
    1999-2010:   0.841 0.500

F, age effect:
--------------
                0      1      2      3      4
1983-1988:  0.085  0.618  1.277  2.257  2.257
1989-1998:  0.287  0.404  0.327  0.260  0.260
1999-2010:  0.197  1.697  1.112  0.611  0.611


Exploitation pattern (scaled to mean F=1)
-----------------------------------------
                        0      1      2      3      4
1983-1988 season 1:  0.000  0.520  1.075  1.900  1.900
          season 2:  0.037  0.132  0.273  0.483  0.483

1989-1998 season 1:  0.000  1.039  0.843  0.669  0.669
          season 2:  0.093  0.065  0.053  0.042  0.042

1999-2010 season 1:  0.000  0.692  0.454  0.249  0.249
          season 2:  0.120  0.516  0.338  0.186  0.186
```

Table 4.4.4 (continued). Area-3 Sandeel. SMS settings and statistics.

sqrt(catch variance) ~ CV:

	season	
age	1	2
0		1.243
1	0.470	1.080
2	0.470	1.080
3	0.877	1.559
4	0.877	1.559

Survey catchability:

	age 0	age 1
Dredge survey 2004-2009	2.025	2.025

sqrt(Survey variance) ~ CV:

	age 0	age 1
Dredge survey 2004-2009	0.39	1.03

```
Recruit-SSB
                  alfa      beta        recruit  s2    recruit  s  Hockey
stick.:  161.975      1.000e+005      0.588                          0.767
```

Table 4.4.5 Area-3 Sandeel. Fishing mortality at age

Year/Age	Age 0, 2nd half	Age 1, 1st half	Age 1, 2nd half	Age 2, 1st half	Age 2, 2nd half	Age 3, 1st half	Age 3, 2nd half	Age 4+, 1st half	Age 4+, 2nd half
1983	0.015	0.212	0.054	0.438	0.111	0.774	0.197	0.774	0.197
1984	0.016	0.228	0.057	0.470	0.117	0.832	0.207	0.832	0.207
1985	0.014	0.114	0.050	0.235	0.103	0.416	0.182	0.416	0.182
1986	0.044	0.432	0.160	0.892	0.330	1.578	0.583	1.578	0.583
1987	0.002	0.478	0.008	0.988	0.016	1.747	0.028	1.747	0.028
1988	0.037	0.650	0.133	1.344	0.274	2.376	0.485	2.376	0.485
1989	0.086	0.966	0.061	0.783	0.049	0.621	0.039	0.621	0.039
1990	0.120	0.454	0.085	0.368	0.069	0.292	0.054	0.292	0.054
1991	0.089	0.616	0.062	0.500	0.051	0.396	0.040	0.396	0.040
1992	0.041	0.398	0.029	0.323	0.023	0.256	0.019	0.256	0.019
1993	0.146	0.507	0.103	0.412	0.083	0.326	0.066	0.326	0.066
1994	0.056	0.618	0.039	0.501	0.032	0.397	0.025	0.397	0.025
1995	0.027	0.419	0.019	0.340	0.016	0.270	0.012	0.270	0.012
1996	0.192	0.264	0.135	0.214	0.110	0.170	0.087	0.170	0.087
1997	0.140	0.785	0.099	0.637	0.080	0.505	0.064	0.505	0.064
1998	0.227	0.744	0.160	0.604	0.130	0.479	0.103	0.479	0.103
1999	0.138	0.794	0.592	0.520	0.388	0.286	0.213	0.286	0.213
2000	0.008	1.413	0.034	0.926	0.022	0.509	0.012	0.509	0.012
2001	0.137	0.605	0.588	0.397	0.385	0.218	0.212	0.218	0.212
2002	0.004	1.104	0.016	0.724	0.011	0.398	0.006	0.398	0.006
2003	0.049	0.390	0.209	0.256	0.137	0.141	0.075	0.141	0.075
2004	0.029	0.630	0.125	0.413	0.082	0.227	0.045	0.227	0.045
2005	0.001	0.232	0.005	0.152	0.003	0.084	0.002	0.084	0.002
2006	0.002	0.133	0.011	0.087	0.007	0.048	0.004	0.048	0.004
2007	0.000	0.550	0.000	0.361	0.000	0.198	0.000	0.198	0.000
2008	0.000	0.483	0.001	0.317	0.001	0.174	0.000	0.174	0.000
2009	0.007	0.126	0.029	0.083	0.019	0.046	0.011	0.046	0.011
2010	0.003	0.531	0.012	0.348	0.008	0.191	0.004	0.191	0.004
arith. mean	0.058	0.531	0.103	0.487	0.095	0.498	0.099	0.498	0.099

Table 4.4.6. Sandeel in Area-3 : Annual Fishing mortality (F) at age

Year/Age	Age 0	Age 1	Age 2	Age 3	Age 4	Avg. 1-2
1983	0.015	0.313	0.610	1.068	1.068	0.461
1984	0.016	0.335	0.653	1.144	1.143	0.494
1985	0.014	0.185	0.364	0.644	0.645	0.274
1986	0.044	0.673	1.318	2.311	2.313	0.996
1987	0.002	0.609	1.167	1.996	1.992	0.888
1988	0.037	0.922	1.785	3.087	3.085	1.353
1989	0.086	1.243	0.962	0.757	0.755	1.102
1990	0.120	0.641	0.494	0.390	0.389	0.567
1991	0.089	0.823	0.634	0.499	0.498	0.728
1992	0.041	0.527	0.404	0.317	0.317	0.466
1993	0.146	0.722	0.557	0.440	0.440	0.639
1994	0.056	0.806	0.620	0.487	0.486	0.713
1995	0.027	0.545	0.418	0.328	0.327	0.482
1996	0.192	0.443	0.344	0.274	0.275	0.393
1997	0.140	1.058	0.818	0.645	0.644	0.938
1998	0.227	1.059	0.820	0.649	0.648	0.939
1999	0.138	1.468	0.930	0.518	0.520	1.199
2000	0.008	1.743	1.103	0.605	0.603	1.423
2001	0.137	1.230	0.781	0.437	0.439	1.005
2002	0.004	1.369	0.861	0.471	0.469	1.115
2003	0.049	0.660	0.415	0.230	0.230	0.538
2004	0.029	0.891	0.557	0.306	0.305	0.724
2005	0.001	0.300	0.185	0.100	0.100	0.243
2006	0.002	0.179	0.111	0.060	0.060	0.145
2007	0.000	0.692	0.430	0.233	0.233	0.561
2008	0.000	0.611	0.379	0.206	0.205	0.495
2009	0.007	0.185	0.115	0.063	0.063	0.150
2010	0.003	0.678	0.422	0.229	0.229	0.550
arith. mean	0.058	0.747	0.652	0.661	0.660	0.699

Table 4.4.7. Area-3 : Stock numbers (millions). Age 0 at start of 2nd half-year, age 1+ at start of 1st half-year

Year/Age	Age 0	Age 1	Age 2	Age 3	Age 4
1983	95516	21771	6006	167	30
1984	41724	36033	5901	1468	38
1985	286170	15727	9585	1388	270
1986	365405	108074	4720	2892	465
1987	78692	133871	21149	588	197
1988	309837	30068	29120	3281	68
1989	102349	114361	4858	2443	97
1990	216582	35954	14482	894	666
1991	93327	73547	7417	3960	569
1992	233200	32705	13192	1810	1490
1993	222141	85698	7542	3948	1294
1994	181307	73534	16460	1946	1811
1995	132734	65645	13473	4088	1272
1996	877160	49452	14970	3996	2068
1997	61490	277229	11726	4582	2409
1998	102830	20462	40482	2422	2033
1999	138736	31363	2928	8225	1285
2000	100061	46297	2773	499	2941
2001	106966	38010	3850	454	1071
2002	18722	35728	4075	745	517
2003	51309	7141	4119	827	434
2004	21719	18714	1386	1177	522
2005	32138	8079	3110	358	664
2006	101614	12290	2252	1126	488
2007	63225	38811	3761	867	786
2008	62109	24208	7913	1110	700
2009	56611	23774	5270	2437	782
2010		21530	7192	2014	1557
2011			4420	2131	1514

Table 1. Area-3 : Estimated recruitment, total stock biomass (TBS), spawning stock biomass (SSB), landings weight (Yield) and average fishing mortality.

Year	Recruits (million)	TSB (tonnes)	SSB (tonnes)	Yield (tonnes)	Mean F ages 1-2
1983	95516	204087	70030	100319	0.461
1984	41724	304943	95029	118660	0.494
1985	286170	256612	145024	57942	0.274
1986	365405	755786	162613	414970	0.996
1987	78692	1055170	274509	400412	0.888
1988	309837	639106	390599	392969	1.353
1989	102349	816196	129173	492824	1.102
1990	216582	444664	208931	219103	0.567
1991	93327	758524	214932	368581	0.728
1992	233200	403083	197823	195700	0.466
1993	222141	757402	216905	304880	0.639
1994	181307	786066	289149	498568	0.713
1995	132734	631264	217572	283604	0.482
1996	877160	818232	374016	281281	0.393
1997	61490	1680050	268957	628039	0.938
1998	102830	601131	404561	521133	0.939
1999	138736	425795	189954	207622	1.199
2000	100061	457862	117124	284412	1.423
2001	106966	352710	89817	215066	1.005
2002	18722	325982	73002	223786	1.115
2003	51309	130514	79167	67104	0.538
2004	21719	166809	40782	95556	0.724
2005	32138	135932	78233	30597	0.243
2006	101614	146910	61391	19490	0.145
2007	63225	369724	83898	120138	0.561
2008	62109	331119	132474	98341	0.495
2009	56611	312618	104734	43481	0.150
2010		342967	201678	79991	0.550
2011			153095*		
arith. mean	153840	514688	174661	241592	0.699
geo. mean	104485				

***excl. a very small contribution from Age 1**

Table 4.4.9. Sandeel in Area-3. Input values for preliminary short term forecast

	Age 0	Age 1	Age 2	Age 3	Age 4
Stock numbers(2011)	104484.5	input	4419.62	2131.17	1513.87
Exploitation patttern 1st half	NA	0.531471	0.348465	0.191478	0.191478
Exploitation patttern 2nd half	0.002765	0.0119	0.007802	0.004287	0.004287
Weight in the stock 1st half	NA	6.883333	14.91	23.03667	21.79333
Weight in the catch 1st half	NA	6.883333	14.91	23.03667	21.79333
weight in the catch 2nd half	5.63	7.356667	12.03	18.05667	14.75667
Proportion mature(2011)	0	0.04	0.92	1	1
Proportion mature(2012)	0	0.05	0.77	1	1
Natural mortality 1st half	NA	0.46	0.44	0.31	0.28
Natural mortality 2nd half	0.96	0.58	0.42	0.37	0.36

Table 4.4.10. Sandeel in Area-3. Preliminary short term forecast for different assumption about recruitment

Basis: Fsq=F(2010)=0.45; Yield(2010)=80; Recruitment(2010)= input; Recruitment(2011)= geometric mean (GM) = 104 billion;

F multiplier	Basis: Recruitment(2010)	F (2011)	Landings (2011)	SSB (2011)	SSB (2012)	%SSB Change*	%TAC Change**
0	GM* 0	0	0	143	98	-31%	-100%
0	GM* 0.2	0	0	145	130	-10%	-100%
0	GM* 0.4	0	0	147	163	11%	-100%
0.002	GM* 0.6	0.001	0	149	195	31%	-100%
0.380	GM* 0.8	0.171	45	152	195	29%	-44%
0.687	GM* 1	0.309	90	154	195	27%	13%

***SSB in 2012 relative to SSB in 2011**

**** TAC in 2011 relative to landings in 2010**

Table 4.5.1. Area-4 Sandeel. Catch numbers (millions) by half-year

Year/Age	Age 0, 2nd half	Age 1, 1st half	Age 1, 2nd half	Age 2, 1st half	Age 2, 2nd half	Age 3, 1st half	Age 3, 2nd half	Age 4+, 1st half	Age 4+, 2nd half
1994	0	1079	258	1532	63	5177	259	2106	160
1995	4	2699	4	1232	1	531	0	30	0
1996	2769	685	2734	2371	3705	445	244	122	1177
1997	0	2924	1390	295	36	1710	44	419	10
1998	0	2148	60	3748	96	234	6	129	3
1999	0	1492	88	1150	47	1560	47	255	12
2000	0	6530	0	376	0	322	0	296	0
2001	10	2044	65	4952	20	600	1	377	0
2002	0	323	0	772	0	490	0	97	0
2003	180	4319	175	1001	12	2719	6	1252	2
2004	0	924	4	221	1	46	0	82	0
2005	0	47	0	138	0	30	0	17	0
2006	0	8	2	0	0	0	0	0	0
2007	0	2	0	0	0	0	0	0	0
2008	0	205	0	18	0	4	0	1	0
2009	0	0	0	0	0	0	0	0	0

Table 4.5.2. Area-4 Sandeel. Individual mean weight(g) at age in the catch and in the sea

Year/Age	Age 0, 2nd half	Age 1, 1st half	Age 1, 2nd half	Age 2, 1st half	Age 2, 2nd half	Age 3, 1st half	Age 3, 2nd half	Age 4+, 1st half	Age 4+, 2nd half
1994	4.0	11.2	11.1	11.4	14.6	15.1	18.5	21.1	23.5
1995	7.3	8.8	11.9	16.4	13.7	19.9	16.7	16.2	20.5
1996	7.6	5.2	9.0	12.7	16.0	18.4	21.9	22.8	27.1
1997	4.0	6.8	6.9	7.6	10.7	11.4	15.4	18.4	15.1
1998	3.6	6.2	6.2	10.6	10.8	13.9	14.1	14.8	18.9
1999	4.0	6.2	6.9	11.0	12.1	16.3	18.3	20.4	21.0
2000	4.0	4.2	9.1	8.7	16.0	14.2	18.6	18.7	24.9
2001	3.5	3.5	3.8	6.1	6.8	9.2	10.7	14.5	14.8
2002	4.0	3.7	9.1	5.9	16.0	9.4	18.6	17.8	24.9
2003	3.4	5.1	5.2	7.4	5.8	9.1	7.3	12.2	9.4
2004	4.0	4.2	3.3	7.8	5.7	9.7	8.1	14.4	10.3
2005	4.0	4.2	9.1	6.1	16.0	8.6	18.6	11.0	24.9
2006	4.1	6.2	10.3	10.1	12.6	12.4	14.4	14.8	15.9
2007	4.0	5.7	9.1	9.6	16.0	12.0	18.6	13.1	24.9
2008	4.0	5.7	9.1	9.7	16.0	12.0	18.6	13.7	24.9
2009	4.0	5.9	9.1	10.8	16.0	15.6	18.6	19.8	24.9

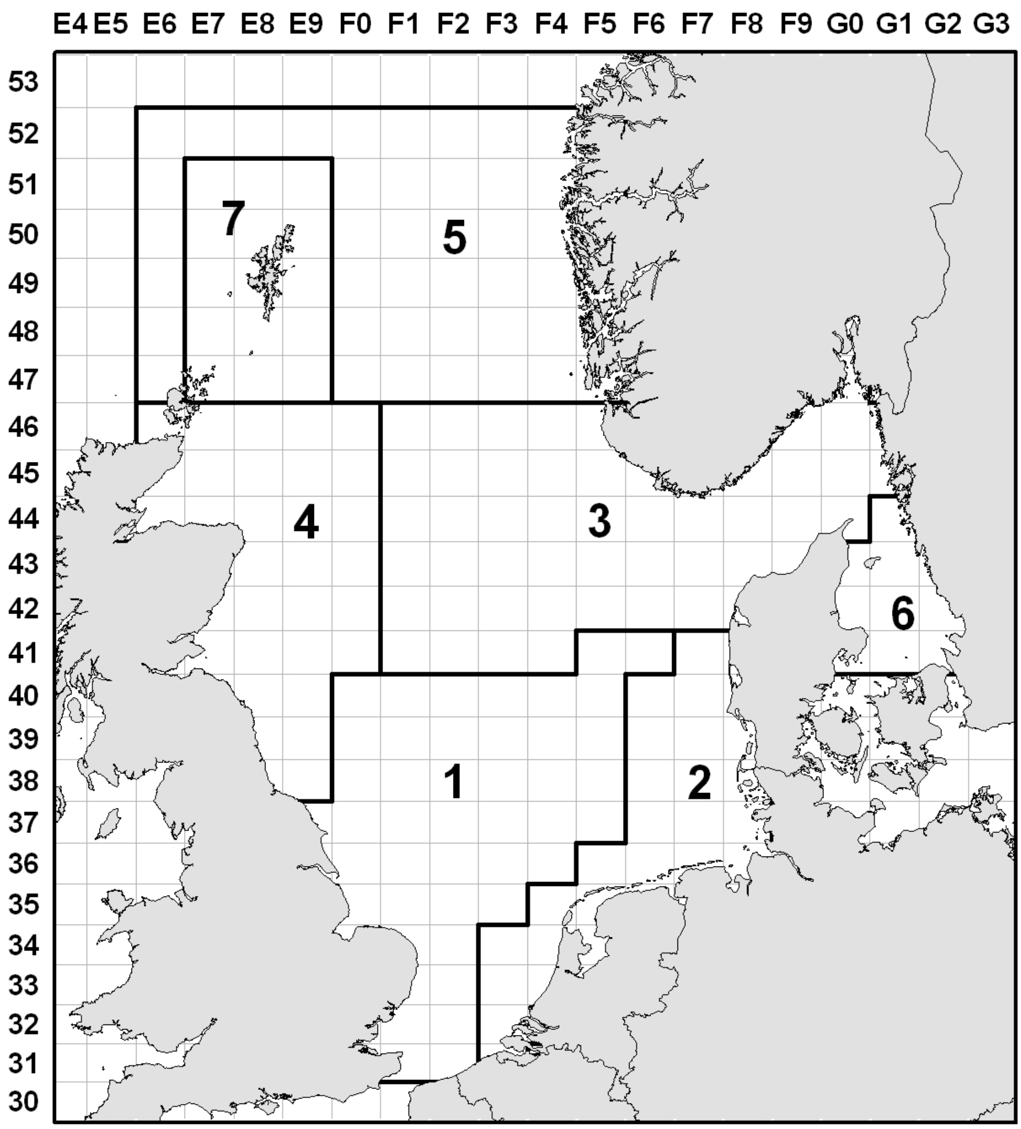


Figure 4.1.1 Sandeel in Division IV. Sandeel assessment areas.

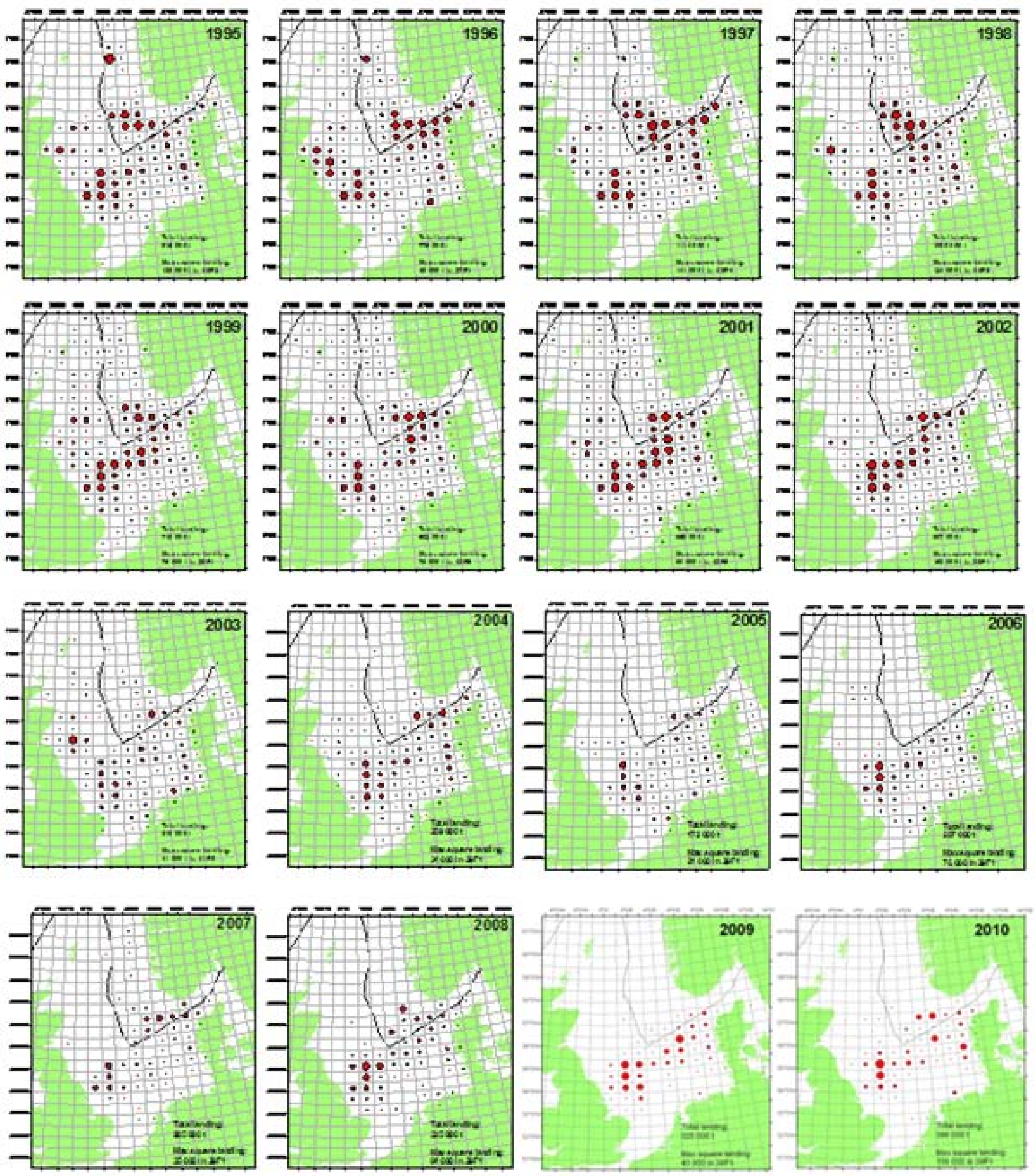


Figure 4.1.2. Sandeel in IV. Landings by Ices rectangles 1995-2010.

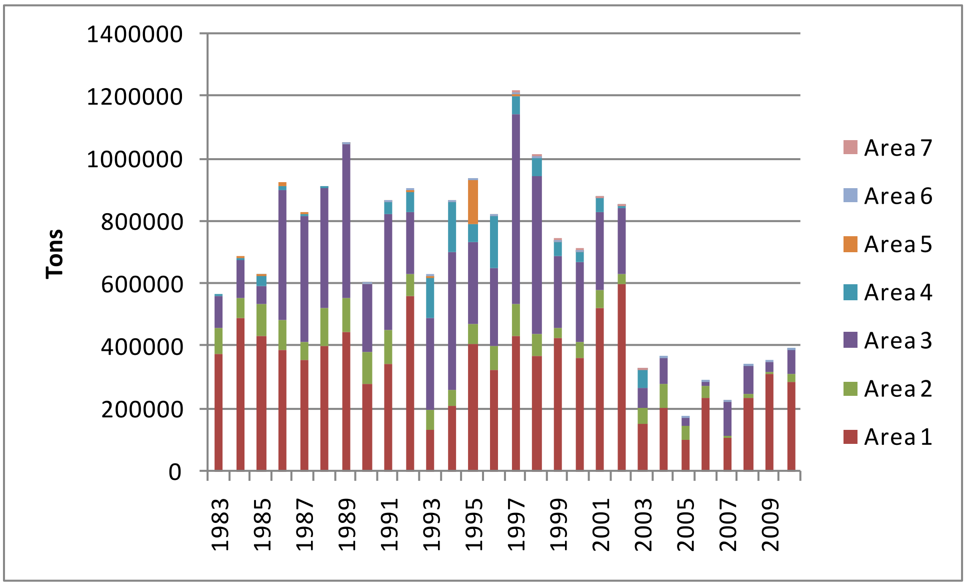


Figure 4.1.3. Sandeel in IV. Total annual landings by area.

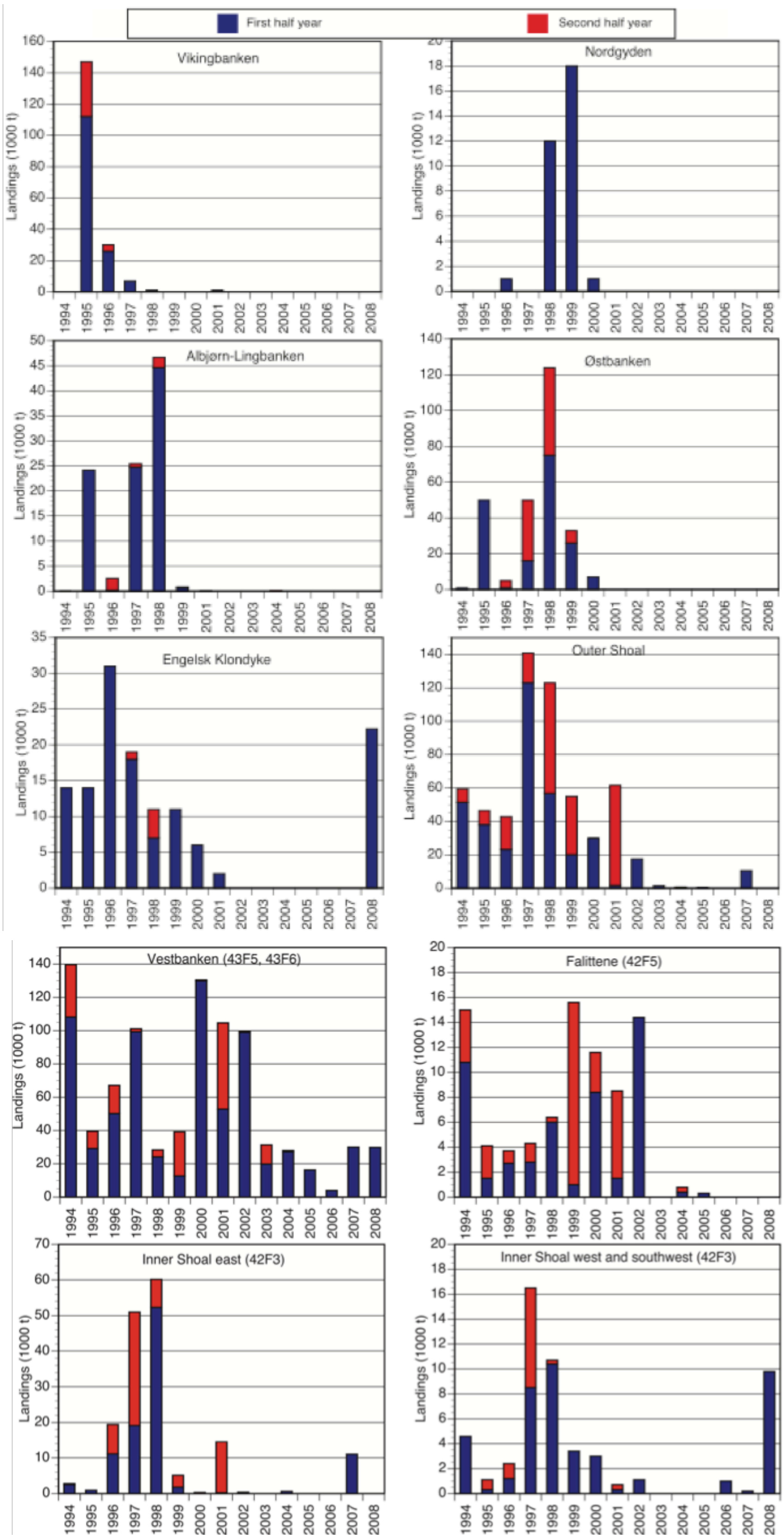


Figure 4.1.4. Sandeel in IV. Sandeel landings from Norwegian fishing banks 1994-2008 in the 1st (blue) and 2nd (red) half-year. Landings in 2nd half-year are mainly 0-group

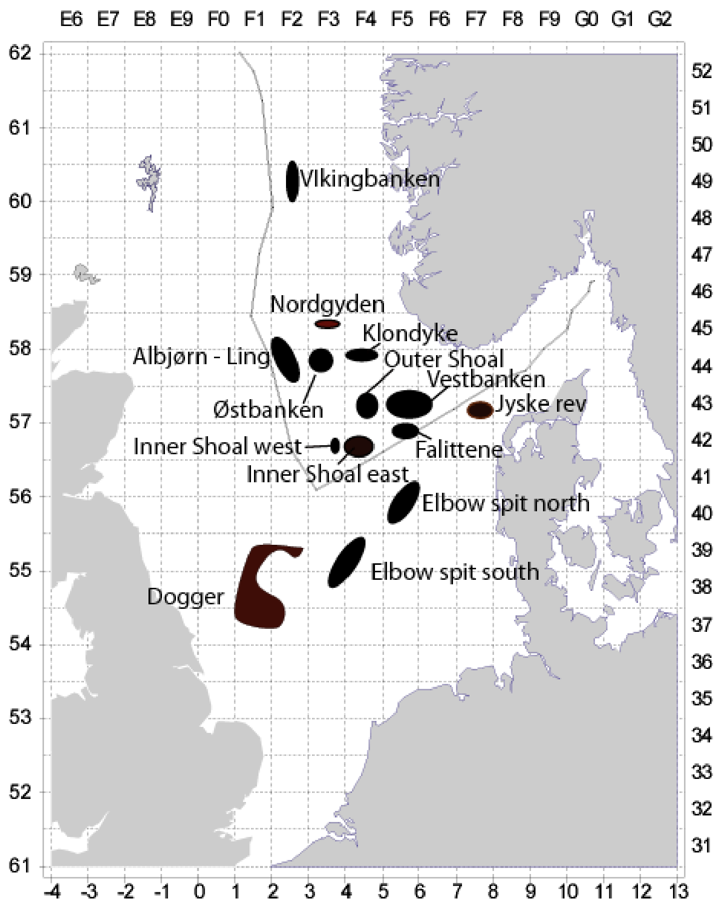


Figure 4.1.5. Sandeel fishing grounds in the Norwegian EEZ and the main fishing grounds in the EU EEZ.

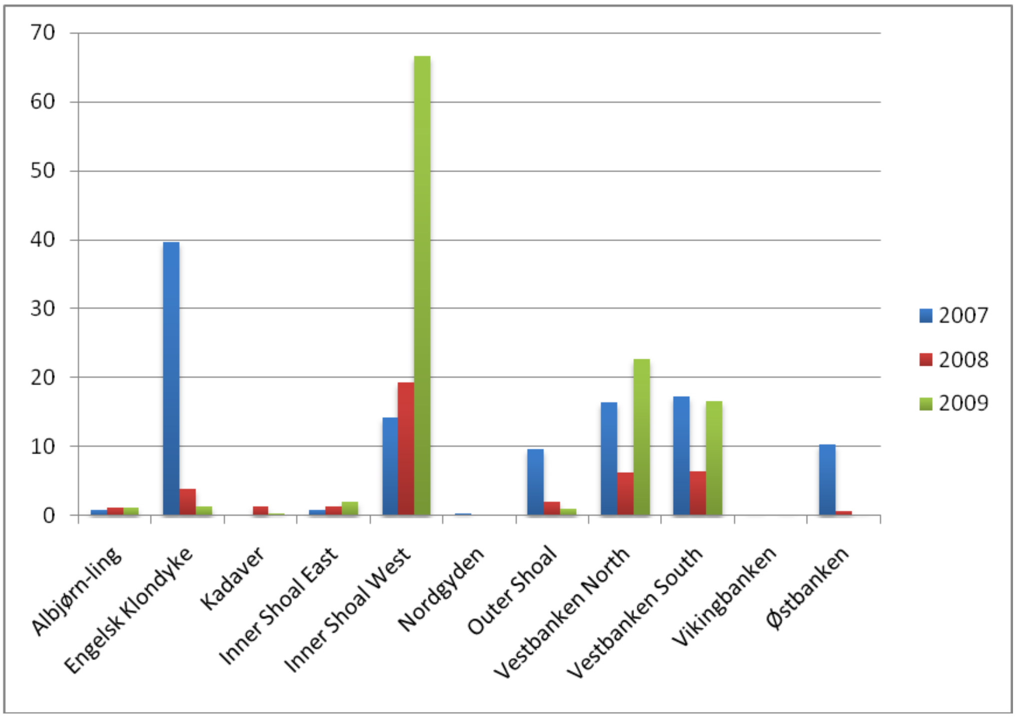


Figure 4.1.6. Relative densities (sA) of sandeel on various fishing grounds in the Norwegian EEZ in April-May 2007, 2008 and 2009.

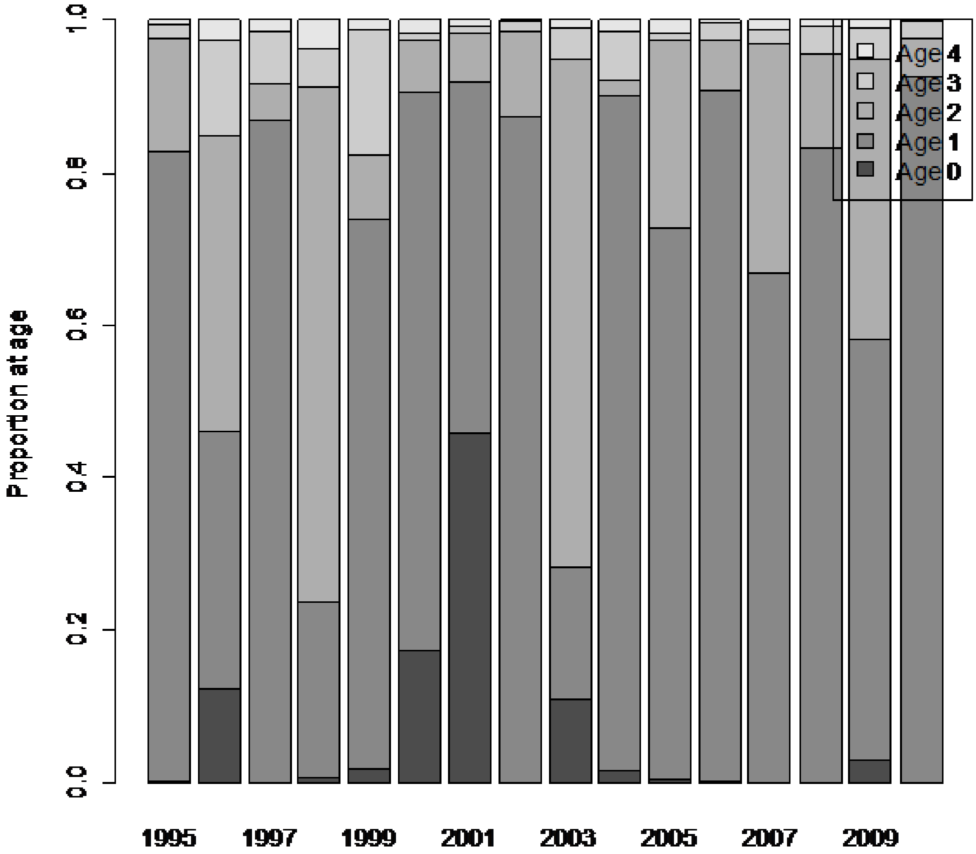


Figure 4.2.1 . Sandeel in Area-1. Catch numbers, Proportion at age.

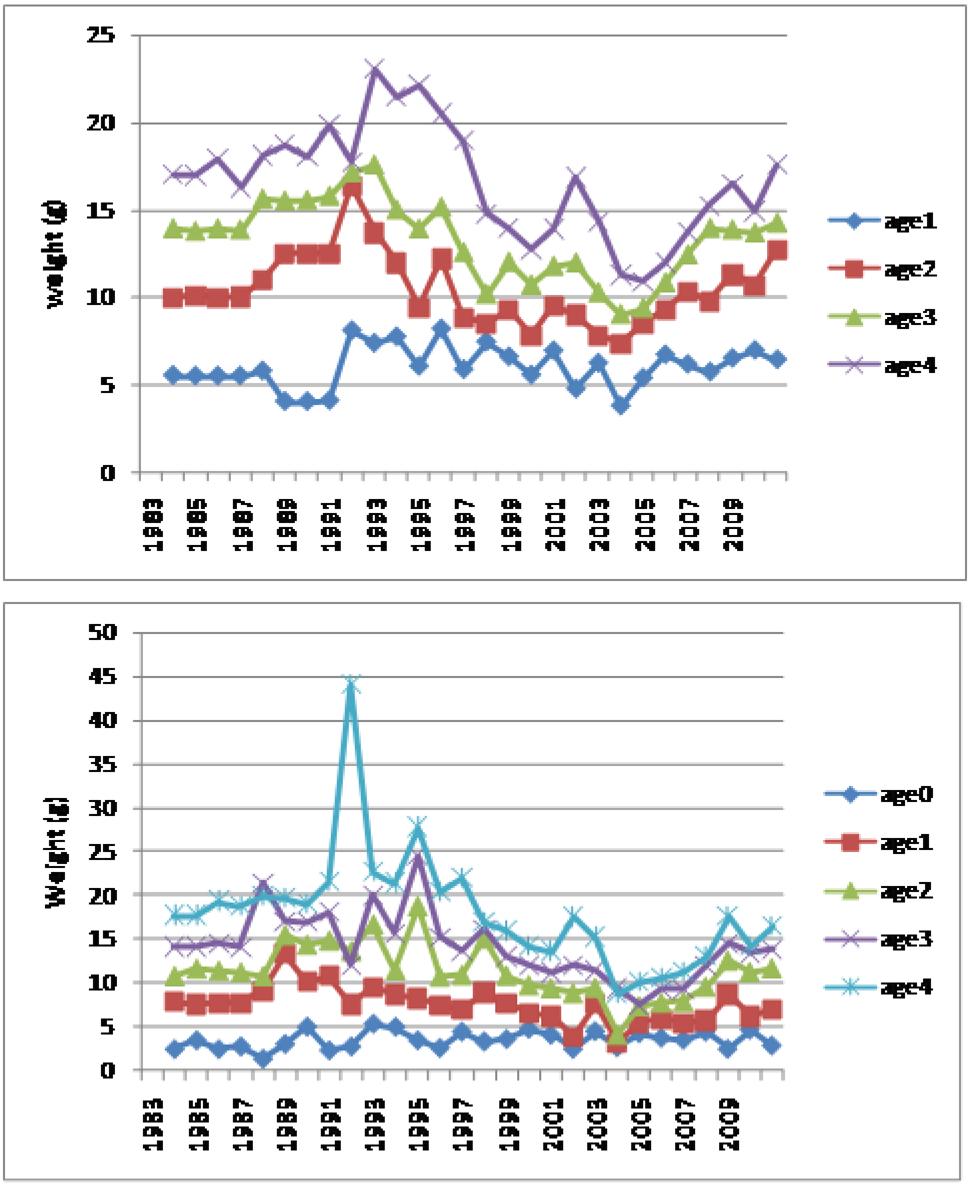


Figure 4.2.2. Sandeel in Area-1. Individual mean weights (g) at age in 1st (upper) and 2nd (lower) half-year.

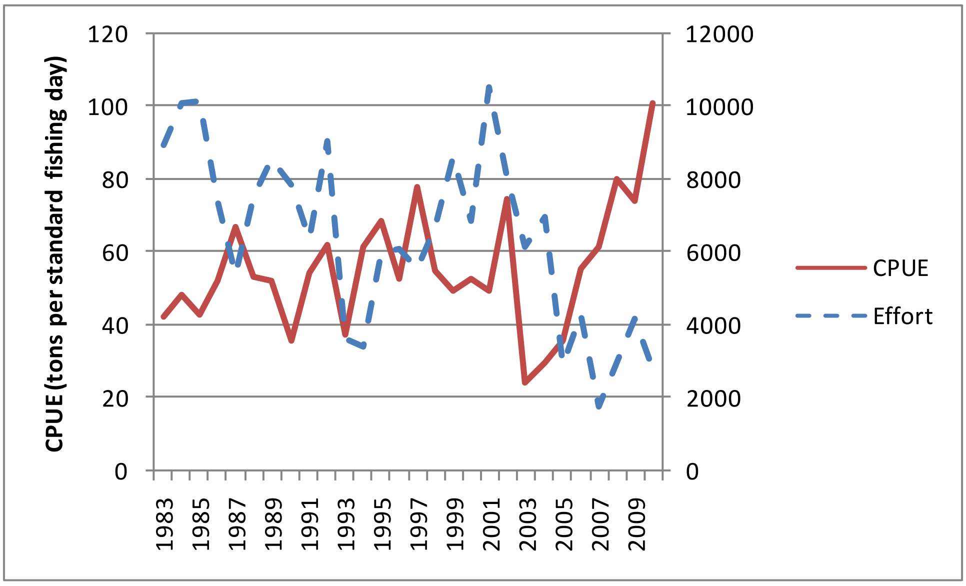


Figure 4.2.3. Sandeel in Area-1. Effort (days fishing for a standard 200 GT vessel) and CPUE (tons per standard fishing day)

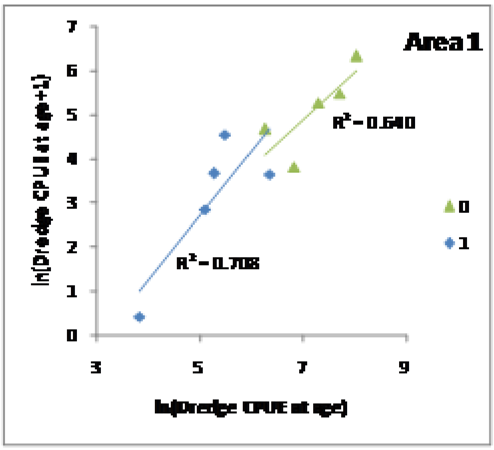


Figure 4.2.4. Sandeel in Area-1. Internal consistence by age of the Danish dredge survey.

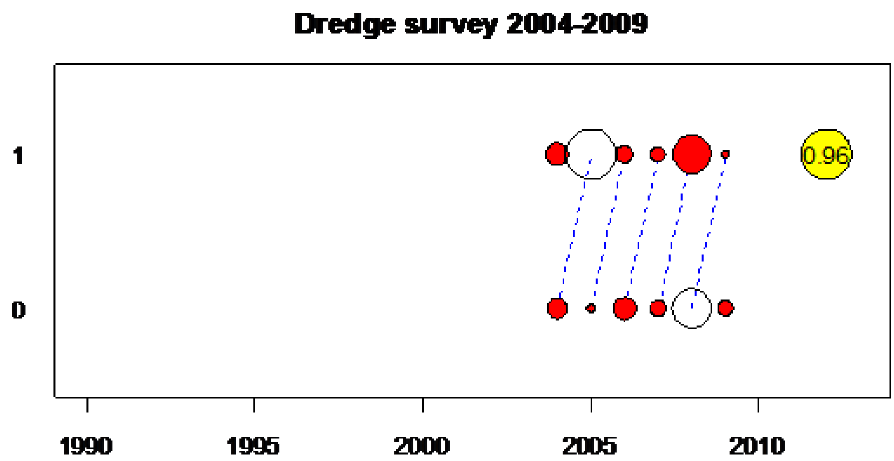


Figure 4.2.5. Sandeel in Area-1. Dredge survey residuals (log(observed CPUE) - log(expected CPUE). 'Red' dots show a positive residual.

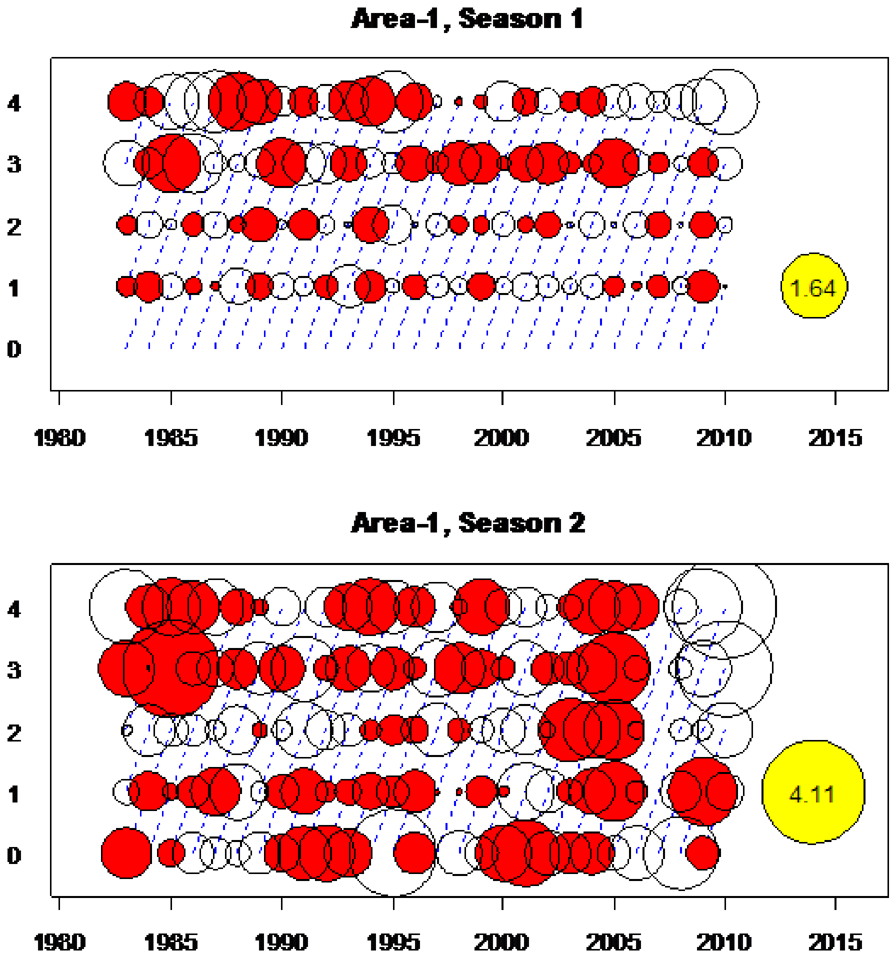


Figure 4.2.6. Sandeel in Area 1. Catch at age residual (log(observed catch) - log(expected catch). 'Red' dots show a positive residual.

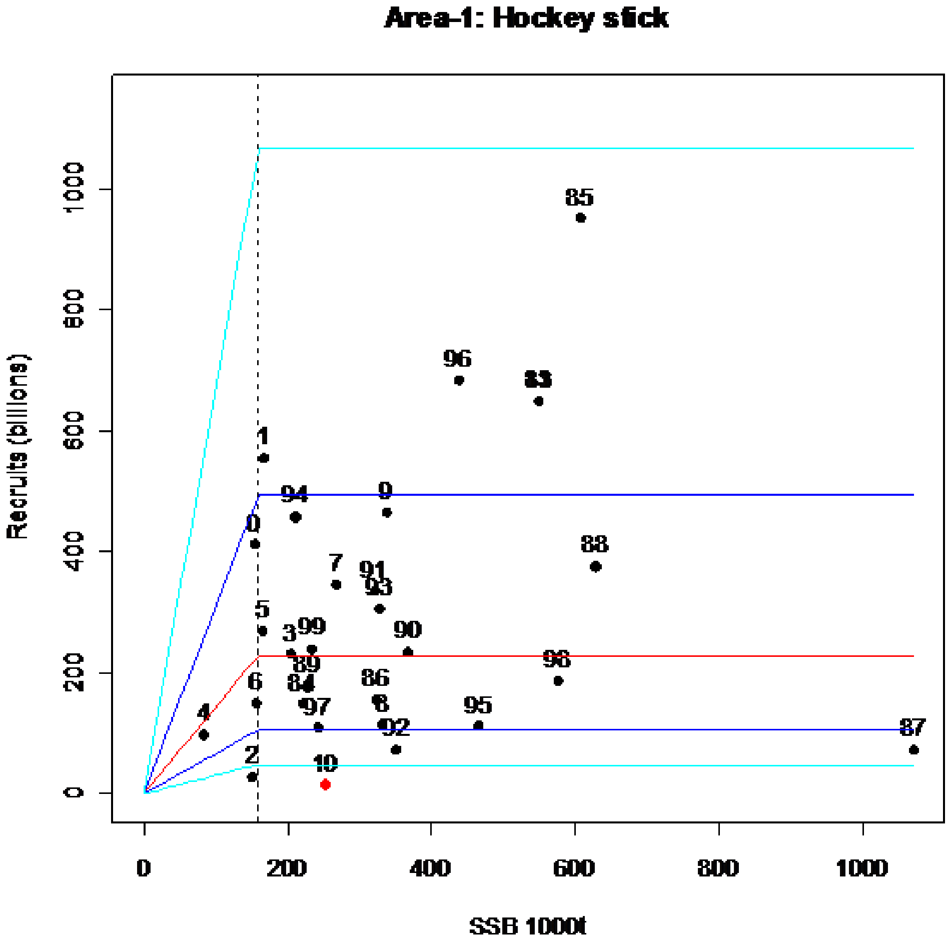


Figure 4.2.7. Sandeel in Area 1. Estimated stock recruitment relation. The 2010 recruitment is highly uncertain and has not been used for the estimation.

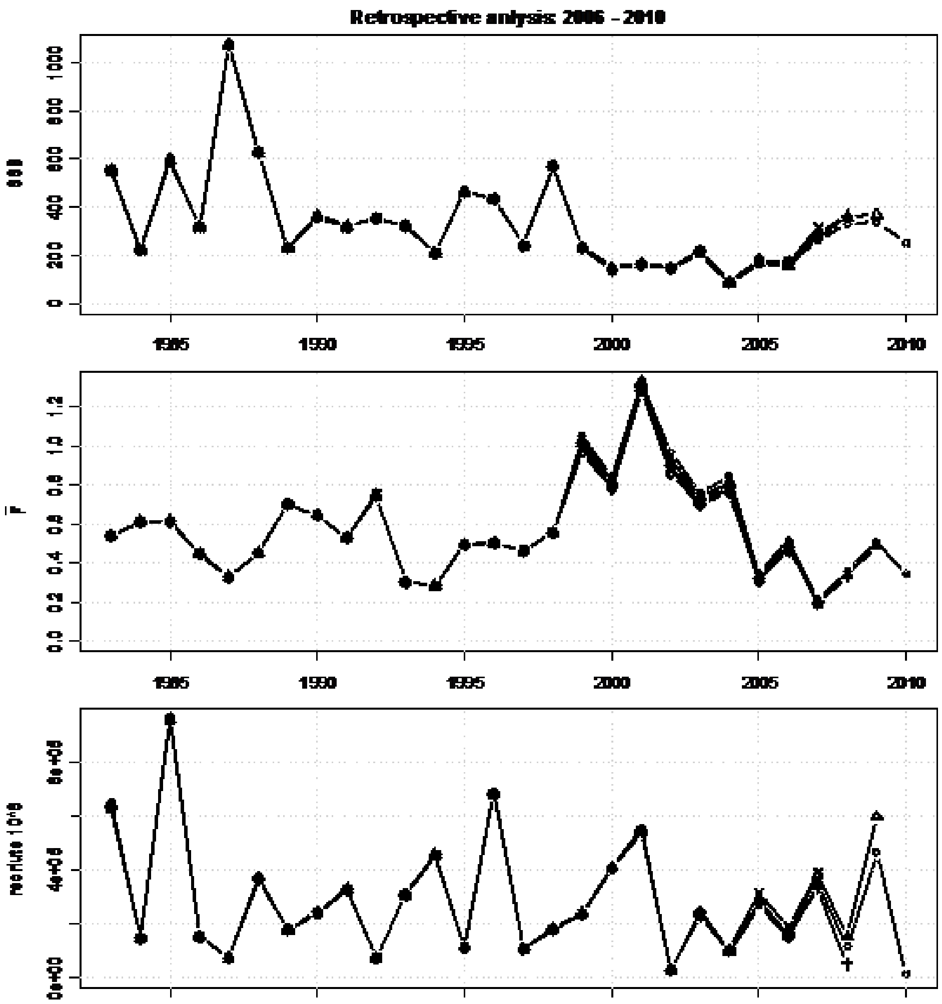


Figure 4.2.8. Sandeel in Area-1. Sandeel retrospective plot. Recruitment in 2010 is a random number.

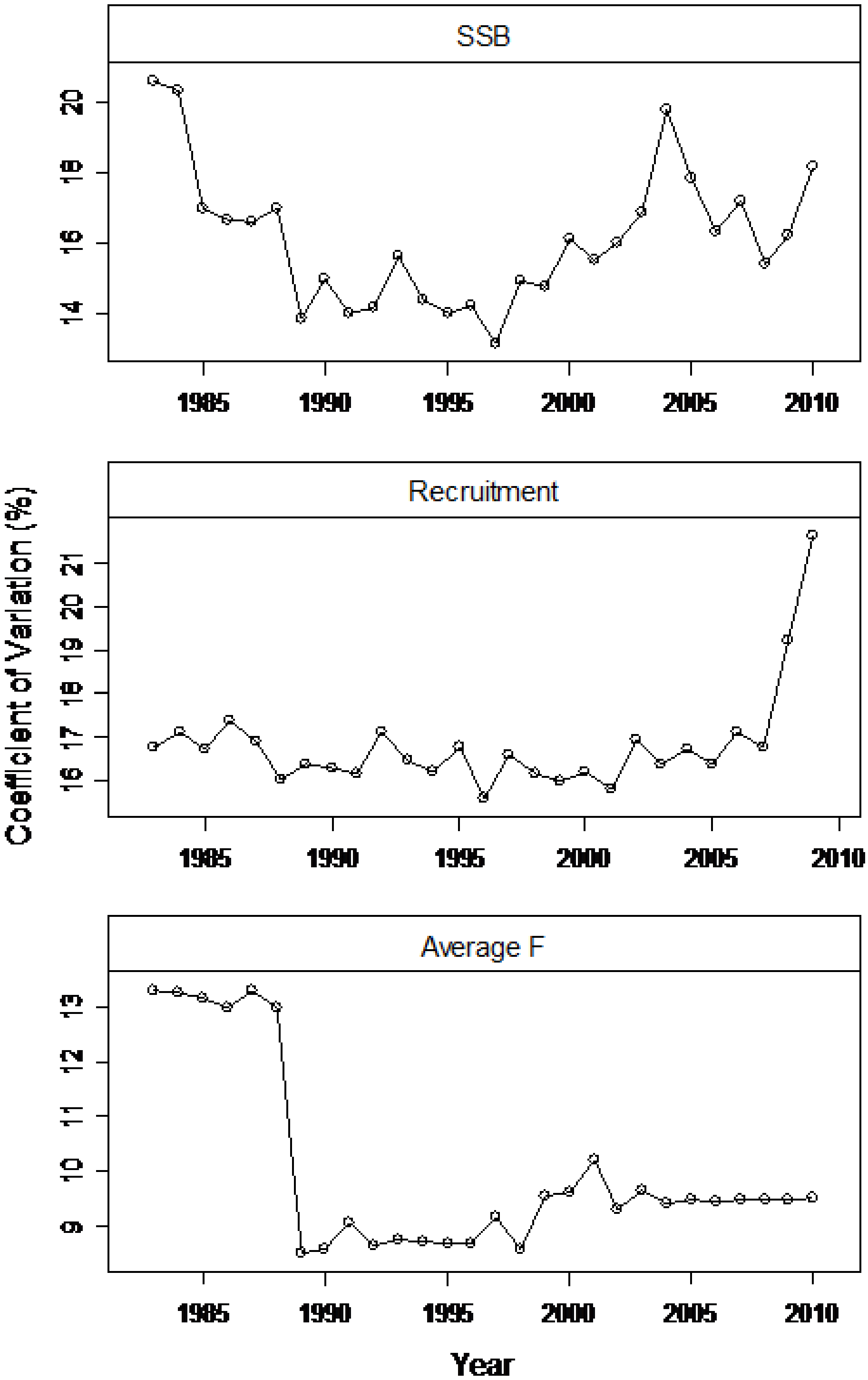


Figure 4.2.9 . Sandeel in Area-1. Uncertainties of model output estimated from parameter uncertainties derived from the Hessian matrix and the delta method.

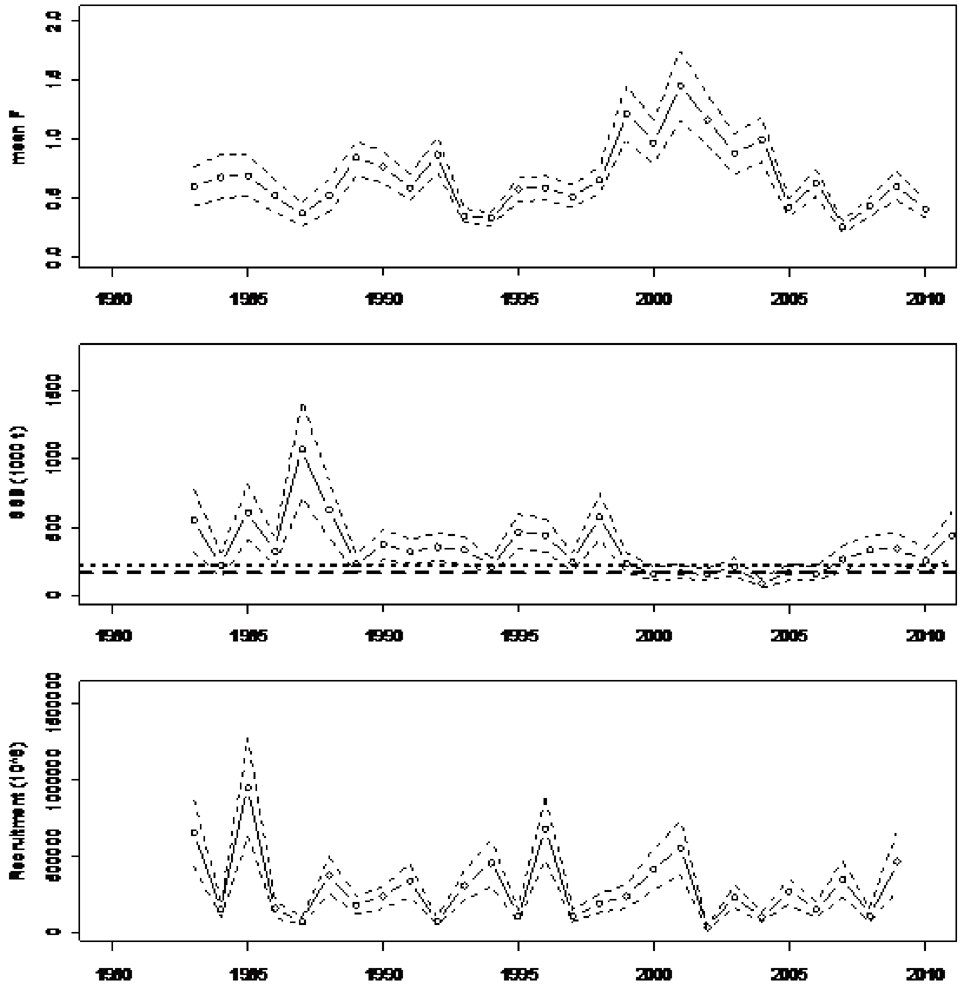


Figure 4.2.10 . Sandeel in Area-1. Model output with mean values and plus/minus 2 * standard deviation.

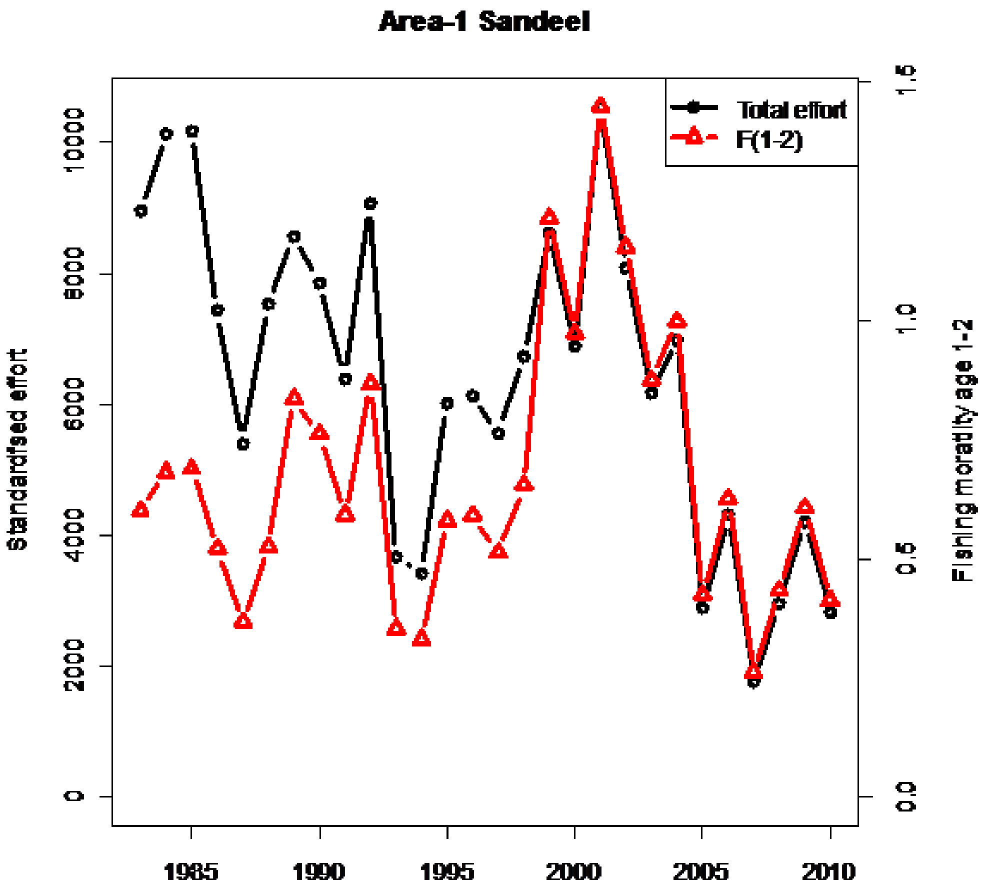


Figure 4.2.11 . Sandeel in Area-1. Total effort (days fishing for a standard 200 GT vessel) and estimated average Fishing mortality.

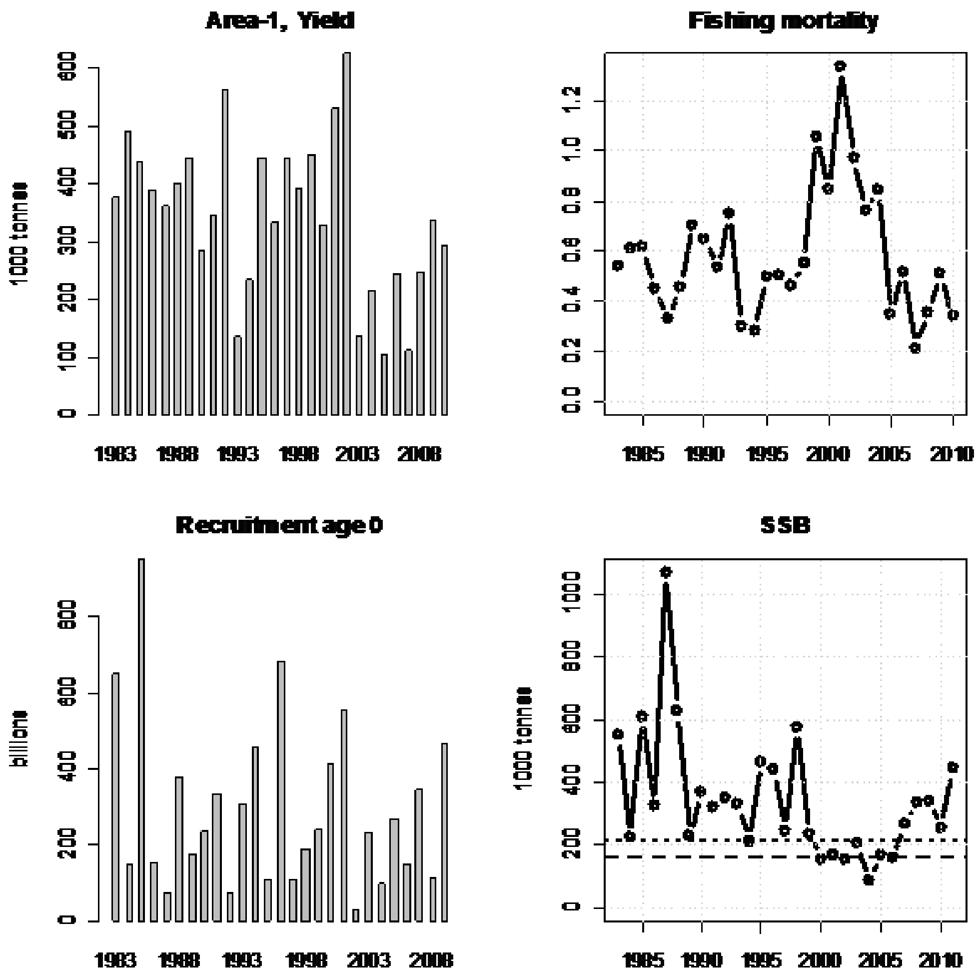


Figure 4.2.12. Sandeel in Area-1. Stock summary.

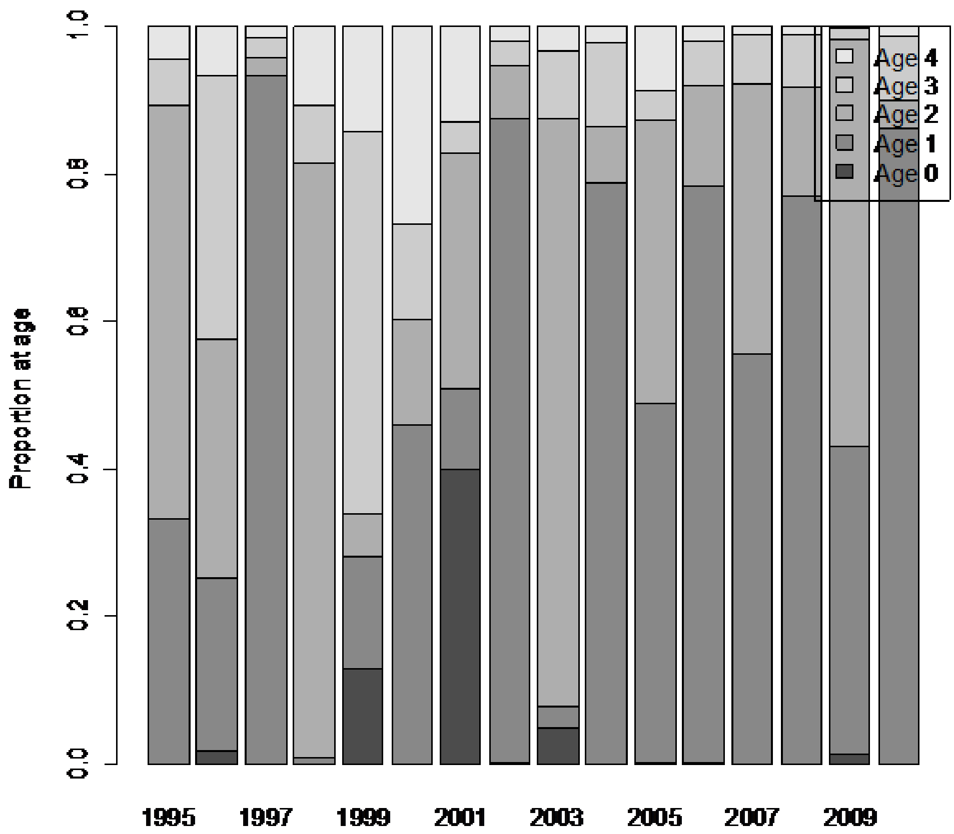


Figure 4.3.1. Sandeel in Area-2. Catch numbers; proportion at age.

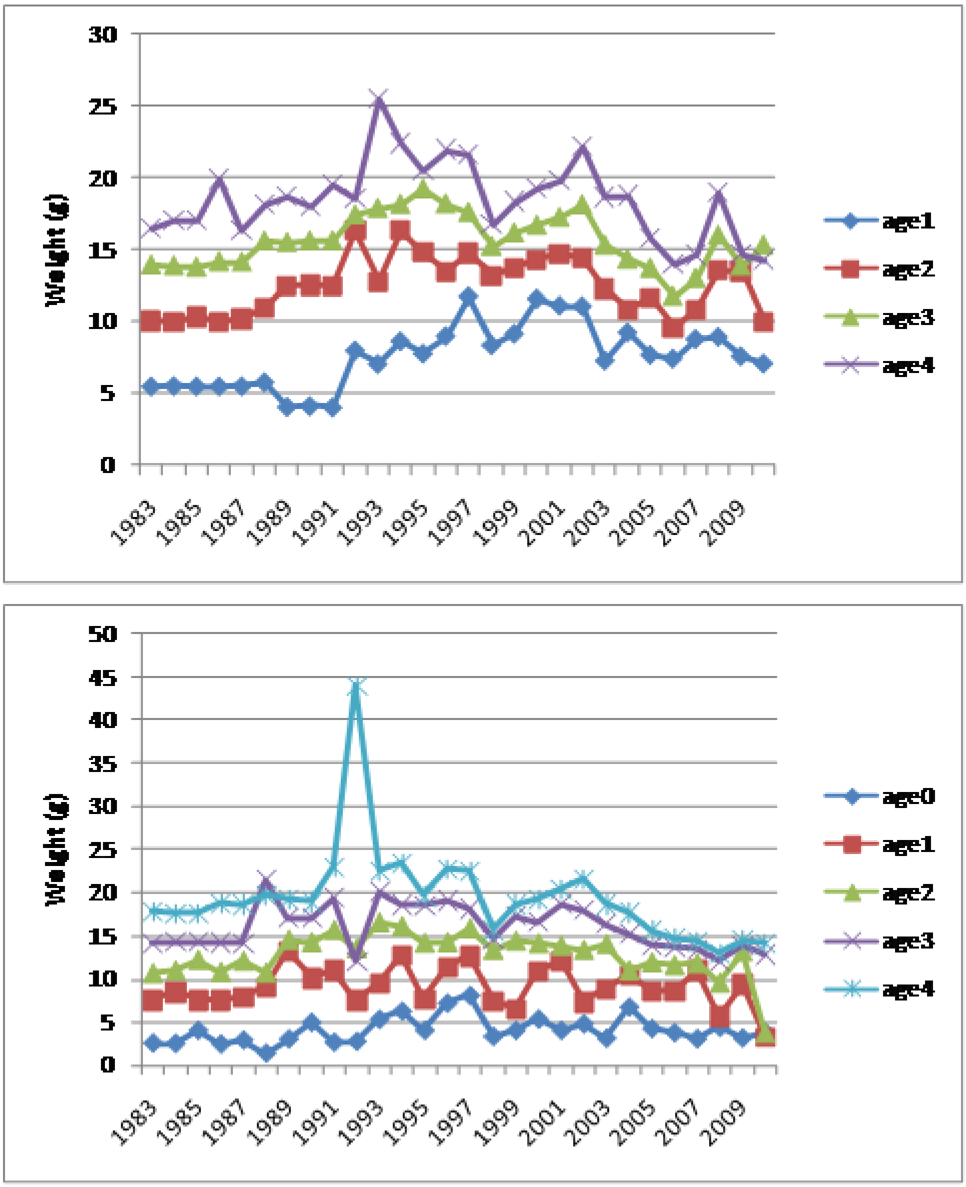


Figure 4.3.2 Sandeel in Area-2. Individual mean weights (g) at age in 1st (upper) and 2nd (lower) half-year.

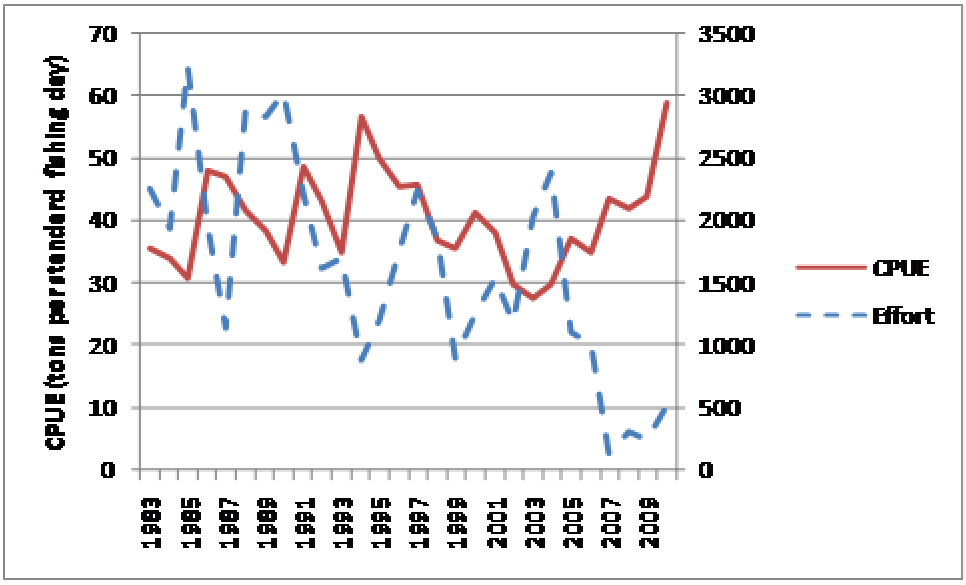


Figure 4.3.3. Sandeel in Area-2. Effort (days fishing for a standard 200 GT vessel) and CPUE (tons per standard fishing day)

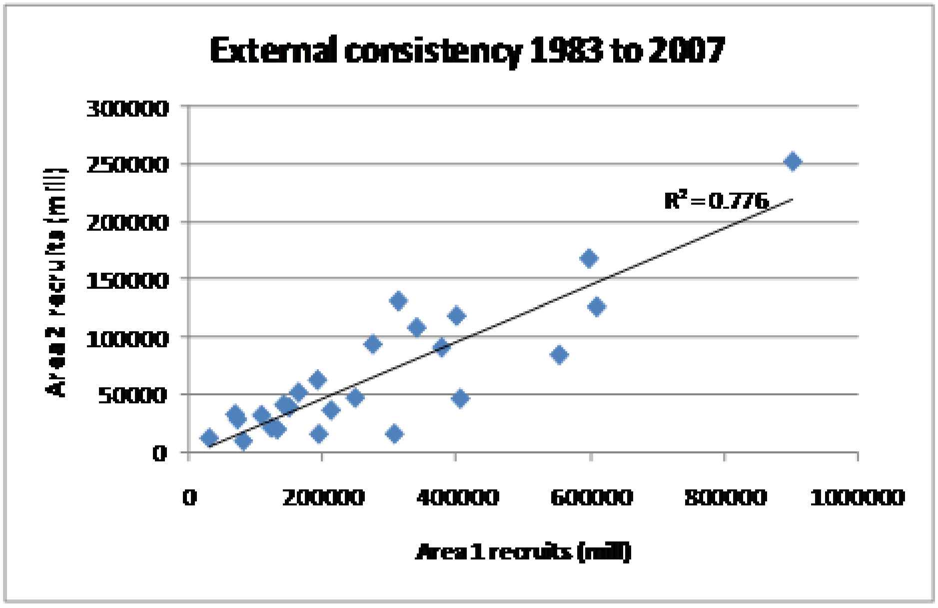


Figure 4.3.4. Sandeel in Area-2. Consistency of recruitments in Area-1 and Area-2

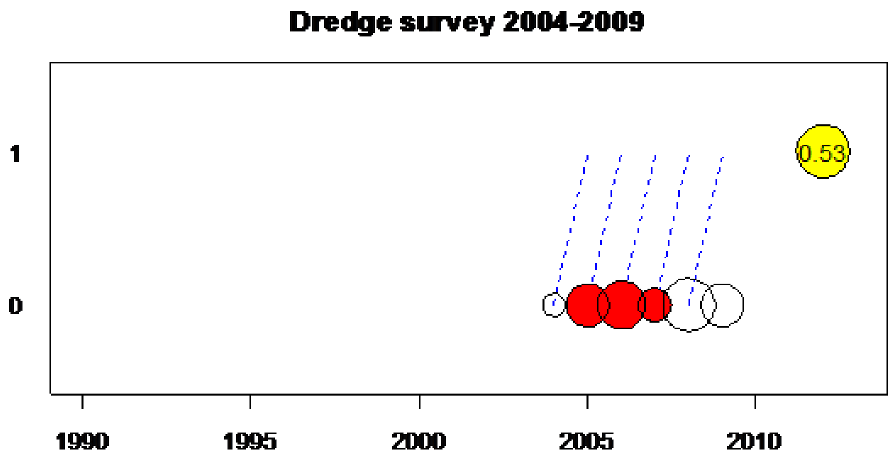


Figure 4.3.5. Sandeel in Area-2. Dredge survey residuals (log(observed CPUE) – log(expected CPUE). Red dots show a positive residual.

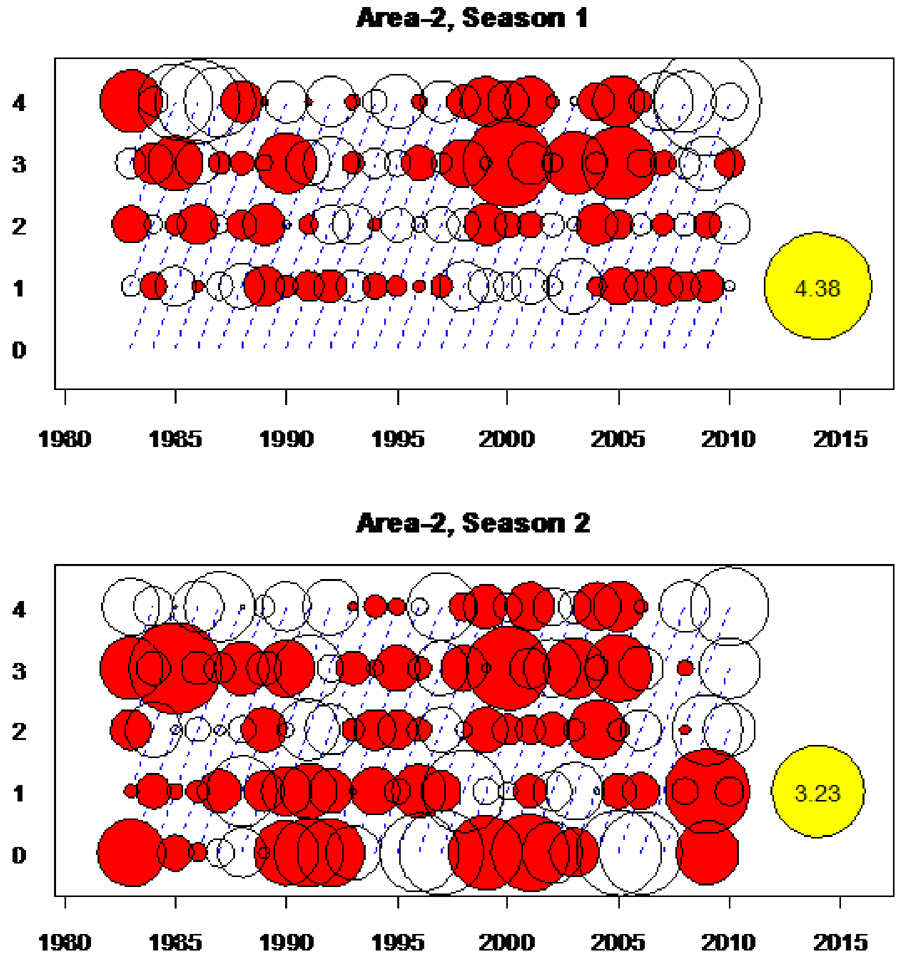


Figure 4.3.6. Sandeel in Area-2. Catch at age residuals (log(observed CPUE) – log(expected CPUE). Red dots show a positive residual.

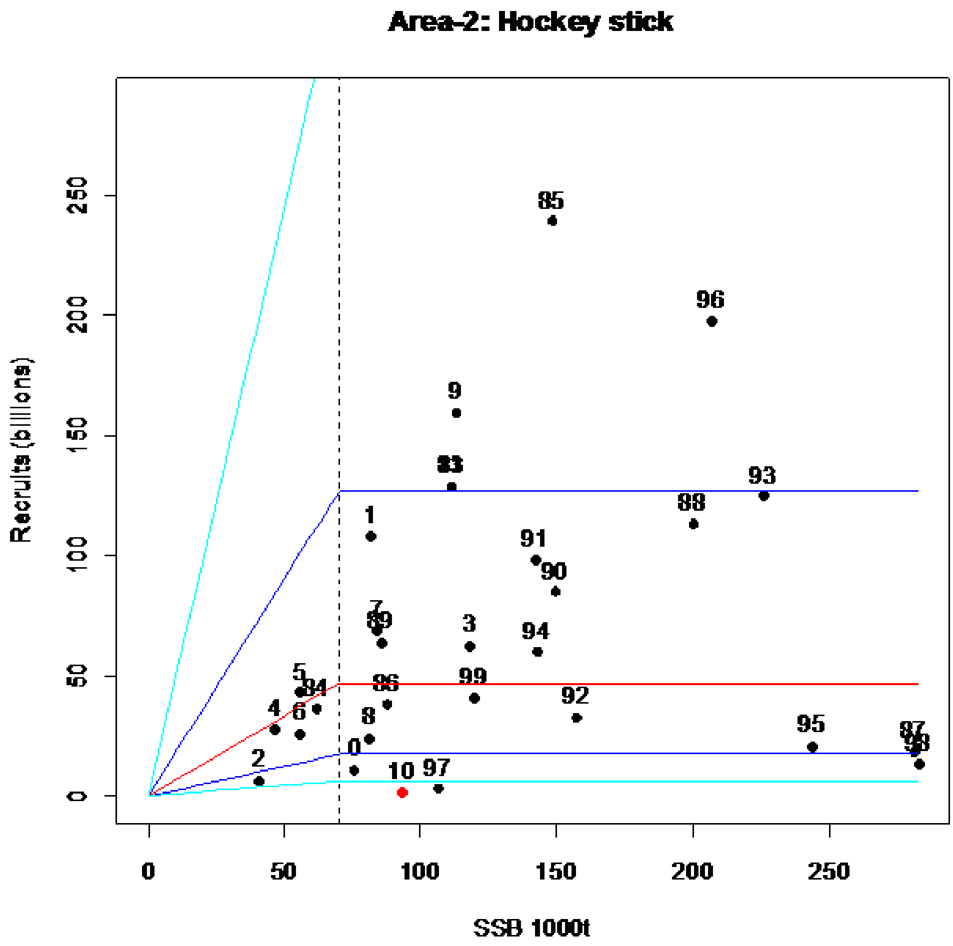


Figure 4.3.7. Sandeel in Area-2. Estimated stock recruitment relation. The 2010 recruitment is highly uncertain and was not used for the estimation.

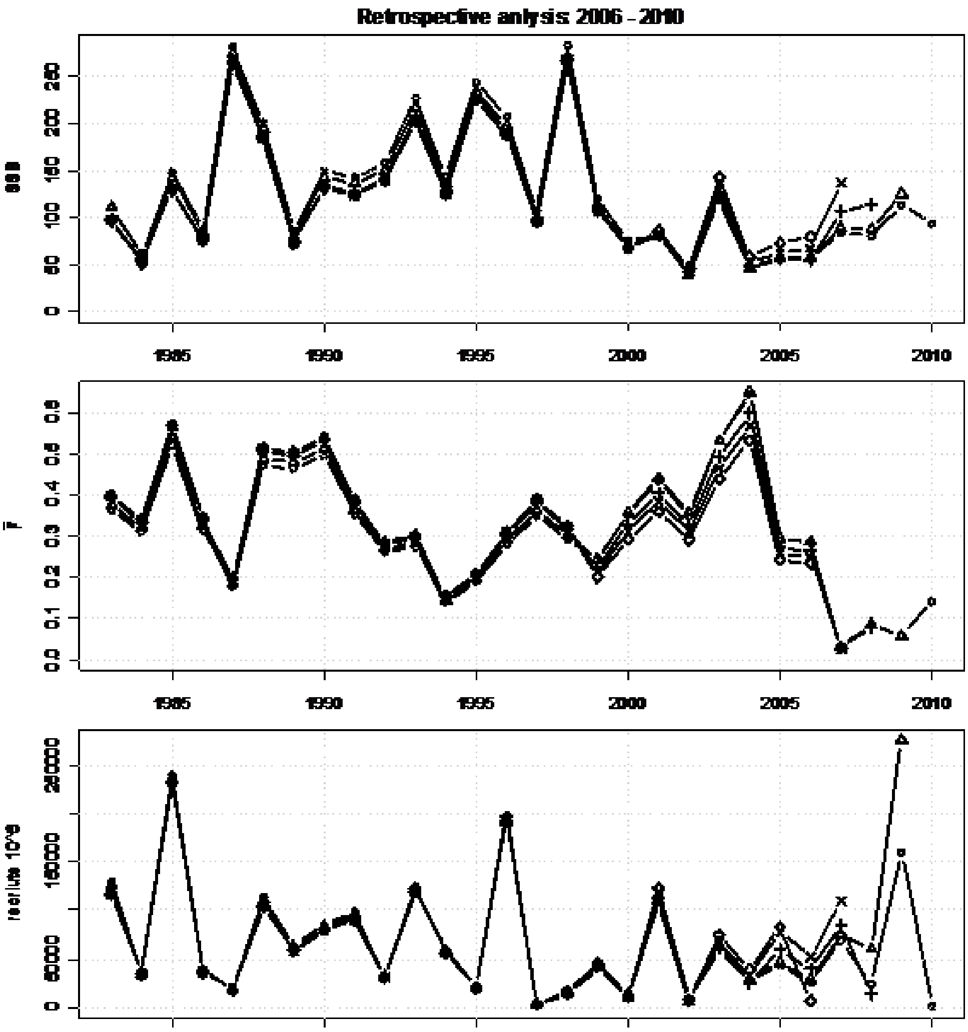


Figure 4.3.8.Sandeel in Area-2. Sandeel retrospective plot. Recruitment in 2010 is a random number and should be disregarded.

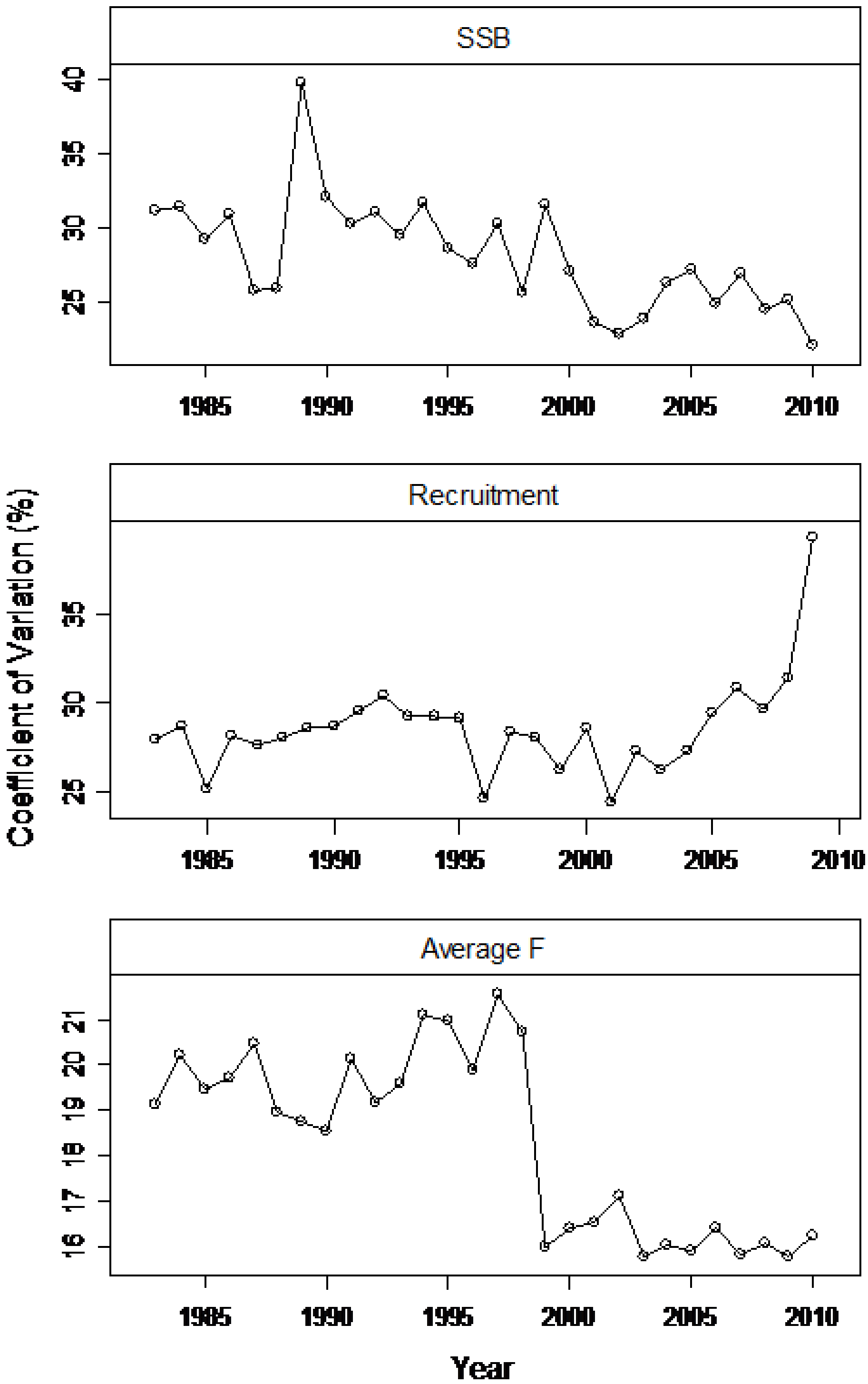


Figure 4.3.9. Sandeel in Area-2. Uncertainties of model output estimated from parameter uncertainties derived from the Hessian matrix and the delta method.

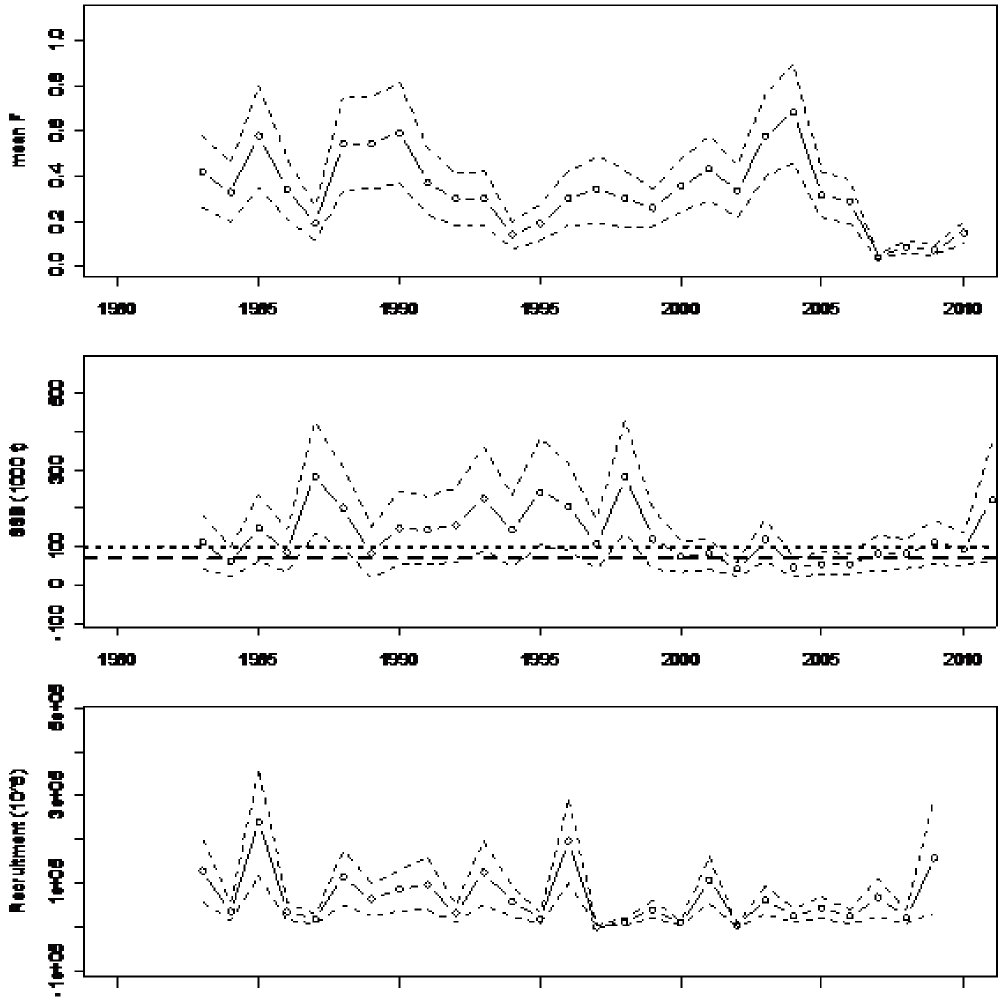


Figure 4.3.10. Sandeel in Area-2. Model output with mean values and plus/minus 2*standard deviation (95% confidence interval).

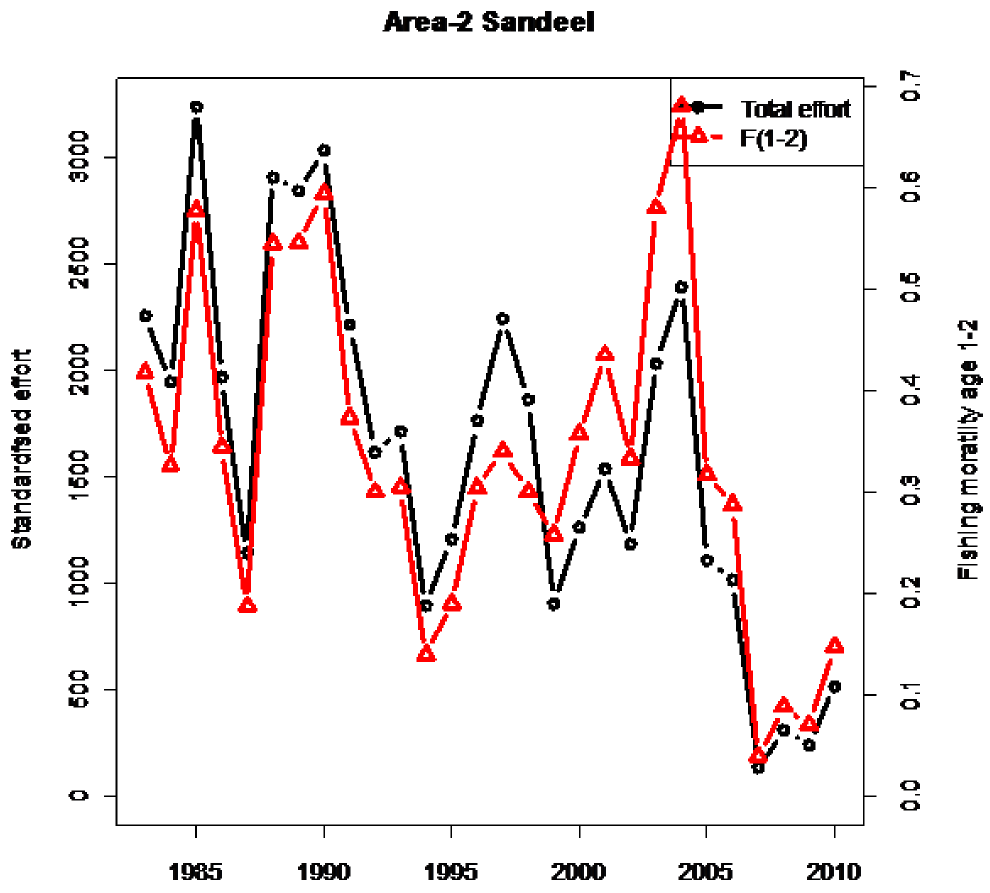


Figure 4.3.11. Sandeel in Area-2. Total effort (days fishing for a standard 200GT vessel) and estimated average Fishing mortality.

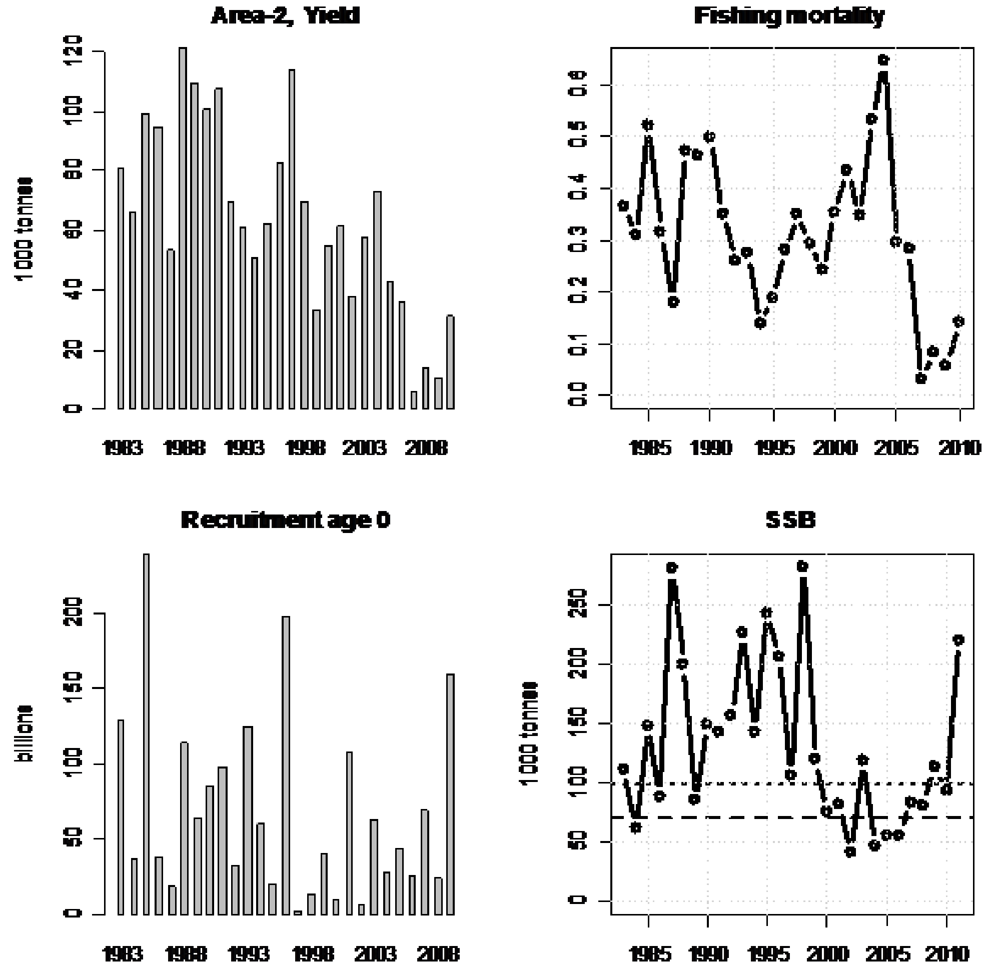


Figure 4.3.12.Sandeel in Area-2. Stock summary.

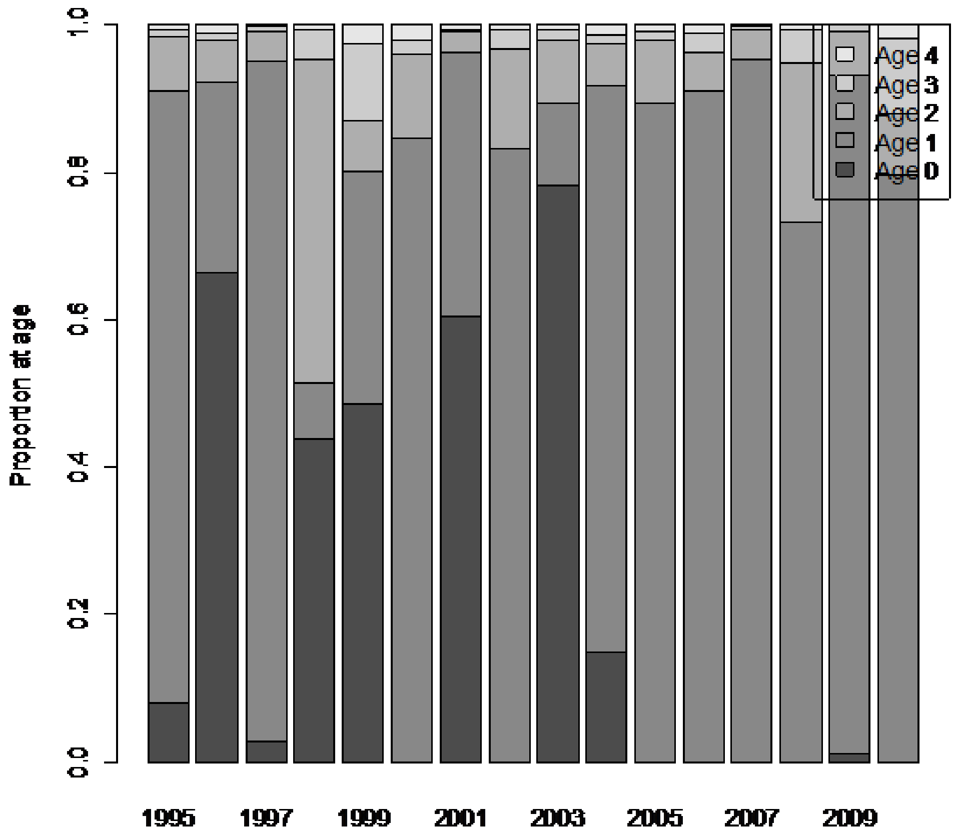
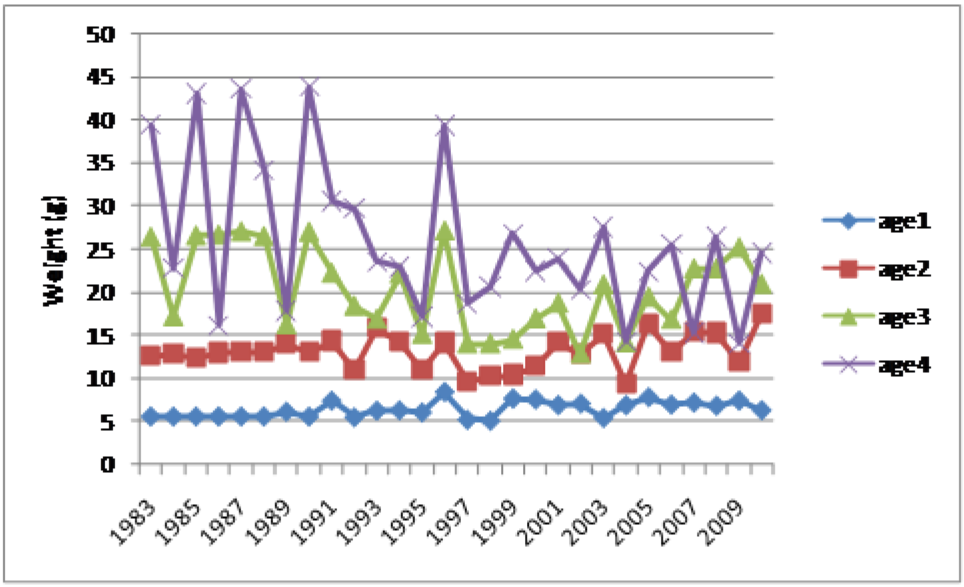


Figure 4.4.1. Sandeel in Area-3. Catch numbers; proportion mature.



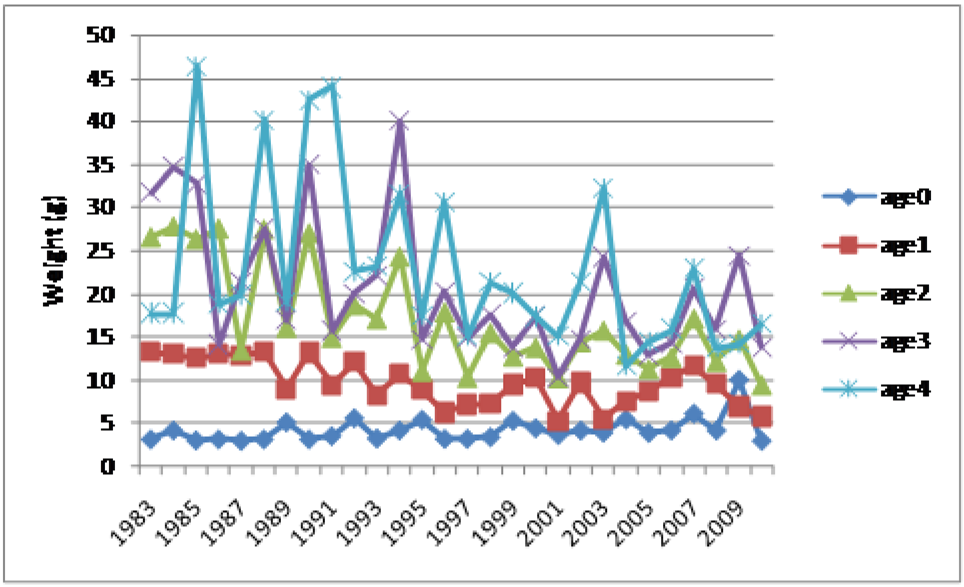


Figure 4.4.2. Sandeel in Area-2. Individual mean weights (g) at age in 1st (upper) and 2nd (lower) half-year.

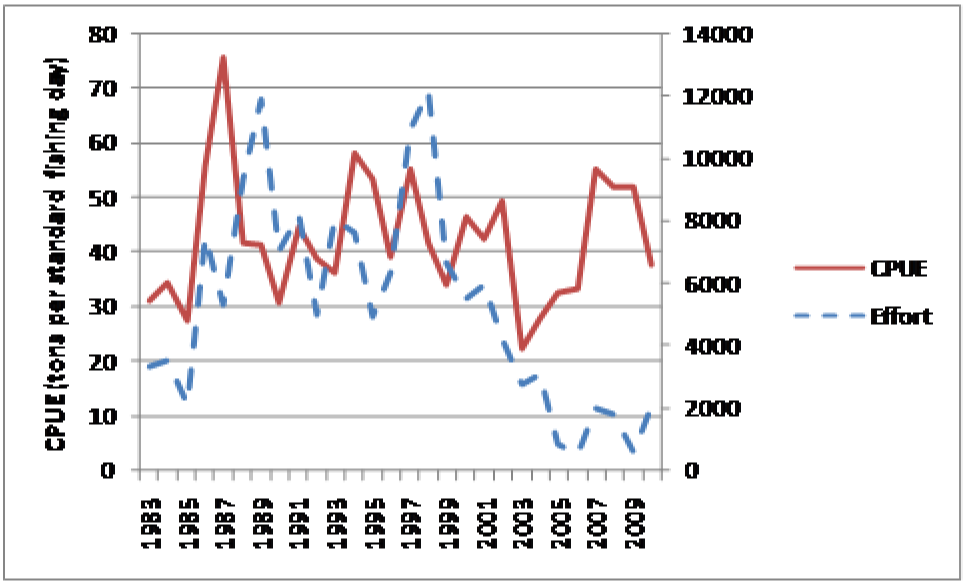


Figure 4.4.3. Sandeel in Area-3. Effort (days fishing for a standard 200 GT vessel) and CPUE (tons per standard fishing day).

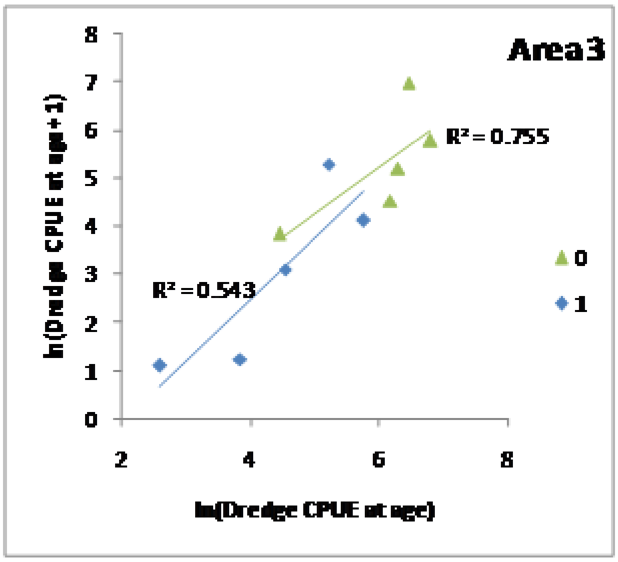


Figure 4.4.4. Internal consistency by age of the Danish dredge survey.

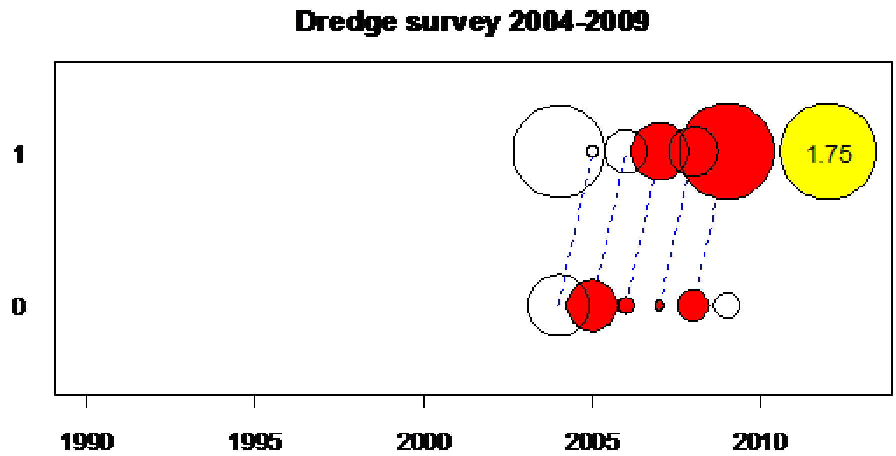
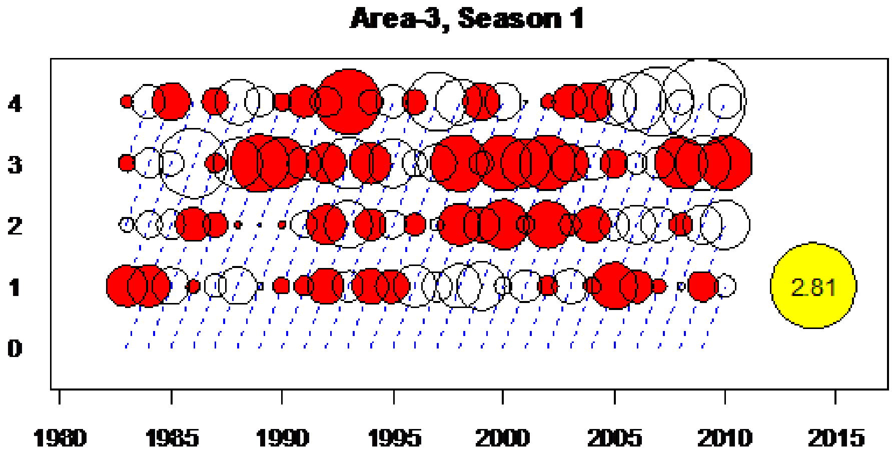


Figure 4.4.5. Sandeel in Area-3. Dredge survey residuals (log(observed CPUE) – log(expected CPUE). Red dots show a positive residual.



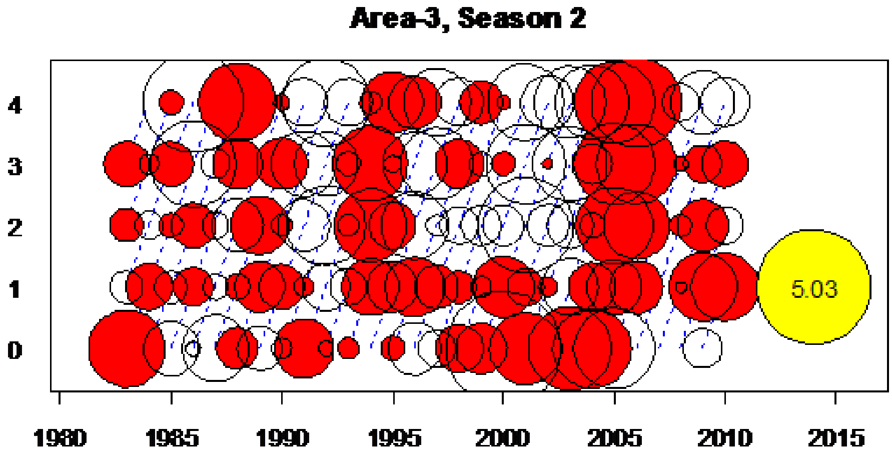


Figure 4.4.6.Sandeel in Area-3. Catch at age residuals (log(observed CPUE) – log(expected CPUE). Red dots show a positive residual.

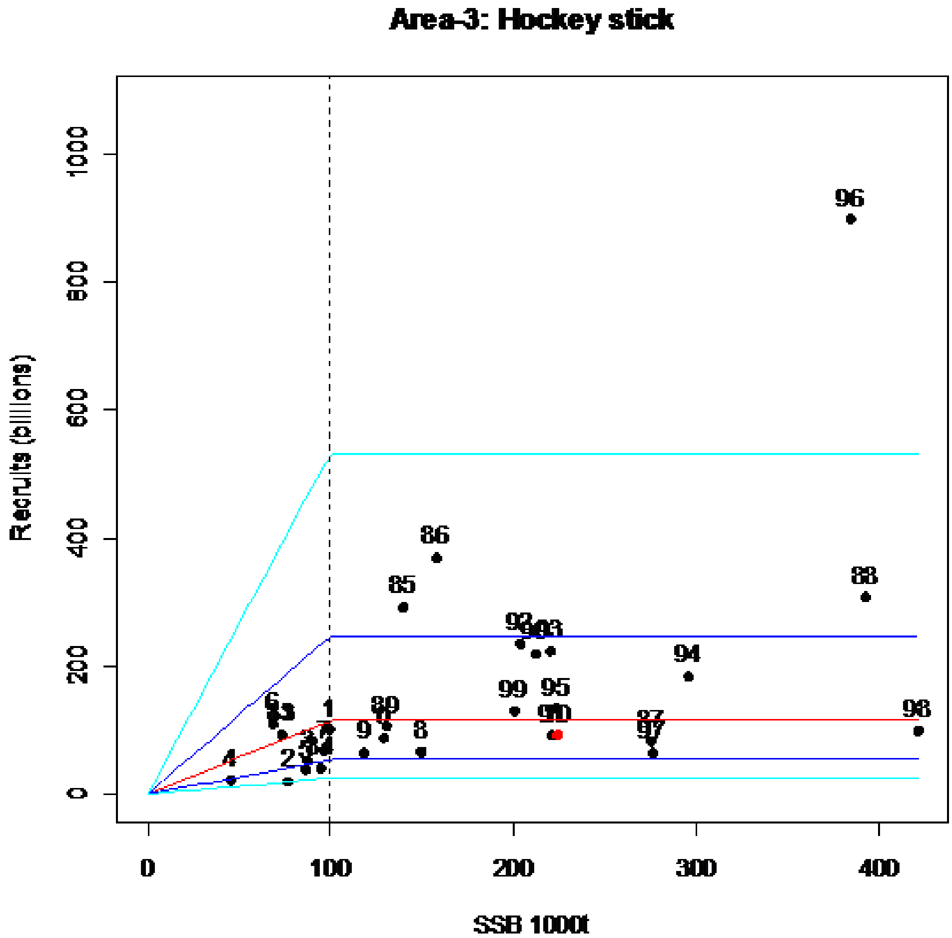


Figure 4.4.7. Sandeel in Area-3. Estimated stock-recruitment relation. The 2010 recruitment is highly uncertain and was not used in the estimation.

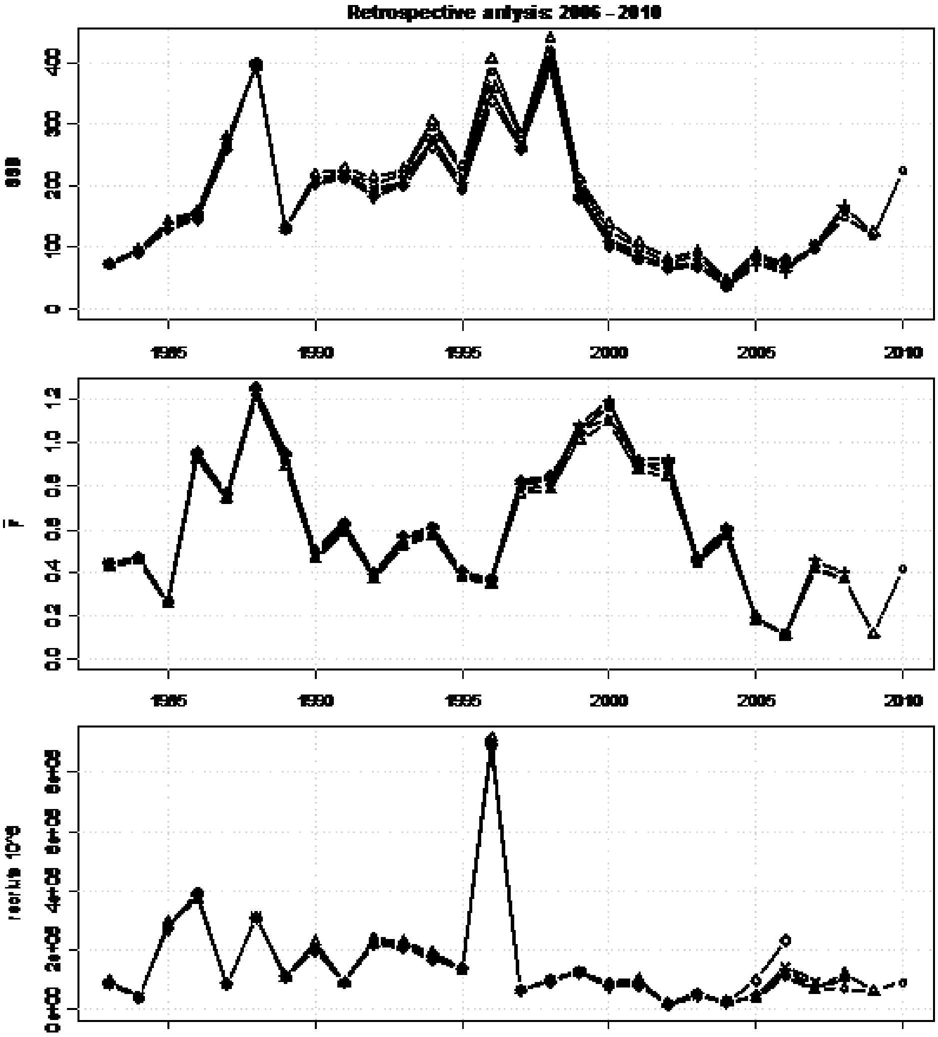


Figure 4.4.8. Sandeel in Area-3. Sandeel retrospective plot.

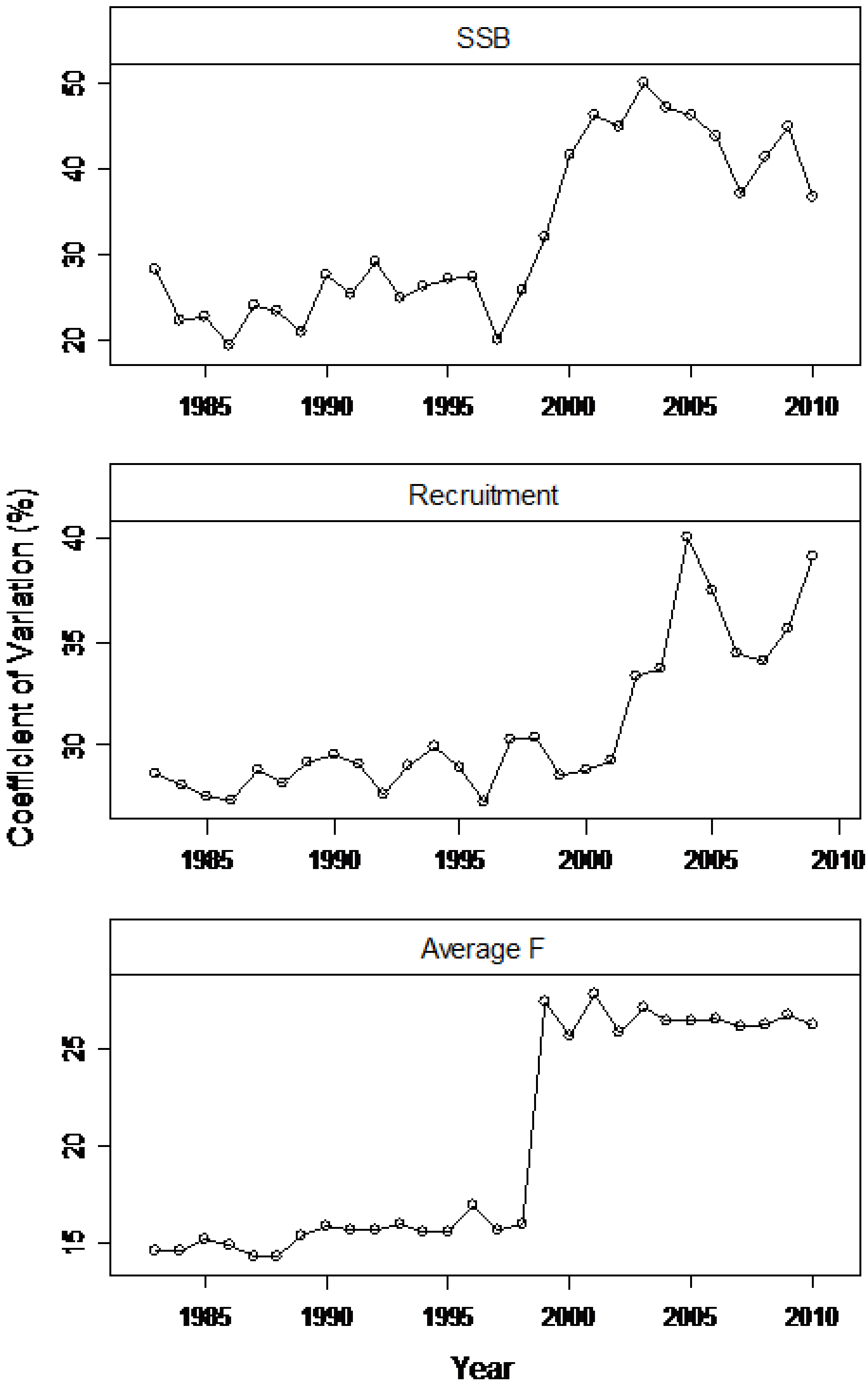


Figure 4.4.9. Sandeel in Area-3. Uncertainties of model output estimated from parameter uncertainties derived from the Hessian matrix and the delta method.

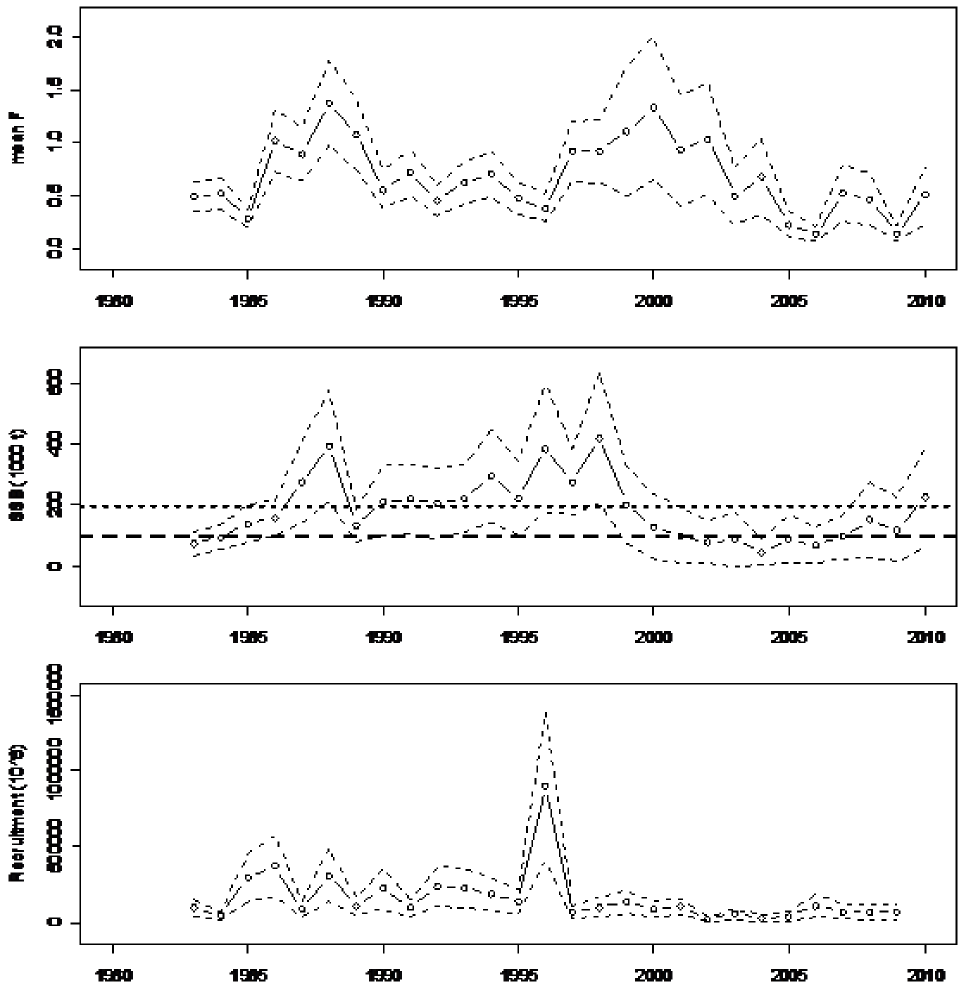


Figure 4.4.10. Sandeel in Area-3. Model output with mean values and plus/minus 2*standard deviation.

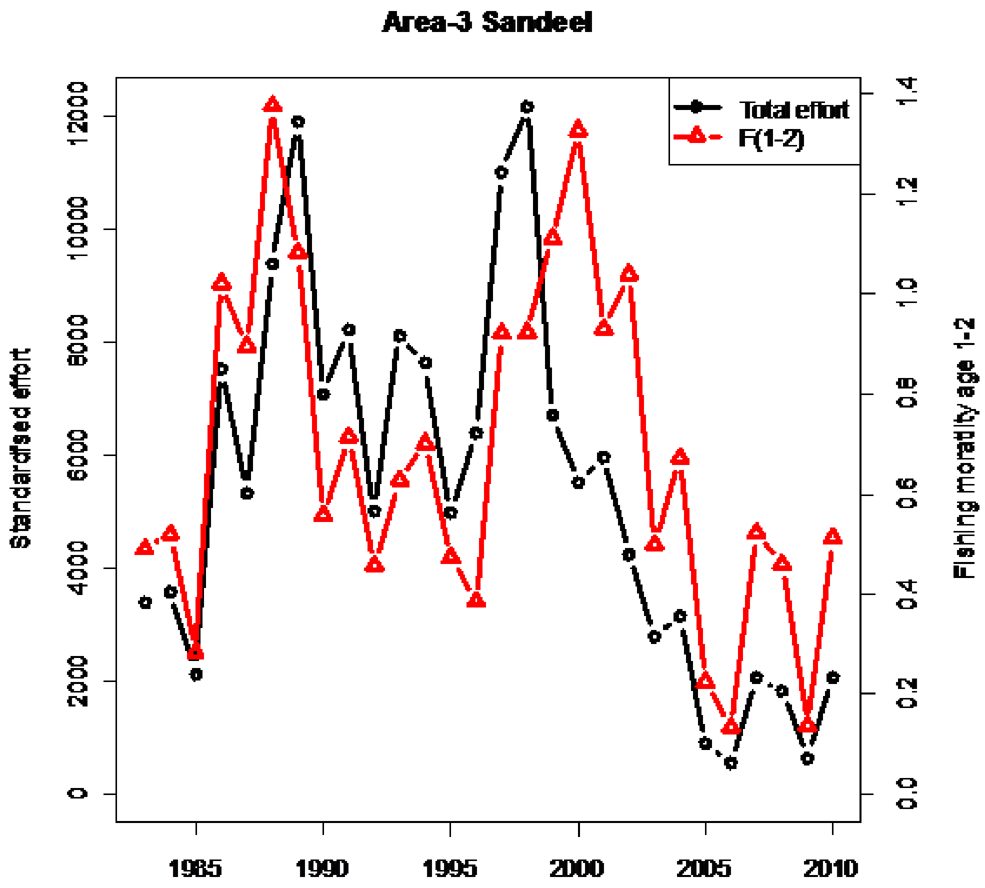


Figure 4.4.11. Sandeel in Area-3. Total effort (days fishing for a standard 200GT vessel) and estimated average Fishing mortality.

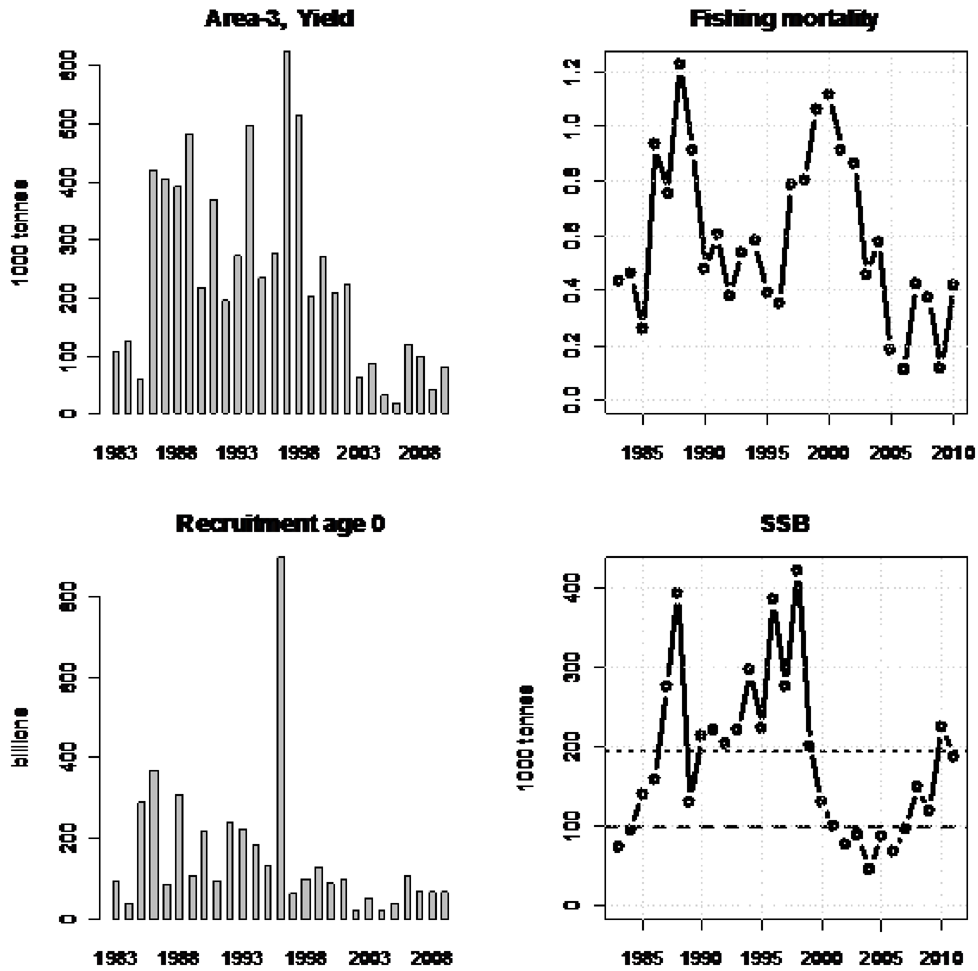


Figure 4.4.12. Sandeel in Arrea-3. Stock summary.

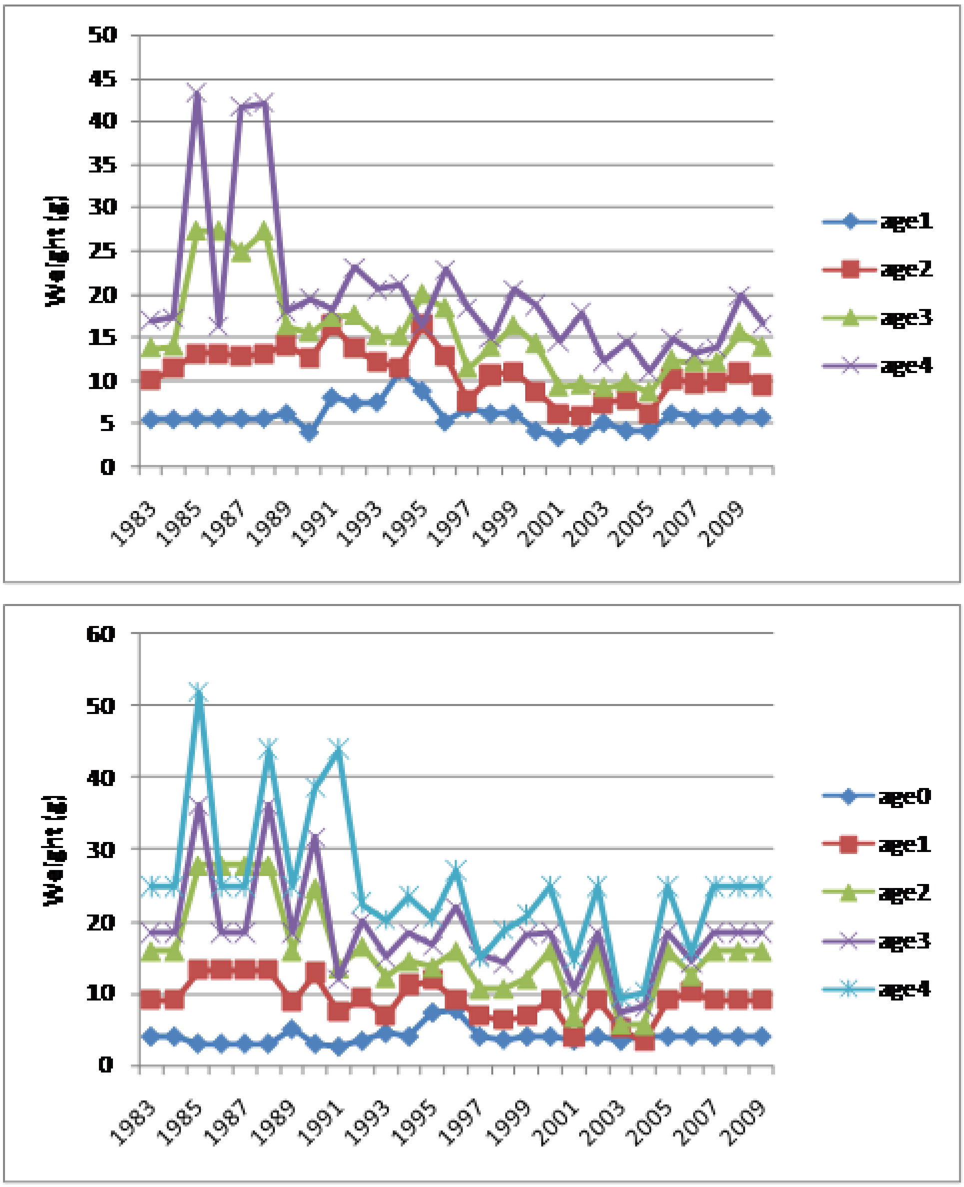


Figure 4.5.1 Sandeel in Area-4. Individual mean weights (g) at age in 1st (upper) and 2nd (lower) half-year.

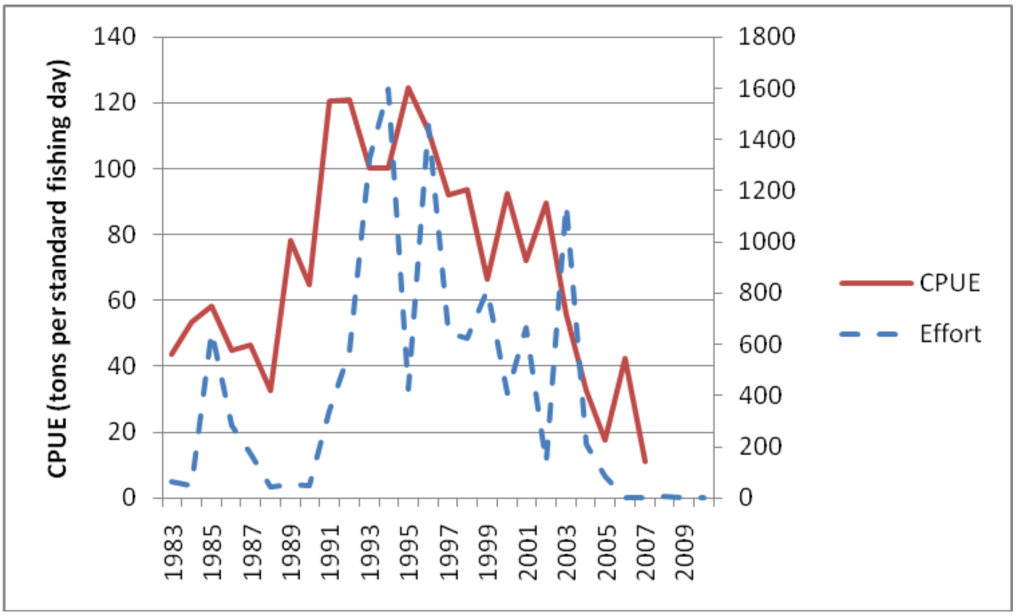


Figure 4.5.2.Sandeel in Area-4. Effort (days fishing for a standard 200GT vessel) and CPUE(tons per standard fishing day).

5 Norway Pout in ICES Subarea IV and Division IIIa (May 2010)

Introduction: Update assessment

The May 2010 assessment of Norway pout in the North Sea and Skagerrak is an up-date assessment from the May and September 2009 assessments, which basically are up-date assessments of the 2004 and 2006 benchmark assessments using the same tuning fleets and parameter settings. The assessment is a "real time" monitoring (and management) run up to 1st April 2010, but includes new information from second half year 2009 and 1st quarter 2010.

Furthermore, a short term prognosis (Forecast) up to 1st January 2011 is given for the stock based on the up-date assessment.

5.1 General

5.1.1 Ecosystem aspects

Stock definition: Norway pout is a small, short-lived gadoid species, which rarely gets older than 5 years (Lambert, Nielsen, Larsen and Sparholt, 2009). It is distributed from the west of Ireland to Kattegat, and from the North Sea to the Barents Sea. The distribution for this stock is in the northern North Sea (>57°N) and in Skagerrak at depths between 50 and 250 m (Raitt 1968; Sparholt, Larsen and Nielsen 2002b). Spawning in the North Sea takes place mainly in the northern part in the area between Shetland and Norway (Lambert *et al*., 2009).

So far it has been evaluated that around 10 % of the Norway pout reach maturity already at age 1, and that most individuals reach maturity at age 2 on which the maturity ogive in the assessment has been based. Results in a recent paper (Lambert *et al* (2009) indicate that the maturity rate for the 1-group is close to 20% in average (varying between years and sex) with an increasing tendency over the last 20 years. Furthermore, the average maturity rate for 2- and 3-groups in 1st quarter of the year was observed to be only around 90% and 95%, respectively, as compared to 100% used in the assessment. Preliminary results from an analysis of regionalized survey data on Norway pout maturity, presented in Larsen, Lassen, Sparholt and Nielsen (2001), gave no evidence for a stock separation in the whole northern area, and this conclusion is supported by the results in Lambert *et al.* (2009).

The population dynamics of Norway pout in the North Sea and Skagerrak are very dependent on changes caused by high recruitment variation and variation in predation mortality (or other natural mortality causes) due to the short life span of the species (Sparholt *et al.* 2002a,b; Lambert *et al.* 2009). With present fishing mortality levels in recent years the status of the stock is more determined by natural processes and less by the fishery, and in general the fishing mortality on 0-group Norway pout is low (ICES WGNSSK Reports). However, there is a need to ensure that the stock remains high enough to provide food for a variety of predator species. This stock is among other important as food source for other species (e.g. saithe, haddock, cod and mackerel) (ICES-SGMSNS 2006). Natural mortality levels by age and season used in the stock assessment do include the predation mortality levels estimated for this stock from the most recent multi-species stock assessment performed by ICES (ICES-SGMSNS 2006).

Natural mortality varies between age groups, and natural mortality at age varies over different time periods. Even though different sources of information (surveys, MSVPA) give slightly different perception of natural mortality at age (see below), the natural mortalities obtained from the most recent run with the North Sea MSVPA model (presented and used in the ICES SGMSNS (2006)) indicate high predation mortality on Norway pout. Especially the more recent high abundance of saithe predators and the more constant high stock level of western mackerel as likely predators on smaller Norway pout are likely to significantly affect the Norway pout population dynamics. However, interspecific density dependent patterns in Norway pout growth and maturity ware not found in relation to stock abundance of those predators but rather in relation to North Sea cod and whiting stock abundance (Lambert, Nielsen, Larsen and Sparholt, 2009).

In order to protect other species (cod, haddock, saithe and herring as well as mackerel, squids, flatfish, gurnards, Nephrops) there is a row of technical management measures in force for the small meshed fishery in the North Sea such as the closed Norway pout box, by-catch regulations, minimum mesh size, and minimum landing size (cf **Stock Annex (Q5))**.

5.1.2 Fisheries

The fishery is mainly performed by Danish and Norwegian vessels using small mesh trawls in the north-western North Sea, especially at the Fladen Ground and along the edge of the Norwegian Trench in the north-eastern part of the North Sea. Main fishing seasons are 3rd and 4th quarters of the year with also high catches in 1st quarter of the year especially previous to 1999. The average quarterly spatial distribution of the Norway pout catches during a ten year period from 1994-2003 is shown in figures in the **Stock Annex (Q5)**. The Norway pout fishery is a mixed commercial, small meshed fishery conducted mainly by Denmark and Norway directed towards Norway pout as one of the target species together with Blue Whiting.

Landings have been low since 2001, and the 2003-2004 landings were the lowest on record. Effort in 2003 and 2004 has been historically low and well below the average of the 5 previous years (**Table** 5.2.9). The effort in the Norway pout fishery was in 2002 at the same level as in the previous eight years before 2001. The targeted Norway pout fishery was closed in 2005, in the first half year of 2006, as well as in all of 2007, but Norway pout were in the periods of closure taken as a by-catch in the Norwegian mixed blue whiting and Norway pout fishery, as well as in a small experimental fishery in 2007. The fishery was open for the second half year of 2006 and in all of 2008 and 2009 based on recent strong year classes being on or above the long term average level. However, the Norwegian part of the Norway pout fishery was only open from May to August in 2008. Despite opening of the fishery by 1st January 2008 (with an preliminary quota of 41.3 kt as well as a final quota of 114.6 t set late in 2008) only 30.4 kt was taken by Denmark, and the Norwegian catches were 5.7 kt, i.e. 36.1 kt in total. According to information from the fishery associations this was due mainly to high fuel prices and only to a minor extent late setting of the final quota affecting the trade of individual Danish vessel quotas, and less due to the by-catch percentages of other species in the fishery. In 2009, the fishery was opened with a preliminary TAC around 26 kt (EU), and a final TAC of 116 kt (EU), but total catches in 2009 was only around 54.5 kt (17.5 t by Denmark and 37.0 kt by Norway). In 2009, the Danish fishery was limited by relatively high by-catches of especially whiting as well as high fuel prices. For 2010, a preliminary TAC of 75.9 kt (EU) was set with recommendations of a final TAC of 162 kt (EU 81 kt and Norway 81 kt) Trends in yield are shown in **Table** 5.2.2 and **Figures** 5.3.2-3. Agreed TAC by year is shown in Table 5.2.1.

By-catch of herring, saithe, cod, haddock, whiting, and monkfish at various levels in the small meshed fishery in the North Sea and Skagerrak directed towards Norway pout has been documented (Degel *et al*., 2006, ICES CM 2007/ACFM:35, (WD 22 and section 16.5.2.2)), and recent by-catch numbers are given in section 2 of this report. In general, the by-catch levels of these gadoids have decreased in the Norway pout fishery over the years. By-catch levels of whiting and cod in the combined Danish small meshed fishery is shown in sections 12 and 14, respectively, of this report. Review of scientific documentation reveals that by-catch reduction gear selective devices can be used in the Norway pout fishery, significantly reducing by-catches of juvenile gadoids, larger gadoids, and other non-target species (Nielsen and Madsen, 2006, ICES CM 2007/ACFM:35, WD 23 and section 16.5.2.2). By-catches of other species should also be taken into account in management of the fishery. Existing technical measures such as the closed Norway pout box, minimum mesh size in the fishery, and by-catch regulations to protect other species have been maintained. A detailed description of the regulations and their background can be found in the **Stock Annex (Q5))**.

5.1.3 ICES advice

In September 2009 the advice on North Sea Norway pout was updated with the addition of the 3rd quarter 2009 English and Scottish groundfish surveys.

Based on the estimates of SSB in September 2009, ICES classified the stock to show full reproductive capacity ($SSB>B_{pa}$). Catches and fishing mortality was low in 2008 and first half year 2009. Fishing mortality has generally been lower than the natural mortality for this stock and has decreased in recent years well below the long term average F (0.6). Recruitment in 2008 was just below the long term average and in 2009 above average.

The targeted fishery for Norway pout was closed in 2005, the first half year 2006, and all of 2007. For these periods ICES advised a closure of the fishery (i.e. a TAC=0 t) in the EC zone and a TAC of 5 000 t in the Norwegian zone – the latter to allow for by-catches of Norway pout in the directed Norwegian blue whiting fishery. Recruitment reached historical minima in 2003-2004 and was low in 2006, but was about the long term average (at 80 billions, arithmetic mean) in 2005, 2007, and 2008. In 2009 recruitment was well above the long term average. Based on the real time management and confirmation of recruitment estimates through consecutive surveys, the fishery was opened in 2008 and 2009, but the TAC was not taken in 2008.

ICES advised in autumn 2009 - on the basis of precautionary limits - that in order to maintain the spawning stock biomass above B_{pa} in 2010 catches should be restricted to less than 307,000 t in 2010. The catch forecast for 2010 carried out in the autumn 2009 assumed status quo fisheries in 2009, with catches of 45 000 t, which was well below the TAC for 2009. In case a quota of 157 000 t was fully taken in 2009 it would result in lower catch forecasts for 2010 (226 000 t to be at B_{pa} by 2011).

There is bi-annual information available to perform real time monitoring and management of the stock. This can be carried out both with fishery independent and fishery dependent information as well as a combination of those. Real time advice (forecast) and management options for 2010 will be provided for the stock in spring 2010 as well.

ICES provides advice according to 3 management strategies for the stock (see below). The final 2009 ICES advice for 2010 has under the escapement strategy (real time management) been a final TAC of 307 000 t, under the long term fixed TAC strategy a TAC on 50 000 t , and under the long term fixed fishing mortality or fishing effort strategy (TAE) a TAC on 279 000 t corresponding to a fixed F=0.35.

ICES advices that there is a need to ensure that the stock remains high enough to provide food for a variety of predator species. It is advised that by-catches of other species should also be taken into account in management of the fishery. Also it is advised that existing measures to protect other species should be maintained.

Biological reference points for the stock have been set by ICES at B_{lim} = 90 000 t as the lowest historical observed biomass (SSB) before 2000 (1986, 1989) and B_{pa} = 150 000 t. However, in 2005 the SSB was as low as 55 000 t from which the stock has recovered. No F-based reference points are advised for this stock.

5.1.4 Management up to 2010

There is no specific management objective set for this stock. With present fishing mortality levels the status of the stock is more determined by natural processes and less by the fishery. The European Community has decided to apply the precautionary approach in taking measures to protect and conserve living aquatic resources, to provide for their sustainable exploitation and to minimise the impact of fishing on marine ecosystems.

ICES advised in 2005 real time management of this stock. In previous years the advice was produced in relation to a precautionary TAC, which was set to 198 000 t in the EC zone and 50 000 t in the Norwegian zone. On basis of the advice for 2005 from ICES, EU and Norway agreed to close the directed Norway pout fishery in 2005 and in the first part of 2006, and in all of 2007. In 2005 and 2007, the TAC was 0 in the EC zone and 5 000 t in the Norwegian zone – the latter to allow for by-catches of Norway pout in the directed Norwegian blue whiting fishery. On basis of the real time management advice provided by ICES in spring 2006 EU set a quota on 95.000 t for 2006 (intended for the whole year in the EC zone), while the advice in autumn 2006 taking the low recruitment in 2006 into consideration led to a closure of the fishery again by 1st of January 2007. This advice was reiterated by ICES in May 2007, and resulted in a management where the directed Norway pout fishery continued to be closed for all of 2007. Following the September 2007 real time management advice the fishery was opened again 1st of January 2008 with a preliminary TAC of 41.3 kt t and a final TAC of 115 kt. In 2009, a preliminary TAC was set around 26 kt (EU-part), and a final TAC of 116 kt (EU-part)

In managing this fishery by-catches of other species have been taken into account. Existing technical measures such as the closed Norway pout box, minimum mesh size in the fishery, and by-catch regulations to protect other species have been maintained.

Long term management strategies have been evaluated for this stock. (See section 5.11). An overview of recent relevant management measures and regulations for the Norway pout fishery and the stock can be found in the **Stock Annex (Q5)).**

5.2 Data available

5.2.1 Landings

Data for annual nominal landings of Norway pout as officially reported to ICES are shown in **Table** 5.2.1. Historical data for annual landings as provided by Working Group members are presented in **Table** 5.2.2, and data for national landings by quarter of year and by geographical area are given in **Table** 5.2.3.

Both the Danish and Norwegian landings of Norway pout were low in 2008 and 2009 and the TAC was not reached. The most recent catches have been included in the update assessment.

5.2.2 Age compositions in Landings

Age compositions were available from Norway and Denmark (except for Norway 2008). Catch at age by quarter of year is shown in **Table** 5.2.4. Only very few biological samples were taken from the low Norway pout catches in 2005, first half year 2006 and in 2007. Danish data are in the InterCatch database, but not Norwegian data.

Landings for the 1^{st} quarter 2010 are very low (below 500 t). At present there is no biological information for this catch, and consequently catches of 0 individuals per age (for age group 1-3) have been assumed for the first quarter in 2010 in the SXSA.

5.2.3 Weight at age

Mean weight at age in the catch is estimated as a weighted average of Danish and Norwegian data. Mean weight at age in the catch is shown in **Table** 5.2.5 and the historical levels, trends and seasonal variation in this is shown in **Figure** 5.2.1. In general, the mean weights at age in the catches are variable between seasons of year. Mean weight at age in the stock is given in **Table** 5.2.6. The same mean weight at age in the stock is used for all years. The reason for mean weight at age in catch is not used as estimator of weight in the stock is mainly because of the smallest 0-group fish are not fully recruited to the fishery in 3^{rd} quarter of the year because of likely strong effects of selectivity in the fishery. The estimation of mean weights at age in the catches and the used mean weights in the stock in the assessment is described in the **Stock Annex (Q5)).**

Mean landings weight at age from Danish and Norwegian fishery from 2005-2007 are uncertain because of the few observations. Missing values have been filled in using a combination of sources (values from 2004, from adjacent quarters and areas, and from other countries within the same year). The assumptions of no changes in weight at age in catch in these years do not affect assessment output significantly because the catches in the same period were low. Also, mean weights at age values for 2008 are uncertain given low landings and few observations. Among other, Danish data have been applied for the Norwegian catch as there has been no individual sampling in Norway for 2008. Mean weight at age data is available from both Danish and Norwegian fishery in 2009.

Danish data are in the InterCatch database, but not Norwegian data.

5.2.4 Maturity and natural mortality

Maturity and natural mortality used in the assessment is described in the **Stock Annex (Q5)**. Proportion mature and natural mortality by age and quarter used in the assessment is given in **Table** 5.2.6.

The same proportion mature and natural mortality are used for all years in the assessment. The proportion mature used is 0% for the 0-group, 10% of the 1-group and 100% of the 2+-group independent of sex. Results in a recent paper (Lambert *et al.* (2009) indicate that the maturity rate for the 1-group is close to 20% in average (varying between years and sex) with an increasing tendency over the last 20 years. Furthermore, the average maturity rate for 2- and 3-groups in 1st quarter of the year was observed to be only around 90% and 95%, respectively, as compared to 100% used in the assessment.

The natural mortality is set to 0.4 for all age groups in all seasons that result in an annual natural mortality of 1.6 for all age groups.

In response to the wish from ACFM RG 2006 on a separate description of natural mortality aspects for Norway pout in the North Sea a summary of the September 2006 benchmark assessment on this issue is given in the **Stock Annex (Q5)**. In conclusion from the exploratory runs using different natural mortalities no conclusions could be reached as the mortality between age groups was contradictive and inconclusive between periods (variable) from the different sources used (see **Stock Annex (Q5)**) showing different trends with no obvious biological explanation. On that basis it was in the 2006 benchmark assessment decided that the final assessment continues using the baseline assessment constant values for natural mortality at age and quarter by year as in previous years assessment. This has been adopted in this years up-date assessment.

5.2.5 Catch, Effort and Research Vessel Data

Description of catch, effort and research vessel data used in the assessment is given in the **Stock Annex (Q5).** Data used in the present assessment is given in **Table**s 5.2.7-5.2.11 as described below. No commercial fishery tuning fleet is included for 2005-2009 except for second half year 2006. Recent catch information for 2008-2009 is included in this assessment. Catches in all of 2005 as well as in 1st quarter 2009 were nearly 0 and only very limited information exists about this catch. Consequently, there has been assumed and used low catches of 0.1 million individuals per age (for age groups 1-3) per quarter in the SXSA for 2005 and 0-catches for 1st quarter 2009.

5.2.5.1 Effort standardization:

The method for effort standardization of the commercial Norway pout fishery tuning fleet is described in the **Stock Annex (Q5)**, which has also been used with up-dated data in the May 2009 assessment. However, no standardized effort data and cpue-indices for the commercial fishery tuning fleet has been included for 2005-2008 except for 2nd half year 2006. Information from 2nd half year 2006 has been included. The results of the standardization are also presented in the **Stock Annex (Q5).**

Up-dated effort data from the commercial fishery is given in **Tables** 5.1.7-5.1.9, and the CPUE trends in the commercial fishery are shown in **Table** 5.2.10 and **Figure** 5.2.2.

5.2.5.1.1 Danish effort data

Table 5.2.7 shows CPUE data by vessel size category and year for the Danish commercial fishery in ICES area IVa. The basis for these data is described in the **Stock Annex(Q5)**. However, no Danish effort data exist for the commercial fishery tuning fleet in 2005, the first part of 2006, and in 2007 due to closure of the fishery. Data for 2008 and 2009 has been included.

5.2.5.1.2 Norwegian effort data

Observed average GRT and effort for the Norwegian commercial fleets are given in **Table** 5.2.8, however, no Norwegian effort data exist for the commercial fishery tuning fleet in 2005, the first part of 2006, and in 2007. Norwegian effort data for the directed Norway pout fishery in 2008 has not been prepared because the fishery has been on low level. Data for 2009 has been included.

5.2.5.1.3 Standardized effort data

The resulting combined and standardized Danish and Norwegian effort for the commercial fishery used in the assessment is presented in **Table** 5.2.9. However, no standardized effort data for the commercial fishery tuning fleet is included for 2005-2008 except for 2nd half year 2006. Standardized effort data for 2008 for the Danish part of the fleet, as well as for both the Danish and Norwegian fleets in 2009, is presented in the table.

5.2.5.1.4 Commercial fishery standardized CPUE data

Combined CPUE indices by age and quarter for the commercial fishery tuning fleet are shown in **Table** 5.2.10. Trends in CPUE (normalized) by quarterly commercial tuning fleet and survey tuning fleet for each age group and all age groups together are shown in **Figure** 5.2.2. However, no combined CPUE indices by age and quarter for the commercial fishery tuning fleet are used for 2005, first half year 2006 and for 2007-2010.

5.2.5.1.5 Research vessel data

Survey indices series of abundance of Norway pout by age and quarter are for the assessment period available from the IBTS (International Bottom Trawl Survey 1st and 3rd quarter) and the EGFS (English Ground Fish Survey, 3rd quarter) and SGFS (Scottish Ground Fish Survey, 3rd quarter), **Table** 5.2.11. The new survey data from the 1st quarter 2010 IBTS and the 3rd quarter 2009 IBTS research surveys have been included in this assessment (as well as the 3rd quarter 2009 EGFS and SGFS research survey information which also were included in the September 2009 assessment). The survey data time series including the new information is presented in **Table** 5.2.11, as well as trends in survey indices in **Figure** 5.2.2. Surveys covering the Norway pout stock are described in the **Stock Annex (Q5)**. Survey data time series used in tuning of the Norway pout stock assessment are described below.

Revision of assessment tuning fleets

The revision of the tuning fleets used in the benchmark 2004 assessment - as used also in the 2005-2006 and 2007-2010 up-date assessments - is summarised in **Table** 5.3.1. Details of the revision are described in the **Stock Annex (Q5).**

Apart from the up-dated catch data and research survey indices, all other data and data standardization methods used in this assessment are identical to those used and described in the May and September 2009 assessments (see also **Table** 5.3.1).

5.3 Catch at Age Data Analyses

5.3.1 Review of last year's assessment

There are no review comments to reply to for the technical review of the May 2009 assessment. It should just be noted that the back-shifting of recruitment season from quarter 3 to quarter 2 is not a new setting in the assessment, but standard procedure according to the real time assessment performed partly in May and September of the year.

With respect to the technical review based on the September 2009 assessment: The main concern of the review group was that the projections for 2010 and 2011 include estimates of F for the remainder of the year based on Fsq (2008) which was very low due to a significant undershoot of the TAC. The low F in 2008 was partly affected by the high fuel costs, which have subsided in 2009. If there is a substantial increase in F during the later part of 2009 the projections/advise for 2010 would change substantially. The RG notes that whiles there are no noted indications of a major change, it is however possible as there are a range of other external drivers that can impact of fishing patterns and in a short time frame which may violate the Fsq assumption. However, if one did occur it could be evaluated at the spring review and adjusted accordingly as the major component of the fishery has traditionally occurred in the last 2 quarters. The RG considers it appropriate that a range of forecasts are presented based on various TAC uptake scenarios in the intermediate year.

In reply to this, the forecast in September 2009 already included effects of different scenarios of catch levels in 2009, and also evaluated scenarios with an exploitation pattern similar to the long term exploitation pattern from 1991-2004 compared to the 2008 exploitation pattern. The exploitation pattern in recent year has been remained at a low level, and in the most recent years the TAC has not been taken. The latter is partly due to fishing costs (especially fuel costs) and by-catch levels according to by-catch restrictions. In order to enable management to reflect on sudden changes in the stock dynamics (especially due to recruitment) and changes in exploitation pattern there is performed a real time assessment on half year basis for the stock. Accordingly, the fishery is managed by setting a preliminary TAC in the first part of the year, and a final quota for the last part of the year

The short term forecast table should highlight the three accepted management strategies and their associated effects on landings and SSB, which is included in the report.

As noted by the WG, further work is needed on the commercial tuning fleet data. The WG is encouraged to collaborate with SGGEM (Study Group on Gear and Effort Metrics) to investigate possible metrics that could provide more precise estimators of effort. This could also help address the concerns of technological creep associated with the effort control strategy.

The WG note that there is an apparent link between effort and F, this relationship should be presented and explored as part of any future benchmark assessments. This could be part of a wider work item on issues relating to commercial tuning fleets.

5.3.2 Final Assessment

The SXSA (Seasonal Extended Survivors Analysis) was used to estimate quarterly stock numbers (and fishing mortalities) for Norway pout in the North Sea and Skagerrak in May 2010. A general description of and reference to documentation for the SXSA model is given in the **Stock Annex (Q5).** Stock indices and assessment settings used in the assessment is presented in **Tables** 5.3.1-2. The SXSA uses the geometric mean for the stock-recruitment relationship (see **Table** 5.3.6).

In contrast to the September 2009 assessment, no back-shifting of the third quarter survey indices was undertaken, and the recruitment season to the fishery in the assessment is, accordingly, set to quarter 3. All other aspects and settings in the assessment are an up-date of the May 2009 and September 2009 assessments.

Results of the SXSA analysis are presented in **Table** 5.3.1-2 (assessment model parameters, settings, and options), **Table** 5.3.3 (population numbers at age (recruitment), SSB and TSB), **Table** 5.3.4 (fishing mortalities by year), **Table** 5.3.5 (diagnostics), and Table 5.3.6 (stock summary). The summary of the results of the assessment are shown in **Table** 5.3.6 and **Figures** 5.3.1-5.

Fishing mortality has generally been lower than natural mortality and has decreased in the recent decade below the long term average (0.6). Fishing mortality for the 1st and 2nd quarter has decreased to insignificant levels in recent years (F less than 0.05), while fishing mortality for 3rd and especially 4th quarter, that historically constitutes the main part of the annual F, has also decreased moderately during the last decade. Fishing mortality in 2005, first part of 2006, and in 2007 was close to zero due to the closure of the Norway pout fishery in these periods. Fishing mortality has been low in 2008 and 2009, and the TACs has not been fished up.

Spawning stock biomass (SSB) has since 2001 decreased continuously until 2005 but has in recent years increased again due to the average 2005, 2007 and 2008 year classes, and the strong 2009 year class, and the lowered fishing mortality. The stock biomass fell to a level well below $\mathbf{B_{lim}}$ in 2005 which is the lowest level ever recorded. By 1st January 2007 and 2008 the stock was at $\mathbf{B_{pa}}$ (=MSY $\mathbf{B_{trigger}}$) (i.e. at increased risk of suffering reduced reproductive capacity), while the stock by 1st January 2009 and 1st January 2010 has been well above Bpa (i.e. the stock show full reproductive capacity).

5.3.3 Comparison with 2009 assessment

The final, accepted May 2010 SXSA assessment run was compared to the September 2009 SXSA assessment. The results of the comparative run between the May 2010 and the September 2009 assessments are shown in **Figure** 5.3.5. The retrospective analysis based on the May 2010 assessment is shown in **Figure** 5.3.4. The resulting outputs of these assessments showed to be identical giving similar perception of stock status and dynamics. The difference in recruitment is because of use of different recruitment seasons in the two assessments (as described above).

5.4 Historical stock trends

The assessment and historical stock performance is consistent with previous years assessments.

5.5 Recruitment Estimates

The long-term average recruitment (age 0, 3rd quarter) is 83 billions (arithmetic mean) and 69 billions (geometric mean) for the period 1983-2010 (**Table** 5.3.6). Recruitment is highly variable and influences SSB and TSB rapidly due to the short life span of the species. The recruitment in 2005, 2007 and 2008 (age 0, 3rd quarter) has been around the long term average, while the 2006 year class was weak. The 2008 year class was above long term average (94 billions), and the 2009 year class is very strong (140 billions).

5.6 Short-term prognoses

Deterministic short-term prognoses were performed for the Norway pout stock. The forecast was calculated as a stock projection up to 1st of January 2011 using full assessment information for 2009 and 1st quarter 2010, i.e. it is based on the SXSA assessment estimate of stock numbers at age at the start of 2010.

The purpose of the forecast is to calculate the catch of Norway pout in 2010 which would result in SSB at or above $\mathbf{B_{pa}}$ = MSY $\mathbf{B_{trigger}}$ (=150 000 t)1st of January 2011. The forecast is based on an escapement management strategy but also providing output for the long term fixed E or F management strategy and a long term fixed TAC strategy for Norway pout (see ICES WGNSSK Report ICES CM 2007/ACFM:30 section 5.3, and ICES AGNOP Report ICES CM 2007/ACFM:39, and the ICES AGSANNOP Report ICES CM 2007/ACFM:40 as well as section 5.11 below).

Input to the forecast is given in **Table** 5.6.1. Observed fishing mortalities for all quarters of 2009 have been used (assessment year). The forecast assumes a 2010 (the forecast year) fishing pattern scaled to the average standardized exploitation pattern (F) for 2008 and 2009 (both years included and standardized with yearly Fbar to F(1,2)=1). The standardized 2008 exploitation pattern was used in the 2009 ICES WGNSSK Report. Recruitment in the forecast year is assumed to the 25th percentile = 48 087 millions of the SXSA recruitment estimates (GM = 68 730 millions) in the 3rd quarter of the year. The background for selecting recent years exploitation pattern in this forecast is that 2004 was the last year where the directed Norway pout fishery was open in all seasons of the year, except for 2008 and 2009 where the fishery was open all of the year in the EU Zone (but only May-August 2008 in the Norwegian zone). The catches in 2008 and 2009 have been relatively low and the exploitation pattern between seasons (and ages) is very different from the average previous long term (1991-2004) exploitation pattern. The targeting in the small meshed trawl fishery has changed recently where targeting of Norway pout has decreased (see also the **Stock Annex (Q5)**).

The weight at age in the catch per quarter is based on estimated mean weight at age in catches in the assessment year of the forecast (2009) and based on recent running 5 year averages (i.e. for the 5 last years with covering observations) for the forecast year (2010). The constant weight at age in stock by year and quarter of year used in the SXSA assessment has also been used in the forecast for 2010.

The results of the forecasts are presented in **Table** 5.6.2. It can be seen that if the objective is to maintain the spawning stock biomass above MSY $B_{trigger}$ = B_{pa} by 1st of January 2011 then a catch around 434 000 t can be taken in 2010 according to the escapement strategy. Under a fixed F-management-strategy with F around 0.35 a catch around 125 000 t can be taken in 2010. Under a fixed TAC strategy a TAC of 50 000 t can be taken in 2009 (corresponding to a F around 0.13) according to the long term management strategies.

5.7 Medium-term projections

No medium-term projections are performed for this stock. The stock contains only a few age groups and is highly influenced by recruitment.

5.8 Biological reference points

	Type	Value	Technical basis
MSY Approach	MSY $B_{trigger}$	150 000 t	MSY $B_{triger} = B_{MSY} = B_{pa} = B_{lim}\ e^{0.3\text{-}0.4*1.65}$ (SD): 150 000 t.
	F_{MSY}	Undefined	No target reference points advised
Precautionary approach	B_{lim}	90 000 t	$B_{lim} = B_{loss}$, the lowest observed biomass in the 1980s
	B_{pa}	150 000 t	Below this value probability of below-average recruitment increases.
	F_{lim}	Undefined	None advised
	F_{pa}	Undefined	None advised

(unchanged since: 2010)

Biomass based reference points have been unchanged since 1997 given MSY $B_{trigger} = B_{pa}$.

Norway pout is a short lived species and most likey an one time spawner. The population dynamics of Norway pout in the North Sea and Skagerrak are very dependent on changes caused by recruitment variation and variation in predation (or other natural) mortality, and less by the fishery. Recruitment is highly variable and influences SSB and TSB rapidly due to the short life span of the species. (Basis: Sparholt, Larsen and Nielsen 2002a,b; Lambert, Nielsen, Larsen and Sparholt 2009). Furthermore, 10 % of age 1 is considered mature and is included in SSB. Therefore, the recruitment in the year after the assessment year does influence the SSB in the following year. Also, Norway pout is to limited extent exploited already from age 0. All in all, the stock is very dependent of yearly dynamics and should be managed as a short lived species.

On this basis B_{pa} is considered a good proxy for a SSB reference level for MSY $B_{trigger}$. B_{lim} is defined as B_{loss} and is based on the observations of stock developments in SSB (especially in 1989 and 2005) been set to 90 000 t. MSY $B_{trigger} = B_{pa}$ has been calculated from

$$B_{pa} = B_{lim}\ e^{0.3*1.65}\ \text{(SD)}.$$

A SD estimate around 0.3-0.4 is considered to reflect the real uncertainty in the assessment. This SD-level also corresponds to the level for SD around 0.2-0.3 recommended to use in the manual for the Lowestoft PA Software (CEFAS, 1999). The relationship between the Blim and $B_{MSY} = B_{pa}$ (90 000 and 150 000 t) is 0.6.

5.9 Quality of the assessment

The estimates of the SSB, recruitment and the average fishing mortality of the 1- and 2-group are consistent with the estimates of previous years assessment. This appears from the results of the assessment as well as from Figures 5.3.4 and 5.3.5 with among other the comparisons of the 2009 assessment.

The assessment is considered appropriate to indicate trends in the stock and immediate changes in the stock because of the seasonal assessment taking into account the seasonality in fishery, use seasonal based fishery independent information, and using most recent information about recruitment. The assessment provides stock status and year class strengths of all year classes in the stock up to the first quarter of the assessment year. The real time assessment method with up-date every half year also gives a good indication of the stock status the 1st January the following year based on projection of existing recruitment information in 3rd quarter of the assessment year.

5.10 Status of the stock

Based on the estimates of SSB in September 2009, ICES classified the stock at full reproductive capacity with SSB well above Bpa at the start of 2009 (up to 1st July 2009). Also, the most recent estimates of SSB (Q1 2010) show full reproductive capacity of the stock (SSB> MSY $B_{trigger} = B_{pa}$).

Fishing mortality has generally been lower than the natural mortality for this stock and has decreased in recent years well below the long term average F (0.6). Targeted fishery for Norway pout was closed in 2005, first half year 2006, and in all of 2007 and fishing mortality and effort has accordingly reached historical minima in these periods (**Table** 5.3.6). The fishery was open for the second half year of 2006 and in all of 2008 and 2009. Despite opening of the fishery by 1st January 2008 (with an preliminary quota of 41.3 kt and a final quota of 114.6 t set late in 2008) only 36.1 kt was taken in total. In 2009, the fishery was opened with a preliminary TAC around 26 kt (EU), and a final EU TAC of 116 kt, but total catches in 2009 was only around 54.5 kt (17.5 t by Denmark (EU) and 37.0 kt by Norway). For 2010, a preliminary TAC of 75.9 kt (EU) has been set.

Recruitment reached historical minima in 2003-2004 and the recruitment in 2005, 2007 and 2008 has been around the long term average (83 billions), while the 2006 year class was weak. The 2008 recruitment was above long term average (94 billions), and the 2009 year class is very strong (140 billions). (**Tables** 5.3.3 and Table 5.3.6).

5.11 Management considerations

There are no management objectives for this stock.

From the results of the forecast presented here it can be seen that if the objective is to maintain the spawning stock biomass above a reference level of MSY $B_{trigger} = B_{pa}$ by 1st of January 2011 then a catch around 434 000 t can be taken in 2010 according to the escapement strategy. Under a fixed F-management-strategy with F around 0.35 a catch around 125 000 t can be taken in 2010. Under a fixed TAC strategy a TAC of 50 000 t can be taken in 2010 (corresponding to a F around 0.13) according to the long term management strategies (see section 5.11.1 below).

There is consistent bi-annual information available to perform real time monitoring and management of the stock. This can be carried out both with fishery independent and fishery dependent information as well as a combination of those. Real time advice (forecast) and management options for 2010 will be provided for the stock in autumn 2009.

Norway pout is a short lived species and most likey a one time spawner. The population dynamics of Norway pout in the North Sea and Skagerrak are very dependent on changes caused by recruitment variation and variation in predation (or other natural) mortality, and less by the fishery. Recruitment is highly variable and influences SSB and TSB rapidly due to the short life span of the species. (Basis: Sparholt, Larsen and Nielsen 2002a,b; Lambert, Nielsen, Larsen and Sparholt 2009). On this basis B_{pa} is considered a good proxy for a SSB reference level for MSY $B_{trigger}$.

There is a need to ensure that the stock remains high enough to provide food for a variety of predator species. Natural mortality levels by age and season used in the stock assessment reflect the predation mortality levels estimated for this stock from the most recent multi-species stock assessment performed by ICES (ICES-SGMSNS 2006).

An overview of recent relevant management measures and regulations for the Norway pout fishery and the stock can be found in the **Stock Annex (Q5)**.

Historically, the fishery includes bycatches especially of haddock, whiting, saithe, and herring. Existing technical measures to protect these bycatch species should be maintained or improved. Bycatches of these species have been low in the recent decade. Sorting grids in combination with square mesh panels have been shown to reduce bycatches of whiting and haddock by 57% and 37%, respectively (Eigaard and Holst, 2004; ICES CM 2006/ACFM:35); ICES suggests that these devices (or modified forms of those) should be brought into use in the fishery. The introduction of these technical measures should be followed up by adequate control measures of landings or catches at sea to ensure effective implementation of the existing bycatch measures. An overview of recent relevant management measures and regulations for the Norway pout fishery and the stock can be found in the **Stock Annex (Q5).**

5.11.1 Long term management strategies

ICES has evaluated and commented on three management strategies, following requests from managers – fixed fishing mortality (F=0.35), Fixed TAC (50 000 t), and a variable TAC escapement strategy. The evaluation shows that all three management strategies are capable of generating stock trends that stay at or above B_{pa} = $B_{MSY\text{-}trigger}$, i.e. away from B_{lim} with a high probability in the long term and are, therefore, considered to be precautionary. ICES does not recommend any particular one of the strategies.

The choice between different strategies depends on the requirements that fisheries managers and stakeholders have regarding stability in catches or the overall level of the catches. The escapement strategy has higher long term yield compared to the fixed fishing mortality strategy, but at the cost of a substantially higher probability of having closures in the fishery. If the continuity of the fishery is an important property, the fixed F (equivalent to fixed effort) strategy will perform better. Recent years TAC's indicate choice of a management strategy close to the fixed F strategy.

A detailed description of the long term management strategies and management plan evaluations can be found in the **Stock Annex (Q5)** and in the ICES AGNOP 2007 (ICES CM 2007/ACFM:39), ICES WGNSSK 2007 (ICES CM 2007/ACFM:30) and the ICES AGSANNOP (ICES CM 2007/ACFM:40) reports.

5.12 Other issues

Recommendations for future assessments:

The WG recommend a benchmark-assessment for the stock in 2012.

Coming benchmark assessment should consider new biological information (new estimates of spawning maturity, estimates of growth and growth parameters as well as of natural mortality published recently in ICES J. Mar. Sci. should be evaluated in context of the assessment). This includes recent developments in research survey based natural mortality estimates and new research results on natural mortality for the stock as well as up-dated natural mortality from the MSVPA model. Also variation in maturity at age as well as growth variation in the stock should be considered in relation to the assessment based on new research results. It is suggested that variable M be examined to determine the amount of biomass removed via predation.

Furthermore, consideration of revision of the tuning fleets with special focus on the commercial tuning fleets should be done in a coming benchmark assessment (see also the May 2007 assessment ICES CM 2007/ACFM:18 and 30, as well as the **Stock Annex (Q5)).** This includes evaluation of the quality of the assessment with respect to inclusion of historical time series for fisheries data. The fluctuations in the fisheries effort over times and between seasons should be evaluated.

Evaluation of survey based assessment and/or more simple assessment methods: Assessment of stock status based exclusively on survey indices should be considered, and robustness of survey indices should be considered.

Recent developments in relation to implementation of seasonal stochastic assessment models not dependent on constant exploitation patterns (F-patterns between years and ages) should be considered for the assessment of the stock.

New research findings on developments in by-catch reducing gear devices should be reported and evaluated under ecosystem aspects and fisheries aspects in relation to future benchmark assessment.

Trends and dynamics in landings and other available relevant information of Norway pout in VIa should be evaluated and brought forward to ACOM.

Table 5.2.1 NORWAY POUT IV & IIIa. Nominal landings (tonnes) from the North Sea and Skagerrak / Kattegat, ICES areas IV and IIIa in the period 1999-2009, as officially reported to ICES and EU.

By-catches of Norway pout in other (small meshed) fishery included.

Norway pout ICES area IIIa

Country	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Denmark	7,194	14,545	13,619	3,780	4,235	110	-	18	24	156	4 *
Faroe Islands	-	-	-	-	50	45	-	-	-	-	-
Norway	-	-	-	96	30	41	-	2	34	-	209
Sweden	-	133	780	-	-	-	-	-	-	-	-
Germany	-	-	-	-	-	54	-	-	-	-	-
Total	7,194	14,678	14,399	3,876	4,315	250	0	20	58	156	213

*Preliminary.

Norway pout ICES area IVa

Country	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Denmark	39,319	133,149	44,818	68,858	12,223	10,762	941***	39,531	2,032 *****	32,158	17,769 *
Faroe Islands	2,534		49	3,367	2,199	1,085	24	-	-	-	-
Netherlands	-	-	-	-	-	-	-	-	-	-	22
Germany	-	-	-	-	-	27	-	15	-	-	-
Norway	44,841	48,061	17,158	23,657	11,357	4,953	311	13,618	4,712	6,650	36,961
Sweden	-	-	-	-	-	-	-	-	-	10	
Total	86,694	181,210	62,025	95,882	25,779	16,827	1,092	53,164	6,744	38,818	54,752

*Preliminary.

Norway pout ICES area IVb

Country	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Denmark	5,299	158	632	556	191	473	-	394	0	244	589 *
Faroe Islands	-	-	-	12	125	29	-	-	-	-	22
Germany	-	2	-	-	-	26	-	19	-	3	75
Netherlands	-	3	-	-	-	-	-	-	-	-	-
Norway	-	34	-	-	-	-	-	2	0	0	82
Sweden	-	-	-	-	-	88	-	-	-	-	-
UK (E/W/NI)	-	+	-	+	-	-	-	-	-	-	-
UK (Scotland)	-	-	-	-	-	-	-	-	-	-	-
Total	5,299	197	632	568	316	616	0	415	0	247	768

*Preliminary.

Norway pout ICES area IVc

Country	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Denmark	514	182	304	-	-	-	-	-	-	-	-
Netherlands	+	-	-	-	-	-	-	-	-	-	-
UK (E/W/NI)	-	-	+	-	-	-	-	-	-	-	-
Total	0	0	0	0	0	0	0	0	0	0	0

*Preliminary.

Norway pout Sub-area IV and IIIa (Skagerrak) combined

Country	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Denmark	51,812	147,852	59,069	73,194	16,649	11,345	941***	39,943	2,056	32,558	18,362
Faroe Islands	2,534	0	49	3,379	2,374	1,159	24	0	0	0	22
Norway	44,841	48,095	17,158	23,753	11,387	4,994	311	13,622	4,746	6,650	37,252
Sweden	0	133	780	0	0	88	0	0	0	10	0
Netherlands	0	3	0	0	0	0	0	0	0	0	22
Germany	0	2	0	0	0	107	0	34	0	3	75
UK	0	0	0	0	0	0	0	0	0	0	0
Total nominal landings	99,187	196,085	77,056	100,326	30,410	17,693	1,252	53,599	6,802	39,221	55,733
By-catch of other species and other	-7,187	-11,685	-11,456	-23,626	-5,510	-4,193	-	-6,973	-	-3,083	-1,233
WG estimate of total landings (IV+IIIaN)	92,000	184,400	65,600	76,700	24,900	13,500	-	46,626	-	36,138	54,500
Agreed TAC	220,000	220,000	211,200	198,000	198,000	198,000	0****	95,000	0****	114,616	116,279

* provisional
** provisional
*** 781 ton from trial fishery (directed fishery); 160 ton from by-catches in other fisheries
**** A by-catch qouta of 5000 t has been set.
***** 681 t taken in trial fishery; 1300 t in by-catches in other (small meshed) fisheries.
+ Landings less than 1
n/a not available

Table 5.2.2 NORWAY POUT IV & IIIa. Annual landings ('000 t) in the North Sea and Skagerrak (not incl. Kattegat, IIIaS) by country, for 1961-2009 (Data provided by Working Group members). (Norwegian landing data include landings of by-catch of other species). Includes by-catch of Norway pout in other (small meshed) fisheries).

Year	Denmark		Faroes	Norway	Sweden	UK (Scotland)	Others	Total
	North Sea	Skagerrak						
1961	20.5	-	-	8.1	-	-	-	28.6
1962	121.8	-	-	27.9	-	-	-	149.7
1963	67.4	-	-	70.4	-	-	-	137.8
1964	10.4	-	-	51	-	-	-	61.4
1965	8.2	-	-	35	-	-	-	43.2
1966	35.2	-	-	17.8	-	-	+	53.0
1967	169.6	-	-	12.9	-	-	+	182.5
1968	410.8	-	-	40.9	-	-	+	451.7
1969	52.5	-	19.6	41.4	-	-	+	113.5
1970	142.1	-	32	63.5	-	0.2	0.2	238.0
1971	178.5	-	47.2	79.3	-	0.1	0.2	305.3
1972	259.6	-	56.8	120.5	6.8	0.9	0.2	444.8
1973	215.2	-	51.2	63	2.9	13	0.6	345.9
1974	464.5	-	85.0	154.2	2.1	26.7	3.3	735.8
1975	251.2	-	63.6	218.9	2.3	22.7	1	559.7
1976	244.9	-	64.6	108.9	+	17.3	1.7	437.4
1977	232.2	-	48.8	98.3	2.9	4.6	1	387.8
1978	163.4	-	18.5	80.8	0.7	5.5	-	268.9
1979	219.9	9	21.9	75.4	-	3	-	329.2
1980	366.2	11.6	34.1	70.2	-	0.6	-	482.7
1981	167.5	2.8	16.4	51.6	-	+	-	238.3
1982	256.3	35.6	12.3	88	-	-	-	392.2
1983	301.1	28.5	30.7	97.3	-	+	-	457.6
1984	251.9	38.1	19.11	83.8	-	0.1	-	393.01
1985	163.7	8.6	9.9	22.8	-	0.1	-	205.1
1986	146.3	4	2.5	21.5	-	-	-	174.3
1987	108.3	2.1	4.8	34.1	-	-	-	149.3
1988	79	7.9	1.3	21.1	-	-	-	109.3
1989	95.7	4.2	0.8	65.3	+	0.1	0.3	166.4
1990	61.5	23.8	0.9	77.1	+	-	-	163.3
1991	85	32	1.3	68.3	+	-	+	186.6
1992	146.9	41.7	2.6	105.5	+	-	0.1	296.8
1993	97.3	6.7	2.4	76.7	-	-	+	183.1
1994	97.9	6.3	3.6	74.2	-	-	+	182
1995	138.1	46.4	8.9	43.1	0.1	+	0.2	236.8
1996	74.3	33.8	7.6	47.8	0.2	0.1	+	163.8
1997	94.2	29.3	7.0	39.1	+	+	0.1	169.7
1998	39.8	13.2	4.7	22,1	-	-	+	57.7
1999	41	6.8	2.5	44.2	+	-	-	94.5
2000	127	9.3	-	48	0.1	-	+	184.4
2001	40.6	7.5	-	16.8	0.7	+	+	65.6
2002	50.2	2.8	3.4	23.6	-	-	-	80.0
2003	9.9	3.4	2.4	11.4	-	-	-	27.1
2004	8.1	0.3	-	5	-	-	0.1	13.5
2005	0.9*	-	-	1	-	-	-	1.9
2006	35.1	0.1	-	11.4	-	-	-	46.6
2007	2.0**	-	-	3.7	-	-	-	5.7
2008	30.4	-	-	5.7	+	-	+	36.1
2009	17.5	-	-	37.0	+	-	+	54.5

* 781 t taken in a trial fishery; 160 t in by-catches in other (small meshed) fisheries.

** 681 t taken in trial fishery; 1300 t in by-catches in other (small meshed) fisheries.

Table 5.2.3 NORWAY POUT IV & IIIa. National landings (t) by quarter of year 1995-2009. (Data provided by Working Group members. Norwegian landing data include landings of by-catch of other species). (By-catch of Norway pout in other (small meshed) fisheries included).

Year	Quarter	Denmark									Norway		Total
	Area	IIIaN	IIIaS	Div. IIIa	IVaE	IVaW	IVb	IVc	Div. IV	Div. IV + IIIaN	IVaE	Div. IV	Div. IV + IIIaN
1995	1	576	9	585	19,421	1,336	7	-	20,764	21,339	15521	15521	36,860
	2	10,495	290	10,793	2,841	30	3,670	-	6,540	17,035	10639	10639	27,674
	3	20,563	976	21,540	13,316	17,681	11,445	-	42,442	63,004	5790	5790	68,794
	4	14,748	2,681	17,430	10,812	56,159	1,426	-	68,396	83,145	11131	11131	94,276
	Total	46,382	3,956	50,347	46,390	75,205	16,547	-	138,142	184,524	43,081	43081	227,605
1996	1	1,231	164	1,395	6,133	3,149	658	2	9,943	11,174	10604	10604	21,778
	2	7,323	970	8,293	1,018	452	1,476	-	2,946	10,269	4281	4281	14,550
	3	20,176	836	21,012	7,119	17,553	1,517	-	26,188	46,364	27466	27466	73,830
	4	5,028	500	5,528	9,640	25,498	42	-	35,180	40,208	5466	5466	45,674
	Total	33,758	2,470	36,228	23,910	46,652	3,692	2	74,257	108,015	47,817	47817	155,832
1997	1	2,707	460	3,167	6,203	2,219	7	-	8,429	11,137	4183	4183	15,320
	2	5,656	200	5,857	141	-	45		185	5,842	8466	8466	14,308
	3	16,432	649	17,081	19,054	21,024	740	-	40,818	57,250	21546	21546	78,796
	4	4,464	1,042	5,505	6,555	38,202	7		44,765	49,228	4884	4884	54,112
	Total	29,259	2,351	31,610	31,953	61,445	799	-	94,197	123,456	39,079	39079	162,535
1998	1	1,117	317	1,434	7,111	2,292	-	-	9,403	10,520	8913	8913	19,433
	2	3,881	103	3,984	131	5	124	-	259	4,140	7885	7885	12,025
	3	6,011	406	6,417	7,161	1,763	2,372	-	11,297	17,308	3559	3559	20,867
	4	2,161	677	2,838	1,051	17,752	77	-	18,880	21,041	1778	1778	22,819
	Total	13,171	1,503	14,673	15,454	21,811	2,573	-	39,838	53,009	22,135	22135	75,144
1999	1	4	12	15	2,769	1,246	1	-	4,016	4,020	3021	3021	7,041
	2	1,568	36	1,605	953	361	418	-	1,731	3,300	10321	10321	13,621
	3	3,094	109	3,203	7,500	3,710	2,584	-	13,794	16,887	24449	24449	41,336
	4	2,156	517	2,673	3,577	16,921	928	1	21,426	23,583	6385	6385	29,968
	Total	6,822	674	7,496	14,799	22,237	3,931	1	40,968	47,790	44,176	44176	91,966
2000	1	0	11	12	3,726	1,038	-	-	4,764	4,765	5440	5440	10,205
	2	929	15	944	684	22	227	-	933	1,862	9779	9779	11,641
	3	7,380	139	7,519	1,708	5,613	515	-	7,836	15,216	28428	28428	43,644
	4	947	209	1,157	1,656	111,732	76	-	113,464	114,411	4334	4334	118,745
	Total	9,257	375	9,631	7,774	118,406	818	-	126,998	136,255	47,981	47981	184,236
2001	1			302	7,341	9,734	103	72	17,250	17,250	3838	3838	21,088
	2			2,174	31	30	269	-	330	330	9268	9268	9,598
	3			2,006	15	154	191	-	360	360	2263	2263	2,623
	4			3,059	2,553	19,826	329	-	22,708	22,708	1426	1426	24,134
	Total			7,541	9,940	29,744	892	72	40,648	40,648	16,795	16795	57,443
2002	1	-	1	1	4,869	1,660	114	-	6,643	6,643	1896	1896	8,539
	2	883	161	1,045	56	9	22	-	87	970	5563	5563	6,533
	3	1,567	213	1,778	2,234	14,739	104	-	17,077	18,644	14147	14147	32,791
	4	393	100	492	1,787	24,273	335	-	26,395	26,788	2033	2033	28,821
	Total	2,843	475	3,316	8,946	40,681	575	-	50,202	53,045	23,639	23639	76,684
2003	1	-	1	1	615	581	22	-	1,218	1,218	1977	1977	3,195
	2	246	160	406	76	-	22	-	98	344	2773	2773	3,117
	3	2,984	1,005	3,989	172	1,613	89	-	1,874	4,858	5989	5989	10,847
	4	188	547	735	0	6270	457	-	6,727	6,915	644	644	7,559
	Total	3,418	1,713	5,131	863	8,464	590	-	9,917	13,335	11,383	11,383	24,718
2004	1	316	-	316	87	650	-	-	737	1,053	989	989	2,042
	2	-	-	-	-	-	7	-	7	7	660	660	667
	3	14	-	14	289	1,195	9	-	1,493	1,507	2484	2484	3,991
	4	13	-	13	93	5,683	107	-	5,883	5,896	865	865	6,761
	Total	343	-	343	469	7,528	123	-	8,120	8,463	4,998	4,998	13,461
2005	1	-	-	-	9	-	-	-	9	9	12	12	21
	2	-	-	-	151	-	-	-	151	151	352	352	503
	3	-	-	-	781	-	-	-	781	781	387	387	1,168
	4	-	-	-	-	-	-	-	-	-	211	211	211
	Total	-	-	-	941	-	-	-	941	941	962	962	1,903
2006	1	-	-	-	75	83	-	-	158	158	2,205	2205	2,363
	2	-	-	-	-	-	15	-	15	15	2,846	2846	2,861
	3	114	-	114	-	649	20	-	669	783	5,749	5749	6,532
	4	3	-	3	-	34,262	-	-	34,262	34,265	605	605	34,870
	Total	117	-	117	75	34,994	35	-	35,104	35,221		11,405	46,626
2007	1	-	-	-	561	789	-	-	1,350	1,350	74	74	1,424
	2	-	-	-	4	-	-	-	4	4	1,097	1097	1,101
	3	1	2	3	-	-	-	-	-	1	2,429	2429	2,430
	4	-	-	-	-	682	-	-	682	682	155	155	837
	Total	1	2	3	565	1,471	-	-	2,036	2,037		3,755	5,792
2008	1	125	-	125	19	86	123	-	228	353	7	7	360
	2	-	-	-	-	-	30	-	30	30	1,803	1803	1,833
	3	-	-	-	-	6,102	-	-	6,102	6,102	3,582	3582	9,684
	4	-	-	-	-	22,686	1,239	-	23,925	23,925	336	336	24,261
	Total	125	-	125	19	28,874	1,392	-	30,285	30,410		5,728	36,138
2009	1	1	-	1	22	515	-	-	537	538	2	2	540
	2	-	-	-	-	-	-	-	-	-	4,026	4026	4,026
	3	2	-	2	-	11,567	-	-	11,567	11,569	31,251	31251	42,820
	4	-	-	-	-	5,399	4	-	5,403	5,403	1,736	1736	7,139
	Total	3	-	3	22	17,481	4	-	17,507	17,510	37,015	37,015	54,525

Table 5.2.4 NORWAY POUT in IV and IIIaN (Skagerrak). Catch in numbers at age by quarter (millions). SOP is given in tonnes. Data for 1990 were estimated within the SXSA program used in the 1996 assessment.

Age	Year	1983				1984				1985			
	Quarter	1	2	3	4	1	2	3	4	1	2	3	4
0		0	0	446	2671	0	0	1	2231	0	0	6	678
1		4,207	1826	5825	4296	2,759	2252	5290	3492	2,264	857	1400	2991
2		1,297	1234	1574	379	1,375	1165	1683	734	1,364	145	793	174
3		15	10	17	7	143	269	8	0	192	13	19	0
4+		0	2	0	0	0	0	0	0	1	0	0	0
SOP		58587	69964	216106	131207	56790	56532	152291	110942	57464	15509	62489	92017
Age	Year	1986				1987				1988			
	Quarter	1	2	3	4	1	2	3	4	1	2	3	4
0		0	0	0	5572	0	0	8	227	0	0	741	3146
1		396	260	1186	1791	2687	1075	1627	2151	249	95	183	632
2		1069	87	245	39	401	60	171	233	700	74	250	405
3		72	3	6	0	12	0	0	5	20	0	0	0
4+		3	0	0	0	1	0	0	0	0	0	0	0
SOP		37889	7657	45085	89993	33894	15435	38729	60847	22181	3559	21793	61762
Age	Year	1989				1990				1991			
	Quarter	1	2	3	4	1	2	3	4	1	2	3	4
0		0	0	159	4854	0	0	20	993	0	0	734	3486
1		1736	678	1672	1741	1840	1780	971	1181	1501	636	1519	1048
2		48	133	266	93	584	572	185	116	1336	404	215	187
3		6	6	5	13	20	19	6	4	93	19	22	18
4+		0	0	0	0	10	0	0	0	6	0	0	0
SOP		15379	13234	55066	82880	28287	39713	26156	45242	42776	20786	62518	64380
Age	Year	1992				1993				1994			
	Quarter	1	2	3	4	1	2	3	4	1	2	3	4
0		0	0	879	954	0	0	96	1175	0	0	647	4238
1		3556	1522	3457	2784	1942	813	1147	1050	1975	372	1029	1148
2		1086	293	389	267	699	473	912	445	591	285	421	134
3		118	20	1	2	15	58	19	2	56	29	71	0
4+		3	0	0	0	0	0	0	0	0	0	0	0
SOP		64224	27973	114122	96177	36206	29291	62290	53470	34575	15373	53799	79838
Age	Year	1995				1996				1997			
	Quarter	1	2	3	4	1	2	3	4	1	2	3	4
0		0	0	700	1692	0	0	724	2517	0	0	109	343
1		3992	1905	2545	3348	535	560	1043	650	672	99	3090	1922
2		240	256	47	59	772	201	1002	333	325	131	372	207
3		6	32	3	3	14	38	37	0	79	119	105	35
4+		0	0	0	0	0	0	0	0	0	0	0	0
SOP		36942	28019	69763	97048	21888	13366	74631	46194	15320	8708	78809	54100
Age	Year	1998				1999				2000			
	Quarter	1	2	3	4	1	2	3	4	1	2	3	4
0		0	0	94	339	0	0	41	1127	0	0	73	302
1		261	210	411	531	202	318	1298	576	653	280	1368	4616
2		690	310	332	215	128	220	338	160	185	207	266	245
3		47	18	2	13	73	93	35	23	3	48	20	6
4+		8	24	0	0	1	0	0	0	0	0	0	0
SOP		19562	12026	20866	22830	7833	12535	41445	30497	10207	11589	44173	119001
Age	Year	2001				2002				2003			
	Quarter	1	2	3	4	1	2	3	4	1	2	3	4
0		0	0	32	368	0	0	340	290	0	0	7	1
1		220	133	122	267	485	351	621	473	59	64	191	54
2		845	246	27	439	148	24	284	347	76	49	121	161
3		35	100	1	1	17	5	24	26	22	25	16	32
4+		0	0	0	0	0	0	0	0	0	0	0	1
SOP		21400	11778	4630	26565	8553	6686	32922	28947	3190	3106	10842	7549
Age	Year	2004				2005				2006			
	Quarter	1	2	3	4	1	2	3	4	1	2	3	4
0		0	0	14	57	*	*	*	*			10	368
1		13	4	51	100	*	*	*	*	30	56	130	1086
2		55	16	51	78	*	*	*	*	52	45	65	50
3		9	6	7	2	*	*	*	*	9	24	7	1
4+		0	0	0	0	*	*	*	*	0	0	0	0
SOP		2040	667	4018	6762	8	8	13	13	2205	2848	6551	34949
Age	Year	2007				2008				2009			
	Quarter	1	2	3	4	1	2	3	4	1	2	3	4
0		0	0	0	0	0	0	0	1179	0	0	58	12
1		20	41	32	10	5	54	166	438	50	36	621	169
2		43	26	16	6	10	41	115	31	1	47	613	27
3		0	0	2	1	0	0	0	0	0	5	9	1
4+		0	0	0	0	0	0	0	0	0	0	0	0
SOP		1428	1100	2430	838	361	1840	8532	24111	538	2105	36661	6509

In 2007-08: Catch numbers from Norwegian fishery calculated from Norwegian total catch weight divided by mean weight at age from Danish Fishery.

Table 5.2.5 NORWAY POUT in IV and IIIaN (Skagerrak). Mean weights (grams) at age in catch, by quarter 1983-2009, from Danish and Norwegian catches combined. Data for 1974 to 1982 are assumed to be the same as in 1983. See footnote concerning data from 2005-2008. The mean weights at age weighted with catch number by area, quarter and country (DK, N).

Year	1983				1984				1985			
Quarter of year	1	2	3	4	1	2	3	4	1	2	3	4
Age 0			4.00	6.00			6.54	6.54			8.37	6.23
1	7.00	15.00	25.00	23.00	6.55	8.97	17.83	20.22	7.86	12.56	23.10	26.97
2	22.00	34.00	43.00	42.00	24.04	22.66	34.28	35.07	22.7	28.81	36.52	40.90
3	40.00	50.00	60.00	58.00	39.54	37.00	34.10	46.23	45.26	43.38	58.99	
4									41.80			

Year	1986				1987				1988			
Quarter of year	1	2	3	4	1	2	3	4	1	2	3	4
Age 0				7.20			5.80	7.40			9.42	7.91
1	6.69	14.49	28.81	26.90	8.13	12.59	20.16	23.36	9.23	11.61	26.54	30.60
2	29.74	42.92	43.39	44.00	28.26	31.51	34.53	37.32	27.31	33.26	39.82	43.31
3	44.08	55.39	47.60		52.93			46.60	38.38			
4	82.51				63.09				69.48			

Year	1989				1990				1991			
Quarter of year	1	2	3	4	1	2	3	4	1	2	3	4
Age 0			7.48	6.69			6.40	6.67			6.06	6.64
1	7.98	13.49	26.58	26.76	6.51	13.75	20.29	28.70	7.85	12.95	30.95	30.65
2	26.74	28.70	35.44	34.70	25.47	25.30	32.92	38.90	20.54	28.75	44.28	43.10
3	39.95	44.39		46.50	37.72	40.35	39.40	52.94	35.43	49.87	67.25	59.37
4					68.00				44.30			

Year	1992				1993				1994			
Quarter of year	1	2	3	4	1	2	3	4	1	2	3	4
Age 0		8.00	6.70	8.14			4.40	8.14			5.40	8.81
1	8.78	11.71	26.52	27.49	9.32	14.76	25.03	26.24	8.56	15.22	29.26	31.23
2	25.73	31.25	42.42	44.14	24.94	30.58	35.19	36.44	25.91	29.27	38.91	49.59
3	41.80	49.49	50.00	50.30	46.50	48.73	55.40	70.80	42.09	46.88	53.95	
4	43.90											

Year	1995				1996				1997			
Quarter of year	1	2	3	4	1	2	3	4	1	2	3	4
Age 0			5.01	7.19			3.88	5.95			3.61	10.18
1	7.70	10.99	25.37	24.6	8.95	12.06	27.81	28.09	7.01	11.69	20.14	22.11
2	24.69	22.95	33.40	39.57	21.47	25.72	40.90	38.81	23.11	26.40	31.13	32.69
3	50.78	37.69	45.56	57.00	37.58	37.94	50.44	56.00	39.11	34.47	44.03	38.62
4												

Year	1998				1999				2000			
Quarter of year	1	2	3	4	1	2	3	4	1	2	3	4
Age 0			4.82	8.32			2.84	7.56			7.21	13.86
1	8.76	12.55	23.82	24.33	8.98	12.40	22.16	25.60	10.05	15.65	23.76	22.98
2	22.16	25.27	31.73	30.93	25.84	24.15	32.66	37.74	19.21	25.14	38.90	34.48
3	34.84	32.18	44.92	33.24	36.66	35.24	43.98	51.63	32.10	41.30	39.61	50.04
4	42.40	40.00			46.57	46.57						

Year	2001				2002				2003			
Quarter of year	1	2	3	4	1	2	3	4	1	2	3	4
Age 0			6.34	7.90			7.28	7.20			9.12	9.79
1	8.34	16.79	27.00	30.01	8.59	16.40	27.13	27.47	11.58	13.13	28.33	15.98
2	21.50	23.57	39.54	35.51	25.98	30.39	43.37	36.87	22.85	26.19	38.01	31.87
3	39.84	37.63	54.20	55.70	32.30	40.10	54.11	41.28	34.96	39.89	46.24	45.79
4											70.00	70.00

Year	2004				2005				2006			
Quarter of year	1	2	3	4	1	2	3	4	1	2	3	4
Age 0			9.80	7.89			9.8	7.89			8.90	8.90
1	11.54	14.63	31.02	31.75	11.97	14.65	31.02	31.75	14.80	14.70	27.42	26.92
2	27.41	26.22	38.44	39.31	27.90	26.24	38.44	39.31	27.20	26.24	39.16	47.80
3	41.52	34.80	49.50	49.80	41.36	34.80	49.50	49.80	40.60	34.80	49.80	48.50
4												

Year	2007				2008			
Quarter of year	1	2	3	4	1	2	3	4
Age 0			8.9	8.9				9.9
1	7.8	7.8	45.00	45.00	11.0	11.0	26.8	24.40
2	29.86	29.86	57.07	57.07	29.8	29.8	35.6	56.0
3	41.52	34.80	56.22	56.22	56.0	56.0		
4								

Mean weights at age from Danish and Norwegian landings from 2005-2008 uncertain because of few observations and use of values from 2004 and from adjacent quarters in the same year where observations have been missing.

Table 5.2.6 NORWAY POUT IV & IIIaN (Skagerrak). Mean weight at age in the stock, proportion mature and natural mortality used in the assessment (as well as revised natural mortality used in previous exploratory assessment runs).

Age	Weight (g)				Proportion mature	M (quarterly)	Revised M vers.1 (quarterly)
	Q1	Q2	Q3	Q4			(Exploratory run)
0	-	-	4	6	0	0.4	0.25
1	7	15	25	23	0.1	0.4	0.25
2	22	34	43	42	1	0.4	0.55
3	40	50	60	58	1	0.4	0.75

Table 5.2.7 NORWAY POUT IV & IIIaN (Skagerrak). Danish CPUE data (tonnes / fishing day) and fishing activities by vessel category for 1988-2009. Non-standardized CPUE-data for the Danish part of the commercial tuning fleet. (Logbook information).

Vessel GRT	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
51-100	20.27	14.58	10.03	12.56	31.75	31	24.8	29.53	-	20
101-150	18.83	19.59	17.38	24.14	26.42	23.72	26.76	38.96	20.48	22.68
151-200	22.71	23.17	25.6	28.22	34.2	27.36	31.52	34.73	22.05	27.45
201-250	30.44	26.1	24.87	29.74	36	27.76	40.59	39.34	24.96	30.59
251-300	23.29	26.14	21.3	28.15	31.9	32.05	36.98	38.84	31.43	32.55
301-	38.81	28.58	24.96	36.48	42.6	34.89	44.91	57.9	39.14	43.01

1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-
16.85	12.43	29.13	-	20.45	-	-	-	-	-	-
19.68	26.69	48.55	25.35	17.09	12.94	8.88	n/a*	-	n/a*	-
17.48	23.98	45.92	20.02	21.73	10.8	5.50	n/a*	41.11	n/a*	-
32.32	31	64.33	52.95	46.36	30.86	37.14	n/a*	60.39	n/a*	79.13

2009
-
-
-
-
-
94.78

* Non-available data from 2005 and 2007 is due to closure of the Norway pout fishery the whole year

Data for 2006 and 2008 does only cover 2nd half year as the directed fishery was closed 1st half year 2006 and very low 1st half year 2008.

Data for 2008 only covers Danish directed fishery for Norway pout

Table 5.2.8 NORWAY POUT IV & IIIaN (Skagerrak). Effort in days fishing and average GRT of Norwegian vessels fishing for Norway pout by quarter, 1983-2009.

	Quarter 1		Quarter 2		Quarter 3		Quarter 4	
Year	Effort	Aver. GRT	Effort	Aver. GRT	Effort	Aver. GRT	Effort	Aver. GRT
1983	293	167.6	1168	168.4	2039	159.9	552	171.7
1984	509	178.5	1442	141.6	1576	161.2	315	212.4
1985	363	166.9	417	169.1	230	202.8	250	221.4
1986	429	184.3	598	148.2	195	197.4	222	226.0
1987	412	199.3	555	170.5	208	158.4	334	196.3
1988	296	216.4	152	146.5	73	191.1	590	202.9
1989	132	228.5	586	113.5	1054	192.1	1687	178.7
1990	369	211.0	2022	171.7	1102	193.9	1143	187.6
1991	774	196.1	820	180.0	1013	179.4	836	187.7
1992	847	206.3	352	181.3	1030	202.2	1133	199.8
1993	475	227.5	1045	206.6	1129	217.8	501	219.8
1994	436	226.5	450	223.5	1302	212.0	686	211.4
1995	545	223.6	237	233.8	155	221.7	297	218.1
1996	456	213.6	136	219.9	547	208.3	132	207.2
1997	132	202.4	193	218.9	601	194.8	218	182.3
1998	497	192.6	272	213.6	263	176.8	203	193.8
1999	267	173.0	735	180.1	1165	187.4	229	166.9
2000	294	197.1	348	180.7	929	205.3	196	219.3
2001	252	203.4	297	192.9	130	165.0	65	219.4
2002	90	208.6	246	189.1	1022	211.7	205	182.2
2003	162	219.1	320	215.3	550	252.8	75	208.4
2004	94	214.6	85	196.7	210	220.9	99	197.9
2005*	0	0.0	0	0.0	0	0.0	0	0.0
2006*	0	0.0	0	0.0	169	267.1	132	279.0
2007*	0	0.0	0	0.0	0	0.0	0	0.0
2008**	**	**	**	**	**	**	**	**
2009	0	0.0	123	278.0	594	366.8	70	340.7

* 0-values in all of 2005 and 2007 as well as in first half year 2006 are due to closure of the fishery (no directed fishery for Norway pout)

** No effort data provided from Norway due to small directed Norway pout fishery.

Table 5.2.9 NORWAY POUT IV and IIIaN (Skagerak). Combined Danish and Norwegian fishing effort (standardised) to be used in the assessment.

	Quarter 1			Quarter 2			Quarter 3			Quarter 4			Year total		
Year	Norway	Denmark	Total	Norway	Denmark	Total	Norway	Denmark	Total	Norway	Denmark	Total	Norway	Denmark	Total
1987	441	1125	1566	547	31	578	197	1192	1388	355	1634	1989	1540	3981	5522
1988	315	881	1196	144	13	156	75	416	491	617	1891	2507	1150	3201	4351
1989	146	776	922	485	195	680	1093	1746	2839	1701	2280	3981	3424	4999	8423
1990	406	990	1395	2002	87	2089	1162	462	1624	1185	1650	2835	4754	3189	7943
1991	824	1316	2140	833	33	866	1027	484	1511	869	1721	2590	3553	3554	7107
1992	866	2089	2955	354	17	371	1051	1527	2578	1154	1240	2393	3424	4873	8298
1993	483	1232	1715	1056	37	1094	1145	1557	2702	508	1668	2176	3193	4494	7687
1994	463	1263	1726	477	74	551	1363	616	1978	717	1224	1942	3020	3177	6197
1995	577	808	1385	254	99	352	164	851	1015	313	1483	1796	1308	3241	4548
1996	478	577	1055	144	184	328	570	758	1328	137	1237	1374	1329	2756	4085
1997	137	393	530	203	17	220	617	1241	1857	220	1118	1338	1177	2768	3945
1998	509	445	954	285	34	319	264	560	824	208	455	663	1265	1494	2760
1999	266	304	571	740	56	796	1184	386	1570	226	731	957	2417	1477	3894
2000	303	302	605	351	75	425	965	220	1185	207	1898	2104	1825	2494	4319
2001	261	440	701	304	15	319	128	48	176	69	540	608	762	1042	1804
2002	94	387	480	251	21	271	1069	674	1744	207	550	757	1621	1632	3252
2003	171	211	382	336	15	351	599	79	678	78	101	179	1184	406	1590
2004	99	151	246	87	35	122	222	65	287	102	95	197	510	346	856
2005*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2006*	0	0	0	0	0	0	186	32		147	641	787	333	673	1005
2007*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2008**	n/a	6	6	n/a	0	0	n/a	161	161	n/a	244	244	n/a	411	411
2009	0	13	13	137	0	137	699	109	808	81	27	108	917	149	1066

* 0-values in all of 2005 and 2007 as well as in first half year 2006 are due to closure of the fishery (no directed fishery for Norway pout). The 0-values not used in assessment.

** Data for 2008 does only include information from the Danish small meshed fishery as no data was provided from Norway on this. Data not used in assessment.

Table 5.2.10 NORWAY POUT IV & IIIaN (Skagerrak). CPUE indices (´000s per fishing day) by age and quarter from Danish and Norwegian commercial fishery (CF) in the North Sea (Area IV, commercial tuning fleet).

Year	CF, 1st quarter				CF, 3rd quarter				CF, 4th quarter			
	0-group	1-group	2-group	3-group	0-group	1-group	2-group	3-group	0-group	1-group	2-group	3-group
1982	.	2144.5	169.0	87.9	.	1320.2	86.5	12.4	368.4	1050.5	16.0	0.0
1983	.	1524.2	470.0	5.4	.	969.6	262.0	2.8	604.9	972.9	85.9	1.7
1984	.	1137.9	566.8	59.1	.	990.2	314.9	1.5	462.0	723.1	152.1	0.0
1985	.	877.1	528.2	74.3	.	599.0	339.0	8.3	183.6	809.5	47.2	0.0
1986	.	108.5	292.9	19.8	.	531.1	109.7	2.7	892.9	277.1	5.9	0.0
1987	.	1701.8	254.2	7.7	.	1141.9	118.9	0.0	111.1	1074.9	115.6	2.5
1988	.	205.5	584.0	16.4	.	373.1	510.0	0.0	1175.5	252.0	161.5	0.0
1989	.	1862.8	52.1	7.6	.	386.3	69.7	0.0	1185.8	488.6	22.7	3.2
1990	.	1065.1	451.5	25.7	.	571.3	126.7	7.2	444.6	394.9	39.7	2.3
1991	.	693.9	623.8	43.4	.	668.6	44.0	1.0	1006.5	397.7	71.6	6.6
1992	.	1130.2	361.0	39.7	.	1011.6	144.2	0.4	190.5	1104.5	106.1	1.0
1993	.	1122.3	403.7	7.9	.	384.9	328.9	6.9	427.1	474.8	203.2	0.8
1994	.	1102.1	341.3	32.6	.	520.1	203.4	35.7	1953.6	591.0	69.0	0.0
1995	.	2850.1	171.3	4.0	.	1864.2	38.6	3.0	198.7	1705.6	33.0	1.7
1996	.	365.7	732.0	13.2	.	346.7	715.5	27.5	1066.5	473.4	242.5	0.2
1997	.	990.6	480.2	146.8	.	1256.7	154.4	56.5	75.2	1347.0	152.9	25.9
1998	.	150.0	723.5	49.3	.	319.5	350.1	1.1	233.1	775.7	322.9	20.0
1999	.	351.0	224.6	128.0	.	726.4	213.8	22.0	1086.8	516.2	166.9	24.1
2000	.	1079.3	305.3	4.5	.	895.6	207.0	17.2	122.2	2180.3	114.9	2.8
2001	.	300.7	1198.6	50.1	.	369.2	142.7	6.3	559.2	322.6	720.8	1.5
2002	.	1010.9	308.4	34.8	.	321.3	157.9	13.5	383.2	602.0	454.9	34.9
2003	.	153.6	200.1	57.2	.	174.7	156.1	23.3	3.9	276.4	893.3	178.2
2004	.	26.9	189.7	35.1	.	176.1	177.6	24.0	289.1	505.5	394.6	8.6
2005	.	.	.	.	.	.	.	.	.	.	.	.
2006	.	.	.	.	.	588.6	294.2	32.6	467.1	1379.8	64.0	0.9
2007	.	.	.	.	.	.	.	.	.	.	.	.
2008	.	.	.	.	.	.	.	.	.	.	.	.
2009	.	.	.	.	.	.	.	.	.	.	.	.
2010	.	.	.	.	.	.	.	.	.	.	.	.

Table 5.2.11 NORWAY POUT IV & IIIA (Skagerrak). Research vessel indices (CPUE in catch in number per trawl hour) of abundance for Norway pout.

Year	IBTS/IYFS[1] February (1st Q)			EGFS[2,3] August				SGFS[4] August				IBTS 3rd Quarter[1]			
	1-group	2-group	3-group	0-group	1-group	2-group	3-group	0-group	1-group	2-group	3-group	0-group	1-group	2-group	3-group
1971	,556	22	-	-	-	-	-	-	-	-	-	-	-	-	-
1972	2,578	872	3	-	-	-	-	-	-	-	-	-	-	-	-
1973	4,207	438	-	-	-	-	-	-	-	-	-	-	-	-	-
1974	25,557	391	24	-	-	-	-	-	-	-	-	-	-	-	-
1975	4,573	1,880	4	-	-	-	-	-	-	-	-	-	-	-	-
1976	4,411	371	2	-	-	-	-	-	-	-	-	-	-	-	-
1977	6,093	273	42	-	-	-	-	-	-	-	-	-	-	-	-
1978	1,479	575	47	-	-	-	-	-	-	-	-	-	-	-	-
1979	2,738	316	75	-	-	-	-	-	-	-	-	-	-	-	-
1980	3,277	550	29	-	-	-	-	-	1,928	346	12	-	-	-	-
1981	1,092	377	15	-	-	-	-	-	185	127	9	-	-	-	-
1982	4,537	262	59	6,594	2,609	39	77	8	991	44	22	-	-	-	-
1983	2,258	592	7	6,067	1,558	114	0.4	13	490	91	1	-	-	-	-
1984	4,994	982	75	457	3,605	359	14	2	615	69	8	-	-	-	-
1985	2,342	1,429	73	362	1,201	307	0	5	636	173	5	-	-	-	-
1986	2,070	383	20	285	717	150	80	38	389	54	9	-	-	-	-
1987	3,171	481	61	8	552	122	0.9	7	338	23	1	-	-	-	-
1988	124	722	15	165	102	134	20	14	38	209	4	-	-	-	-
1989	2,013	255	172	1,531	1,274	621	20	2	382	21	14	-	-	-	-
1990	1,295	748	39	2,692	917	158	23	58	206	51	2	-	-	-	-
1991	2,450	712	130	1,509	683	399	6	10	732	42	6	7,301	1,039	189	2
1992	5,071	885	32	2,885	6,193	1,069	157	12	1,715	221	24	2,559	4,318	633	48
1993	2,682	2,644	258	5,698	3,278	1,715	0	2	580	329	20	4,104	1,831	608	53
1994	1,839	374	66	7,764	1,305	112	7	136	387	106	6	3,196	704	102	14
1995	5,940	785	77	7,546	6,174	387	14	37	2,438	234	21	2,860	4,440	597	69
1996	923	2,631	228	3,456	1,332	319	3	127	412	321	8	4,554	762	362	12
1997	9,752	1,474	670	1,045	6,262	376	30	1	2,154	130	32	490	3,447	236	46
1998	1,010	5,336	265	2,573	404	260	0	2,628	938	127	5	2,931	801	748	12
1999	3,527	597	667	6,358	1,930	88	26	3,603	1,784	179	37	7,844	2,367	201	94
2000	8,095	1,535	65	2,005	6,261	141	2	2,094	6,656	207	23	1,643	7,868	282	11
2001	1,305	2,861	235	3,948	1,013	693	5	759	727	710	26	2,088	1,274	862	27
2002	1,795	809	880	9,678	1,784	61	21	2,559	1,192	151	123	1,974	766	64	48
2003	1,239	575	94	379	681	85	5	1,767	779	126	1	1,812	1,063	146	7
2004	895	376	34	564	542	90	7	731	719	175	19	773	647	153	12
2005	691	131	37	6,912	803	67	11	3,073	343	132	18	2,614	439	125	17
2006	3,340	146	27	1,680	2,147	151	18	1,127	1,285	69	9	1,349	1,869	150	15
2007	1,286	778	23	3,329		332	1	5,003	1,023	395	8	4,143	1,191	447	11
2008	2,345	506	186	1,435	1,084	253	35	3,456	1,263	263	57	3,000	1,636	271	58
2009	5,413	1,618	150	6,401	1,371	428	3	5,835	1,750	202	16	5,898	2,562	254	11
2010	4,657	1,455	136	-	5,368-	-	-	-	-	-	-	-	-	-	-

[1]International Bottom Trawl Survey, arithmetic mean catch in no./h in standard area. [2]English groundfish survey, arithmetic mean catch in no./h, 22 selected rectangles within Roundfish areas 1, 2, and 3. [3]1982-91 EGFS numbers adjusted from Granton trawl to GOV trawl by multiplying by 3.5. Minor GOV sweep changes in 2006 EGFS. [4]Scottish groundfish surveys, arithmetic mean catch no./h. Survey design changed in 1998 and 2000. [5]English groundfish survey: Data for 1996, 2001, 2002, and 2003 have been revised compared to the 2003 assessment. In 2007, numbers for 1997 and 1998 as well as 2002 has been adjusted based on new automatic calculation and processing process has been introduced. SGFS survey area changed slightly in 2009 and onwards, which is evaluated to have no main effect for the Norway pout indices as the indices are weighted by sub-area.

Table 5.3.1 Norway pout IV & IIIaN (Skagerak). Stock indices and tuning fleets used in final 2004 benchmark assessment as well as in the 2005-2010 assessments compared to the 2003 assessment.

		2003 ASSESSMENT	2004, 2005, April 2006 ASSESSMENT	Sept. 2006 ASSESSMENT	2007-10 ASSESSMENTS
Recruiting season		3rd quarter	2nd quarter (SXSA)	3rd quarter (SMS); 2nd quarter (SXSA)	3rd quarter (SXSA)
Last season in last year		3rd quarter	2nd quarter (SXSA)	3rd quarter (SMS); 2nd quarter (SXSA)	1st quarter (SXSA)
Plus-group		4+	4+ (SXSA)	None (SMS); 4+ (SXSA)	4+ (SXSA)
FLT01: comm Q1					
	Year range	1982-2003	1982-2004	1982-2004	1982-2004, 2006
	Quarter	1	1	1	1
	Ages	1-3	1-3	1-3	1-3
FLT01: comm Q2			NOT USED	NOT USED	NOT USED
	Year range	1982-2003			
	Quarter	2			
	Ages	1-3			
FLT01: comm Q3					
	Year range	1982-2003	1982-2004	1982-2004	1982-2004, 2006
	Quarter	3	3	3	3
	Ages	0-3	1-3	1-3	1-3
FLT01: comm Q4					
	Year range	1982-2003	1982-2004	1982-2004	1982-2004, 2006
	Quarter	4	4	4	4
	Ages	0-3	0-3	0-2 (SMS); 0-3 (SXSA)	0-3 (SXSA)
FLT02: ibtsq1					
	Year range	1982-2003	1982-2006	1982-2006	1982-2010
	Quarter	1	1	1	1
	Ages	1-3	1-3	1-3	1-3
FLT03: egfs					
	Year range	1982-2003	1992-2005	1992-2005	1992-2009
	Quarter	3	Q3 -> Q2	Q3 -> Q2	Q3
	Ages	0-3	0-1	0-1	0-1
FLT04: sgfs					
	Year range	1982-2003	1998-2006	1998-2006	1998-2009
	Quarter	3	Q3 -> Q2	Q3 -> Q2	Q3
	Ages	0-3	0-1	0-1	0-1
FLT05: ibtsq3		NOT USED			
	Year range		1991-2005	1991-2005	1991-2009
	Quarter		3	3	Q3
	Ages		2-3	2-3	2-3

Table 5.3.2 Norway pout IV & IIIaN (Skagerrak). Baseline run with SXSA seasonal extended survivor analysis): Parameters, settings and the options of the SXSA as well as the input data used in the SXSA.

SURVIVORS ANALYSIS OF: Norway pout stock in May 2010

Run: Baseline May 2010 (Summary from NP510_01)

The following parameters were used:

```
Year range:                                 1983 - 2010
Seasons per year:                           4
The last season in the last year is season:        1
Youngest age:                        0
Oldest age:                                 3
Plus age:                                   4
Recruitment in season:                             3
Spawning in season:                         1
```

The following fleets were included:

```
Fleet  1:    commercial q134 (Q1: Age 1-3; Q2: None; Q3: Age 1-3; Q4:
0-3)
Fleet  2:          ibtsq1       (Age 1-3)
Fleet  3:          egfsq3       (Age 0-1)
Fleet  4:          sgfsq3       (Age 0-1)
Fleet  5:          ibtsq3       (Age 2-3)
```

The following options were used:

```
1: Inv. catchability:                              2
  (1: Linear; 2: Log; 3: Cos. filter)
2: Indiv. shats:                                   2
  (1: Direct; 2: Using z)
3: Comb. shats:                                    2
  (1: Linear; 2: Log.)
4: Fit catches:                                    0
  (0: No fit; 1: No SOP corr; 2: SOP corr.)
5: Est. unknown catches:                           0
  (0: No; 1: No SOP corr; 2: SOP corr; 3: Sep. F)
6: Weighting of rhats:                             0
  (0: Manual)
7: Weighting of shats:                             2
  (0: Manual; 1: Linear; 2: Log.)
8: Handling of the plus group:                     1
  (1: Dynamic; 2: Extra age group)
```

Data were input from the following files:

```
Catch in numbers:                                  canum.qrt
Weight in catch:                            weca.qrt
Weight in stock:                                   west.qrt
Natural mortalities:                               natmor.qrt
Maturity ogive:                                    matprop.qrt
Tuning data (CPUE):                                tun2010.xsa
Weighting for rhats:                               rweigh.xsa
```

Table 5.3.3 Norway pout IV & IIIaN (Skagerrak). Seasonal extended survivor analysis (SXSA). Stock numbers, SSB and TSB at start of season.

Year	1983				1984				1985			
Season	1	2	3	4	1	2	3	4	1	2	3	4
AGE												
0	*	*	147984.	98831.	*	*	79985.	53615.	*	*	57189.	38330.
1	108876.	69537.	45117.	25474.	64062.	40683.	25426.	12712.	34112.	21012.	13383.	7825.
2	13108.	7724.	4167.	1505.	13558.	7963.	4384.	1561.	5663.	2679.	1677.	476.
3	115.	65.	36.	10.	698.	350.	15.	3.	445.	142.	84.	40.
4+	6.	3.	0.	0.	1.	0.	0.	0.	2.	1.	1.	0.
SSN	24117.				20663.				9522.			
SSB	369537.				371071.				166405.			
TSN	122105.	77329.	197303.	125819.	78318.	48996.	109810.	67892.	40223.	23834.	72334.	46671.
TSB	1055457.	1309068.	1901177.	1242654.	774659.	898518.	1145014.	679838.	381312.	413411.	640509.	432262.

Year	1986				1987				1988			
Season	1	2	3	4	1	2	3	4	1	2	3	4
AGE												
0	*	*	106223.	71204.	*	*	31015.	20783.	*	*	85579.	56759.
1	25138.	16526.	10865.	6312.	43168.	26736.	17041.	10091.	13746.	9011.	5962.	3847.
2	2796.	999.	599.	201.	2765.	1525.	973.	512.	5004.	2781.	1804.	1004.
3	176.	59.	37.	20.	103.	59.	39.	26.	153.	86.	58.	39.
4+	27.	16.	11.	7.	18.	11.	8.	5.	17.	11.	8.	5.
SSN	5514.				7202.				6548.			
SSB	87691.				96166.				126755.			
TSN	28138.	17600.	117734.	77743.	46053.	28331.	49076.	31418.	18919.	11889.	93410.	61653.
TSB	246060.	285684.	724469.	581974.	368123.	456462.	594289.	379842.	213354.	234641.	572383.	473448.

Year	1989				1990				1991			
Season	1	2	3	4	1	2	3	4	1	2	3	4
AGE												
0	*	*	91137.	60961.	*	*	85654.	57399.	*	*	162899.	108593.
1	35471.	22355.	14430.	8304.	36890.	23221.	14108.	8662.	37663.	24017.	15579.	9199.
2	2061.	1342.	791.	312.	4141.	2298.	1072.	567.	4839.	2151.	1111.	568.
3	342.	224.	145.	94.	133.	73.	33.	17.	285.	115.	62.	23.
4+	29.	20.	13.	9.	58.	31.	21.	14.	18.	7.	5.	3.
SSN	5979.				8021.				8909.			
SSB	85480.				125498.				145225.			
TSN	37903.	23941.	106516.	69679.	41222.	25623.	100888.	66660.	42805.	26290.	179655.	118387.
TSB	308947.	393272.	768019.	575287.	357902.	431803.	743413.	568449.	382501.	439514.	1092532.	888334.

Year	1992				1993				1994			
Season	1	2	3	4	1	2	3	4	1	2	3	4
AGE												
0	*	*	69513.	45876.	*	*	48710.	32572.	*	*	206642.	137987.
1	69938.	43969.	28227.	16091.	29970.	18500.	11735.	6927.	20872.	12374.	7990.	4513.
2	5308.	2669.	1549.	720.	8507.	5130.	3052.	1299.	3783.	2052.	1142.	421.
3	228.	57.	22.	14.	264.	165.	63.	27.	506.	294.	173.	58.
4+	3.	0.	0.	0.	7.	5.	3.	2.	18.	12.	8.	5.
SSN	12533.				11775.				6395.			
SSB	175013.				219107.				119099.			
TSN	75477.	46695.	99310.	62700.	38749.	23800.	63563.	40827.	25180.	14732.	215955.	142984.
TSB	615626.	753107.	1051629.	676368.	407920.	460447.	623221.	410851.	250591.	270734.	1085809.	952772.

Year	1995				1996				1997			
Season	1	2	3	4	1	2	3	4	1	2	3	4
AGE												
0	*	*	65263.	43174.	*	*	158336.	105543.	*	*	45067.	30121.
1	89025.	56407.	36251.	22216.	27555.	18033.	11629.	6941.	68686.	45492.	30413.	17857.
2	2085.	1201.	595.	361.	12151.	7513.	4871.	2445.	4120.	2495.	1566.	745.
3	173.	111.	49.	30.	193.	118.	48.	2.	1366.	851.	473.	231.
4+	42.	28.	19.	13.	26.	18.	12.	8.	7.	4.	3.	2.
SSN	11203.				15126.				12362.			
SSB	117475.				295812.				193754.			
TSN	91325.	57748.	102177.	65794.	39925.	25681.	174896.	114939.	74180.	48843.	77522.	48956.
TSB	678333.	894107.	1195842.	786921.	469409.	532821.	1136430.	895743.	626479.	810031.	1036308.	636141.

Table 5.3.3 (Cont´d.). Norway pout IV & IIIaN (Skagerrak).

Year	1998				1999				2000			
Season	1	2	3	4	1	2	3	4	1	2	3	4
AGE												
0	*	*	63054.	42189.	*	*	154560.	103571.	*	*	53531.	35823.
1	19910.	13132.	8631.	5448.	28003.	18605.	12211.	7122.	68503.	45384.	30193.	19119.
2	10396.	6404.	4039.	2435.	3218.	2052.	1195.	525.	4302.	2733.	1662.	897.
3	330.	182.	107.	71.	1456.	916.	538.	332.	221.	146.	58.	22.
4+	128.	79.	33.	22.	51.	34.	23.	15.	214.	144.	96.	64.
SSN	12845.				7526.				11588.			
SSB	263010.				151520.				163430.			
TSN	30764.	19798.	75864.	50166.	32728.	21608.	168528.	111566.	73241.	48406.	85540.	55925.
TSB	388443.	428269.	648092.	484830.	327939.	396567.	1007213.	826559.	595001.	788999.	1043896.	693617.

Year	2001				2002				2003			
Season	1	2	3	4	1	2	3	4	1	2	3	4
AGE												
0	*	*	47464.	31790.	*	*	32882.	21763.	*	*	14570.	9761.
1	23766.	15751.	10449.	6905.	21008.	13685.	8886.	5448.	14351.	9572.	6363.	4109.
2	9036.	5365.	3395.	2253.	4410.	2835.	1880.	1028.	3265.	2126.	1385.	829.
3	401.	240.	79.	52.	1151.	758.	504.	318.	405.	254.	150.	88.
4+	53.	36.	24.	16.	45.	30.	20.	14.	201.	135.	90.	60.
SSN	11867.				7707.				5306.			
SSB	234439.				160276.				109331.			
TSN	33256.	21392.	61411.	41016.	26614.	17308.	44173.	28571.	18222.	12086.	22558.	14846.
TSB	384165.	432671.	601824.	447213.	292626.	341234.	464773.	317527.	199742.	236083.	285914.	192977.

Year	2004				2005				2006			
Season	1	2	3	4	1	2	3	4	1	2	3	4
AGE												
0	*	*	18819.	12603.	*	*	74123.	49686.	*	*	35842.	24018.
1	6542.	4374.	2929.	1922.	8402.	5632.	3775.	2530.	33305.	22301.	14903.	9883.
2	2710.	1771.	1174.	745.	1207.	809.	542.	363.	1696.	1094.	696.	413.
3	424.	277.	181.	116.	436.	292.	196.	131.	243.	156.	85.	51.
4+	72.	48.	32.	22.	91.	61.	41.	27.	106.	71.	48.	32.
SSN	3860.				2573.				5376.			
SSB	85195.				54941.				76306.			
TSN	9748.	6471.	23136.	15408.	10135.	6793.	78676.	52738.	35351.	23622.	51574.	34398.
TSB	126409.	142389.	209867.	157841.	107871.	129982.	425915.	379175.	286130.	383511.	550987.	391758.

Year	2007				2008				2009			
Season	1	2	3	4	1	2	3	4	1	2	3	4
AGE												
0	*	*	65148.	43670.	*	*	93979.	62996.	*	*	139598.	93528.
1	15798.	10574.	7054.	4702.	29273.	19618.	13106.	8650.	41262.	27618.	18484.	11882.
2	5736.	3810.	2533.	1685.	3143.	2099.	1373.	826.	5439.	3645.	2405.	1110.
3	236.	158.	106.	70.	1125.	754.	505.	338.	528.	354.	233.	149.
4+	55.	37.	25.	17.	57.	38.	26.	17.	238.	160.	107.	72.
SSN	7607.				7253.				10332.			
SSB	149774.				137842.				183039.			
TSN	21825.	14579.	74866.	50143.	33598.	22509.	108989.	72828.	47468.	31777.	160827.	106741.
TSB	249304.	298123.	552199.	444976.	322261.	405473.	792919.	631261.	442991.	564866.	1137890.	889722.

Year	2010
Season	1
AGE	
0	*
1	62684.
2	7826.
3	723.
4+	148.
SSN	14965.
SSB	253220.
TSN	71380.
TSB	648129.

Table 5.3.4 Norway pout IV & IIIaN (Skagerrak). Seasonal extended survivor analysis (SXSA). Fishing mortalities by quarter of year.

Year	1983				1984				1985			
Season	1	2	3	4	1	2	3	4	1	2	3	4
AGE												
0	*	*	0.004	0.033	*	*	0.000	0.052	*	*	0.000	0.022
1	0.048	0.032	0.169	0.226	0.054	0.069	0.285	0.393	0.084	0.051	0.135	0.587
2	0.127	0.213	0.578	0.355	0.130	0.193	0.590	0.770	0.337	0.068	0.774	0.557
3	0.169	0.195	0.785	1.537	0.281	1.609	0.939	0.000	0.684	0.120	0.321	0.000
4+	0.000	1.807	*	*	0.000	0.000	0.000	0.000	0.438	0.000	0.000	0.000
F (1- 2)	0.087	0.122	0.374	0.290	0.092	0.131	0.438	0.581	0.210	0.059	0.455	0.572

Year	1986				1987				1988			
Season	1	2	3	4	1	2	3	4	1	2	3	4
AGE												
0	*	*	0.000	0.099	*	*	0.000	0.013	*	*	0.011	0.069
1	0.019	0.019	0.141	0.408	0.078	0.050	0.122	0.293	0.022	0.013	0.038	0.219
2	0.588	0.111	0.641	0.263	0.191	0.049	0.235	0.735	0.184	0.033	0.182	0.629
3	0.643	0.061	0.216	0.000	0.153	0.000	0.010	0.259	0.172	0.000	0.000	0.000
4+	0.142	0.000	0.000	0.000	0.070	0.000	0.000	0.000	0.000	0.000	0.000	0.000
F (1- 2)	0.303	0.065	0.391	0.336	0.135	0.049	0.179	0.514	0.103	0.023	0.110	0.424

Year	1989				1990				1991			
Season	1	2	3	4	1	2	3	4	1	2	3	4
AGE												
0	*	*	0.002	0.101	*	*	0.000	0.021	*	*	0.005	0.040
1	0.061	0.037	0.150	0.287	0.062	0.097	0.087	0.179	0.049	0.033	0.125	0.147
2	0.029	0.127	0.502	0.432	0.185	0.350	0.231	0.280	0.395	0.254	0.263	0.487
3	0.022	0.033	0.039	0.182	0.199	0.370	0.243	0.320	0.482	0.221	0.552	1.662
4+	0.000	0.000	0.000	0.000	0.231	0.000	0.000	0.000	0.508	0.000	0.000	0.000
F (1- 2)	0.045	0.082	0.326	0.360	0.124	0.224	0.159	0.229	0.222	0.143	0.194	0.317

Year	1992				1993				1994			
Season	1	2	3	4	1	2	3	4	1	2	3	4
AGE												
0	*	*	0.015	0.026	*	*	0.002	0.045	*	*	0.004	0.038
1	0.063	0.043	0.159	0.232	0.082	0.055	0.125	0.201	0.121	0.037	0.168	0.359
2	0.280	0.142	0.354	0.565	0.104	0.118	0.434	0.512	0.207	0.182	0.560	0.468
3	0.874	0.533	0.058	0.194	0.070	0.529	0.438	0.095	0.143	0.127	0.643	0.000
4+	*	*	*	*	0.028	0.000	0.000	0.000	0.000	0.000	0.000	0.000
F (1- 2)	0.172	0.092	0.256	0.399	0.093	0.086	0.280	0.356	0.164	0.110	0.364	0.413

Year	1995				1996				1997			
Season	1	2	3	4	1	2	3	4	1	2	3	4
AGE												
0	*	*	0.013	0.049	*	*	0.006	0.029	*	*	0.003	0.014
1	0.056	0.042	0.089	0.199	0.024	0.038	0.114	0.120	0.012	0.003	0.131	0.139
2	0.149	0.293	0.099	0.219	0.080	0.033	0.281	0.179	0.100	0.065	0.331	0.399
3	0.040	0.412	0.078	0.128	0.091	0.472	1.572	0.159	0.072	0.184	0.306	0.198
4+	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
F (1- 2)	0.102	0.168	0.094	0.209	0.052	0.036	0.198	0.149	0.056	0.034	0.231	0.269

Year	1998				1999				2000			
Season	1	2	3	4	1	2	3	4	1	2	3	4
AGE												
0	*	*	0.002	0.010	*	*	0.000	0.013	*	*	0.002	0.010
1	0.016	0.020	0.059	0.125	0.009	0.021	0.137	0.103	0.012	0.008	0.056	0.338
2	0.084	0.060	0.105	0.113	0.049	0.138	0.406	0.444	0.053	0.096	0.213	0.390
3	0.188	0.128	0.018	0.254	0.063	0.130	0.081	0.088	0.015	0.493	0.526	0.378
4+	0.078	0.447	0.000	0.000	0.013	0.006	0.000	0.000	0.000	0.000	0.000	0.000
F (1- 2)	0.050	0.040	0.082	0.119	0.029	0.079	0.272	0.273	0.033	0.052	0.135	0.364

Year	2001				2002				2003			
Season	1	2	3	4	1	2	3	4	1	2	3	4
AGE												
0	*	*	0.001	0.014	*	*	0.013	0.016	*	*	0.001	0.000
1	0.011	0.010	0.014	0.048	0.028	0.032	0.088	0.111	0.005	0.008	0.037	0.016
2	0.120	0.057	0.010	0.265	0.041	0.010	0.200	0.502	0.029	0.028	0.111	0.263
3	0.112	0.655	0.017	0.021	0.018	0.008	0.058	0.105	0.067	0.125	0.136	0.553
4+	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.005	0.026
F (1- 2)	0.065	0.034	0.012	0.156	0.035	0.021	0.144	0.306	0.017	0.018	0.074	0.140

Table 5.3.4 (Cont´d.). Norway pout IV & IIIaN (Skagerrak).

Year	2004				2005				2006			
Season	1	2	3	4	1	2	3	4	1	2	3	4
AGE												
0	*	*	0.001	0.005	*	*	0.000	0.000	*	*	0.000	0.019
1	0.002	0.001	0.021	0.065	0.000	0.000	0.000	0.000	0.001	0.003	0.011	0.142
2	0.025	0.011	0.054	0.134	0.000	0.000	0.000	0.000	0.038	0.052	0.120	0.159
3	0.026	0.025	0.047	0.018	0.000	0.000	0.001	0.001	0.043	0.203	0.106	0.017
4+	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
F (1- 2)	0.014	0.006	0.038	0.100	0.000	0.000	0.000	0.000	0.019	0.027	0.065	0.150

Year	2007				2008				2009			
Season	1	2	3	4	1	2	3	4	1	2	3	4
AGE												
0	*	*	0.000	0.000	*	*	0.000	0.023	*	*	0.001	0.000
1	0.002	0.005	0.006	0.003	0.000	0.003	0.015	0.063	0.001	0.002	0.042	0.017
2	0.009	0.008	0.007	0.004	0.004	0.024	0.106	0.047	0.000	0.016	0.360	0.029
3	0.001	0.001	0.018	0.011	0.000	0.001	0.000	0.000	0.000	0.018	0.048	0.003
4+	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
F (1- 2)	0.005	0.007	0.007	0.003	0.002	0.014	0.061	0.055	0.001	0.009	0.201	0.023

Year	2010
Season	1
AGE	
0	*
1	0.000
2	0.000
3	0.000
4+	0.000
F (1- 2)	0.000

Table 5.3.5 Norway pout IV & IIIaN (Skagerrak). SXSA (Seasonal extended survivor analysis). Diagnostics of the SXSA.

Log inverse catchabilities, fleet no: 1 (commercial q134)

Year 1983-2010 (all quarters of year); (The same for all years; estimated and held constant by year as option in SXSA)

Season	1	2	3	4
AGE				
0	*	*	*	11.537
1	10.720	*	9.874	9.179
2	9.252	*	8.757	8.428
3	9.252	*	8.757	8.428

Log inverse catchabilities, fleet no: 2 (ibtsq1)

Year 1983-2010 (all quarters of year); (The same for all years; estimated and held constant by year as option in SXSA)

Season	1	2	3	4
AGE				
0	*	*	*	*
1	2.465	*	*	*
2	1.489	*	*	*
3	1.489	*	*	*

Log inverse catchabilities, fleet no: 3 (egfsq3)

Year 1992-2009 (all quarters of year); (The same for all years; estimated and held constant by year as option in SXSA)

Season	1	2	3	4
AGE				
0	*	*	2.837	*
1	*	*	1.626	*
2	*	*	*	*
3	*	*	*	*

Log inverse catchabilities, fleet no: 4 (sgfsq3)

Year 1998-2009 (all quarters of year); (The same for all years; estimated and held constant by year as option in SXSA)

Season	1	2	3	4
AGE				
0	*	*	2.965	*
1	*	*	1.898	*
2	*	*	*	*
3	*	*	*	*

Log inverse catchabilities, fleet no: 5 (ibtsq3)

Year 1991-2009 (all quarters of year); (The same for all years; estimated and held constant by year as option in SXSA)

Season	1	2	3	4
AGE				
0	*	*	*	*
1	*	*	*	*
2	*	*	1.511	*
3	*	*	1.511	*

Table 5.3.5 (Cont´d.). Norway pout IV & IIIaN (Skagerrak).

Weighting factors for computing survivors:
Fleet no: 1 (commercial q134)

Year 1983-2010 (all quarters of year); (The same for all years; estimated and held constant by year as option in SXSA)

Season	1	2	3	4
AGE				
0	*	*	*	1.071
1	1.339	*	3.174	2.069
2	2.155	*	1.694	1.244
3	1.256	*	0.831	0.765

Weighting factors for computing survivors:
Fleet no: 2 (ibtsq1)

Year 1983-2010 (all quarters of year); (The same for all years; estimated and held constant by year as option in SXSA)

Season	1	2	3	4
AGE				
0	*	*	*	*
1	1.680	*	*	*
2	1.812	*	*	*
3	1.061	*	*	*

Weighting factors for computing survivors:
Fleet no: 3 (egfsq3)

Year 1992-2009 (all quarters of year); (The same for all years; estimated and held constant by year as option in SXSA)

Season	1	2	3	4
AGE				
0	*	*	1.347	*
1	*	*	2.183	*
2	*	*	*	*
3	*	*	*	*

Weighting factors for computing survivors:
Fleet no: 4 (sgfsq3)

Year 1998-2009 (all quarters of year); (The same for all years; estimated and held constant by year as option in SXSA)

Season	1	2	3	4
AGE				
0	*	*	1.763	*
1	*	*	2.507	*
2	*	*	*	*
3	*	*	*	*

Weighting factors for computing survivors:
Fleet no: 5 (ibtsq3)

Year 1991-2009 (all quarters of year); (The same for all years; estimated and held constant by year as option in SXSA)

Season	1	2	3	4
AGE				
0	*	*	*	*
1	*	*	*	*
2	*	*	1.447	*
3	*	*	0.847	*

Table 5.3.6 Norway pout IV & IIIaN (Skagerrak). Stock summary table. (SXSA Baseline May 2010).

(Recruits in millions. SSB and TSB in t, and Yield in '000 t).

Year	Recruits (age 0 3rd qrt)	SSB (Q1)	TSB (Q3)	Landings ('000 t)	Fbar(1-2)
1983	147984	369537	1901177	457.6	0.873
1984	79985	371071	1145014	393.01	1.242
1985	57189	166405	640509	205.1	1.296
1986	106223	87691	724469	174.3	1.095
1987	31015	96166	594289	149.3	0.877
1988	85579	126755	572383	109.3	0.660
1989	91137	85480	768019	166.4	0.813
1990	85654	125498	743413	163.3	0.736
1991	162899	145225	1092532	186.6	0.876
1992	69513	175013	1051629	296.8	0.919
1993	48710	219107	623221	183.1	0.815
1994	206642	119099	1085809	182.0	1.051
1995	65263	117475	1195842	236.8	0.573
1996	158336	295812	1136430	163.8	0.435
1997	45067	193754	1036308	169.7	0.590
1998	63054	263010	648092	57.7	0.291
1999	154560	151520	1007213	94.5	0.653
2000	53531	163430	1043896	184.4	0.584
2001	47464	234439	601824	65.6	0.267
2002	32882	160276	464773	80.0	0.506
2003	14570	109331	285914	27.1	0.249
2004	18819	85195	209867	13.5	0.158
2005	74123	54941	425915	1.9	0.000
2006	35842	76306	550987	46.6	0.261
2007	65148	149774	552199	5.7	0.022
2008	93979	137842	792919	36.1	0.132
2009	139598	183039	1137890	54.5	0.234
2010		253220			
Arit mean	**82,769**	**168,443**	**816,020**		**0.600**
Geomean	**68,730**				

Table 5.6.1 NORWAY POUT IV and IIIaN (Skagerrak). Input data to forecast May 2010.

Basis: HCR with 2009 observed exploitation pattern and 2010 (forecast year quarter 1-4) fishing pattern scaled to the average 2008-2009 seasonal exploitation pattern (standardized with the 2008 and 2009 Fbar to F(1,2)=1). Recruitment in forecast year is assumed to the 25% percentile = 47087 millions (of the long term geometric mean 66883 millions) in the 3rd quarter of the year.

Year	Season	Age	N	F	WEST	WECA	M	PROPMAT
2009	1	0	0	0.000	0.000	0.000	0.4	0
2009	1	1	41262	0.001	0.007	0.010	0.4	0.1
2009	1	2	5439	0	0.022	0.024	0.4	1
2009	1	3	764	0.000	0.040	0.039	0.4	1
2009	2	0	0	0.000	0.000	0.000	0.4	0
2009	2	1	27618	0.002	0.015	0.019	0.4	0
2009	2	2	3645	0.016	0.034	0.026	0.4	0
2009	2	3	514	0.018	0.050	0.040	0.4	0
2009	3	0	139598	0.001	0.004	0.007	0.4	0
2009	3	1	18484	0.042	0.025	0.028	0.4	0
2009	3	2	2405	0.360	0.043	0.030	0.4	0
2009	3	3	340	0.048	0.060	0.052	0.4	0
2009	4	0	93528	0	0.006	0.009	0.4	0
2009	4	1	11882	0.017	0.023	0.033	0.4	0
2009	4	2	1110	0.029	0.042	0.032	0.4	0
2009	4	3	221	0.003	0.058	0.056	0.4	0

Year	Season	Age	N	F	WEST	WECA	M	PROPMAT
2010	1	0	0	0.000	0.000	0.000	0.4	0
2010	1	1	62684	0.002	0.007	0.012	0.4	0.1
2010	1	2	7826	0.015	0.022	0.026	0.4	1
2010	1	3	871	0.000	0.040	0.039	0.4	1
2010	2	0	0	0.000	0.000	0.000	0.4	0
2010	2	1	0	0.016	0.015	0.015	0.4	0
2010	2	2	0	0.125	0.034	0.026	0.4	0
2010	2	3	0	0.042	0.050	0.037	0.4	0
2010	3	0	48087	0.002	0.004	0.009	0.4	0
2010	3	1	0	0.147	0.025	0.029	0.4	0
2010	3	2	0	1.171	0.043	0.036	0.4	0
2010	3	3	0	0.103	0.060	0.049	0.4	0
2010	4	0	0	0.087	0.006	0.009	0.4	0
2010	4	1	0	0.275	0.023	0.027	0.4	0
2010	4	2	0	0.240	0.042	0.038	0.4	0
2010	4	3	0	0.006	0.058	0.050	0.4	0

Table 5.6.2 NORWAY POUT IV and IIIaN (Skagerrak). Results of the short term forecast (May 2010) with different levels of fishing mortality. Shaded scenarios are not considered consistent with the precautionary approach of B(MSY)=Bpa..

Basis: HCR with 2009 observed exploitation pattern and 2010 (forecast year quarter 1-4) fishing pattern scaled to the average 2008-2009 seasonal exploitation pattern (standardized with the 2008 and 2009 Fbar to F(1,2)=1). Recruitment in forecast year is assumed to the 25% percentile = 47087 millions (of the long term geometric mean 66883 millions) in the 3rd quarter of the year

SSB in the start of the Forecast year (1st Jan. 2010): 251 000 t

F(2010)	Landings(2010) `000 t	SSB(2011) ´000t
0.0	0	364
0.1	39	342
0.129	50	336
0.2	79	321
0.3	109	305
0.35	125	297
0.4	141	289
0.5	170	274
0.6	198	259
0.7	224	246
0.8	249	234
0.9	272	223
1.0	294	213
1.1	316	203
1.2	336	193
1.3	357	184
1.4	375	176
1.5	392	168
1.6	409	161
1.7	425	154
1.762	434	150
1.8	440	148
1.9	455	141
2.0	469	136
2.1	483	130
2.2	496	125
2.3	509	120
2.4	521	115
2.5	533	110
2.6	544	106
2.7	555	102
2.8	566	98
2.9	576	94
3.0	586	91
3.016	588	90
3.1	596	87
3.2	605	84

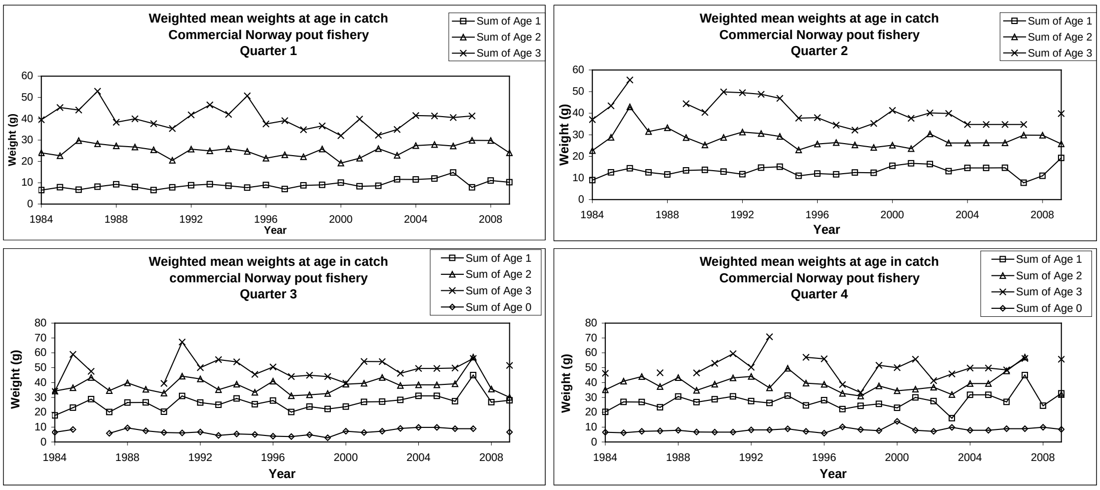


Figure 5.2.1. NORWAY POUT IV and IIIaN (Skagerrak). Weighted mean weights at age in catch of the Danish and Norwegian commercial fishery for Norway pout by quarter of year during the period 1982-2010.

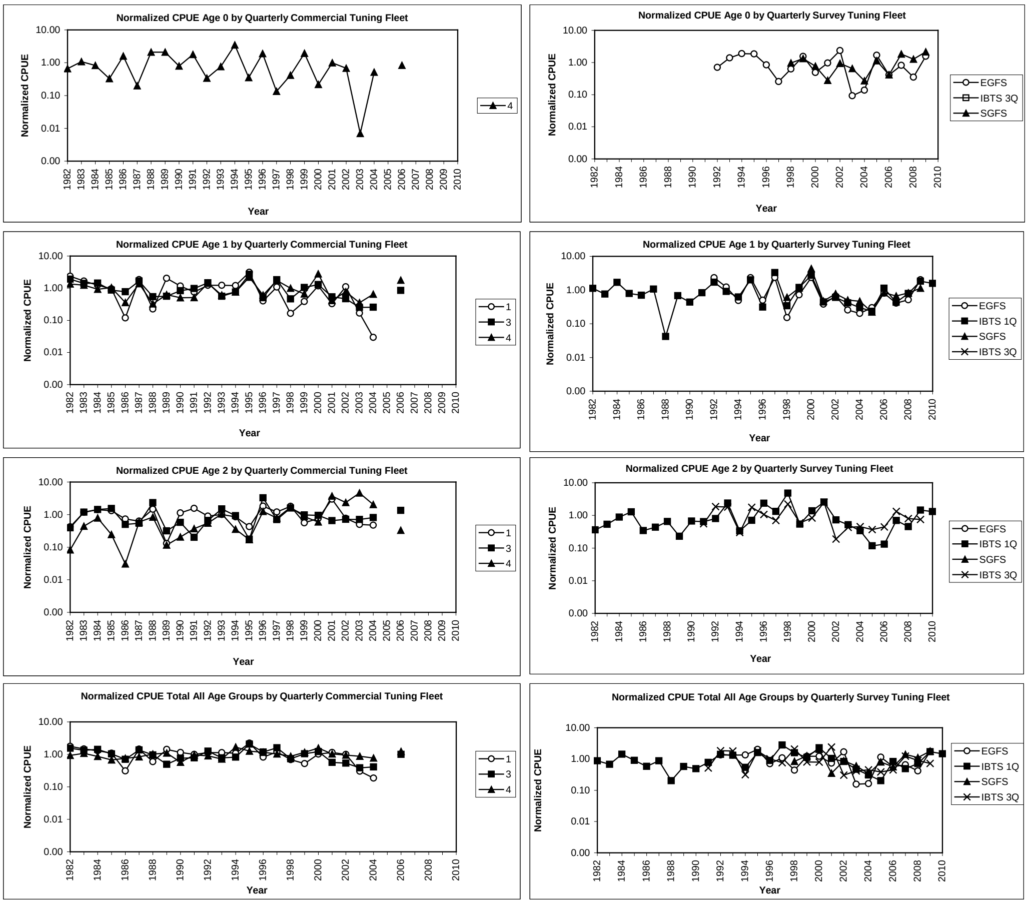


Figure 5.2.2 NORWAY POUT IV and IIIaN (Skagerrak). Trends in CPUE (normalized to unit mean) by quarterly commercial tuning fleet and survey tuning fleet used in the Norway poutSXSA assessment for each age group and all age groups together.

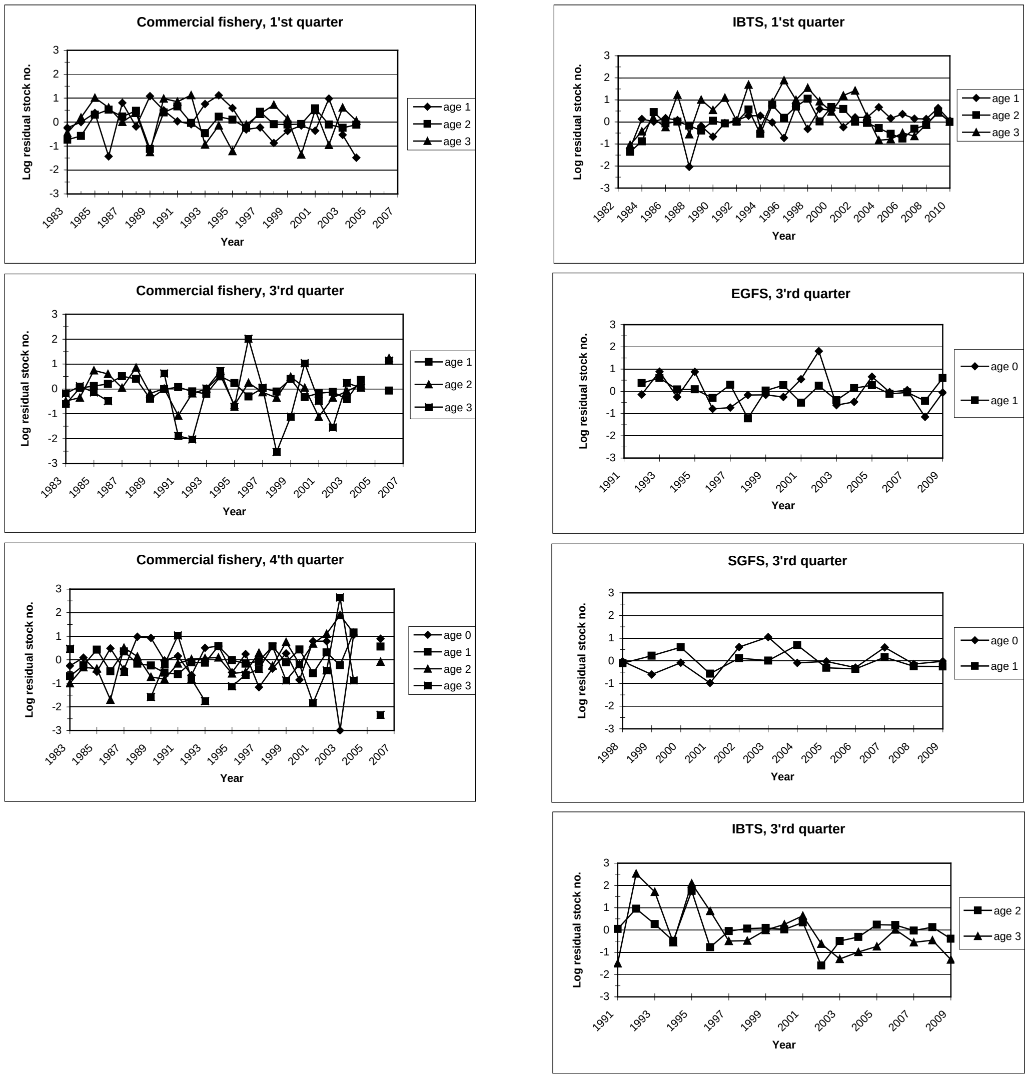


Figure 5.3.1 Norway pout IV & IIIaN (Skagerrak). Log residual stock numbers (log (Nhat/N)) per age group. SXSA divided by fleet and season.

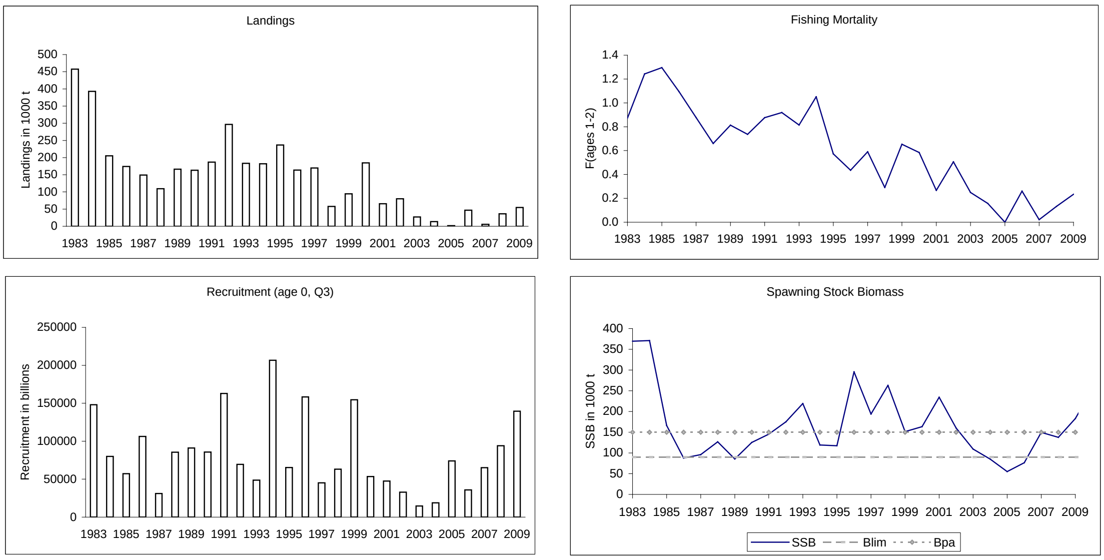


Figure 5.3.2 Norway Pout IV and IIIaN (Skagerrak). Stock Summary Plots. SXSA baseline run May 2010.

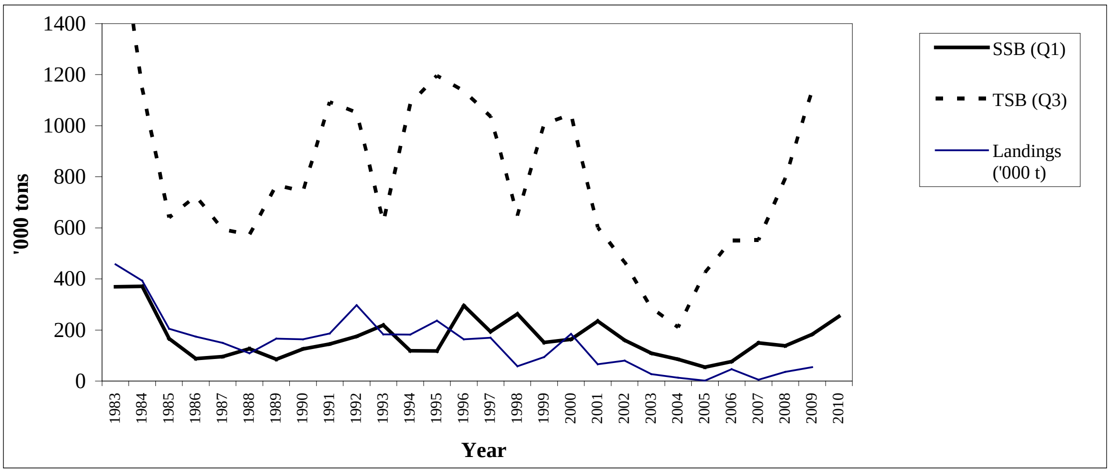


Figure 5.3.3 Norway pout IV & IIIaN (Skagerrak). Trends in yield, SSB and TSB during the period 1983-2010.

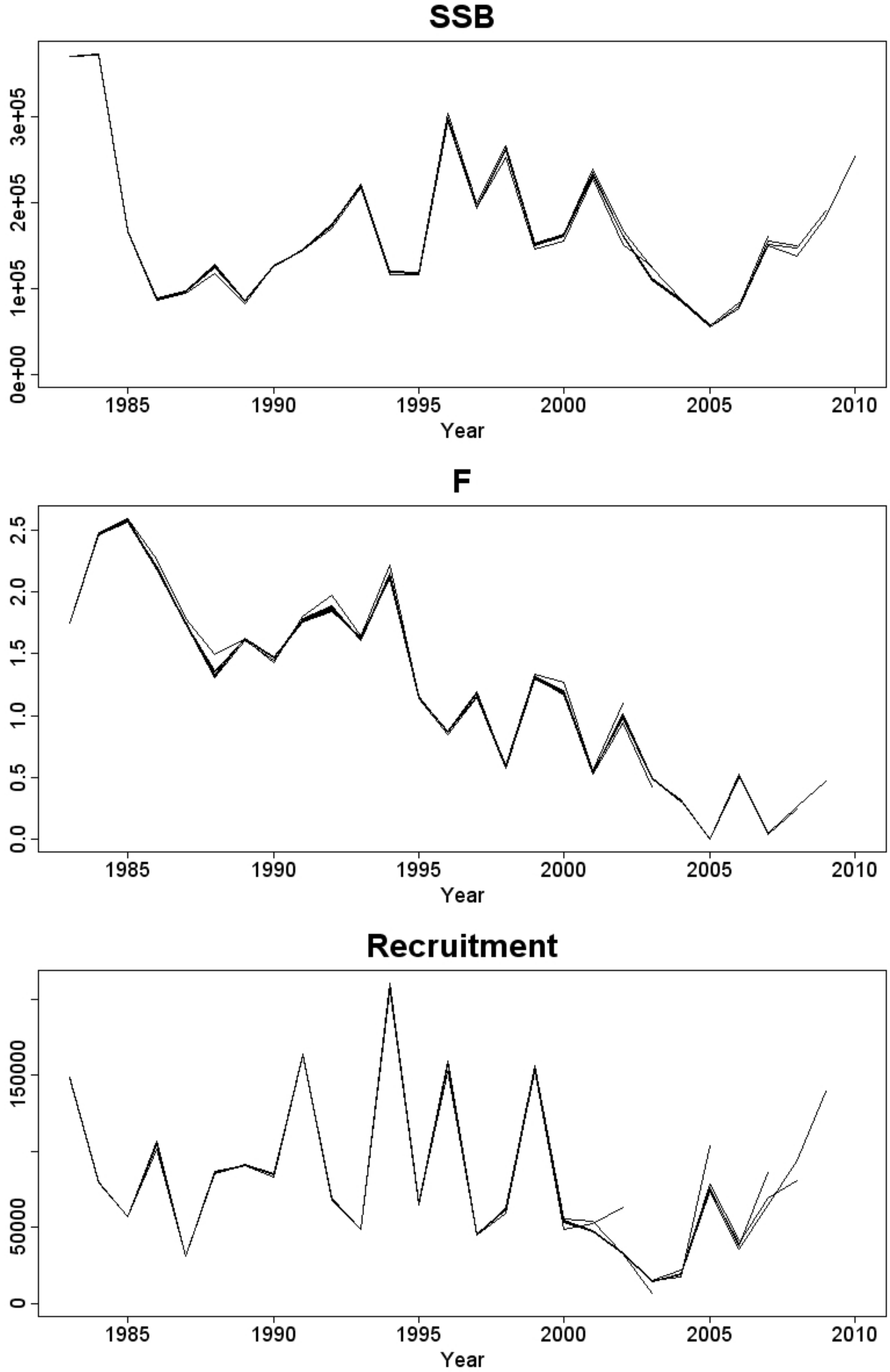


Figure 5.3.4 **Norway pout IV & IIIaN (Skagerrak). Retrospective plots of final SXSA assessment May 2010, with terminal assessment year ranging from 2002-2009.**

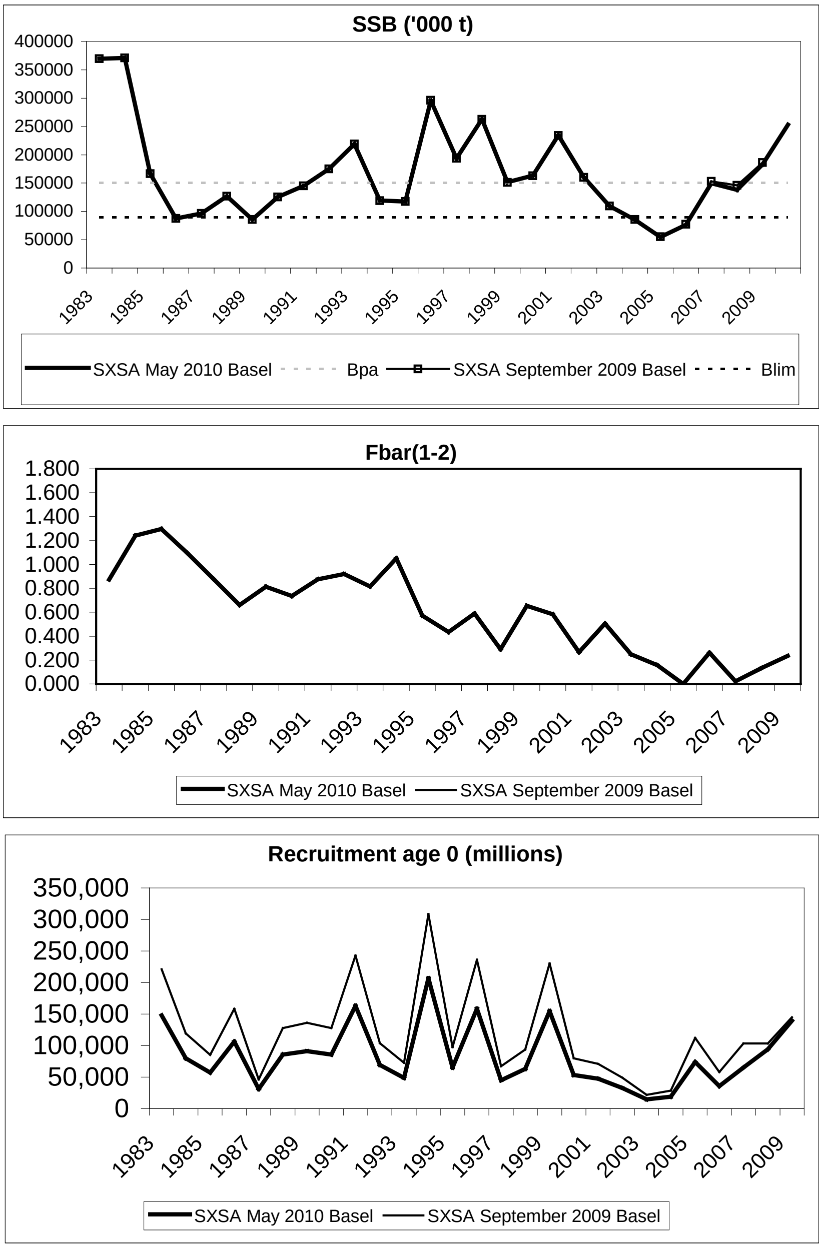


Figure 5.3.5 Norway pout IV and IIIaN (Skagerrak). Comparison of May 2010 SXSA baseline assessment with SXSA September 2009 baseline assessment.

(OBS: In Sept 2009 recruitment were calculated for 2nd quarter and in May 2010 for 3rd quarter)

5. Norway Pout in ICES Subarea IV and Division IIIa (Updated September 2010)

Introduction: Update assessment

The September 2010 assessment of Norway pout in the North Sea and Skagerrak is an update assessment from the May 2010 and September 2009 assessments, which basically are up-date assessments of the 2004 and 2006 benchmark assessments using the same tuning fleets and parameter settings. The assessment is a "real time" monitoring (and management) run up to 1st July 2010, but includes new information from 2nd quarter 2010 and new research survey information from 3rd quarter 2010 (backshifted to 2nd quarter).

Furthermore, a short term prognosis (Forecast) up to 1st January 2012 is given for the stock based on the up-date assessment.

5.1 General

5.1.1 Ecosystem aspects

(See May 2010 WGNSSK Report).

5.1.2 Fisheries

The fishery is mainly performed by Danish and Norwegian vessels using small mesh trawls in the north-western North Sea, especially at the Fladen Ground and along the edge of the Norwegian Trench in the north-eastern part of the North Sea. Main fishing seasons are 3rd and 4th quarters of the year with also high catches in 1st quarter of the year especially previous to 1999. In recent years there has also been conducted Norwegian fishery in 2nd quarter of the year. The average quarterly spatial distribution of the Norway pout catches during a ten year period from 1994-2003 is shown in figures in the **Stock Annex (Q5)**. The Norway pout fishery is a mixed commercial, small meshed fishery conducted mainly by Denmark and Norway directed towards Norway pout as one of the target species together with Blue Whiting.

Landings have been low since 2001, and the 2003-2004 landings were the lowest on record. Effort in 2003 and 2004 has been historically low and well below the average of the 5 previous years. The effort in the Norway pout fishery was in 2002 at the same level as in the previous eight years before 2001. The targeted Norway pout fishery was closed in 2005, in the first half year of 2006, as well as in all of 2007, but Norway pout were in the periods of closure taken as a by-catch in the Norwegian mixed blue whiting and Norway pout fishery, as well as in a small experimental fishery in 2007. The fishery was open for the second half year of 2006 and in all of 2008 and 2009 based on recent strong year classes being on or above the long term average level. However, the Norwegian part of the Norway pout fishery was only open from May to August in 2008. Despite opening of the fishery by 1st January 2008 (with an preliminary quota of 41.3 kt as well as a final quota of 114.6 t set late in 2008) only 30.4 kt was taken by Denmark, and the Norwegian catches were 5.7 kt, i.e. 36.1 kt in total. According to information from the fishery associations this was due mainly to high fuel prices and only to a minor extent late setting of the final quota affecting the trade of individual Danish vessel quotas, and less due to the by-catch percentages of other species in the fishery. In 2009, the fishery was opened with a preliminary TAC around 26 kt (EU), and a final TAC of 116 kt (EU), but total catches in 2009 was only around 54.5 kt (17.5 t by Denmark and 37.0 kt by Norway). In 2009, the Danish fishery was limited by relatively high by-catches of especially whiting as well as high fuel prices. For 2010, a preliminary TAC of 75.9 kt (EU) was set with recommendations of a final TAC of 162 kt (EU 81 kt and Norway 81 kt). In the first half year 2010 the total landings have been 19.7 kt of which 18.9 is from Norwegian fishery in the 2nd quarter 2010. By 1st of October 2010 the total catches are around 80 kt Trends in yield are shown in **Table** 5.3.5 and **Figures** 5.3.1-3.

By-catch of herring, saithe, cod, haddock, whiting, and monkfish at various levels in the small meshed fishery in the North Sea and Skagerrak directed towards Norway pout has been documented (Degel *et al*., 2006, ICES CM 2007/ACFM:35, (WD 22 and section 16.5.2.2)), and recent by-catch numbers are given in section 2 of the WGNSSK May 2010 Report By-catch levels of whiting and cod in the combined Danish small meshed fishery is also shown in sections 12 and 14, respectively. In general, the by-catch levels of these gadoids have decreased in the Norway pout fishery over the years. Review of scientific documentation reveals that by-catch reduction gear selective devices can be used in the Norway pout fishery, significantly reducing by-catches of juvenile gadoids, larger gadoids, and other non-target species (Nielsen and Madsen, 2006, ICES CM 2007/ACFM:35, WD 23 and section 16.5.2.2; Eigaard and Nielsen, ICES CM2009/M:22). Sorting grids have been used in the Norwegian fishery in 2010. Existing technical measures such as the closed Norway pout box, minimum mesh size in the fishery, and by-catch regulations to protect other species have been maintained. A detailed description of the regulations and their background can be found in the **Stock Annex (Q5))**.

5.1.3 ICES advice

Based on the estimates of SSB in May 2010, ICES classified the stock to show full reproductive capacity ($SSB>B_{pa}$). Catches and fishing mortality was low in 2008 and 2009. Fishing mortality has generally been lower than the natural mortality for this stock and has decreased in recent years well below the long term average F (0.6).

Recruitment reached historical minima in 2003-2004 but subsequently increased. In 2009 recruitment was well above the long term average. Based on the real time management and confirmation of recruitment estimates through consecutive surveys, the fishery was open in 2008 and 2009, but the TAC was not taken in 2008 and 2009.

ICES provides advice according to 3 management strategies for the stock (see Section 5.11). ICES advised in May 2010 - on the basis of precautionary limits - that in order to maintain the spawning stock biomass above B_{pa} in 2010 catches should be restricted to less than 434,000 t in 2010 under the escapement strategy (real time management), under the long term fixed TAC strategy a TAC on 50 000 t (corresponding to a F around 0.13), and under the long term fixed fishing mortality or fishing effort strategy (TAE) a TAC on 125 000 t corresponding to a fixed F=0.35.

There is bi-annual information available to perform real time monitoring and management of the stock. This can be carried out both with fishery independent and fishery dependent information as well as a combination of those. Real time advice (forecast) and management options for 2010 and 2011 will be provided for the stock in autumn 2010 as well (the present September 2010 up-date assessment and forecast).

ICES advices that there is a need to ensure that the stock remains high enough to provide food for a variety of predator species. It is advised that by-catches of other species should also be taken into account in management of the fishery. Also it is advised that existing measures to protect other species should be maintained.

Biological reference points for the stock have been set by ICES at B_{lim} = 90 000 t as the lowest historical observed biomass (SSB) before 2000 (1986, 1989) and B_{pa} = 150 000 t. However, in 2005 the SSB was as low as 55 000 t from which the stock has recovered. No F-based reference points are advised for this stock.

5.1.4 Management up to 2010

There is no specific management objective set for this stock. With present fishing mortality levels the status of the stock is more determined by natural processes and less by the fishery. The European Community has decided to apply the precautionary approach in taking measures to protect and conserve living aquatic resources, to provide for their sustainable exploitation and to minimise the impact of fishing on marine ecosystems.

ICES advised in 2005 real time management of this stock. In previous years the advice was produced in relation to a precautionary TAC, which was set to 198 000 t in the EC zone and 50 000 t in the Norwegian zone. On basis of the advice for 2005 from ICES, EU and Norway agreed to close the directed Norway pout fishery in 2005 and in the first part of 2006, and in all of 2007. In 2005 and 2007, the TAC was 0 in the EC zone and 5 000 t in the Norwegian zone – the latter to allow for by-catches of Norway pout in the directed Norwegian blue whiting fishery. On basis of the real time management advice provided by ICES in spring 2006 EU set a quota on 95.000 t for 2006 (intended for the whole year in the EC zone), while the advice in autumn 2006 taking the low recruitment in 2006 into consideration led to a closure of the fishery again by 1st of January 2007. This advice was reiterated by ICES in May 2007, and resulted in a management where the directed Norway pout fishery continued to be closed for all of 2007. Following the September 2007 real time management advice the fishery was opened again 1st of January 2008 with a preliminary TAC of 41.3 kt t and a final TAC of 115 kt. In 2009, a preliminary TAC was set around 26 kt (EU-part), and a final TAC of 116 kt (EU-part). For 2010, a preliminary TAC of 75.9 kt (EU) was set with recommendations of a final TAC of 162 kt (EU 81 kt and Norway 81 kt).

In managing this fishery by-catches of other species have been taken into account. Existing technical measures such as the closed Norway pout box, minimum mesh size in the fishery, and by-catch regulations to protect other species have been maintained.

Long term management strategies have been evaluated for this stock. (See Section 5.11). An overview of recent relevant management measures and regulations for the Norway pout fishery and the stock can be found in the **Stock Annex (Q5).**

5.2 Data available

The new survey data from the 3rd quarter 2010 EGFS and SGFS research surveys have been included in the up-dated assessment in September 2010, where this 3rd quarter information from these two surveys has been back-shifted to 2nd quarter 2010 in the assessment. From 2009 and onwards the SGFS changed it survey area slightly with a few more hauls in the northern North Sea and a few less hauls in the German Bight.

This is not evaluated to influence the indices significantly as the indices are based on weighted sub-area averages. The survey data time series including the new information are presented in **Table** 5.2.1.

Furthermore, landings for the first half year 2010 have been up-dated and included in the update assessment as well compared to the May 2010 assessment. Data for national landings by quarter of year and by geographical area are given in **Table** 5.2.2 as provided by working group members. As no age composition data for Norwegian landings have been provided for 2007 and 2008 because of small catches the catch at age numbers from Norwegian fishery are calculated from Norwegian total catch weight divided by mean weight at age from the Danish fishery. As no age composition data for the Danish landings in first half year 2010 have been sampled because of very small catches the catch at age numbers from Danish fishery is calculated from Danish total catch weight divided by mean weight at age from the Norwegian fishery in 2010. Age compositions are shown in **Table** 5.2.3, and the mean weight at age in catches are shown in **Table** 5.2.4 In general, the estimates of mean weight at age from Danish and Norwegian landings from 2005-2010 are uncertain because of the small sample sizes. In certain cases use of values from 2004, from adjacent quarters and areas, and from other countries within the same year and area has been necessary where observations are missing for the period 2005-2008. However, this uncertainty in the catch numbers and the mean weight at age in catch in the recent years do not affect assessment output significantly because the catches in the same period in general were low.

All other data and data standardization methods used in this September 2010 up-date assessment are identical to those used and described in the May 2010 assessment as well as previous up-date assessments.

5.3 Catch at Age Data Analyses

5.3.1 Final Assessment

The SXSA (Seasonal Extended Survivors Analysis) was used to estimate quarterly stock numbers (and fishing mortalities) for Norway pout in the North Sea and Skagerrak in September 2010. A general description of and reference to documentation for the SXSA model is given in the **Stock Annex (Q5).** Stock indices and assessment settings used in the assessment is presented in **Tables** 5.2.1 and 5.3.1. The SXSA uses the geometric mean for the stock-recruitment relationship (see **Table** 5.3.5).

In the September 2010 assessment back-shifting of the third quarter survey indices (EGFS and SGFS) was undertaken, and the recruitment season to the fishery in the assessment is, accordingly, set to quarter 2. All other aspects and settings in the assessment are an up-date of the May 2010 and September 2009 assessments which basically are up-date assessments of the 2004 and 2006 benchmark assessments using the same tuning fleets and parameter settings.

Results of the SXSA analysis are presented in **Table** 5.3.1 (assessment model parameters, settings, and options), **Table** 5.3.2 (population numbers at age (recruitment), SSB and TSB), **Table** 5.3.3 (fishing mortalities by year), **Table** 5.3.4 (diagnostics), and **Table** 5.3.5 (stock summary). The summary of the results of the assessment are shown in **Table** 5.3.5 and **Figures** 5.3.1-3.

Fishing mortality has generally been lower than natural mortality and has decreased in the recent decade below the long term average (0.6). Fishing mortality for the 1^{st} and 2^{nd}

quarter has decreased to insignificant levels in recent years (F less than 0.05), while fishing mortality for 3rd and especially 4th quarter, that historically constitutes the main part of the annual F, has also decreased moderately during the last decade. Fishing mortality in 2005, first part of 2006, and in 2007 was close to zero due to the closure of the Norway pout fishery in these periods. Fishing mortality has been low since 2008, and the TACs have not been taken.

Spawning stock biomass (SSB) declined between 2001 and 2005 but has subsequently increased to well above Bpa (i.e. the stock show full reproductive capacity) following a combination of stronger recruitments and lower fishing mortalities. The most recent recruitment indices from 3rd quarter 2010 indicates the 2010 year class to be lowest on record since 1983. On this basis the SSB is expected to decrease in 2011 due to the high natural mortality and low 10% maturation at age 1 (see forecast).

5.4 Historical stock trends

The assessment and historical stock performance is consistent with previous years assessments including the May 2010 assessment.

5.5. Recruitment Estimates

The long-term average recruitment (age 0, 2nd quarter) is 121 billions (arithmetic mean) and 97 billions (geometric mean) for the period 1983-2010 (**Table** 5.3.5). Recruitment is highly variable and influences SSB and TSB rapidly due to the short life span of the species. The 2009 year class was very strong (227 billions) and the most recent recruitment indices from 3rd quarter 2010, at 22 billions indicates the 2010 year class to be lowest since 1983 (although similar to 2003 and 2004).

5.6 Short-term prognoses

Deterministic short-term prognoses were performed for the Norway pout stock. The forecast was calculated as a stock projection up to 1st of January 2012 using full assessment information for 2009 and 1st half year 2010, i.e. it is based on the SXSA assessment estimate of stock numbers at age at the middle of 2010.

The purpose of the forecast is to calculate the catch of Norway pout in 2010 and 2011 which would result in SSB at or above $\mathbf{B_{pa}}$ = MSY $\mathbf{B_{trigger}}$ (=150 000 t) 1st of January 2011 and 1st January 2012. The forecast is based on an escapement management strategy but also providing output for the long term fixed E or F management strategy and a long term fixed TAC strategy for Norway pout (see ICES WGNSSK Report ICES CM 2007/ACFM:30 section 5.3, and ICES AGNOP Report ICES CM 2007/ACFM:39, and the ICES AGSANNOP Report ICES CM 2007/ACFM:40 as well as section 5.11).

Input to the forecast is given in **Table** 5.6.1. Observed fishing mortalities for quarters 1 and 2 of 2010 have been used (assessment year). For quarters 3 and 4 of 2010 the fishing pattern was estimated as the average standardized exploitation pattern (F) for 2008 and 2009 multiplied by a factor 0.453. This results in a total catch in 2010 of 162 kt which is equal to the final TAC set for 2010. Given the pattern of landings observed so far in 2010 this appears to be a realistic assumption (see section 5.1.2).

An exploratory forecast was made where the fishing mortalities in quarter 3 and 4 of 2010 was down scaled with the option of adjusting the total catch in 2010 to the level where the stock would be at Bpa also by 1st January 2012. This was done by down scaling the average standardized exploitation pattern (F) for 2008 and 2009 used in quarter 3 and 4 2010 with a factor 0.25 (not shown).

The forecast assumes that F in 2011 was scaled to the average standardized exploitation pattern (F) for 2008 and 2009 . Recruitment in the assessment year is from the SXSA assessment (3rd quarter 2010 0-group estimate backshifted to 2nd quarter 2010) = 21 590 millions, and recruitment in the forecast year is assumed to the 25th percentile = 69 785 millions of the SXSA recruitment estimates (GM = 97 336 millions) in the 2nd quarter of the year. The background for selecting recent years exploitation pattern in this forecast is that 2004 was the last year where the traditional directed Norway pout fishery was open in all seasons of the year, except for 2008 and 2009 where the fishery was open all of the year in the EU Zone (but only May-August 2008 in the Norwegian zone). The catches in 2008 and 2009 have been relatively low and the exploitation pattern between seasons (and ages) is very different from the average previous long term (1991-2004) exploitation pattern. The targeting in the small meshed trawl fishery has changed recently where targeting of Norway pout has decreased (see also the **Stock Annex (Q5)**).

The weight at age in the catch per quarter is based on estimated mean weight at age in catches in the assessment year for quarter 1 and 2 in 2010 of the forecast and based on recent running 5 year averages (i.e. for the 5 last years with covering observations) for the second and 3rd quarter of 2010 (assessment year) as well as for the forecast year (2011). The constant weight at age in stock by year and quarter of year used in the SXSA assessment has also been used in the forecast for 2010 and 2011.

Ten percent of age 1 is mature and is included in SSB. Therefore, the recruitment in 2010 does influence the SSB in 2011.

The results of the forecasts are presented in **Table** 5.2.2. On the assumption that the total TAC of 162 kt in 2010 will be taken there can be taken no catch in 2011 according to the escapement strategy. A total catch of 162 kt in 2010 and no catch in 2011 will result in a spawning stock biomass of 141 kt by 1st of January 2012, i.e. a less than MSY $B_{escapement}$ (but above B_{lim}). In order to achieve $SSB_{2012} > B_{escapement}$ then the catch in 2010 should not exceed 102 000 t in addition to a zero catch in 2012. The reason for this closure of the directed Norway pout fishery is the very low 2010 recruitment and the high natural mortality as well as the short life span of the stock. The escapement strategy is in force in 2010 and results in advice of closure of the directed Norway pout fishery in 2011. Under a fixed F-management-strategy with F around 0.35 in 2011 as well as under a fixed TAC strategy with a TAC of 50 000 t 2011 the stock will decrease to be under Bpa by 1st of January 2012 according to the long term management strategies.

5.7 Medium-term projections

No medium-term projections are performed for this stock. The stock contains only a few age groups and is highly influenced by recruitment.

5.8 Biological reference points

	Type	Value	Technical basis
MSY Approach	MSY $B_{trigger}$	150 000 t	MSY $B_{triger} = B_{MSY} = B_{pa} = B_{lim}\ e^{0.3\text{-}0.4*1.65}$ (SD): 150 000 t.
	F_{MSY}	Undefined	No target reference points advised
Precautionary Approach	B_{lim}	90 000 t	$B_{lim} = B_{loss}$, the lowest observed biomass in the 1980s
	B_{pa}	150 000 t	Below this value probability of below-average recruitment increases.
	F_{lim}	Undefined	None advised
	F_{pa}	Undefined	None advised

(unchanged since: 2010)

Biomass based reference points have been unchanged since 1997 given MSY $B_{trigger} = B_{pa}$.

Norway pout is a short lived species and most likely a one time spawner. The population dynamics of Norway pout in the North Sea and Skagerrak are very dependent on changes caused by recruitment variation and variation in predation (or other natural) mortality, and less by the fishery. Recruitment is highly variable and influences SSB and TSB rapidly due to the short life span of the species. (Basis: Sparholt, Larsen and Nielsen 2002a,b; Lambert, Nielsen, Larsen and Sparholt 2009). Furthermore, 10 % of age 1 is considered mature and is included in SSB. Therefore, the recruitment in the year after the assessment year does influence the SSB in the following year. Also, Norway pout is to limited extent exploited already from age 0. All in all, the stock is very dependent of yearly dynamics and should be managed as a short lived species.

On this basis B_{pa} is considered a good proxy for a SSB reference level for MSY $B_{trigger}$. B_{lim} is defined as B_{loss} and is based on the observations of stock developments in SSB (especially in 1989 and 2005) been set to 90 000 t. MSY $B_{trigger} = B_{pa}$ has been calculated from

$$B_{pa} = B_{lim}\ e^{0.3*1.65}\ \text{(SD)}.$$

A SD estimate around 0.3-0.4 is considered to reflect the real uncertainty in the assessment. This SD-level also corresponds to the level for SD around 0.2-0.3 recommended to use in the manual for the Lowestoft PA Software (CEFAS, 1999). The relationship between the Blim and $B_{MSY} = B_{pa}$ (90 000 and 150 000 t) is 0.6.

5.9 Quality of the assessment

The estimates of the SSB, recruitment and the average fishing mortality of the 1- and 2-group are consistent with the estimates of previous years assessment.

The assessment is considered appropriate to indicate trends in the stock and immediate changes in the stock because of the seasonal assessment taking into account the seasonality in fishery, use seasonal based fishery independent information, and using most recent information about recruitment. The assessment provides stock status and year class strengths of all year classes in the stock up to the second quarter of the assessment year. The real time assessment method with up-date every half year also gives a good indication of the stock status the 1st January the following year based on projection of existing recruitment information in 3rd quarter of the assessment year.

5. 10 Status of the stock

Based on the estimates of SSB in May 2009, ICES classified the stock at full reproductive capacity with SSB well above Bpa at the start of 2010 (up to 1st April 2010), and also the September 2010 assessment estimates of SSB show full reproductive capacity of the stock (SSB> MSY $B_{trigger}$ = B_{pa}) in first half year 2010.

Fishing mortality has generally been lower than the natural mortality for this stock and has decreased in recent years well below the long term average F (0.6). The fishery was open in all of 2008 and 2009. Despite opening of the fishery by 1st January 2008 (with an preliminary quota of 41.3 kt and a final quota of 114.6 t set late in 2008) only 36.1 kt was taken in total. In 2009, the fishery was opened with a preliminary TAC around 26 kt (EU), and a final EU TAC of 116 kt, but total catches in 2009 was only around 54.5 kt (17.5 t by Denmark (EU) and 37.0 kt by Norway). For 2010, a preliminary TAC of 75.9 kt (EU) was set with recommendations of a final TAC of 162 kt (EU 81 kt and Norway 81 kt).

The 2008 recruitment was above long term average (141billions), and the 2009 year class was very strong (227 billions). The most recent recruitment indices from 3rd quarter 2010 (September 2010 assessment) indicates the 2010 year class to be lowest on record (22 billions) since 1983 and at the same level as in 2003 and 2004. (**Tables** 5.3.2 and Table 5.3.5).

5.11 Management considerations

There are no management objectives for this stock.

The catch in the first half year 2010 has been around 20 kt which is considerably higher than in first half year of 2008 and 2009, respectively. By 1st of October 2010 the total catches are around 80 kt of which Norway has taken a little more than 60 kt and Denmrk a little less than 20 kt according to the official online Danish and Norwegian catch statistics. On this basis it is evaluated realistic that the total TAC of 162 kt in 2010 will be taken. With this catch scenario in 2010 there can be taken no catch in 2011 according to the escapement strategy. A total catch of 162 kt in 2010 and no catch in 2011 will result in a spawning stock biomass of 141 kt by 1st of January 2012, i.e. a little less than MSY $B_{escapement}$. With the objective to maintain the spawning stock biomass above a reference level of MSY $B_{escapement}$ by 1st of January 2012 then the catch in 2010 should not exceed 102 000 t and no catch in the directed Norway pout fishery in 2011 can be taken The reason for this closure of the directed Norway pout fishery is the very low 2010 recruitment and the high natural mortality as well as the short life span of the stock. The escapement strategy is in force in 2010 and results in advice of closure of the directed Norway pout fishery in 2011. Under a fixed F-management-strategy with F around 0.35 in 2011 as well as under a fixed TAC strategy with a TAC of 50 000 t 2011 the stock will decrease to be under Bpa by 1st of January 2012 according to the long term management strategies.

Norway pout is a short lived species and most likey an one time spawner. The population dynamics of Norway pout in the North Sea and Skagerrak are very dependent on changes caused by recruitment variation and variation in predation (or other natural) mortality, and less by the fishery. Recruitment is highly variable and influences SSB and TSB rapidly due to the short life span of the species. (Basis: Sparholt, Larsen and Nielsen 2002a,b; Lambert, Nielsen, Larsen and Sparholt 2009). On this basis B_{pa} is considered a good proxy for a SSB reference level for MSY $B_{trigger}$.

There is bi-annual information available to perform real time monitoring and management of the stock. This can be carried out both with fishery independent and fishery dependent information as well as a combination of those. Real time advice (forecast) and management options for 2010 is provided for the stock in autumn 2010 through the present September 2010 up-date assessment and forecast.

There is a need to ensure that the stock remains high enough to provide food for a variety of predator species. Natural mortality levels by age and season used in the stock assessment reflect the predation mortality levels estimated for this stock from the most recent multi-species stock assessment performed by ICES (ICES-SGMSNS 2006).

An overview of recent relevant management measures and regulations for the Norway pout fishery and the stock can be found in the **Stock Annex (Q5)**.

Historically, the fishery includes bycatches especially of haddock, whiting, saithe, and herring. Existing technical measures to protect these bycatch species should be maintained or improved. Bycatches of these species have been low in the recent decade. Sorting grids in combination with square mesh panels have been shown to reduce bycatches of whiting and haddock by 57% and 37%, respectively (Eigaard and Holst, 2004; Nielsen and Madsen 2006; Eigaard and Nielsen, 2009). ICES suggests that these devices (or modified forms of those) should be brought into use in the fishery. In 2010 grids have been used in the Norwegian fishery. The introduction of these technical measures should be followed up by adequate control measures of landings or catches at sea to ensure effective implementation of the existing bycatch measures. An overview of recent relevant management measures and regulations for the Norway pout fishery and the stock can be found in the **Stock Annex (Q5).**

Historically, the fishery includes bycatches especially of haddock, whiting, saithe, and herring. Existing technical measures to protect these bycatch species should be maintained or improved. Bycatches of these species have been low in the recent decade. Sorting grids possibly in combination with square mesh panels have been shown to reduce bycatches of whiting and haddock by 57% and 37%, respectively (Eigaard and Holst, 2004; Nielsen and Madsen, 2006; Eigaard and Nielsen, 2009); ICES suggests that these devices (or modified forms of those) should be brought into use in the fishery. In 2010 grids have been used in the Norwegian fishery. The introduction of these technical measures should be followed up by adequate control measures of landings or catches at sea to ensure effective implementation of the existing bycatch measures.

5.11.1 Long term management strategies

ICES has evaluated and commented on three management strategies, following requests from managers – fixed fishing mortality (F=0.35), Fixed TAC (50 000 t), and a variable TAC escapement strategy. The evaluation shows that all three management strategies are capable of generating stock trends that stay at or above $B_{pa} = B_{MSY\text{-}trigger}$, i.e. away from B_{lim} with a high probability in the long term and are, therefore, considered to be precautionary. ICES does not recommend any particular one of the strategies.

The choice between different strategies depends on the requirements that fisheries managers and stakeholders have regarding stability in catches or the overall level of the catches. The escapement strategy has higher long term yield compared to the fixed fishing mortality strategy, but at the cost of a substantially higher probability of having closures in the fishery. If the continuity of the fishery is an important property, the fixed F (equivalent to fixed effort) strategy will perform better. Recent years TAC's indicate choice of a management strategy close to the fixed F strategy.

A detailed description of the long term management strategies and management plan evaluations can be found in the **Stock Annex (Q5)** and in the ICES AGNOP 2007 (ICES CM 2007/ACFM:39), ICES WGNSSK 2007 (ICES CM 2007/ACFM:30) and the ICES AGSANNOP (ICES CM 2007/ACFM:40) reports.

5.11.2 Other issues

See May 2010 WGNSSK Report.

Table 5.2.1 NORWAY POUT IV & IIIaN (Skagerrak). (September Update) Research vessel indices (CPUE in catch in number per trawl hour) of abundance for Norway pout.

Year	IBTS/IYFS[1] February (1st Q)			EGFS[2,3] August				SGFS[4] August				IBTS 3rd Quarter[1]			
	1-group	2-group	3-group	0-group	1-group	2-group	3-group	0-group	1-group	2-group	3-group	0-group	1-group	2-group	3-group
1971	1,556	22	-	-	-	-	-	-	-	-	-	-	-	-	-
1972	2,578	872	3	-	-	-	-	-	-	-	-	-	-	-	-
1973	4,207	438	-	-	-	-	-	-	-	-	-	-	-	-	-
1974	25,557	391	24	-	-	-	-	-	-	-	-	-	-	-	-
1975	4,573	1,880	4	-	-	-	-	-	-	-	-	-	-	-	-
1976	4,411	371	2	-	-	-	-	-	-	-	-	-	-	-	-
1977	6,093	273	42	-	-	-	-	-	-	-	-	-	-	-	-
1978	1,479	575	47	-	-	-	-	-	-	-	-	-	-	-	-
1979	2,738	316	75	-	-	-	-	-	-	-	-	-	-	-	-
1980	3,277	550	29	-	-	-	-	-	1,928	346	12	-	-	-	-
1981	1,092	377	15	-	-	-	-	-	185	127	9	-	-	-	-
1982	4,537	262	59	6,594	2,609	39	77	8	991	44	22	-	-	-	-
1983	2,258	592	7	6,067	1,558	114	0.4	13	490	91	1	-	-	-	-
1984	4,994	982	75	457	3,605	359	14	2	615	69	8	-	-	-	-
1985	2,342	1,429	73	362	1,201	307	0	5	636	173	5	-	-	-	-
1986	2,070	383	20	285	717	150	80	38	389	54	9	-	-	-	-
1987	3,171	481	61	8	552	122	0.9	7	338	23	1	-	-	-	-
1988	124	722	15	165	102	134	20	14	38	209	4	-	-	-	-
1989	2,013	255	172	1,531	1,274	621	20	2	382	21	14	-	-	-	-
1990	1,295	748	39	2,692	917	158	23	58	206	51	2	-	-	-	-
1991	2,450	712	130	1,509	683	399	6	10	732	42	6	7,301	1,039	189	2
1992	5,071	885	32	2,885	6,193	1,069	157	12	1,715	221	24	2,559	4,318	633	48
1993	2,682	2,644	258	5,698	3,278	1,715	0	2	580	329	20	4,104	1,831	608	53
1994	1,839	374	66	7,764	1,305	112	7	136	387	106	6	3,196	704	102	14
1995	5,940	785	77	7,546	6,174	387	14	37	2,438	234	21	2,860	4,440	597	69
1996	923	2,631	228	3,456	1,332	319	3	127	412	321	8	4,554	762	362	12
1997	9,752	1,474	670	1,045	6,262	376	30	1	2,154	130	32	490	3,447	236	46
1998	1,010	5,336	265	2,573	404	260	0	2,628	938	127	5	2,931	801	748	12
1999	3,527	597	667	6,358	1,930	88	26	3,603	1,784	179	37	7,844	2,367	201	94
2000	8,095	1,535	65	2,005	6,261	141	2	2,094	6,656	207	23	1,643	7,868	282	11
2001	1,305	2,861	235	3,948	1,013	693	5	759	727	710	26	2,088	1,274	862	27
2002	1,795	809	880	9,678	1,784	61	21	2,559	1,192	151	123	1,974	766	64	48

2003	1,239	575	94	379	681	85	5	1,767	779	126	1	1,812	1,063	146	7
2004	895	376	34	564	542	90	7	731	719	175	19	773	647	153	12
2005	691	131	37	6,912	803	67	11	3,073	343	132	18	2,614	439	125	17
2006	3,340	146	27	1,680	2,147	151	18	1,127	1,285	69	9	1,349	1,869	150	15
2007	1,286	778	23	3,329		332	1	5,003	1,023	395	8	4,143	1,191	447	11
2008	2,345	506	186	1,435	1,084	253	35	3,456	1,263	263	57	3,000	1,636	271	58
2009	5,413	1,618	150	6,401	1,371	428	3	5,835	1,750	202	16	5,898	2,562	254	11
2010	4,657	1,455	136	235	5,368 3,977	626	31	1,449	5,101	930	29	-	-	-	-

[1]International Bottom Trawl Survey, arithmetic mean catch in no./h in standard area. [2]English groundfish survey, arithmetic mean catch in no./h, 22 selected rectangles within Roundfish areas 1, 2, and 3. [3]1982-91 EGFS numbers adjusted from Granton trawl to GOV trawl by multiplying by 3.5. Minor GOV sweep changes in 2006 EGFS. [4]Scottish groundfish surveys, arithmetic mean catch no./h. Survey design changed in 1998 and 2000. [5]English groundfish survey: Data for 1996, 2001, 2002, and 2003 have been revised compared to the 2003 assessment. In 2007, numbers for 1997 and 1998 as well as 2002 has been adjusted based on new automatic calculation and processing process has been introduced. SGFS survey area changed slightly in 2009 and onwards, which is evaluated to have no main effect for the Norway pout indices as the indices are weighted by sub-area.

Table 5.2.2 NORWAY POUT IV & IIIaN.(Skagerrak) (September Update) National landings (t) by quarter of year 1995-2010.(Data provided by Working Group members. Norwegian landing data include landings of by-catch of other species).(By-catch of Norway pout in other (small meshed) fisheries included).

Year	Quarter	Denmark									Norway		Total
	Area	IIIaN	IIIaS	Div. IIIa	IVaE	IVaW	IVb	IVc	Div. IV	Div. IV + IIIaN	IVaE	Div. IV	Div. IV + IIIaN
1995	1	576	9	585	19,421	1,336	7	-	20,764	21,339	15521	15521	36,860
	2	10,495	290	10,793	2,841	30	3,670	-	6,540	17,035	10639	10639	27,674
	3	20,563	976	21,540	13,316	17,681	11,445	-	42,442	63,004	5790	5790	68,794
	4	14,748	2,681	17,430	10,812	56,159	1,426	-	68,396	83,145	11131	11131	94,276
	Total	46,382	3,956	50,347	46,390	75,205	16,547	-	138,142	184,524	43,081	43081	227,605
1996	1	1,231	164	1,395	6,133	3,149	658	2	9,943	11,174	10604	10604	21,778
	2	7,323	970	8,293	1,018	452	1,476	-	2,946	10,269	4281	4281	14,550
	3	20,176	836	21,012	7,119	17,553	1,517	-	26,188	46,364	27466	27466	73,830
	4	5,028	500	5,528	9,640	25,498	42	-	35,180	40,208	5466	5466	45,674
	Total	33,758	2,470	36,228	23,910	46,652	3,692	2	74,257	108,015	47,817	47817	155,832
1997	1	2,707	460	3,167	6,203	2,219	7	-	8,429	11,137	4183	4183	15,320
	2	5,656	200	5,857	141	-	45		185	5,842	8466	8466	14,308
	3	16,432	649	17,081	19,054	21,024	740	-	40,818	57,250	21546	21546	78,796
	4	4,464	1,042	5,505	6,555	38,202	7		44,765	49,228	4884	4884	54,112
	Total	29,259	2,351	31,610	31,953	61,445	799	-	94,197	123,456	39,079	39079	162,535
1998	1	1,117	317	1,434	7,111	2,292	-	-	9,403	10,520	8913	8913	19,433
	2	3,881	103	3,984	131	5	124	-	259	4,140	7885	7885	12,025
	3	6,011	406	6,417	7,161	1,763	2,372	-	11,297	17,308	3559	3559	20,867
	4	2,161	677	2,838	1,051	17,752	77	-	18,880	21,041	1778	1778	22,819
	Total	13,171	1,503	14,673	15,454	21,811	2,573	-	39,838	53,009	22,135	22135	75,144
1999	1	4	12	15	2,769	1,246	1	-	4,016	4,020	3021	3021	7,041
	2	1,568	36	1,605	953	361	418	-	1,731	3,300	10321	10321	13,621
	3	3,094	109	3,203	7,500	3,710	2,584	-	13,794	16,887	24449	24449	41,336
	4	2,156	517	2,673	3,577	16,921	928	1	21,426	23,583	6385	6385	29,968
	Total	6,822	674	7,496	14,799	22,237	3,931	1	40,968	47,790	44,176	44176	91,966
2000	1	0	11	12	3,726	1,038	-	-	4,764	4,765	5440	5440	10,205
	2	929	15	944	684	22	227	-	933	1,862	9779	9779	11,641
	3	7,380	139	7,519	1,708	5,613	515	-	7,836	15,216	28428	28428	43,644
	4	947	209	1,157	1,656	111,732	76	-	113,464	114,411	4334	4334	118,745
	Total	9,257	375	9,631	7,774	118,406	818	-	126,998	136,255	47,981	47981	184,236
2001	1			302	7,341	9,734	103	72	17,250	17,250	3838	3838	21,088
	2			2,174	31	30	269	-	330	330	9268	9268	9,598
	3			2,006	15	154	191	-	360	360	2263	2263	2,623
	4			3,059	2,553	19,826	329	-	22,708	22,708	1426	1426	24,134
	Total			7,541	9,940	29,744	892	72	40,648	40,648	16,795	16795	57,443
2002	1	-	1	1	4,869	1,660	114	-	6,643	6,643	1896	1896	8,539
	2	883	161	1,045	56	9	22	-	87	970	5563	5563	6,533
	3	1,567	213	1,778	2,234	14,739	104	-	17,077	18,644	14147	14147	32,791
	4	393	100	492	1,787	24,273	335	-	26,395	26,788	2033	2033	28,821
	Total	2,843	475	3,316	8,946	40,681	575	-	50,202	53,045	23,639	23639	76,684
2003	1	-	1	1	615	581	22	-	1,218	1,218	1977	1977	3,195
	2	246	160	406	76	-	22	-	98	344	2773	2773	3,117
	3	2,984	1,005	3,989	172	1,613	89	-	1,874	4,858	5989	5989	10,847
	4	188	547	735	0	6270	457	-	6,727	6,915	644	644	7,559
	Total	3,418	1,713	5,131	863	8,464	590	-	9,917	13,335	11,383	11,383	24,718
2004	1	316	-	316	87	650	-	-	737	1,053	989	989	2,042
	2	-	-	-	-	-	7	-	7	7	660	660	667
	3	14	-	14	289	1,195	9	-	1,493	1,507	2484	2484	3,991
	4	13	-	13	93	5,683	107	-	5,883	5,896	865	865	6,761
	Total	343	-	343	469	7,528	123	-	8,120	8,463	4,998	4,998	13,461
2005	1	-	-	-	9	-	-	-	9	9	12	12	21
	2	-	-	-	151	-	-	-	151	151	352	352	503
	3	-	-	-	781	-	-	-	781	781	387	387	1,168
	4	-	-	-	-	-	-	-	-	-	211	211	211
	Total	-	-	-	941	-	-	-	941	941	962	962	1,903
2006	1	-	-	-	75	83	-	-	158	158	2,205	2205	2,363
	2	-	-	-	-	-	15	-	15	15	2,846	2846	2,861
	3	114	-	114	-	649	20	-	669	783	5,749	5749	6,532
	4	3	-	3	-	34,262	-	-	34,262	34,265	605	605	34,870
	Total	117	-	117	75	34,994	35	-	35,104	35,221		11,405	46,626
2007	1	-	-	-	561	789	-	-	1,350	1,350	74	74	1,424
	2	-	-	-	4	-	-	-	4	4	1,097	1097	1,101
	3	1	2	3	-	-	-	-	-	1	2,429	2429	2,430
	4	-	-	-	-	682	-	-	682	682	155	155	837
	Total	1	2	3	565	1,471	-	-	2,036	2,037		3,755	5,792
2008	1	125	-	125	19	86	123	-	228	353	7	7	360
	2	-	-	-	-	-	30	-	30	30	1,803	1803	1,833
	3	-	-	-	-	6,102	-	-	6,102	6,102	3,582	3582	9,684
	4	-	-	-	-	22,686	1,239	-	23,925	23,925	336	336	24,261
	Total	125	-	125	19	28,874	1,392	-	30,285	30,410		5,728	36,138
2009	1	1	-	1	22	515	-	-	537	538	2	2	540
	2	-	-	-	-	-	-	-	-	-	4,026	4026	4,026
	3	2	-	2	-	11,567	-	-	11,567	11,569	31,251	31251	42,820
	4	-	-	-	-	5,399	4	-	5,403	5,403	1,736	1736	7,139
	Total	3	-	3	22	17,481	4	-	17,507	17,510	37,015	37,015	54,525
2010	1	-	-	-	-	-	-	-	-	-	104	104	104
	2	216	-	216	-	485	60	-	545	761	18,895	18895	19,656

Table 5.2.3 NORWAY POUT in IV and IIIaN (Skagerrak). (September Update) Catch in numbers at age by quarter (millions). SOP is given in tonnes. Data for 1990 were estimated within the SXSA program used in the 1996 assessment.

Age	Year	1983				1984				1985			
	Quarter	1	2	3	4	1	2	3	4	1	2	3	4
0		0	0	446	2671	0	0	1	2231	0	0	6	678
1		4,207	1826	5825	4296	2,759	2252	5290	3492	2,264	857	1400	2991
2		1,297	1234	1574	379	1,375	1165	1683	734	1,364	145	793	174
3		15	10	17	7	143	269	8	0	192	13	19	0
4+		0	2	0	0	0	0	0	0	1	0	0	0
SOP		58587	69964	216106	131207	56790	56532	152291	110942	57464	15509	62489	92017
Age	Year	1986				1987				1988			
	Quarter	1	2	3	4	1	2	3	4	1	2	3	4
0		0	0	0	5572	0	0	8	227	0	0	741	3146
1		396	260	1186	1791	2687	1075	1627	2151	249	95	183	632
2		1069	87	245	39	401	60	171	233	700	74	250	405
3		72	3	6	0	12	0	0	5	20	0	0	0
4+		3	0	0	0	1	0	0	0	0	0	0	0
SOP		37889	7657	45085	89993	33894	15435	38729	60847	22181	3559	21793	61762
Age	Year	1989				1990				1991			
	Quarter	1	2	3	4	1	2	3	4	1	2	3	4
0		0	0	159	4854	0	0	20	993	0	0	734	3486
1		1736	678	1672	1741	1840	1780	971	1181	1501	636	1519	1048
2		48	133	266	93	584	572	185	116	1336	404	215	187
3		6	6	5	13	20	19	6	4	93	19	22	18
4+		0	0	0	0	10	0	0	0	6	0	0	0
SOP		15379	13234	55066	82880	28287	39713	26156	45242	42776	20786	62518	64380
Age	Year	1992				1993				1994			
	Quarter	1	2	3	4	1	2	3	4	1	2	3	4
0		0	0	879	954	0	0	96	1175	0	0	647	4238
1		3556	1522	3457	2784	1942	813	1147	1050	1975	372	1029	1148
2		1086	293	389	267	699	473	912	445	591	285	421	134
3		118	20	1	2	15	58	19	2	56	29	71	0
4+		3	0	0	0	0	0	0	0	0	0	0	0
SOP		64224	27973	114122	96177	36206	29291	62290	53470	34575	15373	53799	79838
Age	Year	1995				1996				1997			
	Quarter	1	2	3	4	1	2	3	4	1	2	3	4
0		0	0	700	1692	0	0	724	2517	0	0	109	343
1		3992	1905	2545	3348	535	560	1043	650	672	99	3090	1922
2		240	256	47	59	772	201	1002	333	325	131	372	207
3		6	32	3	3	14	38	37	0	79	119	105	35
4+		0	0	0	0	0	0	0	0	0	0	0	0
SOP		36942	28019	69763	97048	21888	13366	74631	46194	15320	8708	78809	54100
Age	Year	1998				1999				2000			
	Quarter	1	2	3	4	1	2	3	4	1	2	3	4
0		0	0	94	339	0	0	41	1127	0	0	73	302
1		261	210	411	531	202	318	1298	576	653	280	1368	4616
2		690	310	332	215	128	220	338	160	185	207	266	245
3		47	18	2	13	73	93	35	23	3	48	20	6
4+		8	24	0	0	1	0	0	0	0	0	0	0
SOP		19562	12026	20866	22830	7833	12535	41445	30497	10207	11589	44173	119001
Age	Year	2001				2002				2003			
	Quarter	1	2	3	4	1	2	3	4	1	2	3	4
0		0	0	32	368	0	0	340	290	0	0	7	1
1		220	133	122	267	485	351	621	473	59	64	191	54
2		845	246	27	439	148	24	284	347	76	49	121	161
3		35	100	1	1	17	5	24	26	22	25	16	32
4+		0	0	0	0	0	0	0	0	0	0	0	1
SOP		21400	11778	4630	26565	8553	6686	32922	28947	3190	3106	10842	7549
Age	Year	2004				2005				2006			
	Quarter	1	2	3	4	1	2	3	4	1	2	3	4
0		0	0	14	57	*	*	*	*			10	368
1		13	4	51	100	*	*	*	*	30	56	130	1086
2		55	16	51	78	*	*	*	*	52	45	65	50
3		9	6	7	2	*	*	*	*	9	24	7	1
4+		0	0	0	0	*	*	*	*	0	0	0	0
SOP		2040	667	4018	6762	8	8	13	13	2205	2848	6551	34949
Age	Year	2007				2008				2009			
	Quarter	1	2	3	4	1	2	3	4	1	2	3	4
0		0	0	0	0	0	0	0	1179	0	0	58	12
1		20	41	32	10	5	54	166	438	50	36	621	169
2		43	26	16	6	10	41	115	31	1	47	613	27
3		0	0	2	1	0	0	0	0	0	5	9	1
4+		0	0	0	0	0	0	0	0	0	0	0	0
SOP		1428	1100	2430	838	361	1840	8532	24111	538	2105	36661	6509
Age	Year	2010											
	Quarter	1	2										
0		0	0										
1		0	671										
2		0	194										
3		0	33										
4+		0	0										
SOP		0	18594										

In 2007-08: Catch numbers from Norwegian fishery calculated from Norwegian total catch weight divided by mean weight at age from Danish Fishery.

In 2010: Catch in numbers from Danish fishery calculated from Danish total catch weight divided by mean weight at age from Norwegian fishery.

Table 5.2.4 NORWAY POUT in IV and IIIaN (Skagerrak). (September Update) Mean weights (grams) at age in catch, by quarter 1983-2010, from Danish and Norwegian catches combined. Data for 1974 to 1982 are assumed to be the same as in 1983. See footnote concerning data from 2005-2008. The mean weights at age weighted with catch number by area, quarter and country (DK, N).

Year	1983				1984				1985			
Quarter of year	1	2	3	4	1	2	3	4	1	2	3	4
Age 0			4.00	6.00			6.54	6.54			8.37	6.23
1	7.00	15.00	25.00	23.00	6.55	8.97	17.83	20.22	7.86	12.56	23.10	26.97
2	22.00	34.00	43.00	42.00	24.04	22.66	34.28	35.07	22.7	28.81	36.52	40.90
3	40.00	50.00	60.00	58.00	39.54	37.00	34.10	46.23	45.26	43.38	58.99	
4									41.80			
Year	1986				1987				1988			
Quarter of year	1	2	3	4	1	2	3	4	1	2	3	4
Age 0				7.20			5.80	7.40			9.42	7.91
1	6.69	14.49	28.81	26.90	8.13	12.59	20.16	23.36	9.23	11.61	26.54	30.60
2	29.74	42.92	43.39	44.00	28.26	31.51	34.53	37.32	27.31	33.26	39.82	43.31
3	44.08	55.39	47.60		52.93			46.60	38.38			
4	82.51				63.09				69.48			
Year	1989				1990				1991			
Quarter of year	1	2	3	4	1	2	3	4	1	2	3	4
Age 0			7.48	6.69			6.40	6.67			6.06	6.64
1	7.98	13.49	26.58	26.76	6.51	13.75	20.29	28.70	7.85	12.95	30.95	30.65
2	26.74	28.70	35.44	34.70	25.47	25.30	32.92	38.90	20.54	28.75	44.28	43.10
3	39.95	44.39		46.50	37.72	40.35	39.40	52.94	35.43	49.87	67.25	59.37
4					68.00				44.30			
Year	1992				1993				1994			
Quarter of year	1	2	3	4	1	2	3	4	1	2	3	4
Age 0		8.00	6.70	8.14			4.40	8.14			5.40	8.81
1	8.78	11.71	26.52	27.49	9.32	14.76	25.03	26.24	8.56	15.22	29.26	31.23
2	25.73	31.25	42.42	44.14	24.94	30.58	35.19	36.44	25.91	29.27	38.91	49.59
3	41.80	49.49	50.00	50.30	46.50	48.73	55.40	70.80	42.09	46.88	53.95	
4	43.90											
Year	1995				1996				1997			
Quarter of year	1	2	3	4	1	2	3	4	1	2	3	4
Age 0			5.01	7.19			3.88	5.95			3.61	10.18
1	7.70	10.99	25.37	24.6	8.95	12.06	27.81	28.09	7.01	11.69	20.14	22.11
2	24.69	22.95	33.40	39.57	21.47	25.72	40.90	38.81	23.11	26.40	31.13	32.69
3	50.78	37.69	45.56	57.00	37.58	37.94	50.44	56.00	39.11	34.47	44.03	38.62
4												
Year	1998				1999				2000			
Quarter of year	1	2	3	4	1	2	3	4	1	2	3	4
Age 0			4.82	8.32			2.84	7.56			7.21	13.86
1	8.76	12.55	23.82	24.33	8.98	12.40	22.16	25.60	10.05	15.65	23.76	22.98
2	22.16	25.27	31.73	30.93	25.84	24.15	32.66	37.74	19.21	25.14	38.90	34.48
3	34.84	32.18	44.92	33.24	36.66	35.24	43.98	51.63	32.10	41.30	39.61	50.04
4	42.40	40.00			46.57	46.57						
Year	2001				2002				2003			
Quarter of year	1	2	3	4	1	2	3	4	1	2	3	4
Age 0			6.34	7.90			7.28	7.20			9.12	9.79
1	8.34	16.79	27.00	30.01	8.59	16.40	27.13	27.47	11.58	13.13	28.33	15.98
2	21.50	23.57	39.54	35.51	25.98	30.39	43.37	36.87	22.85	26.19	38.01	31.87
3	39.84	37.63	54.20	55.70	32.30	40.10	54.11	41.28	34.96	39.89	46.24	45.79
4											70.00	70.00
Year	2004				2005				2006			
Quarter of year	1	2	3	4	1	2	3	4	1	2	3	4
Age 0			9.80	7.89			9.8	7.89			8.90	8.90
1	11.54	14.63	31.02	31.75	11.97	14.65	31.02	31.75	14.80	14.70	27.42	26.92
2	27.41	26.22	38.44	39.31	27.90	26.24	38.44	39.31	27.20	26.24	39.16	47.80
3	41.52	34.80	49.50	49.80	41.36	34.80	49.50	49.80	40.60	34.80	49.80	48.50
4												
Year	2007				2008				2009			
Quarter of year	1	2	3	4	1	2	3	4	1	2	3	4
Age 0			8.9	8.9				9.9			6.6	8.5
1	7.8	7.8	45.00	45.00	11.0	11.0	26.8	24.40	10.2	19.3	28.0	32.7
2	29.86	29.86	57.07	57.07	29.8	29.8	35.6	56.0	24.0	25.8	30.1	32.0
3	41.52	34.80	56.22	56.22	56.0	56.0				39.8	51.5	55.7
4												
Year	2010											
Quarter of year	1	2										
Age 0												
1		16.50										
2		30.50										
3		48.30										
4												

Mean weights at age from Danish and Norwegian landings from 2005-2008 uncertain because of few observations and use of values from 2004 and from adjacent quarters in the same year where observations have been missing. No mean weight at age data delivered by Norway in 2007-2008.

Table 5.3.1 Norway pout IV & IIIaN (Skagerak). (September Update) Baseline run with SXSA (seasonal extended survivor analysis) of Norway pout in the North Sea and Skagerrak: Parameters, settings and the options of the SXSA as well as the input data used in the SXSA.

SURVIVORS ANALYSIS OF: Norway pout stock in September 2010

Run: Baseline September 2010 (Summary from NP910_1)

The following parameters were used:

```
Year range:                                           1983     -
2010
Seasons per year:                                     4
The last season in the last year is season :          2
Youngest age:                                         0
Oldest age:                                           3
Plus age:                                             4
Recruitment in season:                                2
Spawning in season:                                   1
```

The following fleets were included:

```
Fleet  1:  commercial q134
Fleet  2:  ibtsq1
Fleet  3:  egfsq3
Fleet  4:  sgfsq3
Fleet  5:  ibtsq3
```

The following options were used:

```
1: Inv. catchability:                                 2
  (1: Linear; 2: Log; 3: Cos. filter)
2: Indiv. shats:                                      2
  (1: Direct; 2: Using z)
3: Comb. shats:                                       2
  (1: Linear; 2: Log.)
4: Fit catches:                                       0
  (0: No fit; 1: No SOP corr; 2: SOP corr.)
5: Est. unknown catches:                              0
  (0: No; 1: No SOP corr; 2: SOP corr; 3: Sep. F)
6: Weighting of rhats:                                0
  (0: Manual)
7: Weighting of shats:                                2
  (0: Manual; 1: Linear; 2: Log.)
8: Handling of the plus group:                        1
  (1: Dynamic; 2: Extra age group)
```

Data were input from the following files:

```
Catch in numbers:       canum.qrt
Weight in catch:        weca.qrt
Weight in stock:        west.qrt
Natural mortalities:    natmor.qrt
Maturity ogive:         matprop.qrt
Tuning data (CPUE):     tun2010.xsa
Weighting for rhats:    rweigh.xsa
```

Table 5.3.2 Norway pout IV & IIIaN (Skagerak). (September Update) Seasonal extended survivor analysis (SXSA) of Norway pout in the North Sea and Skagerrak. Stock numbers, SSB and TSB at start of season.

Year	1983				1984				1985			
Season	1	2	3	4	1	2	3	4	1	2	3	4
AGE												
0	*	220766.	147984.	98831.	*	119327.	79987.	53616.	*	85316.	57189.	38330.
1	108875.	69537.	45117.	25474.	64062.	40683.	25426.	12712.	34113.	21013.	13384.	7825.
2	13108.	7724.	4167.	1505.	13558.	7963.	4384.	1561.	5663.	2679.	1677.	476.
3	115.	65.	36.	10.	698.	350.	15.	3.	445.	142.	84.	40.
4+	6.	3.	0.	0.	1.	0.	0.	0.	2.	1.	1.	0.
SSN	24117.				20663.				9522.			
SSB	369537.				371068.				166405.			
TSN	122105.	298095.	197303.	125819.	78318.	168323.	109813.	67893.	40224.	109151.	72335.	46671.
TSB	1055452.	1309061.	1901170.	1242650.	774656.	898516.	1145023.	679848.	381319.	413422.	640521.	432269.

Year	1986				1987				1988			
Season	1	2	3	4	1	2	3	4	1	2	3	4
AGE												
0	*	158471.	106226.	71205.	*	46268.	31015.	20783.	*	127671.	85581.	56760.
1	25138.	16526.	10865.	6312.	43169.	26737.	17042.	10092.	13746.	9011.	5962.	3847.
2	2797.	999.	599.	201.	2765.	1525.	973.	512.	5004.	2781.	1804.	1004.
3	176.	59.	37.	20.	103.	59.	39.	26.	153.	86.	58.	39.
4+	27.	16.	11.	7.	18.	11.	8.	5.	17.	11.	8.	5.
SSN	5514.				7203.				6548.			
SSB	87696.				96169.				126761.			
TSN	28138.	176070.	117737.	77745.	46055.	74600.	49076.	31419.	18919.	139560.	93412.	61655.
TSB	246065.	285689.	724483.	581987.	368132.	456474.	594303.	379850.	213359.	234646.	572394.	473458.

Year	1989				1990				1991			
Season	1	2	3	4	1	2	3	4	1	2	3	4
AGE												
0	*	135955.	91134.	60959.	*	127772.	85648.	57395.	*	242907.	162826.	108544.
1	35472.	22356.	14430.	8304.	36888.	23220.	14108.	8662.	37660.	24015.	15578.	9198.
2	2061.	1342.	791.	312.	4141.	2298.	1072.	567.	4839.	2150.	1111.	568.
3	342.	224.	145.	94.	133.	73.	33.	17.	285.	115.	62.	23.
4+	29.	20.	13.	9.	58.	31.	21.	14.	18.	7.	5.	3.
SSN	5979.				8021.				8908.			
SSB	85482.				125501.				145218.			
TSN	37904.	159897.	106513.	69677.	41221.	153393.	100881.	66655.	42802.	269195.	179580.	118337.
TSB	308954.	393282.	768017.	575281.	357896.	431793.	743375.	568416.	382476.	439480.	1092203.	888017.

Year	1992				1993				1994			
Season	1	2	3	4	1	2	3	4	1	2	3	4
AGE												
0	*	103683.	69501.	45868.	*	72664.	48708.	32571.	*	308458.	206765.	138069.
1	69906.	43947.	28212.	16081.	29965.	18496.	11732.	6926.	20871.	12374.	7989.	4513.
2	5308.	2668.	1549.	720.	8500.	5126.	3049.	1297.	3782.	2052.	1142.	421.
3	228.	56.	21.	14.	264.	165.	63.	27.	505.	293.	172.	57.
4+	3.	0.	0.	0.	7.	5.	3.	2.	18.	12.	8.	5.
SSN	12529.				11768.				6392.			
SSB	174976.				218952.				119020.			
TSN	75444.	150355.	99283.	62682.	38737.	96456.	63556.	40822.	25176.	323187.	216077.	143066.
TSB	615381.	752762.	1051201.	676085.	407732.	460238.	623025.	410722.	250508.	270657.	1086238.	953227.

Year	1995				1996				1997			
Season	1	2	3	4	1	2	3	4	1	2	3	4
AGE												
0	*	97361.	65263.	43174.	*	236575.	158581.	105707.	*	67236.	45069.	30122.
1	89081.	56444.	36276.	22233.	27555.	18033.	11629.	6941.	68796.	45565.	30462.	17890.
2	2085.	1201.	595.	361.	12162.	7520.	4876.	2449.	4120.	2495.	1566.	745.
3	172.	111.	48.	30.	193.	118.	48.	2.	1369.	853.	474.	232.
4+	42.	28.	19.	13.	26.	18.	12.	8.	7.	4.	3.	2.
SSN	11208.				15137.				12375.			
SSB	117487.				296052.				193920.			
TSN	91380.	155146.	102202.	65810.	39937.	262263.	175146.	115107.	74292.	116154.	77575.	48991.
TSB	678694.	894643.	1196457.	787301.	469649.	533073.	1137626.	896869.	627338.	811213.	1037614.	636952.

Table 5.3.2 (Cont´d.). Norway pout IV & IIIaN (Skagerak). (September Update)

Year	1998				1999				2000			
Season	1	2	3	4	1	2	3	4	1	2	3	4
AGE												
0	*	93869.	62922.	42101.	*	230678.	154628.	103617.	*	79857.	53530.	35822.
1	19911.	13133.	8631.	5449.	27944.	18566.	12185.	7105.	68534.	45405.	30207.	19128.
2	10418.	6419.	4049.	2442.	3218.	2052.	1196.	525.	4290.	2725.	1657.	893.
3	330.	182.	107.	71.	1461.	919.	540.	334.	221.	146.	58.	22.
4+	129.	80.	33.	22.	52.	34.	23.	15.	215.	144.	97.	65.
SSN	12868.				7524.				11580.			
SSB	263525.				151667.				163242.			
TSN	30787.	113682.	75743.	50085.	32674.	252249.	168571.	111595.	73260.	128277.	85548.	55930.
TSB	388964.	428803.	648007.	484590.	327714.	396131.	1006945.	826503.	595005.	789069.	1044006.	693675.

Year	2001				2002				2003			
Season	1	2	3	4	1	2	3	4	1	2	3	4
AGE												
0	*	70635.	47348.	31712.	*	48776.	32696.	21639.	*	21770.	14593.	9776.
1	23766.	15751.	10449.	6905.	20956.	13650.	8863.	5432.	14267.	9516.	6326.	4083.
2	9042.	5369.	3398.	2255.	4410.	2835.	1880.	1028.	3254.	2119.	1380.	826.
3	398.	238.	78.	51.	1152.	759.	505.	319.	405.	254.	150.	88.
4+	54.	36.	24.	16.	44.	30.	20.	13.	201.	135.	90.	60.
SSN	11870.				7702.				5287.			
SSB	234489.				160263.				109050.			
TSN	33260.	92029.	61297.	40940.	26562.	66050.	43963.	28431.	18128.	33793.	22540.	14834.
TSB	384212.	432735.	601412.	446781.	292286.	340735.	463477.	316438.	198934.	235008.	284865.	192358.

Year	2004				2005				2006			
Season	1	2	3	4	1	2	3	4	1	2	3	4
AGE												
0	*	28258.	18942.	12686.	*	110692.	74199.	49737.	*	53853.	36099.	24190.
1	6552.	4381.	2934.	1925.	8457.	5669.	3800.	2547.	33340.	22324.	14918.	9894.
2	2693.	1760.	1167.	740.	1209.	810.	543.	364.	1707.	1102.	701.	417.
3	422.	276.	180.	115.	432.	290.	194.	130.	244.	157.	85.	51.
4+	72.	48.	32.	22.	90.	61.	41.	27.	105.	71.	47.	32.
SSN	3842.				2577.				5390.			
SSB	84747.				54867.				76549.			
TSN	9740.	34723.	23255.	15488.	10188.	117521.	78777.	52805.	35396.	77506.	51851.	34583.
TSB	126028.	142040.	210093.	158157.	108144.	130455.	426789.	379831.	286589.	384094.	552627.	393178.

Year	2007				2008				2009			
Season	1	2	3	4	1	2	3	4	1	2	3	4
AGE												
0	*	96973.	65003.	43573.	*	141457.	94822.	63561.	*	227149.	152263.	102017.
1	15914.	10651.	7106.	4737.	29208.	19574.	13077.	8630.	41641.	27872.	18654.	11996.
2	5743.	3815.	2536.	1687.	3167.	2114.	1384.	833.	5426.	3636.	2399.	1106.
3	238.	159.	107.	70.	1126.	755.	506.	339.	533.	357.	235.	150.
4+	55.	37.	25.	17.	58.	39.	26.	17.	239.	160.	107.	72.
SSN	7627.				7271.				10362.			
SSB	150093.				138389.				183223.			
TSN	21950.	111635.	74776.	50083.	33558.	163939.	109814.	73381.	47839.	259175.	173658.	115342.
TSB	250351.	299514.	553110.	445319.	322397.	405411.	796045.	634518.	445561.	568544.	1192676.	943198.

Year	2010	
Season	1	2
AGE		
0	*	21590.
1	68375.	45833.
2	7902.	5297.
3	720.	483.
4+	149.	100.
SSN	15608.	
SSB	258836.	
TSN	77146.	73302.
TSB	689597.	897306.

Table 5.3.3 Norway pout IV & IIIaN (Skagerak). (September Update) Seasonal extended survivor analysis (SXSA) of Norway pout in the North Sea and Skagerrak. Fishing mortalities by quarter of year.

Year	1983				1984				1985			
Season	1	2	3	4	1	2	3	4	1	2	3	4
AGE												
0	*	0.000	0.004	0.033	*	0.000	0.000	0.052	*	0.000	0.000	0.022
1	0.048	0.032	0.169	0.226	0.054	0.069	0.285	0.393	0.084	0.051	0.135	0.587
2	0.127	0.213	0.578	0.355	0.130	0.193	0.590	0.770	0.337	0.068	0.774	0.557
3	0.169	0.195	0.785	1.537	0.281	1.609	0.939	0.000	0.685	0.120	0.321	0.000
4+	0.000	1.807	*	*	0.000	0.000	0.000	0.000	0.438	0.000	0.000	0.000
F (1- 2)	0.087	0.122	0.374	0.290	0.092	0.131	0.438	0.581	0.210	0.059	0.455	0.572

Year	1986				1987				1988			
Season	1	2	3	4	1	2	3	4	1	2	3	4
AGE												
0	*	0.000	0.000	0.099	*	0.000	0.000	0.013	*	0.000	0.011	0.069
1	0.019	0.019	0.141	0.408	0.078	0.050	0.122	0.293	0.022	0.013	0.038	0.219
2	0.588	0.111	0.641	0.263	0.191	0.049	0.235	0.735	0.184	0.033	0.182	0.629
3	0.643	0.061	0.216	0.000	0.153	0.000	0.010	0.259	0.172	0.000	0.000	0.000
4+	0.142	0.000	0.000	0.000	0.070	0.000	0.000	0.000	0.000	0.000	0.000	0.000
F (1- 2)	0.303	0.065	0.391	0.336	0.135	0.049	0.179	0.514	0.103	0.023	0.110	0.424

Year	1989				1990				1991			
Season	1	2	3	4	1	2	3	4	1	2	3	4
AGE												
0	*	0.000	0.002	0.101	*	0.000	0.000	0.021	*	0.000	0.005	0.040
1	0.061	0.037	0.150	0.287	0.062	0.097	0.087	0.179	0.049	0.033	0.125	0.147
2	0.029	0.127	0.502	0.432	0.185	0.350	0.231	0.280	0.395	0.254	0.263	0.487
3	0.022	0.033	0.039	0.182	0.199	0.370	0.243	0.320	0.482	0.220	0.552	1.661
4+	0.000	0.000	0.000	0.000	0.231	0.000	0.000	0.000	0.508	0.000	0.000	0.000
F (1- 2)	0.045	0.082	0.326	0.360	0.124	0.224	0.159	0.229	0.222	0.143	0.194	0.317

Year	1992				1993				1994			
Season	1	2	3	4	1	2	3	4	1	2	3	4
AGE												
0	*	0.000	0.015	0.026	*	0.000	0.002	0.045	*	0.000	0.004	0.038
1	0.064	0.043	0.159	0.232	0.082	0.055	0.125	0.201	0.121	0.037	0.168	0.359
2	0.280	0.142	0.354	0.566	0.104	0.118	0.435	0.513	0.207	0.183	0.561	0.468
3	0.875	0.534	0.058	0.194	0.070	0.529	0.439	0.095	0.143	0.127	0.645	0.000
4+	*	*	*	*	0.028	0.000	0.000	0.000	0.000	0.000	0.000	0.000
F (1- 2)	0.172	0.092	0.257	0.399	0.093	0.086	0.280	0.357	0.164	0.110	0.364	0.414

Year	1995				1996				1997			
Season	1	2	3	4	1	2	3	4	1	2	3	4
AGE												
0	*	0.000	0.013	0.049	*	0.000	0.006	0.029	*	0.000	0.003	0.014
1	0.056	0.042	0.089	0.199	0.024	0.038	0.114	0.120	0.012	0.003	0.130	0.139
2	0.149	0.293	0.099	0.219	0.080	0.033	0.281	0.178	0.100	0.065	0.331	0.399
3	0.040	0.412	0.078	0.128	0.091	0.472	1.573	0.160	0.072	0.183	0.306	0.197
4+	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
F (1- 2)	0.102	0.168	0.094	0.209	0.052	0.036	0.198	0.149	0.056	0.034	0.231	0.269

Table 5.3.3 (Cont´d.). Norway pout IV & IIIaN (Skagerak). (September Update)

Year	1998				1999				2000			
Season	1	2	3	4	1	2	3	4	1	2	3	4
AGE												
0	*	0.000	0.002	0.010	*	0.000	0.000	0.013	*	0.000	0.002	0.010
1	0.016	0.020	0.059	0.125	0.009	0.021	0.137	0.103	0.012	0.008	0.056	0.338
2	0.083	0.060	0.104	0.112	0.049	0.138	0.406	0.444	0.054	0.096	0.213	0.392
3	0.188	0.128	0.018	0.254	0.062	0.130	0.080	0.087	0.015	0.492	0.526	0.377
4+	0.078	0.445	0.000	0.000	0.013	0.006	0.000	0.000	0.000	0.000	0.000	0.000
F (1- 2)	0.050	0.040	0.082	0.119	0.029	0.080	0.272	0.273	0.033	0.052	0.135	0.365

Year	2001				2002				2003			
Season	1	2	3	4	1	2	3	4	1	2	3	4
AGE												
0	*	0.000	0.001	0.014	*	0.000	0.013	0.016	*	0.000	0.001	0.000
1	0.011	0.010	0.014	0.048	0.028	0.032	0.088	0.111	0.005	0.008	0.037	0.016
2	0.120	0.057	0.010	0.265	0.041	0.010	0.200	0.502	0.029	0.028	0.112	0.265
3	0.113	0.661	0.017	0.021	0.018	0.008	0.058	0.105	0.067	0.125	0.136	0.553
4+	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.005	0.026
F (1- 2)	0.065	0.034	0.012	0.156	0.035	0.021	0.144	0.307	0.017	0.018	0.075	0.140

Year	2004				2005				2006			
Season	1	2	3	4	1	2	3	4	1	2	3	4
AGE												
0	*	0.000	0.001	0.005	*	0.000	0.000	0.000	*	0.000	0.000	0.019
1	0.002	0.001	0.021	0.065	0.000	0.000	0.000	0.000	0.001	0.003	0.011	0.142
2	0.025	0.011	0.054	0.135	0.000	0.000	0.000	0.000	0.038	0.051	0.119	0.157
3	0.026	0.025	0.047	0.018	0.000	0.000	0.001	0.001	0.043	0.202	0.106	0.017
4+	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
F (1- 2)	0.014	0.006	0.038	0.100	0.000	0.000	0.000	0.000	0.019	0.027	0.065	0.150

Year	2007				2008				2009			
Season	1	2	3	4	1	2	3	4	1	2	3	4
AGE												
0	*	0.000	0.000	0.000	*	0.000	0.000	0.023	*	0.000	0.000	0.000
1	0.002	0.005	0.006	0.003	0.000	0.003	0.015	0.063	0.001	0.002	0.041	0.017
2	0.009	0.008	0.007	0.004	0.004	0.024	0.106	0.046	0.000	0.016	0.361	0.030
3	0.001	0.001	0.018	0.010	0.000	0.001	0.000	0.000	0.000	0.018	0.047	0.003
4+	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
F (1- 2)	0.005	0.006	0.006	0.003	0.002	0.014	0.061	0.055	0.001	0.009	0.201	0.023

Year	2010	
Season	1	2
AGE		
0	*	0.000
1	0.000	0.018
2	0.000	0.045
3	0.000	0.086
4+	0.000	0.000
F (1- 2)	0.000	0.032

Table 5.3.4 Norway pout IV & IIIaN (Skagerak). (September Update) SXSA (Seasonal extended survivor analysis) of Norway pout in the North Sea and Skagerrak. Diagnostics of the SXSA.

Log inverse catchabilities, fleet no: 1 (commercial q134)

Year 1983-2010 (all quarters of year); (The same for all years; estimated and held constant by year as option in SXSA)

Season	1	2	3	4
AGE				
0	*	*	*	11.538
1	10.720	*	9.873	9.179
2	9.251	*	8.757	8.428
3	9.251	*	8.757	8.428

Log inverse catchabilities, fleet no: 2 (ibtsq1)

Year 1983-2010 (all quarters of year); (The same for all years; estimated and held constant by year as option in SXSA)

Season	1	2	3	4
AGE				
0	*	*	*	*
1	2.469	*	*	*
2	1.490	*	*	*
3	1.490	*	*	*

Log inverse catchabilities, fleet no: 3 (egfsq3)

Year 1992-2010 (all quarters of year); (The same for all years; estimated and held constant by year as option in SXSA)

Season	1	2	3	4
AGE				
0	*	3.301	*	*
1	*	2.078	*	*
2	*	*	*	*
3	*	*	*	*

Log inverse catchabilities, fleet no: 4 (sgfsq3)

Year 1998-2010 (all quarters of year); (The same for all years; estimated and held constant by year as option in SXSA)

Season	1	2	3	4
AGE				
0	*	3.308	*	*
1	*	2.297	*	*
2	*	*	*	*
3	*	*	*	*

Log inverse catchabilities, fleet no: 5 (ibtsq3)

Year 1991-2009 (all quarters of year); (The same for all years; estimated and held constant by year as option in SXSA)

Season	1	2	3	4
AGE				
0	*	*	*	*
1	*	*	*	*
2	*	*	1.511	*
3	*	*	1.511	*

Table 5.3.4 (Cont´d.). Norway pout IV & IIIaN (Skagerak). (September Update)

Weighting factors for computing survivors:
Fleet no: 1 (commercial q134)

Year 1983-2010 (all quarters of year); (The same for all years; esti-mated and held constant by year as option in SXSA)

Season	1	2	3	4
AGE				
0	*	*	*	1.071
1	1.339	*	3.178	2.071
2	2.156	*	1.696	1.243
3	1.256	*	0.831	0.765

Weighting factors for computing survivors:
Fleet no: 2 (ibtsq1)

Year 1983-2010 (all quarters of year); (The same for all years; esti-mated and held constant by year as option in SXSA)

Season	1	2	3	4
AGE				
0	*	*	*	*
1	1.682	*	*	*
2	1.811	*	*	*
3	1.061	*	*	*

Weighting factors for computing survivors:
Fleet no: 3 (egfsq3)

Year 1992-2010 (all quarters of year); (The same for all years; esti-mated and held constant by year as option in SXSA)

Season	1	2	3	4
AGE				
0	*	1.305	*	*
1	*	2.288	*	*
2	*	*	*	*
3	*	*	*	*

Weighting factors for computing survivors:
Fleet no: 4 (sgfsq3)

Year 1998-2010 (all quarters of year); (The same for all years; esti-mated and held constant by year as option in SXSA)

Season	1	2	3	4
AGE				
0	*	1.675	*	*
1	*	2.586	*	*
2	*	*	*	*
3	*	*	*	*

Weighting factors for computing survivors:
Fleet no: 5 (ibtsq3)

Year 1991-2009 (all quarters of year); (The same for all years; esti-mated and held constant by year as option in SXSA)

Season	1	2	3	4
AGE				
0	*	*	*	*
1	*	*	*	*
2	*	*	1.448	*
3	*	*	0.846	*

Table 5.3.5 Norway pout IV & IIIaN (Skagerak). (September Update) Stock summary table. (SXSA Baseline September 2010). (Recruits in millions. SSB and TSB in t, and Yield in '000 t).

Year	Recruits (age 0 2nd qrt)	SSB (Q1)	TSB (Q3)	Landings ('000 t)	Fbar(1-2)
1983	220766	369537	1901170	457.6	0.873
1984	119327	371068	1145023	393.0	1.242
1985	85316	166405	640521	205.1	1.296
1986	158471	87696	724483	174.3	1.095
1987	46268	96169	594303	149.3	0.877
1988	127671	126761	572394	109.3	0.660
1989	135955	85482	768017	166.4	0.813
1990	127772	125501	743375	163.3	0.736
1991	242907	145218	1092203	186.6	0.876
1992	103683	174976	1051201	296.8	0.920
1993	72664	218952	623025	183.1	0.816
1994	308458	119020	1086238	182.0	1.052
1995	97361	117487	1196457	236.8	0.573
1996	236575	296052	1137626	163.8	0.435
1997	67236	193920	1037614	169.7	0.590
1998	93869	263525	648007	57.7	0.291
1999	230678	151667	1006945	94.5	0.654
2000	79857	163242	1044006	184.4	0.585
2001	70635	234489	601412	65.6	0.267
2002	48776	160263	463477	80.0	0.507
2003	21770	109050	284865	27.1	0.250
2004	28258	84747	210093	13.5	0.158
2005	110692	54867	426789	1.9	0.000
2006	53853	76549	552627	46.6	0.261
2007	96973	150093	553110	5.7	0.020
2008	141457	138389	796045	36.1	0.132
2009	227149	183223	1192676	54.5	0.234
2010	21590	258836			
Arit mean	**120,571**	**168,685**	**818,285**		**0.600**
Geomean	**97,336**				

Table 5.6.1 NORWAY POUT IV and IIIaN (Skagerrak). Input data to forecast (September 2010).

Basis: HCR with 2010 quarter 1-2 observed fishing mortality (F) for assessment year, and for 2010 quarter 3-4 assessment year a fishing pattern scaled to the average 2008-2009 seasonal exploitation pattern (standardized with the 2008 and 2009 Fbar to F(1,2)=1) multiplied with a factor 0.453 in order to fit catch in 2010 to the agreed TAC=162 kt. In the 2011 forecast year quarter 1-4 the fishing pattern has been scaled to the average 2008-2009 seasonal exploitation pattern. Recruitment in forecast year is assumed to the 25% percentile = 69785 millions (of the long term geometric mean 97336 millions) in the 2nd quarter of the year.

Year	Season	Age	N	F	WEST	WECA	M	PROPMAT
2010	1	0	0	0.000	0.000	0.000	0.4	0
2010	1	1	68375	0.000	0.007	0.012	0.4	0.1
2010	1	2	7902	0	0.022	0.026	0.4	1
2010	1	3	720	0.000	0.040	0.039	0.4	1
2010	2	0	21590	0.000	0.000	0.000	0.4	0
2010	2	1	0	0.018	0.017	0.015	0.4	0
2010	2	2	0	0.045	0.031	0.026	0.4	0
2010	2	3	0	0.086	0.048	0.037	0.4	0
2010	3	0	0	0.001	0.004	0.009	0.4	0
2010	3	1	0	0.065	0.025	0.029	0.4	0
2010	3	2	0	0.531	0.043	0.036	0.4	0
2010	3	3	0	0.045	0.060	0.049	0.4	0
2010	4	0	0	0.039	0.006	0.009	0.4	0
2010	4	1	0	0.125	0.023	0.027	0.4	0
2010	4	2	0	0.108	0.042	0.038	0.4	0
2010	4	3	0	0.003	0.058	0.050	0.4	0

Year	Season	Age	N	F	WEST	WECA	M	PROPMAT
2011	1	0	0	0.000	0.000	0.000	0.4	0
2011	1	1	0	0.002	0.007	0.012	0.4	0.1
2011	1	2	0	0.015	0.022	0.026	0.4	1
2011	1	3	0	0.000	0.040	0.039	0.4	1
2011	2	0	69785	0.000	0.000	0.000	0.4	0
2011	2	1	0	0.016	0.015	0.015	0.4	0
2011	2	2	0	0.125	0.034	0.026	0.4	0
2011	2	3	0	0.042	0.050	0.037	0.4	0
2011	3	0	0	0.002	0.004	0.009	0.4	0
2011	3	1	0	0.144	0.025	0.029	0.4	0
2011	3	2	0	1.173	0.043	0.036	0.4	0
2011	3	3	0	0.100	0.060	0.049	0.4	0
2011	4	0	0	0.087	0.006	0.009	0.4	0
2011	4	1	0	0.275	0.023	0.027	0.4	0
2011	4	2	0	0.238	0.042	0.038	0.4	0
2011	4	3	0	0.006	0.058	0.050	0.4	0

Table 5.6.2 NORWAY POUT in IV & IIIaN (Skagerrak), September 2010.

Results of the short term forecast for Norway pout September 2010. Basis: HCR with 2010 quarter 1-2 observed fishing mortality (F) for assessment year, and for 2010 quarter 3-4 assessment year a fishing pattern scaled to the average 2008-2009 seasonal exploitation pattern (standardized with the 2008 and 2009 Fbar to F(1,2)=1) multiplied with a factor 0.453 in order to fit catch in 2010 to the agreed TAC=162 kt. In the 2011 forecast year quarter 1-4 the fishing pattern has been scaled to the average 2008-2009 seasonal exploitation pattern. Recruitment in forecast year is assumed to the 25% percentile = 69785 millions (of the long term geometric mean 97336 millions) in the 2nd quarter of the year.

Basis: F (2010) = TAC Constraint (162 kt) Fsq=0.446; R(2011) = 25 % percentile of long term recruitment (1983-2009) = ~ 70 billion; SSB (2011) = 288 kt;

Rationale	Landings 2011	Basis	F 2011	SSB 2012	%SSB change[1)]
MSY approach	0	MSY $B_{escapement}$	0	141	- 204
Precautionary approach	0	B_{pa}	0	141	- 204
Zero Catch	0	No fishery	0	141	- 204
Status quo					
	50	Fixed TAC Strat.	0.21	112	-257
	77	Fixed F Strat.	0.35	98	- 293
	93	B_{lim}	0.44	90	- 320

Weights in '000 tonnes.

1) SSB 2012 relative to SSB 2011.

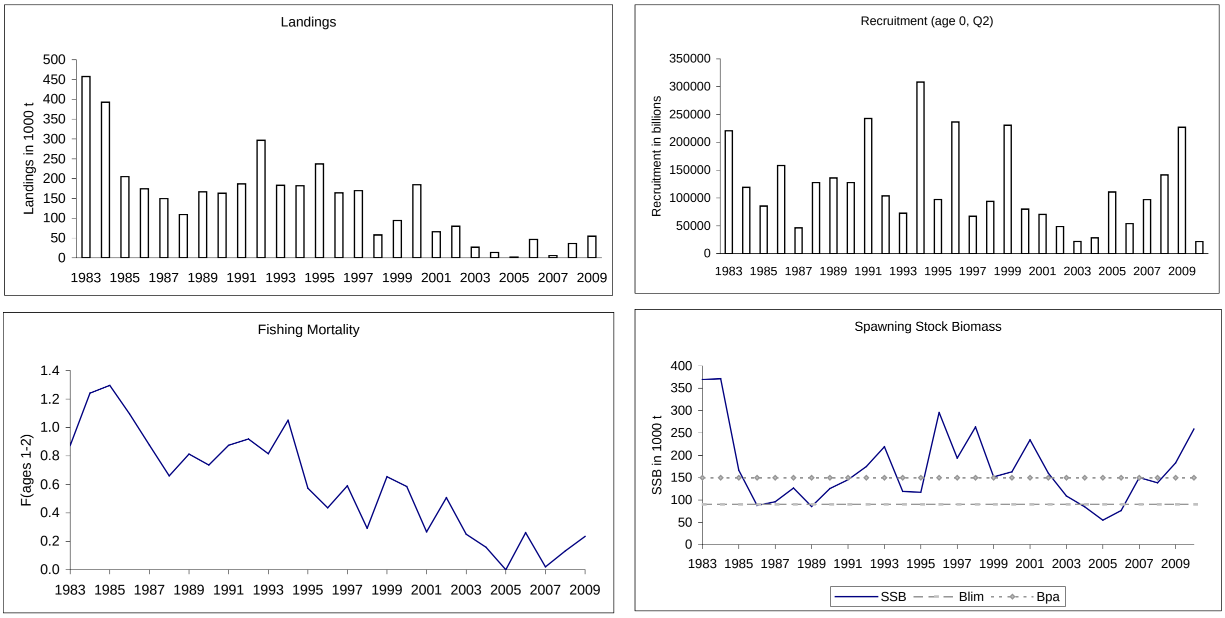


Figure 5.3.1 Norway Pout IV and IIIaN (Skagerak). Stock Summary Plots. SXSA baseline run September 2010.

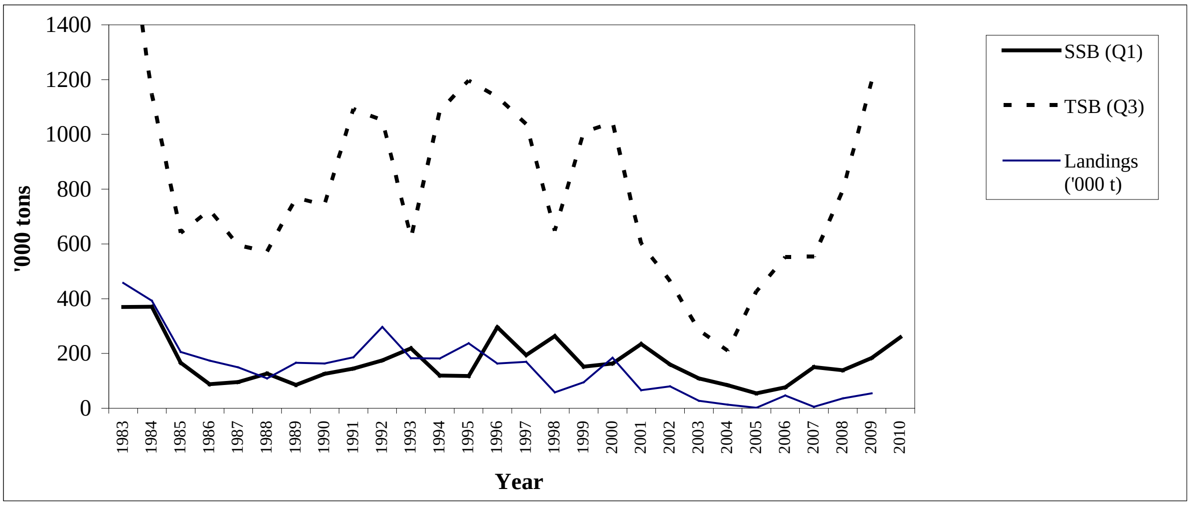


Figure 5.3.2 Norway pout in IV and IIIaN (Skagerak). (September Update) Trends in yield, SSB and TSB for Norway pout in the North Sea and Skagerrak during the period 1983-2010.

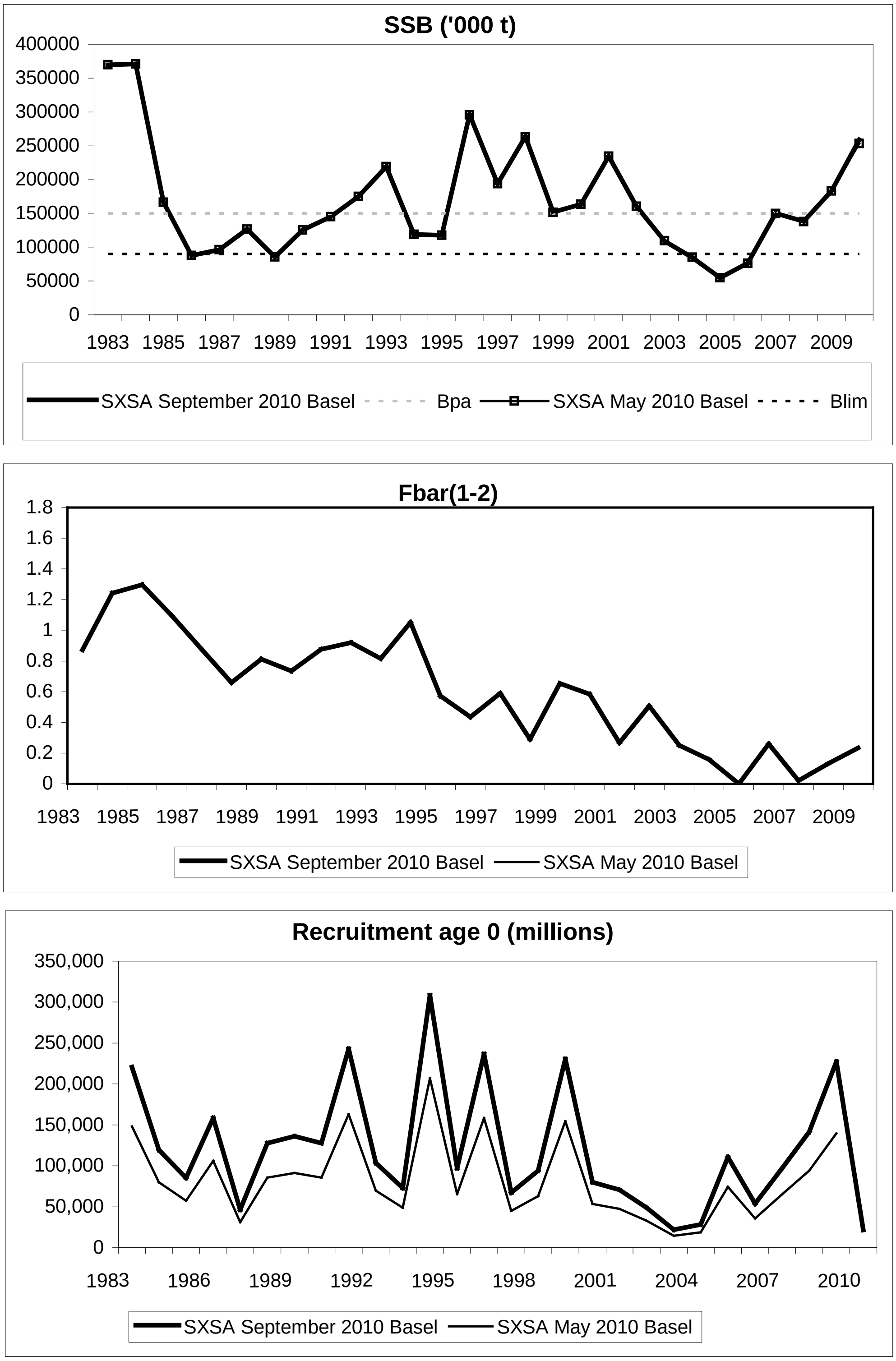


Figure 5.3.3 Norway pout IV and IIIaN (Skagerak). (September Update) Comparison of September 2010 SXSA baseline assessment with SXSA May 2010 baseline assessment. (OBS: In September 2010 recruitment were calculated for 2nd quarter of the year and in May 2010 for 3rd quarter)

6 Plaice in Division VIId

This assessment of plaice in Division VIId was made following methodological information described in the Stock Annex revised during ICES WKFLAT 2010.

6.1 General

6.1.1 Ecosystem aspects

No new information on ecosystem aspects was presented at the working group in 2010.

All available information on ecological aspects can be found in the Stock Annex.

6.1.2 Fisheries

Plaice is mainly caught in beam trawl 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, where the main fleet segments are the English and Belgian beam trawlers. The Belgian beam trawlers fish mainly in the 1st (targeting spawning concentrations in the central Eastern Channel) and 4th quarter and their area of activity covers almost the whole of VIId south of the 6 miles contour off the English coast. There is only light activity by this fleet between April and September. The second offshore fleet consists mainly of French large otter trawlers from Boulogne, Dieppe. The target species of these vessels are cod, whiting, plaice, mackerel, gurnards and cuttlefish and the fleet operates throughout VIId. The inshore trawlers and netters are mainly vessels <10 m 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 latter two groups are active when plaice is spread over the whole area and IVc.

Due to the minimum mesh size (80 mm) in the mixed beam trawl fishery, a large number of undersized plaice are discarded. The 80-mm mesh size is not matched to the minimum landing size of plaice (27 cm). Management measures directed at sole fisheries will also impact the plaice fisheries.

The first quarter is usually the most important for the fisheries but the share of the landings for this quarter has been decreasing from the early 1990s to a value around 30 – 38% of the total recently. In 2009, the beginning of the year remains predominant with the first semester corresponding to 55% of the total landings (see text table below).

Quarter	Landings	Cum. Landings	Cum. %
I	848	848	29
II	728	1575	55
III	590	2165	75
IV	719	2884	100

However, following the ICES WKFLAT 2010 conclusions, 65% of the first quarter catches were removed. These 65% were estimated during ICES WKFLAT 2010, based on published tagging results and some previous studies (e.g. Burt et al. 2006, Hunter et al. 2004, Kell et al. 2004) showing that 50% of the fish caught during the first quarter are fish coming from area IV to spawn. The same study also shown that 15% of the fish caught during the first quarter were fishes from area VIIe. Table 6.1.2.1 shows the Quarter1 landings and the corresponding removals. Removing this part of the catches allows for assessing the stock resident biomass. All the following figures will take into account this Quarter1 removal.

Age distributions (exploitation pattern) may be quite different between quarters, as shown for 2009 in Figure 6.1.2.1, with recruit at age 1 starting to be caught after summer. This is in line with what is known of the biology of this species, which operates spawning migration (from VIId, VIIe and IV) in the centre of the Eastern channel during winter.

Belgium beam trawlers are increasingly being equipped with 3D mapping sonar which opens up new areas to fishing (close to wrecks) and very few French vessels have shifted from otter trawl to Danish seine recently (WGFTFB, 2007). These changes are not likely to have modified the fisheries behaviour or affected the data entering into the assessment model.

6.1.3 ICES advice

2008 advice: The new landings, cpue, and survey data available for this stock do not change the perception of the stock and do not give reason to change the advice from 2007. The advice for the fishery in 2009 is therefore the same as the advice given in 2007 for the 2008 fishery: "In the absence of short-term forecasts, ICES recommends that landings do not increase above the average of landings from the last three years (2004–2006), corresponding to 3500 t."

2009 advice: In the absence of a short-term forecast, ICES advises on the basis of exploitation boundaries in relation to precautionary considerations that landings in 2010 should not increase above the average of landings from the last three years (2006–2008), corresponding to landings less than 3 500 t.

6.1.4 Management

There are no explicit management objectives for this stock.

The TACs have been set to 5050t for 2007-2008, 4646t for 2009 and 4274t for 2010 for the combined ICES Divisions VIId & VIIe.

The minimum landing size for plaice is 27 cm, which is not in accordance with the minimum mesh size of 80 mm, permitted for catching plaice by beam and otter trawling. Fixed nets are required to use 100-mm mesh since 2002 although an exemption to permit 90 mm has been in force since that time.

For 2009, Council Regulation (EC) N°43/2009 allocates different amounts of Kw*days by Member State and area to different groups of vessels depending on gear and mesh size (see section 2 for complete list). The areas are Kattegat, part of IIIa not covered by Skaggerak and Kattegat, ICES zone IV, EC waters of ICES zone IIa, ICES zone VIId, ICES zone VIIa, ICES zone VIa and EC waters of ICES zone Vb. The grouping of fishing gear concerned are: Bottom trawls, Danish seines and similar gear, excluding beam trawls of mesh size: TR1 (≤100mm) – TR2 (≤70 and ≤100mm) – TR3 (≤16 and ≤32mm); Beam trawl of mesh size: BT1 (≤120mm) – BT2 (≤80 and ≤120mm); Gill nets excluding trammel nets: GN1; Trammel nets: GT1 and Longlines: LL1.

For 2010 Council Regulation (EC) N°53/2010 has updated Council Regulation (EC) N°43/2009 with new allocations, based on the same effort groups of vessels and areas as stipulated in Council Regulation (EC) N°43/2009. (see section 2 for complete list).

Demersal fisheries in the area are mixed fisheries, with many stocks exploited together in various combinations in the various fisheries. In these cases, management advice must consider both the state of individual stocks and their simultaneous exploitation in demersal fisheries. Stocks in the poorest condition, particularly those which suffer from reduced reproductive capacity, become the overriding concern for the management of mixed fisheries, where these stocks are exploited either as a targeted species or as a bycatch.

Fisheries in Division IIIa (Skagerrak–Kattegat), in Subarea IV (North Sea), and in Division VIId (Eastern Channel) should in 2010 be managed according to the following rules, which should be applied simultaneously:

Demersal fisheries

- should minimize bycatch or discards of cod;
- should implement TACs or other restrictions that will curtail fishing mortality for those stocks mentioned above for which reduction in fishing pressure is advised;
- should be exploited within the precautionary exploitation limits or where appropriate on the basis of management plan results for all other stocks (see text table above);
- where stocks extend beyond this area, e.g. into Division VI (saithe and anglerfish) or are widely migratory (Northern hake), should take into account the exploitation of the stocks in these areas so that the overall exploitation remains within precautionary limits;
- should have no landings of angel shark and minimum bycatch of spurdog, porbeagle, and common skate and undulate ray.

6.2 Data available

6.2.1 Catch

Landings data as reported to ICES together with the total landings estimated by the Working Group are shown in Table 6.2.1.1. From 1992 to 2002, the landings have remained steady between 5100 t and 6300 t. The 2009 landings of 2883t (2332t attributed to the resident stock and 551t removed from the first quarter as estimated to be resulting from catches coming from VIIe and IV to spawn) are close to the lowest observed over the time series. As usual, France contributed the largest share (45%) of the total VIId landings in 2009 followed by Belgium (34%) and UK (21%) which is nearly unchanged since 2007.

Routine discard monitoring has recently begun following the introduction of the EU data collection regulations. Discards data for 2008 are available from France and UK (Tables 6.2.1.2 and Figure 6.2.1.1a-c) although sampling levels are not high. Discards from the Belgian beam trawler fleet could not be processed in time for the working group due to logistic problems.

The percentage discarded per period, métier and country (Table 6.2.1.3) is highly variable within metier and from year to year. In every case, this percentage is substantial. Gillnetters had no discards in 2006 which was considered doubtful. In 2007, 26% of the catch were discarded by this metier but again the sampling level is too low (4 trips) to consider this rate to be representative. In 2008, 15% of the catches were discarded by gillnetters but again, only 3 trips were sampled. French trawlers had a discard rate of 33% in 2008 (74% in 2007). The discard rate for beam trawlers is 63% (45% in 2007).

For 2009 discard data were available from France and UK for the Working group and will be available after the meeting from the Belgian Beam Trawler. It was stated during the Benchmark that further work will be carried out during the year 2010 and following the results of this intersessional work, a new recommendation will have to be made for further proceedings.

The time series of discards is currently not long enough to be used in analytical assessment.

An average total fish mortality Z of 0.85 is estimated from catch curves slopes (figure 6.2.1.2).

Uk, France and Belgian have provided data this year under the ICES InterCatch format.

6.2.2 Age compositions

Age compositions of the landings are presented in Table 6.2.2.1.

6.2.3 Weight at age

Weight at age in the catch is presented in Table 6.2.3.1 and weight at age in the stock in Table 6.2.3.2, both are presented Figure 6.2.3.1. The procedure for calculating mean weights is described in the Stock Annex.

6.2.4 Maturity and natural mortality

Information about maturity per age class is given with the table included in this section. At an age of three years more than 50 percent and at age four years 96 percent of the plaice are mature. The natural mortality is assumed at a fixed value of 0.1 through all ages.

Age	1	2	3	4	5	6	7	8	9	10
Proportion of mature	0	0.15	0.53	0.96	1	1	1	1	1	1

6.2.5 Catch, effort and research vessel data

Effort and CPUE data are available from Belgian Beam Trawlers commercial fleets (Figure 6.2.5.1).

The survey series consist of:

UK Beam Trawlers

French Ground Fish Survey

International Young fish survey.

All survey and commercial data available for calibration of the assessment are presented in Tables 6.2.5.1 and Figure 6.2.5.2 and fully described in the Stock Annex. The Belgian beam trawler fleet has been increasing since 1998 due to the absence of restriction on fishing efforts. This effort is decreasing since 2007. However, LPUE has been decreasing for Belgium to its lowest level in 2006 and has remained stable since then.

6.3 Data analyses

6.3.1 Reviews of last years assessment

In 2009, RGNSSK stated, as in 2008 that :

- There is a stock definition problems, which is tricky to solve. Mixing stocks during feeding period (North Sea and Channel stocks). Rate of mixing is not known for assessment.
- New discarding information available, however time series considered too short to be taken into account in assessment. Discarding figures in the report are good, showing where Achilles heel is.
- The sampling seems to be adequate, but it seems that discarding estimates and stock identity are major problems for assessment. Discarding in 1-3 quarters high and dependent on gear in use. By omitting young fish discards, is influencing short term predictions, by boosting SSB somewhat upwards, but perhaps not Fs.
- The assessment has a tendency to overestimate SSB and underestimate F, especially from 2000 when surveys and commercial fleets information began to diverge.
- There is no new elements in the assessment. A conclusion is that the assessment is indicative for trends only

WKFLAT 2010 concluded that:

- The discard time series was considered too short and too variable to be used in the assessment
- The 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 recommendation from WKFLAT is that **this assessment is 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 does not recommend this as an analytical assessment, as it will not be useful for calculation of reference points.

6.3.2 Exploratory catch-at-age-based analyses

Catch at age analysis was carried out according to the specifications in the Stock Annex. The model used was XSA.

A preliminary inspection of the quality of international catch-at-age was carried out using separable VPA with a reference age of 3, terminal F=0.8 and terminal S=0.8. The log catch ratio residuals of the separable VPA (Figure 6.3.2.1) showed no special pattern nor large values for the recent years of data, which suggests a relative consistency of the catch-at-age matrix.

The log catchability residuals from single fleet runs (with settings as in XSA and F shrinkage = 1.0) are shown in Figure 6.3.2.2 for all the fleets. Together with the two surveys covering the entire geographical area of the stock (UK BTS and French GFS). There is a jump in the residuals of the UK BTS in 2000, correlated to the decrease of the SSB that same year and the discrepancy between the surveys and the commercial fleets originates from that period. A similar pattern occurs also in the log catchability residuals of this survey for sole VIId. The log catchability residuals from a XSA run combining all fleets are shown in Figure 6.3.2.3. The patterns in log q residuals, already shown in the previous assessment remained unchanged.

6.3.3 Exploratory survey-based analyses

The survey-based analysis was carried out with SURBA software, the results being shown in Figures 6.3.3.1. The parameters used for this exercise are a smoothing coefficient lambda set to 1.0 and a reference age set to 4, the age range being 0−10+, the range of F values for calculating the mean being 3 to 6 like the XSA analysis. The SURBA analysis has been proven to be insensitive to the choice of the initial parameters in the neighbourhood of those chosen here (ICES WGNSSK 2005). Figures 6.3.3.1 shows a good performance of the UK beam trawl survey for tracking year classes through time.

The retrospective analysis (Figure 6.3.3.2) does not show tendencies to under or over estimate Z or SSB but the estimates of mean Z are given with confidence bounds that question on the quality of this information. Some extreme values prevent from drawing a contrasted picture of the recruitment estimates by SURBA.

6.3.4 Conclusions drawn from exploratory analyses

There is a decreasing trend in the contribution of the first quarter to the whole landings, where a fishery on the spawners takes place, yielding an age distribution different from the rest of the year. It is unknown whether there is major inter-annual variability in the immigration from the North Sea to these spawning grounds, which could distort any catch-based analysis. Any migration events taking place in the first quarter cannot be represented in the surveys in the second semester.

Discarding is shown to take place and is substantial, but is constrained to younger ages. The year range of the data series is too short to make use of it in the analysis.

Both landings-at-age and tuning fleets information are highly dependent on the accuracy of the spatial declaration of the fishing activity as an important component of the fisheries operates on the borderline to ICES subdivision IVc.

Figure 6.3.4.1 compares the single fleet performances to the final assessment. The two main surveys, and particularly the UK BTS, keep diverging from the commercial fleet. A map of UK BTS indices per tow locations from 1996 to 2006 (Figure 6.3.4.2) shows that the catches of plaice by the survey occur mainly inshore, whereas the commercial fisheries spread all over the Channel as plaice is mainly taken as a by-catch. It is important to notice that the three surveys occur in the second half of the year, whereas the period when the most plaice is landed is the first semester. A part of the annual dynamic of the stock seems to be missing in the survey indices.

6.3.5 Final assessment

The settings in the XSA assessment for last year are (parameters were changed in 2010 following Benchmark conclusions):

Year of assessment:		2009	2010
Assessment model:		XSA	XSA
Assessment software		FLR library	FLR library
Fleets:			
UK Inshore Trawlers	Age range	**Excluded**	**Excluded**
UK Beam Trawl	Age range	**2–10**	**Excluded**
BE Beam Trawlers	Age range	2–10	2–10
FR Otter Trawlers	Age range	**2–10**	**Excluded**
UK Beam Trawl Survey	Age range	1–6	4–6
FR Ground Fish Survey	Age range	**1–3**	**2–3**
Intern’l Young Fish Survey	Age range	1	1
Catch/Landings			
Age range:		1–10+	1–10+
Landings data:		1980–2008	1980–2009
Discards data		None	None
Model settings			
Fbar:		3–6	3–6
Time series weights:		None	None
Power model for ages:		No	No
Catchability plateau:		Age 7	Age 7
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

The final XSA output is given in Table 6.3.5.1 (diagnostics), table 6.3.5.2 (fishing mortalities) and Table 6.3.5.3 (stock numbers). A summary of the XSA results is given in Table 6.5.3.4 and trends in yield, fishing mortality, recruitment and spawning stock and Total Stock biomass are shown in Figure 6.3.5.4. Retrospective patterns for the final run are shown in Figure 6.3.5.5

6.4 Historic Stock Trends

The 1985 year class dominates the history of this stock. The 1985 year class was followed by the 4 most productive years in history in terms of landings. A second peak occurred with the 1996 year class, although estimated to be at 65% of the 1985 year class. The ephemeral peek of SSB in 1999 has been followed by years of stepped decline. Previous reports (WGNSSK, 2008 and 2009) considered the SSB to be stable at its lowest level for the 2003–2007 period. This low SSB situation was confirmed by the fisher’s perception and assessed by a survey in France in 2006.

6.5 Recruitment estimates

Considering the truncation of the surveys ages ranges for the XSA agreed during the Benchmark, the recruitment is poorly estimated.

The 2008 year class used for predictions was calculated as the geometric mean recruitment over the period 2000-2007, applying the observed fishing mortality of age 1 in 2009 to get the number of age 2 in 2010.

The 2009 and 2010 year classes were estimated using the average recruitment calculated over the period 2000–2007. The truncation was meant to take into account the relative stability of the recruitment in the recent years at a lower level than at the beginning of the series. The geometric mean was about 12 millions 1-year-old-fish. Year class strength estimates used for short term prognosis are summarized in the text table below.

Year Class	At age in 2010	XSA	GM (00-07)	Accepted estimate
2008	2	4927	**11203**	10633
2009	1	-	**12295**	GM (00-07)
2010&2011	0	-	**12295**	GM (00-07)

6.6 Short-term forecasts

The short term prognosis was carried out with FLSTF (FLR package). The average F for the last three years was used for the forecast. The exploitation pattern used (Figure 6.6.1 an 6.6.2) was the mean F-at-age over the period 2007–2009, scaled by the Fbar(3-6) to the level of last year. The weights used for prediction were the average over the last three years.

Input to the short term predictions are presented in Table 6.6.1 and results in Table 6.6.2.

Assuming status quo F implies a catch in 2010 in VIId of 2740t (the agreed TAC is 4274t for both VIId and VIIe) and a catch of 2760t in 2011. Assuming *status quo* F will result in a spawning biomass resident in VIId in 2011 and 2012 of 3840t and 3840t , respectively.

All this short term forecast was made following the Benchmark conclusions. The catches do not then take into account catches of fish from VIIe and IV coming in the first quarter to spawn. These levels of catches cannot be compared to the level of catches estimated in the previous assessment, they are given for trends only.

6.7 Medium-term forecasts

No medium-term forecast is available for this stock.

6.8 Biological reference points

Previous Reference Points:

ICES considers that:	ICES proposes that:
B_{lim} = 5 600 t	B_{pa} = 8 000 t
F_{lim} = 0.54	F_{pa} = 0.45.
Technical basis	
B_{lim} ~ B_{loss} (= 5 584 t)	B_{pa} = 1.4 B_{lim}
F_{lim} = F_{loss}	F_{pa} = 5th percentile of F_{loss}; long-term SSB > B_{pa} and P (SSB_{MT} < B_{pa}) < 10%

The current assessment is indicative for trends only, therefore the biological reference points are not valid anymore for being used in the advice.

6.9 Quality of the assessment

- The sampling for plaice in VIId are considered to be at a reasonable level
- Discarding of plaice is significant and variable depending on the gear used. The omission of young fish discards has influence on the forecast and the predictions, but is not considered to severely affect the estimates of F and SSB. The assessment had a tendency to overestimate SSB and underestimate F, especially from 2000 when surveys and commercial fleets information began to diverge. 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.
- Trends from surveys and commercial fleets are similar before and after 2000. The rescaling of surveys estimates operated in 2000 is consistent with the shift in log q residuals seen for FR GFS and UK BTS, both for plaice and sole in VIId.

6.10 Status of the stock

Fishing mortality and SSB are only given here for trends. F has been stable for the last five years.

The spawning stock biomass has followed a stepped decline in the last 10 years, following a peek generated by the strong 1996 year class. The current level of SSB is stable at a low level, and this confirms the fisher's impression assessed by a survey in France in 2006.

6.11 Management considerations

The Spawning Biomass estimated in 2009, corresponding to the spawning biomass resident in VIId was close to its lowest level. Projections indicate that the SSB will remain stable in the near future.

The stock identity of plaice in the Channel is unclear and may raise some issues :

- The TAC is combined for Divisions VIId and VIIe. Plaice in VIIe is considered at risk of being harvested unsustainably and estimated from trends in the assessment to be at a very low level.
- The plaice stock in VIId is mostly harvested in a mixed fishery with sole in VIId. There exists a directed fishery on plaice occurring in a limited period at the beginning of the year on the spawning grounds. Plaice is mainly taken as by-catch by the demersal fisheries, especially targeting sole.

Due to the minimum mesh size (80 mm) in the mixed beam and otter trawl fisheries, a large number of undersized plaice are discarded. The 80 mm mesh size is not matched to the minimum landing size of plaice (27 cm). Measures taken specifically to control sole fisheries will impact the plaice fisheries.

The retrospective pattern in the assessment caused by the difference in the mortality signals between commercial and survey information has improved due to the removal of the first ages of the UK-BTS and the removal of the first quarter catches.

The perception of historical stock trends from UK BTS differs from that of the commercial tuning series. This is interpreted as if the survey 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. It is also known that plaice undergo spawning and feeding migrations, and one possibility is that the survey fleets are estimating F only in the resident stock, as they are done outside the spawning period, while the commercial fleets operate throughout the year possibly estimating F on an additional migratory component that enters VIId to spawn.

EU Council Regulation (EC) N°53/2010 allocates different amounts of Kw*days by Member State and area to different effort groups of vessels depending on gear and mesh size. The new regime has not reduced effort directed at plaice in this area in 2010.

Sources

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Table 6.1.2.1 - Plaice in VIId. Nominal landings, and Quarter1 removal

Year	Total Landings	Landings Quarter 1	Total Landings after removing 65% of Q1 catches	Percentage removal
1980	2650	908	2060	22
1981	4769	1635	3706	22
1982	4865	1668	3781	22
1983	5043	1729	3919	22
1984	5161	1770	4011	22
1985	6022	2064	4680	22
1986	6834	2343	5311	22
1987	8366	2868	6502	22
1988	10420	3572	8098	22
1989	8758	3002	6807	22
1990	9047	3101	7031	22
1991	7813	2678	6072	22
1992	6337	2173	4925	22
1993	5331	1828	4143	22
1994	6121	2099	4757	22
1995	5130	1758	3987	22
1996	5393	1849	4191	22
1997	6307	2207	4872	23
1998	5762	1993	4467	22
1999	6326	2116	4951	22
2000	6014	2647	4293	29
2001	5266	1820	4083	22
2002	5777	2340	4256	26
2003	4536	1340	3665	19
2004	4007	1268	3183	21
2005	3446	1114	2722	21
2006	3305	1019	2643	20
2007	3674	1207	2889	21
2008	3491	1120	2763	21
2009	2883	848	2332	19

Table 6.2.1.1 - Plaice in VIId. Nominal landings (tonnes) as officially reported to ICES , 1976-2009.

Year	Belgium	Denmark	France	UK(E+W)	Others	Total reported	Un-allocated	Quarter1 removal	Total as used by WG (7)	Total landings reported in VIIe (8)	Agreed TAC (5)
1976	147	1(1)	1439	376	-	1963	-		1963	640	
1977	149	81(2)	1714	302	-	2246	-		2246	702	
1978	161	156(2)	1810	349	-	2476	-		2476	784	
1979	217	28(2)	2094	278	-	2617	-		2617	977	
1980	435	112(2)	2905	304	-	3756	-1106	590	2060	1079	
1981	815	-	3431	489	-	4735	34	1063	3706	1501	
1982	738	-	3504	541	22	4805	60	1084	3781	1688	
1983	1013	-	3119	548	-	4680	363	1124	3919	1495	
1984	947	-	2844	640	-	4431	730	1151	4011	1547	
1985	1148	-	3943	866	-	5957	65	1342	4680	1441	
1986	1158	-	3288	828	488 (2)	5762	1072	1523	5311	1810	
1987	1807	-	4768	1292	-	7867	499	1864	6502	1958	8300
1988	2165	-	5688 (2)	1250	-	9103	1317	2322	8098	2458	9960
1989	2019	+	3265 (1)	1383	-	6667	2091	1951	6807	2358	11700
1990	2149	-	4170 (1)	1479	-	7798	1249	2016	7031	2593	10700
1991	2265	-	3606 (1)	1566	-	7437	376	1741	6072	1848	10700
1992	1560	1	3099	1553	19	6232	105	1412	4925	1624	9600
1993	877	+(2)	2792	1075	27	4771	560	1188	4143	1417	8500
1994	1418	+	3199	993	23	5633	488	1364	4757	1156	9100
1995	1157	-	2598 (2)	796	18	4569	561	1143	3987	1031	8000
1996	1112	-	2630 (2)	856	+	4598	795	1202	4191	1044	7530
1997	1161	-	3077	1078	+	5316	991	1435	4872	1323	7090
1998	854	-	3276 (23)	700	+	4830	932	1295	4467	1131	5700
1999	1306	-	3388 (23)	743	+	5437	889	1375	4951	1271	7400
2000	1298	-	3183	752	+	5233	781	1721	4293	1281	6500
2001	1346	-	2962	655	+	4963	303	1183	4083	1106	6000
2002	1204		3454	841		5499	278	1521	4256	1257	6700
2003	998	-	2893	756	3	4650	-114	871	3665	1218	6000
2004	954		2766	582	10	4312	-305	824	3183	1154	6060
2005	832		2432	421	21	3706	-260	724	2722	1199	5150
2006	1024		1935	549	17	3525	-220	662	2643	1313	5080
2007	1355		2017	461	12	3845	-171	785	2889	1003	5050
2008	1386		1740	466	17	3609	-118	728	2763	974	4646
2009	988		0 (6)	609		1597	1286	551	2332		4274

1 Estimated by the working group from combined Division VIId+e
2 Includes Division VIIe
3 Provisional
4 Data provided to the WG but not officially provided to ICES
5 TAC´s for Divisions VII d, e.
6 Unavailable
7 takes into account the removal of 65% of the Quarter 1 catches
8 Plaice in VIIe. Nominal landings (t) in Division VIIe, as used by Working Group (ICES WGCSE REPORT 2009)

Table 6.2.1.2. Plaice in VIId. Discards

	FR - Gillnet		FR - Trawl						UK - Trawl			
	Q4		Q2		Q3		Q4		Q2		Q4	
Trips	1		4		1		5		2		6	
Hauls	3		27		3		16		2		43	
Length	DIS	LAN	DIS	LAN	DIS	LAN	DIS	LAN	DIS	LAN	DIS	LAN
10												
11												
12												
13												
14			12									
15			24									
16												
17			63								7	
18			104									
19			730						2		24	
20			960						1		43	
21			662								33	
22			785								100	
23			893								201	
24			702					5	5		301	
25	6		261	340					3		370	
26	12		187	1242				5	1	1	376	1
27	6	4	626	2949				126	2	6	390	5
28	6	2	7	2922		3		88		8	296	34
29		8		1970		11		340		2	159	93
30		16		2316		8	78	136		7	51	163
31		2		2068		3		500		3	21	104
32		4		2408		5		541		4		120
33				1749				392		5	8	75
34		6		1427				614		3		94
35				1109				324		4		89
36				272		3		25		4		81
37		2		335				22				84
38				314				15		2		56
39		2		357				8		1	1	67
40		4		313				73		1	5	57
41				321				8				43
42				103				25				33
43				25								34
44		6		3				33				24
45								126				16
46												14
47												22
48												16
49				84								11
50				3								11
51				3								2
52												7
53										1		6
54				19								8
55												3
56												4
57												
58												
59												
60												
61												
62												1
63												
total	30	56	6014	22652	0	32	78	3403	14	52	2382	1378

Table 6.2.1.3a. Plaice in VIId. Landings (L), discards (D) and percentage discards (%D) per period, métier and country in 2008.

Period	Métier	Country	Numbers				%D
			Trips sampled	Hauls sampled	Landed	Discarded	
Quarter 2	Trawl	France	4	27	628	357	36%
Quarter 2	Beam Trawl	UK	2	2	52	14	21%
Quarter 3	Trawl	France	1	3	12	0	0%
Quarter 4	Trawl	France	5	16	98	1	1%
Quarter 4	Gillnet	France	1	3	28	5	15%
Quarter 4	Beam Trawl	UK	6	43	1378	2382	63%
2008	Gillnet	France	1	3	28	5	15%
2008	Trawl	France	10	46	738	358	33%
2008	Beam Trawl	UK	8	45	1430	2396	63%

Table 6.2.1.3b. Plaice in VIId. Landings (L), discards (D) and percentage discards (%D) per period, métier and country in 2007.

Period	Métier	Country	Numbers				%D
			Trips sampled	Hauls sampled	Landed	Discarded	
Quarter 1	Gillnet	France	2	6	13	15	54%
Quarter 1	Beam Trawl	UK	4	12	59	45	43%
Quarter 2	Trawl	France	5	14	115	424	79%
Quarter 2	Beam Trawl	UK	10	37	1087	1025	49%
Quarter 3	Trawl	France	14	23	65	121	65%
Quarter 3	Beam Trawl	UK	5	27	65	75	54%
Quarter 4	Trawl	France	8	47	17	4	19%
Quarter 4	Gillnet	France	2	14	30	0	0%
Quarter 4	Beam Trawl	UK	1	16	164	0	0%
2007	Gillnet	France	4	20	43	15	26%
2007	Trawl	France	27	84	197	549	74%
2007	Beam Trawl	UK	20	92	1375	1145	45%

Table 6.2.2.1. Plaice in VIId. Landings in numbers (thousands)

	1	2	3	4	5	6	7	8	9	10+
1980	53	2409	1235	451	409	62	39	37	3	87
1981	16	2116	5346	1771	216	123	40	33	42	165
1982	265	1212	5466	2489	564	148	73	49	16	74
1983	92	2574	2468	4393	714	166	69	90	3	85
1984	350	1669	5611	2072	1384	386	176	73	28	83
1985	142	4988	4835	3643	309	427	119	71	117	40
1986	679	4176	5543	2798	1113	405	192	53	14	26
1987	25	6984	5752	2553	916	318	315	113	78	60
1988	16	4264	14352	3584	842	403	329	93	80	140
1989	826	3286	5477	6743	1854	401	200	126	61	168
1990	1632	2248	6398	4238	2618	587	190	151	147	191
1991	1542	5107	3976	3329	1612	1112	209	86	74	106
1992	1665	5295	3386	1284	883	750	531	145	76	98
1993	740	6739	2982	944	376	338	255	216	83	121
1994	1242	3144	5441	2041	606	293	222	195	200	251
1995	2592	3938	2266	2084	616	156	181	156	94	220
1996	1119	4315	2801	1080	1004	348	134	128	126	278
1997	550	3844	5962	2517	678	502	337	155	88	249
1998	464	3929	6937	2543	393	97	87	58	33	148
1999	741	1648	9653	4962	715	118	63	60	29	99
2000	1383	5988	3065	4614	878	158	57	19	25	75
2001	2682	3486	2726	1289	1222	188	58	13	8	53
2002	902	5089	4128	1477	1234	697	189	48	21	74
2003	646	4293	4499	1293	289	256	211	47	36	43
2004	967	4285	4064	642	251	106	91	96	28	36
2005	324	2905	3087	1545	350	141	78	66	53	36
2006	509	2577	2486	1176	621	149	57	67	40	53
2007	790	2536	2140	1242	617	377	103	31	12	43
2008	360	3406	1947	1123	458	205	193	22	13	24
2009	312	2216	2600	867	356	227	120	49	14	50

Table 6.2.3.1. Plaice in VIId. Weights in the landings

	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9	Age 10+
1980	0.309	0.312	0.499	0.627	0.787	1.139	1.179	1.293	1.475	1.557
1981	0.239	0.299	0.373	0.464	0.712	0.87	0.863	0.897	0.992	1.174
1982	0.245	0.271	0.353	0.431	0.64	0.795	1.153	1.067	1.504	1.355
1983	0.266	0.296	0.349	0.42	0.542	0.822	0.953	1.144	0.943	1.591
1984	0.233	0.295	0.336	0.402	0.508	0.689	0.703	0.945	1.028	1.427
1985	0.254	0.278	0.301	0.427	0.502	0.57	0.557	1.081	0.849	1.421
1986	0.226	0.306	0.331	0.406	0.546	0.486	0.629	0.871	1.446	1.579
1987	0.251	0.282	0.36	0.477	0.577	0.783	0.735	1.142	1.268	1.515
1988	0.292	0.268	0.321	0.432	0.56	0.657	0.77	0.908	1.218	1.328
1989	0.201	0.268	0.321	0.37	0.473	0.648	0.837	0.907	1.204	1.519
1990	0.201	0.256	0.326	0.378	0.483	0.61	0.781	0.963	1.159	1.31
1991	0.225	0.277	0.311	0.39	0.454	0.556	0.745	1.087	0.924	1.602
1992	0.182	0.277	0.352	0.429	0.509	0.585	0.701	0.837	0.85	1.195
1993	0.22	0.272	0.336	0.432	0.507	0.591	0.741	0.82	0.934	1.156
1994	0.243	0.27	0.288	0.356	0.466	0.576	0.686	0.928	0.969	1.287
1995	0.218	0.271	0.313	0.39	0.485	0.688	0.612	0.806	1.15	1.298
1996	0.221	0.3	0.29	0.396	0.475	0.643	0.764	0.934	1.057	1.312
1997	0.199	0.252	0.298	0.332	0.442	0.577	0.801	0.894	1.055	1.395
1998	0.159	0.244	0.267	0.381	0.502	0.762	0.839	0.981	0.986	1.379
1999	0.197	0.245	0.235	0.306	0.461	0.751	0.768	0.868	0.885	1.508
2000	0.207	0.245	0.261	0.283	0.375	0.576	0.687	0.875	0.926	1.067
2001	0.215	0.252	0.303	0.37	0.447	0.642	0.876	1.008	1.144	1.223
2002	0.254	0.256	0.309	0.376	0.438	0.562	0.627	0.88	0.909	1.33
2003	0.254	0.268	0.271	0.363	0.556	0.643	0.624	0.85	0.583	1.205
2004	0.217	0.243	0.295	0.421	0.493	0.61	0.636	0.933	1.093	1.348
2005	0.21	0.263	0.293	0.36	0.527	0.536	0.753	0.778	0.82	1.014
2006	0.209	0.263	0.318	0.374	0.463	0.611	0.711	0.732	0.858	1.071
2007	0.246	0.293	0.322	0.382	0.473	0.541	0.685	0.793	0.983	1.193
2008	0.244	0.286	0.334	0.404	0.509	0.596	0.727	1.316	0.921	1.254
2009	0.141	0.255	0.3	0.399	0.488	0.608	0.893	0.932	1.022	1.277

Table 6.2.3.2. Plaice in VIId. Weights in the stock.

	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9	Age 10+
1980	0.171	0.332	0.482	0.622	0.751	0.87	0.977	1.074	1.161	1.339
1981	0.11	0.216	0.317	0.414	0.506	0.594	0.677	0.756	0.83	1.042
1982	0.105	0.208	0.308	0.406	0.502	0.596	0.687	0.776	0.862	1.118
1983	0.097	0.192	0.286	0.379	0.47	0.56	0.648	0.735	0.821	1.169
1984	0.082	0.164	0.248	0.333	0.42	0.507	0.596	0.686	0.777	1.086
1985	0.084	0.171	0.259	0.348	0.44	0.533	0.628	0.725	0.824	1.206
1986	0.101	0.205	0.311	0.42	0.532	0.646	0.763	0.882	1.004	1.313
1987	0.122	0.242	0.361	0.479	0.596	0.712	0.826	0.939	1.051	1.306
1988	0.084	0.168	0.254	0.34	0.427	0.514	0.603	0.692	0.783	0.952
1989	0.079	0.162	0.25	0.342	0.439	0.541	0.648	0.759	0.874	1.211
1990	0.085	0.23	0.322	0.346	0.465	0.549	0.748	0.899	0.979	1.766
1991	0.143	0.219	0.275	0.335	0.375	0.472	0.633	1.057	1.022	1.502
1992	0.088	0.241	0.336	0.421	0.477	0.521	0.634	0.713	0.741	1.229
1993	0.108	0.258	0.296	0.379	0.493	0.539	0.573	0.699	0.787	1.056
1994	0.165	0.198	0.276	0.331	0.383	0.493	0.603	0.903	0.781	1.15
1995	0.124	0.257	0.286	0.354	0.442	0.707	0.531	0.703	1.092	1.194
1996	0.178	0.229	0.263	0.347	0.354	0.474	0.536	0.907	0.958	1.126
1997	0.059	0.202	0.256	0.266	0.417	0.53	0.665	0.686	0.972	1.364
1998	0.072	0.203	0.273	0.361	0.53	0.67	0.629	0.656	0.915	1.107
1999	0.072	0.172	0.213	0.351	0.429	0.644	0.76	0.782	0.593	1.166
2000	0.068	0.184	0.204	0.246	0.355	0.554	0.693	0.817	0.89	1.131
2001	0.093	0.206	0.274	0.338	0.404	0.624	0.844	0.989	1.153	1.405
2002	0.102	0.206	0.281	0.379	0.467	0.558	0.61	0.759	1.053	1.25
2003	0.103	0.191	0.249	0.33	0.496	0.492	0.548	0.748	0.522	0.982
2004	0.172	0.183	0.268	0.408	0.471	0.521	0.616	0.892	1.102	1.287
2005	0.096	0.201	0.269	0.308	0.47	0.492	0.707	0.629	0.814	0.89
2006	0.106	0.209	0.275	0.336	0.397	0.525	0.636	0.704	0.842	1.09
2007	0.125	0.224	0.265	0.323	0.431	0.463	0.62	0.831	1.04	1.222
2008	0.155	0.253	0.285	0.343	0.41	0.447	0.615	0.755	0.912	1.266
2009	0	0.222	0.277	0.37	0.46	0.486	0.756	0.824	1.238	1.3

Table 6.2.5.1. Plaice in VIId. Tuning fleets

E.CHANNEL PLAICE 2010 WK (fleet) using 65% removal for the first quarter

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BE CBT

1981 2009

1 1 0 1

2 10

24.4	174.1	687.1	361.9	41.3	13.15	5.05	4.5	8.1	8.9
29.8	89.95	650.05	419.75	114.4	33.65	12.65	3.9	2.65	2.7
26.4	290.8	398.85	844.35	100.65	32.05	13.9	19.25	0.65	0.75
35.4	56.25	958.1	434.55	284.85	81.65	36.95	17.15	3.45	4.2
33.4	340.1	686.55	680.25	57.5	120.5	32.1	19.55	3.35	3.5
30.8	427.6	696.55	407.15	164.6	88.7	36.9	6.75	3.65	3.8
49.3	1186.25	1000.1	542.55	209.2	56.3	94.05	24.85	16.95	8.9
48.9	471.4	2601.25	794.15	144.8	67	69	22.15	15.65	14.9
43.8	45	1057.7	1800	593.8	129.6	68.9	37.05	13.25	0.1
38.5	227.15	1639.05	1184.9	614.4	112.65	27	31	7.9	8.8
32.8	363.35	1030.1	700.9	664.4	426.05	53.1	21.7	36.15	1.05
30.9	542.7	629.35	246.5	169.05	172.25	97.3	35.45	37.3	4.1
28.2	298.35	417.05	167.05	120.25	74.15	45.45	38.1	6.7	11.5
32.8	258.85	767.8	870.1	163.35	80.6	66.6	46.25	54.9	22.65
31.7	24.2	361.15	564.45	241.8	50.15	85.5	50.1	15.7	0.7
32.6	157.9	420.2	330.25	307.4	83.65	28.2	30.4	23.45	26.85
39.7	0	169.65	550.9	336.85	174.8	85.2	22.35	16.65	6.65
23.6	83.35	457.4	313.05	62.2	19.5	20.5	9.1	9.3	7.2
27.6	23.15	951.9	771.2	209.3	38.25	14.35	7.65	8.15	6.85
37	33.75	205.25	293.7	130.75	23.9	6.9	3.3	5.85	0.85
40.2	244.5	1018.25	627.4	408.25	69.35	15.45	5.4	4.35	15.85
41.1	283.35	934.25	439.5	396.65	95.15	43.2	6.35	3.7	17.95
40	254.45	745.55	363.2	90.05	110.5	81.4	15.9	11.05	15.8
39.1	188.45	789.9	186.5	91.65	29.3	40.35	30.7	8.1	13.65
44	200.15	492.55	473.5	160.2	48.9	26.8	23.6	14.15	0.45
56.9	297.6	551.35	474.45	275.5	48.85	21.5	26	25.75	15.9
65.1	545.9	601.45	479.15	326	247.2	68.95	14.55	4.25	25.65
54.5	506	655.9	572.55	208.4	87.9	121.5	8	1.35	6.1
49.9	589.45	725.2	196.85	136.65	80	54.8	9.85	2	10.35

Table 6.2.5.1.(cont.) Plaice in VIId. Tuning fleets

UK BTS

1988 2009

1	1	0.5	0.75
4	6		
1	7	4.6	1.5
1	19.9	3.3	1.5
1	6.7	7.5	1.8
1	5.3	5.4	3.2
1	4.2	5.6	4.9
1	1.7	1.9	1.6
1	5.6	1.9	0.8
1	3.7	1.5	0.6
1	0.7	1.3	0.9
1	0.6	0.3	0.3
1	3.1	0.3	0.2
1	2.9	1	0.2
1	13.8	3.5	0.9
1	7.1	10.9	1.9
1	3.5	1.8	3.5
1	2.9	1.6	0.8
1	3.4	0.9	0.2
1	10.3	2.9	1.2
1	3.3	2.6	0.8
1	3.9	1.7	2
1	3	2.3	1.1
1	5.1	2	1.7

Table 6.2.5.1.(cont.) Plaice in VIId. Tuning fleets

FR GFS

1988 2009

1	1	0.75	1
2	3		
1	17.6	9.9	
1	7.4	2.7	
1	1.2	2.7	
1	2.1	0.8	
1	3.6	1.9	
1	8.8	4.2	
1	2.2	0.8	
1	3	1.1	
1	2.6	0.3	
1	8.3	4.3	
1	14	3.1	
1	4.2	7.7	
1	13.7	3.4	
1	3.5	1.2	
1	6.5	3.4	
1	9.4	1.3	
1	9.3	4.5	
1	12.4	6.8	
1	9.9	3.8	
1	8.6	3.6	
1	19.2	2.5	
1	7.4	1.8	

Table 6.2.5.1.(cont.) Plaice in VIId. Tuning fleets

IN YFS

1987 2006

1	1	0.5	0.75
1	1		
1	1.44		
1	1.3		
1	0.6		
1	0.7		
1	0.6		
1	1.8		
1	0.8		
1	0.8		
1	1.7		
1	0.7		
1	0.8		
1	0.8		
1	0.8		
1	0.48		
1	0.83		
1	0.92		
1	0.2		
1	0.78		
1	0.17		
1	0.3		

Table 6.3.5.1. Plaice in VIId. XSA diagnostics

```
FLR XSA Diagnostics 2010-05-08 09:09:01

CPUE data from My.Fleet

Catch data for 30 years. 1980 to 2009. Ages 1 to 10.

   fleet first age last age first year last year alpha beta
1 BE CBT         2        9       1981      2009     0    1
2 UK BTS         4        6       1988      2009   0.5 0.75
3 FR GFS         2        3       1988      2009  0.75    1
4 IN YFS         1        1       1987      2006   0.5 0.75


 Time series weights :

   Tapered time weighting not applied

Catchability analysis :

    Catchability independent of size for all ages

    Catchability independent of age for ages >   7

Terminal population estimation :

    Survivor estimates shrunk towards the mean F
    of the final   5 years or the  3 oldest ages.

    S.E. of the mean to which the estimates are shrunk =   1

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

   prior weighting not applied

Regression weights
     year
age   2000 2001 2002 2003 2004 2005 2006 2007 2008 2009
  all    1    1    1    1    1    1    1    1    1    1


 Fishing mortalities
    year
age   2000  2001  2002  2003  2004  2005  2006  2007  2008  2009
  1  0.114 0.187 0.063 0.053 0.096 0.038 0.065 0.065 0.028 0.058
  2  0.722 0.410 0.565 0.418 0.508 0.407 0.415 0.464 0.383 0.219
  3  0.598 0.760 1.089 1.356 0.782 0.748 0.644 0.640 0.695 0.500
  4  0.969 0.479 1.144 1.147 0.605 0.689 0.632 0.692 0.733 0.681
  5  0.891 0.652 1.052 0.620 0.619 0.695 0.581 0.715 0.522 0.477
  6  0.538 0.416 0.865 0.558 0.428 0.758 0.639 0.753 0.483 0.472
  7  0.715 0.339 0.853 0.619 0.349 0.574 0.713 1.141 1.010 0.513
  8  0.428 0.305 0.460 0.462 0.561 0.405 1.305 0.971 0.711 0.671
  9  0.549 0.285 1.036 0.659 0.494 0.616 0.410 0.809 1.368 1.306
  10 0.549 0.285 1.036 0.659 0.494 0.616 0.410 0.809 1.368 1.306
```

Table 6.3.5.1. (cont.) Plaice in VIId. XSA diagnostics

XSA population number (thousands)

year \ age	1	2	3	4	5	6	7	8	9	10
2000	13493	12246	7154	7815	1564	400	117	56	62	185
2001	16515	10893	5385	3558	2683	580	211	52	33	225
2002	15555	12392	6540	2279	1993	1265	347	136	34	119
2003	13184	13217	6372	1992	657	630	482	134	78	93
2004	11112	11315	7875	1486	572	320	326	235	76	96
2005	9146	9135	6162	3260	734	279	189	208	121	81
2006	8470	7968	5502	2639	1480	331	118	96	126	163
2007	13274	7180	4759	2614	1269	749	158	52	24	81
2008	13486	11259	4085	2271	1184	562	319	46	18	33
2009	5773	11861	6948	1844	987	635	314	105	20	72

Estimated population abundance at 1st Jan 2010

year \ age	1	2	3	4	5	6	7	8	9	10
2010	267	4927	8624	3814	844	554	359	170	49	5

Fleet: BE CBT

Log catchability residuals.

age \ Year	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
2	-0.084	-0.240	0.395	-1.359	0.366	0.502	0.333	0.094	-2.017	0.301	0.910
3	0.307	-0.340	-0.016	-0.028	-0.133	-0.010	-0.422	-0.136	-0.324	0.453	0.799
4	0.376	-0.004	0.318	-0.034	-0.032	-0.333	-0.428	-0.465	-0.117	0.088	0.101
5	-0.603	0.008	-0.356	0.027	-1.256	-0.406	-0.617	-0.890	0.314	-0.185	0.569
6	-0.738	-0.309	-0.228	0.160	0.303	-0.020	-1.077	-0.895	-0.011	-0.064	0.566
7	-0.433	-0.513	-0.705	0.294	-0.062	-0.193	0.268	-0.336	-0.298	-0.955	0.003
8	-0.085	0.233	0.788	-0.378	0.708	-1.035	-0.410	-0.376	-0.173	-0.471	-0.544
9	0.007	0.063	0.071	-0.151	-0.872	-0.115	0.113	-0.070	-0.025	-0.557	0.359

age \ Year	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
2	1.226	0.412	0.893	-1.748	-0.302	NA	-0.922	-1.519	-1.419	0.422
3	0.508	-0.115	0.131	0.138	-0.110	-1.514	-0.281	0.010	-0.914	0.918
4	-0.266	-0.486	0.659	0.168	0.274	0.504	0.304	0.500	-1.027	0.184
5	-0.353	-0.218	0.066	0.224	0.452	1.258	0.429	0.875	-0.184	0.188
6	0.294	-0.283	-0.044	-0.272	-0.033	0.995	0.426	0.840	-0.412	0.089
7	-0.269	-0.327	-0.122	0.524	-0.502	0.601	0.409	0.518	-0.426	-0.487
8	0.343	-0.587	0.152	0.128	0.053	-0.261	-0.037	-0.175	-0.540	-0.141
9	0.473	-0.361	0.150	-0.156	-0.038	0.044	0.250	0.066	-0.026	0.092

age \ year	2002	2003	2004	2005	2006	2007	2008	2009
2	0.317	0.200	0.171	0.162	0.508	1.052	0.639	0.707
3	0.582	0.609	0.295	-0.182	-0.192	-0.150	0.263	-0.145
4	0.363	0.429	-0.099	-0.152	-0.155	-0.298	0.189	-0.562
5	0.433	-0.003	0.229	0.333	-0.067	0.125	-0.187	-0.206
6	-0.366	0.469	-0.177	0.399	-0.023	0.644	-0.071	-0.164
7	0.083	0.415	0.057	0.048	0.176	1.038	0.995	0.202
8	-1.030	-0.027	0.199	-0.247	0.813	0.500	0.104	-0.469
9	-0.059	0.285	-0.059	-0.116	0.146	-0.022	-0.478	-0.537

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

	2	3	4	5	6	7	8	9
Mean_Logq	-7.1207	-5.3309	-4.7895	-4.8654	-5.1170	-5.0702	-5.0702	-5.0702
S.E_Logq	0.8819	0.4900	0.3841	0.5121	0.4775	0.4826	0.4695	0.2868

Table 6.3.5.1. (cont.) Plaice in VIId. XSA diagnostics

Fleet: UK BTS

Log catchability residuals.

age \ year	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
4	-0.228	0.244	-0.346	-0.181	0.157	-0.694	0.192	-0.324	-1.317	-1.419	-0.174	-0.619	0.563	0.381	0.531	0.480	0.596	0.971	0.008	0.222	0.126	0.832
5	0.363	-0.226	-0.113	0.078	0.476	-0.255	-0.077	-0.606	-0.674	-1.155	-1.046	-0.332	0.587	1.035	-0.221	0.503	0.065	1.034	0.152	-0.036	0.216	0.231
6	-0.237	-0.115	0.062	-0.248	0.773	-0.226	-0.606	-0.697	-0.510	-1.027	-0.606	-0.560	0.402	0.700	0.811	-0.158	-0.948	1.186	0.534	0.705	0.228	0.533

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

	4	5	6
Mean_Logq	-6.2364	-6.0722	-6.1004
S.E_Logq	0.6213	0.5679	0.6321

Fleet: FR GFS

Log catchability residuals.

age \ year	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
2	0.393	-0.355	-1.588	-0.919	-0.551	0.023	-0.589	-0.602	-1.194	-0.358	-0.057	-0.298	1.102	-0.417	0.208	0.384	0.607	1.021	0.940	0.945	1.228	0.079
3	0.058	-0.730	-0.428	-0.935	0.066	0.429	-1.331	-0.333	-2.049	0.417	-0.436	0.342	0.334	-0.283	0.851	0.147	0.678	1.307	0.748	0.835	0.672	-0.358

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

	2	3
Mean_Logq	-7.1800	-7.3761
S.E_Logq	0.7742	0.7954

Fleet: IN YFS

Log catchability residuals.

age \ year	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
1	0.243	0.284	0.032	0.005	-0.262	0.552	0.513	0.215	0.607	-0.477	-0.523	0.417	0.173	-0.242	0.149	0.234	-1.133	0.426	-0.939	-0.277

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

	1
Mean_Logq	-9.8681
S.E_Logq	0.4842

Table 6.3.5.1. (cont.) Plaice in VIId. XSA diagnostics

```
Terminal year survivor and F summaries:
  Age 1 Year class = 2008

source
survivors         N scaledWts
     4927         1         1

 Age 2 Year class = 2007

source
       survivors N scaledWts
BE CBT     17488 1     0.304
FR GFS      9334 1     0.391
fshk        3849 1     0.305

 Age 3 Year class = 2006

source
       survivors N scaledWts
BE CBT      3781 2     0.534
FR GFS      5176 2     0.285
fshk        2416 1     0.181

 Age 4 Year class = 2005

source
       survivors N scaledWts
BE CBT       621 3     0.565
UK BTS      1941 1     0.156
FR GFS      1843 2     0.079
IN YFS       640 1     0.075
fshk         858 1     0.125

 Age 5 Year class = 2004

source
       survivors N scaledWts
BE CBT       540 4     0.533
UK BTS       677 2     0.275
FR GFS      1334 2     0.043
IN YFS       217 1     0.043
fshk         387 1     0.106

 Age 6 Year class = 2003

source
       survivors N scaledWts
BE CBT       295 5     0.556
UK BTS       521 3     0.298
FR GFS       848 2     0.024
IN YFS       549 1     0.023
fshk         255 1     0.098

 Age 7 Year class = 2002

source
       survivors N scaledWts
BE CBT       181 6     0.659
UK BTS       190 3     0.196
FR GFS       478 2     0.013
IN YFS        55 1     0.012
fshk         100 1     0.119
```

Table 6.3.5.1. (cont.) Plaice in VIId. XSA diagnostics

Age 8 Year class = 2001

source	survivors	N	scaledWts
BE CBT	49	7	0.714
UK BTS	85	3	0.081
FR GFS	85	2	0.006
IN YFS	62	1	0.005
fshk	38	1	0.194

Age 9 Year class = 2000

source	survivors	N	scaledWts
BE CBT	4	8	0.780
UK BTS	10	3	0.020
FR GFS	6	2	0.001
IN YFS	6	1	0.001
fshk	18	1	0.199

Table 6.3.5.2. Plaice in VIId. Fishing mortality (F) at age

age	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
1	0.00284696	0.00171953	0.01456214	0.00621542	0.01855609	0.00668148	0.01582562	0.00113202	0.00083649	0.07208971	0.1180525	0.0999309	0.08136576
2	0.19747602	0.13447271	0.15552632	0.17136516	0.13352154	0.34954166	0.24576261	0.20006746	0.24013508	0.21062724	0.254688	0.5679583	0.50884522
3	0.31613411	0.76673209	0.52902545	0.47620251	0.59830284	0.61126598	0.72128101	0.55183022	0.69922378	0.48664185	0.7022072	0.8369366	0.82172682
4	0.42720148	0.88936048	0.8993076	0.96578375	0.83416412	0.88592474	0.77439606	0.77231456	0.70735095	0.74566643	0.7680099	0.8806533	0.62952848
5	0.6896929	0.3312861	0.70199419	0.62020146	0.83566557	0.24177523	0.65621309	0.55036709	0.55298651	0.88670892	0.6451147	0.6647656	0.53496262
6	0.42893255	0.39850175	0.3536142	0.40094158	0.72075549	0.59037464	0.50505137	0.34600174	0.44049573	0.49149129	0.6923279	0.5537338	0.66412216
7	0.41162531	0.48033699	0.39049923	0.24736091	0.86790672	0.44345354	0.5108503	0.83186515	0.64164275	0.36281647	0.4035075	0.4997413	0.49510255
8	0.26759332	0.65578018	1.80694374	1.04916437	0.3962714	0.95670542	0.32564424	0.5678909	0.55158878	0.48069278	0.4533265	0.2871789	0.6842049
9	0.37046118	0.49379342	0.71754354	0.37117423	0.98206678	1.96618532	0.44679648	0.97860954	0.90464262	0.75731599	1.5726499	0.3719801	0.38988583
10	0.37046118	0.49379342	0.71754354	0.37117423	0.98206678	1.96618532	0.44679648	0.97860954	0.90464262	0.75731599	1.5726499	0.3719801	0.38988583
	year												
age	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
1	0.0782295	0.0973011	0.1405411	0.05042072	0.02080114	0.04477724	0.05596163	0.1140156	0.1872034	0.06289913	0.05288508	0.09594277	0.03795133
2	0.4766981	0.4814279	0.4433614	0.3251756	0.21854421	0.18144165	0.19808802	0.7215817	0.4101547	0.56512509	0.4177401	0.50776108	0.4069713
3	0.5326645	0.7873039	0.6783706	0.57713219	0.88386225	0.6678971	0.7769857	0.5984923	0.7598017	1.08906236	1.35592463	0.78191403	0.7479518
4	0.4989676	0.7594409	0.7072587	0.71621838	1.49431532	1.10753639	1.39053535	0.96922	0.479388	1.14385328	1.14680227	0.60527646	0.68945359
5	0.3333943	0.614395	0.4766945	0.79264022	1.293209	0.90632757	0.99442975	0.8913933	0.6516533	1.05246712	0.62005403	0.61867768	0.69531372
6	0.3553933	0.4170701	0.275855	0.47960266	1.10271619	0.54076394	0.67599822	0.5380471	0.4156853	0.86532619	0.55770239	0.42765105	0.75819982
7	0.4370402	0.3713281	0.4354738	0.35770372	1.07480007	0.48895049	0.7292485	0.7154285	0.3391205	0.85263462	0.61866053	0.34901216	0.57417262
8	0.3400227	0.6225404	0.4291844	0.55622466	0.80612187	0.45395673	0.64562719	0.4276424	0.3051722	0.45969835	0.46199176	0.56124276	0.40468256
9	0.9769687	0.5332456	0.6175043	0.65037765	0.83423707	0.33733382	0.38357525	0.5491977	0.2849999	1.03588333	0.65916336	0.49375722	0.61622577
10	0.9769687	0.5332456	0.6175043	0.65037765	0.83423707	0.33733382	0.38357525	0.5491977	0.2849999	1.03588333	0.65916336	0.49375722	0.61622577
	year												
age	2006	2007	2008	2009									
1	0.06525886	0.06460944	0.02846343	0.05849648									
2	0.41544215	0.46403957	0.38270724	0.21870256									
3	0.64427974	0.63992179	0.69516858	0.49991771									
4	0.63184208	0.69193655	0.73341703	0.6812464									
5	0.5810396	0.71540983	0.52242821	0.47689581									
6	0.63854034	0.75252782	0.48310741	0.47186145									
7	0.71286472	1.14132717	1.00968631	0.51315046									
8	1.30475641	0.9706983	0.71114136	0.67074548									
9	0.4099167	0.80893351	1.36790007	1.30587627									
10	0.4099167	0.80893351	1.36790007	1.30587627									

Table 6.3.5.3. Plaice in VIId. Stock number at age

	year												
age	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
1	19598.7176	9790.362	19270.5315	15609.2035	20013.3355	22417.152	45462.7428	23229.943	20116.6403	12484.798	15407.8607	17045.8357	22399.371
2	14130.5478	17683.2378	8843.46618	17184.6222	14036.2783	17775.8845	20148.8034	40490.506	20995.5409	18187.0692	10510.9969	12389.2025	13956.9142
3	4790.94637	10494.622	13987.2258	6849.34197	13100.4917	11113.0906	11339.6006	14258.9145	29994.0813	14941.9844	13330.8862	7372.332	6352.6182
4	1363.57342	3160.069	4411.12981	7456.74521	3849.52619	6516.56189	5456.77397	4987.9254	7430.1948	13487.6748	8310.6111	5976.7468	2888.6736
5	863.76963	804.8553	1174.95914	1623.88795	2568.5339	1512.53334	2431.29049	2276.096	2084.8679	3314.1498	5789.8701	3488.6794	2241.6743
6	186.86791	392.1378	522.8928	526.8914	790.2719	1007.69918	1074.66687	1141.3469	1187.7902	1085.1508	1235.5203	2748.3347	1623.7814
7	119.94854	110.1089	238.20019	332.20833	319.27503	347.7979	505.24847	586.8179	730.6705	691.8396	600.6323	559.4307	1429.4095
8	165.00196	71.9116	61.629	145.85489	234.72189	121.28537	201.97987	274.2939	231.0998	348.0409	435.5187	363.0264	307.1015
9	11.37577	114.2471	33.77285	9.15398	46.22163	142.89784	42.15869	131.9633	140.6549	120.4531	194.7326	250.438	246.4839
10	295.75375	442.8476	150.35522	288.52558	138.49791	48.43188	76.12547	100.3761	244.5093	329.86	250.5597	357.9858	317.4437
	year												
age	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
1	10338.379	14082.3748	20782.9529	23924.2581	28086.6138	11139.4141	14313.2346	13492.5938	16514.9188	15554.7632	13184.0031	11112.0988	9146.34707
2	18683.9921	8650.6424	11560.8327	16339.6068	20583.1382	24890.6429	9637.98826	12246.2892	10893.0535	12392.1191	13216.5228	11314.8851	9134.80394
3	7592.2638	10495.7352	4836.5694	6714.4471	10680.4656	14968.2007	18784.8425	7153.66194	5385.12918	6540.21878	6372.14166	7875.27159	6161.73283
4	2527.2714	4032.8177	4321.7702	2220.728	3411.4223	3993.0453	6945.06196	7815.15341	3557.7633	2279.23448	1991.5401	1485.88565	3260.28184
5	1392.7343	1388.4287	1707.49	1927.8519	981.7846	692.6808	1193.65233	1564.38934	2682.75604	1993.20532	657.03785	572.41329	733.98589
6	1187.9872	902.9164	679.6194	959.1862	789.596	243.7548	253.2157	399.55176	580.48126	1265.15081	629.56696	319.79738	278.99213
7	756.2642	753.4197	538.3774	466.6959	537.2602	237.1767	128.43193	116.54104	211.09245	346.60028	481.84401	326.14101	188.677
8	788.3279	442.018	470.264	315.1618	295.2948	165.9493	131.61155	56.04475	51.56355	136.07085	133.69185	234.85303	208.16222
9	140.1865	507.7003	214.6074	277.0256	163.5079	119.3252	95.36635	62.44134	33.06608	34.38577	77.74835	76.21405	121.23334
10	203.0432	635.1096	499.9222	607.9056	458.931	540.5439	324.36216	184.66378	225.32287	119.20595	93.42403	95.74539	81.02197
	year												
age	2006	2007	2008	2009									
1	8470.06542	13273.9472	13486.4003	5772.71376									
2	7967.75873	7179.85635	11259.2929	11860.557									
3	5502.04825	4758.63606	4084.66535	6948.22745									
4	2639.01631	2613.89303	2270.58905	1844.24729									
5	1480.47066	1269.42515	1184.00664	986.71135									
6	331.35029	749.25227	561.66726	635.38507									
7	118.27161	158.32276	319.43312	313.50089									
8	96.14562	52.46357	45.75534	105.30507									
9	125.66694	23.59672	17.98289	20.33141									
10	163.4917	81.39494	32.768	71.88134									

Table 6.3.5.4. Plaice in VIId. Summary table

	recruitment	ssb	catch	landings	discards	fbar3-6	Y/ssb
1980	19599	4257	2060	2060	0	0.47	0.48
1981	9790	4917	3706	3706	0	0.6	0.75
1982	19271	5589	3781	3781	0	0.62	0.68
1983	15609	5972	3919	3919	0	0.62	0.66
1984	20013	5315	4010	4010	0	0.75	0.75
1985	22417	5844	4680	4680	0	0.58	0.8
1986	45463	7382	5311	5311	0	0.66	0.72
1987	23230	9673	6502	6502	0	0.56	0.67
1988	20117	9436	8098	8098	0	0.6	0.86
1989	12485	10109	6807	6807	0	0.65	0.67
1990	15408	10243	7031	7031	0	0.7	0.69
1991	17046	7541	6072	6072	0	0.73	0.81
1992	22399	6417	4925	4925	0	0.66	0.77
1993	10338	5470	4143	4143	0	0.43	0.76
1994	14082	6031	4757	4757	0	0.64	0.79
1995	20783	5330	3987	3987	0	0.53	0.75
1996	23924	4860	4191	4191	0	0.64	0.86
1997	28087	5117	4872	4872	0	1.19	0.95
1998	11139	5804	4467	4467	0	0.81	0.77
1999	14313	6020	4951	4951	0	0.96	0.82
2000	13493	4125	4294	4294	0	0.75	1.04
2001	16515	4303	4083	4083	0	0.58	0.95
2002	15555	4323	4256	4256	0	1.04	0.98
2003	13184	2983	3665	3665	0	0.92	1.23
2004	11112	3065	3183	3183	0	0.61	1.04
2005	9146	3035	2722	2722	0	0.72	0.9
2006	8470	3092	2643	2643	0	0.62	0.85
2007	13274	2880	2889	2889	0	0.7	1
2008	13486	2817	2763	2763	0	0.61	0.98
2009	5773	3275	2332	2332	0	0.53	0.71

Table 6.6.1. Plaice in VIId. Input to catch forecast

Age	Stock	Mat	M	F
1	12295	0	0.1	0.04
2	10633	0.15	0.1	0.31
3	8624	0.53	0.1	0.53
4	3814	0.96	0.1	0.61
5	844	1	0.1	0.5
6	554	1	0.1	0.49
7	359	1	0.1	0.77
8	170	1	0.1	0.68
9	49	1	0.1	1.01
10	23	1	0.1	1.01

Table 6.6.2. Plaice in VIId. Management option table

2010					
fmult	f3-6	landings	catch	ssb	
1	0.532	2735	2735	3775	
2011					
fmult	f3-6	landings	catch	ssb 2011	ssb 2012
1	0.532	2758	2758	3839	3834

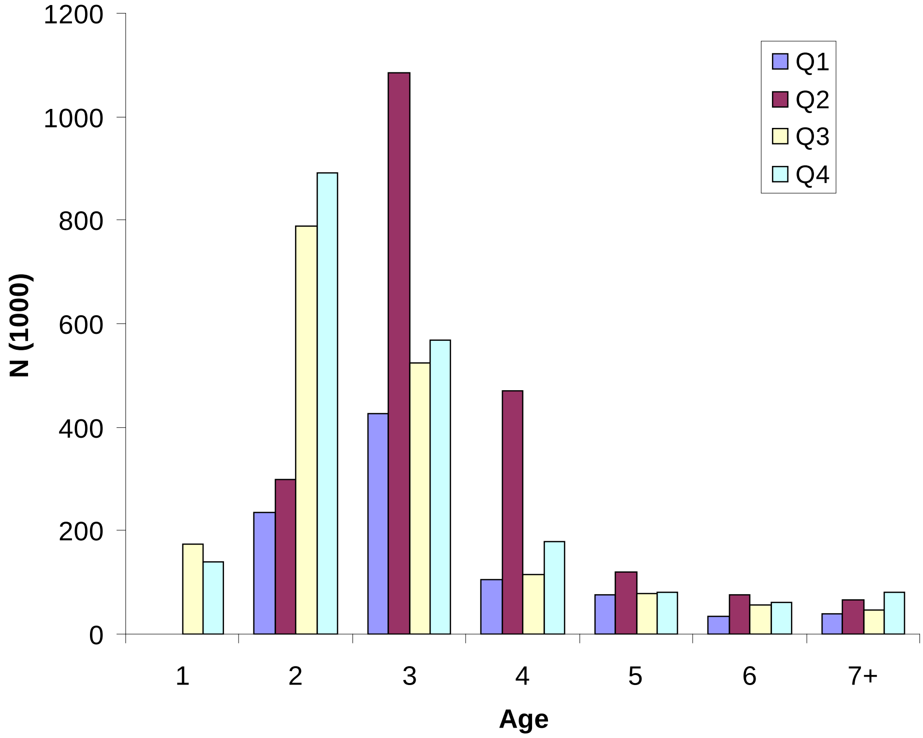


Figure 6.1.2.1. Plaice in VIId. Age distribution in the landings per quarter.

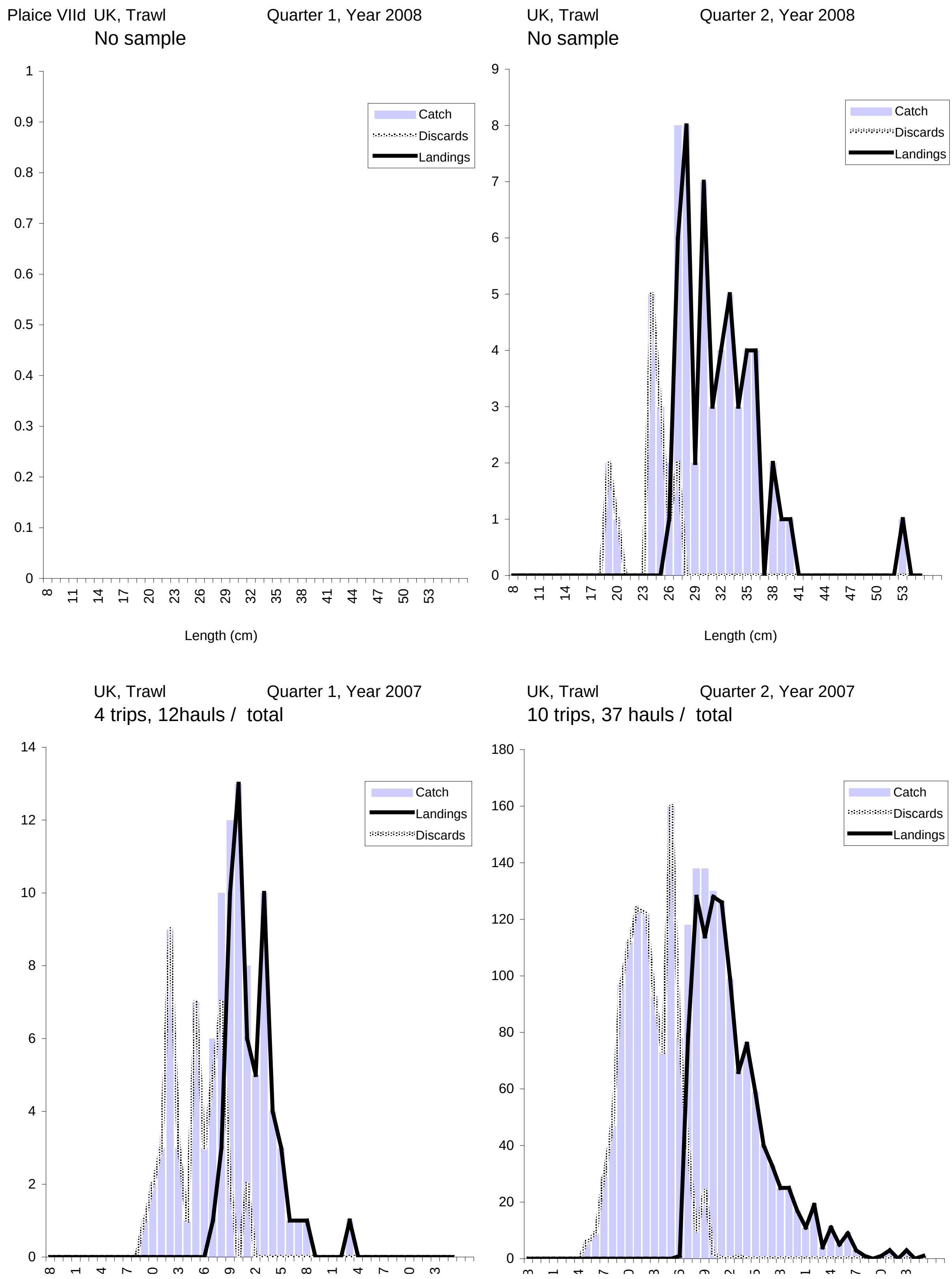


Figure 6.2.1.1a - Plaice VIId - Length structure of discards and landings collected by observations on board

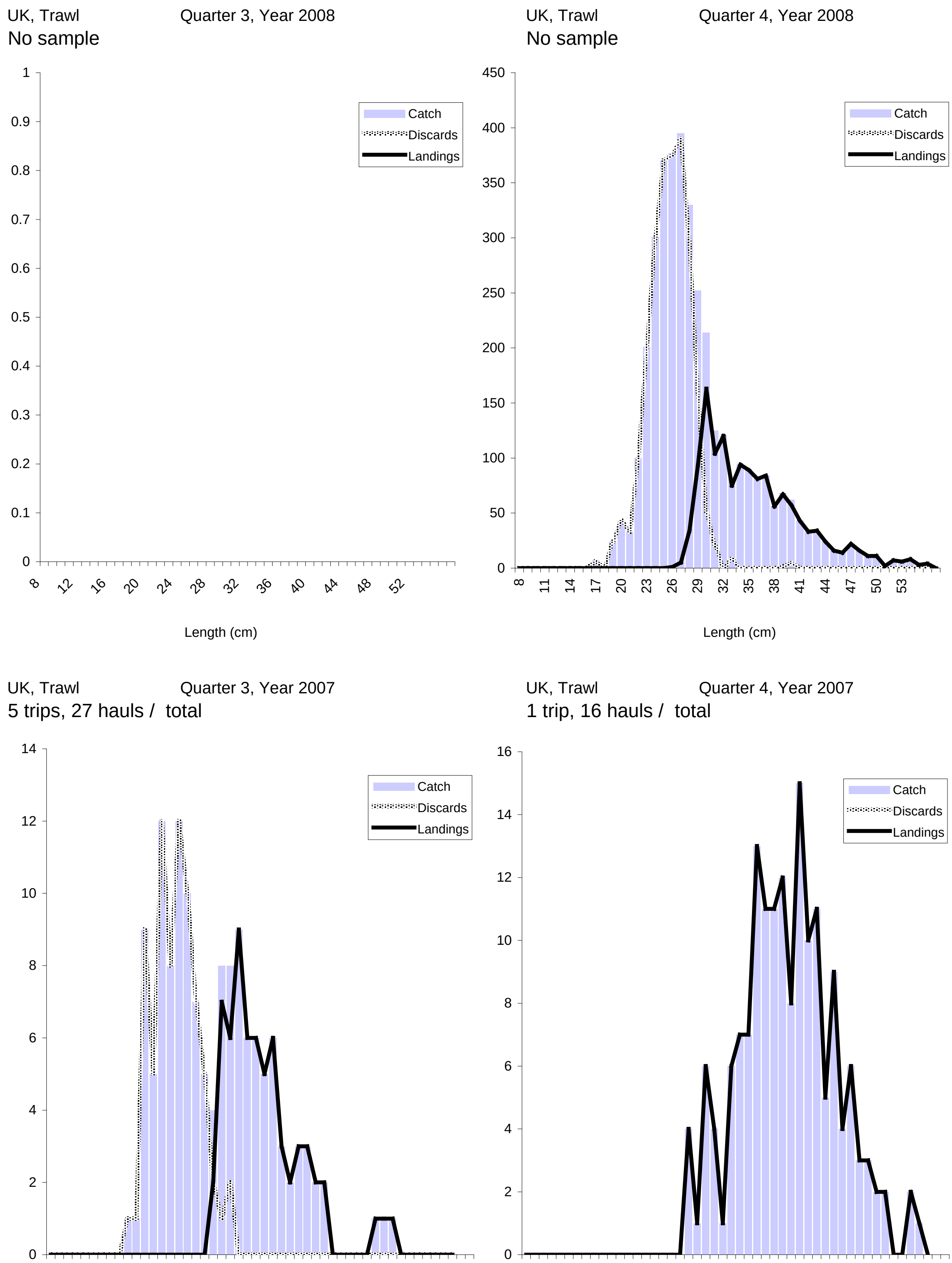


Figure 6.2.1.1a (cont.) - Plaice VIId - Length structure of discards and landings collected by observations on board

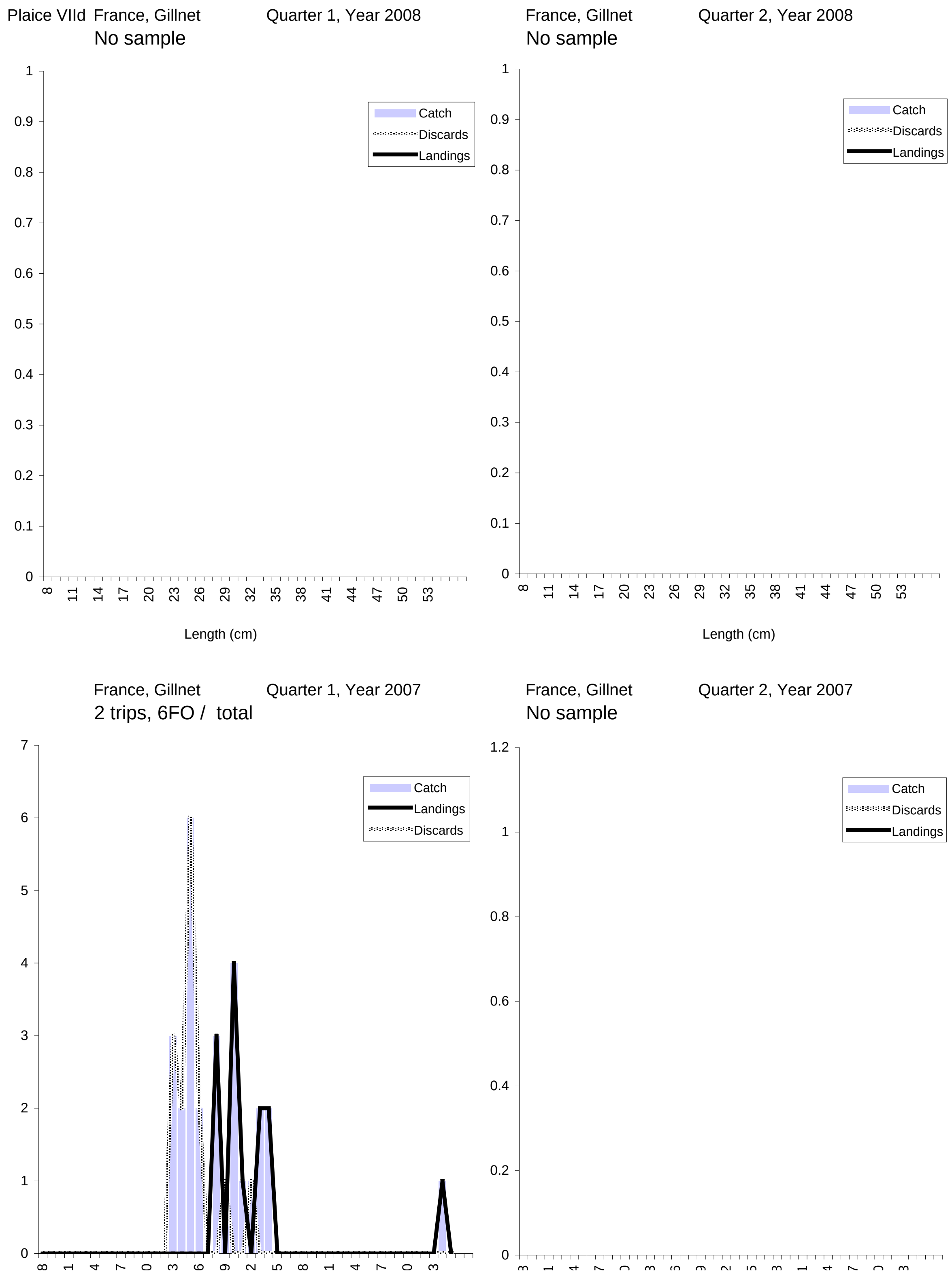


Figure 6.2.1.1b - Plaice VIId - Length structure of discards and landings collected by observations on board

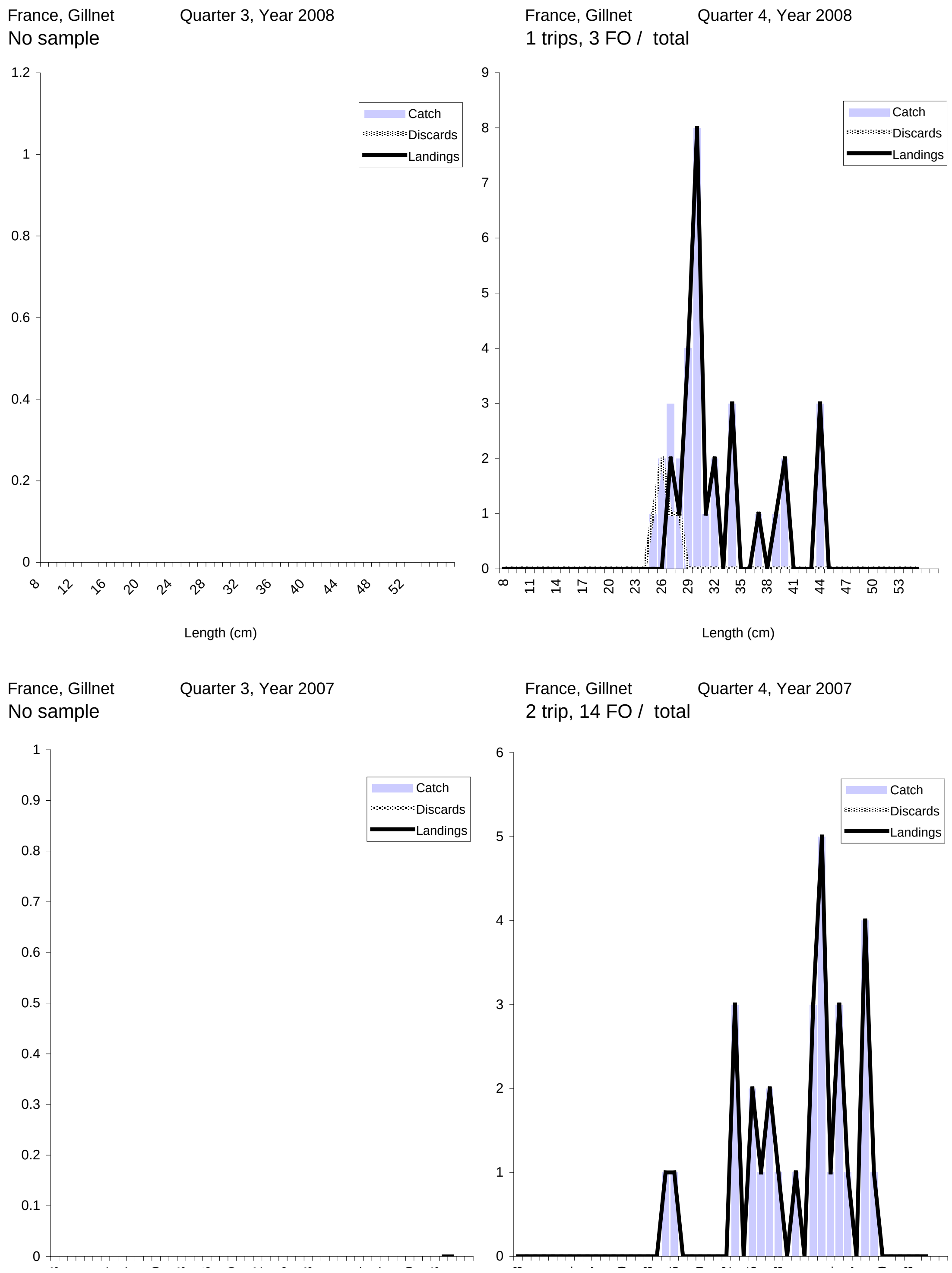


Figure 6.2.1.1b (cont.) - Plaice VIId - Length structure of discards and landings collected by observations on board

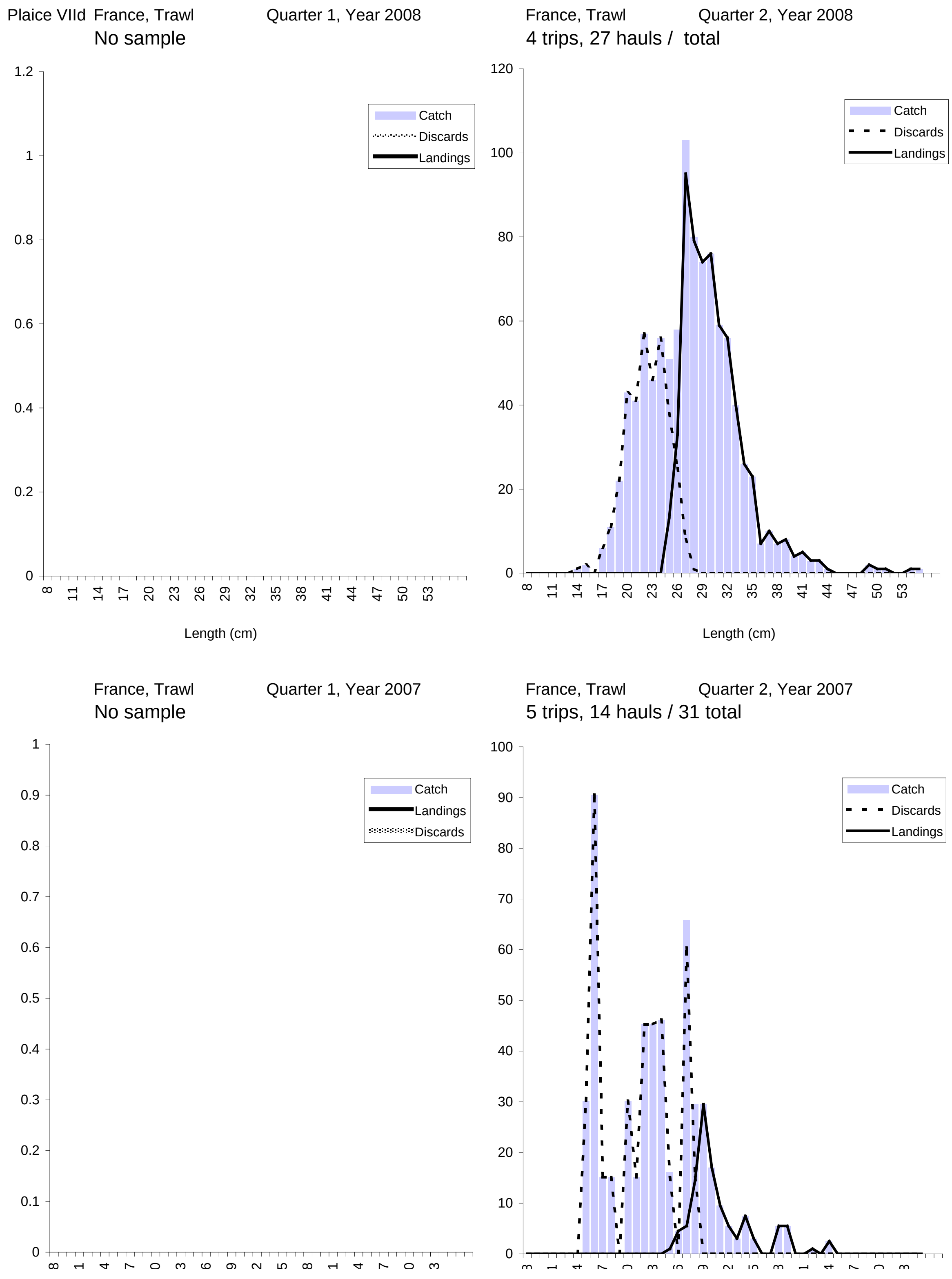


Figure 6.2.1.1c - Plaice VIId - Length structure of discards and landings collected by observations on board

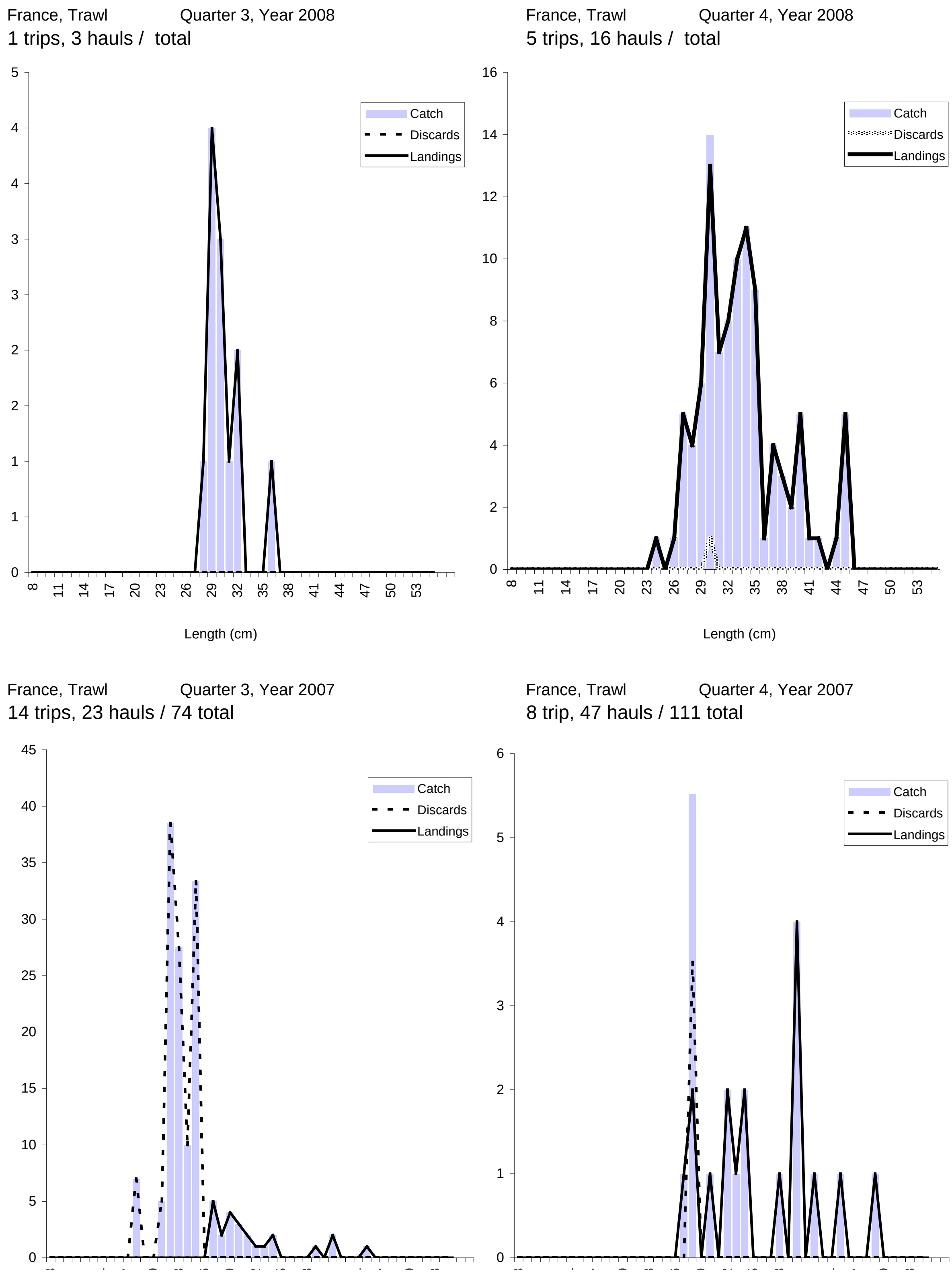


Figure 6.2.1.1c (cont.) - Plaice VIId - Length structure of discards and landings collected by observations on board

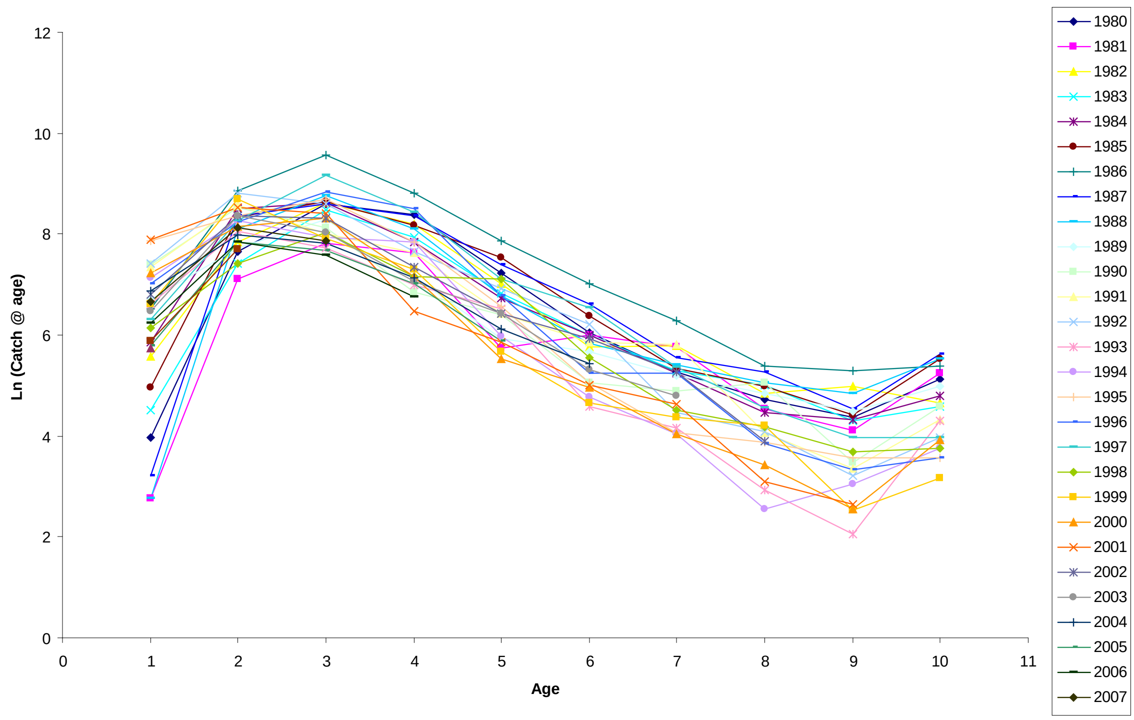


Figure 6.2.1.2a. Plaice in VIId. Catch curves by year class.

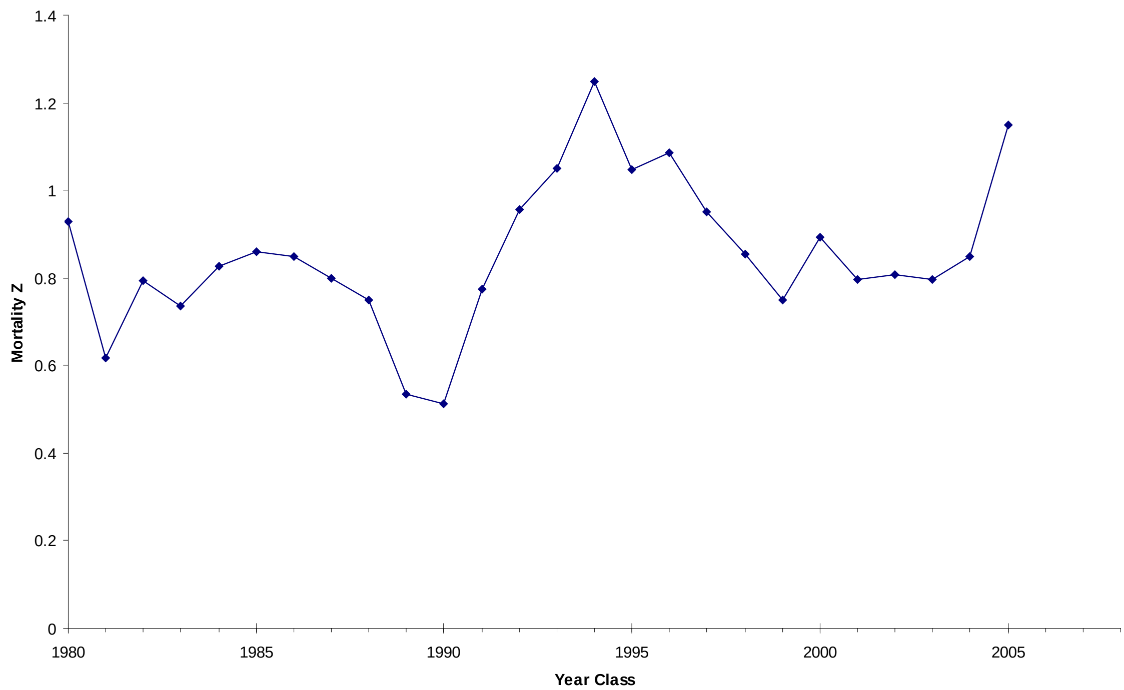


Figure 6.2.1.2b. Plaice in VIId. Evolution of fish mortality.

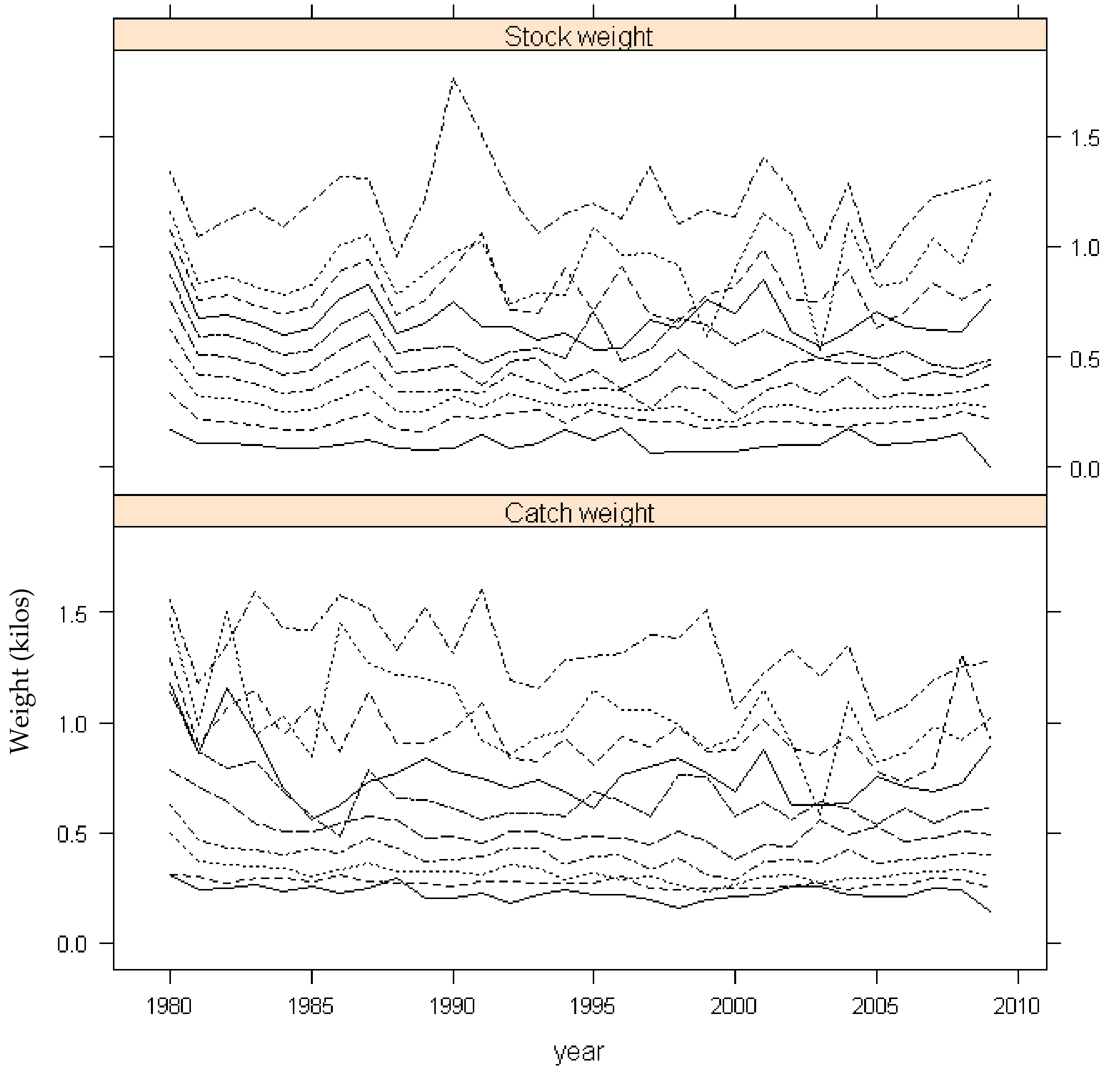


Figure 6.2.3.1. Plaice in VIId. Stock and Catch weight

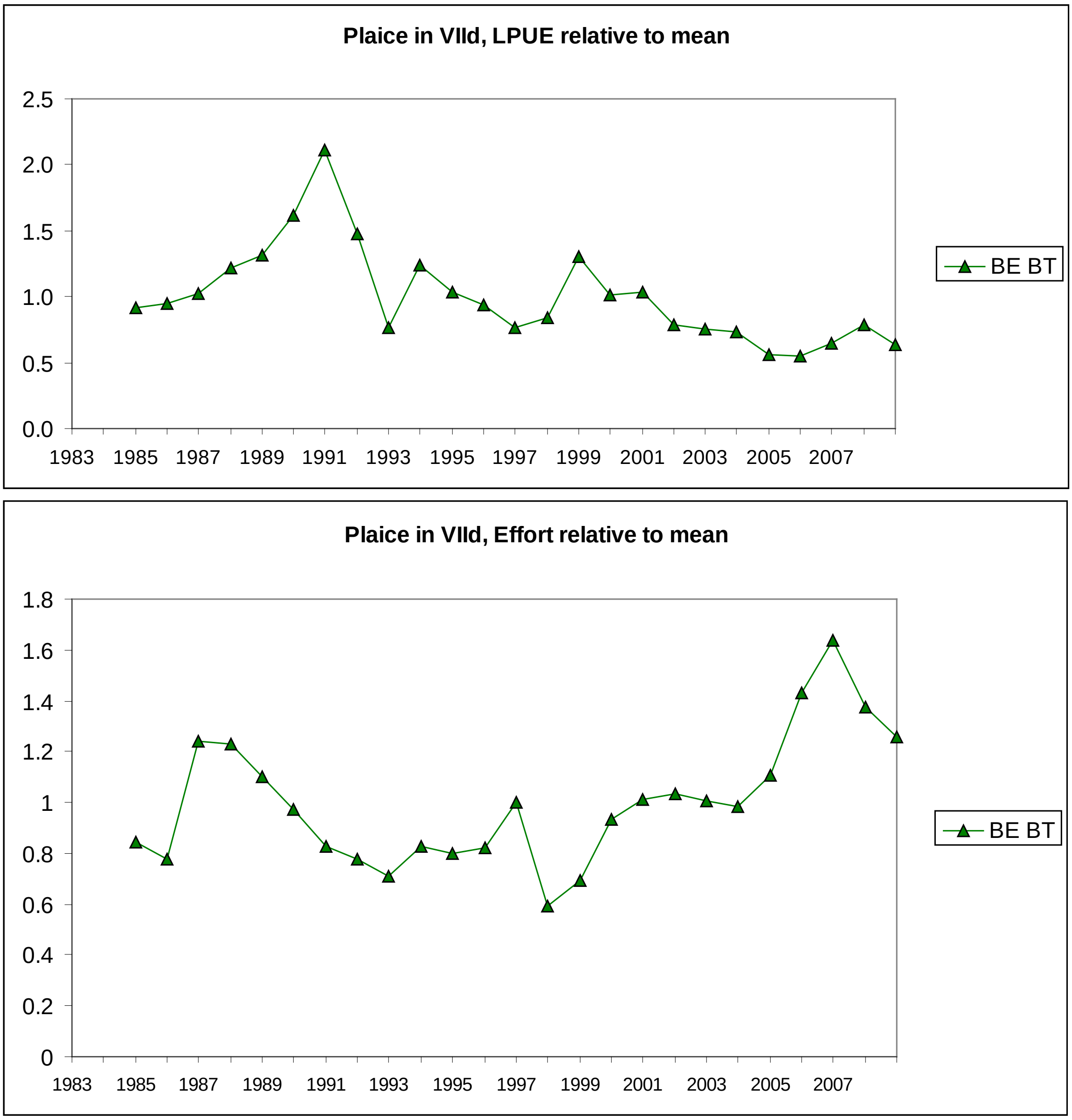


Figure 6.2.5.1 - Plaice in VIId. LPUE and effort

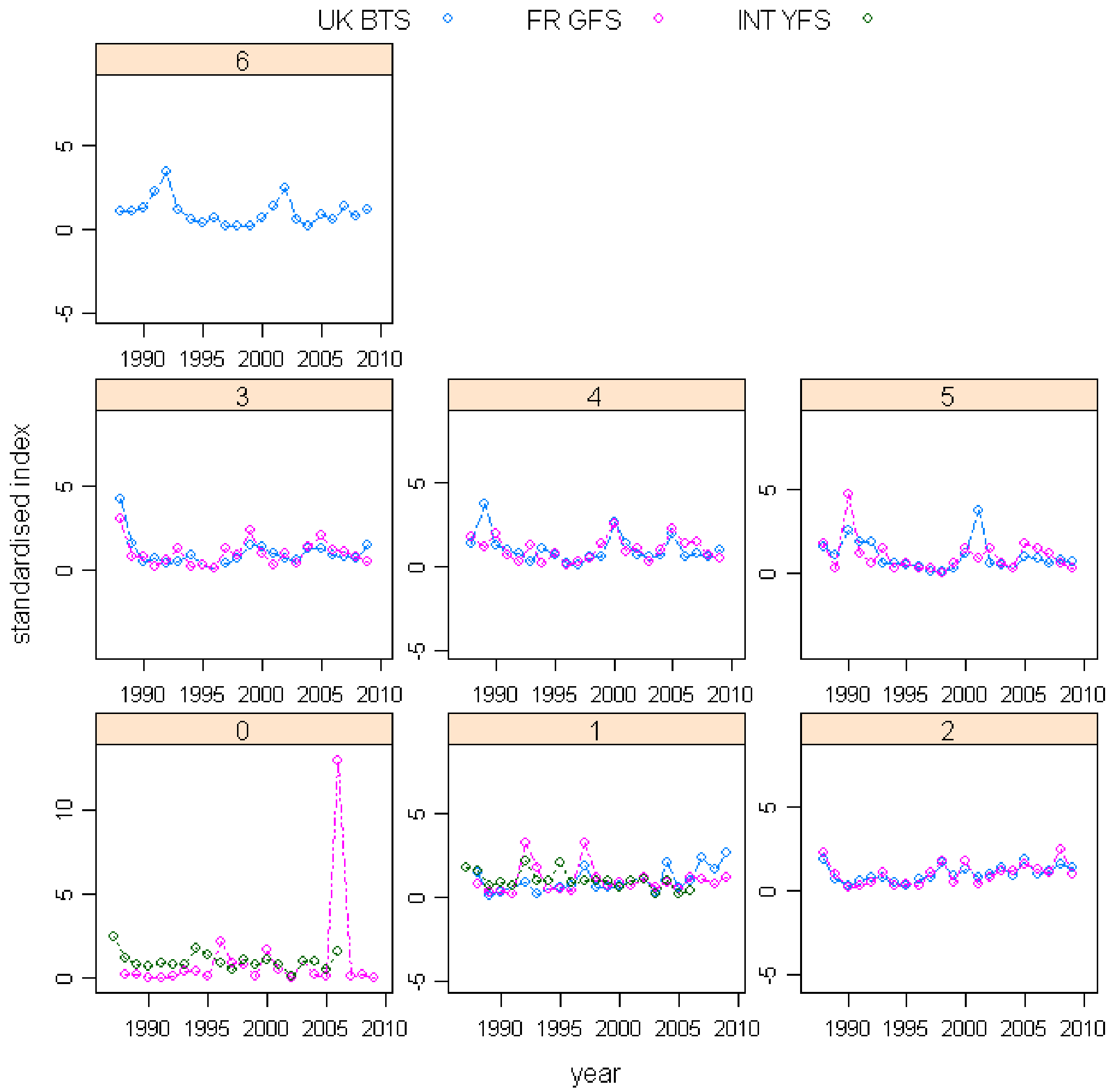


Figure 6.2.5.2. Plaice in VIId. Between survey consistency. Mean standardised indices by surveys for each age

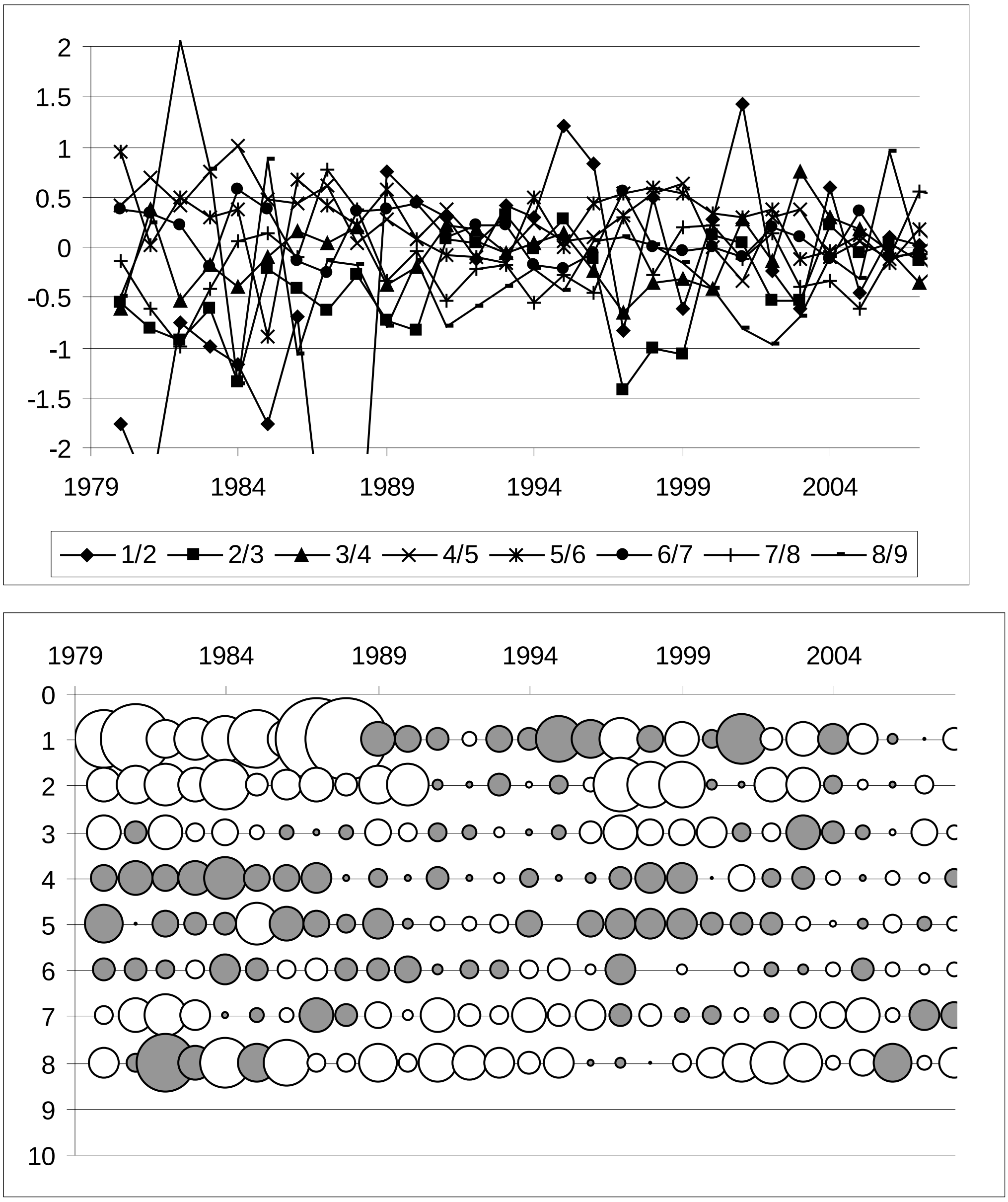


Figure 6.3.2.1 - Plaice in VIId. Separable VPA

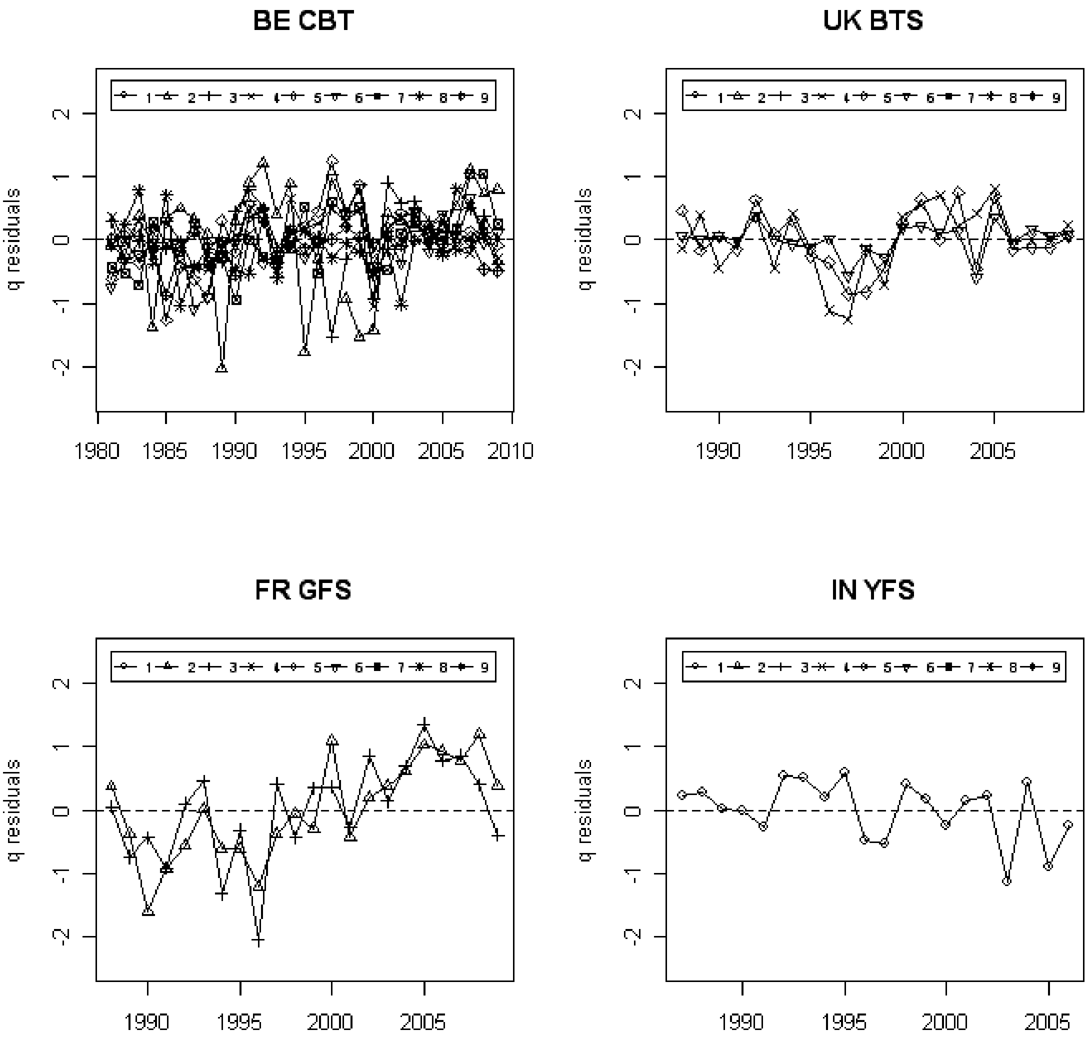


Figure 6.3.2.2. Plaice in VIId. Log q residuals for the single fleet runs (XSA settings and F shrinkage = 1.0)

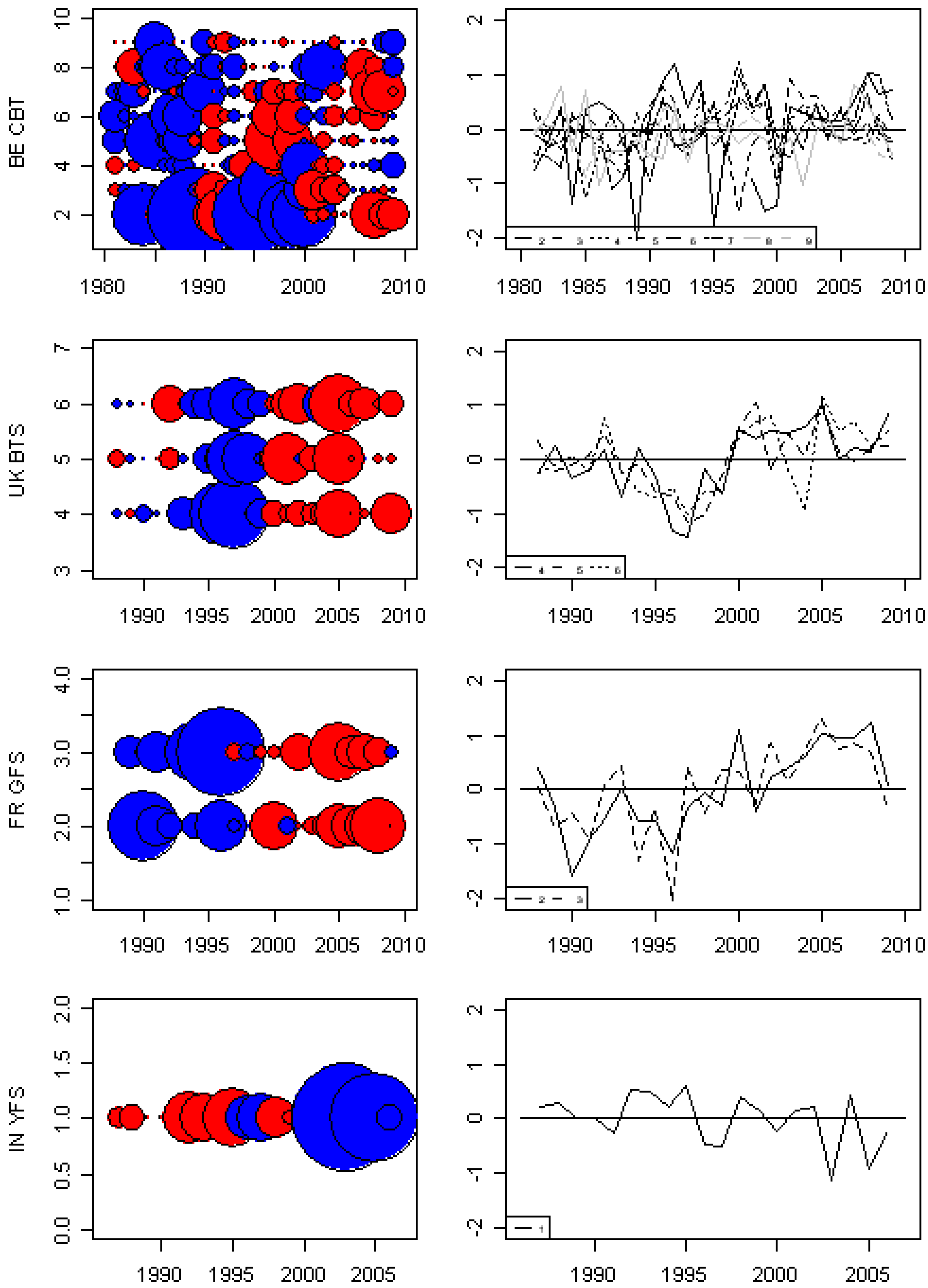


Figure 6.3.2.3. Plaice in VIId. Log q residuals. All fleets combined. Settings as proposed section 6.3.5.

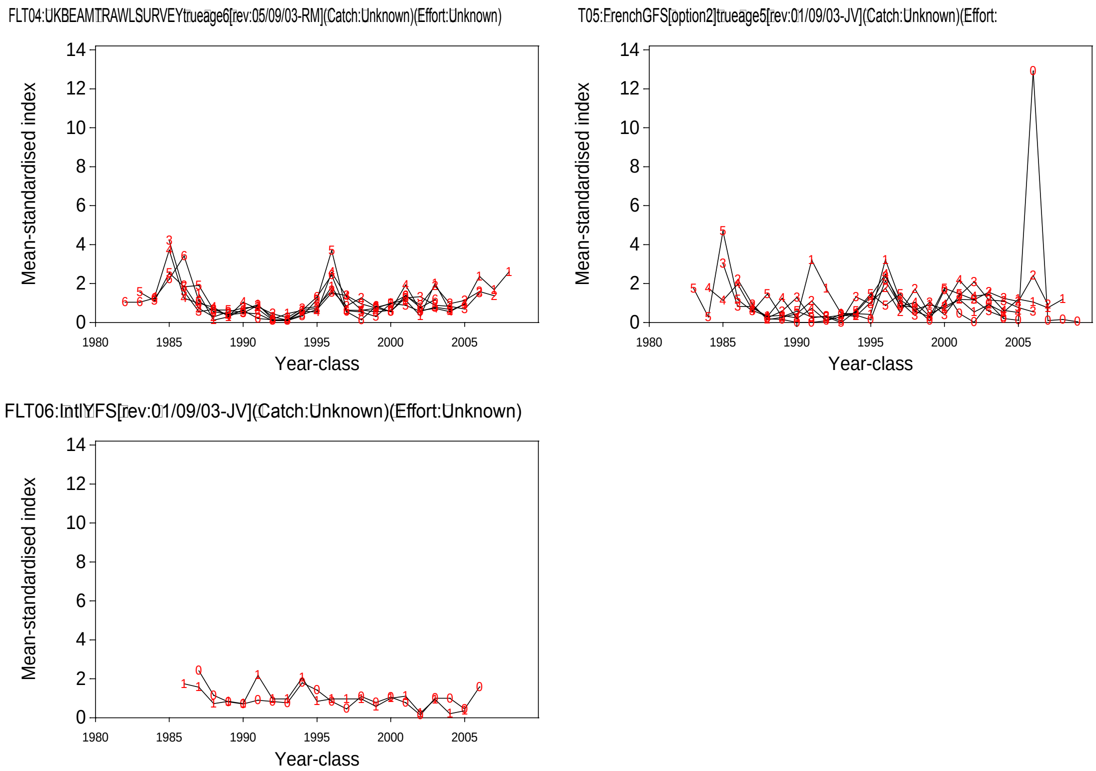


Figure 6.3.3.1. Plaice in VIId. Within survey consistency. Mean standardised indices by year class for each of the surveys.

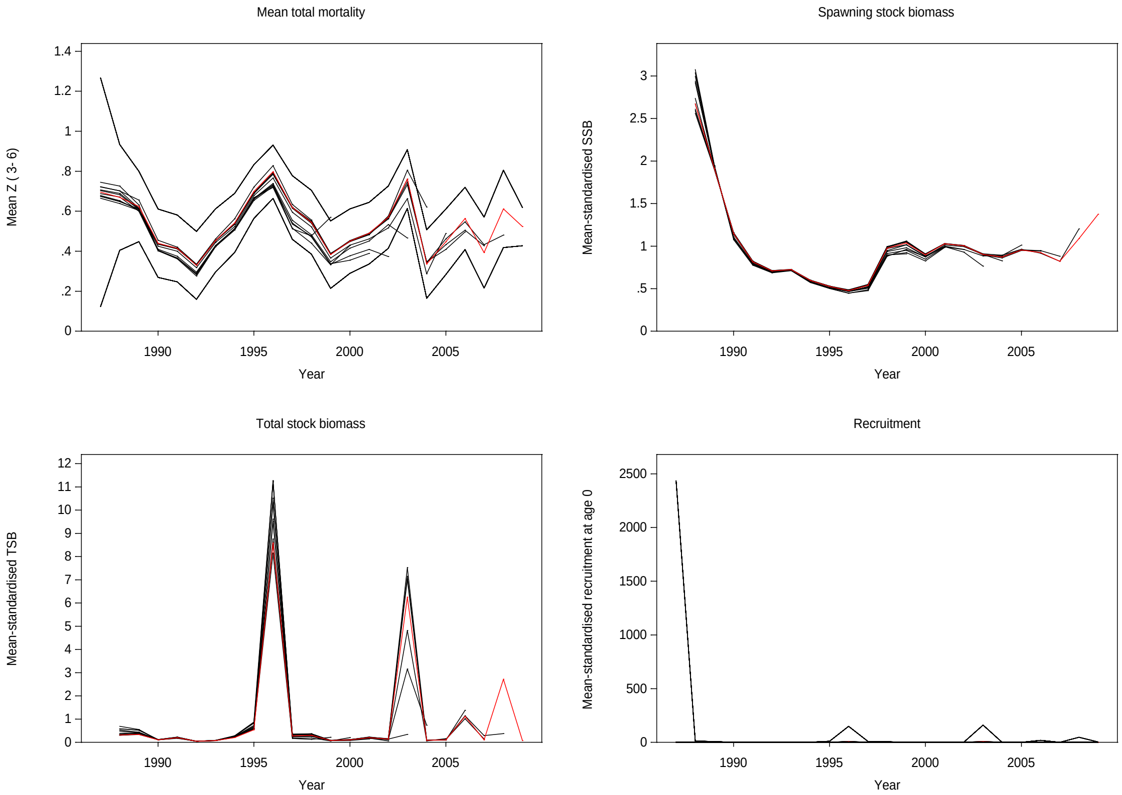


Figure 6.3.3.2. Plaice in VIId. Summary plots of the retrospective analysis from SURBA

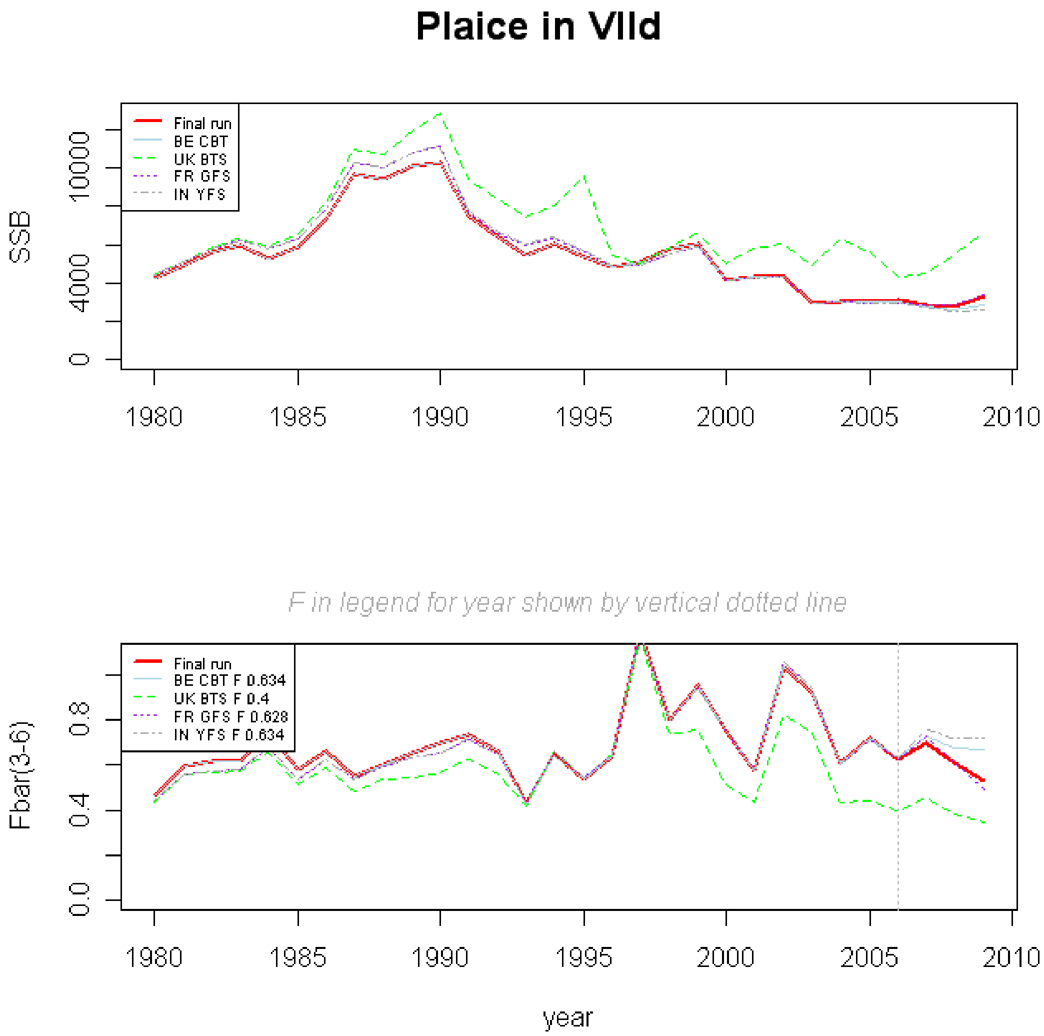


Figure 6.3.4.1. Plaice in VIId. Individual fleet historical performance.

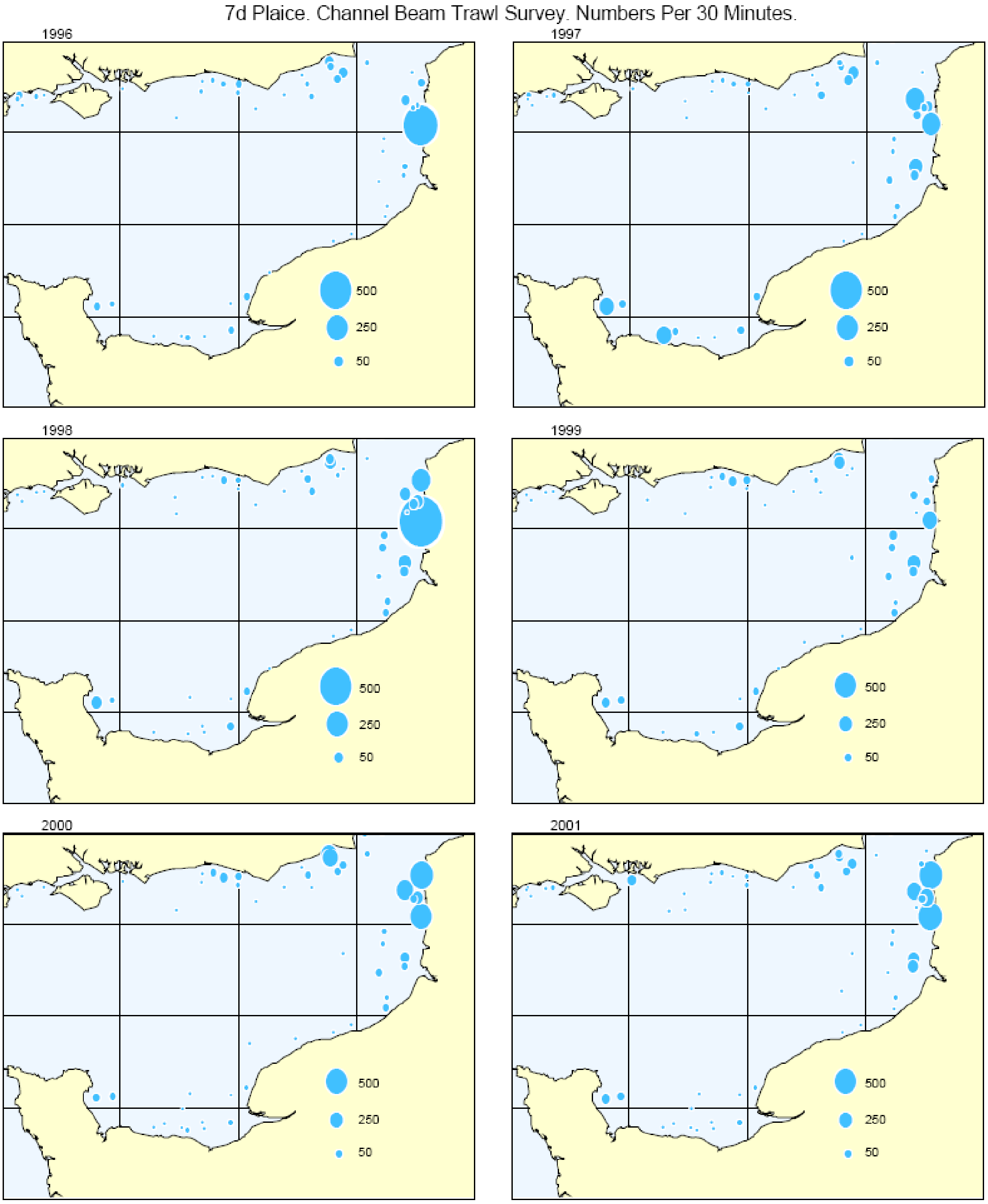


Figure 6.3.4.2. Plaice in VIId. Locations of tows and relative indices of the UK BTS survey from 1996 to 2006.

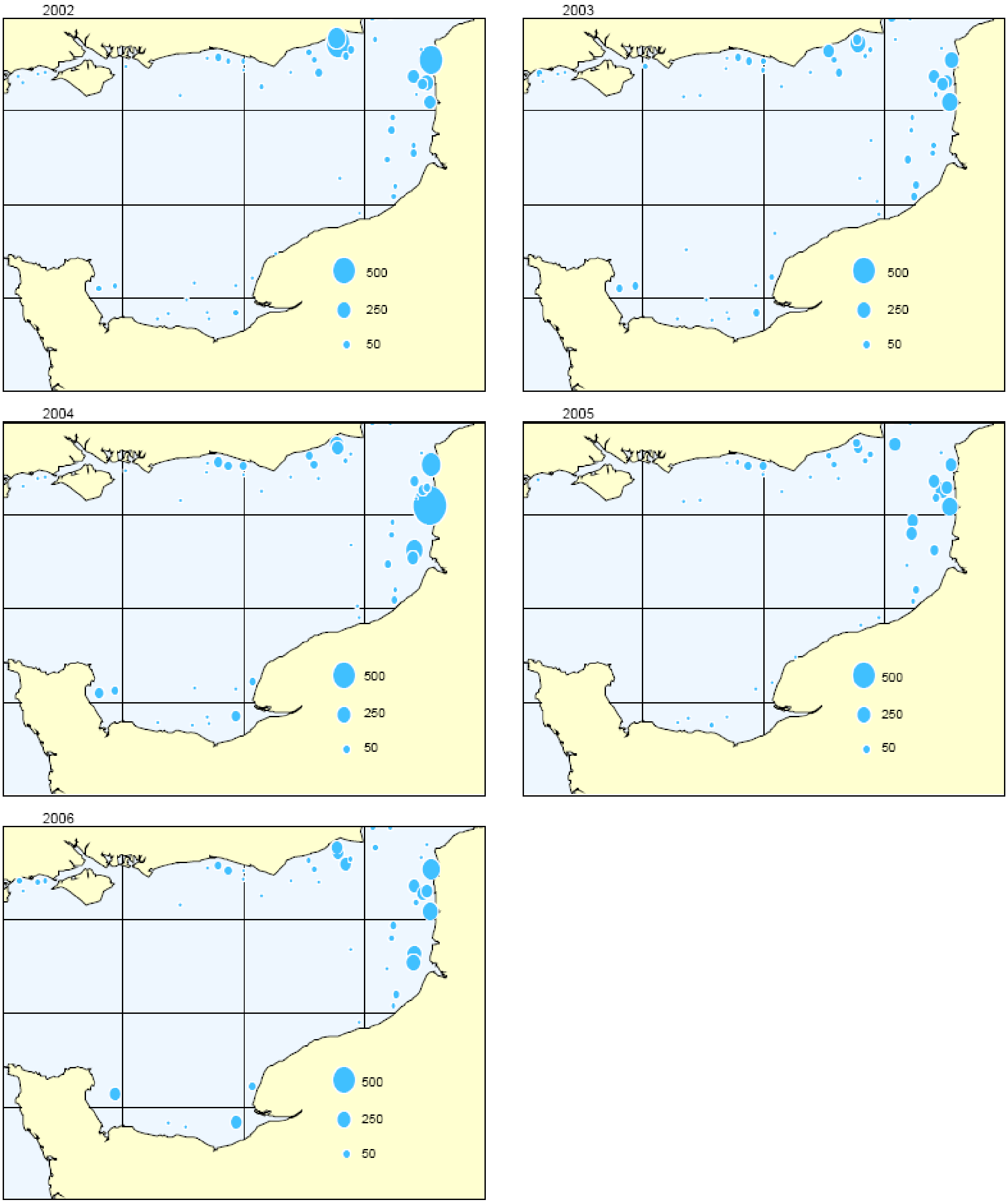


Figure 6.3.4.2. Plaice in VIId. Locations of tows and relative indices of the UK BTS survey from 1996 to 2006.

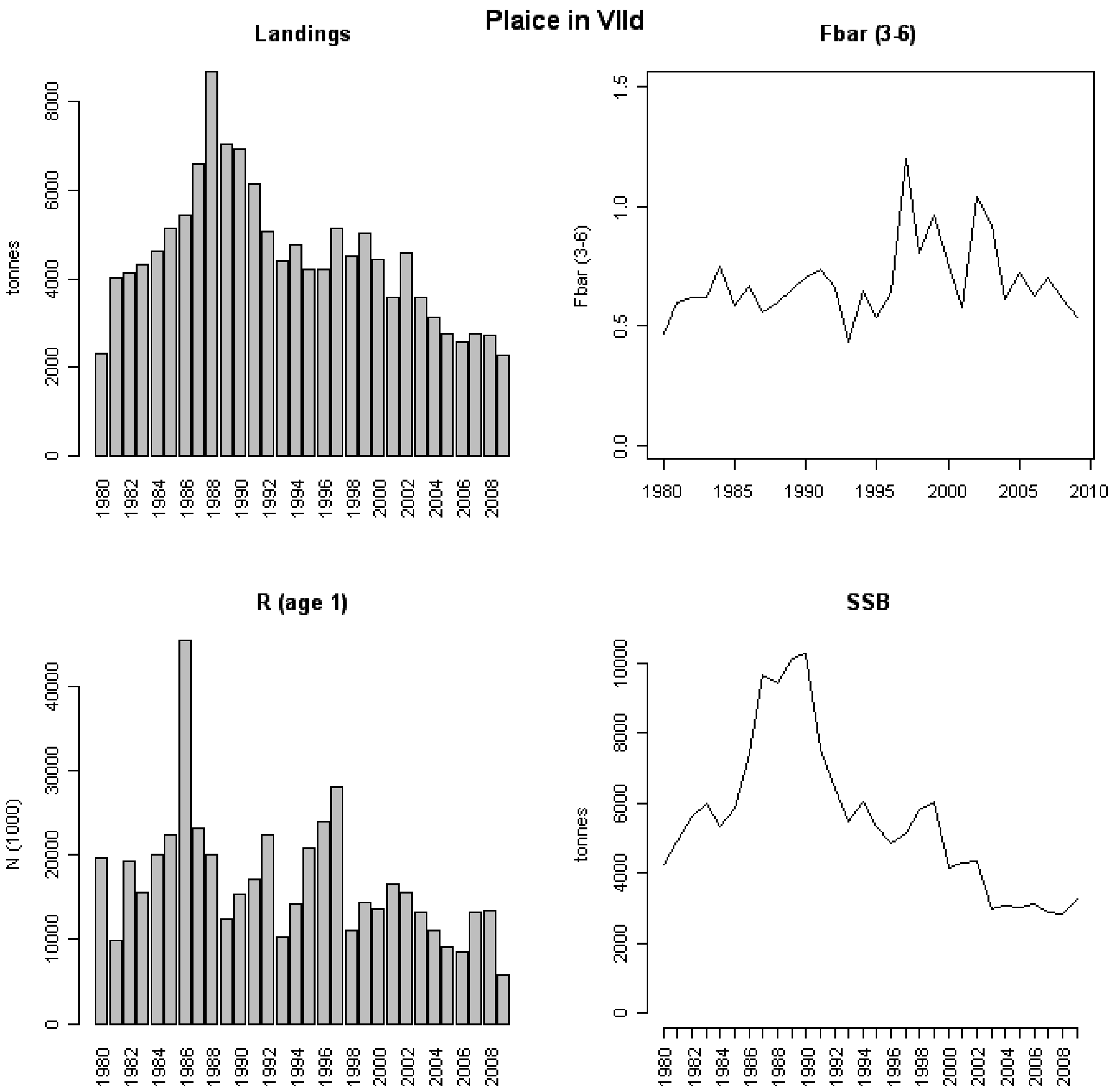


Figure 6.3.5.4. Plaice in VIId. Summary of assessment results

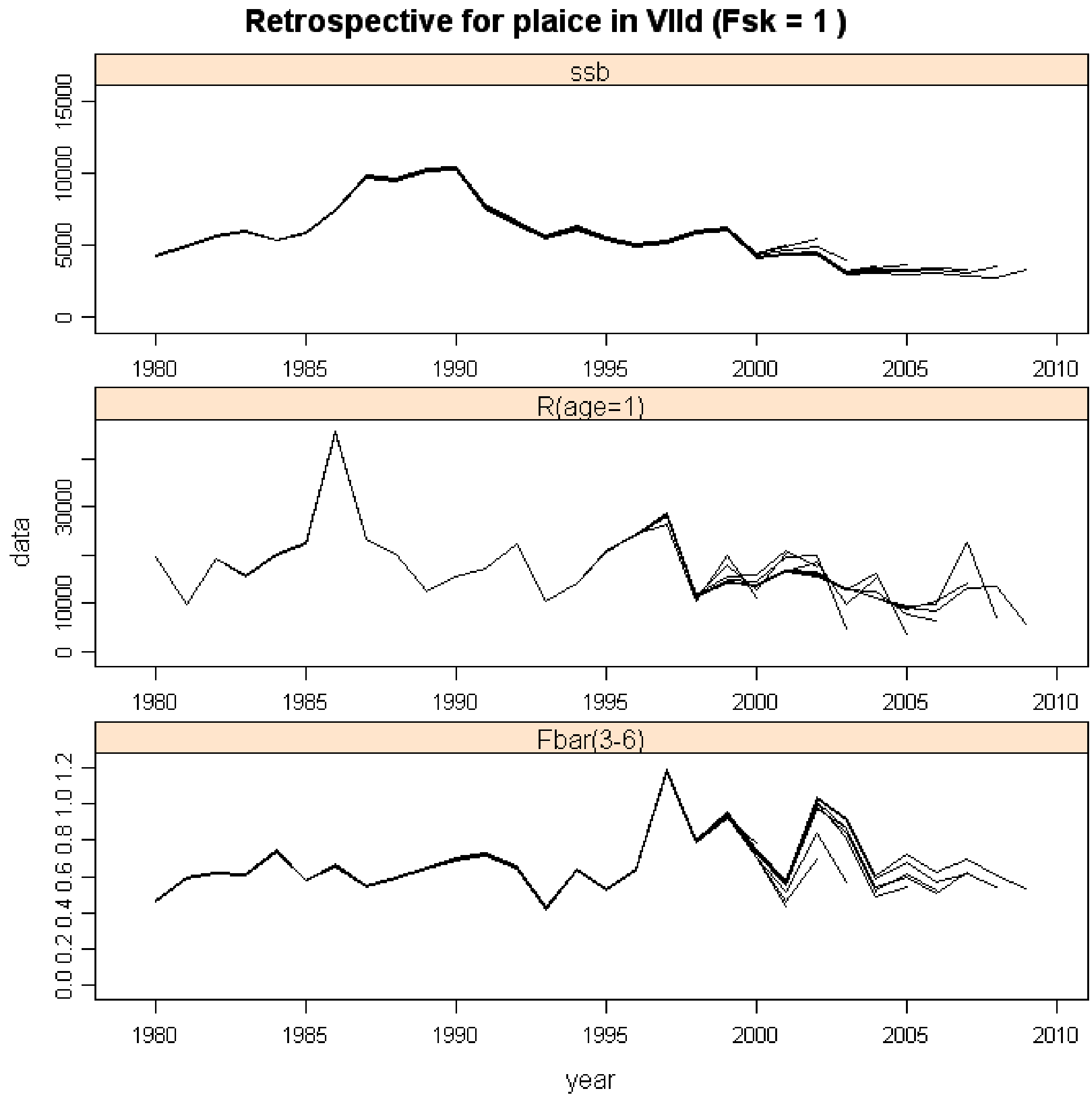


Figure 6.3.5.5 Plaice in VIId. Retrospective analysis

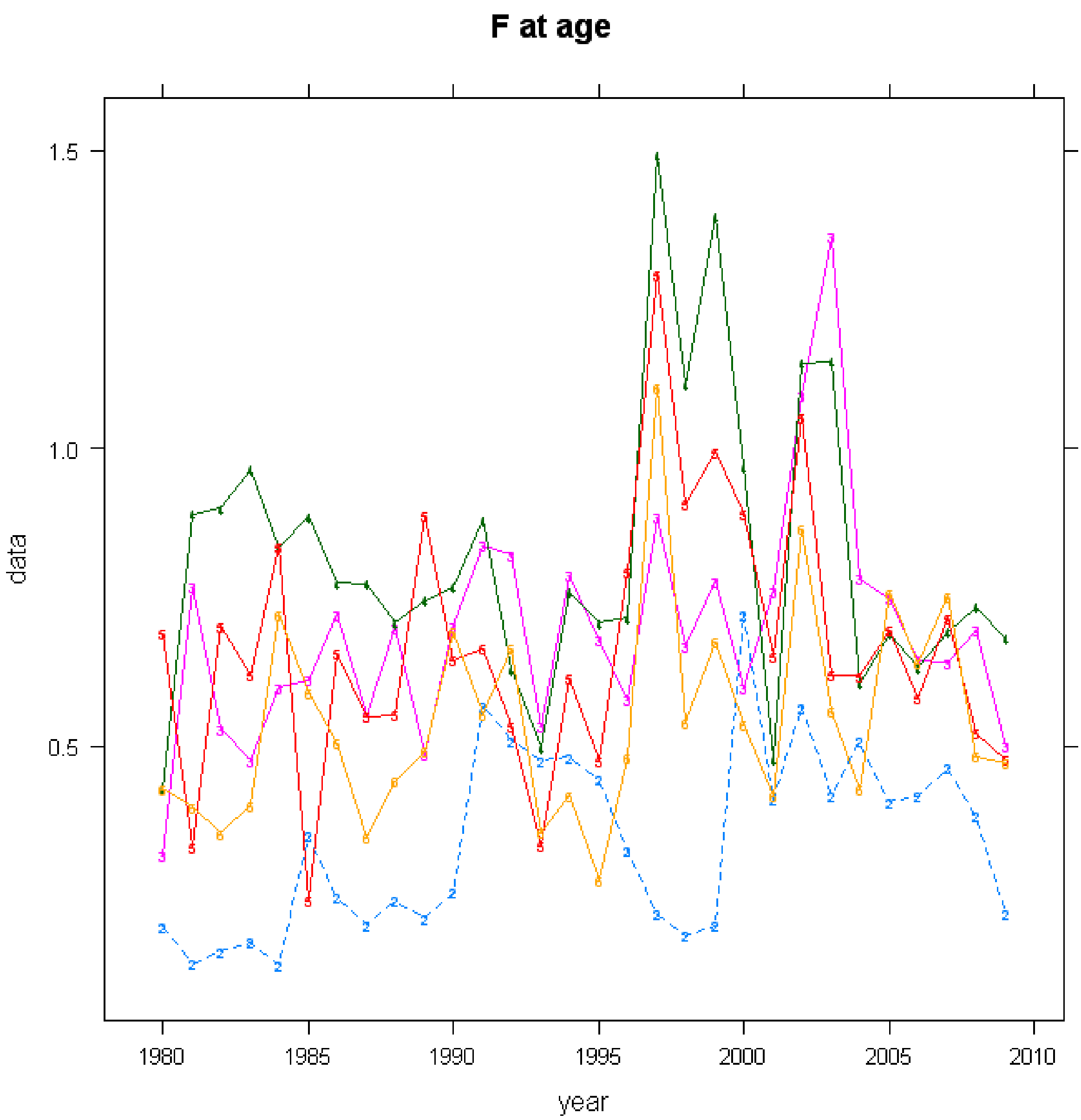


Figure 6.6.1 Plaice in VIId. Trends in F (Age 2 to 6)

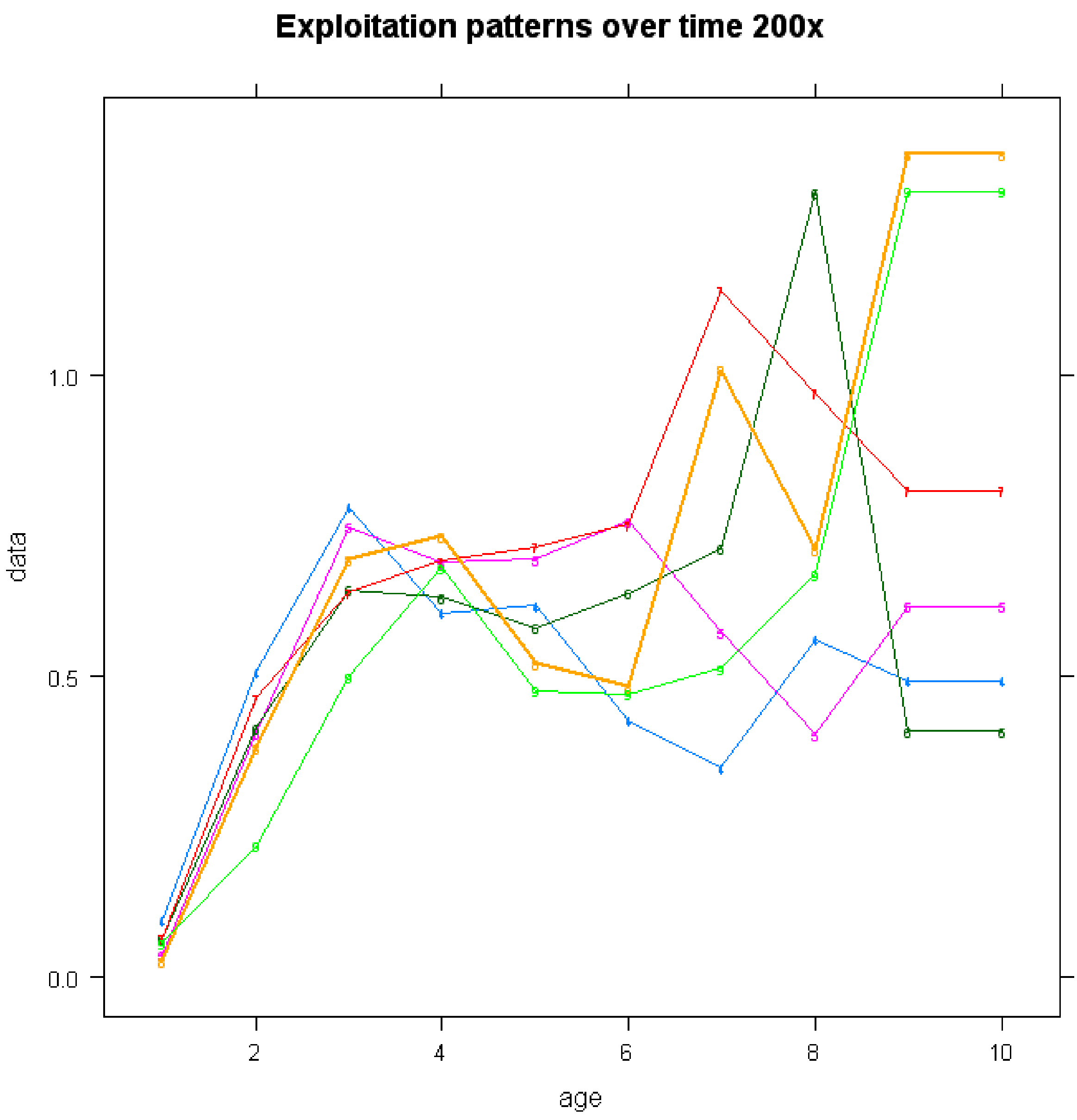


Figure 6.6.2 Plaice in VIId. Exploitation patterns over the last 6 years

7 Plaice in IIIa

This year, exploratory analyses were conducted with XSA, SAM and SURBA, but no final assessment was produced.

A large number of issues were investigated during WG sessions in 2006, 2007, and 2009 but the last analytical assessment accepted by the WG was in 2004.

The assessment of this stock suffers from a number of issues, mainly dealing with (i) catch at age information and (ii) survey spatial coverage. Catch at age issues relate both to the fisheries mainly taking place in the South-Western entrance of Skagerrak where some mixing may occur with North Sea plaice, and to large intrinsic variability in growth within the distributional area, which may not be sufficiently covered by the sampling. Survey issues arise from the survey stations exclusively sampling the Eastern side of the stock distribution where only limited fishing occurs.

These issues cannot be easily addressed through a standard benchmarking procedure and would require large-scale improvement in both commercial and survey sampling design. The WG considers that analytical assessment is not appropriate until these issues are solved.

Reflecting the uncertainty in data the standard trial runs performed by this year's WG showed large fluctuations in F and SSB and large retrospective patterns in F.

7.1 Ecosystem aspects

A general description of the ecosystem is given in the Stock Annex.

7.1.1 Fisheries

A general description of the fishery is given in the Stock Annex.

Technical Conservation Measures

Minimum Landing Size is 27 cm.

Closed areas were implemented by Denmark and Sweden in the Southeast Kattegat and North of Oresund from the fourth quarter of 2008, with the aim of protecting spawning cod. Two smaller areas are to be closed on a permanent basis while one large area is to be closed during the first quarter only.

Changes in fleet dynamics

Implementation of a number of changes in the regulatory systems in the Kattegat and Skagerrak between 2007 and 2008 (see also 7.1.4 and 7.2.4) may have significantly changed the fishing patterns of the Danish and Swedish fleets, thereby affecting their consistency as tuning fleets. Two of these fleets are still used as tuning indices in the exploratory assessments, but this should be further investigated in future assessment.

Fisheries Science Partnerships

No Fisheries Science Partnerships are applicable for this stock

Additional information provided by the fishing industry

7.1.2 ICES Advice

In 2007 ICES noted that there were indications that the biomass and recruitment had increased in the recent years. There were no indications that the current catch level was detrimental to the stock and therefore the advice for 2008 was not to increase the catches above the most recent (2006) catch at 9400 t. In 2008, 2009 and 2010 the data available gave no reason to change the advice from 2007. The advice for the fishery in 2011 is therefore the same as the advice given since 2007: "Landings should not exceed the level recorded in 2006 at 9400 t."

7.1.3 Management

There are no explicit management objectives for this stock.

TAC in 2009 was 11 688 t, which is similar to the TAC 2008. The TAC was split between Skagerrak and Kattegat, with 9 350 t and 2 338 t, respectively. In most years the combined TAC for the area has been largely higher than the actual landings estimates. (Figure 7.1.1). In 2009 65% of the TAC in Skagerrak and 28% of the TAC in Kattegat were taken (Table 7.1.4).

Effort in plaice IIIa fisheries has been regulated through the implementation of a days-at-sea regulation for the cod recovery plan and fishing effort limitation of the long term management plan (EC Council Regulation No. 2056/2001; EC Council Regulation No 676/2007; EC Council Regulation 40/2008).

From 2009 the fishery was regulated by Council Regulation (EC) N°43/2009 allocating different amounts of Kw*days by Member State and area to different effort groups of vessels depending on gear and mesh size. The areas are Kattegat, part of IIIa not covered by Skagerrak and Kattegat, ICES zone IV, EC waters of ICES zone IIa, ICES zone VIId, ICES zone VIIa, ICES zone Via and EC waters of ICES zone Vb. The grouping of fishing gear concerned are: Bottom trawls, Danish seines and similar gear, excluding beam trawls of mesh size: TR1 (≤ 100 mm) – TR2 (≤ 70 and < 100 mm) – TR3 (≤ 16 and < 32 mm); Beam trawl of mesh size: BT1 (≤ 120 mm) – BT2 (≤ 80 and < 120 mm); Gill nets excluding trammel nets: GN1; Trammel nets: GT1 and Longlines: LL1.

In addition to these common European rules, additional national management actions have been implemented, with the specific aim of protecting spawning cod in the Kattegat. In 2008, a new effort restriction system was implemented both in Denmark and Sweden according to which one day present in the Kattegat during the period 1 February 2008 to 30 April counted as 2.5 days. This regulation ceased January 1, 2009 with the introduction of new regulations using KW days and closed areas. In 2008 the WGBFAS noted that due to these effort restrictions, the usage of *Nephrops* trawls equipped with species sorting grid (which allows most cod to escape from the trawl) increased considerably in the Swedish fishery, as this type of trawl is not effort regulated. This change in fishing pattern is believed to have reduced cod discards (WGBFAS 2008).

Finally, in 2007, a new rights-based regulation system was introduced in Denmark for the allocation of national quotas. Before that year the quotas were split into 14-days rations which were continuously adjusted to the amount of quota left. In 2007 this system was changed to a complex system were individual rights are attached to the vessels and not to the owners (FKA - Vessel Quota Share), with specific provisions for coastal and recreational fisheries. 2007 was considered a transition year to the new system. It is acknowledged that this complex system may have dramatically affected the structure of Danish fisheries, but no quantitative analyses were made available.

7.2 Data available

7.2.1 Catch

The official landings reported to ICES are given in Table 7.1.1. The annual landings used by the Working Group, available since 1972, are given by country for Kattegat and Skagerrak separately in Tables 7.1.2 and 7.1.3. At the start of this period, landings were mostly taken in the Kattegat but from the mid-1970s, the major proportion of the landings has been taken in Skagerrak may be due to the restrictive management measures implemented in the Kattegat to protect spawning cod.

According to official national statistics, total landings in 2009 were estimated at 6 696 t, 25% lower than in 2008.

Previously, misreporting had been considered to potentially occur in the area between the North Sea and the Skagerrak. Fish taken in ICES rectangle 43F8 for example can be reported as coming from either of the two areas. In recent years a substantial part of the landings from that rectangle has been reported as being caught in Skagerrak. But information from the fishery suggests that the fishery really takes place in the Skagerrak part of the rectangle, and that there is currently no incentive for mis-reporting either from Div. IV to IIIa or vica versa. However, this particular rectangle represents a very large part of the landings for this stock (Figure 7.2.1), and small relative errors in catch allocation to one or another stock following administrative boundaries may potentially lead to dramatic variations in the catch information. Additional checks should be performed using VMS data in a future benchmark assessment.

Danish and Swedish sampling levels for IIIaN and IIIaS are available in Section 1.2, and landings at age are presented on Figure 7.2.2.

Discards time series from Denmark and Sweden over 2002-2009 were made available to the WG (second semester 2004 data missing for Sweden). Total amount was estimated between 1 500 to 2 600 tonnes by year, corresponding to 15-25 % of the catch in weight (Table 7.2.3).

Since 2004, Denmark and Sweden have put a significant amount of effort into increasing the quality of age reading for plaice in IIIa through a series of workshops and otolith exchanges between age readers. Significant improvement in the consistency have been reached, although some uncertainties remain, particularly for Kattegat plaice and for fish older than 6.

It is thus considered that the variability of growth is a more important source of uncertainty in the catch matrix than the age reading process in itself. A thorough analysis of the extent and stratification of the national sampling programs (for Denmark in particular) should be conducted in order to reduce the confidence interval of length distribution at age.

Landings and discards at age were raised using ICES InterCatch database.

7.2.2 Weight at age

Weight at age in landings is presented in Table 7.2.2 and Figure 7.2.3. The procedure for calculating mean weights was revised in 2006 and is described in the Stock Annex. Weight at age in discards is presented in Table 7.2.5 and Figure 7.2.4.

7.2.3 Maturity and natural mortality

Natural mortality is assumed constant for all years and is set at 0.1 for all ages.

The maturity ogive was revised during the 2006 WG, and uses a fixed value per age based on 1994-2005 average of IBTS 1st quarter data. (Table 7.2.7)

7.2.4 Catch, effort and research vessel data

The description of tuning fleets is given in the Stock Annex.

There is no evidence of major issues with regards to misreporting in this stock. However, a number of issues remain for the reliability of the two commercial tuning fleets. First, most fisheries take place in the rectangle 43F8 at the border between Skagerrak and the North Sea, and the catches may include an unknown level of individuals belonging to the North Sea stock. Increased concentration of effort on the Skagerrak side of the border may also have occurred based on regulatory opportunities, such as higher TAC and reduced number of days at sea allowed, creating incentives for selecting fishing grounds closer to the homeport. Second, Danish fisheries have been through dramatic changes since 2007, with the introduction of FKA (Vessel Quota Share) and more recently, the implementation of closed areas and KWdays from 2009. This may have affected the efficiency of the plaice fishery. No further investigations have been made so far, but LPUEs in both 2008 and 2009 were higher than during the recent past (Figure 7.2.7 and 7.2.8).

In 2007 the WG discussed the limited spatial coverage of the four surveys with regards to main fishing grounds. IBTS sampling in Skagerrak is mostly limited to the Eastern part around Skagen in Northern Denmark, (Figures 7.2.5 and 7.2.6) while most of the fisheries take place in the North Western area close to the North Sea border. This has not been addressed further yet.

In addition, some intersessional work on the reconstruction of Swedish surveys since 1901 (Cardinale et al., 2009) have evidenced a decrease in the stock abundance on the Eastern side of the stock distribution over the XXth century, but no sign of impaired recruitment across the time series. Largest recruitment indices were indeed mostly observed over the latest time period.

7.3 Data analyses

7.3.1 Catch-at-age matrix

The Landings-at-age matrix is shown on the figure 7.2.2. The matrix shows a limited ability to track down the cohorts over time. Year classes 2001 and 2003 were tracked as relatively large

7.3.2 Catch curve cohort trends

Log Catch curves by cohort (figure 7.3.2) show an increasing steepness over the period 2000-2005, when the proportion of fish older than 6 years decreased in the catches. This pattern seems to be less pronounced over the last three years.

7.3.3 Tuning series

The commercial tuning series show the same limited internal consistency as the catch at age matrix, with limited tracking of the cohorts (Figure 7.3.4) whereas the surveys are more internally consistent (Figures 7.3.5. and 7.3.6).

7.4 Exploratory analysis

This year (similar to last year), the WG decided not to present a final assessment, but to run an exploratory assessment using all tuning series and following the settings described in the Stock Annex.

7.4.1 Exploratory XSA

The pattern in the residual plot (Figure 7.3.7) indicates a conflict between the scientific surveys and the commercial catch at age matrixes.

The retrospective plot of the assessment (Figure 7.3.8) indicates the dramatic variability in Fbar and the strong retrospective pattern in the estimates of recruitment and SSB.

7.4.2 Exploratory SAM analysis

An exploratory assessment was made with the SAM model using the same input data as applied in the XSA. The residuals (Figure 7.3.9) seemed less noisy than the residuals from the XSA run but the trends in SSB and F of the two approaches appear very different.

7.4.3 Exploratory Survey Based analysis

The average CPUE by survey were estimated using indices at age and stock weight at age (Figure 7.3.1). The four indices show a global CPUE increase in the period 2000-2006 compared to the nineties. 2006 is the highest level for all surveys, while 2007 was lower. 2008 indices are slightly inconsistent across surveys, since both spring surveys show a strong decrease to levels close to 1999 while the winter surveys show a relative increase compared to 2007. There is thus a larger uncertainty about the relative status in the Eastern component of the stock in 2008 compared to the last decade.

7.4.4 Conclusions drawn from exploratory analyses

The assessments in 2010 were exploratory only. The conflicting results from the different approaches with regard to F, SSB and R indicate that the data issues have not been resolved yet. The most important data issues would require in-depth intersessional work to be resolved, in particular with regards to sampling procedures and investigation of the stock origin of catches in the western Skagerrak / Northeastern North Sea. The WG still highlights these as necessary prerequisite in order to improve the quality of the plaice IIIa assessment

It is suggested that a Benchmark assessment for plaice in IIIa is scheduled for 2012.

7.4.5 Final assessment

The WG decided not to include a final assessment

7.5 Historic Stock Trends

No historical stock trends are available from the final assessment.

7.6 Recruitment estimates

Not available

7.7 Short-term forecasts

Not performed

7.8 Medium-term forecasts - none

7.9 Biological reference points

	ICES considers that:	ICES proposed that:
Precautionary Approach reference points	B_{lim} cannot be accurately defined.	B_{pa} = 24 000 t.
	F_{lim} cannot be accurately defined.	F_{pa} = 0.73.
Target reference points		F_y undefined.

Technical basis

	$\mathbf{B_{pa}}$ = smoothed $\mathbf{B_{loss}}$ (no sign of impairment).
	$\mathbf{F_{pa}} = \mathbf{F_{med}}$.

7.10 Quality of the assessment

The exploratory analyses indicated that the uncertainty in data remains to be solved.

The issues are primarily related to (i) catch at age information and (ii) survey spatial coverage. The catch at age issues relate both to the fisheries mainly taking place in the South-Western entrance of Skagerrak where some mixing may occur with North Sea plaice, and to large intrinsic variability in growth within the distributional area, which may not be sufficiently covered by the sampling. The survey issues arise from the survey stations sampling exclusively the Eastern side of the stock distribution where only limited fishing occurs.

7.11 Status of the Stock

It is not possible to provide a reliable status of the stock based on analytical assessment. However, a number of indicators tend to sustain the hypothesis that the stock is not exploited unsustainably. Landings have been stable over a long time period, and always lower than the TAC. The effort of commercial fleets has decreased, and LPUEs have been largely above average in 2008. There has never been sign of impaired recruitment. However, the Eastern component of the stock covered by the surveys may have declined compared to its highest level of 2006.

7.12 Management Considerations

In 2007, ICES identified key issues that would need to be resolved before reaching further improvements in the assessment. The various surveys give a reasonably consistent result for the eastern part of the area. The status of the western part is more uncertain, due to potential mixing with North Sea plaice and limited survey coverage. The landings-at-age matrix does not show proper tracking of the cohorts, probably due to i) mixing of the IIIa stock with the North Sea plaice stock on the main fishing ground in southwestern Skagerrak, and ii) age misspecification due to low sampling levels.

In 2010, The WG still considered these issues as outstanding. The Working group recommends therefore that scientific effort is conducted towards improvement of the biological knowledge on plaice in the South-Western area / Eastern North Sea. In particular, the harbour sampling program should be screened for reducing the uncertainty in growth variability, and methods should be developed to investigate the stock provenance of plaice catches in this area. Furthermore, survey coverage in that region should be strengthened.

However, the WG also considered some ways forward, for example by splitting the stock area into two management areas, for example one part covering the stock away from the mixing area (e.g. Eastern Skagerrak-Kattegat), where there would be potentially more precise information in the data for conducting a stock assessment, and a second part covering the mixing area, which could be considered as a data-poor area where specific management considerations could be developed. Following the conclusion of the WKFLAT 2010 it is recommended to explore the potential for performing a combined assessment of the continuum of plaice stocks from Kattegat to the English Channel. All this should be investigated in a future benchmark assessment, which has been proposed for 2012.

Additional considerations are given for this stock.

Plaice is taken both in a directed fishery and as an important by-catch in a mixed cod-*Nephrops*- plaice fishery. North Sea cod, which is estimated to be below $\mathbf{B}_{\mathrm{lim}}$, has a stock area that includes the Skagerrak (Division IIIaN). Kattegat cod is also well below $\mathbf{B}_{\mathrm{lim}}$ (Division IIIa South). Management of plaice in IIIa must therefore take account for state of the cod stocks.

There has been suspicion that restrictive by-catch rules on cod in Kattegat create a major incentive to misreport catches in the Western Baltic, although no evidence is available from the industry (ICES_WGBFAS 2008, 2009). The consequences for potential misreporting of plaice have not been investigated, but it is not considered as a major issue. The TAC for plaice is not restrictive, either in the Kattegat or in the Western Baltic, and the amount of landings are small in both areas compared to Skagerrak.

7.13 References

ICES 2008. Report of the Baltic Fisheries Assessment Working Group (WGBFAS), 8-17 April 2008, ICES Headquarters, Copenhagen. ICES CM 2008\ACOM:06. 692 pp.

ICES 2009. Report of the Baltic Fisheries Assessment Working Group (WGBFAS), 22-28 April 2009, ICES Headquarters, Copenhagen. ICES CM 2008\ACOM: (*not available yet*).

Table 7.1.1 Plaice in IIIa. Official landings in tonnes as reported to ICES and WG estimates, 1972-2009

Year	Denmark		Sweden		Germany		Belgium		Norway		Netherlands		Total			
	Official	WG est.	Official	WG est.	Official	WG est.	Official	WG est.	Official	WG est.	Official	WG est.	Official	Unalloc.	WG est.	TAC
1972		20,599		418		77				3					21,097	
1973		13,892		311		48				6					14,257	
1974		14,830		325		52				5					15,212	
1975		15,046		373		39				6					15,464	
1976		18,738		228		32		717		6					19,721	
1977		24,466		442		32		846		6					25,792	
1978		26,068		405		100		371		9					26,953	
1979		20,766		400		38		763		9					21,976	
1980		15,096		384		40		914		11					16,445	
1981		11,918		366		42		263		13					12,602	
1982		10,506		384		19		127		11					11,047	
1983		10,108		489		36		133		14					10,780	
1984		10,812		699		31		27		22					11,591	
1985		12,625		699		4		136		18					13,482	
1986		13,115		404		2		505		26					14,052	
1987		14,173		548		3		907		27					15,658	19,250
1988		11,602		491		0		716		41					12,850	19,750
1989		7,023		455		0		230		33					7,741	19,000
1990		10,559		981		2		471		69					12,082	13,000
1991		7,546		737		34		315		68					8,700	11,300
1992		10,582		589		117		537		106					11,931	14,000
1993		10,419		462		37		326		79					11,323	14,000
1994		10,330		542		37		325		91					11,325	14,000
1995	9,722	9,722	470	470	48	48	302	302	224	224			10,766	0	10,766	14,000
1996	9,593	9,641	465	465	31	11			428	428			10,517	28	10,545	14,000
1997	9,505	9,504	499	499	39	39			249	249			10,292	-1	10,291	14,000
1998	7,918	7,918	393	393	22	21			181	181			8,514	-1	8,513	14,000
1999	7,983	7,983	373	394	27	27			336	336			8,719	21	8,740	14,000
2000	8,324	8,324	401	414	15	15			163	163			8,789	127	8,916	14,000
2001	11,114	11,114	385	385	1	0			61	61			11,561	-1	11,560	11,750
2002	8,275	8,276	322	338	29	29			58	58			8,684	17	8,701	12,800
2003	6,884	6884	377	396	14	14			341	341	1494	1584	9,110	109	9,219	16,600
2004	7,135	7,135	317	244	77	77			106	106	1455	1511	9,090	-17	9,073	11,173
2005	5,605	5,619	244	244	21	47			116	116	808	915	6,794	147	6,941	9,500
2006	7,690	7,689	349	350	34	34			142	142	1,167	1,190	9,382	23	9,405	9,600
2007	6,665	6,664	333	331	31	31			99	100		1,659	7,128		8,785	10,625
2008	7,768	7,767	356	355	23	11			79	79	433	403	8,659	-44	8,615	11,688
2009		6,183		176		18				60		255			6,692	11688

Table 7.1.2 Plaice in Kattegat. Landings in tonnes Working Group estimates, 1972-2009

Year	Denmark	Sweden	Germany	Belgium	Norway	Total
1972	15,504	348	77			15,929
1973	10,021	231	48			10,300
1974	11,401	255	52			11,708
1975	10,158	296	39			10,493
1976	9,487	177	32			9,696
1977	11,611	300	32			11,943
1978	12,685	312	100			13,097
1979	9,721	333	38			10,092
1980	5,582	313	40			5,935
1981	3,803	256	42			4,101
1982	2,717	238	19			2,974
1983	3,280	334	36			3,650
1984	3,252	388	31			3,671
1985	2,979	403	4			3,386
1986	2,470	202	2			2,674
1987	2,846	307	3			3,156
1988	1,820	210	0			2,030
1989	1,609	135	0			1,744
1990	1,830	202	2			2,034
1991	1,737	265	19			2,021
1992	2,068	208	101			2,377
1993	1,294	175	0			1,469
1994	1,547	227	0			1,774
1995	1,254	133	0			1,387
1996	2,337	205	0			2,542
1997	2,198	255	25			2,478
1998	1,786	185	10			1,981
1999	1,510	161	20			1,691
2000	1,644	184	10			1,838
2001	2,069	260				2,329
2002	1,806	198	26			2,030
2003	2,037	253	6			2,296
2004	1,395	137	77			1,609
2005	1,104	100	47			1,251
2006	1,355	175	20			1,550
2007	1,198	172	10			1,380
2008	866	136	6			1,008
2009	570	84	5			659

* years 1972-1990 landings refers to IIIA

Table 7.1.3. Plaice in Skagerrak. Landings in tonnes. Working Group estimates, 1972-2009

Year	Denmark	Sweden	Germany	Belgium	Norway	Netherlands	Total
1972	5,095	70			3		5,168
1973	3,871	80			6		3,957
1974	3,429	70			5		3,504
1975	4,888	77			6		4,971
1976	9,251	51		717	6		10,025
1977	12,855	142		846	6		13,849
1978	13,383	94		371	9		13,857
1979	11,045	67		763	9		11,884
1980	9,514	71		914	11		10,510
1981	8,115	110		263	13		8,501
1982	7,789	146		127	11		8,073
1983	6,828	155		133	14		7,130
1984	7,560	311		27	22		7,920
1985	9,646	296		136	18		10,096
1986	10,645	202		505	26		11,378
1987	11,327	241		907	27		12,502
1988	9,782	281		716	41		10,820
1989	5,414	320		230	33		5,997
1990	8,729	779		471	69		10,048
1991	5,809	472	15	315	68		6,679
1992	8,514	381	16	537	106		9,554
1993	9,125	287	37	326	79		9,854
1994	8,783	315	37	325	91		9,551
1995	8,468	337	48	302	224		9,379
1996	7,304	260	11		428		8,003
1997	7,306	244	14		249		7,813
1998	6,132	208	11		98		6,449
1999	6,473	233	7		336		7,049
2000	6,680	230	5		67		6,982
2001	9,045	125			61		9,231
2002	6,470	140	3		58		6,671
2003	4,847	143	8		74	1,584	6,656
2004	5,717	179			106	1,511	7,513
2005	4,515	144			116	915	5,690
2006	6,334	175	14		142	1,190	7,855
2007	5,467	159	21		100	1,659	7,406
2008	6,901	219	5		79	403	7,607
2009	5,617	92	13		60	253	6,035

Table 7.1.4 Plaice IIIa. Initial and final quota and quota uptake by country.
(source - EU Commision database FIDES - on Danish Fiskeridirektoratet http://www.fd.dk)

Nation		Belgium	Germany		Denmark		EU		UK	Netherlands	Sweden		TAC	
		03AN.	03AN.	03AS.	03AN.	03AS.	03AN.	03AS.	03AN.	03AN.	03AN.	03AS.	03AN.	03
1998	Landings	1	7	21	6.115	1.84	6.327	2.046	.	.	204	186	6.327	
	Initial Quota	70	40	30	8.72	2.49	10.98	2.8	.	.	470	280	11.2	
	Final Quota	0	80	70	10.43	2.45	10.98	2.8	.	.	470	280	11.2	
	Quota use	.	8%	30%	59%	75%	58%	73%	.	.	43%	66%	56%	
1999	Landings	.	17	7	6.469	1.511	6.707	1.674	.	2	219	156	6.707	
	Initial Quota	.	40	30	8.72	2.49	10.98	2.8	.	1.68	470	280	11.2	
	Final Quota	.	90	80	10.42	2.44	10.98	2.8	.	0	470	280	11.2	
	Quota use	.	19%	9%	62%	62%	61%	60%	.	.	47%	56%	60%	
2000	Landings	.	0	9	6.675	1.656	6.902	1.857	.	.	227	192	6.902	
	Initial Quota	.	40	30	8.72	2.49	10.98	2.8	.	.	470	280	11.2	
	Final Quota	.	90	30	10.42	2.49	10.98	2.8	.	.	470	280	11.2	
	Quota use	.	0%	31%	64%	67%	63%	66%	.	.	48%	68%	62%	
2001	Landings	.	1	2	9.018	2.085	9.139	2.345	0	.	121	259	9.139	
	Initial Quota	.	40	20	7.31	2.09	9.21	2.35	0	.	390	240	9.4	
	Final Quota	.	22	2	9.028	2.09	9.21	2.35	0	.	160	258	9.4	
	Quota use	.	3%	80%	100%	100%	99%	100%	.	.	75%	100%	97%	
2002	Landings	5	24	5	6.476	1.806	6.641	2.015	.	.	137	205	6.641	
	Initial Quota	38	26	16	4.983	1.424	6.272	1.6	.	958	267	160	6.4	
	Final Quota	0	39	21	7.888	1.88	8.279	2.112	.	0	352	210	8.448	
	Quota use	.	61%	22%	82%	96%	80%	95%	.	.	39%	98%	79%	
2003	Landings	.	7	6	4.848	2.034	6.344	2.288	.	1.347	142	248	6.344	
	Initial Quota	80	53	33	10.339	2.955	13.014	3.32	.	1.988	554	332	13.28	
	Final Quota	0	53	33	10.419	2.955	13.014	3.32	.	1.988	554	332	13.28	
	Quota use	.	14%	19%	47%	69%	49%	69%	.	68%	26%	75%	48%	
2004	Landings	.	76	5	5.726	1.398	7.358	1.54	.	1.383	173	137	7.358	
	Initial Quota	.	38	19	7.397	1.658	9.31	1.863	.	1.422	396	186	9.5	
	Final Quota	.	128	19	7.327	1.658	9.31	1.863	.	1.459	396	186	9.5	
	Quota use	.	59%	28%	78%	84%	79%	83%	.	95%	44%	73%	77%	
2005	Landings	1	14	7	4.507	1.1	5.488	1.205	.	828	139	98	5.488	
	Initial Quota	46	30	19	5.917	1.691	7.448	1.9	.	1.138	317	190	7.6	
	Final Quota	0	30	19	5.963	1.691	7.448	1.9	.	1.138	317	190	7.6	
	Quota use	.	47%	36%	76%	65%	74%	63%	.	73%	44%	52%	72%	
2006	Landings	.	21	12	6.333	1.355	7.652	1.536	.	1.123	175	169	7.652	
	Initial Quota	.	31	19	5.979	1.709	7.526	1.92	.	1.15	320	192	7.68	
	Final Quota	.	31	19	6.15	1.719	7.526	1.92	.	1.165	180	182	7.68	
	Quota use	.	67%	61%	103%	79%	102%	80%	.	96%	97%	93%	100%	
2007	Landings	.	18	11	5441	1201	7222	1383	.	1605	158	171	7222	
	Initial Quota	.	34	21	6617	1891	8330	2125	.	1273	355	213	8500	
	Final Quota	.	34	23	6241	2063	8330	2289	.	1625	247	213	8500	
	Quota use	.	53%	48%	87%	58%	87%	60%	.	99%	64%	80%	85%	
2008	Landings		16	6	6904	863				427	217	137		
	Initial Quota		37	23	7280	2081	9163	2338		1400	390	234	9350	
	Final Quota		37	23	8400	2131				466	260	184	9350	
	Quota use		0.44	0.24	0.82	0.4				0.92	0.83	0.74		

Table 7.2.1. Plaice IIIa. Landings at age (thousand) ; Plaice in IIIa (Kattegat Skagerrak)

Year	Age 2	3	4	5	6	7	8	9	10
1978	489	15692	39531	24919	8011	620	63	63	108
1979	1105	9789	29655	20807	7646	2514	170	75	105
1980	362	4772	16353	12575	6033	2393	949	203	104
1981	190	4048	13098	10970	4306	1427	546	213	216
1982	526	2067	9204	10602	5554	1851	758	301	161
1983	1481	9715	8630	8026	2673	925	531	257	202
1984	2154	12620	11140	4463	2183	985	904	695	457
1985	1400	8641	21798	6232	1715	698	260	197	324
1986	375	4366	14749	19193	4477	633	274	154	239
1987	623	4227	12400	17710	10205	2089	373	242	315
1988	101	3052	12037	13783	6860	2745	946	322	292
1989	1012	3844	7102	6255	2708	1171	549	254	372
1990	3147	8748	8623	9718	3222	981	481	349	428
1991	2309	8611	9583	4663	2893	892	306	156	224
1992	904	3858	11759	17427	4297	1033	296	115	142
1993	1038	3505	10088	13233	6891	1657	376	104	116
1994	1411	6919	8016	9859	8002	2780	448	111	93
1995	446	2277	6606	11530	6622	4929	853	137	116
1996	4527	5353	7971	5283	4751	1812	1355	151	68
1997	529	4733	6379	9465	5104	3072	1369	849	150
1998	563	6710	8219	6856	2971	791	385	234	234
1999	687	2704	8432	8520	7419	1301	380	77	149
2000	1223	3937	8302	11212	3599	888	139	17	36
2001	3981	9172	9399	11001	4744	410	102	19	47
2002	364	5008	8861	7528	4843	1766	448	51	29
2003	3481	4686	9098	9279	4330	969	138	19	16
2004	1724	17816	4271	4056	1994	265	97	11	18
2005	3775	4853	9688	3389	1754	768	169	63	19
2006	1288	13064	9241	7045	1293	673	216	38	28
2007	4788	8085	8282	4398	3407	512	140	61	31
2008	1627	7164	8859	5735	2499	1516	90	98	94
2009	1319	8239	7112	2963	1058	222	107	2	6

Table 7.2.2. Plaice IIIa. Mean weight at age in catch(kg)

	age								
Year	2	3	4	5	6	7	8	9	10
1978	0.236	0.248	0.268	0.322	0.417	0.598	0.752	0.818	0.875
1979	0.222	0.255	0.267	0.297	0.378	0.451	0.655	0.922	1.033
1980	0.261	0.274	0.306	0.345	0.414	0.579	0.640	0.753	0.859
1981	0.230	0.263	0.296	0.357	0.432	0.537	0.671	0.813	0.951
1982	0.270	0.301	0.286	0.318	0.386	0.544	0.704	0.813	0.934
1983	0.285	0.274	0.293	0.356	0.423	0.483	0.531	0.647	1.090
1984	0.282	0.299	0.304	0.372	0.403	0.406	0.383	0.360	0.605
1985	0.278	0.282	0.308	0.354	0.437	0.544	0.680	0.737	0.832
1986	0.250	0.277	0.284	0.310	0.384	0.531	0.707	0.850	0.983
1987	0.322	0.280	0.281	0.292	0.363	0.527	0.711	0.904	1.065
1988	0.252	0.267	0.268	0.290	0.350	0.475	0.567	0.755	1.025
1989	0.274	0.263	0.282	0.320	0.376	0.466	0.635	0.741	0.937
1990	0.292	0.288	0.294	0.337	0.397	0.498	0.684	0.775	1.078
1991	0.263	0.270	0.259	0.274	0.365	0.492	0.584	0.670	1.003
1992	0.309	0.310	0.272	0.280	0.336	0.500	0.646	0.817	0.943
1993	0.267	0.272	0.271	0.295	0.338	0.441	0.566	0.712	1.020
1994	0.275	0.263	0.272	0.289	0.330	0.381	0.516	0.658	0.892
1995	0.263	0.301	0.303	0.289	0.328	0.368	0.499	0.736	0.871
1996	0.266	0.268	0.294	0.384	0.399	0.436	0.430	0.561	0.928
1997	0.300	0.294	0.283	0.299	0.341	0.410	0.465	0.445	0.586
1998	0.260	0.250	0.280	0.327	0.398	0.464	0.515	0.587	0.702
1999	0.271	0.271	0.290	0.290	0.294	0.336	0.370	0.656	0.643
2000	0.257	0.262	0.276	0.302	0.355	0.388	0.517	0.857	0.968
2001	0.257	0.272	0.290	0.322	0.310	0.425	0.589	0.836	0.777
2002	0.246	0.271	0.270	0.287	0.338	0.402	0.595	0.794	1.149
2003	0.243	0.252	0.271	0.290	0.298	0.400	0.464	0.605	0.845
2004	0.240	0.276	0.320	0.347	0.378	0.523	0.786	0.844	0.693
2005	0.244	0.260	0.292	0.327	0.348	0.381	0.513	0.664	1.092
2006	0.246	0.267	0.289	0.342	0.335	0.355	0.456	0.587	0.873
2007	0.245	0.286	0.316	0.317	0.348	0.363	0.527	0.509	0.929
2008	0.267	0.292	0.294	0.329	0.396	0.457	0.549	0.522	0.502
2009	0.242	0.284	0.323	0.373	0.479	0.531	0.669	0.878	0.957

Table 7.2.3. Plaice IIIa. Discards in weight (tonnes)

Year	Denamark	Sweden
2002	2002	486
2003	2089	584
2004	1628	273
2005	1363	302
2006	1282	347
2007	1401	484
2008	1201	330
2009	1288	215

Table 7.2.4. Plaice IIIa. Discard numbers ('000)

Year \ Age	0	1	2	3	4	5	6	7	8	9	10
2002	4	2592	7175	5886	3001	944	226	64	7	3	2
2003	4	2600	10159	5452	2506	954	251	65	6	2	2
2004	4	1664	4839	5506	2058	793	225	40	4	1	1
2005	4	814	4733	4579	2018	745	213	55	11	1	1
2006	6	739	3650	5247	1812	723	179	40	3	0	0
2007	5	1046	5131	4403	2151	797	229	57	26	10	3
2008	5	741	5049	4187	1913	660	206	48	11	6	3
2009	7	581	3601	4495	1839	606	187	44	7	0	1

Table 7.2.5. Plaice IIIa. Discard mean weight (kg)

Year \ Age	0	1	2	3	4	5	6	7	8	9	10
2002	0.03	0.07	0.12	0.14	0.15	0.17	0.26	0.27	0.32	0.32	0.30
2003	0.03	0.06	0.12	0.14	0.15	0.16	0.23	0.27	0.30	0.30	0.30
2004	0.03	0.08	0.11	0.14	0.15	0.16	0.18	0.28	0.30	0.30	0.30
2005	0.03	0.08	0.11	0.13	0.15	0.16	0.18	0.21	0.16	0.30	0.44
2006	0.03	0.08	0.12	0.14	0.15	0.16	0.21	0.25	0.27	0.30	0.30
2007	0.03	0.09	0.12	0.14	0.16	0.17	0.18	0.20	0.23	0.24	0.21
2008	0.03	0.07	0.09	0.13	0.16	0.18	0.17	0.28	0.21	0.15	0.15
2009	0.03	0.07	0.11	0.14	0.16	0.18	0.18	0.33	0.28	0.30	0.21

Table 7.2.6. Plaice IIIa. Mean weight at age in stock (kg)

Year	Age 2	3	4	5	6	7	8	9	10
1978	0.091	0.159	0.253	0.295	0.341	0.399	0.426	0.509	0.635
1979	0.091	0.159	0.253	0.295	0.341	0.399	0.426	0.509	0.635
1980	0.091	0.159	0.253	0.295	0.341	0.399	0.426	0.509	0.635
1981	0.091	0.159	0.253	0.295	0.341	0.399	0.426	0.509	0.635
1982	0.091	0.159	0.253	0.295	0.341	0.399	0.426	0.509	0.635
1983	0.091	0.159	0.253	0.295	0.341	0.399	0.426	0.509	0.635
1984	0.091	0.159	0.253	0.295	0.341	0.399	0.426	0.509	0.635
1985	0.091	0.159	0.253	0.295	0.341	0.399	0.426	0.509	0.635
1986	0.091	0.159	0.253	0.295	0.341	0.399	0.426	0.509	0.635
1987	0.091	0.159	0.253	0.295	0.341	0.399	0.426	0.509	0.635
1988	0.091	0.159	0.253	0.295	0.341	0.399	0.426	0.509	0.635
1989	0.091	0.159	0.253	0.295	0.341	0.399	0.426	0.509	0.635
1990	0.091	0.159	0.253	0.295	0.341	0.399	0.426	0.509	0.635
1991	0.091	0.159	0.253	0.295	0.341	0.399	0.426	0.509	0.635
1992	0.091	0.159	0.253	0.295	0.341	0.399	0.426	0.509	0.635
1993	0.091	0.159	0.253	0.295	0.341	0.399	0.426	0.509	0.635
1994	0.091	0.159	0.253	0.295	0.341	0.399	0.426	0.509	0.635
1995	0.081	0.192	0.306	0.26	0.334	0.385	0.403	0.567	0.695
1996	0.099	0.17	0.287	0.327	0.312	0.317	0.311	0.424	0.443
1997	0.123	0.165	0.243	0.299	0.353	0.495	0.572	0.544	0.689
1998	0.063	0.133	0.223	0.297	0.386	0.451	0.43	0.392	0.501
1999	0.09	0.133	0.208	0.294	0.319	0.346	0.414	0.618	0.849
2000	0.064	0.133	0.196	0.295	0.318	0.316	0.845	0.8	0.926
2001	0.085	0.145	0.234	0.299	0.288	0.382	0.655	0.781	0.699
2002	0.064	0.122	0.162	0.304	0.328	0.372	0.389	0.769	0.932
2003	0.092	0.133	0.179	0.287	0.294	0.348	0.415	0.557	0.782
2004	0.065	0.12	0.169	0.34	0.368	0.473	0.68	0.809	0.969
2005	0.083	0.129	0.214	0.301	0.326	0.349	0.455	0.537	0.73
2006	0.075	0.132	0.215	0.333	0.315	0.415	0.515	0.56	0.826
2007	0.066	0.129	0.212	0.309	0.357	0.44	0.504	0.45	0.909
2008	0.056	0.125	0.197	0.318	0.374	0.462	0.597	0.732	1.022
2009	0.059	0.115	0.191	0.343	0.401	0.605	0.747	1.048	1.135

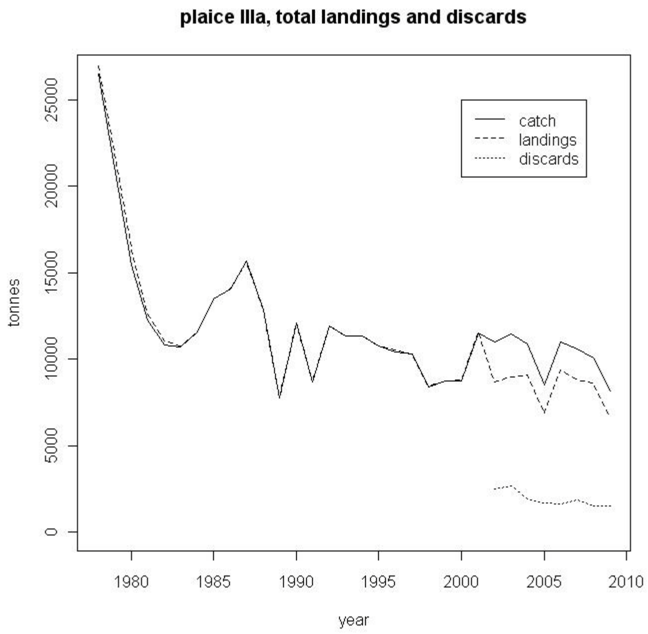
Table 7.2.7. Plaice IIIa 2006 WGNSSK, ANON, COMBSEX, PLUSGROUP . maturity

2007-05-05 00:43:50 units= NA

year	age 2	3	4	5	6	7	8	9	10
all	0.54	0.74	0.88	0.92	0.94	1	1	1	1

Table 7.2.8. Plaice IIIa. Tuning fleets.

[1] "Final Tuning File"									
106									
DK Gillnetters									
1995	2009								
1	1	0	1						
2	10								
236150	41004	162022	481951	1218991	661753	725503	138092	21132	15729
199512	159746	347956	526608	521810	494928	203666	147976	14233	4957
206792	41993	443102	393385	459126	314599	249657	142019	58770	15011
169842	22639	248607	449714	564524	254092	76487	42318	27666	31299
193717	47487	109450	503992	623875	772756	155731	50526	14452	14580
174610	30628	158975	516760	642735	302086	85045	16696	2099	4582
263858	170611	265684	492485	1059222	629625	66119	19361	2947	5080
199439	25874	322449	386538	366741	362332	224494	70754	11011	8426
170502	138544	168218	436703	518599	301809	105409	18907	2335	2511
152678	45145	756831	293827	284613	156901	30654	13285	1506	3642
119359	113387	162549	537575	255771	138559	66752	18560	8054	1921
163118	34391	525195	530686	466561	95788	47550	23536	6328	1710
127209	51305	177146	433268	383912	341224	42487	13976	5308	1360
162827	91680	677422	671484	536109	274896	142787	8049	6317	4531
162329	57592	587305	853890	412443	172438	27419	16721	537	734
DK Seiners									
1995	2009								
1	1	0	1						
2	10								
848990	155505	483163	1237122	2102300	1537781	1039883	145632	22771	19269
829741	671949	1146592	1643737	877448	817287	295731	209090	20906	7373
760695	99282	1097581	1727655	2229125	1100779	739059	319951	250184	29125
726990	113924	1884590	2083633	1781242	779096	207230	96901	56672	58032
822345	197769	601501	2398479	2485717	2164017	319256	89023	19404	39372
920377	291648	1236918	2880342	4216432	1227383	377336	53683	2629	4390
1026524	1545624	3602553	3074242	3346357	1336759	127829	30600	6680	9428
887462	108998	1717074	3300009	2939239	1745286	567066	132372	11880	7025
699429	985829	1658716	3194559	3065635	1240986	234046	40482	4406	3225
641455	582551	5697194	1385089	1168507	587432	82853	14087	2057	3006
514275	1476819	1663149	2875087	892939	442738	170333	32412	8271	2719
449215	369650	3752667	2660569	1929726	346736	173716	52471	10513	2232
416847	1130631	2175839	2741921	1129860	837340	108032	26929	10781	2858
492237	1046295	3871426	3011190	1774239	624904	432156	15886	17151	8606
511145	596521	4092247	2836371	1068803	412662	86203	28744	625	2875
KASU_Q4									
1994	2009								
1	1	0.83	1						
1	6								
1	0.88	10.52	5.88	0.37	0.99	0.03			
1	1.68	10.33	3.77	0.19	1.1	0.06			
1	2.41	38.57	12.67	0.42	0.47	0.1			
1	11.09	11.47	4.35	1.26	0.65	0.36			
1	17.87	14.8	5.2	3.5	0	0.11			
1	101.15	38.86	7.22	0.92	0.56	0.63			
1	102.98	129.85	16.63	0	0.49	0.49			
1	52.93	99.92	29.79	1.71	0.49	0.85			
1	46.14	18.37	25.15	12.39	1.24	0.15			
1	42.17	61.79	14.91	6.26	3.38	0.35			
1	15.03	70.85	80.23	12.3	12.6	11.7			
1	108.73	42.47	8.28	1.38	0.09	0.07			
1	56.28	77.13	60.47	11.28	6.31	2.4			
1	42.76	45.99	11.39	2.74	0.48	0			
1	35.09	110.67	51.84	12.24	2.17	0.12			
1	28.49	70.4	21.51	2.29	0.82	0			
KASU_Q1									
1996	2009								
1	1	0.25	0.33						
1	6								
1	2.27	23.62	26.53	6.46	2.06	0.81			
1	0.05	11.49	19.45	4.39	1.75	0.68			
1	-9	-9	-9	-9	-9	-9			
1	4.68	25.95	22.42	2.94	1.27	0.15			
1	33.05	196.25	47.5	9.06	1.87	1.65			
1	11.47	127.73	73.92	6.67	1.7	1.33			
1	20.89	45.71	78.3	31.99	2.26	0.44			
1	9.67	143.32	38.2	33.56	6.16	0.17			
1	7.28	81.75	74.97	25.99	13.14	4.26			
1	13.49	163.55	100.77	19.07	4.36	1.75			
1	16.17	152.56	217.54	37.31	6	0.4			
1	7.65	107.93	116.95	36.77	6.6	1.15			
1	20.77	40.83	46.72	16.83	3.75	0.63			
1	4.12	73.67	127.13	28.5	6.84	2.12			
IBTS_Q1_backshifted									
1990	2009								
1	1	0.99	1						
1	6								
1	9.55	21.09	11.19	3.71	0.29	0.09			
1	9.21	18.69	12.32	2.86	0.38	0.11			
1	14.58	13.39	13.41	12.1	4.63	0.54			
1	19.29	13.75	3.9	2.33	2.54	0.57			
1	10.12	21.41	8.92	2.43	1.74	0.79			
1	47.74	30.49	9.76	3.34	0.74	0.35			
1	20.89	46.75	9.57	3.34	0.18	0.07			
1	15.73	17.19	9.5	3.28	0.77	0.23			
1	44.6	19.46	5.92	5.68	0.31	0.19			
1	131.44	72.73	14.98	5.36	3.37	0.31			
1	55.16	91.76	20.41	3.22	2.09	0.79			
1	15.57	66.06	44.18	10.8	1.93	1.62			
1	95.55	50.85	46.2	33.62	6.34	1.05			
1	40.79	116.25	33.62	27.51	25.39	1.61			
1	117.05	85.37	51.22	21.28	31.61	9.21			
1	37.98	97.57	22.76	13.04	4.18	13.95			
1	52.12	83.73	83.43	27.32	15.66	6.02			
1	49.43	45.97	20.66	7.63	5.71	2.53			
1	17.03	29.41	7.75	3.15	1.36	0.68			
1	11.22	43	25.42	8.94	3.27	1.09			
IBTS_Q3									
1997	2009								
1	1	0.83	1						
1	6								
1	16.39	17.39	8.42	2.23	0.79	0.45			
1	27.92	19.97	5.26	3.66	0.43	0			
1	77.47	59.45	14.35	1.53	1.7	0.31			
1	-9	-9	-9	-9	-9	-9			
1	19.31	109.31	63.62	9.13	3.77	1.03			
1	66.31	54.15	33.27	24.38	4.12	0.45			
1	14.98	40.93	6.95	9.84	9.28	1.11			
1	51.95	39.99	41.41	3.77	5.49	3.96			
1	17.76	60.04	13.52	15.78	3.69	3.7			
1	24.39	59.55	72.11	18.14	13.09	6.99			
1	29.7	49.56	30.19	16.02	5.78	3.28			
1	5.11	98.32	33.39	21.08	6.32	1.48			
1	13.46	53.65	105.15	15.32	3.39	0.94			



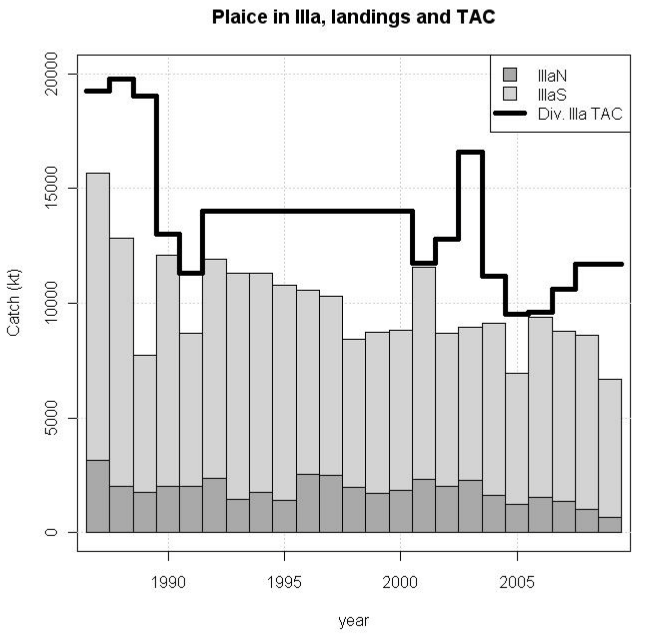


Figure 7.1.1. Plaice IIIa. Upper : Total landings and discards, 1978-2008. Lower : Landings by area and combined TAC

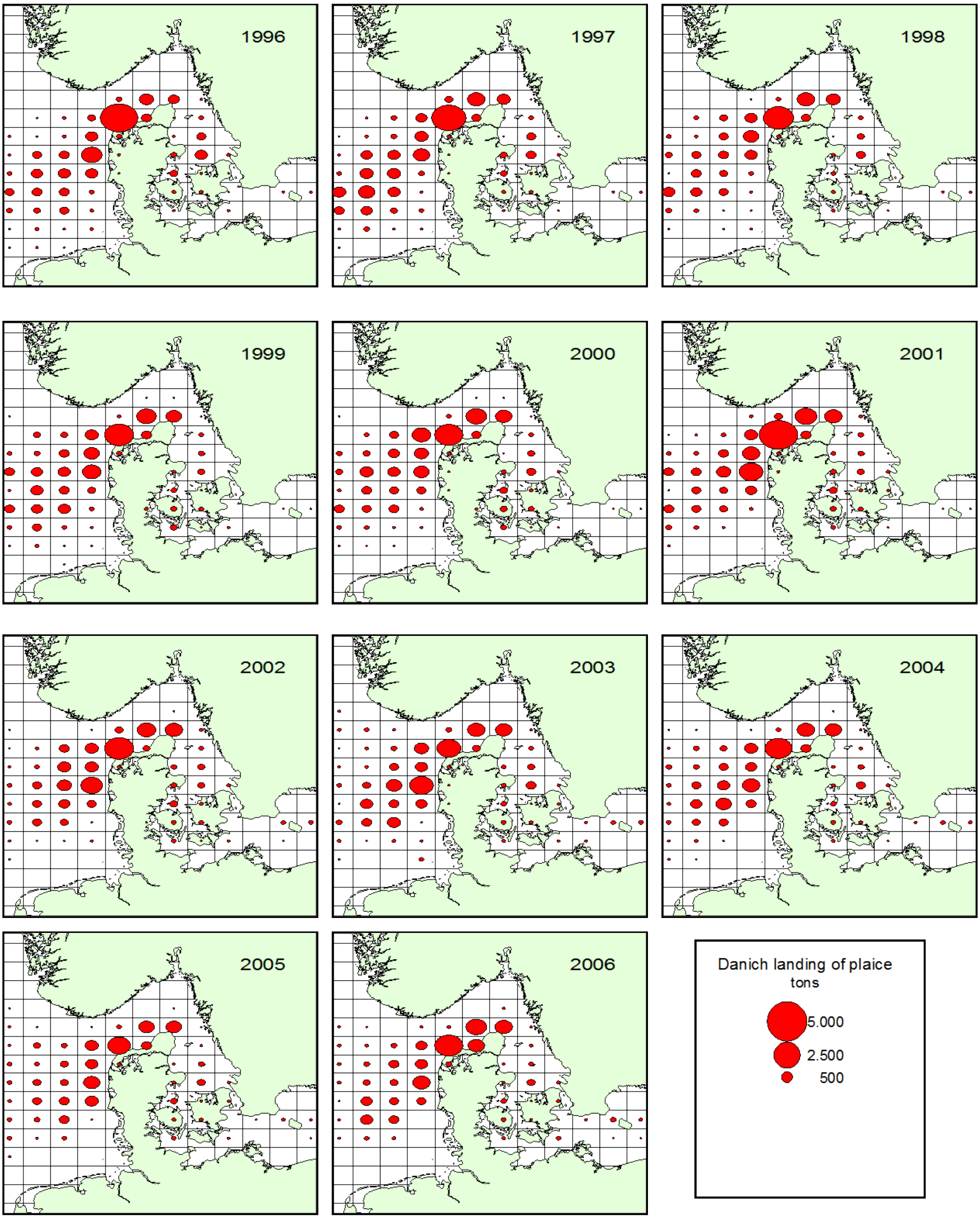


Figure 7.2.1. Annual distribution of Danish plaice landings (from WGNSSK 2007).

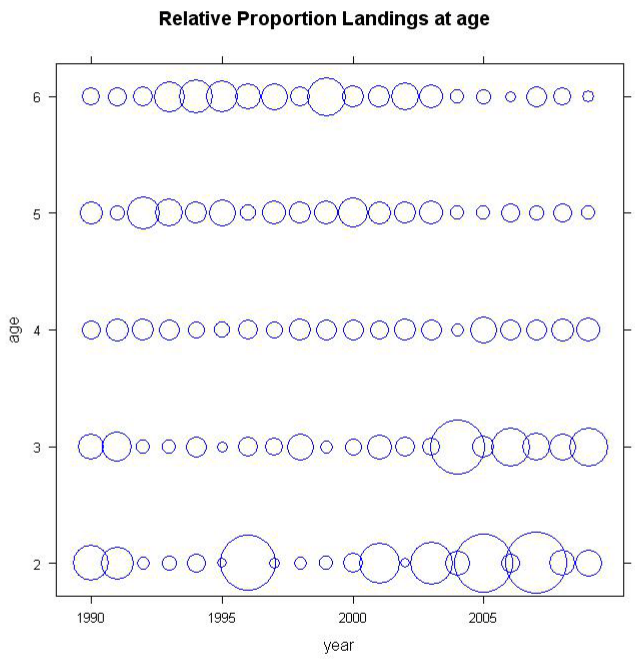


Figure 7.2.2. Plaice IIIa. Relative landings at age.

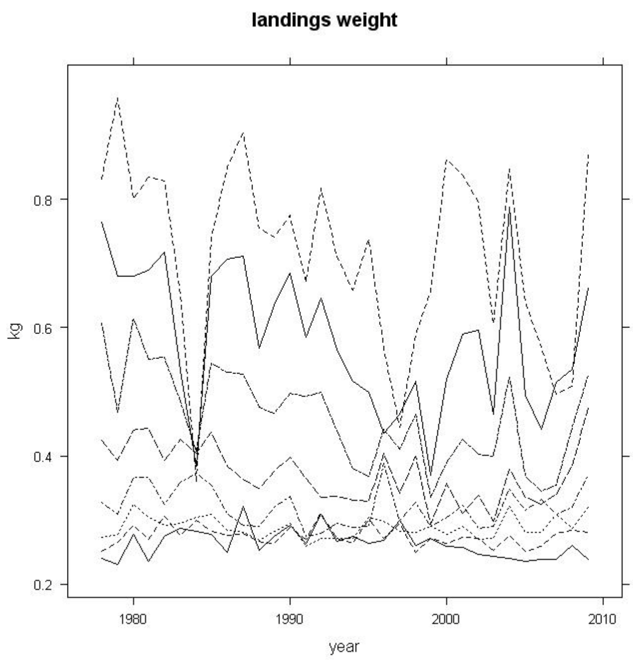


Figure 7.2.3. Landings weight at age

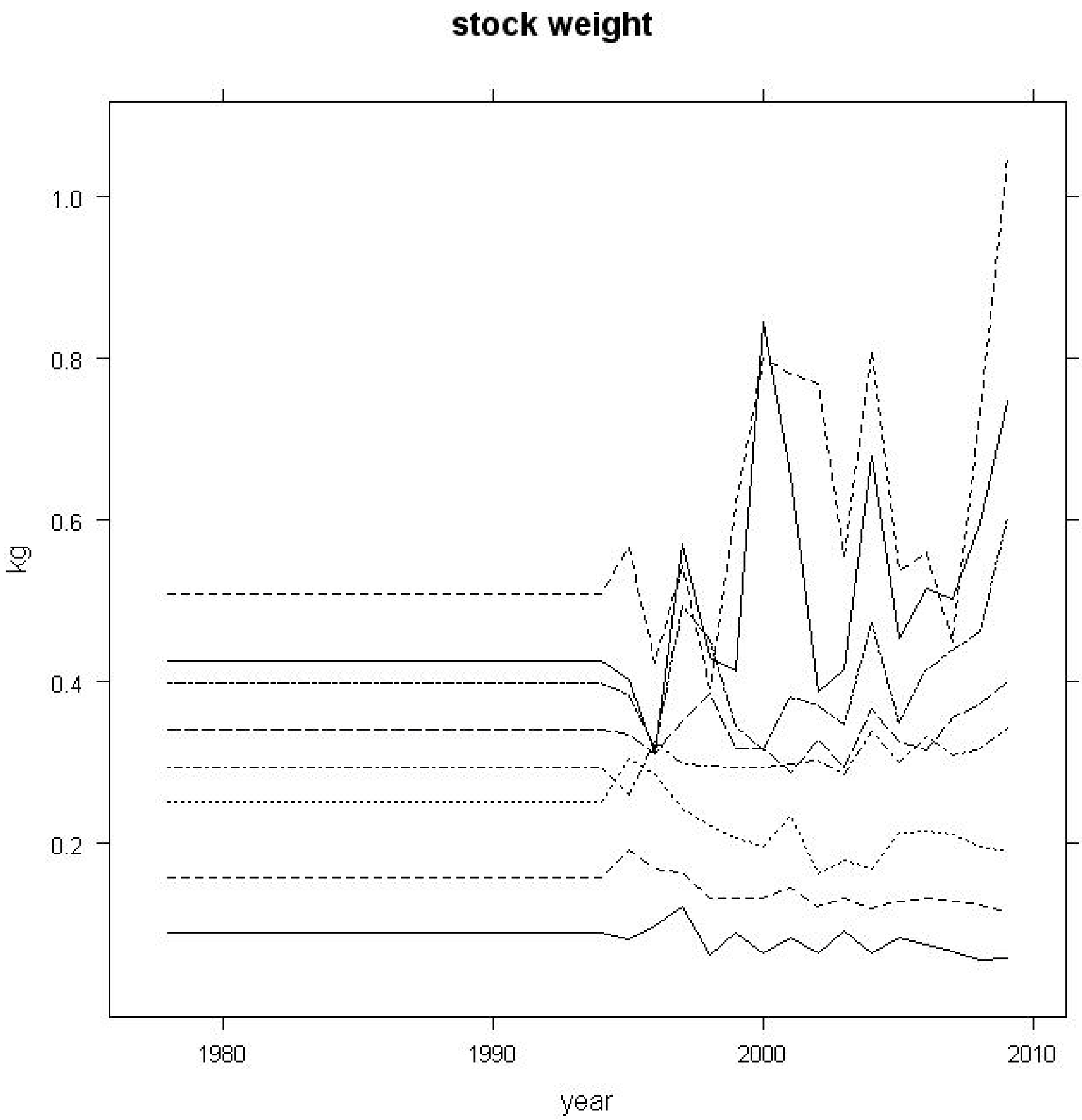


Figure 7.2.4. Stock weight at age

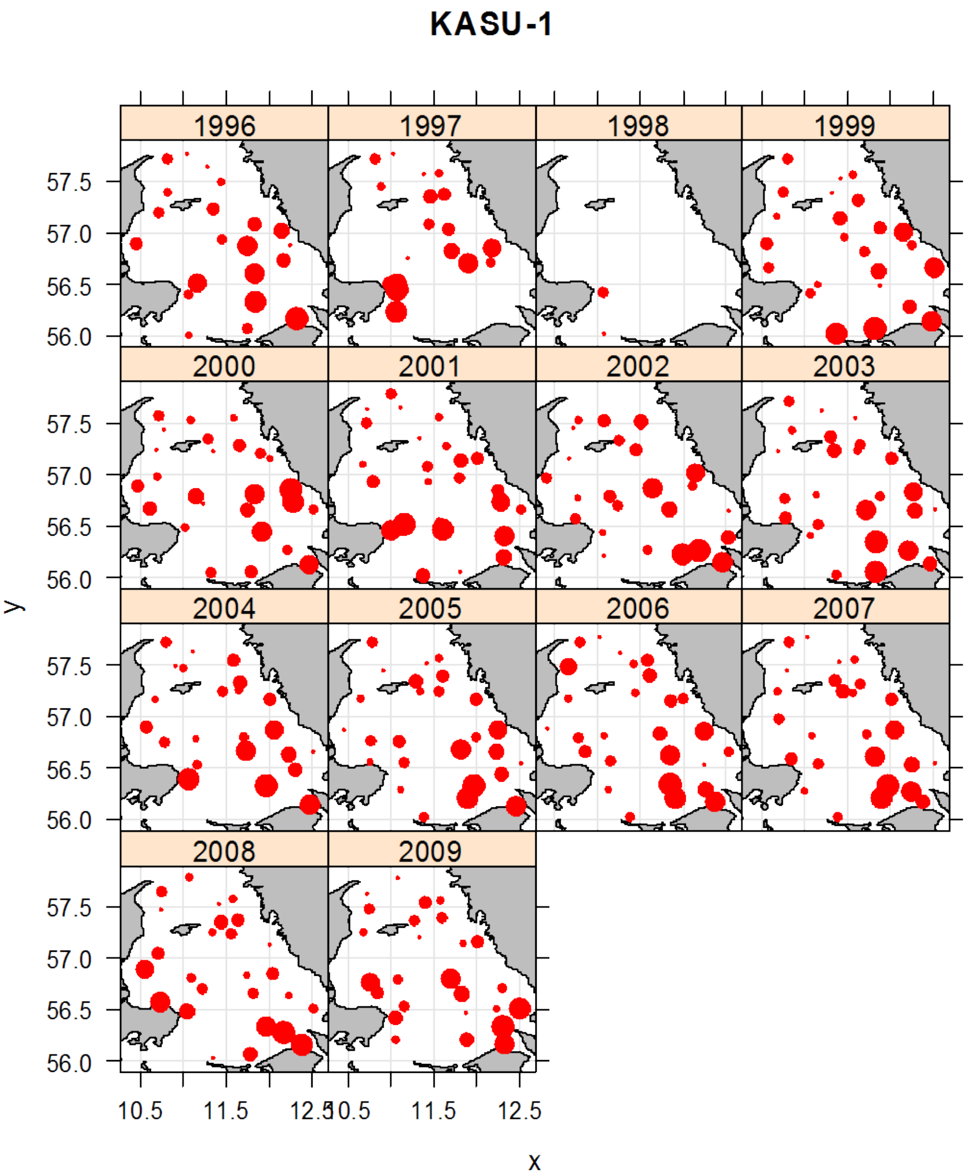
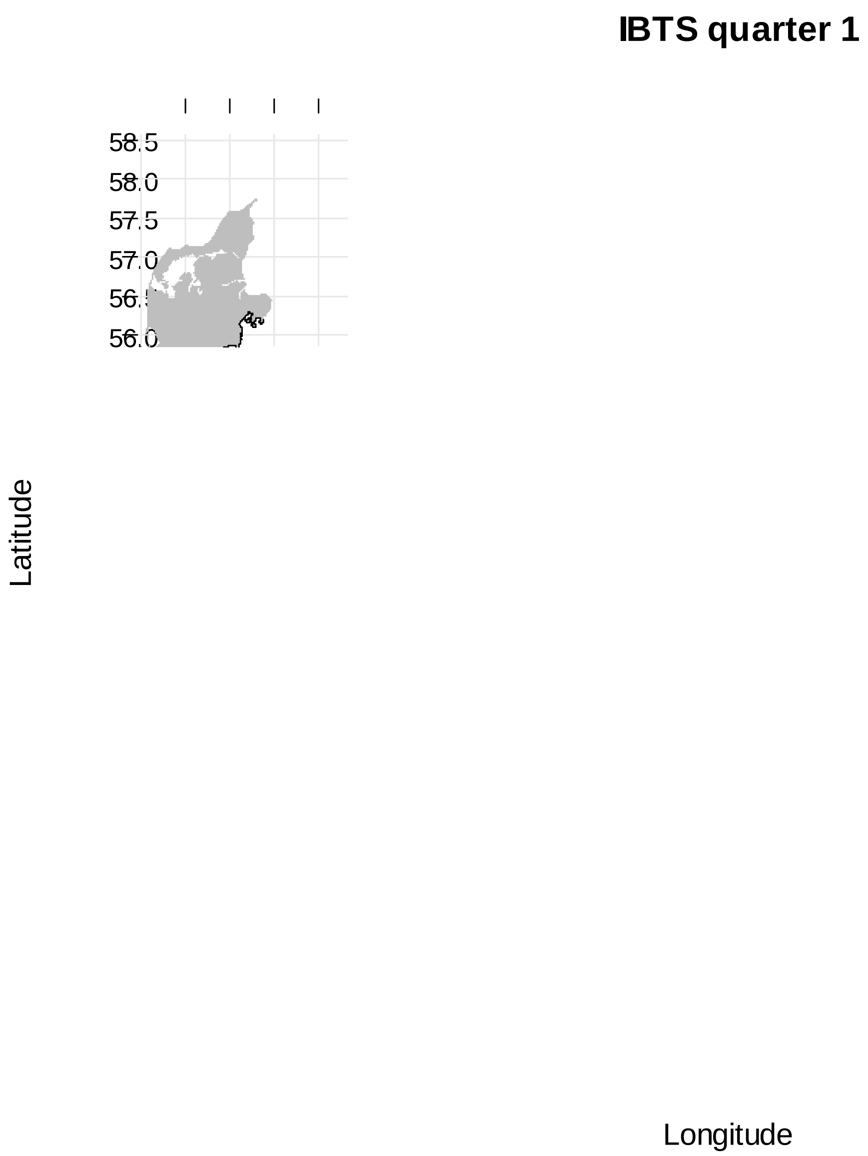


Figure 7.2.5. Plaice IIIa. Distribution and abundance of KASU Q1 catches.


IBTS quarter 1
58.5
58.0
57.5
57.0
56.0
Latitude
Longitude

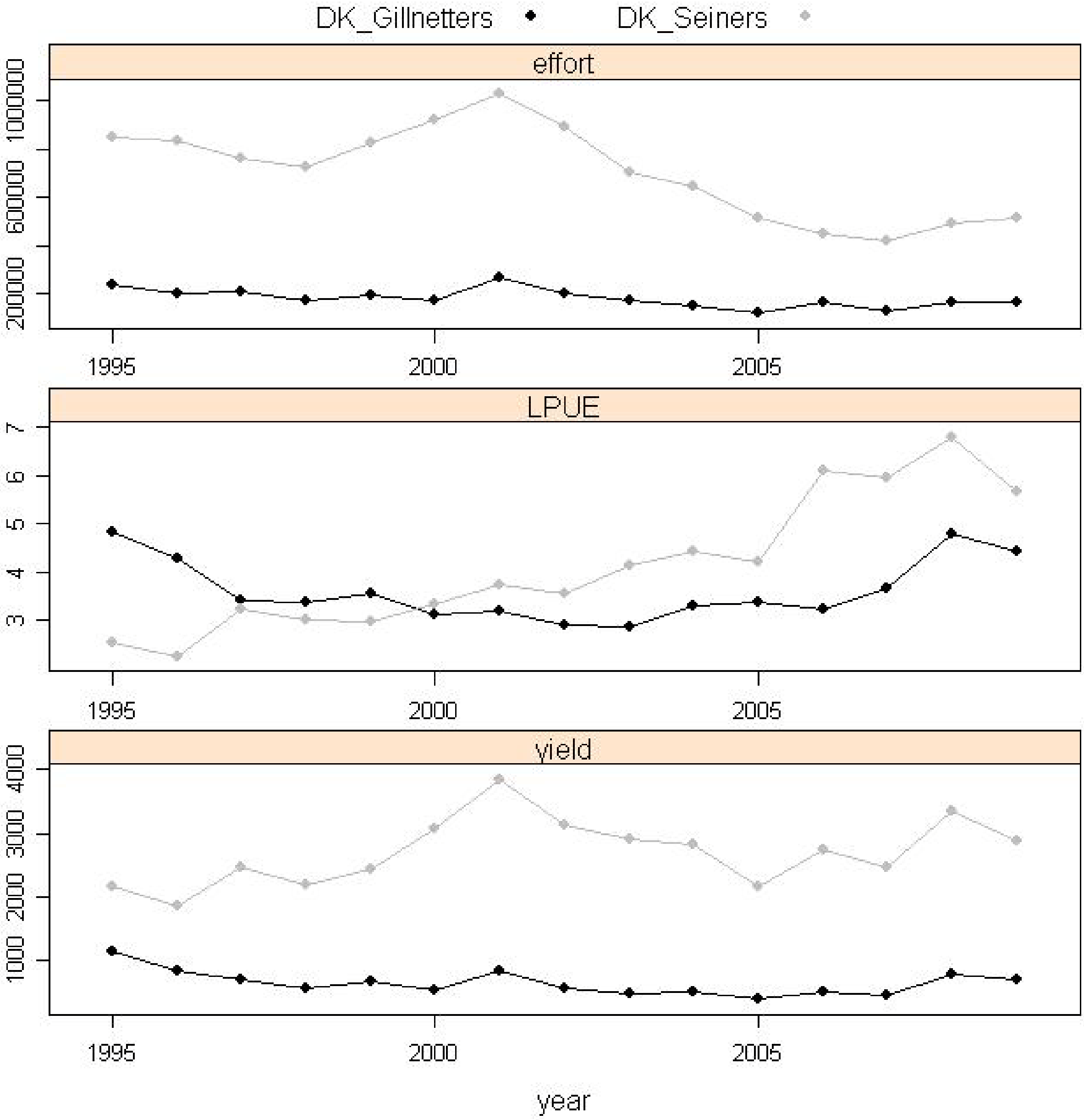


Figure 7.2.7. Plaice IIIa. Effort, landing and LPUE for the Danish commercial tuning fleets.

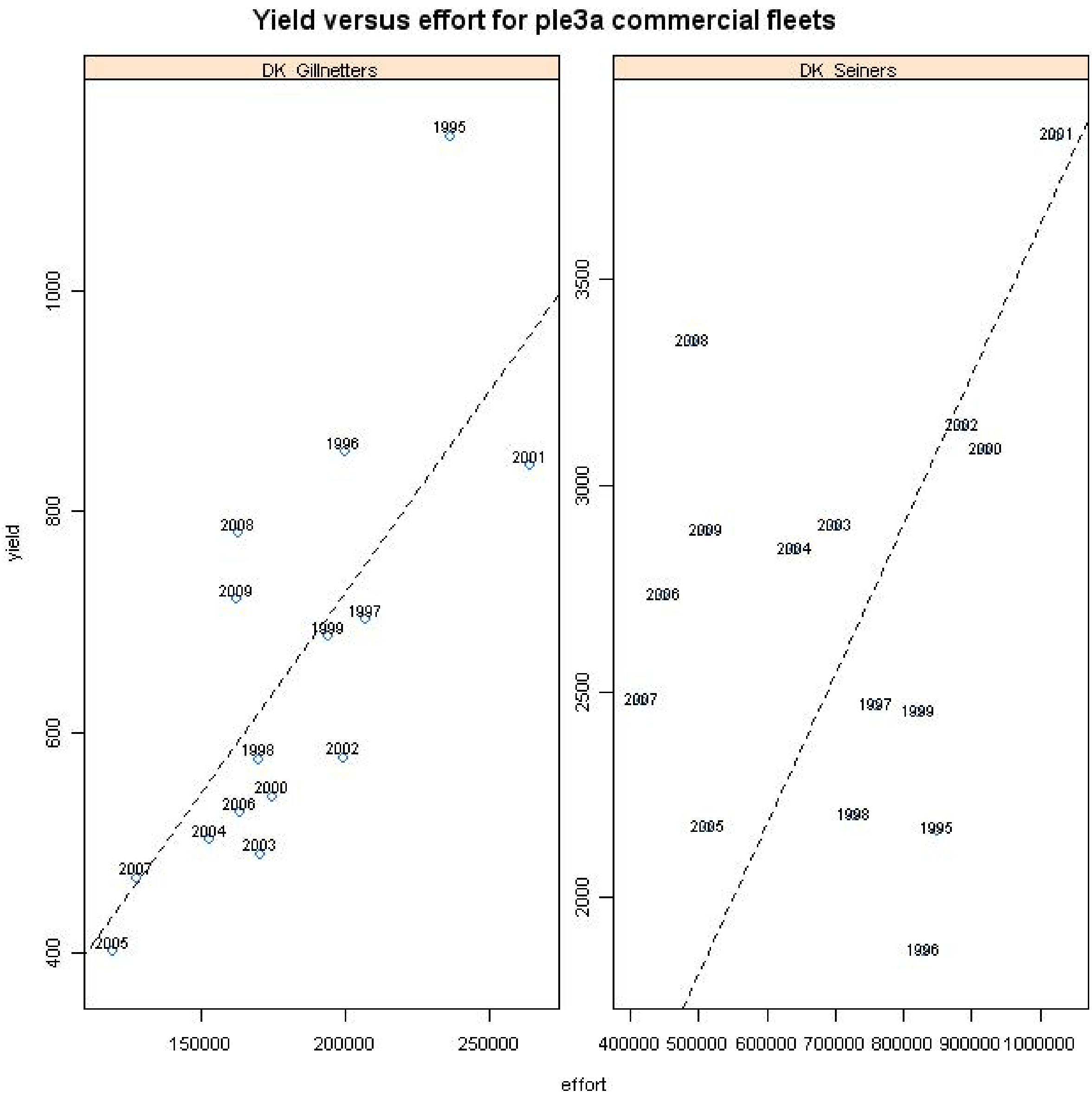


Figure 7.2.8. Plaice IIIa. Yield vs. effort for the commercial tuning fleets.

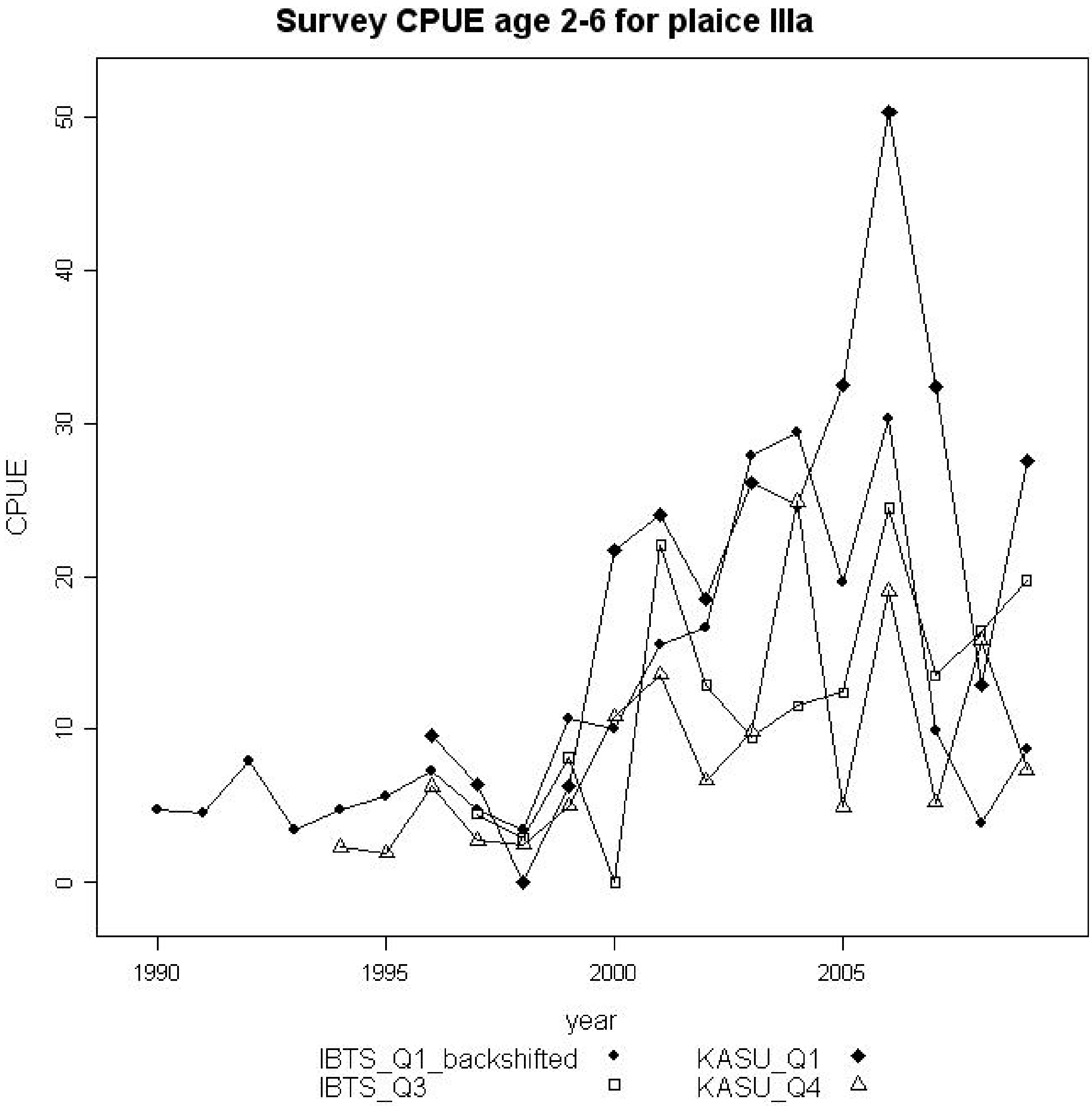


Figure 7.3.1. Plaice IIIa. Log catch curves by cohort in the landings at age

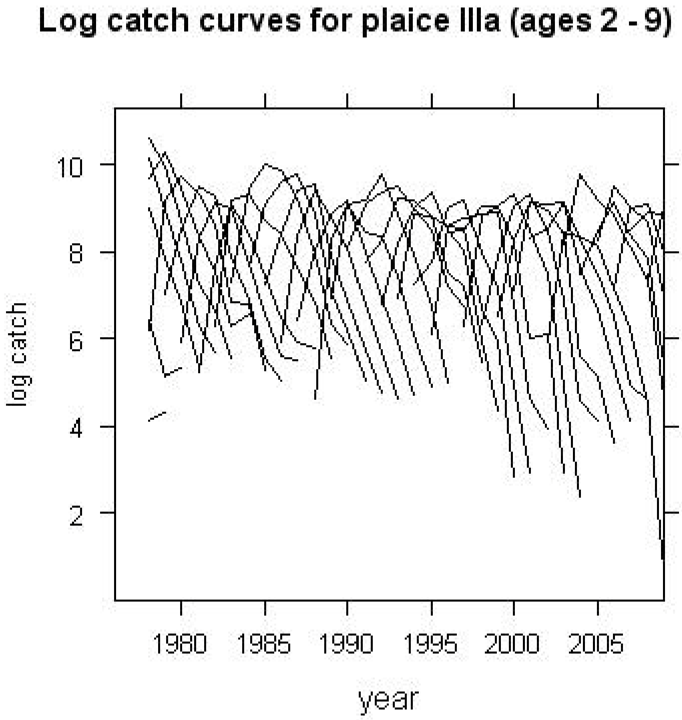
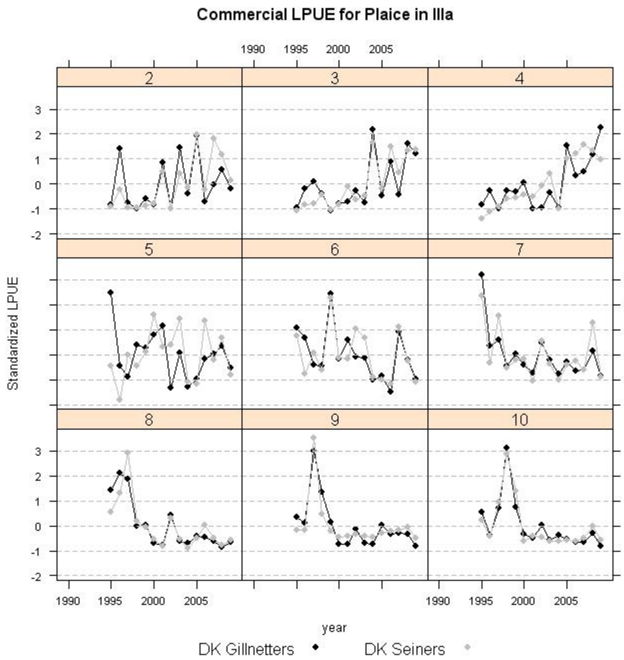


Figure 7.3.2. Plaice IIIa. Log catch curves by cohort in the landings at age



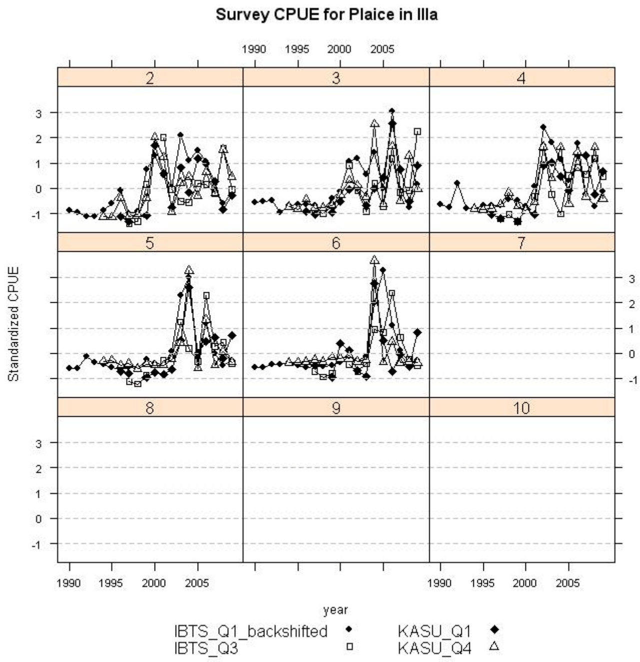
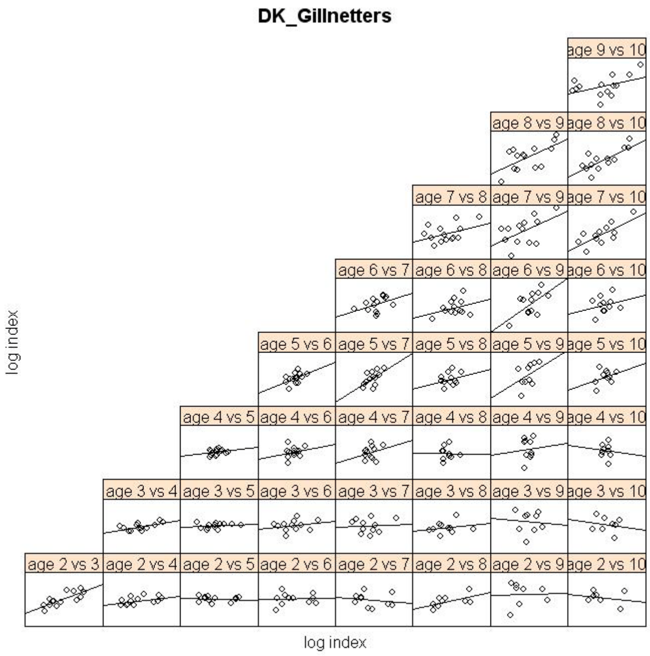


Figure 7.3.3. Plaice IIIa. Standardised Abundance index from tuning series.



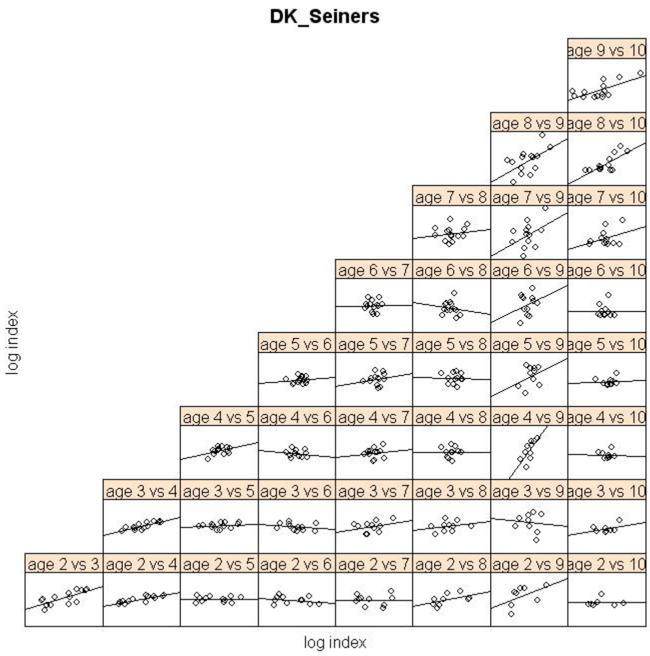
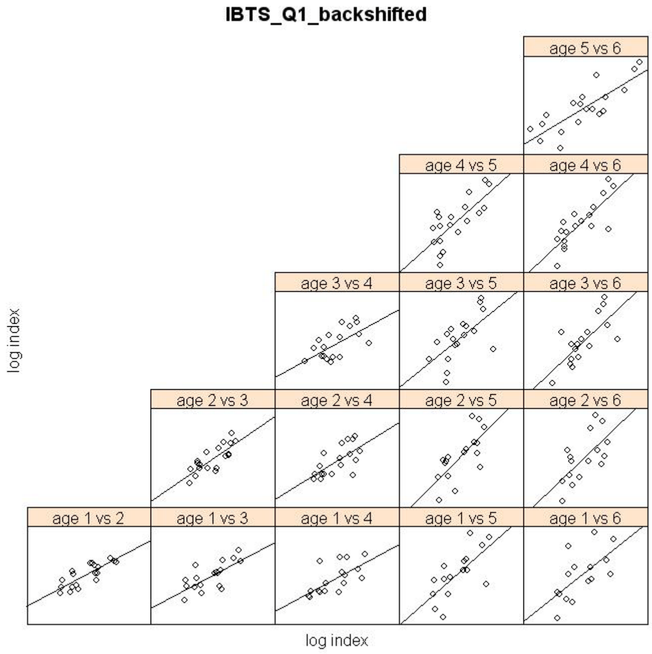


Figure 7.3.4. Plaice IIIa. Internal consistency for the commercial tuning fleets: matrix scatterplots and Log cohort abundance. Up : DK_Gillnetters. Bottom: DK_Seiners.



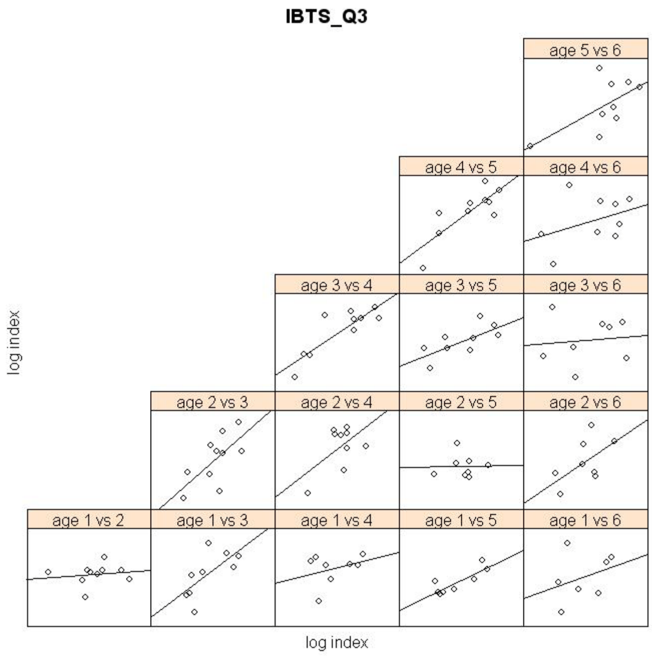
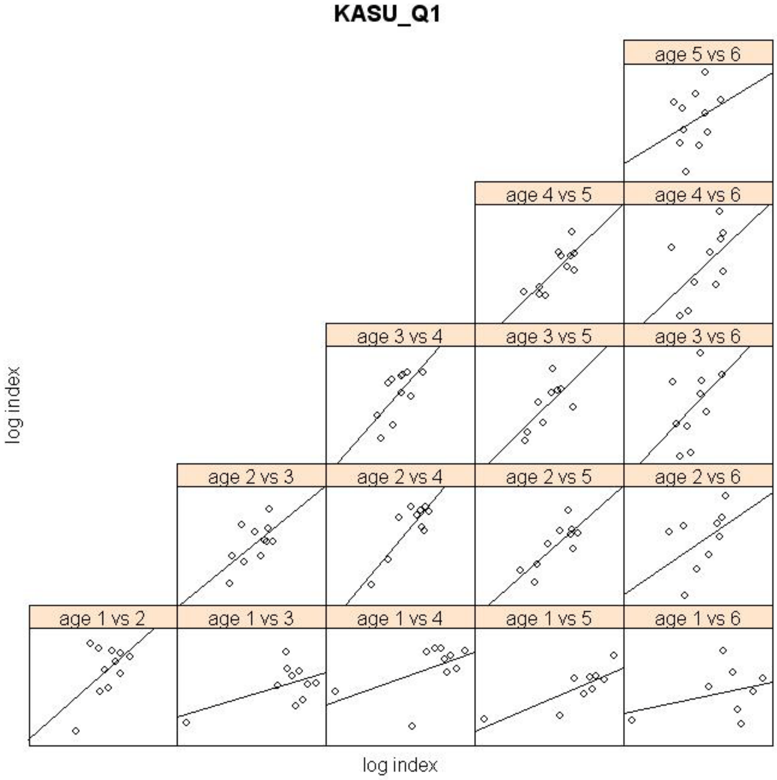


Figure 7.3.5. Plaice IIIa. Internal consistency for the IBTS survey: matrix scatterplots and Log cohort abundance. Top : IBTS Q1 backshifted. Bottom: IBTS Q3.



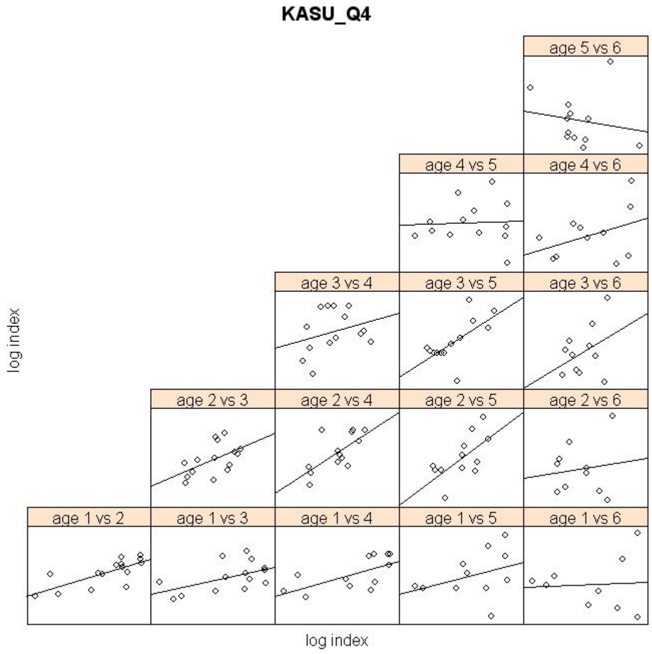


Figure 7.3.6 Internal consistency for the KASU survey: matrix scatterplots and Log cohort abundance. Top : KASU Q1. Bottom: KASU Q4.

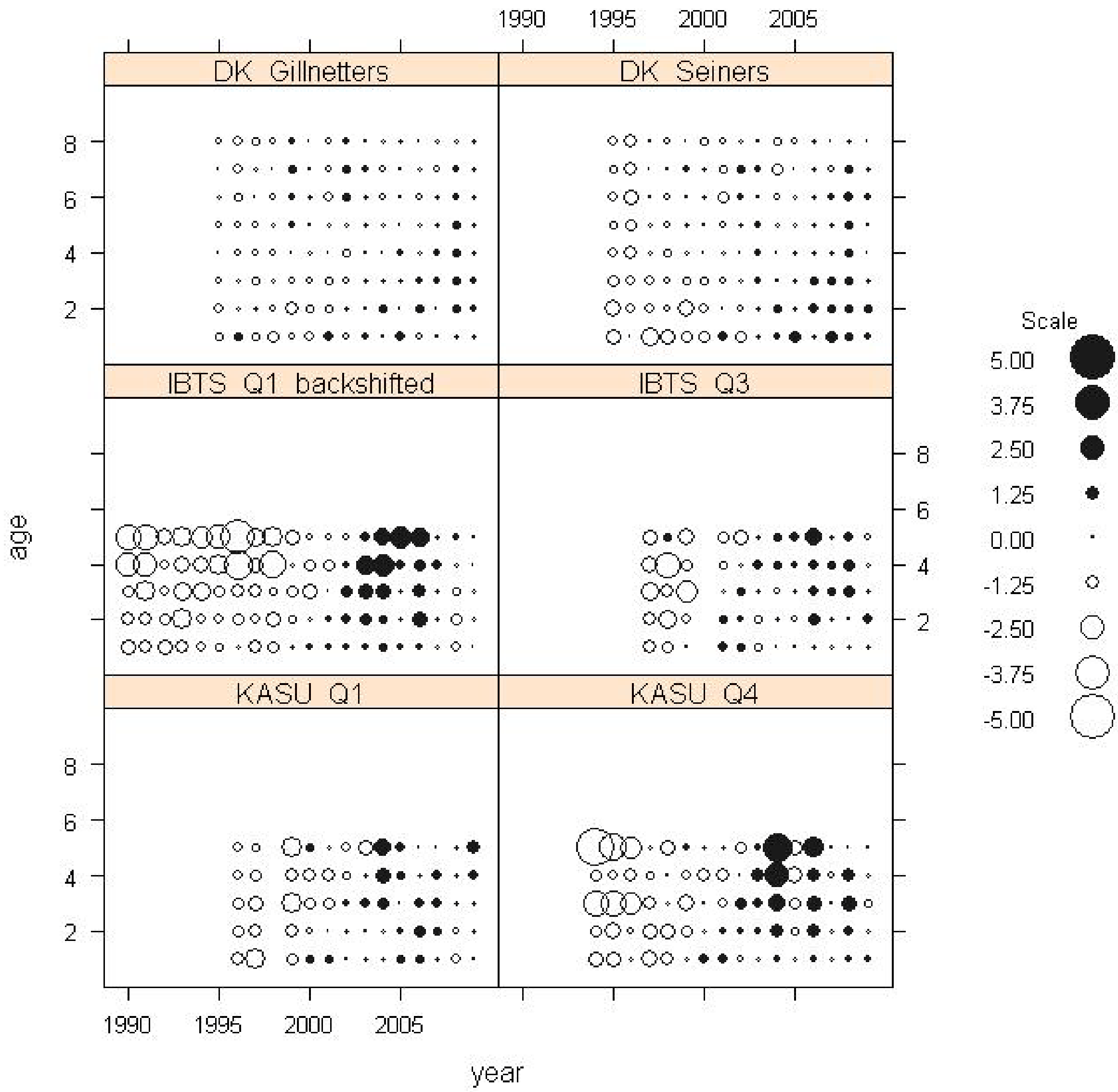


Figure 7.3.7. Plaice IIIa. Log catchability residuals for combined XSA

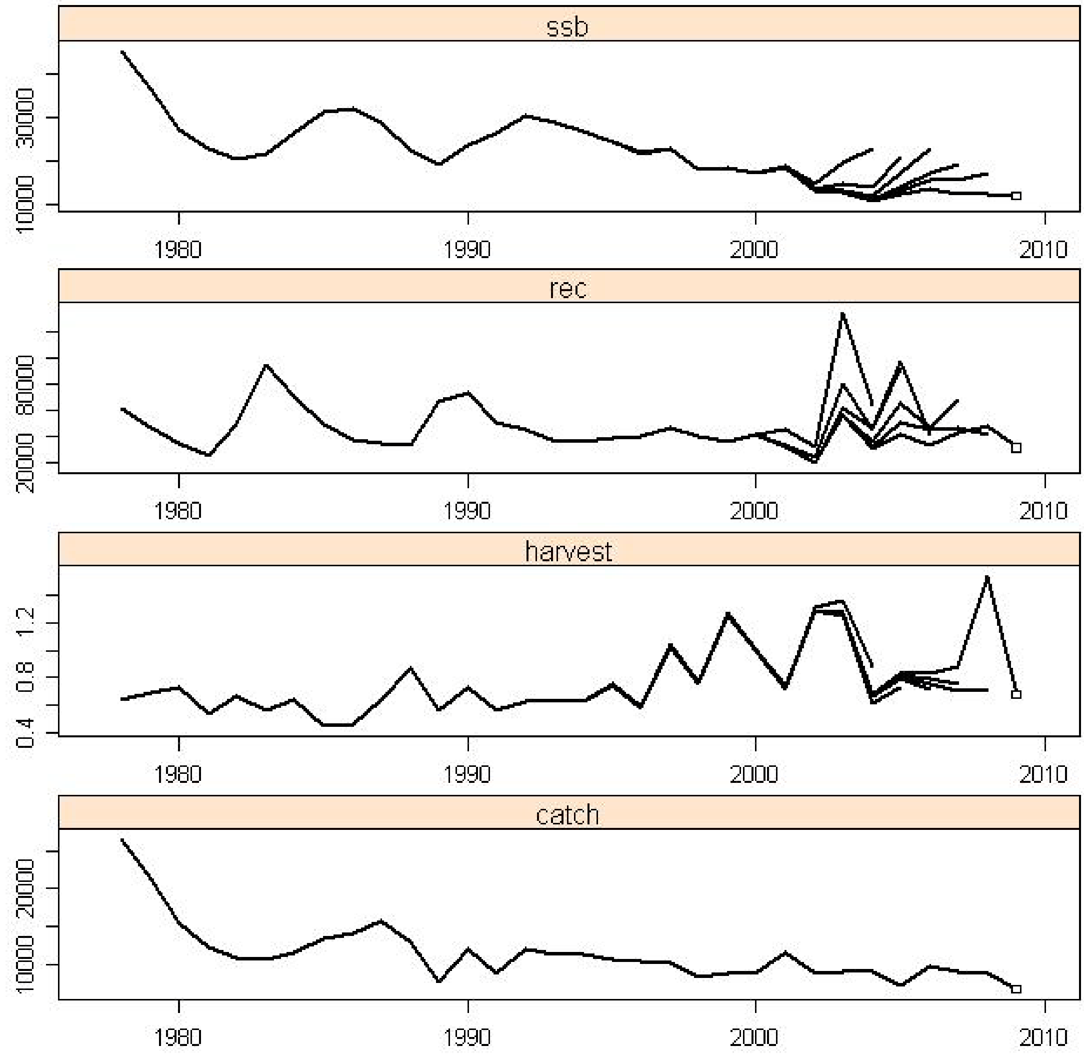


Figure 7.3.8. Plaice IIIa. SPALY run. Log q residuals and retrospective pattern.

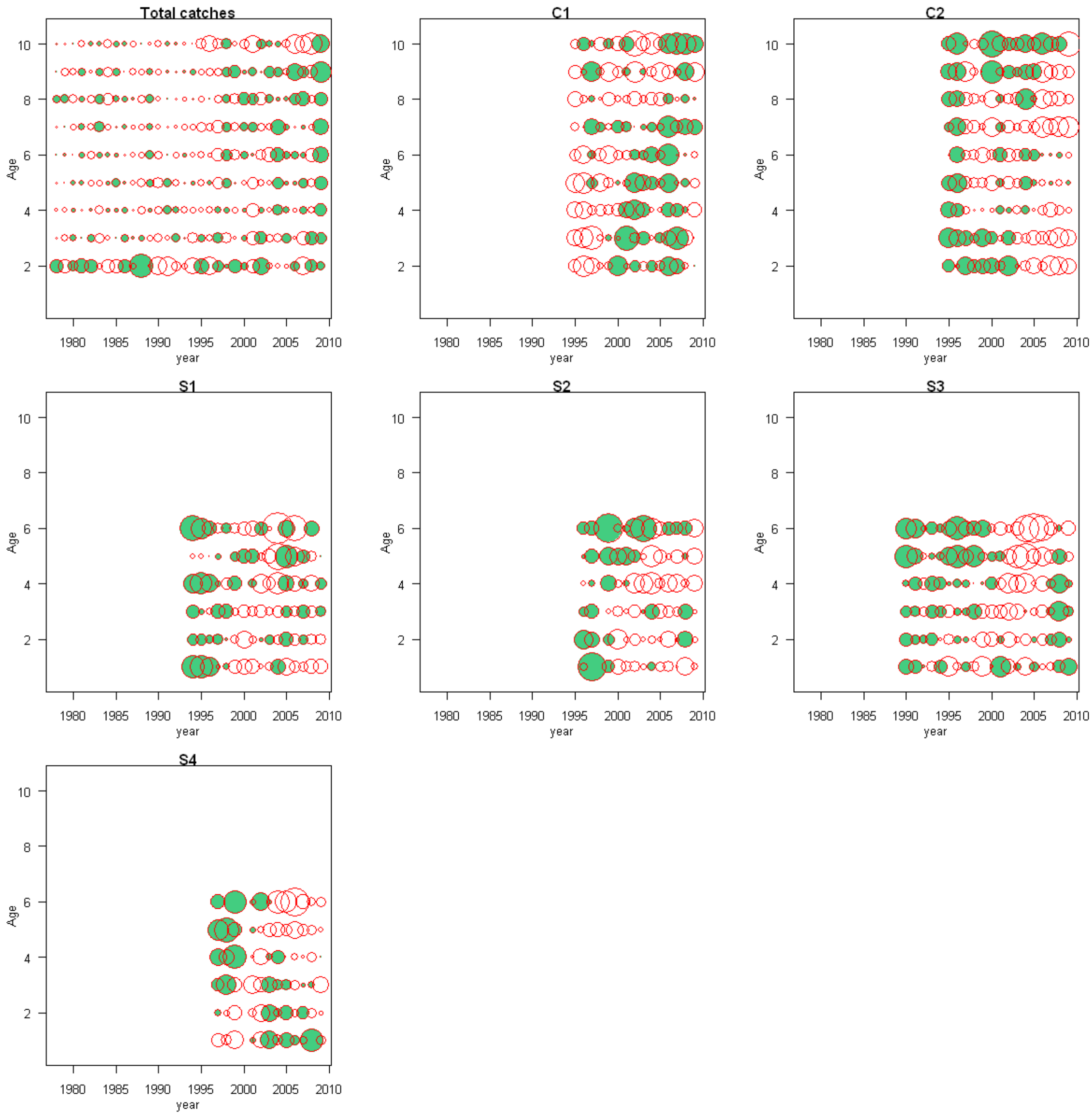


Figure 7.3.9. Plaice IIIa. Normalized residuals for the base run. Blue circles indicate a positive residual and filled green circle indicate a negative residual. The normalized residuals (both positive and negative) for the current user specified run are shown as overlying red circles.

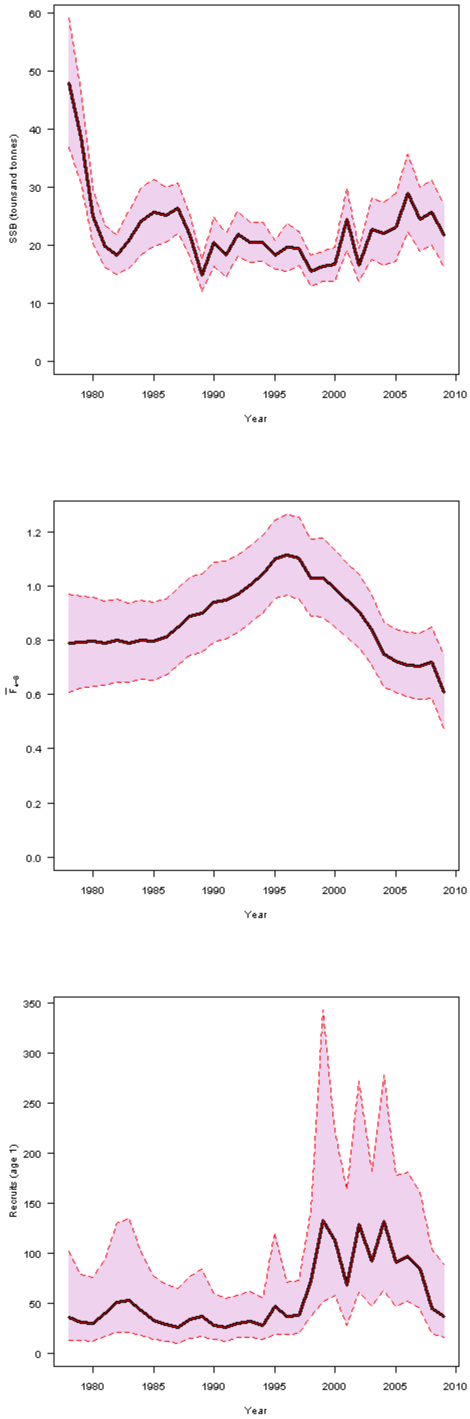


Figure 7.3.10. Plaice IIIa. Estimates from SAM with 95% confidence intervals using same inputs as XSA. Upper: Spawning stock biomass. Middle: Average fishing mortalities (ages 4-8). Lower: Number of one year old cods entering the population.

8 Plaice in Subarea IV

A Stock Annex is available for North Sea plaice. Therefore only deviations from the stock annex are presented within this Section of the report.

8.1 General

8.1.1 Ecosystem aspects

No new information on ecosystem aspects was presented at the working group in 2010. All available information on ecosystem aspects can be found in the Stock Annex.

8.1.2 Fisheries

No new information on fisheries aspects was presented at the working group in 2010. All available information can be found in the Stock Annex

8.1.3 ICES Advice

The information in this section is taken from the ACOM summary sheet 2009, section 6.4.7:

Single-stock exploitation boundaries

Exploitation boundaries in relation to existing management plans

"According to the management plan adopted by the EU in 2007, the fishing mortality in 2010 should be at the target F (= 0.3) with the constraint that the change in TAC should not be more than 15%. In this case the 15% limit is the determining factor, resulting in a TAC of no more than 73 400t".

Exploitation boundaries in relation to high long-term yield, low risk of depletion of production potential and considering ecosystem effects

"The current total fishing mortality (including discards) is estimated to be 0.24, which is above the rate expected to lead to high long-term yields and low risk of stock depletion (F_{max})."

Exploitation boundaries in relation to precautionary limits

"The exploitation boundaries in relation to precautionary limits imply human consumption landings of less than 144 400 t in 2011, which is expected to maintain SSB above B_{pa} in 2011, while maintaining F below F_{pa}."

Advice for mixed fisheries management

The information in this section is taken from the North Sea Advice overview section 6.3 in the ICES Advisory report 2008. The information has not been updated in 2009.

Fisheries in Division IIIa (Skagerrak–Kattegat), in Subarea IV (North Sea), and in Division VIId (Eastern Channel) should in 2009 be managed according to the following rules, which should be applied simultaneously:

Demersal fisheries

- *should minimize bycatch or discards of cod;*
- *should implement TACs or other restrictions that will curtail fishing mortality for those stocks mentioned above for which reduction in fishing pressure is advised;*
- *should be exploited within the precautionary exploitation limits or where appropriate on the basis of management plan results for all other stocks (see text table above);*
- *where stocks extend beyond this area, e.g. into Division VI (saithe and anglerfish) or are widely migratory (Northern hake), should take into account the exploitation of the stocks in these areas so that the overall exploitation remains within precautionary limits;*
- *should have no landings of angel shark and minimum bycatch of spurdog, porbeagle, and common skate and undulate ray.*

Mixed fisheries management options should be based on the expected catch in specific combinations of effort in the various fisheries, taking into consideration the advice given above. The distributions of effort across fisheries should be responsive to objectives set by managers, which is also the basis for the scientific advice presented above.

Key points highlighted in the ACOM 2009 summary sheet

Based on the most recent estimate of SSB (in 2009) and fishing mortality (in 2008), ICES classifies the stock as having full reproductive capacity and as being harvested sustainably. SSB is estimated to have increased above the Bpa. Fishing mortality is estimated to have decreased to below Fpa and Ftarget. Recruitment has been of average strength from 2005 onwards. The recruitment in 2008 is just below the long-term average.

Fishing effort has been substantially reduced since 1995, including the decommissioning of 25 vessels in 2008. The reduction in fishing effort is reflected in recent estimates of fishing mortality. There are indications that technical efficiency has increased in this fishery, which may have reduced the effect of the reduction in effort, but this may have been counteracted by decreases in fishing efficiency resulting from reduced fishing speed in an attempt to reduce fuel consumption

The combination of days-at-sea regulations, high oil prices, and the decreasing TAC for plaice and the relatively stable TAC for sole, appear to have induced a more southern fishing pattern in the North Sea. This concentration of fishing effort results in increased discarding of juvenile plaice that are mainly distributed in those areas. This process could be aggravated by movement of juvenile plaice to deeper waters in recent years where they become more susceptible to the fishery. Also the lpue data show a slower recovery of stock size in the southern regions that may be caused by higher fishing effort in the more coastal regions.

The assessment is considered to be highly uncertain, partly because discards form a substantial part of the total catch and cannot be well estimated from the low number of annual sampling trips, but most importantly due to the large differences in abundance observed in the different regions of the North Sea. The TAC constraint in the EU management plan is designed to allow for the uncertainty in the assessment.

8.1.4 Management

A long term management plan proposed by the Commission of the European Community was adopted by the Council of the European Union in June 2007 and first implemented in 2008 (EC Council Regulation No 676/2007). The plan consists of two stages. The aim of the first phase is to ensure the return of the stocks of plaice and sole to within safe biological limits. This should be reached through a reduction of fishing mortality by 10% in relation to the fishing mortality estimated for the preceding year until an F of *circa* 0.3 is reached. ICES interprets the F for the preceding year as the estimate of F for the year in which the assessment is carried out. The basis for this F estimate will be constant over the years. The plan sets a maximum change of 15% of the TAC between consecutive years.

ICES has evaluated the agreed long-term management plan (Council Regulation (EC) No. 676/2007) for plaice and sole. For plaice, the management plan evaluation is not yet conclusive with regards to consistency with the precautionary approach. The Review of an evaluation of the management plan for fisheries exploiting the stocks of plaice and sole in the North Sea (Council Regulation (EC) No 676/272) can be found in annex.

The implementation of the management plan resulted in an agreed TAC of 55 500 tonnes in 2009 and 63 825 tonnes in 2010.

For 2010 Council Regulation (EC) N°23/2010 allocates different amounts of Kw*days by Member State and area to different effort groups of vessels depending on gear and mesh size. The area’s are Kattegat, part of IIIa not covered by Skagerrak and Kattegat, ICES zone IV, EC waters of ICES zone IIa, ICES zone VIId, ICES zone VIIa, ICES zone Via and EC waters of ICES zone Vb. The grouping of fishing gear concerned are: Bottom trawls, Danish seines and similar gear, excluding beam trawls of mesh size: TR1 (≤ 100 mm) – TR2 (≤ 70 and < 100 mm) – TR3 (≤ 16 and < 32 mm); Beam trawl of mesh size: BT1 (≤ 120 mm) – BT2 (≤ 80 and < 120 mm); Gill nets excluding trammel nets: GN1; Trammel nets: GT1 and Longlines: LL1.

8.2 Data available

8.2.1 Catch

Total landings of North Sea plaice in 2009 (Table 8.2.1) were estimated by the WG at 54 973 t, an increase of 6 098 t from the 2008 landings. The 55 500 t TAC for 2009 was almost completely taken, being only 527 t higher than the WG estimated landings. The discards time series used in the assessment was derived from Dutch, Danish, German and UK discards observations for 2000–2009, as is described in the stock annex.

Official landings data was not available at the time of the working group meeting for Denmark and France (Table 8.2.1). Hence no official total landings have been calculated.

The Danish discards for 2000-2008 were revised, resulting in lower discards estimates throughout the time-series. Because the Danish landings are only a small fraction of the total landings, these revisions have only a limited effect on the total discards estimates.

The Dutch discards data for 2009 were derived from a combination of the observer programme that has been running since 2000, and a new self-sampling programme.

The estimates from both programmes were combined to come up with an overall estimate of discarding by the Dutch beam trawl fleet.

To reconstruct the number of plaice discards at age before 2000, catch numbers at age are calculated from fishing mortality at age corrected for discard fractions, using a reconstructed population and selection and distribution ogives (ICES CM 2005/ACFM:07 Appendix 1).

Figure 8.2.1 presents a time series of landings, catches and discards from these different sources.

8.2.2 Age compositions

The landing numbers at age are presented in Table 8.2.2. The discard numbers at age were calculated using the discards raising procedures described in the stock annex. The discard numbers at age are presented in Table 8.2.3. Catch numbers-at-age are presented as the sum of landings numbers at age and discards numbers at age in Table 8.2.4. Figure 8.2.3 presents the landings-at-age, and discards-at-age. Figure 8.2.4 presents the resulting catch-at-age.

8.2.3 Weight at age

Stock weights at age are presented in Table 8.2.5. Stock weight at age has varied considerably over time, especially for the older ages. There has been a long-term decline in the observed stock weight at age (Figure 8.2.5). This may be due to non-representative sampling of the different sexes in the population, mainly in the Dutch sampling programme. The stock weights of the older ages are based on the market samples in the first quarter, when the mature animals spawn. In these market samples, the sex ratio for the older ages is skewed towards the lighter males. Discard, landing, and catch weights at age are presented in Table 8.2.6, 8.2.7 and 8.2.8 respectively. Figure 8.2.5 presents the stock, discards, landings and catch weights at age.

8.2.4 Maturity and natural mortality

Natural mortality is assumed to be 0.1 for all age groups and constant over time. A fixed maturity ogive (Table 8.2.9) is used for the estimation of SSB in North Sea plaice.

8.2.5 Catch, effort and research vessel data

Three different survey indices can been used as tuning fleets are (Table 8.2.10 and Figure 8.2.6.):

- Beam Trawl Survey RV Isis (BTS-Isis)
- Beam Trawl Survey RV Tridens (BTS-Tridens)
- Sole Net Survey in September-October (SNS)

Traditionally, for the Sole Net Survey (SNS & SNSQ2) ages 1 to 3 are used for tuning the North Sea plaice assessment and the 0-group index is used in the RCT3 analysis for recent recruitment estimates. The internal consistency of the survey indices used for tuning appears relatively high for the entire age-range of each individual survey (Figures 8.2.7–8.2.9). However the consistency at young ages is fairly poor for the BTS-Tridens survey.

In the previous report it was observed that the BTS-Tridens index in 2008 was very high compared to previous years. An investigation of the raw length distribution corrected for effort extracted from the ICES database indeed indicated that large number of individuals were observed onboard the Tridens. Also the 2008 index data point within each internal consistency plot (Figure 8.2.7) didn't show up as an outlier, suggesting that the large number of individuals resulted from high survival of the year class in question.

An additional survey index that used for recruitment estimates is (Table 8.2.11):

- Demersal Fish Survey (DFS)

At the time of the working group meeting Belgian data for this index was not available for the estimates in 2009.

Commercial LPUE series (consisting of an effort series and landings-at-age series) that can be used as tuning fleets are (Table 8.2.12 and Figure 8.2.11):

- The Dutch beam trawl fleet
- The UK beam trawl fleet excluding all flag vessels

Effort has decreased in the Dutch beam trawl fleet since the early/mid 1990s. Up until 2002, the age-classes available in both the Dutch and the UK fleets generally show equal trends in LPUE through time.

The commercial LPUE data of the Dutch beam trawl-fleet, which dominated the fishery, will most likely be biased due to (individual) quota restrictions and increased fuel prices, which caused fishermen to leave productive fishing grounds in the more northern region. A method that corrects for such spatial changes in effort has been developed (WGNSSK 2009 WD 1 Quirijns and Poos). Under the assumption that discarding is negligible for the older ages, the LPUE represents CPUE, and this time series could be used to tune age structured assessment methods. Also, age-aggregated LPUE series, corrected for directed fishing under a TAC-constraint (see Quirijns and Poos 2008, WD 1), by area and fleet component, can be used as indication of stock development (Figure 8.2.12). This series has not been updated for 2009 due to discrepancies in the effort data for 2009.

Effort of the Dutch beam trawl fleet and of the English beam trawl vessels landing in the Netherlands, by area and fleet component from 1990 up to 2008, are in Figure 8.2.13 and Figure 8.2.14 shows the spatial distribution of effort.

Plaice LPUE, corrected for directed fishing under a TAC constraint, of the Dutch fleet shows a substantial decrease in the years 1990–1997, after which overall LPUE remains more or less at the same level. In 2004 the Dutch LPUE in the more northern and central North Sea has increased substantially. In 2008 an increase in the more southern North Sea also becomes evident The LPUE pattern of the Dutch fleet appears to correspond well with the stock dynamics of the XSA assessment. On average the LPUE first decreased to about 58% of the level it had in 1990, but has been increasing the last four years from about 1 ton/day up to 1.4 ton/day.

In the benchmark assessment, first attempts were made to include the LPUE into the stock assessment. This resulted in lower SSBs and higher F estimates, which was thought to be caused by reduction in fishing speed due to increased fuel prices and unrecorded discarding of marketable plaice. Consequently the WKFLAT recommended to include the LPUE index in to the assessment process, but to exclude LPUE series the final assessment run upon which management advice is based.

This year, only a very limited number of countries put their landings data in InterCatch before the agreed deadline. After the deadline several, though not all, countries added their landings data to the InterCatch database. Because of time constraints and incomplete data, InterCatch was not used for raising the landings.

8.3 Data analyses

The assessment of North Sea plaice by XSA was carried out using the FLR (FLCore v. 3.0 and FLXSA v.1.99-100) in R version 2.8.1. All other post-analyses were done using FLR packages.

8.3.1 Reviews of last year's assessment

General comments

Discards were noted to be a major concern for this stock. This is an established issue with regards to the accuracy of this stock assessment. Discard observation time series are lengthening allowing for better analysis of raising methods for discards data and estimation of previous discards patterns. Also, new a new self-sampling discards programme has been initiated by the Dutch, aiming to improve the overall coverage of discards sampling in the biggest fleet fishing this stock.

Technical comments

- Large differences observed in the tuning indices trends. One index indicates higher stock abundance than the other two. Also general decline recently for commercial indices, yet general increase from trawl surveys. Residual patterns with indices for final XSA.

It is thought that spatial differences in stock abundance and fishing activity can account for these differences. The commercial fleet is concentrating more effort in the southern North Sea where sole is more plentiful but plaice less so compared with more northerly areas. The BTS-Tridens survey (indicating the highest stock abundance) covers these northerly areas.

- LPUE index used in process but excluded from the final assessment run for management advice, reduced biomass and increased F.

The LPUE series were examined in detail when this stock was benchmarked in 2009 (WKFLAT 2009) and it was decided to include these only for additional information as trends in these indices are not believe to be fully indicative of stock abundance due to changes in fleet targeting, catchability and location over time.

8.3.2 Exploratory catch-at-age-based analyses

The following exploratory analysis have been carried out:

1. explore sensitivity to plusgroup age in the XSA
2. explore sensitivity to different combinations of tuning series in XSA
3. examine use of the combined BTS survey (BTS-Tridens + BTS-Isis)
4. examine incorporation of 50% of first quarter landings of plaice in area VIId into the North Sea (IV) assessment
5. stock assessment using the statistical catch-at-age model as described in Aarts & Poos (2009).

Plusgroup age

The effect of setting the plus-group at different ages was studied by running XSA with either a plus group at age 10 or at 15. The setting of the plus group has an effect on both the SSB and F estimates coming from the XSA assessment (Fig 8.3.1). In the beginning of the resulting time series, the SSB is higher with the plus group set at age 15 compared to age 10. In the more recent part of the assessment, the SSB estimates are lower when using a plus group at age 15 compared to age 10. For the estimates of fishing mortality the opposite effect can be found.

The proportion of fish older than 10 found in the catches has decreased in recent years (to 0 in some ages for some years). This can lead to inconsistencies in the resultant XSA numbers at age matrix that can affect the estimate of SSB, such as in 2006.

Different combinations of tuning series

A series of XSA runs was carried out with all possible permutations of the available survey tuning fleets. The settings of the XSA model were the same as in WGNSSK 2009. The results (Figure 8.3.2) also this year indicate that the selection of tuning fleets does strongly affect the perception of SSB and F in the most recent part of the assessment; The variance in the SSB estimates for the terminal year as a result of the permutations is high. The inclusion of only the BTS –Tridens would lead to a much higher perception of the final year SSB, combined with a much lower F estimate. Inclusion of only the BTS index, or a combination of the indices result in estimates between these two extremes.

Combined BTS survey

Combining the BTS-Tridens and BTS-Isis surveys into one has minimal effect on the perception of the stock: a short deviation from SPALY (same procedure as last year) estimates in the early 1990s and a slightly higher estimate of SBS and very slight lowering of the estimate of F in the recent period (Figure 8.3.3). This is most likely due to the weightings at age used in combining the two indices being very similar to the relative weightings at age assigned to each index when fit separately in the XSA. Similar to the results above, when the SNS series is excluded and only the combined index is used in the XSA, a much higher estimate of SSB (and correspondingly lower estimate of F) is produced.

Addition of English Channel (VIId) catch

It is suspected that plaice from the North Sea management area migrate to the eastern English Channel (area VIId) in the first quarter to spawn (see the Section 6 for further details). During this time they are landed by the fleets fishing in that area. It is estimated that in the region of 50% of first quarter landings in this area come from plaice that spend the rest of the year in the North Sea management area. The addition of first quarter landings from area VIId had a negligible impact on the estimated SSB and F levels throughout the time series (Figure 8.3.4). This result was not unexpected as these catches are in the range of 424 – 1 786 t per year, representing a very small proportion of the total catch taken in the North Sea.

Statistical catch at age-model

The statistical catch at age (SCA) model that can be used to assess the North Sea plaice stock is described in Aarts and Poos (2009). This model uses the same tuning survey indices as the XSA used in the final run. Rather than using the reconstructed discards, the model estimates the discards based on the total mortality that can be estimated from the tuning series, while the fishing mortality can be estimated from the landings, and the background natural mortality is assumed to be constant for all ages and years. The starting values for the optimizer are taken from the Aarts and Poos article, except of course for the recruitment and F estimates in 2008 and 2009. The SCA model estimates similar stock trends compared to the XSA in the final run. The median SSB in 2009 is estimated to be 379 000 tonnes, with 95% confidence bounds between 325 000 and 436 000 t (Figure 8.3.5 top left). The 95% confidence bounds for F range between 0.14 and 0.21 (Figure 8.3.5 top right). Figure 8.3.6 shows the log catchability residuals for the three tuning series. Like in the XSA assessment, the BTS- Tridens is characterised by positive residuals for all ages in the last two years, notably 2008 when very high catch rates were reported. Also, the SNS survey has all negative residuals since 2002. Figure 8.3.5 (bottom) shows that the discards are underestimated by the model since 2005. This is mainly caused by an underestimation of age 2 (Figure 8.3.7) which is the age where most discarding (in weight) takes place. This underestimation of age 2 discarding is likely the result of (i) a low number of degrees of freedom that are used to describe the discarding selectivity pattern, (ii) a solution of the model to accommodate the low SNS estimates (by estimating lower discards, the model tries to decrease F, explaining the low recruitment estimated by SNS, and the high number of mature individuals indicated by the BTS surveys. In the future, the selectivity pattern for the discards could be described by more degrees of freedom (used in the basic spline). Also, a penalty could be introduced on deviation from the observed total discards in weight.

8.3.3 Conclusions drawn from exploratory analyses

As was done in previous years, the plus group was set to 10, which has a minor effect on the assessment of F and SSB in the terminal year, but accounts for the recent decline in catches in the oldest ages. The different survey tuning series available give different perceptions of the development of the stock in the most recent part of the assessment. This difference in the signals from different areas in the North Sea corresponds to the observations from the landings per unit effort from the Dutch beam trawl fleet. Because the working group has not been able to model these differences, all the available survey tuning indices are used to average across the signals. The combined BTS survey and inclusion of area VIId Q1 landings had negligible effects on the results and are excluded from the final assessment. The SCA results are in good agreement with XSA findings.

8.3.4 Final assessment

The settings for the final assessment that is used for the catch option table is given below:

Year	2010
Catch at age	Landings + (reconstructed) discards based on NL, DK + UK + GE fleets
Fleets (years; ages)	BTS-Isis 1985–2008; 1–8 BTS-Tridens 1996–2008; 1–9 SNS 1982–2008 (excl. 2003); 1–3
Plus group	10
First tuning year	1982
Last data year	2009
Time series weights	No taper
Catchability dependent on stock size for age <	1
Catchability independent of ages for ages >=	6
Survivor estimates shrunk towards the mean F	5 years / 5 years
s.e. of the mean for shrinkage	2.0
Minimum standard error for population estimates	0.3
Prior weighting	Not applied

The full diagnostics are presented in Table 8.3.1. The XSA model stopped after 41 iterations. The log catchability residuals for the tuning fleets in the final run are dominated by negative values for the SNS tuning index in the most recent period, and positive values for the BTS-Tridens in the younger ages (Figure 8.3.9). This is potential due to a shift in the location of juvenile plaice offshore, away from the SNS survey area towards the BTS-Tridens survey area. However, the importance of the SNS survey in estimating recruits in previous years results in this survey still carrying a much higher weighting for age 1 estimates than the BTS-Tridens. The high BTS-Tridens tuning index for 1 year old individuals leads to a high residual in the XSA assessment for this age in the survey in recent years. Fishing mortality and stock numbers are shown in Tables 8.3.2 and 8.3.3. respectively. The SSB in 2009 was estimated at 380 kt. Mean F(2–6) was estimated at 0.24. Recruitment of the 2008 year class, in 2009 at the age of 1, was estimated at 1018 million in the XSA. Retrospective analyses of the XSA presented in Figure 8.3.11 indicate that historic estimates for SSB in 2006 and 2007 were much lower compared to the current estimate but values in 2008 were more similar. This is reflected correspondingly in the estimates of fishing mortality. This is likely the result of the increase of younger individuals in the more northern region (surveyed by the Tridens but not by the higher weighted SNS), that have aged and therefore only recently have a high impact on the estimation of the stock size.

8.4 Historic Stock Trends

Table 8.4.1. and Figures 8.4.1 and 8.4.2 present the trends in landings, mean F(2–6), F(human consumption, 2–6), F(discards, 2–3), SSB, TSB and recruitment since 1957. Reported landings gradually increased up to the late 1980s and then rapidly declined until 1995, in line with the decrease in TAC. The landings show a general decline from 1987 onwards, slightly increasing in recent years. Discards were particularly high in 1997 and 1998 (reconstructed), and in 2001 and 2003 (observed), resulting from strong year classes. Fishing mortality increased until the late 1990s and reached its highest observed level in 1997. Since then, the estimates of fishing mortality have been fluctuating strongly. However, overall F has been lower since 2004, rapidly decreasing down to 0.24 in 2008 and staying at the same level in 2009. The peaks during 1997–1998 and 2001 have been mainly caused by peaks in F(discards). The F(human consumption) is estimated to decline since 1997, with little inter-annual variability. This year (2009), the F(human consumption) is the lowest estimate historically. Current fishing mortality is estimated at 0.24 (Fhc,2–6 = 0.12). The SSB increased to a peak in 1967 when the strong 1963 year class became mature. Since then, SSB declined to a level of around 260 kt in the early 1980s. Due to the recruitment of the strong year-classes 1981 and 1985, SSB again increased to a peak in 1987 of around 448 kt followed by a rapid decline (to 1996). SSB then fluctuated around 220 kt for 10 years. Over the last five years SSB has been rapidly increasing and is currently (2009) estimated at 380 kt. In plaice the inter-annual variability in recruitment is relatively small, except for a limited number of strong year classes. Previously only year classes 1963, 1981, 1985 and 1996 were considered to be strong. Including discard data in the assessment alters the recruitment estimates and indicates that 1984, 1986, 1987 were also relatively strong year classes and that the 1985 year class was by far the strongest year class on record. Recruitment shows a periodic change with relatively poor recruitment in the 1960s and relatively strong recruitment in the 1980s. The recruitment level in the 1990s appears to be somewhat lower than in the 1980s. The 1996 and 2001 year classes are estimated to be relatively strong, while the year classes since 2002 appear weak to average. The 2008 year class, estimated at 1018 kt, is above the long term geometric mean.

The North Sea Fishers' Survey for 2009 resulted in a total of 176 responses. The respondents were divided into 3 three groups; the large vessel group was dominated by respondents fishing with beam trawls (77%), the majority stating that the plaice abundance has increased from last year (80% of respondents). This is a similar response as recorded in the 2007 and 2008 surveys and is consistent with the trends in the assessment. The modal response for trends in discarding was that there was “no change”, however more respondents than last year believed there had been an increase in discarding rates. This follows from, and is in close agreement with, the 2008 survey in which comments received for plaice from the respondents indicate that abundances were increasing, that there had been “enormous” increases and that abundances are the “highest for 25 years”, and that quota for plaice is too low.

8.5 Recruitment estimates

Input to the RCT3 analysis is presented in Table 8.5.1. Estimates from the RCT3 analysis of age 1 are presented in Table 8.5.2, and of age 2 in Table 8.5.3. For year class 2009 (age 1 in 2010) the values predicted by the two surveys (SNS and DFS) in RCT3 differ considerably (two orders of magnitude) and have high prediction standard errors (Table 8.5.2.). Also, the Belgian data for the most recent DFS estimate was not available. Therefore the geometric mean, lower than the RCT3 estimate, was accepted for the short-term forecasts. Also for year class 2008 (age 2 in 2010), the estimates from SNS 0-group and the BTS 1-group differ considerably from the and DFS 0-group and SNS 1-group and all have high prediction standard errors. The SNS 1-group and BTS 1-group estimates (also used for the XSA) have relatively lower standard errors, though these are still fairly uncertain. The WG decided to use the XSA estimate for the 2008 year class. In practice the estimates (XSA survivors, RCT3 or geometric mean) are quite similar.

The recruitment estimates from the different sources are summarized in the text table below.

Year class	At age in 2010	XSA Survivors	RCT3	GM 1957–2007	Accepted estimate
2008	2	**778204**	741267	672776	XSA survivors
2009	1		1161744	**915040**	GM 1957–2007
2010	0			**915040**	GM 1957–2007

8.6 Short-term forecasts

Short-term prognoses have been carried out in FLR using FLSTF (1.99). Weight-at-age in the stock and weight-at-age in the catch are taken to be the average over the last 3 years. The exploitation pattern was taken to be the mean value of the last three years, scaled to F in 2009. The proportion of landings at age was taken to be the mean of the last three years, this proportion was used for the calculation of the discard and human consumption partial fishing mortality. Population numbers at ages 2 and older are XSA survivor estimates. Numbers at age 1 and recruitment of the 2009 year-class are taken from the long-term geometric mean (1957-2007). Input to the short term forecast is presented in table 8.6.1. The management options are given in Tables 8.6.2A-B. In recent years the management options were given for three different assumptions on the F values in the intermediate year: A) F is assumed to be equal to the estimate for F in the previous year, B) F is set such that the landings in the intermediate year equal the TAC for that year, and C) F is assumed to be 0.9 times F in the previous year. Option C was only considered previously because the long term management plan for this stock advised 10% annual decreases in F. However, the TAC for 2010 was set assuming the F target for the management plan had been met and therefore no 10% reduction in F was required. Hence only options A and B are considered for F in 2010 in the projections presented in the current report. The table below shows the predicted F values in the intermediate year, SSB for 2011 and the corresponding landings for 2010, given the different assumptions about F in the intermediate year in the two scenarios.

Scenario	Assumption	F_{2010}	SSB_{2011}	$Landings_{2010}$
A	$F_{2010} = F_{2009}$ (Fsq)	0.240	481 823	61 795
B	$Landings_{2010} = TAC_{2010}$	0.249	478 525	63 825

The detailed tables for forecasts based on the two scenarios are given in Table 8.6.3A-B. ICES interprets the F for the preceding year as the estimate of F for the year in which the assessment is carried out. The basis for this F estimate in the preceding year will be a constant application of the procedure used by ICES in 2008 (see section 8.1.4). Using this ICES rule of application they will present scenario A as the basis for its forecast.

Yield and SSB, per recruit, under the condition of the current exploitation pattern are given in Figure 8.6.1 and Table 8.6.4. Fmax is estimated at 0.2.

8.7 Medium-term forecasts

No medium term projections were done for this stock.

8.8 Biological reference points

8.8.1 Precautionary approach reference points

The current precautionary approach reference points were established by the WGNSSK in 2004, when the discard estimates were included in the assessment for the first time. The stock-recruitment relationship for North Sea plaice did not show a clear breakpoint where recruitment is impaired at lower spawning stocks. Therefore, ICES considered that $\mathbf{B_{lim}}$ can be set at $\mathbf{B_{loss}}$=160 000 t and that $\mathbf{B_{pa}}$ can then be set at 230 000 t using the default multiplier of 1.4 (although the WG acknowledges that, since the noisy discards estimates have been included, the uncertainty of the estimates of stock status is much greater than that, see Dickey-Collas et al. 2008). $\mathbf{F_{lim}}$ was set at $\mathbf{F_{loss}}$ (0.74). $\mathbf{F_{pa}}$ was proposed to be set at 0.6 which is the 5th percentile of $\mathbf{F_{loss}}$ and gave a 50% probability that SSB is around $\mathbf{B_{pa}}$ in the medium term. Equilibrium analysis suggests that F of 0.6 is consistent with an SSB of around 230 000 t.

8.8.2 F_{MSY} reference points

Results from stochastic stock-recruit fits using the ADMB CEFAS software (cf section 1.3.1) for three alternative stock-recruit models are presented in Figures 8.8.1-5 and Table 8.8.1. F_{MSY} reference points were selected on the basis of these stochastic age-structured MSY equilibrium analyses. These analyses produced a range of potential estimates given assumptions made on the form of the stock-recruit relationship and considering uncertainty in the estimation of numbers at age and biological (weights at age, maturity and natural mortality) and fishery (selectivity at age) parameters. This simple analysis thus ignores density dependent growth and mortality. For the final estimations, biological and fishery parameters were estimated based on the XSA results and observations for the period 2002-2009.

In cases where the majority of stochastic stock-recruit model fits fell out of the range of the deterministic fit to the data, it can be concluded that the stock-recruit form is unrealistic and not suitable for the data and the level of uncertainty associated with the parameters. The Beverton-Holt stock recruit relationship fails in this regard and therefore was not considered as a suitable stock-recruit relationship to consider in the defining of F_{MSY} reference points for this stock.

In cases where the Fmax is poorly estimated by the stock recruit relationship, basing Fmsy on such a curve could result in a value lying close to that of Fcrash, particularly in a segmented regression form with poor information around the origin, as is the case for this stock. That both the segmented regression and per-recruit analysis suggests a high degree of uncertainty with regards to Fmax could be down to the assumptions made about the uncertainties input into the analyses. Given the lack of any clear patterns in the stock-recruit data, a segmented regression model fit, while uncertain around the origin, probably provide the most cautious fit to the data. Hence it was decided not to reject estimated reference points resulting from this stock-recruit model.

Biological realism and acceptability should also be considered, for example in the case of accepting a Ricker stock-recruit form, a reasonable argument or evidence supporting negative feedback effects on recruitment level should exist. This is currently lacking for the North Sea plaice stock, though it is not unreasonable to assume that at extremely high biomasses, some negative feedback factors would come into play. Also, CVs on the estimated parameters in the stochastic equilibrium analysis were low and the resultant distribution on equilibria more compact, allowing greater confidence in the reference points estimated assuming this stock-recruit fit.

Given the above considerations, a range of F_{MSY} values is proposed: 0.2 – 0.3. The lower end of this range is based on the deterministic segmented regression estimate of F_{MSY} (due to the high CV on the stochastic estimate) and the upper end is based on the median of the stochastic estimate of F_{MSY} based on the Ricker stock recruitment curve.

	ICES considered that:	**ICES proposed that:**
Precautionary Approach Reference point	$\mathbf{B_{lim}}$ is 160 000 t	$\mathbf{B_{pa}}$ be set at 230 000 t
	$\mathbf{F_{lim}}$ is 0.74	$\mathbf{F_{pa}}$ be set at 0.60
Target reference points		$\mathbf{F_{MSY}}$ is in the range of 0.2-0.3

8.9 Quality of the assessment

Large differences are found in the trends in tuning series over the last seven years. The more northern BTS-Tridens index indicates much higher stock abundances than the two other tuning indices, BTS-Isis and particularly the SNS. The assessment which only includes the BTS-Tridens suggest an estimate of SSB which is significantly higher than the SSB estimate tuned using the BTS-Isis and SNS index. This suggests a large spatial heterogeneity of the stock which is either explained by increased northwards migration or a higher survival in the more northern region due to an overall decrease in fishery induced mortality. The spatial difference of the stock trends is corroborated by the area disaggregated LPUE estimates from the Dutch beam trawl fleet. However, the historic development of the stock abundance as estimated by XSA shows good correspondence with the development of the average commercial LPUE of the Dutch beam trawl fleet.

A strong retrospective analysis of the assessment shows considerable recurring bias (Figure 8.3.7), though this has decreased in the most recent year. This retrospective pattern is the result of the high 2006-2008 tuning indices in general, and the fact that the cohorts being estimated stronger by BTS Tridens than the other surveys now reach the age where the index receives a higher weighting in the assessment.

The assessment presented by the WG incorporates discards. WGNSSK noted in 2002 (ICES 2003) that not considering discard catches in stock assessments could introduce bias and affect estimates of F and stock biomass, particularly when discard patterns vary over time. Currently fleet level discard estimates are available for the past nine years. However, total sampling effort of the discards is low, and data is sparse. Also, samples may not always be available from relevant fleets and fisheries within a country. Particularly the UK and Dutch >100mm fishery, comprising >20% of the landings is poorly sampled. Discard observation time series are lengthening allowing for better analysis of raising methods for discards data and estimation of previous discards patterns. Also, new a new self-sampling discards programme has been initiated by the Dutch, aiming to improve the overall coverage of discards sampling in the biggest fleet fishing this stock.

The assessment is considered to be uncertain because discards form a substantial part of the total catch but are currently not well estimated from the sparse sampling trips.

8.10 Status of the Stock

SSB in 2010 is estimated around 435 thousand tonnes which is above Bpa (230 000 t). Fishing mortality is estimated to have remained constant from 2008 to 2009 at a value of 0.24 (both below Fpa = 0.60), and is currently below the long term management target F of 0.30. At the same time, Fishing mortality of the human consumption part of the catch is estimated to be 0.12. Projected landings for 2011 at Fsq are 66 kt, which is slightly higher than to the projected landings for 2010 at Fsq (62 kt) which is again higher than the estimated landings of 2009 (55 kt). Projected discards for 2011 are approximately equal to the projected discards for 2009 at Fsq, but this is mainly based on the estimates of the abundance of year classes 2008 and 2009 coming in. Therefore, development of discarding in the next couple of years will depend on the true size of these year classes.

8.11 Management Considerations

Plaice is mainly taken by beam trawlers in a mixed fishery with sole in the southern and central part of the North Sea.

Fishing effort has been substantially reduced since 1995. The reduction in fishing effort appears to be reflected in recent estimates of fishing mortality. There are indications that technical efficiency has increased in this fishery, but these may have been counteracted by decreases in fishing efficiency resulting from reduced fishing speed in an attempt to reduce fuel consumption.

Technical measures applicable to the mixed flatfish fishery will affect both sole and plaice. The minimum mesh size of 80 mm in the beam trawl fishery selects sole at the minimum landing size. However, this mesh size generates high discards of plaice which are selected from 17 cm with a minimum landing size of 27 cm. Recent discards estimates indicate fluctuations around 50% discards in weight. Mesh enlargement would reduce the catch of undersized plaice, but would also result in loss of marketable sole.

The combination of days-at-sea regulations, high oil prices, and the decreasing TAC for plaice and the relatively stable TAC for sole, have induced a more coastal fishing pattern in the southern North Sea. This concentration of fishing effort results in increased discarding of juvenile plaice that are mainly distributed in those areas. This process could be aggravated by movement of juvenile plaice to deeper waters in recent years where they become more susceptible to the fishery. Also the LPUE data show a slower recovery of stock size in the southern regions that may be caused by higher fishing effort in the more coastal regions.

The Plaice Box is a partially closed area along the continental coast that was instigated in phases starting in 1989. The area has been closed to most categories of vessels > 300hp all year round since 1995. The most recent EU funded evaluation by Beare et al. (2010) reported the Plaice Box as having very little negative or positive impact on the plaice stock.

The stock dynamics are dependent on the occurrence of strong year classes, but increased stock size in the more northern region of the North sea is most likely the direct consequence of reduced fishing mortality in this region.

The mean age in the landings is currently around age 4, but used to be nearer to age 5 in the beginning of the time series. This change may be caused by the high exploitation levels, but also by the shift in the spatial distribution of fishing effort towards inshore waters and by the shift in the spatial distribution of the fish. A lower exploitation level is expected to improve the survival of plaice, which could enhance the stability in the catches.

A shift in the age and size at maturation of plaice has been observed (Grift *et al.* 2003): plaice become mature at younger ages and at smaller sizes in recent years than in the past. There is a risk that this is caused by a genetic fisheries-induced change: those fish that are genetically programmed to mature late at large sizes are likely to have been removed from the population before they have had a chance to reproduce and pass on their genes. This results in a population that consists ever more of fish that are genetically programmed to mature early at small sizes. Reversal of such a genetic shift may be difficult. This shift in maturation also leads to mature fish being of a smaller size at age, because growth rate diminishes after maturation.

A long term management plan proposed by the Commission of the European Community was adopted by the Council of the European Union in June 2007 and first implemented in 2008 (EC Council Regulation No 676/2007). The plan consists of two stages. The aim of the first phase is to ensure the return of the stocks of plaice and sole in the North sea to within safe biological limits. This should be reached through an annual reduction of fishing mortality (F) by 10% in relation to the fishing mortality estimated for the preceding year. ICES interprets the F for the preceding year as the estimate of F for the year in which the assessment is carried out. The basis for this F estimate in the preceding year will be a constant application of the procedure used by ICES in 2007. The plan sets a maximum change of 15% of the TAC between consecutive years ICES has evaluated the agreed long-term management plan (Council Regulation (EC) No. 676/2007) for plaice and sole. For plaice, the management plan evaluation is not yet conclusive with regards to consistency with the precautionary approach. A new evaluation of this management plan is currently underway, taking into account issues highlighted by reviews of the previous evaluation. This new evaluation will also further evaluate the management plan in terms of its compatibility with Fmsy based management and targets.

The assessment is considered to be highly uncertain most importantly because the different survey tuning series in different areas of the North Sea indicate different trends in the most recent development of the stock. This uncertainty is compounded by a relatively strong retrospective pattern, where this years' assessment result estimates higher SSBs and lower fishing mortalities for the most recent years. However, this retrospective pattern is decreasing in recent years.

Table 8.2.1. North Sea Plaice. Nominal landings

YEAR	Belgium	Denmark	France	Germany	Nether-lands	Norway	Sweden	UK	Others	Total	Un-allocated	WG estimate	TAC
1980	7005	27057	711	4319	39782	15	7	23032		101928	38023	139951	
1981	6346	22026	586	3449	40049	18	3	21519		93996	45701	139697	105000
1982	6755	24532	1046	3626	41208	17	6	20740		97930	56616	154546	140000
1983	9716	18749	1185	2397	51328	15	22	17400		100812	43218	144030	164000
1984	11393	22154	604	2485	61478	16	13	16853		114996	41153	156149	182000
1985	9965	28236	1010	2197	90950	23	18	15912		148311	11527	159838	200000
1986	7232	26332	751	1809	74447	21	16	17294		127902	37445	165347	180000
1987	8554	21597	1580	1794	76612	12	7	20638		130794	22876	153670	150000
1988	11527	20259	1773	2566	77724	21	2	24497	43	138412	16063	154475	175000
1989	10939	23481	2037	5341	84173	321	12	26104		152408	17410	169818	185000
1990	13940	26474	1339	8747	78204	1756	169	25632		156261	-21	156240	180000
1991	14328	24356	508	7926	67945	560	103	27839		143565	4438	148003	175000
1992	12006	20891	537	6818	51064	836	53	31277		123482	1708	125190	175000
1993	10814	16452	603	6895	48552	827	7	31128		115278	1835	117113	175000
1994	7951	17056	407	5697	50289	524	6	27749		109679	713	110392	165000
1995	7093	13358	442	6329	44263	527	3	24395		96410	1946	98356	115000
1996	5765	11776	379	4780	35419	917	5	20992		80033	1640	81673	81000
1997	5223	13940	254	4159	34143	1620	10	22134		81483	1565	83048	91000
1998	5592	10087	489	2773	30541	965	2	19915	1	70365	1169	71534	87000
1999	6160	13468	624	3144	37513	643	4	17061		78617	2045	80662	102000
2000	7260	13408	547	4310	35030	883	3	20710		82151	-1001	81150	97000
2001	6369	13797	429	4739	33290	1926	3	19147		79700	2147	81847	78000
2002	4859	12552	548	3927	29081	1996	2	16740		69705	512	70217	77000
2003	4570	13742	343	3800	27353	1967	2	13892		65669	820	66489	73250
2004	4314	12123	231	3649	23662	1744	1	15284		61008	428	61436	61000
2005	3396	11385	112	3379	22271	1660	0	12705		54908	792	55700	59000
2006	3487	11907	132	3599	22764	1614	0	12429		55933	2010	57943	57441
2007	3866	8128	144	2643	21465	1224	4	11557		49031	713	49744	50261
2008	3396	8229	125	3138	20312	1051	20	11411		47682	1193	48875	49000
2009	3474	N/A*	N/A*	2931	23152	1116	1	13143		N/A*	-	54973	55500
2010													63825

*** Official estimates not available.**

Table 8.2.2. North Sea plaice. Landing numbers-at-age

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year	age 1	2	3	4	5	6	7	8	9	10
1957	0	4315	59818	44718	31771	8885	11029	9028	4973	10859
1958	0	7129	22205	62047	34112	19594	8178	8000	6110	13148
1959	0	16556	30427	25489	41099	22936	13873	6408	6596	16180
1960	0	5959	61876	51022	21321	27329	14186	9013	5087	15153
1961	0	2264	33392	67906	32699	12759	14680	9748	5996	14660
1962	0	2147	35876	66779	50060	20628	9060	9035	5257	12801
1963	0	4340	21471	76926	54364	31799	12848	6833	7047	16592
1964	0	14708	40486	64735	57408	37091	15819	6595	3980	16886
1965	0	9858	42202	53188	43674	30151	18361	8554	4213	17587
1966	0	4144	65009	51488	36667	27370	16500	10784	6467	14928
1967	0	5982	30304	112917	41383	22053	16175	8004	6728	11175
1968	0	9474	40698	38140	123619	17139	10341	10102	3925	13365
1969	3	15017	45187	36084	35585	102014	10410	6086	8192	16092
1970	76	17294	51174	56153	40686	35074	78886	6311	4185	14840
1971	19	29591	48282	33475	26059	22903	16913	29730	6414	16910
1972	2233	36528	62199	52906	23043	16998	14380	10903	18585	15651
1973	1268	31733	59099	73065	42255	13817	8885	9848	6084	23978
1974	2223	23120	55548	42125	41075	19666	8005	6321	5568	21980
1975	981	28124	61623	31262	25419	21188	11873	5923	4106	19695
1976	2820	33643	77649	96398	13779	9904	9120	6391	2947	12552
1977	3220	56969	43289	66013	83705	9142	5912	5022	4061	9191
1978	1143	60578	62343	54341	50102	35510	5940	3352	2419	7468
1979	1318	58031	118863	48962	47886	39932	24228	4161	2807	9288
1980	979	64904	133741	77523	24974	17982	13761	8458	1864	5377
1981	253	100927	122296	57604	35745	12414	9564	8092	4874	5903
1982	3334	47776	209007	69544	28655	16726	7589	5470	4482	8653
1983	1214	119695	115034	99076	29359	12906	8216	4193	3013	8287
1984	108	63252	274209	53549	37468	13661	6465	5544	2720	6565
1985	121	73552	144316	185203	32520	15544	6871	3650	2698	5798
1986	1674	67125	163717	93801	84479	24049	9299	4490	2733	6950
1987	0	85123	115951	111239	64758	34728	11452	4341	2154	5478
1988	0	15146	250675	74335	47380	25091	16774	5381	3162	6233
1989	1261	46757	105929	231414	52909	19247	10567	7561	2120	5580
1990	1550	32533	97766	110997	159814	26757	8129	4216	3451	3808
1991	1461	43266	83603	116155	72961	77557	14910	5233	3141	5591
1992	3410	43954	85120	72494	72703	33406	29547	6970	3200	6928
1993	3461	53949	98375	72286	51405	29001	13472	11272	3645	5883
1994	1394	45148	101617	80236	38542	20388	15323	6399	5368	5433
1995	7751	36575	81398	78370	36499	17953	9772	4366	2336	3753
1996	1104	42496	64382	46359	32130	14460	10605	4528	2624	4892
1997	892	42855	86948	43669	22541	13518	6362	3632	2179	4181
1998	196	30401	68920	56329	16713	6432	4986	2506	1761	3119
1999	549	8689	155971	39857	24112	6829	2783	2246	1521	3093
2000	2634	15819	39550	164330	14993	9343	2130	1030	940	2097
2001	4509	35886	52480	48238	89949	6836	4418	1127	637	2309
2002	1233	15596	58262	48361	36551	37877	4644	1788	742	1586
2003	694	42594	47802	48894	27126	15999	17069	1608	650	859
2004	543	10317	102332	35165	20527	11293	4787	4555	412	540
2005	2937	16685	26069	82278	17039	9533	5332	2614	2223	613
2006	355	18987	67465	25254	42525	6555	4967	2053	1235	1319
2007	1286	19205	37309	47053	14971	17142	2459	1856	543	1259
2008	380	10970	42865	37970	29476	5700	6752	912	673	896
2009	1492	10726	50436	33911	20969	16551	2987	3967	556	763

Table 8.2.3. North Sea Plaice. Discards numbers-at-age

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year \ age	1	2	3	4	5	6	7	8	9	10
1957	32356	45596	9220	909	961	25	0	0	0	0
1958	66199	73552	23655	2572	2137	65	0	0	0	0
1959	116086	127771	46402	11407	4737	106	0	0	0	0
1960	73939	167893	44948	997	1067	519	0	0	0	0
1961	75578	144609	89014	538	1612	130	0	0	0	0
1962	51265	181321	87599	21716	799	186	0	0	0	0
1963	90913	136183	129778	9964	2112	188	0	0	0	0
1964	66035	153274	64156	33825	3011	323	0	0	0	0
1965	43708	426021	59262	3404	923	267	0	0	0	0
1966	38496	163125	349358	14399	1402	125	0	0	0	0
1967	20199	133545	87532	152496	623	260	0	0	0	0
1968	73971	72192	46339	26530	22436	58	0	0	0	0
1969	85192	67378	16747	19334	773	2024	0	0	0	0
1970	123569	152480	27747	1287	5061	161	0	0	0	0
1971	69337	96968	42354	2675	426	81	0	0	0	0
1972	70002	55470	33899	5714	567	73	0	0	0	0
1973	132352	49815	4008	673	1289	67	0	0	0	0
1974	211139	308411	3652	285	611	109	0	0	0	0
1975	244969	280130	190536	4807	253	123	0	0	0	0
1976	183879	140921	71054	18013	174	41	0	0	0	0
1977	256628	103696	79317	33552	9317	129	0	0	0	0
1978	226872	154113	27257	10775	1244	570	0	0	0	0
1979	293166	215084	57578	18382	589	310	0	0	0	0
1980	226371	122561	932	687	193	86	0	0	0	0
1981	134142	193241	1850	373	431	55	0	0	0	0
1982	411307	204572	4624	1109	216	98	0	0	0	0
1983	261400	436331	30716	2235	804	72	0	0	0	0
1984	310675	313490	52651	24529	1492	69	0	0	0	0
1985	405385	229208	35566	2221	200	78	0	0	0	0
1986	1117345	490965	48510	26470	1451	146	0	0	0	0
1987	361519	1374202	180969	1427	1348	248	0	0	0	0
1988	348597	608109	459385	61167	882	177	0	0	0	0
1989	213291	485845	193176	85758	7224	115	0	0	0	0
1990	145314	279298	168674	28102	5011	177	0	0	0	0
1991	183126	301575	141567	40739	5528	939	0	0	0	0
1992	138755	219619	94581	34348	4307	880	0	0	0	0
1993	96371	154083	48088	11966	1635	216	0	0	0	0
1994	62122	95703	35703	1038	822	144	0	0	0	0
1995	118863	82676	15753	860	663	120	0	0	0	0
1996	111250	331065	27606	3930	451	116	0	0	0	0
1997	128653	510918	193828	588	271	108	0	0	0	0
1998	104538	646250	191631	53354	297	33	0	0	0	0
1999	127321	208401	231769	54869	278	58	0	0	0	0
2000	103468	171213	51092	64971	1230	241	263	167	0	0
2001	30346	352452	186900	74744	54276	152	45	1	0	0
2002	309822	177574	76246	12113	1571	661	107	1	0	0
2003	67718	517641	52582	19130	3843	386	5751	1	0	0
2004	232936	179561	115746	6614	1047	232	37	1	0	0
2005	93585	324744	43297	19440	4098	5968	147	1	0	0
2006	220501	223814	107163	9129	2324	249	732	194	0	0
2007	77239	203775	66539	8999	736	6972	170	1644	0	0
2008	135339	251389	34997	4568	1644	328	8845	885	0	0
2009	148639	191957	66063	9165	1973	1106	136	3220	0	0

Table 8.2.4. North Sea plaice. Catch numbers-at-age

2010-05-06 12:13:46 units= thousands

year	age 1	2	3	4	5	6	7	8	9	10
1957	32356	49911	69038	45627	32732	8910	11029	9028	4973	10859
1958	66199	80681	45860	64619	36249	19659	8178	8000	6110	13148
1959	116086	144327	76829	36896	45836	23042	13873	6408	6596	16180
1960	73939	173852	106824	52019	22388	27848	14186	9013	5087	15153
1961	75578	146873	122406	68444	34311	12889	14680	9748	5996	14660
1962	51265	183468	123475	88495	50859	20814	9060	9035	5257	12801
1963	90913	140523	151249	86890	56476	31987	12848	6833	7047	16592
1964	66035	167982	104642	98560	60419	37414	15819	6595	3980	16886
1965	43708	435879	101464	56592	44597	30418	18361	8554	4213	17587
1966	38496	167269	414367	65887	38069	27495	16500	10784	6467	14928
1967	20199	139527	117836	265413	42006	22313	16175	8004	6728	11175
1968	73971	81666	87037	64670	146055	17197	10341	10102	3925	13365
1969	85195	82395	61934	55418	36358	104038	10410	6086	8192	16092
1970	123645	169774	78921	57440	45747	35235	78886	6311	4185	14840
1971	69356	126559	90636	36150	26485	22984	16913	29730	6414	16910
1972	72235	91998	96098	58620	23610	17071	14380	10903	18585	15651
1973	133620	81548	63107	73738	43544	13884	8885	9848	6084	23978
1974	213362	331531	59200	42410	41686	19775	8005	6321	5568	21980
1975	245950	308254	252159	36069	25672	21311	11873	5923	4106	19695
1976	186699	174564	148703	114411	13953	9945	9120	6391	2947	12552
1977	259848	160665	122606	99565	93022	9271	5912	5022	4061	9191
1978	228015	214691	89600	65116	51346	36080	5940	3352	2419	7468
1979	294484	273115	176441	67344	48475	40242	24228	4161	2807	9288
1980	227350	187465	134673	78210	25167	18068	13761	8458	1864	5377
1981	134395	294168	124146	57977	36176	12469	9564	8092	4874	5903
1982	414641	252348	213631	70653	28871	16824	7589	5470	4482	8653
1983	262614	556026	145750	101311	30163	12978	8216	4193	3013	8287
1984	310783	376742	326860	78078	38960	13730	6465	5544	2720	6565
1985	405506	302760	179882	187424	32720	15622	6871	3650	2698	5798
1986	1119019	558090	212227	120271	85930	24195	9299	4490	2733	6950
1987	361519	1459325	296920	112666	66106	34976	11452	4341	2154	5478
1988	348597	623255	710060	135502	48262	25268	16774	5381	3162	6233
1989	214552	532602	299105	317172	60133	19362	10567	7561	2120	5580
1990	146864	311831	266440	139099	164825	26934	8129	4216	3451	3808
1991	184587	344841	225170	156894	78489	78496	14910	5233	3141	5591
1992	142165	263573	179701	106842	77010	34286	29547	6970	3200	6928
1993	99832	208032	146463	84252	53040	29217	13472	11272	3645	5883
1994	63516	140851	137320	81274	39364	20532	15323	6399	5368	5433
1995	126614	119251	97151	79230	37162	18073	9772	4366	2336	3753
1996	112354	373561	91988	50289	32581	14576	10605	4528	2624	4892
1997	129545	553773	280776	44257	22812	13626	6362	3632	2179	4181
1998	104734	676651	260551	109683	17010	6465	4986	2506	1761	3119
1999	127870	217090	387740	94726	24390	6887	2783	2246	1521	3093
2000	106102	187032	90642	229301	16223	9584	2393	1197	940	2097
2001	34855	388338	239380	122982	144225	6988	4463	1128	637	2309
2002	311055	193170	134508	60474	38122	38538	4751	1789	742	1586
2003	68412	560235	100384	68024	30969	16385	22820	1609	650	859
2004	233479	189878	218078	41779	21574	11525	4824	4556	412	540
2005	96522	341429	69366	101718	21137	15501	5479	2615	2223	613
2006	220856	242801	174628	34383	44849	6804	5699	2247	1235	1319
2007	78525	222980	103848	56052	15707	24114	2629	3500	543	1259
2008	135719	262359	77862	42538	31120	6028	15597	1797	673	896
2009	150131	202683	116499	43076	22942	17657	3123	7187	556	763

Table 8.2.5. North Sea plaice. Stock weight-at-age

2010-05-06 12:13:48 units= kg

year \ age	1	2	3	4	5	6	7	8	9	10
1957	0.038	0.102	0.157	0.242	0.325	0.485	0.719	0.682	0.844	1.143
1958	0.041	0.093	0.180	0.272	0.303	0.442	0.577	0.778	0.793	1.112
1959	0.045	0.106	0.173	0.264	0.329	0.470	0.650	0.686	0.908	1.042
1960	0.038	0.111	0.181	0.272	0.364	0.469	0.633	0.726	0.845	1.090
1961	0.037	0.098	0.185	0.306	0.337	0.483	0.579	0.691	0.779	1.067
1962	0.036	0.096	0.173	0.301	0.424	0.573	0.684	0.806	0.873	1.303
1963	0.041	0.103	0.176	0.273	0.378	0.540	0.663	0.788	0.882	1.252
1964	0.024	0.113	0.184	0.296	0.373	0.477	0.645	0.673	0.845	1.232
1965	0.031	0.068	0.198	0.294	0.333	0.430	0.516	0.601	0.722	0.909
1966	0.031	0.099	0.127	0.305	0.403	0.455	0.503	0.565	0.581	0.984
1967	0.029	0.104	0.179	0.205	0.442	0.528	0.585	0.650	0.703	0.985
1968	0.055	0.094	0.175	0.287	0.344	0.532	0.592	0.362	0.667	0.887
1969	0.047	0.158	0.188	0.266	0.344	0.390	0.565	0.621	0.679	0.857
1970	0.043	0.113	0.236	0.274	0.369	0.410	0.468	0.636	0.732	0.896
1971	0.051	0.109	0.251	0.344	0.413	0.489	0.512	0.583	0.696	0.877
1972	0.056	0.158	0.218	0.407	0.473	0.534	0.579	0.606	0.655	0.929
1973	0.037	0.134	0.237	0.308	0.468	0.521	0.566	0.583	0.617	0.804
1974	0.049	0.105	0.217	0.416	0.437	0.524	0.570	0.629	0.652	0.852
1975	0.063	0.141	0.187	0.388	0.483	0.544	0.610	0.668	0.704	0.943
1976	0.082	0.169	0.226	0.308	0.484	0.550	0.593	0.658	0.694	0.931
1977	0.064	0.184	0.265	0.311	0.405	0.551	0.627	0.690	0.667	0.938
1978	0.064	0.151	0.319	0.373	0.411	0.467	0.547	0.630	0.704	0.943
1979	0.062	0.179	0.258	0.365	0.414	0.459	0.543	0.667	0.764	1.004
1980	0.049	0.163	0.289	0.428	0.444	0.524	0.582	0.651	0.778	1.058
1981	0.041	0.140	0.239	0.421	0.473	0.536	0.570	0.624	0.707	1.033
1982	0.048	0.128	0.250	0.351	0.490	0.589	0.631	0.679	0.726	0.981
1983	0.045	0.128	0.242	0.381	0.494	0.559	0.624	0.712	0.754	0.917
1984	0.048	0.129	0.216	0.413	0.464	0.571	0.649	0.692	0.787	1.029
1985	0.048	0.146	0.232	0.320	0.452	0.536	0.635	0.656	0.764	1.011
1986	0.043	0.126	0.245	0.311	0.440	0.533	0.692	0.779	0.888	1.092
1987	0.036	0.105	0.200	0.383	0.401	0.503	0.573	0.711	0.747	0.984
1988	0.036	0.097	0.172	0.264	0.426	0.467	0.547	0.644	0.706	0.973
1989	0.039	0.101	0.192	0.247	0.362	0.484	0.553	0.616	0.759	0.884
1990	0.043	0.108	0.176	0.261	0.343	0.422	0.555	0.647	0.701	0.972
1991	0.048	0.131	0.184	0.260	0.342	0.401	0.463	0.633	0.652	0.826
1992	0.043	0.121	0.199	0.270	0.318	0.403	0.500	0.573	0.683	0.834
1993	0.050	0.119	0.208	0.315	0.330	0.391	0.490	0.587	0.633	0.811
1994	0.053	0.141	0.214	0.290	0.360	0.404	0.462	0.533	0.653	0.798
1995	0.050	0.142	0.254	0.336	0.399	0.448	0.509	0.584	0.678	0.804
1996	0.044	0.117	0.229	0.368	0.390	0.462	0.488	0.554	0.660	0.815
1997	0.035	0.115	0.233	0.359	0.439	0.492	0.521	0.543	0.627	0.852
1998	0.038	0.081	0.207	0.333	0.474	0.577	0.581	0.648	0.656	0.812
1999	0.044	0.091	0.150	0.319	0.437	0.524	0.586	0.644	0.664	0.780
2000	0.051	0.106	0.165	0.219	0.408	0.467	0.649	0.695	0.656	0.787
2001	0.061	0.122	0.202	0.233	0.331	0.452	0.560	0.641	0.798	0.830
2002	0.048	0.118	0.213	0.301	0.319	0.403	0.446	0.612	0.685	0.873
2003	0.057	0.111	0.227	0.269	0.344	0.391	0.464	0.600	0.714	0.787
2004	0.047	0.116	0.201	0.306	0.384	0.430	0.489	0.495	0.780	0.875
2005	0.053	0.106	0.216	0.237	0.378	0.422	0.434	0.527	0.621	1.010
2006	0.052	0.130	0.190	0.316	0.354	0.424	0.439	0.506	0.583	0.731
2007	0.047	0.093	0.235	0.238	0.337	0.394	0.458	0.412	0.526	0.548
2008	0.048	0.114	0.196	0.274	0.355	0.429	0.484	0.627	0.598	0.731
2009	0.052	0.114	0.194	0.344	0.373	0.412	0.472	0.540	0.565	0.632

Table 8.2.6. North Sea plaice. Landings weight-at-age

2010-05-06 12:13:50 units= kg

year \ age	1	2	3	4	5	6	7	8	9	10
1957	0.000	0.183	0.223	0.287	0.392	0.506	0.592	0.654	0.440	1.108
1958	0.000	0.211	0.235	0.275	0.358	0.482	0.546	0.654	0.707	1.055
1959	0.000	0.223	0.251	0.299	0.370	0.483	0.605	0.637	0.766	1.021
1960	0.000	0.201	0.238	0.291	0.389	0.488	0.605	0.688	0.729	1.101
1961	0.000	0.194	0.237	0.307	0.418	0.517	0.613	0.681	0.825	1.088
1962	0.000	0.204	0.240	0.290	0.387	0.523	0.551	0.669	0.751	1.090
1963	0.000	0.258	0.292	0.325	0.407	0.543	0.636	0.680	0.729	1.048
1964	0.000	0.252	0.275	0.314	0.391	0.491	0.633	0.705	0.743	1.012
1965	0.000	0.243	0.284	0.323	0.387	0.474	0.542	0.667	0.730	0.892
1966	0.000	0.236	0.275	0.354	0.444	0.493	0.569	0.635	0.703	0.950
1967	0.000	0.237	0.285	0.328	0.433	0.558	0.609	0.675	0.753	0.998
1968	0.000	0.275	0.307	0.341	0.377	0.532	0.607	0.613	0.706	0.937
1969	0.230	0.311	0.328	0.352	0.380	0.436	0.606	0.693	0.696	0.945
1970	0.307	0.279	0.310	0.347	0.408	0.432	0.486	0.655	0.725	0.869
1971	0.264	0.329	0.368	0.416	0.463	0.531	0.560	0.627	0.722	0.920
1972	0.253	0.304	0.362	0.440	0.507	0.556	0.625	0.664	0.693	0.965
1973	0.286	0.332	0.361	0.426	0.511	0.566	0.636	0.659	0.711	0.884
1974	0.296	0.322	0.367	0.420	0.494	0.574	0.631	0.719	0.733	0.960
1975	0.265	0.319	0.351	0.446	0.526	0.624	0.676	0.747	0.832	1.082
1976	0.272	0.302	0.347	0.385	0.526	0.609	0.657	0.723	0.760	1.005
1977	0.254	0.324	0.354	0.381	0.419	0.557	0.648	0.722	0.716	0.980
1978	0.235	0.304	0.356	0.383	0.422	0.473	0.587	0.662	0.748	0.916
1979	0.235	0.310	0.348	0.387	0.428	0.473	0.549	0.674	0.795	0.959
1980	0.241	0.290	0.349	0.406	0.479	0.552	0.596	0.671	0.782	1.027
1981	0.241	0.279	0.335	0.423	0.514	0.568	0.615	0.653	0.738	1.025
1982	0.281	0.264	0.313	0.427	0.517	0.612	0.668	0.716	0.743	0.990
1983	0.199	0.248	0.298	0.381	0.512	0.600	0.673	0.766	0.810	0.978
1984	0.229	0.259	0.279	0.369	0.483	0.603	0.673	0.714	0.824	1.019
1985	0.242	0.259	0.284	0.330	0.453	0.565	0.664	0.714	0.788	1.001
1986	0.218	0.266	0.300	0.343	0.420	0.482	0.667	0.742	0.843	1.001
1987	0.218	0.246	0.296	0.347	0.397	0.498	0.576	0.719	0.819	0.978
1988	0.218	0.250	0.274	0.347	0.446	0.504	0.599	0.688	0.801	0.999
1989	0.233	0.276	0.305	0.327	0.386	0.525	0.594	0.660	0.780	0.929
1990	0.267	0.281	0.293	0.312	0.360	0.440	0.588	0.681	0.749	0.989
1991	0.219	0.276	0.283	0.295	0.352	0.438	0.509	0.646	0.720	0.887
1992	0.246	0.258	0.285	0.312	0.335	0.417	0.521	0.594	0.702	0.875
1993	0.243	0.267	0.282	0.318	0.348	0.413	0.506	0.616	0.704	0.836
1994	0.223	0.256	0.278	0.330	0.387	0.437	0.489	0.595	0.713	0.883
1995	0.270	0.275	0.299	0.336	0.399	0.451	0.525	0.607	0.729	0.902
1996	0.236	0.276	0.302	0.350	0.414	0.479	0.491	0.580	0.709	0.844
1997	0.206	0.269	0.310	0.361	0.453	0.520	0.598	0.611	0.678	0.917
1998	0.150	0.256	0.305	0.388	0.489	0.597	0.623	0.684	0.689	0.900
1999	0.242	0.249	0.276	0.350	0.449	0.539	0.621	0.672	0.742	0.802
2000	0.221	0.259	0.276	0.305	0.420	0.486	0.664	0.690	0.729	0.862
2001	0.236	0.264	0.289	0.306	0.361	0.477	0.586	0.701	0.787	0.793
2002	0.232	0.259	0.283	0.309	0.341	0.436	0.500	0.678	0.745	0.881
2003	0.227	0.248	0.281	0.319	0.363	0.406	0.477	0.641	0.750	0.837
2004	0.212	0.245	0.280	0.325	0.394	0.433	0.505	0.552	0.789	0.861
2005	0.267	0.262	0.277	0.327	0.385	0.427	0.463	0.545	0.603	0.888
2006	0.257	0.272	0.289	0.338	0.399	0.409	0.475	0.489	0.533	0.755
2007	0.262	0.267	0.303	0.345	0.378	0.452	0.539	0.481	0.590	0.619
2008	0.247	0.265	0.306	0.343	0.403	0.453	0.538	0.726	0.640	0.637
2009	0.183	0.273	0.326	0.375	0.436	0.501	0.553	0.632	0.695	0.825

Table 8.2.7. North Sea plaice. Discards weight-at-age

2010-05-06 12:13:52 units= kg

year \ age	1	2	3	4	5	6	7	8	9	10
1957	0.044	0.104	0.146	0.181	0.206	0.244	0.244	0.231	0	0
1958	0.047	0.096	0.158	0.188	0.200	0.244	0.000	0.000	0	0
1959	0.051	0.107	0.155	0.186	0.197	0.231	0.000	0.000	0	0
1960	0.045	0.112	0.159	0.188	0.204	0.212	0.244	0.000	0	0
1961	0.044	0.100	0.160	0.194	0.204	0.220	0.220	0.000	0	0
1962	0.042	0.098	0.155	0.193	0.213	0.221	0.221	0.231	0	0
1963	0.048	0.105	0.156	0.188	0.205	0.231	0.221	0.231	0	0
1964	0.032	0.114	0.160	0.192	0.204	0.221	0.244	0.231	0	0
1965	0.038	0.072	0.166	0.192	0.212	0.221	0.231	0.000	0	0
1966	0.038	0.101	0.125	0.194	0.205	0.231	0.231	0.244	0	0
1967	0.036	0.105	0.158	0.169	0.220	0.220	0.244	0.244	0	0
1968	0.060	0.096	0.156	0.191	0.192	0.244	0.220	0.000	0	0
1969	0.052	0.146	0.162	0.186	0.211	0.212	0.000	0.231	0	0
1970	0.049	0.114	0.179	0.189	0.196	0.000	0.220	0.231	0	0
1971	0.057	0.110	0.183	0.200	0.212	0.000	0.000	0.231	0	0
1972	0.061	0.147	0.173	0.211	0.211	0.244	0.000	0.000	0	0
1973	0.043	0.131	0.179	0.195	0.211	0.244	0.000	0.000	0	0
1974	0.054	0.106	0.173	0.212	0.220	0.231	0.244	0.000	0	0
1975	0.068	0.136	0.162	0.206	0.221	0.244	0.244	0.000	0	0
1976	0.085	0.153	0.176	0.195	0.220	0.000	0.244	0.000	0	0
1977	0.069	0.160	0.186	0.196	0.198	0.220	0.000	0.000	0	0
1978	0.069	0.143	0.197	0.205	0.211	0.213	0.231	0.000	0	0
1979	0.066	0.158	0.185	0.204	0.220	0.231	0.221	0.244	0	0
1980	0.055	0.149	0.191	0.212	0.231	0.000	0.000	0.000	0	0
1981	0.048	0.135	0.179	0.212	0.220	0.000	0.000	0.000	0	0
1982	0.054	0.126	0.182	0.203	0.231	0.244	0.244	0.000	0	0
1983	0.051	0.126	0.180	0.205	0.211	0.244	0.000	0.000	0	0
1984	0.053	0.127	0.172	0.211	0.205	0.000	0.244	0.000	0	0
1985	0.054	0.139	0.177	0.197	0.231	0.244	0.000	0.000	0	0
1986	0.049	0.124	0.181	0.196	0.220	0.244	0.244	0.000	0	0
1987	0.043	0.105	0.166	0.205	0.220	0.231	0.000	0.000	0	0
1988	0.043	0.098	0.153	0.185	0.220	0.244	0.000	0.000	0	0
1989	0.046	0.102	0.163	0.181	0.196	0.000	0.000	0.000	0	0
1990	0.051	0.111	0.157	0.186	0.212	0.231	0.000	0.000	0	0
1991	0.055	0.130	0.161	0.185	0.203	0.221	0.231	0.231	0	0
1992	0.050	0.122	0.167	0.188	0.204	0.212	0.231	0.244	0	0
1993	0.056	0.121	0.171	0.197	0.211	0.231	0.244	0.000	0	0
1994	0.060	0.140	0.175	0.194	0.213	0.244	0.244	0.221	0	0
1995	0.058	0.141	0.186	0.201	0.220	0.232	0.232	0.244	0	0
1996	0.052	0.122	0.179	0.205	0.221	0.232	0.000	0.000	0	0
1997	0.044	0.117	0.178	0.203	0.221	0.244	0.000	0.000	0	0
1998	0.047	0.086	0.170	0.199	0.220	0.000	0.244	0.000	0	0
1999	0.053	0.097	0.143	0.197	0.220	0.000	0.000	0.000	0	0
2000	0.059	0.110	0.151	0.174	0.244	0.000	0.203	0.000	0	0
2001	0.068	0.122	0.167	0.178	0.197	0.244	0.000	0.244	0	0
2002	0.056	0.119	0.172	0.193	0.198	0.220	0.000	0.000	0	0
2003	0.064	0.113	0.176	0.187	0.203	0.211	0.221	0.000	0	0
2004	0.054	0.117	0.167	0.194	0.198	0.220	0.204	0.000	0	0
2005	0.061	0.108	0.172	0.179	0.221	0.206	0.221	0.231	0	0
2006	0.060	0.128	0.163	0.196	0.199	0.204	0.212	0.220	0	0
2007	0.055	0.097	0.179	0.179	0.196	0.199	0.231	0.200	0	0
2008	0.056	0.116	0.165	0.188	0.189	0.231	0.220	0.191	0	0
2009	0.060	0.116	0.164	0.200	0.203	0.212	0.211	0.220	0	0

Table 8.2.8. North Sea plaice. Catch weight-at-age

2010-05-06 12:13:55 units= kg

year \ age	1	2	3	4	5	6	7	8	9	10
1957	0.044	0.111	0.213	0.284	0.387	0.506	0.592	0.654	0.440	1.108
1958	0.047	0.106	0.195	0.272	0.349	0.481	0.546	0.654	0.707	1.055
1959	0.051	0.120	0.193	0.264	0.352	0.482	0.605	0.637	0.766	1.021
1960	0.045	0.115	0.205	0.289	0.380	0.483	0.605	0.688	0.729	1.101
1961	0.044	0.101	0.181	0.306	0.408	0.514	0.613	0.681	0.825	1.088
1962	0.042	0.099	0.180	0.266	0.384	0.520	0.551	0.669	0.751	1.090
1963	0.048	0.110	0.175	0.309	0.399	0.541	0.636	0.680	0.729	1.048
1964	0.032	0.126	0.205	0.272	0.382	0.488	0.633	0.705	0.743	1.012
1965	0.038	0.076	0.215	0.315	0.384	0.471	0.542	0.667	0.730	0.892
1966	0.038	0.104	0.149	0.319	0.435	0.492	0.569	0.635	0.703	0.950
1967	0.036	0.111	0.191	0.237	0.430	0.554	0.609	0.675	0.753	0.998
1968	0.060	0.117	0.226	0.279	0.348	0.531	0.607	0.613	0.706	0.937
1969	0.052	0.176	0.283	0.294	0.376	0.432	0.606	0.693	0.696	0.945
1970	0.049	0.131	0.264	0.343	0.385	0.430	0.486	0.655	0.725	0.869
1971	0.057	0.161	0.281	0.400	0.459	0.529	0.560	0.627	0.722	0.920
1972	0.067	0.209	0.295	0.418	0.500	0.555	0.625	0.664	0.693	0.965
1973	0.045	0.209	0.350	0.423	0.502	0.565	0.636	0.659	0.711	0.884
1974	0.057	0.121	0.355	0.419	0.490	0.573	0.631	0.719	0.733	0.960
1975	0.069	0.153	0.208	0.414	0.523	0.621	0.676	0.747	0.832	1.082
1976	0.088	0.182	0.265	0.355	0.522	0.607	0.657	0.723	0.760	1.005
1977	0.071	0.218	0.245	0.318	0.397	0.552	0.648	0.722	0.716	0.980
1978	0.070	0.188	0.307	0.353	0.417	0.469	0.587	0.662	0.748	0.916
1979	0.067	0.190	0.295	0.337	0.426	0.471	0.549	0.674	0.795	0.959
1980	0.056	0.198	0.348	0.405	0.478	0.550	0.596	0.671	0.782	1.027
1981	0.048	0.184	0.332	0.422	0.510	0.565	0.615	0.653	0.738	1.025
1982	0.056	0.152	0.310	0.423	0.515	0.610	0.668	0.716	0.743	0.990
1983	0.052	0.152	0.273	0.377	0.504	0.598	0.673	0.766	0.810	0.978
1984	0.053	0.149	0.261	0.319	0.473	0.600	0.673	0.714	0.824	1.019
1985	0.054	0.168	0.263	0.329	0.451	0.564	0.664	0.714	0.788	1.001
1986	0.049	0.141	0.273	0.310	0.416	0.481	0.667	0.742	0.843	1.001
1987	0.043	0.113	0.217	0.345	0.393	0.496	0.576	0.719	0.819	0.978
1988	0.043	0.102	0.196	0.274	0.442	0.502	0.599	0.688	0.801	0.999
1989	0.047	0.117	0.213	0.288	0.363	0.522	0.594	0.660	0.780	0.929
1990	0.053	0.129	0.207	0.287	0.356	0.439	0.588	0.681	0.749	0.989
1991	0.056	0.148	0.206	0.266	0.341	0.436	0.509	0.646	0.720	0.887
1992	0.055	0.145	0.223	0.272	0.327	0.412	0.521	0.594	0.702	0.875
1993	0.062	0.159	0.246	0.301	0.343	0.412	0.506	0.616	0.704	0.836
1994	0.064	0.177	0.252	0.328	0.383	0.436	0.489	0.595	0.713	0.883
1995	0.071	0.182	0.281	0.334	0.396	0.450	0.525	0.607	0.729	0.902
1996	0.054	0.139	0.265	0.338	0.411	0.477	0.491	0.580	0.709	0.844
1997	0.045	0.129	0.219	0.359	0.451	0.518	0.598	0.611	0.678	0.917
1998	0.047	0.094	0.206	0.296	0.484	0.594	0.623	0.684	0.689	0.900
1999	0.054	0.103	0.197	0.261	0.446	0.535	0.621	0.672	0.742	0.802
2000	0.063	0.123	0.205	0.268	0.406	0.473	0.614	0.593	0.729	0.862
2001	0.090	0.135	0.194	0.228	0.300	0.472	0.580	0.701	0.787	0.793
2002	0.057	0.130	0.220	0.286	0.335	0.432	0.489	0.677	0.745	0.881
2003	0.066	0.123	0.226	0.282	0.344	0.401	0.413	0.640	0.750	0.837
2004	0.054	0.124	0.220	0.304	0.385	0.428	0.503	0.551	0.789	0.861
2005	0.067	0.116	0.212	0.299	0.353	0.342	0.457	0.544	0.603	0.888
2006	0.060	0.139	0.212	0.300	0.388	0.401	0.441	0.466	0.533	0.755
2007	0.058	0.112	0.224	0.319	0.370	0.379	0.519	0.349	0.590	0.619
2008	0.057	0.122	0.243	0.326	0.392	0.441	0.358	0.462	0.640	0.637
2009	0.061	0.124	0.234	0.338	0.416	0.483	0.538	0.448	0.695	0.825

Table 8.2.9. North Sea plaice. Natural mortality at age and maturity ate age vector used in assessments

age	1	2	3	4	5	6	7	8	9	10
natural mortality	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
maturity	0	0.5	0.5	1.0	1.0	1.0	1.0	1.0	1.0	1.0

Table 8.2.10 North Sea plaice. Survey tuning indices. Indices used in the final assessment are emboldened

North Sea plaice. Survey tuning indices
2010-05-06 11:21:45
BTS-Isis (ages 1-8 used in assessment)

	Effort	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	9
1985	**1**	**137**	**173.9**	**36.06**	**11.00**	**1.273**	**0.973**	**0.336**	**0.155**	0.091
1986	**1**	**667**	**131.7**	**50.17**	**9.21**	**3.780**	**0.400**	**0.418**	**0.147**	0.070
1987	**1**	**226**	**764.2**	**33.84**	**4.88**	**1.842**	**0.607**	**0.252**	**0.134**	0.078
1988	**1**	**680**	**147.0**	**182.31**	**9.99**	**2.810**	**0.814**	**0.458**	**0.036**	0.112
1989	**1**	**468**	**319.3**	**38.66**	**47.30**	**5.850**	**0.833**	**0.311**	**0.661**	0.132
1990	**1**	**185**	**146.1**	**79.34**	**26.35**	**5.469**	**0.758**	**0.189**	**0.383**	0.239
1991	**1**	**291**	**159.4**	**33.95**	**13.57**	**4.313**	**5.659**	**0.239**	**0.204**	0.092
1992	**1**	**361**	**174.5**	**29.25**	**5.96**	**3.748**	**2.871**	**1.186**	**0.346**	0.050
1993	**1**	**189**	**283.4**	**62.78**	**8.27**	**1.128**	**1.130**	**0.584**	**0.464**	0.155
1994	**1**	**193**	**77.1**	**34.46**	**10.59**	**2.667**	**0.600**	**0.800**	**0.895**	0.373
1995	**1**	**266**	**40.6**	**13.22**	**7.53**	**1.110**	**0.806**	**0.330**	**1.051**	0.202
1996	**1**	**310**	**206.9**	**21.47**	**4.47**	**3.134**	**0.838**	**0.044**	**0.161**	0.122
1997	**1**	**1047**	**59.2**	**17.18**	**2.67**	**0.257**	**0.358**	**0.157**	**0.111**	0.000
1998	**1**	**348**	**402.7**	**44.96**	**8.29**	**1.224**	**0.339**	**0.149**	**0.213**	0.072
1999	**1**	**293**	**121.6**	**171.25**	**3.39**	**1.956**	**0.127**	**0.130**	**0.027**	0.030
2000	**1**	**267**	**69.3**	**29.35**	**22.36**	**0.570**	**0.162**	**0.502**	**0.027**	0.012
2001	**1**	**207**	**72.2**	**17.84**	**9.17**	**8.716**	**0.270**	**0.131**	**0.038**	0.040
2002	**1**	**519**	**44.5**	**14.90**	**4.99**	**2.539**	**1.321**	**0.085**	**0.128**	0.000
2003	**1**	**133**	**159.1**	**10.06**	**5.55**	**1.426**	**1.133**	**0.638**	**0.111**	0.096
2004	**1**	**234**	**39.6**	**61.91**	**6.15**	**2.464**	**1.492**	**0.952**	**2.842**	0.000
2005	**1**	**163**	**66.2**	**6.76**	**12.79**	**1.084**	**1.164**	**0.290**	**0.152**	0.492
2006	**1**	**129**	**36.4**	**18.11**	**2.98**	**5.890**	**0.867**	**0.757**	**0.040**	0.269
2007	**1**	**312**	**67.2**	**19.71**	**14.42**	**2.942**	**6.085**	**0.684**	**0.831**	0.156
2008	**1**	**222**	**120.7**	**30.11**	**9.07**	**7.205**	**0.618**	**1.715**	**0.292**	0.229
2009	**1**	**409**	**105.2**	**45.98**	**13.01**	**4.029**	**3.474**	**0.574**	**2.128**	0.278

BTS-Tridens (all used in assessment)

	Effort	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
1996	**1**	**1.643**	**6.02**	**4.45**	**2.90**	**2.04**	**1.57**	**0.721**	**0.415**	**0.190**
1997	**1**	**0.221**	**7.12**	**9.13**	**3.25**	**2.10**	**1.52**	**0.401**	**0.819**	**0.354**
1998	**1**	**0.228**	**32.25**	**9.57**	**4.87**	**2.20**	**1.27**	**0.929**	**0.762**	**0.304**
1999	**1**	**2.692**	**7.71**	**35.23**	**5.56**	**2.50**	**1.93**	**0.633**	**0.761**	**0.309**
2000	**1**	**4.795**	**13.45**	**12.91**	**16.96**	**2.88**	**1.72**	**0.933**	**0.805**	**0.218**
2001	**1**	**2.154**	**8.61**	**9.90**	**6.68**	**7.36**	**1.05**	**0.592**	**0.418**	**0.505**
2002	**1**	**18.553**	**12.91**	**9.54**	**6.41**	**4.18**	**4.42**	**0.743**	**0.741**	**0.394**
2003	**1**	**3.975**	**41.69**	**13.38**	**9.06**	**5.08**	**2.81**	**3.920**	**0.703**	**0.740**
2004	**1**	**5.985**	**15.78**	**31.49**	**9.43**	**4.32**	**2.44**	**1.242**	**2.500**	**0.409**
2005	**1**	**6.876**	**23.37**	**12.23**	**17.67**	**2.82**	**6.87**	**1.565**	**0.567**	**3.574**
2006	**1**	**6.725**	**32.19**	**25.73**	**11.37**	**10.92**	**1.99**	**3.897**	**0.864**	**0.723**
2007	**1**	**26.571**	**23.73**	**19.55**	**23.18**	**4.90**	**10.15**	**1.974**	**3.786**	**0.323**
2008	**1**	**17.467**	**50.46**	**25.59**	**18.39**	**18.97**	**6.24**	**12.747**	**2.657**	**6.749**
2009	**1**	**12.110**	**41.69**	**43.33**	**19.13**	**12.05**	**11.77**	**3.081**	**10.119**	**1.567**

Table 8.2.10 North Sea plaice. Survey tuning indices. (Cont'd)

SNS (ages 1-3 from 1982 onwards used in the assessment)

	Effort	**1**	**2**	**3**	4	5
1970	1	9311	9732	3273	770	170
1971	1	13538	28164	1415	101	50
1972	1	13207	10780	4478	89	84
1973	1	65643	5133	1578	461	15
1974	1	15366	16509	1129	160	82
1975	1	11628	8168	9556	65	15
1976	1	8537	2403	868	236	0
1977	1	18537	3424	1737	590	213
1978	1	14012	12678	345	135	45
1979	1	21495	9829	1575	161	17
1980	1	59174	12882	491	180	24
1981	1	24756	18785	834	38	32
1982	**1**	**69993**	**8642**	**1261**	88	8
1983	**1**	**33974**	**13909**	**249**	71	6
1984	**1**	**44965**	**10413**	**2467**	42	0
1985	**1**	**28101**	**13848**	**1598**	328	17
1986	**1**	**93552**	**7580**	**1152**	145	30
1987	**1**	**33402**	**32991**	**1227**	200	30
1988	**1**	**36609**	**14421**	**13153**	1350	88
1989	**1**	**34276**	**17810**	**4373**	7126	289
1990	**1**	**25037**	**7496**	**3160**	816	422
1991	**1**	**57221**	**11247**	**1518**	1077	128
1992	**1**	**46798**	**13842**	**2268**	613	176
1993	**1**	**22098**	**9686**	**1006**	98	60
1994	**1**	**19188**	**4977**	**856**	76	23
1995	**1**	**24767**	**2796**	**381**	97	38
1996	**1**	**23015**	**10268**	**1185**	45	47
1997	**1**	**95901**	**4473**	**497**	32	0
1998	**1**	**33666**	**30242**	**5014**	50	10
1999	**1**	**32951**	**10272**	**13783**	1058	17
2000	**1**	**22855**	**2493**	**891**	983	17
2001	**1**	**11511**	**2898**	**370**	176	691
2002	**1**	**30809**	**1103**	**265**	65	69
2003	1	NA	NA	NA	NA	NA
2004	**1**	**18202**	**1350**	**1081**	51	27
2005	**1**	**10118**	**1819**	**142**	366	8
2006	**1**	**12164**	**1571**	**385**	52	54
2007	**1**	**14175**	**2134**	**140**	52	0
2008	**1**	**14706**	**2700**	**464**	179	34
2009	**1**	**14860**	**2019**	**492**	38	20

Table 8.2.11. North Sea plaice. DFS index catches (numbers per hour), used only for RCT3. Note: estimates in 2009 exclude Belgian data.

DFS

	Effort	age 0	age 1
1981	1	605.96	169.78
1982	1	433.67	299.36
1983	1	431.72	163.53
1984	1	261.80	124.19
1985	1	716.29	103.27
1986	1	200.11	288.27
1987	1	516.84	195.87
1988	1	318.36	116.45
1989	1	435.70	125.72
1990	1	465.47	130.13
1991	1	498.49	152.35
1992	1	351.59	137.08
1993	1	262.26	75.16
1994	1	445.66	30.60
1995	1	184.51	37.74
1996	1	572.80	116.89
1997	1	149.19	209.92
1998	1	NA	NA
1999	1	NA	NA
2000	1	183.83	11.31
2001	1	500.43	5.90
2002	1	210.70	17.79
2003	1	359.59	11.31
2004	1	243.15	14.97
2005	1	129.25	NA
2006	1	232.28	NA
2007	1	175.65	NA
2008	1	186.87	NA
2009	1	227.98	NA

Table 8.2.12 North Sea plaice. Commercial tuning fleets (not used in the final assessment)

North Sea plaice. Commercial tuning fleets (not used in the final assessment)
2010-05-06 11:21:48

NL Beam Trawl

		2	3	4	5	6	7	8	9
1989	72.5	557.8	1016	1820	318.1	132.9	72.3	37.45	13.06
1990	71.1	308.8	844	701	1076.2	171.4	51.8	25.18	16.33
1991	68.5	401.5	619	776	448.1	497.7	100.4	28.53	16.60
1992	71.1	341.4	623	448	382.1	171.9	133.4	34.66	13.97
1993	76.9	358.3	605	407	256.2	142.8	78.5	46.96	13.33
1994	81.4	370.9	591	441	188.8	97.5	75.8	35.21	23.70
1995	81.2	277.3	536	417	178.0	81.0	42.1	19.08	11.47
1996	72.1	368.9	383	290	193.9	73.7	50.5	18.95	13.09
1997	72.0	320.8	634	252	95.6	60.2	28.0	13.54	6.39
1998	70.2	217.8	463	381	91.0	32.6	19.4	9.53	4.47
1999	67.3	64.5	1134	271	164.3	44.6	14.8	12.38	7.52
2000	64.6	138.9	263	1118	89.6	60.1	11.4	5.20	3.31
2001	61.4	264.3	367	321	664.6	44.7	28.6	6.35	3.19
2002	56.7	177.0	575	383	250.8	292.2	18.5	9.96	2.75
2003	51.6	372.8	387	406	186.4	103.8	129.1	6.03	5.02
2004	48.1	102.5	925	228	150.5	73.8	30.6	44.51	1.95
2005	49.1	154.2	222	727	96.2	59.2	34.1	14.81	23.54
2006	44.1	245.7	593	190	452.9	45.9	50.7	16.30	28.55
2007	42.9	201.6	416	464	109.7	208.1	23.1	26.62	7.53
2008	30.2	186.9	624	420	337.4	44.6	80.9	11.69	5.86

English Beam trawl excl Flag-vessels

		4	5	6	7	8	9	10	11	12
1990	102.3	27.0	92.7	17.46	11.08	7.06	8.23	2.45	1.662	0.958
1991	123.6	21.9	28.6	53.39	10.72	6.77	3.45	4.94	1.828	1.481
1992	151.5	19.2	29.3	18.40	24.25	6.39	3.68	3.20	3.281	1.096
1993	146.6	23.4	20.9	17.26	6.30	12.80	4.33	2.73	2.435	1.739
1994	131.4	23.1	22.0	13.49	9.53	4.51	6.47	3.28	1.438	1.218
1995	105.0	34.0	15.8	14.05	9.71	5.90	3.16	3.60	2.733	1.362
1996	82.9	13.3	19.0	10.74	10.08	6.55	4.68	2.50	3.305	1.966
1997	76.3	16.4	11.1	13.97	7.85	8.99	6.62	2.77	1.940	3.001
1998	68.8	23.6	13.0	8.97	8.69	5.04	6.03	4.61	1.948	1.599
1999	68.6	14.7	15.2	6.66	4.77	5.35	3.76	3.27	2.813	1.429
2000	57.8	63.2	15.0	9.95	4.41	2.44	3.48	1.87	1.782	2.526
2001	54.1	14.7	45.0	8.89	6.21	2.48	1.72	2.07	0.906	1.682
2002	30.6	23.4	20.8	29.61	5.13	4.12	1.41	1.73	1.503	1.340

Table 8.3.1. North Sea plaice. XSA diagnostics from final run

FLR XSA Diagnostics 2010-05-06 14:00:21

CPUE data from xsa.indices

Catch data for 53 years. 1957 to 2009. Ages 1 to 10.

	fleet	first age	last age	first year	last year	alpha	beta
1	BTS-Isis	1	8	1985	2009	0.66	0.75
2	BTS-Tridens	1	9	1996	2009	0.66	0.75
3	SNS	1	3	1982	2009	0.66	0.75

Time series weights :

Tapered time weighting not applied

Catchability analysis :

Catchability independent of size for all ages

Catchability independent of age for ages > 6

Terminal population estimation :

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

S.E. of the mean to which the estimates are shrunk = 2

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

prior weighting not applied

Regression weights

age \ year	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
all	1	1	1	1	1	1	1	1	1	1

Fishing mortalities

age \ year	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
1	0.119	0.070	0.210	0.144	0.219	0.137	0.290	0.082	0.191	0.168
2	0.368	0.719	0.590	0.626	0.642	0.504	0.525	0.471	0.380	0.426
3	0.331	0.990	0.516	0.619	0.469	0.451	0.462	0.396	0.264	0.257
4	0.584	0.890	0.639	0.474	0.501	0.369	0.374	0.234	0.248	0.204
5	0.553	0.802	0.676	0.705	0.239	0.452	0.245	0.260	0.176	0.184
6	0.494	0.433	0.451	0.614	0.547	0.241	0.228	0.180	0.135	0.129
7	0.292	0.399	0.524	0.467	0.323	0.482	0.117	0.116	0.152	0.086
8	0.205	0.195	0.245	0.298	0.141	0.259	0.330	0.088	0.097	0.087
9	0.330	0.144	0.170	0.118	0.103	0.085	0.168	0.110	0.020	0.035
10	0.330	0.144	0.170	0.118	0.103	0.085	0.168	0.110	0.020	0.035

XSA population number (NA)

year \ age	1	2	3	4	5	6	7	8	9	10
2000	991191	639225	337810	544968	40139	25850	9929	6787	3512	7810
2001	540350	795939	400484	219442	274990	20887	14274	6708	5002	18103
2002	1726207	455774	350797	134668	81575	111630	12252	8670	4997	10661
2003	537804	1266052	228653	189466	64328	37549	64349	6567	6143	8107
2004	1248173	421550	612659	111405	106730	28747	18390	36518	4412	5775
2005	791655	907301	200817	346915	61062	76051	15049	12051	28709	7908
2006	922375	624505	496183	115723	217144	35145	54069	8405	8417	8973
2007	1046417	624515	334116	282853	72005	153819	25328	43503	5468	12660
2008	821795	872142	352979	203537	202618	50212	116243	20417	36033	47945
2009	1017863	614491	539583	245324	143705	153734	39699	90345	16765	22990

Table 8.3.1. cont. North Sea plaice. XSA diagnostics from final run.

Estimated population abundance at 1st Jan 2010

year \ age	1	2	3	4	5	6	7	8	9	10
2010	0	778204	363228	377440	181013	108214	122318	32954	74918	14642

Fleet: BTS-Isis

Log catchability residuals.

Age \ year	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
1	-1.219	-0.565	-0.811	0.406	0.417	-0.408	0.224	0.584	0.323	0.485
2	0.309	-0.295	0.561	-0.290	0.584	0.105	0.371	0.627	1.204	0.289
3	-0.068	0.385	-0.263	0.515	-0.295	0.499	-0.018	0.047	0.927	0.404
4	-0.295	-0.142	-0.543	-0.108	0.495	0.576	0.094	-0.389	0.133	0.528
5	-0.549	0.022	-0.348	0.297	0.678	-0.331	0.012	0.247	-0.656	0.314
6	0.318	-0.612	-0.699	-0.013	0.176	-0.318	0.850	0.571	0.231	-0.165
7	0.079	0.122	-0.209	-0.244	-0.263	-0.669	-0.737	-0.011	-0.553	0.839
8	-0.103	-0.041	-0.394	-1.138	0.825	0.525	0.101	0.391	-0.418	0.222

Age	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
1	-0.192	-0.158	0.523	0.506	0.269	-0.026	0.287	0.146	-0.098	-0.321
2	-0.247	0.434	-0.769	0.390	0.292	-0.408	-0.337	-0.356	-0.078	-0.357
3	-0.144	0.468	-0.508	0.629	0.778	-0.022	-0.226	-0.607	-0.500	0.226
4	0.306	0.180	-0.188	0.494	-0.131	0.006	0.240	-0.057	-0.408	0.245
5	-0.317	0.860	-1.236	0.374	0.491	-0.503	0.475	0.368	0.050	-0.238
6	0.178	0.532	-0.127	0.048	-0.898	-1.013	-0.332	-0.408	0.643	1.138
7	-0.019	-1.917	-0.434	-0.291	-0.441	0.932	-0.699	-0.891	-0.574	0.977
8	1.929	-0.010	-0.268	0.448	-1.397	-1.671	-1.325	-0.332	-0.159	1.257

Age	2005	2006	2007	2008	2009
1	-0.284	-0.566	0.047	0.023	0.407
2	-0.708	-0.917	-0.343	-0.154	0.091
3	-0.886	-0.797	-0.364	-0.088	-0.093
4	-0.253	-0.607	-0.024	-0.147	-0.005
5	-0.351	-0.073	0.348	0.149	-0.083
6	-0.299	0.169	0.608	-0.591	0.012
7	0.102	-0.475	0.181	-0.398	-0.465
8	-0.480	-1.404	-0.185	-0.468	0.024

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

	1	2	3	4	5	6	7	8
Mean_Logq	-8.0369	-8.3926	-9.0252	-9.6253	-10.199	-10.5483	-10.5483	-10.5483
S.E_Logq	0.4633	0.5045	0.4845	0.3299	0.473	0.5482	0.6106	0.8369

Fleet: BTS-Tridens

Log catchability residuals.

age \ year	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
1	-1.206	-3.747	-2.631	-0.229	0.145	-0.083	1.007	0.586	0.207	0.743	0.676	1.777	1.676	1.080
2	-1.287	-1.072	-0.318	-0.649	-0.231	-0.648	0.223	0.399	0.538	0.067	0.776	0.433	0.789	0.981
3	-0.473	-0.508	-0.286	-0.171	-0.210	-0.182	-0.420	0.418	0.183	0.340	0.187	0.261	0.382	0.480
4	-0.457	-0.196	-0.243	0.158	-0.476	-0.282	-0.012	-0.124	0.467	-0.135	0.526	0.246	0.354	0.175
5	-0.361	0.077	0.171	-0.055	0.327	-0.485	0.077	0.529	-0.468	-0.184	-0.246	0.067	0.327	0.222
6	-0.170	-0.006	0.045	0.496	0.020	-0.296	-0.527	0.223	0.303	0.150	-0.329	-0.207	0.394	-0.095
7	-0.447	-0.824	0.212	-0.185	0.225	-0.518	-0.050	-0.085	-0.084	0.461	-0.163	-0.086	0.281	-0.111
8	-0.390	0.404	0.396	0.615	0.397	-0.254	0.097	0.360	-0.198	-0.490	0.342	0.005	0.413	0.257
9	-0.195	0.165	0.049	0.035	-0.162	0.192	-0.036	0.351	0.079	0.360	0.048	-0.367	0.723	0.039

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

	1	2	3	4	5	6	7	8	9
Mean_Logq	-12.2296	-10.2085	-9.6577	-9.4200	-9.4086	-9.2214	-9.2214	-9.2214	-9.2214
S.E_Logq	1.5699	0.7168	0.3562	0.3261	0.3126	0.2938	0.3392	0.3476	0.2685

Table 8.3.1. cont. North Sea plaice. XSA diagnostics from final run.

Fleet: SNS
Log catchability residuals.

age	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
1	0.38	0.09	0.453	-0.43	-0.16	-0.35	-0.14	0.18	-0.04	0.97
2	0.57	0.26	0.429	0.76	-0.17	0.40	0.37	0.68	0.12	0.70
3	0.28	-1.20	0.319	0.29	0.08	-0.11	1.36	1.00	0.75	0.35

Age	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
1	0.92	0.55	0.55	-0.19	-0.39	0.51	0.55	0.46	-0.11	-0.23
2	1.07	0.81	0.53	0.06	0.41	-0.37	0.78	0.80	-0.75	-0.57
3	0.96	0.27	0.18	-0.22	1.04	-0.58	1.91	1.73	-0.04	-0.63

Age	2002	2003	2004	2005	2006	2007	2008	2009
1	-0.30	NA	-0.50	-0.69	-0.55	-0.67	-0.32	-0.54
2	-1.07	NA	-0.76	-1.32	-1.08	-0.81	-0.97	-0.88
3	-1.16	NA	-0.35	-1.28	-1.18	-1.84	-0.79	-1.16

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

	1	2	3
Mean_Logq	-3.5030	-4.4660	-5.5904
S.E_Logq	0.4838	0.7339	0.9726

Terminal year survivor and F summaries:

Age 1 Year class = 2008

source	survivors	N	scaledWts
BTS-Isis	1168705	1	0.483
BTS-Tridens	2290851	1	0.041
SNS	455986	1	0.444
fshk	706405	1	0.032

Age 2 Year class = 2007

source	survivors	N	scaledWts
BTS-Isis	384666	2	0.493
BTS-Tridens	1072538	2	0.140
SNS	218008	2	0.342
fshk	292664	1	0.025

Age 3 Year class = 2006

source	survivors	N	scaledWts
BTS-Isis	352599	3	0.404
BTS-Tridens	659750	3	0.376
SNS	161377	3	0.206
fshk	218941	1	0.014

Age 4 Year class = 2005

source	survivors	N	scaledWts
BTS-Isis	160520	4	0.449
BTS-Tridens	237048	4	0.450
SNS	91550	3	0.091
fshk	99065	1	0.009

Age 5 Year class = 2004

source	survivors	N	scaledWts
BTS-Isis	86203	5	0.402
BTS-Tridens	144595	5	0.534
SNS	37258	3	0.056
fshk	68892	1	0.008

Age 6 Year class = 2003

source

	survivors	N	scaledWts
BTS-Isis	108829	6	0.349
BTS-Tridens	139148	6	0.608
SNS	50513	3	0.037
fshk	54927	1	0.006

Age 7 Year class = 2002

source

	survivors	N	scaledWts
BTS-Isis	22492	7	0.319
BTS-Tridens	40809	7	0.662
SNS	11816	2	0.013
fshk	11027	1	0.006

Age 8 Year class = 2001

source

	survivors	N	scaledWts
BTS-Isis	74253	8	0.291
BTS-Tridens	76243	8	0.689
SNS	54372	2	0.015
fshk	33980	1	0.006

Age 9 Year class = 2000

source

	survivors	N	scaledWts
BTS-Isis	14280	8	0.211
BTS-Tridens	14970	9	0.775
SNS	8926	2	0.009
fshk	3568	1	0.005

Table 8.3.2. North Sea plaice. Fishing mortality estimates in final XSA run

Plaice in IV . harvest
2010-05-06 13:57:15 units= f

year	age 1	2	3	4	5	6	7	8	9	10
1957	0.077	0.229	0.255	0.304	0.347	0.208	0.274	0.314	0.290	0.290
1958	0.105	0.250	0.302	0.358	0.374	0.321	0.268	0.291	0.323	0.323
1959	0.152	0.310	0.355	0.376	0.412	0.383	0.350	0.309	0.367	0.367
1960	0.108	0.318	0.353	0.384	0.366	0.419	0.383	0.359	0.383	0.383
1961	0.097	0.289	0.344	0.357	0.417	0.330	0.361	0.437	0.381	0.381
1962	0.096	0.319	0.373	0.398	0.434	0.426	0.362	0.350	0.395	0.395
1963	0.149	0.364	0.418	0.434	0.423	0.474	0.450	0.452	0.448	0.448
1964	0.032	0.399	0.448	0.469	0.540	0.488	0.403	0.390	0.459	0.459
1965	0.068	0.267	0.397	0.412	0.355	0.508	0.417	0.352	0.410	0.410
1966	0.071	0.356	0.388	0.430	0.477	0.343	0.506	0.409	0.435	0.435
1967	0.054	0.352	0.405	0.408	0.476	0.504	0.310	0.435	0.428	0.428
1968	0.197	0.287	0.344	0.361	0.366	0.323	0.410	0.289	0.351	0.351
1969	0.149	0.313	0.327	0.341	0.315	0.428	0.295	0.399	0.356	0.356
1970	0.223	0.435	0.492	0.505	0.462	0.504	0.594	0.261	0.467	0.467
1971	0.196	0.332	0.388	0.388	0.407	0.395	0.428	0.412	0.407	0.407
1972	0.232	0.381	0.401	0.413	0.419	0.443	0.408	0.478	0.434	0.434
1973	0.113	0.394	0.433	0.542	0.545	0.413	0.387	0.480	0.475	0.475
1974	0.221	0.399	0.491	0.515	0.596	0.452	0.394	0.465	0.486	0.486
1975	0.355	0.501	0.531	0.557	0.600	0.618	0.477	0.503	0.553	0.553
1976	0.333	0.407	0.426	0.432	0.383	0.434	0.518	0.452	0.445	0.445
1977	0.323	0.472	0.495	0.500	0.665	0.420	0.441	0.533	0.514	0.514
1978	0.305	0.429	0.464	0.471	0.461	0.520	0.461	0.427	0.470	0.470
1979	0.427	0.638	0.666	0.675	0.683	0.708	0.704	0.605	0.678	0.678
1980	0.238	0.469	0.667	0.622	0.508	0.517	0.492	0.502	0.530	0.530
1981	0.178	0.485	0.576	0.600	0.582	0.450	0.505	0.534	0.536	0.536
1982	0.242	0.518	0.695	0.674	0.602	0.521	0.481	0.536	0.565	0.565
1983	0.237	0.519	0.569	0.748	0.605	0.528	0.461	0.474	0.565	0.565
1984	0.300	0.552	0.584	0.604	0.640	0.542	0.482	0.574	0.571	0.571
1985	0.262	0.473	0.492	0.698	0.485	0.506	0.507	0.489	0.539	0.539
1986	0.284	0.609	0.633	0.633	0.716	0.714	0.568	0.648	0.739	0.739
1987	0.215	0.641	0.679	0.731	0.770	0.636	0.787	0.501	0.661	0.661
1988	0.232	0.612	0.659	0.673	0.713	0.673	0.637	0.971	0.742	0.742
1989	0.211	0.581	0.593	0.617	0.637	0.618	0.587	0.586	1.251	1.251
1990	0.161	0.473	0.572	0.538	0.675	0.582	0.505	0.434	0.515	0.515
1991	0.238	0.605	0.659	0.698	0.587	0.707	0.659	0.631	0.594	0.594
1992	0.214	0.553	0.652	0.672	0.794	0.487	0.558	0.657	0.902	0.902
1993	0.220	0.487	0.605	0.648	0.746	0.710	0.318	0.378	0.771	0.771
1994	0.163	0.485	0.611	0.713	0.636	0.643	0.913	0.219	0.277	0.277
1995	0.121	0.459	0.646	0.771	0.745	0.600	0.643	0.635	0.104	0.104
1996	0.096	0.546	0.687	0.733	0.750	0.654	0.761	0.621	0.889	0.889
1997	0.065	0.796	0.926	0.746	0.781	0.726	0.589	0.566	0.611	0.611
1998	0.153	0.493	1.001	1.073	0.636	0.464	0.565	0.430	0.523	0.523
1999	0.174	0.477	0.517	1.177	0.641	0.507	0.329	0.475	0.447	0.447
2000	0.119	0.368	0.331	0.584	0.553	0.494	0.292	0.205	0.330	0.330
2001	0.070	0.719	0.990	0.890	0.802	0.433	0.399	0.195	0.144	0.144
2002	0.210	0.590	0.516	0.639	0.676	0.451	0.524	0.245	0.170	0.170
2003	0.144	0.626	0.619	0.474	0.705	0.614	0.467	0.298	0.118	0.118
2004	0.219	0.642	0.469	0.501	0.239	0.547	0.323	0.141	0.103	0.103
2005	0.137	0.504	0.451	0.369	0.452	0.241	0.482	0.259	0.085	0.085
2006	0.290	0.525	0.462	0.374	0.245	0.228	0.117	0.330	0.168	0.168
2007	0.082	0.471	0.396	0.234	0.260	0.180	0.116	0.088	0.110	0.110
2008	0.191	0.380	0.264	0.248	0.176	0.135	0.152	0.097	0.020	0.020
2009	0.168	0.426	0.257	0.204	0.184	0.129	0.086	0.087	0.035	0.035

Table 8.3.3. North Sea plaice. Stock number estimates in the final XSA runs

Plaice in IV . stock.n
2010-05-06 13:57:18 units= NA

year \ age	1	2	3	4	5	6	7	8	9	10
1957	457973	256778	322069	182986	117504	49780	48438	35192	20763	45210
1958	698110	383614	184865	225749	122171	75186	36568	33338	23255	49887
1959	863386	568706	270362	123650	142799	76063	49331	25309	22555	55137
1960	757298	670799	377298	171551	76786	85609	46907	31440	16805	49877
1961	860576	614899	441591	239779	105744	48183	50972	28949	19875	48420
1962	589154	706789	416674	283132	151855	63044	31337	32158	16921	41052
1963	688366	484324	465009	259569	172009	89026	37245	19737	20503	48075
1964	2231500	536380	304564	276885	152215	101919	50127	21480	11359	47991
1965	694573	1956330	325547	176043	156783	80258	56631	30309	13162	54735
1966	586777	586899	1355540	198052	105458	99441	43686	33776	19288	44345
1967	401295	494319	371937	832385	116531	59210	63824	23833	20304	33590
1968	434277	343893	314556	224454	500704	65484	32351	42364	13952	47348
1969	648869	322587	233484	201830	141578	314124	42894	19435	28723	56233
1970	650576	506081	213512	152352	129908	93520	185267	28910	11797	41652
1971	410270	471051	296427	118122	83215	74030	51104	92598	20156	52938
1972	366617	305254	305838	182003	72494	50103	45122	30153	55506	46556
1973	1312009	263017	188694	185322	108922	43137	29096	27149	16912	66364
1974	1132726	1060052	160417	110708	97545	57136	25825	17876	15198	59729
1975	864773	821976	643812	88838	59831	48609	32888	15753	10162	48500
1976	692682	548525	450535	342684	46074	29718	23712	18465	8620	36563
1977	988665	449171	330275	266210	201243	28417	17430	12780	10628	23942
1978	912345	647406	253598	182219	146168	93607	16894	10147	6787	20862
1979	891239	608629	381577	144234	102938	83416	50378	9636	5993	19712
1980	1128156	526305	290915	177429	66449	47031	37199	22538	4761	13668
1981	865944	804536	297898	135126	86149	36186	25369	20569	12348	14882
1982	2031170	655698	448153	151458	67118	43539	20882	13857	10914	20964
1983	1308491	1443460	353260	202293	69838	33268	23392	11676	7335	20073
1984	1259358	934165	777188	181001	86673	34500	17757	13351	6576	15791
1985	1848419	843888	486900	392310	89506	41365	18156	9917	6807	14557
1986	4760609	1286790	475587	269456	176694	49864	22568	9893	5502	13900
1987	1962845	3243133	633464	228453	129409	78140	22104	11575	4680	11833
1988	1770461	1432168	1546356	290743	99541	54212	37434	9107	6344	12425
1989	1186811	1270384	703021	723770	134181	44160	25017	17916	3122	8131
1990	1036516	869783	642864	351602	353191	64212	21540	12585	9019	9905
1991	914585	798177	490389	328242	185828	162794	32481	11758	7377	13061
1992	776744	651967	394198	229534	147764	93483	72635	15207	5661	12161
1993	530684	567595	339205	185748	106060	60448	51973	37617	7130	11430
1994	442947	385219	315695	167606	87929	45514	26903	34212	23315	23533
1995	1164164	340377	214579	155030	74346	42117	21652	9768	24869	39904
1996	1290364	932940	194551	101746	64911	31921	20918	10296	4685	8667
1997	2155842	1060695	488817	88535	44228	27742	15018	8839	5009	9559
1998	774928	1827459	432991	175218	38011	18319	12140	7538	4543	8009
1999	840878	601558	1009903	143943	54210	18214	10426	6242	4436	8984
2000	991191	639225	337810	544968	40139	25850	9929	6787	3512	7810
2001	540350	795939	400484	219442	274990	20887	14274	6708	5002	18103
2002	1726207	455774	350797	134668	81575	111630	12252	8670	4997	10661
2003	537804	1266052	228653	189466	64328	37549	64349	6567	6143	8107
2004	1248173	421550	612659	111405	106730	28747	18390	36518	4412	5775
2005	791655	907301	200817	346915	61062	76051	15049	12051	28709	7908
2006	922375	624505	496183	115723	217144	35145	54069	8405	8417	8973
2007	1046417	624515	334116	282853	72005	153819	25328	43503	5468	12660
2008	821795	872142	352979	203537	202618	50212	116243	20417	36033	47945
2009	1017863	614491	539583	245324	143705	153734	39699	90345	16765	22990
2010	-	778191	363216	377418	181003	108206	122309	32951	74911	34718

Table 8.4.1. North Sea plaice. Stock summary table.

	recruits	ssb	catch	landings	discards	F2-6	F hc2-6	F dis2-3	Y/ssb
1957	457973	273010	78443	70563	7880	0.27	0.22	0.12	0.26
1958	698110	287066	88191	73354	14837	0.32	0.24	0.19	0.26
1959	863386	296271	109164	79300	29864	0.37	0.24	0.24	0.27
1960	757298	307214	117334	87541	29793	0.37	0.27	0.23	0.28
1961	860576	319935	118474	85984	32490	0.35	0.24	0.27	0.27
1962	589154	371316	125375	87472	37903	0.39	0.25	0.29	0.24
1963	688366	368352	148376	107118	41258	0.42	0.27	0.36	0.29
1964	2231500	361209	147571	110540	37031	0.47	0.30	0.32	0.31
1965	694573	343910	140223	97143	43080	0.39	0.28	0.25	0.28
1966	586777	359195	166552	101834	64718	0.40	0.24	0.34	0.28
1967	401295	412583	163365	108819	54546	0.43	0.25	0.32	0.26
1968	434277	400991	139521	111534	27987	0.34	0.21	0.22	0.28
1969	648869	376355	142820	121651	21169	0.34	0.25	0.17	0.32
1970	650576	332875	159982	130342	29640	0.48	0.35	0.28	0.39
1971	410270	314677	136939	113944	22995	0.38	0.29	0.22	0.36
1972	366617	316590	142475	122843	19632	0.41	0.33	0.19	0.39
1973	1312009	266570	143783	130429	13354	0.47	0.41	0.13	0.49
1974	1132726	278439	157485	112540	44945	0.49	0.41	0.20	0.40
1975	864773	291427	195235	108536	86699	0.56	0.37	0.43	0.37
1976	692682	307673	166917	113670	53247	0.42	0.30	0.27	0.37
1977	988665	314341	176689	119188	57501	0.51	0.34	0.31	0.38
1978	912345	301173	159639	113984	45655	0.47	0.36	0.22	0.38
1979	891239	295406	213282	145347	67935	0.67	0.49	0.36	0.49
1980	1128156	269508	171031	139951	31080	0.56	0.49	0.16	0.52
1981	865944	260344	172778	139747	33031	0.54	0.47	0.16	0.54
1982	2031170	260750	203674	154547	49127	0.60	0.51	0.22	0.59
1983	1308491	312149	218521	144038	74483	0.59	0.48	0.26	0.46
1984	1259358	321042	226963	156147	70816	0.58	0.43	0.28	0.49
1985	1848419	344210	220387	159838	60549	0.53	0.44	0.23	0.46
1986	4760609	370838	295300	165347	129953	0.66	0.49	0.34	0.45
1987	1962845	448345	344194	153670	190524	0.69	0.48	0.51	0.34
1988	1770461	389836	310898	154475	156423	0.67	0.40	0.51	0.40
1989	1186811	414787	277611	169818	107793	0.61	0.38	0.46	0.41
1990	1036516	379598	227465	156240	71225	0.57	0.38	0.39	0.41
1991	914585	349654	228939	148004	80935	0.65	0.42	0.47	0.42
1992	776744	284338	182239	125190	57049	0.63	0.42	0.40	0.44
1993	530684	247527	152129	117113	35016	0.64	0.50	0.28	0.47
1994	442947	224265	134177	110392	23785	0.62	0.51	0.24	0.49
1995	1164164	217717	120184	98356	21828	0.64	0.55	0.21	0.45
1996	1290364	180429	133722	81673	52049	0.67	0.52	0.35	0.45
1997	2155842	206699	183193	83048	100145	0.80	0.52	0.69	0.40
1998	774928	227179	175285	71534	103751	0.73	0.38	0.60	0.31
1999	840878	202350	151638	80662	70976	0.66	0.37	0.38	0.40
2000	991191	229154	125459	81148	44311	0.47	0.32	0.26	0.35
2001	540350	271900	182272	81963	100309	0.77	0.31	0.71	0.30
2002	1726207	199295	124607	70217	54390	0.57	0.37	0.42	0.35
2003	537804	228558	144294	66502	77792	0.61	0.38	0.45	0.29
2004	1248173	209023	115902	61436	54466	0.48	0.29	0.43	0.29
2005	791655	245870	109576	55700	53876	0.40	0.20	0.38	0.23
2006	922375	255522	119789	57943	61846	0.37	0.19	0.38	0.23
2007	1046417	259832	89179	49744	39435	0.31	0.15	0.34	0.19
2008	821795	359187	94749	48874	45875	0.24	0.14	0.24	0.14
2009	1017863	380234	100198	54973	45225	0.24	0.12	0.27	0.14

Table 8.5.1. North Sea plaice. Input table for RCT3 analysis.

Year	XSA1	XSA2	SNS0	SNS1	SNS2	BTS1	BTS2	DFS0
1968	648869	506081	-11	-11	9731.5	-11	-11	-11
1969	650576	471051	-11	9311	28163.5	-11	-11	-11
1970	410270	305254	1200	13539	10779.7	-11	-11	-11
1971	366617	263017	4456	13207	5133.3	-11	-11	-11
1972	1312009	1060052	7758	65643	16508.9	-11	-11	-11
1973	1132726	821976	7183	15366	8168.4	-11	-11	-11
1974	864773	548525	2568	11628	2402.6	-11	-11	-11
1975	692682	449171	1314	8537	3423.8	-11	-11	-11
1976	988665	647406	11166	18537	12678.0	-11	-11	-11
1977	912345	608629	4373	14012	9828.8	-11	-11	-11
1978	891239	526305	3268	21495	12882.3	-11	-11	-11
1979	1128156	804536	29058	59174	18785.3	-11	-11	-11
1980	865944	655698	4210	24756	8642.0	-11	-11	-11
1981	2031170	1443460	35506	69993	13908.6	-11	-11	606.0
1982	1308491	934165	24402	33974	10412.8	-11	-11	433.7
1983	1259358	843888	32942	44965	13847.8	-11	173.9	431.7
1984	1848419	1286790	7918	28101	7580.4	136.8	131.7	261.8
1985	4760609	3243133	47256	93552	32991.1	667.4	764.2	716.3
1986	1962845	1432168	8820	33402	14421.1	225.8	147.0	200.1
1987	1770461	1270384	21335	36609	17810.2	680.2	319.3	516.8
1988	1186811	869783	15670	34276	7496.0	467.9	146.1	318.4
1989	1036516	798177	24585	25037	11247.2	185.3	159.4	435.7
1990	914585	651967	9369	57221	13841.8	291.4	174.5	465.5
1991	776744	567595	17257	46798	9685.6	360.9	283.4	498.5
1992	530684	385219	6473	22098	4976.6	189.0	77.1	351.6
1993	442947	340377	9234	19188	2796.4	193.3	40.6	262.3
1994	1164164	932940	26781	24767	10268.2	265.6	206.9	445.7
1995	1290364	1060695	12541	23015	4472.7	310.3	59.2	184.5
1996	2155842	1827459	84042	95901	30242.2	1046.8	402.7	572.8
1997	774928	601558	17344	33666	10272.1	347.6	121.6	149.2
1998	840878	639225	25522	32951	2493.4	293.3	69.3	-11
1999	991191	795939	39262	22855	2898.5	267.5	72.2	-11
2000	540350	455774	24214	11511	1102.7	206.5	44.5	183.8
2001	1726207	1266052	99628	30809	-11	519.2	159.1	500.4
2002	537804	421550	31202	-11	1349.7	132.8	39.6	210.7
2003	1248173	907301	-11	18202	1818.9	233.7	66.2	359.6
2004	791655	624505	13537	10118	1571.0	163.0	36.4	243.2
2005	922375	624515	27391	12164	2133.9	128.6	67.2	129.3
2006	-11	-11	51124	14175	2700.4	312.0	120.7	232.3
2007	-11	-11	40581	14706	2018.7	221.6	105.2	175.7
2008	-11	-11	50179	14860	-11	409.0	-11	186.9
2009	-11	-11	53259	-11	-11	-11	-11	228.0

Table 8.5.2. North Sea plaice. RCT3 results for age 1.

```
Analysis by RCT3 ver3.1 of data from file : ple_iv1.txt
North Sea Plaice Age 1

Data for    6 surveys over   40 years :  1970 - 2009
Regression type = C, Tapered time weighting not applied, Survey weighting not
applied

Final estimates shrunk towards mean
Minimum S.E. for any survey taken as    .00
Minimum of   3 points used for regression

Forecast/Hindcast variance correction used.

Yearclass 2009
        I-----------Regression----------I I-----------Prediction---------I
Survey/  Slope Inter-    Std Rsquare  No.  Index     Pred   Std       WAP
Series          cept  Error          Pts  Value    Value  Error  Weights
SNS0        .98  4.53    .90    .259   35  10.88    15.19   .965     .186
DFS0       2.22  1.05    .93    .275   23   5.43    13.12  1.007     .171
                                      VPA Mean =   13.84   .519     .643

 Year     Weighted      Log     Int     Ext     Var
 Class     Average      WAP     Std     Std    Ratio
          Prediction           Error   Error
 2009     1161744     13.97     .42     .45     1.19
```

Table 8.5.3. North Sea plaice. RCT3 results for age 2.

```
Analysis by RCT3 ver3.1 of data from file : ple_iv2.txt
North Sea Plaice Age 2

Data for    6 surveys over   40 years :  1970 - 2009
Regression type = C, Tapered time weighting not applied, Survey weighting not
applied

Final estimates shrunk towards mean
Minimum S.E. for any survey taken as    .00
Minimum of   3 points used for regression

Forecast/Hindcast variance correction used.

Yearclass 2008
        I-----------Regression----------I I-----------Prediction---------I
Survey/  Slope Inter-    Std Rsquare  No.  Index     Pred   Std       WAP
Series          cept  Error          Pts  Value    Value  Error  Weights
SNS0        .87   5.26    .76    .328   35  10.82    14.67   .814     .140
SNS1      1.20   1.35    .56    .466   35   9.61    12.85   .594     .263
BTS1      1.55   4.88    .70    .388   22   6.02    14.19   .754     .163
DFS0      2.19    .91    .93    .262   23   5.24    12.40  1.020     .089
                                      VPA Mean =   13.52   .519     .345

 Year     Weighted      Log     Int     Ext     Var
 Class     Average      WAP     Std     Std    Ratio
          Prediction           Error   Error
 2008      741267     13.52     .30     .35     1.32
```

Table 8.6.1. North Sea plaice. Input to the short term forecast (f values presented are for Fsq)

age	year	f	f.disc	f.land	stock.n	catch.wt	landings.wt	discards.wt	stock.wt	mat	M
1	2010	0.134	0.13	0.00	915040	0.06	0.23	0.06	0.05	0.0	0.1
2	2010	0.388	0.36	0.02	778191	0.12	0.27	0.11	0.11	0.5	0.1
3	2010	0.279	0.15	0.12	363216	0.23	0.31	0.17	0.21	0.5	0.1
4	2010	0.209	0.03	0.18	377418	0.33	0.35	0.19	0.29	1.0	0.1
5	2010	0.189	0.01	0.18	181003	0.39	0.41	0.20	0.36	1.0	0.1
6	2010	0.135	0.02	0.12	108206	0.43	0.47	0.21	0.41	1.0	0.1
7	2010	0.108	0.02	0.08	122309	0.47	0.54	0.22	0.47	1.0	0.1
8	2010	0.083	0.04	0.04	32951	0.42	0.61	0.20	0.53	1.0	0.1
9	2010	0.050	0.00	0.05	74911	0.64	0.64	0.00	0.56	1.0	0.1
10	2010	0.050	0.00	0.05	34718	0.69	0.69	0.00	0.64	1.0	0.1
1	2011	0.134	0.13	0.00	915040	0.06	0.23	0.06	0.05	0.0	0.1
2	2011	0.388	0.36	0.02		0.12	0.27	0.11	0.11	0.5	0.1
3	2011	0.279	0.15	0.12		0.23	0.31	0.17	0.21	0.5	0.1
4	2011	0.209	0.03	0.18		0.33	0.35	0.19	0.29	1.0	0.1
5	2011	0.189	0.01	0.18		0.39	0.41	0.20	0.36	1.0	0.1
6	2011	0.135	0.02	0.12		0.43	0.47	0.21	0.41	1.0	0.1
7	2011	0.108	0.02	0.08		0.47	0.54	0.22	0.47	1.0	0.1
8	2011	0.083	0.04	0.04		0.42	0.61	0.20	0.53	1.0	0.1
9	2011	0.050	0.00	0.05		0.64	0.64	0.00	0.56	1.0	0.1
10	2011	0.050	0.00	0.05		0.69	0.69	0.00	0.64	1.0	0.1
1	2012	0.134	0.13	0.00	915040	0.06	0.23	0.06	0.05	0.0	0.1
2	2012	0.388	0.36	0.02		0.12	0.27	0.11	0.11	0.5	0.1
3	2012	0.279	0.15	0.12		0.23	0.31	0.17	0.21	0.5	0.1
4	2012	0.209	0.03	0.18		0.33	0.35	0.19	0.29	1.0	0.1
5	2012	0.189	0.01	0.18		0.39	0.41	0.20	0.36	1.0	0.1
6	2012	0.135	0.02	0.12		0.43	0.47	0.21	0.41	1.0	0.1
7	2012	0.108	0.02	0.08		0.47	0.54	0.22	0.47	1.0	0.1
8	2012	0.083	0.04	0.04		0.42	0.61	0.20	0.53	1.0	0.1
9	2012	0.050	0.00	0.05		0.64	0.64	0.00	0.56	1.0	0.1
10	2012	0.050	0.00	0.05		0.69	0.69	0.00	0.64	1.0	0.1

Table 8.6.2A. North Sea plaice. Results from the short term forecast assuming $F_{2010} = F_{2009}$

year	fmult	f2-6	f_dis2-3	f_hc2-6	landings	discards	catch	ssb2010
2010	1	0.24	0.26	0.24	61795	42333	104177	435248

year	fmult	f2-6	f_dis2-3	f_hc2-6	landings	discards	catch	ssb	ssb2012
2011	0.2	0.048	0.05	0.05	14345	9666	24023	481823	614340
2011	0.3	0.072	0.08	0.07	21304	14283	35604	481823	602769
2011	0.4	0.096	0.10	0.10	28124	18762	46910	481823	591472
2011	0.5	0.120	0.13	0.12	34810	23108	57947	481823	580443
2011	0.6	0.144	0.16	0.14	41364	27325	68723	481823	569674
2011	0.7	0.168	0.18	0.17	47790	31418	79246	481823	559158
2011	0.8	0.192	0.21	0.19	54089	35390	89523	481823	548888
2011	0.9	0.216	0.23	0.22	60266	39246	99559	481823	538856
2011	1.0	0.240	0.26	0.24	66322	42989	109363	481823	529058
2011	1.1	0.264	0.29	0.26	72261	46623	118940	481823	519486
2011	1.2	0.288	0.31	0.29	78085	50152	128297	481823	510134
2011	1.3	0.312	0.34	0.31	83797	53578	137439	481823	500996
2011	1.4	0.336	0.36	0.34	89399	56906	146373	481823	492067
2011	1.5	0.360	0.39	0.36	94893	60139	155104	481823	483342
2011	1.6	0.384	0.42	0.38	100283	63279	163637	481823	474813
2011	1.7	0.408	0.44	0.41	105570	66330	171978	481823	466478
2011	1.8	0.432	0.47	0.43	110757	69295	180133	481823	458329
2011	1.9	0.456	0.49	0.46	115845	72175	188105	481823	450363
2011	2.0	0.480	0.52	0.48	120838	74975	195900	481823	442575

Table 8.6.2B. North Sea plaice. Results from the short term forecast assuming a F for 2010 such that the landings in 2010 equal the TAC for 2010

year	fmult	f2-6	f_dis2-3	f_hc2-6	landings	discards	catch	ssb2010
2010	1.03649	0.249	0.27	0.25	63825	43647	107522	435248

year	fmult	f2-6	f_dis2-3	f_hc2-6	landings	discards	catch	ssb	ssb2012
2011	0.2	0.048	0.05	0.05	14218	9602	23832	478525	609937
2011	0.3	0.072	0.08	0.07	21116	14189	35322	478525	598462
2011	0.4	0.096	0.10	0.10	27877	18638	46538	478525	587260
2011	0.5	0.120	0.13	0.12	34504	22955	57487	478525	576323
2011	0.6	0.144	0.16	0.14	41001	27145	68179	478525	565644
2011	0.7	0.168	0.18	0.17	47370	31210	78618	478525	555215
2011	0.8	0.192	0.21	0.19	53614	35156	88814	478525	545030
2011	0.9	0.216	0.23	0.22	59737	38987	98771	478525	535082
2011	1.0	0.240	0.26	0.24	65741	42705	108497	478525	525364
2011	1.1	0.264	0.29	0.26	71628	46315	117999	478525	515871
2011	1.2	0.288	0.31	0.29	77402	49821	127282	478525	506597
2011	1.3	0.312	0.34	0.31	83064	53225	136353	478525	497535
2011	1.4	0.336	0.36	0.34	88618	56531	145216	478525	488679
2011	1.5	0.360	0.39	0.36	94066	59742	153879	478525	480025
2011	1.6	0.384	0.42	0.38	99409	62862	162345	478525	471567
2011	1.7	0.408	0.44	0.41	104651	65893	170621	478525	463300
2011	1.8	0.432	0.47	0.43	109793	68838	178712	478525	455218
2011	1.9	0.456	0.49	0.46	114839	71700	186622	478525	447317
2011	2.0	0.480	0.52	0.48	119789	74481	194357	478525	439592

Table 8.6.3A. North Sea plaice. Detailed STF table, assuming $F_{2010} = F_{2009}$

age	f	fdisc	fland	stck n	catch wt	land wt	dis wt	stwt	mat	M	catchn	catch	landn	land	discn	disc	SSB	TSB
1	0.134	0.13	0.00	915040	0.06	0.23	0.06	0.05	0.0	0.1	109542	6432	1063	245	108479	6183	0	44837
2	0.388	0.36	0.02	778191	0.12	0.27	0.11	0.11	0.5	0.1	239111	28545	14415	3866	224695	24642	41633	83266
3	0.279	0.15	0.12	363216	0.23	0.31	0.17	0.21	0.5	0.1	84338	19686	37748	11764	46591	7889	37835	75670
4	0.209	0.03	0.18	377418	0.33	0.35	0.19	0.29	1.0	0.1	67752	22189	56896	20162	10856	2052	107690	107690
5	0.189	0.01	0.18	181003	0.39	0.41	0.20	0.36	1.0	0.1	29671	11639	27834	11288	1836	360	64256	64256
6	0.135	0.02	0.12	108206	0.43	0.47	0.21	0.41	1.0	0.1	13017	5652	11255	5275	1762	377	44545	44545
7	0.108	0.02	0.08	122309	0.47	0.54	0.22	0.47	1.0	0.1	11892	5610	9215	5008	2677	591	57648	57648
8	0.083	0.04	0.04	32951	0.42	0.61	0.20	0.53	1.0	0.1	2499	1049	1324	812	1175	239	17343	17343
9	0.050	0.00	0.05	74911	0.64	0.64	0.00	0.56	1.0	0.1	3504	2249	3504	2249	0	0	42175	42175
10	0.050	0.00	0.05	34718	0.69	0.69	0.00	0.64	1.0	0.1	1624	1126	1624	1126	0	0	22123	22123
1	0.134	0.13	0.00	915040	0.06	0.23	0.06	0.05	0.0	0.1	109542	6432	1063	245	108479	6183	0	44837
2	0.388	0.36	0.02	723923	0.12	0.27	0.11	0.11	0.5	0.1	222436	26554	13410	3596	209026	22923	38730	77460
3	0.279	0.15	0.12	477514	0.23	0.31	0.17	0.21	0.5	0.1	110878	25881	49626	15466	61252	10372	49741	99482
4	0.209	0.03	0.18	248646	0.33	0.35	0.19	0.29	1.0	0.1	44636	14619	37484	13283	7152	1352	70947	70947
5	0.189	0.01	0.18	277192	0.39	0.41	0.20	0.36	1.0	0.1	45439	17824	42626	17287	2812	551	98403	98403
6	0.135	0.02	0.12	135611	0.43	0.47	0.21	0.41	1.0	0.1	16314	7084	14105	6611	2209	473	55826	55826
7	0.108	0.02	0.08	85546	0.47	0.54	0.22	0.47	1.0	0.1	8318	3924	6445	3503	1872	413	40321	40321
8	0.083	0.04	0.04	99372	0.42	0.61	0.20	0.53	1.0	0.1	7537	3163	3994	2448	3543	722	52303	52303
9	0.050	0.00	0.05	27440	0.64	0.64	0.00	0.56	1.0	0.1	1283	824	1283	824	0	0	15449	15449
10	0.050	0.00	0.05	94323	0.69	0.69	0.00	0.64	1.0	0.1	4412	3059	4412	3059	0	0	60103	60103
1	0.134	0.13	0.00	915040	0.06	0.23	0.06	0.05	0.0	0.1	109542	6432	1063	245	108479	6183	0	44837
2	0.388	0.36	0.02	723923	0.12	0.27	0.11	0.11	0.5	0.1	222436	26554	13410	3596	209026	22923	38730	77460
3	0.279	0.15	0.12	444214	0.23	0.31	0.17	0.21	0.5	0.1	103146	24076	46165	14387	56980	9649	46272	92545
4	0.209	0.03	0.18	326891	0.33	0.35	0.19	0.29	1.0	0.1	58682	19219	49279	17463	9403	1777	93273	93273
5	0.189	0.01	0.18	182616	0.39	0.41	0.20	0.36	1.0	0.1	29935	11743	28082	11389	1853	363	64829	64829
6	0.135	0.02	0.12	207677	0.43	0.47	0.21	0.41	1.0	0.1	24984	10848	21601	10124	3383	724	85494	85494
7	0.108	0.02	0.08	107211	0.47	0.54	0.22	0.47	1.0	0.1	10424	4917	8078	4390	2347	518	50532	50532
8	0.083	0.04	0.04	69503	0.42	0.61	0.20	0.53	1.0	0.1	5272	2212	2794	1712	2478	505	36582	36582
9	0.050	0.00	0.05	82754	0.64	0.64	0.00	0.56	1.0	0.1	3871	2484	3871	2484	0	0	46590	46590
10	0.050	0.00	0.05	104763	0.69	0.69	0.00	0.64	1.0	0.1	4900	3398	4900	3398	0	0	66756	66756

Table 8.6.3B. North Sea plaice. Detailed STF table, forecast assuming a F for 2010 such that the landings in 2010 equal the TAC for 2010

Age	f	fdis	fland	stck	catch	land	dis	stock	mat	M	catch	catch	land	land	dis	dis	SSB	TSB
				n	wt	wt	wt	wt			n		n		n			
1	0.139	0.14	0.00	915040	0.06	0.23	0.06	0.05	0.0	0.1	113272	6651	1099	254	112173	6394	0	44837
2	0.403	0.38	0.02	778191	0.12	0.27	0.11	0.11	0.5	0.1	246229	29395	14844	3981	231385	25375	41633	83266
3	0.289	0.16	0.13	363216	0.23	0.31	0.17	0.21	0.5	0.1	87000	20308	38939	12135	48061	8138	37835	75670
4	0.216	0.03	0.18	377418	0.33	0.35	0.19	0.29	1.0	0.1	69972	22916	58760	20822	11212	2119	107690	107690
5	0.196	0.01	0.18	181003	0.39	0.41	0.20	0.36	1.0	0.1	30653	12024	28756	11662	1897	372	64256	64256
6	0.140	0.02	0.12	108206	0.43	0.47	0.21	0.41	1.0	0.1	13461	5845	11638	5454	1822	390	44545	44545
7	0.112	0.03	0.09	122309	0.47	0.54	0.22	0.47	1.0	0.1	12303	5803	9533	5181	2769	611	57648	57648
8	0.086	0.04	0.05	32951	0.42	0.61	0.20	0.53	1.0	0.1	2587	1085	1371	840	1216	248	17343	17343
9	0.052	0.00	0.05	74911	0.64	0.64	0.00	0.56	1.0	0.1	3628	2329	3628	2329	0	0	42175	42175
10	0.052	0.00	0.05	34718	0.69	0.69	0.00	0.64	1.0	0.1	1682	1166	1682	1166	0	0	22123	22123
1	0.134	0.13	0.00	915040	0.06	0.23	0.06	0.05	0.0	0.1	109542	6432	1063	245	108479	6183	0	44837
2	0.388	0.36	0.02	720384	0.12	0.27	0.11	0.11	0.5	0.1	221349	26425	13345	3579	208004	22811	38541	77081
3	0.279	0.15	0.12	470795	0.23	0.31	0.17	0.21	0.5	0.1	109318	25517	48928	15248	60390	10226	49041	98082
4	0.209	0.03	0.18	246127	0.33	0.35	0.19	0.29	1.0	0.1	44184	14470	37104	13148	7080	1338	70228	70228
5	0.189	0.01	0.18	275090	0.39	0.41	0.20	0.36	1.0	0.1	45094	17689	42303	17156	2791	547	97657	97657
6	0.135	0.02	0.12	134680	0.43	0.47	0.21	0.41	1.0	0.1	16202	7035	14009	6565	2194	469	55443	55443
7	0.108	0.02	0.08	85125	0.47	0.54	0.22	0.47	1.0	0.1	8277	3904	6414	3485	1863	411	40122	40122
8	0.083	0.04	0.04	98982	0.42	0.61	0.20	0.53	1.0	0.1	7507	3150	3978	2439	3529	719	52098	52098
9	0.050	0.00	0.05	27357	0.64	0.64	0.00	0.56	1.0	0.1	1280	821	1280	821	0	0	15402	15402
10	0.050	0.00	0.05	94150	0.69	0.69	0.00	0.64	1.0	0.1	4404	3053	4404	3053	0	0	59993	59993
1	0.134	0.13	0.00	915040	0.06	0.23	0.06	0.05	0.0	0.1	109542	6432	1063	245	108479	6183	0	44837
2	0.388	0.36	0.02	723923	0.12	0.27	0.11	0.11	0.5	0.1	222436	26554	13410	3596	209026	22923	38730	77460
3	0.279	0.15	0.12	442043	0.23	0.31	0.17	0.21	0.5	0.1	102642	23959	45940	14317	56702	9602	46046	92092
4	0.209	0.03	0.18	322291	0.33	0.35	0.19	0.29	1.0	0.1	57856	18948	48586	17217	9270	1752	91960	91960
5	0.189	0.01	0.18	180767	0.39	0.41	0.20	0.36	1.0	0.1	29632	11624	27798	11274	1834	359	64172	64172
6	0.135	0.02	0.12	206102	0.43	0.47	0.21	0.41	1.0	0.1	24794	10766	21437	10047	3357	718	84845	84845
7	0.108	0.02	0.08	106475	0.47	0.54	0.22	0.47	1.0	0.1	10353	4883	8022	4360	2330	514	50185	50185
8	0.083	0.04	0.04	69162	0.42	0.61	0.20	0.53	1.0	0.1	5246	2201	2780	1704	2466	502	36402	36402
9	0.050	0.00	0.05	82429	0.64	0.64	0.00	0.56	1.0	0.1	3855	2475	3855	2475	0	0	46408	46408
10	0.050	0.00	0.05	104543	0.69	0.69	0.00	0.64	1.0	0.1	4890	3390	4890	3390	0	0	66615	66615

Table 8.6.4. North Sea plaice. Yield and spawning biomass per recruit reference points

	Fish Mort Ages 2-6	Yield/R	SSB/R
Average last 3 years	0.26	0.09	0.80
Fmax	0.20	0.09	1.19
F0.1	0.14	0.09	1.64
Fmed	0.44	0.07	0.33

Table 8.8.1. North Sea plaice. Results of stochastic stock recruit fits for three different models (Ricker, Beverton-Holt and Smooth hockeystick/segmented regression) and per-recruit analyses.

Ricker

564/1000 Iterations resulted in feasible parameter estimates

	Fcrash	Fmsy	Bmsy	MSY	Alpha	Beta	Unscaled Alpha	Unscaled Beta
Deterministic	0.712	0.356	425	70	0.998	0.947	8.955	0.003
Mean	0.672	0.332	437	78	1.014	0.979	9.915	0.004
5%ile	0.401	0.191	250	39	0.891	0.475	5.299	0.002
25%ile	0.515	0.243	319	60	0.952	0.778	7.322	0.003
50%ile	0.640	0.299	381	74	1.013	0.977	9.389	0.004
75%ile	0.772	0.378	463	89	1.068	1.179	11.738	0.004
95%ile	1.090	0.592	715	118	1.151	1.482	16.395	0.005
CV	0.345	0.419	0.793	0.620	0.080	0.307	0.344	0.307

Beverton-Holt

519/1000 Iterations resulted in feasible parameter estimates

	Fcrash	Fmsy	Bmsy	MSY	Alpha	Beta	Unscaled Alpha	Unscaled Beta
Deterministic	5.000	0.196	1130	90	1.004	1.004	945.800	0.030
Mean	1.160	0.148	8994	158	0.801	1.061	1477.511	179.356
5%ile	0.413	0.018	589	52	0.440	0.935	902.289	9.201
25%ile	0.641	0.108	916	80	0.694	1.009	1013.295	30.986
50%ile	0.889	0.151	1358	102	0.838	1.057	1133.710	65.369
75%ile	1.300	0.194	2897	141	0.937	1.110	1368.055	139.686
95%ile	3.188	0.245	37046	288	1.053	1.198	2157.441	410.275
CV	0.734	0.452	5.230	4.516	0.244	0.073	2.485	6.330

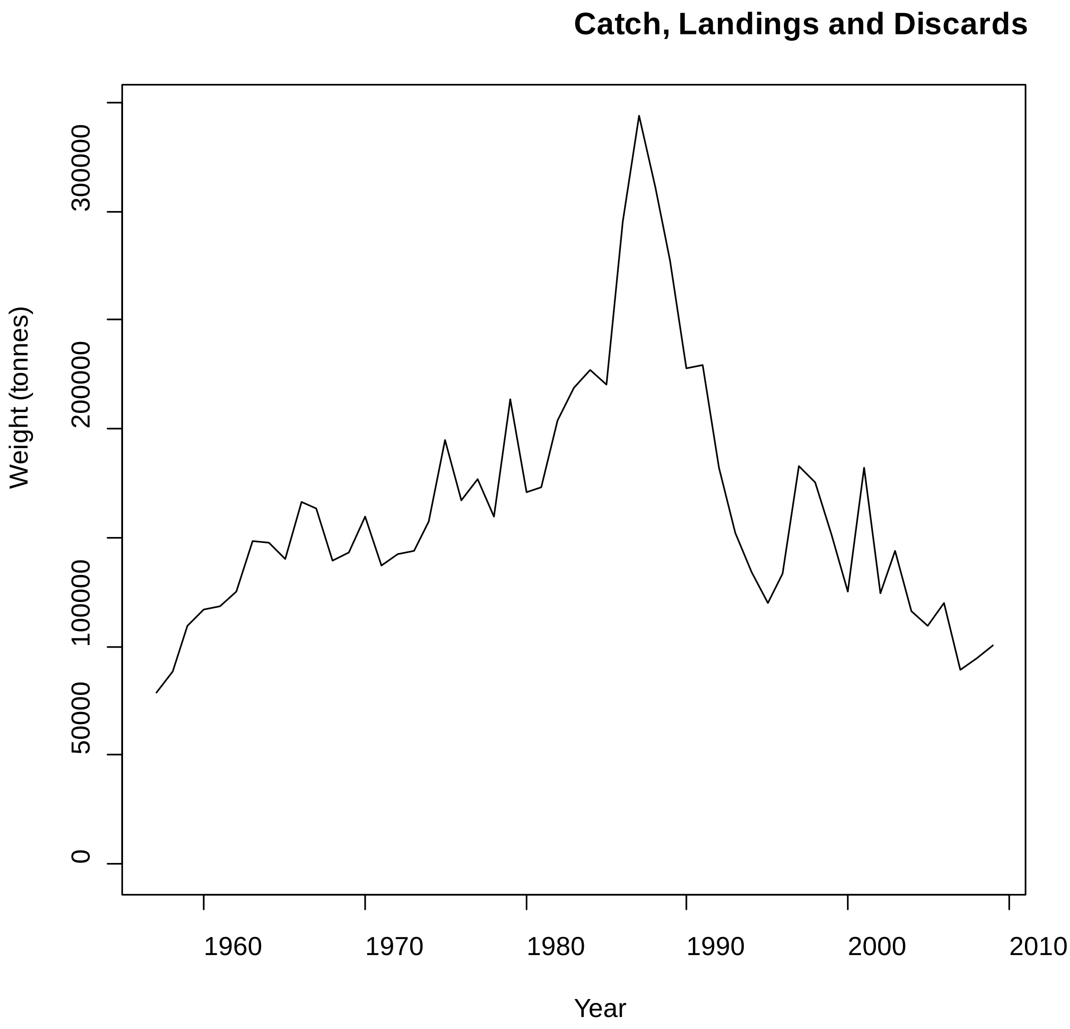
Smooth hockeystick

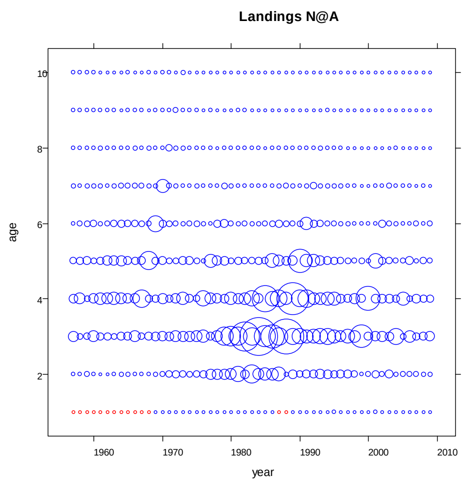
564/1000 Iterations resulted in feasible parameter estimates

	Fcrash	Fmsy	Bmsy	MSY	Alpha	Beta	Unscaled Alpha	Unscaled Beta
Deterministic	0.557	0.196	1108	88	0.739	0.596	2.570	180.400
Mean	0.453	0.167	4983	100	0.644	0.706	2.241	213.753
5%ile	0.292	0.019	426	48	0.512	0.603	1.780	182.582
25%ile	0.366	0.121	687	69	0.588	0.635	2.046	192.309
50%ile	0.425	0.171	993	87	0.643	0.691	2.237	209.301
75%ile	0.513	0.218	1804	110	0.699	0.760	2.433	230.021
95%ile	0.700	0.291	27705	216	0.783	0.866	2.725	262.320
CV	0.309	0.470	2.035	0.506	0.125	0.118	0.125	0.118

Per recruit

	F35	F40	F01	Fmax	Bmsypr	MSYpr	Fpa	Flim
Deterministic	0.157	0.136	0.144	0.196	1.195	0.095	0.600	0.740
Mean	0.111	0.096	0.116	0.167	5.240	0.105		
5%ile	0.003	0.003	0.004	0.019	0.461	0.052		
25%ile	0.092	0.079	0.081	0.121	0.710	0.074		
50%ile	0.120	0.103	0.121	0.171	1.034	0.091		
75%ile	0.144	0.125	0.157	0.218	1.988	0.115		
95%ile	0.187	0.161	0.206	0.291	29.237	0.227		
CV	0.461	0.464	0.508	0.472	2.017	0.499		


Catch, Landings and Discards
Weight (tonnes)
0
50000
100000
200000
300000
1960
1970
1980
1990
2000
2010
Year



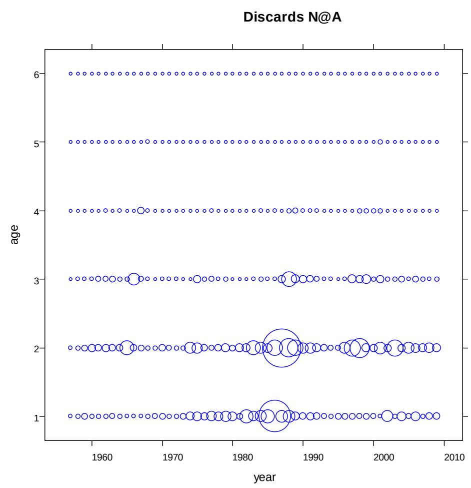


Figure 8.2.3 North Sea plaice. Landing numbers-at-age (left) and discards numbers-at-age (right).

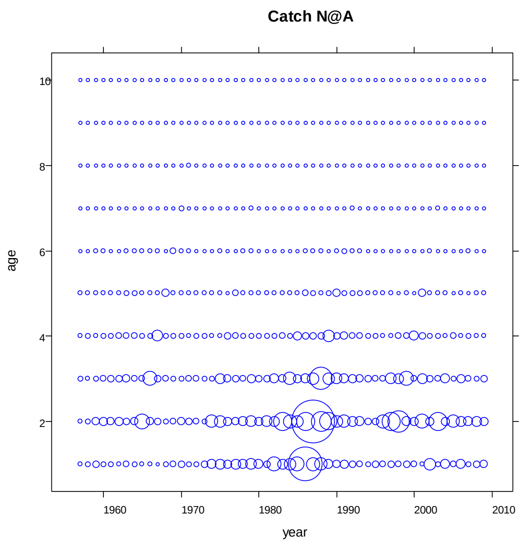
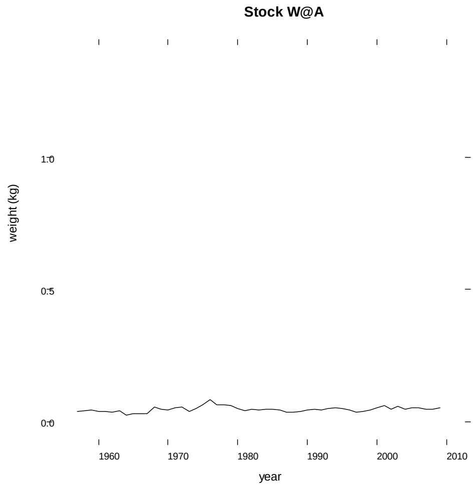


Figure 8.2.4 North Sea plaice. Catch numbers-at-age.


Stock W@A
weight (kg)
1.0
0.5
0.0
1960
1970
1980
1990
2000
2010
year

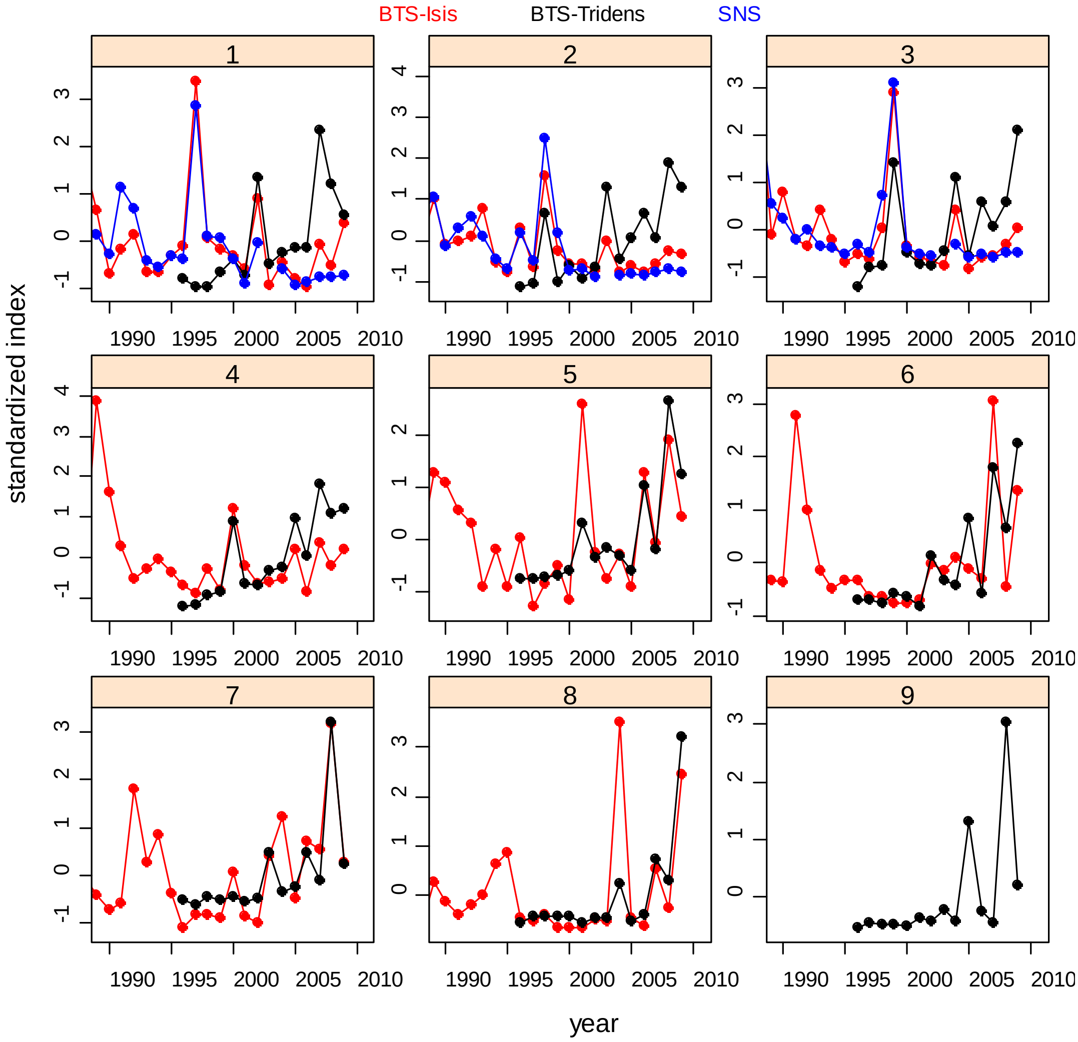


Figure 8.2.6 North Sea plaice. Standardized survey tuning indices used for tuning XSA: BTS-Isis (red), BTS-Tridens (black) and SNS (blue). Note: only ages used in the assessment are presented.

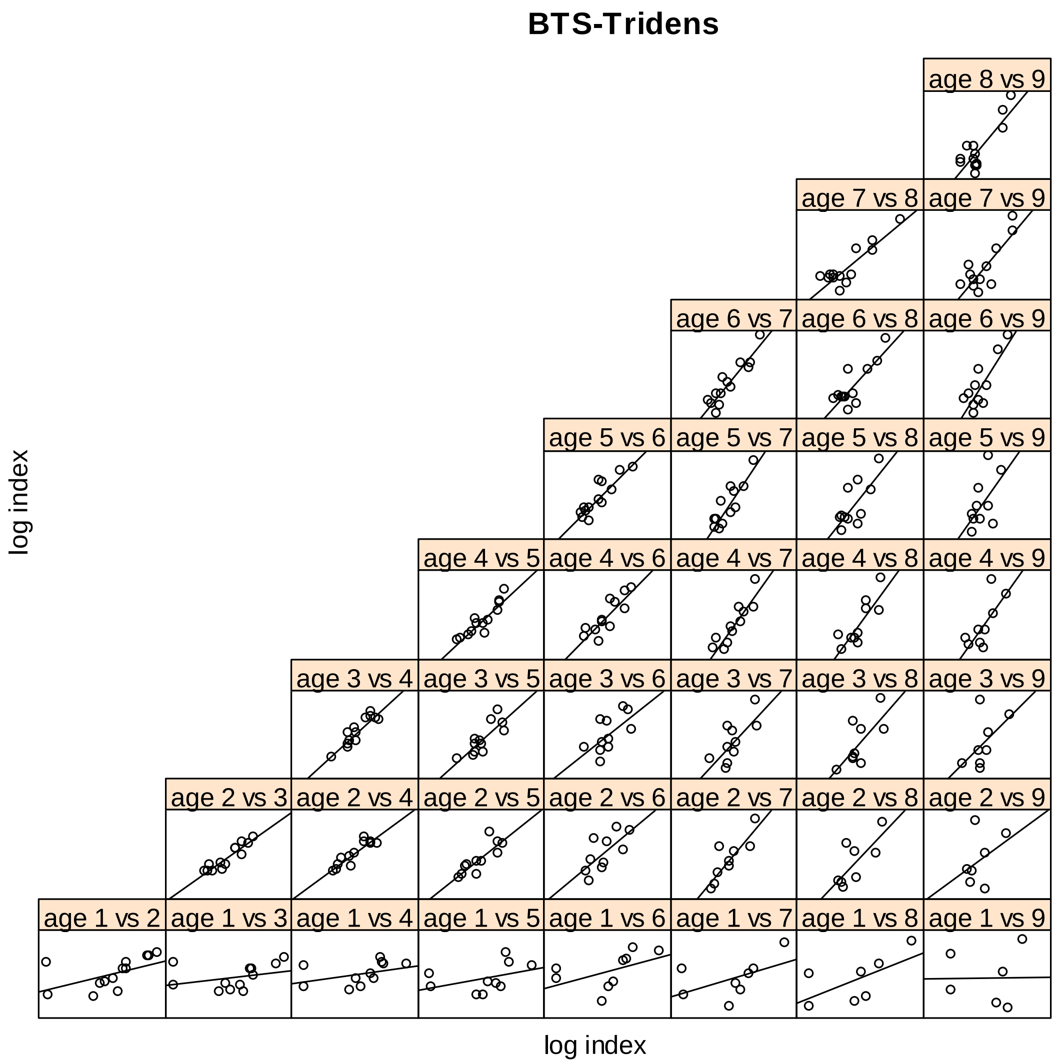


Figure 8.2.7 North Sea plaice. Internal consistency plot for the BTS-Tridens survey.

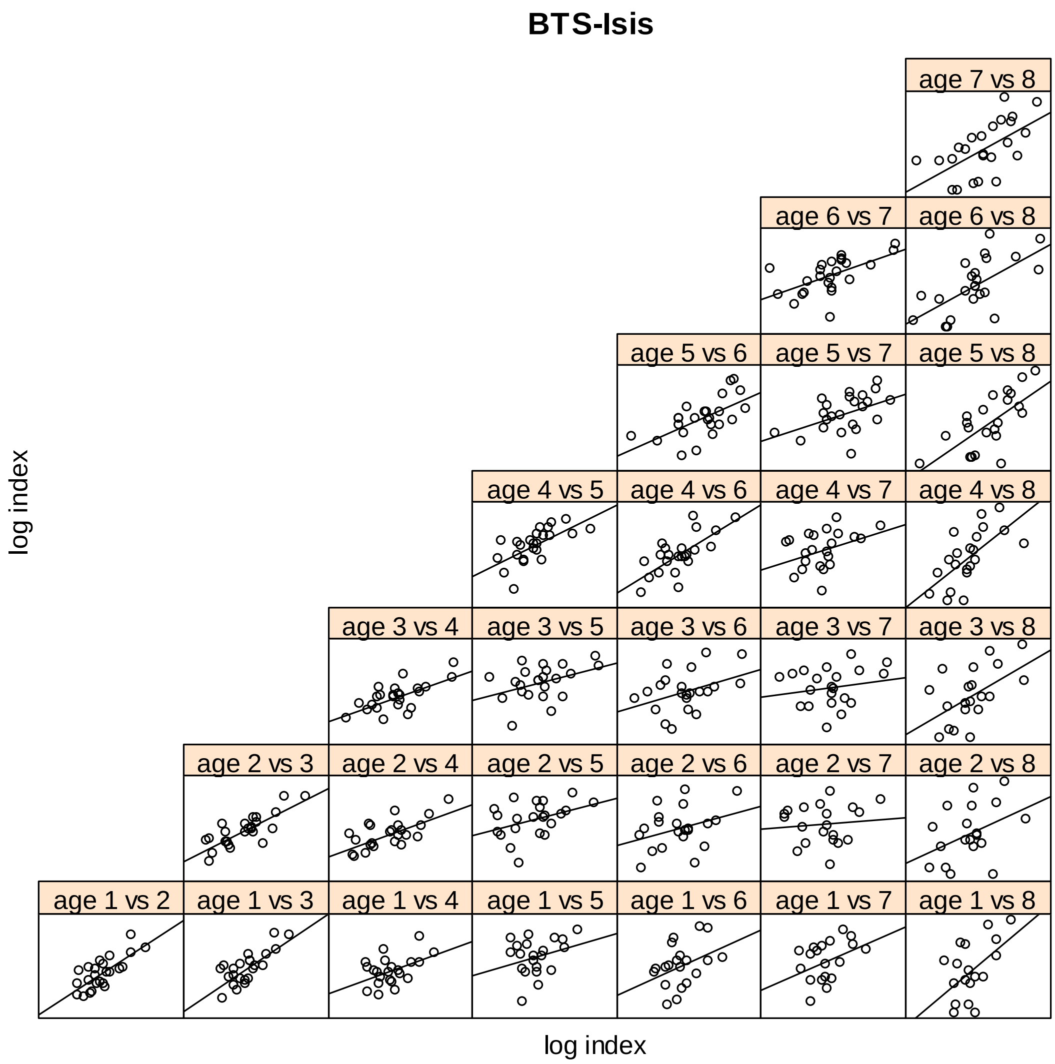


Figure 8.2.8. North Sea plaice. Internal consistency plot for the BTS-Isis survey.

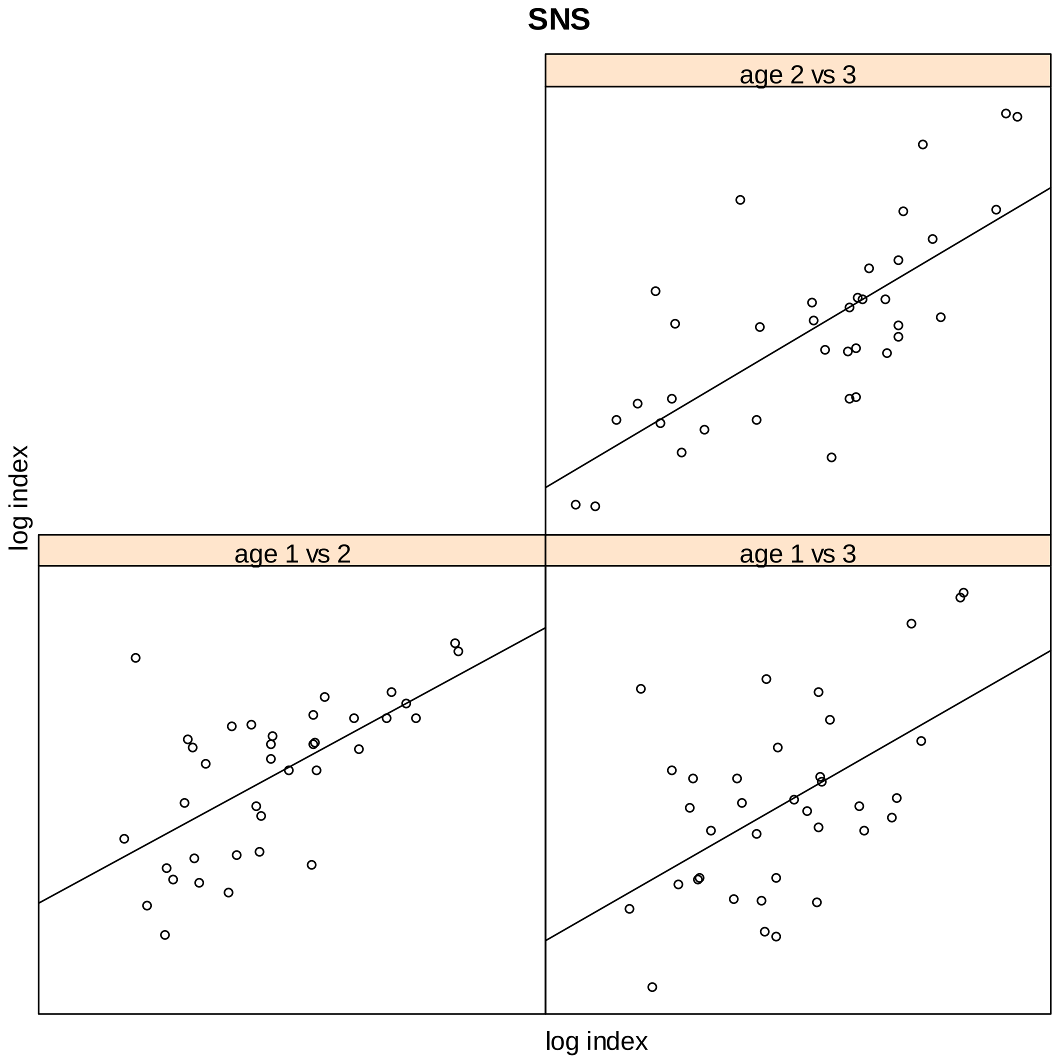


Figure 8.2.9. North Sea plaice. Internal consistency plot for the SNS survey.

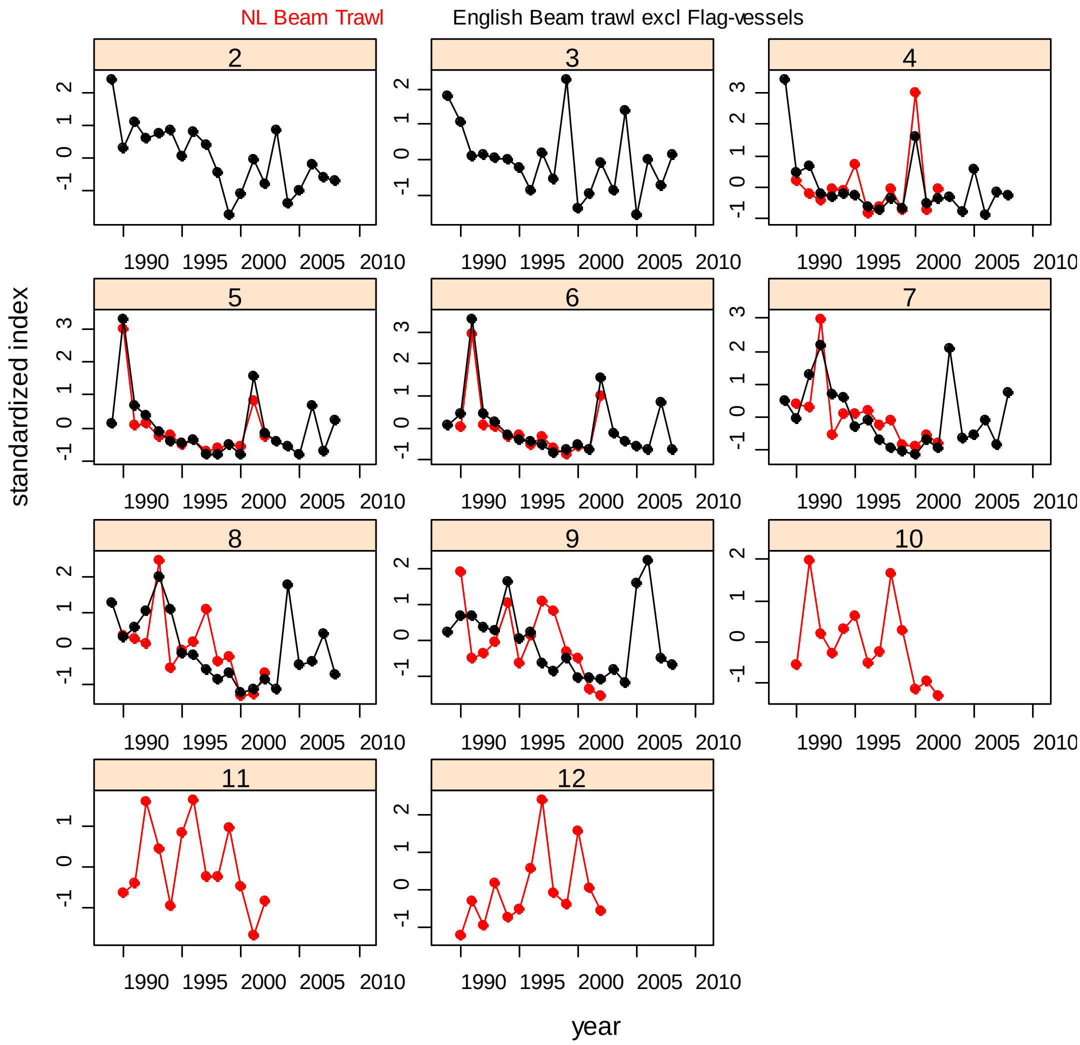


Figure 8.2.11 North Sea plaice. Standardized commercial tuning indices available for tuning: Dutch beam trawl fleet (red) and UK beam trawl fleet excluding all flag vessels (black).

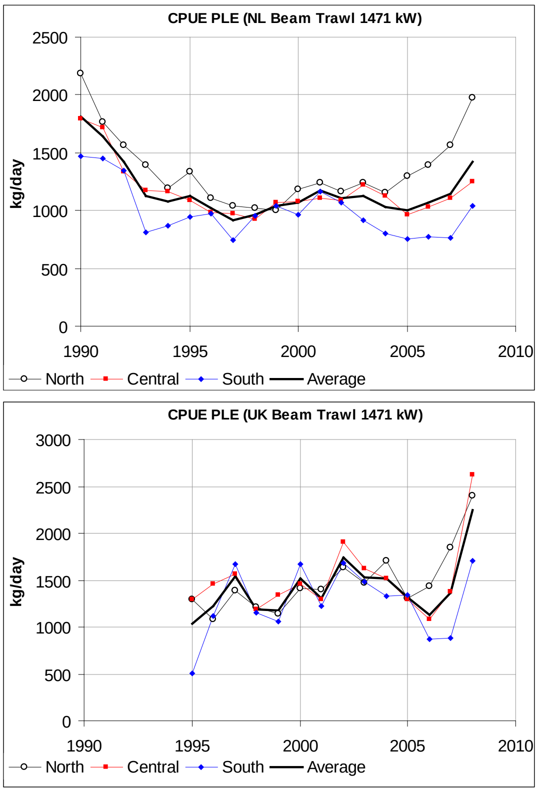


Figure 8.2.12. North Sea plaice. LPUE of the Dutch (left) and UK large trawler fleet (right), in areas north, central and south and the combined North Sea. Source: VIRIS Taken from Quirijns and Poos 2009,Working paper 1 . Note: these series were not updated with 2009 data.

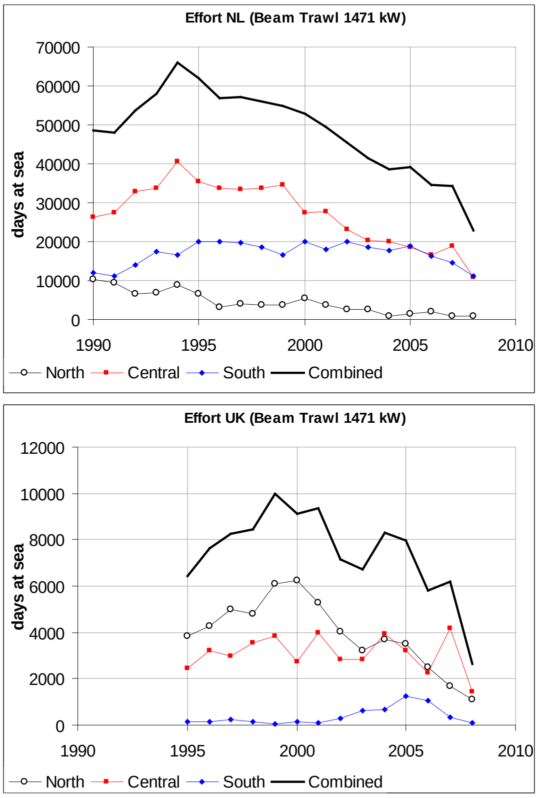


Figure 8.2.13. North Sea plaice. Effort (days at sea per 1471 kW vessel) for the Dutch fleet (left) and UK large trawler fleet (right), in areas north, central and south and the combined North Sea. Source: VIRIS. Taken from Quirijns and Poos 2009, Working paper 1.

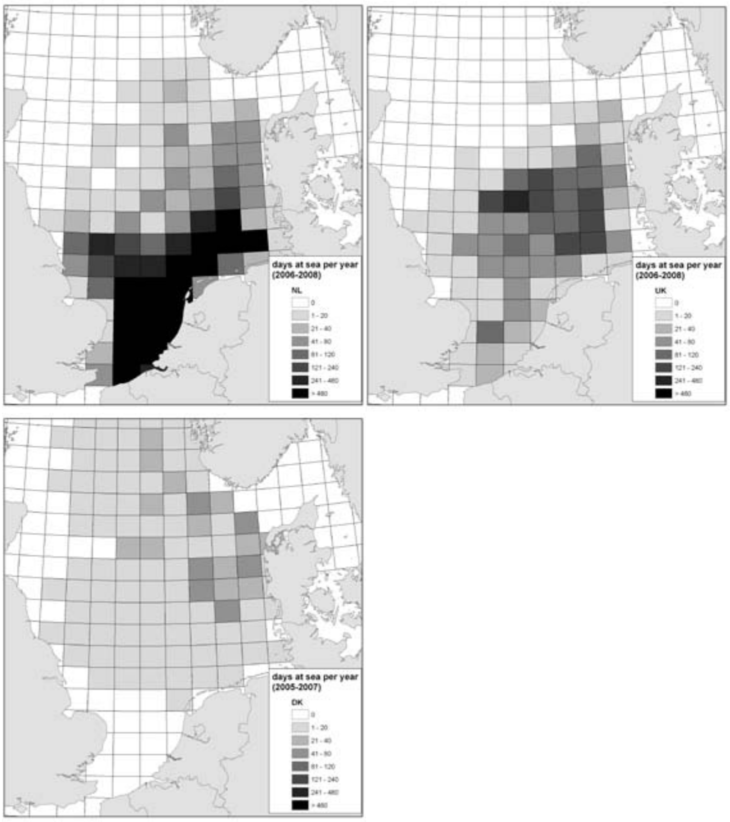
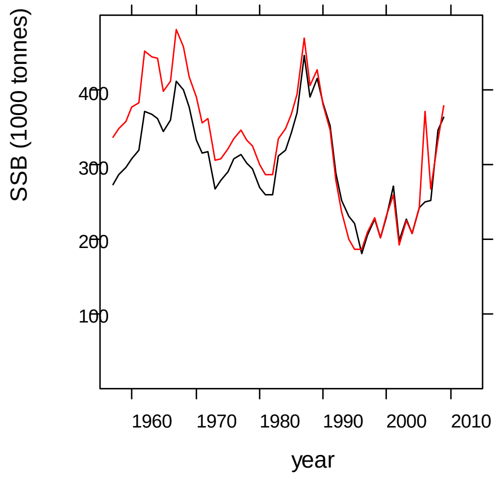


Figure 8.2.14. North Sea plaice. Annual fishing effort by the North Sea trawling fleet: Dutch vessels (left); UK flag vessels (middle); and Danish vessels (right). Expressed in days at sea, averaged over the period 2006-2008 (except for Danish data which cover the period 2005-2007). Source: EC logbook data.



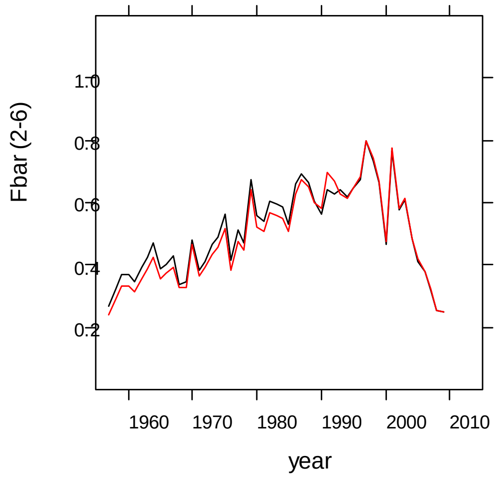


Figure 8.3.1. North Sea plaice. XSA results with respect to SSB (left) and F (right) estimate for different plus group settings used in the assessment. Red line indicates plus group at age 15, black line indicates plus group at age 10.

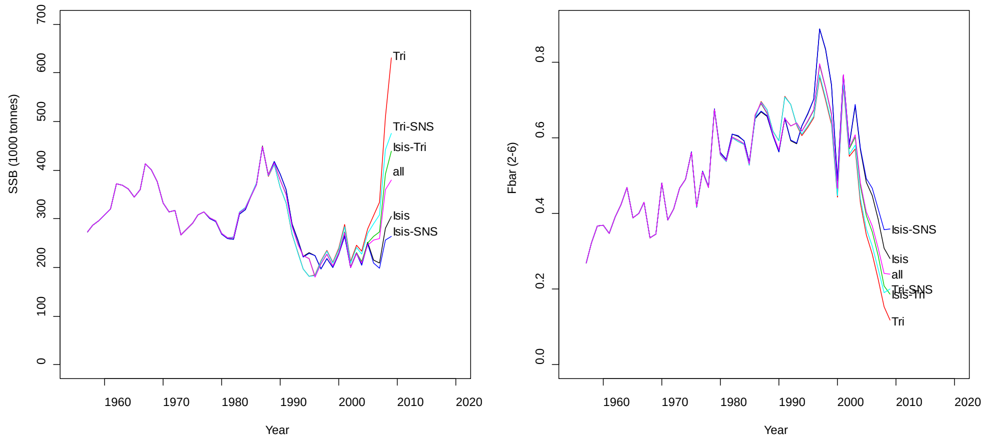


Figure 8.3.2 North Sea plaice XSA results with respect to SSB (left) and F (right) estimates for different permutations of the available survey tuning indices. XSA run with only SNS survey tuning index is omitted because no reliable SSB or F estimates are available owing to the limited age range (only ages 1–3). Labels indicate used tuning indices.

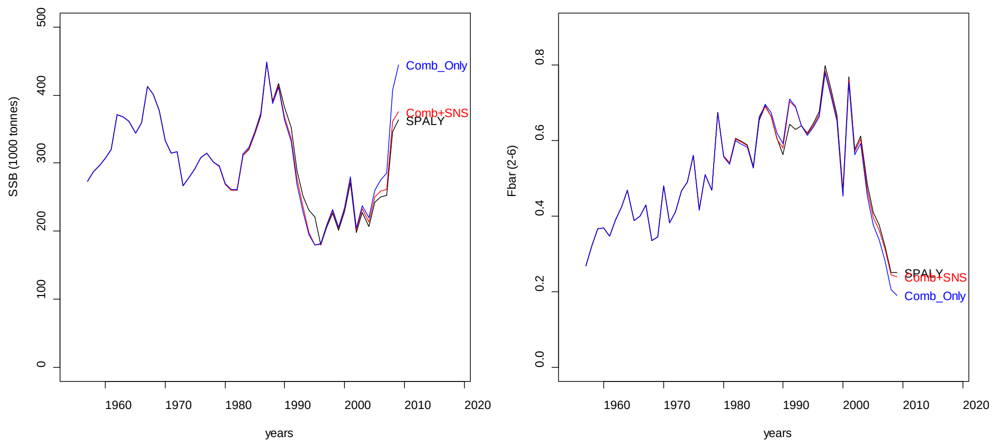


Figure 8.3.3 North Sea plaice XSA results with respect to SSB (left) and F (right) estimates using the combined BTS survey (BTS-Isis and BTS-Tridens) with different permutations of the available survey tuning indices. Labels indicate used tuning indices (SPALY=same procedure as last year i.e. BTS-Isis and BTS-Tridens separate with SNS survey).

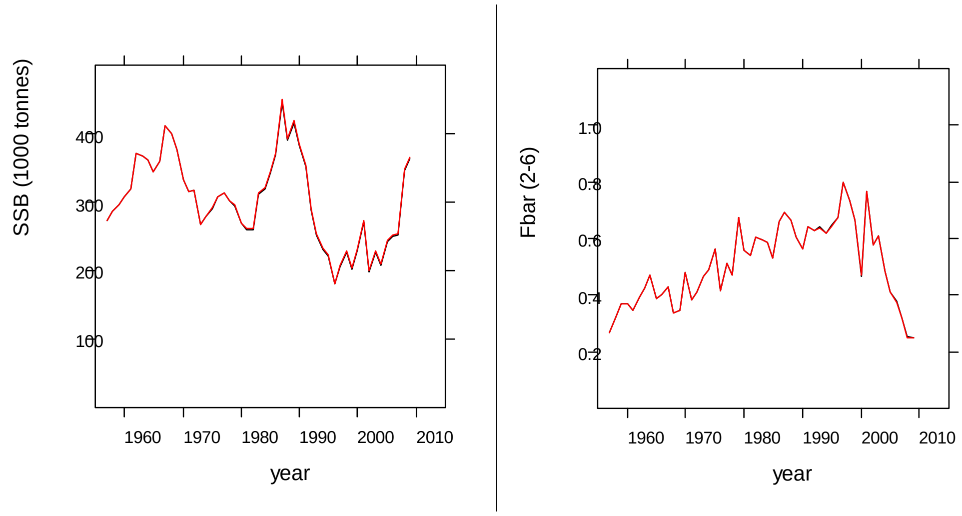


Figure 8.3.4. North Sea plaice. XSA results with respect to SSB (left) and F (right) estimate with (black line) and without (red line) 50% of Q1 catches from area VIId included. Note: the black line is predominantly hidden beneath the red line due to near identical outputs.

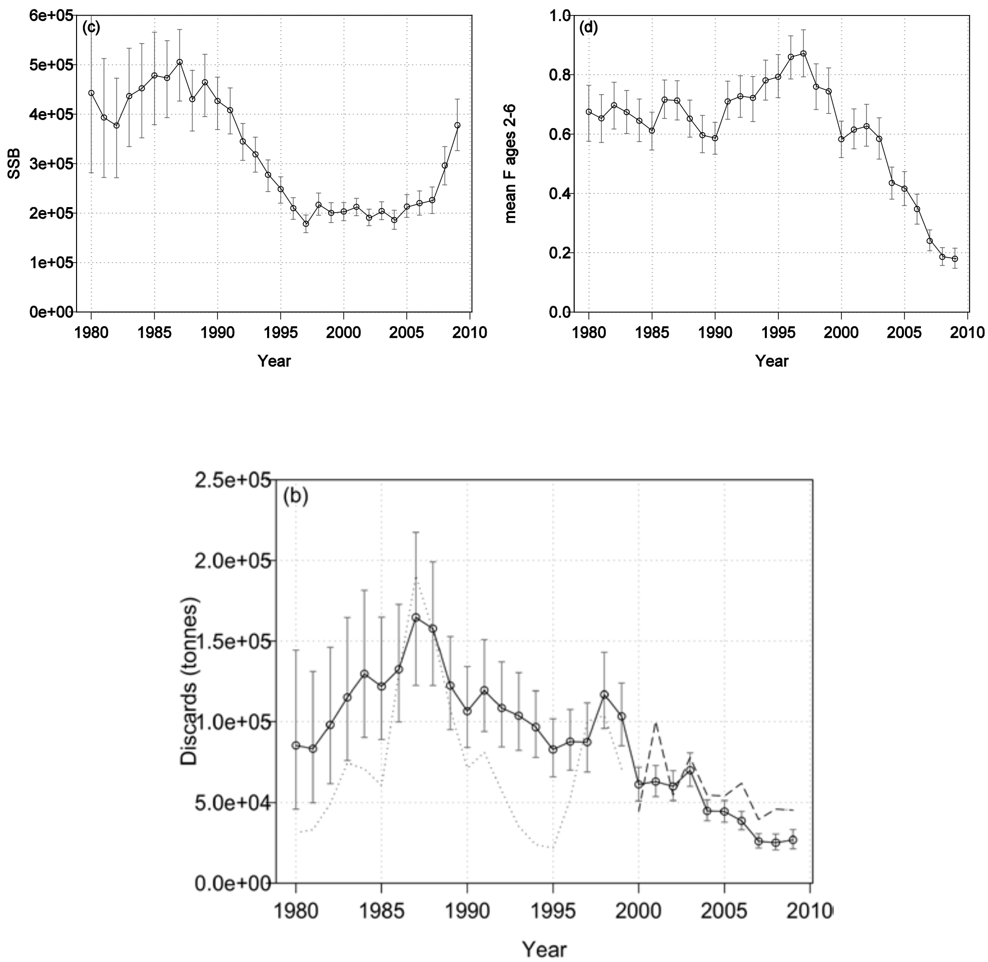


Figure 8.3.5 North Sea plaice. SCA output. A comparison of the median estimate of SSB (top left), Fbar (top right) and Discard (bottom) estimates obtained by running the Statistical catch at age model. Vertical bars represent the 95% confidence interval of the estimation. The dashed line in the SCA discard estimates shows the observed discards and the dotted line the reconstructed discards using the current method used in the XSA (see Aarts & Poos 2009)

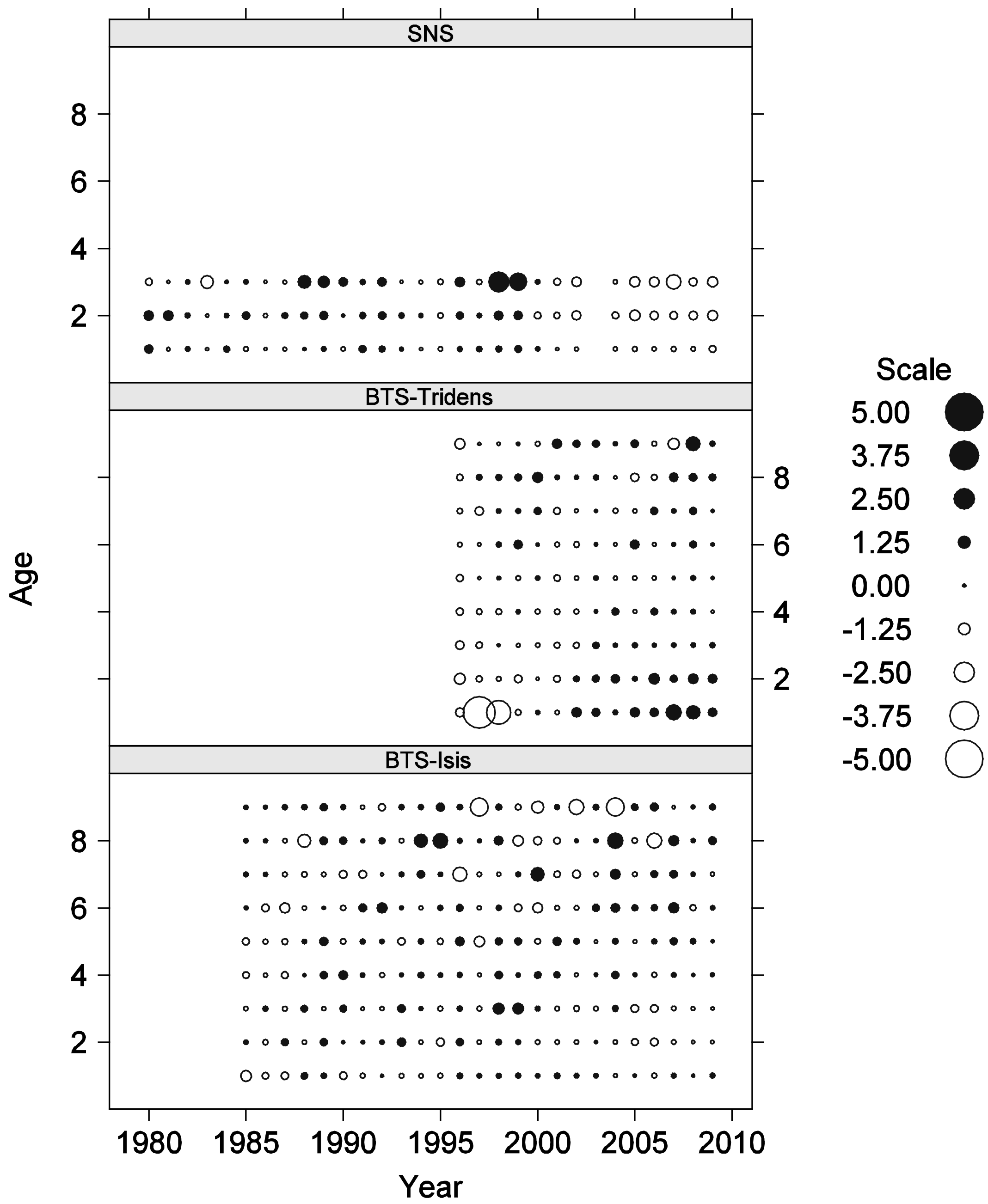


Figure 8.3.6. North Sea plaice. SCA output. Log catchability residuals from the three tuning series.

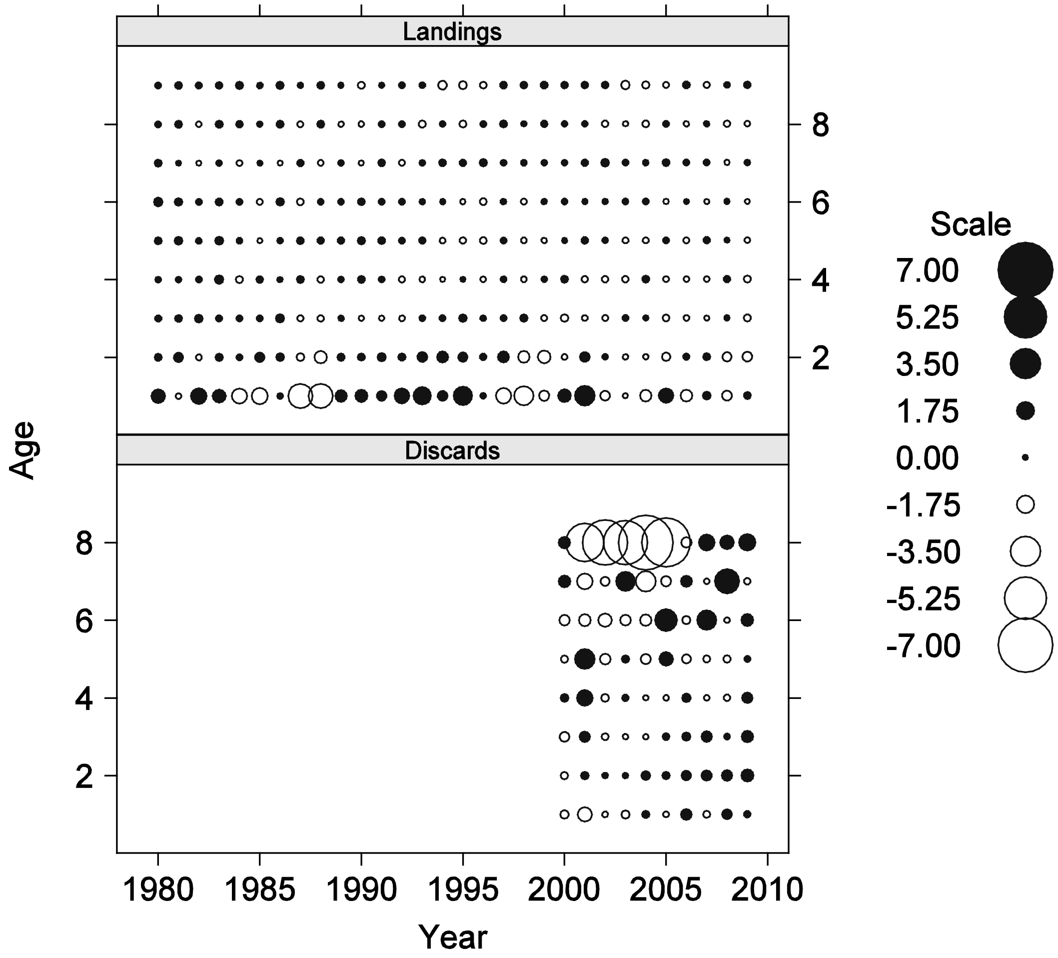


Figure 8.3.7 North Sea plaice. SCA output. Model log residuals of the landings and discard data (see Aarts & Poos 2009).

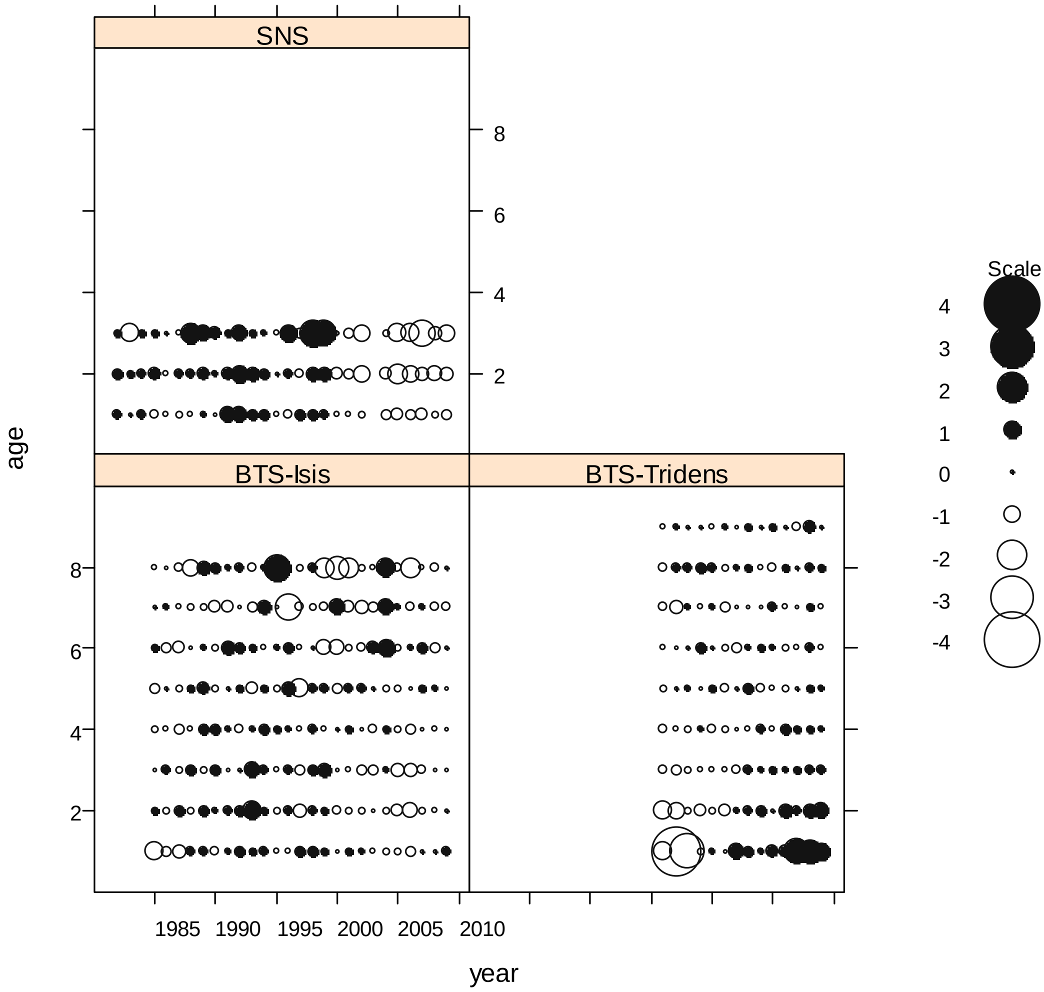


Figure 8.3.8. North Sea plaice. Log catchability residuals for the final XSA run from the three tuning series.

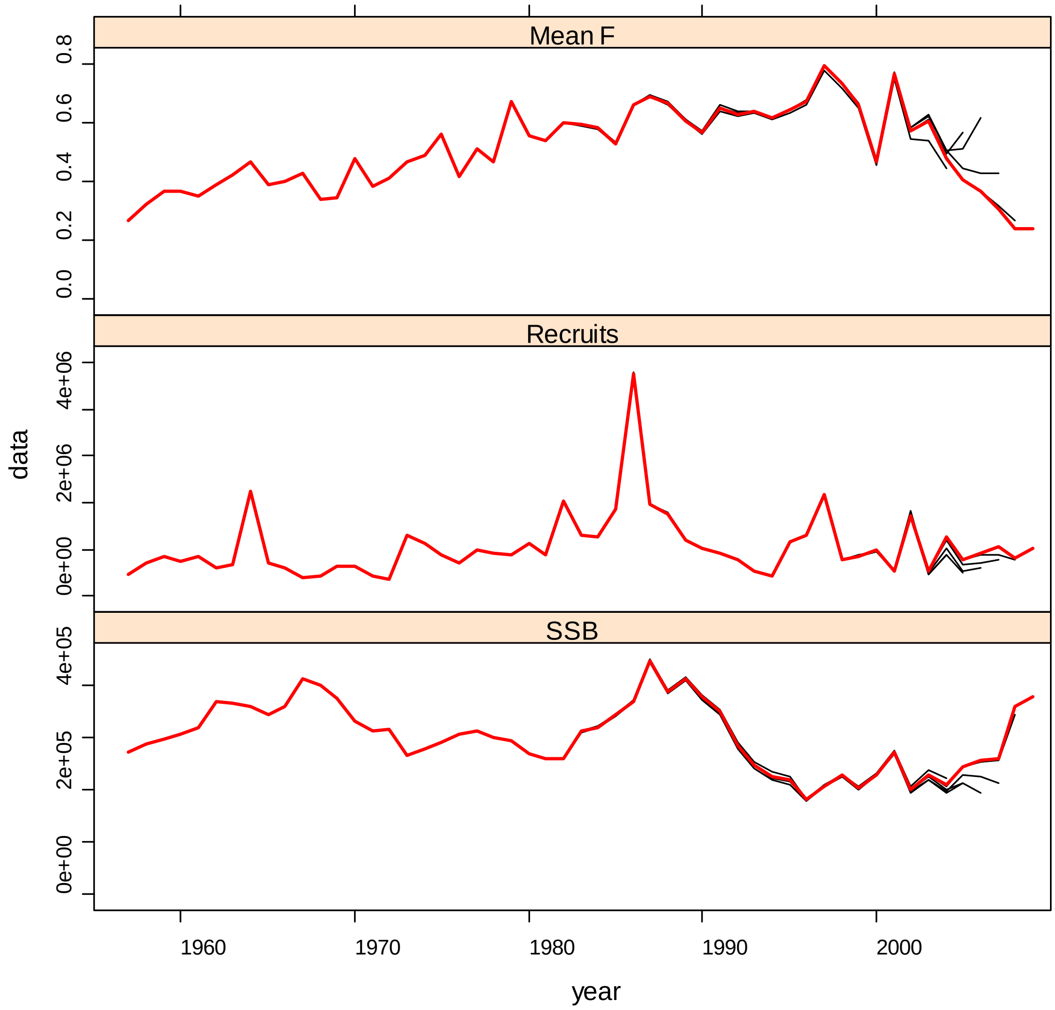
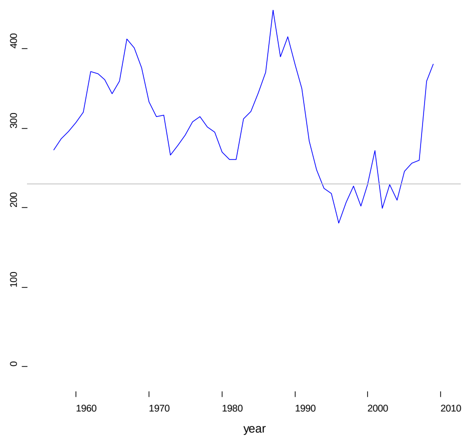


Figure 8.3.11. North Sea plaice. Retrospective pattern of the final XSA run with respect to SSB, recruitment and F.


400
300
200
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0
1960
1970
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1990
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2010
year

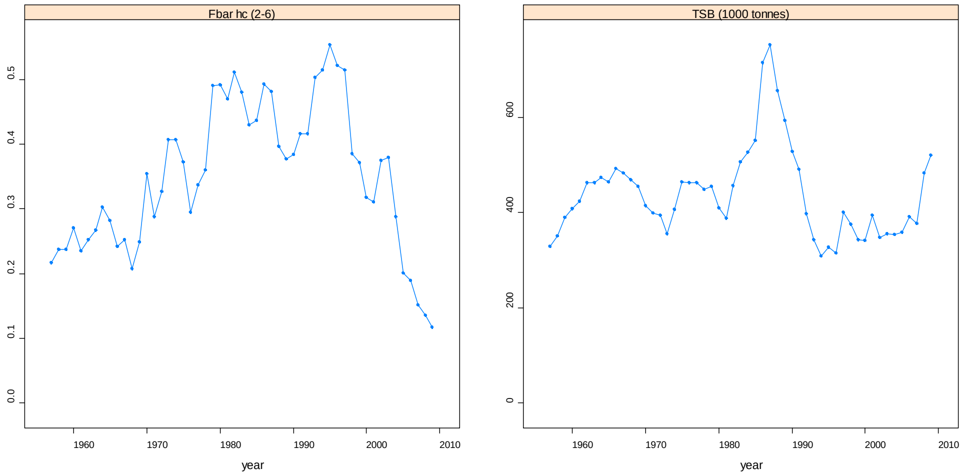

Figure 8.4.2. North Sea plaice. Stock summary figure. Time series on human consumption (left) fishing mortality and total stock biomass (right)

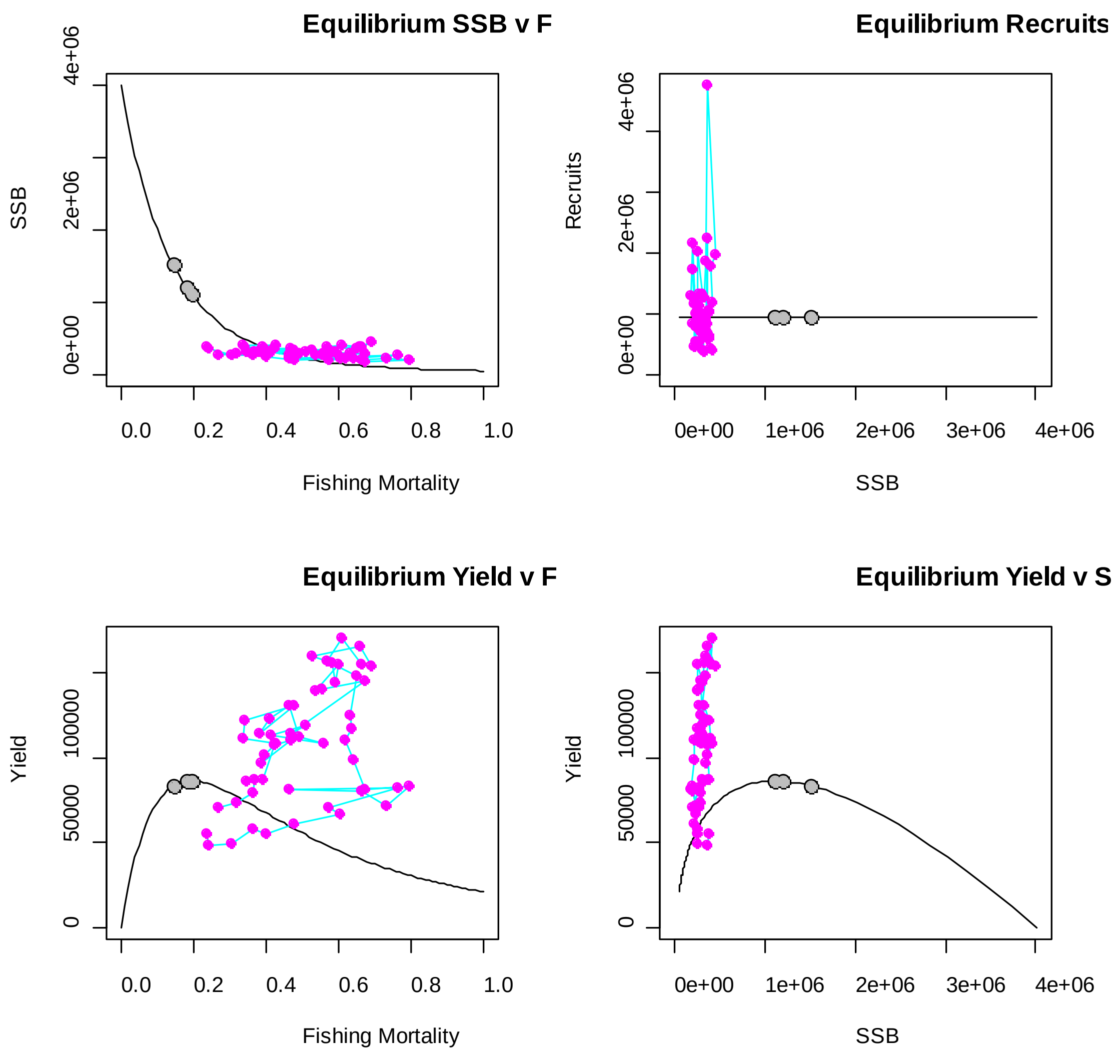

Figure 8.6.1 North Sea plaice. Yield per recruit analysis.

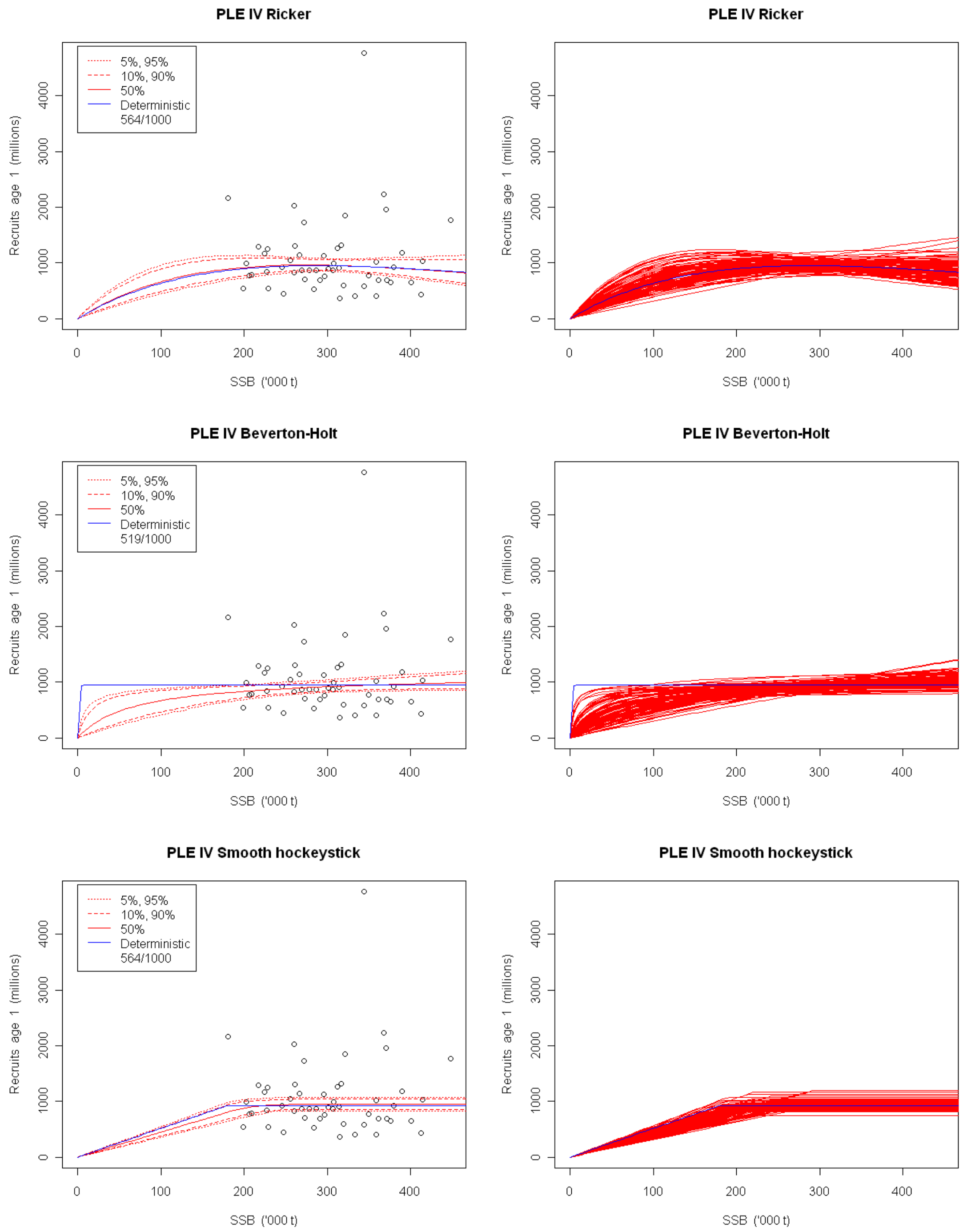

Figure 8.8.1 North Sea plaice. Stochastic stock recruit fits for three different models: Ricker (top), Beverton-Holt (middle) and Smooth hockeystick (segmented regression; bottom).

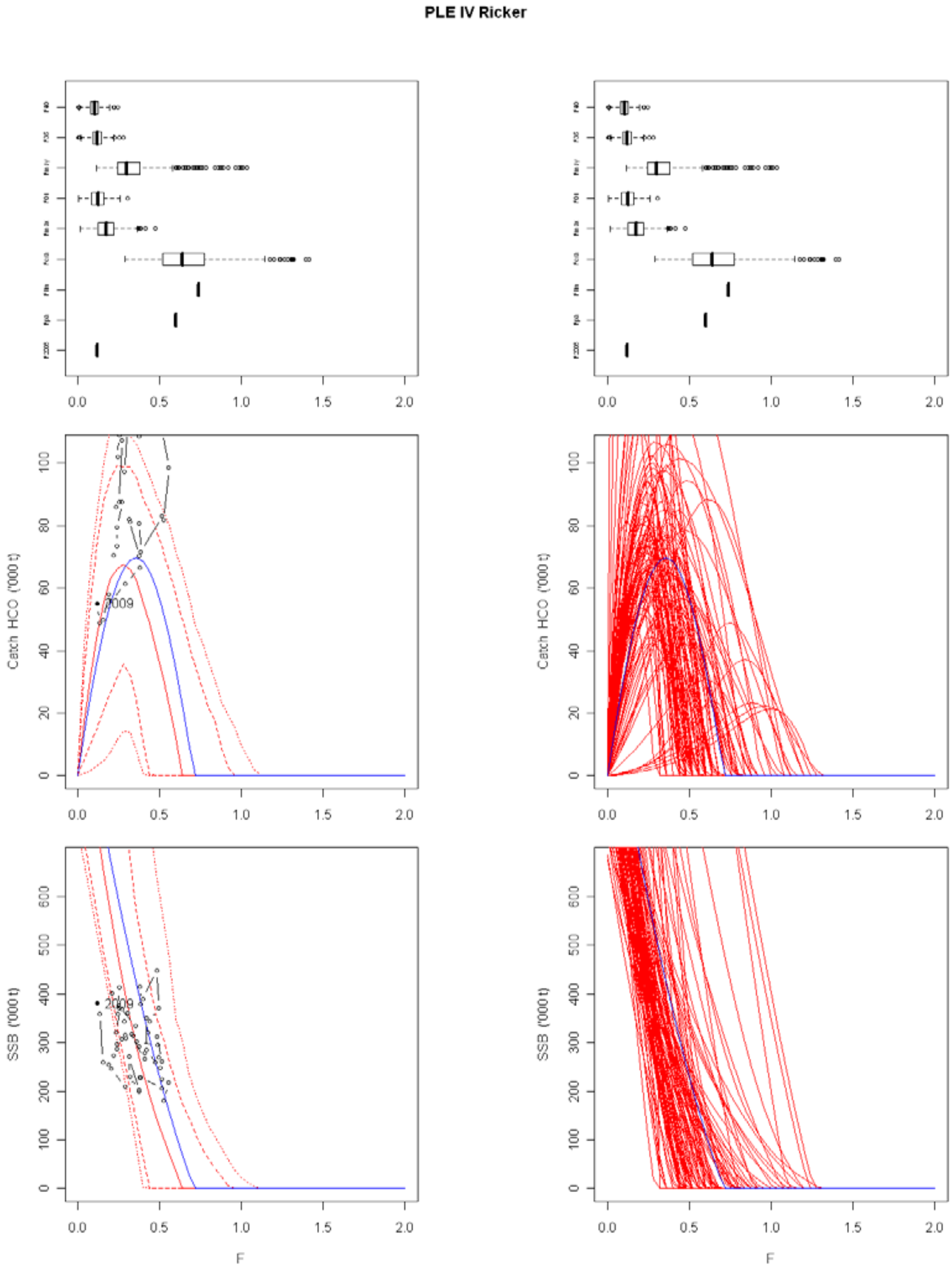

Figure 8.8.2 North Sea plaice. Stochastic equilibrium analyses based on Ricker stock recruit fits and resultant distributions of biological reference points.

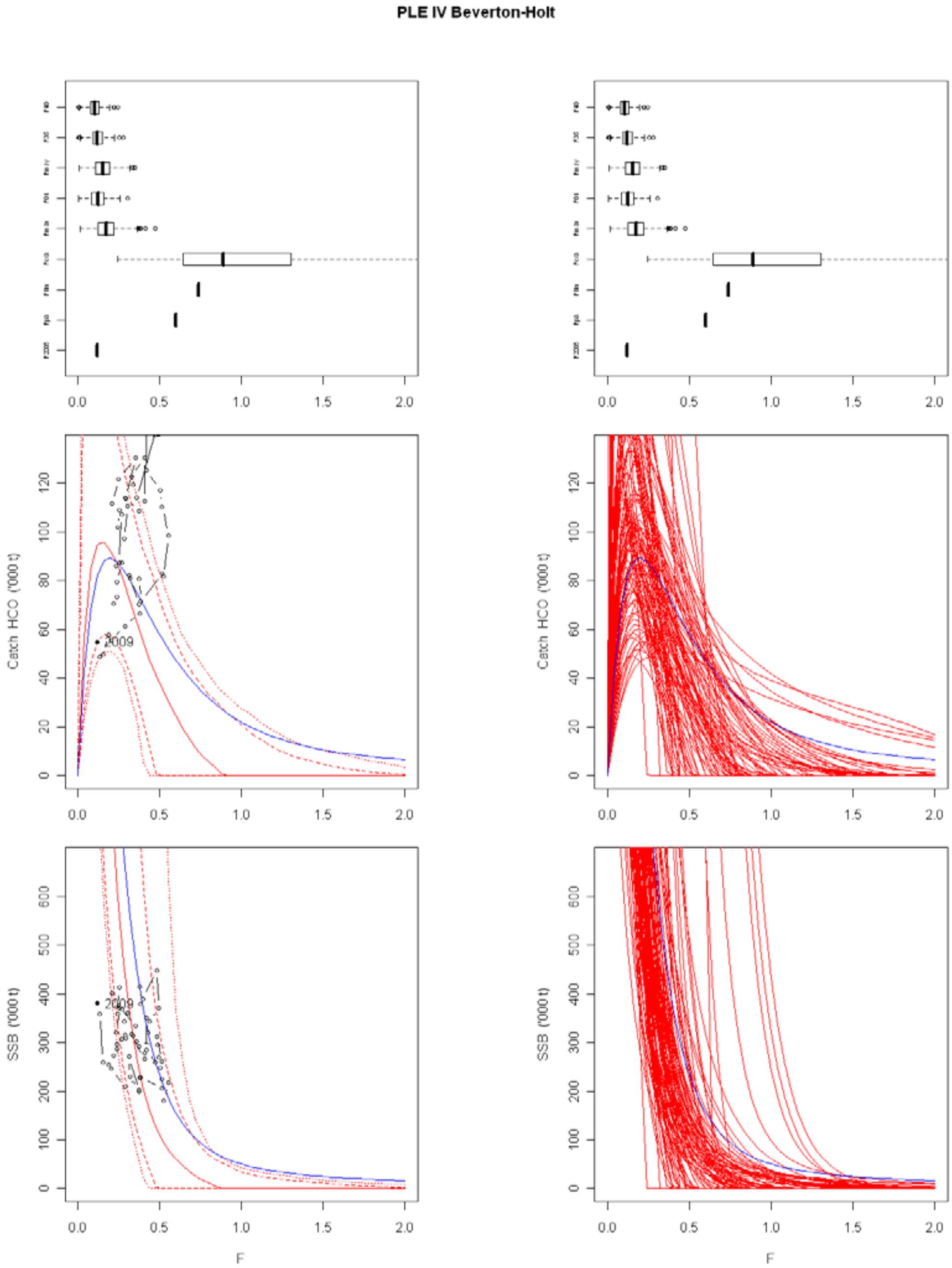

Figure 8.8.3 North Sea plaice. Stochastic equilibrium analyses based on Beverton-Holt stock re-cruit fits and resultant distributions of biological reference points.

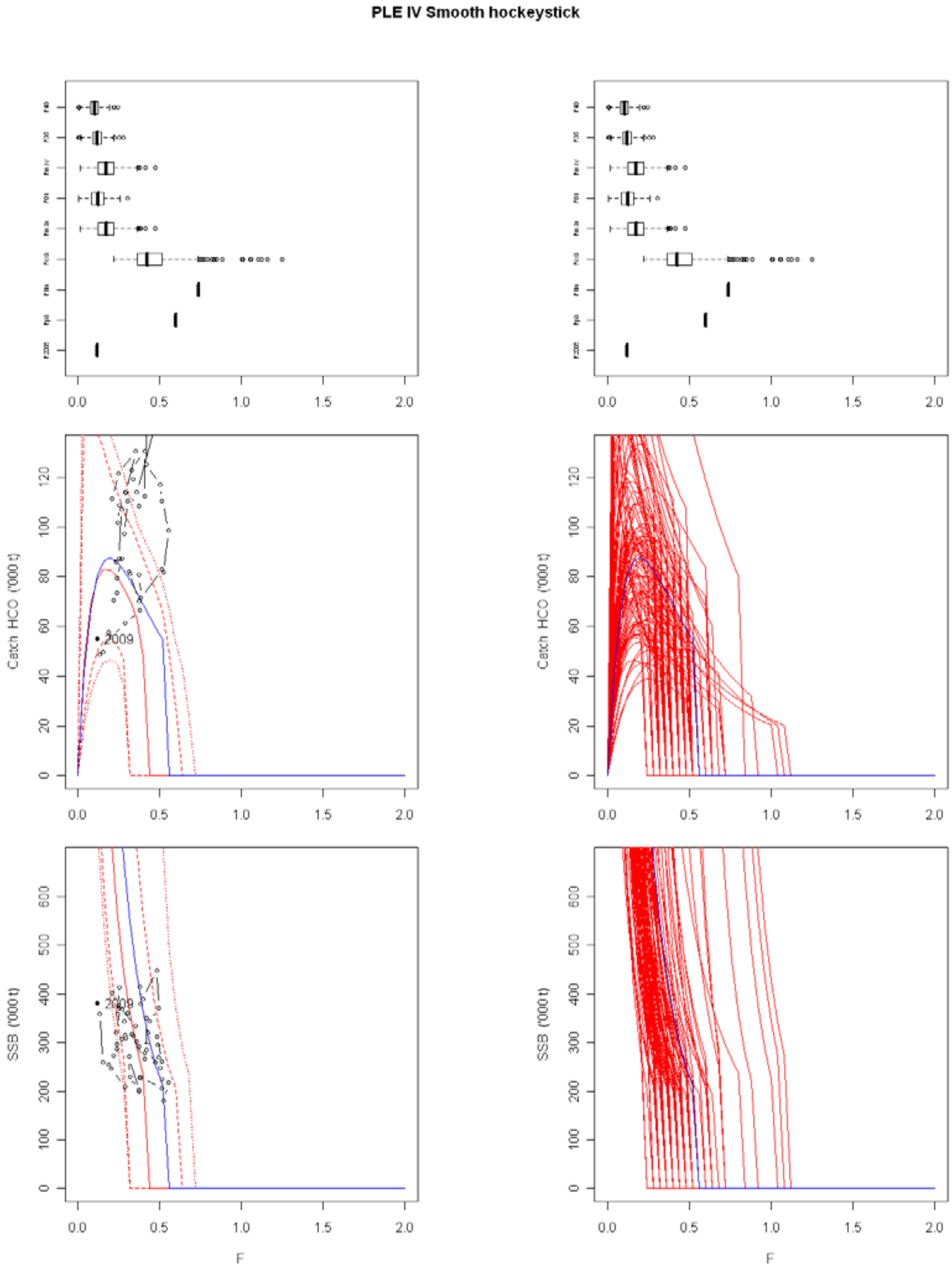

Figure 8.8.4 North Sea plaice. Stochastic equilibrium analyses based on the smooth hockeystick (segmented regression) stock recruit fits and resultant distributions of biological reference points.

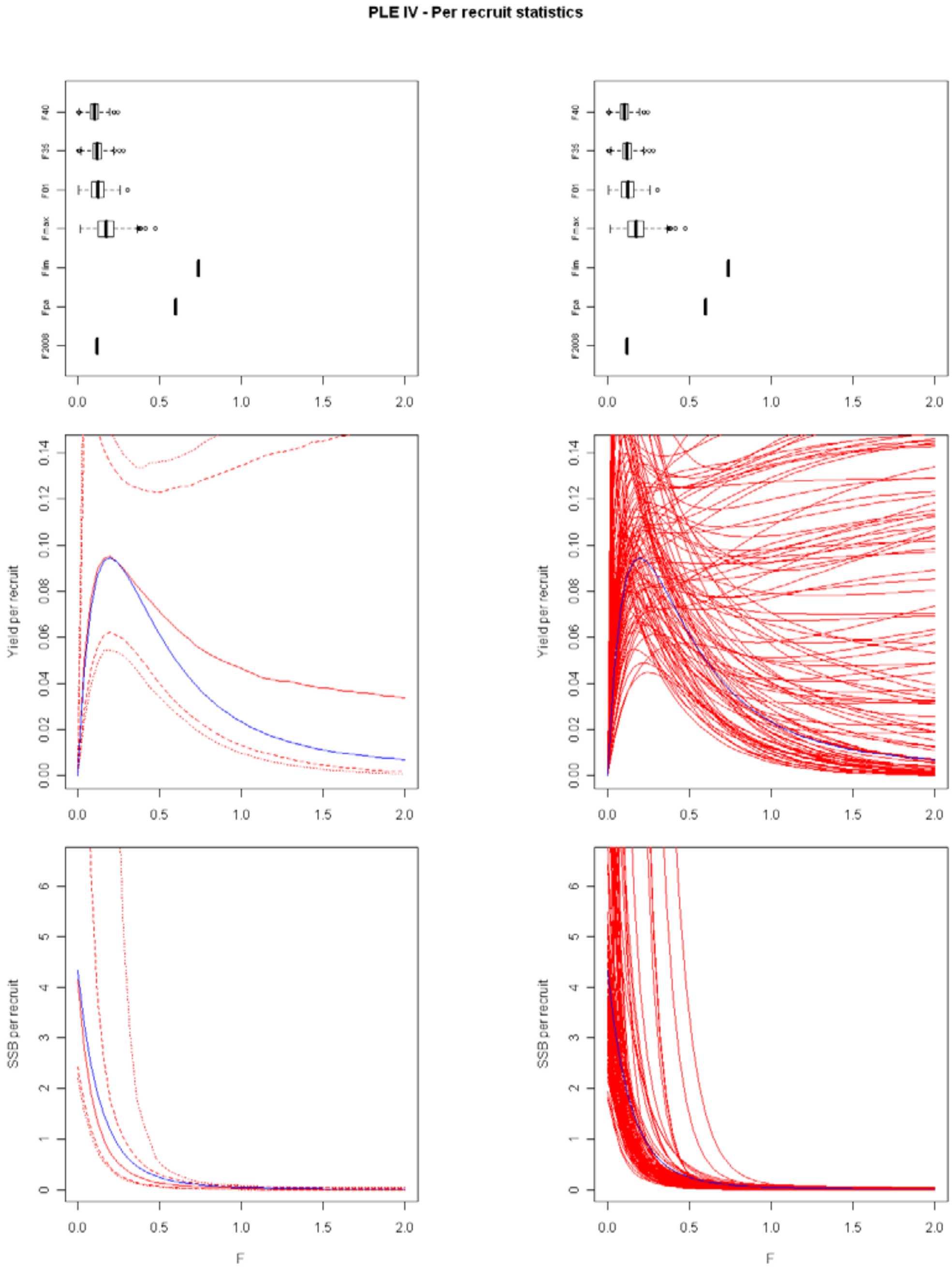

Figure 8.8.5 North Sea plaice. Stochastic equilibrium per-recruit analyses and resultant distributions of biological reference points.

9 Sole in Subarea VIId

The assessment of sole in subarea VIId is presented here as an update assessment.

All the relevant biological and methodological information can be found in the Stock Annex dealing with this stock. Here, only the basic input and output from the assessment model will be presented.

9.1 General

9.1.1 Ecosystem aspects

No new information on ecosystem aspects was presented at the working group in 2010.

All available information on ecological aspects can be found in the Stock Annex.

9.1.2 Fisheries

A detailed description of the fishery can be found in the Stock Annex.

It is likely that the high oil prices have had some impact on the fishing behavior of the Belgian and UK beam trawl fleets. For the French and UK inshore fleets however this will probably not be the case since they fish predominantly in the inshore areas.

For the thirteenth consecutive year, neither France, Belgium nor UK was able to take up their quota (see section 9.2.1).

9.1.3 ICES advice

In the advice for 2009 and 2010, ICES considered the stock as having full reproductive capacity and at risk of being harvested unsustainably.

Single-stock exploitation boundaries

Exploitation boundaries in relation to high long-term yield, low risk of depletion of production potential and considering ecosystem effects

Fishing mortality in 2008 is estimated at 0.45, above the range that would lead to high long-term yields and low risk of stock depletion.

Exploitation boundaries in relation to precautionary limits

The fishing mortality in 2010 should be below F_{pa} *corresponding to landings less than 3190 t in 2010, which is expected to keep SSB above* B_{pa} *in 2011.*

Demersal fisheries in the area are mixed fisheries, with many stocks exploited together in various combinations in the various fisheries. In these cases, management advice must consider both the state of individual stocks and their simultaneous exploitation in demersal fisheries. Stocks in the poorest condition, particularly those which suffer from reduced reproductive capacity, become the overriding concern for the management of mixed fisheries, where these stocks are exploited either as a targeted species or as a bycatch.

Fisheries in Division IIIa (Skagerrak–Kattegat), in Subarea IV (North Sea), and in Division VIId (Eastern Channel) should in 2010 be managed according to the following rules, which should be applied simultaneously:

Demersal fisheries

- *should minimize bycatch or discards of cod;*
    - *should implement TACs or other restrictions that will curtail fishing mortality for those stocks mentioned above for which reduction in fishing pressure is advised;*
    - *should be exploited within the precautionary exploitation limits or where appropriate on the basis of management plan results for all other stocks (see text table above);*
    - *where stocks extend beyond this area, e.g. into Division VI (saithe and anglerfish) or are widely migratory (Northern hake), should take into account the exploitation of the stocks in these areas so that the overall exploitation remains within precautionary limits;*
    - *should have no landings of angel shark and minimum bycatch of spurdog, porbeagle, and common skate and undulate ray.*

9.1.4 Management

No explicit management objectives are set for this stock.

Management of sole in VIId is by TAC and technical measures. The agreed TACs in 2009 and 2010 are 5274t and 4219t respectively. Technical measures in force for this stock are minimum mesh sizes and minimum landing size. The minimum landing size for sole is 24cm. Demersal gears permitted to catch sole are 80mm for beam trawling and 80mm 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.

For 2009 Council Regulation (EC) N°43/2009 allocates different amounts of Kw*days by Member State and area to different effort groups of vessels depending on gear and mesh size. The area's are Kattegat, part of IIIa not covered by Skaggerak and Kattegat, ICES zone IV, EC waters of ICES zone IIa, ICES zone VIId, ICES zone VIIa, ICES zone Via and EC waters of ICES zone Vb. The grouping of fishing gear concerned are: Bottom trawls, Danish seines and similar gear, excluding beam trawls of mesh size: TR1 (≤ 100 mm) – TR2 (≤ 70 and < 100 mm) – TR3 (≤ 16 and < 32 mm); Beam trawl of mesh size: BT1 (≤ 120 mm) – BT2 (≤ 80 and < 120 mm); Gill nets excluding trammel nets: GN1; Trammel nets: GT1 and Longlines: LL1.

For 2010 Council Regulation (EC) N°53/2010 has updated Council Regulation (EC) N°43/2009 with new allocations, based on the same effort groups of vessels and areas as stipulated in Council Regulation (EC) N°43/2009. (see section 2 for complete list).

9.2 Data available

9.2.1 Catch

UK landings submitted to the Working Group for 2008 were revised upward by 1% to 686t. The 2008 values for the numbers at age were therefore also updated. Total landings now amount to 4517t instead of 4510t.

The 2009 landings used by the Working Group were 4969t (Table 9.2.1) which is 6% below the agreed TAC of 5274t and 18% above the predicted landings at a status quo fishing mortality in 2009 (4194t). The contribution of France, Belgium and the UK to the landings in 2009 is 55%, 30% and 15% respectively.

Landing data reported to ICES are shown in Table 9.2.1 together with the total landings estimated by the Working Group. As in last year's assessment, misreporting by UK beam trawlers from Division VIIe into VIId have been taken into account and corrected accordingly (see also section 9.11). It should be noted that historically there is also thought to be a considerable under-reporting by small vessels, which take up a substantial part of the landings in the eastern Channel. In the UK buyers and sellers registration is considered to have reduced this significantly since 2005. Substantial progress has been made in recent years by including all return rates of the small vessels.

Discard estimates since 2005 are available for the UK static gear. French static gear and Otter trawl is available from 2005 until 2008 (Figure 9.2.1a-c). French discard data for 2009 was not available to the Working Group. Numbers are raised to the sampled trips. It should be noted that the number of sampled trips is low. Discard from the Belgian beam trawler fleet could not been processed in time for the working group due to the shift of the working group to an earlier time in the year. The data will be available later in the year when time and manpower permits to compile the data.

The available information suggests that discards are not a substantial part of the catch for this high valued species. Although French otter trawl discards information suggest that occasionally discarding of predominantly 1-year old fish occur in the first and second quarter. These otter trawls only comprise 13% of the sole landings in VIId. Observer information from one single UK beam trawl trip in the 4th quarter in 2008 indicates high discard rates of sole. However it should be noted that markets at that time of the year were heavily affecting discards of flatfish, including sole. The information from that single trip is therefore not representative for the UK beam trawl fleet at any time in the year. The Working Group decided not to include discards in the assessment at this stage due to the scarcity of the data but will monitor the situation in the future.

UK and FR have provided data this year under the ICES InterCatch format. Belgium is working to provide data using this format for the next working group.

9.2.2 Age compositions

Quarterly data for 2009 were available for landing numbers and weight at age, for the French, Belgian, and UK fleets. These comprise 100% of the international landings. Age compositions of the landings are presented in Table 9.2.2.

9.2.3 Weight at age

Weight at age in the catch is presented in Table 9.2.3 and weight at age in the stock in Table 9.2.4. The procedure for calculating mean weights is described in the Stock Annex.

9.2.4 Maturity and natural mortality

As in previous assessments, a knife-edged maturity-ogive was used at age 3.

Natural mortality is assumed at fixed values (0.1) for all ages in time.

9.2.5 Catch, effort and research vessel data

Available estimates of effort and LPUE are presented in Tables 9.2.5a,b and Figures 9.2.2a-c. Revisions have been made to the UK effort and LPUE series for 2008. There were no revisions to the Belgium and French data series No French effort and LPUE was available for 2009. Effort for the Belgian beam trawl fleet increased to the highest level in 2007 with a slight decrease in 2008 and 2009. This is mainly due to the unrestrictive "days at sea" EU regulation in ICES subdivision VIId from 2005 until 2007, as well as the good fishing opportunities for sole in that area. The mobile Belgian fleet are predominantly fishing in the most favourable area which is subdivision VIId at the moment. The UK (E&W) beam trawl fleet effort increased from the late 80's, reaching its peak in 1997. Since then, effort has decreased and fluctuated around 60% of its peak level. Information has been provided on effort and LPUE from the recent period of the French fleets in the Eastern Channel. This short data series will be extended historically and for recent years and therefore will provide information on the trends in the main French fisheries.

Belgian LPUE has fluctuated around the mean with no strong trend until recently when catch rates have been increasing consistent with the UK beam trawl fleet up to 2005. Both fleets show a decrease in 2006 and 2007 with a slight increase in 2008. In 2009, the LPUE of the UK beam trawl decreased whereas the LPUE for the Belgian beam trawl fleet increased. The recent time series of the French beam trawl LPUE has been decreasing until 2006 with a slight increase in 2007 and 2008. The French OTB and GTR show also a slight increase in the last few years.

Survey and commercial data used for calibration of the assessment are presented in Table 9.2.6.

The data for 2008 for the UK beam trawl series was revised. The UK survey component of the Young fish survey (YFS) was last conducted in 2006. In the absence of any update of the UK component, it was decided at the Benchmark working group (WKFLAT – February 2009) that the UK component should still be used in the assessment independently from the French component of the YFS index. It was also noted that the lack of information from the UK YFS will affect the quality of the recruitment estimates and therefore the forecast. (see also section 9.3.2).

Investigations at the WKFLAT of a possible horse power correction for the Belgian beam trawl fleet indicate that a more realistic approach could be implemented. Due to lack of time and manpower, the recalculation could not be conducted for this assessment. However the Working Group considered it as a priority for implementation at the next update assessment.

9.3 Data analyses

9.3.1 Reviews of last year's assessment

The RG noted that similar pattern of trends in residuals for sole and plaice in this area were observed and requested that the WG should look into this feature in VIId at the benchmark assessment. Unfortunately this was not addressed at the WKFLAT. Due to work pressure at this year's meeting, the Working Group was also unable to fully evaluate this feature. However, the Working Group agreed fully to address this issue as soon as possible.

9.3.2 Exploratory catch at age analysis

Catch at age analysis was carried out according to the specifications in the Stock Annex. The model used was XSA. The results of exploratory XSA runs, which are not included in this report, are available in ICES files.

A preliminary inspection of the quality of international catch-at-age data was carried out using separable VPA with a reference age of 4, terminal F=0.5 and terminal S=0.8. The log-catch ratios for the fully recruited ages (3-10) did not show any patterns or large residuals (in ICES files).

The tuning data were examined for trends in catchability by carrying out XSA tuning runs (lightly shrunk (se=2.0), mean q model for all ages, full time series and untapered), using data for each of the four fleets individually (in ICES files). Apart from the first few year's in the Belgian series (1982-1985, which were excluded from the analyses, as in previous assessments), there were no strong trends for any of the fleets. The Belgian beam trawl fleet had a somewhat noisier log catchability residual pattern, especially for age 2 and age 11. Year effects were noted for the UK(E&W) beam trawl fleet (UK-BT) in 2000. The UK(E&W) beam trawl survey (UK-BTS) showed year effects for 3 consecutive years (1999, 2000 and 2001). It was also noted that the log catchability residual of the separate Young Fish Survey components (YFS-UK and YFS-FR) were noisier than the combined Young Fish Survey index, used in previous assessments.

The time series of the standardized indices for ages 1 to 6 from the five tuning fleets (BEL-BT commercial, UK-BT commercial, UK-BTS survey, YFS-UK survey and the YFS-FR survey) are plotted in Figure 9.2.3. All tuning fleets appear to track the year classes reasonably well for ages 2 to 6. For age 1, the two Young Fish Survey components from UK and France are not always consistent in estimating the year class strength. Investigations of the standardised indices from both the separate components of the Young Fish Survey and the combined index for age 1 (ICES files), show that the combined index and the UK component estimate year class strength to be more similar than the French component. Internal consistency plots for the 2 commercial fleets and the UK beam trawl survey are presented in Figure 9.2.4-6. The internal consistency of the Belgian beam trawl fleet appears relatively high for the older ages. The UK commercial fleet and the UK beam trawl survey show high consistencies for the entire age-range.

The catchability residuals for the proposed final XSA are shown in Figure 9.3.1a-b and the XSA tuning diagnostics are given in Table 9.3.1.

In general, estimates between fleets are consistent for ages 2 and above (Figure 9.3.2), apart from the estimates from the YFS-FR for ages 2, 4, 5, 8 and 9. In this year's assessment the estimates for the recruiting year class 2008 were estimated by the UK beam trawl survey (UK-BTS) and the French component of the Young Fish Survey (YFS-FR) which have both an equal weighting of about 45% to the final survivor estimates. F-shrinkage giving 9% of the weighting. It should be noted that both surveys are estimating this year class as high (UK-BTS) and very high (YFS-FR) (see also section 9.5).

At age 2, the 2006 year-class is estimated to have similar abundance by most of the tuning fleets. Only the French component of the Young Fish Survey (YFS-FR) estimates it to be weak. Most of the weighting is given by the commercial UK BT fleet (42%) and the UK BTS survey (39%).

Apart from age 1 (9%), F shrinkage gets low weights for all ages (< 2%). The weighting of the 3 surveys decreases for the older ages as the commercial fleets are given more weight (Figure 9.3.2).

9.3.3 Exploratory survey-based analyses

In 2005, exploratory SURBA-runs (v3.0) were carried out on the UK(E&W) Beam-trawl Survey (UK-BTS) (1988-2004) and the International Young Fish Survey (1988-2004) to investigate whether the surveys-only analysis suggests different trends in Recruitment, SSB and fishing mortality. From the diagnostics on Mean Z, it was concluded that the surveys could not estimate any trend in fishing mortality. Given also that the SSB and recruitment trends from both XSA and SURBA runs showed similar patterns, the Working Group decided to accept the XSA as the final assessment.

In this update assessment SURBA runs were not executed.

9.3.4 Conclusion drawn from exploratory analyses

The XSA analysis was taken as the final assessment, giving mostly consistent survivor estimates between fleets for ages 2 and above. The estimates of the recruiting age 1 (year class 2008) are far above average values in the time series. (Table 9.3.1 and Table 9.3.4). Although both surveys (UK-BTS and YFS-FR) estimate the 2008 year class as exceptional, the Working Group decided that the final XSA survivor estimates of 157912 fish at age 1 should not be accepted for any forecasts (see section 9.5).

9.3.5 Final assessment

The final settings used in this year's assessment are specified as in the stock annex and are detailed below:

	2010 assessment		
Fleets	Years	Ages	α-β
BEL-BT commercial	86-09	2-10	0-1
UK-BT commercial	86-09	2-10	0-1
UK-BTS survey	88-09	1-6	0.5-0.75
YFS – survey (combined index UK-FR)			
YFS-UK - survey	87-**06**	1-1	0.5-0.75
YFS-FR - survey	87-09	1-1	0.5-0.75
-First data year	1982		
-Last data year	2009		
-First age	1		
-Last age	11+		
Time series weights	None		
-Model	No Power model		
-Q plateau set at age	7		
-Survivors estimates shrunk towards mean F	5 years / 5 ages		
-s.e. of the means	2.0		
-Min s.e. for pop. Estimates	0.3		
-Prior weighting	None		

The final XSA output is given in Table 9.3.2 (fishing mortalities) and Table 9.3.3 (stock numbers). A summary of the XSA results is given in Table 9.3.4 and trends in yield, fishing mortality, recruitment and spawning stock biomass are shown in Figure 9.3.3.

Retrospective patterns for the final run are shown in Figure 9.3.4. There is good consistency between estimates in successive years. The upward revision of the 2007 year class by almost 200% from the weakest in the time series to a below average strength is due to the availability in this year's assessment of 2 commercial fleet (BEL-BT and

UK-BT) estimates for that year class. Both commercial fleets as well as one survey estimating the strength of the 2007 year class as just below average.

Fishing mortality for 2008 have been revised downward by 5% SSB upward by 4% respectively.

9.4 Historical Stock Trends

Trends in landings, SSB, F(3-8) and recruitment are presented Table 9.3.4 and Figure 9.3.3.

For most of the time series, fishing mortality has been fluctuating between Fpa (0.4) and Flim (0.57). In the early 90's it dropped below Fpa. Since 1999 it decreased steadily from 0.55 to around 0.4 in 2001 after which it remained stable until 2005. In the last 4 years fishing mortality has increased again above the Fpa value.

Recruitment has fluctuated around 25 million recruits with occasional strong year classes. Four of the highest values in the time series have been recorded in the last 8 years.

The spawning stock biomass has been stable for most of the time series. Since 2001 SSB has increased due to average and above average year classes to well above Bpa (8000 t).

9.5 Recruitment estimates

The 2007 year class in 2008 was estimated in last year's assessment, by XSA to be below average at 9 million fish. This year's assessment has revised the 2007 year class upwards to 27 million fish. This strong revision is mainly due to the availability in this year's assessment of survivor estimates from two commercial fleets and an upward revision by the UK-BTS survey for that year class. 91% of the weight estimate comes from the tuning fleets, giving rather similar results. The XSA survivor estimates for this year class were used for further prediction.

The 2008 year class in 2009 was estimated by XSA to be 158 million one year olds which is by far the highest in the time series. Although both survivor estimates from the two surveys indicate exceptional year class strength, they do differ substantially in magnitude (121 million and 300 million) with high internal standard errors of 0.87 and 0.93 respectively. The weak shrinkage with a survivor estimate of 10 million fish has only a weighting of 9% in the survivor estimates of that year class, and therefore little impact on the final survivors estimates. The Working group decided not to accept the XSA estimates for that year class. RCT3 runs were carried out. Input to the RCT3 model is given in Table 9.5.1 and results are presented in Table 9.5.2a-b. The RCT3 estimates for the 2008 year class at age 1 are 47 million fish, and were taken forward in the predictions. The estimate at age 1 was reduced with fishing mortality and natural mortality to obtain the estimate at age 2 for the prediction.

The long term GM recruitment (23 million, 1982-2007) was assumed for the 2009 and subsequent year classes.

Although the RCT3 results for the 2009 year class are not used for prediction, it should be noted that the French Young fish survey (YFS-FR) at age 0 (not included in the XSA) confirms an average 2009 year class.

The working group estimates of year class strength used for prediction can be summarised as follows:

Year class	At age in 2010	**XSA**	**GM 82-07**	**RCT3**	Accepted Estimate
2007	3	18983	15589	-	XSA
2008	2	142680	21010	42897*	RCT3
2009	1	-	23382	24831	GM 1982-07
2010 & 2011	recruits	-	23382	-	GM 1982-07

*** 47475 reduced with fishing mortality and natural mortality**

Investigations for possible Fmsy candidates for this stock were done with the ADMB PLOTMSY program (Section 1.3.1) . The inputs are the standard SEN and SUM files, used to produce the standard graphs. The results are shown in Table 9.5.3 and Figures 9.5.1-3. The working group decided that the use of a "smooth hockey stick" was the best option as a stock/recruitment relationship for this stock (Figure 9.5.1.). It should be noted however that there are no observations below 8000 tonnes SSB, and therefore the trajectory of the hockey stick assumption are conservative. The analysis also show that Fmax is poorly defined (Figure 9.5.2) and that Fmsy candidates at or below 0.29 may be appropriate for sole in VIId.

9.6 Short term forecasts

The short term prognosis was carried out according to the specifications in the stock annex. As fishing mortality has fluctuated in the last three years, the selection pattern for prediction has been taken as a 3 year unscaled average. Weights at age in the catch and in the stock are averages for the years 2007-2009.

Input to the short term predictions and the sensitivity analysis are presented in Table 9.6.1. Results are presented in Table 9.6.2 (management options) and Table 9.6.3 (detailed output).

Assuming *status quo* F, implies a catch in 2010 of 5240t (the agreed TAC is 4219t) and a catch of 5580t in 2011. Assuming *status quo* F will result in a SSB in 2011 and 2012 of 13420t and 12070t respectively.

Assuming *status quo* F, the proportional contributions of recent year classes to the landings in 2011 and SSB in 2012 are given in Table 9.6.4. The assumed GM recruitment accounts for 11 % of the landings in 2011 and 25 % of the 2012 SSB.

Results of a sensitivity analysis are presented in Figure 9.6.1 (probability profiles). The approximate 90% confidence intervals of the expected status quo yield in 2011 are 3500t and 8500t. There is about 8% probability that at current fishing mortality SSB will fall below the B_{pa} of 8000t in 2012.

9.7 Medium-term forecasts and Yield per recruit analyses

This year, no Medium-term forecasts were carried out for this stock.

Yield-per-recruit results, long-term yield and SSB, conditional on the present exploitation pattern and assuming *status quo* F in 2010, are given in Table 9.7.1 and Figure 9.7.1. F_{max} is calculated by this year's assessment to be 0.28(0.48 = F_{sq}).

9.8 Biological reference points

		Basis
Flim	0.55	Fishing mortality at or above which the stock has shown continued decline.
Fpa	0.40	F is considered to provide approximately 95% probability of avoiding Flim
Blim	-	Not defined
Bpa	8000	Lowest observed biomass at which there is no indication of impaired recruitment.
Fmax	0.28- 0.30	Using MFDP program Using PLOTMSY program
Fmsy	0.29	PLOTMSY program
F2009	0.51	
Fsq	0.48	

9.9 Quality of the assessment

- Revisions in 2008 landings for UK (E&W) together with the income of 2 commercial tuning series to estimate the 2007 year class (see section 9.2.5) resulted in an downward revision of fishing mortality in 2008 by 5% and a upward revision of SSB by 3%. Recruitment in 2008 was revised upward by 197%.
- The trends and estimates of fishing mortality, SSB and recruitment were consistent with last year's assessment apart from the upward revision of the 2008 year class by 197% from one of the weakest year classes in the time series to a just below average value.
- Except year classes 2002, 2003 and 2006, all year classes from 1998 are estimated to be at or above long term average which explains the increase in SSB since 1998. Year class 2008 is predicted by two surveys to be the by far the highest in the time series. The Working Group however decided not to use the XSA estimates for prediction but the more conservative RCT3 estimates.
- Information available on discards for 2009 suggest, as in previous years that discards are not substantial and therefore discards are not incorporated in the assessment. Discard information from French otter trawls suggest however that some discarding of 1 year old sole is taking place in the first two quarters of the year. Although the observed discarding at age 1 will not affect the assessment substantially, they will have an impact on forecasts, but the low level of discards are not considered a significant factor in catch forecasts.
- The UK component of the YFS index is not available for 2007, 2008 and 2009, resulting in the unavailability of the combined YFS-index. This combined index has been estimating the incoming year class strength very consistently, hereby providing reliable estimates to the forecasts. Although results of using the YFS indices separately (YFS-FR for 1987-present and YFS-UK for 1987-2006), did not show apparent changes in retrospective patterns, it was noted that the lack of information from the UK YFS will affect the quality of the recruitment estimates and therefore the forecast.

- The use of a more realistic effort correction for Belgian beam trawl fleet is likely to improve the tuning results for that fleet. These effort corrections should be implemented at the next update assessment.
- There is no apparent stock/recruitment relationship for this stock and no evidence of reduced recruitment at low levels of SSB (Figure 9.9.1). However to identify possible candidates for Fmsy, the Working Group decided to use a smooth hockey stick as the most appropriate stock/recruitment relationship.
- The historical performance of this assessment is rather noisy (Figure 9.9.2) but has been more constant in recent years.
- There is misreporting from adjacent areas. The Working group has addressed this by modifying landings data accordingly. Since 2002 the UK(E&W) beam trawl landings from two rectangles 28E8 and 29E8 (in VIId) were re-allocated to VIIe on a quarterly basis, (based on information provided to the Working Group by the fishing industry) and the age compositions raised accordingly. This was done back to 1986. For VIId sole, UK(E&W) beam trawl and otter trawl data are processed together (as trawl), so the landings from these two rectangles were removed from the trawl data on a quarterly basis, and the age compositions adjusted to take that into account.
- Sampling for sole landings in division VIId are considered to be at a reasonable level.

9.10 Status of the Stock

Fishing mortality has been stable between 2000 and 2005 around Fpa. In the last 4 years fishing mortality has increased to values between Fpa (0.4) and Flim (0.57).

The spawning stock biomass has been stable for most of the time series and SSB is presently well above Bpa. The strong 2004 and 2005 year class increased SSB to around record high level of the time series in 2008. The potentially very strong 2008 year class could even increase SSB in the future.

9.11 Management Considerations

- There is misreporting from adjacent areas. The Working group has addressed this by modifying landings data accordingly. Since 2002 the UK(E&W) beam trawl landings from two rectangles 28E8 and 29E8 (in VIId) were re-allocated to VIIe on a quarterly basis, (based on information provided to the Working Group by the fishing industry) and the age compositions raised accordingly.
- There is a less than 10% probability that SSB will decrease to B_{pa} in the short term due to the strong 2008 year class.
- EU Council Regulation (EC) N°53/2010 allocates different amounts of Kw*days by Member State and area to different effort groups of vessels depending on gear and mesh size. The new regime has not reduced effort directed at sole in this area in 2010.
- Due to the minimum mesh size (80 mm) in the mixed beam trawl fishery, a large number of (undersized) plaice are discarded. The 80-mm mesh size is not matched to the minimum landing size of plaice. Measures to reduce discarding of plaice in the sole fishery would greatly benefit the plaice

stock and future yields. Mesh enlargement would reduce the catch of undersized plaice, but would also result in short-term loss of marketable sole. An increase in the minimum landing size of sole could provide an incentive to fish with larger mesh sizes and therefore mean a reduction in the discarding of plaice.

Table 9.2.1 Sole VIId. Nominal landings (tonnes) as officially reported to ICES and used by the Working Group

Year	Belgium	France	UK(E+W)	others	reported	Unallocated*	Total used by WG	TAC
1974	159	383	309	3	854	30	884	
1975	132	464	244	1	841	41	882	
1976	203	599	404	.	1206	99	1305	
1977	225	737	315	.	1277	58	1335	
1978	241	782	366	.	1389	200	1589	
1979	311	1129	402	.	1842	373	2215	
1980	302	1075	159	.	1536	387	1923	
1981	464	1513	160	.	2137	340	2477	
1982	525	1828	317	4	2674	516	3190	
1983	502	1120	419	.	2041	1417	3458	
1984	592	1309	505	.	2406	1169	3575	
1985	568	2545	520	.	3633	204	3837	
1986	858	1528	551	.	2937	995	3932	
1987	1100	2086	655	.	3841	950	4791	3850
1988	667	2057	578	.	3302	551	3853	3850
1989	646	1610	689	.	2945	860	3805	3850
1990	996	1255	785	.	3036	611	3647	3850
1991	904	2054	826	.	3784	567	4351	3850
1992	891	2187	706	10	3794	278	4072	3500
1993	917	2322	610	13	3862	437	4299	3200
1994	940	2382	701	14	4037	346	4383	3800
1995	817	2248	669	9	3743	677	4420	3800
1996	899	2322	877	.	4098	699	4797	3500
1997	1306	1702	933	.	3941	823	4764	5230
1998	541	1703	803	.	3047	316	3363	5230
1999	880	2251	769	.	3900	235	4135	4700
2000	1021	2190	621	.	3832	-356	3476	4100
2001	1313	2482	822	.	4617	-592	4025	4600
2002	1643	2780	976	.	5399	-666	4733	5200
2003	1657	3475	1114	1	6247	-1209	5038	5400
2004	1485	3070	1112	.	5667	-841	4826	5900
2005	1221	2832	567	.	4620	-236	4384	5700
2006	1547	2627	678	.	4852	-18	4834	5720
2007	1530	2981	801	1	5313	-147	5166	6220
2008	1368	2880	724	.	4972	-455	4517	6593
2009	1475	n/a **	753	.	2228	2741	4969	5274

* Unallocated mainly due misreporting

** Preliminary

Table 9.2.2 - Sole VIId - Landing numbers at age (kg)

Run title : Sole in VIId - 2010WG - Sol7d.txt

At 23/04/2010 15:00

Table 1 Catch numbers at age Numbers*10**-3

YEAR	1982	1983	1984	1985	1986	1987	1988	1989
AGE								
1	155	0	24	49	49	9	95	163
2	2625	852	1977	3693	1251	3117	2162	3484
3	5256	3452	3157	5211	5296	3730	7174	3220
4	1727	3930	2610	1646	3195	3271	1602	4399
5	570	897	1900	1027	904	2053	1159	1434
6	653	735	742	1860	768	1042	856	840
7	549	627	457	144	1056	1090	388	571
8	240	333	317	158	155	784	255	201
9	122	108	136	156	190	111	256	166
10	83	89	99	69	212	163	83	224
+gp	202	193	238	128	372	459	275	282
0 TOTALNUM	12182	11216	11657	14141	13448	15829	14305	14984
TONSLAND	3190	3458	3575	3837	3932	4791	3853	3805
SOPCOF %	97	99	99	100	100	100	100	100

Table 1 Catch numbers at age Numbers*10**-3

YEAR	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
AGE										
1	1245	383	105	85	31	838	9	24	33	168
2	2851	7166	4046	5028	694	2977	1825	1489	1376	3268
3	5580	4105	8789	6442	6203	4375	7764	6068	5609	8506
4	1151	4160	1888	5444	5902	4765	3035	5008	2704	3307
5	1496	604	1993	1008	3404	2968	3206	2082	1636	1311
6	301	996	288	563	584	1980	1823	1670	609	869
7	390	257	368	162	567	375	1283	916	558	350
8	260	247	135	188	109	278	271	775	441	672
9	129	258	171	116	147	88	319	239	354	351
10	126	92	95	62	93	106	112	169	239	192
+gp	489	382	231	129	258	241	344	267	301	359
0 TOTALNUM	14018	18650	18109	19227	17992	18991	19991	18707	13860	19353
TONSLAND	3647	4351	4072	4299	4383	4420	4797	4764	3363	4135
SOPCOF %	100	100	100	100	100	100	100	100	100	100

Table 1 Catch numbers at age Numbers*10**-3

YEAR	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
AGE										
1	138	168	707	379	1030	206	608	175	149	216
2	3586	6042	7011	10957	4254	3468	7370	6511	2702	2911
3	4852	6194	7513	5086	8623	4034	3753	7316	8516	4303
4	4395	1595	3767	3178	2545	5458	2821	2990	4145	6886
5	1076	2491	1414	1805	2272	1543	3433	1500	1267	2440
6	505	728	655	671	1108	1143	1103	2038	849	714
7	319	290	298	588	371	633	796	751	751	517
8	148	128	129	198	448	218	403	467	356	613
9	328	56	97	70	94	283	191	257	164	226
10	150	81	57	88	88	127	208	162	134	220
+gp	248	265	197	245	233	271	307	230	247	386
0 TOTALNUM	15745	18038	21845	23265	21066	17384	20993	22397	19280	19432
TONSLAND	3476	4025	4733	5038	4826	4383	4833	5166	4517	4969
SOPCOF %	100	100	100	100	100	100	100	100	100	100

Table 9.2.3 - Sole VIId - Catch weights at age (kg)

Run title : Sole in VIId - 2010WG - Sol7d.txt

At 23/04/2010 15:00

Table 2 Catch weights at age (kg)

YEAR	1982	1983	1984	1985	1986	1987	1988	1989
AGE								
1	0.102	0.000	0.100	0.090	0.135	0.095	0.102	0.106
2	0.171	0.173	0.178	0.182	0.180	0.175	0.152	0.154
3	0.225	0.230	0.234	0.230	0.212	0.236	0.226	0.192
4	0.312	0.302	0.314	0.281	0.306	0.295	0.278	0.271
5	0.386	0.404	0.380	0.368	0.363	0.353	0.36	0.293
6	0.428	0.436	0.436	0.394	0.387	0.407	0.409	0.358
7	0.439	0.435	0.417	0.516	0.437	0.411	0.459	0.388
8	0.509	0.524	0.538	0.543	0.520	0.482	0.514	0.472
9	0.502	0.537	0.529	0.594	0.502	0.465	0.553	0.515
10	0.463	0.583	0.565	0.595	0.523	0.538	0.563	0.547
+gp	0.6729	0.6283	0.7135	0.8005	0.6015	0.6176	0.6647	0.7014
0 SOPCOFAC	0.9713	0.991	0.9884	0.998	1.0006	1.0004	1.0001	0.9994

Table 2 Catch weights at age (kg)

YEAR	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
AGE										
1	0.120	0.114	0.103	0.085	0.099	0.129	0.142	0.139	0.132	0.130
2	0.178	0.161	0.153	0.147	0.150	0.176	0.165	0.153	0.159	0.151
3	0.238	0.208	0.203	0.197	0.186	0.179	0.178	0.188	0.172	0.189
4	0.289	0.266	0.267	0.247	0.235	0.230	0.229	0.233	0.235	0.215
5	0.349	0.354	0.290	0.335	0.288	0.255	0.269	0.292	0.286	0.260
6	0.339	0.394	0.403	0.384	0.355	0.333	0.324	0.343	0.343	0.280
7	0.470	0.421	0.391	0.537	0.381	0.357	0.361	0.390	0.383	0.290
8	0.465	0.430	0.462	0.553	0.505	0.385	0.405	0.404	0.417	0.341
9	0.487	0.434	0.459	0.515	0.484	0.490	0.435	0.503	0.484	0.358
10	0.518	0.478	0.463	0.766	0.496	0.494	0.465	0.474	0.435	0.374
+gp	0.5621	0.5656	0.5661	0.6666	0.6156	0.6536	0.5854	0.6509	0.6162	0.5354
0 SOPCOFAC	0.9995	1.0001	1.0001	1.0002	1.0001	0.9997	0.9999	1	1.0013	0.9992

Table 2 Catch weights at age (kg)

YEAR	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
AGE										
1	0.145	0.108	0.120	0.114	0.120	0.135	0.139	0.163	0.148	0.144
2	0.142	0.152	0.162	0.170	0.179	0.172	0.162	0.190	0.164	0.177
3	0.176	0.211	0.204	0.208	0.205	0.208	0.192	0.202	0.201	0.197
4	0.223	0.283	0.253	0.257	0.255	0.253	0.249	0.227	0.244	0.255
5	0.332	0.288	0.316	0.277	0.296	0.303	0.284	0.276	0.262	0.279
6	0.377	0.334	0.375	0.357	0.304	0.337	0.328	0.294	0.321	0.356
7	0.424	0.367	0.376	0.381	0.348	0.368	0.353	0.315	0.435	0.322
8	0.427	0.374	0.393	0.438	0.403	0.433	0.402	0.378	0.411	0.455
9	0.384	0.493	0.469	0.482	0.492	0.570	0.457	0.441	0.377	0.415
10	0.459	0.511	0.420	0.494	0.509	0.445	0.450	0.439	0.498	0.472
+gp	0.68	0.5445	0.5308	0.5274	0.525	0.5369	0.557	0.5206	0.5127	0.6326
0 SOPCOFAC	1.0009	1.0005	0.9995	1.0002	0.9983	0.9989	1	1.0026	0.9991	0.9994

Table 9.2.4 - Sole VIId - Stock weights at age (kg)

Run title : Sole in VIId - 2010WG - Sol7d.txt

At 23/04/2010 15:00

Table 3 Stock weights at age (kg)

YEAR	1982	1983	1984	1985	1986	1987	1988	1989
AGE								
1	0.059	0.070	0.067	0.065	0.070	0.072	0.05	0.05
2	0.114	0.135	0.131	0.129	0.136	0.139	0.145	0.113
3	0.167	0.197	0.192	0.192	0.198	0.203	0.223	0.182
4	0.217	0.255	0.249	0.254	0.256	0.262	0.268	0.269
5	0.263	0.309	0.304	0.315	0.309	0.318	0.365	0.323
6	0.306	0.359	0.355	0.376	0.358	0.370	0.425	0.335
7	0.347	0.406	0.403	0.436	0.403	0.417	0.477	0.48
8	0.384	0.448	0.448	0.495	0.443	0.461	0.498	0.504
9	0.418	0.487	0.490	0.554	0.480	0.500	0.572	0.586
10	0.4500	0.5220	0.5290	0.6110	0.5120	0.5360	0.636	0.536
+gp	0.53	0.6008	0.6265	0.7798	0.5761	0.6156	0.7498	0.7135

Table 3 Stock weights at age (kg)

YEAR	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
AGE										
1	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050
2	0.138	0.138	0.144	0.130	0.116	0.126	0.155	0.139	0.140	0.128
3	0.232	0.225	0.199	0.189	0.161	0.129	0.176	0.165	0.158	0.180
4	0.305	0.279	0.277	0.246	0.215	0.220	0.258	0.220	0.233	0.205
5	0.400	0.380	0.305	0.366	0.273	0.234	0.286	0.264	0.299	0.253
6	0.361	0.384	0.454	0.377	0.316	0.333	0.308	0.317	0.374	0.277
7	0.476	0.410	0.405	0.545	0.368	0.357	0.366	0.376	0.363	0.298
8	0.535	0.449	0.459	0.560	0.530	0.330	0.391	0.404	0.357	0.324
9	0.571	0.474	0.430	0.559	0.461	0.614	0.438	0.563	0.450	0.336
10	0.507	0.451	0.528	0.813	0.470	0.382	0.466	0.494	0.372	0.323
+gp	0.5765	0.6203	0.5269	0.5664	0.6122	0.6292	0.6304	0.6536	0.5768	0.5118

Table 3 Stock weights at age (kg)

YEAR	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
AGE										
1	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050
2	0.122	0.127	0.136	0.151	0.137	0.157	0.161	0.163	0.158	0.169
3	0.148	0.157	0.179	0.207	0.185	0.203	0.185	0.195	0.191	0.186
4	0.208	0.216	0.209	0.249	0.236	0.241	0.246	0.239	0.250	0.244
5	0.402	0.226	0.258	0.314	0.265	0.267	0.272	0.286	0.294	0.279
6	0.440	0.223	0.254	0.376	0.267	0.309	0.326	0.297	0.368	0.351
7	0.395	0.231	0.301	0.399	0.273	0.349	0.339	0.340	0.401	0.353
8	0.554	0.253	0.234	0.418	0.331	0.401	0.394	0.400	0.476	0.435
9	0.443	0.256	0.326	0.446	0.504	0.608	0.416	0.433	0.463	0.439
10	0.420	0.301	0.404	0.444	0.409	0.425	0.461	0.446	0.402	0.486
+gp	0.6822	0.4204	0.4170	0.5032	0.4501	0.5602	0.5553	0.5182	0.5663	0.6596

Table 9.2.5a **Sole in VIId. Indices of effort**

Year	France Beam trawl[1]	France GTR_Demersal_fish[4]	France OTB_Demersal_fish[4]	France TBB_Demersal_fish[4]	England & Wales Beam trawl[2]	Belgium Beam trawl[3]
1971						
1972						
1973						
1974						
1975						5.02
1976						6.56
1977						6.87
1978						8.22
1979						7.30
1980						12.81
1981						19.00
1982						23.94
1983						23.64
1984						28.00
1985						25.29
1986					2.79	23.54
1987					5.64	27.11
1988					5.09	38.52
1989					5.65	35.67
1990					7.27	30.33
1991	10.69				7.67	24.29
1992	10.52				8.78	21.99
1993	10.22				6.40	20.02
1994	10.61				5.43	25.17
1995	12.38				6.89	24.17
1996	14.09				10.31	25.00
1997	10.92				10.25	30.89
1998	11.71				7.31	18.12
1999	10.63				5.86	21.39
2000	13.78				5.65	30.54
2001	11.38				7.64	32.39
2002		14.91	23.88	4.06	7.90	33.68
2003		15.35	23.18	4.16	6.69	47.50
2004		15.07	21.16	4.00	4.87	41.60
2005		16.60	17.57	3.16	6.00	35.80
2006		16.87	20.74	3.68	5.94	48.80
2007		17.18	20.72	3.39	5.00	57.90
2008		13.16	16.43	3.44	6.21	48.50
2009		n/a	n/a	n/a	6.22	45.27

[1]in Kg/1000 h*KW-04

[1] Beam trawl >= 10m in millions hp hrs >10% sole

[3]Fishing hours (x 10^3) corrected for fishing power using P = 0.000204 BHP^1.23

[4] Days at sea (x 10^3)

Table 9.2.5b Sole in VIId. LPUE indices

Year	France[1] Beam trawl	France GTR_Demersal_fish[4]	France OTB_Demersal_fish[4]	France TBB_Demersal_fish[4]	England & Wales[2] Beam trawl	Belgium[3] Beam trawl
1971						
1972						
1973						
1974						
1975						24.09
1976						27.28
1977						29.99
1978						26.27
1979						37.42
1980						23.26
1981						24.52
1982						23.65
1983						22.37
1984						21.61
1985						22.90
1986					39.48	33.48
1987					32.82	36.56
1988					27.67	15.89
1989					26.59	16.82
1990					26.88	25.94
1991	18.52				22.09	22.56
1992	18.12				25.29	29.11
1993	21.60				23.75	34.77
1994	17.78				31.83	27.89
1995	18.46				28.39	24.70
1996	19.79				25.79	29.80
1997	14.41				25.40	32.57
1998	17.33				25.71	23.51
1999	30.40				27.29	26.41
2000	19.10				27.46	24.49
2001	46.10				26.58	24.58
2002		101.29	30.39	152.67	31.63	27.33
2003		111.29	31.43	142.72	32.81	33.13
2004		102.13	26.96	132.65	38.80	30.86
2005		101.53	27.47	124.39	40.51	31.97
2006		90.48	30.39	90.06	39.01	27.47
2007		99.68	32.31	110.72	35.58	23.43
2008		107.17	34.39	116.23	37.51	24.58
2009		n/a	n/a	n/a	29.08	29.27

[1] in h*KW-04

[2] in Kg/1000 HP*HRS >10% sole

[3] in Kg/hr corrected for fishing power using P = 0.000204 BHP^1.23

[4] in Kilos/days at sea

Table 9.2.6 - Sole VIId - tuning files

Bolded numbers = used in XSA

SOLE 7d,TUNING - Tun7d.txt - 2010WG

105	1													
BEL BT														
1980	2009													
1	1	0	1											
2	15													
12.8	69.3	46.1	298.7	189.6	57.4	24.7	10.3	5.1	8.6	3.1	5.5	2.4	2.6	37.9
19.0	640.7	161.4	82.1	312.8	229.6	44.7	32.9	33.1	6.9	9.0	18.4	9.3	0.8	51.9
23.9	148.7	980.9	128.0	93.4	155.9	112.6	38.8	60.1	15.2	14.0	7.4	12.5	5.9	54.3
23.6	190.4	373.0	818.9	65.5	54.0	81.7	73.2	23.5	20.2	27.0	5.0	1.0	7.1	33.0
28.0	603.8	347.2	311.2	436.0	53.7	38.5	104.9	59.9	25.4	23.2	25.3	9.0	8.2	42.4
25.3	382.9	612.1	213.0	209.1	260.2	58.2	34.1	48.0	31.0	16.9	19.6	9.2	7.7	21.3
23.4	215.0	1522.3	675.0	233.7	170.6	194.0	30.1	53.1	64.2	32.6	12.7	2.6	43.0	29.3
27.1	843.6	451.0	739.3	724.4	344.5	232.4	152.7	25.3	86.5	56.0	56.1	54.5	9.3	109.0
38.5	131.6	990.4	243.3	362.9	216.7	111.8	41.8	73.8	47.0	9.8	22.3	35.8	8.6	25.3
35.7	47.5	512.6	543.6	748.0	276.6	225.0	53.1	36.4	12.7	4.7	0.0	0.0	4.7	27.0
30.3	1011.4	1375.2	218.1	366.2	85.3	198.2	65.5	39.0	22.4	22.2	25.4	2.8	24.0	18.2
24.3	320.2	1358.6	710.1	125.6	283.9	60.6	56.2	21.0	19.8	22.2	18.0	5.6	0.3	21.4
22.0	499.3	1613.7	523.3	477.7	36.9	67.9	28.2	31.7	11.2	11.4	6.0	5.7	3.2	16.7
20.0	1654.5	1520.4	889.5	215.5	78.5	38.9	40.8	37.8	11.3	8.7	13.3	1.5	3.0	22.4
22.2	196.9	1183.2	1598.5	912.9	201.0	160.0	39.5	33.8	46.2	16.0	10.2	14.9	8.8	18.6
24.2	206.2	542.7	671.3	590.9	409.4	100.6	40.3	25.4	14.2	9.3	5.0	11.9	3.4	8.0
25.0	284.1	975.5	628.7	560.1	354.3	316.8	68.3	77.6	34.2	26.2	15.8	10.8	1.1	4.2
30.9	196.0	1282.3	966.1	500.2	422.3	301.1	144.7	56.6	29.3	25.8	12.1	12.6	3.4	1.4
18.1	254.1	450.3	375.4	175.1	54.8	116.1	95.9	59.1	12.4	16.0	7.7	2.9	4.4	19.2
21.4	367.7	1043.6	640.2	308.3	94.6	48.7	90.6	68.3	28.2	44.7	22.9	4.7	8.5	11.3
30.5	569.1	1170.7	1225.1	239.1	139.4	68.4	66.6	74.4	46.0	26.9	7.6	6.6	0.3	1.9
32.4	1055.5	1385.4	375.0	617.9	351.1	105.4	31.6	15.2	18.7	35.5	11.6	6.9	12.3	4.6
33.7	1267.7	1612.6	804.3	286.3	122.4	95.7	45.2	24.8	28.6	15.8	13.8	8.0	6.0	2.6
47.5	2157.2	1848.1	1368.5	737.0	395.3	191.8	97.9	15.0	47.9	33.5	30.8	37.9	0.0	1.2
41.6	959.7	1846.2	778.1	1050.9	331.1	82.3	93.5	30.7	51.2	22	34.8	0.7	8.3	0.7
35.8	1150.8	1156.5	1259.7	309.1	201.7	156.5	74.2	37.9	16.4	44.8	1.3	6.2	0.8	3.3
48.8	1341.0	1050.9	1009.4	885.8	434.9	370.7	147.7	79.2	75.7	35.9	25.4	27.4	19.5	4.1
57.9	1736.5	1888.6	808.5	415.2	550.6	207.8	258.0	117.2	47.6	36.6	21.5	9.2	5.5	31.4
48.5	249.7	1383.2	1435	427.6	217.5	324.1	137.3	75.7	65.6	48.5	7.5	7.0	0.0	24.7
45.3	1095.4	1185.9	1333.6	930.5	280.7	192	169.8	68.1	64.8	42.6	19.4	24.6	4.9	37.9
UK BT														
1986	2009													
1	1	0	1											
2	15													
2.8	30.0	144.8	100.5	28.0	28.8	39.4	1.2	2.4	5.2	2.5	2.8	1.5	1.7	5.3
5.6	251.8	106.0	143.5	99.2	18.6	14.6	37.6	1.4	0.4	3.3	1.1	1.5	3.3	2.4
5.1	112.3	281.3	56.4	62.9	39.6	9.0	11.5	16.2	2.0	0.2	4.6	4.9	0.0	0.2
5.7	162.3	78.1	144.2	18.2	31.7	23.1	5.1	4.2	16.3	1.0	0.6	2.2	2.7	12.9
7.3	112.6	327.4	47.7	66.1	14.1	15.1	15.1	4.1	7.4	22.2	1.9	0.4	3.4	7.6
7.7	349.0	139.2	195.2	8.4	30.7	5.1	7.4	10.9	2.7	1.9	8.4	0.3	0.0	5.0
8.8	240.1	516.6	81.3	167.5	11.1	20.3	6.4	14.6	4.9	2.2	1.5	3.3	0.1	2.5
6.4	174.9	222.5	218.9	34.6	52.7	5.2	10.7	4.5	3.0	3.3	1.1	1.3	2.1	2.8
5.4	33.6	260.9	144.1	113.3	27.5	45.5	4.4	10.5	3.2	4.1	3.7	2.4	1.6	9.3
6.9	181.1	106.9	220.4	107.6	94.6	18.3	37.5	5.4	9.4	2.0	4.3	4.4	0.9	7.7
10.3	295.8	251.3	79.5	169.0	84.6	67.4	17.5	33.2	4.1	8.8	4.2	5.4	3.6	11.9
10.3	268.5	331.1	158.5	42.4	125.2	50.8	48.7	11.6	23.0	2.7	7.1	1.1	3.8	7.6
7.3	252.6	169.4	97.5	65.2	22.1	51.7	28.8	22.4	5.8	12.5	2.0	5.3	1.5	9.0
5.9	170.0	300.0	105.6	43.6	31.8	12.3	26.3	12.9	7.3	3.4	3.8	0.7	2.5	4.1
5.7	152.1	178.8	171.4	54.7	25.8	18.2	6.9	21.6	9.7	5.7	2.3	4.2	0.6	7.9
7.6	284.3	268.0	101.0	111.9	44.0	19.0	19.6	5.8	14.7	12.1	5.0	1.4	3.0	4.7
7.9	314.6	449.0	222.2	71.7	54.9	22.9	18.6	6.0	3.1	5.2	2.3	2.4	0.4	2.9
6.7	386.0	220.8	149.5	64.8	27.2	32.0	15.0	5.6	5.8	0.9	4.2	2.8	1.9	5.1
4.9	111.9	440.4	103.2	62.2	32.6	9.6	18.2	4.3	3.2	2.9	0.5	3.3	1.2	4.2
6.0	170.7	178.3	376.4	69.4	72.3	35.4	17.4	15.6	11.2	4.3	7.9	2.7	3.2	10.9
5.9	395.2	350.5	113.5	189.0	31.7	28.1	13.6	9.0	5.4	2.8	0.8	1.5	0.3	2.9
5.0	167.8	303.7	114.9	34.6	102.8	24.0	23.6	9.4	1.3	4.1	2.8	0.9	1.8	6.0
6.2	152.5	612.9	184.7	40.7	24.7	34.2	12.6	4.4	6.4	4.6	1.3	2.3	0.1	3.6
6.2	286.8	112.3	270.0	97.8	15.2	12.3	26.3	7.6	13.7	2.7	0.3	1.8	1.9	0.9

Table 9.2.6 - Sole VIId - tuning files - continued

Bolded numbers = used in XSA

UK BTS						
1988	**2009**					
1	**1**	**0.5**	**0.75**			
1	**6**					
1	**8.20**	**14.20**	**9.90**	**0.80**	**1.30**	**0.60**
1	**2.60**	**15.40**	**3.40**	**1.70**	**0.60**	**0.20**
1	**12.10**	**3.70**	**3.40**	**0.70**	**0.80**	**0.20**
1	**8.90**	**22.80**	**2.20**	**2.30**	**0.30**	**0.50**
1	**1.40**	**12.00**	**10.00**	**0.70**	**1.10**	**0.30**
1	**0.50**	**17.50**	**8.40**	**7.00**	**0.80**	**1.00**
1	**4.80**	**3.20**	**8.30**	**3.30**	**3.30**	**0.20**
1	**3.50**	**10.60**	**1.50**	**2.30**	**1.20**	**1.50**
1	**3.50**	**7.30**	**3.80**	**0.70**	**1.30**	**0.90**
1	**19.00**	**7.30**	**3.20**	**1.30**	**0.20**	**0.50**
1	**2.00**	**21.20**	**2.50**	**1.00**	**0.90**	**0.10**
1	**28.10**	**9.40**	**13.20**	**2.50**	**1.70**	**1.30**
1	**10.49**	**22.03**	**4.15**	**4.24**	**1.03**	**0.58**
1	**9.09**	**21.01**	**8.36**	**1.20**	**1.91**	**0.54**
1	**31.76**	**11.42**	**5.42**	**3.45**	**0.27**	**0.71**
1	**6.47**	**28.48**	**4.13**	**2.46**	**1.58**	**0.30**
1	**7.35**	**8.49**	**7.71**	**1.57**	**1.45**	**0.99**
1	**25**	**5.04**	**2.86**	**3.47**	**1.63**	**1.02**
1	**6.3**	**29.2**	**2.8**	**2**	**1.9**	**0.3**
1	**2.1**	**21.9**	**12.9**	**1.2**	**0.8**	**1.2**
1	**2.9**	**6.5**	**7.2**	**4.8**	**0.2**	**0.5**
1	**30.5**	**13.3**	**5.4**	**4.3**	**3.8**	**0.4**
YFS-UK						
1981	**2006**					
1	**1**	**0.5**	**0.75**			
0	**1**					
1	0.11	0.45				
1	4.63	0.36				
1	25.45	1.52				
1	4.33	4.04				
1	7.65	2.94				
1	6.45	1.45				
1	16.85	**1.38**				
1	2.59	**1.87**				
1	6.67	**0.62**				
1	6.7	**1.90**				
1	1.81	**3.69**				
1	2.26	**1.50**				
1	14.19	**1.33**				
1	13.07	**2.68**				
1	7.53	**2.91**				
1	1.85	**0.57**				
1	4.23	**1.12**				
1	7.97	**1.12**				
1	2.63	**1.47**				
1	1.16	**2.47**				
1	4.75	**0.38**				
1	4.45	**4.15**				
1	4.55	**1.44**				
1	6.98	**2.72**				
1	9.97	**4.07**				
1	3.09	**2.21**				
YFS-FR						
1987	**2009**					
1	**1.00**	**0.50**	**0.75**			
0	1					
1	0.75	**0.07**				
1	0.04	**0.17**				
1	17.43	**0.14**				
1	0.57	**0.54**				
1	1.04	**0.38**				
1	0.48	**0.22**				
1	0.27	**0.03**				
1	4.04	**0.70**				
1	3.50	**0.28**				
1	0.28	**0.15**				
1	0.07	**0.03**				
1	10.52	**0.10**				
1	2.84	**0.35**				
1	2.41	**0.31**				
1	4.32	**1.21**				
1	0.94	**0.11**				
1	0.21	**0.32**				
1	7.29	**0.15**				
1	0.05	**0.82**				
1	1.04	**0.83**				
1	0.03	**0.08**				
1	6.58	**0.06**				
1	2.47	**2.78**				

Table 9.3.1 - Sole VIId - XSA diagnostics

Lowestoft VPA Version 3.1

23/04/2010 14:59

Extended Survivors Analysis

Sole in VIId - 2010WG - Sol7d.txt

Catch data for 28 years. 1982 to 2009. Ages 1 to 11.

Fleet	First year	Last year	First age	Last age	Alpha	Beta
BEL BT	1986	2009	2	10	0	1
UK BT	1986	2009	2	10	0	1
UK BTS	1988	2009	1	6	0.5	0.75
YFS-UK	1987	2009	1	1	0.5	0.75
YFS-FR	1987	2009	1	1	0.5	0.75

Time series weights :

Tapered time weighting not applied

Catchability analysis :

Catchability independent of stock size for all ages

Catchability independent of age for ages >= 7

Terminal population estimation :

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

S.E. of the mean to which the estimates are shrunk = 2.000

Minimum standard error for population
estimates derived from each fleet = .300

Prior weighting not applied

Tuning converged after 88 iterations

Regression weights

1	1	1	1	1	1	1	1	1	

Fishing mortalities

Age	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
1	0.005	0.007	0.016	0.019	0.059	0.006	0.016	0.011	0.006	0.001
2	0.174	0.255	0.374	0.325	0.28	0.255	0.26	0.211	0.214	0.136
3	0.579	0.45	0.508	0.452	0.407	0.413	0.428	0.394	0.416	0.546
4	0.526	0.336	0.482	0.371	0.38	0.433	0.502	0.634	0.36	0.618
5	0.383	0.569	0.496	0.397	0.437	0.371	0.472	0.483	0.536	0.331
6	0.381	0.43	0.252	0.411	0.402	0.364	0.439	0.504	0.492	0.583
7	0.377	0.348	0.278	0.335	0.371	0.375	0.412	0.536	0.311	0.559
8	0.39	0.227	0.229	0.269	0.408	0.345	0.385	0.402	0.464	0.399
9	0.359	0.223	0.24	0.168	0.177	0.433	0.51	0.403	0.213	0.535
10	0.243	0.125	0.329	0.318	0.293	0.34	0.581	0.976	0.337	0.434

1

XSA population numbers (Thousands)

YEAR \ AGE	1	2	3	4	5	6	7	8	9	10
2000	3.14E+04	2.36E+04	1.16E+04	1.13E+04	3.55E+03	1.68E+03	1.07E+03	4.82E+02	1.14E+03	7.30E+02
2001	2.63E+04	2.83E+04	1.80E+04	5.88E+03	6.03E+03	2.19E+03	1.04E+03	6.63E+02	2.95E+02	7.23E+02
2002	4.66E+04	2.36E+04	1.98E+04	1.04E+04	3.80E+03	3.09E+03	1.29E+03	6.62E+02	4.78E+02	2.14E+02
2003	2.07E+04	4.15E+04	1.47E+04	1.08E+04	5.79E+03	2.10E+03	2.17E+03	8.83E+02	4.77E+02	3.40E+02
2004	1.90E+04	1.83E+04	2.71E+04	8.45E+03	6.74E+03	3.52E+03	1.26E+03	1.41E+03	6.11E+02	3.65E+02
2005	3.76E+04	1.62E+04	1.25E+04	1.63E+04	5.23E+03	3.94E+03	2.13E+03	7.85E+02	8.46E+02	4.63E+02
2006	4.03E+04	3.39E+04	1.13E+04	7.51E+03	9.59E+03	3.26E+03	2.48E+03	1.32E+03	5.03E+02	4.96E+02
2007	1.65E+04	3.59E+04	2.36E+04	6.69E+03	4.11E+03	5.41E+03	1.90E+03	1.48E+03	8.15E+02	2.73E+02
2008	2.67E+04	1.47E+04	2.63E+04	1.44E+04	3.21E+03	2.30E+03	2.96E+03	1.01E+03	8.98E+02	4.93E+02
2009	1.58E+05	2.40E+04	1.07E+04	1.57E+04	9.10E+03	1.70E+03	1.27E+03	1.96E+03	5.74E+02	6.56E+02

Estimated population abundance at 1st Jan 2010

0.00E+00	1.43E+05	1.90E+04	5.63E+03	7.66E+03	5.91E+03	8.59E+02	6.57E+02	1.19E+03	3.04E+02

Taper weighted geometric mean of the VPA populations:

2.52E+04	2.08E+04	1.57E+04	8.84E+03	4.74E+03	2.68E+03	1.62E+03	9.94E+02	6.11E+02	3.85E+02

Standard error of the weighted Log(VPA populations) :

0.5183	0.3756	0.3648	0.4292	0.4486	0.4624	0.4829	0.4912	0.4714	0.5191

Table 9.3.1 - Sole VIId - XSA diagnostics - continued

Log catchability residuals.

Fleet : BEL BT

Age	1986	1987	1988	1989
1 : at this age				
2	0.02	0.56	-0.74	-2.58
3	0.72	-0.22	-0.44	-0.01
4	0.18	0.36	-0.73	-0.41
5	-0.09	0.58	-0.22	1.02
6	-0.13	0.9	-0.23	0.28
7	-0.2	0.59	0.05	0.34
8	0.02	-0.09	-0.78	-0.07
9	0.79	0.26	-0.74	-0.37
10	0.09	2.29	1.29	-2.09

Age	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
1 : at this age										
2	1.1	-0.78	-0.05	1.29	-0.31	-0.77	-0.13	-0.75	-0.35	0.37
3	0.08	0.82	0.09	0.24	-0.03	-0.3	-0.06	0.37	-0.23	0.03
4	-0.15	0.06	0.39	-0.05	0.56	-0.34	0.27	0.34	0.26	0.51
5	-0.08	-0.03	0.24	-0.03	0.27	-0.07	-0.12	0.47	-0.16	0.46
6	-0.18	0.64	-0.49	-0.86	0.4	0.07	0.12	0.14	-0.27	-0.1
7	0.57	0.08	-0.21	0.02	0.03	-0.02	0.26	0.23	-0.21	0.01
8	-0.25	-0.01	-0.15	-0.23	0.32	-1.1	-0.03	-0.18	0.08	-0.19
9	0.34	-0.65	0	0.7	-0.16	0.21	-0.13	0.06	-0.03	0.01
10	-0.17	0.54	-0.64	-0.52	1.41	-0.73	1.16	-0.95	-0.09	-0.51

Age	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
1 No data for this fleet at this age										
2	0.05	0.46	0.84	0.44	0.56	1.01	0.11	0.12	-0.75	0.27
3	0.42	0.03	0.07	0.14	-0.37	0.09	-0.21	-0.54	-0.77	0.1
4	0.33	-0.35	-0.12	-0.03	-0.21	-0.21	0.06	-0.15	-0.29	-0.27
5	-0.32	0.12	-0.26	-0.12	0.23	-0.62	-0.43	-0.51	-0.03	-0.32
6	0.07	0.69	-0.83	0.46	-0.11	-0.58	0.1	-0.31	-0.21	0.45
7	-0.24	0.14	-0.24	-0.39	-0.54	-0.27	0.15	-0.28	-0.2	0.3
8	0.53	-0.67	-0.35	-0.19	-0.5	-0.03	-0.16	0.13	0.09	-0.33
9	-0.24	-0.59	-0.62	-1.5	-0.89	-0.74	0.25	-0.06	-0.51	0.05
10	-0.32	-1.33	0.37	0.07	0.19	-1.01	0.25	0.38	0	-0.18

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

Age	2	3	4	5	6	7	8	9	10
Mean Log q	-7.0563	-5.8071	-5.6733	-5.564	-5.742	-5.6928	-5.6928	-5.6928	-5.6928
S.E(Log q)	0.8256	0.3653	0.3298	0.3748	0.4546	0.2899	0.3869	0.5591	0.9462

Regression statistics :

Ages with q independent of year class strength and constant w.r.t. time.

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
2	0.85	0.387	7.5	0.23	24	0.71	-7.06
3	1.5	-1.699	3.87	0.34	24	0.53	-5.81
4	0.97	0.175	5.77	0.64	24	0.33	-5.67
5	1.17	-0.812	5.07	0.51	24	0.44	-5.56
6	1.13	-0.536	5.47	0.44	24	0.52	-5.74
7	1	-0.029	5.69	0.73	24	0.3	-5.69
8	1.25	-1.446	5.6	0.61	24	0.42	-5.87
9	1.41	-1.309	5.66	0.31	24	0.73	-5.88
10	-3.21	-5.535	6.9	0.07	24	2.01	-5.71
1							

Fleet : UK BT

Age	1986	1987	1988	1989
1 : at this age				
2	-0.38	0.37	0.56	-0.07
3	0.49	-0.1	0.32	-0.05
4	0.51	0.4	-0.06	0.22
5	0.3	0.54	0.43	-0.48
6	0.39	-0.28	0.27	0.13
7	0.65	-0.3	-0.14	0.22
8	-0.77	0.38	0.26	-0.26
9	0.13	-0.76	0.07	-0.38
10	0.01	-1.21	0.46	0.31

Age	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
1 No data for this fleet at this age										
2	-0.23	-0.1	-0.42	-0.37	-1.23	-0.2	0.23	0.11	-0.01	0.33
3	0.07	-0.31	-0.13	-0.54	-0.14	-0.67	-0.53	0.12	-0.3	0.07
4	-0.13	0.03	-0.44	-0.2	-0.33	-0.09	-0.81	-0.25	-0.07	0.11
5	0.01	-1.21	0.49	-0.34	-0.03	-0.13	-0.05	-0.52	0.14	0.18
6	-0.38	-0.26	-0.6	0.06	-0.01	0.04	-0.25	0.2	-0.09	0.28
7	-0.26	-0.94	-0.19	-0.54	0.49	-0.16	-0.09	-0.13	0.2	0.24
8	0.02	-0.57	-0.4	-0.12	-0.16	0.39	-0.2	0.14	0.09	0.18
9	-0.18	0.15	0.45	0.02	0.38	0.22	0.21	-0.11	0.22	-0.05
10	0.46	0.01	-0.24	-0.4	0.45	0.42	0.23	0.22	0.37	-0.25

Table 9.3.1 - Sole VIId - XSA diagnostics - continued

Age	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
1 : at this age										
2	-0.15	0.04	0.34	0.12	0	0.33	0.44	-0.33	0.25	0.36
3	0.22	-0.17	0.24	-0.03	0.35	0.01	0.8	0.08	0.47	-0.28
4	0.16	-0.1	0.15	-0.17	0.02	0.48	0.09	0.45	-0.18	0.23
5	0.27	0.24	0.19	-0.21	-0.07	0.06	0.51	-0.17	0.05	-0.21
6	0.24	0.23	-0.01	-0.09	-0.11	0.35	-0.24	0.63	-0.16	-0.31
7	0.43	0.18	0.09	0.09	-0.23	0.34	-0.01	0.32	-0.09	-0.15
8	0.26	0.61	0.52	0.2	0.31	0.62	-0.13	0.49	0.06	0.1
9	0.52	0.2	-0.28	-0.21	-0.4	0.47	0.49	0.17	-0.99	0.15
10	0.11	0.18	-0.09	0.23	-0.13	0.7	0.02	-0.44	0.03	0.56

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

Age	2	3	4	5	6	7	8	9	10
Mean Log q	-6.4973	-5.8065	-5.7825	-5.9432	-5.9146	-6.0011	-6.0011	-6.0011	-6.0011
S.E(Log q)	0.3879	0.3503	0.3087	0.3901	0.2881	0.3473	0.3702	0.3833	0.4175

Regression statistics :

Ages with q independent of year class strength and constant w.r.t. time.

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
2	1.07	-0.299	6.25	0.46	24	0.42	-6.5
3	0.95	0.267	6	0.56	24	0.34	-5.81
4	0.93	0.497	6.02	0.69	24	0.29	-5.78
5	0.76	1.819	6.56	0.72	24	0.28	-5.94
6	0.76	2.627	6.38	0.85	24	0.2	-5.91
7	0.76	2.194	6.34	0.8	24	0.25	-6
8	0.81	1.69	6.11	0.78	24	0.28	-5.92
9	0.87	0.93	6.04	0.69	24	0.33	-5.98
10	0.87	0.929	5.93	0.71	24	0.36	-5.92
1							

Fleet : UK BTS

Age	1986	1987	1988	1989
1	99.99	99.99	0.34	-0.38
2	99.99	99.99	1.02	0.19
3	99.99	99.99	0.63	0.6
4	99.99	99.99	-0.31	-0.06
5	99.99	99.99	0.46	0.19
6	99.99	99.99	0.1	-0.79
7 : at this age				
8 : at this age				
9 No data for this fleet at this age				
10 No data for this fleet at this age				

Age	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
1	0.21	0.13	-1.69	-2.03	-0.23	-0.2	-0.2	1.11	-0.71	1.56
2	-0.77	0.1	-0.36	0.07	-1.02	-0.23	-0.26	-0.29	0.37	0.1
3	-0.51	-0.4	0.1	0.03	0.1	-1	-0.36	-0.15	-0.5	0.75
4	0.02	0.03	-0.65	0.59	-0.02	-0.34	-0.8	-0.28	-0.25	0.55
5	-0.12	-0.21	-0.06	0.03	0.42	-0.4	-0.28	-1.19	0.16	1.02
6	-0.27	0.08	0.35	0.32	-0.85	0.23	-0.05	-0.58	-1.09	1.28
7 : at this age										
8 : at this age										
9 : at this age										
10 : at this age										

Age	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
1	0.39	0.43	1.11	0.34	0.57	1.08	-0.36	-0.57	-0.73	-0.16
2	0.54	0.36	0.01	0.33	-0.1	-0.51	0.51	0.14	-0.18	-0.01
3	0.23	0.41	-0.09	-0.09	-0.11	-0.33	-0.24	0.53	-0.14	0.54
4	0.59	-0.14	0.45	0	-0.2	-0.03	0.23	-0.08	0.37	0.33
5	0.32	0.52	-1.02	0.26	0.05	0.38	-0.01	-0.02	-1.13	0.65
6	0.57	0.27	0.09	-0.29	0.38	0.27	-0.72	0.21	0.18	0.31
7 : at this age										
8 : at this age										
9 : at this age										
10 : at this age										

Table 9.3.1 - Sole VIId - XSA diagnostics - continued

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

Age	1	2	3	4	5	6
Mean Log q	-8.3301	-7.3446	-7.7377	-8.0897	-8.1591	-8.2435
S.E(Log q)	0.8662	0.4534	0.4445	0.3777	0.5573	0.5467

Regression statistics :

Ages with q independent of year class strength and constant w.r.t. time.

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
1	0.74	0.943	8.83	0.39	22	0.64	-8.33
2	0.78	1.086	7.94	0.54	22	0.35	-7.34
3	0.93	0.276	7.87	0.44	22	0.42	-7.74
4	0.76	1.809	8.34	0.74	22	0.27	-8.09
5	0.82	0.789	8.22	0.5	22	0.46	-8.16
6	1	0.004	8.24	0.42	22	0.56	-8.24
1							

Fleet : YFS-UK

Age	1986	1987	1988	1989
1	99.99	0.65	0.1	-0.57
2	: at this age			
3	: at this age			
4	: at this age			
5	: at this age			
6	: at this age			
7	: at this age			
8	: at this age			
9	: at this age			
10	: at this age			

Age	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
1	-0.41	0.48	-0.39	0.19	0.43	0.85	-0.78	-0.49	-0.06	-0.16
2	: at this age									
3	: at this age									
4	: at this age									
5	: at this age									
6	: at this age									
7	: at this age									
8	No data for this fleet at this age									
9	No data for this fleet at this age									
10	No data for this fleet at this age									

Age	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
1	0.18	-1.51	0.31	0.07	0.81	0.5	-0.18	99.99	99.99	99.99
2	No data for this fleet at this age									
3	: at this age									
4	: at this age									
5	: at this age									
6	: at this age									
7	No data for this fleet at this age									
8	No data for this fleet at this age									
9	No data for this fleet at this age									
10	No data for this fleet at this age									

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

Age	1
Mean Log q	-9.5644
S.E(Log q)	0.5845

Regression statistics :

Ages with q independent of year class strength and constant w.r.t. time.

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
1	1.24	-0.542	9.42	0.22	20	0.74	-9.56

Table 9.3.1 - Sole VIId - XSA diagnostics - continued

Fleet : YFS-FR

Age		1986	1987	1988	1989
	1	99.99	-0.27	-0.24	0
	2	No data for this fleet at this age			
	3	No data for this fleet at this age			
	4	No data for this fleet at this age			
	5	No data for this fleet at this age			
	6	No data for this fleet at this age			
	7	No data for this fleet at this age			
	8	No data for this fleet at this age			
	9	No data for this fleet at this age			
	10	No data for this fleet at this age			

Age		1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
	1	0.39	0.27	-0.25	-1.54	1.14	0.57	-0.06	-2.05	-0.41	0.47
	2	No data for this fleet at this age									
	3	No data for this fleet at this age									
	4	No data for this fleet at this age									
	5	No data for this fleet at this age									
	6	No data for this fleet at this age									
	7	No data for this fleet at this age									
	8	No data for this fleet at this age									
	9	No data for this fleet at this age									
	10	No data for this fleet at this age									

Age		2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
	1	0.17	1.71	-1.26	0.63	-0.02	0.96	0.91	-0.54	-1.31	0.74
	2	No data for this fleet at this age									
	3	No data for this fleet at this age									
	4	No data for this fleet at this age									
	5	No data for this fleet at this age									
	6	No data for this fleet at this age									
	7	No data for this fleet at this age									
	8	No data for this fleet at this age									
	9	No data for this fleet at this age									
	10	No data for this fleet at this age									

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

Age	1
Mean Log q	-11.6264
S.E(Log q)	0.9108

Regression statistics :

Ages with q independent of year class strength and constant w.r.t. time.

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
1	0.71	1.118	11.21	0.42	23	0.64	-11.63

Terminal year survivor and F summaries :

Age 1 Catchability constant w.r.t. time and dependent on age

Year class = 2008

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
BEL BT	1	0	0	0	0	0	0
UK BT	1	0	0	0	0	0	0
UK BTS	121750	0.886	0	0	1	0.476	0.002
YFS-UK	1	0	0	0	0	0	0
YFS-FR	299762	0.93	0	0	1	0.431	0.001
F shrinkage mean	10411	2				0.093	0.02

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
142680	0.61	0.69	3	1.136	0.001

Table 9.3.1 - Sole VIId - XSA diagnostics - continued

Age 2 Catchability constant w.r.t. time and dependent on age

Year class = 2007

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
BEL BT	24871	0.843	0	0	1	0.093	0.106
UK BT	27121	0.396	0	0	1	0.421	0.097
UK BTS	16132	0.411	0.297	0.72	2	0.391	0.158
YFS-UK	1	0	0	0	0	0	0
YFS-FR	5100	0.93	0	0	1	0.076	0.434
F shrinkage mean	9990	2				0.019	0.245

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
18983	0.26	0.22	6	0.859	0.136

Age 3 Catchability constant w.r.t. time and dependent on age

Year class = 2006

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
BEL BT	5522	0.342	0.29	0.85	2	0.258	0.555
UK BT	5273	0.267	0.26	0.97	2	0.402	0.575
UK BTS	6493	0.307	0.297	0.97	3	0.298	0.489
YFS-UK	1	0	0	0	0	0	0
YFS-FR	3289	0.93	0	0	1	0.029	0.809
F shrinkage mean	8012	2				0.013	0.413

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
5633	0.17	0.12	9	0.716	0.546

Age 4 Catchability constant w.r.t. time and dependent on age

Year class = 2005

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
BEL BT	5057	0.245	0.188	0.77	3	0.295	0.831
UK BT	9297	0.21	0.188	0.9	3	0.384	0.533
UK BTS	8844	0.248	0.132	0.53	4	0.269	0.554
YFS-UK	6429	0.599	0	0	1	0.03	0.703
YFS-FR	18983	0.93	0	0	1	0.013	0.296
F shrinkage mean	11108	2				0.01	0.464

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
7661	0.13	0.11	13	0.844	0.618

Age 5 Catchability constant w.r.t. time and dependent on age

Year class = 2004

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
BEL BT	4199	0.213	0.071	0.34	4	0.337	0.44
UK BT	5536	0.192	0.124	0.65	4	0.385	0.35
UK BTS	9915	0.235	0.078	0.33	5	0.243	0.21
YFS-UK	9735	0.599	0	0	1	0.02	0.214
YFS-FR	15419	0.93	0	0	1	0.008	0.14
F shrinkage mean	3956	2				0.007	0.462

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
5914	0.12	0.1	16	0.834	0.331

Table 9.3.1 - Sole VIId - XSA diagnostics - continued

Age 6 Catchability constant w.r.t. time and dependent on age

Year class = 2003

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
BEL BT	960	0.219	0.147	0.67	5	0.3	0.535
UK BT	848	0.187	0.186	0.99	5	0.471	0.588
UK BTS	712	0.255	0.241	0.95	6	0.206	0.67
YFS-UK	1938	0.599	0	0	1	0.009	0.3
YFS-FR	840	0.93	0	0	1	0.004	0.592
F shrinkage me	1223	2				0.01	0.442

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
859	0.12	0.1	19	0.786	0.583

Age 7 Catchability constant w.r.t. time and dependent on age

Year class = 2002

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
BEL BT	718	0.192	0.132	0.69	6	0.412	0.522
UK BT	585	0.174	0.039	0.22	6	0.444	0.61
UK BTS	707	0.243	0.084	0.35	6	0.126	0.528
YFS-UK	703	0.599	0	0	1	0.006	0.53
YFS-FR	1228	0.93	0	0	1	0.003	0.337
F shrinkage mean	993	2				0.009	0.402

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
657	0.12	0.05	21	0.456	0.559

Age 8 Catchability constant w.r.t. time and age (fixed at the value for age) 7

Year class = 2001

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
BEL BT	904	0.179	0.039	0.22	7	0.429	0.498
UK BT	1510	0.167	0.113	0.68	7	0.464	0.326
UK BTS	1308	0.239	0.095	0.4	6	0.093	0.369
YFS-UK	1624	0.599	0	0	1	0.005	0.307
YFS-FR	338	0.93	0	0	1	0.002	1.002
F shrinkage mean	1178	2				0.008	0.402

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
1190	0.11	0.07	23	0.62	0.399

Age 9 Catchability constant w.r.t. time and age (fixed at the value for age) 7

Year class = 2000

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
BEL BT	279	0.185	0.086	0.47	8	0.397	0.572
UK BT	332	0.173	0.061	0.35	8	0.517	0.499
UK BTS	251	0.234	0.176	0.75	6	0.07	0.618
YFS-UK	67	0.599	0	0	1	0.004	1.437
YFS-FR	1678	0.93	0	0	1	0.001	0.121
F shrinkage mean	516	2				0.011	0.348

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
304	0.12	0.05	25	0.455	0.535

Age 10 Catchability constant w.r.t. time and age (fixed at the value for age) 7

Year class = 1999

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
BEL BT	364	0.179	0.103	0.58	9	0.359	0.454
UK BT	393	0.161	0.21	1.31	9	0.562	0.427
UK BTS	435	0.237	0.07	0.3	6	0.065	0.393
YFS-UK	461	0.599	0	0	1	0.003	0.375
YFS-FR	454	0.93	0	0	1	0.001	0.379
F shrinkage mean	337	2				0.009	0.483

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
385	0.11	0.09	27	0.834	0.434

Table 9.3.2 - Sole VIId - Fishing mortality (F) at age

Run title : Sole in VIId - 2010WG - Sol7d.txt

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Table 8 Fishing mortality (F) at age

YEAR	1982	1983	1984	1985	1986	1987	1988	1989
AGE								
1	0.0129	0	0.0012	0.004	0.002	0.0009	0.0039	0.0102
2	0.1858	0.0820	0.1139	0.2227	0.1199	0.1521	0.2601	0.1711
3	0.3101	0.3520	0.4309	0.4328	0.5032	0.5446	0.5408	0.6715
4	0.4841	0.3574	0.4348	0.3716	0.4572	0.5914	0.421	0.6658
5	0.2309	0.4423	0.2607	0.2703	0.3191	0.5305	0.3796	0.7297
6	0.2266	0.4623	0.7104	0.389	0.2964	0.6517	0.3893	0.4617
7	0.4664	0.3146	0.5173	0.251	0.3544	0.7789	0.475	0.4321
8	0.4093	0.5081	0.2314	0.2996	0.4145	0.4292	0.3636	0.4279
9	0.3456	0.2898	0.3551	0.1527	0.624	0.5218	0.215	0.3791
10	0.3367	0.4047	0.4163	0.2732	0.2847	1.723	0.8349	0.2638
+gp	0.3367	0.4047	0.4163	0.2732	0.2847	1.723	0.8349	0.2638
0 FBAR 3- 8	0.3546	0.4061	0.4309	0.3357	0.3908	0.5877	0.4282	0.5648

Table 8 Fishing mortality (F) at age

YEAR	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
AGE										
1	0.0300	0.0116	0.0033	0.0053	0.0012	0.0463	0.0005	0.0009	0.0019	0.0067
2	0.2220	0.2154	0.1466	0.1914	0.0495	0.1396	0.1212	0.0959	0.0593	0.2375
3	0.4010	0.5034	0.3942	0.3256	0.3392	0.4364	0.5651	0.6418	0.5428	0.5405
4	0.4750	0.5216	0.4044	0.4017	0.4937	0.4199	0.5438	0.7798	0.5855	0.6343
5	0.4394	0.4348	0.4503	0.3483	0.4179	0.4382	0.4910	0.7935	0.5558	0.5560
6	0.2867	0.5209	0.3383	0.1955	0.3103	0.4058	0.4672	0.4540	0.4968	0.5734
7	0.3582	0.3758	0.3273	0.2881	0.2748	0.2986	0.4438	0.4015	0.2385	0.5255
8	0.3174	0.3589	0.3076	0.2467	0.2854	0.1880	0.3256	0.4666	0.3051	0.4439
9	0.4760	0.5271	0.4010	0.4186	0.2768	0.3491	0.3042	0.4702	0.3569	0.3765
10	0.4888	0.6549	0.3318	0.2202	0.6173	0.2932	0.8858	0.2334	1.0893	0.2972
+gp	0.4888	0.6549	0.3318	0.2202	0.6173	0.2932	0.8858	0.2334	1.0893	0.2972
0 FBAR 3- 8	0.3796	0.4526	0.3704	0.3010	0.3535	0.3645	0.4727	0.5896	0.4541	0.5456

Table 8 Fishing mortality (F) at age

YEAR	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	FBAR 07-09
AGE											
1	0.0046	0.0067	0.0161	0.0195	0.0588	0.0058	0.0160	0.0112	0.0059	0.0014	0.0062
2	0.1739	0.2546	0.3743	0.3252	0.2796	0.2553	0.2599	0.2114	0.2144	0.1362	0.1873
3	0.5795	0.4505	0.5082	0.4525	0.4069	0.4126	0.4276	0.3939	0.4159	0.5462	0.4520
4	0.5265	0.3358	0.4820	0.3705	0.3805	0.4328	0.5022	0.6344	0.3599	0.6179	0.5374
5	0.3835	0.5693	0.4959	0.3975	0.4375	0.3714	0.4723	0.4834	0.5360	0.3311	0.4501
6	0.3806	0.4300	0.2522	0.4105	0.4021	0.3640	0.4389	0.5043	0.4923	0.5827	0.5265
7	0.3771	0.3481	0.2784	0.3349	0.3713	0.3748	0.4124	0.5356	0.3108	0.5588	0.4684
8	0.3902	0.2270	0.2290	0.2689	0.4079	0.3453	0.3855	0.4020	0.4638	0.3987	0.4215
9	0.3587	0.2226	0.2401	0.1677	0.1766	0.4332	0.5097	0.4027	0.2132	0.5345	0.3835
10	0.2433	0.1253	0.3291	0.3176	0.2925	0.3402	0.5806	0.9757	0.3365	0.4344	0.5822
+gp	0.2433	0.1253	0.3291	0.3176	0.2925	0.3402	0.5806	0.9757	0.3365	0.4344	
0 FBAR 3- 8	0.4396	0.3934	0.3743	0.3725	0.4010	0.3835	0.4398	0.4923	0.4298	0.5059	

Table 9.3.3 - Sole VIId - Stock numbers at age

Run title : Sole in VIId - 2010WG - Sol7d.txt

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Table 10 Stock number at age (start of year) Numbers*10**-3

YEAR	1982	1983	1984	1985	1986	1987	1988	1989
AGE								
1	12732	21343	21513	12910	25725	10976	25837	16810
2	16275	11373	19312	19443	11635	23230	9922	23288
3	20721	12229	9480	15594	14079	9338	18055	6922
4	4731	13749	7782	5575	9153	7702	4901	9512
5	2906	2638	8703	4559	3479	5243	3857	2911
6	3385	2087	1534	6067	3148	2288	2791	2388
7	1548	2442	1190	682	3720	2118	1079	1711
8	751	879	1613	642	480	2362	879	607
9	439	451	478	1158	430	287	1391	553
10	305	281	306	303	900	209	154	1015
+gp	740	607	732	561	1574	579	507	1275
0 TOTAL	64534	68080	72642	67493	74323	64330	69374	66992

Table 10 Stock number at age (start of year) Numbers*10**-3

YEAR	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
AGE										
1	44273	34871	33639	16781	26584	19451	18932	27783	17997	26273
2	15055	38876	31188	30338	15103	24025	16803	17122	25116	16253
3	17758	10910	28360	24371	22668	13006	18907	13468	14076	21417
4	3200	10760	5967	17301	15924	14610	7607	9722	6414	7401
5	4423	1801	5779	3603	10476	8795	8687	3996	4033	3232
6	1270	2579	1055	3333	2302	6241	5134	4811	1635	2093
7	1362	863	1386	680	2481	1527	3764	2912	2765	900
8	1005	861	536	904	462	1705	1025	2185	1763	1971
9	358	662	544	357	639	314	1279	670	1240	1176
10	343	201	354	330	212	438	200	853	379	785
+gp	1324	831	857	685	586	994	611	1345	472	1464
0 TOTAL	90369	103214	109664	98683	97437	91107	82949	84867	75891	82965

Table 10 Stock number at age (start of year) Numbers*10**-3

YEAR	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	GMST 82-07	AMST 82-07
AGE													
1	31377	26265	46593	20661	18963	37632	40339	16452	26724	157912	0*	23382	25104
2	23613	28260	23606	41487	18334	16179	33855	35922	14720	24039	142680**	21010	22524
3	11598	17955	19824	14691	27116	12543	11340	23622	26310	10749	18983	15589	16540
4	11288	5879	10354	10791	8455	16333	7512	6691	14415	15706	5633	8483	9204
5	3551	6033	3802	5785	6741	5229	9587	4114	3210	9101	7661	4690	5152
6	1677	2190	3089	2095	3518	3938	3264	5409	2296	1700	5914	2747	3051
7	1068	1037	1289	2172	1258	2129	2476	1904	2956	1270	859	1599	1787
8	482	663	662	883	1406	785	1324	1483	1008	1960	657	968	1089
9	1144	295	478	477	611	846	503	815	898	574	1190	603	677
10	730	723	214	340	365	463	496	273	493	656	304	374	430
+gp	1204	2362	736	944	963	985	729	385	906	1147	1057		
0 TOTAL	87732	91661	110647	100325	87729	97062	111426	97071	93936	224813	184937		

* Replaced with GM (23382) in prediction

** Replaced with RCT3 estimates of 42897 in prediction

Table 9.3.4 - Sole VIId - Summary

Run title : Sole in VIId - 2010WG - Sol7d.txt

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Table 16 Summary (without SOP correction)

	RECRUITS Age 1	TOTALBIO	TOTSPBIO	LANDINGS	YIELD/SSB	FBAR 3- 8
1982	12732	10433	7826	3190	0.4076	0.3546
1983	21343	12626	9596	3458	0.3603	0.4061
1984	21513	12976	9005	3575	0.3970	0.4309
1985	12910	13354	10007	3837	0.3834	0.3357
1986	25725	14002	10619	3932	0.3703	0.3908
1987	10976	13030	9011	4791	0.5317	0.5877
1988	25837	12891	10160	3853	0.3792	0.4282
1989	16810	11936	8464	3805	0.4495	0.5648
1990	44273	13942	9650	3647	0.3779	0.3796
1991	34871	15900	8792	4351	0.4949	0.4526
1992	33639	17391	11218	4072	0.3630	0.3704
1993	16781	17953	13170	4299	0.3264	0.3010
1994	26584	15652	12571	4383	0.3487	0.3535
1995	19451	15122	11122	4420	0.3974	0.3645
1996	18932	15724	12173	4797	0.3941	0.4727
1997	27783	14366	10596	4764	0.4496	0.5896
1998	17997	12557	8140	3363	0.4131	0.4541
1999	26273	12468	9074	4135	0.4557	0.5456
2000	31377	13003	8553	3476	0.4064	0.4396
2001	26265	12536	7634	4025	0.5273	0.3934
2002	46593	14110	8570	4733	0.5523	0.3743
2003	20661	17704	10406	5038	0.4841	0.3725
2004	18963	14896	11436	4826	0.4220	0.4010
2005	37632	15838	11416	4383	0.3839	0.3835
2006	40339	17289	9822	4833	0.4921	0.4398
2007	16452	17581	10904	5166	0.4738	0.4923
2008	26724	16872	13210	4517	0.3419	0.4298
2009	47475[1]	23554	11595	4969	0.4285	0.5059
2010	23382[2]	19247[3]	11072[3]			0.4760[4]
Arith. Mean	29905	14847	10169	4237	0.4219	0.4291
0 Units	(Thousands)	(Tonnes)	(Tonnes)	(Tonnes)		

[1] Original XSA value 157912 replaced with 47475 from RCT3 (see section 9.5)

[2] Geometric mean 1982-2007

[3] From forecast

[4] $F_{(07\text{-}09)}$ NOT rescaled to F_{2009}

Table 9.5.1 - Sole VIId – RCT3 input

Yearclass	XSA (Age 1)	XSA (Age 2)	YF-FR0	YF-FR1	bts1	bts2
1981	12732	11373	3.33	0.07	-11	-11
1982	21343	19312	1.04	0.02	-11	-11
1983	21513	19443	0.79	-11	-11	-11
1984	12910	11635	-11	-11	-11	-11
1985	25725	23230	-11	-11	-11	-11
1986	10976	9922	-11	0.07	-11	14.20
1987	25837	23288	0.75	0.17	8.20	15.40
1988	16810	15055	0.04	0.14	2.60	3.70
1989	44273	38876	17.43	0.54	12.10	22.80
1990	34871	31188	0.57	0.38	8.90	12.00
1991	33639	30338	1.04	0.22	1.40	17.50
1992	16781	15103	0.48	0.03	0.50	3.20
1993	26584	24025	0.27	0.70	4.80	10.60
1994	19451	16803	4.04	0.28	3.50	7.30
1995	18932	17122	3.50	0.15	3.50	7.30
1996	27783	25116	0.28	0.03	19.00	21.20
1997	17997	16253	0.07	0.10	2.00	9.44
1998	26273	23613	10.52	0.35	28.14	22.03
1999	31377	28260	2.84	0.31	10.49	21.01
2000	26265	23606	2.41	1.21	9.09	11.42
2001	46593	41487	4.32	0.11	31.76	28.48
2002	20661	18334	0.94	0.32	6.47	8.49
2003	18963	16179	0.21	0.15	7.35	5.04
2004	37632	33855	7.29	0.82	25.00	29.20
2005	40339	35922	0.05	0.83	6.30	21.86
2006	-11	-11	1.04	0.08	2.14	6.50
2007	-11	-11	0.03	0.06	2.90	13.3
2008	-11	-11	6.58	2.78	30.5	-11
2009	-11	-11	2.47	-11	-11	-11

Table 9.5.2a - Sole VIId – RCT3 output (1 year olds)

Analysis by RCT3 ver3.1 of data from file :7DREC1.txt

7D Sole (1year olds)

Data for 4 surveys over 29 years : 1981 - 2009

Regression type = C
Tapered time weighting not applied
Survey weighting not applied

Final estimates shrunk towards mean
Minimum S.E. for any survey taken as .00
Minimum of 3 points used for regression

Forecast/Hindcast variance correction used.

Yearclass = 2007

Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
	I-----------Regression			----------I	I-----------Prediction			---------I	
YF-FR0	1.29	8.89	1.03	.108	22	.03	8.93	1.134	.039
YF-FR1	3.51	9.22	.66	.267	22	.06	9.42	.725	.095
bts1	.63	8.88	.43	.386	19	1.36	9.73	.477	.220
bts2	.89	7.83	.37	.524	20	2.66	10.19	.401	.312
					VPA Mean =		10.07	.388	.334

Yearclass = 2008

Survey/ Series	**Slope**	**Inter- cept**	**Std Error**	**Rsquare**	**No. Pts**	**Index Value**	**Predicted Value**	**Std Error**	**WAP Weights**
	I-----------Regression			**----------I**	**I-----------Prediction**			**-------------------I**	
YF-FR0	**1.29**	**8.89**	**1.03**	**.108**	**22**	**2.03**	**11.50(98716)**	**1.143**	**.062**
YF-FR1	**3.51**	**9.22**	**.66**	**.267**	**22**	**1.39**	**14.08(1302766)**	**1.070**	**.071**
bts1	**.63**	**8.88**	**.43**	**.386**	**19**	**3.47**	**11.06(63577)**	**.500**	**.325**
bts2									
					VPA Mean =		**10.07(23624)**	**.388**	**.542**

Yearclass = 2009

Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
	I-----------Regression			----------I	I-----------Prediction			-----------------I	
YF-FR0	1.29	8.89	1.03	.108	22	1.24	10.49(35954)	1.105	.110
YF-FR1									
bts1									
bts2									
					VPA Mean =		10.07(23624)	.388	.890

Year Class	Weighted Average Prediction	Log WAP	Int Std Error	Ext Std Error	Var Ratio	VPA	Log VPA
2007	20526	9.93	.22	.16	.50		
2008	**47475**	**10.77**	**.29**	**.61**	**4.52**		
2009	24831	10.12	.37	.13	.13		

Table 9.5.2b - Sole VIId – RCT3 output (2 year olds)

Analysis by RCT3 ver3.1 of data from file :S7DREC2.txt

7D Sole (2year olds)

Data for 4 surveys over 29 years : 1981 - 2009

Regression type = C
Tapered time weighting not applied
Survey weighting not applied

Final estimates shrunk towards mean
Minimum S.E. for any survey taken as .00
Minimum of 3 points used for regression

Forecast/Hindcast variance correction used.

Yearclass = 2007

Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
	Regression					Prediction			
YF-FR0	1.32	8.75	1.06	.104	22	.03	8.79	1.164	.037
YF-FR1	3.52	9.10	.67	.265	22	.06	9.31	.728	.094
bts1	.64	8.74	.44	.379	19	1.36	9.61	.487	.210
bts2	.88	7.75	.36	.539	20	2.66	10.08	.390	.328
					VPA Mean =		9.96	.387	.332

Yearclass = 2008

Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
	Regression					Prediction			
YF-FR0	1.32	8.75	1.06	.104	22	2.03	11.42(91126)	1.174	.060
YF-FR1	3.52	9.10	.67	.265	22	1.39	13.99(1190638)	1.076	.071
bts1	.64	8.74	.44	.379	19	3.47	10.96(57526)	.511	.317
bts2									
					VPA Mean =		9.96(21163)	.387	.551

Yearclass = 2009

Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
	Regression					Prediction			
YF-FR0	1.32	8.75	1.06	.104	22	1.24	10.39	1.135	.104
YF-FR1									
bts1									
bts2									
					VPA Mean =		9.96	.387	.896

Year Class	Weighted Average Prediction	Log WAP	Int Std Error	Ext Std Error	Var Ratio	VPA	Log VPA
2007	18466	9.82	.22	.16	.51		
2008	42352	10.65	.29	.61	4.52		
2009	22194	10.01	.37	.13	.13		

Table 9.5.3 - Sole VIId - FMSY summary

Stock name
sole_VIId.SUM
Sen filename
sole_viid.sen
pf, pm
0 0
Number of iterations
1000
Simulate variation in Biological parameters
TRUE
SR relationship constrained
TRUE

Ricker
765/1000 Iterations resulted in feasible parameter estimates

	Fcrash	Fmsy	Bmsy	MSY	ADMB Alpha	ADMB Beta	Unscaled Alpha	Unscaled Beta
Deterministic	1.6316	0.6788	6511	4256	1.3624	1.2732	11.7716	0.0002
Mean	1.3883	0.6881	6982	4998	1.4241	1.3709	15.8765	0.0002
5%ile	0.5984	0.2811	3918	3380	1.1098	0.6168	5.1116	0.0001
25%ile	0.8698	0.4350	4815	4080	1.2713	1.0661	8.9878	0.0001
50%ile	1.1605	0.6046	6034	4719	1.4011	1.3697	13.3182	0.0002
75%ile	1.7539	0.8210	7775	5595	1.5527	1.7004	20.3751	0.0002
95%ile	2.8448	1.4268	13189	7410	1.8164	2.0511	32.9287	0.0003
CV	0.5312	0.5403	0.6452	0.2845	0.1527	0.3290	0.6381	0.3290

Beverton-Holt
737/1000 Iterations resulted in feasible parameter estimates

	Fcrash	Fmsy	Bmsy	MSY	ADMB Alpha	ADMB Beta	Unscaled Alpha	Unscaled Beta
Deterministic	5.0000	0.2718	14992	3936	0.8036	0.8039	23516.7000	3.1112
Mean	1.4049	0.1685	131834	11542	0.6100	0.8999	112126.0053	40085.7108
5%ile	0.4079	0.0202	9340	3086	0.2075	0.7654	21858.0000	197.0020
25%ile	0.6672	0.1039	15793	3791	0.4958	0.8358	24707.0000	869.9070
50%ile	1.1335	0.1638	25344	4442	0.6549	0.8901	28853.0000	2576.0500
75%ile	1.8134	0.2266	54508	5707	0.7648	0.9520	38115.3000	6593.3600
95%ile	3.4908	0.3422	358704	12775	0.8645	1.0809	91073.0800	29392.1000
CV	0.6909	0.5751	8.5503	10.2951	0.3319	0.1066	14.6532	18.9735

Smooth hockeystick
761/1000 Iterations resulted in feasible parameter estimates

	Fcrash	Fmsy	Bmsy	MSY	ADMB Alpha	ADMB Beta	Unscaled Alpha	Unscaled Beta
Deterministic	0.5148	0.2721	14582	3833	0.6214	0.7570	1.5030	7616.1100
Mean	0.4195	0.2675	28092	4090	0.5791	0.8402	1.4007	8452.7560
5%ile	0.2809	0.0302	7897	2990	0.4761	0.7633	1.1516	7678.8900
25%ile	0.3466	0.1905	9056	3570	0.5355	0.7862	1.2953	7909.8600
50%ile	0.4023	0.2851	12232	3983	0.5760	0.8200	1.3933	8249.7300
75%ile	0.4818	0.3459	20814	4505	0.6192	0.8814	1.4977	8866.9200
95%ile	0.6066	0.4460	136179	5425	0.6818	0.9723	1.6490	9781.4400
CV	0.2367	0.4488	1.7301	0.1903	0.1063	0.0827	0.1063	0.0827

Per recruit

	F35	F40	F01	Fmax	Bmsypr	MSYpr	Fpa	Flim
Deterministic	0.1185	0.0971	0.0982	0.2721	0.6370	0.1674	0.4	0.55
Mean	0.1020	0.0847	0.0921	0.3778	1.1900	0.1734		
5%ile	0.0012	0.0010	0.0014	0.0304	0.3339	0.1329		
25%ile	0.0432	0.0344	0.0423	0.1959	0.3887	0.1558		
50%ile	0.1130	0.0938	0.1004	0.3019	0.5238	0.1706		
75%ile	0.1534	0.1286	0.1374	0.4229	0.8763	0.1887		
95%ile	0.1943	0.1626	0.1763	0.9927	5.7386	0.2220		
CV	0.6431	0.6488	0.6423	1.0186	1.7263	0.1593		

Table 9.6.1 - Sole in VIId
Input for catch forecast and linear sensitivity analysis

Label	Value	CV	Label	Value	CV
Number at age			Weight in the stock		
N1	23381	0.39	WS1	0.050	0.00
N2	42897	0.61	WS2	0.163	0.03
N3	18983	0.26	WS3	0.191	0.02
N4	5633	0.17	WS4	0.244	0.02
N5	7660	0.13	WS5	0.286	0.03
N6	5914	0.12	WS6	0.339	0.11
N7	858	0.12	WS7	0.365	0.09
N8	656	0.12	WS8	0.437	0.09
N9	1190	0.11	WS9	0.445	0.04
N10	304	0.12	WS10	0.445	0.09
N11	1056	0.11	WS11	0.581	0.12
H.cons selectivity			Weight in the HC catch		
sH1	0.0060	0.76	WH1	0.152	0.07
sH2	0.1870	0.3	WH2	0.177	0.07
sH3	0.4520	0.15	WH3	0.200	0.01
sH4	0.5370	0.22	WH4	0.242	0.06
sH5	0.4500	0.31	WH5	0.272	0.03
sH6	0.5260	0.06	WH6	0.324	0.1
sH7	0.4680	0.22	WH7	0.357	0.19
sH8	0.4210	0.18	WH8	0.415	0.09
sH9	0.3830	0.36	WH9	0.411	0.08
sH10	0.5820	0.56	WH10	0.470	0.06
sH11	0.5820	0.56	WH11	0.555	0.12
Natural mortality			Proportion mature		
M1	0.1	0.1	MT1	0	0
M2	0.1	0.1	MT2	0	0.1
M3	0.1	0.1	MT3	1	0.1
M4	0.1	0.1	MT4	1	0
M5	0.1	0.1	MT5	1	0
M6	0.1	0.1	MT6	1	0
M7	0.1	0.1	MT7	1	0
M8	0.1	0.1	MT8	1	0
M9	0.1	0.1	MT9	1	0
M10	0.1	0.1	MT10	1	0
M11	0.1	0.1	MT11	1	0
Relative effort in HC fihery			Year effect for natural mortality		
HF10	1	0.09	K10	1	0.1
HF11	1	0.09	K11	1	0.1
HF12	1	0.09	K12	1	0.1
Recruitment in 2007 and 2008					
R11	23382	0.39			
R12	23382	0.39			

Table 9.6.2 Sole in VIId - Management option table

MFDP version 1a
Run: S7d_fin
Sole in VIId
Time and date: 13:09 08/05/2010
Fbar age range: 3-8

2010 Biomass	SSB	FMult	FBar	Landings
19247	11072	1.0000	0.4760	5244

2011 Biomass	SSB	FMult	FBar	Landings	2012 Biomass	SSB
18025	13422	0.0000	0.0000	0	22921	18296
.	13422	0.1000	0.0476	676	22160	17538
.	13422	0.2000	0.0952	1323	21434	16814
.	13422	0.3000	0.1428	1941	20740	16122
.	13422	0.4000	0.1904	2532	20077	15461
.	13422	0.5000	0.2380	3098	19444	14829
.	13422	0.6000	0.2856	3639	18838	14226
.	13422	0.7000	0.3332	4156	18260	13650
.	13422	0.8000	0.3808	4652	17707	13099
.	13422	0.9000	0.4284	5126	17178	12572
.	13422	1.0000	0.4760	5579	16673	12069
.	13422	1.1000	0.5236	6014	16190	11588
.	13422	1.2000	0.5712	6429	15728	11128
.	13422	1.3000	0.6188	6827	15286	10689
.	13422	1.4000	0.6664	7209	14863	10268
.	13422	1.5000	0.7140	7574	14459	9866
.	13422	1.6000	0.7616	7924	14072	9481
.	13422	1.7000	0.8092	8259	13702	9113
.	13422	1.8000	0.8568	8580	13348	8761
.	13422	1.9000	0.9044	8888	13009	8425
.	13422	2.0000	0.9520	9183	12685	8102

Input units are thousands and kg - output in tonnes

Fmult corresponding to Fpa = 0.84

.	13422	0.84	0.3998	4844	17492	12885

Fmult corresponding to Fmsy = 0.6

.	13422	0.6	0.2856	3639	18838	14226

Bpa = 8 000 t

Table 9.6.3 Sole in VIId. Detailed results

MFDP version 1a
Run: S7d_fin
Time and date: 13:09 08/05/2010
Fbar age range: 3-8

Year: 2010		F multiplier: 1		Fbar: 0.476					
Age	**F**	**CatchNos**	**Yield**	**StockNos**	**Biomass**	**SSNos(Jan)**	**SSB(Jan)**	**SSNos(ST)**	**SSB(ST)**
1	0.0062	137	21	23382	1169	0	0	0	0
2	0.1873	6985	1236	42897	7007	0	0	0	0
3	0.4520	6594	1319	18983	3619	18983	3619	18983	3619
4	0.5374	2238	542	5633	1376	5633	1376	5633	1376
5	0.4502	2652	722	7661	2194	7661	2194	7661	2194
6	0.5264	2314	749	5914	2003	5914	2003	5914	2003
7	0.4684	307	110	859	313	859	313	859	313
8	0.4215	216	89	657	287	657	287	657	287
9	0.3835	362	149	1190	530	1190	530	1190	530
10	0.5822	128	60	304	135	304	135	304	135
11	0.5822	446	248	1057	615	1057	615	1057	615
Total		22379	5244	108537	19247	42258	11072	42258	11072

Year: 2011		F multiplier: 1		Fbar: 0.476					
Age	**F**	CatchNos	Yield	StockNos	Biomass	SSNos(Jan)	SSB(Jan)	SSNos(ST)	SSB(ST)
1	0.0062	137	21	23382	1169	0	0	0	0
2	0.1873	3424	606	21027	3434	0	0	0	0
3	0.4520	11179	2236	32184	6136	32184	6136	32184	6136
4	0.5374	4344	1051	10930	2671	10930	2671	10930	2671
5	0.4502	1031	281	2978	853	2978	853	2978	853
6	0.5264	1729	560	4419	1497	4419	1497	4419	1497
7	0.4684	1129	404	3161	1153	3161	1153	3161	1153
8	0.4215	160	66	487	213	487	213	487	213
9	0.3835	119	49	390	174	390	174	390	174
10	0.5822	310	145	734	326	734	326	734	326
11	0.5822	290	161	688	400	688	400	688	400
Total		23851	5579	100380	18025	55971	13422	55971	13422

Year: 2012		F multiplier: 1		Fbar: 0.476					
Age	**F**	**CatchNos**	**Yield**	**StockNos**	**Biomass**	**SSNos(Jan)**	**SSB(Jan)**	**SSNos(ST)**	**SSB(ST)**
1	0.0062	137	21	23382	1169	0	0	0	0
2	0.1873	3424	606	21027	3434	0	0	0	0
3	0.4520	5480	1096	15776	3008	15776	3008	15776	3008
4	0.5374	7364	1782	18531	4528	18531	4528	18531	4528
5	0.4502	2001	545	5778	1655	5778	1655	5778	1655
6	0.5264	672	218	1718	582	1718	582	1718	582
7	0.4684	844	302	2362	861	2362	861	2362	861
8	0.4215	588	244	1790	782	1790	782	1790	782
9	0.3835	88	36	289	129	289	129	289	129
10	0.5822	101	48	240	107	240	107	240	107
11	0.5822	303	168	719	418	719	418	719	418
Total		21002	5065	91613	16673	47204	12069	47204	12069

Input units are thousands and kg - output in tonnes

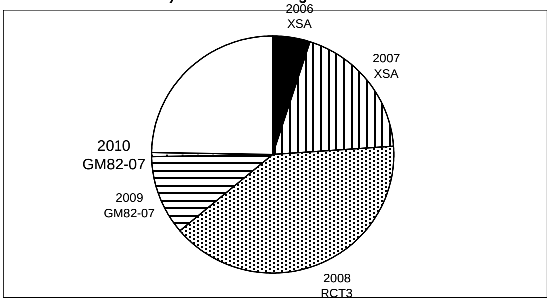
Table 9.6.4 Sole VIId
Stock numbers of recruits and their source for recent year classes used in predictions, and the relative (%) contributions to landings and SSB (by weight) of these year classes

Year-class	2006	2007	2008	2009	2010
Stock No. (thousands) of 1 year-olds	16452	26724	47475	23382	23382
Source	XSA	XSA	RCT3	GM82-07	GM82-07
Status Quo F:					
% in 2010 landings	10.3	25.1	23.6	0.4	-
% in 2011 landings	5.0	18.8	40.1	10.9	0.4
% in 2010 SSB	12.4	32.7	0.0	0.0	-
% in 2011 SSB	6.4	19.9	45.7	0.0	0.0
% in 2012 SSB	4.8	13.7	37.5	24.9	0.0

GM : geometric mean recruitment

Sole VIId : Year-class % contribution to

a) 2011 landings



b) 2012 SSB

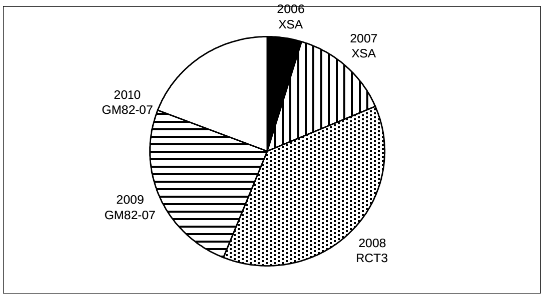


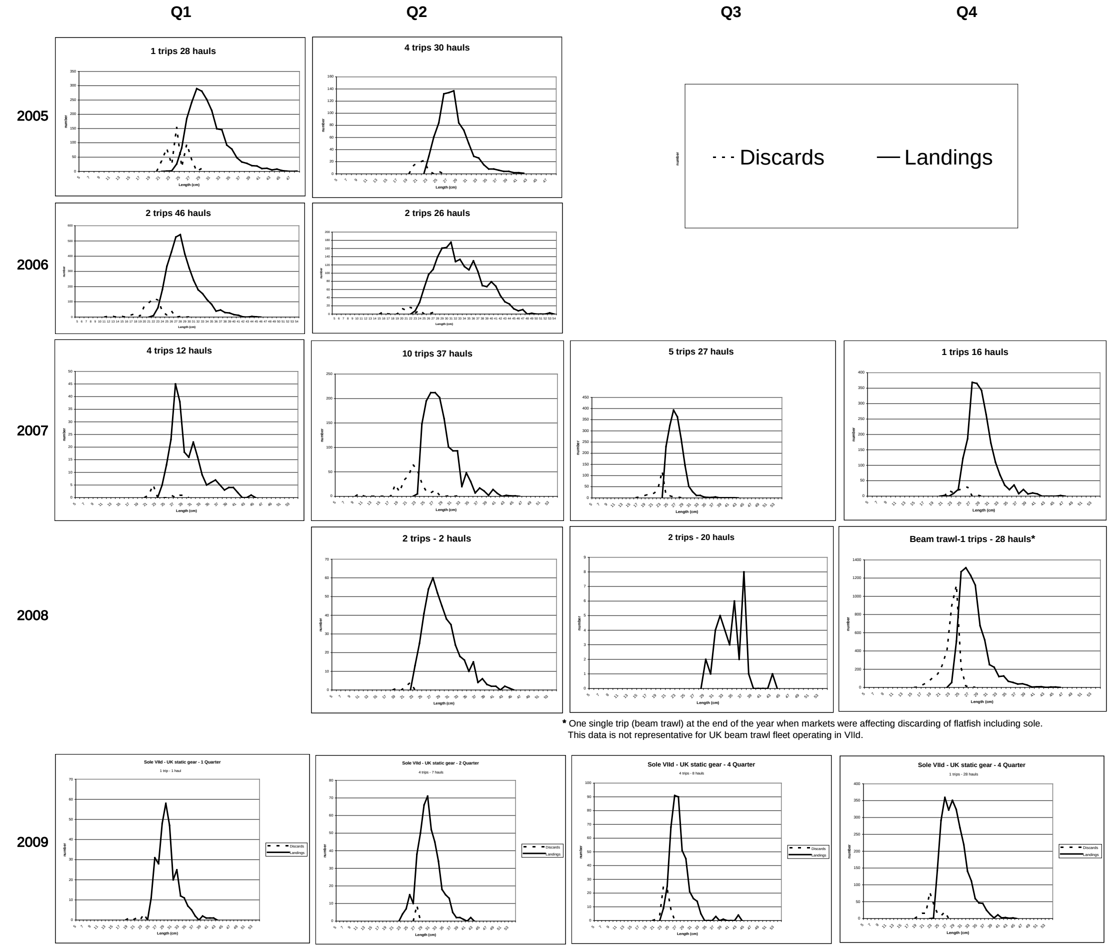
Table 9.7.1 - Sole in VIId Yield per recruit summary table

MFYPR version 2a
Run: S7d_fin_yield
Time and date: 13:30 08/05/2010
Yield per results

FMult	Fbar	CatchNos	Yield	StockNos	Biomass	SpwnNosJan	SSBJan	SpwnNosSpwn	SSBSpwn
0.0000	0.0000	0.0000	0.0000	10.5083	3.9777	8.6035	3.7799	8.6035	3.7799
0.1000	0.0476	0.2873	0.1086	7.6388	2.4475	5.7345	2.2498	5.7345	2.2498
0.2000	0.0952	0.4261	0.1459	6.2546	1.7567	4.3509	1.5591	4.3509	1.5591
0.3000	0.1428	0.5093	0.1608	5.4251	1.3694	3.5219	1.1719	3.5219	1.1719
0.4000	0.1904	0.5654	0.1669	4.8672	1.1248	2.9646	0.9274	2.9646	0.9274
0.5000	0.2380	0.6060	0.1691	4.4643	0.9582	2.5622	0.7609	2.5622	0.7609
0.6000	0.2856	0.6369	0.1696	4.1589	0.8385	2.2574	0.6413	2.2574	0.6413
0.7000	0.3332	0.6611	0.1692	3.9192	0.7490	2.0182	0.5518	2.0182	0.5518
0.8000	0.3808	0.6807	0.1685	3.7259	0.6800	1.8255	0.4829	1.8255	0.4829
0.9000	0.4284	0.6969	0.1677	3.5667	0.6254	1.6669	0.4284	1.6669	0.4284
1.0000	0.4760	0.7105	0.1668	3.4333	0.5813	1.5341	0.3844	1.5341	0.3844
1.1000	0.5236	0.7222	0.1659	3.3199	0.5450	1.4212	0.3482	1.4212	0.3482
1.2000	0.5712	0.7322	0.1651	3.2222	0.5147	1.3240	0.3180	1.3240	0.3180
1.3000	0.6188	0.7409	0.1643	3.1371	0.4891	1.2395	0.2925	1.2395	0.2925
1.4000	0.6664	0.7487	0.1636	3.0623	0.4672	1.1652	0.2707	1.1652	0.2707
1.5000	0.7140	0.7555	0.1630	2.9959	0.4482	1.0994	0.2518	1.0994	0.2518
1.6000	0.7616	0.7617	0.1624	2.9367	0.4317	1.0407	0.2353	1.0407	0.2353
1.7000	0.8092	0.7672	0.1619	2.8834	0.4171	0.9880	0.2208	0.9880	0.2208
1.8000	0.8568	0.7723	0.1614	2.8351	0.4041	0.9403	0.2080	0.9403	0.2080
1.9000	0.9044	0.7769	0.1609	2.7912	0.3926	0.8969	0.1965	0.8969	0.1965
2.0000	0.9520	0.7811	0.1605	2.7510	0.3821	0.8573	0.1862	0.8573	0.1862

Reference point	F multiplier	Absolute F
Fbar(3-8)	1.0000	0.476
FMax	0.5949	0.2832
F0.1	0.2188	0.1041
F35%SPR	0.2548	0.1213
Fmed	0.8767	0.4173
Fhigh	0.6319	0.3008

Figure 9.2.1a - Sole VIId - UK Length distributions of discarded and retained fish from discard sampling studies for static gear (2005 - 2006 - 2007 - 2008 - 2009) and one beam trawl trip in 2008



* One single trip (beam trawl) at the end of the year when markets were affecting discarding of flatfish including sole. This data is not representative for UK beam trawl fleet operating in VIId.

Figure 9.2.1b - Sole VIId - French Length distributions of discarded and retained fish from discard sampling studies for Otter trawl (2005 - 2006 - 2007 - 2008)

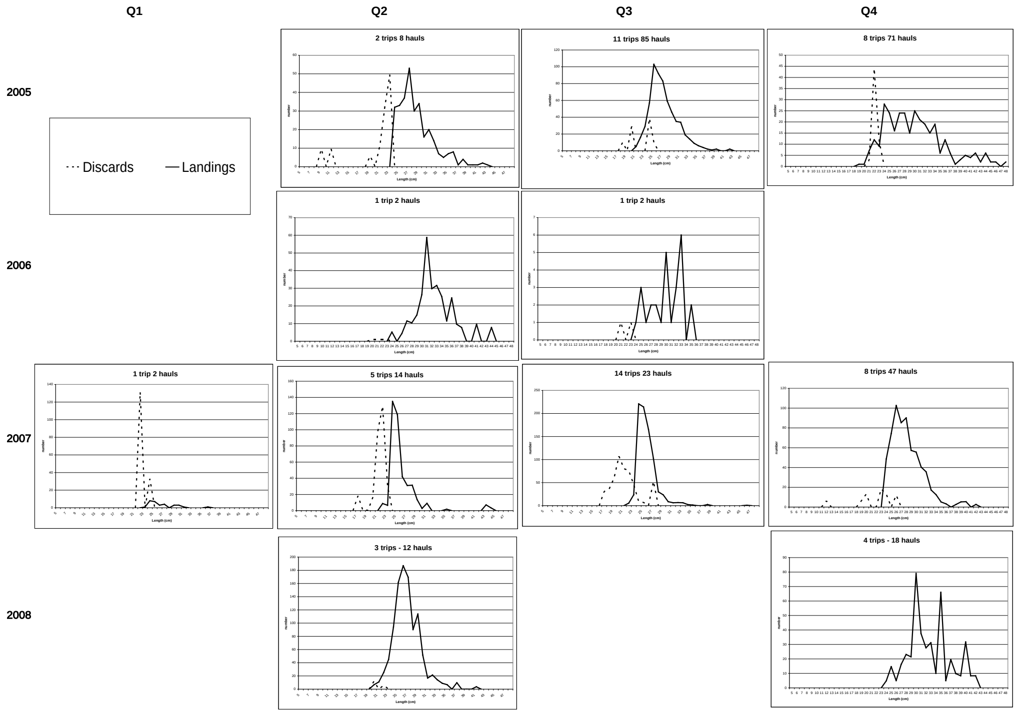


Figure 9.2.1c - Sole VIId - French Length distributions of discarded and retained fish from discard sampling studies fo Gillnets (2005 - 2007 - 2008)

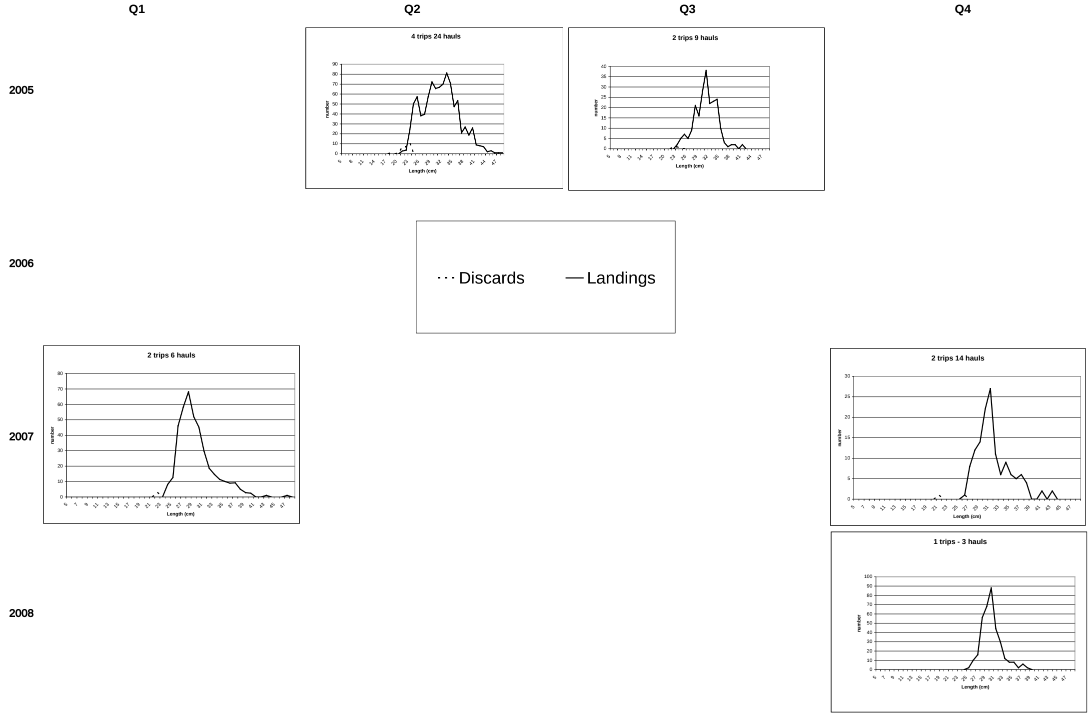


Figure 9.2.2a

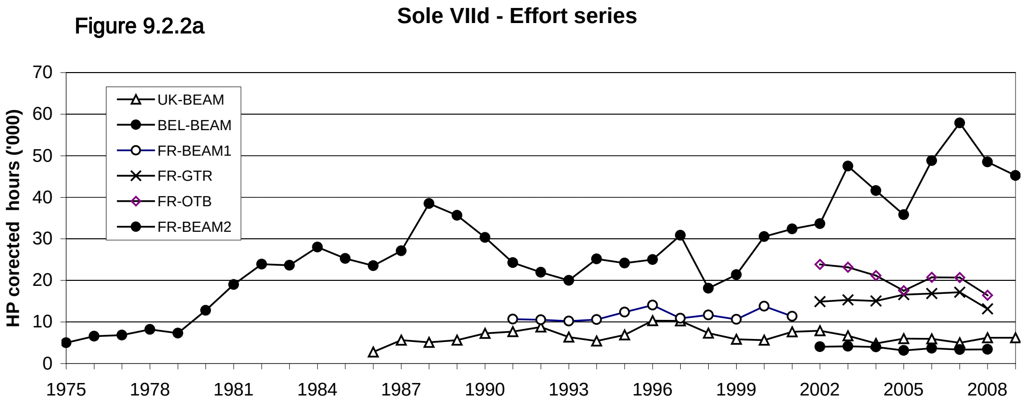


Figure 9.2.2b

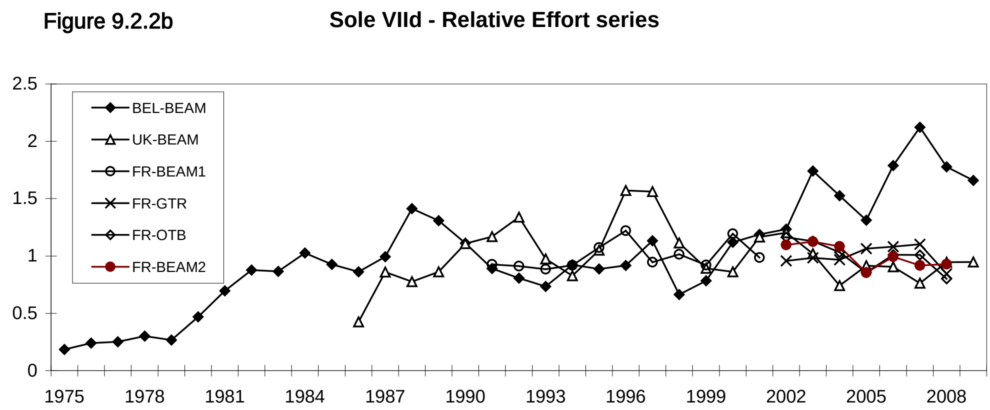
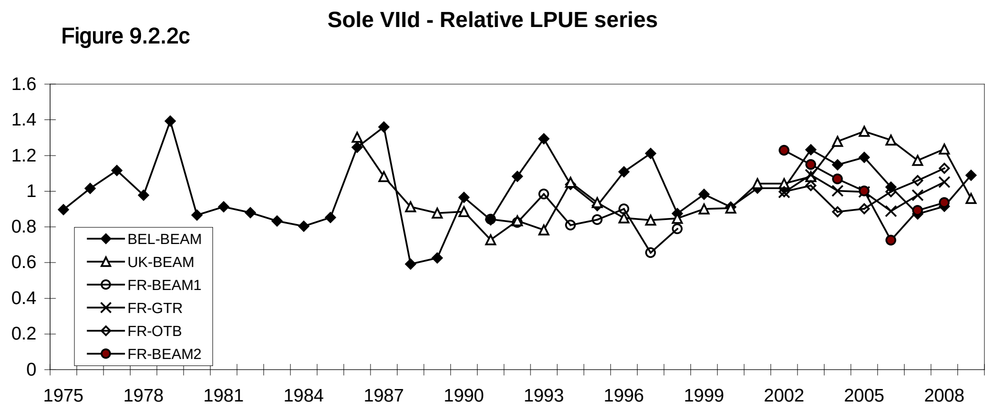
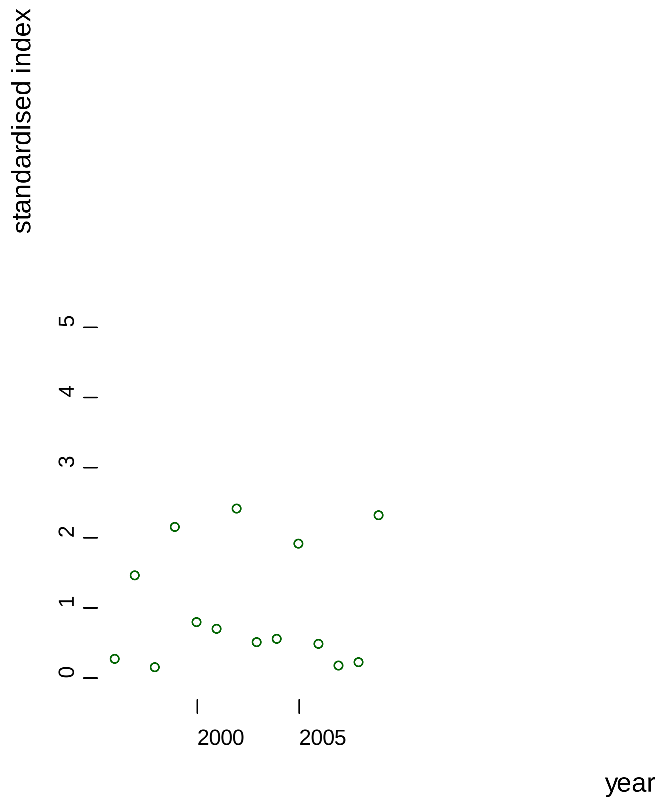


Figure 9.2.2c




standardised index
0
1
2
3
4
5
2000
2005
year

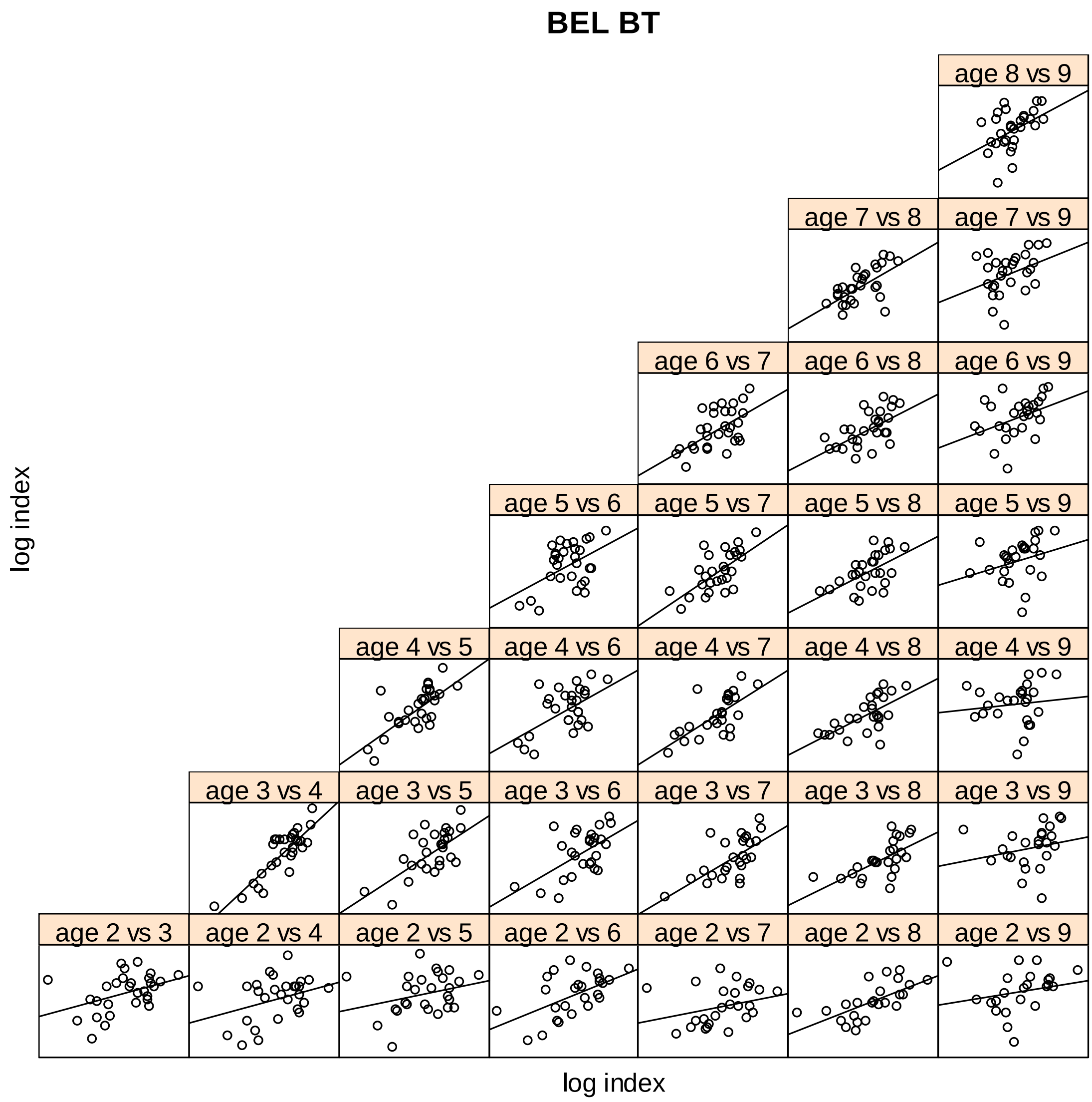


Figure 9.2.4 Sole in VIId. Internal concistency plot for the Belgian commercial fleet (BEL-BT).

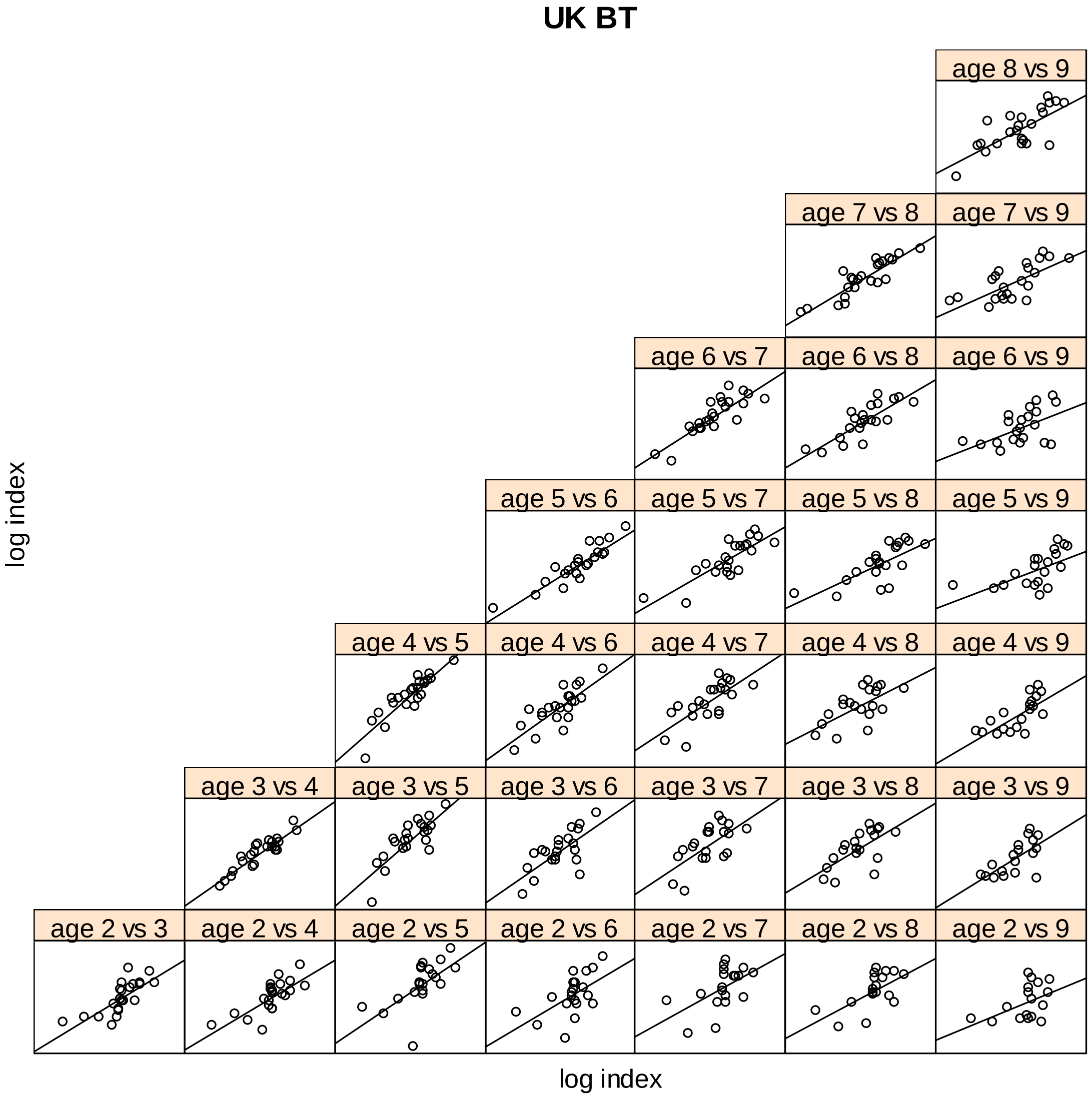


Figure 9.2.5 Sole in VIId. Internal concistency plot for the UK commercial fleet (UK-BT).

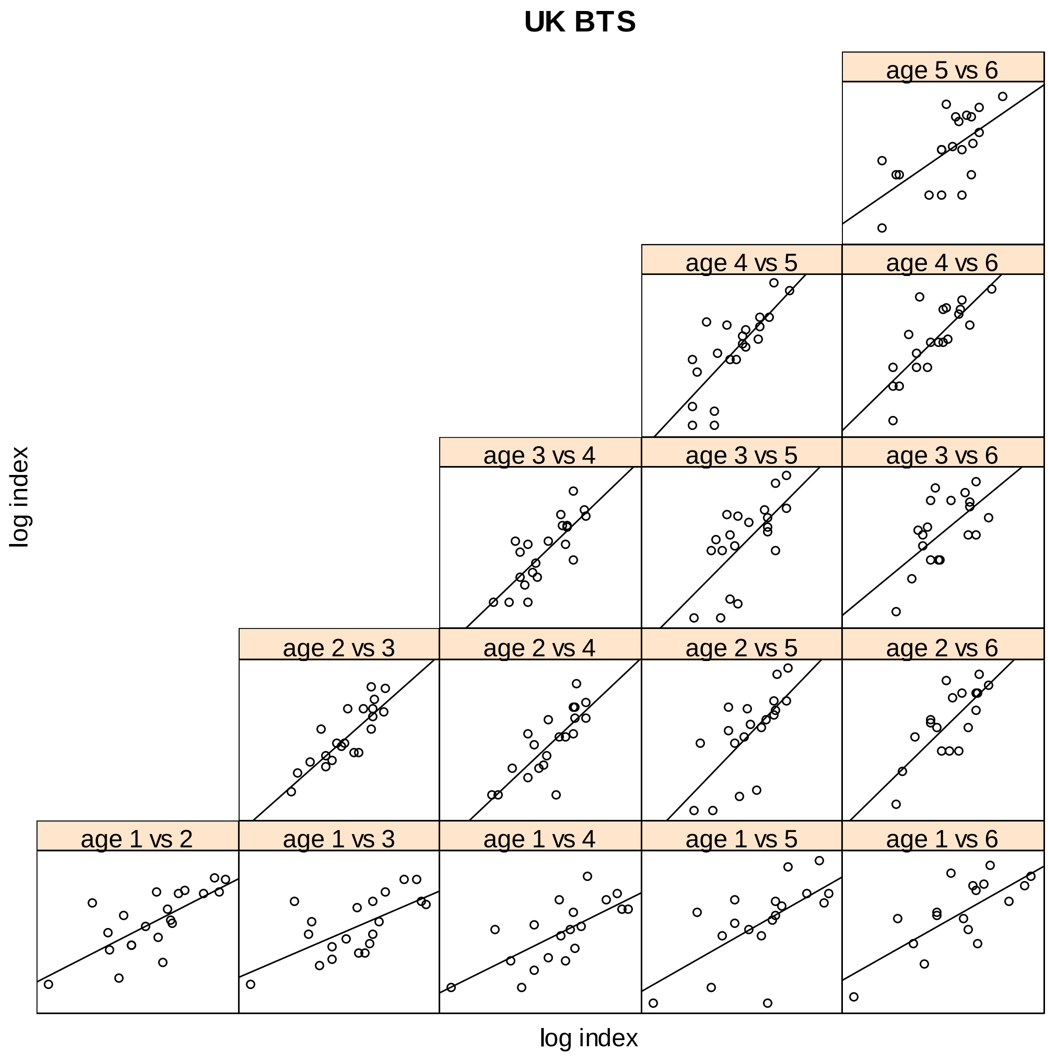


Figure 9.2.6 Sole in VIId. Internal concistency plot for the UK beam trawl survey (UK-BTS).

Figure 9.3.1a - VIId SOLE LOG CATCHABILITY RESIDUAL PLOTS - Final XSA

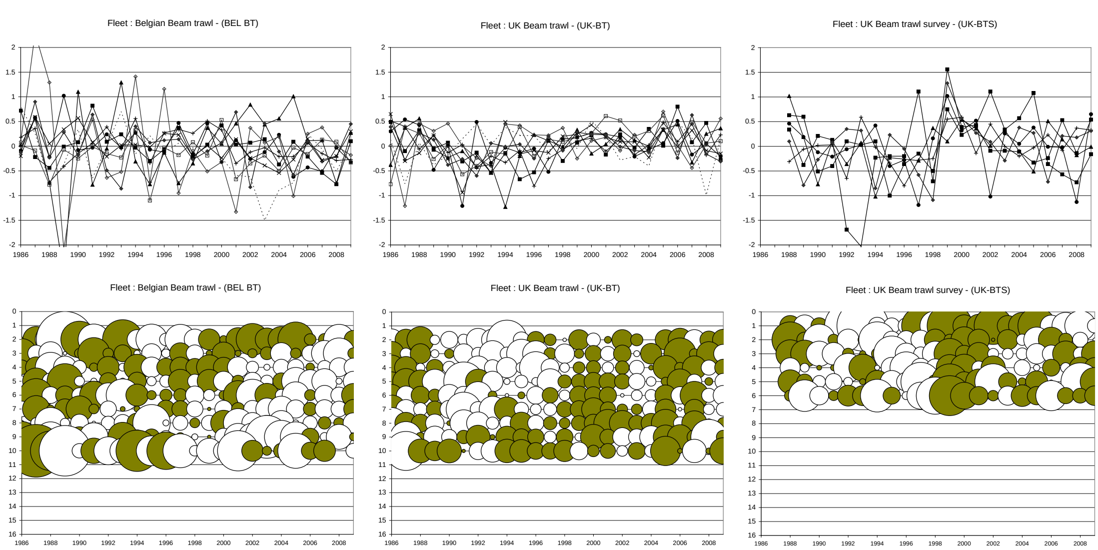


Figure 9.3.1b - VIId SOLE LOG CATCHABILITY RESIDUAL PLOTS - Final XSA

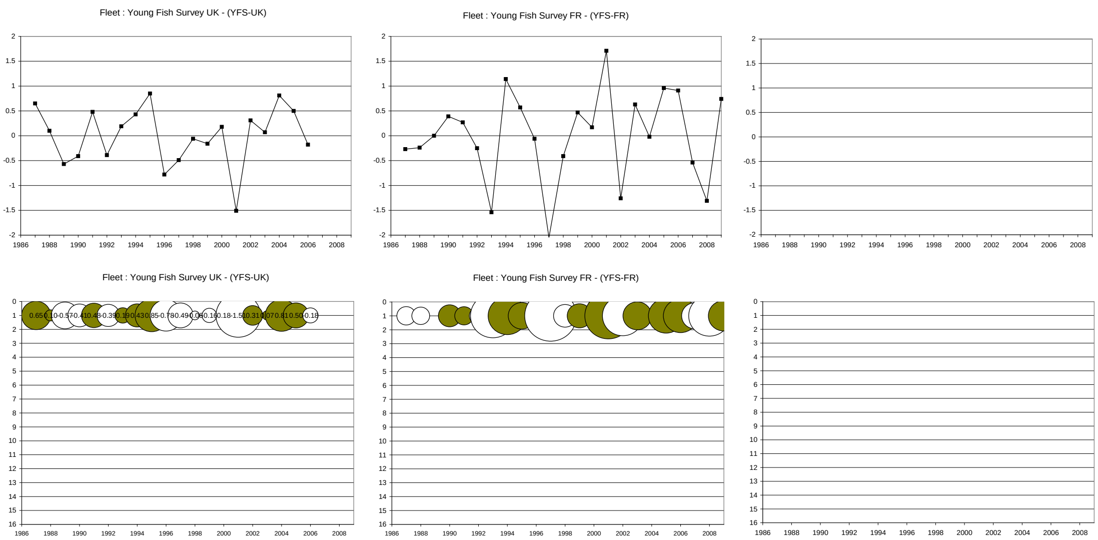


Figure 9.3.2 Sole in VIId. Estimates of survivors from different fleets and shrinkage, as well as their different weighting in the final XSA-run

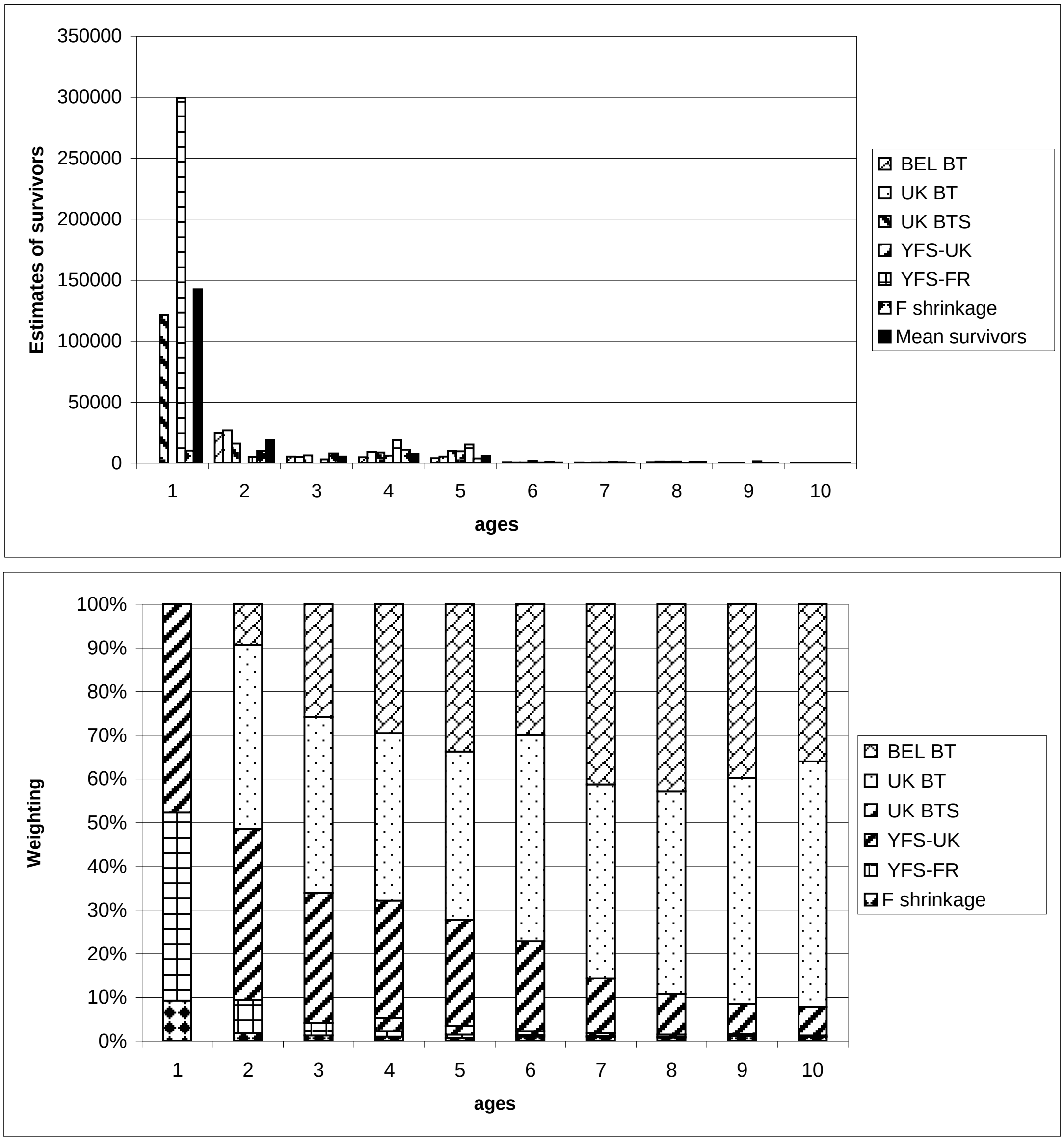
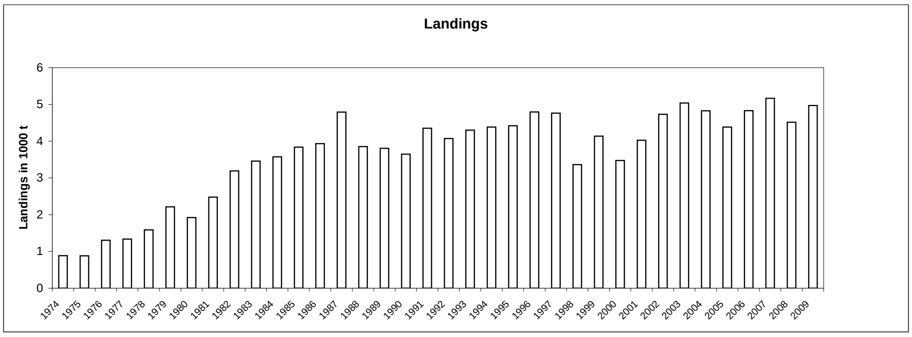
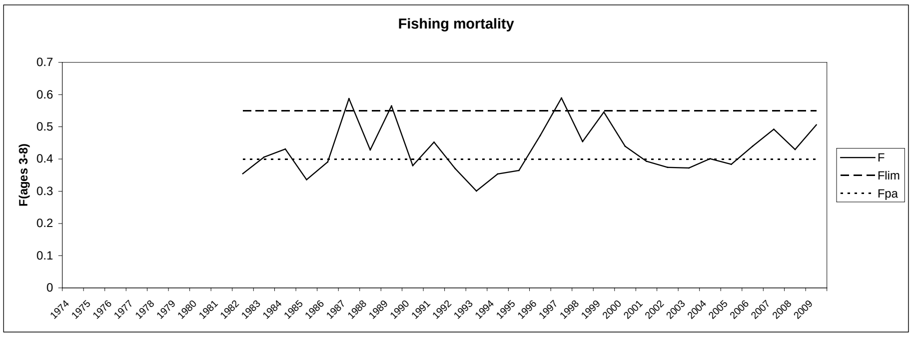
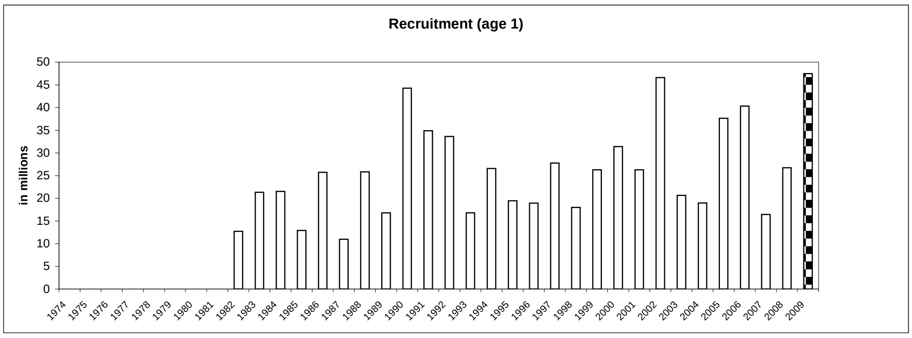


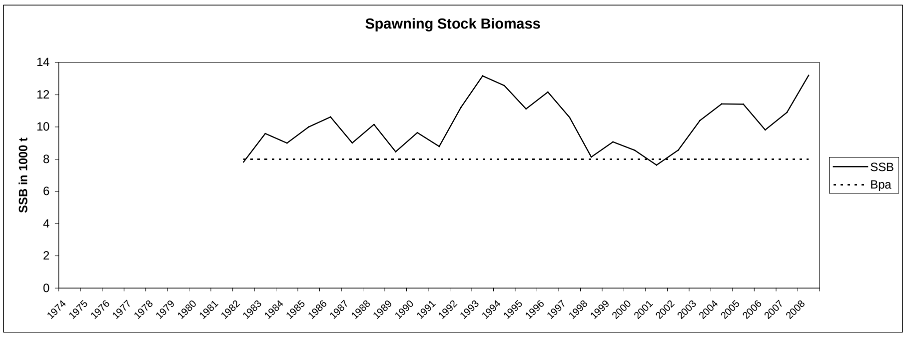
Figure 9.3.3 Sole in VIId. Summary plots







* Original XSA value 157912 replaced with RCT3 estimate of 47475



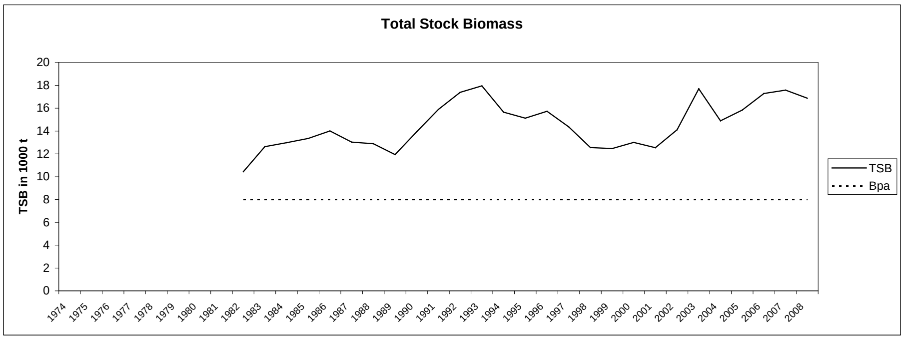
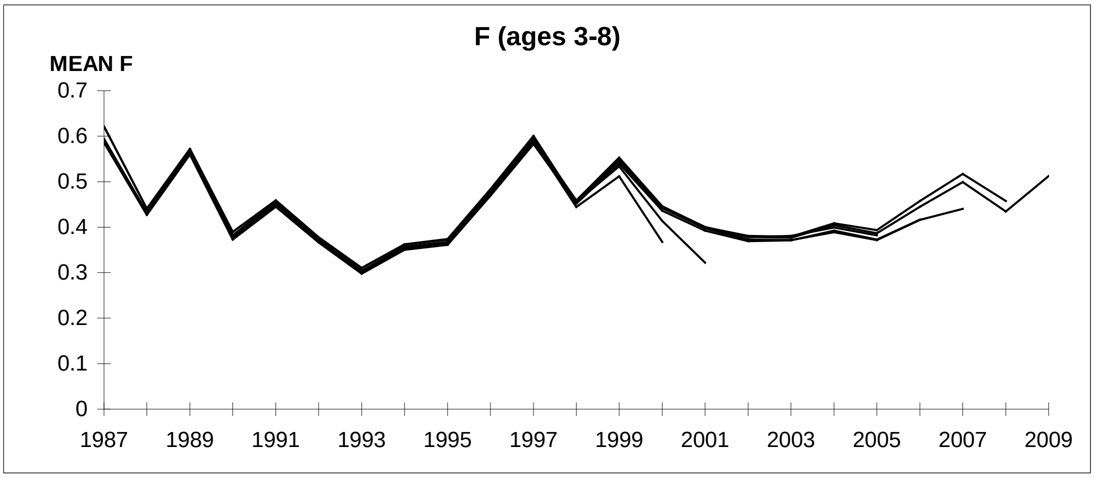
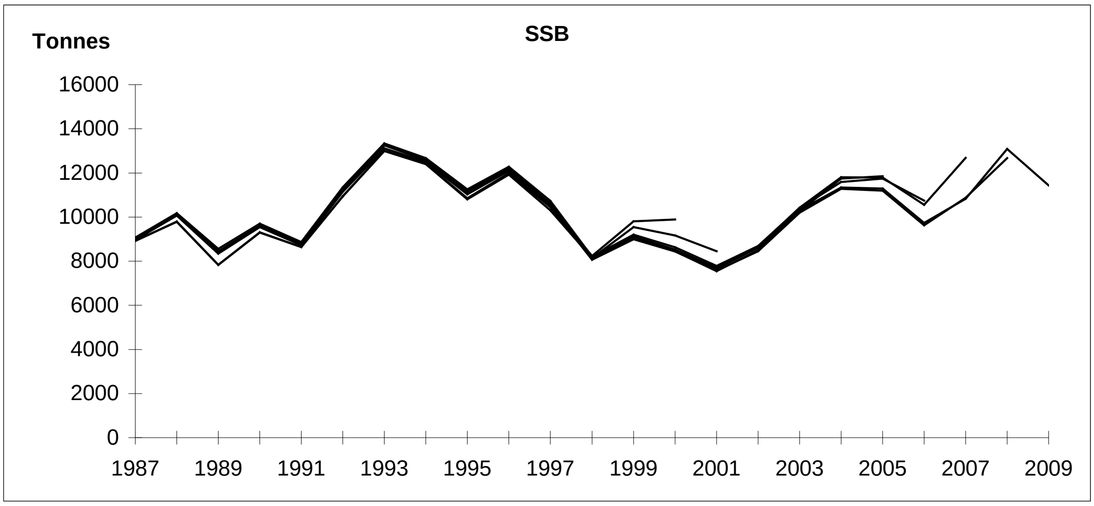
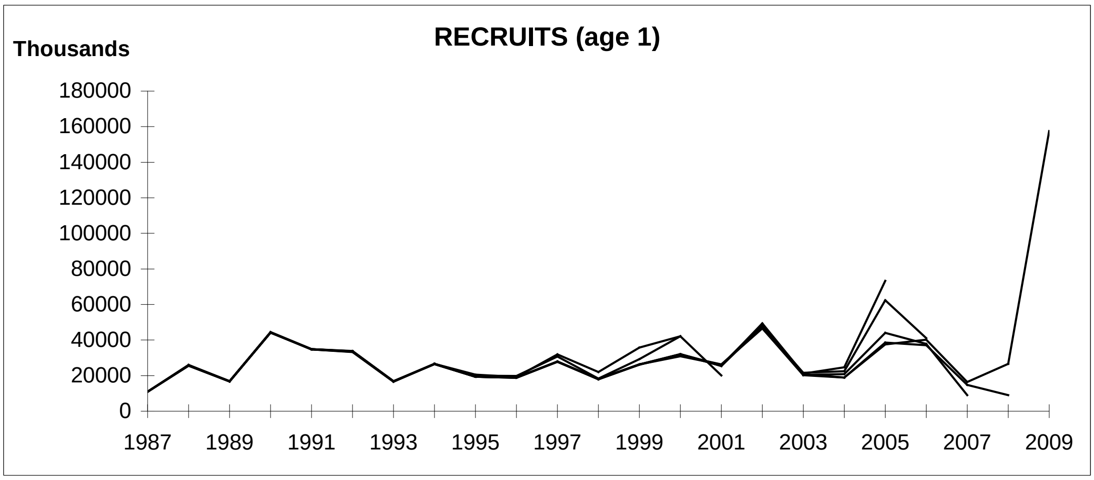


Figure 9.3.4 - Sole VIId retrospective XSA analysys (shinkage SE=2.0)







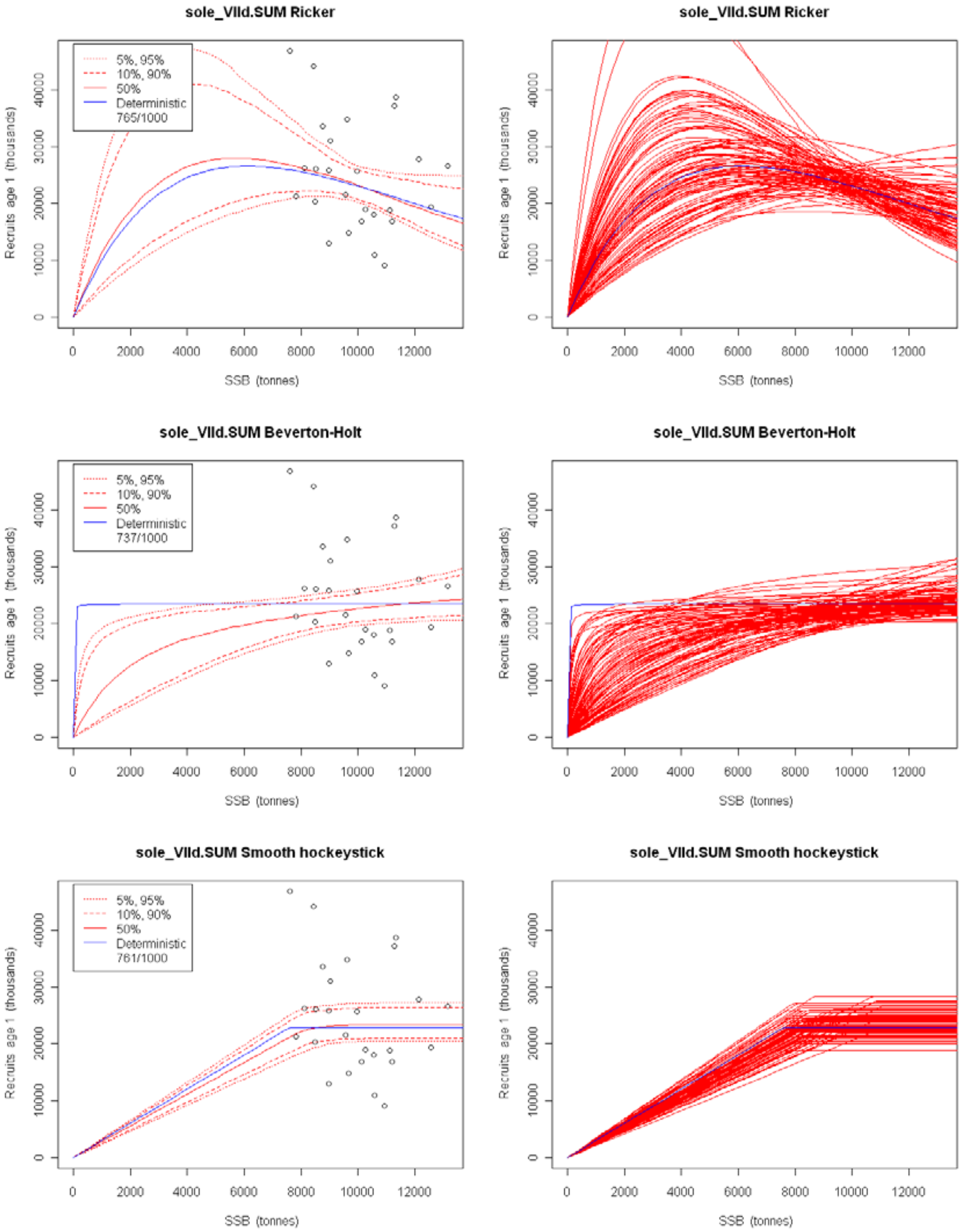


Figure 9.5.1 Sole in VIId – Stock / recruitment model-fit

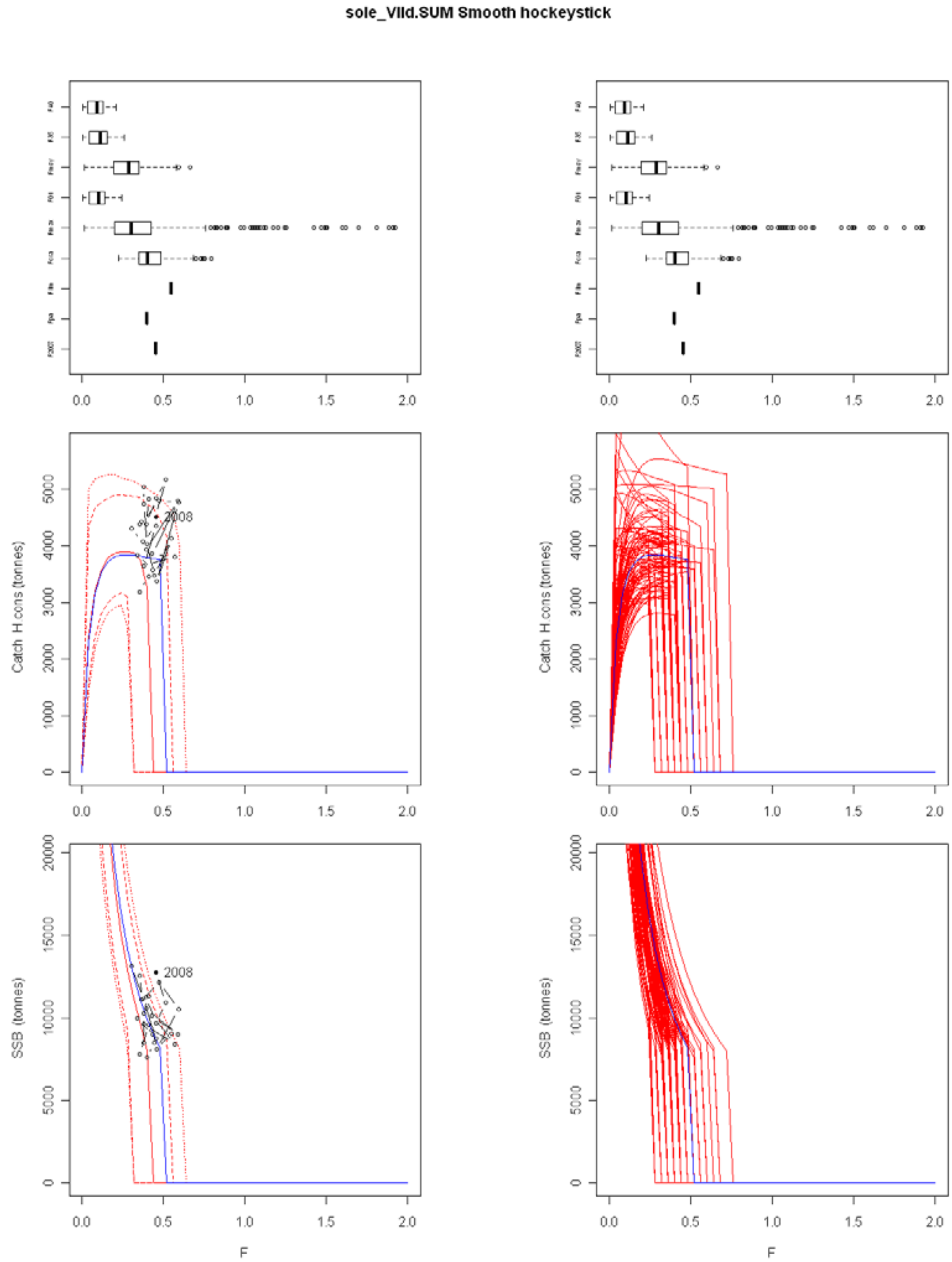


Figure 9.5.2 Sole in VIId – FMSY summary (Stock / Recruiment hockeystick model)

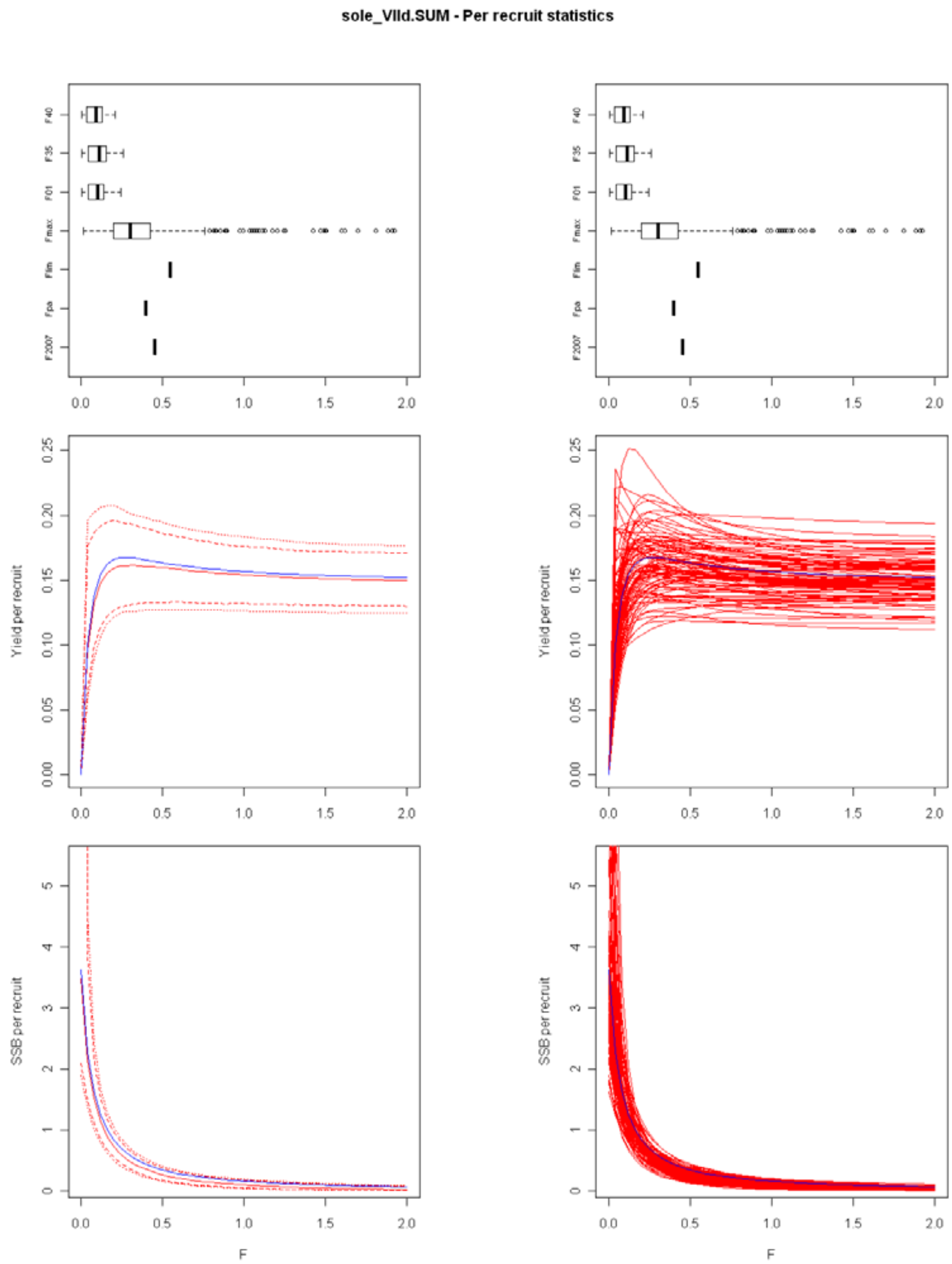
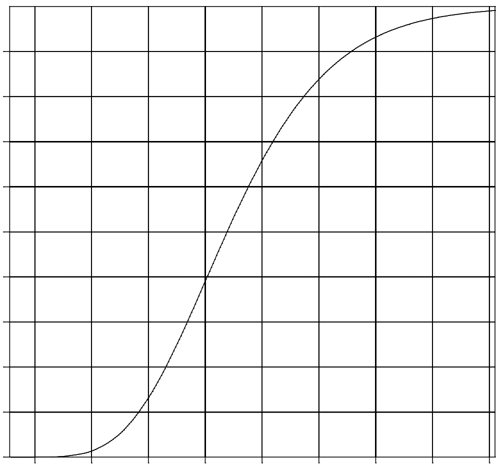


Figure 9.5.3 Sole in VIId – Yield / Recruit summary



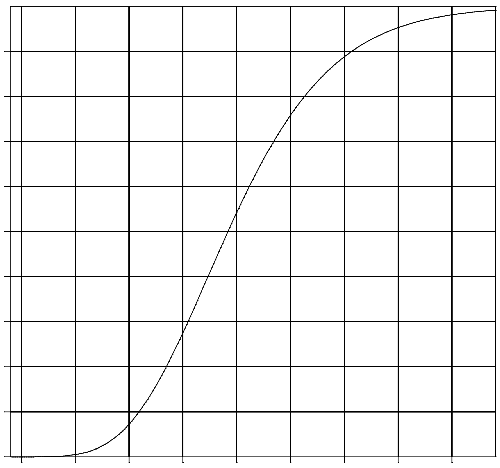
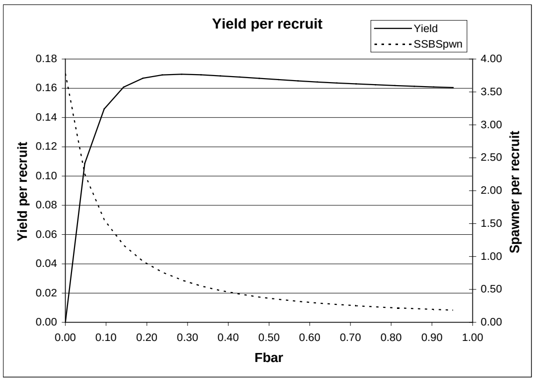
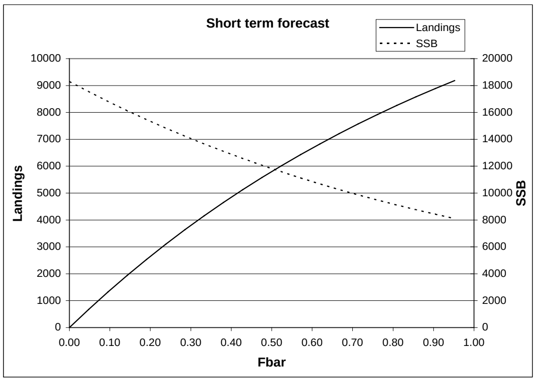


Figure 9.7.1 - Sole in VIId Yield per recruit and short term forecast plots





MFYPR version 2a
Run: S7d_fin_yield
Time and date: 13:30 08/05/2010

Reference point	F multiplier	Absolute F
Fbar(3-8)	1.0000	0.4760
FMax	0.5949	0.2832
F0.1	0.2188	0.1041
F35%SPR	0.2548	0.1213

MFDP version 1a
Run: S7d_fin
Sole in VIId
Time and date: 13:09 08/05/2010
Fbar age range: 3-8

Input units are thousands and kg - output in tonnes

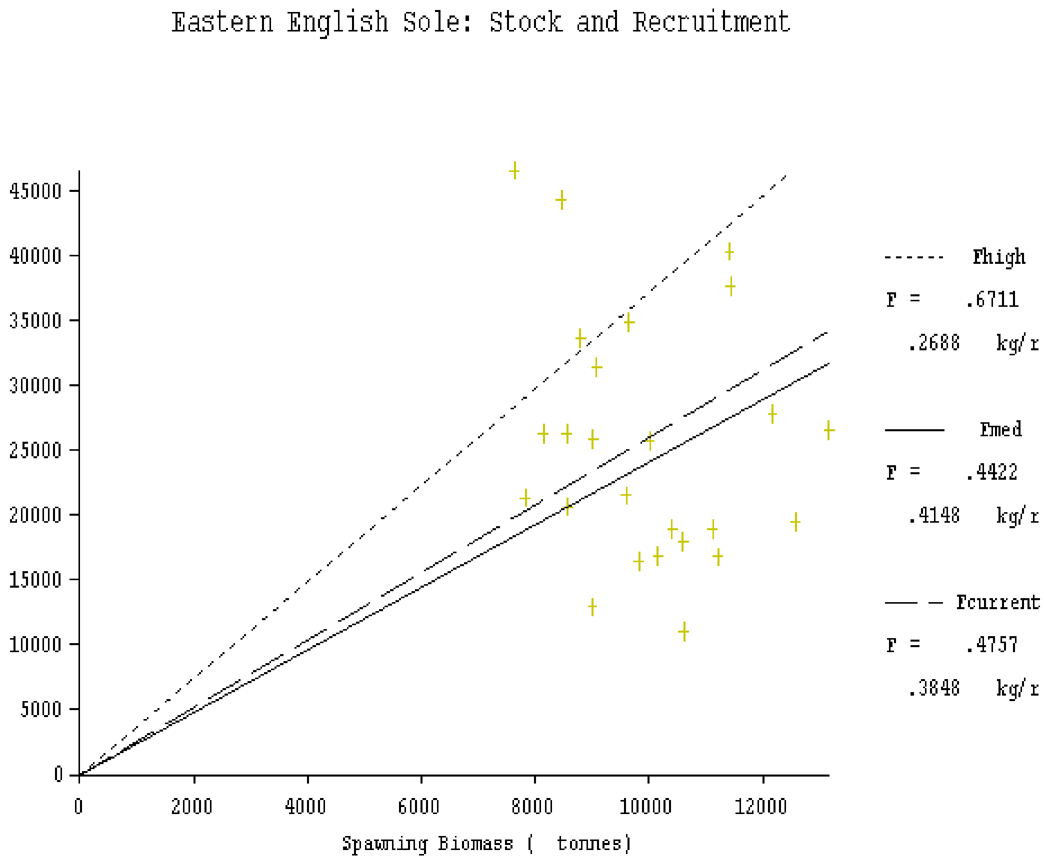
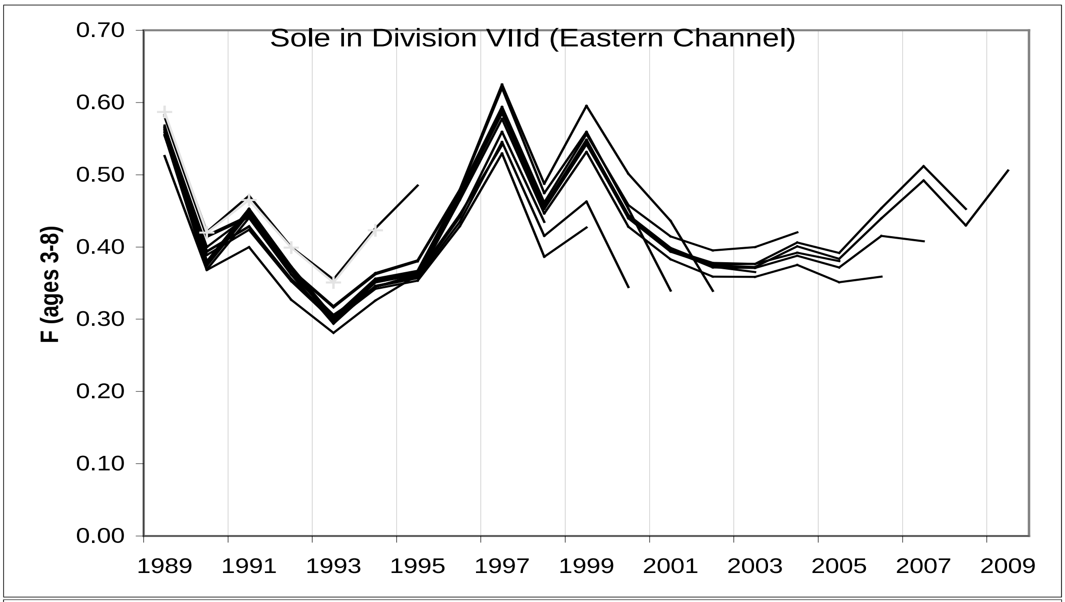
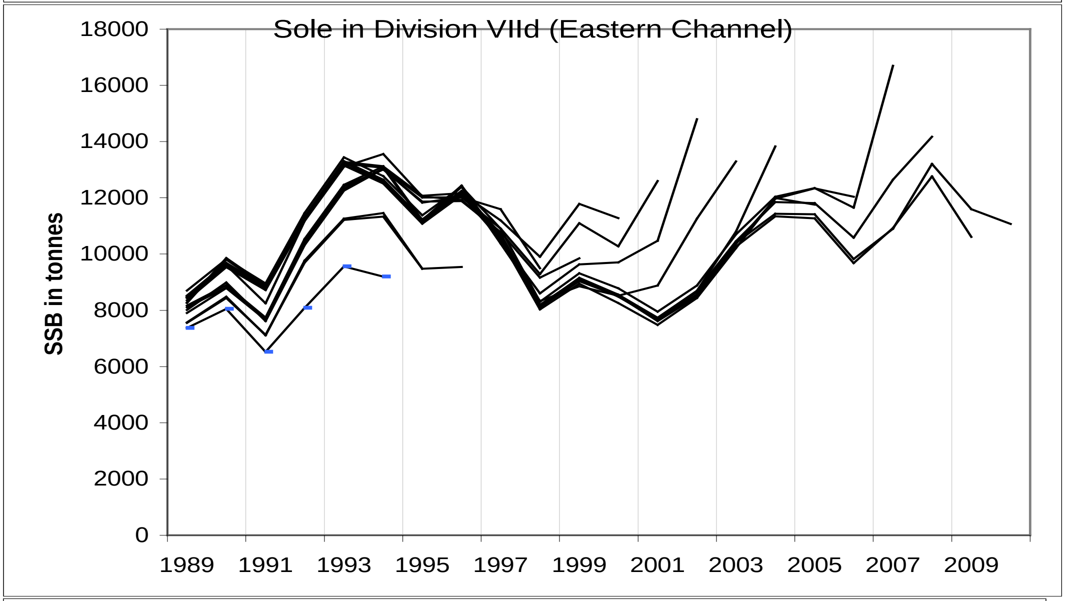
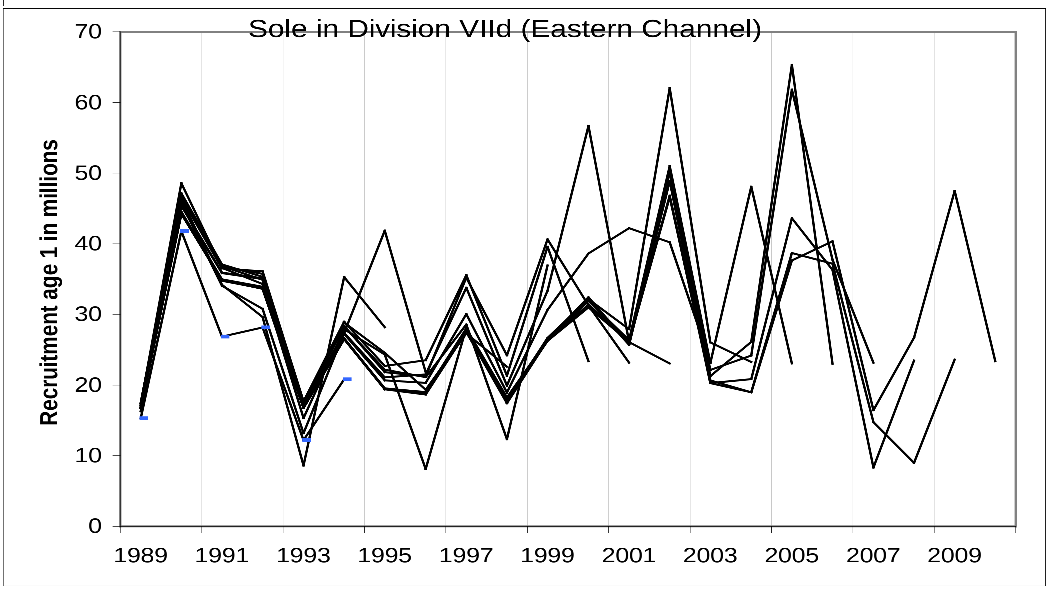


Figure 9.9.1 - Sole VIId Stock/recruitment plot

Figure 9.9.2 Sole in VIId. Historical Performance of assessment of successive WG assessment and forecast







10 Sole in Subarea IV

The assessment of sole in Subarea IV is presented as an update assessment with minor analysis requested by the review group. The most recent benchmark assessment was carried out in early 2010 (ICES WKFLAT 2010).

10.1 General

10.1.1 Ecosystem aspects

Sole growth rates in relation to changes in environmental factors were analysed by Rijnsdorp *et al.* (2004). Based on market sampling data it was concluded that both length at age and condition factors of sole increased since the mid 1960s to a high point in the mid 1970s. Since the mid 1980s, length at age and condition have been intermediate between the troughs (1960) and peaks (mid 1970s). Growth rates of the juvenile age groups were negatively affected by intra-specific competition. Length of 0-group fish in autumn showed a positive relationship with sea temperature in the 2nd and 3rd quarters, but for the older fish no temperature effect was detected. The overall pattern of the increase in growth and the later decline correlated with temporal patterns in eutrophication; in particular the discharge of dissolved phosphates from the Rhine. Trends in the stock indicators e.g. SSB and recruitment, did not coincide, however, with observed patterns in eutrophication.

In recent years no changes in the spatial distribution of juvenile and adult soles have been observed (Grift et al. 2004, Verver *et al,* 2001). The proportion of undersized sole (<24 cm) inside the Plaice Box did not change after its closure to large beamers and remained stable at a level of 60–70% (Grift *et al.*, 2004). The different length groups showed different patterns in abundance. Sole of around 5 cm showed a decrease in abundance from 2000 onwards, while groups of 10 and 15 cm were stable. The largest groups showed a declining trend in abundance, which had already set in years before the closure.

Mollet *et al* (2007) used the reaction norm approach to investigate the change in maturation in North Sea sole and showed that age and size at first maturity significantly shifted to younger ages and smaller sizes. These changes occurred from 1980 onwards. Size at 50% probability of maturation at age 3 decreased from 29 to 25 cm.

10.1.2 Fisheries

Sole is mainly caught by beam trawlers. A large proportion of the fishing effort on sole is exerted by the Dutch beam trawl fleet targeting sole and plaice with 80 mm mesh size. Fishing effort by the Dutch fleet peaked in the mid 1990s and has decreased thereafter and is now at a level comparable to the 1980s. In addition to the Dutch Beam trawl fleet sole is also caught by Belgian and German beam trawlers, by UK otter trawlers, and by a Danish fleet fishing with fixed nets.

The days at sea regulations, high oil prices, and different patterns in the history of changes in the TACs between plaice and sole have led to a transfer of effort from the northern to the southern North Sea. Here, sole and juvenile plaice tend to be more abundant leading to an increase in discarding of small plaice.

A change in efficiency of the commercial Dutch beam trawl fleet has been described by Rijnsdorp *et al* (2006) and was analyzed by the 2006 working group. Although the efficiency change improved XSA estimates, it was not included in the final assessment for data consistency reasons.

10.1.3 ICES Advice

Based on the most recent estimate of SSB (in 2009) and fishing mortality (in 2008), ICES classifies the stock as having full reproductive capacity and is being harvested sustainably. SSB has fluctuated around the precautionary reference points for the last decade, but has increased since 2008 owing to a large incoming 2005 year class and reduced fishing mortality. Fishing mortality has shown a declining trend since 1995 and is currently estimated to be below Fpa. The assessment suggests that the 2006 year class was below average, and 2007 average.

Single-stock exploitation boundaries

Considering the options below, ICES advises on the basis of exploitation boundaries in relation to the agreed management plan that landings should be less that 14 100 t in 2010.

Exploitation boundaries in relation to the agreed management plan

According to the management plan adopted by the EC in 2007, fishing mortality in 2010 should be reduced by 10% compared to the fishing mortality estimated for the preceding year (F2008=F2009=0.34) with the constraints that the TAC should not be changed by more than 15%. A 10% reduction in fishing mortality corresponds to an F of 0.304 and landings of 14 100t in 2010 which is within the 15% change (TAC 2009=14 000t).

Exploitation boundaries in relation to high long-term yield, low risk of depletion of production potential and considering ecosystem effects

The current fishing mortality is within the range that is expected to lead to high long-term yields and low risk to stock depletion.

Exploitation boundaries in relation to precautionary limits

The fishing mortality in 2010 should be no more than Fpa, corresponding to landings of less than 17800t.

Mixed fishery advice:

The information in this section is taken from the North Sea Advice overview section 6.3 in the ICES Advisory report 2008. The information has not been updated in 2009.

Demersal fisheries in the area are mixed fisheries, with many stocks exploited together in various combinations in the various fisheries. In these cases, management advice must consider both the state of individual stocks and their simultaneous exploitation in demersal fisheries. Stocks in the poorest condition, particularly those which suffer from reduced reproductive capacity, become the overriding concern for the management of mixed fisheries, where these stocks are exploited either as a targeted species or as a by-catch. The exploitation of sole and plaice are closely connected as they are caught together in fisheries mainly targeting sole, which are more valuable. This means that the minimum mesh size is decided on the basis of the more valuable species(sole), resulting in substantial discards of undersized plaice. The mixed fisheries for flatfish are dominated by a mixed beam trawl fishery using 80 mm mesh in the southern North Sea where up to 80% in number of all plaice caught are being discarded. Additionally, a shift in the age and size at maturation of plaice has been observed (Grift *et al.*, 2004): plaice become mature at younger ages and at smaller sizes in recent years than in the past. There is a risk that this is caused by a genetic fisheries-induced change: Those fish that are genetically programmed to mature late at large sizes are likely to have been removed from the population before they have had a chance to reproduce and pass on their genes. This shift in maturation also leads to mature fish being of a smaller size-at-age. Measures to reduce discarding in the mixed beam trawl fishery would greatly benefit the plaice stock and future yields. In order to improve the selection pattern, mesh size increases or configuration changes (i.e. square mesh) would help reduce the discards. However, this would result in a short-term loss of marketable sole. Readjustment of minimum landing sizes corresponding to an improved selection pattern could be considered.

Roundfish are caught in otter trawl and seine fisheries, with a 120 mm minimum mesh size. This is a mixed demersal fishery with more specific targeting of individual species in some areas and/or seasons. Cod, haddock, and whiting form the predominant roundfish catch although there can be important bycatches of other species, notably saithe and anglerfish in the northern and eastern North Sea and of *Nephrops* in the more offshore *Nephrops* grounds. Cod and whiting also comprise a bycatch in the beam trawl fisheries. Static gear fisheries with mesh sizes generally in excess of140 mm are also used to target cod. Saithe in the North Sea are mainly taken in a directed trawl fishery in deeper water near the northern shelf edge and the Norwegian Deeps. There is little bycatch of other demersal species associated with this directed fishery.

Discards remain high in most of the fisheries (whiting, haddock, plaice, and cod). Any improvements to gear selectivity which would contribute to a reduction in catches of small fish must take into account the effect on the other species within the mixed fishery. For instance, mesh enlargement in the flatfish fishery would reduce the catch of undersized plaice, but would also result in short-term loss of marketable sole. An increase in the minimum landing size of sole could provide an incentive to fish with larger mesh sizes and therefore mean a reduction in the discarding of plaice.

Nephrops fisheries take place in discrete areas where appropriate muddy seabed sediment is found. Targeted *Nephrops* fisheries on these grounds are taken predominantly in trawls with mesh sizes of between 70 mm and 100 mm using single- or multiple-rig trawls. UK legislation prohibits the use of meshes less than 100 mm in most of its twin-trawl *Nephrops* fishery, particularly in the offshore areas. *Nephrops* fishing grounds vary from small, localized inshore grounds to more offshore large areas such as the Fladen Ground in the northern North Sea, and while there is bycatch and discarding of other demersal species associated with *Nephrops*, the general nature of these fisheries and their bycatch can vary widely. Prior to the increase in minimum mesh size (MMS) in 2003, a significant proportion of the vessels reporting *Nephrops* also recorded significant catches of other whitefish species. These vessels used 100 mm mesh in order to avoid catch composition regulations. However, following the mesh size increases almost all of these vessels switched to 80 mm mesh to avoid losses of *Nephrops*. This is likely to have resulted in increased discards because of lower selection and highgrading due to catch composition regulations associated with the mesh size. There is an urgent need to obtain selection patterns similar to a 120 mm mesh codend while still retaining *Nephrops* (Graham and Ferro, 2004). Solutions could, e.g., include modifications to the square mesh panel construction and location. Small-mesh industrial fisheries for sandeel and Norway pout occur separately in the North Sea. Sandeel fisheries take place throughout the North Sea in areas defined by the appropriate sandy seabed sediment. These fisheries have a low bycatch rate of important demersal species. Fishing for Norway pout takes place in the northern and northeastern North Sea and has high bycatch rates of other species such as haddock and whiting. This impact has been considerably reduced since the mid-1990s following reductions in the abundance of the bycatch species and consequent low TACs.

The available national logbook data suggest that landed bycatch of fish for human consumption from the *Pandalus* fisheries in Skagerrak and the Norwegian deep amounts to 10–15% of landed shrimp. In the Fladen Ground fishery for *Pandalus* (Danish logbook records) this bycatch varies from 8% to 20% relative to shrimp landings.

10.1.4 Management

The TAC for 2010 was set at 14 100 tones. The TAC for 2009 was 14 000 tonnes, which is 48 tonnes higher than the working group estimated landings (Table 10.2.1).

A long term management plan proposed by the Commission of the European Community was adopted by the Council of the European Union in June 2007 and first implemented in 2008 (EC Council Regulation No 676/2007). The plan consists of two stages. The first phase aims to ensure the return of the stocks of plaice and sole to within safe biological limits. This should be reached through a reduction of fishing mortality by 10% in relation to the fishing mortality estimated for the preceding year until an F of *circa* 0.2 is reached. ICES interprets the F for the preceding year as the estimate of F for the year in which the assessment is carried out. The basis for this F estimate will be constant over the years. The plan sets a maximum change of 15% in TAC between consecutive years.

Articles 1 to 9 of Council Regulation (EC) No 676/2007 of 11 June 2007 establishing a multiannual plan for fisheries exploiting stocks of plaice and sole in the North Sea. Official Journal L 157 , 19/06/2007 P. 0001–0006

CHAPTER I

SUBJECT-MATTER AND OBJECTIVE

Article 1

Subject-matter

This Regulation establishes a multiannual plan for the fisheries exploiting the stocks of plaice and sole that inhabit the North Sea.

For the purposes of this Regulation, "North Sea" means the area of the sea delineated by the International Council for the Exploration of the Sea as Subarea IV.

Article 2

Safe biological limits

1) *For the purposes of this Regulation, the stocks of plaice and sole shall be deemed to be within safe biological limits in those years in which, according to the opinion of the Scientific, Technical, and Economic Committee for Fisheries (STECF), all of the following conditions are fulfilled:*

the spawning biomass of the stock of plaice exceeds 230 000 tonnes;

the average fishing mortality rate on ages two to six years experienced by the stock of plaice is less than 0,6 per year;

the spawning biomass of the stock of sole exceeds 35 000 tonnes;

the average fishing mortality rate on ages two to six years experienced by the stock of sole is less than 0,4 per year.

If the STECF advises that other levels of biomass and fishing mortality should be used to define safe biological limits, the Commission shall propose to amend paragraph 1.

Article 3

Objectives of the multiannual plan in the first stage

2) *The multiannual plan shall, in its first stage, ensure the return of the stocks of plaice and of sole to within safe biological limits.*

3) *The objective specified in paragraph 1 shall be attained by reducing the fishing mortality rate on plaice and sole by 10% each year, with a maximum TAC variation of 15% per year until safe biological limits are reached for both stocks.*

Article 4

Objectives of the multiannual plan in the second stage

4) *The multiannual plan shall, in its second stage, ensure the exploitation of the stocks of plaice and sole on the basis of maximum sustainable yield.*

5) *The objective specified in paragraph 1 shall be attained while maintaining the fishing mortality on plaice at a rate equal to or no lower than 0,3 on ages two to six years.*

6) *The objective specified in paragraph 1 shall be attained while maintaining the fishing mortality on sole at a rate equal to or no lower than 0,2 on ages two to six years.*

Article 5

Transitional arrangements

7) *When the stocks of plaice and sole have been found for two years in succession to have returned to within safe biological limits the Council shall decide on the basis of a proposal from the Commission on the amendment of Articles 4(2) and 4(3) and the amendment of Articles 7, 8 and 9 that will, in the light of the latest scientific advice from the STECF, permit the exploitation of the stocks at a fishing mortality rate compatible with maximum sustainable yield.*

8) *The Commission's proposal for review shall be accompanied by a full impact assessment and shall take into account the opinion of the North Sea Regional Advisory Council.*

CHAPTER II

TOTAL ALLOWABLE CATCHES

Article 6

Setting of total allowable catches (TACs)

Each year, the Council shall decide, by qualified majority on the basis of a proposal from the Commission, on the TACs for the following year for the plaice and sole stocks in the North Sea in accordance with Articles 7 and 8 of this Regulation.

Article 7

Procedure for setting the TAC for plaice

9) *The Council shall adopt the TAC for plaice at that level of catches which, according to a scientific evaluation carried out by STECF is the higher of:*

a) that TAC the application of which will result in a 10% reduction in the fishing mortality rate in its year of application compared to the fishing mortality rate estimated for the preceding year;

b) that TAC the application of which will result in the level of fishing mortality rate of 0,3 on ages two to six years in its year of application.

Where application of paragraph 1 would result in a TAC which exceeds the TAC of the preceding year by more than 15%, the Council shall adopt a TAC which is 15% greater than the TAC of that year.

Where application of paragraph 1 would result in a TAC which is more than 15% less than the TAC of the preceding year, the Council shall adopt a TAC which is 15% less than the TAC of that year.

Article 8

Procedure for setting the TAC for sole

10) The Council shall adopt a TAC for sole at that level of catches which, according to a scientific evaluation carried out by STECF is the higher of:

c) that TAC the application of which will result in the level of fishing mortality rate of 0,2 on ages two to six years in its year of application;

d) that TAC the application of which will result in a 10% reduction in the fishing mortality rate in its year of application compared to the fishing mortality rate estimated for the preceding year.

Where the application of paragraph 1 would result in a TAC which exceeds the TAC of the preceding year by more than 15%, the Council shall adopt a TAC which is 15% greater than the TAC of that year.

Where the application of paragraph 1 would result in a TAC which is more than 15% less than the TAC of the preceding year, the Council shall adopt a TAC which is 15% less than the TAC of that year.

CHAPTER III

FISHING EFFORT LIMITATION

Article 9

Fishing effort limitation

11) The TACs referred to in Chapter II shall be complemented by a system of fishing effort limitation established in Community legislation.

12) Each year, the Council shall decide by a qualified majority, on the basis of a proposal from the Commission, on an adjustment to the maximum level of fishing effort available for fleets where either or both plaice and sole comprise an important part of the landings or where substantial discards are made and subject to the system of fishing effort limitation referred to in paragraph 1.

13) The Commission shall request from STECF a forecast of the maximum level of fishing effort necessary to take catches of plaice and sole equal to the European Community's share of the TACs established according to Article 6. This request shall be formulated taking account of other relevant Community legislation governing the conditions under which quotas may be fished.

14) The annual adjustment of the maximum level of fishing effort referred to in paragraph 2 shall be made with regard to the opinion of STECF provided according to paragraph 3.

15) *The Commission shall each year request the STECF to report on the annual level of fishing effort deployed by vessels catching plaice and sole, and to report on the types of fishing gear used in such fisheries.*

16) *Notwithstanding paragraph 4, fishing effort shall not increase above the level allocated in 2006.*

17) *Member States whose quotas are less than 5% of the European Community's share of the TACs of both plaice and sole shall be exempted from the effort management regime.*

18) *A Member State concerned by the provisions of paragraph 7 and engaging in any quota exchange of sole or plaice on the basis of Article 20(5) of Regulation (EC) No 2371/2002 that would result in the sum of the quota allocated to that Member State and the quantity of sole or plaice transferred being in excess of 5% of the European Community's share of the TAC shall be subject to the effort management regime.*

19) *The fishing effort deployed by vessels in which plaice or sole are an important part of the catch and which fly the flag of a Member State concerned by the provisions of paragraph 7 shall not increase above the level authorised in 2006.*

ICES evaluated the management plan for North Sea plaice and sole at the end of May 2008. It was accepted for sole and ICES concluded that it was in accordance with the precautionary approach (unpublished review of an evaluation of the management plan for fisheries exploiting the stocks of plaice and sole in the North Sea (EC 676/2007) by ICES in 2008, see also Machiels et al. ICES WGNSSK, 2008, WD2).

The minimum landing size of North Sea sole is 24 cm. A closed area has been in operation since 1989 (the plaice box) and since 1995 this area has been closed in all quarters. The closed area applies to vessels using towed gears, but vessels smaller than 300 HP are exempted from the regulation. An additional technical measure concerning the fishing gear is the restriction of the aggregated beam length of beam trawlers to 24 m. In the 12 nautical mile zone and in the plaice box the maximum aggregated beam-length is 9 m.

Effort has been restricted because of implementation of a days-at-sea regulation for the cod recovery plan and fishing effort limitation of the long term management plan (EC Council Regulation No. 2056/2001; EC Council Regulation No 676/2007; EC Council Regulation 40/2008).

For 2008 Council Regulation N°40/2008, annex IIa allocates different days at sea depending on gear, mesh size and catch composition. (see section 2for a complete list). The days at sea limitations for the major fleets operating in ICES sub-area IV can be summarised as follows: Beam trawlers can fish between 119–143 days per year. Trawls or Danish seines can fish between 103 and 280 days per year. Gillnets are allowed to fish between 140 and 162 days per year and Trammel nets between 140 and 205 days.

For 2009 and 2010, Council Regulation (EC) N°43/2009 and Council Regulation (EC) N°23/2010 allocate different amounts of Kw*days by Member State and area to different effort groups of vessels depending on gear and mesh size. (see section 1.2.1 for complete list). The area's are Kattegat, part of IIIa not covered by Skagerak and Kattegat, ICES zone IV, EC waters of ICES zone IIa, ICES zone VIId, ICES zone VIIa, ICES zone Via and EC waters of ICES zone Vb. The grouping of fishing gear concerned are: Bottom trawls, Danish seines and similar gear, excluding beam trawls of mesh size: TR1 (≤ 100 mm) – TR2 (≤ 70 and < 100 mm) – TR3 (≤ 16 and < 32 mm);

Beam trawl of mesh size: BT1 (≤ 120 mm) – BT2 (≤ 80 and < 120 mm); Gill nets excluding trammel nets: GN1; Trammel nets: GT1 and Longlines: LL1.

Technical measures applicable to the flatfish beam trawl fishery before 2000 were an exemption to use 80 mm mesh cod-end when fishing south of 55°North. From January 2000, the exemption area extends from 55°North to 56°North, east of 5°East latitude. Fishing with 80 mm mesh cod-end is permitted within that area provided that the landings comprise at least 70% of a mix of species, which are defined in the technical measures of the European Community (EC Council Regulation 1543/2000). In January 2002 the cod recovery plan was instigated, which allowed a maximum cod by-catch of 20% of the total catch. In the area extending from 55°North to 56° North, east of 5°East latitude, a maximum cod by-catch of 5% is allowed. Minimum cod-end mesh in this area is 100 mm, while above 56°North the minimum cod-end mesh is 120 mm (EC Council Regulation 2056/2001) .

10.2 Data available

Catch

Landings data by country and TACs are presented in Table 10.2.1 and total landings are presented in Figure 10.2.1a. In 2009 approximately 110% of the TAC was taken. The discards percentages observed in the Dutch discard sampling programme sampling beam trawl vessels fishing for sole with 80 mm mesh size were much lower for sole (for 2002–2008, between 10–17% by weight, see Table 10.2.2) than for plaice. No significant trends in discard percentages were observed. Inclusion of a stable time series of discards in the assessment will have minor effect on the relative trends in stock indicators (Kraak *et a*l 2002; Van Keeken *et al* 2003). The main reason for not including discards in the assessment is that the discarding is relatively low in all periods for which observations are available. In addition, gaps in the discard sampling programs result in incomplete time series.

Age compositions

The age composition of the landings is presented in Table 10.2.3. Age compositions and mean weight at age in the landings were available on a quarterly basis from Denmark, France, Germany (sexes combined) and The Netherlands (by sex). Age compositions on an annual basis were available from Belgium (by sex). Overall, the samples are thought to be representative of around 85% of the total landings in 2009. The age compositions were combined separately by sex on a quarterly basis and then raised to the annual international total (see also section 1.2.4). Recently the sole population (Figure 10.2.1) has been dominated by the strong 2005 year class which were age 4 in 2009 (~26 million). Log catch ratios and catch curves for sole ages 2 to 9 are summarised in Figures 10.2.2 a and b (1957 to 2009).

This year, only a very limited number of countries put their landings data in InterCatch before the agreed deadline. After the deadline several, though not all, countries added their landings data to the InterCatch database. Because of time constraints and incomplete data, InterCatch was not used for raising the landings.

Weight at age

Weights at age in the landings for both sexes combined (Table 10.2.4) are measured weights from the various national market sampling programs. Weights at age in the stock (stock weights, Table 10.2.5) are the average weights from the 2nd Quarter landings. Over the entire time series, weights were higher between the mid 1970s and mid 1980s (Figs 10.2.1c & d) for the younger age groups compared to time periods before and after. Estimates of weights for the older ages fluctuate more because of smaller samples sizes due to decreasing numbers of older fish in the stock and hence landings.

The stock weights at age data for the two sexes separately are available from the different countries fishing for sole over different time-spans and the trends were explored during the Benchmark Assessment (WKFLAT 2010) when it was demonstrated that the weighted averaging procedure for combining the data of the different countries to obtain North Sea wide estimates of stock weights by sex results in the same dome-shaped pattern in the two sexes separately as is observed when the sexes are combined. The stock weights of females and males show similar trends (see WKFLAT Final Report 2010) . As expected, the female weights are higher than the male weights. This is especially pronounced in the older ages, and caused by the differential growth rates.

In order to test whether the dome shaped pattern was caused by a bias due to differences in the protocols used by the contributing countries over time, a GAM regression model was fitted to the data during WKFLAT. The model disentangled country, year and sex effects for each of the ages i on the stock weight W_i separately, by using:

$$W_i = s(year) + s(year, by=sex) + sex + country,$$

where sex and country are factor variables , and s(year) is a smooth function of numeric 'year'. The term s(year, by=sex) allows for testing whether the shape of the stock weight change over time is different for each sex.

The model results indicated that there has been a dome shaped pattern in the stock weights over time, independent of the difference in countries that contribute to the data. There were significant differences in the level or *average stock weight* by age observed by the different countries. The stock weights observed in the UK, for example, were generally lower than those observed elsewhere. On the other hand, the German stock weights at age are generally higher. Strikingly, the difference between the countries appears to increase with increasing age of the fish. WKFLAT 2010 concluded that the spatio-temporal patterns in sole weight at age required some more investigation.

WKFLAT 2010 also noted a substantial change in sex ratio in sole at the larger market categories in the Dutch market data. Market category (MC) 5 represents the smallest/youngest fish and MC 1 the largest/oldest. In the mid-1980s, for example, there were *ca* 50 times more females in MC 1 than males while by the late 2000s this had changed to *ca* 500 times more females (see WKFLAT 2010 Final Report). It was not thought that this is due to a sampling bias. It was suggested the observation might be related to a closure of the Plaice Box where sole spawn, but this was rejected as an explanation since only sole caught by boats > 300hp were used in the investigation. WKFLAT 2010 concluded that this phenomenon required further investigation.

10.2.1 Maturity and natural mortality

As in previous North Sea sole assessments, a knife-edged maturity-ogive was used, assuming full maturation at age 3. The maturity-ogive is based on market samples of females from observations in the sixties and seventies. Mollet *et. al*. (2007) described the shift of the age at maturity towards younger ages and these results were considered at the benchmark assessment. Dutch market sampling data 1957-2008 summarizing the state of sexual maturity of sole were gathered together and combined with data from the surveys. Considerable problems were encountered, however, when an attempt was made to estimate a long-term trend from the data. Firstly the state of sexual maturity should be assessed from individuals caught during Quarter 1 due to the possibility of confusion between immature fish and post-spawners. Secondly the MLS for sole is 23cm meaning that there are very few immature individuals available at all and survey data could not be used because they are only available for Quarter 3. Thirdly there is considerable doubt whether male sole can be staged at all due to their minute gonads (A. Rijnsdorp, pers.com.). At the Benchmark Assessment a very crude time-invariant ogive was estimated according to a logistic regression model [e.g. Probablity of being mature was modelled as a function of age and sex]. According to this model 29% of age 1 female sole, 78% age 2 female sole and 97% of age 3 female sole are sexually mature. Males mature earlier and 50% of age 1s, 89% of age 2s and 99% of age 3s are mature. More work is required before reliable time trends in these data can be derived and the question of the staging of male sole needs to be addressed.

Natural mortality in the period 1957–2009 has been assumed constant over all ages at 0.1, except for 1963 where a value of 0.9 was used to take into account the effect of the severe winter (1962–1963) (ICES-FWG 1979). The current winter (2009-2010) has also been particularly cold and WKFLAT suggested that its potential influence on the sole stock should be carefully considered in the future.

10.2.2 Catch, effort and research vessel data

One commercial and two survey series were used to tune the assessment. Effort for the Dutch commercial beam trawl fleet is expressed as total HP effort days and was revised in 2009 due to a database change. Effort increased between 1997 and 1998 where it peaked and has since steadily declined. Effort during 2009 was <50% of the level in 1998 in the series (Table 10.2.6 and 10.2.7 cont.). A slight increase in fishing effort (ca 5%) was recorded between 2008 and 2009.

Trends in the revised commercial LPUE of the Dutch beam trawl fleet are compared with the 'old' values in Figure 10.2.3. The LPUE estimated for 2009 (354 kg day^{-1}) was substantially above the 1997-2009 mean (253 kg day^{-1}).

The BTS (Beam Trawl Survey) is carried out in the southern and south-eastern North Sea in August and September using an 8m beam trawl. The SNS (Sole Net Survey) is a coastal survey with a 6m beam trawl carried out in the 3rd quarter. In 2003 the SNS survey was carried out during the 2nd quarter and data from this year were omitted (Table 10.2.7 and Figure 10.2.4). The research vessel survey time series have been revised by WGBEAM (ICES-WGBEAM, 2009), because of small corrections in data bases and new solutions for missing lengths in the age-length-keys.

10.3 Data analyses

The assessment of North Sea sole was carried out using the FLR version of XSA (2.8.1) in R version 2.8.1.

Reviews of last year's assessment

Comments made in 2009 by the RGNSSK (Technical Minutes), which accepted last year's assessment, are summarised below in italics, and it is explained how this WG addressed the comments.

General comments

Fishing effort and fishing mortality have been substantially reduced since 1995. Mixed fisheries for sole and plaice complicates the management, current minimum mesh size is suitable for sole but generates high discards of plaice. Sole stock dynamics is heavily dependent on occasional strong year classes. Evolutionary effects of fishing: age and size at first maturity shifted to younger ages from 1980 onwards. This will be one of the issues in the next benchmark assessment.

Technical comments

The scenarios in the short-term forecasts are almost similar and therefore there is no big difference in the results – uncertainty in the results is certainly larger than the differences.

Figures 10.3.2. and 10.3.4.: It seems that in the retrospective analysis the commercial indices were used in the analysis for mean F (black lines in Fig. 10.3.2.) but survey indices for recruitment and SSB (grey lines)? Check which series was used in actual calculations. WGNSSK 2010 comment**:** This is just a misunderstanding. The grey lines are indeed a retrospective pattern fitted with just survey data while the black lines are a retrospective pattern fitted with commercial tuning only. This is just an 'exploratory' assessment demonstrating the different signals due to the two main types of tuning series.

Fig. 10.4.1.: The bottom right panel is landings, not recruitment. Caption needs to be changed. WGNSSK 2010 comment: this was changed.

Fig. 10.6.2.: The equilibrium curves presented here do not fit the with the data points. Recruitment seems not to be dependent of the SSB, and the yield not dependent on F. Are there environmental effects that determine the recruitment? Could such factors be incorporated in the analysis? The number of recruits and SSB have been fluctuating within a steady range since the latter half of the 1990s even if F has been decreasing. WGNSSK 2010 comment: indeed it appears that there is a weak relationship between R and SSB within the observed range of the data.

Conclusions

The assessment has been performed correctly but the reference points may be uncertain. The stock seems to fluctuate almost irrespective of the fishing effort.

10.3.1 Exploratory catch-at-age-based analysis

Three tuning indices were included in the assessment. During the Benchmark Assessment (WKFLAT 2010) a large range of exploratory analyses were carried out to explore the sensitivity of the assessment to various combinations of input data. Sex separated assessments were done and a range of commercial tuning indices - including one derived from 'specialist sole boats' suggested by the fishing industry – were tried (see WKFLAT 2010 Final Report for details).

The main problem in the North Sea sole stock assessment is a consistent bias in the retrospective pattern, particularly on fishing mortality. When survey data (BTS-ISIS and SNS) were used alone in the assessment the retrospective pattern reverses, suggesting conversely that F estimates have been too low over the last few years. Hence survey data suggest higher Fs, and commercial data lower Fs (see Figure 10.3.2), the different tuning series thus conveying different information. This problem was investigated exhaustively during the Benchmark Assessment (WKFLAT 2010). The conclusion was to recommend an XSA model tuned with commercial fleet data cut off before 1997 (see Table 10.2.7). This eliminated the retrospective bias problem because the smaller subset of the commercial data clearly has less of a problem with time-dependent or evolving catchabilities. This corroborated the finding of a break-point in the catchability estimates for the commercial tuning index in the mid 90s described in the 2005 Report of the working group on the assessment of demersal stocks in the North Sea and Skagerrak.

Standardized log catchability residual plots of the 3 tuning series included as single fleets in XSA assessments are shown in Figure 10.3.1 and the log catchability residual plots for the combined fleets of the 3 tuning series are shown in Figure 10.3.3. Figure 10.3.2 shows the XSA retrospective analysis of fishing mortality for different combinations of indices. Figure 10.3.4 presents the retrospective analysis of F, SSB and recruitment when the 3 fleets of the tuning series were combined. The plot shows that mean F was slightly overestimated in 2008.

In addition to XSA , SCAA (Statistical Catch-at-Age) and SAM (State space models) were also described and fitted to the North Sea sole data during WKFLAT 2010. Here the results from a SAM fit to the latest data for North Sea sole are displayed (see Figure 10.3.5a,b,c). The model gives similar outputs and time trends to the XSA. SSB, for example, estimated by SAM was 33 900t in 2009 versus 34 600t in 2009 for XSA (see Table 10.4.1).

Exploratory investigation of Maximum Sustainable Yield

Estimates of MSY, FMSY and BMSY were made using the approach of Darby and Oliveira (see WKFRAME Final Report, 2010 and section 1.3.1). The estimates were based on the following three non-linear models fitted to stock-recruit data: Ricker, Beverton and Holt and "Smooth Hockeystick"(see Figure 10.3.6). The fit to Beverton and Holt was poor. Both the Ricker and the "Smooth Hockeystick" model gave acceptable fits but, since Fmax was so poorly defined in the sole stock recruitment relationship, the Smooth Hockeystick model had also to be rejected. This leaves the Ricker function as our 'best' model to describe the data from a statistical standpoint and it was selected as our final model. It is, however, more difficult (but probably not impossible) to explain the selection of the Ricker model biologically (ie. cannibalism is unlikely in sole). The data and some diagnostics for the three fits are displayed in Table 10.3.4. The Ricker fits are highlighted in green. **Fmsy** was estimated to be 0.22; **Bmsy** to be 43 800t; and MSY to be 17 000t. This model also suggests that there is a 5% chance of 'crashing the stock' (Fcrash) at a fishing mortality of 0.28.

Exploratory survey-based analyses

No survey-based analysis was carried out in this year's WG.

Conclusions drawn from exploratory analyses

The WG concluded that the 2009 update assessment would be done with an XSA tuned with two survey series (BTS-ISIS and SNS) and one commercial series (NL beam trawl LPUE). See also recommendations from WKFLAT 2010 summarised below..

Final assessment

Catch at age analysis was carried out with XSA using the settings given below.

YEAR	2008	2009	2010
Catch at age	Landings	Landings	Landings
Fleets	BTS-Isis 1985–2007 SNS 1982–2007 Nl-BT 1990–2007	BTS-Isis 1985–2008 SNS 1982–2008 Nl-BT 1990–2008	BTS-Isis 1985–2009 SNS 1982–2009 Nl-BT 1997–2009
Plus group	10	10	10
First tuning year	1982	1982	1982
Last data year	2007	2008	2009
Time series weights	No taper	No taper	No taper
Catchability dependent on stock size for age <	2	2	2
Catchability independent of ages for ages >=	7	7	7
Survivor estimates shrunk towards the mean F	5 years / 5 ages	5 years / 5 ages	5 years / 5 ages
s.e. of the mean for shrinkage	2.0	2.0	2.0
Minimum standard error for population estimates	0.3	0.3	0.3
Prior weighting	Not applied	Not applied	Not applied

The full diagnostics are presented in Table 10.3.1. The XSA model converged after 27 iterations. A summary of the input data is given in Figure 10.2.1. Figure 10.3.2 shows the log catchability residuals for the tuning fleets in the final run. Fishing mortality and stock numbers per age group are shown in Tables 10.3.2 and 10.3.3 respectively. The SSB in 2008 was estimated at around 38 000 t (Table 10.4.1) which has decreased to around 35 000 t in 2009. Mean F(2–6) was estimated at 0.36 which has increased since last year but is still an historically low value (see Table 10.4.1). Recruitment of the 2008 year class, in 2009 (age 1), was estimated at 103 million. Retrospective analysis is presented in Figure 10.3.4. Slight underestimation of mean *F* from 2000 to 2005 were observed and an overestimation between 2006 and 2008. In the same period estimations of recruitment and SSB were relatively unbiased (Figure 10.3.4).

10.4 Historic Stock Trends

Table 10.4.1. and Figure 10.4.1 present the trends in landings, mean F(2–6), recruitment and SSB since 1957.

Reported landings increased to the end of the 1960s, showed a period of lower landings until the end of the 1980s and a period of higher landings (30 000 t) again during the early 1990s. In 2009 landings were estimated to be around 14 000 t.

Recruitment was high in 1959 and 1964 and SSB increased from the end of the 1950s to a peak in early 1960s, followed by a period of declining SSB until the 1990s. Recruitment was high in 1988 and 1992. Between 1990–1995 a period of higher SSB was observed. The SSB in 2009 is estimated at around 35 000 t. Recruitment in 2009 of the 2008 year class at the age of 1 was estimated at 103 million, higher than the long term geometric mean of 94 million.

Fishing mortality on age 2–6 was around 0.2 when the time-series begins in 1957. After then it increased steadily with large variation from circa 0.4–0.5 per year around 1970, to 0.5 to 0.6 per year up to 2000. In recent years fishing mortality has decreased gradually although the 2009 value is higher than that observed for 2008, increasing from 0.35 per year in 2008 to 0.36 per year in 2009 (Table 10.4.1).

10.5 Recruitment estimates

Recruitment estimation was carried out using RCT3. Input to the RCT3 model is presented in Table 10.5.1. Results are presented in Table 10.5.2 for age-1 and Table 10.5.3 for age-2. Average recruitment of 1-year-old-fish in the period 1957–2007 was around 94 million (geometric mean). For year class 2009 (age 1 in 2010) the value predicted by the RCT3 (67 900) was approximately 30% lower than the geometric mean (Table 10.5.2.). The estimate was based on the estimate of the DFS0 survey (25 million) and showed a large standard error (1) , and therefore the geometric mean was accepted for the short-term forecasts.

For year class 2008 (age 2 in 2010), the data are also noisy (high s.e. of the predicted value, Table 10.5.3.). Apart from DFS0 data the RCT3 estimate is based on the same data as the XSA; the WG finds it undesirable to use the same data twice and therefore accepts the XSA estimate. The year class strength estimates from the different sources are summarized in the table below and the estimates used for the short-term forecast are bold-underlined.

Year Class	Age in 2010	XSA thousands	RCT3 thousands	GM(1957–2007) thousands
2008	2	**91 400**	86 500	83 800
2009	1		67 900	**94 000**
2010	Recruit			**94 000**

10.6 Short-term forecasts

The short-term forecasts were carried out with FLR using FLSTF (1.9.9). Weight-at-age in the stock and weight-at-age in the catch are taken to be the average over the last 3 years. The exploitation pattern was taken to be the mean value of the last three years. Weight-at-age in the stock and weight-at-age in the catch were taken to be the mean of the last three years. Population numbers at ages 2 and older are XSA survivor estimates. Numbers at age 1 and recruitment of the 2007 year-class are taken from the long-term geometric mean (1957–2007: 94 million).

Input to the short term forecast is presented in Table 10.6.1. The management options are given in Table 10.6.2 (A-C). The management options are given for three different assumptions on the F values for 2010; A) F2010 is assumed to be equal to Fsq, the average estimate for F from 2007 to 2009 scaled to 2009; B) F2010 is 0.9 times Fsq; and C) F2010 is set such that the landings in 2010 equal the TAC of that same year. The table below shows the predicted F values in the intermediate year, SSB for 2011 and the corresponding landings for 2010, given the different assumptions about F in the intermediate year in the different scenarios.

Scenario	Assumption	F_{2011}	SSB_{2012}	$Landings_{2011}$
A	$F_{2010} = F_{sq}$	0.36	35 700	14 800
B	$F_{2010} = 0.9F_{sq}$	0.32	36 500	14 000
C	F~$Landings_{2010} = TAC_{2010}$	0.32	37 300	13 800

The detailed tables for a forecast based on these 3 scenarios are given in Table 10.6.3A-C. At status quo fishing mortality in 2010 and 2011, SSB is expected to remain stable at 35 300 t in 2011. The 2012 SSB is predicted to be 35 700 t. The landings at Fsq are expected to be around 14 500 t in 2010 which is above the 2010 TAC (14 000t). The landings in 2011 are predicted to be around 14 800 t at Fsq.

Figure 10.6.1 shows the projected contribution of different sources of information to estimates of the landings in 2012 and of the SSB in 2012, when fishing at Fsq. The landings in 2012 will consist for a large part of uncertain year classes (2007–2009),. The contribution of year classes 2009 and 2010 to SSB forecast in 2012 is approximately 40%. These forecasts are subject to revision by ACFM in October 2009 when new survey information becomes available.

Yield and SSB, per recruit, under the condition of the current exploitation pattern and assuming Fsq as exploitation rate in 2009 are given in Figure 10.6.2 (see also Table 10.6.4). Fmax is poorly defined at 0.58.

10.7 Medium-term forecasts

No medium term projections were done this year.

10.8 Biological reference points

The current reference points are $\mathbf{B_{lim}} = \mathbf{B_{loss}} =$ 25 000 t and $\mathbf{B_{pa}}$ is set at 35 000 t using the default multiplier of 1.4. $\mathbf{F_{pa}}$ was proposed to be set at 0.4 which is the 5th percentile of $\mathbf{F_{loss}}$ and gave a 50% probability that SSB is around $\mathbf{B_{pa}}$ in the medium term. Equilibrium analysis suggests that F of 0.4 is consistent with an SSB of around 35 000 t. In the MSY approach F_{MSY} was estimated to be 0.22 using a Ricker Stock Recruitment relationship.

	Type	Value(5%ile-95%ile)	Technical basis
MSY Approach	MSY $B_{trigger}$	35 000 t	Default to value of B_{pa}
	$F_{MSY\text{-}Ricker}$	0.22(0.13-0.39)	Median of stochastic MSY analysis assuming Ricker Stock-Recruit relationship (WGNSSK 2010)
Precautionary Approach	B_{lim}	25 000 t	B_{loss}
	B_{pa}	35 000 t	B_{pa}1.4*B_{lim}
	F_{lim}	Not defined	
	F_{pa}	0.4	$F_{pa} = 0.4$ implies $B_{eq} > B_{pa}$ and $P(SSB_{MT} < B_{pa}) < 10\%$

10.9 Quality of the assessment

This year's assessment of North Sea sole was carried out as an update assessment based on the benchmark analyses performed in early 2010. Retrospective patterns from previous years suggested that F was over-erestimated last year but underestimated in previous years, while SSB was overestimated. The historic performance of the assessment is summarized in Figure 10.3.4.

The XSA assessment showed a slight decrease in SSB in 2009 (35 000t) compared to 2008 (38 000t) caused by the gradual extinction of the strong 2005 year class combined with the rather stable trend in fishing effort between 2008 and 2009 (see Table 10.2.6).

To conclude Benchmark Assessment Meeting (WKFLAT 2010) for this stock made the following recommendations:

- "The problem of retrospective bias in the assessment should be eliminated by truncating the uncorrected CPUE series at 1997.
- XSA is the model that should be used in preference to SAM. This decision was mainly steered by the potential issues with the expertise required . WKFLAT considers SAM to be a very sound approach for modeling North Sea sole. In particular the confidence bounds that the model is capable of providing will be useful for informing management. The SAM model should be run alongside the XSA model. The next benchmark dealing with Sole in sub-area IV should consider switching to SAM if sufficient experience is gained using it and interpreting its results.
- The temporal trends in the weight-at-age data should be further investigated. There was no significant interaction between sex and trend, and the trend in the data seems to be a real function of changing growth. There was, however, a strong country effect identified, ie. Weights-at-age of soles collected by Germany were, for example, higher than those collected by the other countries (UK, Belgium & The Netherlands). WKFLAT suggested that this was a spatial effect, ie. weights-at-age data collected by the Germans come (typically) from further North where fish are larger for a given age. Since the effort by the main fishery for this stock (Dutch Beam trawlers) has shifted south and west, WKFLAT recommends further analysis into the spatial trends in these input data.
- Sex ratios in the largest market sampling categories were much more female biased than they had been in the past. Explanations for this observation (sampling bias versus real biological effects) should be explored in detail.
- There is no clear 'management' related reason why the sexes in sole should be modeled separately and lumping the sexes does not cause much bias. From a biological perspective (e.g. evolutionary effects of fishing) the sex dependent differences in selection patterns (mortality) due to growth, however, have the potential to inform management in the future. The independent trajectories of the female and male parts of the sole stock should, therefore, be studied in more detail.
- The UK beam trawl and Belgian survey indices for sole (and plaice) should be published by WGBEAM whose members should discuss them in the context of patterns and differences observed in the Dutch BTS (ISIS and Tridens) and SNS data. We know that large spatial changes in the distribution of plaice in the North Sea have occurred, viz. the migration of juvenile plaice out of the Plaice Box. WGBEAM should investigate spatial changes in the distribution of sole.
- The data available had too few immature individuals for a reliable estimate of long term trend in the proportion of mature fish in the population. Small individual sole sampled during the Belgian, German, Dutch, and British discarding programmes (Quarter 1) should be sexed and staged so that a reliable time series can be constructed.

- The likely impact of the 2009-2010 cold winter (in 1963 natural mortality was set as 0.9) was not assessed but WKFLAT recommends that this should be monitored carefully.

10.10 Status of the Stock

Fishing mortality was estimated at 0.36 in 2009 which is below Fpa (=0.4). The SSB in 2009 was estimated at about 35 000 t which is above both Blim (25 000t) and Bpa (35 000 t). Two weak year classes in 2003 and 2004 were followed by a strong year class in 2005 the impact of which is now being seen in the SSB estimations. Projected landings for 2011 at Fsq are 14 800t, slightly higher than projected landings for 2010 (14 500).

10.11 Management Considerations

Sole is mainly taken by beam trawlers in a mixed fishery with plaice in the southern and central part of the North Sea. Fishing effort (kWdays) has been substantially reduced since 1995. The fall reversed between 2008 and 2009 (see Table. 10.2.6). Technical measures applicable to the mixed flatfish fishery will affect both sole and plaice. The minimum mesh size of 80 mm in the beam trawl fishery selects sole at the minimum landing size. However, this mesh size generates high discards of plaice. Mesh enlargement would reduce the catch of undersized plaice, but would also result in loss of marketable sole. The combination of days-at-sea regulations, higher oil prices, and decreasing TAC for plaice and relatively stable TAC for sole, appear to have induced a shift in fishing effort towards the southern North Sea. This concentration of fishing effort result in higher plaice discards because juveniles are mainly distributed in this area.

The sole stock dynamics are heavily dependent on the occasional occurrence of strong year classes.

The mean age in the landings is estimated at 3.7 in 2009, but used to be around age 6 in the late 1950s and early 1960s. A lower exploitation level is expected to improve the survival of sole to the spawning population, which could enhance the stability in the catches.

The peaks in the historical time-series of SSB of North Sea sole correspond with the occasional occurrence of strong year classes. Due to high fishing mortality, SSB declined during the nineties. The fishery opportunities and SSB are now dependent on incoming year classes and can therefore fluctuate considerably between years. The SSB and landings in recent years have been dominated by the 2001 and 2005 year classes.

For sole there will be new recruitment information from the 3rd quarter surveys. ICES will only issue an updated advice if these surveys provide a very different perspective on the short-term developments.

Table 10.2.1 Sole in Sub-Area IV: Nominal landings and landings as estimated by the Working Group (tonnes).

Year	Belgium	Denmark	France	Germany	Netherlands	UK (E/W/NI)	Other countries	Total reported	Unallocated landings	WG Total	TAC
1982	1900	524	686	266	17686	403	2	21467	112	21579	21000
1983	1740	730	332	619	16101	435		19957	4970	24927	20000
1984	1771	818	400	1034	14330	586	1	18940	7899	26839	20000
1985	2390	692	875	303	14897	774	3	19934	4314	24248	22000
1986	1833	443	296	155	9558	647	2	12934	5266	18200	20000
1987	1644	342	318	210	10635	676	4	13829	3539	17368	14000
1988	1199	616	487	452	9841	740	28	13363	8227	21590	14000
1989	1596	1020	312	864	9620	1033	50	14495	7311	21806	14000
1990	2389	1427	352	2296	18202	1614	263	26543	8577	35120	25000
1991	2977	1307	465	2107	18758	1723	271	27608	5905	33513	27000
1992	2058	1359	548	1880	18601	1281	277	26004	3337	29341	25000
1993	2783	1661	490	1379	22015	1149	298	29775	1716	31491	32000
1994	2935	1804	499	1744	22874	1137	298	31291	1711	33002	32000
1995	2624	1673	640	1564	20927	1040	312	28780	1687	30467	28000
1996	2555	1018	535	670	15344	848	229	21199	1452	22651	23000
1997	1519	689	99	510	10241	479	204	13741	1160	14901	18000
1998	1844	520	510	782	15198	549	339	19742	1126	20868	19100
1999	1919	828		1458	16283	645	501	21634	1841	23475	22000
2000	1806	1069	362	1280	15273	600	539	20929	1603	22532	22000
2001	1874	772	411	958	13345	597	394	18351	1593	19944	19000
2002	1437	644	266	759	12120	451	292	15969	976	16945	16000
2003	1605	703	728	749	12469	521	363	17138	782	17920	15850
2004	1477	808	655	949	12860	535	544	17828	-681	17147	17000
2005	1374	831	676	756	10917	667	357	15579	776	16355	18600
2006	980	585	648	475	8299	910		11933	667	12600	17670
2007	955	413	401	458	10365	1203	5	13800	835	14635	15000
2008	1379	507	714	513	9456	851	15	13435	710	14145	12800
2009	1353	NA	NA	555	9606	951	1	NA	NA	13952	14000
2010											14100

*No official landings were available from Denmark or France.

Table 10.2.2 Sole in sub-area IV: Overview of landings and discards numbers and weights (kg) per hour and there percentages in the Dutch discards

		Numbers			Weight		
Period	trips	Landings	Discards	%D	Landings	Discards	%D
	n	$n \cdot h^{-1}$	$n \cdot h^{-1}$		$kg \cdot h^{-1}$	$kg \cdot h^{-1}$	
1976–1979	21	116	8	6%	38	1	3%
1980–1983	22	84	23	21%	27	3	9%
1989–1990	6	286	83	22%	72	11	13%
1999–2001	20	92	21	19%	22	2	8%
2002	6	124	37	24%	18	3	13%
2003	9	95	32	25%	20	3	14%
2004	8	174	58	25%	28	5	17%
2005	9	99	29	23%	20	2	11%
2006	9	64	26	29%	16	2	13%
2007	10	94	27	23%	22	2	10%

Table 10.2.3 Sole in sub-area IV: Landings numbers at age (thousands)

2010-05-05 15:47:02 units= thousands

	age									
year	1	2	3	4	5	6	7	8	9	10
1957	0	1415	10148	12642	3762	2924	6518	1733	509	6288
1958	0	1854	8440	14169	9500	3484	3008	4439	2253	6557
1959	0	3659	12025	10401	8975	5768	1206	2025	2574	5615
1960	0	12042	14133	16798	9308	8367	4846	1593	1056	7901
1961	0	959	49786	19140	12404	4695	3944	4279	836	7254
1962	0	1594	6210	59191	15346	10541	4826	4112	2087	7494
1963	0	676	8339	8555	46201	8490	6658	2423	3393	8384
1964	55	155	2113	5712	3809	17337	3126	1810	818	3015
1965	0	47100	1089	1599	5002	2482	12500	1557	1525	3208
1966	0	12278	133617	990	1181	3689	744	6324	702	2450
1967	0	3686	25683	85127	1954	536	1919	760	5047	2913
1968	1037	17148	13896	24973	48571	462	245	1644	324	6523
1969	396	23922	21451	5326	12388	25139	331	244	1190	5272
1970	1299	6140	25993	8235	1784	3231	11960	246	140	5234
1971	420	33369	14425	12757	4485	1442	2327	7214	192	4594
1972	358	7594	36759	7075	4965	1565	523	1232	4706	2801
1973	703	12228	12783	16187	4025	2324	994	765	1218	5790
1974	101	15380	21540	5487	7061	1922	1585	658	401	4814
1975	264	22954	28535	11717	2088	3830	790	907	508	3445
1976	1041	3542	27966	14013	4819	966	1909	550	425	2663
1977	1747	22328	12073	15306	7440	1779	319	1112	256	2115
1978	27	25031	29292	6129	6639	4250	1738	611	646	1602
1979	9	8179	41170	16060	2996	3222	1747	816	241	1527
1980	637	1209	12511	17781	7297	1450	2197	1409	367	1203
1981	423	29217	3259	6866	8223	3661	948	886	766	908
1982	2660	26435	45746	1843	3535	4789	1678	615	605	1278
1983	389	34408	41386	21189	624	1378	1950	978	386	1176
1984	191	30734	43931	22554	8791	741	854	1043	524	894
1985	165	16618	43213	20286	9403	3556	209	379	637	975
1986	374	9363	18497	17702	7747	5515	2270	110	283	1682
1987	94	29053	22046	8899	6512	3119	1567	903	81	694
1988	10	13219	47182	15232	4381	3882	1551	891	524	317
1989	117	46387	18263	22654	4624	1653	1437	647	458	468
1990	863	11939	104454	9767	9194	3349	1043	1198	554	845
1991	120	13163	25420	77913	6724	3675	1736	719	730	1090
1992	980	6832	44378	16204	38319	2477	3041	741	399	1180

1993	54	50451	16768	31409	13869	24035	1489	1184	461	842
1994	718	7804	87403	13550	18739	5711	11310	464	916	908
1995	4801	12767	16822	68571	6308	7307	1995	6015	295	668
1996	172	18824	16190	16964	27257	3858	4780	943	3305	988
1997	1590	6047	23651	7325	5108	12793	1201	2326	333	1688
1998	244	56648	15141	14934	3496	1941	4768	794	1031	846
1999	287	15762	72470	8187	6111	1212	664	1984	331	812
2000	2351	15073	32738	42803	3288	2477	804	435	931	714
2001	884	25846	21595	19876	16730	1427	834	274	168	724
2002	1055	11053	32852	12290	8215	6448	673	597	89	364
2003	1048	32330	17498	16090	5820	3906	2430	400	128	451
2004	516	14950	47970	9524	7457	2165	901	961	389	389
2005	1156	7417	23141	29523	4262	3948	1524	616	785	401
2006	6814	9690	10109	9340	10640	1572	1533	704	363	538
2007	317	39888	10887	6447	5741	5513	824	729	501	544
2008	1920	6200	36690	5878	2870	2346	2562	439	481	450
2009	1616	10327	10678	26319	3250	1638	1577	1519	309	857

Table 10.2.4 Sole in sub-area IV: Landing weights at age (kg)

2010-05-05 15:45:35 units= kg

year	age 1	2	3	4	5	6	7	8	9	10
1957	0.000	0.154	0.177	0.204	0.248	0.279	0.290	0.335	0.436	0.408
1958	0.000	0.145	0.178	0.220	0.254	0.273	0.314	0.323	0.388	0.413
1959	0.000	0.162	0.188	0.228	0.261	0.301	0.328	0.321	0.373	0.426
1960	0.000	0.153	0.185	0.235	0.254	0.277	0.301	0.309	0.381	0.418
1961	0.000	0.146	0.174	0.211	0.255	0.288	0.319	0.304	0.346	0.419
1962	0.000	0.155	0.165	0.208	0.241	0.295	0.320	0.321	0.334	0.412
1963	0.000	0.163	0.171	0.219	0.258	0.309	0.323	0.387	0.376	0.485
1964	0.153	0.175	0.213	0.252	0.274	0.309	0.327	0.346	0.388	0.480
1965	0.000	0.169	0.209	0.246	0.286	0.282	0.345	0.378	0.404	0.480
1966	0.000	0.177	0.190	0.180	0.301	0.332	0.429	0.399	0.449	0.501
1967	0.000	0.192	0.201	0.252	0.277	0.389	0.419	0.339	0.424	0.491
1968	0.157	0.189	0.207	0.267	0.327	0.342	0.354	0.455	0.465	0.508
1969	0.152	0.191	0.196	0.255	0.311	0.373	0.553	0.398	0.468	0.523
1970	0.154	0.212	0.218	0.285	0.350	0.404	0.441	0.463	0.443	0.533
1971	0.145	0.193	0.237	0.322	0.358	0.425	0.420	0.490	0.534	0.547
1972	0.169	0.204	0.252	0.334	0.434	0.425	0.532	0.485	0.558	0.629
1973	0.146	0.208	0.238	0.346	0.404	0.448	0.552	0.567	0.509	0.586
1974	0.164	0.192	0.233	0.338	0.418	0.448	0.520	0.559	0.609	0.653
1975	0.129	0.182	0.225	0.320	0.406	0.456	0.529	0.595	0.629	0.669
1976	0.143	0.190	0.222	0.306	0.389	0.441	0.512	0.562	0.667	0.665
1977	0.147	0.188	0.236	0.307	0.369	0.424	0.430	0.520	0.562	0.619
1978	0.152	0.196	0.231	0.314	0.370	0.426	0.466	0.417	0.572	0.666
1979	0.137	0.208	0.246	0.323	0.391	0.448	0.534	0.544	0.609	0.763
1980	0.141	0.199	0.244	0.331	0.371	0.418	0.499	0.550	0.598	0.684
1981	0.143	0.187	0.226	0.324	0.378	0.424	0.442	0.516	0.542	0.630
1982	0.141	0.188	0.216	0.307	0.371	0.409	0.437	0.491	0.580	0.656
1983	0.134	0.182	0.217	0.301	0.389	0.416	0.467	0.489	0.505	0.642
1984	0.153	0.171	0.221	0.286	0.361	0.386	0.465	0.555	0.575	0.634
1985	0.122	0.187	0.216	0.288	0.357	0.427	0.447	0.544	0.612	0.645
1986	0.135	0.179	0.213	0.299	0.357	0.407	0.485	0.543	0.568	0.610
1987	0.139	0.185	0.205	0.277	0.356	0.378	0.428	0.481	0.393	0.657
1988	0.127	0.175	0.217	0.270	0.354	0.428	0.484	0.521	0.559	0.712
1989	0.118	0.173	0.216	0.288	0.336	0.375	0.456	0.492	0.470	0.611
1990	0.124	0.183	0.227	0.292	0.371	0.413	0.415	0.514	0.476	0.620
1991	0.127	0.186	0.210	0.263	0.315	0.436	0.443	0.467	0.507	0.558
1992	0.146	0.178	0.213	0.258	0.298	0.380	0.409	0.460	0.487	0.556
1993	0.097	0.167	0.196	0.239	0.264	0.300	0.338	0.441	0.496	0.603
1994	0.143	0.180	0.202	0.228	0.257	0.300	0.317	0.432	0.409	0.510
1995	0.151	0.186	0.196	0.247	0.265	0.319	0.344	0.356	0.444	0.591
1996	0.163	0.177	0.202	0.234	0.274	0.285	0.318	0.370	0.390	0.594
1997	0.151	0.180	0.206	0.236	0.267	0.296	0.323	0.306	0.384	0.440
1998	0.128	0.182	0.189	0.252	0.262	0.289	0.336	0.292	0.335	0.504
1999	0.163	0.179	0.212	0.229	0.287	0.324	0.354	0.372	0.372	0.453
2000	0.145	0.170	0.200	0.248	0.290	0.299	0.323	0.368	0.402	0.427
2001	0.143	0.185	0.202	0.270	0.275	0.333	0.391	0.414	0.433	0.493
2002	0.140	0.183	0.211	0.243	0.281	0.312	0.366	0.319	0.571	0.536
2003	0.136	0.182	0.214	0.256	0.273	0.317	0.340	0.344	0.503	0.431
2004	0.127	0.180	0.209	0.252	0.263	0.284	0.378	0.367	0.327	0.425
2005	0.172	0.185	0.207	0.243	0.241	0.282	0.265	0.377	0.318	0.401
2006	0.156	0.190	0.220	0.263	0.291	0.322	0.293	0.358	0.397	0.397
2007	0.154	0.180	0.205	0.237	0.253	0.273	0.295	0.299	0.281	0.326
2008	0.150	0.181	0.223	0.240	0.265	0.324	0.314	0.297	0.307	0.418
2009	0.138	0.185	0.202	0.256	0.275	0.278	0.325	0.334	0.303	0.398

Table 10.2.5 Sole in sub-area IV: Stock weights at age (kg)

2010-05-05 15:47:05 units= kg

year	1	2	3	4	5	6	7	8	9	10
1957	0.025	0.070	0.147	0.187	0.208	0.253	0.262	0.355	0.390	0.365
1958	0.025	0.070	0.164	0.205	0.226	0.228	0.297	0.318	0.393	0.422
1959	0.025	0.070	0.159	0.198	0.239	0.271	0.292	0.276	0.303	0.426
1960	0.025	0.070	0.163	0.207	0.234	0.240	0.268	0.242	0.360	0.431
1961	0.025	0.070	0.148	0.206	0.235	0.232	0.259	0.274	0.281	0.396
1962	0.025	0.070	0.148	0.192	0.240	0.301	0.293	0.282	0.273	0.441
1963	0.025	0.070	0.148	0.193	0.243	0.275	0.311	0.363	0.329	0.465
1964	0.025	0.070	0.159	0.214	0.240	0.291	0.305	0.306	0.365	0.474
1965	0.025	0.140	0.198	0.223	0.251	0.297	0.337	0.358	0.526	0.460
1966	0.025	0.070	0.160	0.149	0.389	0.310	0.406	0.377	0.385	0.505
1967	0.025	0.177	0.164	0.235	0.242	0.399	0.362	0.283	0.381	0.459
1968	0.025	0.122	0.171	0.248	0.312	0.280	0.629	0.416	0.410	0.486
1969	0.025	0.137	0.174	0.252	0.324	0.364	0.579	0.415	0.469	0.521
1970	0.025	0.137	0.201	0.275	0.341	0.367	0.423	0.458	0.390	0.554
1971	0.034	0.148	0.213	0.313	0.361	0.410	0.432	0.474	0.483	0.533
1972	0.038	0.155	0.218	0.313	0.419	0.443	0.443	0.443	0.508	0.602
1973	0.039	0.149	0.226	0.322	0.371	0.433	0.452	0.472	0.446	0.536
1974	0.035	0.146	0.218	0.329	0.408	0.429	0.499	0.565	0.542	0.618
1975	0.035	0.148	0.206	0.311	0.403	0.446	0.508	0.582	0.580	0.650
1976	0.035	0.142	0.201	0.301	0.379	0.458	0.508	0.517	0.644	0.665
1977	0.035	0.147	0.202	0.291	0.365	0.409	0.478	0.487	0.531	0.644
1978	0.035	0.139	0.211	0.290	0.365	0.429	0.427	0.385	0.542	0.644
1979	0.045	0.148	0.211	0.300	0.352	0.429	0.521	0.562	0.567	0.743
1980	0.039	0.157	0.200	0.304	0.345	0.394	0.489	0.537	0.579	0.645
1981	0.050	0.137	0.200	0.305	0.364	0.402	0.454	0.522	0.561	0.622
1982	0.050	0.130	0.193	0.270	0.359	0.411	0.429	0.476	0.583	0.642
1983	0.050	0.140	0.200	0.285	0.329	0.435	0.464	0.483	0.510	0.636
1984	0.050	0.133	0.203	0.268	0.348	0.386	0.488	0.591	0.567	0.664
1985	0.050	0.127	0.185	0.267	0.324	0.381	0.380	0.626	0.554	0.642
1986	0.050	0.133	0.191	0.278	0.345	0.423	0.495	0.487	0.587	0.686
1987	0.050	0.154	0.191	0.262	0.357	0.381	0.406	0.454	0.332	0.620
1988	0.050	0.133	0.193	0.260	0.335	0.409	0.417	0.474	0.486	0.654
1989	0.050	0.133	0.195	0.290	0.350	0.340	0.411	0.475	0.419	0.595
1990	0.050	0.148	0.203	0.294	0.357	0.447	0.399	0.494	0.481	0.653
1991	0.050	0.139	0.184	0.254	0.301	0.413	0.447	0.522	0.548	0.573
1992	0.050	0.156	0.194	0.257	0.307	0.398	0.406	0.472	0.500	0.540
1993	0.050	0.128	0.184	0.229	0.265	0.293	0.344	0.482	0.437	0.583
1994	0.050	0.143	0.174	0.209	0.257	0.326	0.349	0.402	0.494	0.459
1995	0.050	0.151	0.179	0.240	0.253	0.321	0.365	0.357	0.545	0.545
1996	0.050	0.147	0.178	0.208	0.274	0.268	0.321	0.375	0.402	0.546
1997	0.050	0.150	0.190	0.225	0.252	0.303	0.319	0.325	0.360	0.424
1998	0.050	0.140	0.173	0.234	0.267	0.281	0.328	0.273	0.336	0.455
1999	0.050	0.131	0.187	0.216	0.259	0.296	0.340	0.322	0.369	0.464
2000	0.050	0.139	0.185	0.226	0.264	0.275	0.287	0.337	0.391	0.376
2001	0.050	0.144	0.185	0.223	0.263	0.319	0.327	0.421	0.410	0.530
2002	0.050	0.145	0.197	0.245	0.267	0.267	0.299	0.308	0.435	0.435
2003	0.050	0.146	0.194	0.240	0.256	0.288	0.330	0.312	0.509	0.470
2004	0.050	0.137	0.195	0.240	0.245	0.305	0.316	0.448	0.356	0.601
2005	0.050	0.150	0.189	0.234	0.237	0.258	0.276	0.396	0.369	0.428
2006	0.050	0.148	0.197	0.250	0.270	0.319	0.286	0.341	0.409	0.456
2007	0.050	0.152	0.179	0.216	0.242	0.245	0.275	0.252	0.257	0.364
2008	0.050	0.154	0.198	0.212	0.239	0.302	0.282	0.231	0.274	0.400
2009	0.050	0.142	0.185	0.232	0.255	0.279	0.283	0.333	0.302	0.390

Table 10.2.6 Sole in subarea IV: Effort and CpUE series. Note: see Table 10.2.1 for (Netherlands) for source of landings estimates.

year	landings (tons)	Effort(new) HP days (·10^6)	Lpue(new) kg· 1000HP days^{-1}
1997	11894.4	72.0	165.2
1998	17606.2	70.2	250.8
1999	19086.3	67.3	283.6
2000	16750.8	68.4	244.9
2001	16197.3	64.8	250
2002	13789.4	59.1	233.3
2003	14442.8	55.7	259.3
2004	14862.9	51.5	288.6
2005	12775.8	52.4	243.8
2006	8396.6	46.9	179
2007	11085.4	45.1	245.8
2008	9455.6	32.5	290.9
2009	12038	34	354.1

Table 10.2.7 Sole in subarea IV: Tuning data. BTS and SNS surveys and commercial series from NL beam trawl.

2010-05-10 17:04:17 BTS-ISIS units= NA

		1	2	3	4	5	6	7	8	9
1985	1	7.031	7.121	3.695	1.654	0.688	0.276	0.000	0.000	0.000
1986	1	7.168	5.183	1.596	0.987	0.623	0.171	0.158	0.000	0.018
1987	1	6.973	12.548	1.834	0.563	0.583	0.222	0.228	0.058	0.000
1988	1	83.111	12.512	2.684	1.032	0.123	0.149	0.132	0.103	0.014
1989	1	9.015	68.084	4.191	4.096	0.677	0.128	0.242	0.000	0.051
1990	1	37.839	24.487	21.789	0.778	1.081	0.770	0.120	0.115	0.025
1991	1	4.035	28.841	6.872	6.453	0.136	0.135	0.063	0.045	0.013
1992	1	81.625	22.284	10.449	2.529	3.018	0.090	0.162	0.078	0.020
1993	1	6.350	42.345	1.338	5.516	3.371	6.199	0.023	0.084	0.053
1994	1	7.660	7.121	19.743	0.124	1.636	0.088	0.983	0.009	0.000
1995	1	28.125	8.458	6 .268	5.129	0.363	0.805	0.316	0.734	0.039
1996	1	3.975	7.634	1.955	1.785	2.586	0.326	0.393	0.052	0.264
1997	1	169.343	4.919	2.985	0.739	0.710	0.380	0.096	0.035	0.042
1998	1	17.108	27.422	1.862	1.242	0.073	0.015	0.391	0.000	0.000
1999	1	11.960	18.363	15.783	0.584	1.920	0.310	0.218	0.604	0.003
2000	1	14.594	6.144	4.045	1.483	0.263	0.141	0.060	0.007	0.150
2001	1	7.998	9.963	2.156	1.564	0.684	0.074	0.037	0.028	0.000
2002	1	20.989	4.182	3.428	0.886	0.363	0.361	0.032	0.069	0.000
2003	1	10.507	9.947	2.459	1.670	0.360	0.187	0.319	0.000	0.020
2004	1	4.192	4.354	3.553	0.644	0.626	0.118	0.070	0.073	0.000
2005	1	5.534	3.395	2.377	1.303	0.167	0.171	0.077	0.047	0.000
2006	1	17.089	2.332	0.278	0.709	0.479	0.151	0.088	0.000	0.007
2007	1	7.498	19.504	1.464	0.565	0.315	0.537	0.031	0.009	0.000
2008	1	15.247	9.062	12.298	1.313	0.222	0.279	0.202	0.028	0.047
2009	1	15.950	4.999	2.858	4.791	0.252	0.124	0.272	0.079	0.000

SNS units= NA

		1	2	3	4
1970	1	5410	734	238	35
1971	1	903	1831	113	3
1972	1	1455	272	149	0
1973	1	5587	935	84	37
1974	1	2348	361	65	0
1975	1	525	865	177	18
1976	1	1399	74	229	27
1977	1	3743	776	104	43
1978	1	1548	1355	294	28
1979	1	94	408	301	78
1980	1	4313	89	109	61
1981	1	3737	1413	50	20
1982	1	5857	1146	228	7
1983	1	2621	1123	121	40
1984	1	2493	1100	318	74
1985	1	3619	716	167	49
1986	1	3705	458	69	31
1987	1	1948	944	65	21
1988	1	11227	594	282	82
1989	1	2831	5005	208	53
1990	1	2856	1120	914	100
1991	1	1254	2529	514	624
1992	1	11114	144	360	195
1993	1	1291	3420	154	213
1994	1	652	498	934	10
1995	1	1362	224	143	411
1996	1	218	349	30	36
1997	1	10279	154	190	27
1998	1	4095	3126	142	99
1999	1	1649	972	456	10
2000	1	1639	126	166	118
2001	1	970	655	107	36
2002	1	7548	379	195	0
2003	1	NA	NA	NA	NA
2004	1	1370	624	393	69
2005	1	568	163	124	0
2006	1	2726	117	25	30
2007	1	849	911	33	40
2008	1	1259	259	325	0
2009	1	1932	344	62	103

Table 10.2.7 cont.

2010-05-08 12:13:05[1] NL Beam Trawl units= NA

	E	2	3	4	5	6	7	8	9
1997	72.0	62.6	256	62.6	46.2	135.7	6.90	25.00	1.319
1998	70.2	720.4	129	158.4	26.0	16.3	48.36	3.01	4.801
1999	67.3	175.6	820	61.7	66.3	10.8	4.99	22.69	1.976
2000	68.4	180.0	432	317.9	29.9	23.1	6.65	4.71	9.371
2001	64.8	289.0	211	231.0	201.9	11.1	7.81	2.10	1.435
2002	59.1	152.4	420	134.3	102.1	86.0	7.17	6.50	0.914
2003	55.7	465.8	207	223.4	61.0	50.7	35.22	4.04	1.113
2004	51.5	217.3	723	109.4	98.2	23.1	12.43	10.52	2.621
2005	52.4	96.6	312	401.3	72.4	38.2	17.58	5.52	11.813
2006	46.9	144.8	166	143.0	175.4	20.3	20.15	11.13	5.736
2007	45.1	737.8	170	99.4	81.1	82.0	7.43	7.23	2.816
2008	32.5	145.1	885	100.2	57.4	39.0	44.15	6.09	5.446
2009	34.0	254.6	227	562.9	59.2	32.4	27.56	23.38	1.824

Table 10.3.1. Sole in sub area IV: XSA diagnostics

FLR XSA Diagnostics 2010-05-08 12:13:27

CPUE data from xsa.indices

Catch data for 53 years. 1957 to 2009. Ages 1 to 10.

	fleet	first age	last age	first year	last year	alpha	beta
1	BTS-ISIS	1	9	1985	2009	0.66	0.75
2	SNS	1	4	1970	2009	0.66	0.75
3	NL Beam Trawl	2	9	1997	2009	0	1

Time series weights :

Tapered time weighting not applied

Catchability analysis :

Catchability independent of size for ages > 1

Catchability independent of age for ages > 7

Terminal population estimation :

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

S.E. of the mean to which the estimates are shrunk = 2

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

prior weighting not applied

Regression weights

age \ year	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
all	1	1	1	1	1	1	1	1	1	1

Fishing mortalities

age \ year	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
1	0.020	0.015	0.006	0.013	0.012	0.026	0.034	0.006	0.025	0.017
2	0.241	0.286	0.232	0.231	0.235	0.220	0.274	0.251	0.141	0.164
3	0.584	0.563	0.627	0.611	0.554	0.605	0.464	0.496	0.342	0.341
4	0.802	0.759	0.646	0.638	0.707	0.701	0.463	0.537	0.484	0.391
5	0.627	0.757	0.733	0.644	0.612	0.711	0.519	0.510	0.431	0.479
6	0.784	0.541	0.658	0.839	0.464	0.681	0.549	0.493	0.358	0.415
7	0.886	0.585	0.469	0.490	0.408	0.616	0.542	0.551	0.397	0.385
8	0.768	0.769	0.992	0.499	0.324	0.479	0.570	0.475	0.567	0.384
9	0.456	0.679	0.537	0.515	1.187	0.424	0.511	0.928	0.586	0.899
10	0.456	0.679	0.537	0.515	1.187	0.424	0.511	0.928	0.586	0.899

XSA population number (NA)

year \ age	1	2	3	4	5	6	7	8	9	10
2000	123072	74114	77819	81610	7424	4791	1438	853	2673	2041
2001	62890	109124	52724	39272	33128	3590	1979	537	358	1535
2002	183396	56064	74154	27165	16628	14061	1891	997	225	916
2003	83962	164940	40215	35848	12889	7231	6590	1071	335	1173
2004	44153	74975	118490	19743	17131	6126	2828	3651	589	583
2005	48196	39460	53619	61584	8805	8408	3484	1702	2390	1216
2006	216019	42510	28650	26504	27640	3913	3852	1703	954	1407
2007	55007	188980	29247	16307	15098	14889	2045	2027	871	938
2008	81516	49471	133054	16108	8623	8200	8228	1067	1141	1062
2009	102743	71932	38866	85491	8984	5072	5188	5008	548	1507

Estimated population abundance at 1st Jan 2010

year \ age	1	2	3	4	5	6	7	8	9	10
2010	3032	91428	55264	25010	52320	5037	3032	3194	3087	202

Fleet: BTS-ISIS

Log catchability residuals.

year

age	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
1	-0.179	-0.668	-0.097	-0.086	-0.252	0.181	-0.379	0.095	-0.113	0.142	0.495	-0.121	0.703	0.070	0.113	-0.071	0.093	-0.172	0.029	-0.005	0.090
2	0.063	-0.521	-0.238	0.542	0.320	0.744	0.384	1.068	0.142	-0.041	0.455	-0.151	-0.060	0.047	0.437	-0.288	-0.159	-0.399	-0.613	-0.647	-0.265
3	-0.035	-0.245	-0.502	-0.588	0.545	0.160	0.469	0.358	-0.755	0.428	0.843	0.227	0.055	0.105	0.664	0.043	-0.212	-0.044	0.225	-0.528	-0.102
4	0.243	-0.264	-0.296	-0.045	0.893	-0.234	-0.185	0.301	0.618	-2.184	0.140	0.789	0.332	0.286	0.011	-0.578	0.177	-0.103	0.248	-0.059	-0.497
5	-0.016	0.235	0.043	-0.950	0.302	0.431	-1.039	-0.196	1.561	0.296	-0.238	0.434	0.985	-0.980	1.768	0.119	-0.329	-0.291	-0.107	0.139	-0.446
6	0.158	-0.392	0.114	-0.429	-0.123	1.254	-0.870	-0.502	1.359	-0.921	0.465	0.729	-0.437	-1.802	1.407	0.242	-0.285	0.017	0.152	-0.407	-0.200
7	0.000	0.217	0.358	0.086	0.464	0.199	-0.761	-0.152	-1.189	-0.049	1.093	0.338	0.105	0.188	1.406	0.481	-0.533	-0.715	0.352	-0.377	-0.344
8	0.000	0.000	0.021	0.107	0.000	0.437	-0.090	0.040	-0.106	-1.379	0.239	0.321	-1.162	0.000	1.289	-1.228	0.623	1.062	0.000	-0.650	-0.218
9	0.000	-0.089	0.000	-0.394	-0.098	-0.262	-0.649	-0.056	0.239	0.000	0.915	-0.220	1.262	0.000	-1.083	0.475	0.000	0.000	0.579	0.000	0.000

year

age	2006	2007	2008	2009
1	-0.398	0.153	0.263	0.112
2	-0.677	-0.061	0.435	-0.518
3	-1.720	-0.057	0.448	0.218
4	-0.430	-0.119	0.699	0.259
5	-0.672	-0.492	-0.338	-0.219
6	0.347	0.241	0.087	-0.204
7	-0.363	-0.767	-0.394	0.357
8	0.000	-2.049	-0.207	-0.845
9	-1.520	0.000	0.257	0.000

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

	2	3	4	5	6	7	8	9
Mean_Logq	-8.8701	-9.4254	-9.7022	-9.8548	-10.0527	-9.8712	-9.8712	-9.8712
S.E_Logq	0.4597	0.5362	0.5994	0.6915	0.7197	0.5846	0.7407	0.5514

Regression statistics

Ages with q dependent on year class strength

	slope	intercept
Age 1	0.747321	9.558937

Fleet: SNS

Log catchability residuals.

year

age	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
1	0.284	0.166	-0.015	0.505	-0.020	-0.118	-0.331	0.064	0.381	-0.149	0.083	0.015
2	0.793	0.839	0.052	0.663	-0.618	0.267	-1.315	0.127	0.455	0.326	0.131	0.424
3	0.538	0.218	-0.248	0.293	-0.666	-0.028	0.277	0.306	0.496	0.344	0.323	0.821
4	0.142	-2.515	NA	-0.362	NA	-0.647	-0.729	-0.138	0.193	0.441	0.017	-0.126

age	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
1	0.257	-0.147	0.344	0.447	-0.041	0.185	-0.206	0.097	-0.268	-0.039
2	0.215	0.243	0.267	0.549	-0.165	-0.042	0.277	0.493	0.442	0.733
3	0.025	-0.683	0.441	-0.146	-0.401	-0.856	0.145	0.528	-0.026	0.862
4	0.065	-0.340	0.142	-0.009	-0.459	-0.318	0.689	-0.189	0.980	0.745

year

age	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
1	-0.020	-0.009	-0.243	-0.203	-0.756	0.137	0.269	0.000	-0.299	-0.093	0.256	NA
2	-1.191	0.409	0.082	-0.394	-0.453	-0.741	0.658	0.281	-1.392	-0.098	-0.017	NA
3	-0.024	0.069	0.362	0.048	-0.964	0.287	0.517	0.106	-0.165	-0.229	0.075	NA
4	1.004	0.630	-1.435	0.882	0.152	0.289	1.023	-0.790	0.157	-0.328	NA	NA

age	2004	2005	2006	2007	2008	2009
1	0.366	-0.190	-0.430	-0.071	-0.137	-0.073
2	0.193	-0.518	-0.887	-0.342	-0.337	-0.412
3	0.256	-0.069	-1.143	-0.863	-0.199	-0.627
4	0.973	NA	-0.326	0.499	NA	-0.314

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

                2       3       4
Mean_Logq -4.7452 -5.5035 -6.0609
S.E_Logq   0.5735  0.4847  0.7329

 Regression statistics
 Ages with q dependent on year class strength
         slope intercept
Age 1 0.7503624   5.70392


 Fleet:  NL Beam Trawl

 Log catchability residuals.

   year
age 1997   1998   1999   2000   2001   2002   2003   2004   2005   2006   2007   2008   2009
2 -0.672  0.132 -0.465 -0.085  0.023  0.024  0.062  0.090 -0.087  0.270  0.395  0.057  0.255
3 -0.136 -0.313 -0.036  0.071 -0.267  0.108  0.008  0.151  0.127  0.061  0.075  0.141  0.010
4 -0.237  0.102 -0.341 -0.245  0.149 -0.075  0.154  0.066  0.226 -0.068  0.087  0.084  0.098
5 -0.078 -0.330  0.076 -0.335  0.135  0.132 -0.167  0.011  0.416  0.071 -0.099  0.078  0.090
6  0.176 -0.071 -0.255  0.072 -0.477  0.255  0.469 -0.315 -0.033  0.044  0.076 -0.131  0.188
7 -0.506  0.111 -0.335  0.227 -0.061 -0.152  0.200 -0.033  0.198  0.202 -0.159  0.161  0.146
8  0.455 -0.479  0.048  0.354  0.010  0.614 -0.145 -0.494 -0.305  0.437 -0.212  0.300  0.017
9 -0.310 -0.143  0.309 -0.237 -0.004 -0.054 -0.263  0.312  0.092  0.327 -0.113  0.130 -0.096


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

                2       3       4       5       6       7       8       9
Mean_Logq -5.7704 -4.9413 -4.8855 -4.8377 -4.9966 -5.1511 -5.1511 -5.1511
S.E_Logq   0.2900  0.1512  0.1776  0.2040  0.2548  0.2333  0.3650  0.2221

Terminal year survivor and F summaries:

 Age 1 Year class = 2008

source
         survivors N scaledWts
BTS-ISIS    106235 1     0.401
SNS          82987 1     0.484
fshk         73976 1     0.015
nshk         82727 1     0.100

 Age 2 Year class = 2007

source
              survivors N scaledWts
BTS-ISIS          54837 2     0.333
SNS               43219 2     0.324
NL Beam Trawl     71350 1     0.334
fshk              38978 1     0.009
```

Age 3 Year class = 2006

source	survivors	N	scaledWts
BTS-ISIS	33053	3	0.272
SNS	18444	3	0.284
NL Beam Trawl	25821	2	0.436
fshk	15898	1	0.007

Age 4 Year class = 2005

source	survivors	N	scaledWts
BTS-ISIS	51037	4	0.235
SNS	35420	4	0.226
NL Beam Trawl	62877	3	0.532
fshk	31793	1	0.008

Age 5 Year class = 2004

source	survivors	N	scaledWts
BTS-ISIS	5024	5	0.209
SNS	2818	3	0.119
NL Beam Trawl	5613	4	0.661
fshk	4131	1	0.011

Age 6 Year class = 2003

source	survivors	N	scaledWts
BTS-ISIS	2109	6	0.183
SNS	2761	4	0.098
NL Beam Trawl	3384	5	0.710
fshk	2338	1	0.010

Age 7 Year class = 2002

source	survivors	N	scaledWts
BTS-ISIS	3193	7	0.190
SNS	2909	3	0.037
NL Beam Trawl	3222	6	0.764
fshk	2286	1	0.010

Age 8 Year class = 2001

source	survivors	N	scaledWts
BTS-ISIS	1980	8	0.177
SNS	4192	2	0.023
NL Beam Trawl	3395	7	0.788
fshk	2317	1	0.012

Age 9 Year class = 2000

source	survivors	N	scaledWts
BTS-ISIS	148	8	0.097
SNS	248	3	0.011
NL Beam Trawl	203	8	0.868
fshk	577	1	0.023

Table 10.3.2. Sole in sub area IV: fishing mortality at age

2010-05-08 12:13:36 units= f

year	age 1	2	3	4	5	6	7	8	9	10
1957	0.000	0.021	0.127	0.255	0.259	0.228	0.292	0.167	0.241	0.241
1958	0.000	0.017	0.149	0.235	0.276	0.361	0.345	0.295	0.303	0.303
1959	0.000	0.034	0.130	0.246	0.205	0.239	0.182	0.366	0.248	0.248
1960	0.000	0.029	0.158	0.241	0.323	0.267	0.289	0.344	0.294	0.294
1961	0.000	0.018	0.145	0.295	0.252	0.239	0.174	0.397	0.272	0.272
1962	0.000	0.019	0.141	0.229	0.363	0.313	0.367	0.247	0.304	0.304
1963	0.000	0.053	0.179	0.422	0.402	0.509	0.482	0.457	0.479	0.479
1964	0.000	0.020	0.326	0.250	0.486	0.365	0.516	0.325	0.390	0.390
1965	0.000	0.107	0.169	0.388	0.321	0.600	0.432	0.465	0.443	0.443
1966	0.000	0.124	0.437	0.204	0.490	0.368	0.318	0.360	0.349	0.349
1967	0.000	0.114	0.365	0.488	0.683	0.382	0.296	0.549	0.481	0.481
1968	0.011	0.308	0.695	0.643	0.505	0.296	0.268	0.394	0.422	0.422
1969	0.008	0.333	0.690	0.553	0.682	0.472	0.318	0.412	0.489	0.489
1970	0.010	0.152	0.643	0.547	0.320	0.331	0.381	0.367	0.390	0.390
1971	0.011	0.334	0.558	0.672	0.577	0.410	0.374	0.370	0.483	0.483
1972	0.005	0.238	0.659	0.519	0.531	0.358	0.227	0.309	0.390	0.390
1973	0.007	0.207	0.693	0.606	0.558	0.451	0.360	0.532	0.503	0.503
1974	0.001	0.188	0.593	0.642	0.513	0.502	0.561	0.382	0.522	0.522
1975	0.007	0.278	0.551	0.667	0.476	0.514	0.351	0.645	0.506	0.506
1976	0.010	0.107	0.565	0.510	0.564	0.374	0.463	0.391	0.634	0.634
1977	0.013	0.263	0.554	0.615	0.494	0.370	0.181	0.476	0.282	0.282
1978	0.001	0.236	0.573	0.537	0.523	0.517	0.660	0.544	0.496	0.496
1979	0.001	0.225	0.660	0.632	0.485	0.459	0.368	0.663	0.379	0.379
1980	0.004	0.128	0.557	0.591	0.584	0.406	0.579	0.504	0.630	0.630
1981	0.003	0.255	0.525	0.602	0.531	0.580	0.449	0.430	0.501	0.501
1982	0.019	0.232	0.698	0.564	0.635	0.600	0.508	0.521	0.520	0.520
1983	0.003	0.311	0.600	0.727	0.334	0.482	0.462	0.556	0.644	0.644
1984	0.003	0.292	0.723	0.684	0.673	0.733	0.552	0.426	0.581	0.581
1985	0.002	0.319	0.748	0.779	0.602	0.561	0.411	0.448	0.444	0.444
1986	0.002	0.143	0.621	0.700	0.689	0.767	0.756	0.351	0.629	0.629
1987	0.001	0.239	0.512	0.612	0.532	0.582	0.450	0.686	0.419	0.419
1988	0.000	0.238	0.662	0.715	0.615	0.621	0.569	0.442	0.999	0.999
1989	0.001	0.126	0.527	0.689	0.431	0.437	0.434	0.436	0.379	0.379
1990	0.005	0.137	0.406	0.528	0.588	0.565	0.482	0.694	0.727	0.727
1991	0.002	0.091	0.425	0.533	0.753	0.436	0.572	0.637	1.121	1.121
1992	0.003	0.120	0.436	0.467	0.482	0.611	0.694	0.452	0.791	0.791
1993	0.001	0.182	0.423	0.557	0.827	0.561	0.820	0.564	0.499	0.499
1994	0.013	0.141	0.481	0.636	0.677	0.882	0.496	0.576	1.043	1.043
1995	0.054	0.306	0.446	0.768	0.612	0.539	0.790	0.474	0.792	0.792
1996	0.004	0.275	0.698	0.984	0.709	0.845	0.727	0.991	0.459	0.459
1997	0.006	0.154	0.580	0.702	0.816	0.765	0.611	0.856	1.082	1.082
1998	0.002	0.281	0.619	0.794	0.771	0.754	0.642	0.955	1.089	1.089
1999	0.004	0.176	0.612	0.717	0.794	0.589	0.554	0.534	1.336	1.336
2000	0.020	0.241	0.584	0.802	0.627	0.784	0.886	0.768	0.456	0.456
2001	0.015	0.286	0.563	0.759	0.757	0.541	0.585	0.769	0.679	0.679
2002	0.006	0.232	0.627	0.646	0.733	0.658	0.469	0.992	0.537	0.537
2003	0.013	0.231	0.611	0.638	0.644	0.839	0.490	0.499	0.515	0.515
2004	0.012	0.235	0.554	0.707	0.612	0.464	0.408	0.324	1.187	1.187
2005	0.026	0.220	0.605	0.701	0.711	0.681	0.616	0.479	0.424	0.424
2006	0.034	0.274	0.464	0.463	0.519	0.549	0.542	0.570	0.511	0.511
2007	0.006	0.251	0.496	0.537	0.510	0.493	0.551	0.475	0.928	0.928
2008	0.025	0.141	0.342	0.484	0.431	0.358	0.397	0.567	0.586	0.586
2009	0.017	0.164	0.341	0.391	0.479	0.415	0.385	0.384	0.899	0.899

Table 10.3.3 Sole in sub area IV: stock numbers at age

2010-05-08 12:13:38 units= NA

year	age 1	2	3	4	5	6	7	8	9	10
1957	128913	72455	89309	59106	17319	15058	27046	11837	2500	30811
1958	128646	116645	64214	71157	41456	12092	10843	18272	9062	26295
1959	488778	116404	103781	50075	50907	28474	7627	6950	12311	26789
1960	61716	442265	101846	82467	35416	37526	20278	5754	4362	32547
1961	99499	55843	388723	78710	58640	23192	25996	13739	3691	31944
1962	22899	90030	49617	304373	53013	41261	16519	19770	8361	29934
1963	20424	20719	79946	38988	219104	33371	27307	10356	13977	32251
1964	539159	8304	7993	27187	10396	59622	8154	6857	2666	9789
1965	121982	487799	7366	5222	19166	5784	37457	4405	4483	9391
1966	39909	110374	396576	5629	3204	12584	2872	22002	2504	8711
1967	75191	36111	88191	231736	4152	1776	7877	1891	13893	7983
1968	99252	68036	29169	55369	128708	1898	1097	5302	988	19822
1969	50869	88820	45250	13175	26344	70258	1278	760	3234	14263
1970	137891	45652	57613	20539	6855	12054	39659	841	455	16958
1971	42107	123534	35467	27405	10751	4505	7833	24508	527	12561
1972	76403	37700	80036	18370	12662	5462	2705	4874	15314	9082
1973	105045	68792	26889	37454	9892	6734	3453	1950	3238	15324
1974	109975	94380	50614	12171	18492	5122	3883	2179	1037	12388
1975	40825	99414	70768	25308	5793	10016	2806	2006	1346	9085
1976	113295	36689	68119	36890	11754	3256	5419	1788	952	5931
1977	140307	101523	29828	35034	20050	6051	2027	3088	1095	9018
1978	47127	125294	70623	15505	17141	11065	3783	1531	1736	4286
1979	11664	42617	89560	36039	8200	9194	5969	1770	804	5074
1980	151574	10546	30781	41875	17332	4570	5255	3739	825	2690
1981	148896	136544	8392	15951	20977	8742	2755	2665	2043	2411
1982	152374	134324	95758	4493	7902	11158	4428	1592	1568	3297
1983	141488	135343	96396	43130	2313	3788	5541	2410	855	2590
1984	70850	127653	89734	47855	18870	1499	2116	3159	1250	2122
1985	81670	63926	86270	39406	21847	8712	652	1103	1866	2845
1986	159308	73741	42036	36955	16359	10823	4501	391	637	3766
1987	72702	143792	57817	20440	16600	7433	4547	1913	249	2124
1988	455761	65694	102472	31344	10030	8826	3759	2624	872	523
1989	108274	412380	46868	47840	13872	4908	4293	1926	1527	1555
1990	177524	97859	329012	25036	21738	8154	2869	2518	1127	1708
1991	70435	159810	77190	198343	13363	10924	4192	1604	1139	1684
1992	353383	63618	132081	45664	105355	5695	6388	2142	767	2253
1993	69162	318822	51065	77298	25905	58879	2797	2888	1233	2242
1994	56976	62529	240492	30255	40065	10247	30413	1114	1487	1461
1995	95962	50871	49155	134466	14487	18427	3840	16760	567	1275
1996	49342	82263	33885	28476	56443	7108	9723	1576	9444	2811
1997	270702	44482	56528	15260	9629	25144	2762	4251	529	2659
1998	113617	243429	34497	28652	6840	3854	10582	1356	1634	1328
1999	82211	102573	166378	16812	11719	2864	1641	5040	472	1145
2000	123072	74114	77819	81610	7424	4791	1438	853	2673	2041
2001	62890	109124	52724	39272	33128	3590	1979	537	358	1535
2002	183396	56064	74154	27165	16628	14061	1891	997	225	916
2003	83962	164940	40215	35848	12889	7231	6590	1071	335	1173
2004	44153	74975	118490	19743	17131	6126	2828	3651	589	583
2005	48196	39460	53619	61584	8805	8408	3484	1702	2390	1216
2006	216019	42510	28650	26504	27640	3913	3852	1703	954	1407
2007	55007	188980	29247	16307	15098	14889	2045	2027	871	938
2008	81516	49471	133054	16108	8623	8200	8228	1067	1141	1062
2009	102743	71932	38866	85491	8984	5072	5188	5008	548	1507
2010	NA	91428	55264	25010	52320	5037	3032	3194	3086	757

Table 10.3.4 Sole in sub area IV: estimates for Fcrash, Fmsy, Bmsy, and MSY according to the formulation of Darby and Oliveira (see WKFRAME 2010). The top table (Ricker) was the model selected.

Ricker

768/1000 Iterations resulted in feasible parameter estimates

	Fcrash	Fmsy	Bmsy	MSY	ADMB Alpha	ADMB Beta	Unscaled Alpha	Unscaled Beta
Deterministic	0.83	0.31	45.14	16.77	0.73	1.14	5.83	0.02
Mean	0.57	0.23	46.15	17.10	0.75	1.14	6.07	0.02
5%ile	0.28	0.13	32.92	11.40	0.62	0.73	3.90	0.01
25%ile	0.37	0.18	38.38	14.61	0.68	0.97	5.00	0.02
50%ile	0.49	0.22	43.83	16.94	0.74	1.15	5.98	0.02
75%ile	0.67	0.28	50.51	19.16	0.80	1.32	6.99	0.02
95%ile	1.05	0.39	65.55	23.13	0.89	1.54	8.74	0.03
CV	0.56	0.35	0.27	0.22	0.11	0.22	0.24	0.22

Beverton-Holt

732/1000 Iterations resulted in feasible parameter estimates

	Fcrash	Fmsy	Bmsy	MSY	ADMB Alpha	ADMB Beta	Unscaled Alpha	Unscaled Beta
Deterministic	5.00	0.58	23.36	15.82	1.46	1.46	95.73	0.00
Mean	1.21	0.17	104.20	15.56	1.25	1.47	116.80	11.26
5%ile	0.36	0.02	20.90	10.32	0.85	1.22	87.78	0.65
25%ile	0.57	0.11	36.58	12.93	1.09	1.35	98.18	3.99
50%ile	0.88	0.16	53.60	14.87	1.27	1.47	110.56	8.00
75%ile	1.46	0.22	82.33	17.39	1.43	1.57	128.07	15.16
95%ile	3.32	0.36	462.19	22.97	1.60	1.74	165.22	32.87
CV	0.77	0.59	1.61	0.25	0.19	0.11	0.23	1.00

Smooth hockeystick

768/1000 Iterations resulted in feasible parameter estimates

	Fcrash	Fmsy	Bmsy	MSY	ADMB Alpha	ADMB Beta	Unscaled Alpha	Unscaled Beta
Deterministic	0.49	0.49	27.66	15.75	0.68	0.56	1.73	27.56
Mean	0.37	0.31	48.13	16.14	0.76	0.54	1.94	26.55
5%ile	0.19	0.10	18.92	11.34	0.51	0.38	1.29	18.33
25%ile	0.27	0.22	23.46	14.05	0.63	0.44	1.60	21.29
50%ile	0.34	0.29	28.93	15.90	0.74	0.52	1.89	25.51
75%ile	0.44	0.38	36.99	18.05	0.89	0.62	2.25	30.18
95%ile	0.66	0.57	118.73	21.16	1.08	0.81	2.75	39.48
CV	0.42	0.45	1.78	0.20	0.23	0.28	0.23	0.28

Table 10.4.1. Sole in sub area IV: XSA summary

	recruitment	ssb	landings	tsb	fbar2-6	Y/ssb
1957	128913	55108	12067	63403	0.178	0.22
1958	128646	60920	14287	72301	0.207	0.23
1959	488778	65582	13832	85949	0.171	0.21
1960	61716	73400	18620	105902	0.204	0.25
1961	99499	117103	23566	123500	0.190	0.20
1962	22899	116835	26877	123710	0.213	0.23
1963	20424	113635	26164	115596	0.313	0.23
1964	539159	37131	11342	51191	0.289	0.31
1965	121982	30034	17043	101375	0.317	0.57
1966	39909	84259	33340	92983	0.325	0.40
1967	75191	82980	33439	91252	0.406	0.40
1968	99252	72335	33179	83117	0.489	0.46
1969	50869	55307	27559	68747	0.546	0.50
1970	137891	50730	19685	60432	0.399	0.39
1971	42107	43806	23652	63520	0.510	0.54
1972	76403	47525	21086	56272	0.461	0.44
1973	105045	36855	19309	51202	0.503	0.52
1974	109975	36167	17989	53795	0.488	0.50
1975	40825	38530	20773	54672	0.497	0.54
1976	113295	38975	17326	48150	0.424	0.44
1977	140307	34878	18003	54713	0.459	0.52
1978	47127	36308	20280	55374	0.477	0.56
1979	11664	44872	22598	51704	0.492	0.50
1980	151574	33457	15807	41025	0.453	0.47
1981	148896	22982	15403	49133	0.499	0.67
1982	152374	32806	21579	57887	0.546	0.66
1983	141488	39799	24927	65821	0.491	0.63
1984	70850	43203	26839	63724	0.621	0.62
1985	81670	40678	24248	52880	0.602	0.60
1986	159308	33901	18201	51674	0.584	0.54
1987	72702	29270	17368	55049	0.495	0.59
1988	455761	38474	21590	69999	0.570	0.56
1989	108274	33780	21805	94041	0.442	0.65
1990	177524	89601	35120	112960	0.445	0.39
1991	70435	77416	33513	103151	0.448	0.43
1992	353383	77175	29341	104769	0.423	0.38
1993	69162	55414	31491	99682	0.510	0.57
1994	56976	74273	33002	86063	0.563	0.44
1995	95962	59040	30467	71519	0.534	0.52
1996	49342	38370	22651	52929	0.702	0.59
1997	270702	27800	14901	48007	0.603	0.54
1998	113617	20576	20868	60337	0.644	1.01
1999	82211	41513	23475	59061	0.578	0.57
2000	123072	38631	22641	55087	0.607	0.59
2001	62890	30203	19944	49061	0.581	0.66
2002	183396	30827	16945	48126	0.579	0.55
2003	83962	25018	17920	53297	0.593	0.72
2004	44153	36999	18757	49478	0.515	0.51
2005	48196	31839	16355	40167	0.583	0.51
2006	216019	23695	12594	40787	0.454	0.53
2007	55007	17698	14635	49173	0.458	0.83
2008	81516	37601	14071	49296	0.351	0.37
2009	102743	34620	13952	49971	0.358	0.40

Table 10.5.1. Sole in sub area IV: RCT3 input table

Year Class	age 1	age 2	DFS 0	SNS 1	SNS 2	BTS 1
1970	42107	37700	-11	903	272	-11
1971	76403	68792	-11	1455	935	-11
1972	105045	94380	-11	5587	361	-11
1973	109975	99414	-11	2348	864	-11
1974	40825	36689	-11	525	74	-11
1975	113295	101523	168.84	1399	776	-11
1976	140307	125294	82.28	3743	1355	-11
1977	47127	42617	33.8	1548	408	-11
1978	11664	10546	96.87	94	89	-11
1979	151574	136544	392.08	4313	1413	-11
1980	148896	134324	404	3737	1146	-11
1981	152374	135343	293.93	5856	1123	-11
1982	141488	127653	328.52	2621	1100	-11
1983	70850	63926	104.38	2493	716	-11
1984	81670	73741	186.53	3619	458	7.03
1985	159308	143792	315.03	3705	944	7.17
1986	72702	65694	73.22	1948	594	6.97
1987	455761	412380	523.86	11227	5005	83.11
1988	108274	97859	50.07	2831	1120	9.01
1989	177524	159810	77.8	2856	2529	37.84
1990	70435	63618	21.09	1254	144	4.03
1991	353383	318822	391.93	11114	3420	81.63
1992	69162	62529	25.3	1291	498	6.35
1993	56976	50871	25.13	652	224	7.66
1994	95962	82263	69.11	1362	349	28.13
1995	49342	44482	19.07	218	154	3.98
1996	270702	243429	59.62	10279	3126	169.34
1997	113617	102573	44.08	4095	972	17.11
1998	82211	74114	-11	1649	126	11.96
1999	123072	109124	-11	1639	655	14.59
2000	62890	56064	15.51	970	379	8
2001	183396	164940	85.31	7547	-11	20.99
2002	83962	74975	64.97	-11	624	10.51
2003	44153	39460	16.82	1370	163	4.19
2004	48196	42510	40.1	568	117	5.53
2005	216019	188980	46.81	2726	911	17.09
2006	-11	-11	14.69	849	259	7.5
2007	-11	-11	23.51	1259	344	15.25
2008	-11	-11	26.74	1932	-11	15.95
2009	-11	-11	25.36	-11	-11	-11

Table 10.5.2. Sole in sub area IV: RCT3 analysis – age 1

```
Analysis by RCT3 ver3.1 of data from file : altin_1.txt, Sole North Sea Age 1


 Data for    4 surveys over   40 years :  1970 - 2009
 Regression type = C
 Tapered time weighting not applied
 Survey weighting not applied
 Final estimates shrunk towards mean
 Minimum S.E. for any survey taken as    .00
 Minimum of   3 points used for regression

 Forecast/Hindcast variance correction used.


 Yearclass =   2009

          I-----------Regression----------I  I-----------Prediction---------I

 Survey/  Slope  Inter-   Std  Rsquare  No.  Index Predicted   Std     WAP
 Series           cept   Error          Pts  Value   Value    Error   Weights

 DFS0    1.25   5.99   1.11   .311     29   3.27   10.08    1.198     .251

                                        VPA Mean =   11.47     .693     .749

 Year     Weighted      Log     Int     Ext     Var
 Class     Average      WAP     Std     Std    Ratio
          Prediction            Error   Error

 2009       67894     11.13     .60     .60     1.01
```

Table 10.5.3. Sole in sub area IV: Output RCT3 – age 2

```
Analysis by RCT3 ver3.1 of data from file : altin_2.txt, Sole North Sea Age 2


 Data for    4 surveys over   40 years :  1970 - 2009
 Regression type = C
 Tapered time weighting not applied
 Survey weighting not applied
 Final estimates shrunk towards mean
 Minimum S.E. for any survey taken as    .00
 Minimum of   3 points used for regression

 Forecast/Hindcast variance correction used.

 Yearclass =   2008

          I-----------Regression----------I  I-----------Prediction---------I

 Survey/  Slope  Inter-   Std  Rsquare  No.  Index Predicted   Std     WAP
 Series           cept   Error          Pts  Value   Value    Error   Weights

 DFS0      1.24   5.91   1.11   .315     29   3.32   10.05    1.187     .046
 SNS1       .76   5.58    .36   .793     35   7.57   11.33     .380     .451
 BTS1       .78   9.38    .39   .746     22   2.83   11.58     .422     .367

                                        VPA Mean =   11.37     .693     .136

 Year     Weighted      Log     Int     Ext     Var
 Class     Average      WAP     Std     Std    Ratio
          Prediction            Error   Error

 2008       86520     11.37     .26     .18      .50
```

Table 10.6.1. Sole in sub area IV: STF Input table (F values presented are for Fsq)

age	year	f	stock.n	stock.wt	landings.wt	mat	M
1	2010	0.015	94011	0.05	0.15	0	0.1
2	2010	0.170	91428	0.15	0.18	0	0.1
3	2010	0.362	55264	0.19	0.21	1	0.1
4	2010	0.433	25010	0.22	0.25	1	0.1
5	2010	0.435	52320	0.25	0.27	1	0.1
6	2010	0.388	5037	0.28	0.29	1	0.1
7	2010	0.409	3032	0.28	0.31	1	0.1
8	2010	0.437	3194	0.27	0.31	1	0.1
9	2010	0.740	3086	0.28	0.30	1	0.1
10	2010	0.740	757	0.38	0.38	1	0.1
1	2011	0.015	94011	0.05	0.15	0	0.1
2	2011	0.170		0.15	0.18	0	0.1
3	2011	0.362		0.19	0.21	1	0.1
4	2011	0.433		0.22	0.25	1	0.1
5	2011	0.435		0.25	0.27	1	0.1
6	2011	0.388		0.28	0.29	1	0.1
7	2011	0.409		0.28	0.31	1	0.1
8	2011	0.437		0.27	0.31	1	0.1
9	2011	0.740		0.28	0.30	1	0.1
10	2011	0.740		0.38	0.38	1	0.1
1	2012	0.015	94011	0.05	0.15	0	0.1
2	2012	0.170		0.15	0.18	0	0.1
3	2012	0.362		0.19	0.21	1	0.1
4	2012	0.433		0.22	0.25	1	0.1
5	2012	0.435		0.25	0.27	1	0.1
6	2012	0.388		0.28	0.29	1	0.1
7	2012	0.409		0.28	0.31	1	0.1
8	2012	0.437		0.27	0.31	1	0.1
9	2012	0.740		0.28	0.30	1	0.1
10	2012	0.740		0.38	0.38	1	0.1

Table 10.6.2. (A) Sole in sub area IV: STF option table, assuming F(2010) = F(sq)

fmult	year	ssb	f2-6	recruits	landings
1	2010	32944	0.358	94011	14557

year	fmult	f2-6	landings	ssb	ssb2012
2011	0.0	0.000	0	35283	49691
2011	0.1	0.036	1738	35283	48041
2011	0.2	0.072	3414	35283	46452
2011	0.3	0.107	5029	35283	44923
2011	0.4	0.143	6586	35283	43451
2011	0.5	0.179	8087	35283	42033
2011	0.6	0.215	9535	35283	40667
2011	0.7	0.250	10931	35283	39351
2011	0.8	0.286	12278	35283	38083
2011	0.9	0.322	13578	35283	36862
2011	1.0	0.358	14832	35283	35685
2011	1.1	0.394	16042	35283	34550
2011	1.2	0.429	17210	35283	33457
2011	1.3	0.465	18338	35283	32403
2011	1.4	0.501	19427	35283	31386
2011	1.5	0.537	20479	35283	30406
2011	1.6	0.572	21495	35283	29460
2011	1.7	0.608	22476	35283	28548
2011	1.8	0.644	23424	35283	27668
2011	1.9	0.680	24340	35283	26819
2011	2.0	0.716	25225	35283	26000

Table 10.6.2. (B) Sole in sub area IV: STF option table, assuming F(2010) = 0.9*F(sq)

fmult	year	ssb	f2-6	recruits	landings
0.9	2010	32944	0.322	95024	13332

year	fmult	f2-6	landings	ssb	ssb2012
2011	0.0	0.000	0	36452	51018
2011	0.1	0.036	1792	36452	49318
2011	0.2	0.072	3519	36452	47681
2011	0.3	0.107	5183	36452	46105
2011	0.4	0.143	6787	36452	44587
2011	0.5	0.179	8334	36452	43126
2011	0.6	0.215	9825	36452	41719
2011	0.7	0.250	11264	36452	40364
2011	0.8	0.286	12651	36452	39059
2011	0.9	0.322	13989	36452	37801
2011	1.0	0.358	15280	36452	36589
2011	1.1	0.394	16526	36452	35421
2011	1.2	0.429	17729	36452	34296
2011	1.3	0.465	18890	36452	33210
2011	1.4	0.501	20010	36452	32164
2011	1.5	0.537	21092	36452	31156
2011	1.6	0.572	22137	36452	30183
2011	1.7	0.608	23147	36452	29245
2011	1.8	0.644	24122	36452	28340
2011	1.9	0.680	25064	36452	27466
2011	2.0	0.716	25974	36452	26624

Table 10.6.2. (C) Sole in sub area IV: STF option table, assuming F(2010)~Landings for 2010=TAC for 2010

fmult	year	ssb	f2-6	recruits	landings
0.954	2010	32944	0.341	95024	14000

year	fmult	f2-6	landings	ssb	ssb2012
2011	0.0	0.000	0	35815	50379
2011	0.1	0.036	1764	35815	48704
2011	0.2	0.072	3465	35815	47092
2011	0.3	0.107	5104	35815	45541
2011	0.4	0.143	6684	35815	44046
2011	0.5	0.179	8207	35815	42607
2011	0.6	0.215	9676	35815	41222
2011	0.7	0.250	11093	35815	39887
2011	0.8	0.286	12460	35815	38601
2011	0.9	0.322	13778	35815	37361
2011	1.0	0.358	15051	35815	36167
2011	1.1	0.394	16279	35815	35016
2011	1.2	0.429	17464	35815	33907
2011	1.3	0.465	18608	35815	32837
2011	1.4	0.501	19712	35815	31806
2011	1.5	0.537	20779	35815	30812
2011	1.6	0.572	21810	35815	29853
2011	1.7	0.608	22805	35815	28928
2011	1.8	0.644	23766	35815	28035
2011	1.9	0.680	24695	35815	27174
2011	2.0	0.716	25593	35815	26344

Table 10.6.3. (A) Sole in sub area IV: STF detailed, assuming F(2010) = F(sq)

age	year	f	stock.n	stock.wt	land.wt	mat	M	land.n	landings	SSB	TSB
1	2010	0.015	94011	0.05	0.15	0	0.1	1303	193	0	4701
2	2010	0.170	91428	0.15	0.18	0	0.1	13654	2504	0	13653
3	2010	0.362	55264	0.19	0.21	1	0.1	16012	3389	10353	10353
4	2010	0.433	25010	0.22	0.25	1	0.1	8395	2067	5502	5502
5	2010	0.435	52320	0.25	0.27	1	0.1	17638	4698	12836	12836
6	2010	0.388	5037	0.28	0.29	1	0.1	1547	455	1387	1387
7	2010	0.409	3032	0.28	0.31	1	0.1	971	305	849	849
8	2010	0.437	3194	0.27	0.31	1	0.1	1080	337	869	869
9	2010	0.740	3086	0.28	0.30	1	0.1	1545	463	857	857
10	2010	0.740	757	0.38	0.38	1	0.1	379	145	291	291
1	2011	0.015	94011	0.05	0.15	0	0.1	1303	193	0	4701
2	2011	0.170	83826	0.15	0.18	0	0.1	12519	2296	0	12518
3	2011	0.362	69764	0.19	0.21	1	0.1	20214	4278	13069	13069
4	2011	0.433	34825	0.22	0.25	1	0.1	11690	2878	7662	7662
5	2011	0.435	14676	0.25	0.27	1	0.1	4947	1318	3600	3600
6	2011	0.388	30631	0.28	0.29	1	0.1	9407	2766	8434	8434
7	2011	0.409	3092	0.28	0.31	1	0.1	990	311	866	866
8	2011	0.437	1823	0.27	0.31	1	0.1	617	193	496	496
9	2011	0.740	1867	0.28	0.30	1	0.1	935	280	518	518
10	2011	0.740	1659	0.38	0.38	1	0.1	831	319	639	639
1	2012	0.015	94011	0.05	0.15	0	0.1	1303	193	0	4701
2	2012	0.170	83826	0.15	0.18	0	0.1	12519	2296	0	12518
3	2012	0.362	63963	0.19	0.21	1	0.1	18533	3923	11982	11982
4	2012	0.433	43963	0.22	0.25	1	0.1	14758	3633	9672	9672
5	2012	0.435	20436	0.25	0.27	1	0.1	6889	1835	5014	5014
6	2012	0.388	8592	0.28	0.29	1	0.1	2639	776	2366	2366
7	2012	0.409	18801	0.28	0.31	1	0.1	6021	1889	5264	5264
8	2012	0.437	1859	0.27	0.31	1	0.1	629	196	506	506
9	2012	0.740	1065	0.28	0.30	1	0.1	533	160	296	296
10	2012	0.740	1522	0.38	0.38	1	0.1	762	293	586	586

Table 10.6.3. (B) Sole in sub area IV: STF detailed, assuming F(2010) = 0.9*F(sq)

age	year	f	stock.n	stock.wt	land.wt	mat	M	land.n	landings	SSB	TSB
1	2010	0.013	95024	0.05	0.15	0	0.1	1186	176	0	4751
2	2010	0.153	91428	0.15	0.18	0	0.1	12389	2272	0	13653
3	2010	0.326	55264	0.19	0.21	1	0.1	14655	3102	10353	10353
4	2010	0.390	25010	0.22	0.25	1	0.1	7707	1897	5502	5502
5	2010	0.392	52320	0.25	0.27	1	0.1	16193	4314	12836	12836
6	2010	0.349	5037	0.28	0.29	1	0.1	1417	417	1387	1387
7	2010	0.368	3032	0.28	0.31	1	0.1	890	279	849	849
8	2010	0.393	3194	0.27	0.31	1	0.1	992	310	869	869
9	2010	0.666	3086	0.28	0.30	1	0.1	1436	430	857	857
10	2010	0.666	757	0.38	0.38	1	0.1	352	135	291	291
1	2011	0.015	95024	0.05	0.15	0	0.1	1317	195	0	4751
2	2011	0.170	84854	0.15	0.18	0	0.1	12672	2324	0	12672
3	2011	0.362	70963	0.19	0.21	1	0.1	20561	4352	13294	13294
4	2011	0.433	36108	0.22	0.25	1	0.1	12121	2984	7944	7944
5	2011	0.435	15325	0.25	0.27	1	0.1	5166	1376	3760	3760
6	2011	0.388	31994	0.28	0.29	1	0.1	9826	2890	8809	8809
7	2011	0.409	3214	0.28	0.31	1	0.1	1029	323	900	900
8	2011	0.437	1899	0.27	0.31	1	0.1	642	201	517	517
9	2011	0.740	1950	0.28	0.30	1	0.1	976	292	541	541
10	2011	0.740	1787	0.38	0.38	1	0.1	894	343	688	688
1	2012	0.015	95024	0.05	0.15	0	0.1	1317	195	0	4751
2	2012	0.170	84730	0.15	0.18	0	0.1	12654	2320	0	12653
3	2012	0.362	64747	0.19	0.21	1	0.1	18760	3971	12129	12129
4	2012	0.433	44718	0.22	0.25	1	0.1	15011	3696	9838	9838
5	2012	0.435	21188	0.25	0.27	1	0.1	7143	1903	5198	5198
6	2012	0.388	8972	0.28	0.29	1	0.1	2755	810	2470	2470
7	2012	0.409	19637	0.28	0.31	1	0.1	6289	1973	5498	5498
8	2012	0.437	1933	0.27	0.31	1	0.1	654	204	526	526
9	2012	0.740	1110	0.28	0.30	1	0.1	556	166	308	308
10	2012	0.740	1613	0.38	0.38	1	0.1	808	310	621	621

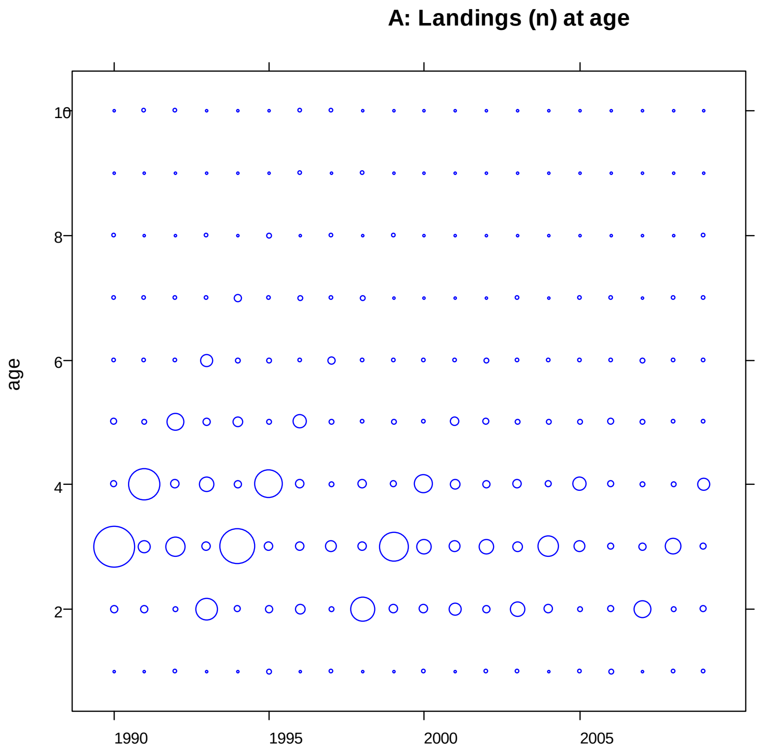
Table 10.6.3. (C) Sole in sub area IV: STF detailed, assuming F(2010) = TAC

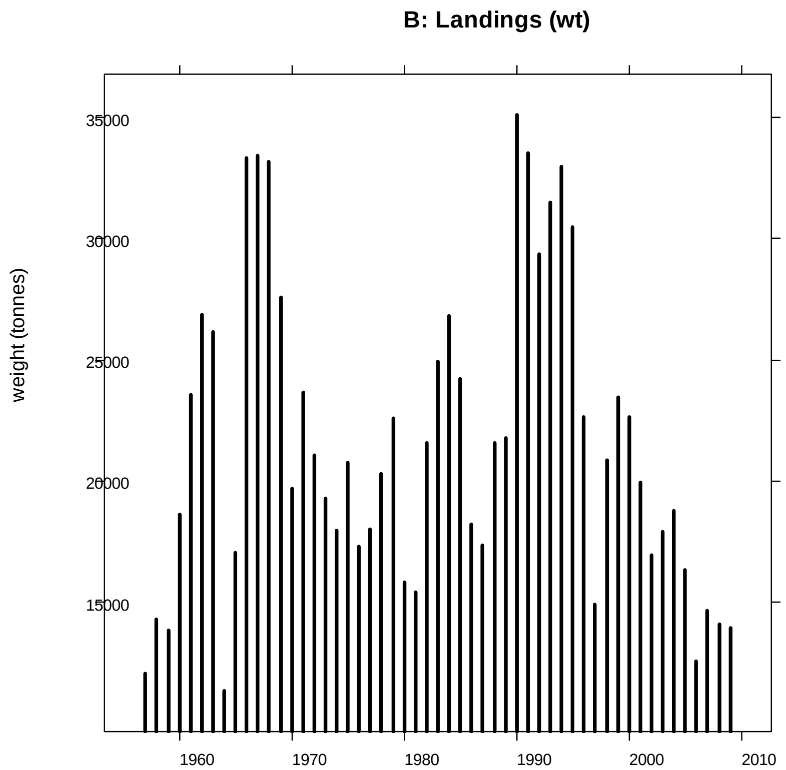
age	year	f	stock.n	stock.wt	land.wt	mat	M	landings.n	landings	SSB	TSB
1	2010	0.014	95024	0.05	0.15	0	0.1	1257	187	0	4751
2	2010	0.163	91428	0.15	0.18	0	0.1	13075	2398	0	13653
3	2010	0.345	55264	0.19	0.21	1	0.1	15394	3258	10353	10353
4	2010	0.413	25010	0.22	0.25	1	0.1	8082	1990	5502	5502
5	2010	0.415	52320	0.25	0.27	1	0.1	16981	4523	12836	12836
6	2010	0.370	5037	0.28	0.29	1	0.1	1488	438	1387	1387
7	2010	0.390	3032	0.28	0.31	1	0.1	934	293	849	849
8	2010	0.417	3194	0.27	0.31	1	0.1	1040	325	869	869
9	2010	0.706	3086	0.28	0.30	1	0.1	1496	448	857	857
10	2010	0.706	757	0.38	0.38	1	0.1	367	141	291	291
1	2011	0.015	95024	0.05	0.15	0	0.1	1317	195	0	4751
2	2011	0.170	84787	0.15	0.18	0	0.1	12662	2322	0	12661
3	2011	0.362	70313	0.19	0.21	1	0.1	20373	4312	13172	13172
4	2011	0.433	35410	0.22	0.25	1	0.1	11886	2926	7790	7790
5	2011	0.435	14971	0.25	0.27	1	0.1	5047	1344	3673	3673
6	2011	0.388	31251	0.28	0.29	1	0.1	9597	2822	8604	8604
7	2011	0.409	3147	0.28	0.31	1	0.1	1008	316	881	881
8	2011	0.437	1858	0.27	0.31	1	0.1	628	196	505	505
9	2011	0.740	1905	0.28	0.30	1	0.1	953	285	529	529
10	2011	0.740	1717	0.38	0.38	1	0.1	859	330	661	661
1	2012	0.015	95024	0.05	0.15	0	0.1	1317	195	0	4751
2	2012	0.170	84730	0.15	0.18	0	0.1	12654	2320	0	12653
3	2012	0.362	64696	0.19	0.21	1	0.1	18745	3968	12120	12120
4	2012	0.433	44309	0.22	0.25	1	0.1	14874	3662	9748	9748
5	2012	0.435	20778	0.25	0.27	1	0.1	7005	1866	5098	5098
6	2012	0.388	8765	0.28	0.29	1	0.1	2692	792	2413	2413
7	2012	0.409	19181	0.28	0.31	1	0.1	6143	1928	5371	5371
8	2012	0.437	1893	0.27	0.31	1	0.1	640	200	515	515
9	2012	0.740	1086	0.28	0.30	1	0.1	543	163	301	301
10	2012	0.740	1563	0.38	0.38	1	0.1	783	301	602	602

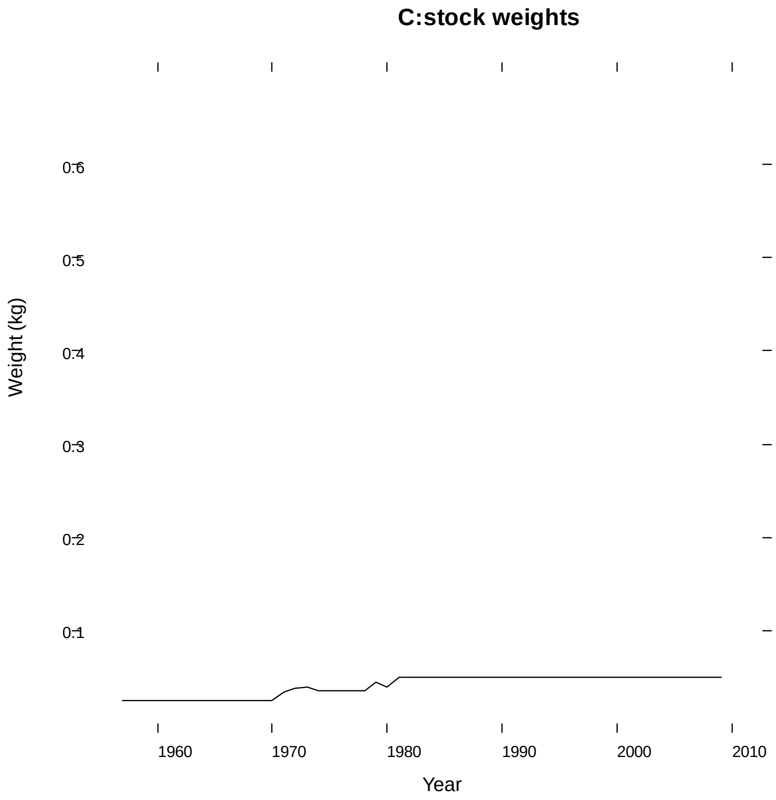
Table 10.6.4 Yield and spawning biomass per Recruit F-reference points (2010).

	Fish Mort Ages 2-6	Yield/R	SSB/R
Average last 3 years	0.39	0.16	0.35
Fmax *	0.58	0.17	0.24
F0.1	0.08	0.13	1.08
Fmed	0.31	0.16	0.43

*Poorly defined


A: Landings (n) at age
age
10
8
6
4
2
1990
1995
2000
2005


B: Landings (wt)
weight (tonnes)
35000
30000
25000
20000
15000
1960
1970
1980
1990
2000
2010


C:stock weights
Weight (kg)
0.6
0.5
0.4
0.3
0.2
0.1
1960
1970
1980
1990
2000
2010
Year

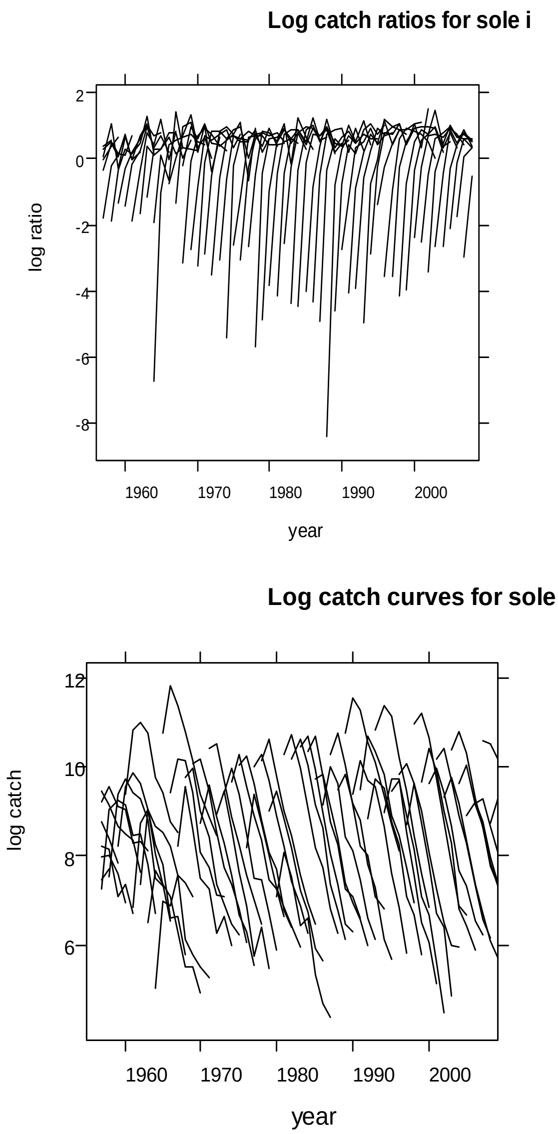
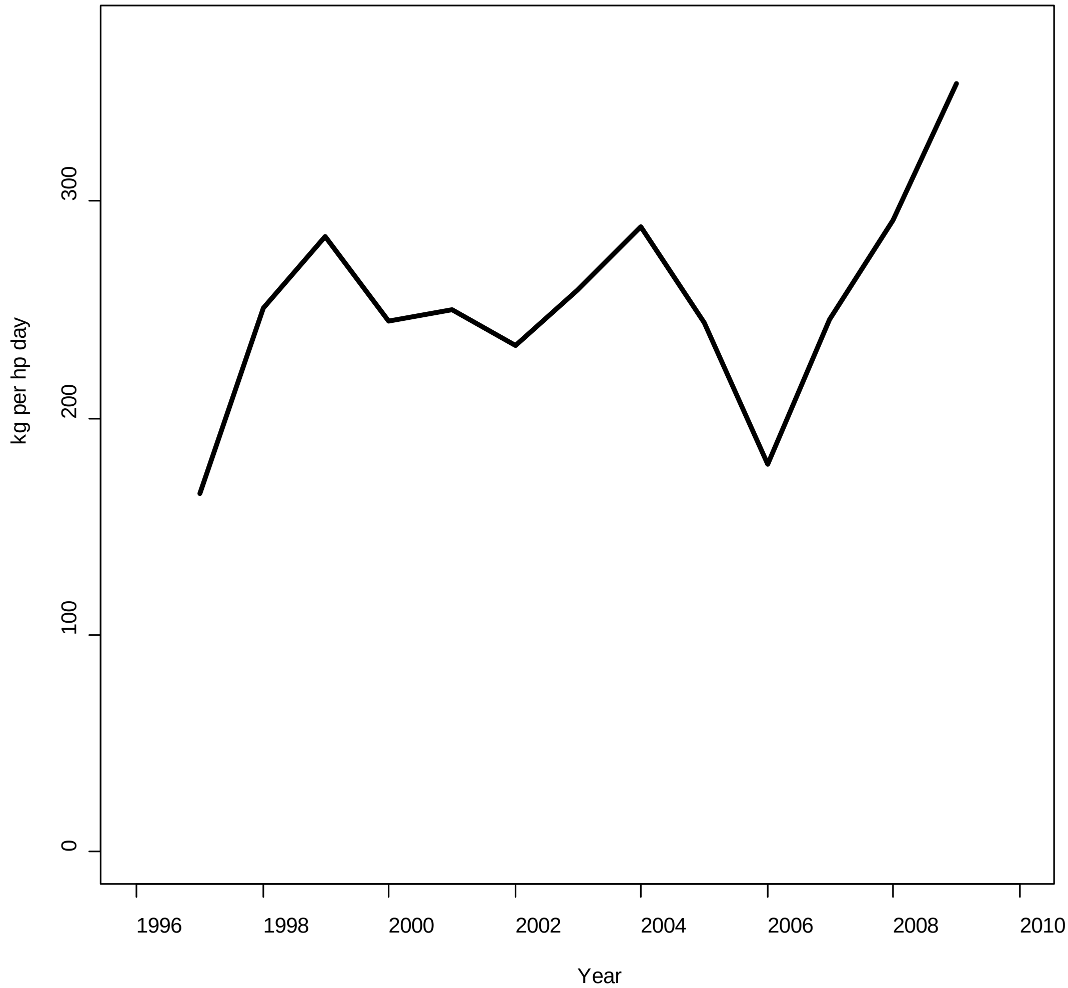


Figure 10.2.2. Sole in Sub-Area IV: Log catch ratios (left) and catch curves (right) from 1957 to 2008.


kg per hp day
0
100
200
300
1996
1998
2000
2002
2004
2006
2008
2010
Year

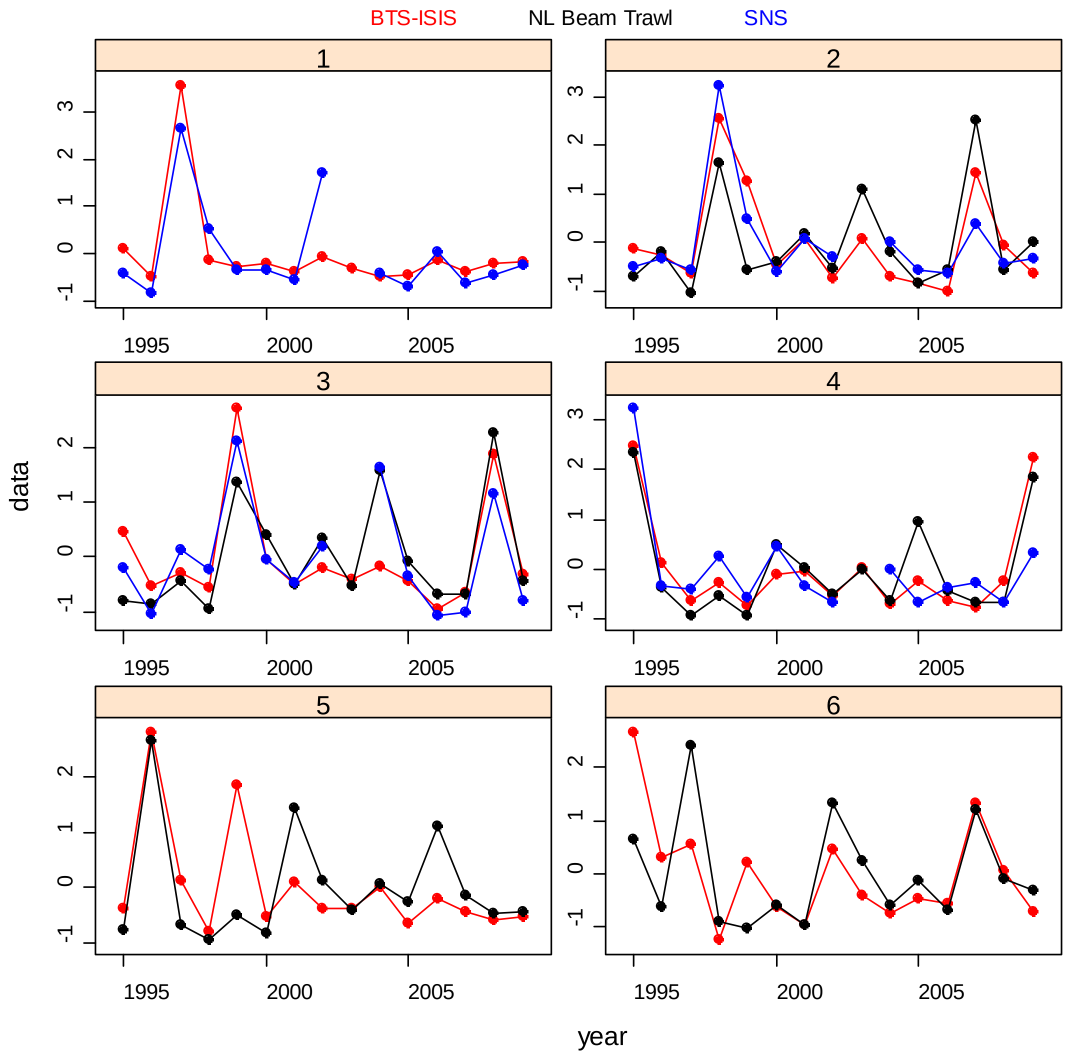


Figure 10.2.4 Sole in sub-area IV. Time series of the standardized indices age 1 to 6 from the three tuning fleets used in the final XSA assessment (BTS-ISIS, SNS and NL beam trawl).

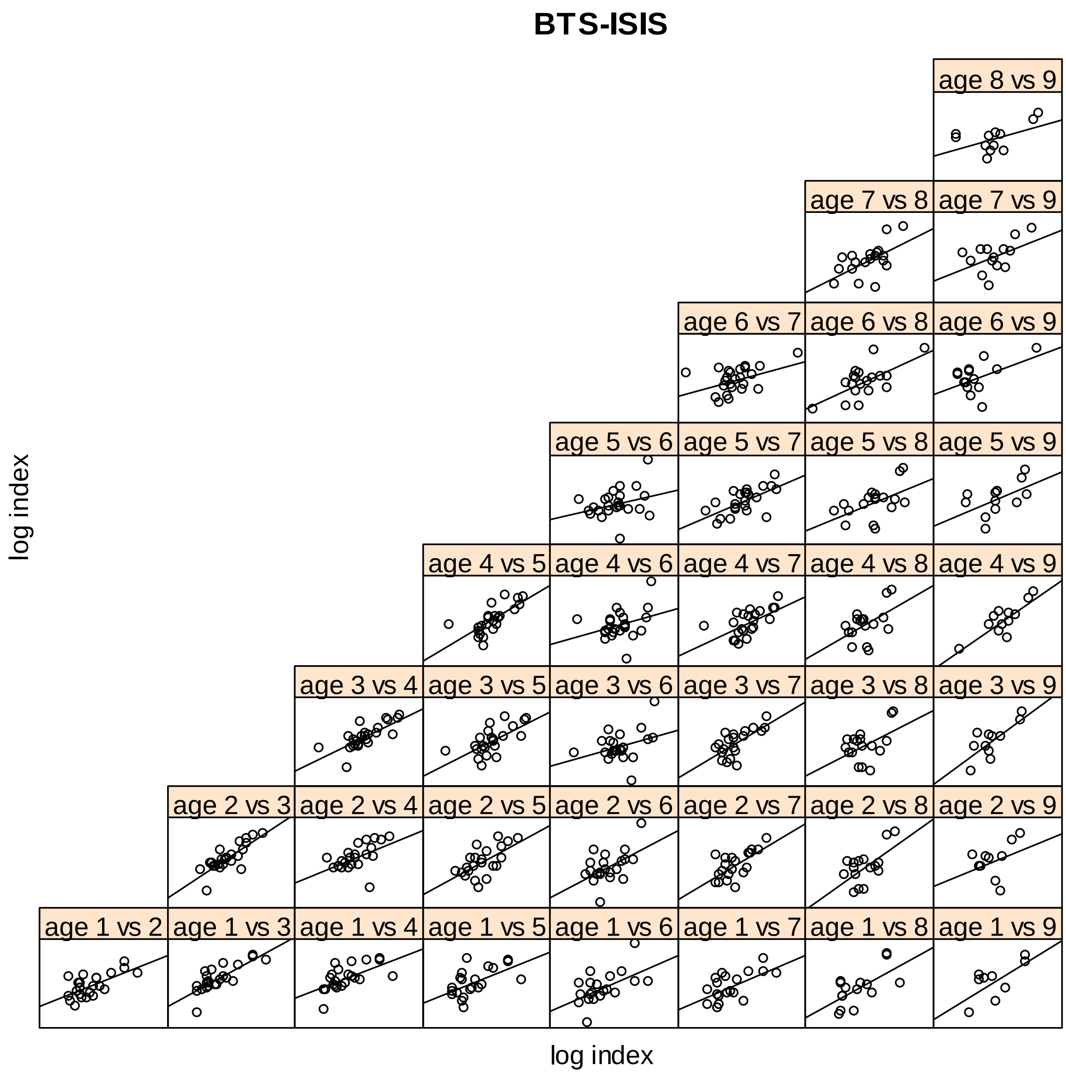


Figure 10.2.5 Sole in sub-area IV. Internal consistency in BTS-ISIS survey tuning index.

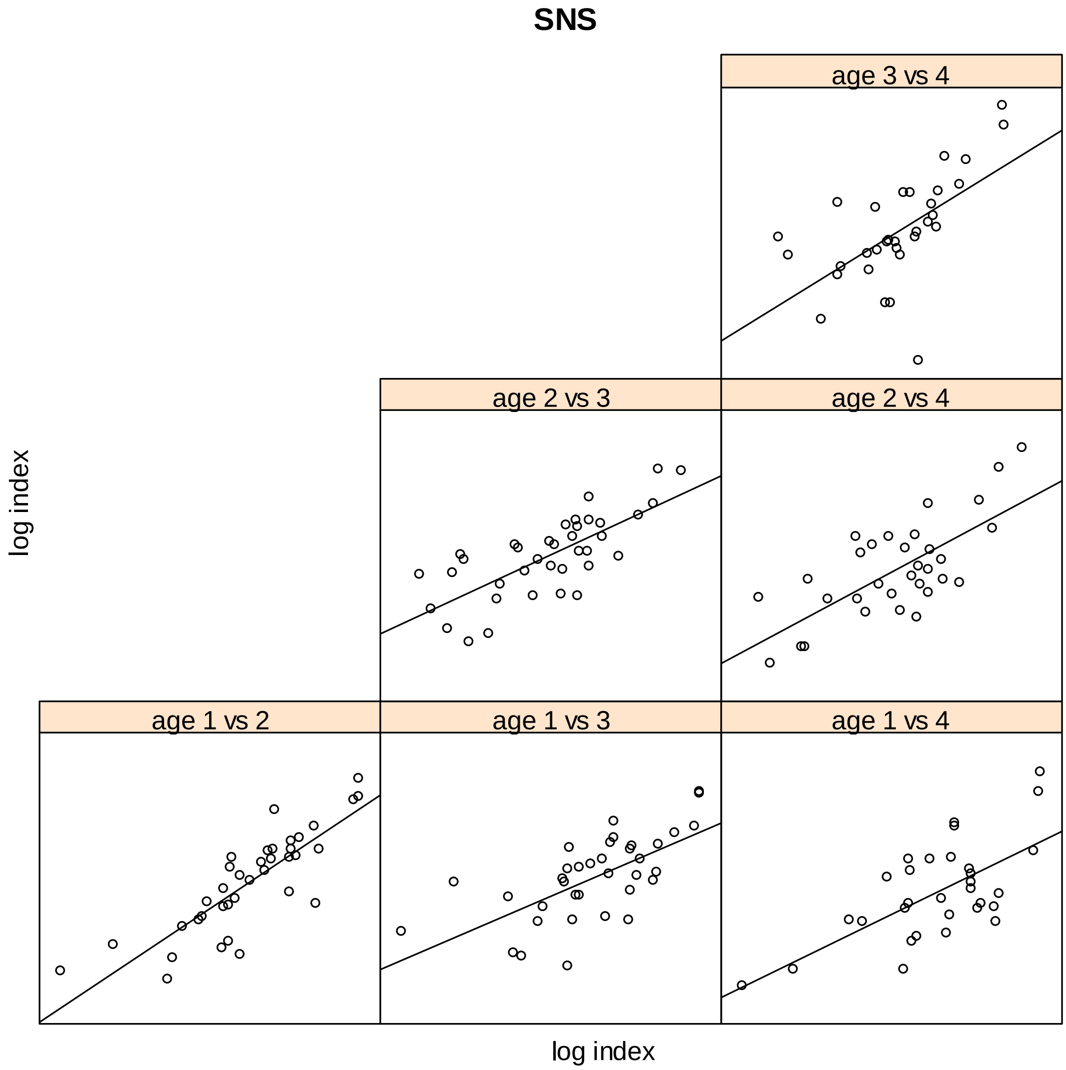


Figure 10.2.6 Sole in sub-area IV. Internal consistency in SNS survey tuning index.

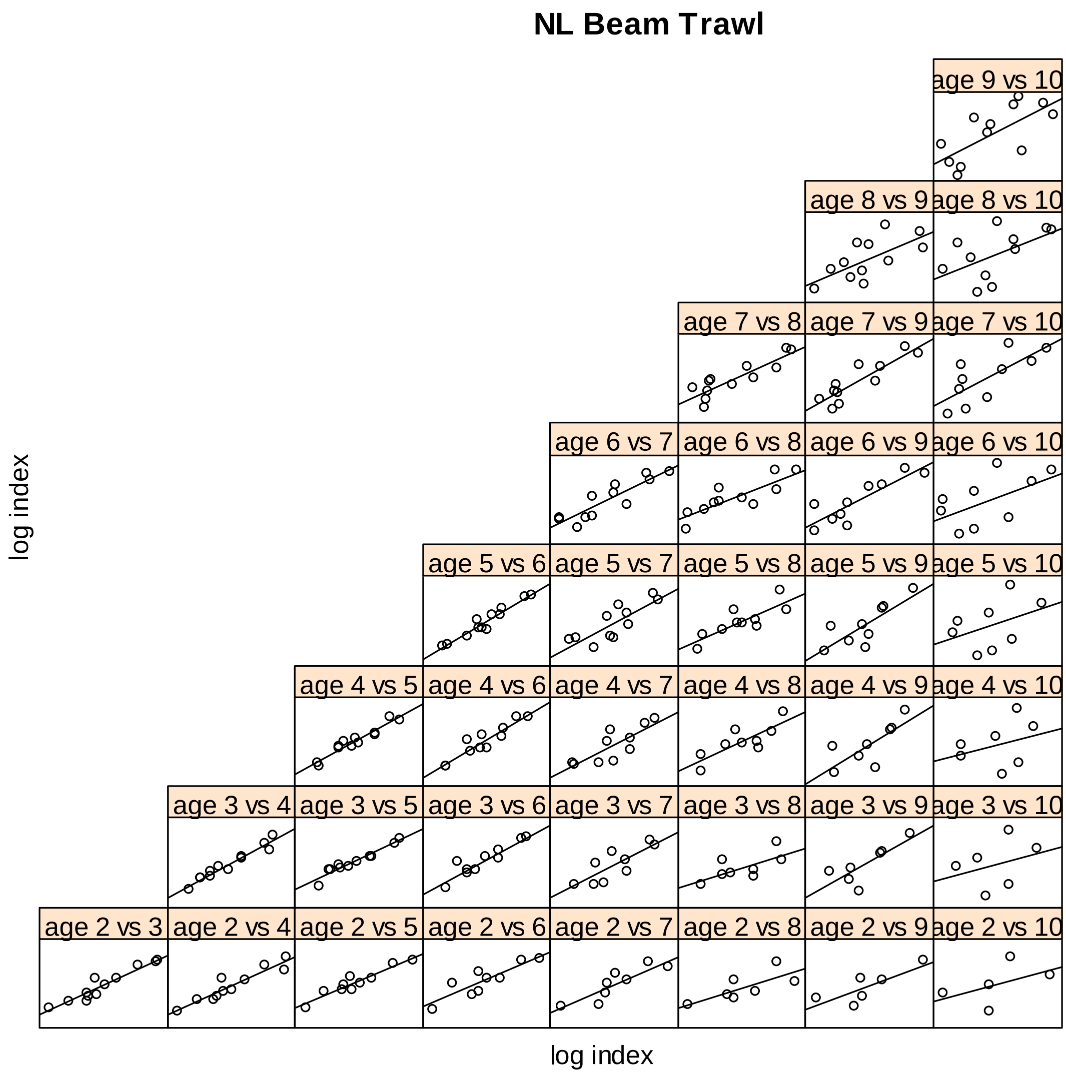


Figure 10.2.7 Sole in sub-area IV. Internal consistency in NL Beam trawl commercial tuning index.

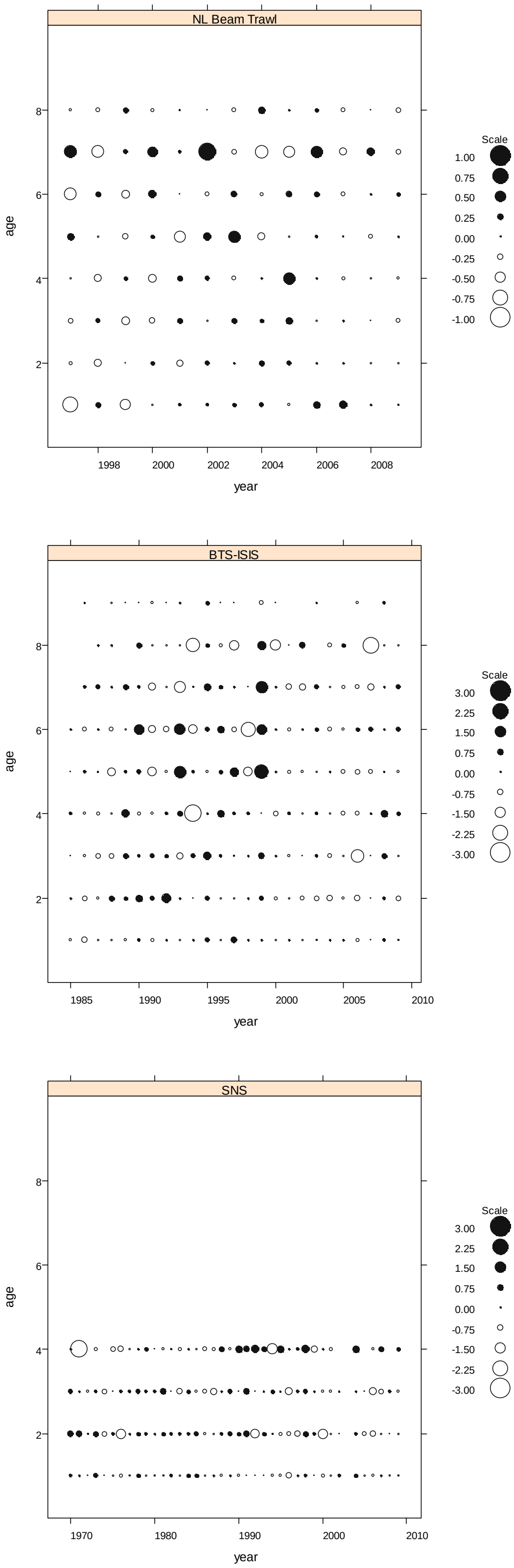


Figure 10.3.1 Sole in sub-area IV. log catchability residuals for the tuning fleets, BTS, SNS and NL beam trawl, from exploratory single fleet runs. Closed and dark- circles indicate positive residuals, Open circles indicate negative residuals

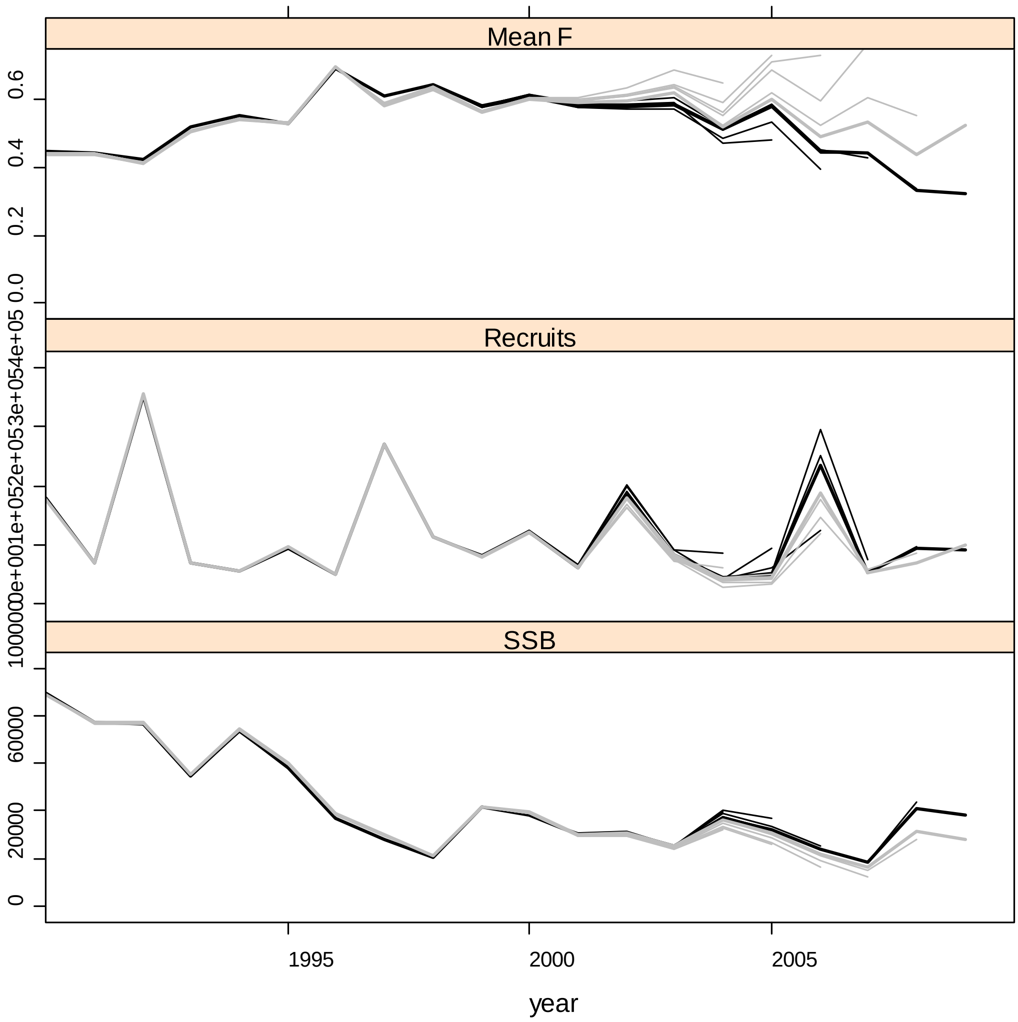


Figure 10.3.2 Sole in sub-area IV. XSA retrospective analysis of assessment estimates of fishing mortality using different combinations of indices. Grey lines: using survey indices only. Black lines: using commercial indices only.

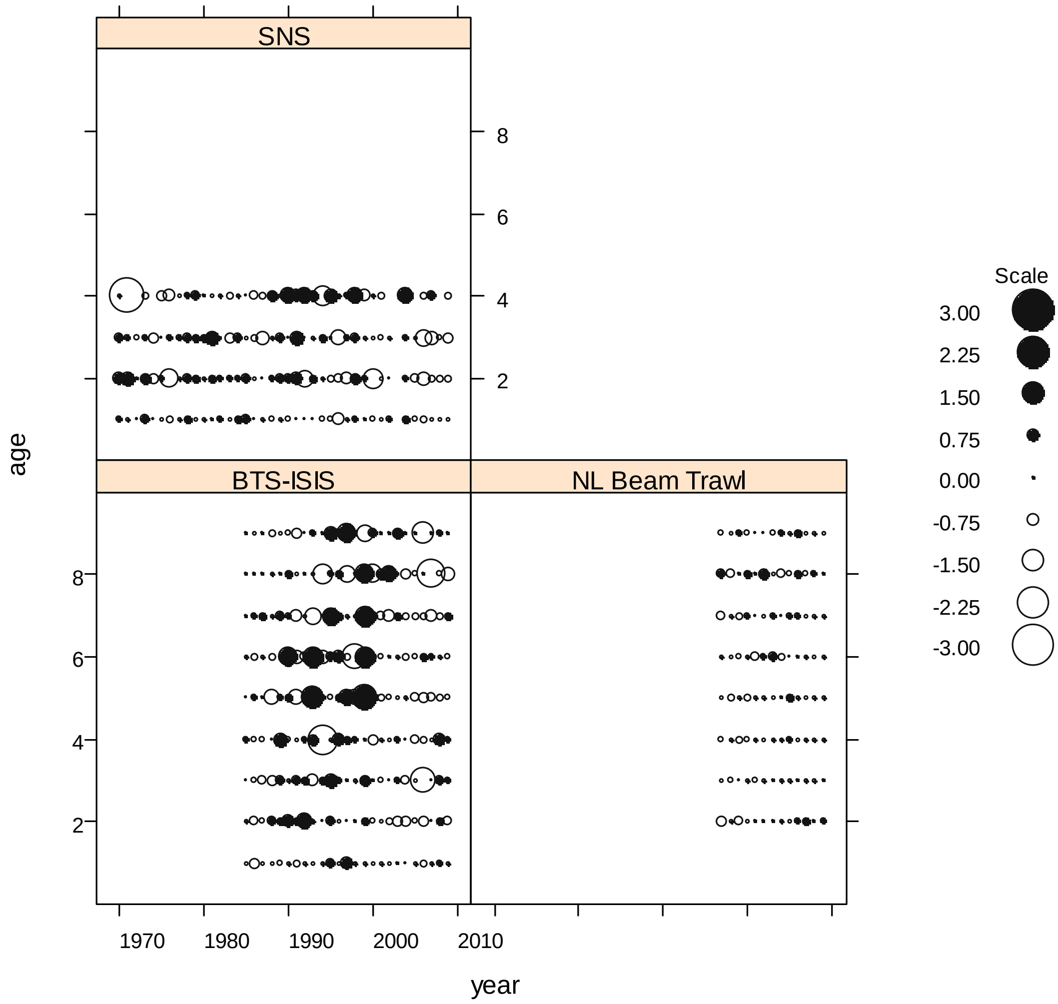


Figure 10.3.3 Sole in sub-area IV. log catchability residuals for the tuning fleets, BTS, SNS and NL beam trawl, in the final run. Closed and dark- circles indicate positive residuals, Open circles indicate negative residuals

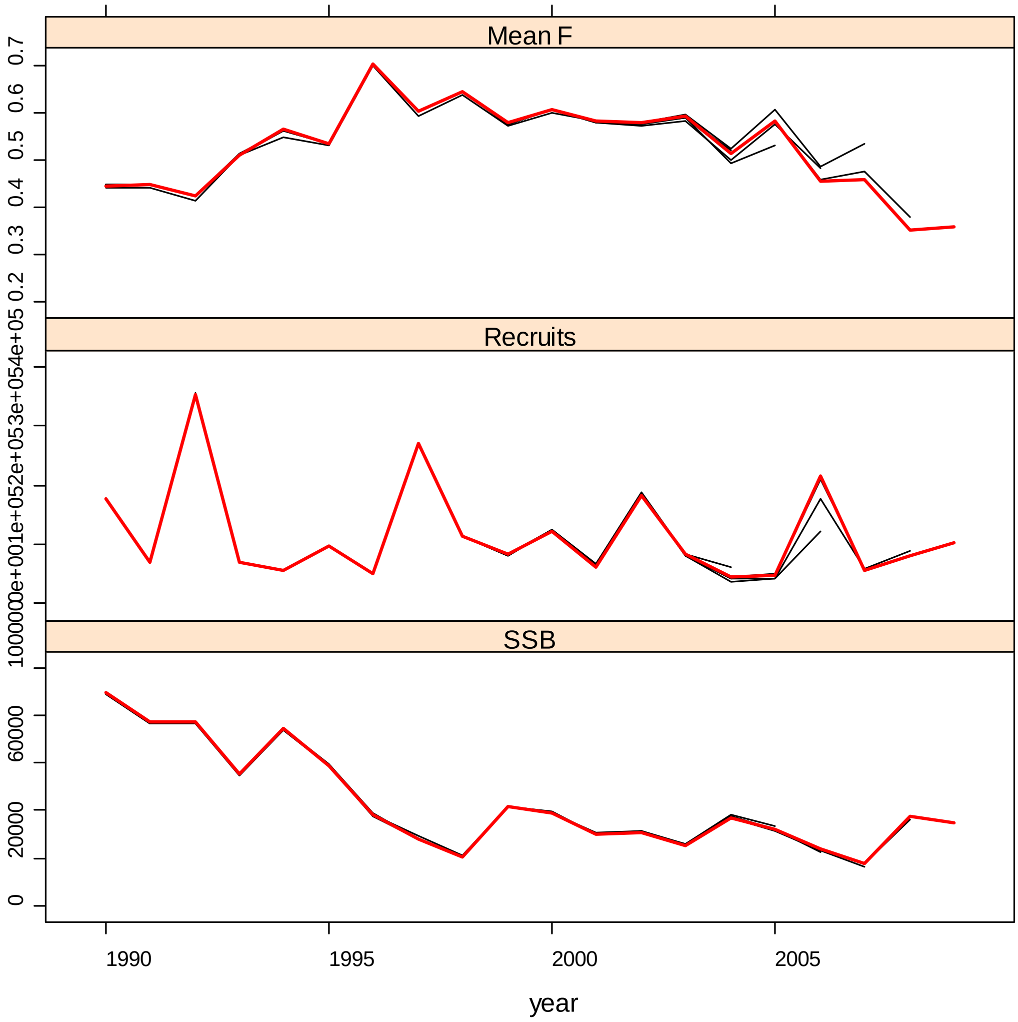


Figure 10.3.4 Sole in sub-area IV. Retrospective analysis of F, SSB and recruitment for 1990–2009

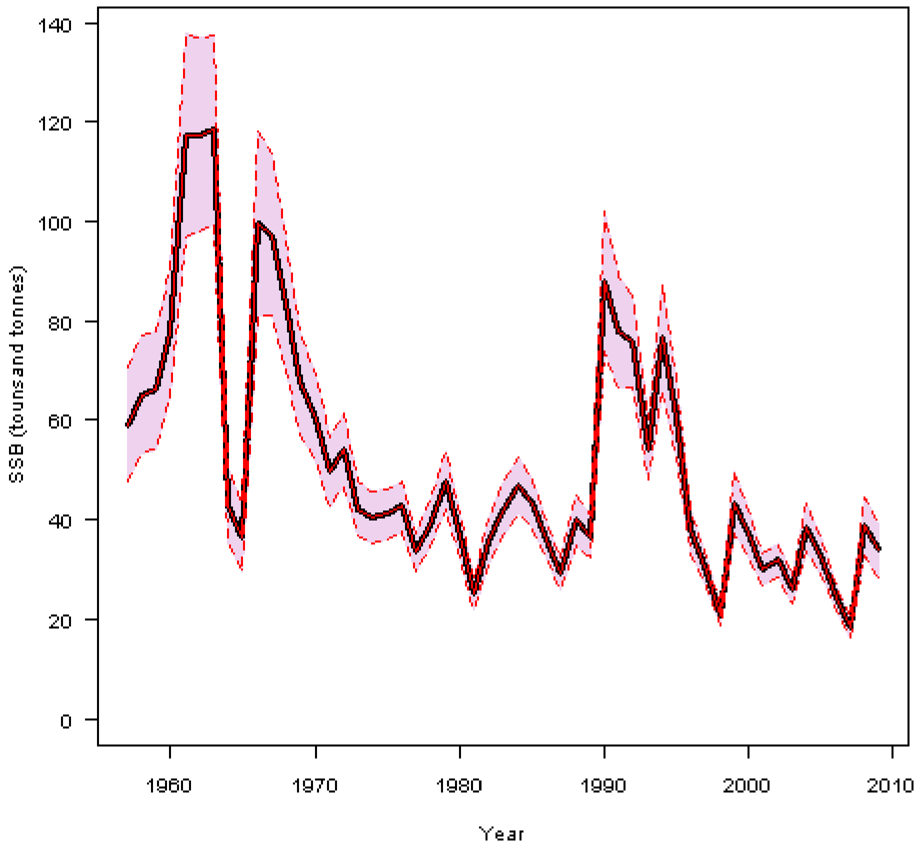


Figure 10.3.5a Sole in sub-area IV: SSB 1957–2009 output by SAM model.

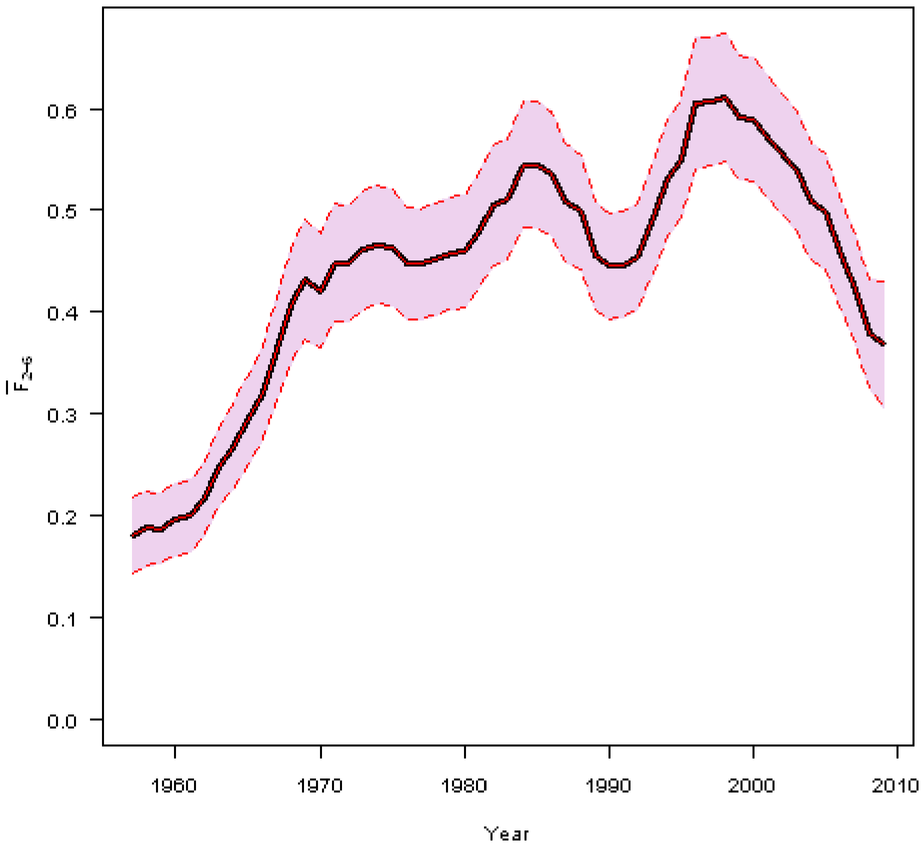


Figure 10.3.5b Sole in sub-area IV: Fishing mortality on ages 2-6 1957–2009 output by SAM model.

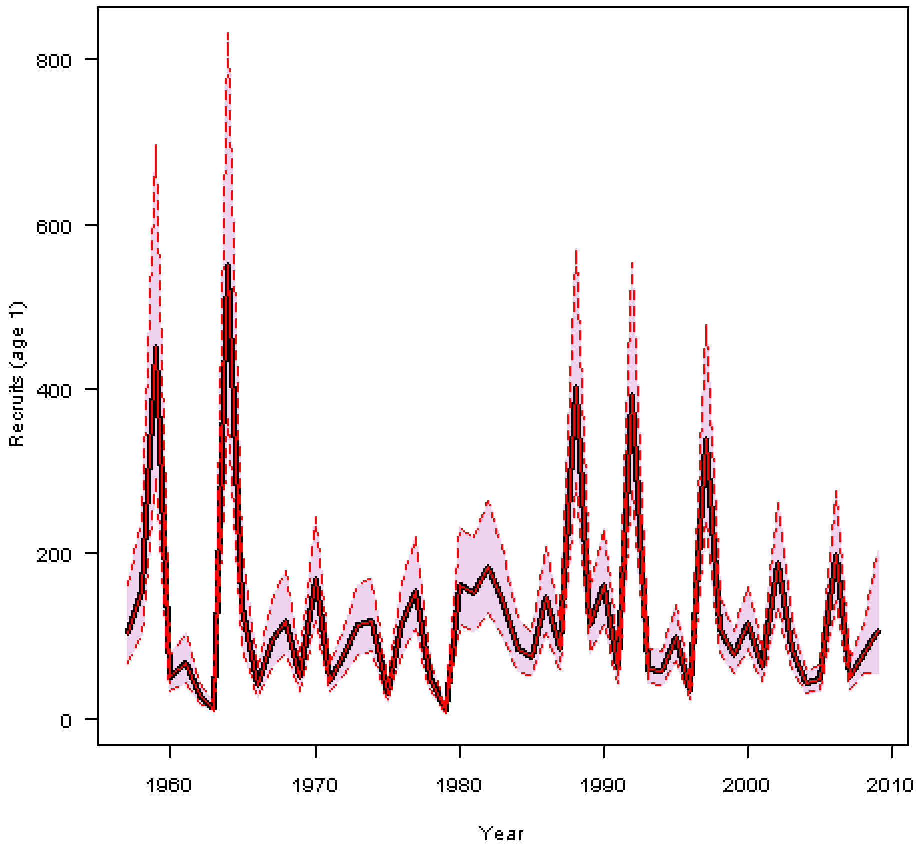


Figure 10.3.5c Sole in sub-area IV: Recruitment 1957–2009 output by SAM model.

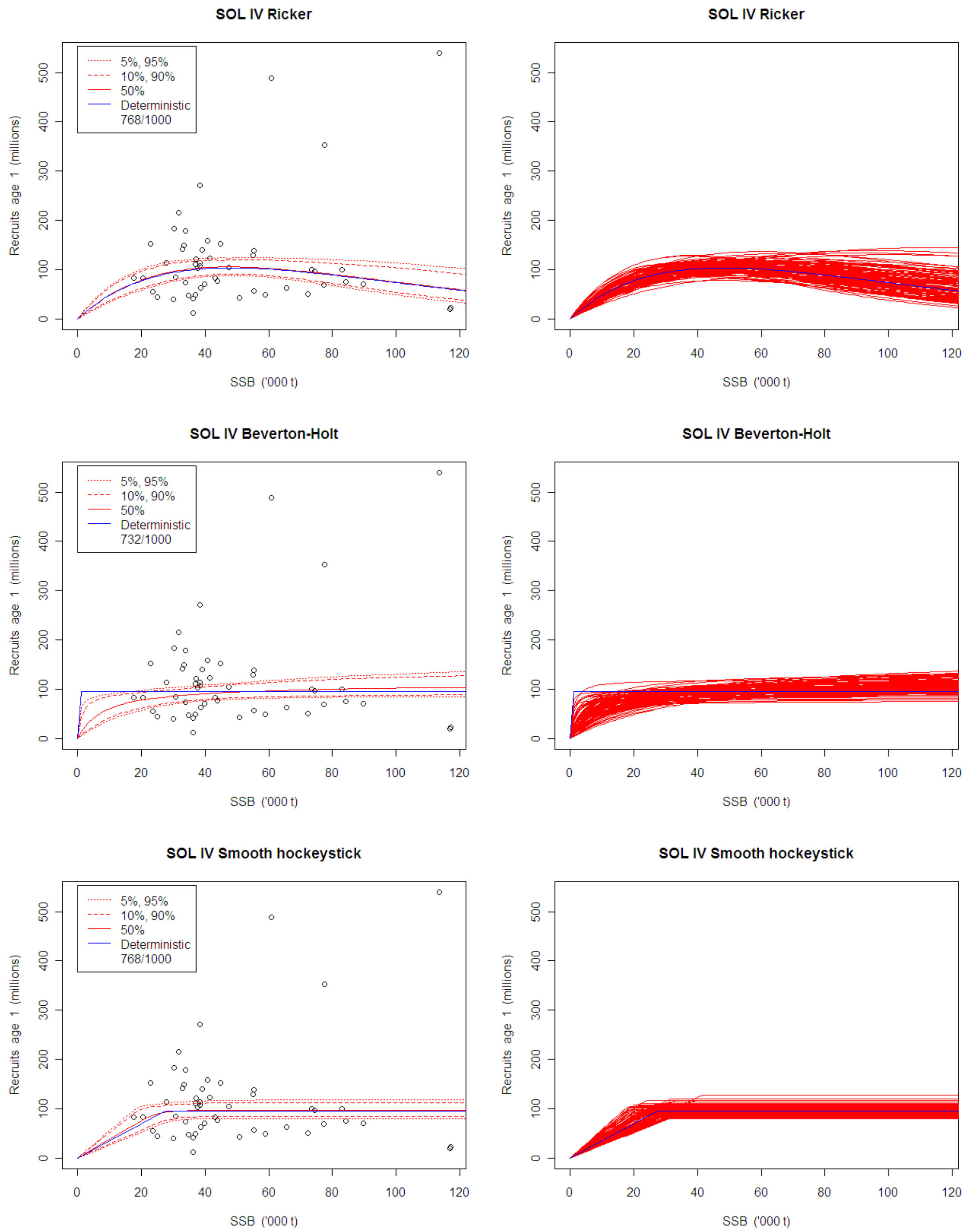


Figure 10.3.6 Sole in sub-area IV: Stock recruitment relationships fitted with Ricker (middle), Beverton and Holt and Smooth Hockeystick models.

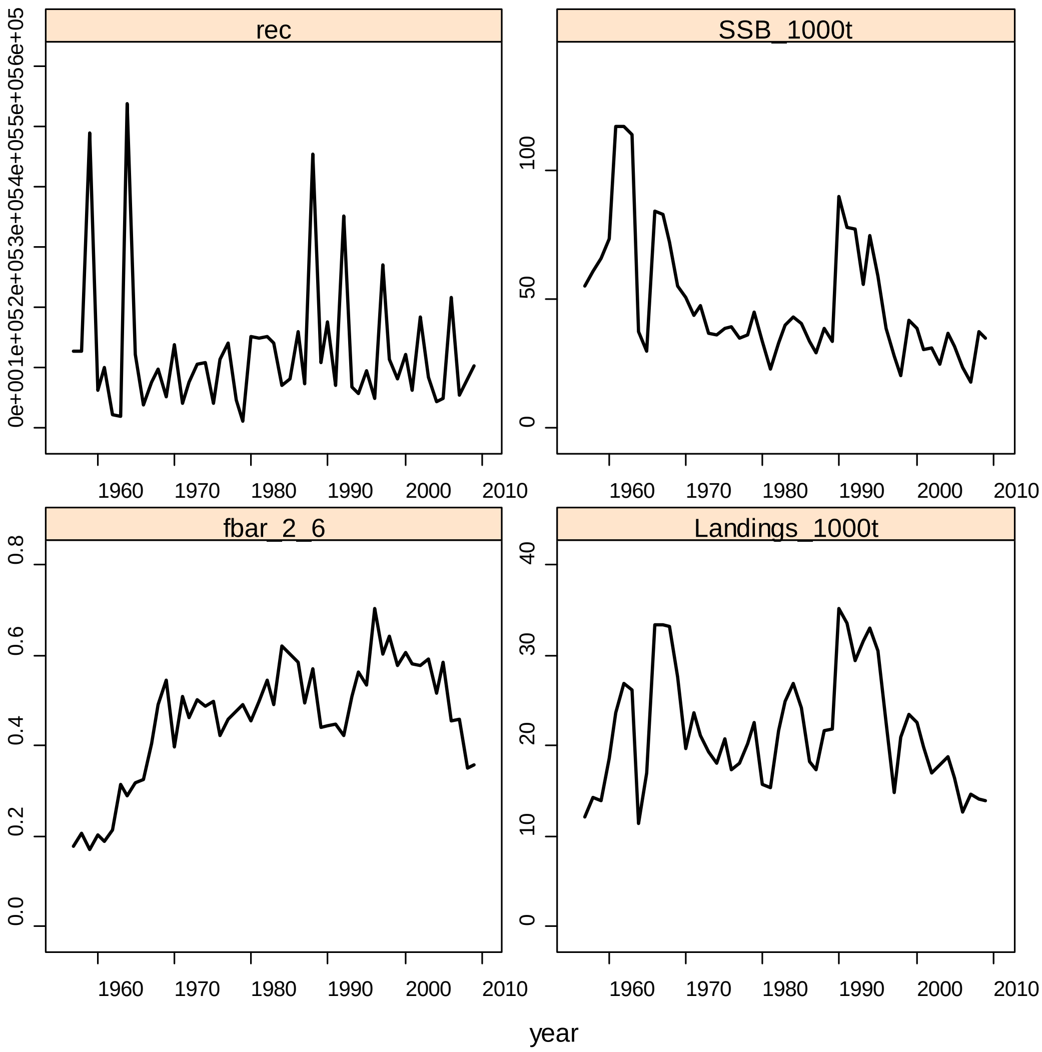
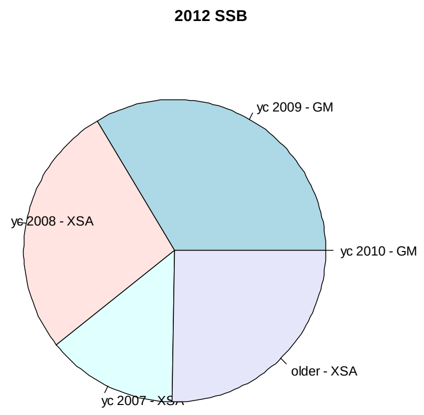


Figure 10.4.1 Sole in sub-area IV 1957-2008. XSA summary plots. Time series of SSB (top left), TSB (top right), mean fishing mortality (bottom left) and recruitment (bottom right).



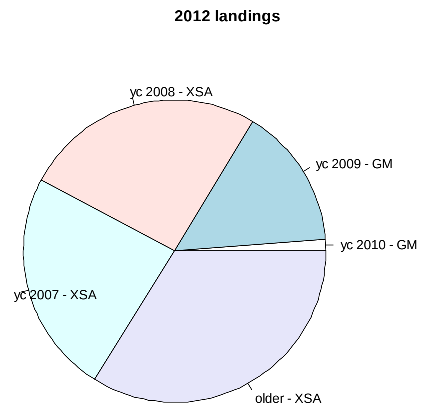
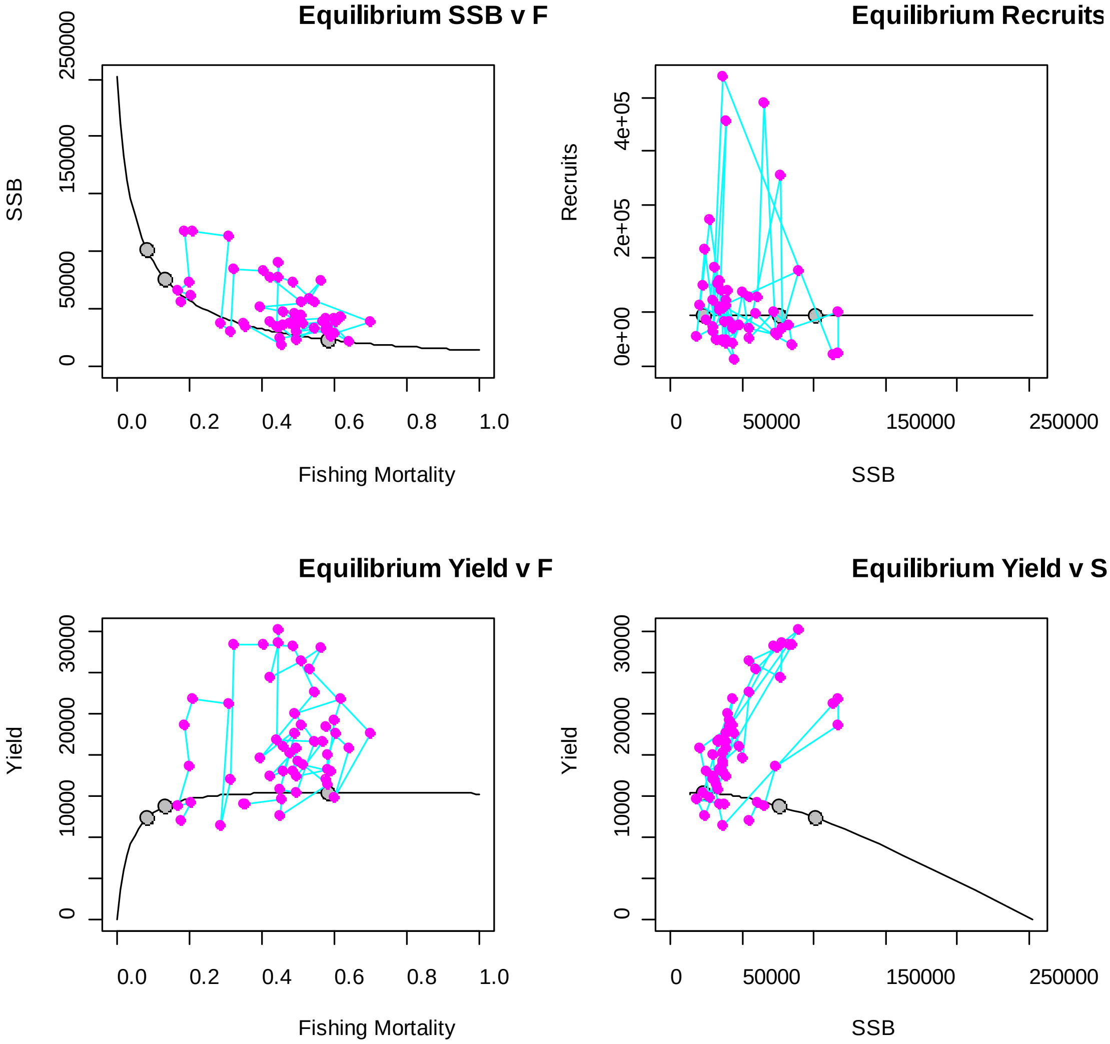


Figure 10.6.1 Sole in sub-area IV. Relative year class contribution to 2012 predicted SSB (left) and 2012 landings (right). Stock numbers of 1 year olds: (2005/XSA) 48 200, (2006/XSA) 216 019, (2007/XSA) 55 000 (2008/XSA) 81 500, (2009/XSA) 102 700 & (2010/GM) 94 000.



	Fish Mort Ages 2-6	Yield/R	SSB/R
Average last 3 years	0.39	0.16	0.35
Fmax	0.58	0.17	0.24
F0.1	0.08	0.13	1.08
Fmed	0.31	0.16	0.43

Figure 10.6.2 Sole in sub-area IV. YPR results.

11 Saithe in Subareas IV, VI and Division IIIa

The 2010 assessment of saithe (Pollachius virens) in Subareas IV and VI and Division IIIa should formally be classified as an update assessment, using the same settings and tuning series as last year. As several tuning indexes were missing or possible biased for the 2010 assessment, the assessment could not be conducted as an update assessment. The assessment of the 2009 working group meeting was accepted by the ACOM review group in June 2009. This assessment has been used as a basis for the sensitivity analysis and forecasts run in 2010.

11.1 Ecosystem aspects

See stock annexe.

11.1.1 Fisheries

See stock annexe.

Since the fish are distributed inshore until they are about 3 years old, discarding of young fish is assumed to be a small problem in this fishery. Problems with by-catches in other fisheries when saithe quotas are exceeded may cause discarding, and recent analysis suggest that for example the cod management plan requires a 30 % reduction of saithe quotas to reach the target F for cod (ICES 2009). French and German trawlers are targeting saithe and have large quotas. The Norwegian trawlers have a total ban for discarding, and restricted bycatch allowances. They have to move out of the area when the boat quotas are reached, and in addition the fishery is closed if the seasonal quota is reached.

In 2009 the landings were estimated to be around 105 529 t in Sub-area IV and Division IIIa, and 6963 t in Sub-Area VI, which both are well below the TACs for these areas (125 934 and 13 066 t respectively). Significant discards are observed only in Scottish trawlers. However, as Scottish discarding rates are not considered representative of the majority of the saithe fisheries, these have not been used in the assessment. Ages 1 and 2 are mainly distributed close to the shores and are normally very scarce in the main fishing areas for saithe. Therefore, these age-groups are not relevant for discarding practices in the North Sea.

ICES advice for 2011

ICES consider the stock as having full reproductive capacity and as being harvested sustainably.

Exploitation boundaries in relation to existing management plans

"ICES has based the advice at the ICES MSY Framework, using forward analysis from the 2009 assessment. This corresponds to landings of 103 000 t in 2011. This corresponds to the TAC from the management plan (Target F=0.3)."

Exploitation boundaries in relation to high long-term yield, low risk of depletion of production potential and considering ecosystem effects

"The current fishing mortality (2006-2008 average) is estimated at 0.27, which is close to the management plan target rate expected to lead to high long-term yields (F = 0.3). "

Exploitation boundaries in relation to precautionary limits

"The exploitation boundaries in relation to precautionary limits imply landings of less than 125 000 t in 2011, and the SSB is expected to be around B_{pa} (200 000 t) in 2012. "

ICES conclusion on exploitation boundaries

"ICES has evaluated the agreed management plan to be in accordance to the precautionary approach, and the target fishing mortality in the management plan is expected to give high long-term yield in the present situation with a stock that is above B_{pa}. ICES recommends to use the MSY Framework and to limit landings in 2011 to 103 000 t in Division IIIa,Sub Area IV and VI."

11.1.2 Management

The ICES advice applies to the combined areas IIIa, IV, and VI.

Management of saithe is by TAC and technical measures. The fishery is not regulated by days at sea for vessels that have less bycatch than 5% of each cod, plaice and sole. The agreed TAC for saithe in Sub-area IV and Division IIIa for 2010 are 107 044 t and 13 066 t, for Sub-area VI.

In 2004 EU and Norway *"agreed to implement a long-term plan for the saithe stock in the Skagerrak, the North Sea and west of Scotland, which is consistent with a precautionary approach and designed to provide for sustainable fisheries and high yields. The plan shall consist of the following elements:*

1. *Every effort shall be made to maintain a minimum level of Spawning biomass (SSB) greater than 106 000 tonnes (B_{lim}).*
2. *Where the SSB is estimated to be above 200 000 tonnes the Parties agreed to restrict their fishing on the basis of a TAC consistent with a fishing mortality rate of no more than 0.30 for appropriate age groups.*
3. *Where the SSB is estimated to be below 200 000 tonnes but above 106 000 tonnes The TAC shall not exceed a level which, on the basis of a scientific evaluation by ICES, will result in a fishing mortality rate equal to 0.30-0.20*(200 000-SSB)/94 000.*
4. *Where the SSB is estimated by the ICES to be below the minimum level of SSB of 106 000 tonnes the TAC shall be set at a level corresponding to a fishing mortality rate of no more than 0.1.*
5. *Where the rules in paragraphs 2 and 3 would lead to a TAC which deviates by more than 15% from the TAC the preceding year the Parties shall fix a TAC that is no more than 15% greater or 15% less than the TAC of the preceding year.*
6. *Notwithstanding paragraph 5 the Parties may where considered appropriate reduce the TAC by more than 15% compared to the TAC of the preceding year.*
7. *A review of this arrangement shall take place no later than 31 December 2007.*

This arrangement enters into force on 1 January 2005."

11.1.3 Evaluation of the Management plan

This assessment is run in terms with the management plan which is consistent with the precautionary approach in the short term conditional on the absence of major changes in the productivity and the absence of measurement and implementation error (ICES Advice 2008, Book 6, Paragraph 6.3.3.3.).

11.2 Data available

11.2.1 Catch

Landings by country and TACs are presented in Table 11.2.1. Minor revisions were applied to the 2008 landings. In the data provided, landings from the industrial fleet are only specified when saithe is delivered separately, and therefore bycatch of saithe that has not been separated from the bulk catch, will not be reported as saithe.

11.2.2 Age compositions

Age compositions of the landings are presented in Table 11.2.2. Landings-at-age data by fleet were supplied by Denmark, Germany, France, Norway, UK (England), and UK (Scotland) for Area IV and only UK (Scotland) for Area VI. The differences between the sum-of-products (SOP) and the working group less than1 % in 2009. The catch data were raised using the ICES database Intercatch. Figure 11.2.1 shows that the proportions in the age distribution in later years reflect the strong year classes.

11.2.3 Weight at age

Weights at age in the catch are presented in Table 11.2.3 and Figure 11.2.2. These are also used as stock weights. There has been a decreasing trend in mean weights from the mid-1990s for ages 4 and older, but the decline now seems to be halted, and a small increase in weight at age are now observed for all ages except age 3 and 7.

11.2.4 Maturity and natural mortality

A natural mortality rate of 0.2 is used for all ages and years, and the following maturity ogive is used for all years:

Age	1	2	3	4	5	6	7+
Proportion mature	0.0	0.0	0.0	0.15	0.7	0.9	1.0

11.2.5 Catch, effort and research vessel data

Normally, 5 indexes are presented for the working group, but the Norwegian Bottom trawl Index has not been used in the tuning since 2007.

Commercial fleets:

- French demersal trawl, age range: 3-9, year range 1990-2008 ("FRATRB")
- German bottom trawl, age range: 3-9, year range 1995-2009 ("GEROTB")
- Norwegian bottom trawl, age range: 3-9, year range 1980-2009 ("NORTRL") (Part 1 : 1980-1992, part 2 : 1993-2009)

Surveys:

- Norwegian acoustic survey, age range 3-6, year range 1995-2008 ("NORACU")
- IBTS quarter 3, age range: 3-5, year range 1991-2008 ("IBTSq3")

For the 2010 assessment, the French demersal trawl ("FRATRB") and the "NORACU" could not be provided. The IBTS q3 was provided, but IMR (Norway) did not participate in the cruise in 2009, normally this party covers large part of the distribution area of the larger saithe. It was not possible to adapt the remaining cruise plans to fully cover up for the missing Norwegian stations. The data available for the working group for the tuning in 2010 is shown in Table 11.2.5.

11.3 Data analyses

All catch-data were loaded and raised using the ICES software in Intercatch.

Reruns of the 2009 assessment was done exploratory to see the effect of the missing indexes. Due to the results shown for the reruns, the working group considers a 4 year projection of the 2009 assessment to be the best procedure for 2010. See 11.3.5, Sensitivity analysis.

11.3.1 Reviews of last year's assessment

The Review Group in ACOM had the following technical comments:

"Assessment model: XSA, 3 commercial and one survey fleet for tuning."

The tuning fleets that has been used was 2 commercial ("GER OTR" and "FRATRB") and two survey fleets ("IBTS Q3" and "NORACU").

"Estimates of recruitment are uncertain in recent years. The 2005 year class was thought to be strong in last year's assessment, this year there are no indication it has developed."

In 2007, the status of the 2004 (not 2005) year-class was adjusted to the mean of the 3 highest year-classes in the last 20 years. Assessments in 2008 and 2009 indicated that this was a reasonable adjustment. The 2010 value of this year-class in the German demersal trawl index confirms the 2004 year-class to be strong.

"TAC lower than landings."

TAC has been higher than the landings after 2001, not lower (nor for 2009).

A possible index for recruitment will be considered by the benchmark in 2011.

11.3.2 Exploratory survey-based analyses

Log-abundance indices by cohort for the tuning series are shown in Figure 11.3.1. The pattern is similar to the pattern in the catch data curves (Figure 11.3.9), with partial recruitment of age 3 for recent cohorts. The curves for the most recent cohorts of the NORTRL time series show a pattern that differs from earlier cohorts in the NORTRL series and from the curves of the other tuning series (Figure 11.3.1), suggesting higher mean age in the catches. This indicates changes in the exploitation pattern or data problems in the Norwegian trawler fleet and led to the exclusion of the series from tuning. However, the reintroduction of the fleet in the tuning should be considered at a future benchmark assessment.

Within-survey correlations for the available tuning series are shown in Figures 11.3.2 – 11.3.6. For the FRATRB the relationship between cohort values from one age to the next is significant, except for the ages 3 to 4 (Figure 11.3.6). The poor relationship between the two youngest ages can be explained by variation in the recruitment to the fishery. For the other tuning series, there is a better relationship between the ages 3 and 4, but not as strong as between the older ages (Figures 11.3.2 – 11.3.5). The age 4 to 5 in the Norwegian index seems not significant. For the NORACU series there is also a poor relationship between age 5 and 6, which may be explained by the movement of older fish out of the survey area (Figure 11.3.3).

The two survey time series are relatively consistent (Figure 11.3.7). They are, however, not entirely independent since the age-disaggregation of both indices is based on the same age and length samples. The relative CPUEs in the commercial tuning series are compared in Figure 11.3.8. For age 3, 8 and 9 the consistency between the series is poor, but better for the age groups in-between.

In the 2009 assessment, the time series of the “GEROTB” and “FRATRL” and the surveys indicated a very strong 2004 cohort, while in the “NORTRL” series it appeared medium strong at best (Figure 11.3.8), which gave rise to some uncertainty.

11.3.3 Exploratory catch-at-age-based analyses

Catch curves (log catch-numbers-at-age linked by cohort) for the total catch-at-age matrix are shown in Figure 11.3.9. The plot shows that age 3 is partly recruited to the fishery for recent cohorts, but fully recruited for some of the earlier cohorts. Moreover the catch curves are less steep in recent years compared to earlier. The trend in the gradients is in agreement with the trend in estimated fishing mortality.

11.3.4 Conclusions drawn from exploratory analyses

The catch curves of the total landings data indicate changes in the relative exploitation of age 3 with time. A likely explanation of this apparent change in exploitation pattern is that the proportion of catches taken by purse seine decreased significantly in the early 1990s, and purse seiners mainly target young saithe. Therefore, it may now be more appropriate to use a reference F that does not include age 3. Such a change of the reference F will affect the biological reference points and is outside the scope of this update assessment.

The explorations of the within and between consistencies in the available tuning series indicate that the abundance indices of age 3 are uncertain, and that age 4 indices seem to give more reliable information about year class strength.

11.3.5 Sensitivity analysis

Reruns of the 2009 assessment with the same indexes that were provided for 2010 and the full 2009 assessment were compared to see how the missing indexes would affect the 2009 assessment. The estimate of survivors of each age at 1st January 2009 (intermediate year) assessed by different combinations of indexes are shown in the table below.

Run\ Age	4	5	6	7	8	9	10
1	50520	81267	12022	39521	6388	5929	4875
2	50605	78883	10639	39587	6428	6037	4817
3	85549	134022	17393	38559	5826	6454	5261
4	83918	135092	18728	38728	5777	6459	5314
5	84698	123209	18969	42477	7397	7428	6399
6	86002	121230	16799	42737	7601	7489	6352

1) Original 2009 assessment, all available data.

2) Original 2009 assessment, but with Norwegian stations taken out of the whole IBTS Q3 time series.

3) Assessment 2009 with original indexes up to 2007 for NORACU, French CPUE, German CPUE and IBTS Q3 without Norwegian stations. For 2008, the only data included is the new IBTS Q3 and the German CPUE index.

4) Assessment 2009 with original indexes up to 2007 for NORACU, French CPUE, German CPUE and original IBTS. For 2008, the only data included is the original IBTS Q3 and the German CPUE index.

5) The 2009 assessment done with only two indexes: the original IBTS Q3 and the German CPUE index.

6) The 2009 assessment done with two indexes: the only new IBTS Q3 and the German CPUE index.

The reruns of the 2009 assessment shows that all possible combinations of available indexes in 2010, i.e. run 3-6, clearly and significantly overestimate the number of survivors in the intermediate year by more than 30 %.

The sensitivity analysis also included reruns of the 2009 assessment to explore the effect on SSB and F_{3-6}, which showed a difference in the estimate for F_{3-6} from over 0.31 (original assessment with IBTS Q3 without Norwegian data) to less than 0.23 (Figure 11.3.5.1). The same settings gives estimates of SSB in 2008 from around 260 586 tonnes (original assessment) to 301592 (using only the German CPUE and original IBTS Q3), see Figure 11.3.5.2. These exploratory runs shows that SSB and F_{3-6} are very sensitive to the availability of indexes.

For comparison, estimated survivors (table below), F3-6 (Figure 11.3.5.3) and SSB (Figure 11.3.5.4) for an exploratory assessment for 2010 were estimated.

Run nr	4	5	6	7	8	9	10
1	38590	20977	27947	5903	22317	4109	4804
2	40536	22821	27567	5592	22651	4187	4864
3	42379	25779	29244	8658	23283	5638	5926
4	42913	28511	28604	8027	24179	5855	6040

Runs of a 2010 exploratory assessment, showing the survivors estimated at 1.St January 2010 (Intermediate year) for possible combinations of available indexes.

1) Exploratory 2010 assessment, all available data. Indexes from 2009 include IBTS Q3 and German CPUE index. Up to 2008, all indexes are used.

2) Exploratory 2010 assessment with new IBTS Q3 index and German CPUE index as indexes in 2009. Up to 2008, all indexes are used.

3) Exploratory 2010 assessment, old IBTS Q3 and German CPUE indexes for the whole period, no other indexes used.

4) Exploratory 2010 assessment, new IBTS Q3 and German CPUE indexes for the whole period, no other indexes used.

11.3.6 Final assessment

Given the uncertainty highlighted by the sensitivity testing above, the absence of the three tuning series prevents the running of either an update assessment or a semi-benchmark therefore no final XSA assessment was conducted in 2010. Settings from the 2008 and 2009 assessments are also presented.

Year of assessment:	2008	2009	2010
Assessment model:	no change	no change	No assessment
Fleets:	no change	no change	No assessment
	no change	no change	No assessment
	no change	no change	No assessment
	no change	no change	No assessment
Age range:	no change	no change	No assessment
Catch data:	1967-2007	1967-2008	No assessment
Fbar:	no change	no change	No assessment
Time series weights:	no change	no change	No assessment
Power model for ages:	no change	no change	No assessment
Catchability plateau:	no change	no change	No assessment
Survivor est. shrunk towards the mean F:	no change	no change	No assessment
S.e. of mean (F-shrinkage):	no change	no change	No assessment
Min. s.e. of population estimates:	no change	no change	No assessment
Prior weighting:	no change	no change	No assessment
Number of iterations before convergence:	47	47	No assessment

11.4 Historic Stock Trends

The historic stock and fishery trends are presented by the 2009 assessment in Figure 11.4.1 and Table 11.4.1. The reported landings increased from 1967 to the highest observed landing levels in the mid-1970s. After 1976 the landings decreased rapidly to a stable level between 1979-1981 and increased again from 1981 to 1985. From 1985 the reported landings decreased and levelled off in 1989 to a fairly stable level where they have stayed since. During the last 8 years (2002-2009), TAC levels have been higher than the reported landings. Landings in 2009 (not shown in figure) were 112 492 t, TAC was 139 000 t.

The fishing mortality shows the same trends as landings in the period 1967-1985, while it has decreased nearly continuously since 1985 until present, dropping below F_{lim} in 1993 and below F_{pa} in 1997. Estimated SSB increased from 1967 reaching the highest observed level in 1974 after which it decreased to below B_{lim} in 1990. After 1991 SSB increased to above B_{pa} in 2001 until it reached 279 thousand t in 2005, and has decreased again in the latest years.

Both the level and the variation in estimated recruitment (at age 3) are higher before about 1985 than after, e.g., the six strongest year classes observed all occurred in the earliest period. The 2004 year class is not as strong as suggested last year and emerges at about 40% above the geometrical long-term mean (1988-2006). The 2005 year class appears to be very poor.

11.5 Recruitment estimates

There are no indications of the 2006 year class to be strong. Reliable abundance information does not exist for the subsequent year classes. It was therefore decided to use the geometric mean of recruits (age 3 from the final assessment) from the period 1988-2006 as the estimated recruitment for these year classes. The reason for excluding data before 1988 is that the recruitment dynamics (level and variation) seems quite different before and after 1988.

11.6 Short-term forecasts

Because the assessment is currently a fully deterministic XSA, the short term projection can be done in FLR using FLSTF. Weight-at-age in the stock and weight-at-age in the catch are taken to be the mean of the last 3 years. The exploitation pattern is taken to be the mean value of the last three years. Population numbers at ages 4 and older are XSA survivor estimates, numbers at age 3 are taken from the geometric mean for the years 1988 – assessment year.

The short-term prognosis analysis was run for 4 years, using the 2009 assessment values as input.

Population numbers at the beginning of the forecast period are the XSA survivor estimates from the final assessment in 2009.

The management options are given in Table 11.6.2. Status quo fishing mortality (F_{sq}) in 2009 and 2010 is expected to lead to landings of about 100 000 tonnes in 2010 and a drop to 235 000 t in the expected spawning stock biomass in 2010. A fishing mortality in 2010 according to the EU-Norway management plan is expected to lead to landings of 106 000 t and an SSB of 223 000 t in 2011. Due to the TAC constraint in the management plan, landings in 2010 was constrained to 118 000 t and the SSB in 2011 is expected to be 212 000 t. Stock numbers of recruits and their sources for recent year-classes used in the predictions and relative contributions in the landings and SSB is shown in table 11.6.3.

11.7 Medium-term and long-term forecasts

No medium-term or long-term forecasts were carried out.

11.8 Biological reference points

The biological reference points were derived in 2006 and are:

$\mathbf{F}_{0.1}$	0.10	$\mathbf{F}_{lim}$	0.60
$\mathbf{F}_{max}$	0.22	$\mathbf{F}_{pa}$	0.40
$\mathbf{F}_{med}$	0.35	$\mathbf{B}_{lim}$	106 000 t
$\mathbf{F}_{high}$	>0.49	$\mathbf{B}_{pa}$	200 000 t

These reference points refer to an Fbar from ages 3 to 6. The proportion of catches taken by purse seine decreased significantly in the early 1990s. This caused a change in the exploitation pattern as the purse seiners mainly targeted young saithe. Therefore, it may be more appropriate to use a reference F that does not include age 3.

The influence on the maturity ogive from the observed decrease in the weight at age is unknown, but it is reasonable to believe that the spawning capacity of the stock will be affected.

The change of the reference F and the possible change in maturity may affect the biological reference points but revising reference points is outside the scope of this update assessment.

11.9 Estimation of F_{MSY}

The estimation of F_{MSY} values for Saithe was carried out with the Cefas ADMB module (methodology see section 1.3.1). As sensitivity analysis F_{MSY} was also estimated using FLR (methodology see section 1.3.2). For both methodologies the sensitivity against different stock recruitment relationships (Ricker, Bev-Holt, Hockey stick) was tested. In addition, with FLR it was analysed how sensitive F_{MSY} estimates are towards different input values, i.e what is the impact of using a three years mean compared to a 7 years mean for the exploitation pattern and weight at age. Both choices can be seen as representative for the recent period of low weights at age (Figure 11.2.2). A retrospective analysis how F_{MSY} values varied in time completed the analysis.

Since there is no accepted assessment for 2010, the accepted assessment from 2009 was taken as basis for the calculations.

11.9.1 Sensitivity towards different stock recruitment relationships using the CEFAS ADMB module

A mean over the last three years was used as input for the exploitation pattern and mean weight at age in the stock and in the landings (discard is neglected in the assessment). The CVs were calculated from the FLR xsa.res object (standard VPA sen output file). For natural mortality and proportion mature for age groups with a proportion mature <1 a CV of 0.1 was assumed.

The fit to stock recruitment data was poor for all types of recruitment relationships (Figure 11.9.1). Especially, there are no data near the origin. However, the AIC criterion was highest for the Ricker curve (AIC=60.9), the AIC for the Beverton and Holt and Hockey stick recruitment curve were lower and very similar (AIC=58.0 and 58.2). The estimated deterministic F_{MSY} value was 0.28 for the Ricker, 0.24 for the Beverton and Holt and 0.32 for the Hockey stick recruitment curve (Table 11.9.1). The median of bootstrap estimates were 0.30, 0.20 and 0.30 with a considerable variability around it.

11.9.2 Sensitivity towards different methodologies

The deterministic estimates for F_{msy} from the ADMB module and FLR analysis were very similar when using a mean over the last three years as input for the exploitation pattern and mean weight at age. The comparison was only carried out for the Beverton-Holt and the hockey stick recruitment curve. The small differences are a result from different fits to the stock-recruitment data between ADMB and R.

Stock recruitment relationship	ADMB estimate	FLR estimate
Beverton-Holt	0.243093	0.23438
Hockey stick	0.324764	0.3264

Bootstrap estimates cannot be compared directly since the CEFAS ADMB module uses estimated CVs from the VPA sen file (three year's mean and sd from the complete time series) while the FLR methodology directly bootstraps from the observed input values (complete time series 1967 to 2008). By directly bootstrapping from the input data also no uncertainty around the constant natural mortality and proportion mature values can be taken into account.

Never the less, when using the CEFAS ADMB module, the following F_{msy} values were estimated:

Stock recruitment relationship	Methodology	0.05 %	0.25 %	0.50 %	0.75 %	0.95 %
Beverton-Holt	ADMB	0.102	0.164	0.198	0.242	0.334
Hockey stick	ADMB	0.131	0.227	0.295	0.387	0.537

The FLR analysis gave the estimated values:

Stock recruitment relationship	Methodology	0.05 %	0.25 %	0.50 %	0.75 %	0.95 %
Beverton-Holt	FLR	0.136	0.177	0.213	0.254	0.319
Hockey stick	FLR	0.162	0.209	0.243	0.269	0.309

The median was in the same order of magnitude in both approaches, however, the 75% and 95% percentile differed to a larger extent for the Hockey stick recruitment curve.

11.9.3 Sensitivity towards input data using FLR

The deterministic estimates for Fmsy differed depending on whether the average over the last three years or over the last seven years was chosen as input for the exploitation pattern and weight at age. Deterministic values are lower for the 7 years average for both recruitment curves tested.

Stock recruitment relationship	FLR estimate (3 years average)	FLR estimate (7 years average)
Beverton-Holt	0.234	0.189
Hockey stick	0.326	0.230

The reason for the differences is a substantial change in the exploitation pattern (Figure 11.9.2) next to a decline in weight at age especially for older age groups (Figure 11.2.2). When looking at changes of Fmsy estimates over time (3 years moving average for exploitation pattern and weight at age), an increase in deterministic Fmsy estimates for the most recent years becomes obvious (Figure 11.9.3).

11.9.4 Conclusions from the sensitivity analyses

The analyses showed that Fmsy estimates for this stock are sensitive to the choice of the stock recruitment relationship and assumptions on what part of the time series is used as input. Also the way bootstrapping is performed has some influence on stochastic estimates for Fmsy.

Therefore, the decision on a suitable range of Fmsy values is difficult. For this report only an adhoc solution was possible given the short amount of time available to assessment working group. More evaluations have to be carried out during the benchmark meeting next year to come up with estimates based on proper science.

For the short term forecast and this year's advice the estimates for Fmsy were chosen based on the AIC of the stock recruitment fits and the assumption that an average over the last three years is most representative for the current status of the stock and the fishery. As methodology the CEFAS ADMB module was chosen. The deterministic estimates and the median values were not influenced to a large extent anyhow. However, it has to be kept in mind that the range of suitable Fmsy proxies can differ depending on what bootstrap methodology is used.

Based on the AIC criterion the Ricker recruitment curve could be rejected. For the Beverton-Holt curve the point of maximum curvature lies outside the range of observations and the steepness is poorly defined (Figure 11.9.1). Therefore, the hockey stick recruitment curve was chosen as being most appropriate. The median value of the bootstrap estimates was 0.3 (Table 11.9.1, Figure 11.9.4). This was chosen as target for the advice based on Fmsy having in mind that there is a considerable uncertainty around it. The 5% percentile from the bootstrap distribution was 0.13 and the 95% percentile was 0.54 for the Hockey stick recruitment curve (Table 11.9.1). The peak in equilibrium landings is well defined and suggests that the stock is currently harvested at an optimal level (Figure 11.9.4).

11.10 Quality of the assessment and forecast

The poor reliability of the recruitment (age 3) estimate is a major problem for the saithe assessment. To improve the reliability of the information about year class strength before age 4, IMR in Norway has since 2006 carried out an acoustic recruitment survey for saithe (ages 2-4) along the Norwegian west coast. The usefulness of this survey has not yet been evaluated but can be a candidate index for a benchmark for the stock in 2011.

Another problem with the assessment is the necessity to use commercial CPUE for tuning, as the survey series that are used only contain usable information for ages 3-6. There are many reasons for why commercial CPUE may fail to track changes in abundance. A serious one would be hyperstability; that is commercial catch rates remain high while population abundance drops, which may occur when vessels are able to locate high fish concentrations independently of population size. Hyperstability may be demonstrated if the degree of the fleet's spatial concentration is monitored. Norway and Germany have now permitted the use of data from their satellite-based vessel monitoring systems for research purposes, which makes it possible to perform such monitoring of the German and Norwegian tuning fleets.

11.11 Status of the Stock

The general perception of the status of the saithe stock is more uncertain as long as there has been no assessment. However, fishing mortality is assumed to be below F_{pa} and the spawning stock biomass is assumed to be above B_{pa}.

11.12 Management Considerations

The ICES advice applies to the combined areas IIIa, IV, and VI.

The total landings in 2009 in areas IIIa and IV are considerably lower than the TAC, as was also the case in the 7 previous years. Information from fishermen indicates that low prices for saithe combined with high fuel prices may be causing this, but there are also claims that the abundance of saithe has been reduced in the most recent years, and that young saithe cannot be found at the traditional grounds.

By-catch of other demersal fish species occurs in the trawl fishery for saithe. This should be considered especially for the cod management plan (WGMIXEDFISH, 2009) Saithe is also taken as unintentional by-catch in other fisheries, and discards may occur if the vessels do not have a saithe quota.

The spawning stock of saithe in the North Sea is expected to remain above B_{pa} if the TAC for 2011 is set according to the ICES MSY Framework and the agreed management plan.

Since recruitment at age 3 tends to be poorly estimated in the XSA, the size of the 2005 and 2006 year classes is uncertain, but since the year classes are expected to be rather poor, only very large relative errors will make a large impact on the forecast. The Norwegian acoustic survey will be conducted in 2010, and significant new information on this year class can be expected this year. Also, the French Trawl index might become available in autumn 2010.

In 2008 ICES carried out an evaluation of the management plans agreed between Norway and the European Community (ICES Advice, 2008. Book 6.), and the response is described below:

Recent reductions in recruitment levels and growth rates indicate that the productivity of the saithe stock in the North Sea, Skagerrak, and West of Scotland has declined. Assuming continuation of the current selection pattern and growth rates, annual yields are expected to be relatively stable at about 100 000 t for fishing mortalities between 0.1 and 0.4. A target F below 0.3, or an increase in the upper SSB threshold (i.e., above the current B_{pa} = 200 000t), are likely to give similar yields with lower risks in the medium term.

The 15% TAC change constraint is likely to be invoked in ~50% of the years in which the harvest control rule is applied. TAC constraints less than 15% would require a lower target fishing mortality in order to balance the increased risk to the stock. The equilibrium yield from the saithe stock is fairly insensitive to the TAC constraint. Given the relatively low productivity of saithe (low mean recruitment and low weight-at-age) in recent times, the limited treatment of measurement errors in the assessment, and implementation errors in the fishery, the harvest control rule should be reviewed again within 4 years after the evaluation.

References

ICES. 2009. Report of the Workshop on Mixed Fisheries Advice for the North Sea, 26-28 August 2009, Copenhagen, Denmark. ICES CM 2009\ACOM:47. 62 pp.

Table 11.2.1 Nominal landings (in tonnes) of Saithe in Subarea IV and Division IIIa and SubareaVI, 2000-2009, as officially reported to ICES, and WG estimates

SAITHE IV and IIIa

Country	2000	2001	2002	2003	2004*	2005*	2006	2007*	2008*	2009*
Belgium	122	24	107	45	22	28	16	18	7	27
Denmark	3529	3575	5668	6954	7991	7498	7471	5458	8069	-
Faroe Islands		289	872	495	558	184	62	15	108	-
France	19200	20472	25441	18001	13628	10768	15739	13043	15302	-
Germany	9273	9479	10999	8956	9589	12401	14390	12790	14141	13689
Greenland	60	152	62	1616	403		-	-	-	-
Ireland	1				1		0	-	81	81
Netherlands	11	20	6		3	40	28	5	3	17
Norway	43665	44397	60013	61735	62783	67365	61268	45395	62055	57708
Poland	747	727	752	734*	0	1100	-	-	1407	988
Russia	67					35	2	5	5	13
Sweden	1468	1627	1863	1876	2249	2114	1695	1380	1639	1363
UK (E/W/NI)	1227	1186	2521	1215	457	1190	9129**	9628**	11701**	12545**
UK (Scotland)	5484	5219	6596	5829	5924	7703				
Total reported	85395	88541	114900	107467	103608	110575	109800	87377	114517	86431
Unallocated	2281	1030	1291	-5809	-3646	968	7312	6241	-3084	-19098
W.G. Estimate	87676	89571	116191	101658	99962	111543	117112	93618	111433	105529
TAC	85000	87000	135000	165000	190000	145000	123250	135900	135900	125934

*Preliminary, [2]Preliminary data reported in IVa
**Scotland+E/W/NI combined

Table 11.2.1 continued

SAITHE VI

Country	2000	2001	2002	2003	2004*	2005*	2006	2007*	2008*	2009*
Faroe Islands				2	34	21	76	32	23	-
France	3310	5157	3062	3499	3053	3452	5782	3956	2617	-
Germany	305	466	467	54	4	373	532	580	147	298
Ireland	410	399	91	170	95	168	243	322	208	208
Netherlands	-	-	-	-	-	-	-	-	1	-
Norway	58	31	12	28	16	20	28	377	78	68
Russia	25	1	1	6	6	25	7	2	50	4
Spain	3	15	4	6	2	3	-	-	-	-
UK (E/W/NI)	276	273	307	263	37	203	2748**	1419**	2887**	3501**
UK (Scotland)	2463	2246	1567	1189	1563	4433				
Total reported	6850	8588	5513	5215	4810	8699	9416	6688	6011	4079
Unallocated	-960	-1770	-327	35	-296	-2960	848	98	1223	-2884
W.G.Estimate	5890	6818	5186	5250	4514	5739	8568	6786	7234	6963
TAC	7000	9000	14000	17119	20000	15044	12787	14100	14100	13066

*Preliminary
**Scotland+E/W/NI combined

SAITHE IV, IIIa and VI

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
WG estimate	93566	96389	121377	106908	104476	117282	125680	100404	118667	112492
TAC	92000	96000	149000	182119	210000	160044	136037	150000	150000	139000

Table 11.2.2 Saithe in Sub-Areas IV, VI and Division IIIa. Landed numbers (thousands) at age.

Year	3	4	5	6	7	8	9	10
1967	17330	16220	15531	2303	1594	292	198	183
1968	23223	21231	13184	6023	429	242	123	145
1969	30235	17681	11057	7609	5738	791	626	150
1970	37249	76661	15000	12128	3894	1792	318	267
1971	69808	57792	32737	4736	4248	2843	1874	774
1972	48075	66095	25317	21207	3672	2944	1641	1607
1973	54332	37698	26849	16061	8428	2000	1357	2381
1974	66938	33740	14123	20688	14666	5199	1477	1955
1975	56987	25864	10319	7566	13657	9357	3501	2687
1976	207823	53060	11696	6253	3976	5362	3586	3490
1977	27461	54967	14755	5490	3777	3447	3812	4701
1978	35059	27269	18062	3312	1138	1033	768	3484
1979	16332	14216	11182	8699	2805	733	540	2089
1980	17494	12341	9015	6718	5658	1150	509	2302
1981	26178	8339	6739	3675	3335	3396	657	2536
1982	31895	40587	9174	5978	2145	1454	982	1254
1983	28242	20604	26013	5678	4893	1494	1036	1327
1984	80933	32172	12957	13011	1657	1252	335	646
1985	134024	55605	13281	4765	3005	682	399	742
1986	55434	91223	15186	5381	2603	1456	445	900
1987	31220	97470	13990	3158	1811	1240	910	700
1988	32578	26408	35323	3828	1908	1104	776	680
1989	22128	30752	13187	10951	1557	739	419	488
1990	40808	19583	11322	4714	2776	745	281	364
1991	46117	29871	7467	3583	1716	953	367	458
1992	18404	33614	12753	3193	1524	696	518	422
1993	37823	20828	11845	3125	1568	1511	814	1026
1994	19958	40194	13034	4297	947	346	427	794
1995	26664	26034	14797	3774	3494	674	552	800
1996	11066	38861	11786	7731	3163	808	210	491
1997	15036	19299	30177	3676	2640	1012	291	288
1998	10363	31017	16367	16077	2231	1206	567	277
1999	9429	13872	26684	8389	10070	2346	891	657
2000	7064	17295	8940	12339	3159	3226	641	441
2001	16052	17646	22421	3349	3586	1772	1614	245
2002	19914	42331	8871	8899	2437	2976	1865	1623
2003	11661	20209	25759	6269	7061	1512	1979	1039
2004	5315	14987	17696	13412	3820	4104	1118	806
2005	13933	12508	16861	17796	11585	2838	2248	460
2006	9871	28211	12355	9364	11375	5958	1545	1432
2007	17486	7982	21443	7367	5639	5230	1800	975
2008	9692	24765	8119	17113	4561	3418	2407	1737
2009	8921	12154	16120	4605	1075	354	221	3175

Table 11.2.3 Saithe in Sub-Areas IV, VI and Division IIIa. Landings weights at age (kg).

1967	0.930494678	1.361966356	2.103520269	3.185805333	3.754136087	5.316166479	5.890544156	7.719028477
1968	1.278419957	1.652107703	1.988615783	3.009267209	4.040352644	4.427818579	6.13554762	7.405543295
1969	0.966263	1.556806587	2.261373963	2.713251598	3.558796117	4.406254148	5.220325712	6.767484155
1970	0.941353404	1.440751169	2.058677702	2.718026722	3.599481887	4.463234505	5.687082608	6.845166388
1971	0.839924242	1.348003462	2.177523715	2.93596542	3.765685107	4.633854833	5.172478074	6.162973111
1972	0.808180473	1.195822587	1.961043781	2.368722592	3.794116059	4.227618995	4.630360692	6.326276442
1973	0.821153977	1.406119292	1.640959483	2.570850842	3.357112202	4.684370641	4.813775385	6.444916363
1974	0.860827378	1.560602809	2.383353656	2.752657931	3.428561556	4.497745005	5.712830057	7.857026084
1975	0.892762321	1.497665247	2.490352039	3.300232764	3.764738436	4.295708751	5.539569181	7.561972024
1976	0.702359129	1.309179414	2.260435379	3.070625632	4.034676695	4.383334188	5.111708412	7.146960272
1977	0.759824582	1.256004675	1.934809356	3.110692694	4.161836084	4.604505221	4.858881445	6.541870972
1978	0.821451935	1.326695441	2.15452338	3.340097504	4.522141218	4.900461116	5.44942428	7.400016389
1979	1.10719885	1.622755404	2.238144923	3.095009869	4.050355797	5.274203314	6.307720998	7.9551298
1980	0.954564574	1.821159875	2.391103105	3.030033425	4.089521797	5.126187014	5.93925148	8.147613487
1981	0.960755041	1.821065206	2.717469662	3.586785083	4.535951632	5.477588988	6.980359849	8.723661326
1982	1.085733031	1.574611862	2.529304007	3.220198939	4.20688743	5.125104539	5.904916009	8.823199041
1983	1.027607156	1.717811116	2.149312198	3.137714957	3.690568516	4.631691025	5.505291703	8.452864265
1984	0.794834901	1.61389279	2.296569424	2.689908208	3.895895241	4.664702759	6.182988724	8.473517169
1985	0.663166392	1.26540668	1.950454313	2.771542498	3.406689659	4.949925319	5.864877957	8.8543279
1986	0.694333574	1.03531467	1.794424672	2.431551607	3.571744255	4.20940032	5.650590042	8.218360414
1987	0.673903105	0.876301065	1.823596731	3.07466071	4.209820812	5.329991501	6.128423201	8.602585457
1988	0.778699363	0.980999886	1.385900055	2.790711265	4.023782554	5.254403223	6.322138367	8.648891708
1989	0.895408027	1.0362447	1.419623322	1.998408754	3.913866221	5.01745719	6.429831195	8.430751
1990	0.844064679	1.195794928	1.582796574	2.247220897	3.241866112	4.858316749	6.314902002	8.41624235
1991	0.791308619	1.157891089	1.75225416	2.364563037	3.165312262	4.222060285	6.066125487	8.191436033
1992	0.964109905	1.189289558	1.606634302	2.241706452	3.667703127	4.329641865	5.412480427	7.04546426
1993	0.899366067	1.260282378	1.754410382	2.636278757	3.185073015	3.979839155	5.080186636	6.890875919
1994	0.943860799	1.118840882	1.600960199	2.433688087	3.617457331	4.78693941	6.547877271	8.3255942
1995	1.002171357	1.293749659	1.815861703	2.561938788	3.554925037	4.767029301	5.267393389	7.890716412
1996	0.966806802	1.187341842	1.80683793	2.367844143	2.95178423	4.705251299	6.092215267	8.38209242
1997	0.904711071	1.144757383	1.452210736	2.586729011	3.555576221	4.5250732	6.157524789	8.86631455
1998	0.891665055	0.966045458	1.392525832	1.744015731	2.948607742	3.882886372	4.99553018	7.227328289
1999	0.880831304	1.060500629	1.211167421	1.753690439	2.337413356	3.493383477	4.843800772	6.745200741
2000	1.027398206	1.126608782	1.538893108	1.684271012	2.593588616	3.084245236	4.773302891	7.461488691
2001	0.802314046	1.071713424	1.3129726	2.094966352	2.546055458	3.48475876	4.140998145	6.140962435
2002	0.805662391	0.859358095	1.324276319	1.752387235	2.288539292	3.108905439	3.920647214	3.747242616
2003	0.717968286	0.954282404	1.082914134	1.660893504	2.248368612	3.348036556	3.77326773	4.293629598
2004	0.876625679	1.01544323	1.257386043	1.582219287	2.475318019	3.10267214	4.285838159	5.555876349
2005	0.666444813	1.073497785	1.301473489	1.600735476	1.997741553	3.008536568	3.795907346	4.884539331
2006	0.893129269	0.998640538	1.348256651	1.737846265	2.077221672	2.577891808	3.783913963	5.349166416
2007	0.744150	1.098278	1.157892	1.627950	2.003928	2.670087	3.267037	4.987300001
2008	0.8894305	1.0982021	1.4308487	1.6533089	2.2946675	2.8274756	3.3615961	4.2953598
2009	0.71202	1.19347	1.48859	1.97395	2.27151	2.90726	3.41540	4.32817

Table 11.2.5 Saithe in Sub-Areas IV,VI and Division IIIa. Tuning data, effort and index values.

FRATRB_IV

1990				2008			
1		1		0		1	
3				9			
21758	3379.574	2471.553	1405.54	304.063	290.298	32.728	14.813
15248	1381.383	2538.766	731.379	372.239	130.79	67.67	11.93
7902	717.161	1480.817	498.716	73.572	24.402	7.133	5.741
13527	3917.8	2253.44	1162.23	103.625	8.299	8.648	6.183
14417	1770.754	3652.84	1381.104	434.086	38.895	5.317	2.71
14632	3151.807	1682.869	921.653	225.695	70.393	24.088	13.317
16241	895.031	4286.247	1053.226	535.95	107.63	24.634	15.158
12903	1087.28	1914.745	3175.192	190.091	83.908	16.535	13.738
13559	799.753	2538.413	1870.453	1480.902	52.256	23.023	10.381
14588	852.467	1233.817	2666.699	620.174	399.661	24.212	13.688
8695	889.314	1993.229	1038.898	1195.148	214.774	180.514	31.751
6366	724.1021	1339.454	2372.881	269.951	144.906	25.554	29.28
11022	3275.662	7576.645	1220.435	1242.118	175.302	151.434	40.935
10536	1516.931	3235.528	2354.784	264.339	325.113	80.521	112.883
5234	447.218	977.66	1020.943	494.617	92.582	35.628	19.772
3015	406.936	660.534	643.107	428.406	209.713	15.685	14.262
5710	1681.537	3142.212	551.3929	144.5056	199.2849	39.65778	13.23932
8255	4200.934	1040.925	2807.48	240.7597	99.80143	3.070924	1
7016	878.509	1522.508	245.447	949.847	164.900	34.288	33.320

NORTRL_IV1

1980	1992						
1	1	0	1				
3	9						
18317	186	1290	658	980	797	261	60
28229	88	844	1345	492	670	699	119
47412	6624	12016	2737	2112	341	234	19
43099	4401	4963	8176	1950	2367	481	357
47803	20576	7328	2207	3358	433	444	106
66607	27088	21401	5307	1569	637	56	46
57468	5297	29612	3589	818	393	122	25
30008	2645	18454	2217	290	235	201	198
18402	3132	2042	2214	141	157	74	134
17781	649	2126	835	694	309	154	65
10249	804	781	924	519	203	63	12
28768	14348	4968	1194	518	203	51	56
35621	3447	9532	4031	1087	465	165	109

NORTRL_IV2

1993	2009						
1	1	0	1				
3	9						
24572	7635	4028	2878	1018	526	365	252
30628	3939	16098	4276	926	251	72	203
32489	4347	9366	5412	833	1644	273	203
40400	3790	14429	4414	2765	1144	189	16
36026	2894	5266	9837	1419	892	299	72
24510	1376	8279	5454	5662	977	489	243
21513	813	2595	6869	2368	3602	1168	346
15520	284	1628	2054	4261	1066	1203	221
23106	4808	5228	6513	935	1235	509	390
38114	4015	12063	3474	3775	981	1632	1050

```
41645   1630    5451    10452   3602    4432    792     1004
32726   663     2677    5709    6578    2256    2640    656
34964   1202    3080    5177    9204    6954    1728    1434
30190   797     4116    3842    4611    7310    3974    811
26354   1563    1442    4684    3506    2655    3121    887
32550   2308    10354   3664    8357    2155    1619    1234
34360   1071    3257    5936    1254    5334    1636    933
GER_OTB_IV
1995    2009
1       1       0       1
3       9
21167   1158    2359    1350    589     152     30      16
19064   510     3167    1081    517     257     148     41
21707   816     2475    3636    292     163     70      24
20153   591     2744    1395    1776    238     100     39
18596   284     1065    2264    943     1015    77      36
12223   542     2185    823     1216    242     325     38
11008   892     1329    2317    372     532     249     155
12789   650     3658    1230    1100    99      140     69
14560   500     1399    2630    438     392     58      72
13708   334     2040    1928    1079    200     235     47
11700   434     510     1623    1543    787     205     119
10815   374     1575    690     668     685     350     147
12606   937     713     2813    607     405     417     175
12871   477     3151    627     1662    354     220     223
16692   359     759     1263    316     708     314     271
NORACU
1995    2008
1       1       0.5     0.75
3       6
1       56244   4756    1214    174
1       21480   29698   6125    4593
1       22585   16188   24939   3002
1       15180   48295   13540   11194
1       16933   21109   27036   4399
1       34551   82338   14213   13842
1       72108   28764   17405   3870
1       82501   163524  17479   4475
1       67774   107730  41675   4581
1       34153   43811   31636   6413
1       48446   36560   27859   10174
1       18909   58132   11378   7922
1       77958   12070   32445   2384
1       7122    18989   4180    10262
IBTSq3
1991    2009
1       1       0.5     0.75
3       5
1       1.946   0.402   0.064
1       1.077   2.760   0.516
1       7.965   2.781   1.129
1       1.117   1.615   0.893
1            13.959     2.501   1.559
1       3.825   6.533   1.112
1       3.756   3.351   7.461
1       1.181   4.134   1.351
1       2.086   1.907   3.155
1       3.479   8.836   1.081
1            21.614     6.206   3.959
1            10.748       18.974        1.327
1            19.272       23.802     13.402
1       4.979   6.896   3.158
1       8.893   6.870   4.994
1            10.636       29.820        2.934
1            34.017     5.593     11.763
1       3.438   5.827   0.952
1       1.346   1.703   0.568
```

Table 11.4.1. Saithe in Sub-Areas IV,VI and Division IIIa. Historic stock and fishery trends as found in the 2009 assessment.

	recruitment	ssb	catch	landings	tsb	fbar3-6	Y/ssb
1967	127456	150838	88339	88326	395635	0.322	0.59
1968	114114	211723	113742	113751	520415	0.291	0.54
1969	300688	263959	130579	130588	694142	0.262	0.49
1970	291835	312007	235006	234962	890606	0.408	0.75
1971	327931	429569	265359	265381	1018304	0.329	0.62
1972	171372	474093	261917	261877	903657	0.395	0.55
1973	152852	534485	242509	242499	847490	0.416	0.45
1974	148740	554906	298347	298351	833739	0.556	0.54
1975	181239	472066	271607	271584	743441	0.482	0.58
1976	384110	351531	343889	343967	752269	0.760	0.98
1977	118014	263121	216394	216395	509431	0.615	0.82
1978	92451	268089	155123	155141	463822	0.477	0.58
1979	77643	241049	128352	128360	419124	0.396	0.53
1980	67133	235143	131896	131908	396741	0.443	0.56
1981	172784	241188	132271	132278	495098	0.306	0.55
1982	109899	210412	174338	174351	511580	0.469	0.83
1983	118183	214207	180041	180044	467077	0.548	0.84
1984	205164	176555	200845	200834	465755	0.678	1.14
1985	311634	160708	220865	220869	490232	0.716	1.37
1986	287798	151675	198609	198596	486876	0.822	1.31
1987	112969	153036	167503	167514	384757	0.651	1.09
1988	115053	148003	135176	135172	320280	0.630	0.91
1989	77604	114924	108894	108877	257669	0.687	0.95
1990	119906	102863	103830	103800	262848	0.611	1.01
1991	138452	100556	108071	108048	282256	0.583	1.07
1992	92781	102300	99745	99742	277071	0.628	0.97
1993	151493	108038	111498	111491	324625	0.517	1.03
1994	102360	116560	109621	109622	315870	0.518	0.94
1995	224246	134910	121795	121810	455399	0.425	0.90
1996	110295	154068	114971	114997	442090	0.423	0.75
1997	162821	193791	107348	107327	464437	0.296	0.55
1998	71182	192535	106128	106123	383323	0.353	0.55
1999	139349	201501	110530	110716	398073	0.368	0.55
2000	94158	187825	85781	91322	403914	0.316	0.49
2001	221180	209595	91740	95042	482351	0.284	0.45
2002	186591	202665	107984	115395	497912	0.256	0.57
2003	123597	232874	98830	105569	467139	0.235	0.45
2004	86544	275553	94807	104237	473389	0.203	0.38
2005	211250	279263	115603	124532	513495	0.270	0.45
2006	56975	276987	122417	125680	487257	0.293	0.45
2007	173991	264369	94609	101202	469669	0.264	0.38
2008	**72416**	**260592**	**111412**	**119305**	**464469**	**0.303**	**0.46**

Table 11.6.1 Saithe in Sub-Areas IV, VI and Division IIIa. Input data for short term forecast.

age	year	f	stock.n	stock.wt	landings.wt	mat	M
3	2009	0.163	121834	0.84	0.84	0.00	0.2
4	2009	0.242	50520	1.07	1.07	0.15	0.2
5	2009	0.372	81267	1.31	1.31	0.70	0.2
6	2009	0.369	12022	1.67	1.67	0.90	0.2
7	2009	0.456	39520	2.13	2.13	1.00	0.2
8	2009	0.440	6387	2.69	2.69	1.00	0.2
9	2009	0.337	5929	3.47	3.47	1.00	0.2
10	2009	0.337	8364	4.88	4.88	1.00	0.2
3	2010	0.163	121834	0.84	0.84	0.00	0.2
4	2010	0.242	84708	1.07	1.07	0.15	0.2
5	2010	0.372	32470	1.31	1.31	0.70	0.2
6	2010	0.369	45877	1.67	1.67	0.90	0.2
7	2010	0.456	6806	2.13	2.13	1.00	0.2
8	2010	0.440	20505	2.69	2.69	1.00	0.2
9	2010	0.337	3367	3.47	3.47	1.00	0.2
10	2010	0.337	8358	4.88	4.88	1.00	0.2
3	2011	0.163	121834	0.84	0.84	0.00	0.2
4	2011	0.242	84708	1.07	1.07	0.15	0.2
5	2011	0.372	54443	1.31	1.31	0.70	0.2
6	2011	0.369	18330	1.67	1.67	0.90	0.2
7	2011	0.456	25974	2.13	2.13	1.00	0.2
8	2011	0.440	3531	2.69	2.69	1.00	0.2
9	2011	0.337	10811	3.47	3.47	1.00	0.2
10	2011	0.337	6857	4.88	4.88	1.00	0.2
3	2012	0.163	121834	0.84	0.84	0.00	0.2
4	2012	0.242	84708	1.07	1.07	0.15	0.2
5	2012	0.372	54443	1.31	1.31	0.70	0.2
6	2012	0.369	30734	1.67	1.67	0.90	0.2
7	2012	0.456	10378	2.13	2.13	1.00	0.2
8	2012	0.440	13477	2.69	2.69	1.00	0.2
9	2012	0.337	1862	3.47	3.47	1.00	0.2
10	2012	0.337	10332	4.88	4.88	1.00	0.2

Table 11.6.2 Saithe in Sub-Areas IV, VI and Division IIIa. Management option table.

year	fmult	f3-6	landings	ssb
2009	1	0.294	112488	263384

year	fmult	f3-6	landings	ssb
2010	1	0.294	103279	232386

year	fmult	f3-6	landings	ssb	ssb2012
2011	0.0000000	0.000	0	223107	312247
2011	0.7000000	0.201	72809	223107	245822
2011	0.8000000	0.229	81950	223107	237627
2011	0.9000000	0.258	90807	223107	229722
2011	1.1000000	0.315	107710	223107	214734
2011	1.2000000	0.344	115775	223107	207632
2011	1.3000000	0.372	123592	223107	200779
2011	1.4000000	0.401	131172	223107	194165
2011	1.0000000	0.287	99391	223107	222094
2011	0.3489951	0.100	38334	223107	277033
2011	0.5234927	0.150	55954	223107	261024
2011	1.0469854	0.300	103332	223107	218603
2011	1.1516839	0.330	111910	223107	211032
2011	0.6979903	0.200	72623	223107	245989
2011	1.3959805	0.400	130872	223107	194427
2011	1.1953083	0.342	115402	223107	207960

Table 11.6.3 Saithe in Sub-Areas IV, VI and Division IIIa. Stock numbers of recruits and their source for recent year-classes used in predictions, and relative (%) contributions to landings and SSB (by weight) of these year-classes.

Year-class	2003	2004	2005	2006	2007
Stock no. (thousands) of 3 years old	56975	173991	72416	121834	121834
Source	XSA	XSA	XSA	GM88-06	GM88-06
Status Quo F:					
% in 2009 landings	5.14	27.42	9.57	12.8	-
% in 2010 landings	4.74	21.15	11.86	17.41	13.94
% in 2011 landings	3.04	18.23	8.54	20.14	17.68
% in 2009 SSB	6.87	28.34	3.06	0	-
% in 2010 SSB	6.17	29.44	12.76	5.80	0.00
% in 2011 SSB	4.17	24.27	12.18	22.18	6.04
% in 2012 SSB	2.85	16.02	9.77	20.62	22.42

Table 11.9.1 The estimates of the North Sea saithe biomass and fishing mortality reference levels derived from the fit of three stock and recruit relationships and the yield per recruit Fmsy proxies.

Stock name								
Saithe								
Sen filename								
wgnssk_saithe_final.sen								
pf, pm								
0	0							
Number of iterations								
1000								
Simulate variation in Biological parameters								
TRUE								
SR relationship constrained								
TRUE								
Ricker								
549/1000 Iterations resulted in feasible parameter estimates								
	Fcrash	Fmsy	Bmsy	MSY	ADMB Alpha	ADMB Beta	Unscaled Alpha	Unscaled Beta
Deterministi	0.589369	0.284019	289.895	129.499	1.31618	0.509573	1.45724	0.00337913
Mean	0.65130373	0.30752875	300.214226	141.212939	1.338910572	0.525464359	1.525003383	0.003484512
5%ile	0.4503996	0.222082	212.0112	108.1942	1.118462	0.355238	1.114688	0.002355688
25%ile	0.5538	0.267905	255.998	125.508	1.24	0.45506	1.32685	0.00301764
50%ile	0.633387	0.303315	288.093	141.134	1.33335	0.522544	1.49931	0.00346515
75%ile	0.725282	0.340454	334.156	154.36	1.43172	0.590231	1.68738	0.003914
95%ile	0.9177992	0.4079354	421.9836	176.946	1.582678	0.7094866	2.07539	0.004704818
CV	0.22010075	0.18590401	0.21942096	0.15816857	0.105879467	0.202484679	0.193672588	0.202484676
Beverton-Holt								
527/1000 Iterations resulted in feasible parameter estimates								
	Fcrash	Fmsy	Bmsy	MSY	ADMB Alpha	ADMB Beta	Unscaled Alpha	Unscaled Beta
Deterministi	1.69324	0.243093	314.875	116.42	0.661829	0.738764	151.554	17.5299
Mean	1.44041641	0.20549467	648.063217	139.340416	0.5926353	0.7780123	175.4539336	54.86579186
5%ile	0.6075711	0.1017228	207.1085	97.51147	0.410876	0.6760777	135.0292	5.627463
25%ile	0.867818	0.1637485	339.0325	116.6285	0.5246895	0.732405	150.0385	20.49055
50%ile	1.23885	0.198205	461.109	133.462	0.603385	0.771313	166.233	39.6466
75%ile	1.76172	0.2423335	642.6305	153.9015	0.6685125	0.816406	191.1655	75.71025
95%ile	3.036682	0.3342189	1373.163	198.7263	0.7428219	0.9013591	244.1192	148.4554
CV	0.5375351	0.35474842	1.47574924	0.23945084	0.172250453	0.086990181	0.218208927	0.95728037
Smooth hockeystick								
549/1000 Iterations resulted in feasible parameter estimates								
	Fcrash	Fmsy	Bmsy	MSY	ADMB Alpha	ADMB Beta	Unscaled Alpha	Unscaled Beta
Deterministi	0.561445	0.324764	215.214	113.628	1.02079	0.432787	0.678964	102.326
Mean	0.52738972	0.31175374	418.922885	129.926941	0.848291475	0.557834973	0.564229273	131.8920947
5%ile	0.3739204	0.1310054	115.6656	101.1336	0.6305876	0.4367062	0.4194264	103.2528
25%ile	0.455219	0.227317	175.814	114.122	0.749066	0.475917	0.498231	112.524
50%ile	0.514272	0.29546	274.145	127.727	0.844879	0.526985	0.56196	124.598
75%ile	0.584401	0.386528	406.514	141.196	0.942245	0.613307	0.626721	145.008
95%ile	0.7206278	0.5370198	824.0874	168.201	1.076486	0.7807754	0.716007	184.6028
CV	0.20293089	0.40509332	1.94049818	0.16661582	0.162589747	0.192045347	0.162589905	0.192045414
Per recruit								
	F35	F40	F01	Fmax	Bmsypr	MSYpr	Fpa	Flim
Deterministi	0.135211	0.11433	0.137372	0.324766	1.54884	0.817752	0.4	0.6
Mean	0.12845028	0.10856676	0.13208302	0.46430879	2.88233765	0.895761415		
5%ile	0.05281606	0.04350872	0.05289764	0.136196	0.8267514	0.7274558		
25%ile	0.107125	0.0906711	0.105452	0.232008	1.23031	0.809013		
50%ile	0.132809	0.112301	0.137756	0.302349	1.90721	0.878834		
75%ile	0.154557	0.131329	0.160344	0.421923	2.75162	0.960965		
95%ile	0.1853658	0.1569214	0.1956422	1.546772	5.996338	1.129634		
CV	0.31537984	0.31811521	0.33202273	1.04098857	1.930596269	0.136009581		

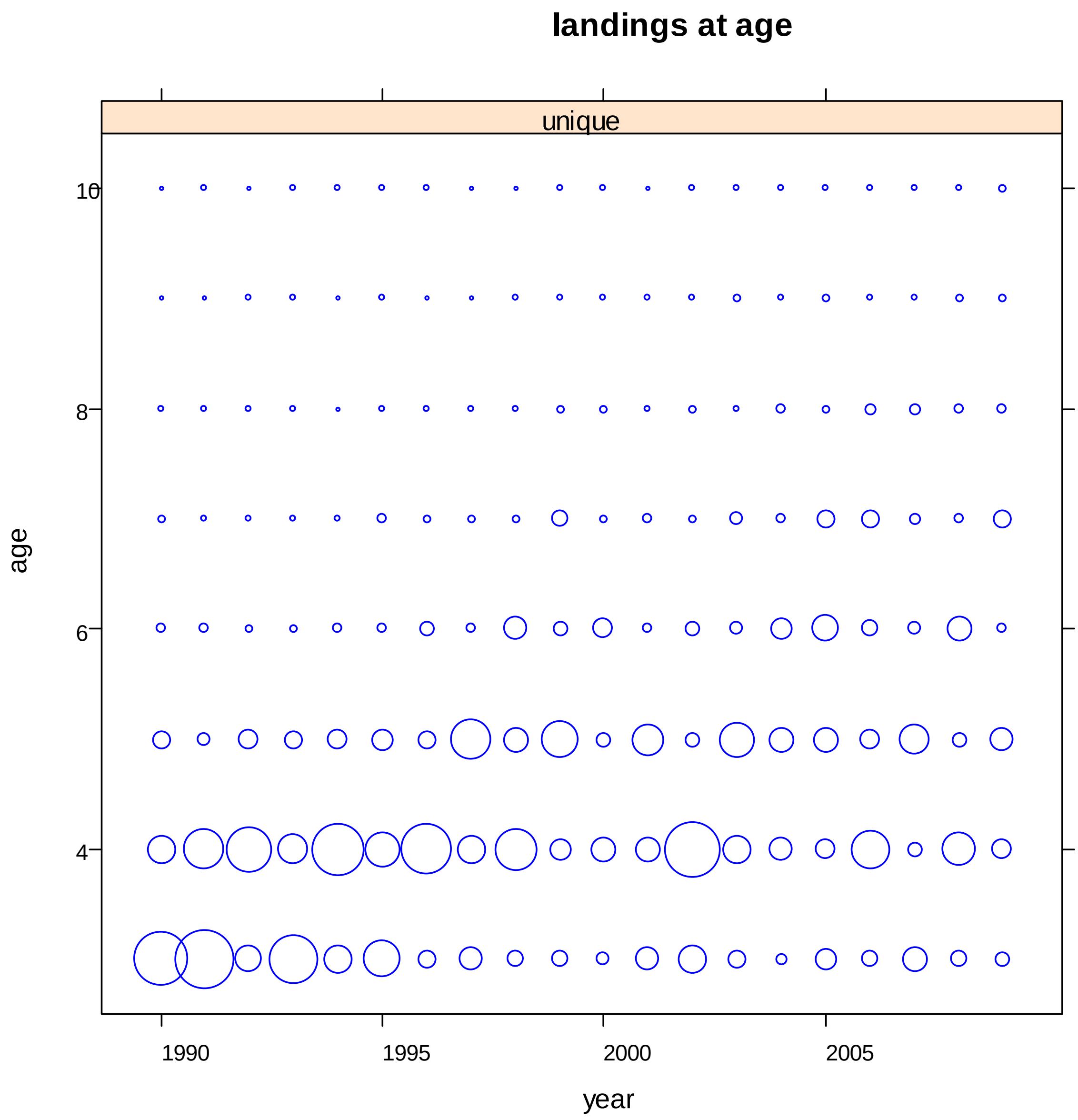
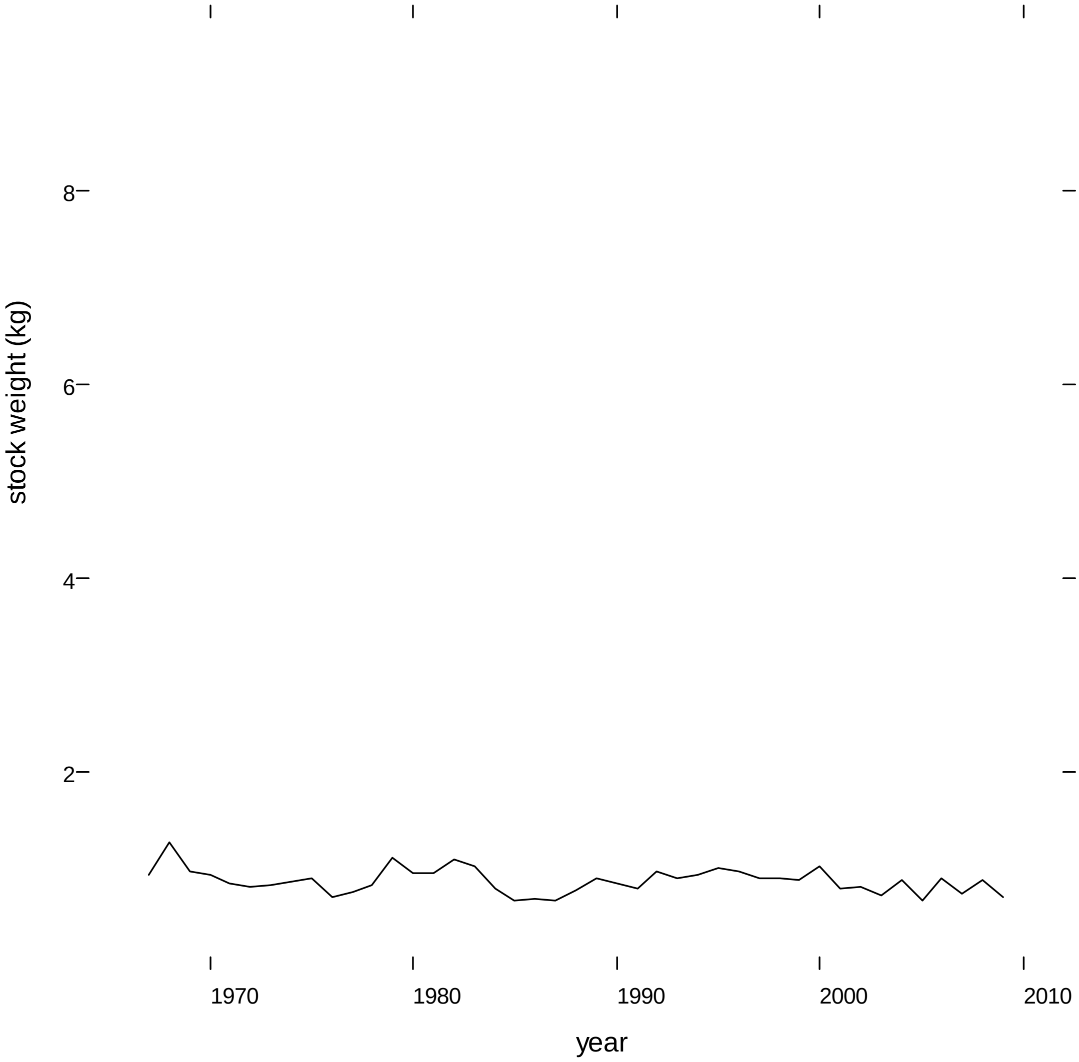


Figure 11.2.1. Saithe in Sub-Area IV, VI and Division IIIa, catch at age.



8
6
4
2
stock weight (kg)
1970
1980
1990
2000
2010
year

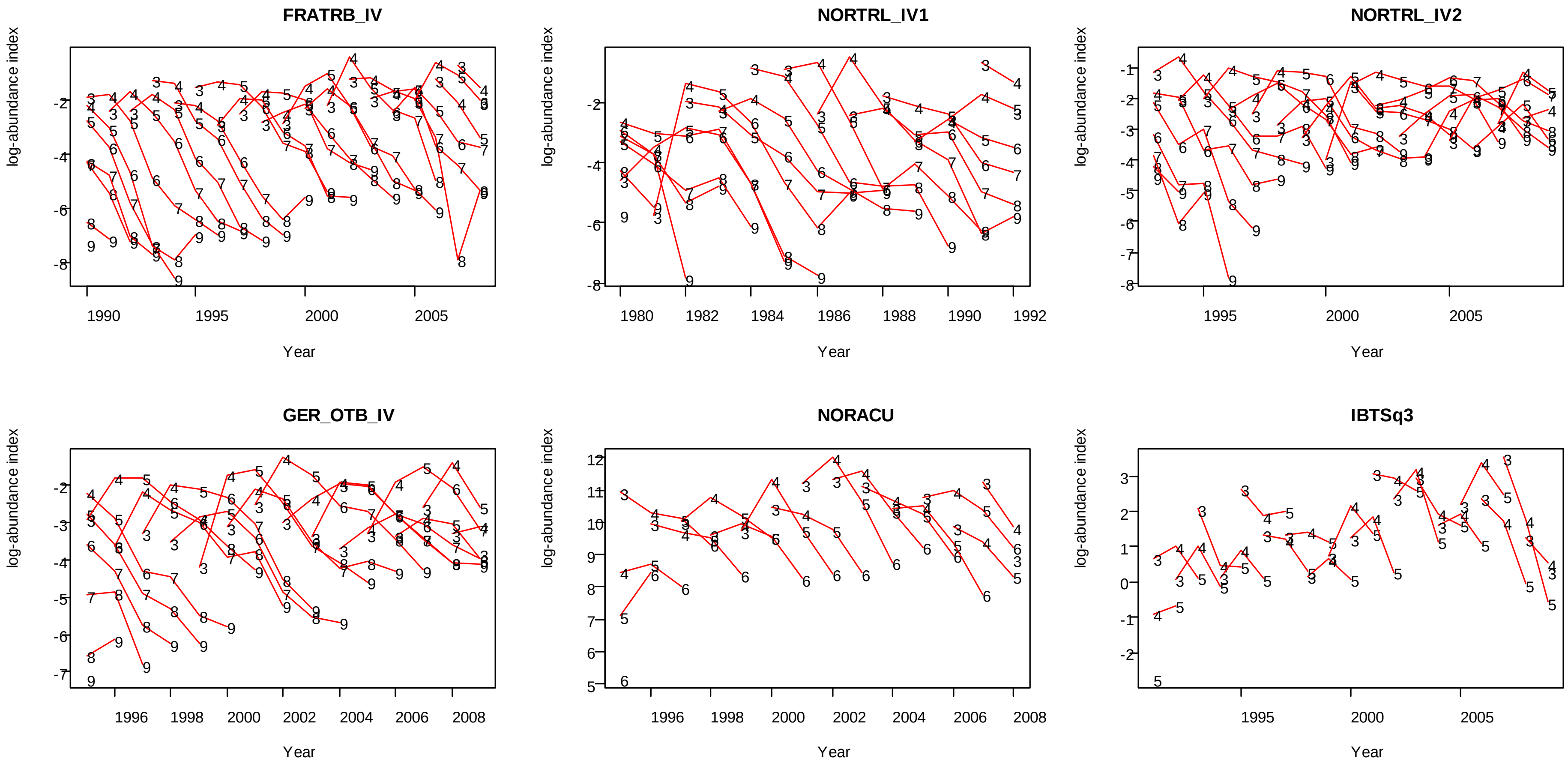


Figure 11.3.1 Saithe in Sub-Area IV, VI and Division IIIa. Log-abundance indices by cohort for each of the available tuning series.

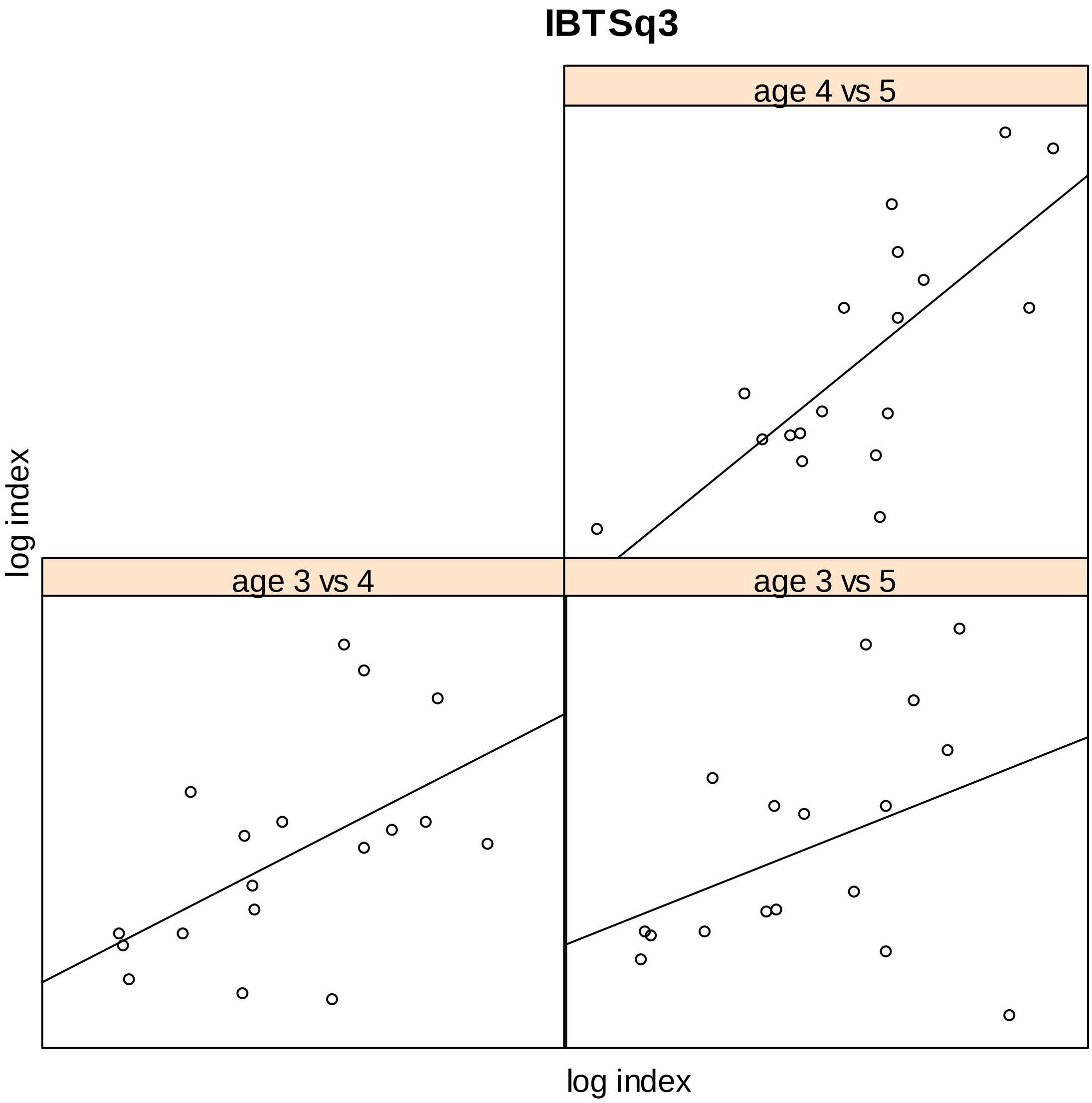


Figure 11.3.2. Saithe in Sub-Area IV, VI and Division IIIa Within-survey correlations for IBTSq3 for the period 1991-2009.

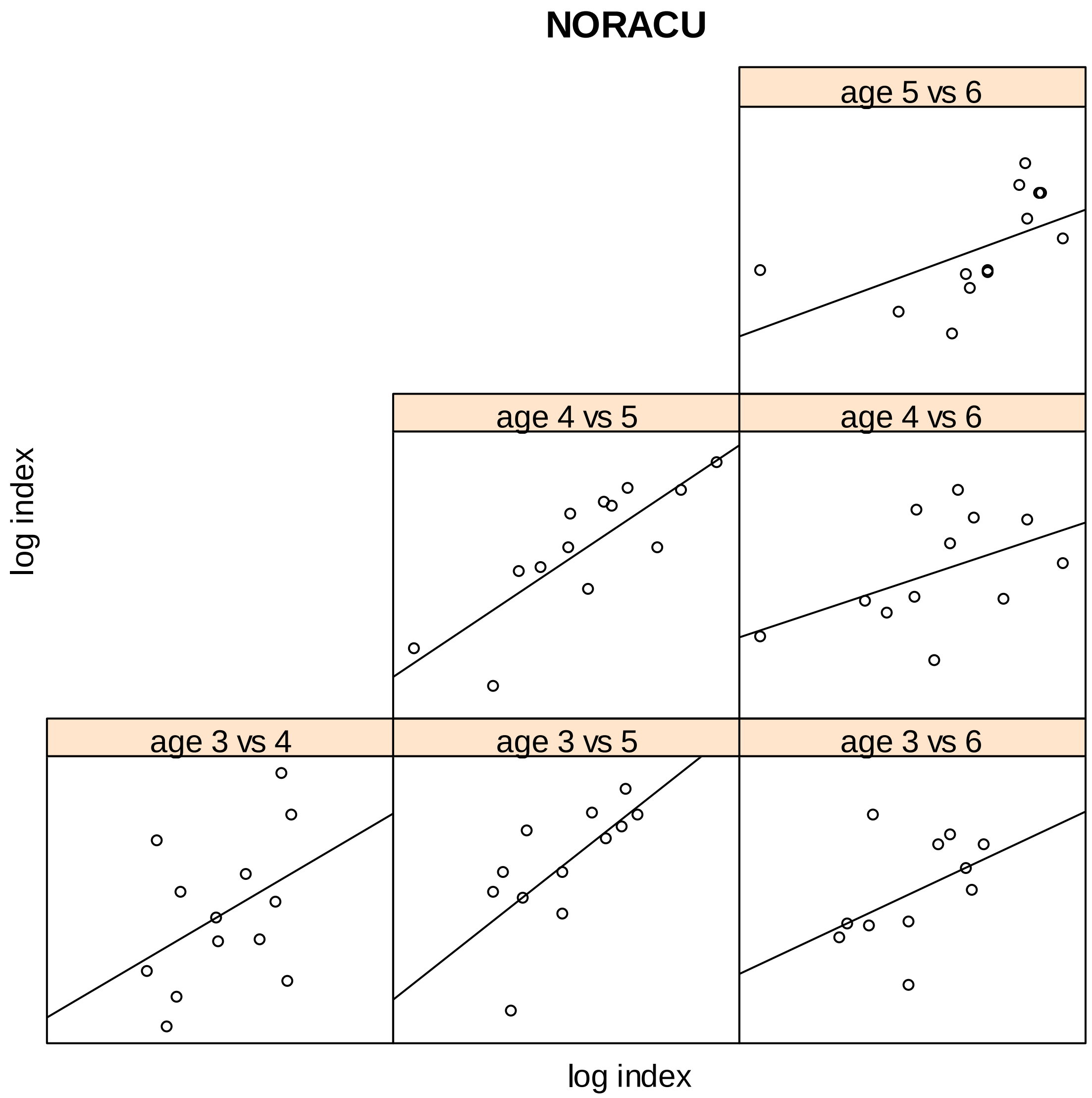


Figure 11.3.3. Saithe in Sub-Area IV, VI and Division IIIa Within-survey correlations for NORACU for the period 1991-2008.

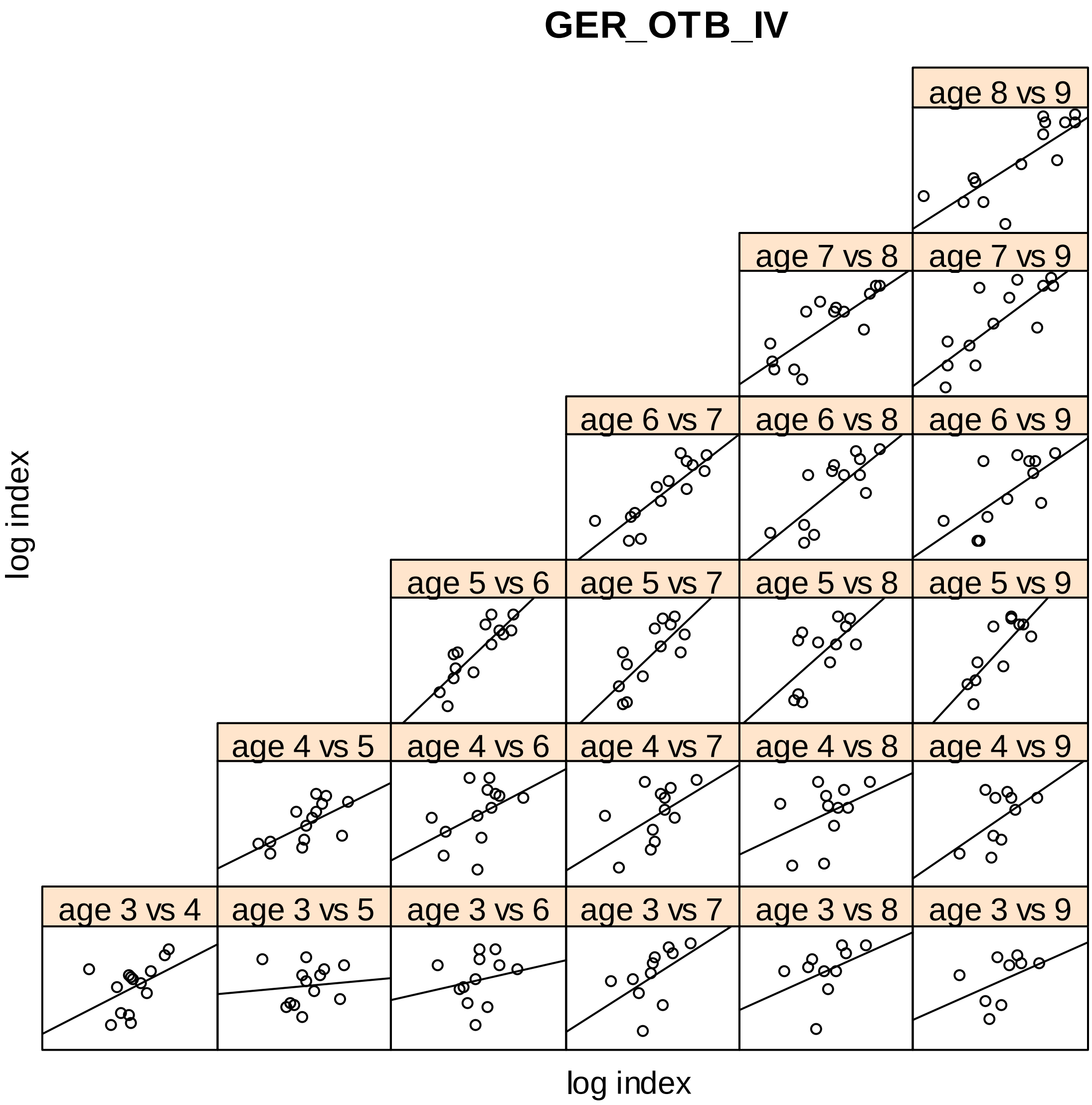


Figure 11.3.4. Saithe in Sub-Area IV, VI and Division IIIa Within-survey correlations for GEROTB.

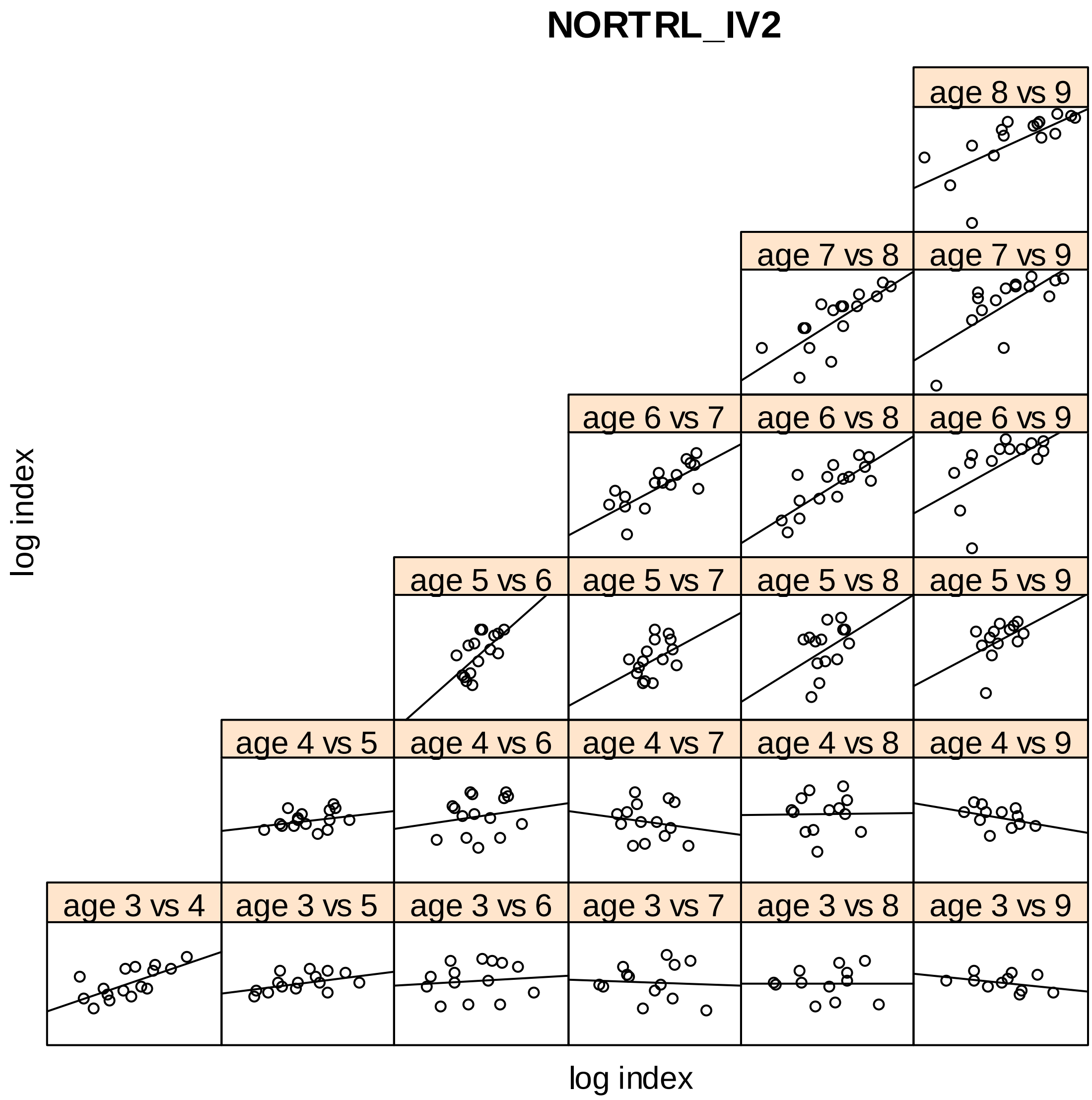


Figure 11.3.5. Saithe in SubArea IV, VI and Division IIIa Within-survey correlations for NORTRL.

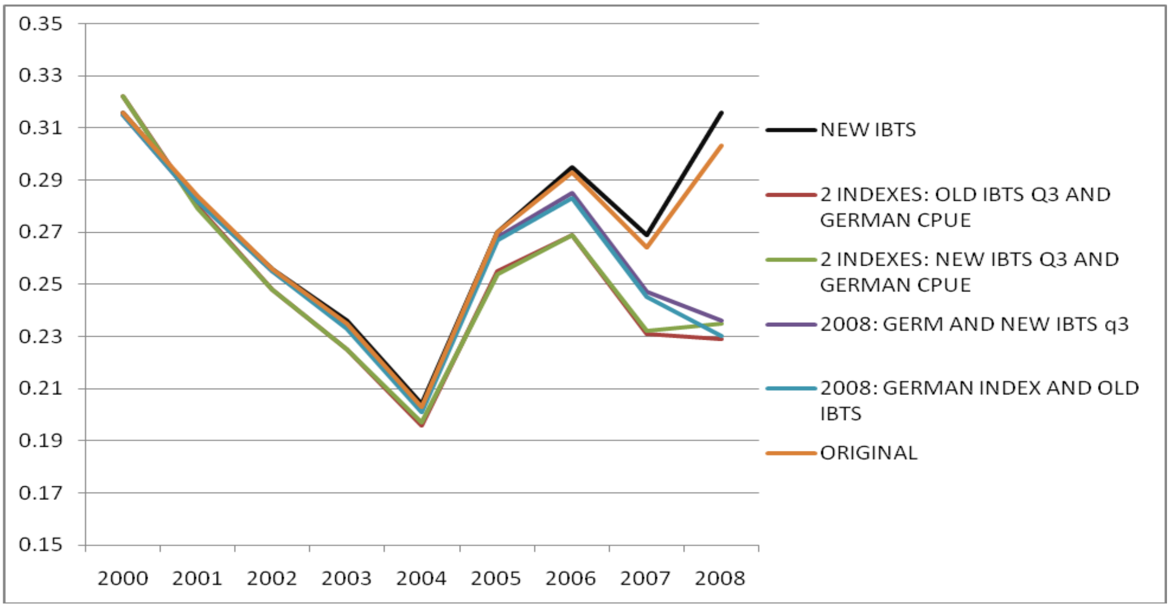


Figure 11.3.5.1 Re-run of the 2009 assessment showing $F_{3\text{-}6}$ for the different combinations of indexes.

NEW IBTS: Original 2009 assessment, but with Norwegian stations taken out of the whole IBTS Q3 time series.

2 INDEXES: OLD IBTS Q3 AND GERMAN CPUE: The 2009 assessment done with only two indexes: the original IBTS Q3 and the German CPUE index.

2 INDEXES: NEW IBTS Q3 AND GERMAN CPUE: The 2009 assessment done with two indexes: the only new IBTS Q3 and the German CPUE index.

2008: GERM AND NEW IBTS Q: Assessment 2009 with original indexes up to 2007 for NORACU, French CPUE, German CPUE and IBTS Q3 without Norwegian stations. For 2008, the only data included is the new IBTS Q3 and the German CPUE index.

2008: GERMAN INDEX AND OLD IBTS: Assessment 2009 with original indexes up to 2007 for NORACU, French CPUE, German CPUE and original IBTS. For 2008, the only data included is the original IBTS Q3 and the German CPUE index.

ORIGINAL: Original 2009 assessment, all available data.

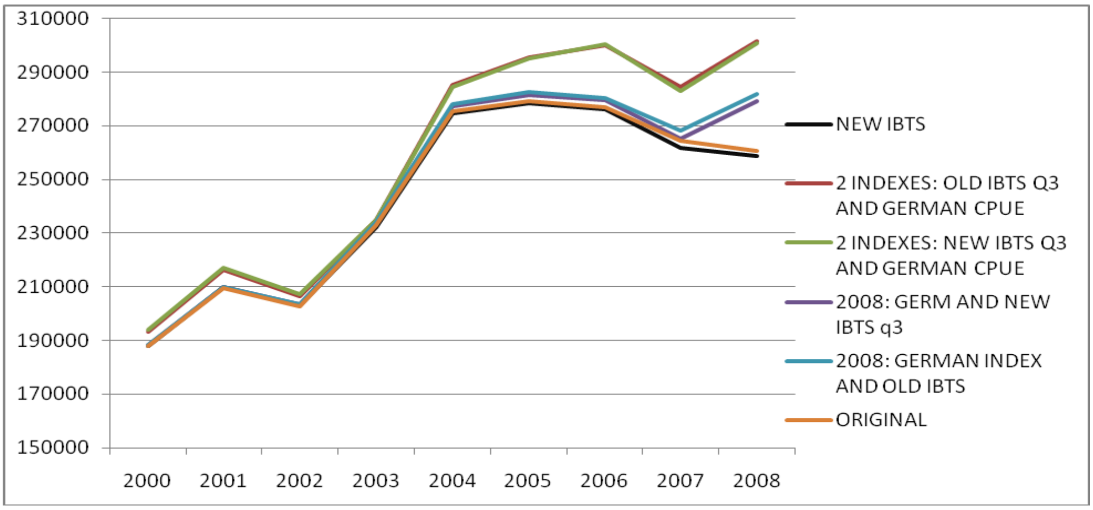


Figure 11.3.5.2 Re-run of the 2009 assessment showing SSB for the different combinations of indexes.

For detailed explanations: see Figure 11.3.5.1.

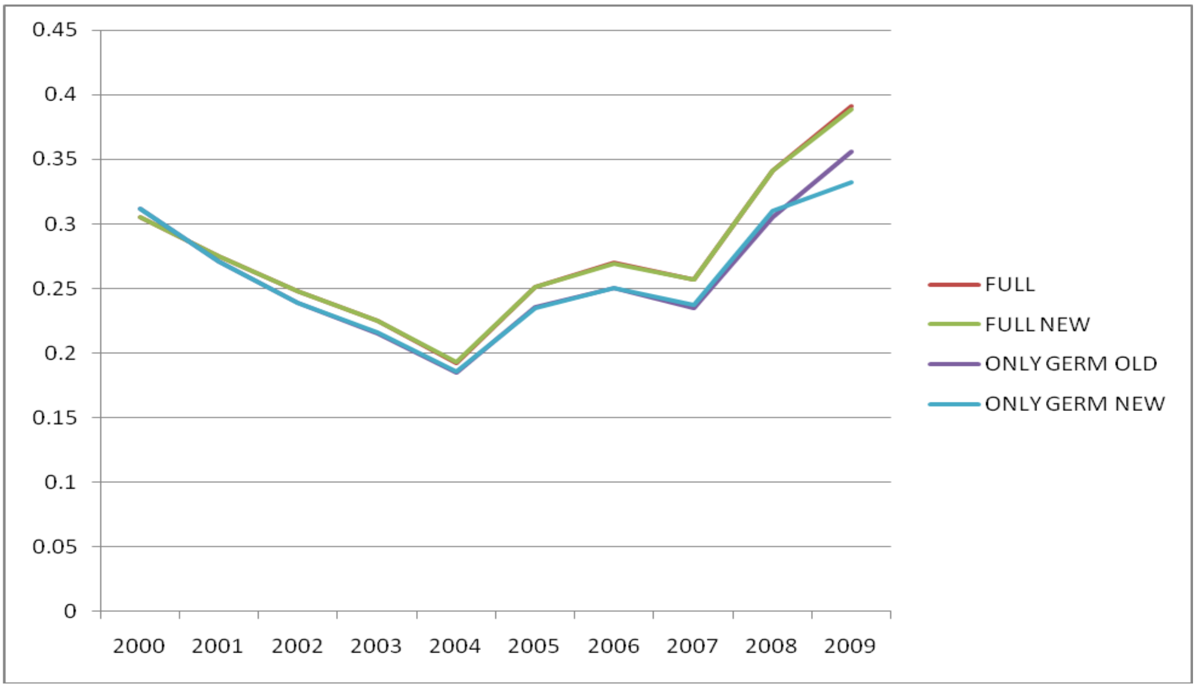


Figure 11.3.5.3. Estimated F3-6 from an exploratory 2010 assessment.

FULL: Exploratory 2010 assessment, all available data. Indexes from 2009 include IBTS Q3 and German CPUE index. Up to 2008, all indexes are used.

FULL NEW: Exploratory 2010 assessment with new IBTS Q3 index and German CPUE index as indexes in 2009. Up to 2008, all indexes are used.

ONLY GERM OLD: Exploratory 2010 assessment, old IBTS Q3 and German CPUE indexes for the whole period, no other indexes used.

ONLY GERM NEW: Exploratory 2010 assessment, new IBTS Q3 and German CPUE indexes for the whole period, no other indexes used.

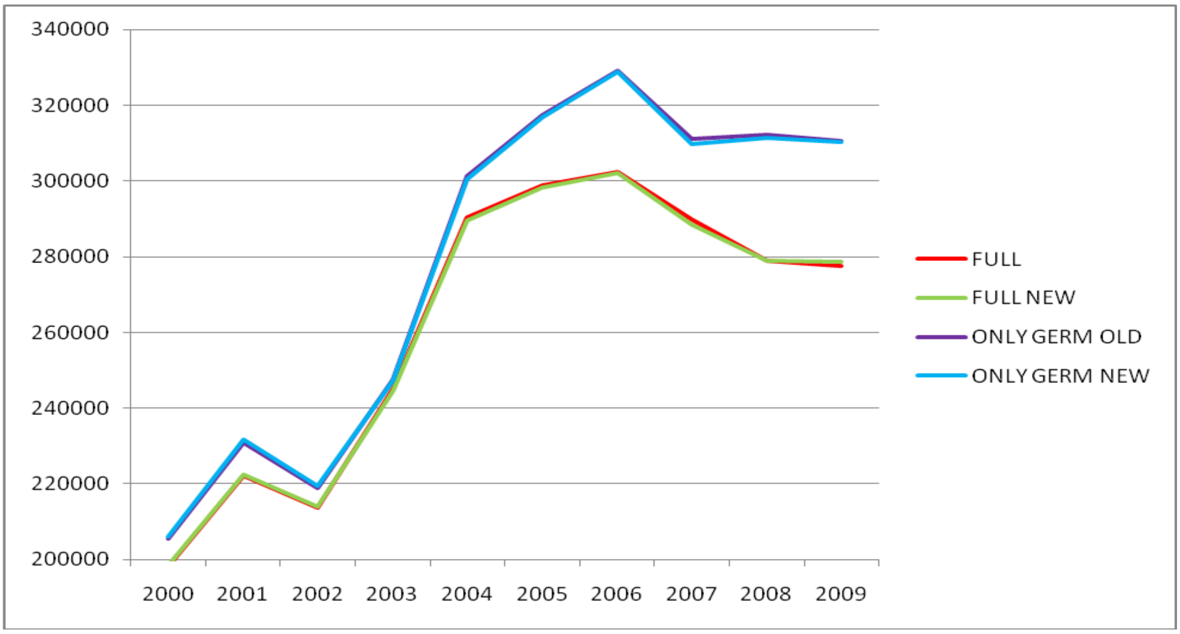


Figure 11.3.5.4. Estimated SSB from an exploratory 2010 assessment. For detailed description, see Figure 11.3.5.3.

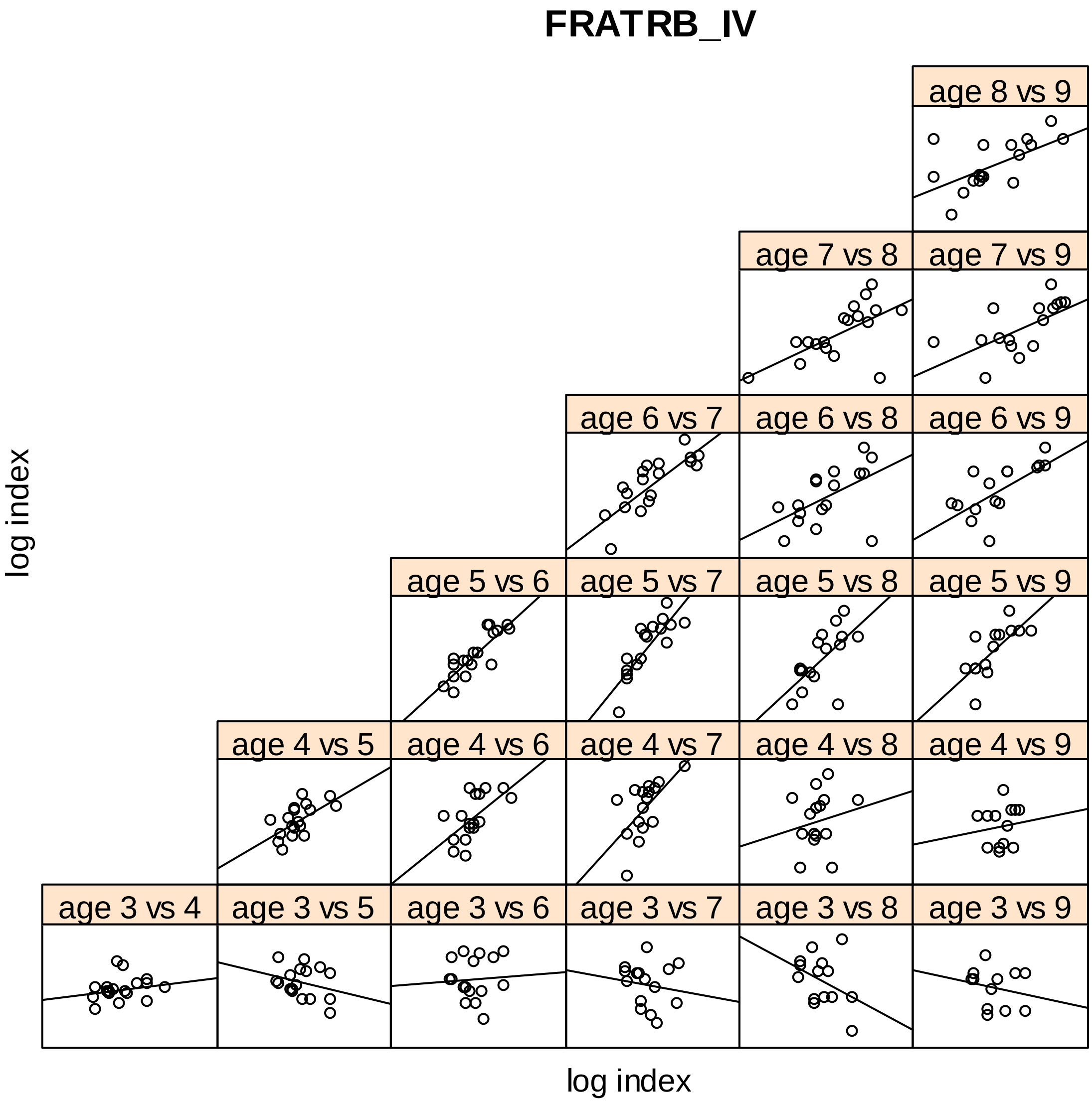


Figure 11.3.6. Saithe in Sub-Area IV, VI and Division IIIa Within-survey correlations for FRATRB.

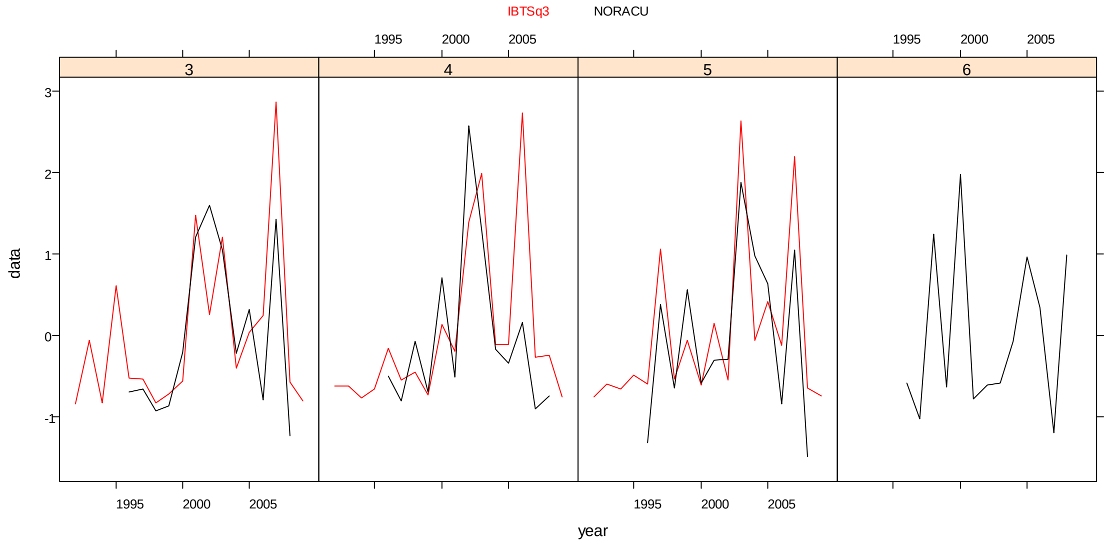


Figure 11.3.7. Saithe in Sub-Area IV, VI and Division IIIa. Standardised indices from the two survey time series.

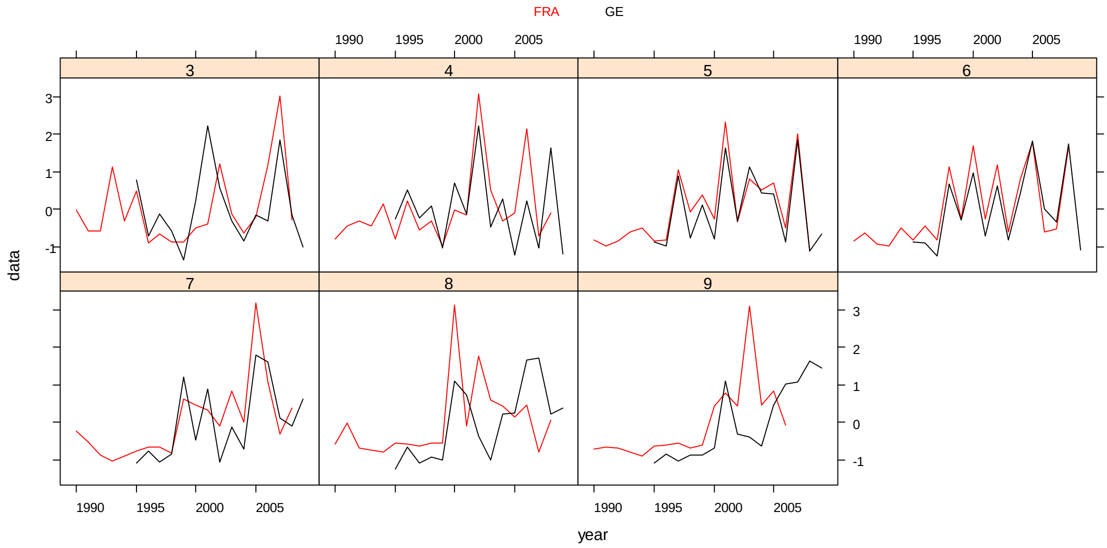


Figure 11.3.8. Saithe in Sub-Area IV, VI and Division IIIa. Standardised indices from the two commercial tuning series.

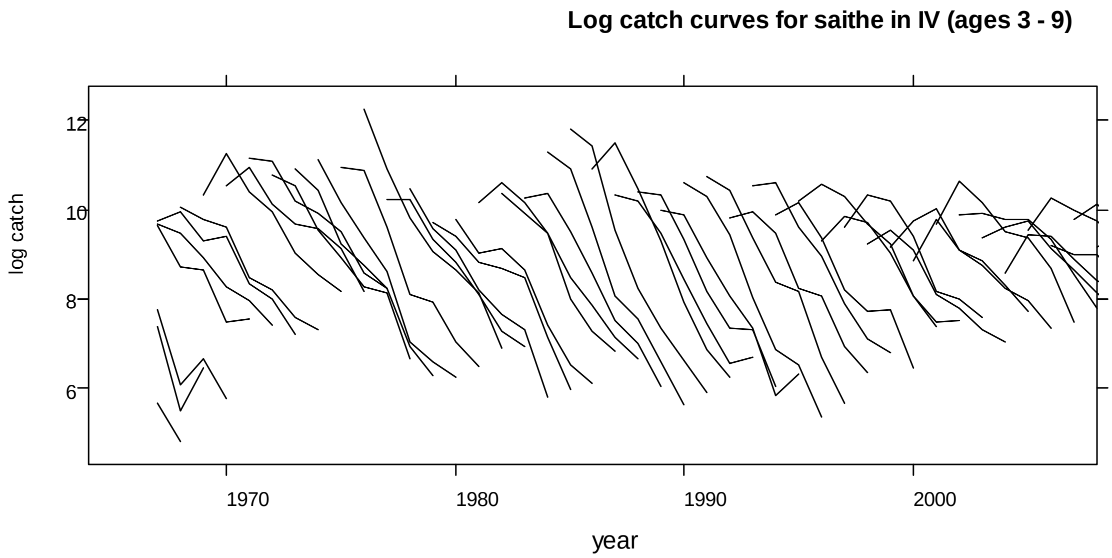


Figure 11.3.9. Saithe in Sub-Area IV, VI and Division IIIa. Log of catch curves for saithe.

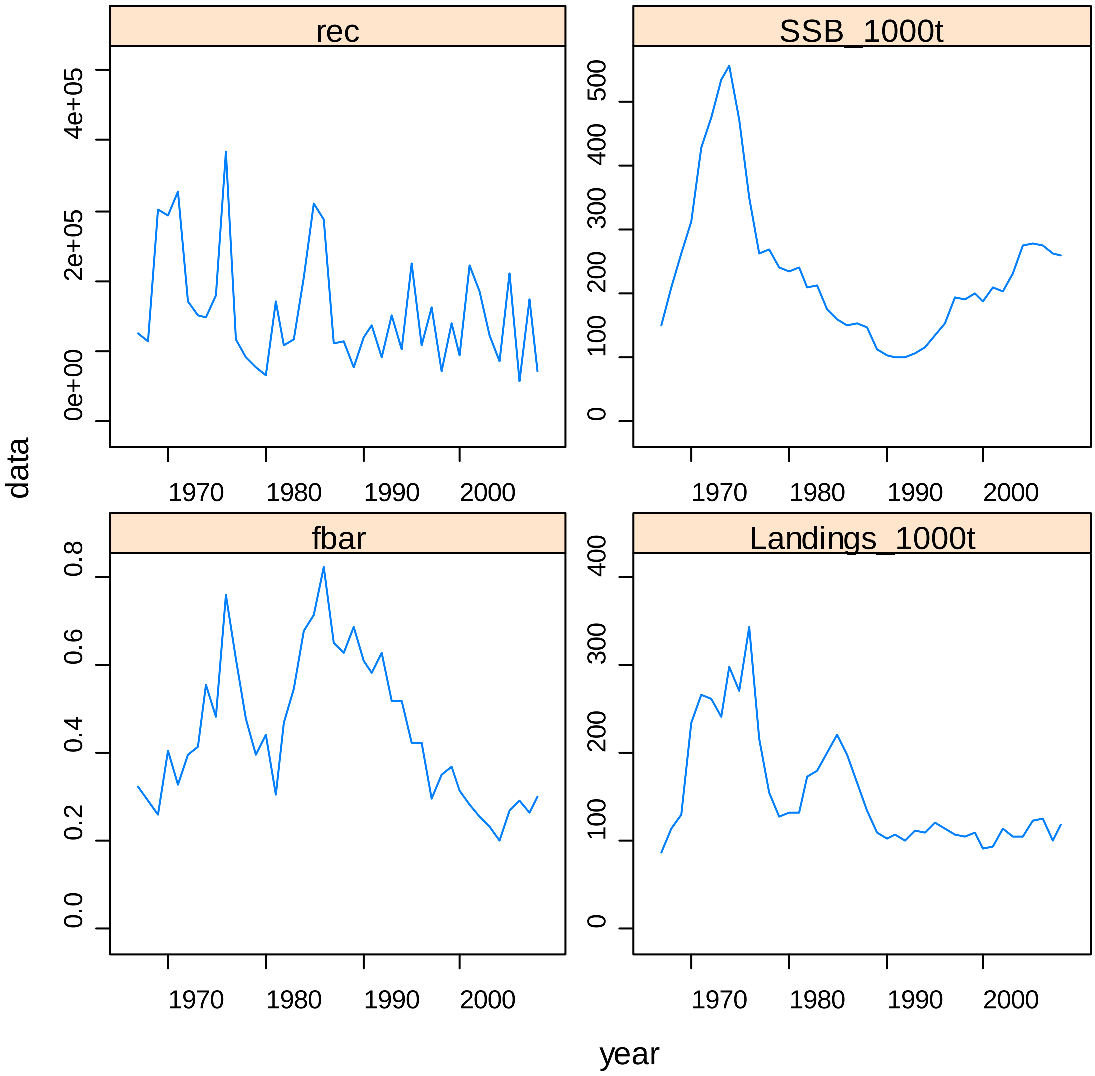


Figure 11.4.1 From the 2009 assessment: Stock summary, historical trends in recruitment, SSB, $F_{3\text{-}6}$ and landings.

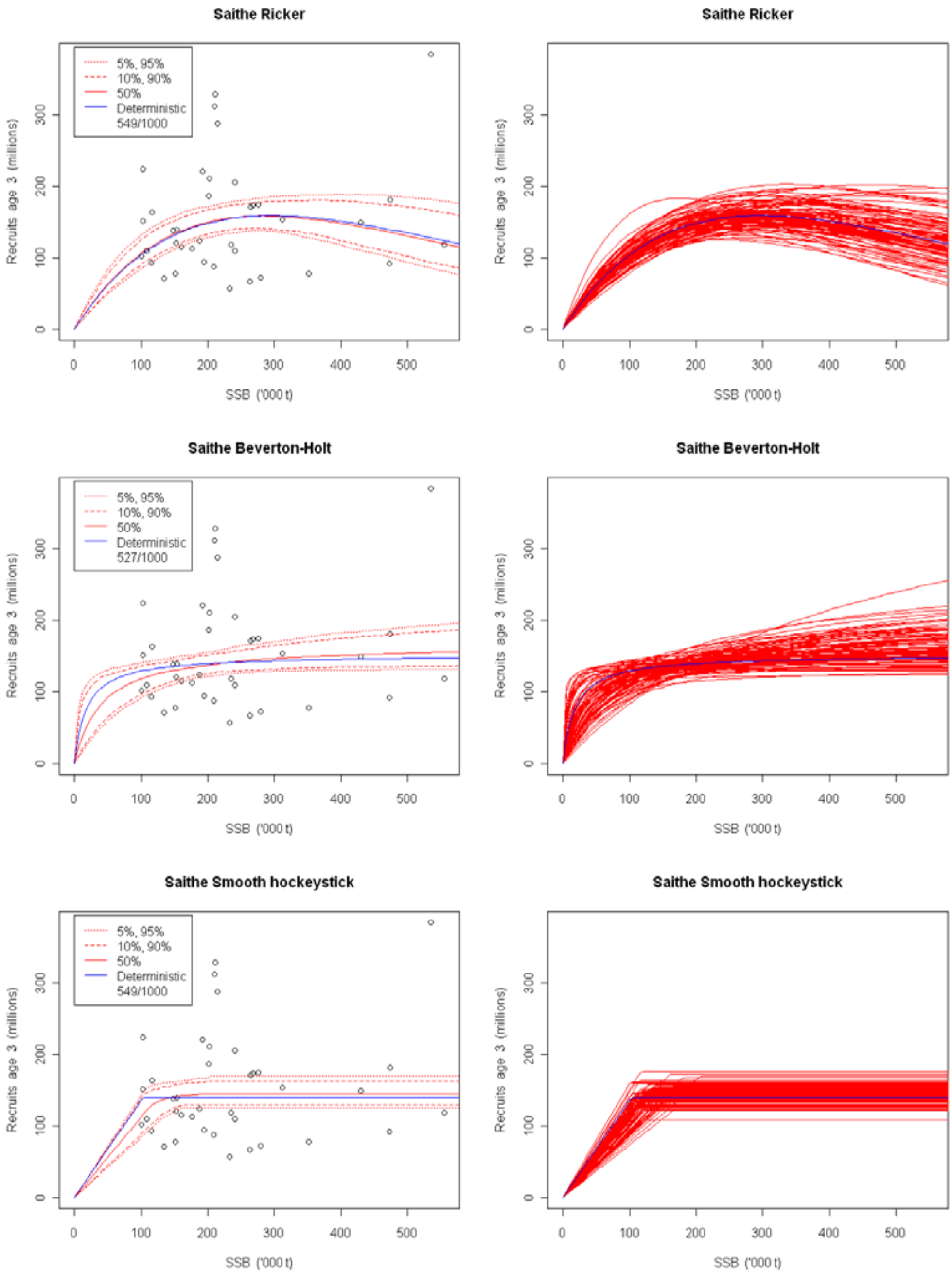


Figure 11.9.1. Figure 1 (a) Ricker, (b) Beverton - Holt and (c) smooth hockey stick curves fitted to the North Sea saithe stock and recruitment curves. The 95th, 90th, median, 10th, and 5th percentiles derived from MCMC re-sampling are illustrated in red; the deterministic estimates in blue.

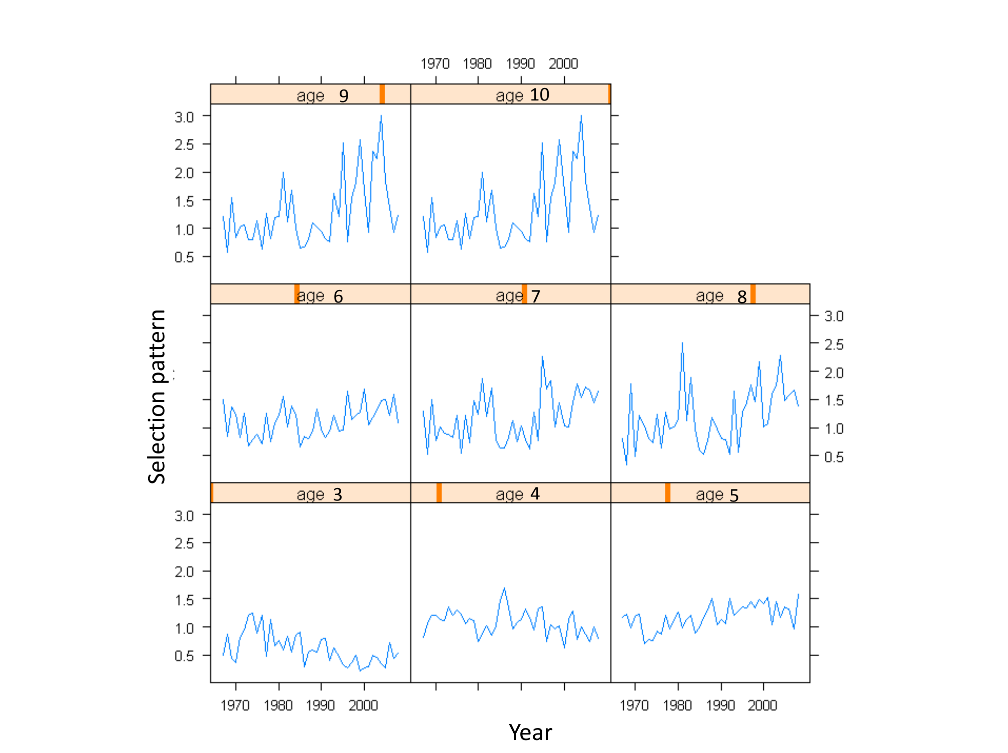


Figure 11.9.2. Changes in selection pattern over time (selectivity= F_{age}/Fbar).

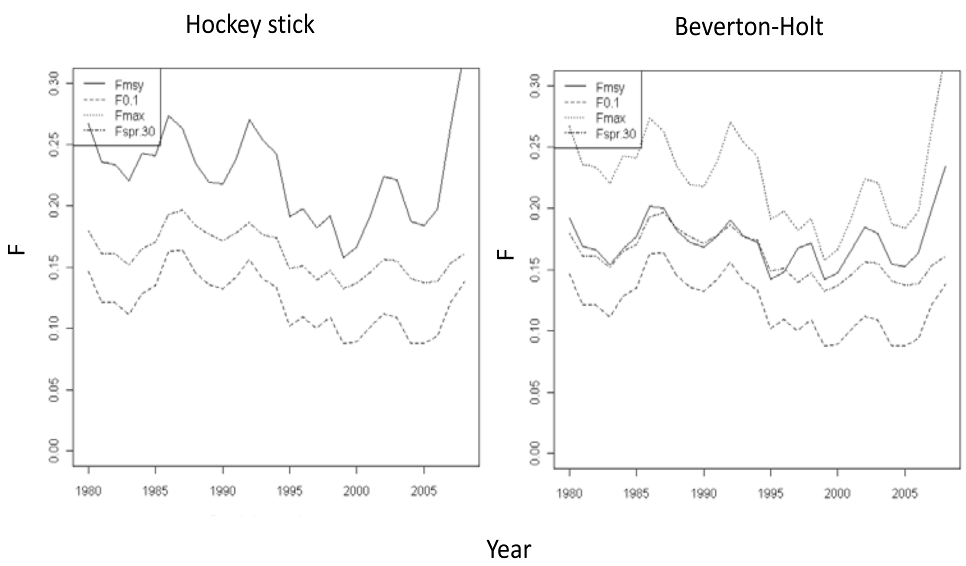


Figure 11.9.3. Changes in Fmsy estimates over time when applying a three years moving average for weight at age and the exploitation patern.

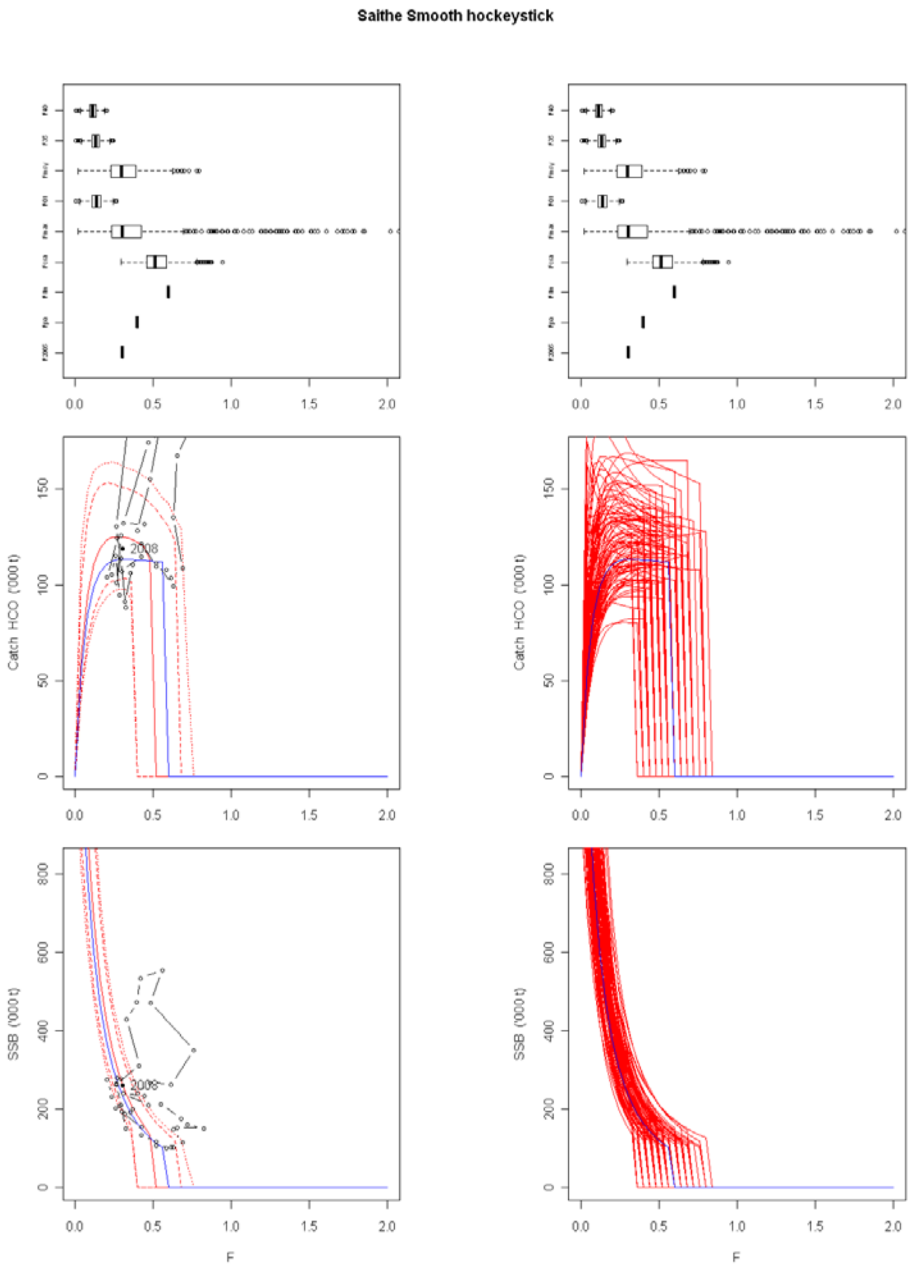


Figure 11.9.4 Figure 5 North Sea saithe smooth hockey stick stock and recruitment model estimates. (a) Box plots of Fmsy and Fcrash with proxies for Fmsy based on the yield per recruit: Fmax, F0.1, F35% and F40% SPR also Flim, Fpa and F in the final year; (b) equilibrium landings versus fishing mortality; (c) equilibrium SSB versus fishing mortality. The left hand figures illustrate the percentiles from 1000 MCMC re-samples with the assessment data points, the right hand figure 100 illustrative re-samples.

12 Whiting in Subarea IV and Divisions VIId and IIIa

Sections 12.1 to 12.11 contain the assessment relating to whiting in the North Sea (ICES Subarea IV) and eastern Channel (ICES Division VIId). The current assessment is formally classified as an update assessment. A benchmark was held for this stock in January 2009. The conclusions from the benchmark were that the assessment was consistent since 1995 and offers a reliable basis for determining stock status, including estimation of current stock size and fishing mortality. Landings of whiting from Division IIIa are given in section 12.12

12.1 General

12.1.1 Stock Definition

No new information was presented at the working group. A summary of available information on stock-definition can be found in the Stock Annex prepared at WKROUND (2009)

12.1.2 Ecosystem aspect

No new information was presented at the working group. A summary of available information on ecosystem aspects is presented in the Stock Annex prepared at WKROUND (2009).

12.1.3 Fisheries

Information on the fishery (and its historical development) is contained in the Stock Annex prepared at WKROUND (2009).

The recent low TACs combined with local aggregations of whiting on the East English Coast and East of Shetland has resulted in a rapid uptake of the whiting quota in recent years. In the first five months of 2008 34% of the UK North Sea quota was taken. In 2009, in the first five months 52% of the UK North Sea quota was taken. Furthermore, several fleets have taken their annual allocation within this period. A similar picture is true of 2010.

Changes in fleet dynamics

In Belgium the use of bigger meshes in the top panel of beam trawler gear is expected to reduce the by-catch of roundfish species, especially haddock and whiting.

In Scotland there has been a shift for Scottish vessels from using 100 mm-110 mm for whitefish on the west coast ground (Area VI) to 80 mm prawn codends in the North Sea (area IV). Fuel costs are a major driver, in this and all fisheries. The implications are that there will be increased effort in the North Sea with more effort by less selective gears; this implies increased bycatches and discards.

There was a new 2008 Scottish Conservation Credits scheme, with a number of implications:

In early 2008, a one-net rule was introduced in Scotland as part of the new Conservation credits scheme. This is likely to improve the accuracy of reporting of landings to the correct mesh size range. Another element of the package is the standardisation of the mesh size rules for twin rig vessels so that 80mm mesh can be used in both Areas IV and VI (north of 56°N) by twin rig vessels – previously the minimum mesh size for twin rig in area VI was 100mm. As a result there may be some migration of twin riggers from area IV to area VI, thus switching effort from IV to VI. Implications: Whitefish selection may improve because from July 2008, all nets in the 80mm range will have to have a 110 mm square mesh panel installed.

Scottish seiners have been granted a derogation from the 2 net rule until the end of January 2009 to continue to carry 2 nets (e.g. 100 –119 mm as well as 120 mm). They are required to record landings from each net on a separate log-sheet and to carry observers when requested. Implications: Potential for misreporting by mesh category

From February 2008 there has been a concerted effort not to target cod. Real time closures and gear measures are designed to reduce cod mortality. Implication: that there may have been greater effort exerted on haddock, whiting, monk, flats and *Nephrops*.

There were further additions to the Scottish Conservation Credits scheme for 2009:

Changes in gear that are required to qualify for the Scottish Conservation Credits Scheme (CCS; see Section 13.1.4) are likely to reduce bycatch (and therefore) discards of whiting in the *Nephrops* fishery in particular. In 2008 Scottish vessels were included in the CCS unless they opted out of it, and as only one or two vessels have chose to do so, compliance was been close to 100%. In 2009, the CCS is the only option available to Scottish skippers

Technical Conservation Measures

The option of 18 extra days if a 120 mm SMP at 4–9m was used with a 95 mm x 5 mm double codend was not taken up by the Scottish prawn fleet in 2007. The main reasons were that prawns would be lost due to twisting and too many marketable haddock and whiting lost which the extra days would not make up for. In 2008 this option attracted 39 extra days but was in competition with the Scottish Conservation Credits option whereby 21 extra days are available when a 110 mm SMP is used with an 80 mm codend. Implications: Possibly a 30% increase in L50 of haddock, whiting, saithe due to use of 110 mm SMP.

A large number of 110 mm SMPs were bought in the first months of 2008 by the prawn fleet so that they qualify for the basic Conservation Credits scheme. Probably affects most (~80%) of the fleet

Information for previous years is available in the stock annex.

Industry Contributed Reports

The Fisheries Science Partnership's North East Cod survey has been running since 2003, and covers a small but commercially important area of the North Sea on the north east coast of England. The survey does not only measure cod, but also give an index of whiting abundance for ages 0 to 7+. The final report (De Oliviera *et al*., 2009) documents the spatial distribution and abundance of whiting from 2003 to 2008. This publication shows that the local abundance of whiting has increased in this area, particularly over the years 2005 to 2008; this is also noted in the North Sea Stock survey (Laurensen 2008). The survey also notes a particularly large amount of age 1 whiting in the study area in 2008.

A new Fisheries Science partnership survey was launched in 2009 and will continue in 2010. This survey targets 6 representative fishing areas covering IVa and IVb and uses commercial gears and commercial vessels to compare catch rates by age across substrate and also attempts a comparison with IBTS catch rates.

Additional information provided by the fishing industry

Several letters were received in 2009 highlighting the effect of the reduced TAC for whiting in specific areas of the North Sea over the last five years. This problem is specifically evident where whiting abundance has been increasing in contrast the wider North Sea stock abundance. Whiting has been attracting high market value in the last three years and the value of whiting quota has increased substantially. This has resulted in higher discarding in some areas simply through the unavailability of affordable quota. These letters ask that managers provide means for whiting quota reaching these areas.

In 2010 Fishers have observed a greater amount of larger, older whiting as a proportion of the whiting catch; the reports suggest that whiting were seen over a wider area than previous years and in greater abundance. During 2009 and into 2010 vessels intentionally avoided areas of known whiting abundance, a reaction and output of a shortage of whiting quota; Shetland fishers strayed from traditional patterns of fishing to fish haddock off the Buchan Coast, this was a significant shift by a fleet that is normally repetitive and artisanal by nature.

2009 witnessed a shift by some vessels to fish the West of Scotland and Rockall bank this shift was prompted by both a shortage of quota and a lack of effort; 2010 has witnessed a similar but larger pattern.

12.1.4 ICES Advice

ICES advice for 2009:

In the absence of defined reference points, the state of the stock cannot be evaluated. An analytical assessment estimates SSB in 2008 a being at the lowest level since the beginning of the time-series in 1990. Fishing mortality has decreased through the time-series, but increased in recent years to twice F_{max}. Recruitment has been very low since 2001.

ICES advice for 2010:

In the absence of defined reference points, the state of the stock cannot be evaluated. An analytical assessment estimates SSB in 2009 as being near the lowest level since the beginning of the time-series in 1990. Fishing mortality has declined from 2000-2004, but increased in recent years. Recruitment has been very low since 2002, with an indication of a modest improvement in the 2007 year class

12.1.5 Management

Management of whiting is by TAC and technical measures. The agreed TACs for whiting in Subarea IV and Division IIa (EU waters) was 15 170 t in 2009 and 12 900 t in 2010. There is no separate TAC for Division VIId, landings from this Division are counted against the TAC for Divisions VIIb-k combined (16 940 t in 2009 and 14 410 t in 2010).

TACs for this stock are split between two areas: (i) Subarea IV and Division IIa (EU waters) and, (ii) Divisions VIIb-k. Since 1996 when the North Sea and eastern Channel whiting assessments were first combined into one. The human consumption landings in Divisions IV and VIId are calculated as 75% and 25% of the combined area totals. The figures used as the basis for the division of the TAC are the average proportion of the official landings for the past three years.

EU technical regulations in force in 2004 and 2005 are contained in Council Regulation (EC) 850/98 and its amendments. For the North Sea, the basic minimum mesh size for towed gears for roundfish was 120 mm from the start of 2002, although under a transitional arrangement until 31 December 2002 vessels were allowed to fish with a 110 mm codend provided that the trawl was fitted with a 90 mm square mesh panel and the catch composition of cod retained on board was not greater than 30% by weight of the total catch. From 1 January 2003, the minimum mesh size for towed roundfish gears has been 120 mm. Restrictions on fishing effort were introduced in 2003 and details of its implementation in 2004 can be found in Annex V of Council Regulation (EC) no. 2287/2003; for 2005 in Annex IVa of Council Regulation (EC) no 27/2005 and for 2006 in Annex IIa of Council Regulation (EC) 51/2006. Currently, vessels fishing with towed gears for roundfish in Subareas IV and VIId and Division IIa (EU waters) are restricted to 103 days at sea per year, excluding derogations. The minimum landing size for whiting in the North Sea is 27 cm. The minimum mesh size for whiting in Division VIId is 80 mm, with a 27 cm minimum landing size.

Whiting are a by-catch in some *Nephrops* fisheries that use a smaller mesh size, although landings are restricted through by-catch regulations. They are also caught in flatfish fisheries that use a smaller mesh size. Industrial fishing with small-meshed gear is permitted, subject to by-catch limits of protected species including whiting. Regulations also apply to the area of the Norway pout box, preventing industrial fishing with small meshes in an area where the by-catch limits are likely to be exceeded.

Conservation credit scheme

During 2008, 15 real-time closures (RTCs) were implemented under the Scottish Conservation Credits Scheme (CCS). By May 2009, 46 further RTCs had been implemented (with a target of 150 for the year), and the CCS been adopted by 439 Scottish and around 30 English and Welsh vessels. It has two central themes aimed at reducing the capture of cod through (i) avoiding areas with elevated abundances of cod through the use of compulsory Real Time Closures (RTCs) and voluntary 'amber zones' and (ii) the use of more species selective gears. Within the scheme, efforts are also being made to reduce discards generally. Although the scheme is intended to reduce mortality on cod, it will undoubtedly have an effect on the mortality of associated species such as haddock. Whether this effect is positive or negative remains to be seen; however, early indications suggest that improved gear selectivity is likely to contribute to reductions in fishing mortality and discard levels, particularly of haddock and whiting, and there is evidence that the exploitation patterns for haddock and whiting across all participating vessels have improved since the introduction of the CCS scheme.

In early 2008, a one-net rule was introduced in Scotland as part of the CCS. This is likely to have improved the accuracy of reporting of landings to the correct mesh size range. However, Scottish seiners were granted a derogation from the one-net rule until the end of January 2009, and were allowed to carry two nets (e.g. 100-119 mm as well as 120+ mm). They were required to record landings from each net on a separate logsheet and to carry observers when requested (ICES-WGFTFB 2008).

12.2 Data available

Due to continuing problems in InterCatch with the application of foreign discard rate estimates to unsampled fleets (see section 1.2), the international catch data for whiting have been aggregated using a spreadsheet (as has been the case for the previous three years). See section 13.2 for a brief overview.

Whiting discards in VIId

France provided discards data including numbers at age and mean weights at age for the years 2003 to 2007 for ICES Subarea IV and Division VIId separately. France is the main prosecutor of the VIId whiting fishery and takes around 15 % of the IV landings. The French IV discard age compositions have been included and the North Sea data worked up resulting in a minor change to the age compositions of filled in fleets in 2003 to 2007. To include the VIId discard estimated discards from missing years were estimated. This was done by fitting a logistic regression to estimate the probability of discarding at age given total catch. Age was treated as continuous and there was a random intercept and slope covarying for each year. The discard numbers were estimated from the mean intercept and slope (b_0 and b_1) by

$$\hat{p}_a = \frac{e^{b_0 + b_1 \text{age}}}{1 + e^{b_0 + b_1 \text{age}}}$$

and

$$\hat{d}_{ay} = \frac{\hat{p}_a}{1 - \hat{p}_a} l_{ay}$$

Where l_{ay} are the estimated numbers landed in year y at age a, and $\hat{d}_{ay}$ are the estimates of numbers discarded in year y at age a. The fitted ogive is presented in Figure 12.2.1.

To assess the sensitivity of including extra fish in the assessment an XSA run was conducted using the update settings and a summary is presented in Figure 12.2.2. The perception of the stock changes very slightly by including VIId discards, recruitment, SSB and TSB are revised upwards slightly and the changes in F are even more slight and mostly downwards revisions. The WG decided to use the dataset including estimates of VIId discards.

12.2.1 Catch

Total nominal landings are given in Table 12.2.1 for the North Sea (Subarea IV) and Eastern Channel (Division VIId). Industrial bycatch is almost entirely due to the Danish sandeel, sprat and Norway pout fisheries.

In the 2009 roundfish benchmark workshop (WKROUND, 2009) it was decided to truncate the catch data from 1990. This is due to unresolved discrepancies between survey and catch data prior to 1990.

Working group estimates of weights and numbers of the catch components for the North Sea and Eastern Channel are given in Tables 12.2.2 and 12.2.3, both tables cover the period 1990 to 2008. Total catch is similar to that of last year with a reduction in the North Sea catch offset by an increase in the VIId catch. North Sea discards have decreased and are now the lowest in the series. The reported tonnages of the catch components remain among the lowest in the series due to a restrictive TAC, and whiting industrial by-catch remains low even following the reopening of the fishery for Norway pout in 2008. For the Eastern Channel, the total catch in 2009 is an increase on the last two years and is above the mean of the series, whereas the total catch from the North Sea is the lowest in the series.

Figure 12.2.3 plots the trends in the commercial catch for each component along with the IV and IIa TAC. Each component shows a general decline with recent landings stable while discards decline. Figure 12.2.4 plots trends in the commercial catch components as they contribute to the total. Industrial by-catch can be seen to be removing proportionately less through time. Human consumption landings have fluctuated around 45% of the total catch during the period 1990–2004, rising to 60% in the recent years. The proportion of discards has increased over the last ten years, but has been decreasing in the most recent period.

12.2.2 Age compositions

Age compositions in the landings are supplied by Scotland, England and France. Age compositions in the discards are supplied by Scotland, England, Germany and Denmark. There were no age compositions available for industrial bycatch this year.

Limited sampling of the industrial bycatch component has resulted in the 2006 data appearing as an outlier and the 2007 to 2009 data was deemed unreliable. This applies to both the age compositions and the estimates of mean weights at age. Thus the data for 2006 to 2009 have been replaced with an estimate $\hat{n}_{a,y}$ given by:

$$\hat{n}_{a,y} = \hat{N}_y \hat{p}_{a,y},$$

where $\hat{p}_{a,y}$ is the mean proportion at age over the years 1990 to 2005, and $\hat{N}_y$ is estimated to give a sums of products correction (SOP) factor of 1 by

$$\hat{N}_y = \frac{\sum_a \hat{p}_{a,y} \hat{w}_{a,y}}{W_y},$$

where W_y is the reported weight of industrial bycatch. Here $\hat{w}_{a,y}$ have been estimated by taking the mean weights at age in the industrial bycatch over the period 1995 to 2005 (zero weights are taken as missing values).

Proportion in number at ages 1 to 8+ in the catch of human consumption landings, discards and industrial by-catch are plotted in Figure 12.2.5. This shows a general decline in discards and industrial bycatch for ages 1 to 4, stable proportions for ages 5 to 7 and increasing discards at age 8+.

Total international catch numbers at age (IV and VIId combined) are presented in Table 12.2.4. Total catch comprises human consumption landings, discards and industrial by-catch for reduction purposes. Discards are for the North Sea (IV) and Eastern Channel (VIId). Total international human consumption landings are given in Table 12.2.5. Discard numbers at age are presented in Table 12.2.6. Industrial by-catch numbers at age for the North Sea are presented in Table 12.2.7.

12.2.3 Weight at age

Mean weights at age (Subarea IV and Division VIId combined) in the catch are presented in Table 12.2.8. These are also used as stock weights. Mean weights at age (both areas combined) in human consumption landings are presented in Table 12.2.9, and for the discards and industrial by-catch in the North Sea in Tables 12.2.10 and 12.2.11. These are shown graphically in Figure 12.2.6, which indicates a recent increase in mean weight at age in the landings and catch for all ages, and a reasonably constant mean weight for all other ages in the other catch components apart from age 4 and older discards in the most recent year. This anomaly was preset in both Scottish and Danish sampling but not present in English samples. These recent high weights are more similar to landings and industrial bycatch weights at these age and may reflect discarding of marketable fish due to the restrictive TAC. From 1992 ages 6 and above in the catch and landings have shown a periodic increase and decrease in mean weight.

Unrepresentative sampling of industrial bycatch in 2006 to 2008 resulted in poor estimates of the mean weights at age and these have been replaced by the mean weight at age for the period 1995 to 2005 (zero weights are taken as missing values).

Mean weight at age in the catch by cohort is plotted in Figure 12.2.7. This figure shows declining mean weights in early cohorts at older ages, slow growth for the 1999 to 2002 cohorts, and steeper growth for the most recent cohorts.

12.2.4 Maturity and natural mortality

Values for maturity remain unchanged from those used in recent assessments and are:

Age	1	2	3	4	5	6	7	8+
Maturity Ogive	0.11	0.92	1	1	1	1	1	1

Their derivation is given in the Stock Annex.

Values of Natural mortality are taken from WGSAM (2008), and are smoothed estimates of annual natural mortality estimated from the key SMS for the North Sea and are given in table 12.2.12. Values for 2008 and 2009 are those estimated for 2007.

12.2.5 Catch, effort and research vessel data

Survey distributions at age for recent years are given in Figure 12.2.8 for the IBTS Q1 (2005 – 2010, ages 1 to 4+) and in Figure 12.2.9 for the IBTS Q3 survey (2004 – 2009, ages 1 to 4+). The IBTS Q1 plots show

- Increased recruitment in 2008 to 2010
- In 2008, the numbers of age 2 whiting exceeded that observed at age 1 in 2007
- The 2007 cohort does not change in abundance from 2008 to 2009 and becomes more concentrated in distribution by 2010.
- The 2008 cohort does not appear to decline from 2009 to 2010.
- The survey does not see many whiting to the east of Shetland.
- The IBTS Q3 plots show:
- Increased recruitment in 2008 and 2009
- The numbers of age 1 whiting in 2008 do not change much in abundance from 2008 to 2009, but their distribution seems to contract.
- The survey does not see many whiting the east of Shetland.

Survey tuning indices used in the assessment are presented in Table 12.2.13. These are ages 1 to 5 from the IBTS Q1 and Q3 from 1990 to 2009 and 1991 to 2009, respectively. The report of the 2001 meeting of this WG (ICES WGNSSK 2002), and the ICES advice for 2002 (ICES ACFM 2001) provides arguments for the exclusion of commercial CPUE tuning series from calibration of the catch-at-age analysis see also section 14.2.4. Such arguments remain valid and only survey data have been considered for tuning purposes. All available tuning series are presented in the Stock Annex prepared at the WKROUND (2009).

12.3 Data analyses

12.3.1 Summary of 2009 benchmark workshop

The benchmark workshop focused on trying to resolve the historical discrepancy between catch and surveys (see Figure 12.3.1). There are three potential sources of this discrepancy: changes in bias in the estimate of catch magnitude; changes in survey catchability; or changes in natural mortality due to predation and or regime shift. To address these issues the group decided to:

- use estimates of natural mortality from WGSAM (2008), the multispecies assessment working group;
- investigate the historical perception of the catch data, in particular the industrial by-catch data, from previous North Sea working group reports;
- investigate the potential for changes in catchability in the IBTS surveys.

The group also looked at changes in the distribution of commercial landings (Figure 12.3.2) with respect to survey abundance, and whiting spawning areas (as estimated by the distribution of whiting eggs, Figure 12.3.3).

Given the length of the workshop it was not possible to answer all questions rigorously; however future work was suggested (investigation of survey catchability and historical perception of catch data quality) and is currently underway. In the event that the discrepancy between surveys and catch is resolved biomass and fishing mortality precautionary reference points may be reinstated, in the mean time, it was suggested that yield per recruit fishing mortality reference points be investigated. Specifically, a time series of Fmax and F0.1 should be made available to the assessment working group. This work will appear in section 12.8 of this report.

The final conclusions of the benchmark working group were that the current assessment methodology was appropriate for assessing stock trends and for short term forecast purposes. These details are contained in the stock annex prepared at WKROUND (2009).

12.3.2 Reviews of last year's assessment

Two commente were made, firstly that the Review group agreed with the Working group conclusions and the second was a comment on the retrospectives patterns.

There is a good explanation for the retrospective patterns which are predominantly consistent upwards revisions of recruitment, SSB and TSB, with downwards revisions of F (see section 12.3.3).

12.3.3 Exploratory survey-based analyses

Catch curve analyses are shown in Figures 12.3.4 to 12.3.5. These show consistent tracking of year classes (since catch curves are mostly smooth) with the exception being the IBTS Q1 index of age 1 for the 2006 year class. Evident are the low 2002 – 2006 year classes. Most unusually is the lack of decline from 2009 to 2010 for the 2005 to 2008 year classes. The IBTS Q1 seems to have vastly underestimated the size of the 2006 yearclass at age 1, while the 2007 year class also seems to have been underestimated at age 1 and potentially the same could be said of the 2008 yearclass. The IBTS

Q3 survey shows low mortality for the 2006 year class, and a potential under estimate of the 2007 yearclass at age 1; the numbers at age 2 in the 2007 yearclass are among the highest in the series.

The explanation of the retrospective pattern follows from the fact that the surveys see very slow rates of decline in the recent cohorts but the catch data and the values of natural mortality set against the size of the stock say that there must be a decline through cohort, so to balance this the model says there are more recruits than we thought year on year. This pattern seems set to continue into 2010 (Figure 12.3.4).

The consistency within surveys is assessed using correlation plots. Only survey indices used in the final assessment are presented as this is an update assessment. The IBTS Q1 and Q3 surveys both show good internal consistency across all ages (Figure 12.3.6 and 12.3.7).

A generalized additive mixed model (GAMM) was fitted to the age aggregated survey indices to approximate the local trend in SSB in the northern and southern North Sea. Indices were aggregated for each haul by multiplying each index by its mean weight in the stock and then by its maturity before summing across age. This gives an SSB proxy by haul. The GAMM that was fitted was for a smooth trend in time for each area (north, south) and allowed each stat square to vary about the mean trend in a consistent way from year to year. Normal errors were assumed and the SSB proxy was logged (zero values replaced with half the minimum observed) as this eased implementation. The model was fitted separately to quarter 1 and quarter 3 surveys. The fits are presented in Figures 12.3.8 on the log scale and show similar trend across surveys: decreasing trend in the north and a variable recently increasing trend in the south.

12.3.4 Exploratory catch-at-age-based analyses

Catch curves for the catch data are plotted in Figure 12.3.9 and shows numbers-at-age on the log scale linked by cohort. This shows partial recruitment to the fishery up to age 3. Also evident is the persistence of the 1999 to 2001 year classes in the catch and the recent low catches of the 2002 – 2007 year classes.

Within cohort correlations between ages are presented in Figure 12.3.10. In general catch numbers correlate well between cohorts with the relationship breaking down as you compare cohorts across increasing years.

Single fleet XSA runs were conducted to compare trends in the catch data with trends in the survey data. These used the same procedure as this years' final assessment. Summary plots of these runs are presented in Figure 12.3.11. The population trends from each survey are consistent; however, the absolute levels of the F and SSB estimates differ over the last 10 years. The IBTS Q1 gives a higher F, lower SSB and lower recruitment than the IBTS Q3. Residual patterns (Figure 12.3.12) show that both the 2006 and 2007 yearclasses have negative residuals at age 1 for both surveys.

12.3.5 Conclusions drawn from exploratory analyses

Catch curve analysis and correlation plots show that in general both surveys and catch data track cohorts well and are internally consistent. However, beginning with the 2006 year class, the IBTS Q1 appears to be underestimating the abundance of age 1 and 2 whiting. This will have implications for the estimation of recruitment at age 1 in 2007, and will likely lead to retrospective patterns due to upward revisions in the estimates of recruitment.

12.3.6 Final assessment

The final assessment was an XSA fitted to the combined landings, discard and industrial by-catch data for the period 1990–2009. This is the same procedure as last year and that agreed at WKROUND (2009). The settings are contained in the table below. Those from previous years are also presented.

	year range used	2006	2007	2008	**2009-2010**
Catch at age data		1980- Ages 1 to 8+	1980- Ages 1 to 8+	1980- Ages 1 to 8+	**1990- Ages 1 to 8+**
Calibration period		1990-2005	1990-2006	1990-2007	**1990-2009**
ENGGFS Q3 GRT (1990-1991	-	Ages 1 to 6	-	-	-
ENGGFS Q3 (GOV)	-	Ages 1 to 6	Ages 1 to 6	Ages 1 to 6	-
SCOGFS Q3 (Scotia II)	-	Ages 1 to 6	-	-	-
SCOGFS Q3 (Scotia III)	-	Ages 1 to 6	Ages 1 to 6	Ages 1 to 6	-
IBTS Q1	**1990-2008**	Ages 1 to 5	Ages 1 to 5	Ages 1 to 5	**Ages 1 to 5**
IBTS Q3	**1991-2008**	-	-	-	**Ages 1 to 5**
Catchability independent of stock size		Age 1	Age 1	Age 1	**Age 1**
Catchability plateau		Age 4	Age 4	Age 4	**Age 4**
Weighting		Tricubic over 16 years	Tricubic over 17 years	Tricubic over 18 years	**No taper weighting**
Shrinkage		Last 3 years and 4 ages	Last 3 years and 4 ages	Last 3 years and 4 ages	**Last 3 years and 4 ages**
Shrinkage SE		2.0	2.0	2.0	**2.0**
Minimum SE for fleet survivors estimates		0.3	0.3	0.3	**0.3**

Full diagnostics for the final XSA run are given in Table 12.3.1. Residual plots are presented in Figure 12.3.13. These show contrasting trends between the IBTS Q1 and Q3 surveys in the recent years: IBTS Q1 has negative residuals for 2005 and 2006 and at ages 3-5 for 2007-2008, while the IBTS Q3 survey has all positive residuals from ages 3 to 5 from 2005 to 2008. The IBTS Q3 survey also has positive residuals for all ages in the final year. Both surveys indicate that the survey catchability of age 1 whiting was reduced during 2005 to 2008. Recruitment in 2009 is not consistently estimated by both surveys, the 2009 estimate being a balance of the two. The contribution of each tuning fleet to the estimated of survivors in the most recent year is given in Figure 12.3.14.

Fishing mortality estimates are presented in Table 12.3.2, the stock numbers in Table 12.3.3 and the assessment summary in Table 12.3.4 and Figure 12.3.15. Fishing mortality at age is plotted in Figure 12.3.16. Fishing mortality can be seen to be increasing sharply on ages 2 - 5, with a slower increase on ages 6 and 7. Fishing mortality on age 7 is very noisy in the beginning of the series.

A retrospective analysis is shown in Figures 12.3.17 and 12.3.18. This shows a consistent bias in recruitment over the last four years. The largest revision in recruitment is in 2007 which coincides with large negative residuals and the poorly estimated 2006 yearclass. This translates directly to a large revision of TSB in 2007. As whiting are 90% mature at age 2, this large revision in recruitment in 2007 follows through to SSB in 2008.

Comparing directly to last years assessment, Figures 12.3.19 and 12.3.20 show the proportional change in stock number estimates and F estimates at age (as a proportion of the 2009 assessment estimates). It can be seen that the majority of the upwards revision in TSB comes from increased estimate of recruitment in the 2006 and 2007 cohorts, coupled with a decrease in F at age estimates for these same cohorts.

12.4 Historic Stock Trends

A plot of estimated F-at-age over the years 2007 to 2009 is presented in Figure 12.4.1. This figure shows the decline in F at older ages.

Contribution of age classes to TSB and SSB is shown in Figure 12.4.2 and as proportions in Figure 12.4.3. This shows the important contribution of ages 1 and 2 to the TSB. These figures also show that in 2009, 80% of the TSB is ages 1 and 2. The distribution of ages looks similar to that of 2000, although there are proportionately more age 2 in 2009.

Historic trends for F, SSB and recruitment are presented in Figure 12.2.10.

12.5 Recruitment estimates

The RCT3 estimate of recruitment in 2010 was 1 725 million. The geometric mean of the last 5 years is 1 592 million. RCT input tables are presented in Table 12.5.1, and RCT3 output is presented in Table 12.5.2.

It was agreed to use the RCT3 estimates for recruitment in 2009, and the geometric mean (2005 to 2009) for recruitment in 2011 and 2012. These estimates may well under-estimate the recruitment potential; the recent survey indices in the model are treated as underestimates while the short span geometric mean was used as the stock was in a phase of low recruitment. However, given the potentially fragile state of the stock and that this is an update assessment; it was considered the better option to take the cautious update approach.

The following table summarises recruitment assumptions for the short term forecast together with XSA estimated recruitment from the previous two years – values used for recruitment are in **bold**.

year class	XSA (millions)	RCT3 (millions)	Geometric mean
2007	2757	-	-
2008	2102	1799	-
2009	-	**1725**	-
2010	-		**1592**
2011	-		**1592**

12.6 Short-term forecasts

A short-term forecast was carried out based on the final XSA assessment. XSA survivors in 2009 were used as input population numbers for ages 2 and older. Recruitment assumptions are detailed in section 12.5.

The exploitation pattern was chosen as the mean exploitation pattern over the years 2007–2009. Given the recent changes in F(2–6) this exploitation pattern was scaled to the mean F(2–6) in 2009 for forecasts (Figure 12.4.1).

Partial F at age for each catch component was estimated by splitting the forecast F at age using the mean proportion in the catch of each catch component over the years 2007 – 2009 (Figure 12.2.X).

Mean weights at age are generally consistent over the recent period but there are trends at some ages (Figure 12.2.3), particularly ages 4 and over in the discards. This is thought to reflect recent trends in discarding. The mean over the last three years was used for the purposes of forecasting.

The input to the forecast is shown in Table 12.6.1. Results are presented in Table 12.6.2.

No TAC constraint was applied in the intermediate year since it is not considered that fishing will stop when the TAC is reached.

Estimated landings in 2009 were 19 320 t; based on 2009 data the TAC for 2009 for area IV and VIId combined was 19 300 t. This is calculated as 87% of the TAC for Subarea IV and Division IIa (15 170 t) and 36% of the TAC for Divisions VIIb-k combined (14 410 t), based on the division of the 2009 TAC. Applying this to 2010, the TAC for IV and VIId in 2010 is 16 410 t. Assuming $F_{2010}=F_{2009}$ and unconstrained landings results in human consumption landings in 2010 of 21 790 t from a total catch of 37 750 t resulting in an SSB in 2011 of 172 700 t, a reduction from 179 920 t estimated for 2010. For the same fishing mortality in 2011, human consumption landings are predicted to be 23 560 t resulting in an SSB in 2012 of 162 020 t. Under the assumptions of the prediction, SSB in 2011 will increase by 9% (as compared to that estimated for 2009) in the absence of fishing in 2010.

To maintain a stable SSB landings should not exceed 11 100 t

The intermediate year forecast predicts that at status quo fishing mortality, human consumption landings will exceed the TAC for 2010 by 7 150 t.

12.7 MSY estimation and medium-term forecasts

No medium-term forecasts were carried out on this stock.

For the first time the basis for ICES advice will be to aim for maximum sustainable yield or MSY using the reference points Fmsy and Btrigger.

There were two methods presented unfortunately neither method was set up to deal with an industrial bycatch fleet. This will be remedied later in the year, however, in the mean time no Fmsy reference points are presented for this stock. However from preliminary analysis ignoring industrial bycatch Fmsy appears to be well defined in conjunction with the Ricker, Shepherd and Beverton and Holt recruitment models. The ranges of Fmsy for these preliminary runs were 0.33 using the Ricker model and 0.45 when using the Shepherd or Beverton and Holt models. In these fits the Shepherd model had reduced to the Beverton and Holt model. The model with the lowest AIC the Beverton and Holt, however the Ricker was a competing model.

12.8 Biological reference points

The precautionary fishing mortality and biomass reference points agreed by the EU and Norway, (unchanged since 1999), are as follows:

B_{lim} = 225,000 t; B_{pa} = 315,000 t; F_{lim} = 0.90; F_{pa} = 0.65.

The WG considers that these reference points are not applicable to the current assessment (see discussion in 12.9)

F0.1 and Fmax was estimated based on the F at age from the final XSA assessment in each year back to 1993. F0.1 has been stable historically at around 0.4 but due to the shape of the yield per recruit curve, a maximum is often not reached, thus Fmax is not defined for several years. The WG considers that yield per recruit F reference points are not applicable to this stock since Fmax is undefined in most years, and the estimate of F0.1 is very variable in recent years (see WGNSSK, 2009 section 12.8).

12.9 Quality of the assessment

Previous meetings of this WG and the benchmark workshop (WKROUND, 2009) have concluded that the survey data and commercial catch data contain different signals concerning the stock. Analyses by working group members and by the SGSIMUW in 2005 indicate that data since the early- to mid- 1990s are sufficiently consistent to undertake a catch-at-age analysis calibrated against survey data from 1990. This has been taken forward into prediction for catch option purposes. However, due to the lack of concordance in the data pre-dating the early 1990s, the working group considers that it is not possible categorically to classify the current state of the stock with reference to precautionary reference points as the biomass reference points are derived from a consideration of the stock dynamics at a time when the commercial catch-at-age data and the survey data conflict.

The low size of the age 4 + stock makes the forecast sensitive to recruitment assumptions. Recruitment in 2007 – 2008 appears to have been underestimated by the age 1 survey indices of the IBTS Q1 and Q2. It follows that the RCT3 estimate may well be an underestimate, and from the IBTS Q1 survey indices it looks as though recruitment will be revised upwards again next year. However, why the IBTS Q1 survey is catching as many age 3s as it did age 2s and 1s of the 2007 cohort is not understood and as such represents a weakness in the assessment.

Due to the likely population structuring in the North Sea and Eastern Channel, it is probable that the overall stock estimates may not reflect trends in more localised areas.

Given the spatial structure of the whiting stock and of the fleets exploiting it, it is important to have data that covers all fleets. Considering that age 1 and age 2 whiting make up a large proportion of the total stock biomass, good information of the discarding practices of the major fleets is important. Discard information was supplied by France for 2003 – 2007 but was not supplied for 2008 or 2009.

Survey information for VIId was not available in a form that could be used by the working group. Due to the recent changes in distribution of the stock, tuning information from this area would be extremely useful, and could improve the estimate of recruitment in the most recent year.

Age distributions and mean weights at age have been estimated for the industrial bycatch since 2006. This is due to low sampling levels of the Danish industrial bycatch fisheries. Although the fishery only comprises around 0.03% by weight of the total catch, the bycatch of whiting is mostly young fish. This means that no cohort information is coming from the industrial component of the catch and this potentially reduces our ability to estimate the recruitment of the recent year classes.

The historic performance of the assessment is summarised in Figure 12.9.1.

12.10 Status of the Stock

The working group considers the status of the stock unknown with respect to biological reference points and MSY reference points for the reasons given in section 12.9 and 12.7. Nevertheless all indications are that the stock, at the level of the entire North Sea and Eastern Channel, has been at a historical low level relative to the period since 1990 and the recent increase is in large part due to an improved perception of recruitment in 2008. Fishing mortality, previously estimated to be low relative to the period since 1990, increased to a moderate level since 2005.

The recent estimates of older whiting (ages 8 and above) is unprecedented in the assessment period. These fish have come from a period of moderate recruitment (1999 to 2002) implying that further moderate recruitments may be sufficient to allow an improvement in the stock.

12.11 Management Considerations

Mean F has decreased from historical levels, but has remained at a moderate level over the past four years. Despite lower catches and fishing mortality from 2002 to 2005, a series of low recruitments is determining the stock dynamics and has resulted in SSB declining to its lowest level. Recent recruitment has been improved and has resulted in an increase of the SSB, however this is mainly due to 2 and 3 year old fish.

Whiting mature at age 2 and grow quickly at young ages, therefore an increase in SSB is seen the year immediately after a good recruitment. Managers should consider the age structure of the population as well as the SSB since at low stock sizes short term forecasts are highly sensitive to recruitment assumptions.

Catches of whiting have been declining since 1980 (from 224 000 t in 1980 to 27 000 t in 2007, including discards and industrial bycatch). Distribution maps of survey IBTS indices show a change in distribution of the stock which is now located mainly in the central North Sea. Catch rates from localized fleets may not represent trends in the overall North Sea and English Channel population. The localized distribution of the population is known to be resulting in substantial differences in the quota uptake rate. This is likely to result in localized discarding problems that should be monitored carefully.

Whiting are caught in mixed demersal roundfish fisheries, fisheries targeting flatfish, the *Nephrops* fisheries, and the Norway pout fishery. The current minimum mesh-size in the targeted demersal roundfish fishery in the northern North Sea has resulted in reduced discards from that sector compared with the historical discard rates. Mortality has increased on younger ages due to increased discarding in the recent year as a result of recent changes in fleet dynamics of *Nephrops* fleets and small mesh fisheries in the southern North Sea. The bycatch of whiting in the Norway pout and sandeel fisheries is dependent on activity in that fishery, which has recently declined after strong reductions in the fisheries.

Catches of whiting in the North Sea are also likely to be affected by the effort reduction seen in the targeted demersal roundfish and flatfish fisheries, although this will in part be offset by increases in the number of vessels switching to small mesh fisheries.

Recent measures to improve survival of young cod, such as the Scottish Credit Conservation Scheme, and increased uptake of more selective gear in the North Sea and Skagerrak, should be encouraged for whiting.

ICES has developed a generic approach to evaluate whether new survey information that becomes available in September forms a basis to update the advice. ICES will publish new advice in October 2009 if this is the case.

12.12 Whiting in Division IIIa

The new data available for this stock are too sparse to revise the advice from last year and therefore no assessment of this stock was undertaken.

Total landings are shown in Table 12.12.1.

Plots of the IBTS Q1 and IBTS Q3 are shown in Figures 12.12.1 and 12.12.2.

Table 12.2.1 Whiting in Subarea IV and Division VIId. Nominal landings (in tonnes) as officially reported to ICES, and agreed TAC.

Subarea IV

Country	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Belgium	268	529	536	454	270	248	144	105	92	45	107	161
Denmark	46	58	105	105	96	89	62	57	251	78	42	
Faroe Islands	1	1	0	0	17	5	0	0	0	0	0	
France	1908	0	2527	3455	3314	2675	1721	1059	2445	2876	1788	
Germany	103	176	424	402	354	334	296	149	252	75	76	125
Netherlands	1941	1795	1884	2478	2425	1442	977	802	702	618	656	893
Norway	65	68	33	44	47	38	23	16	18	11	92	73
Sweden	0	9	4	6	7	10	2	1	2	1	2	4
UK (E.&W)	2909	2268	1782	1301	1322	680	1209	2653				
UK (Scotland)	16696	17206	17158	10589	7756	5734	5057	5361				
UK (Total)									11481	12101	10386	8852
Total	**23938**	**22110**	**24453**	**18834**	**15608**	**11256**	**9491**	**10202**	**15242**	**15805**	**13149**	**10109**
Unallocated landings	-78	3870	57	586	312	-596	-261	308	-95	381	250	3084
WG estimate of H.Cons. landings	23690	25700	24280	19260	14870	10450	8950	10680	15097	15666	13479	13193
WG estimate of discards	12715	23519	23221	16480	17524	26135	18142	10300	14018	5206	8496	5129
WG estimate of Ind. By-catch	3490	5040	9160	940	7270	2730	1210	890	2190	1240	1020	1350
WG estimate of total catch	**39895**	**54259**	**56661**	**36680**	**39664**	**39315**	**28302**	**21870**	**31305**	**22112**	**22995**	**19672**

Table 12.2.1 (Cont'd) Whiting in Subarea IV and Division VIId. Nominal landings (in tonnes) as officially reported to ICES, and agreed TAC.

Division VIId

Country	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Belgium	53	48	65	75	58	66	45	45	71	75	68	68
France	4495	-	5875	6338	5172	6478	-	3819	3019	2648	3510	
Netherlands	32	6	14	67	19	175	132	125	117	118	162	140
UK (E.&W)	185	135	118	134	112	109	80	86	71	59		
UK (Scotland)	+	-	-	-	-	-	-	-	-	-		
UK (Total)											87	137
Total	**4765**	**189**	**6072**	**6614**	**5361**	**6828**	**274**	**4074**	**3279**	**2899**	**3827**	**345**
Unallocated	-165	4241	-1772	-814	439	-1118	4076	716	164	355	644	5782
W.G Estimate of H.Cons. landings	4600	4430	4300	5800	5800	5710	4350	4790	3443	3254	4471	6127
WG estimate of discards	3215	3571	4129	3110	1356	605	908	2220	2292	1764	1944	2381
W.G. estimate Catch	**7815**	**8001**	**8429**	**8910**	**7156**	**6315**	**5258**	**7010**	**5735**	**5018**	**6415**	**8508**

Estimated Catch Subarea IV and Division VIId

	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
W.G. estimate	47710	62260	65090	45590	46820	45630	33560	28880	37040	27130	29410	28180

Annual TAC for Subarea IV and Division IIa

	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
TAC	60,000	44,000	30,000	29,700	41,000	16,000	16,000	28,500	23,800	23,800	17,850	15,173	12897

Annual TAC for Divisions VIIb-k combined

	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
TAC	27,000	25,000	22,000	21,000	31,700	31,700	27,000	21,600	19,940	19,940	19,940	16,949	14,407

Table 12.2.2 Whiting in IV and VIId. WG estimates of catch components by weight ('000s tonnes).

	Sub Area IV (North Sea)				VIId (Eastern Channel)			Total	VIId HC as a proportion of total HC
year	H.cons.	Disc.	Ind.BC	Tot.Catch	H.Cons	Disc.	Tot. Catch		
1990	42.18	54.49	51.34	148.01	3.48	3.33	6.81	154.82	7.6%
1991	46.21	33.63	39.76	119.60	5.72	4.22	9.94	129.54	11.0%
1992	45.21	30.56	25.04	100.81	5.74	4.09	9.83	110.64	11.3%
1993	46.61	42.98	20.72	110.31	5.21	2.97	8.18	118.49	10.1%
1994	41.87	33.06	17.47	92.40	6.62	3.85	10.47	102.87	13.7%
1995	40.55	30.31	27.38	98.24	5.39	3.24	8.63	106.87	11.7%
1996	35.55	28.15	5.12	68.82	4.95	3.37	8.32	77.14	12.2%
1997	30.94	17.20	6.21	54.35	4.62	3.00	7.62	61.97	13.0%
1998	23.69	12.72	3.49	39.90	4.60	3.21	7.81	47.71	16.3%
1999	25.70	23.52	5.04	54.26	4.43	3.57	8.00	62.26	14.7%
2000	24.28	23.22	9.16	56.66	4.30	4.13	8.43	65.09	15.0%
2001	19.26	16.48	0.94	36.68	5.80	3.11	8.91	45.59	23.1%
2002	14.87	17.52	7.27	39.66	5.80	1.36	7.16	46.82	28.1%
2003	10.45	26.14	2.73	39.32	5.71	0.60	6.31	45.63	35.3%
2004	8.95	18.14	1.21	28.30	4.35	0.91	5.26	33.56	32.7%
2005	10.68	10.30	0.89	21.87	4.79	2.22	7.01	28.88	31.0%
2006	15.10	14.02	2.19	31.31	3.44	2.29	5.73	37.04	18.6%
2007	15.67	5.21	1.24	22.11	3.25	1.76	5.02	27.13	17.2%
2008	13.48	8.50	1.02	23.00	4.47	1.94	6.41	29.41	24.9%
2009	13.19	5.13	1.35	19.67	6.13	2.38	8.51	28.18	31.7%
min.	8.95	5.13	0.89	19.67	3.25	0.60	5.02	27.13	7.6%
mean	26.22	22.56	11.48	60.26	4.94	2.78	7.72	67.98	19.0%
max.	46.61	54.49	51.34	148.01	6.62	4.22	10.47	154.82	35.3%

Table 12.2.3 Whiting in IV and VIId. Total catch numbers at age (thousands).

year	1	2	3	4	5	6	7	8+
1990	261582	511864	129982	84700	31157	1934	718	109
1991	143975	201864	189791	36424	25578	5340	526	268
1992	234225	173487	89846	91887	11661	6635	2546	112
1993	226530	176241	127778	46490	45414	3899	1501	754
1994	191819	162764	99571	51279	18708	17917	1258	514
1995	150531	147195	114812	35895	15096	5120	4473	470
1996	87822	121287	101159	48686	14120	4642	1281	1095
1997	61476	80759	85623	42254	18344	3335	1012	456
1998	91107	50325	44370	36601	17673	6347	1417	405
1999	196195	98064	46790	34120	18299	7444	2021	672
2000	85607	133019	65070	23961	16190	8752	4306	1263
2001	54185	83345	52748	20809	9203	4815	2231	1268
2002	52361	63869	84953	34369	8041	2043	1459	755
2003	83680	111144	55866	41840	14218	2358	473	397
2004	47967	23009	32557	30401	21755	8342	1351	307
2005	47805	34627	12204	18146	14931	8979	3041	654
2006	73908	42198	21652	8642	15076	11822	4618	1458
2007	39041	34000	24900	9905	4009	7656	5267	3117
2008	68641	30459	24261	14024	4417	1876	3955	2952
2009	23283	57768	15601	11887	5413	1421	615	2863

Table 12.2.4 Whiting in IV and VIId. Human consumption landings numbers at age (thousands).

year	1	2	3	4	5	6	7	8+
1990	6910	52533	43850	48537	16845	1341	605	107
1991	11565	42525	88974	25738	21261	4581	396	268
1992	9565	44697	47843	59208	9784	6099	1453	107
1993	5957	28935	63383	32819	33741	2932	1339	753
1994	17124	31351	45492	36289	13920	14407	914	439
1995	8829	28027	58046	27775	13652	4911	4359	463
1996	12517	26611	47125	35828	11861	4396	1103	1095
1997	6511	23436	47717	31503	15615	2931	1010	439
1998	17071	19828	24860	24473	14579	5395	1204	299
1999	16661	26669	25504	23465	14483	6554	1854	587
2000	15384	31808	28283	14241	11775	6618	3758	1157
2001	12260	28476	27293	17491	8633	4503	2091	1249
2002	2610	10346	30890	22353	6712	1710	1330	639
2003	403	11613	13990	18974	9513	1861	443	396
2004	3973	2812	9629	13302	11846	4409	747	274
2005	11009	10414	5669	10926	10283	5933	2343	429
2006	11055	11023	8494	5362	12259	10161	4118	1192
2007	10378	14740	16491	7666	3310	6681	4227	2638
2008	13234	12334	14120	9106	3564	1519	2505	2235
2009	2769	35182	9816	9491	4300	1244	544	2381

Table 12.2.5 Whiting in IV and VIId. Discard numbers at age (thousands). , representing North Sea and Eastern Channel discards.

year	1	2	3	4	5	6	7	8+
1990	86632	252415	35100	23562	11719	247	85	0
1991	89856	88996	79866	5311	1910	93	60	0
1992	109761	69838	29686	23921	1237	356	1065	2
1993	131353	109037	53233	9514	10840	522	131	0
1994	97165	106415	39763	10105	2910	2351	7	0
1995	56191	84955	52414	7382	1370	210	114	6
1996	44630	89255	51332	11889	2237	243	179	0
1997	26719	35236	33760	9677	2453	402	3	17
1998	49253	24164	18000	11381	3032	940	213	106
1999	103445	59013	16098	9215	3132	863	167	85
2000	51223	84523	25445	3123	2302	1554	476	107
2001	41444	52416	23727	2805	418	272	140	19
2002	11620	34778	45478	9845	1124	213	129	116
2003	65829	94497	39301	21654	4314	449	30	1
2004	31169	15698	21879	16951	9909	3922	605	33
2005	25753	23486	6041	7192	4616	2992	688	216
2006	51961	25906	10935	2474	2595	1598	493	265
2007	22508	16283	7153	1784	572	940	1037	478
2008	50361	15683	9112	4545	750	327	1447	716
2009	13828	19352	4422	1901	976	138	66	482

Table 12.2.6 Whiting in IV and VIId. Industrial bycatch numbers at age (thousands). Representing the industrial fishery in the North Sea.

year	1	2	3	4	5	6	7	8+
1990	168040	206916	51033	12601	2592	346	29	2
1991	42554	70343	20951	5376	2408	667	70	0
1992	114899	58952	12318	8758	639	180	29	3
1993	89219	38270	11162	4157	832	445	31	0
1994	77530	24998	14316	4885	1878	1160	337	75
1995	85510	34213	4351	738	73	0	0	0
1996	30675	5421	2702	970	21	2	0	0
1997	28247	22087	4146	1074	276	2	0	0
1998	24782	6334	1511	746	62	12	0	0
1999	76088	12381	5188	1440	684	27	0	0
2000	19000	16688	11341	6597	2113	580	73	0
2001	481	2453	1728	514	152	40	0	0
2002	38131	18745	8585	2170	205	120	0	0
2003	17448	5034	2575	1213	390	49	0	0
2004	12824	4499	1049	147	0	11	0	0
2005	11043	726	494	28	32	54	10	8
2006	10892	5270	2222	806	223	63	7	1
2007	6155	2978	1256	456	126	36	4	1
2008	5046	2441	1030	374	103	29	3	1
2009	6685	3234	1364	495	137	39	4	1

Table 12.2.7 Whiting in IV and VIId. Total catch mean weights at age (kg).

year	1	2	3	4	5	6	7	8+
1990	0.084	0.137	0.209	0.251	0.279	0.411	0.498	0.594
1991	0.103	0.168	0.216	0.289	0.306	0.339	0.365	0.401
1992	0.085	0.184	0.255	0.276	0.331	0.346	0.313	0.506
1993	0.073	0.174	0.249	0.316	0.328	0.346	0.400	0.379
1994	0.084	0.167	0.254	0.327	0.382	0.376	0.419	0.431
1995	0.089	0.180	0.256	0.340	0.384	0.429	0.434	0.419
1996	0.094	0.167	0.234	0.302	0.388	0.407	0.431	0.432
1997	0.096	0.178	0.241	0.295	0.333	0.384	0.387	0.422
1998	0.091	0.179	0.235	0.280	0.314	0.340	0.333	0.369
1999	0.079	0.174	0.231	0.256	0.289	0.305	0.311	0.291
2000	0.117	0.181	0.237	0.287	0.286	0.276	0.275	0.268
2001	0.101	0.192	0.244	0.282	0.268	0.298	0.284	0.292
2002	0.070	0.155	0.218	0.273	0.303	0.350	0.343	0.336
2003	0.057	0.118	0.193	0.259	0.299	0.354	0.385	0.368
2004	0.111	0.150	0.213	0.253	0.286	0.285	0.286	0.351
2005	0.124	0.199	0.239	0.250	0.282	0.305	0.298	0.287
2006	0.131	0.180	0.231	0.274	0.288	0.360	0.345	0.316
2007	0.098	0.206	0.257	0.325	0.345	0.309	0.309	0.319
2008	0.099	0.210	0.277	0.313	0.401	0.407	0.317	0.354
2009	0.090	0.221	0.287	0.380	0.401	0.464	0.392	0.328

Table 12.2.8 Whiting in IV and VIId. Human consumption landings mean weights at age (kg).

year	1	2	3	4	5	6	7	8+
1990	0.206	0.222	0.263	0.296	0.337	0.455	0.533	0.597
1991	0.202	0.249	0.252	0.308	0.317	0.349	0.387	0.401
1992	0.194	0.246	0.289	0.306	0.340	0.356	0.383	0.501
1993	0.194	0.248	0.284	0.345	0.358	0.385	0.418	0.379
1994	0.182	0.248	0.297	0.346	0.392	0.382	0.412	0.410
1995	0.171	0.256	0.299	0.367	0.397	0.437	0.437	0.421
1996	0.169	0.222	0.274	0.329	0.408	0.415	0.452	0.432
1997	0.171	0.206	0.260	0.315	0.349	0.401	0.386	0.424
1998	0.164	0.208	0.259	0.304	0.331	0.361	0.348	0.427
1999	0.184	0.237	0.271	0.281	0.303	0.316	0.320	0.301
2000	0.166	0.227	0.272	0.299	0.292	0.313	0.276	0.269
2001	0.160	0.216	0.268	0.285	0.267	0.301	0.288	0.293
2002	0.183	0.214	0.260	0.293	0.313	0.364	0.350	0.333
2003	0.208	0.228	0.258	0.308	0.311	0.374	0.391	0.369
2004	0.210	0.216	0.242	0.290	0.326	0.330	0.334	0.363
2005	0.205	0.253	0.277	0.270	0.308	0.339	0.313	0.313
2006	0.217	0.254	0.285	0.295	0.298	0.377	0.353	0.331
2007	0.199	0.264	0.280	0.351	0.361	0.319	0.332	0.338
2008	0.223	0.265	0.324	0.356	0.431	0.424	0.359	0.374
2009	0.204	0.246	0.318	0.386	0.404	0.464	0.404	0.329

Table 12.2.9 Whiting in IV and VIId. Discard mean weights at age (kg), representing North Sea and Eastern Channel discards.

year	1	2	3	4	5	6	7	8+
1990	0.095	0.130	0.183	0.186	0.196	0.249	0.302	0.000
1991	0.089	0.154	0.177	0.213	0.230	0.253	0.268	0.000
1992	0.093	0.173	0.210	0.215	0.241	0.245	0.220	1.183
1993	0.087	0.160	0.205	0.237	0.235	0.225	0.213	0.000
1994	0.090	0.151	0.203	0.230	0.244	0.254	0.332	0.000
1995	0.102	0.163	0.204	0.233	0.247	0.247	0.332	0.290
1996	0.094	0.151	0.198	0.225	0.281	0.265	0.304	0.000
1997	0.125	0.181	0.213	0.225	0.233	0.256	0.617	0.352
1998	0.086	0.173	0.204	0.228	0.234	0.224	0.247	0.206
1999	0.100	0.166	0.197	0.201	0.225	0.231	0.212	0.227
2000	0.127	0.167	0.195	0.226	0.209	0.219	0.222	0.264
2001	0.084	0.183	0.217	0.259	0.248	0.240	0.225	0.243
2002	0.130	0.167	0.196	0.224	0.224	0.225	0.272	0.352
2003	0.062	0.105	0.170	0.214	0.262	0.257	0.293	0.055
2004	0.131	0.158	0.203	0.223	0.239	0.235	0.227	0.245
2005	0.124	0.177	0.207	0.221	0.223	0.235	0.245	0.224
2006	0.131	0.161	0.193	0.229	0.233	0.247	0.273	0.246
2007	0.065	0.170	0.214	0.225	0.247	0.237	0.215	0.217
2008	0.072	0.181	0.213	0.230	0.265	0.328	0.244	0.293
2009	0.089	0.193	0.243	0.376	0.393	0.484	0.286	0.319

Table 12.2.10 Whiting in IV and VIId. Industrial bycatch mean weights at age (kg).

year	1	2	3	4	5	6	7	8+
1990	0.073	0.123	0.181	0.201	0.280	0.355	0.335	0.472
1991	0.105	0.136	0.215	0.272	0.265	0.279	0.322	0.000
1992	0.068	0.151	0.235	0.244	0.364	0.219	0.256	0.282
1993	0.045	0.156	0.260	0.264	0.307	0.235	0.392	0.000
1994	0.055	0.131	0.259	0.388	0.521	0.555	0.440	0.555
1995	0.072	0.160	0.312	0.373	0.511	0.000	0.000	0.000
1996	0.064	0.151	0.239	0.233	0.347	0.250	0.000	0.000
1997	0.051	0.145	0.252	0.321	0.348	0.588	0.000	0.000
1998	0.049	0.115	0.220	0.304	0.286	0.000	0.000	0.000
1999	0.027	0.077	0.144	0.194	0.286	0.000	0.000	0.000
2000	0.051	0.166	0.242	0.289	0.339	0.000	0.588	0.000
2001	0.055	0.118	0.225	0.320	0.351	0.386	0.000	0.000
2002	0.044	0.101	0.185	0.294	0.415	0.380	0.000	0.000
2003	0.035	0.102	0.189	0.302	0.418	0.462	0.000	0.000
2004	0.032	0.083	0.143	0.264	0.362	0.380	0.000	0.000
2005	0.043	0.133	0.196	0.205	0.366	0.438	0.541	0.530
2006	0.046	0.119	0.208	0.277	0.362	0.401	0.564	0.530
2007	0.046	0.119	0.208	0.277	0.362	0.401	0.564	0.530
2008	0.046	0.119	0.208	0.277	0.362	0.401	0.564	0.530
2009	0.046	0.119	0.208	0.277	0.362	0.401	0.564	0.530

Table 12.2.11 Whiting in IV and VIId. Natural mortality at age. These data come from the key run of the multispecies working group (WGSAM, 2008), data is available up to 2007. Natural mortality for 2008 and 2009 is assumed equal to that in 2007.

year	1	2	3	4	5	6	7	8+
1990	1.312	0.495	0.381	0.373	0.362	0.345	0.334	0.306
1991	1.321	0.485	0.374	0.367	0.358	0.341	0.332	0.308
1992	1.332	0.479	0.368	0.361	0.354	0.339	0.330	0.310
1993	1.347	0.475	0.363	0.357	0.352	0.336	0.329	0.312
1994	1.364	0.473	0.359	0.353	0.350	0.335	0.328	0.314
1995	1.383	0.472	0.356	0.350	0.348	0.333	0.328	0.315
1996	1.405	0.471	0.354	0.347	0.347	0.332	0.328	0.316
1997	1.429	0.470	0.351	0.344	0.345	0.331	0.328	0.317
1998	1.455	0.470	0.349	0.341	0.343	0.330	0.328	0.317
1999	1.483	0.471	0.346	0.337	0.342	0.330	0.328	0.317
2000	1.514	0.474	0.344	0.334	0.340	0.331	0.329	0.317
2001	1.548	0.480	0.344	0.331	0.340	0.333	0.332	0.318
2002	1.584	0.490	0.344	0.329	0.341	0.336	0.336	0.321
2003	1.619	0.502	0.345	0.329	0.342	0.340	0.340	0.324
2004	1.651	0.516	0.348	0.329	0.344	0.345	0.345	0.327
2005	1.679	0.531	0.350	0.329	0.347	0.350	0.350	0.331
2006	1.705	0.546	0.353	0.329	0.350	0.355	0.356	0.335
2007	1.731	0.562	0.356	0.330	0.353	0.360	0.361	0.339
2008	1.731	0.562	0.356	0.330	0.353	0.360	0.361	0.339
2009	1.731	0.562	0.356	0.330	0.353	0.360	0.361	0.339

Table 12.2.12 Whiting in IV and VIId. Tuning series used in the assessment and forecast. Data used in the assessment is in bold.

International bottom trawl survey (IBTS) quarter 1

year	effort	1	2	3	4	5	6+
1990	100	**519**	**862**	**198**	**92**	**17**	4
1991	100	**1008**	**686**	**480**	**71**	**38**	8
1992	100	**907**	**666**	**240**	**151**	**13**	14
1993	100	**1076**	**523**	**245**	**65**	**59**	11
1994	100	**722**	**627**	**181**	**68**	**12**	9
1995	100	**679**	**448**	**239**	**58**	**12**	6
1996	100	**502**	**486**	**245**	**70**	**23**	10
1997	100	**288**	**342**	**163**	**60**	**18**	9
1998	100	**543**	**161**	**125**	**54**	**15**	9
1999	100	**676**	**305**	**95**	**57**	**26**	11
2000	100	**757**	**538**	**182**	**53**	**20**	15
2001	100	**649**	**598**	**299**	**98**	**26**	26
2002	100	**671**	**417**	**275**	**67**	**22**	10
2003	100	**132**	**299**	**237**	**133**	**48**	13
2004	100	**185**	**90**	**173**	**100**	**49**	22
2005	100	**168**	**56**	**31**	**56**	**38**	29
2006	100	**223**	**92**	**33**	**17**	**28**	27
2007	100	**42**	**166**	**71**	**19**	**9**	25
2008	100	**268**	**206**	**66**	**22**	**8**	15
2009	100	**210**	**294**	**93**	**27**	**12**	13
2010	100	326	228	243	95	29	28

International bottom trawl survey (IBTS) quarter 3

year	effort	0	1	2	3	4	5	6+
1991	100	537	**703**	**159**	**79**	**15**	**5**	1
1992	100	1379	**601**	**296**	**72**	**57**	**10**	6
1993	100	919	**639**	**177**	**66**	**15**	**16**	3
1994	100	611	**678**	**220**	**75**	**20**	**5**	3
1995	100	729	**620**	**291**	**107**	**22**	**6**	3
1996	100	317	**546**	**278**	**129**	**34**	**7**	4
1997	100	2063	**333**	**181**	**109**	**28**	**11**	4
1998	100	2632	**331**	**150**	**53**	**31**	**11**	5
1999	100	2499	**1204**	**191**	**54**	**24**	**10**	4
2000	100	1968	**942**	**327**	**64**	**14**	**7**	5
2001	100	3031	**645**	**282**	**95**	**19**	**4**	8
2002	100	264	**732**	**237**	**125**	**34**	**5**	3
2003	100	363	**246**	**302**	**135**	**66**	**16**	5
2004	100	711	**162**	**48**	**64**	**45**	**31**	12
2005	100	163	**180**	**71**	**28**	**45**	**29**	34
2006	100	203	**173**	**85**	**32**	**13**	**23**	25
2007	100	822	**96**	**64**	**38**	**12**	**8**	21
2008	100	758	**357**	**66**	**31**	**14**	**4**	15
2009	100	590	**581**	**382**	**41**	**12**	**8**	7

Table 12.3.1 Whiting in IV and VIId. XSA tuning diagnostics.

FLR XSA Diagnostics 2010-05-18 17:46:33

CPUE data from index.xsa

Catch data for 20 years. 1990 to 2009. Ages 1 to 8.

	fleet	first age	last age	first year	last year	alpha	beta
1	IBTS_Q1	1	5	1990	2009	0	0.25
2	IBTS_Q3	1	5	1991	2009	0.5	0.75

Time series weights :

Tapered time weighting not applied

Catchability analysis :

Catchability independent of size for all ages

Catchability independent of age for ages > 4

Terminal population estimation :

Survivor estimates shrunk towards the mean F
of the final 3 years or the 4 oldest ages.

S.E. of the mean to which the estimates are shrunk = 2

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

prior weighting not applied

Regression weights

age \ year	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
all	1	1	1	1	1	1	1	1	1	1

Fishing mortalities

age \ year	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
1	0.056	0.046	0.049	0.245	0.123	0.092	0.150	0.086	0.061	0.027
2	0.342	0.166	0.165	0.364	0.251	0.329	0.301	0.263	0.248	0.182
3	0.560	0.279	0.326	0.271	0.219	0.266	0.476	0.394	0.414	0.259
4	0.596	0.410	0.348	0.308	0.271	0.212	0.361	0.498	0.483	0.438
5	0.797	0.577	0.320	0.275	0.305	0.241	0.323	0.334	0.519	0.411
6	0.942	0.708	0.279	0.169	0.304	0.234	0.366	0.323	0.308	0.375
7	1.530	0.811	0.572	0.110	0.161	0.202	0.214	0.331	0.332	0.186
8	1.530	0.811	0.572	0.110	0.161	0.202	0.214	0.331	0.332	0.186

XSA population number (Thousand)

year \ age	1	2	3	4	5	6	7	8
2000	3330579	581885	180394	63039	34948	16922	6481	1819
2001	2645388	692866	257259	73028	24869	11210	4740	2622
2002	2397016	537771	363096	138006	34807	9939	3961	2008
2003	864583	468260	279567	185852	70118	17980	5377	4474
2004	949473	134065	197011	150907	98293	37821	10809	2431
2005	1254392	161184	62252	111809	82856	51347	19776	4204
2006	1245186	213346	68230	33617	65083	46013	28659	8942
2007	1128174	194800	91438	29784	16854	33212	22368	13034
2008	2757337	183398	85408	43198	13013	8481	16771	12325
2009	2102888	459585	81619	39530	19166	5441	4349	20036

Estimated population abundance at 1st Jan 2010

year \ age	1	2	3	4	5	6	7	8
2010	0	362668	218361	44095	18337	8929	2608	14372

Table 12.3.1 Whiting in IV and VIId. XSA tuning diagnostics (cont.).

Fleet: IBTS_Q1

Log catchability residuals.

age \ year	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
1	-0.148	0.540	0.491	0.555	0.228	0.298	0.361	0.068	0.341	0.151
2	-0.301	0.338	0.254	0.155	0.212	-0.050	0.163	0.176	-0.310	0.011
3	-0.049	0.044	0.181	0.070	-0.031	0.029	0.109	-0.194	-0.123	-0.173
4	-0.118	0.317	-0.042	0.010	0.084	0.052	-0.038	-0.184	-0.233	0.022
5	-0.644	0.289	-0.307	-0.014	-0.559	-0.409	0.150	-0.350	-0.624	-0.097

age \ year	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
1	0.143	0.222	0.359	-0.223	0.011	-0.364	-0.062	-1.632	-0.681	-0.658
2	0.232	0.144	0.036	-0.132	-0.097	-0.742	-0.522	0.153	0.424	-0.143
3	0.271	0.377	-0.045	0.061	0.090	-0.456	-0.488	-0.010	-0.019	0.357
4	0.291	0.738	-0.296	0.096	0.012	-0.269	-0.275	-0.011	-0.221	0.064
5	-0.070	0.495	-0.023	0.054	-0.268	-0.362	-0.403	-0.195	-0.092	-0.036

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

	1	2	3	4	5
Mean_Logq	-12.9482	-11.7235	-11.6626	-11.8619	-11.8619
S.E_Logq	0.5243	0.2942	0.2227	0.2452	0.2975

Fleet: IBTS_Q3

Log catchability residuals.

age \ year	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1	-0.019	-0.077	-0.126	0.007	0.052	0.290	0.067	-0.287	0.633	0.237
2	-0.503	0.013	-0.321	-0.282	0.068	0.144	0.068	0.122	0.097	0.286
3	-0.920	-0.156	-0.293	0.004	0.113	0.333	0.247	-0.231	0.089	0.087
4	-0.280	-0.103	-0.496	-0.108	-0.002	0.194	-0.061	0.074	0.071	-0.171
5	-0.562	0.441	-0.312	-0.358	-0.014	-0.083	0.110	-0.042	-0.166	-0.188

age \ year	2001	2002	2003	2004	2005	2006	2007	2008	2009
1	0.103	0.353	0.425	-0.146	-0.320	-0.299	-0.816	-0.408	0.330
2	-0.141	-0.056	0.455	-0.200	0.063	-0.037	-0.245	-0.161	0.633
3	-0.051	-0.089	0.213	-0.206	0.129	0.317	0.146	0.023	0.247
4	-0.088	-0.198	0.145	-0.049	0.218	0.281	0.355	0.130	0.086
5	-0.398	-0.693	-0.283	0.034	0.106	0.158	0.521	0.160	0.383

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

	1	2	3	4	5
Mean_Logq	-12.0382	-11.8667	-12.0713	-12.2952	-12.2952
S.E_Logq	0.3433	0.2722	0.2894	0.2075	0.3288

Table 12.3.1 Whiting in IV and VIId. XSA tuning diagnostics (cont.).

```
 Terminal year survivor and F summaries:

 Age 1 Year class =2008

source
        scaledWts survivors yrcls
IBTS_Q1     0.294    187821  2008
IBTS_Q3     0.684    504482  2008
fshk        0.022     82484  2008

 Age 2 Year class =2007

source
        scaledWts survivors yrcls
IBTS_Q1     0.491    189196  2007
IBTS_Q3     0.496    411117  2007
fshk        0.013    137125  2007

 Age 3 Year class =2006

source
        scaledWts survivors yrcls
IBTS_Q1     0.493     63029  2006
IBTS_Q3     0.493     56422  2006
fshk        0.014     24033  2006

 Age 4 Year class =2005

source
        scaledWts survivors yrcls
IBTS_Q1     0.491     19548  2005
IBTS_Q3     0.491     19990  2005
fshk        0.017     17579  2005

 Age 5 Year class =2004

source
        scaledWts survivors yrcls
IBTS_Q1     0.473      8614  2004
IBTS_Q3     0.505     13096  2004
fshk        0.022      9302  2004

 Age 6 Year class =2003

source
     scaledWts survivors yrcls
fshk         1      2965  2003

 Age 7 Year class =2002

source
     scaledWts survivors yrcls
fshk         1      1124  2002
```

Table 12.3.2 Whiting in IV and VIId. Final XSA fishing mortality.

year	1	2	3	4	5	6	7	8+	Fbar(2-6)
1990	0.182	0.516	0.825	0.910	1.143	0.876	0.957	0.957	0.854
1991	0.100	0.476	0.488	0.738	1.039	0.735	0.763	0.763	0.695
1992	0.178	0.373	0.537	0.579	0.696	1.111	1.286	1.286	0.659
1993	0.154	0.448	0.709	0.751	0.808	0.644	1.031	1.031	0.672
1994	0.141	0.353	0.663	0.897	1.026	1.174	0.523	0.523	0.823
1995	0.126	0.342	0.601	0.661	0.934	1.169	1.501	1.501	0.741
1996	0.106	0.319	0.551	0.687	0.738	1.101	1.479	1.479	0.679
1997	0.097	0.304	0.512	0.572	0.747	0.450	0.939	0.939	0.517
1998	0.101	0.243	0.349	0.518	0.608	0.774	0.408	0.408	0.498
1999	0.149	0.357	0.485	0.601	0.648	0.680	0.729	0.729	0.554
2000	0.056	0.342	0.560	0.596	0.797	0.942	1.530	1.530	0.647
2001	0.045	0.166	0.279	0.410	0.577	0.708	0.811	0.811	0.428
2002	0.049	0.165	0.326	0.348	0.320	0.279	0.572	0.572	0.288
2003	0.245	0.364	0.271	0.308	0.275	0.169	0.110	0.110	0.277
2004	0.123	0.251	0.219	0.271	0.305	0.304	0.161	0.161	0.270
2005	0.092	0.329	0.266	0.212	0.241	0.234	0.202	0.202	0.256
2006	0.150	0.301	0.476	0.361	0.323	0.367	0.214	0.214	0.366
2007	0.086	0.263	0.394	0.498	0.334	0.323	0.332	0.332	0.362
2008	0.061	0.248	0.415	0.483	0.519	0.308	0.332	0.332	0.395
2009	0.027	0.182	0.259	0.438	0.411	0.375	0.186	0.186	0.333

Table 12.3.3 Whiting in IV and VIId. Final XSA stock numbers.

year	1	2	3	4	5	6	7	8+	total
1990	3027987	1627756	279884	170849	54832	3940	1378	203	5166829
1991	2928959	679484	592399	83809	47350	12174	1163	577	4345915
1992	2800544	707340	259875	250277	27764	11716	4151	176	4061843
1993	3109975	618701	301696	105179	97729	9711	2750	1337	4247078
1994	2893868	693422	245804	103309	34737	30656	3642	1461	4006899
1995	2539825	642919	303641	88415	29599	8776	6780	682	3620637
1996	1764473	561404	284839	116529	32168	8209	1955	1600	2771177
1997	1358029	389366	254707	115184	41414	10867	1958	856	2172381
1998	1957304	295256	179472	107412	46067	13888	4979	1403	2605781
1999	2974671	412873	144772	89350	45524	17792	4602	1493	3691077
2000	3329187	581674	180360	63036	34947	16922	6481	1819	4214426
2001	2644618	692640	257213	73027	24869	11210	4741	2622	3710940
2002	2396698	537670	363032	137996	34811	9940	3961	2008	3486116
2003	864501	468208	279533	185833	70116	17983	5377	4475	1896026
2004	949430	134049	196979	150883	98279	37820	10811	2431	1580682
2005	1254349	161175	62242	111787	82838	51338	19775	4204	1747708
2006	1245278	213338	68225	33611	65067	46001	28652	8940	1709112
2007	1128337	194817	91434	29781	16849	33201	22359	13029	1529807
2008	2757095	183427	85417	43195	13010	8478	16763	12319	3119704
2009	2102169	459464	81596	39516	19160	5439	4347	20025	2731716
2010	0	362554	218383	44088	18328	8925	2607	14362	669247

Note that stock numbers in 2010 are estimates of survivors from 2009.

Table 12.3.4 Whiting in IV and VIId. Final XSA summary table.

	recruitment (age 1)	tsb	ssb	catch	landings	discards	industrial bycatch	Y/ssb	fbar(2-6)
1990	3028	596457	352244	154780	48993	54447	51340	0.14	0.85
1991	2929	587287	309657	129490	56154	33576	39760	0.18	0.70
1992	2801	518173	295900	110580	55041	30499	25040	0.19	0.66
1993	3110	480063	269395	118450	54794	42936	20720	0.20	0.67
1994	2894	482055	256445	102820	52340	33010	17470	0.20	0.82
1995	2540	467922	257485	106840	49182	30278	27380	0.19	0.74
1996	1764	378815	223699	77100	43869	28111	5120	0.20	0.68
1997	1358	314124	192550	61930	38558	17162	6210	0.20	0.52
1998	1957	324579	161829	47680	31505	12685	3490	0.19	0.50
1999	2975	383604	168707	62220	33701	23479	5040	0.20	0.55
2000	3329	572570	217479	65040	32709	23171	9160	0.15	0.65
2001	2645	495564	247201	45560	28170	16450	940	0.11	0.43
2002	2397	383982	228000	46800	22026	17504	7270	0.10	0.29
2003	865	237653	189377	45630	16765	26135	2730	0.09	0.28
2004	949	248456	153053	33560	14208	18142	1210	0.09	0.27
2005	1254	276554	135558	28880	17690	10300	890	0.13	0.26
2006	1245	274511	126252	37040	20832	14018	2190	0.17	0.37
2007	1128	211024	109400	27130	20684	5206	1240	0.19	0.36
2008	2757	366995	120986	29440	19894	8526	1020	0.16	0.39
2009	2102	347650	171143	28160	21701	5109	1350	0.13	0.33
min	865	211024	109400	27130	14208	5206	890	0.09	0.26
mean	2207	400020	211327	70051	34585	23455	12012	0.16	0.53
max	3329	596457	352244	154780	56154	54447	51340	0.20	0.85
units	millions	tonnes	tonnes	tonnes	tonnes	tonnes	tonnes		

Table 12.5.1 Whiting in IV and VIId. RCT3 input table

Whi4&7d (age 1)

4	21	2			
1991	3028	**518.94**	**686.45**	**-11.00**	**-11.00**
1992	2929	**1007.62**	**665.71**	**-11.00**	**703.37**
1993	2801	**907.30**	**522.81**	**536.99**	**600.87**
1994	3110	**1075.62**	**627.41**	**1379.46**	**638.72**
1995	2894	**721.71**	**448.48**	**919.19**	**677.65**
1996	2540	**678.59**	**485.97**	**610.74**	**619.79**
1997	1764	**502.36**	**342.21**	**729.25**	**545.71**
1998	1358	**287.73**	**160.70**	**316.50**	**332.97**
1999	1957	**543.12**	**305.45**	**2062.67**	**330.60**
2000	2975	**676.27**	**537.86**	**2631.69**	**1203.50**
2001	3329	**756.87**	**598.39**	**2498.55**	**941.66**
2002	2645	**648.65**	**416.82**	**1968.07**	**645.00**
2003	2397	**670.59**	**298.87**	**3031.44**	**732.14**
2004	865	**131.60**	**89.73**	**264.06**	**246.16**
2005	949	**184.61**	**55.97**	**363.41**	**161.56**
2006	1254	**167.63**	**92.38**	**711.28**	**179.50**
2007	1245	**223.01**	**166.13**	**162.59**	**172.79**
2008	1128	**42.19**	**205.56**	**202.83**	**95.65**
2009	2757	**267.75**	**294.36**	**821.74**	**356.90**
2010	2102	**209.79**	**227.87**	**757.81**	**581.36**
2011	-11	**326.13**	**-11.00**	**589.77**	**-11.00**

ibtsq1age1
ibtsq1age2
ibtsq3age0
ibtsq3age1

Table 12.5.2 Whiting in IV and VIId. RCT3 output table.

Analysis by RCT3 ver3.1 of data from file :

whiin.dat

Whi4&7d (age 1)

Data for 4 surveys over 21 years : 1990 - 2010

Regression type = C
Tapered time weighting not applied
Survey weighting not applied
Final estimates not shrunk towards mean
Estimates with S.E.'S greater than that of mean
+ included
Minimum S.E. for any survey taken as .00
Minimum of 3 points used for regression

Forecast/Hindcast variance correction used.

Yearclass = 2008

Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
	I-----------Regression----------I					I-----------Prediction---------I			
ibtsq1	.64	3.76	.30	.703	19	5.35	7.19	.331	.179
ibtsq1	.65	3.91	.18	.865	19	5.43	7.44	.199	.497
ibtsq3	.65	3.24	.41	.565	17	6.63	7.55	.451	.096
ibtsq3	.75	3.08	.27	.752	18	6.37	7.84	.293	.228
					VPA Mean =		7.61	.450	.000

Yearclass = 2009

Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
	I-----------Regression----------I					I-----------Prediction---------I			
ibtsq1	.64	3.77	.31	.675	20	5.79	7.49	.338	.627
ibtsq1									
ibtsq3	.65	3.23	.40	.563	18	6.38	7.39	.438	.373
ibtsq3									
					VPA Mean =		7.62	.438	.000

Year Class	Weighted Average Prediction	Log WAP	Int Std Error	Ext Std Error	Var Ratio	VPA	Log VPA
2008	1799	7.50	.14	.12	.78	2103	7.65
2009	1725	7.45	.27	.05	.03		

Table 12.6.1 Whiting in IV and VIId. Short term forecast table.

2010

Biomass	SSB	Catch Fmult	Catch Fbar	Catch Yeild	Landings Fbar	Landings Yeild	Discards Fbar	Discards Yeild	Industrial Fbar	Industrial Yeild	biomass 2011	ssb 2011
332956	**179924**	1	0.33	37753	0.24	21790	0.08	13592	0.01	2371	313150	172699

2011

	Biomass	SSB	Catch Fmult	Catch Fbar	Catch Yeild	Landings Fbar	Landings Yeild	Discards Fbar	Discards Yeild	Industrial Fbar	Industrial Yeild	biomass 2012	ssb 2012	% TAC change
	313150	172699	0	0.01	2500	0	0	0	0	0.01	2500	336234	195954	-100
	313150	172699	0.1	0.05	6592	0.02	2685	0.01	1435	0.01	2472	332344	192085	-84
	313150	172699	0.2	0.08	10571	0.05	5290	0.02	2837	0.01	2444	328570	188333	-69
	313150	172699	0.3	0.11	14441	0.07	7817	0.02	4207	0.01	2417	324907	184691	-55
	313150	172699	0.4	0.14	18207	0.1	10270	0.03	5546	0.01	2390	321353	181157	-40
Stable Biomass	313150	172699	0.44	0.15	19523	0.11	**11127**	0.03	6015	0.01	2381	320111	**179924**	-35
	313150	172699	0.5	0.17	21870	0.12	12651	0.04	6854	0.01	2365	317902	177728	-26
15 % TAC reduction	313150	172699	0.58	0.2	24905	0.14	**14620**	0.05	7942	0.01	2343	315048	174892	-15
	313150	172699	0.6	0.21	25434	0.15	14963	0.05	8132	0.01	2339	314552	174399	-13
No TAC change	313150	172699	0.7	0.24	28903	0.17	**17206**	0.06	9382	0.01	2314	311299	171167	0
	313150	172699	0.8	0.27	32279	0.19	19385	0.06	10605	0.01	2290	308141	168029	13
	313150	172699	0.9	0.3	35566	0.22	21501	0.07	11800	0.01	2266	305074	164983	25
Status Quo	313150	172699	1	0.33	38766	0.24	**23555**	0.08	12969	0.01	2242	302095	162024	37
	313150	172699	1.1	0.37	41883	0.27	25551	0.09	14113	0.01	2219	299201	159151	49
	313150	172699	1.2	0.4	44918	0.29	27490	0.1	15232	0.01	2196	296389	156360	60
	313150	172699	1.3	0.43	47875	0.31	29373	0.1	16327	0.01	2174	293657	153648	71
	313150	172699	1.4	0.46	50755	0.34	31203	0.11	17399	0.01	2152	291003	151014	81
	313150	172699	1.45	0.48	52272	0.35	32165	0.12	17966	0.01	2141	289608	149630	87
	313150	172699	1.5	0.49	53562	0.36	32982	0.12	18449	0.01	2131	288423	148454	92
	313150	172699	1.6	0.53	56297	0.39	34711	0.13	19477	0.01	2110	285915	145966	102
	313150	172699	1.7	0.56	58964	0.41	36391	0.14	20483	0.01	2090	283477	143548	112
	313150	172699	1.8	0.59	61563	0.44	38025	0.14	21469	0.01	2069	281107	141198	121

Table 12.12.1 Nominal landings (t) of Whiting from Division IIIa as supplied by the Study Group on Division IIIa Demersal Stocks (ICES 1992b) and updated by the Working Group.

Year	Denmark (1)			Norway	Sweden	Others	Total
1975	19,018			57	611	4	19,690
1976	17,870			48	1,002	48	18,968
1977	18,116			46	975	41	19,178
1978	48,102			58	899	32	49,091
1979	16,971			63	1,033	16	18,083
1980	21,070			65	1,516	3	22,654
	Total consumption	Total industrial	Total				
1981	1,027	23,915	24,942	70	1,054	7	26,073
1982	1,183	39,758	40,941	40	670	13	41,664
1983	1,311	23,505	24,816	48	1,061	8	25,933
1984	1,036	12,102	13,138	51	1,168	60	14,417
1985	557	11,967	12,524	45	654	2	13,225
1986	484	11,979	12,463	64	477	1	13,005
1987	443	15,880	16,323	29	262	43	16,657
1988	391	10,872	11,263	42	435	24	11,764
1989	917	11,662	12,579	29	675	-	13,283
1990	1,016	17,829	18,845	49	456	73	19,423
1991	871	12,463	13,334	56	527	97	14,041
1992	555	3,340	3,895	66	959	1	4,921
1993	261	1,987	2,248	42	756	1	3,047
1994	174	1,900	2,074	21	440	1	2,536
1995	85	2,549	2,634	24	431	1	3,090
1996	55	1,235	1,290	21	182	-	1,493
1997	38	264	302	18	94	-	414
1998	35	354	389	16	81	-	486
1999	37	695	732	15	111	-	858
2000	59	777	836	17	138	1	992
2001	61	970[1]	1,031[1]	27	126	+	1,184[1]
2002	101	975[1]	1,076[1]	23	127	1	1,227[1]
2003	93	654[1]	747[1]	20	71	2	840[1]
2004	93	1,120[1]	1,213[1]	17	74	1	1,305[1]
2005	49	907[1]	956[1]	13	73	0	1,042[1]
2006	59[1]	290[1]	349[1]	n/a	n/a	n/a	349[1]
2007			54	14	82	1	151
2008			53	14	52	n/a	119
2009		32	224[2]	*	19	-	243

[1] Values from 1992 updated by WGNSSK (2007)

[2] Includes 192 tonnes of discards

* data not available at time of WG

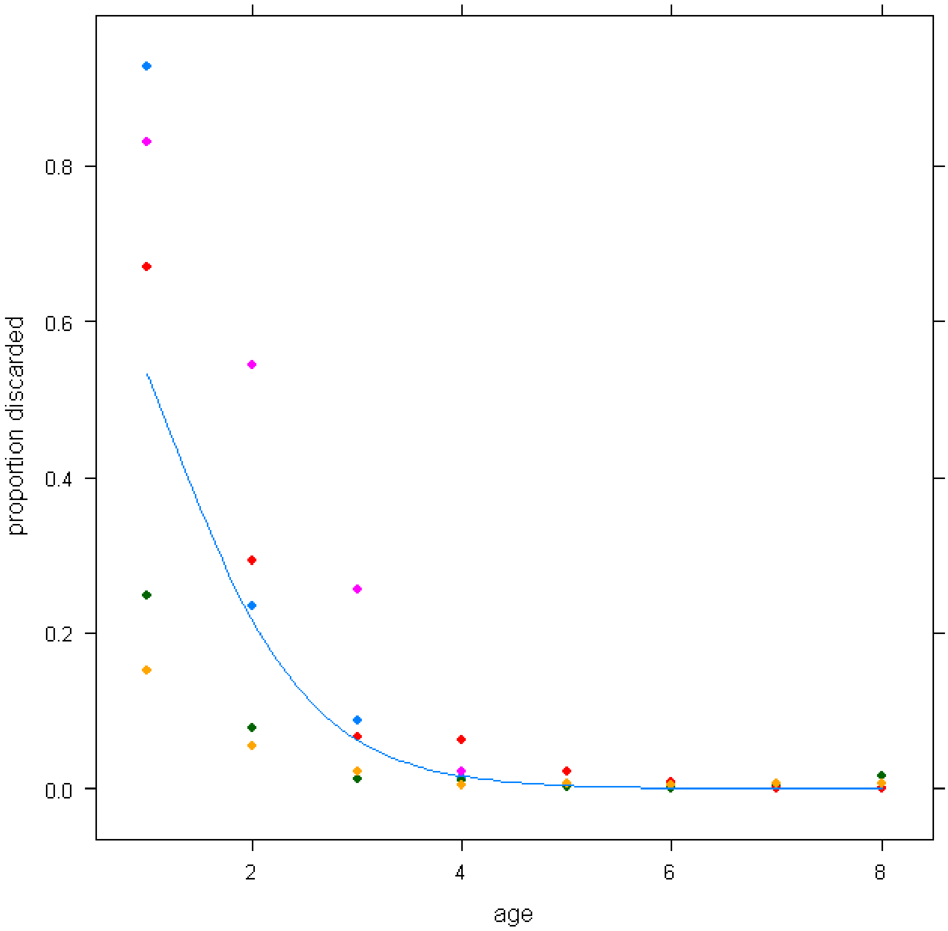


Figure 12.2.1 Whiting in IV and VIId. GLMM fit to VIId discard data. The dots represent the proportion of the total catch discarded at age coloured by year. The blue line is the fixed effect population mean and is the ogive applied to all unsampled years.

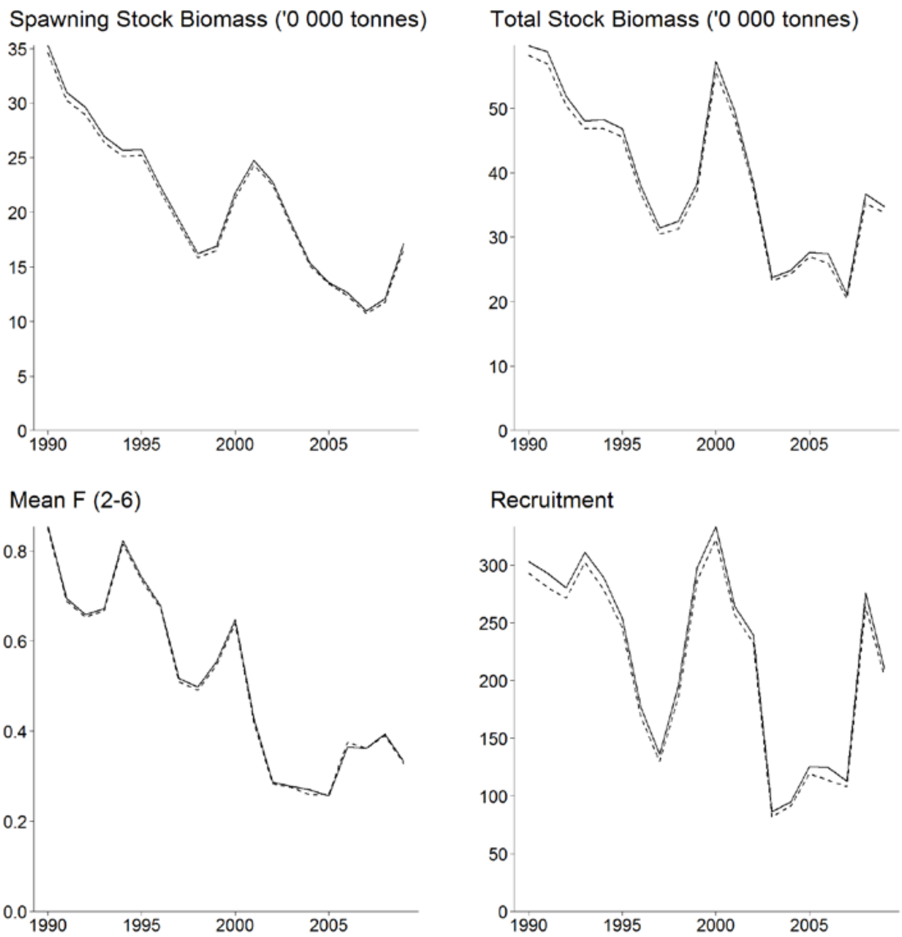


Figure 12.2.2 Whiting in IV and VIId. A stock summary plot from an XSA assessment using last years settings comparing the change in perception of the stock by introducing VIId discard estimates.

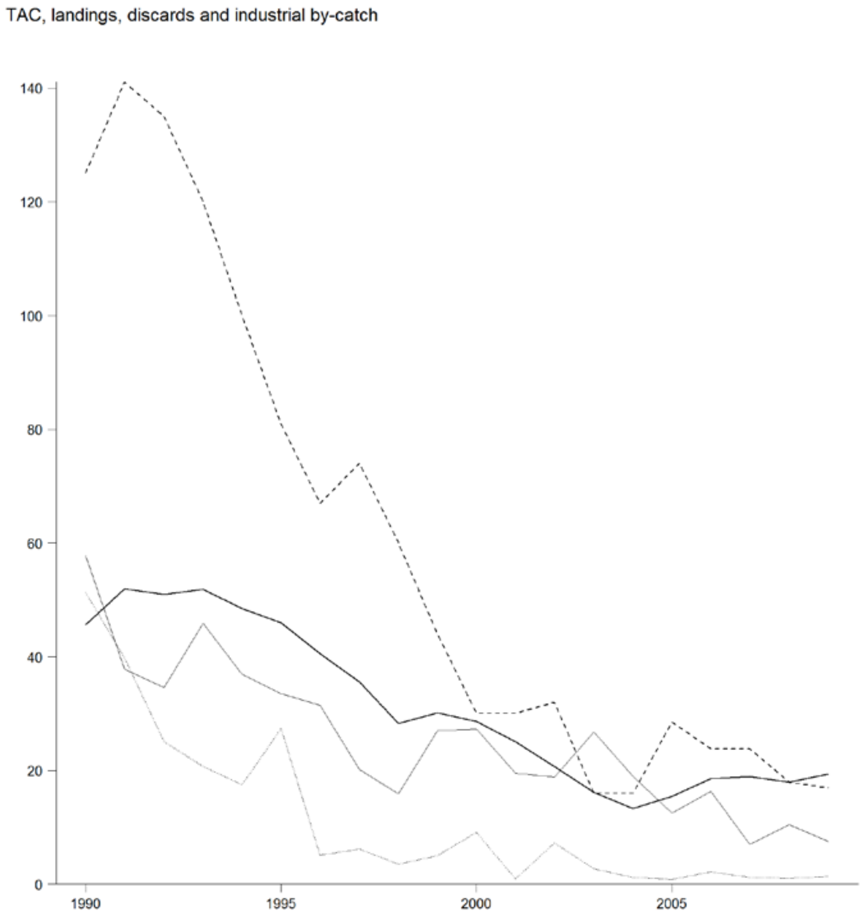


Figure 12.2.3 Whiting in IV and VIId. Time series of each catch component. Human consumption landings (black line) , followed by discards (dark grey line) and lastly industrial bycatch (light grey line). Also shown as a dashed line is the TAC for Subarea IV and Division IIa.

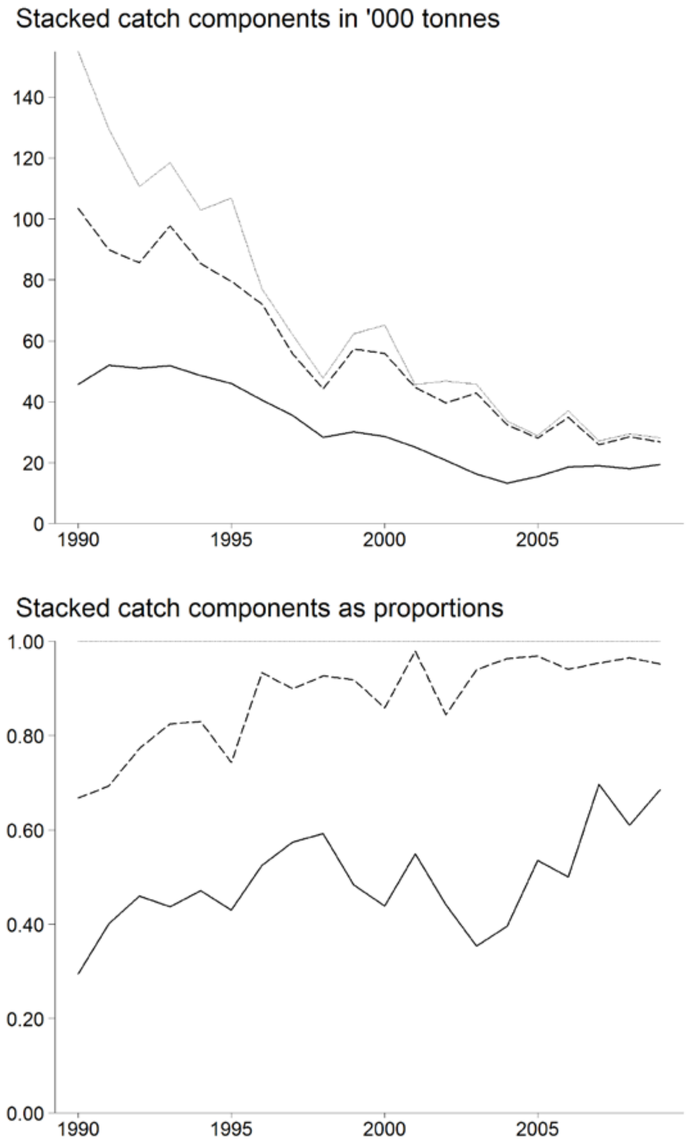


Figure 12.2.4 Whiting in IV and VIId. Time series of catch components as they contribute to total catch. Human consumption landings (black line) , followed by discards (dashed line) and lastly industrial bycatch (grey line).

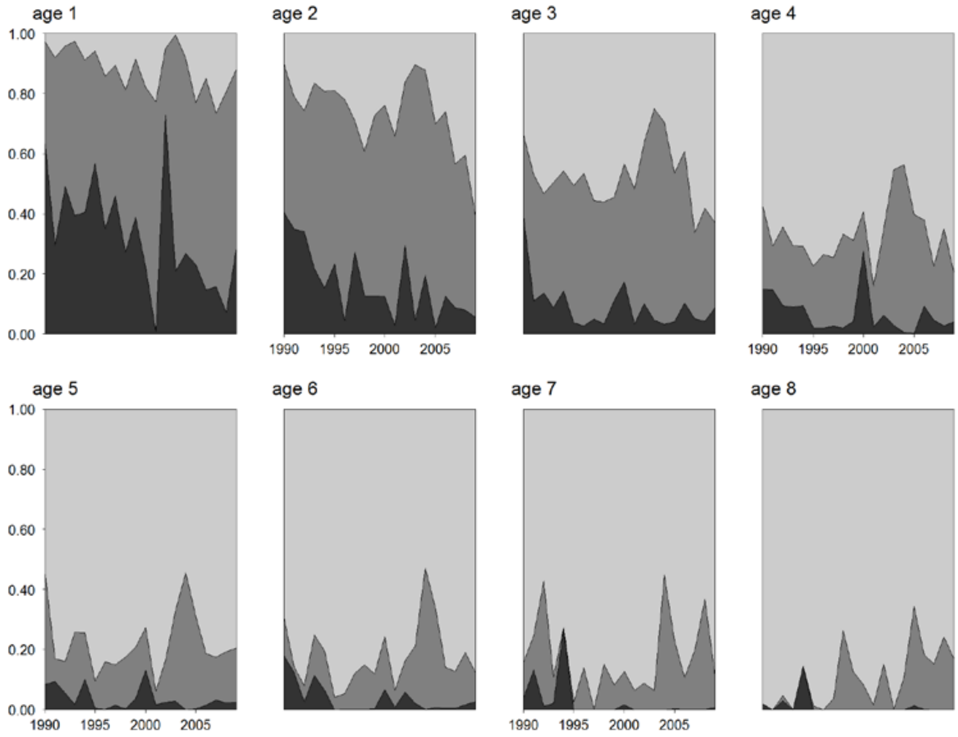


Figure 12.2.5 Whiting in IV and VIId. Proportion by number for each catch component. Landings are light grey; discards are medium grey and industrial by-catch are dark grey.

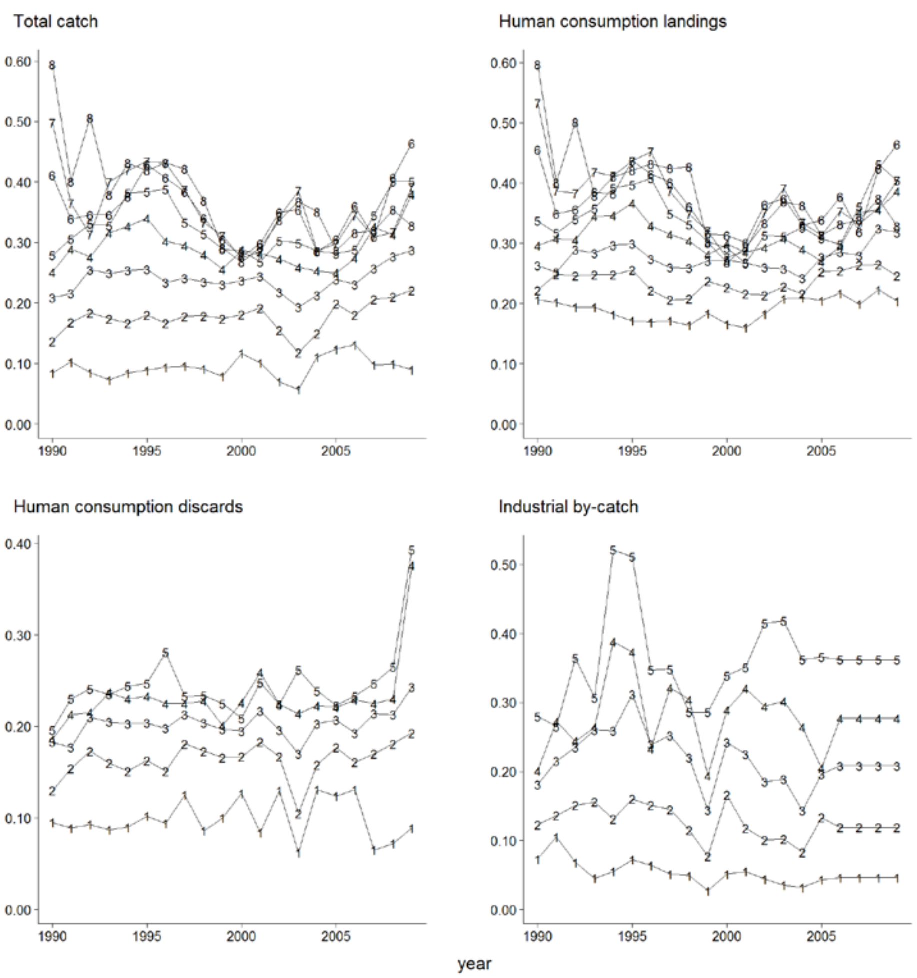


Figure 12.2.6 Whiting in IV and VIId. Mean weights at age (kg) by catch component. Catch mean weights are also used as stock mean weights.

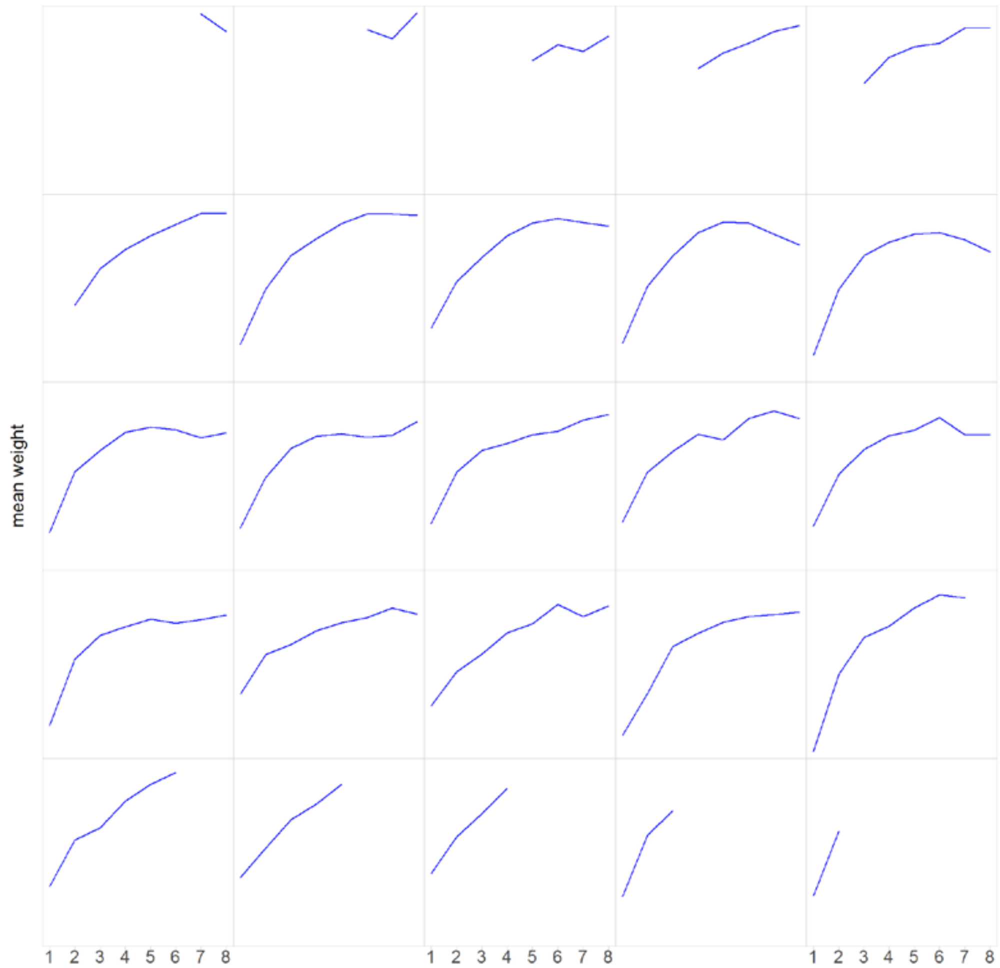


Figure 12.2.7 Whiting in IV and VIId. Mean weights at age (kg) by catch component. Catch mean weights are also used as stock mean weights. The final panel (bottom right) is the 2007 year class.

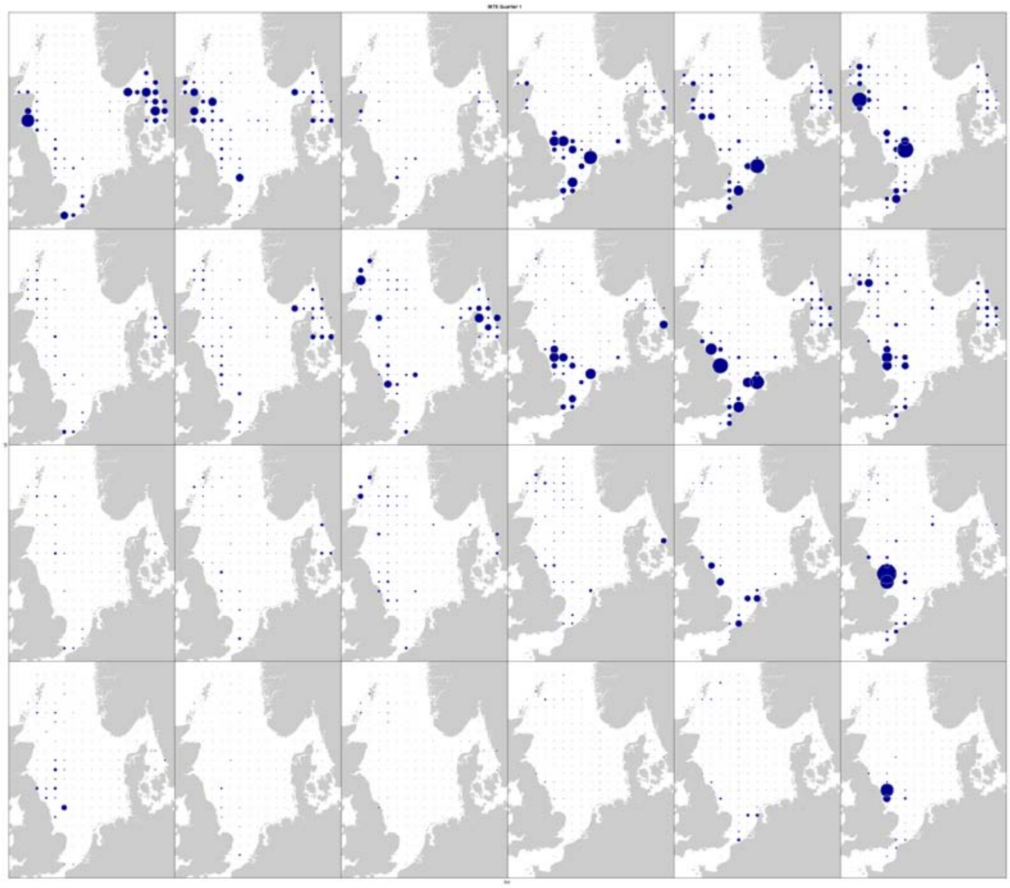


Figure 12.2.8 Whiting in IV and VIId. Distribution plot of the IBTS quarter 1 Survey age 1 to 4+. Ages are on rows, years on columns from left to right 2005 to 2010.

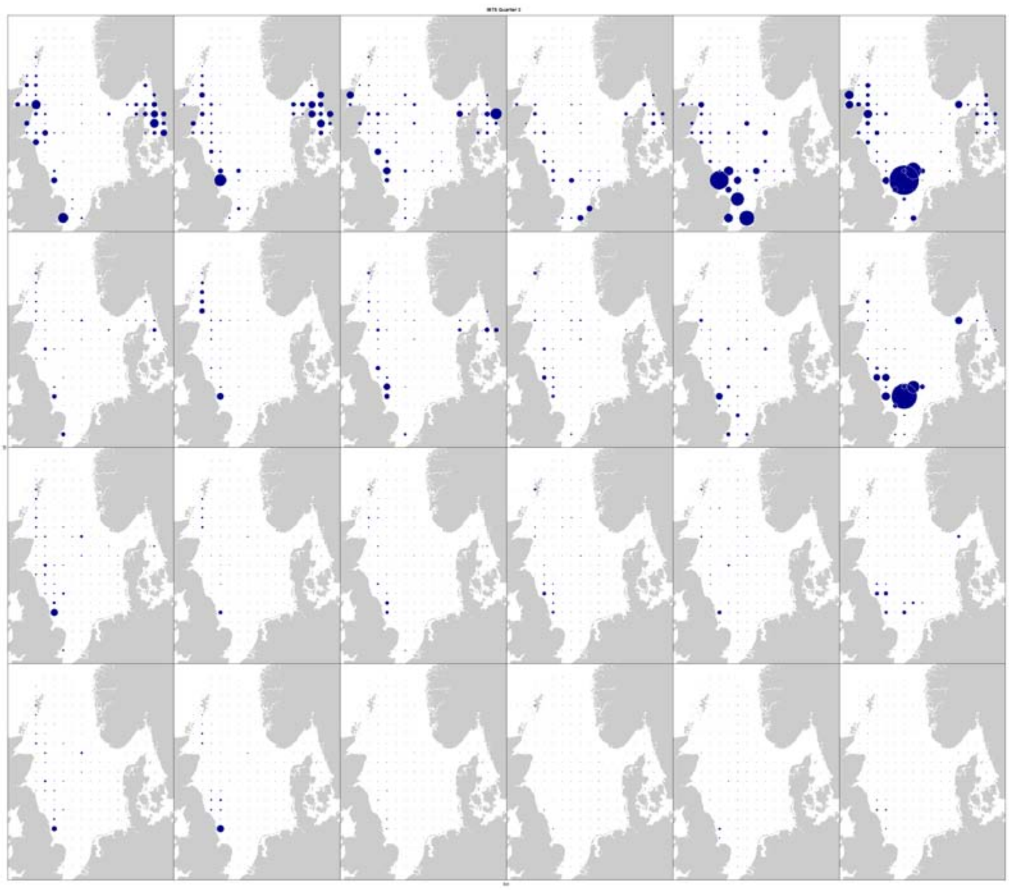


Figure 12.2.9 Whiting in IV and VIId. Distribution plot of the IBTS quarter 3 Survey age 1 to 4+. Ages are on rows, years on columns from left to right 2004 to 2009.

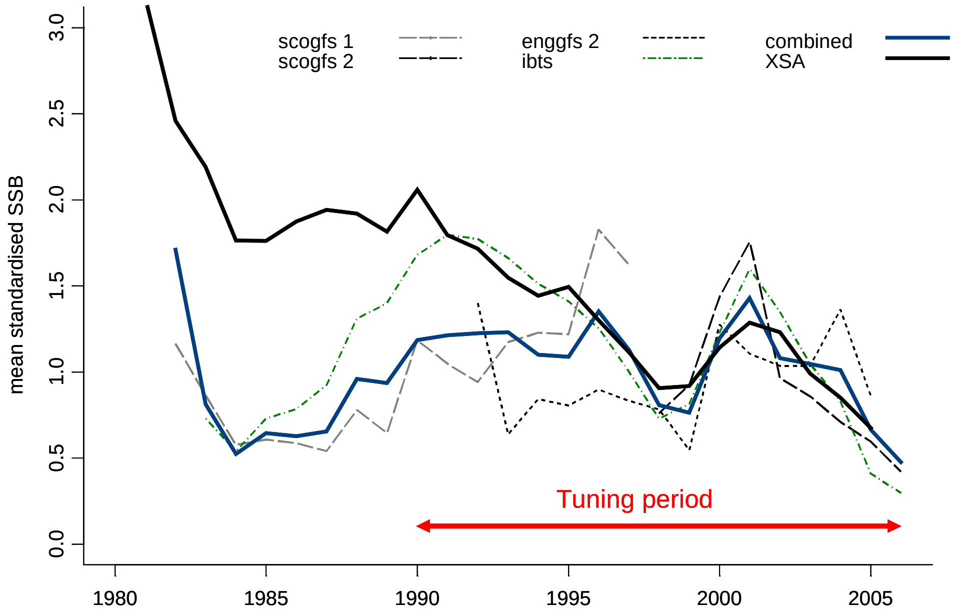


Figure 12.3.1 Whiting in IV and VIId. Analysis conducted in WGNSSK (2007) showing catch based estimates of spawning stock biomass (black line) along side survey based estimates of spawning stock biomass (blue, and dashed lines), the blue line showing an estimate based on all the surveys. These are scaled so that the mean of each line over the years 1996 – 2006 is one.

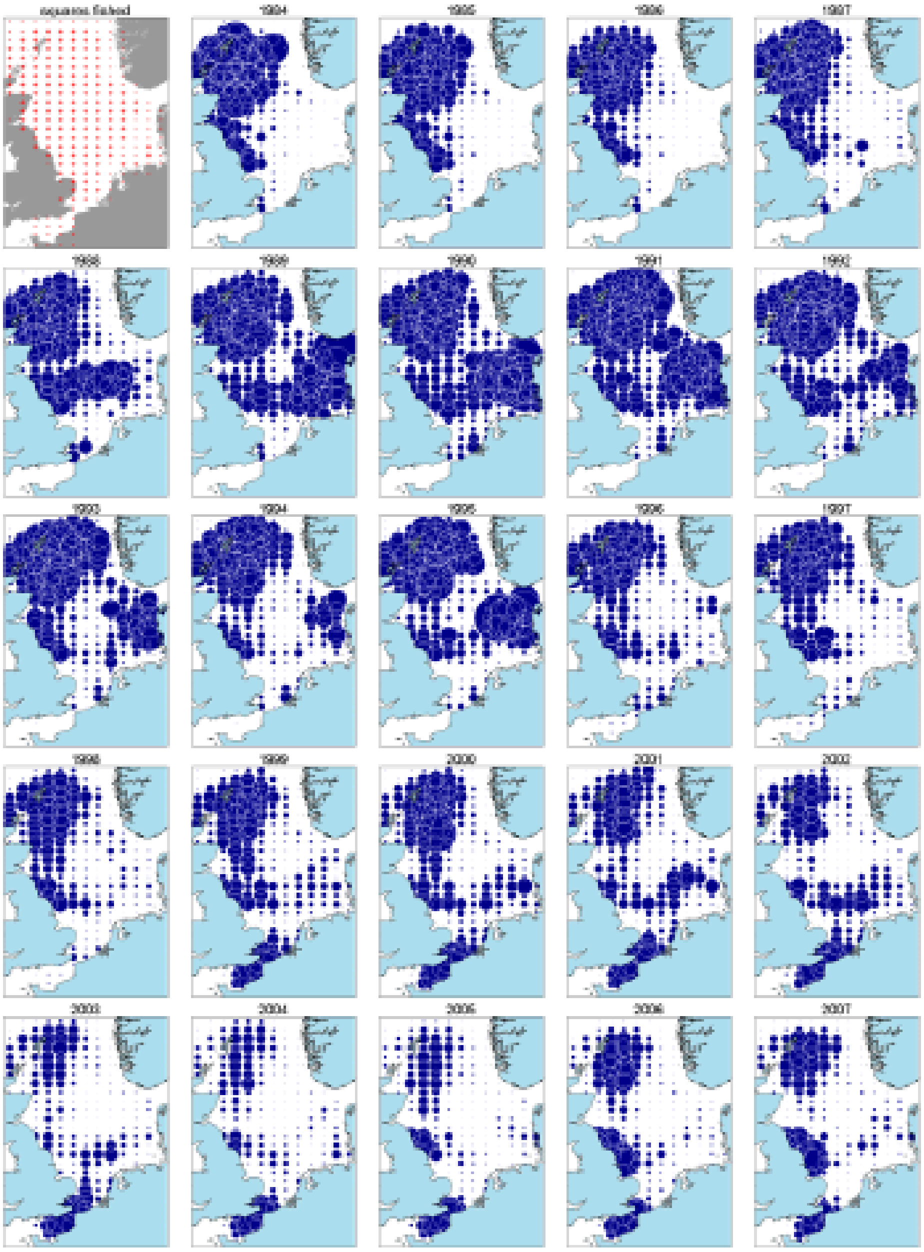


Figure 12.3.2 Whiting in Subarea IV and Division VIId. Commercial landings (human consumption and industrial fisheries in tonnes) by ICES statistical rectangle over the years 1984 to 2007. The same scaling is used in each map. In the top left plot a '+' indicates where landings are reported / available in every year (1984 – 2007), '-' indicates that for some years no landings were reported / available for that square. Danish industrial bycatch was available from 1988. French human consumption landings were available from 1999.

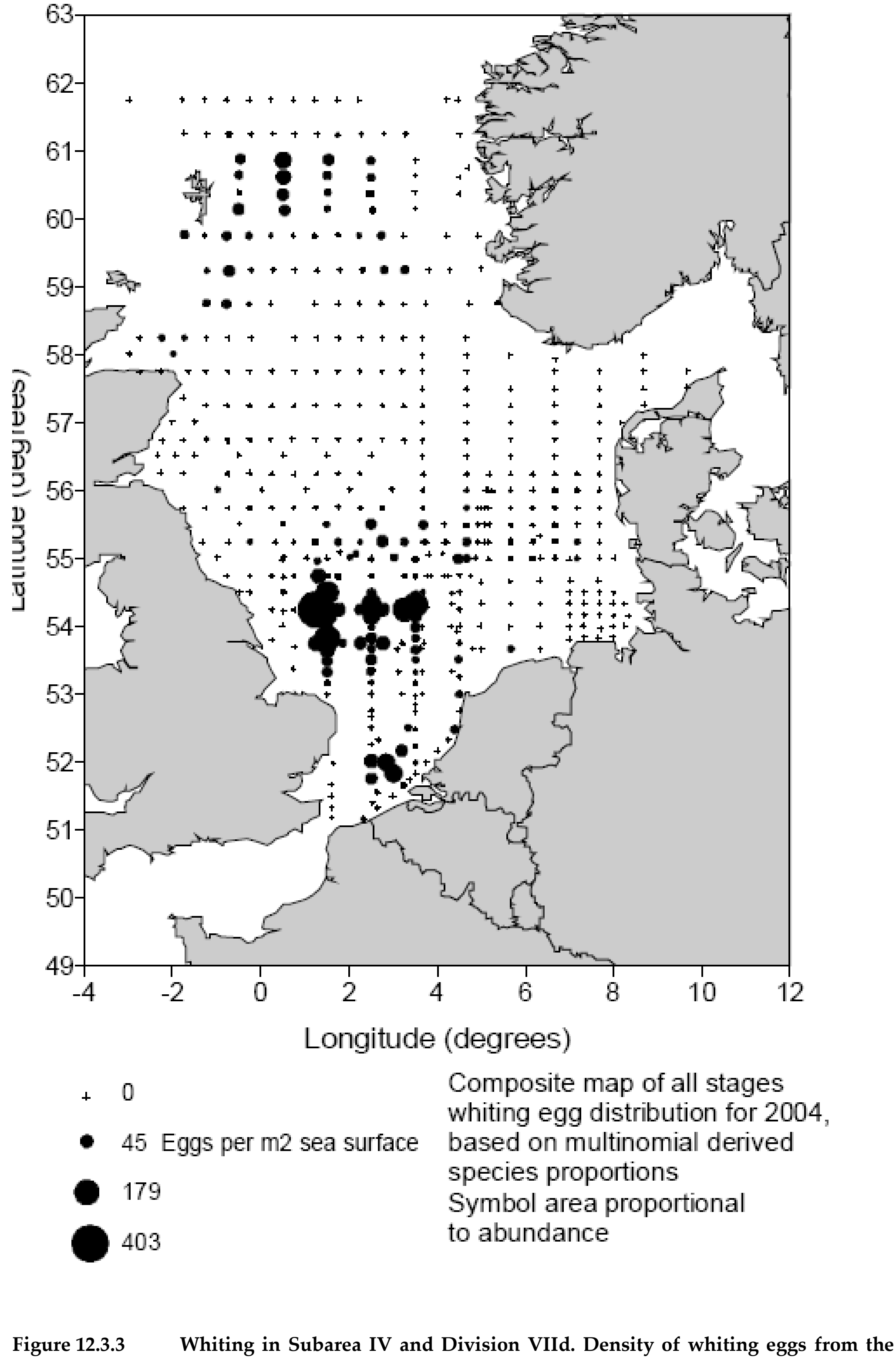


Figure 12.3.3 Whiting in Subarea IV and Division VIId. Density of whiting eggs from the 2004 ICES icthyoplankton survey.

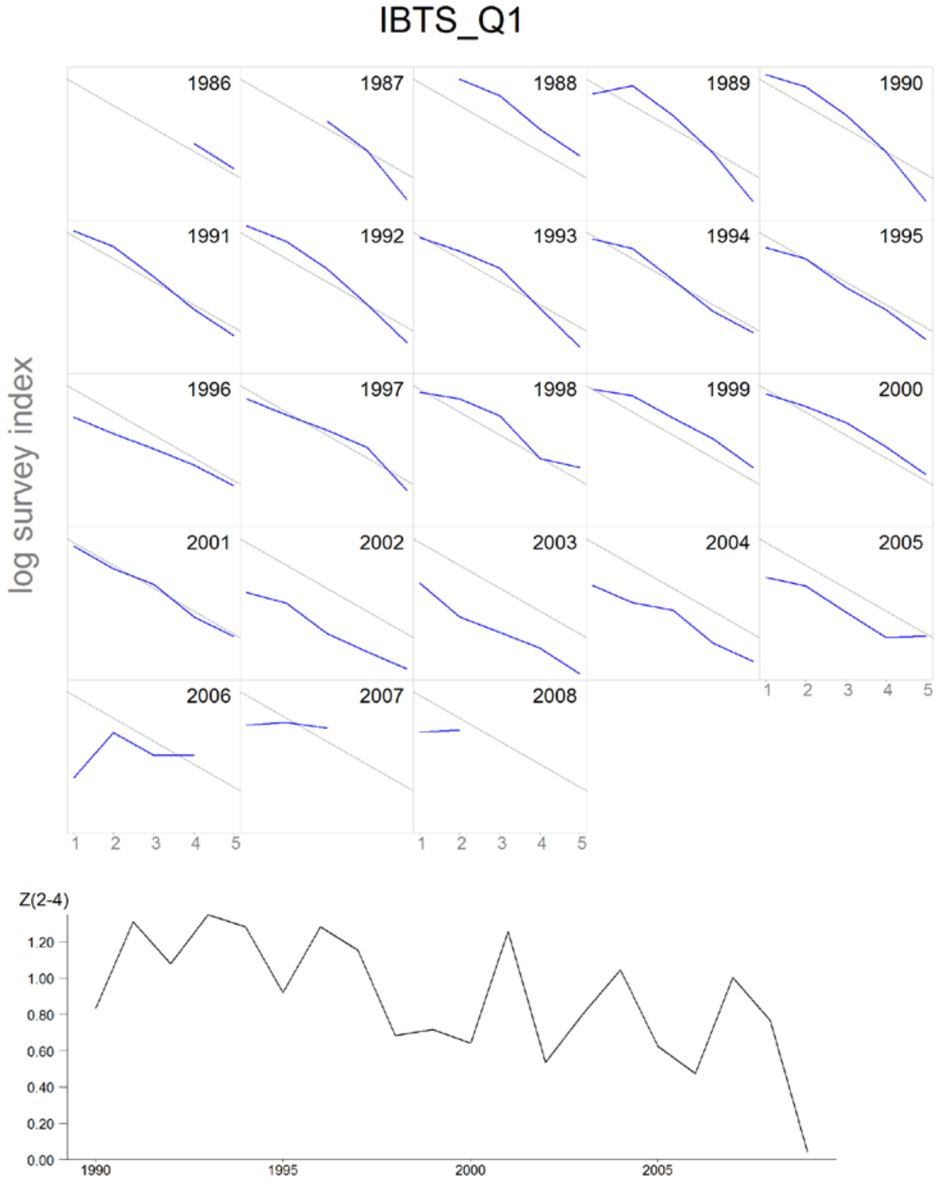


Figure 12.3.4 Whiting in IV and VIId. Top panel: Log indices by cohort for the IBTS Quarter 1 survey (ages 1 to 5). The year specifies the year-class. A reference a line with constant intercept and gradient representing a Z of 0.8 has been drawn in grey. Bottom panel: a raw estimate of annual mean Z averaged over ages 2 to 4, Z at age was estimated as log index (y, a) – log index (y+1, a+1).

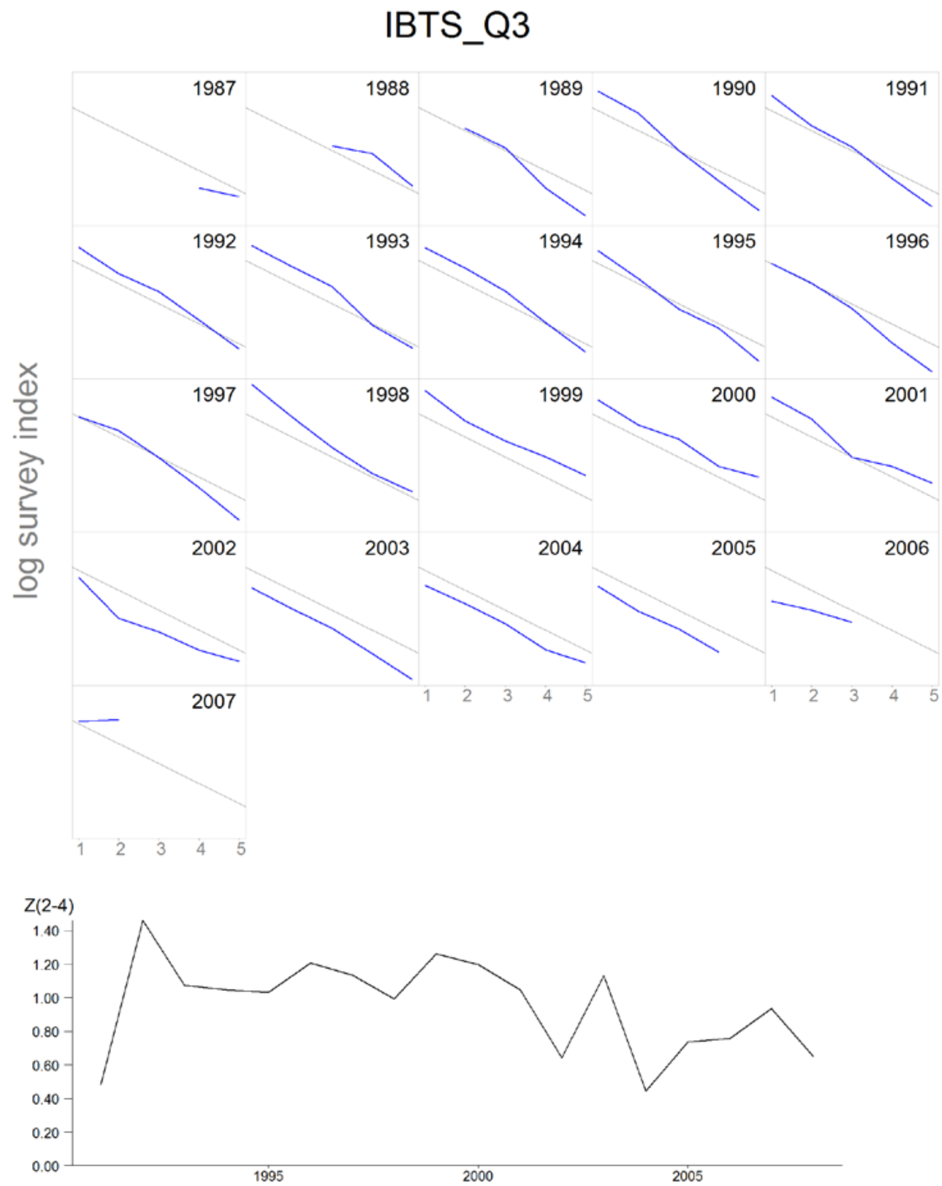


Figure 12.3.5 Whiting in IV and VIId. Top panel: Log indices by cohort for the IBTS Quarter 3 survey (ages 1 to 5). The year specifies the year-class. A reference a line with constant intercept and gradient representing a Z of 0.8 has been drawn in grey. Bottom panel: a raw estimate of annual mean Z averaged over ages 2 to 4, Z at age was estimated as log index (y, a) – log index (y+1, a+1).

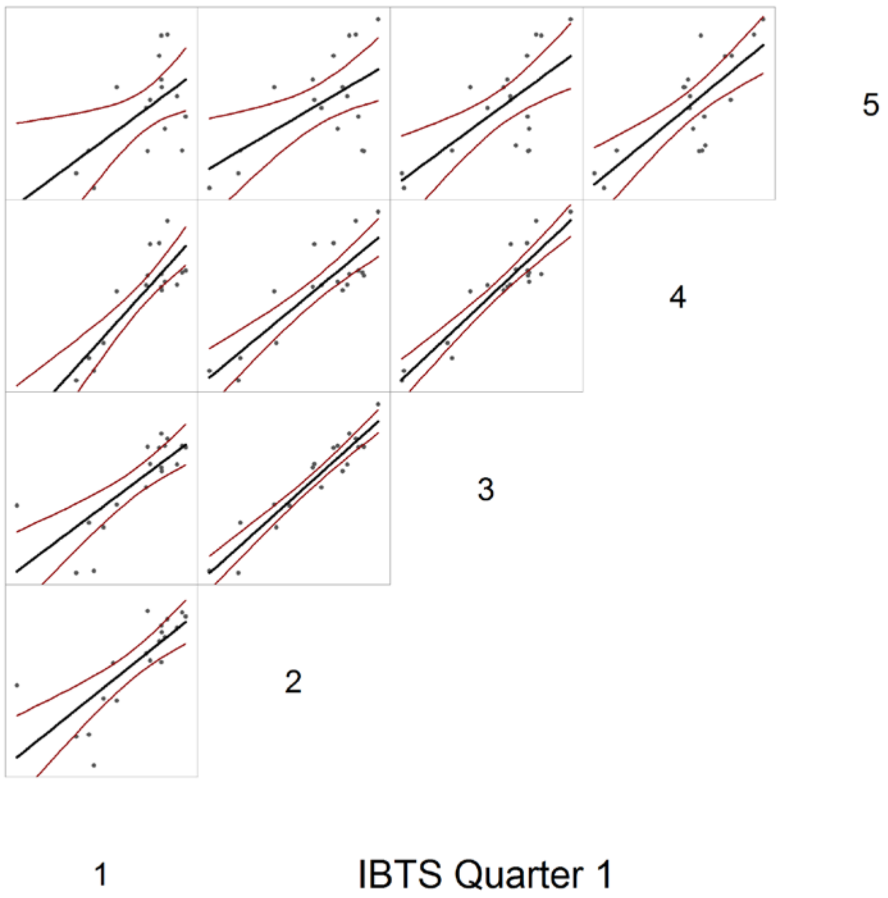


Figure 12.3.6 Whiting in IV and VIId. Within survey correlations for the IBTS quarter 1 survey (1990–2006). Individual points are given by cohort, the line is a normal linear model fit. Thick lines represent a significant (p<0.05) regression and the curved lines are approximate 95% confidence intervals.

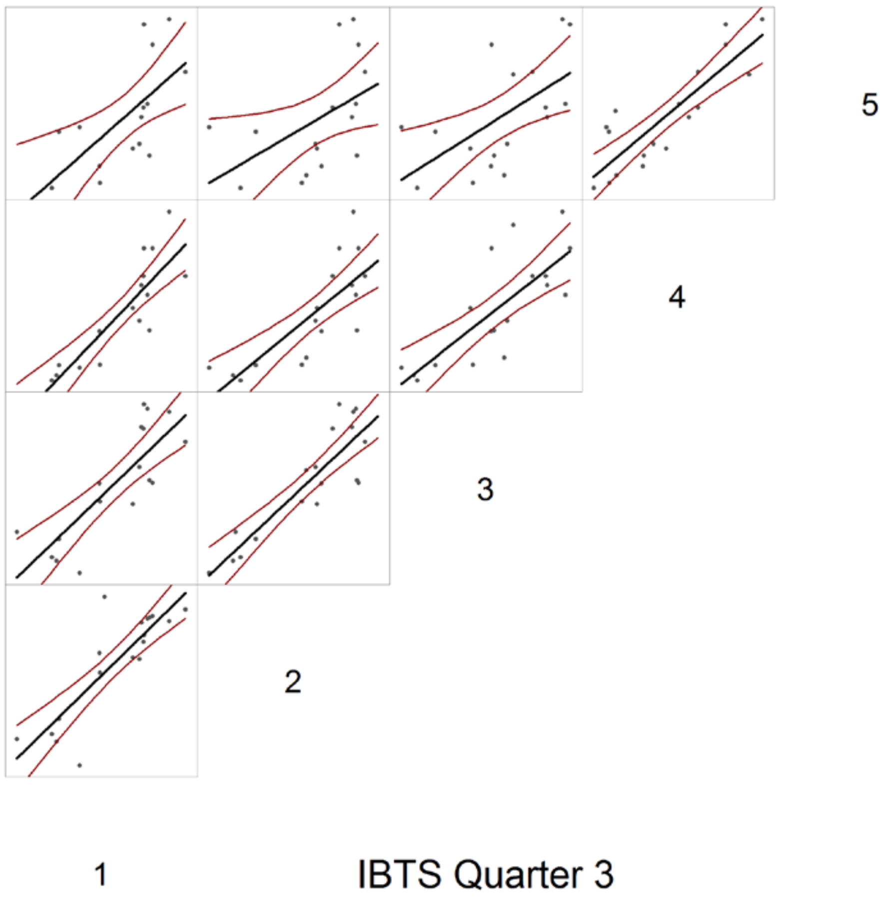


Figure 12.3.7 Whiting in IV and VIId. Within survey correlations for the IBTS quarter 3 survey (1990–2006). Individual points are given by cohort, the line is a normal linear model fit. Thick lines represent a significant (p<0.05) regression and the curved lines are approximate 95% confidence intervals.

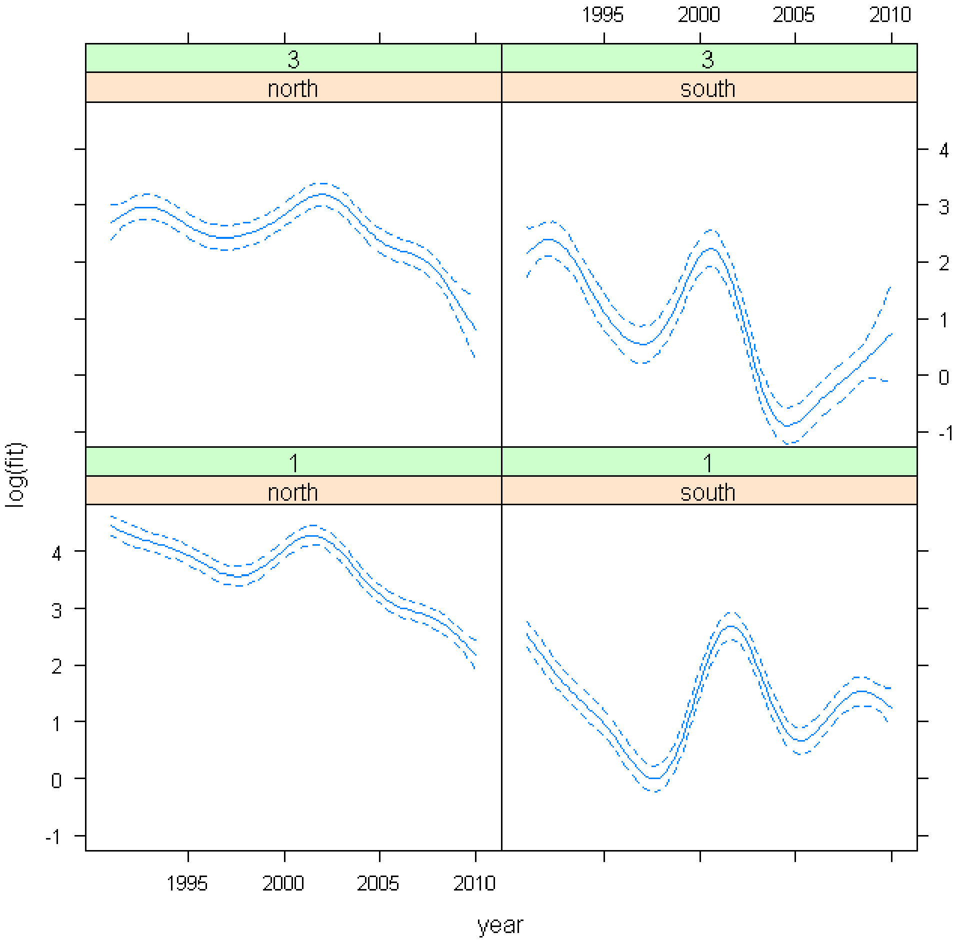


Figure 12.3.8 Whiting in IV and VIId. Approximate north south trends in abundance from the IBTS Q1 and IBTS Q3 surveys. The fits are on the log abundance scale. North consists of IBTS areas 1 to 4, and south IBTS areas 5 to 7.

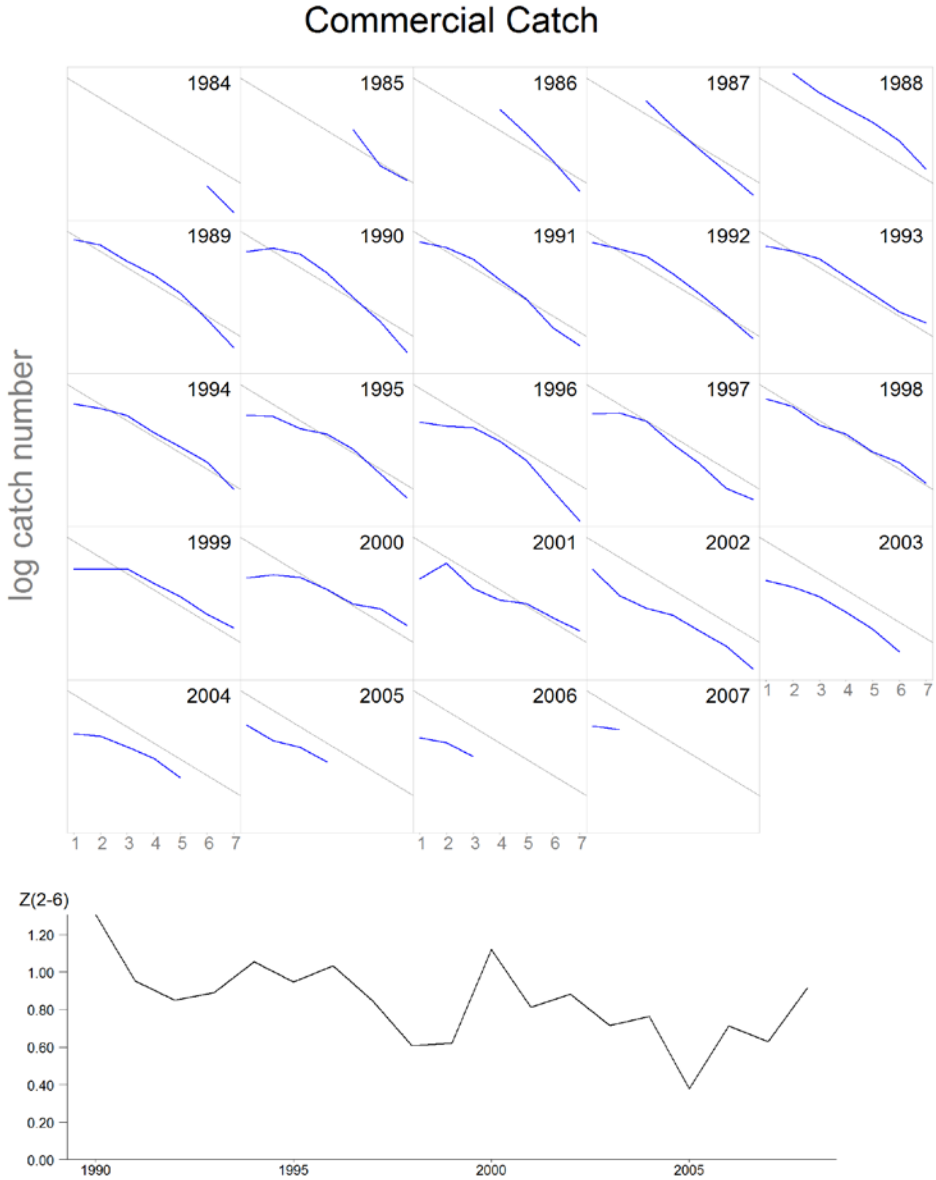


Figure 12.3.9 Whiting in IV and VIId. Top panel: Log catch number by cohort (ages 1 to 7). The year specifies the year-class. A reference a line with constant intercept and gradient representing a Z of 0.8 has been drawn in grey. Bottom panel: a raw estimate of annual mean Z averaged over ages 2 to 6, Z at age was estimated as log catch (y, a) – log catch (y+1, a+1).

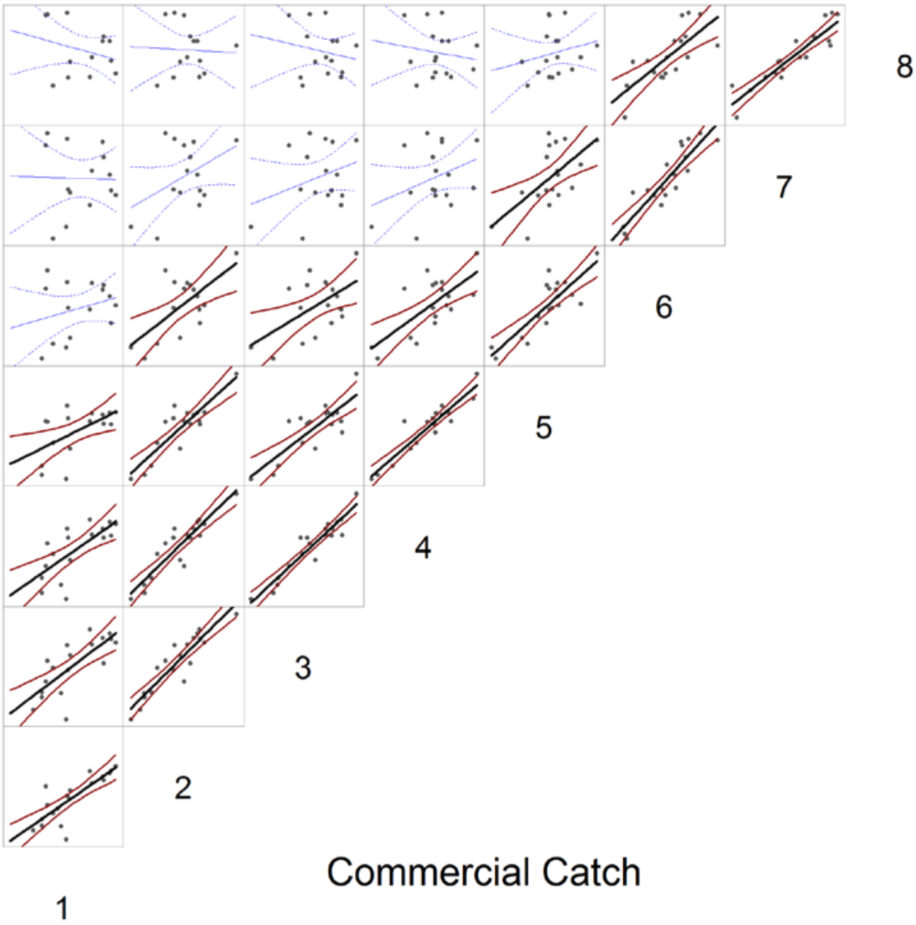


Figure 12.3.10 Whiting in IV and VIId. Correlations in the catch at age matrix (log numbers). Individual points are given by cohort, the line is a normal linear model fit. Thick lines represent a significant (p<0.05) regression.

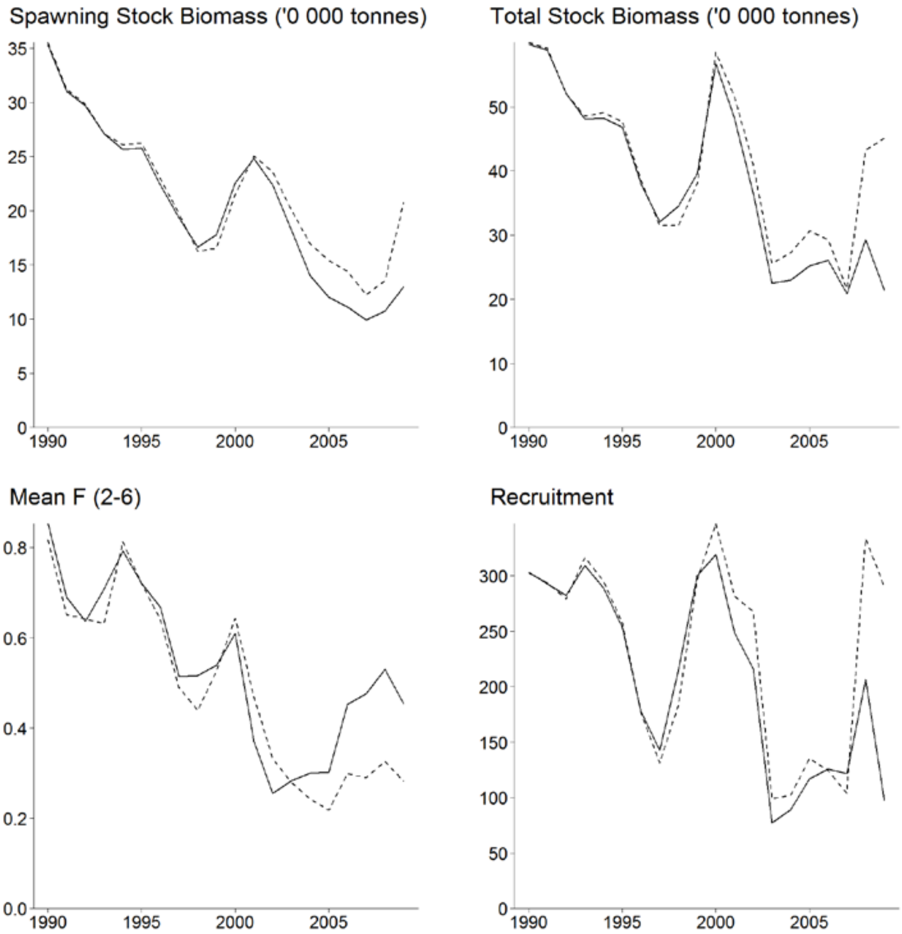


Figure 12.3.11 Whiting in IV and VIId. Comparison of spawning stock biomass, total stock biomass, mean F(2-6) and recruitment for individual tuning fleet XSA runs (with the settings used in the final assessment). Solid line: IBTS Q1; dotted line: IBTS Q3

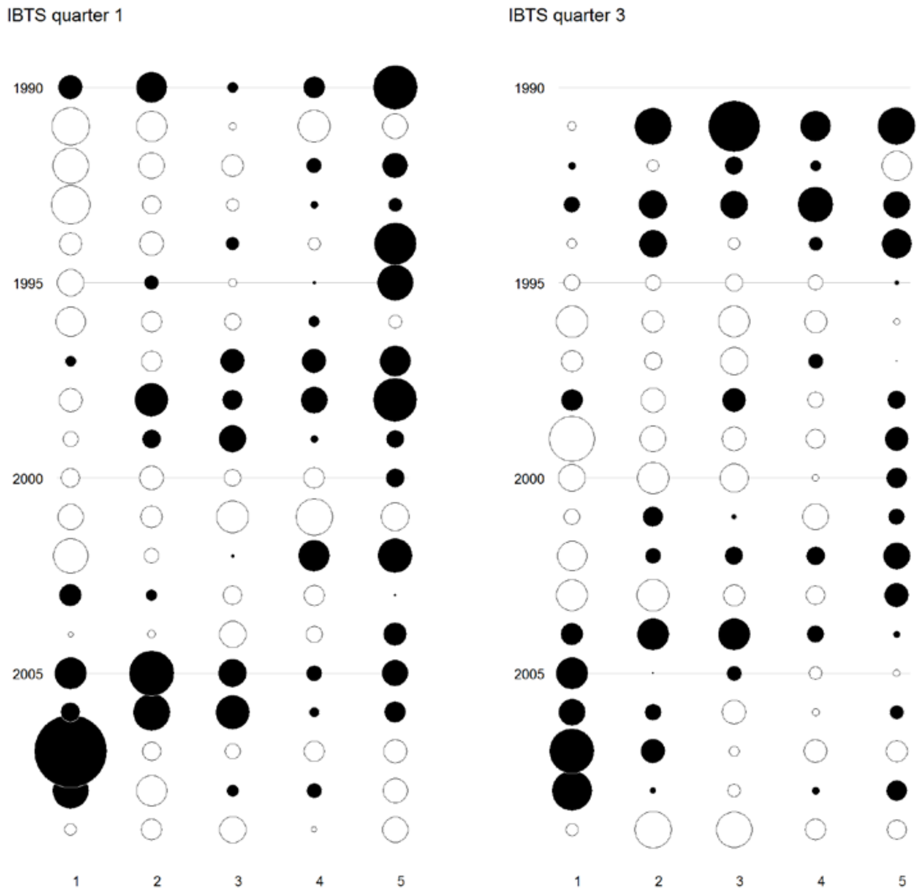


Figure 12.3.12 Whiting in IV and VIId. Residuals from single fleet XSA runs. Black signifies a negative residual and white signifies a positive residual.

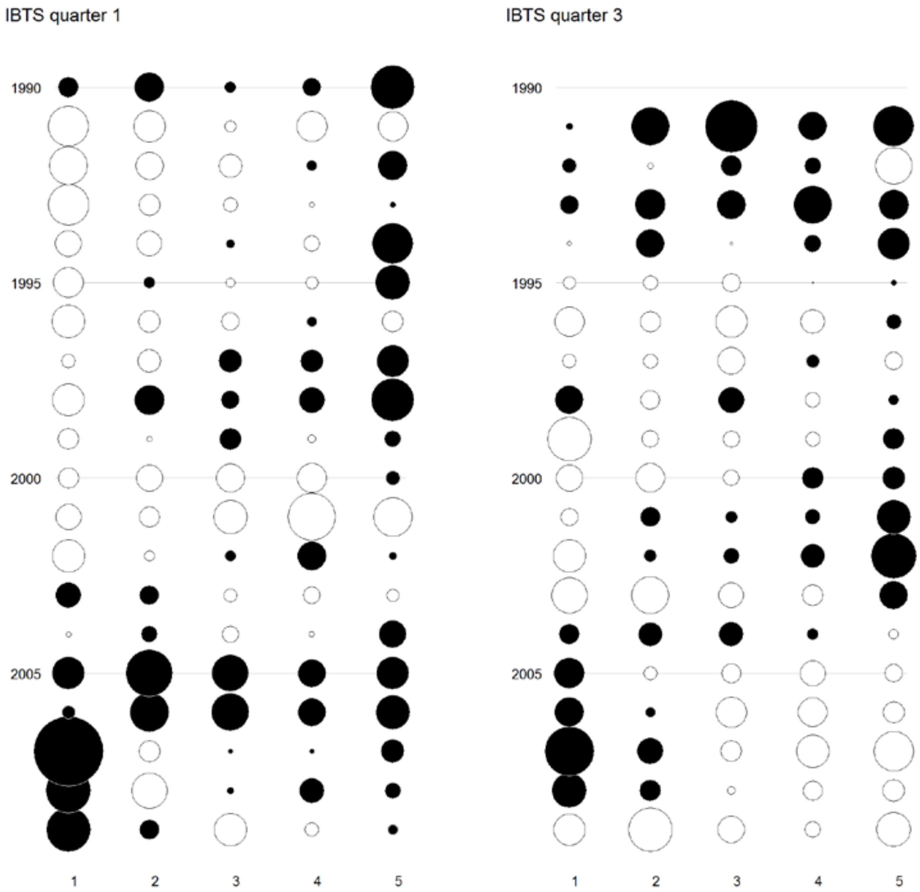


Figure 12.3.13 Whiting in IV and VIId. XSA final run: log catchability residuals. Black signifies a negative residual and white signifies a positive residual.

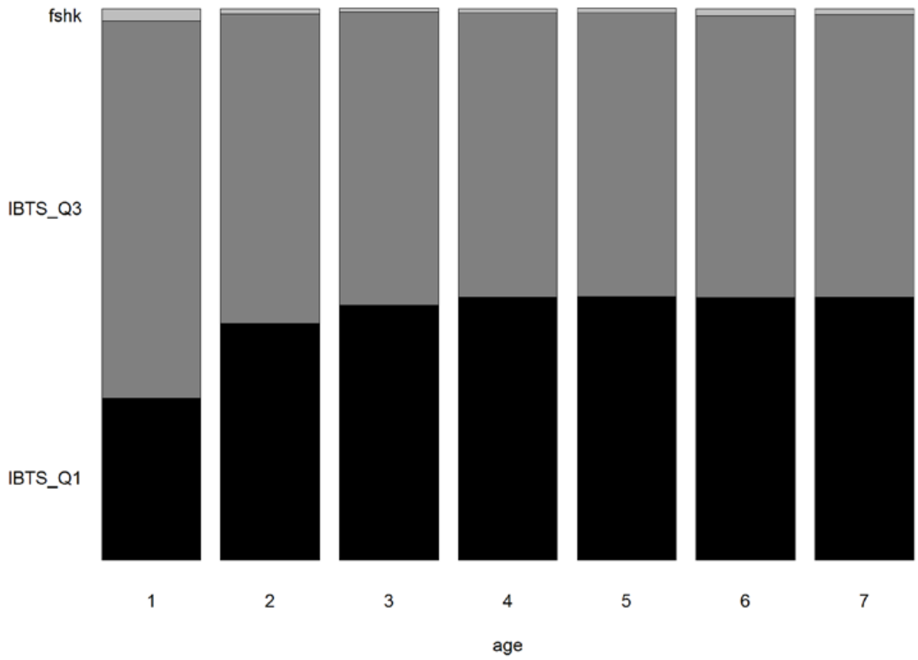


Figure 12.3.14 Whiting in IV and VIId. XSA final run: Contribution by survey and shrinkage to survivors from 2009.

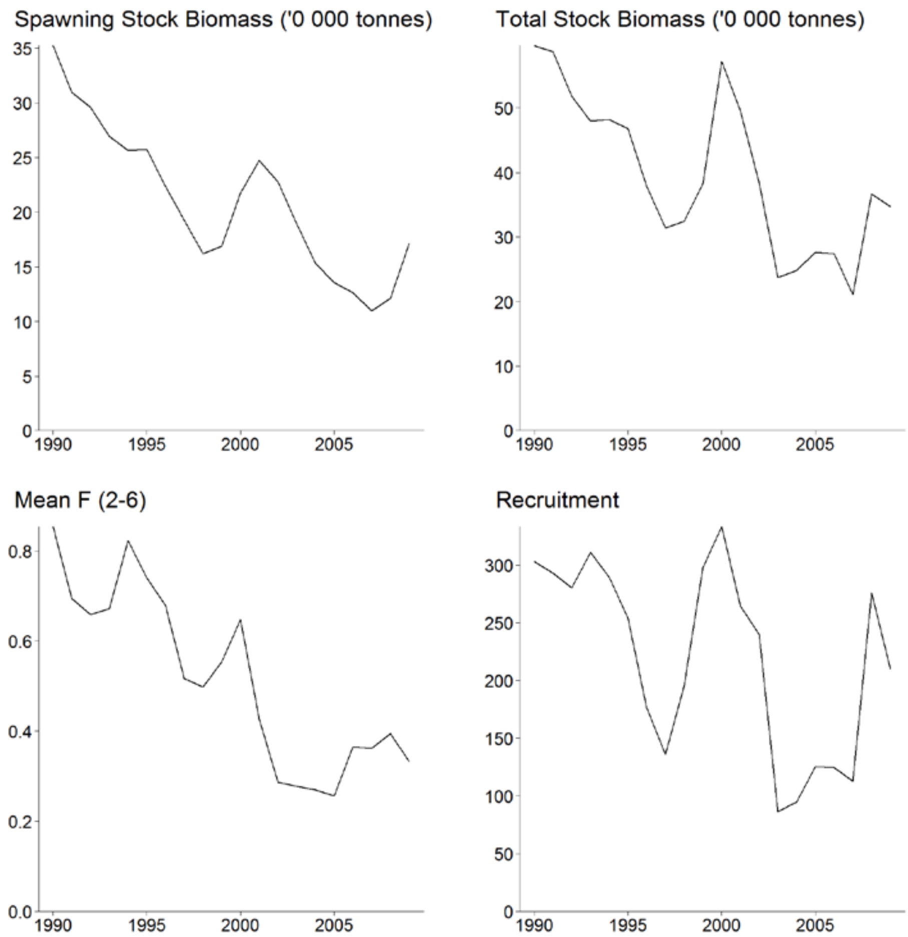


Figure 12.3.15 Whiting in IV and VIId. XSA final run: Summary plots.

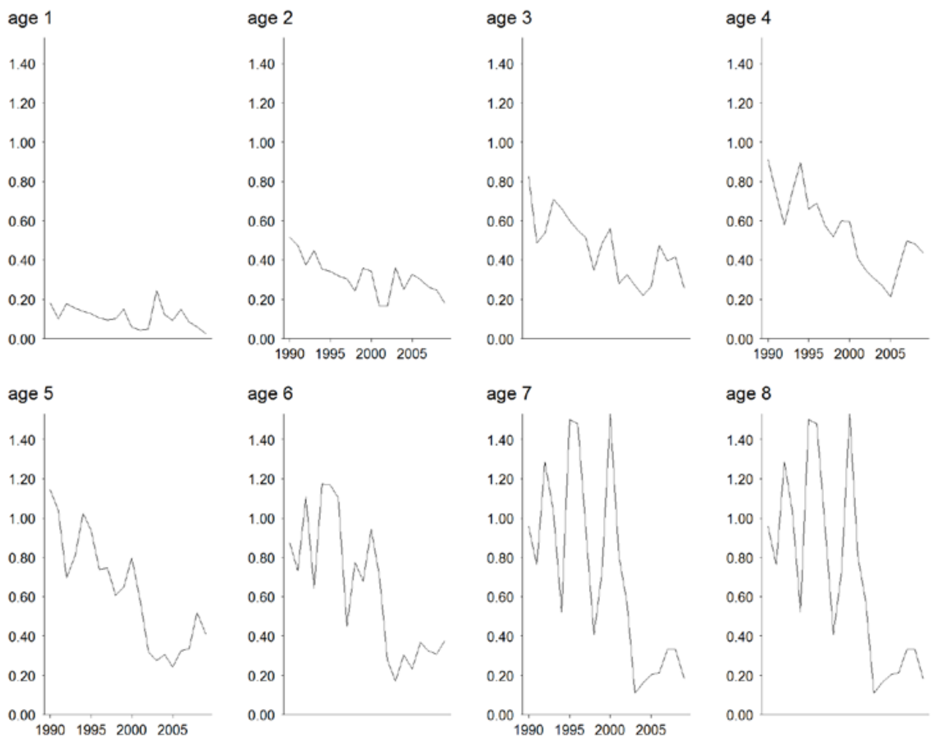


Figure 12.3.16 Whiting in IV and VIId. XSA final run: XSA fishing mortality at age.

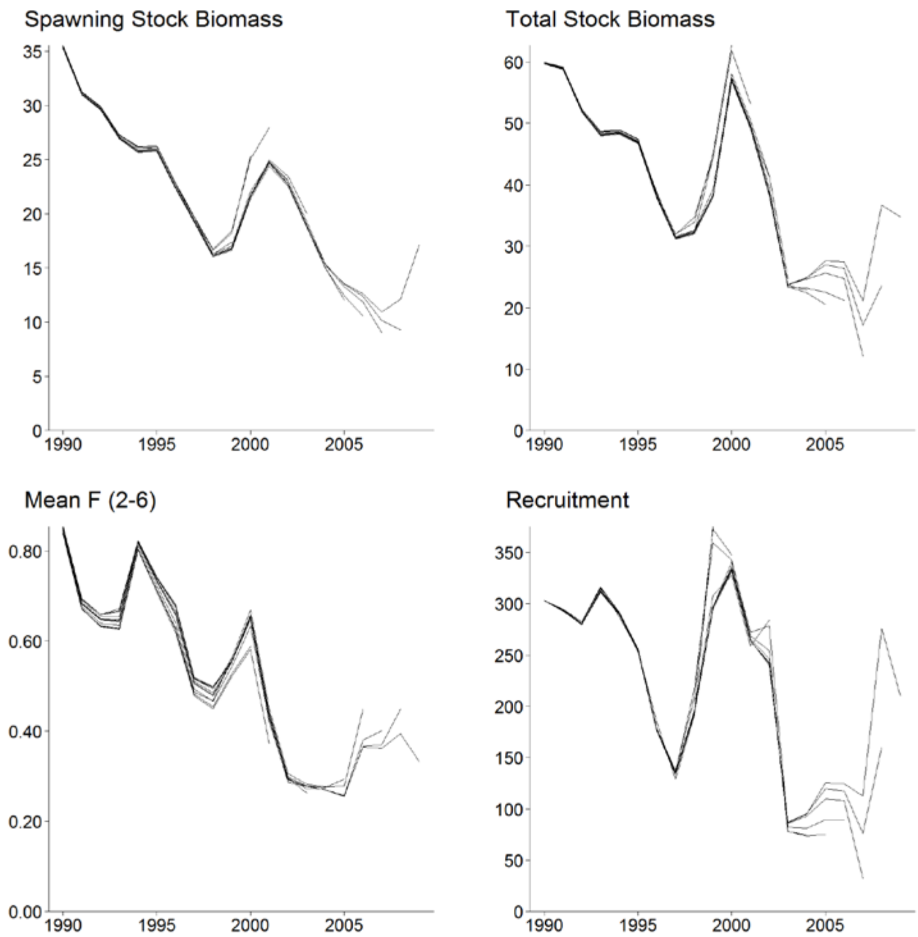


Figure 12.3.17 Whiting in IV and VIId. XSA final run: retrospective patterns. The y axis represents the percentage difference from the most recent assessment.

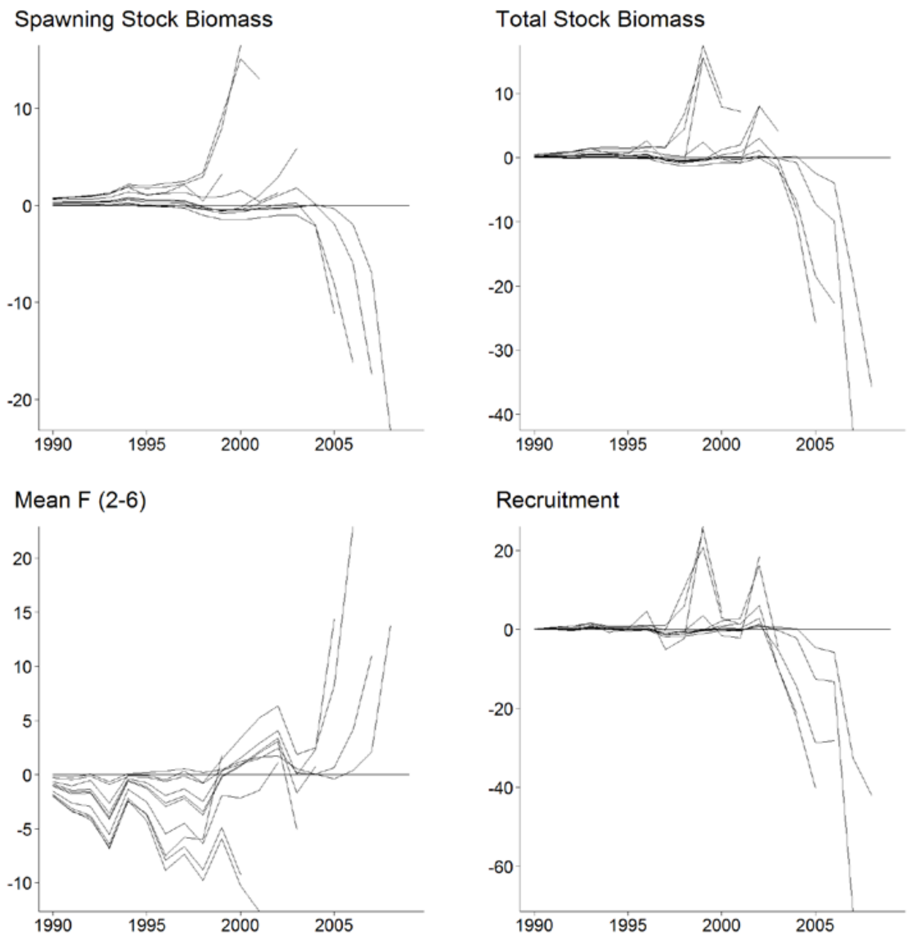


Figure 12.3.18 Whiting in IV and VIId. XSA final run: retrospective patterns. The y axis represents the percentage difference from the most recent assessment.

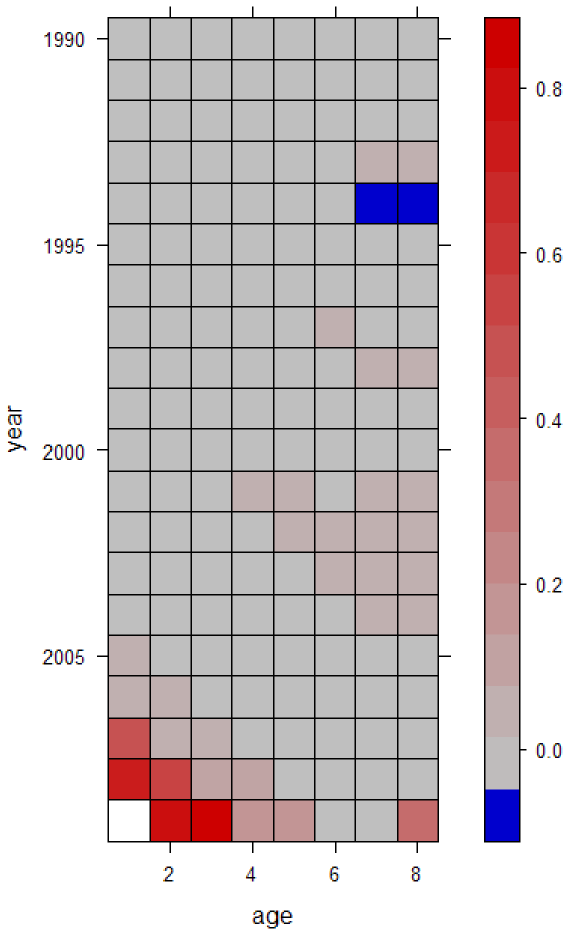


Figure 12.3.19 Whiting in IV and VIId. Comparison of the estimates of N at age between this years assessment and last years assessment. The scale is a proportional change with respect to last years assessment, for example the estimate of numbers at age 2 in 2009 has increased by around 65%.

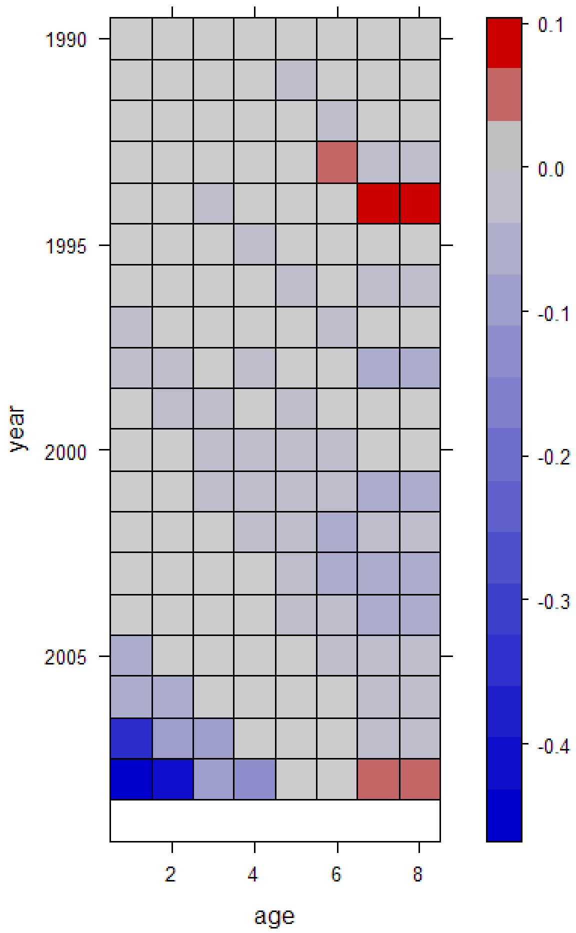


Figure 12.3.20 Whiting in IV and VIId. Comparison of the estimates of F at age between this year and last. The scale is a proportional change with respect to last years assessment, for example the estimate of F at age 1 in 2008 has decreased by around 45%.

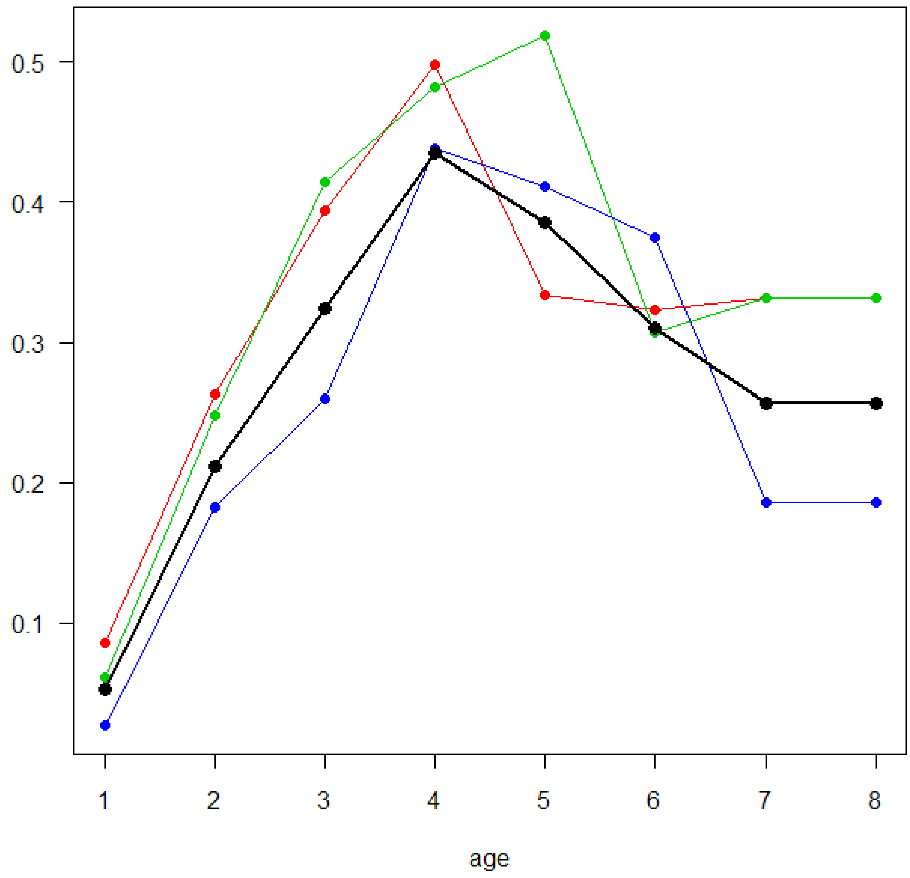


Figure 12.4.1 Whiting in IV and VIId. Changes in estimated exploitation pattern. From 2007 to 2009 from ages 1 to 8+. Red and green lines are 2007 and 2008. Current year F is blue. Forecast F is black.

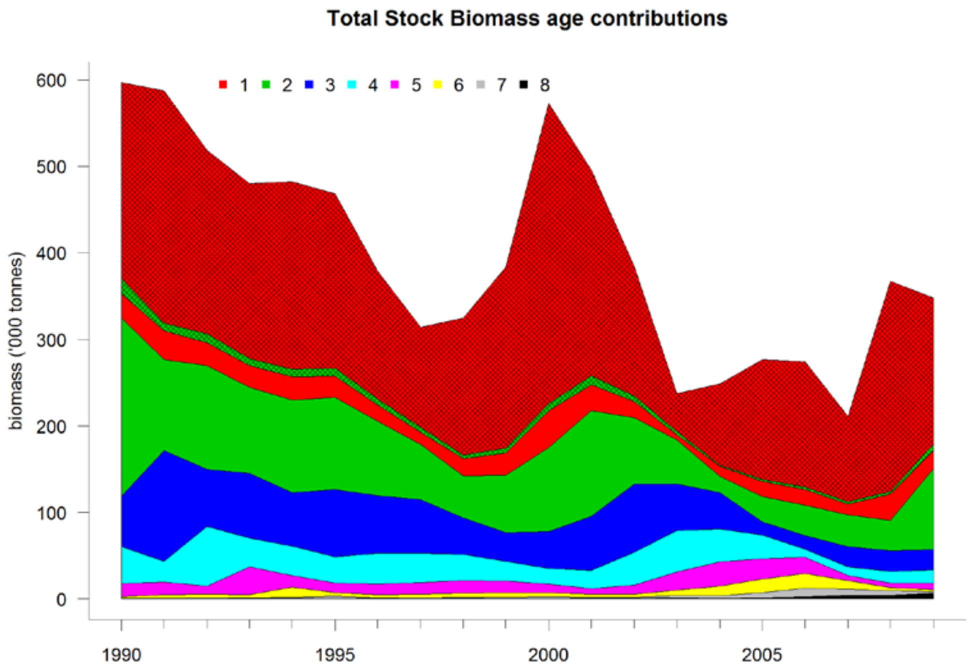


Figure 12.4.2 Whiting in IV and VIId. Age contributions to the SSB and TSB. Biomass not contributing to SSB is overlaid with hatched lines: immature age 1 lies over immature age 2, and the immature biomass lies over mature age 1, mature age 2 etc.

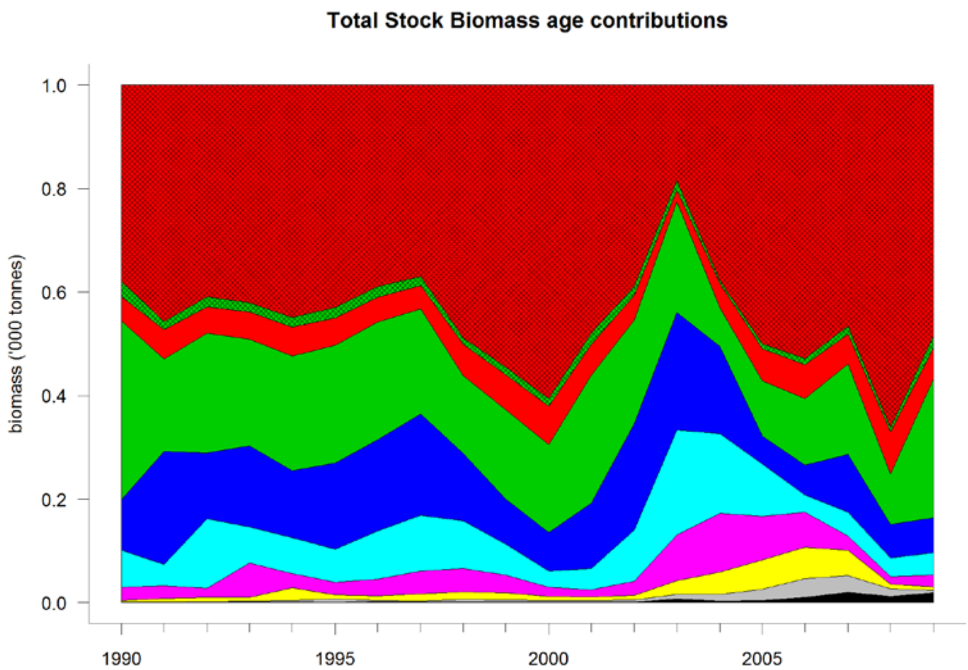


Figure 12.4.3 Whiting in IV and VIId. Age contributions to the SSB and TSB shown as proportions of the total stock biomass. Biomass not contributing to SSB is overlaid with hatched lines: immature age 1 lies over immature age 2, and the immature biomass lies over mature age 1, mature age 2 etc.

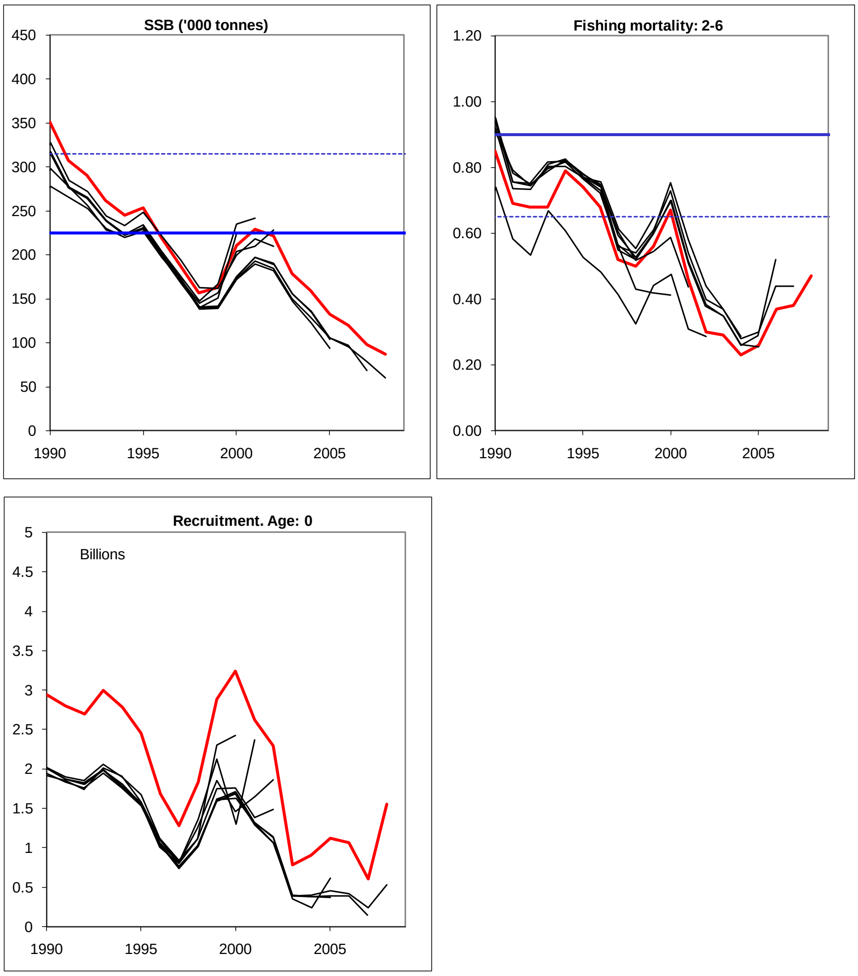


Figure 12.9.1 Whiting in IV and VIId. Historical performance of the assessment.

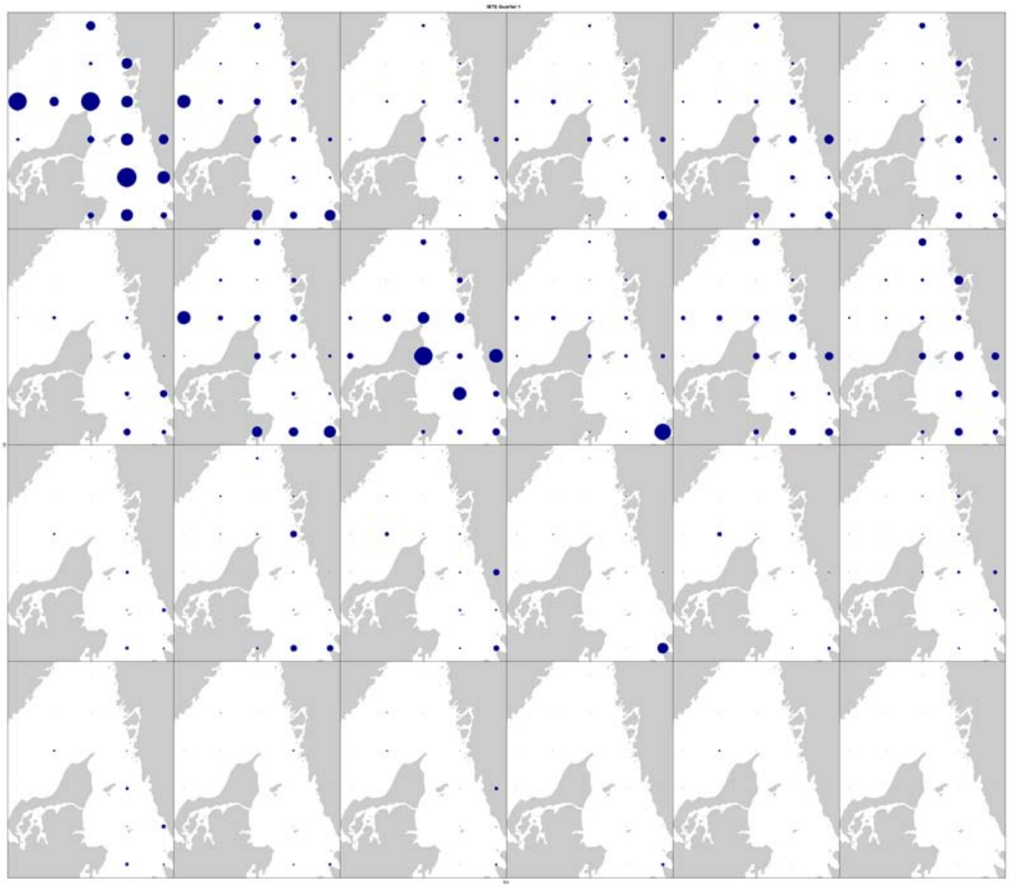


Figure 12.12.1 Whiting in IV and VIId. Distribution plot of the IBTS quarter 1 Survey age 1 to 4+ for demersal areas 9 and 10. Ages are on rows, years on columns from left to right 2005 to 2010.

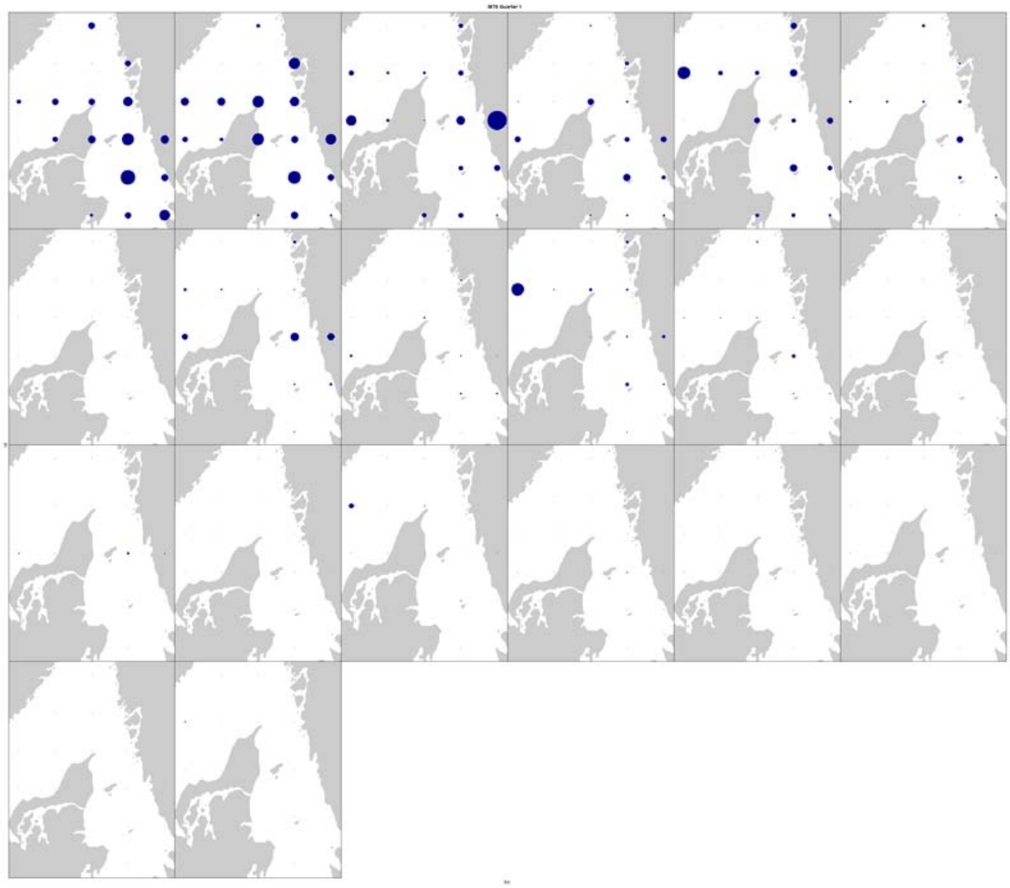


Figure 12.12.2 Whiting in IV and VIId. Distribution plot of the IBTS quarter 3 Survey age 1 to 4+ for demersal areas 9 and 10. Ages are on rows, years on columns from left to right 2004 to 2009.

13 Haddock in Subarea IV and Division IIIa (N)

The assessment of haddock presented in this section is an update assessment. No changes have been made to the run settings and model configurations used in last year's assessment. Recommendations for issues to be considered at the forthcoming benchmark meetings are given in Section 13.9.

13.1 General

13.1.1 Ecosystem aspects

Ecosystem aspects are summarised in the Stock Annex.

13.1.2 Fisheries

A general description of the fishery (along with its historical development) is presented in the Stock Annex. Most of the information presented below and in the Stock Annex pertains to the Scottish fleet, which takes the largest proportion of the haddock stock. This fleet is not just confined to the North Sea, as vessels will sometimes operate in Divisions VIa (off the west coast of Scotland), VIb (Rockall) and Vb (Faroes)

Changes in fleet dynamics

There have been no decommissioning schemes affecting haddock fisheries since the major rounds in 2002 and 2004. Scottish vessels have been taking up opportunities for oil support work during 2006-2009 with a view to saving quota and days at sea.

With the reduced cod and whiting quota in recent years, many vessels have tended to concentrate more on the haddock fishery, with others taking the opportunity to move between the *Nephrops* and demersal fisheries (particularly during 2006 and 2007 – there may have been fewer boats changing focus in this way in 2008 and 2009). Accompanying the change in emphasis towards the haddock fishery, there has also been a tendency to target smaller fish in response to market demand. Some trawlers operating in the east of the North Sea have used 130 mm mesh (to ensure they meet regulations), and this is likely to improve selectivity for haddock. Fish from the moderate 2005 year class now form the bulk of haddock catches, and discarding rates for these fish declined during 2008 and 2009 as they grew beyond the minimum landings size. The decline may also have been due to other measures related to the Scottish Conservation Credits scheme (CCS; see Section 13.1.4).

There have been a number of specific changes with the Scottish fleet in 2009. Many vessels have been spending more time (in some cases, the first four months of the year) in Division VIa and Rockall in order to save their more limited North Sea days allocation. Reduced numbers of larger haddock around Shetland have led to some vessels fishing off north-east Scotland instead at certain times. Some vessels have found that reduced haddock quotas combined with increased costs of leasing have diminished their ability to predominately fish haddock. On the other hand, reduced whiting quota has led other vessels to focus more specifically on haddock.

A more complete history of the North Sea haddock fishery is given in the Stock Annex. It is difficult to conclude what will be the likely effect of the recent fishery changes on haddock mortality. Changes in gear that are required to qualify for the Scottish CCS are likely to reduce bycatch (and therefore) discards of haddock in the

Nephrops fishery in particular. The inclusion of Scottish vessels in the CCS has been mandatory since the beginning of 2009, and compliance has been close to 100%. Cod avoidance under the real-time closures scheme (which is a component of the CCS) could also have moved vessels away from haddock concentrations, but the extent of this depends on how closely cod and haddock distributions are linked, and on how successful the avoidance strategies have been. On the other hand, vessels catching fewer cod may increase their exploitation of haddock in order to maintain economic viability.

Additional information provided by the fishing industry

Haddock are still the mainstay of the Scottish whitefish fleet, and have become increasingly so following cod-avoidance initiatives under the Scottish Conservation Credits scheme. Quota uptake for the international fleet for 2009 was around 73%, which is the highest since 2003 (76%). The projected UK quota uptake for 2010 is thought to be higher still, partly because of the increased importance of haddock mentioned above. UK uptake thus far in 2010 (as of 5th May) was 32.8%, compared with 25.1% at the same date in 2009.

13.1.3 ICES advice

ICES advice for 2009

In June 2008, ICES concluded the following:

> *Based on the most recent estimate of SSB (in 2008) and fishing mortality (in 2007), ICES classifies the stock as having full reproductive capacity and being harvested sustainably. SSB in 2008 is estimated to be above B_{pa}. Fishing mortality in 2007 is estimated to be below F_{pa}, but above the target F_{HCR} (0.3) specified in the EU–Norway management plan. The influence of the strong 1999 year class on the stock is diminishing. The 2005 year class is estimated to be above average.*

As in 2007, the 2008 Q3 North Sea surveys for haddock (EngGFS and ScoGFS) did not change the perception of recruitment significantly compared to the estimates available in June. Therefore, ICES did not change its advice in October 2008.

ICES advice for 2010

In June 2009, ICES concluded the following:

> *Based on the most recent estimate of SSB (in 2009) and fishing mortality (in 2008), ICES classifies the stock as having full reproductive capacity and being harvested sustainably. SSB in 2009 is estimated to be above Bpa, although SSB has been declining since 2002. Fishing mortality in 2008 is estimated to be below Fpa, and below the target FHCR (0.3) specified in the EU–Norway management plan. Recruitment is characterized by occasional large yield-classes, the last of which was the strong 1999 year class. Apart from the 2005 year class which is about average, recent recruitment has been poor.*

The 2009 Q3 North Sea surveys for haddock (EngGFS and ScoGFS) did indicate a significant change in the perception of recruitment compared to the estimates available in June, with evidence of a larger year class than assumed in the forecast. However, on further inspection it became clear that the increased recruitment would not alter the landings forecast according to the management plan. Therefore, ICES did not change its advice in October 2009. However, it should be noted that the forecast of

SSB for 2011 and beyond was significantly increased by the larger year class estimate. It is also worth noting that the forecast revision protocol currently used by ICES is to be reviewed at the WKFREQ meeting planned for August 2010, and may itself be revised.

13.1.4 Management

North Sea haddock are jointly managed by the EU and Norway under an agreed management plan, the details of which are given in the Stock Annex. The plan was modified during 2008 to allow for limited interannual quota flexibility, following the meeting in June of the Norway-EC Working Group on Interannual Quota Flexibility and subsequent simulation analysis (Needle 2008a). The review and potential revision planned for 2009 was postponed until 2010. This review will be conducted by Marine Scotland – Science during the weeks following the May 2010 WGNSSK meeting: it will be based on the updated assessment, so could not be carried out beforehand, and the time required for the evaluations meant that they could not be completed during the WGNSSK meeting itself.

Annual management of the fishery operates through TACs for two discrete areas. The first is Subarea IV and Division IIIa (EC waters), which are considered jointly. The 2009 and 2010 TACs for haddock in this area were 42 110 t and 35 794 t respectively. The second area is Divisions IIIa-d, for which the TACs for 2009 and 2010 were 2 590 t and 2 201 t respectively.

During 2008, 15 real-time closures (RTCs) were implemented under the Scottish Conservation Credits Scheme (CCS). In 2009, 144 RTCs were implemented, and the CCS was adopted by 439 Scottish and around 30 English and Welsh vessels. To date in 2010, 53 RTCs have been generated. The CCS has two central themes aimed at reducing the capture of cod through (i) avoiding areas with elevated abundances of cod through the use of Real Time Closures (RTCs) and (ii) the use of more species selective gears. Within the scheme, efforts are also being made to reduce discards generally. Although the scheme is intended to reduce mortality on cod, it will undoubtedly have an effect on the mortality of associated species such as haddock.

Recent work tracking Scottish vessels in 2009 (Needle, pers. comm.) has concluded that vessels did indeed move from areas of higher to lower cod concentration following real-time closures during the first and third quarters (there was no significant effect during the second and fourth quarters). Whether this effect is positive for haddock (e.g. moving vessels away for areas inhabited by both cod and haddock) or negative (e.g. increasing targeting on haddock to compensate for forgone cod catches) remains to be seen (see also Section 13.1.2). However, early indications suggest that improved gear selectivity is likely to contribute to reductions in fishing mortality and discard levels, particularly of haddock and whiting, and there is evidence that the exploitation patterns for haddock and whiting across all participating vessels have improved since the introduction of the CCS scheme (see, for example, Section 13.4 below).

In early 2008, a one-net rule was introduced in Scotland as part of the CCS. This is likely to have improved the accuracy of reporting of landings to the correct mesh size range. However, Scottish seiners were granted a derogation from the one-net rule until the end of January 2009, and were allowed to carry two nets (e.g. 100-119 mm as well as 120+ mm). They were required to record landings from each net on a separate logsheet and to carry observers when requested (ICES-WGFTFB 2008).

The remaining technical conservation measures in place for the haddock fisheries are summarised in the Stock Annex. New EU effort regulations for 2010 are listed in Section 14.1.

13.2 Data available

Collation issues for catch data

Due to continuing problems in InterCatch with the application of foreign discard rate estimates to unsampled fleets (see Section 1.2), the international catch data for haddock have been aggregated using a spreadsheet approach (as has been the case for the previous three years). Some brief notes are provided here which are intended to clarify issues that have arisen with this process. Further information on the data collation method used can be found in the Stock Annex.

Broadly, the approach to collating the data was the same as for the previous years. However, the approach to raising by the responsible stock coordinator (Marine Scotland - Science) changed, as did procedures for dealing with data by France.

For the data collation of the international landings and discards, the approach to the estimating of discards for unsampled catches was essentially the same as for the previous year, i.e. the discard ratio (of sampled landings to the entire fleets landings) was used to estimate discards allocated to any unsampled catches. The estimated numbers at age and mean weights at age from sampled catches were applied to unsampled catches, weighted by the estimated numbers at age from the sampled catches. In addition, some minor data revisions were received for 2008 from UK(E&W).

Some notes on particular aspects are given under headings below.

Danish discards data

Discards data were received from Denmark but some of the fish weights, particularly those at older ages appeared to be unusual, with several weights at age appearing as simply 0.5kg or 0.4 kg across several (e.g. 4) age classes in a quarter. When this was the case the numbers of fish at age were generally estimated to be very low, perhaps indicating that very few weights were available for the raising process. These features of Danish data submissions were the result of an approach taken by them to assign typical weights and ages when only length data were available

German data

No age composition data were available from Germany.

Norwegian data

Estimates of numbers at age and mean weights at age were provided for Norwegian landings data. The estimates of fish weights at age 1 and age 2 were quite low in comparison to other countries' estimates.

13.2.1 Catch

Official landings data for each country participating in the fishery are presented in Table 13.2.1.1, together with the corresponding WG estimates and the agreed international quota (listed as "total allowable catch", or TAC). The full time series of landings, discards and industrial by-catch (IBC) is presented in Table 13.2.1.2. These data are illustrated further in Figure 13.2.1.1. The total landed yield of the international fishery increased slightly between 2008 and 2009. The WG estimates (Table 13.2.1.2) suggest that haddock discarding decreased further during 2009. This may be due in part to a) the growth beyond the minimum landing size of the moderate 2005 year class, and b) fleet behaviour changes related to cod avoidance measures. Subarea IV discard estimates are derived from data submitted by several countries. As Scotland is the principal haddock fishery in that area, Scottish discard practices dominate the overall estimates. The approach used to collate discard data has changed to conform with the EU Data Collection Framework (DCF), beginning with the 2009 data year. Direct comparisons with the previous method are not available, but the plot of discard rates by age in Figure 13.2.1.2 shows that the 2009 estimates are well within the range of recent variation. This suggests that the new collation method has not changed the perception of discard rates for haddock. Industrial bycatch (IBC) has declined considerably from the high levels observed until the late 1990s.

13.2.2 Age compositions

Total catch-at-age data are given in Table 13.2.2.1, while catch-at-age data for each catch component are given in Tables 13.2.2–4. The fishery in 2009 (landings for human consumption) was still very strongly reliant on the moderate 2005 year class. The strong 1999 year class is still present in the plus-group but is beginning to fade from the fishery: the size of the plus-group is declining from its recent high. Discards predominantly consist of medium-sized fish aged 2-4 (from the 2005-2007 year classes). Vessels seldom exhaust their quota in this fishery, and discarding behaviour is thought to be driven by a complicated mix of economic and other market-driven factors.

13.2.3 Weight at age

Weight-at-age for the total catch in the North Sea is given in Table 13.2.3.1. Weight-at-age in the total catch is a number-weighted average of weight-at-age in the human consumption landings, discards and industrial bycatch components. Weight-at-age in the stock is assumed to be the same as weight-at-age in the total catch. The mean weights-at-age for the separate catch components are given in Tables 13.2.3.2-4 and are illustrated in Figure 13.2.3.1: this shows the declining trend in weights-at–age for older ages, as well as some evidence for reduced growth rates for large year classes. A number of models of haddock growth are currently under development, and this issue will be addressed at the forthcoming haddock benchmark planned for early 2011.

13.2.4 Maturity and natural mortality

Maturity and natural mortality are assumed to be fixed over time and are given below. The basis for these estimates is described in the Stock Annex.

Age	0	1	2	3	4	5	6	7+
Natural mortality	2.05	1.65	0.40	0.25	0.25	0.20	0.20	0.20
Proportion mature	0.00	0.01	0.32	0.71	0.87	0.95	1.00	1.00

13.2.5 Catch, effort and research vessel data

Survey distribution and annual density at age for recent years is given in Figure 13.2.5.1 for the IBTS Q1 survey (for 2004-2010). Figure 13.2.5.2 gives the equivalent survey distribution for the ScoGFS Q3 survey alone (for 2005-2009). All plots show a north to north-westerly distribution of haddock. The moderate 2005 year class can also be identified and tracked through time, and the IBTS Q1 plot shows the emergence of the reasonable 2010 year class.

Data available for calibration of the assessment are presented in Table 13.2.5.1. The LPUE indices from Scottish commercial fleets presented at previous WGs (ScoLtr and ScoSei) can no longer be generated in that form, and as the effort data in those indices was only indicative, it was decided that they should no longer be presented here. The IBTS Q1 data are shown as collated, including the plus-group (ages 6 and older) which cannot be used in standard XSA tuning. XSA also cannot use data from the current year (2010). For this reason, the IBTS Q1 data are backshifted before being used in XSA – that is, all ages and years are reduced by one, and the survey is considered to have taken place at the very end of the previous year.

Trends in survey indices are shown in Figure 13.2.5.3. These indicate reasonably good consistency in stock signals from different surveys: in particular, all three surveys indicate the increase in recruitment for the 2009 year class.

Although (as mentioned above) the previously-available Scottish LPUE series can no longer be generated, effort data from the extant STECF database can be provided. These are summarised for 2000-2008 in Figure 13.2.5.4 for all vessels thought to be capable of participating in the haddock fishery (namely otter trawlers and seiners). International effort declined from 2000 to 2007. The increase in 2008 can be seen to be due mostly to non-Scottish vessels, and so may not have a significant effect on the haddock fishery. Some of the slight increase in Scottish effort is likely to have been due to the development of a seasonal squid fishery in the Moray Firth, which also is thought to have little impact on haddock. 2009 effort data has not yet been collated in this form.

The data available are summarised in the following table: data used in the final assessment are highlighted in bold.

Country	Fleet	Quarter	Code	Year range	Age range available	Age range used
Scotland	Groundfish survey	Q3	**ScoGFS Aberdeen Q3**	**1982-1997**	0-8	**0-7**
	Groundfish survey	Q3	**ScoGFS Q3 GOV**	**1998-2009**	0-8	**0-7**
England	Groundfish survey	Q3	**EngGFS Q3 GRT**	**1977-1991**	0-10+	**0-7**
	Groundfish survey	Q3	**EngGFS Q3 GOV**	**1992-2009**	0-10+	**0-7**
International	Groundfish survey	Q1	**IBTS Q1 (backshifted)**	**1982-2009**	0-5+	**0-4**

13.3 Data analyses

The intention for this year was to perform an update assessment; that is, to carry out the same procedure as last year. This has been done using FLXSA (the FLR implementation of XSA) as the main assessment method. Separable VPA results are presented along with catch curves and intra-series correlations to check for data consistency and validity. The results of a SURBA analysis are also shown, to corroborate the update assessment.

13.3.1 Reviews of last year's assessment

At its meeting in May 2009, RGNSSK raised a number of issues. These are listed below, along with the WG response and actions taken (if applicable).

1) *"There have been some very significant changes in the weights at age in 2008 for ages 4-7. This will have an impact on biomass estimates."*

- Weight modelling for the forecast uses the same procedure as last year (see below). Two papers on growth modelling for haddock are in preparation and will be presented at the forthcoming benchmark early in 2011.

2) *"Many factors have changed in this fishery with the Conservation Credit Scheme (CCS). Real-time closures for cod, one–net rules, etc have likely changed exploitation patterns."*

- Discards have declined, but quota uptake is likely to be larger as vessels seek to avoid cod. Total catch was therefore largely unchanged from 2008 to 2009.

3) *"Age structure could be expanded given they are actually be aged (Table 12.2.2.1). Also noted that plus group is larger than any since mid-1970's."*

- The ages used in the assessment will be considered during the forthcoming benchmark. The plus-group is declining as the 1999 year class diminishes.

The points which have not been addressed here need to be considered during the forthcoming benchmark meeting, to be held early in 2011 (see Section 13.9).

13.3.2 Exploratory catch-at-age-based analyses

i) The catch-at-age data, in the form of log-catch curves linked by cohort (Figure 13.3.2.1), indicates partial recruitment to the fishery up to age 2. Gradients between consecutive values within a cohort from ages 2 to 4 have reduced for recent cohorts, reflecting a reduction in fishing mortality. Recent catch curves have also lost much of the regularity of more historical catch curves, which may reflect the lower sample size available from reduced landings. Figure 13.3.2.2 plots the negative gradient of straight lines fitted to each cohort over the age range 2–4, which can be viewed as a rough proxy for average total mortality for ages 2–4 in the cohort. These negative gradients are also lower in recent cohorts except for an apparent rise in the 2004 cohort, although this has been followed by a sharp decrease for the 2005 cohort.

Cohort correlations in the catch-at-age matrix (plotted as log-numbers) are shown in Figure 13.3.2.3. These correlations show good consistency within cohorts up to the plus-group, verifying the ability of the catch-at-age data to track relative cohort strengths (although data for ages 0 and 1 are slightly more variable).

Residuals from a separable VPA carried out on the catch data (Figure 13.3.2.4) show very few outliers, and none greater than ±3. This supports the conclusion that catch data are appropriately consistent.

Single-fleet XSAs for the final assessment were produced to investigate the sensitivity of XSA to the effects of tuning by individual fleets. Results are shown in Figure 13.3.2.5 for the latter halves of the EngGFS Q3 and ScoGFS Q3 series, as well as for the IBTS Q1 series, with corresponding log-catchability residual plots shown in Figure 13.3.2.6. Overall trends are similar for the three tuning fleets, and the absolute levels are more consistent towards the end of the time series than in last year's WG.

13.3.3 Exploratory survey-based analyses

A SURBA run (version 3.0) was carried out using the same combination of tuning indices as in the update XSA assessments, except that the IBTS Q1 survey was not backshifted as SURBA can accommodate survey data from the current year. The summary plot from this run is given is Figure 13.3.3.1. The stock trends are in broad agreement with those from the XSA assessment. The main exceptions are total mortality, which is estimated to have risen much more quickly during 2003-2006 before falling in 2007 (the rise in the very last year is an artefact of the SURBA model); and SSB which appears to have recovered considerably in 2007 and 2008 with the growth of the moderate 2005 year class. The SURBA estimates of recruitment confirm that the 2006-2009 year classes were poor, and that the 2009 year class appears to be stronger. The IBTS Q1 indices from 2010 are available, but cannot be used directly to indicate recruitment for the 2010 year class as the survey takes place too early in the year for these juveniles to be caught.

Log catch curves for the survey indices are given in Figure 13.3.3.2. Overall, these show good tracking of cohort strength, although there is a tendency for reduced survey catchability on younger ages (shown by the "hooks" at the start of some of the curves). It is also noticeable that catchability characteristics appear to be quite different for each time-period of the ScoGFS survey: the Aberdeen trawl did not appear to catch young haddock as well as the GOV trawl. Cohort correlations in the index-at-age matrices (plotted as log-numbers) are shown in Figure 13.3.3.3. These correlations show good consistency for nearly all of the cohorts and ages used in the final assessment (with a few minor exceptions).

13.3.4 Conclusions drawn from exploratory analyses

Exploratory analyses using survey and catch data do not indicate any serious problems with these data for North Sea haddock. One potential methodological issue remains which has not yet been addressed in the assessment. The update assessment sets the maximum iterations for the FLXSA algorithm to a high value (200), so that the iteration process continues until the algorithm has converged. However, doing this also increases the final-year SSB considerably (see, for example, Figure 13.3.3.4). FLXSA (and XSA) has no goodness-of-fit criteria, and it is not clear what the correct approach should be in this situation. This issue was raised in last year's report, and was explored in considerable detail at the 2009 meeting of WG on Methods of Fish Stock Assessment (ICES-WGMG 2009). WGMG concluded that the length of time the model took to converge was a concern, and also observed (using simulated data) that iterations were as likely to move the assessment away from the true value as towards it. In this year's assessment the previous method has been retained, and it may or may not be a problem, but the WG has concerns about its validity which need to be addressed in the forthcoming benchmark (see Section 13.9).

13.3.5 Final assessment

The final XSA assessment uses the following settings, which are the same as those used last year (except for the addition of another year of data). XSA settings from a number of recent years are compared in the Stock Annex.

Assessment year		2010
q plateau		6
Tuning fleet year ranges	EngGFS Q3	77-91; 92-09
	ScoGFS Q3	82-97; 98-09
	IBTS Q1*	82-09
Tuning fleet age ranges	EngGFS Q3	0-7
	ScoGFS Q3	0-7
	IBTS Q1*	0-4
*Backshifted		

The final XSA assessment tuning diagnostics are presented in Table 13.3.5.1. It should be noted that the estimate of survivors in the plus-group provided by the available version of FLXSA was incorrect (as pointed out during autumn 2009), and this estimate has been overwritten following a spreadsheet-based recalculation. Log-catchability residuals are given in Figure 13.3.5.1, and a comparison of fleet-based contributions to survivors in Figure 13.3.5.2. These do not indicate any reason to deviate from the update procedure. Fishing mortality estimates for the final XSA assessment are presented in Table 13.3.5.2, the stock numbers in Table 13.3.5.3, and the assessment summary in Table 13.3.5.4 and Figure 13.3.5.3. A retrospective analysis, shown in Figure 13.3.5.4, indicates very little retrospective bias in the assessment.

13.4 Historical Stock Trends

The historical stock and fishery trends are presented in Figure 13.3.5.3.

Landings yield has stabilised since 2000, partly due (in the most recent years) to the limitation of inter-annual TAC variation to ±15% in the EU-Norway management plan. Discards have fluctuated in the same period due to the appearance and subsequent growth of the 1999 and 2005 year classes, while industrial bycatch (IBC) is now at a very low level for haddock (see also Figure 13.2.1.1).

The estimated fishing mortality for 2009 has maintained the reduction first seen in 2007, and is estimated to be below the management plan target of 0.3. Fluctuations around the target-F rate of the management plan are an expected consequence of the lag between data collection and management action, and should not be taken to indicate that the plan is not working. The 2006-2008 year classes were weak, and the fishery has been sustained in recent years by the 2005 year class. Recruitment of the 2009 year class shows improvement, although the estimated number of young fish is less than that for the 1999 or 2005 year classes. The final XSA assessment indicates a slow reduction in SSB as the 2005 year class is fished, but the 2009 year class can be expected to impact beneficially on SSB in future if fishing mortality remains low..

13.5 Recruitment estimates

There are no indications of incoming year class strength available to the WG. The ScoGFS and EngGFS Q3 survey indices for 2010 are not yet available. The IBTS Q1 indices are available, but do not include age-0 recruiting fish as these are too small to be caught (or are not yet hatched) when the survey takes place. For this reason, recruitment estimates of the 2010 year class are based on a mean of previous recruitment.

In the past, a strong year class has generally been followed by a sequence of low recruitments (Figure 13.5.1.1). In order to take this feature into account, the geometric mean of the five lowest recruitment values over the period 1994–2007 (3823 millions) has been assumed for recruitment in 2010-2012. Recruitment estimates for 2008 and 2009 are not included in this calculation, because the two most recent XSA estimates of recruitment are thought to be relatively uncertain. The following table summarises the recruitment, age 1 and age 2 assumptions for the short term forecast.

Year class	Age in 2010	XSA estimate (millions)	Geometric mean of 5 lowest recruitments 1994-2007
2008	2	121	
2009	1	467	
2010	0		3823
2011	Age 0 in 2011		3823
2012	Age 0 in 2012		3823

13.6 Short-term forecasts

Weights-at-age

The perceived slow growth of the above-average 1999 and 2000 year classes continues to be modeled in the short-term forecast. Mean stock weights for these year classes were calculated using proportional increments. That is: growth from age a to a+1 for these year classes was estimated using the mean proportional increment (a+1)/a calculated over all other year classes for which this information is available. This method was approved by RGNSSK in 2006 as being appropriate to project weights-at-age, although alternatives are being explored and the issue needs to be considered at a forthcoming benchmark. Mean stock weights for other ages (except the plus-group) in the forecast where taken as a 5-year average (2005–2009), omitting the 1999 and 2000 year classes from the calculation where appropriate. For the plus-group weights, an alternative XSA assessment was run using a plus-group at age 13. The abundances and fishing mortality estimates from this were then used as the basis for a simple deterministic 3-year forecast to give abundances from ages 0-13+ for 2010-2012. These were then used in turn in weighted-average calculations to generate the required forecast mean weights for the plus-group at age 8. The outcome is summarized in Figure 13.6.1.

The human consumption mean weights at age were derived in the same manner as for the stock weights-at-age (see Figure 13.6.2). However, mean weights at age for the 1999 and 2000 year classes did not show unusual growth in the discard and industrial bycatch components, so future mean weights-at-age were set to the average for the years 2005–2009 for these components.

Finally, the weights-at-age for 2009-11 assumed in the forecast presented at last year's WG are compared with the equivalent values set in this year's WG in Figure 13.6.3. These show only minor discrepancies.

Fishing mortality

Estimated mean fishing mortality in 2009 was very similar to 2008, at around 0.23. The WG decided that it would be reasonable to assume that this level would continue into the forecast period. Rather than just use the 2009 fishing mortalities at age for the forecast, a three-year average exploitation pattern scaled to the level of the mean 2009 fishing mortality was used. While this is a change from the update procedure, it gives similar results (see Figure 13.6.4) and is less subject to noise in the most recent assessment year.

Given the choice of fishing-mortality rates discussed above, partial fishing mortality values were obtained for each catch component (human consumption, discards and bycatch) by using the relative contribution (averaged over 2007-2009) of each component to the total catch.

Forecast results

The inputs to the short-term forecast are presented in Table 13.6.1. Results for the short-term forecasts are presented in Table 13.6.2. No TAC constraint in 2010 was used. The *status quo* forecast indicated landings in the intermediate year of 30820 t, which was around 80% of the available quota for 2010 (37995 t). Although this uptake is higher than in recent years, information from the industry suggests that this is quite likely. Full quota uptake is not likely, however, so a TAC constraint in the intermediate year was not thought to be appropriate.

Assuming *status quo* F in both 2010 and 2011, SSB is expected to increase to 212 kt in 2011, and again in 2012 to 228 kt. In this case, human consumption yield will be around 29 kt in 2011, with associated discards of 14 kt. The increase in SSB results from a combination of continued low *F*, and the growth (in individual weight) of members of the 2005 and 2009 year classes. The increase in discards is largely due to the appearance in the fishery of the 2009 year class.

Several alternative options have been highlighted in Table 13.6.2. Among these are a forecast with total fishing mortality fixed to the level specified in the EU-Norway management plan (F = 0.3), and forecasts using a range of estimates of *F*(msy) as the basis (see Section 13.7). Under the management plan, 2011 landings yield of 36 kt (a 5% reduction on the 2010 quota) and discards of 17 kt lead to SSB in 2012 of 218 kt. All of these SSB forecasts for 2012 are above B_{pa} (140 kt) and the the trend in SSB for the near future is likely to be upwards. As usual, further strong year classes will be needed to maintain this increase.

The following table compares the intermediate-year (2009) forecast from the 2009 WG with the 2009 observations and assessment results from the 2010 WG:

WG	Landings 2009	F(landings) 2009	Discards 2009	F(discards) 2009	SSB 2010
2009 forecast	44700	0.15	8647	0.09	170697
2010 assessment	32807	0.13	10548	0.10	193641

Landings in 2009 proved to be around 75% of the TAC-constrained prediction from last year's assessment, which reflects the quota uptake level. Human consumption fishing mortality was consequently slightly less than predicted. On the other hand, discards in 2009 were rather higher than expected, as is the forecast SSB in 2010. This latter point may be due to changes in assumptions on mean weights-at-age, but is more likely to be due to under-utilisation of the quota.

13.7 MSY estimation and medium-term forecasts

No specific medium-term forecasts have been carried out for this stock. However, management simulations over the medium-term period have been performed for haddock (most recently by Needle 2008a, b), as discussed briefly in Section 13.1.4 above.

For the first time this year, the basis for ICES advice will be maximum sustainable yield, or MSY (and associated fishing mortality F_{msy} and biomass $B_{trigger}$). The WG was provided with no specific guidance on how this was to be estimated for different stocks, apart from some useful general comments in the WKFRAME report, and it was left to individual stock assessors to determine draft proposals for MSY for their stocks.

In this Section, nine point estimates for F_{msy} are presented for North Sea haddock, with approximate 90% confidence intervals for each. All estimates were generated using similar age-structured analyses, but differ in details and results. The details concerned include such aspects as the stock-recruitment model used, whether growth and maturity was assumed to be varying or fixed, and how many years were to be used to calculate average growth and maturity. These are difficult issues to resolve, and it is correspondingly difficult to derive a single estimate of F_{msy} for this stock. The following text summarises model results and conclusions, along with a fuller account of the equilibrium model (as this was not used in the same implementation for other stocks in this WG report).

Equilibrium age-structured model

This implementation was developed in the Marine Laboratory, Aberdeen, and is coded in R. It was used to generate F_{msy} estimates for the WKFRAME meeting (ICES-WKFRAME 2010), and the following text is adopted from that report.

F_{msy}, B_{msy} and MSY can be calculated for any given stock, using a combination of fitted stock-recruit, yield-per-recruit and SSB-per-recruit curves. The estimation proceeds as follows:

1) Draw a stock-recruit plot: that is, a curve illustrating the fitted relationship between recruitment R and spawning-stock biomass S. Denote this curve by $R = \mathbf{G}(S)$.

2) Draw a second plot, containing both yield-per-recruit and spawner-per-recruit curves. Denote these by $Y/R = \mathbf{H}(F)$ and $S/R = \mathbf{I}(F)$.

3) For any given F (say, F'), the corresponding point on the spawner-per-recruit curve is given by $S'/R' = \mathbf{I}(F')$.

4) Take the reciprocal, so that $R'/S' = 1/\mathbf{I}(F')$. This denotes the *slope* of a straight line on the stock-recruit plot, that passes through the origin and cuts the curve at $(S', \mathbf{G}(S')) = (S', R')$. Hence such a line on a stock-recruit plot does not specify directly a particular fishing mortality rate, but the reciprocal of its slope does.

5) Iterate through multipliers $E_i \in [0.0, 2.0]$, and hence fishing mortalities (since $F_i = E_i \times F_{sq}$). For any E_i, $R_i/S_i = 1/\mathbf{I}(F_i) = 1/\mathbf{I}(E_i \times F_{sq})$. This is the slope of the line on the stock-recruit plot that intersects the stock-recruit curve at (S_i, R_i).

6) The yield-pre-recruit curve is written as $Y/R = \mathbf{H}(F)$. From this we can obtain yield $Y = R \times \mathbf{H}(F)$. For a given E_i, $Y_i = R_i \times \mathbf{H}(F_i) = R_i \times \mathbf{H}(E_i \times F_{sq})$. Plotting these for all *i* gives the yield curve $Y = \mathbf{J}(F)$, for which we can obtain F_{msy} by maximising:

$$F_{msy} = F \text{ such that } \frac{dY}{dF} = 0.$$

7) Note that the same procedure can be carried out for spawning biomass, so we can plot yield *Y* against spawner biomass *S* to estimate at what biomass yield is maximised.

The calculation is repeated for 1000 bootstrapped stock-recruit curves, which are obtained by sampling from a multivariate normal distribution determined by the variance-covariance matrix of the estimated stock-recruit model parameters,

The assumed form of the underlying stock-recruit curve is very influential in the derivation of F_{msy} estimates, but is also very difficult to determine for North Sea haddock. The main drawback of this particular implementation is that it only includes the Ricker stock-recruit model so far, and thus does not permit evaluation of the sensitivity of F_{msy} estimates to stock-recruit assumptions. It also does not yet allow for annual variation in biological parameters such as growth and maturity. On the other hand, it does carry out retrospective F_{msy} estimation automatically.

Figure 13.7.1 shows the yield-per-recruit curves for each of the catch components, and demonstrates that only one such component (landings) has a maximum YPR. This value (F_{max} = 0.48), along with that of $F_{0.1}$ (0.17), is illustrated in the plot of landings YPR (and SSB per recruit) in Figure 13.7.2. Figure 13.7.3 gives the fitted Ricker stock-recruit curve with confidence limits, along with the multivariate distribution of resampled Ricker parameters for the bootstrap. Note that these are the rescaled Ricker α and β parameters: the resampling is actually carried out for the estimation parameters which are on the log scale.

The deterministic MSY estimates (that is, using only the best-fitting Ricker model) are given in Figure 13.7.4, and summarised in Table 13.7.1 and Figure 13.7.17. Retrospective estimates of MSY and related values are provided in Figure 13.7.5 (fishing mortality), 13.7.6 (biomass) and 13.7.7 (yield). Estimates of F_{msy} have been relatively consistent from year to year, at or around 0.4 with lower and upper bounds of around 0.25 and 0.6 respectively. The estimates of MSY and B_{msy} are uncertain and smoothly varying through time, but are seldom significantly different from the historical landings estimate. However, the most recent estimates for F, SSB and landings yield are now all below their MSY-derived counterparts.

The ADMB model (with or without biological variation)

The ADMB model is described in detail in Section 1.3.1 – here we only present the output plots (Figures 13.7.7 to 13.7.12) and compare results with the other models in Figure 13.7.17. and Table 13.7.1.

The FLR model

The FLR model is also described in detail elsewhere (Section 1.3.2), and as above, we will restrict ourselves here to output plots (Figures 13.7.13 to 13.7.16) and results comparisons (Figure 13.7.17, Table 13.7.1).

Conclusion

Figure 13.7.17 and Table 13.7.1 compares the values and confidence limits of F_{msy} estimated using nine different approaches (and four separate software implementations). The mean point estimates lie in the range 0.25 - 0.43: this widens to 0.18 - 0.60 when confidence intervals are included. Although this is quite wide, the overall impression from Figure 13.7.17 is that F_{msy} is likely to lie above the target value in the EU-Norway management plan (0.3) and the *status quo* assessment estimate (around 0.25). It is not straightforward to understand how these F_{msy} estimates could be this high. Two potential hypotheses have been considered by the WG: the spasmodic nature of haddock recruitment may permit higher sustainable exploitation than would otherwise be the case, or it may be that the spasmodic recruitment pattern renders equilibrium analyses unreliable. Certainly the management evaluations carried out for this stock (Needle 2008a,b), which used more dynamic recruitment simulations and did not assume equilibrium, concluded that the maximum sustainable yield was likely to occur at or around an F value of 0.3. The WG has not been able to reach a definitive conclusion on this matter.

13.8 Biological reference points

Biological reference points for this stock are given in the Stock Annex.

13.9 Quality of the assessment

Survey data are consistent both within and between surveys, and the catch data are internally consistent. Trends in mortality from catch data and survey indices are quite similar. Only minor changes were made to the data collation or assessment methodology from last year's assessment. There is very little retrospective bias. The stock estimates from the current and previous assessments are compared in Figure 13.9.1.

Several issues remain of some concern with the assessment, and will need to be addressed during the forthcoming benchmark process early in 2011:-

1) The issue of stock structure and identity for haddock in the north-east Atlantic is potentially very important. A number of studies in recent years have suggested that haddock spawned on the west coast of Scotland (Division VIa) may contribute to the North Sea population, and there is evidence of strong links between the two stocks. This needs to be investigated at the benchmark meeting, which should therefore also include consideration of the Division VIa assessment.
2) The SSB estimates generated by the XSA/FLXSA model is strongly dependent (for haddock) on the number of algorithm iterations permitted. Interim results suggest that changes of ±40% or more are possible. There is no goodness-of-fit statistic in XSA which would help in the determination of the most suitable number of iterations, so the choice becomes essentially *ad hoc*. This is not a satisfactory situation and will have to be remedied. Alternative models should be explored, following work done by WGMG (ICES-WGMG 2009).
3) Haddock growth is not yet clearly understood, and may be driven by density-dependent effects, environmental influences or a combination of both.. The pragmatic solution of applying proportional increments as a basis for predicting the weight at age for the 1999 and 2000 year classes incorporates the history of growth in the stock, while recognising the apparent slow

growth rate of these cohorts. However, scientific papers currently in preparation will suggest that alternative growth models may be more appropriate, and these need to be explored further.

4) In a similar vein, the proportion of mature individuals in each age-class is likely to vary by year and cohort. The effect of using year specific maturity data obtained from surveys should be considered, as well as methods by which this can be modelled in forecasts. The same consideration applies to estimates of natural mortality (M); biannually-updated values of M are now used in the assessment for North Sea cod, for example (see Section 14).

5) Exploitation rates also vary by cohort. The implications of this for forecasting should be addressed.

6) It is likely that haddock will continue to experience sporadic large year classes. The problem of how to accommodate these year classes in the plus-group structure of the assessment will therefore not go away, and a robust approach is needed that will remove the requirement to change the plus-group whenever a large year class enters it.

7) Survey indices from the IBTS Q1 series have traditionally been supplied by ICES using a 6+ age group. Information on large year classes at ages older than 5 is therefore lost from the tuning process. The WG recommends that ICES supply these data for a greater true age range, and that the implications of this be explored in the benchmark assessment.

8) The haddock assessment uses separate Scottish and English Q3 groundfish survey series, rather than the combined IBTS Q3 series. The former are longer, but the latter has more sample points and should therefore be less variable. This choice should be considered in detail, although recognising that the IBTS Q3 series itself has caused problems for this year's cod and saithe assessments (see, for example, Section 14).

9) A longer time-series of discard data from UK(E&W) was made available this year (see Section 13.2). Its inclusion in the overall discard estimation procedure is a question that should be resolved.

10) The benchmark meeting may be an opportunity to reconsider the question of F_{msy} for North Sea haddock, which was left unresolved in Section 13.7 above.

13.10 Status of the Stock

The historical perception of the haddock stock remains unchanged from last year's assessment. Fishing mortality is now estimated to have remained at a low level (around 0.23) in 2009 and is now close to the historical minimum. This is well below F_{pa} (0.7), and is also lower than the mortality rate recommended in the management plan (0.3) and most interim estimates of F_{msy}. Discards have also decreased in 2009, possibly due to the growth past the MLS of fish of the 2005 year class, although discards are likely to increase again in the near future as the moderate 2009 year class enters the fishery. Spawning stock biomass (178 kt in 2009) is predicted to increase in the near future, and remains well above B_{pa} (140 kt). The 2006-2008 year classes were estimated to be weak, but the 2009 year class is thought to be stronger.

Figure 13.10.1 gives the results of the North Sea stock survey from 2009. The international industry perception is of increasing haddock abundance in the central and northern North Sea in 2009, which is borne out by landings data (if not necessarily by

SSB estimates for that year). Anecdotal information from the Scottish industry agrees with the perception of increasing or stable haddock numbers, although this varies form area to area: for example, haddock (particularly large haddock) have not been particularly plentiful around Shetland.

13.11 Management Considerations

In 2006 the EU and Norway agreed a revised management plan for this stock, which states that every effort will be made to maintain a minimum level of SSB greater than 100 000 t (B_{lim}). Furthermore, fishing will be restricted on the basis of a TAC consistent with a fishing mortality rate of no more than 0.30 for appropriate age groups, along with a limitation on interannual TAC variability of ±15%. Following a minor revision in 2008, interannual quota flexibility ("banking and borrowing") of up to ±10% is permitted (although this facility has not yet been used). The stipulations of the management plan have been adhered to by the EU and Norway since its implementation in January 2007. Fishing mortality fell while the 1999 year class dominated the fishery, and this year class was allowed to contribute to the fishery and the stock for much longer than if the plan had not been in place. SSB has declined as the 1999 year class has passed out of the stock, although the decline has been slowed temporarily by the growth of the moderately-sized 2005 year class. The slightly less abundant 2009 year class is predicted in short-term forecasts to lead to future increases in SSB, but further good year classes will be required to maintain this rise. F now appears to fluctuating around or below the target level (0.3) as predicted by management evaluations.

Keeping fishing mortality close to the target level would be preferable to encourage the sustainable exploitation of the 2005 and 2009 year classes. As the 2005 year class entered the fishery, discards were fairly substantial in 2006 and 2007, although they were considerably lower in 2008 and 2009. Discards are predicted to increase in 2011 and beyond as the 2009 year class enters the fishery. Further improvements to gear selectivity measures, allowing for the release of small fish, would be highly beneficial not only for the haddock stock, but also for the survival of juveniles of other species that occur in mixed fisheries along with haddock. Similar considerations also apply to spatial management approaches (such as real-time closures), and other measures intended to reduce unwanted bycatch and discarding of various species (such as the Scottish Conservation Credits scheme; see Section 13.1.4).

Haddock is a specific target for some fleets, but is also caught as part of a mixed fishery catching cod, whiting and Nephrops. It is important to consider both the species-specific assessments of these species for effective management, as well as the latest developments in the mixed fisheries approach. This is not straightforward when stocks are managed via a series of single-species management plans that do not incorporate mixed-stocks considerations. However, a reduction in effort on one stock may lead to a reduction or an increase in effort on another, and the implications of any change need to be considered carefully.

References

ICES-WGMG, 2009. Report of the ICES Working Group on Methods of Fish Stock Assessment. ICES CM 2009/RMC:12.

Needle, C. L., 2008a. Evaluation of interannual quota flexibility for North Sea haddock: Final report. Working paper for the ICES Advisory Committee (ACOM), September 2008.

Needle, C. L., 2008b. Management strategy evaluation for North Sea haddock. *Fisheries Research*, 94(2): 141–150.

Table 13.2.1.1. Haddock in Subarea IV and Division IIIa. Nominal landings (000 t) during 2002–2009, as officially reported to, and estimated by, ICES, along with WG estimates of catch components, and corresponding TACs. Landings estimates for 2009 are preliminary. Quota up-take estimates are also given, calculated as the WG estimates of landings divided by available quota.

Sum of Landings		Year								
ICES area	Country	2002	2003	2004	2005	2006	2007	2008	2009	2010
Division IIIa	Belgium	0	0	0	0	0	0	0		
	Denmark	3791	1741	1116	615	1001	1054	1052		
	Faeroe Islands	0	0	0	0	0	0	0		
	Germany	239	113	69	69	186	206	87	105	
	Netherlands	0	6	1	0	0	0	0	0	
	Norway	149	211	154	93	113	152	170	121	
	Portugal	0	0	0	0	30	37	0		
	Sweden	393	165	158	180	246	278	276	165	
	UK - Eng+Wales+N.Irl.	0	0	0	0	0	0	0		
	UK - Scotland	0	0	0	0	0	0	0		
	UK - all								0	
Division IIIa Total		4572	2236	1498	957	1576	1727	1585	391	
Subarea IV	Belgium	559	374	373	190	105	179	113	108	
	Denmark	5123	3035	2075	1274	759	645	501		
	Faeroe Islands	25	12	22	22	4	0	3		
	France	914	1108	552	439	444	498	448		
	Germany	852	1562	1241	733	725	727	393	657	
	Greenland	0	149	686	18	5	8	0		
	Ireland	0	1	0	0	0	0	0		
	Netherlands	359	187	104	64	33	55	29	27	
	Norway	2404	2196	2258	2089	1798	1706	1482	1276	
	Poland	17	16	0	0	8	8	16	0	
	Portugal	0	0	0	0	76	0	0		
	Sweden	572	477	188	135	100	130	83	141	
	UK - Eng+Wales+N.Irl.	3647	1561	1159	651	485	1799	1378		
	UK - Scotland	39624	31527	39339	25319	31905	24919	25987		
	UK - all								28475	
Subarea IV Total		54096	42205	47997	30934	36447	30674	30433	30684	
TAC	TAC IIIa	6300	3150	4940	4018	3189	3360	2856	2590	2201
	TAC IV	104000	51735	77000	66000	51850	54640	46444	42110	35794
TAC Total		110300	54885	81940	70018	55039	58000	49300	44700	37995
WG Division I	WG estimates of discards	0	195	112	217	970	816	646	556	
	WG estimates of IBC	0	0	0	0	0	0	0	0	
	WG estimates of landings	4137	1808	1443	764	1537	1515	1374	1515	
WG Division IIIa Total		4137	2003	1555	981	2507	2332	2020	2072	
WG Subarea	WG estimates of discards	45892	23499	15439	8416	16943	27805	12532	9986	
	WG estimates of IBC	3717	1150	554	168	535	48	199	52	
	WG estimates of landings	54171	40140	47253	47616	36074	29418	28893	31264	
WG Subarea IV Total		103780	64788	63246	56200	53551	57271	41624	41302	

WG estimated quota uptake	53%	76%	59%	69%	68%	53%	61%	73%

Table 13.2.1.2. Haddock in Subarea IV and Division IIIa. Working Group estimates of catch components by weight (000 tonnes).

	Subarea IV				Division IIIa(N)				Combined			
Year	Landings	Discards	IBC	Total	Landings	Discards	IBC	Total	Landings	Discards	IBC	Total
1963	68.4	189.3	13.7	271.4	0.4	-	-	0.4	68.8	189.3	13.7	271.8
1964	130.6	160.3	88.6	379.5	0.4	-	-	0.4	131.0	160.3	88.6	379.9
1965	161.7	62.3	74.6	298.6	0.7	-	-	0.7	162.4	62.3	74.6	299.3
1966	225.6	73.5	46.7	345.8	0.6	-	-	0.6	226.2	73.5	46.7	346.3
1967	147.4	78.2	20.7	246.3	0.4	-	-	0.4	147.7	78.2	20.7	246.7
1968	105.4	161.8	34.2	301.4	0.4	-	-	0.4	105.8	161.8	34.2	301.8
1969	331.1	260.1	338.4	929.5	0.5	-	-	0.5	331.6	260.1	338.4	930.0
1970	524.1	101.3	179.7	805.1	0.7	-	-	0.7	524.8	101.3	179.7	805.8
1971	235.5	177.8	31.5	444.8	2.0	-	-	2.0	237.5	177.8	31.5	446.8
1972	193.0	128.0	29.6	350.5	2.6	-	-	2.6	195.5	128.0	29.6	353.1
1973	178.7	114.7	11.3	304.7	2.9	-	-	2.9	181.6	114.7	11.3	307.6
1974	149.6	166.4	47.5	363.5	3.5	-	-	3.5	153.1	166.4	47.5	367.0
1975	146.6	260.4	41.5	448.4	4.8	-	-	4.8	151.3	260.4	41.5	453.2
1976	165.7	154.5	48.2	368.3	7.0	-	-	7.0	172.7	154.5	48.2	375.3
1977	137.3	44.4	35.0	216.7	7.8	-	-	7.8	145.1	44.4	35.0	224.5
1978	85.8	76.8	10.9	173.5	5.9	-	-	5.9	91.7	76.8	10.9	179.4
1979	83.1	41.7	16.2	141.0	4.0	-	-	4.0	87.1	41.7	16.2	145.0
1980	98.6	94.6	22.5	215.7	6.4	-	-	6.4	105.0	94.6	22.5	222.1
1981	129.6	60.1	17.0	206.7	6.6	-	-	6.6	136.1	60.1	17.0	213.2
1982	165.8	40.6	19.4	225.8	7.5	-	-	7.5	173.3	40.6	19.4	233.3
1983	159.3	66.0	12.9	238.2	6.0	-	-	6.0	165.3	66.0	12.9	244.2
1984	128.2	75.3	10.1	213.6	5.4	-	-	5.4	133.6	75.3	10.1	218.9
1985	158.6	85.2	6.0	249.8	5.6	-	-	5.6	164.1	85.2	6.0	255.4
1986	165.6	52.2	2.6	220.4	2.7	-	-	2.7	168.2	52.2	2.6	223.1
1987	108.0	59.1	4.4	171.6	2.3	-	-	2.3	110.3	59.1	4.4	173.9
1988	105.1	62.1	4.0	171.2	1.9	-	-	1.9	107.0	62.1	4.0	173.1
1989	76.2	25.7	2.4	104.2	2.3	-	-	2.3	78.4	25.7	2.4	106.5
1990	51.5	32.6	2.6	86.6	2.3	-	-	2.3	53.8	32.6	2.6	88.9
1991	44.7	40.2	5.4	90.2	3.1	-	-	3.1	47.7	40.2	5.4	93.3
1992	70.2	47.9	10.9	129.1	2.6	-	-	2.6	72.8	47.9	10.9	131.7
1993	79.6	79.6	10.8	169.9	2.6	-	-	2.6	82.2	79.6	10.8	172.5
1994	80.9	65.4	3.6	149.8	1.2	-	-	1.2	82.1	65.4	3.6	151.0
1995	75.3	57.4	7.7	140.4	2.2	-	-	2.2	77.5	57.4	7.7	142.6
1996	76.0	72.5	5.0	153.5	3.1	-	-	3.1	79.2	72.5	5.0	156.6
1997	79.1	52.1	6.7	137.9	3.4	-	-	3.4	82.5	52.1	6.7	141.3
1998	77.3	45.2	5.1	127.6	3.8	-	-	3.8	81.1	45.2	5.1	131.3
1999	64.2	42.6	3.8	110.7	1.4	-	-	1.4	65.6	42.6	3.8	112.0
2000	46.1	48.8	8.1	103.0	1.5	-	-	1.5	47.6	48.8	8.1	104.5
2001	39.0	118.3	7.9	165.2	1.9	-	-	1.9	40.9	118.3	7.9	167.1
2002	54.2	45.9	3.7	103.8	4.1	-	-	4.1	58.3	45.9	3.7	107.9
2003	40.1	23.5	1.1	64.8	1.8	0.2	-	2.0	41.9	23.7	1.1	66.8
2004	47.3	15.4	0.6	63.2	1.4	0.1	-	1.6	48.7	15.6	0.6	64.8
2005	47.6	8.4	0.2	56.2	0.8	0.2	-	1.0	48.4	8.6	0.2	57.2
2006	36.1	16.9	0.5	53.6	1.5	1.0	-	2.5	37.6	17.9	0.5	56.1
2007	29.4	27.8	0.0	57.3	1.5	0.8	-	2.3	30.9	28.6	0.0	59.6
2008	28.9	12.5	0.2	41.6	1.4	0.6	-	2.0	30.3	13.2	0.2	43.6
2009	31.3	10.0	0.1	41.3	1.5	0.6	-	2.1	32.8	10.5	0.1	43.4
Min	28.9	8.4	0.0	41.6	0.4	0.1	-	0.4	30.3	8.6	0.0	43.6
Mean	118.1	81.0	27.3	226.3	2.9	0.5	-	2.9	121.0	81.1	27.3	229.3
Max	524.1	260.4	338.4	929.5	7.8	1.0	-	7.8	524.8	260.4	338.4	930.0

- denotes missing data.

Table 13.2.2.1. Haddock in Subarea IV and Division IIIa. Numbers at age data (thousands) for total catch. Data used in the assessment are highlighted in bold.

	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	8+
1963	**1359**	**1305780**	**334952**	**20958**	**13026**	**5780**	**502**	**653**	566	59	18	0	0	0	0	0	**643**
1964	**139777**	**7425**	**1295363**	**135110**	**9066**	**5348**	**2405**	**287**	236	231	25	0	0	0	0	0	**492**
1965	**649768**	**367500**	**15151**	**649052**	**29485**	**4659**	**1972**	**452**	107	90	41	0	0	0	0	0	**238**
1966	**1666973**	**1005922**	**25658**	**6423**	**412510**	**9978**	**1045**	**601**	165	90	23	2	0	0	0	0	**280**
1967	**305249**	**837155**	**89068**	**4863**	**3585**	**177851**	**2443**	**215**	216	57	34	0	0	0	0	0	**307**
1968	**11105**	**1097030**	**439209**	**19592**	**1947**	**2528**	**45971**	**325**	40	13	5	0	0	0	0	0	**58**
1969	**72559**	**20469**	**3575922**	**303333**	**7594**	**2410**	**2515**	**19128**	200	24	7	0	0	0	0	0	**231**
1970	**924601**	**266151**	**218362**	**1908087**	**57430**	**1178**	**1196**	**256**	5954	67	11	19	0	0	0	0	**6051**
1971	**330673**	**1810248**	**70951**	**47518**	**400415**	**10371**	**462**	**195**	147	1592	160	3	5	0	0	0	**1907**
1972	**240896**	**676001**	**586824**	**40591**	**21211**	**157994**	**3563**	**190**	34	27	408	11	0	0	0	0	**480**
1973	**59872**	**364918**	**570428**	**240603**	**6192**	**4467**	**39459**	**1257**	108	29	109	49	5	0	0	0	**300**
1974	**601412**	**1214416**	**175587**	**331870**	**54206**	**1873**	**1348**	**10917**	242	23	32	4	5	0	0	0	**306**
1975	**44946**	**2097588**	**639003**	**58837**	**108892**	**15808**	**983**	**620**	2714	266	63	11	0	8	0	0	**3062**
1976	**167173**	**167693**	**1055191**	**210308**	**9950**	**31186**	**4995**	**206**	76	759	60	3	0	0	0	0	**898**
1977	**114954**	**250593**	**106012**	**390344**	**40051**	**4304**	**6261**	**1300**	135	29	200	3	0	1	0	0	**368**
1978	**285842**	**454920**	**146179**	**30321**	**113601**	**8704**	**1264**	**2075**	402	116	15	64	13	2	0	0	**612**
1979	**841439**	**345398**	**203196**	**41225**	**7402**	**28006**	**2235**	**262**	483	152	54	12	11	1	0	0	**713**
1980	**374959**	**660144**	**331838**	**72505**	**10392**	**1897**	**8061**	**598**	121	162	75	31	9	3	1	0	**402**
1981	**646419**	**134440**	**421348**	**142948**	**15205**	**2034**	**457**	**2498**	125	64	23	30	4	1	3	0	**250**
1982	**278705**	**275385**	**85474**	**299211**	**41382**	**3377**	**713**	**279**	784	30	15	7	2	2	0	0	**840**
1983	**639814**	**156256**	**251703**	**73666**	**127173**	**16480**	**1708**	**297**	61	190	53	6	4	4	0	0	**318**
1984	**95502**	**432178**	**167411**	**122784**	**22067**	**32649**	**3788**	**596**	84	41	112	16	5	1	1	0	**260**
1985	**139579**	**178878**	**533698**	**78633**	**37430**	**5303**	**7354**	**965**	212	52	21	88	4	0	0	0	**377**
1986	**56503**	**160359**	**178798**	**323638**	**27682**	**9690**	**1237**	**1810**	237	117	49	32	36	13	4	1	**489**
1987	**9419**	**277705**	**250003**	**47378**	**67865**	**4760**	**2877**	**545**	778	135	36	50	27	29	5	8	**1068**
1988	**10808**	**29420**	**484481**	**89071**	**13432**	**18579**	**1602**	**639**	166	141	50	18	11	10	15	1	**412**
1989	**10704**	**47271**	**35097**	**182331**	**18037**	**2631**	**4044**	**508**	199	83	30	13	6	2	2	1	**337**
1990	**55473**	**81336**	**101513**	**18674**	**56696**	**3731**	**878**	**1320**	206	78	41	11	11	1	4	2	**354**
1991	**123910**	**224136**	**78092**	**23167**	**3882**	**12525**	**976**	**401**	614	148	54	6	5	1	2	1	**831**
1992	**270758**	**194249**	**252884**	**32482**	**6550**	**1250**	**4861**	**454**	300	293	124	22	6	2	0	0	**747**
1993	**141209**	**345275**	**261834**	**108395**	**7105**	**1697**	**450**	**1138**	146	103	144	59	3	2	0	0	**457**
1994	**85966**	**96850**	**296528**	**100465**	**29608**	**1919**	**573**	**191**	509	115	32	27	25	5	0	0	**713**
1995	**201260**	**296237**	**85826**	**167801**	**25875**	**7644**	**511**	**127**	45	62	19	8	6	2	1	0	**143**
1996	**148437**	**46689**	**357942**	**56894**	**55147**	**7503**	**3052**	**756**	52	31	25	5	8	3	1	0	**125**
1997	**28855**	**132262**	**85854**	**213293**	**15273**	**15407**	**1892**	**679**	62	15	12	4	4	4	2	0	**103**
1998	**22115**	**82770**	**166732**	**49550**	**107995**	**5741**	**3561**	**472**	140	14	6	5	2	2	1	1	**171**
1999	**84408**	**80970**	**121249**	**87242**	**24740**	**39860**	**2338**	**1595**	342	41	6	2	1	1	0	0	**393**
2000	**6632**	**349063**	**88623**	**43352**	**26357**	**6026**	**8708**	**560**	234	32	12	2	1	1	0	0	**282**
2001	**2531**	**85436**	**632880**	**32344**	**8886**	**4123**	**1561**	**1305**	195	64	17	3	1	0	0	0	**280**
2002	**50754**	**18400**	**66343**	**242196**	**6547**	**2039**	**1066**	**549**	458	265	15	8	5	0	0	0	**751**
2003	**9072**	**19548**	**14261**	**44747**	**109063**	**1969**	**602**	**271**	109	89	38	5	1	0	0	0	**243**
2004	**1030**	**10538**	**18122**	**6573**	**34945**	**91121**	**724**	**147**	56	35	35	10	1	0	0	0	**137**
2005	**4814**	**10505**	**18394**	**11385**	**3329**	**25077**	**58753**	**314**	89	34	10	7	4	1	0	0	**145**
2006	**2412**	**106506**	**26164**	**16813**	**7482**	**2970**	**13685**	**30229**	123	29	16	6	3	0	0	0	**177**
2007	**1788**	**18788**	**155749**	**13899**	**6463**	**2353**	**1426**	**5973**	6776	69	7	14	3	1	0	0	**6870**
2008	**1940**	**12595**	**29534**	**70919**	**4169**	**1440**	**648**	**311**	1247	2448	5	8	1	1	0	0	**3710**
2009	**8462**	**6043**	**14868**	**20335**	**71832**	**1349**	**510**	**313**	160	236	538	6	2	0	0	0	**942**

Table 13.2.2.2. Haddock in Subarea IV and Division IIIa. Numbers at age data (thousands) for landings. Data used in the assessment are highlighted in bold.

	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	8+
1963	**0**	**27353**	**118185**	**16692**	**12212**	**5644**	**498**	**653**	566	59	18	0	0	0	0	0	**643**
1964	**0**	**48**	**250523**	**86368**	**8166**	**4689**	**2283**	**286**	236	231	25	0	0	0	0	0	**492**
1965	**0**	**2636**	**3445**	**335396**	**23479**	**4063**	**1852**	**446**	107	90	41	0	0	0	0	0	**238**
1966	**0**	**12976**	**6724**	**4250**	**372535**	**9188**	**1018**	**599**	165	90	23	2	0	0	0	0	**280**
1967	**0**	**54953**	**33894**	**3845**	**3345**	**174011**	**2421**	**215**	216	57	34	0	0	0	0	0	**307**
1968	**0**	**18443**	**139035**	**14557**	**1806**	**2495**	**45047**	**324**	40	13	5	0	0	0	0	0	**58**
1969	**0**	**139**	**713860**	**166997**	**6542**	**2014**	**2381**	**18876**	200	24	7	0	0	0	0	0	**231**
1970	**0**	**2259**	**51861**	**1133133**	**50823**	**1012**	**1131**	**254**	5954	67	11	19	0	0	0	0	**6051**
1971	**0**	**34019**	**25862**	**35168**	**369443**	**10006**	**455**	**195**	147	1592	160	3	5	0	0	0	**1907**
1972	**0**	**12778**	**207267**	**33215**	**19853**	**156344**	**3550**	**190**	34	27	408	11	0	0	0	0	**480**
1973	**0**	**6024**	**205717**	**193852**	**5829**	**4238**	**39336**	**1257**	108	29	109	49	5	0	0	0	**300**
1974	**0**	**23993**	**52416**	**227998**	**46793**	**1785**	**1232**	**10693**	242	23	32	4	5	0	0	0	**306**
1975	**0**	**24144**	**200961**	**38295**	**90302**	**15524**	**978**	**620**	2709	266	63	11	0	8	0	0	**3057**
1976	**0**	**2301**	**223465**	**142803**	**9721**	**28103**	**4978**	**206**	76	759	60	3	0	0	0	0	**898**
1977	**0**	**8484**	**31741**	**249285**	**37092**	**4057**	**6021**	**1300**	135	29	200	3	0	1	0	0	**368**
1978	**0**	**12883**	**54630**	**25305**	**100036**	**8568**	**1152**	**2070**	402	116	15	64	13	2	0	0	**612**
1979	**0**	**14009**	**110008**	**36486**	**7284**	**27543**	**2219**	**262**	483	152	54	12	11	1	0	0	**713**
1980	**0**	**8982**	**141895**	**61901**	**9063**	**1843**	**7975**	**591**	121	161	75	31	9	3	1	0	**401**
1981	**0**	**1759**	**153466**	**112407**	**14679**	**2025**	**455**	**2498**	125	64	23	30	4	1	3	0	**250**
1982	**0**	**7373**	**38819**	**236209**	**37728**	**2913**	**713**	**279**	784	30	15	7	2	2	0	0	**840**
1983	**0**	**7101**	**109201**	**52566**	**117819**	**15760**	**1603**	**297**	61	190	53	6	4	4	0	0	**318**
1984	**0**	**19501**	**75963**	**104651**	**21372**	**31874**	**3788**	**596**	84	41	112	16	5	1	1	0	**260**
1985	**0**	**2120**	**248125**	**70806**	**36734**	**5076**	**7329**	**965**	212	52	21	88	4	0	0	0	**377**
1986	**0**	**12132**	**62362**	**261225**	**27548**	**9671**	**1237**	**1810**	237	117	49	32	36	13	4	1	**489**
1987	**0**	**6896**	**113196**	**37763**	**66221**	**4760**	**2877**	**545**	778	135	36	50	27	29	5	8	**1068**
1988	**0**	**1524**	**146403**	**76925**	**12024**	**18310**	**1602**	**639**	166	141	50	18	11	10	15	1	**412**
1989	**0**	**4519**	**16387**	**128051**	**16762**	**2574**	**3916**	**498**	199	83	30	13	6	2	2	1	**336**
1990	**0**	**5493**	**43168**	**14338**	**45015**	**3269**	**775**	**1242**	202	78	41	11	11	1	4	2	**350**
1991	**0**	**19482**	**46902**	**21841**	**3812**	**12337**	**976**	**401**	614	148	54	6	5	1	2	1	**831**
1992	**0**	**2853**	**117953**	**28828**	**6485**	**1247**	**4779**	**454**	300	293	124	22	6	2	0	0	**747**
1993	**0**	**2488**	**77820**	**86806**	**6976**	**1686**	**450**	**1119**	146	103	144	59	3	2	0	0	**457**
1994	**0**	**467**	**69457**	**70354**	**27587**	**1860**	**524**	**191**	509	115	32	27	25	5	0	0	**713**
1995	**0**	**1870**	**29177**	**101663**	**24715**	**7565**	**511**	**127**	45	62	19	8	6	2	1	0	**143**
1996	**0**	**742**	**74892**	**36685**	**47168**	**7501**	**3052**	**756**	52	31	25	5	8	3	1	0	**125**
1997	**0**	**1409**	**23943**	**123178**	**14028**	**15208**	**1892**	**679**	62	15	12	4	4	4	2	0	**103**
1998	**0**	**822**	**38321**	**36736**	**92738**	**5607**	**3543**	**472**	140	14	6	5	2	2	1	1	**171**
1999	**0**	**994**	**25856**	**53192**	**23301**	**37630**	**2155**	**1595**	342	41	6	2	1	1	0	0	**393**
2000	**0**	**4750**	**30316**	**28653**	**23407**	**5873**	**8644**	**560**	234	32	12	2	1	1	0	0	**282**
2001	**0**	**611**	**67196**	**16117**	**7406**	**3929**	**1561**	**1295**	191	64	17	3	1	0	0	0	**276**
2002	**0**	**639**	**13666**	**111346**	**5640**	**2004**	**1066**	**419**	458	265	15	8	5	0	0	0	**751**
2003	**0**	**32**	**1091**	**13925**	**73059**	**1920**	**571**	**270**	109	89	38	5	1	0	0	0	**242**
2004	**0**	**481**	**2897**	**4101**	**22159**	**73191**	**710**	**139**	56	35	35	10	1	0	0	0	**137**
2005	**0**	**782**	**5490**	**8086**	**2926**	**21703**	**54742**	**313**	89	34	10	7	4	1	0	0	**145**
2006	**0**	**2062**	**9849**	**10267**	**6302**	**2705**	**12486**	**28158**	116	28	15	6	3	0	0	0	**168**
2007	**0**	**1111**	**28030**	**10083**	**5932**	**2290**	**1422**	**5918**	6705	69	7	14	3	1	0	0	**6799**
2008	**0**	**278**	**6176**	**48247**	**3915**	**1401**	**625**	**309**	1241	2444	5	8	1	1	0	0	**3700**
2009	**0**	**481**	**4548**	**9477**	**58043**	**1289**	**506**	**312**	160	235	534	6	2	0	0	0	**937**

Table 13.2.2.3. Haddock in Subarea IV and Division IIIa. Numbers-at-age data (thousands) for discards. Data used in the assessment are highlighted in bold.

	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	8+
1963	**42**	**1047925**	**193718**	**3476**	**708**	**51**	**2**	**0**	0	0	0	0	0	0	0	0	**0**
1964	**2395**	**4182**	**623111**	**13597**	**262**	**21**	**10**	**0**	0	0	0	0	0	0	0	0	**0**
1965	**5307**	**110628**	**4020**	**130369**	**3641**	**4**	**1**	**0**	0	0	0	0	0	0	0	0	**0**
1966	**7880**	**444111**	**12388**	**1166**	**24114**	**35**	**2**	**0**	0	0	0	0	0	0	0	0	**0**
1967	**6250**	**389691**	**49635**	**863**	**216**	**1576**	**9**	**0**	0	0	0	0	0	0	0	0	**0**
1968	**39**	**615649**	**219022**	**3006**	**94**	**15**	**186**	**0**	0	0	0	0	0	0	0	0	**0**
1969	**1732**	**5152**	**1158445**	**37686**	**420**	**16**	**8**	**0**	0	0	0	0	0	0	0	0	**0**
1970	**51717**	**92978**	**77992**	**289679**	**2640**	**13**	**4**	**0**	0	0	0	0	0	0	0	0	**0**
1971	**7586**	**1205838**	**35117**	**8960**	**24590**	**66**	**2**	**0**	0	0	0	0	0	0	0	0	**0**
1972	**4231**	**424657**	**322547**	**6353**	**1212**	**1212**	**13**	**0**	0	0	0	0	0	0	0	0	**0**
1973	**18540**	**241423**	**352310**	**46740**	**352**	**33**	**123**	**0**	0	0	0	0	0	0	0	0	**0**
1974	**24758**	**915157**	**90904**	**57011**	**2814**	**6**	**4**	**0**	0	0	0	0	0	0	0	0	**0**
1975	**630**	**1478590**	**353422**	**15781**	**13388**	**143**	**0**	**0**	0	0	0	0	0	0	0	0	**0**
1976	**2191**	**98420**	**648662**	**38317**	**183**	**137**	**0**	**0**	0	0	0	0	0	0	0	0	**0**
1977	**11812**	**95090**	**44918**	**73431**	**605**	**9**	**0**	**0**	0	0	0	0	0	0	0	0	**0**
1978	**5250**	**316339**	**80219**	**4207**	**12085**	**72**	**106**	**0**	0	0	0	0	0	0	0	0	**0**
1979	**1824**	**205555**	**75517**	**3232**	**34**	**84**	**0**	**0**	0	0	0	0	0	0	0	0	**0**
1980	**644**	**369727**	**168124**	**2346**	**39**	**0**	**0**	**0**	0	0	0	0	0	0	0	0	**0**
1981	**1509**	**33434**	**237524**	**25928**	**86**	**3**	**0**	**0**	0	0	0	0	0	0	0	0	**0**
1982	**3703**	**93865**	**31915**	**49462**	**1845**	**0**	**0**	**0**	0	0	0	0	0	0	0	0	**0**
1983	**151108**	**85338**	**128171**	**15966**	**7112**	**717**	**105**	**0**	0	0	0	0	0	0	0	0	**0**
1984	**2915**	**314421**	**80803**	**13430**	**327**	**240**	**0**	**0**	0	0	0	0	0	0	0	0	**0**
1985	**17501**	**165086**	**267747**	**6088**	**149**	**4**	**8**	**0**	0	0	0	0	0	0	0	0	**0**
1986	**23807**	**108204**	**114606**	**61612**	**31**	**12**	**0**	**0**	0	0	0	0	0	0	0	0	**0**
1987	**1166**	**188582**	**133010**	**9320**	**1506**	**0**	**0**	**0**	0	0	0	0	0	0	0	0	**0**
1988	**1528**	**24588**	**325259**	**9684**	**788**	**67**	**0**	**0**	0	0	0	0	0	0	0	0	**0**
1989	**1790**	**40211**	**16959**	**51491**	**814**	**20**	**42**	**0**	0	0	0	0	0	0	0	0	**1**
1990	**52477**	**68625**	**56359**	**3977**	**10190**	**235**	**77**	**0**	0	0	0	0	0	0	0	0	**0**
1991	**7001**	**182162**	**27942**	**725**	**27**	**145**	**0**	**0**	0	0	0	0	0	0	0	0	**0**
1992	**29056**	**110995**	**123961**	**3298**	**38**	**0**	**65**	**0**	0	0	0	0	0	0	0	0	**0**
1993	**16715**	**235123**	**170794**	**18375**	**48**	**3**	**0**	**1**	0	0	0	0	0	0	0	0	**0**
1994	**16059**	**82033**	**217538**	**29100**	**1862**	**53**	**48**	**0**	0	0	0	0	0	0	0	0	**0**
1995	**3228**	**191807**	**54448**	**65250**	**1095**	**79**	**0**	**0**	0	0	0	0	0	0	0	0	**0**
1996	**3968**	**35340**	**275597**	**16870**	**7872**	**2**	**0**	**0**	0	0	0	0	0	0	0	0	**0**
1997	**7162**	**85588**	**50976**	**85664**	**1061**	**182**	**0**	**0**	0	0	0	0	0	0	0	0	**0**
1998	**3132**	**72793**	**112075**	**10165**	**13766**	**71**	**18**	**0**	0	0	0	0	0	0	0	0	**0**
1999	**14588**	**69196**	**90861**	**31119**	**1094**	**2064**	**180**	**0**	0	0	0	0	0	0	0	0	**0**
2000	**2474**	**272894**	**36568**	**12614**	**2764**	**148**	**64**	**0**	0	0	0	0	0	0	0	0	**0**
2001	**545**	**61878**	**529908**	**6100**	**1446**	**186**	**0**	**10**	4	0	0	0	0	0	0	0	**4**
2002	**946**	**3872**	**48189**	**127212**	**403**	**8**	**0**	**130**	0	0	0	0	0	0	0	0	**0**
2003	**4927**	**13533**	**11069**	**29537**	**34480**	**37**	**31**	**1**	0	0	0	0	0	0	0	0	**1**
2004	**1030**	**9467**	**14960**	**2388**	**12528**	**17177**	**5**	**3**	0	0	0	0	0	0	0	0	**0**
2005	**4814**	**9546**	**12807**	**3273**	**394**	**3369**	**3810**	**0**	0	0	0	0	0	0	0	0	**0**
2006	**2412**	**102672**	**15599**	**6304**	**1133**	**219**	**1125**	**1963**	6	1	1	0	0	0	0	0	**8**
2007	**1788**	**17650**	**127501**	**3810**	**530**	**63**	**4**	**55**	71	0	0	0	0	0	0	0	**71**
2008	**1928**	**12235**	**23078**	**22492**	**202**	**22**	**18**	**1**	6	4	0	0	0	0	0	0	**10**
2009	**8447**	**5527**	**10224**	**10809**	**13770**	**53**	**2**	**0**	0	1	4	0	0	0	0	0	**5**

Table 13.2.2.4. Haddock in Subarea IV and Division IIIa. Numbers-at-age data (thousands) for IBC. Data used in the assessment are highlighted in bold.

	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	8+
1963	**1317**	**230502**	**23050**	**791**	**105**	**85**	**3**	**0**	0	0	0	0	0	0	0	0	**0**
1964	**137382**	**3195**	**421729**	**35144**	**638**	**638**	**112**	**1**	0	0	0	0	0	0	0	0	**0**
1965	**644461**	**254237**	**7686**	**183288**	**2365**	**592**	**118**	**6**	0	0	0	0	0	0	0	0	**0**
1966	**1659093**	**548835**	**6546**	**1007**	**15861**	**755**	**25**	**2**	0	0	0	0	0	0	0	0	**0**
1967	**298999**	**392510**	**5539**	**155**	**24**	**2264**	**12**	**0**	0	0	0	0	0	0	0	0	**0**
1968	**11066**	**462938**	**81153**	**2029**	**46**	**19**	**738**	**1**	0	0	0	0	0	0	0	0	**0**
1969	**70826**	**15178**	**1703617**	**98650**	**632**	**380**	**126**	**252**	0	0	0	0	0	0	0	0	**0**
1970	**872884**	**170914**	**88509**	**485274**	**3967**	**153**	**61**	**2**	0	0	0	0	0	0	0	0	**0**
1971	**323088**	**570391**	**9972**	**3390**	**6381**	**299**	**6**	**0**	0	0	0	0	0	0	0	0	**0**
1972	**236664**	**238566**	**57010**	**1023**	**146**	**439**	**0**	**0**	0	0	0	0	0	0	0	0	**0**
1973	**41332**	**117470**	**12402**	**11**	**11**	**196**	**0**	**0**	0	0	0	0	0	0	0	0	**0**
1974	**576654**	**275266**	**32266**	**46862**	**4600**	**82**	**112**	**224**	0	0	0	0	0	0	0	0	**0**
1975	**44317**	**594854**	**84620**	**4761**	**5203**	**141**	**5**	**0**	5	0	0	0	0	0	0	0	**5**
1976	**164982**	**66973**	**183064**	**29188**	**46**	**2946**	**17**	**0**	0	0	0	0	0	0	0	0	**0**
1977	**103142**	**147019**	**29352**	**67628**	**2355**	**238**	**240**	**0**	0	0	0	0	0	0	0	0	**0**
1978	**280592**	**125698**	**11330**	**809**	**1480**	**64**	**6**	**5**	0	0	0	0	0	0	0	0	**0**
1979	**839615**	**125834**	**17671**	**1507**	**84**	**379**	**16**	**0**	0	0	0	0	0	0	0	0	**0**
1980	**374315**	**281436**	**21820**	**8258**	**1291**	**54**	**86**	**7**	0	1	0	0	0	0	0	0	**1**
1981	**644910**	**99247**	**30358**	**4613**	**440**	**6**	**2**	**0**	0	0	0	0	0	0	0	0	**0**
1982	**275002**	**174147**	**14740**	**13540**	**1810**	**464**	**0**	**0**	0	0	0	0	0	0	0	0	**0**
1983	**488707**	**63818**	**14331**	**5134**	**2242**	**3**	**0**	**0**	0	0	0	0	0	0	0	0	**0**
1984	**92587**	**98257**	**10644**	**4702**	**368**	**535**	**0**	**0**	0	0	0	0	0	0	0	0	**0**
1985	**122078**	**11672**	**17826**	**1739**	**547**	**223**	**17**	**0**	0	0	0	0	0	0	0	0	**0**
1986	**32696**	**40023**	**1831**	**802**	**103**	**7**	**0**	**0**	0	0	0	0	0	0	0	0	**0**
1987	**8253**	**82226**	**3797**	**295**	**138**	**0**	**0**	**0**	0	0	0	0	0	0	0	0	**0**
1988	**9280**	**3309**	**12819**	**2462**	**620**	**202**	**0**	**0**	0	0	0	0	0	0	0	0	**0**
1989	**8914**	**2541**	**1751**	**2789**	**460**	**37**	**86**	**10**	0	0	0	0	0	0	0	0	**0**
1990	**2996**	**7218**	**1986**	**359**	**1491**	**227**	**25**	**78**	4	0	0	0	0	0	0	0	**4**
1991	**116909**	**22493**	**3248**	**601**	**43**	**43**	**0**	**0**	0	0	0	0	0	0	0	0	**0**
1992	**241702**	**80402**	**10971**	**356**	**27**	**3**	**17**	**0**	0	0	0	0	0	0	0	0	**0**
1993	**124495**	**107664**	**13220**	**3214**	**82**	**9**	**0**	**18**	0	0	0	0	0	0	0	0	**0**
1994	**69907**	**14349**	**9534**	**1011**	**160**	**7**	**1**	**0**	0	0	0	0	0	0	0	0	**0**
1995	**198032**	**102560**	**2201**	**888**	**65**	**0**	**0**	**0**	0	0	0	0	0	0	0	0	**0**
1996	**144469**	**10608**	**7453**	**3338**	**107**	**0**	**0**	**0**	0	0	0	0	0	0	0	0	**0**
1997	**21694**	**45264**	**10935**	**4451**	**184**	**17**	**0**	**0**	0	0	0	0	0	0	0	0	**0**
1998	**18983**	**9155**	**16337**	**2649**	**1490**	**63**	**0**	**0**	0	0	0	0	0	0	0	0	**0**
1999	**69820**	**10780**	**4531**	**2932**	**344**	**166**	**3**	**0**	0	0	0	0	0	0	0	0	**0**
2000	**4158**	**71419**	**21740**	**2085**	**186**	**5**	**0**	**0**	0	0	0	0	0	0	0	0	**0**
2001	**1987**	**22946**	**35776**	**10127**	**35**	**8**	**0**	**0**	0	0	0	0	0	0	0	0	**0**
2002	**49807**	**13889**	**4489**	**3638**	**504**	**27**	**0**	**0**	0	0	0	0	0	0	0	0	**0**
2003	**4145**	**5983**	**2101**	**1285**	**1524**	**12**	**0**	**0**	0	0	0	0	0	0	0	0	**0**
2004	**0**	**590**	**265**	**84**	**258**	**753**	**8**	**4**	0	0	0	0	0	0	0	0	**0**
2005	**0**	**176**	**97**	**26**	**9**	**5**	**201**	**1**	0	0	0	0	0	0	0	0	**0**
2006	**0**	**1772**	**716**	**241**	**47**	**46**	**74**	**108**	1	0	0	0	0	0	0	0	**1**
2007	**1**	**27**	**218**	**6**	**1**	**0**	**0**	**0**	0	0	0	0	0	0	0	0	**0**
2008	**12**	**82**	**280**	**180**	**52**	**18**	**4**	**1**	0	0	0	0	0	0	0	0	**0**
2009	**15**	**36**	**97**	**48**	**19**	**6**	**2**	**0**	0	0	0	0	0	0	0	0	**0**

Table 13.2.3.1. Haddock in Subarea IV and Division IIIa. Mean weight at age data (kg) for total catch. Data used in the assessment are highlighted in bold.

	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	8+
1963	**0.012**	**0.123**	**0.253**	**0.473**	**0.695**	**0.807**	**1.004**	**1.131**	1.173	1.576	1.825	0.000	0.000	0.000	0.000	0.000	**1.228**
1964	**0.011**	**0.118**	**0.239**	**0.403**	**0.664**	**0.814**	**0.909**	**1.382**	1.148	1.470	1.781	0.000	0.000	0.000	0.000	0.000	**1.331**
1965	**0.010**	**0.069**	**0.226**	**0.366**	**0.648**	**0.845**	**1.193**	**1.173**	1.482	1.707	2.239	0.000	0.000	0.000	0.000	0.000	**1.697**
1966	**0.010**	**0.088**	**0.247**	**0.367**	**0.533**	**0.949**	**1.266**	**1.525**	1.938	1.727	2.963	2.040	0.000	0.000	0.000	0.000	**1.955**
1967	**0.011**	**0.115**	**0.281**	**0.461**	**0.594**	**0.639**	**1.057**	**1.501**	1.922	2.069	2.348	0.000	0.000	0.000	0.000	0.000	**1.996**
1968	**0.010**	**0.126**	**0.253**	**0.510**	**0.731**	**0.857**	**0.837**	**1.606**	2.260	2.702	2.073	0.000	0.000	0.000	0.000	0.000	**2.343**
1969	**0.011**	**0.063**	**0.216**	**0.406**	**0.799**	**0.891**	**1.031**	**1.094**	2.040	3.034	3.264	0.000	0.000	0.000	0.000	0.000	**2.180**
1970	**0.013**	**0.073**	**0.222**	**0.352**	**0.735**	**0.874**	**1.191**	**1.362**	1.437	2.571	3.950	3.869	0.000	0.000	0.000	0.000	**1.462**
1971	**0.011**	**0.107**	**0.247**	**0.362**	**0.506**	**0.887**	**1.267**	**1.534**	1.337	1.275	1.969	4.306	3.543	0.000	0.000	0.000	**1.349**
1972	**0.024**	**0.116**	**0.243**	**0.388**	**0.506**	**0.606**	**1.000**	**1.366**	2.241	2.006	1.651	2.899	0.000	0.000	0.000	0.000	**1.741**
1973	**0.044**	**0.112**	**0.241**	**0.373**	**0.586**	**0.649**	**0.725**	**1.044**	1.302	2.796	1.726	2.020	2.158	0.000	0.000	0.000	**1.732**
1974	**0.024**	**0.128**	**0.227**	**0.344**	**0.549**	**0.892**	**0.896**	**0.952**	1.513	2.315	2.508	4.152	2.264	0.000	0.000	0.000	**1.724**
1975	**0.020**	**0.101**	**0.242**	**0.357**	**0.450**	**0.680**	**1.245**	**1.124**	1.093	1.720	2.217	2.854	0.000	3.426	0.000	0.000	**1.183**
1976	**0.013**	**0.125**	**0.225**	**0.402**	**0.512**	**0.589**	**0.922**	**1.933**	1.784	1.306	2.425	2.528	0.000	0.000	0.000	0.000	**1.425**
1977	**0.019**	**0.109**	**0.243**	**0.347**	**0.602**	**0.614**	**0.803**	**1.181**	1.943	2.322	1.780	3.189	0.000	4.119	0.000	0.000	**1.900**
1978	**0.011**	**0.144**	**0.256**	**0.420**	**0.443**	**0.719**	**0.745**	**0.955**	1.398	2.124	2.868	1.849	2.454	4.782	0.000	0.000	**1.652**
1979	**0.009**	**0.096**	**0.292**	**0.444**	**0.637**	**0.664**	**0.934**	**1.187**	1.187	1.468	2.679	1.624	1.760	1.643	0.000	0.000	**1.377**
1980	**0.012**	**0.104**	**0.286**	**0.488**	**0.733**	**1.046**	**0.936**	**1.394**	1.599	1.593	1.726	3.328	1.119	3.071	3.111	0.000	**1.758**
1981	**0.009**	**0.074**	**0.265**	**0.477**	**0.745**	**1.148**	**1.480**	**1.180**	1.634	1.764	1.554	1.492	3.389	4.273	1.981	0.000	**1.686**
1982	**0.011**	**0.100**	**0.293**	**0.462**	**0.785**	**1.170**	**1.441**	**1.672**	1.456	2.634	2.164	1.924	1.886	3.179	0.000	0.000	**1.520**
1983	**0.022**	**0.136**	**0.298**	**0.449**	**0.651**	**0.916**	**1.215**	**1.162**	1.920	1.376	1.395	1.907	2.853	4.689	0.000	0.000	**1.554**
1984	**0.010**	**0.141**	**0.302**	**0.489**	**0.671**	**0.805**	**1.097**	**1.100**	1.868	2.425	1.972	2.247	2.422	2.822	4.995	0.000	**2.050**
1985	**0.013**	**0.149**	**0.280**	**0.481**	**0.668**	**0.858**	**1.049**	**1.459**	1.833	2.124	2.145	2.003	2.387	0.000	0.000	0.000	**1.936**
1986	**0.025**	**0.124**	**0.242**	**0.397**	**0.613**	**0.863**	**1.257**	**1.195**	1.715	1.525	2.484	2.653	2.538	3.075	2.778	2.894	**1.916**
1987	**0.008**	**0.126**	**0.267**	**0.406**	**0.615**	**1.029**	**1.276**	**1.433**	1.529	1.877	2.054	1.940	2.471	2.411	2.996	2.638	**1.673**
1988	**0.024**	**0.166**	**0.217**	**0.418**	**0.590**	**0.748**	**1.284**	**1.424**	1.551	1.627	1.680	3.068	2.468	2.885	3.337	2.863	**1.784**
1989	**0.027**	**0.198**	**0.304**	**0.372**	**0.606**	**0.811**	**0.982**	**1.364**	1.655	1.684	2.248	2.166	2.364	2.389	2.307	1.146	**1.755**
1990	**0.044**	**0.195**	**0.293**	**0.434**	**0.474**	**0.772**	**0.971**	**1.168**	1.530	2.037	2.653	2.530	2.392	3.444	1.852	4.731	**1.857**
1991	**0.029**	**0.179**	**0.322**	**0.473**	**0.640**	**0.651**	**1.042**	**1.232**	1.481	1.776	1.996	2.253	2.404	1.070	3.509	2.936	**1.584**
1992	**0.018**	**0.108**	**0.307**	**0.486**	**0.748**	**1.016**	**0.896**	**1.395**	1.537	1.912	1.997	2.067	2.441	1.781	0.000	0.000	**1.784**
1993	**0.010**	**0.116**	**0.282**	**0.447**	**0.680**	**0.894**	**1.173**	**1.102**	1.592	1.737	1.920	1.718	2.274	2.516	0.000	0.000	**1.753**
1994	**0.017**	**0.116**	**0.251**	**0.420**	**0.597**	**0.943**	**1.208**	**1.570**	1.469	1.620	2.418	2.108	2.849	2.403	0.000	0.000	**1.615**
1995	**0.013**	**0.102**	**0.301**	**0.366**	**0.597**	**0.768**	**1.118**	**1.444**	1.761	1.873	1.881	2.508	1.674	1.699	2.243	0.000	**1.866**
1996	**0.019**	**0.128**	**0.248**	**0.399**	**0.490**	**0.795**	**0.879**	**0.855**	1.833	2.018	1.623	2.393	2.369	2.598	3.439	0.000	**1.925**
1997	**0.021**	**0.134**	**0.286**	**0.362**	**0.591**	**0.621**	**0.921**	**0.974**	1.647	2.209	2.146	2.032	2.757	2.262	2.867	0.000	**1.893**
1998	**0.023**	**0.154**	**0.258**	**0.405**	**0.442**	**0.660**	**0.769**	**1.113**	1.200	1.834	2.340	2.150	1.115	2.423	2.085	2.509	**1.346**
1999	**0.023**	**0.168**	**0.244**	**0.365**	**0.480**	**0.499**	**0.691**	**0.785**	0.758	1.258	1.559	1.913	2.232	2.392	0.000	0.000	**0.836**
2000	**0.048**	**0.120**	**0.256**	**0.370**	**0.501**	**0.619**	**0.653**	**1.104**	1.100	1.757	1.963	2.323	2.385	2.315	0.000	0.000	**1.229**
2001	**0.021**	**0.110**	**0.217**	**0.315**	**0.472**	**0.706**	**0.762**	**0.975**	1.893	1.216	2.144	2.891	3.237	0.000	0.000	0.000	**1.769**
2002	**0.016**	**0.100**	**0.271**	**0.328**	**0.541**	**0.744**	**0.931**	**0.848**	1.426	1.942	2.346	1.840	2.349	0.000	0.000	0.000	**1.637**
2003	**0.030**	**0.097**	**0.214**	**0.330**	**0.406**	**0.682**	**0.791**	**1.158**	1.384	1.658	2.181	2.209	2.506	0.000	0.000	0.000	**1.631**
2004	**0.053**	**0.177**	**0.256**	**0.410**	**0.404**	**0.445**	**0.744**	**1.071**	1.372	1.741	1.777	2.355	2.172	0.000	0.000	0.000	**1.647**
2005	**0.055**	**0.200**	**0.295**	**0.387**	**0.522**	**0.484**	**0.521**	**0.882**	1.119	1.360	1.835	2.682	2.553	2.319	0.000	0.000	**1.348**
2006	**0.048**	**0.122**	**0.289**	**0.358**	**0.470**	**0.545**	**0.546**	**0.549**	0.996	1.584	2.129	2.513	1.823	0.000	0.000	0.000	**1.263**
2007	**0.039**	**0.163**	**0.228**	**0.423**	**0.499**	**0.624**	**0.717**	**0.716**	0.749	0.909	2.278	0.954	1.712	2.348	0.000	0.000	**0.753**
2008	**0.038**	**0.181**	**0.257**	**0.365**	**0.607**	**0.700**	**0.842**	**1.109**	0.947	0.877	1.680	1.969	0.914	0.224	0.000	0.000	**0.903**
2009	**0.048**	**0.208**	**0.306**	**0.323**	**0.386**	**0.718**	**0.908**	**1.008**	1.510	1.366	1.013	0.983	1.150	0.000	0.000	0.000	**1.186**

Table 13.2.3.2. Haddock in Subarea IV and Division IIIa. Mean weight at age data (kg) for landings. Data used in the assessment are highlighted in bold.

	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	8+
1963	**0.000**	**0.233**	**0.326**	**0.512**	**0.715**	**0.817**	**1.009**	**1.131**	1.173	1.576	1.825	0.000	0.000	0.000	0.000	0.000	**1.228**
1964	**0.000**	**0.221**	**0.313**	**0.459**	**0.695**	**0.870**	**0.934**	**1.386**	1.148	1.470	1.781	0.000	0.000	0.000	0.000	0.000	**1.331**
1965	**0.000**	**0.310**	**0.357**	**0.410**	**0.679**	**0.907**	**1.242**	**1.182**	1.482	1.707	2.239	0.000	0.000	0.000	0.000	0.000	**1.697**
1966	**0.000**	**0.301**	**0.384**	**0.416**	**0.553**	**0.995**	**1.288**	**1.529**	1.938	1.727	2.963	2.040	0.000	0.000	0.000	0.000	**1.955**
1967	**0.000**	**0.260**	**0.404**	**0.510**	**0.614**	**0.645**	**1.063**	**1.501**	1.922	2.069	2.348	0.000	0.000	0.000	0.000	0.000	**1.996**
1968	**0.000**	**0.256**	**0.361**	**0.591**	**0.761**	**0.863**	**0.846**	**1.610**	2.260	2.702	2.073	0.000	0.000	0.000	0.000	0.000	**2.343**
1969	**0.000**	**0.178**	**0.302**	**0.506**	**0.870**	**0.984**	**1.065**	**1.102**	2.040	3.034	3.264	0.000	0.000	0.000	0.000	0.000	**2.180**
1970	**0.000**	**0.242**	**0.310**	**0.403**	**0.786**	**0.949**	**1.235**	**1.370**	1.437	2.571	3.950	3.869	0.000	0.000	0.000	0.000	**1.462**
1971	**0.000**	**0.256**	**0.335**	**0.399**	**0.524**	**0.905**	**1.281**	**1.534**	1.337	1.275	1.969	4.306	3.543	0.000	0.000	0.000	**1.349**
1972	**0.000**	**0.244**	**0.329**	**0.421**	**0.523**	**0.609**	**1.003**	**1.366**	2.241	2.006	1.651	2.899	0.000	0.000	0.000	0.000	**1.741**
1973	**0.000**	**0.225**	**0.315**	**0.406**	**0.606**	**0.663**	**0.726**	**1.044**	1.302	2.796	1.726	2.020	2.158	0.000	0.000	0.000	**1.732**
1974	**0.000**	**0.275**	**0.320**	**0.389**	**0.585**	**0.908**	**0.954**	**0.963**	1.513	2.315	2.508	4.152	2.264	0.000	0.000	0.000	**1.724**
1975	**0.000**	**0.258**	**0.345**	**0.408**	**0.487**	**0.686**	**1.248**	**1.124**	1.094	1.720	2.217	2.854	0.000	3.426	0.000	0.000	**1.184**
1976	**0.000**	**0.250**	**0.344**	**0.467**	**0.516**	**0.614**	**0.923**	**1.933**	1.784	1.306	2.425	2.528	0.000	0.000	0.000	0.000	**1.425**
1977	**0.000**	**0.286**	**0.362**	**0.396**	**0.614**	**0.630**	**0.817**	**1.181**	1.943	2.322	1.780	3.189	0.000	4.119	0.000	0.000	**1.900**
1978	**0.000**	**0.275**	**0.356**	**0.457**	**0.470**	**0.725**	**0.789**	**0.956**	1.398	2.124	2.868	1.849	2.454	4.782	0.000	0.000	**1.652**
1979	**0.000**	**0.274**	**0.361**	**0.468**	**0.642**	**0.668**	**0.935**	**1.187**	1.187	1.468	2.679	1.624	1.760	1.643	0.000	0.000	**1.377**
1980	**0.000**	**0.299**	**0.367**	**0.526**	**0.750**	**1.056**	**0.934**	**1.392**	1.599	1.592	1.726	3.328	1.119	3.071	3.111	0.000	**1.758**
1981	**0.000**	**0.339**	**0.385**	**0.525**	**0.754**	**1.149**	**1.481**	**1.180**	1.634	1.764	1.554	1.492	3.389	4.273	1.981	0.000	**1.686**
1982	**0.000**	**0.300**	**0.364**	**0.507**	**0.818**	**1.237**	**1.441**	**1.672**	1.456	2.634	2.164	1.924	1.886	3.179	0.000	0.000	**1.520**
1983	**0.000**	**0.312**	**0.387**	**0.482**	**0.663**	**0.925**	**1.243**	**1.162**	1.920	1.376	1.395	1.907	2.853	4.689	0.000	0.000	**1.554**
1984	**0.000**	**0.281**	**0.376**	**0.515**	**0.677**	**0.810**	**1.097**	**1.100**	1.868	2.425	1.972	2.247	2.422	2.822	4.995	0.000	**2.050**
1985	**0.000**	**0.277**	**0.359**	**0.502**	**0.671**	**0.871**	**1.051**	**1.459**	1.833	2.124	2.145	2.003	2.387	2.471	2.721	3.970	**1.936**
1986	**0.000**	**0.276**	**0.351**	**0.433**	**0.613**	**0.863**	**1.257**	**1.195**	1.715	1.525	2.484	2.653	2.538	3.075	2.778	2.894	**1.916**
1987	**0.000**	**0.274**	**0.345**	**0.451**	**0.622**	**1.029**	**1.276**	**1.433**	1.529	1.877	2.054	1.940	2.471	2.411	2.996	2.638	**1.673**
1988	**0.000**	**0.258**	**0.324**	**0.445**	**0.619**	**0.752**	**1.284**	**1.424**	1.551	1.627	1.680	3.068	2.468	2.885	3.337	2.863	**1.784**
1989	**0.000**	**0.310**	**0.388**	**0.415**	**0.617**	**0.810**	**0.982**	**1.361**	1.653	1.684	2.236	2.166	2.364	2.389	2.307	1.146	**1.752**
1990	**0.000**	**0.308**	**0.379**	**0.484**	**0.516**	**0.802**	**1.039**	**1.191**	1.543	2.037	2.653	2.530	2.392	3.444	1.852	4.731	**1.868**
1991	**0.000**	**0.319**	**0.377**	**0.480**	**0.643**	**0.653**	**1.042**	**1.232**	1.481	1.776	1.996	2.253	2.404	1.070	3.509	2.936	**1.584**
1992	**0.000**	**0.336**	**0.379**	**0.510**	**0.751**	**1.017**	**0.904**	**1.395**	1.538	1.912	1.997	2.067	2.441	1.781	0.000	0.000	**1.784**
1993	**0.000**	**0.326**	**0.393**	**0.483**	**0.684**	**0.896**	**1.173**	**1.111**	1.592	1.737	1.920	1.718	2.274	2.516	0.000	0.000	**1.753**
1994	**0.000**	**0.288**	**0.390**	**0.482**	**0.617**	**0.962**	**1.296**	**1.570**	1.469	1.620	2.418	2.108	2.849	2.403	2.580	0.000	**1.615**
1995	**0.000**	**0.323**	**0.403**	**0.425**	**0.608**	**0.772**	**1.118**	**1.444**	1.761	1.873	1.881	2.508	1.674	1.699	2.243	0.000	**1.866**
1996	**0.000**	**0.351**	**0.364**	**0.475**	**0.523**	**0.795**	**0.879**	**0.855**	1.833	2.018	1.623	2.393	2.369	2.598	3.439	0.000	**1.925**
1997	**0.000**	**0.388**	**0.416**	**0.417**	**0.614**	**0.624**	**0.921**	**0.974**	1.647	2.209	2.146	2.032	2.757	2.262	2.867	2.782	**1.893**
1998	**0.000**	**0.280**	**0.377**	**0.444**	**0.462**	**0.666**	**0.771**	**1.113**	1.200	1.834	2.340	2.150	1.115	2.423	2.085	2.509	**1.346**
1999	**0.000**	**0.291**	**0.349**	**0.423**	**0.489**	**0.511**	**0.729**	**0.785**	0.758	1.258	1.559	1.913	2.232	2.392	2.912	2.225	**0.836**
2000	**0.000**	**0.345**	**0.370**	**0.423**	**0.524**	**0.626**	**0.656**	**1.104**	1.100	1.757	1.963	2.323	2.385	2.315	3.595	1.843	**1.229**
2001	**0.000**	**0.433**	**0.355**	**0.447**	**0.505**	**0.723**	**0.762**	**0.980**	1.922	1.216	2.144	2.891	3.237	2.534	1.239	3.425	**1.787**
2002	**0.000**	**0.475**	**0.458**	**0.399**	**0.570**	**0.750**	**0.931**	**1.000**	1.426	1.942	2.346	1.840	2.349	2.762	0.000	0.000	**1.637**
2003	**0.000**	**0.311**	**0.438**	**0.476**	**0.443**	**0.687**	**0.798**	**1.159**	1.386	1.659	2.181	2.209	2.506	2.606	1.981	3.092	**1.633**
2004	**0.000**	**0.369**	**0.388**	**0.489**	**0.460**	**0.469**	**0.747**	**1.086**	1.372	1.741	1.777	2.355	2.172	0.000	0.000	0.000	**1.647**
2005	**0.000**	**0.400**	**0.401**	**0.429**	**0.551**	**0.512**	**0.533**	**0.883**	1.119	1.360	1.835	2.682	2.553	2.319	3.431	0.000	**1.348**
2006	**0.000**	**0.396**	**0.389**	**0.422**	**0.514**	**0.581**	**0.582**	**0.580**	1.051	1.663	2.236	2.641	1.926	3.022	2.901	2.709	**1.331**
2007	**0.000**	**0.383**	**0.386**	**0.473**	**0.515**	**0.631**	**0.718**	**0.719**	0.753	0.909	2.278	0.954	1.712	2.348	4.244	0.000	**0.757**
2008	**0.000**	**0.364**	**0.409**	**0.414**	**0.621**	**0.705**	**0.859**	**1.113**	0.949	0.877	1.695	1.969	0.914	0.224	3.792	3.024	**0.904**
2009	**0.000**	**0.444**	**0.433**	**0.409**	**0.412**	**0.732**	**0.912**	**1.009**	1.511	1.369	1.017	0.983	1.150	3.158	2.115	0.000	**1.190**

Table 13.2.3.3. Haddock in Subarea IV and Division IIIa. Mean weight at age data (kg) for discards. Data used in the assessment are highlighted in bold.

	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	8+
1963	**0.064**	**0.139**	**0.218**	**0.327**	**0.397**	**0.321**	**0.321**	**0.000**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**
1964	**0.065**	**0.177**	**0.249**	**0.306**	**0.337**	**0.321**	**0.321**	**0.000**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**
1965	**0.064**	**0.131**	**0.200**	**0.341**	**0.613**	**0.321**	**0.321**	**0.000**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**
1966	**0.063**	**0.141**	**0.208**	**0.244**	**0.310**	**0.321**	**0.321**	**0.000**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**
1967	**0.064**	**0.171**	**0.209**	**0.274**	**0.306**	**0.321**	**0.321**	**0.000**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**
1968	**0.063**	**0.186**	**0.212**	**0.256**	**0.318**	**0.321**	**0.321**	**0.000**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**
1969	**0.064**	**0.129**	**0.216**	**0.237**	**0.301**	**0.321**	**0.321**	**0.000**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**
1970	**0.063**	**0.129**	**0.210**	**0.238**	**0.263**	**0.321**	**0.321**	**0.000**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**
1971	**0.063**	**0.134**	**0.201**	**0.242**	**0.263**	**0.321**	**0.321**	**0.000**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**
1972	**0.063**	**0.139**	**0.206**	**0.237**	**0.261**	**0.321**	**0.321**	**0.000**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**
1973	**0.063**	**0.131**	**0.201**	**0.235**	**0.263**	**0.321**	**0.321**	**0.000**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**
1974	**0.062**	**0.145**	**0.200**	**0.233**	**0.259**	**0.321**	**0.321**	**0.000**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**
1975	**0.050**	**0.123**	**0.200**	**0.257**	**0.275**	**0.348**	**0.000**	**0.000**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**
1976	**0.079**	**0.176**	**0.197**	**0.237**	**0.292**	**0.337**	**0.000**	**0.000**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**
1977	**0.071**	**0.196**	**0.197**	**0.216**	**0.309**	**0.347**	**0.000**	**0.000**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**
1978	**0.037**	**0.180**	**0.199**	**0.222**	**0.224**	**0.265**	**0.284**	**0.000**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**
1979	**0.053**	**0.118**	**0.219**	**0.242**	**0.259**	**0.340**	**0.000**	**0.000**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**
1980	**0.051**	**0.149**	**0.231**	**0.274**	**0.324**	**0.000**	**0.000**	**0.000**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**
1981	**0.073**	**0.160**	**0.198**	**0.290**	**0.650**	**0.727**	**0.000**	**0.000**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**
1982	**0.072**	**0.197**	**0.248**	**0.271**	**0.264**	**0.000**	**0.000**	**0.000**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**
1983	**0.067**	**0.187**	**0.237**	**0.347**	**0.476**	**0.711**	**0.792**	**0.000**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**
1984	**0.046**	**0.162**	**0.245**	**0.317**	**0.300**	**0.314**	**0.000**	**0.000**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**
1985	**0.040**	**0.155**	**0.214**	**0.264**	**0.336**	**0.423**	**0.421**	**0.000**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**
1986	**0.045**	**0.138**	**0.184**	**0.245**	**0.408**	**0.329**	**0.000**	**0.000**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**
1987	**0.023**	**0.159**	**0.200**	**0.225**	**0.287**	**0.000**	**0.000**	**0.000**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**
1988	**0.063**	**0.172**	**0.170**	**0.238**	**0.254**	**0.360**	**0.000**	**0.000**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**
1989	**0.085**	**0.187**	**0.229**	**0.268**	**0.335**	**0.708**	**0.844**	**0.000**	2.572	0.000	3.048	0.000	0.000	0.000	0.000	0.000	**2.810**
1990	**0.046**	**0.196**	**0.229**	**0.249**	**0.266**	**0.290**	**0.333**	**0.000**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**
1991	**0.065**	**0.179**	**0.243**	**0.344**	**0.464**	**0.493**	**0.000**	**0.000**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**
1992	**0.043**	**0.137**	**0.246**	**0.286**	**0.347**	**0.000**	**0.415**	**0.000**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**
1993	**0.027**	**0.142**	**0.237**	**0.287**	**0.344**	**0.369**	**0.000**	**0.369**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**
1994	**0.044**	**0.126**	**0.211**	**0.269**	**0.306**	**0.304**	**0.270**	**0.000**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**
1995	**0.064**	**0.131**	**0.251**	**0.275**	**0.363**	**0.384**	**0.000**	**0.000**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**
1996	**0.046**	**0.138**	**0.219**	**0.279**	**0.297**	**0.358**	**0.000**	**0.000**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**
1997	**0.063**	**0.161**	**0.254**	**0.286**	**0.321**	**0.385**	**0.000**	**0.000**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**
1998	**0.041**	**0.162**	**0.231**	**0.293**	**0.315**	**0.391**	**0.428**	**0.000**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**
1999	**0.049**	**0.183**	**0.217**	**0.273**	**0.307**	**0.304**	**0.250**	**0.000**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**
2000	**0.030**	**0.129**	**0.246**	**0.281**	**0.319**	**0.355**	**0.287**	**0.000**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**
2001	**0.045**	**0.116**	**0.205**	**0.307**	**0.308**	**0.364**	**0.000**	**0.411**	0.416	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.416**
2002	**0.042**	**0.166**	**0.226**	**0.268**	**0.352**	**0.378**	**0.000**	**0.357**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**
2003	**0.046**	**0.125**	**0.222**	**0.265**	**0.332**	**0.536**	**0.654**	**0.951**	0.946	1.154	0.000	0.000	0.000	0.000	0.000	0.000	**1.015**
2004	**0.053**	**0.171**	**0.232**	**0.280**	**0.308**	**0.342**	**0.639**	**0.716**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**
2005	**0.055**	**0.185**	**0.251**	**0.283**	**0.313**	**0.305**	**0.345**	**0.621**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**
2006	**0.048**	**0.116**	**0.228**	**0.257**	**0.233**	**0.152**	**0.162**	**0.115**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**
2007	**0.039**	**0.149**	**0.193**	**0.292**	**0.315**	**0.370**	**0.427**	**0.342**	0.368	0.400	0.000	0.000	0.000	0.000	0.000	0.000	**0.368**
2008	**0.038**	**0.177**	**0.216**	**0.261**	**0.374**	**0.531**	**0.353**	**0.449**	0.463	0.596	0.321	0.000	0.000	0.000	0.000	0.000	**0.520**
2009	**0.048**	**0.188**	**0.250**	**0.248**	**0.279**	**0.409**	**0.433**	**0.425**	0.366	0.409	0.452	0.000	0.000	0.000	0.000	0.000	**0.442**

Table 13.2.3.4. Haddock in Subarea IV and Division IIIa. Mean weight at age data (kg) for IBC. Data used in the assessment are highlighted in bold.

	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	8+
1963	**0.010**	**0.040**	**0.180**	**0.302**	**0.400**	**0.420**	**0.440**	**0.000**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**
1964	**0.010**	**0.040**	**0.180**	**0.302**	**0.400**	**0.420**	**0.440**	**0.500**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**
1965	**0.010**	**0.040**	**0.180**	**0.302**	**0.400**	**0.420**	**0.440**	**0.500**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**
1966	**0.010**	**0.040**	**0.180**	**0.302**	**0.400**	**0.420**	**0.440**	**0.500**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**
1967	**0.010**	**0.040**	**0.180**	**0.302**	**0.400**	**0.420**	**0.440**	**0.000**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**
1968	**0.010**	**0.040**	**0.180**	**0.302**	**0.400**	**0.420**	**0.440**	**0.500**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**
1969	**0.010**	**0.040**	**0.180**	**0.302**	**0.400**	**0.420**	**0.440**	**0.500**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**
1970	**0.010**	**0.040**	**0.180**	**0.302**	**0.400**	**0.420**	**0.440**	**0.500**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**
1971	**0.010**	**0.040**	**0.180**	**0.302**	**0.400**	**0.420**	**0.440**	**0.000**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**
1972	**0.023**	**0.067**	**0.136**	**0.255**	**0.288**	**0.231**	**0.000**	**0.000**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**
1973	**0.035**	**0.068**	**0.141**	**0.246**	**0.327**	**0.396**	**0.000**	**0.000**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**
1974	**0.022**	**0.058**	**0.150**	**0.260**	**0.359**	**0.579**	**0.277**	**0.447**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**
1975	**0.020**	**0.039**	**0.173**	**0.275**	**0.267**	**0.413**	**0.585**	**0.000**	0.585	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.585**
1976	**0.012**	**0.046**	**0.181**	**0.304**	**0.473**	**0.360**	**0.725**	**0.000**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**
1977	**0.013**	**0.042**	**0.184**	**0.307**	**0.490**	**0.352**	**0.442**	**1.234**	1.315	1.319	0.000	0.000	0.000	0.000	0.000	0.000	**1.317**
1978	**0.011**	**0.040**	**0.174**	**0.286**	**0.372**	**0.473**	**0.411**	**0.456**	1.315	0.000	1.400	0.000	0.000	0.000	0.000	0.000	**1.345**
1979	**0.009**	**0.039**	**0.177**	**0.285**	**0.384**	**0.461**	**0.735**	**1.234**	1.315	0.000	1.400	0.000	0.000	0.000	0.000	0.000	**1.333**
1980	**0.012**	**0.039**	**0.176**	**0.268**	**0.623**	**0.722**	**1.102**	**1.591**	0.000	1.796	0.000	0.000	0.000	0.000	0.000	0.000	**1.796**
1981	**0.009**	**0.040**	**0.176**	**0.371**	**0.467**	**0.858**	**1.200**	**1.234**	1.315	1.319	1.400	0.000	0.000	0.000	0.000	0.000	**1.346**
1982	**0.010**	**0.040**	**0.206**	**0.379**	**0.636**	**0.751**	**1.225**	**1.233**	1.315	1.319	0.000	0.000	0.000	0.000	0.000	0.000	**1.316**
1983	**0.008**	**0.047**	**0.173**	**0.428**	**0.584**	**1.006**	**1.225**	**1.234**	1.315	1.319	0.000	0.000	0.000	0.000	0.000	0.000	**1.318**
1984	**0.009**	**0.045**	**0.211**	**0.414**	**0.626**	**0.751**	**1.225**	**1.234**	1.315	1.319	1.400	1.400	0.000	0.000	0.000	0.000	**1.356**
1985	**0.009**	**0.043**	**0.186**	**0.371**	**0.550**	**0.563**	**0.565**	**1.234**	1.315	1.319	1.400	0.000	0.000	0.000	0.000	0.000	**1.319**
1986	**0.010**	**0.040**	**0.186**	**0.375**	**0.626**	**1.259**	**1.225**	**1.234**	1.315	1.319	1.400	0.000	0.000	0.000	0.000	0.000	**1.328**
1987	**0.006**	**0.038**	**0.258**	**0.442**	**0.908**	**1.171**	**1.225**	**1.234**	1.315	1.319	0.000	0.000	0.000	0.000	0.000	0.000	**1.316**
1988	**0.018**	**0.077**	**0.196**	**0.274**	**0.455**	**0.549**	**1.225**	**1.234**	1.315	1.319	1.400	0.000	0.000	0.000	0.000	0.000	**1.330**
1989	**0.015**	**0.165**	**0.251**	**0.347**	**0.670**	**0.923**	**1.065**	**1.492**	1.315	0.000	1.400	0.000	0.000	0.000	0.000	0.000	**1.329**
1990	**0.005**	**0.104**	**0.229**	**0.506**	**0.609**	**0.842**	**0.829**	**0.796**	0.956	1.319	0.000	0.000	0.000	0.000	0.000	0.000	**0.956**
1991	**0.027**	**0.058**	**0.206**	**0.357**	**0.472**	**0.477**	**1.225**	**1.234**	1.315	1.319	0.000	0.000	0.000	0.000	0.000	0.000	**1.316**
1992	**0.015**	**0.059**	**0.217**	**0.422**	**0.552**	**0.615**	**0.548**	**1.234**	0.621	0.820	0.000	0.000	0.000	0.000	0.000	0.000	**0.659**
1993	**0.008**	**0.053**	**0.206**	**0.399**	**0.521**	**0.578**	**1.225**	**0.582**	1.315	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**1.315**
1994	**0.011**	**0.055**	**0.155**	**0.435**	**0.595**	**0.698**	**0.490**	**0.000**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**
1995	**0.012**	**0.045**	**0.193**	**0.285**	**0.387**	**0.000**	**0.000**	**0.000**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**
1996	**0.018**	**0.077**	**0.136**	**0.162**	**0.264**	**0.000**	**0.000**	**0.000**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**
1997	**0.007**	**0.076**	**0.149**	**0.309**	**0.419**	**0.601**	**0.000**	**0.000**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**
1998	**0.020**	**0.075**	**0.166**	**0.291**	**0.351**	**0.453**	**0.000**	**0.000**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**
1999	**0.018**	**0.064**	**0.177**	**0.304**	**0.416**	**0.309**	**0.000**	**0.000**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**
2000	**0.058**	**0.070**	**0.113**	**0.176**	**0.370**	**0.203**	**0.000**	**0.000**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**
2001	**0.014**	**0.086**	**0.133**	**0.110**	**0.353**	**0.431**	**0.000**	**0.000**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**
2002	**0.016**	**0.064**	**0.178**	**0.283**	**0.374**	**0.431**	**0.000**	**0.000**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**
2003	**0.012**	**0.031**	**0.056**	**0.231**	**0.326**	**0.339**	**0.000**	**0.000**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**
2004	**0.000**	**0.116**	**0.183**	**0.255**	**0.276**	**0.446**	**0.539**	**0.840**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**
2005	**0.000**	**0.107**	**0.187**	**0.239**	**0.268**	**0.287**	**0.598**	**0.619**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**
2006	**0.000**	**0.127**	**0.232**	**0.273**	**0.273**	**0.280**	**0.283**	**0.286**	0.287	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.287**
2007	**0.035**	**0.141**	**0.192**	**0.290**	**0.315**	**0.370**	**0.427**	**0.342**	0.368	0.400	0.000	0.000	0.000	0.000	0.000	0.000	**0.368**
2008	**0.042**	**0.146**	**0.291**	**0.388**	**0.454**	**0.526**	**0.414**	**0.406**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**
2009	**0.047**	**0.180**	**0.252**	**0.247**	**0.279**	**0.410**	**0.417**	**0.413**	0.400	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.400**

Table 13.2.5.1. Haddock in Subarea IV and Division IIIa. Data available for calibration of the assessment. Data used in the final assessment are highlighted in bold.

EngGFS Q3 GRT. Period: 0.5 - 0.75

	Effort	0	1	2	3	4	5	6	7
1977	100	**53.480**	**6.681**	**3.206**	**6.163**	**0.925**	**0.073**	**0.091**	0.013
1978	100	**35.827**	**13.688**	**2.618**	**0.239**	**2.220**	**0.214**	**0.005**	0.074
1979	100	**87.551**	**29.555**	**5.461**	**0.872**	**0.108**	**0.438**	**0.035**	0.005
1980	100	**37.403**	**62.331**	**16.732**	**2.570**	**0.273**	**0.042**	**0.142**	0.022
1981	100	**153.746**	**17.318**	**43.910**	**7.557**	**0.742**	**0.064**	**0.003**	0.061
1982	100	**28.134**	**31.546**	**7.980**	**11.800**	**1.025**	**0.237**	**0.098**	0.015
1983	100	**83.193**	**21.820**	**10.952**	**2.143**	**2.174**	**0.265**	**0.040**	0.013
1984	100	**22.847**	**59.933**	**6.159**	**3.078**	**0.418**	**0.478**	**0.103**	0.013
1985	100	**24.587**	**18.656**	**23.819**	**2.111**	**0.698**	**0.196**	**0.128**	0.041
1986	100	**26.600**	**14.974**	**4.472**	**3.382**	**0.277**	**0.175**	**0.038**	0.036
1987	100	**2.241**	**28.194**	**4.310**	**0.532**	**0.686**	**0.048**	**0.033**	0.003
1988	100	**6.073**	**2.856**	**18.352**	**1.549**	**0.160**	**0.279**	**0.041**	0.012
1989	100	**9.428**	**8.168**	**1.447**	**3.968**	**0.253**	**0.031**	**0.061**	0.014
1990	100	**28.188**	**6.645**	**1.983**	**0.287**	**0.878**	**0.048**	**0.026**	0.012
1991	100	**26.333**	**11.505**	**0.961**	**0.231**	**0.048**	**0.219**	**0.005**	0.007

EngGFS Q3 GOV. Period: 0.5 - 0.75

Year	Effort	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1992	100	**246.059**	**58.746**	**29.133**	**1.742**	**0.146**	**0.037**	**0.251**	0.010	0.135	0.000	0.016	0.000	0.000	0.000	0.000
1993	100	**40.336**	**73.145**	**17.435**	**4.951**	**0.176**	**0.048**	**0.000**	0.026	0.003	0.000	0.000	0.000	0.000	0.000	0.000
1994	100	**279.344**	**23.990**	**26.992**	**2.511**	**0.894**	**0.058**	**0.003**	0.003	0.000	0.003	0.000	0.000	0.000	0.000	0.000
1995	100	**53.435**	**113.775**	**13.223**	**11.032**	**0.827**	**0.275**	**0.021**	0.000	0.000	0.008	0.000	0.000	0.000	0.003	0.000
1996	100	**61.301**	**26.747**	**43.044**	**3.603**	**2.052**	**0.207**	**0.088**	0.006	0.000	0.003	0.000	0.000	0.000	0.000	0.000
1997	100	**40.653**	**45.346**	**12.608**	**19.968**	**0.719**	**0.718**	**0.067**	0.019	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1998	100	**15.747**	**26.497**	**16.778**	**4.079**	**4.141**	**0.226**	**0.141**	0.009	0.021	0.000	0.000	0.000	0.000	0.000	0.000
1999	100	**626.610**	**16.551**	**8.404**	**3.663**	**1.258**	**1.201**	**0.040**	0.036	0.011	0.000	0.000	0.000	0.000	0.000	0.000
2000	100	**92.139**	**249.813**	**4.528**	**1.634**	**0.740**	**0.336**	**0.350**	0.000	0.004	0.000	0.000	0.000	0.000	0.000	0.000
2001	100	**1.097**	**28.622**	**96.498**	**3.039**	**0.828**	**0.350**	**0.135**	0.058	0.177	0.003	0.000	0.000	0.000	0.000	0.000
2002	100	**2.721**	**3.954**	**22.559**	**60.583**	**0.542**	**0.097**	**0.153**	0.096	0.034	0.007	0.000	0.000	0.000	0.000	0.000
2003	100	**3.199**	**6.015**	**1.247**	**13.967**	**45.079**	**0.719**	**0.026**	0.221	0.082	0.014	0.000	0.000	0.000	0.000	0.003
2004	100	**3.398**	**6.599**	**3.864**	**0.448**	**6.836**	**17.406**	**0.217**	0.093	0.089	0.083	0.082	0.000	0.000	0.000	0.000
2005	100	**122.383**	**9.740**	**5.992**	**2.584**	**1.249**	**6.617**	**3.654**	0.021	0.007	0.000	0.000	0.000	0.000	0.000	0.000
2006	100	**12.838**	**54.403**	**3.226**	**1.137**	**0.426**	**0.148**	**0.861**	1.547	0.027	0.011	0.003	0.000	0.000	0.000	0.000
2007	100	**8.463**	**10.628**	**43.401**	**1.402**	**0.624**	**0.092**	**0.078**	0.315	0.559	0.046	0.015	0.000	0.000	0.000	0.000
2008	100	**2.613**	**6.494**	**5.801**	**18.534**	**0.727**	**0.266**	**0.137**	0.024	0.099	0.183	0.000	0.000	0.000	0.000	0.000
2009	100	**28.978**	**5.532**	**6.781**	**4.636**	**7.147**	**0.108**	**0.099**	0.000	0.036	0.080	0.010	0.000	0.000	0.000	0.000

Table 13.2.5.1. Haddock in Subarea IV and Division IIIa. Data available for calibration of the assessment. Data used in the final assessment are highlighted in bold.

ScoGFS Aberdeen Q3. Period: 0.5 - 0.75

Year	Effort	0	1	2	3	4	5	6	7	8
1982	100	**1235**	**2488**	**996**	**1336**	**115**	**7**	**2**	1	2
1983	100	**2203**	**1813**	**1611**	**372**	**455**	**53**	**12**	1	1
1984	100	**873**	**4367**	**788**	**336**	**55**	**65**	**9**	5	1
1985	100	**818**	**1976**	**2981**	**232**	**103**	**14**	**22**	4	2
1986	100	**1747**	**2329**	**574**	**598**	**36**	**27**	**4**	3	1
1987	100	**277**	**2393**	**704**	**106**	**128**	**8**	**5**	1	2
1988	100	**406**	**467**	**1982**	**170**	**27**	**23**	**2**	1	1
1989	100	**432**	**886**	**214**	**574**	**31**	**4**	**7**	1	1
1990	100	**3163**	**1002**	**240**	**32**	**103**	**7**	**1**	3	1
1991	100	**3471**	**1705**	**178**	**21**	**5**	**16**	**2**	1	1
1992	100	**8270**	**3832**	**963**	**48**	**8**	**3**	**8**	1	1
1993	100	**859**	**5836**	**1380**	**269**	**6**	**4**	**1**	3	1
1994	100	**13762**	**1265**	**2080**	**210**	**53**	**2**	**1**	1	1
1995	100	**1566**	**8153**	**734**	**926**	**74**	**28**	**2**	0	0
1996	100	**1980**	**2231**	**4705**	**231**	**206**	**22**	**6**	1	0
1997	100	**972**	**2779**	**849**	**1397**	**66**	**56**	**6**	1	1

ScoGFS Q3 GOV. Period: 0.5 - 0.75

Year	Effort	0	1	2	3	4	5	6	7	8
1998	100	**3280**	**6349**	**1924**	**490**	**511**	**24**	**18**	2	1
1999	100	**66067**	**1907**	**1141**	**688**	**197**	**164**	**6**	7	1
2000	100	**11902**	**30611**	**460**	**221**	**130**	**73**	**27**	4	3
2001	100	**79**	**3790**	**11352**	**179**	**65**	**40**	**18**	14	1
2002	100	**2149**	**675**	**2632**	**6931**	**70**	**37**	**18**	3	3
2003	100	**2159**	**1172**	**307**	**2092**	**4344**	**22**	**17**	8	2
2004	100	**1729**	**1198**	**547**	**101**	**819**	**1420**	**9**	1	1
2005	100	**19708**	**761**	**657**	**153**	**112**	**347**	**483**	4	3
2006	100	**2280**	**7275**	**272**	**158**	**33**	**14**	**73**	227	2
2007	100	**1119**	**1810**	**5527**	**117**	**57**	**11**	**5**	38	36
2008	100	**1885**	**733**	**1002**	**2424**	**28**	**24**	**6**	2	8
2009	100	**9015**	**877**	**547**	**469**	**1185**	**37**	**8**	6	0

IBTS Q1. Period: 0.0 - 0.25.

Year	Effort	1	2	3	4	5	6
1983	100	**302.278**	**403.079**	**89.463**	**116.447**	**13.182**	2.046
1984	100	**1072.285**	**221.275**	**127.770**	**20.410**	**20.900**	4.608
1985	100	**230.968**	**833.257**	**107.598**	**32.317**	**3.575**	6.567
1986	100	**573.023**	**266.912**	**303.546**	**17.888**	**6.490**	2.150
1987	100	**912.559**	**328.062**	**45.201**	**58.262**	**4.345**	2.434
1988	100	**101.691**	**677.641**	**97.149**	**12.684**	**13.965**	2.072
1989	100	**219.705**	**98.091**	**274.788**	**16.653**	**2.113**	4.697
1990	100	**217.448**	**139.114**	**32.997**	**50.367**	**3.163**	1.801
1991	100	**680.231**	**134.076**	**25.032**	**4.260**	**8.476**	2.430
1992	100	**1141.396**	**331.044**	**17.035**	**3.026**	**0.664**	2.202
1993	100	**1242.121**	**519.521**	**152.384**	**8.848**	**1.076**	0.953
1994	100	**227.919**	**491.051**	**97.656**	**23.308**	**1.566**	0.788
1995	100	**1355.485**	**201.069**	**176.165**	**24.354**	**5.286**	0.816
1996	100	**267.411**	**813.268**	**65.869**	**46.691**	**7.734**	3.061
1997	100	**849.943**	**353.882**	**466.731**	**24.987**	**15.238**	3.429
1998	100	**357.597**	**420.926**	**103.531**	**112.632**	**8.758**	5.412
1999	100	**211.139**	**222.907**	**127.064**	**48.217**	**36.650**	4.350
2000	100	**3734.185**	**107.060**	**48.638**	**24.549**	**15.589**	10.052
2001	100	**894.651**	**2255.213**	**47.899**	**10.962**	**7.218**	5.760
2002	100	**58.211**	**492.299**	**1387.877**	**10.010**	**7.457**	4.344
2003	100	**89.958**	**38.585**	**251.271**	**524.144**	**4.275**	2.364
2004	100	**71.875**	**79.622**	**35.473**	**173.589**	**330.011**	1.065
2005	100	**69.976**	**60.993**	**32.625**	**10.997**	**61.287**	95.689
2006	100	**1212.163**	**47.784**	**28.576**	**8.977**	**4.404**	53.175
2007	100	**109.096**	**963.325**	**36.609**	**15.483**	**3.374**	21.385
2008	100	**60.115**	**106.489**	**239.315**	**14.783**	**1.554**	6.332
2009	100	**74.687**	**140.045**	**102.941**	**135.663**	**2.523**	2.260
2010	100	**685.730**	**72.980**	**68.894**	**51.497**	**90.247**	9.001

Table 13.3.5.1. Haddock in Subarea IV and Division IIIa. XSA final assessment: Tuning diagnostics.

```
FLR XSA Diagnostics 2010-05-05 22:05:57

CPUE data from x.idx

Catch data for 47 years. 1963 to 2009. Ages 0 to 8.

                  fleet first age last age first year last year alpha beta
1         EngGFS Q3 GRT         0        6       1977      1991   0.5 0.75
2         EngGFS Q3 GOV         0        6       1992      2009   0.5 0.75
3    ScoGFS Aberdeen Q3         0        6       1982      1997   0.5 0.75
4         ScoGFS Q3 GOV         0        6       1998      2009   0.5 0.75
5 IBTS Q1 (backshifted)         0        4       1982      2009  0.99    1


 Time series weights:

   Tapered time weighting not applied

Catchability analysis:

    Catchability independent of size for ages >   0

    Catchability independent of age for ages >   6

Terminal population estimation:

    Survivor estimates shrunk towards the mean F
    of the final   5 years or the  3 oldest ages.

    S.E. of the mean to which the estimates are shrunk =   2

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

   prior weighting not applied

Regression weights
     year
age   2000 2001 2002 2003 2004 2005 2006 2007 2008 2009
  all    1    1    1    1    1    1    1    1    1    1


 Fishing mortalities
   year
age  2000  2001  2002  2003  2004  2005  2006  2007  2008  2009
  0 0.001 0.002 0.039 0.006 0.001 0.000 0.001 0.001 0.001 0.001
  1 0.047 0.059 0.123 0.101 0.049 0.050 0.049 0.042 0.044 0.030
  2 0.730 0.279 0.142 0.332 0.322 0.283 0.437 0.227 0.211 0.162
  3 0.831 0.783 0.187 0.153 0.289 0.401 0.533 0.515 0.175 0.253
  4 0.725 0.417 0.369 0.127 0.182 0.246 0.538 0.427 0.301 0.286
  5 0.234 0.234 0.161 0.184 0.152 0.197 0.373 0.330 0.161 0.153
  6 0.310 0.087 0.087 0.065 0.095 0.139 0.157 0.308 0.141 0.078
  7 0.165 0.069 0.040 0.029 0.020 0.054 0.098 0.095 0.101 0.093
  8 0.165 0.069 0.040 0.029 0.020 0.054 0.098 0.095 0.101 0.093


 XSA population number (Thousand)
      age
year         0        1       2       3       4      5      6      7     8
  2000 26349166 17325267  208956   87066   57942  31981  36104   4061  2036
  2001  2829047  3389678 3174344   67509   29550  21865  20731  21681  4634
  2002  3740286   363289  613546 1609668   24033  15171  14171  15561 21256
  2003  3903706   463295   61706  356955 1039873  12939  10577  10638  9510
  2004  3841042   499288   80409   29687  238508 713606   8811   8114  7569
  2005 39784392   494107   91270   39063   17319 154912 501802   6559  3019
  2006  8020876  5119913   90289   46120   20375  10550 104140 357679  2091
  2007  5148801  1031701  936604   39102   21081   9265   5951  72880 83554
  2008  3634119   662189  189905  500308   18186  10715   5456   3581 42610
  2009 20203448   467142  121654  103116  327054  10484   7469   3881 11653
```

Table 13.3.5.1. cont. Haddock in Subarea IV and Division IIIa. XSA final assessment: Tuning diagnostics.

Estimated population abundance at 1st Jan 2010

year \ age	0	1	2	3	4	5	6	7	8
2010	193837	2597923	87069	69376	62366	191334	7365	5655	**11589**

[Note: plus-group survivors modified to correct FLXSA error]

Fleet: EngGFS Q3 GRT

Log catchability residuals.

age \ year	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
0	0.379	-0.271	-0.123	0.575	0.989	0.130	-0.093	0.117	-0.112	-0.676	-0.379
1	-0.503	-0.243	-0.007	0.157	0.434	0.295	0.360	0.159	0.392	-0.207	-0.319
2	0.225	-0.305	-0.110	0.312	0.544	0.381	0.104	-0.036	0.060	0.076	-0.444
3	-0.243	-0.813	0.123	0.560	0.818	0.364	0.304	0.169	0.231	-0.408	-0.510
4	0.363	0.178	-0.135	0.377	0.488	0.034	0.002	0.030	0.089	-0.211	-0.467
5	0.229	0.185	-0.084	0.285	0.034	0.165	-0.082	-0.178	0.466	0.047	-0.479
6	0.259	-0.657	-0.420	0.206	-1.013	1.525	-0.724	0.253	-0.225	-0.073	-0.199

age \ year	1988	1989	1990	1991
0	-0.243	0.053	-0.163	-0.183
1	-0.120	0.214	0.024	-0.637
2	0.175	0.054	-0.076	-0.961
3	0.173	0.030	-0.124	-0.676
4	-0.150	0.009	-0.047	-0.560
5	0.129	-0.375	-0.192	-0.151
6	0.964	0.142	0.963	-0.999

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

	1	2	3	4	5	6
Mean_Logq	-15.5123	-15.0317	-15.2085	-15.3530	-15.5376	-15.9806
S.E_Logq	0.3308	0.3661	0.4593	0.2895	0.2546	0.7383

Regression statistics
Ages with q dependent on year class strength

	slope	intercept
Age 0	0.8580926	16.96445

Fleet: EngGFS Q3 GOV

Log catchability residuals.

age \ year	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
0	0.142	0.175	0.009	0.228	0.029	0.188	-0.016	-0.227	0.052	-0.251
1	0.266	0.084	0.132	0.184	0.109	0.251	0.220	0.022	0.057	-0.470
2	0.463	0.012	-0.096	0.313	-0.064	0.045	0.081	0.010	-0.342	-0.284
3	0.382	0.069	-0.511	0.212	0.209	0.179	-0.146	-0.212	-0.340	0.505
4	-0.218	-0.340	-0.108	-0.105	-0.083	-0.106	-0.131	-0.228	-0.456	0.139
5	0.094	0.361	-0.033	0.140	-0.051	0.161	-0.040	0.001	-0.544	-0.123
6	1.254	0.000	-0.494	0.213	0.420	0.110	-0.345	-0.535	0.000	-0.536

age \ year	2002	2003	2004	2005	2006	2007	2008	2009
0	-0.071	-0.043	-0.012	-0.094	0.038	0.153	-0.077	-0.222
1	-0.177	-0.014	-0.028	0.372	-0.247	-0.282	-0.330	-0.150
2	-0.179	-0.659	0.201	0.489	-0.024	0.106	-0.321	0.250
3	-0.044	-0.026	-0.895	0.653	-0.252	0.112	-0.068	0.175
4	-0.108	0.395	0.015	0.978	-0.078	0.200	0.422	-0.191
5	-1.086	1.091	0.247	0.836	-0.169	-0.541	0.270	-0.614
6	-0.031	-1.524	0.799	-0.392	-0.254	0.301	0.847	0.169

Table 13.3.5.1. cont. Haddock in Subarea IV and Division IIIa. XSA final assessment: Tuning diagnostics.

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

	1	2	3	4	5	6
Mean_Logq	-14.7564	-14.2995	-14.4758	-14.8113	-15.2540	-15.8316
S.E_Logq	0.2325	0.2925	0.3687	0.3330	0.5088	0.6306

Regression statistics
Ages with q dependent on year class strength

	slope	intercept
Age 0	0.615087	16.44025

Fleet: ScoGFS Aberdeen Q3

Log catchability residuals.

age \ year	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
0	-0.136	-0.733	-0.254	-0.588	-0.648	0.111	-0.206	-0.187	0.270	0.370
1	-0.217	-0.100	-0.433	0.174	-0.040	-0.758	0.097	0.021	0.160	-0.519
2	0.290	0.178	-0.102	-0.028	0.013	-0.266	-0.060	0.132	-0.197	-0.657
3	0.236	0.604	0.005	0.074	-0.089	-0.072	0.015	0.148	-0.267	-1.023
4	0.027	0.618	0.182	0.356	-0.071	0.034	0.251	0.090	-0.010	-0.641
5	-1.092	0.573	0.091	0.091	0.442	-0.007	-0.102	-0.159	0.147	-0.503
6	-0.274	0.164	-0.092	0.106	-0.233	0.006	0.035	0.069	-0.203	0.176

age \ year	1992	1993	1994	1995	1996	1997
0	0.656	-0.027	0.779	0.348	0.168	0.077
1	0.320	0.340	-0.027	0.332	0.409	0.242
2	-0.224	0.198	0.064	0.144	0.445	0.069
3	-0.426	-0.061	-0.209	0.518	0.246	0.303
4	-0.400	-0.997	-0.211	0.203	0.340	0.228
5	0.130	0.424	-0.853	0.403	0.255	0.158
6	0.049	0.227	-0.045	0.102	-0.025	-0.062

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

	1	2	3	4	5	6
Mean_Logq	-10.6322	-10.1142	-10.3514	-10.6256	-10.8942	-11.1649
S.E_Logq	0.3375	0.2590	0.3854	0.4032	0.4634	0.1472

Regression statistics
Ages with q dependent on year class strength

	slope	intercept
Age 0	0.8641435	13.38721

Fleet: ScoGFS Q3 GOV

Log catchability residuals.

age \ year	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
0	-0.016	-0.157	0.039	-1.447	0.512	0.468	0.332	0.036	-0.083	-0.191
1	0.808	-0.122	-0.025	-0.475	0.072	0.367	0.282	-0.161	-0.242	-0.035
2	0.065	0.162	-0.480	-0.275	-0.178	0.088	0.395	0.427	-0.348	0.194
3	-0.071	0.310	-0.147	-0.133	-0.018	0.269	-0.190	0.020	-0.032	-0.178
4	-0.040	0.101	-0.012	-0.223	0.029	0.238	0.076	0.749	-0.453	-0.010
5	-0.077	0.215	0.134	-0.087	0.155	-0.191	-0.053	0.093	-0.321	-0.459
6	-0.014	-0.043	-0.173	-0.163	0.218	0.440	0.005	-0.027	-0.333	-0.058

age \ year	2008	2009
0	0.434	0.072
1	-0.494	0.025
2	0.072	-0.119
3	0.092	0.078
4	-0.651	0.195
5	0.070	0.520
6	0.107	0.042

Table 13.3.5.1. cont. Haddock in Subarea IV and Division IIIa. XSA final assessment: Tuning diagnostics.

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

	1	2	3	4	5	6
Mean_Logq	-9.8655	-9.5405	-9.7621	-10.0865	-10.5516	-11.3125
S.E_Logq	0.3624	0.2848	0.1643	0.3509	0.2593	0.1971

Regression statistics
Ages with q dependent on year class strength

	slope	intercept
Age 0	0.8106716	12.23060

Fleet: IBTS Q1 (backshifted)

Log catchability residuals.

age \ year	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
0	-0.352	-0.389	-0.434	0.020	-0.258	0.171	0.174	0.136	-0.001	0.463	0.154
1	-0.149	-0.323	-0.219	0.073	-0.129	-0.157	0.410	0.032	0.040	-0.278	0.195
2	-0.053	-0.202	0.069	-0.172	-0.232	0.005	0.169	0.419	-0.129	-0.801	0.114
3	-0.001	-0.028	-0.061	-0.215	-0.042	0.120	0.094	-0.009	0.056	-0.661	0.219
4	0.116	-0.109	-0.221	-0.056	0.282	0.190	0.127	0.231	-0.138	-0.378	-0.035

age \ year	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
0	-0.187	-0.050	-0.129	0.450	0.191	-0.018	-0.011	0.289	0.055	0.192
1	-0.252	0.011	-0.114	0.413	0.222	0.094	-0.354	-0.026	0.095	-0.154
2	-0.244	-0.292	-0.174	0.206	0.024	0.049	-0.224	0.015	0.212	0.010
3	-0.221	-0.071	-0.248	0.252	-0.084	0.294	-0.206	-0.339	-0.223	-0.029
4	-0.039	-0.205	0.240	-0.004	0.408	0.104	0.265	-0.126	0.273	-0.124

age \ year	2003	2004	2005	2006	2007	2008	2009
0	-0.060	-0.073	0.166	-0.375	-0.466	0.033	0.311
1	0.305	-0.088	-0.321	0.344	-0.263	0.456	0.139
2	0.538	0.180	-0.118	0.294	-0.377	0.359	0.354
3	0.338	0.201	-0.165	0.345	0.447	-0.224	0.464
4	0.214	0.058	0.111	-0.027	-0.947	-0.440	0.233

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

	1	2	3	4
Mean_Logq	-11.8368	-11.8768	-12.1707	-12.4999
S.E_Logq	0.2427	0.2817	0.2590	0.2781

Regression statistics
Ages with q dependent on year class strength

	slope	intercept
Age 0	0.9115207	13.54703

Terminal year survivor and F summaries:

Age 0 Year class =2009

source	scaledWts	survivors	yrcls
EngGFS Q3 GOV	0.441	1810325	2009
ScoGFS Q3 GOV	0.079	2839267	2009
IBTS Q1 (backshifted)	0.441	3653309	2009
fshk	0.010	2923624	2009
nshk	0.029	2665868	2009

Age 1 Year class =2008

source	scaledWts	survivors	yrcls
EngGFS Q3 GOV	0.377	74943	2008
ScoGFS Q3 GOV	0.238	89276	2008
IBTS Q1 (backshifted)	0.377	100053	2008
fshk	0.009	49052	2008

Table 13.3.5.1. cont. Haddock in Subarea IV and Division IIIa. XSA final assessment: Tuning diagnostics.

Age 2 Year class =2007

source	scaledWts	survivors	yrcls
EngGFS Q3 GOV	0.330	89051	2007
ScoGFS Q3 GOV	0.331	61596	2007
IBTS Q1 (backshifted)	0.331	98855	2007
fshk	0.009	34787	2007

Age 3 Year class =2006

source	scaledWts	survivors	yrcls
EngGFS Q3 GOV	0.236	74253	2006
ScoGFS Q3 GOV	0.376	67395	2006
IBTS Q1 (backshifted)	0.376	99166	2006
fshk	0.011	38093	2006

Age 4 Year class =2005

source	scaledWts	survivors	yrcls
EngGFS Q3 GOV	0.311	158105	2005
ScoGFS Q3 GOV	0.273	232584	2005
IBTS Q1 (backshifted)	0.404	241492	2005
fshk	0.012	155819	2005

Age 5 Year class =2004

source	scaledWts	survivors	yrcls
EngGFS Q3 GOV	0.243	3985	2004
ScoGFS Q3 GOV	0.738	12389	2004
fshk	0.019	4422	2004

Age 6 Year class =2003

source	scaledWts	survivors	yrcls
EngGFS Q3 GOV	0.164	6695	2003
ScoGFS Q3 GOV	0.816	5897	2003
fshk	0.020	2514	2003

Age 7 Year class =2002

source	scaledWts	survivors	yrcls
fshk	1	1494	2002

Table 13.3.5.2. Haddock in Subarea IV and Division IIIa. Estimates of fishing mortality at age from the final XSA assessment. Estimates refer to the full year (January – December) except for age 0, for which the mortality rate given refers to the second half-year only (July – December).

	0	1	2	3	4	5	6	7	8+
1963	0.002	0.125	0.805	0.668	0.762	0.902	0.648	0.778	0.778
1964	0.043	0.059	0.457	1.174	0.751	0.886	1.365	1.012	1.012
1965	0.071	1.359	0.421	0.513	0.984	1.275	1.026	1.108	1.108
1966	0.070	1.304	0.828	0.367	0.792	1.237	1.225	1.098	1.098
1967	0.002	0.262	1.085	0.412	0.382	1.057	1.313	0.927	0.927
1968	0.002	0.051	0.578	0.908	0.304	0.528	0.900	0.582	0.582
1969	0.017	0.021	0.654	1.377	1.333	0.801	1.871	1.352	1.352
1970	0.030	0.503	1.036	1.145	1.274	0.781	1.364	1.153	1.153
1971	0.012	0.474	0.665	0.793	0.860	0.873	0.838	0.866	0.866
1972	0.032	0.168	0.793	1.380	1.183	1.120	0.880	1.074	1.074
1973	0.002	0.373	0.565	1.161	0.873	0.910	0.995	0.936	0.936
1974	0.013	0.351	0.934	0.945	1.006	0.751	0.791	0.859	0.859
1975	0.011	0.333	0.957	1.261	1.085	1.005	1.264	1.131	1.131
1976	0.029	0.306	0.808	1.310	0.797	1.215	1.103	1.050	1.050
1977	0.012	0.327	0.995	1.014	1.083	1.080	0.870	1.023	1.023
1978	0.020	0.373	0.989	1.123	1.068	0.759	1.197	0.823	0.823
1979	0.033	0.171	0.827	1.077	1.050	0.890	0.441	0.879	0.879
1980	0.068	0.182	0.689	1.009	0.986	0.907	0.702	0.200	0.200
1981	0.057	0.176	0.439	0.895	0.633	0.531	0.570	0.487	0.487
1982	0.039	0.172	0.417	0.779	0.773	0.282	0.356	0.849	0.849
1983	0.027	0.151	0.653	0.961	1.032	0.871	0.225	0.246	0.246
1984	0.016	0.125	0.670	0.972	0.970	0.869	0.494	0.114	0.114
1985	0.016	0.208	0.613	0.967	1.032	0.679	0.479	0.222	0.222
1986	0.003	0.129	1.029	1.239	1.335	0.880	0.324	0.204	0.204
1987	0.006	0.106	0.909	1.077	1.080	0.924	0.717	0.230	0.230
1988	0.004	0.135	0.786	1.310	1.221	1.100	0.979	0.335	0.335
1989	0.003	0.106	0.655	0.974	1.218	0.884	0.761	1.032	1.032
1990	0.005	0.184	1.113	1.143	1.074	0.958	0.864	0.606	0.606
1991	0.013	0.152	0.778	1.037	0.844	0.763	0.721	1.452	1.452
1992	0.018	0.136	0.725	1.132	1.081	0.764	0.781	0.916	0.916
1993	0.030	0.161	0.790	0.999	0.893	0.998	0.702	0.413	0.413
1994	0.004	0.145	0.542	1.018	0.920	0.670	1.227	0.749	0.749
1995	0.040	0.099	0.486	0.828	0.878	0.669	0.371	1.057	1.057
1996	0.019	0.062	0.431	0.853	0.785	0.715	0.625	1.675	1.675
1997	0.006	0.118	0.396	0.587	0.624	0.540	0.388	0.269	0.269
1998	0.006	0.123	0.581	0.490	0.733	0.524	0.226	0.156	0.156
1999	0.002	0.157	0.761	0.845	0.520	0.693	0.419	0.149	0.149
2000	0.001	0.047	0.730	0.831	0.725	0.234	0.310	0.165	0.165
2001	0.002	0.059	0.279	0.783	0.417	0.234	0.087	0.069	0.069
2002	0.039	0.123	0.142	0.187	0.369	0.161	0.087	0.040	0.040
2003	0.006	0.101	0.332	0.153	0.127	0.184	0.065	0.029	0.029
2004	0.001	0.049	0.322	0.289	0.182	0.152	0.095	0.020	0.020
2005	0.000	0.050	0.283	0.401	0.246	0.197	0.139	0.054	0.054
2006	0.001	0.049	0.437	0.533	0.538	0.373	0.157	0.098	0.098
2007	0.001	0.042	0.227	0.515	0.427	0.330	0.308	0.095	0.095
2008	0.001	0.044	0.211	0.175	0.301	0.161	0.141	0.101	0.101
2009	0.001	0.030	0.162	0.253	0.286	0.153	0.078	0.093	0.093

Table 13.3.5.3. Haddock in Subarea IV and Division IIIa. Estimates of stock numbers at age from the final XSA assessment. Estimates refer to January 1st, except for age 0 for estimates refer to July 1st. *Estimated survivors.

	0	1	2	3	4	5	6	7	8+
1963	2315030	25450196	739728	48724	27677	10747	1164	1334	1295
1964	9155436	297538	4315469	221619	19450	10060	3569	499	839
1965	26286793	1128473	53888	1832192	53363	7147	3397	746	385
1966	68923264	3150893	55672	23718	854126	15539	1635	997	455
1967	388351663	8274726	164299	16311	12803	301155	3694	393	552
1968	17114887	49884892	1222290	37210	8411	6807	85639	814	144
1969	12133832	2199299	9099632	459731	11689	4833	3285	28519	336
1970	87606938	1536014	413405	3171948	90348	2402	1776	414	9575
1971	78212538	10946327	178355	98334	786435	19681	901	372	3580
1972	21427136	9950039	1308927	61465	34648	259112	6729	319	791
1973	72955839	2671988	1614657	396949	12048	8265	69183	2285	536
1974	132873951	9370481	353235	615310	96813	3918	2725	20938	578
1975	11407920	16889731	1267401	93022	186329	27561	1514	1011	4896
1976	16403514	1452471	2324435	326392	20523	49016	8261	350	1498
1977	26225562	2051724	205458	694198	68599	7202	11913	2244	624
1978	39836601	3334900	284215	50927	196165	18079	2002	4088	1187
1979	72668689	5025802	441105	70833	12904	52521	6927	495	1326
1980	15808409	9053091	813839	129319	18784	3518	17659	3648	2443
1981	32619403	1900560	1449347	273846	36728	5458	1163	7164	710
1982	20491922	3967323	306086	626556	87121	15186	2629	539	1597
1983	66958895	2538027	641241	135196	223910	31330	9377	1507	1604
1984	17181545	8390384	418951	223760	40280	62151	10739	6132	2666
1985	23921369	2177599	1421977	143767	65908	11897	21343	5365	2085
1986	49039922	3029435	339817	516225	42572	18297	4942	10820	2908
1987	4156493	6292876	511528	81399	116426	8726	6213	2926	5703
1988	8337572	531706	1086846	138202	21582	30783	2837	2483	1589
1989	8606453	1069459	89221	331876	29027	4955	8392	873	568
1990	28354085	1104110	184674	31072	97558	6689	1677	3211	852
1991	27479704	3630257	176400	40679	7719	25944	2100	579	1170
1992	41901153	3493139	598966	54308	11236	2586	9909	836	1354
1993	13129112	5296994	585730	194455	13630	2970	986	3714	1479
1994	56008457	1639510	865976	178255	55783	4344	896	400	1474
1995	14371503	7179399	272425	337704	50165	17315	1820	215	238
1996	21449472	1777903	1248981	112343	114920	16234	7260	1028	165
1997	12791143	2708037	320985	544159	37284	40833	6502	3182	480
1998	9948546	1636313	462117	144872	235561	15559	19490	3612	1303
1999	134816209	1272790	277981	173257	69098	88150	7544	12735	3125
2000	26349166	17325267	208956	87066	57942	31981	36104	4061	2036
2001	2829047	3389678	3174344	67509	29550	21865	20731	21681	4634
2002	3740286	363289	613546	1609668	24033	15171	14171	15561	21256
2003	3903706	463295	61706	356955	1039873	12939	10577	10638	9510
2004	3841042	499288	80409	29687	238508	713606	8811	8114	7569
2005	39784392	494107	91270	39063	17319	154912	501802	6559	3019
2006	8020876	5119913	90289	46120	20375	10550	104140	357679	2091
2007	5148801	1031701	936604	39102	21081	9265	5951	72880	83554
2008	3634119	662189	189905	500308	18186	10715	5456	3581	42610
2009	20203448	467142	121654	103116	327054	10484	7469	3881	11653

Table 13.3.5.4. Haddock in Subarea IV and Division IIIa. Stock summary table.

	Recruitment	TSB	SSB	Catch	Landings	Discards	Bycatch	Yield/SSB	Mean F(2-4)
1963	2315030	3412701	137055	271851	68821	189329	13700	0.502	0.745
1964	9155436	1281826	417718	379915	131006	160309	88600	0.314	0.794
1965	26286793	1081002	521742	299344	162418	62326	74600	0.311	0.639
1966	68923264	1480501	427843	346349	226184	73465	46700	0.529	0.662
1967	388351663	5527478	224795	246664	147742	78222	20700	0.657	0.626
1968	17114887	6852044	259402	301821	105811	161810	34200	0.408	0.597
1969	12133832	2477693	810551	930043	331625	260065	338353	0.409	1.121
1970	87606938	2541785	900224	805776	524773	101274	179729	0.583	1.152
1971	78212538	2546522	420406	446824	237502	177776	31546	0.565	0.773
1972	21427136	2182357	302983	353084	195545	127954	29585	0.645	1.119
1973	72955839	4088682	297174	307595	181592	114736	11267	0.611	0.866
1974	132873951	4711758	260806	366992	153057	166429	47505	0.587	0.962
1975	11407920	2385721	238380	453205	151349	260369	41487	0.635	1.101
1976	16403514	1097926	309693	375305	172680	154462	48163	0.558	0.972
1977	26225562	1069943	242616	224516	145118	44376	35022	0.598	1.031
1978	39836601	1138716	138480	179376	91683	76789	10903	0.662	1.060
1979	72668689	1353459	117535	145020	87069	41710	16240	0.741	0.985
1980	15808409	1472494	170015	222126	105041	94614	22472	0.618	0.895
1981	32619403	997751	258040	213240	136132	60067	17041	0.528	0.656
1982	20491922	1093126	321860	233283	173335	40564	19383	0.539	0.656
1983	66958895	2254798	277512	244212	165337	65977	12898	0.596	0.882
1984	17181545	1692366	225142	218946	133568	75298	10080	0.593	0.870
1985	23921369	1189450	262185	255366	164119	85249	5998	0.626	0.871
1986	49039922	1943062	238038	223081	168236	52202	2643	0.707	1.201
1987	4156493	1098458	167552	173852	110299	59143	4410	0.658	1.022
1988	8337572	630869	160401	173123	106973	62148	4002	0.667	1.106
1989	8606453	623939	128104	106529	78439	25680	2410	0.612	0.949
1990	28354085	1583131	81098	88934	53780	32565	2589	0.663	1.110
1991	27479704	1553449	63406	93286	47715	40185	5386	0.753	0.886
1992	41901153	1364067	103579	131650	72790	47934	10927	0.703	0.979
1993	13129112	1018551	139119	172550	82176	79608	10766	0.591	0.894
1994	56008457	1485784	161604	151020	82074	65370	3576	0.508	0.826
1995	14371503	1171553	162830	142524	77458	57372	7695	0.476	0.731
1996	21449472	1059726	201869	156609	79148	72461	5000	0.392	0.690
1997	12791143	977290	226177	141347	82574	52089	6684	0.365	0.536
1998	9948546	792868	203387	131316	81054	45160	5101	0.399	0.601
1999	134816209	3589482	157280	112021	65588	42598	3835	0.417	0.709
2000	26349166	3494867	135386	104457	47553	48770	8134	0.351	0.762
2001	2829047	1216246	311073	166960	40856	118225	7879	0.131	0.493
2002	3740286	878071	512091	107922	58348	45857	3717	0.114	0.233
2003	3903706	762039	500358	66806	41964	23692	1150	0.084	0.204
2004	3841042	766270	429280	64839	48734	15551	554	0.114	0.264
2005	39784392	2684230	370764	57162	48357	8637	168	0.130	0.310
2006	8020876	1321268	295845	56056	37613	17908	535	0.127	0.503
2007	5148801	734269	215671	59643	30939	28657	48	0.143	0.390
2008	3634119	555227	210408	43640	30248	13194	199	0.144	0.229
2009	20203448	1296022	178165	43407	32807	10548	52	0.184	0.234
Units	Thousands	Tonnes	Tonnes	Tonnes	Tonnes	Tonnes	Tonnes		

Table 13.6.1. Haddock in Subarea IV and Division IIIa. Short-term forecast input.

MFDP version 1a
Run: had01
Time and date: 14:39 10/05/2010
Fbar age range (Total) : 2-4
Fbar age range Fleet 1 : 2-4
Fbar age range Fleet 2 : 2-4

2010

Age	N	M	Mat	PF	PM	SWt
0	3823274	2.05	0.00	0	0	0.045
1	2597923	1.65	0.01	0	0	0.175
2	87069	0.40	0.32	0	0	0.275
3	69376	0.25	0.71	0	0	0.371
4	62366	0.25	0.87	0	0	0.497
5	191334	0.20	0.95	0	0	0.614
6	7365	0.20	1.00	0	0	0.707
7	5655	0.20	1.00	0	0	0.853
8	11589	0.20	1.00	0	0	1.256

Catch

Age	Sel	CWt	DSel	DCWt
0	0.000	0.000	0.001	0.046
1	0.002	0.397	0.031	0.163
2	0.040	0.404	0.131	0.228
3	0.154	0.429	0.092	0.268
4	0.251	0.523	0.030	0.303
5	0.166	0.632	0.005	0.353
6	0.133	0.721	0.002	0.344
7	0.084	0.861	0.000	0.390
8	0.084	1.263	0.001	0.443

IBC

Age	Sel	CWt
0	0.000	0.025
1	0.000	0.140
2	0.001	0.231
3	0.000	0.287
4	0.001	0.318
5	0.001	0.375
6	0.000	0.428
7	0.000	0.413
8	0.000	0.352

2011

Age	N	M	Mat	PF	PM	SWt
0	3823274	2.05	0.00	0	0	0.045
1	.	1.65	0.01	0	0	0.175
2	.	0.40	0.32	0	0	0.275
3	.	0.25	0.71	0	0	0.371
4	.	0.25	0.87	0	0	0.524
5	.	0.20	0.95	0	0	0.614
6	.	0.20	1.00	0	0	0.707
7	.	0.20	1.00	0	0	0.853
8	.	0.20	1.00	0	0	1.318

Catch

Age	Sel	CWt	DSel	DCWt
0	0.000	0.000	0.001	0.046
1	0.002	0.397	0.031	0.163
2	0.040	0.404	0.131	0.228
3	0.154	0.429	0.092	0.268
4	0.251	0.550	0.030	0.303
5	0.166	0.632	0.005	0.353
6	0.133	0.721	0.002	0.344
7	0.084	0.861	0.000	0.390
8	0.084	1.326	0.001	0.443

IBC

Age	Sel	CWt
0	0.000	0.025
1	0.000	0.140
2	0.001	0.231
3	0.000	0.287
4	0.001	0.318
5	0.001	0.375
6	0.000	0.428
7	0.000	0.413
8	0.000	0.352

2012

Age	N	M	Mat	PF	PM	SWt
0	3823274	2.05	0.00	0	0	0.045
1	.	1.65	0.01	0	0	0.175
2	.	0.40	0.32	0	0	0.275
3	.	0.25	0.71	0	0	0.371
4	.	0.25	0.87	0	0	0.497
5	.	0.20	0.95	0	0	0.614
6	.	0.20	1.00	0	0	0.707
7	.	0.20	1.00	0	0	0.853
8	.	0.20	1.00	0	0	1.542

Catch

Age	Sel	CWt	DSel	DCWt
0	0.000	0.000	0.001	0.046
1	0.002	0.397	0.031	0.163
2	0.040	0.404	0.131	0.228
3	0.154	0.429	0.092	0.268
4	0.251	0.523	0.030	0.303
5	0.166	0.632	0.005	0.353
6	0.133	0.721	0.002	0.344
7	0.084	0.861	0.000	0.390
8	0.084	1.550	0.001	0.443

IBC

Age	Sel	CWt
0	0.000	0.025
1	0.000	0.140
2	0.001	0.231
3	0.000	0.287
4	0.001	0.318
5	0.001	0.375
6	0.000	0.428
7	0.000	0.413
8	0.000	0.352

Input units are thousands and kg - output in tonnes

Table 13.6.2. Haddock in Subarea IV and Division IIIa. Short-term forecast output. A number of management options are highlighted.

MFDP version 1a
Run: had01
Time and date: 14:39 10/05/2010
Fbar age range (Total) : 2-4
Fbar age range Fleet 1 : 2-4
Fbar age range Fleet 2 : 2-4

2010

Biomass	SSB	Catch FMult	Fbar	Yield	Landings FBar	Yield	Discards FBar	Yield	IBC FMult	FBar	Yield
849428	193641	1	0.233	41396	0.148	30820	0.084	10485	1	0.0007	91

2011 / **2012** — 2010 TAC 37995

Biomass	SSB	Catch FMult	Fbar	Yield	Landings FBar	Yield	Discards FBar	Yield	IBC FMult	FBar	Yield	2012 Biomass	SSB	TAC change	
568552	211757	0.00	0.001	116	0.000	0	0.000	0	1	0.001	116	579609	266370	-100%	
.	211757	0.10	0.023	4497	0.014	2978	0.008	1404	1	0.001	115	574864	262340	-92%	0.1 * F(sq)
.	211757	0.10	0.024	4674	0.015	3098	0.008	1461	1	0.001	115	574672	262177	-92%	
.	211757	0.20	0.047	9159	0.030	6145	0.017	2900	1	0.001	114	569820	258057	-84%	
.	211757	0.25	0.058	11193	0.037	7526	0.021	3554	1	0.001	114	567621	256190	-80%	0.25 * F(sq)
.	211757	0.30	0.071	13570	0.045	9140	0.025	4317	1	0.001	113	565052	254009	-76%	
.	211757	0.40	0.094	17910	0.059	12086	0.034	5712	1	0.001	112	560367	250032	-68%	
.	211757	0.50	0.117	22178	0.074	14982	0.042	7085	1	0.001	111	555763	246124	-61%	0.5 * F(sq)
.	211757	0.60	0.140	26378	0.089	17830	0.051	8438	1	0.001	110	551238	242284	-53%	
.	211757	0.70	0.164	30510	0.104	20631	0.059	9770	1	0.001	109	546792	238510	-46%	
.	211757	0.75	0.175	32508	0.111	21984	0.063	10415	1	0.001	109	544644	236688	-42%	0.75 * F(sq)
.	211757	0.80	0.187	34576	0.119	23385	0.068	11082	1	0.001	109	542421	234802	-38%	
.	211757	0.90	0.210	38576	0.134	26094	0.076	12374	1	0.001	108	538126	231158	-31%	0.9 * F(sq)
.	211757	1.00	0.233	42511	0.148	28758	0.084	13646	1	0.001	107	533905	227577	-24%	Status quo
.	211757	1.10	0.257	46384	0.163	31379	0.093	14899	1	0.001	106	529756	224058	-17%	Lower bound of F(msy) rang
	211757	1.14	0.265	47739	0.168	32296	0.096	15338	1	0.001	106	528305	222827	-15%	15% TAC decrease
.	211757	1.20	0.280	50194	0.178	33956	0.101	16133	1	0.001	105	525677	220599	-11%	
.	211757	1.25	0.292	52150	0.186	35278	0.106	16767	1	0.001	104	523587	218826	-7%	1.25 * F(sq)
.	211757	1.29	0.300	53443	0.191	36152	0.108	17187	1	0.001	104	522205	217654	-5%	Management plan
.	211757	1.30	0.303	53944	0.193	36491	0.110	17349	1	0.001	104	521669	217200	-4%	
	211757	1.36	0.317	56169	0.202	37995	0.115	18071	1	0.001	103	519292	215185	0%	Roll-over TAC
.	211757	1.40	0.327	57634	0.208	38985	0.118	18546	1	0.001	103	517728	213859	3%	
.	211757	1.60	0.373	64841	0.237	43851	0.135	20888	1	0.001	102	510047	207348	15%	15% TAC increase
.	211757	1.70	0.396	68358	0.252	46225	0.143	22032	1	0.001	101	506304	204175	22%	
.	211757	1.80	0.420	71819	0.267	48560	0.152	23159	1	0.001	100	502625	201057	28%	
.	211757	1.90	0.443	75227	0.282	50858	0.160	24270	1	0.001	99	499007	197992	34%	
.	211757	2.00	0.466	78581	0.297	53119	0.169	25364	1	0.001	98	495451	194979	40%	
	211757	2.05	0.477	80019	0.304	54086	0.173	25835	1	0.001	98	493937	193697	42%	Upper bound of F(msy) rang
.	211757	3.00	0.700	109396	0.446	73839	0.253	35466	1	0.001	91	462994	167499	94%	F(pa)

Table 13.7.1. Haddock in Subarea IV and Division IIIa. Summary of MSY estimates: 5th. 50th and 95th percentiles, and the mean estimates.

	F(MSY)			
Model	5th %ile	50th %ile	95th %ile	Mean
ADMB Ricker	0.250	0.371	0.565	0.379
ADMB Bev-Holt	0.178	0.257	0.330	0.254
ADMB hockey	0.244	0.348	0.595	0.357
ADMB* Ricker	0.303	0.420	0.589	0.430
ADMB* Bev-Holt	0.214	0.282	0.328	0.281
ADMB* hockey	0.386	0.386	0.386	0.386
Equilibirum Ricker	0.285	0.416	0.591	0.415
FLR deterministic	0.424	0.424	0.425	0.424
FLR stochastic	0.400	0.400	0.450	0.415
Min	0.178	0.257		0.254
Max		0.424	0.595	0.430

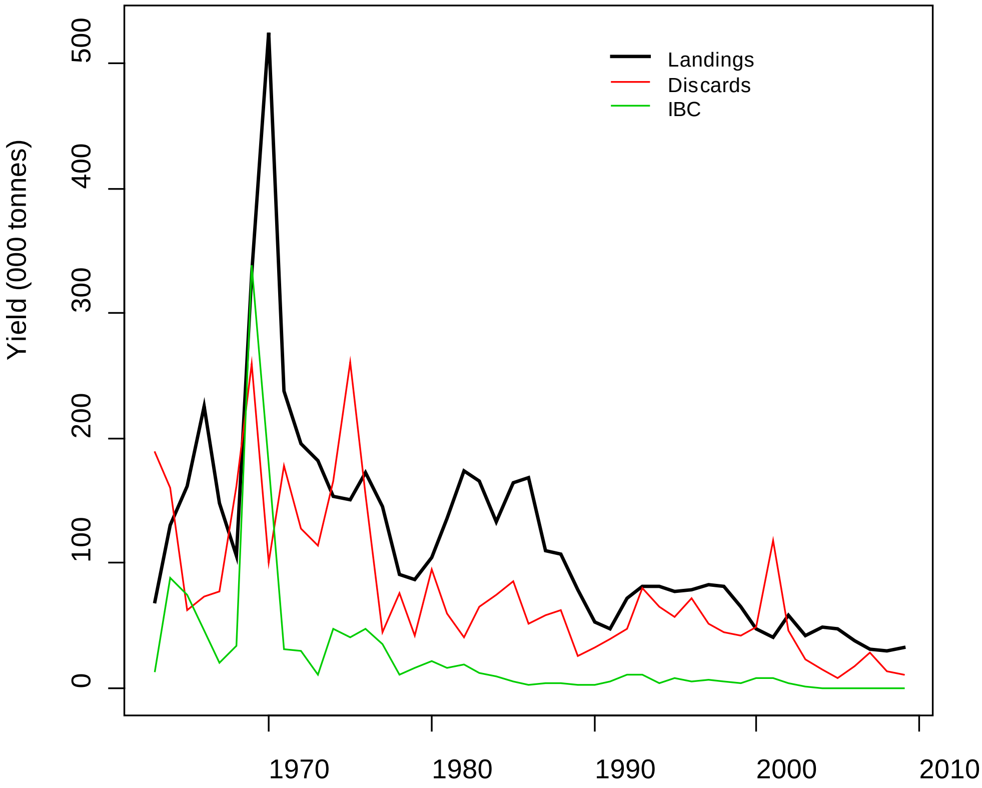


Figure 13.2.1.1. Haddock in Subarea IV and Division IIIa. Yield by catch component.

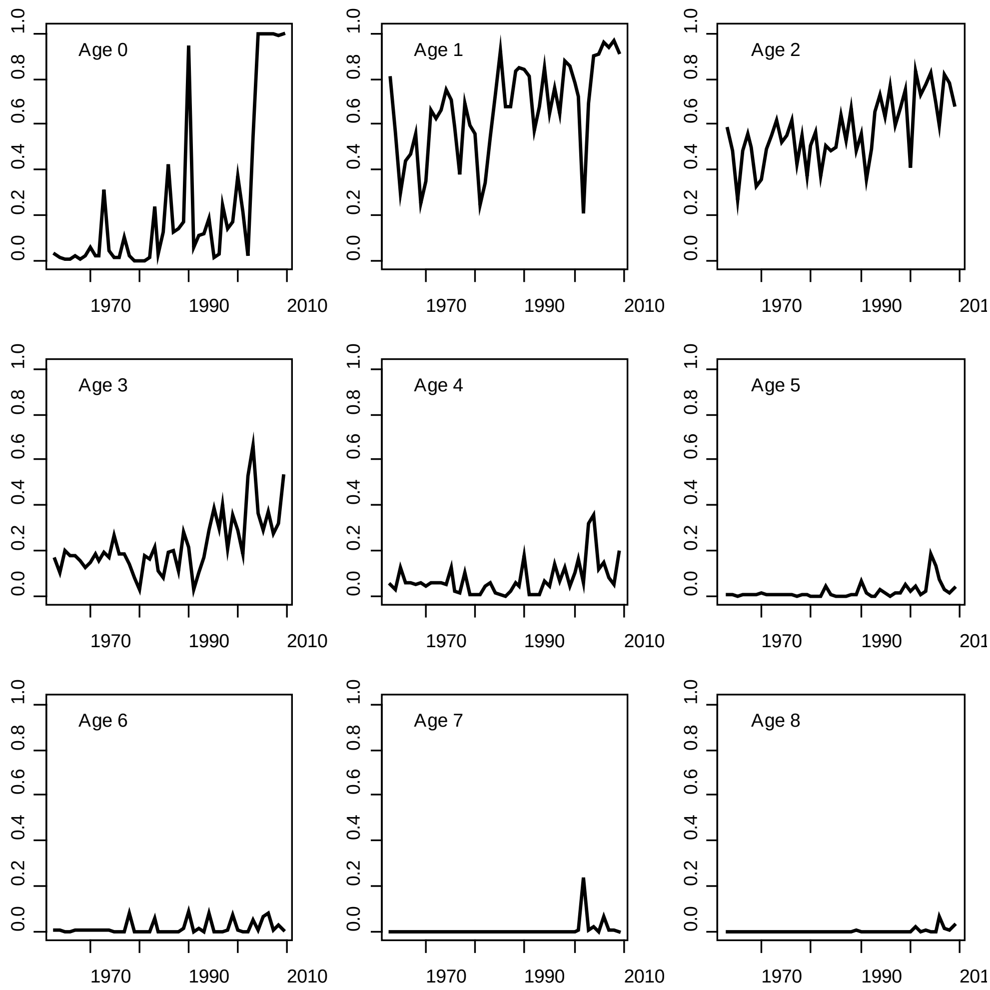
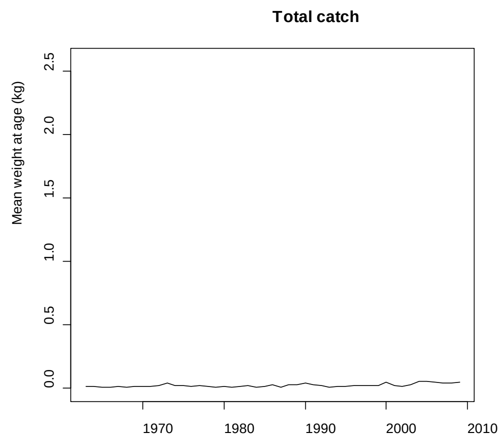


Figure 13.2.1.2. Haddock in Subarea IV and Divisions IIIa. Proportion of total catch discarded, by age and year.


Total catch
Mean weight at age (kg)
0.0
0.5
1.0
1.5
2.0
2.5
1970
1980
1990
2000
2010

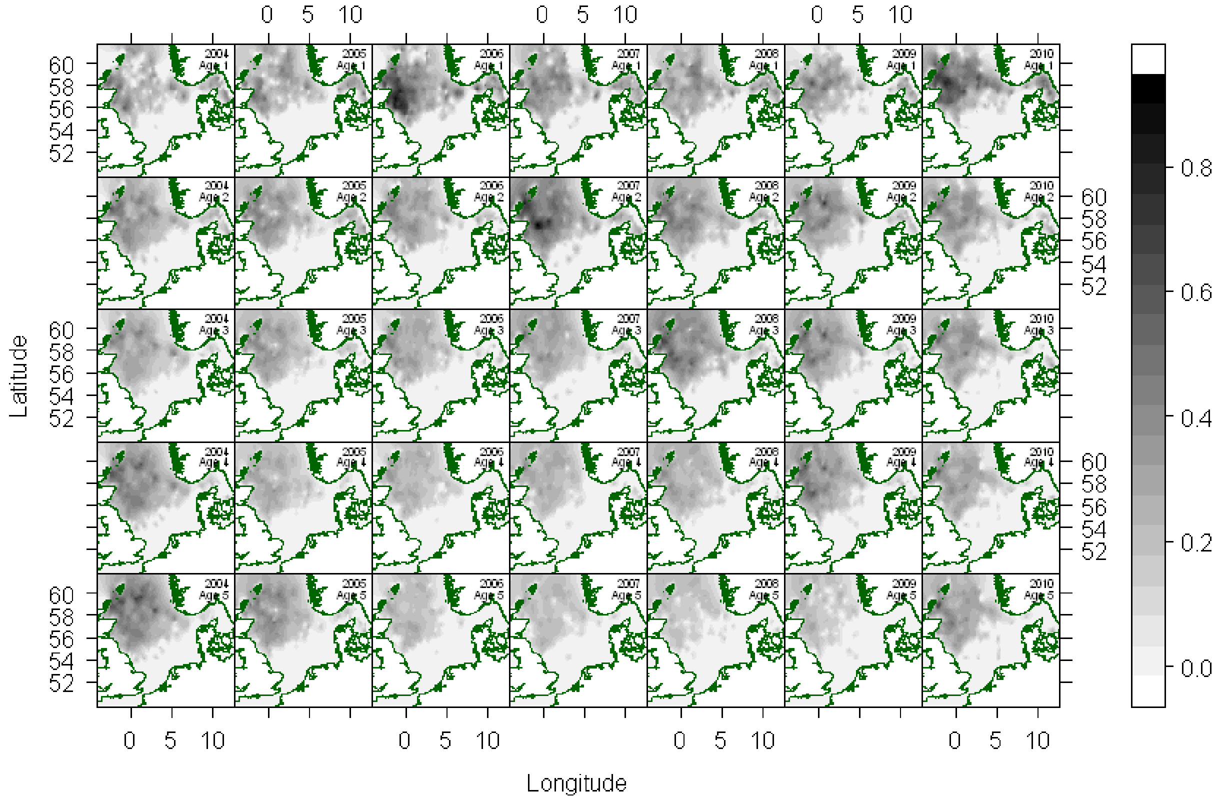


Figure 13.2.5.1. Haddock in Subarea IV and Division IIIa. Spatial distribution from the IBTS Q1 survey. Contour scale (given in the bar to the right) is the square root of survey CPUE, rescaled to lie between 0 and 1.

Figure 13.2.5.2. Haddock in Subarea IV and Division IIIa. Spatial distribution from the ScoGFS Q3 survey.

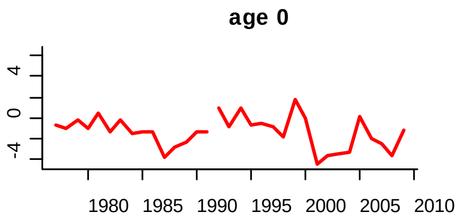


Figure 13.2.5.3. Haddock in Subarea IV and Division IIIa. Survey log CPUE (catch per unit effort) at age.

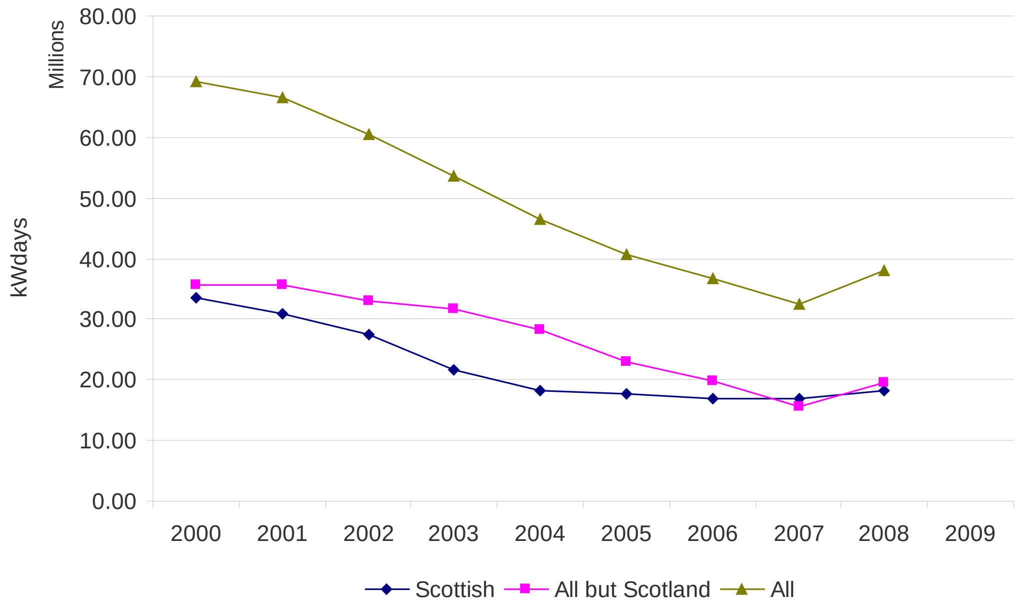


Figure 13.2.5.4. Haddock in Subarea IV and Division IIIa. Reported effort (in kW days) for otter trawlers and seiners in the North Sea. The green line shows all countries, the blue line shows effort for vessels from Scotland (the main haddock fishing country), and the pink line gives all countries except Scotland. Source: STECF.

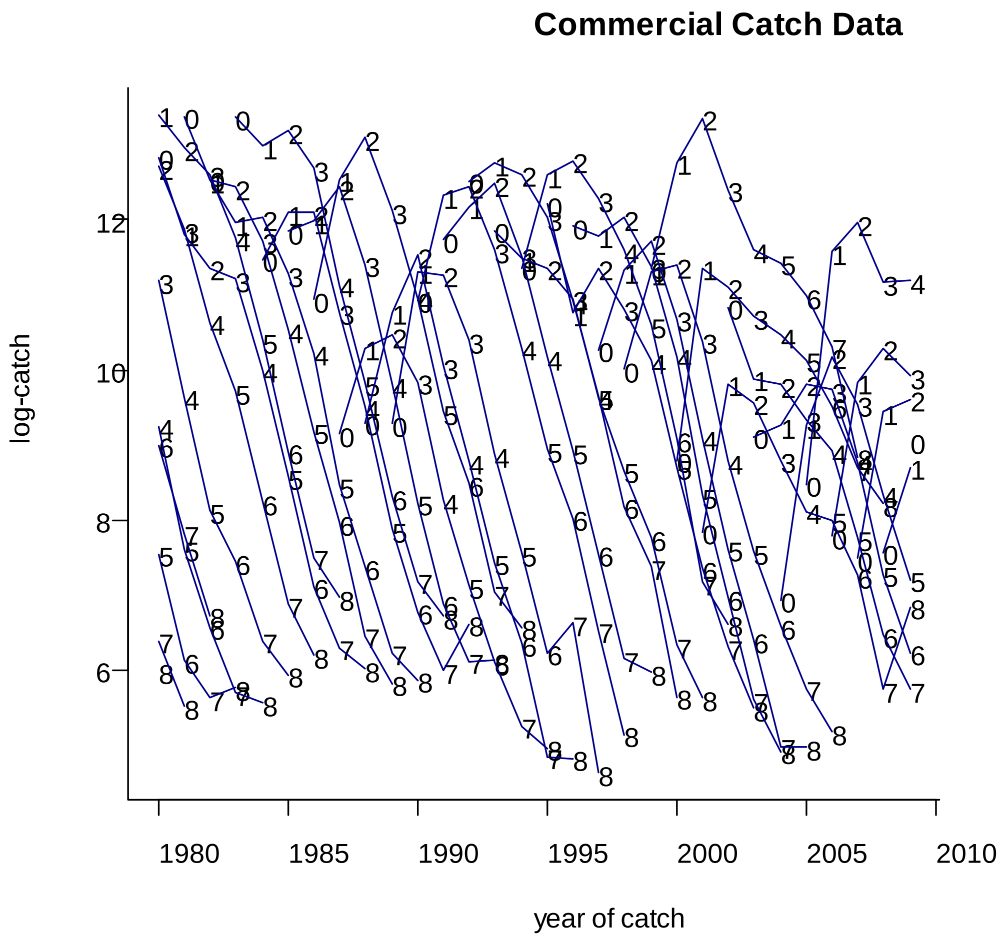


Figure 13.3.2.1. Haddock in Subarea IV and Division IIIa. Log catch curves by cohort for total catches.

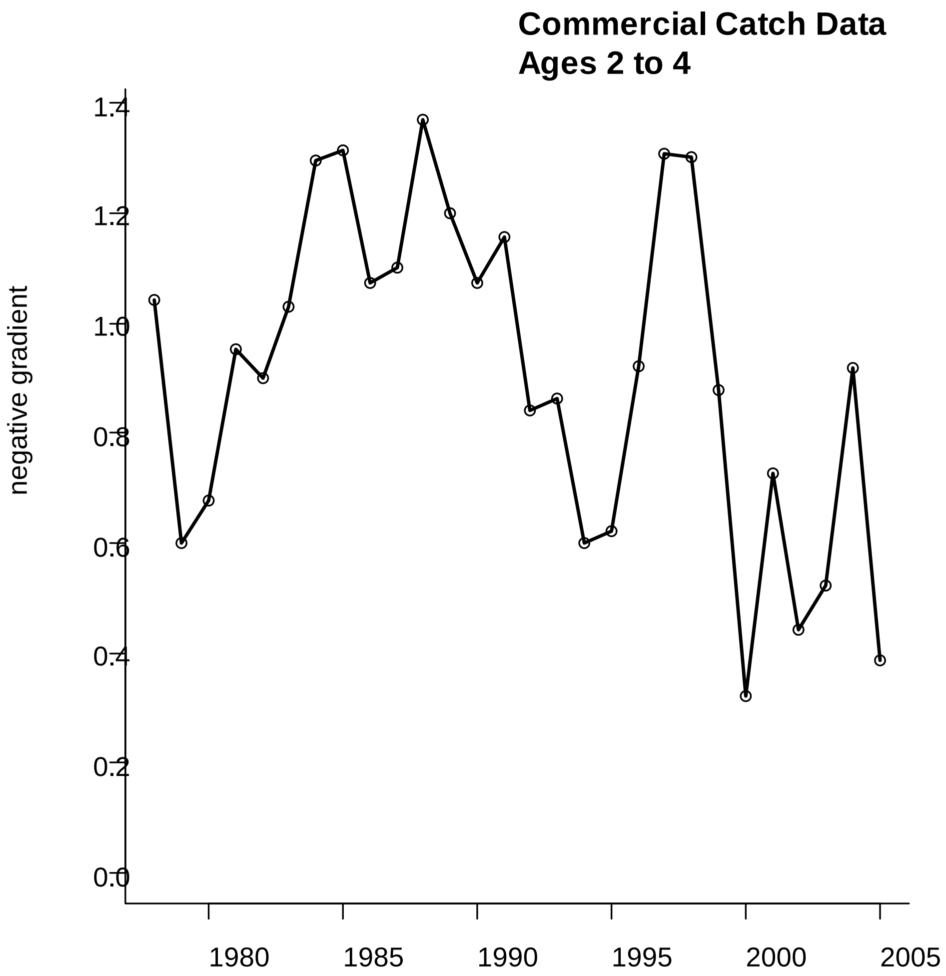


Figure 13.3.2.2. Haddock in Subarea IV and Division IIIa. Negative gradients of log catches per cohort, averaged over ages 2-4. The x-axis represents the spawning year of each cohort.

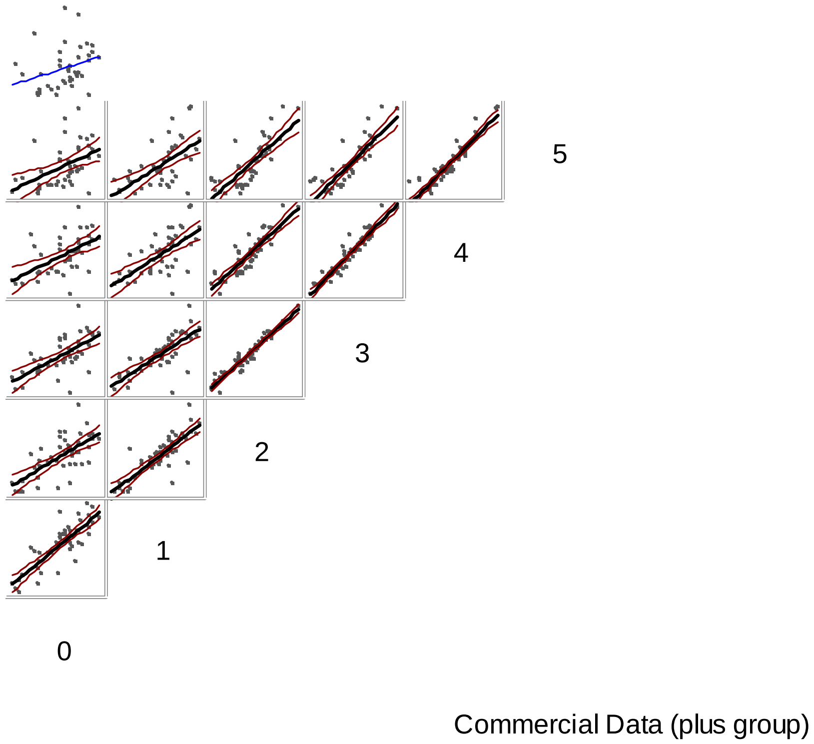
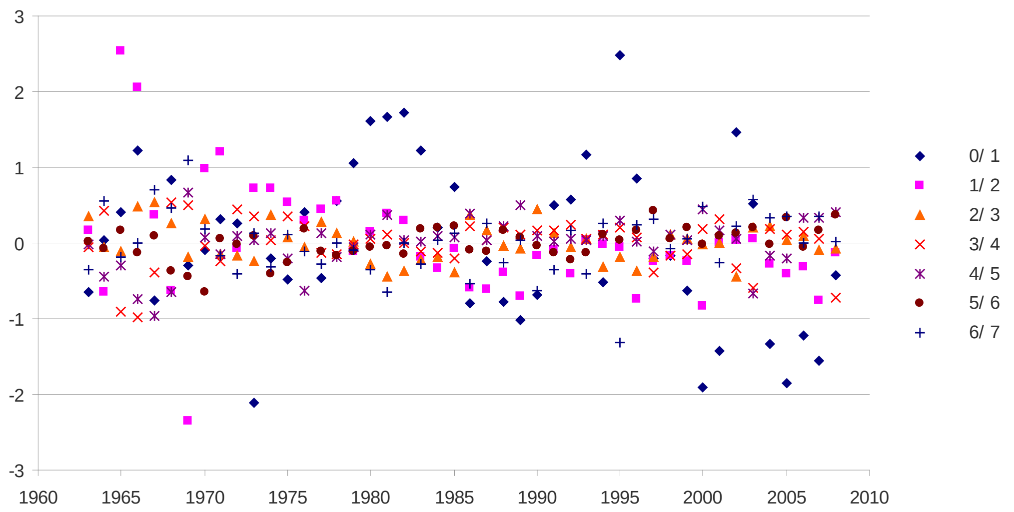


Figure 13.3.2.3. Haddock in Subarea IV and Division IIIa. Correlations in the catch-at-age matrix (including the plus-group for ages 8 and older), comparing estimates at different ages for the same year-classes (cohorts). In each plot, the straight line is a normal linear model fit: a thick line represents a significant ($p < 0.05$) regression, while a thin line is not significant. Approximate 95% confidence intervals for each fit are also shown.



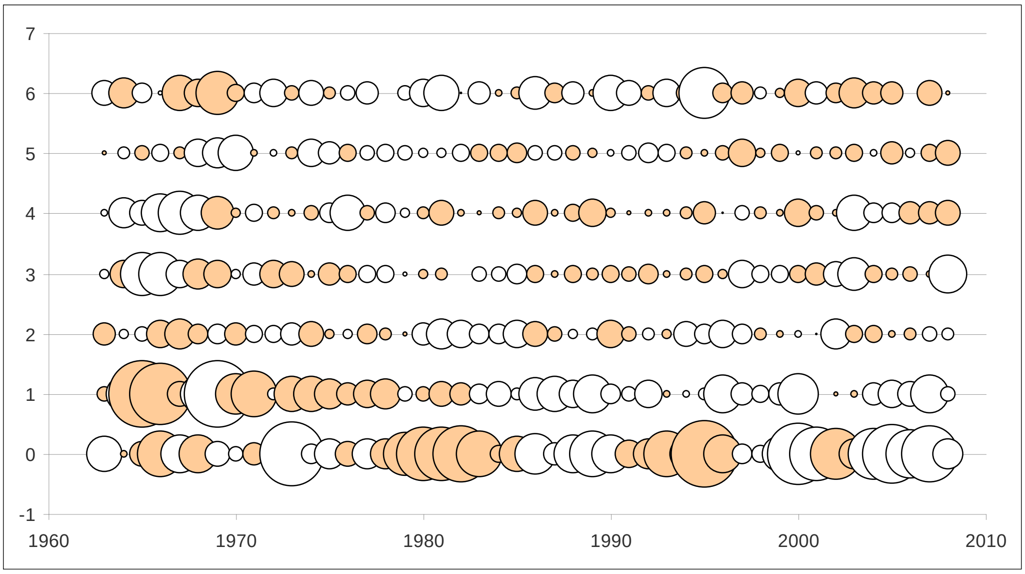


Figure 13.3.2.4. Haddock in Subarea IV and Division IIIa. Residuals from separable VPA analysis. The x-axis labels give the first year only of the actual year ratio used (so "1970" denotes 1970/1971). The y-axis labels for the lower plot give the first age only of the actual age ratio used (so "1" denotes ½). The area of the bubbles in the lower plot is proportional to the size of the residual.

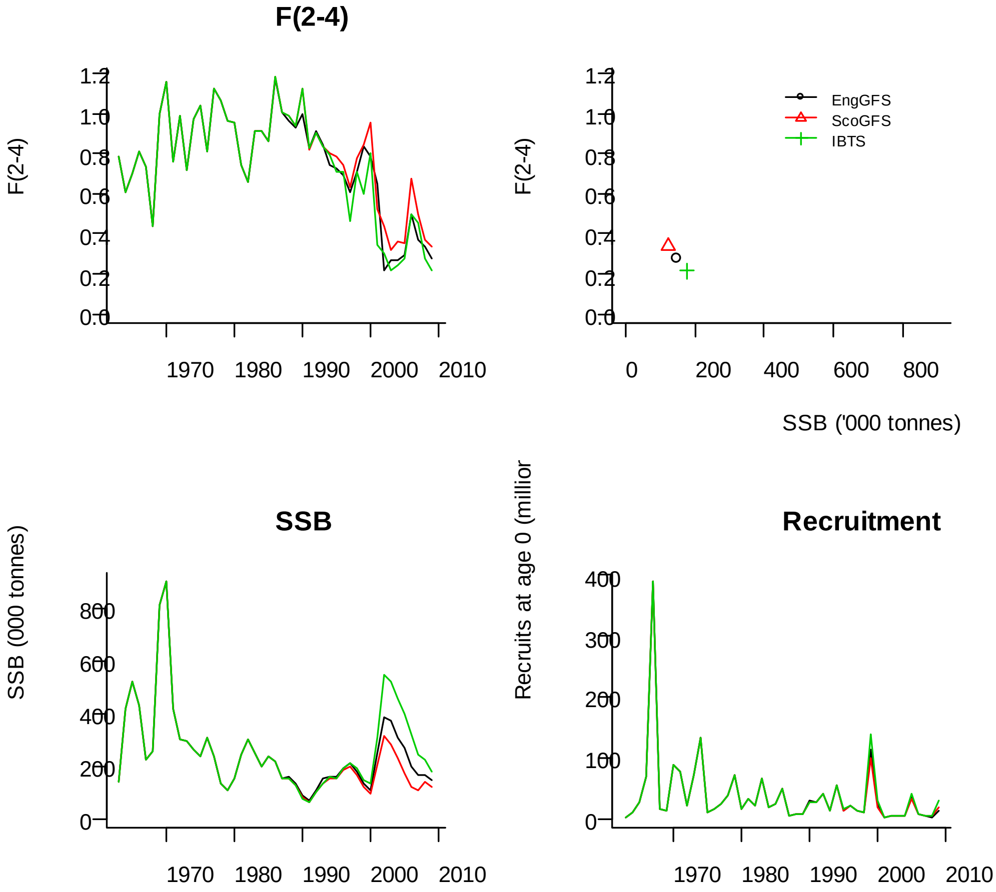
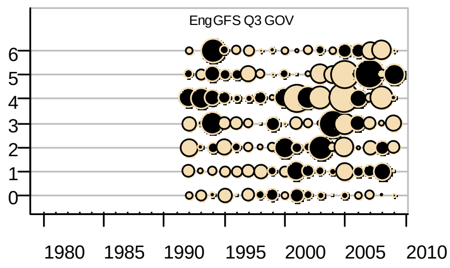


Figure 13.3.2.5. Haddock in Subarea IV and Division IIIa. Stock summary plots for single-fleet XSA runs. Only the more recent segments of the EngGFS and ScoGFS surveys have been used here. Final year (2009) values of SSB and mean F(2-4) are plotted against each other in the upper right plot.



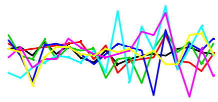


Figure 13.3.2.6. Haddock in Subarea IV and Division IIIa. Log catchability residuals from single-fleet XSA runs. Only the more recent segments of the EngGFS and ScoGFS surveys have been used here.

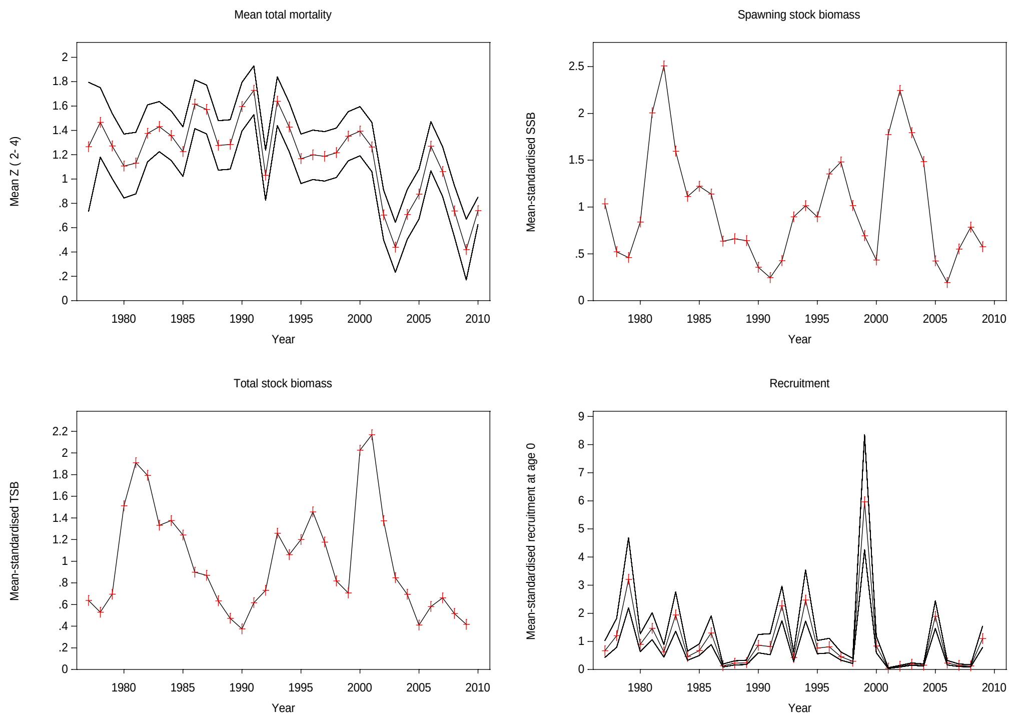
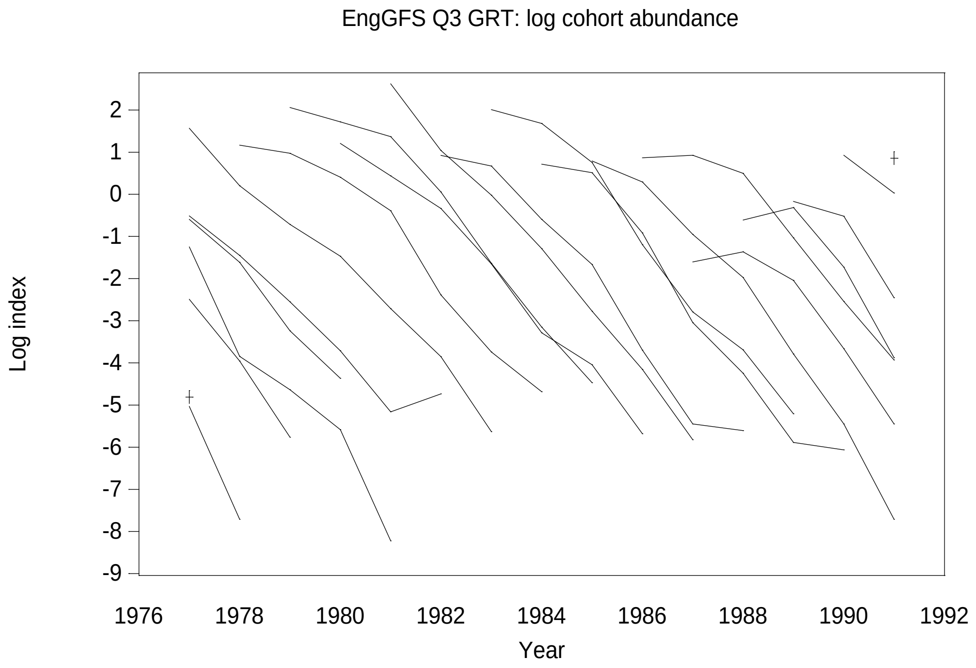


Figure 13.3.3.1. Haddock in Subarea IV and Division IIIa. Summary plots from an exploratory SURBA assessment, using all available surveys (EngGFS Q3, ScoGFS Q3, IBTS Q1). Solid lines give median estimates, dotted lines give approximate 95% confidence bounds for mean Z and recruitment.



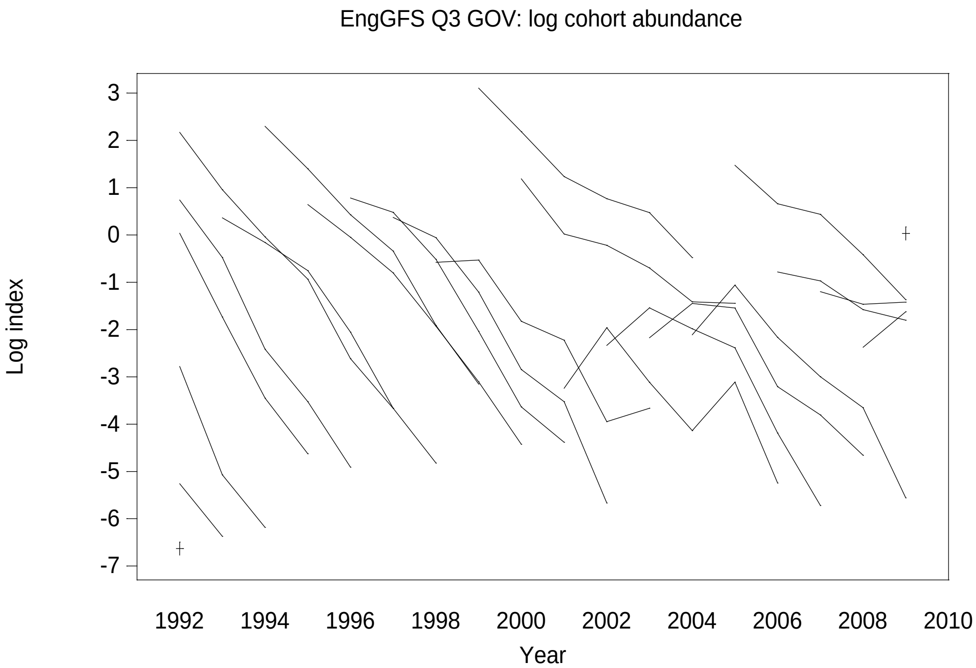
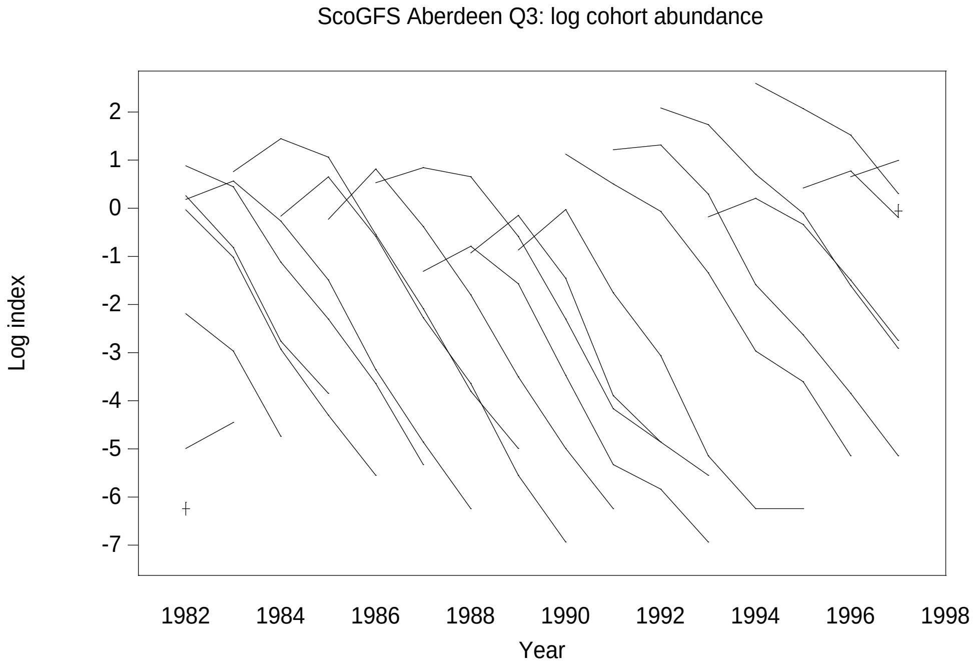


Figure 13.3.3.2. Haddock in Subarea IV and Division IIIa. Log abundance indices by cohort for each of the five survey indices.



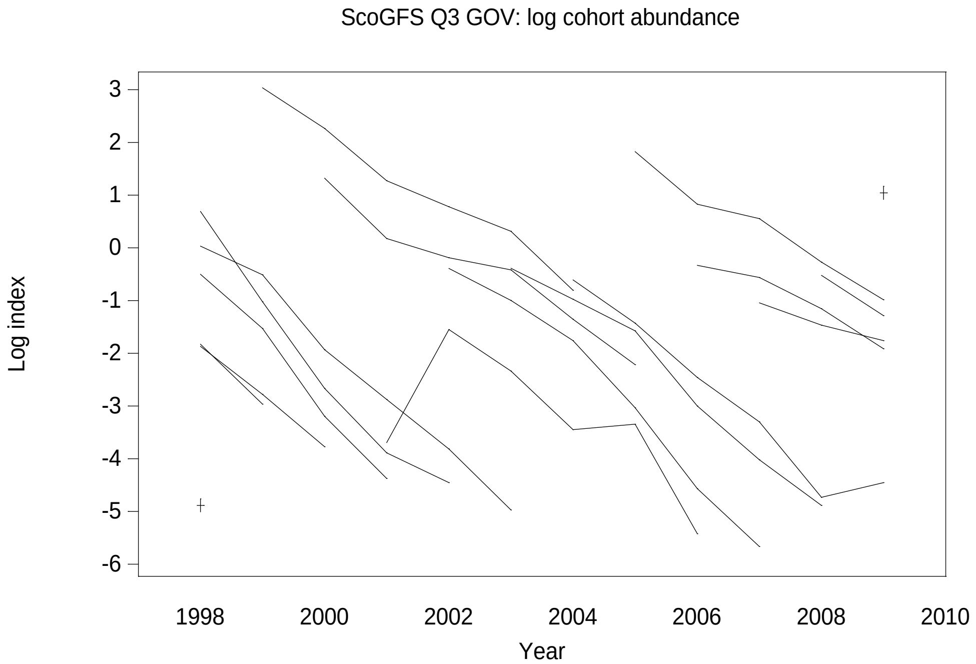


Figure 13.3.3.2. Haddock in Subarea IV and Division IIIa. Log abundance indices by cohort for each of the five survey indices (cont.)

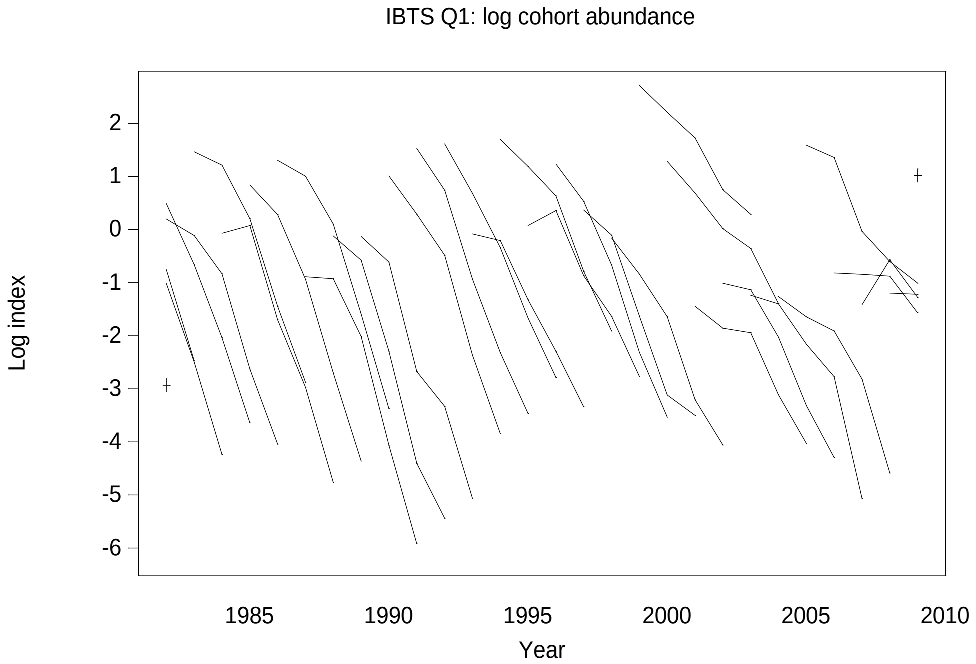


Figure 13.3.3.2. Haddock in Subarea IV and Division IIIa. Log abundance indices by cohort for each of the five survey indices (cont.).

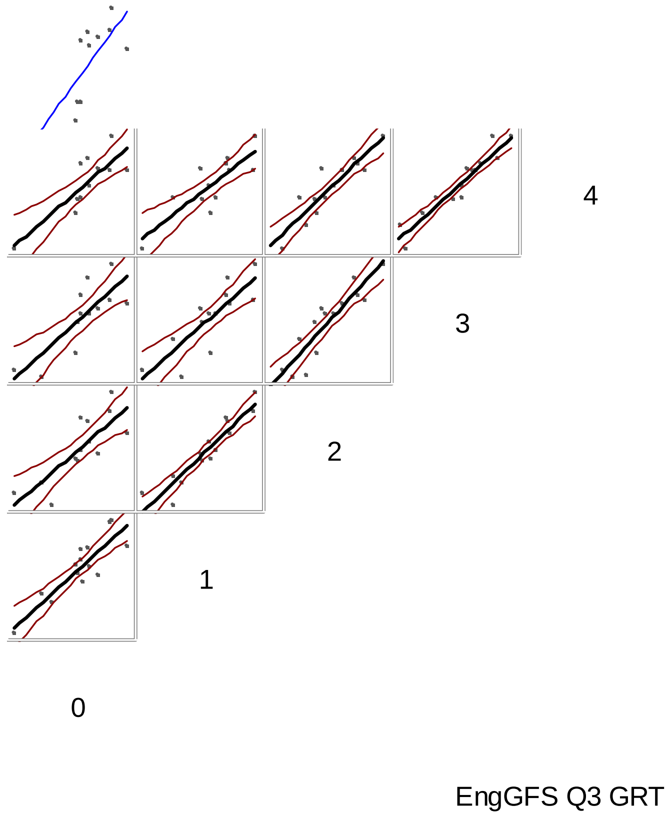


Figure 13.3.3.3. Haddock in Subarea IV and Division IIIa. Within-survey correlations for the EngGFS (GRT) survey series, comparing index values at different ages for the same year-classes (cohorts). In each plot, the straight line is a normal linear model fit: a thick line represents a significant ($p < 0.05$) regression, while a thin line is not significant. Approximate 95% confidence intervals for each fit are also shown.

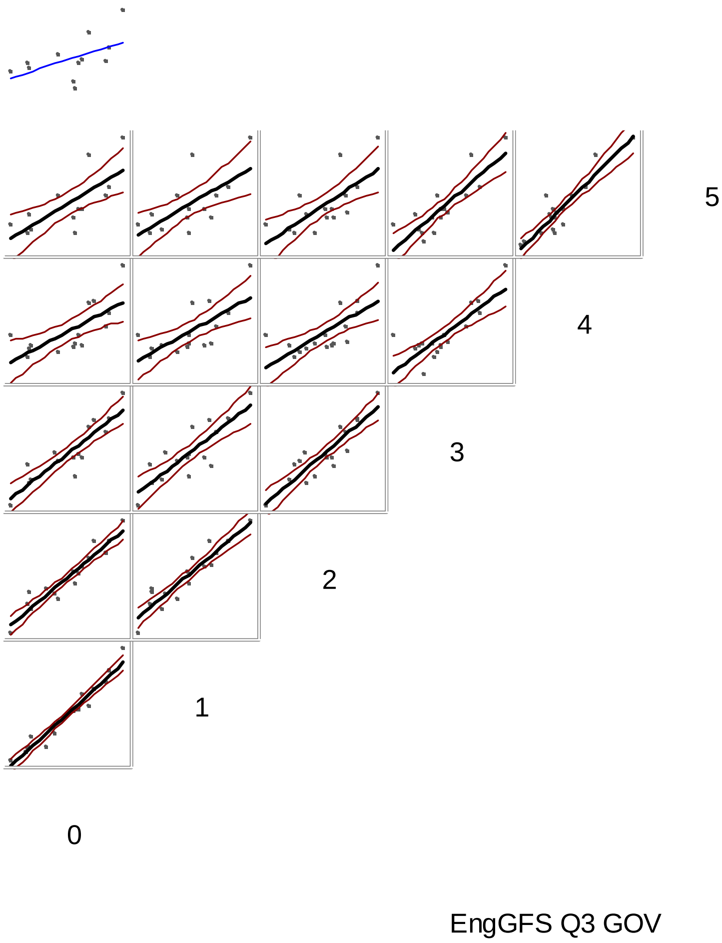


Figure 13.3.3.3. cont. Haddock in Subarea IV and Division IIIa. Within-survey correlations for the EngGFS (GOV) survey series, comparing index values at different ages for the same year-classes (cohorts). In each plot, the straight line is a normal linear model fit: a thick line represents a significant ($p < 0.05$) regression, while a thin line is not significant. Approximate 95% confidence intervals for each fit are also shown.

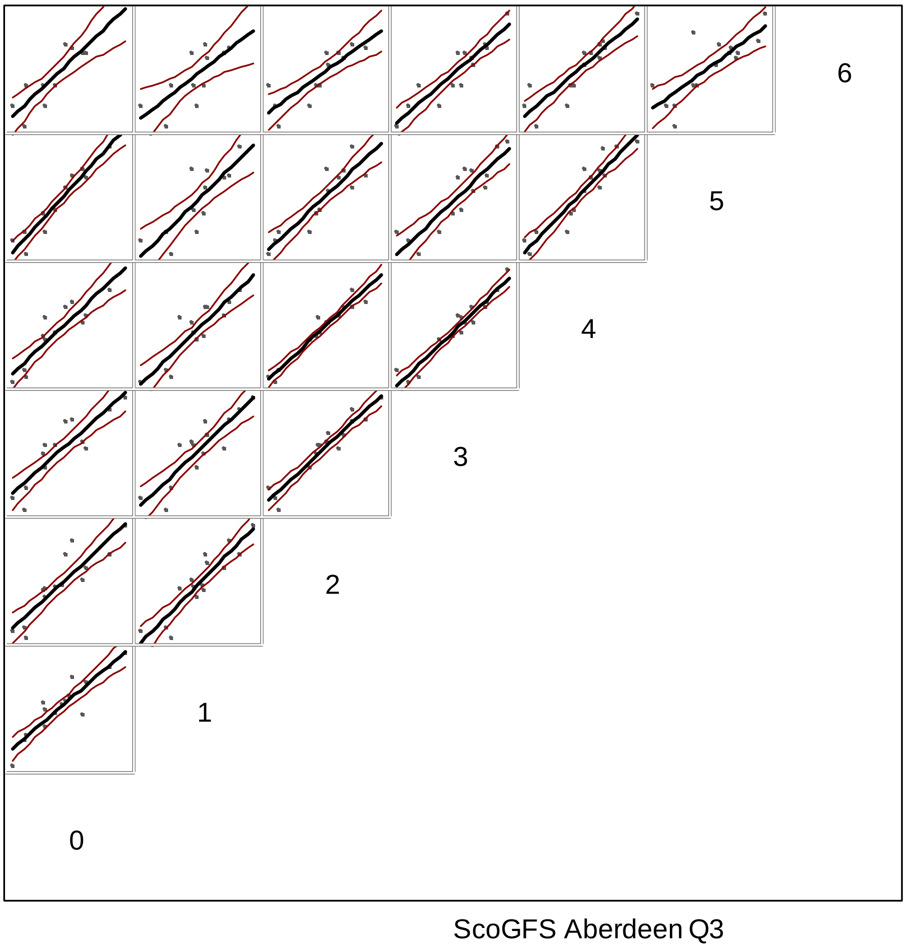


Figure 13.3.3.3. cont. **Haddock in Subarea IV and Division IIIa. Within-survey correlations for the ScoGFS (Aberdeen) survey series, comparing index values at different ages for the same year-classes (cohorts). In each plot, the straight line is a normal linear model fit: a thick line represents a significant ($p < 0.05$) regression, while a thin line is not significant. Approximate 95% confidence intervals for each fit are also shown.**

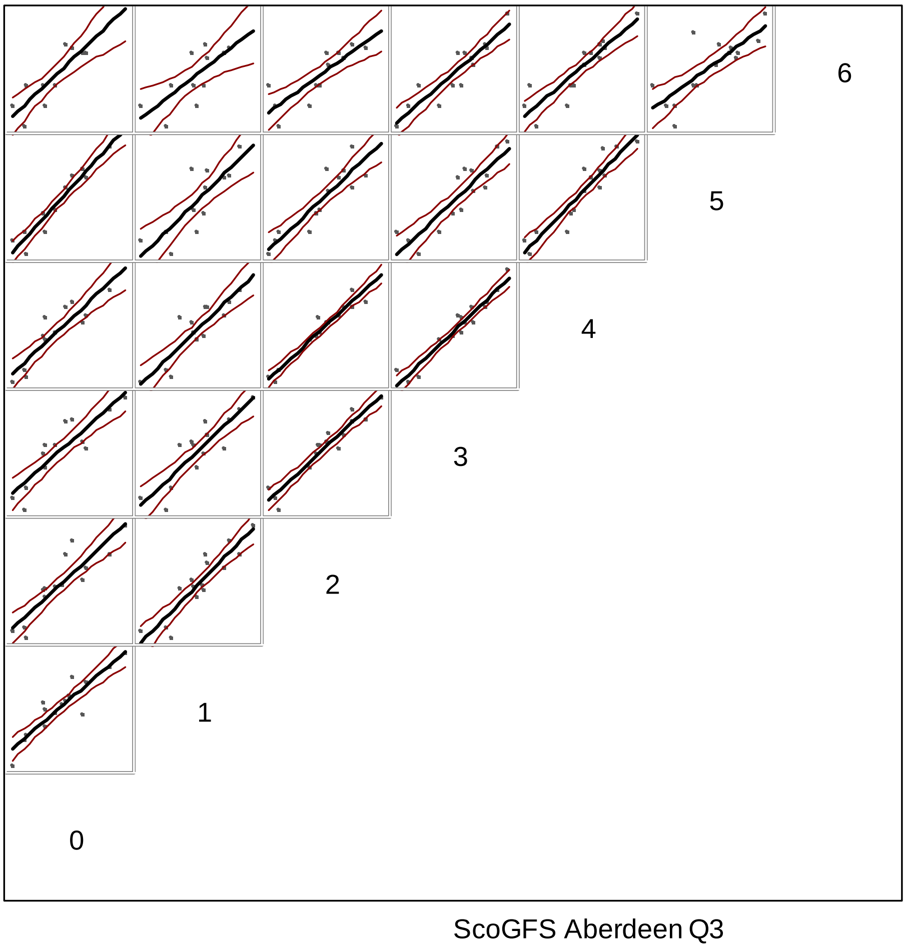


Figure 13.3.3.3. cont. Haddock in Subarea IV and Division IIIa. Within-survey correlations for the ScoGFS (GOV) survey series, comparing index values at different ages for the same year-classes (cohorts). In each plot, the straight line is a normal linear model fit: a thick line represents a significant ($p < 0.05$) regression, while a thin line is not significant. Approximate 95% confidence intervals for each fit are also shown.

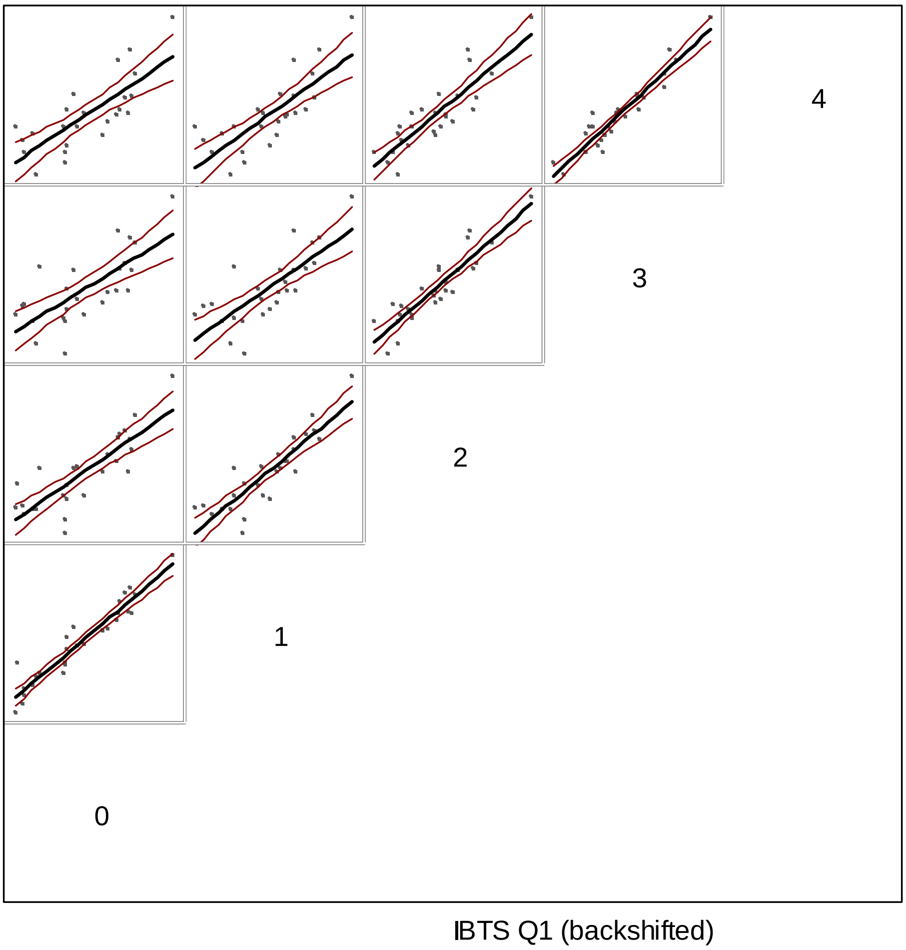


Figure 13.3.3.3. cont. Haddock in Subarea IV and Division IIIa. Within-survey correlations for the IBTS Q1 survey series, comparing index values at different ages for the same year-classes (cohorts). In each plot, the straight line is a normal linear model fit: a thick line represents a significant ($p < 0.05$) regression, while a thin line is not significant. Approximate 95% confidence intervals for each fit are also shown.

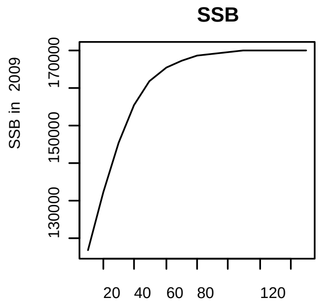
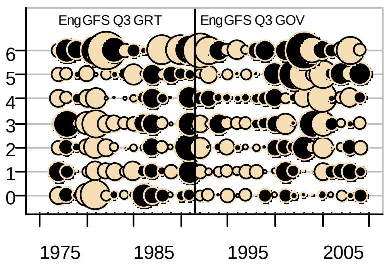


Figure 13.3.3.4. Haddock in Subarea IV and Division IIIa. Top row: SSB. Middle row: mean F(2–4). Bottom row: recruitment-at-age 0. Left column: relationship between the estimate for 2009 and the number of iterations run (red lines indicate 30 iterations; blue lines indicate iterations required for convergence). Middle column: contour plot of difference between estimates over the whole time-series between one iteration and the next. Right plot: estimated time-series from all iterations (grey lines), with 30 iterations (red line) and converged iterations (blue line) highlighted. The number of iterations required for convergence (120) is given in a legend to the top-left plot.



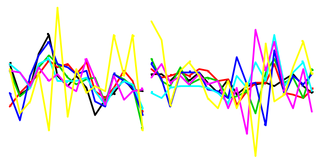


Figure 13.3.5.1 Haddock in Subarea IV and Division IIIa. Log catchability residuals for final XSA assessment. Both EngGFS and ScoGFS are split when used as tuning indices, and this split is shown by vertical lines on the relevant plots.

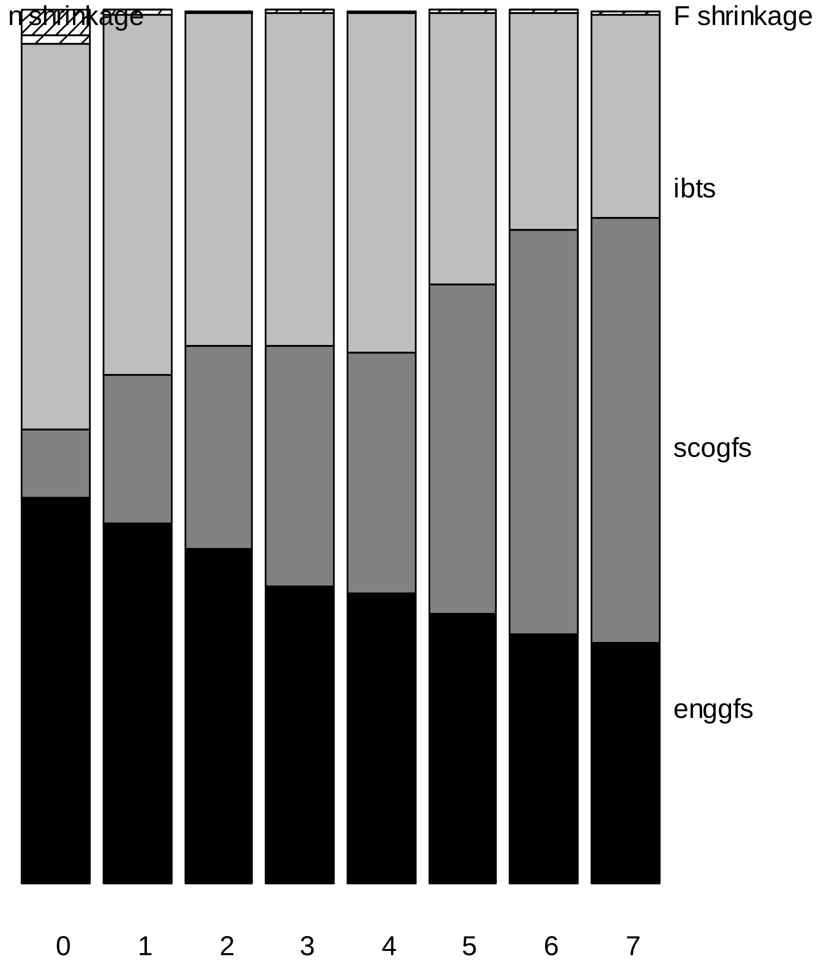


Figure 13.3.5.2. Haddock in Subarea IV and Division IIIa. Contribution to survivors' estimates in final XSA assessment.

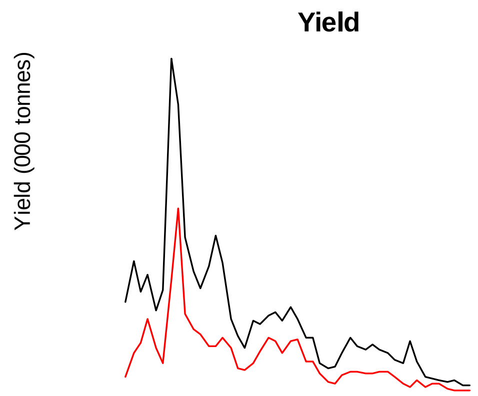


Figure 13.3.5.3. Haddock in Subarea IV and Division IIIa. Summary plots for final XSA assessment. Dotted horizontal lines indicate F_{pa} (top right plot) and B_{pa} (bottom left plot), while solid horizontal lines indicate F_{lim} and B_{lim} in the same plots.

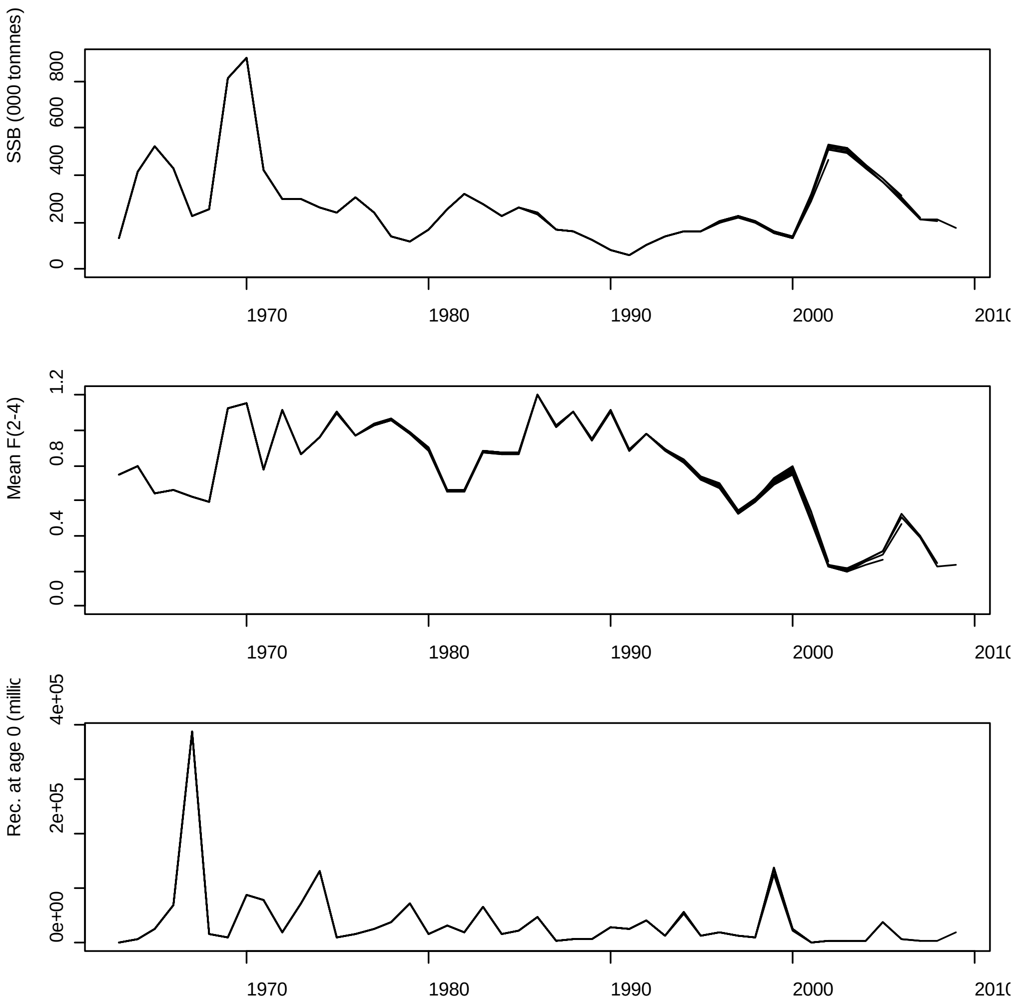


Figure 13.3.5.4. Haddock in Subarea IV and Division IIIa. Eight-year retrospective plots for final XSA assessment.

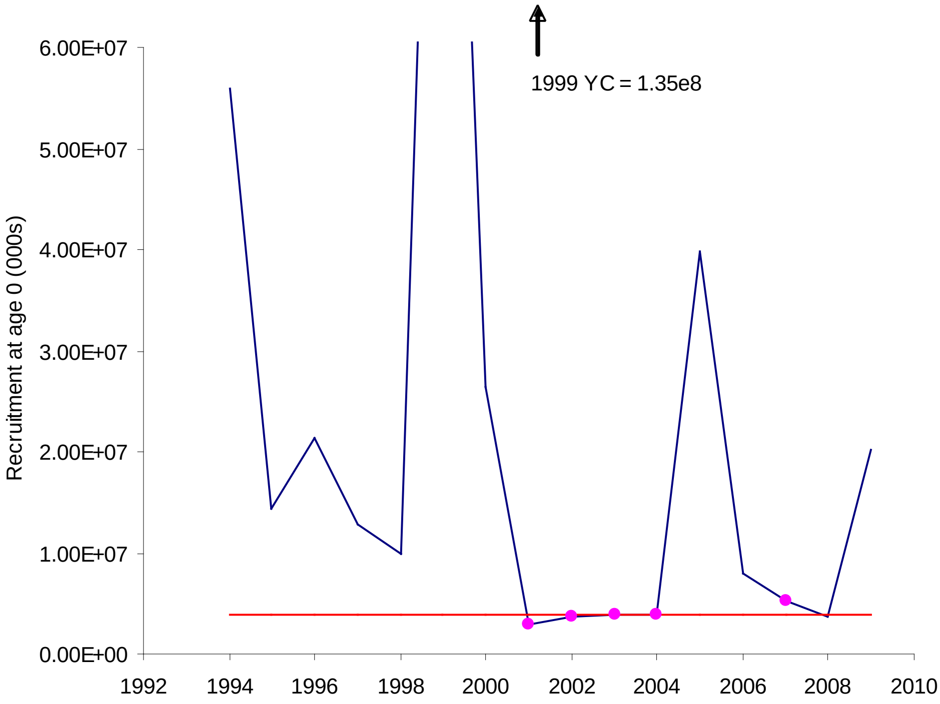


Figure 13.5.1.1. Haddock in Subarea IV and Division IIIa. Estimated recruitment from the final XSA assessment for 1994-2009 (black line), with 5 lowest values (pink dots) and geometric mean of these (red line).

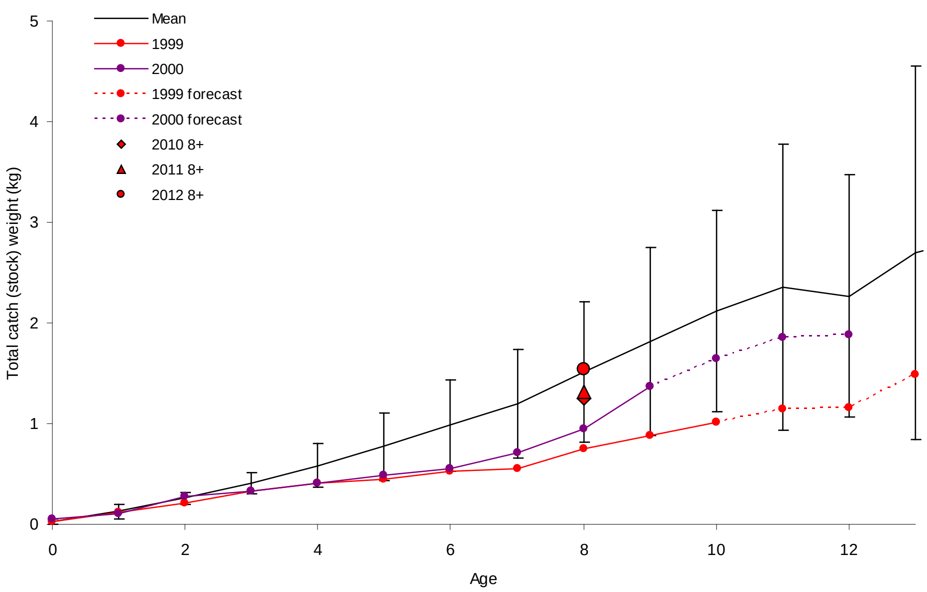


Figure 13.6.1. Haddock in Subarea IV and Division IIIa. Results of growth modelling for total catch weights (also used as stock weights) using proportional increments. Black line: arithmetic mean weight-at-age of 1953-2009 cohorts (error bars give ±2 standard deviations). Red and purple lines: weights-at-age for the 1999 and 2000 cohorts respectively (solid = observed, dotted = forecast). Large red symbols indicate forecast weight for the 8+ group in 2010 (diamond), 2011 (triangle) and 2012 (circle).

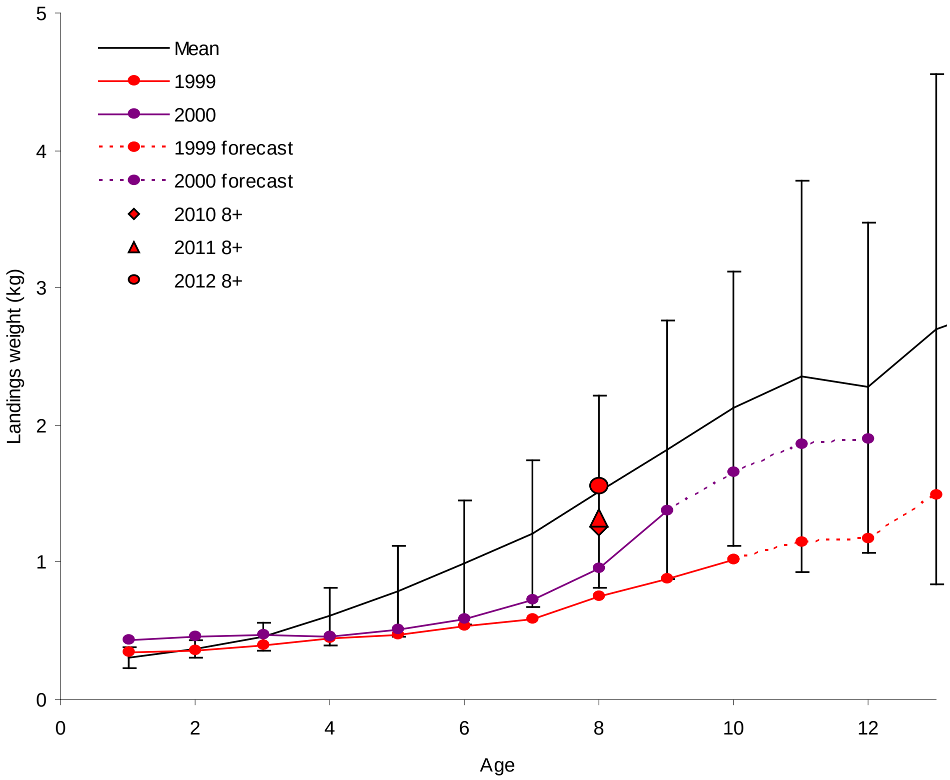


Figure 13.6.2. Haddock in Subarea IV and Division IIIa. Results of growth modelling for human consumption landings using proportional increments. Black line: arithmetic mean weight-at-age of 1953-2009 cohorts (error bars give ±2 standard deviations). Red and purple lines: weights-at-age for the 1999 and 2000 cohorts respectively (solid = observed, dotted = forecast). Large red symbols indicate forecast weight for the 8+ group in 2010 (diamond), 2011 (triangle) and 2012 (circle).

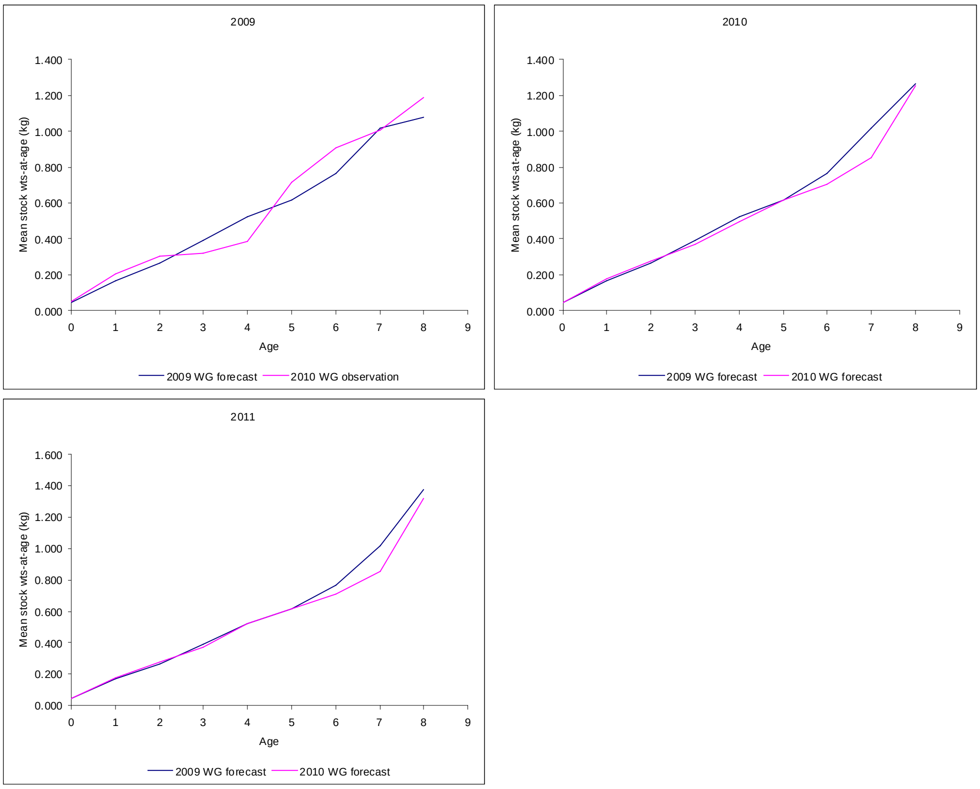


Figure 13.6.3. Haddock in Subarea IV and Division IIIa. Comparison of weights-at-age for 2009-11 from the 2009 WG, with the weights-at-age for 2009-11 from the 2010- WG.

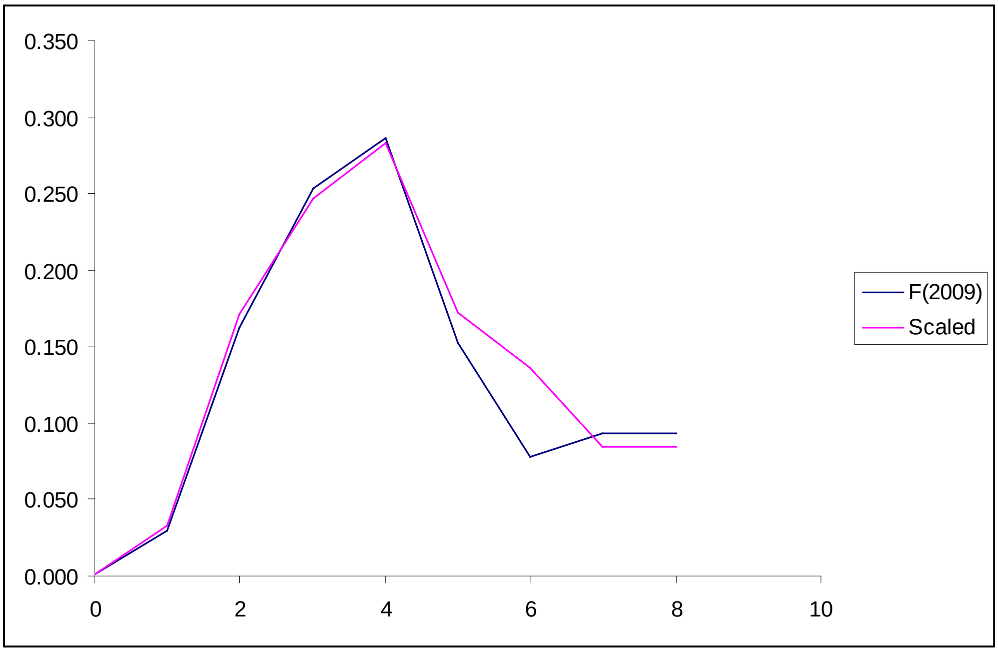


Figure 13.6.4. Haddock in Subarea IV and Division IIIa. Comparison of fishing mortality estimates for 2009 with a three-year (2007-2009) mean exploitation pattern scaled to the mean level of the 2009 estiumates.

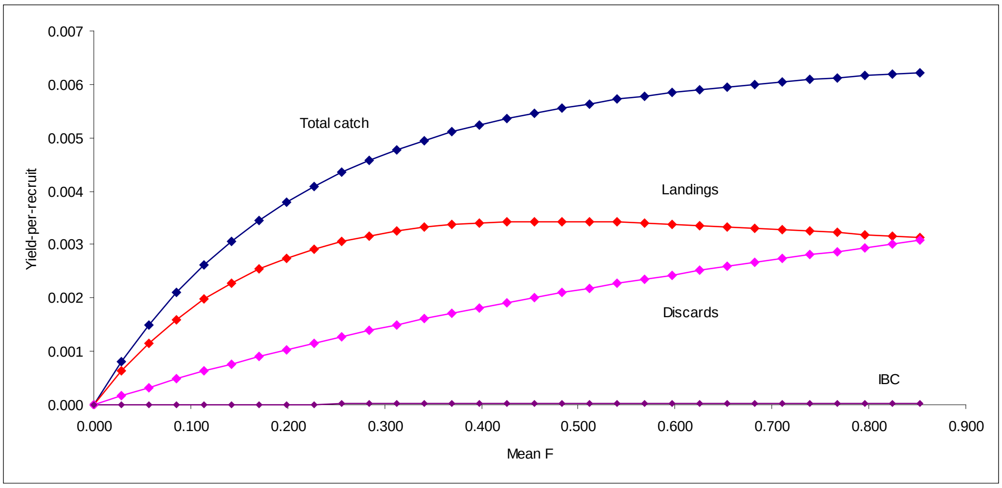


Figure 13.7.1. Haddock in Subarea IV and Division IIIa. Yield-per-recruit curves for each catch component: total catch, landings, discards and industrial bycatch.

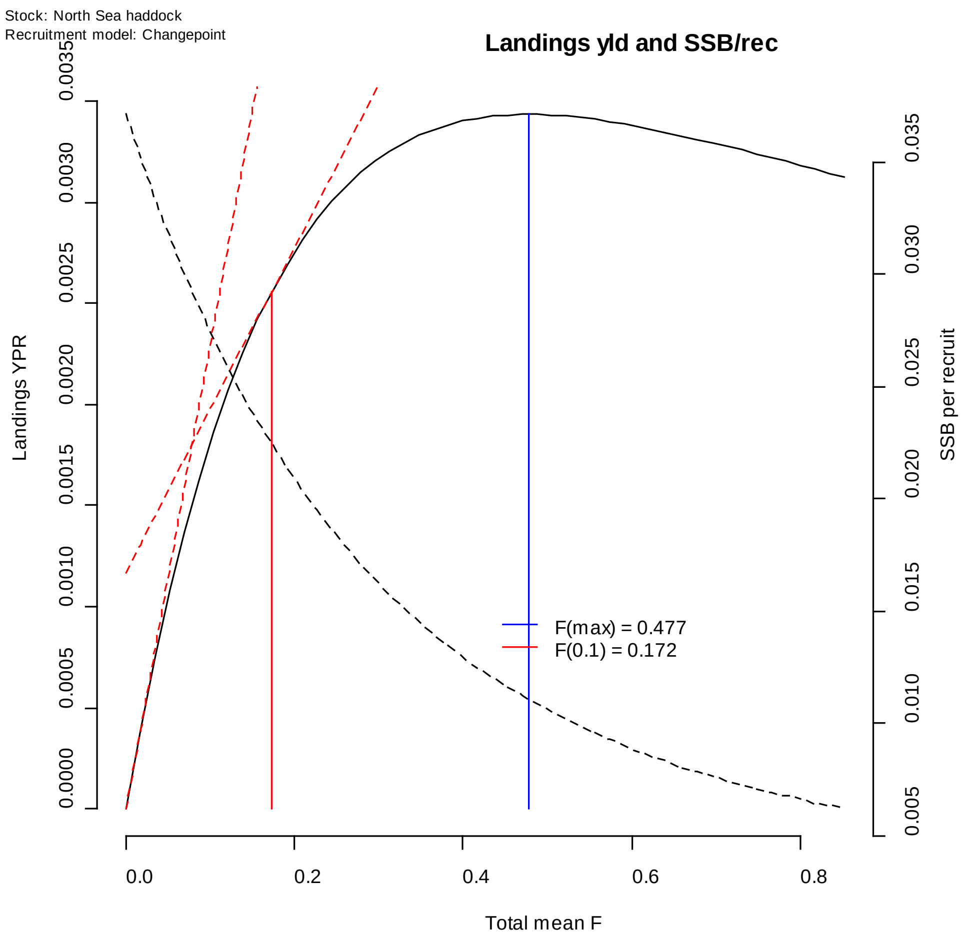


Figure 13.7.2. Haddock in Subarea IV and Division IIIa. Equilibrium MSY model. Landings yield-per-recruit (solid black line) and SSB-per-recruit (dotted black line), with estimated values for F_{max} (solid blue line) and $F_{0.1}$ (solid red line). Dotted red lines give slope of the YPR curve at the origin and a line tangent to the YPR curve with a slope 10% that of the origin.

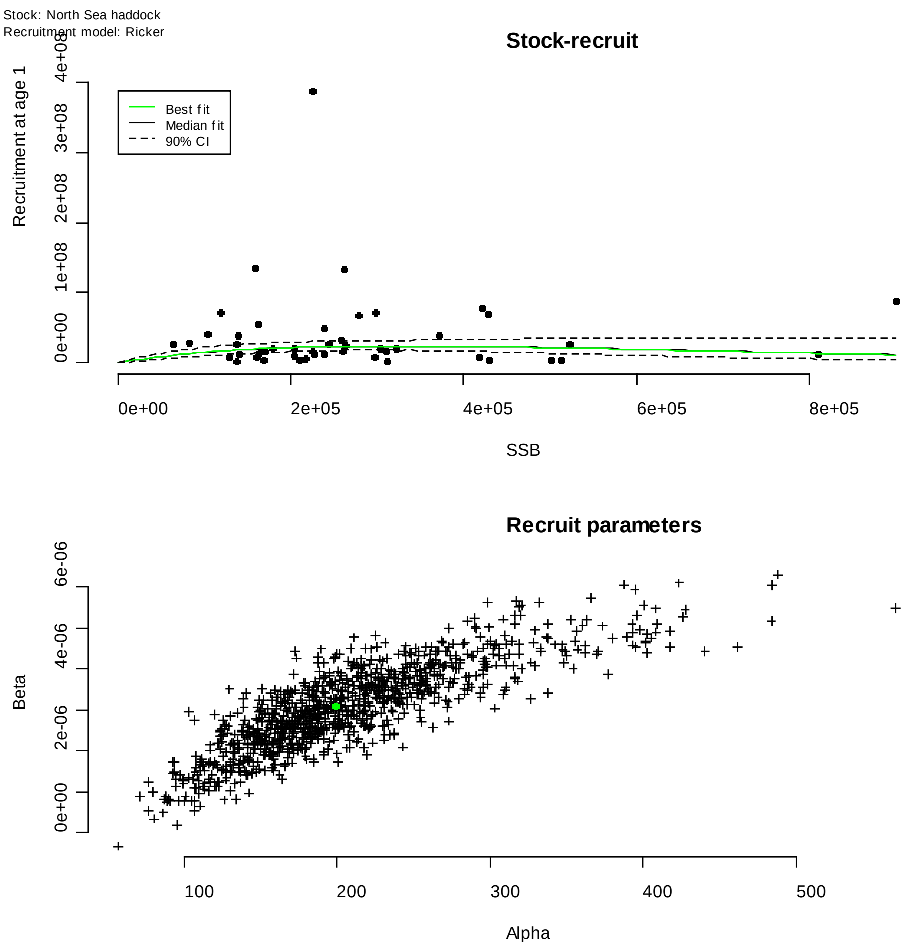


Figure 13.7.3. Haddock in Subarea IV and Division IIIa. Equilibrium MSY model. Ricker stock-recruit model fit (upper plot) and resampled Ricker α and β parameters (lower plot). The best fit in both plots is highlighted in green.

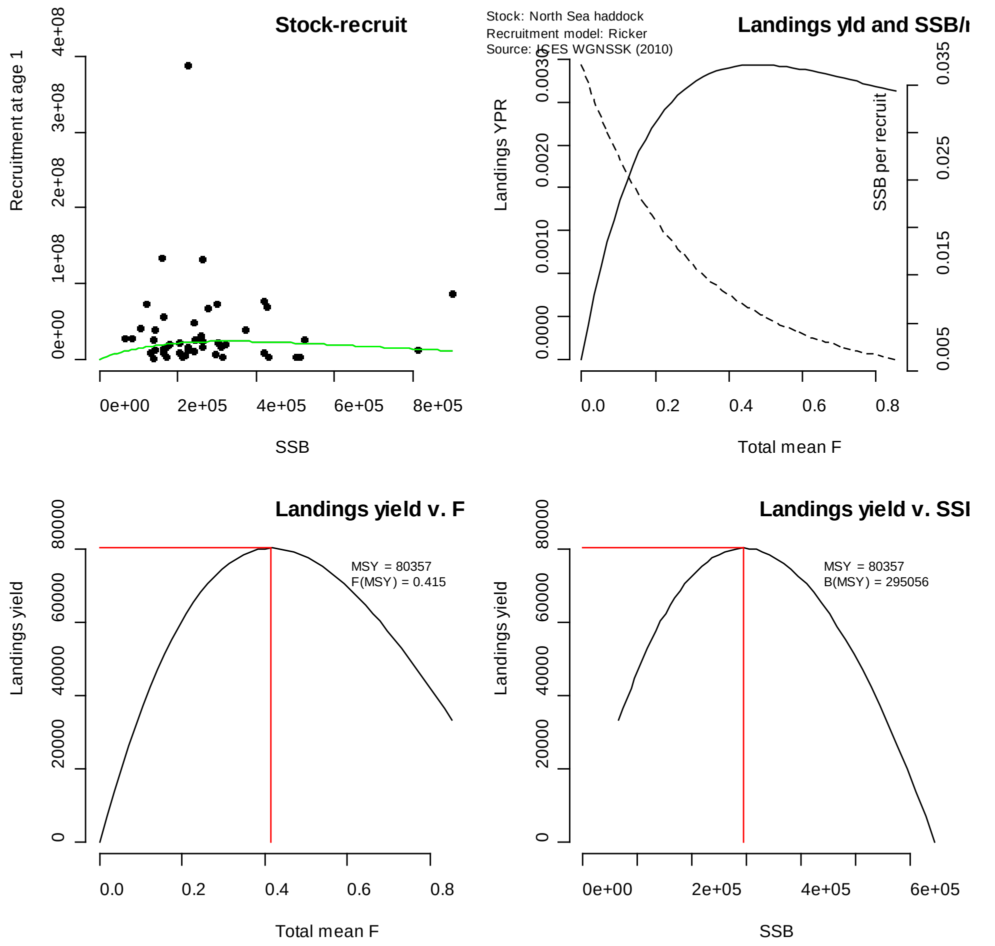


Figure 13.7.4. Haddock in Subarea IV and Division IIIa. Deterministic MSY estimates from the equilibrium model.

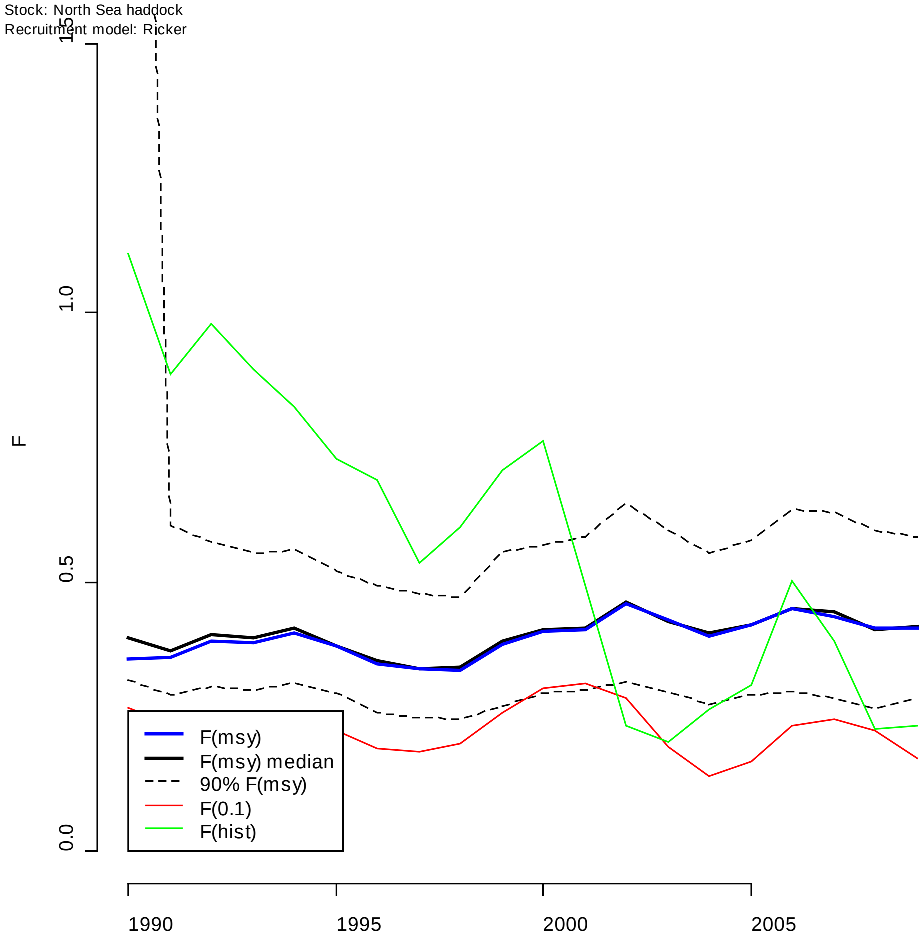


Figure 13.7.5. Haddock in Subarea IV and Division IIIa. Equilibrium MSY model. Retrospective estimates of F_{msy} (mean, median and confidence limits), $F_{0.1}$ and the estimated historical value. The -axis gives the final year included in each estimation.

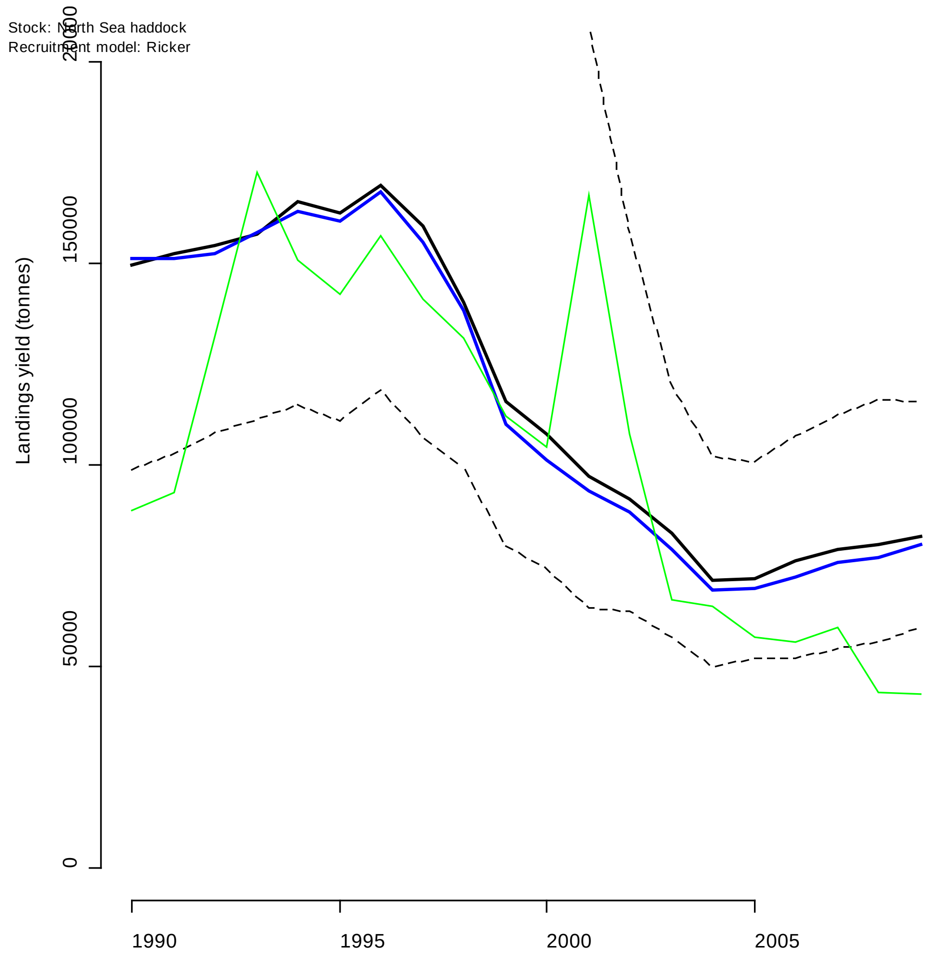


Figure 13.7.5. Haddock in Subarea IV and Division IIIa. Equilibrium MSY model. Retrospective estimates of MSY: mean (blue), median (black) and confidence limits (dotted), along with the estimated historical value (green). The -axis gives the final year included in each estimation.

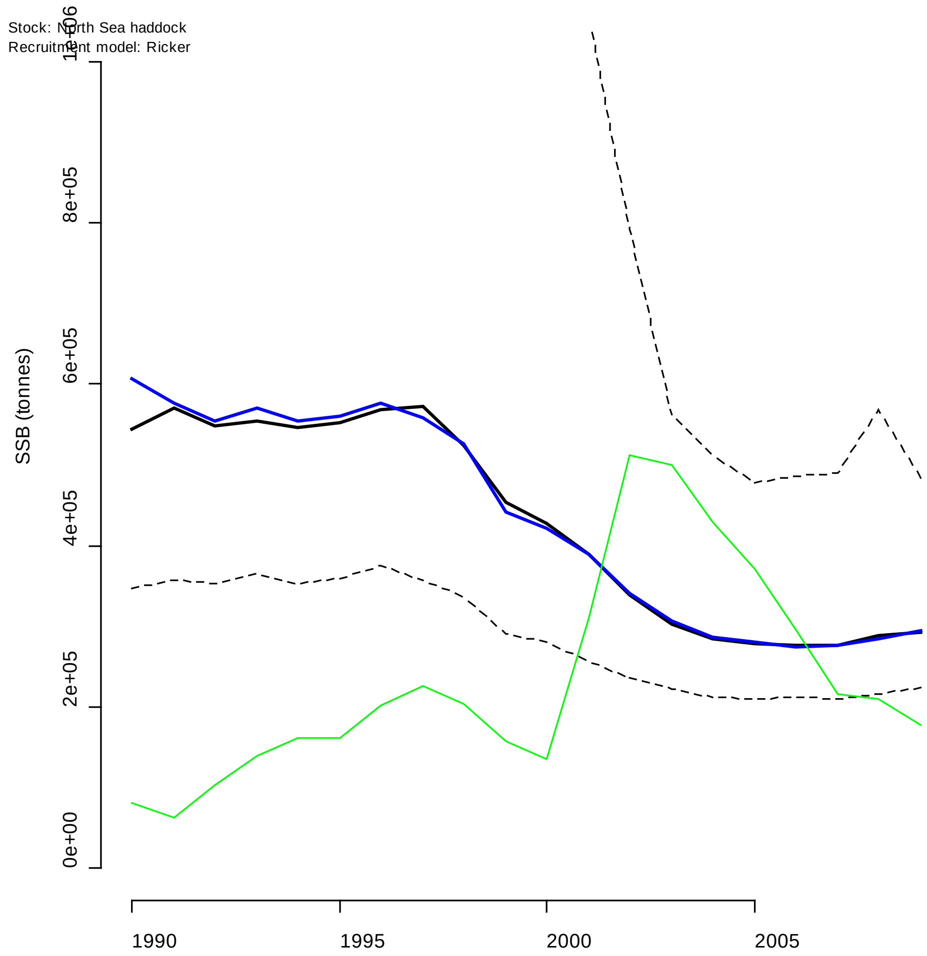


Figure 13.7.6. Haddock in Subarea IV and Division IIIa. Equilibrium MSY model. Retrospective estimates of B_{msy}: mean (blue), median (black) and confidence limits (dotted), along with the estimated historical value (green). The -axis gives the final year included in each estimation.

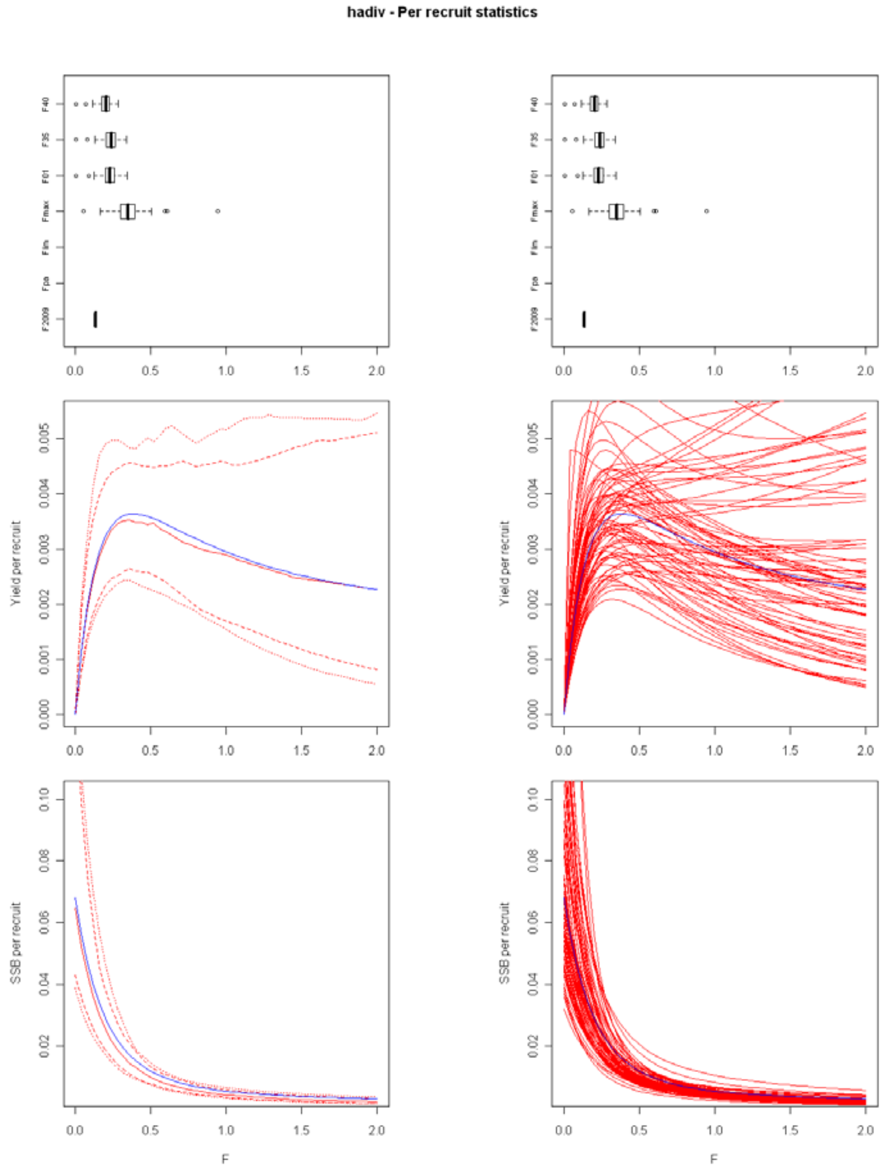


Figure 13.7.7. Haddock in Subarea IV and Division IIIa. ADMB MSY model. Stochastic YPR reference point estimates.

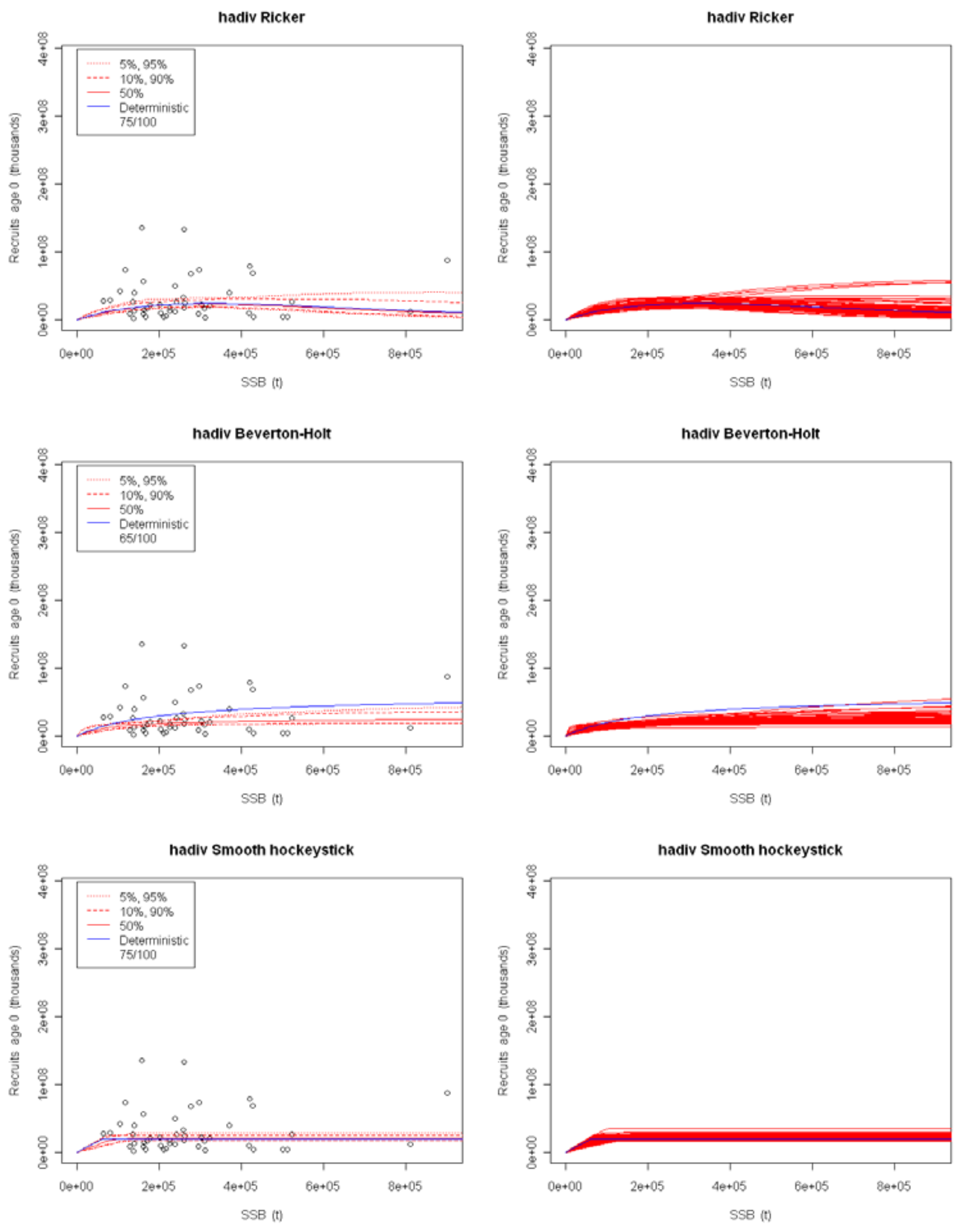


Figure 13.7.8. Haddock in Subarea IV and Division IIIa. ADMB MSY model. Stochastic stock-recruit model fits.

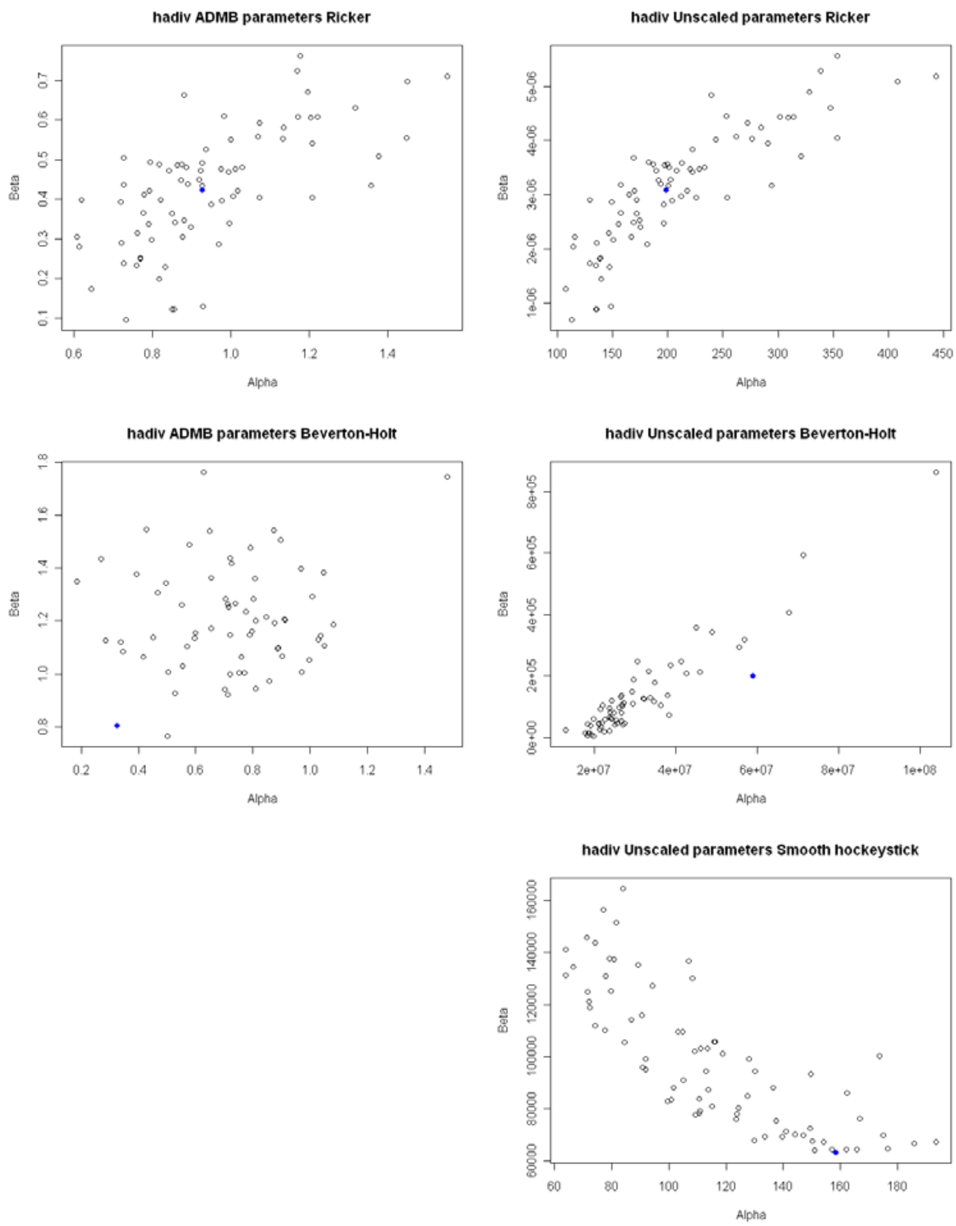


Figure 13.7.9. Haddock in Subarea IV and Division IIIa. ADMB MSY model. Resampled stock-recruit parameters.

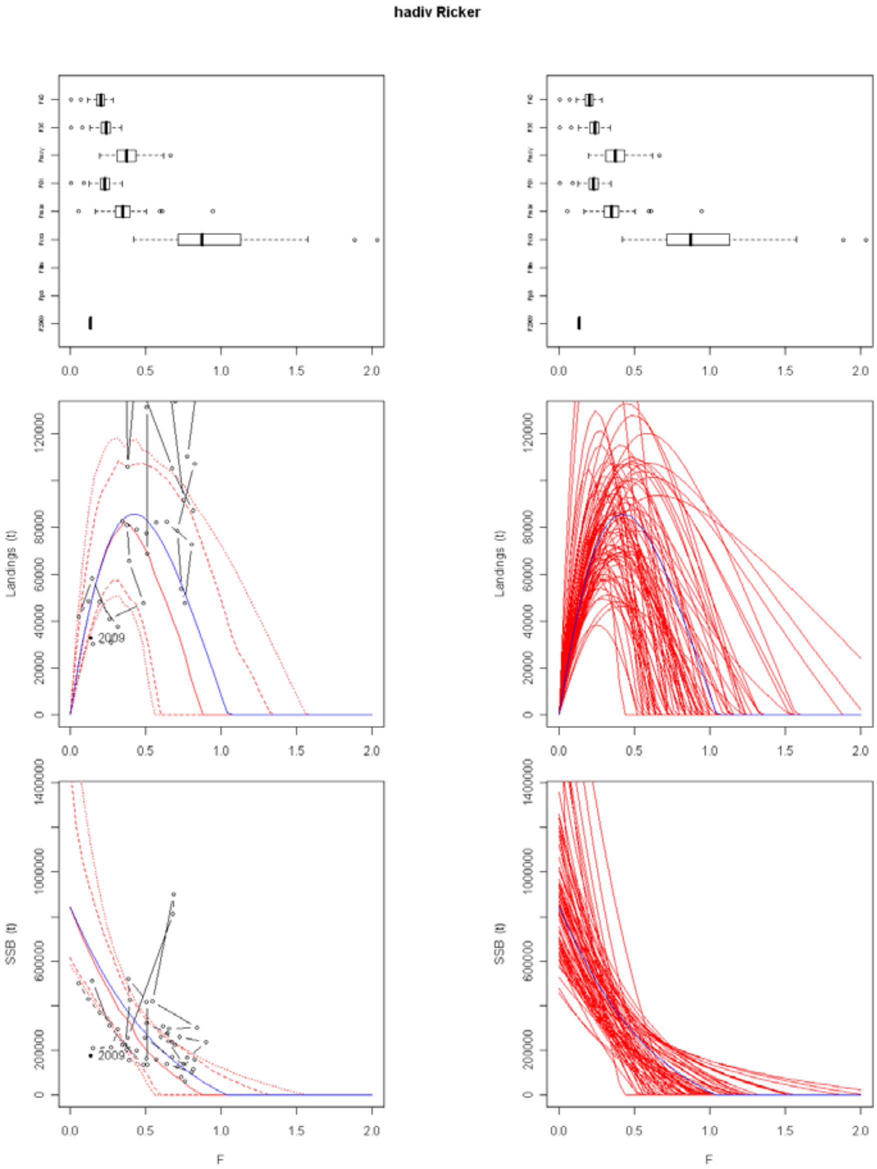


Figure 13.7.10. Haddock in Subarea IV and Division IIIa. ADMB MSY model. Summary plots for MSY estimation with the Ricker stock-recruit model.

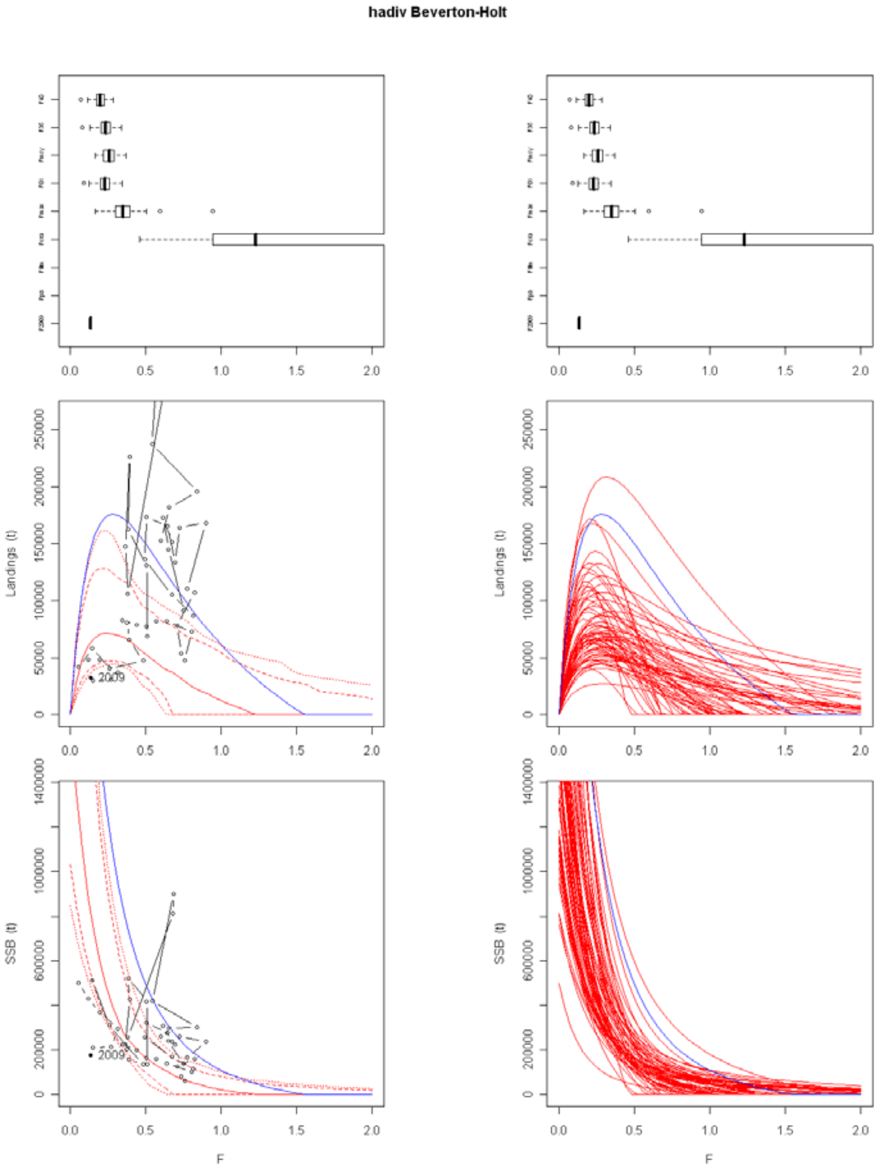


Figure 13.7.11. Haddock in Subarea IV and Division IIIa. ADMB MSY model. Summary plots for MSY estimation with the Beverton-Holt stock-recruit model.

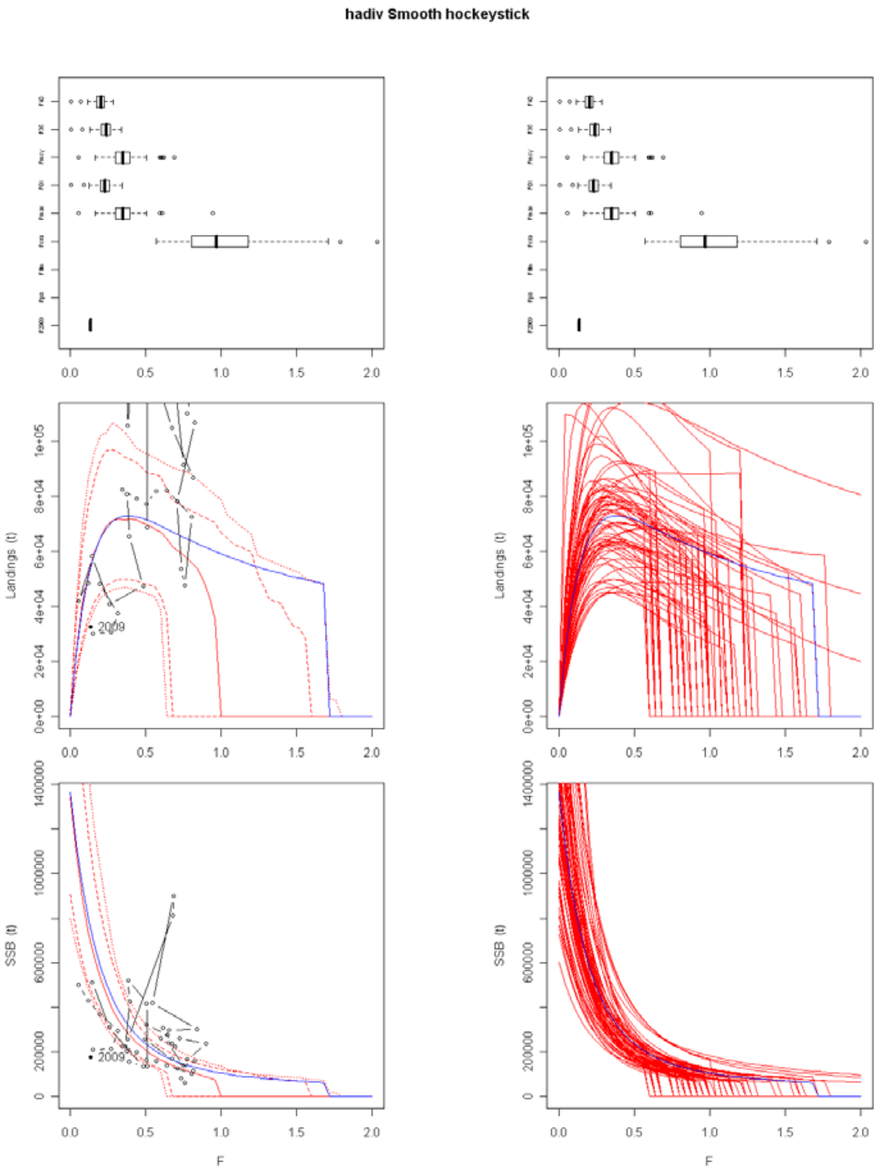


Figure 13.7.12. Haddock in Subarea IV and Division IIIa. ADMB MSY model. Summary plots for MSY estimation with the smooth hockey-stick stock-recruit model.

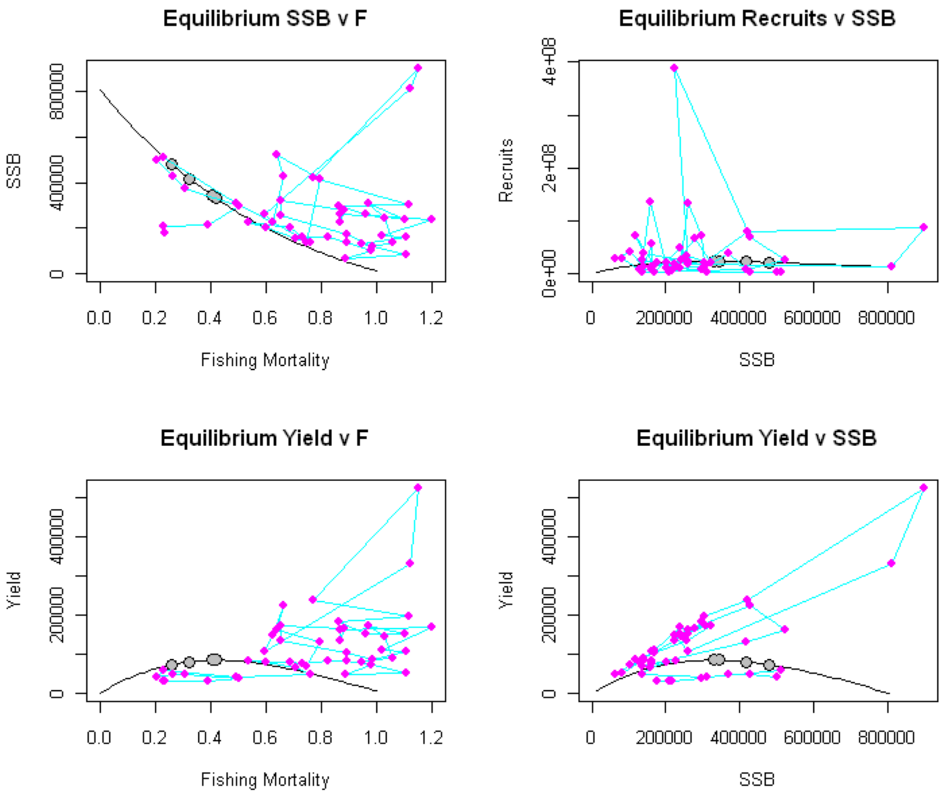


Figure 13.7.13. Haddock in Subarea IV and Division IIIa. FLR MSY model. Summary plots.

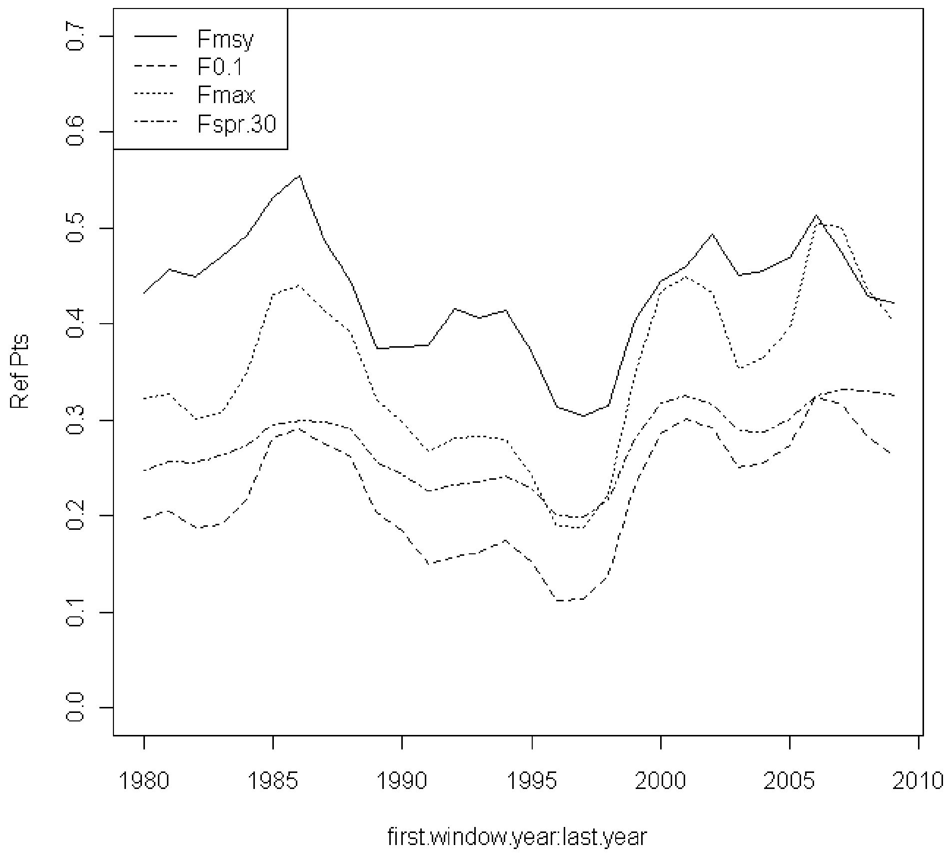


Figure 13.7.14. Haddock in Subarea IV and Division IIIa. FLR MSY model. Retrospective estimates of fishing mortality reference points.

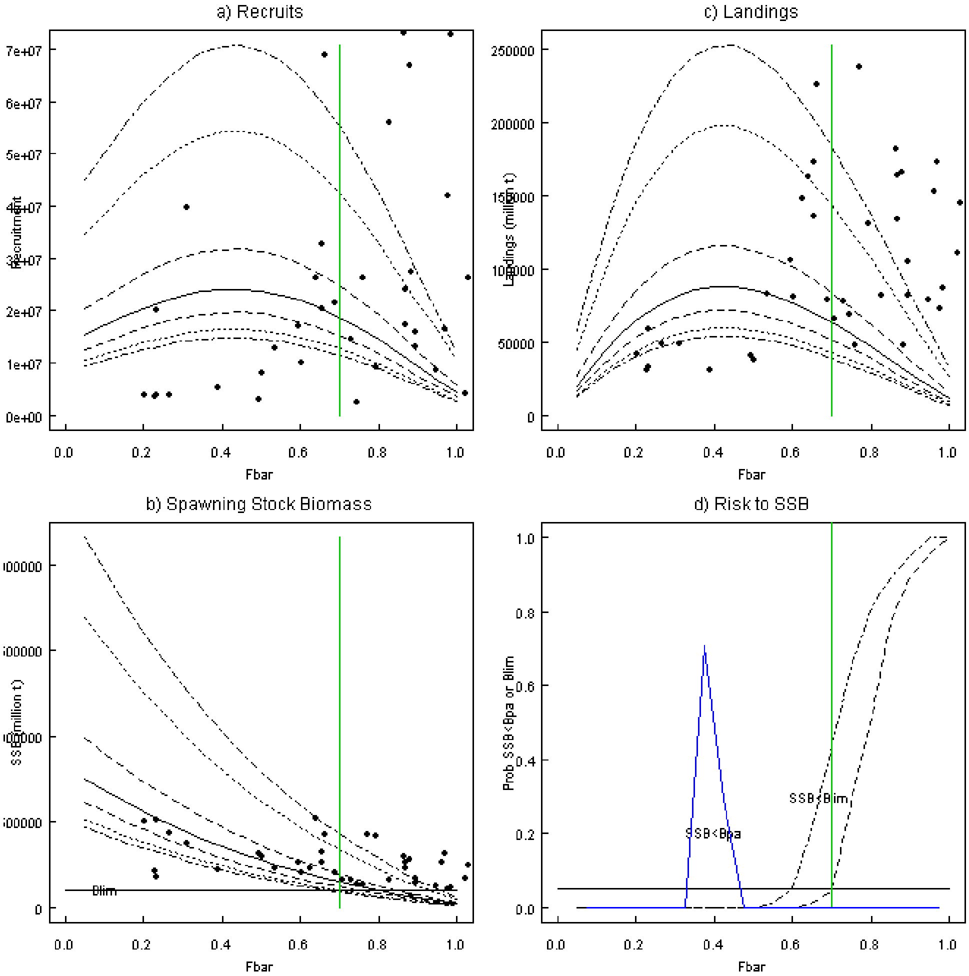


Figure 13.7.15. Haddock in Subarea IV and Division IIIa. FLR MSY model. Summary of stochastic estimates.

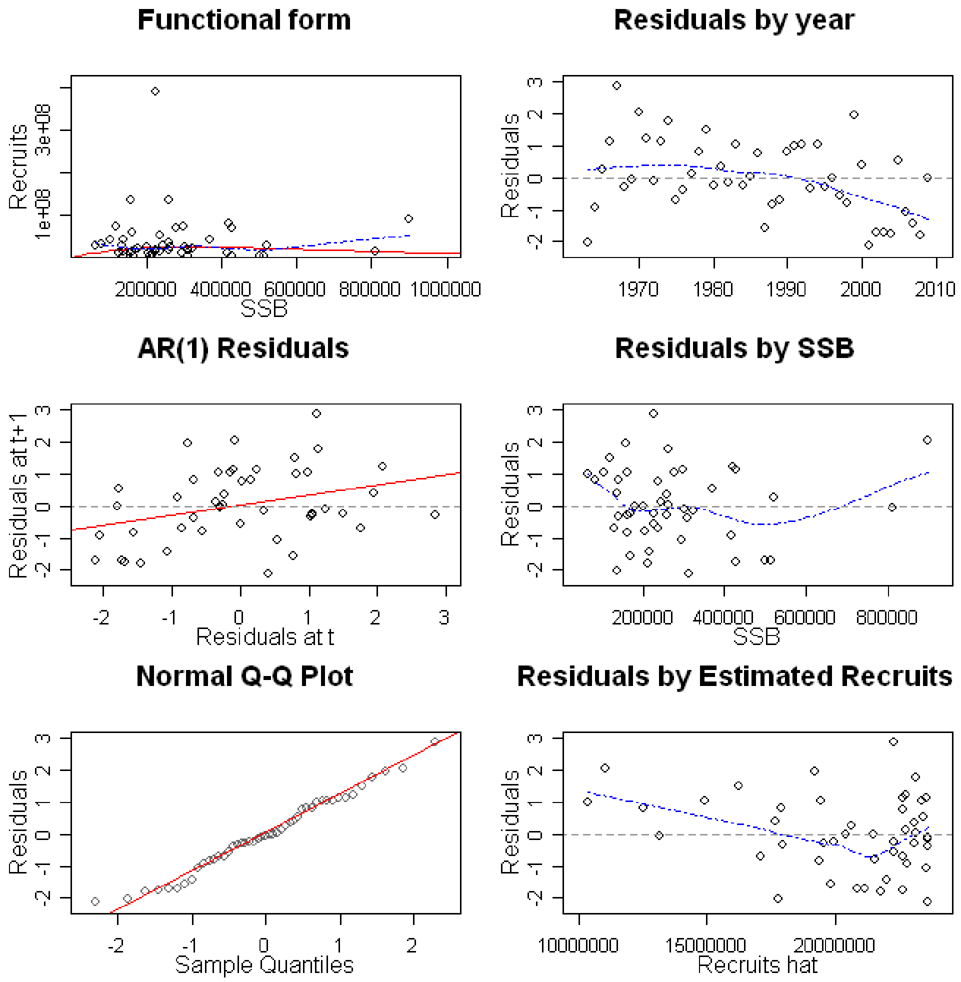


Figure 13.7.16. Haddock in Subarea IV and Division IIIa. FLR MSY model. Fit diagnostics for Ricker stock-recruit model.

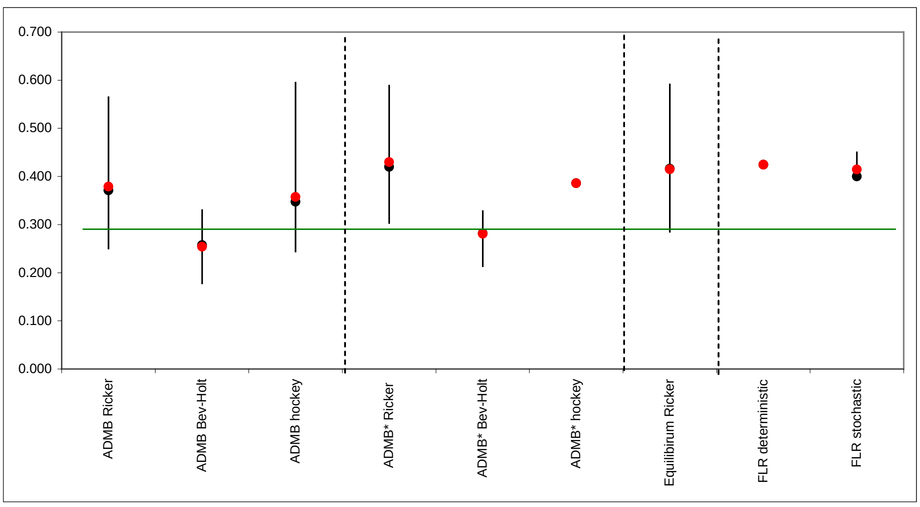


Figure 13.7.17. Haddock in Subarea IV and Division IIIa. Comparison of F_{msy} estimates generated using nine different methods (and four implementations). Red dots give mean estimates, black dots medians, and whiskers 90% confidence intervals. The horizontal green line highlights the target value in the EU-Norway management plan (0.3).

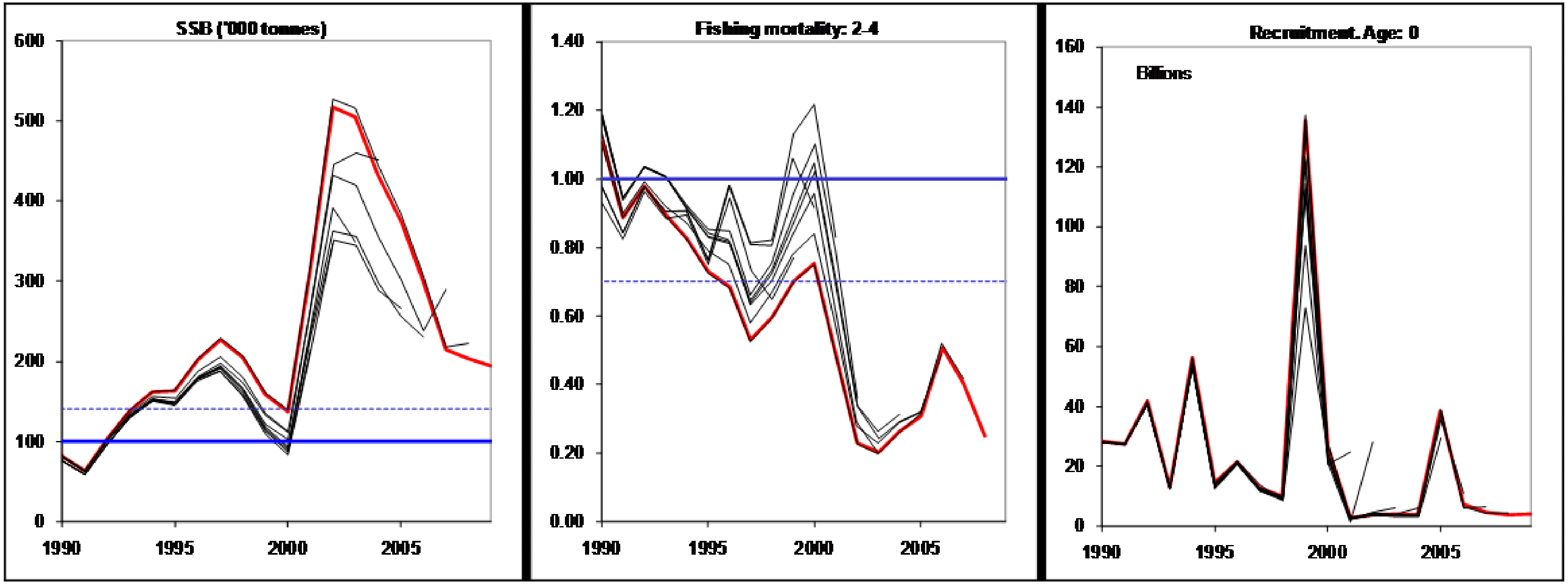


Figure 13.9.1. Haddock in Subarea IV and Division IIIa. Historical assessment quality plot.

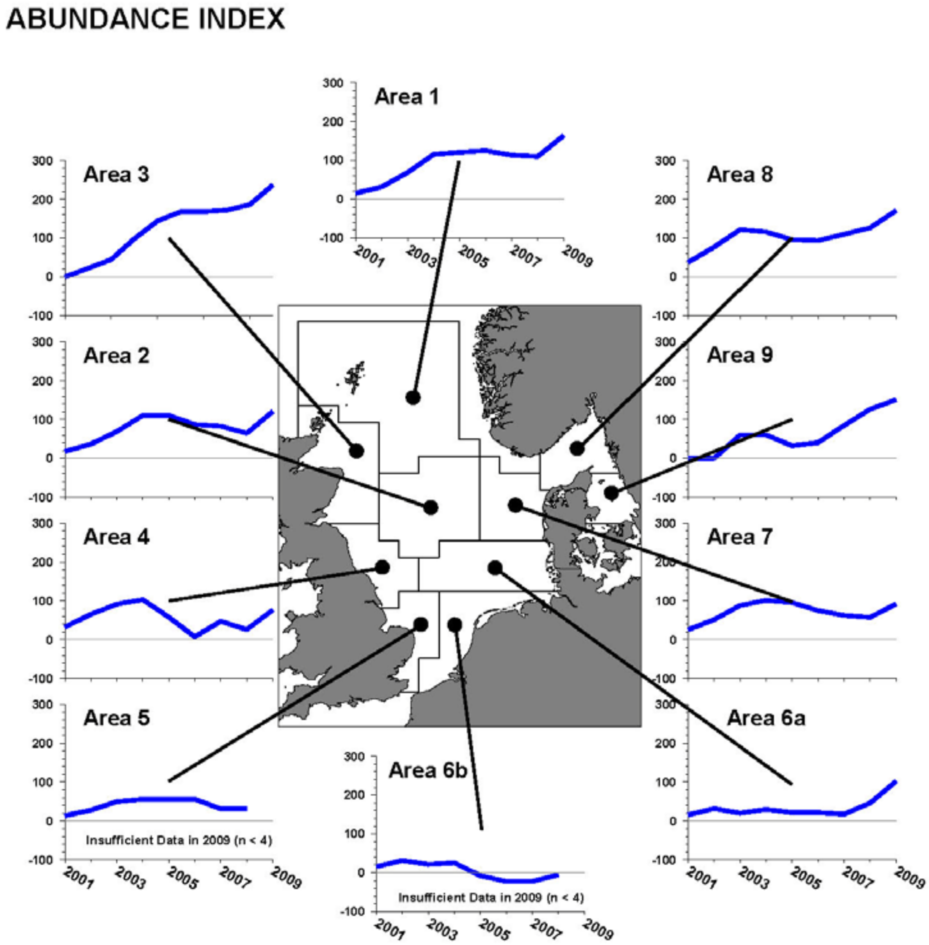


Figure 13.10.1. Haddock in Subarea IV and Division IIIa. Results of 2009 North Sea Stock Survey: cumulative time series of index of perceptions of haddock abundance Source: Napier (2009)

14 Cod

This assessment relates to the cod stock in the North Sea (Sub-area IV), the Skagerrak (the northern section of Division IIIa) and the eastern Channel (Division VIId). This assessment is presented as an update assessment based on the revised assessment protocol specified by the 2009 meeting of WKROUND (ICES-WKROUND 2009).

A stock annex (within Annex 3 to this report) records more detail and references historic information on the stock definition, ecosystem aspects and the fisheries. This report section records only recent developments and new information presented to WGNSSK.

14.1 General

14.1.1 Stock definition

No new information was presented at the EG. A summary of available information on stock definition can be found in the Stock Annex.

14.1.2 Ecosystem aspects

No new information was presented at the EG. A summary of available information on ecosystem aspects is presented in the Stock Annex.

14.1.3 Fisheries

Cod are caught by virtually all the demersal gears in Sub-area IV and Divisions IIIa (Skagerrak) and VIId, including beam trawls, otter trawls, seine nets, gill nets and lines. Most of these gears take a mixture of species. In some of them, cod are considered to be a by-catch (for example in beam trawls targeting flatfish), and in others the fisheries are directed mainly towards cod (for example, some of the fixed gear fisheries). A summary of historic information on the directed and by-catch cod fisheries and past and current technical measures used for the management of cod is presented in the Stock Annex**.**

Technical Conservation Measures

In 2009 a new system of effort management, by setting effort ceilings (kilowatt-days), has been introduced in accordance with the new cod management plan (EC 1342/2008). The number of kw-days utilized was estimated for the different metiers of the national fleets during a reference period selected by each nation (2004-2006 or 2005-2007). From these reference values, the effort in the primary metiers catching cod (with discard and bycatch taken into account) will be reduced in direct proportion to reductions in fishing mortality until the new cod management plan target fishing mortality of 0.4 is achieved. EC 1342/2008 specifies that for 2009 a 25% reduction in effort shall be applied to metiers using Otter Trawls, Danish Seines or similar gears with mesh size 80 mm and larger and Gill Nets. However, if certain national fleet segments can provide proof that they use highly selective gears and/or that their catches per fishing trip comprise less than 5% cod, the 25% reductions will not pertain. National fleet segments with less than 1.5% cod catches can apply to be excluded from the effort management regime completely. ICES-WGFTFB (2009) report the new measures introduced by the new cod management plan to be causing difficulties in a number of countries, with shifts in effort from areas where the kw days allocated to vessels are felt inadequate to areas without effort or less restricted by effort caps.

Changes in national fleet dynamics

The ICES WGFTFB meeting, which provides information on developments of fleets and gear impacting on the North Sea fisheries, was scheduled to meet after the WGNSSK 2010; a summary of information on fleet dynamics for all countries will be available in the ICES WGFTFB 2010 report.

Scotland

During 2008, 15 real-time closures (RTCs) were implemented under the Scottish Conservation Credits Scheme (CCS). In 2009, 144 RTCs were implemented, and the CCS was adopted by 439 Scottish and around 30 English and Welsh vessels. To date in 2010, 53 RTCs have been generated. The CCS has two central themes aimed at reducing the capture of cod through (i) avoiding areas with elevated abundances of cod through the use of Real Time Closures (RTCs) and (ii) the use of more species selective gears. Within the scheme, efforts are also being made to reduce discards generally. Although the scheme is intended to reduce mortality on cod, it will undoubtedly have an effect on the mortality of associated species such as haddock.

Recent work tracking Scottish vessels in 2009 (Needle, pers. comm.) has concluded that vessels did indeed move from areas of higher to lower cod concentration following real-time closures during the first and third quarters (there was no significant effect during the second and fourth quarters).

In early 2008, a one-net rule was introduced in Scotland as part of the CCS. This is likely to have improved the accuracy of reporting of landings to the correct mesh size range. However, Scottish seiners were granted a derogation from the one-net rule until the end of January 2009, and were allowed to carry two nets (e.g. 100-119 mm as well as 120+ mm). They were required to record landings from each net on a separate logsheet and to carry observers when requested (ICES-WGFTFB 2008).

Industry representative report that fishers are now managing opportunity in a more sensible way. Fishers are avoiding known cod areas so as not to have to discard quality fish due to the effect that this now has on the morale of crews. This new approach to management is further prompted by the requirement to retain suitable levels of quota in the main species in order to gain entry to the Norwegian zone (EU Norway Accord) of the North Sea. Many whitefish vessels operate in the Norwegian zone at some point in the year.

A shift by some vessels to fish the West of Scotland and Rockall bank was witnessed in 2009; this shift was prompted by both a shortage of quota and a lack of effort. A similar but larger pattern was witnessed in 2010.

Due to the new by-catch limits (30%) introduced from February 2009 as part of the new technical measures in Area VIa, the west coast grounds, inside the 200 m line, are effectively closed to Scottish vessels, with whitefish vessels fishing outside the 200 m line or shifting to North Sea grounds. The effort shift associated with this is expected to be large.

Offshore *Nephrops* vessels are making up their days from a combination of *Nephrops* and whitefish but using the same 100 mm codend to for both in the North Sea. The reason for this is down to the uncertainty at the start of each fishing trip on how the fish by-catch (>35% of the catch must be *Nephrops*) will work out. Therefore vessels leave port with 100 mm codends with lifting bags rigged. If fish are the main component then the rearmost meshes attaching the bag to the codend are cut (i.e. removing the lifting bag) and the vessel is now targeting fish for the trip. This behaviour results in mis-reporting .

General

Decommissioning schemes are still active, removing several 24m+ French whitefish vessels targeting mixed demersal fish from areas including VIId, and reducing the Dutch beam trawl fleet by 7.5% since 2008.

Several larger French trawlers using mesh size range 70–99 mm have moved further north in the North sea (south east of Scotland in Area IVb) because of the low abundance of whiting in VIId, and also to reduce fuel consumption by increasing the duration of their individual trip (from 2 days long to 4 or 5 days long).

Fisheries Science Partnerships (FSP)

A series of new and ongoing collaborative studies were presented to WGNSSK providing information on a number of species; details are listed below. The WG welcomes FSP studies of this format, particularly on a regional basis as they enhance the ability of the group to interpret information and analyses, and enhance the quality of management advice that the group can provide.

UK - North East Coast Cod Survey

The NE Coast cod survey (De Oliveira and Elliot 2010) is a designated time-series survey conducted since 2003 as part of the UK Fisheries Science Partnership. The objective of the survey series is to provide year-on-year comparative information on distribution, relative abundance and size/age composition of cod and whiting off the NE coast of England. The surveys also provide data on catches of other species important to the NE coast fishery, including haddock. The population of cod in the survey area has primarily comprised 1- and 2-year-olds, with some 3- and 4-year-olds. Older fish have been scarce due to offshore migration of mature fish. The relative strength of recent year classes of cod, as indicated by the time-series of FSP catch rates of 1-year-olds, has been similar to the trends given by recent ICES assessments for North Sea cod. The FSP survey confirms that the 2006 and 2007 year classes are roughly the same size and about half as abundant as the relatively strong 2005 year class. A comparison of different seabed types indicates that catches of cod are significantly greater on the hard ground, but that trends are similar between hard and soft ground.

North Sea Whitefish Survey

Following an initial attempt at initiating the North Sea Whitefish (NSW) survey during September and October 2008, which was abandoned because of poor weather then, the survey was rescheduled to June and/or July 2009. Fishing operations began on 3 June and were completed after four fishing trips on 29 July. Each of the specified fishing grounds was visited and 18 tows were completed on hard and soft substratum. Length distributions from cod, haddock, whiting, saithe and plaice, and the volume of the catch of all other species, were recorded. Otoliths were collected from the largest cod, haddock and whiting for age determination at Cefas. The survey otoliths were then combined with those from the Cefas ICES (IBTS) third-quarter survey which was conducted immediately after the FSP survey, in order to provide full coverage of the length distributions caught during the survey.

The preliminary survey results were encouraging; the NSW recording a good range of ages for all target species in all of the areas surveyed, with variations across the North Sea that will allow the testing of a number of questions related to substratum, gear and spatial distribution of the target species. Throughout the survey area, catch rates of the target gadoid species were higher on hard ground than on soft. The differences in catch rates may result from substratum preferences or differences in gear catchability, but at this early stage in the series, neither of these possibilities can be tested. Overall, the age structure recorded on soft ground was similar to that on hard. In most of the areas surveyed, differences in age distribution appear to be related to the area of fishing rather than the substratum fished.

When compared at an overall North Sea scale, the relative indices at age of cod, haddock and whiting abundance from the NSW and IBTSQ3 surveys were similar. Catches of older fish were more frequent and showed less noise in the NSW data than in the IBTSq3, particularly for cod. In addition, differences in the relative catch rates of older whiting between the two surveys will require particular attention as the time-series develops. The results indicate the potential for a time-series based on commercial vessels, derived across the areas surveyed. Such a series could be used to follow the development of the stock dynamics of key North Sea species and to investigate the dynamics of each on soft and hard substrata as population abundance changes over time.

UK - Codwatch

A second UK FSP project initiated in 2007 (the "North Sea Codwatch" project, Large et al., 2009) has been mapping the distribution of young cod of the 2005 and 2006 year classes in the North Sea using a fisher self-sampling scheme (www.cefas.co.uk/fsp). The project involves 12 Eastern England Fish Producer Organisation (EEFPO) vessels, representing a wide range of fishing gears and target species, and operating throughout the North Sea. These vessels observed and recorded the incidence, fine-scale distribution and abundance of the 2005 - 2008 year classes of cod, and of cod in general in the North Sea from commercial catches made between April 2007 and March 2009.

Based on fishers' perception of current year class strength relative to previous year classes (participants have an average of 30 years fishing experience), the 2007 North Sea Codwatch results suggested that the 2005 year class was widely distributed throughout the North Sea (appearing in most sampled areas), with the highest levels of abundance occurring in the western-central North Sea in Q3, and in the western central and southern North Sea in Q4. Of all rectangles sampled (153 in total), only 19% recorded perceptions of "high" or "very high" abundance of the 2005 year class relative to historical abundance (the remainder recording perceptions of "zero", "low" or "moderate" abundance), but the proportion of rectangles recording "high" or "very high" increased with time (from 10% in Q2 to 26% in Q4).

In contrast, the 2006 year class was present in relatively few of the sampled rectangles, with 80% of sampled rectangles recording perceptions of "zero" or "low", but skippers noted that this may be a consequence of the low selectivity for young fish by the gear used. This year class was indicated to be more abundant at age 2 in the first two quarters of 2008, particularly in the southern North Sea in Q1 and in the central and southern North Sea (western part) in Q2. This trend is likely be largely driven by higher selectivity as the fish grow and recruit to the fishery.

The 2007 and 2008 year classes as 1-year-olds were present in relatively few of the rectangles sampled in 2008 and in Q1 2009, respectively. A comparison of data for 1-

year-olds in Q1 of 2007, 2008 and 2009 suggest that the 2006, 2007 and 2008 year classes of cod may all have been of comparable strength.

Industry contributors commented that, in their opinion, the low estimates of relative abundance for all cod year classes observed during this project could be attributed to the use of larger mesh codends than used five years ago, and the transfer of effort to areas with few cod in order to eke out quotas and to minimise discards. In their opinion, low absolute abundance should not be interpreted solely as poor recruitment. Fishers independently have also reported greater abundance of cod in areas where historical abundance was low, despite this feature not showing clearly in the results of Codwatch thus far.

Denmark - REX

A collaborative biologist-fishermen project on spatially-explicit management methods for North Sea cod (REX) was initiated by DTU Aqua (National Institute of Aquatic Resources at the Technical University of Denmark) and the Danish Fishermen Association in summer 2006 (Wieland *et al*. 2010). Three commercial vessels representing different fishing methods participated in the study. These were a trawler, a flyshooter and a gillnetter. The main objective of the surveys has been to provide information on distribution, density and size composition of North Sea cod in particular in respect to bottom type and for comparison with the IBTS.

Catch rates from the 1st quarter were much higher than those from the 3rd quarter for both the flyshooter and trawler, but not for the gillnetter. Although seasonal differences may explain this to some extent, the efficiency of both the trawler and flyshooter depends on visibility in the water, and the 1st and 3rd quarter differences may result from high water turbidity caused by the more frequent storm events in the 1st quarter, an interpretation supported by the more consistent rates obtained between the 1st and 3rd quarter for the gillnetter.

On average, CPUE on gravel and stone bottom (trawler and flyshooter) or at ship wrecks and stone reefs (gillnetter) were considerably higher than on smooth sand bottom, an exception being at three sand bottom locations in the 3rd quarter of 2008, where mainly 80cm+ cod feeding intensively on sandeel were caught. A comparison between different bottom types found consistency at ages 1-3, but differences for older ages, implying that considering smooth bottom types alone may lead to biased and noisy estimates for the older ages. A comparison with the IBTS survey for the 3rd quarter in 2008 and 2009 showed differences in trends for the older ages, implying the IBTS surveys, which predominantly cover sand bottom types, may not provide representative estimates of abundance for older ages of cod, because rough bottom types are widely extended throughout the North Sea.

The North Sea Stock Survey

The North Sea Stock Survey (Napier 2009) was available to WGNSSK in order for the fishers' perception of the state of the stock to be considered as part of the assessment process. Responses were fairly evenly distributed across all three size classes of vessels, although with a slightly greater proportion in the largest size class (> 24 m). Of the fishing gears, the trawl and beam trawl each accounted for almost one third of responses, with most of the remainder from gill nets and *Nephrops* trawls.

The spatial distribution of the change in the perceived abundance since 2001 is recorded by survey area in Figure 14.23. Overall, about three quarters of respondents reported that cod were 'more' or 'much more' abundant in 2009. This was also the case in most of the individual areas; in eight of the 10 areas more than two thirds of respondents reported cod to be ‘more’ or ‘much more’ abundant. These proportions were particularly high in the northern and southern areas (areas 1 and 3, and 5 , 6a and 6b).

Overall, more than 80% of respondents reported catching ‘all sizes’ of cod in 2009. Significant proportions of respondents reported catching ‘mainly large cod’ in both northern and southern areas of the North Sea (areas 1, 6b, 7 and 9). The main reports of catches of ‘mostly small’ cod were from the central North Sea (area 2).

Overall, 43% of respondents reported ‘no change’ in the level of discarding of cod in 2009; 36% reported ‘more’ discarding and 22% reported ‘less’. Of the respondents who did report changes, the majority reported ‘more’ or ‘much more’ in the northern, eastern and southern North Sea (areas 1, 3, 4, 5, 6a and 6b). In the remaining areas (2, 7 and 8) opinion was roughly evenly split between those who thought there was more discarding and those who thought there was less.

Overall, almost half of respondents reported ‘high’ levels of recruitment of cod in 2009, and almost as many reported ‘moderate’ levels. The same was true of most individual areas, with the majority of respondents reported recruitment to be ‘moderate’ or ‘high’ in most areas.

14.1.4 Management

Management of cod is by TAC and technical measures. The agreed TACs for Cod in Division IIIa (Skagerrak), VIId and Sub-area IV were as follows:

TAC(000t)	2005	2006	2007	2008	2009	2010
IIIa (Skagerrak)	3.9	3.3	2.9	3.2	4.1	4.8
IIa + IV	27.3	23.2	20.0	22.2	28.8	33.6
VIId					1.7	2.0

There was no TAC for cod set for Division VIId alone until 2009. Landings from Division VIId were counted against the overall TAC agreed for ICES Divisions VII b-k.

For 2009 Council Regulation (EC) N°43/2009 allocates different amounts of Kw*days by Member State and area to different effort groups of vessels depending on gear and mesh size. (see section 1.2.1 for complete list). The area’s are Kattegat, part of IIIa not covered by Skaggerak and Kattegat, ICES zone IV, EC waters of ICES zone IIa, ICES zone VIId, ICES zone VIIa, ICES zone Via and EC waters of ICES zone Vb. The grouping of fishing gear concerned are: Bottom trawls, Danish seines and similar gear, excluding beam trawls of mesh size: TR1 (≤ 100 mm) – TR2 (≤ 70 and < 100 mm) – TR3 (≤ 16 and < 32 mm); Beam trawl of mesh size: BT1 (≤ 120 mm) – BT2 (≤ 80 and < 120 mm); Gill nets excluding trammel nets: GN1; Trammel nets: GT1 and Longlines: LL1.

For 2010 Council Regulation (EC) N°53/2010 has updated Council Regulation (EC) N°43/2009 with new allocates, based on the same effort groups of vessels and areas as stipulated in Council Regulation (EC) N°43/2009.

Demersal fisheries in the area are mixed fisheries, with many stocks exploited together in various combinations in the various fisheries. In these cases, management advice must consider both the state of individual stocks and their simultaneous exploitation in demersal fisheries. Stocks in the poorest condition, particularly those which suffer from reduced reproductive capacity, become the overriding concern for the management of mixed fisheries, where these stocks are exploited either as a targeted species or as a bycatch.

Fisheries in Division IIIa (Skagerrak–Kattegat), in Subarea IV (North Sea), and in Division VIId (Eastern Channel) should in 2010 be managed according to the following rules, which should be applied simultaneously:

Demersal fisheries

- should minimize bycatch or discards of cod;
- should implement TACs or other restrictions that will curtail fishing mortality for those stocks mentioned above for which reduction in fishing pressure is advised;
- should be exploited within the precautionary exploitation limits or where appropriate on the basis of management plan results for all other stocks (see text table above);
- where stocks extend beyond this area, e.g. into Division VI (saithe and anglerfish) or are widely migratory (Northern hake), should take into account the exploitation of the stocks in these areas so that the overall exploitation remains within precautionary limits;
- should have no landings of angel shark and minimum bycatch of spurdog, porbeagle, and common skate and undulate ray.

EU Cod Recovery plans

A Cod Recovery Plan which detailed the process of setting TACs for the North Sea cod was in place until 2008. Details of it are given in EC 423/2004 and previous working group reports. ICES considered the recovery plan as not consistent with the precautionary approach because it did not result in a closure of the fisheries for cod at a time of very low stock abundance and until an initial recovery of the cod SSB had been proven.

In April 2008, the European Commission adopted a proposal to amend the cod recovery plan, based on input from stakeholders, and on scientific advice from both ICES and STECF that current measures have been inadequate to reduce fishing pressure on cod to enable stock recovery. The main changes proposed were replacing targets in terms of biomass levels with new targets expressed as optimum fishing rates intended to provide high sustainable yield, and introducing a new system of effort management by setting effort ceilings (kilowatt-days) for groups of vessels or fleet segments to be managed at a national level by Member States. The new system is intended to be simpler, more flexible and more efficient than the previous one, allowing effort reductions to be proportionate to targeted reductions in fishing mortality for the segments that contribute the most to cod mortality, while for other segments effort will be frozen at the average level for 2005-2007.

In December 2008 the European Commission and Norway agreed on a new cod management plan implementing the new system of effort management and a target fishing mortality of 0.4. ICES has evaluated the management plan in 2009 and considers it to be in accordance with the precautionary approach if it is implemented and enforced adequately. Discarding in excess of the assumptions under the management plan will affect the effectiveness of the plan. The evaluation is most sensitive to assumptions about implementation error (i.e. TAC and effort overshoot and the consequent increase in discards).. Details of it are given in EC 1342/2008. The HCR for setting TAC for the North Sea cod stock are as follows:

Article 7: Procedure for setting TACs for cod stocks in the Kattegat the west of Scotland and the Irish Sea

1. Each year, the Council shall decide on the TAC for the following year for each of the cod stocks in the Kattegat, the west of Scotland and the Irish Sea. The TAC shall be calculated by deducting the following quantities from the total removals of cod that are forecast by STECF as corresponding to the fishing mortality rates referred to in paragraphs 2 and 3:

(a) a quantity of fish equivalent to the expected discards of cod from the stock concerned;

(b) as appropriate a quantity corresponding to other sources of cod mortality caused by fishing to be fixed on the basis of a proposal from the Commission.

Article 8: Procedure for setting TACs for the cod stock in the North Sea, the Skagerrak and the eastern Channel

1. Each year, the Council shall decide on the TACs for the cod stock in the North Sea, the Skagerrak and the eastern Channel. The TACs shall be calculated by applying the reduction rules set out in Article 7 paragraph 1(a) and (b).

2. The TACs shall initially be calculated in accordance with paragraphs 3 and 5. From the year where the TACs resulting from the application of paragraphs 3 and 5 would be lower than the TACs resulting from the application of paragraphs 4 and 5, the TACs shall be calculated according to the paragraphs 4 and 5.

3. Initially, the TACs shall not exceed a level corresponding to a fishing mortality which is a fraction of the estimate of fishing mortality on appropriate age groups in 2008 as follows: 75 % for the TACs in 2009, 65 % for the TACs in 2010, and applying successive decrements of 10 % for the following years.

4. Subsequently, if the size of the stock on 1 January of the year prior to the year of application of the TACs is:

(a) above the precautionary spawning biomass level, the TACs shall correspond to a fishing mortality rate of 0,4 on appropriate age groups;

*(b) between the minimum spawning biomass level and the precautionary spawning biomass level, the TACs shall not exceed a level corresponding to a fishing mortality rate on appropriate age groups equal to the following formula: 0,4 – (0,2 * (Precautionary spawning biomass level – spawning biomass) / (Precautionary spawning biomass level – minimum spawning biomass level))*

(c) at or below the limit spawning biomass level, the TACs shall not exceed a level corresponding to a fishing mortality rate of 0,2 on appropriate age groups.

5. Notwithstanding paragraphs 3 and 4, the Council shall not set the TACs for 2010 and subsequent years at a level that is more than 20 % below or above the TACs established in the previous year.

6. Where the cod stock referred to in paragraph 1 has been exploited at a fishing mortality rate close to 0,4 during three successive years, the Commission shall evaluate the application of *this Article and, where appropriate, propose relevant measures to amend it in order to ensure exploitation at maximum sustainable yield.*

Article 9: Procedure for setting TACs in poor data conditions

Where, due to lack of sufficiently accurate and representative information, STECF is not able to give advice allowing the Council to set the TACs in accordance with Articles 7 or 8, the Council shall decide as follows:

(a) where STECF advises that the catches of cod should be reduced to the lowest possible level, the TACs shall be set according to a 25 % reduction compared to the TAC in the previous year;

(b) in all other cases the TACs shall be set according to a 15 % reduction compared to the TAC in the previous year, unless STECF advises that this is not appropriate.

Article 10: Adaptation of measures

1. When the target fishing mortality rate in Article 5(2) has been reached or in the event that STECF advises that this target, or the minimum and precautionary spawning biomass levels in Article 6 or the levels of fishing mortality rates given in Article 7(2) are no longer appropriate in order to maintain a low risk of stock depletion and a maximum sustainable yield, the Council shall decide on new values for these levels.

2. In the event that STECF advises that any of the cod stocks is failing to recover properly, the Council shall take a decision which:

(a) sets the TAC for the relevant stock at a level lower than that provided for in Articles 7, 8 and 9;

(b) sets the maximum allowable fishing effort at a level lower than that provided for in Article 12;

(c) establishes associated conditions as appropriate.

14.2 Data available

14.2.1 Catch

Landings data from human consumption fisheries for recent years as officially reported to ICES together with those estimated by the WG are given for each area separately and combined in Table 14.1.

The Netherlands, France, Belgium and Sweden, who respectively landed 10%,6%, 4% and 1% of all cod for combined area IV and VIId in 2009, do not provide discard estimates for this combined area. Similarly, Germany, the Netherlands and Belgium, who landed 1% or less of all cod in area IIIa, do not provide discard estimates for this area. Norwegian discarding is illegal, so although this nation landed in 2009 13% and 9% of all cod in combined area IV and VIId, and area IIIa respectively, it does not provide discard estimates.

The landings estimate for 2009 is 30.8 thousand tonnes, split as follows for the separate areas (thousand tonnes):

	Landings	TAC	Discards
IIIa-Skagerrak	3.9	4.1	2.4
IV	25.7	28.8	12.2
VIId	1.2	1.7	
Total	30.8	34.6	14.6

*A separate TAC for Division VIId was provided for the first time in 2009.

WG estimates of discards are also shown in the above table.

Discard numbers-at-age were estimated for areas IV and VIId by applying the Scottish discard ogives to the international landings-at-age. For 2006, Denmark was excluded from this calculation as they provided their own discard estimates. For 2007-2009, Scottish, Danish, German and England & Wales discard estimates were combined (sum of discards divided by sum of landings) and used to raise landings-at-age from the remaining nations in sub-area IV to account for missing discards. Discard numbers-at-age for IIIa-Skagerrak were based on observer sampling estimates. For 2006-2009, Danish and Swedish discard estimates were combined (sum of discards divided by sum of landings) and used to raise landings-at-age from the remaining nations in Division IIIa-Skagerrak to account for missing discards. Although in some cases other nations' discard proportions are available for a range of years, these have not been transmitted to the relevant WG data coordinator in an appropriate form for inclusion in the international dataset. Figure 14.1a plots reported landings and estimated discards used in the assessment.

For cod in IV, IIIa-Skagerrak and VIId, ICES first raised concerns about the misreporting and non-reporting of landings in the early 1990s, particularly when TACs became intentionally restrictive for management purposes. Some WG members have since provided estimates of under-reporting of landings to the WG, but by their very nature these are difficult to quantify. In terms of events since the mid-1990s, the WG believes that under-reporting of landings may have been significant in 1998 because of the abundance in the population of the relatively strong 1996 year-class as 2-year-olds. The landed weight and input numbers at age data for 1998 were adjusted to include an estimated 3 000t of under-reported catch. The 1998 catch estimates remain unchanged in the present assessment.

For 1999 and 2000, the WG has no *a priori* reason to believe that there was significant under-reporting of landings. However, the substantial reduction in fishing effort implied by the 2001, 2002 and 2003 TACs is likely to have resulted in an increase in unreported catch in those years. Anecdotal information from the fisheries in some countries indicated that this may indeed have been the case, but the extent of the alleged under-reporting of catch varies considerably. Since the WG has no basis to judge the overall extent of under-reported catch, it has no alternative than to use its best estimates of landings, which in general are in line with the officially reported landings. An attempt is made to incorporate a statistical correction to the sum of reported landings and discards data in the assessment of this stock, but the figures shown in Table 14.1 and Figure 14.1a nevertheless comprise the input values to the assessment. Buyers and Sellers legislation introduced in the UK towards the end of 2005 is expected to have improved the accuracy of reported cod landings for the UK. This has brought the UK in line with existing EU legislation.

The by-catch of cod from the Danish and Norwegian industrial fisheries that was sent for reduction to fishmeal and oil in 2009 was 81??? tonnes (Table 2.1.3##).

Age compositions

Age compositions were provided by Denmark, England, Germany, the Netherlands, Scotland and Sweden. However, the landings age composition data for Germany provided very low mean weights at age for older cod for 2009, and it was subsequently discovered that there was an error in the data. Until this problem is sorted the German landings age composition data has been omitted for 2009.

Landings in numbers at age for age groups 1-11+ and 1963-2009 are given in Table 14.2. SOP values are shown. These data form the basis for the catch at age analysis but do not include industrial fishery by-catches landed for reduction purposes. By-catch estimates are available for the total Danish and Norwegian small-meshed fishery in the Skagerrak and also Sub-area IV (Table 14.1). During the last five years an average of 81% (69% in 2009) of the international landings in number were accounted for by juvenile cod aged 1-3. In 2009, age 1 cod comprised 32% of the total catch by number, age 2, 39% and age 3, 14%.

Discard numbers-at-age are shown in Table 14.3. The proportions of the estimated total numbers discarded are plotted in Figure 14.1b and the proportion of the estimated discards for ages 1-3, in Figure 14.1c. Estimated total numbers discarded have varied between 35 and 55% from 1995 to 2005, but have shown an increase to above 70% since 2006, due to the stronger 2005 year class entering the fishery (estimated to be almost the size of the 1999 year class), and a mismatch between the TAC and effort. The total numbers discarded has decreased to 62% in 2009. Historically, the proportion of numbers discarded at age 1 have fluctuated around 80% with no decline apparent after the introduction of the 120mm mesh in 2002. During the last four years, it is estimated to be above 90%. At ages 2 to 4 discard proportions have been increasing steadily and are currently estimated to be 62% at age 2, 34% of age 3 and 12% of 4 year old cod (the 2005 year class) in 2008. Note that these observations refer to numbers discarded, not weight.

Intercatch

Intercatch has been used wherever possible in the compilation of catch data for North Sea cod. However, a complete dataset is needed so that outputs from Intercatch can be fully compared and verified with those from ad-hoc spreadsheets. Until it is possible to make such a comparison, the spreadsheets submitted by each country to the stock co-ordinator will continue to form the primary basis for compilation of cod catch data.

For 2009, it has not been possible to create an estimate of international catch numbers at age and mean weights at age in Intercatch because the international dataset in Intercatch is incomplete. The countries that have not imported the 2009 data for NS cod are: UK(Scotland), Norway, France, Belgium and Faroes.

The reluctance of some nations to import data into Intercatch is because it cannot estimate discards for countries not submitting discard data. A solution to this problem currently requires a discard ratio to be calculated outside of Intercatch (from samples with discard data). This ratio could be applied to those data for which no discards had been sampled and the relevant (created) discard data files could then be fed back into Intercatch. Once this is done, the database would no longer contain just the data submitted by institutes, as the estimated discards are not the data as supplied. There also appears to be no flag to indicate that these "estimated" discards are indeed estimated. This has implications for data provenance, particularly for those nations where discard bans are in place. It is important to distinguish between "observed" and "inferred" data and there therefore remains a strong discomfort with populating a database with discards for certain countries as estimated from other countries' data.

A further problem is that the procedure that Intercatch uses to apply weighting factors when estimating international mean weights at age has given different results to those from the recent series of estimates for the stocks of cod, haddock and whiting in Division VIa. If this discrepancy cannot be resolved, then a formal argument of "correctness" for the approach taken by Intercatch should be provided.

14.2.2 Weight at age

Mean weight at age data for landings, discards and catch, are given in Tables 14.4-6. Total catch mean weight values were also used as stock mean weights. Long-term trends in mean catch weight at age for ages 1-9 are plotted in Figure 14.2, which indicates that there have been short-term trends in mean weight at age and that the decline noted during the 90's at ages 3-5 now seems to have been reversed, most likely as a result of high-grading. Ages 1 and 2 show little absolute variation over the long-term.

14.2.3 Maturity and natural mortality

In the historic assessments natural mortality for cod is assumed to be constant in time. However, calculations with the SMS key run (Stochastic Multi Species Model; Lewy and Vinther, 2004), carried out by the Working Group on Multi Species Assessment Methods (ICES WGSAM 2008), indicate that predation mortalities (M2) declined substantially over the last 30 years for age 1 and age 2 cod. In addition, calculations with the latest 4M key run (Vinther et al., 2002), carried out during the EU project BECAUSE (contract number SSP8 CT 2003 502482) in 2007, indicate a systematic increasing trend for older ages (3–6) of cod due to seal predation. A review of the WGSAM estimates was carried out at the 2009 WKROUND benchmark assessment of the North Sea cod (ICES-WKROUND 2009), and the variable time series of M, which include the major sources of predation on North Sea cod, was considered appropriate for use in future assessments. Table 14.7b shows estimates of M, based on multi species considerations adopted for the revised assessment. For 2008 and 2009 the same natural mortalities were applied as for 2007 since no new estimates are available. WKROUND also concluded that as new stomach data (e.g. on seal predation) become available, a revision of more recent M2 values to reflect the current status of the food web, should be considered.

Values for maturity are given in Table 14.7a, they are applied to all years and are unchanged from those used in recent assessments. ICES-WKROUND (2009) also examined systematic changes in age at maturation which has increased in a number of cod stocks. In recent years, North Sea cod has shown changes in maturity with fish maturing at a younger age and smaller size. The variable maturity data leads to a substantial deterioration in model fit, and therefore does not help explain the relationship between SSB and recruitment. ICES-WKROUND (2009) concluded that until further investigations are carried on issues linked to earlier maturity, for example relating the quality of reproductive output of young first time spawners to recruitment success, the constant maturity ogive should be used for future assessments.

14.2.4 Catch, effort and research vessel data

Reliable, individual, disaggregated trip data were not available for the analysis of CPUE. Since the mid-to-late 1990s, changes to the method of recording data means that individual trip data are now more accessible than before; however, the recording of fishing effort as hours fished has become less reliable as it is not a mandatory field in the logbook data. Consequently, the effort data, as hours fished, are not considered to be representative of the fishing effort actually deployed. The WG has previously argued that, although they are in general agreement with the survey information, commercial CPUE tuning series should not be used for the calibration of assessment models due to potential problems with effort recording and hyper-stability (ICES-WGNSSK 2001), and also changes in gear design and usage, as discussed by ICES-WGFTFB (2006, 2007). Therefore, although the commercial fleet series are available, only survey and commercial landings and discard information are analysed within the assessment presented.

Two survey series are used within this assessment:

- Quarter 1 international bottom-trawl survey (IBTSQ1): ages 1–6+, covering the period 1976–2010. This multi-vessel survey covers the whole of the North Sea using fixed stations of at least two tows per rectangle with the GOV trawl.
- Quarter 3 international bottom-trawl survey (IBTSQ3): ages 0–6+, covering the period 1991–2009. This multi-vessel survey covers the whole of the North Sea using fixed stations of at least two tows per rectangle with the GOV trawl.

The data used for calibrating the catch-at-age analysis are shown in Table 14.8.

Maps showing the IBTS distribution of cod are presented in Figures 14.3a-b (ages 1-3+). The recent dominant effect of the size and distribution of the 1996 and, to a lesser extent, the 1999 and 2005 year-classes are clearly apparent from these charts. Fish of older ages continued to decline until 2006 due to the very weak 2000, 2002 and 2004 year classes, but have subsequently begun to increase, especially in the north and west. The abundance of 3+ fish is still at a low level compared to historic levels but is increasing. There is some indication of increased abundance of age 1 fish (2009 year class) in the north west in 2010 (Figure 14.3a).

An analysis of IBTSQ1 data by Rindorf and Vinther (WD 4 in ICES-WGNSSK, 2007) illustrated the increased importance of recruitment from the Skagerrak. The survey indices from IBTSQ1 and Q3 used in the stock assessment only include catch rates from the three most easterly rectangles of Skagerrak. WKROUND (2009) compared the standard and an extended area IBTS index for IBTS Q1 and Q3. The indices show minor changes for the ages used in the assessment (1–5 for IBTSQ1 and 1–4 for IBTSQ3) when the index is extended. The largest changes occur at the younger ages, particularly for age 0 in IBTSQ3, which is not used in the assessment. Residuals for B-Adapt runs including the standard and extended indices indicate a slight improvement in fit for the extended indices run compared to the standard indices run. Given the improved fit for the extended indices and other benefits of using these indices (such as better coverage of the stock distribution area), WKROUND concluded that it would be beneficial for the North Sea cod assessment to use the extended indices in future analyses.

Correspondence between WGNSSK and the IBTSWG during spring 2009 discussed the addition of the suggested areas to the calculation of the extended index. Some of the rectangles were not covered by surveys each year and a modified list was agreed. Unfortunately, after calculation of the extended area and standard indices using the IBTS Q1 2009 values, large differences between the indices were noted at the older ages, that did not occur in previous years. There was insufficient time before the WGNSSK meeting to investigate the reason for the differences and therefore a decision was made to continue with the standard indices for a further year before the transition to the extended area surveys was undertaken.

The Norwegian survey, which has been part of the IBTS Q3 survey since 1999, was unable to participate in this survey in 2009. A working document submitted by Parker-Humphreys to the IBTSWG in 2009 (ICES-IBTSWG 2009) investigated the impact of excluding the Norwegian survey on the IBTS Q3 index and found that for North Sea cod, the index was sensitive to the inclusion/exclusion of the Norwegian survey (Figure 14.3c). The IBTS WG concluded that this analysis "leads to questions regarding the suitability of the current indices, given the changes in catchability seen with the introduction of the Norway dataset in 1999."

14.3 Data analyses

14.3.1 Reviews of last year's assessment

In 2009, the North Sea Ecosystem Review Group concluded that "the methodology was well explained and there were no specific comments" and that "the assessment has been performed correctly and estimates of stock status are consistent with other methods e.g. SURBA, SAM".

14.3.2 Exploratory survey-based analyses

Survey abundance indices are plotted in log-mean standardised form by year and cohort in Figure 14.4a for the IBTSQ1 survey, together with log-abundance curves and associated negative gradients for the age range 2-4. Similar plots are shown for the IBTSQ3 survey in Figure 14.4b. The log-mean standardised curves indicate no obvious year effects (top-left plots), and tracks cohort signals well (top right) The log abundance curves for each survey series indicate consistent gradients (bottom left), with less steep gradients in recent years (bottom right).

Figures 14.5a and b show within-survey consistency (in cohort strength) for the IBTSQ1 and Q3 surveys, while Figure 14.5c shows between-survey consistency (for each age) for the two surveys. These show generally good consistency, justifying their use for survey tuning. Correlations deteriorate for age 5 for the IBTSQ3 survey, and this age is not used for tuning.

The SURBA survey analysis model was fitted to the survey data for the IBTSQ1 and IBTSQ3. The summary plots are presented in Figures 14.6a-b.

Biomass - Both time series estimated in SURBA indicate that spawning stock biomass reached the lowest level in the time series in 2005-6 caused by a series of poor recruitments coupled with high fishing mortality and discard rates at the youngest ages, but that it is now increasing again because the stronger 2005 year class is maturing. This increase can also be seen in the time series for total stock biomass.

Total mortality – In all SURBA model fits, there is a high level of uncertainty in the model estimates, and trends in mean Z cannot be determined with any confidence.

Recruitment – SURBA estimates of recruitment appear to have very wide confidence intervals for the IBTSQ3 survey, the reason for which is not immediately clear. The IBTSQ1 survey indicates that the recruiting years classes since 1996 have been relatively weak, but that the 2005 year class is one of the highest of the recent low values. The variation recorded in year class strength at age 1 is substantially higher than that recorded subsequently at ages 2 and 3, indicating that the high rates of discarding (90%) and high mortality rates at this age are resulting in reduced contributions from one year old fish to the stock and catches. Although still uncertain, the 2010 data from the IBTS Q1 indicates that the 2009 year class may be the same level as the 2005 year class.

14.3.3 Exploratory catch-at-age-based analyses

Catch-at-age matrix and Separable VPA

The total catch-at-age matrix (combination of landings and discards shown in Tables 14.2 and 14.3) is expressed as numbers at age, and proportions-at-age, standardised over time in Figure 14.7. It shows clearly the contribution of the 1996 and 1999 year classes to catches in recent years, with the larger 1996 year class disappearing more rapidly from the catches compared to the 1999 year class. It also shows the greater proportion of older fish in the catches at the start of the time series relative to recent years. The 2005 year class now features strongly in the catch.

As in previous years, a separable VPA model was used to examine the structure of the catch numbers at age data before its use in a catch at age analysis. The fitted model indicates that the age structure of the recorded landings may have changed in the last two years, positive residuals at the youngest ages in the most recent year and negative at the oldest. This may be an effect of the high grading, discarding noted earlier. The catch data are not subject to large random or process errors that would lead to concerns as to the way in which the recorded catch has been processed.

Catch curve cohort trends

The top panel of Figure 14.8 presents the log catch curve plot for the catch at age data. Through time there is an increase in the slope of the cohort plots indicating faster removal rates or high total mortality. In the most recent years there has been a gradual decrease in the slope at the youngest ages – a sign of decreased mortality rates. The bottom panel plots the negative slope of a regression fitted to the ages 2-4, the age range used as the reference for mortality trends. The decrease in the negative slope indicates that total mortality rates at the ages comprising the dominant ages within the fishery are declining.

State-Space Model

Nielsen (ICES WGNSSK 2008 WD) presented state-space model (SAM) estimates applied to the North Sea cod data. The model was evaluated for the cod assessment at WKROUND (2009). WKROUND debated the retro of the SAM model, and the hypersensitive F pattern in the B-ADAPT, but could not reach an agreement. It adopted the SAM model for Kattegat and Western Baltic cod but concluded that "the approach requires further development and evaluation for other stocks" (WKROUND-2009). The decision was made to continue using B-ADAPT for update assessments, with the SAM model run in parallel as "a comparative model for North Sea cod, with the potential long term goal of becoming a primary assessment model for this stock" (WKROUND-2009).

The WG therefore fitted the SAM model in parallel to the B-ADAPT assessment in order to continue the comparative series alternative model analyses. SAM showed the same pattern in SSB and recruitment as B-ADAPT (Figure 14.9). The overall development in Fbar is also the same in the estimates from SAM and B-ADAPT, but the changes in the SAM Fbar estimates are less pronounced than the B-ADAPT, and the overestimation retrospective pattern noted before is still present (Figure 14.10a). The greater fluctuation in B-ADAPT Fbar estimates is a consequence of B-ADAPT assuming reported catches and age compositions known without error (Figure 14.10a). The estimated catch multiplier (Figure 14.9) shows some differences to B-ADAPT, and the two models diverge in the two final years. Residual patterns for IBTS Q3 show similar trends for the two models (Figure 14.11 and Figure 14.13). However the SAM estimates of Fbar and SSB are relatively insensitive whether only one or both IBTS surveys are included (Figure 10b).

B-ADAPT

The following table presents a selection of the runs considered, comprising single fleet B-ADAPT runs fitted to the IBTSQ1 and IBTSQ3 groundfish surveys respectively, and the update assessment (using the same settings as last year).

Description	Period for catch multiplier
Single Fleet Runs	
1. IBTSQ1	1998-2009
2. IBTSQ3	1998-2009
Candidate Assessments	
3. Update assessment	1993-2009

Single fleet runs of the B-ADAPT model were fitted to the IBTSQ1 (run 1) and IBTSQ3 (run 2) groundfish surveys in order to examine the time series of estimates derived from independent survey data sets. Because B-ADAPT requires a reasonable period of overlap (at least 5 years) between the survey data and the period for which a catch multiplier is not estimated, and because the base run estimated catch multipliers close to 1 for 1997, the IBTSQ3 run only estimated the catch multiplier for the period 1998-2009, with the values used for the period 1993-1997 taken from the updated assessment (run 3). To ensure consistency between the single fleet runs, the same procedure was used for IBTSQ1 (setting multipliers for 1993-1997 equal to base run values, and estimating those from 1998 on), despite enough data being available for estimating catch multipliers from 1993.

Figure 14.12 plots trajectories of SSB, recruitment (age 1), mean F(2-4) and the catch multiplier for the two single fleet runs, together with the "update" assessment, which combines the two surveys, but bases the update on the assuming the same range of catch multipliers for the single fleet runs given above. The single fleet runs indicate that the estimated removals since 1998 are higher than indicated by the catch data, and SSB is now no longer in decline having attained the lowest level in the time series in 2006. However, the single fleet runs diverge in recent years, with higher SSBs, a much higher catch multiplier, and initially lower but then higher Fs for IBTSQ3. This divergence is a concern and is also reflected in the residual plots for the update assessment.

Residual plots are shown in Figure 14.13 for the update assessment, indicating model misspecification in the most recent years showing generally negative residuals for IBTSQ1, and positive ones for IBTSQ3. This confirms that the two IBTS surveys are providing conflicting information, given the assumptions in the model. Retrospective plots for the base run are shown in Figure 14.14. These show a slight underestimation of fishing mortality prior to 2007, but a relatively large change in 2007 for F(2-4) and the catch multiplier. A summary of the update assessment in terms of population trends is provided in Figure 14.15, and the mean fishing mortality split into landings and discards using reported catch data in Figure 14.16.

14.3.4 Final assessment

Given concerns about residual trends in recent years (Figure 14.13), also reflected in the divergence between the IBTS Q1 and Q3 single fleet runs (Figure 14.12), the update assessment is not accepted as the final assessment for 2010. Several features point to the IBTS Q3 survey as being a potential problem, and these are discussed in Section 14.9.

14.4 Historic Stock Trends

Although a final assessment is not presented in 2010 for North Sea cod, the update assessment is still indicative of stock and fishery trends, and these are presented in Figures 14.15 and Table 14.12.

Recruitment has fluctuated at a relatively low level since 1998. The 1996 year class was the last large year class that contributed to the fishery, and subsequent year classes have been the lowest in the time series apart from the 1999 and 2005 year classes. The addition of discards to the assessment has raised the overall level of recruitment abundance but not the trend in recent year class strengths. The 2006, 2007 and 2008 year classes are estimated to be weak, and there is some indication (Figures 14.3a and 14.6a) that the 2009 year class may be stronger (about the size of the 2005 year class).

Fishing mortality increased until the early 1980's remained high until 2000 after which it has generally declined.

SSB declined steadily during the 1970's and 80's. There was a small increase in SSB following the recruitment of the 1995 and 1996 year classes, but with low recruitment abundance since 1998 and continued high mortality rates, SSB continued to decline. SSB is estimated to have increased in recent years from the lowest level in the time series 2006. TSB estimates have been increasing for longer than SSB because of the 2005 year class, but this year class is now maturing and contributing to SSB.

The North Sea Fishers' Survey indicates that perceptions of cod abundance in recent years has been of a general increase throughout the North Sea, which is consistent with the stronger 2005 year class entering the fishery.

14.5 Recruitment estimates

The lack of a final assessment means no forecasts are presented for North Sea cod.

14.6 MSY estimation

The ADMB module was used to estimate Fmsy and potential proxies for the North Sea cod stock. The model applied assumes a single species harvest scenario with no density dependent variation in growth and mortality rates at high stock abundance.

Input data

Input data was taken from the 2009 assessment as the current update assessment was not accepted. Bootstrap estimates of the 2008 fishing and discard mortality rates were used for the selection at age vectors (medians) and their uncertainty (c.v.), weights at age were derived from the most recent 10 years for catch and stock weights and from the most recent three years for discard weights, as discard rates have been increasing in recent years - for ages 3 and older, discard rates were predominantly 0 in earlier years. Maturity and natural mortality at age were taken as the average over the most recent three years. Input data is tabulated in Tables 14.13 and 14.14.

Stock and recruitment

Ricker, Beverton-Holt and the smooth hockey stick stock and recruitment curves were fitted to the data and the diagnostic output evaluated (Table 14.15a-c and Figure 14.17a-c) to determine the appropriate curve for the estimation of Fmsy or its proxies. Re-scaling of the input data (expressed relative to the mean) and re-parameterisation of the stock-recruit curves in the case of the Ricker and Beverton-Holt formulations is needed in order to ease estimation and reduce correlations in the estimable parameters. Table 14.15a-c therefore reports two sets of stock-recruit parameters, the first re-scaled (and re-parameterised in the case of Ricker and Beverton-Holt) and reported as "ADMB" parameters, and the second given in the original scale and reported as "Unscaled".

Figure 14.17a-c illustrates the uncertainty inherent in the estimation of the stock and recruitment curves. The ADMB model uses MCMC re-sampling to derive alternative fits of the stock and recruit curve based on the variance-covariance structure of the parameters estimated from the initial model fit. The left hand curves in each figure illustrate the confidence intervals from X/1000 re-samples from the MCMC chain; where X (recorded in the legend) represents the number of successful samples in which the calculation of the reference points do not hit a bound (hitting a bound implies these reference points cannot be estimated when the yield per recruit curve is calculated). The right hand figures present curves plotted from the first successful 100 MCMC re-samples for illustration.

Figure 14.18 presents estimates for the fit of the Ricker curve:

a) box plots of the estimated Fmsy fishing mortality with proxies for Fmsy, based on the yield per recruit definitions of Fmax, F0.1, F35% and F40% SPR, and also Flim, Fpa and F in the final year, for comparison;

b) the equilibrium landings versus fishing mortality plot based on the fitted stock and recruit curve and the selection and weight at age data, together with historic values of landings and assessment estimates of F. The left hand figure illustrates the percentiles from the successful re-samples of the MCMC chain (where reference point bounds are not violated), and the right hand figure the first 100 successful re-samples;

c) the equilibrium SSB versus fishing mortality relationship for the fitted stock and recruit curve, selection, weight and maturity at age data, together with the assessment estimates of SSB and F. As fishing mortality approaches Fcrash the stock declines to zero at equilibrium; at low mortality rates there is a substantial rebuilding well above the assessment estimates.

Figures 14.19 and 14.20 present similar plots to those in Figure 14.18 for the Beverton-Holt and smooth hockey stick functions. Table 14.15a-c presents the estimated values, percentiles and coefficient of variation for each of the stock and recruitment curves.

Yield per recruit

Figure 14.21a-c presents the yield per recruit output from the model:

a) The estimates of Fmax, F0.1, F35% and F40% SPR with Flim Fpa and the final year F.

b) The human consumption yield per recruit at specified levels of fishing mortality.

c) The spawner biomass per recruit at the specified level of fishing mortality.

Table 14.15d presents the yield pre recruit estimates.

Results

The AICc values are similar for each curve, the smooth hockey stick has the lowest value but the difference between values is small relative to the scale and there is no clear appropriate model selection based on this statistic.

All of the models have well defined behaviour close to the origin and therefore Fcrash - the mortality that reduces the stock to zero - is well estimated, with similar estimates for each model fit. The median values of Fcrash (Ricker 0.92, Beverton Holt 0.90, Hockey stick 0.88) are close to the current Flim (0.86), which is therefore consistent with the most recent time series of data. Similarly the lower 5th percentiles of the Fcrash distribution (Ricker 0.67, Beverton Holt 0.67, Hockey stick 0.65) are very close to Fpa (0.65) which is also considered consistent with the new data.

For both the Ricker and Beverton-Holt curves, one of the ADMB parameters is well-defined (11% c.v.), while the other is poorly determined (>70% c.v.). In the case of the Beverton-Holt curve, both unscaled parameters are very poorly determined (>700% c.v.s), highlighting the importance of re-parameterisation of the usual Beverton-Holt formulation prior to estimation. In contrast, both smooth hockey stick parameters are well determined with c.v.s of 12% and 17%. Although Bmsy levels are very poorly determined in all three cases (c.v.s ranging from 200% to 650%), and MSY in the case of Ricker and Beverton-Holt (c.v.s of 600% to 700%) the corresponding Fmsy level is reasonably well determined for all three models, with c.v.s ranging from 20% to 31%, and median values ranging from 0.16 to 0.42. The Ricker curve provides the highest and most precisely determined Fmsy value, and is also regarded as the most biologically plausible model for cod, given that cod are cannibalistic. However, the fit of the stock-recruit curves (AICc values) and corresponding estimates of precision for parameters (stock-recruit and Fmsy) does not exclude any of the models from being considered, and Fmsy values from all three models are therefore presented.

Conclusion

The models used do not included uncertainty due to ecosystem effects and multi-species interactions affecting growth, maturity and natural mortality and therefore the stock trajectory estimated at low fishing mortality rates is considered to be highly uncertain.

Fmsy estimates are reasonably well determined for all three models and these models cannot be distinguished based on the current data. Consequently the definition of Fmsy for the North Sea cod stock is dependent on whether it is considered that recruitment will be reduced or either remain constant or continue to increase at high stock abundance - the choice between the Ricker on the one hand and the smooth hockey stick and Beverton-Holt models on the other. The Ricker curve is the most plausible based on biological considerations; density dependent mortality rates have been recorded in the North Sea and are included in the cod assessment based on estimates from the MSVPA model. However until more data is collated at high stock abundance the recruitment dynamics at high stock abundance will be uncertain.

Consequently a definitive Fmsy value cannot be determined for North Sea cod based on the current information. On the basis of the three models that have equally plausible fits to the stock and recruit estimates, fishing mortalities in the range of 0.16-0.42 would be considered consistent with Fmsy for the North Sea cod.

14.7 Short-term forecasts

The lack of a final assessment means no forecasts are presented for North Sea cod.

14.8 Medium-term forecasts

The lack of a final assessment means no forecasts are presented for North Sea cod.

14.9 Biological reference points

The Precautionary Approach reference points for cod in IV, IIIa (Skagerrak) and VIId have been unchanged since 1998. They are:

	Type	Value	Technical basis
Precautionary approach	B_{lim}	70 000 t	B_{loss} (~1995)
	B_{pa}	150 000 t	B_{pa} = Previous MBAL and signs of impaired recruitment below 150 000 t.
	F_{lim}	0.86	F_{lim} = F_{loss} (~1995)
	F_{pa}	0.65	F_{pa} = Approx. 5th percentile of F_{loss}, implying an equilibrium biomass > B_{pa}.
Targets	F_y	0.4	EU/Norway agreement December 2009

Unchanged since 1998

Yield and spawning biomass per Recruit F-reference points:

	Fish Mort Ages 2-4	Yield/R	SSB/R
Average last 3 years	0.70	0.34	0.45
F_{max}	0.19	0.62	3.36
$F_{0.1}$	0.13	0.59	4.73
F_{med}	0.84	0.28	0.30

Estimated by ICES in 2010, based on the assessment performed in 2009 (ICES-WGNSSK 2009), and making the same assumptions about input values underlying the MSY analysis presented in Section 14.6.

14.10 Quality of the assessment

The quality of the commercial landings and catch-at-age data for this stock deteriorated in the 1990s following reductions in the TAC without associated control of fishing effort. The WG considers the international landings figures from 1993 onwards to have inaccuracies that lead to retrospective underestimation of fishing mortality and over estimation of spawning stock biomass and other problems with an analytical assessment. The mismatch between reported and actual landings is now estimated to be decreasing.

Prior to 2006 estimates of discards for areas IV and VIId are taken from the Scottish discard sampling program and the average proportions across gears applied to raise the landings data from other areas. If the gear and fishery characteristics differ this could introduce bias. This bias is likely to introduce sensitivity to the estimates of the youngest age classes (1 and 2) and will not affect estimates of SSB. For 2006, Scottish discard sampling was used to raise all landings data apart from Danish landings, because Danish discard data were provided. For 2007 onwards, a combination of Scottish, Danish, German and England and Wales discard estimates was used to raise landings from countries that did not provide discard estimates. Although discard estimates were provided by Denmark for years prior to 2006, and by Germany and England and Wales for years prior to 2007, these have not been used as it was not possible to re-work earlier discard estimates.

The North Sea surveys have good consistency within and between the indices. The indication that SSB in 2006 was at or around a historical low, and is now increasing, is supported by the SAM model, the SURBA analyses and single survey assessment model fits. The low level of recent recruitments is consistent between model fits and within and between survey indices, which also confirm a higher 2005 year class compared to recent years. Despite these consistencies, normalised residual plots for the update assessment reveal model misspecification (opposing trends towards the end of each set of residuals from the IBTS Q1 and Q3 fits), indicating that under the assumptions of the model, the two IBTS indices are providing conflicting information in recent years. This is borne out in the single fleet runs, which reveal different trends in SSB, F and the catch multiplier in recent years. For this reason, the update assessment has not been accepted for 2010.

A possible reason for the problematic residual trends in the update assessment may lie with the IBTS Q3 survey index, and there are several pointers to this. The SURBA fit for this index provides very imprecise estimates of recruitment (much more than for the IBTS Q1 fit), indicating a potential problem with the underlying data. Furthermore, the SAM model also indicates trends in the normalised residuals for the most recent years for the IBTS Q3 data. Finally, the IBTSWG expressed doubts about the suitability of the IBTS Q3 index after analyses showed that for North Sea cod, the index was sensitive to the inclusion/exclusion of the Norwegian survey time series (the Norwegian survey did not take place in 2009). However, the update assessment is relatively insensitive to the inclusion/exclusion of the Norwegian data from the IBTS Q3 index (Figure 14.22), indicating that the problem with this index may be wider than just the inclusion/exclusion of Norwegian data, and may also apply to the IBTS Q1 index. Further analyses of these indices and appropriate models for this stock are required prior to the next assessment of North Sea cod.

The survey indices from IBTSQ1 and Q3 used in the stock assessment only include catch rates from the three most easterly rectangles of Skagerrak. A series of investigations at WKNSSK and WKROUND have established that more of the Skagerrak area should be considered for inclusion in the IBTS standard areas for abundance indices. The data sets were prepared for the meeting but significant differences in the values calculated for the standard area and the extended area were recorded for 2009. Until this is examined in detail the new indices could not be applied.

The B-ADAPT model was developed to correct for retrospective bias by estimating the quantity of additional "unallocated removals" that would be required to be added or removed from the catch-at-age data in order to remove any persistent trends in survey catchability. The unallocated removals figures given by B-ADAPT could potentially include components due to increased natural mortality and discarding as well as misreported landings.

The estimates of bias can also be influenced by any trends in survey catchability or outlying values, particularly where the calibration period surveys are noisy at the oldest and youngest ages. For this reason, the bootstrap percentiles are used to provide stock and exploitation trends and the estimated values should not be over-interpreted.

Values for natural mortality have been updated this year ,they are smoothed annual model estimates from a multi-species VPA fitted by the Multi-species WG in 2007. The maturity are constant by year at values were estimated using the International Bottom trawl Survey series 1981-1985. These values were derived for the North Sea.

14.11 Status of the Stock

The status of the stock cannot be determined at this stage because of residual trends for recent years in the update assessment, possibly due to uncertainty in the compilation of the 2009 IBTS Q3 indices, highlighted by the absence of Norway from the sampling programme in 2009. Further analysis will be undertaken in order to determine a suitable index for the assessment of the stock to be used in the October update.

14.12 Management Considerations

Although the current SSB and fishing mortality are uncertain, it is clear that the stock has begun to recover from the low levels to which it was reduced in early 2000, at which recruitment was impaired and the biological dynamics of the stock difficult to predict.

In recent years, emergency measures have been taken and a recovery plan implemented with the aim of reversing the declining trend in SSB and increasing the spawning stock above Blim. These measures have contributed to a reduction in fishing mortality and a rebuilding of SSB.

There is a need to reduce fishing induced mortality on North Sea cod further , particularly for younger ages, in order to allow more fish to reach maturity and increase the probability of good recruitment. This could be achieved by reducing discarding which in 2008 was estimated to be at the same level as or exceeding landings mortality. In the last three years highgrading of cod has increased substantially. In 2009, 93% of 1 year old, 62% of 2 year old, 34% of 3 year old and 18% of 4 year old cod (the 2005 year class) were discarded.

Because the fishery is at present so dependent on incoming year classes, fishing mortalities on these year classes are high, and only 12% of 2 year olds currently survive to maturity (compared to 22% in the early 1960s). At the same time, the unbalanced age structure of the stock reduces its reproductive capacity even if a sufficient SSB were reached, as first-time spawners reproduce less successfully than older fish. Both factors are believed to have contributed to the reduction in recruitment of cod.

The recruitment of the relatively more abundant year class to the fishery may have no beneficial effect on the stock if they are caught and heavily discarded. In 2006, the 2005 year class comprised 62% of the total catch by number, in 2007 it comprised 55%, in 2008 33% and in 2009 11%. The last substantial year class to enter the fishery was the 1996 year class. This year class was a prominent feature in all surveys, was heavily exploited and discarded by the fishery at ages 1-5, and disappeared relatively quickly from the fishery.

French fishers have been reporting substantial discards of undersize cod in the eastern Channel (VIId) in 2007 and early 2008. Relatively large numbers of the 2006 year class were first observed as 0-group fish in several surveys in the eastern Channel and southern North Sea. This year class has been observed again in large numbers as age 2 fish in the French groundfish survey in eastern Channel, and by French fishers targeting cuttlefish in this area. This appears to be a localised phenomenon, since this 2006 year class is estimated to be poor, based on the North Sea IBTS Q1 and Q3 surveys.

Several nations who make substantial landings of cod do not supply the WG with estimates of discards, despite the requirement to do so according to EU data collection regulations. In order to improve the quality of the assessment, and hence management advice, these nations should be encouraged to do so.

Recent measures to improve survival of young cod, such as the Scottish Credit Conservation Scheme, and increased uptake of more selective gear such as the Eliminator Trawl, should be encouraged. .

The reported landings in 2009 were 30 800 t and the estimated discards in 2009 were 14 600 t, giving a total of 45 400 t. Surveys indicate that the year classes are depleting faster than one would expect from these catches and point to unaccounted removals. There is no documented information on the source of these unaccounted removals; while it is assumed that these removals originate mostly from fishing activities, changes in natural mortality may also have an influence. Their magnitude is difficult to predict in the future. Plausible fishery-based contributions to these unaccounted removals are discards that do not count against quota, and the mis- and underreporting of catches. The recent recorded landings (2005-2009) have fluctuated between 30% and 55% of the total removals. This indicates that the management system does not control the catches effectively.

Cod are taken by towed gears in mixed demersal fisheries, which include haddock, whiting, Nephrops, plaice, and sole. They are also taken in directed fisheries using fixed gears.

Cod catch in Division VIId is managed by a TAC for Divisions VIIb-k,VIII, IX, X, and CECAF 34.1.1, (i.e. the TAC covers a small proportion of the North Sea cod stock together with cod in Divisions VIIe-k). Division VIId was allocated a separate TAC from 2009 onwards which was adjusted inline with the revision to the North Sea TAC.

It is considered that conclusions drawn from the trends in the historic stock dynamics are robust to the uncertainty in the level of recent recorded catches.

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Table 14.1 Nominal landings (in tons) of COD in IIIa (Skagerrak), IV and VIId, 1991-2009 as officially reported to ICES, and as used by the Working Group.

Sub-area IV

Country	1991	1992	1993	1994	1995	1996	1997	1998	1999
Belgium	2,331	3,356	3,374	2,648	4,827	3,458	4,642	5,799	3,882
Denmark	18,997	18,479	19,547	19,243	24,067	23,573	21,870	23,002	19,697
Faroe Islands	23	109	46	80	219	44	40	102	96
France	975	2,146	1,868	1,868	3,040	1,934	3,451	2,934	.
Germany	7,278	8,446	6,800	5,974	9,457	8,344	5,179	8,045	3,386
Greenland	-	-	-	-	-	-	-	-	-
Netherlands	6,831	11,133	10,220	6,512	11,199	9,271	11,807	14,676	9,068
Norway	6,022	10,476	8,742	7,707	7,111	5,869	5,814	5,823	7,432
Poland	15	-	-	-	-	18	31	25	19
Sweden	784	823	646	630	709	617	832	540	625
UK (E/W/NI)	14,249	14,462	14,940	13,941	14,991	15,930	13,413	17,745	10,344
UK (Scotland)	29,060	28,677	28,197	28,854	35,848	35,349	32,344	35,633	23,017
Total Nominal Catch	86,565	98,107	94,380	87,457	111,468	104,407	99,423	114,324	77,566
Unallocated landings	1,968	-758	10,200	7,066	8,555	2,161	2,746	7,779	826
WG estimate of total landings	**88,533**	**97,349**	**104,580**	**94,523**	**120,023**	**106,568**	**102,169**	**122,103**	**78,392**
Agreed TAC	**100,000**	**100,000**	**101,000**	**102,000**	**120,000**	**130,000**	**115,000**	**140,000**	**132,400**

Division VIId

Country	1991	1992	1993	1994	1995	1996	1997	1998	1999
Belgium	182	187	157	228	377	321	310	239	172
Denmark	-	1	-	9	-	-	-	-	-
France	.	2,079	1,771	2,338	3,261	2,808	6,387	7,788	.
Netherlands	-	2	-	-	-	-	-	19	3
UK (E/W/NI)	341	443	530	312	336	414	478	618	454
UK (Scotland)	2	22	2	<0.5	<0.5	4	3	1	-
Total Nominal Catch	525	2,734	2,460	2,887	3,974	3,547	7,178	8,665	629
Unallocated landings	1,361	-65	-28	-37	-10	-44	-135	-85	6,229
WG estimate of total landings	**1,886**	**2,669**	**2,432**	**2,850**	**3,964**	**3,503**	**7,043**	**8,580**	**6,858**

Division IIIa (Skagerrak)**

Country	1991	1992	1993	1994	1995	1996	1997	1998	1999
Denmark	10,294	11,187	11,994	11,921	15,888	14,573	12,159	12,339	8,682
Germany	3	-	530	399	285	259	81	54	54
Norway	924	1,208	1,043	850	1,039	1,046	1,323	1,293	1,146
Sweden	3,846	2,523	2,575	1,834	2,483	1,986	2,173	1,900	1,909
Others	38	102	88	71	134	-	-	-	-
Norwegian coast *	854	923	909	760	846	748	911	976	788
Danish industrial by-catch *	953	1,360	511	666	749	676	205	97	62
Total Nominal Catch	15,105	15,020	16,230	15,075	19,829	17,864	15,736	15,586	11,791
Unallocated landings	-3,046	-1,018	-1,493	-1,814	-7,720	-1,615	-790	-255	-817
WG estimate of total landings	**12,059**	**14,002**	**14,737**	**13,261**	**12,109**	**16,249**	**14,946**	**15,331**	**10,974**
Agreed TAC	**15,000**	**15,000**	**15,000**	**15,500**	**20,000**	**23,000**	**16,100**	**20,000**	**19,000**

Sub-area IV, Divisions VIId and IIIa (Skagerrak) combined

	1991	1992	1993	1994	1995	1996	1997	1998	1999
Total Nominal Catch	102,195	115,861	113,070	105,419	135,271	125,818	122,337	138,575	89,986
Unallocated landings	283	-1,841	8,679	5,215	825	502	1,821	7,439	6,239
WG estimate of total landings	**102,478**	**114,020**	**121,749**	**110,634**	**136,096**	**126,320**	**124,158**	**146,014**	**96,225**

** Skaggerak/Kattegat split derived from national statistics

* The Danish industrial by-catch and the Norwegian coast catches are not included in the (WG estimate of) total landings of Division IIIa

. Magnitude not available - Magnitude known to be nil <0.5 Magnitude less than half the unit used in the table n/a Not applicable

Division IIIa (Skagerrak) landings not included in the assessment

Country	1991	1992	1993	1994	1995	1996	1997	1998	1999
Norwegian coast *	854	923	909	760	846	748	911	976	788
Danish industrial by-catch *	953	1,360	511	666	749	676	205	97	62
Total	**1,807**	**2,283**	**1,420**	**1,426**	**1,595**	**1,424**	**1,116**	**1,073**	**850**

Table 14.1 cont. Nominal landings (in tons) of COD in IIIa (Skagerrak), IV and VIId, 1991-2009 as officially reported to ICES, and as used by the Working Group.

Sub-area IV									
Country	2001	2002	2003	2004	2005	2006	2007	2008	2009
Belgium	2,470	2,616	1,482	1,627	1,722	1,309	1,009	894	924
Denmark	8,358	9,022	4,676	5,889	6,291	5,105	3,430	3,831	4,406
Faroe Islands	9	34	36	37	34	3	-	16	.
France	717	1,777	620	294	664	354	659	573	.
Germany	1,810	2,018	2,048	2,213	2,648	2,537	1,899	1,736	2,374
Greenland	-	-	-	-	35	23	17	.	.
Netherlands	3,574	4,707	2,305	1,726	1,660	1,585	1,523	1,896	3,297
Norway	4,369	5,217	4,417	3,223	2,900	2,749	3,057	4,128	4,234
Poland	18	39	35	-	-	-	1	2	3
Sweden	661	463	252	240	319	309	387	439	378
UK (E/W/NI)	4,087	3,112	2,213	1,890	1,270	1,491	1,587	1,546	.
UK (Scotland)	15,640	15,416	7,852	6,650	4,936	6,857	6,511	7,185	.
UK (combined)	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	11,403
Others	-	-	-	-	-	786	.	.	.
Norwegian indust by-catch *	.	.	.	.	.	48	101	22	4
Danish industrial by-catch *	.	.	.	.	.	34	18	46	76
Total Nominal Catch	41,713	44,421	25,936	23,789	22,479	23,108	20,080	22,246	27,019
Unallocated landings	-740	-121	-89	-240	1,391	-915	-397	-51	-1,361
WG estimate of total landings	**40,973**	**44,300**	**25,847**	**23,549**	**23,870**	**22,193**	**19,683**	**22,195**	**25,658**
Agreed TAC	**48,600**	**49,300**	**27,300**	**27,300**	**27,300**	**23,205**	**19,957**	**22,152**	**28,798**

Division VIId									
Country	2001	2002	2003	2004	2005	2006	2007	2008	2009
Belgium	93	51	54	47	51	80	84	154	71
Denmark	-	-	-	-	-	-	-	.	.
France	1,677	1,361	1,730	810	986	1,124	1,743	1,326	.
Netherlands	17	6	36	14	9	9	59	30	44
UK (E/W/NI)	249	145	121	103	184	267	175	144	.
UK (Scotland)	-	-	-	-	-	1	12	7	.
UK (conbined)	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	134
Total Nominal Catch	2,036	1,563	1,941	974	1,230	1,481	2,073	1,661	250
Unallocated landings	-463	1,534	-707	-167	-197	-354	-333	-307	996
WG estimate of total landings	**1,573**	**3,097**	**1,234**	**807**	**1,033**	**1,127**	**1,740**	**1,354**	**1,246**
Agreed TAC									**1,678**

Division IIIa (Skagerrak)**									
Country	2001	2002	2003	2004	2005	2006	2007	2008	2009
Denmark	5,870	5,511	3,054	3,009	2,984	2,478	2,228	2,534	3,018
Germany	32	83	49	99	86	84	67	52	44
Norway	762	645	825	856	759	628	681	779	440
Sweden	1,035	897	510	495	488	372	370	365	459
Others	-	-	27	24	21	373	385	13	2
Norwegian coast *	846	.	.	720	759	524	494	498	342
Danish industrial by-catch *	687	.	.	10	18	9	.	-	1
Total Nominal Catch	7,699	7,136	4,465	4,483	4,338	3,935	3,731	3,743	3,963
Unallocated landings	-613	332	-674	-696	-533	-569	-785	-445	-85
WG estimate of total landings	**7,086**	**7,468**	**3,791**	**3,787**	**3,805**	**3,366**	**2,946**	**3,298**	**3,878**
Agreed TAC	**7,000**	**7,100**	**3,900**	**3,900**	**3,900**	**3,315**	**2,851**	**3,165**	**4,114**

Sub-area IV, Divisions VIId and IIIa (Skagerrak) combined									
	2001	2002	2003	2004	2005	2006	2007	2008	2009
Total Nominal Catch	51,448	53,120	32,342	29,246	28,047	28,524	25,884	27,650	31,232
Unallocated landings	-1,816	1,745	-1,470	-1,103	661	-1,838	-1,515	-803	-450
WG estimate of total landings	**49,632**	**54,865**	**30,872**	**28,143**	**28,708**	**26,686**	**24,369**	**26,847**	**30,781**

** Skaggerak/Kattegat split derived from national statistics

* The Danish and Norwegian industrial by-catch and the Norwegian coast catches are not included in the (WG estimate of) total landings

. Magnitude not available - Magnitude known to be nil <0.5 Magnitude less than half the unit used in the table n/a Not applicable

Division IV and IIIa (Skagerrak) landings not included in the assessment									
Country	2001	2002	2002	2004	2003	2006	2007	2008	2009
Norwegian coast *	846	.	.	720	759	524	494	498	342
Norwegian indust by-catch *	.	.	.	.	.	48	101	22	4
Danish industrial by-catch *	687	.	.	10	18	43	18	46	77
Total	**1,533**	**.**	**.**	**730**	**777**	**615**	**613**	**566**	**423**

Table 14.2 Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId. Landings numbers at age (Thousands).

Landings numbers at age (thousands)

AGE/YEAR	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973
1	3214	5029	15813	18224	10803	5829	2947	54493	44824	3832	25966
2	42591	22486	51888	62516	70895	83836	22674	33917	155345	187686	31755
3	7030	20104	17645	29845	32693	42586	31578	18488	17219	48126	54931
4	3536	4306	9182	6184	11261	12392	13710	13339	6754	5682	14072
5	2788	1917	2387	3379	3271	6076	4565	6297	7101	2726	2206
6	1213	1818	950	1278	1974	1414	2895	1763	2700	3201	1109
7	81	599	658	477	888	870	588	961	893	1680	1060
8	492	118	298	370	355	309	422	209	458	612	489
9	14	94	51	126	138	151	147	186	228	390	80
10	6	12	75	56	40	111	46	98	77	113	58
+gp	0	4	8	83	17	24	78	40	94	18	162
TOTALNUM	60965	56486	98957	122538	132335	153600	79651	129791	235691	254064	131888
TONSLAND	116457	126041	181036	221336	252977	288368	200760	226124	328098	353976	239051
SOPCOF %	100	100	100	100	100	100	100	100	100	100	100

AGE/YEAR	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
1	15562	33378	5724	75413	29731	34837	62605	20279	66777	25733	64751
2	58920	47143	100283	51118	175727	91697	104708	189007	65299	129632	66428
3	11404	18944	18574	25621	17258	44653	35056	34821	60411	21662	31276
4	15824	4663	6741	4615	9440	4035	12316	9019	9567	11900	4264
5	4624	7563	1741	2294	3003	3395	1965	4118	3476	2830	3436
6	961	2067	3071	836	1108	712	1273	785	2065	1258	1019
7	438	449	924	1144	410	398	495	604	428	595	437
8	395	196	131	371	405	140	197	134	236	181	244
9	332	229	67	263	153	158	74	65	78	90	60
10	81	95	63	26	36	42	55	37	27	28	45
+gp	189	63	43	96	44	17	25	21	16	23	20
TOTALNUM	108729	114791	137361	161797	237314	180085	218770	258889	208380	193932	171978
TONSLAND	214279	205245	234169	209154	297022	269973	293644	335497	303251	259287	228286
SOPCOF %	100	100	100	100	100	101	100	100	99	100	100

AGE/YEAR	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
1	8845	100239	24915	21480	22239	11738	13466	27668	4783	15557	15717
2	118047	32437	128282	55330	36358	54290	23456	32059	55272	25279	63586
3	18995	34109	9800	43955	18193	11906	16776	8682	11360	21144	12943
4	7823	5814	8723	3134	9866	4339	3310	5007	3190	3083	5301
5	1377	2993	1534	2557	1002	2468	1390	1060	1577	870	802
6	1265	604	1075	655	1036	310	1053	491	435	519	286
7	373	556	235	295	251	310	225	329	204	142	151
8	173	171	215	66	140	54	139	52	108	58	42
9	79	69	55	63	27	60	28	40	18	32	15
10	16	44	48	23	31	12	4	17	10	7	13
+gp	31	23	12	18	10	9	10	9	13	16	5
TOTALNUM	157022	177058	174895	127577	89153	85496	59857	75415	76970	66706	98861
TONSLAND	214629	204053	216212	184240	139936	125314	102478	114020	121749	110634	136096
SOPCOF %	100	101	100	100	100	99	100	99	99	99	98

AGE/YEAR	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
1	4938	23769	1255	5941	8294	2220	7192	400	1589	1502	1906
2	36805	29194	81737	9731	23033	20832	7870	9615	4083	8210	4931
3	23364	18646	16958	32224	6472	6200	13252	3511	4949	2865	4447
4	3169	6499	5967	4034	6697	1142	2519	2660	1965	1628	1015
5	1860	1238	2402	1446	1021	1080	366	449	988	474	471
6	399	700	509	626	385	144	349	66	150	392	151
7	162	153	236	223	139	84	51	49	43	44	116
8	88	47	41	91	40	27	31	13	23	11	22
9	43	14	16	14	18	14	13	7	8	8	4
10	4	15	4	10	5	6	5	3	3	2	2
+gp	8	10	12	2	1	1	0	1	0	0	0
TOTALNUM	70837	80285	109137	54342	46105	31750	31649	16774	13800	15135	13064
TONSLAND	126320	124158	146014	96225	71371	49694	54865	30872	28188	28708	26590
SOPCOF %	100	100	100	100	100	100	100	102	100	100	103

AGE/YEAR	2007	2008	2009
1	1241	556	649
2	6852	3400	4458
3	2443	4293	2826
4	1532	1064	2654
5	307	697	498
6	114	170	235
7	39	70	48
8	36	30	32
9	6	21	14
10	1	4	8
+gp	0	3	3
TOTALNUM	12573	10307	11424
TONSLAND	24433	26847	30782
SOPCOF %	100	99	99

Table 14.3 Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId. Discard numbers at age (Thousands).

Discards numbers at age (thousands)

AGE/YEAR	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973
1	16231	8089	98414	108921	50467	31272	2515	53225	260226	38442	86349
2	20003	6199	6632	22236	24861	23073	10331	8700	37412	59641	17475
3	33	116	90	71	160	198	113	153	47	178	247
4	0	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0	0	0	0
+gp	0	0	0	0	0	0	0	0	0	0	0
TOTALNUM	36267	14404	105136	131229	75489	54542	12959	62078	297686	98261	104071
TONSDISC	12247	4731	29251	38109	23438	17575	4816	17928	84392	33848	30190
SOPCOF %	100	101	100	100	100	100	101	101	100	100	100

AGE/YEAR	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
1	124777	137341	227925	474377	29043	584603	1189692	156878	183476	55478	540795
2	15958	16296	83630	48189	78477	5302	17751	34559	8448	11237	12594
3	71	0	193	466	0	0	0	80	99	25	5
4	0	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0	0	0	0
+gp	0	0	0	0	0	0	0	0	0	0	0
TOTALNUM	140807	153637	311747	523032	107520	589904	1207444	191516	192022	66740	553394
TONSDISC	39807	37060	72840	139820	32583	163279	295449	57897	54501	22101	151923
SOPCOF %	100	100	100	100	100	100	100	101	100	102	100

AGE/YEAR	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
1	63659	565753	24732	15461	178265	34194	48110	104321	34112	324703	45425
2	36780	5784	62194	17179	8751	48699	8495	10065	29119	17012	44083
3	115	305	0	218	492	79	454	2	12	162	30
4	0	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0	0	0	0
+gp	0	0	0	0	0	0	0	0	0	0	0
TOTALNUM	100555	571842	86927	32858	187508	82972	57059	114388	63242	341877	89539
TONSDISC	31503	139081	27839	10714	62119	27022	18552	36920	21860	99578	32188
SOPCOF %	100	100	100	101	100	100	101	100	100	100	100

AGE/YEAR	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
1	14451	87308	15608	31550	37981	5600	13373	8511	11865	11290	26690
2	23376	13892	91140	5737	5650	33946	2622	9976	4661	5673	5563
3	774	41	1514	8437	0	773	1972	1118	1158	108	804
4	0	0	0	0	0	0	0	69	0	19	53
5	0	0	0	0	0	0	0	11	0	4	12
6	0	0	0	0	0	0	0	2	0	3	2
7	0	0	0	0	0	0	0	1	0	0	1
8	0	0	0	0	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0	0	0	0
+gp	0	0	0	0	0	0	0	0	0	0	0
TOTALNUM	38601	101241	108262	45725	43631	40319	17967	19688	17684	17097	33126
TONSDISC	14255	33616	40480	14180	13713	13871	5706	6372	5849	6272	8050
SOPCOF %	100	100	100	102	100	100	100	101	102	103	102

AGE/YEAR	2007	2008	2009
1	14622	8384	8947
2	20183	9165	7203
3	1506	7474	1482
4	371	149	601
5	49	21	36
6	25	13	16
7	0	0	8
8	2	3	0
9	0	0	0
10	0	0	2
+gp	0	0	0
TOTALNUM	36757	25210	18295
TONSDISC	23636	21814	14593
SOPCOF %	100	100	101

Table 14.4 Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId. Landings weights at age (kg).

Landings weights at age (kg)

AGE/YEAR	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973
1	0.538	0.496	0.581	0.579	0.590	0.640	0.544	0.626	0.579	0.616	0.559
2	1.004	0.863	0.965	0.994	1.035	0.973	0.921	0.961	0.941	0.836	0.869
3	2.657	2.377	2.304	2.442	2.404	2.223	2.133	2.041	2.193	2.086	1.919
4	4.491	4.528	4.512	4.169	3.153	4.094	3.852	4.001	4.258	3.968	3.776
5	6.794	6.447	7.274	7.027	6.803	5.341	5.715	6.131	6.528	6.011	5.488
6	9.409	8.520	9.498	9.599	9.610	8.020	6.722	7.945	8.646	8.246	7.453
7	11.562	10.606	11.898	11.766	12.033	8.581	9.262	9.953	10.356	9.766	9.019
8	11.942	10.758	12.041	11.968	12.481	10.162	9.749	10.131	11.219	10.228	9.810
9	13.383	12.340	13.053	14.060	13.589	10.720	10.384	11.919	12.881	11.875	11.077
10	13.756	12.540	14.441	14.746	14.271	12.497	12.743	12.554	13.147	12.530	12.359
+gp	0.000	18.000	15.667	15.672	19.016	11.595	11.175	14.367	15.544	14.350	12.886

AGE/YEAR	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
1	0.594	0.619	0.568	0.541	0.573	0.550	0.550	0.723	0.589	0.632	0.594
2	1.039	0.899	1.029	0.948	0.937	0.936	1.003	0.837	0.962	0.919	1.007
3	2.217	2.348	2.470	2.160	2.001	2.411	1.948	2.190	1.858	1.835	2.156
4	4.156	4.226	4.577	4.606	4.146	4.423	4.401	4.615	4.130	3.880	3.972
5	6.174	6.404	6.494	6.714	6.530	6.579	6.109	7.045	6.785	6.491	6.190
6	8.333	8.691	8.620	8.828	8.667	8.474	9.120	8.884	8.903	8.423	8.362
7	9.889	10.107	10.132	10.071	9.685	10.637	9.550	9.933	10.398	9.848	10.317
8	10.791	10.910	11.340	11.052	11.099	11.550	11.867	11.519	12.500	11.837	11.352
9	12.175	12.339	12.888	11.824	12.427	13.057	12.782	13.338	13.469	12.797	13.505
10	12.425	12.976	14.139	13.134	12.778	14.148	14.081	14.897	12.890	12.562	13.408
+gp	13.731	14.431	14.760	14.362	13.981	15.478	15.392	18.784	14.608	14.426	13.472

AGE/YEAR	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
1	0.590	0.583	0.635	0.585	0.673	0.737	0.670	0.699	0.699	0.677	0.721
2	0.932	0.856	0.976	0.881	1.052	0.976	1.078	1.146	1.065	1.075	1.021
3	2.141	1.834	1.955	1.982	1.846	2.176	2.038	2.546	2.479	2.201	2.210
4	4.164	3.504	3.650	3.187	3.585	3.791	3.971	4.223	4.551	4.471	4.293
5	6.324	6.230	6.052	5.992	5.273	5.931	6.082	6.247	6.540	7.167	7.220
6	8.430	8.140	8.307	7.914	7.921	7.890	8.033	8.483	8.094	8.436	8.980
7	10.362	9.896	10.243	9.764	9.724	10.235	9.545	10.101	9.641	9.537	10.282
8	12.074	11.940	11.461	12.127	11.212	10.923	10.948	10.482	10.734	10.323	11.743
9	13.072	12.951	12.447	14.242	12.586	12.803	13.481	11.849	12.329	12.223	13.107
10	14.443	13.859	18.691	17.787	15.557	15.525	13.171	13.904	13.443	14.247	12.052
+gp	16.588	14.707	16.604	16.477	14.695	23.234	14.989	15.794	13.961	12.523	13.954

AGE/YEAR	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
1	0.699	0.656	0.542	0.640	0.611	0.725	0.758	0.608	0.700	0.828	0.750
2	1.117	0.960	0.922	0.935	1.021	1.004	1.082	1.174	0.997	1.190	1.161
3	2.147	2.120	1.724	1.663	1.747	2.303	1.916	1.849	2.014	1.978	2.192
4	4.034	3.821	3.495	3.305	3.216	3.663	3.857	3.256	3.096	3.690	3.731
5	6.637	6.228	5.387	5.726	4.903	5.871	5.372	5.186	5.172	5.060	5.660
6	8.494	8.394	7.563	7.403	7.488	7.333	7.991	7.395	7.426	7.551	6.882
7	9.729	9.979	9.628	8.582	9.636	9.264	9.627	8.703	8.675	9.607	8.896
8	11.080	11.424	10.643	10.365	10.671	10.081	10.403	12.178	9.797	11.229	10.639
9	12.264	12.300	11.499	11.600	10.894	12.062	10.963	12.846	11.684	11.501	12.216
10	12.756	12.761	13.085	12.330	11.414	12.009	12.816	10.771	13.058	13.333	9.212
+gp	11.304	13.416	14.921	11.926	15.078	10.196	11.842	17.494	14.140	15.340	10.773

AGE/YEAR	2007	2008	2009
1	0.805	0.801	0.721
2	1.161	1.503	1.345
3	2.376	2.511	2.693
4	4.046	4.026	4.193
5	5.523	5.777	6.177
6	8.197	7.164	7.711
7	8.986	9.358	8.327
8	9.777	10.909	10.299
9	12.358	11.596	10.1
10	13.725	15.278	11.89
+gp	9.482	13.653	13.598

Table 14.5 Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId. Discard weights at age (kg).

Discards weights at age (kg)

AGE/YEAR	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973
1	0.270	0.270	0.269	0.269	0.269	0.269	0.268	0.268	0.268	0.268	0.268
2	0.393	0.393	0.392	0.392	0.392	0.392	0.392	0.392	0.392	0.392	0.392
3	0.505	0.508	0.506	0.509	0.506	0.505	0.504	0.505	0.508	0.507	0.507
4	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
5	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
6	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
7	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
8	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
9	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
10	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
+gp	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

AGE/YEAR	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
1	0.268	0.227	0.189	0.255	0.287	0.276	0.242	0.279	0.274	0.297	0.270
2	0.392	0.359	0.354	0.382	0.309	0.361	0.411	0.396	0.489	0.458	0.469
3	0.508	0.000	0.412	0.376	0.000	0.000	0.000	0.517	0.593	0.534	0.509
4	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
5	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
6	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
7	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
8	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
9	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
10	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
+gp	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

AGE/YEAR	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
1	0.276	0.242	0.237	0.300	0.326	0.260	0.315	0.314	0.274	0.287	0.316
2	0.376	0.365	0.353	0.339	0.431	0.371	0.366	0.408	0.429	0.362	0.404
3	0.652	0.437	0.000	0.463	0.484	0.526	0.395	2.309	0.705	0.483	0.553
4	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
5	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
6	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
7	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
8	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
9	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
10	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
+gp	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

AGE/YEAR	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
1	0.342	0.313	0.358	0.257	0.298	0.232	0.294	0.259	0.293	0.284	0.179
2	0.380	0.453	0.375	0.389	0.422	0.361	0.420	0.344	0.384	0.468	0.426
3	0.515	0.616	0.481	0.422	0.000	0.406	0.340	0.540	0.427	1.084	0.751
4	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.675	0.000	4.099	1.300
5	0.000	0.000	0.000	0.000	0.000	0.000	0.000	2.272	0.000	4.501	2.862
6	0.000	0.000	0.000	0.000	0.000	0.000	0.000	2.849	0.000	8.197	4.663
7	0.000	0.000	0.000	0.000	0.000	0.000	0.000	3.585	0.000	0.000	10.895
8	0.000	0.000	0.000	0.000	0.000	0.000	0.000	5.033	0.000	0.000	0.000
9	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
10	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
+gp	0.000	0.000	0.000	0.000	0.000	0.000	0.000	5.771	0.000	0.000	0.000

AGE/YEAR	2007	2008	2009
1	0.231	0.299	0.365
2	0.762	0.683	0.854
3	1.881	1.660	1.733
4	4.136	2.459	3.338
5	6.141	2.848	6.444
6	9.724	8.051	7.944
7	1.735	1.239	12.963
8	12.032	0.576	2.466
9	0.000	0.000	0
10	0.000	0.000	12.014
+gp	0.500	0.500	0.000

Table 14.6 Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId. Catch and stock weights at age (kg).

Catch weights at age (kg)

AGE/YEAF	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973
1	0.314	0.357	0.313	0.314	0.326	0.328	0.416	0.449	0.313	0.300	0.335
2	0.808	0.762	0.900	0.836	0.868	0.847	0.755	0.845	0.834	0.729	0.700
3	2.647	2.367	2.295	2.437	2.395	2.215	2.127	2.028	2.188	2.080	1.912
4	4.491	4.528	4.512	4.169	3.153	4.094	3.852	4.001	4.258	3.968	3.776
5	6.794	6.447	7.274	7.027	6.803	5.341	5.715	6.131	6.528	6.011	5.488
6	9.409	8.520	9.498	9.599	9.610	8.020	6.722	7.945	8.646	8.246	7.453
7	11.562	10.606	11.898	11.766	12.033	8.581	9.262	9.953	10.356	9.766	9.019
8	11.942	10.758	12.041	11.968	12.481	10.162	9.749	10.131	11.219	10.228	9.810
9	13.383	12.340	13.053	14.060	13.589	10.720	10.384	11.919	12.881	11.875	11.077
10	13.756	12.540	14.441	14.746	14.271	12.497	12.743	12.554	13.147	12.530	12.359
+gp	0.000	18.000	15.667	15.672	19.016	11.595	11.175	14.367	15.544	14.350	12.886

AGE/YEAF	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
1	0.304	0.304	0.199	0.295	0.432	0.291	0.258	0.329	0.358	0.403	0.304
2	0.901	0.760	0.722	0.673	0.743	0.905	0.917	0.769	0.908	0.882	0.921
3	2.206	2.348	2.449	2.128	2.001	2.411	1.948	2.186	1.856	1.833	2.156
4	4.156	4.226	4.577	4.606	4.146	4.423	4.401	4.615	4.130	3.880	3.972
5	6.174	6.404	6.494	6.714	6.530	6.579	6.109	7.045	6.785	6.491	6.190
6	8.333	8.691	8.620	8.828	8.667	8.474	9.120	8.884	8.903	8.423	8.362
7	9.889	10.107	10.132	10.071	9.685	10.637	9.550	9.933	10.398	9.848	10.317
8	10.791	10.910	11.340	11.052	11.099	11.550	11.867	11.519	12.500	11.837	11.352
9	12.175	12.339	12.888	11.824	12.427	13.057	12.782	13.338	13.469	12.797	13.505
10	12.425	12.976	14.139	13.134	12.778	14.148	14.081	14.897	12.890	12.562	13.408
+gp	13.731	14.431	14.760	14.362	13.981	15.478	15.392	18.784	14.608	14.426	13.472

AGE/YEAF	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
1	0.314	0.293	0.437	0.466	0.364	0.382	0.392	0.395	0.327	0.305	0.420
2	0.800	0.782	0.773	0.753	0.931	0.690	0.889	0.970	0.845	0.788	0.768
3	2.132	1.822	1.955	1.974	1.810	2.165	1.994	2.545	2.478	2.188	2.207
4	4.164	3.504	3.650	3.187	3.585	3.791	3.971	4.223	4.551	4.471	4.293
5	6.324	6.230	6.052	5.992	5.273	5.931	6.082	6.247	6.540	7.167	7.220
6	8.430	8.140	8.307	7.914	7.921	7.890	8.033	8.483	8.094	8.436	8.980
7	10.362	9.896	10.243	9.764	9.724	10.235	9.545	10.101	9.641	9.537	10.282
8	12.074	11.940	11.461	12.127	11.212	10.923	10.948	10.482	10.734	10.323	11.743
9	13.072	12.951	12.447	14.242	12.586	12.803	13.481	11.849	12.329	12.223	13.107
10	14.443	13.859	18.691	17.787	15.557	15.525	13.171	13.904	13.443	14.247	12.052
+gp	16.588	14.707	16.604	16.477	14.695	23.234	14.989	15.794	13.961	12.523	13.954

AGE/YEAF	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
1	0.433	0.386	0.372	0.317	0.354	0.372	0.456	0.275	0.341	0.348	0.217
2	0.831	0.797	0.633	0.732	0.903	0.605	0.916	0.752	0.671	0.895	0.771
3	2.095	2.117	1.622	1.405	1.747	2.093	1.712	1.533	1.713	1.945	1.972
4	4.034	3.821	3.495	3.305	3.216	3.663	3.857	3.191	3.096	3.695	3.610
5	6.637	6.228	5.387	5.726	4.903	5.871	5.372	5.113	5.172	5.055	5.590
6	8.494	8.394	7.563	7.403	7.488	7.333	7.991	7.270	7.426	7.555	6.848
7	9.729	9.979	9.628	8.582	9.636	9.264	9.627	8.630	8.675	9.607	8.911
8	11.080	11.424	10.643	10.365	10.671	10.081	10.403	12.056	9.797	11.229	10.639
9	12.264	12.300	11.499	11.600	10.894	12.062	10.963	12.846	11.684	11.501	12.216
10	12.756	12.761	13.085	12.330	11.414	12.009	12.816	10.771	13.058	13.333	9.212
+gp	11.304	13.416	14.921	11.926	15.078	10.196	11.842	17.351	14.140	15.340	10.773

AGE/YEAF	2007	2008	2009
1	0.276	0.330	0.389
2	0.863	0.904	1.042
3	2.187	1.971	2.363
4	4.064	3.834	4.035
5	5.607	5.692	6.195
6	8.467	7.228	7.727
7	8.917	9.321	8.98
8	9.902	9.879	10.212
9	12.358	11.596	10.1
10	13.725	15.278	11.916
+gp	8.154	13.295	13.598

Table 14.7a Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId. Proportion mature by age-group.

Age group	Proportion mature
1	0.01
2	0.05
3	0.23
4	0.62
5	0.86
6	1.0
7+	1.0

Table 14.7b Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId. Natural mortality by age-group.

	Age						
Year	1	2	3	4	5	6	7+
1963	0.78	0.42	0.33	0.22	0.21	0.22	0.2
1964	0.82	0.43	0.34	0.22	0.21	0.22	0.2
1965	0.85	0.44	0.35	0.22	0.21	0.22	0.2
1966	0.87	0.45	0.36	0.22	0.21	0.22	0.2
1967	0.89	0.46	0.37	0.22	0.21	0.22	0.2
1968	0.91	0.46	0.37	0.22	0.21	0.22	0.2
1969	0.92	0.47	0.38	0.22	0.21	0.22	0.2
1970	0.92	0.47	0.38	0.22	0.21	0.22	0.2
1971	0.92	0.47	0.38	0.22	0.21	0.23	0.2
1972	0.93	0.47	0.38	0.22	0.21	0.23	0.2
1973	0.92	0.46	0.38	0.22	0.21	0.23	0.2
1974	0.92	0.46	0.37	0.22	0.21	0.23	0.2
1975	0.92	0.45	0.37	0.22	0.21	0.23	0.2
1976	0.92	0.45	0.37	0.22	0.21	0.23	0.2
1977	0.92	0.44	0.36	0.22	0.22	0.23	0.2
1978	0.92	0.43	0.36	0.23	0.22	0.23	0.2
1979	0.92	0.43	0.36	0.23	0.22	0.24	0.2
1980	0.91	0.42	0.36	0.23	0.22	0.24	0.2
1981	0.9	0.41	0.36	0.23	0.22	0.24	0.2
1982	0.89	0.41	0.36	0.23	0.22	0.24	0.2
1983	0.87	0.4	0.36	0.23	0.22	0.25	0.2
1984	0.85	0.39	0.36	0.23	0.22	0.25	0.2
1985	0.83	0.38	0.36	0.23	0.23	0.25	0.2
1986	0.81	0.38	0.36	0.23	0.23	0.26	0.2
1987	0.79	0.37	0.36	0.24	0.23	0.26	0.2
1988	0.77	0.36	0.37	0.24	0.23	0.27	0.2
1989	0.75	0.35	0.37	0.24	0.24	0.28	0.2
1990	0.73	0.35	0.38	0.24	0.24	0.28	0.2
1991	0.72	0.34	0.39	0.25	0.24	0.29	0.2
1992	0.7	0.34	0.4	0.25	0.25	0.3	0.2
1993	0.7	0.34	0.41	0.26	0.25	0.31	0.2
1994	0.69	0.33	0.42	0.26	0.25	0.31	0.2
1995	0.68	0.33	0.43	0.26	0.26	0.32	0.2
1996	0.67	0.32	0.44	0.27	0.26	0.33	0.2
1997	0.65	0.31	0.44	0.27	0.26	0.34	0.2
1998	0.63	0.31	0.45	0.27	0.27	0.34	0.2
1999	0.61	0.3	0.45	0.27	0.27	0.34	0.2
2000	0.58	0.29	0.44	0.27	0.27	0.35	0.2
2001	0.56	0.29	0.44	0.27	0.27	0.35	0.2
2002	0.53	0.28	0.43	0.27	0.27	0.35	0.2
2003	0.51	0.28	0.42	0.27	0.27	0.34	0.2
2004	0.5	0.27	0.41	0.27	0.27	0.34	0.2
2005	0.49	0.27	0.4	0.26	0.26	0.34	0.2
2006	0.47	0.27	0.39	0.26	0.26	0.33	0.2
2007	0.46	0.26	0.38	0.26	0.26	0.33	0.2
2008*	0.46	0.26	0.38	0.26	0.26	0.33	0.2
2009*	0.46	0.26	0.38	0.26	0.26	0.33	0.2

***No new keyrun was carried out in these years by WGSAM, so 2008-9 values are set equal to the 2007 values. This implicitly assumes that cannibalism is still at the same magnitude as in 2007. The next WGSAM keyrun is due in October 2010 (for years up to 2009).**

Table 14.8 Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId. Survey tuning CPUE. Data used in the assessment are highlighted in bold text

North Sea/Skagerrak/Eastern Channel Cod, Tuning data for extended survey. Updated 06 May 10
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IBTS_Q1_std, 6 is a plusgroup

1983	2010					
1	1	0	0.25			
1	5					
1	**4.734**	**16.699**	**2.749**	**1.932**	**0.798**	1.357
1	**15.856**	**8.958**	**4.059**	**0.905**	**0.976**	0.875
1	**0.928**	**18.782**	**3.217**	**1.744**	**0.476**	0.930
1	**16.785**	**3.627**	**7.079**	**2.242**	**1.280**	0.967
1	**9.425**	**28.833**	**1.515**	**1.789**	**0.636**	0.819
1	**5.638**	**6.334**	**6.204**	**0.658**	**0.860**	1.127
1	**15.117**	**6.328**	**5.044**	**2.345**	**0.394**	0.992
1	**3.953**	**15.665**	**1.885**	**1.034**	**0.967**	0.619
1	**2.481**	**4.714**	**4.254**	**0.861**	**0.420**	0.771
1	**13.129**	**4.346**	**1.183**	**0.996**	**0.288**	0.483
1	**13.088**	**19.521**	**2.025**	**0.688**	**0.565**	0.377
1	**14.660**	**4.387**	**2.876**	**0.815**	**0.483**	0.521
1	**9.832**	**22.062**	**2.731**	**1.105**	**0.276**	0.335
1	**3.441**	**7.970**	**5.922**	**0.679**	**0.639**	0.384
1	**39.951**	**6.897**	**2.247**	**1.069**	**0.458**	0.417
1	**2.672**	**26.368**	**2.003**	**0.884**	**0.505**	0.392
1	**2.112**	**1.583**	**8.078**	**0.764**	**0.439**	0.495
1	**6.563**	**3.767**	**0.738**	**2.050**	**0.387**	0.504
1	**2.786**	**8.647**	**1.659**	**0.231**	**0.394**	0.262
1	**7.755**	**3.380**	**4.278**	**0.496**	**0.119**	0.218
1	**0.584**	**2.860**	**1.144**	**1.361**	**0.514**	0.192
1	**6.740**	**1.985**	**1.288**	**0.347**	**0.432**	0.224
1	**2.272**	**2.197**	**0.629**	**0.551**	**0.227**	0.424
1	**6.642**	**1.644**	**0.994**	**0.293**	**0.152**	0.270
1	**3.091**	**5.830**	**1.222**	**0.423**	**0.261**	0.286
1	**2.694**	**1.261**	**2.498**	**0.579**	**0.400**	0.164
1	**1.230**	**2.772**	**0.928**	**0.925**	**0.301**	0.254
1	**4.800**	**3.702**	**1.485**	**0.487**	**0.474**	0.235

IBTS_Q3_std, 6 is a plusgroup

1991	2009						
1	1	0.5	0.75				
0	4						
1	29.207	**8.170**	**2.438**	**1.164**	**0.164**	0.066	0.069
1	19.591	**43.487**	**3.596**	**0.737**	**0.457**	0.153	0.136
1	16.288	**10.473**	**7.903**	**0.861**	**0.183**	0.136	0.061
1	16.112	**42.737**	**6.155**	**2.389**	**0.213**	0.082	0.073
1	10.864	**22.282**	**17.419**	**1.468**	**0.762**	0.068	0.070
1	68.916	**10.283**	**5.327**	**1.833**	**0.390**	0.183	0.036
1	0.130	**60.518**	**5.471**	**1.659**	**0.636**	0.130	0.125
1	91.708	**2.397**	**20.057**	**1.294**	**0.386**	0.235	0.117
1	9.543	**11.952**	**0.961**	**3.863**	**0.291**	0.089	0.037
1	1.845	**10.689**	**2.294**	**0.205**	**0.523**	0.075	0.090
1	4.669	**4.723**	**5.533**	**0.792**	**0.150**	0.153	0.145
1	0.767	**11.334**	**2.117**	**1.557**	**0.439**	0.100	0.046
1	12.854	**1.735**	**2.475**	**0.516**	**0.483**	0.401	0.504
1	2.287	**12.178**	**1.703**	**1.088**	**0.202**	0.143	0.046
1	13.755	**4.745**	**2.062**	**0.622**	**0.218**	0.049	0.124
1	7.329	**15.215**	**1.890**	**1.252**	**0.219**	0.044	0.059
1	8.105	**9.101**	**6.154**	**0.983**	**0.344**	0.137	0.122
1	1.384	**9.228**	**3.311**	**3.003**	**0.532**	0.206	0.109
1	1.834	**6.926**	**2.648**	**0.684**	**0.625**	0.122	0.141

Table 14.9a Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId. B-ADAPT base run tuning model specification

Lowestoft VPA Program
8/05/2010 13:17
Adapt Analysis
North Sea/Skagerrak Tuning data. INCLUDES DISCARDS

CPUE data from file Cod347_2010_std.tun

Catch data for 47 years : 1963 to 2009. Ages 1 to 7+

Fleet	First year	Last year	First age	Last age	Alpha	Beta
IBTS_Q1_std	1983	2010	1	5	0	0.25
IBTS_Q3_std	1991	2009	1	4	0.5	0.75

Time series weights :

Tapered time weighting not applied

Catchability analysis :

Fleet	PowerQ ages<x	QPlateau ages>x
IBTS_Q1_std	1	5
IBTS_Q3_std	1	3

Catchability independent of stock size for all ages

Bias estimation : Bias estimated for the final 17 years.
Oldest age F estimates in 1963 to 2010 calculated as 1.000 * the mean F of ages 3- 5
Total catch penalty: lambda = 0.500

Individual fleet weighting not applied

INITIAL SSQ =	41.97547	SSQ =	28.27963	IFAIL =	3
PARAMETERS =	22	QSSQ =	27.51961	IFAILCV = 0	
OBSERVATIONS =	233	CSSQ =	0.76002		

Table 14.9b Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId. B-ADAPT base run IBTSQ1 tuning diagnostics

Fleet : IBTS_Q1_std

Log index residuals

Age	1983	1984	1985	1986	1987	1988	1989	1990
1	-0.69	-0.59	-1.75	-0.65	0.25	0.16	0.20	-0.01
2	0.11	0.03	0.16	-0.19	0.39	-0.22	0.21	0.48
3	0.00	-0.10	0.13	0.40	0.00	0.08	0.68	0.04
4	-0.12	0.06	0.06	0.76	0.09	0.10	0.27	0.18
5	-0.09	-0.11	0.03	0.32	0.22	0.05	0.28	0.11

Age	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1	-0.74	0.18	0.93	-0.24	0.16	-0.31	0.95	0.30	-0.50	0.11
2	0.18	-0.17	0.60	-0.28	0.38	-0.12	0.14	0.34	-0.40	0.02
3	0.46	-0.29	0.03	-0.21	0.05	0.27	-0.28	-0.29	0.37	-0.24
4	0.22	-0.03	0.02	0.18	-0.28	-0.22	-0.21	-0.20	0.01	0.60
5	-0.09	-0.29	0.02	0.43	-0.40	-0.15	0.11	-0.30	0.00	0.41

Age	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
1	0.43	0.84	-0.91	1.12	0.25	0.43	0.38	0.19	-0.50	99.99
2	0.14	0.20	-0.40	0.14	-0.35	-0.32	-0.06	-0.83	-0.19	0.25
3	0.14	0.27	-0.28	0.00	-0.34	-0.38	0.03	-0.26	-0.31	-0.07
4	-0.14	-0.23	0.20	-0.35	0.10	-0.26	-0.49	-0.05	-0.25	0.11
5	0.00	-0.20	0.67	-0.17	-0.08	-0.42	0.05	-0.09	-0.32	-0.15

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

Age	1	2	3	4	5
Mean Log	-10.7175	-9.601	-9.3593	-9.0851	-8.6503
S.E(Log q	0.6504	0.3219	0.2791	0.278	0.2643

Regression statistics :

Ages with q independent of year class strength and constant w.r.t. time.

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
1	1.16	-0.955	10.44	0.59	27	0.75461	-10.72
2	0.79	3.627	10.01	0.92	27	0.20971	-9.6
3	0.81	2.641	9.55	0.88	27	0.20345	-9.36
4	0.89	1.141	9.08	0.81	27	0.24591	-9.09
5	1.03	-0.307	8.67	0.77	27	0.27814	-8.65

Table 14.9c Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId. B-ADAPT base run IBTSQ3 tuning diagnostics

Fleet : IBTS_Q3_std

Log index residuals

Age	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1	-0.43	0.49	-0.24	0.04	0.04	-0.23	0.35	-0.79	0.31	-0.43
2	-0.21	-0.07	0.07	0.25	0.55	-0.15	0.09	0.46	-0.65	-0.19
3	-0.26	-0.27	-0.19	0.13	0.08	-0.18	0.00	-0.01	0.53	-0.78
4	-0.71	-0.07	-0.47	-0.48	0.11	0.03	0.02	-0.15	0.01	0.22
5	No data for this fleet at this age									

Age	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
1	-0.14	0.17	-0.79	0.64	-0.03	0.19	0.40	0.31	0.15	99.99
2	-0.09	-0.19	-0.12	0.12	-0.22	-0.05	0.11	0.35	-0.08	99.99
3	-0.11	-0.12	-0.42	0.38	0.17	0.31	0.23	0.51	0.00	99.99
4	0.15	0.51	0.01	-0.11	0.01	0.10	-0.05	0.48	0.19	99.99
5	No data for this fleet at this age									

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

Age	1	2	3	4
Mean Log	-9.2718	-9.2949	-9.301	-9.301
S.E(Log q)	0.4062	0.2771	0.3252	0.2995

Regression statistics :

Ages with q independent of year class strength and constant w.r.t. time.

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
1	0.9	0.861	9.55	0.82	19	0.36964	-9.27
2	0.82	2.696	9.67	0.93	19	0.19459	-9.29
3	0.86	1.144	9.43	0.8	19	0.27836	-9.3
4	1	-0.026	9.31	0.69	19	0.30927	-9.31

Table 14.9d Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId. B-ADAPT base run parameter estimates

Parameters			Variance covariance matrix																					
Age	Survivors	s.e log est	0.06	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1	47680	0.24	0.00	0.06	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	-0.01
2	21801	0.25	0.00	0.01	0.08	0.01	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01
3	4466	0.28	0.00	0.01	0.01	0.08	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01
4	3530	0.28	0.00	0.01	0.02	0.02	0.23	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	-0.04
5	1070	0.47	0.01	0.01	0.01	0.01	0.01	0.04	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
			0.00	0.00	0.00	0.00	0.00	0.00	0.05	-0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Year	Multiplier	s.e log est	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	0.04	-0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1993	1.20	0.20	0.00	0.00	0.00	0.00	0.00	0.01	0.00	-0.01	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1994	0.96	0.23	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.05	-0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1995	1.39	0.21	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	-0.01	0.04	-0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1996	1.43	0.20	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	-0.01	0.04	-0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1997	0.98	0.23	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	-0.01	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1998	1.07	0.19	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.05	-0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1999	1.23	0.20	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	0.05	-0.01	0.00	0.00	0.00	0.00	0.00	0.00
2000	1.13	0.19	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	0.04	0.00	0.00	0.00	0.00	0.00	0.00
2001	1.06	0.23	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.06	-0.01	0.00	0.00	0.00	0.00
2002	1.42	0.21	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	0.04	-0.01	0.00	0.00	0.00
2003	2.32	0.19	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	0.06	0.00	0.00	0.00
2004	1.29	0.23	0.00	0.01	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.06	-0.01	0.00
2005	1.71	0.21	0.00	0.01	0.00	0.00	-0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	0.05	-0.01
2006	1.41	0.24	0.00	-0.01	-0.01	-0.01	-0.04	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	0.07
2007	1.44	0.25																						
2008	1.82	0.22																						
2009	2.06	0.26																						

Table 14.10 Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId. B-ADAPT base run median fishing mortality at age.

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Table 8 Fishing mortality (F) at age

AGE\YEAR	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972
1	0.1180	0.0423	0.2771	0.2534	0.1305	0.1851	0.0286	0.1536	0.3147	0.2157
2	0.6451	0.4183	0.4529	0.6199	0.5633	0.6578	0.4593	0.6087	0.9088	0.9396
3	0.3690	0.5654	0.6420	0.5759	0.7007	0.7197	0.5520	0.6996	0.7367	0.8541
4	0.4839	0.4459	0.6163	0.5487	0.5045	0.7347	0.6164	0.5504	0.6972	0.6751
5	0.4063	0.5417	0.4880	0.4941	0.6517	0.5774	0.6857	0.6641	0.6613	0.7030
6	0.4197	0.5177	0.5821	0.5396	0.6189	0.6772	0.6180	0.6380	0.6984	0.7441
+gp	0.4197	0.5177	0.5821	0.5396	0.6189	0.6772	0.6180	0.6380	0.6984	0.7441
FBAR 2- 4	0.4993	0.4765	0.5704	0.5815	0.5895	0.7041	0.5426	0.6196	0.7809	0.8229

AGE\YEAR	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
1	0.3538	0.4723	0.2849	0.5882	0.5534	0.1499	0.8930	1.0001	0.5506	0.4646
2	0.8401	0.8581	0.8182	1.2282	1.1762	1.1723	0.7565	0.8993	1.0053	0.9407
3	0.7763	0.6385	0.7488	0.8409	0.7481	0.8960	0.8941	0.9352	0.9583	1.1707
4	0.7752	0.6199	0.6792	0.7749	0.5862	0.7909	0.6225	0.7836	0.7838	0.9166
5	0.6252	0.6509	0.7101	0.5996	0.6874	1.0254	0.7840	0.7461	0.6916	0.8533
6	0.7256	0.6364	0.7127	0.7385	0.6739	0.9041	0.7669	0.8216	0.8112	0.9802
+gp	0.7256	0.6364	0.7127	0.7385	0.6739	0.9041	0.7669	0.8216	0.8112	0.9802
FBAR 2- 4	0.7972	0.7055	0.7487	0.9480	0.8368	0.9531	0.7577	0.8727	0.9158	1.0094

AGE\YEAR	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
1	0.2916	0.8466	0.4774	0.8044	0.2170	0.2472	0.5731	0.3814	0.3923	0.3979
2	1.0524	0.9879	1.0817	0.9318	1.0910	1.0005	0.9283	1.2109	0.8234	0.8384
3	1.1244	0.9420	0.9075	0.9954	0.8528	1.0903	1.0144	0.8787	0.8535	0.6972
4	0.9148	0.8212	0.7644	0.9450	0.8969	0.8851	0.9391	0.8290	0.7779	0.7926
5	0.8154	0.7825	0.7304	0.8034	0.7430	0.7767	0.8644	0.6885	0.7478	0.6639
6	0.9515	0.8486	0.8008	0.9146	0.8309	0.9174	0.9393	0.7987	0.7931	0.7177
+gp	0.9515	0.8486	0.8008	0.9146	0.8309	0.9174	0.9393	0.7987	0.7931	0.7177
FBAR 2- 4	1.0305	0.9171	0.9179	0.9574	0.9469	0.9920	0.9606	0.9729	0.8182	0.7759

AGE\YEAR	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
1	0.2938	0.6404	0.3055	0.1719	0.2534	0.2542	0.4288	0.2568	0.1527	0.2567
2	1.0329	0.7013	1.0533	0.9944	0.7759	1.0097	0.8171	0.8782	0.8537	0.4754
3	0.9645	0.7657	0.9281	1.0653	0.9313	0.9931	1.4472	1.1123	0.7343	0.8976
4	0.9929	0.6996	0.7945	0.8751	0.8950	0.9743	1.2371	1.2361	0.8295	0.9977
5	0.8989	0.6573	0.6214	0.9051	0.8304	0.9475	1.1577	1.2954	0.8119	0.9312
6	0.9529	0.7075	0.7811	0.9488	0.8852	0.9715	1.2809	1.2148	0.7918	0.9419
+gp	0.9529	0.7075	0.7811	0.9488	0.8852	0.9715	1.2809	1.2148	0.7918	0.9419
FBAR 2- 4	0.9971	0.7236	0.9251	0.9783	0.8671	0.9924	1.1672	1.0751	0.8061	0.7899

AGE\YEAR	2003	2004	2005	2006	2007	2008	2009
1	0.3852	0.2857	0.3204	0.3108	0.3140	0.2008	0.2779
2	1.0540	0.7279	0.6477	0.6652	0.5778	0.7413	0.6692
3	0.8719	0.9526	0.6497	0.7015	0.5698	0.8541	0.9326
4	0.8844	1.0151	0.8593	0.6769	0.6074	0.5245	0.9556
5	1.0229	0.7139	0.7574	0.8021	0.4626	0.7118	0.6212
6	0.9260	0.8931	0.7554	0.7264	0.5465	0.6977	0.8440
+gp	0.9260	0.8931	0.7554	0.7264	0.5465	0.6977	0.8440
FBAR 2- 4	0.9364	0.8982	0.7187	0.6806	0.5841	0.7095	0.8530

Table 14.11 Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId. B-ADAPT base run median population numbers at age.

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Table 10 Stock number at age (start of year) Numbers*10**-3

AGE\YEAR	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972
1	249718	462750	687286	835166	748976	329855	295479	1143743	1687701	329293
2	157713	101732	195367	222662	271562	269935	110340	114432	390898	490970
3	26607	54365	43557	79995	76384	97605	88266	43564	38910	98457
4	10179	13227	21985	16153	31378	26182	32826	34758	14799	12738
5	9194	5035	6796	9526	7489	15205	10079	14222	16087	5914
6	3912	4964	2374	3381	4711	3164	6919	4115	5934	6731
+gp	1892	2236	2700	2916	3403	3250	3035	3459	3796	5839
TOTAL	459217	644308	960065	1169799	1143902	745195	546944	1358293	2158126	949942

AGE\YEAR	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
1	561402	550554	1030925	769399	1898803	638410	1502822	2807522	609627	983478
2	104719	157056	136821	308981	170280	435083	218995	245208	415711	142910
3	119921	28535	42037	38492	57688	33825	87639	66859	65553	100962
4	28661	37733	10409	13732	11468	19047	9633	25006	18309	17541
5	5204	10595	16292	4235	5078	5121	6862	4107	9075	6643
6	2373	2258	4480	6492	1885	2049	1474	2514	1563	3647
+gp	3907	3326	2209	2563	4231	1914	1535	1646	1686	1364
TOTAL	826187	790057	1243172	1143896	2149432	1135451	1828960	3152863	1121523	1256545

AGE\YEAR	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
1	470856	1485857	272216	1668790	363028	238095	630948	199507	260126	546515
2	253796	147368	272357	73644	332124	132621	86095	168033	65658	85532
3	37022	59388	37151	63141	19836	77052	34022	23979	35277	20514
4	21846	8391	16152	10459	16281	5898	17889	8521	6811	10173
5	5573	6953	2933	5975	3230	5223	1915	5502	2926	2436
6	2271	1979	2552	1122	2126	1221	1909	635	2174	1090
+gp	1622	1530	1326	1565	1090	842	819	882	807	953
TOTAL	792986	1711465	604687	1824698	737715	460953	773595	407058	373779	667213

AGE\YEAR	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
1	253683	933220	410258	233787	734884	96056	176681	298594	85979	153946
2	182307	93454	246590	153234	100786	296575	39691	62401	128920	42062
3	26324	46084	33484	61869	40767	33804	78843	12873	19326	40893
4	6848	6624	14137	8569	13604	10292	7949	11761	2717	5945
5	3587	1951	2536	4903	2707	4215	2955	1749	2605	901
6	977	1133	791	1050	1517	905	1242	704	365	879
+gp	759	530	593	760	491	520	639	351	316	241
TOTAL	474485	1082996	708389	464173	894757	442367	308000	388434	240227	244867

AGE\YEAR	2003	2004	2005	2006	2007	2008	2009
1	72800	106957	86305	209886	100583	104946	97958
2	70049	29745	48707	38309	95853	46098	54287
3	19622	18371	10985	19369	14949	41268	16794
4	10796	5379	4715	3838	6476	5763	11878
5	1667	3402	1493	1538	1493	2708	2602
6	270	456	1274	539	529	723	1016
+gp	276	221	200	481	306	491	437
TOTAL	175480	164531	153678	273960	220189	201997	184973

Table 14.12a Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId. B-ADAPT median stock and management metrics.

Run title: North Sea/Skagerrak/Eastern Channel Cod
Tuning data. INCLUDES DISCARDS
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B-ADAPT median values

	RECRUITS Age 1 ('000)	TSB (tons)	SSB (tons)	CATCH (tons)	YIELD/SSB	FBAR 2-4
1963	249718	443856	164821	128686	0.781	0.499
1964	462750	530389	166809	130740	0.784	0.477
1965	687286	695016	193421	210237	1.087	0.570
1966	835166	846628	225100	259416	1.152	0.581
1967	748976	900304	249059	276387	1.110	0.589
1968	329855	797607	254722	305911	1.201	0.704
1969	295479	654250	252744	205510	0.813	0.543
1970	1143743	993899	260553	243867	0.936	0.620
1971	1687701	1201678	264800	412264	1.557	0.781
1972	329293	863226	243532	387737	1.592	0.823
1973	561402	683266	205762	269139	1.308	0.797
1974	550554	650496	233150	253989	1.089	0.705
1975	1030925	728266	211890	242349	1.144	0.749
1976	769399	644409	180579	307102	1.701	0.948
1977	1898803	946599	163815	349038	2.131	0.837
1978	638410	817810	150864	328585	2.178	0.953
1979	1502822	964889	158450	430688	2.718	0.758
1980	2807522	1255362	179034	590678	3.299	0.873
1981	609627	844173	190515	393451	2.065	0.916
1982	983478	834918	184954	359372	1.943	1.009
1983	470856	638926	148887	281696	1.892	1.031
1984	1485857	825394	131990	379974	2.879	0.917
1985	272216	505132	124377	247031	1.986	0.918
1986	1668790	761629	115131	341047	2.962	0.957
1987	363028	563628	107497	244809	2.277	0.947
1988	238095	432248	98891	194798	1.970	0.992
1989	630948	469624	92916	202639	2.181	0.961
1990	199507	323785	81366	153021	1.881	0.973
1991	260126	301442	78101	121204	1.552	0.818
1992	546515	428467	77358	151755	1.962	0.776
1993	253683	372434	78840	174247	2.210	0.997
1994	933220	516805	75188	203846	2.711	0.724
1995	410258	528397	95221	222222	2.334	0.925
1996	233787	441378	103559	197824	1.910	0.978
1997	734884	537270	91452	173884	1.901	0.867
1998	96056	348556	76291	179993	2.359	0.992
1999	176681	254411	73461	137037	1.865	1.167
2000	298594	240251	48706	95119	1.953	1.075
2001	85979	181377	38605	75718	1.961	0.806
2002	153946	216204	46580	80830	1.735	0.790
2003	72800	150116	43109	75801	1.758	0.936
2004	106957	127624	39534	53023	1.341	0.898
2005	86305	131687	36347	51482	1.416	0.719
2006	209886	143726	34889	52674	1.510	0.681
2007	100583	184861	42853	66398	1.549	0.584
2008	104946	205398	58458	84110	1.439	0.709
2009	97958	212321	68560	91428	1.334	0.853
2010			55789			

Table 14.12b Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId. Landings, discards and estimated total removals, based on the B-Adapt base run.

	Landings	Discards	Catch (L+D)	Total estimated removals
1985	214.6	31.5	246.1	247.0
1986	204.1	139.1	343.1	341.0
1987	216.2	27.8	244.1	244.8
1988	184.2	10.7	195.0	194.8
1989	139.9	62.1	202.1	202.6
1990	125.3	27.0	152.3	153.0
1991	102.5	18.6	121.0	121.2
1992	114.0	36.9	150.9	151.8
1993	121.7	21.9	143.6	174.2
1994	110.6	99.6	210.2	203.8
1995	136.1	32.2	168.3	222.2
1996	126.3	14.3	140.6	197.8
1997	124.2	33.6	157.8	173.9
1998	146.0	40.5	186.5	180.0
1999	96.2	14.2	110.4	137.0
2000	71.4	13.7	85.1	95.1
2001	49.7	13.9	63.6	75.7
2002	54.9	5.7	60.6	80.8
2003	30.9	6.4	37.2	75.8
2004	28.2	5.8	34.0	53.0
2005	28.7	6.3	35.0	51.5
2006	26.6	8.1	34.6	52.7
2007	24.4	23.6	48.1	66.4
2008	26.8	21.8	48.7	84.1
2009	30.8	14.6	45.4	91.4

Table 14.13 Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId. The input sen file for the estimation of the North Sea cod biomass and fishing mortality reference levels

cod347				
	1	7	2008	3
	1	1	0	
'N1'		110222	0.652	
'N2'		62801	0.288	
'N3'		13551	0.239	
'N4'		12154	0.239	
'N5'		2633	0.202	
'N6'		608	0.59	
'N7'		379	0.272	
'sH1'		0.012	0.322	
'sH2'		0.245	0.199	
'sH3'		0.324	0.223	
'sH4'		0.488	0.238	
'sH5'		1.021	0.635	
'sH6'		0.777	0.349	
'sH7'		0.814	0.349	
'sD1'		0.174	0.322	
'sD2'		0.66	0.199	
'sD3'		0.565	0.223	
'sD4'		0.068	0.238	
'sD5'		0.031	0.635	
'sD6'		0.06	0.349	
'sD7'		0.024	0.349	
'WH1'		0.723	0.112	
'WH2'		1.123	0.143	
'WH3'		2.055	0.137	
'WH4'		3.589	0.097	
'WH5'		5.425	0.062	
'WH6'		7.483	0.05	
'WH7'		9.832	0.04	
'WD1'		0.236	0.255	
'WD2'		0.624	0.282	
'WD3'		1.431	0.419	
'WD4'		2.632	0.542	
'WD5'		3.95	0.48	
'WD6'		7.479	0.345	
'WD7'		7.288	0.792	

'WS1'		0.329	0.196
'WS2'		0.801	0.138
'WS3'		1.828	0.136
'WS4'		3.553	0.093
'WS5'		5.41	0.061
'WS6'		7.501	0.059
'WS7'		9.801	0.036
'M1'		0.46	0.1
'M2'		0.26	0.1
'M3'		0.38	0.1
'M4'		0.26	0.1
'M5'		0.26	0.1
'M6'		0.33	0.1
'M7'		0.2	0.1
'MT1'		0.01	0
'MT2'		0.05	0.1
'MT3'		0.23	0.1
'MT4'		0.62	0.1
'MT5'		0.86	0
'MT6'		1	0
'MT7'		1	0
'R06'		108859	0.51
'R07'		108859	0.51
'HF06'		1	0.05
'HF07'		1	0.05
'HF08'		1	0.05
'K06'		1	0.1
'K07'		1	0.1
'K08'		1	0.1
Cod			
	347		
	1		
	1	7	1
	2		
H.cons.			
	2	4	
Discards			
	2	4	
	1963	2007	

Stock numbers in 2008 are Badapt survivors

Table 14.14 Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId. The input sum file for the estimation of the North Sea cod biomass and fishing mortality reference levels

Stock summary		Cod in Division 347	
	12		
	1	0	0
Year			
	1963	2008	
Recruits		age 1	(millions)
	1	1000000	
SSB		('000 t)	
	1000		
TSB		('000 t)	
	1000		
Catch		Total ('000 t)	
	1000		
Catch		H.cons ('000 t)	
	1000		
Not used		used	
	1000		
Not used		used	
	1000		
Mean F		Total	
	2	4	
Mean F		H.cons.	
	2	4	
Not used		used	
	0	0	
Not used		used	
	0	0	

1963	249.72	164.82	443.86	128.69	116.44	12.25	0	0.499	0.499	0	0
1964	462.75	166.81	530.39	130.74	126.01	4.73	0	0.477	0.477	0	0
1965	687.29	193.42	695.02	210.24	180.99	29.24	0	0.570	0.570	0	0
1966	835.17	225.10	846.63	259.42	221.31	38.10	0	0.581	0.581	0	0
1967	748.98	249.06	900.30	276.39	252.95	23.44	0	0.589	0.589	0	0
1968	329.85	254.72	797.61	305.91	288.34	17.57	0	0.704	0.704	0	0
1969	295.48	252.74	654.25	205.51	200.70	4.81	0	0.543	0.543	0	0
1970	1143.74	260.55	993.90	243.87	225.95	17.91	0	0.620	0.620	0	0
1971	1687.70	264.80	1201.68	412.26	327.92	84.35	0	0.781	0.781	0	0
1972	329.29	243.53	863.23	387.74	353.90	33.84	0	0.823	0.823	0	0
1973	561.40	205.76	683.27	269.14	238.96	30.18	0	0.797	0.797	0	0
1974	550.55	233.15	650.50	253.99	214.20	39.79	0	0.705	0.705	0	0
1975	1030.93	211.89	728.27	242.35	205.28	37.07	0	0.749	0.749	0	0
1976	769.40	180.58	644.41	307.10	234.24	72.86	0	0.948	0.948	0	0
1977	1898.80	163.82	946.60	349.04	209.19	139.85	0	0.837	0.837	0	0
1978	638.41	150.86	817.81	328.58	296.10	32.48	0	0.953	0.953	0	0
1979	1502.82	158.45	964.89	430.69	268.38	162.31	0	0.758	0.758	0	0
1980	2807.52	179.03	1255.36	590.68	294.43	296.24	0	0.873	0.873	0	0
1981	609.63	190.52	844.17	393.45	335.55	57.91	0	0.916	0.916	0	0
1982	983.48	184.95	834.92	359.37	304.62	54.75	0	1.009	1.009	0	0
1983	470.86	148.89	638.93	281.70	259.57	22.13	0	1.031	1.031	0	0
1984	1485.86	131.99	825.40	379.97	228.14	151.83	0	0.917	0.917	0	0
1985	272.22	124.38	505.14	247.03	215.41	31.62	0	0.918	0.918	0	0
1986	1668.79	115.13	761.66	341.05	202.81	138.23	0	0.957	0.957	0	0
1987	363.03	107.50	563.69	244.81	216.88	27.93	0	0.947	0.947	0	0
1988	238.09	98.89	432.37	194.80	184.09	10.71	0	0.992	0.992	0	0
1989	630.94	92.91	469.89	202.64	140.34	62.30	0	0.961	0.961	0	0
1990	199.51	81.36	324.24	153.02	125.88	27.14	0	0.973	0.973	0	0
1991	260.09	78.09	302.49	121.20	102.63	18.58	0	0.818	0.818	0	0
1992	546.89	77.34	431.77	151.76	114.64	37.12	0	0.776	0.776	0	0
1993	254.72	78.81	378.35	173.98	147.50	26.48	0	0.992	0.992	0	0
1994	939.24	75.50	528.70	203.16	106.92	96.24	0	0.718	0.718	0	0
1995	413.64	95.55	538.07	223.24	180.54	42.70	0	0.927	0.927	0	0
1996	233.28	103.59	451.44	199.41	179.19	20.22	0	0.986	0.986	0	0
1997	734.27	91.12	547.97	173.41	136.46	36.95	0	0.867	0.867	0	0
1998	96.66	76.43	356.66	179.32	140.40	38.92	0	0.995	0.995	0	0
1999	177.84	74.32	259.32	138.46	120.67	17.78	0	1.167	1.167	0	0
2000	299.67	49.05	245.48	96.18	80.68	15.50	0	1.074	1.074	0	0
2001	86.37	38.83	185.04	75.89	59.33	16.56	0	0.801	0.801	0	0
2002	155.47	47.15	220.07	81.56	73.88	7.68	0	0.790	0.790	0	0
2003	73.60	43.64	153.70	76.70	63.57	13.12	0	0.930	0.930	0	0
2004	106.66	40.05	131.02	53.93	44.66	9.27	0	0.903	0.903	0	0
2005	88.39	36.56	135.03	51.86	42.56	9.30	0	0.725	0.725	0	0
2006	218.42	34.47	147.07	53.27	40.89	12.38	0	0.694	0.694	0	0
2007	98.28	42.31	184.30	70.10	35.63	34.47	0	0.619	0.619	0	0
2008	120.16	57.28	184.30	90.69	50.03	40.65	0	0.788	0.788	0	0

Table 14.15 Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId. The estimates of the North Sea cod biomass and fishing mortality reference levels derived from the fit of three stock and recruit relationships and the yield per recruit Fmsy proxies.

(a) Ricker

	Fcrash	Fmsy	Bmsy	MSY	ADMB Alpha	ADMB Beta	Unscaled Alpha	Unscaled Beta	AICc
Deterministic	0.89	0.41	5800	2352	0.788	0.044	3.779	0.0003	96.67
Mean	0.94	0.43	6681	2612	0.782	0.198	4.406	0.0012	
5%ile	0.67	0.32	538	250	0.649	0.017	3.444	0.0001	
25%ile	0.80	0.37	886	379	0.726	0.082	3.946	0.0005	
50%ile	0.92	0.42	1498	629	0.777	0.174	4.309	0.0011	
75%ile	1.05	0.48	2938	1296	0.832	0.291	4.776	0.0018	
95%ile	1.33	0.58	15081	5947	0.927	0.468	5.653	0.0028	
CV	0.22	0.20	6.52	5.96	0.11	0.73	0.16	0.73	

(b) Beverton-Holt

	Fcrash	Fmsy	Bmsy	MSY	ADMB Alpha	ADMB Beta	Unscaled Alpha	Unscaled Beta	AICc
Deterministic	0.89	0.17	57874	9627	0.045	1.268	16739	4458	96.68
Mean	0.93	0.16	79553	9385	0.249	1.345	15742	4290	
5%ile	0.67	0.08	3667	605	0.020	1.134	1323	249	
25%ile	0.79	0.13	7391	1181	0.103	1.242	2126	464	
50%ile	0.90	0.16	13787	2040	0.215	1.323	3521	853	
75%ile	1.03	0.18	32388	4298	0.356	1.440	7316	1917	
95%ile	1.32	0.23	202380	21379	0.572	1.615	38137	10447	
CV	0.21	0.29	5.18	7.05	0.75	0.11	7.74	7.93	

(c) Smooth hockey-stick

	Fcrash	Fmsy	Bmsy	MSY	ADMB Alpha	ADMB Beta	Unscaled Alpha	Unscaled Beta	AICc
Deterministic	0.90	0.19	2359	437	0.424	1.345	1.946	180.52	93.67
Mean	0.90	0.18	4365	470	0.435	1.402	1.997	188.26	
5%ile	0.65	0.08	1352	267	0.361	1.067	1.660	143.20	
25%ile	0.77	0.15	1939	361	0.401	1.225	1.842	164.53	
50%ile	0.88	0.18	2484	437	0.431	1.363	1.977	182.96	
75%ile	1.01	0.21	3418	543	0.466	1.565	2.139	210.13	
95%ile	1.25	0.26	8438	761	0.515	1.837	2.366	246.63	
CV	0.21	0.31	2.06	0.36	0.12	0.17	0.12	0.17	

(d) Yield per recruit

	F35	F40	F01	Fmax	Fpa	Flim
Deterministic	0.16	0.13	0.13	0.19	0.650	0.86
Mean	0.14	0.12	0.11	0.18		
5%ile	0.03	0.03	0.03	0.08		
25%ile	0.11	0.09	0.09	0.15		
50%ile	0.14	0.12	0.12	0.18		
75%ile	0.17	0.15	0.14	0.21		
95%ile	0.21	0.18	0.18	0.26		
CV	0.37	0.38	0.36	0.31		

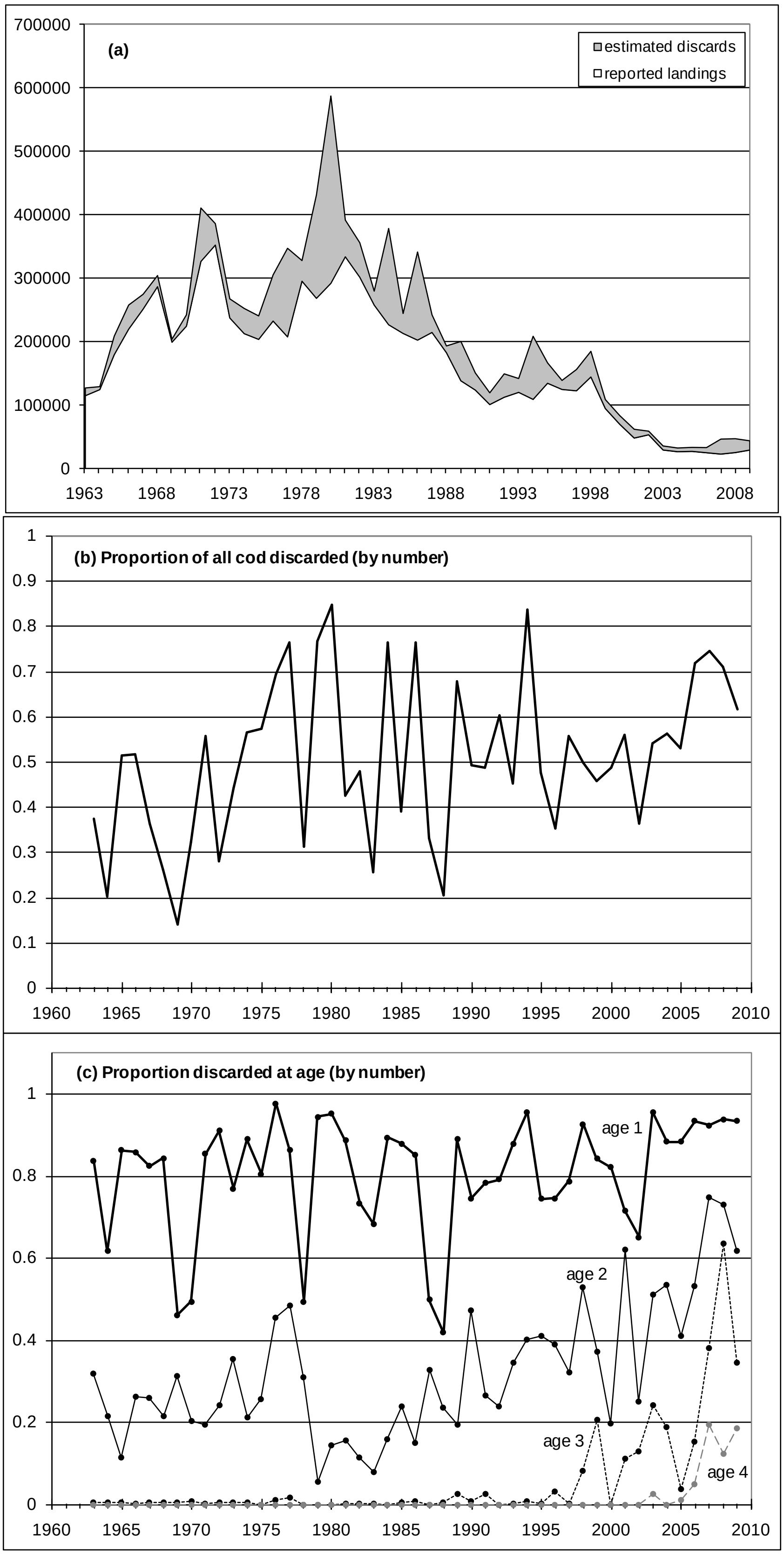


Figure 14.1a Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId: (a) stacked area plot of reported landings and estimated discards (in tons); (b) proportion of total numbers caught that are discarded; and (c) proportion of total numbers caught at age that are discarded

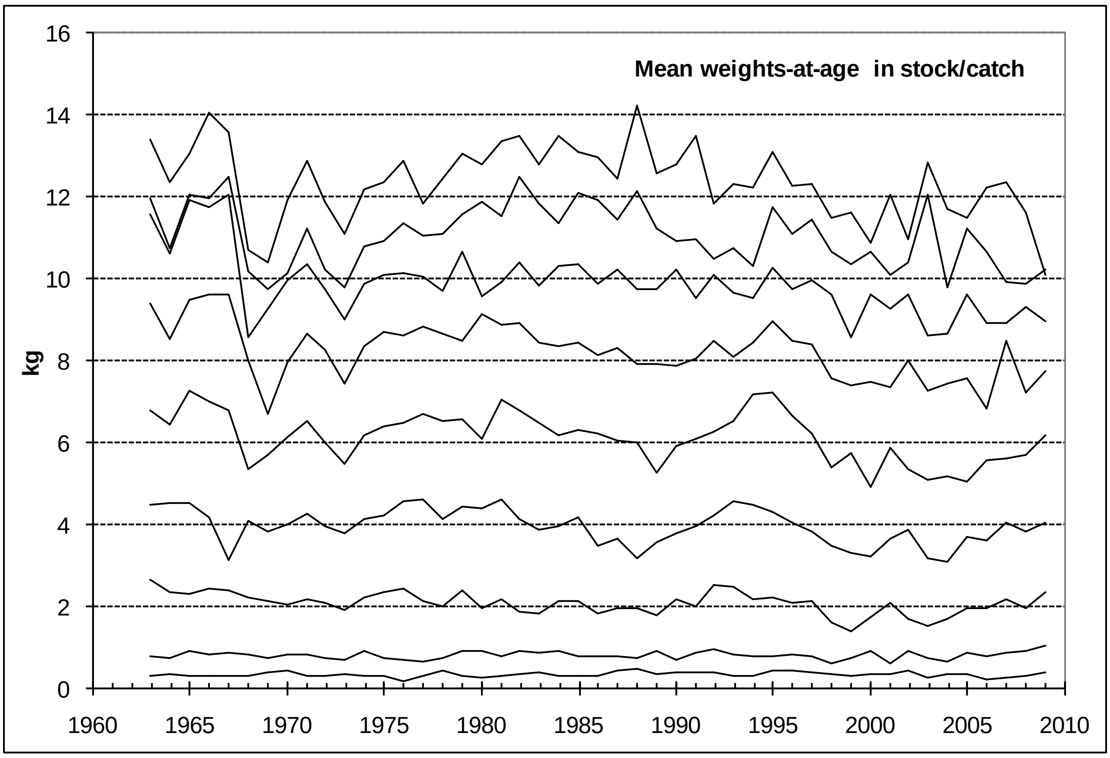


Figure 14.2 Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId: Mean weight at age in the catch for ages 1-9.

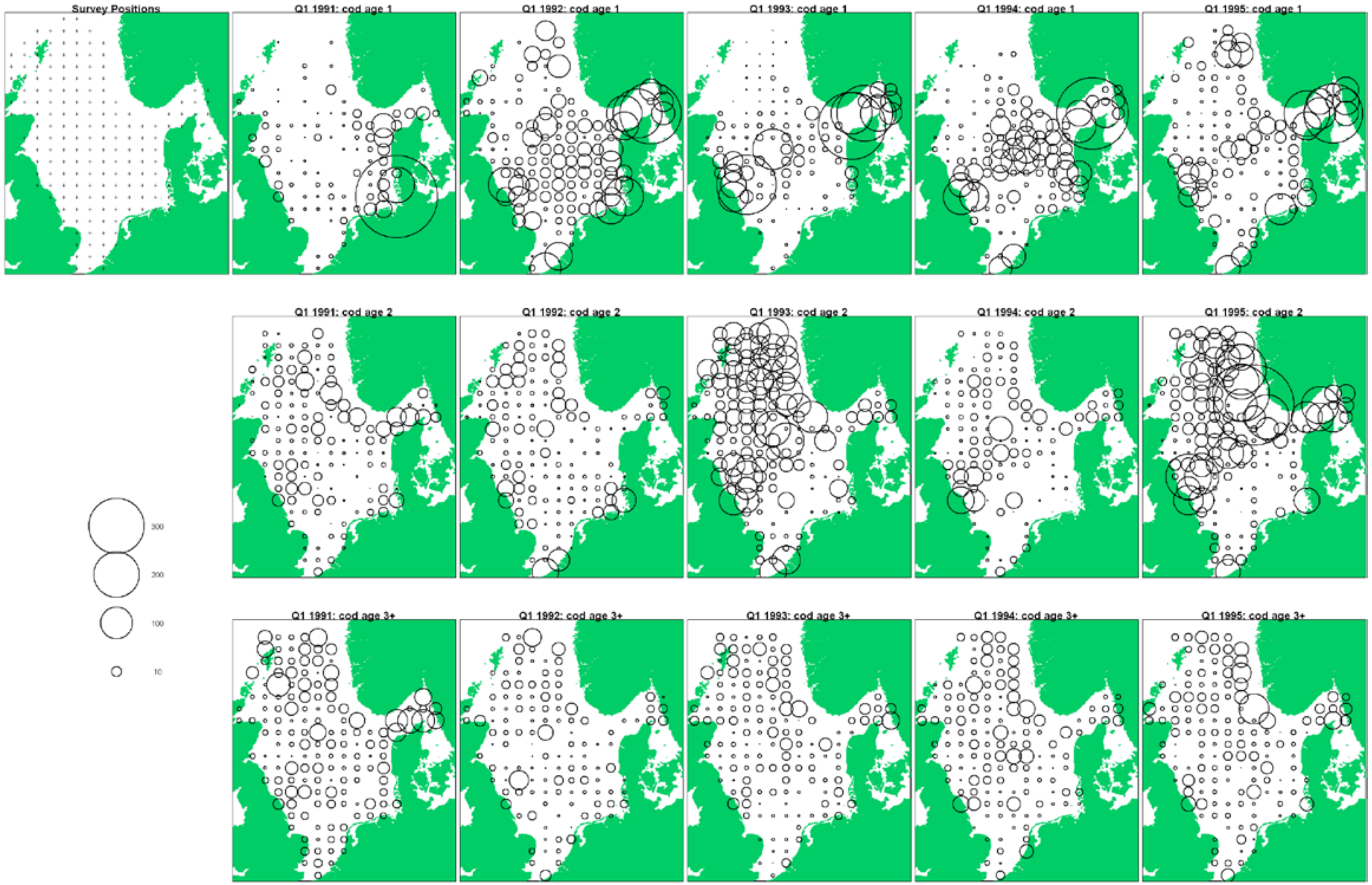


Figure 14.3(a) Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId. Distribution charts of cod ages 1-3+ caught in the IBTS Q1 survey 1991-2010 in the North Sea.

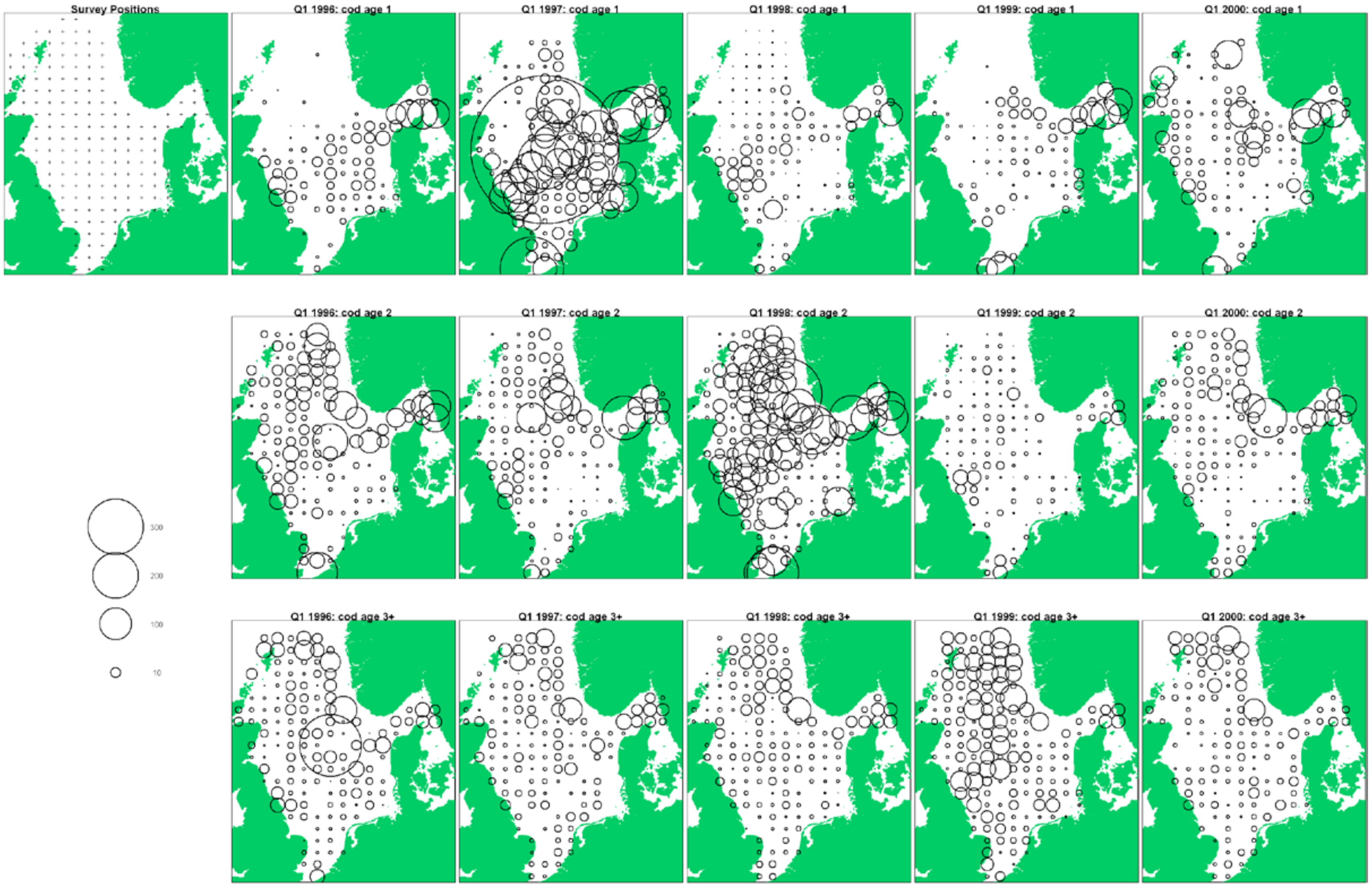


Figure 14.3(a) contd. Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId. Distribution charts of cod ages 1-3+ caught in the IBTS Q1 survey 1991-2010 in the North Sea.

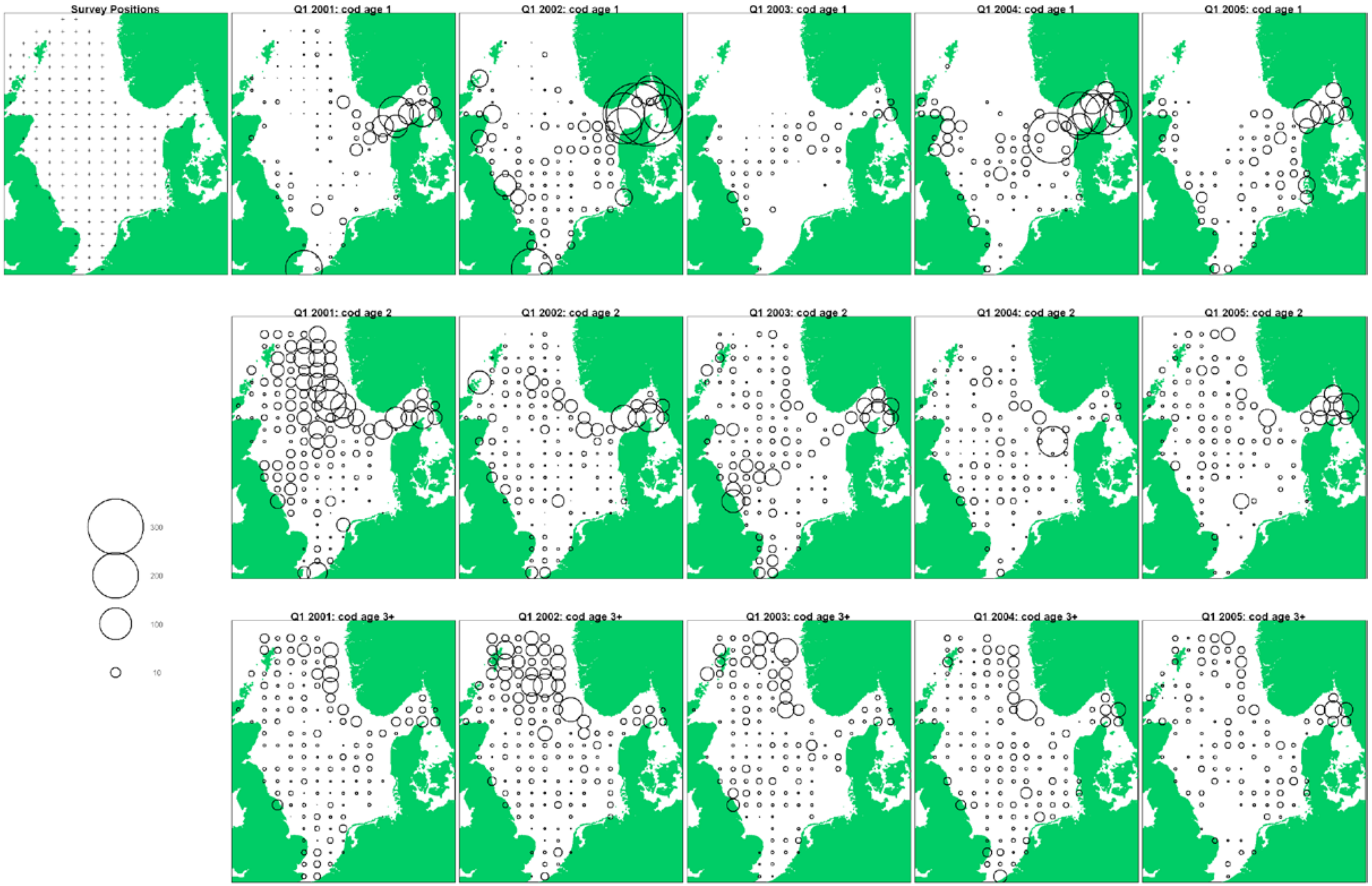


Figure 14.3(a) contd. Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId. Distribution charts of cod ages 1-3+ caught in the IBTS Q1 survey 1991-2010 in the North Sea.

Figure 14.3(a) contd. Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId. Distribution charts of cod ages 1-3+ caught in the IBTS Q1 survey 1991-2010 in the North Sea.

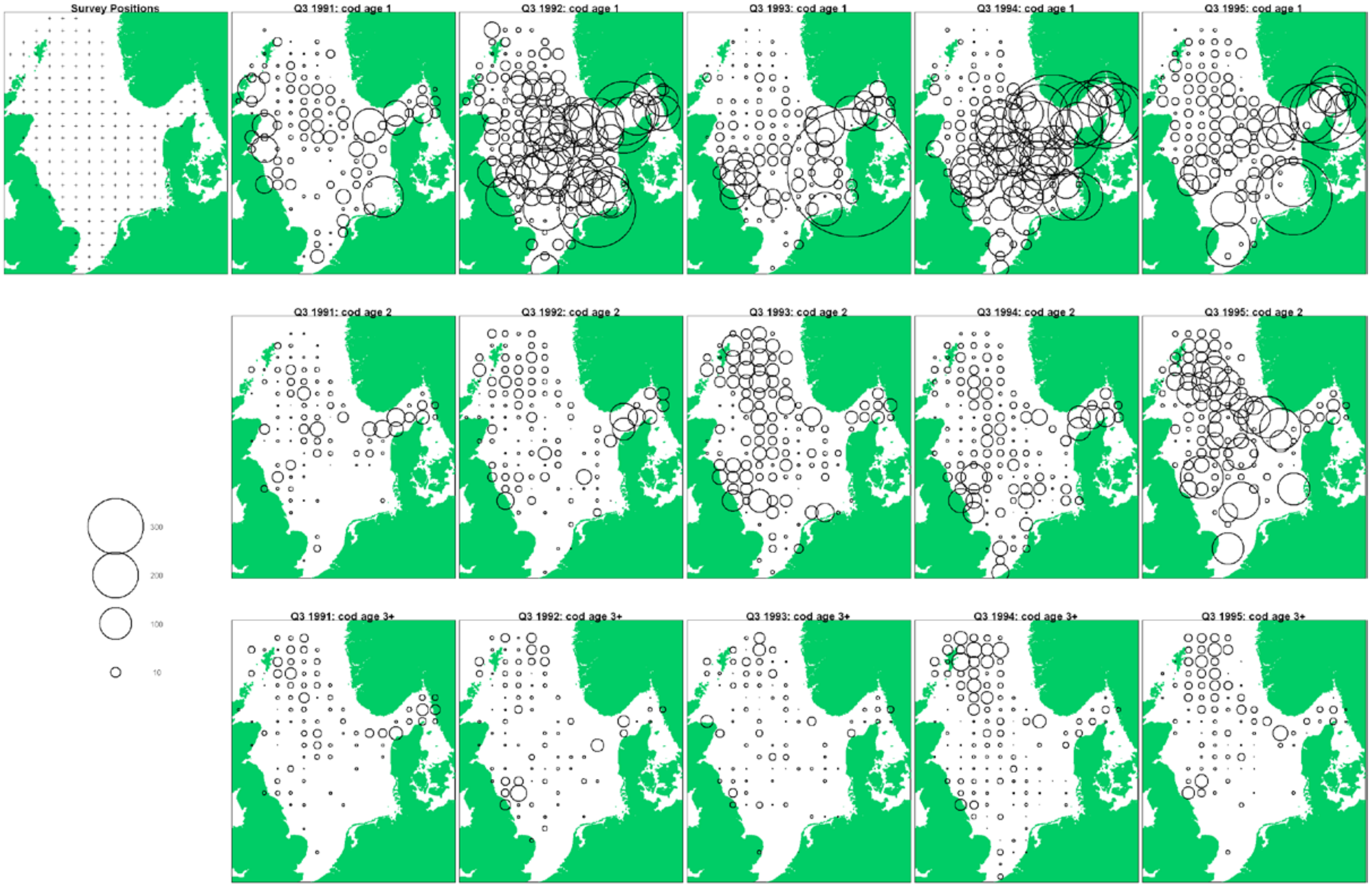


Figure 14.3(b). Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId. Distribution charts of cod ages 1-3+ caught in the IBTS Q3 survey 1991-2009 in the North Sea.

Figure 14.3(b) contd. Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId. Distribution charts of cod ages 1-3+ caught in the IBTS Q3 survey 1991-2009 in the North Sea.

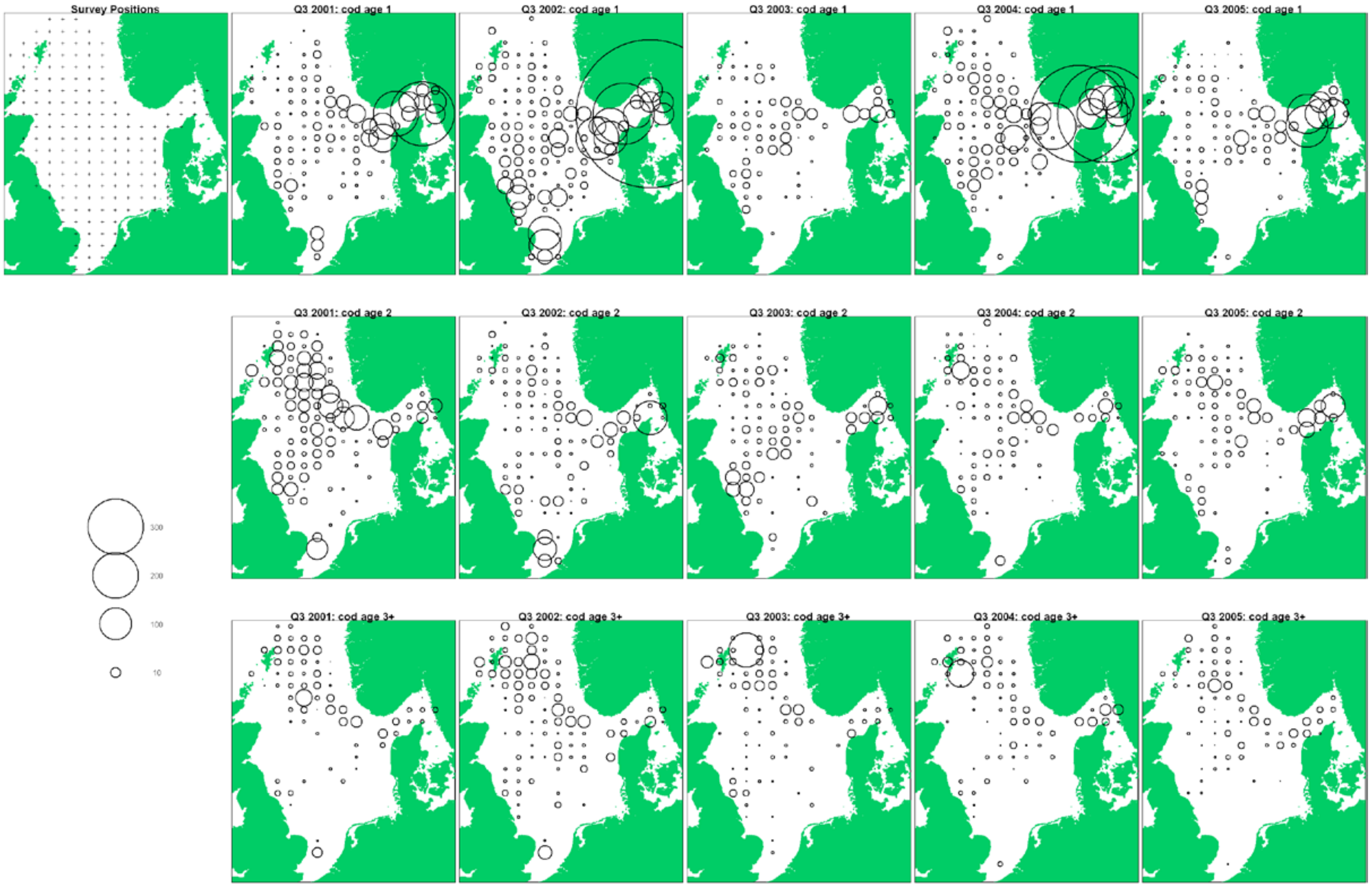


Figure 14.3(b) contd. Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId. Distribution charts of cod ages 1-3+ caught in the IBTS Q3 survey 1991-2009 in the North Sea.

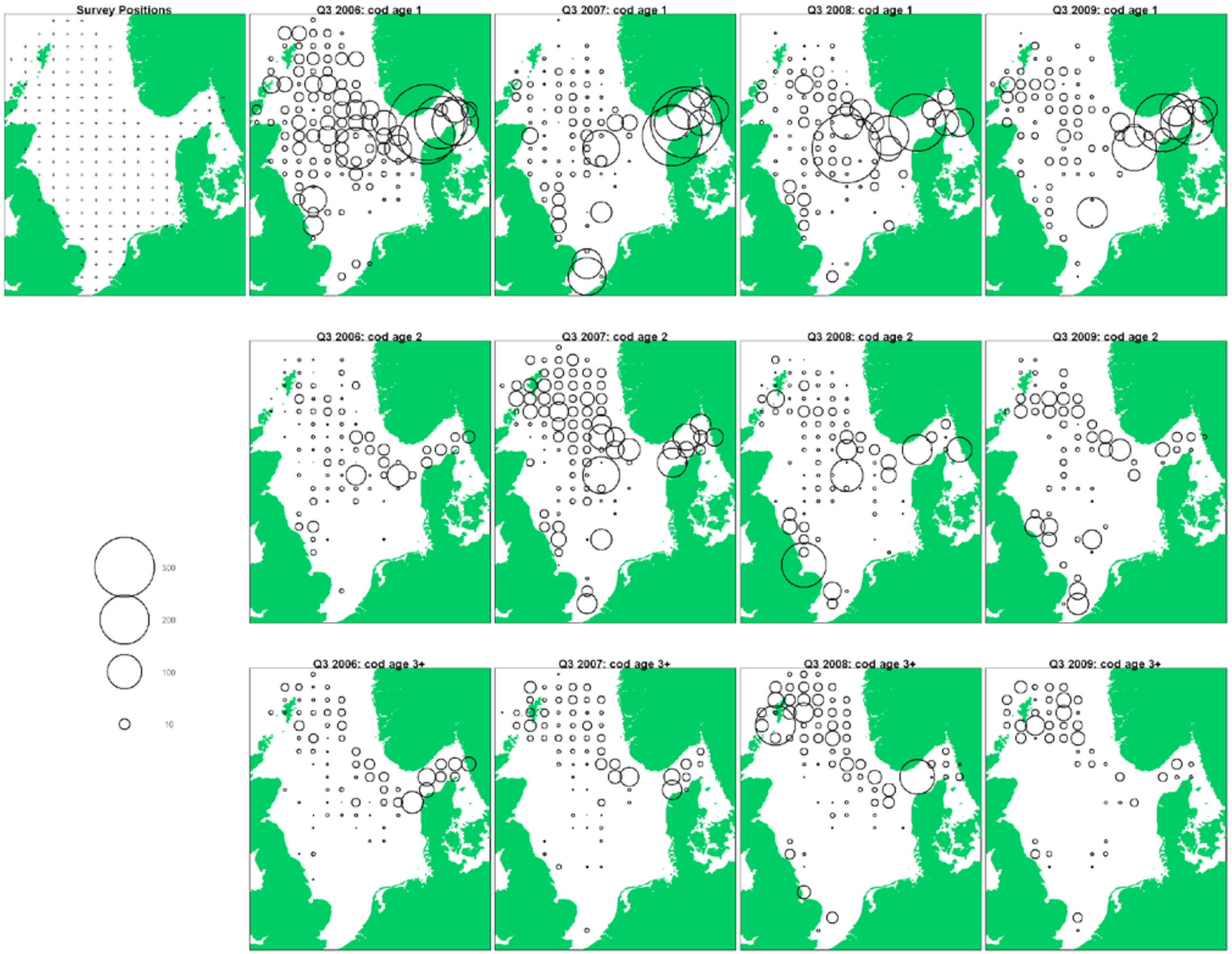
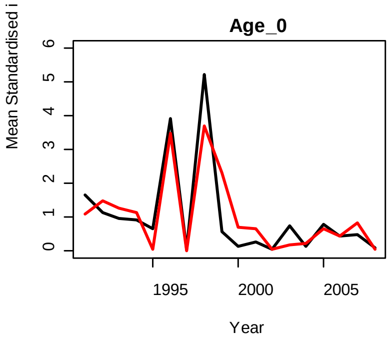


Figure 14.3(b) contd. Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId. Distribution charts of cod ages 1-3+ caught in the IBTS Q3 survey 1991-2009 in the North Sea.


Age_0
Mean Standardised i
0
1
2
3
4
5
6
1995
2000
2005
Year

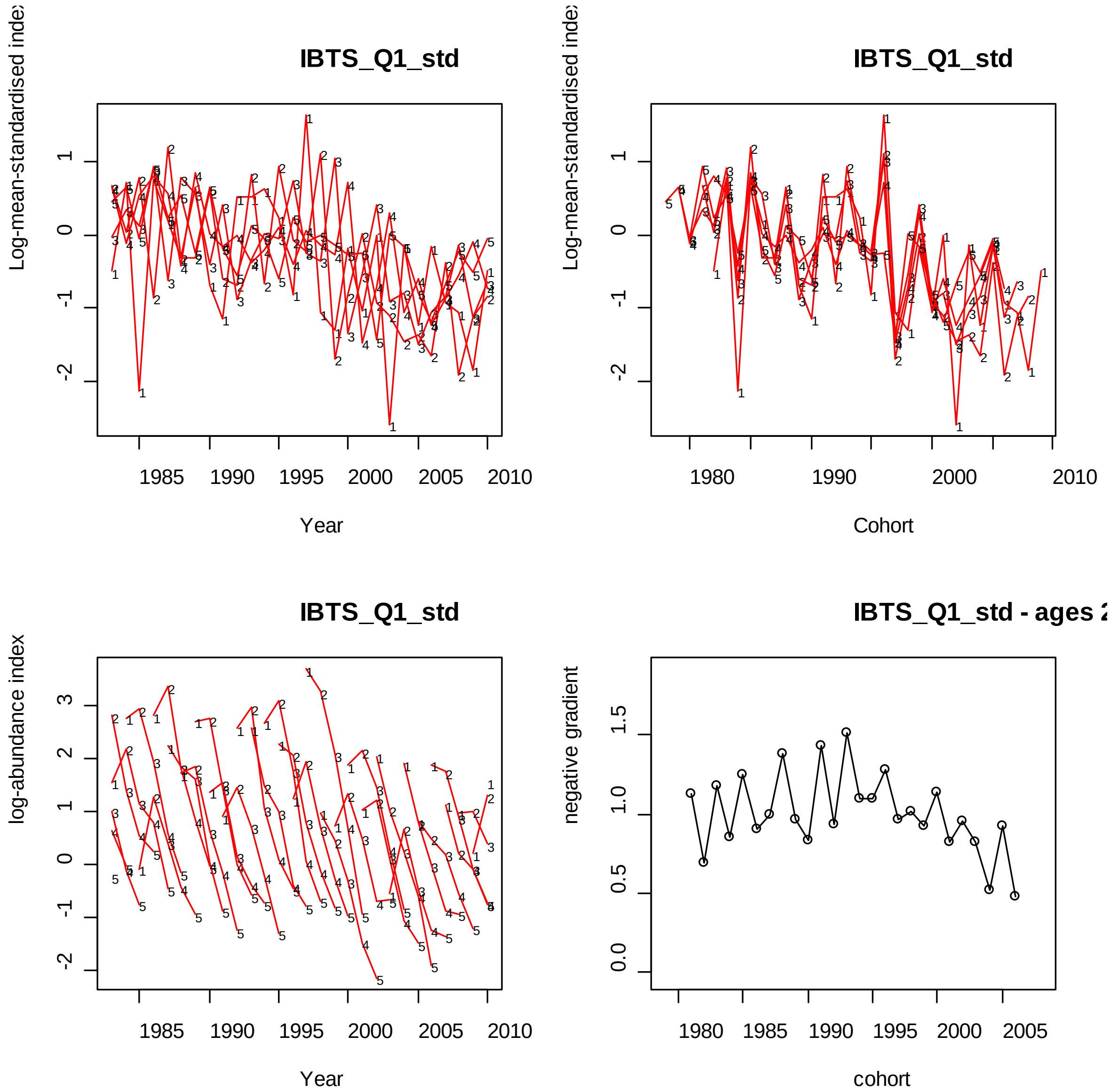


Figure 14.4a Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId. Log mean standardised indices plotted by year (top left) and cohort (top right), log abundance curves (bottom left) and associated negative gradients for each cohort across the reference fishing mortality of age 2-4 (bottom right), for the IBTSQ1 standard area groundfish survey.

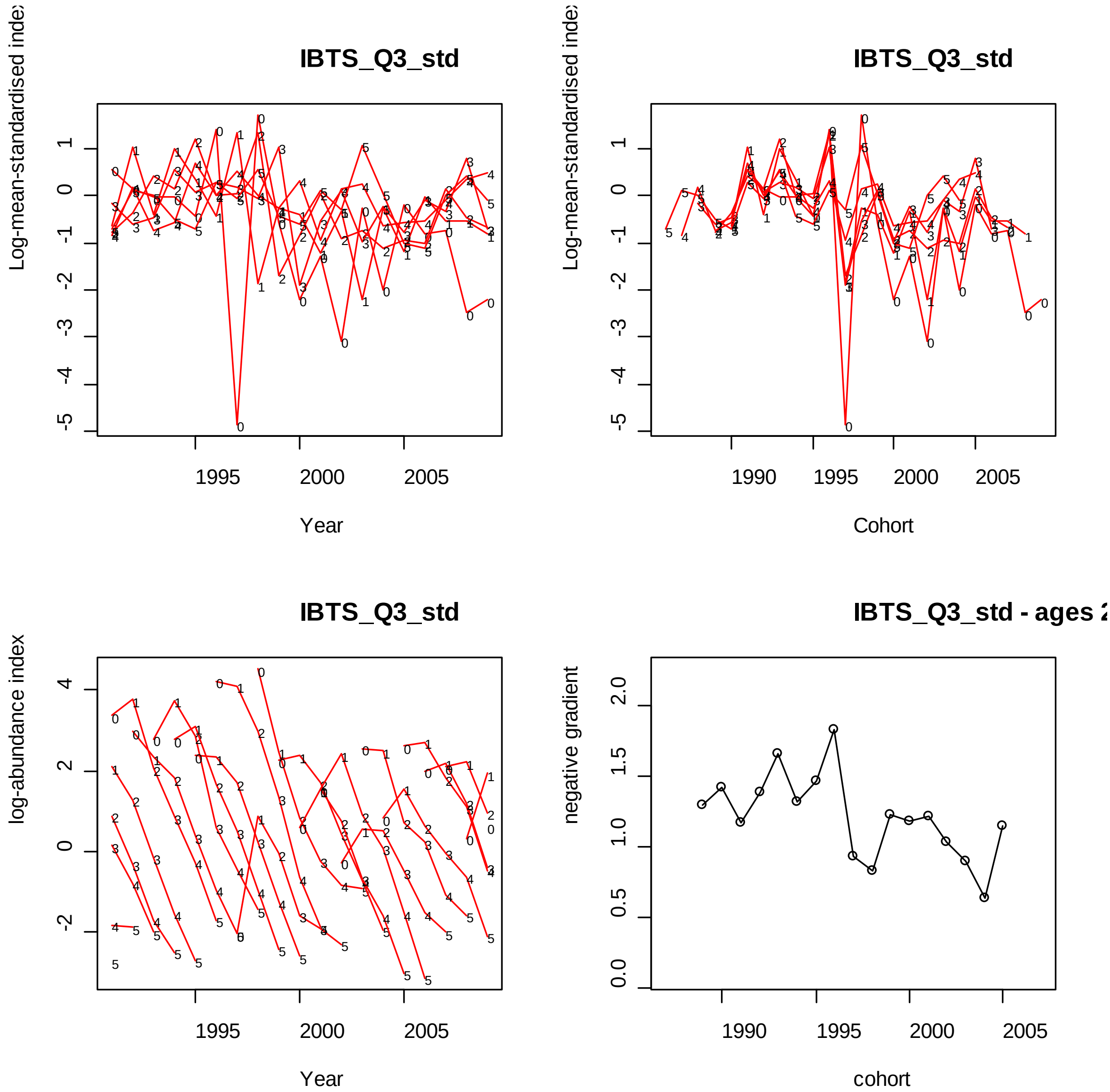
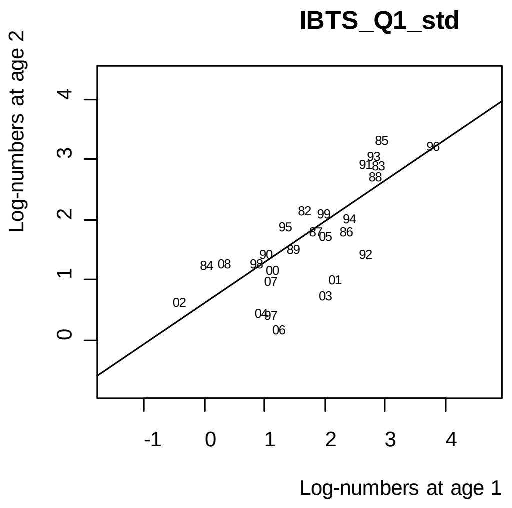
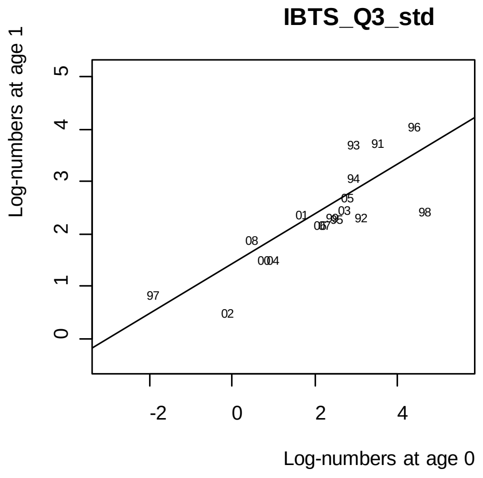


Figure 14.4b Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId. Log mean standardised indices plotted by year (top left) and cohort (top right), log abundance curves (bottom left) and associated negative gradients for each cohort across the reference fishing mortality of age 2-4 (bottom right), for the IBTSQ3 standard area groundfish survey.


IBTS_Q1_std
Log-numbers at age 2
Log-numbers at age 1
0
1
2
3
4
-1
0
1
2
3
4
85
96
93
91
83
88
82
99
94
95
87
05
86
90
89
92
84
08
98
00
07
01
02
03
04
97
06


IBTS_Q3_std
Log-numbers at age 1
Log-numbers at age 0
0
1
2
3
4
5
-2
0
2
4
96
93
91
94
05
01
03
92
98
08
97
02


Age 1
Log-numbers: IBTS_Q3_std
Log-numbers: IBTS_Q1_std
5
4
3
2
1
0
-1
0
1
2
3
4
96
91
93
94
05
03
01
99
92
98
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08
04
00
97
02

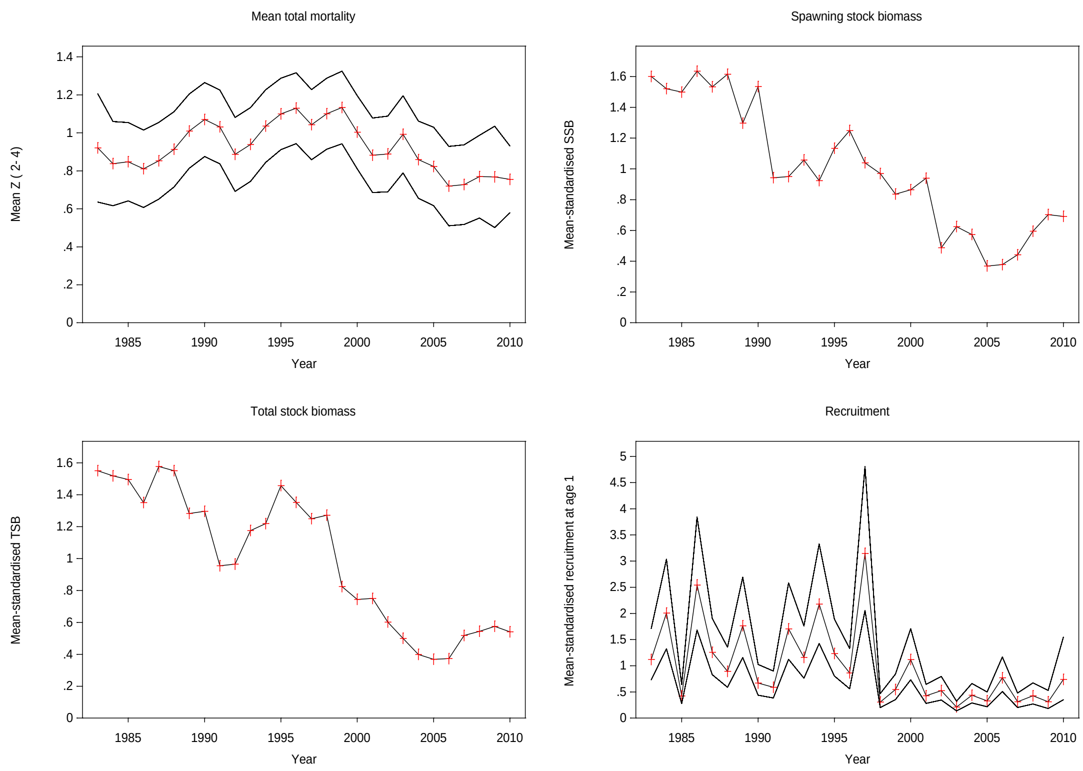

Figure 14.6a Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId. Surba summary plots for estimates of total mortality, spawning stock biomass, total biomass and recruitment for the IBTSQ1 survey. The smoothing parameter λ is set to 2, and reference age at 3. Broken lines are 95% confidence bounds.

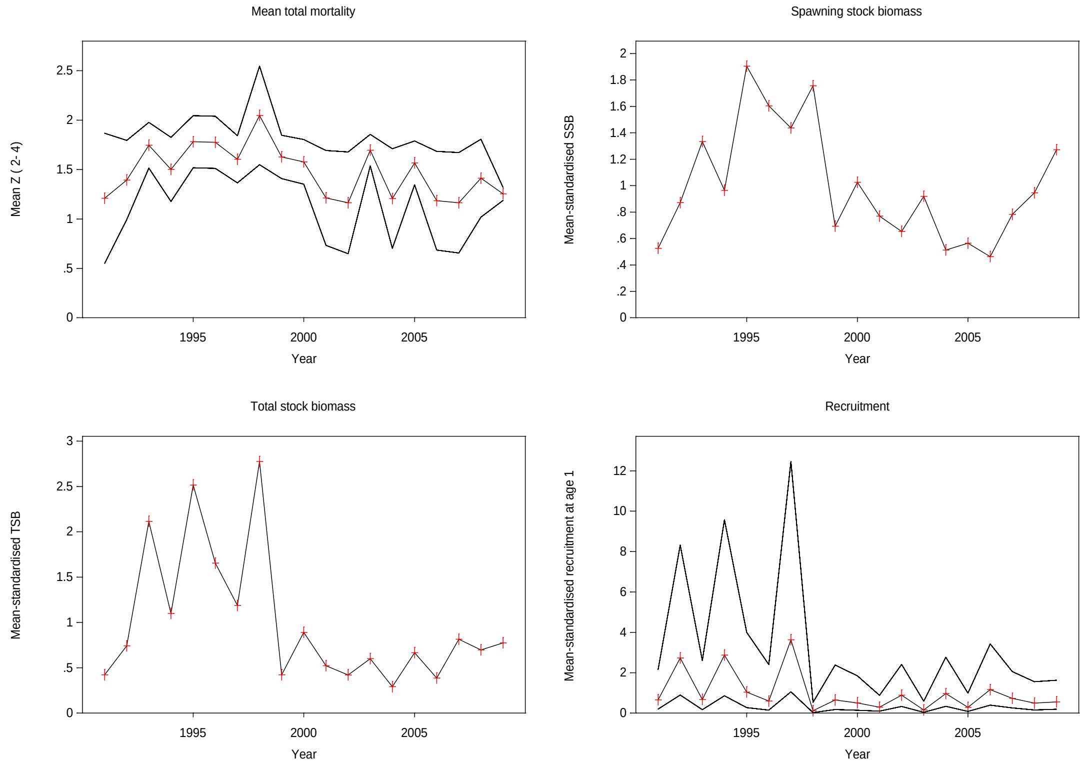

Figure 14.6b Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId. Surba summary plots for estimates of total mortality, spawning stock biomass, total biomass and recruitment for the IBTSQ3 survey. The smoothing parameter λ is set to 2, and reference age at 3. Broken lines are 95% confidence bounds.

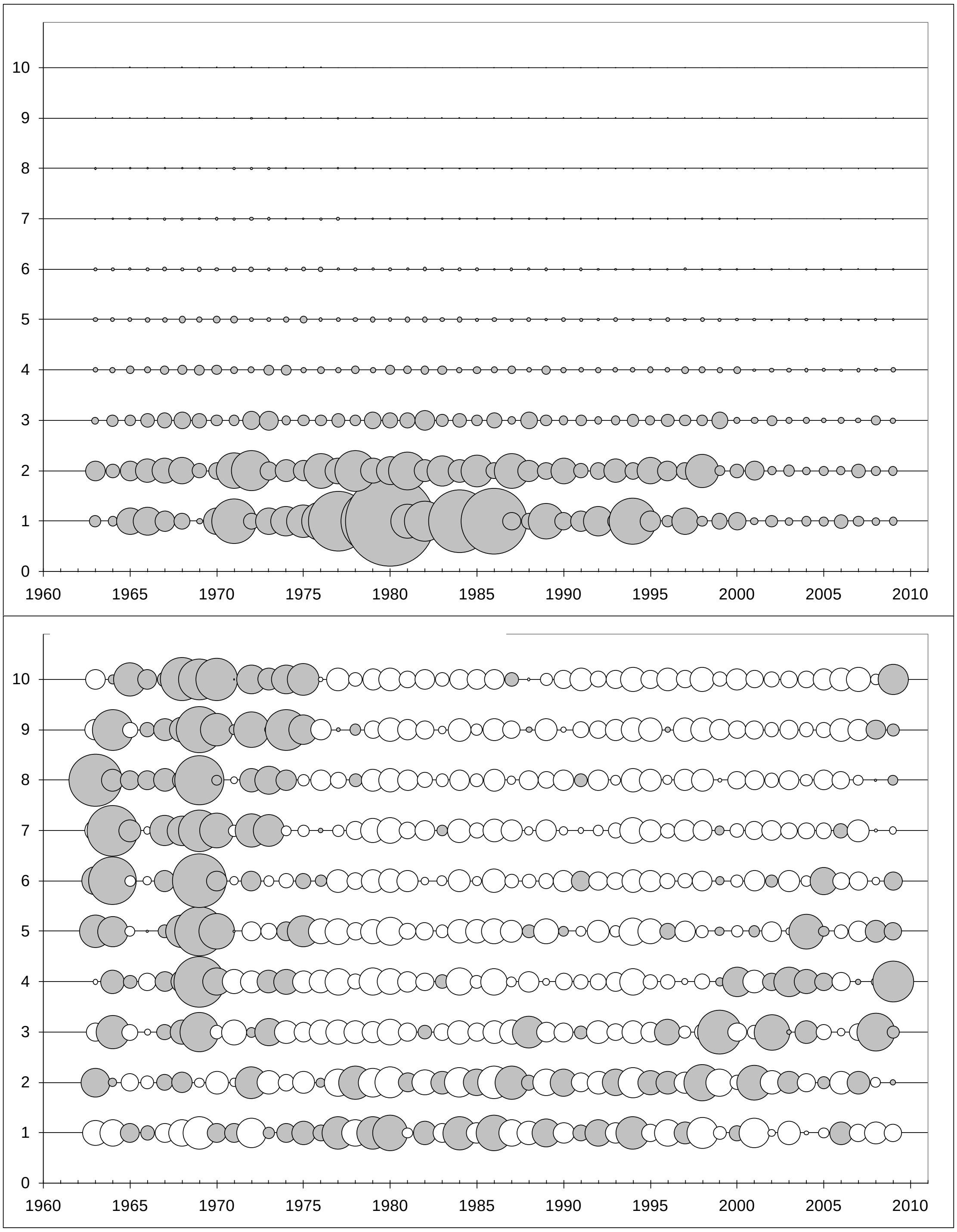

Figure 14.7 Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId. Total catch-at-age matrix expressed as (a) numbers-at-age and (b) proportions-at-age, which have been standardised over time (for each age, this is achieved by subtracting the mean proportion-at-age over the time series, and dividing by the corresponding variance). Grey bubbles indicate proportions above the mean over the time series at each age.

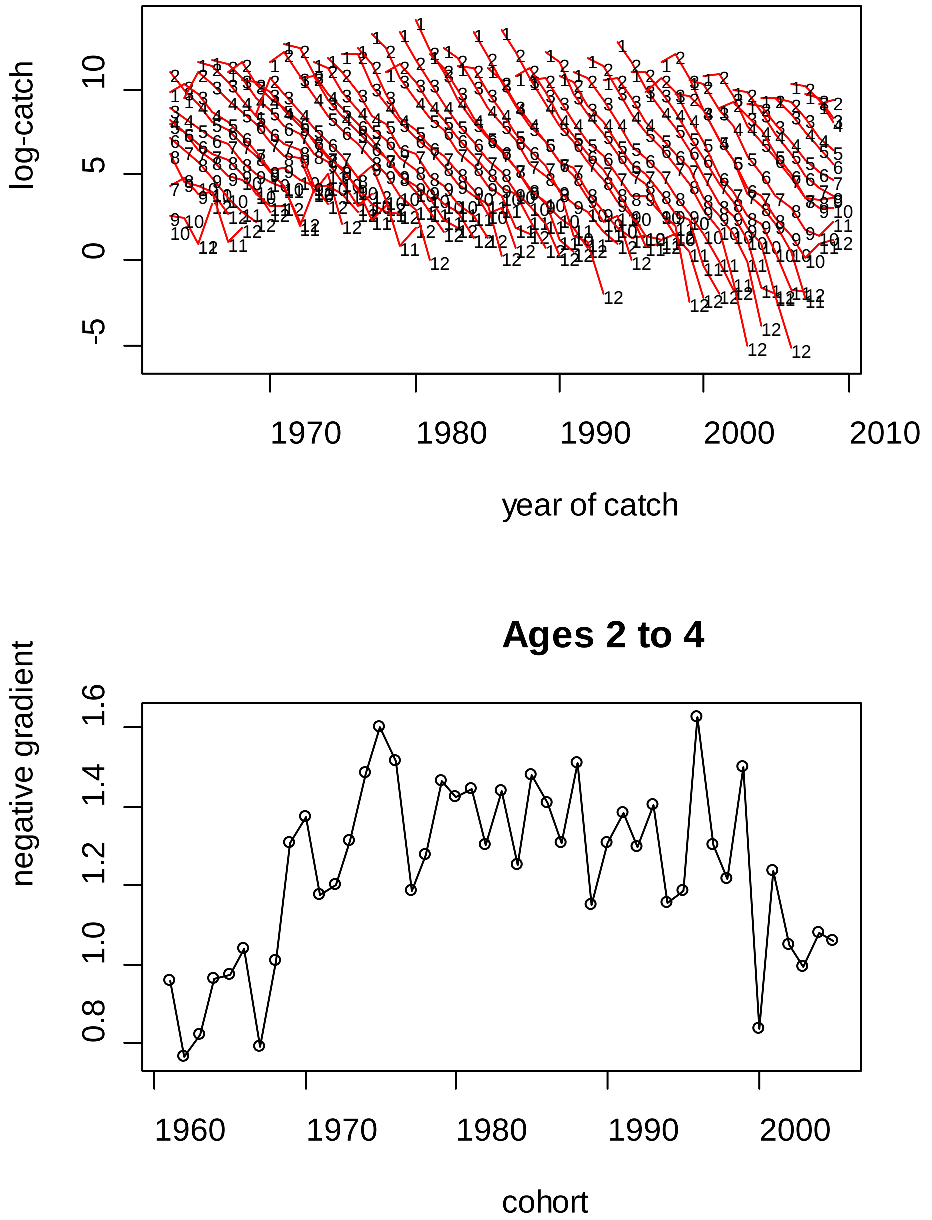

Figure 14.8 Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId. Log-catch cohort curves (top panel) and the associated negative gradients for each cohort across the reference fishing mortality of age 2-4.

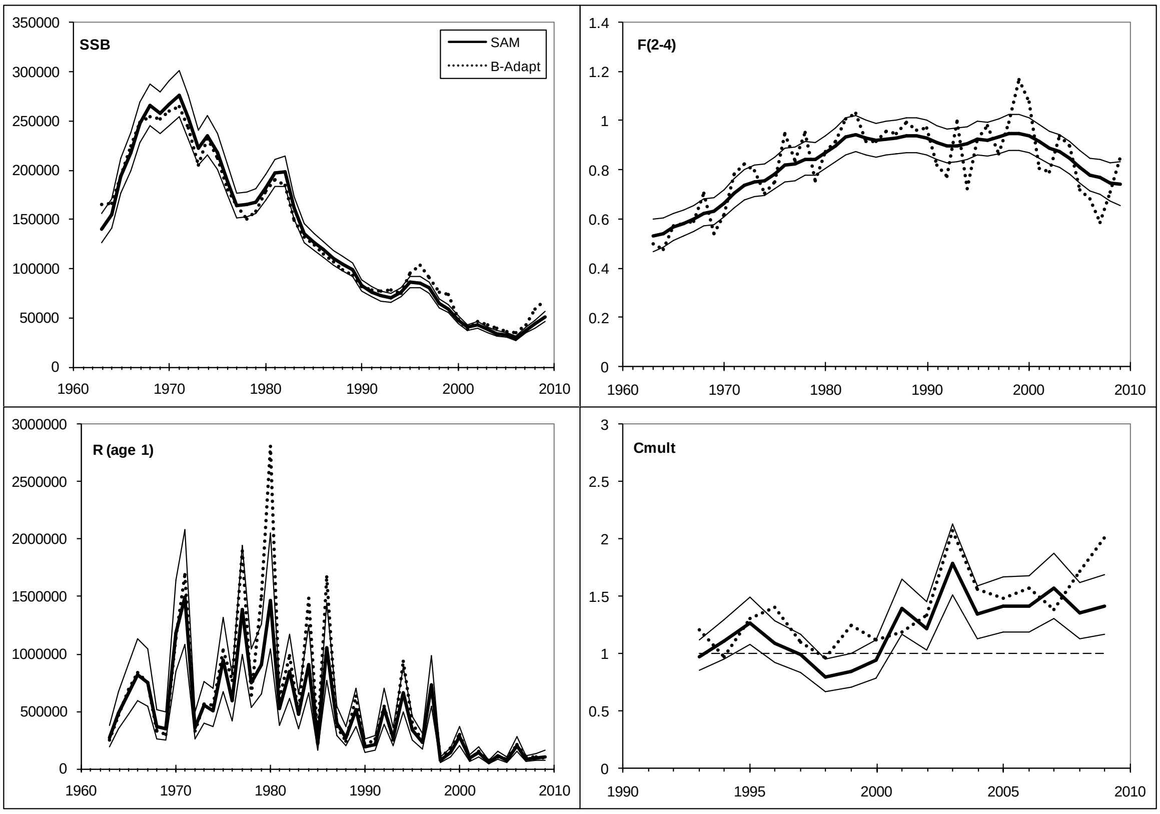

Figure 14.9 Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId. Estimated SSB, F (2-4), recruitment (age 1) and the catch multiplier from the SAM model. Solid black lines (heavy lines=estimate, light lines=point-wise 95% confidence intervals) are from the SAM model, and dotted lines from the final B-ADAPT run (median estimates, see Figure 14.15).

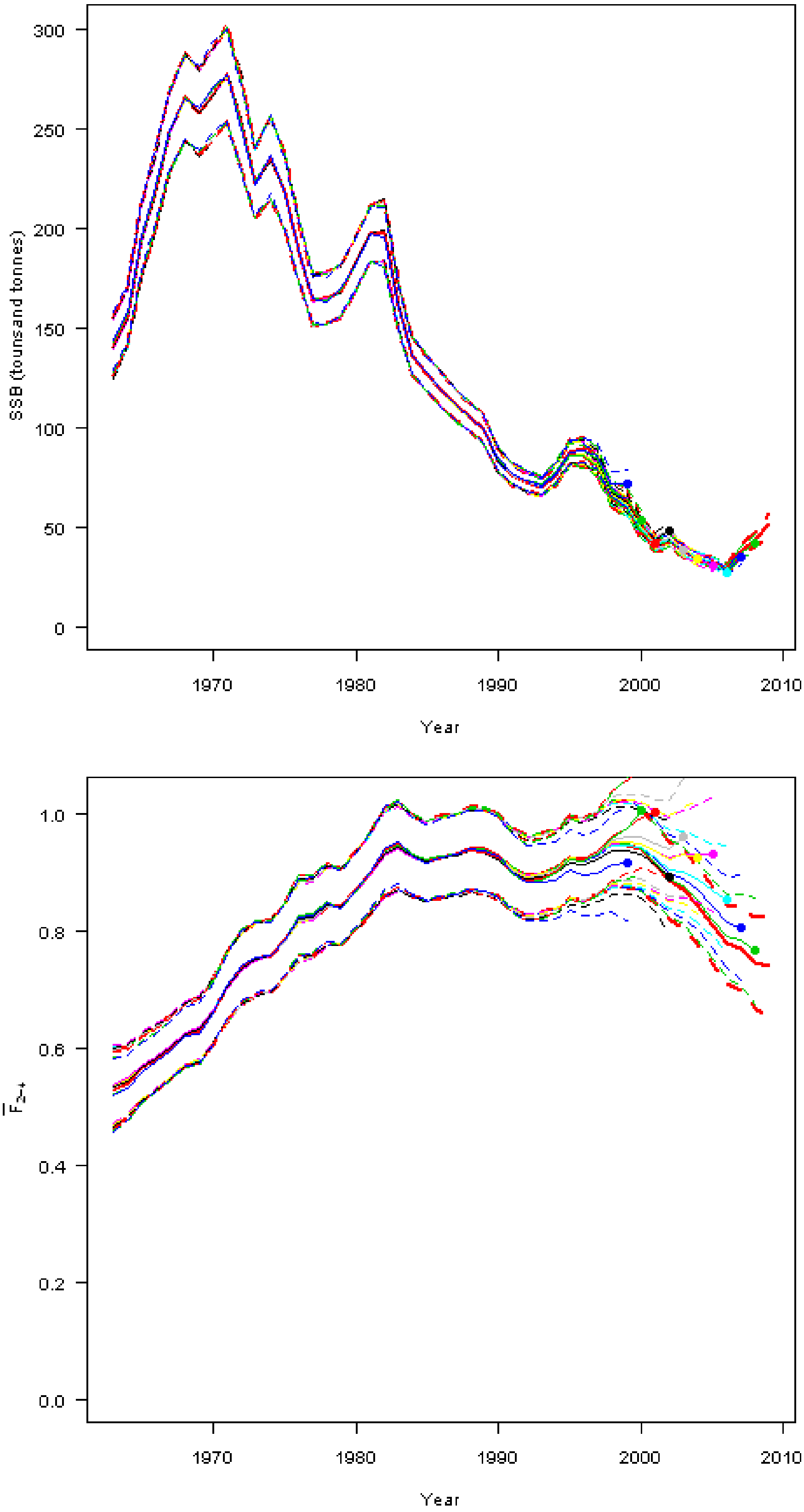

Figure 14.10 Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId. Estimated yearly SSB and average fishing motality (solid line), and corresponding 95% confidence intervals retrospective estimates from the SAM model.

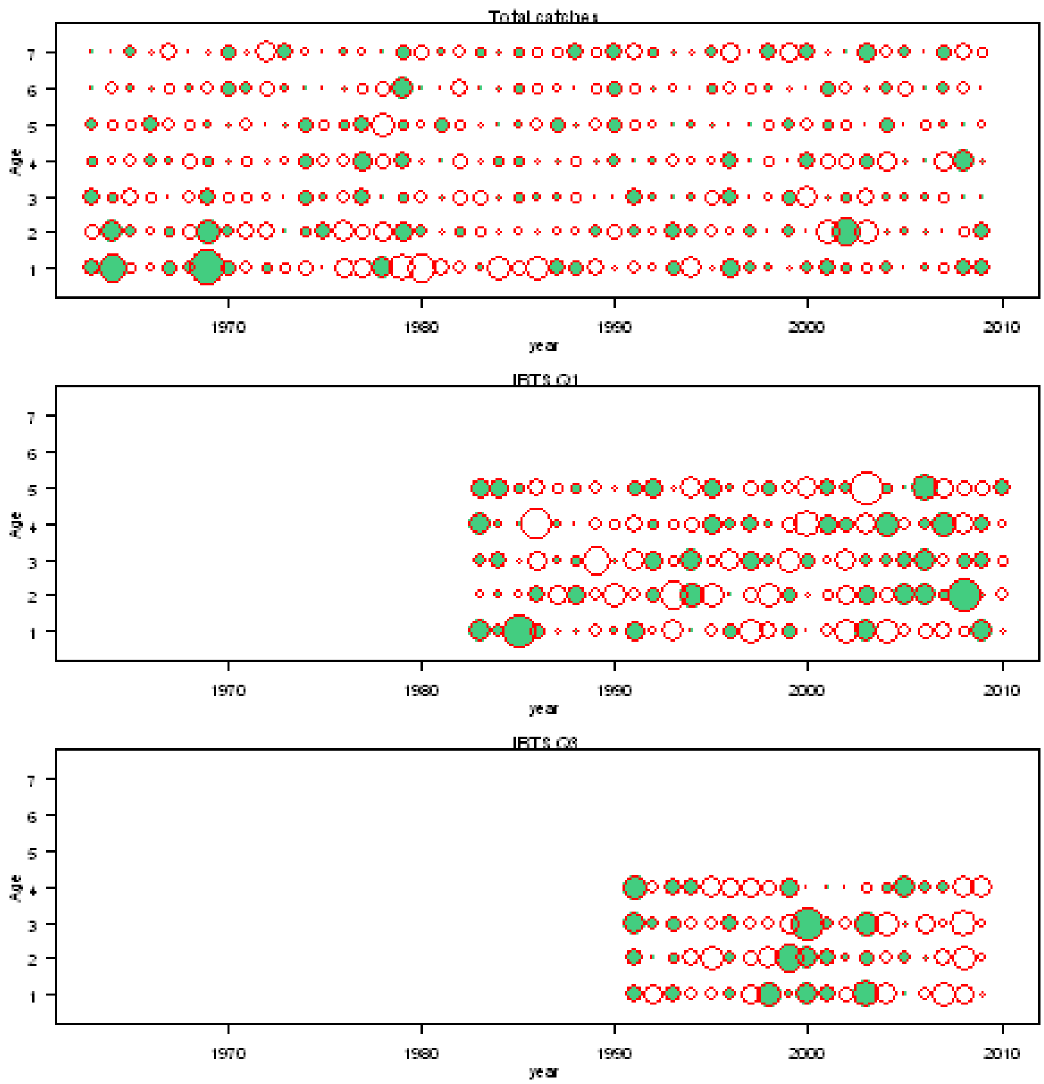

Figure 14.11 Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId. Normalized residuals for the SAM model, for total catch, IBTSQ1 and IBTSQ3. Empty circles indicate a positive residual and filled circles negative residual.

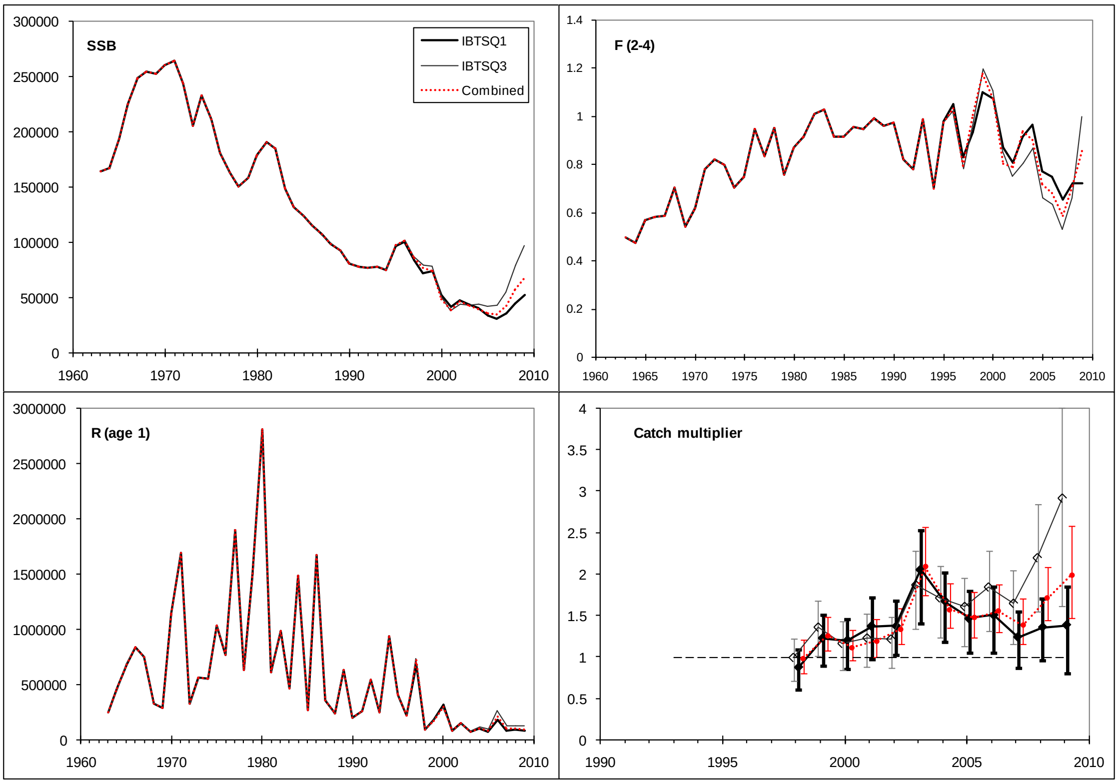

Figure 14.12 Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId. Median of bootstrap estimates of spawning stock biomass (SSB), recruitment (R (age 1)), average fishing mortality (F (2-4)) and the catch multiplier for B-ADAPT single fleet runs for the IBTSQ1 and Q3 groundfish surveys. The error bars in the catch multiplier plot indicate 5th and 95th percentiles. The base run (see Figure 14.15), which combines both surveys, is also shown as a broken red line.

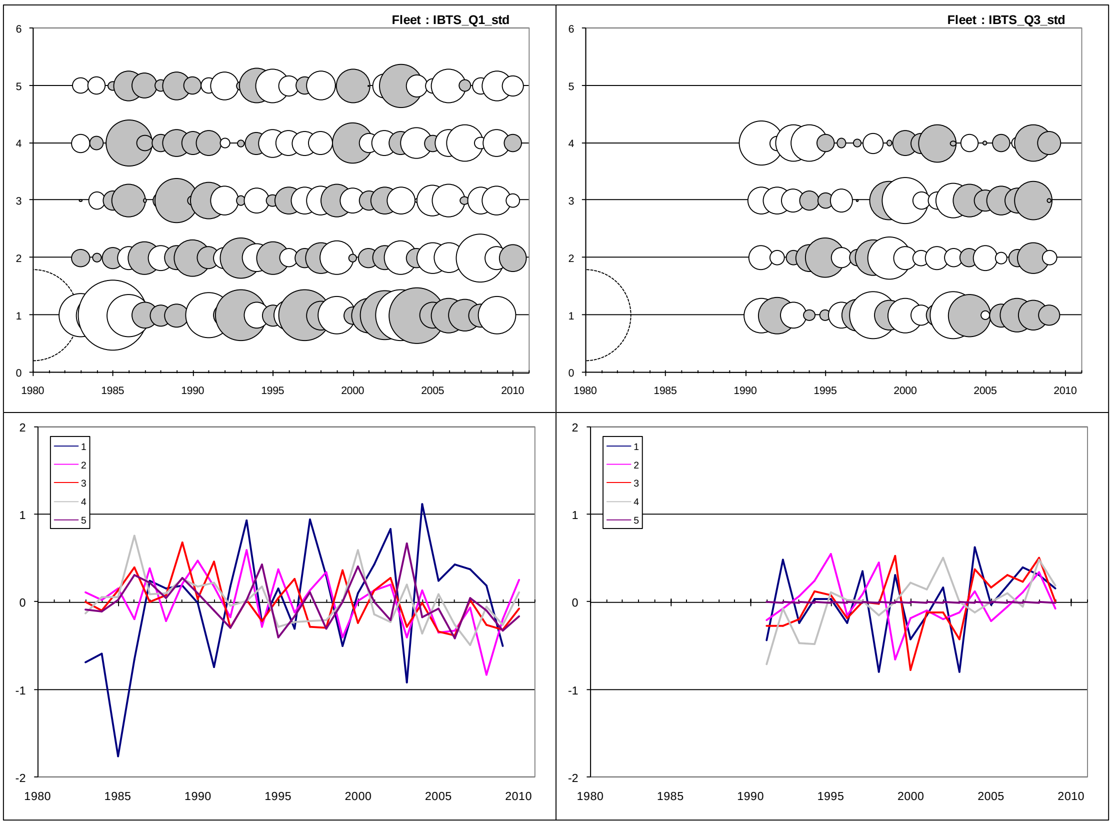

Figure 14.13 Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId. Residual plots for the B-Adapt base run. In the top row grey bubbles indicate positive values, and white ones negative. The partially displayed dotted bubble indicates an absolute residual of size 3. The bottom row provides an alternative display of the residuals.

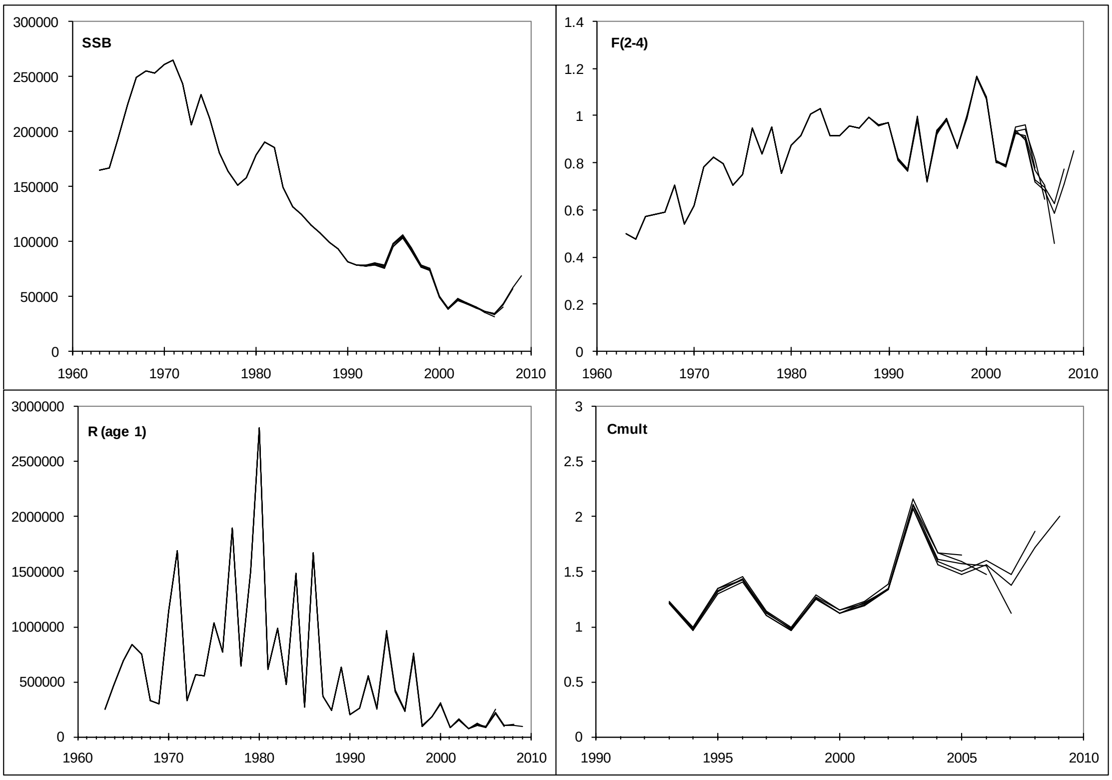

Figure 14.14 Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId. 5-year retrospective plots of median bootstrap values for SSB, Recruitment (age 1), F(2-4) and the catch multiplier for B-Adapt base run.

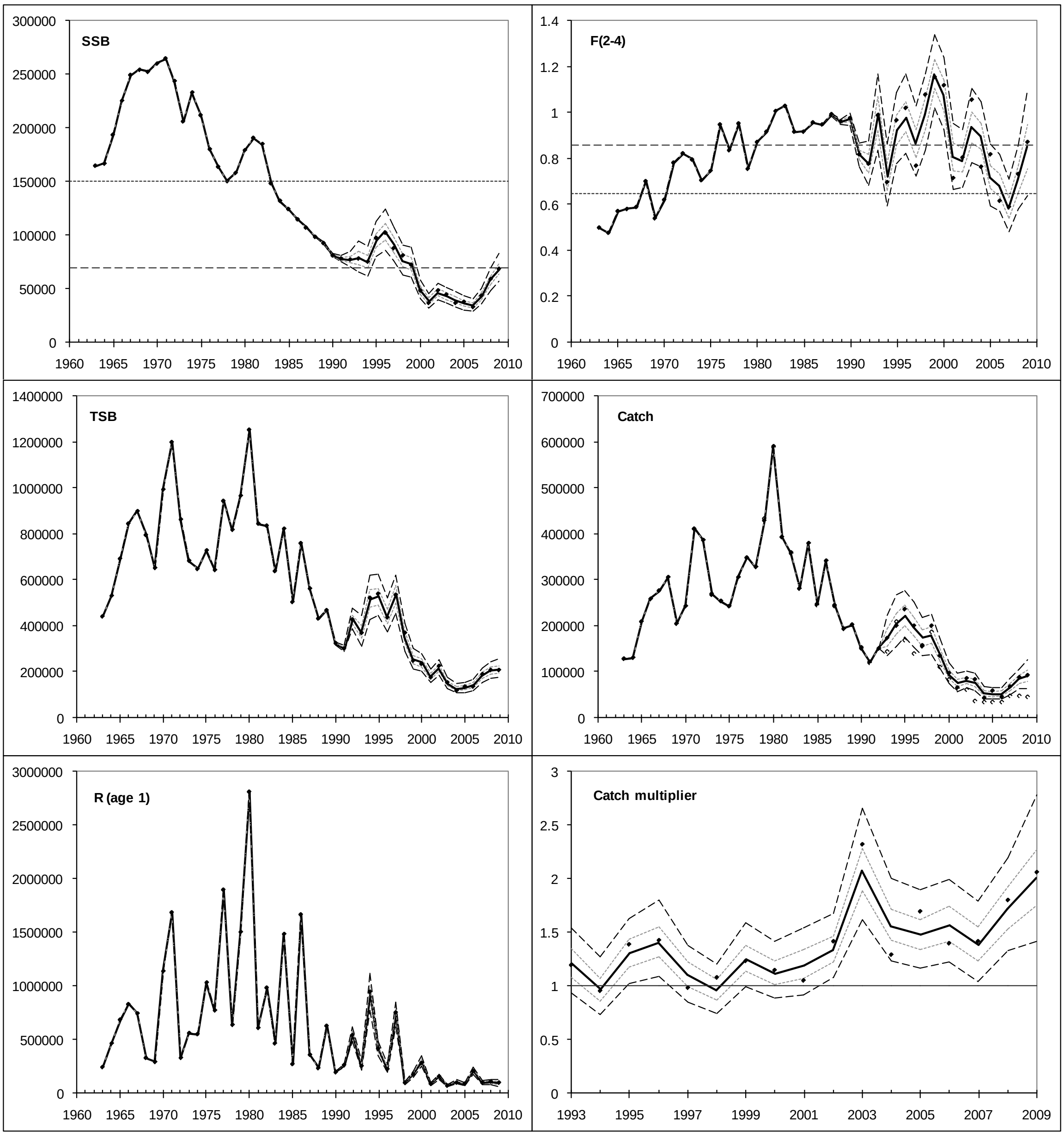

Figure 14.15 Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId. Clockwise from top left, percentiles (5,25,50,75,95) of the estimated spawning stock biomass (SSB), total stock biomass (TSB), recruitment (R(age 1)), the catch multiplier, catch and mean fishing mortality for ages 2-4 (F(2-4)), from the B-ADAPT update run. The heavy lines represent the bootstrap median, the light broken lines the 25th and 75th percentiles and the heavy broken lines the 5th and 95th percentiles. The solid diamonds represent point estimates, and the open diamonds given in the catch plot the recorded total catch. The horizontal broken lines in the SSB plot indicate Blim=70 000t and Bpa=150 000t, and those in the F(2-4) plot Fpa=0.65 and Flim=0.86. The horizontal solid line in the catch multiplier plot indicates a multiplier of 1. Catch, SSB and TSB are in tons, and R in thousands.

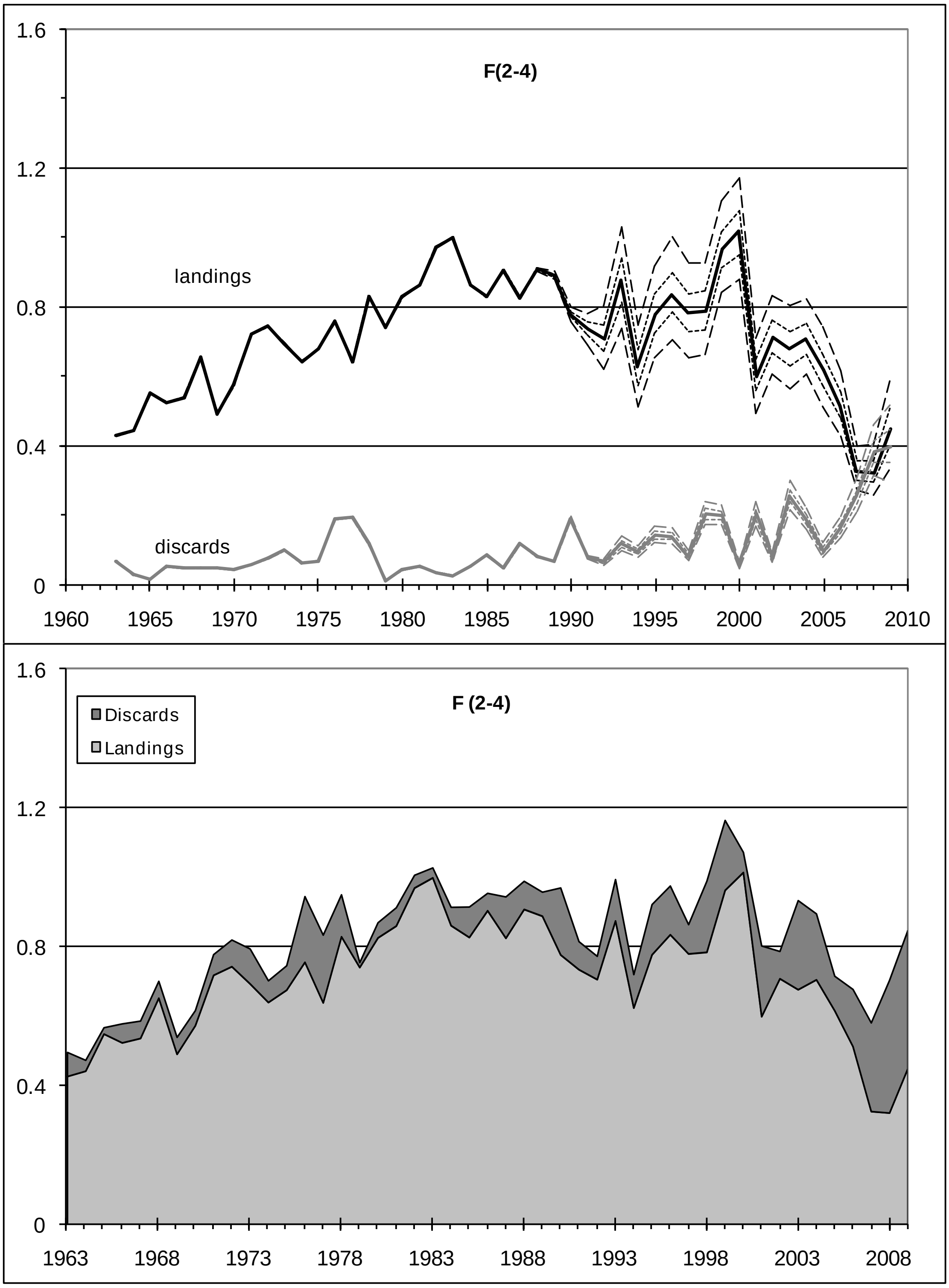

Figure 14.16 Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId. The mean fishing mortality for ages 2-4 (F(2-4)) shown in Figure 14.15, but split into landings and discards components by using ratios calculated from the landings and discards numbers at age from the reported catch data. The top panel shows bootstrap medians (heavy lines) with 25th and 75th percentiles (light broken lines), and 5th and 95th percentiles (heavy broken lines), while the bottom panel shows a stacked-area plot of the bootstrap medians.

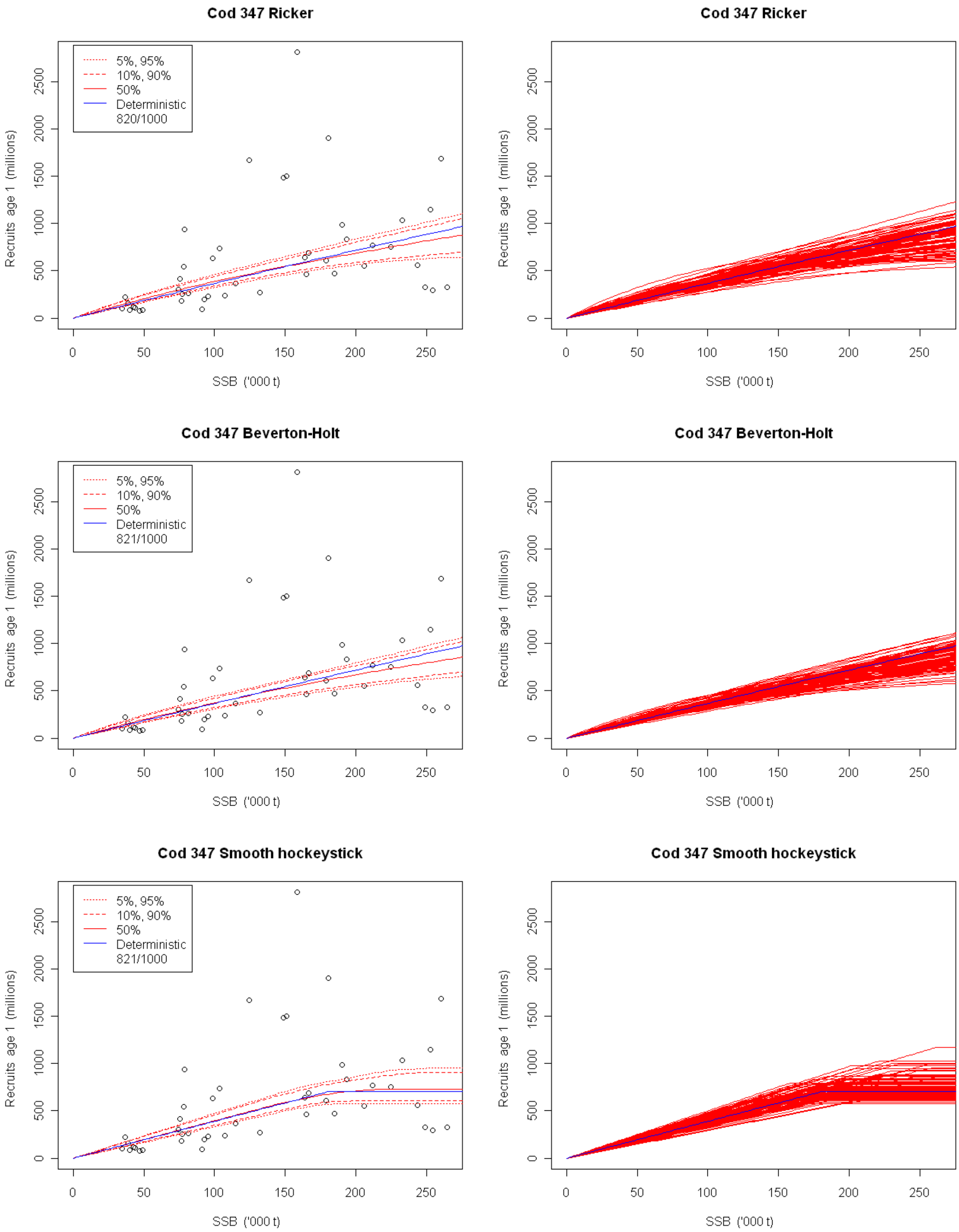

Figure 14.17 Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId. Ricker, Beverton-Holt and smooth hockeystick model fits to stock assessment data (from ICES-WGNSSK 2009), together with the uncertainty inherent in the estimation of these curves. The left hand curves in each figure illustrate the confidence intervals from X/1000 re-samples (printed at the bottom of the legend) from the MCMC chain; where X (recorded in the legend) represents the number of successful samples in which Fcrash and FMSY are well defined (only these samples are used in the diagnostic and yield plots). The right hand figures present curves plotted from the first 100 successful re-samples for illustration. The blue line indicates a deterministic estimate, separate from the MCMC chain.

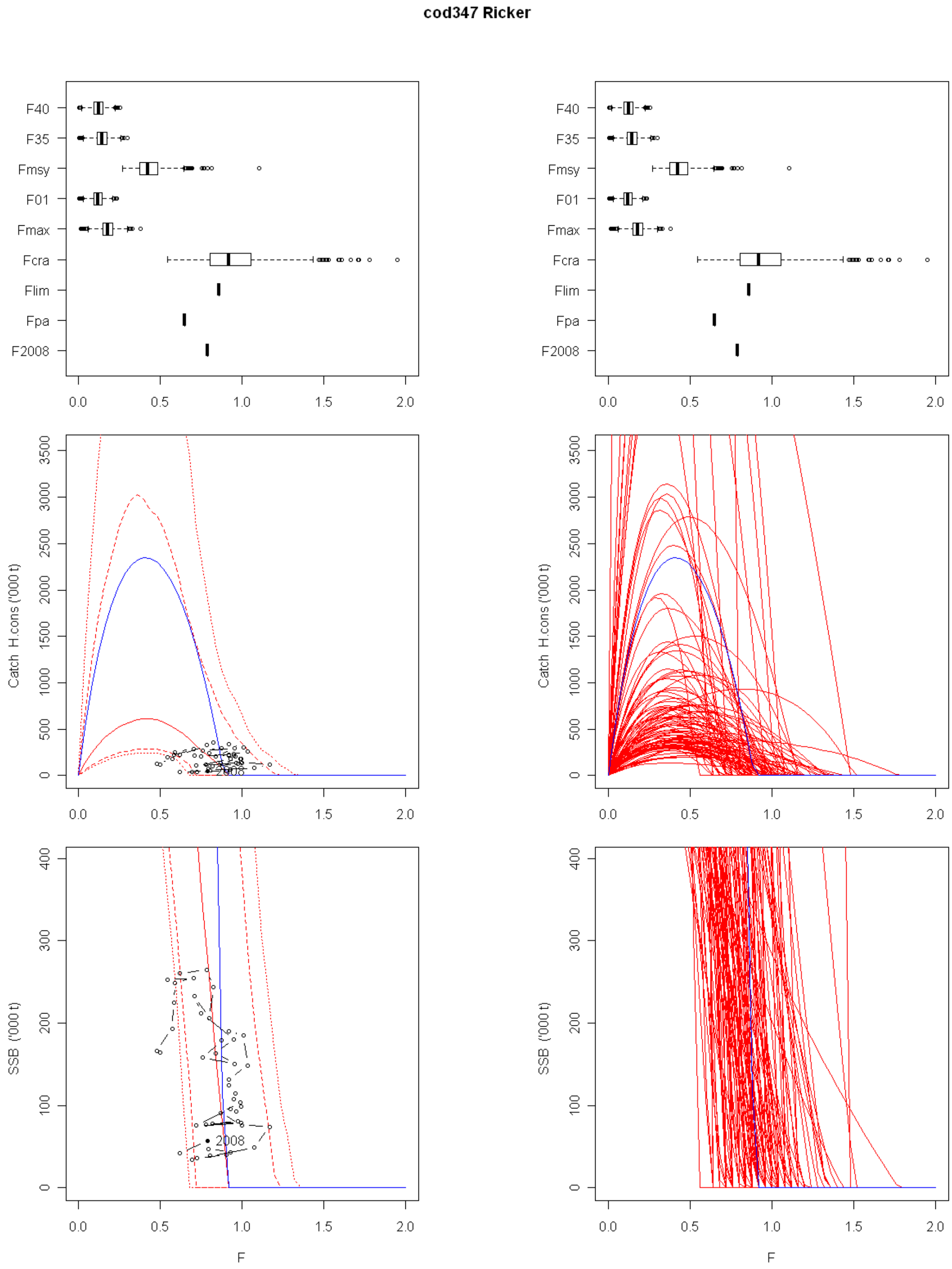

Figure 14.18 Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId. Ricker stock-recruit model estimates: (a) Box plots of Fmsy and Fcrash with proxies for Fmsy based on the yield per recruit: Fmax, F0.1, F35% and F40% SPR, and also Flim, Fpa and F in the final year for comparison; (b) equilibrium landings versus fishing mortality; (c) equilibrium SSB versus fishing mortality. Assessment data points are included in the two bottom left-hand plots for comparison. See Figure 14.19 for further details.

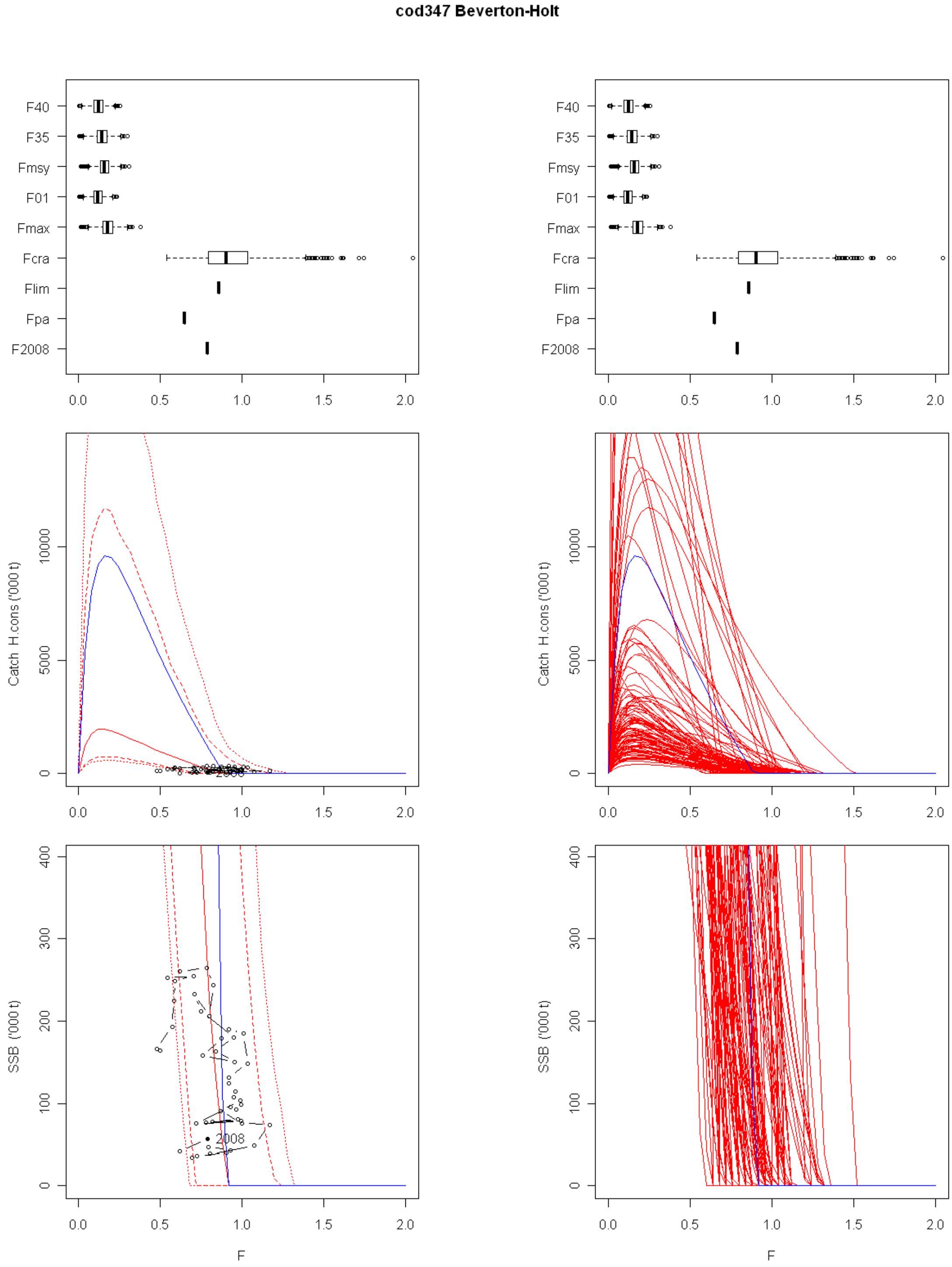

Figure 14.19 Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId. Beverton-Holt stock-recruit model estimates: (a) Box plots of Fmsy and Fcrash with proxies for Fmsy based on the yield per recruit: Fmax, F0.1, F35% and F40% SPR, and also Flim, Fpa and F in the final year for comparison; (b) equilibrium landings versus fishing mortality; (c) equilibrium SSB versus fishing mortality. Assessment data points are included in the two bottom left-hand plots for comparison. See Figure 14.19 for further details.

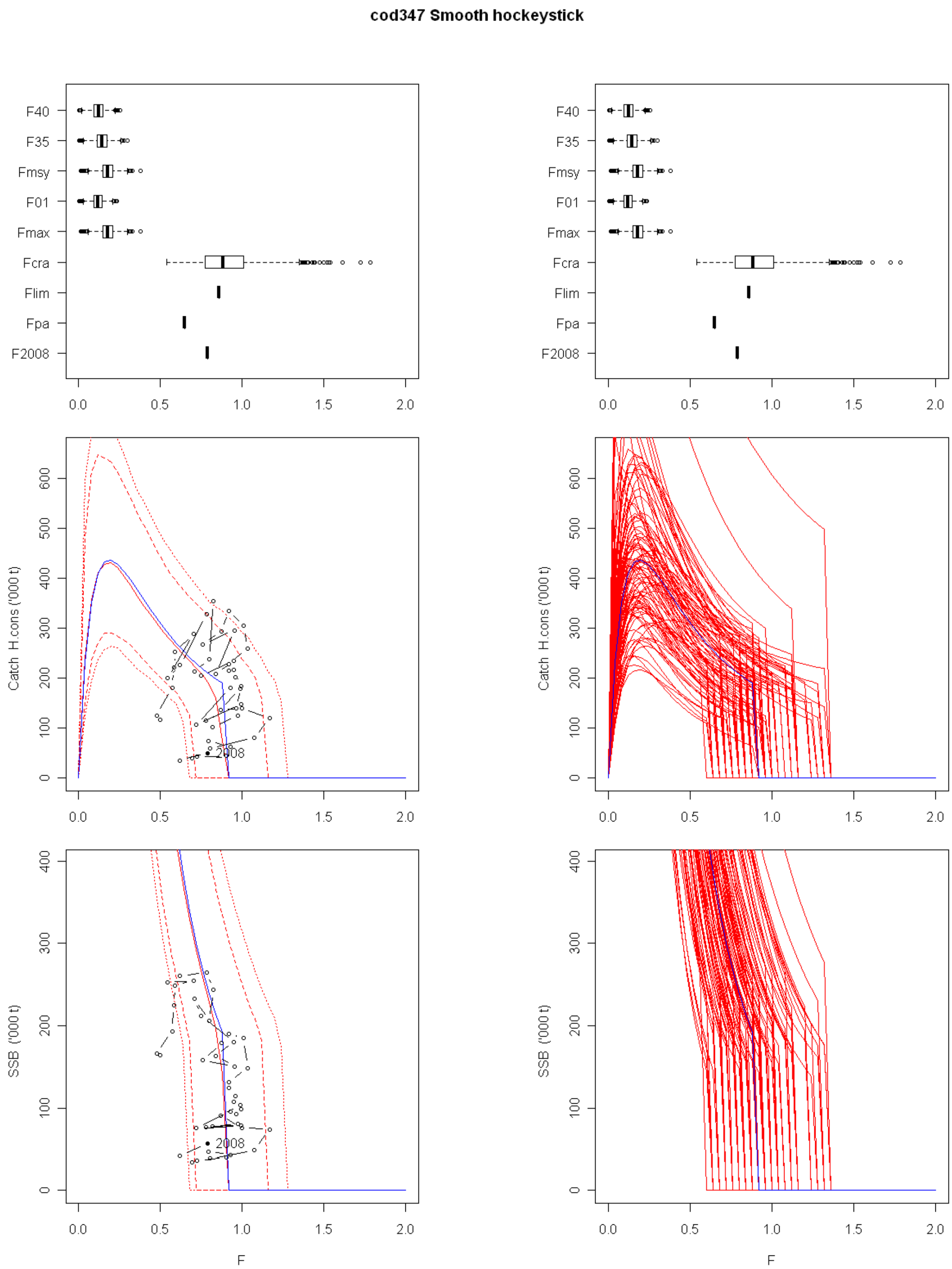

Figure 14.20 Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId. Smooth hockestick stock-recruit model estimates: (a) Box plots of Fmsy and Fcrash with proxies for Fmsy based on the yield per recruit: Fmax, F0.1, F35% and F40% SPR, and also Flim, Fpa and F in the final year for comparison; (b) equilibrium landings versus fishing mortality; (c) equilibrium SSB versus fishing mortality. Assessment data points are included in the two bottom left-hand plots for comparison. See Figure 14.19 for further details.

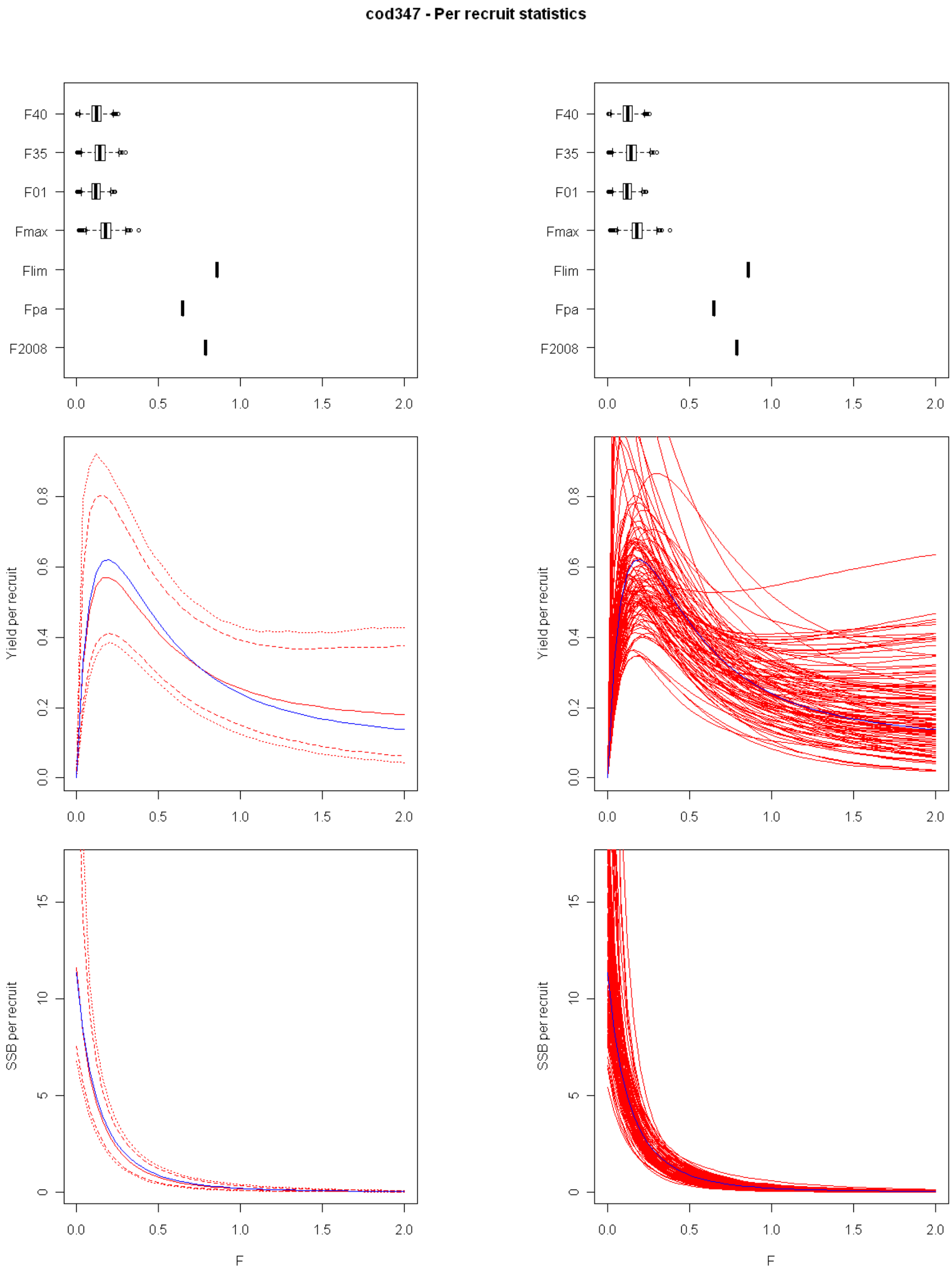

Figure 14.21 Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId. Yield per recruit estimates: (a) box plots of the proxies for Fmsy: Fmax, F0.1, F35% and F40% SPR, and also Flim, Fpa and F in the final year for comparison; (b) landings yield per recruit (kg); (c) SSB per recruit (kg).

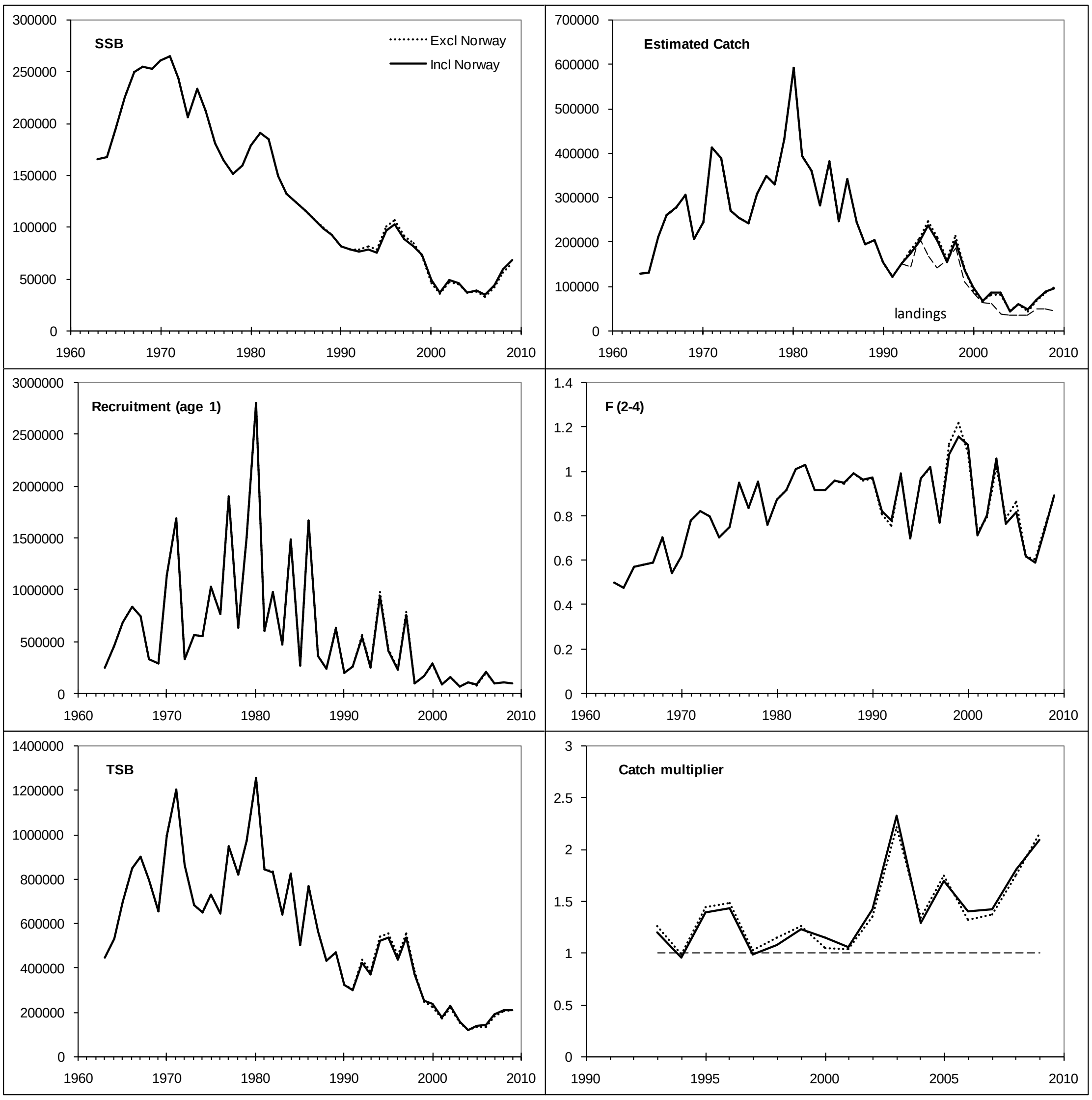

Figure 14.22 Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId. Comparison of the point estimates of spawning stock biomass (SSB), total stock biomass (TSB), recruitment (R(age 1)), the catch multiplier, catch and mean fishing mortality for ages 2-4 (F(2-4)) from the update assessment, where the Norway surveys are included/excluded from the IBTS Q3 index.

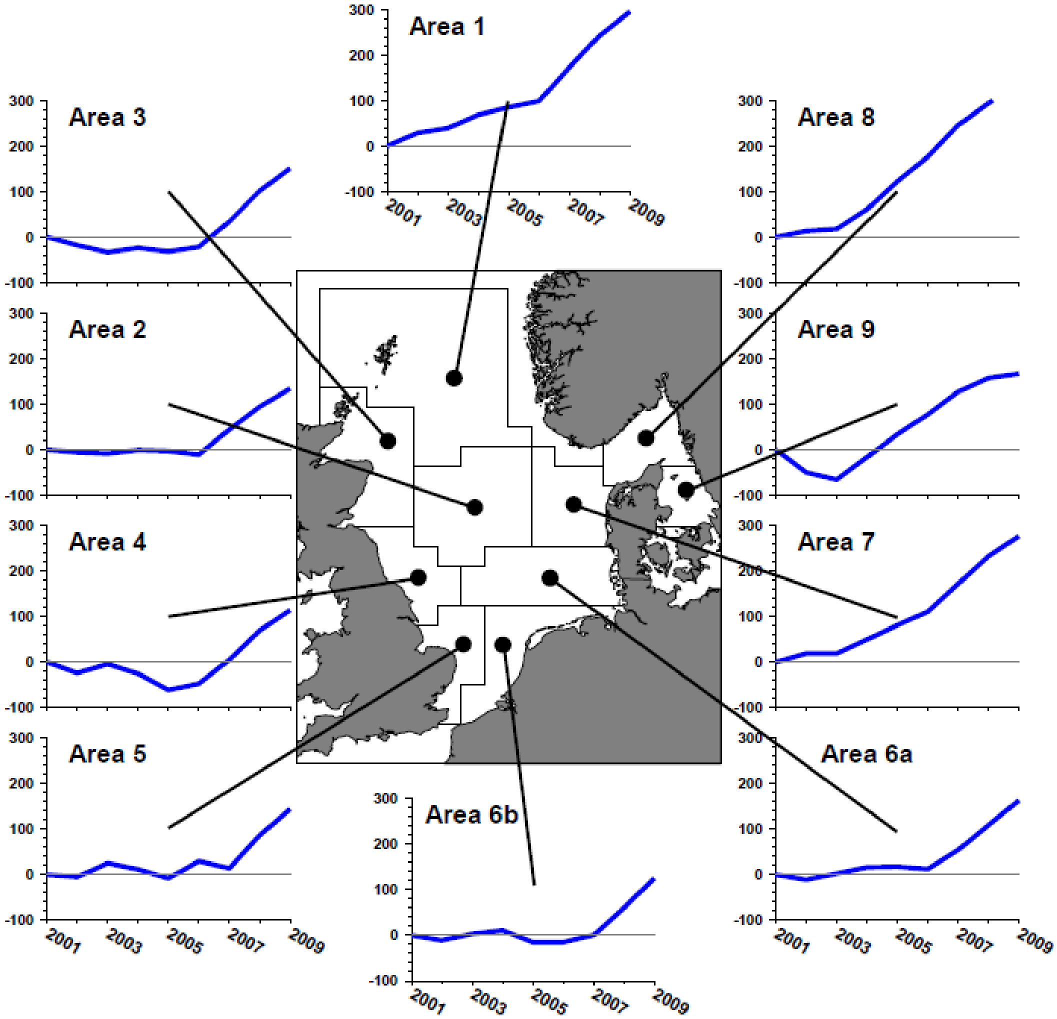

Figure 14.23 Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId. The North Sea Stock Survey fishers perception of the change abundance of North Sea cod since 2003 (Napier 2009).

Annex 1 – List of Participants

Working Group on the Assessment of Demersal Stocks in the North Sea and Skagerrak

5 - 11 May 2010**

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Annex 2 – Update forecasts and assessments

2.1 Summary

The Working Group on the Assessment of Demersal Stocks in the North Sea and Skagerrak [WGNSSK] (Chair: Ewen Bell, UK and Clara Ulrich, DK) met by correspondence at the beginning of October 2010 to evaluate new information from the fisheries independent surveys carried out during 2010 subsequent to the meeting of the group in May.

The WGNSSK followed the protocol defined by the Ad hoc Group on Criteria for Reopening Fisheries Advice (AGCREFA; ICES CM 2008/ACOM:60) in its evaluation of the survey information - fitting the RCT3 regression model to data that included the 2010 survey information to estimate the 2010 recruitment abundance and then comparing the prediction and its associated uncertainty with the estimate from previous surveys used as the basis for the ACOM spring advice.

Some problems occurred due to the sometimes late and incomplete submission of the data, and therefore the indices used in the current update must be considered as provisional and will likely be revised for the assessment in May next year.

The comparisons indicated that there was potential for re-opening of the advice for sole, resulting in the same TAC in 2011 as 2010 under the Management Plan. The estimates of recruitment for plaice and haddock are unchanged from the values used in the spring, as the estimate from the new information does not differ from the assumptions used in the spring forecast.

2.2 Cod in Sub-Area IV, VIID and IIIa

In addition to the results of the most recent survey being presented, the results of intercessional work on the assessment as carried out in May are presented which the group considers fundamental to the deliberations of ACOM in deciding whether to reopen the advice for North Sea Cod.

2.2.1 New survey information

Research surveys were conducted as part of the IBTS 3rd quarter survey of 2010. This survey, in conjunction with the IBTS quarter 1 survey, provides information on year class strength for the incoming year class (2009 year class) that could potentially be used in a TAC forecast. However, these surveys are not considered to provide reliable enough information on the incoming year class to be used in the TAC forecast, and the approach for North Sea cod has been to replace estimates of the incoming 2009 year class, and subsequent year classes, with re-sampled values from the 1997-2008 year classes. Nevertheless, an RCT3 analysis was conducted to see if the information on the 2009 year class provided by these surveys is significantly different to the median implied by the forecast re-sampling.

2.2.2 RCT3 Analysis

RCT3 was run using the new information from the surveys to predict recruitment at age 1 in 2010. The input data are presented in Table 2.2.1 and the output in Table 2.2.2.

2.2.3 Update protocol calculations

The recruitment at age 1 value for 2010 used in the forecast was 106684. This was based on values sampled from the 1997-2008 year classes, and was a median from the 1000 B-Adapt bootstraps. According to the protocol (AGCREFA), this is compared with the output from RCT3 as follows:

Log WAP = 11.89, internal s.e. = 0.4, D = 0.78

2.2.4 Forecast

The absolute value of D is less than 1, so under AGCREFA conditions this does not warrant consideration for re-opening the advice for North Sea cod. It should be noted, however, that re-opening the advice would not have been considered, regardless of the value of D, because the most recent survey estimates of age 1 receives no weight in the assessment, and do not feature in the TAC forecast as it is currently performed.

2.2.5 Conclusions on new recruitment estimates

Based on considering only the most recent estimate of age 1 in the surveys as a criteria for re-opening advice, it is not appropriate to re-open advice for North Sea cod because the absolute value of D is less than 1, and because the most recent survey estimates of age 1 do not feature in either the assessment or the TAC forecast.

2.2.6 Additional information concerning the uncertainty in North Sea cod assessment

A major issue encountered by the WGNSSK in its May meeting has been the uncertainty around North Sea cod assessment. The main issue identified in this time was the lack of consistency between the abundance indices measured by IBTS Q1 and IBTS Q3 respectively. Since these conflicting trends are being treated differently in different assessment models, this led to substantial differences in the final year estimates between B-Adapt and SAM. As a consequence, the status of the stock is considered uncertain, even though it can be considered with high certainty to be much lower than historical records.

Some intercessional was performed between the May meeting and the updated process in October (, section 2.9), where it is observed a change in the spatial distribution of cod in IBTS Q3 for ages 2+. Since this is only observed to a lower extent by IBTS Q1, this pattern change leads to high mortality estimates.

These findings are consistent with independent biological observations suggesting both a northwards migration of cod in the North Sea (e.g. Rindorf and Lewy, 2006) and the existence of more or less independent sub-stocks cod components in the North Sea, which are likely suffering different exploitation rates that could lead to local depletion. A second potential explanation for this change in pattern observed by the IBTS q3 survey would be a change in migration pattern for older fish in the southern North Sea whilst a third could be a change in catchability of older fish as a result of change in RV or gear configuration.

As noted by this WG in May, increases in fishing mortality rate and the level of unallocated mortality in recent years are considered highly uncertain; subsequent analysis has established that they are most likely an artefact of a change in the spatial distribution of cod in the third quarter that has occurred since 2004. WG considers that a detailed analysis is necessary, in order to investigate the consequences of these factors on the trends in assessment model estimates before the next assessment in May 2011.

Independent of the uncertainty in the recent survey data the stock is still estimated to be well below safe levels with low levels of recruitment and fishing mortality rates that are above the management plan target. ACOM advice in June noted that the uncertainty in recent trends in mortality rates and population abundance made no significant difference to the forecast levels of catches and biomass because estimates for the most recent years were very similar; this is also the case for the revised assessment structure.

Table 2.2.1 The RCT3 input data file updated with the North Sea cod CPUE from the third quarter IBTS surveys.

Cod NS & Skag. Age 1

2	26	2	
'Yearclass'	'Badapt'	'Q1_1'	'Q3_1'
1982	470856	4.734	-11
1983	1485857	15.856	-11
1984	272216	0.928	-11
1985	1668790	16.785	-11
1986	363028	9.425	-11
1987	238095	5.638	-11
1988	630948	15.117	-11
1989	199507	3.953	-11
1990	260126	2.481	8.17
1991	546515	13.129	43.487
1992	253683	13.088	10.473
1993	933220	14.66	42.737
1994	410258	9.832	22.282
1995	233787	3.441	10.283
1996	734884	39.951	60.518
1997	96056	2.672	2.397
1998	176681	2.112	11.952
1999	298594	6.563	10.689
2000	85979	2.786	4.723
2001	153946	7.755	11.334
2002	72800	0.584	1.735
2003	106957	6.74	12.178
2004	86305	2.272	4.745
2005	209886	6.642	15.215
2006	100583	3.091	9.101
2007	104946	2.694	9.228
2008	97958	1.23	6.926
2009	-11	4.8	7.283

Table 2.2.2 The RCT3 output file for North Sea cod.

```
Analysis by RCT3 ver3.1 of data from file :

 nscod2.txt

 Cod NS & Skag. Age 1

 Data for    2 surveys over   28 years :  1982 - 2009

 Regression type = C
 Tapered time weighting not applied
 Survey weighting not applied
 Final estimates not shrunk towards mean
 Estimates with S.E.'S greater than that of mean
+                                                   included
 Minimum S.E. for any survey taken as    .00
 Minimum of   3 points used for regression

 Forecast/Hindcast variance correction used.

 Yearclass =   2009

         I-----------Regression----------I  I-----------Prediction---------I

 Survey/  Slope  Inter-   Std  Rsquare  No.  Index Predicted   Std     WAP
 Series          cept   Error           Pts  Value   Value    Error   Weights

 Q1_1      1.45   9.71    .74   .596     27   1.76   12.26     .785     .254
 Q3_1      1.08   9.48    .42   .781     19   2.11   11.76     .459     .746

                                        VPA Mean =   12.44     .884     .000


 Year     Weighted       Log      Int      Ext     Var      VPA       Log
 Class     Average       WAP      Std      Std    Ratio               VPA
          Prediction             Error    Error

 2009      145639     11.89      .40      .22      .30
```

2.3 Haddock in Sub-Area IV and Division IIIa

2.3.1 New survey information

The new data available for a potential autumn forecast are the third-quarter groundfish surveys carried out by Scotland (ScoGFS) and England (EngGFS), and the international third-quarter IBTS survey (IBTS Q3). The latter is not used in the haddock assessment or forecast, and is not considered further here. The full available dataset for the ScoGFS and EngGFS series is given in Table 2.3.1. The following analysis compares the effect of the new survey data with the forecast provided by the relevant assessment Working Group (ICES-WGNSSK 2010), according to the protocol specified by the ICES Ad hoc Group on Criteria for Reopening Fisheries Advice (ICES-AGCREFA 2008). The Workshop on the Reopening Framework and the Frequency of the Assessment (WKFREQ) was to have considered potential revisions to the protocol, but was postponed until March 2011 at the earliest..

2.3.2 RCT3 analysis

Following the protocol stipulated by AGCREFA (ICES 2008), an RCT3 analysis was run to provide an estimate of the abundance of the incoming (2010) year class at age 0. The RCT3 input and output files are given in Tables 2.3.2 and 2.3.3.

Update protocol calculations

The outcome of the application of the protocol was as follows:

Calculations for 2010 year class	
Log WAP from RCT3	8.06
Log of recruitment assumed in spring	8.25
Int SE of log WAP	0.23
Distance D	**-0.82**

2.3.3 Conclusions from protocol

As the distance -1.0 < D < 1.0, the protocol concludes that **the advisory process for North Sea haddock should not be reopened.** The autumn indices suggest that the incoming year class is rather weaker than had been assumed in the forecast produced in May 2010 (since D < 0.0), but the difference is not significant enough to warrant reconsideration of the advice.

Table 2.3.1. Haddock in Sub-Area IV and Division IIIa. Indices from the third-quarter English (EngGFS) and Scottish (ScoGFS) groundfish survey series. New data from autumn 2009 are highlighted.

ENGGFS Q3 GOV							
1992	2010						
1	1	0.5	0.75				
0	6						
100	246.059	58.746	29.133	1.742	0.146	0.037	0.251
100	40.336	73.145	17.435	4.951	0.176	0.048	0.000
100	279.344	23.990	26.992	2.511	0.894	0.058	0.003
100	53.435	113.775	13.223	11.032	0.827	0.275	0.021
100	61.301	26.747	43.044	3.603	2.052	0.207	0.088
100	40.653	45.346	12.608	19.968	0.719	0.718	0.067
100	15.747	26.497	16.778	4.079	4.141	0.226	0.141
100	626.610	16.551	8.404	3.663	1.258	1.201	0.040
100	92.139	249.813	4.528	1.634	0.740	0.336	0.350
100	1.097	28.622	96.498	3.039	0.828	0.350	0.135
100	2.721	3.954	22.559	60.583	0.542	0.097	0.153
100	3.199	6.015	1.247	13.967	45.079	0.719	0.026
100	3.398	6.599	3.864	0.448	6.836	17.406	0.217
100	122.383	9.740	5.992	2.584	1.249	6.617	3.654
100	12.838	54.403	3.226	1.137	0.426	0.148	0.861
100	8.463	10.628	43.401	1.402	0.624	0.092	0.078
100	2.613	6.494	5.801	18.534	0.727	0.266	0.137
100	28.978	5.532	6.781	4.636	7.147	0.108	0.099
100	**3.065**	**46.229**	**2.959**	**2.103**	**2.175**	**3.716**	**0.284**

SCOGFS Q3 GOV							
1998	2010						
1	1	0.5	0.75				
0	6						
100	3280	6349	1924	490	511	24	18
100	66067	1907	1141	688	197	164	6
100	11902	30611	460	221	130	73	27
100	79	3790	11352	179	65	40	18
100	2149	675	2632	6931	70	37	18
100	2159	1172	307	2092	4344	22	17
100	1729	1198	547	101	819	1420	9
100	19708	761	657	153	112	347	483
100	2280	7275	272	158	33	14	73
100	1119	1810	5527	117	57	11	5
100	1885	733	1002	2424	28	24	6
100	9015	877	547	469	1185	37	8
100	**115**	**8328**	**680**	**297**	**303**	**811**	**4**

Table 2.3.2. Haddock in Sub-Area IV and Division IIIa. RCT3 input file. Data from surveys in autumn 2009 are highlighted in bold.

HADDOCK IN IV, RCT3 INPUT VALUES									
8	30	2							
'YEARCLASS'	'VPA'	'IBTS1'	'IBTS2'	'EGFS0'	'EGFS1'	'EGFS2'	'SGFS0'	'SGFS1'	'SGFS2'
1981	32619.403	-1	403.079	-1	-1	-1	-1	-1	-1
1982	20491.922	302.278	221.275	-1	-1	-1	-1	-1	-1
1983	66958.895	1072.285	833.257	-1	-1	-1	-1	-1	-1
1984	17181.545	230.968	266.912	-1	-1	-1	-1	-1	-1
1985	23921.369	573.023	328.062	-1	-1	-1	-1	-1	-1
1986	49039.922	912.559	677.641	-1	-1	-1	-1	-1	-1
1987	4156.493	101.691	98.091	-1	-1	-1	-1	-1	-1
1988	8337.572	219.705	139.114	-1	-1	-1	-1	-1	-1
1989	8606.453	217.448	134.076	-1	-1	-1	-1	-1	-1
1990	28354.085	680.231	331.044	-1	-1	29.133	-1	-1	-1
1991	27479.704	1141.396	519.521	-1	58.746	17.435	-1	-1	-1
1992	41901.153	1242.121	491.051	246.059	73.145	26.992	-1	-1	-1
1993	13129.112	227.919	201.069	40.336	23.990	13.223	-1	-1	-1
1994	56008.457	1355.485	813.268	279.344	113.775	43.044	-1	-1	-1
1995	14371.503	267.411	353.882	53.435	26.747	12.608	-1	-1	-1
1996	21449.472	849.943	420.926	61.301	45.346	16.778	-1	-1	1924.000
1997	12791.143	357.597	222.907	40.653	26.497	8.404	-1	6349.000	1141.225
1998	9948.546	211.139	107.060	15.747	16.551	4.528	3280.000	1907.141	460.380
1999	134816.209	3734.185	2255.213	626.610	249.813	96.498	66067.310	30610.761	11352.408
2000	26349.166	894.651	492.299	92.139	28.622	22.559	11902.085	3789.563	2632.471
2001	2829.047	58.211	38.585	1.097	3.954	1.247	78.620	674.629	306.570
2002	3740.286	89.958	79.622	2.721	6.015	3.864	2149.357	1171.747	547.075
2003	3903.706	71.875	60.993	3.199	6.599	5.992	2159.063	1197.900	657.000
2004	3841.042	69.976	47.784	3.398	9.740	3.226	1729.375	761.000	272.366
2005	39784.392	1212.163	963.325	122.383	54.403	43.401	19708.000	7274.775	5527.486
2006	8020.876	109.096	106.489	12.838	10.628	5.801	2280.197	1809.595	1002.000
2007	5148.801	60.115	140.045	8.463	6.494	6.781	1118.878	733.000	547.365
2008	3634.119	74.687	72.980	2.613	5.532	**2.959**	1885.000	877.189	**679.988**
2009	20203.448	685.730	-1	28.978	**46.229**	-1	9014.824	**8328.400**	-1
2010	-1	-1	-1	**3.065**	-1	-1	**115.438**	-1	-1

Table 2.3.3. Haddock in Sub-Area IV and Division IIIa. RCT3 output file.

```
Analysis by RCT3 ver3.1 of data from file :

 hadivrct.in

 HADDOCK IN IV, RCT3 INPUT VALUES


 Data for    8 surveys over   30 years :  1981 - 2010

 Regression type = C
 Tapered time weighting not applied
 Survey weighting not applied
 Final estimates not shrunk towards mean
 Estimates with S.E.'S greater than that of mean
+                                                   included
 Minimum S.E. for any survey taken as    .00
 Minimum of   3 points used for regression

 Forecast/Hindcast variance correction used.

 Yearclass =   2010

         I-----------Regression----------I  I-----------Prediction---------I

 Survey/  Slope  Inter-   Std  Rsquare  No.  Index Predicted   Std     WAP
 Series           cept   Error          Pts  Value   Value    Error   Weights

 IBTS1
 IBTS2
 EGFS0      .66   7.25    .21   .967     18   1.40    8.18     .236     .932
 EGFS1
 EGFS2
 SGFS0      .81   2.63    .67   .783     12   4.76    6.48     .876     .068
 SGFS1
 SGFS2

                                        VPA Mean =    9.63    1.016     .000


 Year     Weighted      Log      Int      Ext      Var      VPA       Log
 Class     Average      WAP      Std      Std     Ratio               VPA
          Prediction             Error    Error

 2010        3176      8.06      .23      .43     3.51
```

2.4 Saithe in Subarea IV, VI and Division IIIa

Since there was no assessment conducted in May 2010 due to a number of missing tuning data in 2009, no update was performed in October 2010.

2.5 Whiting in Sub-Area IV and VIID

2.5.1 Whiting in Sub-Area IV and Division IIIa

New survey information

Several research vessel surveys were conducted in the third quarter of 2010 combining to produce the 2010 Quarter 3 IBTS indices.

RCT3 analysis

Following the protocol stipulated by AGCREFA (ICES 2008), an RCT3 analysis was run to provide an estimate of the abundance of the incoming (2009) year class at age 1. The RCT3 input and output files are given in Tables 2.5.1 and 2.5.2.

Update protocol calculations

The outcome of the application of the protocol was as follows:

Calculations for 2009 year class	
Log WAP from RCT3	7.24
Log of recruitment assumed in spring	17.17
Int SE of log WAP	0.29
Distance D	**-0.73**

Conclusions from protocol

The value of D is not less than -1 and not greater than 1, so the most recent information is not sufficiently different from that available in May, 2010. Therefore the forecast from September still stands and the advice will not be reopened.

Table 2.5.1. Whiting in Sub-Area IV and Division VIId. RCT3 input file.

```
Whi4&7d (age 1)
1     20    2
1990  2929  703.37
1991  2801  600.87
1992  3110  638.72
1993  2894  677.65
1994  2540  619.79
1995  1764  545.71
1996  1358  332.97
1997  1957  330.60
1998  2975  1203.50
1999  3329  941.66
2000  2645  645.00
2001  2397  732.14
2002  865   246.16
2003  949   161.56
2004  1254  179.50
2005  1245  172.79
2006  1128  95.65
2007  2757  356.90
2008  2102  581.36
2009  -11   266.61
ibtsq3age1
```

```
Analysis by RCT3 ver3.1 of data from file :
 whiin2.dat
 Whi4&7d (age 1)
 Data for    1 surveys over   20 years :  1990 - 2009
 Regression type = C
 Tapered time weighting not applied
 Survey weighting not applied
 Final estimates not shrunk towards mean
 Estimates with S.E.'S greater than that of mean
+                                                    included
 Minimum S.E. for any survey taken as    .00
 Minimum of   3 points used for regression
 Forecast/Hindcast variance correction used.

 Yearclass =   2009

          I-----------Regression----------I  I-----------Prediction---------I

 Survey/  Slope  Inter-   Std  Rsquare   No.  Index Predicted   Std     WAP
 Series          cept    Error           Pts  Value   Value    Error   Weights
 ibtsq3    .75   3.08     .26    .748     19   5.59    7.25     .288    1.000
                                         VPA Mean =    7.59     .439     .000

 Year     Weighted      Log     Int     Ext     Var      VPA      Log
 Class     Average      WAP     Std     Std    Ratio              VPA
          Prediction           Error   Error

 2009        1403      7.25     .29     .00      .00
```

D = (7.25 – log(1725))/0.29= -0.70, negative signal, but no different from spring assumptions.

2.6 North Sea plaice

2.6.1 New survey information

The new survey information that is available comes from the Beam Trawl Survey (BTS), that was initiated in 1985 and was set up to obtain indices of the younger age groups of plaice and sole, covering the south-eastern part of the North Sea

This survey is usually conducted with the RV Isis (BTS-Isis). However, some technical issues occurred in 2010. During the third week of the survey it was not possible to fish due to bad weather. In the fourth week (of five) of the survey, the hydraulic system of RV Isis broke down. The priority stations were taken over by RV Tridens, using the RV Isis gear (an 8-m beam trawl with 40 mm stretched mesh codend); therefore, the index is calculated for the complete Isis index area.

2.6.2 RCT3 Analysis

The RCT3 analysis on the BTS ISIS survey indices for ages 1 and 2 was conducted as specified in the Report of the Ad hoc Group on Criteria for Reopening Fisheries Advice (AGCREFA; ICES CM 2008/ACOM:60). Hence, the specifications for the RCT3 were:

Regression type?	C
Tapered time weighting required?	N
Shrink estimates toward mean?	N
Exclude surveys with SE's greater than that of mean:	N
Enter minimum log S.E. for any survey:	0.0
Min. no. of years for regression (3 is the default)	3
Apply prior weights to the surveys?	N

The input data including the assessment estimates for the two ages are presented in Table 2.6.1. In 2010, the new data comprises age 1 of year class 2009 and age 2 of year class 2008. The last 4 years from the assessment estimates were removed from the time series.

2.6.3 Update protocol calculations

The outcomes from the RCT3 analyses for the two ages are presented in table 2.6.2. For age 1, the D value for this age indicates a slightly positive signal (D=+0.05), but since D<1 then it is not considered significantly different from the spring assumption. For age 2 the D value indicates a negative index (D=-0.46). As again this value is less than 1, it was not considered necessary to update the spring assessment. The full RCT3 analysis table is given in Table 2.6.3 and the revised recruitment estimates in Table 2.6.4.

2.6.4 Conclusions from protocol

If the TAC is advised according to the management plan, then the new option table results in a TAC advice that is equal to the advice of June 2009 (63 825 t). The rationale behind this is that The TAC is bound by the upper 15% TAC change constraint, at 63 825 t.

Following the AGCREFA protocol, the new available survey indices for North Sea plaice ages 1 and 2 do indicate an increase in abundance but the revised level of catch is constrained by the limitation on TAC change and there is no requirement to reopen the advice.

Table 2.6.1 North Sea plaice RCT3 input data

```
North Sea Plaice Age 1
1      26     2
1984   1848419       136.8
1985   4760609       667.4
1986   1962845       225.8
1987   1770461       680.2
1988   1186811       467.9
1989   1036516       185.3
1990   914585 291.4
1991   776744 360.9
1992   530684 189.0
1993   442947 193.3
1994   1164164       265.6
1995   1290364       310.3
1996   2155842       1046.8
1997   774928 347.6
1998   840878 293.3
1999   991191 267.5
2000   540350 206.5
2001   1726207       519.2
2002   537804 132.8
2003   1248173       233.7
2004   791655 163.0
2005   922375 128.6
2006   -11           312.0
2007   -11           221.6
2008   -11           409.0
2009   -11           261.1
BTS1

North Sea Plaice Age 2
1      26     2
1983   843888 173.893
1984   1286790       131.704
1985   3243133       764.186
1986   1432168       146.993
1987   1270384       319.272
1988   869783 146.071
1989   798177 159.424
1990   651967 174.526
1991   567595 283.400
1992   385219 77.139
1993   340377 40.618
1994   932940 206.883
1995   1060695       59.241
1996   1827459       402.657
1997   601558 121.551
1998   639225 69.252
1999   795939 72.236
2000   455774 44.475
2001   1266052       159.120
2002   421550 39.623
2003   907301 66.176
2004   624505 36.385
2005   624515 67.169
2006   -11           120.728
2007   -11           105.222
2008   -11           84.254
BTS2
```

Table 2.6.2 North Sea plaice RCT3 output for age 1 and 2 and D calculation

D calculation North Sea plaice age 1

```
Analysis by RCT3 ver3.1 of data from file : ple_iv1.txt, NS Plaice Age 1, 1
surveys over 1984 - 2009

Regression type = C, Tapered time weighting not applied, Survey weighting not
applied
Final estimates not shrunk towards mean
Estimates with S.E.'S greater than that of mean
+                                                   included
Minimum S.E. for any survey taken as     .03, Minimum of    3 points used for
regression
Forecast/Hindcast variance correction used.

2009     I-----------Regression----------I  I-----------Prediction---------I

Survey/  Slope  Inter-   Std  Rsquare  No.  Index Predicted   Std     WAP
Series           cept   Error          Pts  Value   Value    Error   Weights
BTS1     1.67   4.45    .77   .354     22   5.57   13.77     .830    1.000

                                      VPA Mean =   13.90     .559     .000

Year     Weighted      Log     Int
Class     Average      WAP     Std
          Prediction           Error
 2009   956823     13.77     .83

Plaice age 1 D= (13.77 - log( 915040 ))/0.83  =  0.05.
```

D calculation North Sea plaice age 2

```
Analysis by RCT3 ver3.1 of data from file : ple_iv2.txt, NS Plaice Age 2, Data
for 1 surveys over:  1983 - 2008

Regression type = C, Tapered time weighting not applied, Survey weighting not
applied
Final estimates not shrunk towards mean
Estimates with S.E.'S greater than that of mean
+                                                   included
Minimum S.E. for any survey taken as     .00, Minimum of    3 points used for
regression

Forecast/Hindcast variance correction used.

2008     I-----------Regression----------I  I-----------Prediction---------I

Survey/  Slope  Inter-   Std  Rsquare  No.  Index Predicted   Std     WAP
Series           cept   Error          Pts  Value   Value    Error   Weights

BTS2       .90   9.32    .49   .547     23   4.45   13.32     .528    1.000

                                       VPA Mean =   13.62     .529     .000


Year     Weighted      Log     Int
Class     Average      WAP     Std
         Prediction           Error

2008      608350     13.32     .53

Plaice age 2 D= (13.32 - log(778204 ))/0.53=  -0.46.
```

2.7 North Sea sole

2.7.1 New survey information

The new survey information that is available comes from the Sole Net Survey (SNS) and the Beam Trawl Survey (BTS). The BTS was initiated in 1985 and was set up to obtain indices of the younger age groups of plaice and sole, covering the south-eastern part of the North Sea

The BTS survey is usually conducted with the RV Isis (BTS-Isis). However, some technical issues occurred in 2010. During the third week of the survey it was not possible to fish due to bad weather. In the fourth week (of five) of the survey, the hydraulic system of RV Isis broke down. The priority stations were taken over by RV Tridens, using the RV Isis gear (an 8-m beam trawl with 40 mm stretched mesh codend); therefore, the index is calculated for the complete Isis index area.

The use of the SNS in the update forecast for this stock is a departure from what was done in previous years. These additional data are available due to the additional week in getting the updates out this year (due to late changes in the IBTS). The calculations using only the BTS would have resulted in TAC advice for 2011 being considerably different (>15kt as opposed to 14.1kt), therefore demonstrating that in order for the updated advice to be as robust as possible we should wait for the SNS to be ready.

2.7.2 RCT3 Analysis

The RCT3 analysis on the SNS and BTS ISIS survey indices for ages 1 and 2 was conducted as specified in the Report of the Ad hoc Group on Criteria for Reopening Fisheries Advice (AGCREFA; ICES CM 2008/ACOM:60). Hence, the specifications for the RCT3 were:

Regression type?	C
Tapered time weighting required?	N
Shrink estimates toward mean?	N
Exclude surveys with SE's greater than that of mean:	N
Enter minimum log S.E. for any survey:	0.0
Min. no. of years for regression (3 is the default)	3
Apply prior weights to the surveys?	N

The input data including the assessment estimates for the two ages are presented in Table 2.7.1. In 2009, the new data comprises age 1 of year class 2009 and age 2 of year class 2008. The last 4 years from the assessment estimates were removed from the time series.

2.7.3 Update protocol calculations

The outcomes from the RCT3 analyses for the two ages are presented in table 2.7.2. For age 1, the D value for this age indicates a strongly positive signal (D=2.40). As this value is largely above 1, the forecast should be recalculated. For age 2 the D value was -1.21 indicating a strong negative revision of the year class compared to the spring assessment. The full RCT3 analysis table is given in Table 2.7.3 and the revised recruitment estimates in Table 2.7.4.

The input to the North Sea sole forecast is provided in Tables 2.7.5, the detailed output in Table 2.7.6 and the short term management summary table in Table 2.7.7.

2.7.4 Conclusions from protocol

Following the AGCREFA protocol, the new available survey indices for North Sea sole ages 1 and 2 indicate a large increase in estimated recruitment using the new information and the forecast should be recalculated.

As a result of this, TAC advice under the various scenarios increases substantially. As an example, the advice according to the management plan, which was 13.6 kt in June, and would now be 14.1 kt, and now implies a 0% change on the 2010 value.

Table 2.7.1 North Sea sole RCT3 input data

```
Sole    North   Sea     Age     1
3       40      2
1970    42107   -11     903     -11
1971    76403   -11     1455    -11
1972    105045  -11     5587    -11
1973    109975  -11     2348    -11
1974    40825   -11     525     -11
1975    113295  168.84  1399    -11
1976    140307  82.28   3743    -11
1977    47127   33.8    1548    -11
1978    11664   96.87   94      -11
1979    151574  392.08  4313    -11
1980    148896  404     3737    -11
1981    152374  293.93  5856    -11
1982    141488  328.52  2621    -11
1983    70850   104.38  2493    -11
1984    81670   186.53  3619    7.03
1985    159308  315.03  3705    7.17
1986    72702   73.22   1948    6.97
1987    455761  523.86  11227   83.11
1988    108274  50.07   2831    9.01
1989    177524  77.8    2856    37.84
1990    70435   21.09   1254    4.03
1991    353383  391.93  11114   81.63
1992    69162   25.3    1291    6.35
1993    56976   25.13   652     7.66
1994    95962   69.11   1362    28.13
1995    49342   19.07   218     3.98
1996    270702  59.62   10279   169.34
1997    113617  44.08   4095    17.11
1998    82211   -11     1649    11.96
1999    123072  -11     1639    14.59
2000    62890   15.51   970     8
2001    183396  85.31   7547    20.99
2002    83962   64.97   -11     10.51
2003    44153   16.8    1370    4.19
2004    48196   40.1    568     5.53
2005    216019  46.81   2726    17.09
2006    -11     14.69   849     7.5
2007    -11     23.51   1259    15.25
2008    -11     26.74   1932    15.95
2009    -11     25.36   2637    54.811
DFS0
SNS1
BTS1
```

Table 2.7.1 (continued) North Sea sole RCT3 input data

Sole North Sea-Age 2

Sole North Sea Age 2

5 40 2

1970	37700	-11	903	272	-11	-11
1971	68792	-11	1455	935	-11	-11
1972	94380	-11	5587	61	-11	-11
1973	99414	-11	2348	864	-11	-11
1974	36689	-11	525	74	-11	-11
1975	101523	168.84	1399	776	-11	-11
1976	125294	82.28	3743	1355	-11	-11
1977	42617	33.8	1548	408	-11	-11
1978	10546	96.87	94	89	-11	-11
1979	136544	392.08	4313	1413	-11	-11
1980	134324	404	3737	1146	-11	-11
1981	135343	293.93	5856	1123	-11	-11
1982	127653	328.52	2621	1100	-11	-11
1983	63926	104.38	2493	716	-11	7.121
1984	73741	186.53	3619	458	7.03	5.183
1985	143792	315.03	3705	944	7.17	12.548
1986	65694	73.22	1948	594	6.97	12.512
1987	412380	523.86	11227	5005	83.11	68.084
1988	97859	50.07	2831	1120	9.01	24.487
1989	159810	77.8	2856	2529	37.84	28.841
1990	63618	21.09	1254	144	4.03	22.284
1991	318822	391.93	11114	3420	81.63	42.345
1992	62529	25.3	1291	498	6.35	7.121
1993	50871	25.13	652	224	7.66	8.458
1994	82263	69.11	1362	349	28.13	7.634
1995	44482	19.07	218	154	3.98	4.919
1996	243429	59.62	10279	3126	169.34	27.422
1997	102573	44.08	4095	972	17.11	18.363
1998	74114	-11	1649	126	11.96	6.144
1999	109124	-11	1639	655	14.59	9.963
2000	56064	15.51	970	379	8	4.182
2001	164940	85.31	7547	-11	20.99	9.947
2002	74975	64.97	-11	624	10.51	4.354
2003	39460	16.82	1370	163	4.19	3.395
2004	42510	40.1	568	117	5.53	2.332
2005	188980	46.81	2726	911	17.09	19.504
2006	-11	14.69	849	259	7.5	9.062
2007	-11	23.51	1259	344	15.25	4.999
2008	-11	26.74	1932	237	15.95	10.707
2009	-11	25.36	2637	-11	54.81	-11

DFS0
SNS1
SNS2
BTS1
BTS2

Table 2.7.2 North Sea sole RCT3 analysis and D value with the new survey

D calculation North Sea sole age 1

```
Analysis by RCT3 ver3.1 of data from file : altin_1.txt, NS Sole Age 1, 2 sur-
veys over 1984 - 2009

Regression type = C, Tapered time weighting not applied, Survey weighting not
applied
Final estimates not shrunk towards mean
Estimates with S.E.'S greater than that of mean
+                                                    included
Minimum S.E. for any survey taken as    .03, Minimum of   3 points used for
regression

Forecast/Hindcast variance correction used.

2009      I-----------Regression----------I  I-----------Prediction---------I

Survey/  Slope  Inter-   Std  Rsquare  No.  Index Predicted   Std     WAP
Series           cept   Error          Pts  Value   Value    Error   Weights

BTS1       .77   9.50    .39   .751     22   4.02   12.62     .432     .486
SNS1       .76   5.79    .39   .756     21   7.88   11.74     .420     .514

                                        VPA Mean =   11.59     .656     .000


Year     Weighted      Log     Int     Ext     Var
Class     Average      WAP     Std     Std     Ratio
         Prediction           Error   Error

2009      192112      12.17     .30     .44     2.11
```

Sole age 1 D = (12.17 - log(**94000**))/0.30 = 2.40 strong positive signal, different from spring assumptions

D calculation North Sea sole age 2

```
Analysis by RCT3 ver3.1 of data from file : altin_2.txt, NS Sole-Age 2, 2 sur-
veys over 1983 - 2008

Regression type = C, Tapered time weighting not applied, Survey weighting not
applied
Final estimates not shrunk towards mean
Estimates with S.E.'S greater than that of mean
+                                                    included
Minimum S.E. for any survey taken as    .03, Minimum of   3 points used for
regression
Forecast/Hindcast variance correction used.

2008       I-----------Regression----------I  I-----------Prediction---------I

Survey/  Slope  Inter-   Std  Rsquare  No.  Index Predicted   Std     WAP
Series           cept   Error          Pts  Value   Value    Error   Weights

BTS2       .98   9.01    .43   .707     23   2.46   11.43     .457     .390
SNS2       .66   7.21    .34   .798     22   5.47   10.84     .366     .610

                                        VPA Mean =   11.46     .648     .000


Year     Weighted      Log     Int     Ext     Var
Class      Average     WAP     Std     Std     Ratio
          Prediction           Error   Error

2008       64169      11.07     .29     .29     1.03
```

Sole age 2 D= (11.07 - log(**91400**))/0.29= -1.21 negative signal, different from spring assumptions.

Table 2.7.3 North Sea sole full RCT3 output all survey data

Age 1

Analysis by RCT3 ver3.1 of data from file: altin_1.txt, NS Sole Age 1, 3 surveys over 1970 - 2009

Regression type = C, Tapered time weighting not applied, Survey weighting not applied
Final estimates shrunk towards mean
Minimum S.E. for any survey taken as .00, Minimum of 3 points used for regression

Forecast/Hindcast variance correction used.

2009	I-----------Regression----------I					I-----------Prediction---------I			
Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
DFS0	1.25	5.99	1.11	.311	29	3.27	10.08	1.198	.047
SNS1	.76	5.68	.37	.789	35	7.88	11.67	.385	.453
BTS1	.77	9.50	.39	.751	22	4.02	12.62	.432	.360
						VPA Mean =	11.47	.693	.140

Year Class	Weighted Average Prediction	Log WAP	Int Std Error	Ext Std Error	Var Ratio	VPA	Log VPA
2009	148935	11.91	.26	.36	1.92		

Age 2

Analysis by RCT3 ver3.1 of data from file: altin_2.txt, NS Sole age 2, 5 surveys over 1970 - 2009

Regression type = C, Tapered time weighting not applied, Survey weighting not applied

Final estimates shrunk towards mean
Minimum S.E. for any survey taken as .00
Minimum of 3 points used for regression

Forecast/Hindcast variance correction used.

2008	I-----------Regression----------I					I-----------Prediction---------I			
Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
DFS0	1.24	5.91	1.11	.315	29	3.32	10.05	1.187	.027
SNS1	.76	5.58	.36	.793	35	7.57	11.33	.380	.267
SNS2	.76	6.53	.40	.760	35	5.47	10.68	.417	.222
BTS1	.78	9.38	.39	.746	22	2.83	11.58	.422	.217
BTS2	.98	9.01	.43	.707	23	2.46	11.43	.457	.185
						VPA Mean =	11.37	.693	.081

Year Class	Weighted Average Prediction	Log WAP	Int Std Error	Ext Std Error	Var Ratio
2008	75082	11.23	.20	.17	.75

Table 2.7.4 Updated North Sea sole recruitment table

Recruitment table. Choices are bold and underlined

YEAR CLASS	AGE IN 2010	XSA THOUSANDS	RCT3 THOUSANDS	GM(1957 – 2007) THOUSANDS
2008	2	91 400	75 082	83 800
2009	1		148 935	94 000
2010	Recruit			94 000

Table 2.7.5 North Sea sole STF Input table

age	year	f	stock.n	stock.wt	landings.wt	mat	M
1	2010	0.015	148935	0.05	0.15	0	0.1
2	2010	0.170	75082	0.15	0.18	0	0.1
3	2010	0.362	55264	0.19	0.21	1	0.1
4	2010	0.433	25010	0.22	0.25	1	0.1
5	2010	0.435	52320	0.25	0.27	1	0.1
6	2010	0.388	5037	0.28	0.29	1	0.1
7	2010	0.409	3032	0.28	0.31	1	0.1
8	2010	0.437	3194	0.27	0.31	1	0.1
9	2010	0.740	3086	0.28	0.30	1	0.1
10	2010	0.740	757	0.38	0.38	1	0.1
1	2011	0.015	94011	0.05	0.15	0	0.1
2	2011	0.170		0.15	0.18	0	0.1
3	2011	0.362		0.19	0.21	1	0.1
4	2011	0.433		0.22	0.25	1	0.1
5	2011	0.435		0.25	0.27	1	0.1
6	2011	0.388		0.28	0.29	1	0.1
7	2011	0.409		0.28	0.31	1	0.1
8	2011	0.437		0.27	0.31	1	0.1
9	2011	0.740		0.28	0.30	1	0.1
10	2011	0.740		0.38	0.38	1	0.1
1	2012	0.015	94011	0.05	0.15	0	0.1
2	2012	0.170		0.15	0.18	0	0.1
3	2012	0.362		0.19	0.21	1	0.1
4	2012	0.433		0.22	0.25	1	0.1
5	2012	0.435		0.25	0.27	1	0.1
6	2012	0.388		0.28	0.29	1	0.1
7	2012	0.409		0.28	0.31	1	0.1
8	2012	0.437		0.27	0.31	1	0.1
9	2012	0.740		0.28	0.30	1	0.1
10	2012	0.740		0.38	0.38	1	0.1

Table 2.7.6 North Sea sole Detailed STF table

age	year	f	st.n	st.wt	l.wt	mat	M	land.n	land	SSB	TSB
1	2010	0.015	148935	0.05	0.15	0	0.1	2064	306	0	7447
2	2010	0.170	75082	0.15	0.18	0	0.1	11213	2056	0	11212
3	2010	0.362	55264	0.19	0.21	1	0.1	16012	3389	10353	10353
4	2010	0.433	25010	0.22	0.25	1	0.1	8395	2067	5502	5502
5	2010	0.435	52320	0.25	0.27	1	0.1	17638	4698	12836	12836
6	2010	0.388	5037	0.28	0.29	1	0.1	1547	455	1387	1387
7	2010	0.409	3032	0.28	0.31	1	0.1	971	305	849	849
8	2010	0.437	3194	0.27	0.31	1	0.1	1080	337	869	869
9	2010	0.740	3086	0.28	0.30	1	0.1	1545	463	857	857
10	2010	0.740	757	0.38	0.38	1	0.1	379	145	291	291
1	2011	0.015	94011	0.05	0.15	0	0.1	1303	193	0	4701
2	2011	0.170	132800	0.15	0.18	0	0.1	19832	3637	0	19831
3	2011	0.362	57291	0.19	0.21	1	0.1	16600	3513	10732	10732
4	2011	0.433	34825	0.22	0.25	1	0.1	11690	2878	7662	7662
5	2011	0.435	14676	0.25	0.27	1	0.1	4947	1318	3600	3600
6	2011	0.388	30631	0.28	0.29	1	0.1	9407	2766	8434	8434
7	2011	0.409	3092	0.28	0.31	1	0.1	990	311	866	866
8	2011	0.437	1823	0.27	0.31	1	0.1	617	193	496	496
9	2011	0.740	1867	0.28	0.30	1	0.1	935	280	518	518
10	2011	0.740	1659	0.38	0.38	1	0.1	831	319	639	639
1	2012	0.015	94011	0.05	0.15	0	0.1	1303	193	0	4701
2	2012	0.170	83826	0.15	0.18	0	0.1	12519	2296	0	12518
3	2012	0.362	101332	0.19	0.21	1	0.1	29360	6214	18983	18983
4	2012	0.433	36103	0.22	0.25	1	0.1	12119	2984	7943	7943
5	2012	0.435	20436	0.25	0.27	1	0.1	6889	1835	5014	5014
6	2012	0.388	8592	0.28	0.29	1	0.1	2639	776	2366	2366
7	2012	0.409	18801	0.28	0.31	1	0.1	6021	1889	5264	5264
8	2012	0.437	1859	0.27	0.31	1	0.1	629	196	506	506
9	2012	0.740	1065	0.28	0.30	1	0.1	533	160	296	296
10	2012	0.740	1522	0.38	0.38	1	0.1	762	293	586	586

Table 2.7.7 North Sea sole STF results: Management summary table

fmult	year	ssb	f2-6	recruit	landings
1	2010	32944	0.358	148935	14222

year	fmult	f2-6	landings	ssb	ssb2012
2011	0.0	0.000	0	32947	55509
2011	0.1	0.036	1794	32947	53807
2011	0.2	0.072	3525	32947	52166
2011	0.3	0.107	5196	32947	50583
2011	0.4	0.143	6811	32947	49057
2011	0.5	0.179	8369	32947	47584
2011	0.6	0.215	9875	32947	46163
2011	0.7	0.250	11330	32947	44791
2011	0.8	0.286	12736	32947	43468
2011	0.9	0.322	14095	32947	42190
2011	1.0	0.358	15408	32947	40956
2011	1.1	0.394	16678	32947	39765
2011	1.2	0.429	17906	32947	38614
2011	1.3	0.465	19094	32947	37503
2011	1.4	0.501	20243	32947	36429
2011	1.5	0.537	21354	32947	35391
2011	1.6	0.572	22430	32947	34388
2011	1.7	0.608	23471	32947	33419
2011	1.8	0.644	24479	32947	32482
2011	1.9	0.680	25454	32947	31575
2011	2.0	0.716	26399	32947	30699

Basis: F (2010) = Fsq = mean (F2007-2009) scaled to 2009 = 0.36; R(2010) = RCT3 = 149 million ; Landings(2010)= 14.74; SSB (2011) =32.9

Rationale	Landings (2011)	Basis	F(2011)	SSB 2012	% SSB Change	% TAC change 2)
MSY framework	10.1	FMSY	0.22	46.0	+40%	-28%
MSY transition	14.4	F_{MSY} Transition	0.33	41.9	+27%	+2%
Precautionary approach	16.9	F_{sq}*1.11 (F_{pa})	0.4	39.6	+20%	+20%
Management plan	14.1	F_{sq}*0.9	0.32	42.2	+28%	+0%
Zero catch	0	F=0	0	55.5	+69%	-100 %
Status quo	12.0	Fsq*0.745	0.27	44.2	+34%	-15%
	12.7	F_{sq}*0.8	0.29	43.5	+32%	-10%
	14.1	Fsq*0.9	0.32	42.2	+28%	-0%
	15.4	F_{sq}*1	0.36	41.0	+24%	+9%
	16.2	F_{sq}*1.06	0.38	40.2	+21%	+15%
	16.9	F_{sq}*1.11= F_{pa}	0.4	39.6	+20%	+20%

The revised recruitment index for sole ate age 1 in 2010 has a D >> 1. The revised age 2 has a D < 1. Subsequent recruitment estimates based on RCT indicate a larger than average recruitment for age 1 and a smaller number of age 2 than was assumed in the assessment. As a result of this, TAC advises based on the different rationales are all increased substantially. As an example, the advice according to the management plan, which was 13.6 kt in June, would now be 14.1 kt.

2.8 References

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2.9 Review of the IBTS Cod Survey Data with particular reference to its use in the North Sea Cod Stock Assessment

Chris Darby, Matt Parker-Humphreys, Cefas UK. 20 September 2010

SUMMARY

1) This note outlines the problems that occurred in the fitting of the assessment model and the provision of advice for the North Sea cod as highlighted at the meeting of the ICES assessment working group (WGNSSK) in May 2010.

2) It then describes a recent change in the spatial distribution of the International Council for the Exploration of the Seas (ICES) International Bottom Trawl Survey third quarter survey (IBTSq3) that has not been considered previously. An obvious link would be to the recent temperature changes recorded in the North Sea but the precise reasons for the change in distribution are unknown.

3) It is recommended that the IBTS quarter 3 survey (IBTSq3) data for ages 2+ should not be included within the cod assessment without a detailed review of the surveys spatial coverage and the formulation by which the cod abundance indices for those ages are derived.

4) The first quarter IBTS survey (IBTSq1) has not undergone the recent distributional changes and the spring survey is considered to represent full spatial coverage of the cod population, at all ages.

5) A re-analysis of the assessment excluding the IBTSq3 data in which the spatial changes have occurred (ages 2+) indicates lower estimates of unallocated mortality and consequently fishing mortality rates in recent years; indicating that spatial changes are likely to have resulted in the unexpectedly high catch multipliers and fishing mortality rates estimated in May 2010.

6) Despite the reductions in fishing mortality rate, recent recruitment is still estimated to have been low and spawning stock biomass, although recovering, is well below the required target levels.

7) The results are not considered a final assessment of the status of the stock and a further re-analysis will be needed in October 2010 when the new IBTSq3 recruitment data are available. Subsequently, updated forecasts may be required depending on the outcome of the ICES' update process.

BACKGROUND

1) Since 2004 the assessment of the North Sea cod has been conducted using a model which estimates unallocated mortality from the stock (e.g. additional discarding, natural mortality and/or under-reporting). A benchmark review of the stock data and assessment model was conducted in 2009 which recommended continued application of the model as well as the parallel application of a state space model which also estimates unallocated mortality but makes alternative assumptions about the underlying fishery dynamics.

2) In general, the assessment models provide similar estimates of the well studied historic trends in the stock and fishery dynamics (Figure 1, from the May 2010 assessment). After a protracted period of very high exploita-

tion rates, followed by a series of poor recruitments, the North Sea cod spawning stock biomass was reduced between 1999 and 2007 to well below the precautionary reference level Blim. Prior to the last two years fishing mortality is estimated to have been reduced and, aided by the "improved" 2005 year class, SSB has gradually increased; it is currently estimated to be just below Blim.

3) At the May 2010 meeting of the ICES North Sea stock assessment group (WGNSSK) it was noted that, when applied independently to the two survey series (IBTSq1, IBTSq3) used for the assessment model calibration, diverging trends in recent fishing mortality estimates were observed (Figure 2). Assessments fitted to the first quarter survey series indicated declining or stable mortality rates in recent years; when fitted to the third quarter survey, rapidly increasing mortality rates were estimated in recent years. The alternative model was less sensitive to the fitted data and indicated stable or declining rates.

4) Independent of the model and data set, SSB was estimated to be recovering but still well below safe level defined by precautionary reference level Bpa.

5) The WG could not identify the reasons for the differences between the survey information series concluding that there was insufficient time allowed to carry out a full analysis of the problem at the May meeting and recommended not using the assessment for advice until a full review and analysis could be conducted in time for the next release of ICES fisheries advice in October 2010.

6) ICES ACOM decided that although the fishing mortality and population abundance trends in the recent years differed and are therefore considered highly uncertain, the final year estimates from the fitting different models were similar and therefore a forecast could be provided; ACOM considered the TAC advice to be insensitive to the assessment method.

7) Despite the warnings about the uncertainty as to the recent trend in fishing mortality issued by WGNSSK, management decisions are being formulated based on its direction and magnitude. Therefore it is essential that the cause of the uncertainty is established.

THE IBTS SURVEY DATA

1) Recently, work has begun at Cefas to review the process by which the IBTS survey indices are derived and to derive estimates of index uncertainty. The study will allow the influence of spatial, regional, national and vessel effects on the derived indices to be evaluated.

2) Maps produced from the analysis were used to compare the spatial distribution of the IBTSq1 (Figures 3a-f) and IBTSq3 (Figures 4a-f) surveys in recent years in order to establish whether there have been any significant changes that could account for the differences in the mortality rate trends derived from the separate indices.

3) In spring the IBTSq1 survey (Figures 3a-f) has recorded cod as being distributed throughout the North Sea with a relatively stable spatial pattern of catches for all ages. Cod age 1 are generally distributed in the central North Sea in a band from the Skagerrak to the north east coast of England. They spread north west and south east as the abundance increases. The contraction to the central belt is most noticeable in the distribution of the most recent weak year classes. Ages 2 and older are more wide spread,

with concentrations on the north east coast of England, between the Shetlands and Norway and between Norway and Denmark. The central tendencies of the spring concentrations have remained relatively stable through the time period, independent of the abundance.

4) The autumn distribution of cod in the IBTSq3 survey (Figures 4a-f) remained relatively unchanged until around 2003/2004, following which ages 2 and older have become increasingly concentrated in the northern region of the survey area. In recent years most of the positive catch rates of ages 3+ have been located in the most northerly areas of the survey against the northern boundary of the survey area. Catch rates in the southern region of the IBTSq3 survey area (the majority of rectangles) are very low or zero; this has been true of age 4 and 5 throughout the time series but has been recorded in ages 2 and 3 since 2003/4.

5) Note: the survey catch rates are relative indices and zeroes in the southern area do not indicate an absence of cod but a low density compared to historic catches within the same series.

6) The reasons for the change in distribution are unknown but an obvious link would be to the recent temperature changes recorded in the North Sea. Alternatively, the more recent period of low recruitment could have been more severe in the southern North Sea but this would not account for the presence of cod in these regions in the spring IBTSq1 survey.

IMPLICATIONS FOR THE ICES COD ASSESSMENT

1) A change in the distribution of cod and concentration in the northern area, during the summer/autumn, has obvious implications for the advice regarding cod avoidance and potential mixed fisheries interactions with the haddock fishery for instance. In terms of the ICES stock assessment there are more compelling reasons for concern:

2) The change in the distribution and concentration could lead to a change in survey catchability, dependent on vessel coverage and the approach used to calculate the index. A pressing question is whether the survey stations in the northern area cover the full distribution of the cod in the summer and autumn and whether there is a need to extend coverage to, for instance, the western side of the Shetland Isles. The recent reduction in Norwegian effort in the northern area and the absence of their survey in that area from IBTSq3 2009 are therefore a concern; although WGNSSK has shown that this has a limited effect.

3) The distribution change is also likely to result in a change in relative catchability:

   a) between the spring and autumn surveys, resulting in the differing fishing mortality trends noted by WGNSSK (Figure 2) - because IBTSq1 has not exhibited the change, and

   b) between the ages within the IBTSq3 (ages 3+ have exhibited a more severe change in distribution since 2003/4 than ages 1 and 2). If the changes in distribution have resulted in reduced average catch rates at the older ages or boas in the derived indices, it is likely to have resulted in the estimated increased fishing and unallocated mortalities in the fits to the IBTSq3 when compared to IBTSq1.

AN ASSESSMENT CALIBRATED TO IBTSq1 AGES 1 - 5 and IBTSq3 AGE1

1) Cefas has conducted an illustrative assessment fitted to IBTSq1 ages 1 - 5 and IBTSq3 age 1 on the basis that:

   i) IBTSq1 has not been affected by the spatial distribution changes recorded in IBTSq3;

   ii) IBTSq3 age 1 appears to be unaffected by the changes that the older ages have exhibited; and

   iii) IBTSq3 age 1 provides a valuable update indicator of the year class strength from the previous year.

2) Figure 5 presents the assessment model estimates which can be compared to those from the May 2010 assessment presented in Figure 1.

3) Removing from the assessment the IBTSq3 ages that appear to have undergone the spatial change results in a 20% reduction in the estimate of unallocated catches; recent estimates are equivalent to those of the previous years rather than exhibiting a substantial increase. As a direct consequence fishing mortality rates in the most recent years are not estimated to have increased strongly in 2008 and 2009 but have remained relatively stable; the 2009 estimates is 10% lower than estimated in May 2010.

4) Spawning stock biomass is estimated to be 20% lower by the revision to the data structure. Apart from the improved 2005 year class, recruitment has been very low in recent years. Spawning stock biomass levels are increasing, but are still low compared to historic estimates, precautionary reference levels and the required targets.

5) The Cefas analysis indicates that the May 2010 assessment model, rejected by WGNSSK, but accepted by the ICES ACOM is likely to be biased as a result of the spatial changes recorded within the distribution of the stock in the third quarter. It is considered that it is not appropriate to calibrate the North Sea cod assessment models using ages 2+ from the IBTSq3 until the consequences of the recent distribution changes have been more fully evaluated and explained. The evaluation should include:

   a) an extension of the survey area to the north and west (using additional data if available and or future additional tows),

   b) the appropriateness of the current survey vessel and station distribution

   c) the method of calculating indices due to the increased concentration of catches in the northern areas.

Cefas 20/9/2010

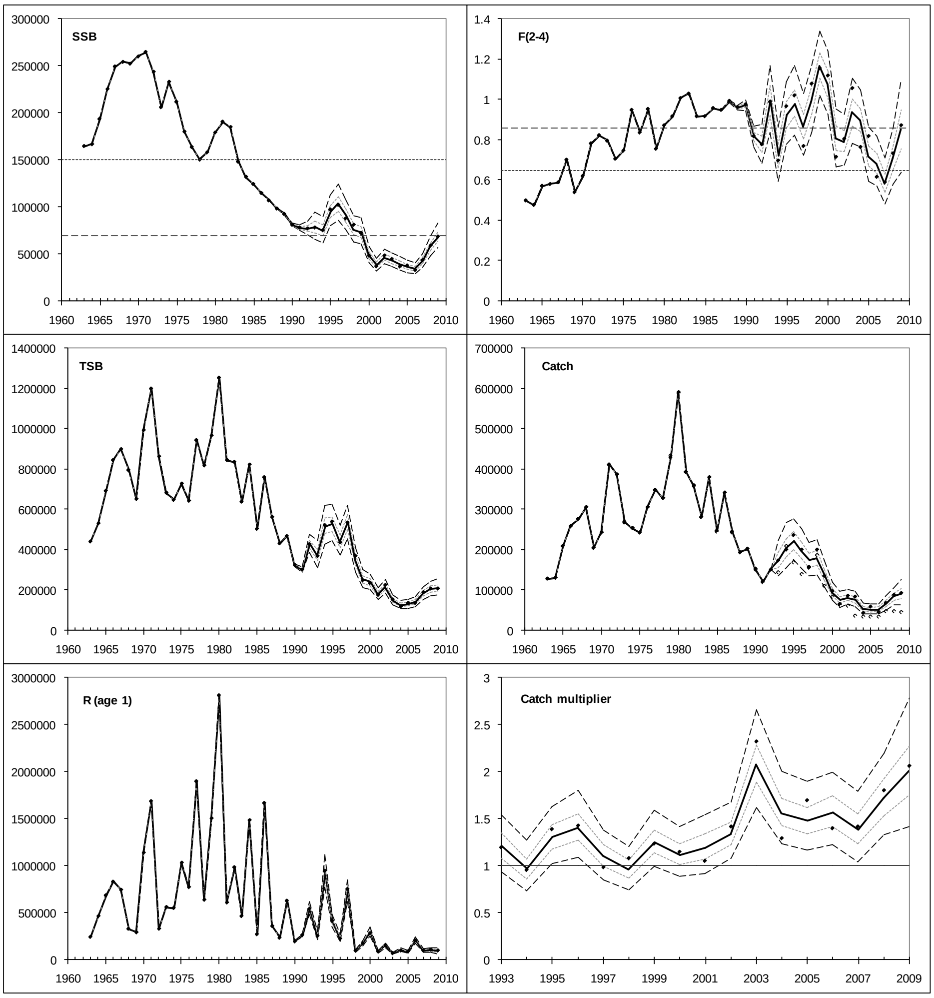

Figure 1. Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId. The ICES WGNSSK May 2010 rejected assessment. Clockwise from top left, percentiles (5,25,50,75,95) of the estimated spawning stock biomass (SSB), total stock biomass (TSB), recruitment (R(age 1)), the catch multiplier, catch and mean fishing mortality for ages 2-4 (F(2-4)), The heavy lines represent the bootstrap median, the broken lines the 5th, 25th, 75th and 95th percentiles.

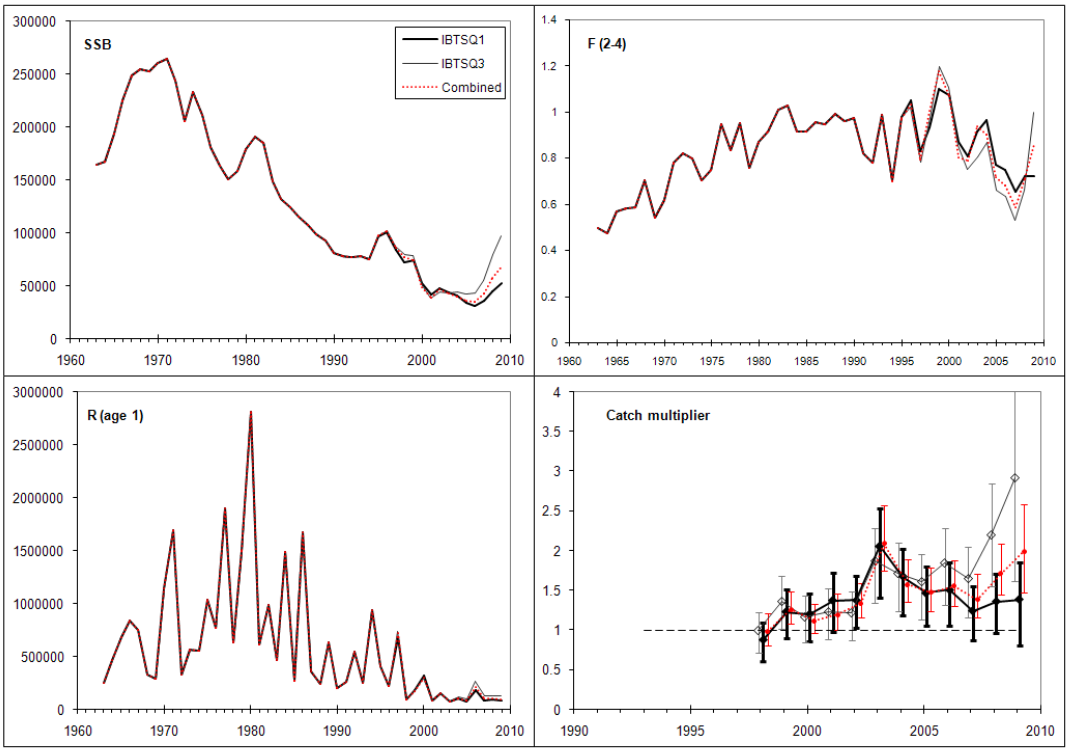

Figure 2 Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId. The May 2010 WGNSSK comparison between the estimated spawning biomass recruitment and catch multiplier trends from fits of the base model to the two survey series. Fits to the IBTSQq3 survey indicate higher mortality rates in recent years as a result of significantly higher estimates of catch multipliers.

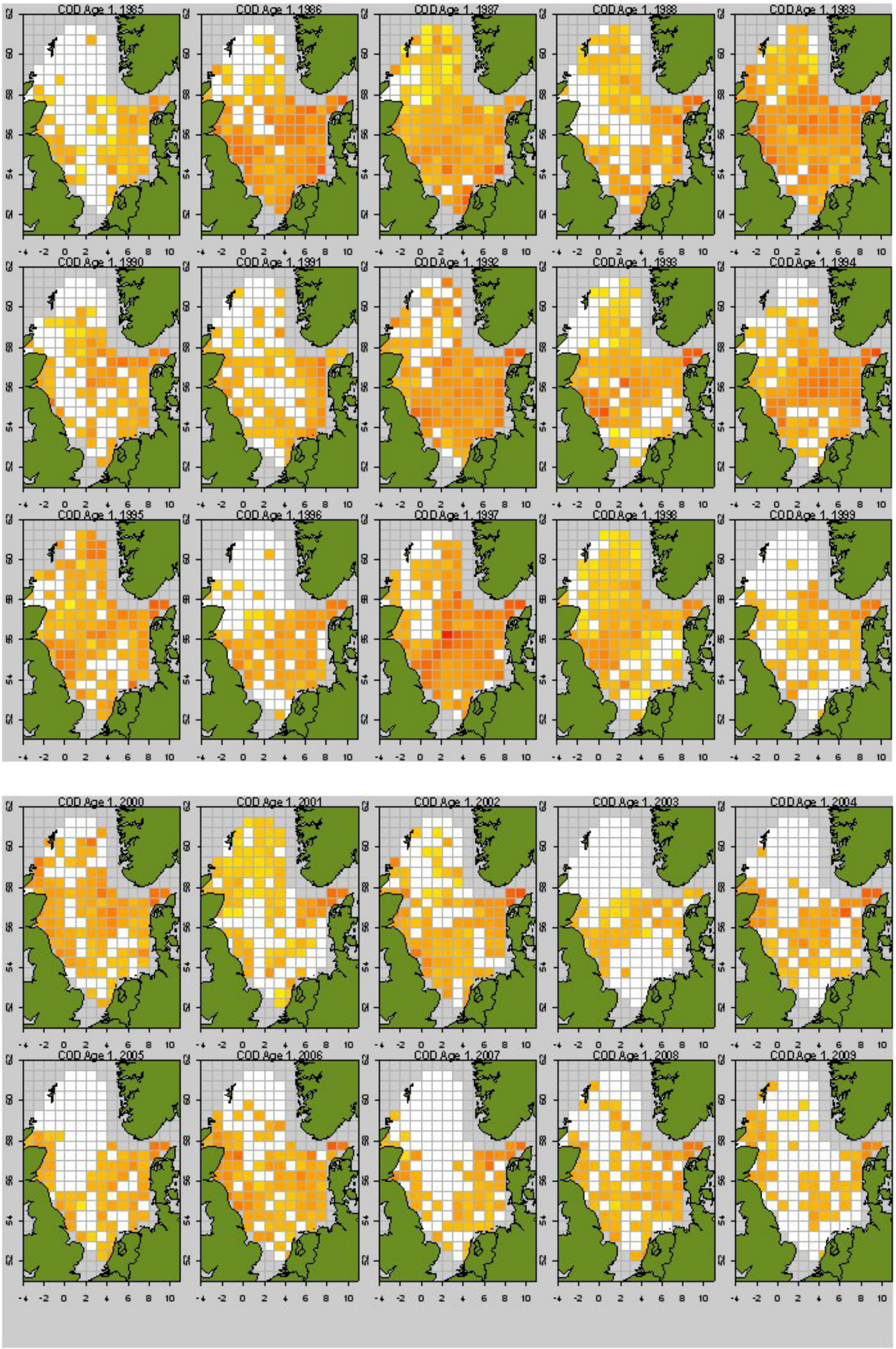

Figure 3a Average IBTSq1 age 1 log catch numbers recorded within each ICES statistical rectangle from 1985 to 2009, grey - no samples, white - zero catch, yellow low density -> red high density.

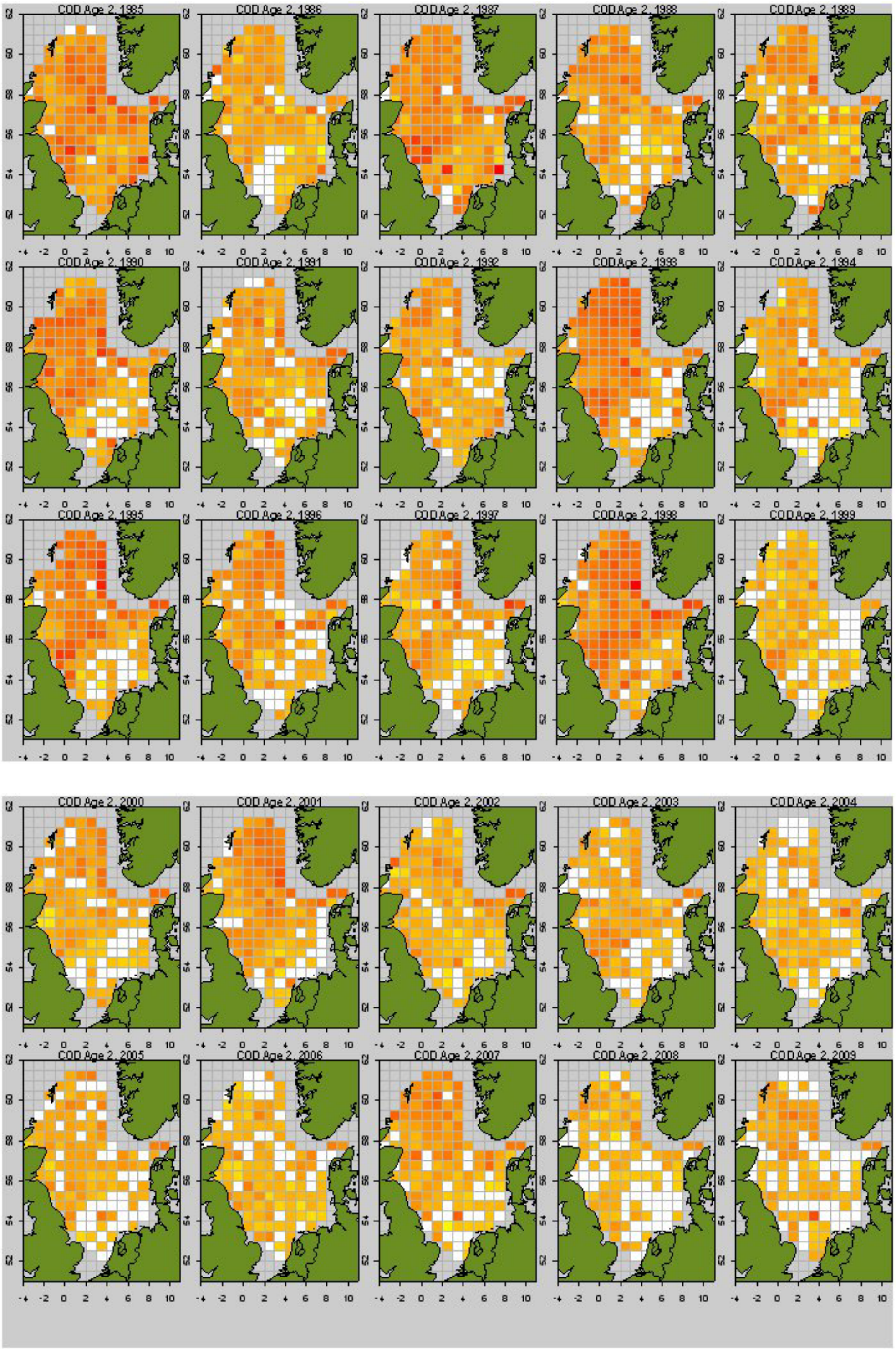

Figure 3b Average IBTSq1 age 2 log catch numbers recorded within each ICES statistical rectangle from 1985 to 2009, grey - no samples, white - zero catch, yellow low density -> red high density.

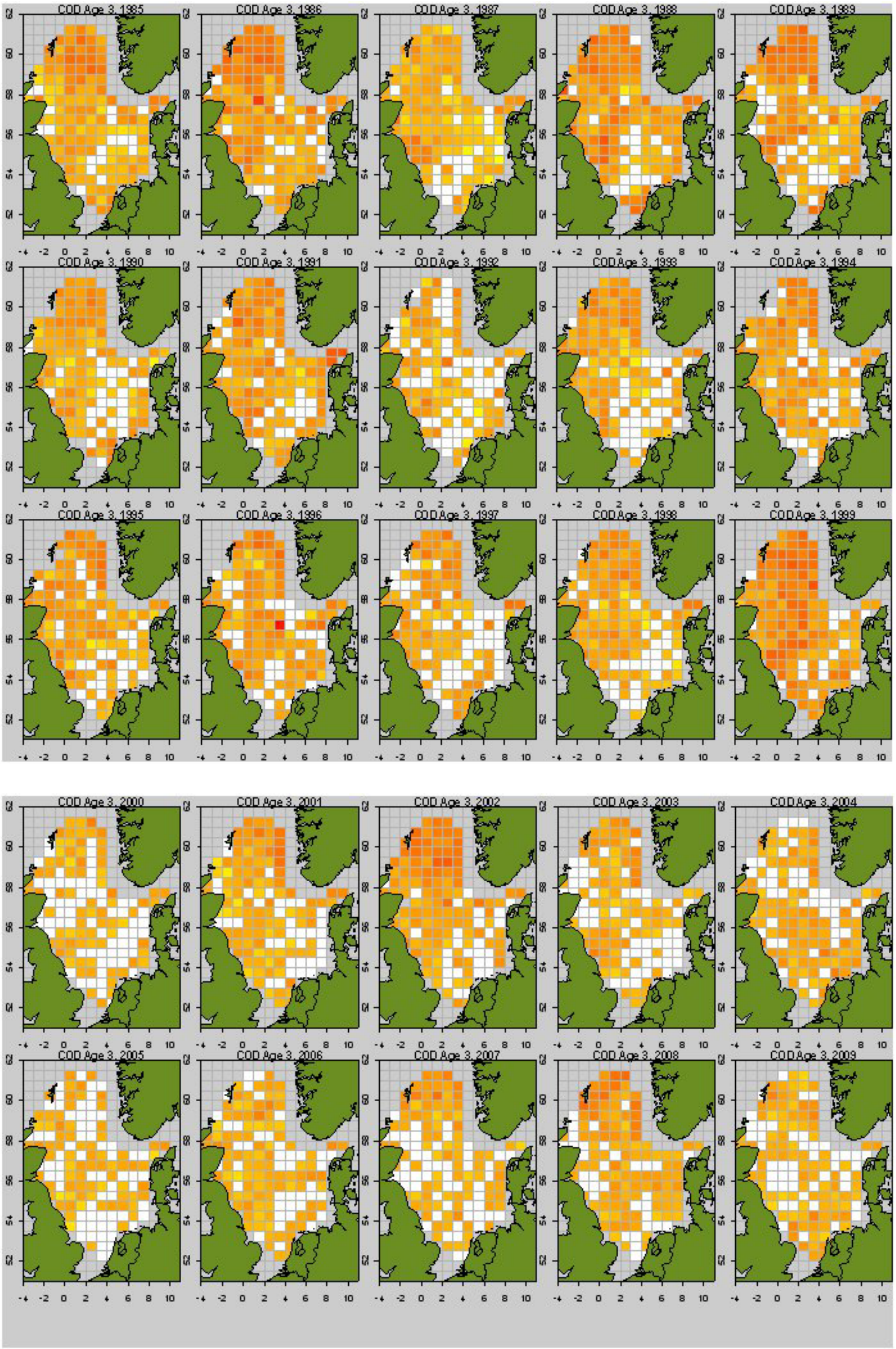

Figure 3c Average IBTSq1 age 3 log catch numbers recorded within each ICES statistical rectangle from 1985 to 2009, grey - no samples, white - zero catch, yellow low density -> red high density.

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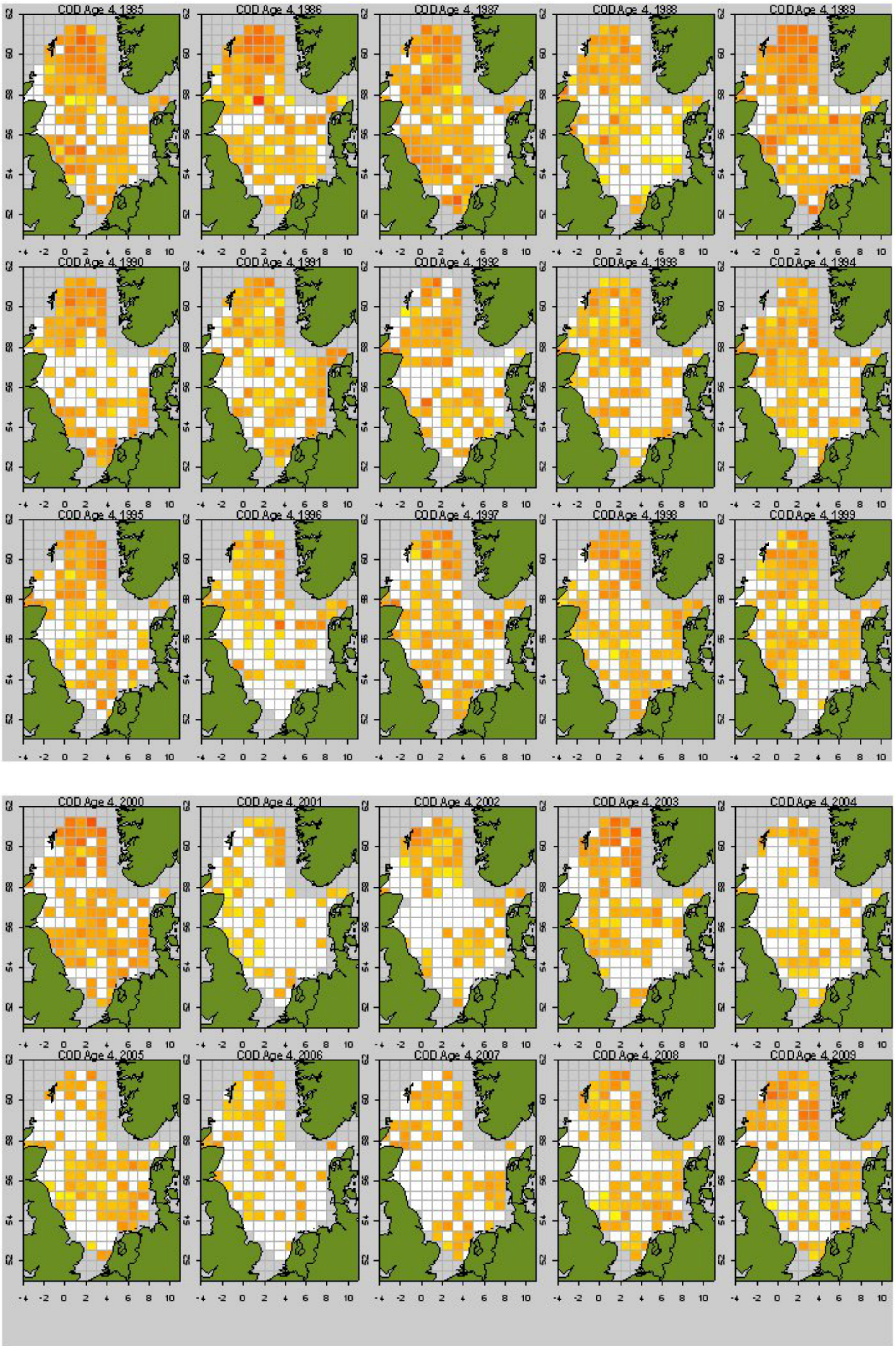

Figure 3d Average IBTSq1 age 4 log catch numbers recorded within each ICES statistical rectangle from 1985 to 2009, grey - no samples, white - zero catch, yellow low density -> red high density.

Figure 3e Average IBTSq1 age 5 log catch numbers recorded within each ICES statistical rectangle from 1985 to 2009, grey - no samples, white - zero catch, yellow low density -> red high density.

Figure 3f Average IBTSq1 age 6+ log catch numbers recorded within each ICES statistical rectangle from 1985 to 2009, grey - no samples, white - zero catch, yellow low density -> red high density.

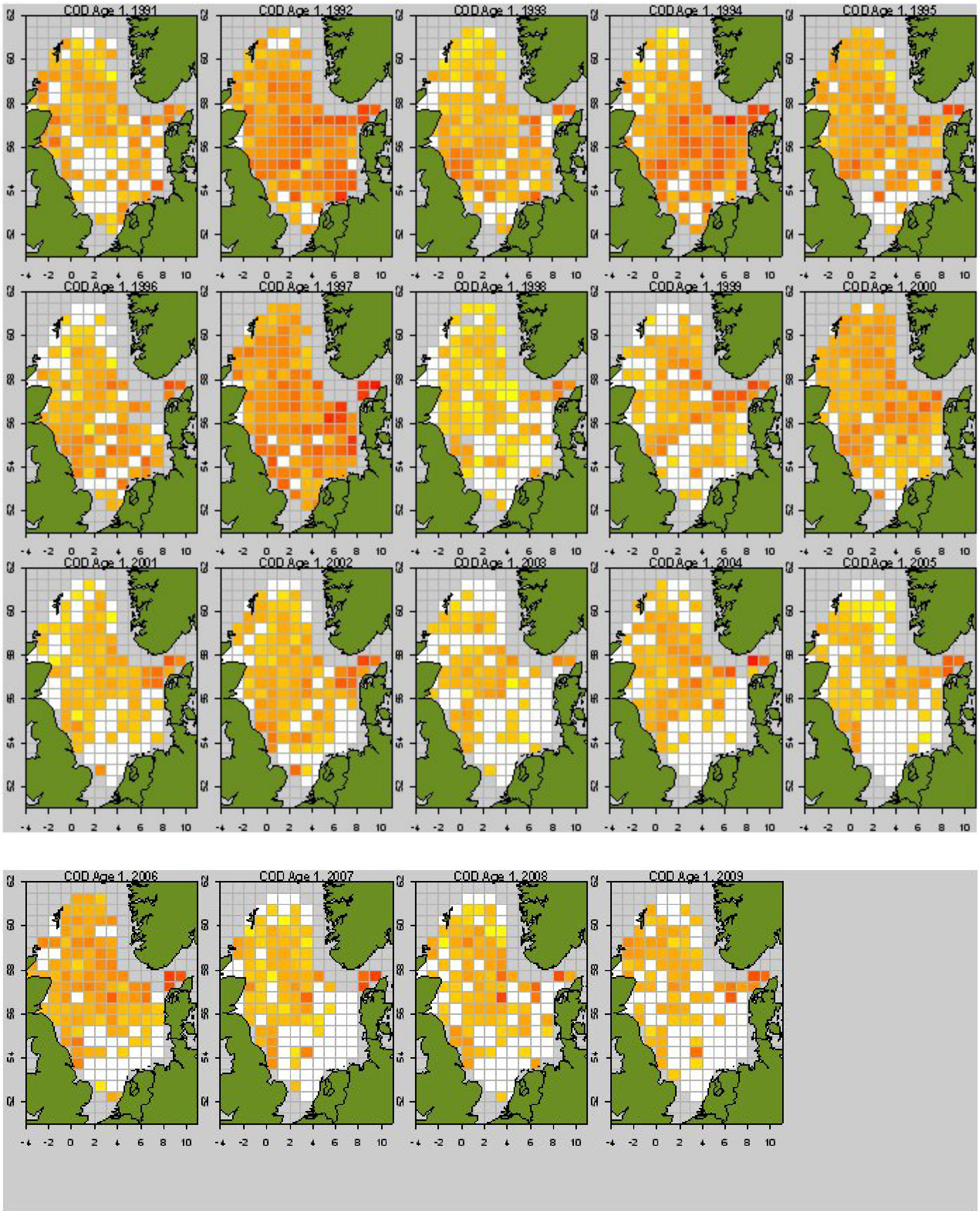

Figure 4a Average IBTSq3 age 1 log catch numbers recorded within each ICES statistical rectangle from 1991 to 2009, grey - no samples, white - zero catch, yellow low density -> red high density.

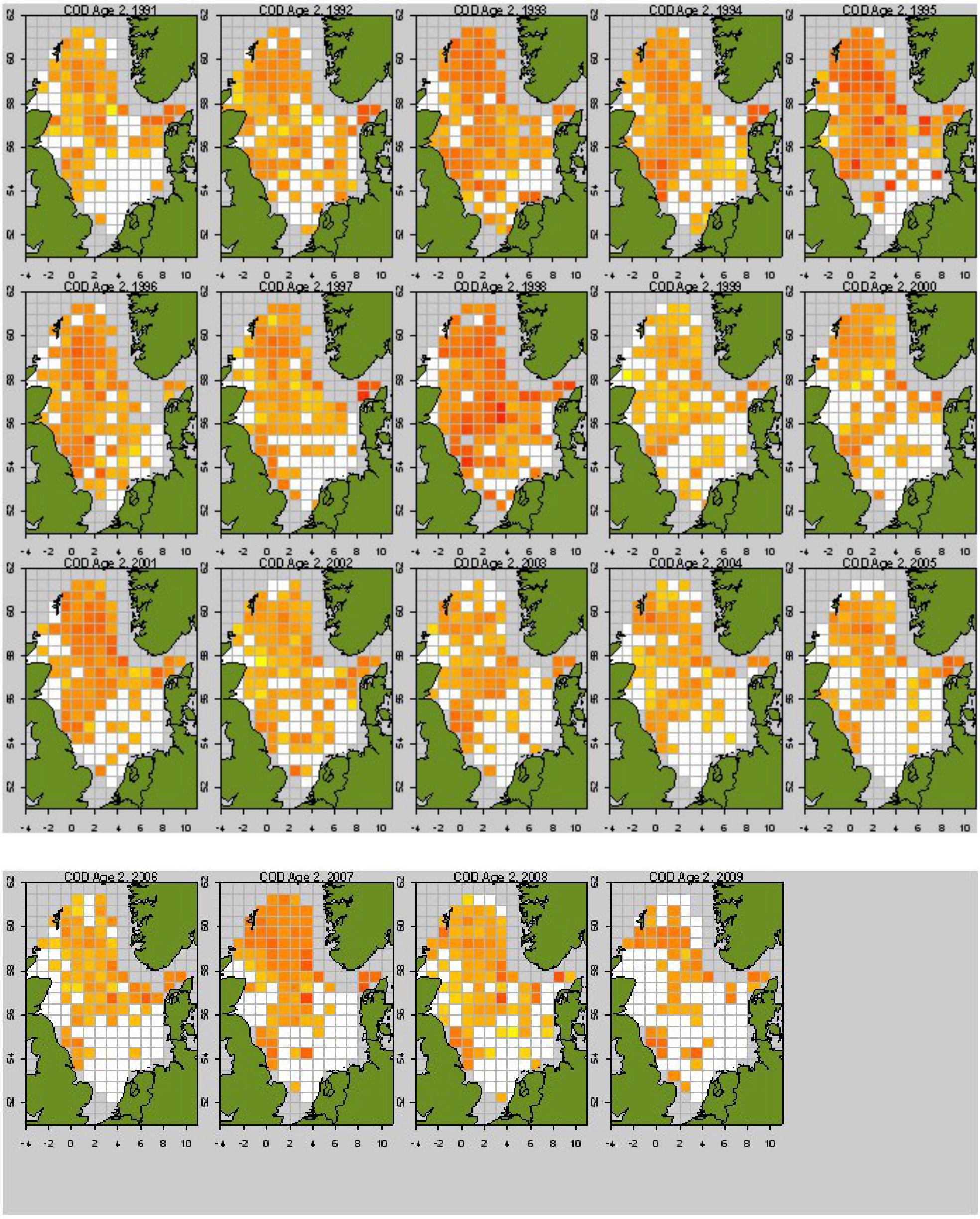

Figure 4b Average IBTSq3 age 2 log catch numbers recorded within each ICES statistical rectangle from 1991 to 2009, grey - no samples, white - zero catch, yellow low density -> red high density.

Figure 4c Average IBTSq3 age 3 log catch numbers recorded within each ICES statistical rectangle from 1991 to 2009, grey - no samples, white - zero catch, yellow low density -> red high density.

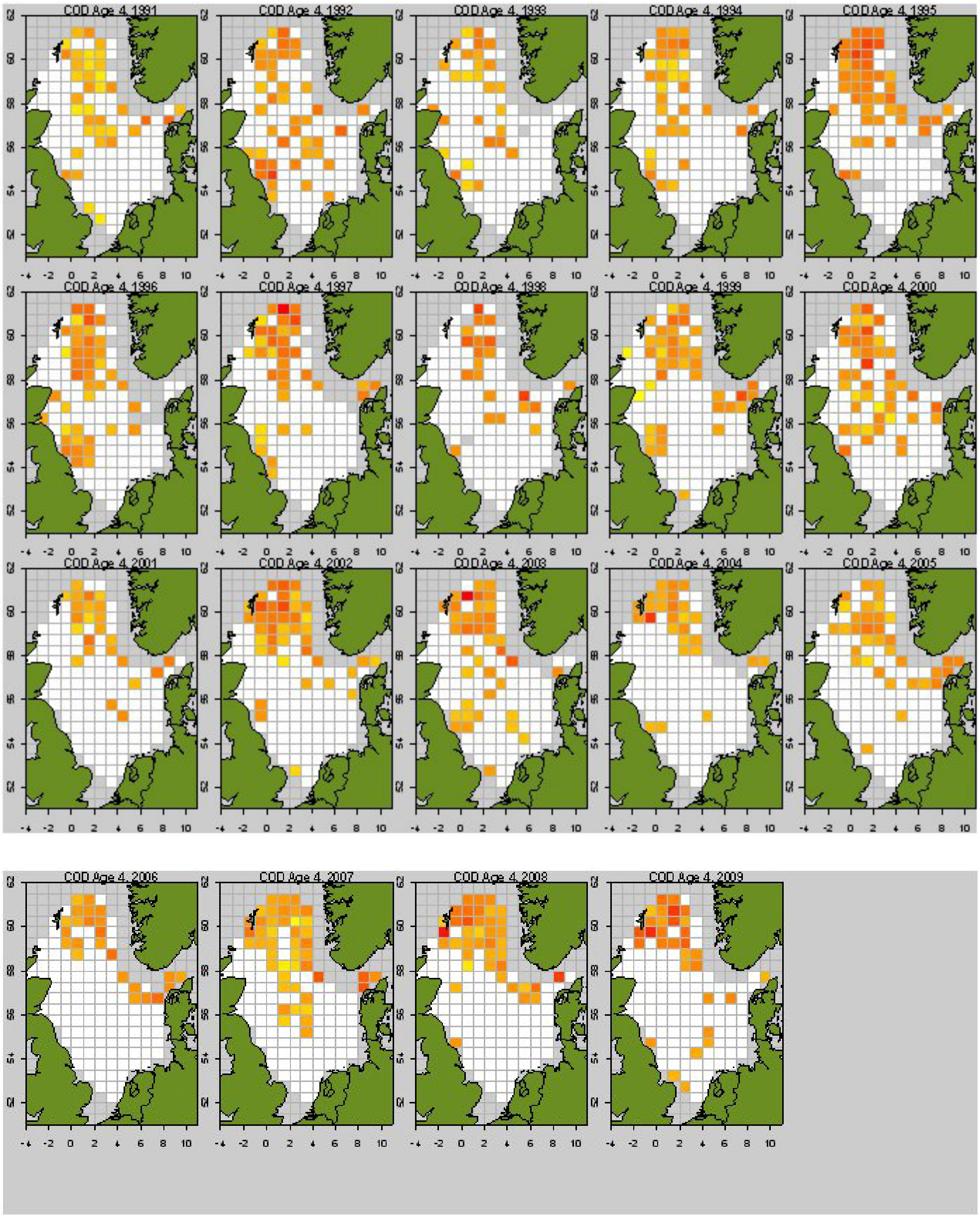

Figure 4d Average IBTSq3 age 4 log catch numbers recorded within each ICES statistical rectangle from 1991 to 2009, grey - no samples, white - zero catch, yellow low density -> red high density.

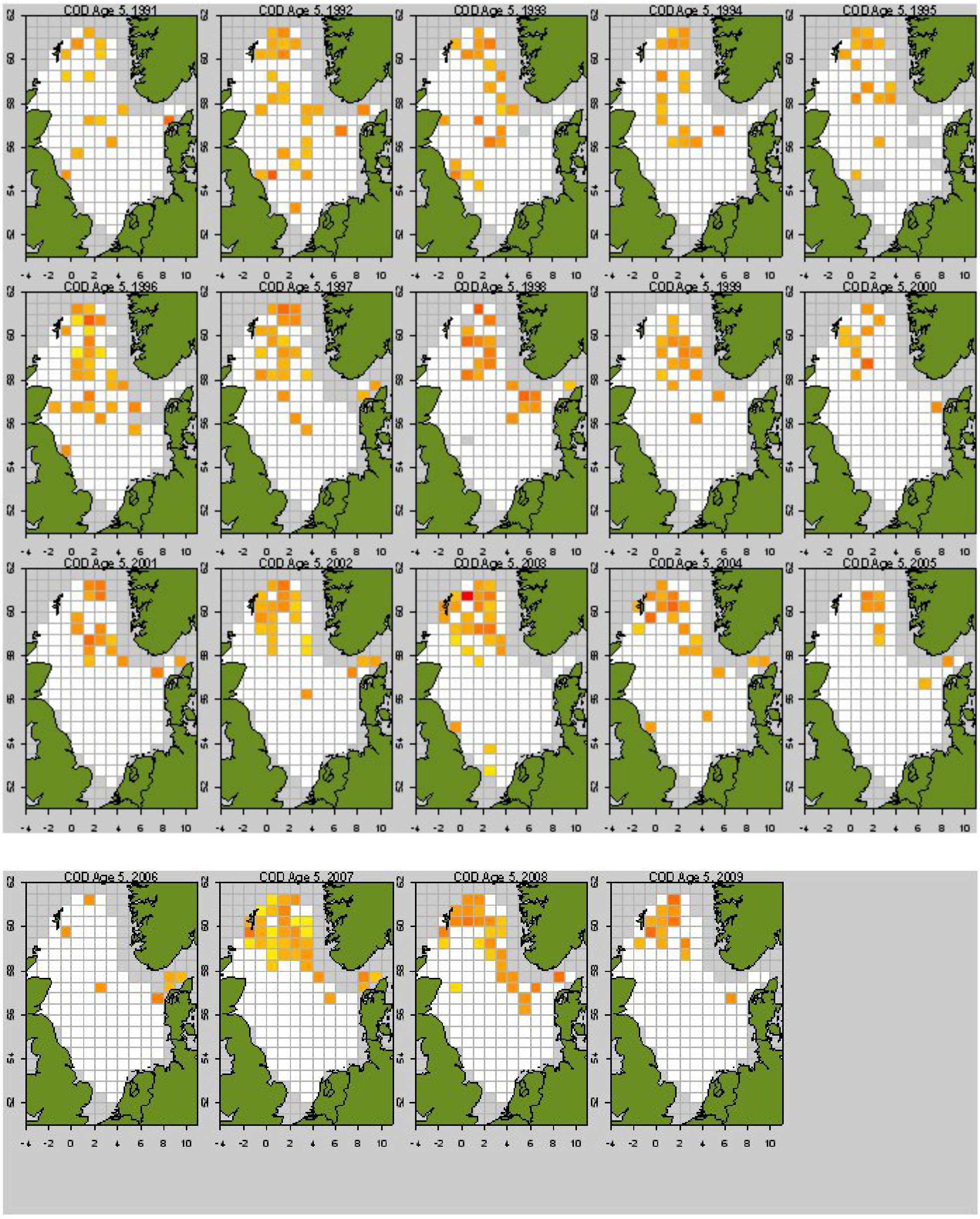

Figure 4e Average IBTSq3 age 5 log catch numbers recorded within each ICES statistical rectangle from 1991 to 2009, grey - no samples, white - zero catch, yellow low density -> red high density.

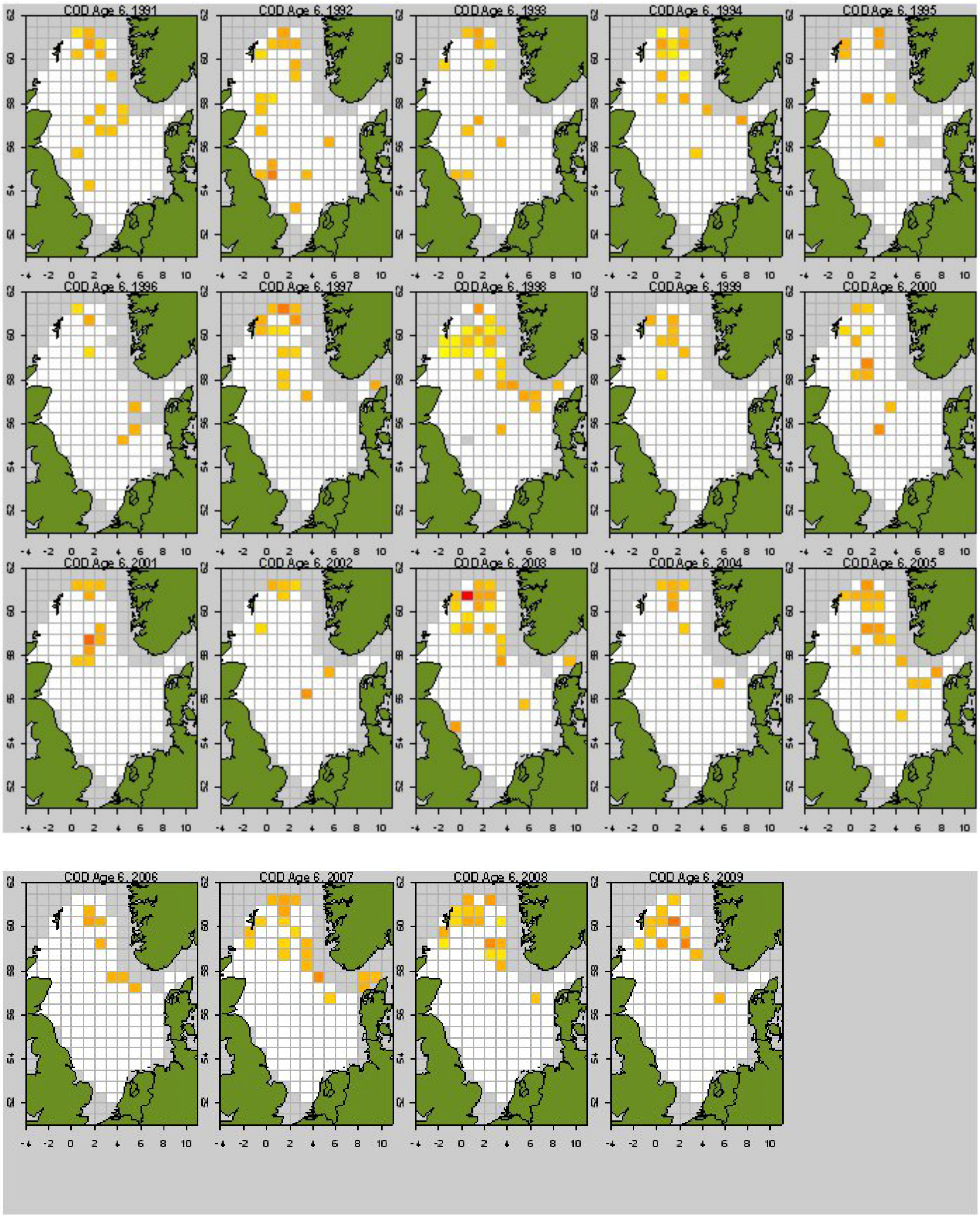

Figure 4f Average IBTSq3 age 6+ log catch numbers recorded within each ICES statistical rectangle from 1991 to 2009, grey - no samples, white - zero catch, yellow low density -> red high density.

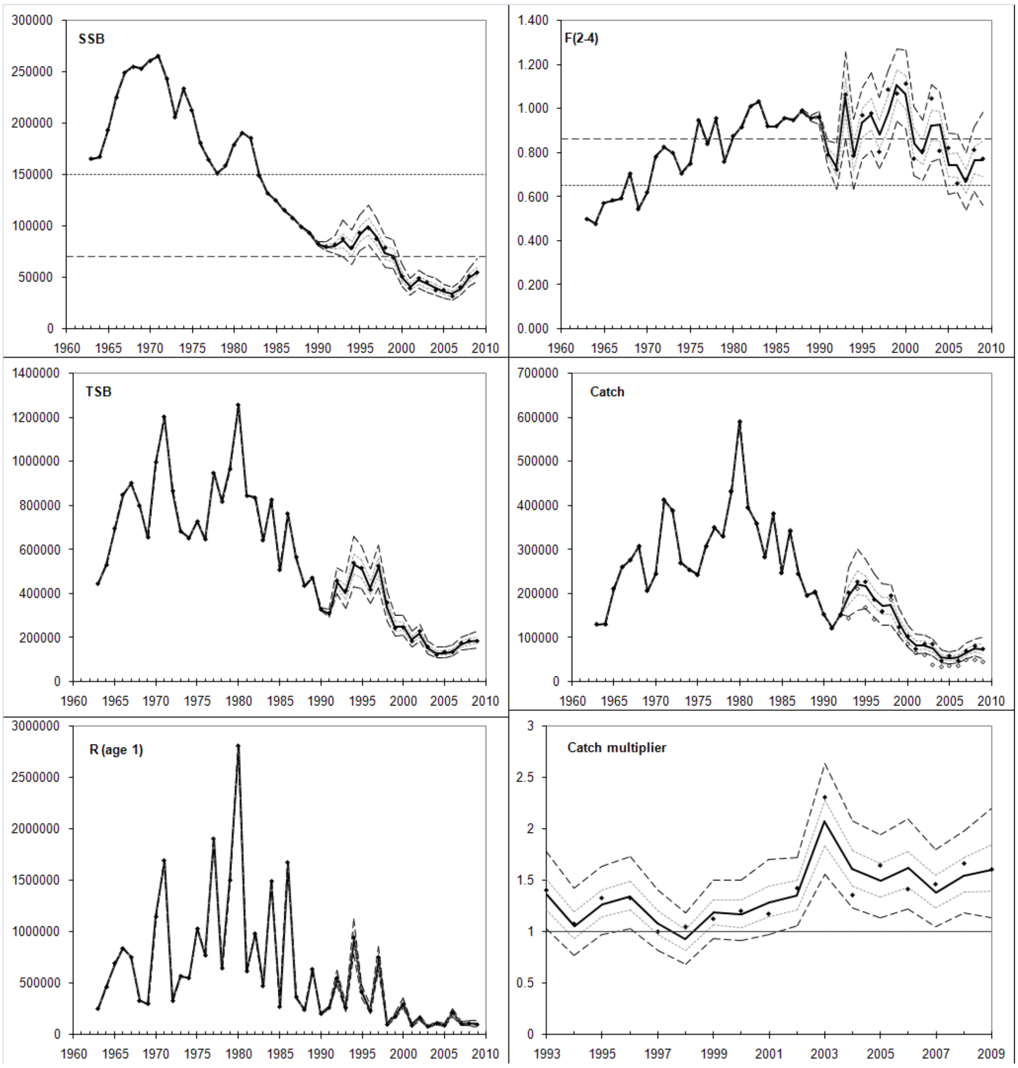

Figure 5. Cod in Subarea IV and Divisions IIIa (Skagerrak) and VIId. Assessment based on the IBTSq1 survey, all ages, and IBTSq3 age 1. Clockwise from top left, percentiles (5,25,50,75,95) of the estimated spawning stock biomass (SSB), total stock biomass (TSB), recruitment (R(age 1)), the catch multiplier, catch and mean fishing mortality for ages 2-4 (F(2-4)). The heavy lines represent the bootstrap median, the broken lines the 5th, 25th, 75th and 95th percentiles.

Annex 03 -Stock Annexes

Stock Annex - North Sea Sole

Stock specific documentation of standard assessment procedures used by ICES.

Stock:	North Sea sole
Working Group:	WGNSSK
Date:	3 March 2010
By:	Jan Jaap Poos

A. General

A.1 Stock definition

The North Sea sole is defined to be a single stock in ICES area IV. The stock assessment is done accordingly, assuming sole in the North Sea is a closed stock.

A.2 Fishery

North Sea sole is taken mainly in a mixed flatfish fishery by beam trawlers in the southern and south-eastern North Sea. Directed fisheries are also carried out with seines, gill nets, and twin trawls, and by beam trawlers in the central North Sea. The minimum mesh sizes enforced in these fisheries (80 mm in the mixed beam trawl fishery) are chosen such that they correspond to the Minimum Landing Size for sole. Due to the minimum mesh size, large numbers of (undersized) plaice are discarded. Fleets exploiting North Sea sole have generally decreased in number of vessels in the last 10 years. However, in some instances, reflagging vessels to other countries has partly compensated these reductions. Besides having reduced in number of vessels, the fleets have also shifted towards two categories of vessels: 2000HP (the maximum engine power allowed) and 300 HP (the maximum engine power for vessels that are allowed to fish within the 12 mile coastal zone and the plaice box).

In recent times the days at sea regulations, high oil prices, and different patterns in the history of changes in the TACs of plaice and sole have led to a transfer of effort from the northern to the southern North Sea. Here, sole and juvenile plaice tend to be more abundant leading to an increase in discarding of small plaice. A change in efficiency of the commercial Dutch beam trawl fleet has been described by Rijnsdorp *et al.* (2006). This change in efficiency is related to changes in targeting and the change in spatial distribution (Quirijns *et al.* 2008, Poos *et al.* 2010). An analysis of the changes in efficiency by the 2006 North Sea demersal assessment working group showed that the increase in efficiency was especially pronounced between 1990 (the beginning of the time series for which data was available) to 1996-1998, after which the efficiency seemed to decrease slightly. The data for which this could be analyzed spanned 1990 to 2002, so the efficiency changes since 2002 could not be estimated.

Conservation schemes and technical conservation measures

Fishing effort has been restricted for demersal fleets in a number of EC regulations (EC Council Regulation No. 2056/2001, No. 51/2006, No. 41/2007 and No. 40/2008, annex II_a). For example, for 2007, Council Regulation (EC) No 41/2007 allocated different days at sea depending on gear, mesh size, and catch composition: Beam Trawls could fish between 123 and 143 days per year. Trawls or Danish seines could fish between 103 and 280 days per year. Gillnets could allowed to fish between 140 and 162 days per year. Trammel nets could fish between 140 and 205 days per year.

Several technical measures are applicable to the mixed fishery for flatfish species in the North Sea: mesh size regulations, minimum landing size, gear restrictions and a closed area (the plaice box).

Mesh size regulations for towed trawl gears require that vessels fishing North of 55°N (or 56°N east of 5°E, since January 2000) should have a minimum mesh size of 100 mm, while to the south of this limit, where the majority the sole fishery takes place, an 80 mm mesh is allowed. In the fishery with fixed gears a minimum mesh size of 100mm is required.

The minimum landing size of North Sea sole is 24 cm. The maximum aggregated beam length of beam trawlers is 24 m. In the 12 nautical mile zone and in the plaice box the maximum aggregated beam-length is 9m. A closed area has been in operation since 1989 (the plaice box). Since 1995 this area was closed in all quarters. The closed area applies to vessels using towed gears, but vessels smaller than 300 HP are exempted from the regulation.

A.3 Ecosystem aspects

Sole growth rates in relation to changes in environmental factors were analysed by Rijnsdorp *et al*. (2004). Based on market sampling data it was concluded that both length at age and condition factors of sole increased since the mid 1960s to a high point in the mid 1970s. Since the mid 1980s, length at age and conditions have been intermediate between the troughs (1960) and peaks (mid 1970s). Growth rates of the juvenile age groups were negatively affected by intra-specific competition. Length of 0-group fish in autumn showed a positive relationship with sea temperature in the 2nd and 3rd quarters, but for the older fish no temperature effect was detected. The overall pattern of the increase in growth and the later decline correlated with temporal patterns in eutrophication; in particular the discharge of dissolved phosphates from the Rhine. Trends in the stock indicators e.g. SSB and recruitment, did not coincide, however, with observed patterns in eutrophication.

In recent years no changes in the spatial distribution of juvenile and adult soles have been observed (Grift *et al*. 2004, Verver *et al,* 2001). The proportion of undersized sole (<24 cm) inside the Plaice Box did not change after its closure to large beamers and remained stable at a level of 60 – 70% (Grift *et al*., 2004). The different length groups showed different patterns in abundance. Sole of around 5 cm showed a decrease in abundance from 2000 onwards, while groups of 10 and 15 cm were stable. The largest groups showed a declining trend in abundance, which had already set in years before the closure.

Mollet *et al* (2007) used the reaction norm approach to investigate the change in maturation in North Sea sole and showed that age and size at first maturity signifi-cantly shifted to younger ages and smaller sizes. These changes occurred from 1980 onwards. Size at 50% probability of maturation at age 3 decreased from 29 to 25 cm.

B. Data

B.1 Commercial catch

Landings data by country and TACs are available since 1957. The Netherlands has the largest proportion of the landings, followed by Belgium. Discards data is only available from the Netherlands, where a discards sampling programme has been carried out on board 80 mm beam trawl vessels fishing for sole since 2000. The discards percentages observed in the Dutch discard sampling programme were much lower for sole (for 2002 – 2008, between 10 – 17 % by weight) than for plaice. No significant trends in discard percentages have been observed since the start of the programme. Inclusion of a stable time series of discards in the assessment will have minor effect on the relative trends in stock indicators (Kraak *et al.* 2002; Van Keeken *et al.* 2003). The main reason for not including discards in the assessment is that the discarding is relatively low in all periods for which observations are available. In addition, the time series of sampling data is short and gaps in the discard sampling programs render them incomplete.

Age and sex compositions and mean weight at age in the landings have been available for different countries for different years. In the more recent years, age compositions and mean weight at age in the landings have been available on a quarterly basis from Denmark, France, Germany (sexes combined) and The Netherlands (by sex). Age compositions on an annual basis were previously available from Belgium (by sex). Overall, the samples are thought to be representative of around 85 % of the total landings. For the final assessment, the age compositions are combined separately by sex on a quarterly basis and then raised to the annual international total. Alternatively, sex separated landings-at-age and weights-at age can be calculated from the data. Since the mid 1990s, annual Sole catches have been dominated by single strong year classes (e.g. the 2005 year class).

B.2 Biological

Weight at age

Weights at age in the landings are measured weights from the various national market sampling programs. Weights at age in the stock are the 2nd quarter landings weights, as estimated by the Fishbase database computer program used for raising North Sea sole data. Over the entire time series, weights were higher during the 1980s compared to time periods before and after. Estimates of weights for older ages fluctuate more because of smaller samples sizes due to decreasing numbers of older fish in the stock and landings.

Natural mortality

Natural mortality in the period 1957 – 2008 has been assumed constant over all ages at 0.1, except for 1963 where a value of 0.9 was used to take into account the effect of the severe winter (1962 – 1963; ICES-FWG 1979).

Maturity

The maturity-ogive is based on market samples of females from observations in the sixties and seventies. Mollet *et. al*. (2007) described the shift of the age at maturity towards younger ages. A knife-edged maturity-ogive is used, assuming no maturation at ages 1 and 2, and full maturation at age 3.

B.3 Surveys

There are 3 trawl surveys that could potentially be used as tuning indices for the assessment of North Sea sole.

- The BTS-ISIS (Beam Trawl Survey)
- The SNS (Sole Net Survey)

- The UK Corystes survey

The BTS-ISIS (Beam Trawl Survey) is carried out in the southern and south-eastern North Sea in August and September using an 8m beam trawl. The SNS (Sole Net Survey) is a coastal survey with a 6m beam trawl carried out in the 3rd quarter. In 2003 the SNS survey was carried out during the 2nd quarter and data from this year were. The research vessel survey time series have been revised by WGBEAM (ICES-WGBEAM, 2009). WKFLAT 2010 decided to use only the BTS-ISIS and the SNS surveys as tuning series, because of lack of information on the raising procedure and spatial coverage of the UK Corystes series. In the assessment, the BTS-ISIS and SNS indices, calculated by WGBEAM, are used for tuning the stock assessment.

B.4 Commercial LPUE

There is one commercial fleet available that can be used as a tuning series for the stock assessment, being the Dutch beam trawl fleet. This fleet takes more than 70% of the landings, and is relatively homogeneous in terms of size and engine power. The data from this commercial fleet can be estimated using two different methods. The first method uses the total landings, and creates the age distribution for these landings by segregating the total landings into market categories, with age distributions being known within market categories through market sampling. Effort for the Dutch commercial beam trawl fleet is expressed as total HP effort days. Effort nearly doubled between 1978 and 1994 and has declined since 1996. Effort during 2008 was <40% of the maximum (1994) in the series. A decline of circa 25% was recorded in 2008 following the decommissioning that took place during 2008.

Alternatively, the data for the Dutch beam trawl fleet can be raised as described by (WGNSSK 2008, WD1). This allows reviewing the LPUE trends in different areas of the North Sea. The data are based on various sources (WGNSSK 2008, WD1). There is a clear separation in LPUE between areas, with the southern area producing a substantially higher LPUE than the northern area. Average LPUE of a standardized NL beam trawler (1471 kW) over the period 1999 to 2007 was 266 kg day_{-1}, and the data have a significant ($P<0.01$) temporal trend of -6.1 kg day^{-1} $year^{-1}$.

The stock assessment uses the tuning index resulting from using the first method to calculate the commercial index. Owing to the strong changes in catchability in the in the first part of the time series, only the data from 1997 onwards is to be used in the assessment.

C. Historical Stock Development

WKFLAT 2010 decided that XSA should be used for providing advice, while also using the SAM models concurrently. There are currently three methods that could be used to provide an assessment of North Sea sole, being XSA, the ANP model (Aarts and Poos, 2009), and the SAM model (WKROUND 2009, WD14). The XSA assumes the catch-at-age matrix is complete and without error. The Aarts and Poos method is a variety of statistical catch-at-age model, that uses splines to estimate the selectivity patterns in the surveys and for the catch-at-age matrix. WKFLAT tested an adaptation of the original ANP model, where the discards estimation procedures were not incorporated. The SAM model is a state-space assessment model, similar to TSA. The advantage of using ANP and SAM would be that they take into account (and show) the uncertainty of the assessment inputs and outputs. The disadvantage of using ANP is that it can only assess the stock status for those years where survey data is available. Once a new benchmark group decides that there is no problem with the operational aspects of using SAM for North Sea sole, we recommend replacing the use of XSA with SAM.

Model used as a basis for advice

The North Sea sole advice is based on the XSA stock assessment. Settings for the final assessment are given below:

Setting/Data	Values/source
Catch at age	Landings (since 1957, ages 1- 10).
Tuning indices	BTS-Isis 1985-assessment year 1-9 SNS 1982-assessment year 1-4 NL-beam trawl index 1997-assessment year 2-9
Plus group	10
First tuning year	1982
Time series weights	No taper
Catchability dependent on stock size for age <	2
Catchability independent of ages for ages >=	7
Survivor estimates shrunk towards the mean F	5 ages / 5 years
s.e. of the mean for shrinkage	2.0
Minimum standard error for population estimates	0.3
Prior weighting	Not applied

The SAM model

Setting/Data	Values/source
Catch at age	Landings (since 1957, ages 1:10)
Tuning indices	BTS-Isis 1985-assessment year 1-9 SNS 1982-assessment year 1-4 NL-beam trawl index 1997-assessment year 2-9
Plus group	10
First tuning survey year	1982
Catchability independent of ages for ages >=	7
Prior weighting	Not applied

D. Short-term Projection

Because the assessment on which the advice is based is currently a fully deterministic XSA, the short term projection can be done in FLR using FLSTF. Weight-at-age in the stock and weight-at-age in the catch are taken to be the mean of the last 3 years. The exploitation pattern is taken to be the mean value of the last three years, scaled to the last years F. Population numbers at ages 2 and older are XSA survivor estimates, unless there is consistent indication from the most recent recruitment surveys of a stronger or weaker year class. Numbers at age 1 and recruitment (age 0) are taken from the long-term geometric mean.

Management options are given for three different assumptions on the F values in the "intermediate" year; (A) F in the "intermediate" year is assumed to be equal to the average estimate for F of the last three assessment years scaled to the last years F; (B) F2009 is 0.9 times the average estimate for F of the last three assessment years scaled to the last years F; and (C) F in the "intermediate" year is set such that the landings in the intermediate year equal the TAC of that year. ACOM in 2009 has decided to use option (A)

E. Medium-Term Projections

Generally, no medium-term projections are done for this stock.

F. Long-Term Projections

Generally, no long- term projections are done for this stock.

G. Biological Reference Points

The current reference points were established by the WGNSSK in 1998. The current reference points are $\mathbf{B_{lim}}$= $\mathbf{B_{loss}}$= 25 000 t and $\mathbf{B_{pa}}$ is set at 35 000 t using the default multiplier of 1.4. $\mathbf{F_{pa}}$ was proposed to be set at 0.4 which is the 5th percentile of $\mathbf{F_{loss}}$ and gave a 50% probability that SSB is around $\mathbf{B_{pa}}$ in the medium term. Equilibrium analysis suggests that F of 0.4 is consistent with an SSB of around 35 000 t. Given that the assessment results in terms of historic biomass estimates did not change substantially following the updates in assessment methodology in WKFLAT2010, the estimates of these reference points are still valid.

	Type	Value	Technical basis
Precautionary approach	B_{lim}	25,000 t	B_{loss}
	B_{pa}	35,000 t	B_{pa}1.4 *B_{lim}
	F_{lim}	Not defined	
	F_{pa}	0.40	F_{pa} = 0.4 implies B_{eq} >B_{pa} and P(SSB_{MT} < B_{pa}) < 10%.
Targets	F_{mgt}	0.2	EU management plan

H. (unchanged since 1998, target added in 2008)

I.

J. Other Issues

None identified

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Stock Annex - Saithe in IV, VI and IIIa

Stock specific documentation of standard assessment procedures used by ICES.

Stock:	Saithe in IV, VI and IIIa
Working Group:	WGNSSK
Date:	18 May 2010
By:	Alexander Kempf

A. General

A.1 Stock definition

The saithe stock is defined to be a single stock in ICES area IV, IIIa and VI. The stock assessment is done accordingly.

A.2 Fishery

Saithe in the North Sea are mainly taken in a direct trawl fishery in deep water along the Northern Shelf edge and the Norwegian Trench. Norwegian, French, and German trawlers take the majority of the catches. In the first quarter of the year the fisheries are directed towards mature fish in spawning aggregations, while concentrations of immature fish (age 3-4) often are targeted during the rest of the year. In recent years the French fishery has deployed less effort along the Norwegian Trench, while the German and Norwegian fisheries have maintained their effort there.

The main fishery developed in the beginning of the 1970s. The fishery in Area VI consists largely of a directed French, German, and Norwegian deep-water fishery operating on the shelf edge, and a Scottish fishery operating inshore. In both areas most of the saithe do not enter the main fishery before age 3, because the younger ages are staying in inshore waters. A small proportion of the total catch is taken in a limited purse seine fishery along the west coast of Norway targeting juveniles (age 2-4). In the Norwegian coastal purse seine fishery inside the 4 nm limit (south of 62°N), the minimum landing size is 32 cm.

Since the fish are distributed inshore until they are about 3 years old, discarding of young fish is assumed to be a small problem in this fishery. Problems with by-catches in other fisheries when saithe quotas are exceeded may cause discarding. French and German trawlers are targeting saithe and they have larger quotas, so the problem may be less in these fleets. The Norwegian trawlers move out of the area when the boat quotas are reached, and in addition the fishery is closed if the seasonal quota is reached.

In 2009 the landings were estimated to be around 105 529 t in Subarea IV and Division IIIa, and 6963 t in Subarea VI, which both are well below the TACs for these areas (125 934 and 13 066 t respectively). Significant discards are observed only in Scottish trawlers. However, as Scottish discarding rates are not considered representative of the majority of the saithe fisheries, these have not been used in the assessment. Ages 1 and 2 are mainly distributed close to the shores and are very scarce in the main fishing areas for saithe. Therefore, these age-groups are not relevant for discarding practices in the North Sea.

Conservation schemes and technical conservation measures

Management of saithe is by TAC and technical measures. The available kw-days at sea for community vessels is restricted via the cod management plan (Council regulation 1342/2008). Only some vessels were exempted from these effort restrictions in 2009 due to low bycatch (<1,5%) of cod. In the Norwegian zone (south of 62°N) the current minimum landing size is 40 cm, while in the EU zone it is 35 cm. Discards are not allowed in the Norwegian zone.

A.3 Ecosystem aspects

The geographical distributions of juvenile (< age 3) and adult saithe differ. Typical for all saithe stocks are the inshore nursery grounds. Juvenile saithe in the North Sea are therefore mainly distributed along the west and south coast of Norway, the coast of Shetland and the coast of Scotland. At around age 3 the individuals gradually migrate from the coastal areas to the northern part of the North Sea (57°N - 62°N).

The age at first maturity is between 4 and 6 years, and spawning takes place in January-March at about 200 m depth along the Northern Shelf edge and the western edge of the Norwegian Trench. Larvae and post-larvae are widely distributed in Atlantic water masses across the northern part of the North Sea, and around May the 0-group appears along the coasts (of Norway, Shetland and Scotland). The mechanisms behind the 0-group's migration from oceanic to coastal areas remain unknown, but it seems like they are actively swimming towards the coasts. The west coast of Norway is probably the most important nursery ground for saithe in the North Sea.

When saithe exceeds 60-70 cm in length the diet changes from plankton (krill, copepods, fish larvae) to fish (mainly Norway pout, blue whiting, haddock and herring). Large saithe (>70 cm) has a highly migratory behaviour and the feeding migrations extend from far into the Norwegian Sea to the Norwegian coast.

Tagging experiments by various countries have shown that exchange takes place between all saithe stock components in the northeast Atlantic. In particular, exchange between the saithe stock north of 62°N (Northeast Arctic saithe) and saithe in the North Sea has been observed.

A sharp decline in the mean weight at age was observed from the mid-1990s, but now seems to be halted. There is insufficient information to establish whether this decline is linked to changes in the environment. The reduced growth rates have an effect on stock productivity and the consequences need to be further explored. However, there are no indications that the observed decline in weight at age is density dependent (Evaluation of the EU-Norway saithe management plan).

The impact of a large saithe stock on prey species such as Norway pout and herring is unknown. Poor spatial and temporal sampling of stomach data of saithe make the estimation of the saithe diet uncertain.

B. Data

B.1 Commercial catch

In the data provided, landings from the industrial fleet are only specified when saithe is delivered separately, and therefore bycatch of saithe that has not been separated from the bulk catch, will not be reported as saithe. Landings-at-age data by fleet are supplied by Denmark, Germany, France, Norway, UK (England), and UK (Scotland) for Area IV and only UK (Scotland) for Area VI.

B.2 Biological

Weight at age

Weights at age in the landings are measured weights from the various national observer and market sampling programs. These are also used as stock weights. There has been a decreasing trend in mean weights from the mid-1990s for ages 4 and older, but the decline now seems to be halted.

Natural mortality

A natural mortality rate of 0.2 is used for all ages and years

Maturity

Following maturity ogive is used for all years:

Age	1	2	3	4	5	6	7+
Proportion mature	0.0	0.0	0.0	0.15	0.7	0.9	1.0

B.3 Surveys and commercial tuning fleets

Normally, 5 indexes are presented for the working group, but the Norwegian Bottom trawl Index has not been used in the tuning since 2007.

Commercial fleets:

- French demersal trawl, age range: 3-9, year range 1990-2008 (“FRATRB”)
- German bottom trawl, age range: 3-9, year range 1995-2009 (“GEROTB”)
- Norwegian bottom trawl, age range: 3-9, year range 1980-2009 (“NORTRL”)

  (Part 1 : 1980-1992, part 2 : 1993-2009)

Surveys:

- Norwegian acoustic survey, age range 3-6, year range 1995-2008 (“NORACU”)
- IBTS quarter 3, age range: 3-5, year range 1991-2008 (“IBTSq3”)

C. Historical Stock Development

FLXSA is used to providing advice. The XSA assumes the catch-at-age matrix is complete and without error.

Model used as a basis for advice

The settings in final XSA assessment for the years 2007 to 2009:

Year of assessment:	2007	2008	2009
Assessment model:	XSA	no change	no change
Fleets:	FRAtrb (age range: 3-9, 1990 onwards)	no change	no change
	GERotb (age range: 3-9, 1995 onwards)	no change	no change
	NORacu (age range: 3-6, 1996 onwards)	no change	no change
	IBTSq3 (age range: 3-5, 1992 onwards)	no change	no change
Age range:	3-10+	no change	no change
Catch data:	1967-2006	1967-2007	1967-2008
Fbar:	3-6	no change	no change
Time series weights:	Tricubic over 20 years	no change	no change
Power model for ages:	No	no change	no change
Catchability plateau:	Age 7	no change	no change
Survivor est. shrunk towards the mean F:	5 years / 3 ages	no change	no change
S.e. of mean (F-shrinkage):	1.0	no change	no change
Min. s.e. of population estimates:	0.3	no change	no change
Prior weighting:	No	no change	no change
Number of iterations before convergence:	51	47	47

D. Short-term Projection

Because the assessment on which the advice is based is currently a fully deterministic XSA, the short term projection can be done in FLR using FLSTF. Weight-at-age in the stock and weight-at-age in the catch are taken to be the mean of the last 3 years. The exploitation pattern is taken to be the mean value of the last three years. Population numbers at ages 4 and older are XSA survivor estimates, numbers at age 3 are taken from the geometric mean for the years 1988 – assessment year.

E. Medium-Term Projections

Generally, no medium-term projections are done for this stock.

F. Long-Term Projections

Generally, no long- term projections are done for this stock.

G. Biological Reference Points

The biological reference points were derived in 2006 and are:

$\mathbf{F}_{0.1}$	0.10	$\mathbf{F}_{lim}$	0.60
$\mathbf{F}_{max}$	0.22	$\mathbf{F}_{pa}$	0.40
$\mathbf{F}_{med}$	0.35	$\mathbf{B}_{lim}$	106 000 t
$\mathbf{F}_{high}$	>0.49	$\mathbf{B}_{pa}$	200 000 t

These reference points refer to an Fbar from ages 3 to 6. The proportion of catches taken by purse seine decreased significantly in the early 1990s. This caused a change in the exploitation pattern as the purse seiners mainly targeted young saithe. Therefore, it may be more appropriate to use a reference F that does not include age 3. The influence on the maturity ogive from the observed decrease in the weight at age is unknown, but it is reasonable to believe that the spawning capacity of the stock will be affected. This has to be evaluated during the next benchmark in 2011.

H. Other Issues

None identified

Stock Annex: FU32 Norwegian Deep

Stock specific documentation of standard assessment procedures used by ICES.

Stock	Norwegian Deep *Nephrops* (FU32)
Date:	07/05/2010 (WGNSSK2010)
Revised by	Guldborg Søvik

A. General

A.1 Stock definition

Throughout its distribution, *Nephrops* is limited to muddy habitat, and requires sediment with a silt & clay content of between 10 – 100 % to excavate its burrows, which means that the distribution of suitable sediment defines the species distribution. Adult *Nephrops* only undertake small-scale movements (a few 100 m) but larval transfer may occur between separate mud patches in some areas. FU 32 (the Norwegian Deep) is located in the eastern part of ICES Division IVa. Its western boundary is adjacent to the Fladen Ground area, while the Norwegian coast constitutes its eastern boundary. *Nephrops* has been caught on most trawl stations of the Norwegian annual shrimp cruise covering the area (Figure A1-1). This indicates that the species is widely distributed in FU 32, but the exact distribution of the stock is not known.

A.2 Fishery

Traditionally, Danish and Norwegian fisheries have exploited this stock, while exploitation by UK vessels has been insignificant. Since 2000, Sweden have landed small amounts (Table A2-1, Figure A2-1). Denmark accounts for the majority of landings from FU 32: from the mid-1990s the Danish share of the landings has been between 80 and 90 %. As the Danish landings have decreased in recent years (2007-2009), this number has decreased (69 % in 2009).

Denmark

A description of the Danish *Nephrops* fisheries in Subareas IIIa and IV (including the one in the Norwegian Deep) was given in the 1999 WGNEPH report (ICES, WGNEPH 1999a). Danish VMS data show that the Danish vessels fish exclusively in the western part of the Norwegian Deep (Figure A2-2). Due to changes in the management regime (mesh size regulations regarding target species) in the Norwegian zone of the northern North Sea in 2002, there was a switch to increasing Danish effort targeting *Nephrops* in the mixed fisheries in the Norwegian Deep. However, a distinction between the fishing effort directed at *Nephrops,* roundfish or anglerfish is not always clear. The mesh size in the trawls catching *Nephrops* is >100 mm. The use of twin trawls has been widespread for many years.

Norway

The Norwegian fleet fish *Nephrops* all year round. The *Nephrops* fishery north of 60 °N (with 15-30% of the Norwegian FU 32 landings (2001-2009)) is mainly a creel fishery, with some landings from *Nephrops* trawls (Figure A2-3). The fishery south of 60 °N, on the other hand, is mainly a trawl fishery (*Nephrops* trawls and bycatch from shrimp trawls), with some landings from creels. *Nephrops* recordings in Norwegian log books from FU 32 are incomplete, with log book catches constituting 15-40% of the landings in 2001-2008. In 2007 and 2008 the highest recorded effort (hrs trawled) was allocated to the ICES statistical rectangle 44F9 (Figure A2-4). These incomplete effort figures are not representative of the spatial distribution of the fishery as is illustrated by Figure A2-5 showing the Norwegian landings per ICES statistical rectangle. Landings per statistical rectangle is available for the first time in 2009. In addition to rectangle 44F9, the Norwegian *Nephrops* fishery is mainly located in the northern part of Skagerrak, along the Skagerrak coast, and along the coast of western Norway, including the fjords. According to the logbooks there has been a change in the most commonly used mesh size. In 1999, 90% of the vessels used 70-80 mm trawls according to the logbooks. In 2000-2005 small-meshed trawls (70-80 mm) taking 17% of the *Nephrops* catches performed 22% of the trawling hours. In 2008 all logbook recorded catches (except bycatch in shrimp trawls) were from trawls with mesh size of 120 mm. According to the logbooks most vessels undertake 1-3 hauls per day, with an average duration of each haul of 6.3 hrs. The fishing trips last from 1 to 9 days.

The recreational fishery for *Nephrops* along the Norwegian coast has increased in recent years, but the extent of this fishery is not known.

Regulations

The minimum legal size is 40 mm CL, which is higher than the minimum landing size of 25 mm CL in the rest of the North Sea (EU legislation). This is part of an agreement between Norway, Sweden and Denmark. Size can also be measured as total length, with a minimum legal size of 130 mm.

Trawls with mesh sizes down to 70 mm are legal, but require square meshes in the cod end. It is illegal to fish with more than two trawls south of 62 ºN. When fishing for *Nephrops* with gear with mesh size not less than 70 mm, the bycatch of halibut, cod, haddock, hake, plaice, witch flounder, dab, lemon sole, sole, turbot, brill, megrim, whiting, fluke, eel, saithe, lobster, and crab may not exceed 70 % of the total weight of the catch.

A.3 Ecosystem aspects

Sediment maps for the Norwegian Deep (Figure A3-1) indicate that the area of suitable sediment for *Nephrops* is larger than the current extent of the fishery, and there may be possibilities of expansion into new grounds on which *Nephrops* is not currently exploited or only slightly exploited. These grounds are mainly found along the Norwegian coast as the Danish fishery takes place along the western slope of the Norwegian Deep (Figure A2-2).

The *Nephrops* directed trawl fisheries are characterised by large amounts of non-commercial bycatch and *Nephrops* below MLS. The discard mortality is considered to be high (75 %, Wyman et al. 1999). The *Nephrops* trawl is constructed to scare the animals out of their burrows and as such is destructive to the bottom habitat.

B. Data

B.1 Commercial catch

Onboard sampling of catches (split into discard and landings component) are carried out by Danish observers, providing information on size distribution and sex ratio (Figure A2-1). Onboard sampling of the landings components are also carried out by the Norwegian coast guard, mainly on Danish trawlers.

Since 2003 the Danish at-sea-sampling programme has provided data for discard estimates (Figure A2-1). However, the samples have not covered all quarters. There were no discards data for 2008.

B.2 Biological

No biological data exist for this stock.

B.3 Surveys

No survey abundance index is available for this stock. The annual Norwegian shrimp survey covers most of the area, however, the catches of *Nephrops* in the survey trawl (Campelen 1800/35 bottom trawl with rockhopper gear, cod end mesh size is 22 mm with 6 mm lining net) are too small and variable to provide an abundance index. This is partly due to the fact that the survey is designed to cover shrimp grounds. The survey data only give an impression of the distribution of *Nephrops* in FU 32 (Figure A1-1).

B.4 Commercial CPUE

A catch-per-unit-effort time-series is available from the Danish trawl fleet (Figure A2-1). CPUE is estimated using officially recorded effort (days fished). There is no account taken of any technological creep in the fleet.

Catch-per-unit-effort time-series from the Norwegian fleet in FU 32 are not utilized, due to the scarce data. Furthermore, the recordings of the various gears seems to be inconsistent, both between years as well as between the landings statistics and the logbooks. For instance, records on the use of *Nephrops* trawls are completely lacking in the 2006-2008 logbooks, while a substantial part of the landings in the same time period are recorded as caught by *Nephrops* trawl in the official landings statistics.

The state of the stock is assessed based on the Danish CPUE.

C. Historical Stock Development

None

D. Short-Term Projection

None

E. Medium-Term Projections

None

F. Long-Term Projections

None

G. Biological Reference Points

None specified.

H. Other Issues

I. References

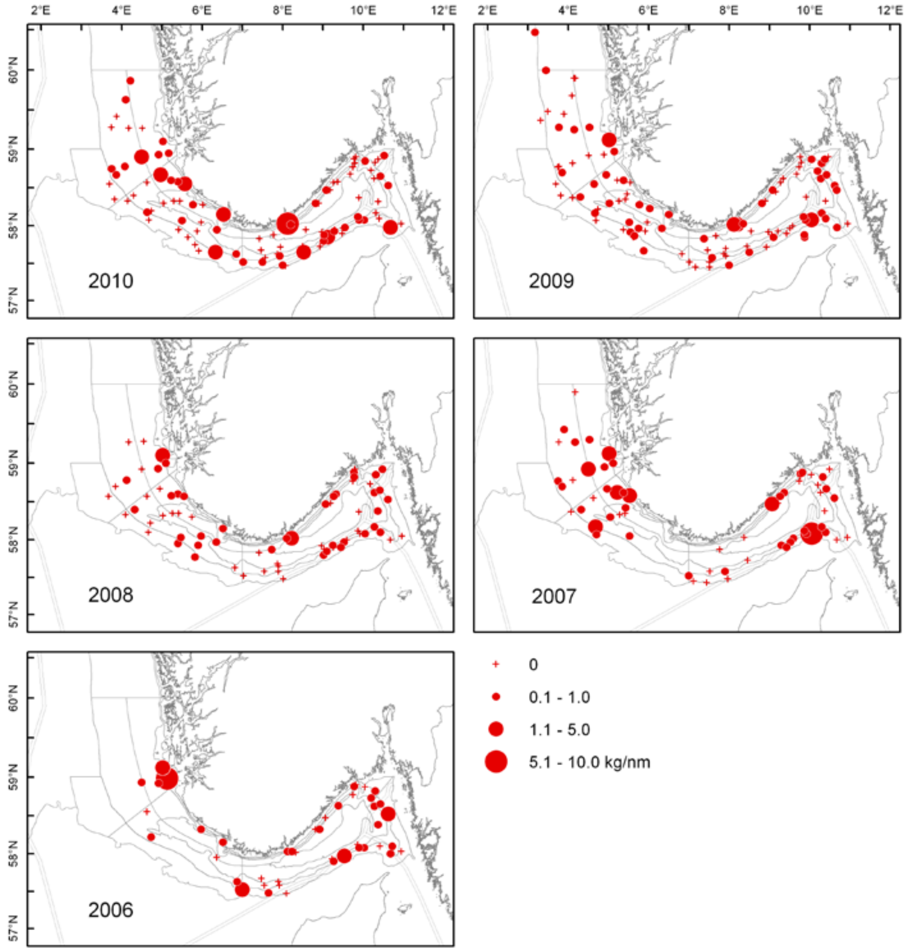


Figure A1-1. ***Nephrops*** **Norwegian Deep (FU 32). Catches (kg/nm trawled) from the Norwegian shrimp survey, January-February 2006-2010.**

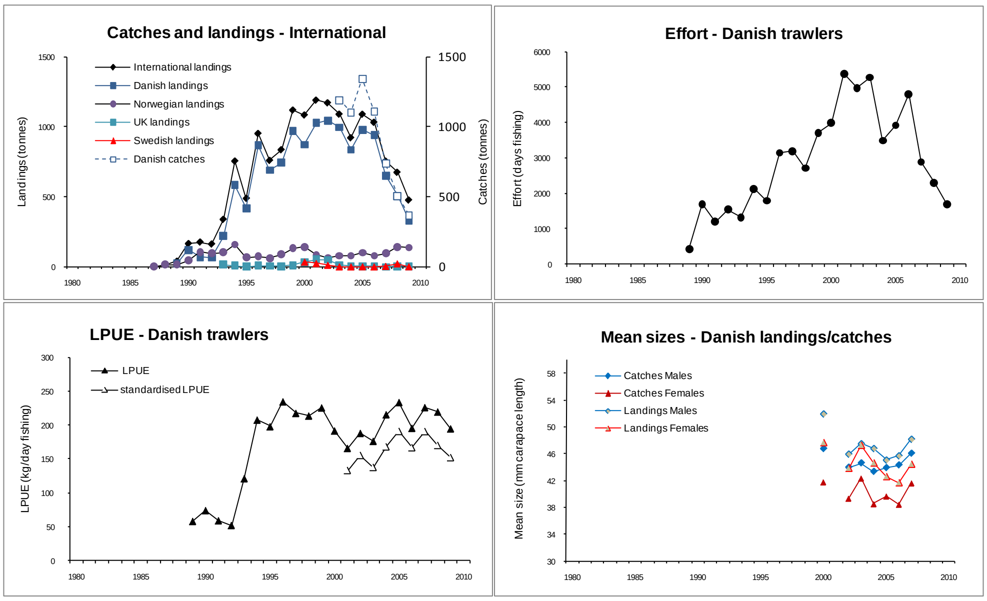


Figure. A2-1. ***Nephrops*** **Norwegian Deep (FU 32). Long term landings, Danish effort, Danish LPUE and Danish mean sizes of catches and landings.**

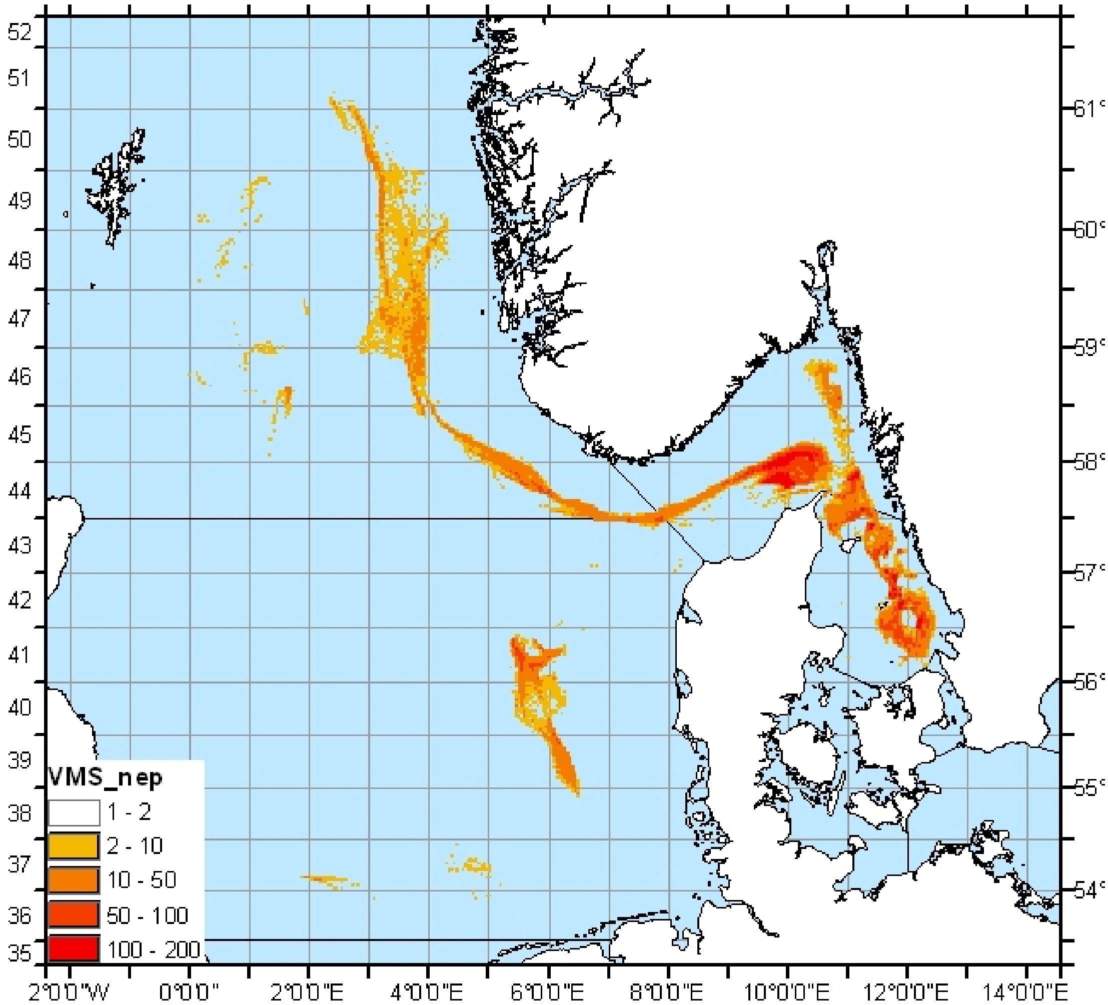


Figure A2-2. ***Nephrops*** **Norwegian Deep (FU 32). VMS data showing the spatial distribution of the Danish and Swedish fleet fishing for** ***Nephrops*** **in Skagerrak and the North Sea. The Swedish vessels are mainly fishing in Kattegat and the northeastern part of Skagerrak.**

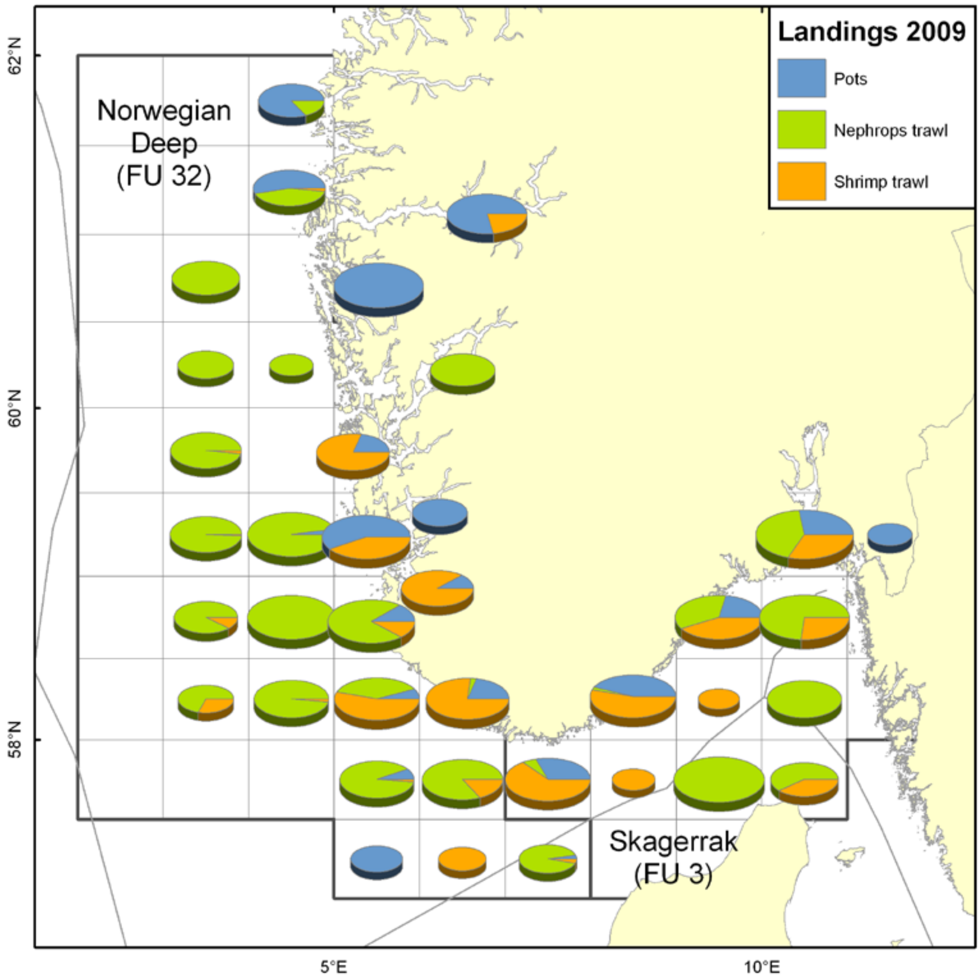


Figure A2-3. ***Nephrops*** **Norwegian Deep (FU 32). Norwegian landings per gear type and ICES statistical rectangle in 2009. The size of the symbols are porportional to the catch in the corresponding rectancles (scaled down by a log-transformation).**

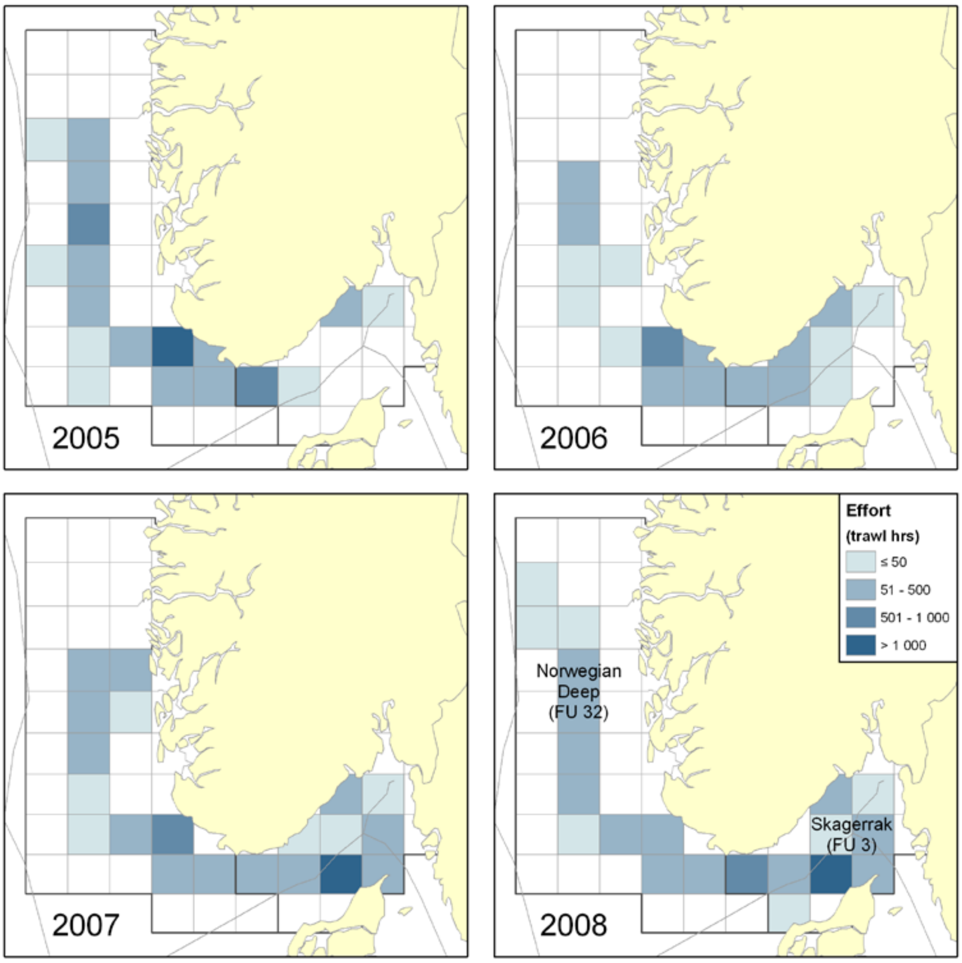


Figure A2-4. ***Nephrops*** **Norwegian Deep (FU 32). Effort (hrs trawled) per ICES statistical recatangle from Norwegian logbooks 2005-2008.**

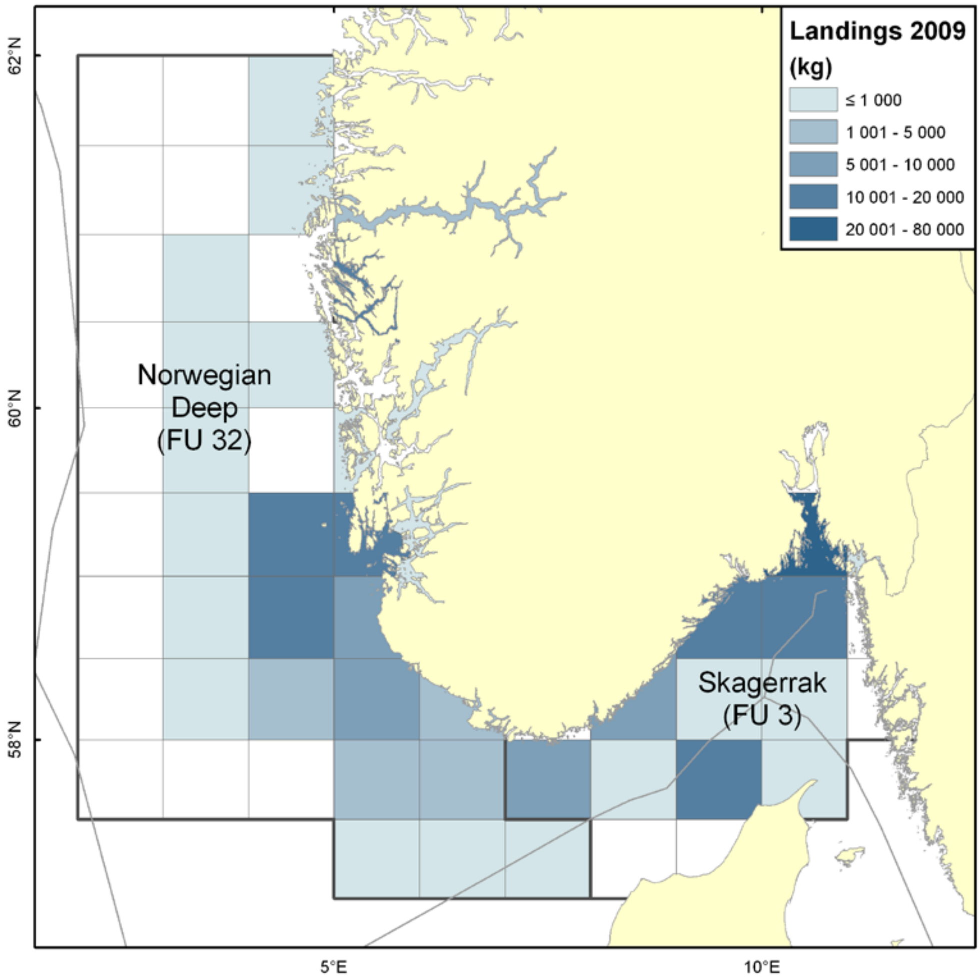


Figure A2-5. *Nephrops* Norwegian Deep (FU 32). Norwegian landings (kg) per ICES statistical rectangle in 2009.

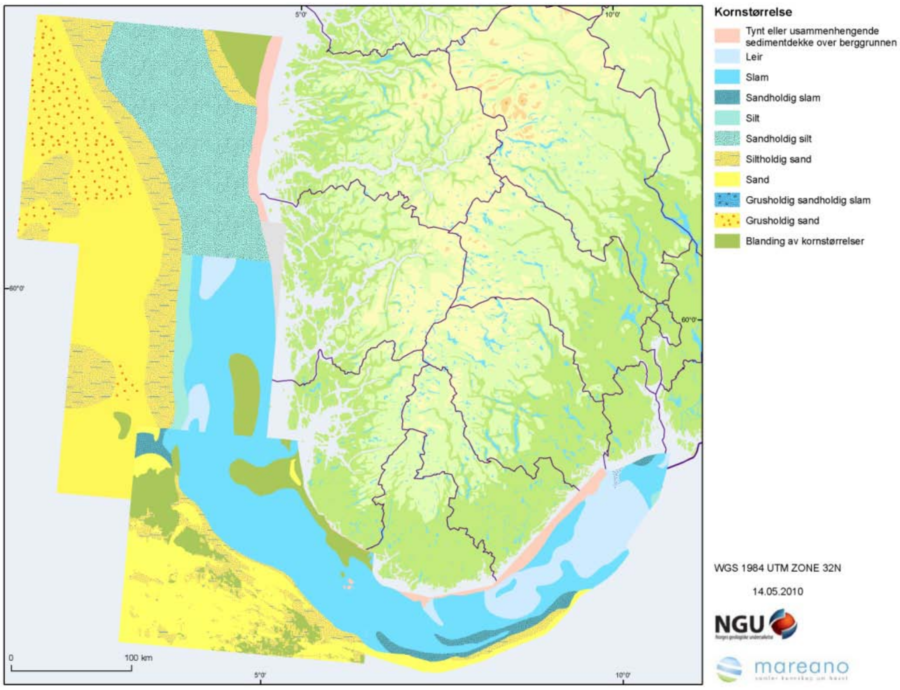


Figure A3-1. Sediment map of the Norwegian Deep and Skagerrak. Map from www.mareano.no.

Table A2-1. ***Nephrops*** **Norwegian Deep (FU 32). Landings, and Danish effort and LPUE.**

Year	Landings	Effort	LPUE
1993	339	1317	121
1994	755	2126	208
1995	489	1792	198
1996	952	3139	235
1997	760	3189	218
1998	836	2707	214
1999	1119	3710	226
2000	1084	3986	192
2001	1190	5372	166
2002	1171	4968	188
2003	1090	5273	177
2004	922	3488	216
2005	1089	3919	234
2006	1032	4796	196
2007	755	2878	226
2008	675	2301	220
2009*	477	1694	195

Stock Annex: FU6, Farn Deeps

Stock specific documentation of standard assessment procedures used by ICES.

Stock	Farn Deeps *Nephrops* (FU06
Date:	06/03/2009 (WKNEPH2009)
Revised by	Ewen Bell/Jon Elson

A. General

A.1 Stock definition

Throughout its distribution, *Nephrops* is limited to muddy habitat, and requires sediment with a silt & clay content of between 10 – 100% to excavate its burrows, and this means that the distribution of suitable sediment defines the species distribution. Adult *Nephrops* only undertake very small-scale movements (a few 100 m) but larval transfer may occur between separate mud patches in some areas. In the Farn Deeps area the *Nephrops* stock inhabits a large continuous area of muddy sediment extending North from 54° 45′ - 54° 35′N and 0° 40′ - 1° 30′N with smaller patches to the east and west.

A.2 Fishery

In 2001 the cod recovery plan was introduced and the number of vessels recorded in this fishery and landing into England increased from around 160 in 2000 to and fluctuated around 200 between 2001 and 2003. In 2004 the number returned to around 160 vessels but stepped up to 230 vessels in 2006. Although a small increase was apparent in the number of the local fleet turning to *Nephrops* the increase in the number of visiting Scots, Northern Irish and other English vessels was greater. Visiting Scottish vessels consistently make up about 30 to 40% of the fleet during the season and account for between 20 and 30% of the landings by weight. Since 2000 there has been an increase in the effort of vessels targeting *Nephrops* using multi rig trawls. In 2004 they accounted for about 10% of the landings by weight and 20% by 2006. Over 25% of the entire fleet uses multi rigs mainly through an influx of up to 19 Northern Irish and 30 Scottish multi riggers visiting the area - coming into the fishery for the frst time over the last two years. Both single and multi trawl fleets were affected by Technical Conservation Measures and Cod recovery plans. The single trawl fleet in general switched from a 70mm to an 80 mm cod end mesh in 2002. Multi rigged vessels targeting prawns use 95mm cod end mesh. The average vessel size of the visitors has remained relatively stable but average horse power has increased. With decommissioning the average size and power of the local fleet has declined slightly. Currently the average size of the local fleet is 11m with an average engine power of around 140 kW.

The fishery is exploited throughout the year, with the highest landings made between October and March. Fishing is usually limited to a trip duration of one day with 2 hauls of 3-4 hours being carried out. The main landing ports are North Shields, Blyth, Amble and Hartlepool where, respectively, on average 45, 32, 10 and 7% of the landings from this fishery are made.

The minimum landing size for *Nephrops* in the Farn Deeps is 25mm CL. Discarding generally takes place at sea, but can continue alongside the quay. Landings are usually made by category for whole animals, often large and medium and a single category for tails. However, landings to merchants of one category of unsorted whole and occasionally one of tails is becoming more common. Depending on the number of small, the category of tails is often roughly sorted as whole and left on deck for tailing later. This category is only landed once tailed. The local enforcement agency is discouraging the practice of tailing after tying up alongside.

Regulations

UK legislation (SI 2001/649, SSI 2000/227) requires at least a 90mm square mesh panel in trawls from 80 to 119mm, where the rear of the panel should be not more than 15m from the cod-line. The length of the panel must be 3m if the engine power of the vessel exceeds 112 kW, otherwise a 2m panel may be used. Under UK legislation, when fishing for *Nephrops*, the cod-end, extension and any square mesh panel must be constructed of single twine, of a thickness not exceeding 4mm for mesh sizes 70-99mm, while EU legislation restricts twine thickness to a maximum of 8mm single or 6mm double.

Under EU legislation, a maximum of 120 meshes round the cod-end circumference is permissible for all mesh sizes less than 90mm. For this mesh size range, an additional panel must also be inserted at the rear of the headline of the trawl. UK legislation also prohibits twin or multiple rig trawling with a diamond cod end mesh smaller that 100mm in the north Sea south of 57o30'N.

Legislation on catch composition for fishing N or S of 55° along with other cod recovery measures may have affected where and when effort is targeted which in turn could affect catch length distributions. This latitude bisects the Farn Deeps *Nephrops* fishery.

A.3 Ecosystem aspects

No information on the ecosystem aspects of this stock has been collated by the Working Group.

B. Data

B.1 Commercial catch

Three types of sampling occur on this stock, landings sampling, catch sampling and discard sampling providing information on size distribution and sex ratio. Landing and catch sampling occurs at North Shields, Blyth, Amble and Hartlepool.

Historically, estimates of discarding were made using the difference between the catch samples and the landings samples. For the period prior to 2002, catch length samples and landings length samples are considered to be representative of the fishery. An estimate of retained numbers at length was obtained for this period from the catch sample using a discard ogive estimated from data from the 1990s, a raising factor was then determined such that the retained numbers at length matched the landings numbers at length. This raising factor was then applied to the estimate of discard numbers at length.

More recently, there has been concern that the landings sampling may be missing portions of the landings landed as tails (as opposed to whole individuals) thus leading to an artificial inflation of the estimated discards. On-board discard sampling has been of sufficient frequency since 2002 to enable the estimation of discards from these data. There are two modes of operation for "tailing" in the FU6 *Nephrops* fishery, some vessels tail at sea, others tail at the quayside. Discard estimates from the latter category only sample those animals discarded at sea, the undersize individuals discarded at the quayside are not sampled, consequently the proportion of discards at sizes below MLS for this tailing practice are very low (Figure B.1.1). Discard trips, which saw discarding of less than 50% of individuals below MLS, were ignored. Annual discard ogives showed no systematic change, therefore a single ogive was constructed from the pooled data from 2002–2007 (Figure B.1.2). This was then applied to the catch data to produce estimates of landings at length.

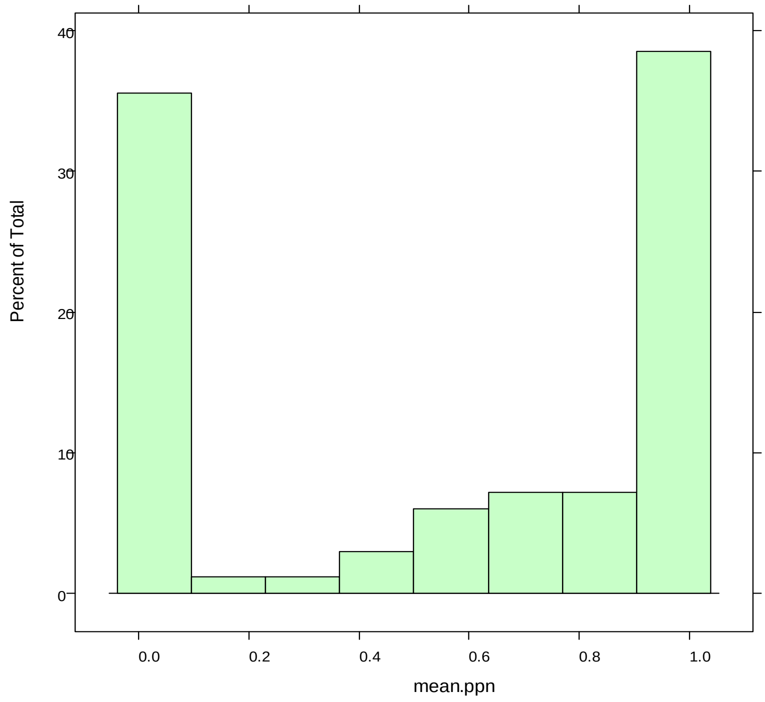


Figure B.1.1. Farn Deeps (FU 6): Histogram of proportion individuals <26mm discarded.

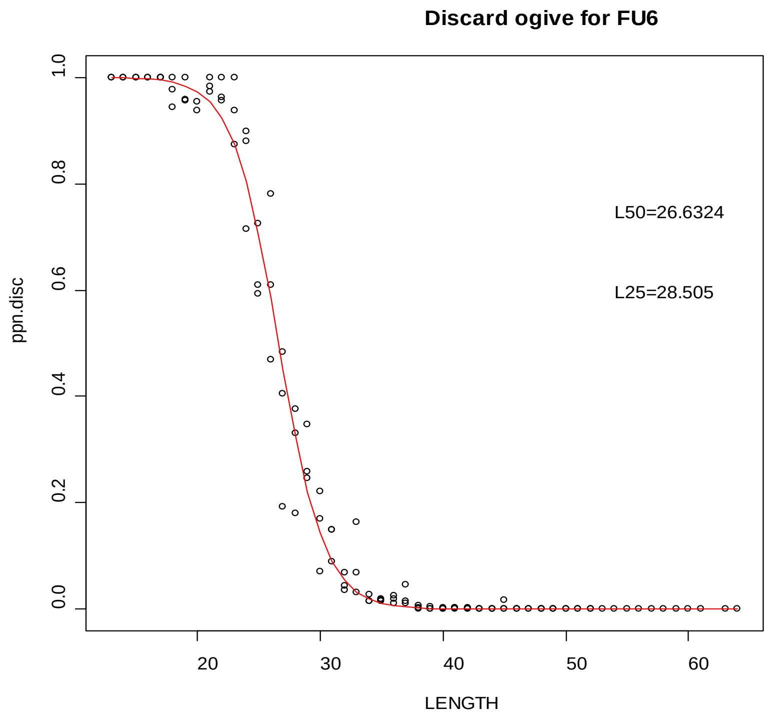


Figure B.1.2. Farn Deeps (FU 6): Discard ogive selected for FU6 *Nephrops*, trip level data pooled to year.

B.2 Biological

Mean weights-at-age for this stock are estimated from fixed weight-length relationships derived from samples collected from this fishery (Macer unpublished data).

A natural mortality rate of 0.3 was assumed for all age classes and years for males and immature females, with a value of 0.2 for mature females based on Morizur, 1982. The lower value for mature females reflects the reduced burrow emergence while ovigerous and hence an assumed reduction in predation.

The size at maturity for females was recalculated at ICES-WKNEPH 2006 to be 24.8mm CL 24 mm CL was used in assessments prior to 2009. A sigmoid maturity function is now used: L25 = 24.5mm, L50 = 25mm

Growth parameters are estimated from observations from this fishery (Macer, unpublished data) and comparison with adjacent stocks.

The time-invariant values used for proportion mature at age are: males age 1+: 100%; females age 1: 0%; age 2+: 100%. The source of the value for females is based on observations on 50% berried CL.

Discard survival (previously set at 25 %) was set to zero from 1991.

Summary:

Growth :

Males; L_∞ = 66mm, k = 0.16

Immature Females; L_∞ = 66mm, k = 0.16

Mature Females; L_∞ = 58mm, k = 0.06,

Size at maturity L25=24.5mm, L50=25mm.

Weight length parameters:

Males a = 0.00038, b = 3.17

Females a= 0.00091, b = 2.895

Discards

Discard survival rate: 0%.

Discard proportion: 29.5%

B.3 Surveys

Abundance indices are available from the following research-vessel surveys:

Underwater TV survey: years 1996 – present. Surveys have been conducted in Spring and/or Autumn each year but only consistently in Autumn from 2001. In 2008 there was an historical revision of burrow density estimates from the TV survey. Previous estimates of burrow density had assumed that station density was independent of burrow density based analysis that showed there was no evidence of differences in trends in burrow density between the different strata in the fishery (ICES WGNEPH, 2000). The assumption led to an unstratified mean density being used and multiplied by the total area to arrive at overall abundance. Analysis of burrow density by rectangle has since shown that the distribution of stations is positively correlated with burrow density and therefore the unstratified mean density will overestimate burrow density. In order to compensate for the bias in sampling density, burrow abundance estimates are made for each rectangle and then summed to give the new total.

A number of factors are suspected to contribute bias to the surveys. In order to use the survey abundance estimate as an absolute it is necessary to correct for these potential biases. The history of bias estimates are as follows.

	Time period	Edge effect	detection rate	species identification	occupancy	Cumulative bias
FU 6: Farn Deeps	<=2009	1.3	0.85	1.05	1	

B.4 Commercial CPUE

Catch-per-unit-effort time-series are available from the following fleets:

- UK *Nephrops* trawl gears. CPUE is estimated using officially recorded effort (hours fished) although the recording of effort is not mandatory. Combined effort for English and Scottish *Nephrops* trawlers (single trawl and multiple trawl) is raised to the total landings reported by the four gear goups - *Nephrops* single trawl, multiple *Nephrops* trawl, Light trawl and multiple demersal trawl. There is no account taken of any technological creep in the fleet.

The registered buyers and sellers legislation brought in by the UK in 2006 changed the reporting procedure, which effectively breaks the continuity in the series at that point. The accuracy of the reported landings has significantly improved since then but there is currently little that can be done to determine and correct for any differences in the two series.

B.5 Other relevant data

C. Historical Stock Development

1. Survey indices are worked up annually resulting in the TV index.
2. Adjust index for bias (see section B3). The combined effect of these biases is to be applied to the new survey index.
3. Generate mean weight in landings. Check the time series of mean landing weights for evidence of a trend in the most recent period. If there is no firm evidence of a recent trend in mean weight use the average of the three most recent years. If, however, there is strong evidence of a recent trend then apply most recent value (don't attempt to extrapolate the trend further in the future).

D. Short-Term Projection

4. The catch option table will include the harvest ratios associated with fishing at $F_{0.1}$ and Fmax. These values have been estimated by the Benchmark Workshop (see section 9.2) and are to be revisited by subsequent benchmark groups. The values are FU specific and have been put in the Stock Annexes.
5. Create catch option table on the basis of a range of harvest ratios ranging from 0 to the maximum observed ratio or the ratio equating to F_{max}, whichever is the larger. Insert the harvest ratios from step 4 and also the current harvest ratio.
6. Multiply the survey index by the harvest ratios to give the number of total removals.
7. Create a landings number by applying a discard factor. This conversion factor has been estimated by the Benchmark Workshop and is to be revisited at

subsequent benchmark groups. The value is FU specific and has been put in the Stock Annex.

8. Produce landings biomass by applying mean weight.

The suggested catch option table format is as follows.

			Implied fishery	
	Harvest rate	Survey Index	Retained number	Landings (tonnes)
	0%	12345	0	0.00
	2%	"	247	123.45
	4%	"	494	246.90
	6%	"	741	370.35
	8%	"	988	493.80
F0.1	8.60%	"	1062	530.84
	10%	"	1235	617.25
	12%	"	1481	740.70
Fmax	13.50%	"	1667	833.29
	14%	"	1728	864.15
	16%	"	1975	987.60
	18%	"	2222	1111.05
	20%	"	2469	1234.50
	22%	"	2716	1357.95
Fcurrent	21.5%	"	2654	1327.09

E. Medium-Term Projections

None

F. Long-Term Projections

None

G. Biological Reference Points

None specified.

Harvest ratios equating to fishing at F0.1 and Fmax were calculated in WKNeph (2009). These calculations assume that the TV survey has a knife-edge selectivity at 17mm and that the supplied length frequencies represented the population in equilibrium.

F-reference point	Harvest ratio
$F_{0.1}$	8.2%
F_{max}	13.3%

H. Other Issues

I. References

Stock Annex: FU7, Fladen Ground

Stock specific documentation of standard assessment procedures used by ICES.

Stock	Fladen Ground *Nephrops* (FU 7)
Date:	09 March 2009 (WKNEPH2009)
Revised by	Sarah Clarke/Carlos Mesquita

A. General

A.1 Stock definition

Throughout its distribution, *Nephrops* is limited to muddy habitat, and requires sediment with a silt & clay content of between 10–100% to excavate its burrows. This means that the distribution of suitable sediment defines the species distribution. Adult *Nephrops* only undertake very small scale movements (a few 100 m) but larval transfer may occur between separate mud patches in some areas. The Fladen Ground is located towards the centre of the northern part of Division IV. Its eastern boundary is adjacent to the Norwegian Deeps area, while its western boundary borders the Moray Firth functional unit (FU9). There is some evidence for overlap of habitat at the boundary of these areas. The ground represents one of the largest areas of soft muddy sediments in the North Sea and there are wide variations in sediment composition across the ground. *Nephrops* is distributed throughout the area and is associated with various benthic communities reflecting the variations in physical environment.

A.2 Fishery

The Fladen fishery (FU7), the largest Scottish *Nephrops* fishery, takes a mixed catch with haddock, whiting, cod, monkfish and flatfish such as megrim, also making an important contribution to vessel earnings. The Fladen *Nephrops* fleet comprises vessels from 12m up to 35m fishing mainly with 80mm twin-rig. The fleet has a diverse range of boats, and includes some of the largest most modern purpose built boats in the Scottish fleet and vessels which have recently converted to *Nephrops* fishing.

The area supports well over 100 vessels and the majority of the fleet (80%) fish out of Fraserburgh, with the other important ports being Peterhead, Buckie, Macduff, and Aberdeen. Boats fish varying lengths of trip between 3 days (small boats) and 8-9 day trips (larger vessels). During 2006 and 2007 around 20 vessels joined the fleet and 5 ongoing new boat builds have the capability to fish at Fladen. Some whitefish vessels have converted to *Nephrops* twin-rigging.

The Fladen fishery generally follows a similar pattern every year, with different areas of the Fladen grounds producing good fishing at different times of the year (boats fish the north of the ground in winter, then move east towards the sector line in the summer). During 2004-5 this seasonal pattern was less apparent with fishing being good throughout the year on a range of grounds. There was also no lull in catch rates which traditionally happens in April-May. In 2006 however, there was a return to a more usual pattern of fishing with catches poor for most of the spring and slowly getting better throughout the summer. Some participating vessels explored slightly different areas to fish in 2006, particularly on the eastern edge of the ground. Bad weather at the start of 2006 and part of 2007 also contributed to the slower start to the fishery in these years. In some years, high squid abundance in the Moray Firth attracts Fladen vessels but in the last two years this was not so evident compared to 2005.

Other developments include the capability of freezing at sea and in one case, processing at sea. A recent tendency towards shorter trip lengths and improved handling practice is associated with market demand for high quality *Nephrops* which appears to have increased dramatically. The implementation of buyers and sellers legislation in 2006 has reduced the problem of underreporting and prices have risen, while weighing at sea has improved the accuracy of reported landings.

A.3 Ecosystem aspects

No information on the ecosystem aspects of this stock has been collated by the Working Group.

B. Data

B.1 Commercial catch

Length compositions of Scottish landings and discards are obtained during monthly market sampling and quarterly on-board observer sampling respectively. Levels of sampling have increased since 2000 and are considered adequate for providing representative length structure of removals at the Fladen Ground. Although assessments based on detailed catch analysis are not presently possible, examination of length compositions can provide a preliminary indication of exploitation effects.

LPUE and CPUE data were available for Scottish *Nephrops* trawls. Table B1-1 shows the data for single trawls, multiple trawls and combined. Examination of the long term commercial LPUE data (Figure B1-1) suggests a rapid increase since 2003. It is likely, however, that improved reporting of landings data) in recent years particularly arising from 'buyers and sellers legislation has contributed to the increase. The high levels have been maintained since 2003. In addition, effort recording in terms of hours fished is non-mandatory and therefore it is unclear whether these trends and those that are discussed below are actually indicative of trends in LPUE.

Males consistently make the largest contribution to the landings (Figure B1-2), although the sex ratio does vary. In earlier years effort was generally highest in the latter part of the year in this fishery, but the pattern varies between years, and the seasonal pattern does not appear as strong in recent years. LPUE of both sexes remained relatively constant up to 2002, and in common with the overall figure has shown a marked increase since then. This suggests that exploitation (or other external factors) are not disproportionately affecting one sex or the other. LPUE is fairly similar through the year for males but for females there is no consistent pattern in these data.

LPUE data for each sex, above and below 35 mm CL, are shown in Figure B1-3. This size was chosen for all the Scottish stocks examined as the size above which the effects of discarding practices were not expected to occur and the size below which recruitment events might be observed in the length composition. The data show a rise in LPUE in all categories since 2001. There is, however, no apparent lag between the increased LPUEs of <35mm animals and >35mm animals which one might expect if the reason was increasing abundance.

B.2 Biological

Dynamics for this stock are poorly understood and studies to estimate growth have not been carried out. Parameters applied in a preliminary length-based assessment and age (with length) based simulation to inform the catch forecast process were as follows: natural mortality was assumed to be 0.3 for males of all ages and in all years. Natural mortality was assumed to be 0.3 for immature females, and 0.2 for mature females.

SUMMARY

Von Bertalanffy growth parameters are as follows:

Males; L_∞ = 66mm, k = 0.16

Immature Females; L_∞ = 66mm, k = 0.16

Mature Females; L_∞ = 56mm, k = 0.10,

Size at maturity = 25mm

Weight length parameters:

Males a = 0.0003, b = 3.25

Females a= 0.00074, b = 2.91

Discards

Discard survival rate: 25%.

Discard proportion: 13.8%

B.3 Surveys

TV surveys using a stratified random design are available for FU 7 since 1992 (missing survey in 1996). Underwater television surveys of *Nephrops* burrow number and distribution, reduce the problems associated with traditional trawl surveys that arise from variability in burrow emergence of *Nephrops*.

On average, about 60 stations have been considered valid each year with over 70 stations in the last three years. Data are raised to a stock area of 28153 km^2 based on the stratification. General analysis methods for underwater TV survey data are similar for each of the Scottish surveys. The ground has a range of mud types from soft silty clays to coarser sandy muds, the latter predominate (Figure B3–1). Most of the variance in the survey is associated with this variable sediment which surrounds the main centres of abundance. Abundance is generally higher in the soft and intermediate sediments located to the centre and south east of the ground but in 2007, higher densities were also recorded in the more northerly parts of the ground. In general the confidence intervals have been fairly stable in this survey.

A number of factors are suspected to contribute bias to the surveys. In order to use the survey abundance estimate as an absolute it is necessary to correct for these potential biases. The history of bias estimates are given in the following table and are based on simulation models, preliminary experimentation and expert opinion, the biases associated with the estimates of *Nephrops* abundance in the Fladen are:

	Time period	Edge effect	detection rate	species identification	occupancy	Cumulative bias
FU 7: Fladen	<=2009	1.45	0.9	1	1	

B.4 Commercial CPUE

Scottish *Nephrops* trawl gears: Landings, discards and effort data for Scottish *Nephrops* trawl gears are used to generate a CPUE index. CPUE is estimated using officially recorded effort (hours fished) although the recording of effort is not mandatory. Combined effort for *Nephrops* single trawl and multiple *Nephrops* trawl is raised to landings reported by the four gears listed above. Discard sampling commenced in 1990 for this fishery, and for years prior to this, an average of the 1990 and 1991 values is applied. There is no account taken of any technological creep in the fleet.

For more information see section B.1

B.5 Other relevant data

C. Historical Stock Development

1. Survey indices are worked up annually resulting in the TV index.
2. Adjust index for bias (see section B3). The combined effect of these biases is to be applied to the new survey index.
3. Generate mean weight in landings. Check the time series of mean landing weights for evidence of a trend in the most recent period. If there is no firm evidence of a recent trend in mean weight use the average of the three most recent years. If, however, there is strong evidence of a recent trend then apply most recent value (don't attempt to extrapolate the trend further in the future).

D. Short-Term Projection

4. The catch option table will include the harvest ratios associated with fishing at $F_{0.1}$ and Fmax. These values have been estimated by the Benchmark Workshop (see section 9.2) and are to be revisited by subsequent benchmark groups. The values are FU specific and have been put in the Stock Annexes.
5. Create catch option table on the basis of a range of harvest ratios ranging from 0 to the maximum observed ratio or the ratio equating to F_{max}, whichever is the larger. Insert the harvest ratios from step 4 and also the current harvest ratio.
6. Multiply the survey index by the harvest ratios to give the number of total removals.
7. Create a landings number by applying a discard factor. This conversion factor has been estimated by the Benchmark Workshop and is to be revisited at subsequent benchmark groups. The value is FU specific and has been put in the Stock Annex.
8. Produce landings biomass by applying mean weight.

The suggested catch option table format is as follows.

			Implied fishery	
	Harvest rate	Survey Index	Retained number	Landings (tonnes)
	0%	12345	0	0.00
	2%	"	247	123.45
	4%	"	494	246.90
	6%	"	741	370.35
	8%	"	988	493.80
F0.1	8.60%	"	1062	530.84
	10%	"	1235	617.25
	12%	"	1481	740.70
Fmax	13.50%	"	1667	833.29
	14%	"	1728	864.15
	16%	"	1975	987.60
	18%	"	2222	1111.05
	20%	"	2469	1234.50
	22%	"	2716	1357.95
Fcurrent	21.5%	"	2654	1327.09

E. Medium-Term Projections

None presented

F. Long-Term Projections

None presented

G. Biological Reference Points

Harvest ratios equivalent to fishing at F0.1 and Fmax were calculated in WKNeph (2009). These calculations assume that the TV survey has a knife-edge selectivity at 17mm.

F-reference point	Harvest ratio
F0.1	9.3%
Fmax	15.8%

H. Other Issues

I. References

Table B1-1. *Nephrops*, Fladen (FU 7): Landings (tonnes), effort ('000 hours trawling) and LPUE (kg/hour trawling) of Scottish *Nephrops* trawlers, 1981-2007 (data for all *Nephrops* gears combined, and for single and multirigs separately).

Year	All *Nephrops* gears combined			Single rig			Multirig		
	Landings	Effort	LPUE	Landings	Effort	LPUE	Landings	Effort	LPUE
1981	304	8.6	35.3	304	8.6	35.3	na	na	na
1982	382	12.2	31.3	382	12.2	31.3	na	na	na
1983	548	15.4	35.6	548	15.4	35.6	na	na	na
1984	549	11.4	48.2	549	11.4	48.2	na	na	na
1985	1016	26.6	38.2	1016	26.6	38.2	na	na	na
1986	1398	37.8	37.0	1398	37.8	37.0	na	na	na
1987	1024	41.6	24.6	1024	41.6	24.6	na	na	na
1988	1306	41.7	31.3	1306	41.7	31.3	na	na	na
1989	1719	47.2	36.4	1719	47.2	36.4	na	na	na
1990	1703	43.4	39.2	1703	43.4	39.2	na	na	na
1991	3024	78.5	38.5	410	11.4	36.0	2614	67.1	39.0
1992	1794	38.8	46.2	340	9.4	36.2	1454	29.4	49.5
1993	2033	49.9	40.7	388	9.6	40.4	1645	40.3	40.8
1994	1817	48.8	37.2	301	8.4	35.8	1516	40.4	37.5
1995	3569	75.3	47.4	2457	52.3	47.0	1022	23.0	44.4
1996	2338	57.2	40.9	2089	51.4	40.6	249	5.8	42.9
1997	2713	76.5	35.5	2013	54.7	36.8	700	21.8	32.1
1998	2291	60.0	38.2	1594	39.6	40.3	697	20.5	34.0
1999	2860	76.8	37.2	1980	50.3	39.4	880	26.5	33.2
2000	2915	92.1	31.7	2002	62.9	31.8	913	29.2	31.3
2001	3539	108.2	32.7	2162	65.8	32.9	1377	42.4	32.5
2002	4513	109.6	41.2	2833	58.9	48.1	1680	50.7	33.1
2003	4175	53.7	77.7	3388	42.8	79.2	787	10.9	72.2
2004	7274	56.1	129.8	6177	47.5	130.2	1097	8.6	127.6
2005	8849	61.3	144.4	6834	43.4	157.5	2015	17.9	112.7
2006	9469	65.7	144.1	7149	50.2	142.4	2320	15.5	149.7
2007	11054	69.6	158.8	8232	52.2	157.7	2822	17.4	162.2

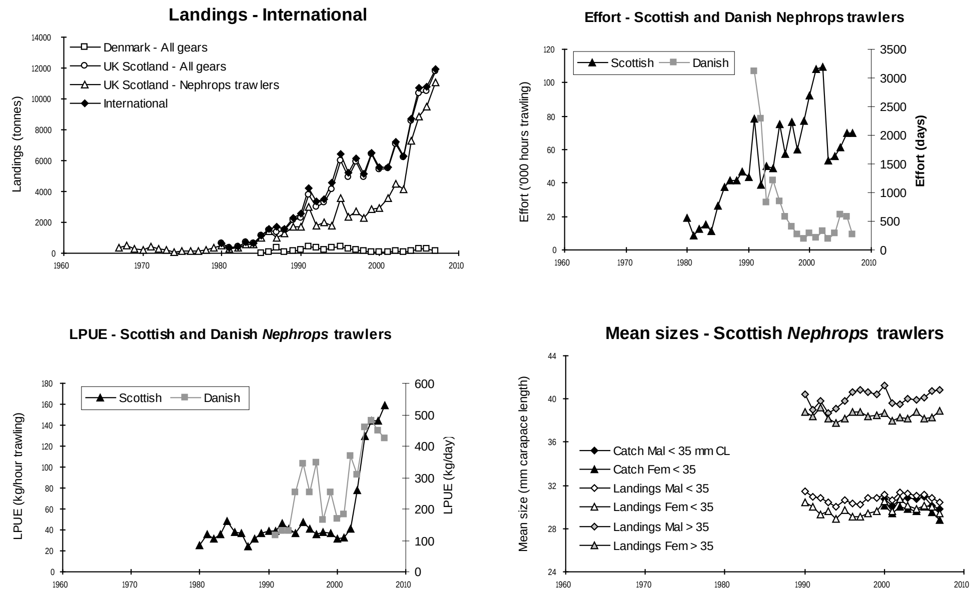


Figure B1-1. *Nephrops*, Fladen (FU 7), Long term landings, effort, LPUE and mean sizes.

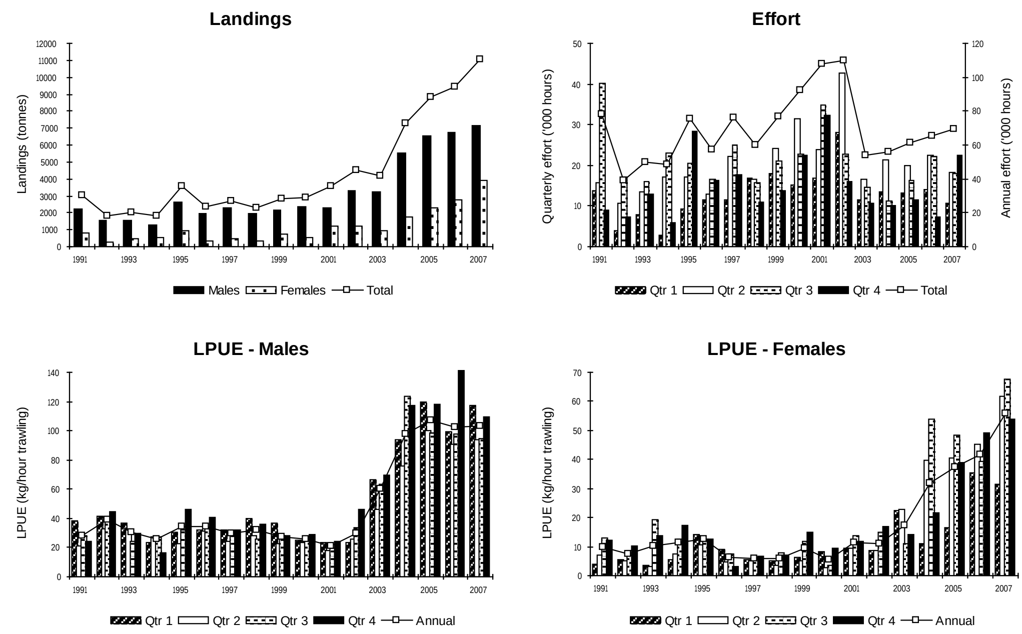


Figure B1-2. ***Nephrops*****, Fladen (FU 7), Landings, effort and LPUEs by quarter and sex from Scottish** ***Nephrops*** **trawlers.**

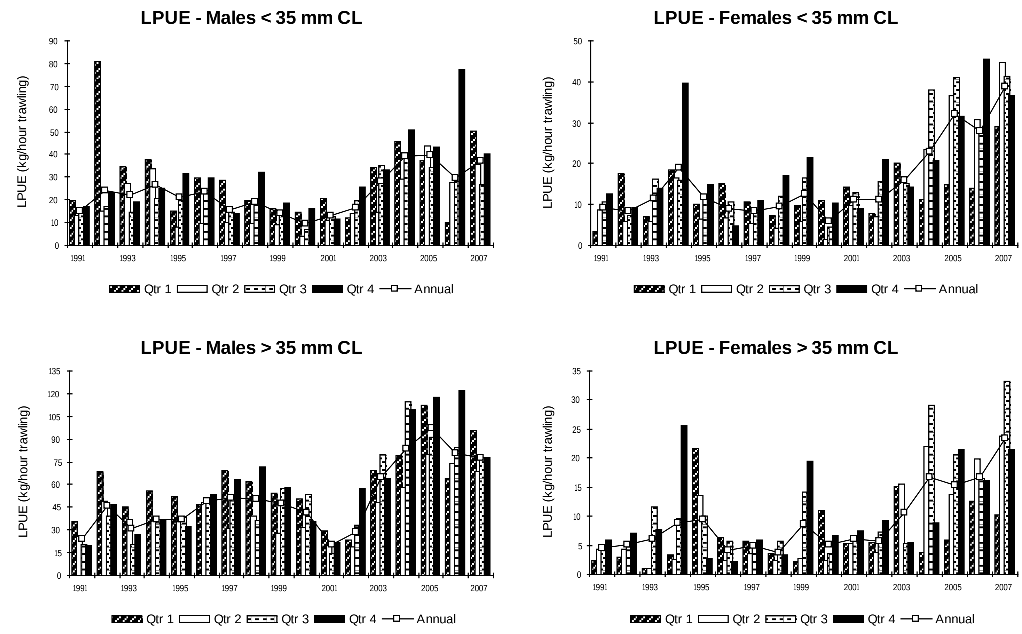


Figure B1-3. ***Nephrops*****, Fladen (FU 7), CPUEs by sex and quarter for selected size groups, Scottish** ***Nephrops*** **trawlers.**

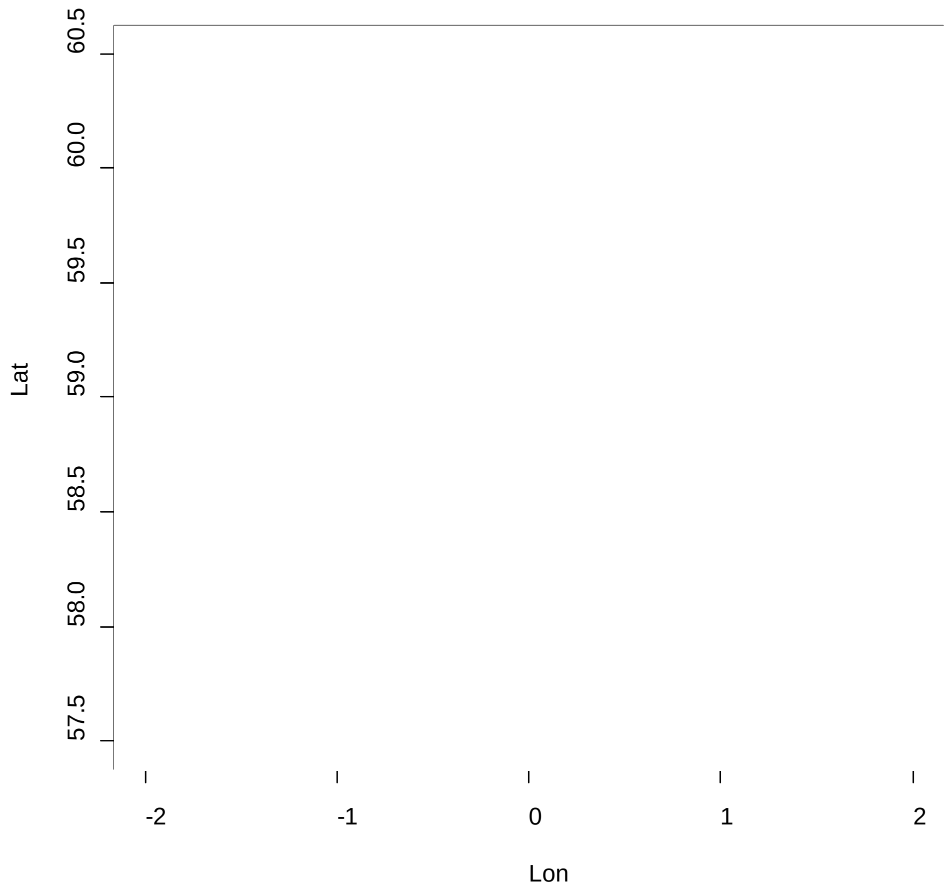


Figure B3–4. Distribution of *Nephrops* sediments in the Fladen Ground (FU 7). Thick dashed lines represent the boundary of the functional unit. Sediments are: Dark grey – Mud; Grey – Sandy Mud, Light Grey – Muddy.

Stock Annex: FU8, Firth of Forth

Stock specific documentation of standard assessment procedures used by ICES.

Stock	Firth of Forth *Nephrops* (FU 8)
Date:	09 March 2009 (WKNEPH2009)
Revised by	Sarah Clarke/Carlos Mesquita

A. General

A.1 Stock definition

Throughout its distribution, *Nephrops* is limited to muddy habitat, and requires sediment with a silt & clay content of between 10–100% to excavate its burrows. This means that the distribution of suitable sediment defines the species distribution. Adult *Nephrops* only undertake very small scale movements (a few 100 m) but larval transfer may occur between separate mud patches in some areas. The Firth of Forth is located close inshore to the Scottish coast, towards the west of the central part of Division IV. The mud substrate in the Firth of Forth area is mainly muddy sand and sandy mud, and there is only a small amount of the softest mud. The population of *Nephrops* in this area is composed of smaller animals. Earlier research suggested that residual currents moving southward from this area transport some larvae to the Farn Deeps – recent larval surveys have not been undertaken, however, and it is unclear how significant this effect is. Outside the functional unit, a *Nephrops* population is found on a smaller patch of mud beyond the northern boundary, off Arbroath.

A.2 Fishery

The *Nephrops* fishery is located throughout the Firth but is particularly focussed on grounds to the east and south east of the Isle of May. Grounds located further up the Firth occur in areas closer to industrial activity and shipping.

Most of the vessels are resident in ports around the Firth of Forth, particularly at Pittenweem, Port Seton and Dunbar. Some vessels, normally active in the Farn Deeps, occasionally come north from Eyemouth and South Shields. During 2006 and 2007 the number of vessels regularly fishing in the Firth of Forth was been around 40 (23 under 10m and 19 over 10m vessels). This number varies seasonally with vessels from other parts of the UK increasing the size of the fleet. Local boats sometimes move to other grounds when catch rates drop during the late spring *Nephrops* moulting period. Traditionally, Firth of Forth boats move south to fish the Farn Deeps grounds. Single trawl fishing with 80 mm mesh size is the most prevalent method. Some vessels utilise a 90mm codend. A couple of vessels have the capability for twin rigging. Night fishing for *Nephrops* is commonest in the summer. Day fishing is the norm in winter. A very small amount of creeling for *Nephrops* takes place, this is mostly by crab and lobster boats.

Nephrops is the main target species with diversification by some boats to squid, and also surf clams. Only very small amounts of whitefish are landed. The area is characterised by catches of smaller *Nephrops* and discarding is sometimes high. The latest information for 2007 suggests that large catches of small *Nephrops* were taken. In the past, small prawns generally led to high tail:whole prawn ratios in this fishery but in recent years a small whole prawn ‘paella’ market developed.

In 2006, buyers and sellers regulations led to increased traceability and improved reporting of catches. This continued and improved further in 2007 and the reporting of landings is now considered to be much more reliable.

A.3 Ecosystem aspects

No information on the ecosystem aspects of this stock has been collated by the Working Group.

B. Data

B.1 Commercial catch

Length compositions of landings and discards are obtained during monthly market sampling and quarterly on-board observer sampling respectively. Levels of sampling are considered adequate for providing representative length structure of removals in the Firth of Forth. Although assessments based on detailed catch analysis are not presently possible, examination of length compositions can provide a preliminary indication of exploitation effects.

LPUE and CPUE data were available for Scottish *Nephrops* trawls. Table B1-1 shows the data for single trawls, multiple trawls and combined. Examination of the long term commercial LPUE data (Figure B1-1) suggests that the stock is currently very abundant but the recent improvements in reporting of landings (due to 'buyers and sellers' legislation) may mean this is an artefact generated by more complete landings data. In addition, effort recording in terms of hours fished is non-mandatory which will also affect the trends in LPUE.

Males consistently make the largest contribution to the landings (Figure B1-2), although the sex ratio does vary. Effort is generally highest in the 3rd quarter of the year in this fishery, but although the pattern was fairly stable in the early years, the pattern does not appear as strong in recent years and is 2007 was fairly evenly spread throughout the year. LPUE of both sexes has fluctuated through the time series and is currently at a high level. The comments about the quality of landings data are relevant here too. LPUE is generally higher for males in the 1st and 4th quarters, and for females in the 3rd quarter – the period when they are not incubating eggs.

CPUE data for each sex, above and below 35 mm CL, are shown in Figure B1-3. This size was chosen for all the Scottish stocks examined as the size above which the affects of discarding practices were not expected to occur and the size below which recruitment events might be observed in the length composition. The data show a slight peak in CPUE for smaller individuals (both sexes) in 1999, with a decline after this, followed by a steady increase in both sexes from 2002 onwards. The CPUE for larger individuals showed a similar pattern with higher values in the most recent years.

B.2 Biological

Dynamics for this stock are poorly understood and studies to estimate growth have not been carried out. Assumed biological parameters are as follows: natural mortality was assumed to be 0.3 for males of all ages and in all years. Natural mortality was assumed to be 0.3 for immature females, and 0.2 for mature females.

SUMMARY

Growth parameters

Males; L_∞ = 66mm, k = 0.163

Immature Females; L_∞ = 66mm, k = 0.163

Mature Females; L∞ = 58mm, k = 0.065,

Size at maturity = 26mm

Weight length parameters:

Males a = 0.00028, b = 3.24

Females a= 0.00085, b = 2.91

Discards

Discard survival rate: 25%.

Discard rate: 34.6%

B.3 Surveys

TV surveys using a stratified random design are available for FU 8 since 1993 (missing surveys in 1995 and 1997). Underwater television surveys of *Nephrops* burrow number and distribution, reduce the problems associated with traditional trawl surveys that arise from variability in burrow emergence of *Nephrops*. On average, about 40 stations have been considered valid each year with more stations sampled in the last three years. The survey in 2006 was conducted in December so that densities may not be strictly compatible with the remainder of the series. Abundance data are raised to a stock area of 915 km^2. General analysis methods for underwater TV survey data are similar for each of the Scottish surveys. The ground is predominantly of coarser muddy sand (Figure B3–1). Depending on the year, high variance in the survey is associated with different strata and there is no clear distributional or sedimentary pattern in this area. Abundance is generally higher towards the central part of the ground and around the Isle of May. In recent years higher densities have been recorded over quite wide areas. Confidence intervals have been fairly stable in this survey.

A number of factors are suspected to contribute bias to the surveys. In order to use the survey abundance estimate as an absolute it is necessary to correct for these potential biases. The history of bias estimates are given in the following table and are based on simulation models, preliminary experimentation and expert opinion, the biases associated with the estimates of *Nephrops* abundance in the Firth of Forth are:

	Time period	**Edge effect**	**detection rate**	**species identification**	**occupancy**	**Cumulative bias**
FU 8: Firth of Forth	<=2009	1.23	0.9	1.05	1	

B.4 Commercial CPUE

Scottish *Nephrops* trawl gears: Landings, discards and effort data for Scottish *Nephrops* trawl gears are used to generate a CPUE index. CPUE is estimated using officially recorded effort (hours fished) although the recording of effort is not mandatory. Combined effort for *Nephrops* single trawl and multiple *Nephrops* trawl is raised to landings reported by the four gears listed above. Discard sampling commenced in 1990 for this fishery, and for years prior to this, an average of the 1990 and 1991 values is applied. There is no account taken of any technological creep in the fleet.

For more information see section B.1

B.5 Other relevant data

C. Historical Stock Development

1. Survey indices are worked up annually resulting in the TV index.
2. Adjust index for bias (see section B3). The combined effect of these biases is to be applied to the new survey index.
3. Generate mean weight in landings. Check the time series of mean landing weights for evidence of a trend in the most recent period. If there is no firm evidence of a recent trend in mean weight use the average of the three most recent years. If, however, there is strong evidence of a recent trend then apply most recent value (don't attempt to extrapolate the trend further in the future).

D. Short-Term Projection

4. The catch option table will include the harvest ratios associated with fishing at $F_{0.1}$ and Fmax. These values have been estimated by the Benchmark Workshop (see section 9.2) and are to be revisited by subsequent benchmark groups. The values are FU specific and have been put in the Stock Annexes.
5. Create catch option table on the basis of a range of harvest ratios ranging from 0 to the maximum observed ratio or the ratio equating to F_{max}, whichever is the larger. Insert the harvest ratios from step 4 and also the current harvest ratio.
6. Multiply the survey index by the harvest ratios to give the number of total removals.
7. Create a landings number by applying a discard factor. This conversion factor has been estimated by the Benchmark Workshop and is to be revisited at subsequent benchmark groups. The value is FU specific and has been put in the Stock Annex.
8. Produce landings biomass by applying mean weight.

The suggested catch option table format is as follows.

			Implied fishery	
	Harvest rate	Survey Index	Retained number	Landings (tonnes)
	0%	12345	0	0.00
	2%	"	247	123.45
	4%	"	494	246.90
	6%	"	741	370.35
	8%	"	988	493.80
F0.1	8.60%	"	1062	530.84
	10%	"	1235	617.25
	12%	"	1481	740.70
Fmax	13.50%	"	1667	833.29
	14%	"	1728	864.15
	16%	"	1975	987.60
	18%	"	2222	1111.05
	20%	"	2469	1234.50
	22%	"	2716	1357.95
Fcurrent	21.5%	"	2654	1327.09

E. Medium-Term Projections

None presented

F. Long-Term Projections

None presented

G. Biological Reference Points

Harvest ratios equivalent to fishing at F0.1 and Fmax were calculated in WKNeph (2009). These calculations assume that the TV survey has a knife-edge selectivity at 17mm.

F-reference point	Harvest ratio
F0.1	8.0%
Fmax	13.7%

H. Other Issues

I. References

Table B1-1. *Nephrops*, Firth of Forth (FU 8): Landings (tonnes), effort ('000 hours trawling) and LPUE (kg/hour trawling) of Scottish *Nephrops* trawlers, 1981-2007 (data for all *Nephrops* gears combined, and for single and multirigs separately).

Year	All *Nephrops* gears combined			Single rig			Multirig		
	Landings	Effort	LPUE	Landings	Effort	LPUE	Landings	Effort	LPUE
1981	945	42.6	22.2	945	42.6	22.2	na	na	na
1982	1138	51.7	22.0	1138	51.7	22.0	na	na	na
1983	1681	60.7	27.7	1681	60.7	27.7	na	na	na
1984	2078	84.7	24.5	2078	84.7	24.5	na	na	na
1985	1908	73.9	25.8	1908	73.9	25.8	na	na	na
1986	2204	74.7	29.5	2204	74.7	29.5	na	na	na
1987	1582	62.1	25.5	1582	62.1	25.5	na	na	na
1988	2455	94.8	25.9	2455	94.8	25.9	na	na	na
1989	1833	78.7	23.3	1833	78.7	23.3	na	na	na
1990	1901	81.8	23.2	1901	81.8	23.2	na	na	na
1991	1359	69.4	19.6	1231	63.9	19.3	128	5.5	23.3
1992	1714	73.1	23.4	1480	63.3	23.4	198	8.5	23.3
1993	2349	100.3	23.4	2340	100.1	23.4	9	0.2	45.0
1994	1827	87.6	20.9	1827	87.6	20.9	0	0.0	0.0
1995	1708	78.9	21.6	1708	78.9	21.6	0	0.0	0.0
1996	1621	69.7	23.3	1621	69.7	23.3	0	0.0	0.0
1997	2137	71.6	29.8	2137	71.6	29.8	0	0.0	0.0
1998	2105	70.7	29.8	2105	70.7	29.8	0	0.0	0.0
1999	2192	67.7	32.4	2192	67.7	32.4	0	0.0	0.0
2000	1775	75.3	23.6	1761	75.0	23.5	14	0.3	46.7
2001	1484	68.8	21.6	1464	68.3	21.4	20	0.5	40.0
2002	1302	63.6	20.5	1286	63.3	20.3	16	0.3	53.3
2003	1115	53.0	21.0	1082	52.4	20.6	33	0.6	55.0
2004	1651	63.2	26.1	1633	62.9	26.0	18	0.4	49.7
2005	1973	66.6	29.6	1970	66.5	29.6	3	0.1	58.8
2006	2437	61.4	39.7	2432	61.0	39.9	5	0.4	14.2
2007	2622	57.6	45.5	2601	57.1	45.6	21	0.5	43.2

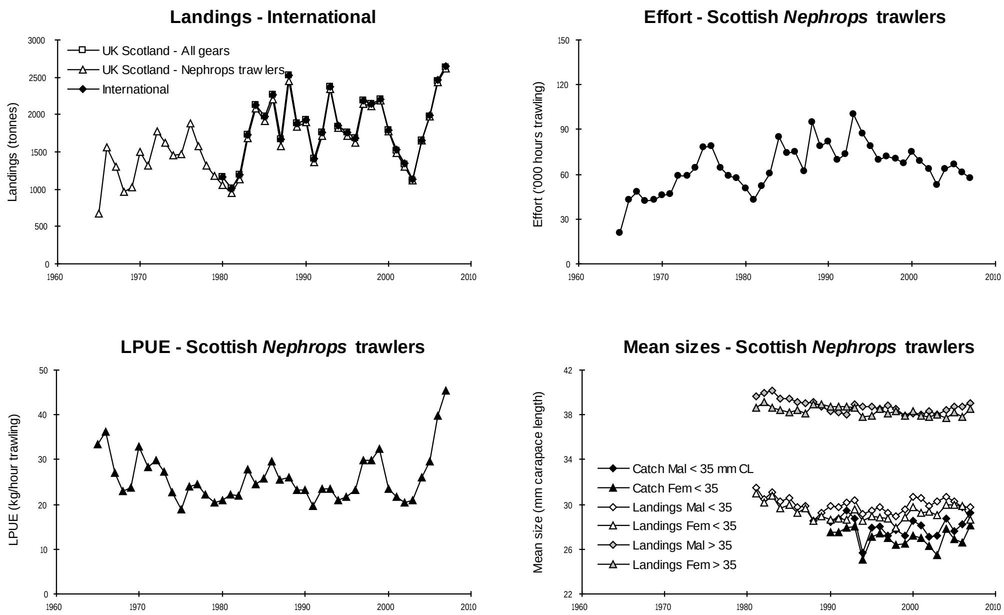


Figure B1-1. *Nephrops*, Firth of Forth (FU 8), Long term landings, effort, LPUE and mean sizes.

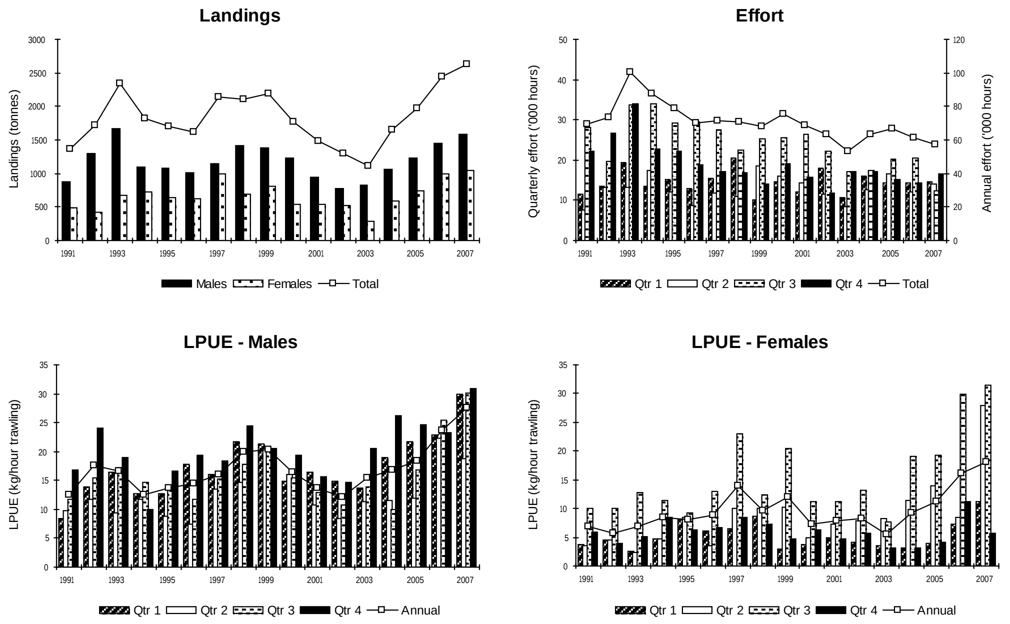


Figure B1-2. ***Nephrops*****, Firth of Forth (FU 8), Landings, effort and LPUEs by quarter and sex from Scottish *Nephrops* trawlers.**

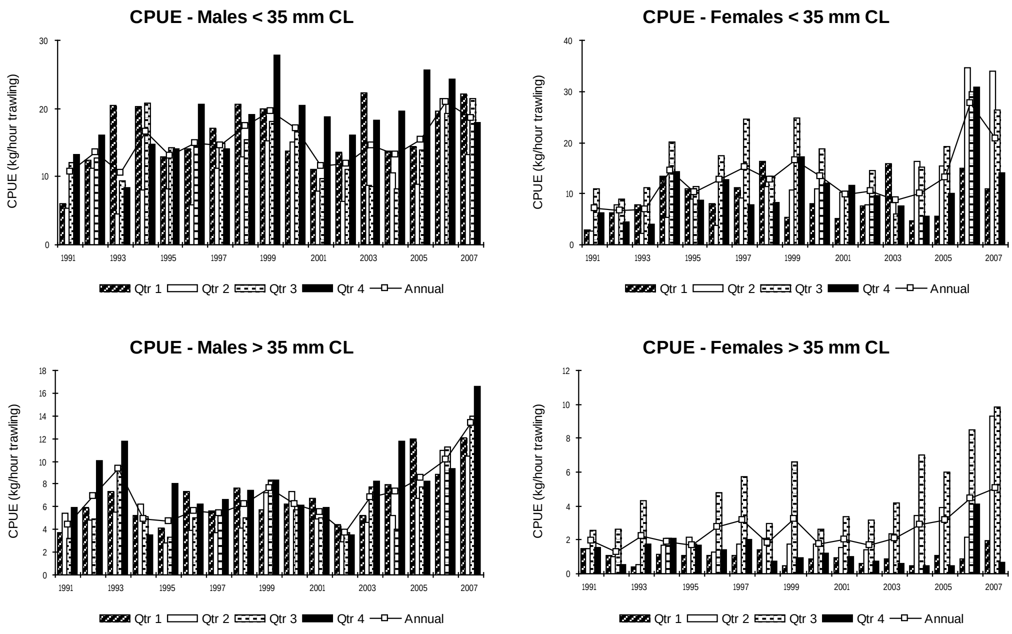


Figure B1-3. ***Nephrops*****, Firth of Forth (FU 8), CPUEs by sex and quarter for selected size groups, Scottish *Nephrops* trawlers.**

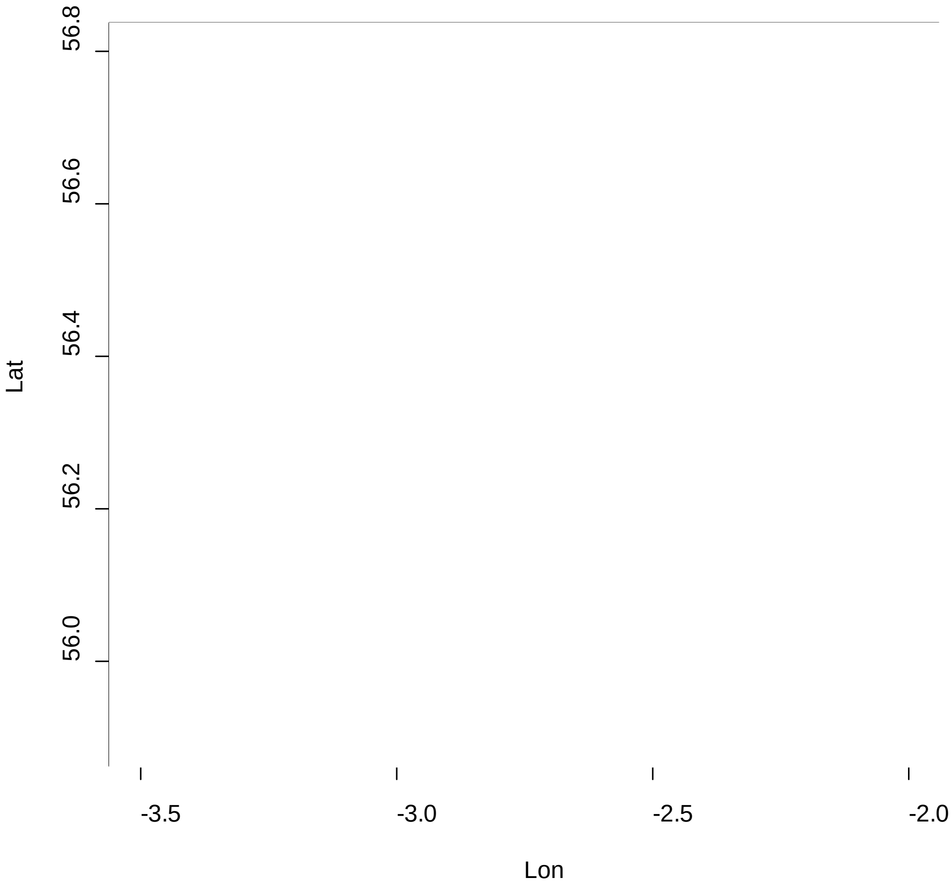


Figure B3–1. Distribution of *Nephrops* sediments in the Firth of Forth (FU 8). Thick dashed lines represent the boundary of the functional unit. Sediments are: Dark grey – Mud; Grey – Sandy Mud, Light Grey – Muddy.

Stock Annex: FU9, Moray Firth

Stock specific documentation of standard assessment procedures used by ICES.

Stock	Moray Firth *Nephrops* (FU 9)
Date:	09 March 2009 (WKNEPH2009)
Revised by	Sarah Clarke/Carlos Mesquita

A. General

A.1 Stock definition

Throughout its distribution, *Nephrops* is limited to muddy habitat, and requires sediment with a silt & clay content of between 10–100% to excavate its burrows. This means that the distribution of suitable sediment defines the species distribution. Adult *Nephrops* only undertake very small scale movements (a few 100 m) but larval transfer may occur between separate mud patches in some areas. The Moray Firth is located to the north west of Division IV. In common with other *Nephrops* fisheries the bounds of the Functional Unit are defined by the limits of muddy substrate. The major *Nephrops* fisheries within this management area fall within 30 miles of the UK coast. The Moray Firth (FU9) is a relatively sheltered inshore area, that supports populations of juvenile pelagic fish and relatively high densities of squid at certain times. The Moray Firth borders the Fladen functional unit (FU7) and there is some evidence of *Nephrops* populations lying across this boundary.

A.2 Fishery

The Moray Firth area is fished by a number of the smaller class of *Nephrops* boat (12-16m) regularly fishing short trips from Buckie, Helmsdale, Macduff and Burghead. Most boats still fish out of Burghead, and are about 15 in number; leaving and returning to port within 24 hours (day boats). Many of the smaller boats are now only manned by one or two people. Several of the larger *Nephrops* trawlers fish the outer Moray Firth grounds on their way to or from the Fladen grounds (especially when they are fishing the Skate Hole area). Also in times of bad weather many of the larger *Nephrops* trawlers which would normally be fishing the Fladen grounds fish the Moray Firth grounds. In recent years a squid fishery has been seasonally important in the Moray Firth. Squid appear to the east of the Firth and gradually move west during the Summer, increasing in size as they shift. During the autumn the movement is reversed. A large fishery took place in 2004 that attracted a number of *Nephrops* vessels and in 2005, additional vessels joined in the seasonal fishery, but catches were noticeably down in 2006. In 2007 however the fishery for squid improved again and a number of boats switched effort until around October, with some boats fishing squid until December.

A.3 Ecosystem aspects

No information on the ecosystem aspects of this stock has been collated by the Working Group.

B. Data

B.1 Commercial catch

Length compositions of landings and discards are obtained during monthly market sampling and quarterly on-board observer sampling respectively. Levels of sampling are considered adequate for providing representative length structure of removals in the Moray Firth. Although assessments based on detailed catch analysis are not presently possible, examination of length compositions can provide a preliminary indication of exploitation effects.

LPUE data were available for Scottish *Nephrops* trawls. Table B1-1 shows the data for single trawls, multiple trawls and combined. Examination of the long term commercial LPUE data (Figure B1-1) suggests that the stock increased in the early- 1980s, declined to a stable level over the next 12 years or so and has recently increased to its highest level in 2007. It is thought that gear efficiency changes have occurred over time, particularly in relation to multiple trawl gears but this has not been quantified. Additionally, improved reporting of landings data in recent years arising from 'buyers and sellers' legislation is likely to also to have contributed to the increase in LPUE. Furthermore, effort recording is non-mandatory in terms of hours fish and therefore it is unclear whether these trends and those that are discussed below are actually indicative of trends in LPUE.

Males generally make the largest contribution to the landings (Figure B1-2), although the sex ratio does vary, and females landings exceeded males in 1994. Effort is generally highest in the 3rd quarter of the year in this fishery, but the pattern varies between years, and the seasonal pattern does not appear as strong in recent years. LPUE of both sexes remained relatively constant up to 2002, but has shown an increase since then. LPUE is generally higher for males in the 1st and 4th quarters, and for females in the 3rd quarter – the period when they are not incubating eggs.

CPUE data for each sex, above and below 35 mm CL, are shown in Figure B1-3. This size was chosen for all the Scottish stocks examined as the general size limit for discarded animals. The data show a slight peak in CPUE for smaller individuals (both sexes) in 1995, with a slight decline after this and relatively stable values from 2001 onwards. There is a peak in catches of small males in 2006 quarter 4 but taken annually the pattern is relatively stable. The CPUE for larger males shows relatively stable levels during the late 1990's, and slightly higher levels in the most recent years, particularly from 2003 onwards. CPUE for large females declined in 2005 but have risen again over the past two years, and showed a significant large value in 2007 quarter 3.

B.2 Biological

Dynamics for this stock are poorly understood and studies to estimate growth have not been carried out. Assumed biological parameters are as follows: natural mortality was assumed to be 0.3 for males of all ages and in all years. Natural mortality was assumed to be 0.3 for immature females, and 0.2 for mature females.

SUMMARY

Growth parameters:

Males; L_∞ = 62mm, k = 0.165

Immature Females; L_∞ = 62mm, k = 0.165

Mature Females; L_∞ = 56mm, k = 0.06,

Size at maturity = 25mm

Weight length parameters:

Males a = 0.00028, b = 3.24

Females a= 0.00074, b = 2.91

Discards

Discard survival rate: 25%

Discard rate: 7.4%

B.3 Surveys

TV surveys are available for FU 9 since 1993 (missing survey in 1995). Underwater television surveys of *Nephrops* burrow number and distribution, reduce the problems associated with traditional trawl surveys that arise from variability in burrow emergence of *Nephrops.*

On average, about 36 stations have been considered valid each year, and are raised to a stock area of 2195 km². General analysis methods for underwater TV survey data are similar for each of the Scottish surveys. The ground is predominantly of coarser muddy sand (Figure B3–1) and most of the variance in the survey is associated with a patchy area of this sediment to the west of the ground. Abundance has generally been higher towards the west of the ground but in recent years higher densities have been recorded throughout, and are quite evenly distributed at the east and west ends in 2006 and 2007. With the exception of 2003, the confidence intervals have been fairly stable in this survey.

A number of factors are suspected to contribute bias to the surveys. In order to use the survey abundance estimate as an absolute it is necessary to correct for these potential biases. The history of bias estimates are given in the following table and are based on simulation models, preliminary experimentation and expert opinion, the biases associated with the estimates of *Nephrops* abundance in the Moray Firth are:

	Time period	Edge effect	detection rate	species identification	occupancy	Cumulative bias
FU 9: Moray Firth	<=2009	1.31	0.9	1	1	

B.4 Commercial CPUE

Scottish *Nephrops* trawl gears: Landings at age and effort data for Scottish *Nephrops* trawl gears are used to generate a CPUE index. CPUE is estimated using officially recorded effort (hours fished) although the recording of effort is not mandatory. Combined effort for *Nephrops* single trawl and multiple *Nephrops* trawl is raised to landings reported by the four gears listed above. Discard sampling commenced in 1990 for this fishery, and for years prior to this, an average of the 1990 and 1991 values is applied. There is no account taken of any technological creep in the fleet.

For more information see section B.1

B.5 Other relevant data

C. Historical Stock Development

1. Survey indices are worked up annually resulting in the TV index.
2. Adjust index for bias (see section B3). The combined effect of these biases is to be applied to the new survey index.
3. Generate mean weight in landings. Check the time series of mean landing weights for evidence of a trend in the most recent period. If there is no firm evidence of a recent trend in mean weight use the average of the three most recent years. If, however, there is strong evidence of a recent trend then apply most recent value (don't attempt to extrapolate the trend further in the future).

D. Short-Term Projection

4. The catch option table will include the harvest ratios associated with fishing at $F_{0.1}$ and Fmax. These values have been estimated by the Benchmark Workshop (see section 9.2) and are to be revisited by subsequent benchmark groups. The values are FU specific and have been put in the Stock Annexes.
5. Create catch option table on the basis of a range of harvest ratios ranging from 0 to the maximum observed ratio or the ratio equating to F_{max}, whichever is the larger. Insert the harvest ratios from step 4 and also the current harvest ratio.
6. Multiply the survey index by the harvest ratios to give the number of total removals.
7. Create a landings number by applying a discard factor. This conversion factor has been estimated by the Benchmark Workshop and is to be revisited at subsequent benchmark groups. The value is FU specific and has been put in the Stock Annex.
8. Produce landings biomass by applying mean weight.

The suggested catch option table format is as follows.

			Implied fishery	
	Harvest rate	Survey Index	Retained number	Landings (tonnes)
	0%	12345	0	0.00
	2%	"	247	123.45
	4%	"	494	246.90
	6%	"	741	370.35
	8%	"	988	493.80
F0.1	8.60%	"	1062	530.84
	10%	"	1235	617.25
	12%	"	1481	740.70
Fmax	13.50%	"	1667	833.29
	14%	"	1728	864.15
	16%	"	1975	987.60
	18%	"	2222	1111.05
	20%	"	2469	1234.50
	22%	"	2716	1357.95
Fcurrent	21.5%	"	2654	1327.09

E. Medium-Term Projections

None presented

F. Long-Term Projections

None presented

G. Biological Reference Points

Harvest ratios equating to fishing at F0.1 and Fmax were calculated in WKNeph (2009). These calculations assume that the TV survey has a knife-edge selectivity at 17mm and that the supplied length frequencies represented the population in equilibrium.

F-reference point	Harvest ratio
F0.1	8.9%
Fmax	16.6%

H. Other Issues

I. References

Table B1-1. *Nephrops*, Moray Firth (FU 9): Landings (tonnes), effort ('000 hours trawling) and LPUE (kg/hour trawling) of Scottish *Nephrops* trawlers, 1981-2007 (data for all *Nephrops* gears combined, and for single and multirigs separately).

Year	All *Nephrops* gears combined			Single rig			Multirig		
	Landings	Effort	LPUE	Landings	Effort	LPUE	Landings	Effort	LPUE
1981	1298	36.7	35.4	1298	36.7	35.4	na	na	na
1982	1034	28.2	36.7	1034	28.2	36.7	na	na	na
1983	850	21.4	39.7	850	21.4	39.7	na	na	na
1984	960	23.2	41.4	960	23.2	41.4	na	na	na
1985	1908	49.2	38.8	1908	49.2	38.8	na	na	na
1986	1933	51.6	37.5	1933	51.6	37.5	na	na	na
1987	1723	70.6	24.4	1723	70.6	24.4	na	na	na
1988	1638	60.9	26.9	1638	60.9	26.9	na	na	na
1989	2102	69.6	30.2	2102	69.6	30.2	na	na	na
1990	1700	58.4	29.1	1700	58.4	29.1	na	na	na
1991	1284	47.1	27.3	571	25.1	22.7	713	22.0	32.4
1992	1282	40.9	31.3	624	24.8	25.2	658	16.1	40.9
1993	1505	48.6	31.0	783	28.1	27.9	722	20.6	35.0
1994	1178	47.5	24.8	1023	42.0	24.4	155	5.5	28.2
1995	967	30.6	31.6	857	27.0	31.7	110	3.6	30.6
1996	1084	38.2	28.4	1057	37.4	28.3	27	0.8	33.8
1997	1102	47.7	23.1	960	42.5	22.6	142	5.1	27.8
1998	739	34.4	21.5	576	28.1	20.5	163	6.3	25.9
1999	813	35.5	22.9	699	31.5	22.2	114	4.0	28.5
2000	1343	49.5	27.1	1068	39.8	26.8	275	9.7	28.4
2001	1188	47.6	25.0	913	37.0	24.7	275	10.6	25.9
2002	1526	35.5	43.0	649	27.2	23.9	234	7.9	29.6
2003	1718	41.1	41.8	737	25.3	29.1	135	3.6	37.5
2004	1818	36.9	49.3	1100	29.2	37.7	123	2.5	49.2
2005	1526	37.6	40.6	1309	34.0	38.5	217	3.6	60.3
2006	1718	41.1	41.8	1477	37.4	39.5	241	3.7	65.1
2007	1818	36.9	49.3	1503	32.4	46.4	315	4.5	70.0

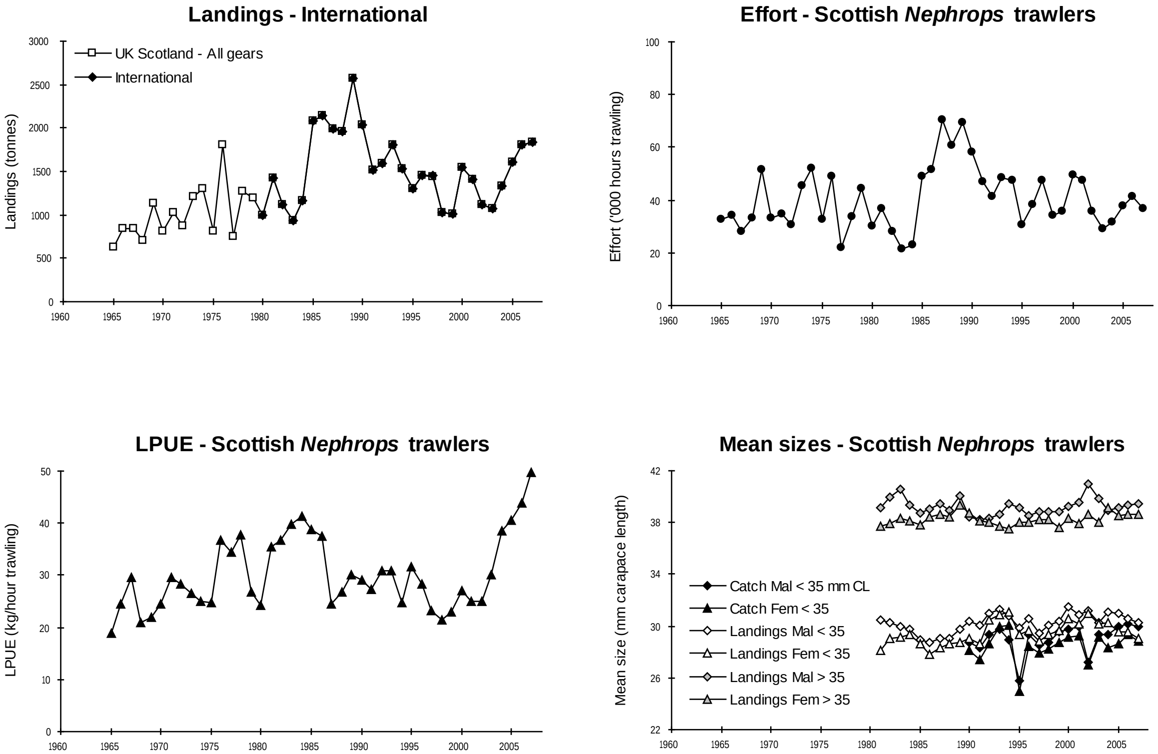


Figure B1-1. ***Nephrops*****, Moray Firth (FU 9), Long term landings, effort, LPUE and mean sizes.**

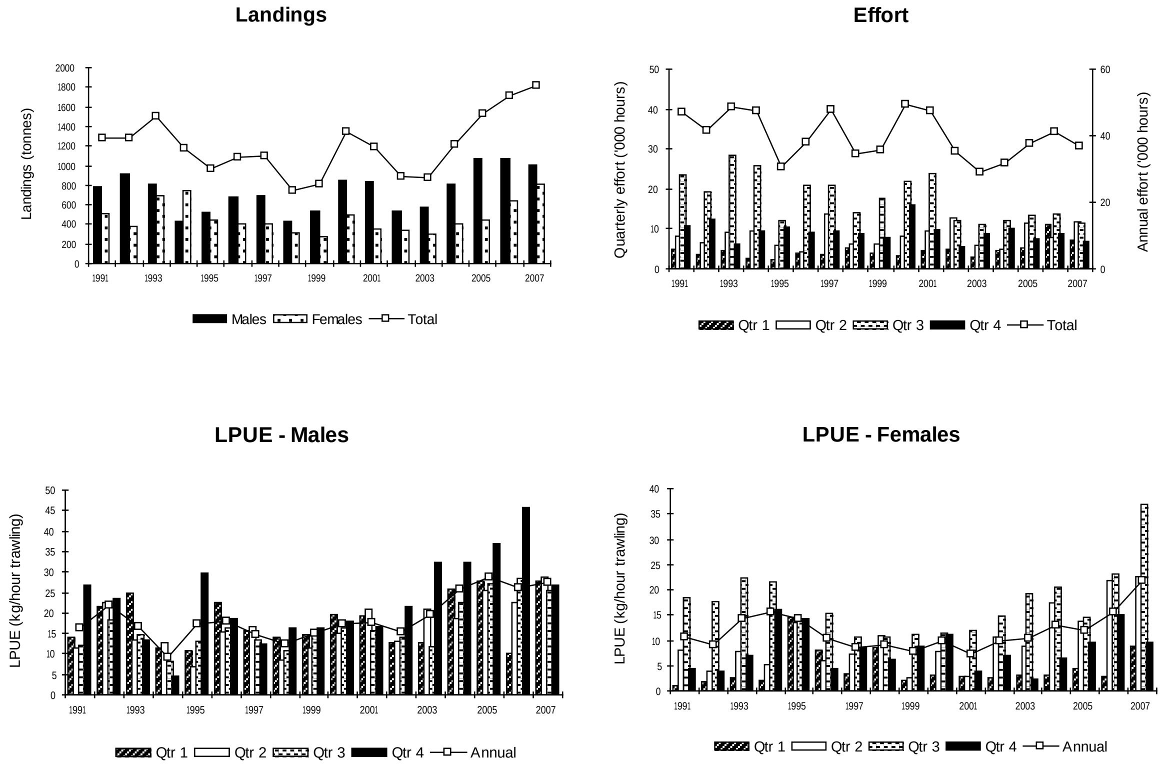


Figure B1-2. *Nephrops*, Moray Firth (FU 9), Landings, effort and unstandardised LPUEs by quarter and sex from Scottish *Nephrops* trawlers.

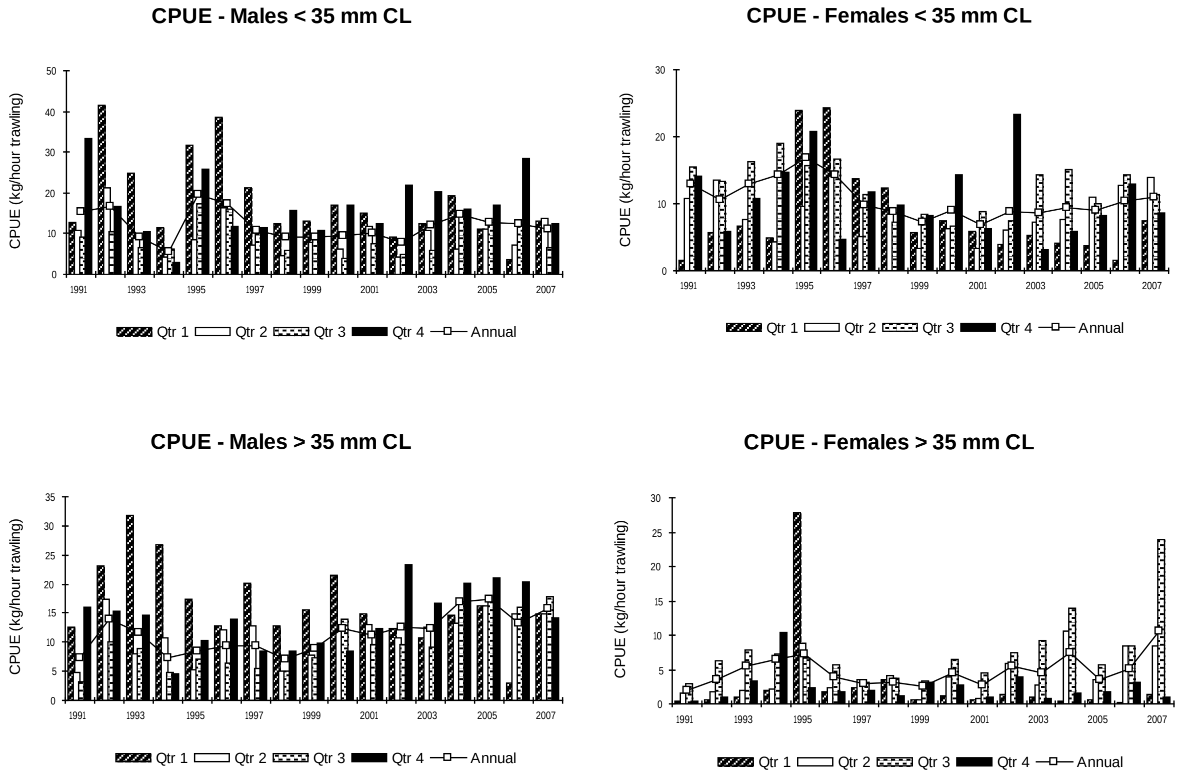


Figure B1-3. *Nephrops*, Moray Firth (FU 9), CPUEs by sex and quarter for selected size groups, Scottish *Nephrops* trawlers.

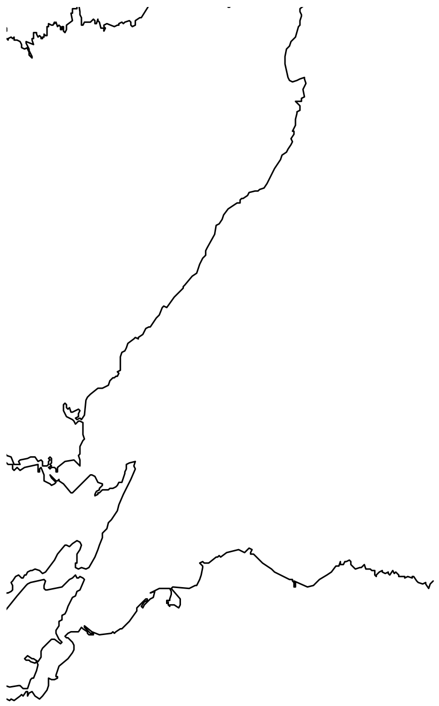


Figure B3–1. Distribution of *Nephrops* sediments in the Moray Firth (FU 9). Thick dashed lines represent the boundary of the functional unit. Sediments are: Dark grey – Mud; Grey – Sandy Mud, Light Grey – Muddy.

Stock annex: Haddock in Subarea IV and Division IIIa(N)

Stock specific documentation of the standard assessment procedures used by ICES.

Stock:	Haddock in Subarea IV and Division IIIa(N) (Skagerrak)
Working Group:	ICES Working Group on the Assessment of Demer sal Stocks in the North Sea and Skagerrak (WGNSSK)
Date:	May 2009
Author:	Coby Needle

A. General

A.1. Stock definition

Haddock in Subarea IV and Division IIIa (N) occupy the northern and central North Sea and Skagerrak and are possibly linked to the Division VIa stock on the West of Scotland. Haddock are seldom found below 300 m, and prefer depths between 50 m and 200 m. They are found as juvenile fish in coastal areas in particular in the Moray Firth, around Orkney and Shetland, along the continental shelf at around 200 m and continuing round to the Skagerrak. Adult fish are predominantly found around Shetland and in the northern North Sea near the continental shelf edge.

A.2. Fishery

Most of the information presented below pertains to the Scottish demersal whitefish fleet, which takes the largest proportion of the haddock stock. This fleet is not just confined to the North Sea, as vessels will sometimes operate in Divisions VIa (off the west coast of Scotland) and VIb (Rockall): it is also a multi-species fishery that lands a number of species other than haddock.

A.2.1. Management plans

In 1999 the EU and Norway "agreed to implement a long-term management plan for the haddock stock, which is consistent with the precautionary approach and is intended to constrain harvesting within safe biological limits and designed to provide for sustainable fisheries and greater potential yield." This plan was implemented in January 2005, updated in December 2006, and implemented in revised form in January 2007. It consists of the following elements:

1) *Every effort shall be made to maintain a minimum level of Spawning Stock Biomass greater than 100,000 tonnes (Blim).*

2) *For 2007 and subsequent years the Parties agreed to restrict their fishing on the basis of a TAC consistent with a fishing mortality rate of no more than 0.3 for appropriate age-groups, when the SSB in the end of the year in which the TAC is applied is estimated above 140,000 tonnes (Bpa).*

3) *Where the rule in paragraph 2 would lead to a TAC which deviates by more than 15% from the TAC of the preceding year the Parties shall establish a TAC that is no more than 15% greater or 15% less than the TAC of the preceding year.*

4) *Where the SSB referred to in paragraph 2 is estimated to be below Bpa but above Blim the TAC shall not exceed a level which will result in a fishing mortality rate equal to 0.3-0.2*(Bpa-SSB)/(Bpa-Blim). This consideration overrides paragraph 3.*

5) *Where the SSB referred to in paragraph 2 is estimated to be below Blim the TAC shall be set at a level corresponding to a total fishing mortality rate of no more than 0.1. This consideration overrides paragraph 3.*

6) *In order to reduce discarding and to increase the spawning stock biomass and the yield of haddock, the Parties agreed that the exploitation pattern shall, while recalling that other demersal species are harvested in these fisheries, be improved in the light of new scientific advice from inter alia ICES.*

7) *In the event that ICES advices that changes are required to the precautionary reference points Bpa (140 000 t) or Blim (100 000 t) the parties shall meet to review paragraphs 1-5.*

8) *No later than 31 December 2009, the parties shall review the arrangements in paragraphs 1 to 7 in order to ensure that they are consistent with the objective of the plan. This review shall be conducted after obtaining inter alia advice from ICES concerning the performance of the plan in relation to its objective.*

In October 2007, ICES evaluated this plan and concluded that it could "*provisionally be accepted as precautionary and be used as the basis for advice*." The methods used to reach this conclusion (along with illustrative results) are given in Needle (2008). ICES considers that the agreed Precautionary Approach reference points in the management plan are consistent with the precautionary approach, provided they are used as lower boundaries on SSB, and not as targets.

The plan was modified during 2008 to allow for limited interannual quota flexibility, following the meeting in June of the Norway-EC Working Group on Interannual Quota Flexibility and subsequent simulation analysis (Needle 2008).

Further technical conservation measures

EU technical regulations in force are contained in Council Regulation (EC) 850/98 and its amendments. This regulation prescribes the minimum target species composition for different mesh size ranges. In 2001, haddock in the whole of NEAFC region 2 were a legitimate target species for towed gears with a minimum codend mesh size of 100 mm. As part of the cod recovery measures, the EU and Norway introduced additional technical measures from 1 January 2002 (EC 2056/2001). The basic minimum mesh size for towed gears for cod from 2002 was 120 mm, although in a transitional arrangement running until 31 December 2002 vessels were allowed to exploit cod with 110-mm codends provided that the trawl was fitted with a 90-mm square mesh panel and the catch composition of cod retained on board was not greater than 30% by weight of the total catch. From 1 January 2003, the basic minimum mesh size for towed gears for cod was 120 mm. The minimum mesh size for vessels targeting haddock in Norwegian waters is also 120 mm.

At the December Council 2006 (EC 41/2006), additional derogations were introduced to allow additional days fishing in the smaller mesh (90 mm) trawl fishery where vessels fitted a square mesh window close to the cod end to allow for improved selectivity of these gears (and hence the possibility of lower haddock discards). The change in mesh size was expected to shift exploitation patterns to older ages and increase the weight-at-age for retained fish from younger age classes. Improvements in the exploitation pattern were not immediately observed, however, and it was not possible to determine if this was due to confounding effects from other fleet segments.

Effort restrictions in the EC were introduced in 2003 (EC 2341/2002, Annex XVII, amended in EC 671/2003). Effort restriction measures were revised for 2005 (EC 27/2005, Annex IV). Effort regulations for 2008 in days at sea per vessel and gear category are summarised in the following table, which only shows changes in 2008 compared to 2007 (2006 is included for comparison). The changes (2007-2008) are intended to lead to a cut in effort of 10% for the main gears catching cod.

Maximum number of days a vessel can be present in the North Sea, Skagerrak and Eastern Channel, by gear category and special condition (see EC 40/2008 for more details). The table only shows changes in 2008 compared to 2007, but 2006 is also included for comparison.

	Area			Max days at sea		
Description of gear and special condition (if applicable)	IV,II	Skag	VIId	2006	2007	2008
Trawls or Danish seines with mesh size ≥ 120mm	x	x	x	103	96	86
Trawls or Danish seines with mesh size ≥ 100mm and < 120mm	x	x	x	103	95	86
Trawls or Danish seines with mesh size ≥ 90mm and < 100mm	x		x	227	209	188
Trawls or Danish seines with mesh size ≥ 90mm and < 100mm		x		103	95	86
Trawls or Danish seines with mesh size ≥ 70mm and < 90mm	x			227	204	184
Trawls or Danish seines with mesh size ≥ 70mm and < 90mm			x	227	221	199
Beam trawls with mesh size ≥ 120mm	x	x		143	143	129
Beam trawls with mesh size ≥ 100mm and < 120mm	x	x		143	143	129
Beam trawls with mesh size ≥ 80mm and < 90mm	x	x		143	132	119
Gillnets and entangling nets with mesh sizes ≥ 150mm and < 220mm	x	x	x	140	130	117
Gillnets and entangling nets with mesh sizes ≥ 110mm and < 150mm	x	x	x	140	140	126
Trammel nets with mesh size < 110mm. The vessel shall be absent from port no more than 24h.	x		x	205	205	185*

*** For member states whose quotas less than 5% of the Community share of the TACs of both plaice and sole, the number of days at sea shall be 205**

In early 2008, a one-net rule was introduced in Scotland as part of the new conservation credits scheme (Section 13.1.4). This is likely to have improved the accuracy of reporting of landings to the correct mesh size range. However, Scottish seiners were granted a derogation from the one-net rule until the end of January 2009, and were allowed to carry two nets (e.g. 100-119 mm as well as 120+ mm). They were required to record landings from each net on a separate logsheet and to carry observers when requested (ICES-WGFTFB 2008).

Under the provisions laid down in point 8.5 of Annex IIa to the 2008 year's EU TAC and Quota Regulation, Scotland implemented in 2008 a national KWdays scheme known as the **Conservation Credits Scheme** (CCS). The principle of this two-part scheme involves credits (in terms of additional time at sea) in return for the adoption of and adherence to measures which reduce mortality on cod and lead to a reduction in discard numbers. The initial scheme was implemented from the beginning of February 2008 and granted vessels their 2007 allocation of days (operated as hours at sea) in return for observance of Real Time Closures (RTC) and a one-net rule, adoption of more selective gears (110mm square meshed panels in 80mm gears or 90mm SMP in

95mm gear), agreeing to participate in additional gear trials and participation in an enhanced observer scheme.

For the first part of 2008 the RTC system was designed to protect aggregations of larger, spawning cod (>50cm length). Trigger levels leading to closures were informed by commercial catch rates of cod observed by FRS on board vessels. During 2008, there were 15 such closures. Protection agency monitoring suggested good observance.

A joint industry/science partnership (SISP) undertook a number of gear trials in 2008 examining methods to improve selectivity and reduce discards and an enhanced observer scheme has been announced by the Scottish Government. Results and citation? Conservation credits and EU regs 2009.

Fleet changes and development

The number of Scottish-based vessels (over 10 m) in the demersal sector was reduced by approximately one third (98 vessels) during 2002, the bulk of this being due to vessels accepting decommissioning. Although the decommissioning scheme encompassed all vessel types and sizes, the vessels eventually decommissioned included a significant number of older boats and those with track record of catching cod. Amongst the remaining vessels there has been a reduction in the segment operating seine net or pair seine. The observed shift towards pair trawling from single-vessel seine and trawls in the early 2000's may have implied an increase in catchability, but the decommissioning rounds in 2002 and 2003 included a slightly higher proportion of pair trawlers, resulting in no real overall change in fleet composition.

The number of Scottish based vessels (over 10 m) in the demersal sector was reduced by 67 in a further decommissioning round in 2004. More recently, increased fuel prices have resulted in a shift from twin trawl to single trawl and pair seine/trawl by many boats in the Scottish demersal mixed fishery sector (ICES-WGFTFB 2006). The observed shift towards pair trawling from single seine may be explained by a standardization of reporting and recording of gear types. Vessels previously participating in the seine net class may have included vessels operating pair seine whereas this classification is now recorded as pair trawl.

In 2005, there was an expansion in the squid fishery in the Moray Firth area resulting from increased effort from smaller (<10m) vessels, and from a number of larger vessels that had switched from demersal fisheries for haddock and cod, to squid fisheries, in order to avoid days-at-sea restrictions (ICES-WGFTFB 2006). The mesh regulation for squid fishing is 40 mm codend, which could lead to bycatch/discard of young haddock and cod. In 2006 and 2007, the squid fishery declined: vessels that shifted away from squid targeted *Nephrops* instead. However, the potential remains for high bycatches of young gadoids in the future, given the small mesh size used.

During 2008, a number of Scottish vessels switched focus to the Rockall area to take advantage of the increased quota there. The economic benefit of being able to land more haddock outweighed the costs involved in steaming to Rockall in a climate of increased fuel prices. This fishery is very dependent on good weather, however, and is not a consistent feature. At the same time, several vessels switched from whitefish fishing in Division VIa to *Nephrops* exploitation in Subarea IV using 80-mm gear (ICES-WGFTFB 2008). This may have implications for haddock bycatch in the *Nephrops* fishery, although (under the stipulations of the Scottish conservations credits scheme; see above), nets in the 80mm range will had to have a 110mm square mesh panel installed from July 2008. Compliance was close to 100% during 2008. Trials suggested that this square-mesh panel increased the 50% selection length (L_{50}) for haddock by around 30%, which implied increased escapement of young haddock from the *Nephrops* fishery.

Also during 2008, a number of Scottish vessels moved from twin to single trawls, and there was also an increase in the use of pair trawl/seine. Some high-powered white-fish vessels switched to *Nephrops* and were targeting North Sea grounds with double bag trawls. This was very much driven by fuel costs, and may have had implications for reduced LPUE and increases in discarding.

Analysis of fishing effort trends in the major fleets exploiting North Sea cod indicates that fishing effort in those fleets has been decreasing since the mid-1990s due to a combination of decommissioning and days-at-sea regulations (STECF-SGRST-05-01 & 04, 2005). The decrease in effort is most pronounced in the years 2002 and beyond.

Information presented to ICES in 2008 noted that the UK large mesh demersal trawl fleet category (>100 mm, 4A) has been reduced by decommissioning and days-at-sea regulations to 40% of the levels recorded in the EU reference year of 2001. There was a movement into the 70–90 mm sector to increase days at sea in 2002 and 2003, but the level of effort stabilised in 2004. The effort of the combined trawl gears has shown a continued decrease of 36% overall, from the EU reference year of 2001 (STECF-SGRST-05-01 & 04, 2005).

A.3. Ecosystem aspects

The North Sea haddock stock is characterised by sporadically high recruitment leading to dominant year-classes in the fishery. These large year-classes may grow more slowly than less abundant year-classes, possibly due to density dependent effects. Haddock primarily prey on benthic and epibenthic invertebrates, sandeels and demersal herring egg deposits. They are an important prey species, mainly for saithe and other gadoids

B. Data

B.1. Commercial catch

Age compositions

To be written.

Data exploration

To be written.

B.2. Biological Information

Weight at age

To be written.

Maturity and natural mortality

To be written.

Recruitment

To be written.

B.3. Surveys

To be written.

Data exploration

To be written.

B.4. Commercial CPUE

B.5. Other relevant data

C. Historical stock development

Model used as a basis for advice

The advice is based on assessments carried out using the XSA model (Shepherd, Darby and Flatman) implemented as the FLXSA module of the FLR library (FLR) of the R statistical package.

Model Options chosen

XSA model settings used in the WGs from 2004 to 2007 were as follows:

Assessment year		2004	2005	2006	2007
q plateau		2	3	3	6
Tuning fleet year ranges	EngGFS Q3	92-03	77-91; 92-04	77-91; 92-05	77-91; 92-06
	ScoGFS Q3	82-03	82-97; 98-04	82-97; 98-05	82-97; 98-06
	IBTS Q1*	82-03	82-04	82-05	82-06
Tuning fleet age ranges	EngGFS Q3	0-5	0-5	0-5	0-7
	ScoGFS Q3	0-5	0-5	0-5	0-7
	IBTS Q1*	0-4	0-4	0-4	0-4

*Backshifted

The default update setting is that used in the 2007 WG, with the addition of extra years as required.

Input data types and characteristics:

Tuning data:

See table above.

Recruitment estimation

Recruits at age 0 are generated by FLXSA.

D. Short-term projection

Initial stock size

Deterministic starting populations taken from VPA survivors.

Maturity

Average of final three years of assessment data (constant for North Sea haddock).

Natural mortality

Average of final three years of assessment data (constant for North Sea haddock).

F and M before spawning

Both taken as zero.

Weight-at-age in the catch

The perceived slow growth of the above-average 1999 and 2000 year-classes pose a problem for the short-term forecast. Mean stock weights for these year classes were calculated using proportional increments. That is: growth from age *a* to *a*+1 for these year-classes was estimated using the mean proportional increment (*a*+1)/*a* calculated over all other year classes for which this information is available. This method was approved by RGNSSK in 2006 as being appropriate to project weights at age, although alternatives are being explored and the issue needs to be considered at a forthcoming benchmark. Mean stock weights for other ages (except the plus-group) in the forecast where taken as a 5-year average, omitting the 1999 and 2000 year classes from the calculation where appropriate. For the plus-group weights, an alternative XSA assessment was run using a plus-group at age 13. The abundances and fishing mortality estimates from this were then used as the basis for a simple deterministic 3-year forecast to give abundances from ages 0-13+ for the forecast years. These were then used in turn in weighted-average calculations to generate the required forecast mean weights for the plus-group at age 8.

The human consumption mean weights at age were derived in the same manner as for the stock weights-at-age. However, mean weights at age for the 1999 and 2000 year classes did not show unusual growth in the discard and industrial bycatch components, so future mean weights-at-age were set to the average of the last five assessment years.

Weight-at-age in the stock

Same as weight-at-age in the catch.

Exploitation pattern

Fishing mortalities in the forecast are taken to be the same as in the final assessment year.

Intermediate year assumptions

Running the haddock forecast assuming status quo F in the intermediate year can lead to landings that are greater than the available quota. In recent years, a combination of low F, TAC constraints limiting the decline of quota, and market forces has meant that full uptake of the quota is unlikely. While it is difficult to predict the extent of the undershoot, it would certainly be an error to forecast an overshoot, and a TAC-constrained forecast is a compromise. If the status quo forecast indicates an undershoot of quota, then no TAC constraint is used.

Stock recruitment model used

North Sea haddock shows no detectable influence of stock size on subsequent recruitment. In addition, there are no observed indications of incoming year-class strength available to the WG. The ScoGFS and EngGFS Q3 survey indices are not yet available. The IBTS Q1 indices are available, but do not include age-0 recruiting fish as these are too small to be caught (or are not yet hatched) when the survey takes place. For this reason, recruitment estimates of the incoming year-class are based on a mean of previous recruitment.

In the past, a strong haddock year-class has generally been followed by a sequence of low recruitments. In order to take this feature into account, the geometric mean of the five lowest recruitment values over the period from 1994 to $y - 3$ (where y is the year of the assessment WG) has been assumed for recruitment in the years y, $y + 1$

and $y + 2$. Recruitment estimates for years $y - 2$ and $y - 1$ are not included in this calculation, because the most recent two XSA estimates of recruitment are thought to be relatively uncertain.

Procedures used for splitting projected catches

Three-year average of catch component ratios.

E. Medium-term projections

Medium-term projections, in the sense of biological simulations assuming fixed mortality, are no longer carried out for this stock on an annual basis. However, management simulations are regularly performed to evaluate management plan proposals, and these are similar in some ways to medium-term projections (see Section A.2.1 above).

F. Long-term projections

Yield and spawning-stock-biomass per recruit analyses are carried out for this stock as part of the annual assessment process. The MFYPR software is used for this purpose.

G. Biological reference points

The Precautionary Approach reference points for cod in IV, IIIa (Skagerrak) and VIId have been unchanged since 2007. They are:

	Type	Value	Technical basis
Precautionary approach	B(lim)	100 000 tonnes	Smoothed B(loss)
	B(pa)	140 000 tonnes	B(pa) = 1.4 * B(lim) (*)
	F(lim)	1.0	F(lim) = 1.4 * F(pa) (*)
	F(pa)	0.7	10% probability that SSB(MT) < B(pa)
Targets	F(HCR)	0.3	Based on HCR simulations and agreed in the management plan

***The multiplier of 1.4 is derived from exp(σ²), where σ² ~ 0.34 is intended to reflect the variability of the time-series concerned (B or F).**

Yield and spawning biomass per recruit reference points

Include summaries from recent MSY work.

H. Other issues

No other issues.

I. References

To be completed.

Annex 4 Technical Minutes of the North Sea Review Group (RGNS) 2010

14-27 May 2010, Fairhaven Massachusetts, USA

Reviewers: Steve Cadrin (co-chair), Tony Wood (co-chair), Adam Barkley, Greg DeCelles, Dan Goethel, Fiona Hogan, Nikki Jacobson, Dave Martins, Owen Nichols, Yuying Zhang

Expert Groups:

- Working Group on the Assessment of Demersal Stocks in the North Sea and Skagerrak (WGNSSK; Clara Ulrich and Ewen Bell, chairs)
- Baltic Fisheries Assessment Working Group (WGBFAS; Michele Casini, chair)
- Herring Assessment Working Group (HAWG; Tomas Gröhsler and Maurice Clarke, chairs)
- Workshop on the Application of Advisory Framework to Data Poor stocks (WKFRAME; Ciaran Kelly, chair)

Secretariat: Barbara Schoute

Process: The ICES advisory service quality assurance program requested that a team of graduate and post-doctoral students and their professor serve as a student review group, as specified in Guidelines for Review Groups (ACOM 2009). The group initially met on 14 May to review the ICES advisory process, RG guidelines and to assign several WG report sections to each reviewer. A second meeting was held on 17 May to review standard ICES assessment models (XSA, ICA, B-ADAPT, and SAM). Members reviewed WG report sections independently, then presented their summaries and reviews to the group in a series of meetings from 19 to 24 May discuss reviewers' draft technical minutes and form RG conclusions.

General Comments: - Stock assessment reports for 23 stocks were reviewed (Table1). The EG reports were informative and generally complete. EG decisions about data, model choice and specification and interpretations were clearly explained and justified. The RG concludes that the reports are technically correct, and the RG agrees with EG recommendations, with few exceptions. In nearly all cases, the assessments appropriately applied the procedures specified in the stock annexes.

Some general issues were raised for many stocks.

- Documentation of SAM: Expert group suggests a transition to SAM as the assessment model for several stocks. However, the review group suggests that better documentation of SAM will be needed. The current reference for SAM is the ICES WGBFAS Report 2008 Working Paper 7. The working paper is not a complete source document, should be peer reviewed, and made available to reviewers.
- Discarded catch remains a major source of uncertainty in many assessments. Guidance on estimating discards in recent years and historically would be beneficial.
- MSY - ICES is developing new reference points to use in a Maximum Sustainable Yield framework. The Expert Groups have been asked to provide new reference points for stocks with an analytical assessment. The RG audited calculations of these reference points where these are presented. In

many assessments, MSY $B_{trigger}$ was not estimated. In other, MSY $B_{trigger}$ was not clearly defined.

- Retrospective analysis results would be more quantitative if retrospective metrics were used to describe the degree of retrospectivity, e.g. rho (Mohn, R. 1999. The retrospective problem in sequential population analysis: An investigation using cod fishery and simulated data. ICES Journal of Marine Science, 56: 473–488).
- For ease of use by the advice drafting group several figures/tables from EG reports are included in this document.

Table 1. Stocks reviewed ordered by expert group (EG), and type of assessment (Ass).

EG	Fish Stock	Stock Name	Assess. [1]	Assess. model
HAWG	her-3a22	Herring in Division IIIa and Subdivisions 22 - 24 (Western Baltic spring spawners)	Y	FLICA
HAWG	her-47d3	Herring in Subarea IV and Divisions IIIa and VIId (North Sea autumn spawners)	Y	FLICA
HAWG	**spr-kask**	**Sprat in Division IIIa (Skagerrak - Kattegat)**	**N**	**Catch only**
HAWG	**spr-nsea**	**Sprat in Subarea IV (North Sea)**	**N**	**Trends**
WGBFAS	cod-kat	Cod in Division IIIa East (Kattegat)	Y	SAM
WGBFAS	Sole-kask	Sole in Division IIIa (Skagerrak - Kattegat)	Y	SAM
WGNSSK	cod-347d	Cod in Subarea IV, Divison VIId & Division IIIa (Skagerrak)	Y	B-Adapt
WGNSSK	had-34	Haddock in Subarea IV (North Sea) and Division IIIa	Y	XSA
WGNSSK	sai-3a46	Saithe in Subarea IV (North Sea) Division IIIa West (Skagerrak) and Subarea VI	Y	XSA
WGNSSK	whg-47d	Whiting Subarea IV (North Sea) & Division VIId (Eastern Channel)	Y	XSA
WGNSSK	ple-eche	Plaice in Division VIId (Eastern Channel)	Y	XSA
WGNSSK	ple-nsea	Plaice Subarea IV (North Sea)	Y	XSA
WGNSSK	sol-eche	Sole in Division VIId (Eastern Channel)	Y	XSA
WGNSSK	sol-nsea	Sole in Subarea IV (North Sea)	Y	XSA
WGNSSK	nop-34	Norway Pout in Subarea IV and Division IIIa -- in year[3]	Y	S-XSA
WGNSSK	nep-5	*Nephrops* in Division IVbc (Botney Gut - Silver Pit, FU 5)	Y	trends
WGNSSK	nep-6	*Nephrops* in Division IVb (Farn Deeps, FU 6)	Y	UWTV[2]
WGNSSK	nep-7	*Nephrops* in Division IVa (Fladen Ground, FU 7)	Y	UWTV
WGNSSK	nep-8	*Nephrops* in Division IVb (Firth of Forth, FU8)	Y	UWTV
WGNSSK	nep-9	*Nephrops* in Division IVa (Moray Firth, FU9)	Y	UWTV
WGNSSK	nep-10	*Nephrops* in Division IVa (Noup, FU 10)	Y	Trends
WGNSSK	nep-32	*Nephrops* in Division IVa (Norwegian Deeps, FU 32)	Y	Trends
WGNSSK	nep-33	*Nephrops* in Division IVb (Off Horn Reef, FU 33)	Y	Trends
WGNSSK	nep-iiia	*Nephrops* in Division IIIa (Skagerak Kattegat, FU 3,4)	Y	Trends
WGNSSK	**ple-kask**	**Plaice in Division IIIa (Skagerrak - Kattegat) [4]**	**Y**	**SURBA/ trends**
WGNSSK	**san-nsea**	**Sandeel in Subarea IV excluding the Shetland area**	**Y**	**S-XSA**
WGNSSK	**san-shet**	**Sandeel in Division IVa North of 59° N and West of 0 ° E – (Shetland area)**	**N**	**Catch only**
WGNSSK	**san-kask**	**Sandeel in Division IIIa (Skagerrak – Kattegatt**	**N**	**Catch only**
WGNSSK	**whg-kask**	**Whiting in Division IIIa (Skagerrak - Kattegat)**	**N**	**Catch only**

1. Assessment to be ran Yes or No. no generally means there is only catch data available.

2. UWTV: Underwater TV survey results, see annexes for these stocks.

3. Norway Pout in Subarea IV and Division IIIa: In May, the in-year assessment for this stock is done, indicating the catch options for the rest of 2010.

4. Plaice in Division IIIa (Skagerrak - Kattegat) - ple-kask: In 2009, an exploratory assessment was run (and described in a stock annex). Since there was no change in the perception of the stock, no new advice was given. New advice will only be given for 2011 due to unresolved key issues. The WG will likely rerun the exploratory assessment and work further on improving this. If time allows, the RG is welcome to comment on the explorations and propose different options.

***Note: Stocks in bold were not reviewed because assessments were not available (SPR-KASK, SPR-NSEA, SAN-SHET, SAN-KASK, WHT-KASK), the stock is awaiting a benchmark in September (SAN-NSEA), or see bullet 4 (PLE-KASK).**

Stock: Her-3a22 (HAWG Section3: Herring in Division IIIa and Subdivisions 22-24)

1) **Assessment type:** Update assessment with one additional year of catch and survey data
2) **Assessment**: Analytical
3) **Forecast**: Presented (short term), long-term forecasts were not provided.
4) **Assessment model**: ICA – tuning by 1 commercial (total summed over all areas and fleets) + 3 surveys (2 acoustic and 1 larval).
5) **Consistency:** Update of 2008 benchmark assessment (previous year assessment considered reliable and consistent).
6) **Stock status**: F(0.5)>F_{msy}(0.25), no other reference points available, suggest SSB breakpoint=110,000t (lowest observed stock size). Current SSB at lowest level seen in time-series and high risk of continued recruitment failure.
7) **Man. Plan**: Suggest a severe reduction in F. Using F_{msy} framework where SSB below breakpoint gives F_{msy}-slope=0.167 resulting in an increase in SSB to 111,200t. Any F's significantly higher (including F_{msy}) lead to a continued SSB<SSB breakpoint and continued risk of recruitment failure.

General comments

The assessment result section was well done and very concise. The results were clearly presented and a thorough job was done of presenting the model diagnostics and explaining possible reasons for observed residual patterns.

The short term projection section was similarly well done. Due to the complications of assigning catch between areas and the numerous catch options this section could easily become unwieldy and unclear, but an excellent job of summarizing and explaining key points was done.

Map describing key banks and area names/numbers would be useful.

Technical comments

It would be of benefit to reviewers if more detailed information (in the annex or the assessment document itself) was provided on

- Otolith micro-structure techniques for splitting catch between WBSS and NSAS in division IIIa
- Acoustic survey procedures and techniques for estimating biomass and numbers at age

Conclusions

Overall the assessment appears very well done. Conclusions regarding stock status are accurate.

Questions that could use clarification:

- Is herring bycatch in sprat fishery kept or discarded? If kept then assumption of zero discards seems accurate given the fleet dynamics described.
- Is there a particular reason for the acoustic surveys not taking place during spring spawning times? It would seem that surveying the population during spawning and on spawning grounds would reduce the uncertainty associated with herring from other stock units being accidentally included in the survey.
- What is the constant M=0.2 for age-2+ ringers based on? If it is based on oldest ages seen or similar calculations, then only changing M of younger fish to account for MSVPA calculations might be inappropriate. It is likely that increasing M at younger ages would require decreasing M at older ages in order to maintain the same maximum age seen. Otherwise, M for all ages should be estimated from the MSVPA. Also, it would be worthwhile to investigate changes in M as increases might be a cause for the recent decline in stock productivity (especially if younger ages are undergoing stronger predation and not reaching maturity).

Comments/Suggestions:

- Commercial sampling seems appropriate as does the method of assigning catch and weight at age where no sampling is available. Some sectors provide no information on landings and some fleets (i.e. Norway Skagerrak) have no sampling.
- Assuming constant maturity can highly influence SSB estimates and it is inappropriate especially due to the observed yearly variations. Continued work to update maturity ogives should be a priority.
- Using a start date of 1991 for the model seems appropriate due to changes in fishing patterns and lack of reliable data for splitting NSAS and WBSS catch. However, by not using historical data the model cannot provide estimates of historical recruitment and SSB levels, which would be helpful to compare with current levels and inform decisions regarding overall stock health.
- The issue of insufficient sampling of catches in IVaE for splitting catch between NSAS and WBSS is extremely disturbing. Efforts should be made so that this is a priority in the future.
- Due to the extreme differences in the way that the fleets exploit the resource (i.e. directed vs. bycatch fisheries) it seems inadvisable to use a single selectivity pattern for all fleets. It might be of interest to investigate using a more flexible model that allows for multiple fleets with differing selectivity patterns.
- It appears that the fishery has been undergoing growth overfishing for much of the time-series, which could be another explanation for the low stock production. It appears that in the last year 50% of the catch has been age-2 or

younger, while over the years of highest recruitment these ages have made up almost 75% of the catch in number (i.e. ~1996-2003; Figure 3.6.1.1). In addition, even though the age-2 and younger fish made up ~75% of the catch in numbers, they only accounted for ~less than 50% of the catch in weight indicating the more yield could be harvested from fewer older fish (Figure 3.6.1.2)

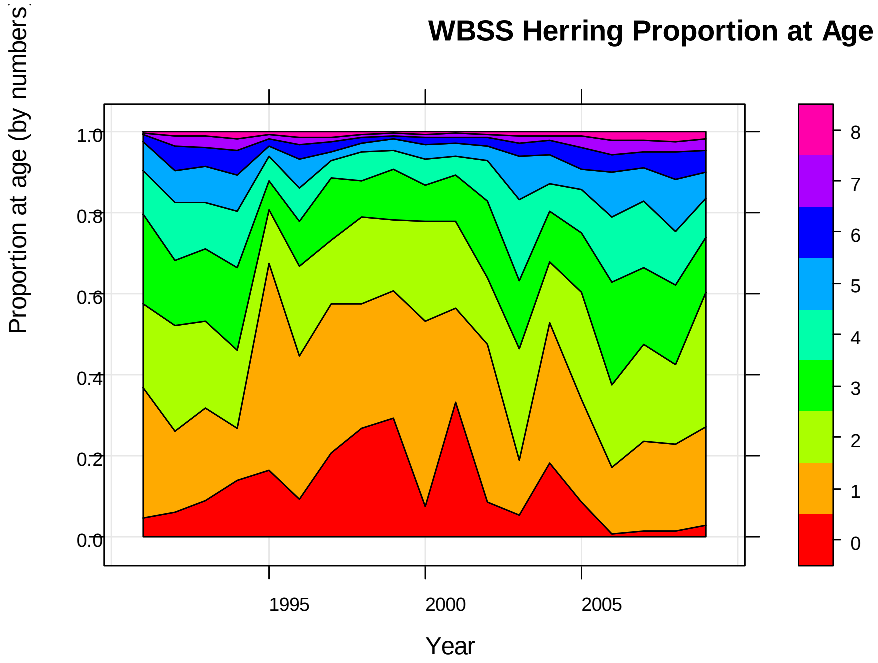


Figure 3.6.1.1 Western Baltic Spring Spawning Herring. Proportion (by numbers) of a given age (in winter rings) in the catch.

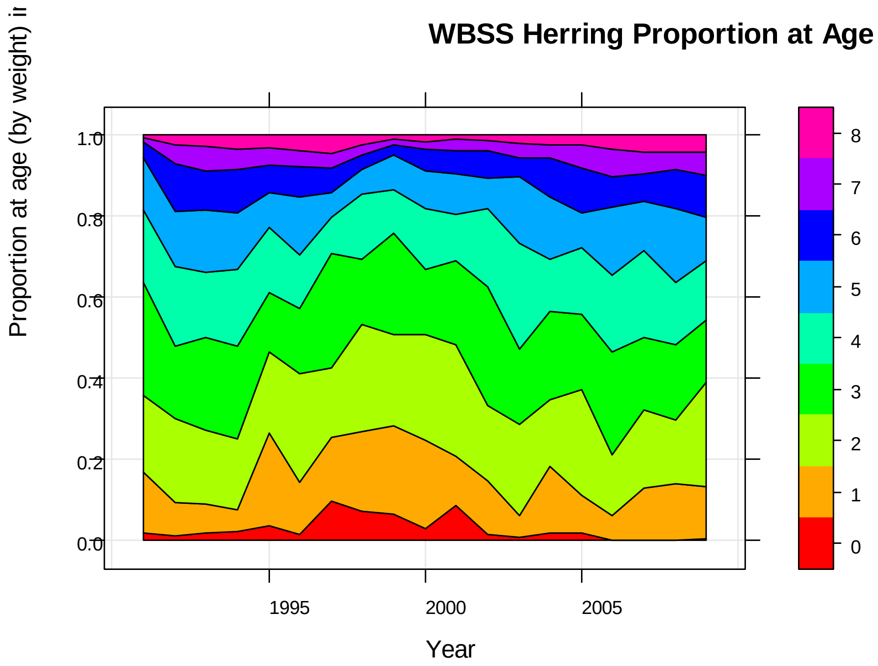


Figure 3.6.1.2 Western Baltic Spring Spawning Herring. Proportion (by weight) of a given age (in winter rings) in the catch.

Since only 20% of age-2 fish are mature this means that even when large recruitment events occur in the fishery they are unable to survive to maturation because of such high fishing pressure. Trends in SSB and recruitment appear to support this hypothesis. High recruitment events from 1996 to 2000 are also associated with some of the highest catch percentages associated with age-2 and younger fish. Only slight increases occur in subsequent years in SSB, while a series of such high recruitment events would be expected to produce large increase in SSB for a number of years following these events. After a short peak, SSB quickly declines and recruitment has been mostly decreasing since 2000 (Figure 3.6.4.2).

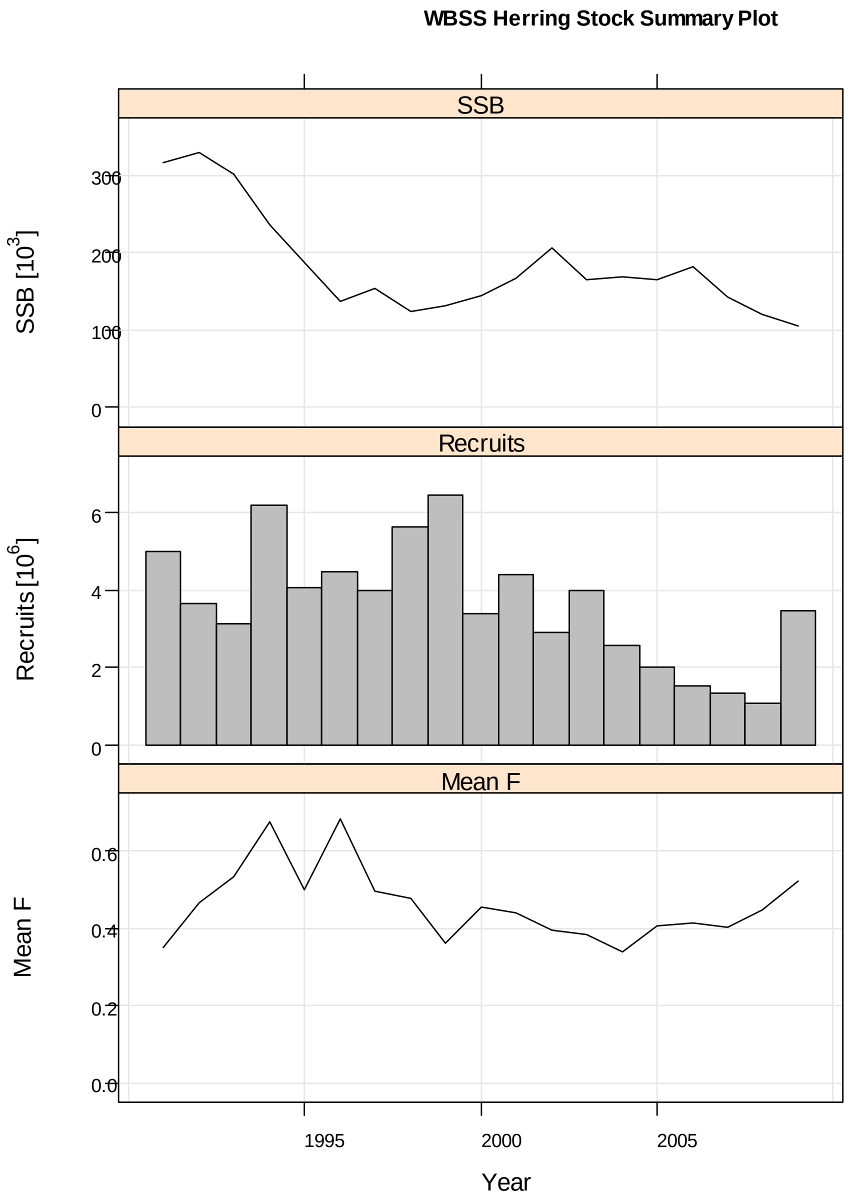


Figure 3.6.4.2 Western Baltic Spring Spawning Herring. Stock summary plot. Top panel: Spawning stock biomass. Second panel: Recruitment (at age 0-wr) as a function of time. Bottom panel:: Mean annual fishing mortality on ages 3-6 ringers as a function of time.

It is suggested that F should be decreased on all ages, but investigations on ways to decrease fishing mortality on the youngest ages should be made a research priority.

This will help avoid growth overfishing in the future so that strong recruitment events will lead to rebuilding of SSB and hopefully higher stock production.

- It appears that, as for most herring species, there exists complex population structure within the WBSS statistical areas. Evidence suggests that local spawning areas, especially in many of the fjords, create discrete spawning populations. In addition, recent molecular genetics studies indicate multiple sub-populations within the WBSS management units. In the future, it might be appropriate to investigate the use of a stock synthesis type model, which allows for discrete growth patterns for individual sub-populations and allows for mixing between sub-populations. Also, a full meta-population model might be appropriate to account for different recruitment functions by sub-population, while allowing for mixing during various life stages. In order to pursue either model type it is probable that more information would need to be gathered on migration patterns and fine-scale population structure. The possibility of meta-population structure is important here because it has been shown that as individual sub-populations are fished out the stability and persistence of the overall meta-population is decreased. It is possible that such a situation is currently occurring in the area and could be another possible explanation for decreases in stock productivity.

Stock: Her-47d3 (HAWG Section 2: Herring in Subarea IV Division IIIa and VIId (North Sea))

1) Assessment Type: Updated
2) Assessment: Analytical
3) Forecast:
   - A short term (3-year) forecast was completed assuming the recruitment is constant and in a low level since 2002. The projection result indicates that the SSB will increase above B_{pa} in 2011 and above $B_{trigger}$ in 2012, as long as the management plan is adhered to.
   - The method used for predictions in 2010 is slightly different from the method in 2009. The difference in catch, recruitment has led to a significant increase in SSB.
   - Neither the medium term projection, nor the long term projection was done, but the medium term projections can be made as needed.
4) **Assessment method**: An integrated catch analysis (FLICA) was used and calibrated with catch, recruitment, the MLAI, MIK (IBTS age 0), bottom trawl survey (IBTS ages 1-5) and acoustic survey.
5) **Consistency**:
   - The current assessment method (FLICA) was the same as the previous assessment.
   - The benchmark stock assessment took place in 2006. Some 2010 data have been updated (e.g. IBTS survey); while the other input data are still in 2009.
   - The current fishery status of the North Sea herring is consistent to what the fishery status was in 2009.
   - There are some differences between the 2010 stock assessment results and the 2009 stock assessment results, e.g. mean fishing mortality (age 2 - age 6) is lower the biomass is higher and the maturation rate is higher.
   - In the Stock Annex 3, 6 years catch data are supposed to be used in the objective function; while only 5 years catch data were described in the stock assessment report. (The stock assessment report didn't indicate why one year catch data were eliminated. In addition, the subscription in the objective function in the Stock Annex 3 should also be updated).
   - Retrospective analysis has been done for the selectivity pattern, spawning stock biomass, recruits, mean fishing mortality (age 2 - age 6) and year class cohorts. Generally, these parameters are consistent over the last 10 years. (Page 58 the last fourth line: "An eight year analytic retrospective shows the current consistency of the assessment", should it be a 10-year analytical retrospective analysis?)
6) **Stock Status**:
   - SSB(1.29 million tonnes)< B_{pa}(1.3 million tons), SSB ~ B_{lim} (800,000 tons). $B_{trigger}$ = 1.5 million tonnes. The fishery is classified as being at the risk of having reduced reproductive capacity and is being har-

vested sustainably. The stock assessment report didn't provide any basis for biomass-based biological reference points.

- F_{pa} is equal to F_{MSY} (F_{target}). There is no F_{lim}. The current F_{2-6}(0.11) is less than F_{target} (0.25). And there is 15% constraint in TAC. The fishing mortality-based biological reference point is based on an investigation of risk to falling below B_{lim}, F_{MSY} and consideration of fishery.

7) **Management Plan**: The EU-Norway management plan stipulates overall fishing mortalities for juveniles and adults. The total TAC limit for 2010 is 177, 877 t. The by-catch ceiling was also set for fleet B.

General Comments:

- Ecosystem considerations were slightly discussed in the stock assessment report and Stock Annex 3. But the information is too general to help advice and few references were cited.
- It is good to have the age-varying natural mortality. And it would be better to have a time-varying natural mortality.
- It might be a better idea to isolate the Downs herring as a separate stock in the stock assessment when the data are ready.

Technical Comments:

- Some discard data has been listed in tables, but not consistently available for whole time series. Some discard data may be underestimated, e.g. year 2009. It is also unclear if the discard data was applied in the model, and how it was applied in the stock assessment model. (The discard is in biomass unit and the input catch is in number.)
- The misreported and unallocated catches are another source of uncertainty. The negative values are very confusing, especially for some values < 100%, e.g. -185% in Table 2.2.5.
- The RSS of surveys, especially the acoustic survey take a large portion in the total RSS. It is better to standardize the survey before the RSS calculation.
- Table 2.2.1-Table 2.2.4: should the sum of the bottom 4 tables equals to the upper table?
- Figure 2.1.1: It would be better to have subregions indicated in the map.
- Table 2.2.1 and Table 2.2.2: wrong order.
- Figure 2.2.1 bottom figure: legend missing and no text related to this figure.
- Figure 2.3.1.2- Figure 2.3.1.3, Figure 2.3.2.1-Figure 2.3.2.4, although indicated in the note, scales are needed.
- Table 2.3.3.1: missing.
- Figure not in order, e.g. Figure 2.6.3.1 comes in section 2.5.2.
- Figure 2.6.1.18: didn't explain in the text.
- The order of figures should correspond to the description in text, e.g. 2.6.1.24 – Figure 2.6.1.31.
- When describing the "figures" in tables, please use "values".
- Page 47 the last third line: "were" should be "where".

Conclusion:

- The RG agrees with the WG that FLICA assessment is an acceptable update for the North Sea herring assessment.
- The SSB has been maintained close to B_{pa} and is expected to be above B_{pa} after 2011. The fishing mortality has been controlled the level lower than F_{pa}. The precautionary approach seems appropriate in managing the North Sea herring stock.
- For migration stock, such like the North Sea herring, it is better to set separate TACs and assess stock separately for each subregion.

Stock: COD-KAT (WGBFAS Section 2.2: Cod in Division IIIa East (Kattegat)

1) **Assessment Type**: Update
2) **Assessment**: Analytical
3) **Forecast**: None presented (due to uncertainty in estimates in recent years).
4) **Assessment method**: SAM- Including four tuning surveys (Havfisken-4Q, Havfisken-1Q, IBTS-3Q, IBTS-1Q) , two model runs (with, and without estimating unaccounted removals).
5) **Consistency**: No retrospective analysis provided.
6) **Stock Status**: The SSB(1100 tonnes) for this stock is at reduced reproductive capacity (SSB< B_{lim}(6400 tonnes)). The assessment model was run with and without estimating unallocated removals. The SSB for both model runs are at all-time low levels. The current F is between 0.2 and 1.1. The fishing mortality rate in relation to precautionary limits is not defined, because the reference points F_{lim} and F_{pa} are not defined. B_{pa} = 10500 tonnes and $B_{trigger}$ was not mentioned in Assessment or annex. B_{msy} and F_{msy} were not discussed in assessment, but mentioned in Advice for 2011.
7) **Management Plan**: Put in place in 2008, TAC to be reduced by 25% when advised to reduce cod catches to lowest possible level.

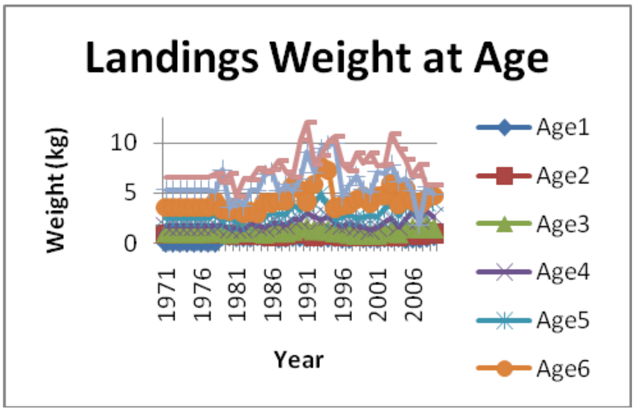
General Comments:

- The report was well written and concise.
- The report thoroughly explained why discard were not used (discard estimates considered uncertain due to low sampling level, high variability in discard rate and the calculation procedure of averaging discard rate over four years)
- Unaccounted removals may be up to 5x larger than the TAC.
- Did a good job laying out problems with the data (gear changes, poor sampling, new regulations, etc.)
- Did not include discards (~39% discard rate) or recreational catch (~20% of total catch) in Assessment.
- Recruitment conclusion says natural mortality was uncertain, but they assumed 0.2 for all ages.
- Landings have declined since 1997 (9000t to 200t), but it wasn't specified if it was due to regulations or lower abundance.
- Denmark has higher landings, but lower discards why? (sampling, misreporting, efficiency…).
- There is an indication of high transport of cod larvae from the North Sea to Kattegat, but still poor recruitment in Kattegat (increased natural mortality?) Is this accounted for in either Cod assessment?
- Technical measures were discussed (sorting grates), but the effectiveness was not discussed (lack of data or just not included?)
- Ecosystem considerations were not mentioned in the assessment document.

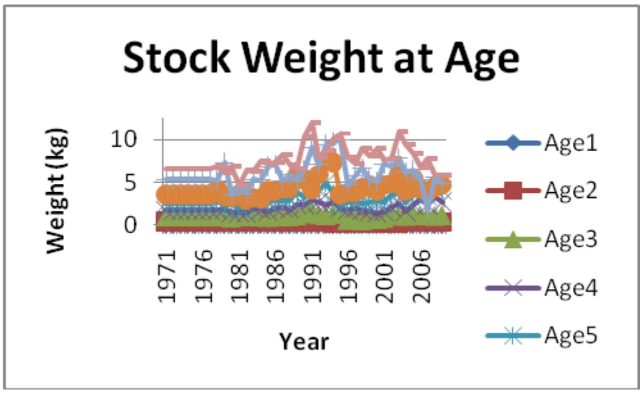
- Assessment document provided very little information about the SAM assessment model that was used in the assessment. The Annex and cited website were not very informative either.

Technical Comments:

- Tables 2.2.6-2.2.9 show ages 1-8+, but state the assessment used 1-6+, perhaps assessment has enough data to use ages 1-8+.
- Mean weight at age sampling problem -Q2 ages 6 have a higher mean weight then ages 7 in both fleets both indicate low sample sizes, Q3 ages 5-6 and 7-8, and Q4 ages 7-8, all with small sample sizes (Table 2.2.5).
- There was not plot of weight at age, created below from the tables indicated. Seems like there is some inconsistencies in the weight at age data. Possibly poor sampling.



Made from table 2.2.7



Made from Table 2.2.8

- Index consistency plots showed that the landings-at-age data was the most consistent for tracking cohorts.

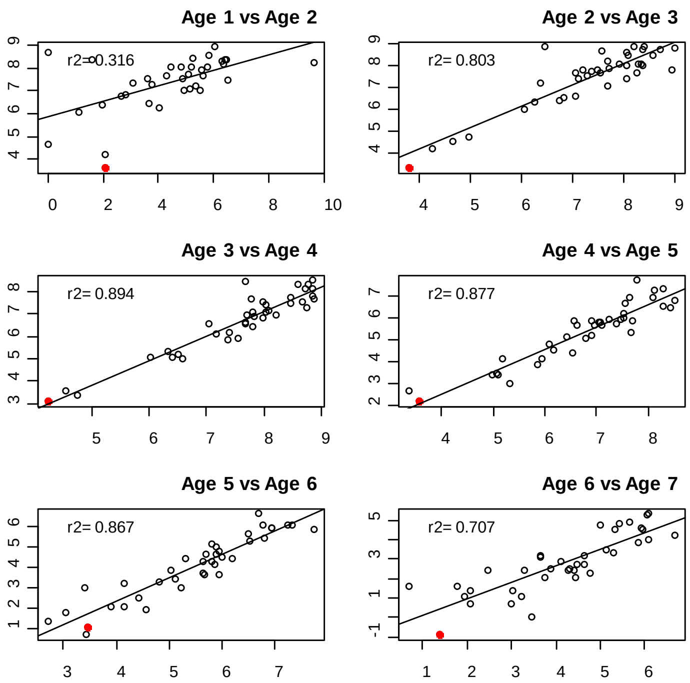


Figure 2.2.2. Cod in the Kattegat. Numbers at age in landings vs numbers at age+1 of the same cohort in the following year (on logarithmic scale). Individual points are given by year-class. The red dots highlight the information from the latest year.

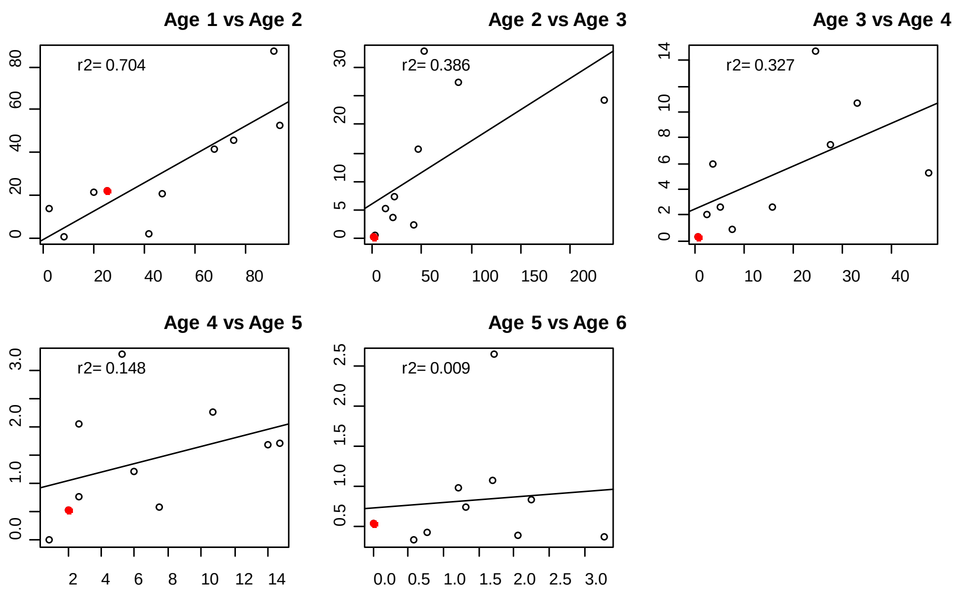


Figure 2.2.4a. Cod in Kattegat. IBTS 1st quarter survey numbers at age vs numbers at age +1 of the same cohort in the following year in the period 2000-2009. Individual points are given by year-class. Red dots highlight the information from the latest year.

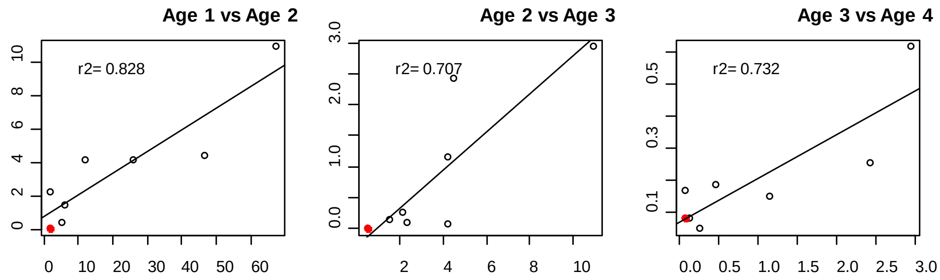


Figure 2.2.4 b. Cod in Kattegat. IBTS 3rd quarter survey numbers at age vs numbers at age +1 of the same cohort in the following year in the period 2000-2009. Individual points are given by year-class. Red dots highlight the information from the latest year.

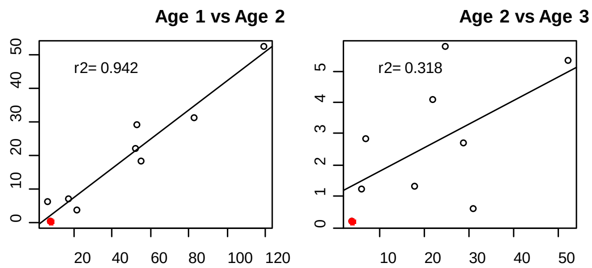


Figure 2.2.4c. Cod in Kattegat. Havfisken 1st quarter survey numbers at age vs numbers at age +1 of the same cohort in the following year in the period 2000-2009. Individual points are given by year-class. Red dots highlight the information from the latest year.

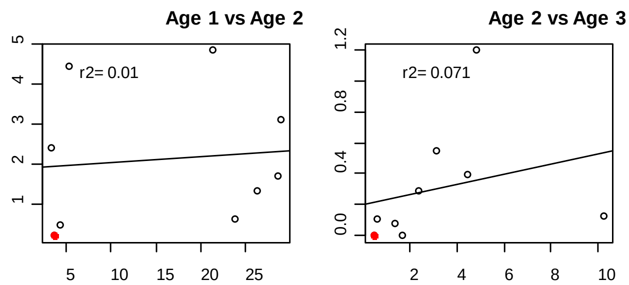
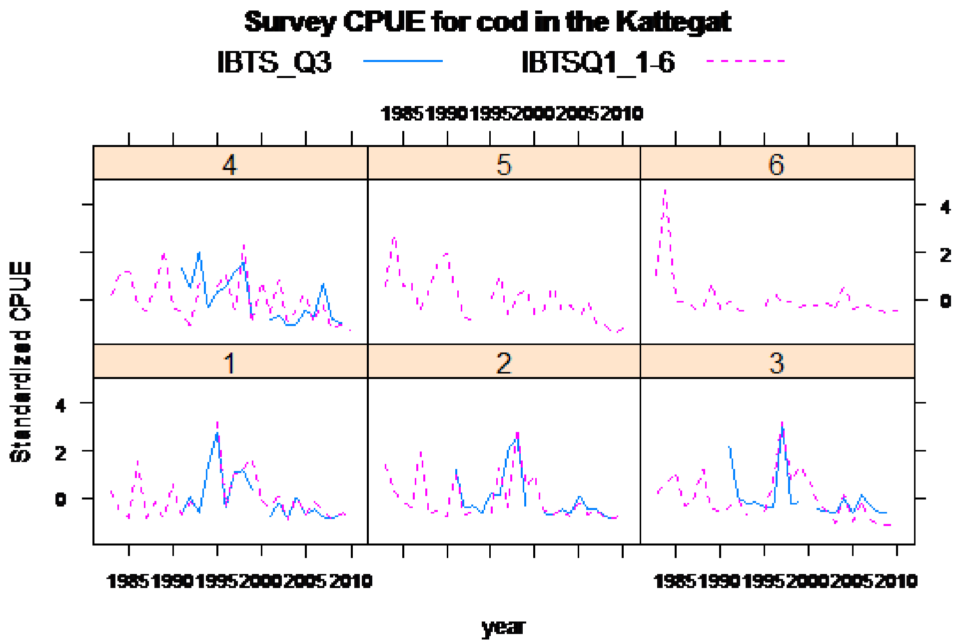


Figure 2.2.4 d. Cod in Kattegat. Havfisken 4th quarter survey numbers at age vs numbers at age +1 of the same cohort in the following year in the period 2000-2009. Individual points are given by year-class. Red dots highlight the information from the latest year

- The surveys seemed to show consistency among surveys.



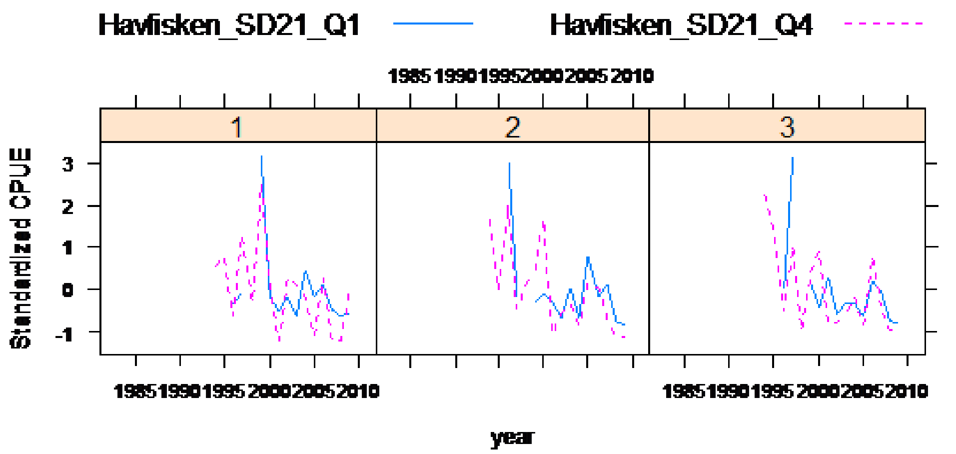


Figure 2.2.3 Cod in the Kattegat. CPUE from IBTS and Havfisken surveys by age-groups.

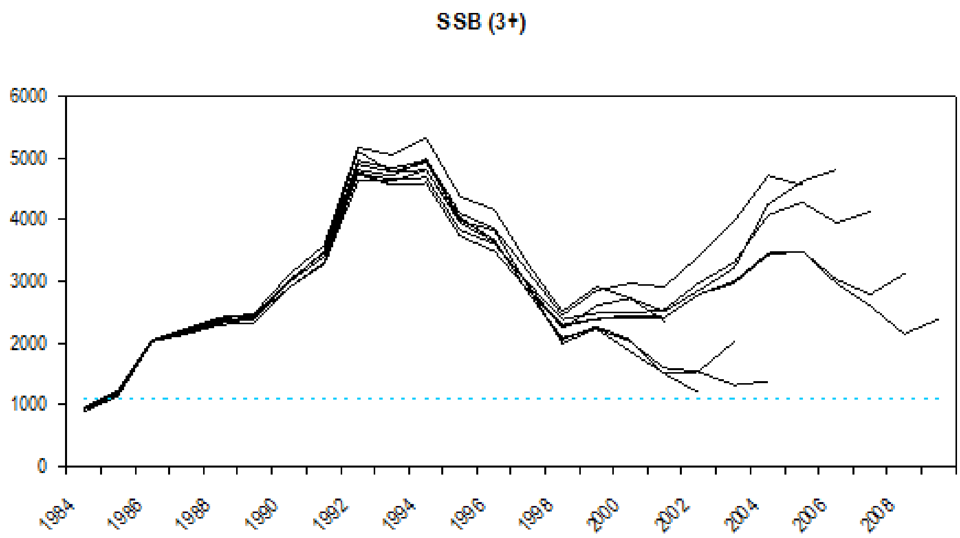
- SSB plot did not include B_{pa} or B_{lim} lines
- Drastic difference between F estimates (0.179-1.066) excluding or estimating discard. The WG indicated that there is a problem and they are not reliably estimated (no F reference points either).
- F_{bar} is 3-5 in the assessment but the annex states F at age is constant for 4+, Assessment document did not explain why F_{bar} differed from Annex.
- Figure 2.2.7 is not good enough quality, also what do red polygons represent?

Conclusions:

- The RG feels that the WG has supported the draft advice based on the assessment results and the RG agrees with the ICES draft advice of 'No catch' in 2011. 'No catch/No fishery' has been advised since 2002. As per the Management plan the TAC will be reduced by 25%.
- If the assessment model is not estimating discards or unaccounted removals or recreational catch, then this assessment is missing some vital components. The WG states that discards are not reliably estimated so it makes sense why they are not included, but with such a large amount of the catch being left out it makes more sense as to why the F estimates are so different. In this case when discards are not included or estimated in the assessment the calculations for SSB and B are incorrect because a large portion of the catch isn't being 'seen', which will reduce SSB and increase F.
- The perceived large amount of discards should be looked into further. Size distribution of discards would be a good start. The WG also mentioned possible high grading, but that might not be reported discards.
- Weight at age data seemed to be poor, in the future focusing on weight at age sampling may help improve future assessments.

Stock: SOL-KASK (WGBFAS Section 3: Sole in Division IIIa and Subregions 22-23 (Skagerrak, Kattegat and the Belts))

1) **Assessment type**: Update
2) **Assessment**: Analytical
3) **Forecast**: Short term forecast was presented. Long-term forecast (20 yrs.) was performed to establish MSY based reference points.
4) **Assessment Model**: SAM with four tuning fleets (DTU Aqua Survey Q4, Official logbooks from trawlers 12-20m, Private logbooks from 6 trawlers and private logbooks from 3 gillnetters). An XSA was also performed for comparison.
5) **Consistency**:
   - A benchmark assessment was performed in early 2010 and it was decided that the SAM method is preferred over XSA, which was formerly used for this stock.
   - The area has also been changed to include ICES subdivisions 22 and 23 (the Belts).
   - There has been a recent retrospective pattern of overestimating SSB.



6) **Stock Status**: 2009: F_{bar}(0.28)<F_{pa} (0.30) and SSB(2370 tonnes)>$B_{TRIGGER}$(2000 tonnes). $B_{TRIGGER}$ is based on the lowest estimated biomass in the time series. 2007 & 2008: F_{pa}(0.3)<F<F_{MSY}(0.38). In 2008 SSB<$B_{TRIGGER}$. Catches have been consistent (~640t) in recent years.
7) **Management Plan**: No specific management plan is in place. If the EU designates IIIa sole as a cat. 1 stock the plan will be to manage at F_{MSY} and avoid TAC changes >25% between years.

General Comments

- The report is well written and easy to understand
- It should be stated how many boats are in the sole fleet, relative the level of logbook sampling. Private logbooks from 6 trawlers and 3 gillnet boats are used to tune the SAM model, but it is unclear if this sample is representative of the fleet.
- The increased catches of age 2 individuals in recent years (2007-2009) is a concern, as these fish are potentially being harvested before they can spawn. The assessment currently assumes a knife-edged maturity schedule, with sole reaching maturity at age 3. Increases in mesh sizes may help prevent recruitment overfishing.
- Biological sampling was recognized as being inadequate in 2009. In 2009, there were 43 sole samples from the Skagerrak, 367 from the Kattegat and 325 from the Belts. In addition, sampling was not consistent throughout the year, as samples were only obtained from the Skagerrak in quarter 2. This sampling will need to be improved in upcoming years to allow the SAM model to be used in the future.
- Ecosystem considerations were not updated in this assessment. Ecosystem changes (i.e., temperature) may have a large impact on the productivity of this stock, as it is near the edge of its' geographic distribution. These ecosystem considerations should be explored further in the future.

Technical Comments

- The assessment was performed as was prescribed in the stock annex.
- MSY based reference points were calculated for this stock. The MSY reference points were derived using a long-term (20 year) operating model. The projection assumed a knife-edged maturity (at age 3), mean weight at age, and recruitment drawn from a Ricker stock-recruit function. Stochastic scenarios calculated an F_{MSY} estimate of 0.38, which results in a small (<5%) long-term probability of SSB declining below $B_{TRIGGER}$.
- In general, there is good agreement between the SAM and XSA models. However, it should be noted that the SAM model is more optimistic in recent years with regards to F and SSB since 2003.
- Residuals (Fig 3.19) suggest that the SAM model may be overestimating SSB in recent years.
- The omission of discard data is a concern, especially for the 2002-2005 period when discarding rates/misreporting may have been high due to quota restrictions. Catches for these years have been reallocated to adjust for this (Table 3.2). For example, misreporting and discarding were believed to be on the order of magnitude of 50% in 2002, and 100% in 2003 and 2004. However, it would help if the EG provided more information on how realistic they believe these reallocation amounts are, and describe how these reallocations may affect the assessment if the values are inaccurate.
- In Table 3.2 there were large changes in the corrected catches in 1990 (+427) and 1996 (-597) without any explanation for these major changes. Some clarification would help.
- It appears that Figures 3.5 and 3.6 would be helpful in examining the spatial patterns of survey catches, but the plots are too small to allow interpretation.

- It would be helpful to include the reference points for this stock in the stock summary plots (Figure 3.16).
- The advice report states that subdivisions 22-24 were added to the assessment in 2010, while the WGBFAS 2010 report states that subdivisions 22 and 23 were added to the assessment.

Conclusions:

- The assessment has been performed correctly and appears to form a solid basis for proposing future management measures for this stock.
- ICES draft advice is to limit landings to <760t, which is less than landings at F_{MSY} (860t). The RG agrees with the WG on the draft advice. However, the stock should be monitored closely in the future, as recruitment indices have been low in recent years, and recruitment overfishing may be occurring.
- Biological sampling needs to be improved for this stock. In particular, the maturity schedule needs to be investigated. Currently, a knife-edged maturity schedule is used, and if this schedule is inaccurate, it could lead to large changes in the perception of SSB. Catch at age sampling also needs to improve to allow the use of the SAM or XSA assessment models in future years. The weight at age schedule is also highly variable, and likely represents the low level of biological sampling for this stock.

Stock: COD-347d (WGNSSK Section 14: Cod in Sub Area IV(a,b), northern IIIa Skagerrak, and eastern Channel VIId)

1) **Assessment type:** Update assessment, Benchmark assessment done 2009, (ICES-WKROUND 2009).
2) **Assessment**: Analytical
3) **Forecast**: No short term forecast presented. Medium term and Long term projections are not carried out for this stock.
4) **Assessment model**: B-Adapt VPA using commercial landings and discard information. A state space model (SAM) is used for comparison with B-Adapt. There are two surveys International Bottom Trawl Survey Quarter 1 (IBTSQ1) and International Bottom Trawl Survey Quarter 3 (IBTSQ3). A SURBA survey analysis model is fitted to the survey data.
5) **Consistency**: Last year the assessment was accepted, this year the assessment was not accepted because of conflicting survey trends and unknown discards.
6) **Stock status**: Not determined in 2010. In 2009, SSB (68,650 tons) < B_{lim} (70,000 tons) and < B_{pa} (150,000 tons). F_{2009}(0.85)>F_{pa}(0.65)<F_{lim}(0.86). R at lowest levels for the time series. SSB_{2010} (55,789 tons) continues on an upward trend from the lowest level observed in the time series (34,889 tons) recorded in 2006. MSY $B_{trigger}$ was not estimated.
7) **Management Plan**: EU cod recovery plan in place up to 2008. Considered not consistent with precautionary approach since failed to close fisheries for cod at low stock abundance, failed to reduce fishing pressure on cod to enable stock recovery.

   Modified in 2009 by a new effort management system setting effort ceilings (kilowatt-days) in accordance with new cod management plan (EC1342/2008). Kilowatt-days allocated to vessels based on gear and mesh size used. Fleet effort will be reduced in proportion with reductions in fishing mortality until target fishing mortality of F 0.4 is reached. In 2009 a 25% reduction in kilowatt- days is applied across fleets, with exceptions for selective gears that reduce cod catch (catch<5% cod). Fleets with < 1.5% cod catch may be excluded from effort management completely. Real time closures (RTC's) occur to avoid areas of high cod abundance. In addition to the technical measures above, cod are managed by a TAC in each area. The TAC in area VIId only since 2009. Discarding and a high proportion of the catch at young ages will limit the effectiveness of the new management plan.

General comments

- The Working Group (WG) is commended for producing a high quality section. It is evident that a great deal of work and effort went into its production. It is clearly written, easy to follow and interpret. Complex issues are concisely described.
- This assessment suffers from misreporting of landings, misreporting of fishery discards as well as non reporting of discard and associated data by member countries. ICES has raised concerns in the past on misreporting and non reporting of cod landings, the extent of which are difficult to quantify.

- The accepted benchmark assessment included a residual pattern that indicated conflicting trends between Q1 and Q3 surveys and results are sensitive to the choice of which surveys are included in the assessment. The residual pattern and sensitivity have grown worse since the benchmark assessment, leading the EG to reject the assessment this year.

  Plot of sensitivity analyses with and without Q1 and Q3. Residual compensation plots (Figure 14.1.2, and 14.1.3).

- The Netherlands, France, Belgium and Sweden, who land 10%, 6%, 4% and 1% of all cod respectively for combined area IV and VIId, do not provide discard estimates. Similarly, Germany, the Netherlands and Belgium, who landed 1% or less of all cod in area IIIa, do not provide discard estimates. Norwegian discarding is illegal, however, it lands 13% and 9% of all cod in combined area IV and VIId in 2009 respectively, in addition to IIIa. It does not provide discard estimates.
- During the last 5 years, an average of 81% of the international catch in number were comprised of juvenile cod aged 1-3 compared to 85% in 2009.
- The RG agrees with the WG that the extended area survey merits further investigation to improve model fit of future assessments. The lack of the Norwegian survey in 2009 should be examined as a cause of problems seen for the first time in the ITSQ3 indices, especially considering the Norwegian survey has been part of the ITSQ3 survey since 1999.
- The RG agrees with the WG that the long term assessment strategy should evolve from using B-Adapt to SAM, especially considering results were similar during comparative runs. The move to a SAM model should coincide with improvements in discard reporting by representative countries.
- The various Fishermen Science Partnership (FSP) surveys (UK North East Coast Cod Survey, North Sea Whitefish Survey, UK CodWatch, Denmark REX) as described by the Working Group (WG) are encouraged to continue so that results may not only be used to track cod stock dynamics in the North Sea, but perhaps one day be formalized as a time series based survey considered in the stock assessment model, especially considering the North Sea Whitefish FSP Survey relative abundance indices were similar to the (IBTSQ3) survey. The value added by FSP's is that fishermen become more directly engaged in solving problems and finding solutions necessary to rebuild the fishery.

Technical comments

- The assessment has been done as outlined in the Stock Annex.
- Landings of cod ages 1-3 in 2009 is described as 69% however should it be 85% (age-1= 32% + age-2 32% + age-3 14%) (See page 11 Age compositions, 2nd paragraph)?
- Reference to Div VIa on page 12, Intercatch. Should this be IVa?
- Table 14.8 should include a column for year as well column headings for ages 1-5, 6+.
- A detailed map of the stock areas and fishing banks (Dogger Bank, German-Bights, Moray Firth), should be included in the Annex.

Conclusions

The assessment has been performed correctly. The B-Adapt model is used in order to estimate unrecorded and unreported catch. Future improvements in estimates of catch removals as well as reported discards should facilitate a move away from B-Adapt to a state space (SAM) model similar to other North Sea cod stocks. Revised natural mortality estimates from updated seal stomach sampling results should be included in the next assessment. Causes for the divergent behavior of residual patterns seen in the IBTSQ1 and IBTSQ3 indices should be examined prior to the next assessment.

The RG would like to note that the conflicting survey trends, residual patterns and sensitivity of the assessment to survey options were properties of the approved benchmark assessment. However, the problem has gradually worsened over the last 2 years (2009 and 2010 updates). The RG agrees that the conflicting trends add model uncertainty to the B-ADAPT calibration and model estimate of discards. However, the RG feels that the assessment is informative for determining stock size relative to reference points, but perhaps not for catch projections. With all due respect to WGNSSK's expertise on the stock, fishery and assessment, we feel the NS cod assessment was no worse than some other accepted assessments in the region, and not much worse than the accepted benchmark assessment for North Sea cod.

Stock: HAD-34 (WGNSSK Section 13: Haddock in Subarea IV and Division IIIa (North Sea)

1) **Assessment type:** update
2) **Assessment**: analytical
3) **Forecast**: Short term projections with recruitment being assumed as the geometric mean of the five lowest values from 1994-2007 were performed. Long term forecasts were performed with an equilibrium age structured model in R to determine MSY. However no definitive conclusion could be made due to recruitment variability.
4) **Assessment model**: XSA – tuning by fleets (Scotland, England, International) compared to single fleet XSA and SURBA to corroborate assessment
5) **Consistency**: Discards collated differently to conform with EU Data Collection Framework beginning in 2009. Retrospective patterns were minimal.
6) **Stock status**: Stock has full reproductive capacity and is harvested sustainably. SSB (178,000 t) is above B_{pa} (140,000 t) and B_{lim} (100,000 t) though declining since 2002. F (0.23) is below F_{pa} (0.7) and F_{msy} (0.3) Recent recruitment has been low. MSY $B_{trigger}$ was not estimated.
7) **Man. Plan.**: Agreed 2006: SSB above 100,000 t (B_{lim}) fishing mortality to be no more than 0.3.

General comments

This section was easy to follow and provided sufficient history of the fishery, response to issues from last year's assessment, and explanation of this update assessment. A few general comments are below.

- The new approach to collate discard data, though found to provide estimates within historical range, should probably be evaluated quantitatively before use.
- Research into fishing behavior would likely be useful to better understand effort and discarding behavior.
- The log catchability residuals for the final assessment (Figure 13.3.5.1) do show some patterns in the residuals for certain years, for example around 1991 for all fleets.
- It is not stated why the method of F at age estimation for the short term forecast was changed.
- The consistency of B_{lim} and F_{MSY} needs to be evaluated.

Technical comments

- The report is still in draft form.
- Section 13.2.2, second line, "Tables 13.2.2-4." should be "Tables13.2.2.2-.4"
- Table 13.2.5.1 and the table in report which summarizes Table 13.2.5.1 should be reviewed again to ensure consistency. Reasoning for the age range used for each country would be useful to include in report.

- Figure 13.2.5.4 should be removed as it is not mentioned in the text any longer.
- Figure 13.3.2.3 shows the plus group at age 8 and above while earlier in the report Table 13.2.5.1 and show data only to age 6 was used for the assessment, while the table in the text which is not numbered shows that data to age 7 was used in the assessment.

Conclusions

The assessment has been performed correctly. The concerns brought up in this report were thoughtful and seem necessary to be addressed at the next benchmark. It would be useful to include survey information into assessment, this is valuable data not being used. While the importance of accounting for biological interactions is discussed, methods for directly incorporating ecosystem evaluation/management are not included.

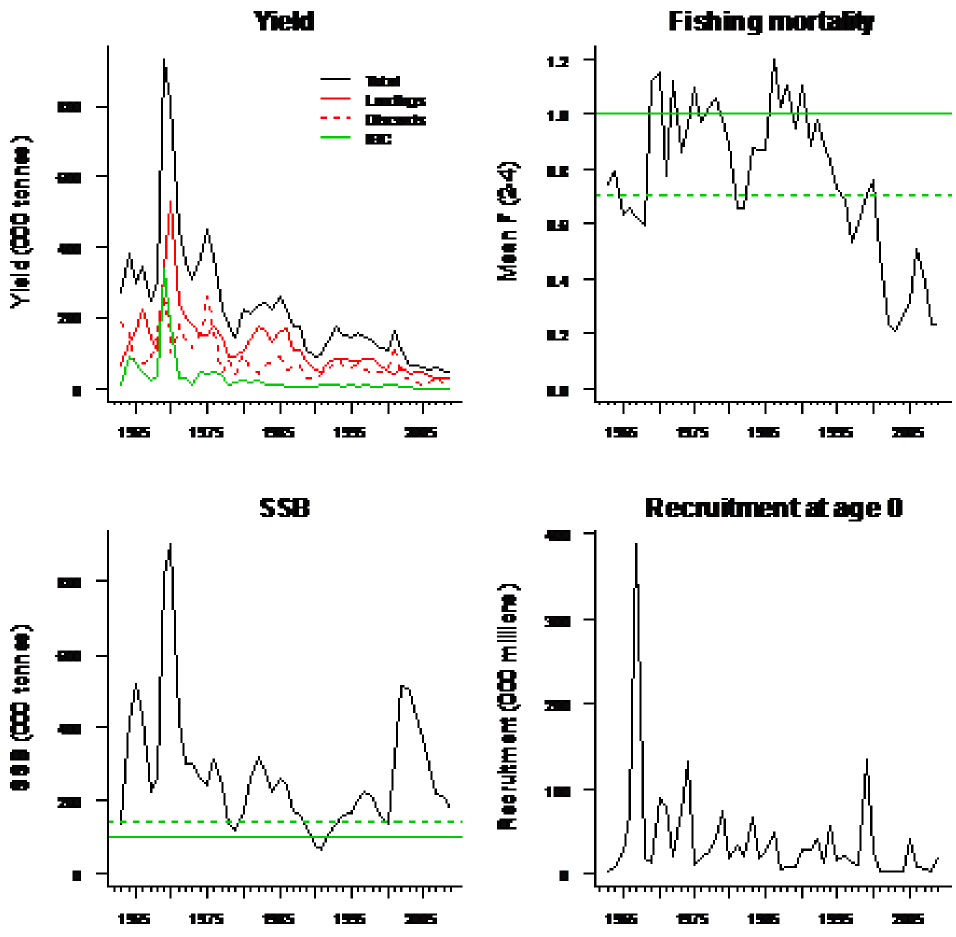


Figure 13.3.5.3. Haddock in Subarea IV and Division IIIa. Summary plots for final XSA assessment. Dotted horizontal lines indicate F_{pa} (top right plot) and B_{pa} (bottom left plot), while solid horizontal lines indicate F_{lim} and B_{lim} in the same plots.

Stock SAI-3a46 (WGNSSK Section 11: Saithe in Subareas IV, VI, and Division IIIa

1) **Assessment Type:** Scheduled update, not performed.

2) **Assessment:** Analytical, not performed because two tuning indices were unavailable, and a third was incomplete, leaving only a single fishery-based index for tuning (see below).

3) **Forecast:** Short-term forecast presented based on 2009 assessment.

4) **Assessment Model:** XSA, four tuning indices (two commercial: French demersal trawl "FRATRB", German bottom trawl "GEROTB"; two surveys: Norwegian acoustic "NORACU", IBTS q3).

5) **Consistency:**

This update is a projection from the 2009 assessment.

No retrospective analysis was presented. There is no reference to the date of the original benchmark in the 2009 WG report or in the recently prepared stock annex (which was not included in the WGNSSK 2009 report and is essentially identical to the 2009 WG assessment text).

6) Stock Status:

ICES considers the stock as having full reproductive capacity and as being harvested sustainably. The current fishing mortality (2006-2008 average) is estimated at 0.27, which is close to the management plan target rate expected to lead to high long-term yields (F = 0.3). The exploitation boundaries in relation to precautionary limits imply landings of less than 125 000 t in 2011, and the SSB is expected to be around B_{pa} (200 000 t) in 2012.

The biological reference points were derived in 2006 and are:

$\mathbf{F}_{0.1}$	0.10	$\mathbf{F}_{lim}$	0.60
$\mathbf{F}_{max}$	0.22	$\mathbf{F}_{pa}$	0.40
$\mathbf{F}_{med}$	0.35	$\mathbf{B}_{lim}$	106 000 t
$\mathbf{F}_{high}$	>0.49	$\mathbf{B}_{pa}$	200 000 t

7) Management Plan:

The management plan was developed by the EU and Norway in 2004 and entered into force in 2005, using TACs (15% rule) and technical measures. ICES has evaluated the agreed management plan to be in accordance to the precautionary approach, and the target fishing mortality in the management plan is expected to give high long-term yield in the present situation with a stock that is above Bpa. ICES recommends to use the MSY Framework and to limit landings in 2011 to 103 000 t in Division IIIa, Sub Area IV and VI.

General Comments:

A full assessment was not performed because two of the tuning indices (FRATRB and NORACU) were unavailable, and a third (IBTS q3) was not conducted in most of the species' distributional area (Norway did not participate). Thorough sensitivity analyses were performed to explore the effects of re-running the 2009 assessment with all combinations of available 2010 data, which indicated that errors were too great to conduct an update assessment.

A short-term forecast was projected using the FLSTF tool in FLR and used to outline management options, which are summarized above under "Stock Status".

There were some limited ecosystem aspects mentioned in 2009, which were generally well incorporated into discussions of stock structure and distribution of immature fish in the 2010 report.

No discard data are used, with the general argument that younger fish are not distributed within the range of the fishery. Significant discards are only observed in Scottish trawlers, which are not considered representative of the fishery and were not included. The possibility of discards from other fisheries is acknowledged.

This stock is scheduled for a benchmark assessment in 2011, during which some of the technical comments below could be addressed.

Technical Comments:

None of the available documents (including the 2009 report, stock annex) indicate how the maturity ogive was derived. Depending on when it was derived, and given observed declines in weight at age, it may need to be recalculated.

Changes in exploitation rates of age-3 fish over time seem to indicate that age-4 indices are a better indicator of year class strength – this may be worth exploring in the upcoming benchmark.

No description of the FLSTF tool (FLR) is given in any of the available documents.

Poor reliability of recruitment (age-3) estimates are a chronic issue for this assessment. Incorporation of ages 2-4 indices from Norwegian acoustic recruitment surveys conducted since 2006 may help with this issue. An *ad hoc* analysis of stock-recruitment relationships was conducted using the CEFAS ADMB module, indicating the "hockey stick" model is the most appropriate.

The tables and figures were well-prepared and matched text references well, although some figures would benefit from more detailed labeling (e.g. ages).

Conclusions:

The RG generally agrees with the WG on the management recommendations, and in particular the proposed work to be conducted in the 2011 benchmark.

Stock: WHG-47d (WGNSSK Section 12: Whiting in Subarea IV and Divisions VIId and IIIa

1) **Assessment Type:** Update, benchmark in January 2009

2) **Assessment:** Analytical

3) **Forecast:** short-term presented

4) **Assessment Model:** XSA, two tuning indices (IBTS q1 and q3)

5) **Consistency:** Retrospective analysis continues to indicate large deviations between annual assessments – recent stock size under-estimates will likely be revised in subsequent assessments.

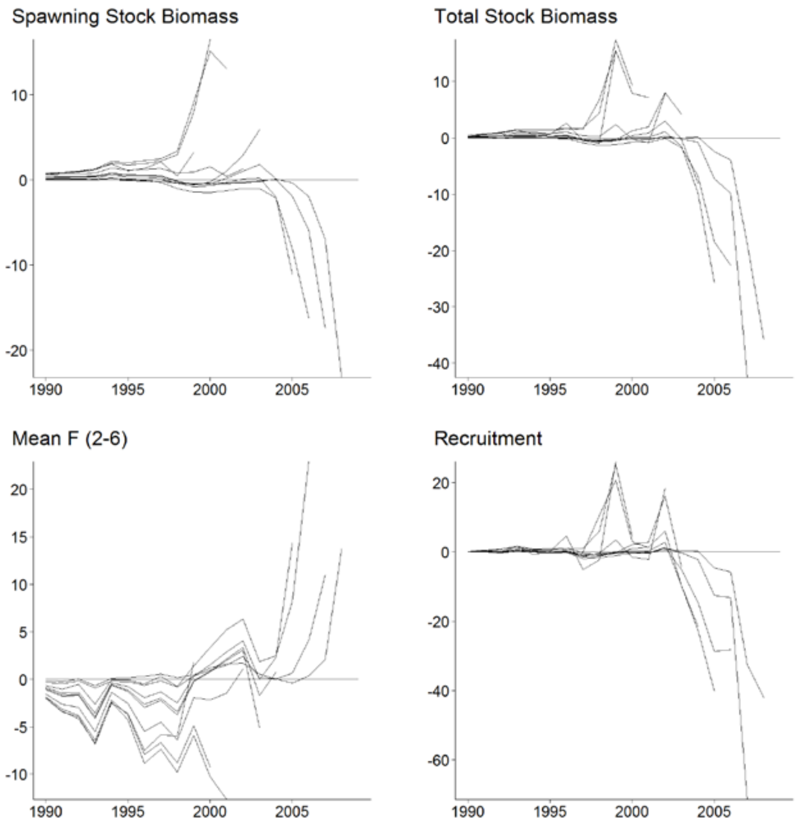


Figure 12.3.18 Whiting in IV and VIId. XSA final run: retrospective patterns. The y axis represents the percentage difference from the most recent assessment.

6) **Stock Status**:

No defined reference points (see below) - SSB at lowest level since 1990. F declined 2000-2004, but seems to be increasing. Recruitment has been low since 2002; some indications of improvement beginning with 2007 year class (but note difficulties with recruitment estimates – see below). TACs are often met or exceeded before year's end. MSY $B_{trigger}$ was not estimated.

7) **Management Plan**:

No defined reference points (EU/Norway defined BRPs in 1999 using data during time of major discrepancy between survey and catch data and considered inappropriate by RG/WG).

General Comments:

This assessment was very well written, including a comprehensive introduction that featured a concise summary of the regulatory scheme and description of the fishery, as well as incorporation of fishermen's observations and preliminary cooperative research results. An effort was made to address inconsistencies in data and differences between catch and survey indices, which was a focus of the 2009 workshop (WKROUND 2009). Efforts are currently underway to address historic survey catchability issues and catch data quality.

There were some limited ecosystem aspects mentioned in 2009, particularly pertaining to predation on young fish, which might be worth looking at due to evidence for variability in spatiotemporal patterns of recruitment observed in surveys (differences between quarters and latitude).

In future assessments, an effort should be made to assess the effectiveness of recent conservation measures to reduce fishing mortality and look for trends that correspond with the fishermen's observations summarized in the assessment.

The discard data is problematic, but a good effort was made to address gaps through modeling/averaging. The issues with discard data is likely still a big part of the inconsistency between catch and survey data, which has been a chronic issue for this assessment, especially for small fish. For example, the lack of data from the industrial fishery (many small fish despite small percentage of total catch) seemingly affects the weight at age data (see Technical Comments below).

Technical Comments:

On p. 5, it is noted that a logistic regression was fitted to discard data, but the associated figure 12.2.1 calls it a GLMM – if it is in fact a GLMM and not just a simple logistic regression (GLM), then more detail should be given in text.

There are several apparent problems with the weight at age data, some of which are addressed in the assessment. Particularly for ages >6, there are many instances in which cohorts decrease in mean weight as they increase in age (Tables 12.2.7 – 12.2.10; Figures 12.2.6, 12.2.7). While this is mentioned in the text, it does not seem to have been addressed in the model. A model run with an age 6+ group might be appropriate to explore the effects of the above.

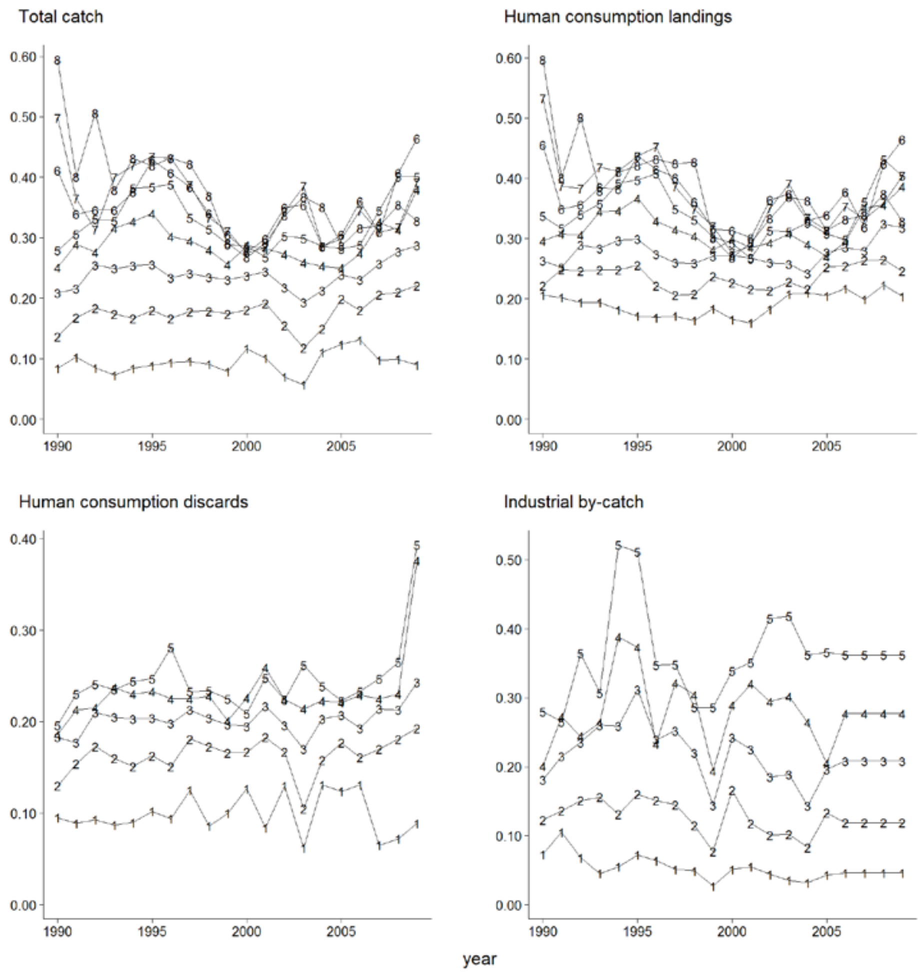


Figure 12.2.6 Whiting in IV and VIId. Mean weights at age (kg) by catch component. Catch mean weights are also used as stock mean weights.

The maturity ogive was based on data collected during the IBTS from 1981-1985. Catchability differences from these surveys led to pre-1990 data being excluded from all other analyses (see 2009 WGNSSK report p. 930), and it is also possible that age at maturity could have changed in 25 years. An updated calculation may be warranted.

Age	1	2	3	4	5	6	7	8+
Maturity Ogive	0.11	0.92	1	1	1	1	1	1

There was good consistency between cohorts in surveys, while recruitment indices were inconsistent between surveys, rendering it necessary to average estimates.

Section 12.6 (short-term forecasts) contains some errors in the text. The third paragraph refers to a Figure 12.2.X. The comments on mean weight at age in the fourth paragraph refer to Figure 12.2.3, which shows trends in discards relative to the TAC, but does not relate to the age-specific comments in the text in which it is referenced.

Section 12.11 notes that, "ICES will publish new advice in October 2009", if September survey information indicates changes should be made – should this read "2010"?

The tables and figures were generally well-prepared and matched text references well, although many figures, especially distribution plots, need legends, labels – see 2009 report. A few comments on smaller details of the tables and figures follow:

Table 12.6.1 contains typos in the headers (spelling of "yield").

Figure 12.19.1 (historical performance of assessment) is missing.

The caption for Figure 12.3.17 needs to be corrected – not percentages.

The captions for Figures 12.12.1 and 12.12.2 need to be corrected – IIIa not IV/VIId.

Conclusions:

The RG generally agrees with the WG on the assessment, recommendations, and future work. While the recommendation for 2011 landings appears to meet the stated goal of preserving SSB, and the management considerations are thoroughly discussed, the lack of applicable biological reference points for this stock should be addressed in the future.

Stock: PLE-ECHE (WGNSSK Section 6: Plaice in Division VIId (Eastern Channel)

1) **Assessment Type**: Update
2) **Assessment**: Trends; WKFLAT (2010) rejected the analytical assessment as a basis for catch advice because of unknown magnitude of discards and stock identity.
3) **Forecast**: Short-term (Average F in last 3 years)
4) **Assessment method**: exploratory XSA-3 surveys (UK beam trawl ages 4-6, FR Groundfish Survey ages 2-3, International young fish survey age 1) and 1 commercial fleet (BE Beam Trawlers age 2-10) , exploratory SURBA model
5) **Consistency**: Assessment based on trends because of rejected analytical assessment.

   Minor retrospective patterns in SSB (overestimation) and F (underestimation). Parameters included in model changed from 2009.
6) **Stock Status**: Trends only. Provisional estimate of SSB (3275t) < Blim (5400t) and Fpa (0.45) < Fbar (0.53) < Flim (0.54), invalid because of trends only analysis.
7) **Management Plan**: No information on management plan provided

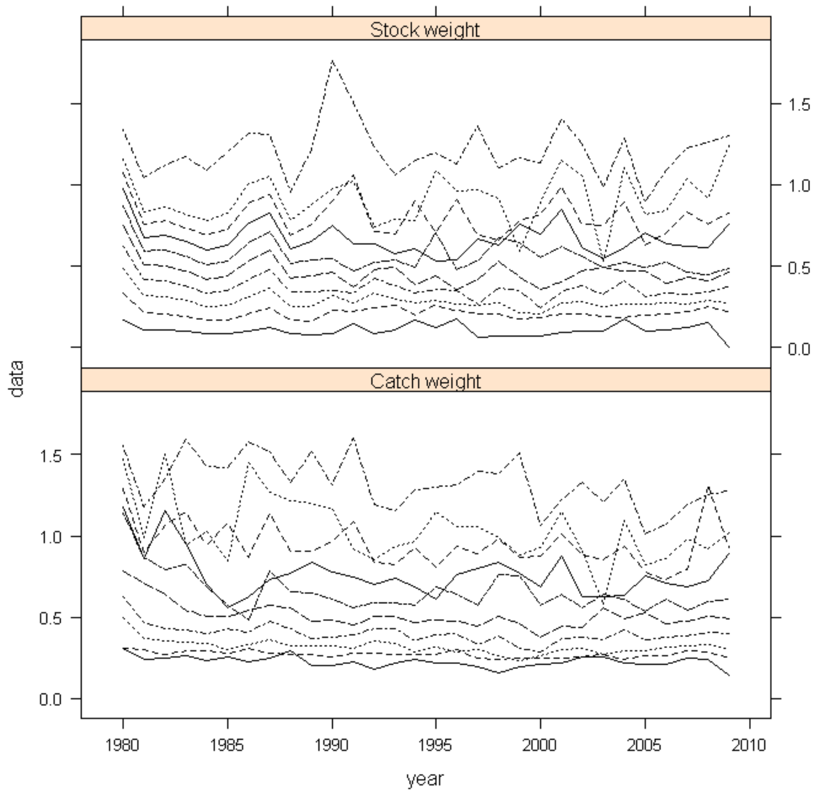
General Comments:

- Well written and concise
- MSY reference points were not mentioned in Assessment or annex
- Discards were not included in the assessment because the time-series was too short and sampling was poor.
- 65% of the first quarter catches were re-allocated based on WKFLAT (2010) (tagging results showing 50% of fish caught during Q1 are coming from area IV to spawn).
- Annex mentioned discarding possibly large (40% by weight), but survival studies show decent survival (50%-otter trawl, 20%-2hr beam trawl tow, 40% 1 hour beam trawl tow)
- Discarding may largely constitute juveniles (Length frequency plots show this)
- Assessment stated that no new Ecosystem data was present at the 2010 WG

Technical Comments:

- Page three cites “see text table above” with no table included.
- Benchmark WKFLAT2010 concluded this assessment could only determine recent trends in F and SSB
- Parameters of the XSA model changed but they didn’t explain why they were changed from the previous years
- A few minor spelling errors with the word peak (used peek when it should be peak section 6.4 and 6.10)
- Figure 6.2.3.1,6.3.5.5, 6.6.1, 6.6.2 need legends and axis labels

- Table 6.2.1.1 Unallocated removals were all negative until 2009, and in 2009 it becomes large and positive. Why is there such a large change?
- Table 6.2.1.1 show fleet is catching only 55% of the TAC is this a matter of plaice being a low priority species or having low abundance?
- High discard rates are shown, but what are the fleet coverage?
- Weight at age problems (ages 5-6, 6-7 and 8-9), but sampling intensity is not discussed.



- Figure 6.1.2.1 shows landings of Age 1 fish in Q3 and Q4. Why are age 1 fish being landed?
- Figure 6.3.2.1 the top plot is too busy to visualize anything

Conclusions:

RG feels the WG has supported the draft advice based on the assessment results and the RG agrees with the ICES draft advice of "catch not to exceed average recent landings."

While the assessment is to be used only for current trends, the results indicate that F is being reduced, while SSB seems to be slightly increasing in recent years.

If the assessment model is not estimating discards The WG states that discard data is a short time series and has relatively low sampling making it unusable in the assessment. The perceived large amount of discards should be looked into further especially if a large portion of those discards are juvenile fish.

Stock: PLE-NSEA (WGNSSK Section 8: Plaice in Area IV (North Sea))

1) **Assessment type:** Update assessment with one additional year of catch (not all catch has been officially reported by member countries, WG estimated total catch) and survey data
2) **Assessment**: Analytical
3) **Forecast**: Presented (short term)
4) **Assessment model**: XSA – tuning by 3 surveys (2 beam trawl and 1 sole net)
5) **Consistency**: Update of 2009 benchmark assessment. Some fairly strong retrospective patterns exist over the last 5 years resulting in underestimation of SSB and overestimation of F.
6) **Stock status**: F=0.24 which is close to F_{msy}=0.3 (ill defined based on age-structured equilibrium analysis) and well below F_{pa}=0.60 (based on 5^{th} percentile of Floss=0.74). SSB=380,234t which is well above MSY $B_{trigger}$=230,000t = B_{pa} (based on 1.4 B_{lim}) and B_{lim}=160,000t (based on lowest observed biomass in time-series). It is noted that due to high discards and high discard uncertainty the assessment is considered highly uncertain. Thus, although stock status appears to be at full reproductive capacity and fishing is sustainable, this perception is highly dependent on assumed levels of discards.
7) **Man. Plan**: ICES draft advice suggests a TAC of 73,400t corresponding to an increase in F of 12% in order to maintain F on order of F_{msy}=0.3 (F is currently less than F_{msy}). This is based on a 2007 EC management plan that proposed to return plaice to within safe biological limits by reducing F by 10% until Fmsy was reached using a maximum change in TAC of 15% per year. It is still uncertain whether Fmsy=0.3 is within safe biological limits due to uncertainty in the current MSY framework for plaice (due to lack of strong stock-recruit relations for plaice) and uncertainty in assessment results.

General comments

Although the RG believes that the WG followed the stock annex well and provided an excellent assessment given the high uncertainty in discards, the RG agrees that the assessment appears highly uncertain. The stock status appears correctly defined as being fished sustainably and being at full reproductive capacity, but this basis appears to be uncertain due to high uncertainties in discard estimates and estimates of F_{msy}. In addition, the plaice stock appears to be dominated by intermittent, very large year classes which have not been seen for many years. Although recruitment seems fairly steady and at average levels compared to the historic time-series, it is disconcerting that larger year classes have not been observed considering the model predictions of extremely large SSB and historically low F's.

The assessment was very well done. The number and variation of sensitivity runs was both helpful and informative. Also, the model diagnostics were superb. An excellent job was done with highlighting residual patterns and explaining possible reasons that these patterns might arise.

Technical comments

Discard uncertainty is driving both the assessment and the setting of the TAC. A number of comments/questions arise regarding this issue:

- What is the assumed discard mortality? It is not mentioned in the assessment or annex and plays an important role in determining F levels, etc… (See Plaice division VIId stock annex, section 6.A.3, which sites two studies on plaice discard mortality in the sole fishery. Discard mortality is estimated to be >50% in small otter trawls and between 20% and 40% for large beam trawls).
- It would be beneficial to include more detailed descriptions (probably within the stock annex) of how discards are reconstructed for the time period prior to discard sampling. A few formulas/paragraphs of text would help reviewers to better understand this process and possibly provide insight on how it might be enhanced. Additionally, a brief background description within the stock annex regarding the SCA model would also be helpful.
- No tables of sampling effort are provided in the assessment or annex. Although it is mentioned in the text when sampling is low, it would be useful for reviewers to actually see the data on sampling intensity. It is difficult to make inferences about output results without being able to judge the confidence in the model inputs. This applies not only to discard sampling, but also to length, age, maturity and sex ratios for all fleets involved in the fishery.
- Obviously, as mentioned numerous times, sampling of discards is much too low across the fishery. The number one priority for this stock should be to greatly increase sampling effort of all fleets in the sole and plaice fisheries in the North Sea. It is especially disconcerting that the main UK fleets are not sampled especially considering they make up 24% of total catch.
- The recent redistribution of fishing effort to plaice nursery grounds may prove to be a large future hindrance to stock rebuilding. In recent years total catch is dominated by age-3 and younger fish, while only 50% of age-3 and age-2 fish are mature while no age-1 fish are assumed mature. If juvenile plaice are being caught and discarded, then large recruitment events may never have the chance to add to the SSB as young fish will not reach maturity. Although this is a difficult issue due to sole/plaice interactions and the fact that larger mesh sizes would lead to escapement of juvenile plaice, but also adult sole, research should be focused towards determining ways to avoid juvenile plaice bycatch.
- Continued work should be done regarding reconstructing plaice discard estimates. It might also be helpful to run sensitivity runs to these estimates. This seems especially important considering the large discrepancies between reconstructed discard estimates and those estimated within the SCA model (Figure 8.3.5). The SCA model also shows promise and continued work with this model should be carried out and XSA vs. SCA comparisons should continue.

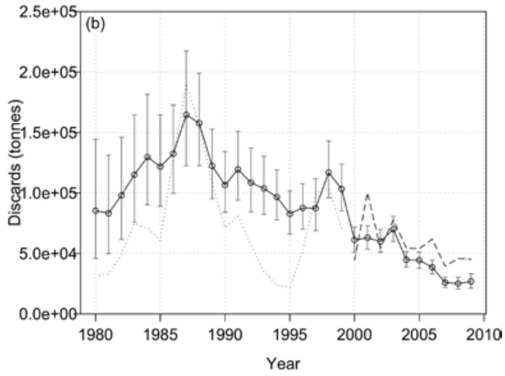


Figure 8.3.5 North Sea plaice. SCA output. A comparison of the median estimate of Discards obtained by running the Statistical catch at age model. Vertical bars represent the 95% confidence interval of the estimation. The dashed line in the SCA discard estimates shows the observed discards and the dotted line the reconstructed discards using the current method used in the XSA (see Aarts & Poos 2009).

The high variation in weight at age especially for older ages combined with the severe reduction in catch past age-6 and the observed zero catches for many ages past age-10 suggest that it might be suitable to truncate the age range of the assessment even further. Sensitivity runs indicated that an age 10+ group was more appropriate than the 15+ group. It is suggested that future sensitivity runs should investigate the use of either a 6+ or 7+ formulation.

Both natural mortality at age and maturity at age should be revisited for this stock. Even though it has been observed that fish are maturing earlier, it is still assumed that maturity at age is constant. It is suggested that maturity at age should be investigated and perhaps a yearly varying maturity schedule used. The natural mortality estimate is even more problematic because of its direct influence on stock status, but also because of the lack of information on how M estimates were derived. According to the stock annex: "Natural mortality is assumed to be .1 for all age groups and constant over time. These values are probably derived from war-time estimates (Beverton and Holt, 1957)." It should first be determined what these estimates are based on, then conduct research on what the current levels of M are. It is very likely that M has changed since WWII. It is possible that the observed distributional shift of juvenile plaice may be connected to changes in environment that have led to changes in M rates on younger ages. Time-varying and/or age-varying M might be appropriate for this stock.

Although the sensitivity run of adding the catch in the first quarter of the year from area VIId to the catch of North Sea plaice (due to assumed spawning of a portion of the NS stock within the English channel) showed little effect on the area IV plaice assessment, investigations should be undertaken into how this might affect the area VIId assessment. It is likely that since the VIId stock is smaller the effect will be much greater on that stock than on the North Sea stock.

It is agreed that although the commercial tuning indices provide a good comparison to assessment outputs, they are likely inappropriate for use within the final assessment due to the affect of TACs on effort and the fact that most plaice is now caught as bycatch in the sole fishery.

Conclusions

Overall, this assessment is very well done considering the issues with discards that have no easy or apparent solution. Continued use of sensitivity runs and numerous model comparisons, especially with the SCA model will be important features of future assessments.

Due to the strong and changing spatial structure within the North Sea stock it might be of interest to investigate a spatial model. A model such as that developed for Bering Sea Pollock might be useful because it can account for the spatial structure of the fleets, surveys, and stock itself. One option could be to separate the North Sea into a northern and southern component. This would require splitting catches between components, but would allow the Tridens survey to be applied solely to the northern area and the SNS to be applied solely to the southern area. In addition, ontogenetic migration from southern nursery areas to northern adult grounds could be included along with spawning migrations during the year (and possibly to areas such as VIId in the English Channel). The main advantage of such a model is that it would make better use of the surveys, which cover different spatial components of the stock and are currently providing the largest residuals and residual patterns. In addition, it might allow for more accurate discard estimates if data on discards in the northern and southern units could be obtained. The reason being that it appears that recent discards are predominantly within the southern area due to sole fishing on plaice juvenile nursery grounds. By separating northern from southern discards it might provide more reliable overall discard estimates since northern discards are likely somewhat lower and involve older fish.

Stock: SOL-ECHE (WGNSSK Section 9: Sole in Divisions VIId (Eastern Channel)

1) **Assessment Type**: Updated

2) **Assessment:** Analytical

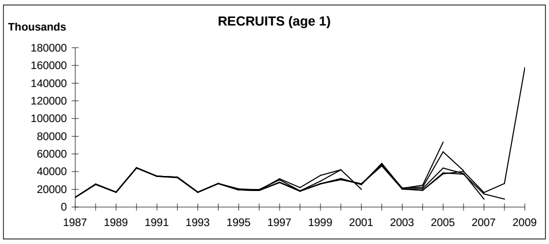
3) **Forecast**:

- A short term (3-year) forecast was completed assuming the selection pattern and the weight at age are constant and the same as the averages of the years 2007-2009. Assuming status quo fishing mortality will result in a higher SSB in 2011 and 2012.
- A sensitivity analysis has also been conducted in the short term forecast. If keeping the current fishing mortality, there is about 8% probability that SSB will fall below the B_{pa} of 8000 tons in 2012.
- Neither the medium term projection, nor the long term projection was done. There is no reason stated in the report why longer term projection wasn't conducted.
- A yield-per-recruitment analysis has been carried out, and F_{max} has been calculated.

4) **Assessment method**: An extended survivor analysis (XSA) was used in the assessment of the Eastern Channel sole; and calibrated with Belgian commercial landings, UK commercial landings, UK beam trawl survey, UK Young Fish Survey, and French Young Fish Survey. However, for recruitment, the estimation in 2008 is from the RCT3 model; the estimations for 2009 and 2010, 2011 are from the GM 82-07 model.

5) **Consistency**:

- The current assessment method (XSA) was the same as in the previous assessment.
- The benchmark stock assessment took place in 2009.
- In 2009, the Young Fish Survey was separated into two components due to the cessation of the UK component in 2007.
- The landing indices and the survey indices are internally consistent with each other.
- The output data are consistent among each other. However, the recruitment estimations come from different models.
- According to the historical assessment results, the SSBs were overestimated before 2008 but was underestimated in 2009; while the fishing mortalities were underestimated before 2007 (except 2003), but overestimated after 2008. This might result from the fluctuating estimation of the recruitment.
- Retrospective analyses have been done for the spawning stock biomass, recruits, and mean fishing mortality. The SSB and the fishing mortality are consistent over the last 10 years. However, the retrospective pattern for XSA estimated recruitments in recent years is large and abnormal (Figure 9.3.4, see attachment).



6) **Stock Status**:

- B_{pa} equals 8000 tons. This value is the lowest observed biomass at which there is no indication of impaired recruitment. B_{lim} hasn't been defined. The current SSB is more than B_{pa} since 2002. The fishery can be classified as having full reproductive capacity.
- F_{pa} is 0.4 year^{-1}. F_{lim} is 0.55 year^{-1}. F_{msy} is 0.29 year^{-1}. F_{max} is around 0.28 year^{-1}. F_{lim} is the fishing mortality at/above which the stock has shown continued decline. F_{pa} is the fishing mortality which provide approximately 95% probability of avoiding F_{lim}. The current F is larger than F_{MSY} and F_{pa} and close to F_{lim}. The fishery is at risk of being harvested unsustainably.
- According to the assessment results, since 2008, the SSB has been decreasing and the fishing mortality has been increasing.

7) **Management Plan**: There is no specific management objectives are known to ICES. It is said in the stock assessment report that the agreed TAC in 2010 is 4219 tons, but no basis has been provided. Regulations have been defined to define the minimum mesh sizes for various types of trawls. The minimum landing size for Eastern Channel sole is 24 cm.

General Comments:

- The French effort and LPUE are still not available for 2009. The horse power for Belgian beam trawl fleet is suggested to be corrected. As France and Belgian have taken 50% and 30% of the sole landings in the Eastern Channel. It is necessary to include the French commercial landings and Belgian survey to calibrate the model.
- The Ecosystem considerations were discussed in Stock Annex. The biological information is in detail; while the environmental information is more general.
- The natural mortality is constant. It would be better to have a time-varying and age-varying natural mortality.
- The SSB-R curve is hard to define because of lacking the observations below 8000 tons SSB (see attachment).
- Uncertainty has been appropriately estimated for key parameters to forecast future stock status.

Technical Comments:

- Some discard information is available, but not for the whole time series. Therefore, it is not included in the stock assessment model. The misreport is another imperfection. The RG suggests better monitoring programs should be developed to cover the whole range of the Eastern Channel sole stock distribution.
- Table 9.2.4 the stock weights at age has a decrease in the age 9 and the age 10 suggesting poor sampling.

- Figure 9.2.3: The sub figure is not in order and the figure 1 has high value. See attachment.
- Figure 9.3.1a: legend is needed. See attachment.
- The tables and figures are pasted as figures, e.g. Table 9.2.4, Figure 9.3.1a. The resolution is very low. See attachment.

Conclusion:

- The XSA assessment is acceptable. But a more powerful tool could be considered to prove the recruitment estimation.
- When the F is larger than 0.4 year^{-1}, the slope of the per-recruitment curve is very flat.
- The French commercial landings are not included in the model. Some surveys is not consistent available for whole time series. Need to improve the quality and quantity of the fishery independent data.
- An appropriate harvest control rule should be adopted to reduce the fishing mortality, so the Eastern Channel sole fishery will be harvested sustainably.
- The Eastern Channel sole fishery is mixed with other demersal fisheries. More effort should be made to minimize the bycatch and discards of other species, e.g. cod.

Stock: SOL-NSEA (WGNSSK Section 10: Sole in Area IV (North Sea)

1) **Assessment type:** Update assessment, Benchmark assessment done early 2010, (ICES-WKFLAT 2010).
2) **Assessment**: Analytical
3) **Forecast**: A short term forecast presented. No medium term projections were performed this year. Generally, no long term projections done for this stock. The long term management plan aims for exploitation at F = 0.2. ICES has evaluated the long-term plan and concluded that it leads on average to a low risk of $B < B_{lim}$ within the next 10 years.
4) **Assessment model**: XSA, discard information not used. A state space model (SAM) is used for comparison with XSA. One commercial fisheries time series and two scientific surveys are used in the assessment. The commercial survey consists of yearly trends in LPUE from a Dutch commercial beam trawl fishery. The two scientific surveys are the BTS (Beam Trawl Survey) using 8 m beam trawl in the southern and southeast North sea during August and September and SNS (Sole Net Survey) using a 6 m beam trawl along the coast in the 3rd quarter.
5) **Consistency**: During Benchmark Assessment a range of exploratory analysis were performed and different models were tested including SCAA, XSA, and SAM with various combinations of input data. The XSA model, tuned with commercial data from 1997 onward, performed best and was recommended. Recent slight retrospective pattern.
6) **Stock status**: In 2009, F (0.36) < F_{pa}(0.40) SSB (35,000 tons) above B_{lim} (25,000 tons) and equal to B_{pa} (35,000 tons). R in 2009 estimated at 103 million fish, which is higher than the long-term average of 94 million fish. A Ricker function was chosen as the best model fit to estimate **Fmsy** at 0.22; **Bmsy** at 43 800t; and MSY at 17 000t. The $B_{trigger}$ is 35,000t as the default B_{pa} value. ICES classifies the stock as having full reproductive capacity and is harvested sustainably. SSB stable at precautionary reference points for the past decade. F declining trend since 1995. F in 2009 less than 50% of the level in 1998.
7) **Man. Plan.**: EC management plan adopted in 2007, incorporates a fishing mortality reduction of 10% from F in the previous year until F of .2 is reached. The reductions in F correspond to a reduction in TAC. The change in TAC cannot be greater than 15% in consecutive years. Fishing effort controls are in place where days at sea are limited depending on gear, mesh size, and catch composition. There are exploitation boundaries A closed area (the plaice box) has been in effect since 1989 and closed indefinitely in since 1995. Technical measures include a minimum mesh size of 80 mm (3.14") that corresponds with a minimal landing size (MLS) of 24 cm (9.4"). Maximum beam trawl width is 24 m, and further restricted to 9m inside of 12 nm

General comments

The report is clearly written easy to follow and interpret. Ecosystem aspects are well described in the annex.

Since the maturity ogive for sole is based on market sampling from the 1960's and 1970's, the RG concurs with the WG that more work needs to be done to update the age at maturity data to improve the models in use.

Consistent slight bias in the recent retrospective pattern, particularly on F was explored exhaustively during the Benchmark Assessment (WKFLAT 2010).

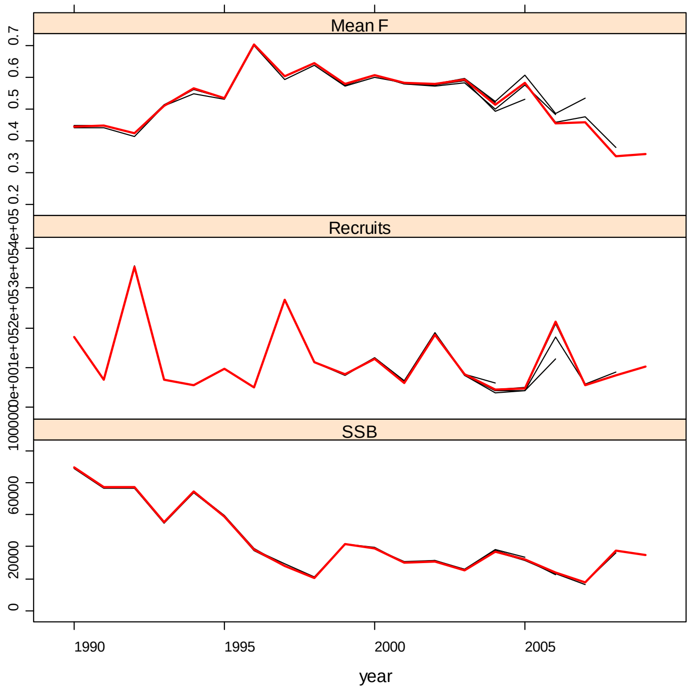


Figure 10.3.4 Sole in subarea IV. Retrospective analysis of F, SSB and recruitment for 1990–2009

Management: A study on the change in maturation for North Sea sole was completed in 2007 and shows size and age at first maturity significantly shifted to younger ages and smaller sizes from 1980's onwards. In order to reverse the decline in reproductive potential for this stock, the RG concurs with the WG that changes in mesh size should be considered in the future.

The high discard of plaice (up to 80% of all plaice caught are discarded in the southern North Sea) is seen as a major problem in the mixed fishery that uses 80mm (3.1" mesh). An increase in mesh size would reduce discards of plaice and increase yield in both the sole and plaice fishery.

Technical comments

The assessment has been done as outlined in the Stock Annex.

Adding a detailed map of the stock areas and fishing banks would be helpful in the Annex.

Section 10.1.3 ICES Advice. A codend configuration change to a square mesh would likely not reduce discards of plaice. In general a square mesh retains more flatfish while roundfish such as cod haddock and Saithe escape more readily from square panels. Conversely, a diamond mesh releases greater numbers of flatfish compared with roundfish.

Section 10.2.1 states the MLS for sole is 23 cm, but it's listed as 24 cm elsewhere in the document.

Figure 10.4.1. The figure legend is incorrect. It states the top left graph is SSB when it should be recruitment.

Conclusions

The assessment has been performed correctly. The RG agrees with all eight recommendations put forth by the WG following the Benchmark Assessment (WKFLAT 2010). The RG concurs that the XSA model continue to be used and that the SAM model be run alongside XSA to compare model results. The confidence bounds produced by SAM will be useful for informing management and the WG should consider switching to SAM in the future.

Stock: NOP-34 (WGNSSK Section 13: Norway Pout in Subarea IV and Division IIIa)

1) **Assessment type:** update
2) **Assessment**: analytical
3) **Forecast**: Short term to January 2011 to calculate catch which will result in SSB at or above B_{msy}.
4) **Assessment model**: S-XSA (Seasonal Extended Survivors Analysis)
5) **Consistency**: Assessment consistent with last year and stock annex. Retrospective patterns were seen mostly in recruitment and in general were minor.
6) **Stock status**: SSB (253,220 t) well above B_{msy} (150,000 t), at full reproductive capacity. B_{lim} = 90,000 t based on lowest observed biomass. Fishing mortality lower than natural mortality.
7) **Man. Plan.**: None but B_{msy} is defined as 150,000 t (based on B_{pa}) and F_{msy} is undefined because thought to be affected more by natural predators than humans. MSY $B_{trigger}$ = B_{pa}.

General comments

This section was easy to follow and concise with a good background of the fishery, past management and ecosystem concerns.

Technical comments

New additions to report are highlighted, this should be removed.

Conclusions

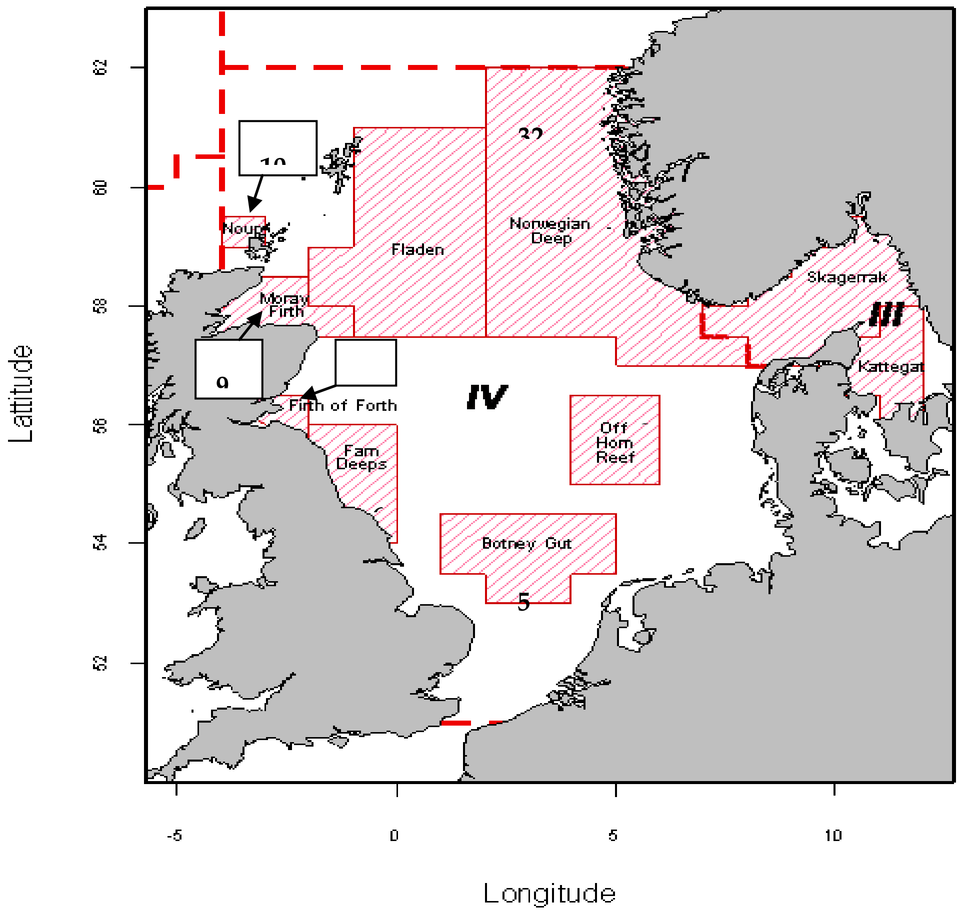
The assessment has been performed correctly. The ecosystem considerations were thoughtful and will likely benefit the upcoming benchmark.

Stock NEP-IV (WGNSSK: *Nephrops* in Subarea IV.)

This division contains Functional Units 5, 6, 7, 8, 9, 10, 32 and 33. A TAC has been set for the entire Subarea for 2010 at 24,688 tonnes in EU waters and 1200 tonnes in Norwegian waters.

General comments for all *Nephrops* function units in Subarea IV (North Sea).

Figure 1 **Functional Units in the North Sea and Skagerrak/Kattegat region.**



<u>Discards</u>

Discard rate is not presented for the FUs that use trends as their assessment model, i.e. 5, 10, 32 and 33. These data are not available for each FU.

Discard rate is presented as a percentage of landings for FUs that have a TV survey, i.e. 6, 7, 8 and 9. A discard proportion is used to calculate the short term forecasts. The calculation of this proportion is not described.

<u>Variability in Landings data</u>

In various places throughout all the Subarea IV FUs, a change in legislation is mentioned but it is not clear whether the same legislation is affecting all FUs. This change occurred in 2006 and affected landings reporting. This reduced the time series available for examination as data before 2006 was called into question. The logbook effort data changed and this affected the CPUEs but it is not clear whether this is because of this legislation or technology changes.

General Biology

Males dominate landings in all FUS. In 2 FUs females have periodically dominated landings. This may be due to decreased burrowing activity. Frequency of these events should be monitored to detect changes in sex ratio and impacts on recruitment.

TV Survey Abundance Estimates

Abundance estimates exhibit some variability, i.e. measurement error. For surveys that sample multiple times per year it is possible to pick which season best describes the stock, e.g. autumn in FU 6.

They also overestimate the abundance and a bias correction factor is required for each stock.

The surveys are based on burrow density. Because of the burrowing behavior of this species, the surveys cannot collect data on length and sex compositions of the stock.

MSY Considerations

Section 2 is referred to but could not find it.

For FUs that have a TV survey, a harvest ratio is calculated and used as F_{MSY} proxies.

An equation used to calculate the projected harvest rate is only provided for FU 6. It is unclear if the same equation is used for FU 7, 8 and 9.

They are calculated but no plans for implementation are provided; for FU 6 enforcement is mentioned as it’s currently not possible to control effort between FUs.

Short-term forecasts

The predicted MSY landings are provided for FU 6, 7, 8 and 9 based on a range of harvest ratios. They are compared to the F_{MSY} proxies to see if the predicted landings will exceed this amount.

The short-term forecasts are sensitive to survey bias correction being valid in future years and to fluctuations in the discard proportion

Conclusions

An improvement to the management of this FU would be to manage at the FU level as opposed to the Subarea level. This would also allow the F_{MSY} proxies calculated for suitable FUs to be utilized. Under the current management strategy, it may be difficult to enforce FU specific TACs if a Subarea IV TAC remains in place.

These *Nephrops* FUs are data-poor and require improved data for all aspects of the fishery, landings, discards, length composition and expansion of the survey.

Nephrops (*Division IVa* (Botney Gut) WGNSSK Section 3, nep-5)

1) **Assessment type: SALY**
2) **Assessment**: trends
3) **Forecast**: not presented
4) **Assessment model**: LPUE data
5) **Consistency**: There was no reference to previous reviews.
6) **Stock status**: It is considered to be sufficient to sustain fleets exploiting stock. For many years total landings have been at a level of 1000 t. Peak landings were in 2001-2002 with around 1200 t. In 2009 total landings amounted to around 700 t. Nations fishing this stock have changed over time.
7) **Man. Plan.**: Management is at the Subarea level. The 2010 TAC was set at 24,688 tonnes in EC waters with 1200 tonnes in Norwegian waters.

General comments

The stock annex was unavailable for this FU.

A recommended research section may be appropriate for this stock.

Discard data were not presented.

A change in CPUE occurred in 2006. It is unclear whether this was related to the change in legislation mentioned in other FU.

Growth data is assumed to be similar to Scottish stocks. Do these growth parameters describe growth in the remaining FUs?

Technical comments

The available discards are for the Belgian fleet that comprised a small component of the fishery for the time period collected. Are these considered representative of the other nations discards? If all the nations use a similar mesh size this may be a valid assumption.

Status of the stock is based on effort data with no investigation into the extent that technological changes affect these estimates over time. The change in legislation in 2006 may also have an impact on these estimates, however, there is no mention of this for FU5.

Conclusions

The group outlined an appropriate management strategy considering the data poor nature of the fishery. An improvement to the management of this FU would be to manage at the FU level as opposed to the Subarea level

Nephrops (Division IVa (Farn Deeps) WGNSSK Section 3, nep-6)

1) **Assessment type: SALY**
2) **Assessment**: UWTV
3) **Forecast**: Short term forecast presented.
4) **Assessment model**: Stock abundance is estimated from TV surveys.
5) **Consistency**: This stock was subject to an assessment in 2009 that indicated it was declining.
6) **Stock status**: It is considered to be in a depleted state. In 2009 total landings were 2,711 tonnes, a large increase on the low 2008 value (1,218t) but below the levels of both 2006 and 2007.
7) **Man. Plan.**: Management is at the Subarea level. The 2010 TAC was set at 24,688 tonnes in EC waters with 1200 tonnes in Norwegian waters. Landings within FU6 were advised to remain below that of F2008; landings should remain below 1,210 tonnes within FU6.

General comments

Males dominate the catch. Twice during the survey history females have dominated. This may need to be monitored more closely to see if it becomes a more common trend indicating a change in the sex ratio and the impacts on recruitment. The length frequency distributions are already suggesting some reduced recruitment.

Directed fishing effort has increased since 2000 but LPUE has not changed dramatically in this time period. An increase in LPUE occurred in 2005 & 2006, however, this may be due to the change in legislation.

Discard data were not presented but discard survival is 0% based on fishermen behaviour.

Technical comments

$B_{trigger}$ is set to be 968 million, i.e. the 2007 bias adjusted TV abundance when the stock was first considered depleted. The 2010 F should be based on current F and F_{MSY} and is calculated using the HR equation. F35%SpR is discussed above this but it is unclear which F is being recommended.

The survey is assumed to overestimate abundance by 20%. Status of the stock is based on effort data with no investigation into the extent that technological changes affect these estimates over time. The change in legislation in 2006 may also have an impact on these estimates, however, there is no mention of this for FU5.

Conclusions

The group outlined an appropriate management strategy considering the data poor nature of the fishery. An improvement to the management of this FU would be to manage at the FU level as opposed to the Subarea level.

Nephrops (Division IVa (Fladen Ground) WGNSSK Section 3, nep-7)

1) **Assessment type: SALY**
2) **Assessment**: UWTV
3) **Forecast**: Short term forecast presented.
4) **Assessment model**: Stock abundance is estimated from TV surveys.
5) **Consistency**: This stock was subject to an assessment in 2009 that indicated it was being harvested sustainable.
6) **Stock status**: It is considered to be sustainable. Total international landings (as reported to the WG) in 2009 were over 13,300 tonnes (approximately 1000 tonnes greater than the 2008 total), consisting of 13,200 tonnes landed by Scotland and 130 tonnes landed by Denmark.
7) **Man. Plan.**: Management is at the Subarea level. The 2010 TAC was set at 24,688 tonnes in EC waters with 1200 tonnes in Norwegian waters.

General comments

Discard rates are presented for this FU and were 10% of total landings in 2009. This differs to the discard rate (13.8%) used in the short-term forecast.

The review group has highlighted two important factors that may affect the abundance estimates: gaps in the survey with relation to stock distribution and poor quality Scottish reporting data. The survey data is thought to underestimate the population slightly, however, in another section it states that an overestimation factor must be applied (35% overestimation).

Final assessment is independent of official statistics.

No explanation about the recent large fluctuations in the estimated abundances is provided. A large increase was noticed recent years but 2009 showed a 25% decrease from the 2008 value.

Technical comments

The stock is assumed to have a low growth rate based on the survey absolute density ($0.2\ m^{-2}$). This forms the basis of choosing the F_{MSY} proxy, $F_{0.1(T)}$. The $B_{trigger}$ is calculated as 2767 million individuals. The 2011 harvest prediction is 13,276 tonnes. The current harvest ratio is less than that of F_{MSY}.

Conclusions

The group outlined an appropriate management strategy considering the data poor nature of the fishery. An improvement to the management of this FU would be to manage at the FU level as opposed to the Subarea level

Nephrops (Division IVa (Firth of Forth) WGNSSK Section 3, nep-8)

1) **Assessment type: SALY**
2) **Assessment**: UWTV
3) **Forecast**: Short term forecast presented.
4) **Assessment model**: Stock abundance is estimated from TV surveys.
5) **Consistency**: This stock was subject to an assessment in 2009 that indicated it was being harvested sustainable.
6) **Stock status**: It is considered to be sustainable. Reported landings have increased dramatically since 2003 (although this may have been due to increased reporting as well as increased actual landings) and the value for 2009 of over 2,600 tonnes is the highest in the available time series.
7) **Man. Plan.**: Management is at the Subarea level. The 2010 TAC was set at 24,688 tonnes in EC waters with 1200 tonnes in Norwegian waters. ICES recommended in 2009 that the Firth of Forth landings should not exceed 1,567 tonnes, i.e. they shouldn't exceed F_{max}..

General comments

There is a universal management plan for the majority of the *Nephrops* FUs in terms of allowable landings, however, this doesn't seem to extend to fishing regulations. This FU has a higher discard rate (25 – 50%) potentially because of the smaller mesh used in this fishery.

The survey data is thought to overestimate the population by 18%. The survey doesn't encompass the entire fishing grounds in this area. The Scottish effort data is of poor quality. It is unclear what data are used to estimate the extent of the fishery in these other areas.

Technical comments

The fishery is considered sustainable despite the estimated harvest rates being above F_{max}. The recommended F_{msy} proxy is $F_{max(T)}$ considering the high densities observed in the survey and the sustained high harvests. The $B_{trigger}$ is calculated to be 292 million individuals.

The 2011 harvest prediction is 1,379 tonnes using the F_{msy} proxy harvest ratio. The transition landings would be 1992 tonnes.

Conclusions

The group outlined an appropriate management strategy considering the data poor nature of the fishery. An improvement to the management of this FU would be to manage at the FU level as opposed to the Subarea level. Discards in this FU need to be reduced.

Nephrops (Division IVa (Moray Firth) WGNSSK Section 3, nep-9)

1) **Assessment type: SALY**
2) **Assessment**: UWTV
3) **Forecast**: Short term forecast presented.
4) **Assessment model**: Stock abundance is estimated from TV surveys.
5) **Consistency**: This stock was subject to an assessment in 2009 that indicated it was being harvested sustainable.
6) **Stock status**: It is considered to be sustainable. Total landings (as reported to the WG) in 2009 were just over 1,000 tonnes, a 30 % reduction on the 2008 landings. Following a number of years of increasing reported landings (which may have been due to increased reporting as well as increased actual landings), the landings have fallen by over 40 % in a two year period.
7) **Man. Plan.**: Management is at the Subarea level. The 2010 TAC was set at 24,688 tonnes in EC waters with 1200 tonnes in Norwegian waters.

General comments

There seems to be some uncertainty about the landings in this FU because of increased level of reporting and a potential increase in landings. Despite these two factors, landings have recently decreased by 40%.

Changes in the landings have occurred but no explanation is provided. In 2009 females dominated the catch; males typical form the majority of the catch. This phenomenon was observed in another FU. For this FU, it is suggested that this in combination with the reductions in discards (from 35% to 8%) may indicate the stock is experiencing reduced recruitment. However, the reduced discards could be attributable to changes in fishing behavior. This potential reduction in recruitment is not taken into account in the harvest level.

The survey data is thought to overestimate the population by 21%.

Technical comments

The recommended F_{msy} proxy is $F_{35\%SPR(T)}$ as historic landings have been near this harvest rate and are thought to be sustainable. The $B_{trigger}$ is calculated to be 262 million individuals.

The 2011 harvest prediction is 1,171 tonnes using the F_{msy} proxy harvest ratio. The transition landings would be 1264 tonnes.

Conclusions

The group outlined an appropriate management strategy considering the data poor nature of the fishery. An improvement to the management of this FU would be to manage at the FU level as opposed to the Subarea level.

Nephrops (Division IVa (Noup) WGNSSK Section 3, nep-10)

1) **Assessment type: None.**
2) **Assessment**: trends
3) **Forecast**: No short term forecast is presented.
4) **Assessment model**: No assessment.
5) **Consistency**: The 2008 advice was for 2009 and 2010.
6) **Stock status**: It is considered to be sustainable. Total landings (as reported to the WG) in 2009 were 89 tonnes, a reduction of almost 50 % since 2008.
7) **Man. Plan.**: Management is at the Subarea level. The 2010 TAC was set at 24,688 tonnes in EC waters with 1200 tonnes in Norwegian waters.

General comments

This is a data-poor stock and needs more data collection in order to conduct an analysis.

An UWTV survey was conducted in 4 nonconsecutive years (1994, 1999, 2006 and 2007). No survey is available in recent years and the assessment has to use trends in LPUE data.

Technical comments

Conclusions

The group outlined an appropriate management strategy considering the data poor nature of the fishery. An improvement to the management of this FU would be to manage at the FU level as opposed to the Subarea level.

Nephrops (Division IVa (Norwegian Deep) WGNSSK Section 3, nep-32)

1) **Assessment type: SALY**
2) **Assessment**: trends
3) **Forecast**: not presented
4) **Assessment model**: Danish CPUE data
5) **Consistency**: Last review considered data inadequate for advice. Some additional landings available this year but no improvement in data quality.
6) **Stock status**: It is considered to be sustainable at current level. International landings from the Norwegian Deep increased from less than 20 t in the mid-1980s to 1,190 t in 2001, the highest figure so far (Table 3.3.7.1, Figure 3.3.7.1). Since then landings have declined and total landings in 2009 amounted to only 477 t, due to a reduction of Danish landings. This is the lowest figure since 1994. Danish vessels used to take 80-90% of total landings, but in 2009 this percentage decreased to 69 %. Norwegian landings increased from 2007 to 2008-2009 by around 45 %.
7) **Man. Plan.**: The EU fisheries in FU 32 take place mainly in the Norwegian zone of the North Sea. The EU fisheries are managed by a separate TAC for this area. For 2008 and 2009 the agreed TAC for EU vessels was respectively 1300 and 1200 t. There are no quotas for the Norwegian fishery.

General comments

The document was well laid out well but would be easier to understand if the sections in the stock annex that are referred to in the document were referenced with the section letter.

A recommended research section may be appropriate for this stock.

Ecosystem aspects is a description of potential expansions of the fishery based on habitat without any discussion on the impacts on the habitat itself. Landings are hovering around an average daily landing (200kg/day), it is unclear where the expansion is expected to come from.

Technical comments

It is unclear what catch has not been uploaded, i.e. year, fleet, etc (Section 3.3.7.2.1).

Assessment is based solely on logbook data that appear incomplete. The quality of the Danish data has been called into question and it formerly comprised the majority of the landings.

It is unclear why the survey data don't correspond to the landings data. From Figures 1 and 3 the survey appears to overlap with the fishing grounds. No details on the type of net used in the Norwegian shrimp survey are provided. This may explain why survey catches of *Nephrops* are insufficient to construct fishery independent abundance indices.

An explanation of why the Danish landings have decreased from 90% to ~69% seems necessary. A number of explanations are possible, data quality, increases in fishing effort by other countries decreasing Danish landings, changes in discards.

Discards from the Danish at-sea-sampling programme are mentioned in the review but no trends are presented, unless the Danish catches in Fig. 3.3.7.1 includes discards.

What are the desired lengths for *Nephrops* in this fishery? The recent increase in lengths is lower than “historic” (2000) data suggest.

Conclusions

The group outlined an appropriate management strategy considering the data poor nature of the fishery. They also outlined the caveats and their hesitations of using the data as they are and required data to improve the assessment and ensure the fishery is harvesting sustainably. An improvement to the management of this FU would be to manage at the FU level as opposed to the Subarea level.

Nephrops (Division IVa (Off Horns Reef) WGNSSK Section 3, nep-33)

1) **Assessment type: None.**
2) **Assessment**: trends
3) **Forecast**: No short term forecast is presented.
4) **Assessment model**: No assessment.
5) **Consistency**:
6) **Stock status**: It is considered to be sustainable.
7) **Man. Plan.**: Management is at the Subarea level. The 2010 TAC was set at 24,688 tonnes in EC waters with 1200 tonnes in Norwegian waters.

General comments

This is a data-poor stock and needs more data collection in order to conduct an analysis.

Technical comments

Conclusions

The group outlined an appropriate management strategy considering the data poor nature of the fishery. An improvement to the management of this FU would be to manage at the FU level as opposed to the Subarea level.

Stock NEP-IIIa (WGNSSK Section 3: Nephrops (Subareas IIIa and IV (Skagerrak and Kattegat)))

1) **Assessment type**: Update
2) **Assessment**: Trends
3) **Forecast**: None presented. No biological reference points have been established for this stock.
4) **Assessment Model**: Trends in LPUE for the Danish and Swedish fleets from 1990-2009. Trends in discard rates (of undersized Nephrops) are used as a proxy of recruitment.
5) **Consistency:**
   - LPUE trends were used as the basis for the last assessment in 2008, which was accepted.
   - In 2008, the resource was considered to be harvested at a sustainable level. The same conclusion was reached in the current assessment.
6) **Stock Status**: The WG concluded that current levels of exploitation are sustainable. Recent trends (2006-2009) in LPUE suggest that the stock biomass has increased by 11.7%, and preliminary data from the Danish underwater TV survey (2007-2009) suggest that harvest rates are low (~10%).
7) **Man. Plan**: No specific management plan is in place. Nephrops in Subareas IIIa and IV could be classified as a category 8 stock. If it is, the rule set by the EU would dictate that the TAC can not change by more than 15% from the previous two years.

General Comments

- The report is well written and easy to understand. Changes in the management of the fleet, and technical changes in the gear used by the fleet are described well.
- Efforts should be made to improve the biological sampling for the Danish fleet in the Skagerrak, which takes the majority (~60%) of the landings in this area. Improved biological sampling will allow managers to better perceive changes in the stock status (i.e. change in mean size).
- The high discard rates of undersized Nephrops (~75% by number in the catch) in this fishery are a concern. Recent efforts to incorporate more size selective gear in the fleet is an improvement, and these efforts should continue in the future.
- Expansion of the underwater TV survey is planned, and the survey data will be used in the next assessment. This survey will provide a valuable source of fishery-independent data to assess this stock. The RG agrees that the survey should continue to be expanded in the future. Most of the survey takes place in the Kattegat, and the RG suggests that efforts should be made to survey the Skagerrak as well.

Technical Comments

- It would have been helpful for the RG to receive all of the tables, figures and text in a single document for this stock.

- The WG notes that technical creep in LPUE trends may be a problem, as the fishery has shifted to a vessel quota share management system. If the efficiency of the fleet has improved, the recent increases in LPUE may not reflect an increase in the biomass of this stock. Continued efforts should be made to standardize fishery dependent (LPUE) data amongst fleets.

Conclusions:

- The RG agrees with the WG that this stock appears to be harvested at a sustainable level. LPUE has been increasing in recent years, and discard data suggest that recruitment is at fairly high levels.

Technical Minutes

Review of ICES WGNSSK Report 2010 (Sandeel and Norway Pout), 17 September

Reviewers:	Norman Graham
	Robert Furness
Chair WG:	Clara Ulrich
	Ewen Bell
Secretariat:	Barbara Schoute

General

The Sandeel assessment has been greatly improved in 2010 by moving to a more biologically realistic assessment, based on the known spatial structure of stocks within the North Sea with differing dynamics in these different areas.

General comments regarding the common modeling approach used across all sandeel areas (1-3)

The model used for the basis of the advice has changed for IV sandeel due to findings of a recent benchmark workshop (WKSAN, 2010). Previous assessments considered sandeel as a single North Sea stock, where as in practice, it comprises of a number of discrete sub-populations. ICES now provide specific assessments for seven sub-areas in ICES division IV. Three of these areas (1-3) have full analytical assessments proving estimates of both F and SSB with preliminary forecast. The forecasts are subject to revision in January 2011 when recent survey data becomes available. For area 4, trends in CPUE are provided together with a survey index. For areas 5-7 total catch weights are provided.

This reviewer welcomes the shift to providing assessments at a more realistic spatial resolution. The report notes in each of the sections where an analytical assessment has been performed that "the quality of the present assessment is considered much improved" – however, is it the quality of the assessment (method) or the assessment area that has been improved? The justification in the benchmark report (WGSAN, 2010) for switching from SXSA to SMS-effort seems to be based on the splitting up of the assessment area rather than a detailed comparison between the two methods at the same spatial resolution. The only justification given is that on a trial run of SXSA for area 1 "failed to give satisfactory results". It would have been much more prudent and transparent if a fuller comparison of the two methods were undertaken. The switch to area based assessments, which is very welcome, does make any contrast with the 2009 SXSA assessment impossible. Give that there are differences in the underlying assumptions in each modeling approach, a contrast of the outputs from full runs with both SMS-effort and SXSA would help test to give some better insight into the validity of these assumptions. While I fully acknowledge that this is an issue more directed at the benchmark, I believe that this switch has impacted on the 2010 assessment review process, in particular the inability to compare the output from the 'new' model in contrast to the 'old' approach. It would be helpful if the assessment could be combined in some way (total biomass across all assessed areas and a weighted F estimate) so as to allow a comparison with last years approach. Simply jumping from one modeling approach to another without transparency is not a scientifically sound approach.

The SMS-effort assumes a fixed (1:1) relationship between effort and F. This is based on the output from a trial run (SXSA area 1 2010) from WGSAN, 2010 (p 50.). It is noted however, that the model shown in figure 5.2 (WGSAN, 2010) is derived from a SXSA run which has *not given "a satisfactory result" (p51, section 5.2). The underlying assumption of F=E may indeed be ok, but given that E is driving the model estimate of F, more transparency and detail on the validity of this assumption is needed. It is further noted that plot of standardized E and modeled F "shows a clear relationship" - this is not surprising that the F estimate is being driven by effort on a fixed relationship. It is important that this is not translated as being a 'true' relationship as this could be misleading.*

The review notes the acknowledgement that is given to technological creep in the fishery, by assuming different catchability and efficiency between certain periods. It is noted however, that the fixed periods are long and to assume fixed catchability over this time frame (~10 years) is probably not advisable. For area 1 there are three separable periods and for area 2 there are two periods. There is no justification provided for this difference and it should be noted that if the selection of the fleet has changed during the period of assumed constant catchability, then this could potentially bias the model estimate of SSB. The WG are encouraged to justify the periods of assumed constant catchability in each area (e.g. why the difference between area 1 and area 2?). It is unclear from the stock annex how the selection parameters by age are derived – are they model outputs and if so do they match the changes in exploitation of the fleets – is there supporting evidence that fleets have switched to targeting different age components of the stock. Overall, there is a need to improve the detail provided in the stock annex so that it is more transparent and obvious why certain assumptions have been made and on what basis e.g. fixed catchability and time window. The model estimates very different selection profiles between the windows of fixed catchability. If these are violated in practice, this could potentially result in biases in estimation of SSB.

The switch to area based assessment is welcome given the potential for local stock depletions and the need for more spatially defined management measures. Sandeel are an important food species for a number of sea bird species and the provision of more spatially defined assessment allows for management that is more in line with the ecosystem approach. The working group are further encouraged to develop ecosystem considerations including minimum stock (sandeel area) requirements to avoid risk to heavily dependent seabird populations.

Section 4.1.1. Ecosystem aspects. This section simply refers to the stock annex for information on ecosystem aspects, and the very short text presented is based mainly on previous advice rather than on the new stock annex. It would be better to summarise the material presented in the new stock annex. In particular, the key point that local depletion of sandeels on particular banks may lead to local impacts on dependent predators, and so there is a need to avoid local depletion of the sort that has been evident in recent years, particularly on certain banks in Areas 3 and 4. This is a separate issue from maintaining adequate SSB of sandeels to ensure recruitment.

Sandeel advice is based on an "escapement strategy" to maintain SSB above B_{lim}. ICES uses B_{pa} as a target after the fishery has taken place, with B_{pa} set above B_{lim} to an extent that accounts to some extent for uncertainty in estimation of SSB and B_{lim}. In the Sandeel assessments, the stock is modelled using SMS. This model estimates confidence limits for various parameters based on the fit of the data that are input into the model. However, the model does not explicitly incorporate some of the uncertainty in the input data. For example, it assumes fixed values of natural mortality across years (though allowing age-specific fixed values). At present, although sandeel stocks are modelled separately for different areas of the North Sea, natural mortality rates are set to the same values for all areas. This is because the mortality data are aggregated for the whole North Sea. Yet we know that, for example, abundances of cod, haddock whiting, mackerel, herring, seabirds and marine mammals are very different in sandeel areas 1, 2 and 3, etc., and so natural mortality rates are most unlikely to be identical in all areas. It should be an objective to disaggregate the predation estimates by sandeel areas in order to provide more reliable area-based estimates of natural mortality for each separate assessment.

If Natural mortality is higher or lower than input values, that simply shifts up or down the estimated stock biomass, and does not alter pattern across years. However, if Natural mortality fluctuates from year to year, then the pattern of stock size will be altered as well. Natural mortality has been shown to differ between years, with what looks like trends over periods of years (as reported in previous ICES sandeel working group reports). Furthermore, it is logical that natural mortality rates will actually fluctuate from year to year as sandeel abundance changes. Since most sandeel predators are much longer-lived than sandeels, their numbers will not track changes in sandeel abundance, and so predation rates are likely to increase when sandeel abundance is lower and fall when sandeel abundance increases. There will also be longer time trends as predator stocks go up or down. Modelling to assess the impact of such variation would be useful to give a better indication of the confidence limits for key statistics derived from the SMS model where such variation is ignored.

The values of B_{lim} estimated for each sandeel area are simply presented as numbers, without any assessment of their accuracy in sections 4.2.12, 4.3.12 and 4.4.12. It would be preferable to see the logical arguments for the values chosen, and some assessment of the accuracy of those values or alternatives.

The RG acknowledges the intense effort expended by the working group to produce the report.

The Review Group considered the following stocks:

- Sandeel area 1
- Sandeel area 2
- Sandeel area 3
- Sandeel area 4

Sandeel in IV – area 1 (WGNSSK section 4.2))

1) **Assessment type:** update based on recent benchmark
2) **Assessment**: analytical
3) **Forecast**: presented but should be treated as preliminary until new survey data becomes available in January 2011.
4) **Assessment model**: Stochastic Multi-Species Model (SMS) modified to model F as a function of effort
5) **Consistency**: This is a new assessment method. Recent assessments were done using a seasonal XSA (SXSA). The new model is based on a recent benchmark (WKSAN, 2010). It is not possible to assess the consistency (in estimates of stock biomass and exploitation) relative to previous years.
6) **Stock status**: $B>B_{pa}$, there are no F reference points for this stock, R is variable and the 2010 is well above the geometric mean.
7) **Man. Plan.**: There are no agreed management plans for this stock.

General comments

No area specific comments – please refer to general comments above

Technical comments

More justification for the choice of time windows or constant catchability needed and the impact that possible violation of this assumption may have on the estimate of SSB should be included in section on quality of assessment

Conclusions

The assessment has been performed correctly but refer to general comments above.

Sandeel in IV – area 2 (WGNSSK section 4.3))

1) **Assessment type:** **update based on recent benchmark**
2) **Assessment**: analytical
3) **Forecast**: presented but should be treated as preliminary until new survey data becomes available in January 2011.
4) **Assessment model**: Stochastic Multi-Species Model (SMS) modified to model F as a function of effort
5) **Consistency**: This is a new assessment method. Recent assessments were done using a seasonal XSA (SXSA). The new model is based on a recent benchmark (WKSAN, 2010). It is not possible to assess the consistency (in estimates of stock biomass and exploitation) relative to previous years.
6) **Stock status**: Blim>B>B_{pa}, there are no F reference points for this stock, R is variable and the 2010 is well above the geometric mean.
7) **Man. Plan.**: There are no agreed management plans for this stock.

General comments

No area specific comments – please refer to general comments above

Technical comments

More justification for the choice of time windows or constant catchability needed and the impact that possible violation of this assumption may have on the estimate of SSB should be included in section on quality of assessment. Why is there a different separable time frame for area 2 in contrast to area 1?

Section 4.3.14 State of the stock considers SSB in 2010 to be around twice Bpa (100,000 tonnes). This contradicts table which gives a 2010 estimate of 93408. Shouldn't it read that in 2010 SSB is just below Bpa but is forecast to be around twice Bpa in 2011?

Conclusions

The assessment has been performed correctly but refer to general comments above.

Sandeel in IV – area 3 (WGNSSK section 4.4))

1) **Assessment type:** **update based on recent benchmark**
2) **Assessment**: analytical
3) **Forecast**: presented but should be treated as preliminary until new survey data becomes available in January 2011.
4) **Assessment model**: Stochastic Multi-Species Model (SMS) modified to model F as a function of effort
5) **Consistency**: This is a new assessment method. Recent assessments were done using a seasonal XSA (SXSA). The new model is based on a recent benchmark (WKSAN, 2010). It is not possible to assess the consistency (in estimates of stock biomass and exploitation) relative to previous years.
6) **Stock status**: $B > B_{pa}$, there are no F reference points for this stock, R is variable and the 2010 is well above the geometric mean.
7) **Man. Plan.**: There are no agreed management plans for this stock.

General comments

Regarding sandeel area 3 (section 4.4) there is good presentation of the EU approach using dredge sampling and SMS, but there is very little mention of the Norwegian procedures, which are very different, using acoustic survey, and closed areas. Nor is there any explanation of how the management in this area can incorporate the two divergent approaches of Norway and the EU.

– please refer to general comments above

Technical comments

More justification for the choice of time windows or constant catchability needed and the impact that possible violation of this assumption may have on the estimate of SSB should be included in section on quality of assessment. Section 4.4.14 "SSB in 2010 is estimated to be just below Bpa in 2011" does not make sense – shouldn't it be SSB in 2010 is above Bpa but is estimated to be just below in 2011?

Conclusions

The assessment has been performed correctly but refer to general comments above.

Sandeel in IV – area 4 (WGNSSK section 4.5))

1) **Assessment type:** no assessment
2) **Assessment**: trends in CPUE
3) **Forecast**: not presented
4) **Assessment model**: none
5) **Consistency**:
6) **Stock status**:
7) **Man. Plan.**: There are no agreed management plans for this stock.

General comments

There is no text on Management for area 4, despite the observation reported in the text that there was a strong 2009 year class in that area, which suggests that a limited fishery may be supported by the current stock indicated by the Scottish dredge survey.

– please refer to general comments above

Technical comments

No comments

Conclusions

No comments

Norway Pout in ICES Subarea IV and Division IIIa nop-34

1 **Assessment type:** **update** (from May with 2011 survey data). Last benchmark was 2004

2 **Assessment**: analytical

3 **Forecast**: presented

4 **Assessment model**: SXSA (seasonal extended survivors analysis)

5 **Consistency**: SPALY with no back shifting of 3rd Q indices. The assessment is consistent with 2008 fall update under real time monitoring

6 **Stock status**: SSB(258,836t) > B_{pa}(150,000t), no F reference points but F (2009) is low (0.23), R in 2010 is estimated to be the lowest in the times series.

7 **Man. Plan.**: There is no agreed management plan for this stock although ICES ICES has evaluated and commented on three management strategies, following requests from managers – fixed fishing mortality (F=0.35), Fixed TAC (50 000 t), and a variable TAC escapement strategy. There is no non-zero-catch option in 2011 that is consistent with maintaining SSB above B_{pa}.

General comments

The updated assessment changed little in terms of 2009 SSB based on new survey data which is above B_{pa}. The EG are commended on the level of detail available in the stock annex, a substantial amount of useful background information is provided and this aids the review process considerably. There are no specific issues associated with the technicalities of the assessment or forecast

The primary issue for the stock is the historically low recruitment observed (Q3, 2010) in the times series and is below the 2003 and 2004 levels that led to the closure of the fishery in 2005.

Note that the text on technical measures in "Management considerations" is repeated twice. Small mesh fisheries of this type can be associated with high by-catches of other species. However, the appropriate sections containing quantitative by-catch data were missing from the report (namely 2 and 16) although some data were obtained from individual stock sections (cod and whiting). This limited any comment on the wider ecosystem impacts associated with the fishery.

Conclusions

The update assessment was consistent with past assessments and I agree with the conclusions.

The WG recommendations for further analyses in a benchmark in 2012 to take account of new data on maturity, growth rate and natural mortality rates, seem to make good sense

Annex 05 Recommendations

The following table summarises the main recommendations arising from the WGNSSK and identifies suggested responsibilities for action.

Recommendation	For follow up by:
The WGNSSK expressed major concerns that the duration of the WG (7 days), agreed in September 2009 on the basis of fairly routine ToRs, has not been reconsidered after the addition of the new MSY ToR and the changes in the format of advice, especially since it was anticipated that such changes would result in significant workload. The WG did thus not have time to address all ToRs to its entire satisfaction. The WG recommends thus that the duration of the WG is better matched with the amount of work required.	ACOM, ICES Secretariat.
Extensive discussions have taken place around the estimation of Fmsy, and some progresses have been achieved in this regard. But the lack of time has not made possible any proper consideration of MSY Btrigger, which has been set to the default value Bpa for all stocks. The WG considers that the basis for chosing Bpa is inconsistent with the general MSY framework and recommends that further scientific discussions are undertaken for providing more consistent estimates.	ACOM
The WG sees some fundamental differences between the PA framework, which worked out limits reference points largely based on observed historical data, and the MSY framework, which builds on fuzzier potential future targets. There is thus more inherent uncertainty in Fmsy than in Fpa. But the WG doesn't feel that this conceptual and intrinsic difference is properly communicated through a single Fmsy value. While The WG understands that such a single value (median) is necessary for the advice itself, a range of Fmsy values (e.g. 25-75 quantiles) that could also potentially achieve maximum long-term yield should also be mentioned in the advice sheet.	ACOM
In direct relation to the previous point, the new format of the advice sheet requires to chose between the "*below*" or the "*above*" option, for the consideration of the current F compared to reference points. The WG considers that this is not entirely appropriate for Fmsy, since Fmsy is a target and not a limit. Given the dynamic nature of fish stocks, long-term maximum yield is uncertain and would be achieved within a range of equilibrium F values. Therefore, there should be an option for stating that F is "*in the range of*" Fmsy.	ACOM
The WG experienced signifcant discussions around differences in results from various statistical tools available to fit Stock Recruitment Relationships, and was concerned by the risk of poor fitting of this SRR, which can undermine the statistical estimation of Fmsy. The WG recommends that the Methods WG investigates this further and provides guidelines on optimal procedures.	MGWG
The WG was concerned that the IBTS indices did not appear robust to the hindrance of some nations to conduct their survey, as an International Survey should by definition be independent of the nation conducting it. The WG recommends that adequate statistical sensitivity analyses should be performed to insure robust raising methods.	WGIBTS, ICES secretariat

The UK beam trawl and Belgian survey indices for sole and plaice should be published by WGBEAM whose members should discuss them in the context of patterns and differences observed in the Dutch BTS (ISIS and Tridens) and SNS data. We know that large spatial changes in the distribution of plaice in the North Sea have occurred, viz. the migration of juvenile plaice out of the Plaice Box. WGBEAM should investigate spatial changes in the distribution of sole.	WGBEAM
The WG feels that there are still some potential gaps between the data collections programs and the metier-based sampling discussed in DCF and RCM in the one hand, and the way this is used for raising catch data for WGNSSK in the other hand (for both landings and discards). There is often unsufficient knowledge in the WG on how the data are raised before being provided to stock coordinators. The raising is largely done within a country based on national samples, before being provided, and not by metier across nations which would potentially allow different stratification for the data raising. The WG recommends better communication between the various data forums in order to consider whether the current sampling raising procedures are still appropriate.	ACOM, PGCCDBS, RCM North Sea, stock coordinators
Regarding the benchmark for the Saithe stock (sai-3a46) scheduled for 2011, the WG recommends that the schedule of the benchmark workshop is set accounting for the schedule of the IBTS survey, given that key personal might be at sea in the beginning of the year.	ICES Secretariat, IMR Norway
There is a persistent issue in the definition and the estimation of the plaice stocks, since large-scale mixing occurs between the continuum of plaice stock units ranging from the English Channel (VIIe) to the Kattegat (IIIa). WKFLAT 2010 recommended that further investigations are done towards combined-areas assessment and management. WGNSSK endorses this recommendation and suggests additional consideration of this during the benchmark WKFLAT 2012, or as a dedicated Study Group similar to the SGHERWAY.	ACOM
The previous Nephrops benchmark (WKNEPH 2009) only looked at UW-TV surveys issues, but did not properly explore the other input data used in the assessments (landings, discards, raising procedures etc). The WG recommends that another Nephrops benchmark is convened as early as possible.	ACOM
There is a request for a benchmark assessment for Norway Pout in 2012	ACOM
The assessment update procedure in october was fraught with timing difficulties induced by changes to IBTS indices, resulting in a delay of about a week in the delivery of annexe 02. These delays allowed the Sole Net Survey (SNS) to be finalised and incorporated into the Sole update forecast for the first time. The inclusion of this series had a significant impact upon the TAC forecast and is considered to have improved the robustness. It is recommended that the deadline for updated forecasts in future years is postponed by one week to allow the IBTS index to be quality controlled before its release and also permit the SNS index to be finalised and incorporated.	ACOM